MPInterconsulting
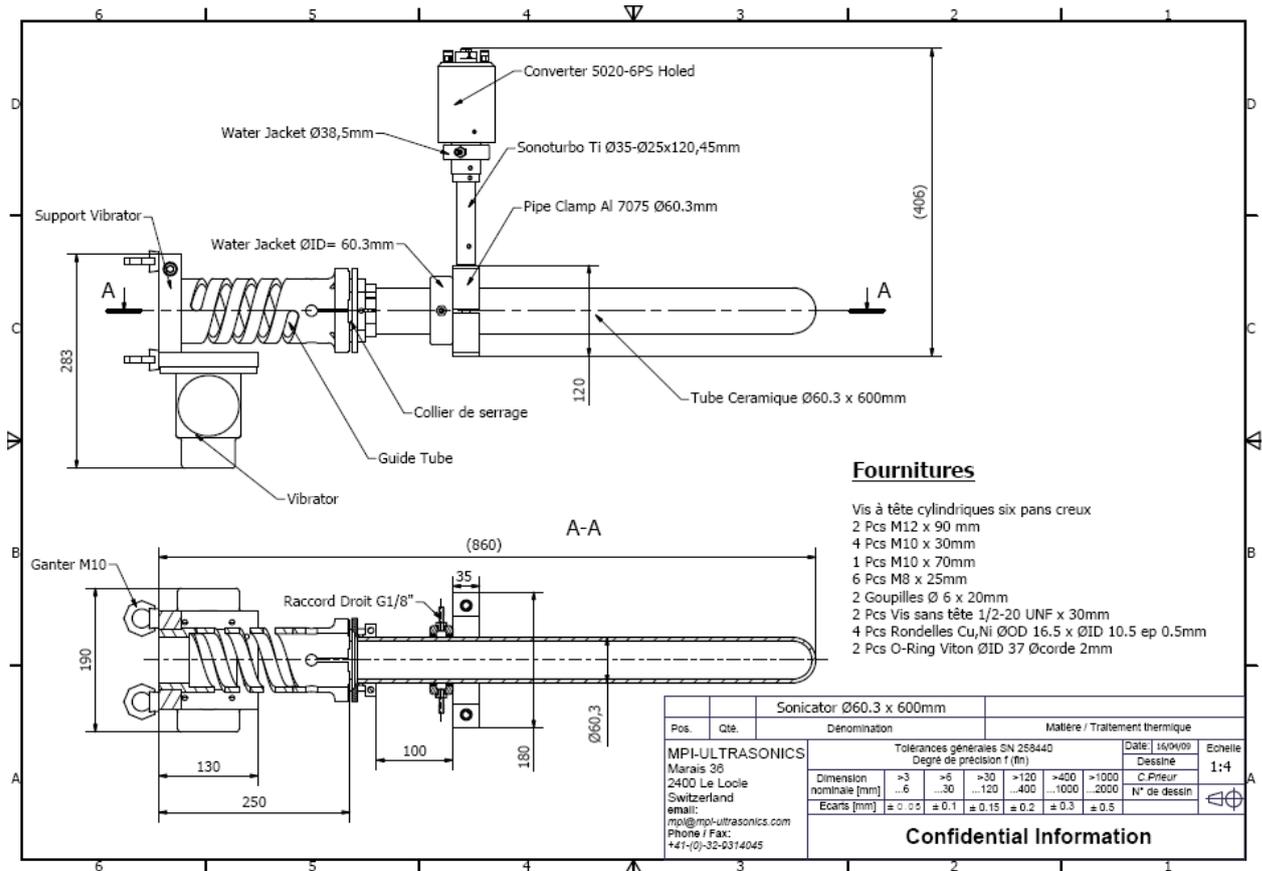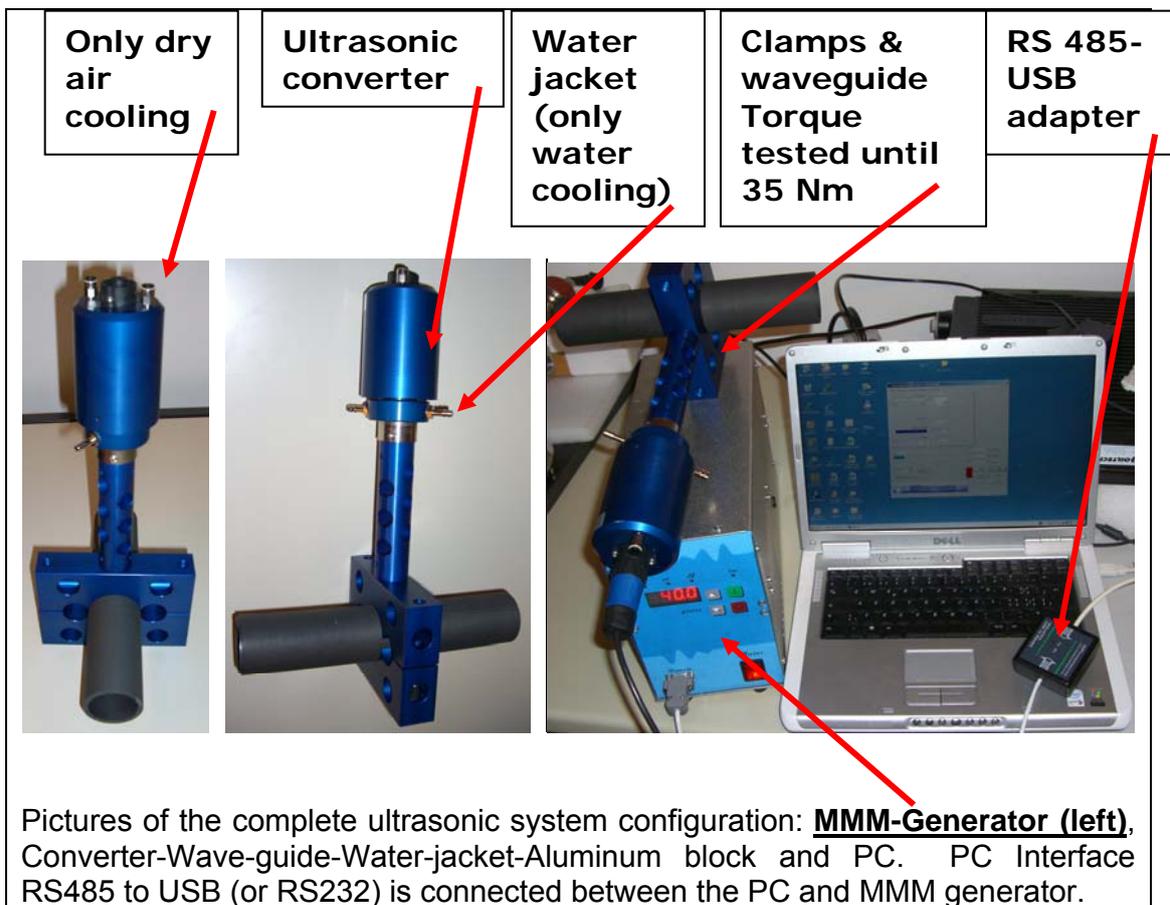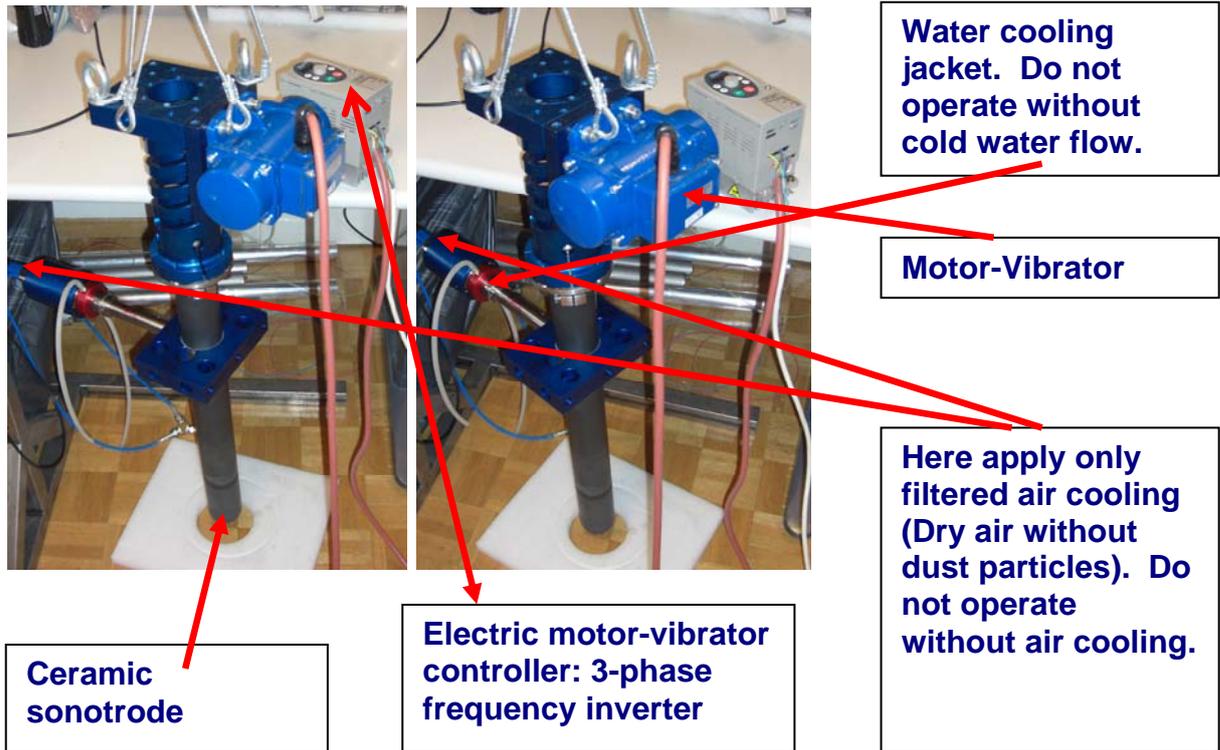## ULTRASONICS - SONOCHEMISTRY - INNOVATION

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http://mastersonic.com

ULTRASONICALLY ASSISTED ALUMINUM PROCESSING

Converter 5020-6PS Holed
Water Jacket Ø38,5mm
Sonoturbo Ti Ø35-Ø25x120,45mm
Support Vibrator
Water Jacket ØID= 60.3mm
Pipe Clamp Al 7075 Ø60.3mm
(406)
283
120
Collier de serrage
Tube Ceramique Ø60.3 x 600mm
Guide Tube
Vibrator

Fournitures

Vis à tête cylindriques six pans creux
2 Pcs M12 x 90 mm
4 Pcs M10 x 30mm
1 Pcs M10 x 70mm
6 Pcs M8 x 25mm
2 Goupilles Ø 6 x 20mm
2 Pcs Vis sans tête 1/2-20 UNF x 30mm
4 Pcs Rondelles Cu,Ni ØOD 16.5 x ØID 10.5 ep 0.5mm
2 Pcs O-Ring Viton ØID 37 Øcorde 2mm

Ganter M10
Raccord Droit G1/8"
A-A
(860)
190
35
Ø60.3
100
180
130
250

Sonicator Ø60.3 x 600mm

Pos.	Qté.	Dénomination				Matière / Traitement thermique		

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Tolérances générales SN 258440
Degré de précision f (fin)

Dimension nominale [mm]	>3 ...6	>6 ...30	>30 ...120	>120 ...400	>400 ...1000	>1000 ...2000
Ecarts [mm]	± 0.05	± 0.1	± 0.15	± 0.2	± 0.3	± 0.5

Date: 16/04/09
Dessiné C.Prieur
N° de dessin
Echelle 1:4

Confidential Information

Water cooling jacket. Do not operate without cold water flow.

Motor-Vibrator

Here apply only filtered air cooling (Dry air without dust particles). Do not operate without air cooling.

Ceramic sonotrode

Electric motor-vibrator controller: 3-phase frequency inverter

Only dry air cooling

Ultrasonic converter

Water jacket (only water cooling)

Clamps & waveguide Torque tested until 35 Nm

RS 485-USB adapter

Pictures of the complete ultrasonic system configuration: **MMM-Generator (left)**, Converter-Wave-guide-Water-jacket-Aluminum block and PC. PC Interface RS485 to USB (or RS232) is connected between the PC and MMM generator.

Apply only proper fastening tools (see below pictures with different clamps-fastening examples): **Torque for ceramic resonator fastening is 35 Nm.**

Pictures presenting ultrasonic converter with water jacket (upper part), wave-guide (middle part) and aluminum clamps on the graphite tube (bottom).

Ultrasonic generator settings:

Please first READ ALL INSTRUCTIONS FROM THIS DOCUMENT:

On the back side of the generator there is small circular connector which should be in its place. This is serving as an enable-key for the generator. All generator settings are already made (before delivery). Inductive compensation is also made (no need to change). No need to make new settings (except later, when you start loading the sonotrode you could make very small variations around already made settings). Generator operates very strongly and please do not increase power too much since something could be damaged (good and safe operating power setting for this system, when main supply voltage is 230 VAC/50 Hz, is between 20% and 40%). Applying higher power settings can damage ceramic sonotrode. When you test the mechanically unloaded system (free, as it is, in air), please use minimal power-level settings (just to start seeing that system is vibrating well; -for instance power level 10%).

Good operating power or good operating regime is achieved when: everything operates smoothly, when you would not hear strange, low frequency, crashing, hammering, repetitive, clipping, sparking and screaming noise on mechanical parts of the system. If you hear any strange randomized and pulsating noise, usually this is the sign that certain parts of the construction are not screwed/fixed sufficiently strongly, or that you gave too high power to the load (reduce the power on the generator, make refastening of critical parts, make slight modification of operating frequency and try reducing sweeping range). Problems on bolted joints can be noticed using infrared camera: on places where excessive heat is generated mechanical connection is problematic (clipping...). If you do not have infrared camera, just hand touch all oscillating parts and you will notice unsymmetrical and excessive heating.

Client should use his own PC. Software **mpi_ix.exe** for the MSG.1200.IX should be installed (download software here:

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/).

Do not forget to install drivers (software) for USB, Generator-to-PC-interface. Drivers can be downloaded from here:

http://www.mastersonics.com/documents/mmm_basics/mmm_power_supplies/rs485-USB-adapter-software/

Or, find, download and install latest drivers here:

http://www.ftdichip.com/FTDrivers.htm

Later please pay attention to select and connect a proper serial port (software is giving you selection of 10 serial ports and you need to test and find which one is free in your PC and it should be activated).

All important data, software and instructions regarding MMM generator are on MPI-Mastersonics web site here:

http://www.mastersonics.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/

The idea behind making holes in the vibrating aluminum clamps is to make such aluminum blocks more flexible, more elastic and to reduce metal rigidity in order to facilitate vibrations and increase amplitude on the contact surface with the graphite tube. Every circular hole (in clamps and waveguide) is reacting as a kind of mass-spring oscillator (with relatively high mechanical quality factor), this way facilitating complex vibration of the aluminum clamps.
Converter should be strongly fixed (by screwing) to one side of aluminum clamps (always using the waveguide between the converter and aluminum clamp), this way taking care that vibrations on the ceramic tube will be uniformly distributed and maximized.

In operation, the biggest care should be taken to keep constant low temperature on the ultrasonic converter (always below 50 degrees Celsius). Water jacket should be connected to a water flow in order to keep wave-guide cold and to stop heat penetration from aluminum block towards the converter. Certain forced air flow should be realized inside of the housing of the ultrasonic converter in order to keep converter cold (using pressurized, filtered dry air: where dust particles are smaller than 5 micrometers).

Usually, when generator settings are well made, when mechanical fixation is sufficiently strong, and when aluminum clamps are properly fixed, converter will not generate heat, or better to say that temperature on the converter body would increase very slowly. Significant heating of the converter parts is always indicating that MMM generator settings are not well made, or that there is a problem in mechanical assembling (parts are not strongly fixed). In such situations, stop the generator, reduce the operating power and search for new settings (later in this document, you will see what good settings found in MPI lab are).

When new settings are found, ultrasonic power could be increased. Aluminum clamps and graphite tube will take so much of ultrasonic power as acoustic loading conditions would allow. Generator is able to deliver 1200 Watts (and converter can accept 3000W), but in most of situations (like this one you have) aluminum clamps would take significantly less ultrasonic power because of acoustical loading conditions, acoustic impedances, geometry etc. In your case you could expect operating power levels which are in the range of 100 W, maybe 200 to 400 W.

You should experiment (with low power settings; -around 20%) in no-load open-air conditions in order to find the best generator settings and best loading of aluminum clamps and graphite tube.

All metal-to-metal joints (contact surfaces) realized by screwing should be clean, without any particles and dry (no water between contact surfaces) in order to avoid bad acoustic coupling and destruction of contact surfaces. If you intend to make new aluminum parts, the best aluminum for ultrasonic applications is AL-7075.

After creating regular operating conditions, generator settings should be again readjusted, since initial mechanical oscillating system would change by presence of different loading conditions and different added masses.

Do not apply maximal power settings of the generator, because after certain power level, increasing the power would start producing negative effects, non-linear oscillations, clipping and heat (and graphite tube will brake).

For putting the generator in operation and making proper generator settings (learning process), please download the instructions here (very important, read carefully, go step by step, do not neglect something):

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/instructions-for-first-time-users-ix-generators.pdf

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/ix-single-converter-settings.pdf

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/ix-single-converter-settings.pdf

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/um_msg_ix_yf_2005.pdf

Read also all documents from here:

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/

If under certain settings generator starts going into overloading state (stopping operation), reduce the power and slowly and systematically change some of setting conditions. Do not force repeatedly the generator to go often in overloading conditions, because this way you would damage the generator, converter and/or mechanical parts.

Above given instructions are generally valid for all MMM and IX generators (like your generator). Details regarding settings and optimal conditions would always be different, depending on operating conditions, geometry of oscillating objects, loading conditions etc. Here given general instructions are good to get basic knowledge and experience regarding how to operate MMM generator and how to make setting, but in client's real operating conditions, **the same, here given instructions should be applied creatively and with intellectual flexibility (meaning client should find new set of best operating conditions that are similar, but maybe not identical to here described settings)**.

All initial settings (realized in MPI Lab) are already memorized inside of the generator (Read data first).   Do not change settings in the very first steps. Later you will have a chance to change settings. Do not go too high with operating frequency (for this system all good operating frequencies are between 17.500 and

20000 Hz). To get initial experience, please first test the system as it is (water loaded, in order to repeat here-given settings/instructions…).

You have the generator MSG.1200.IX-LF, which accepts 208 to 230 VAC, main supply voltage. Avoid using step-up or step-down transformers for creating necessary main supply AC voltage. In USA the AC voltage between 2-phases is 208 VAC, and this is acceptable main supply (ask certified technician to make connections). Regarding new settings and readjustments it is important not to go too far from here listed settings. Test new operating conditions only under low power (between 15% and 30%... generator is very strong and you will not need very high power… maximum 40% will be OK).

Be very careful and respect all instructions given here.

Settings using the control software for ultrasonic generator are:

Good initial generator settings for resonating SIALON tube in water-load conditions, found in MPI laboratory during initial testing are (see below):

DDS:

Frequency: Best operating, free-running frequency in this case is 17.720 kHz, when operating in water-load conditions (in MPI lab). Later, under real liquid-metal loading, the optimal operating frequency will be slightly different. In any other case, experiment carefully with fine frequency tuning between 17.5 and 21.5 kHz... (VERY IMPORTANT, DO NOT NEGLECT). SIALON tube and ultrasonic converter could be damaged if you increase operating frequency (since optimal resonant frequency of ultrasonic converter is between 18 and 21 kHz).

Sweeping: Keep at 0.020 kHz (IMPORTANT). Later, experiment using other values (below 0.020 kHz). In this case lower values are more convenient (better results).

POWER: Keep low power, between 10% and 30 %. Start testing with low power (example: 15%) in water-load conditions (and later increase to a maximum value around 30% in liquid-metal operating conditions). Work at minimum power that is producing good results, linear, smooth and stable oscillations, and minimal heating on the converter and other solid parts. Electrically increasing power after certain threshold level will mostly produce excessive heat dissipation and non-linear oscillating effects (and this could damage ultrasonic converter and ceramic resonator; -generator and transducer are very powerful and if you increase the power, when system is not loaded, mechanical components of the system would start generating non-linear and clipping vibrations and screaming or cracking noise and this can damage mechanical components. First apply both, air and water cooling (alternative cooling is cold nitrogen-air mixture). Do not enter water inside of the ultrasonic converters (only air). Avoid testing in no-load or air-load conditions (oscillating amplitudes could be too high).

Max. Current: 2 A (no need to go higher for this application). This is internal electronic protection of ultrasonic generator.

PWM period: keep 0.010 s (maybe later you could try increasing until 0.10s). This is low frequency PWM, or pulse train modulation (until 100 Hz). PWM period is irrelevant when ratio = 100%.

PWM ratio: 100% (maybe later you could try reducing until 80% or 50%, in order to try pulsing liquid processing).

FSWM: Frequency shift with modulation. FSWM is the regulating domain where we can influence fluids rotation (under ultrasonic processing).

1. **FSWM-range: 0.020 kHz to 0.050 kHz. FSWM modulating (sweeping) interval should be relatively low (short); - until 50 Hz, because inertia**

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of mechanical load is not able to follow higher modulating, frequency intervals.

2. **FSWM-ratio: 20 to 35%.** Rotating speed (frequency) is directly dependent on FSWM-ratio,
3. **FSWM-period: 0.010 to 0.016.** Liquid rotating speed is also very much dependent on FSWM period.
4. Keep "Sweeping" on the first DDS tab to certain low level (max. 20). This is randomised frequency jumping (has certain influence on liquid rotation and uniform distribution of acoustic activity).

To get a better feeling about mentioned rotating effects, please download and see movie files from the following address (web links):

ultrasonic-fluids-rotation-mmm.zip

(**http://www.mastersonics.com/documents/mmm_applications/**)

See also:
http://www.mastersonics.com/documents/mmm_applications/ultrasonic_metallurgy/

DMMM,

Q-factor: In this case set to 0 (zero). Test from 20 to 50 (also good until 100),

Frequency correction: Maximum 120 - 130. Test other values below 130.
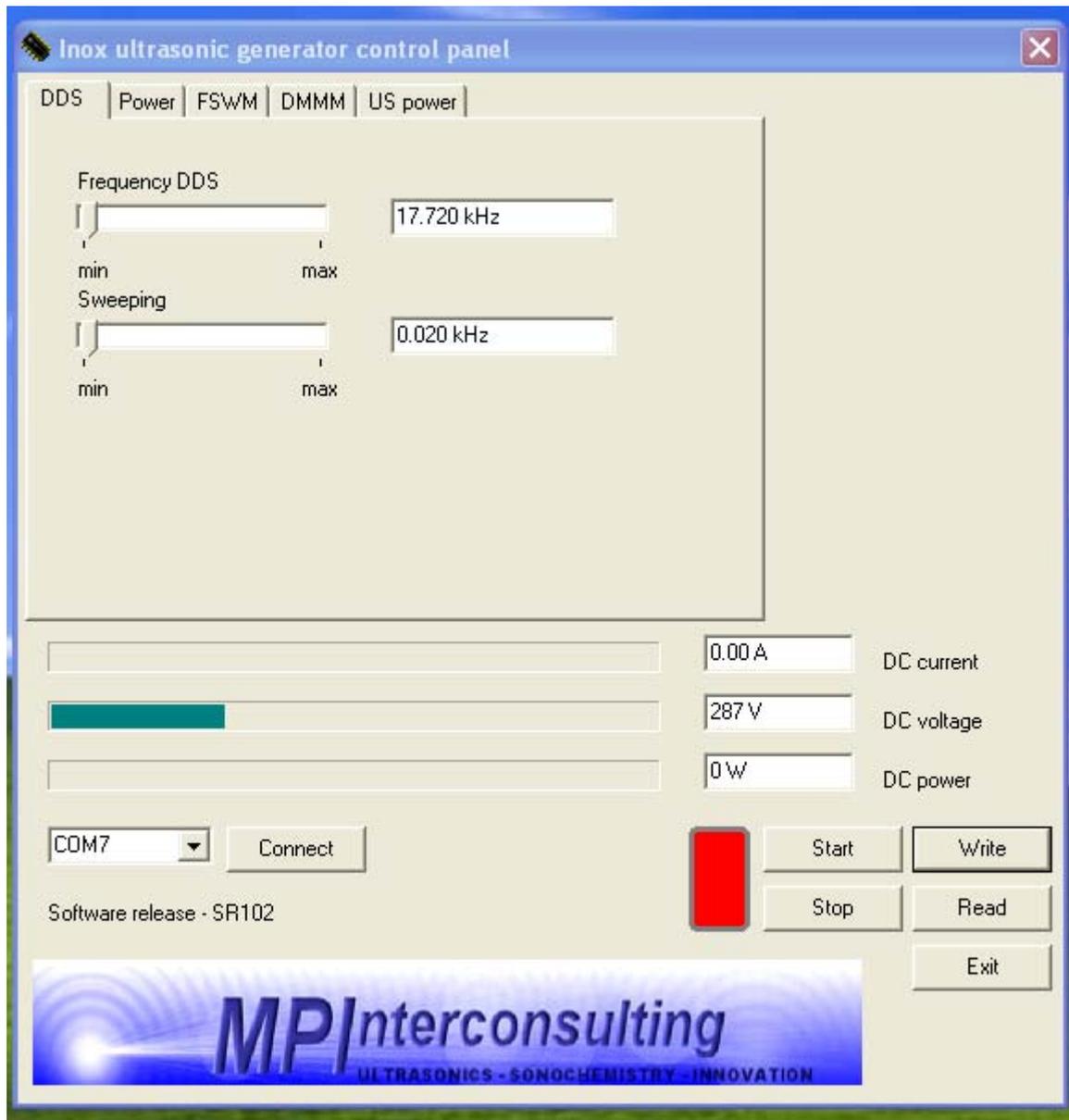
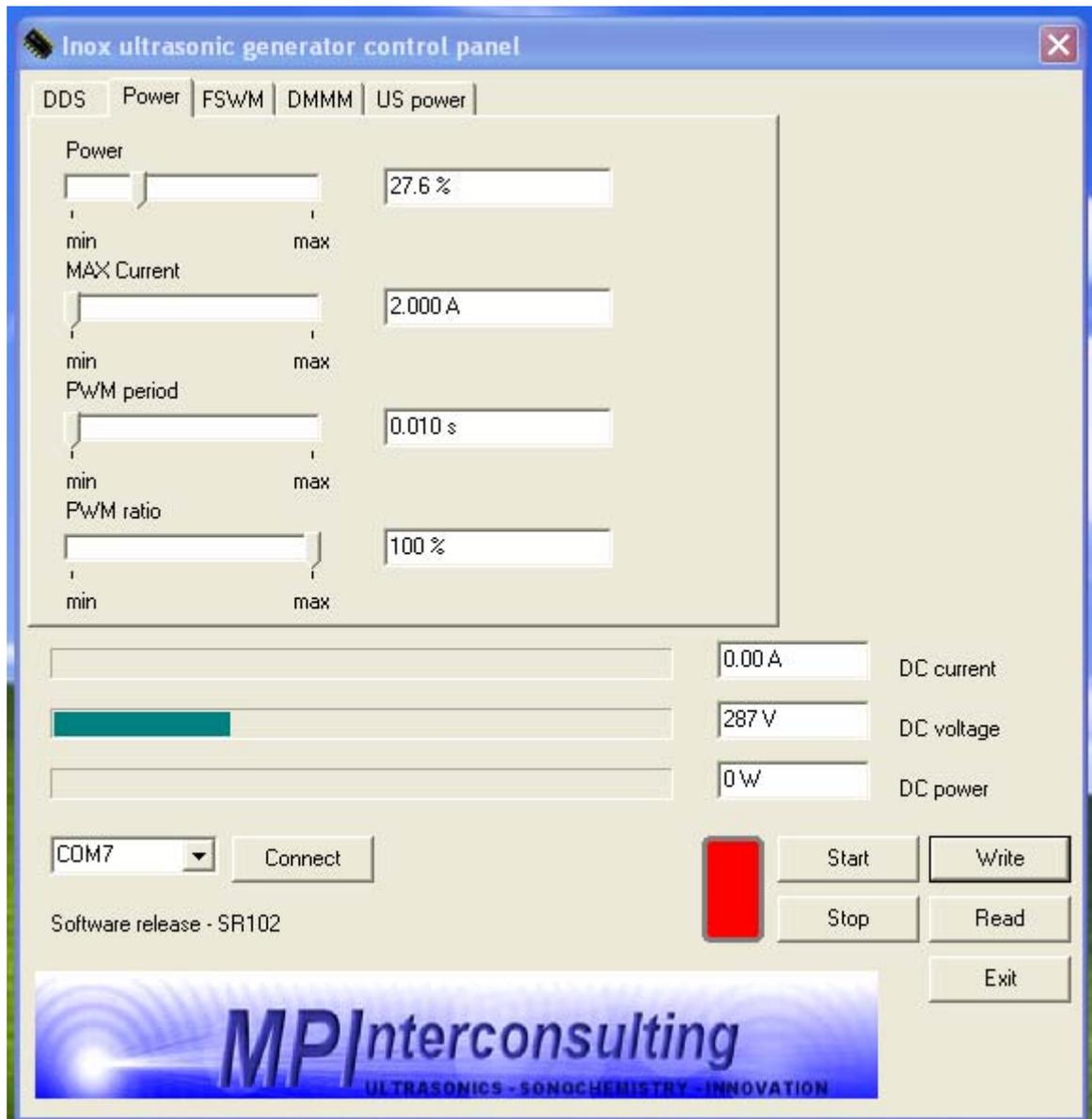**Amplification factor: In this case set to 0 (not recommendable to go higher).**

US POWER: set between 300 and 500 (can also operate well below 300). Work at minimum power that is producing good results, linear, smooth and stable oscillations, and minimal heating on the converter and resonating system parts (read all documentation on MPI web sites first).
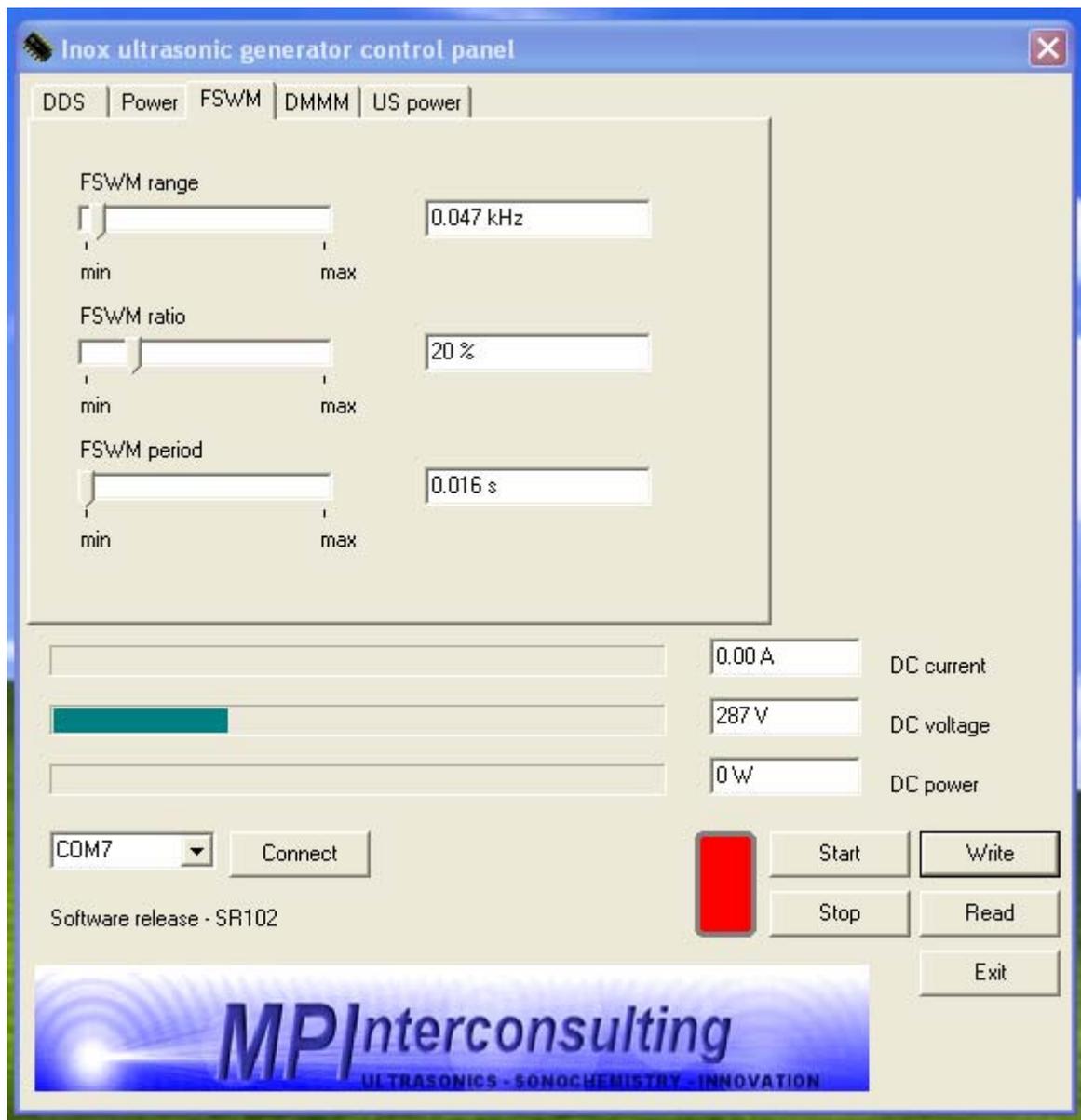
In loading, operating conditions, above-given initial settings should be readjusted to rich maximal ultrasonic activity (start the tuning process again, slowly and step by step).

All of here listed data and settings are internally memorized inside of ultrasonic generator MSG.1200.IX.
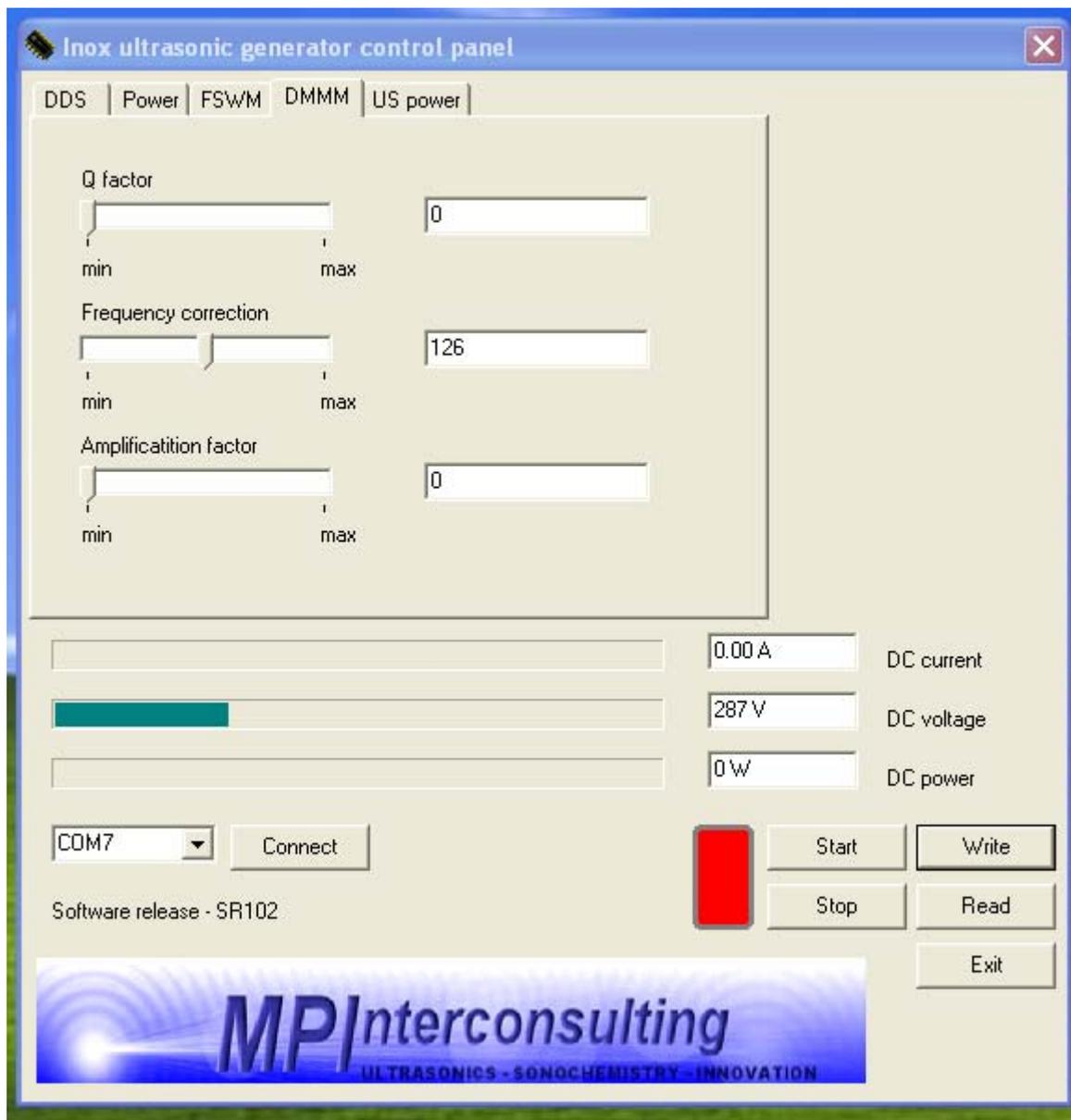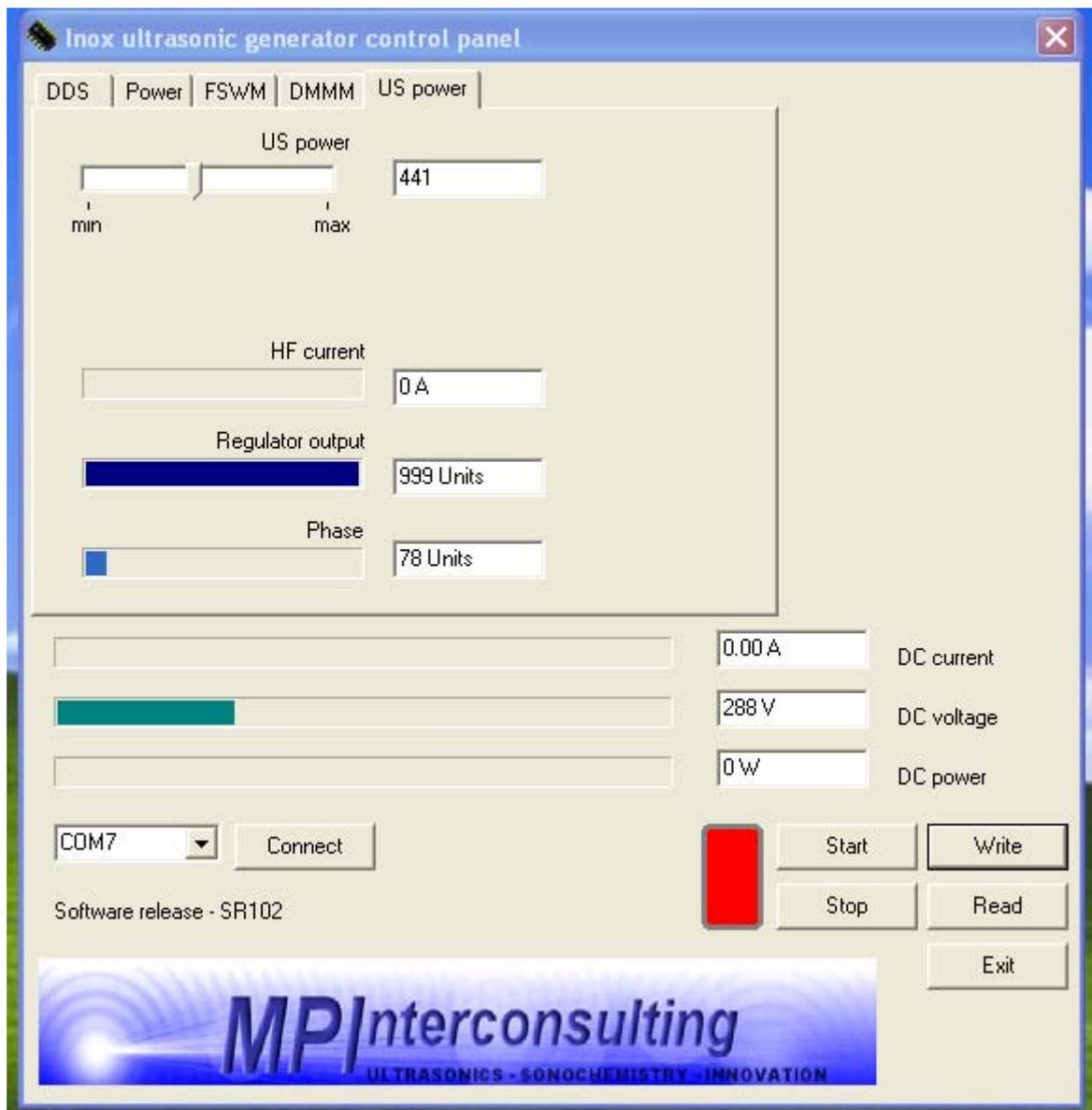

Next pages are showing all generator settings:

FSWM-range: 0.020 kHz to 0.050 kHz
FSWM-ratio: 20 to 35%
FSWM-period: 0.010 to 0.016

5. **FSWM modulating (sweeping) interval should be relatively low (short); - until 50 Hz, because inertia of mechanical load is not able to follow higher modulating, frequency intervals.**
6. **FSWM is the regulating domain where we can create fluid rotation. Rotating speed (frequency) is directly dependent on FSWM-ratio,**
7. **and also very much dependent on FSWM period.**
8. **Keep "Sweeping" on the first DDS tab to certain low level (max. 20). This is randomised frequency jumping.**

Using Motor Vibrator

This combination is giving a chance to combine low frequency vibrations from a variable speed electric motor and ultrasonic vibrations. Motor-Vibrator is driven by 3-phase frequency inverter. Frequency inverter has single phase 230 Vac input and it is producing variable frequency 3-phase output. Please read all documentation regarding frequency inverter. Do not increase the frequency of the Vibrator-Motor more than level 25. The level 25 is the display reading on the frequency inverter and corresponds to certain optimal frequency output of the frequency inverter (and this corresponds to approx. 2500 or 3000 rpm = rotations per minute, of the Motor-Vibrator). You can try increasing for a short time the rpm of the Motor-Vibrator until level 30 on the frequency inverter. Read original documentation regarding Motor-Vibrator and Frequency inverter. In case of damaging something order and buy the same components from the same sources (ask for instructions).

In case of breaking some parts, you will get information where to buy new parts (nothing under warranty since this is non-standard R&D, experimental model and mistakes and damages are possible).

230 Vac Main power input

Display. Optimal level: 25 Maximal 30. Motor-Vibrator Will fail on higher speeds

3-phase cable output for Motor-Vibrator

Motor-Vibrator

3-phase frequency inverter