Technical Data Piezo Micropump PSS20

1. Specifications

Pump type	Piezoelectric diaphragm pump
Weight	2 g
Power consumption	< 80 mW
Self-priming	suction pressure > 30 mbar; 60 Hz, 260 Vpp, rectangle-signal , H_2O
Pumping media	Liquids, gas and mixtures
Operating temperature range	-10°C - 75°C
Life time	5000 h
IP code	IP33
Materials in contact with media	PET
Evaluation controller	PSSX, PSSC

Typical values of flow and backpressure (values defined with PSSX: 260 Vpp, rectangle-signal):

Gas	**Max. flow**	25 ml/min (120 Hz)
	Max. back pressure	3kPa (120 Hz)
Water	**Max. flow**	20 ml/min +/- 10% (60 Hz)
	Max. back pressure	15kPa +/- 10% (60Hz)

Flex connector

Lead Wires

Changjiang Rd., Xinbei Dist, Changzhou City, Jiangsu Prov., China.
Phone ：86-519-8829 0908 Fax：86-519-8689 9070
www.piezodata.com , czdaisy@gmail.com

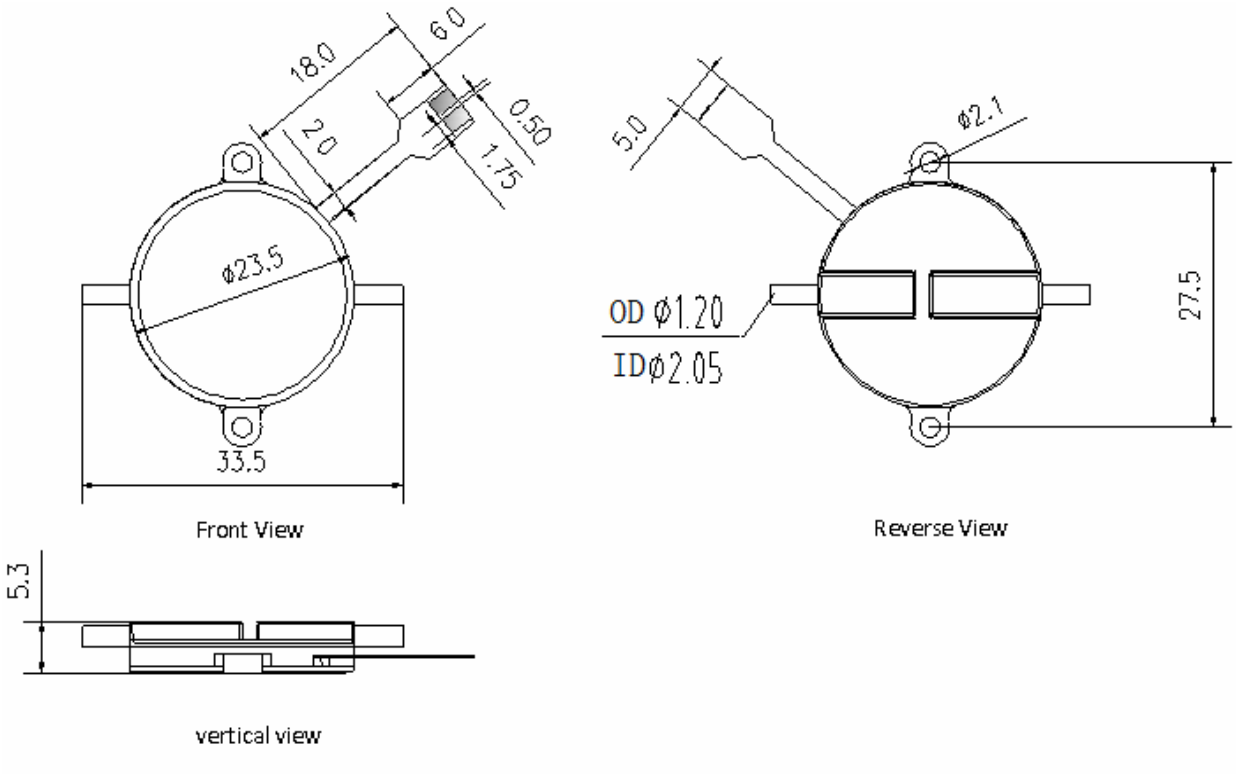
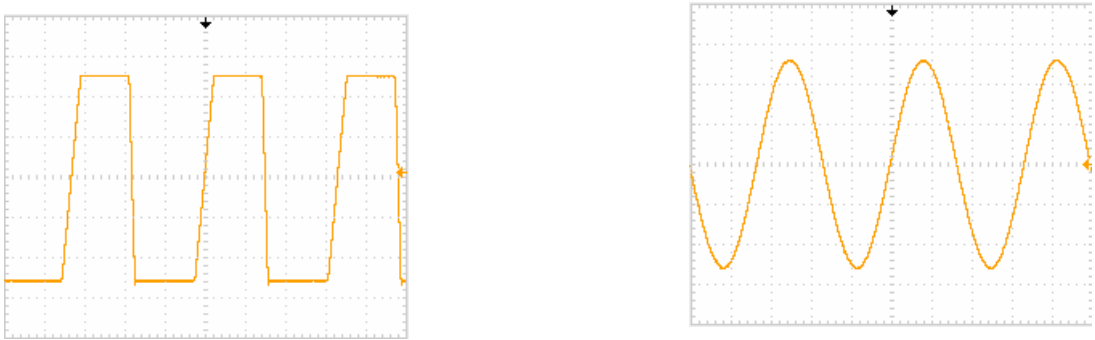


Fig.1 PSS20 (Dimension in mm)

2. Driving the Micro Pump PSS20

The micropump **PSS20** can be driven by alternating, (a) voltages at a maximum amplitude of 260 V, and (b) frequencies between 0 and 200 Hz. The electrical signal forms as Fig.2 shown. The voltage determines the deflection height of the piezo actuator and the frequency determines the number of the deflections. By varying these parameters together with the signal shape (rectangular, sine, SRS), different flow rates can be achieved. A rectangular signal gives highest fluidic flow rate, while a sine wave minimizes the audible noise. The evaluation controllers, PSSX, PSSC, enable the customer to test the micropump for specific applications.



PPSX & PPSC, Rectangle-Signal, 260V_{pp}, 60Hz

Connected to AC110V, 50Hz~120Hz,

PSS20 can keep mute.

Fig.2 Electrical signal forms

There are two ways for customers to get high quality driving solution:

2.1 Operation of the PSSX

Adopt the PSSX controller designed by Kippon, see Fig.2.The customers can adjust the flow rate from 0ml/min to 20ml/min by turning the potentiometer. And adjust the frequency form 15 Hz to 75Hz by turning the frequency meter.

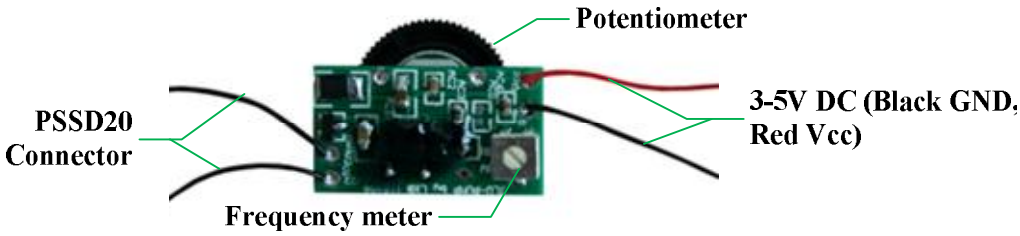
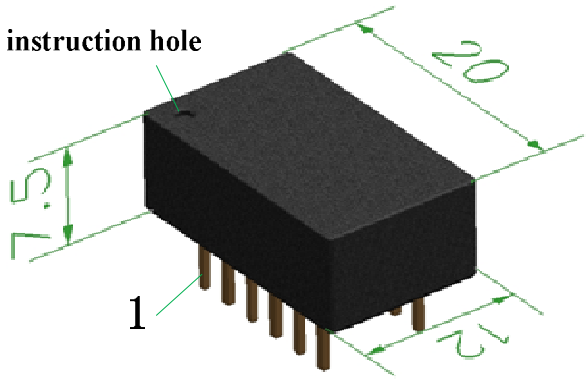


Fig.3 Piezoelectric pump micro controller

Dimensions	**Board:24.5×14×4.5 mm, Knob:5.5×Ø18mm**
Weight	**2.7g**
Pumping media	**Liquids or gases**
Max.flow	**20ml/min**
Controlling parameters	**Amplitude,frequency**
Amplitude range	**0-260V**
Frequency range	**15-75 Hz**
Signal form	**Similar to rectangular**
Power supply	**3-5 V DC**
Current consumption	**Approx.25 mA at 3 V**

2.2 Operation of the PSSC

Take PSSC controller provided by our company, function shown in Fig.4.



(Dimension in mm)

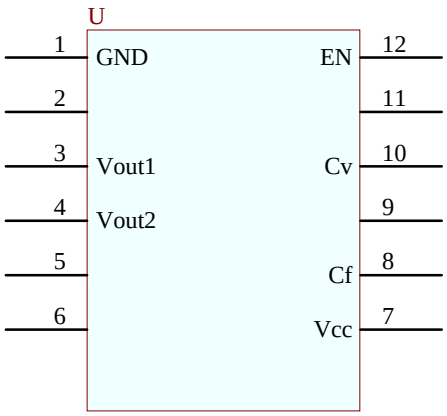


Fig.4 PSSC controller

2.2.1. Pin description

Vcc Power supply voltage

GND Ground

Cv Control for the AC driving voltage(DC analog 0.7-1.3V). The driving voltage increases with the DC analog, and thus the AC driving voltage increases with the DC analog. This input is not necessary in case the user doesn't want to control the driving voltage. As keeping the lead open, the AC voltage is driven at the default maximum driving voltage.

Cf Control for the AC driving frequency (by 5V PWM frequency, 50% duty).Without any inputting, the power will run at the default driving frequency. The inputting frequency divided by 4 will be the driving frequency (i.e. fdrv=fin/4) . The inputting frequency can't be smaller than 60Hz (The frequency can be modified before leaving factory)and that ranged from 60 to 600Hz is recommended. Operations over the recommended ranges may induce permanent decay of the performance.

EN： On/Off control by inputting logic High/Low signal (High;>+1.2V; Low: <0.2V)

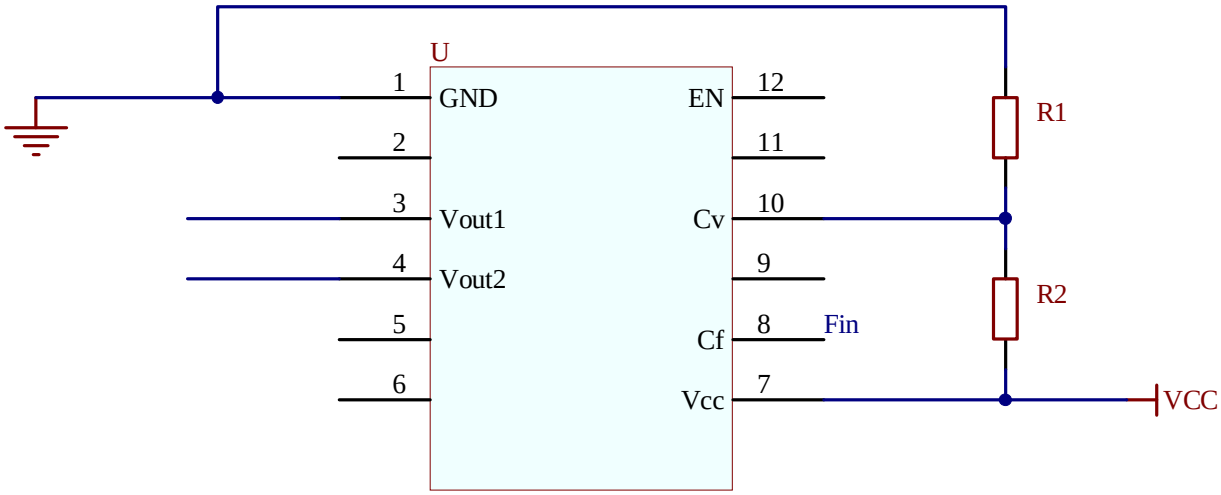
Vout1 one AC output pin

Vout2 another AC output pin

2.2.2. Electrical characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Power supply voltage	Vcc		2.4		5.5	V
Power supply current average	Icc	Vcc=5V			30	mA
Control voltage Cv			0.7		1.3	V
Peak-to-peak output voltage		Cv=0.7V	84	100	122	V
Peak-to-peak output voltage		Cv=1.0v	170	200	230	V
Peak-to-peak output voltage		Cv=1.3v	210	250	280	V
PWM frequency Cf			60		600	HZ
Operating Temperature Range			-40		+85	℃
Storage Temperature Range			-65		+150	℃

2.2.3. Pump rate control via microcontroller



Schematic: external control via microcontroller

Peak-to-Peak Output Voltage of micropump	Vcc(v)	R1	R2
84V(minimum)	3V	3K	10K
200V	3V	10K	20K
~280V(maximum)	3V	19K	25K
84V(minimum)	5V	1.7K	10K
200V	5V	5K	20K
~280V(maximum)	5V	8.8K	25K

Table:Typical resistor values for different pump amplitude values

3. Noise reduction

As there is sine wave voltage used as driving voltage, below 120Hz, PSS20 can keep mute, for example connected to AC110V, 50Hz to 60Hz. There is low noise when PSSX & PSSC driving the micropump, if customer want to reduce the noise please contact with us.

4.Frequently Asked Questions Keppon micropump PSS20

4.1. General

Q What are the characteristics of the PSS20 micropump?

A The PSS20 reaches a back pressure range of up to 15kPa and shows a good self-priming behavior and high bubble tolerance when pumping liquids. Since the PSS20 has only material, polyethylene glycol terephthalate (PET), in contact with the pumping fluid it exhibits a good media tolerance.

Q Is the micropump PSS20 a dosing system?

A The micropump PSS20 is a system to convey a certain volume of fluids over time. The flow rate is adjustable by frequency and amplitude changes of the piezo actuator. Only if the outer conditions are very stable the micropump can be used for dosing either controlled directly or in combination with a timer control. As soon as a temperature change, viscosity change or for example a gas bubble occurs, the flow range will change. Under this conditions or requirements of higher accuracies a flow control needs to be added. Currently we are working on the integration of a flow sensor into the micropump to create a controlled loop system. For more details, please contact us.

Q What about cascading micropumps PSS20?

A To increase the flow rate or the pumping pressure, micropumps can be cascaded. Connecting pumps in parallel multiplies the flow rate while connecting pumps in series multiplies the pressure. The long term stability and performance of these configurations need to be tested individually.

Q Is the micropump PSS20 capable to pump in two directions?

A No, due to the passive check valves the micropump PSS20 can only pump in one direction. However, as the pumps are fluidic ally open while switched off, two pumps can be connected in opposite direction to provide bidirectional flow. Due to the fluidic resistance this will however limit the maximum performance.

Q Why do the micropumps PSS20 generate a sound?

A The piezo actuators are driven by the electronic controller connected to the micropump. When the driving signal is rectangle wave and the set frequency is in the range of human perception, a sound can be heard. If a sinusoidal signal is used within low frequencies (below 120 Hz), the lowest sound generation is reached.

Q Can the pumps be immersed into water?

A As the pumps and especially the electrical connector are not fluid tight in the standard version, the pumps must not be immersed in water or other liquids.

Q Did the micropumps pass an inspection before delivery?

A The micropumps have to pass a final inspection, in which the max. flow of 20 ml/min (DI water, settings PSSX: 60Hz, 260 V_{pp}, rectangle), the maximum pressure of 15kPa and the self-priming characteristics (conditions: suction pressure 3kPa, DI water, settings PSSX: 60 Hz, 260 V_{pp}, SRS) are tested.

4.2. Pumping performance

Q What are the best parameters to start the pump evaluation with the PSSx20-go?

A Using liquids, the signal form rectangle should be used, a good starting point is 260V amplitude and 60 Hz frequency. For high viscous liquids, frequencies below 60 Hz are preferred, while for gases the frequency range above 60 Hz provide the best results. The optimal frequency needs to be determined individually. If the application is very sensitive to noise, the sine signal should be used instead.

Q What is the best way to achieve low flow rates?

A In order to ensure stable pump performance, the frequency and voltage should be lowered。Certainly, when making the frequency higher than the resonant point, the flow rate will decreases but it will make the pump unstable。

Q What is the lowest flow rate that can be achieved?

A The lowest flow rate is very dependent on the conditions in the customers test system. Generally a flow rate of about 20 µl/min for liquids can be achieved in most cases. With thorough optimization much lower rates can be achieved.

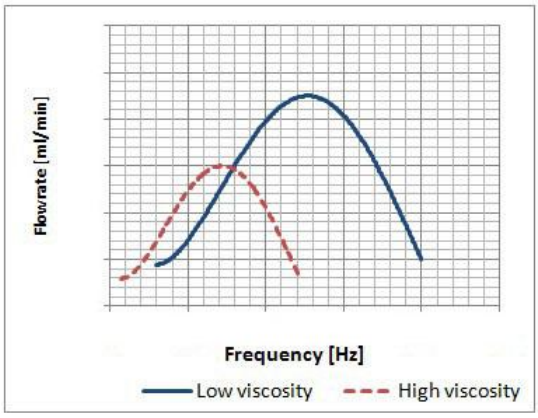
Q What types of fluids can be pumped?

A The PSS20 pumps liquids, gases and mixtures of both. The micropumps were designed to withstand a large variety of media. The function cannot be guaranteed for aggressive chemicals.

NOTE: Please check if your media can be used with the wetted materials of the micropumps. The PSS20 has only one material, polyethylene glycol terephthalate (PET) in contact with the pumped media. In general it is possible to change the material of the pumps in correspondence to the customer's application. Contact us to discuss details.

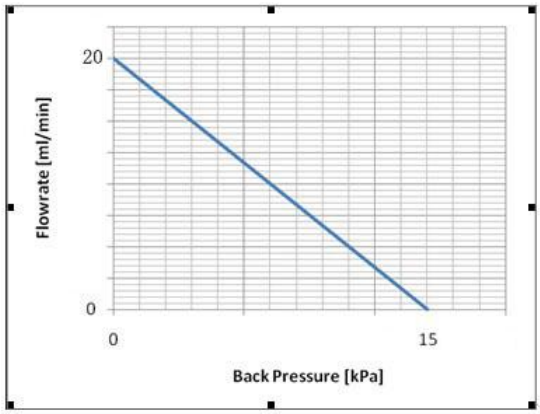
Q Which is the effect of different viscosities on the flow rate?

A As a rule of thumb, the maximum flow rates decreases by the dynamic viscosity in mPas. For example while water with a viscosity of about 1 mPas has a maximum flow rate of 20000 µl/min, with an oil of 100 mPas the maximum flow will be approximately limited to 200 µl/min. Note: The real performance needs to be verified under full application conditions.



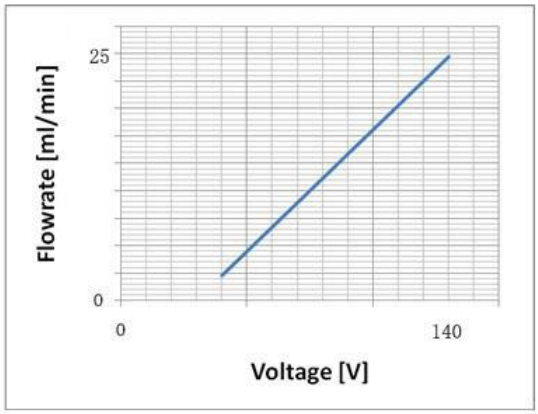
Q What is the relation between pressure and flow rate?

A The flow rate of the pumps shows a linear dependency on the back pressure. At 0 kPa back pressure the pumps achieve the maximum pump rate, at maximum back pressure the flow rate of the pumps decreases to 0 ml/min. If the flow changes due to changing pressure conditions in the application are not acceptable, a close loop controlled pump can be used. Please contact us for further details.



Q What is the relation between amplitude and flow rate?

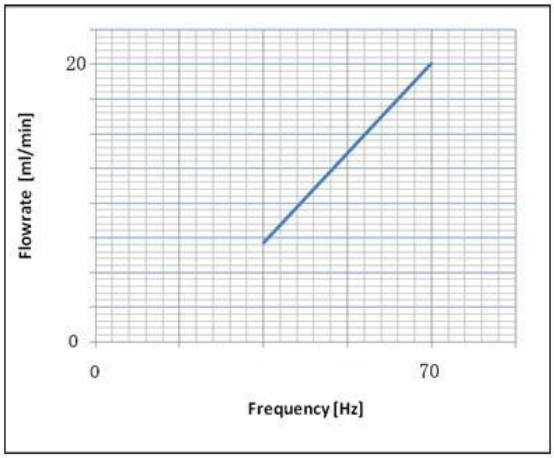
A The amplitude defines the strokes of the actuator and therefore the displacement of the pumped medium per pump cycle. With rising amplitude of the controller voltage, the flow rate rises linearly to the maximum.



Q What is the relation between frequency and flow rate?

A The flow rate increases linearly in a defined frequency range, because the frequency determines the number of pump strokes per unit of time. The characteristic diagram shows a maximum at resonance frequency. At frequencies above the resonant point the flow rate decreases again. The resonance frequency and the maximum flow rate strongly depend on the viscosity of the media. The lower the viscosity, the higher the maximum flow rate and the resonance frequency.

NOTE: The resonance frequency for water is roughly at 60 Hz.

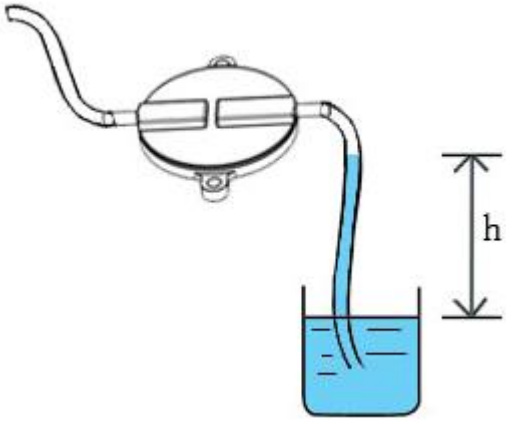


Q How about pumping media with particles?

A The micropumps are capable of moving liquids with particles up to 20 µm, if these do not accumulate. NOTE: Be careful with solids dissolved in solutions (e.g. saltwater). If the dilution rate is not high enough, crystals can form and clog the micropump.

Q Are the micropumps self-priming?

A Generally, yes. The testing conditions are: suction pressure < 40kPa; DI water; setting PSSX: 60 Hz, 260 V, rectangle. The PSS20 normally is able to prime even with higher suction pressures. The self-priming height 'h' can reach about 40 cm.



Q What about the behaviour of bubbles inside the pumped liquids?

A The PSS20 can generally handle bubbles within liquids. As a bubble presents an increased fluidic resistance, in order to achieve stable and reproducible behavior, tubings should be kept as short as possible when bubbles can occur in the application.

NOTE: Usually, the movement of the piezo membrane pushes a volume of liquid through the micropump. When a bubble is inside the pump chamber, the energy is partly used for compressing the gas-bubble instead of moving the fluid – depending on the size of the bubble. This changes the flow rate.

Q What about pumping gas when the micropump was wetted before?

A The micropump is capable to deliver gas. When a liquid has been pumped before, the micropump might show a non-linear behavior concerning the flow rate.

NOTE: Inside the micropump small check valves are used to give direction of the flow. If those valves are wetted, they might stick to the valve seat.

Q Can a flow rate be generated even though the micropump is switched off?

A The micropump is hydrodynamically open, the valves inside the pump are passive valves and only function during pumping operation, and therefore a flow can be generated if a differential pressure between inlet and outlet is present. In order to impede a back flow, Kippon can offers a passive check valves integrated in tube. Please contact us for more information.

NOTE: Differential pressure is also given when the fill level of the reservoirs at in- and outlet differ.

Q Can a flow be generated without pulsation?

A Due to the functional principle of the piezoelectric diaphragm pumps a pulsation free flow can't be generated. However as the displaced volumes are very low the pulsations are much lower than the ones from conventional membrane pumps. The pulsation can be further minimized by using the sine signal and an elastic tubing.

4.3. Electronics

Q What is needed to drive the micropump?

A Everything needed is supplied by the electronic controllers offered by Kippon. The combination of signal, amplitude and frequency defines the performance of the micropump.

Q Should the flow rate be adjusted by the amplitude or by the frequency?

A In general both parameters can be used. As lower amplitudes lead to lower compression in the pump chamber, it is better to do fewer large pump strokes over time. Therefore try to work at a high amplitude level and decrease the frequency until you reach the required flow rate level. In case the flow pulsation is too high, the amplitude should be lowered and frequency increased.

Q How many signal forms can be chosen?

A The PSSX & PSSC generates only one signal form, it is similar to rectangular.

Q What is the power consumption of the controllers?

A The current consumption of the PSSX is roughly 25 mA (3 V), the **PSSC** consumption is 30mA (5 V).

NOTE: For applications which need to be having even lower power consumption, adequate electronics can be developed.

Q Can the micropump PSS20 be driven with a small voltage supply of 3-4 V?

A The PSSX and PSSC provides a standard electronics to drive the pumps from these low voltages.

Generally: The micropumps are developed to suit many different requirements. Since there are many areas of applications, these standard micropumps might not meet your requirements on all aspects. Then the micropumps can be seen as

a basis for customer specific optimizations and developments. All parameters, starting with the materials and ending with the fluidic design, can be changed to suit an application. Please contact us to discuss your requirements. For further questions, please contact: czdaisy@gmail.com