ER10X Extended Bandwidth Research Probe System
Hearing Test Instrument

Operating Instruction Manual

For Research Use Only

ER·10X
EXTENDED-BANDWIDTH RESEARCH PROBE SYSTEM

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Compliance
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13485 : 0023883-00
9001 : 0023884-00

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ER036913-C

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EMAV Plus Software

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In a license agreement between the Boys Town National Research Hospital and Etymotic Research, Inc., Etymotic was granted the right to provide the EMAV Plus software to third party end users of Etymotic's ER10X OAE system.

By: Etymotic Research, Inc.

Standards Compliance

Standard	Issue Date	Title
ISO 14971	2007	Application of Risk Management to Medical Devices
ISO 10993	2009	Biological Evaluation of Medical Devices
FCC Part 15		FCC 47CFR, Part 15.247
EN 61010-1	2010	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

⚠ WARNING

NOTE: This equipment does not qualify as an audiometer on its own. If integrated into an audiometer system, the system, including this equipment, will need to be further assessed under the requirements of EN 60645-1. In particular, this equipment does not provide a non-auditory warning indication to the operator for settings above 100 dB hearing level.

Warranty

ERI warrants that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable specifications. If this instrument does not meet these criteria within one year of original shipment, it will be repaired, or at our option, replaced at no charge when returned to our service facility.

⚠ WARNING

NOTE: Changes in the product not approved by ERI shall void this warranty. ERI shall not be liable for any indirect, special or consequential damages, even if notice has been given of the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

For assistance with this ER·10X Extended Bandwidth Research Probe System contact ERI by phone at (847) 228-0006, by fax at (847) 228-6836, or email at customer-service@etymotic.com.

Intended Use

Use with human subjects should be done under the guidance of an Institutional Review Board (IRB) panel or similar review board. This instrument has no specific medical purpose and thus has not been reviewed for diagnostic purposes by the Food and Drug Administration (FDA).

The ER·10X probe system is intended to be operated primarily by researchers for human and animal studies. Some research with animals is anticipated and extended bandwidth is desired. The instrument is to be used in temperature-controlled offices, hospitals, clinics and other indoor environments.

In this manual the following two labels identify potentially dangerous or destructive conditions and procedures.

⚠ WARNING   The WARNING label identifies conditions or practices that may present danger to the subject and/or user.

⚠ CAUTION   The CAUTION label identifies conditions or practices that could result in damage to the equipment.

NOTE: Notes help you identify areas of possible confusion and avoid potential problems during system operation.

Typical Use Scenario
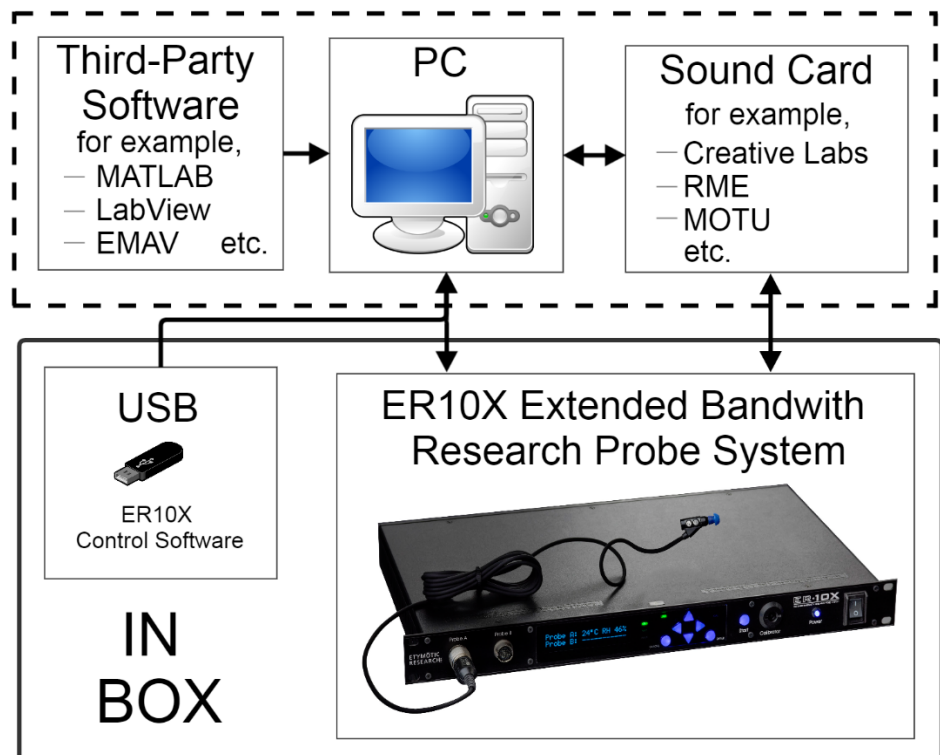
Warnings, Cautions, and Errors

⚠ WARNING

The ER·10X Extended Bandwidth Research Probe System should be powered by the AC mains with the included cable. The design is compatible with a wide range of voltages in use around the world (100 to 240 VAC, 50 to 60 Hz nominal).

No modifications of the equipment are allowed by anyone other than a qualified technician. Modification of the equipment could be hazardous and may void the warranty.

The user is advised to avoid installation and use of this instrument in proximity with other devices or equipment that may emit or be susceptible to electromagnetic interference, including mobile phones. If the instrument is used adjacent to other devices or equipment, the user is instructed to verify that no disturbance is found in the operation of this or other equipment in proximity.

Customer Responsibility

⚠ WARNING

This product and its components will perform reliably only when operated and maintained in accordance with the instructions contained in this manual, accompanying labels, and/or inserts. A defective product should not be used. Make sure all connections to external accessories are snug and secured properly. Parts which may be broken or missing or are visibly worn, distorted, or contaminated should be replaced immediately with clean, genuine replacement parts manufactured by or available from ERI.

This product should not be used in the presence of fluid that can come into contact with any of the electronic components or wiring. Should the user suspect fluids have contacted the system components or accessories, the unit should not be used until deemed safe by an ERI service technician.

Do NOT use in the presence of flammable gaseous mixtures. Users should consider the possibility of explosions or fire when using this instrument in close proximity to flammable anesthetic gases.

Do NOT use the ER·10X in a highly oxygen-enriched environment, such as a hyperbaric chamber, oxygen tent, etc.

Equipment should not be placed in any area where it would be difficult to disconnect the device (i.e. the power cord for the inlet of the control unit)

Equipment should only be used by a trained operator.

Equipment is not user repairable. Repairs must be performed by an ERI service technician only.

⚠ CAUTION	Use and store the instrument indoors only. The equipment must be operated within an ambient temperature range of 15°C to 35°C (59°F to 95°F) and in relative humidity between 30% and 90% (non-condensing).
	When rack mounting the minimum spacing clearance between equipment must be enough to allow the instrument to operate within the temperature specifications.
	Transport and store the instrument in temperatures from +5°C to 40°C (41°F to 104°F).
	Annual calibration is recommended. An ERI service technician must perform electrical safety checks on the unit in order to maintain continued compliance with applicable standards.

Safety Precautions

The following safety precautions must be observed at all times. General safety precautions must be followed when operating electrical equipment. Failure to observe these precautions could result in damage ⚠ to the equipment and injury to the operator or research subject.

The employer should instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his or her work environment to control or eliminate any hazards or other exposure to illness or injury.

It is understood that safety rules within individual organizations vary. If a conflict exists between the material contained in this manual and the rules of the organization using this instrument, the more stringent rules should take precedence.

Cautions - General

⚠ CAUTION	**If the system is not functioning properly, do not operate it until all necessary repairs are made and the unit is tested and calibrated for proper functioning in accordance with ERI published specifications.**
②	Use only the single-use eartips designed for use with this instrument.
	Never insert the probe tube into the ear canal without affixing an eartip.

The eartips are disposable and for single-use only. Do not clean or reuse eartips.

Do not drop or otherwise cause undue impact to this instrument. If the instrument is dropped or otherwise damaged, return it to the manufacturer for repair and/or calibration. Do not use the instrument if any damage is suspected.

Warning - Electric Shock Hazards

WARNING **Do not open the case of the ER·10X Instrument while the instrument is energized.**

The ER·10X system requires a supplemental ground connection to ensure safe operation. The ground lug on the rear of the system marked with a circled ground symbol must be connected as shown in *Figure 1* below before commencing use of this instrument. The terminal must be securely connected to an acceptable earth ground with a No. 16 or larger *insulated* copper conductor which is supplied. This wire must be Green or Green with a Yellow stripe. This wire must be permanently installed; a detachable ground is not acceptable or safe. The standard ring connector will be connected to the ground lug on the rear of the system. The oblong ring terminal connector will fit a #6, #8, or #10 size screw.

To Control Unit   To Ground
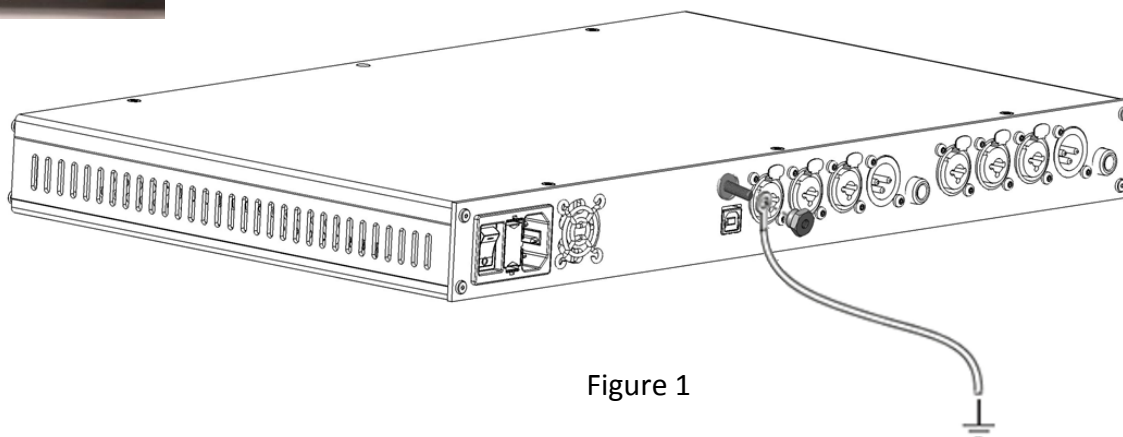
Figure 1

Warning - In Case of Emergency

In case of emergency, disconnect the instrument from the power supply by removing the power cable from the IEC connector as shown in Figure 2 on page 8.

Warning - Explosion

WARNING

This system is not explosion proof. Do not use in the presence of flammable anesthetics or other gases.

Warning - General
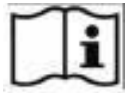
Proper use of this instrument depends on careful reading of all instructions.

Regulatory Symbols

No.	Symbol	IEC Pub.	Description
	SN	980 & 60601-1	Serial Number
		980 & 60601-1	Caution, Consult Accompanying Documents
		980 & 60601-1	Return to Authorized Representative; Special Disposal Required
		980 & 60601-1	Consult Operating Instructions
		60601-1	Keep Dry
		60601-1	Transport and Storage Temperature Range
		60601-1	Electrical Shock Hazard
			Single-Use

Introduction

The purpose of the ER·10X extended bandwidth research probe system is to allow for low-noise otoacoustic measurement over a larger bandwidth used for diagnostic evaluation of the middle and inner ear components of hearing. This system will produce well-calibrated, high-quality acoustic stimuli that covers the full frequency range of human hearing, including the highest frequencies that activate the part of the cochlea most easily damaged by ototoxic drugs, noise and the normal process of aging. The microphones and sound sources in the probes will allow accurate presentation of acoustic stimuli or measure the acoustic emissions generated by the inner ear.

System Overview
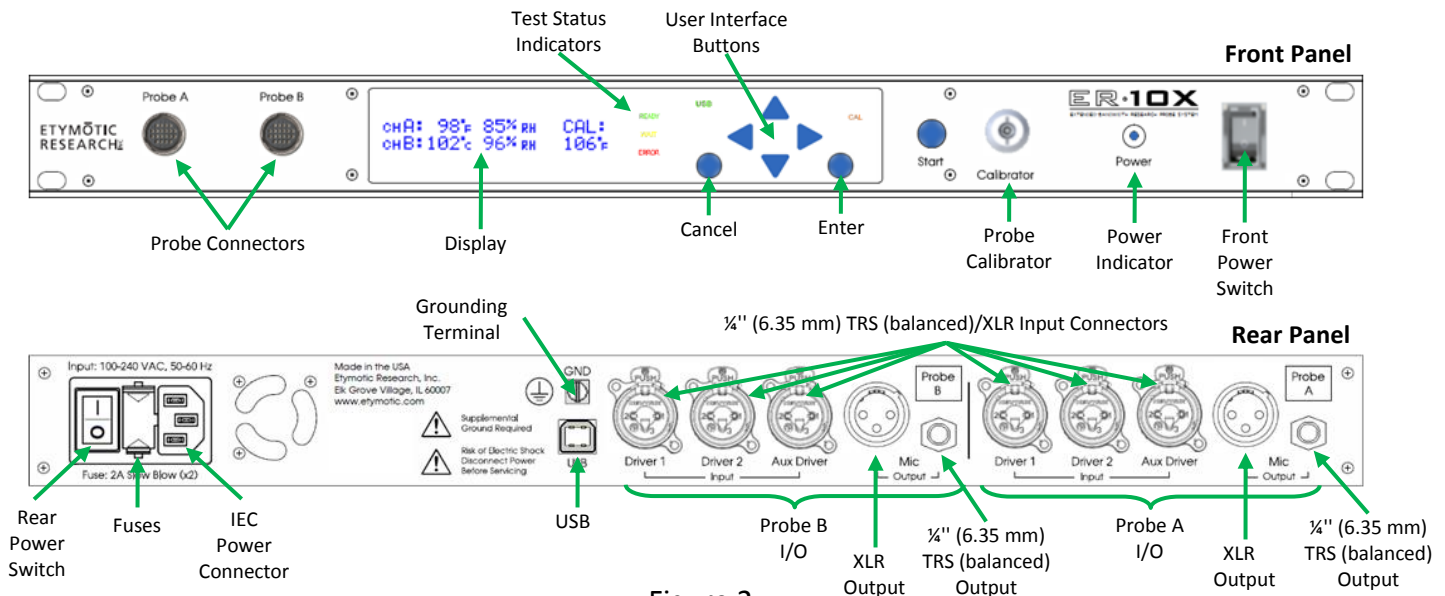
Figure 2

The system consists of the control unit, probe, single-use eartips, replaceable probe tubes and other accessories. The ER·10X instrument contains the hardware and software to elicit test stimuli. The rack-mountable chassis contains circuit boards that provide the signal processing and display probe information. The instrument uses a 2x20 organic light-emitting diode display (OLED) and six light-emitting diodes (LEDs) to provide a visual display of the status to the operator. Seven tactile-type, LED illuminated push buttons located on the front of the instrument allow the user to control testing.

The probe houses 3 receivers, a microphone, combination I2C humidity/temperature sensor, backup thermistor, and a variable-power heating element. The probe is meant to be used to produce test stimuli and measure the sound pressure level (SPL) present in the sealed ear canal. Interface of the instrument to the ear canal is accomplished through eartips, which fit onto the probe tube. The eartips are color coded to facilitate easy selection by size.

⚠ WARNING

This equipment should be checked prior to any contact to the testing subject related to the volume control for the external source feeding the console to ensure that no possible hearing damage can be caused. Low outputs should be set before connecting equipment to the subject.

Features of the ER·10X Extended Bandwidth Research Probe System

The intent of this new probe system is to enhance the performance and capabilities of the current ER-10B+ and ER-10C probe systems and expand capacity in the following areas:

- Extended operating bandwidth beyond 20 kHz
- Extended dynamic range
- Reduced noise and distortion artifacts
- Reduced electrical and acoustic crosstalk
- Add a Thévenin source calibrator to facilitate forward pressure and reflectance measurements
- Integrated probe temperature control
- Integrated calibrator temperature control for those equipped with a heating element
- 2 channel controller system
- Probe includes three receivers with independent drive electronics

Sensitivity and Specificity

Sensitivity and specificity of test results with this type of instrument are based on the test characteristics defined by the user, and may vary depending on environmental and operating conditions.

⚠ CAUTION

NOTE: Noise generated by the calibrator motor can affect the measurement. The sound pressure level emitted by the control unit in the ambient environment with just the motor running is 59 dBA at 1 meter, 65 dBA at 12 inches from the enclosure. The distance is from the control unit and not the sound output at the earpiece of the probe.

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Inputs and Outputs

Driver Input

The ER·10X has 6 inputs as combination female ¼'' (6.35 mm) TRS (balanced)/XLR connectors available on the back panel. Three inputs feed to the drivers of probe A and the other three inputs feed to the drivers of probe B.

XLR Connections

Female   Male

Figure 3

Pin	Function
1	Chassis Ground (Cable Shield)
2	Positive Polarity Terminal (Balanced Audio)
3	Negative Polarity Terminal (Balanced Audio)

Microphone Output

The ER·10X has 2 outputs as male XLR connectors or separate ¼'' (6.35 mm) TRS (balanced) jacks available on the back panel. Separate TRS outputs are provided only for configurability. A TRS output should not be used at the same time as the XLR output for the same channel. One of the outputs feeds from probe A and the other feeds from probe B.

¼'' (6.35 mm) TRS (balanced) Plug

Tip

Ring

Sleeve

ER·10X Probe

The ER·10X has 2 probe connections using a custom Hirose 20-pin connector on the front panel. The probes are designated A and B.

USB Connection

The ER·10X has a USB connection to interface with the PC application and/or ER·10X libraries.

Figure 4

TRS Pin	Equivalent XLR Pin	Function
Tip	2	Positive Polarity Pin
Ring	3	Negative Polarity Pin
Sleeve	1	Ground Pin (Shield)

Setup

Figure 5

Unpacking the System

The following is a list of parts shipped with each ER·10X system.

(1) Control Unit
(1) Probe Kit
(1) AC Power Supply Cable (US)
(1) AC Power Supply Cable (Europe)
(2) XLR Male to ¼'' (6.35 mm) TRS Cable
(1) XLR Female to ¼'' (6.35 mm) TRS Cable
(1) USB A-to-B Cable, 2m (6 foot)
(1) Ground Cable
(1) Box of Single-Use Eartips
(1) Hex Screwdriver
(1) GRAS Coupler Adapter

(1) Calibrator Adapter for Probe Eartip (Figure 9)
(1) USB Flash Drive (Includes Operating Instructions and PC Software)
(1) User Manual

Probe Kit:
(1) Probe
(1) Microphone Shaft Screw
(1) Package of Probe Tubes
(1) Shirt Clip

Sanibel Silicone Eartips Sample Kit contains 130 tips total (various sizes: 3mm to 15mm). [3-5mm, 4-7mm, 7mm, 8mm, 9mm, 10mm, 11mm, 12mm, 13mm, 15mm]

If any parts are missing, contact your special equipment distributor or ERI by phone at (847) 228-0006 during normal business hours or by email at customer-service@etymotic.com. We recommend that you save the shipping box and packing materials in case you need to store or ship the system.

Optional accessories for the ER·10X include an additional probe, probe tubes, and replacement eartips. An additional probe may be ordered from Etymotic Research, Inc. Probe tubes and eartips may be ordered directly from Sanibel Supply at https://www.sanibelsupply.com.

Installing the Control Unit

Select either an area on a table top or an empty rack slot to install the system hardware. The target location must be level, clear of debris, near a free power receptacle, and provide easy access to the front and rear of the system. Place the control unit in the selected area and mount the hardware in place if applicable.

Ensure that both the front and rear POWER switches are in their off (down) positions. Firmly insert the socket of the power cable into the IEC power connection on the rear of the control unit. Firmly insert the plug end of the power cable into the nearest power receptacle which provides AC power at between 100 and 240 VAC at 50 to 60 Hz. Ensure that the system is properly grounded, and then flip the rear POWER switch to the on (up) position.

⚠ WARNING	Discontinue use if AC power cable is damaged. To maintain the safety approvals of the system, replace the damaged AC power cable with one that meets all applicable safety standards and has appropriate regulatory approvals.
⚠ CAUTION	Ensure that the power cable is installed in a location which does not impede walking traffic and is not pinched or bent by surrounding equipment or structures.
⚠ CAUTION	**Risks when rack mounting the equipment.** When installing the equipment in a standard 19-inch rack, consider that during operation, the ambient temperature, the mechanical loading and the electrical potentials will be different from those of devices which are not mounted into a rack. • Make sure that the ambient temperature within the rack does not exceed the permissible temperature limit specified on page 5. • Ensure sufficient ventilation; if necessary, provide additional ventilation. • Make sure that the mechanical loading of the equipment is horizontal with the top side up and is level. • When connecting to the power supply, observe the information indicated on the type plate. • Avoid circuit overloading. If necessary, provide overcurrent protection. • Maintain a minimum clearance of 3 inches on the front and back sides of the chassis for the cooling air inlet and exhaust ports, respectively. • Excess heat in the rack may cause the calibrator of the control unit to exceed the heater set-point. No cooling means are available for the calibrator or probes.
⚠ CAUTION	**When rack mounting, have another person hold the equipment in the rack while you secure it using 4 standard rack mount screws (not provided).**

Installing the Probe

Turn off the ER·10X system, and then insert the probe connector into the socket on the front of the control unit (Figure 6). The plug will fit in only one direction. It will snap in place when inserted properly. To remove the probe, shut off the ER-10X system, and then pull backwards on the knurled connector shell. Take note that the system can handle hot swapping probes, but this is not recommended.

Figure 6

⚠ CAUTION

Misalignment of the plug and socket can cause damage. The plug and socket should be visually inspected prior to each installation of the remote probe. If damage is observed, contact ERI.

Attaching Eartips
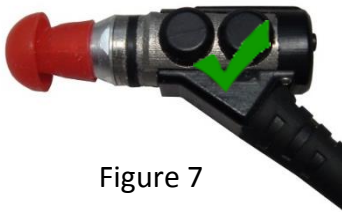
Figure 7

Figure 8

The ER·10X instrument comes with a supply of single-use eartips that fit a variety of ear canal sizes. The probe tube must have an eartip attached before inserting it into an ear canal. The determination of the appropriate eartip size should be made by persons with proper training and experience. The eartip must seal to the ear canal. Best test results are obtained when the eartip is inserted deeply into the ear canal instead of flush with the ear canal opening. Caution must be taken, however, to ensure that the eartip does not extend too deeply into the ear canal. Use only the eartips approved for use with the instrument. The eartips are disposable and should be replaced after each use.
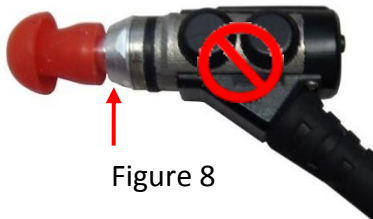
After selecting an eartip, push it onto the probe tube until it is flush against the base of the probe tube (*Figure 7*). Twisting the eartip slightly while pushing it onto the probe is recommended. Be sure the eartip is fully seated on the probe. There should be no gaps between the eartip and the collar of the probe head.

To remove the eartip, grasp the eartip at the base and twist it while pulling it straight off the end of the probe tube. Grasping the base of the eartip will prevent the probe tube from being inadvertently pulled out of the probe head along with the eartip.

NOTE: If the probe tube becomes dirty or clogged, it must be replaced. See the section Probe Tube Replacement on page 36 for further information.

Removing the Calibrator Adapter

To remove the calibrator adapter, use a coin to align the slot shown in Figure 9 to the horizontal position. This should unlock the adapter from the front panel of the ER·10X instrument.

Figure 9

Control Unit Operating Instructions

Preparing the Subject for Testing

Otoscopic examination of the subject's ear canals should be performed prior to testing. Excessive cerumen or vernix in the ear canals may interfere with the test and give invalid or incomplete results. Subjects with excessive cerumen, debris, or foreign bodies in the ear canals should be referred to an audiologist or physician for removal of the blockage prior to testing.

Place the subject in a position that will allow easy access to the ear canal. Use the shirt clip to secure the probe, limiting probe movement. The subject should remain still and quiet while the test is performed.

Turning On the Instrument

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Display 1

To turn on the ER·10X instrument, actuate the POWER switch located on the front panel (see Figure 2 on page 8). The power indicator light will remain on when power is being supplied to the hardware. The Splash Screen (*Display 1*) will appear briefly. All LEDs will remain on as the splash screen is displayed. Once the splash screen is no longer visible, all indicator LEDs will enter their normal operating states.

NOTE: To turn off the instrument simply flip the POWER switch to the off position.

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Indicator LEDs (lights)

The following table explains each LED function during normal operation of the hardware. This does not include when the system is booting or when the system is in firmware update mode. For all indicators, assume that neither the on condition nor the blinking condition are met when the indicator light is off.

Label	Color	Description	When On	When Blinking
ERROR	Red	Indicates error conditions	System error occurred	N/A
WAIT	Yellow	Indicates when the system is performing a requested action	System is performing a requested action	Probe or calibrator has spent more than 30 seconds cooling to set-point
READY	Green	Indicates when system is ready for use	Instrument is not currently performing an action and also not in an error state (when ERROR and WAIT are both off)	N/A
USB	Green	Indicates when a host system is attached to the USB interface	Host system is attached to the USB interface	Command received from attached host
CAL	Amber	Indicates when the calibrator has been moved or is moving to position	Calibrator piston is stopped at a position other than the minimum	Calibrator piston is currently moving
START BUTTON	Blue or Amber	Button backlight used to illuminate button and indicates when the calibrator is warming/cooling to set-point temperature	Button is not pressed & **Blue:** Calibrator heater is off or calibrator temperature has reached set-point **Amber:** Calibrator is either warming or cooling to set-point.	N/A
UP, DOWN, LEFT, RIGHT, ENTER, and CANCEL BUTTONS	Blue	Button backlights used to illuminate buttons	Button is not pressed	N/A

User Settings

The following lists the user changeable settings on the control unit. These settings may be changed directly on the hardware or from a PC through the USB interface.

Heaters

Each probe contains a heating element. Calibrators which contain temperature control circuitry will also contain a heating element. The heaters of each connected probe and calibrator may be independently controlled. The heaters for probe B and the calibrator may be configured to match the set point of probe A.

Each heater set point may be set to *off* or a value between 26.7°C and 40.6°C (80°F and 105°F). The power output of each heater is determined using Proportional-Integral-Derivative (PID) control algorithms. The input used for the probe PID controller is the output of the combination I2C temperature/humidity sensor. The temperature measured from the backup thermistor of the probe is only used as a failsafe to shut off the heater if the I2C sensor ever malfunctions. The input used for the calibrator PID controller is the computed average of the front and rear calibrator temperatures. The temperature of the probes and calibrator are considered to be at the heater set point when the temperature reaches within +/- 0.56°C (+/- 1.0°F) of the set point with hysteresis of 0.28°C (0.5°F).

> **NOTE:** Probe heaters will not be active while Probe Measurement Refresh Rate is set to manual.

> **NOTE:** The fan of the ER·10X system will turn on at full power while the calibrator needs to cool to the selected set point.

Microphone Gain

The microphone gain on the plugin module may be set to between 0 and 40 dB in 1 dB steps. See the microphone path block diagram in Appendix C.

> **NOTE:** The probe microphone will not be powered until the control unit detects and connects to the probe.

Microphone Response

The plugin module contains separate electrical paths for 3 different passive filters: high pass, flat, and custom. These electrical paths are selected using mechanical relays on the plugin module. The custom path is not populated by the factory, so it is up to the user to have components soldered into that path; otherwise, this path will remain open. See the microphone path block diagram in Appendix C for information on the filter construction.

> **NOTE:** There will be no microphone signal output if the custom response setting is selected and the custom filter components have not been populated.

Output Limiter

Each driver is attenuated by about 15 dB using 150 ohm resistors when the output limiter is enabled. A confirmation is always provided when the output limiter is disabled and also on each subsequent boot of the system thereafter until the output limiter is enabled. The confirmation is to ensure that the user is conscious that the receivers are being driven at their full potential. Mechanical relays within the plugin module short each 150 ohm resistor once the output limiter is disabled and confirmed. See the driver path block diagram in Appendix C for information on the output limiter construction.

Probe Measurement Refresh Rate for Temperature and Humidity

The refresh rate may be set to every 0.5 seconds (automatic fast), every 2.5 seconds (automatic slow), or on manual trigger. The reason for this setting is to be able to reduce the risk of noise being added to the analog signal of the probe due to the serial communication. The automatic fast setting runs the serial communication at its fastest speed of 35 kHz. This is recommended if serial communication noise is not apparent in acoustic measurements. The automatic slow setting slows the serial BAUD rate to 50Hz, which may help to reduce noise while still providing measurements and allow the probe heater to function. The manual setting will eliminate the serial signal when measurements are not being manually triggered and thus eliminate the potential serial communication noise. However, the probe heaters will be disabled when the manual setting is selected.

> **NOTE:** This setting does not affect how often the temperature of the probe thermistor is measured. The probe thermistor is always measured once every 0.5 seconds. This temperature value is not presented anywhere on the front panel display, but is provided over the USB interface. The ER·10X System Control application for PC contains a measurement logging feature which captures these data. The probe thermistor measurements are not considered to be as accurate but may have some value while manual measurements are enabled.

Positions

There are three sets of calibrator positions stored on the memory of the ER·10X control unit. Group 4 provides 4 positions, group 5 provides 5 positions, and group 6 provides 6 positions. Each group contains a set of distinct positions, so a total of 15 positions are stored in memory. These positions are used to create cavity sizes in the calibrator tube during the calibration sequence.

Display Units

The temperature display unit may be set to either Celsius or Fahrenheit. The calibrator display unit may be set to Millimeters, Inches, or Cubic Centimeters. The bore diameter calibration stored in system memory as Inches is used to determine values in Cubic Centimeters. By default, this value is 0.3125 Inches.

Buzzer

The control unit contains a buzzer capable of creating a tone at a static volume. This buzzer may be set to on or off. When turned on, the buzzer creates a click sound on each hardware button press and beeps twice on system error. The buzzer is silenced when turned off.

Control Panel

The ER·10X instrument uses 7 buttons to control all functions of the instrument (Figure 10). These buttons are arranged in a directional cursor format (←LEFT, →RIGHT, ↑UP, ↓DOWN, START, ENTER and CANCEL).
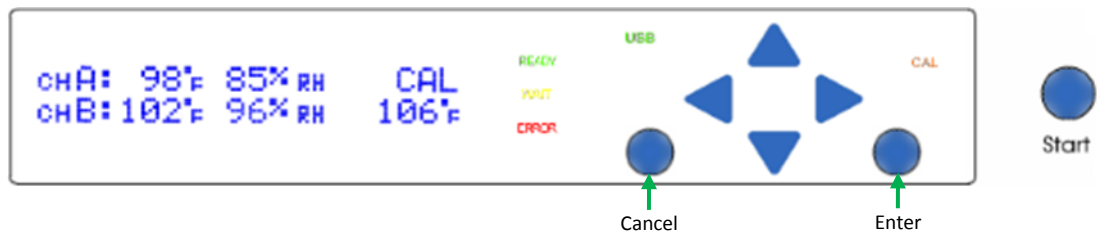
Figure 10

Calibrator Tuning

Display 2

The Calibrator Tuning initialization process (*Display 2*) is executed after the boot sequence is completed, following the splash screen. Calibrator tuning will also execute upon user request. If the tuning process is unable to locate the Home Position, then an error message will be shown. See Appendix E for more information on system error messages. If the tuning succeeds and no other system errors are present, the display will advance to the Main Menu.

Control Unit System Menu

The OLED display of the control unit will display the system menus when calibrator is not moving and system error is not being displayed. Refer to Appendix B for the System Menu Flowchart. Use the ←LEFT or RIGHT→ arrow buttons to parse the different menus. Pressing the CANCEL button will always cancel any uncommitted changes and bring the instrument back to either the previous menu or the main menu. Where applicable, press the ENTER button to enter a sub-menu. Within a sub-menu, use the ←LEFT or RIGHT→ arrow buttons to parse through the different items, ↑UP or ↓DOWN buttons to change the value of the selected item (hold to increment or decrement faster in some sub-menus), or ENTER button to commit all values. When in any system menu item, pressing the START button initiates a calibration sequence. Pressing START+↑UP will begin the Calibrator Tuning process.

Main Menu

`CH A: 23°C 46%RH          CAL`
`CH B: -----------         22°C`

Alternate Text
(when applicable)
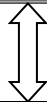
`Calibrator Location`
`         70.21mm`

Display 3

The attached probe status and calibrator temperature are shown on the Main Menu (*Display 3*). The temperature and relative humidity of each connected probe will be displayed. The calibrator temperature on the right will not be shown if the calibrator is not equipped with temperature control circuitry. If the calibrator piston is stopped at a location other than the minimum, alternate text showing the current calibrator position will display every 2 seconds. Pressing the ENTER button while this menu is visible will both trigger a manual measurement and refresh probes which have entered an Error state.

One of the following will display if the temperature and relative humidity are not visible.

- `-----------`: Plugin module is not installed for the given channel
- `Not Present`: Plugin module is installed, but probe is not sensed
- `Connecting`: Probe is attached, and the connecting process is executing
- `No Cal`: Attached probe contains invalid or corrupt calibration data
- `Unsupported`: Firmware may need to be updated to use the attached probe
- `Mismatch`: Mismatch between probe and plugin module; serial numbers must match if probe and plugin module have been matched at the factory
- `Error XXX`: Attached probe experienced an error; a three character error code is provided (see Appendix D for error code description)
- `Bad Mod XXX`: Plugin module experienced an error; a three character error code is provided (see Appendix D for error code description)

NOTE: The displayed measurements for the probe and calibrator may be up to 10 seconds old.

Calibrator Temperature Menu

`Calibrator Temp`
`Front: 21°C Rear:  23°C`

Display 4

If the calibrator is equipped with temperature control circuitry and no calibrator error has occurred, the temperature of the front and rear calibrator sensors are displayed on this menu (*Display 4*). The average of these two temperatures are displayed on the Main Menu (*Display 3*). The bottom line will show "Not Equipped" if there is no temperature control circuitry in the installed calibrator. The bottom line will show "Error:" followed by a 3-character error code if an error occurred with the calibrator. See Appendix D for more information.

Probe Heater Menu

```
Probe Heater
A: 26.7℃  B:  35.6℃
```
Display 5

The probe heater set-points are shown on this menu (*Display 5*). The probe heater may be set to off, or set to a temperature between 26.7°C and 40.6°C (80°F and 105°F). Probe B may also be configured to match whatever value set for probe A. Press ENTER to set the probe heater temperatures.

Calibrator Heater Menu

```
Calibrator Heater
  Match Probe A
```
Display 6

The calibrator heater set-point is shown on this menu (Display 6). The bottom line will show "Not Equipped" and this heater value cannot be changed if there is no temperature control circuitry in the installed calibrator. Otherwise, the calibrator heater may be set to off, matched to the set-point of probe A, or set to a temperature between 26.7°C and 40.6°C (80°F and 105°F). Press ENTER to set the heater temperature.

Microphone Gain Menu

```
Mic Gain
A: 20dB    B:  40dB
```
Display 7

The microphone gain is shown on this menu (*Display 7*). The gain can be set between 0 and 40 dB. Press ENTER to set the gain.

Microphone Response Menu

```
Mic Response
A: HiPass B: Flat
```
Display 8

The microphone response settings are shown on this menu (*Display 8*). The mic response for each probe can be set to High Pass, Flat, or Custom. Press ENTER to set the microphone response.

Output Limiter Menu

```
Output Limiter
  Enabled
```
Display 9

The output limiter setting is shown on this menu (Display 9). This value may either be enabled or disabled. Press ENTER to set the output limiter.

NOTE: A confirmation will be shown once the output limiter is disabled. This same confirmation will be shown on each subsequent boot of the hardware. Press ENTER on the confirmation to disable the output limiter or CANCEL to keep the output limiter enabled.

Probe Measurement Refresh Rate Menu

```
°C/RH  Refresh Rate
 Auto, Fast - 0.5 s
```
Display 10

The probe measurement refresh rate is shown on this menu (Display 10). This value may be set to automatic-fast, automatic-slow, or manual. Press ENTER to set the probe measurement refresh rate.

NOTE: Manual measurements may be triggered by pressing ENTER while the Main Menu is visible.

Calibrator Positions Group Menu

```
Positions Group
 5 Positions
```
Display 11

The calibrator positions group is set using this menu (*Display 11*). This allows the selection of 4, 5, or 6 positions. Press ENTER to set the positions group.

Calibrator Position Menu

```
Calibrator Positions
Press Enter to Set
```
Display 12

Calibrator position are set though this menu (Display 12). Press ENTER to set the positions of the selected group.

Temperature and Calibrator Units Menu

```
Selected Units
Temp: °C  Cal: mm
```
Display 13

The Temperature and Calibrator units are shown on this menu (*Display 13*). The Temperature units can be either °C or °F. The Calibrator units can be one of Millimeters (mm), Inches (in), or Cubic Centimeters (cc). Press ENTER to set the temperature and calibrator units

Buzzer Control Menu

```
Buzzer Control
 On
```
Display 14

The Buzzer Control setting is shown on this menu (*Display 14*). This value may either be on or off. Press ENTER to show the Buzzer Control set menu.

Hardware Information Menu

```
Hardware Information
CTRL: 1512999
```
Display 15

The ER·10X controller serial is shown on this menu (*Display 15*). Press ENTER to show more hardware information details such as probe and module serial numbers, probe service dates, and module revision numbers. Use the ←LEFT or RIGHT→ arrow buttons to parse though this information.

Firmware Information Menu

```
ER10X Probe System
Version 1.00.00
```
Display 16

The controller firmware version number is shown on this menu (*Display 16*). Press ENTER to show more version details. Use the ←LEFT or RIGHT→ arrow buttons to parse though system build date, module firmware versions, and calibrator firmware version.

System Status Menu

```
System Status
  Ready
```
Display 17

The current system status is displayed on this menu (*Display 17*). There are three possible conditions: Ready, Waiting, or Error.

Press ENTER to bring up a list of system errors, if any. Parse through the errors by pressing the ←LEFT or RIGHT→ arrow buttons. The text "No system errors detected" will show if no system errors are present.

Calibration Sequence

The calibration sequence allows for moving the calibrator to all the positions in the selected group from the hardware. The calibrator cannot be accessed through the USB interface while this sequence is executing. Press the START button while any one of the System Menus is visible to begin the calibration sequence. Press the CANCEL button at any time when the calibrator is not moving to immediately exit out of the calibration sequence.

Initial Calibration Sequence Screen

```
Calibration   13.97mm
Press Enter for Pos1
```
Display 18

This is what is shown right after the START button is first pressed (*Display 18*). The value in the upper right is the current location of the calibrator in the selected calibrator unit. Press the ENTER or START button to move to the first position.

Calibration Sequence Moving Screen

```
Calibration.. Moving
Position 1,   70.21mm
```
Display 19

This is what is momentarily shown as the calibrator piston is moving to position (*Display 19*). The bottom line shows to which position index the calibrator is moving and the location for that position index in the selected calibrator unit.

Calibration Sequence at Position Screen

```
Calibration   70.21mm
     At Position 1
```
⇕
```
Calibration   70.21mm
Press Enter for Pos2
```
Display 20

This is what is shown after the calibrator piston has reached a position (*Display 20*). This is similar to the Initial Calibration Sequence Screen, but the bottom line will alternate showing that the calibrator is at a position. Press the ENTER or START button to move to the next position.

Calibration Sequence Final Position Screen

```
Calibration   31.50mm
     At Position 5
```
⇕
```
Calibration   31.50mm
Press Enter for Min
```
Display 21

```
Calibration.. Moving
    Back to Minimum
```
Display 22

This is what is shown once the calibrator piston has reached the final position in the selected group (*Display 21*). Pressing the ENTER or START button here will begin the process of moving the calibrator to the minimum location. The text in *Display 22* will be shown as the calibrator is moving back to the minimum location. Afterwards, the display will go back to showing the System Menu.

PC Software Operating Instructions

Installation Procedure

The PC software is located on the included flash drive. The latest released version may be downloaded from http://www.er10x.com. Follow the instructions in Appendix F in order to install the ER·10X PC Control Software.

Opening Software

Open the "ER10X Control" software suite by either double clicking the shortcut created on the desktop or click on the link created in the start menu under the folder labeled "ER10X".

Instrument Select
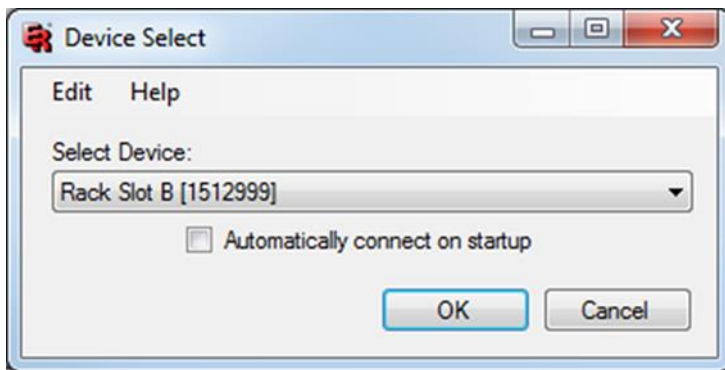
Figure 11

The user will be prompted to select the control unit (*Figure 11*). When selecting an instrument, the previously set instrument label will be shown, if any, along with the serial number of the control unit in brackets.

If the box "Automatically connect on startup" is checked when clicking OK, the "Device Select" prompt will not be shown on the next startup if the selected device is attached.

Edit Controller Label

Figure 12

The control unit label can be changed by selecting EDIT→CHANGE LABEL for the selected instrument. An input box as seen in *Figure 12* will then be displayed. The entered label will be saved on the PC and tied to the serial number.

ER·10X System Control

The system control window (*Figure 13*) is displayed once an instrument is selected. Refer to *Figure 13* for the following items.
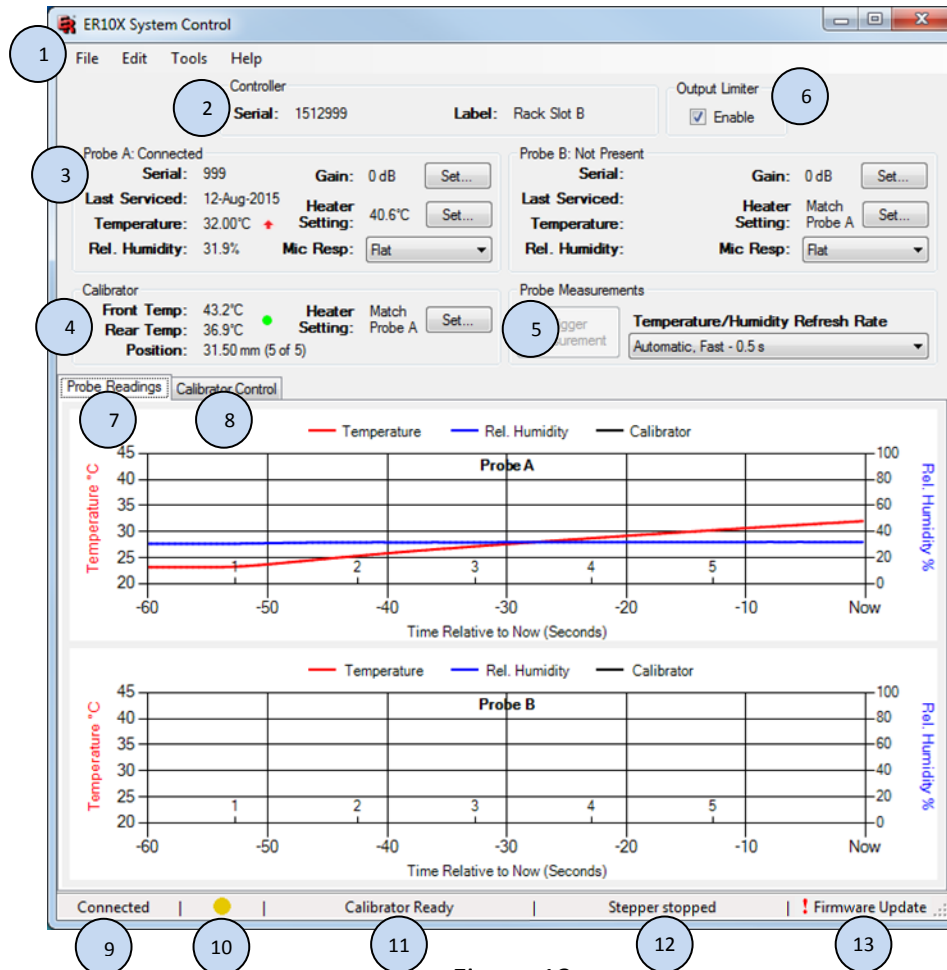
Figure 13

(1) Menu Bar

File Menu

- *Select Another System…*: This allows a different ER·10X system to be selected. The Instrument Select dialog window (*Figure 11*) will pop up after selecting this.
- *Start Measurement Log…* or *Stop Measurement Log*: See the section entitled Measurement Logging on page 30 for more information.
- *Exit*: Exits the application.

Edit Menu

- *Temperature Unit*: The temperature unit displayed for measurements and settings within the application may be changed here. The temperature unit may be set to Celsius or Fahrenheit. This will not set the selected temperature unit on the hardware.

- *Calibrator Unit*: The length or volume unit displayed for the calibrator within the application may be changed here. The calibrator unit may be set to Millimeter, Inch, or Cubic Centimeter. This will not set the selected calibrator unit on the hardware.
- *Position Value*: The position values of the currently selected positions group may be changed here.
- *Change Controller Label…*: The saved label for the selected ER·10X controller may be changed here. The Edit Controller dialog window (*Figure 12*) will pop up after selecting this item.
- *Chart Visibility*: This allows one or both probe charts to be visible under the Probe Readings tab.
- *Chart Series Style*: This sets the series style (aka line style) for the temperature and relative humidity lines shown in the charts under the Probe Readings tab.
- *Chart Time Range*: This sets the amount of time visible on the X axis of the charts under the Probe Readings tab.
- *Chart Time Format*: This sets the time format of the X axis labels for the charts under the Probe Readings tab.
- *Chart Time Reference*: This sets the time reference of the X axis for the charts under the Probe Readings tab. When "Time Relative to Now" is selected, the right most X value will be labeled as "Now" and all other time values will be negative, counting up to 0. When "Timestamp" is used, the X axis will show absolute timestamp values as given by the hardware.

Tools Menu
- *Export Settings…*: Selecting this item will show a save file dialog window where all selected settings may be exported to an ini file.
- *Import Settings…*: Selecting this item will show an open file dialog window where a previously exported settings ini file may be loaded and set. Take note that the buzzer setting may not be changed over the USB interface, so this value will not be set. The temperature and calibrator units only set on the application and cannot be changed on the hardware through the USB interface as well.
- *Reset Settings to Defaults*: Selecting this will set all hardware settings back to their factory defaults after OK is selected on the confirmation dialog.
- *Firmware Management*: See section entitled Updating Control Unit Firmware on page 32 for more information.

Help Menu
- *About*: Selecting this will pop up an about box describing this application and provides information about the connected hardware.

(2) Controller Information

The group box labeled Controller near the top of the window shows the selected controller serial and label.

(3) Probe Control

The group boxes labeled Probe A and Probe B show each probe connection status, serial, last service date, current measurement, and the selected settings. If firmware version 1.2.0 or greater is loaded onto the hardware, one of the following icons will be visible next to the probe temperature when the heater is enabled.

Probe is warming to set point

Probe is at set point

Probe is cooling to set point

(4) Calibrator Temperature and Position

The group box labeled Calibrator shows the current calibrator temperature and position. The calibrator temperature labels and heater setting will show "N/A" if the installed calibrator does not contain a heater element. An icon next to the temperature similar to those seen in the Probe Control (above) may be visible when the calibrator heater is enabled. A position index will be provided when the calibrator is at one of the positions within the selected positions group. The label will show "(min)" or "(max)" when the calibrator is at the minimum or maximum limits.

(5) Probe Measurements

The group box labeled Probe Measurements give the controls for when probe measurements are made. The combo box labeled "Temp/RH Refresh Rate" lists the selectable measurement rates. See the note under Probe Measurement Refresh Rate Menu. The Trigger Measurement button will become enabled when manual refresh is selected. Clicking this button will trigger the next manual temperature and humidity measurement for any attached probe.

(6) Output Limiter Control

The group box labeled Output Limiter provides a check box to enable or disable the probe driver output limiter. A confirmation dialog will show if this checkbox is unchecked.

(7) Probe Readings Tab

The current and past received probe measurements are plotted under the Probe Readings tab. Tick marks at the bottom of each chart represent events when the calibrator has reached its target. A number (1 to 6) will be given above these tick marks when the calibrator has reached a position within the selected positions group. Right click a chart to display the chart controls menu, which provides a subset of items given under the Edit menu pertaining to the charts.

(8) Calibrator Control Tab

The calibrator may be controlled through the Calibrator Control tab. See the section entitled Thévenin Source Calibration for more information.

(9) Connection State

The text on the left side of the bottom tool strip shows if the selected ER·10X system controller is connected to or disconnected from the PC.

(10) Ready, Wait, Error Status

Green, yellow, and red dots will show on the bottom tool strip if at least version 1.2.0 of the system firmware is loaded onto the hardware. These dots mimic the READY, WAIT, and ERROR LEDs of the hardware. Yellow dot is displayed when a probe or calibrator is heating or cooling to set point or the calibrator is busy. The Red dot is displayed when an error has occurred on the hardware. A green dot shows when the system is neither in a waiting state or error state.

(11) Calibrator Task Status

The current calibrator task is shown on the tool strip.

(12) Stepper Status

The stepper status is shown on the tool strip. The stepper controls the movement of the calibrator. The stepper may be stopped, accelerating, top speed, or decelerating.

(13) Firmware Update

The tool strip will show "Firmware Update" if a firmware package is available to be updated on the hardware. Click on this tool strip item or navigate to TOOLS→FIRMWARE MANAGEMENT... to show the Firmware Management window. See the section entitled Updating Control Unit Firmware on page 32 for more information.

Thévenin Source Calibration

Thévenin source calibration is performed using external software provided by the user. The Calibrator Control tab shown in *Figure 14* is used to manually control the position of the piston in the calibrator that sets the length (or volume) of the cavities used to perform Thévenin source calibration. Refer to *Figure 14* for the following items.
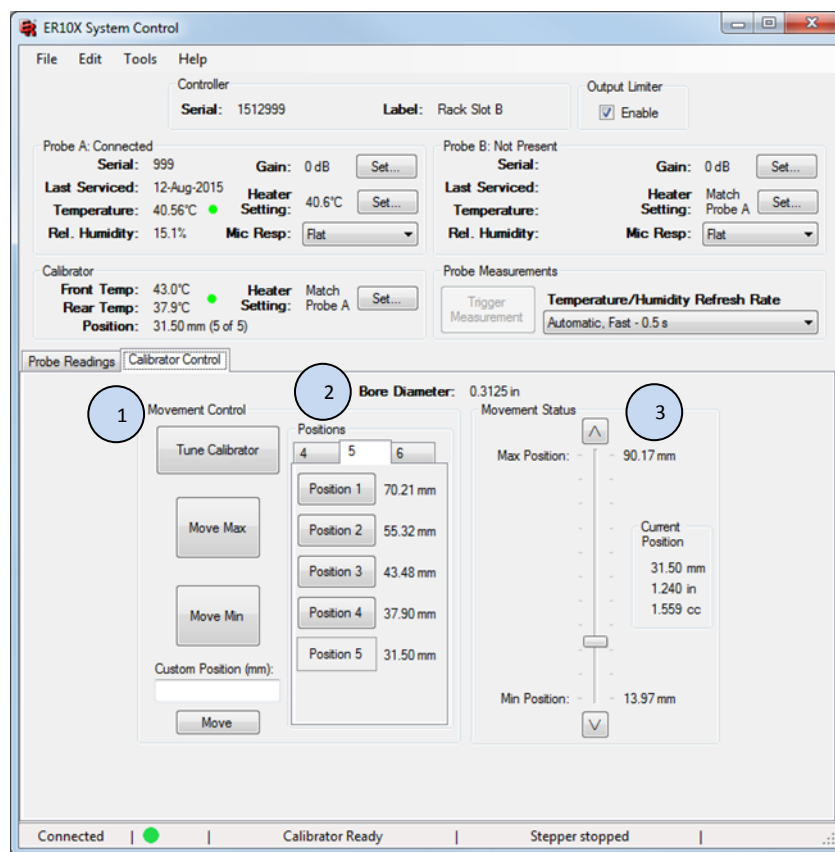

Figure 14

(1) Movement Control

The calibrator is tuned when the unit is turned on. This determines the ranges of piston positions and the corresponding range of possible cavity lengths. The tune setting should be retained as long as the probe system is on, but Calibrator Tuning can be reinitialized any time using the Tune Calibrator button.

A set of pre-determined cavity dimensions is assigned by the set of position buttons. Positions 1 to 4 are given for group 4, positions 1 to 5 are given for group 5, and positions 1 to 6 are given for group 6. Selecting the position tab 4, 5, or 6 will select the corresponding positions group on the hardware and show the position buttons which correspond to that group. Clicking any of the position buttons will move the calibrator to that position. The button will change to a flat style once the calibrator has moved to that position. Right clicking any of the position buttons will show a menu where the position may be changed or set to the current position.

The user may move to a custom position by typing the value into the Custom Position text box and pressing the Move button. Pressing the Move Max or Move Min button will move the calibrator to the minimum or maximum limits. Once the calibrator has reached the selected position, the position setting will be retained by the control unit and will remain even if powered off.

(2) Bore Diameter

The bore diameter reported by the hardware is shown here. This value is always shown in Inches regardless of the selected unit set for the calibrator. The bore diameter is used to determine the volume values.

(3) Movement Status

A visual representation of the current cavity setting is displayed by the slider. Text to the right of the slider also gives the current position in Millimeters, Inches, and Cubic Centimeters. The position of the calibrator may be changed here by dragging the slider up or down, and then releasing the mouse button. Trim buttons on the top and bottom of the slider will move the calibrator 1 step at a time. Clicking and holding the trim buttons will move the calibrator until the mouse button is released.

Measurement Logging

The measurement logging feature of the ER·10X Control application allows for measurement events to be logged to a Comma Separated Values (csv) file. Navigate to FILE->START MEASUREMENT LOG…, and then select a file location to begin logging measurements to file. Navigate to FILE->STOP MEASUREMENT LOG or close the program to stop logging measurements and close the file.

The csv file created by the measurement logging feature may be opened and viewed by nearly any spreadsheet program such as Microsoft Excel. The first row of the log contains the date and time of which the log was created. The second row contains the header information for each subsequent row. There are a total of 18 columns in each row of data. The following is a list of columns in the order that they appear with their description.

- **System Time**
  - The time at which the measurement event was received by the PC in the format of "M/d/yyyy H:mm" i.e. "1/1/2001 13:01". This value depends on the system time reported by Windows.
- **System Time (hours from midnight)**
  - The time at which the measurement event was received by the PC in number of hours from midnight referencing day of the very first measurement in the log. The value is given as a floating point number with microsecond precision. This value depends on the system time reported by Windows.
- **Timestamp (ms)**
  - The timestamp value reported by the hardware at which this measurement was completed in milliseconds as a 64-bit unsigned integer.
- **A Temperature**
  - The temperature of probe A for this measurement taken from the I2C sensor. The unit for this value is whatever temperature unit was selected when the log was started (either Celsius or Fahrenheit).
- **A Relative Humidity (%)**
  - The relative humidity of probe A for this measurement taken from the I2C sensor as a percent.
- **A Therm**
  - The temperature of probe A for this measurement taken from the thermistor. The unit for this value is whatever temperature unit was selected when the log was started (either Celsius or Fahrenheit). This value is not displayed anywhere on the hardware and is not as accurate as the temperature measured by the I2C sensor, but may be useful when manual measurement rate is selected. This temperature value is pulled every 500 ms regardless of the probe measurement rate setting.
- **B Temperature**
  - Same as "A Temperature" but for probe B.
- **B Relative Humidity (%)**
  - Same as "A Relative Humidity (%)" but for probe B.
- **B Therm**
  - Same as "A Therm" but for probe B.
- **Front Calibrator Therm**
  - The temperature of the calibrator for this measurement taken from the front thermistor. The unit for this value is whatever temperature unit was selected when the log was started (either Celsius or Fahrenheit).
- **Rear Calibrator Therm**
  - The temperature of the calibrator for this measurement taken from the rear thermistor. The unit for this value is whatever temperature unit was selected when the log was started (either Celsius or Fahrenheit).

- Calibrator Location (steps)
  - The last known location of the calibrator piston in number of steps back from the minimum position. Each calibrator step is 0.002 inches.
- Calibrator Location
  - The last known location of the calibrator piston in the calibrator unit selected when this log was started (Millimeters, Inches, or Cubic Centimeters).

Updating Control Unit Firmware

Navigate to TOOLS→FIRMWARE MANAGEMENT to update the firmware of the control unit. The window as shown in *Figure 15* is then displayed. The firmware is stored with the PC application and updated with each release.

To update the firmware, press the Write Firmware button. A confirmation dialog will be shown (*Figure 17*). Press the WRITE button to continue.

The firmware write process may take a few minutes to complete. A progress bar provides feedback on the write process (*Figure 16*). Wait until a popup dialog shows that the write process is complete (Figure 18).
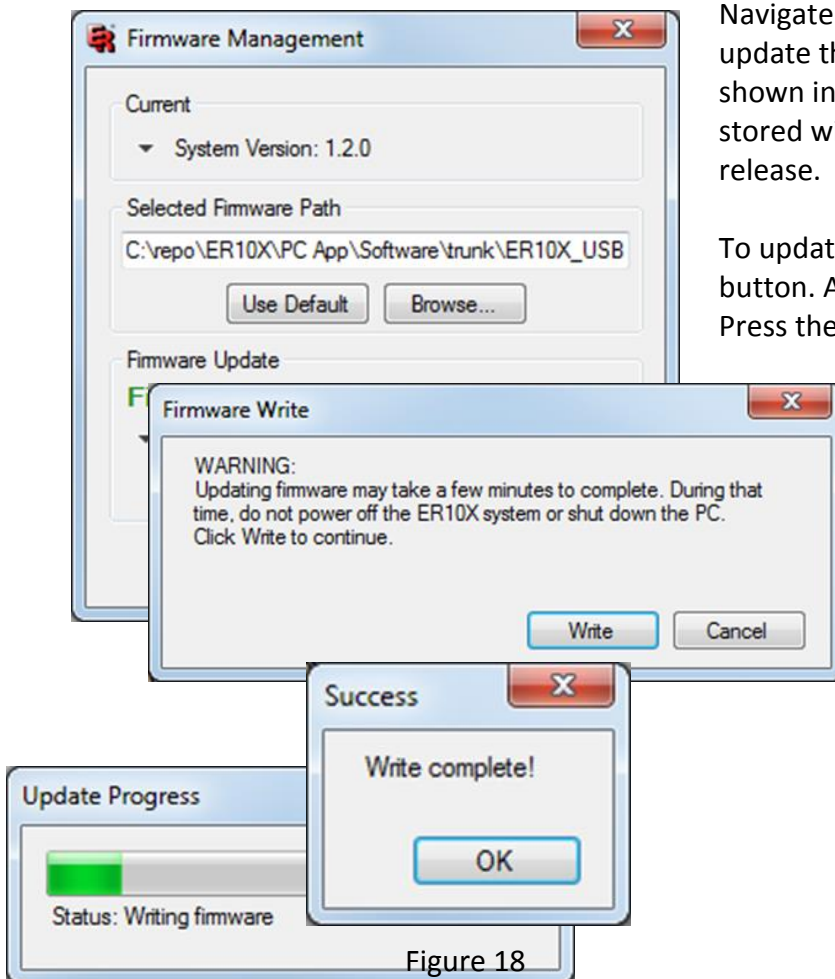
Figure 18

Figure 16

⚠ CAUTION

Do not turn off the control unit or PC during the firmware update process.

Servicing the Instrument

Service must be performed by qualified service personnel only.

Personnel performing this procedure must be trained in proper ESD handling precautions, including the use of wrist straps, static-safe packaging, and static-safe tools.

Plugin Module Replacement

Figure 19

A plugin module (daughter board) is paired with a probe. The plugin module is used to regulate and control the probe.

The control unit will need to be opened to gain access to the plugin module. Before the control unit may be safely opened, **disconnect the control unit from power, and then wait 5 minutes for all heat sinks to cool down**. Remove the 5 screws which hold the top cover in place as seen in *Figure 19*. Gently pull the top cover off and set aside.

 WARNING

Make sure the control unit has been disconnected from power for at least 5 minutes prior to any servicing of the instrument.

 WARNING

Never remove or tamper with the power supply shield (*Figure 20*).
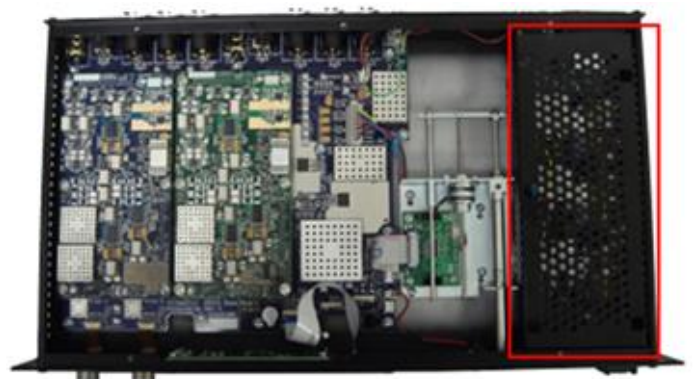
Figure 20
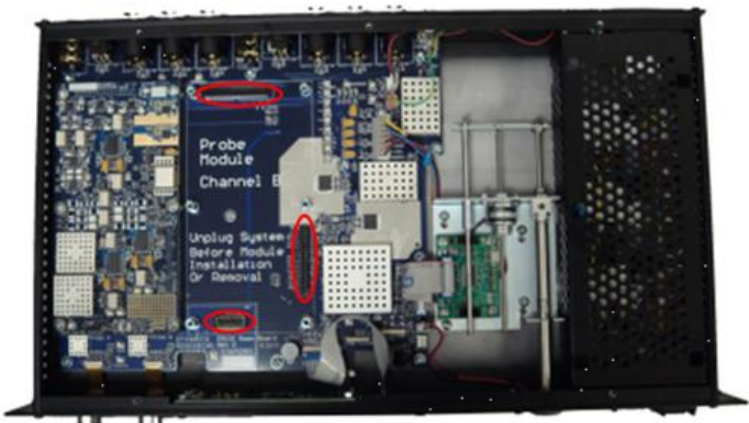
Figure 21

Figure 22

Figure 24

1. Remove the five screws holding the top housing of the chassis in place as shown in Figure 19.

2. Remove the top housing from the chassis.

3. Insert the new plugin module aligning with the sockets as shown in Figure 21. Gently apply force evenly to the front connector (Figure 22), then the side connector, and finally the rear connector.

   NOTE: Always populate Channel A first, prior to the use of Channel B.

4. Push down on all three connectors again to verify that all three connectors are completely seated as shown in Figure 23.

5. Attach the screws to the probe module as shown in Figure 24.

6. Return the top housing of the chassis in place and screw it in place.

Figure 23

Cleaning and Maintenance

Cleaning and Disinfection

Use a new eartip for each subject. Eartips are for single use only. The probe tube, which does not make direct contact with the subject, should be replaced if there is any sign of contamination. Disinfection of the probe tube between subjects is not required.

External parts of the instrument/probe can be cleaned to remove visible particulate contamination. Unplug probe from Controller prior to cleaning. Do not attempt to insert any object into the probe.

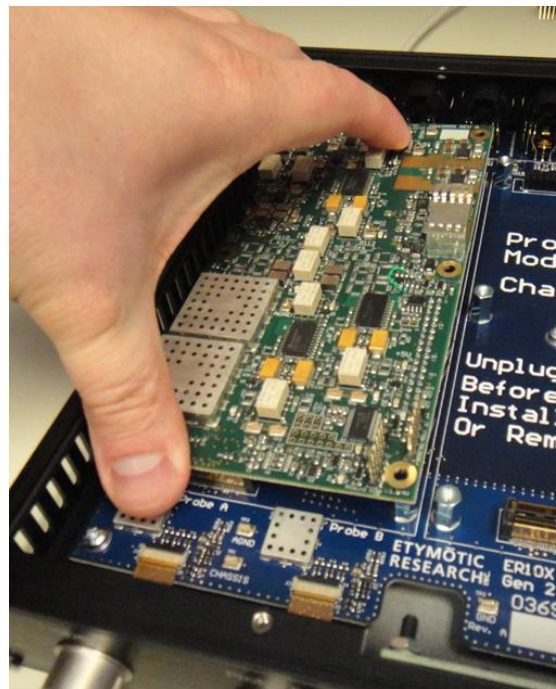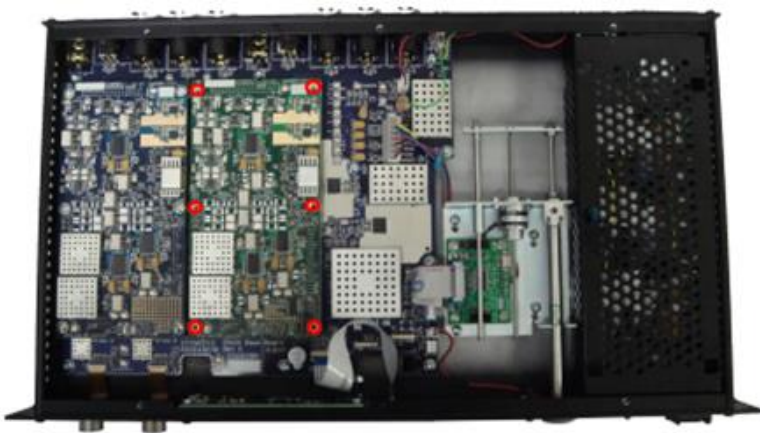This instrument is not designated as a sterile instrument. Wiping with a clean cloth or towel and a mild non alcohol-based disinfecting solution provides a suitable form of cleaning and low-level disinfection of the housing and probe exterior. Repeat this weekly, or as often as conditions warrant, to prevent a build-up of grime from normal handling and use.

Low-level disinfection is recommended for this type of instrument (e.g. Clorox™); however, it may not conform to the infection control guidelines of the user's facility. Disinfection materials and procedures applied in the users' facility may be more appropriate for their environment than the methods outlined above (see cautions below). The frequency of cleaning and disinfecting is dependent on the facility's risk assessment, usage and test environment.

> **Important:**
> - Do not immerse the instrument or probe in fluids or attempt to sterilize the instrument or any of its accessories.
> - Do not allow any fluid to enter the instrument.
> - Do not use autoclave sterilization.
> - Do not use alcohol-based disinfectants.
> - Do not heat the probe assembly above stated operating temperature.
> - Take care not to put excessive pressure on the clear display window or allow any utensil to puncture the display window or control panel.

> **NOTE:** Long-term exposure to any disinfecting agents has the potential to alter the material properties of the plastic housing and labeling of the instrument.

Always follow the safety and disposal guidelines given by the manufacturer of cleaning and disinfectant chemicals.

Maintenance

This instrument requires no regular maintenance beyond routine cleaning and annual calibration. The probe tube requires replacement only when it becomes clogged.

A defective product should not be used. Make sure all connections to external accessories are snug and secured properly. Parts which may be broken or missing or are visibly worn, distorted or contaminated should be replaced immediately with clean, genuine replacement parts manufactured by or available from ERI.

Equipment is not user repairable. Repairs must be performed by an ERI service technician only.

Probe Tube Replacement

Figure 25

Figure 26

Probe tubes are disposable and should be replaced when they become clogged. A package of replacement probe tubes is included with this instrument. Do not attempt to clean the probe tube. Replacement probe tubes may be ordered from Sanibel Supply at https://www.sanibelsupply.com.

To replace the probe tube, use the eartip to grasp the probe tube (the clear plastic tube) and twist slightly while pulling the probe tube straight out of the probe head (Figure 25). Dispose of the used probe tube immediately to avoid confusing used tubes with new tubes. Take a new probe tube from the package and insert the tube into the probe head until it is fully seated (Figure 26). A properly inserted probe tube will snap securely into place when it is fully seated in the probe head.

⚠ CAUTION   DO NOT ATTEMPT TO CLEAN PROBE TUBES. THIS MAY CAUSE DAMAGE TO THE PROBE.

Fuse Replacement

Figure 28

The power entry module fuses are disposable and may be replaced when they become blown. The fuses can be replaced with 2A 250V 5 mm x 20 mm, type 0215002.HXP Slow Blows.

If a fuse blows, the cause of the fault should be determined prior to replacing the fuses. Immediately disconnect the unit and send to ERI for repair if a second set of fuses blow.

Figure 27

To replace the fuses, ensure both power switches are in their OFF positions, and then remove the fuse housing by pressing the clips on both side (*Figure 28*). Fuses may be checked using an ohm meter. Fuses are considered blown if the resistance between the two contacts of the fuse are not near 0 ohms. Dispose of blown fuses immediately to avoid confusing a used fuse with a new fuse. Take a new fuse and insert it into the fuse housing until it is fully seated (*Figure 27*). Insert the fuse housing back into the power entry module until the clips snap into place, and then turn the rear power switch to the ON position.

Troubleshooting

Problem	Solutions
Instrument does not turn on	• Be sure that power is being supplied to the control unit and both power switches are on (See Figure 2). • Refer to section of Fuse Replacement to check if fuses have blown. • Contact ERI for service if the problem persists.
Display is frozen and instrument will not respond to button presses	• Turn off the instrument by using the power switch. Powering the instrument back on again should reset/restore normal function. • Contact ERI for service if the problem persists.
Display shows "FIRMWARE UPDATE MODE"	• Turn off the instrument by using the power switch, ensure that all buttons on the front panel are released, and then power back on. • If the above does not fix the problem, the application firmware may be corrupt. Use the ER·10X Control application and follow instructions on Updating Control Unit Firmware. • Contact ERI for service if the problem persists.

Issues with updating firmware	• Force firmware update by executing the following steps.
	    o Turn off the instrument by using the power switch
	    o Hold ENTER and CANCEL buttons
	    o Turn the power back on
	    o Release the ENTER and CANCEL buttons once "FIRMWARE UPDATE MODE" is displayed
	    o Use the latest version of the ER·10X Control application and follow instructions on Updating Control Unit Firmware
	• Contact ERI for service if the problem persists.

Appendix A: Specifications

Microphone Specifications

Microphone Frequency Range	100 Hz to 16 kHz, ±5 dB, usable to > 40 kHz
Sensitivity	50 mV/Pa, ±1 dB (-46 dB re 1V/µbar): 0 dB SPL= 0 dBµV
Dynamic Range	> 90 dB (200 Hz to 16 kHz)
Acoustical Crosstalk	< -20 dB (Speaker to Speaker)
Output Impedance	< 100 Ω
Noise Level	1 kHz spot noise typically below -17 dB SPL (1 Hz BW)
Programmable Gain	+0 to +40 dB in 1 dB increments

Driver Specifications

Speaker Frequency Range	100 Hz to 20 kHz, usable to >40 kHz
Max Stimulus Output	90 dB nominal
	@ < 0.2 % THD
	@ 1 kHz, 115 dB max
Distortion	DPOAE 2f1-f2 distortion: 1 kHz to 20 kHz
	≥ 90 dB SNR @ 70 dB SPL (P1, P2)
	≥ 80 dB SNR @ 80 dB SPL (P1, P2)
Impulse Response Decay	Ringing down 20 dB or more within 1 ms

FPL Calibrator Specifications

Step Increment	0.05 mm / 0.002 in / 0.004 cc
No. of Positions	4, 5, or 6 programmable positions (15 total)
Minimum Length (Vol)	13.9 mm / 0.55 in / 0.69 cc
Maximum Length (Vol)	90.2 mm / 3.55 in / 4.46 cc
Heater Set-Point	26.7°C to 40.6°C / 80°F to 105°F

System Specifications

Mains Supply (input)	100 to 240 VAC, 50 to 60 Hz
Rated Input Power	45 W max
Chassis Dimensions	483 x 292 x 45 mm (19 x 11.5 x 1.75 in.)
Input Connections	Balanced, ¼'' (6.35 mm) TRS / XLR (2 kΩ Imp.)
Output Connections	Balanced, ¼'' (6.35 mm) TRS / XLR
Probe Cable Length	2.4 meters / 8 feet
User Interface	40-character Organic-Light-Emitting-Diode display
	7-button keypad
Connectors/Communications	USB for communication with PC-based program
	20-pin circular socket connections for probes

ER·10X
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Environmental Requirements

Operating Temperature	15°C to 35°C / 59°F to 95°F
Operating Relative Humidity	30% to 90% (non-condensing)
Transport and Storage Temperature	5°C to 50°C / 41°F to 122°F

 (Pollution Degree) EN 61010-1:2010 specifies the pollution degrees and their requirements as follows. The ER·10X falls under degree 2.

Pollution refers to "addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity."

- Pollution degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
- Pollution degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Pollution degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected. In such conditions, equipment is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.

⚠ WARNING

All circuits connected to the equipment other than mains input must be secondary circuits separated from mains by double or reinforced insulation, or by a grounded shield.

The maximum voltage for the connectors is as follows:

PC Communication		USB:	5V 0.5A
Input Audio	¼'' (6.35 mm) TRS (balanced) / XLR:		2.5V rms
Output Audio	¼'' (6.35 mm) TRS (balanced) / XLR:		12.3V rms

Performance Data

ER10X Average Microphone Frequency Response

Performance Data (cont.)

ER10X Average Driver Frequency Response
Measured in 1/4" 0.4cc Coupler (60118-0)

ER10X Average Auxiliary Driver Frequency Response
Measured in 1/4" 0.4cc Coupler (60118-0)

ER10X Average Noise Floor Frequency Response

ER·10X
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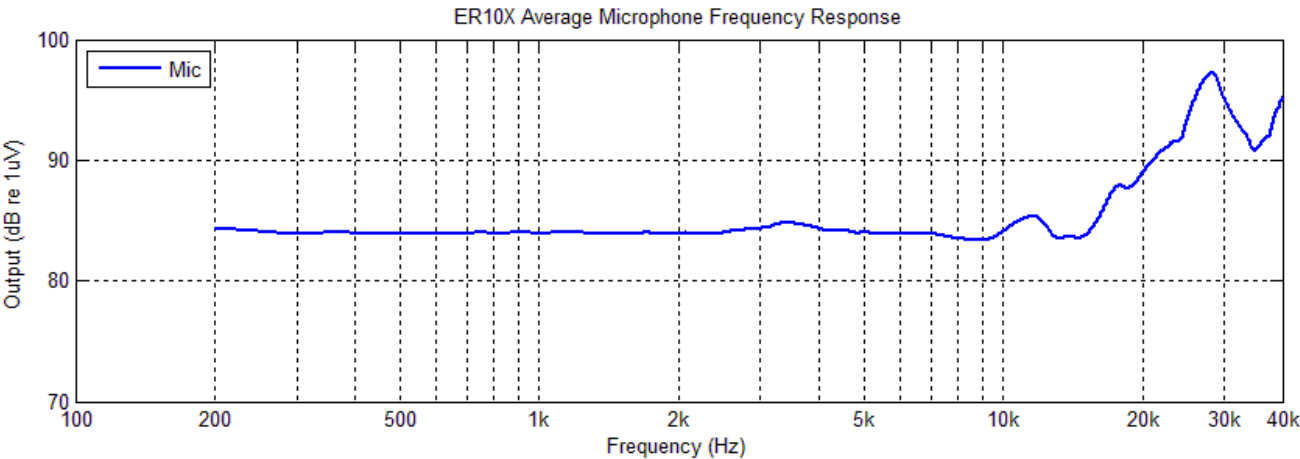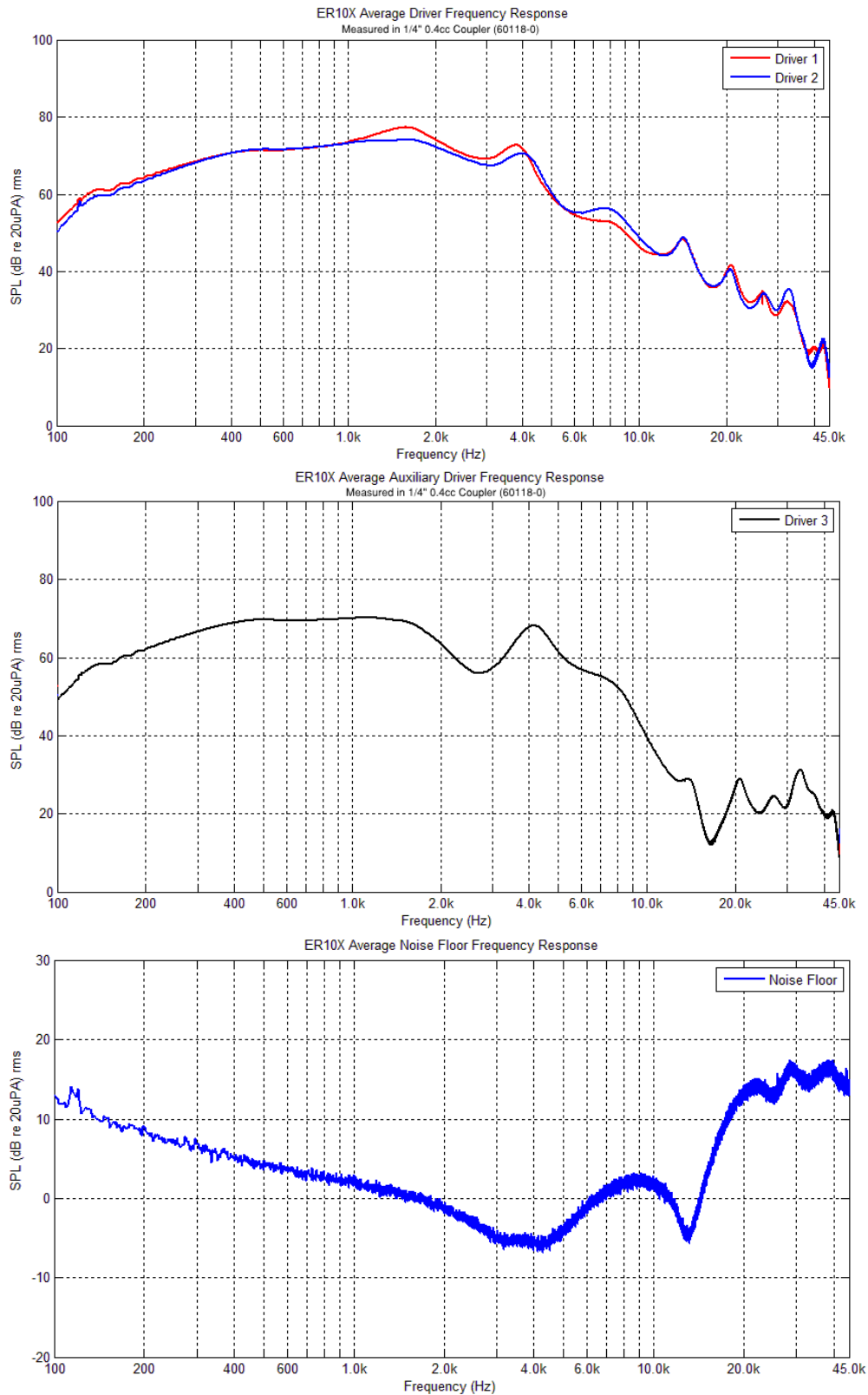
Appendix B: Flowcharts
System Menu Flowchart

Appendix C: Diagrams and Schematics

Driver Path

The following shows one leg of one of the driver paths when a 036955R plugin module is installed for a given channel. The driver paths of each of the three drivers in a probe are the same.
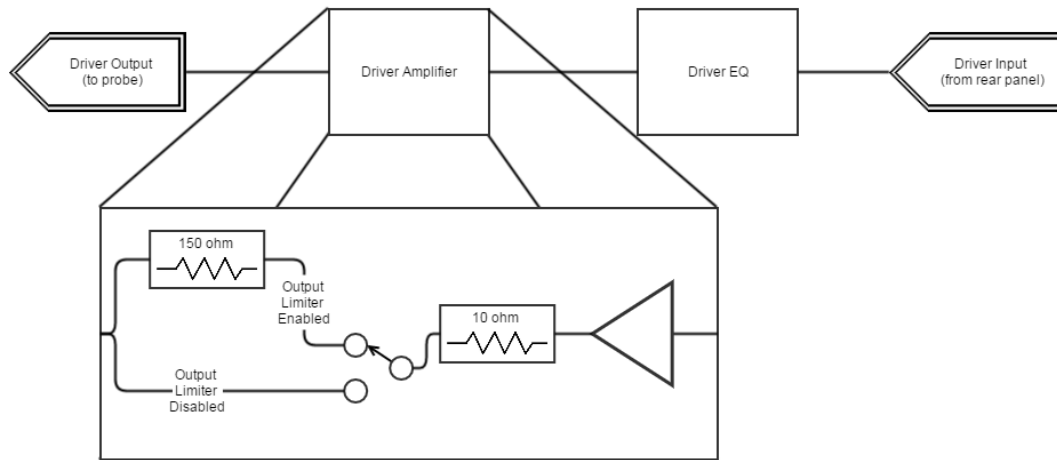
Microphone Path

The following shows one leg of the microphone signal path when a 036955R plugin module is installed for a given channel.

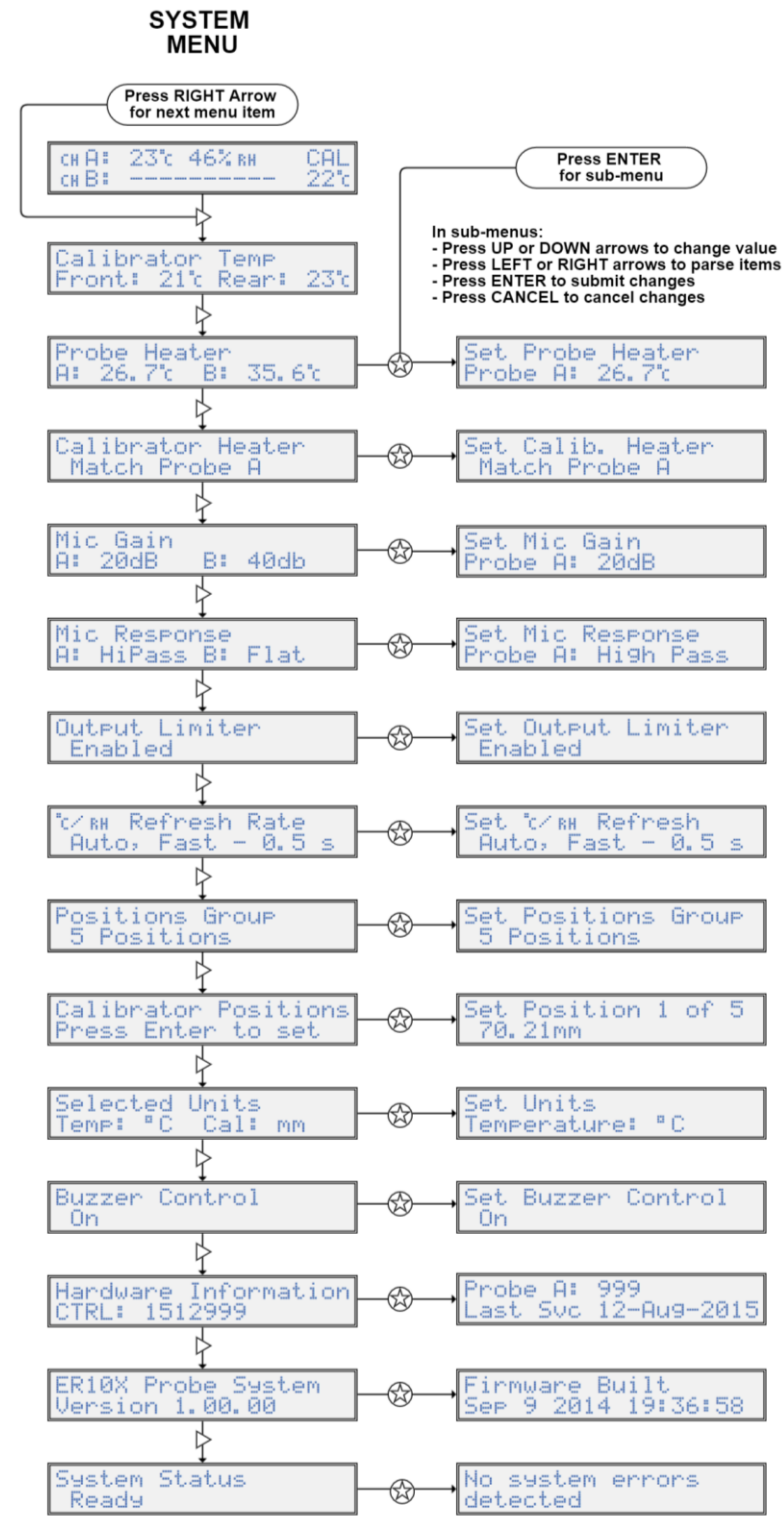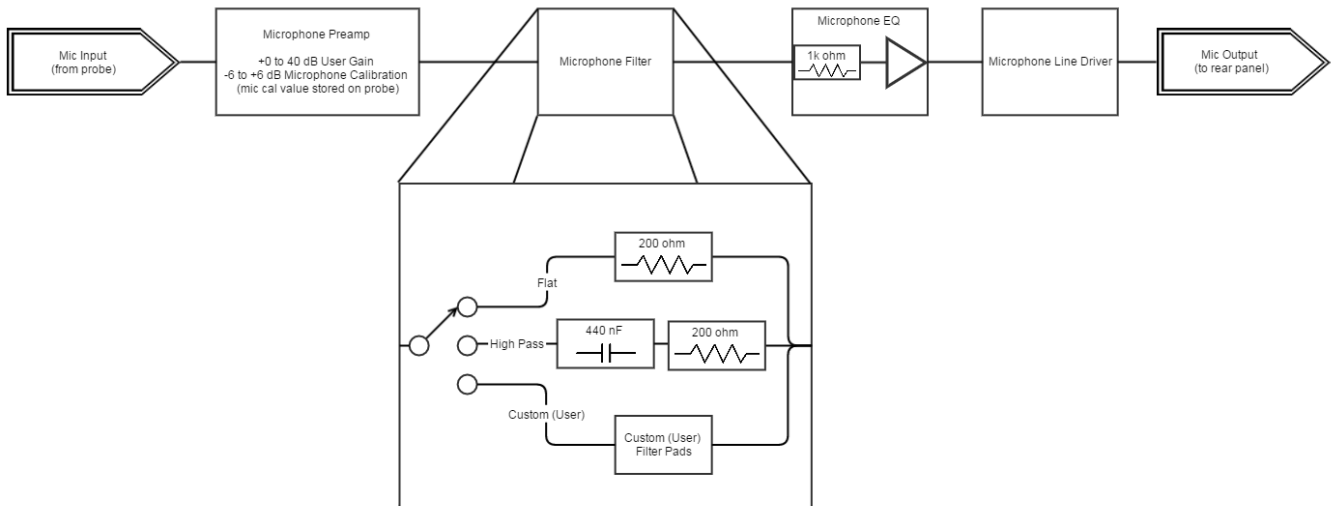There is a high pass filter built into the Microphone EQ block with a corner frequency of less than 100 Hz. This is the corner frequency used when the Flat filter setting is selected.

The 1k ohm resistor within the Microphone EQ block will affect the corner frequency for the High Pass filter setting. Therefore, the corner frequency for this filter is computed as follows.

$$Corner\_Freq_{HighPass} = \frac{1}{2\pi * (200\ \Omega + 1\ k\Omega)\ * 440\ nF} = 301\ Hz$$

Custom (User) Filter Pads

Empty component pads are left on each 036955R plugin module in order to provide the capability to build in a high pass filter with a custom corner frequency.

WARNING		Making modifications to the hardware can be dangerous and must only be performed by a qualified technician. Always ensure that the main power is disconnected from the ER·10X and the system has been given time to cool before beginning such work.
CAUTION		Soldering any components to the plugin module may damage the device and/or void the warranty. Please contact Etymotic Research before implementing a custom filter if there are any questions or concerns.
CAUTION		Proper ESD handling must be observed while implementing the custom filter, including the use of wrist straps, static-safe packaging, and static-safe tools.

The following depicts the unfilled device pads and thru holes for the custom (user) filter on a 036955R plugin module.
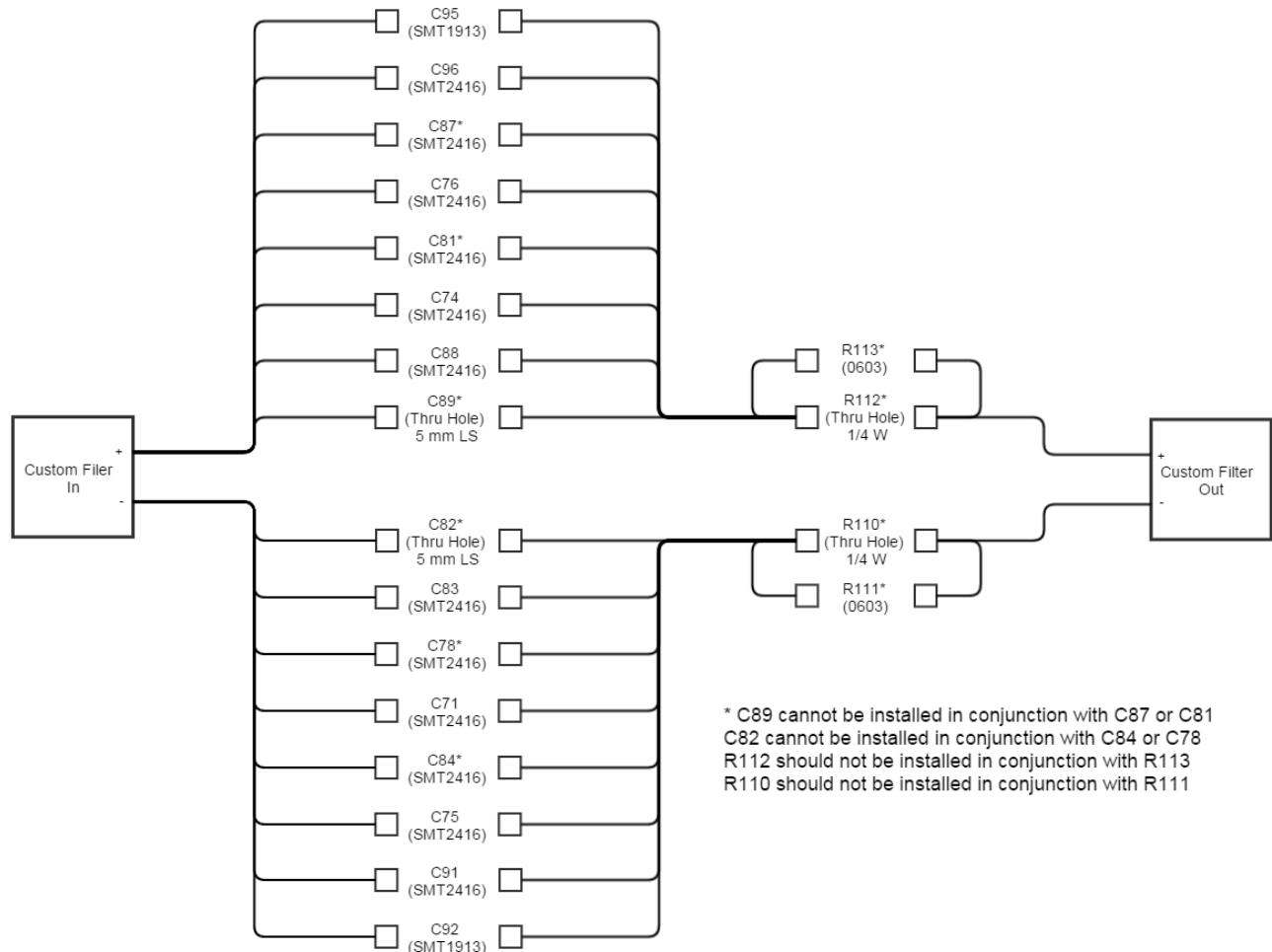
* C89 cannot be installed in conjunction with C87 or C81
C82 cannot be installed in conjunction with C84 or C78
R112 should not be installed in conjunction with R113
R110 should not be installed in conjunction with R111

The 1k ohm resistor within the Microphone EQ block will affect the corner frequency for the custom filter. The corner frequency of the custom filter is computed as follows.

$$Corner\_Freq_{Custom} = \frac{1}{2\pi*(R+1\ k\Omega)\ *C} \text{ in Hertz}$$

Where R is the total resistance of each leg in ohms and C is the total capacitance of each leg in Farads. It is recommended to use the following guidelines when selecting components.

- Use PPS or polypropylene capacitors to keep the electrical noise sensitivity and distortion down.
- Capacitor values should be 2% or better and matched on both sides to minimize noise.
- Use Thin Film resistors to reduce self-noise.
- Resistor values should be 0.1% or better and matched on both sides to minimize noise.

If an R value other than 200 ohms is used, the output will not be at the factory specified level when the custom filter is selected. However, the output level will still be per factory specification if any other filter setting is selected. It is recommended that the end-user use an acoustic calibrator to verify the new gain. The theoretical gain error is computed as follows.

$$Gain_{Custom} = 20 * \log(\frac{1200}{R+1000}) \text{ in decibels}$$

Follow the section on Servicing the Instrument in order to gain access to a plugin module. Remove the desired plugin module from the system before soldering in the custom filter components. The following image shows the location of each custom filter component pad on a 036955R plugin module board.

| | Surface Mount Component | | Thru Hole Component |
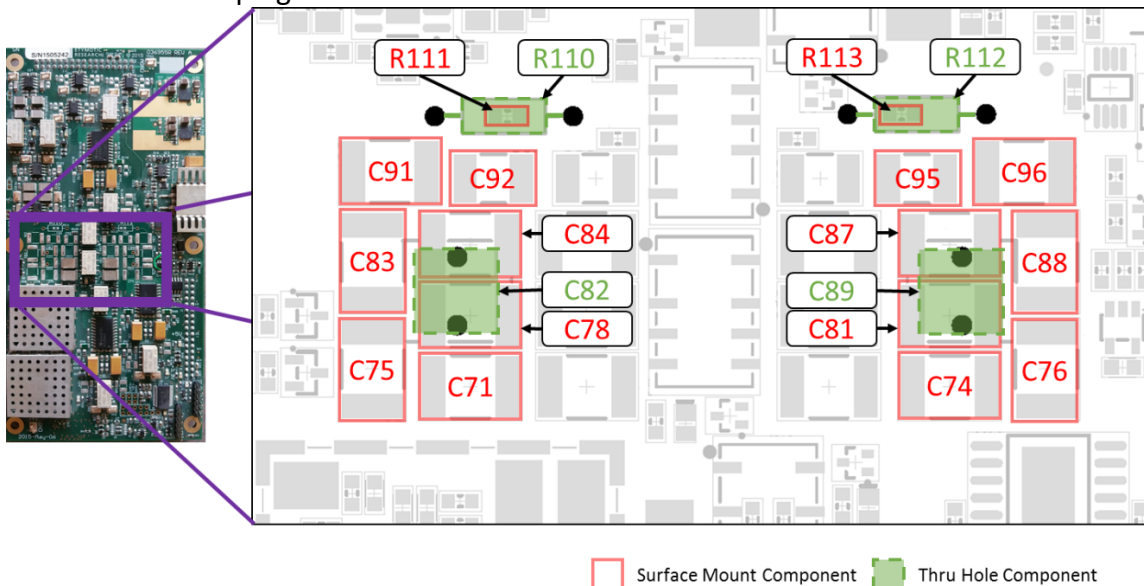
⚠ CAUTION   Do not overheat nearby components as this may affect performance. Do not let solder connect to other components surrounding the custom filter pads. Always inspect all connections before re-inserting the plugin module into the ER·10X system.

Appendix D: Probe, Plugin Module, and Calibrator Error Codes

Probe Error Codes

When "Error" is given for a channel on the main menu, a probe error has occurred. This error is accompanied by a 3-character error code which describes the error. The following image is a sample of what this looks like.

The following is a list of probe error codes with their meanings. For any probe error, pressing the ENTER button while the main menu is visible will attempt to refresh the probe connection.

- **IC1, IC2, IC3, IC4, and IC5:** Serial communication failure
  - This may be due to environmental noise, noisy cable, or noise during attachment.
- **CA1:** Microphone calibration retrieval failed
  - This error is similar to the above errors as it occurs when serial communication has failed while attempting to pull calibration data from the probe.
- **PI1:** Probe initialization failed
  - This error is also similar to the above errors as it occurs when initial serial communication has failed. However, this is more likely to occur when the electronics on the probe have malfunctioned.
- **PL1, PL2, PL3, and PL4:** Plugin module communication failure
  - This may be due to a loose connection to the plugin module, malfunctioning plugin module, or heavy environmental noise.
- **PL5, PL6, and PL7:** Plugin module measurement failure
  - This may be due to malfunctioning thermistor on the probe.
- **CN1:** Timeout during connection
  - This is due to software malfunction.

Plugin Module Error Codes

When "Bad Mod" is given for a channel on the main menu, a plugin module error has occurred. This error is accompanied by a 3-character error code which describes the error. The following image is a sample of what this looks like.

The following is a list of plugin module error codes with their meanings.

- **EM1, EM2, EM3, EI1, EI2, and EI3:** Invalid plugin module storage memory
- **EV0 and EV1:** Plugin version is not supported by this version of the firmware
  - Update the system firmware using the PC application in order to attempt to clear this error.
- **IP1:** Corrupt firmware memory detected on plugin module
  - Updating firmware using the PC application may alleviate this error. Contact ERI if this problem persists.
- **MC1:** Plugin module is detected, but microcontroller was not sensed
  - This may be caused by a loose connection or a major hardware malfunction.
- **UA1:** Communication with the plugin module has failed
  - This is most likely due to a loose connection to the plugin module, hardware malfunction, or heavy environmental noise. If another plugin module is connected, this error will cause the other plugin module to disable with error code "XXX".
- **UA2:** Initial communication with the plugin module has failed
  - This is similar to the above, but may hint at corrupt firmware memory on the plugin module. Updating firmware using the PC application may alleviate this error. Otherwise, this error is most likely caused by a loose connection to the plugin module, hardware malfunction, or heavy environmental noise.
- **DA1:** Settings on the plugin module have become unsynchronized with the system or a plugin reboot has been detected
  - This can only be caused by a major hardware or software fault. Contact ERI if this problem persists.
- **UP1 and UP2:** Firmware update required
  - The version of the firmware on the plugin module is not compatible with the firmware on the system. Update firmware using PC application to clear this error.
- **HR1:** Plugin module unexpectedly released the heater control
  - This is due to software malfunction. If another plugin module is connected, this error will cause the other plugin module to disable with error code "XXX".
- **XXX:** Plugin module disabled because other plugin experienced a critical error

Calibrator Error Codes

When "ERR" is given for the calibrator temperature on the main menu, a calibrator heater error has occurred. The following image is a sample of what this looks like. Take note that dashes (--) will show here if the calibrator installed on the system does not contain a heater element. The calibrator piston is controlled independently of the calibrator heater and may still function if an error occurred with the calibrator heater. Press the RIGHT→ arrow button to change to the calibrator temperature menu for the error code.

```
CH A:  23℃ 46%RH      CAL
CH B:  ----------------- ERR
```

The calibrator temperature menu will show "Error:" followed by a 3-character error code when the calibrator heater error has occurred. The following image is a sample of what this looks like.

```
Calibrator Temp
Error:  HS1
```

The following is a list of calibrator heater error codes with their meanings.

- **HS1, HH1, LL1, HN1, LN1, NH1, NL1, HL1, LH1:** Heater shut down because the temperature at one or both of the sensors reached an extreme
  - This may be caused by sensor malfunction, heater malfunction, or if the system is in an environment which is too hot or too cold.
- **IP1:** Corrupt firmware memory detected on calibrator board
  - Updating firmware using the PC application may alleviate this error. Contact ERI if this problem persists.
- **MC1:** Calibrator with heater is detected, but microcontroller was not sensed
  - This may be caused by a loose connection or a major hardware malfunction.
- **UA1:** Communication with the calibrator has failed
  - This is most likely due to a loose connection to the calibrator board, hardware malfunction, or heavy environmental noise.
- **UA2:** Initial communication with the calibrator has failed
  - This is similar to the above, but may hint at corrupt firmware memory on the plugin module. Updating firmware using the PC application may alleviate this error. Otherwise, this error is most likely caused by a loose connection to the calibrator board, hardware malfunction, or heavy environmental noise.
- **DA1:** Settings on the calibrator have become unsynchronized with the system or a calibrator reboot has been detected
  - This can only be caused by a major hardware or software fault. Contact ERI if this problem persists.
- **UP1 and UP2:** Firmware update required
  - The version of the firmware on the calibrator board is not compatible with the firmware on the system. Update firmware using PC application to clear this error.
- **HR1:** Calibrator board unexpectedly released the heater control
  - This is due to software malfunction.

Appendix E: System Errors

In the unlikely event that a system error occurs, the buzzer will beep twice if the buzzer is enabled and the red ERROR LED will light up when a system error is signaled. One of the following screens will show when an error occurs. These may be cleared from the display by pressing any button. A signaled error will also show up under the System Status Menu.

`!!! System Error !!!` `Display Error`	The system detected a problem with the display. This error will never be visible on the hardware since the display will be disabled when this error occurs.
`!!! System Error !!!` `No Controller Serial`	Serial number for the control unit stored in memory is invalid or missing.
`!!! System Error !!!` `Menu Error`	Menu queue has overloaded. This is a software error which should not occur in normal operation.
`!!! System Error !!!` `System Memory Failed`	Memory access (read or write) has failed.
`Locating Home` `Position **FAILED**`	Calibrator tuning process has failed. This will show as "Calib. Tune Failed" under the System Status Menu.
`Locating Home FAILED` `**NO CALIBRATION**`	Calibrator calibration could not be loaded from memory or could not be found. This will show as "No Calibration Set" under the System Status Menu.
`!!! System Error !!!` `Calib. Frmwr Corrupt`	Invalid or corrupt calibrator firmware detected. Updating system firmware through the PC application may help to resolve this issue. Otherwise, this may be due to hardware malfunction.
`!!! System Error !!!` `Calib. Update Read`	Calibrator firmware needs to be updated. Updating the system firmware through the PC application will clear this error.
`!!! System Error !!!` `Calib. Heater Failed`	The calibrator heater has failed either due to calibrator temperature going above 120 degrees Fahrenheit or hardware malfunction.

|	
`!!! System Error !!!` `Invalid Module A Mem`	Invalid or corrupt storage memory found on module A.
`!!! System Error !!!` `Invalid Module B Mem`	Invalid or corrupt storage memory found on module B.
`!!! System Error !!!` `Mod. A Frmwr Corrupt`	Invalid or corrupt firmware detected on module A. Updating system firmware through the PC application may help to resolve this issue. Otherwise, this may be due to hardware malfunction.
`!!! System Error !!!` `Mod. B Frmwr Corrupt`	Invalid or corrupt firmware detected on module B. Updating system firmware through the PC application may help to resolve this issue. Otherwise, this may be due to hardware malfunction.
`!!! System Error !!!` `Module A Update Read`	Module A firmware needs to be updated. Updating the system firmware through the PC application will clear this error.
`!!! System Error !!!` `Module B Update Read`	Module B firmware needs to be updated. Updating the system firmware through the PC application will clear this error.
`!!! System Error !!!` `Module A Failed`	Module A has failed. An error code will be given on the Main Menu. See Appendix D for more information.
`!!! System Error !!!` `Module B Failed`	Module B has failed. An error code will be given on the Main Menu. See Appendix D for more information.
`!!! System Error !!!` `Module A Disabled`	Module A has been disabled because module B experienced a critical error.
`!!! System Error !!!` `Module B Disabled`	Module B has been disabled because module A experienced a critical error.
`!!! System Error !!!` `A Gain Set Failed`	Setting microphone gain on module A has failed.

``!!! System Error !!!`` ``  B Gain Set Failed``	Setting microphone gain on module B has failed.
``!!! System Error !!!`` ``A Mic Resp Set Fail``	Setting microphone response relay on module A has failed.
``!!! System Error !!!`` ``B Mic Resp Set Fail``	Setting microphone response relay on module B has failed.
``!!! System Error !!!`` ``  Heater A Shutdown``	Module A sensed high (above 120 degrees Fahrenheit) or invalid temperature value and has shut down the heater for probe A.
``!!! System Error !!!`` ``  Heater B Shutdown``	Module B sensed high (above 120 degrees Fahrenheit) or invalid temperature value and has shut down the heater for probe B.
``!!! System Error !!!`` ``  Heater A Failed``	Setting heater power for probe A has failed.
``!!! System Error !!!`` ``  Heater B Failed``	Setting heater power for probe B has failed.
``!!! System Error !!!`` ``Probe A Comm. Failed``	Serial communication to probe A has failed.
``!!! System Error !!!`` ``Probe B Comm. Failed``	Serial communication to probe B has failed.
``!!! System Error !!!`` ``  Probe A No Cal``	Invalid or missing calibration found on probe A.
``!!! System Error !!!`` ``  Probe B No Cal``	Invalid or missing calibration found on probe B.
``!!! System Error !!!`` ``Probe A Unrecognized``	Probe A version is not supported by the system. Updating the system firmware through the PC application may alleviate this error.
``!!! System Error !!!`` ``Probe B Unrecognized``	Probe B version is not supported by the system. Updating the system firmware through the PC application may alleviate this error.

`!!! System Error !!!` `  Probe A Mismatch`	Probe A does not belong with plugin module A.
`!!! System Error !!!` `  Probe B Mismatch`	Probe B does not belong with plugin module B.
`ERROR: Auto Measure` `Reqd for Heater A on`	Heater A cannot be enabled while refresh rate is set to manual. Either shut off heater A or set refresh rate to automatic. This will show as "Htr A Auto Meas Reqd" under the System Status Menu.
`ERROR: Auto Measure` `Reqd for Heater B on`	Heater B cannot be enabled while refresh rate is set to manual. Either shut off heater B or set refresh rate to automatic. This will show as "Htr B Auto Meas Reqd" under the System Status Menu.

# Appendix F: ER10X USB Control - PC Software Installation

1. Execute the ER10X Control Setup located on the included flash drive or download the latest version from http://www.er10x.com. The setup will extract the files necessary in order to install the utility *(See Figure F.1)*.
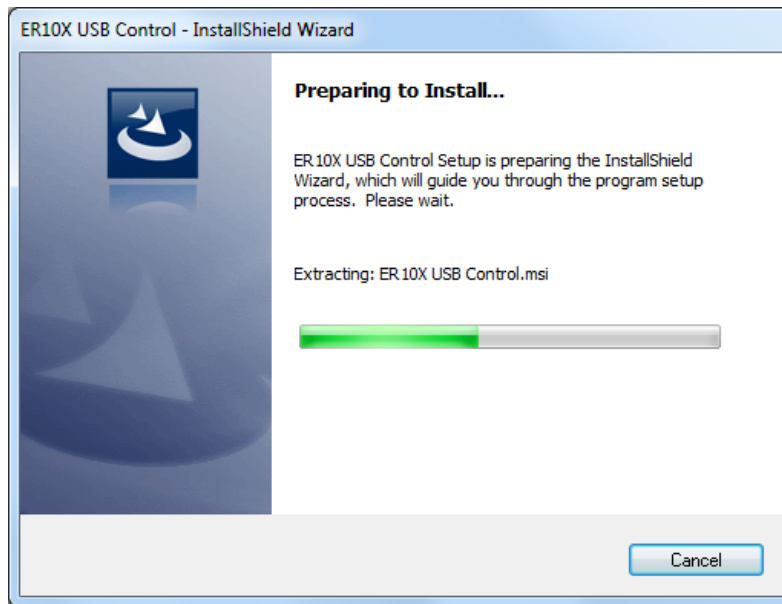
Figure F.1: ER10X Control Extraction Wizard

2. After inflating the necessary files to run the utility, the ER10X Control Setup Wizard will start *(See Figure F.2)*. To continue, click "**Next >**".
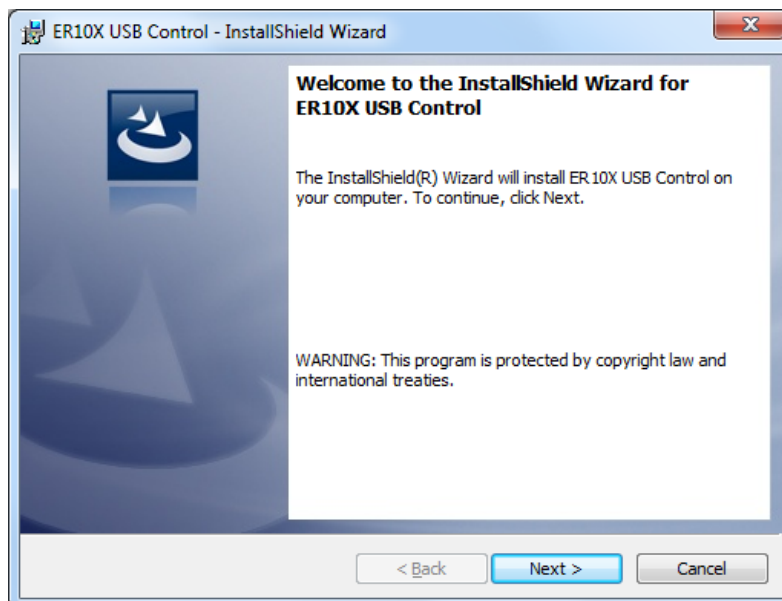

Figure F.2: ER10X Control InstallShield Wizard

3. The License Agreement screen allows you to accept the terms for using this software. You must agree to the terms before continuing with the installation. Click "Next >" to continue after accepting the terms *(See Figure F.3)*.
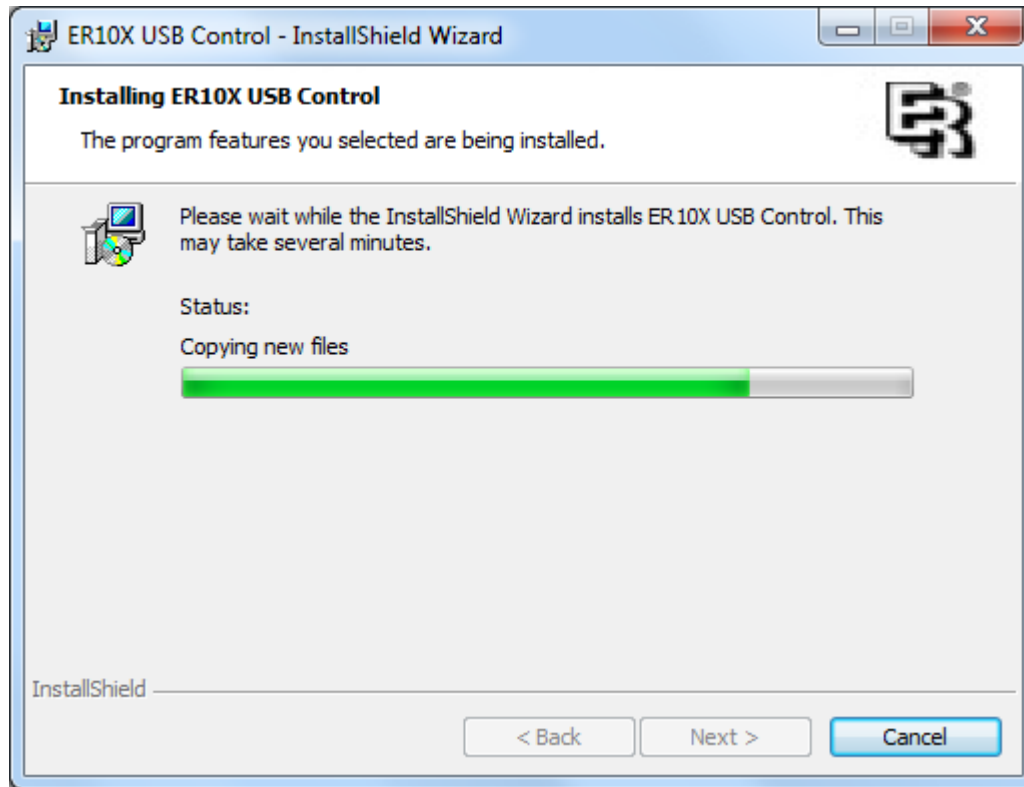

Figure F.3: License Agreement

4. After you have confirmed your selections, the installer is ready to begin. Press "Install" to begin the installation *(See Figure F.4)*.
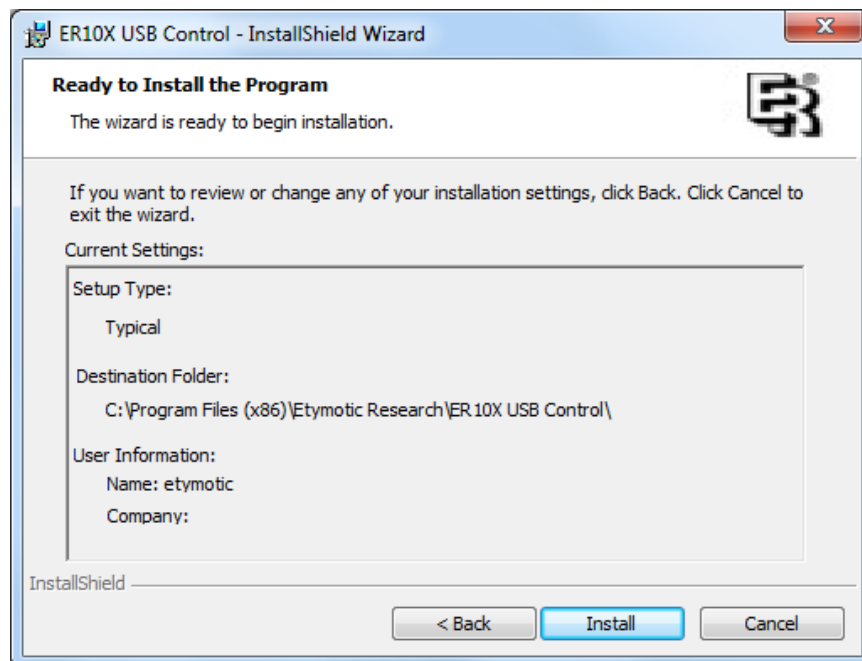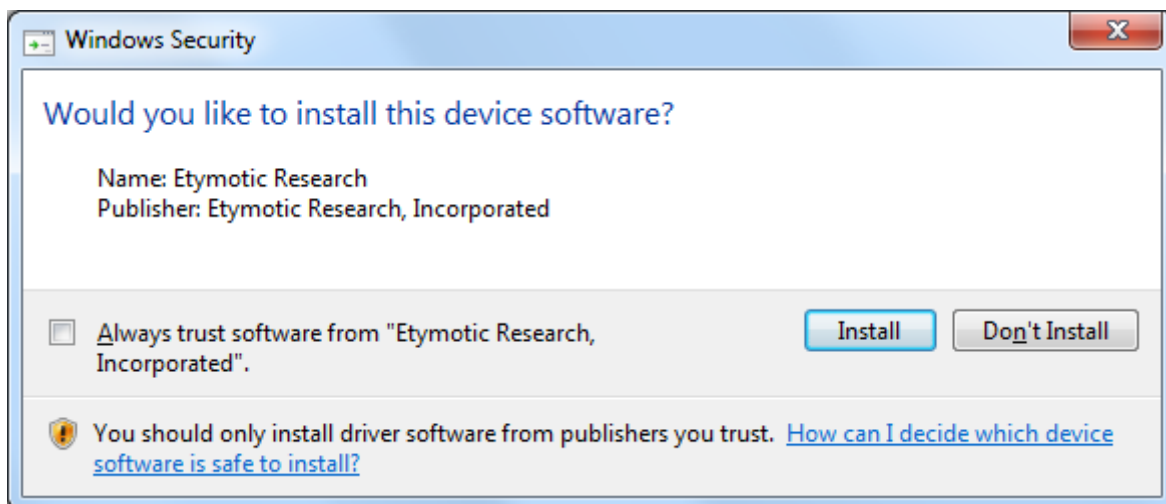

Figure F.4: Ready to Begin Installation

5. The installation process may take a few minutes to complete (*See Figure F.5*).
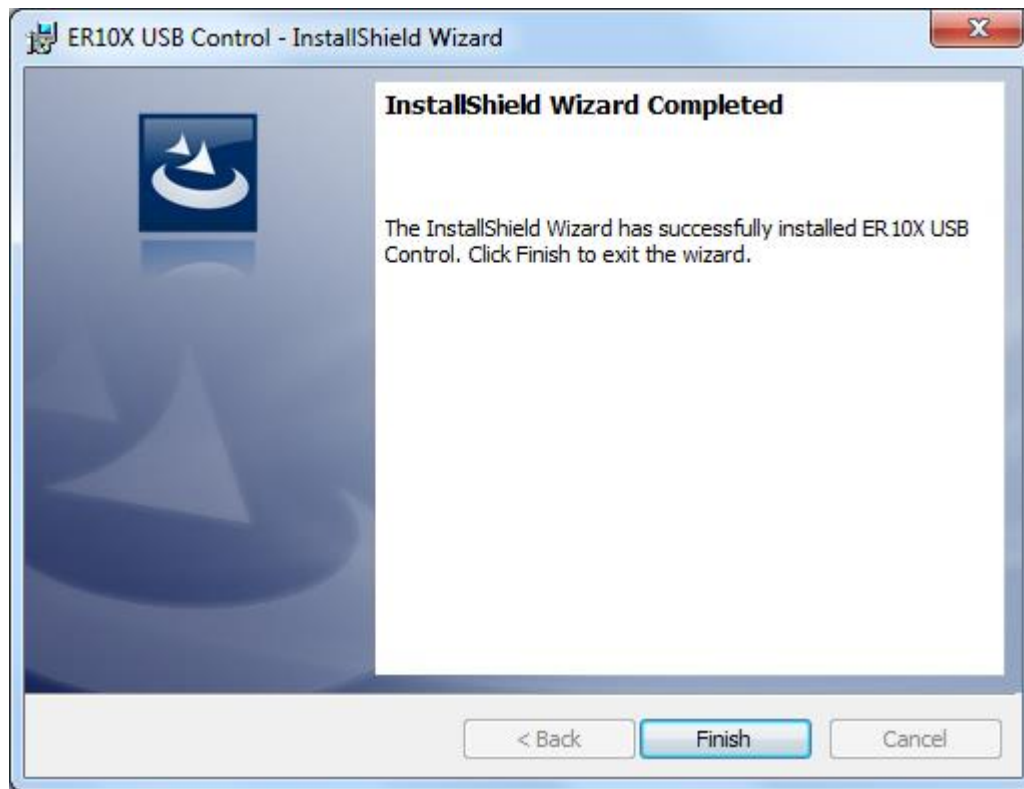

Figure F.5: Installing ER10X Control

6. Windows may ask you to confirm the installation of the ER10X system driver (*See Figure F.6*). This driver is necessary to use this application. Click "Install" to agree to install this driver.

Figure F.6: ER10X Control Driver Installation

7. Click "**Finish**" on the **InstallShield Wizard Completed** screen to exit (*See Figure F.7*).

Figure F.7: ER10X Control InstallShield Wizard Completed