Sonicator® 740

Maintenance Manual

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April 2006 IR7–46

FCC Frequency Interference Statement

WARNING:

This equipment generates and uses radio frequency energy and, if not installed and operated in strict accordance with the manufacturer's instructions, may cause radio frequency interference.

NOTICE 1:

This equipment has been verified to comply with the specifications in Part 18 of FCC Rules, which are designed to provide reasonable protection against radio frequency interference. However, there is no guarantee that interference will not occur in a particular installation.

NOTICE 2:

If this equipment is found to be the source of radio frequency interference, which can be determined by turning the equipment off and on, the user should try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna (as applicable).
- Relocate the Sonicator with respect to the receiver.
- Move the Sonicator away from the receiver.
- Plug the Sonicator into a different outlet than the receiver.
- If necessary, the user should consult with the dealer or manufacturer for additional suggestions. (The user may find FCC's "Interference Handbook" helpful. It is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 004–000–00450–7.)

NOTICE 3:

The manufacturer is not responsible for any interference caused by unauthorized modification to this equipment.

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Limited Warranty

The Sonicator 740 generating unit is warranted against defects in materials and workmanship for a period of two years from date of purchase. The Sonicator 740 applicators and applicator cable are warranted against defects in materials and workmanship for a period of one year from date of purchase. The battery is warranted against defects in materials and workmanship for a period of 90 days from date of purchase. During the applicable warranty period Mettler Electronics Corp. will, at its discretion, either repair or replace the Product without charge for these types of defects.

For service under this warranty, the Product must be returned by the buyer within the applicable warranty period to Mettler Electronics Corp. **Shipping charges to and from Mettler Electronics Corp. under this warranty must be paid by the buyer. The buyer must also include a copy of the sales receipt or other proof of the date of purchase. If the Product is returned without proof of the date of purchase, it will be serviced as an out–of–warranty product at Mettler Electronics Corp.'s prevailing service rates.**

Alteration, misuse, or neglect of the Product voids this warranty. Except as specifically set forth above, Mettler Electronics Corp. makes no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness for a particular purpose, with respect to the Product. If any implied warranties apply as a matter of law, they are limited in duration to one year.

Mettler Electronics Corp. shall not be liable for any indirect, special, consequential or incidental damages resulting from any defect in or use of the Product.

Any legal action brought by the buyer relating to this warranty must be commenced within one year from the date any claim arises and must be brought only in the state or federal courts located in Orange County, California.

Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to the buyer. This warranty gives the buyer specific legal rights, and the buyer may also have other rights which vary from state to state.

Section 1—Introduction

1.1 The Manual

This manual is intended to aid qualified biomedical engineers and technicians in testing, servicing, and repairing Sonicator 740's. It contains an equipment description, operating procedures, theory of operation, test procedures, specifications, and troubleshooting tips. For additional assistance you may contact our service department toll free: (800) 854–9305 or outside the continental US 1(714) 533–2221. The email address for the service department is service@mettlerelectronics.com .

This manual is current as of its publication. Mettler Electronics Corp. may, however, make improvements as required. To receive manual changes, send your name and address to:

Mettler Electronics Corp.
Service Manual Changes
1333 S. Claudina Street
Anaheim, CA 92805.

1.2 The Sonicator 740

The Sonicator 740 is a portable therapeutic ultrasound device from Mettler Electronics Corp. This microprocessor controlled device provides therapeutic ultrasound with enhanced reliability and ease of use. An optional rechargeable battery is available to free the practitioner from depending on wall power. The Sonicator 740 automatically self–tunes to the ultrasound applicator to ensure accurate delivery of ultrasound.

The Sonicator 740 has a standard 5 cm^2 applicator at 1 and 3.2 MHz. An additional two applicators are available. These additional applicators are: 10 cm^2, 1 MHz and 1 cm^2, 3.3 MHz. The 5 and 10 cm^2 applicators are contoured for easy ultrasound application. The pencil–shaped 1 cm^2 applicator is ideal for delivering ultrasound to hard–to–reach and small treatment areas. All applicators attach to the Sonicator 740 using the same universal applicator cable.

The Sonicator 740 produces ultrasound in continuous and 10, 20 and 50% pulsed modes for maximum treatment flexibility. The back-lit liquid crystal display (LCD) informs the practitioner about treatment status. Time and ultrasound output intensity are actively displayed during a treatment. The "ultrasound active" indicator on the display alerts the operator when ultrasound is being delivered by the applicator. An additional LED on the 5 and 10 cm^2 applicators lights when ultrasound is being delivered and flashes when there is a problem with coupling.

Large controls on the silicone rubber keypad provide one touch entry for treatment parameters. An audible tone provides you with further reinforcement that a selection has been made. Error conditions are prominently shown on the display as well as all treatment parameters.

1.3 Precautions

1. The Sonicator 740 operates with high voltages. Servicing should be performed by qualified ultrasound technicians or the unit should be returned to the factory for service.
2. The internal circuit boards are not designed to be serviced at the component level because of the extensive use of surface mount circuitry. Any attempt at replacing a surface mount component may result in damage to the board. Replace entire circuit board assemblies only!

3. For maximum safety, plug the Sonicator 740 into a grounded wall outlet of proper voltage only or use the optional battery. Follow general safety practices for medical electronic equipment.
4. The Sonicator 740 requires 100-240 VAC 50/60 Hz primary power. DISCONNECT THE LINE SUPPLY CORD AND REMOVE THE BATTERY PRIOR TO DISASSEMBLY OF THE UNIT FOR SERVICE. Line supply voltage is present on primary components exposed by removing the back cover.
5. Use calibrated test equipment in good working order.
6. USE OF CONTROLS OR ADJUSTMENTS, OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED IN THIS MANUAL AND IN THE Sonicator 740 INSTRUCTION MANUAL, MAY RESULT IN HAZARDOUS EXPOSURE TO ULTRASONIC ENERGY.
7. Do not operate the Sonicator 740 in close proximity to operating shortwave or microwave diathermies.
8. Replace line fuses with specified type and rating only, to avoid risk of fire or other damage.
9. Do not operate the controls with pointed objects such as pencils, pens, or tools.
10. Make sure all connectors are tight with all pins making good contact when reassembling the unit after service.
11. As a prescription device, the Sonicator 740 may be sold only to, or on the order of, a physician, physical therapist, or other practitioner licensed by the state in which he/she practices.

1.4 Labels

Each medical device must be uniquely identified for traceability and device history. This is accomplished with serial numbered labels unique to each device.

Product labels provide performance data, and must remain on the device at all times. Preserve label integrity during repair and servicing when actions such as removing access covers could cause label damage.

Please include model and serial numbers when requesting service assistance from the factory, including serial number of printed circuit board assembly, as applicable.

Section 2—Equipment Description

2.1 Equipment Layout

The Sonicator 740 is comprised of one custom printed circuit board, one ultrasonic applicator, a silicon rubber control keypad, a main power switch, one universal 15V power supply module, top and bottom enclosures, and miscellaneous hardware and wire harnesses. An optional battery can be used for remote operation. A block diagram is shown in Fig. 2.1.

Display Board
The Display Board contains the microprocessor circuitry, the VCO, the RF power output stage, and networks for matching the circuits to the transducers. Ultrasound RF energy is coupled out through a BNC connector to a short cable that connects to a bulkhead BNC connector at the case bottom. The front panel key switch is connected to this board directly by hitting key targets on the back of the printed circuit board. The display is a custom LCD display that includes an intelligent controller. The main microprocessor communicates to the display via a serial port.

Power Supply Module
Power Supply inputs: Filtered mains power, universal voltage 100 – 240 VAC

Supply output: +15VDC

This standard switching power supply includes overhead and current protection that will shut it down when subjected to overload conditions, avoiding the risk of fire or damage to the supply. This power supply is used in conjunction with a battery for remote use. When running on AC power the battery is always being charged. The battery is a rechargeable lithium ion battery pack rated at 10.8 volts and 4.8 Ah. The battery is a smart battery and includes an integrated battery monitor IC. Battery communication is made across a standard I2C serial bus.

Applicators
A single 5 cm^2 / 1 and 3 MHz applicator connects to the Sonicator 740. Optional 10 cm^2 / 1 MHz and 1 cm^2 / 3.3 MHz applicators are also available. Applicators connect to the unit with a double shielded coaxial universal applicator cable having a BNC connector at both ends.

Other Components
The display board, main board and keypad are mounted to the top enclosure. The input module, power switch, combination therapy receptacle and BNC receptacle for the applicator cable are mounted to the bottom enclosure.

Subassemblies are interconnected with wire harnesses and matched connectors. Connectors cannot be mated to incorrect plugs without excessive force or obvious error.

All wiring and connections in the primary circuit are UL recognized. The primary circuit is all the components and interconnections on the primary winding side of the power transformer.

Software in the microcontroller is an additional component requiring the same controls in manufacturing, processing, and changing as other components.

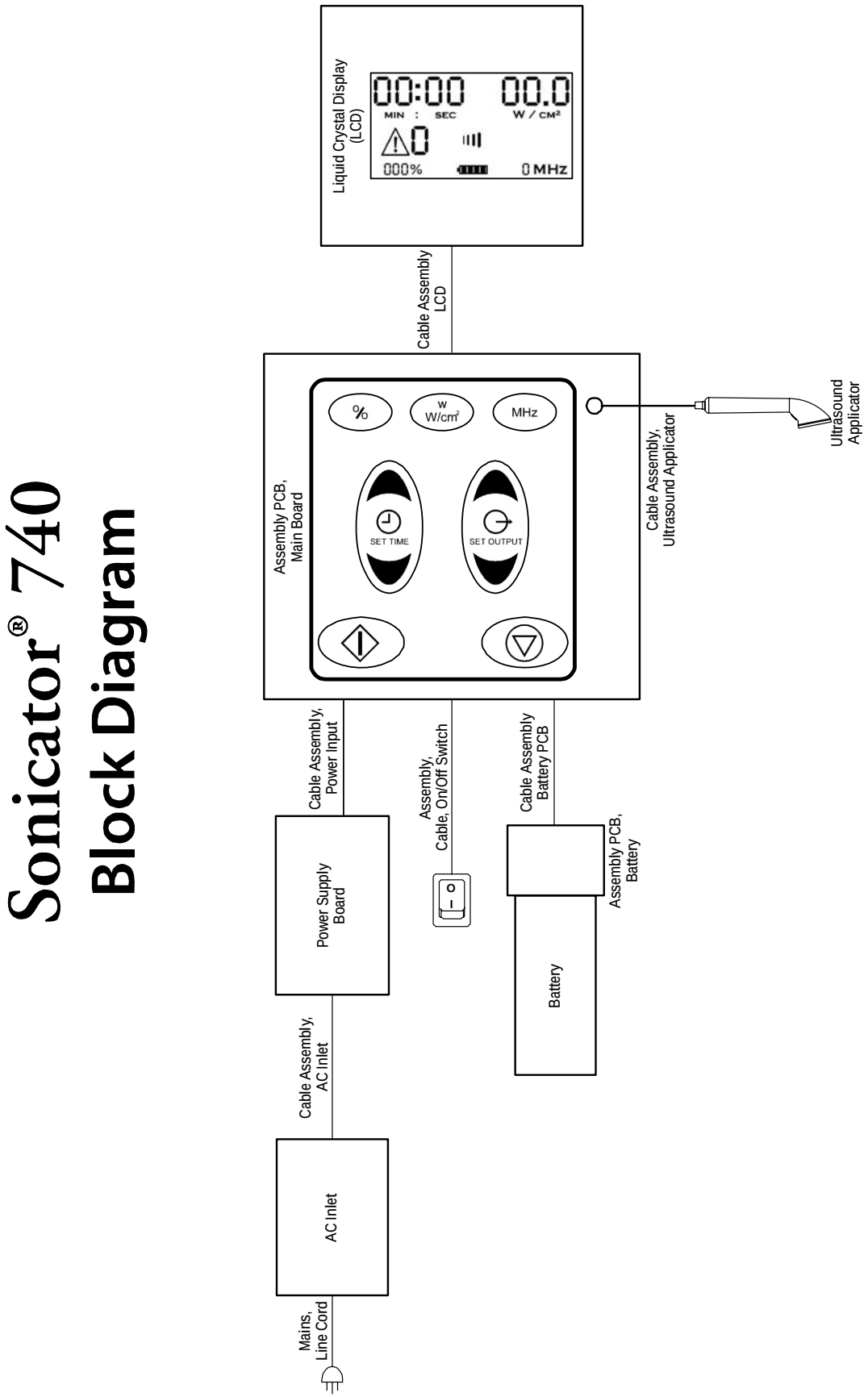


Figure 2.1—Sonicator 740 Simplified Block Diagram

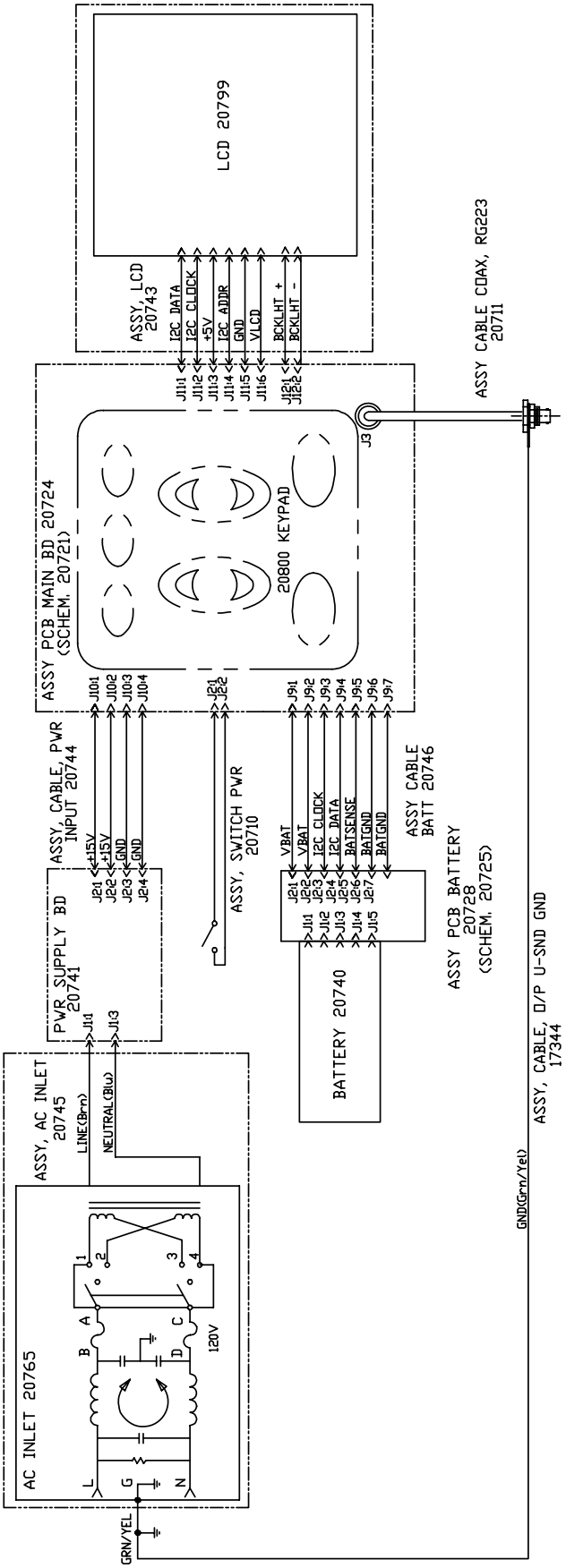


Figure 2.2—Sonicator 740 Block Diagram, Revision E, Details

2.2 Theory of Operation

Overivew

The following discussion can best be understood by referring to Mettler drawing 20720, Functional Block Diagram and drawing 20721, ME740 Schematic.

At the system level, the 740 is composed of four major components: Power supply, Battery and battery interconnect PCBA, Main controller PCBA and the LCD display. The 740 is powered by a universal power supply module with a single, fixed 15VDC output. This 15 volt power is connected directly into the main control PCBA. While the AC line is connected the power supply is always on so that battery charging can occur during off time. The system power switch applies power to the computer and the remainder of the circuits.

The battery is a rechargeable lithium ion battery pack rated at 10.8 volts and 4.8 Ah. The battery is a smart battery and includes an integrated battery monitor IC. Battery communication is made across a standard I2C serial bus.

The display is a custom, fixed segment LCD with a white LED backlight. User inputs made via silicon rubber keys closing a key matrix on the back-side of the controller PCBA.

RF output to the crystal transducer is provide by a BNC connection at the front of the instrument. RF can be set to either 1 or 3 MHz depending upon the transducer attached to the device. The controller automatically detects which transducer is connected by reading the voltage drop created by the internal transducer ID resistor. The output circuits also provide a 2 kHz signal used to light an LED in the transducer, indicating proper skin contact.

Computer Circuits

The microcontroller used in the 740 is a PIC 18F6585, clocked at 8 MHz. RAM memory is internal to the controller IC and the external FLASH memory is contained within U124. The circuit design includes an external reset controller (U134) and a watchdog (U136).

The keyboard interface is comprised of nine I/O port lines individually assigned to each key and includes protection diodes (D9 – D20) for suppression of static discharge pulses.

The LCD interface circuits include LC components to reduce EMI effects and communicate with the computer via the I2C serial bus. The display control circuits include a FET switch as the means for enabling the backlight such that the backlight can be shut off while on battery.

Power Supply Circuits

Three power regulator circuits are used on the 740 design, a 15V to 12/5V switching fly back converter, a 0 to 30Volt variable buck-boost converter and constant current battery charging circuit.

The 12 volt supply down regulates the 15V input from the power supply to supply +12V and +5V to the system. It also steps up the nominal 10.8 V battery voltage to provide the 12V output.

The 0 – 30 Volt supply provides the rail supply for the RF output stage and this voltage is used to set the actual power output. The voltage is set by changing the impedance at pin 3 of U132 by a digitally controlled pot (U4). A power output-to-pot setting chart is created during the calibration process such that software can select the correct power output by setting this voltage during operation.

The battery charger uses a constant current (set by R178) with a full charge cut-off (U130). The charge can be enabled under software direction. The main controller independently communicates with the battery to report charge status, temperature and other fault conditions, thus preventing over-charging or over temperature conditions.

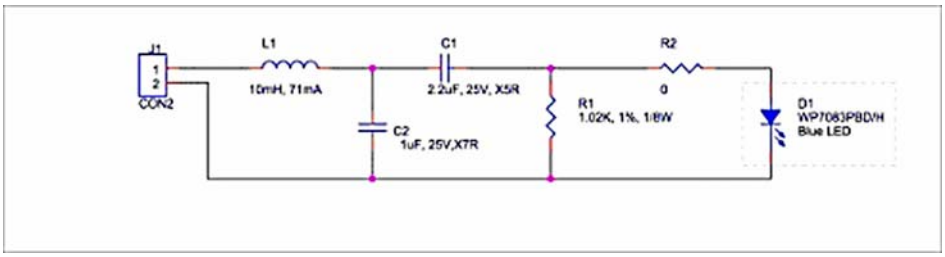
RF Output Circuits

Q102 is the 3 MHz output FET, operating in a Class E switching mode. Power output is set by supply voltage at the drain of Q102. C133-L106 is a matching network that couples the switching power into the transducer. Output current is measured across R62 and is

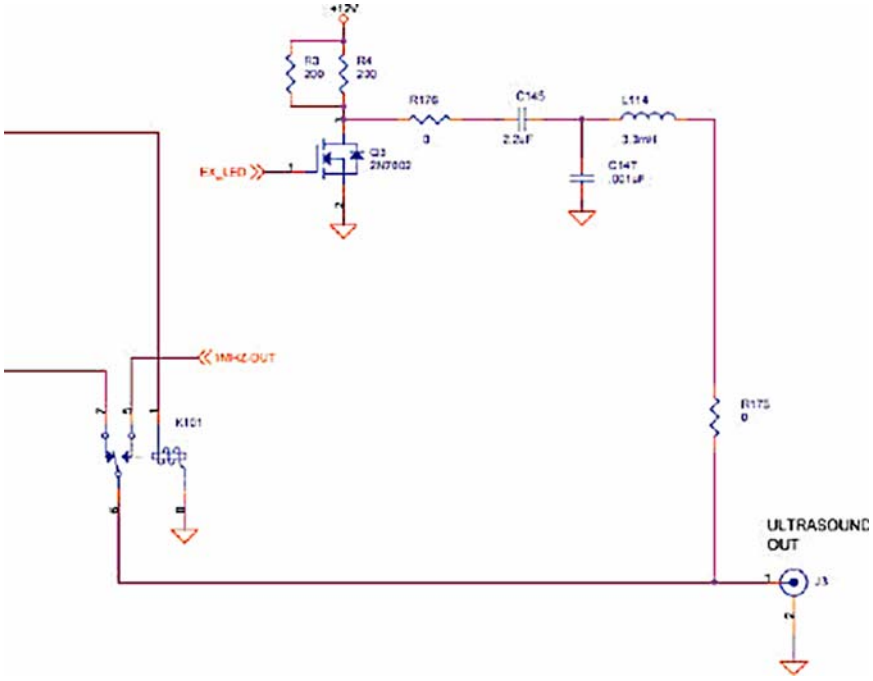
conditioned by U119 and then sent to the main controller's analog to digital converter. Q3 takes a signal from the main controller to produce the 2 kHz contact signal that is merged into the RF output signal. The circuits around Q1 perform identical functions but at 1 MHz. U127 is the base frequency generator for both the 1 and 3 MHz channels. The main controller sends frequency setting commands via a serial interface and the device generates a precise square wave signal at the FREQ-OUT port which is gated into either the 1 or 3 MHz. output drivers.

Contact LED Drive

A blue LED is mounted in the transducer handle to indicate when the transducer is active (LED is ON) and when contact is lost (LED Blinks). The transducer LED is driven by a 50 kHz signal superimposed on the RF drive signal and is coupled to the LED through a band pass circuit, preventing miss-match and RF feedback into the computer electronics. The transducer crystal, being resonant at over 1 MHz, is considered to be a high impedance at 50 kHz and will not respond to this signal. This filter circuit is shown below.



On the 740 board, another matching network is used to couple the 50 kHz signal into the RF line. The matching circuit is shown below.



The RF energy, either 1 or 3 MHz, is selected by Relay 101. FET Q3 is switched at the 50 kHz rate by a microprocessor I/O line. C145, 147 and L114 make up the matching network coupling the signal into the RF output. At the high RF frequencies, this network prevents RF from affecting the circuit operation.

The system design was developed to meet several key objectives, such as

1. Control the power to the patient
2. Be efficient and avoid excessive heating
3. Detect if the transducer is coupled, uncoupled or disconnected
4. Control the frequency of applied energy.

For efficiency, the frequency of the therapeutic ultrasonic energy is equal to the resonance of the crystal used to generate that energy. In this mode, the least amount of electrical energy is required for a given amount of mechanical energy from the crystal. The resonant frequency is determined by looking for a dip in impedance of the transducer as the frequency is varied from a point before the theoretical resonance to just above. Every crystal has been tested to verify there is a resonance in the sweep range.

The impedance of the crystal at resonance is used to determine the voltage that must be applied to the crystal to obtain the user power setting. The relationship between impedance at resonance versus applied voltage to obtain a given power level has been experimentally determined and is tested during final acceptance.

To detect coupling or a failed connection is done by applying acceptance limits to the measured impedance at resonance. In air, the resonance impedance of the crystal will be 100 ohms or less. The resonant impedance will increase with mechanical loading and typically be 6 or more times greater than the unloaded impedance. When the impedance goes this high at resonance, the system declares an unloaded error condition. A disconnected crystal will have an even higher impedance and the system will declare a disconnected applicator.

Obviously, the system function depends on the predictability and repeatability of crystal impedance at resonance. The impedance dip at resonance must be high enough to be detected and the impedance must be in a consistent range to be used to properly determine loading of the crystal and calculate the setting for a particular power setting.

The impedance of the crystal at resonance is calculated from the voltage across a current sense resistor. The current through the sense resistor is proportional to the impedance of the crystal as reflected through a passive impedance matching network.

The VCO is used to sweep the frequency input and the maximum voltage across the sense resistor indicates when the crystal is resonating. The magnitude of the voltage is used to calculate the voltage regulator setting that should be applied at the resonant frequency to obtain the desired ultrasound power output.

2.3 General Specifications:

Input:	100–240 VAC, 50/60 Hz, 1.0 amperes maximum
External Fuse:	1.0 A, 250 V, GDC/S506 5 x 20 mm time delay 2 x T1.0 AL250 V
Optional Battery:	Rechargeable Smart Lithium Ion Battery Pack rated at 10.8 V and 4.8 Ah.
Certification:	The Sonicator 740 complies with the ultrasound performance standards set forth in the Code of Federal Regulations, Title 21 (Food and Drugs), Part 1050.10.
ETL and C-ETL Listed:	Model ME 740 (9801427)
Classification:	Protective Class I Equipment and Internally Powered Equipment Type B Equipment Enclosed equipment without protection against ingress of water. Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with nitrogen oxide.
U.S. Patent Numbers:	U.S. and foreign patents applied for and granted including U.S. Patent Numbers 4,966,131 and 5,095,890
Treatment timer Indicator:	The digital timer indicates time set in minutes and seconds prior

	to the start of treatment and treatment time remaining during treatment or when treatment is temporarily suspended. If no treatment time is set the timer will count up to 30 minutes and then treatment will stop.
Accuracy:	±0.5 minute for times less than 5 minutes ±10% for times from 5 to 10 minutes ±1.0 minute for times greater than 10 minutes
Maximum treatment time:	30 minutes
Size:	13.5 in (L) x 9.5 in (W) x 7 in (H) *34,3 cm (L) x 24,1 cm (W) x 17,8 cm (H)*
Weight:	3.75 pounds *(1,7 kg)* without battery 4.5 pounds *(2,1 kg)* with battery
Temperature:	
Operating:	50°F to 104°F, *+10°C to 40°C*
Non-Operating:	-40°F to 167°F, *-40°C to 75°C*
Humidity:	Operating, 30% to 75% Relative Humidity at 104°F, *40°C* Non-Operating, 5% to 95% Relative Humidity, non-condensing

2.4 Ultrasonic Generator Specifications:

Frequency:	1.0 MHz ±10 % 3.2 MHz ±10 % 3.3 MHz ±10 %
Modes:	Continuous Pulsed 10, 20 and 50% Duty cycle
Modulation:	100%
Modulation Waveform:	Rectangular
Pulse repetition rate: *Modulation Frequency:*	100 Hz ±5% (Pulse Mode)
Pulse duration: *Modulation Period:*	1, 2 or 5 msec ±5 %
Temporal peak/average intensity ratio:	10:1, 5:1 and 2:1 ± 5%
Maximum output power:	22 W with a 10 cm^2 applicator, (ME 7410) 11 W with 5 cm^2 applicator, (ME 7413) 2.2 W with a 1 cm^2 applicator (ME 7431)
Maximum intensity:	2.2 W/cm^2
Indication accuracy:	±20% (for any level above 10% of maximum)
Output description:	The output waveform is continuous or pulsed as programmed by the membrane panel control. In the pulse mode the 1.0, 3.2 or 3.3 MHz is pulse modulated. The power level is adjusted by varying the pulse amplitude. The pulse waveform is shown below:

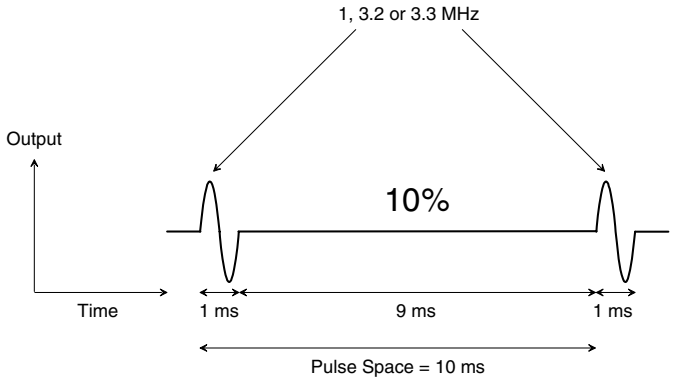


Figure 2.3—10% Pulse Waveform

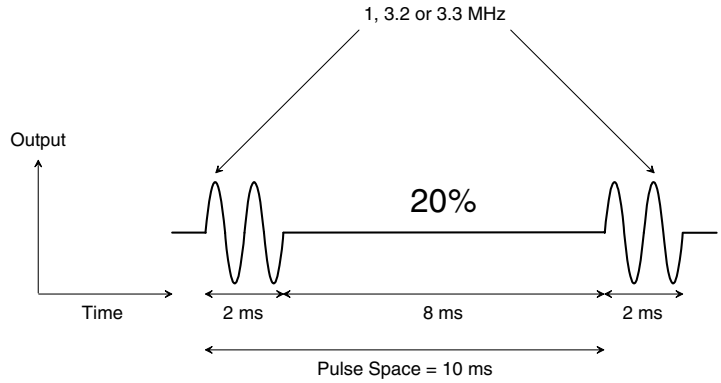


Figure 2.4—20% Pulse Waveform

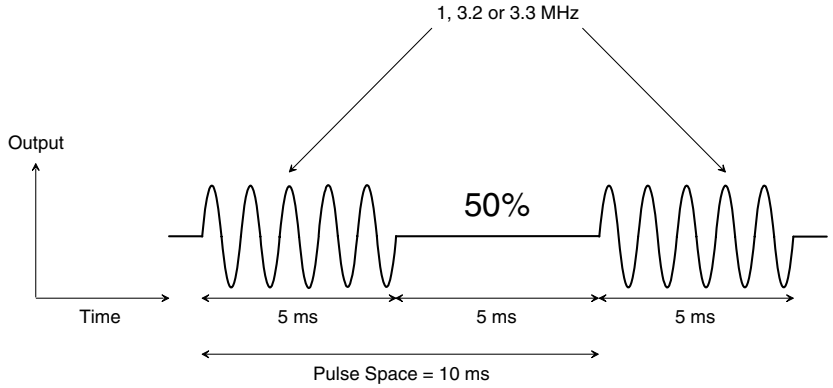


Figure 2.5—50% Pulse Waveform

In the continuous mode, the power is on at least 95% of the time the timer is running. The continuous mode waveform is shown below:

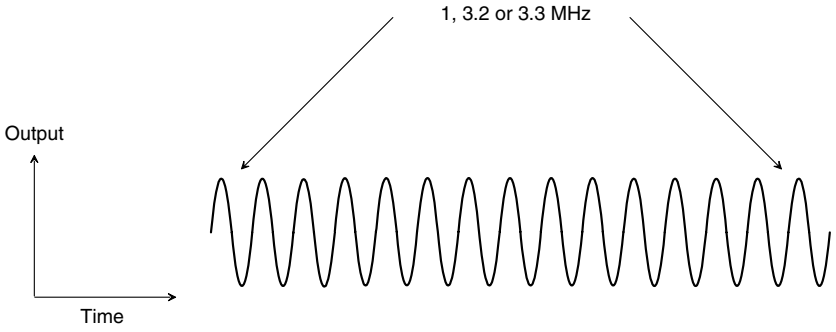


Figure 2.6—Continuous Waveform

2.5 Ultrasonic Applicator Specifications:

Piezoelectric discs: The output transducer utilizes a barium titanate disc with a specially coated face.

Individual Applicator Specification:

Applicator Part Number	**Frequency**	**Effective Radiating Area *(Area)***
ME 7413	1 MHz ±10 %	5 cm² ±20 %
ME 7413	3.2 MHz ±10 %	5 cm² ±20 %
ME 7410	1 MHz ±10 %	10 cm² ±20 %
ME 7431	3.3 MHz ±10 %	1 cm² ±20 %

Beam type: Collimating

Maximum beam non–uniformity ratio: 6:1

Maximum Effective Intensity Ratio: 2:1

Spatial Pattern: The applicator produces a collimated (cylindrical) beam with an area of 1, 5 or 10 cm², measured 5 mm from the ceramic disc surface when the radiation is emitted into the equivalent of an infinite medium of distilled, degassed water at 30° C, and with line voltage variations in the range of the rated value.

The beam of the applicator is circular in all planes parallel to the applicator face. A few inches from the face, it is a single smooth bell-shaped curve. Nearer the face the pattern varies more due to phase cancellations. Sample curves measured in the far field from the surface are shown in Figures 2.7, 2.8, 2.9 and 2.10.

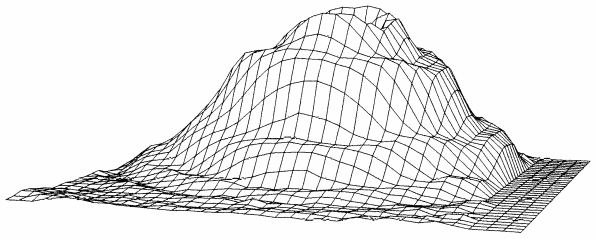


Figure 2.7—10 cm² Applicator (1 MHz), ME 7410,—Three Dimensional Beam Pattern

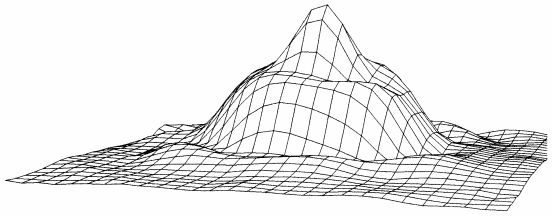


Figure 2.8—5 cm² Applicator (1 MHz), ME 7413,—Three Dimensional Beam Pattern

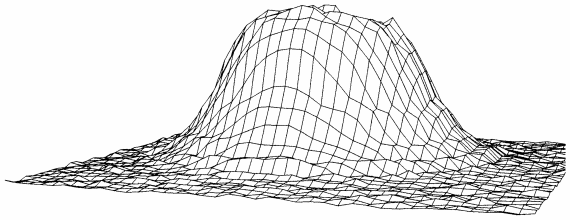


Figure 2.9—5 cm² Applicator (3.2 MHz), ME 7413,—Three Dimensional Beam Pattern

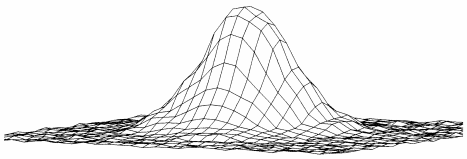


Figure 2.10—1 cm² Applicator (3.3 MHz), ME 7431,—Three Dimensional Beam Pattern

Section 3—Symbol Glossary and List of Abbreviations

3.1 Symbol Glossary

Time symbol

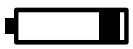
Output symbol

MIN Minutes

SEC Seconds

Ultrasound active when this symbol is shown on the display. This symbol blinks when coupling is inadequate.

Battery symbol when the Sonicator 740 is running off the battery and the unit is unplugged from the wall. Bars indicate degree of charge. Battery symbol will be absent if the battery is not installed. (*1 bar= 0-25%, 2 bars = 26-50%, 3 bars= 51-75% and 4 bars = 76-100%)*



Battery almost empty symbol. The outline of the battery will begin blinking on and off when it is time to recharge the battery.

Battery charging symbol when unit is plugged into the wall. The number of bars (up to four) indicates the degree of charge. (*1 bar= 0-25%, 2 bars = 26-50%, 3 bars= 51-75%, 4 bars = 76-100%)*

Sets duty cycle to continuous (100%) or pulsed (10%, 20% or 50%) ultrasound output.

% Duty cycle for pulsed or continuous ultrasound.

Sets output display to watts or watts per square centimeter.

W Watts

W/cm² Watts per square centimeter

Sets output frequency for 5cm² applicator, either 1 or 3 MHz.

MHz Megahertz

Increases or decreases treatment time.

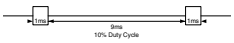
Increases or decreases ultrasound output intensity or power.

Starts treatment, ultrasound output activated.

Temporarily stops treatment while maintaining treatment parameters. Ultrasound output stopped.

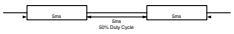
Power On

Power Off

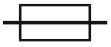


Symbol for 10% duty cycle on serial number label

Symbol for 20% duty cycle on serial number label



Symbol for 50% duty cycle on serial number label



Fuse symbol

SN

Serial number

REF

Catalog number

Alternating current (AC)

Refer to instruction manual for directions.

Non–ionizing radiation

Type B Equipment

IPX0

Not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.

IPX7

Protected against the effects of immersion, applicator only.

Recycle the rechargeable lithium ion battery.

Rechargeable lithium ion battery, dispose of separately from other trash.

UL Recognized Component Mark

Tested to comply with FCC standards

CE mark on battery

ETL and C–ETL Listed

CE Mark

3.2 List of Abbreviations

BNR	—	Beam Non-uniformity Ratio
cm^2	—	Square centimeters
Coll	—	Collimating
ERA	—	Effective Radiating Area
MHz	—	Megahertz (millions of cycles (10^6) per second)
LCD	—	Liquid Crystal Display
LED	—	Light Emitting Diode
W	—	Watt(s)
W/cm^2	—	Watt(s) per square centimeter

Section 4—Installation

4.1 Installation Instructions

1. If you have chosen the optional battery pack, install the battery as seen in Figures 4.4 and 4.5.
2. To install the optional battery first remove the power cord. Then, remove the screws located on the back panel of the Sonicator 740 on either side of the specification label using a Phillips screw driver, Figure 4.4.
3. Place the battery into the compartment as shown in Figure 4.5. Avoid depressing any of the buttons on the keypad while inserting the battery. Turning the unit on its side while installing the battery will keep the pressure off the buttons. If a button is depressed when the battery is being installed a continuous beep will alert the user of this condition. To stop the alarm, remove the battery and reinstall it.
4. Close the battery compartment lid and reattach it by tightening the Phillips head screws.
5. Connect the line cord to the back of the Sonicator 740. (See Figure 3.1)
6. Plug the line cord into a grounded wall outlet that is rated at 100-240 VAC 50/60 Hz. Your mains power supply must match the voltage requirements listed on the serial number label of your device. **Do not connect the Sonicator 740 to a power supply rated differently than that described above.**

   The unit comes equipped with a grounded line cord. This plug provides grounding for the Sonicator 740. Do not defeat its purpose by using adapters or any other means of attaching to a wall outlet.
7. If the optional battery is installed, it will begin charging as soon as the line cord is plugged into the wall. The charging status will be displayed on the display. Full charging takes up to four hours. The unit may be used while it is charging.
8. Push the applicator cable connector into the round BNC receptacle located on the bottom of the Sonicator 740 by lining up the slots with the pegs, pushing in all the way and rotating the ring ¼ turn clockwise. Connect applicator to universal applicator cable using the same technique. To maintain waterproof characteristics of the BNC connectors make sure that all connections are dry before attempting to connect them, Figure 4.6.
9. Place the 5 or 10 cm^2 applicator into its receptacle. Line up the metal disc on the applicator with the floating magnet on wall of the applicator receptacle and secure on the applicator hook, Figure 3.3. A separate receptacle is located on the back of the unit for the 1 cm^2 applicator. Place it crystal-side-in, into the holder. (Figure 4.1)
10. **Warning:** The Sonicator 740 may be susceptible to interference originating from shortwave diathermy units operating in close proximity to it. Avoid operating the Sonicator 740 adjacent to and simultaneously with operating shortwave devices.
11. **Warning:** If the integrity of the external protective conductor in the installation or its arrangement is in doubt, the Sonicator 740 should be operated using the battery.
12. **Do not use sharp objects to operate the silicone rubber keypad controls.** If the tough outer layer of the control is broken, moisture may leak into the unit resulting in switch and main board failure.
13. The optional battery pack may only be used in the Sonicator 740. Do not attempt to use other batteries than Mettler part number ME7401. Additional precautions for handling the optional battery include:
    - Do not store the Sonicator 740 for long periods with the battery installed.

- Keep the Sonicator 740 plugged into the mains to assure full battery charge when needed.
- Do not ship the Sonicator 740 with the battery installed.
- Avoid shorting the battery
- Do not immerse in water.
- Do not disassemble or deform the battery
- Do not expose the battery to fire.
- Do not dispose of the battery in fire.
- Avoid excessive physical shock or vibration.
- Keep out of the reach of children.
- Never use a battery that appears to have suffered abuse.
- Lithium ion batteries are recyclable.
- Regulations for disposal vary for different countries. Dispose of in accordance with local regulations.

Figure 4.1— Back side view of unit—mains power switch, line cord connection, banana jack for combination therapy and 1cm² applicator holder

Figure 4.2—Front side view—Applicator cable connection

Figure 4.3—Side View—Applicator cradle with floating magnet and hook

Figure 4.4—Bottom view—Battery door

Figure 4.5—Installing the Battery

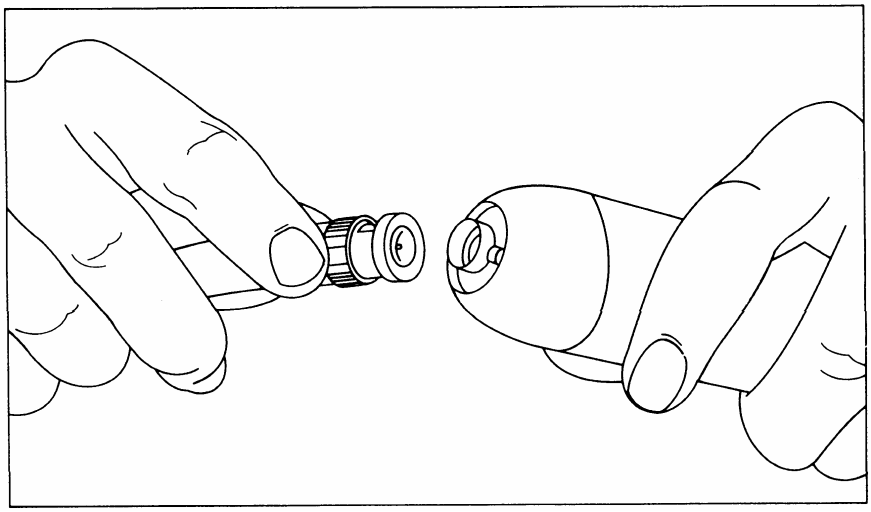
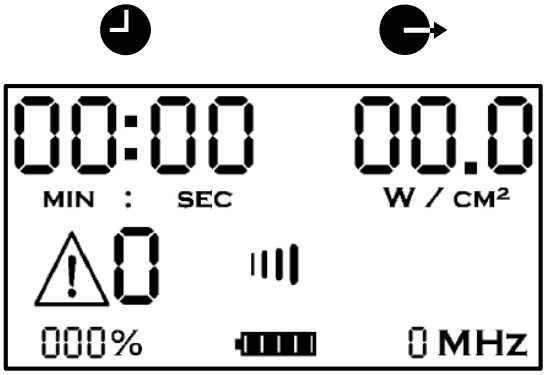


Figure 4.6—Connecting the Applicator to the Universal Applicator Cable,
line up pegs, push in all the way and rotate the ring ¼ turn clockwise

Section 5—Operating Instructions



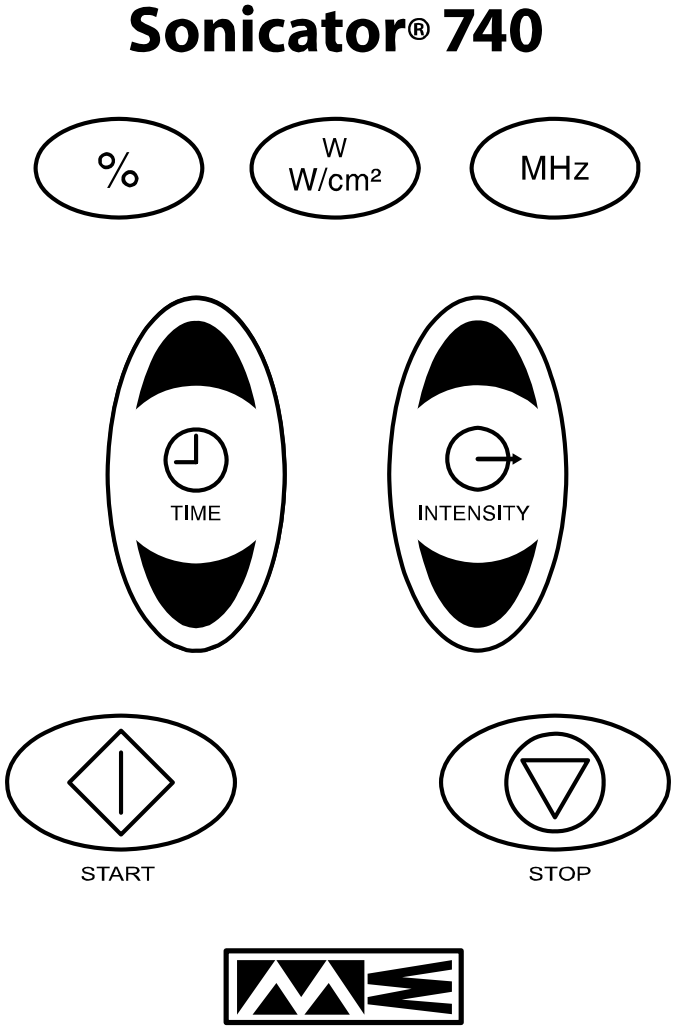
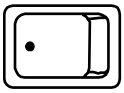


Figure 5.1—Control panel and display

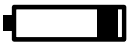
5.1 General Operating Instructions:

Before you start:

a) Review precautions and contraindications in the Instruction Manual.
b) Verify connection of the line cord to a grounded wall receptacle and the Sonicator 740 or that the battery is charged.
c) Check the universal applicator cable connections to the Sonicator 740 and to the applicator of choice to assure secure connection.
d) Note: Descriptions of the symbols used on controls are in Section 3.



1. Turn on the mains power switch by pressing the dot on the switch.



2. When the battery symbol shows one bar remaining and the battery outline begins to flash, plug in the wall to recharge the battery. There may not be enough power remaining to complete your treatment. Please note: you can use the Sonicator 740 while it is recharging.

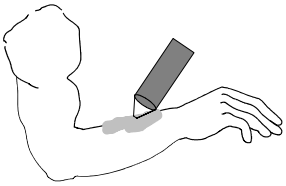
3. Select the desired treatment time by pressing the up arrow on the time control. Only whole minutes can be selected. Treatment times up to 30 minutes may be set. Time is displayed on the LCD. *You can also start a treatment without inputting time. The time will count up and output will stop after 30 minutes.*

4. Select either continuous or pulsed ultrasound by pressing the **%** key. The LED indicator on the key will illuminate when a selection is made.

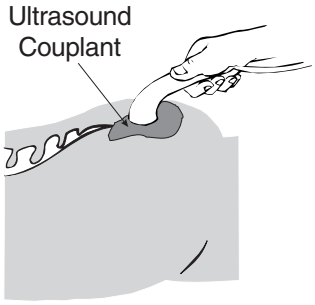
5. Select either watts (W) or watts per square centimeter (W/cm²) using the **W W/cm²** key. The LCD display will show the units of measure that have been selected.

6. Select either 1 or 3 MHz using the **MHz** key when you are using the 5 cm² applicator. The 10 cm² applicator is fixed at 1 MHz and the 1 cm² applicator is fixed at 3 MHz.

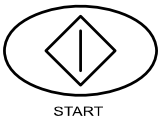
7. Adjust the ultrasound power to the desired intensity using the intensity Up/Down arrows. Pressing the up or down arrow momentarily will increase or decrease the ultrasound power in 0.1 W or W/cm² increments. Holding an arrow down will rapidly raise or lower the ultrasound power. You may also complete this step after you have started the treatment.



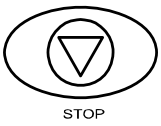
8. Apply a layer of ultrasound couplant gel to the treatment area.



9. Couple the applicator to the treatment area by keeping the entire surface of the applicator in contact with the gel that has been applied to the patient. This will ensure an efficient delivery of therapeutic ultrasound to the patient.



10. Press the start key to begin treatment.



11. If you need to temporarily stop treatment press the stop key pictured on the left. Remaining treatment time and set intensity will be displayed. Ultrasound power will stop and the indicator showing output on the display will go out. To resume treatment press the start key pictured in number 10 above.

12. If the applicator is not in contact with the patient or ultrasound is not being efficiently transmitted to the patient, the ultrasound symbol pictured will blink. The blue LED in the 5 or 10 cm^2 applicator handle will blink if contact is lost.

13. If inadequate coupling occurs for more than 30 continuous seconds the Sonicator 740 will automatically cease ultrasound output, beep twice and display the symbol to the left.

13. **Notes on coupling**: Failure to efficiently transmit therapeutic dosages of ultrasound to the patient can be caused by the following:

    a) Treatment of an irregular area where it is impossible to keep the applicator surface in contact with the gelled patient area. In this case you can try to use a little more gel or perform underwater treatment, if the treatment area is submersible in water.

    b) An inappropriate couplant is being used. Only materials that efficiently transmit ultrasound should be used for therapeutic ultrasound applications. Some creams and oil-based preparations are not efficient ultrasound couplants. If you use these materials the coupling indicator LED may blink and ⚠**2** may be displayed.

    c) Areas of heavy body hair will trap air beneath the hair and prevent ultrasound transmission. Shaving the treatment area prior to treatment or thoroughly wetting the area prior to the application of couplant will result in more efficient transmission of ultrasound.

14. When the set treatment time has elapsed, the unit beeps. Time will be “0” and ultrasound power display will show the set power. The ultrasound power will turn off.

Section 6—Performance and Safety Testing

Equipment Required:

- DVM
- Dual Channel Scope
- 10x Scope Probe
- Frequency Counter
- Ohmic Power Meter
- Ammeter
- Battery Current Test Cable (QT2-19)
- Leakage Current Tester
- Hipot Tester
- Variac
- BNC "T" connector
- Test applicator assembly (crystal removed), one for each model.
- Test jumper with 10 ohm resistor.
- Test jumper with 100 ohm resistor.
- Test extension cable, main power
- Stopwatch
- 90-264 VAC isolation transformer with grounded neutral on secondary.
- ME 740 battery (XB1-13)

Before Testing Units:

1. Review Safety Instructions in User Manual
2. Review Operating Instructions in User Manual
3. Review Keyboard Symbol Definitions in User Manual

Procedure:

Note: Do not connect or disconnect any internal cables with battery installed or unit plugged into the wall.

6.1 Basic Functional Tests:

Note: During these tests, use test jumper across pins of sleep (SW (J2) in place of power switch in ON position, in order to make testing easier.

6.1.1 Visual Check:

6.1.1.1 Check unit for proper construction.

6.1.1.2 Check fuses. (1 Amp, 250V, Time Delay, Low Breaking Capacity)

6.1.1.3 Verify all cable connectors properly installed.

6.1.1.4 Set Power switch to STANDBY.

6.1.2 Power Supply Test:

6.1.2.1 Disconnect DC supply from main board. Disconnect other cables as required.

6.1.2.2 Connect 1K ohm test load on supply output (J2 Pins 1,2 (+) – Pins 3,4 (Ground)).

6.1.2.3 Connect unit to a Variac (no battery installed).

6.1.2.4 Adjust Variac to 115 VAC (DOM) or 230 VAC (CE).

6.1.2.5 Turn on power. Check for +15VDC across test load. (14.7 to 15.3V).

6.1.2.6 Vary Variac from 90VAC to 264VAC and verify output voltage meets specifications in 6.1.2.5. Reset Variac to 115 VAC (DOM) or 230 VAC (CE).

6.1.2.7 Disconnect power supply test load and connect power supply to main board. Verify following voltages:

+12V	Main Board	TP113	(11.7 V to 12.3 V)
+ 5V	Main Board	U133, Pin 3	(4.8 V to 5.2 V)
Gnd	Main Board	J7, Pin 3	

6.1.2.8 Turn switch ON. Verify unit comes on with no battery icons present.

6.1.2.9 Turn switch OFF.

6.1.2.10 Disconnect main power.

6.1.3 Battery Test:

6.1.3.1 Install battery current test cable between battery power cable (P9) and main board PCB (J9).

6.1.3.2 Connect DC ammeter in series with pins 1 and 2 of test cable.

6.1.3.3 Install power text extension cable between power cable (P10) and main board (J10).

6.1.3.4 Disconnect cables that are not required and might interfere with testing.

6.1.3.5 Install fully charged battery.

6.1.3.6 Repeat 6.1.2.7.

6.1.4 Main Board: Power Up Check:

6.1.4.1 With no applicator connected, turn power ON. Verify all LCD segment are displayed before settling to power-on default values. The LCD display should show the error icon and error code 1. Connect transducer and verify the MHz icon displays a frequency consistent with the transducer. (Note: 5 x dual transducer defaults to 1MHz).

6.1.4.2 Verify following default values displayed: power display is 00.0, timer display is 0:00, showing W/cm2 and 100% for pulse percentage. Set power switch to STANDBY and verify unit goes into sleep mode with display completely blank.

6.1.4.3 Set power switch to ON.

6.1.4.4 Verify battery full icon displayed on LCD (all bars and outline are on)

6.1.4.5 Plug in AC.

6.1.4.6 Verify battery outline disappears within five seconds.

6.1.5 Battery Charger/Management Test:

6.1.5.1 Verify charging current less than 100 ma.

6.1.5.2 Unplug AC power and leave unit idle. Verify backlight turns off in 3 minutes +/- 10 seconds.

6.1.5.3 Set power switch to STANDBY. Verify display goes blank.

6.1.5.4 Replace battery with low charge battery. Reconnect AC power. Verify battery icon shows less than four battery segments and segments are flashing to indicate charging.

6.1.5.5 Set power switch to ON position and verify default display comes on with battery segment icons still flashing.

6.1.5.6 Verify and record charging current (1 to 2.0 Amps).

6.1.5.7 Unplug from wall power and remove battery.

6.1.5.8 Reinstall power cord.

6.1.6 Entering Diagnostics Tests:

6.1.6.1 To enter Diagnostic Mode press and hold "Stop" and "%" keys at same time for at least 3 seconds.

6.1.6.2 When in Diagnostic Mode, LCD display shows all zeros in timer and power fields which flash on and off. “MHz” field starts at 0.

6.1.7 Microcontroller Flash Memory (Firmware Revision) Diagnostic:

6.1.7.1 Press “MHz” key to indicate "1" and then "Start" to start the Firmware Revision Diagnostic.

6.1.7.2 Verify LCD time (min:sec) display has a four digit code.

6.1.7.3 Verify code is current software revision per drawing # 20714.

6.1.7.4 Press "Stop" for at least 3 seconds to exit Firmware Revision Diagnostic. “MHz” field displays a 1.

6.1.8 Keyboard Test Diagnostic:

6.1.8.1 Press “MHz” key to indicate "2" and then "Start" to start Keyboard Diagnostic.

6.1.8.2 Press “%” key and verify “188” and icon “%” appear in Pulse Percentage LCD field

6.1.8.3 Press “MHz” key and verify “8” and icon “MHz” appears in MHz LCD field.

6.1.8.4 Press “Start” and verify “8” appears everywhere on LCD fields.

6.1.8.5 Press “Stop” and verify “1” appears everywhere on LCD fields.

6.1.8.6 Press “W W/cm²” and verify “W” and “W/cm²” appears.

6.1.8.7 Press “Time” up key and verify “8888” appear in “MIN:SEC” LCD field.

6.1.8.8 Press “Time” down key and verify “1111” appear in “MIN:SEC” LCD field.

6.1.8.9 Press “Intensity” power up and verify “888” and “W/cm²” appear in “W W/cm²” LCD field.

6.1.8.10 Press “Intensity” power down and verify “111” and “W” appear in “W W/cm²” LCD field.

6.1.8.11 Press "Stop" for at least 3 seconds to exit Keyboard Diagnostic. (NOTE: while pressing STOP for three seconds display will flash all ‘1’s.) The “MHz” field should display a 2.

6.1.9 Display Test Diagnostic:

6.1.9.1 Press “MHz” key to indicate "3" and then "Start" to start Display Diagnostic.

6.1.9.2 All 7 segment fields will count continually from 0-9 then A-F. Text fields, battery icon, and most significant digit of the % setting toggle between on and off. Additionally contact indicator bars and battery segments step from zero to four bars for each count.

6.1.9.3 Press "Stop" for at least 3 seconds to exit Display Diagnostic. “MHz” field displays a 3.

6.1.10 DCO (Digitally Controlled Oscillator) Range Verification:

6.1.10.1 Press “MHz” key to indicate "4" and then "Start" to start DCO Diagnostic. LCD screen should be blank at this point. This diagnostic puts out several starting frequencies to verify proper DCO operation. Though not needed for verification, output frequencies are adjustable in 1 kHz increments. This diagnostic allows adjustment of the 30VDC output and displays setting in hexadecimal format in lower left LCD field. This diagnostic also measures return current and displays it in hexadecimal format in upper right LCD field.

6.1.10.2 Verification of preset frequencies is done by pressing the “MHz” key, stepping through each of the 9 MHz settings. Compare frequency displayed on LCD with range listed in table below. MHz Step # is displayed in lower right of LCD field. Output frequency is displayed in upper left of LCD field.

Setting	MHz Step	#	Frequency	Frequency Range	Measure Point
1 MHz	Sweep Start	1	900 kHz	890-910 kHz	TP7
1 MHz	Center	2	1000 kHz	990-1010 kHz	TP7
1 MHz	Sweep End	3	1100 kHz	1090-1110 kHz	TP7
3.2 MHz	Sweep Start	4	2880 kHz	2850-3010 kHz	TP102
3.2 MHz	Center	5	3200 kHz	3170-3230 kHz	TP102
3.2 MHz	Sweep End	6	3520 kHz	3490-3550 kHz	TP102
3.3 MHz	Sweep Start	7	2970 kHz	2940-3000 kHz	TP102
3.3 MHz	Center	8	3300 kHz	3270-3330 kHz	TP102
3.3 MHz	Sweep End	9	3630 kHz	3600-3660 kHz	TP102

6.1.10.3 Press "Stop" for at least 3 seconds to exit DCO Diagnostic. “MHz” displays a 4.

6.1.11 Generate 30VDC Variable Supply Lookup Table Diagnostic:

6.1.11.1 Connect ME7413 ***and place it in water***. Press “MHz” to indicate "5" and then "Start" to start 30 VDC Variable Supply Lookup Table Generation Diagnostic. Initial LCD screen has 1MHz in MHz field with tuning center frequency in kHz displayed in upper left corner and ID resistor current in lower left corner. ID resistor current is actually displayed across one digit error field and two digit pulse field. Format allows display of 10bit A/D numbers in range 0x000 – 0x3FF. MSB is in error field and two LSBs are in pulse percentage field. Tuning center frequency is displayed in kHz in decimal in timer field using four digits.

6.1.11.2 Observe tuning center frequency in kHz is displayed in upper left corner and is in range of 0900 - 1000. (Note: If tuning frequency is not in this range, hold ‘Stop’ until ‘5’ appears in ‘MHz’ field. Exit diagnostics by holding ‘Stop’ and ‘%’ until default screen appears. Insure that ‘1 MHz’ is displayed. Re-enter diagnostics, press ‘MHz’ unit ‘5’ is in ‘MHz’ field and press ‘Start.’)

6.1.11.3 Connect a voltmeter to variable power supply output (TP106) and ground (TAB of U133). During step 6.1.11.5 verify supply spans between 0 and 30 volts (minimum).

6.1.11.4 Press “W” to change context of LCD screen. Upper left corner has two msb digits displaying 30 VDC output 8 bit value in hex and two LSD digits display the measured A2D most significant 8 bits of the 10-bit A2D value in hex. MHz field shows 1MHz.

6.1.11.5 Observe 30 VDC output increments from 0x00 through 0xFF once. Verify two bars of contact indicator are displayed. This indicates generated table is being written to off chip EEPROM. **Wait for third bar to be lit! This indicates completion of EEPROM write sequence.**

6.1.11.6 Press "Stop" for at least 3 seconds to return to the DCO Diagnostic home screen. “MHz” field displays a 5.

6.1.11.7 Unplug from wall power.

6.1.12 Battery Charge Remaining Diagnostic:

6.1.12.1 Install battery.

6.1.12.2 Press “MHz” to indicate "6" and then "Start" to start Battery Charge Remaining Diagnostic. LCD screen has battery charge remaining in percentage in upper left corner.

6.1.12.3 Press "Stop" for at least 3 seconds to exit Battery Charge Remaining Diagnostic. “MHz” field displays a 6.

6.1.12.4 Remove battery and plug into wall power.

6.1.13 30VDC 8-bit Setting to 30VDC Measured ADC Reading in EEPROM Lookup Table Display Diagnostic:

6.1.13.1 Press “MHz” key to indicate "8" and then "Start" to start Lookup Table Display Diagnostic. LCD screen has 30 VDC 8-bit potentiometer setting in hexadecimal in upper left corner two msb digits in timer field and 30 VDC measured ADC reading eight most significant bits of 10-bit ADC reading in upper left corner two LSB digits in timer field.

6.1.13.2 Verify screen cycles through all 8-bit potentiometer settings (00-FF) and ADC power supply reading ascends monotonically.

6.1.13.3 Press "Stop" for at least 3 seconds to exit Lookup Table Display Diagnostic. “MHz” field displays an 8.

6.1.14.4 Unplug from wall power to reset power.

6.1.14 Backlight Control Diagnostic:

6.1.14.1 Press “MHz” key to indicate "9" and then "Start" to start Backlight Control Diagnostic. LCD screen should be blank.

6.1.14.2 Press “Time" down key to turn off backlight and press "Time" up key to turn on backlight.

6.1.14.3 Press "Stop" for at least 3 seconds to exit Lookup Table Display Diagnostic. “MHz” field displays a 9.

6.1.15 Watch Dog Timer Diagnostic:

6.1.15.1 In Backlight Control Diagnostic, watchdog reset is available to test. Press “W” to send software into an endless loop.

6.1.15.2 To verify watchdog timer, observe unit resets in 10 to 30 seconds. Unit will go through startup routine and return in normal operation mode.

6.1.15.3 Verify proper initialization and default screen displayed.

6.1.16 Exiting Diagnostics Tests:

6.1.16.1 Press "Stop" and "%" for at least 3 seconds to exit diagnostics. *(Note: Step is not required after executing 6.1.15)*

6.1.16.2 Unplug from wall power and remove battery to reset power. Remove all test cables and restore all cables to their original positions.

6.2 Ultrasound Tests:

(Note: Diagnostic 5, section 6.1.11 MUST BE executed at least once before performing these tests).

6.2.1 Output Waveforms:

6.2.1.1 Connect a 10 cm² / 1 MHz applicator to unit with BNC "T" connector.

6.2.1.2 Connect a 10x scope probe to BNC connector.

6.2.1.3 Place applicator in wattmeter.

6.2.1.4 Zero wattmeter.

6.2.1.5 Put 5 minutes on TIME.

6.2.1.6 Press “Start”.

6.2.1.7 Verify LED lit.

6.2.1.8 Set power to 2 W indicated on unit.

6.2.1.9 Verify output waveform is smooth sinewave.

6.2.1.10 Verify proper LCD MHz frequency indicated.

6.2.1.11 Press STOP to stop output. Verify power goes to zero watts and LED not lit.

6.2.1.12 Repeat with other applicators (ME7413, ME7431).

6.2.2 Output Power:

6.2.2.1 Test each applicator as specified below. Verify proper frequency and power ranges are selected for each applicator. Adjust Variac to 115 VAC for domestic units or to 230 VAC for CE units. Verify output frequency on counter is in range for applicator being tested. Verify output power is within allowable range.

10 cm² x 1 MHz	**Watts: Indicated**	**Watts: Measured**
Model 7410	0.0	0.0 - 0.4
Model 7410	5.0	4.0 - 6.0
Model 7410	10.0	8.0 - 12.0
Model 7410	20.0	16.0 - 24.0
Model 7410	22.0 (Max)	(Verify only)
5 cm² x 1 MHz	**Watts: Indicated**	**Watts: Measured**
Model 7413	0.0	0.0 - 0.4
Model 7413	2.0	1.6 - 2.4
Model 7413	5.0	4.0 - 6.0
Model 7413	10.0	8.0 - 12.0
Model 7413	11.0 (Max)	(Verify only)
5 cm² x 3 MHz	**Watts: Indicated**	**Watts: Measured**
Model 7413	0.0	0.0 - 0.4
Model 7413	2.0	1.6 - 2.4
Model 7413	5.0	4.0 - 6.0
Model 7413	10.0	8.0 - 12.0
Model 7413	11.0 (Max)	(Verify only)

1 cm² x 3 MHz	Watts: Indicated	Watts: Measured
Model 7431	0.0	0.0 - 0.4
Model 7431	0.5	0.4 - 0.6
Model 7431	1.0	0.8 - 1.2
Model 7431	2.0	1.6 - 2.4
Model 7431	2.2 (Max)	(Verify only)

6.2.2.2 With 10 cm² / 1 MHz applicator connected, set power to 20 W indicated.

6.2.2.3 Turn Variac down to 90 VAC.

6.2.2.4 Verify power measures from 16.0 to 24.0 W. Measure and record line current.

6.2.2.5 Turn Variac up to 264 VAC

6.2.2.6 Verify power measures from 16.0 to 24.0 W. Measure and record line current.

6.2.2.7 Return input voltage to nominal voltage for unit (Domestic or CE)

6.2.3 Pulse Test:

6.2.3.1. Connect 10 cm² / 1 MHz applicator (ME 7410) to unit.

6.2.3.2 Set scope for 20 v/div and 2 ms/div.

6.2.3.3 Press “Start”. Increase power to 5 W.

6.2.3.4 Press "%" pulse. Verify LCD indicates 50%.

6.2.3.5 Verify output waveform is 5 ms on and 5 ms off. (5% tolerance on measurements)

6.2.3.6 Press "%" pulse. Verify LCD indicates 20%.

6.2.3.7 Verify output waveform is 2 ms on and 8 ms off. (5% tolerance on measurements)

6.2.3.8 Press "%" pulse. Verify LCD indicates 10%.

6.2.3.9 Verify output waveform is 1 ms on and 9 ms off. (5% tolerance on measurements)

6.2.4 Error 1: No Applicator Connected

6.2.4.1 Press “Start”. Disconnect 10 cm² / 1 MHz applicator (ME 7410) to unit.

6.2.4.2 Verify two beeps sound.

6.2.4.3 Verify unit enters STOP.

6.2.4.4 Verify LCD displays error icon and number 1

6.2.4.5 Reconnect applicator. Treatment time remaining should be displayed.

6.2.4.6 Verify correct MHz value displayed.

6.2.4.7 Repeat test with 5 cm² and 1 cm² applicators. Test 5 cm² applicator in both 1 MHz and 3 MHz settings.

6.2.5 Error 2: No Contact

6.2.5.1 Connect 10 cm² / 1 MHz applicator (ME 7410) to unit.

6.2.5.2 Remove applicator from wattmeter. Press "Start".

6.2.5.3 Verify contact indicator (four bar LCD display) and LED are blinking.

6.2.5.4 Wait 30 seconds,

6.2.5.5 Verify two beeps sound.

6.2.5.6 Verify LCD displays error icon and number 2.

6.2.5.7 Repeat test with 5 cm^2 and 1 cm^2 applicators. Test 5 cm^2 applicator at 1 MHz and 3 MHz.

6.2.6 Error 3: No Crystal Connected

6.2.6.1 Connect 10 cm^2 / 1 MHz applicator (ME 7410) *(crystal removed)* to unit.

6.2.6.2 Press "Start".

6.2.6.3 Wait 3 seconds.

6.2.6.4 Verify one beep sounds.

6.2.6.5 Verify LCD displays error icon and number 3.

6.2.7 Error 4: Output Stage Short Circuit

6.2.7.1 Reassemble 10 cm^2 / 1 MHz applicator (ME 7410) and connect to unit with BNC T. Monitor output on scope.

6.2.7.2 Place applicator in water. Press “%” to obtain 50% pulsing.

6.2.7.3 Press "Start" and increase power to a mid scale value.

6.2.7.4 On main board, momentarily jumper across D7 with a 10 ohm resistor.

6.2.7.5 Verify output at BNC T goes to zero.

6.2.7.6 Verify four beeps sound.

6.2.7.7 Verify LCD displays error icon and number 4.

6.2.7.8 Cycle power.

6.2.8 Error 5: Ultrasound Output Out of Calibration

6.2.8.1 Connect 10 cm^2 / 1 MHz applicator (ME 7410) to the unit.

6.2.8.2 Set time. Press "Start". Increase power to maximum power (22.0 W).

6.2.8.3 On Main Board, momentarily short C13 to R25 with 10 ohm jumper.

6.2.8.4 Verify that two beeps sound.

6.2.8.5 Verify LCD displays error icon and number 5.

6.2.8.6 Verify unit will not take any keyboard entries.

6.2.8.7 Set switch to STANDBY then ON.

6.2.8.8 Set time. Press "Start". Increase power to 5 W.

6.2.8.9 On Main Board, momentarily short D7 with 100 ohm jumper.

6.2.8.10 Verify two beeps sound.

6.2.8.11 Verify LCD displays error icon and number 5.

6.2.8.12 Verify unit will not take keyboard entries.

6.2.9 Timer Accuracy

6.2.9.1 Using calibrated stopwatch, verify timer accuracy is better than +/- 30 seconds over 5 minutes.

6.2.9.2 Press “Stop”.

6.3 Burn In:

6.3.1 Connect 10 cm² / 1 MHz applicator (ME 7410) to the unit.

6.3.2 Set output power to maximum.

6.3.3 Adjust time to 30 minutes.

6.3.4 Run unit in count down mode until timer reaches 0:00.

6.3.5 Using the 5 cm² applicator, set for 3 MHz and repeat steps 6.3.2 – 6.3.4.

6.4 Safety Tests:

6.4.1 **Disconnect battery cable from main board (J10).**

6.4.2 **Monitor HV supply current** for any evidence of breakdown indicated by current spikes in reading.

6.4.2 **Leakage Test:** 100 µA RMS Max–Chassis; 50 µA RMS Max from Applicator ring

6.4.3 **Ground Resistance:** Check the resistance from the ground pin on the plug to the ultrasound applicator ring. Resistance should be less than 0.5 ohms.

6.4.5 Reconnect battery cable.

6.5 Final Operation Check

6.5.1 Reconnect unit to rated line supply VARIAC.

6.5.2 Place 10 cm² / 1 MHz applicator (ME 7410) in wattmeter.

6.5.3 Press “Start” and verify all indications normal.

6.5.4 Verify output accuracy compliance using pertinent data in 6.2.2.1.

6.6 Request for Feedback

Valuable customer feedback is lost when field repairs are made without reporting problems to the factory. Mettler Electronics Corp. is determined to provide quality products at reasonable prices. To meet that commitment we need to know how products are performing in the field. Field engineers and technicians performing checks are requested to report problems to the factory Service or QA Department so that appropriate action is taken to prevent problem recurrence.

Section 7—Routine Maintenance

7.1 Cleaning the Sonicator 740 and its Ultrasound Applicator

1. The Sonicator 740 can be wiped off with a damp cloth. The power cord should be disconnected from the unit before this is done. In the case of stubborn dirt a gentle household cleaner can be sprayed on the cloth and then wiped on the unit. If this method is used, remove any cleaner residue with a damp cloth. Do not spray cleaner into the vents of the unit.
2. Use soap and water for routine cleaning of the Sonicator 740 applicator. When disinfection is necessary, wipe with a disinfectant such as a 10% bleach solution. Rinse the applicator thoroughly after disinfection to remove any residue. The Sonicator 740 applicator *is neither autoclavable nor* gas sterilizable.

7.2 Routine Maintenance

1. To assure accurate performance of the Sonicator 740, calibration verification of ultrasonic output should be performed on an annual basis.
2. Standard medical electrical safety checks should be performed annually by qualified biomedical engineers or technicians trained to perform these procedures.
3. Inspect treatment head for cracks, since they may allow ingress of conductive fluid(s).
4. Inspect treatment head cables and associated connectors for damage.
5. Avoid rough handling of the treatment applicator, since it is critical to the safe and effective application of therapeutic ultrasound and relatively fragile.

Section 8—Troubleshooting Guide

8.1 No Display When Main Power Turned On

- If battery is installed, make sure that it is charged up.
- Check line cord connected to line supply.
- Check line cord securely connected to Sonicator 740.
- Check line fuses in power inlet module.
- Check line supply.

8.2 Ultrasound Output Indicator Blinks

- Check applicator cable connection.
- Applicator connector should be pushed into the case connector and locking ring engaged.
- Try another applicator – if light comes on, original applicator may need repair.

8.3 Continuous Audible Alarm

- Occurs when the optional battery is installed.
- A button on the keypad has been pressed while the battery was installed. To stop the alarm, remove the battery and reinstall it. Please note: turning the unit on its side while installing the battery will keep the pressure off the buttons.
- The watchdog timer may have found an error. Unplug unit from the wall and recycle power.

8.4 Error Codes

The Sonicator 740 is equipped with internal diagnostics designed to facilitate operator troubleshooting. An error code ⚠# is displayed in the display if a problem is detected by the microprocessor. Error codes are:

Error code 1 ⚠1:
The Sonicator 740 is unable to detect the presence of an applicator. Check the applicator cable connection. The plug should be pushed into the connector and turned. If the error is still displayed in the timer window, install a different applicator. If the display returns to normal (no error code) the applicator may need repair.

Error code 2 ⚠2:
The applicator has been operating with an inadequate load for thirty consecutive seconds. The timer stops and output goes to zero.

Error code 3 ⚠3:
Indicates improper self–tuning. Install another applicator. If this resolves the error condition, the replaced applicator may need repair. If the error code is still present with the alternate applicator, return the Sonicator 740 and its applicator to the factory for repair.

Error code 4 ⚠4
There is a malfunction in the power output circuitry. Unplug from the wall outlet and remove the battery. Reinstall battery and plug back into the wall. If the error persists, check the 30 volt power regulator for proper voltage.

Error code 5 ⚠5
Output power is not within output tolerances. Unplug from the wall outlet and remove the battery. Reinstall battery and plug back into the wall. If the error persists, check the 30 volt power regulator for proper voltage.

Error code6 ⚠6
Battery is over temperature. Unplug the unit from the wall outlet and remove the battery. Let the battery cool down to room temperature. Reinstall the battery and plug the unit back into the wall. If this error reoccurs, replace the battery.

Section 9 – Replacing Parts

Chassis Disassembly

If it becomes necessary to replace parts in the Unit, the following procedures will enable safe replacement.

Note: All components must be replaced / reinstalled in the same manner as originally installed. Failure to observe this precaution will impair safety and may cause unit to fail hipot testing and damage the unit.

Disconnect the power cord and remove battery before opening unit or unplugging any internal cables. The unit has power applied to the Main Bd. anytime the battery or AC is connected to unit! Removing cables with power applied will damage the Main Board!

Battery Removal

Place Unit upside down on protected surface. Remove the two screws that hold the Battery Door to the Chassis Bottom. Place unit on side to ensure that none of the keys are pressed. This must be done when installing the battery to prevent the unit from setting its alarm (continuous beep). Remove the Battery. When installing Battery line up connector and firmly push battery toward the front of the unit to seat properly.

Opening the Sonicator 740

With Unit upside down on protected surface, remove the six screws that hold the top and bottom chassis together. Carefully turn unit right side up and lift top of unit up just enough to allow you to unplug the cables that connect the chassis together. These four internal cables are the Ultrasound, Battery, Power Supply, and Sleep Switch cables. The Chassis Top can now be removed from the Bottom.

Chassis Bottom Components

The Bottom Chassis contains the following components: Input Module, Ground Receptacle for Combination Therapy, Sleep Switch, Power Supply, Battery Charging Board and Internal Ultrasound Cable.

- **Input Module**—Unplug cable at Power Supply Input. Remove Module by pressing down and outward on the plastic latches at top of unit. The Ground strap from the module must be removed by unscrewing both nuts and lug rings from the Combination Therapy Receptacle. When reassembling, ensure that the Input Module Ground is installed first and its lock washer and nut are secured before installing the other ground down. Also, you must finish installing the Receptacle and both grounds before putting the Module into position.
- **Sleep Switch**—Push it out through the Chassis wall.
- **Battery Charge Board**—Remove the two screws that secure the Board to the chassis and remove.
- **Power Supply**—Unplug Input and Output Power Cables. Remove four screws that secure Power Supply to chassis and lift the Power Supply out.

Top Chassis Components

The Chassis Top houses the Main Board, Keypad, and Display Board.

- **Main Board / Keypad**—Remove the Screw from the upper right hand corner of the EMI box on the board. Remove the other nine screws that secure the board to the Chassis Top.

When lifting the board from the top be careful of the keypad. Disconnect the two cables from the Display at this time. The Keypad must be seated on the ridged frame of the Chassis Top before the Main board is carefully reinstalled (the Display cables should be attached before seating main board).

- **Display**—unscrew the four hold down screws the Standoffs underneath the board should stay threaded to the screws but be careful to not lose them if they come loose. Lift the Display up and disconnect the cables from the Main Board. When installing, connect the cables first, make sure the standoffs are threaded on the screws (or in place over the holes), then place the board.

Appendix A—Measuring Ultrasound Power Output

OHMIC Instruments ultrasound power meters, UPM–series, are traceable to National Institute of Science and Technology (NIST) standards. The UPM–DT–1 is recommended as first choice for measuring applicator output.

Whatever instrument is chosen to make these measurements, some basic principles apply to all. Degassed water must be the medium for ultrasound. Water used in ultrasound power meters must be degassed to less than 4 ppm (dissolved oxygen) for reliable results and adherence to FDA measurement requirements.

Mettler Electronics Corp. developed a good method for degassing water using a canning technique involving a pressure cooker and Mason jars. This is easier than boiling water for 30 minutes and transferring it to plastic bottles while still hot, then placing the bottles in a refrigerator. If interested in this method, send a request to the Mettler QA Department.

Also, when measuring ultrasound output, insure accurate placement of the applicator face over the center of the power meter target. If off center, the target will be moved around by ultrasound resulting in unstable readings.

Ultrasound output measurements should be taken in a stable environment, i.e., no air conditioning drafts across the power meter surface, and no vibrations shaking the power meter mechanism. These influences cause unstable readings and reduce reading repeatability.

Insure the power meter is zeroed between readings to verify a stable reference.

Finally, it is recommended that three sets of readings be taken and the average determined to obtain a more accurate representation of device performance. This helps minimize the effects of measurement variables.

Appendix B—Parts List

Part Number	Description
QR6-01	Assembly, PCB Main Board
QR6-02	Assembly, PCB Battery
TD3-20	Assembly, LCD
TD3-21	Assembly, Cable Power input
TD3-22	Assembly, AC inlet
TD3-23	Assembly, Cable Battery
QR6-04	Assembly, Power Rocker switch
QR6-05	Assembly, Internal U/S coax cable
HG1-39	Keypad
HH3-02	Power Supply
QR4-05	Ground Shield Cable
GG3-05	Plastic Hook, left side
GG3-06	Plastic Hook, right side
KK4-02	Window, LCD Acrylic
7293	Detachable hospital grade line cord, domestic
7296	Detachable mains cord, international
7391	Universal Applicator Cable, Sonicator 715, 716, 730 and 740
7401	Rechargeable Sonicator 740 Battery Pack
7410	740 applicator; 10 cm^2, 1 MHz
7410C	740 applicator; 10 cm^2, 1 MHz, CE
7413	740 applicator; 5 cm^2, 1 MHz and 3.2 MHz
7413C	740 applicator; 5 cm^2, 1 MHz and 3.2 MHz, CE
7431	740 applicator; 1 cm^2, 3.3 MHz
7431C	740 applicator; 1 cm^2, 3.3 MHz, CE