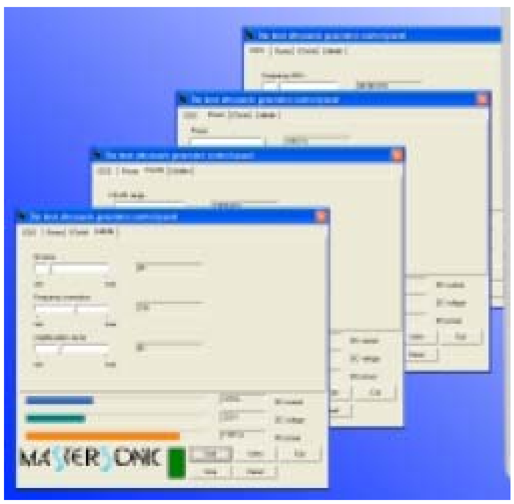
OF, MMM Power Supplies

Technical characteristics	**MSG.300.OF**	**MSG.600.OF**	**MSG.1200.OF**
Main Supply Voltage	220/230 V; 50/60 Hz	220/230 V; 50/60 Hz	220/230 V; 50/60 Hz
Max. Input Power	400 W	700 W	1300 W
Non-modulated, carrier frequency range	19.020kHz ч 46.728 kHz	19.020kHz ч 46.728 kHz	19.020kHz ч 46.728 kHz
Modulated acoustic frequency range	Wideband, from Hz to MHz	Wideband, from Hz to MHz	Wideband, from Hz to MHz
Average Continuous Output Power	300 W	600 W	1200 W
Peak Output (max. pulsed power)	1500 W	3000 W	6000 W
Output HF Voltage	~ 500 V-rms	~ 500 V-rms	~ 500 V-rms
Dimensions (h x w x d)	170x150x150mm	250x150x150mm	230 x 160 x 370
Weight	2 kg	3.6 kg	4 kg

MasterSonic open frame generator modules (OF series) are designed for internal mounting in the control cabinets of Ultrasonic Systems. Such cabinets should be very well ventilated, protecting the generator module from excessive dust, moisture, and harmful chemical agents. The installation and electrical connections of the generator should be performed by a qualified specialist in electronics who is experienced in Power Ultrasonics. MSG.XXX.OF is designed as a component part for integration into Ultrasonic systems. Therefore it is not equipped with a Power Supply ON/OFF switch or output HF connector. Make sure the Ultrasonic System you are assembling is provided with such switch and HF connector. Please read manuals for more information. If necessary, apply an additional EMC/EMI filter. Couple of the best applications for OF-series MMM generators are: Wideband Ultrasonic Cleaning and Sonochemistry Reactors.

ACCESSORIES, INTERFACES, REMOTE, PLC AND PC CONTROLL TOOLS FOR ALL MMM GENERATORS



Handheld Control Unit MSH-1 For manual control and settings

MMM-Link-2339 Adapter RS485 / RS232C+software
MMM-Link-2339_16 Option RS485 Link extender16 generator
MMM-Link-2339_64 Option RS485 Link extender16 generator
Interface cable

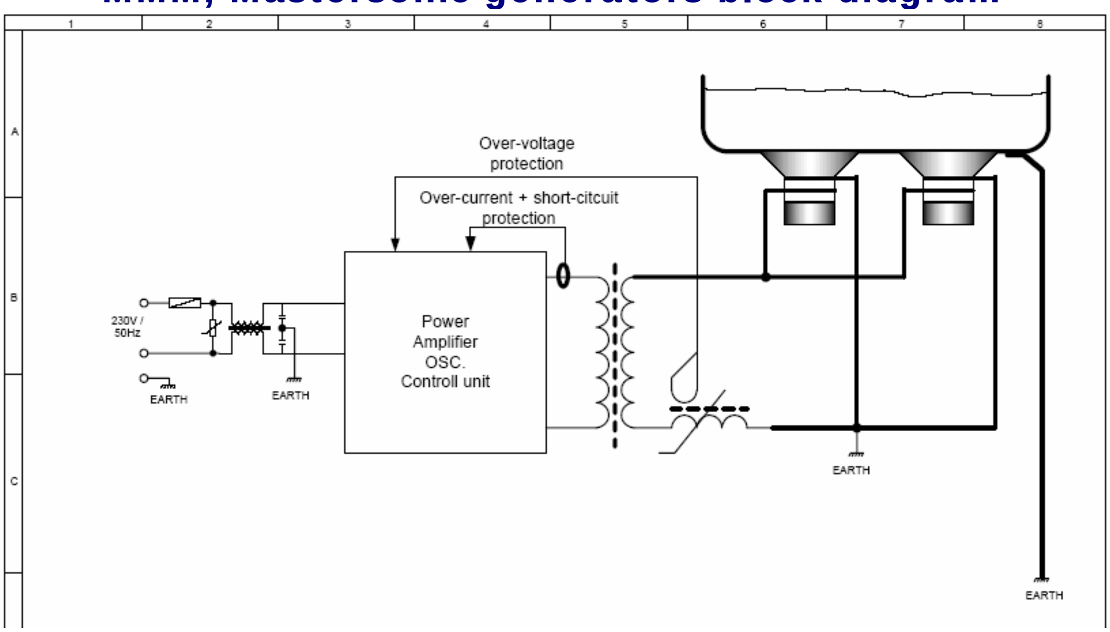
All Mastersonic, MMM generators can be controlled, being connected by RS485 link to a PC, using the software interface for enabling easy visual and multi-parameter control and settings.

Frequency and Sweeping Ranges of MMM Mastersonic Generators

Frequency range	OF	OW	IX
LF-range Resolution (Hz)	17.5 kHz to 28.5 kHz freq-step = 3-30 Hz	17.5 kHz to 28.5 kHz freq-step = 1 Hz	17.5 kHz to 28.5 kHz freq-step = 1 Hz
Standard MF-range Resolution (HZ)	19.020 kHz to 46.728 kHz freq-step = 3-30 Hz	21.5 kHz to 40.5 kHz freq-step = 1 Hz	19.020 kHz to 46.728 kHz freq-step = 1 Hz
HF-range Resolution (Hz)	24 kHz to 45 kHz freq-step = 3 - 30 Hz	24 kHz to 45 kHz freq-step = 1 Hz	24 kHz to 45 kHz freq-step = 1 Hz

LF = Low Frequency Range & fine resolution
MF = Middle Frequency Range = STANDARD = Present Situation
HF = High Frequency Range & fine frequency resolution

MMM, Mastersonic generators block diagram



Every incident overloading, over-voltage, short circuit and over-current on the load side will produce immediate generator STOP. This is realized by internal voltage and current measurements: Signal for any of overloading will stop the generator.

MMM generators Set-Up

Short Resume Valid For All MMM Generators And Important Preliminary Steps:

First, switch-ON the PC and place the generator software "MSG.XXX.OF" 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/s.

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_OF". 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 (Fast Sweeping = 0, Sweeping = 0).

2.) Set generator input/operating power to max. 30% (safe level for initial parameters setting and wideband testing), and then press start button on the software interface.

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 (it will be possible to detect/hear/measure increased amplitudes of ultrasonic waves).

4.) Adjust the inductive compensation by changing ferrite-coil air-gap 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 (Fast sweeping and Sweeping) 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 and generator (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, high mechanical and electrical shocking, and possibly damaging ultrasonic generator, converter and other mechanical parts). If the generator starts going to overload (over-current or over-voltage, or just stops), do not immediately restart the generator; -First you would need to reduce the generator power (30% or below), than slightly change the parameter/s which was/were the source of overloading. After that restart the generator and if necessary repeat adjustment steps from 1. to 6.

7.) Adjust (or readjust) the center operating frequency again to find the maximal load current and minimal phase-difference 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), during the generator and transducer are operating.

After introducing all initial settings as detailed below you may again press the software Start button and increase the power (slowly and not immediately to 100%). 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 (1. to 9.) for all parameters (slightly varying them within the specified ranges) until reaching the highest input DC Power level, and until maximizing the load current.

When you reach the maximal input power and load current, 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/cleaning 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.

Safety Notes:

- Before operating the system be sure to read the Generator Manual.
- The provided Generator is an Open Frame Module intended for integration into a suitable cabinet or enclosure for electrical safety.
- All electrical connections and operations should be performed only by a qualified technician

Settings of MSG.xxx.OF generators

POWER CONNECTIONS

Main Supply Input: 230 VAC, single phase.

For safety reasons recommendable to add grounding.

Open wires: Do not touch non-isolated wires when operating and connected to a main power supply

High Frequency Output Signal (to the converter). Central wire of the coaxial cable has to be connected to the high voltage, HF, middle terminal position.

Do not touch non isolated wires when operating and connected to a main supply.

If step-up and/or step-down autotransformer or isolated regular-transformer is used to create 230 VAC, please apply minimum 3 kW transformer (5 times more than nominal generator power). The best is to have original 230 VAC from the power distribution lines (in that case generator is taking only its nominal power).

Main Supply Input: 230 VAC, single phase.

For safety reasons recommendable to add grounding.

Open wires: Do not touch non-isolated wires when operating and connected to a main power supply

High Frequency Output Signal (to the converter), HF: Central wire of the coaxial cable has to be connected to the high voltage, HF, middle terminal position. HV terminal of the converter/s is the terminal that is electrically isolated from any converter mass (by piezoceramics, presenting very high "Mega-Ohm" resistance). Do not connect any ground to HF. Connect low voltage (LF) only with grounding wire/s. By mixing LF and HF connecting points (wrong load connections) will cause the generator to fail.

MMM open frame generators are made to be low-priced, to have number of options and to be installed in protected cabinets, by companies that are already in ultrasonic business. This is the reason why every open-frame generator-case has holes for installing standard power connectors and switches (which should be installed by the client). In case of heavy-duty and very long or continuous operating regimes, the client is responsible to apply additional forced air-cooling.

CONNECTING LOW SIGNAL CONTROLLS

Manual controls: Handheld Control Unit MSH-1	PC controls: PC, RS-485 interface MSA2339 and control software: msg_xxx_of.exe
	

Both control options are producing the same results, but PC controls are much more user-friendly and comfortable, with all parameters visible and accessible at the same screen. Once settings are made and saved (by any control device) MSH-1 or MSA-2339 can be disconnected and generator will continue operating with the last settings.

MMM Generators OF-Series Set-Up Procedure

Download the control software "msg_xxx_of.exe" from here:
http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-of-generators/latest/msg_xxx_of.exe

OF generators manual is here (read carefully):
http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-of-generators/latest/msg_600_v6.pdf (see in the same location if new, updated documentation is available. Updates are being made monthly).

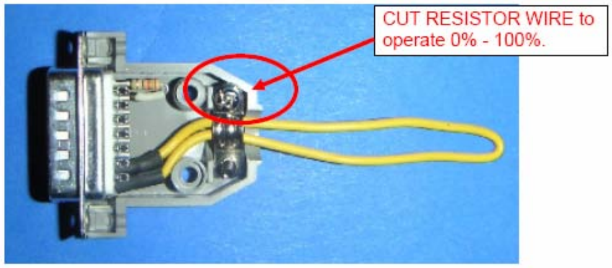
1.) Set all sweeping parameters to 0 (both fast sweeping and sweeping). This will enable generator to operate on constant frequency.

2.) Set the operating power to 30% (safe level for initial parameters setting).

a. IMPORTANT NOTE: All new generators have a safety level resistor installed on the provided Remote Control Connector. The provided connector has two functions:

i. A factory installed resistor inside or outside of this connector is used to keep the initial set-up power level to 30%. After initial set-up this resistor and power limitation should be disabled by opening the connector housing and cutting one or both resistor leads. After removing the resistor load power can be regulated from 0% to 100%. If the resistor is not removed power will always stay limited to 30% (no regulation possible).

ii. A factory installed



wire (on this pictures yellow and red colors) between pins 1 and 2 is acting as a short circuit for the systems external sensor protection option. To operate the generator this short circuit must be in place through the provided wire or through sensors that are normally closed. An open circuit will stop generator operation.

3.) Adjust the **Operating 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 tank should be maximized. If installed piezoelectric ultrasonic transducers are designed to operate on 20 or 28, 40 kHz or some other resonant frequency, MMM generator **Operating Frequency** should also be selected in the same frequency range. For instance, for driving 28 kHz ultrasonic cleaning converters select the **Operating Frequency** of MMM generator between 27.5 and 28.5 kHz (usually less than 28 kHz, because loaded ultrasonic converters are reducing their resonant frequency compared to what is measured with air-load). Of course, make best choice of inductive compensation that would maximize the operations on selected **Operating Frequency**. Selecting the Operating Frequency that is much different than known resonant frequency of ultrasonic converter/s would either damage converters and/or generator, or produce high thermal dissipation. During testing of unknown ultrasonic transducers, reduce the power to 20 or 30% in order to avoid mentioned problems with thermal dissipation, until you find the best natural resonant frequency. Generator and transducers operating in best natural-resonance conditions are producing low thermal losses.

4.) Adjust the inductive compensation in order to get higher load current and maximal acoustic activity in the tank. (After final adjustment the internal inductive compensating ferrite gap may be fixed with a silicone spacer.). **All new MMM generators are delivered without an air-gap in the adjustable ferrite core to minimize a risk of ferrite braking during transport.** If ferrite gap is zero, the inductive compensation has maximal value and most probably that in such conditions your generator will operate giving very low ultrasonic power to its load. Slowly start adjusting/opening ferrite gap and find the optimal inductive compensation for your piezoelectric load. This will maximize ultrasonic output.

5.) Now start experimenting with sweeping controls and set the **Fast Sweeping** adjustment somewhere between minimum and maximum setting of 255. The best fast sweeping position is when you rich either maximal load current or best ultrasonic efficiency, or optimal acoustical spectral content (depending on what in certain conditions is considered as preferable). Fast sweeping is carrier frequency sweeping that is ultrasonic-load dependent. Generally valid is that by enlarging **Fast Sweeping**, ultrasonic load-power would increase or stay stable until certain sweeping-interval threshold, and by continuing increasing the sweeping, ultrasonic load power would gradually decrease. In the same time ultrasonic spectrum in ultrasonic load would become more and more wideband with lot of frequency harmonics and sub-harmonics. Sweeping increase will also make that all ultrasonic transducers presenting ultrasonic load (operating in parallel) would be equally-well driven, regardless if all of them could be mutually very different (good to avoid selection problems in assembling).

6.) Set the **Sweeping** adjustment to level between 2 and 7. The best **Sweeping** position is when you rich either maximal load current or best ultrasonic efficiency, or optimal acoustical spectral content (depending on what in certain conditions is considered as preferable). **Sweeping** is realized as the special MMM, randomized sweeping signal generator, which is randomly and independently changing the carrier frequency, making impossible creation of any standing waves structure. Generally valid is that by enlarging **Sweeping**, ultrasonic load-power would increase or stay stable until certain sweeping-interval-threshold, and by continuing increasing the sweeping ultrasonic load power would gradually decrease. In the same time ultrasonic spectrum in ultrasonic load would become more and more wideband having lot of frequency harmonics and sub-harmonics. Sweeping increase will also make that all ultrasonic transducers presenting ultrasonic load (operating in parallel) would be equally-well driven, regardless if all of them could be mutually very different (good to avoid selection and coupling problems before assembling).

7.) Increase the power until smooth and continuous oscillations are present. If the ultrasonic tank starts producing cracking and sharp noise, stop increasing the power. Always set 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 and generator. Entering into a regime of non-linear and clipping oscillations is not producing better cleaning effects (it is producing only very high noise level, high thermal losses and possibly damaging generator, tank and transducers).

8.) Adjust the operating frequency again to find the maximum load current and minimum phase pint, or to get your preferable acoustic-efficiency result.

9.) Repeat all setting steps 1 through 8 above to find better operating conditions. Do not forget to remove power limiting resistor from the Remote Control Connector.

10.) Additional fine tuning, to get better ultrasonic activity may be made by re-adjusting all sweeping intervals while keeping the same, previously found, operating frequency. For example set Fast Sweeping to 0 and Sweeping to 7, or Fast Sweeping to 100 and Sweeping to 3 or 4 (this is sometimes producing very good results in case of ultrasonic cleaning of fine and sensitive parts in optics, microelectronics and micromechanics). Parameter settings and cavitation effectiveness may be verified by comparison of treated aluminum foil samples. Submerse strips of 3 micrometer thick and soft aluminum foil (kitchen foil) into the bath for fixed periods (e.g. 20 seconds) under various parameter settings. Compare the aluminum foil perforations, holes, and indentations. Uniform pin holes and indentations show good distribution of cavitation.

11.) Newly assembled cleaning tanks should be put in operation for several hours (or much longer) at 50% power to mechanically stabilize the internal structure of transducers. This will improve long-term transducer operation. Later, operating on 100% power would be risk-free and very efficient.

12.) To optimize the system operation be sure to fill the tank with water to about two thirds of its volume (or a little bit more) and keep this level. MMM wideband ultrasonic activity and homogenous 3-D power distribution will not be optimized if the water level is low.

The Power level is given in percentage units (%) from 0% to 100% of the installed load power. For example:

- If the total installed transducer power is only 120 W (3 transducers, each 40 W) and the generator is capable of producing a maximum of 300 W, by setting the generator power to 50% we will not get more than 60 W of ultrasonic power output (not 150 W).

- If we install a transducer group that is able to draw 300 W, and if we are using the generator that is capable of delivering 300 W, by setting the power to 50% we will produce approximately 150 W of ultrasonic power output.

The described power control is only rough load power estimation under optimal loading conditions. The load power is also dependent on liquid temperature, transducers temperature, liquid density and viscosity, relevant electric and mechanical impedances etc. When we are talking about power levels and regulation, usually only water loading is taken into account.

Pay attention to the fact that ultrasonic efficiency and visible waving effects will be maximized if cleaning liquid (or water) is previously degassed. Starting a cleaning tank filed with cold and non degassed water will produce low acoustic activity during first several minutes of operation, and later, after degassing (which is happening in the process of ultrasonic water agitation), ultrasonic activity and efficiency would increase significantly. Frequency and PWM Modulated MMM generator will finish liquid degassing and conditioning much faster than any fixed frequency ultrasonic agitation. In the process of degassing ultrasonic power will continuously grow until degassing is completed and will stay constant if the water temperature and water level is constant. Increasing water temperature to an optimum point will also increase cleaning effects. Temperatures above the optimum point will start to diminish the cleaning effects.

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

Never overheat transducers. 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.

POWER CONTROL OF MMM GENERATORS USING EXTERNAL PLC

1. **When using the PLC voltage output (for MMM generator, power control), the changes of the output voltage between 0 and 3V will cause changes in the generator power from 0 to 100%. Note: Voltage above 3V will initiate generator's digital assignment for switching ON. (see Fig.1)**

2. **When using the PLC current output (from 4 to 20 mA) there must be a 150 Ohm resistor connected between terminals 5 and 6. The power will vary from 20% to 100% (see Fig. 2). Note: If the resistor of 150 Ohm is missing it may cause failure in the analogue input regarding the current signal.**

3. **We have an option for RS458 network. It is an adapter, which can be connected to RS485 connector and allows connecting up to 16 MMM generators in the same network. We also have an adapter for a network of up to 64 generators. These two options are available for the new MSG.XXX.OW generators.**

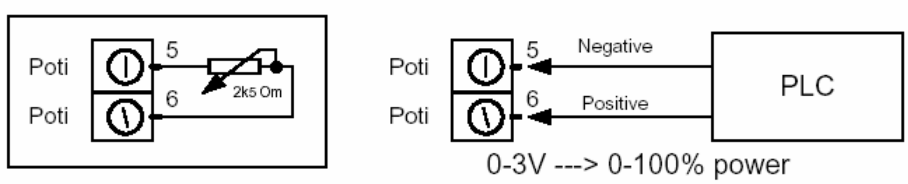


FIG 1

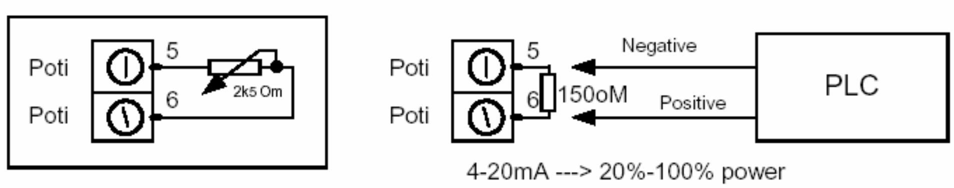


FIG 2

2.3.1. External On/Off Power Control:

External ON/OFF control of the generator is possible through connection of terminals 3,11,4,12 as shown in figure 2.3.1. below. The generator is switched ON or OFF by relay or circuit control between terminals 3 and 4. When the terminals are closed the generator is switched on and when the terminals are open, the generator is switched off.

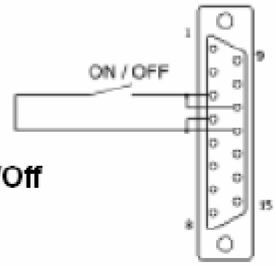


Fig. 2.3.1.a External On/Off Power Control

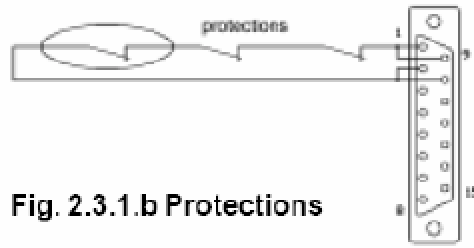


Fig. 2.3.1.b Protections

NOTE: Terminals 3-11 and 4-12 are internaly connected.
NOTE: If the generator has been switched off because of activation of some internal blocking or external protection the terminals remain closed. Next starting of the machine should be done by opening and closing the terminals again.

The MSG.X00.OW generators are equipped with external protection circuit. Different ON/OFF sensor can be connected in that circuit, as shown in fig. 2.3.1b. The sensors can control temperature, level, etc. The protection of the MSG.X00.OF power devices from overheating is serial connected in that circuit.

NOTE: Terminals on pins 1,9 and 2,10 are protection inputs and they should be connected through short circuit enabling the generator to operate. If this circuit is open, the generator will stop operating.

2.3.2. Analog Input Power Control:

The power of the generator can be controlled in the following three ways:

- The power can be set during the parameter setting of the generator.
- The power can be set through the RS 485 serial interface by the changing power command of the Remote Control Panel or PLC.
- The power can be set through the analog input - terminals 7-14 and 8-12. When a 2.5 k-Ohm potentiometer is connected to terminals 7 and 8, as shown on picture 2.3.2., the power is set from 0 to 100%.

NOTE: Terminals 7-14 and 8-12 are internaly connected.

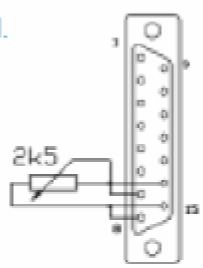


Fig. 2.3.2. Analog Input Power Control

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.

Selected center frequency, in case if the mechanical configuration <u>transducer + sonotrode + Load</u> 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 (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 ultrasonic load, 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 (if the ultrasonic load and transducers are known to MPI) and should not be changed unless different mechanical system or transducer 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 have in mind that such variations should be insignificant or very small).

Here we are adjusting inductive compensation: Do not keep ferrite core without air gap.	

Inductor Gap Fixation Installation Note

for OF and OW series

Following final system adjustment and optimization of all operational parameter including adjustment of the inductive compensation the following steps will help ensure continued stable operation of the adjustable inductance.

ATTENTION: All ultrasonic equipment installation procedures should be undertaken only by a qualified electrical technician. The following described work is normally performed by MPI as part of its quoted installation services. OEM clients, Systems Integrators or End-User clients performing their own installations without MPI' services are liable for any system damage or improper adjustments.

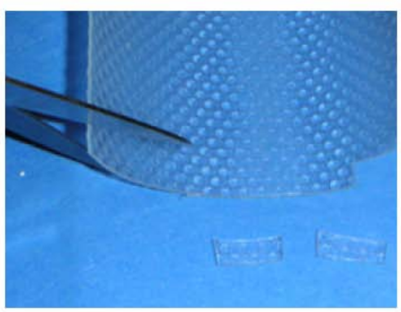
After optimized adjustments and continued operation for some days the internal inductive compensating ferrite gap should be rechecked for optimum setting and fixed to prevent accidental shifting. A silicone spacer and liquid silicon may be used to fix the gap. The following steps may be used:

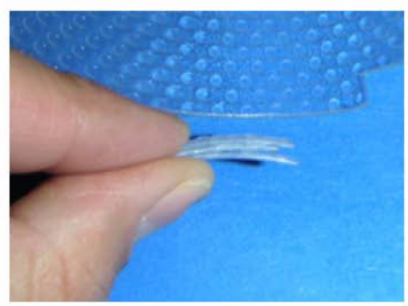
1.) Stop all generator operations, disconnect from the mains power source, and disconnect the transducer load.

2.) Remove the top 4 screws holding the side panel with the mains power and HF transducer connectors.

3.) Carefully pull away the panel to view the adjustable inductor.

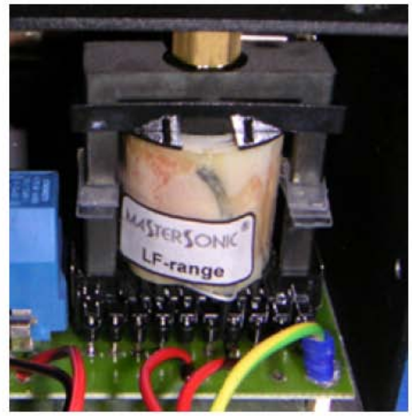
4.) The gap between the ferrite core can be filled with small strips of silicon cut from a sheet and stacked to a suitable thickness.





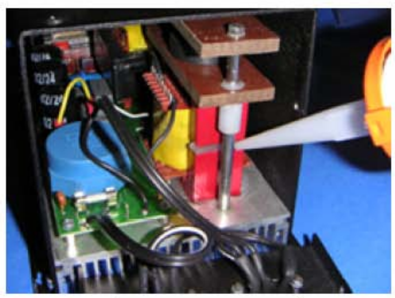
5.) Place the silicon spacers between the ferrite core gap.

MSG.600.OX

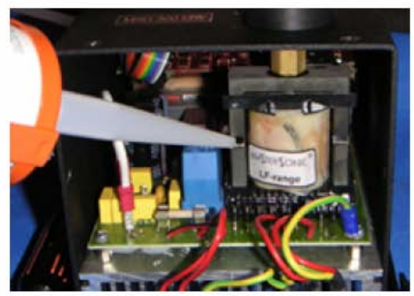


MSG.300.OX

6.) Fix the gap and spaces with liquid silicon.



MSG.600.OX

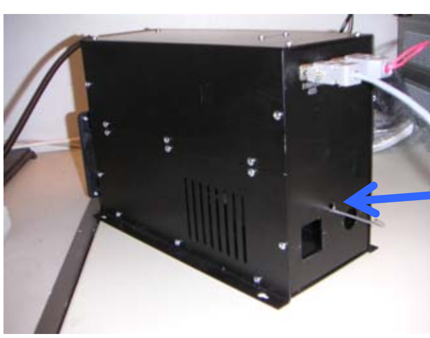


MSG.300.OX

7.) Reassemble the side panel and electrical connections.

8.) Allow the silicon to dry overnight before continued operation.

9.) The ferrite cores should not be left in a free hanging state with empty air gaps, as well as not blocked in the zero or no-gap state.



Adjust the inductive compensation here. Be careful by introducing the adjusting key inside of the generator. This adjustment should be made only by experienced person (not by end user or a client).

MSG.1200.OF

Example of step-by-step settings of cleaning submersible transducers array (40 kHz rectangular transducer box)

Activate the interface software and remove all sweeping and modulating parameters as for instance:

- 1 -

-Frequency: 41.568 kHz (find the best one valid in your specific case)

-Power: Start with 30%, and later you could go to 100% after optimal settings are found experimentally

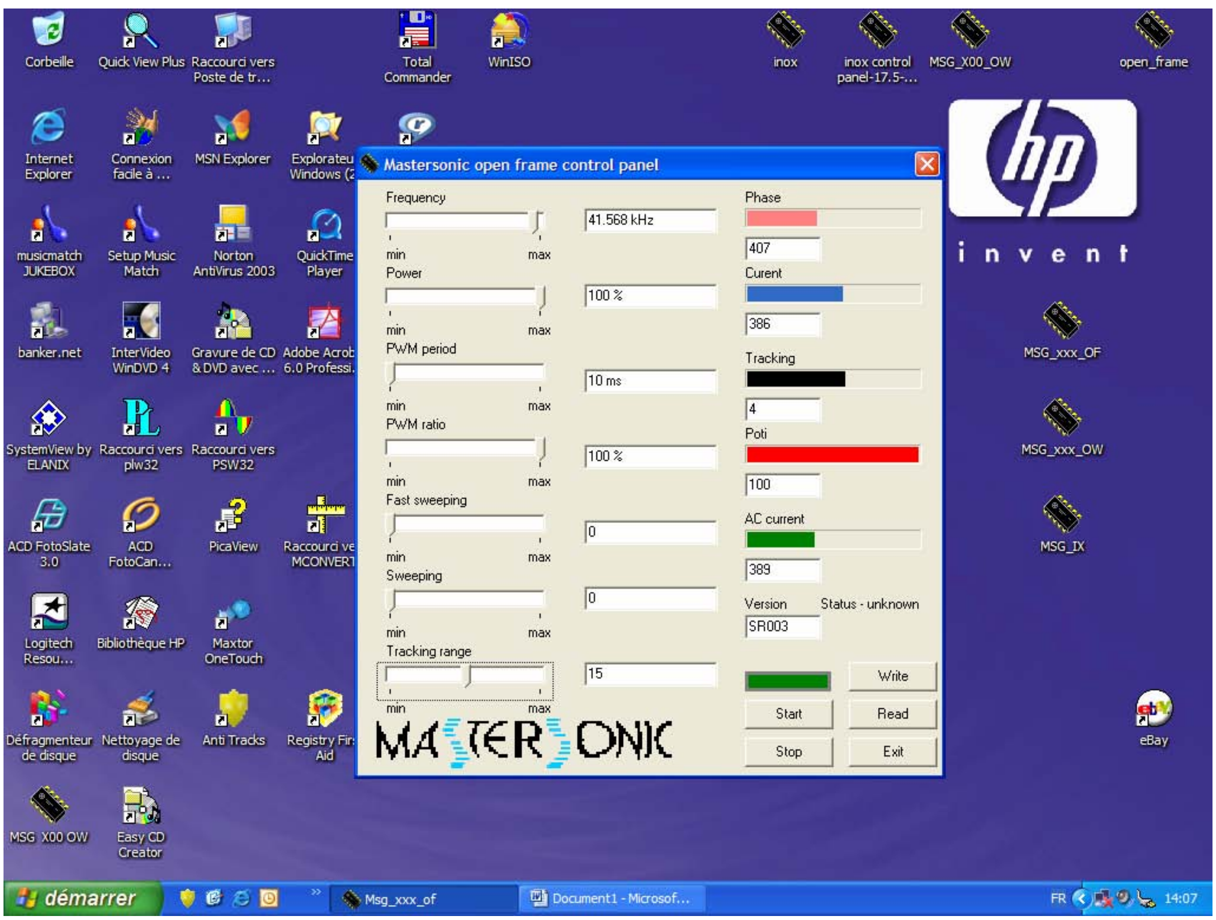
-PWM period: Set on minimum (10 ms).

-PWM Ratio: 100%

-Fast sweeping: 0

-Sweeping: 0

-Tracking range: 15



- 2 -

-Frequency: Keep the same frequency, 41.568 kHz.

-Power: Keep 30%, and later you could go to 100% after optimal settings are found experimentally.

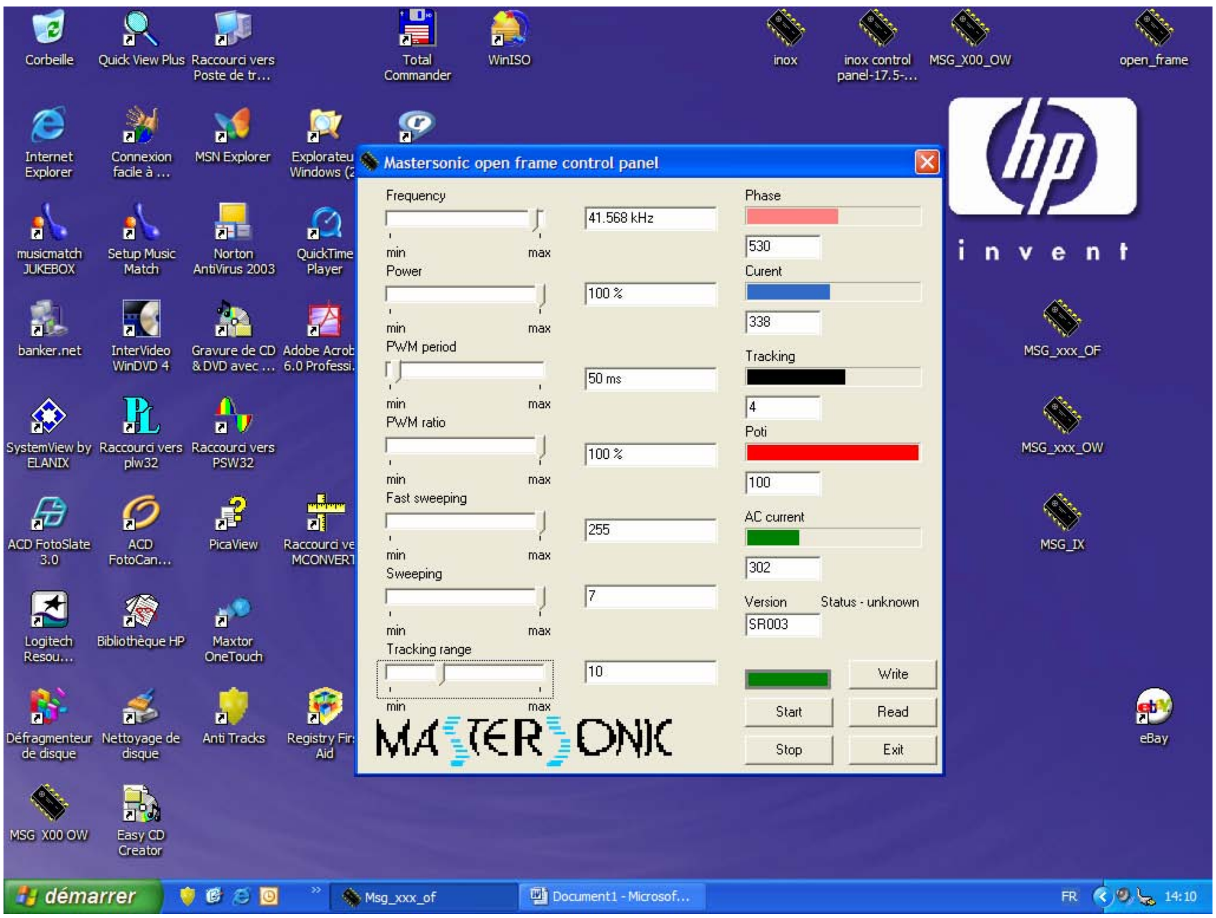
-PWM period: Set on minimum (10 ms), and later go to 50 ms.

-PWM Ratio: Keep 100%, and later you could reduce it.

-Fast sweeping: 255 (monitor ultrasonic activity and find your optimum).

-Sweeping: 7 (monitor ultrasonic activity and find your optimum).

-Tracking range: Keep 15 (monitor ultrasonic activity and find your optimum).



-Frequency: Keep the same frequency, 41.568 kHz, or find the best one valid in your specific case.

-Power: Keep 30%, and later you could go to 100% after optimal settings are found experimentally.

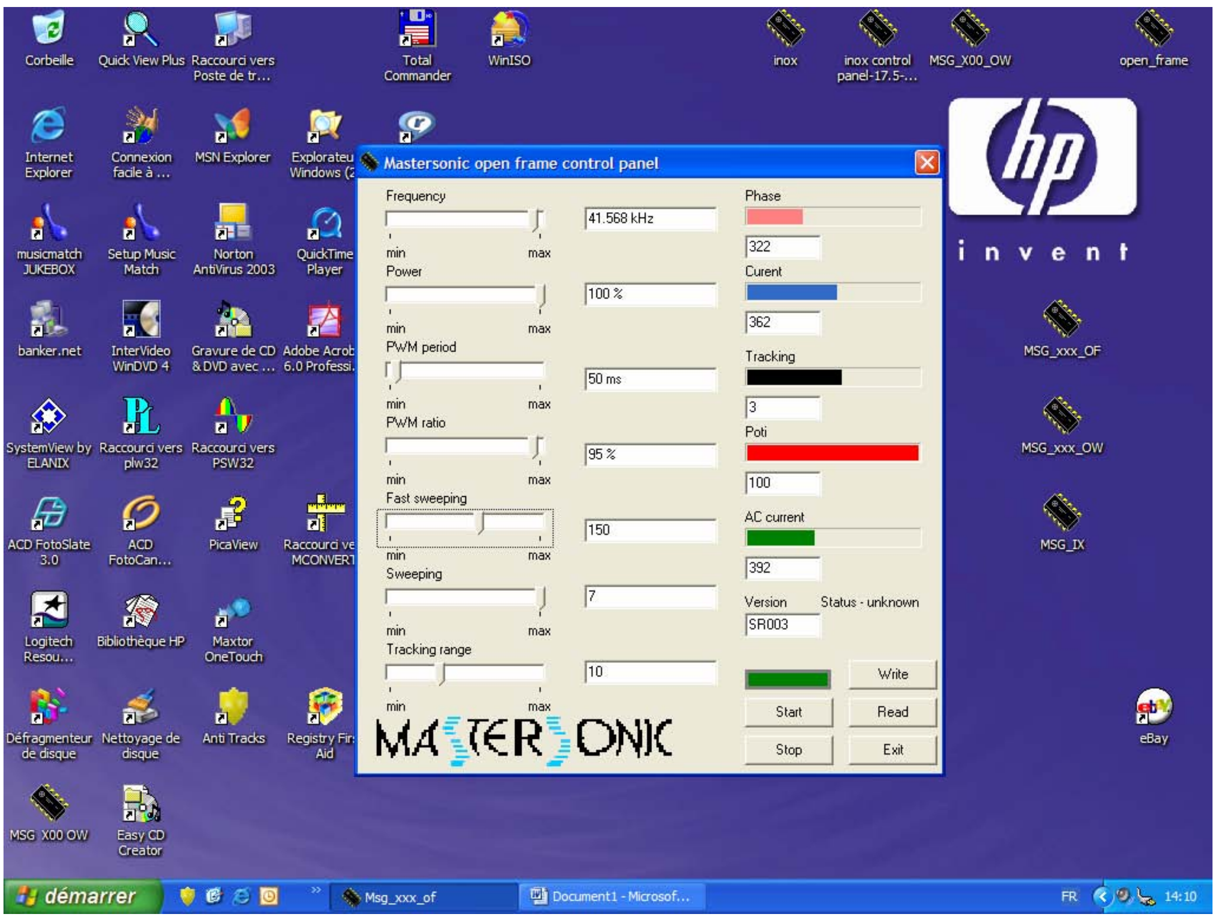
-PWM period: Set on minimum (10 ms), and later go to 50 ms.

-PWM Ratio: Keep 100%, and later you could reduce it.

-Fast sweeping: 255 (monitor ultrasonic activity and find your optimum).

-Sweeping: 7 (monitor ultrasonic activity and find your optimum).

-Tracking range: Keep 15 (monitor ultrasonic activity and find your optimum).



-Frequency: Find the best one valid in your specific case (usually not too far from the initially found one).

-Power: Go to 100% after optimal settings are found experimentally.

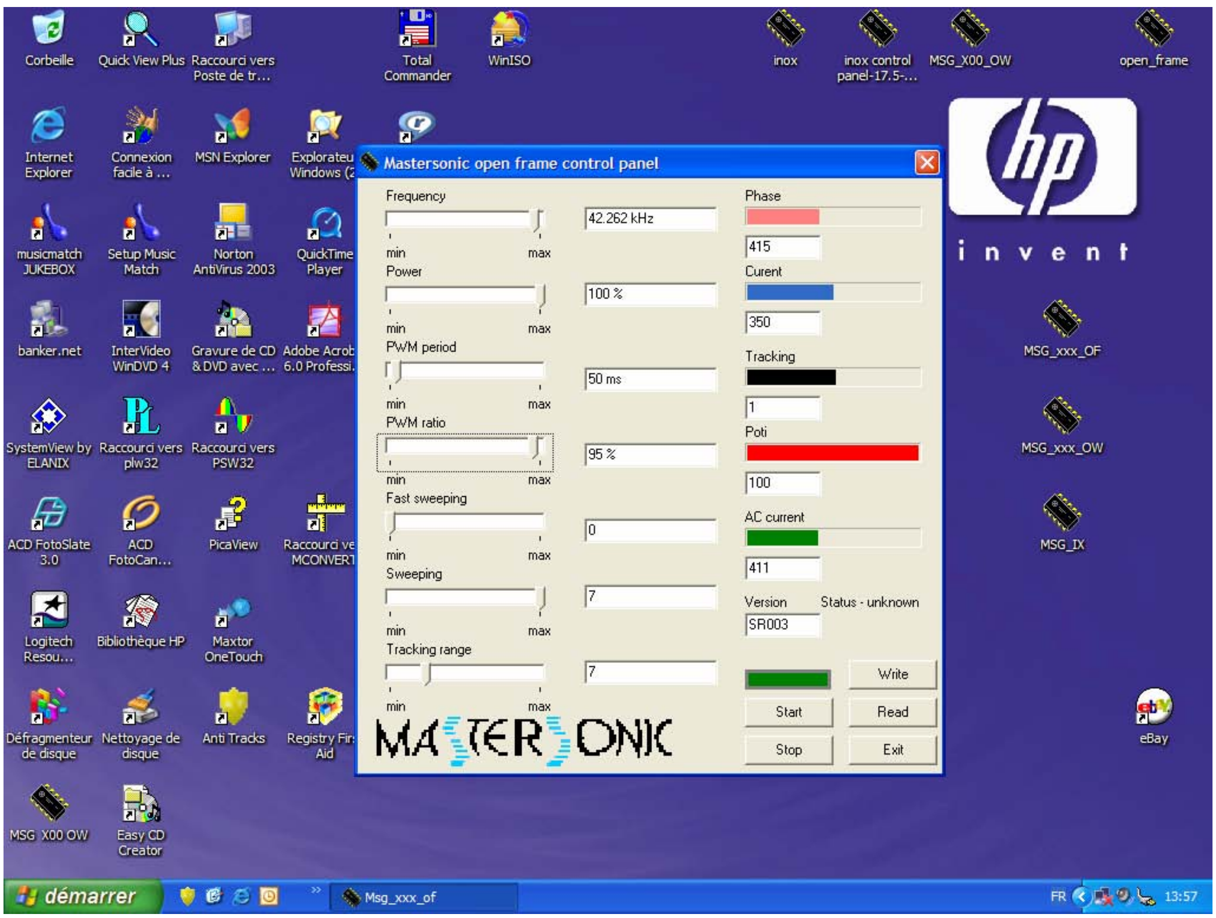
-PWM period: Set on 50 ms.

-PWM Ratio: Try with 95%, and later you could reduce it.

-Fast sweeping: Try with 0 (monitor ultrasonic activity and find your optimum).

-Sweeping: 7 (monitor ultrasonic activity and find your optimum).

-Tracking range: Reduce to 7 (monitor ultrasonic activity and find your optimum).



-Frequency: Find the best one valid in your specific case.

-Power: 100%, after optimal settings are found experimentally.

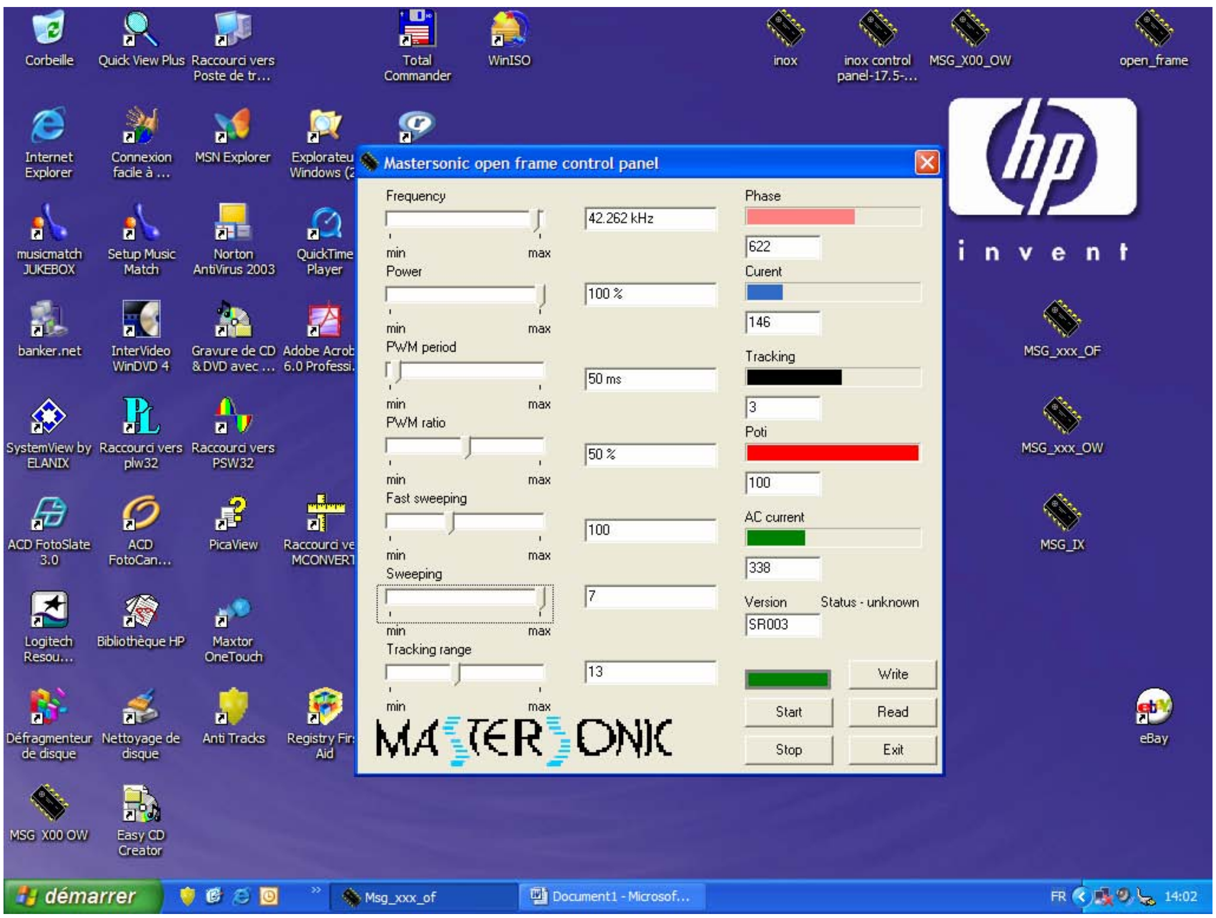
-PWM period: Set on 50 ms.

-PWM Ratio: Try with 50%.

-Fast sweeping: Try with 100 (monitor ultrasonic activity and find your optimum).

-Sweeping: 7 (monitor ultrasonic activity and find your optimum).

-Tracking range: 13 (monitor ultrasonic activity and find your optimum).



Wideband and High-Frequency Regimes Good for Microelectronic and Optical Components Cleaning

-Frequency: Find the best one valid in your specific case.

-Power: 100%, after optimal settings are found experimentally. Reduce the power (as much as necessary) in order to reduce ultrasonic intensity and destructive effects of cavitation.

-PWM period: Set between 30 and 100 ms (for instance on 50 ms). Find the best conditions for every specific cleaning case.

-PWM Ratio: Try between 50% and 95% and find the best one. Decreasing the PWM Ratio would decrease ultrasonic power and increase spectral content of ultrasonic activity (this will make acoustic spectrum larger and produce many frequency harmonics).

-Fast sweeping: Try with 100 to 150 (monitor ultrasonic activity and find your optimum). In some cases select maximum depending on cleaning results. Also in some cases, select Fast Sweeping to be closer to zero.

-Sweeping: Select maximum 7. This will produce largest acoustic spectrum and eliminate creation of standing waves. Larger sweeping is usually reducing delivered ultrasonic power.

-Tracking range: 0. Monitor ultrasonic activity and find your efficiency-optimum, which is usually close to minimum for obtaining wideband and high frequency cleaning effects.

OF - Generator example settings for a small cleaning tank with 40 kHz transducers (not applicable to transducers with other resonant frequencies)

- **Frequency = 39.007 kHz (find the optimal frequency valid for your case)**
- **Power: between 50% and 100% (100% 0nly if the tank is full with water)**
- **PWM period = minimum = 10 ms.**
- **PWM ratio = maximum = 100%**
- **Fast sweeping = 12**
- **Sweeping = 4**
- **Tracking range = 15**

Operating Regimes good for lower frequency submersible cleaning transducers (between 22 and 28 kHz) example:

- **Frequency = 26.041 kHz or between 25 and 27 kHz (find the optimal frequency valid for your case, between 22 and 28 kHz)**
- **Power: between 50% and 100% (100% only if the tank is full with water, and after all settings procedure steps are properly made)**
- **PWM period = between 10 ms and 100 ms. For ultrasonic cleaning 50 ms or 100 ms are often producing good results.**
- **PWM ratio = between 80% and 100% (or better between 90% and 95%).**
- **Fast sweeping = Try first without fast sweeping (=0). Then, if results are OK, set it between 10 and 100 (better 100 for ultrasonic cleaning)**
- **Sweeping = 3 or 4 (Try maximal sweeping level 7, since sometimes higher values are also producing good results, if this is not forcing generator to go to overload or to unstable regime).**
- **Tracking range = 15 +/- 10 (find the best one which is maximizing acoustic activity). If sweeping is set to maximal value 7, than tracking could be set to 0. Experiment and find the best value. Often tracking between 0 and 15 is very good.**

Questions and Answers
Communications with Clients

- My customer has 3 units of 150W (Average Power) 36KHz tubular transducers installed in a cleaning tank. They are all powered individually by 3 generators of 150W each.
  - Can I use a single 600W (Average Power) Mastersonic generator to drive all 3 transducers together since MMM technology can detect the best resonant operating point for the whole system?
  - Will the impedance matching be complicated in this case to allow the transducers be driven parallel?

  DRIVING 2 OR MORE, PHISICALLY OR MECHANICALLY SEPARATED TRANSDUCERS OR TRANSDUCERS' ARRAYS IS NOT RECOMMENDABLE FOR ANY ULTRASONIC GENERATOR BECAUSE OF PROBLEMS RELATED TO ACOUSTIC AND IMPEDANCE-COUPLINGS (and power distribution) BETWEEN SEPARATE TRANSDUCERS. THERE IS MUCH LONGER AND BETTER EXPLANATION, BUT BRIEFLY, THE ANSWER IS: TRY TO AVOID SUCH SITUATIONS. WE CANNOT GO AGAINST PHYSICS AND ACOUSTICS, AND IN ORDER TO MAKE SOMETHING LIKE WHAT YOU

ARE PROPOSING OPERTATING WELL, WE WOULD NEED TO COMPLICATE DESIGN A LOT.

- I have an existing 1000W (Average Power) 35KHz transducer box. We are considering getting one generator to demonstrate and sell this new generation technology to our customers.
    - o As you don't have a 1000W OF generator, can I get the 1200W OF generator to drive the transducer?

    YOU CAN APPLY 1200 W GENERATOR TO DRIVE ALL CLEANING TRANSDUCERS FROM 300 TO 1200 WATTS. IN CASES OF CLEANING BIGGER AND VERY DIRTY SOLID PARTS, IT WOULD BE BETTER TO APPLY TRANSDUCER BOX THAT HAS TRANSDUCERS IN A LOWER FREQUENCY RANGE (25 TO 30 KHZ). IF YOU WOULD LIKE TO CLEAN SENSOTIVE MICROELECTRONICS PARTS, IT IS BETTER TO USE 40 KHZ TRANSDUCER BOX AND TO MAKE RELATIVELY LARGE FREQUENCY MODULATIONS IN ORDER TO GET LOT OF HIGH FREQUENCY HARMONICS.

You are mentioning that the MMM technology can be used in MHz cleaning, please explain to me further about this possibility. In order to apply the MMM system for MHz cleaning, what should be the carrier frequency used?

The carrier frequency of present MMM generators could be 28 or 40 kHz (or any fixed frequency between 18 and 45 kHz, related to the resonant frequency of applied cleaning transducers). After applying number of MMM signal modulations on such fixed-frequency carrier signal, the acoustically measured, resulting frequency-spectrum in water would be wide-band with multifrequency components (lot of harmonics and sub-harmonics). To understand this it would be necessary to learn some signal processing methods from Fourier signal analysis. As the result of wideband MMM ultrasonic-signal modulations you would have many acoustic frequencies between low and MHz range. This is even better (for Cleaning and Sonochemistry) than just MHz fixed frequency.

In conclusion, we can say that MMM ultrasonic generators cannot produce fixed-frequency operating signal in an extremely wide band. High frequency effects are realized dominantly as a part of a wideband ultrasonic spectrum: All frequencies are present at once, is the closest formulation of the MMM concept. We could say that MMM generator would operate on a similar way as a fixed frequency generator, but its acoustic and ultrasonic results (on its load) would have a wideband spectrum (realized by number of carrier-frequency-signal modulations).

All present MMM generators are producing carrier, operating frequency between 18 and 45 kHz (usually covering 3 frequency ranges: LF, MF and HF). In the same time, we can apply different signal and frequency modulations. This way we are producing mixture of different signal harmonics (in an acoustic load), and some of them have very high frequencies. We cannot control and produce only MHz signals.

If we really like to have single and fixed frequency operation using MMM generator, this would be possible only between 18 kHz and 45 kHz. By applying number of signal modulations, fixed frequency ultrasonic signal is transformed into a signal that has wideband spectrum, with many signal harmonics present in such complex signal. It would not be possible to extract and stimulate

operations only at: 100 KHz or 300 KHz, 500 KHz, 700 KHz, 1 MHZ etc. (but all of them, mixed with continuum of other frequencies, would be there with certain intensity, as much as the acoustic nature of the mechanical system of certain acoustic load would allow it to happen). Such mixed-signals ultrasonic activity is enormously efficient regarding cleaning and Sonochemistry-related effects since it is producing effects similar to wideband "white-acoustic-noise" activity with rich presence of cavitation bubbles from very small to very large. Using MMM signal modulations it would also be possible to stimulate only effects with higher frequency spectrum, or to stimulate mostly part of a lower frequency spectrum, but again results will be in the form of frequency-wideband acoustic emission.

Read here much more about the MMM concept:
http://mastersonic.com/documents/mmm_basics_presentation.pdf

To get a visual feeling about MMM wideband activity, download and open the files from here:
http://mastersonic.com/documents/mmm_applications/mmm_cleaning/mmm_cleaning_basics/foil_perforation_test/

I have a question about the MMM system block diagram. You mentioned in the MMM_basics document that a MMM system comprises of:

1) Ultrasonic Power Supply
2) Ultrasonic Converter
3) Acoustical Waveguide
4) Acoustical Load

Correct in general, but in some cases you do not see well where the waveguide is. For educational purposes, it is good to mention waveguide, but in reality, we could work without it (in some specific cases, it is important to have it…).