FONIX® 8000

MAINTENANCE MANUAL

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FRYE

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Chapter 1: Overview

This FONIX 8000 Hearing Aid Test System is designed to test hearing aids. There are two major types of hearing aid tests: coupler and real-ear.

Coupler measurements are performed in a sound chamber using a coupler or artificial ear that directs the sound to a measurement microphone. The measurement microphone thus listens to the sound coming from the hearing aid. The sound chamber is constructed so that external sounds are attenuated and so that there is a place within the box that contains a reference point where the sound is calibrated in both amplitude and frequency. Tests can be performed with a pure tone sound or with a composite form of sound, with many frequencies presented at once.

Tests can also be performed on the hearing aid while it is worn on an actual ear. In this test, the sound is provided by a sound field speaker and controlled by means of a reference microphone placed in close proximity to the test ear and hearing aid. The sound from the hearing aid is measured by a thin hollow silicone rubber probe tube that is placed in the ear next to and typically along side of the hearing aid ear mold in order to pick up the sound generated by the hearing aid.

Tests can also be made of the battery current drain of the hearing aid while in coupler/sound chamber mode, using a special battery pill set that is used to substitute for the battery normally used in the hearing aid. Typically, the current is measured while the hearing aid is being driven by a calibrated sound.

Further tests can be made of the magnetic field sensitivity of a hearing aid operated in telephone coil mode. This is done either by use of a built in coil in the sound chamber of the FONIX 8000 or through external telephone coil.

Intended Use:

The FONIX 8000 has two major intended uses:

- To determine the functionality of a hearing aid. That is, to determine if the hearing aid is functioning within the hearing aid manufacturer's specifications with an acceptable frequency response, battery current drain, distortion, noise, and other characteristics as defined by the applicable standard.
- To determine the frequency response of the hearing aid and be able to compare this frequency response to a target based upon the patient's hearing threshold levels. These measurements can be performed as real-ear or coupler tests.

1.1 Signal Generation Overview

1.1.1 Digital Basis of the Composite Signal

The composite signal is generated by reading 256 16-bit data words in RAM sequentially and doing it over and over again. The program is able to adjust the individual amplitude of each signal component in the series so that it provides a correct amplitude of drive at the test point in the chamber for each test frequency. The test microphone is placed at the reference point in the chamber. Pushing the LEVEL button starts the amplitude correction process. A composite analysis of the chamber is done and correction factors are calculated which alter all of the individual drive components so that the chamber response is flat and at the desired amplitude at this reference point.

One way to think of the test waveform is to picture one sine wave of 100 Hz being built using 256 points, or steps, through the sequential reading of a 16-bit digital RAM. If we wanted to create a signal with two equal value components, we would arithmetically add to this wave a second sinewave, say of 400 Hz. Each cycle of the 400 Hz wave would take exactly one fourth as many steps as the 100 Hz wave to produce (i.e., 64 steps). When these two sets of steps are added together we would get a composite wave with two frequency components.

1.1.2 Component Amplitude Weighting Considerations

The amplitude of each frequency may also be dependent upon its placement in the frequency spectrum. If a white noise equivalent is used, then every multiple of 100 Hz will be used and will have an equal amplitude value. If the ANSI spectrum is to be approximated, the amplitudes of the components in the spectrum will drop at a rate of 6 dB per octave above 900 Hz when viewed on a standard Fast Fourier analyzer.

After the signal is received from the hearing aid and passed through the preamplifier, it is run through a high frequency emphasis amplifier to restore the 6 dB/octave loss so that we can get a compensated gain response picture.

The RMS amplitude of the drive signal increases in proportion to the square root of the sum of the squares of all of its components. Thus, if a particular RMS value of drive signal is needed, both the number and the individual amplitudes of all of the components must be taken into account. A multiple frequency signal will then have smaller component amplitudes to produce the same RMS drive to the device under test as that of a sine wave signal drive which has only one frequency component.

1.1.3 Phase of the Components

Another interesting problem encountered is that the individual components of the wave cannot be allowed to line up in phase, or the composite signal will consist of a series of spikes with very little in between, or an impulse drive. The disadvantage with this type of drive is that it makes very heavy demands on the dynamic range of the hearing aid under test. Hearing aids are not known for their large dynamic ranges, so this type of waveform must be avoided. To produce a moderate crest factor noise equivalent, it is necessary to skew the phases of all of the components so that a given RMS amplitude of signal has a low peak value. A computer program was used to determine the optimum set of phase values.

1.1.4 Special Distortion Measurements

Harmonic distortion tests can be run by generating a signal consisting of only one sine component at a time, and using the Fast Fourier analysis program to determine the spectral distribution of harmonics.

Intermodulation tests are automatically run using the composite waveform. If present, this type of distortion is immediately apparent when viewing the gain or power response of the hearing aid.

1.2 Signal Detection Overview

1.2.1 Fast Fourier Technique

The assumed technique for making response measurements is the Fast Fourier Transform. This technique is ideally suited to a system that is used to analyze a digitally generated waveform, since the sampling process can be locked to the signal generation process, thus eliminating one of the main problems with the FFT, the windowing of the measured waveform. A rectangular window is thus possible and used. That is, all sampled components are used as measured.

1.2.1.1 Windowing

The FFT requires that the signal being sampled is exactly repetitive in order to achieve a clean spectral display. If there is an abrupt discontinuity between the first and last samples taken, the transform can only assume that large high frequency components are present in order to generate the discontinuity. Use of the internally generated signal helps to eliminate this problem; if a random noise is present in the signal being measured, it will appear in the response display.
When the sound drive is switched to "OFF," the 8000 is turned into a general purpose spectrum analyzer and can be used for analysis of signals. When this is done, mathematical windowing is used as is done with standard FFT analyzers. This windowing is done by multiplying the first and last samples taken by a value close to zero. The next two samples in from the ends are multiplied by a larger quantity. In the center of the group of samples, the values are multiplied by a compensating factor greater than unity. The function used is called a Hanning window.

1.2.1.2 Aliasing

A further requirement is that the bandwidth of the measured signal be controlled so that its frequency does not exceed a value of 1/2 the sampling rate. This frequency amplitude control is done with an aliasing filter. A conservative design stops the analysis well before the frequency limit is reached.

Aliasing shows up as a generation of random or non-random dot patterns in the sampled data points, and occurs when the signal can take a number of excursions between samples. This aliasing in an FFT will produce a number of components in the spectrum that are really not there. It is also desirable to eliminate the high frequency components from the signal generator portion of the system. A smoothing filter is used there also.

1.2.1.3 Noise Reduction

The effects of ambient or hearing aid noise can be reduced by the use of time domain signal averaging because the sampling process is exactly synchronized with the signal generator.

Noise reduction averaging is done in steps of 2, 4, 8 and 16. The process is done by use of an averaging buffer. The data is added to the data already in the buffer used to create the last spectral display in a ratio of 1/2, 1/4, etc., depending on the averaging called for. The result of the addition is then divided to get a properly scaled number. The effect of the non-synchronous noise is thus reduced because of the averaging process.

Averaging does not slow down the display process, but does slow down the effect that an acoustical change will cause on the displayed waveform. Changes in the phase of signals will also show up if averaging is being used. The change of phase is accomplished by movement of the hearing aid in a sound field while the measurement is in process. The effect of phase changes is a dropout of the signal and an eventual recovery to the correct level when the motion has ceased.

Modern hearing aids now employ "interesting" signal processing techniques that apparently destroy the phase relationship between input and output signals as a means of preventing feedback. Time domain averaging does not work with this class of device. Further, this class of aid will reduce the gain when a steady state test signal is applied. To enable a reasonable analysis of this modern class of hearing aid, a newer form of composite signal has been developed. It is called "digital speech" and consists of a series of composite signal bursts to imitate speech. The analysis of the hearing aid output has been modified as well, by doing averaging in the frequency domain rather than time. Curve display smoothing can also be applied to remove rough spectra that sometimes result with some of the newer aids.

Chapter 2: Specifications

2.1 ACOUSTICAL OUTPUTS

Frequencies:	200-8000 Hz in 100 Hz intervals (user interface) 200-8000 Hz in 50 Hz intervals (RS232)
Frequency Accuracy:	1%
Amplitudes:	40-100 dB in 5 dB intervals coupler, 40-90 dB in 5 dB intervals real-ear (user interface) 40-100 dB in 0.01 dB intervals coupler, 40-90 dB in 0.01 dB intervals real-ear (RS232)
Accuracy	Coupler: ±1 dB from 300 to 5000 Hz, all others ±3 dB (after leveling) Real-ear: ±3 dB, 200-8000 Hz (after leveling)
Distortion (at 70 dB SPL):	Puretone: < 0.5%, 400-2500 Hz

2.2 TELECOIL OUTPUTS

Field Strength:	1, 1.78, 3.16, 5.62, 10, 17.8, 31.6, 56.2, 100 mA/M (user interface) 0-180 mA/M in 0.01 mA/M specified intervals (RS232)
Accuracy:	Accuracy: ±2 dB

2.3 BATTERY CURRENT

Readout Range:	0.00-25.00 mA
Available Current:	greater than 30 milliamps
Accuracy:	± 5% of reading ± one digit
Resolution:	8 μA
Voltages supplied:	1.5 (silver), 1.3 (zinc air)
Voltage Accuracy:	±15 millivolts. (open circuit)
Resistance accuracy:	(± 6% ± 0.5 ohm)

2.4 DIGITAL READOUT OF SOUND PRESSURE LEVEL

Frequency Range:	200-8000 Hz
Amplitude Range:	0-150 dB SPL
Resolution:	0.1 dB
Accuracy:	Coupler mic: ±1.0 dB ±1 digit, 300-5000 Hz, ±2 dB ± 1 digit all other frequencies Probe mic: ± 2.5 dB ± 1 digit, 250-8000 Hz Ref mic: ± 3 dB ± 1 digit, 100-8000 Hz

2.5 HARMONIC DISTORTION ANALYZER

Type:	2nd, 3rd, Total (2nd plus 3rd)
Resolution:	0.1%

2.6 ATTACK/RELEASE

Range:	1.25 to 5000 mSec.
Accuracy:	Accuracy: ±10 % or ± 2 ms, whichever is larger
Signals:	Puretone: 200-8000 Hz, in 100 Hz intervals (user interface), 50 Hz intervals (RS232), Composite

2.7 AVAILABLE TESTS

Automated Test Sequences:	ANSI S3.22-1987, ANSI S3.22-1996, ANSI S3.22-2003, ANSI S3.22-2009, IEC 60118-7:1994, IEC 60118-7:2005, ANSI S3.42-1992, JIS:2000
Additional Coupler Tests:	Profiler, ISTS, Enhanced DSP, Input/Output, Attack & Release, Battery Current, Coupler Multicurve, Coupler Directional
Real-Ear:	Audiogram Entry, Target Edit, Insertion Gain, Real-ear SPL, Visible Speech
Optional:	Coupler Directional (requires 8120 Polar Plot Chamber)

2.8 POWER

Source voltage:	100-240 volt AC.

Frequency Range:	50-60 Hz.
Power Requirement:	0.6 A.
Fuse:	T 630mAL, 0.63A / 250 V~, Type T, IEC 60127-2 Sheet III (Slo-Blo Type, Glass, 5mm x 20mm). Qty 2.

2.9 ELECTRONICS MODULE

Size:	17.3"W x 10.8"D x 6.5"H (43.9 x 27.4 x 16.5 cm).
Weight:	14.3 lbs.(6.49 kg).

2.10 PRINTER, INTERNAL

Type:	High speed line thermal printer
Paper width:	4.41" (112 mm)

2.11 TEST CHAMBER

8050

Test Area:	5"W x 6"D x 1.5"H (12.7 x 15.2 x 3.8cm).
Ambient Noise Isolation:	45 dB at 1 kHz (allows THD measurement to within 3% at 60 dB source level and a 60 dB ambient).
Size:	11.5"W x 13.5"D x 9.2"H (29.2 x 34.3 x 23.4cm).
Weight:	21.8 lbs. (9.9 kg).

8120

Test Area:	4"W x 4"D x 1.75"H (10.2 x 10.2 x 4.4cm) with Removable Test Surface 4"W x 4"D x 1.75"H + 5.38" cavity height (10.2 x 10.2 x 4.4 + 13.7cm) with Rotating Shaft
Ambient Noise Isolation:	45 dB at 1 kHz (allows THD measurement to within 3% at 60 dB source level and a 60 dB ambient).
Size:	13.5"W x 14.5"D x 19"H (34.3 x 36.8 x 48.3cm). Latch protrudes another 2.25" (5.7 cm) out the front
Weight:	40.4 lbs. (18.3 kg).

2.12 ENVIRONMENTAL CONDITIONS

Shipping/Storage Humidity:	5 to 95 percent relative humidity (non-condensing)
Shipping/Storage Temperature:	-20 to 60 degrees Celsius (-4 to 140 degrees Fahrenheit)
Operating Relative Humidity:	5 to 90 percent relative humidity (non-condensing)
Operating Temperature:	15 to 35 degrees Celsius

2.13 MONITOR HEADSET

Monitored channel:	Probe microphone
Headphone type:	Stereo 3.5mm
Usable headphone impedance:	32 ohms to 600 ohms (intended for Walkman style headphones)

2.14 GUARANTEE

The FONIX 8000 and its accessories are guaranteed to be free from manufacturing defects which would prevent the products from meeting these specifications for a period of one year from date of purchase.

Chapter 3: Specification Test Procedure

3.1 Source Frequency Accuracy

Instrument required: Frequency counter accurate to 0.1 percent and capable of measuring 1000 Hz.

Setup: Enter the Coupler screen. From the menu, set the static tone to single, and the output transducer to Telewand. Exit the menu. Set the amplitude to 100 mA/M and the frequency to 1000Hz. Connect the frequency counter to the sound chamber Telewand connector.

Measurement: The frequency counter should read 1000Hz within 1% plus the tolerance of the counter.

3.2 Digital Measurement and Readout of SPL Accuracy

Instrument required: Precision sound level meter with 1/2 inch condenser microphone. Response set to flat frequency response (C weighted).

Setup: Enter the coupler screen. From the menu, set noise reduction (tone) to "off" and static tone to "single." Exit the menu. Set the 8000 amplitude to 90dB. Place the sound level meter's microphone at the reference point in the sound chamber. Place the 8000 coupler microphone so that its grill is facing the sound level meter's microphone's grill and is 1/8" away from it. Leave the chamber lid open and make sure the room is very quiet.

Measurement: Starting at 200Hz, measure the RMS levels at the reference point with both systems for each puretone frequency. They should agree within 1 dB (+/- 1 digit) from 300 to 5000 Hz and within 2 dB (+/- 1 digit) at all other frequencies, plus the tolerance of the sound level meter.

3.3 Source Attenuator Accuracy

Instrument required: Precision A.C. voltmeter, such as the HP974A, that is accurate at 1KHz, has dB relative and auto ranging features.

Setup: Enter the coupler screen. From the menu, set the static tone to "single", and the output transducer to "telewand." Exit the menu. Set the 8000 to 1KHz and 100mA/M. Connect the voltmeter to the sound chamber telewand connector. Set the meter to autoranging and dB relative modes.

Measurements: Measure the voltage on the voltmeter and set the dB relative to show 0dB at the 100mA/M setting. Reduce the output level on the 8000 to the 56.2mA/M setting and note that the meter reading goes down 5 dB (+/- .5 dB) plus the tolerance of the voltmeter. Repeat this for the 31.6, 17.8, 10, 5.62, 3.16, 1.78 and 1mA/M settings.

3.4 Source Output Amplitude Accuracy

Instrument Required: Precision sound level meter with ½ inch condenser microphone, response set to flat frequency response.

Setup: Enter the Coupler Multicurve screen. In the menu, set the noise reduction (tone) to "off" and the static tone to "single." In the test screen, set the 8000 amplitude to 90dB. Place the coupler microphone at the reference point in the sound chamber. Close the chamber lid. Level the 8000. Replace the coupler microphone with sound level meter's microphone at the reference point in the sound chamber. Close the chamber lid.

Measurement: Starting at 200Hz, measure the RMS levels, at the reference point, with the sound level meter, for each puretone frequency. It should read 90 dBSPL within 1 dB from 300 to 5000 Hz and within 3 dB at other frequencies, plus the tolerance of the sound level meter.

3.5 Telecoil Drive Current Accuracy

Instrument required: Precision A.C. current meter that is accurate to 1 kHz.

Setup: Enter the Coupler Multicurve screen. In the local menu, set static tone to "single" and transducer to "telewand." Connect the current meter to the telewand jack on the 8050 or 8120 sound chamber. In the test screen, adjust the amplitude of the telecoil amplitude. The measured electrical output on the meter should correspond to the displayed telecoil field strength within 2 dB plus the tolerance of the current meter in the following chart:

Electrical output	Field Strength
0.044 mA	1 mA/M
0.079 mA	1.78 mA/M
0.140 mA	3.16 mA/M
0.250 mA	5.62 mA/M

0.444 mA	10 mA/M
0.790 mA	17.8 mA/M
1.404 mA	31.6 mA/M
2.485 mA	56.2 mA/M
4.44 mA	100 mA/M

For example, if the telecoil amplitude is set to 10 mA/M, the meter should read .444 mA within tolerance.

3.6 Battery Simulator Voltage Accuracy

Instrument required: Precision D.C. voltmeter.

Setup: Connect the voltmeter to the battery pill jack in the sound chamber. Make sure nothing else is connected to this jack.

Measurement: Press menu from the opening screen to enter the default settings menu. Press F1 and select "coupler." Set battery chemistry to silver. Measure the voltage and see that it is 1.5V within 15 mV plus the tolerance of the voltmeter. Set battery chemistry to Zinc-Air. Measure the voltage and see that it is 1.3V within 15 mV plus the tolerance of the voltmeter.

Chapter 4: Circuit Description

4.1 General Description

4.1.1 The following boards are used in the 8000 Main Module:

a. Single Board Computer
b. Daughter Board
c. Connector Board
d. Parallel Interface
e. Printer Interface
f. Offline Power Supply
g. Front Panel Keyboard

4.1.2 The following boards are used in the 8050 and 8120 Sound Chambers:

a. Chamber Board (both)
b. Breakout Board (both)
c. Turntable (8120 only)

4.1.3 The Probe Remote Module has:

The Probe Board.

4.1.4 The Single Board Computer(SBC) has:

The X86 microprocessor, BIOS, DRAM, Compact Flash, Display controller with VGA Interface, Audio Codec, RS232 interface, Parallel Port, PC104 Buss, and the Time-of-day clock.

4.1.5 The Parallel Interface Board has:

The 2x13 connector going to the SBC through a cable.
The 2x15 connector that plugs directly into (CN1) Printer Interface Board.

4.1.6 The Printer Interface Board has:

The Parallel Interface (CN1) connector.
The Power connector from the offline power supply .
The Thermal Printer Head, Stepper motor, Paper up, and Head Switch connectors.
A microcontroller and all circuits needed to drive the internal Thermal printer.

Note: A 640 x 416 dot screen image is mapped to the internal printer. Each dot is replaced with a matrix of 2x2 pixels. The printed image is one set of 2 x 416 dots per line, for 832 dots per line. Each line is printed twice to obtain the 2 x 2 matrix for each dot.

4.1.7 The Daughter Board has:

The power interfaces from the offline power supply, and to the SBC.
The PC104 Buss interface from the SBC to three UARTS and two RS232 interfaces.
A microcontroller that interfaces between the SBC and the circuits on the Daughter and the Connector Boards.
The Internal and external Keyboard interfaces.
The interface to the Connector Board.
The audio connector to and from the SBC.
The measurement microphones multiplexer, two channel prescalers, ANSI equalizers, anti-aliasing filters, and the Mic/Line multiplexer.
The speaker current measurement.

4.1.8 The Front Panel Keyboard has:

Twenty-two rubber key switches.
The connector to the Daughter Board.
The Power and Standby LEDs.

4.1.9 The Connector Board has:

The interface to the Daughterboard.
Two channel source attenuators, power amps, and relays directing to module 1 or 2.
The Frye Peripheral Interface(FPI) connectors to Module 1 and 2.
Four channel differential measurement microphone signal receivers.
The Line input and Voice Microphone inputs.
The external keyboard connector.
The RS232 to USB device port circuits and connectors.
The dual USB Host pass through connectors.

4.1.10 The Chamber Board has:

The FPI connector from the Connector Board.
An RS232 interface between the FPI and the microcontroller.
A microcontroller that interfaces between the SBC and the circuits on this board.
Relays that direct the source signals to the speaker, telecoil, or telewand.
The 7020 connector, the connector to the Breakout Board, and the Telewand Jack.
The Chamber Microphone connector, Prescale amplifiers, and differential line driver.
The Battery Simulator circuits and the Battery Pill jack.
The Power/Status and White LED drivers, and the Power/Status LED.
The Turntable control lines and connector to the Turntable Board.

4.1.11 The Turntable Board has:

The connector from the Chamber Board.
The H-Bridge driver to drive the Stepper Motor.
The connector to the Stepper Motor and Shaft Encoder.

4.1.12 The Breakout Board has:

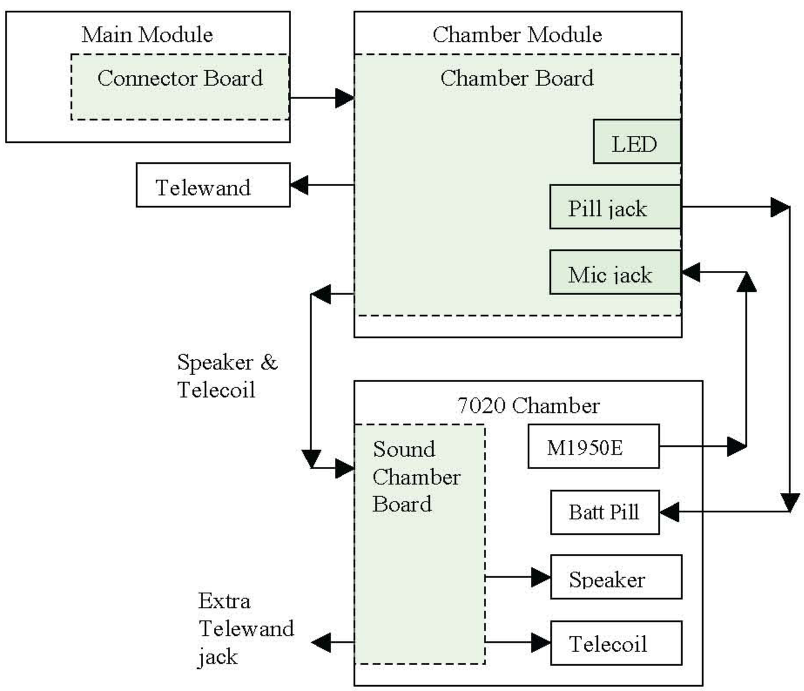
The connector from the Chamber Board.
The Battery Pill, the White LED, the Speaker and both Telecoil jacks.
The Power/Status LED.

4.1.13 The Probe Board has:

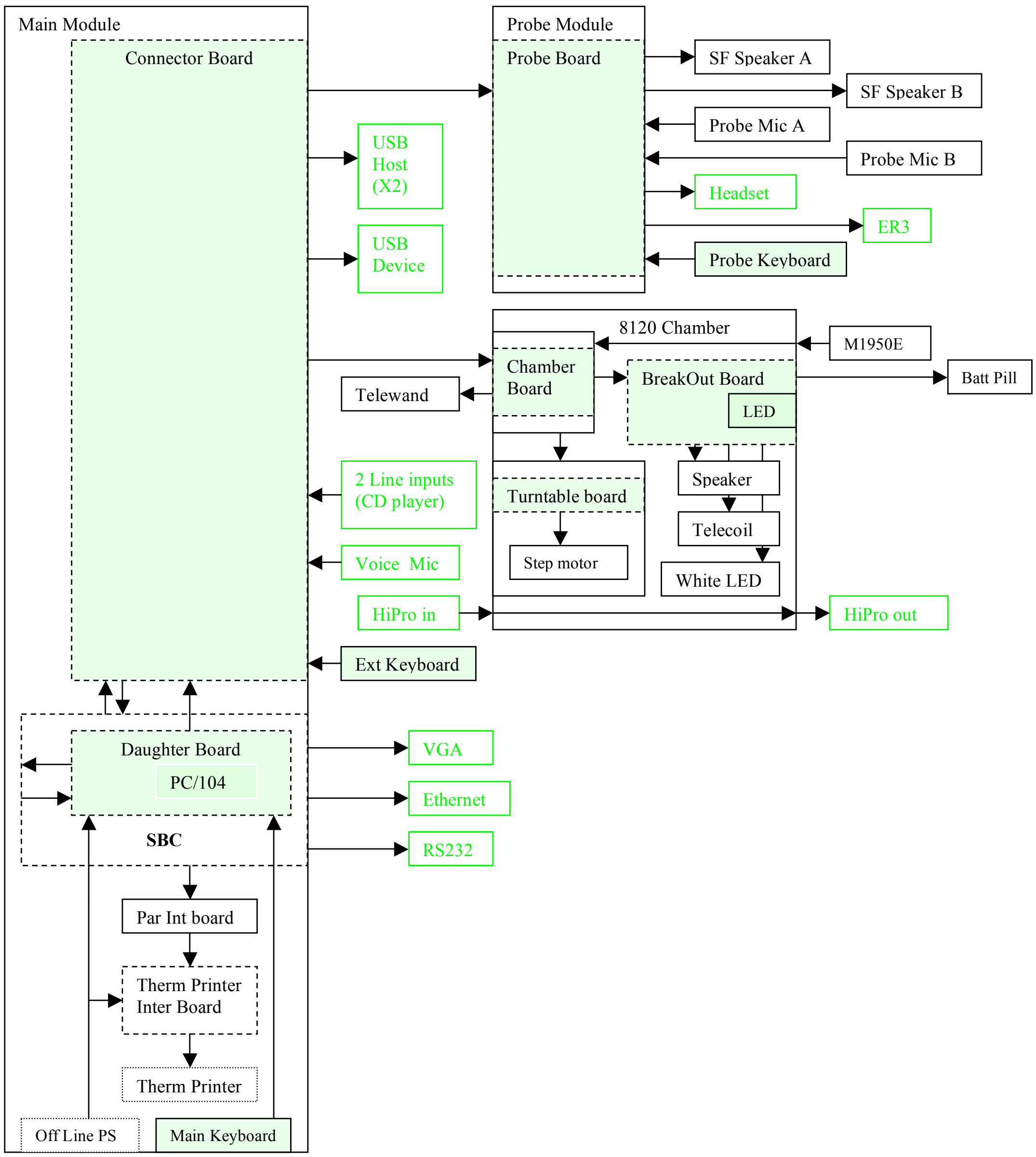
The FPI connector from the Connector Board.
An RS232 interface between the FPI and the microcontroller.
A microcontroller that interfaces between the SBC and the circuits on this board.
Relays that direct the source signals to one of the speakers, the ER3, or to the headphone jack.
Two probe microphone connectors, two instrumentation amps, a microphone multiplexer, two prescale amplifiers, two probe equalizers, and two differential line drivers.
An external keyboard connector and interface.
A Volume control and interface.

4.2 System Block Diagrams

4.2.1 8000 with 7020 chamber Partial System Block Diagram

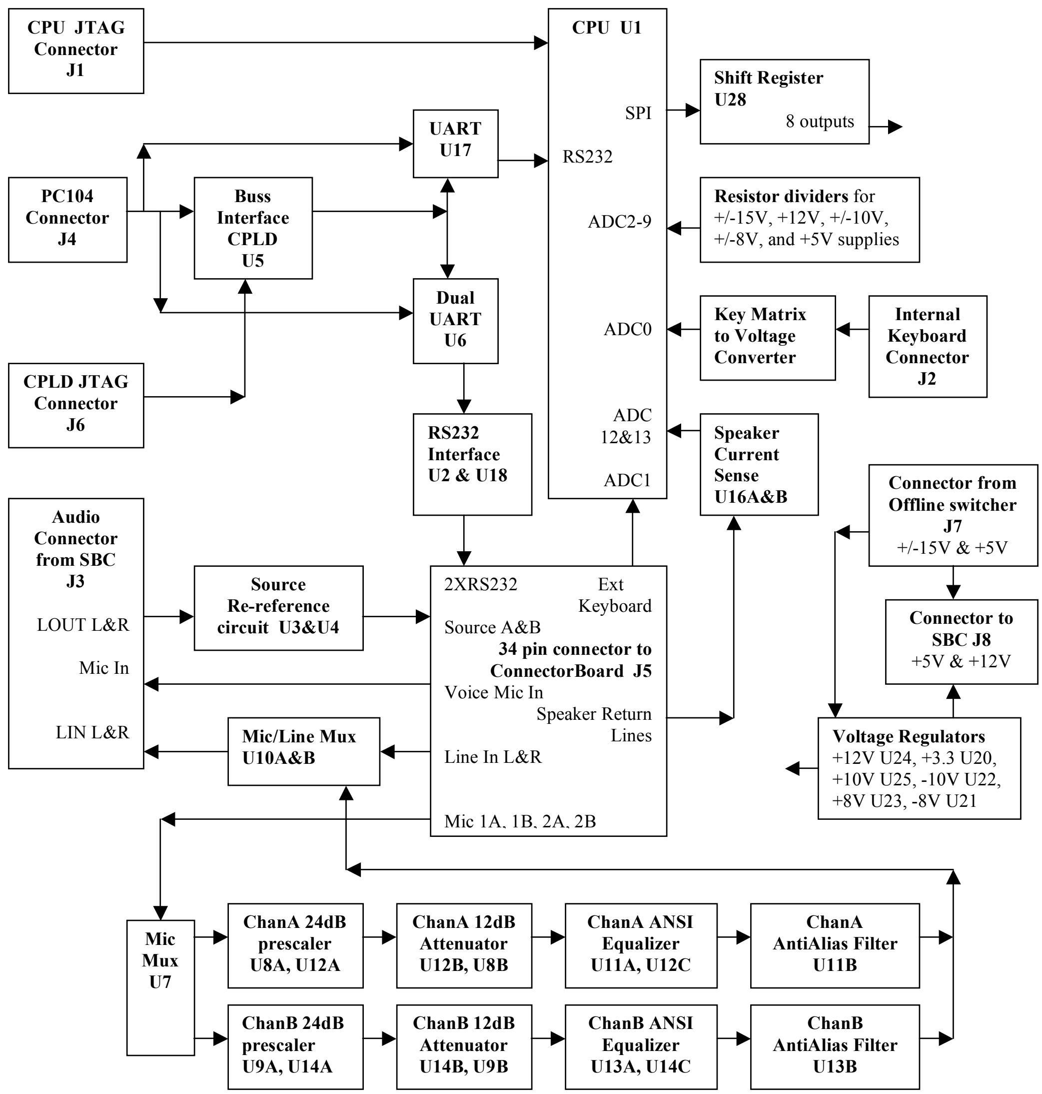


4.2.2 8000 with 8120 Chamber System Block Diagram

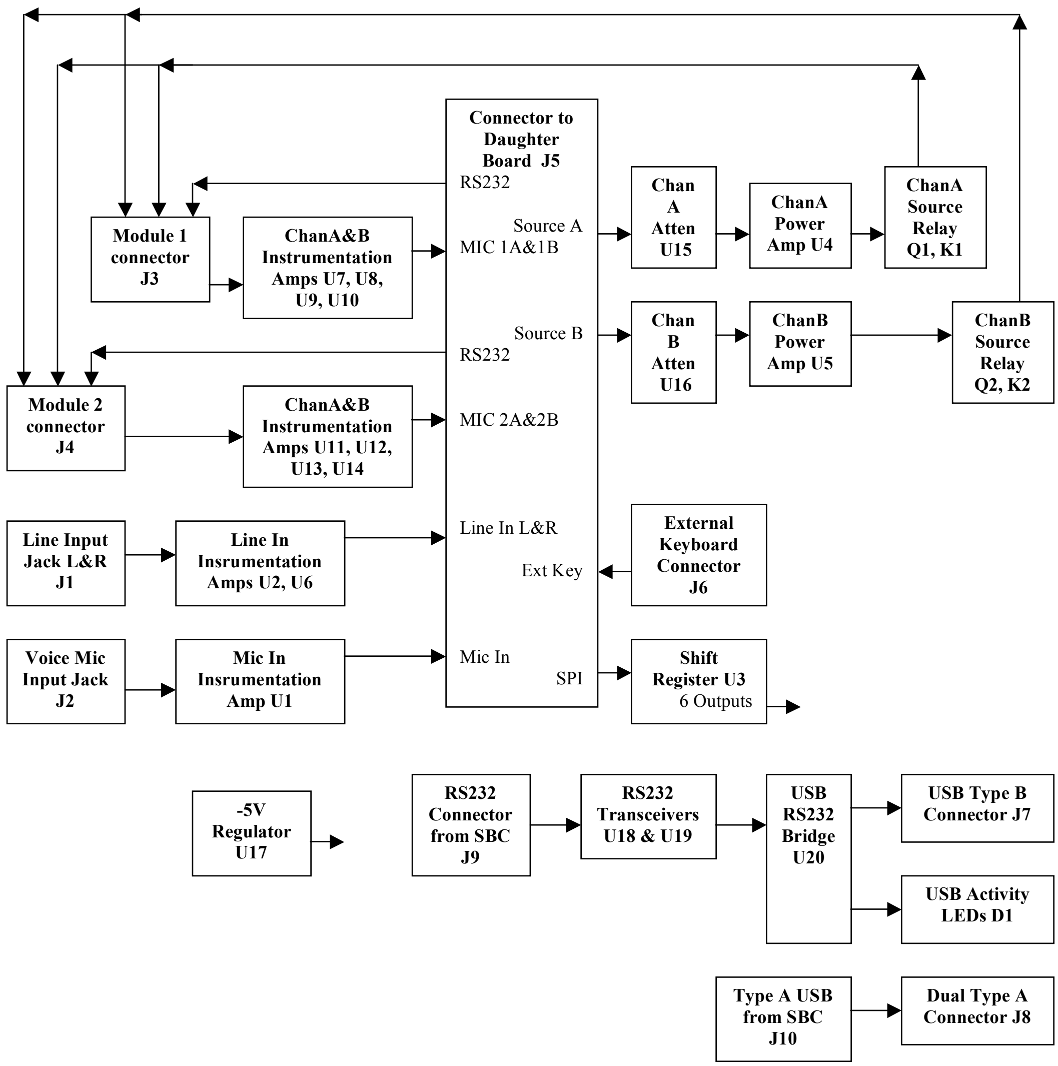


4.3 Circuit Block Diagrams

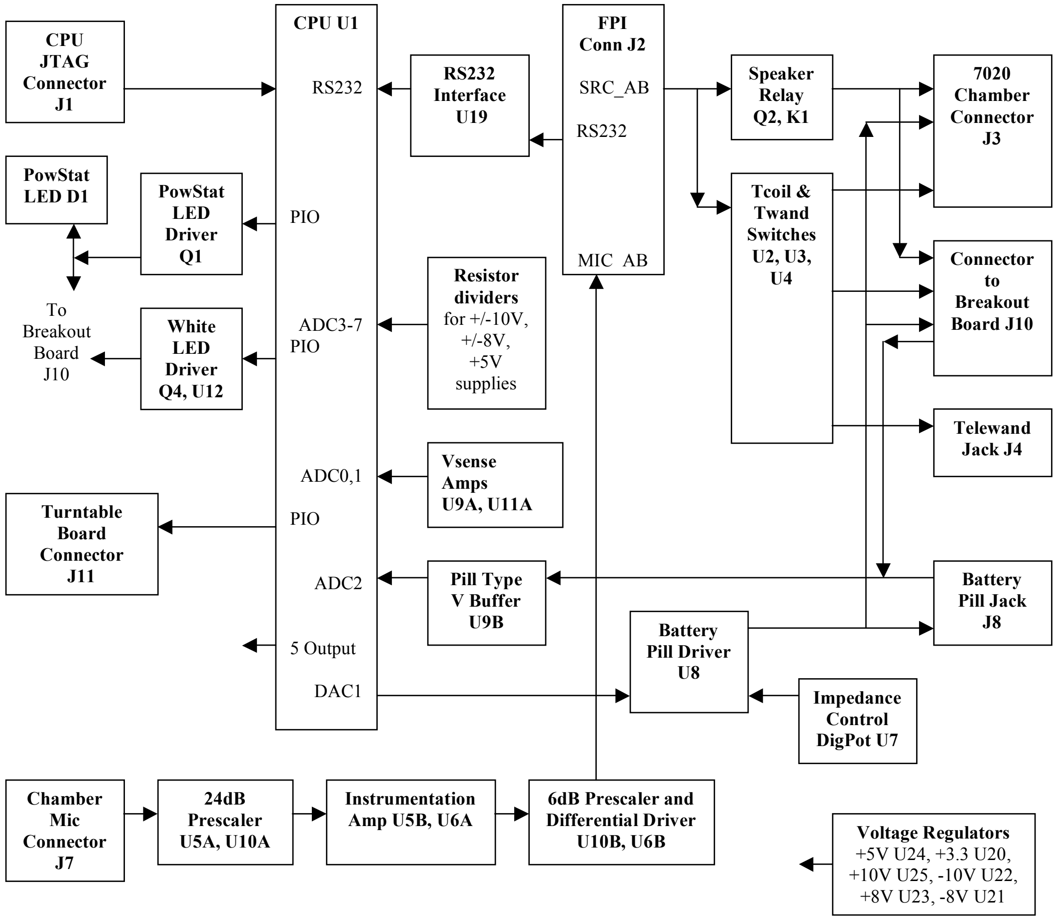
4.3.1 Daughter Board Block Diagram



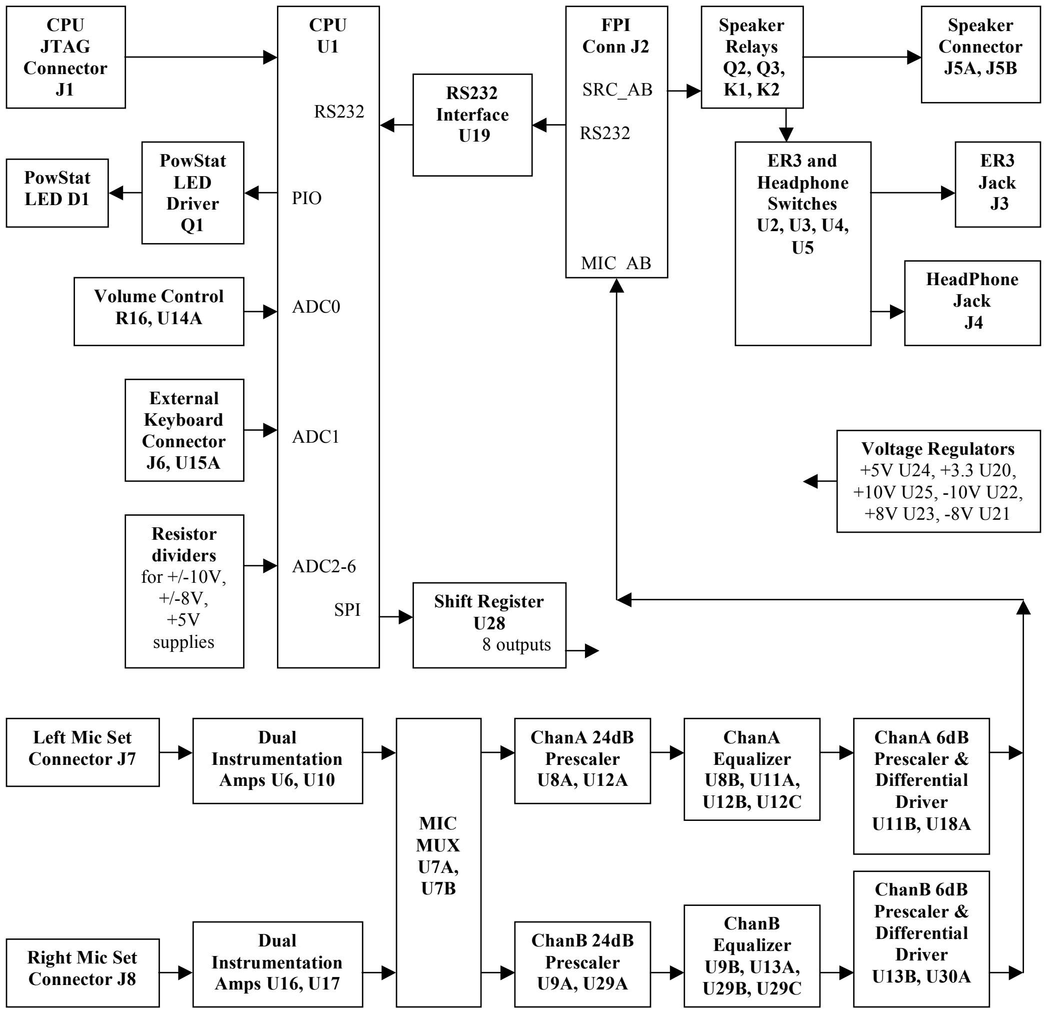
4.3.2 Connector Board Block Diagram



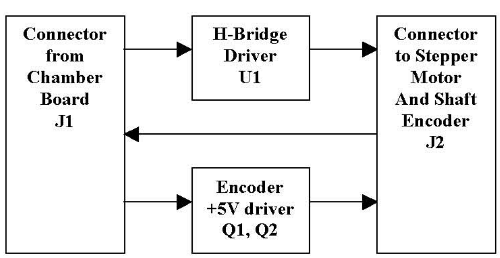
4.3.3 Chamber Board Block Diagram



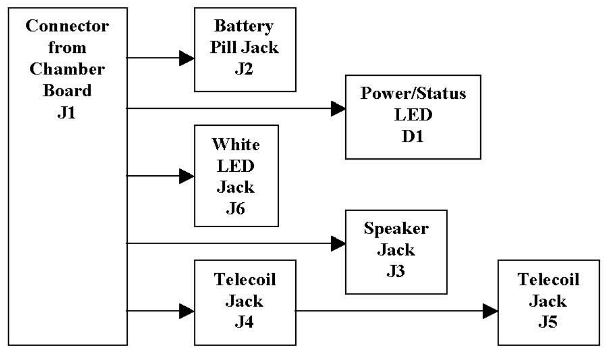
4.3.4 Probe Board Block Diagram



4.3.5 Turntable Board Block Diagram



4.3.6 Breakout Board Block Diagram



4.4 Circuits Detailed Description

All the circuits on each board are described here. The Chamber and Connector boards can be configured more than one way. On these boards, some of the circuits are left off in each configuration.

4.4.1 Source Circuits Signal Flow

4.4.1.1 SBC: The source signal originates at the CODEC on the SBC.

4.4.1.2 Daughterboard schematic (061-0171-0x)

OUTGOING SIGNAL:

Page 3: The two channels arrive on J3 pins 5 and 1. A sample of the analog ground on the SBC is taken from J3 pin 8. U3 and U4 and associated circuits then re-reference the ground of the source signal from the SBC ground to the SPKREF ground which connects to system MECCA on page 5. The two source signals are named “SOURCE_A” and “SOURCE_B” and then sent to the connectorboard via J5 pins 6 and 7. The SPI Buss from U1-A on page 1 is send to the Connectorboard via J5 pins 15, 16, and 17(SPIMOSI, SPICLK, SPICSL).

Page 1: The SPI Buss originates on U1-A pins 46, 40, and 39(SPICLK, SPIMOSI, SPICSL).

RETURNING CURRENT:

Page 3: The source return currents (SRETA and SRETB) arrive on J5 pins 5 and 8.

Page 5: They are then sent to the current measurement circuit comprised of U16 and associated resistors. The currents cause a voltage drop across R71 and R72 which are then amplified and named ADC12 and ADC13. The return currents finally arrive at system Mecca J9.

Page 6: ADC12 and ADC13 arrive at U1 pins 9 and 10.

4.4.1.3 Connectorboard schematic (061-x172-0x)

OUTGOING SIGNAL:

Page 3: SOURCE_A and SOURCE_B arrive on pins 6 and 7 of J5. The SPI Buss from the Daughterboard arrives on J5 pins 15, 16, and 17 (SPIMOSI, SPICLK, SPICSL).

Page 1: SOURCE_A and SOURCE_B are then sent to U15-A and U16-A which are Digital Potentiometers. U15-A and U16-A are used to attenuate the source as needed before sending them on to the Speaker amplifiers U4-A and U5-A. Relays K1 and K2 are then used to direct the two speaker signals to either Module 1 or Module 2. Note the signals are now renamed “SRC_1A”, “SRC_2A”, “SRC_1B” and “SRC_2B”. These four names indicate which channel they are (“A” or “B”), and which module (“1” or “2”) they are being sent to. The SPI Buss from page 3 goes to U3, U15-A and U16-B. U3 is a serial to parallel output shift register that is used to control the Speaker amps Mute and Standby, and the relays on this page. U15-B and U16-B is the SPI interface part of the Digital Potentiometers.

Page 3: SRC_1A and SRC_1B are connected to J3 (Module 1) pins 10 and 4. SRC_2A and SRC_2B are connected to J4 (Module 2) pins 10 and 4. They are then sent to the chamber module via the FPI cables.

RETURNING CURRENT:

Page 3: The source return currents arrive back from the remote modules on J3 and J4 pins 3 and 11. They are named SRETA and SRETB and then sent to the Daughterboard via J5 pins 5 and 8.

4.4.1.4 Chamberboard schematic (061-x178-0x)

OUTGOING SIGNAL:

Page 1: The signals arrive on J2 pins 10 and 4 and are renamed “SRC_A” and “SRC_B”. The Source control signals SPK_A/B, COIL_A/B and LOOP/WAND originate on U1-A pins 43, 44 and 51.

Page 2: SRC_A and SRC_B are then connected to K1, which is used to direct one of them to the chamber speaker. The signal is then renamed “SPK_OUT”. If this is a “Remote Chamber Module”, then the speaker signal is connected to J3 pin 2. SRC_A and SRC_B are also connected to U2-A which is used to direct one of them toward the “Coil”. U4-A is used to direct that Coil signal to either the Telecoil or the Telewand. The Telewand signal is connected to J4 pin 1. If this is a “Remote Chamber Module”, then the Telecoil signal is connected to J3 pin 4. Q2 buffers the SPK_A/B signal from U1-A on page 1. The COIL_A/B and LOOP/WAND signals that control U3-A and U2-A and U4-A come from U1-A on page 1.

Page 4: If this is an 8120 or an 8050, then the SPK_OUT is sent to J10 pin 1, and the Telecoil signal to J10 pin 4.

RETURNING CURRENT:

Page 2: If this is a “Remote Chamber Module”, then the speaker return current arrives at J3 pin 3 and is named SPK_RET. It is then routed to the same channel that the outgoing signal came from (SRET_A or SRET_B) by K1. The telewand current arrives at J3 pin 5 or J4 pin 2 and is named TCOIL_RET. It is then routed to the same channel that the outgoing signal came from (SRET_A or SRET_B) by U3-A.

Page 4: If this is an 8120 or an 8050, then the speaker return current arrives at J10 pin 2 (SPK_RET), and the telecoil return current arrives at J10 pin 3 (TCOIL_RET). See page 2 to see what happens to SPK_RET and TCOIL_RET next.

Page 1: SRET_A and SRET_B are then sent back to the Connectorboard via J2 pins 3 and 11.

4.4.1.5 Breakout Board Schematic (061-0179-0x)

Page 1:

OUTGOING SIGNAL:

The speaker signal arrives on J1 pin 1 and goes through J3 pin 1 to the speaker. The telecoil signal arrives on J1 pin 4, is converted to a current by R1, and then connects to J4 pin 1. The telecoil is connected to all 8 pins of both J4 and J5.

RETURNING CURRENT:

The speaker current returns on J3 pin 2 and then heads back to the Chamberboard on J1 pin 2. The telecoil current returns on J5 pin 8 and then heads back to the Chamberboard on J1 pin 3.

4.4.1.6 Probeboard schematic(061-0177-0x)

OUTGOING SIGNAL:

Page 1: The signals arrive on J2 pins 10 and 4 and are renamed “SRC_A” and “SRC_B”.

Page 2: SRC_A is then connected to K1, which is used to direct it to either speaker A at J5-A pin T4, or toward the ER3(U2-A pin 8) and the Headphone(U4-A pin 8). SRC_B is then connected to K2, which is used to direct it to either speaker B at J5-B pin T2, or toward the ER3(U2-A pin 2) and the Headphone(U4-A pin 2). U2-A is then used to direct the A or B signal to the ER3 at J3 pin 1. U4-A is then used to direct the A or B signal to the both channels of the headphone at J4 pins T3 and R2.

RETURNING CURRENT:

Page 2: The speaker return currents arrive at J5-A pin C6 and J5-B pin C1. They are then connected to SRET_A and SRET_B respectively. The ER3 return current arrives at J3 pin 3 and is routed to the same channel that the outgoing signal came from, (SRET_A or SRET_B), by U3-A. The Headphone return current arrives at J4 pin C1 and is routed to the same channel that the outgoing signal came from, (SRET_A or SRET_B), by U5-A.

Page 1: SRET_A and SRET_B are then sent back to the Connectorboard via J2 pins 3 and 11.

4.4.2 Measurement Microphone Circuits Signal Flow

4.4.2.1 Chamberboard schematic (061-x178-0x)

Page 3: The coupler microphone signal arrives at J7 pin 1. U5-A, U10-A and associated components are the 24dB Prescaler. U5-B, U6-A and associated components re-reference the microphone ground from chassis to the local Analog Ground. U6-A also acts as the positive half of the differential line driver which drives the MICAB+ line. U10-B, U6-B and associated components are the negative half of the differential line driver which drive the MICAB- line. Turning the negative driver on increases the output of the differential receivers on the connectorboard by 6dB. So the negative half of the differential driver is also the 6dB Prescaler. The PRESCALE and 6DB_ATTTEN control signals come from U1-A on page 1. J5 is used to connect the 30.1K -10V bias resistor to the mic input signal if needed. The M1950 does not need this bias current. The older M1750 does need the bias current.

Page 1: The MICAB+ signal is sent out to both the MICA+ and the MICB+ lines on J2 pins 1 and 2. The MICAB- signal is sent out both the MICA- and the MICB- lines on J2 pins 8 and 9. These signals are then sent to the Connectorboard. The PRESCALE and 6DB_ATTEN control signals originate on U1-A pins 54 and 13.

4.4.2.2 Probeboard schematic (061-0177-0x)

Page 3: The Left Reference Microphone signal arrives at J7 pin 1. U6 and associated components re-reference the microphone ground from chassis to the local Analog Ground. The Left Probe Microphone signal arrives at J7 pin 3. U10 and associated components re-reference the microphone ground from chassis to the local Analog Ground. The Right Probe microphone set does the same using J8, U16, and U17.

Page 4: All four microphone signals arrive at U7-A and U7-B. This part connects one of the microphone signals to ChanA, and another one to ChanB. U8-A, U12-A, and associated components are the ChanA 24dB prescaler. U12-B, U8-B, U12-C, and U11-A, and associated components are the ChanA probe equalizer. U11-A also acts as the positive half of the ChanA differential line driver which drives the MICA+ line. U11-B, U18-A, and associated components are the negative half of the ChanA differential line driver which drive the MICA- line. Turning the negative driver on increases the output of the differential receivers on the connectorboard by 6dB. So the negative half of the differential driver is also the 6dB Prescaler. Channel B has the same circuits shown below those just described on the schematic. U28 is a serial to parallel output shift register that the microcontroller U1 uses to control the multiplexer, the prescalers, and the equalizers on this page. The signals on U28 called SPIMOSI, SPICLK, SPICSL come from the SPI interface on the microcontroller U1 on page 1.

Page 1: The MICA+ signal is sent out J2 pin 1. The MICA- signal is sent out J2 pin 8. The MICB+ signal is sent out J2 pin 2. The MICB- signal is sent out J2 pin 9. These signals are then sent to the Connectorboard.

4.4.2.3 Connectorboard schematic (061-x172-0x)

Page 3: The two phases of the two microphone signals arrive on both J3 and J4 pins 1, 8, 2 and 9.

Page 2: The MIC1A+ and MIC1A- signals are RF filtered and then converted from differential to single ended with an AREF ground reference by U7-A, U7-B and U8-A and associated components. The AREF ground is sampled from the Daughterboard analog ground. The other 3 microphone differential signals are handled in the same way by those circuits below and to the right of those just described on the schematic. They are then renamed MIC_1A, MIC_1B, MIC_2A and MIC_2B.

Page 3: MIC_1A, MIC_1B, MIC_2A and MIC_2B are sent to the Daughterboard via J5 pins 1, 2, 3 and 4.

4.4.2.4 Daughterboard schematic (061-0171-0x)

Page 3: MIC_1A, MIC_1B, MIC_2A and MIC_2B arrive on J5 pins 1, 2, 3 and 4.

Page 4: MIC_1A, MIC_1B, MIC_2A and MIC_2B are all connected to U7-A and U7-B. This part connects one of the microphone signals to ChanA, and another one to ChanB. U8-A, U12-A and associated components are the ChanA 24dB prescaler. R35, R36, U12-B and U8-B are the ChanA 12dB attenuator. U12-C, U11-A and associated components are the ChanA ANSI speech filter. U11-B and associated components are the ChanA 16KHz Anti Alias filter. The ChanB signal is handled by the same circuits as described for ChanA and are shown below the ChanA circuits on the schematic. The signals are now renamed MIC_OUT_A and MIC_OUT_B. U28 is a serial to parallel output shift register that the microcontroller U1 uses to control the multiplexer, the prescalers, and the Speech Filters on this page. The signals on U28 called SPIMOSI, SPICLK, SPICSL come from the SPI Buss on the microcontroller U1-A on page 1.

Page 3: MIC_OUT_A is connected to U10-B pin 1 and MIC_OUT_B is connected to U10-A pin 13. These parts are used to select whether the measurement microphone, or the line input for each channel, will be sent to the inputs to the Codec on the SBC. The selected input signals are then sent to the SBC via J3 pins 6 and 2. The control signals MIC/LINE_A and MIC/LINE_B come from U1-A on page 1.

Page 1: U1-A pins 23 and 24 supply the two MIC_LINE multiplexers on page 3 control signals. U1-A pins 39, 40, 46 are the SPI Buss which is sent to U28 on page 4.

4.4.3 SBC to Microcontroller Digital Communication Interface

4.4.3.1 Daughterboard schematic (061-0171-0x)

Page 2: J4 plugs into the PC104 connector on the SBC. U5 decodes the port addresses used by the UARTS on this page. U5 also takes the interrupt requests from the UARTs, assigns them to a PC104 interrupt, and drives them onto the PC104 buss. U5 also drives the chip select lines on the UARTS on this page. U6 is the dual UART that communicates with the external modules. U2 and U18 are the RS232 transceivers that drive and receive the lines that go to the external modules. U17 is a single UART that communicates with the Daughterboard microcontroller on page 1.

Page 1: U1-A RTS, CTS, SOUT and SIN lines (pins 48, 47, 49, 50) connect to the UART on page 2. The DTR3 line goes to the Boot circuit composed of R4, R5, R6, R7 and C3. The boot circuit then drives the U1-A reset input and

Boot Mode pins (28, 15) so that when the TTL DTR goes low, the reset input goes low briefly, and the Boot Mode pin is held low. This puts the microcontroller into boot mode so that the SBC can then make it jump to the Firmware, or update the Firmware in the microcontroller.

Page 3: The TX1, RX1 and DTR1 lines go to the Connectorboard and then to Module 1 via J5 pins 9, 10 and 11. The TX2, RX2 and DTR2 lines go to the Connectorboard and then to Module 2 via J5 pins 12, 13 and 14.

4.4.3.2 Connectorboard schematic (061-x172-0x)

Page 3: The TX1, RX1 and DTR1 lines arrive on J5 pins 9, 10 and 11, and are then send to Module 1 via J3 pins 5, 12 and 6. The TX2, RX2 and DTR2 lines arrive on J5 pins 12, 13 and 14, and are then send to Module 2 via J4 pins 5, 12 and 6.

4.4.3.3 Chamberboard schematic (061-x178-0x)

Page 1: The TX, RX and DTR lines arrive at J2 pins 5, 12 and 6, and are renamed SEROUT, SERIN and DTR. All three lines then go to the RS232 transceiver U19. The TTL SOUT and SIN lines on the transceiver connect directly to the microcontroller U1-A. The TTL DTR line goes to the Boot circuit composed of R4, R5, R6, R7 and C3. The boot circuit then drives the U1-A reset input and Boot Mode pins (28, 15) so that when the TTL DTR goes low, the reset input goes low briefly, and the Boot Mode pin is held low. This puts the microcontroller into boot mode so that the SBC can then make it jump to the Firmware, or update the Firmware in the microcontroller.

4.4.3.4 Probeboard schematic (061-0177-0x)

Page 1: The TX, RX, and DTR lines arrive at J2 pins 5, 12, and 6 and are renamed SEROUT, SERIN, and DTR. All three lines then go to the RS232 transceiver U19. The TTL SOUT and SIN lines on the transceiver connect directly to the microcontroller U1-A. The TTL DTR line goes to the Boot circuit composed of R4, R5, R6, R7, and C3. The boot circuit then drives the U1-A reset input and Boot Mode pins(28, 15) so that when the TTL DTR goes low, the reset input goes low briefly, and the Boot Mode pin is held low. This puts the microcontroller into boot mode so that the SBC can then make it jump to the Firmware, or update the Firmware in the microcontroller.

4.4.4 Power Supply and Voltage Regulators

4.4.4.1. Daughterboard schematic (061-0171-0x)

Page 5: The offline power supply provides +15V and -15V on J7 pins 4 and 1. It also provides +5V on pins 6 and 7. +5V on J7 pin 6 is separately fused by F1 and then sent to the SBC via J8 pin 4. +5V on J7 pin 7 is separately fused by F2 and then used on the Daughterboard. U24 is the +12V regulator. U25 is the +10V regulator. U23 is the +8V regulator. U20 is the +3.3D regulator. L1, R123 and C82 filter the +3.3D so it can be used as the +3.3A supply. U22 is the -10V regulator. U21 is the -8V regulator.

Page 3: The +15V, -15V, +10V, -10V, +5V and +3.3D supplies are sent to the Connectorboard via J5 pins 20, 21, 27, 28, 29 and 30.

Page 6: The power supply voltages are shifted and divided as necessary so they are nominally in the middle of the 0 to +2.5V range by the resistors to the right of of U1-B. They are then fed to the microcontroller ADC2 through ADC9.

4.4.4.2 Connectorboard schematic (061-x172-0x)

Page 3: The +15V, -15V, +10V, -10V, +5V and +3.3D supplies arrive at the Connectorboard on J5 pins 20, 21, 27, 28, 29 and 30. The +15V and -15V are first fused by F1 and F2, renamed +15F and -15F, and then passed along to Module 1 and 2 on J3 and J4 pins 13 and 7. The -15V is regulated down to -5V by U17. The +3.3D is filtered by L13, R123 and C85 to be +3.3A.

4.4.4.3 Chamberboard schematic (061-x178-0x)

Page 1: The +15V and -15V arrive on J2 pins 13 and 7. All supplies on the Chamberboard are derived from +/-15V.

Page 5: U24 is the +5V regulator. R135 and C123 filter the +5V to be used as +5L. U20 regulates the +5V down to +3.3D. L1, R123 and C82 filter the +3.3D to be +3.3A. U25 is the +10V regulator, U23 is the +8V regulator. U22 is the -10V regulator. U21 is the -8V regulator. The power supply voltages are shifted and divided as necessary so they are nominally in the middle of the 0 to +2.5V range by the resistors to the right of of U1-B. They are then fed to the microcontroller ADC3 through ADC7.

4.4.4.4 Probeboard schematic (061-0177-0x)

Page 1: The +15V and -15V arrive on J2 pins 13 and 7. All supplies on the Probeboard are derived from +/-15V.

Page 5: U24 is the +5V regulator. R135 and C123 filter the +5V to be used as +5L. U20 regulates the +5V down to +3.3D. L1, R123, and C82 filter the +3.3D to be +3.3A. U25 is the +10V regulator, U23 is the +8V regulator. U22 is the -10V regulator. U21 is the -8V regulator. The power supply voltages are shifted and divided as necessary so they are nominally in the middle of the 0 to +2.5V range by the resistors to the right of of U1-B. They are then fed to the microcontroller ADC2 through ADC6.

4.4.5 Keyboard Interface Circuits

4.4.5.1 Keyboard Schematic (061-0166-XX)

The cathode of each LED is connected to ground. The anodes are connected to pins 9, 10 and 11 of J1.

The Reset key connects to ground and to pin 19 of J1.

The rest of the keys are wired into an x-y matrix with 5 columns KC0-KC4 and 5 rows KR0-KR4. Pressing one of these keys connects one of the column lines to one of the row lines. KR0-KR4 are connected to J1 pins 1, 2, 3, 4 and 5. KC0-KC4 are connected to J1 pins 12, 13, 14, 15 and 16. KC4 is not being used yet.

4.4.5.2 Daughterboard schematic (061-0171-0x)

Page 1: J2 is the interface to the internal keyboard. The rows and columns from the keyboard connect to the resistors surrounding J2. The resistors generate a different voltage from 0 to 3.3V for each key that is pressed. U15-A buffers that voltage before feeding it to ADC0 on U1-A. The Reset key has a separate line which arrives on J2 pin 19 and is then sent to U1-A pin 34. The Power and Standby LEDs on the keyboard are driven by U1-A pins 31 and 32. The external keyboard signal from page 3 is buffered by U15-B and then fed to ADC1 in U1-A.

Page 3: The external keyboard signal from the Connectorboard arrives at J5 pin 19.

4.4.5.3 Connectorboard schematic (061-x172-0x)

Page 3: The External keyboard signal arrives at J6 pin 3. It is then sent to the Daughterboard via J5 pin 19.

4.4.5.4 Probeboard schematic (061-0177-0x)

Page 1: The External keyboard signal arrives at J6 pin 3. It is then buffered by U15-A and fed to ADC1 on U1-A.

4.4.6 USB Circuits

4.4.6.1 Connectorboard schematic (061-x172-0x)

Page 4: The RS232 interface from the SBC arrives at J9. U18 and U19 convert the signals from RS232 levels to TTL levels. U20 is the RS232 to USB UART. The USB device port is sent to J7. U20 drives the USB Device port activity LEDs on D1. The dual USB Host port signals arrive from the SBC on J10. The Host signals are then filtered and sent out J8.

4.4.7 Turntable Circuits

4.4.7.1 Chamberboard schematic (061-x178-0x)

Page 1: The Turntable control signals originate on U1-A pins 23-26, 37 and 38. They are then sent to the Turntable Board via J11. The shaft encoder signals arrive on J11 pins 12 and 14 and then connect to U1-A pins 29 and 30. The power and grounds needed by the Turntableboard are also send over J11.

4.4.7.2 Turntable board schematic (061-0181-0x)

Page 1: The stepper motor drive signals arrive on J1 pins 1, 3, 5 and 7 and then connect to the inputs of the H-Bridge driver U1 pins 1, 2, 11 and 12. U1 then outputs the motor signals on its output pins 5, 21, 8 and 16 which are then connected to J2 pins 1-4. D1, D2, R4 and C5 and C6 work with a square wave that U1 generates on pin 22 to generate the Bootstrap voltage which is then sent in pin 15 of U1. Q1, Q2 and associated components buffer and level shift the encoder enable signal coming from J1 pin 14 to drive the encoder supply out J2 pin 6. The two shaft encoder signals arrive on J2 pins 7 and 8, and go to the chamberboard on J1 pins 11 and 13. R2 and R3 set the current limiting for U1 when driving the stepper motor.

4.4.8 LED Circuits

4.4.8.1 Daughterboard schematic (061-0171-0x)

Page 1: Q1, R69, R70 and R128 is the Self-Test LED driver. The circuit will drive the LED on unless U1-A drives its pin 14 high. That means that the LED will be lit at power on when U1-A pin 14 is defined as an input.

4.4.8.2 Chamberboard schematic (061-x178-0x)

Page 1: Q1 is the driver for the Power/Status LED. If this is a Chamber Module, then the LED is on the board and shown on this page. If this is an 8120 or an 8050, then the LED is on the Breakout Board. The White LED control signal is level shifted by Q4. U12 regulates the current to the white LED. The white LED is only used on the 8120. Q3, R13, R14, R15 and R16 is the Self-Test LED driver. The circuit will drive the LED on unless U1-A drives its pin 14 high. That means that the LED will be lit at power on when U1-A pin 14 is defined as an input.

Page 4: The white LED signal is sent to the Breakout Board via J10 pin 9. The power status LED signal is sent to the Breakout Board via J10 pin 13.

4.4.8.3 Breakout Board schematic (061-0179-00)

Page 1: The Power/Status LED signal arrives on J1 pin 13 and then connects to D1 anode. The white LED signal arrives on J1 pin 9 and then connects to J6 pin 1.

4.4.9 Battery Simulator Circuits

4.4.9.1 Chamber Board Schematic (061-x178-0x)

Page 4: U1 pin 9 outputs a voltage of from 0 to 2.5V. R35 and R36 divide this voltage down to from 0 to 1.5V and connect it to the non-inverting input of U8-A. U8-A then buffers this voltage and sends it on toward the battery pill. R31 and D2 provide some current limiting protection to the hearing aid and prevent negative transients during power on. The battery current passes through the current sense resistor R50, or through J10 pin 6 to the 25.5ohm resistor on the breakout board. The voltage at the high side of the current sense resistor is sampled via R82 or pin 12 of J10 and connected to one end of the digital pot J7-A, and also to the amplifier U11-A. The output of the amplifier then connects to ADC0 on pin 61 of U1-C. The voltage at the low side of the current sense resistor R50, or via pin J10 pin 7 to the sense resistor on the Breakout Board, is also sampled and connected to the other end of the digital pot J7-A, and also to the amplifier U9-A. The output of this amplifier then connects to ADC1 on pin 62 of U1-C. U11-A and U9-A amplify the difference between the voltage at the DAC1 output on pin 10 of U1-C, and the sense voltages at their non-inverting inputs by three times. The low side of sense resistor R50 also connects to J8 pin T3. The pill type pull up resistor R41 or R60 works with the pill type resistor in the battery pill either through J8 pin R2, or J10 pin 11, to produce a voltage which is buffered by U9-B and then fed to ADC2 on pin 63 of U1-C.

4.4.9.2 Breakout Board Schematic (061-0179-01)

Page 1: The battery current arrives on J1 pin 6 and then connected to the sense resistor R2. The voltage on the high side of the sense resistor is sampled and sent back to the Chamberboard on J1 pin 12. The voltage on the low side of the sense resistor is sampled and sent back to the Chamberboard on J1 pin 7. The battery current is then sent to J2 pin T5. The connection from the pill type resistor on the battery pill is connected from J2 pin R2 to J1 pin 11.

4.4.10 Thermal Printer Circuits

4.4.10.1 Parallel Interface Board (061-0500-0x)

The parallel interface printer data arrives from the SBC at J2. It then leaves to the Printer Interface Board at J1.

4.4.10.2 Printer Interface Board (061-1300-00)

This board is Fujitsu model FTP-622DCL001. The parallel interface printer data arrives at CN1. The power comes in CN10. The printer head plugs into CN8. The head up and paper out switches plug into CN3. The stepper motor plugs into CN13.

Note: There is no schematic for this board.

4.4.10.3 Printer Mechanism

The printer mechanism is high-speed line thermal printer, Fujitsu model FTP-642MCL001 which contains a thermal head, a stepper motor, decelerating gears, a rubber roller (platen), paper feed knob, head-up lever and 3 connectors: 16-pin head connector, 4-pin stepper motor connector and 5 pin sensor connector. The rated speed of this printer is 80 mm per second. The effective printing width is 104 mm, with 832 dots per line and a 0.125 mm dot pitch.

4.4.11 Misc Circuits

4.4.11.1 Daughter Board Schematic (061-0171-0x)

Page 1: J1 is the JTAG interface to U1-A which is only used for software development. Y1 is the 32KHz crystal for U1-A.

Page 6: J6 is the JTAG interface used to program the CPLD U5-C.

4.4.11.2 Connector Board Schematic (061-x172-0x)

Page 2: The Line inputs come in J1 pins 2 and 5. U2-A and U2-B re-reference the Left signal ground from Chassis to AREF which is the Analog ground on the Daughterboard. U6-A and U6-B do the same for the Right channel. The Voice Microphone signal comes in J2 pin 5T. U1-A and U1-B re-reference the ground as with the Line Inputs.

4.4.11.3 Chamber Board Schematic (061-x178-0x)

Page 1: J1 is the JTAG interface to U1-A which is only used for software development. Y1 is the 32KHz crystal for U1-A. The Dallas Interface originates on U1-A pin 53.

Page 3: The Dallas interface from U1-A on page 1 is sent out J7 pin 5.

4.4.11.4 Probeboard schematic (061-0177-0x)

Page 1: J1 is the JTAG interface to U1-A which is only used for software development. Y1 is the 32KHz crystal for U1-A.

Chapter 5: Calibration

There are few calibration adjustments on the 8000, both external and internal to the instrument. Those available are covered in this section.

5.1 Microphones

A sound level calibrator, such as the Quest QC-10 (with the supplied adapter), is used to generate a signal level at a calibrated intensity.

From the Opening Screen, press [MENU] to enter the setup menu. Then press F6 to enter the microphone calibration screen. Place the M1958E in a sound level calibrator. Position the cursor with the left/right key till the selected level matches the calibrator level. Press the Start key to make the calibration.

There are three possible microphones on the FONIX 8000 analyzer:

- Coupler microphone (M1950E or M1958E)
- Probe microphone
- Reference microphone

All 8000 analyzers include a coupler microphone. The procedure for calibrating this microphone is described in Section 5.1.1. 8000 analyzers that do not include the Real-ear Option will only have the coupler microphone.

8000 analyzers with the Real-ear Option have an integrated probe microphone set in addition to the coupler microphone. This consists of a probe microphone integrated into the earhook and a rectangular reference microphone that attaches to the top of the earhook. The procedure for calibrating the integrated probe microphone is described in Section 5.1.2. The procedure for calibrating the rectangular reference microphone is described in Section 5.1.3.

To perform the microphone calibrations, you will need the following equipment, depending on what type of microphones you are calibrating. The adapters come standard with the analyzer. You can purchase additional adapters and a sound calibrator from the factory. (Sound calibrators are special orders and may not be immediately available for purchase.)

- Sound calibrator such as a QC-10 (all calibrations)
- 14 mm-to-1 inch microphone adapter (coupler and old-style reference microphone calibration)
- Probe microphone adapter (probe microphone calibration)

• Rectangular reference microphone adapter (rectangular reference microphone on integrated probe microphone)

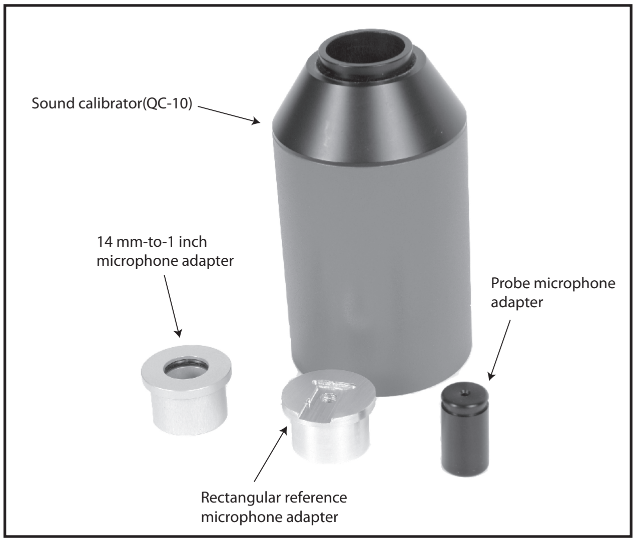


Figure 5.1: Calibration equipment

5.1.1 Calibrating the Coupler Microphone

This procedure describes how to calibrate the coupler microphone.

1. From the Opening Screen, press [MENU] to enter the Setup Menu.
2. Press F6 to enter the Microphone Calibration screen.
3. Put the 14-mm-to-1 inch microphone adapter into the sound level calibrator.
4. Place the coupler microphone in the adapter.
5. Turn on the sound level calibrator.
6. Position the cursor with left/right keys till the selected level matches the calibrator level. Press the [START] key to make the calibration.

Figure 5.1.1: Coupler microphone inserted into sound calibrator.

5.1.2 Calibrating the Probe Microphone

1. From the Opening Screen, press [MENU] to enter the Setup Menu.
2. Press F6 to enter the Microphone Calibration screen.
3. Use the down arrow key to select "Probe Left or Right", "Probe"
4. Put the 14-mm-to-1 inch microphone adapter into the sound level calibrator.

5. Attach a new probe tube to the probe microphone.
6. Thread the probe microphone through the edged side of the probe microphone adapter so that the probe tube sticks out a coupler of millimeters from the other side of the adapter.
7. Secure the probe tube in place by putting a dab of Fun-Tak (Blue Stik) on the edged end of the adapter.
8. Insert the probe microphone adapter with the attached probe microphone into the calibrator. See Figure 5.1.2.
9. Turn on the calibrator.
10. Position the cursor with left/right keys till the selected level matches the calibrator level. Press the [START] key to make the calibration.

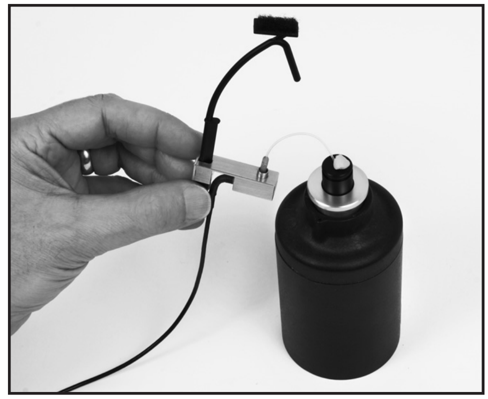


Figure 5.1.2: Integrated probe microphone inserted into sound calibrator.

5.1.3 Calibrating the Rectangular Reference Microphone

This procedure describes how to calibrate the rectangular reference microphone that is part of the integrated probe microphone set.

1. From the Opening Screen, press [MENU] to enter the Setup Menu.
2. Press F6 to enter the Microphone Calibration screen.
3. Use the down arrow key to select "Probe Left or Right", "Ref"
4. Insert the rectangular reference microphone adaptor into the sound calibrator.
5. Remove the reference microphone from the integrated ear hook and insert it into the calibration adapter with the opening of the reference microphone pointing into the calibrator. See Figure 5.1.3. You can use a rubber band to hold the microphone onto the calibrator, if necessary.
6. Turn on the sound calibrator.
7. Position the cursor with left/right keys till the selected level matches the calibrator level. Press the [START] key to make the calibration.

Figure 5.1.3: Rectangular reference microphone inserted into sound calibrator.

Chapter 6: Service and Repair

6.1 Fuse Replacement

If a fuse is blown for some reason, replace it with a like kind and voltage rating.

Warning: Use of fuses with a different type or rating could result in fire and/or electric shock hazards.

6.1.1 Line Fuse Replacement

To change the line fuse, first unplug the line cord from the power entry module. Then using a small screwdriver, pry the top of the module off at the notch near the line cord socket.

Replace the defective fuse(s) located in the cover holder and replace the cover.

Fuse: (T 630mAL) 0.63A / 250 V~, Type T, IEC 60127-2 sheet III (Slo-Blo Type, Glass, 5mm x 20mm).

(See Section 8 - Rear Panel Safety Markings.)

6.1.2 Connector Board Fuse Replacement

Turn off power to the 8000 and remove the line cord. Remove the wrap-around (see 6.2.1).

Replace the defective fuse(s) located in holder F1 and/or F2 on the connector board.

F1 and F2: (T 315mAL) 315mA / 250 V, Type T, IEC 60127-2 sheet III (Slo-Blo Type, Glass, 5mm x 20mm)

6.1.3 Daughter Board Fuse Replacement

Turn off power to the 8000 and remove the line cord. Remove the wrap-around (see 6.2.1).

Replace the defective fuse(s) located in holder F1 and/or F2 on the daughter board.

F1: (F 3.15AL) 3.15A/250V Type F, IEC 30127-2 sheet II (Fast-Acting Type, Glass, 5mm x 20 mm).

F2: (T 315mAL) 315mA/250V Type T, IEC 60127-2 sheet III (Slo-Blo Type, Glass, 5mm x 20mm)

6.2 Electronics Module

6.2.1 Removal and Replacement of the Wrap-around

Wrap-around Removal

The electronics module can be serviced by first removing the wrap-around. Turn off the power to the 8000 and remove the line cord. Remove the nine screws securing wrap-around, located at the back (qty 5) and sides (qty 4) of the instrument. Apply light pressure to both sides of the wrap-around and slide wrap-around toward the back of the instrument approximately 1 inch. You may also need to apply slight downward pressure to keep entire instrument from sliding. The wrap-around front lip should now be clear of bezel. Damage to bezel may occur if wrap-around is not entirely clear of bezel prior to proceeding to the next step. Now, with both hands still on the sides of the wrap-around, lift the wrap-around vertically off of the instrument. Do not try to remove it by sliding it off over the back.

Replacement

When the time comes to replace the wrap-around, reverse the procedure used for removal. Make sure the wrap-around front lip is entirely under the bezel. Install the nine screws securely.

6.2.2 Removal and Replacement of Circuit Boards

The first step in replacement of a circuit board is the removal of the wrap-around. See 6.2.1 for the correct procedure.

6.2.2.1 Removal and Installation of Circuit Board Module

The Circuit Board Module contains the Connector Board (061-x172-0x), Daughter Board (061-0171-0x), Single Board Computer (061-5315-0x), Printer Board (061-1300-00) and Parallel Interface Board (061-0500-0X). Disconnect the Power Supply cable from Printer Board and Daughter Board. Disconnect the printer cables (4) from the Printer Board. Disconnect the keypad cable from the Daughter Board. The Circuit Board Module is secured to the 8000 rear panel and chassis bottom panel with screws. Remove the screws (4) securing the bottom metal panel to chassis bottom. Remove screws (11) at the rear panel. The Circuit Board module is now ready to be removed from the chassis.

Note: removal of individual circuit boards from the chassis may be performed without removing the Circuit Board Module from the chassis. If access to SBC is required, it is recommended that entire Circuit Board Module be removed.

Reinstallation of Circuit Board Module should be done in reverse order of removal.

6.2.2.2 Removal and Installation of Connector Board

Disconnect the Dual USB Host cable that may be there, the Serial Cable, and cable to Daughter Board. Remove screws (2) at rear panel securing the amplifier brackets. Remove nuts on Line Input and Mic Input jacks on the rear panel. The Connector Board is now ready to be removed.

Reinstallation of Connector Board should be done in reverse order of removal.

6.2.2.3 Removal and Installation of Daughter Board

Remove Connector Board. See 6.2.2.2 for procedure.

If unit is still in the chassis, remove main power cable, and keyboard cable. Remove the power output cable to SBC, cable to connector board, and audio cable. Remove screws (4) securing the Daughter Board to SBC. Carefully pull vertically to remove from the SBC. The 2x34 pin PC104 connector may be difficult to disconnect. Take caution not to bend the board or damage pins on the PC104 connector.

Reinstallation of Daughter Board should be done in reverse order of Removal.

6.2.2.4 Removal and Installation of SBC Circuit Board

Remove the Connector Board. See 6.2.2.2 for procedure.

Remove the Daughter Board. See 6.2.2.3 for procedure.

Remove power cable, audio cable, parallel interface cable and Serial cable. Remove screws (4) securing SBC to bottom metal panel. Remove hex jacks on rear panel RS232 and VGA ports.

SBC Circuit Board is now ready to be removed.

Reinstallation of SBC Circuit Board should be done in reverse order of Removal.

6.2.2.5 Removal and Installation of Printer Board

If Printer Board is still in chassis, disconnect printer cables (4) from Printer Board. Remove Parallel Interface Board. Remove screws (4) securing Printer Board to bottom metal panel. Printer Board is now ready to be removed.

Reinstallation of Printer Board should be done in reverse order of Removal.

6.2.3 Removal of Bezel

Disconnect the line cord and remove the wrap-around (see 6.2.1). Disconnect keyboard cable from keyboard. Remove nut securing keyboard to ground bracket. This nut is located at the top center of the keyboard assembly. Then remove the 6 screws holding the printer door hinge and printer door stop. Finally, remove the 6 screws that hold the bezel to the chassis metal front panel.

Reassembly of the bezel should be done in reverse order, taking care not to over-tighten screws.

6.2.4 Replacement of Keyboard

The keyboard may be removed with or without removing bezel.

6.2.4.1 Removal of Keyboard when removing the bezel.

Remove front bezel (see 6.2.3). Remove 7 nuts securing keyboard to bezel. Do **not** remove 2 nuts recessed in bezel, they secure the keyboard assembly together. Keyboard can now be removed from from bezel.

Reassembly of the keyboard should be done in reverse order. Keyboard-to-bezel nut torque: 35 in-oz +/- 5 in-oz. It is critical that keyboard-to-bezel nuts are not over-torqued. If the silicone keypad material is overcompressed, the keys will not be properly vented, and key function may be compromised.

6.2.4.2 Removal of Keyboard without removing the bezel.

Disconnect the line cord and remove wrap-around (see 6.2.1). Disconnect keyboard cable from keyboard. Remove nut securing keyboard to ground bracket. Through the holes located in chassis front panel, remove 7 nuts securing keyboard to bezel.

Note, this method of removing keyboard is not recommended. There is a high possibility of dropping nuts between bezel and chassis metal front panel.

Reassembly of the keyboard should be done in reverse order. Keyboard-to-bezel nut torque: 35 in-oz +/- 5 in-oz. It is critical that keyboard-to-bezel nuts are not over torqued. If the silicone keypad material is overcompressed, the keys will not be properly vented, and key function may be compromised.

6.2.5 Replacement of Printer

Remove the wrap-around (see 6.2.1).

Disconnect 4 cables at printer board serving the printer. Remove paper roll from printer assembly. Turn instrument on its side to gain access to 4 screws securing printer assembly to chassis (located on bottom of instrument). Remove screws and carefully remove entire printer assembly from instrument. Remove 2 screws securing printer motor cover and remove cover. Remove 3 screws securing printer to the printer bracket. Remove the printer.

Reassemble new printer in reverse order. Use loctite threadlocker on 3 screws securing printer to printer bracket.

6.2.6 Replacement of Switching Power Supply

Remove the wrap-around (see 6.2.1).

Remove Power Output Cable, Power Connector Cable and Ground Cable from Switching Power Supply. Turn instrument on its side to gain access to 4 retaining screws, located on bottom of instrument. These screws are color coded yellow for easy identification. Remove screws and remove switching power supply from instrument.

Reassemble new switching power supply in reverse order. Note, if substitute retaining screws are used, maximum thread length shall not exceed ¼" . Potential damage and/or a short circuit may occur to switching power supply and/or instrument if screw contacts circuit board in switching power supply.

6.3 8000 Computer Connection (USB/Serial)

You can connect the FONIX 8000 Hearing Aid Test System to your computer using either the serial port on the back of your analyzer or one of the USB ports. By default, the FONIX 8000 uses the USB port for the connection. You will need to configure the BIOS setting of the system in order to use the serial port instead.

Be extremely careful when change the BIOS Configuration!!! If a bad configuration is made, the 8000 Analyzer may become unusable.

To Enter the BIOS Configuration Screen

1. Plug a USB keyboard into the back of your 8000 analyzer.
2. Use CTRL+ALT+DELETE to reboot your analyzer or just turn it off and turn it back on again.
3. Hold down the delete key when the BIOS splash screen appears. This appears before the linux startup information. If you see the linux startup information, you missed the BIOS splash screen and will need to repeat Step 2.

Important: The BIOS Splash screen should be titled “Phoenix AwardBIOS CMOS Setup Utility.” If the title is something else, do **NOT** continue with these instructions. Instead, contact the Frye factory (support@frye.com) for alternate instructions. **The following instructions are ONLY for the BIOS titled “Phoenix AwardBIOS CMOS Setup Utility.”**

To Configure the Computer Connection for Serial Port:

1. Follow the steps in the “To Enter the BIOS Configuration Screen” Section.
2. Use the up-down arrow keys on your USB keyboard to go to **Integrated Peripherals** and press <Enter>.

3. Use the down arrow key to select **Onboard Serial Port 1** and use the Page up/Page down keys to set the selection to **3F8/IRQ4**.
4. Use the down arrow key to select **Onboard Serial Port 2** and use the Page up/Page down keys to set the selection to **Disabled**.
5. Use the <ESC> key to exit the configuration screen.
6. Use F10 to Save and Exit.
7. Select Y and use the <Enter> key to save the configuration, exit the BIOS Setup screen, and reboot the analyzer. Your new setting will now be in place.

Note: To connect the FONIX 8000 to a computer using the serial port, you must use a null modem cable instead of a standard RS232 cable.

To Configure the Computer Connection for USB Port:

1. Follow the steps in the "To Enter the BIOS Configuration Screen" Section.
2. Use the up-down arrow keys on your USB keyboard to go to **Integrated Peripherals** and press <Enter>.
3. Use the down arrow key to select **Onboard Serial Port 1** and use the Page up/Page down keys to set the selection to **Disabled**.
4. Use the down arrow key to select **Onboard Serial Port 2** and use the Page up/Page down keys to set the selection to **3F8/IRQ4**.
5. Use the <ESC> key to exit the configuration screen.
6. Use F10 to Save and Exit.
7. Select Y and use the <Enter> key to save the configuration, exit the BIOS Setup screen, and reboot the analyzer. Your new setting will now be in place.

Chapter 7: MAINTENANCE

For your safety, disconnect the 8000 from main power while cleaning.

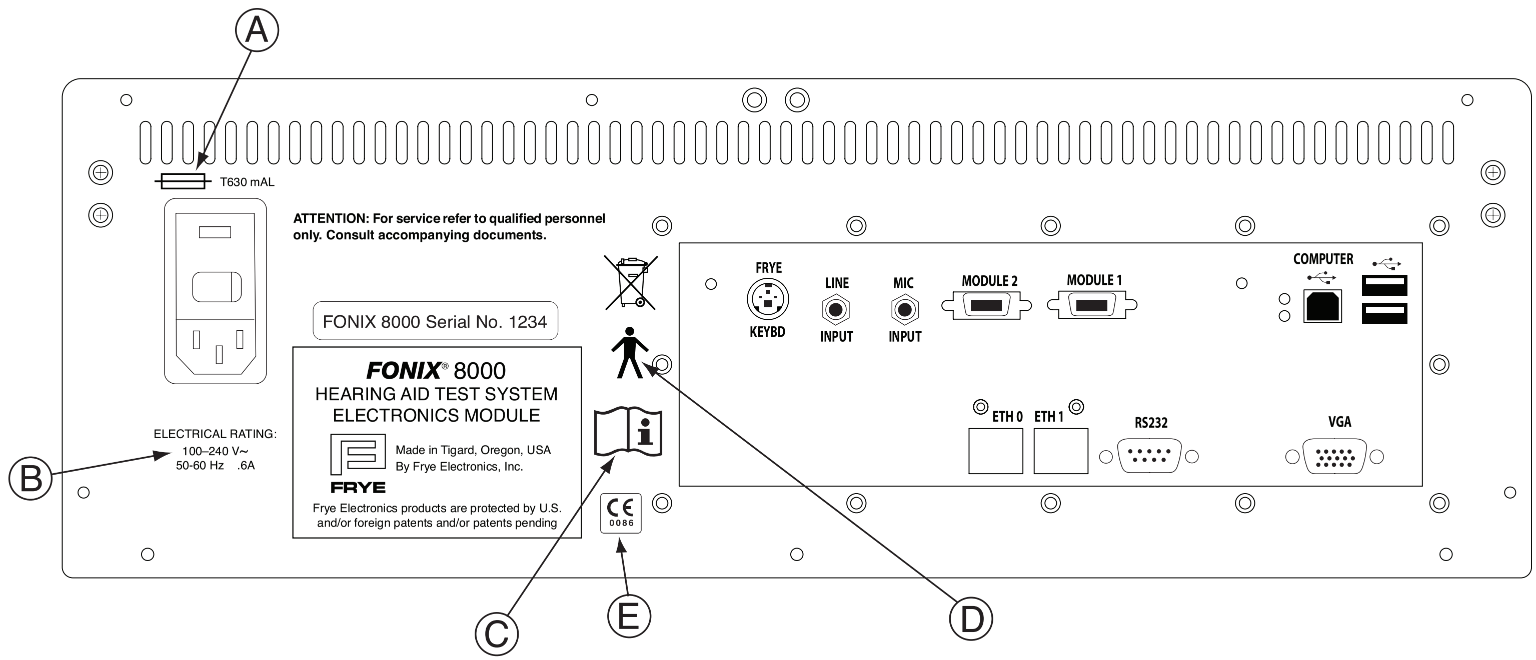
Wipe the 8000 with a slightly moist cloth. Use plain water or water with mild dish-washing detergent. Wipe away any detergent with a moist cloth, then dry the 8000.

Never allow fluid to enter:

- The 8000 Enclosure
- The 8000 switched power entry module.
- The 8000 switching power supply.
- The 8000 electrical connectors.
- The 8000 front panel keyboard.

The microphones should be wiped with a dry cloth. Excess moisture may damage the microphone.

Solvents and abrasives will cause permanent damage to the 8000.



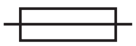
Rear Panel Layout

Letters identify rear panel safety markings

Chapter 8: Safety Information

8.1 Rear Panel Safety Markings

Symbol **Meaning**

(A) 

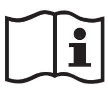
“For continued protection against fire and electrical shock, replace only with same type and rating fuse.”

The fuse specifications indicated on the 8000 Rear Panel are as follows:

Marking:	T 630mAL
Type:	Time lag
Ampere Rating:	630 mA
Voltage Rating:	250 V
Size:	5mm x 20mm

Fuses must conform to IEC 60127-2 sheet III

(B) **100-240 V~** The “~” means AC, alternating current.

(C) 

Read the accompanying documents

(D) 

Type B applied part.

(E) 

0086

CE signifies compliance with the European union’s Medical Devices Directive.

8.2 Safety Classification for IEC 60601-1

Type of protection against electric shock:	Class 1
Degree of protection against electric shock:	Type B
Protection against harmful ingress of water:	IPX0
Mode of operation:	Continuous

The 8000 does not require sterilization or disinfection.

Warning: This equipment is not suitable for use in the presence of a flammable anaesthetic mixture with air or with oxygen or nitrous oxide.

Warning: To avoid the risk of electric shock, this equipment must only be connected to a supply mains with protective earth. Turning the power switch to the off position or disconnecting the power cord isolates the 8000 from the supply mains.

Warning: Do not touch the contacts of connectors and the patient simultaneously.

Warning: Do not modify this equipment without authorization of the manufacturer.

8.3 Connection of peripheral equipment to the 8000

Compliance with IEC 60601-1: 2005 Safety requirements for medical electrical systems must be determined on a case by case basis.

All electrical equipment attached to the 8000, such as video monitors, computer equipment, etc., must, at a minimum, meet one of the following conditions:

1. The equipment complies with IEC 60601-1
2. The equipment complies with relevant IEC and ISO safety standards and is supplied from a medical grade isolation transformer.
3. The equipment complies with relevant IEC and ISO safety standards and is kept at least 1.5 meters from the patient.

The allowable leakage currents of IEC 60601-1: 2005 must not be exceeded. IEC 60601-1: 2005 should be consulted when assembling such a system.

The FONIX 8000 Test System is equipped with USB and RS232 connections that will allow you to connect to a personal computer and exchange data. You will also

need a software program, such as WinCHAP, on your Windows computer that can communicate with the analyzer. It is possible to make your own program using the

FRYERS protocol. See www.frye.com for details.

Failure of the hardware connection or software program could result in incorrect transfer of data.

Connecting the 8000 to other equipment could result in previously unidentified risks to patients, operators of third parties. The installer should identify, analyze and control these risks.

Changes to the network could introduce new risks and require additional analysis. These changes could include:

- Changes to the configuration
- Connection of additional items
- Disconnection of items
- Updates to the connected equipment

8.4 Electromagnetic compatibility

The 8000 complies with IEC 60601-1-2.

The 8000 generates and uses radio frequency energy. In some cases the 8000 could cause interference to radio or television reception. You can determine if the 8000 is the source of such interference by turning the unit off and on.

If you are experiencing interference caused by the 8000, you may be able to correct it by one or more of the following measures:

1. Relocate or reorient the receiving antenna.
2. Increase the distance between the 8000 and the receiver.
3. Connect the 8000 to a different outlet than the receiver.

In some cases radio transmitting devices, such as cellular telephones, may cause interference to the 8000. In this case try increasing the distance between the transmitter and the 8000.

8.5 Disposal of the 8000 and accessories

The 8000 and its accessories contain lead. At the end of its useful life, please recycle or dispose of the 8000 according to local regulations.

Chapter 9: Electromagnetic Compatibility

The 8000 complies with IEC 60601-1-2.

The 8000 generates and uses radio frequency energy. In some cases the 8000 could cause interference to radio or television reception. You can determine if the 8000 is the source of such interference by turning the unit off and on.

If you are experiencing interference caused by the 8000, you may be able to correct it by one or more of the following measures:

1. Relocate or reorient the receiving antenna.
2. Increase the distance between the 8000 and the receiver.
3. Connect the 8000 to a different outlet than the receiver.

In some cases radio transmitting devices, such as cellular telephones, may cause interference to the 8000. In this case try increasing the distance between the transmitter and the 8000.

Warning: The use of accessories, transducers and cables other than those listed in the tables below may result in increased emissions or decreased immunity of the 8000.

Cables with which the 8000 complies with IEC 60601-1-2		
Cable	**Type**	**Maximum Length (m)**
Module 1, 2	15 conductor shielded	3
USB 1, 2	Shielded USB	2
USB (Computer)	Shielded USB	2
RS232	9 Conductor Shielded	2

Accessories with which the 8000 complies with IEC 60601-1-2		
Description	**Manufacturer**	**Model/Part Number**
Sound Chamber	Frye Electronics, Inc.	8120, 8050
Coupler Microphone	Frye Electronics, Inc.	M1958E
LCD VGA monitor	N/A	N/A
Telewand	Frye Electronics, Inc.	043-1053-00

Warning: The 8000 should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the 8000 should be observed for normal operation in the configuration in which it will be used.

<table>
<tr><th colspan="3">Guidance and manufacturer's declaration – electromagnetic emissions</th></tr>
<tr><td colspan="3">The 8000 is intended for use in the electromagnetic environment specified below. The customer or the user of the 8000 should assure that it is used in such an environment.</td></tr>
<tr><td>Emissions test</td><td>Compliance</td><td>Electromagnetic environment - guidance</td></tr>
<tr><td>RF emissions
CISPR 11</td><td>Group 1</td><td>The 8000 uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.</td></tr>
<tr><td>RF emissions
CISPR 11</td><td>Class A</td><td rowspan="3">The 8000 is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.</td></tr>
<tr><td>Harmonic emissions
IEC 61000-3-2</td><td>Class A</td></tr>
<tr><td>Voltage fluctuations/ flicker emissions
IEC 61000-3-3</td><td>Complies</td></tr>
</table>

Guidance and manufacturer's declaration – electromagnetic immunity			
The 8000 is intended for use in the electromagnetic environment specified below. The customer or the user of the 8000 should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment—guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	+/- 6 kV contact +/- 8 kV air	+/- 6 kV contact +/- 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	+/- 2 kV for power supply lines +/- 1 kV for input/output lines	+/- 2 kV for power supply lines +/- 1kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	+/- 1 kV differential mode +/- 2 kV common mode	+/- 1 kV differential mode +/- 2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5% U_t (>95% dip in U_t) for 0.5 cycle 40% U_t (60% dip in U_t) for 5 cycles 70% U_t (30% dip in U_t) for 25 cycles <5% U_t (>95% dip in U_t) for 5 sec	<5% U_t (>95% dip in U_t) for 0.5 cycle 40% U_t (60% dip in U_t) for 5 cycles 70% U_t (30% dip in U_t) for 25 cycles <5% U_t (>95% dip in U_t) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If the user requires continued operation during power mains interruptions, it is recommended that the 8000 be powered from an uninterruptible power supply.
Power frequency (50/60 Hz) Magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical commercial or hospital environment.
Note Ut is the a.c. mains voltage prior to application of the test level.			

Guidance and manufacturer’s declaration – electromagnetic immunity			
The 8000 is intended for use in the electromagnetic environment specified below. The customer or the user of the 8000 should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment —guidance**
			Portable and mobile RF communications equipment should be used no closer to any part of the 8000, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Conducted RF	3 Vrms	3 Vrms	Recommended separation distance
IEC 61000-4-6	150 kHz to 80 MHz		d $= 1.2 \sqrt{P}$
Radiated RF	3 V/m	3 V/m	
IEC 61000-4-3	80 MHz to 2.5 GHz		$d = 1.2 \sqrt{P}$ 80 MHz to 800 MHz
			$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz
			Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).
			Field strengths from fixed RF transmitters as determined by an electromagnetic site survey,[a] should be less than the compliance level in each frequency range.[b]
			Interference may occur in the vicinity of equipment marked with the following symbol: 

Note 1 At 80 MHz and 800 MHz, the higher frequency range applies.

Note 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

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[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the 8000 is used exceeds the applicable RF compliance level above, the 8000 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the 8000.

[b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m

Recommended separation distances between portable and mobile RF communications equipment and the 8000			
The 8000 is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the 8000 can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the 8000 as recommended below, according to the maximum output power of the communications equipment.			
Rated maximum output power of transmitter W	**Separation distance according to frequency of transmitter (**m)		
	150 kHz to 80 MHz $d = 1.2\sqrt{P}$	**80 MHz to 800 MHz** $d = 1.2\sqrt{P}$	**800 MHz to 2.5 GHz** $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended distance *d* in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.