FONIX® 7000

Maintenance Manual

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FRYE

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1. Overview

The 7000, in composite mode of operation, produces a complete set of tones from 200 to 8000 Hz simultaneously, and is able to analyze the response of the hearing aid to this complex signal, and displays 79 components from 200 to 8000Hz simultaneously on a graphical display. The 7000 can also operate in Sine Frequency, Sine Sweep Frequency and Average Option Frequency analysis mode. The frequencies used are from 200 to 8000 Hz in 100 Hz increments. Average Option Frequency (sine mode only) has users choice among 6 sets of 3 frequencies.

The composite technique has the immediate advantage that the response curve for the hearing aid can be viewed in “real time”, and for the first time the effects of altering the setting of a control can be viewed while it is being done. Another advantage of this technique is the capability of measuring the “real” response of an AGC hearing aid, instead of the artificially flattened one obtained with pure tone testing.

Analysis of the hearing aid output is done by first taking 256 samples of the signal. These samples are taken in exact synchronism with the signal generator.

These 256 samples are then passed through a mathematical process called the Fast Fourier Transform, which takes the timed samples and converts them into 128 frequency components. 79 of these components are then displayed on the CRT screen in the form of a graph.

A hard copy of the screen image is available through the use of the built-in thermal printer or external printer

1.1 Signal Generation Overview

1.1.1 Digital Basis

The complex signal is generated by reading 256 12-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 12-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, or 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 to be used, then every multiple of 100 Hz will be used and will have equal value amplitude. If a speech 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 heterodyne or Fast Fourier analyzer. This sloped correction is produced by using analog filters, since we would very quickly run out of digital resolution while covering the 3 octaves between 900 and 7200 Hz. 18 dB equals a ratio of about 8 to 1.

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 7000 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 windowing function used is called a Hanning function.

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.

The usual way to do this is with a multiple stage “brick wall filter”. A conservative design will not use a bandwidth equivalent to the limit stated above. It will instead stop the analysis well before the limit is reached. In the present system, therefore, the upper frequency limit is set at 8000 Hz, even though the theoretical limit is 12800 Hz.

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 low frequency portion of 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 brick wall 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 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.

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 50 milliamps
Accuracy:	± 5% of reading ± one digit
Zero adjust:	Automatic (Remove battery pill then press 7000 LEVEL button.)

Resolution:	0.01 mA
Voltages supplied:	1.5 (silver), 1.3 (zinc air)
Voltage Accuracy:	±15 millivolts.
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 (probe mic) Ref mic: ± 3 dB ± 1 digit, 100-8000 Hz (ref mic)

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, IEC 60118-7:1994, IEC 60118-7:2005, ANSI S3.42-1992, JIS:2000

Additional Coupler Tests:	Enhanced DSP, Input/Output, Attack & Release, Battery Current, Coupler Multicurve
Real-ear Test Screens:	Audiogram Entry, Target Edit, Insertion Gain, Real-ear SPL, Visible Speech

2.8 POWER

Source voltage:	100-240 volt AC.
Frequency Range:	50-60 Hz.
Power Requirement:	0.6 A.
Fuse:	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:	17.4"W x 6.5"H x 14.6"D (44.2 x 16.5 x 37.1 cm).
Weight:	17 lbs.(7.7 kg).

2.10 PRINTER, INTERNAL

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

2.11 PRINTER, EXTERNAL (PRINTER NOT PROVIDED)

Interface:	Parallel
Language:	HP PCL3 and ESC-P/2

2.12 TEST CHAMBER

Test Area:	7"x 7.5"x 1.5 deep (17.8 x 19.1 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:	13.5”W x 18"H x 11.5"D (34.3 x 45.7 x 29.2cm).
Weight:	36 lbs. (16.3 kg).

2.13 MONITOR HEADSET

Monitored channel:	Probe microphone
Headphone type:	Stereo or mono, using 2 or 3 conductor 1/4 inch phone plug
Usable headphone impedance:	32 ohms to 600 ohms (intended for Walkman style headphones)

2.14 GUARANTEE

The FONIX 7000 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.

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 static tone to single. Exit the menu. Set the amplitude to 90dB and the frequency to 1000Hz. Connect the frequency counter to the sound chamber connector, on the 7000, pin 2, ground to pin 3.

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 7000 amplitude to 90dB. Place the sound level meter's microphone at the reference point in the 7020 sound chamber. Place the 7000 coupler microphone so that it's 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 that is accurate to 1KHz.

Setup: Enter the coupler screen. Level the 7000. From the menu, set noise reduction(tone) to off and static tone to single. Exit the menu. Set the 7000 to 1KHz and 100 dB. Connect the voltmeter to the sound chamber connector, on the 7000, pin 2 ground to pin 3.

Measurements: Measure the voltage on the voltmeter. Reduce the output level in 5 dB increments to 40 dB and note that the voltage changes in 5 dB steps +/- .5 dB plus the tolerance of the voltmeter.

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 noise reduction(tone) to off and static tone to single. In the test screen, set the 7000 amplitude to 90dB. Place the coupler microphone at the reference point in the 7020 sound chamber. Close the chamber lid. Level the 7000. Replace the coupler microphone with sound level meter's microphone at the reference point in the 7020 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 telecoil. Connect the current meter to the telecoil jack on the 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/meter
0.079 mA	1.78 mA/meter
0.140 mA	3.16 mA/meter
0.250 mA	5.62 mA/meter
0.444 mA	10 mA/meter
0.790 mA	17.8 mA/meter
1.404 mA	31.6 mA/meter
2.485 mA	56.2 mA/meter
4.44 mA	100 mA/meter

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 7020 sound chamber. Make sure nothing else is connected to this jack.

Measurement: Set the battery type to any Silver position. Measure voltage and see that it is 1.5V within 15 mV plus the tolerance of the voltmeter. Set the battery type to any Zinc Air position. Measure the voltage and see that it is 1.3V within 15 mV plus the tolerance of the voltmeter.

4. Circuit Description

Logic Notation

Some logic circuit inputs and outputs operate with positive true logic. A "+" voltage at such a point is equivalent to a "one." Other inputs and outputs operate just the opposite, with negative true logic. The circuit descriptions which follow label negative true inputs and outputs by a "\."

A high speed data bus is present at the top of many of the circuit boards used. The bottom bus connector is used for analog signals, power, a clocked serial interface, and few digital signals.

General Description

The following boards are used in the 7000:

a. CPU
b. Signal Generator
c. Digitizer
d. Digitizer Connector
e. Printer Controller
f. Power Supply
g. Keyboard

The following boards are used in the 7020 Sound Chamber:

a. Battery Simulator Board
b. Sound Chamber Board

If the Probe Option is ordered, the following boards are included:

The following board is located in the 7000:

Probe Interface Board.

The following boards are located in the Probe Module:

a. Probe Keyboard
b. Preamp Board
c. Probe Connector Board
d. EQ Board

The CPU board contains a 68331 microprocessor. This board has 2 MB Flash ROM and 1 MB SRAM. 16KB EEPROM, Video Controller, UART, Time-of-day clock, and silicon serial number.

The SIGNAL GENERATOR BOARD contains the circuits for conversion of a 256 12-bit word map to an analog signal. The map is loaded to this board from the CPU board. A 5 dB per step attenuator is also built onto the board and is controlled by the CPU. The output signal is delivered to the lower bus for amplification by the power amplifiers. A filter is also located on this board to remove the frequency components above the 8 kHz top frequency.

The DIGITIZER BOARD is also controlled by the CPU. This board contains a CPU controlled prescaler and a brick wall filter to prevent aliasing.

Digitizing is done by means of a 256 sample system and can be synchronized to the signal generator, if desired. The sampling rate is 25.6 kHz, the same rate used by the signal generator.

The 12-bit accurate sampled data is stored in RAM and can be read as desired by the CPU. When performing attack and release measurements, the sampling is done without synchronization with the signal generator.

This board also contains battery voltage generation and current measurement circuits. The amplitude of the current is changed to a voltage that is switched to and measured by the 12-bit A to D converter.

The DIGITIZER CONNECTOR BOARD is an extension to the Digitizer and Probe Boards. This board contains external connectors and controls associated with these boards

The PRINTER BOARD drives the printer using a 16-bit microprocessor. This board also contains 1 MB RAM, 128KB Flash Memory, a CPLD device and a stepper motor driver.

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.

The Printer Board provides connections to the internal printer for the thermal printer head, paper feed motor, paper sensor and head up detection.

An external parallel interface (25 pin D) is provided some HP and Epson compatible external printers. HPCL5 and ESC/P2 languages are used.

The POWER SUPPLY BOARD contains voltage requlators, a 64dB source attenuator, and speaker amplification circuitry. This board contains the external connectors for the sound chamber, sound field speaker, and earphone.

On the KEYBOARD, silicon rubber DPST button elements are used along with LEDs for state indications. The Keyboard is connected to the CPU board.

The BATTERY SIMULATOR BOARD provides selectable power and voltages for the hearing aid battery. This board is located in the 7020 Sound Chamber.

The Probe Option includes all additional circuits and components required to perform real ear measurements. The PROBE INTERFACE BOARD is located in the 7000 electronic module. The remote Probe Module contains the PROBE KEYBOARD, the PROBE PREAMP BOARD, the PROBE CONNECTOR BOARD and the EQ BOARD. The Probe Module is connected to the Probe Interface Board via a cable.

4.1 CPU Board (061-0160-XX)

The CPU Board Includes:

- The CPU including: clock, Supervisor, MC68331 processor, Flash ROM, & SRAM
- The CPLD, which interfaces the CPU to several different circuits and peripherals.
- The BDM interface.
- Silicon Serial Number chip.
- VGA display interface.
- The Front panel keyboard interface.
- The external PS2 keyboard interface.
- The Top Buss Interface and 8MHz clock.
- Two RS232 Serial Ports.
- Non-Volatile EEROM for storing user settings and leveling information.
- The Real Time Clock.
- JTAG port.
- The Bottom Buss serial interface.
- The PS2, both RS232, & the VGA rear panel connectors.
- A pair of RS232 port activity LEDs.

4.1.1 CPU Board CPU Section:

Refer to 7000 CPU Board schematics(drawings 999-2295-XX) for the following discussion.

4.1.1.1 CPU Clock:

Y3 works with the internal oscillator in the 68331(U7:A) to supply the 32.768KHz master reference for the CPU. A multiplier circuit inside the 68331 increases this to 24.117MHz. The 24.117MHz clock is sent out pin 66 of the 68331.

4.1.1.2 CPU Supervisor:

U12 supplies the power-on reset for the CPU and other circuits. JP2 can be connected to a switch and used by a technician to reset the CPU.

4.1.1.3 CPU Chip:

The MC68331 CPU(U7:A) includes these integrated peripherals used on this page:

- 68010 type CPU
- Interrupt Control Unit. We're using 5 of its external interrupts. It also has internal interrupts going to internal peripherals.
- A Chip Select unit. We're using two of its chip selects.
- General Purpose I/O pins. We're using 1 of them on this page.
- A Watchdog Timer.
- BDM port.

4.1.1.4 CPU Buss:

The following lines on the 68331 comprise the CPU Buss:

- ADDR0 through ADDR23 are the address buss.
- DATA0 through DATA15 are the data buss.
- CLKOUT, AS#, DS#, R/W#, SIZ0, SIZ1, CS0#, CS2# are the control buss outputs.
- DSACK0# AND DSACK1# are the acknowledge inputs.

4.1.1.5 CPLD:

The CY37128 CPLD(U2:C) on this page:

- Interfaces to the CPU Buss.
- Generates these additional control buss signals: RD#, WR#, IUDS#, & ILDS#.
- Provides the acknowledge signals to the CPU for the Flash and several peripherals.
- Provides the control signals to and from the Flash ROM.
- Provides two keyboard related interrupts to the CPU.

4.1.1.6 Flash ROM:

U6(AM29F160D) is a FLASH ROM device that holds the 7000 program. This part is non-volatile when power is removed, but can be written to by the CPU. The chip select(FL_CS#) is always active low. The CPLD line WP# is used to control the Write Protect line. JP4 is used to allow programming into write protected sectors when strapped to +12V.

4.1.1.7 RAM:

U1 & U3(ASC4098) are Static RAMs where the 7000 program stores temporary information. The CSRAM0# & CSRAM1# chip selects from the CPU are used to select this part.

4.1.1.8 BDM Interface:

J4 provides the connection between the BDM(Background Debug Mode) interface on the 68331 and an external PC. This is currently only used for software development.

4.1.1.9 Silicon Serial Number:

U11(DS2401) is read by the CPU to find out what this units serial number is. The CPU communicates to this part through a one wire buss implemented on pin PE2 of the 68331.

4.1.2 CPU Board VGA Display Interface:

Refer to 7000 CPU Board schematics (drawing 999-2296-XX) for the following.

4.1.2.1 Display Clock:

Y4 provides the display clock of 25.175MHz.

4.1.2.2 Display Controller:

- The S1D13506(U9) has the following sections in it:
- CPU Buss interface(U9:A)
- DRAM interface(U9:B)
- Digitial Display interface(U9:C) sent to internal connector J6.
- Analog Display interface(U9:D) sent to rear panel connector J9.

4.1.2.3 DRAM:

DRAM IS4141C16100(U10) provides the storage for the display image.

4.1.2.4 CPLD:

The CY37128(U2:G) generates the chip select(CSDISP#) and the Memory/ Registers# signals for the display controller.

4.1.2.5 Analog Display Interface:

U16 provides the 5V supply for the DAC. Q2 provides the reference current for the DAC.

4.1.2.6 Plug and Play Interface:

The ID0 signal from the VGA monitor is sent to SED1355 pin 57. The I2C interface to the VGA monitor is the clock(DSCL) generated by SED1355 pin 59, and the data(DSDA) implemented by 68331(U7:E) pin 13.

4.1.3 CPU Board Front Panel and PS2 Keyboard Interfaces:

Refer to 7000 CPU Board schematics (drawing 999-2297-XX) for the following.

4.1.3.1 Front Panel Keyboard Interface:

The keyboard is connected to internal connector J5. The SN74AC16244(U8) provides a high impedance input for the seven row inputs(KR0 to KR6), and the two discrete switch inputs DS1 and DS2. These keyboard inputs are then passed on to the CPLD(U2:A). The key column outputs(KC0 to KC4) are generated by the CPLD. The CPLD also drives the three LEDs(KEY_LED1 to 3). Each key connects one column to one row. The only exception is the Reset key which connects DS2 to ground.

4.1.3.2 PS2 Keyboard Interface:

The PS2 keyboard is connected to rear panel connector J10. The keyboard clock(AT1_CLK) comes in J10 pin 5, is cleaned up by U8 and R28 and R29, then passed to CPLD pin 99. The keyboard can be held off by holding the clock line low using CPLD pin 68 and Q3. The keyboard bidirectional data line(AT1_DATA) comes in J10 pin 1 and then connects to CPLD pin 66. The second AT keyboard port isn't used.

4.1.4 CPU Board Top Buss Interface:

Refer to 7000 CPU Board schematics (drawing 999-2298-XX) for the following.

4.1.4.1 CPLD:

The CPLD(U2:E) provides the interface between the CPU and the top buss(J2). ECS0-3 are used to select a specific board or boards on the buss.

4.1.4.2 8MHZ Clock:

This clock used by the Signal Generator is produced by Y2.

4.1.5 CPU Board RS232 Ports:

Refer to 7000 CPU Board schematics (drawing 999-2299-XX) for the following.

4.1.5.1 Port0:

The primary serial port originates in the UART inside the CPU(U7:C), is level shifted by MAX1406(U16), then goes to rear panel connector J9. This ports activity on its transmit and receive data lines is monitored by LED's DS1 and DS2.

4.1.5.2 Port1:

The secondary serial port originates in UART ST16C1550(U13), is level shifted by MAX1406(U15), then goes to rear panel connector J8. The CPLD(U2:F) provides the chip select(CSUART#) for U13 on pin 83.

4.1.6 CPU Board Miscellaneous Circuits:

Refer to 7000 CPU Board schematics (drawing 999-2300-XX) for the following.

4.1.6.1 I2C Buss:

A standard I2C two line syncronous communication buss is implemented by general purpose lines PWMA(I2CCLK) and PE3(I2CDAT) of the CPU(U7:B).

4.1.6.2 EEROM:

U5(24C128) is a small EEROM that is non-volatile when power is removed, and can be written to by the CPU to store small amounts of data such as user settings and chamber leveling. The CPU communicates to this part through the I2C buss.

4.1.6.3 Real Time Clock:

Battery BT1 supplies power to real time clock chip DS1307(U4) when the 7000 is not powered up. Y1 is the 32KHz crystal that is used for timekeeping. The CPU communicates with the clock using the I2C buss.

4.1.6.4 JTAG Port:

J3 is used to connect an external PC to the JTAG ports on the CPLD(U2:B). This port is used to program the CPLD.

4.1.6.5 Bottom Buss Serial Interface:

The CPU's(U7:B) syncronous serial pins(SRDATO, SRDATI, SRCLK, SRLAT1, SRLAT2, & SRLAT3) are used to implement the buss.

4.1.6.6 Other Circuits:

The address clock from the Signal Generator board connects from the top buss J2 pin 37 to the CPU(U7:B) PAI pin 4.

The CPU Reset Configuration is determined by R1-R7, R14, R18, R19, R21, R25, R27.

The Display Controller Reset Configuration is determined by R39, R41, R44-R46, & R49.

This board contains the following external connectors:

Serial Port A: 9 pin D, female.

Serial Port B: 9 pin D, male.

External Keyboard: 6 pin mini DIN.

External Monitor: 15 pin D, female.

4.2 Signal Generator Board (061-1025-XX)

This board is designed to generate the signal that is used to test the device. The basic components are a counter, clock signal logic, data input buffers, RAM chips, 12-bit D to A converter, low pass filter, and output amplitude control.

Refer to 7000 Signal Generator Board schematics (drawing 999-2449-XX through 999-2453-XX) for the following.

4.2.1 Counters:

The counter is used to generate the 25.6 kHz clock signal that, when counted by a factor of 256, provides the basic 100 Hz frequency of the system. The clock uses the 8 MHz clock from the CPU processor as a source, and counts this clock successively by 13, 3 and 8. The clock frequency is thus 25.641 kHz, which is .16% high in frequency. The divide by 13 counter is formed by a 4-bit counter (U4E) with feedback to its reset input on the count of 13 through (U2E) and (U3H). The count of 3 is formed by a pair of JK flip-flops (U4F). It produces a nonsymmetrical output, which is used for timing signal generation for clocking the D to A converter. Other signals are also developed by logic elements hung on the divide by 8 counter which is formed by part of the 4-bit binary counter (U4H). These signals are used to control the operation of the A to D converter on the digitizer board.

The final count of 256 is formed by two 4-bit counters, 74LS197s (U2A) and (U2B). This part was chosen because it can also act as a buffer, passing the address from the digital bus connector through to the RAM when the CPU wants to load data into the RAM waveform storage elements. This is done by the use of the PRESET input, which interrupts the count and connects the preset inputs to the outputs.

4.2.2 Logic

A short 1.625 uS clock pulse is derived by logic elements (U4B) 74LS08 and (U3H) 74LS21, working from the divide by 8 (U4H) 74LS93 and the clock pulse drive to the divide by 3 circuit. This pulse is used to drive the divide by 256 counter to step the address by one count at a time.

(U3H)'s output is also used to set the states of a JK flip-flop (U3F). Thus, when the clock pulse falls, the Q output of this flip-flop goes high, enabling (U3D) the 74LS00. The next clock pulse input drives a pulse through (U3D) a NAND gate and drives a RAM\ signal to latch in the next set of data for conversion by the DAC (U1E). Since this pulse is 3.25 uS later than the previous one that upped the address count on the RAM, the new data is solid.

Logic elements are also added to enable the 68000 to send data to memory locations it wishes. This is done by the CPU first setting up the address and data on the appropriate lines, A1 to A8 and ECS3 and D0 to D11. Once these signals are in place, the R/W\ line goes low and the AS\ and UDS\ and LDS\ lines are also sent low, indicating that a write is requested, the addresses are correct, and that both upper and lower data bytes are to be used. A write command for ECS3 is always directed to be sent to this board. A read to this line means that sampled data from the digitizer board is to be read.

Decoding is straightforward. A RW\ signal inverted by (U3E) 74LS04 and an ECS3 signal enable the gate (U3D) 74LS00. Arrival of AS\ low then pushes (U4D) 74LS02 output high, which enables high and low write command gates to the lower 8 and upper 4 bits of the 12-bit word. If LDS\ goes low, and if DTACK\ is high, (U4D) 74LS02 tells (U3D) 74LS00 to accept that OK from the ECS3 decode logic, and data is written to the lower 8 bits by pulling the W\ inputs of (U3A) and (U3B) low. Similar action works on the upper 4 bits with (U3C).

4.2.3 RAM

RAM is formed by three 2114s - (U3A), (U3B) and (U3C). The upper address lines of these chips are tied to ground, thus the upper half of the chips are unused. The four bit chips are arranged to supply storage for the twelve bits of data that arrive from the CPU and that are read out to generate the signal.

An address is delivered from the CPU to the RAM chips when the invertor (U2E) 74LS04 has pulled the Load inputs of the (U2A) and (U2B) counters low and directed their outputs to follow input lines A1 through A8. Data is also coupled to the RAM data lines by the same logic drive line operating on (U2C) 74LS244 and (U2D) 74LS125 for the lower and upper order bits, respectively.

When the DTACK circuit on the CPU pulls DTACK\ low, the write is ended. When the CPU responds to the DTACK, the address strobe command on AS\ is withdrawn.

When the system resumes operation, the count will of course start from the last preset count given the counter chips from the address lines. Since the CPU will probably only write to these locations when it is in the process of changing a complete RAM table of data, the disruption of signal will be a relatively infrequent affair. Programs have also been developed so that when necessary, the RAM is loaded in synchronism with the system so that only a small signal transient is generated by the load process.

4.2.4 Logic Used by the Digitizer Board

The 74LS21 (U3H) and 74LS08 (U4B) tied to the outputs of the divide by 3 and 8 counters provide a short basic clock signal labeled RAM\.

The two sections of the 74LS260 (U4A), a dual 5 input NOR, in combination with the 74LS08 (U4B), provides another signal for the A to D converter called 0SET. The signal goes high only when a complete count of 256 has been completed and the count is about to start again. The count of 0 is anded with the clock pulse to produce the 0 set signal. These two signals then provide the A to D on the digitizer board the information needed to do synchronous sampling.

CE\ tells the A to D chip to perform a function (either read or convert). R/C\ tells it what function to perform. When R/C\ is high, a CE\ causes the A to D chip to read out the binary conversion information to RAM. When R/C\ is low, a CE\ causes the analog to digital conversion to start. Another signal, RAM\, is used to enable the RAM on the digitizer board to be written with the new set of conversion data. This also must occur a short period of time after an address change for proper RAM loading.

Timing is important on these operations because the AD574A used for digitizing takes 35 uS to perform a conversion. The clock rate is 25.6 kHz, or a period of 39 uS. Thus the timing difference between the CE\ pulses that first load the data from the last conversion to a new address in RAM and then start a new conversion must be less than 4 uS. The period of the drive to the divide by 3 circuit has a period of 1.625 uS, and its drive pulse has a width of .625 uS.

R/C\ also is used to drive the sample/hold circuit on the digitizer. A relatively narrow clock pulse of 0.625 uS is derived by using the drive pulse to the divide by 3 counter in combination with logic elements. A pair of CE\ pulses, one for reading and the other for A/D conversion, are generated by the use of a flip-flop (U3F). They are separated by 1.625 uS.

The dual flip-flop (U3F) can be thought of as a delay generator. Normally both outputs of these flip-flops are low, held there by the bias on their JK inputs. When the bias is flipped on the first one, the next pulse's trailing edge flips it high, arming the second flip-flop so that the next pulse's trailing edge will flip its output high. The second flip-flop is always trailing the first one by one pulse.

Clock pulses from (U4E) cause all the action. If the count in U4H is eight, U3Fa is biased to be triggered high. The falling edge of the first clock sets it high. U3Fa high sets the second FF (U3Fb) bias so that it can be triggered high on the second clock. The falling edge of the second pulse also causes (U3Fa) to fall because its bias has been changed. The second FF (U3Fb) is now biased to fall on the third clock pulse.

When it falls, action is terminated until the count of eight is true again. The other logic elements use the delays caused by the serial flip-flop action to generate the timed pulses, RAM\, R/C\, and the dual CE\.

R/C\ starts by being pulled high by the first clock pulse. The falling edge of this pulse sets FF1 (U3Fa) high and this FF1's output is used to extend the time R/C\ stays up. The 100 pF cap holds it up if the FF1 is a little slow in getting up.

RAM\ is generated when (U3D) is armed by FF1 and the second pulse goes high. It also causes the generation of the first CE\ pulse through (U3E) 74LS04 and (U4D) 74LS02.

The falling edge of the second pulse pulls FF1 low and terminates the R/C\ pulse. Thus when the last pulse comes through, it passes through the enabled gates (U4B and U4D) to generate the second and last CE\ pulse and starts the conversion process on the digitizer board. The falling edge of this pulse sets FF2 low again, disarming the gate.

The drive signal, RAM\, enables the RAM chips on the digitizer board to receive information from the A/D converter. It is also used to latch through the data from the signal generator RAM to generate the next programmed level. Examination of the action of the flip-flops will show that the RAM\ clock is exactly one clock cycle later than the cycle that caused an address change, making sure that the data will be solid and stable.

4.2.5 Digital to Analog Converter

All of the latch lines on the DAC811 (U1E) except the WR\ input are tied down, because the eight bit and four bit load features are not used in this design. A 12-bit word is available all at once, so the single instruction RAM\ to load the data will make a clean signal transition possible.

4.2.6 Low Pass Filter

This filter is used to remove the higher order frequency components above 8 kHz that can cause possible difficulties with the signal being processed by the 7000's power amplifier and the device under test. It is formed by a series of op-amps (U1J and U1L) forming two 2-pole filter sections and one 2-pole filter, respectively.

4.3 Digitizer Board (060-2023-XX)

This board contains circuits to preamplify the incoming signals with prescaling controlled by the CPU, a brick wall filter to reduce the high frequency components above 8 kHz, a switch to allow either audio signals or battery current signals to be measured, a sample and hold circuit, an A/D converter, RAM for holding the sampled data in 12-bit words, a counter for deriving addresses for the RAM in data collection, and logic circuits to control the board. A circuit is also included that supplies a battery equivalent voltage and a current voltage converter that ranges up to +5 volts for a current drain of 25 mA. A number of signals are supplied from the signal generator board for timing the sampling operation; look at the description for this board for their derivation.

Digitizer board logic also allows the CPU to read the RAM locations as desired, to control the gain of the prescaling amplifier, to determine the state of the A/D process, to set whether the sampling is to proceed synchronously with the signal generation or not, and to measure either input audio signals or battery current.

4.3.1 Digitizer Board Bus Interfaces & Counter Section:

Refer to 7000 Digitizer Board schematics (drawing 999-2429-XX) for the following.

4.3.1.1 Counters and Control Logic:

The 8 bit counter pair is formed by 74LS197s (U1 and U2) which are used because of their preset feature, allowing the CPU processor to control the address for readout of sampled data. These chips receive a clock signal every 39 uS from the RAM\ line, which is sent over from the signal generator board.

The signal 0SET also comes from the signal generator board. When this signal arrives, the counters are reset to 0 so that they are in synchronization with the counters on the signal generator board if bit 0 is set high on port A22 (U12). If the bit is set low, then nonsynchronous sampling will take place. (U4) 74LS00 supplies the control logic.

The system is designed to start synchronous sampling only when enabled by a momentary negative pulse delivered from bit 1 of the 74LS373 (U12). This action resets flip-flops (U19) and allows the CE\ and RAM\ pulses from the generator board to start clocking data to the RAM by way of the A/D. When the 0SET pulse comes in, the first flip-flop is clocked high. The next 0SET pulse causes the output of the first flip-flop to fall, and then the second Q\ goes low again, stopping the sampling. The sampler has thus caused a synchronous load of 256 words to the RAM, and will not restart until another pulse is received from bit 1 of 74LS373 (U12).

The data can be read out to the CPU through the logic provided. The CPU sets up the address and sets the R/W\ line positive. It also indicates that it wants to address memory at line A23. The reception of these signals forces the 74LS197 counters (U1 and U2) to follow the address from the CPU. When the signals

AS\, UDS\ and LDS\ arrive, indicating that the address is OK and both of the data bytes are needed, the data is clocked out onto the data bus by 74LS244 (U5) and 74LS125 (U6).

4.3.1.2 Logic:

Logic is required to enable the system to read asynchronous sampled data such as the response of the aid in attack and release times measurements.

A logic one is provided to port (U9) 74LS125, bit 1, when an arrival of the R/C\ pulse sets flip-flop (U15), pin 9, high. This signal is used to tell the CPU that a sampling event has taken place and that the data has been transferred to RAM and is in the state to be read out. The act of reading out the value sends a reset pulse to (U15), setting bit 1 low again.

In sine mode, during the loading of the signal generator, it is necessary for the CPU to know when an address change has taken place. This is done by reading bit 0 of port (U9) 74LS125, which is connected to the low order bit of the address counter.

4.3.2 Digitizer Board Track/Hold & A/D Section:

Refer to 7000 Digitizer Board schematics (drawing 999-2430-XX) for the following.

4.3.2.1 Signal Switch/Sample and Hold:

The sample and hold circuit is formed by 4066 CMOS switches (U25) and (U23). C22 and C29 are used as storage capacitors. The circuit is driven by (U18) 3302 and flip-flop (U15) which is clocked by the R/C\ signal from the signal generator board. In normal sampling operation, the FF drives the signal from isolation amplifier (U21) through pin 4 of (U25) into C22. At the same time, the voltage that was delivered to C29 is being read out by op-amp (U24) TL071 through pin 2 of (U23) 4066. On the arrival of the next R/C\ pulse, the switches are changed, so that now C29 is disconnected from the (U24) op-amp input and connected to be charged by the isolation amp (U21). The previously charged C22 is then connected to the readout amp.

Sampling operation takes place when bit 2 is set at port (U12) 74LS373.

Battery current can be read out in the form of a negative voltage offset by setting bit 2 to 0. The low voltage resets flip-flop (U15) and stops the sampling. At the same time, (U23) pin 10 is connected to C22, and this voltage is permanently connected to the input of the readout op-amp (U24) TL071.

4.3.2.2 Analog to Digital Converter:

Analog to digital conversion is performed by the AD574A chip. It is connected to process 12 bits at a shot, and also to load these 12 bits all at once to RAM when commanded. It requires 35 uS to make a conversion. Layout around this part is extremely critical to avoid noise problems. Twelve bits is equivalent to a signal to noise ratio of 4000 to one, or 70 dB.

4.3.3 Digitizer Board RAM & In Port Section:

Refer to 7000 Digitizer Board schematics (drawing 999-2431-XX) for the following.

RAM is formed by the combination of three 2114 chips (U3, U7, U11). They are addressed by the 74LS197 counters (U1, U2). Each chip stores 4 bits of the 12-bit word used by the system.

4.3.4 Digitizer Board Out Port & Prescaler Section:

Refer to 7000 Digitizer Board schematics (drawing 999-2432-XX) for the following.

4.3.4.1 Preamplifier:

The preamp is a single op-amp (U35) TL071 with a gain of about 1.5. Gain is controlled by the 5K pot mounted on the Digitizer Connector Board. Communication occurs with Digitizer Connector Board through J4 connector pin 3.

4.3.4.2 Prescaling Amplifier:

All prescale amplifiers operate in the same way. Operating the switch so that it shorts out the resistor connected to the leg of the minus input to ground effectively switches the stage's gain to the high state. Opening the switch removes the attenuation of the feedback signal and the gain reverts to unity, or 0 dB.

The first amplifier (U34) forms a pair of 20 dB stages. The second forms a single switched 20 dB amp and a 10 dB amp (U36).

The 2.2 uF caps (C36, C34, C40, C35) are used to keep DC offset glitches from forming and being switched into the system when the gain is changed.

4.3.5 Digitizer Board Speech & Alias Filter Section:

Refer to 7000 Digitizer Board schematics (drawing 999-2433-XX) for the following.

4.3.5.1 Low Pass Filter:

This filter is formed by operational amplifiers U27 and U28 and is used to control the bandpass of the signal being sampled to avoid aliasing problems. It is identical in design to that used on the signal generator board.

4.3.5.2 6 dB/Octave Compensation Amp:

TL071 (U31) and 2N4393 FET (Q1) form a high frequency boost filter that can be switched in when it is desired to operate in speech weighted gain mode. The filter is formed by passing the signal through the .016 uF cap around the 11k input resistor. The output feedback resistor is also 11k, so that the gain is unity at low frequencies, but increases at a rate of 6 dB/octave at the corner frequency of 900 Hz. The gain is limited at high frequencies by the 330 ohm series resistor and the 300 pF shunt cap board. board. board.

4.3.6 Digitizer Board Battery Simulator Section:

Refer to 7000 Digitizer Board schematics (drawing 999-2434-XX) for the following.

4.3.6.1 Battery Current Measurement:

A 759 power op-amp (U32) is used for voltage supply, and is current limited by the 2.7 ohm resistor. When a voltage module is connected and a hearing aid is hooked up, current from the aid flows into the (-) input of the second 759 power op-amp (U33). It is equipped with a 200 ohm feedback resistor, giving a 25 mA/5V conversion of current to voltage. Overdrive protection is provided by the catch diodes on the (+) input of the first op-amp and the use of the feedback catch transistor around the second op-amp. The output of the current converter circuit is connected to the proper input of the 4066 CMOS switch (U25) through a 1 meg resistor so that it can be sampled when desired.

Bits 2 and 3 of input port (U9) 74LS125 are also driven by switches on the battery box so that the battery substitution type can be read out.

4.4 Digitizer Connector Board (061-0165-XX)

This board provides external connectors and controls associated with the Digitizer, CPU and Probe Interface Boards. Additionally, circuitry for ESD protection is provided for each connector.

The digitizer board contains the following external connectors and controls:

Probe Module: 15 pin D, female.

Scope Monitor: BNC, Coaxial.

Microphone: 8 pin DIN.

Microphone Gain: Trimming pot.

Refer to 7000 Digitizer Connector Board schematic (drawing 999-2343-XX).

4.5 Printer Controller Board (061-0161-XX)

The Printer Controller Includes:

- The CPU including: clock, supervisor, Phillips PXAG49K8A microcontroller, and SRAM.
- The CPLD, which interfaces the CPU to other circuits and peripherals.
- The Top Buss Interface.
- The Internal Printer Interface.
- The External Printer Parallel Interface.
- The JTAG port.

4.5.1 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.

4.5.2 CPU Section:

Refer to 7000 Printer Board schematics (drawing 999-2309-XX and 999-2310-XX) for the following:

4.5.2.1 CPU Clock:

Y1 provides the 29.4912MHz clock for the microcontroller. A copy of this clock is sent out on pin 20 of microcontroller U4.

4.5.2.2 CPU Supervisor:

U1(MAX708) supplies the power-on reset for the microcontroller and other circuits. The CPU Board can also trigger a printer reset through the RESETIN\ signal on pin 1 of U1. JP1 can be connected to a switch and used by a technician to reset the circuits on this board.

4.5.2.3 Microcontroller:

The microcontroller is a Philips PXAG49K8A (U4). It includes the following resources used in this section:

- Enhanced 8051 type CPU extended to 16 bits.
- Interrupt controller.
- A watchdog timer.
- 64K bytes of internal Flash memory.
- 2K bytes of SRAM.
- General purpose I/O pins. None of them is used in this section.

4.5.2.4 CPU Buss:

The following lines on the microcontroller comprise the CPU Buss:

- A1C, A2C, and A3C are the lower 3 bits of the address buss.
- A4D0 through A19D15 are the multiplexed data buss, and upper 16 bits of the address buss.
- The control lines are: ALE, PSEN\, RD\, WRL\, and WRH\.

The address lines A4 through A19 are latched in the CPLD U5:E in order to demultiplex them from the data buss. Address lines A1C, A2C, A3C, and WRL\, and WRH\ are also latched here.

4.5.2.5 SRAM:

U6 and U7(CY7C1049) are both 512K byte static rams. Together they form a 512K word ram memory. The CPLD U5:E decodes the CPU buss to generate the RD_RAM\, WR_H\, and WR_L\ signals.

4.5.2.6 Internal Flash ROM:

The Program that controls the Printer Board is located in the 64K bytes of Flash Rom inside the microcontroller U4.

4.5.2.7 External Flash ROM:

U8 and U9(AT49F001T) are both 128K byte flash roms. These roms are not currently being used.

4.5.3 Top Buss Interface Section:

Refer to 7000 Printer Board schematic (drawing 999-2309-XX) for the following:

The CPLD(U5:C) provides the interface between the Printer Board CPU Buss and the Top Buss which is at connector(J2). It is through the Top Buss that the CPU Board communicates with the Printer Board.

4.5.4 Internal Printer Interface Section:

Refer to 7000 Printer Board schematics (drawing 999-2311-XX and 999-2312-XX) for the following:

4.5.4.1 Head Interface:

The internal printer head is connected to J14. The internal printer head stores the data needed to print one dot column in an 832 bit shift register. This data is serially shifted in by the microcontroller signals DATA_OUT and CLK which connect to J14 pins 14 and 13 respectively. After the data is shifted into the head, the data is latched by the LATCH\ signal provided by the CPLD(U5:D) which connectes to J14 pin 10. The signals STROBE1\ through STROBE5\ control which of the 5 groups of dots is to be “burned” at any point in time. The STROBE0\ signal controls the circuit composed of U2:A, Q1, and Q2, which connects the 24V supply to the head connector pins 1 and 2 when it is time the heat the dots on the print head. The STROBE(0,2,3) signals come from the CPLD(U5:D). The STROBE(1,4,5) signals come from the CPLD(U5:A).

4.5.4.2 Stepper Motor Drive:

The stepper motor is connected to J11. The microcontroller provides the signal RUN_SM\ to enable the stepper controller in the CPLD(U5:D). The microcontroller also provides the signal CLKB that advances the phase generator in the CPLD(U5:B) from one stepper state to the next. The signals PHASE1, PHASE2, ENABLE1, and ENABLE2 come from the CPLD(U5:D). These signals control the stepper motor driver A3966SLB(U3). U3 provides the four 24V signals(A, A\, B, B\) needed by the stepper motor. The SMD050(E1) is an electronic fuse which will trip if the stepper motor jams or shorts. E1 will automatically reset itself aftet the current overload is removed.

4.5.4.3 Printer Sensor Interface:

The Sensor connector from the printer plugs into J12. The negative true paper out signal from the printer comes in J12 pin 2. It is then inverted by U2:B and the positive true PEND signal is sent to the CPLD(U5A). The positive true Head Up signal from the printer comes in J12 pin 4 and is fed to the CPLD(U5:A). The circuit composed of E1, R12, R13, and CR1 generates the SMV signal which is fed to the CPLD(U5:A). This signal is normally a logic 1 but will go to a logic 0 if the electronic fuse(E1) trips, or if the +24V supply drops.

4.5.5 External Printer Interface Section:

Refer to 7000 Printer Board schematic (drawing 999-2309-XX) for the following:

The External Printer parallel interface connects to J15. The parallel port interface is in the CPLD(U5:C). The diode array CR2 protects the CPLD from static discharges into J15 from people or equipment outside the 7000.

4.5.6 Miscellaneous Section:

4.5.6.1 Beeper:

(Drawing 999-2309-XX) The signal to control the beeper originates in the CPLD(U5:C). It is then amplified by Q3 and fed to the beeper BRT1209(DS1).

4.5.6.2 JTAG Interface:

(Drawing 999-2312-XX) The JTAG interface is composed of J3 and 5 pins on the CPLD(U5:B). It is used to program the CPLD.

4.5.6.3 RS232 Interface:

(Drawing 999-2312-XX) The external RS232 interface is composed of a UART inside the microcontroller, J8, J9, U10, and CR3. Only J9 is actually installed on the board. J9 is currently only used for testing at the factory.

4.5.6.4: Power Supplies:

(Drawing 999-2312-XX) The +5D supply come from the bottom buss pins 3 and 4. The other supplies on the bottom buss are currently not used except at the factory. (Drawing 999-2311-XX) The +24V supply comes from J13.

4.6 Power Supply Board (061-0162-XX)

The Power Supply Board Includes:

- The Voltage Regulators for the Signal Generator, RS232 drivers, & -5A.
- A 64dB source attenuator.
- The Speaker/Earphone amplifier.
- The Chamber speaker/Sound field speaker/Earphone&Telecoil select circuitry.
- A pass through connector for the Battery Simulator on the Digitizer.
- The Sound Chamber, Sound field speaker, and Earphone rear panel connectors.
- Power on LED indicator.

4.6.1 Power Supply Regulator Section:

Refer to 7000 Power Supply Board schematics(drawing 999-2338-XX) for this discussion.

4.6.1.1 Source Attenuator Circuit Power:

78L05(U4) and 79L05(U2) supply the +/-5S for the source attenuator circuits.

4.6.1.2 CPU and Printer Controller Board Power:

LM317(U1) and LM337(U5) provide up to 100mA each for the +/-12V used by the RS232 interfaces on the CPU and Printer Controller boards.

4.6.1.3 Signal, Digitizer and Probe Interface Board Power:

The 79L05(U3) provide up to 100mA for the –5A supply used on the Signal Generator, Digitizer boards, and Probe Interface boards.

4.6.1.4 Power LED:

The Red LED (CR9) is a diagnostic LED for +5D only.

4.6.2 Power Supply Attenuator and Speaker Drive Section:

Refer to 7000 Power Supply Board schematics(drawing 999-2339-XX) for this discussion.

4.6.2.1 Shift Register:

The 74HC595(U6) connects to the bottom buss serial interface. It shifts in and latches the control signals for the attenuators and speaker selection relays.

4.6.2.2 Source Attenuator:

The 1dB attenuator is composed of 74HC4051(U7) and R5-R12. The 8dB attenuator is composed of 74HC4051(U8) and R13-R21. The provide from 0 to 63dB of attenuation.

4.6.2.3 Speaker/Earphone Amplifier:

TDA2030A(U9) and associated components make up the amplifier.

4.6.3 Power Supply Speaker Selection Section:

Refer to 7000 Power Supply Board schematics(drawing 999-2340-XX) for this discussion.

4.6.3.1 Speaker Relays:

Relay(K2) is used to direct the amplifier output to either the chamber connector(J7), or to the other relay. Relay(K1) directs the signal from K2 to either the Earphone(J6) and telecoil, or to the Sound Field jack(J5). Q1 and Q2 buffer the control signals from the shift register before driving the relays.

4.6.3.2 Battery Simulator:

The battery simulator on the digitizer is cabled to J17 and then to the chamber connector (J20).

4.7 Keyboard (061-0166-XX)

Refer to 7000 Keyboard schematic (drawing 999-2423-XX) for the following discussion.

One pole of each LED is connected to ground. Other poles are connected to pins on the 20-pin connector (J5) on the CPU Board (061-0160-XX). See also Table 4.2.1.

Lines 1 through 5 and 12 through 15 of J5 carry the push button switch connections to CPU Board CPLD (U2).

7000 Switch Pattern

CON1	Switch	CON1	Switch
1-12	F1 (SW21)	4-12	Up (SW19)
1-13	F2 (SW1)	4-13	Down (SW5)
1-14	F3 (SW12)	4-14	Left (SW9)
1-15	F4 (SW15)	4-15	Right (SW6)
2-12	F5 (SW20)	5-12	Stop (SW22)
2-13	F6 (SW2)	5-13	Start (SW16)
2-14	F7 (SW7)	5-14	Help (SW14)
2-15	F8 (SW17)	5-15	Menu (SW23)
3-12	Exit (SW4)	19-20	Reset (SW11)
3-13	Print (SW3)		
3-14	Feed (SW13)		
3-15	Level (SW18)		

LED Assignments

10-20	LED1
9-20	LED2
11-20	LED3 (not used)

4.8 7020 Sound Chamber

The 7020 Sound Chamber includes the Battery Simulator Board and the Sound Chamber board, speaker driver, internal loop telecoil, and external connectors:

4.8.1 Battery Simulator Board (061-0167-XX):

Refer to 7020 Keyboard schematic (drawing 999-2389-XX) for the following discussion.

The battery simulator board supplies the correct voltage and impedance to simulate a battery of the size and type selected.

Current is supplied to the battery simulator via the I_SOURCE line. The current on the I_RETURN line is measured by the digitizer board.

If a 1.3V battery is selected, R5 is connected between –5V and the V_SET line. This causes the digitizer board to supply 1.3 V to the battery simulator. If a 1.5V battery is selected, R5 is shorted, causing 1.5 V to be supplied. The V_SENSE and REMOTE_G_SENSE lines provide feedback to the digitizer board to compensate for any voltage drop in the cabling.

When a battery simulator button is pressed, a resistor is connected in series with the battery pill jack. This resistor together with other circuit resistance provides the proper impedance.

BIT_0 is read by the 7000 to determine which battery type has been selected. When a Zinc-air battery is selected, BIT_0 is connected to –5V. If a silver battery is selected, Bit_0 is pulled high by a pull-up resistor on the digitizer board.

4.8.2 Sound Chamber Board (061-0084-XX):

There are only passive circuit elements on the 7020 Sound Chamber Board:

a. 15 Pin D connector to interface with 7000 electronics module.
b. 8 pin connector to interface with Battery Simulator Board.
c. 3 pin connector to interface with external telecoil jack.
d. 2 pin connector to interface with ineternal telecoil.
e. 2 pin connector to interface with speaker driver.

Refer to 7020 Sound Chamber Wiring schematic (drawing 999-2445-XX).

4.9 7000 Probe Option

The 7000 probe option (Quik-Probe) includes the 7000 Probe Interface Board (P/N 061-1089-XX), located inside the 7000 electronics module, the Quik-Probe remote module (hand held cable connected remote control) and accessories.

The Quik-Probe remote module includes 4 circuit boards:

a. Probe Keyboard (P/N 061-0163-XX)
b. Preamp Board (P/N 061-0088-XX)
c. Probe Connector Board (P/N 061-0164-XX)
d. EQ Board (P/N 061-0010-XX)

4.9.1 Probe Interface Board (061-1089-XX)

The 7000 Interface Board has the following functions:

Refer to 7000 Probe Interface Board schematics (drawing 999-2437-XX through 999-2439-XX) for the following discussion.

a. Provides electrostatic discharge protection for the 7000 remote module connector. This protection is provided by keyboard inputs at J5 pins 2, 3, 4, 10, 11, 12 and 13; and by the audio input at J5 pin 8.
b. Provides power for the remote module; limits the available power to a non-destructive level in case of a shorted remote module cable. R23 and R24 limit the power available to the 7812 (+12 V) and 7912 (-12 V) 3 terminal regulators.
c. Interfaces between the 7000 and the remote module push button keys; latches rapid key strokes for later reading by the 7000 CPU. U3D and U1C form R-S flip flops. These flip flops are reset by the 7000 CPU after checking for a key stroke. Transparent latch U3B is permanently wired as transparent. It is used as a tri-state output buffer only. U3B couples the outputs of the R-S flip flops to the CPU data bus.
d. Switches the 7000 prescaler input between the M1750E or M1950E sound chamber microphone and the remote module. (U2MB)
e. Controls the remote module REFERENCE MIC/PROBE MIC switch. (U2B).

4.9.1.1 Probe Interface Board Connectors:

J1	card edge	50 pins	Lower system bus
J2	card edge	50 pins	Upper system bus
J3	square pins	5 pins	to 7000 Digitizer Board (J4)
J5	DIP socket	14 pins	to 7000 Digitizer Conn. Board (J24) for probe module connector
J6	square pins	5 pins	to 7000 Digitizer Conn. Board (J29) for Coupler Microphone Input and gain pot.

4.9.1.2 Interface Board CPU Addresses:

Note that D0–D7 are the high, odd address byte; D8–D15 are the low, even address byte. Away from the CPU board there is no address A0.

READ PORT

D0 D1 D2 D4 D5 D6	(Normally = 0) Each remote module key (except START/STOP) causes a unique combination of 2 bits to go to logic 1.
D3	Spare (logic 0)
D7	STOP/START; (normally logic 0) goes to logic 1 when START/STOP button is pressed or foot switch is pressed. Sense voltage = +18V to insure that foot switch contacts break through any oxide coating.
D8 - D15	Random; not used

WRITE PORT

D0	0 = sound chamber; 1 = Quik-Probe speaker
D1	0 = M1750E or M1950E microphone; 1 = remote module selected microphone
D6	Remote module mic select; 0 = probe mic; 1 = ref mic
D7	Normally 1; set to 0 then back to 1 to reset the key sense R-S flip flops after reading the remote module keyboard
D2 D3 D4 D5	SPARE
D8 - D15	Not used

4.9.2 Probe Keyboard (061-0163-XX)

There are only passive circuit elements on the keyboard. The keyboard connects the remote module to the 7000 cable to the preamp board. It contains etched switch contacts for use with silicon rubber switch buttons. Each switch, when pressed, will connect keyboard data lines to keyboard ground (or via 100 ohms to chassis). Refer to Probe Keyboard schematic (drawing 999-2341-XX).

Switch	**Keyboard**	**Probe Interface Board**
Name	key pressed = logic 0	key pressed = logic 1
[F1]	KD1+KD2	U3B: D2+D1
[F2]	KD2+KD4	U3B: D1+D4
[F3]	KD2+KD3	U3B: D1+D0
[F4]	KD2+KD5	U3B: D1+D5
[F5]	KD2+KD6	U3B: D1+D6
[<]	KD3+KD6	U3B: D0+D6
[>]	KD4+KD5	U3B: D4+D5
[/\]	KD3+KD5	U3B: D0+D5
[\/]	KD3+KD4	U3B: D0+D4
[MENU]	KD1+KD5	U3B: D2+D5
[HELP]	KD1+KD4	U3B: D2+D4
[EXIT]	KD1+KD3	U3B: D2+D3
[LEVEL]	KD1+KD6	U3B: D2+D5
[PRINT]	KD4+KD6	U3B: D4+D6
[STOP]	KD5+KD6	U3B: D5+D6
[START]	KD6+KD7	U3B: D6+D7
[SPARE #1]	KD4+KD7	U3B: D4+D7
[SPARE #2]	KD3+KD7	U3B: D0+D7
[SPARE #3]	KD2+KD7	U3B: D1+D7

The following connections are made between the remote module keyboard and the 7000 interface:

15 pin D connector pin	14 pin DIP connector pin (J22)	Keyboard signal name	7000 Interface signal name
5	10	KD1	D2
12	4	KD2	D1
4	11	KD3	D0
11	3	KD4	D4
3	12	KD5	D5
10	2	KD6	D6
2	13	KD7	D7
1	14	Mic Select	Mic Select
13	5	-12V	-12V
6	9	+12V	+12V
14	6	Headphone Gnd	Headphone Gnd
7	8	Audio	Audio
15	7	Dig. Ground	Mic. Ground
9	1	GND(K)	Keyboard Ground
(SHELL)	(BRAID)	KEYBOARD	SHIELD CHASSIS
8	(NC)	(NC)	(NC)

Notes: D0—D7 are inverted from KD1 - KD7
D0—D7 subscripts do not match KD1 - KD7 subscripts

4.9.3 Probe Connector Board (061-0164-XX)

There are only passive circuit elements on the connector board:

a. The probe/reference microphone connector.
b. The probe monitor headphones jack.
b. The probe monitor headphones level control.

Refer to Probe Connector Board schematic (drawing 999-2342-XX).

4.9.4 Preamp Board (061-0088-XX)

4.9.4.1 Ref Mic Preamp:

U6 provides a high impedance load for the reference microphone and also a small amount of gain to allow calibration pot VR2 to be centered for the "average" reference microphone.

4.9.4.2 Probe Preamp:

U2 provides a high impedance load for the probe microphone. Using the EQ board compensates for irregularities in probe microphone frequency response plus sensitivity, and rolls off high frequencies to avoid measurement error due to amplifier overload in later stages. (See Section 4.8.5 for a description of the EQ board.)

4.9.4.3 Mic Power:

U4 provides a very low impedance power supply for the probe and reference microphones. Since the two microphones share this power supply, it must be regulated to prevent crosstalk between the two microphones.

4.9.4.4 Multiplexer:

U3 simply switches the input of the line driver between the probe preamp and the reference preamp. U3A and U3B short the unused preamp signal to ground to further improve isolation between the two signals. U3 alternates between the two preamps at a rate of a few Hz as controlled by the 7000 CPU.

4.9.4.5 Mecca:

In order to prevent interaction of the amplifiers on the preamp board, a single, very low impedance local ground reference is required. This ground reference is called "mecca" and is indicated on the schematic by a square with 9 circles inside. Mecca is tied to the remote module cable shield, a heavy braid, which is connected to 7000 chassis ground.

4.9.4.6 Line Driver:

The line driver is also an "instrumentation amplifier". The line driver translates the output signal "AUDIO" from mecca ground reference to 7000 microphone ground reference. The accuracy of match between 0.1% resistors R1/R2 and R4/R3 establishes the amount of rejection of ground noise between the 7000 and the preamp board. The line driver provides a low impedance output so that "AUDIO" will have no high frequency roll off due to cable capacitance.

Note that the mic ground cable wire may have a few (less than 10) ohms of resistance.

4.9.4.7 Power Supplies:

The remote module may be connected to the 7000 while the 7000 power is turned on. During this “hot plugging”, +12V, -12V, and ground may be connected in any order. CR1 and CR3 protect against reversed +12V and -12V supplies. CR2 and CR4 prevent +5V and -5V from interacting at power up. This interaction might prevent one of the +/-5 volt supplies from turning on. R21 and/or R23 will open during a gross fault.

4.9.4.8 Headphone Amplifier:

The headphone amplifier allows the 7000 operator to listen to the output of the probe microphone. The headphone amplifier is intended to operate with 24-32 ohm Walkman style stereo headphones. U5, an NE5532 dual op amp, is specified to drive 600 ohm loads. Since R13 and R14 are 604 ohms each, the dual op amp will be unconditionally protected from output short circuits. The headphone amplifier will also work with monaural headphones. If the 7000 operator is hearing impaired, use 600 ohm headphones, which will provide louder output with this headphone amplifier circuit.

4.9.4.9 Microphones:

The probe and reference microphones each contain a microphone element which in turn contains a FET source follower amplifier. Each microphone element has three terminals: +POWER, SIGNAL, and GROUND. Each microphone element SIGNAL terminal receives current from a separate preamp board 47K resistor tied to -5V. This resistor is R8 for the probe mic and R25 for the reference mic.

4.9.5 EQ Board

The EQ board contains components to customize the probe microphone preamp gain and frequency response to match one individual probe microphone. (The serial number on the EQ board must match the probe microphone connected to the remote module.) The EQ board contains a high frequency boost circuit (pins 1, 2 and 3) and a low pass filter (pins 4, 5, 6 and 7) to remove frequencies above the 8000 Hz measurement limit of the 7000.

5. Calibration

There are few calibration adjustments on the 7000, both external and internal to the instrument. Those available are covered in this section.

5.1 Microphones

There are three possible microphones on the FONIX 7000 analyzer:

- Coupler microphone (M1750E or M1950E)
- Probe microphone
- Reference microphone

There are several variations of these microphones that may be available, depending upon when the analyzer was manufactured and whether or not it includes the Real-ear Option.

All 7000 analyzers include a coupler microphone. The procedure for calibrating this microphone is described in Section 5.1.1. 7000 analyzers that do not include the Real-ear Option will only have the coupler microphone.

7000 analyzers with the Real-ear Option manufactured during or after March 2007 will 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.

7000 analyzers with the Real-ear Option manufactured before March 2007 will have a two microphone set consisting of a 14 mm reference microphone and a probe microphone. The procedure for calibrating the reference microphone is described in Section 5.1.4. The procedure for calibrating the probe microphone is described in Section 5.1.2.

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)
- Small flat-head screwdriver (coupler microphone, not pictured)
- Small Phillips-head screwdriver (probe and reference microphones, not pictured)

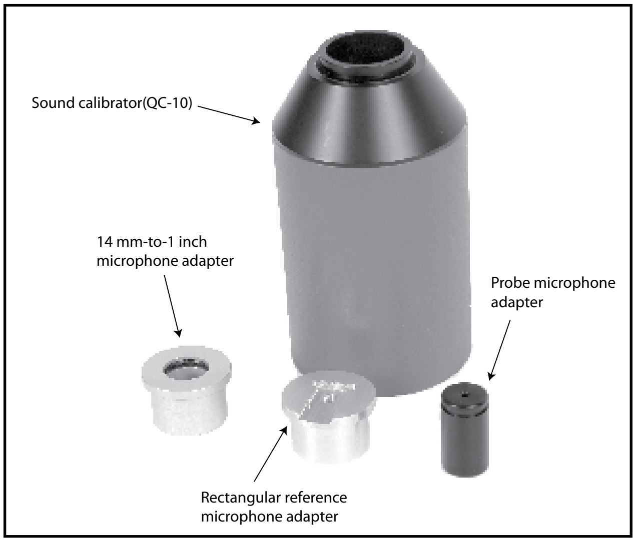


Figure 5.1: Calibration equipment

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. Adjust the "Microphone Gain" pot on the back of the 7000 so that the "Coupler microphone" reading agrees with the calibrator level.

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 Microphone."
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 5.1.2A and 5.1.2B.
9. Turn on the calibrator.
10. Adjust the "Probe Mic" pot on the bottom of the remote module so that the "Probe microphone" reading agrees with the calibrator level.

Figure 5.1.2A: Integrated probe microphone inserted into sound calibrator.

Figure 5.1.2B: Old-style 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 new style integrated probe microphone set. This microphone is not normally available on 7000 analyzers manufactured before March 2007.

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 "Reference Microphone."
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. Adjust the "Ref Mic" pot on the bottom of the remote module so that the "Reference Microphone" reading agrees with the calibrator level.

Figure 5.1.3: Rectangular reference microphone inserted into sound calibrator.

5.1.4 Calibrating the 14-mm Reference Microphone

Follow the instructions found in Section 5.1.3. However, instead of using the rectangular reference microphone adapter, use the 14-mm-to-1 inch adapter. See Figure 5.1.1.

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.

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: 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 Power Supply Board Fuse Replacement

Turn off power to the 7000 and remove the line cord. Remove the wraparound (see 6.2.1). Remove power supply board from unit (see 6.2.2.2).

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

Fuse: 1.6A / 250 V, Type F, IEC 30127-2 sheet II (Fast-Acting Type, Glass,

5mm x 20 mm).

6.2 Electronics Module

6.2.1 Removal and Replacement of the Wraparound

Wraparound Removal
The electronics module can be serviced by first removing the wraparound. Turn off the power to the 7000 and remove the line cord. Remove the eleven screws securing wraparound, located at the back (qty 5) and sides (qty 6) of the instrument. Apply light pressure to both sides of the wraparound and slide wraparound toward the back of the instrument approximately 1 inch. You may also need to apply slight downward pressure to keep entire instrument from sliding. Wrap around front lip should now be clear of bezel. Damage to bezel may occur if wraparound is not

entirely clear of bezel prior to proceeding to next step. Now, with both hands still on sides of the wraparound, lift the wraparound 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 wraparound, reverse the procedure for removal. Make sure the wraparound front lip is entirely under bezel. Install eleven screws securely.

6.2.2 Removal and Replacement of Circuit Boards

There are two types of boards in the 7000. Plug-in variety and Plug-in variety with rear connector plate. The first step in replacement of a circuit board is the removal of the wraparound. See 6.2.1 for the correct procedure.

6.2.2.1 Removal and Installation of Plug-in variety:

These board are easily removed by unplugging connectors and cables that go to them and then unplugging the board itself. These boards are served with two main bus connectors, one on top and one on the bottom. The top bus connector must first be removed. If all cables serving board are accessible, remove cable connectors from board and then unplug board from lower bus connector. If cable connectors are not easily accessible, it may be necessary to unplug the board from the lower bus and raise slightly to gain access to cable connector. The board should now be free to remove from the instrument.

When board is installed into electronics module, reverse the procedure for removal. Note that when boards are installed, the small cable connectors that go to them are color coded. Each connector has a specific color and a color dot marking one end, usually at pin number 1 of the connector. Be sure to match up the colors and the polarities of the connectors.

6.2.2.2 Removal and Installation of Plug-in variety with rear connector plate:

These boards are replaced similarly to plug-in variety boards, except two screws securing rear connector plate must first be removed. Where applicable, remove top bus connector. If all cable connectors serving board are accessible, remove cable connectors from board and then unplug board from lower bus connector. If cable connectors are not easily accessible, it may be necessary to unplug the board from the lower bus and raise slightly to gain access to cable connectors. Due to external connectors penetrating the rear panel of instrument, after initially unplugging board from lower bus, it may be necessary to offset board slightly toward front of instrument prior to lifting board vertically out of unit. Note that these boards do not have guides to restrict lateral movement. The board should now be free to remove from the instrument.

When board is installed into electronics module, reverse the procedure for removal. Note that when boards are installed, the small cable connectors that go to them are color coded. Each connector has a specific color and a color dot marking one end, usually at pin number 1 of the connector. Be sure to match up the colors and the polarities of the connectors.

6.2.3 Replacement of Bezel

Disconnect the line cord and remove the wraparound (see 6.2.1). Remove two nuts securing keyboard cable clamp and unplug keyboard cable from keyboard. Remove nut securing keyboard to ground bracket. This nut is located at top center of 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 with removing 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 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 silicone keypad material to overcompressed, the keys will not be properly vented, and key function may be compromised.

6.2.4.2 Removal of Keyboard without removing bezel.

Disconnect the line cord and remove wraparound (see 6.2.1). Remove two nuts securing keyboard cable clamp and unplug 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 silicone keypad material to overcompressed, the keys will not be properly vented, and key function may be compromised.

6.2.5 Replacement of Switched Power Entry Module

Remove the wraparound (see 6.2.1).

Remove the power cable at power entry module. Handle only the molded plastic housing of the power cable assembly - do not pull on the cable wiring to remove cable. Remove ground wire from power entry module. The power entry module is held into unit by four expanding tabs: two on top and two on bottom. The power entry module is removed by depressing the tabs and pushing the module toward the rear of the panel. A flat blade screwdriver or other tool may aid depressing tabs.

To install the new power entry module, simply insert into opening and push until flange mates with rear metal panel. Make sure fuse holder is on top. Reconnect ground lug and power cable. Note, the power cable connector polarized tab needs to be pointing up.

6.2.6 Replacement of Printer

Remove the wraparound (see 6.2.1).

Disconnect 4 cables at printer board serving printer. Remove paper roll from printer assembly. Turn instrument on 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.

6.2.7 Replacement of Switching Power Supply

Remove the wraparound (see 6.2.1).

Remove Power Output Cable, Power Connector Cable and Ground Cable from Switching Power Supply. Turn instrument on 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 short circuit may occur to switching power supply and/or instrument if screw contacts circuit board in switching power supply.

7. MAINTENANCE

For your safety, disconnect the 7000 from main power while cleaning.

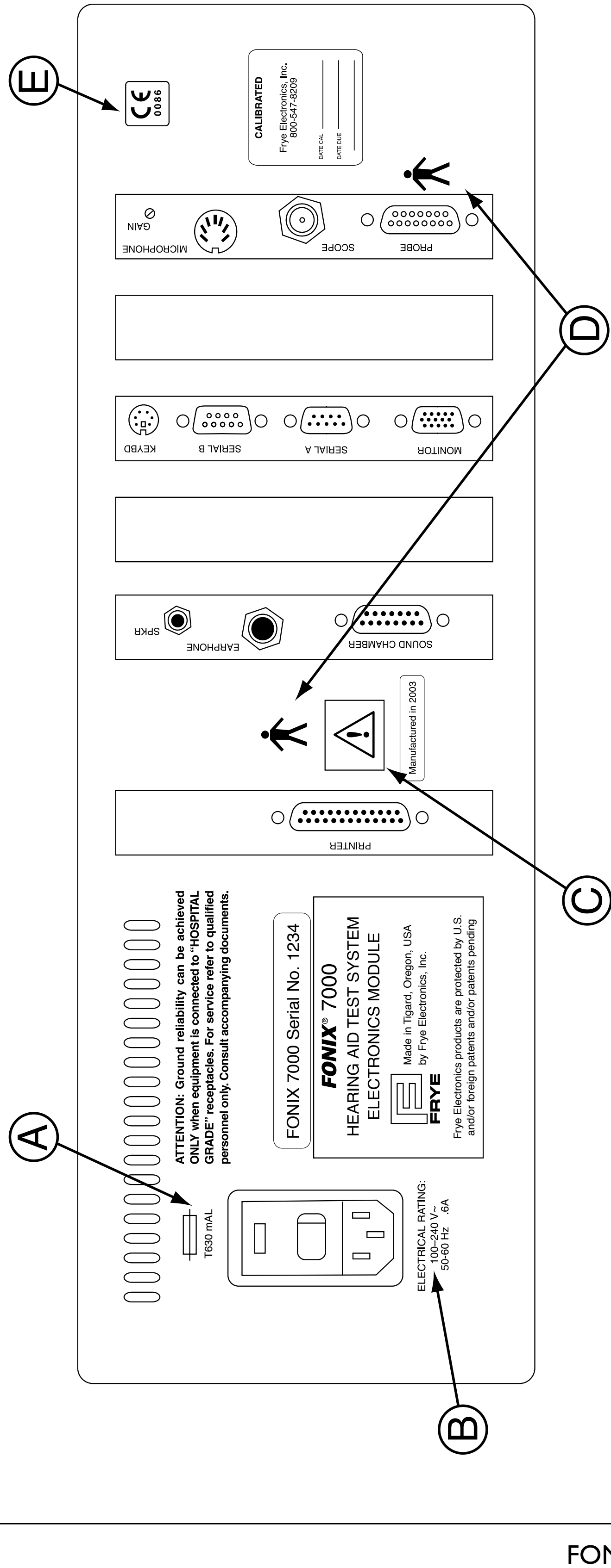
Wipe the 7000 with a slightly moist but not dripping cloth. Use plain water or water with mild dishwashing detergent. Wipe away any detergent with a slightly moist cloth, then dry the 7000.

Never allow fluid to enter:

- The 7000 Enclosure
- The 7000 switched power entry module.
- The 7000 switching power supply.
- The 7000 electrical connectors.
- The 7000 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 7000.



Rear Panel Layout

Letters identify rear panel safety markings

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 7000 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. The probe microphone and insert earphone are type B applied parts according to IEC 60601-1

(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:	Ordinary
Mode of operation:	Continuous

The 7000 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.

8.3 Connection of peripheral equipment to the 7000

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

All electrical equipment attached to the 7000, 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 60601-1-1 must not be exceeded. IEC 60601-1-1 should be consulted when assembling such a system.

8.4 Electromagnetic compatibility

The 7000 complies with IEC 60601-1-2.

The 7000 generates and uses radio frequency energy. In some cases the 7000 could cause interference to radio or television reception. You can determine if the 7000 is the source of such interference by turning the unit off and on.

If you are experiencing interference caused by the 7000, 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 7000 and the receiver.
3. Connect the 7000 to a different outlet than the receiver.

In some cases radio transmitting devices, such as cellular telephones, may cause interference to the 7000. In this case try increasing the distance between the transmitter and the 7000.

8.5 Disposal of the 7000 and accessories

The 7000 and its accessories contain lead. At the end of its useful life, please recycle or dispose of the 7000 according to local regulations.

9. Electromagnetic Compatibility

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 7000.

Cables with which the 7000 complies with IEC 60601-1-2		
Cable	**Type**	**Maximum Length (m)**
Scope	RG-58/U Coaxial	2
Serial A	9 conductor shielded	3
Serial B	9 conductor shielded	3
Sound Chamber	15 conductor shielded	2.5
Printer	25 conductor shielded IEEE 1284	2

Accessories with which the 7000 complies with IEC 60601-1-2		
Description	**Manufacturer**	**Model/Part Number**
Sound Chamber	Frye Electronics, Inc.	7020
Coupler Microphone	Frye Electronics, Inc.	M1950E
LCD VGA monitor		

Warning: The 7000 should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the 7000 should be observed for normal operation in the configuration in which it will be used.

Guidance and manufacturer's declaration – electromagnetic emissions		
The 7000 is intended for use in the electromagnetic environment specified below. The customer or the user of the 7000 should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions CISPR 11	Group 1	The 7000 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.
RF emissions CISPR 11	Class A	The 7000 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.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Guidance and manufacturer's declaration – electromagnetic immunity			
The 7000 is intended for use in the electromagnetic environment specified below. The customer or the user of the 7000 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 7000 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 7000 is intended for use in the electromagnetic environment specified below. The customer or the user of the 7000 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 7000, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	d = $1.2 \sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	$d = 1.2 \sqrt{P}$ 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.

[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 7000 is used exceeds the applicable RF compliance level above, the 7000 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the 7000.

[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 7000			
The 7000 is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the 7000 can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the 7000 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.

10. Schematics

PAGE	CIRCUIT BOARD DESCRIPTION	PART #	DRAWING #
1	7000 CPU Board, CPU Section	061-0160-XX	999-2295-XX
2	7000 CPU Board, VGA Display Interface	061-0160-XX	999-2296-XX
3	7000 CPU Board, Keyboard Interface	061-0160-XX	999-2297-XX
4	7000 CPU Board, Top Bus Interface	061-0160-XX	999-2298-XX
5	7000 CPU Board, RS232 Ports	061-0160-XX	999-2299-XX
6	7000 CPU Board, Miscellaneous Circuits	061-0160-XX	999-2300-XX
7	7000 Printer Board, Printer Section	061-0161-XX	999-2309-XX
8	7000 Printer Board, CPLD/RAM Section	061-0161-XX	999-2310-XX
9	7000 Printer Board, Printers In Section	061-0161-XX	999-2311-XX
10	7000 Printer Board, L. Bus/RS232 Section	061-0161-XX	999-2312-XX
11	7000 Power Supply Board	061-0162-XX	999-2338-XX
12	7000 Power Supply Board	061-0162-XX	999-2339-XX
13	7000 Power Supply Board	061-0162-XX	999-2340-XX
14	7000 Digitizer Connector Board	061-0165-XX	999-2343-XX
15	7000 Keyboard	061-0166-XX	999-2423-XX
16	7000 Digitizer Board, Bus Interf. & Counter	061-0023-XX	999-2429-XX
17	7000 Digitizer Board, Track/Hold & A/D	061-0023-XX	999-2430-XX
18	7000 Digitizer Board, RAM & In Port	061-0023-XX	999-2431-XX
19	7000 Digitizer Board, Out Port & Prescaler	061-0023-XX	999-2432-XX
20	7000 Digitizer Board, Speech & Alias Filter	061-0023-XX	999-2433-XX
21	7000 Digitizer Board, Battery Simulator	061-0023-XX	999-2434-XX
22	7000 Probe Interface Board, Keybd Interface	061-1089-XX	999-2437-XX
23	7000 Probe Interface Board, Output/Mic/Srce	061-1089-XX	999-2438-XX
24	7000 Probe Interface Board, Voltage Reg.	061-1089-XX	999-2439-XX
25	7000 Signal Generator Board, RAM,Counters	061-1025-XX	999-2449-XX
26	7000 Signal Generator Board, Cntrl Port, Att.	061-1025-XX	999-2450-XX

27	7000 Signal Generator Board, DAC, Smooth	061-1025-XX	999-2451-XX
28	7000 Signal Generator Board, Clck, Sgnl Gen.	061-1025-XX	999-2452-XX
29	7000 Signal Generator Board, Voltage Regs.	061-1025-XX	999-2453-XX
30	7000 Probe Preamp Board. Preamps, EQ	061-0088-XX	999-1436-XX
31	7000 Probe Preamp Board, Pwr Sply	061-0088-XX	999-2345-XX
32	7000 Mic EQ Board	061-0010-XX	999-1324-XX
33	7000 Probe Keyboard	061-0163-XX	999-2341-XX
34	7000 Probe Connector Board	061-0164-XX	999-2342-XX
35	7020 Sound Chamber Board	061-0084-XX	999-1655-XX
36	7020 Battery Simulator Board	061-0167-XX	999-2389-XX

PAGE	CABLE & WIRING SCHEMATIC	PART #	DRAWING #
37	7000 5 Circuit IDC Cable	119-0177-XX	999-2407-XX
38	7000 Keyboard Cable	119-0359-XX	999-2408-XX
39	7000 Internal Scope Monitor Cable	119-0355-XX	999-2409-XX
40	7000 14 Pin DIP Cable, 7"	119-0358-XX	999-2410-XX
41	7000 DIP to IDC Socket Cable, 18"	119-0356-XX	999-2411-XX
42	7000 1 Circuit Cable, 12"	119-0357-XX	999-2412-XX
43	7000 Upper Bus	119-0352-XX	999-2414-XX
44	7000 Lower Bus	119-0353-XX	999-2415-XX
45	7000 Power Distribution Wiring		999-2420-XX
46	7000-to-7020 Cable	119-0204-XX	999-2424-XX
47	7020 Sound Chamber Wiring		999-2445-XX
48	M400 Microphone		999-2446-XX
49	M1950E Microphone		999-2535-XX
50	Printer Wiring		999-2448-XX
51	7000/6500 Telewand Telecoil	043-1053-XX	999-2645-XX
52	7000 Probe interface board cable dist.		999-2667-XX
53	M757 Microphone	M757	999-2859-XX