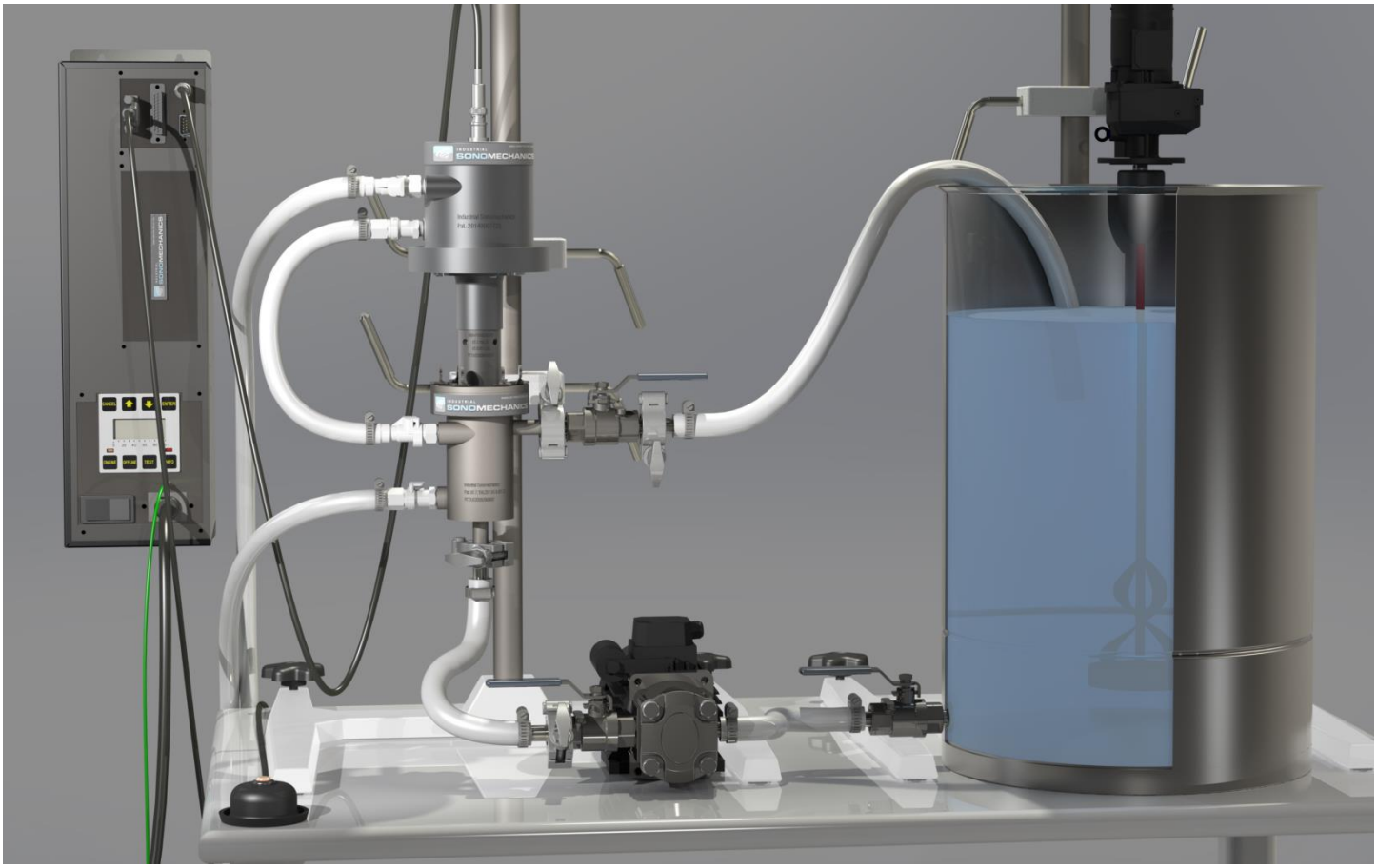
BSP-1200 - BENCH-SCALE ULTRASONIC LIQUID PROCESSOR

USER MANUAL



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Patent Protection:

This ultrasonic equipment is manufactured under U.S. Patent No. 7,156,201, International Patent Application No. PCT/US2008/068697, U.S. Patent No. 8,651,230 and U.S. Patent No. 9,142,751.

Table of Contents

Section 1

Introduction

General User Information

Read This Manual First

Before operating your ultrasonic processor, read this User's Manual to become familiar with the equipment. This will ensure correct and safe operation. The manual is organized to allow you to learn how to safely operate this processor. The examples given are chosen for their simplicity to illustrate basic operation concepts.

Notes, Cautions and Warnings

Throughout this manual we use NOTES to provide information that is important for the successful application and understanding of the product.

In addition, we use special notices to make you aware of safety considerations. These are the CAUTION and WARNING blocks as shown here. They have important information that, if ignored, could have increasingly severe outcomes. These statements help you to identify and avoid hazards and recognize the consequences. One of three different symbols also accompany the CAUTION and WARNING blocks to indicate whether the notice pertains to a condition or practice, an electrical safety issue or an operator protection issue.

Failure to follow any of the statements in the WARNING or CAUTION blocks will void this product's warranty.

NOTE

Note statements provide additional information or highlight procedures.

CAUTION

Caution statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING

Warning statements point out conditions or practices that could result in personal injury or loss of life.

System Overview

The BSP-1200 bench-scale ultrasonic liquid processor is designed for process optimization and medium-scale production. It outputs up to 1,200 W of acoustic power into the processed liquids and operates at the frequency of approximately 20 kHz. The processor is supplied with a 1,200 W **ultrasonic generator**, a water-cooled **piezoelectric transducer**, a **Barbell horn** and an optional **reactor chamber** (flow cell).

Generator

The 1,200 W **generator** has rugged internal circuitry and ensures a continuous resonant frequency lock during operation. The LCD display can be used to change the settings for the ultrasonic amplitude, starting frequency and ramp-up or ramp-down parameters. Constant amplitude is provided, regardless of the power draw, which is automatically adjusted to compensate for variable loading conditions. The ultrasonic vibration amplitude level can be adjusted from 20 to 100 %. The generator passes strict CE test specifications for global applications.

Transducer

The BSP-1200 processor includes a water-cooled **piezoelectric transducer**, SWCT-1200. This transducer has the power rating of 1,200 W, can operate continuously (see CAUTION and WARNING, below) and is sealed to the outside environment, which makes it immune to high-humidity conditions and suitable for processing flammable materials, such as fuels and organic solvents.

CAUTION

The SWCT-1200 transducer must be cooled with water. The water flow rate must be at least 5 L/min and its temperature must be below 15 °C (59 F). Operating the unit without the cooling water may cause irreversible damage and is strictly prohibited.

In no event can the front mass (where it meets the horn) of any transducer used with the BSP-1200 processor be allowed to reach the temperature of 54 °C (130 F).

WARNING

Do not use any solvents or flammable liquids to cool the transducer. Such liquids may destroy the cooling jacket's seals and penetrate the internal area of the transducer, causing an electrical short and/or other irreversible damage to sensitive components.

Barbell Horns

Two types of **Barbell horns** may be utilized with the processor. The Half-wave Barbell Horn (HBH) is typically used in the flow-through processing mode, while the Full-wave Barbell Horn (FBH) is generally preferred for the batch processing mode. The horns have large output tip diameters (typically, 30 - 35 mm) and can deliver high vibration amplitudes - up to 80 - 100 microns. The amplitude is calibrated by a high-precision photonic sensor. The ability to reach high amplitudes at the bench scale gives investigators a wide range of ultrasonic exposure parameters. When optimal conditions are established, the process can be transferred to commercial scale utilizing the ISP-3000 industrial ultrasonic processor.

Reactor Chamber (Flow Cell)

The BSP-1200 processor can be implemented in two processing modes: **batch** and **flow-through** (see below). With the use of the **reactor chamber** (flow cell), the processor can be configured for continuous liquid processing in the flow-through mode. When a large amount of material needs to be processed, this arrangement is preferable to the batch mode because it results in a much higher processing capacity, improved ultrasonic exposure uniformity and better temperature stability. During continuous ultrasonic processing, the use of the reactor chamber ensures that all working liquid is directed through the active cavitation zone(s) created by the incorporated HBH-type horn, resulting in homogeneous processing and high product quality. The reactor chamber supplied with the BSP-1200 processor includes a water-cooling jacket to help maintain the temperature of the working liquid at the desired level.

System Productivity

Productivity rates provided by the BSP-1200 processor are highly dependent on the nature of each process and range from about 1 L/h for challenging tasks (e.g., top-down nano-crystallization of active pharmaceutical compounds) to over 500 L/h for fast processes (e.g., degassing, oxidative waste-water purification, biodiesel production).

Batch Mode

Batch mode processing does not require the reactor chamber. In this mode, the processed liquid is placed in a batch container. Batch mode is commonly used for ultrasonic degassing of oils, paints, epoxies and other liquids as well as for new process investigations.

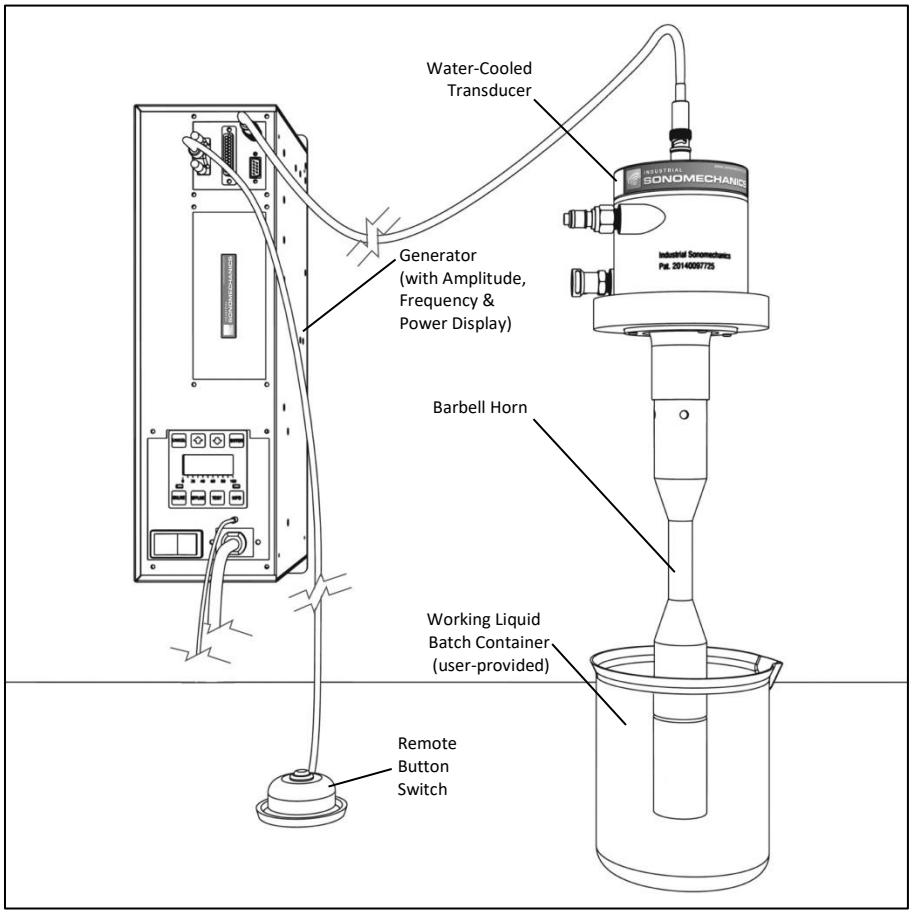


Figure 1 - 1. A schematic of the BSP-1200 ultrasonic processor in its batch configuration is illustrated. The 1,200 W ultrasonic generator excites vibration in the piezoelectric transducer. The vibration amplitude is amplified by the FBH-type Barbell horn, and the ultrasonic energy is delivered to the liquid in the batch container. The horn is immersed into the liquid to its nodal point (to the depth of about 60 – 80 mm). Batch sizes of up to about 2 L can commonly be processed using this setup directly. Larger batches may require that the processed liquid be independently mixed. The liquid may be cooled by using a container with a cooling jacket.

CAUTION

Always make sure to immerse the horn into the liquid to this depth, otherwise upward spraying of the liquid may occur.

CAUTION

Use only the provided support arm to mount the transducer on the support stand.

Flow-Through Mode

Recirculating and **single-pass** configurations are possible in the **flow-through** processing mode. In the recirculating configuration shown below, the material passes through the reactor chamber multiple times, which increases the cumulative exposure time. This configuration is recommended for challenging processes, such as nano-crystallization, nano-emulsification, de-agglomeration, etc. The single-pass configuration is commonly used as a part of multistep processing involving different modalities. In this configuration, the working liquid coming from a previous processing step passes through the reactor chamber, after which it is either collected as the final product or continues down the line for further processing. This arrangement is common for faster processes, such as waste-water purification or biodiesel production.

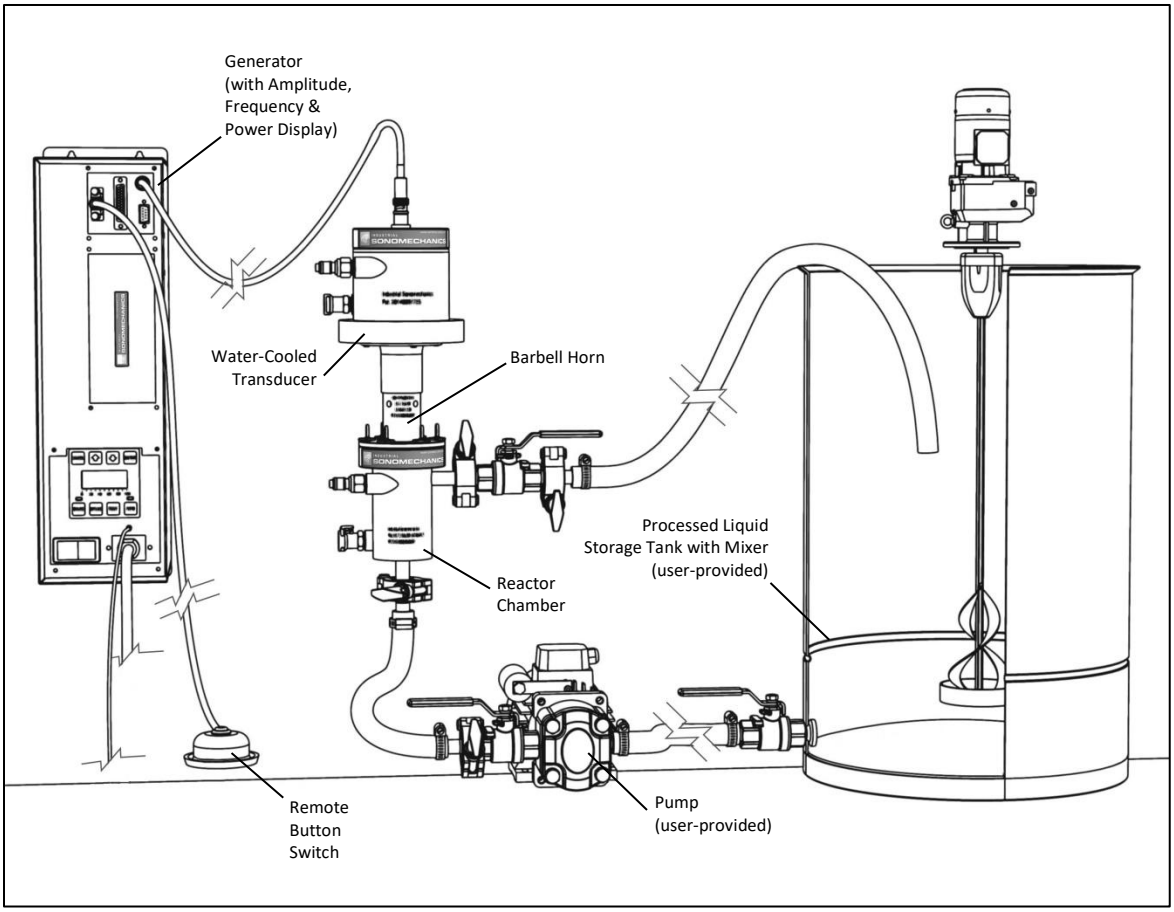


Figure 1 - 2. A schematic of the BSP-1200 ultrasonic processor in its most common recirculating configuration is illustrated. The 1,200 W ultrasonic generator excites vibration in the piezoelectric transducer. The vibration amplitude is then amplified by the HBH-type Barbell Horn, and the ultrasonic energy is delivered to the liquid flowing through the reactor chamber.

CAUTION

Use only the provided support arms to mount the transducer and the reactor chamber on the support stand. Always make sure to support both the transducer and the reactor chamber.

Section 2

Health and Safety

General Considerations

Please observe these health and safety recommendations for safe, efficient, and injury-free operation of your equipment. A typical system consists of the **generator**, remote button **switch**, connecting and grounding **cables**, **transducer**, Barbell **horn** and **reactor chamber**.

CAUTION

Proper Installation – Operate system components only after they are properly installed and checked.

Comply with Regulations – You may be required to add accessories to bring the system into compliance with applicable OSHA regulations for machine guarding and noise exposure.

Avoid physical damage - Do not drop, hit or strain any component of the ultrasonic processor.

WARNING

No Unauthorized Modifications – Do not modify your system in any way unless authorized to do so by the manufacturer. Unauthorized modifications may cause injury to the operator and/or equipment.

Keep the Cover On – Do not remove any equipment cover unless specially directed to do so by the manufacturer. The generator produces hazardous electrical voltages, which could cause injury.

Grounded Electrical Power – Operate this equipment only with a properly grounded electrical connection. (See *Electrical Safety* and the grounding instructions below).

WARNING

Wear ear protection to reduce the noise emitted during ultrasonic processing. In addition, sound absorbing materials, enclosures or sound deflectors may be installed to reduce the noise level.

Domestic and International Power Grounding

For safety, this product has a three-wire, grounding-type power cord. Figure 2 - 1 illustrates the appropriate electrical outlet to use with the power cord that is included with 120 V rated generators shipped to North America. The power cable normally provided for international use is compatible with the power outlet used in many Continental European countries (Refer to Figure 2 - 2.)

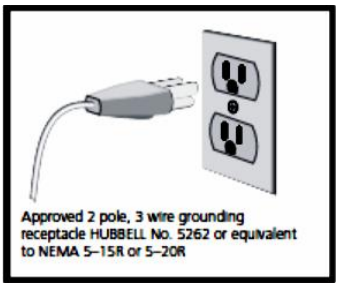


Figure 2 - 1. Example of 120 Volt, Grounded, 3-Prong Receptacle

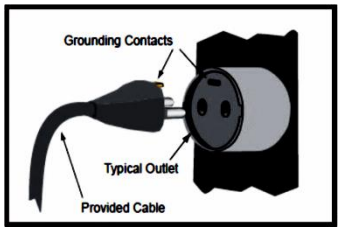


Figure 2 - 2. International 220/240V Grounding

WARNING

If there is any question about the grounding of your receptacle, have it checked by a qualified electrician. Do not cut off the power cord grounding prong or alter the plug in any way. If an extension cord is needed, use a three-wire cord that is in good condition. The cord should have an adequate power rating to do the job safely. It must be plunged into a grounded receptacle. Do not use a two-wire extension cord with this product. If you have a two-prong electrical receptacle, we strongly recommend that you replace it with a properly grounded three-pong type. Have a qualified electrician replace it following the National Electric Code and any local codes and ordinances that apply.

SECTION 3

Generator Installation

Key Generator Features

- **Compact Enclosure Size** means that a very small footprint is required. 220/240VAC systems - come in a low profile (3.5”) compact enclosure. 110/120VAC systems - come in a high profile (5.25”) enclosure.
- **Pulse Width Modulation** incorporates circuitry giving the generator the ability to efficiently change the output amplitude.
- **Linear Ramp Soft-Start** circuitry allows the transducer/horn to be brought to operating amplitude smoothly, minimizing start-up surges and abnormal stress to the transducer, horn and generator.
- **Automatic Tuning** tracks the resonant frequency of the acoustic stack (transducer/horn assembly) and adjusts the generator output frequency to match it. This eliminates the need to manually tune the generator.
- **Line Voltage Regulation** automatically maintains constant amplitude regardless of line voltage deviation. The available output power is maintained with any voltage input within the specified range. This provides consistent system performance regardless of line voltage fluctuations. It also eliminates the need for bulky, external constant-voltage transformers.
- **Load Regulation** provides constant ultrasound amplitude automatically regardless of power draw. The ultrasonic output amplitude level is held to within ±1%.
- **High Line-Voltage Power Supply** means that 220/240VAC systems will operate worldwide at the local high line voltage level, whether it is 200VAC @ 60Hz in Japan, 240VAC @ 50Hz in Europe or 208VAC @ 60Hz in the United States. There are no internal transformer taps to change for world-wide operation.
- **Flow-Through Cooling Tunnel** with a high-performance heat-sink and thermostatically controlled fan reduces thermal gradients and increases component life.
- **AC Power Inrush** protection reduces electrical stress on the internal components by protecting them from AC power start-up transient current surges.
- **Multiple Electronic Overload** protection circuits prevent instantaneous component failure in the event of extreme output overload conditions.
- **CE Certification** means that the system meets the required European standards to be sold and used in Europe.

Unpacking

Carefully open your shipping container and make sure it contains the items shown on the shipping documents. Inspect all items, and report any damage immediately.

Placing

Vertical Panel Mount Chassis

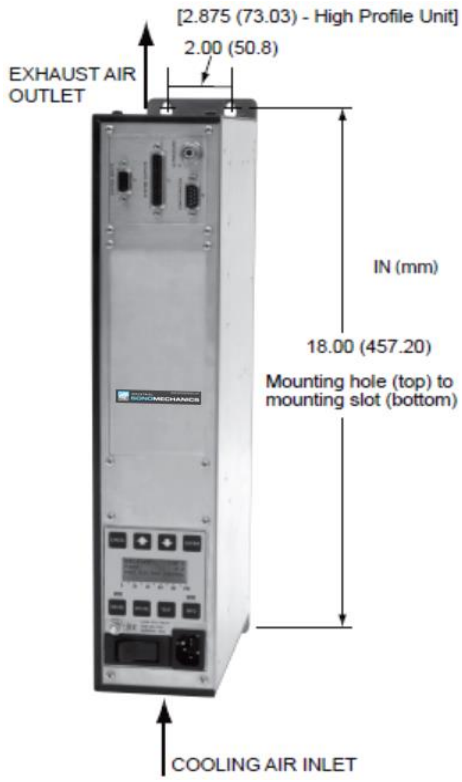


Figure 3 - 1. Vertical Panel Mount Chassis Placement (Low profile unit shown with optional panel mounting plate.)

Make certain the generator placement and cable routing allows for easy access and that they do not interfere with normal operation. The operator should have unobstructed access to any control switches and should have a clear view of the LCD panel, and generator status LEDs.

Hang the generator securely by the upper and lower holes in the mounting panel with its control panel easily accessible as shown in Figure 3-1. Allow at least 5 inches (13 cm) of space on the top and bottom of the generator chassis for air circulation. If the generator is installed inside an enclosure with a front door, be sure to allow at least 3 inches (8 cm) clearance behind the door for the system cables.

CAUTION

Allow 5 inches for air ventilation at the cooling air inlet and at the exhaust air outlet. The fan draws in fresh air to cool the internal components, reduce thermal gradients and increase components' life.

WARNING

Do not allow any liquid or mist to enter the internal area of the generator in any way, for example, through its air inlet or outlet. This may cause an electrical short.

Horizontal Panel Mount Chassis

Generator placement and cable routing should permit easy access and not interfere with normal system operation. Allow at least 5 inches (13 cm) of space on both ends of the generator chassis for air circulation. Allow a 3 inch space (8 cm) in the front of the chassis for cable clearance.

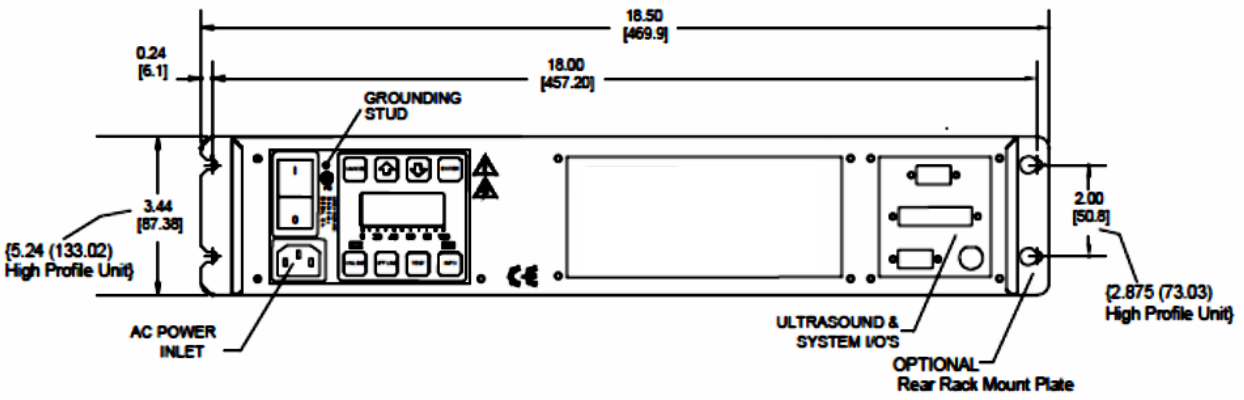
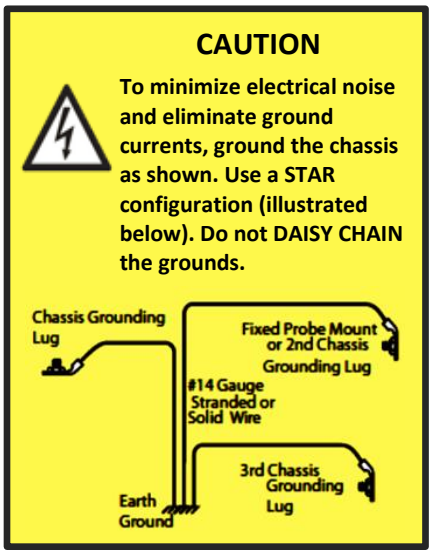


Figure 3 - 2. Horizontal Panel Mount Chassis (low profile unit shown with optional rear rack mount plate)

RFI Grounding

In addition to the safety considerations previously mentioned, proper grounding at the generator power cord is essential for the effective suppression of electrical noise or RFI (Radio Frequency Interference). Every ultrasonic generator contains a RFI filter which blocks noise on the AC power line from entering the system control circuitry. This filter also prevents ultrasonic frequency noise from being fed back into the AC power line. In order for the RFI filter to operate properly, it is necessary to correctly ground the system. Run a grounding wire from the ground stud connection (see Figure 3 - 2) to the nearest grounded metal pipe or equivalent earth ground, and secure it with a ground clamp.



Connecting Cables (Quick Start Guide)

The connections are the same for both the vertical and horizontal generator configurations. However, the panel location of the connectors differs between the two chassis styles. Details about the various system connectors are covered in Section 4.

Power Cords

The 3 - wire grounding AC line cords supplied with the standard generators are matched to the ultrasonic output power rating and the continent of specified use.

NOTE

Horizontal bench generator is shown for reference. Vertically mounted units use the same connections, but those connections have a different orientation. (See Figure 4 - 1).

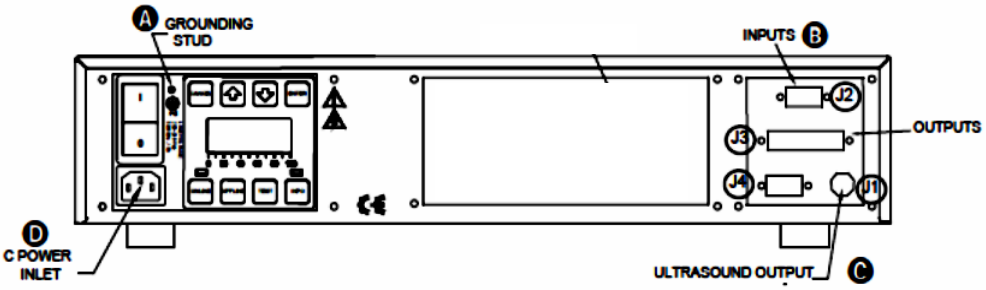


Figure 3 - 3. Horizontal Bench Generator

Connecting System Cables

(See Figure 3 - 3 for connection locations.)

Step 1. Ground the generator chassis using the supplied 14 - Gauge wire - attaching it to the grounding stud.
A in Figure 3 - 3.

Step 2. Attach the included cable with remote button switch to the generator's input HD - 15 connector, J2 on the I/O panel.
B in Figure 3 - 3.

Step 3. Attach the high voltage coax cable from the transducer to the ultrasound output connector J1.
C in Figure 3 - 3.

Step 4. Power cords with an IEC connector are always supplied with bench chassis style and 240 V rated generators. Connect the AC power cord to the generator IEC power inlet connector, and plug the other end into an approved AC outlet. 120 V rated systems have permanently mounted power cords.
D in Figure 3 - 3.

SECTION 4

Generator Connections

Panel Layout Overview

Vertical Panel Mount Chassis

This section provides an overview of the vertical panel mount chassis layout, which includes panel areas dedicated to various standard system functions and options. Figure 4 - 1 illustrates the panel layout for a vertical panel mount chassis.

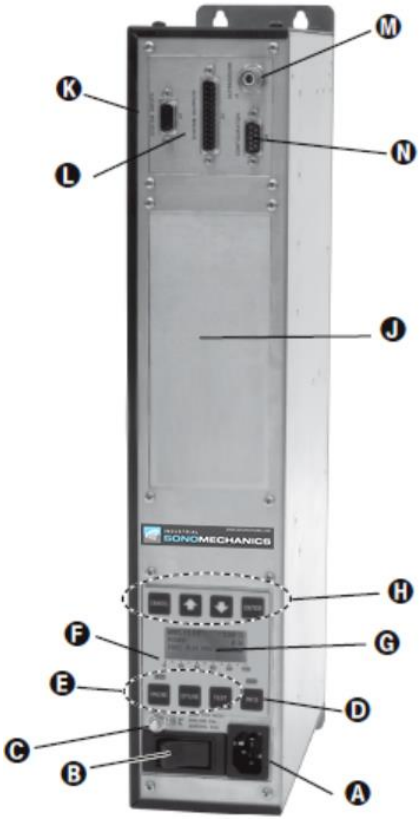


Figure 4 – 1. Panel Layout - Vertical Panel Mount Generator

AC Power Inlet Panel

- **A** IEC Power Inlet Connector – Attaches to an IEC style power cord. 120 V rated systems have permanently mounted power cords.
- **B** Power Switch / Circuit Breaker – Used to switch system power **ON** and **OFF**.
- **C** Chassis Ground Stud – Chassis connection for a protective earth ground.

System Status Control Panel and Display

- **D** **INFO** Key.
- **E** System Operating Mode Keys and Status LEDs.
- **F** Power Output Level Scale.
- **G** 4 - line LCD Display.
- **H** Display Control Keys.
  Section 5 provides descriptions of these basic user controls and status LEDs.
- **J** Blank Panel.

System I/O Panel

- **K** System Input Connector – Connections for system control input signals
- **L** System Output Connector – Connections for system status output signals
- **M** Ultrasound Output Connector – Coaxial high voltage connection to ultrasonic transducer
- **N** Configuration Port Connector – Digital control port to modify system parameters

AC Power Inlet Panel

The standard AC power inlet panel is described in this section.

IEC AC Power Inlet Connector

The IEC AC power inlet connector mounted on the system AC power inlet panel requires a properly configured IEC compliant power cord, which enables worldwide system operation by simply changing the power cord.

Low profile systems are equipped with a 10 Amp rated IEC inlet connector. The high profile systems include a 16/20 ampere rated IEC inlet connector.

An appropriately rated power cord must be securely attached to the system's IEC inlet connector. If the correct power cord configuration is not included with the system for the local AC power outlet at your location, an appropriate IEC power cord should be available from a local electrical parts supplier.

Power Switch/Circuit Breaker

The power switch/circuit breaker has a rocker type actuator switch that will activate or deactivate the AC power to the system. The power **ON** position is marked with the internationally recognized **I** symbol, the power **OFF** position is marked with the **O** symbol. This power switch also integrates an appropriately sized over-current protection circuit breaker function in the generator.

If an over-current condition trips the circuit breaker, it will automatically switch to the **OFF** position. If the overload current that caused the circuit breaker to trip is due to a transient condition, the circuit breaker can be reset by switching the actuator back to the **ON** position. If when resetting the circuit breaker after it has tripped, it immediately trips again, there is likely an internal system malfunction, and the generator will require service.

Do not repeatedly try to reset the circuit breaker. If it trips, this will only cause more damage to the generator.

WARNING

The output from the ultrasound output connector (that drives the attached ultrasonic load) has a very high AC voltage and can exceed 2 amperes of current. It must be securely terminated via the ultrasound cable for safe operation. Use original equipment ultrasound cables for safe and reliable system operation. Improperly assembled ultrasound cables can result in high voltage arcing and will destroy the ultrasound connectors.

Do not use your generator if there is any evidence of arcing (black carbon deposits) on either the ultrasound output connector or the ultrasound cable connectors.

Chassis Ground Stud

The chassis ground stud is used to attach a protective earth ground to the generator. This will aid in the suppression of electrical interference or radio frequency interference (RFI) that is common in an industrial environment. The chassis ground stud is **C** in Figure 4 - 1. Proper system grounding is discussed in Section 3.

Ultrasound Output Connector

The ultrasound output connector used with all standard generators is a high voltage (5000V) coaxial style SHV-BNC connector. This connector provides superior shielding of electrical noise, compared to other types of connectors. The ultrasound output connector mates with a fully shielded coaxial ultrasound cable that is secured with a simple and reliable quarter-turn bayonet style attachment mechanism.

Figure 4 – 2. Ultrasound Output Connector

WARNING

Make sure to always connect the ultrasound cable to both the transducer and generator. Do not activate ultrasound if the cable is not connected to both devices.

SECTION 5

Generator Status and Controls

Control Panel and Display Overview

This section provides an overview of the control panel and display. The panel has two functions:
1) Monitoring, using the LED status lights, and
2) Display and control, using the Display Controls with the LCD display.

Figure 5 - 1 identifies the primary parts of the panel that are described in the pages that follow.

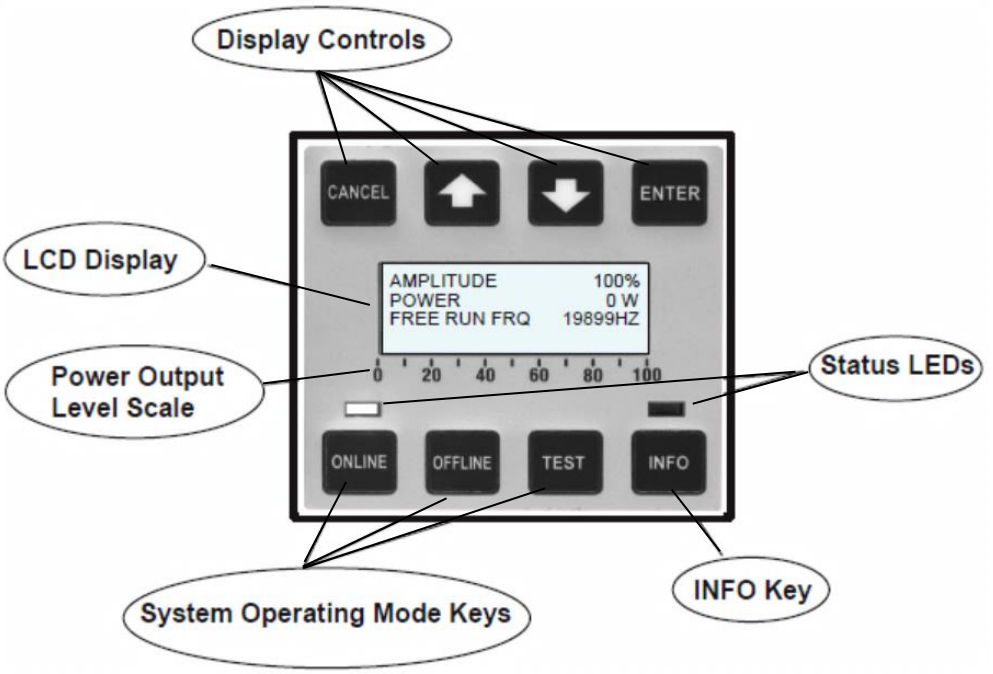


Figure 5 – 1. Control Panel and Display

Display Controls

The four keys on the top of the panel provide control for the LCD display.

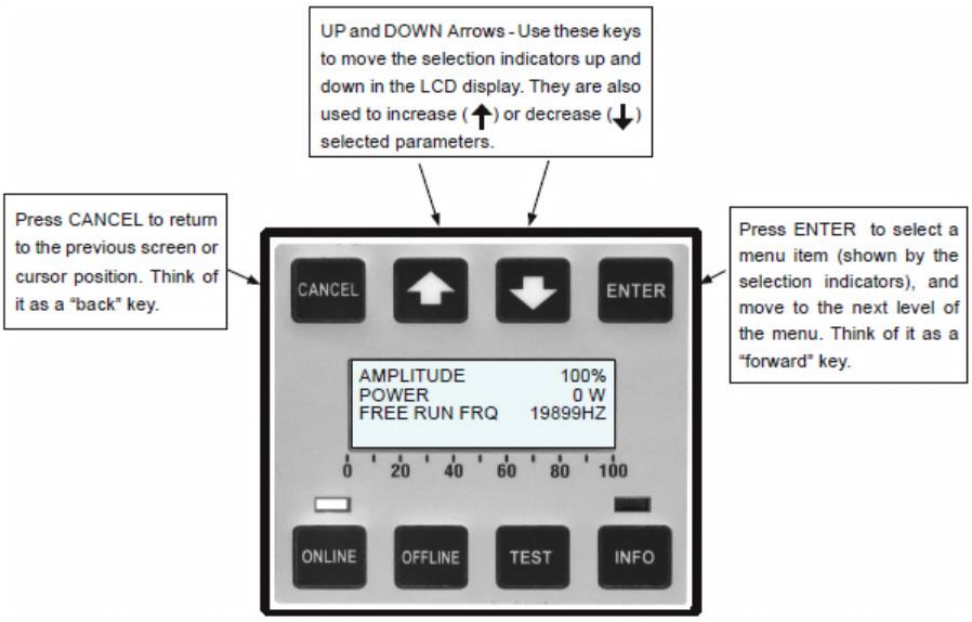


Figure 5 – 2. Control Panel Display Control

LCD Display

The 4-line LCD display gives the operator a basic interface for generator monitoring and control. Figure 5 - 3 illustrates a typical view of the display just after the generator has been powered up.

Figure 5 – 3. Display After Power-up

Power Output Level Scale

Figure 5 - 4 shows what a display might show when the TEST key is pressed. In this example, the generator is producing an ultrasound signal at approximately 90% of its capacity.

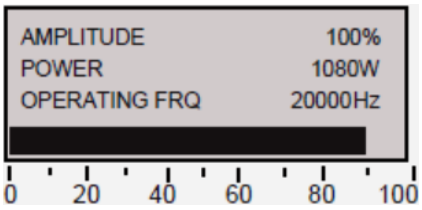


Figure 5 – 4. Power Output Level Scale

System Operating Mode Keys

The system operates in three basic modes: **ONLINE**, **OFFLINE**, and **TEST**.

Figure 5 - 5 shows the mode keys at the bottom of the control/display panel. Also note the location of the left and right status LEDs.

ONLINE

Press the **ONLINE** key to operate in the online mode.

In this mode, ultrasound can be activated. The LED above the **ONLINE** key is GREEN when the generator is online.

OFFLINE

Press the **OFFLINE** key to operate in the offline mode. Select this mode during your process setup without ultrasound activated.

In the offline mode, ultrasound cannot be activated. The LED above the **ONLINE** key is YELLOW when the generator is offline.

TEST

Press (and hold) the **TEST** key to operate in the test mode.

In this mode, ultrasound output will activate for the time that the **TEST** key is pressed. In test mode, the right status LED changes from being GRAY (Off) to GREEN. This mode is typically used when setting up an application. It is not normally used during an actual process.

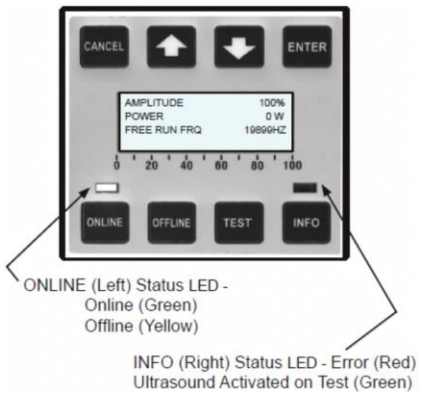


Figure 5 – 5. Operating Mode Keys and LEDs

NOTE

Use the test mode only when:
1). The ONLINE GREEN LED indicates that the generator is online, and
2). When the ultrasound output cable at J1 is connected to a probe/stack.

INFO Key

Press the **INFO** key.

Figure 5 - 6 shows what the **INFO** display looks like.

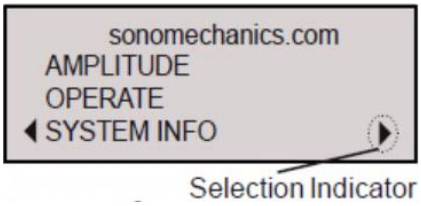


Figure 5 – 6. INFO Display

SYSTEM INFO

Select **SYSTEM INFO** (See the selection indicators shown in Figure 5 - 6), and press **ENTER** to view:

- Firmware revision, and
- System identification including model number

See Figure 5 - 7 for a **SYSTEM INFO** example.

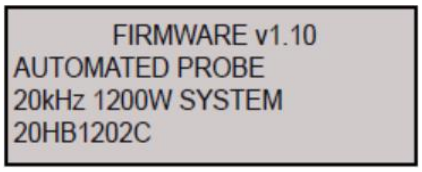


Figure 5 – 7. SYSTEM INFO Example Display

OPERATE

Select **OPERATE**, and press **ENTER** to view:

- Amplitude,
- Power, and
- Free Run Frequency

These values reflect what the parameters were during previous operation.

See Figure 5 - 8 for an example of the **OPERATE** display.

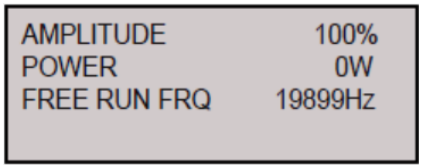


Figure 5 – 8. OPERATE Example Display

AMPLITUDE

Select **AMPLITUDE**, and press **ENTER** to view, and to change the amplitude setting.

Amplitude is a value with a minimum of 20% and a maximum of 100%.

See Figure 5 - 9 for an example of the **AMPLITUDE** display.

Use the **UP** and **DOWN** arrow keys to set the desired value.

Make the change, press **ENTER**, and **ENTRY ACCEPTED** will be displayed confirming that the change was made.

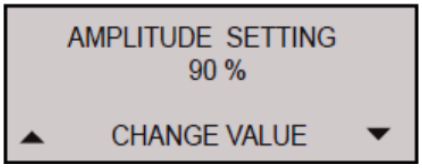


Figure 5 - 9. AMPLITUDE Example Display

NOTE

Pressing the UP arrow key when 100% is displayed will change the percentage to 20%.
Pressing the DOWN arrows key when 20% is displayed changes the percentage to 100%.

Status LEDs

Status LEDs provide operating status for system power, the system operating mode and system output status as described below:

INFO Status Indicator

(*On the panel's right side*)

GREEN = generator ultrasound output is activated.

RED = Could be due to one of the three conditions listed below:

Red Fast Flashing (4 flashes per second) - Indicates an under or over voltage condition in the AC line voltage connected to the generator. If the proper voltage range is not maintained, a line voltage fault will inhibit system operation, and the **INFO** status indicator will flash approximately four times per second. This flashing may occur momentarily when the system power is switched off and does not indicate a problem or malfunction.

RED Slow Flashing (1 flash per second) - Indicates that the DC bus capacitors are not charged to the proper voltage level. This is a normal condition whenever the system is switched on. The DC bus capacitors will normally charge to the proper voltage level within 10 seconds. Then the **ONLINE** indicator should switch to a steady GREEN (if **ONLINE**), or YELLOW (if **OFFLINE**). If the slow flashing indication continues and does not stop, an internal problem is preventing the DC bus capacitors to charge to the proper voltage level. The system will require service, if this fault condition continues to flash and does not stop. Do not allow the system to operate in this fault condition for an extended period of time. There is likely a shorted internal component causing this type of fault condition, and some internal parts might get very hot as a result. If this fault occurs, switch the unit off, and return the generator for service.

Steady RED (No flashing) - Indicates that there is a problem with one of the DC voltage outputs on the system control power supply. If this fault condition occurs, switch off the system power, and return the generator for service.

ONLINE Status Indicator

(*On the panel's left side*)

GREEN = ONLINE

generator ultrasound output is activated.

YELLOW = OFFLINE

generator ultrasound output is deactivated.

Some system fault conditions will reset automatically. A system overload inhibits the ultrasound output when it occurs, but will automatically reset when the next ultrasound activation signal begins.

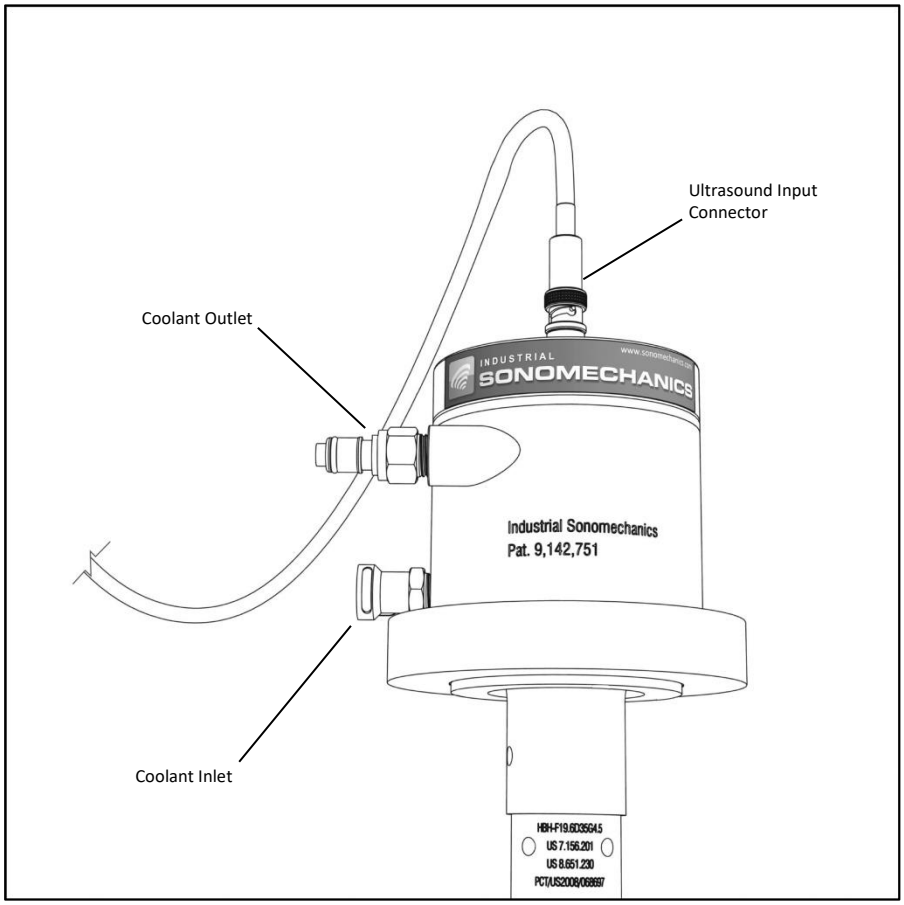
If an over-temperature condition is the cause of the fault indication, the fault condition will automatically reset when the system cools. Most other system fault conditions will not reset. In those cases the generator needs servicing.

SECTION 6

System Assembly, Testing and Operation

SWCT-1200 Ultrasonic Transducer

Ultrasonic transducers are devices used to convert electric energy coming from an ultrasonic generator into mechanical energy in the form of ultrasonic vibrations.



CAUTION

Operating the SWCT-1200 transducer without cooling water may cause irreversible damage and is strictly prohibited.

CAUTION

The ultrasound cable assembly should not be used to carry the transducer or pull it toward the user. Make certain the cable always has slack and is never tensioned. If necessary, move the generator or transducer closer to one another to accomplish this. If this is not possible, contact your ISM client representative to obtain a longer cable.

Figure 6 - 1. Sealed Water-Cooled Piezoelectric Transducer, SWCT-1200

The SWCT-1200 ultrasonic transducer (see Figure 6 - 1) can operate continuously, generating vibration amplitudes up to 24 microns at the frequencies around 20 kHz. This device is compatible with all ISM's ultrasonic horn types. SWCT-1200 is completely sealed to the outside environment, which makes it immune to high-humidity conditions and suitable for processing flammable materials, such as fuels and organic solvents.

WARNING

Do not remove any labels or stickers from the transducer, detach its cooling connectors or open the transducer housing lid. This may allow a liquid to enter the internal area of the transducer and cause an electrical short.

Coolant Inlet & Outlet

In continuous duty operation, it is important to keep the transducer cool with flowing water, supplied through the coolant inlet and taken out of coolant outlet. The water flow rate must be at least 5 L/min and its temperature must be below 15 °C. Other chilled liquids may be used, but their minimum required flow rates are likely to be higher.

Support Arm

The support arm (not visible in Figure 6 - 1) is screwed into the transducer chassis and is used for positioning the transducer in a clamp holder on a support stand.

Ultrasound Input Connector

The ultrasound input connector is a high voltage coaxial style SHV-BNC connector. This connector provides superior shielding of electrical noise. The ultrasound input connector mates with a fully shielded coaxial ultrasound cable that is secured with a simple and reliable quarter-turn bayonet style attachment mechanism.

WARNING

The input into the ultrasound input connector has a very high AC voltage and can exceed 2 amperes of current. It must be securely terminated via the ultrasound cable for safe operation. Use original equipment ultrasound cables for safe and reliable system operation. Improperly assembled ultrasound cables can result in high voltage arcing and will destroy the ultrasound connectors.

Do not use your generator if there is any evidence of arcing (black carbon deposits) on either the ultrasound output connector or the ultrasound cable connectors.

WARNING

Make sure to always connect the ultrasound cable to both the transducer and generator. Do not activate ultrasound if the cable is not connected to both devices.

Ultrasonic Horn

Liquids exposed to high-intensity ultrasound undergo ultrasonic cavitation, which produces violently and asymmetrically imploding bubbles and causes micro-jets that create extreme mechanical shear forces. These forces are responsible for the well-known ability of ultrasound to facilitate many physical and chemical processes. In order to produce sufficient cavitation intensity, ultrasonic transducers are equipped with high-gain acoustic horns, which amplify the vibration amplitudes generated by the transducers and deliver the ultrasonic energy to working liquids.

The BSP-1200 ultrasonic processor is supplied with an HBH (Figure 6 – 2) or FBH-type (Figure 1 -1) ultrasonic Barbell horn.

CAUTION

NEVER clamp the horn in a vise. The resulting scratches or gouges in the surface are stress risers, which may result in cracks.

CAUTION

Do not allow any vibrating surface of a horn or transducer to come in direct contact with any solid object (e.g., batch container, support clamp, reactor chamber) during system operation.

Attaching the Mounting Stud to the Horn*

1. Inspect the stud for cracks or damaged threads. Replace the stud if it is cracked or otherwise damaged.
2. Remove any foreign matter from the threaded stud and the mating hole.
3. Thread the mounting stud into the input* end of the horn and lightly tighten using an Allen wrench in the socket head of the mounting stud.

**Only applies to horns without integrated mounting studs.*

***Always attach and tighten the mounting stud to the horn first, before assembling the horn with the transducer.*

NOTE

Do not apply any grease to the stud threads or the tapped hole. This may cause the stud to loosen. If the stud wanders within the joint, it can vibrate, resulting in excessive heat. In some cases, this can melt the tooling material.

Attaching the Horn to the Transducer

1. Inspect all surfaces to be joined for stress cracks, chips, or gouges. Any of these irregularities will affect operation and could lead to further equipment damage.
2. Ensure that the mating surfaces of the two components are clean and smooth. These surfaces must make intimate contact for the mechanical energy to pass from one component to the next. Pitting or a buildup of old grease and dirt on a mating surface will interfere with the energy transfer and reduce the delivered power.
3. Make sure that the mounting stud in the horn is tight. See the preceding mounting stud assembly instructions.
4. Remove any foreign matter from the threaded stud and mating hole.
5. (For flow through-mode) Place an o-ring followed by the reactor chamber lid over the top of the horn.
6. Place the provided Mylar acoustic interface washer over the mounting stud against the horn's mating surface before assembling the components.
7. Thread the components together by hand and then tighten using the supplied spanner wrenches. See Figure 6 – 2 for the correct tightening procedure.

CAUTION

Never leave a horn-transducer assembly hand-tight. Torque it to the proper specifications before proceeding. If the assembly is installed without being properly torqued down, the assembly may vibrate severely, damaging the mating surfaces and causing the generator to overload. Always use the Mylar washer (one) during this procedure, otherwise mating surfaces may permanently bond. Make sure the washer is in good condition, without scratches or rips. Using a damaged washer may cause the assembly to operate incorrectly.

8. After attaching a new horn, use the *Scan Stack Procedure* described in Appendix I.

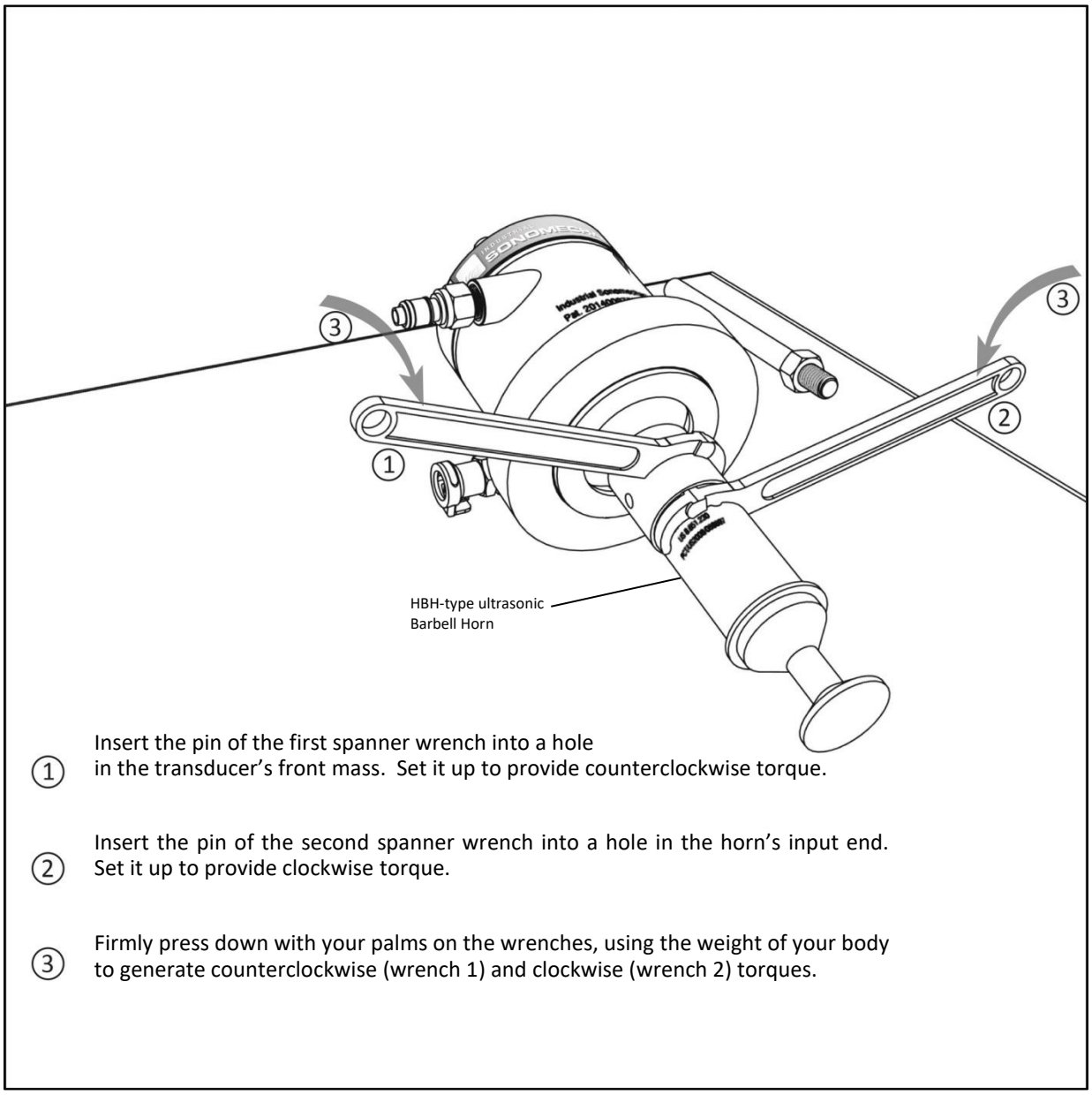


Figure 6 – 2. Transducer – HBH-Type Barbell Horn Tightening Procedure

CAUTION

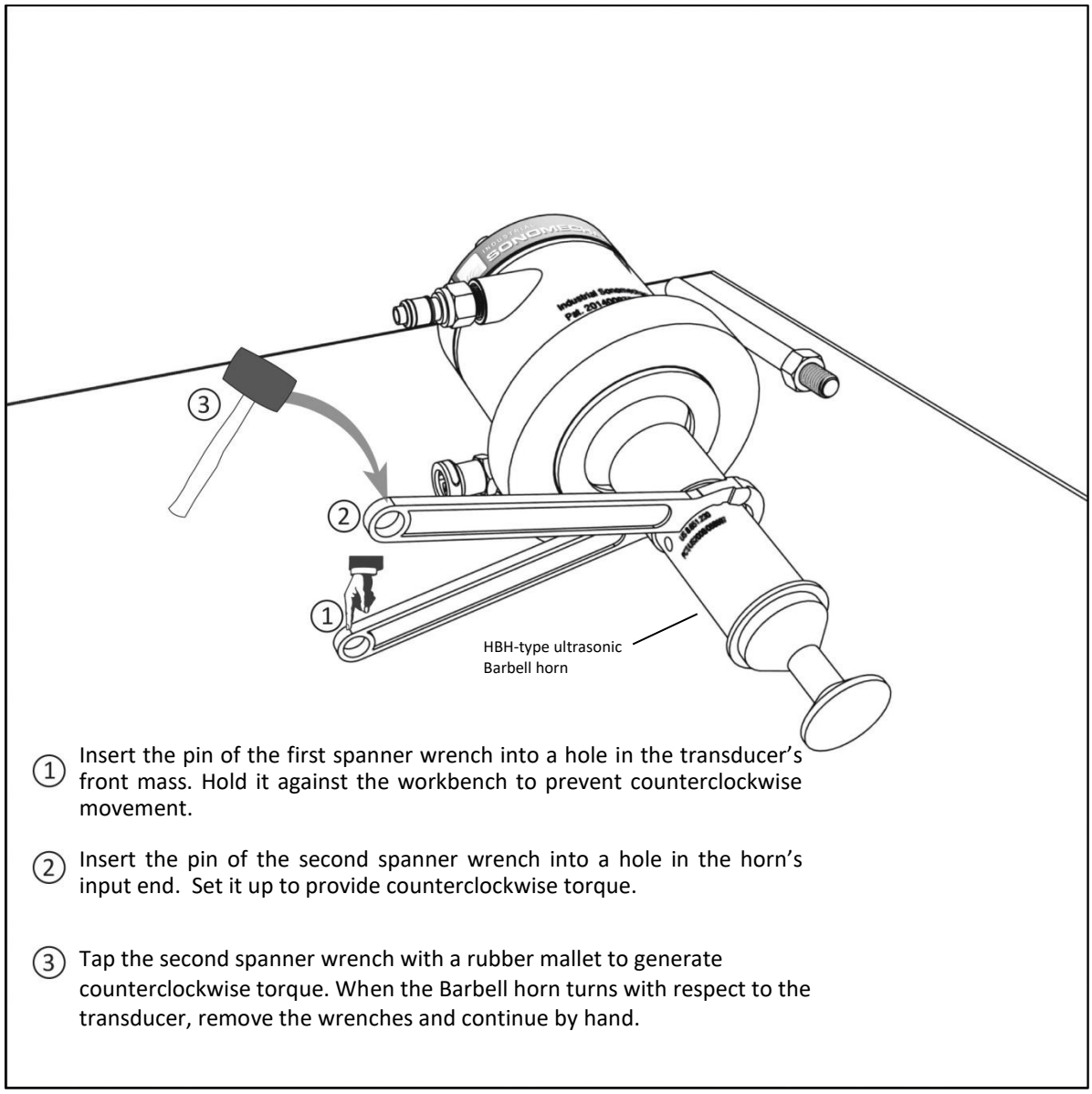
The transducer support arm and reactor chamber should not be attached when attaching the horn to the transducer.

CAUTION

Do not substitute the provided spanner wrenches with any other tools. Never rely on the transducer's support arm instead of the provided spanner wrench during the horn attachment or detachment procedure as it may permanently damage the transducer.

Detaching the Horn from the Transducer

On all transducers and horns with spanner wrench holes, use only the correct size spanner wrenches to provide sufficient torque to loosen a joint. See Figure 6 - 3.



1. Insert the pin of the first spanner wrench into a hole in the transducer's front mass. Hold it against the workbench to prevent counterclockwise movement.
2. Insert the pin of the second spanner wrench into a hole in the horn's input end. Set it up to provide counterclockwise torque.
3. Tap the second spanner wrench with a rubber mallet to generate counterclockwise torque. When the Barbell horn turns with respect to the transducer, remove the wrenches and continue by hand.

Figure 6 – 3. Transducer – HBH-Type Barbell Horn Loosening Procedure

CAUTION

The transducer support arm and reactor chamber should be removed before detaching the horn from the transducer.

CAUTION

Do not substitute the provided spanner wrenches with any other tools. Never rely on the transducer's support arm instead of the provided spanner wrench during the horn attachment or detachment procedure as it may permanently damage the transducer.

Testing the System

Step 1. Plug in the AC line cord to the correct AC power outlet.

Step 2. Connect the included cable with remote button switch to System Input Connector at the generator (**K** on Figure 4 – 1).

Step 3. Using the high-voltage coaxial cable, connect the ultrasound input connector at the transducer (Figure 6 – 1 and 6 – 2) to the ultrasound output connector at the generator (**M** on Figure 4 – 1). The horn should already be attached to the transducer.

Step 4. Insert the ultrasonic horn into water to a depth of between about 45 and about 65 mm.

Step 5. Push the AC Breaker/Switch **A** to the **ON** position.

Step 6. The **INFO LED** on the panel **B** should flash **RED** for 5 – 10 seconds. Then, it turns off (GRAY), and the LED above **ONLINE C** turns GREEN (if **ONLINE**).

Step 7. **ONLINE/OFFLINE** Tests

a. Press the **OFFLINE** key. The LED status indicator **C** turns to YELLOW.

b. Press and hold the **TEST** key. Ultrasound should not activate.

c. Press the **ONLINE** key. The **LED** status indicator **C** will be GREEN.

d. Press and hold the **TEST** key. Ultrasound should activate. The display shows amplitude, power and operating frequency. The segmented power bar graph should also appear. See the sample screen display - Figure 6 - 6.

e. Release the **TEST** key. Ultrasound should deactivate.

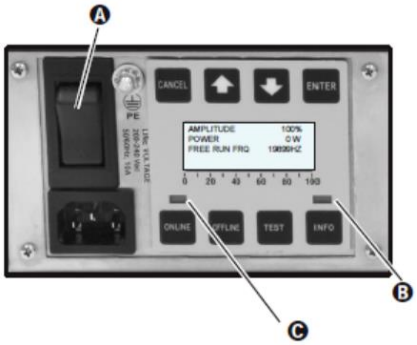


Figure 6 - 5. Control Panel at Startup

NOTE

Inserting the Barbell horn too deep into the processed liquid may cause the system to overload.

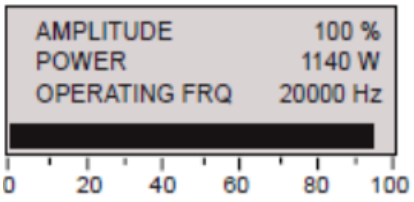


Figure 6 - 6. TEST Screen Display Sample

Running/Stopping the System

Running the System

Press the button on the remote button switch once. Ultrasound should activate. The display shows amplitude, power and operating frequency. The segmented power bar graph should also appear. See the sample screen display - Figure 6 - 6.

Stopping the System

Press the button on the remote button switch once again. Ultrasound will deactivate.

Alternatively, Press the **OFFLINE** key, and the ultrasound signal will deactivate.

CAUTION

Any unusually loud noise from the transducer/horn indicates that they were improperly assembled. If the equipment produces a loud piercing or squealing sound, disassemble the horn from the transducer and repeat the horn attachment procedure following all instructions.

Reactor Chamber

With the use of the reactor chamber (flow cell), the BSP-1200 ultrasonic processor can be configured for continuous liquid processing in a **flow-through mode**. When a large amount of material needs to be processed, this arrangement is preferable to the **batch mode** because it results in a much higher processing capacity, improved ultrasonic exposure uniformity and better temperature stability. During continuous ultrasonic processing, the use of the reactor chamber ensures that all working liquid is directed through the active cavitation zone(s) created by the incorporated Barbell horn (commonly, HBH-type), resulting in homogeneous ultrasonic exposure and high product quality. The reactor chamber commonly includes a water-cooling jacket to help maintain the temperature of the working liquid at a desired level. Alternatively, a separate heat exchanger may be utilized.

Figure 6 – 7 shows the reactor chamber assembled with a Half-wave Barbell Horn (HBH). The output diameter of the horn is commonly in the range of 30 - 35 mm, and the internal volume of the assembly is about 80 ml. The penetration of the horn into the chamber is arranged such that the non-vibrating mounting flange on the horn is "sandwiched" between the body of the reactor chamber and its lid through two O-rings, which ensures a reliable, pressure-resistant seal. The processed liquid is supplied through the "inlet" and collected through the "outlet" sanitary flange connections. Depending on the required process temperature, chilled water or ethylene glycol/water mixture may be supplied through the "cooling" hose barb connections at the reactor chamber's cooling jacket for temperature control.

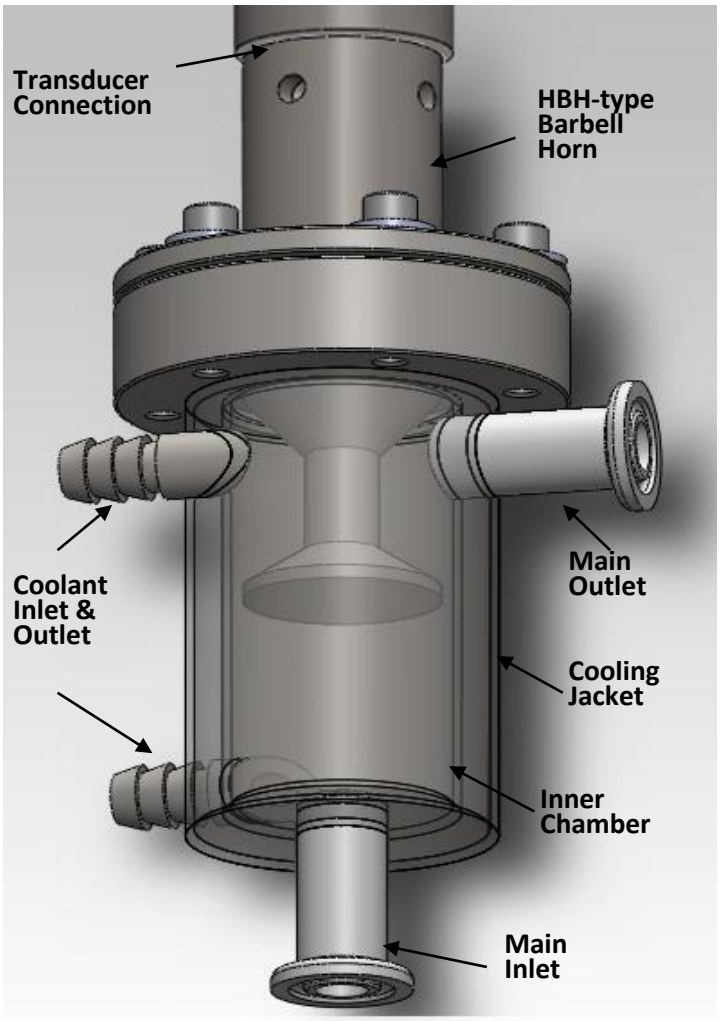


Figure 6 - 7. Reactor Chamber Assembled with a Half-Wave Barbell Horn (HBH)

Assembling the Reactor Chamber with a Barbell Horn

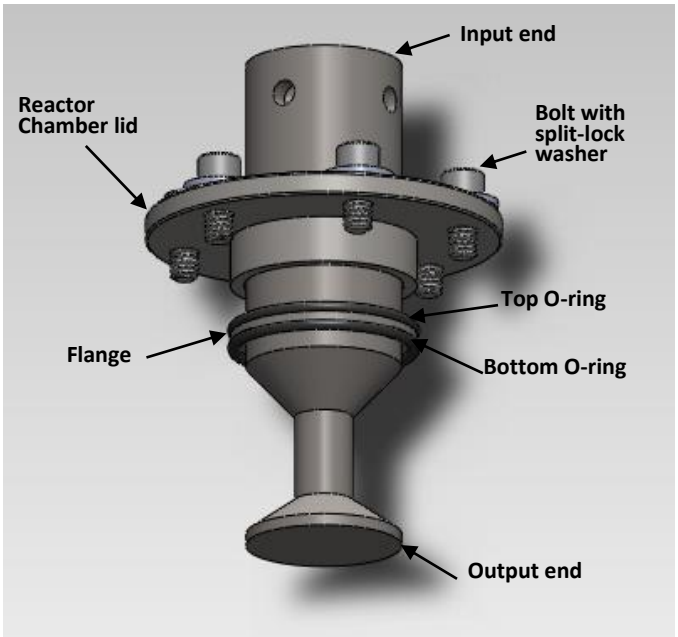


Figure 6 – 8. Step 1.

a) Insert six bolts (commonly, wing bolts) with split-lock washers in the holes in the reactor chamber lid.

b) Place top O-ring over the horn such that it is in contact with the flange from the horn's input end.

c) Place reactor chamber lid with six bolts and washers over the horn from the horn's input end.

d) Place bottom O-ring over the horn such that it is in contact with the flange from the horn's output end. Alternatively, place bottom O-ring into the receiving ring at the reactor chamber body (see Figure 6 – 10).

CAUTION

Do not flip the orientation of the reactor chamber lid.

Make sure to use the supplied O-rings above and below the horn's flange when using the reactor chamber. Failure to include both O-rings may result in a leak and/or incorrect equipment operation.

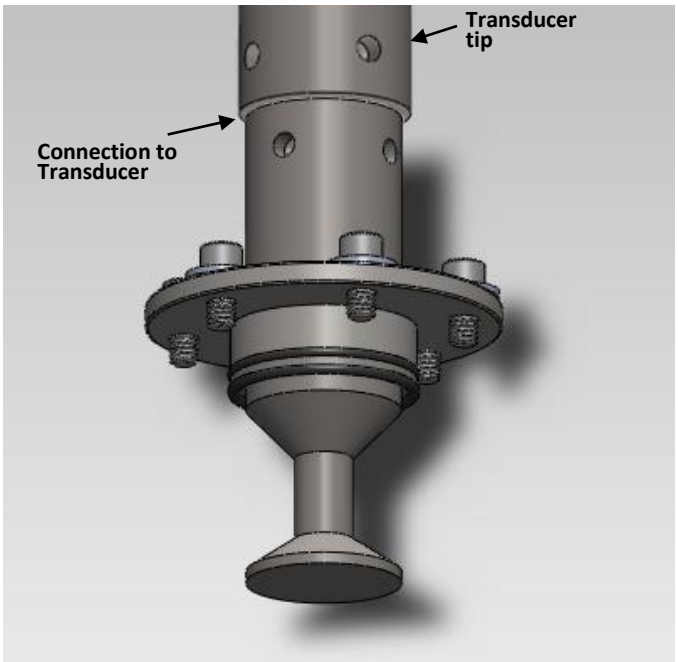


Figure 6 – 9. Step 2.

a) Assemble the transducer with the horn as described in Section 6, subsection "Attaching the Horn to the Transducer" on page 27.

b) Secure the transducer by its support arm in a support stand.

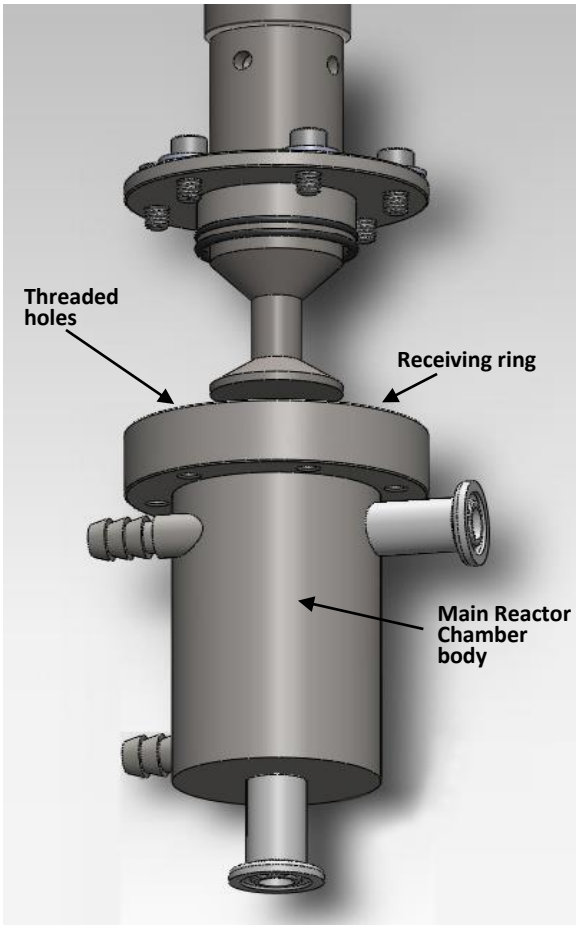


Figure 6 – 10. Step 3.

a) Align the main reactor chamber body such that when it is lifted the horn can enter its internal area.

b) Align the lid such that the bolts match up to the six threaded holes in the receiving ring.

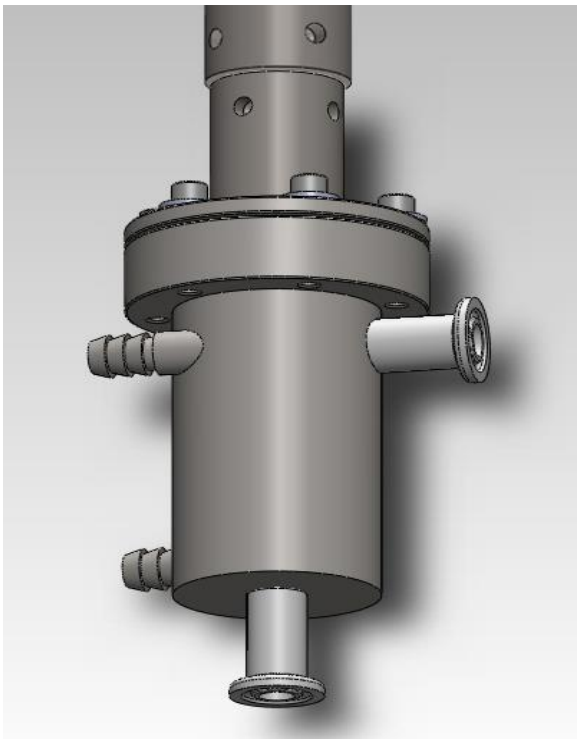


Figure 6 – 11. Step 4.

a) Lift the main reactor chamber body such that the bolts in the lid enter the threaded holes in the receiving ring.

b) Tighten the bolts evenly, maintaining same tension on all sides.

c) Secure the reactor chamber by its support arm in the support stand.

SECTION 7

Troubleshooting

Your Ultrasonic Processor was designed to provide you with years of safe and dependable service. Nevertheless, because of component failure or improper usage, the possibility does exist that it might not perform as it should, shut down or stop working. Before troubleshooting, verify the following items:

1. Make sure that the **ONLINE** status LED is GREEN. If the generator is **OFFLINE**, press the **ONLINE** key (See Figure 7 – 1);
2. Make sure that the high-voltage coaxial cable is connected to the transducer's ultrasound input connector (Figure 6 – 1) and the generator's ultrasound output connector (**M** in Figure 4 – 1);
3. Make sure that both the high-voltage coaxial cable and the cable with remote button switch are securely connected;
4. Make sure the horn and the transducer were properly assembled (page 28).

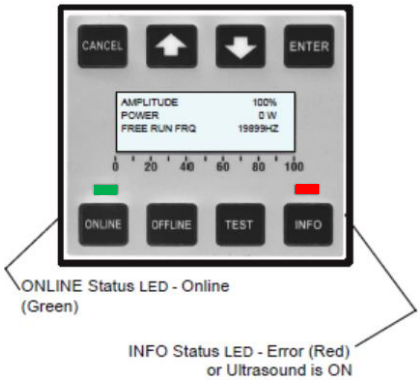


Figure 7 - 1. Status LEDs

CAUTION

Do not make multiple repeated attempts to start the generator after the "overload" error without finding the cause of the problem.

Do not defeat the generator's overload protection by attempting to activate the ultrasonic output at a low amplitude setting (20 – 50 %) when an overload error was repeatedly reported at a higher setting.

NOTE

Be sure to press the ENTER key to clear the fault message and the INFO status LED.

The System Latch Reset Input will only clear the Output I/O faults.

If the fault occurs while using the TEST key, the TEST key will not function again until the ENTER key has first been pressed (to clear the fault message).

Common failures/error messages, probable causes for malfunction and suggested solutions are shown below:

Failure/Error Message	Probable Causes	Suggested Solutions
OVERLOAD – OVER TEMPERATURE…	The generator's surrounding environment is too warm (>100 ˚F, 38 ˚C) for its internal fans to efficiently cool.	Move the generator to a cooler environment (68 – 95 ˚F, 20 – 35 ˚C). If the problem persists, contact ISM.
	The generator's surrounding environment is adequate for cooling, but the internal fans or the connections to the fans are faulty.	Allow the generator to cool while offline for 30 minutes. Test your system and listen for the fan to come on. If the generator becomes hot and the fan has not yet turned on, terminate the test, power off the generator and contact ISM.
OVERLOAD –	A sudden increase in required power was	If the problem persists, contact ISM

V/S VOLTAGE EXCEEDS…	experienced by the generator due to the following possible reasons: Abrupt pressure increase in the reactor chamber; Failed/Broken transducer; Failed/Broken Horn.	
OVERLOAD – FREQUENCY CHECK STACK & CABLE & RAMP UP TIME	Ultrasound cable is not connected to the transducer or generator.	Plug the ultrasound cable into the generator and transducer and test your system.
	System has been assembled improperly or horn/transducer has been damaged.	Disassemble and reassemble your ultrasonic stack (Page 28). Make sure that there is a Mylar washer (one) between the horn and transducer and that they have been properly coupled with the provided spanner wrenches. If the error persists, contact ISM.
	You are testing a new horn for the very first time or using an older horn.	The generator's Free Run Frequency may be too far from the resonance frequency of the horn. See the instructions for "Scanning your Ultrasonic Stack" in Appendix I to reset the Free Run Frequency.
OVERLOAD – AVERAGE POWER ABOVE GENERATOR RATING	The process liquid is too viscous	Try heating the process liquid to decrease its viscosity.
	The horn is inserted too deep into the sample	Use the insertion depth of 3.5 cm as opposed to 6 cm.
	The process liquid is flowing too quickly, building up pressure inside the chamber	Decrease pumping rate.
	Your system has been assembled improperly or your horn/transducer has been damaged	Disassemble and reassemble your ultrasonic stack (Page 28). Make sure that there is a Mylar washer (one) between the horn and transducer and that they have been properly coupled with the provided spanner wrenches. If the error persists, contact ISM.
ERRATIC POWER JUMPS DURING OPERATION	The power reading on the display of the generator should generally be stable within about +/- 100 W, unless the operating procedure changes during processing. Predictable and normal power changes are relatively slow and can be due to the following: An increase in power due to an increase in pressure in the reactor chamber or a deeper insertion of the horn into the working liquid. An increase in power due to an increase in viscosity of the working liquid or the degassing of the working liquid. A decrease in power due to an increase in temperature or a decrease in viscosity of the working liquid. If you notice rapid and high (more than 100 W) power jumps during operation, IMMEDIATELY STOP & CONTACT ISM.	
EQUIPMENT MALFUNCTIONS, LEAKS OR CABLE FRAYING	Manufacturer's error; Careless/frivolous maintenance of equipment; Electric shortage.	Contact ISM for repair.

RAPID HEATING OF THE TRANSDUCER AT THE HORN JUNCTION**	Your system has been assembled improperly or your horn/transducer has been damaged.	Disassemble and reassemble your ultrasonic stack (Page 28). Make sure that there is a Mylar washer (one) between the horn and transducer and that they have been properly coupled with the provided spanner wrenches. If the error persists, contact ISM.

**Due to the high frequency vibrations applied during sonication, the Transducer-Horn junction will always feel hot (and also painful) if it is pressed or grasped. This may be mistaken for "overheating". To correctly judge whether the junction is overheating, initiate ultrasound for 15 seconds, stop the ultrasonic output, and only then feel the junction.

SECTION 8

Generator Specifications

Drawings

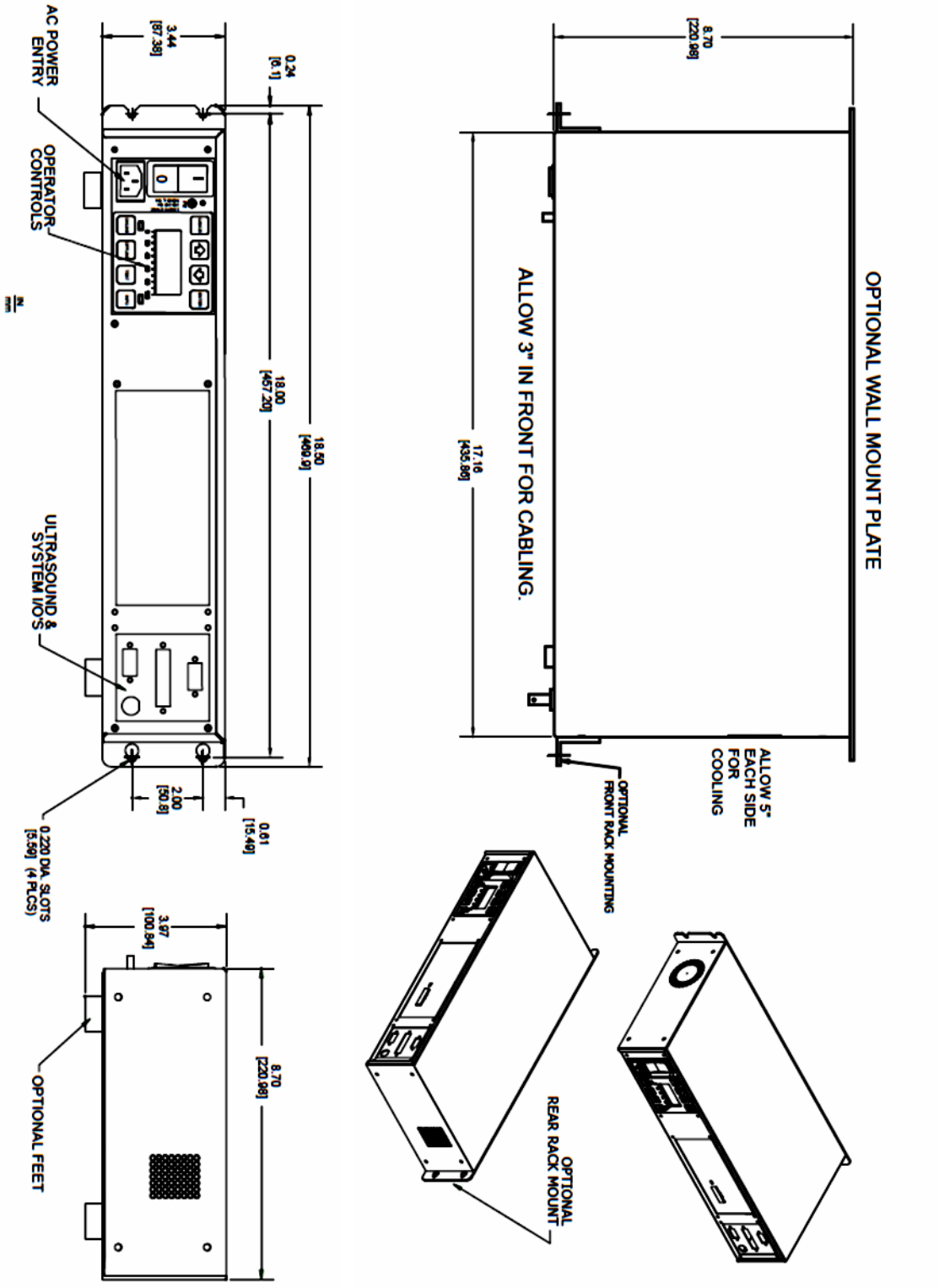


Figure 8 - 1. Low Profile Chassis Drawing

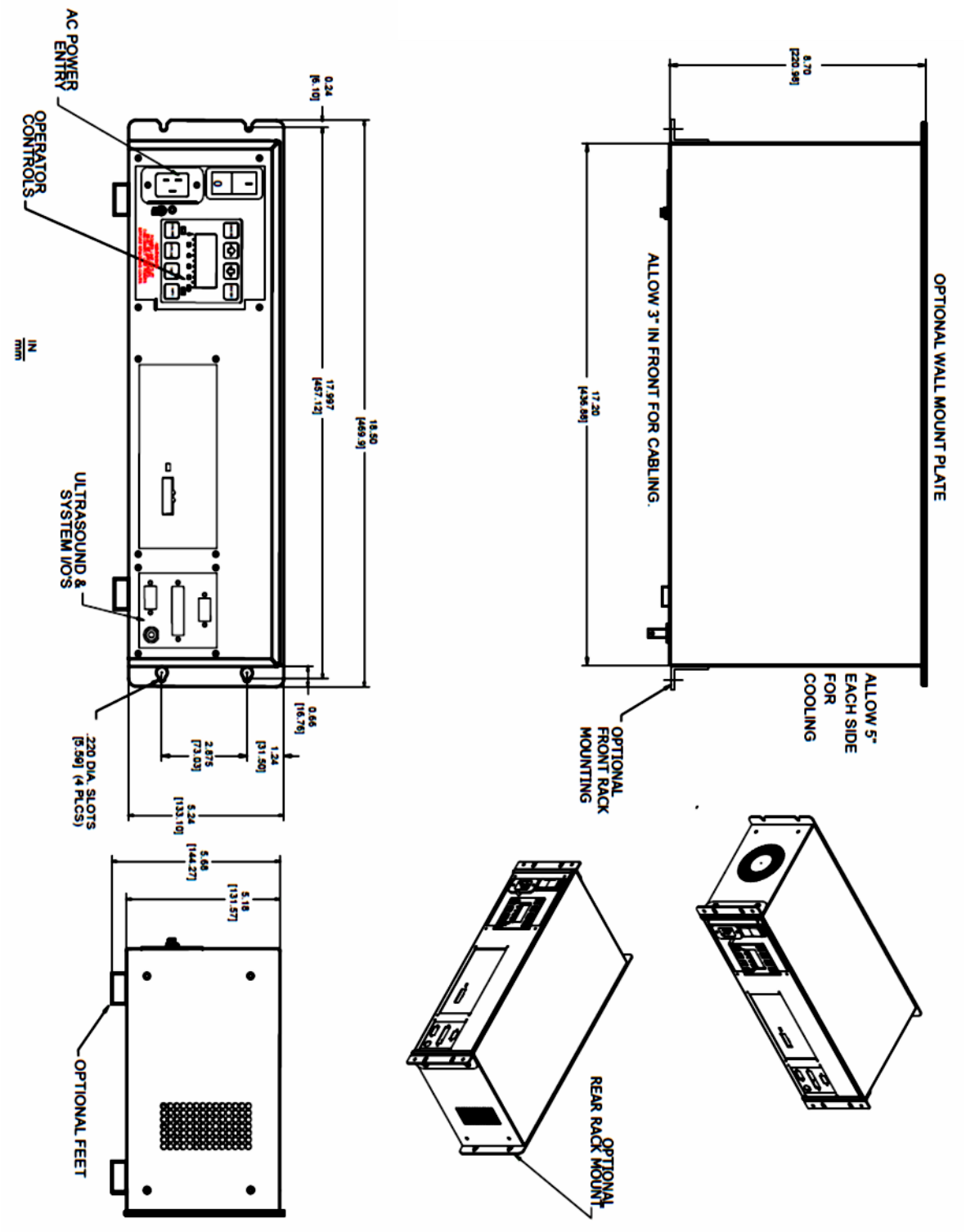


Figure 8 - 2. High Profile Chassis Drawing

Weight:

Low Profile Unit: 24 pounds (10.9 kg)
High Profile Unit : 30 pounds (13.6 kg)

Shipping: Add 5 pounds (2.3 kg) to unit weight for packing materials

AC Power Requirement:

Low Profile Unit: 200-240V 50/60 Hz @ 8 Amps
High Profile Unit : 100-120V 50/60 Hz @ 15 Amps

Operating Environment

Operate the generator within these guidelines:
Temperature: 40°F to 100°F (+5°C to +38°C)
Altitude: 15,000 ft (4572 m)
Air Particulates: Keep the equipment dry. Minimize exposure to moisture, dust, dirt, smoke and mold.
Humidity: 5% to 95% non-condensing @ +5°C to +30°C

Storage guidelines

(Generator is not operating):
Temperature: - 4°F to 158°F (-20°C to +70°C)
Altitude: 40,000 ft (12,190 m)
Air Particulates: Keep the equipment dry. Minimize exposure to moisture, dust, dirt, smoke and mold.
Humidity: 5% to 95% non-condensing @ 0°C to +30°C

Regulatory Agency Compliance

UL: 1012:2010
CSA: C22.2/61010-1-12
IEC/EN: 61010-1:2010

FCC

The generator complies with Federal Communications Commission regulations.

CE Marking

This mark on your equipment certifies that it meets the requirements of the EU (European Union) concerning interference causing equipment regulations. CE stands for Conformité Europeéne (European Conformity). The equipment complies with the following CE requirements.
• The EMC Directive 2004/108/EC
for Heavy Industrial —
EN 61000-6-4: 2001

EN 55011: 2003
EN 61000-6-2: 2001
EN61000–4–2
EN61000–4–3
EN61000–4–4
EN61000–4–5
EN61000–4–6
EN61000–4–8
EN61000–4–11

- The Low Voltage Directive 2006/95/EC.
- The Machinery Directive 2006/42/EC.

EN 60204: 2006
Safety of Machinery - Electrical Equipment of Machines Part 1: General Requirements.

APPENDIX I

Scan Stack Procedure

Scan Stack Procedure

Each time you attach a new ultrasonic horn, you must determine and set its *Free Run Frequency* (FRF). FRF is the initial guess the generator makes when finding the horn's resonant frequency during operation. FRF can be determined by using the *Scan Stack* feature available on the ultrasonic generator's LCD display. Follow the instructions below to scan your ultrasonic stack:

1. Attach the new horn to the ultrasonic transducer using the provided spanner wrenches (page 28) and connect the ultrasound cable from the generator to the top of the transducer.
2. If attached, remove the remote button switch from port J2 and turn the generator on. The generator will display the OPERATE screen showing the AMPLITUDE setting, the current POWER (0 watts if the system is not running) and the current FREE RUN FRQ (FRF) setting.
3. Press CANCEL, use the ↑ ↓ arrows to navigate to ADVANCED HARDWARE and press ENTER.
4. A warning message will display for five seconds. After five seconds, a new menu will appear. Navigate to SETTINGS and press ENTER.
5. Navigate to SYSTEM FREQ LIMITS and press ENTER.
6. Navigate to WIDE and press ENTER.
7. Navigate to SCAN STACK and press ENTER.
8. There should be no liquid or solid in contact with the bottom face of the horn. Wipe the horn clean.
9. Press ENTER to scan the stack. You should hear a quiet buzz for 3 - 5 seconds and then one of the following messages will appear:
    a. A successful scan (XXXXX denotes the resonance frequency of the horn):

    SCAN STACK
    FREQUENCY XXXXX Hz
    ENTER TO SET FREERUN
    CANCEL TO EXIT

    b. An unsuccessful scan:

    SCAN STACK
    SCAN FAILED
    ENTER TO SCAN
    CANCEL TO EXIT

10. If the scan was successful (9a), press ENTER and continue below. If the scan was unsuccessful (9b), press CANCEL and repeat steps 1 - 9. If the problem persists, contact ISM.
11. Navigate to SYSTEM FREQ LIMITS and press ENTER.
12. Navigate to NORMAL and press ENTER.
13. Press CANCEL three times, navigate to OPERATE and press enter.
14. Test your ultrasonic stack in air at 100 % amplitude and record the power. Use the table below and verify that your horn is operating at the proper power (within 40 W of the value tabulated below). If the power displayed is outside of this range, contact ISM.

	Horn ID	Power (@100 %, in Air) [W] (+/-40 W)
BSP-1200	FBH-F20D35G2.1	75
	FBH-F20D35G3.8	100
	HBH-F20D30G2.3	80
	HBH-F20D32G4	100
ISP-3000	HBHB-F20D45G5	180
	HBH-F20D45G4.1	105