MMM IX-Generator and System SETUP

Before operating the system be sure to read the Generator Manual, which can be found on the following address:

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

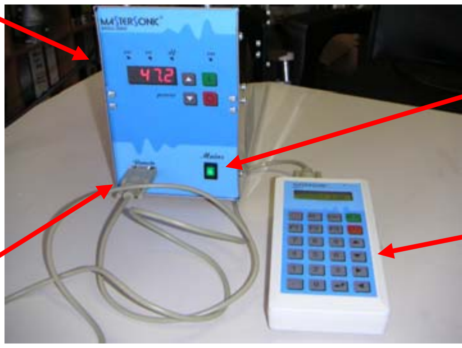
The system can be controlled on two different ways:

A) Using the Handheld Control Unit MSH-1 (Remote Control Panel),
or
B) Connecting the generator to a PC serial port and controlling the system operation from the PC with the provided interface software.

Both options will produce the same results, but using the PC and control software is presenting much more flexible and comfortable way with additional visual and real time information about all operating system parameters.

A) Generator Control using the MSH-1

MMM Generator: MSG.1200.IX



Main Power Switch for power ON and OFF

RS485 generator input connector

MSH-1

1. **Plug-in the connectors between the Handheld Control Unit MSH-1 and RS485-connector on the front panel of the MSG.1200.IX generator. Handheld Control Unit MSH-1 will operate taking the power directly from the generator (no need for external DC power supply). See instructions regarding how to use MSH-1 in the system manual-:**

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

Main Supply Input: 230 VAC/50-60Hz, 30 A

Ultrasonic Reactor Cable: Coax. RG58

For external generator Power ON and OFF switching, cut this yellow wire and install convenient switching device between the open-wire-ends, here.

2. Connect the Ultrasonic System and Main Power Supply cable to the rear panel of the MGG.1200.IX generator. Attention: Apply European 230 VAC, 50/60 Hz, 30 Amp. input power line. When using step-up or step-down transformer, use a 5 kW transformer (to have large safety margin for pulsed-power operations). See instructions in the system manual:

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

Then Switch ON the Main Switch on the generator front panel: See the picture from the step 1.

Comments: Main Supply voltage variations between 208 VAC and 235 VAC are acceptable.

B) <u>Generator Control using the PC serial (RS) port</u>

3. Switch-ON your PC and Download the generator control software file from the following address (if mentioned address can not be activated from this Adobe PDF document, go directly to internet and download the exe file):

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

and then place it on the PC Desktop (the first screen you will see on your monitor, after initiating MS Windows, before using any software). You will see on your PC desktop the following Integrated Circuit Icon: 

. Later, by clicking on that icon you will be able to activate the interface software for MSG.1200.IX control. Wait with software activation until you finalize the step 4. (see below).

4. Take the serial interface MMM-Link-2339 (or MSA2218, RS485 Adapter) and plug its cable-connectors between the PC serial port and RS485-connector on the front panel of the MSG.1200.IX generator (see pictures in step 3.). See instructions regarding how to use MMM-Link-2339 in the system manual:

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

As noted in the step 2. The Main power supply and Reactor cable should be connected to the rear panel of the Generator.

Do not open the generator box. The system is factory regulated in the best possible way, so that you will be able to control your system from the MSH-1 or from the PC interface software.

5. Activate the Generator using the MSH-1 (option A)): See instructions regarding how to use MSH-1 on the system manual:

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

Or you can also activate and control the generator by clicking on the interface-software icon:  Msg_ix.exe **(option B)). See instructions regarding how to use software control in the system manual:**

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

6. Apply the following, initial generator settings (before activating the generator START button, or before sending the ultrasonic power to the reactor):

a) Read pages 13 and 14 of the following document:

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/um_msg_ix_v7.pdf

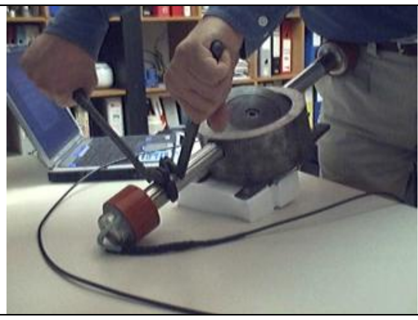
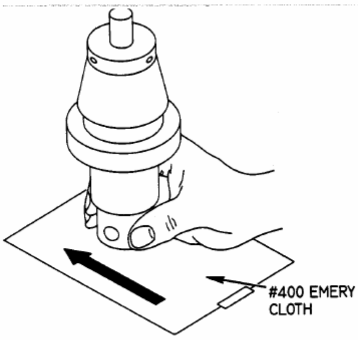
b) Set the Generator Power to not more than 30% of the total power,
c) Set the MAX current to minimum,
d) Set PWM period to: 0.010 s,
e) Set PWM ratio to: 100%,
f) Read and apply the specific document with the best settings for your Ultrasonic System that will be sent to you by MPI.

USEFUL COMENTS AND STEP BY STEP INSTRUCTIONS

This system is presently not available for USA, single-phase main supply voltage 110-120 VAC. You can apply only 230 VAC, European main supply voltage, or USA 2-phase 208 VAC / 60 Hz?

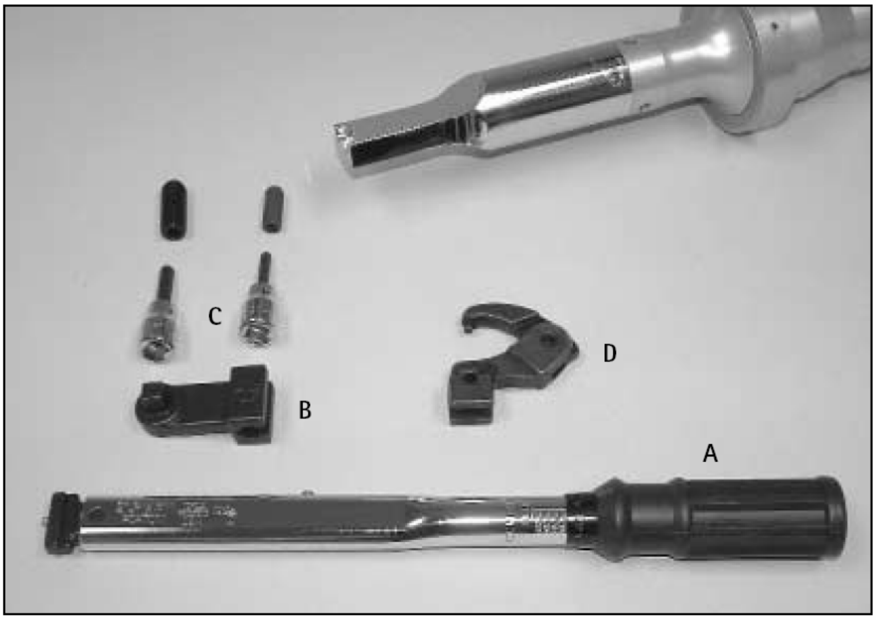
For using USA voltage, ask an expert (electro-technician) to arrange for you the connection between 2 phase lines of USA voltage (such voltage will be 208 VAC; -verify the 208 VAC using voltmeter). Then connect ultrasonic transducer to the generator, and start entering generator settings. Do not activate the generator to produce ultrasonic power output.

Screw and tighten well the hand-piece (transducer with all other mechanical parts). Use special torque wrench keys if supplied with the system. If you did not order a torque wrenches, please find couple of them. Such tools are usually used in assembling ultrasonic plastic welding systems, as for instance (see the following pictures and description below):

	
IMPORTANT: To maintain interface flatness, do not allow part to tilt when stroking. Do not apply downward pressure; the weight of the component is sufficient.  a. Thumb over spanner wrench hole. b. Rotate the part 120 degrees (1/3) to the next hole. c. Provide equal number of strokes at each location (2 or 3).	 

Torque Wrench Kit

Ultrasonic Welding



General Description

Welding systems function with greatest efficiency when the stack components (converter, booster, and horn) are properly assembled and torqued. The Branson Torque Wrench Kit allows for accurate torquing that is traceable back to NIST standards.

Benefits

- Insures proper torque and eliminates failures from improper torquing.
- Can be calibrated to NIST standards.
- Reduces maintenance required because stacks are assembled correctly.

Torque Guidelines

The chart on the back provides guidelines for applying torque with the kit. Please call us if you have difficulty in applying these parameters to your own equipment.

Items in the Kit

A. NIST calibratable torque wrench
B. 3/8" square drive adapter
C. Hex bits (to torque studs into booster/horn)
D. Spanner wrench adapter (to torque stack)

Ordering Information

	Branson EDP No.
15, 20, 30 kHz kit	101-063-617
40 kHz kit	101-063-618
3/8" I.D. Mylar washer	100-063-472
20 kHz 1/2" I.D. Mylar washer	100-063-471
15 kHz 1/2" I.D. Mylar washer	100-063-652

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Applied Technologies Group

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Stack Assembly Guidelines

15, 20, 30 kHz Installation
Clean the mating surfaces of the converter, booster, and horn, and remove any foreign material from the threaded holes.
Install the threaded stud into the top of the booster; torque to specifications. If the stud is dry, apply 1 or 2 drops of a light lubricating oil before installing.
Install the threaded stud into the top of the horn; torque to specifications.
Install a single Mylar washer (matching the size of the washer to the stud) to each interface.
Assemble the converter to the booster and the booster to the horn.
Torque to 220 in.-lbs, 24.85 Nm (15 and 20 kHz) Torque to 185 in.-lbs, 20.9 Nm (30 kHz)

40 kHz Installation
Clean the mating surfaces of the converter, booster, and horn, and remove any foreign material from the threaded holes.
Apply a drop of Loctite® 290 (or equivalent) to the studs on the booster and horn.
Install the threaded stud into the top of the booster; torque to specifications. Let cure for 30 minutes.
Install the threaded stud into the top of the horn; torque to specifications. Let cure for 30 minutes.
Coat each interface surface with a thin film of silicon grease - but do not apply silicon grease to a threaded stud.
Assemble the converter to the booster and the booster to the horn.
Torque to 70 in.-lbs, 7.9 Nm

Stud	Used On	EDP#	Torque
3/8" x 24 x 1"	20, 30 kHz Ti horn	100-098-120	290 in.-lbs., 32.76 Nm
3/8" x 24 x 1-1/4"	20 kHz Al horn	100-098-121	290 in.-lbs., 32.76 Nm
1/2" x 20 x 1-1/4"	15, 20 kHz Ti horn	100-098-370	450 in.-lbs., 50.84 Nm
1/2" x 20 x 1-1/2"	15, 20 kHz Al horn	100-098-123	450 in.-lbs., 50.84 Nm
1/2" x 20 x 1-1/2"	15, 20 kHz booster	100-098-123	450 in.-lbs., 50.84 Nm
M8 x 1.25 *	40 kHz booster/horn	100-098-790	70 in.-lbs., 7.90 Nm

* Add a drop of Loctite® 290 to the stud, torque, and let cure 30 minutes before use.

Connecting Tip to Horn

1. Clean the mating surfaces of the horn and tip, and remove any foreign matter from the threaded stud and the hole.
2. Hand assemble the tip to the horn. Do not use any silicone grease.
3. Torque tip to specifications:

Tip Thread	Torque
1/4-28	110 in.-lbs., 12.42 Nm.
3/8-24	180 in.-lbs., 20.33 Nm.

All metal contact surfaces (between the converter and all other mechanical parts, waveguides, boosters...) should be clean and dry before fastening.

Do not set too high, initial ultrasonic power, since connecting-studs and screws will brake (start always with low operating power). The system you have is power-oversized. It can deliver much more power than necessary to oscillate your parts. Do not exercise using high ultrasonic power (no need for your system). Large safe-operating power margin is important for system safety and reliability, and it is giving you a chance to connect and vibrate different mechanical parts (where you could need to deliver higher power).

If water penetrates inside of metal joints and contact surfaces, remove it before operating the system, since water will start eroding the contact surfaces.

Not-optimal operating regime can be recognized by high audible (low frequency) acoustic noise, irregular shaking and heating of the transducer and other metal parts. Change setting parameters until you reach cold, smooth and optimal oscillations.

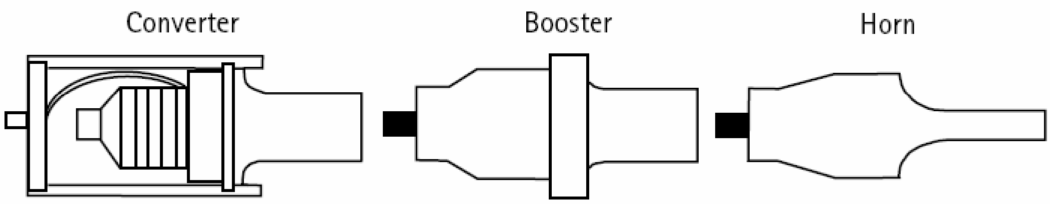
Never overheat the transducer. Try to operate it always below 55° C (measured on the transducer front and back mass, whichever of them reach first that temperature). Heating of the transducer is equal to non-optimal generator settings. Change settings until smooth, uniform, cold and quiet operating regime is achieved.

If you are going to operate your system 24h/7d, or relatively long time and high power (without OFF time periods), please ask for instructions regarding how to make continuous transducer cooling.

The system is well protected and has good galvanic separation from any kind of voltage or current sources (which could cause electric shocks) when using standard main supply plug with internal ground (as usually). In case of in-vivo operations, please apply additional safety standards if necessary.

Please do not change position of any jumper inside of the generator. Everything is well pre-selected for your application. No need to change anything later or to make any intervention inside of the generator box.

If you would use the MMM generator and power converter for materials testing and agitating different metal parts, please first connect to the converter one aluminum waveguide rod, or aluminum plastic-welding booster (ask for instructions if necessary; -use aluminum 7075, length between 120 and 140 mm). Such aluminum interface would basically serve to stabilize vibrations going back and forth from the converter to your test specimen, sonotrode, any other end tool, or ultrasonic load. MMM generators are not typical (fixed-frequency) resonant systems, but still similar logic regarding amplitude amplification (like in cases of ultrasonic plastic welding) is also valid regarding MMM agitation. See the following pictures and



Converter Amplitude x Booster Gain x Horn Gain = Stack Amplitude

Example: 0.0008" or 20 microns x 2 x 3 = 0.0048" or 120 microns

Figure 2. Calculation of Converter/Booster/Horn Stack Gain

Inductive Compensation:

The inductive compensation is associated with finding the resonant frequency of the transducer and is increased and decreased by closing and opening the ferrite core (see the generator manual). The inductive compensation is dependent on the selected system center-frequency, the static capacity of the transducers, loading and their operating mode. When MMM generator is delivered to unknown end-user for unknown application, inductance is set to maximum (zero air gap in the ferrite cores) in order to avoid problems in transport. In such cases user would need to readjust the inductance.

Selected center frequency, in case if the mechanical configuration transducer + sonotrode has several resonant frequencies, would be one that is producing strongest mechanical output when no one frequency modulation is applied, and it should also be in a close vicinity of the resonant frequency of the power ultrasonic converter which is applied. for instance, if power converter itself (non-loaded in air) has 20 kHz as it's best resonant or operating frequency, we will consider (in most of cases) the vicinity of +/- 10% as an acceptable static frequency range (in this case +/- 2 kHz, or we will search for the best center frequency somewhere inside of the frequency range from 18 to 22 kHz). usually inside of the +/-10% frequency interval (related to non-loaded converter resonant frequency) we would be able to find couple or several resonant frequencies of the complete oscillatory system (converter + sonotrode, or converter + waveguide + sonotrode…), and one which is producing the strongest mechanical output (without applying any frequency modulation) should be selected as preferable center frequency. Later on, frequency modulations can be applied in order to additionally optimize mechanical output.

In many cases inductive compensation is not significantly affected by the shape of the horn, or we could safely say that inductive compensation is dominantly dependent on static converter capacitance (but again, certain smaller modifications of pre-selected inductive compensation inside of the +/-10% pre-selected-inductance-range could be expected, caused by sonotrode geometry, mass and acoustic loading, in order to maximize certain resonant regime).

The inductive compensation will come set from MPI in advance and should not be changed unless different mechanical system is applied. In your very first steps, please do not change inductive compensation, since it will be optimally pre-selected for initial mechanical system. Later, if you would change any element of the mechanical system, you could try to vary a little bit the inductive compensation (but please have in mind that such variations should be insignificant or very small).

MMM generators Set-Up

Short Resume Valid For All MMM Generators and Preliminary Steps:

First, switch-ON the PC and place the generator software "MSG_IX" on the PC desktop (by copy & paste).

Then switch-ON the generator (only main voltage supply = ON). Generator is still not producing ultrasonic output (not started).

Connect the MMM generator to ultrasonic converter.

Connect the PC Interface Adapter MSA2339 between the PC serial port and the RS485 connector on the generator front panel.

Provide mains power to the generator and switch on the generator at the front panel.

Start the MMM PC Interface Control Software by activating the icon "MSG_IX". All initial settings will be made using the PC Interface Control Software (before activating the System).

Do not activate the generator to produce an ultrasonic signal. Do not press the Start button provided by the software.

1.) **Set all sweeping parameters to 0. This will enable generator to operate on constant frequency.**
2.) **Set generator input and operating power to max. 30% (safe level for initial parameters setting).**
3.) **Adjust the Operating Frequency (center frequency) to the point where the load (transducer) current is maximal and where at the same time the phase is minimal. At this point the ultrasonic activity in the mechanical system should be maximized.**
4.) **Adjust the inductive compensation in order to get higher load current and maximal acoustic activity. (After final adjustment the internal inductive compensating ferrite gap may be fixed with a silicone spacer.)**
5.) **Set all Sweeping adjustments to the levels which are producing best ultrasonic effects.**
6.) **Increase gradually the power until smooth and continuous oscillations are still present. If the ultrasonic system starts producing cracking and sharp noise, stop increasing the power. Always set operating power to stay within a relatively smooth and quiet operating regime. Increasing the power over the suggested limits will only produce heating and may damage transducers (since system would enter non-linear and unstable regimes). Entering into a regime of non-linear and clipping oscillations is not producing better effects (it is producing only very high noise level, high thermal losses and possibly damaging ultrasonic converter and other mechanical parts).**
7.) **Adjust the center operating frequency again to find the maximum load current and minimum phase point.**

8.) Repeat all setting steps 1 through 8 above to find better operating conditions.

9.) Additional fine tuning, to get better ultrasonic activity may be made by readjusting all sweeping intervals while keeping the same, previously found, operating frequency (center frequency).

After introducing all initial settings as detailed below you may press the software Start button. The Generator will start producing ultrasonic power and the system will start oscillating. You may continue adjusting generator settings when the system is operating.

Monitor the Input DC Power reading (lower right section of the software screen), which is indicating the input power level.

Systematically repeat the fine tuning process for all parameters (slightly varying them within the specified ranges) until reaching the highest input DC Power level.

When you reach the maximal input power, memorize the parameters clicking the Write button on the control software window. All parameters will be stored in an active memory. Now you can start active liquid processing tests. After switching-OFF the system (pressing the software Stop button), and after re-activating the generator for subsequent tests, you can recall all previous stored parameters by clicking on the Read software button. These parameter settings will be read from the generator memory and displayed on the PC control software window.

Example of Appropriate Parameters Step by Step Settings for MMM Ultrasonic System Operation

This example is only applicable to the MMM ultrasonic system delivered with these instructions. This procedure will allow you find the best operating conditions quickly without wasted efforts and without making improper settings that could harm the system. You may make slight parameter variations within the given range. When making new settings and system testing (with new mechanical components and different loading), please reduce the power to 30% and first search for the best operating conditions under low power.

Click on the second page tab “Power”:

Power:

Click on the Power Tab at the top of the PC Interface Control Software and set the input “Power” between 20% and 30% (preferably minimal value) by moving the sliding bar to the left position to max. 30%. This is to ensure that during regulations and settings generator would produce low power output in order to avoid damaging mechanical system. Do not activate the generator (do not click the Start button on the control panel).

MAX Current:

Set “MAX Current” to 2.000 A
After a period of safe operation you may gradually increase the setting to 3 A if you change mechanical system and loading. This is the safe operating margin for your system.

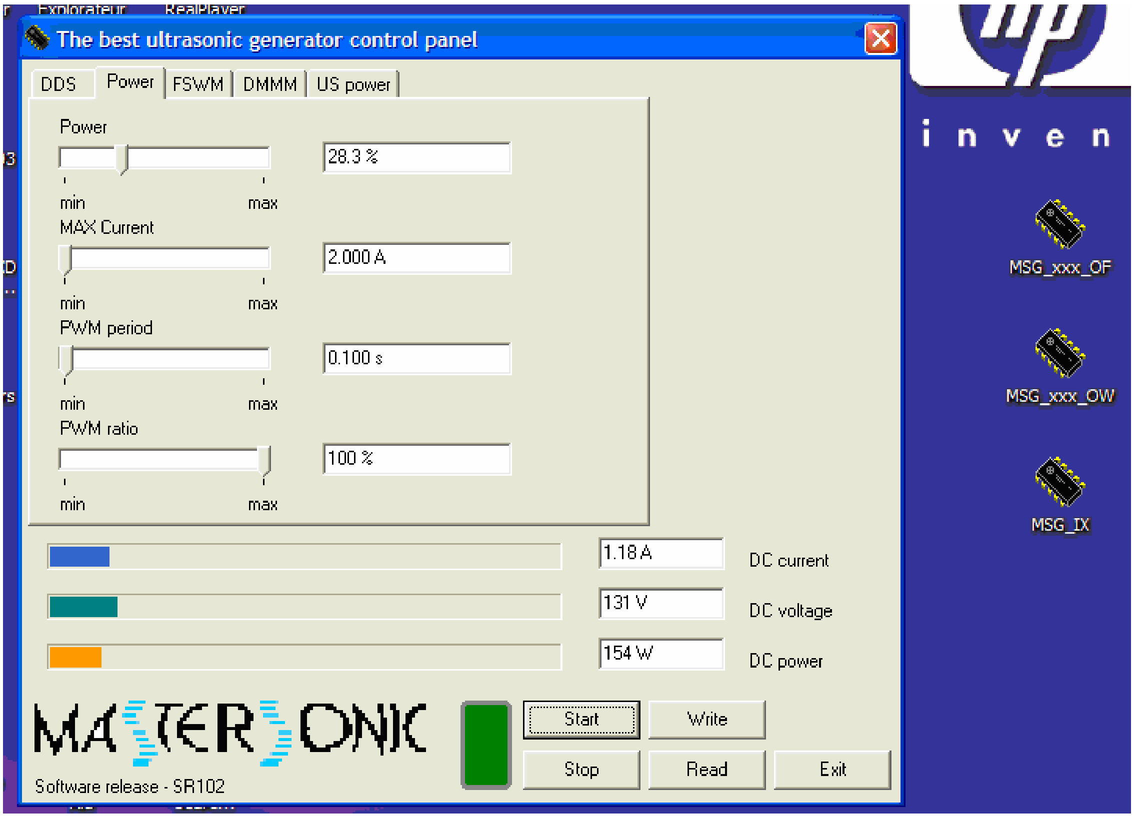
PWM period:

Set at its minimum 0.010 s setting to start. When the PWM ratio is set to less than 100%, you may experiment by increasing it until 0.100 s), while reducing the Power in order to avoid pulsed over-current.

PWM ratio:

Keep at 100% until more experience is gained in using this system. When you are fully aware of all parameters and safe operation conditions you may reduce the PWM ration to 20% to realize low frequency pulsing (ON – OFF) liquid processing regimes.

See the picture below.



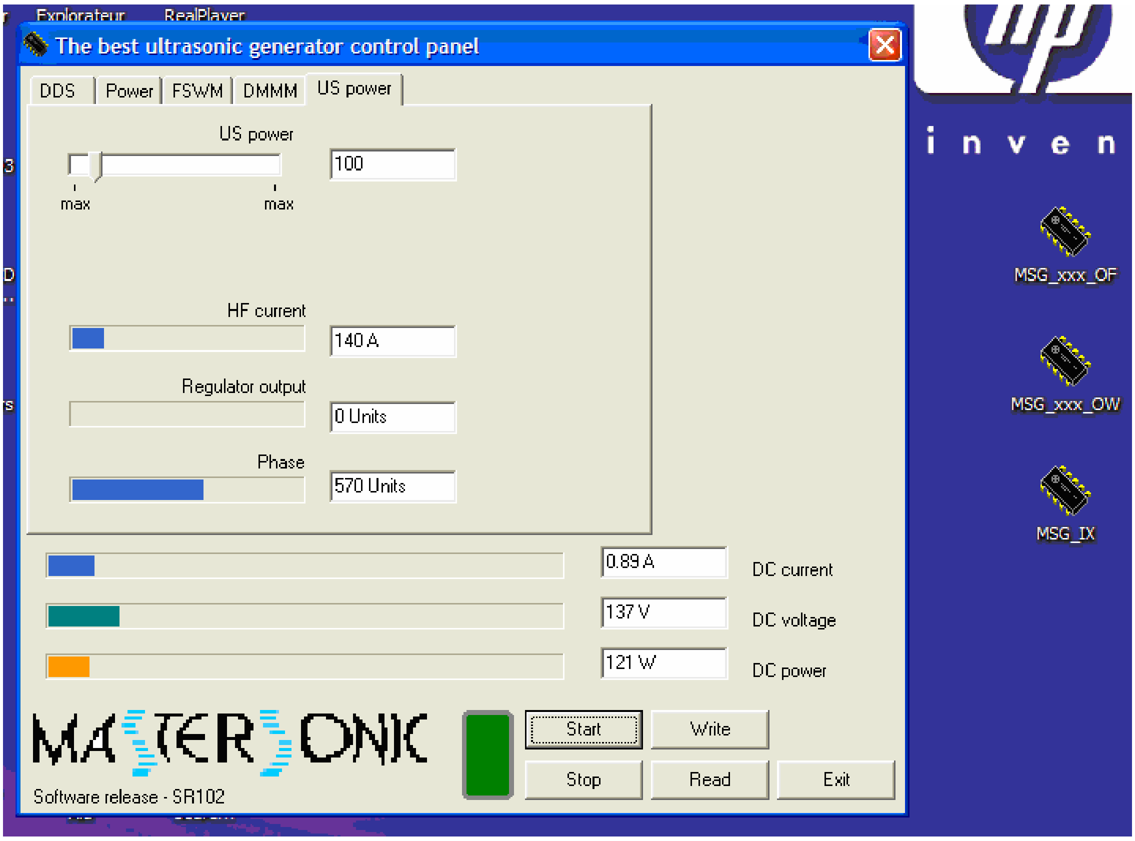
After experimenting in a real operating regime you may increase the power (if becomes necessary). Increasing power over system's safe-operating power limit would mechanically over-stress the system and could cause damage. Increase the power until smooth and continuous oscillations are present. If the ultrasonic system starts producing cracking and sharp noise, stop increasing the power. Always set power to stay within a relatively smooth and quiet operating regime of the mechanical system. Increasing the power over the suggested limits will only produce heating and may damage transducer. Entering into a regime of non-linear and clipping oscillations is not producing better ultrasonic effects (it is producing only high noise level, high thermal losses and possibly damaging the system). Adjust the operating frequency again to find the maximum load current and power. Later repeat all setting steps to find better operating conditions.

PWM modulation is creating low frequency <u>ON</u> and <u>OFF</u> pulse-train regime. Basically, with PWM settings you will create pulse-train-repetitive signal with certain ON-time and certain OFF-time. This looks like hammering. ON and OFF time are programmable, and also repetition frequency of such pulse trains is programmable.

You would probably never need PWM modulation in most of ordinary applications. Try to always to operate the system in a continuous regime (when PWM-ratio = 100%). PWM modulation would change average and pulsed output power, but this is not an interesting option in the very beginning, until you get fully familiar with system operations (just keep it in a continuous regime).

Open the fifth page tab "US power",

and set the output "US Power" between 10 and 100 (preferably minimal value). This is to ensure that during regulations and settings generator would produce very low power-output in order to avoid damaging mechanical system. Do not activate the generator (do not click the Start button on the control panel). See the picture with an example of such settings below.



After experimenting in a real operating regime you may increase the "US power" (if becomes necessary). Increasing US power over system's safe-operating power limit would mechanically over-stress the system and could cause damage. Increase the power until smooth and continuous oscillations are present. If the ultrasonic system starts producing cracking and sharp noise, stop increasing the US power. Always set power to stay within a relatively smooth and quiet operating regime of the mechanical system. Increasing the US power over the suggested limits will only produce heating and may damage transducer. Entering into a regime of non-linear and clipping oscillations is not producing better ultrasonic effects (it is producing only high noise level, high thermal losses and possibly damaging the system). Adjust the operating frequency again to find the maximum load current and power. Later repeat all setting steps to find better operating conditions.

Now open the first page tab "DDS"

Make settings:

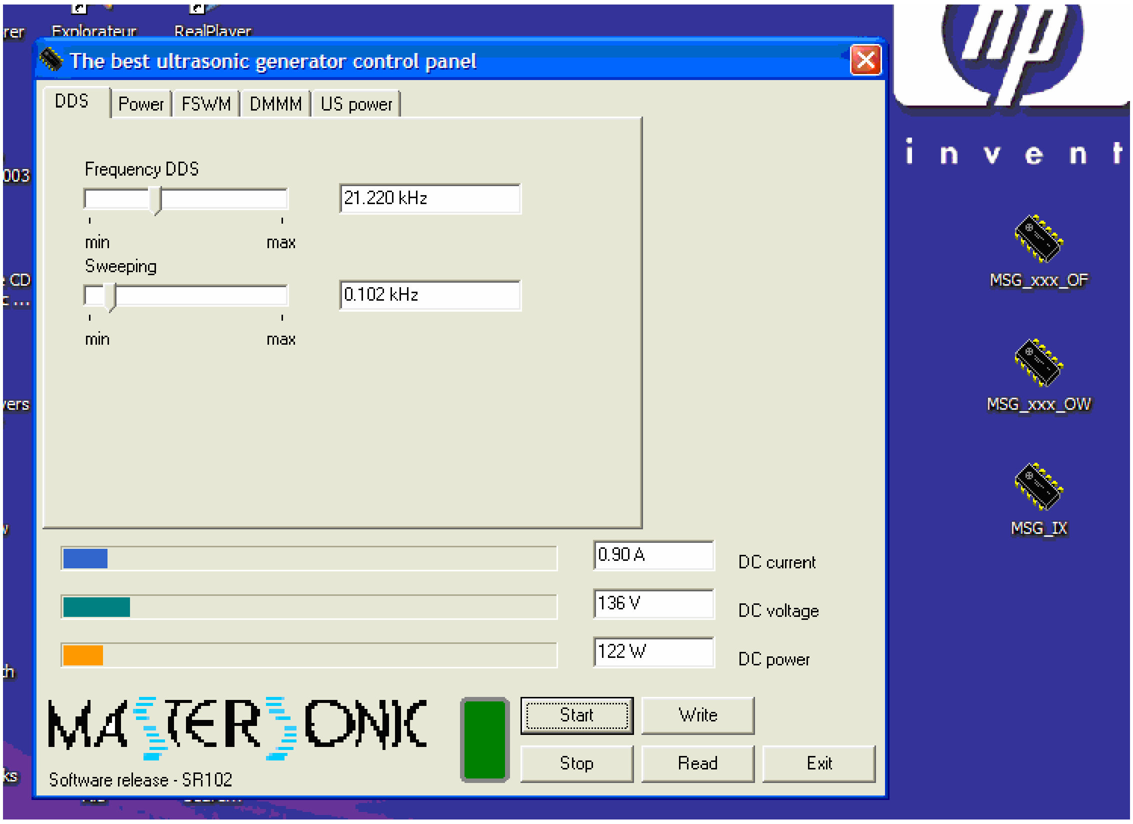
Frequency:

In case of your system always set the central operating "Frequency DDS" in the vicinity of 20 kHz (between 18.5 and 22 kHz; -for instance 21.220 kHz). Click on the Frequency DDS slide bar and set it to 21.220 kHz to start (numbers would change when you change elements of the mechanical system). Using your keyboard Left/Right Arrows or your mouse scroll wheel slowly change the frequency in 1 Hz steps to find the best central frequency point for every new test environment. Experiment until reaching the highest input power by noting the DC Power indicator in the lower right section of the PC control window. As you pass through the best central operating frequency the higher system efficiency is exhibited by improved DC Power delivery.

Sweeping:

Then set "Sweeping" to minimal value or to zero (for instance to less than 0.1 kHz). As above, find the best interval by slowly sweeping across this defined range. The Best setting is when the input system DC Power is maximized, providing that System is producing uniform and continuous sound, without whistling, impulsive, non-periodical and cracking noise.

Still do not activate the generator (do not click the Start button on the control panel). See the picture below.



Now open the third page tab "FSWM"

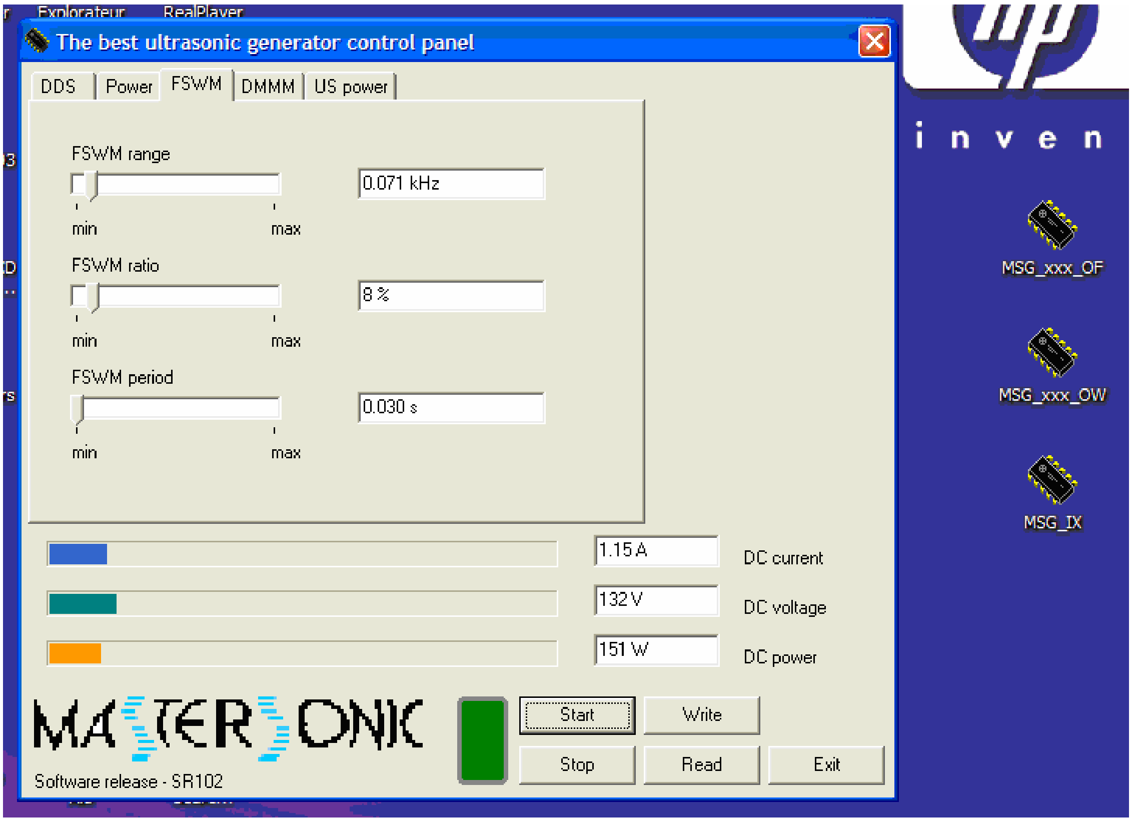
Make settings:

FSWM range:
Set the "FSWM range" to minimum or zero value (for instance to 0.070 kHz). Start with 0.000 kHz and later experiment by going higher until reaching maximal input DC Power, or best ultrasonic processing effects.

FSMW ratio:
Then set "FSWM ratio" between zero and 50% (for instance to 8%). Experiment with different values, until getting the highest input DC Power. Often the best value is 50%.

FSWM period:
Set between 0.010 s and 0.200 s. Start testing with 0.010 s and higher to reach the highest input DC Power (set, for instance to 0.030 s).

Still do not activate the generator (do not click the "Start" button on the control panel). See the picture below.



A good reference to understand the significance of the FSWM adjustments of range, ratio, and period are explained here:
http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/mmm-explanations/modulation_explanatoi.pdf

MMM technology is explained here:
http://mastersonic.com/documents/mmm_basics/general_info/mmm_basics_presentation.pdf

Now open the fourth page tab "DMMM"

Make settings:

Q factor:

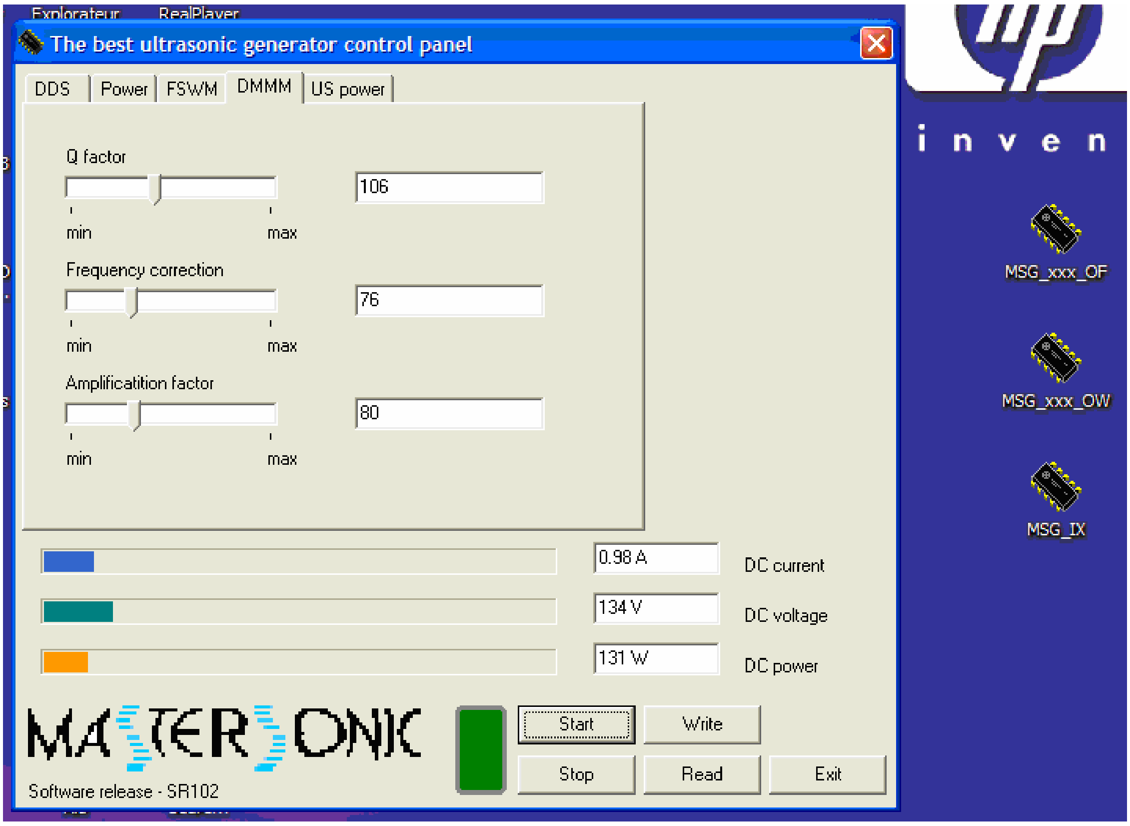
Set the "Q factor" between 100 and 200 (start with 30, and later go higher; -for instance 106). For processing low viscosity and low density liquids, Q-values should be higher. For processing high density and high viscosity liquids, Q-values should be lower. Experiment with different values, until getting the highest input DC Power.

Frequency correction:

Then set "Frequency correction" between 50 and 100 (for instance to 76). Experiment with different values, until getting the highest input DC Power.

Amplification factor:

Then set "Amplification factor" between 50 and 100 (for instance to 80). Start testing with 50 and later adjust until getting highest input DC Power and smooth, cold operation. See the picture below.



Single converter applications with relatively high mechanical quality factor of the oscillating system should have settings for Q-factor higher than 100, and also amplification factor in the first half of the total range. Frequency correction is related to the range of the total frequency modulation: If we would like to operate the system in a narrow frequency range (almost at constant frequency), frequency correction would be closer to the beginning of its interval. If we would like to increase the range/s of frequency modulation/s, frequency correction should be selected closer to maximum. Select the frequency correction by optimizing the mechanical output.

Now go again to the first page tab "DDS" and activate the generator clicking on the "Start" button.

Use the mouse and start fine-regulation of the central operating frequency (Frequency DDS) by trying to maximize the blue DC current and orange DC power indications.

Open one by one all software panel tabs and start slightly varying (or increasing) all setting values, again trying to maximize the blue DC current and orange DC power indications. Stop changing certain parameter when you achieve maximization of mentioned indications and when you are satisfied how your end-piece is oscillating in MMM ultrasonic regime.

Once DDS, DMMM, and FSWM settings are optimized you can increase gradually both, the US power and the input power in order to get more energy into the system.

Once the settings are optimized for the one stem, if you introduce mechanical parts of different size or geometry, then you need to repeat the entire sequence again since the different geometry (or horn) may have a different best operating frequency. Different sizes of mechanical parts would require certain changes to settings (all settings are very much unique and best determined by experimentation).

In every case, mentioned or not mentioned here, please be careful not to overpower or overload the system, because your generator and converter would be able to give much higher mechanical output than you would need.

Settings example (just to give an idea):

DDS:
Frequency = 21.830 kHz (will be different in every new case)
Sweeping = 0.079 kHz

Power:
Power = 20% to 60%. Start with 15%, and under loading increase until 60%
Max. Current = 2A
PWM period = 0.010 s
PWM ratio = 100%

FSWM:
FSWM range = 1.000 kHz
FSWM ratio = 50%
FSWM period = 0.010 s

DMMM:
Q factor = 100
Frequency correction = 84
Amplification factor = 38

US Power:
US power = 100