MASTERSONIC®

MASTERSONIC

MSG-12000-SP

ULTRASONIC GENERATOR

SYSTEM OPERATION MANUAL

issue 2003

CONTENTS

Dear Customer,

The **MASTERSONIC** program represents a brand new approach in **Sonic and Ultrasonic power supplies and equipmen**t.

The **MASTERSONIC power supply equipment** is based on **MMM** Technology, which produces high efficiency active power in wide-band sonic and ultrasonic vibrations. Wide-band sonic and ultrasonic energy (ranging in frequency from infrasonic up to the MHz domain) propagates through arbitrary shaped solid structures, heavy and very-thick-walls metal containers, pressurized reservoirs, very thick metal walls of autoclaves, etc. in many different mechanical structures and in liquids, such as ultrasonic cleaning systems. The secret to its application is a novel sonic / ultrasonic, multi-frequency power supply **(MMM Technolog**y) that can initiate ringing and relaxing, modulated, multimode mechanical oscillations including harmonics and sub-harmonics. The system offers fine control and excellent repeatability from its programmable interface and produces high efficiency active power ranging from below 100 W up to many kW.

Multi-frequency, Multimode, Modulated Sonic & Ultrasonic Vibrations **(MMM** Technology) can be excited in any heavy-duty conditions, producing pulse-repetitive, phase, frequency and amplitude-modulated bulk-wave-excitation covering and sweeping an extremely wide frequency band. Such sonic and ultrasonic driving creates uniform and homogenous distribution of acoustical activity on a surface and inside of the vibrating system, while avoiding the creation of stationary and standing waves, so that the whole vibrating system is fully agitated. Such multi-frequency ultrasonic structural excitation is ideal for agitating arbitrary shaped liquid and solid masses at arbitrary distances and placed in open or pressurized vessels, containers, autoclaves, reservoirs and pipes, at any temperature, while maintaining optimum efficiency of electrical to acoustic energy transfer.

The oscillations of here-described sonic and ultrasonic source are not random – rather they follow a consistent pulse-repetitive pattern, being in the same time frequency, phase and amplitude-modulated by the control system. This avoids the creation of stationary or standing waves (typically produced by traditional ultrasonic systems operating at a single frequency) that generate regions of high and low acoustic activity. **MMM** technology provides great freedom of control, regulation and programming over all vibration, frequency and power parameters.

Fields of possible applications related to **MMM** Technology are: Advanced Ultrasonic Cleaning, Material Processing, Sonochemistry, Liquid Metals and Plastics treatment, Casting, Molding, Injection, Ultrasonically assisted sintering, Liquids Atomization, Liquids Mixing and Homogenization, Materials Testing, Accelerated Aging and Stress Release, Plastic and Metals Welding, etc.

In traditional ultrasonic technology, transducers have been designed to satisfy precise resonant conditions: In order to achieve maximal efficiency, all oscillating elements should operate on the same frequency. **MMM** technology can drive with high efficiency any complex mechanical system up to a mass of several tonnes, consisting of arbitrary resonating elements. **MMM** technology, instead of optimizing transducers to accept certain resonant frequency operation, optimizes the complex electrical driving (or signal shape) to be applicable to any specific oscillating structure, in a wide-band frequency domain, allowing mechanical designers to optimize their mechanical structures without limits.

1. SYSTEM SAFETY

To assure maximum safety during operation, read this manual thoroughly and follow all directions.

- Installation of the MasterSonic generator and associated transducers, the “Mastersonic System”, is to be performed by qualified technical personnel only.

- The Mastersonic System is an electro-mechanical device that under certain circumstances could present an electrical shock hazard to the operator.

- The MasterSonic System should only be used and operated by properly trained and qualified technicians.

- Qualified technicians licensed by the manufacturer should only perform servicing of the Mastersonic System.

- Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous exposure to ultrasonic energy.

- To avoid electric shock, do not remove the case covers from the Mastersonic System. There are no user-serviceable parts inside the device.

- Plugging the Generator unit into a socket that supplies improper voltage may cause the Generator to malfunction or create a shock or fire hazard.

- Proper system grounding cannot be insured unless unit is connected to properly wired 3-phase 440V / 60 Hz outlet with a sufficient current rating.

- Do not remove the grounding prong on the line cord plug.

- The Generator Electrical Supply cord should not be plugged into a device (e.g. “power strips”, “gang plugs”, etc.) other than an industrial grade wall socket. Such other use could cause significant changes in voltage that could result in an electrical fault indication. This condition may occur even though other equipment plugged into multi-outlet sockets continues to operate.

- Do not restrict airflow to the MasterSonic System by covering or enclosing in a sealed housing while in operation. Airflow must circulate through the unit during operation to facilitate proper cooling of electronic components.

- Do not place Generator on towel, foam or other soft surface since the material may block air vents. Blocking vents may cause Generator to overheat and malfunction or create a shock hazard.

- Do not expose or immerse the MasterSonic System or the transducer in water or liquids. The system is not sealed against liquids and exposure may result in damage to the equipment, create a shock hazard, or fire hazard.

- Due to the general operating principles of the MasterSonic System and ultrasonics, this equipment is not suitable for use in environments where danger of explosion exists.

- The Generator should not be turned on until the Transducer Cable has been connected to both the Generator and Transducer. Otherwise, damage to the Generator may result.

- When ultrasound output power is on, do not touch the transducer, booster, sonotrode, waveguide, or any device directly connected to these components; doing so may result in injury.

- Ear protection during operation of the system is highly recommended. Do not position the transducer, booster, sonotrode, waveguide, or any device directly connected to these components near the technician or operators ears. The operating frequency of the MasterSonic System is below, within, and above the range of human hearing, and emits acoustic energy. Do not activate the system if system components are within 4 feet (122 cm) of the ears of technician or operators.

CAUTION: Do not place Generator on towel, foam or other soft surface that may block generator air vents. Blocking any vents may cause the Generator to overheat, malfunction, or create a shock hazard.

CAUTION: Plugging the Generator unit into a socket which supplies improper voltage may cause the Generator to malfunction or create a shock or fire hazard.

CAUTION: The Generator should not be turned on until the Transducer Cable has been connected to both the Generator and Transducer. Otherwise, damage to the Generator may result.

CAUTION: The Generator Electrical Supply cord should not be plugged into a device (e.g. “power strips”, “gang plugs”, etc.) other than an industrial grade wall socket. Such other use could cause significant changes in voltage that could result in an electrical fault indication. This condition may occur even though other equipment plugged into multi-outlet sockets continues to operate.

2. SPECIFICATIONS

2.1. General purpose

MasterSonic MSG 12000 SP is a wideband-frequency generator for supplying ultrasonic piezoelectric loads of the type shown in fig. 2.1.

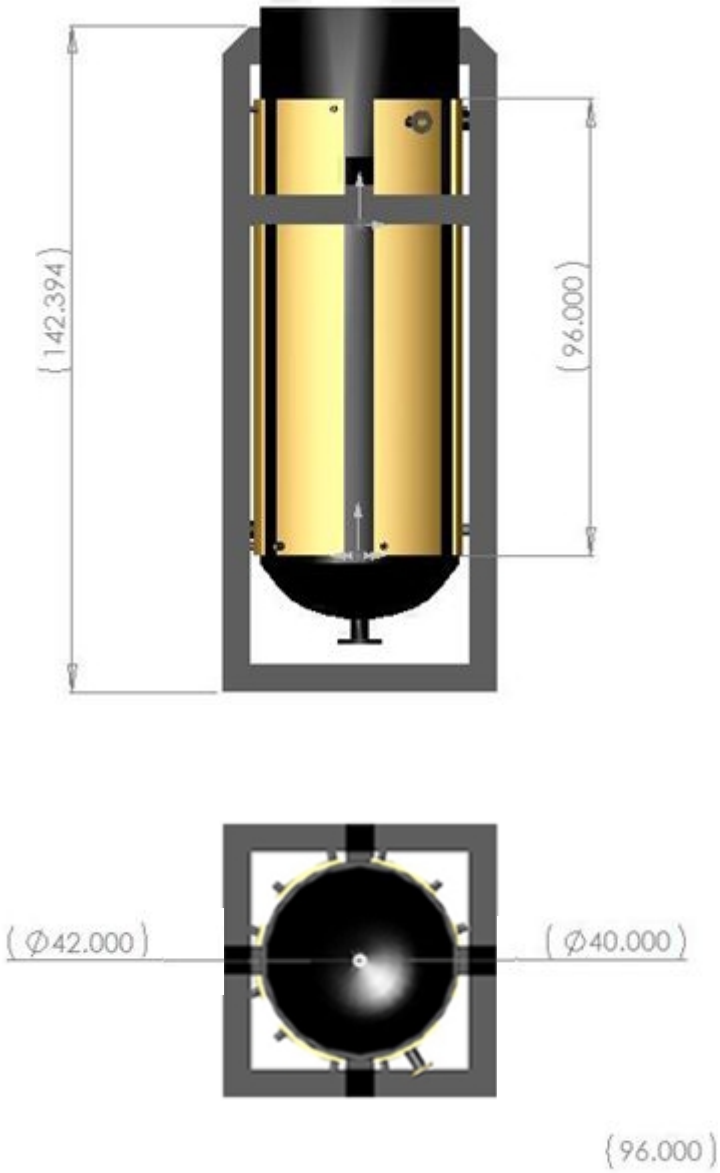


fig.2.1. Drying extractor.

MasterSonic MSG 12000 SP general appearance is shown in fig.2.2.

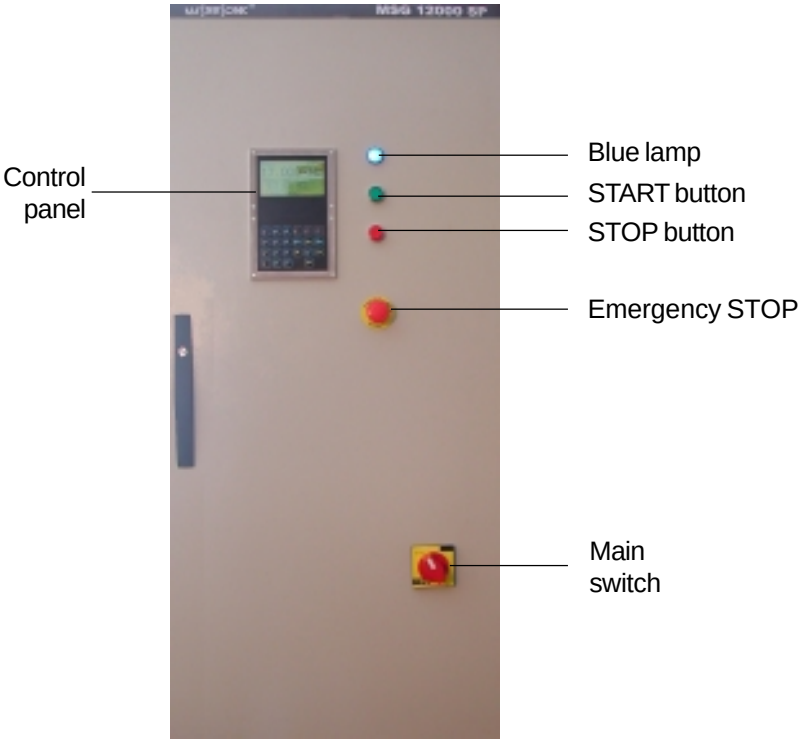


fig.2.2. MasterSonic MSG 12000 SP general appearance (front view) .

2.2. Specifications

* Power supply voltage	3N~440V / 60 Hz 3N~380V/ 50 Hz
* Maximum power consumption	14 kVA
* Output continuous power	12 kW
* Output Carrier Frequency range	15~30 kHz
* Output HF Voltage	~ 500 Vrms
* Peak Output Power (max pulsed power)	40 kW
* IP degree of protection	IP 20
* Dimensions	600x450x1920 mm
* Net weight	kg

2.3. Operating conditions

* Temperature of the environment	from 10°C to 40°C
* Relative air humidity	60% at 20°C/ 5% at 40°C

3. WARRANTY

MasterSonic MSG 12000 SP has 12 months warranty period starting from the installing date and no more than 18 months from the purchase date.

* The warranty covers the amount for repair or for the damaged parts of the device.

* The warranty is not valid when the device is used in a way not described in the Operating Manual or when warranty stickers are removed or damaged.

* An inquiry for warranty service can be made only in the pointed warranty period by fax or post regarding the warranty conditions in the contract.

* The warranty service offered by MasterSonic does not include repair of damaged parts in the warranty period when the damage is due to accidents, calamities, transportation, incorrect usage or negligence, as well as for parts, which are not produced and mounted by MasterSonic. MasterSonic does not offer warranty service after breaking the warranty stickers.

MASTERSONIC DOES NOT BEAR THE RESPONSIBILITY FOR LOSSES OR WHATEVER CIRCUMSTANCIAL DAMAGES, AS WELL AS NEITHER FOR SUPPOSED SUCH, NOR FOR THIRD PARTIED DEMANDS.

4. OUTLOK DESCRIPTION

4.1. Rear panel

Mains inlet for 3N~440V and high frequency outlet are situated on the rear panel, as shown in fig. 4.1.

fig.4.1. Rear panel

4.2. Cooling outlets

The cooling outlets for the ventilator are on the side covers of MSG 12000 SP, as shown in fig. 4.2.

Keep small parts away from the ventilator outlets, in order to prevent blocking of the cooling fans and to ensure good ventilation.

on the left side cover

on the right side cover

fig.4.2. Vent outlets

4.3. Front panel

MasterSonic MSG 12000 SP front panel is shown in fig. 4.3. The CONTROL PANEL, POWER LAMP, START and STOP buttons, EMERGENCY STOP button and MAIN SWITCH are situated on the front panel.

The high frequency generator MSG-12000 SP is switched ON by the MAIN SWITCH. Switching ON the MAIN SWITCH is indicated by the Blue lamp. When the device is switched ON the Blue lamp is lit, when the MAIN SWITCH is switched OFF, the blue lamp is not lit.
When the MAIN SWITCH is ON, the door is blocked and cannot be opened. Turn the MAIN SWITCH OFF before opening the door and servising the generator.
NOTE! When the MAIN SWITCH is ON, the door must not be opened by force, because the inner part of the MAIN SWITCH could be damaged.

START and STOP buttons are placed on the front panel under the Blue lamp. Pushing the green START button will start the generator in operating mode. Before starting the generator, check if the operating parameters are correctly set.
Pushing the red STOP button will stop the generator.

Pushing EMERGENCY STOP button will stop the high freguency generator, the START green button will die out, indicating that the generator is stopped. To continue operation of the generator after the emergency is solved, turn left the Emergency stop button. After releasing EMERGENCY STOP button the generator can resume its operation by pressing Start. Temporary operating parameters will not be lost after pushing Emergency Stop button, only if the generator is not switched off from the mains.
NOTE! EMERGENCY STOP button must be pushed ONLY in case of emergency.

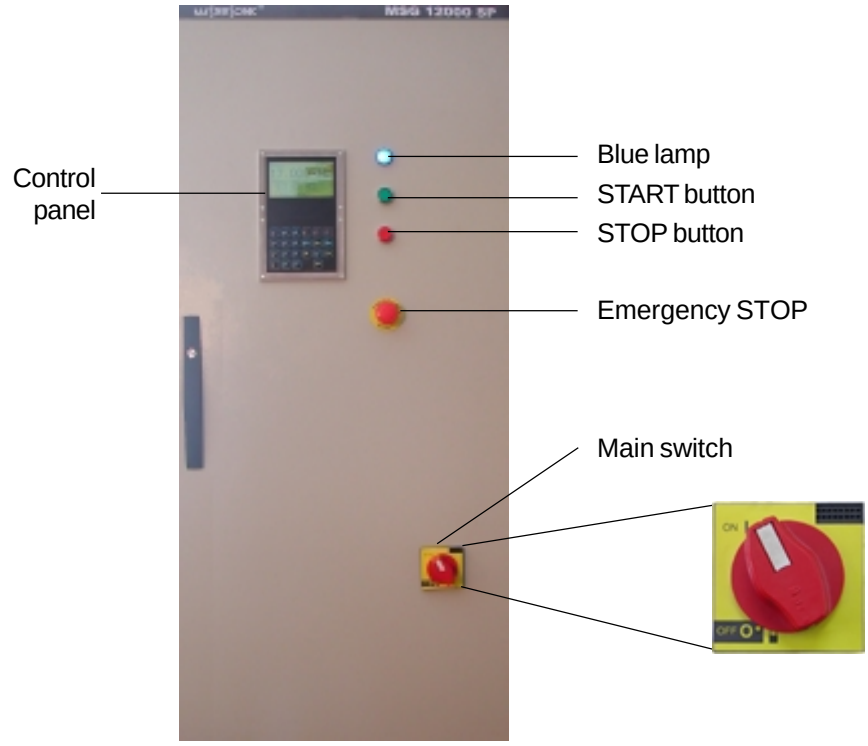


fig.4.3. Front panel

5. CONTROL PANEL

Parameters of the operating mode of MSG 12000 SP are set by the CONTROL PANEL. (fig.5.1).

Control panel consists of LCD display, on which the current status of operating parameters is visualized, and keyboard for setting parameters and chosing the menu on the display (fig.5.2).

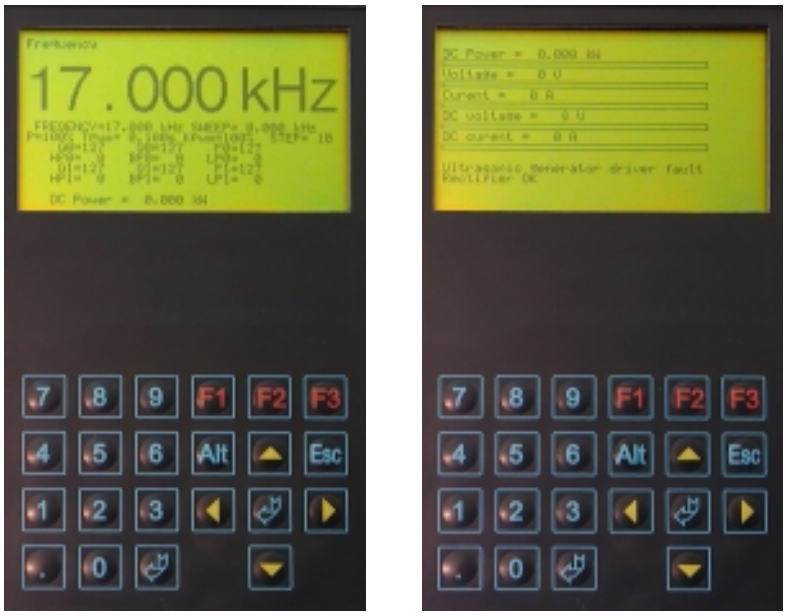


fig.5.1. Control panel

5.1. Keyboard

Control panel keyboard can be considered in the following key groups, concerning their functions: digital keyboard - digits from 0 to 9 and decimal point, function keys - F1 to F3 keys, direction keys - up, down, left and right, and control keys - Alt, Enter and Esc.

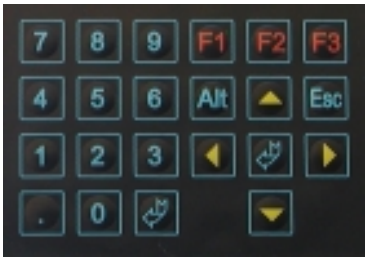


fig.5.2. Control panel keyboard

5.2. Function keys

Function key F1 is used for setting the parameter-step for changing the current parameter when using the Up and Down direction keys. Values that can be set are 1, 10 and 100. By multiple pressing of F1 the value is changing from 1 to 10 or to 100, consecutively. When the required value is displayed, it is automaticaly set. Step 100 is convenient for quick approach of the desired value, while step 1 is suitable for high precision setting. The length of the step depends on the parameter it concerns.
The set step value is also indicated in the main parameter display, described below.

Reserved (not in use in this generator version)

Function key F3 is used for saving the operating parameters in the memory. All set operating parameters are temporary untill saved in the memory.
When turing OFF the generator by the MAIN SWITCH, all unsaved parameters will be lost.
When turning ON the generator by the MAIN SWITCH, the last saved parameters will be loaded as default.
NOTE! Always check the operating parameters after switching ON the generator by the MAIN SWITCH (before pressing the START BUTTON).

5.3. Digital keyboard

Digital keyboard is used for numerical setting the values of the operating parameters.

5.4. Control keys

There are two ENTER keys on the keyboard for convenience (producing the same effect).

Switches over the LCD display between the two display options, described below:
a) parameters display;
b) diagnostic display.

Cancels the current parameter input.

5.5. Direction keys

Keys Left and Right are used for selecting a parameter from the list of parameters in the parameter display, which values must be changed or set.

Keys Up and Down are used for increasing or decreasing the value of the selected parameter by the set parameter step.

Key Left is used as backspace when entering the parameter value by the digital keyboard.

6. LCD DIPLAY

LCD display on the control panel is used for indication of parameters values, for displaying current operating status and diagnostic messages.
Pressing Alt key switches over the LCD display between:
a) parameters display;
b) diagnostic display.
When the generator is switched ON by the Main switch, parameters display will appear on the LCD display.

6.1. Parameters display

Parameters display is the main operating display. (fig.6.1) It displays the values of operating parameters, the set step (increment) value and operating parameters of the two feedbacks. In this display, all operating parameters can be set or changed.

The structure of the display is as follows:

1. In the top left corner the parameter name is displayed and below, in big characters its current value in the corresponding dimension is displayed .

2. Below big characters line, in two lines the values of operating parameters and parameter-step value are displayed.

3. Then the parameters of the two feedback -filters are displayed, below.

4. And the actual value of the DC Input Power is displayed in the last, bottom line.

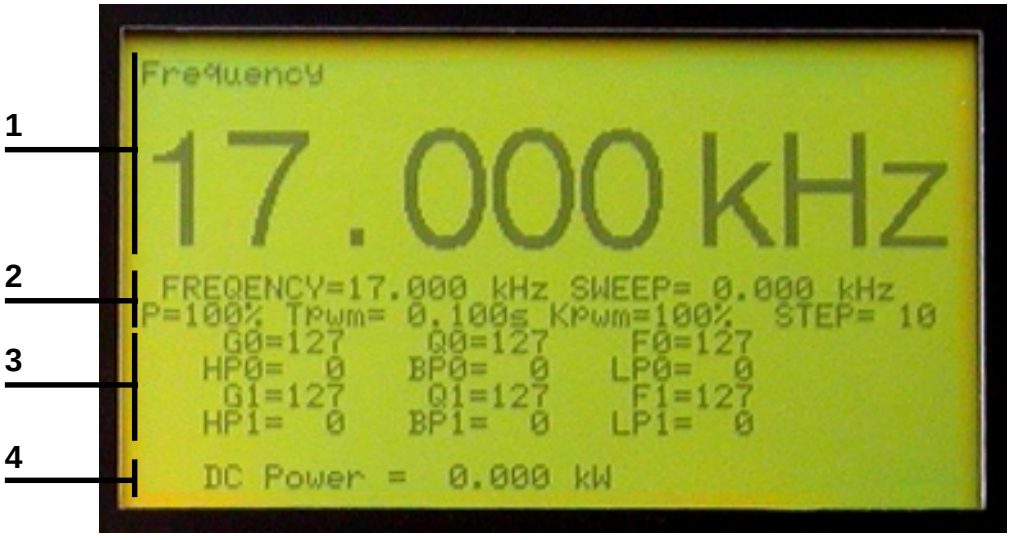


fig.6.1. Parameters display

Main parameters

In Parameters display, the values of two groups of parameters are displayed - main operating parameters of the generator and parameters of the two symmetrical feedback channels - 0 and 1 (section 3).

Main operating parameters:

FREQUENCY The average operating and carrier frequency of the generator, in kHz

SWEEP One-sided frequency sweeping interval, in kHz (max 1 kHz at each side; total 2kHz)

P Output high frequency power, in % of the nominal power

Tpwm The period of the pulse width modulation, in seconds

Kpwm The ratio of the pulse width modulation, in %

Below the main operating parameters, the operating parameters of the two feedback filters are displayed. The feedbacks are mutually symmetrical with all programmable parameters: amplification factor (G0, G1), Q factor (Q0, Q1), frequency (F0, F1), and three filters - High Pass (HP0, HP1), Band Pass (BP0, BP1) and Low Pass (LP0, LP1) filters, with separate amplification controls.

All parameters of the feedbacks are in relative units and vary from 0 to 255.

Feed back operating parameters:		***Range***
G0	amplification factor of feedback 0	0 ÷ 255
Q0	Q factor of feedback 0	0 ÷ 255
F0	frequency of feedback 0	0 ÷ 255
HP0	high pass amplification of feedback 0	0 ÷ 255
BP0	band pass amplification of feedback 0	0 ÷ 255
LP0	low pass amplification of feedback 0	0 ÷ 255
G1	amplification factor of feedback 1	0 ÷ 255
Q1	Q factor of feedback 1	0 ÷ 255
F1	frequency of feedback 1	0 ÷ 255
HP1	high pass amplification of feedback 1	0 ÷ 255
BP1	band pass amplification of feedback 1	0 ÷ 255
LP1	low pass amplification of feedback 1	0 ÷ 255

The feedback frequency band is determined by the values of Q and F.

NOTE! The power distribution and homogeneity of cavitation depends on the chosen feedback parameter (related directly to uniformity of the sonic and ultrasonic fields in the load). Generator tuning, choosing different types of modulation and setting the amplification factors must be done only by a qualified specialist.

6.2. Diagnostic display

Diagnosctic display is shown in fig.6.2. It displays the digital values of the folowing parameters:

1. DC power - output power of the main rectifier consumed by the generator, or input generator power. Generator output or load power is proportional to the input DC power reduced by the power losses.

2. DC Voltage - output voltage of the main rectifier supplying the generator.

3. DC Current - DC current being consumed by the generator, measured at its input.

4. Output Voltage – generator output, high-frequency voltage, supplying the ultrasonic transducers (measured at the output terminals of the generator).

5. Output current - high-frequency current consumed by the generator load (measured at the primary side of the high-frequency output transformer).

Below each parameter-value, its bar-graph for easier visualizing is displayed.

The bottom lines are giving generator diagnostic messages:

6. The first diagnostic line is for messages concerning the status of the generator.

7. The second diagnostic line is for messages concerning the status of the rectifier.

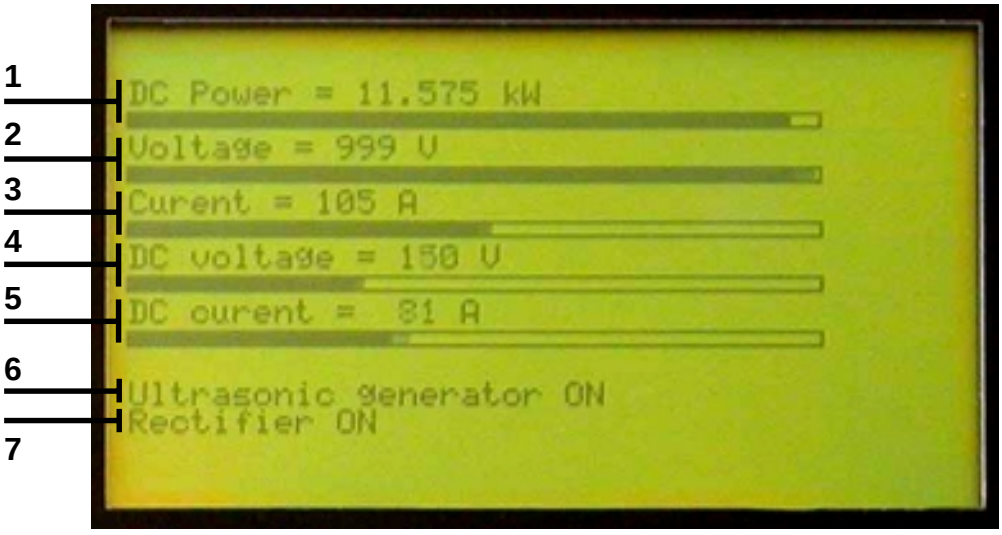


fig.6.2. Diagnostic display

6.2. Diagnostic messages

Diagnostic messages concerning the current status of the generator:

Ultrasonic generator OK - After switching ON the Main Switch, the initial test has passed and the generator is ready for operation.
Ultrasonic generator ON - the generator is switched ON with the Start button.

Error messages:
Ultrasonic generator overcurrent
Ultrasonic generator overheat
Ultrasonic generator driver fault
Ultrasonic generator overvoltage

When a failure is detected, the generator stops, the green button on the front panel dies out and error message is displayed in the corresponding line.

Diagnostic messages concerning the current status of the input Main-power rectifier:

Rectifier OK - After switching ON the Main Switch, the initial test has passed and the rectifier is ready for operation.
Rectifier ON - the rectifier is switched ON with the Start key.

Error messages:
Rectifier overcurrrent -
Rectifier overheat -
Transformer overheat -

When a failure is detected, the generator stops, the green button on the front panel dies out and error message is displayed in the corresponding line.

Error messages, faults and possible solutions are described in **Chapter 10**.

NOTE: Diagnostic messages are staying on the display until pressing the START button again, except for the overheating. Diagnostic messages for overheating are displayed while the generator or rectifier is/are overheated. When the device reaches acceptable temperature, the message disappears and the generator can continue operation.

Diagnostic messages concerning the status of the generator:

There are two kinds of diagnostic messages when the generator is operating correctly.

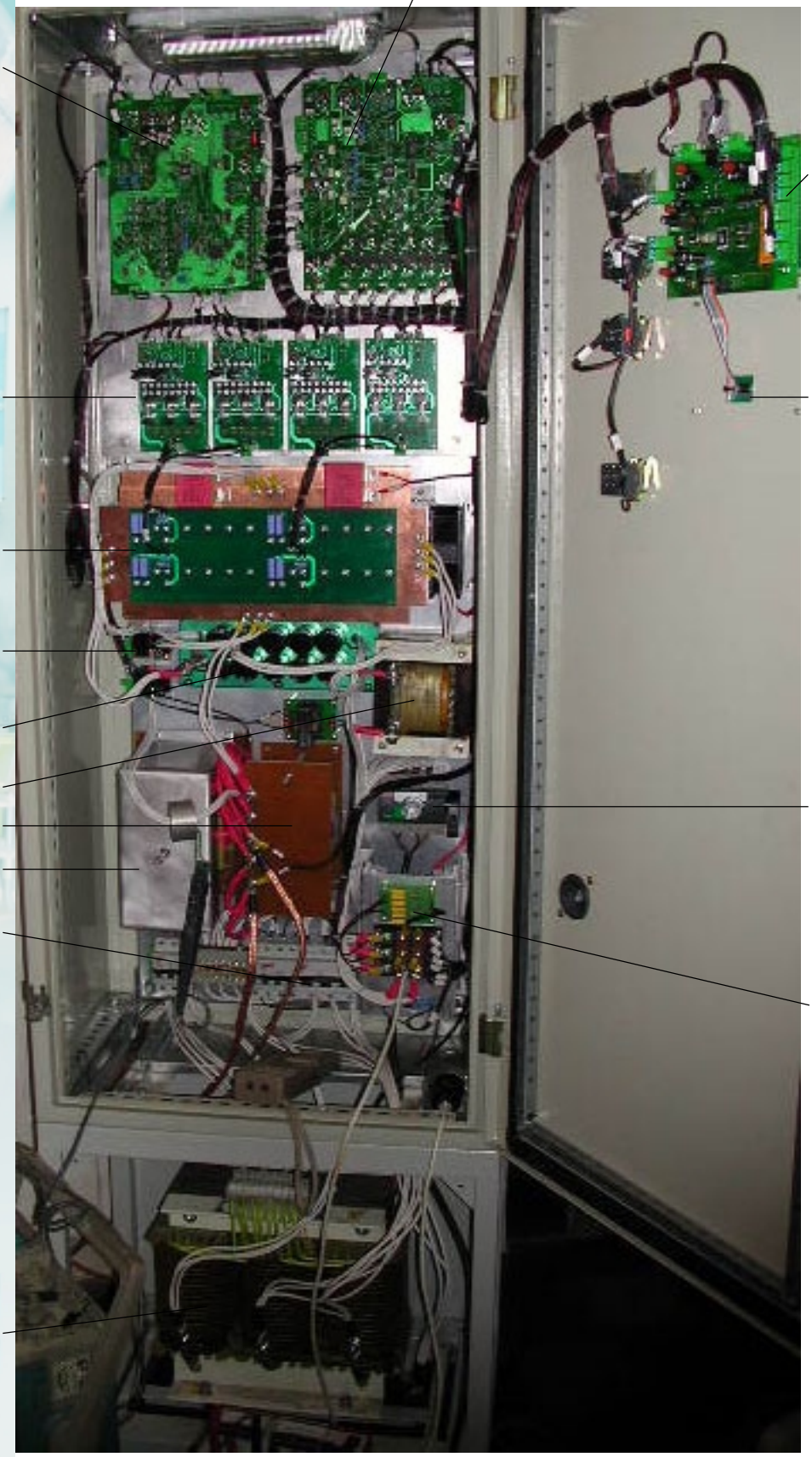
1. When, after switching the Main Switch ON, the initial self-test is done and the device is in order, in the two lines of diagnostic messages is displayed the following text:

Ultrasonic generator OK
Rectifier OK

2. After pressing the Start button, the generator starts operating and in the two lines for diagnostic messages is displayed the following text:

Ultrasonic generator ON
Rectifier ON

7. INSIDE VIEW



8. INSTALLATION AND CONNECTION

Mastersonic MSG 12000 SP generator is specifically designed for vibrating the ultrasonic drying extractor with high power ultrasonic excitation.
Before installing MSG 12000 SP, assure that all requirements for safe operation are observed. Only a specialist in power electronics, who is well acquainted with the device, must perform installation of the generator.

8.1. Assembling the generator

The generator consists of two main parts - the generator and the transformer. They are both mounted in separate cabinets. During the transportation the two cabinets are packed separately.

- Unpack the two cabinets and mount the transformer on the spot appointed in its cabinet. Place the cabinet with the generator on the cabinet with the transformer in such way, that the four openings on the two cabinets coincide. Tighten with screws M8 in the four ends on the floor of the cabinet of the generator. (See fig. 8.1)

fig. 8.1. Mounting screw

8.2. Connecting the transformer

There is an opening for passing the cables from the transformer to the generator between the two cabinets.

- Attach cables with numbers 131, 132 and 133 through the cable opening on the bottom of the generator to the automatic circuit breaker A4.
- Connect the star connection of the auto-transformer by attaching cable 171 to terminal 13.
- Check the terminals of the transformer to assure that they are connected to the proper supplying voltage.
- Connect the primary circuit of the auto-transformer cables with numbers 175, 176 and 177 to the automatic circuit breaker A2.
- Connect cable 141, located in the cabinet of the generator, to the terminals 11 and 12 of the terminal block of the auto-transformer.

fig. 8.2. Connecting the transformer

- Check if all cables are connected according to the given circuit.

After connecting the cables of the transformer, the connections to the acoustic load and to the main supply must be realized.

8.2.1. Mains connection.

- Pass the power supply cable through the corresponding cable entry on the back of the cabinet of the auto-transformer.
- Pass the power supply cable through the cable entry on the bottom of the cabinet of the generator connecting it to the terminal block with terminals R, S, T, N. (See fig.8.3.)

fig. 8.3. Power supply cable

8.2.2. Acoustic load connection

The acoustic load can be connected with three-wire cable. For improved safety the manufacturer strongly recommends connecting the acoustic load using the three wire connection method. See fig. 8.4.

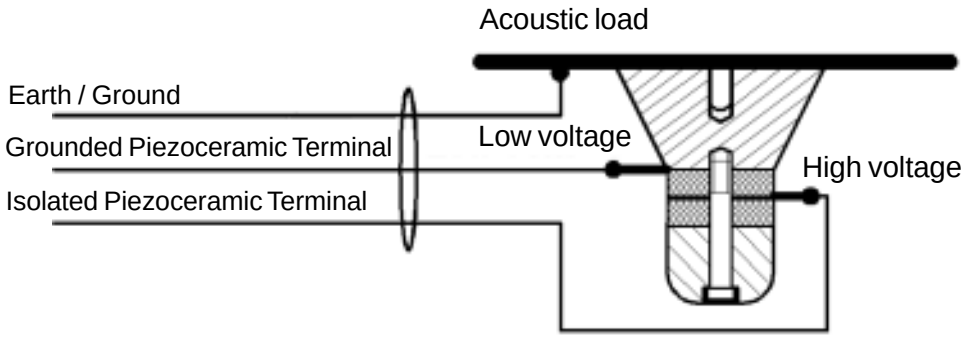


fig. 8.4. Preferred 3-wire acoustic load connection

Isolated Terminal (terminals between ceramic disks or rings without contact to front or back metal mass of the converter) – This wire (normally Red / White / Black depending on supply source) is the HV (High Voltage) terminal of the ultrasonic transducer.

Ground Terminal (terminals in contact with the front or back mass of the converter) – This wire (normally Green or Blue depending on supply source) is the LV (Low Voltage) terminal of the ultrasonic transducer.

Earth/Ground/Mass (normally Yellow / Green / Blue) – This wire is connected to the metal part of the Acoustic Load.

Connect the acoustic load to the MSG12000 SP as follows:

Pass the acoustic load cable through the corresponding cable entry on the back of the cabinet of the auto-transformer.

Connect the Isolated terminal (normally red Black or White)wire to terminal 3-HV on the high frequency terminal block located on the HF transformer. See fig. 8.5.

Connect the Ground Terminal (normally Green, Blue or Yellow) wire to terminal 4-LV on the terminal block located on the HF transformer.

Connect the Earth/Ground/Mass (normally Yellow/Green/Blue) wire to terminal 4-EARTH. On the same terminal must be connected the grounding cable of the acoustic load body (housing).

fig. 8.5. High frequency terminal block

CAUTION: Be careful when handling the acoustic load transducers or cable. The acoustic load may be charged with electro-static high voltage that may produce an electrical shock to the installer if not handled properly. Before installation or before connecting the acoustic load to the Mastersonic generator carefully connect the High Voltage Black wire to the Low Voltage Blue wire to short the circuit and discharge electro-static build-up.

CAUTION: Connecting the Generator unit to mains which supplies improper voltage may cause the Generator to malfunction or create a shock or fire hazard.

CAUTION: The Generator should not be turned on until the Transducer Cable has been connected to both the Generator and Transducer. Otherwise, damage of the Generator may result.

CAUTION: The Generator Electrical Supply cord should not be plugged into a device (e.g. “power strips”, “gang plugs”, etc.) other than an industrial grade wall socket. Such other use could cause significant changes in voltage that could result in an electrical fault indication.
This condition may occur even though other equipment plugged into multi-outlet sockets continues to operate.

8.3. Connecting the generator

After mounting, the generator must be connected to the mains and to the acoustic load. The generator can be switched on after connecting to the mains.
Ensure that the power supply is correctly connected to the mains and that the vessel of the acoustic load is full with a fluid. Check if the control boards and the power stage are fixed well and if all the connectors are switched on.
Be aware that MSG 12000 SP has been tested on equivalent loads before transportation and adjusted to low power of approx. 10% the nominal power.
If everything is checked and appears correct, the Main Switch can be turned ON. When switched ON, the blue lamp on the front panel is lit as well as the LCD display of the control panel. The parameters menu is the default menu on the LCD display.
Push the green button to swith the generator ON. If everything is OK with the generator and acoustic load, then the green lamp will be lit and the generator will start operating with 10% of the nominal power.

Read carefully the following instructions to optimally adjust the generator for your application. The detailed explanation of adjusting MSG 12000 to the acoustic load will help you to obtain excellent results from the generator's operation.

Simplified instructions and parameters' setting for initial adjustment of MSG 12000 SP generator are (the following parameters are settled from the control panel):

1. Set the **FREQUENCY** equal to the nominal frequency of the ultrasonic transducer (equal to central operating frequency of the generator).
2. Set **SWEEP** to 0
3. Set **P** to 10%
4. Set **Tpwm** to 0,1s
5. Set **Kpwm** to 100%
6. Set **G0** to 0
7. Set **Q0** to 0
8. Set **F0** to 0
9. Set **HP0** to 0
10. Set **BP0** to 0
11. Set **LP0** to 0
12. Set **G1** to 0
13. Set **Q1** to 0
14. Set **F1** to 0
15. Set **HP1** to 0
16. Set **BP1** to 0
17. Set **LP1** to 0
18. Setting compensating inductivity (see below)

Compensating Inductivity Setting Sequence:

1. The **Compensating Inductivity** value is determined by the following formula:

$$L = 1.05 \left(\frac{1}{4\pi^2 f^2 . C} - Ls \right)$$

where:

L - inductivity of compensating coil in , H;

f - central operating frequency in Hz;

C - static (1 kHz) capacitance of ultrasonic transducer in , F;

Ls - Leakage Inductivity of the output transformer:

approx. 300. 10^{-6} H = 300µH

The ultrasonic generator MSG 12000 SP is designed for supplying continuously 12kW acoustic load at 20kHz.

The resonant frequency must be set from the control panel. After that, the compensating inductivity must be adjusted using a wrench. See fig.7.6.

fig. 8.6. Adjusting the compensating inductivity

The compensating inductivity can be measured by an inductance meter on terminals 4 and 5 of the terminal block (See fig.8.7.)

fig. 8.7. Measuring the compensating inductivity

19. After switching the generator ON, the output voltage and output current must be checked. They are displayed on the LCD display of the control panel. This way, if the operating mode of the generator is appropriate, can be checked.

20. Increase the power of the generator from 10% to 30%. Adjust the compensating inductivity using a dual channel scope, realizing that the phase between the load current and load voltage must be equal to zero.

21. Increase the power gradually and check if the output voltage and output current are within normal operating conditions.

22. When at full power the phase between the acoustic load current and the output voltage is equal or very close to zero, the system is operational.

ATTENTION!
READ CAREFULLY THROUGHOUT THE MANUAL BEFORE ADJUSTING MSG 12000 SP GENERATOR AND NOT TO MISS ANY STEP!

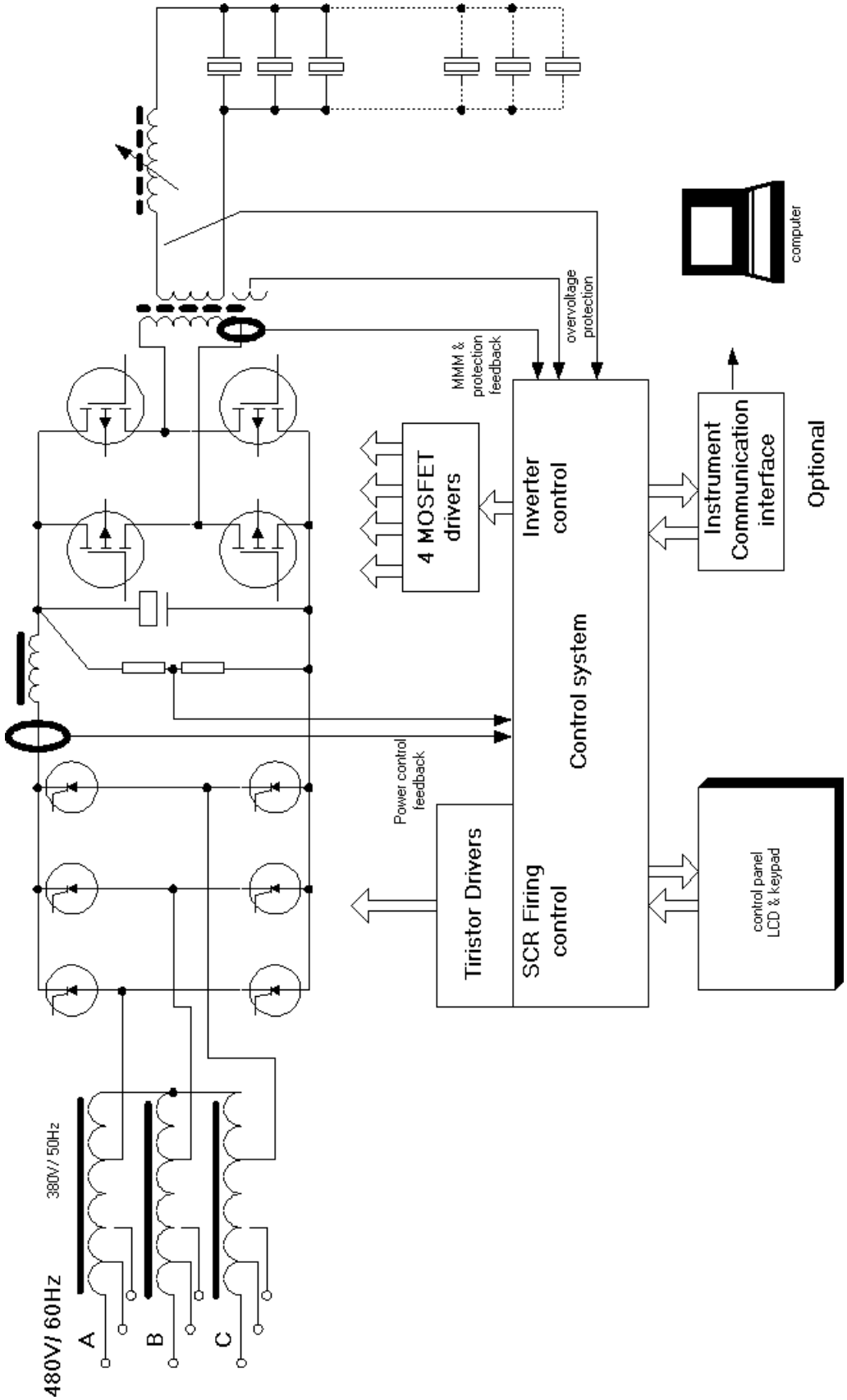


fig.8.8. Block diagram of MSG 12000 SP

8.4. Control block

The generator control block has the following modules on PC boards:
- Rectifier control module
- Inverter control module
- Output drivers blocks
- Control panel module

The generator control is made using several microprocesors, programmable logic and ASIC. In this way, an optimal choice is made between the discrete digital control and fast analogue feedbacks in the processes.
The Block diagram of MSG 12000 SP is shown in fig. 7.8.

8.5. Adjustment and selecting the main operating modes.

In order to achieve perfect operating results, the appropriate operating mode of the acoustic load must be selected.
A table for selecting an operating mode to be settled from the control panel is given below.

Sweep Range	*Feed back 0*	*Feed back 1*	*Operating modes:*
= 0	= 0	= 0	Constant frequency operation
≥ 1	= 0	= 0	Math sweeping only
= 0	≥ 1	= 0	DMMM using feedback 0
= 0	= 0	≥ 1	DMMM using feedback 1
= 0	≥ 1	≥ 1	DMMM mixed usage of feedback0 and feedback1
≥ 1	≥ 1	≥ 1	Mastersonic mode

Description of the main operating modes.

Constant frequency operation mode

This mode is useful during the adjustment of Compensating inductivity or if the generator is used in applications with concentrating the acoustic power in a limited spot.
For this mode set from the control panel the following values of the parameters:
SWEEP = 0.000
G0 = 0
G1 = 0

Math sweeping only mode.

Many acoustic loads, as the ultrasonic cleaners and liquid processing systems are giving very good results using this operating mode.
For this mode set from the control panel the following values of the parameters:
SWEEP = 0.100 kHz - 0.600 kHz (for best results recommended value 0.350kHz)
G0 = 0
G1 = 0

DMMM mode:

Dynamic **M**ultifrequency, **M**ultimode **M**odulation (DMMM) will be activated when minimum one of feedbacks (Feedback0 and/or Feedback1) is involved in MMM signal processing.

Both feedback channels have the same structure, being realized as 2 independent and fully programmable filters.

For selecting DMMM operating mode, set the following values of operating parameters (from the control panel):

- SWEEP = 0; equivalent to “no Math Sweeping”

Amplification factors (G0, or G1, or booth) should have non-zero values ^{3} 1. If any of amplification factors is set to zero, corresponding feedback channel will be deactivated.

- Q factor of the activated feedback channel/s should be properly selected in order to produce optimal acoustic activity (realized by monitoring the results of liquid processing in relation to a selected Q factor).

- Select the characteristic filter/s frequency of activated feedback channel/s, F0 and/or F1, which is directly related to a channel-response time constant.

- Select amplification of the band-pass feedback signal components BP0 and/or BP1.

- Select amplification of high frequency components by high-pass filter/s HP0 and/or HP1.

- Select amplification of low frequency components by low-pass filter/s LP0 and/or LP1.

By setting various amplification factors in filter channels F0 and F1, vibrations with different spectral content can be amplified or attenuated, by defining filters' characteristics. This way, undesirable mechanical vibrating modes can be suppressed and only technologically useful effects amplified, optimizing and increasing the efficiency of Mastersonic MSG 12000 SP generator.

It is essentially important to optimize feedback-channel parameters for every application (by monitoring the acoustic effects of frequency-depending results of liquid processing), since every acoustic load has its acoustic complexity, and should be correctly driven in order to maximize technologically beneficial effects. In order to master the feedback channels' settings it could be useful to get assistance from the Mastersonic team (www.mastersonic.com).

In cases when feedback channels are not properly parameterized, part of useful active ultrasonic power could be dissipated, heating transducers, generator components, and possibly damaging mechanical system.

ATTENTION!

DMMM feedback adjustments cannot be made without using measurement devices able to monitor acoustic activity. During the adjustments process Mastersonic generator should be low power operated (for instance in the range of 30% or less, of nominal generator power).

After you are sure that all DMMM adjustments are properly made, save the parameters and then you could gradually increase the generator power, while controlling the generator operating conditions and liquid processing results. Electrical operating conditions of Mastersonic generator and ultrasonic transducers must be inside of the safe operating area recommended by the producer.

When the satisfactory results of initial tuning are achieved, control generator and liquid processing operation during a long-enough period of time in order to be sure that the system will always produce good results.

ATTENTION!

The Mastersonic generators operating in DMMM mode are creating wide range of sonic and ultrasonic activity, which depends of acoustic and spectral complexity of the acoustic load and mechanical system. Sometimes a part of unpleasant acoustic vibrations could be created, causing discomfort to operating personnel, and in such situations active feedback channels should be readjusted.

COMMENT REGARDING MASTERSONIC OPERATING MODES

The selection of Forced Sweeping modulation, here named “SWEEP” – generates forced MMM sonic and ultrasonic oscillations that are driving the acoustic load. The algorithm implemented in the microprocessor, using the feed-back from the Acoustic Load, calculates specifically modulated frequency out-t, which generates MMM oscillations into acoustic load.

The Dynamic MMM Sweeping modulation, here named (DMMM), will usually provide excellent results in almost any application, because this modulation is designed to excite an Acoustic Load of any size and shape in many of its resonant modes, at the same time. The optimally selected feed-back from the acoustic load (specifically transformed with MMM signal processing block) will initiate real time Dynamic changes of MMM oscillations by tracking the time-evolving load properties in a wide-band and multifrequency regime of oscillations. This will generate completely homogenous 3-Dimensional ultrasonic activity in an ultrasonic acoustic load. The optimal selection of feedback-parameters is very important for generating homogenously distributed 3D acoustic-activity field.

Consequently, the optimal method for obtaining homogenous 3D ultrasonic activity in mechanically different acoustic loads is the heuristic method where the system integrator /s will determine the best settings by testing and analyzing results themselves.

For initial and most-recommendable parameters’ settings choose the following values of operating parameters:

SWEEP = 0.100 kHz - 0.400 kHz (for best results recommended value is 0.250 kHz)

The MasterSonic team is recommending using in any application certain low-level of the SWEEP modulation, combining it with sufficiently high-level of DMMM modulation, in order to excite strong and uniform oscillations inside of any acoustic load. Increasing the value of SWEEP parameter decreases the effective power in the acoustic load. If the acoustic load starts producing unusual, cracking, non-stationary and randomized acoustic noise, the maximal level of both or only one of frequency modulations (SWEEP or DMMM) should be reduced until such noise would disappear.

The following feedback parameters are specifying DMMM mode:

- Amplification - G0 and/or G1 - common amplification factor of the filter in the feedback. (if G1=0 the corresponding feedback1 is switched OFF)

NOTE! *The parameters described below are active only when the feedback is switched ON, i.e. G1 (or G0)* $\geq$ *1*.

- Q factor of the filter Q0 and/or Q1.

- Filter frequency - F0 and/or F1 - determines the time-constant of the frequency-depending part of the filter.

- Amplification of the band pass filter BP0 and/or BP1.

- Amplification of high frequency by high pass filter HP0 and/or HP1.

- Amplification of low frequency by low pass filter LP0 and/or LP1.

By setting various amplifications in the feedback-filters, vibrations with different frequencies can be amplified or suppressed by defining the filter band-pass intervals.

This way, undesirable fluctuations and mechanical vibrations can be suppressed, and effects of technologically useful mechanical vibrations in ultrasonic load increased, automatically increasing efficiency of Mastersonic MSG 12000 SP generator.

It is recommended to inspect carefully the influence of the frequency-depending feedback loops on the acoustic load and the total system.

It is highly recommended that all modifications of the frequency-dependant feedbacks are made after consulting with an Ultrasonics specialist authorized by the producer (www.mastersonic.com).

Not well adjusted frequency amplification in the feedback loops could increase certain problematic resonant vibrations in the system, creating zones of heating in the acoustic load, fluid atomization effects, and in some cases leading to mechanical damage of the system.

ATTENTION!

It is not recommended that adjustments of MASTERSONIC operating modes are made without using proper measurement devices, for monitoring the results of adjustments.

It is not recommended to perform any of adjustments when the generator operates full power, in order to avoid creating damaging mechanical resonance effects.

After you are sure that all (low-power) adjustments of the generator are well-made, save the parameters (F3), and gradually increase output power, controlling the operating regime of the acoustic load and the total system.

During the adjustment of the generator and increasing its power, check the electrical mode of the ultrasonic transducers of the acoustic load. Electrical mode must not be out of the safe operating area recommended by the producer of the ultrasonic transducers.

When a satisfactory results are achieved in the ultrasonic device, control its operation in a long-enough period of time in order to get sure you have guaranteed safe operating mode of the ultrasonic transducer and ultrasonic device. This is due to the specific nature of the Mastersonic generators and the installed high power of MSG 12000 SP.

ATTENTION!

The generators operating in MASTERSONIC mode create a wide range of ultrasonic and sonic fluctuations, which depend on the natural resonant frequencies of the acoustic load and the operated devices and materials in it. This can lead to transducing of ultrasound, which could lead to discomfort of the operating personel near the ultrasonic device. If such a phenomenon is observed, the adjustments of the frequency must be changed, so that the generator not to transduce ultrasound.

9. SETTING PARAMETERS

Main operating parameters can be set in the Parameters display in two ways: by the digital keyboard and by the step key.

9.1. By the digital keyboard

Setting the parameters value by the digital keyboard, numerically:

Choose Parameters display by pressing the Alt key.

Use direction keys Left and Right to select the parameter. The chosen parameter is written in the top left corner of the display. Below, in big characters, its current value is displayed (refer to fig.6.1).

Type the numerical parameter value in the digital keyboard.

After the value is entered, it must be confirmed by pressing **Enter** key. If in the process of typing the value a wrong digit is pressed, the direction key **Left** can be used to turn a digit back (as **backspace**).

9.2. By the step key

Setting the parameters value by the set step key:

Choose Parameters display by pressing the Alt key.

Use direction keys Left and Right to select the parameter. The chosen parameter is written in the top left corner of the display. Below, in big characters, is displayed parameter current value (refer to fig.6.1).

Use direction keys Up and Down to increase or decrease the value of the parameter by the set-step increments. The step value can be 1, 10 or 100. When high precision is needed set the step value to 1. The set step value appears in the Parameters display.

If the step value is not suitable, change it by pressing consecutively the F1 key.

(**Note:** When the parameter value is set using the step, its value is directly accepted and does not need confirmation by pressing the Enter key).

Setting the parameter value using the higher step gives faster approach to the desired value.

Dimension/s of the step increments is parameter-dependent, as follows:

FREQUENCY	1, 10, 100, in Hz
SWEEP	1, 10, 100, in Hz
P	1, 10, 100, in %
Tpwm	1, 10, 100, in ms
Kpwm	1, 10, 100, in %

9.3. Important notices regarding using PWM timing options.

In most of applications for driving different piezoelectric loads it is not necessary or recommendable to use PWM, output-signal modulating options (just set PWM Ratio = 100%).

The safest choices when using PWM options is necessary or beneficial for application are to set the output generator power to 50% of nominal power, and then set the PWM Ratio in the range between 75% and 95%, and PWM Period from 0.01sec to 1sec (for instance in cleaning applications, liquids processing and Sonochemistry). Even in liquid processing and cleaning applications PWM ratio should be kept to 100%, and preferable cleaning effects adjusted by other frequency modulating options (just to underline that PWM output signal modulation should be used only exceptionally and under well controlled conditions)

PWM signal modulation presents Low frequency output power, ON – OFF modulation. Such modulation is basically producing high electrical and mechanical shocking (on both generator and transducer), equal to a kind of pulse – repetitive “hammering” effects, producing unpleasant and cracking, low frequency acoustic effects, and if not well selected could shorten the total operating life of the ultrasonic system. When generator power is set to low or very low values, PWM modulation can be applied without limits. Also when PWM period is set to very long values (PWM frequency = very low), generator can be set to operate high power.

10. ERROR MESSAGES

Generator Error Messages:

Ultrasonic generator over-current –

1. Check the operating frequency. The operating frequency could have too large deviation from the best operating frequency. The generator must be smoothly adjusted to an appropriate operating frequency.

2 Short-circuit in the load. All cables and connections to the load must be carefully checked and the problem must be removed.

Ultrasonic generator overheat –

1. Damaged thermo-sensor- check the sensor and its connection circuit. The sensor must be replaced or its circuit must be repaired, if necessary.

2. Overheating – wait for the generator to cool down. The generator must be readjusted into a more-appropriate mode.

3. Damaged cooling fan – remove the damage and replace the fan.

Ultrasonic generator driver fault –

1. Low power supply to any driver – check supply voltages and remove the problem.

2. Damaged transistor in the power stage – check the power transistors and replaced the damaged one.

Ultrasonic generator over voltage –

1. When the output voltage is too high piezoelectric transducers could be damaged. It is necessary to find a new operating mode with lower output voltage.

2. Damaged element in the voltage feedback - check the voltage feedback circuit, repair and/or replace the damaged element.

Error messages regarding rectifier:

Rectifier over-current –

1. Rectifier is over-loaded. Damage in the power stage – check the elements of the power stage. Repair and/or replace the damaged elements.

2. Damaged element in the current feedback – check the current feedback circuit. Repair and/or replace the damaged element.

Rectifier overheat –

1. Damaged thermo-sensor- check the sensor and its connection circuit. The sensor must be replaced or its circuit must be repaired.

2. Overheating – wait for the rectifier to cool. The generator must be readjusted into a more-appropriate mode.

3. Damaged cooling fan – remove the damage and replace the fan.

Error messages regarding transformer:

Transformer overheat –

1. Damaged temperature-sensor for detecting transformer overheating -check the sensor and its connection circuit. The sensor must be replaced or its circuit must be repaired.

2. Transformer overheated – wait for the transformer to cool. Check the power supply readjusting it to satisfy safe-operating requirements. Check if the transformer is correctly connected and re-connect it if necessary.

11. LIMITATION OF WARRANTY

The product warranty is detailed in the general conditions of sale or as part of a special sale agreement.

The warranty does not apply and may be voided for equipment subject to unauthorized modifications, repair, misuse, abuse, negligence or accident.

Equipment that, in our judgment, shows evidence of having been used in violation of operating instructions will be ineligible for service under this warranty.

The MasterSonic equipment is designed for maximum operator safety and incorporates built-in safety devices. Any modifications to these safety features will void the warranty. The Manufacturer assumes no responsibilities for consequential damages incurred due to modifications to the said equipment.

Under no circumstances shall the Manufacturer be liable to the purchaser or to any other person for any incidental or consequential damages or loss of profit or product resulting from any malfunction or failure of this MasterSonic product.

No liability is assumed for expenses or damages resulting from interruptions in operation of the product or damages to material in process.

The Manufacturer reserves the rights not to warrant horns, sonotrodes, and waveguides of unusual or experimental design that in our judgment are more likely to fail in use.

Within the period guaranteed, we will repair or replace free of charge, at our sole discretion, all parts that are defective because of material or workmanship, not including costs for removing or installing parts.

Liability, whether based on warranty, negligence or other cause, arising out of and/or incidental to sale, use or operation of the transducer elements, or any part thereof, shall not in any case exceed the cost of repair or replacement of the defective equipment, and such repair or replacement shall be the exclusive remedy of the purchaser, and in no case will we be responsible for any and/or all consequential or incidental damages including without limitation, and/or all consequential damages arising out of commercial losses.

12. SERVICE

WARNING: To avoid electric shock, do not remove the case cover from the Generator or Transducer. There are no user-serviceable parts inside any of these components.

IMPORTANT NOTICE: For the protection of employees, shippers, receivers, various personnel, and to remain in compliance with Transit Laws, material returned to the Manufacturer or its designated representatives must be rendered free of any hazardous, noxious or radioactive contamination.

Should the user of this device have any questions or comments as to its specifications, use, limitations, or maintenance, the Manufacturers Service Representative can be contacted as follows:

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APPENDIXES