Instruction Manual

90CA Microphone Calibration System

GRAS Sound & vibration
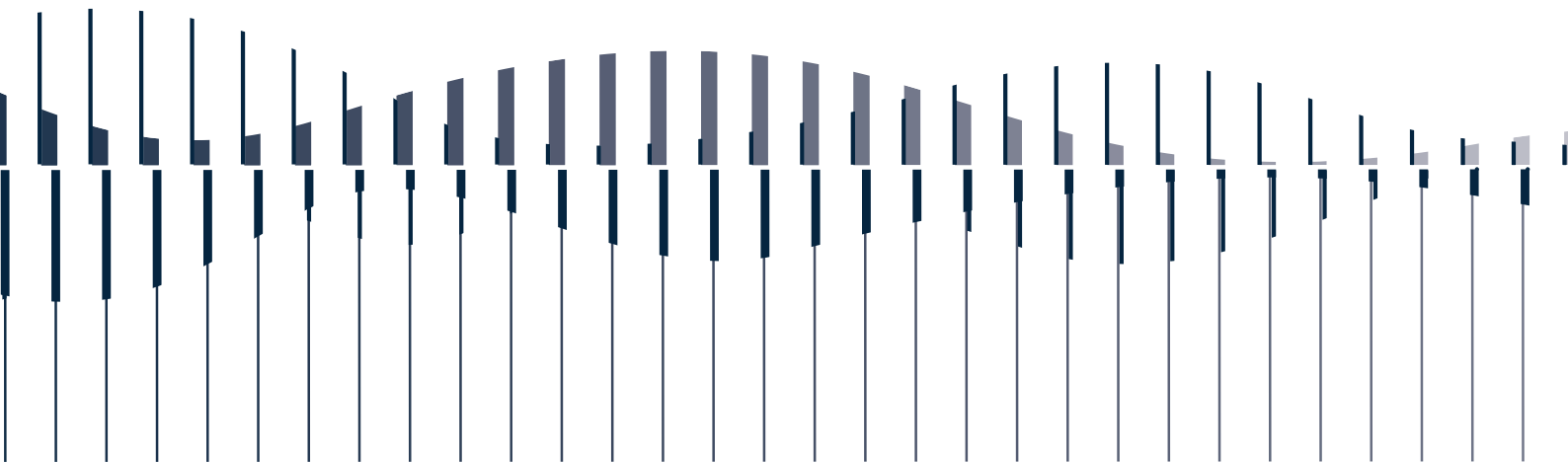
Revision History

Any feedback or questions about this document are welcome at **gras@gras.dk**.

Revision	Date	Description
1	15 October 2009	First publication of this document
2	01 March 2012	Redesign of the manual. Added information about calibration in general, calibration of microphone sets, and preamplifiers. New diagrams and drawings about hardware assembly and electrical connections
3	10 February 2017	File locations on page 64 corrected, new microphone definition file.
4	13 May 2019	Adapter Cable with Optical Isolation added. Warning about uninstalling LabView.

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Trademarks

Contents

Introduction

The G.R.A.S. 90CA Microphone Calibration System provides you with a computer-controlled level and frequency-response calibration of measurement microphones and microphone sets. This highly automated process is convenient, yet reliable, with its ready-to-use software and hardware, and auto-generated customizable documentation. Additional software can be purchased for the calibration of preamplifiers.

Calibration with the 90CA is in compliance with

- ANSI S1.10 – 1966 (R1976)
- IEC Norm 61094-1
- IEC 61094-6

The 90CA provides accurate calibration hardware, easily changeable test conditions and a highly reproducible calibration method

Using This Manual

Inside this manual, you will find

A description of the principles of the 90CA calibration system, with an overview of the hardware and software for the different types of calibration in "" on page 8.

Diagrams and instructions for assembling and connecting the hardware for both the PXI and the PCI version of 90CA "Assembling and Connecting the Hardware" on page 17.

Illustrations of which components of the 90CA to use for the different types of calibration for the different sizes of microphones: "Mounting the Microphones" on page 33.

A description of the special calibration software included with 90CA and where and how you can customize it: "Introducing the Calibration Software SW0002" on page 38.

Detailed calibration procedures for "In general, the indicators are green when the measurement is within the preset limits and red when the the measurement is outside the limits." on page 39, and for G.R.A.S. preamplifiers in "Calibrating a Preamplifier" on page 47 (if you purchased the preamplifier calibration option), and for "High Frequency Calibration" on page 54.

Descriptions of the data files included with 90CA and how to modify them in "Working with the System Files and Documentation" on page 56.

Additional information about the warranty, cleaning instructions, and service and repairs are also provided on page 66.

Introduction to Calibration

For making documented, traceable, and approved measurements, your measurement equipment must be calibrated.

Basically, calibration is a method that establishes the relationship between a measuring device and its measurement units. This is done by comparing a device or the output of an instrument to a standard with known characteristics. As an example, a ruler can be calibrated by comparing it to a known standard. A meter is defined as the length of the path travelled by light in vacuum in 1/299,792,458th of a second. When the relationship between the ruler and this standard is established, the ruler is calibrated and can be trusted to provide reliable measurements.

This section introduces the most commonly used terms in relation to acoustic calibration.

What is Acoustic Calibration?

Calibration means the comparison of the value indicated by a measuring instrument with a nominal value that is provided by a given standard.

The equipment used for the calibration must itself be suitably calibrated to ensure an unbroken trace back to the standard kept at a national or international institute.

The Calibration Pyramid

National / International Standard

Reference Standard — Secondary Calibration

Working Standard — Accredited Calibration

Measuring Instrument — Traceable Calibration
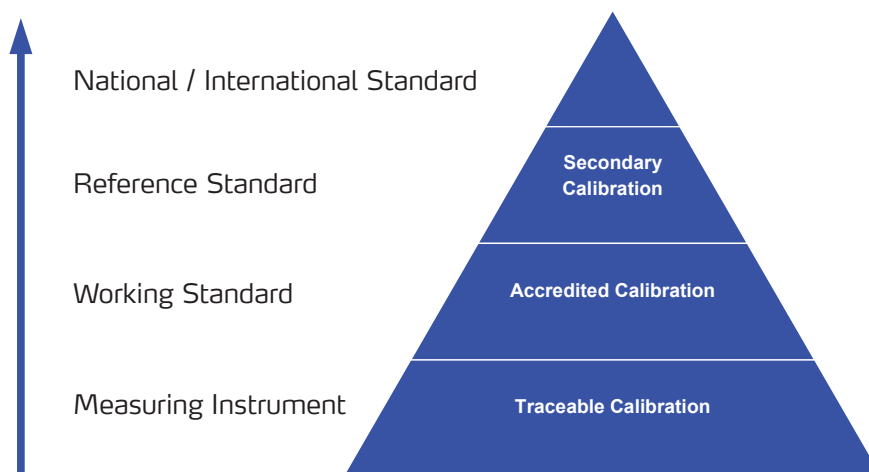
Fig. 1. *The calibration pyramid*

The calibration pyramid is a hierarchy of comparisons of the standards used to calibrate measurement instruments, ranging from the least accurate standard (many working standards) at the bottom of the pyramid to the most accurate standard at the top.

Traceable Calibration

An instrument has a traceable calibration if the measurement instrument used for performing the calibration is traceable to national or international institutes / standards through an unbroken chain of comparisons all having stated uncertainties.

Accredited Calibration

An instrument has an accredited calibration if the calibration is performed by an approved accredited calibration laboratory. Approval for accredited calibration is granted by a national metrology institute after careful evaluation and inspection of the laboratory in question.

Secondary Calibration

The secondary calibration has the next highest metrological quality in an area. The calibration value is assigned by comparison with a primary standard of the same quantity.

Primary Standard

The primary calibration (reference standard) has the highest metrological quality available at a given location or in a given organization. Its value is accepted without reference to other standards of the same quantity.

In many countries, a body has been established to maintain primary standards of measurements that will be used to provide traceability to customers' instruments. The national metrology institute supports the metrological infrastructure in that country by establishing an unbroken chain from the top level of standards to an instrument used for measurement.

National Metrology Institute	Country
DANAK	Denmark
PTB	Germany
NPL	UK
NIST	USA

Fig. 2. Examples of national metrology institutes

Which type of Calibration do I need?

For performing a quality measurement, you must keep these factors in mind:

1. *Resolution:* Does the measurement meet the requirements of the application?

2. *Accuracy:* Does the measurement reflect the true characteristics of what is measured?

3. *Precision:* Do you get the same result each time you measure the same quantity?

The accuracy of the calibration needed is directly dependent on these considerations.

How often should I calibrate?

How often you should calibrate your equipment depends on the type of measurements as well as on your quality assurance system. Use the following guidelines to determine when calibration is needed:

- When you receive a new instrument
- When a specified time period has elapsed (often one year)
- When a specified period of usage (operating hours) has elapsed
- When an instrument has been subjected to shock or vibration that may have affected its performance
- Whenever measurement results appear to be questionable

Reference Standard	Working Standard	Factory Standard
Maximum Accuracy	*Medium Accuracy*	*Lower Accuracy*
Application:	**Application:**	**Application:**
➢ National Institutes ➢ Research and laboratories ➢ Sensor Manufactures	➢ Calibration laboratories ➢ Measuring instrument manufactures	➢ Measuring and control workshops ➢ Industrial testing laboratories ➢ Service / monitoring of testing devices

Fig. 3. *Accuracy of Calibration*

The Concept of the 90CA Microphone Calibration System

The G.R.A.S. Microphone Calibration System 90CA provides you with a convenient, yet reliable and automated level and frequency response calibration of measurement microphones and microphone sets. The 90CA calibrates in compliance with

- ANSI S1.10 – 1966 (R1976)
- IEC Norm 61094-1
- IEC 61094-6

An optional module for calibration of preamplifiers is available.

The 90CA is delivered with ready-to-use software and hardware, as well as preinstalled test parameters for G.R.A.S. microphones and preamplifiers. The 90CA is available in two versions: a PXI-based version with boards for mounting in a NI PXI Express chassis and a PCI-based version with boards for use in a PC. Functionality and specifications are identical for the two. See Packing List and Electrical Connections for further information.

Main Features

- A highly automated and computer-controlled calibration process
- Accurate calibration hardware
- Ready-to-use software and hardware
- Preinstalled test parameters for G.R.A.S. microphones and microphone sets
- Optional software for test of preamplifiers
- Test conditions easily changeable
- Highly reproducible calibration method
- Auto-generated, customizable documentation for printing
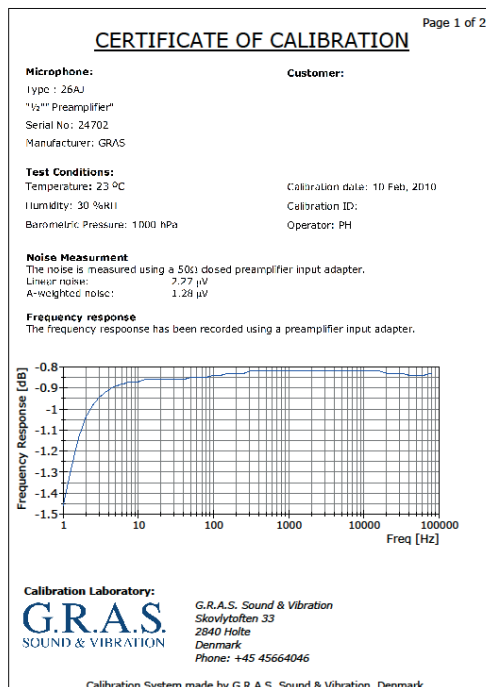
Fig. 4. *Example of a calibration certificate*

Applications

You can use the 90CA Microphone Calibration System for all types of IEC-standardized ⅛", ¼" , ½", and 1" measurement microphones to perform.

- Level calibration of microphones using a pistonphone and the insert voltage technique

- Frequency calibration of microphones using an electrostatic actuator

  Note: For microphones with a non-removable protection grid, frequency calibration is not feasible. For G.R.A.S.' free-field microphones, the system automatically compensates for the free-field correction. For non-G.R.A.S free-field microphones, the free-field correction values can be entered manually.

- Calibration of externally polarized microphone sets

- Calibration of prepolarized microphone sets

- Calibration of preamplifiers

- Calibration up to 92 kHz

  Note: The high-frequency calibration above 92 kHz requires a 33210A or 33220A Signal Generator and a 34410A Digital Multimeter.

These applications are described in this manual.

Traceability and Accrediting

The system has been tested by G.R.A.S. Sound & Vibration and is delivered with a test certificate for the complete system, specific instruments and their serial numbers listed.

The microphones and the pistonphone 42AP that is included are reference traceable to national standards established at National Physical Laboratory (NPL) in Great Britain.

For daily reference instruments check, use the Reference Microphone 40AG that is included.

Accreditation for the 90CA Reference Units

An accredited calibration of the 42AP Pistonphone, the 40AG reference microphone, and the 26AG Insert-Voltage Preamplifier is available from G.R.A.S. Order OP0022 Accredited Calibration of Reference Units.

The Basic Principles of 90CA: Microphone Calibration in Four Easy Steps

The 90CA Microphone Calibration System was designed to eliminate the risk of operator errors during calibration. The workflow is simple and straight-forward with its four steps as shown in the following figure.
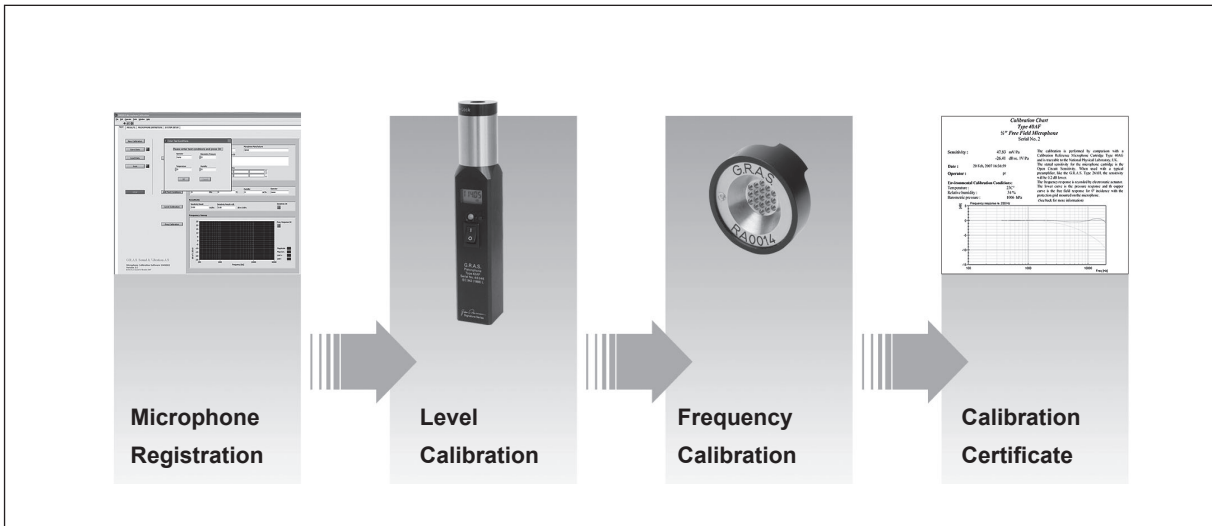
Fig. 5. *The four steps of calibration with the 90CA*

Microphone Registration is the first step. You enter the test conditions (meteorological data) and microphone parameters (sensitivity, frequency response, tolerances, etc.) into the system. The system has a database that already contains calibration information for G.R.A.S. microphones (sensitivity, frequency response, tolerances, and so on). This database can easily be extended to contain the same type of details about microphones from other manufacturers.

Level Calibration uses the pistonphone and an insert-voltage preamplifier to determine the open-circuit sensitivity of the microphone capsule at 250 Hz @114 dB.

Frequency Calibration is performed after the level calibration to determine the frequency response using an electrostatic actuator.

The **Calibration Certificate** is a file that contains all the results for the level and the frequency calibration. The layout, data used, text, and logo for the certificate can be customized. The file can be saved as a PDF file.

Ambient Conditions for the Calibration

Ambient noise: < 65 dB

Temperature: 20 - 25° C

Relative Humidity: 30 – 70 %

Functional Block Diagram
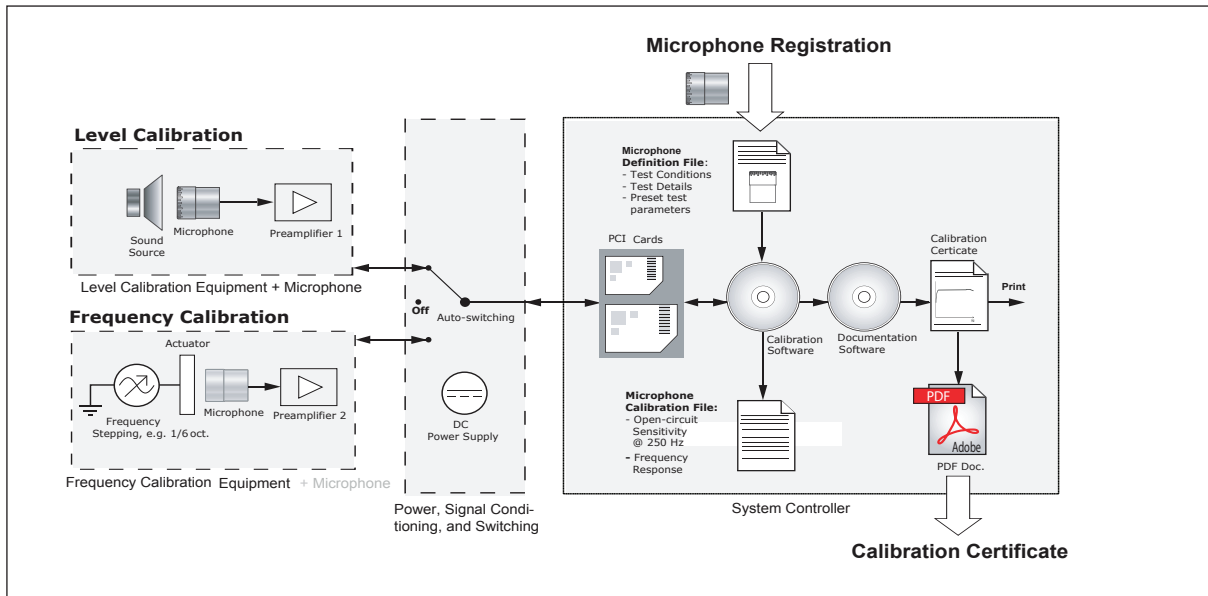
Fig. 6. *The complete microphone calibration system represented by functional blocks*

A overall functional block diagram of the 90CA has four areas as explained here.

The **Level Calibration Equipment** block covers the components needed to determine the microphone's open-circuit sensitivity [mV/Pa].

The **Frequency Calibration Equipment** block covers the components needed to determine the microphone's frequency response.

The **Power, Signal Conditioning, and Switching** block covers the DC power supply, signal conditioning, and automatic switching between level and frequency calibration.

The **System Controller** block covers the following:

- PXI cards for digital I/O and data acquisition with PXI-based system control or equivalent PCI-cards for PCI-based system control

- Preinstalled calibration software (SW0002) specifically designed for the 90CA

- Preinstalled microphone and preamplifier definition files (described elsewhere in this manual)

- Microphone Calibration File for the test results

- Software for generating the documentation - the calibration certificate

Hardware and Software for Level Calibration
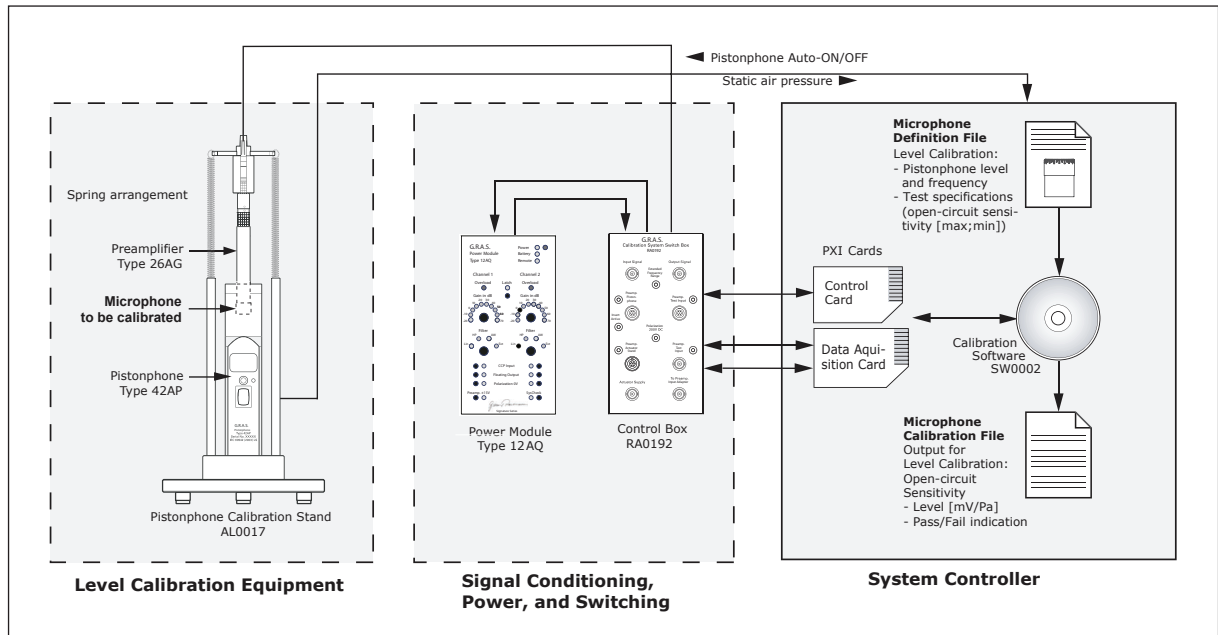
Fig. 7. *Functional block diagram of the 90CA hardware and software for level calibration*

The hardware and software for level calibrations are introduced here.

Level Calibration Equipment

- **Pistonphone 42AP:** A well-defined sound level reference (sound source); it is automatically switched on/off via a COM port, and it automatically reads the static air pressure.

- **½" Preamplifier 26AG** (for ½" microphones) OR (not shown) ¼" Preamplifier 26AN (for ¼" microphones): Both types with an integrated 7-pin LEMO connector and configured for insert-voltage technique.

- **Pistonphone Calibration Stand AL0017:** A fixture for holding the preamplifier securely in place in the pistonphone and ensuring a stable workspace.

Power, Signal Conditioning, and Switching

- **Power Module 12AQ:** A dual-channel power module with supply voltages and signal conditioning for externally polarized and prepolarized preamplifiers/condenser microphones.

- **Control Box RA0192:** Software-controlled switchbox that automatically switches the signal path between level calibration and frequency calibration.

System Controller

The system controller has PXI or PCI cards and software preinstalled.

- **Control Card:** National Instruments Digital I/O PXI-6509 (PCI 6503), Input/ Output Module (A/D Conversion); controls the signal switching between level and frequency calibration.

- **Data Acquisition Card:** National Instruments Dynamic Signal Acquisition Board PXI-4461 (PCI 4461) with 24-bit analog inputs and outputs and a sampling rate of 204.8 kS/s.

- **Microphone Calibration Software**

- **Microphone Definition File:** For level calibration, this input file contains
  - test parameters such as pistonphone level and frequency
  - test specifications for the microphone (microphone sensitivity [max; min]).

- **Microphone Calibration File:** For level calibration, this output file contains:
  - the microphone's open-circuit sensitivity in [dB re. 1 V/Pa] and [mV/Pa]
  - "Pass" / "Fail" indication

Hardware and Software for Frequency Calibration
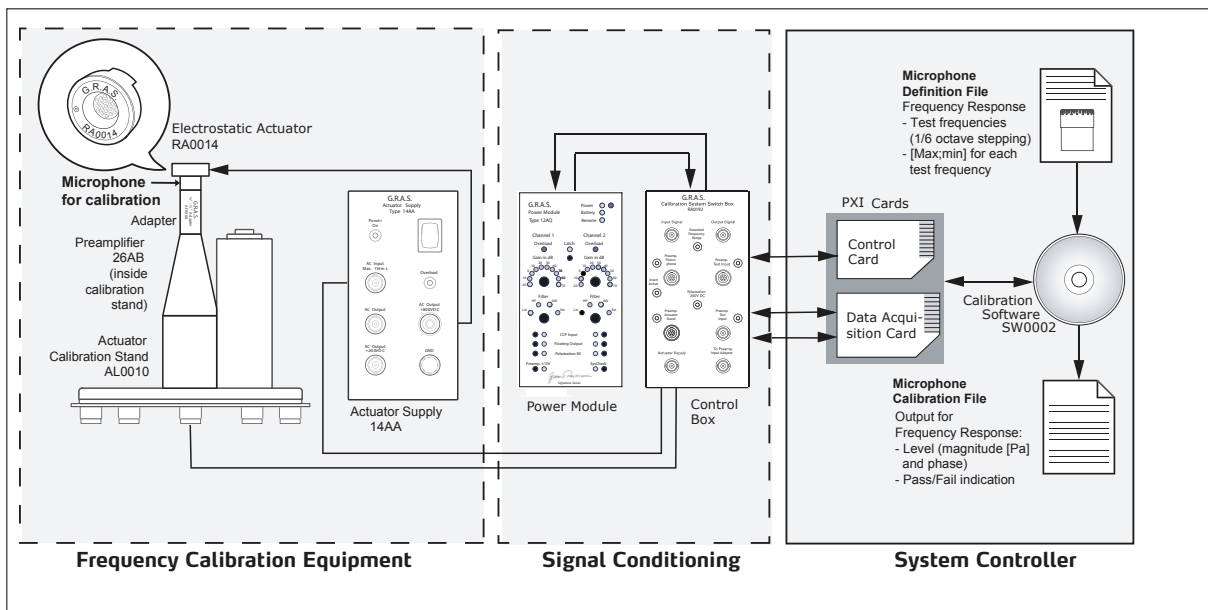
Fig. 8. *Functional block diagram of the 90CA hardware and software for frequency calibration*

The block diagram for frequency calibration is similar to the diagram for level calibration. The details are the same for the system controller and the power, signal conditioning, and switching. The equipment block is different.

Frequency Calibration Equipment

- **¼" Preamplifier 26AB** (¼" -to-½" adapter AF0008 supplied)
  OR (not shown)
  ½" Preamplifier 26AK; both amplifiers with integrated 7-pin LEMO connector.

- **½" Electrostatic Actuator RA0014**: for testing the frequency response of standard ½" and ¼" microphones; an adapter is included for testing ¼" microphones; can be connected directly to the Actuator Supply 14AA.

- **Actuator Calibration Stand AL0010**: provides a convenient platform and has a fixture for holding the preamplifier securely in place as well as recesses and column for safely parking the electrostatic actuator RA0014 and microphone protection grids when not in use.

- **Microphone Set Calibration Stand AL0021:** provides a platform and has a fixture for holding a microphone set securely in place. (Not shown in Fig 8, shown in the connection diagrams for microphone sets in "Assembling and Connecting the Hardware".)

- **Actuator Amplifier 14AA:** includes a 230 V AC power cable.

Delivered Components

The 90CA Microphone Calibration System includes all accessories for calibrating microphones from G.R.A.S.

Packing List for the 90CA

Please note that the included hardware from Natinal Instruments may be newer and improved versions with different product designations than those listed here.

System Controller with preinstalled cards and software	
PCI: System Controller, including: NI Dynamic Signal Acquisition Board PCI-4461 National Instruments Digital I/O PCI-6503, or newer hardware version.	Discontinued
PXI: NI PXIe-8101 Embedded Controller, including: National Instruments PXIe1071 4-Slot 3U PXI Express Chassis NI Dynamic Signal Acquisition Board PXI-4461 National Instruments Digital I/O PXI-6509, or newer hardware versions.	HW1003
National Instruments software Diadem version 10.2 (or later), Base Edition	SW0013
Calibration System Software for 90CA	SW0002
National Instruments Sound and Vibration Analysis SW Run-Time License 779875-01	SW0012
For Level Calibration	
Pistonphone Calibration Stand	AL0017
Intelligent Pistonphone, including RS-232 control cable	42AP
¼" LEMO Insert Voltage Preamplifier	26AN
½" LEMO Insert Voltage Preamplifier	26AG
For Frequency Calibration	
¼" LEMO Preamplifier with Inline Barrel Adapter AF0008 for ¼" preamplifier and ½" microphone	26AB
½" LEMO preamplifier (for use with most non-G.R.A.S. microphones)	26AK
½" Electrostatic actuator (includes ¼" microphone adapter RA0017)	RA0014
Actuator Calibration Stand	AL0010
Microphone Set Calibration Stand	AL0021
Electrostatic Actuator Amplifier, including 230 V AC power cable	14AA
For Power, Signal Conditioning, and Switching	
2-Channel CCP/LEMO Power Module with Signal Conditioning and Computer Interface	12AQ
Control box (no cables included in the box)	RA0192
½" Pressure microphone for reference	40AG
Cables, Connectors, Adapters, and Tools	
National Instruments Cable 180524-10 (50-position ribbon cable)	AA2006

1 m BNC cables (5)	AA0033
3 m LEMO extension cable (3)	AA0008
RS232-USB Adapter with optical isolation	KE0138
BNC T-connector	AC0021
Straight adapter for ½" microphone and ¼" preamplifier	RA0003
⅛ microphone and ¼" preamplifier adapter	RA0063
½" microphone tool	RA0081
¼" microphone tool	RA0200
⅛" microphone tool	RA0210
Documents	
90CA Instruction manual	LI0028
42AP, 12AQ, 14AA Instruction manuals	
G.R.A.S. license for SW0002	
Calibration documentation	
Options	
Preamplifier calibration module	OP0020
Accessories for calibration of 1" microphones	OP0021
Accredited calibration of 42AP Pistonphone, 40AG Reference Microphone, 26AG Preamplifier and 26AK Reference Preapmlifier	OP0022

Assembling and Connecting the Hardware

Workspace for the Assembly

To prepare the assembly, make sure you have at least 1 square meter free space available. For easy day-to-day use, you need easy access to the Level Calibration Equipment and the Frequency Calibration Equipment. The monitor, mouse, and keyboard should be easy to reach. After they are connected, the System Controller, the RA0192 Switch Box, and the 12AQ Power Module can be placed as far away from the other equipment as the available cable lengths allow.

The following pages show how the components of the 90CA are connected for calibration of microphones—both externally polarized and prepolarized (CCP), externally polarized microphone sets, and prepolarized microphone sets. The three setups are very similar.

The main differences are

▪ The AL0010 Electrostatic Calibration Stand is used for calibration of microphones.

▪ The AL0021 Microphone Set Calibration Stand is used for calibration of microphone sets.

▪ LEMO to LEMO cables are used for calibration of microphones and for externally polarized microphone sets. BNC to BNC are used for prepolarized microphone sets.

PXI: Electrical Connections for Calibration of Microphones (Ext. Pol. and Prepol.)

PXI- based System Control and Data Acquisition

NI PXIe 1071 PXI Express Chassis with Embedded Controller, Data Acquisition and I/O Cards

NI PXI - 6509
Digital I/O

NI PXI - 4461
24-bit 204.8 kS/s

AI0
AI1-
AO0
AO1

NI PXIe 8101
Embedded Controller

DVI

RS232 Adapter Cable with Optical Isolation

Control Cable

Level Calibration Equipment

42AP Pistonphone in calibration stand

Frequency Calibration Equipment

Electrostatic Actuator and Actuator Stand

14AA Actuator Supply

G.R.A.S.
Actuator Supply
Type 14AA
Power On
Overload
AC Output +800VDC
GND
AC Input Max. 30mVᵣₘₛ
AC Output
AC Output +800VDC

Signal Switching

RA0192 Switch Box

To Power Module
Control Signals
From Power Module
Isolation Signal
Response Signal (TEDS)
Serial No. XXXXXX
Made in Denmark

G.R.A.S.
Calibration System Switch Box
RA0192
Input Signal
Isolated Response Signal
Polarization Voltage
Output Signal
Primary Test Input
Primary Test Input
To Pistonphone
Polarization Voltage
Primary Test Input
Actuator Supply

Polarization and Supply Voltage

12AQ Power Module

Channel 1
SysCheck
CCP Input
Mic. Input
Output
Channel 2
SysCheck
CCP Input
Mic. Input
Output
Ext. Supply
8-80VDC
RS232
Serial No. XXXX

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PXI: Connections for Test of Microphones (Ext. Pol. and Prepol.)

Important: All electrical devices must be switched off while you are setting up the 90CA.

1. Use the gray 50-position ribbon cable to connect the 6509 Digital I/O card to the "Control Signal" socket on Switch Box RA0192 (socket on the rear).
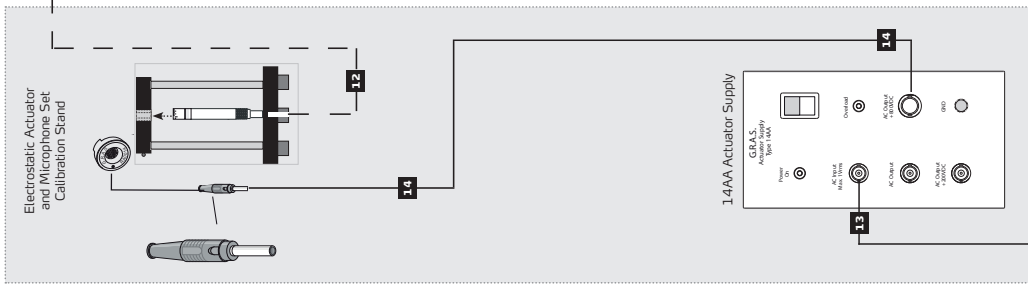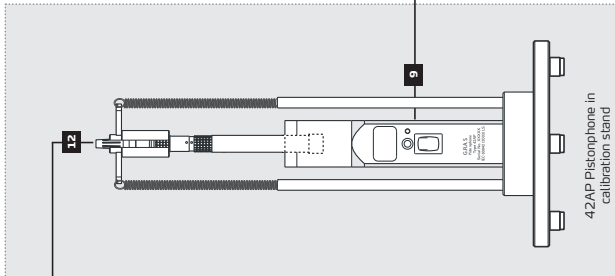
2. Plug the BNC T-connector (two-way splitter) into the "AO 0" socket (output 0) on the NI 4461 Dynamic Signal Acquisition Board.

3. Use a BNC cable to connect one branch of the BNC T-connector to "AI 0" socket (input 0) on the NI 4461 Dynamic Signal Acquisition Board.

4. Use a BNC cable to connect the other branch of the BNC T-connector to the "Excitation Signal" socket on the RA0192 Switch Box (socket on the rear).

5. Use a BNC cable to connect the "AI 1" input socket on the NI 4461 Dynamic Signal Acquisition Board to the "Response Signal" BNC connector on the RA0192 Switch Box (socket on the rear).

6. Connect the keyboard to one of the USB slots on the PXIe 8101 Embedded Controller.

7. Connect the mouse to the other USB slot on the PXIe 8101 Embedded Controller.

8. Connect the monitor to the DVI socket on the PXIe 8101 Embedded Controller

9. Use the control cable for the 42AP to connect it to the COM port of the Adapter Cable with Optical Isolation and then connect this cable to a USB port of the PXI Embedded Controller. (The PXI controller has one more USB slot than shown in the connection diagram.)

10. Use a LEMO-to-LEMO cable to connect the "To Power Module" LEMO-socket on the rear of the RA0192 to the Channel 1 LEMO "Input" on the 12AQ Power Module.

11. Use a BNC cable to connect the "From Power Module" BNC-socket on the rear of the RA0192 to the Channel 1 BNC "Output" on the 12AQ Power Module.

12. Use a LEMO-to-LEMO cable (AA0008) to connect the "Preamp Pistonphone" connector on the RA0192 to the (insert voltage) preamplifier to be mounted in the pistonphone stand.

13. Use a BNC cable to connect the "Actuator Supply" socket on the front panel of the RA0192 to the 14AA "AC Input" socket.

14. Connect the actuator to the "+800VDC" connector on the 14AA.

15. Use a LEMO-to-LEMO cable (AA0008) to connect the preamplifier to be mounted in the electrostatic actuator stand to the RA0192's "Preamp Actuator Stand" input.

PXI: Electrical Connections for Calibration of Externally Polarized Microphone Sets

PXI-based System Control and Data Acquisition

NI PXI-e 1071 PXI Express Chassis with Embedded Controller, Data Acquisition and I/O Cards

NI PXI - 6509 Digital I/O

NI PXI - 4461 24-bit 204.8 kS/s

AI0
AI1
AO0
AO1

NI PXIe 8101 Embedded Controller

DVI

RS232 Adapter Cable with Optical Isolation

Control Cable

Signal Switching

RAO192 Switch Box

To Power Module
Control Signals
From Power Module
Excitation Signal
Response Signal TEDS

Serial No. XXXXX
Made in Denmark

G.R.A.S.
Calibration System Switch Box
RAO192

Input Signal
Extended Frequency Range
Output Signal
Polarize Test Input
Polarized Test Input
Modulation 200V DC
To Polarize Input Adapter
Actuator Supply

Level Calibration Equipment

42AP Pistonphone in calibration stand

G.R.A.S.

Polarization and Supply Voltage

12AQ Power Module

Channel 1
Channel 2
Sys Clock
CCP Input
Mic. Input
Output
Ext. Supply
8-18VDC
RS232

Serial No. XXXX

Frequency Calibration Equipment

Electrostatic Actuator and Microphone Set Calibration Stand

14AA Actuator Supply

G.R.A.S.
Actuator Supply
Type 14AA

Power On
Overload
AC Output ±100V DC
GND
AC Input Max. 18Vdc
AC Output
AC Output ±100V DC

Serial No. XXXXX

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PXI: Connections for Test of Externally Polarized Microphone Sets

Important: All electrical devices must be switched off while you are setting up the 90CA.

1. Use the gray 50-position ribbon cable to connect the 6509 Digital I/O card to the "Control Signal" socket on Switch Box RA0192 (socket on the rear).

2. Plug the BNC T-connector (two-way splitter) into the "AO 0" socket (output 0) on the NI 4461 Dynamic Signal Acquisition Board.

3. Use a BNC cable to connect one branch of the BNC T-connector to "AI 0" socket (input 0) on the NI 4461 Dynamic Signal Acquisition Board.

4. Use a BNC cable to connect the other branch of the BNC T-connector to the "Excitation Signal" socket on the RA0192 Switch Box (socket on the rear).

5. Use a BNC cable to connect the "AI 1" input socket on the NI 4461 Dynamic Signal Acquisition Board to the "Response Signal" BNC connector on the RA0192 Switch Box (socket on the rear).

6. Connect the keyboard to one of the USB slots on the PXIe 8101 Embedded Controller.

7. Connect the mouse to the other USB slot on the PXIe 8101 Embedded Controller.

8. Connect the monitor to the DVI socket on the PXIe 8101 Embedded Controller

9. Use the control cable for the 42AP to connect it to the COM port of the Adapter Cable with Optical Isolation and then connect this cable to a USB port of the PXI Embedded Controller. (The PXI controller has one more USB slot than shown in the connection diagram.)

10. Use a LEMO-to-LEMO cable to connect the "To Power Module" LEMO-socket on the rear of the RA0192 to the Channel 1 LEMO "Input" on the 12AQ Power Module.

11. Use a BNC cable to connect the "From Power Module" BNC-socket on the rear of the RA0192 to the Channel 1 BNC "Output" on the 12AQ Power Module.

12. *For Level calibration:* Use a LEMO-to-LEMO cable (AA0008) to connect the "Preamp Pistonphone" connector on the RA0192 to the microphone set to be mounted in the pistonphone stand.

    For Frequency calibration: Use the same cable to connect the "Preamp Pistonphone" connector on the RA0192 Switch Box to the microphone set to be mounted in the microphone set calibration stand.

13. Use a BNC cable to connect the "Actuator Supply" socket on the front panel of the RA0192 to the 14AA "AC Input" socket.

14. Connect the actuator to the "+800VDC" connector on the 14AA.

PXI: Electrical Connections for Calibration of Prepolarized Microphone Sets

PXI-based System Control and Data Acquisition

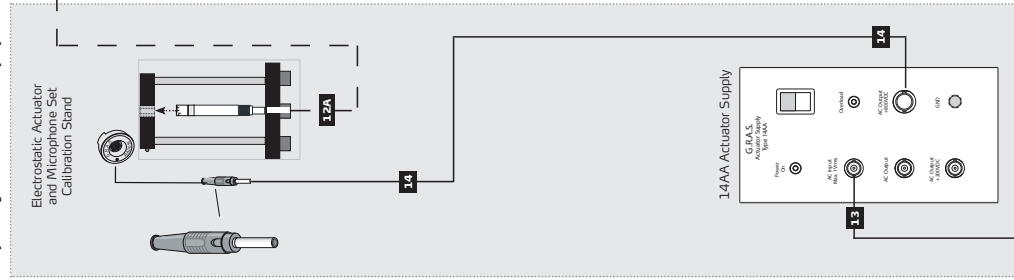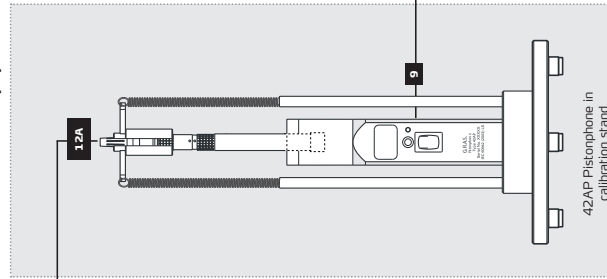NI PXIe 1071 PXI Express Chassis with Embedded Controller, Data Acquisition and I/O Cards

NI PXI - 6509 Digital I/O

NI PXI - 4461 24-bit 204.8 kS/s

AI0
AI1
AO0
AO1

NI PXIe 8101 Embedded Controller

DVI

RS232 Adapter Cable with Optical Isolation

Control Cable

Level Calibration Equipment

42AP Pistonphone in calibration stand

Frequency Calibration Equipment

Electrostatic Actuator and Microphone Set Calibration Stand

Signal Switching

RA0192 Switch Box

G.R.A.S.
Calibration System Switch Box
RA0192

Polarization and Supply Voltage

12AQ Power Module

Channel 1
Channel 2

G.R.A.S.

14AA Actuator Supply

G.R.A.S.
Actuator Supply
Type 14AA

PXI: Connections for Test of Prepolarized Microphone Sets

Important: All electrical devices must be switched off while you are setting up the 90CA.

1. Use the gray 50-position ribbon cable to connect the 6509 Digital I/O card to the "Control Signal" socket on Switch Box RA0192 (on the rear).

2. Plug the BNC T-connector (two-way splitter) into the "AO 0" socket (output 0) on the NI 4461 Dynamic Signal Acquisition Board.

3. Use a BNC cable to connect one branch of the BNC T-connector to "AI 0" socket (input 0) on the NI 4461 Dynamic Signal Acquisition Board.

4. Use a BNC cable to connect the other branch of the BNC T-connector to the "Excitation Signal" socket on the RA 0192 Switch Box (socket on the rear).

5. Use a BNC cable to connect the "AI 1" input socket on the NI 4461 Dynamic Signal Acquisition Board to the "Response Signal" BNC connector on the RA0192 Switch Box (socket on the rear).

6. Connect the Keyboard to one of the USB slots on the PXIe 8101 Embedded Controller.

7. Connect the mouse to the other USB slot on the PXIe 8101 Embedded Controller.

8. Connect the Monitor to the DVI socket on the PXIe 8101 Embedded Controller

9. Use the control cable for the 42AP to connect it to the COM port of the Adapter Cable with Optical Isolation and then connect this cable to a USB port of the PXI Embedded Controller.(The PXI controller has one more USB slot than shown in the connection diagram.)

10. Use a LEMO-to-LEMO cable to connect the "To Power Module" LEMO-socket on the rear of the RA0192 to the Channel 1 LEMO "Input" on the 12AQ Power Module.

11. Use a BNC cable to connect the "From Power Module" BNC-socket on the rear of the RA0192 to the Channel 1 BNC "Output" on the 12AQ Power Module.

12. **(12A)** *For level calibration:* Use a BNC cable to connect the "Preamp Test Input" connector on the RA0192 to the microphone set in the Pistonphone Calibration Stand.

    For frequency calibration: Use the same BNC cable to connect the microphone set to be mounted in the Microphone Set Calibration Stand (AL0021) to the RA0192's "Preamp Test Input" .

13. Use a BNC cable to connect the "Actuator Supply" socket on the front panel of the RA0192 to the 14AA "AC Input" socket.

14. Connect the actuator to the "+800VDC" connector on the 14AA.

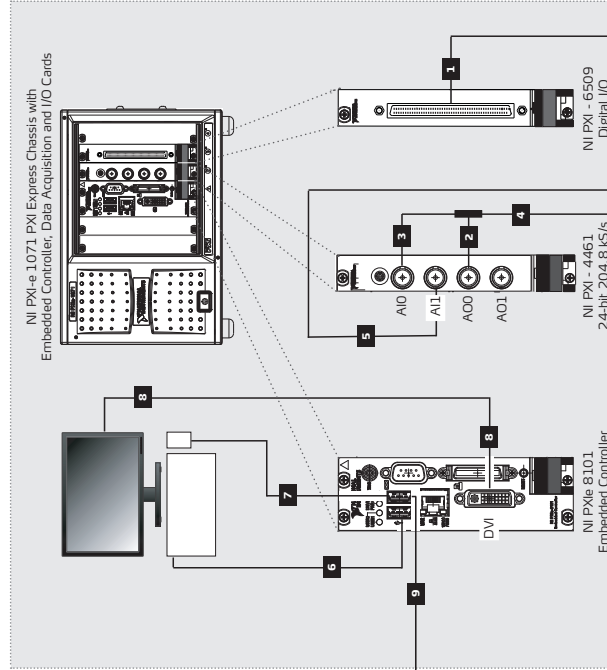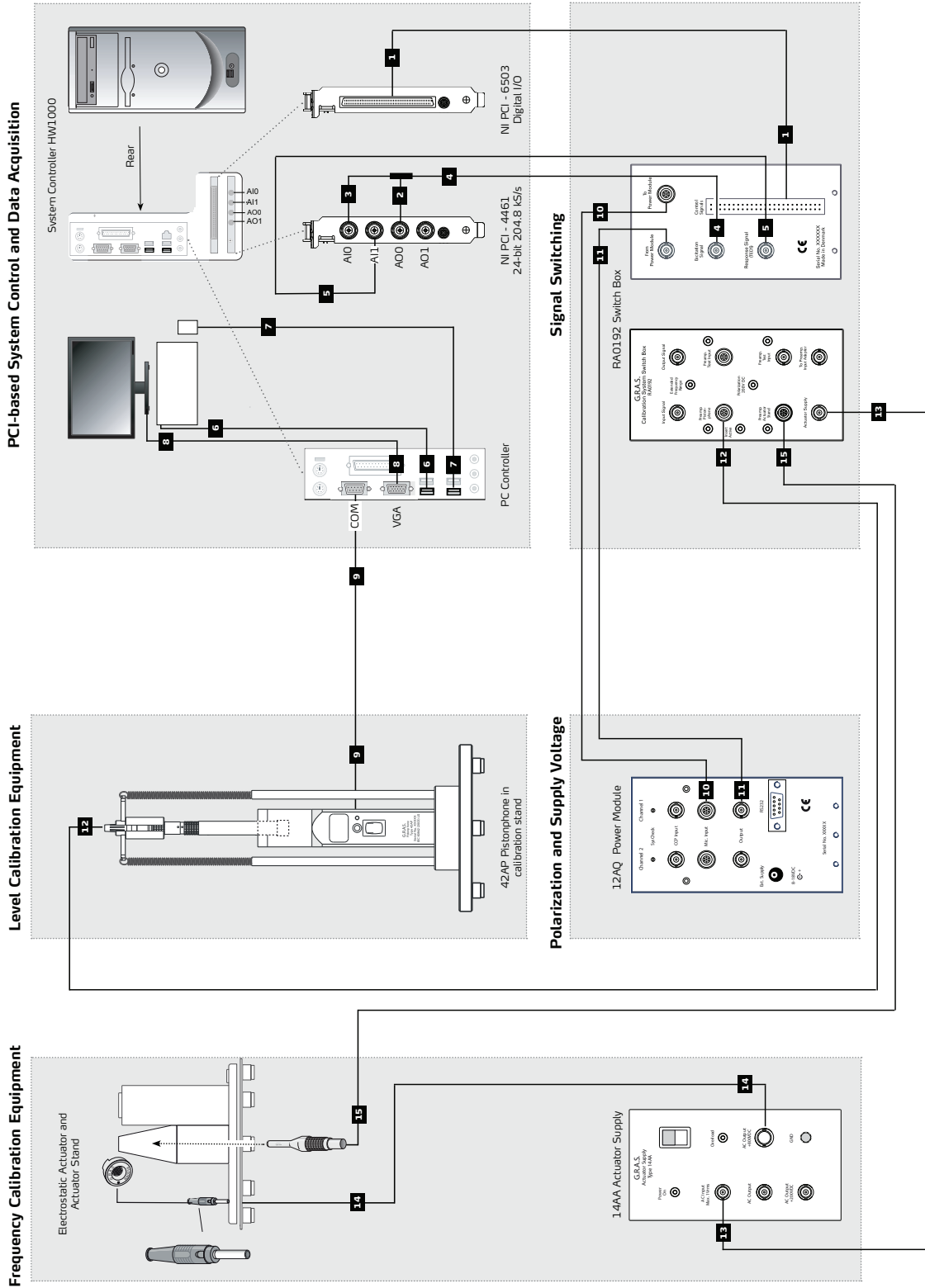# PCI: Electrical Connections for Calibration of Microphones (Ext. Pol. and Prepol.)

PCI-based System Control and Data Acquisition

System Controller HW1000

Rear

AI0
AI1
AO0
AO1

NI PCI - 6503
Digital I/O

NI PCI - 4461
24-bit 204.8 kS/s

AI0
AI1
AO0
AO1

PC Controller

COM

VGA

Signal Switching

RAO192 Switch Box

To Power Module

Control Signal

From Power Module

Excitation Signal

Response Signal

Serial No. XXXXXX
Made in Denmark

G.R.A.S.
Calibration System Switch Box
RAO192

Output Signal

Preamp Test Input

Preamp Test Input

To Preamp Test Board

Input Signal

Preamp Input

Excitation Frequency Meter

Polarization 200V DC

Preamp Output Meter

Preamp Actual Stand

Actuator Supply

Level Calibration Equipment

G.R.A.S.

42AP Pistonphone in calibration stand

Polarization and Supply Voltage

12AQ Power Module

Channel 1

Channel 2

SysCheck

CCP Input

Mic. Input

Output

RS232

Ext. Supply

8-16VDC

Serial No. XXXX X

G.R.A.S.

Frequency Calibration Equipment

Electrostatic Actuator and Actuator Stand

14AA Actuator Supply

Overload

AC Output 200VDC

GND

G.R.A.S.
Actuator Supply
Type 14AA

Power On

AC Input Max 10 Vrms
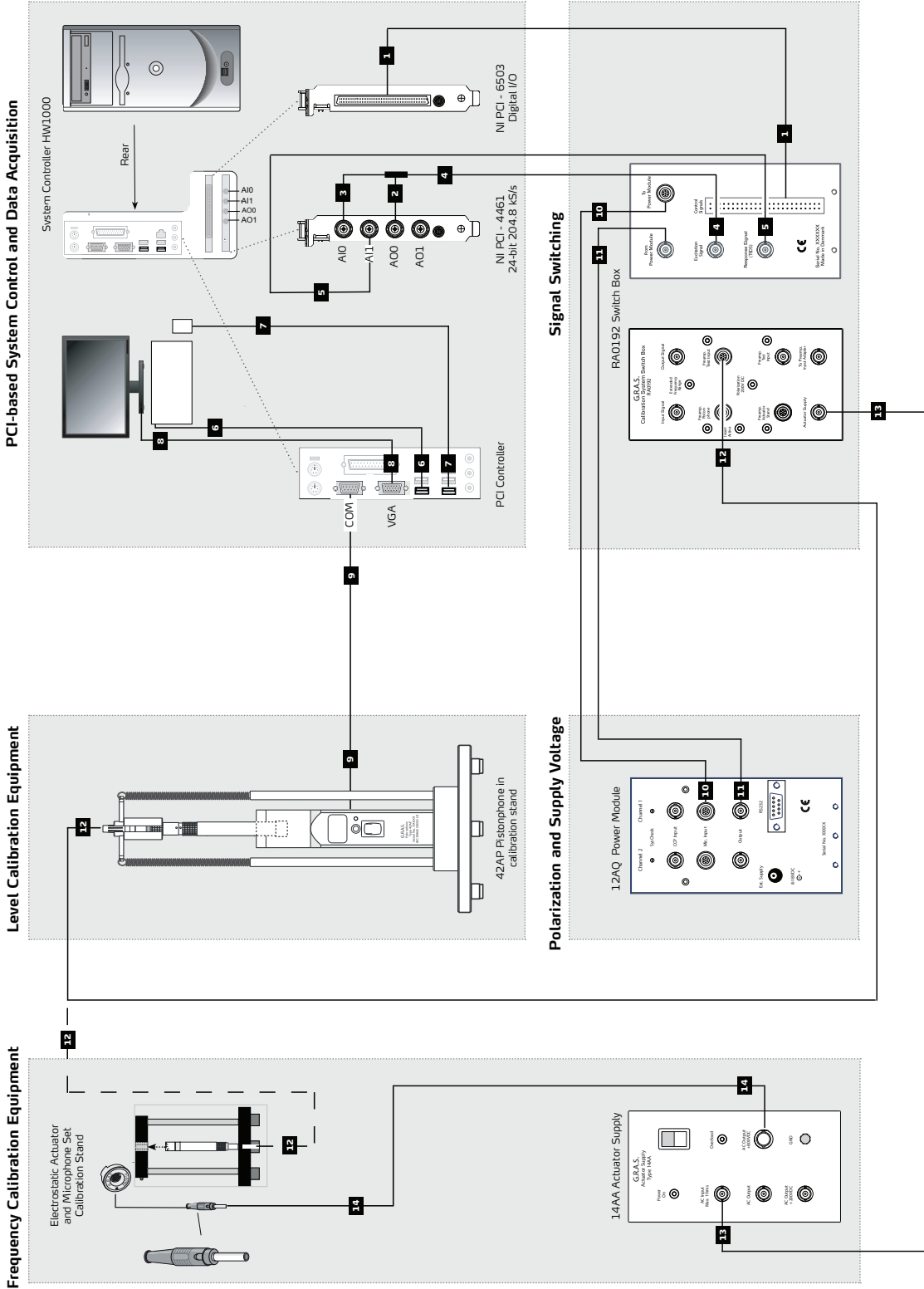
AC Output

AC Output ±200VDC

PCI: Connections for Test of Microphones (Ext. Pol. and Prepol.)

Important: All electrical devices must be switched off while you are setting up the 90CA.

1. Use the gray 50-position ribbon cable to connect the 6503 Digital I/O card to the "Control Signal" socket on Switch Box RA0192 (socket on the rear).

2. Plug the BNC T-connector (two-way splitter) into the "AO 0" socket (output 0) on the NI 4461 Dynamic Signal Acquisition Board.

3. Use a BNC cable to connect one branch of the BNC T-connector to "AI 0" socket (input 0) on the NI 4461 Dynamic Signal Acquisition Board.

4. Use a BNC cable to connect the other branch of the BNC T-connector to the "Excitation Signal" socket on the RA0192 Switch Box (socket on the rear).

5. Use a BNC cable to connect the "AI 1" input socket on the NI 4461 Dynamic Signal Acquisition Board to the "Response Signal" BNC connector on the RA0192 Switch Box (socket on the rear).

6. Connect the keyboard to one of the USB slots on the PC.

7. Connect the mouse another USB slot on the PC.

8. Connect the monitor to the VGA socket on the PC.

9. Use the control cable for the 42AP to connect it to the COM port of the computer (PCI controller).

10. Use a LEMO-to-LEMO cable to connect the "To Power Module" LEMO-socket on the rear of the RA0192 to the Channel 1 LEMO "Input" on the 12AQ Power Module.

11. Use a BNC cable to connect the "From Power Module" BNC-socket on the rear of the RA0192 to the Channel 1 BNC "Output" on the 12AQ Power Module.

12. Use a LEMO-to-LEMO cable (AA0008) to connect the "Preamp Pistonphone" connector on the RA0192 to the (insert voltage) preamplifier to be mounted in the pistonphone stand.

13. Use a BNC cable to connect the "Actuator Supply" socket on the front panel of the RA0192 to the 14AA "AC Input" socket.

14. Connect the actuator to the "+800VDC" connector on the 14AA.

15. Use a LEMO-to-LEMO cable (AA0008) to connect the preamplifier to be mounted in the electrostatic actuator stand to the RA0192's "Actuator Stand".

PCI: Electrical Connections for Calibration of Externally Polarized Microphone Sets
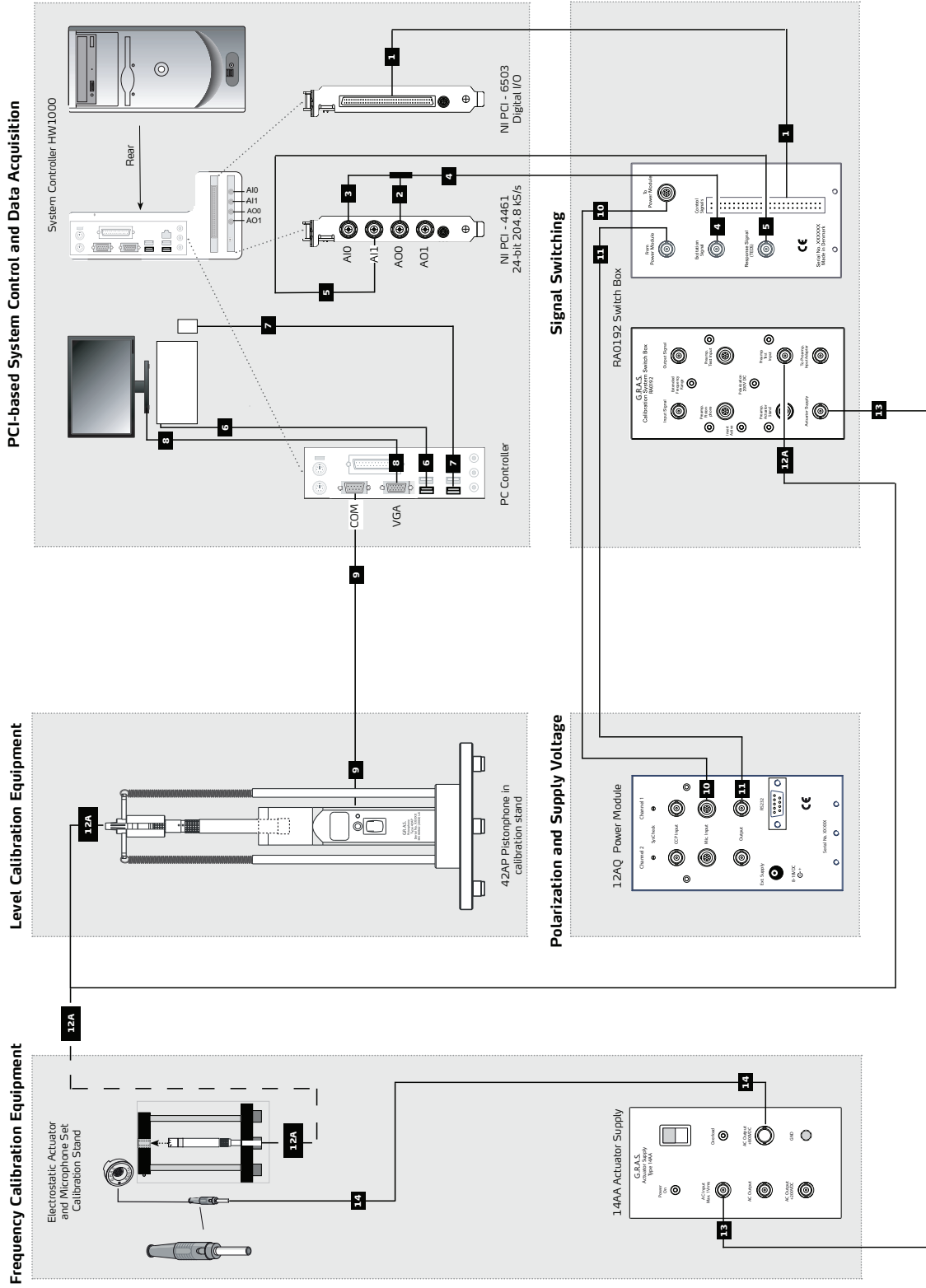
PCI-based System Control and Data Acquisition

System Controller HW1000

Rear

NI PCI - 6503
Digital I/O

AI0
AI1
AO0
AO1

NI PCI - 4461
24-bit 204.8 kS/s

AI0
AI1
AO0
AO1

PCI Controller

COM
VGA

Level Calibration Equipment

G.R.A.S.

42AP Pistonphone in
calibration stand

Frequency Calibration Equipment

Electrostatic Actuator
and Microphone Set
Calibration Stand

G.R.A.S.
Actuator Supply
Type 14AA

14AA Actuator Supply

Power
On

AC Volt.
Max. Volts

AC Output

AC Output
± 800VDC

Overload

AC Output
+800VDC

GND

Signal Switching

To
Power Module

Control
Signal

From
Power Module

Excitation
Signal

Response Signal

Serial No. XXXXXX
Made in Denmark

RA0192 Switch Box

G.R.A.S.
Calibration System Switch Box
RA0192

Input Signal

Output Signal

Polar.
Test Input

External
Frequency
Range

Polarization
(200V DC)

Polar.
Micro-
phone

Polar.
Test
Input

Polar.
Actuator
Stand

Test
Area

To Power
Module Input

Actuator Supply

Polarization and Supply Voltage

12AQ Power Module

Channel 1

Channel 2

Sys. Check

CCP Input

Mic. Input

Output

Ext. Supply

RS232

± 100 DC

Serial No. XXXXX

PCI: Connections for Test of Externally Polarized Microphone Sets

**Important**: All electrical devices must be switched off while you are setting up the 90CA.

1. Use the gray 50-position ribbon cable to connect the 6503 Digital I/O card to the "Control Signal" socket on Switch Box RA0192 (socket on the rear).

2. Plug the BNC T-connector (two-way splitter) into the "AO 0" socket (output 0) on the NI 4461 Dynamic Signal Acquisition Board.

3. Use a BNC cable to connect one branch of the BNC T-connector to "AI 0" socket (input 0) on the NI 4461 Dynamic Signal Acquisition Board.

4. Use a BNC cable to connect the other branch of the BNC T-connector to the "Excitation Signal" socket on the RA0192 Switch Box (socket on the rear).

5. Use a BNC cable to connect the "AI 1" input socket on the NI 4461 Dynamic Signal Acquisition Board to the "Response Signal" BNC connector on the RA0192 Switch Box (socket on the rear).

6. Connect the keyboard to one of the USB slots on the PC

7. Connect the mouse another USB slot on the PC.

8. Connect the monitor to the VGA socket of the PC.

9. Use the control cable for the 42AP to connect it to the COM port of the computer (PCI controller).

10. Use a LEMO-to-LEMO cable to connect the "To Power Module" LEMO-socket on the rear of the RA0192 to the Channel 1 LEMO "Input" on the 12AQ Power Module.

11. Use a BNC cable to connect the "From Power Module" BNC-socket on the rear of the RA0192 to the Channel 1 BNC "Output" on the 12AQ Power Module.

12. *For level calibration:* Use a MEMO cable to connect the "Preamp Test Input" con-nector on the RA0192 to the microphone set in the pistonphone calibration stand.

    For frequency calibration: Use the same LEMO cable to connect the microphone set to be mounted in the microphone set calibration stand (AL0021) to the RA0192's "Preamp Test Input" .

13. Use a BNC cable to connect the "Actuator Supply" socket on the front panel of the RA0192 to the 14AA "AC Input" socket.

14. Connect the actuator to the "+800VDC" connector on the 14AA

PCI: Electrical Connections for Calibration of Prepolarized Microphone Sets

PCI-based System Control and Data Acquisition

System Controller HW1000

Rear

AI0
AI1
AO0
AO1

NI PCI - 6503
Digital I/O

NI PCI - 4461
24-bit 204.8 kS/s

AI0
AI1
AO0
AO1

PC Controller

COM
VGA

Signal Switching

RA0192 Switch Box

To Power Module
Control Signal
From Power Module
Rotation Signal
Response Signal TEDS

Serial No. XXXXX
Made in Denmark

G.R.A.S.
Calibration System
RA0192

Input Signal
Output Signal
External Polarization Voltage
Polarization 200V AC
Polarization Test Field
Polarization Test Field
Polarization Test Field
Polarization Test Field
To Preamp Input/Output
Actuator Supply

Level Calibration Equipment

42AP Pistonphone in calibration stand

G.R.A.S.

Polarization and Supply Voltage

12AQ Power Module

Channel 2
Channel 1
SysCheck
CCP Input
MIC Input
Output
RS232

Ext Supply
8-18VDC

Serial No. XXXX

Frequency Calibration Equipment

Electrostatic Actuator
and Microphone Set
Calibration Stand

14AA Actuator Supply

G.R.A.S.
Actuator Supply
Type 14AA

Power On
AC Input Max 10ms
AC Output
AC Output >200VDC
Overload
AC Output >200VDC
GND

PCI: Connections for Test of Prepolarized Microphone Sets

Important: All electrical devices must be switched off while you are setting up the 90CA.

1. Use the gray 50-position ribbon cable to connect the 6503 Digital I/O card to the "Control Signal" socket on Switch Box RA0192 (on the rear).

2. Plug the BNC T-connector (two-way splitter) into the "AO 0" socket (output 0) on the NI 4461 Dynamic Signal Acquisition Board.

3. Use a BNC cable to connect one branch of the BNC T-connector to "AI 0" socket (input 0) on the NI 4461 Dynamic Signal Acquisition Board.

4. Use a BNC cable to connect the other branch of the BNC T-connector to the "Excitation Signal" socket on the RA 0192 Switch Box (socket on the rear).

5. Use a BNC cable to connect the "AI 1" input socket on the NI 4461 Dynamic Signal Acquisition Board to the "Response Signal" BNC connector on the RA0192 Switch Box (socket on the rear).

6. Connect the keyboard to one of the USB slots on the PC.

7. Connect the mouse to another USB slot on the PC.

8. Connect the monitor to the VGA socket on the PC.

9. Use the control cable for the 42AP to connect it to the COM port of the NI PXIe 8101 Embedded Controller.

10. Use a LEMO-to-LEMO cable to connect the "To Power Module" LEMO-socket on the rear of the RA0192 to the Channel 1 LEMO "Input" on the 12AQ Power Module.

11. Use a BNC cable to connect the "From Power Module" BNC-socket on the rear of the RA0192 to the Channel 1 BNC "Output" on the 12AQ Power Module.

12. **(12A)** *For level calibration:* Use a BNC cable to connect the "Preamp Test Input" connector on the RA0192 to the microphone set in the pistonphone calibration stand.

    For frequency calibration: Use the same BNC cable to connect the microphone set to be mounted in the microphone set Calibration stand (AL0021) to the RA0192's "Preamp Test Input" .

13. Use a BNC cable to connect the "Actuator Supply" socket on the front panel of the RA0192 to the 14AA "AC Input" socket.

14. Connect the actuator to the "+800VDC" connector on the 14AA.

Assembling the 90CA

This section describes the assembly of the stands for the 90CA, as well as the mounting of the microphones, preamplifiers, and accessories.

Assembling the Calibration Stand

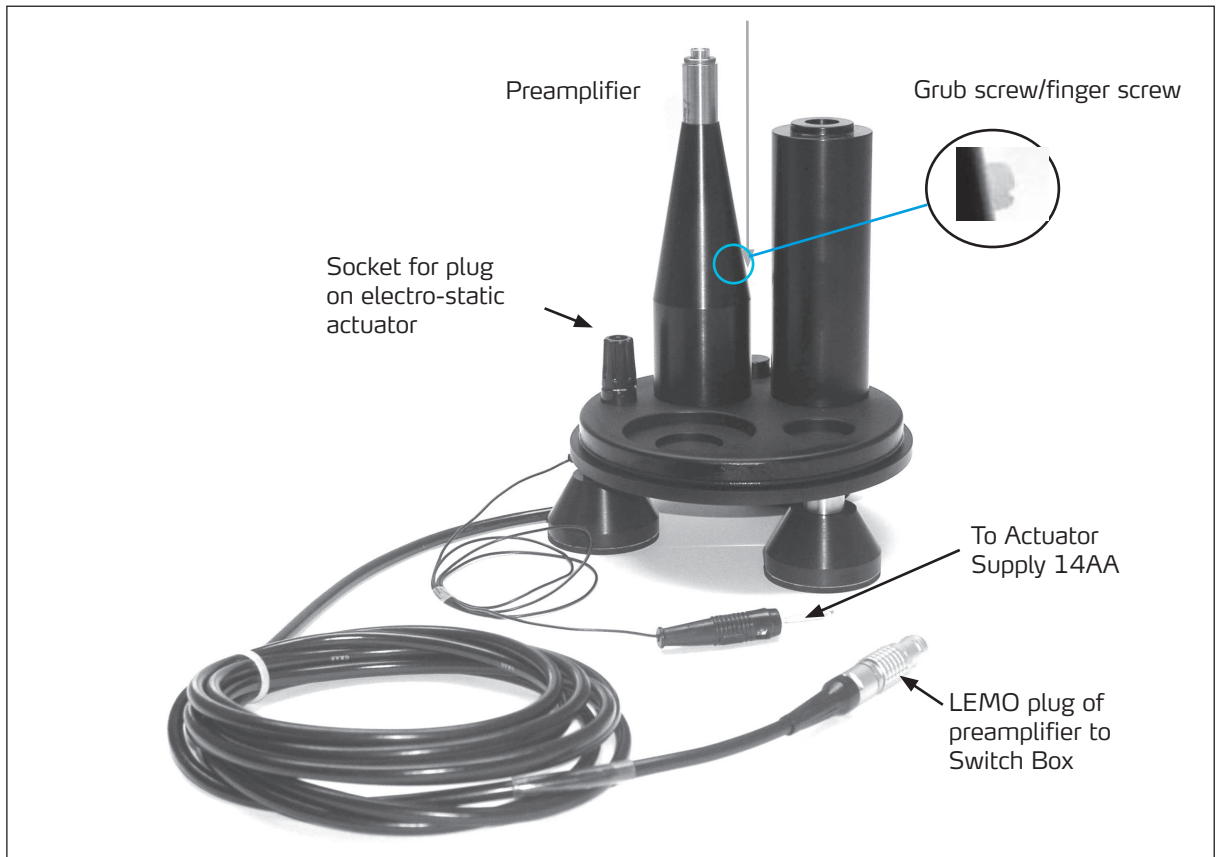Mount the preamplifier onto the pistonphone calibration stand:
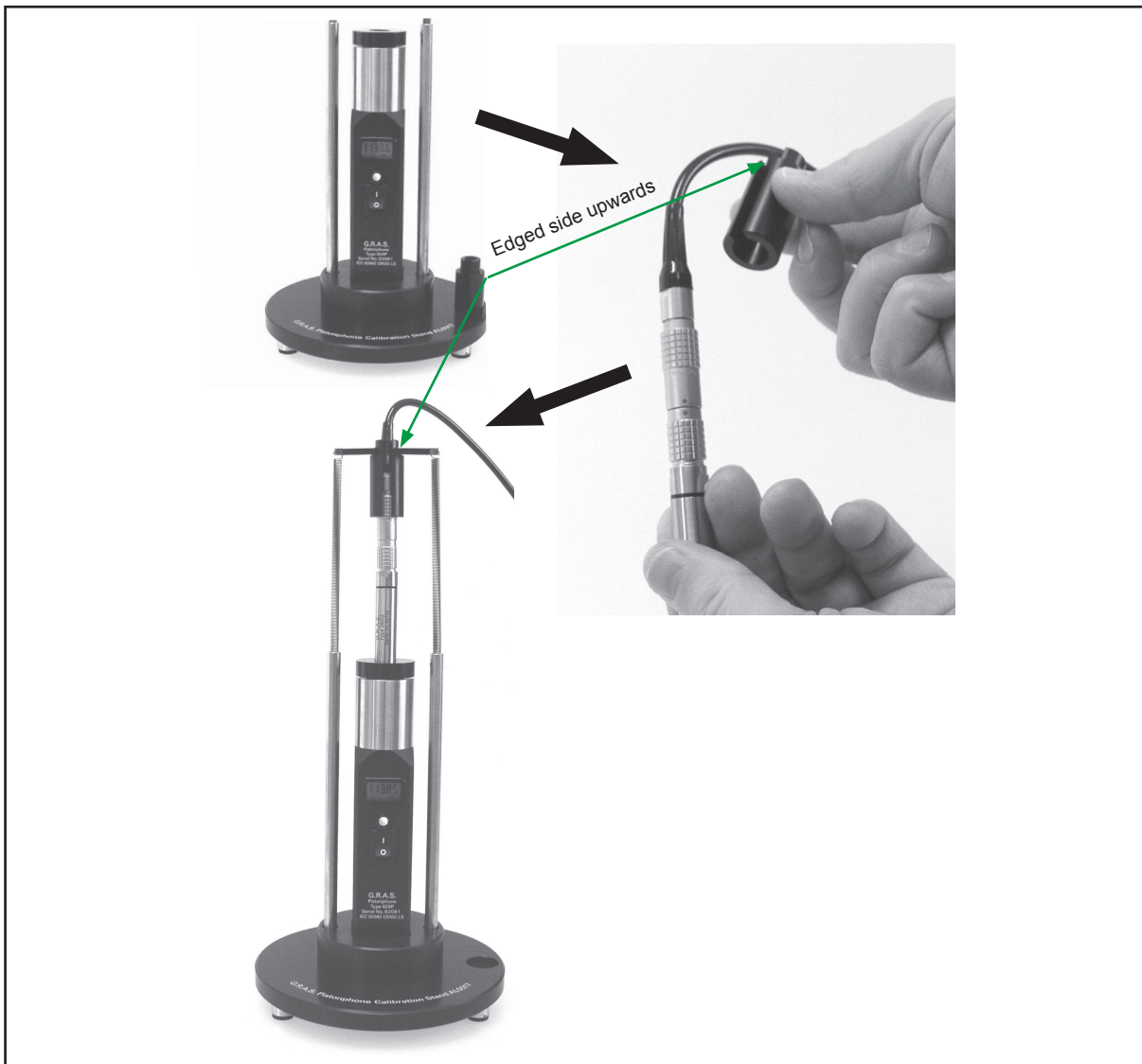
1. Using the cable labeled 12 or 12A in the electrical connections diagrams on the previous pages, connect the preamplifier to the input of the RA0192 Switchbox.

2. Connect the COM port of the computer with the 42AP control input using the control cable delivered with the 42AP (the cable labeled 9 shown in the electrical connections diagrams).

Actuator Stand Assembly

1. Insert the preamplifier into the actuator calibration stand AL0010
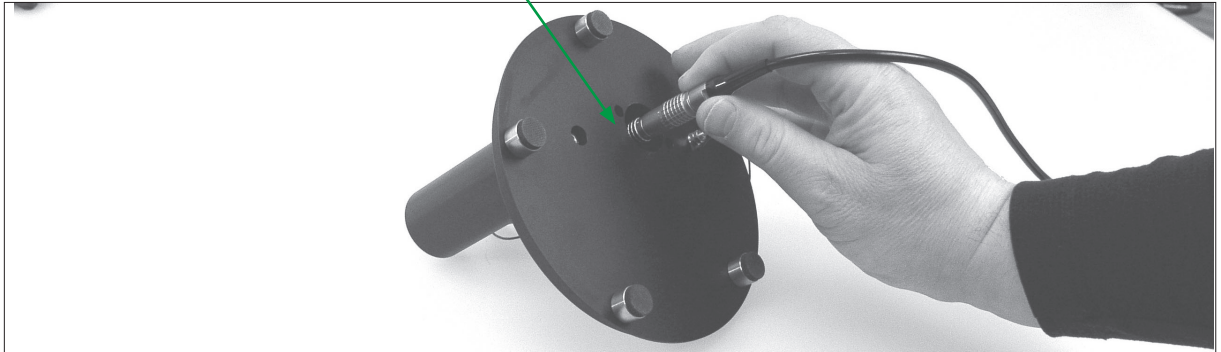
2. Secure the preamplifier with the grub screw/finger screw (shown in the following figure)

Preamplifier   Grub screw/finger screw

Socket for plug on electro-static actuator

To Actuator Supply 14AA

LEMO plug of preamplifier to Switch Box

3. Connect the actuator to the "+800 V DC" connector on the 14AA.

4. Connect the preamplifier to the RA0192 Switch Box using the cable labeled 12A/15 (LEMO to LEMO) in the electrical connections diagrams.

Settings for the Instruments included in the System

In addition to the instructions in this section, always read the manuals supplied with the individual products.

Power Module 12AQ

For all types of microphones, the following settings apply

- Polarization: 200 V

- Gain: "0"

- Filter: "High Pass"

- Preamp Voltage: ±60 V

Note: The system automatically compensates for the free-field correction of free-field microphones. For prepolarized microphones, the polarization voltage is automatically switched off, that is, you do not have to manually switch the RA0192 polarization switch from 200 V to 0 V).

Electrostatic Actuator Amplifier 14AA

This amplifier must be set to the correct local mains power voltage. Default setting is 230 V AC. For information about changing the setting, see the 14AA manual.

Precautions for certain Types of Microphones

Frequency calibration of 1" microphones

Be extremely careful not to scratch the microphone diaphragm when using the RA0015. The three glass pins at the RA0015 electrostatic actuator for 1" microphones are designed to be placed directly on the edge of the microphone diaphragm.

Microphones with non-removable protection grid

Frequency calibration is not feasible for microphones with non-removable protection grids.

Powering on the 90CA

1. Connect the power cable and power supply for each device.

2. Turn on the power for each device.

Mounting the Microphones

⅛" Externally Polarized and Prepolarized G.R.A.S. Microphones

All the items you need for level and frequency calibration of an ⅛" G.R.A.S. microphone are shown on this page.
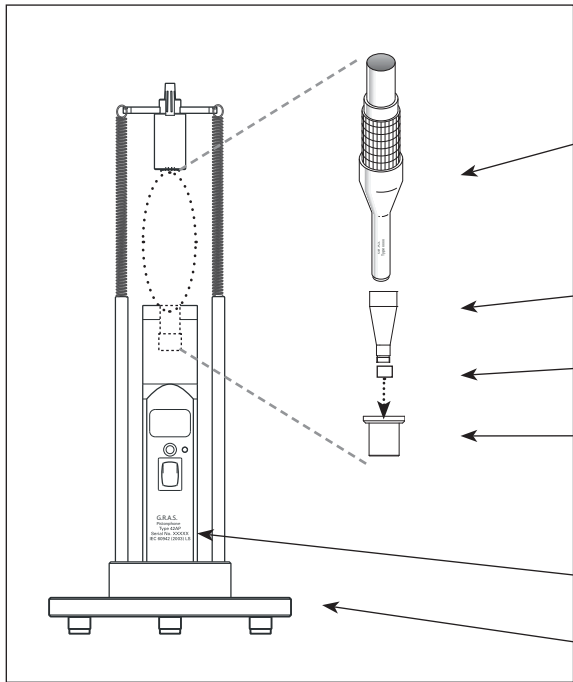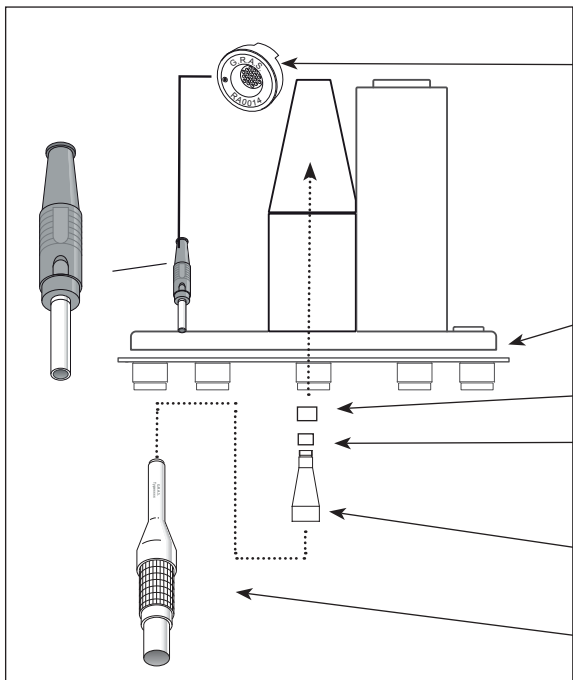
Level Calibration

26AN Preamplifier, insert voltage

RA0063 ⅛" to ¼" Adapter

⅛" microphone (DUT)

RA0069 ½" to ⅛" (Pistonphone) Adapter

42AP Pistonphone

AL0017 Calibration Stand

Frequency Calibration
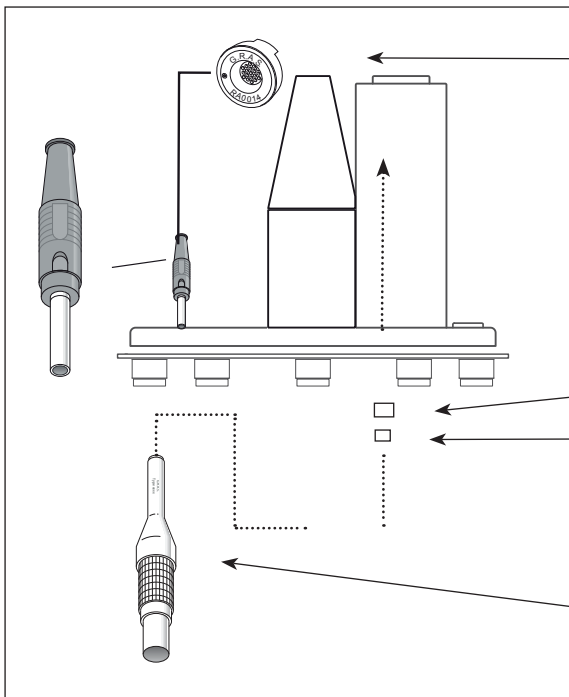
RA0014 Electrostatic Actuator
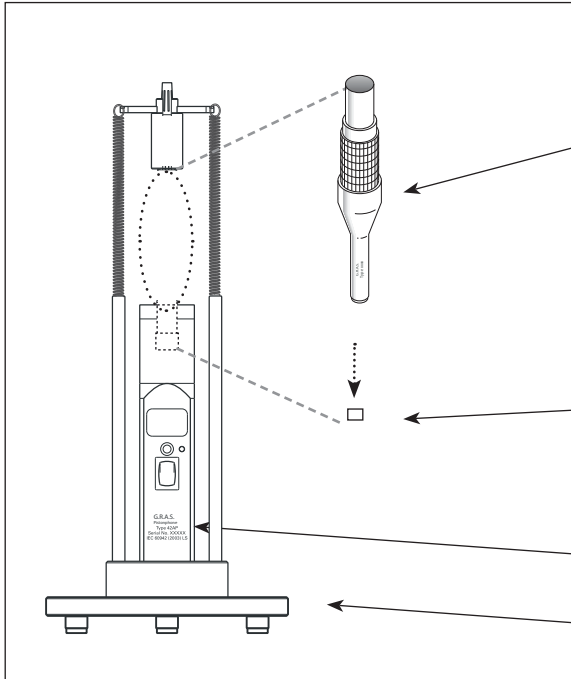
AL0010 Calibration Stand

GR0515 ⅛" to ¼" Adapter (for Actuator)

⅛" microphone (DUT)

RA0063 ⅛" to ¼" Adapter

26AB ¼" preamplifier with integrated LEMO connector

¼" Externally Polarized and Prepolarized G.R.A.S. Microphones

All the items you need for level and frequency calibration of an ¼" G.R.A.S. microphone are shown on this page.
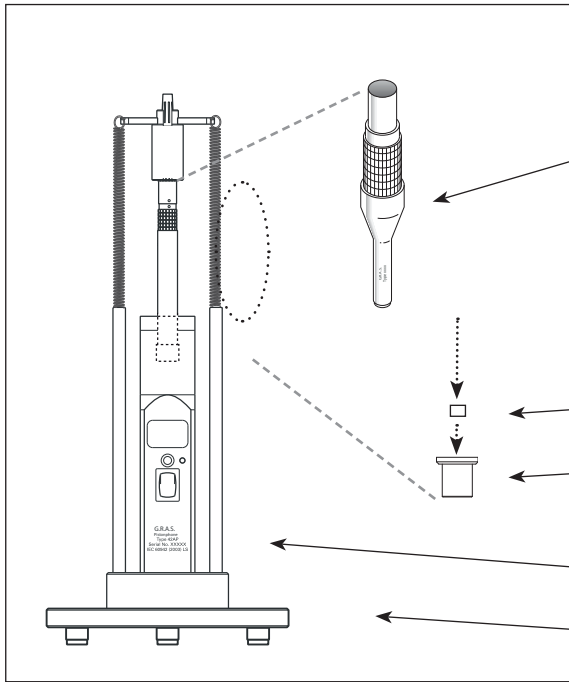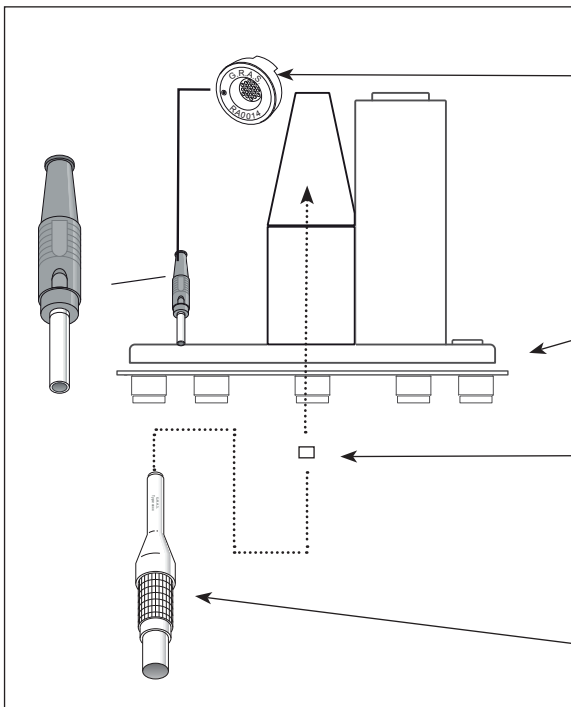
Level Calibration

26AN Preamplifier, insert voltage

¼" microphone (DUT)

RA0049 ¼" to ½" (Pistonphone) Adapter

42AP Pistonphone

AL0017 Calibration Stand

Frequency Calibration

RA0014 Electrostatic Actuator

AL0010 Calibration Stand

GR0324 ¼" to ½" Adapter (for Actuator)

¼" microphone (DUT)

26AB ¼" preamplifier with integrated LEMO connector

½" Externally Polarized and Prepolarized G.R.A.S. Microphones

All the items you need for level and frequency calibration of an ½" G.R.A.S. microphone are shown on this page.

Level Calibration

26AG ½" Preamplifier, insert voltage (26AN ¼" Preamplifier, insert voltage can be used with G.R.A.S. ½" microphones, as shown)

½" microphone (DUT)

42AP Pistonphone

AL0017 Calibration Stand

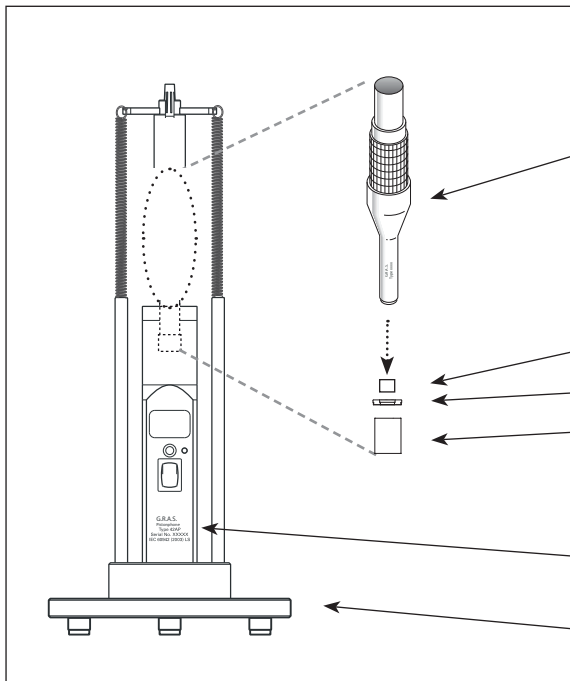**Frequency Calibration**

RA0014 Electrostatic Actuator

AL0010 Calibration Stand

½" microphone (DUT)

26AB ¼" preamplifier with integrated LEMO connector and AF0008 ¼" to ½" Adapter - for G.R.A.S microphones only. A 26AK ½" preamplifier can also be used.

1" Externally Polarized G.R.A.S. Microphones

All the items you need for level and frequency calibration of an ⅛" G.R.A.S. microphone are shown on this page. Only the Device Under Test is not included.

Level Calibration

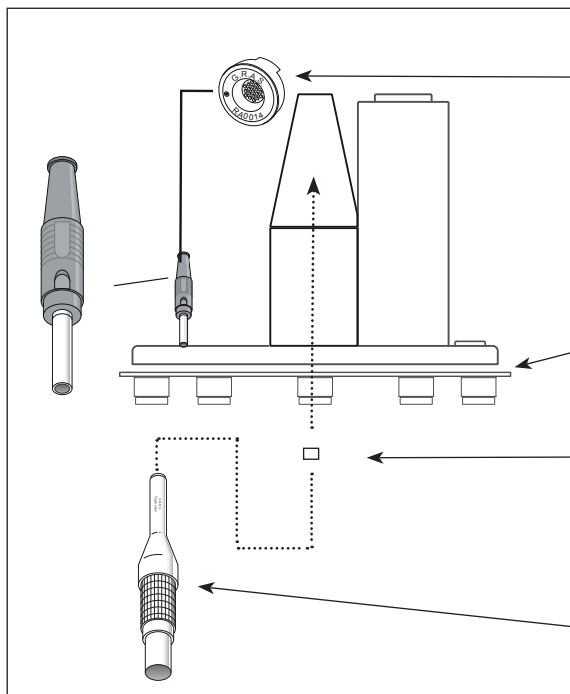26AG ½" Preamplifier, insert voltage

1" microphone (DUT)

RA0017 Adapter

RA0023 coupler replaces the standard coupler on the pistonphone (See manual for 42AP)

42AP Pistonphone.

AL0017 Calibration Stand

Frequency Calibration

RA0015 Electrostatic Actuator

AL0010 Calibration Stand

1" microphone (DUT)

26AB ½" preamplifier with integrated LEMO connector and RA0017 AdapterSystem Verification

Initial verification of the system setup

When you have assembled the 90CA, you can verify that the system is working properly by performing a calibration of the ½" 40AG pressure microphone that is included as reference.

Day-to-day Verification

The 90CA calibration system has been tested by G.R.A.S. Sound & Vibration and is delivered with a test certificate for the complete system, specific instruments, and their serial numbers listed. The 90CA is a very stable system that will calibrate to very tight tolerances.

For daily reference instruments check, use the 40AG Reference Microphone. We recommend a verification on a daily basis – or prior to each calibration session if the system is not used regularly.

This helps you to ensure that all system parameters remain stable. You can also ensure that your calibrations are traceable to a reference. The 40AG reference microphone is part of the 90CA for exactly this purpose.

The following figure shows an example of a log of a daily system verification. This verification consists of a level calibration of the 40AG, including the key parameters of the measurement: temperature, humidity, barometric pressure, and polarization voltage.

Calibration System Verification

System:
Primary Lab 1

Date	Time	Operator	Temperature	Humidity	Barometric Pressure	Reference Microphone	Sensitivity
		Initials	*°C*	*% RH*	*mBar*	*40AG* *Serial number*	*dB re 1V/Pa*
02 Jan 2012	10:45	RH	23.0	28	1006	46466	–39.42
03 Jan 2012	09:58	RH	23.0	31	0994	46466	–39.40
04 Jan 2012	10:14	RH	24.8	29	1022	46466	–39.41
09 Jan 2012	10:16	RH	24.0	31	1028	46466	–39.42
10 Jan 2012	07:20	PA	23.0	30	1030	46466	–39.42
11 Jan 2012	08:47	PA	21.9	32	0998	46466	–39.42
12 Jan 2012	07:59	RH	24.0	33	1011	46466	–39.44

Fig. 9. *Example of a calibration log*

Introducing the Calibration Software SW0002

The 90CA is delivered with the software preinstalled. It can be launched from the desktop as with any Windows application.

IMPORTANT. If you decide to install a new version of LabView, **DO NOT** uninstall the version that comes with the system, because if you do, the calibration software will not work properly, or at all.
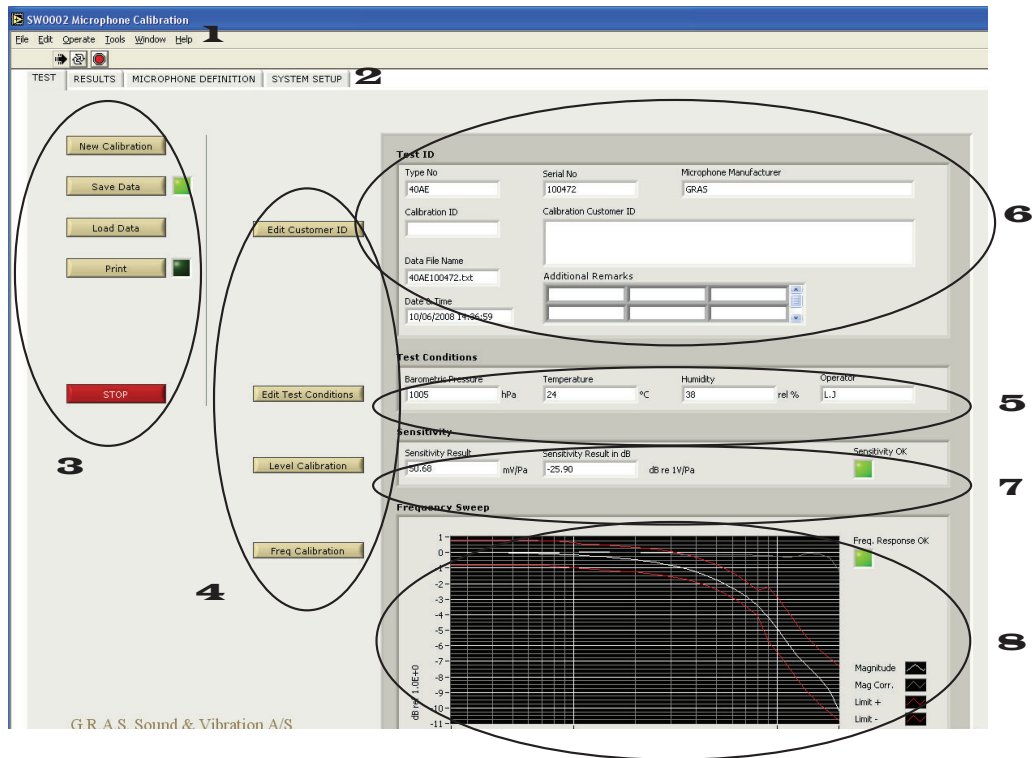
Fig. 10. The 90CA main window for microphone calibration

The main screen offers the following:

1. A conventional software menu bar

2. Tabs where you select the different parts of the calibration process: TEST, where you work during the calibration; RESULTS, where you view the data from your calibration; MICROPHONE DEFINITION; SYSTEM SETUP.

3. Buttons to start and stop calibration, to save, and to print.

4. Buttons for use during the calibration: Start Calibration, Level Calibration, Frequency Calibration, and Edit Test Conditions.

5. The "Test Conditions" you enter are displayed here (part 1 of Microphone Registration).

6. The "Test ID" you enter is displayed here (part 2 of Microphone Registration) .

7. Measured data for the level calibration is displayed here.

8. Measured data for the frequency calibration is displayed here.

In general, the indicators are green when the measurement is within the preset limits and red when the the measurement is outside the limits.

Calibrating Microphones and Microphone Sets

This section describes how to do a calibration of a microphone or microphone set. Your system should already be assembled and connected as described in "Assembling and Connecting the Hardware".

Note: For information about high-frequency calibration, see "High Frequency Calibration" on page 54.

Starting the System

Verify that all connections are correct and that the system is ready for calibration. We recommend a daily system verification using the 40AG as reference microphone. If such a verification is performed regularly, you can ensure that all parts of the system are performing properly and within specification. Keeping a daily log will ensure traceability and that any errors can be detected early.

1. Start up the system controller.

2. Switch on the 12AQ power module, the 14AA electrostatic actuator amplifier, and the 42AP pistonphone.

   Note: Allow up to 20 minutes for the power module to warm up (for the polarization voltage to stabilize.)

3. To start the calibration software, double-click on the desk-top icon:
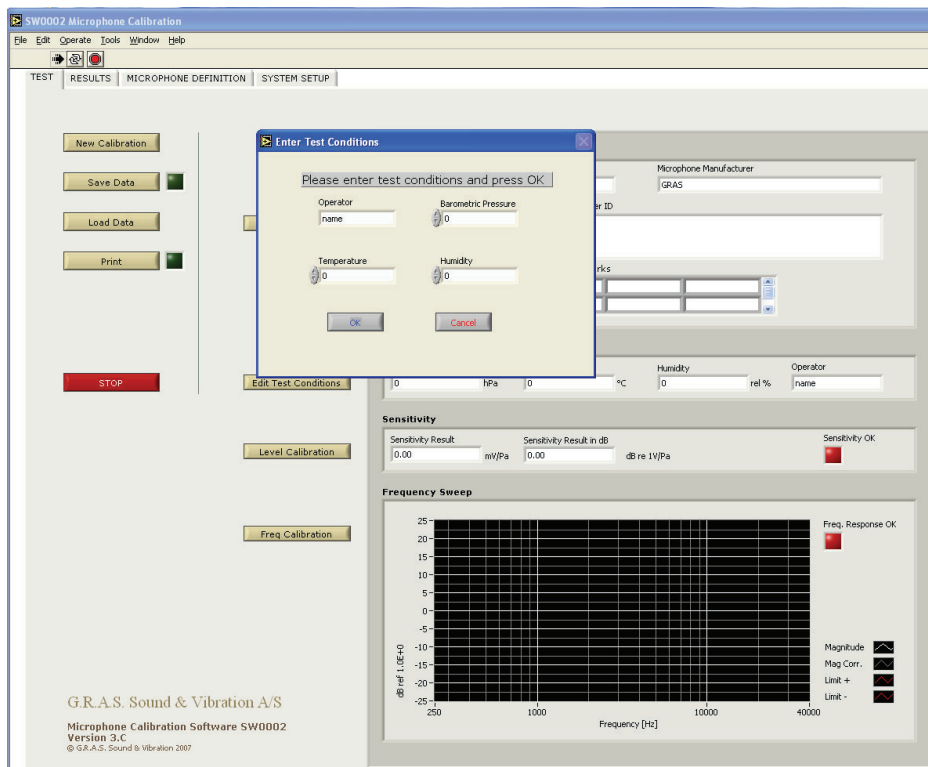
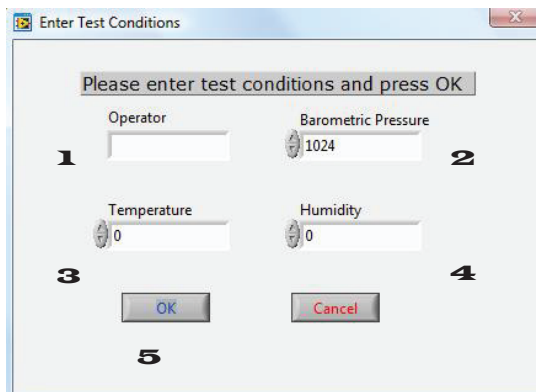   You can now choose Microphone Calibration or Microphone Set Calibration

Fig. 11. Selecting microphone calibration or microphone set calibration

4. Your screen displays the start-up screen with the Test Conditions dialog box in the foreground:
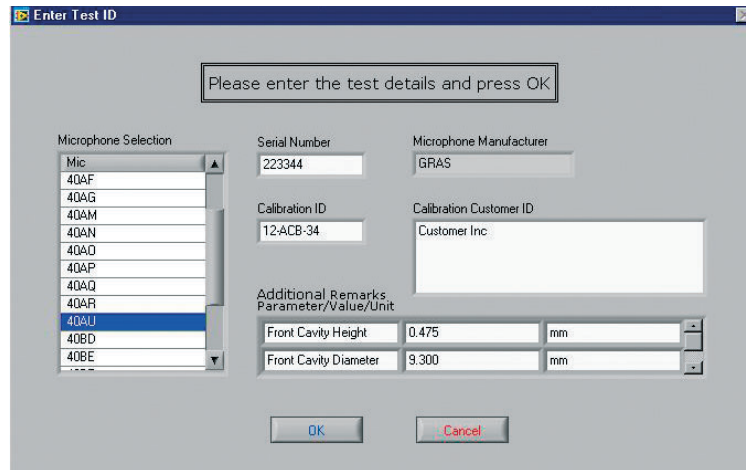
5. Enter Test Conditions:

1. Enter your name or other identification here.

2. The 42AP pistonphone supplies this information automatically. If the 42AP is not connected to the COM port, enter the barometric pressure [hPa] manually, e.g. "1005".

3. Type in the temperature [°C], e.g. "22 ".

4. Type in the relative humidity [%], e.g. "42".

5. To save your data, press "OK".

Step 1: Registering the Microphone

1. Click **New Calibration** and the Test Details dialog box opens. Select a microphone type from the list, enter serial number, Calibration ID, and Customer ID (if needed). The Microphone Manufacturer name is defined in the Microphone Definition File. The Additional Remarks are for any special remarks, such as front cavity height and diameter of a 40AU LS2aP microphone.

The system includes definitions for all G.R.A.S standard microphone types. For a non-G.R.A.S. microphone to appear in the selection menu, you must have registered the microphone in the Microphone Definition File.

2. Carefully inspect the microphone output terminal for dust and dirt. If necessary, clean with compressed air or a small brush.
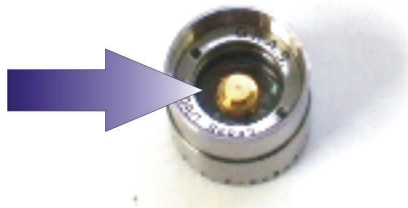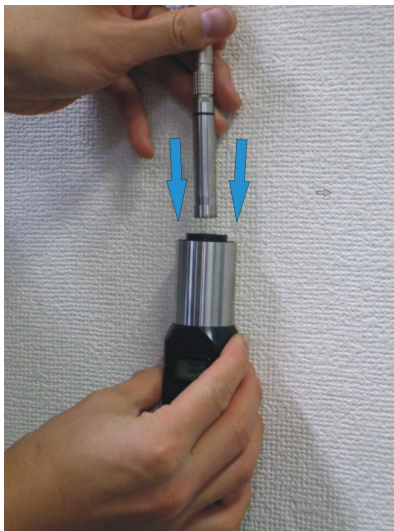
Step 2: Performing a Level Calibration

1. Mount the microphone onto the preamplifier:

    - 26AG for ½" microphones

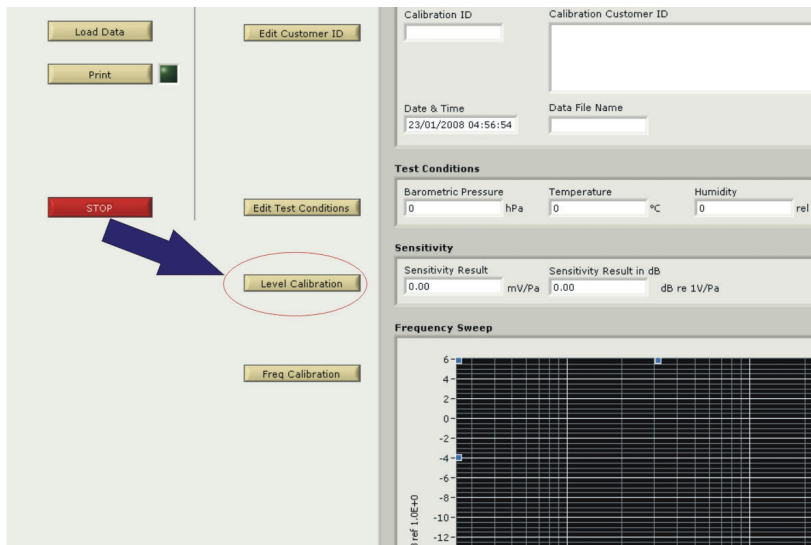   - 26AN for ¼" microphones

2. Place the microphone into the pistonphone 42AP.

    Note: Make sure the microphone is inserted all the way into the coupler.

3. In the main menu, click **Level calibration**.

The software measures the difference between open-circuit and closed-circuit sensitivity. The test has two different steps which appear automatically; first, a closed-circuit sensitivity measurement, and then an insert-voltage measurement to measure the open-circuit sensitivity.

In the first step, the closed circuit sensitivity measurement – two curves, gradually converging – are displayed:
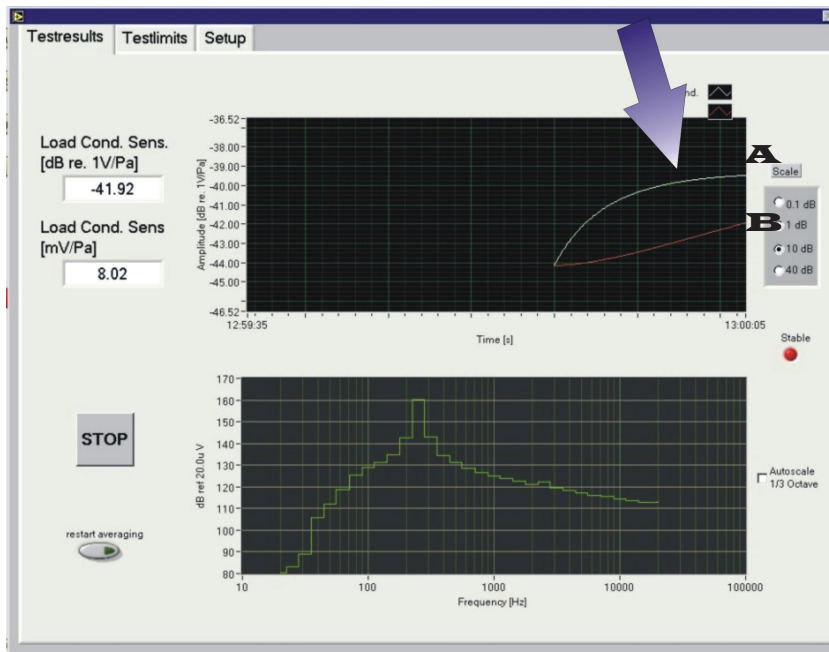
The top, white curve (**A**) represents the instantaneously measured sound pressure level:

The bottom, red curve (**B**) represents the averaged value of the sound pressure level.

4. The amplitude scale (**C**) is initially set to 10 dB. As the curves approach each other, it is recommended to downscale first to 1 dB, and finally to 0.1 dB:
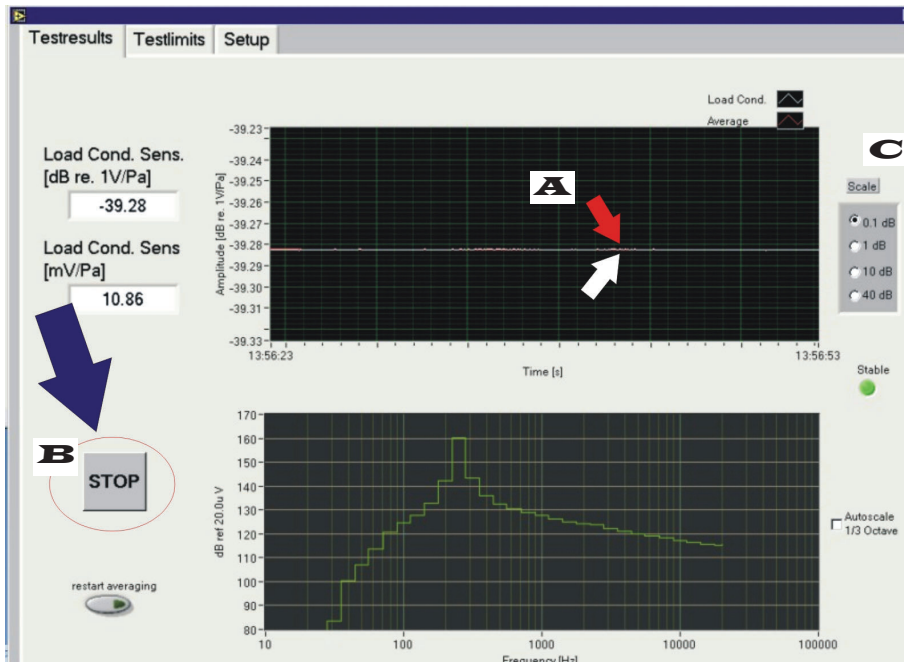

5. When the signals have stabilized (**A**), click **STOP** (**B**). Then, a new window opens and the software switches off the pistonphone (pistonphone LED red) and starts measuring the open-circuit sensitivity by the insert voltage method.

   Note: The scale (**C**) is set to 0.1 dB.

6. When the signals have stabilized, click **OK** and the sensitivity test is finished. Now in the main window, the open-circuit sensitivity will be displayed and an indicator will be green if the sensitivity is verified as OK compared to the microphone definitions.

Step 3: Performing a Frequency Response Calibration

1. Mount the microphone onto the preamplifier in the AL0010 Frequency Calibration Stand

2. Carefully unscrew the microphone protection grid.

3. Place the electrostatic actuator onto the microphone diaphragm

4. In the software main menu, click **FreqCalibration** and a new window opens. This window has a menu bar with the following features: Measurement, Test limits, Setup, and Debug. For measurement, it's only necessary to use the Measurement mode. The rest is only for debugging and information about the setup.

5. Then click **Start Measurement**

   The calibration system displays three curves and the upper and lower test limits for the specific microphone type:
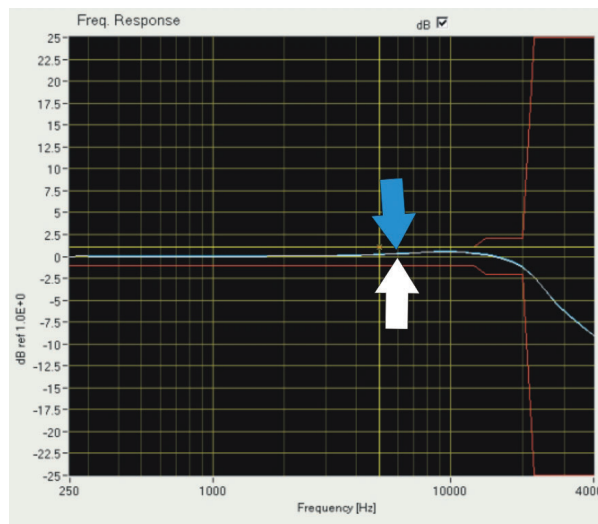
The white curve indicates the most recently measured level

The blue curve indicates the previously measured level.

The yellow curve indicates the free field corrections

The red lines indicate the upper and lower limits for the specific microphone

6. Run the test a couple of times to ensure the microphone capsule is vented. When the white and the blue curves have stabilized, click **Accept**.

   Note: If the "Overload" LED is red, the measurement is probably not valid.

Step 4: Storing Calibration Results

To store the data measured, click **Save Data**. The data will be stored at a path defined in the Microphone Definition File.

To generate a calibration certificate, click **Print**.

Note: The 90CA does not include a printer. You must install a printer to print certificates.
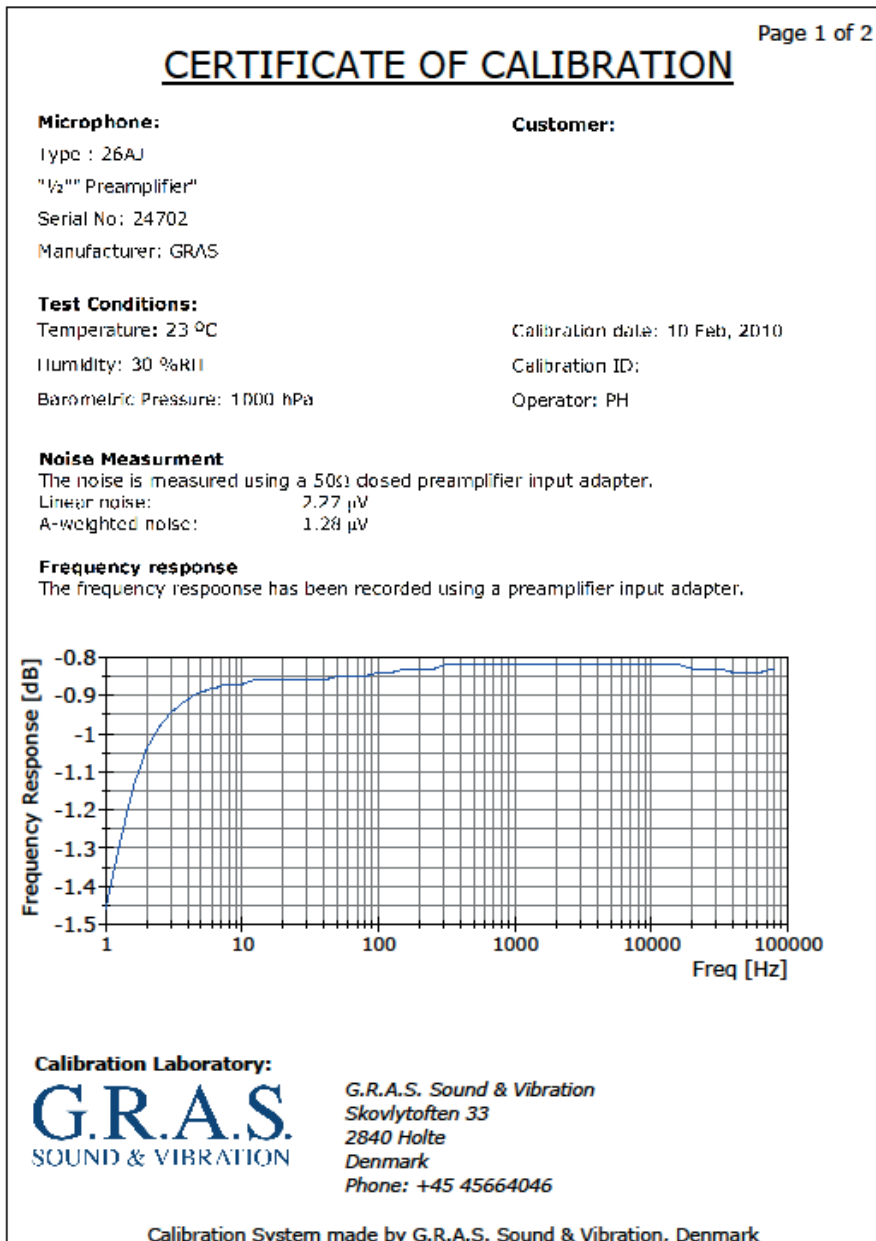

Fig. 12. *Typical G.R.A.S Calibration Chart*

Calibrating a Preamplifier

This section describes how you set up the system for calibration of the preamplifiers and walks you through a typical calibration workflow.

Note: Calibrating preamplifiers is an option package for the 90CA. (Option OP0020). All preamplifiers except insert-voltage preamplifiers and preamplifiers with SysCheck can be calibrated with the 90CA.

Note: For information about high-frequency calibration, see "High Frequency Calibration" on page 54.

Setting up the System for Preamplifier Calibration

The first step in preamplifier calibration is connecting the switchbox to the system. The following table shows which switchbox output to connect to either the system controller or the power module.

Switchbox Slot	Connect With	To
Excitation Signal	BNC cable	AO0 on NI Card 4461 in System Controller
Response Signal (TEDS)	BNC cable	AI1 on NI Card 4461 in System Controller
Control Signals	50-conductor ribbon cable	NI Card PCI-6503 in computer or PXI-6509 in PXie 1071 PXI Express Chassis
From Power Module	BNC cable	Output connector on power module
To Power Module	7-pin LEMO cable	Mic. Input connector on power module

The following image shows the connections between the switchbox and the power module.

When the switchbox is connected to the power module and the system controller, you are ready to use the software for running the calibration programs.

Step 1: Registering Test Conditions

In preparation for your calibration,

1. Disconnect all cables on the *front* panel of the RA0192 switchbox.

2. Connect the 42AP pistonphone to the power module and turn on the pistonphone.

3. On your PC desktop, start the preamplifier calibration by double-clicking the PreAmp calibration icon to open the software control panel.

4. When the software control panel opens, a smaller window also opens where you register the test conditions for the preamplifier.

5. Because the 42AP pistonphone is connected and turned on, the field for the **barometric pressure** in hPa is automatically filled in.

   You must provide

   — the initials or name of the person running this calibration (**operator**),

   — the current **temperature** in °C,

   — and the relative **humidity** in %.

6. Click **OK** to add the information; you are returned to the main screen.

There is one main window for the preamplifier calibration software. This window is shown in the following screenshot.
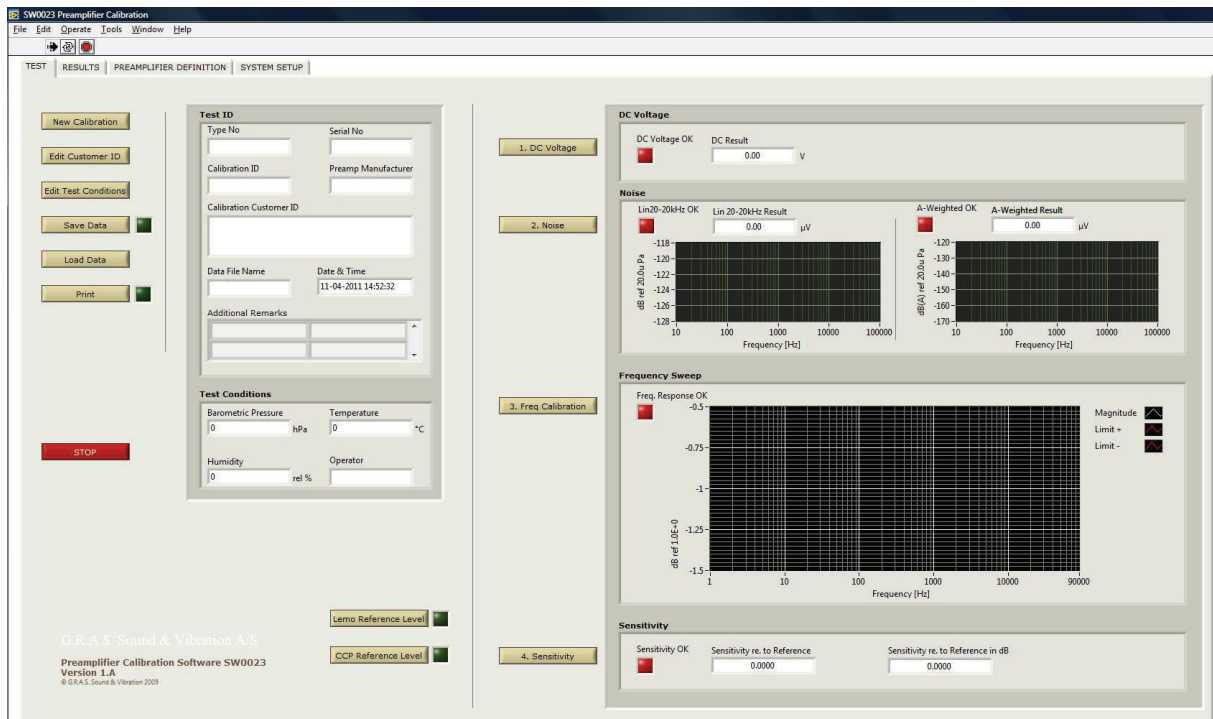
Fig. 13. *The 90CA main window for preamplifier calibration*

This main window is where you can

- **Start** a new calibration
- **Edit** the customer ID
- **Edit** the test conditions
- **Save** data to a .txt file

- **Load** data from a previously saved data file
- **Print**
- **Measure DC voltage** of a preamplifier

- Measure the **noise floor** (linear and A-weighted)
- Measure the **frequency response**
- Measure the **relative sensitivity**
- Measure the **LEMO reference level** (must be done before you can measure the sensitivity)
- Measure the **CCP reference level** (must be done before you can measure the sensitivity)
- **Stop** a calibration process

Registering a New Calibration

After you establish the test conditions, you can start a new calibration.

1. On the main screen, click **New Calibration**; a new window opens.

2. Select the correct preamplifier type that you are about to test.

3. Enter the serial number for the preamplifier.

    The remaining fields are optional and can be used to suit your classification system. Additional information can be valuable when you have a large amount of calibration data in your archives.

4. Click **OK**; this window closes and you return to the main screen.

Measure the DC Voltage

1. (Skip this step for preamplifiers with integrated cables.) Connect a cable to the RA0192 system switchbox connector called "Preamp. Test Input", choosing the cable according to the preamplifier's connector.

    —Use the AA0008 LEMO extension cable for LEMO connectors

    —Use the AA0018 microdot to BNC cable for microdot connectors

    —Use the AA0027 SMB-BNC connector cable for coaxial SMB connectors.

    —Use the AA0033 BNC 50-Ohm cable for BNC connectors.

2. Attach the AE0036 short circuit plug to the BNC connector end of the RA0062 preamplifier input adapter.

    The RA0062 is a 20 pF input adapter that is used as 20 pF dummy load on the preamplifier when you shortcircuit the BNC input.

3. Mount the RA0062 on the ½" preamplifier under test.

    For ¼" preamplifiers, attach a GR0010 adapter to the ¼" preamplifier and then attach the RA0062 preamplifier.

4. Connect the preamplifier to the cable. (Some preamplifiers already have an integrated cable.)

5. On the software main window, click **DC Voltage** to start the DC voltage measurement; a new window opens, which starts the measurement automatically.

6. You can monitor the current level in the DC value field and on the graph.

    The diode indicates whether the current level is within the test limits: green means it is OK; red means it is outside the limits.

7. When the measurement has stabilized and the "DC level OK" indicator is green, you can click **Stop**. The window closes and the measurement results are transferred to the main window.

When finished with the DC voltage measurement, you are ready to verify the self noise of the preamplifier. Leave the setup as it is.

Verify the Self Noise of the Preamplifier

With the same hardware setup as for the DC voltage measurement, you can measure the self noise of the preamplifier.

1. On the main window (the software panel), press **Noise**. A new window opens and the noise measurement starts automatically.

2. You can monitor the current level in the **Total Noise** field and on the two graphs.

   The diode indicates whether the current level is within the test limits: green means it is OK; red means it is outside the limits.

3. When the measurement has stabilized and the "20-20 kHz OK" and "A-Weighted OK" indicators are green, you can press **Stop**. The window closes and the measurement results are transferred to the main window.

After you record the DC voltage and self-noise, you are ready for the second step in calibration.

Step 2: Frequency Response

1. Remove the AE0036 short circuit BNC plug from RA0062.

2. Connect a BNC cable to the BNC connector on RA0062.

3. Connect the other end of the BNC cable to the system switchbox connector called "To Preamp. Input Adapter".

4. On the main window, click **Frequency Calibration**; a new window opens where you can start the frequency sweep measurement.

5. Click **Start Measurement**; the "Sweep in Progress" indicator switches on so it is a bright red light.

6. When the measurement is completed, the indicator switches off so the indicator is dark red.

   The diodes at the top of the window—Freq. OK, Upper Limit OK, and Lower Limit OK—indicate whether the measured sweep is within the test limits; green indicates it is within the limits.

7. When the sweep is finished and the results (the indicators) seem satisfactory), click **Accept** to close the window and transfer the measurement results to the main window.

   If you click **Cancel,** the window closes, but the measurement results are *not* transferred to the main window.

Note: The **Accept** and **Cancel** buttons are inactive during a sweep. Click **Stop Measurement** if you want to stop an active sweep.

This completes the frequency response calibration.

Step 3: LEMO Reference Level and Sensitivity Test

Measuring the LEMO reference level is a necessary step before measuring the sensitivity.

1. Remove the RA0062 from the preamplifier (and GR0010, if used).

2. Remove the preamplifier and its cable from the switchbox.

3. Connect the reference preamplifier (26AG), the reference microphone (40AG), and the cable (AA0008) to the "Preamp. Test Input" on the switchbox.

4. Connect the 40AG to the pistonphone coupler

5. On the main window, click **LEMO Reference Level** to start the LEMO reference level measurement; a new window opens.

6. Select the type of the reference microphone; in this case, select the 40AG.

7. Click **OK**; the window closes

8. The LEMO reference level window opens and the 42AP pistonphone turns on and starts measuring.

9. The current level of the measurement can be seen in the Sensitivity field.

   The "Sensitivity OK" diode indicates whether the current level is within the test limits: green means it is OK; red means it is outside the limits.

10. When the measurement has stabilized and the "Sensitivity OK" indicator is green, you can click **Stop**. The window closes and the measurement results are transferred to the main window.

11. Reconnect the preamplifier, disconnected in step 2, with the reference microphone.

12. On the main window, you can click **Sensitivity** to begin the sensitivity measurement; a new window opens. (This is the same window you saw with the LEMO reference level window.)

13. The 42AP pistonphone turns on and starts measuring automatically when the window opens.

14. The current level of the measurement can be seen in the Sensitivity field.

   The "Sensitivity OK" diode indicates whether the current level is within the test limits: green means it is OK; red means it is outside the limits.

15. When the measurement has stabilized and the "Sensitivity OK" indicator is green, you can click **Stop**. The window closes and the measurement results are transferred to the main window.

Step 4: Storing Calibration Results

You must save and store the results before you can print a calibration sheet.

1. On the main window, click **Save Data**.

2. This stores the data from all the tests in a text file (.txt) on the hard drive.

The filename is generated from the preamplifier type and the serial number of the preamplifier. For example, the file name for a 26AC preamplifier with the serial number 123456 will be 26AC123456.txt.

If the file name already exists, you can choose to create a new file or to overwrite the existing file. Creating a new file attaches a "-1" to the name: 26AC123456-1.txt.

Printing a Calibration Sheet

On the main window, click **Print**.

- A *calibration sheet* is printed if the PC is connected to a printer.

- A *PDF file* is created and stored on the local hard drive at the same time.

If no printer is connected, a PDF file is always saved.

High Frequency Calibration

For high frequency calibration of microphones, microphone sets, or preamplifiers, you must use a signal generator and a digital multimeter capable of dealing with high frequencies, for example these models provided by Keysight, or instruments with similar specifications:

- 33210A or 35500B Signal Generator
- 34465A Digital Multimeter

Connecting the 33210A or 35500B Signal Generator and the 34465A Digital Multimeter.

1. Use a BNC cable to connect the output of 33210A (35500B) to the "Output Signal" (output from generator) on the RA0192.

2. Use an RS-232 cable (Null Modem) to connect the 33210A (35500B) to the computer.

3. Configure the 33210A (35500B) as follows so it can communicate with the computer. Under the I/O menu, add the following information:

Interface	RS-232
Baudrate	9600
Parity	None: 8 Bits

   For more information, see the 33210A (35500B) manual.

4. Use a BNC cable to connect the input of 34410 to the "Input Signal" (input for multimeter) on the RA0192.

5. Use an RS-232 cable (Null Modem) to connect the 34465A to the computer.

6. Configure the 34410 as follows so it can communicate with the computer. Under the I/O menu, add the following information:

Interface	RS-232
Baudrate	9600
Parity	None: 8 Bits

   For more information, see the 34410 manual.

7. Go to the setup file and enter the correct COM port for the 33120A and 34465A, and enter the "Cut-off Frequency" (the frequency where the system starts to use the external signal generator and multimeter); save the file.

When the setup is configured correctly and the connection of the signal generator and the multimeter is done, the system is ready for high frequency calibration.

Calibrate the device as usual; the system automatically switches between using the data acquisition card in the computer and the external signal generator and the multimeter.

The "Cut-off Frequency" entered in the setup file must be included in the frequency list in the definition file. Otherwise, the system cannot switch correctly between using the data acquisition card in the computer and using the external devices.

For example, if a 40DP microphone has a frequency list like the following

....56000, 63000, 71000, 80000, 90000, 100000, 112000, 125000, 140000, 160000, 180000, 200000

then the "Cut-off Frequency" must be one of these frequencies.

If the "Cut-off Frequency" is set to 92 kHz, then

- All frequencies up to 92kHz (including 100 kHz) in the list will be measured by the data acquisition card in the computer.

- Frequencies above 92 kHz will be measured using the 33210A (35500B) generator and the 34465A multimeter.

Note: The system will automatically change the output termination of the 33210A (35500B) signal generator to 50 Ω. If the generator was originally set to "High Z", then the system will *not* set the output termination back to "High Z". Setting it back must be done manually, if needed.

Note: The sampling rate is 204.8 kHz. Therefore, the cut-off frequency should not be set to a value much higher than 92 kHz to avoid aliasing.

Working with the System Files and Documentation

There are several files used by the 90CA that you can edit. This section describes the location of those files and how you can edit and store them.

Viewing and Editing the Microphone and Preamplifier Definition Files

All the microphone and preamplifier definitions used by the 90CA are stored in the "Microphone Definition file" and "Preamplifier Definition file". These files can be read and edited in Notepad or (preferably) in Excel.

C:\Program Files\GRAS Sound & Vibration\SW0002\Microphone Definition file.txt

C:\Program Files\GRAS Sound & Vibration\SW0002\Preamplifier Definition file.txt

Note: The system was designed with a fixed set of parameters for each microphone or preamplifier. You can add definitions of new microphones or preamplifiers to this file, but you cannot remove or add parameters to the fixed set of 22 for microphones or 28 for preamplifiers.

These files contain pre-set test parameters for Level Calibration and Frequency Calibration. Test parameters are pre-set for G.R.A.S. products only.

Adding a new microphone or preamplifier to the definition file

The procedure is the same for microphones and preamplifiers.

1. Collect the data for the new microphone or preamplifier.

2. Create a copy of the existing microphone definition file;
    name it <filename>.new.

3. Rename the existing microphone definition:
    name it <filename>OLD.txt

4. Open <filename>.new with either Excel or Notepad.

5. For a new microphone, copy the first 23 lines.

    For a new preamplifier, copy the first 28 lines.

6. Paste these lines at the bottom of the file.

7. Edit these new lines according tp the data you collected.

8. Save this file as a text file: <filename>.txt.
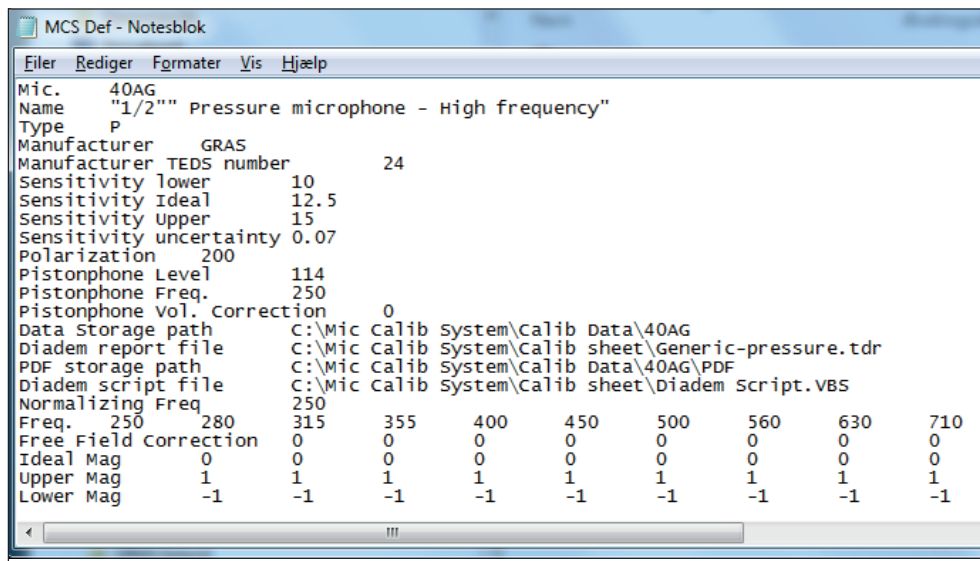
9. Test the file.

Fig. 14. *The microphone definition file*

This screenshot shows a section of a microphone definition file. The following two lists explain the details of the files for microphones and for preamplifiers.

Data in the Microphone Definition List

Identify the microphone with

1. The microphone's type number, such as 40AB, in **Mic**

2. **Name** of the microphone

3. **Type**, as in free field (F), pressure (P), random incidence (R), or other (O)

4. The name of the **Manufacturer**, such as G.R.A.S. Sound & Vibration

List the specifications

5. **Sensitivity Lower** – Lower limit of sensitivity

6. **Sensitivity Ideal** – Nominal value of sensitivity

7. **Sensitivity Higher** – Upper limit of sensitivity

8. **Sensitivity Uncertainty** – Absolute value of the sensitivity's uncertainty

9. **Polarization** – Whether prepolarized (use 0 [V]) or externally polarized (use 200 [V])

10. **Pistonphone Level** – For example, enter 114 dB for the 42AP pistonphone

11. **Pistonphone Frequency** – For example, enter 250 Hz for the 42AP pistonphone

12. **Pistonphone Vol Correction** – the pistonphone volume correction in dB for each microphone type

13. **Data Storage Path** – Where the 90CA stores data

14. **DIAdem report file** – Location and file name of the DIAdem report template (.tdr)

15. **PDF storage path** – Where the 90CA stores the calibration files (as PDFs)

16. **DIAdem script file** – Location and file name of the DIAdem system file used for printing out the calibration sheet

17. **Normalized Freq.** – Frequency to which the frequency response is normalized

18. **Freq.** – Frequencies for which the system calibrates the microphone

19. **Free Field Correction** – Free field corrections for this microphone type

20. **Ideal Mag** – Nominal pressure response [dB] normalized to the frequency stated in line 17.

21. **Upper Mag** – Upper limit for frequency response in dB

22. **Lower Mag** – Lower limit for frequency response in dB

Data in the Preamplifier Definition List

Identify the preamplifier with

1. The preamplifier's type number in **Type**

2. **Name** of the preamplifier

List the specifications

3. **Data Storage Path** – Where the 90CA stores data

4. **Diadem report file** – Location and file name of the DIAdem report template (.tdr)

5. **PDF storage path** – Where the 90CA stores the calibration files (as PDFs)

6. **DIAdem script file** – Location and file name of the DIAdem system file used for printing out the calibration sheet

7. The name of the **Manufacturer**

8. **Test SysCheck** – Option to test SysCheck if included in preamplifier (Yes or No)

9. **Test Insert Voltage** – Option to test Insert Voltage if available (Yes or No)

10. **With TEDS** – Yes, if the preamplifier is built with TEDS

11. **DC Upper Limit** – The maximum DC offset

12. **DC Lower Limit** – The minimum DC offset

13. **Sensitivity Upper Limit** – Upper level of sensitivity

14. **Sensitivity Lower Limit** – Lower level of sensitivity

15. **Noise LIN, Max** – Maximum level of LIN noise

16. **Noise AW Max** – Maximum level of AW noise

17. **SysCheck Freq** – Maximum level of AW noise

18. **SysCheck Upper Limit** – SysCheck upper level tolerance

19. **SysCheck Lower Limit** – SysCheck lower level tolerance

20. **Insert Frequency** – Insert test frequency

21. **Insert Upper Limit** – Upper level tolerance

22. **Insert Lower Limit** – Lower level tolerance

23. **Normalized Freq.** – Frequency to which the frequency response is normalized

24. **IECP on/off** – Indicate whether preamplifier is CCP type

25. **Frequency** – Frequencies for which the system calibrates the microphone

26. **Ideal Mag** – Nominal pressure response [dB] normalized to the frequency stated in line 17.

27. **Upper Mag** – Upper limit for frequency response in dB

28. **Lower Mag** – Lower limit for frequency response in dB

Setup.txt: The Microphone Calibration System Setup File

When you start up the SW0002 Calibration Software for the 90CA, the software reads the text file called setup.txt. Therefore, the location and contents of this file are critical.

Setup.txt must always be located in the same directory as your application file. Your 90CA system is delivered with the file located at

   C:\Program Files\National Instruments\LabVIEW 8.2\setup.txt

To find the location of the default directory:

1. Start the Microphone Calibration System Software,

2. Navigate to the "Setup" Tab

3. The path is listed in the "Default Directory" field.
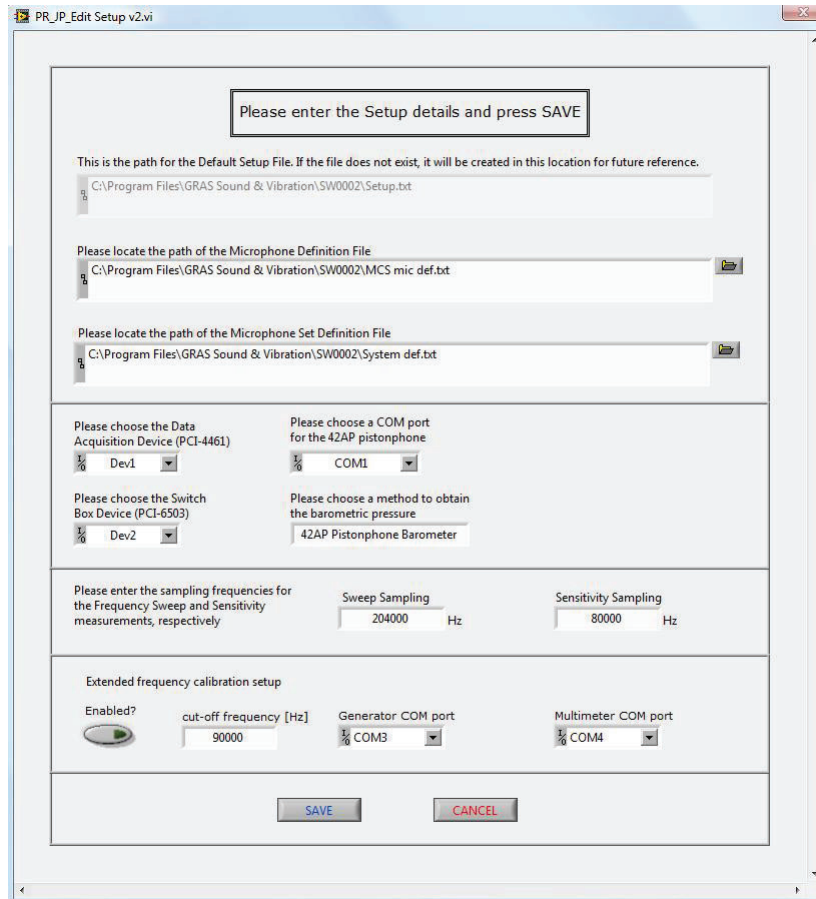
Fig. 15. The edit Setup window

If the file is deleted or moved from the default directory, the system will prompt for the necessary information and create a new Setup.txt file.

Contents of Setup.txt

The Setup.txt contains:

- The locations of the **Microphone Definition File** and the **Microphone Set Definition File**.

- **DAQmx Device Name 4461** – Name of the Data Acquisition Board NI 4461 as defined in the National Instruments Measurement and Automation Explorer.

- **COM port for 42AP interface** – The name of the COM port used for communicating with the 42AP pistonphone

- **DAQmx Device Name 6503** (6509 for PXI-based system) – The name of the NI 6503 board (PXI: 6509) as defined in the National Instruments Measurement and Automation Explorer

- **Method to obtain the Barometric pressure**
  There are four different settings to choose between: "Type in Manually" where you enter the barometric pressure manually, "42AP Pistonphone Barometer" where the 42AP automatically provides the system with the pressure, and "DPI 141 Barometer" and "DPI 142 Barometer" where the barometric pressure is automatically given from the Drüg Barometer Type DPI 141 or DPI 142. Communication with other types of barometers isn't supported by the system.

- **Sampling Rates –** Typical 202 kHz for Sweep Sampling and 80 kHz for Sensitivity Sampling.

- **Extended Frequency Calibration Setup**
  Enabled: Select Enabled to configure the system for high frequency calibration.
  Cut-off frequency: Enter the frequency where you want the system to switch to the 33210A (35500B) generator and the 34465A multimeter.
  Generator COM port – select the COM port used for the signal generator.
  Multimeter COM port – select the COM port used for the multimeter.

- **Additional COM port for external barometer**
  if DPI 141 or DP 142 has been selected in the "Method to obtain Barometric Pressure" field, the name of the COM port used for communicating with the DPI 141 or DPI 142 barometer is shown.

Editing and Saving Setup.txt

Click **Edit System Setup** in the Setup Mode. A new window opens then and the new setup parameters can be made.

In the Setup Mode, you can also view the Measurement setups for Sweep. All these values are automatically reset when you exit the program. Therefore, if you need to save changes to these values, you must do so before exiting the program.

Editing the Calibration Charts in DIAdem

You can customize both the text and the design of the calibration charts. The three report layout files are located in C:\Mic Calib System\Calib Sheet:

- generic-freefield.tdr for free-field microphones
- generic-pressure.tdr for pressure microphones
- generic-random.tdr for random microphones.

To edit the report files,

1. Open DIAdem and go to Navigator mode.

2. Open the report file in the DIAdem Report mode.

3. Click **Print** in the 90CA software program and the calibration data is transferred to the DIAdem Data Portal. (The 90CA provides only the data listed in the Data Portal.) The data from the Data Portal is inserted into the Calibration Certificate with DIAdem expressions.
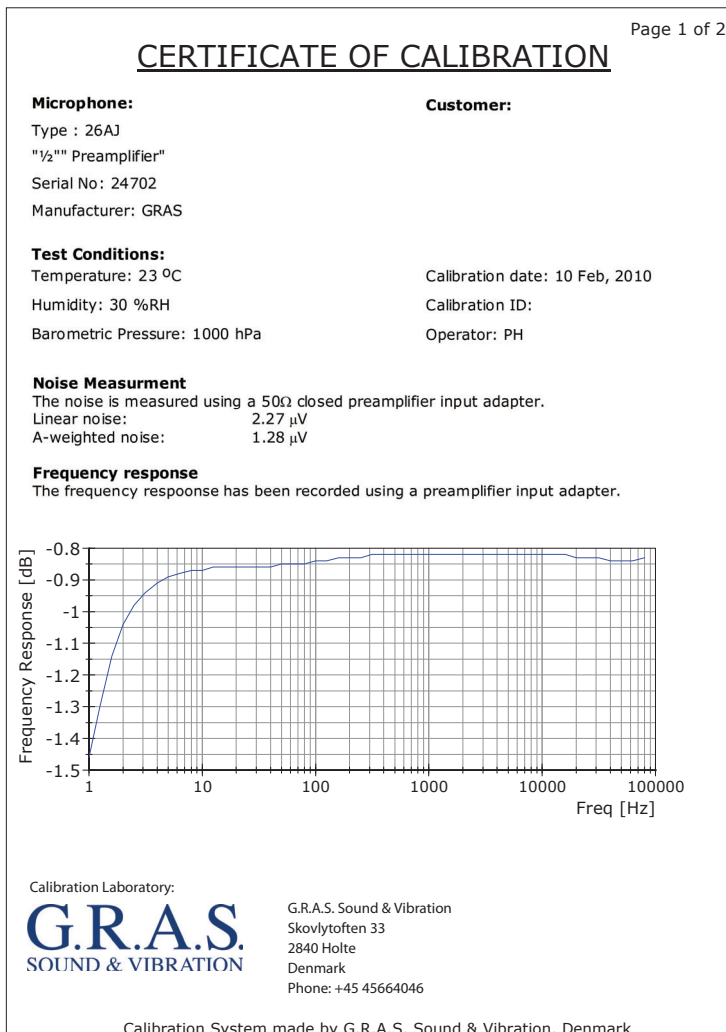

Fig. 16. Calibration certificate, page 1

The calibration certificate is two pages. The first page displays the frequency response, the second page contains all the data.

Freq [Hz]	Pressure Response [Hz]	Random incidence Response [Hz]	Test Status
250	0.00	0.00	OK
280	-0.01	-0.01	OK
315	0.00	0.00	OK
355	-0.01	-0.01	OK
400	-0.01	-0.01	OK
450	-0.01	-0.01	OK
500	-0.01	-0.01	OK
560	-0.01	-0.01	OK
630	-0.01	-0.01	OK
710	-0.02	-0.02	OK
800	-0.02	-0.02	OK
900	-0.02	-0.02	OK
1000	-0.02	-0.02	OK
1120	-0.02	-0.02	OK
1250	-0.03	-0.03	OK
1400	-0.03	-0.03	OK
1600	-0.03	-0.03	OK
1800	-0.03	-0.01	OK
2000	-0.04	0.01	OK
2240	-0.04	0.03	OK
2500	-0.04	0.06	OK
2800	-0.06	0.09	OK
3150	-0.07	0.13	OK
3550	-0.07	0.13	OK
4000	-0.08	0.12	OK
4500	-0.09	0.11	OK
5000	-0.11	0.09	OK
5600	-0.13	0.20	OK
6300	-0.15	0.30	OK
7100	-0.21	0.47	OK
8000	-0.30	0.60	OK
9000	-0.55	0.70	OK
10000	-0.97	0.63	OK
11200	-1.55	0.38	OK
12500	-2.11	0.14	OK
14000	-2.59	-0.12	OK
16000	-3.10	-0.40	OK
18000	-3.84	-1.24	OK
20000	-4.85	-2.35	OK

Fig. 17. *Calibration certificate, page 2*

For more information about the functions of DIAdem and the syntax of the DIAdem expressions, see the Quick Tour in DIAdem Help.

The File Structure on the System Controller

The location of all files is defined in the Microphone Definition File.

Folder Location	What is Stored in this Folder
C:\Program Files\GRAS Sound & Vibration\SW0002	All definition files
C:\Mic Calib System\Calib Data	When a calibration is completed, the calibration data is saved in a text document that is placed in this folder. The calibration certificates in .pdf format are placed in this folder.
C:\Mic Calib System\Calib Sheet	This folder contains ▪ The DIAdem script file ▪ A template for a daily calibration report ▪ An Uncertainty Calculation document

The SW0002 License File

The G.R.A.S. Sound & Vibration calibration software, SW0002, is license protected. The license file, XLicense.txt, is generated by G.R.A.S. when the calibration software is installed on the computer because it is locked to the hardware in the System Controller:

- Data Acquisition NI-card Type PCI-4461/PXI-4461

- Control Switch NI-card Type PCI-6503/PXI-6509

This means that the SW0002 software can only run on a system controller with the two specific NI cards described in the license file. If one of the cards is broken, it cannot be replaced with another card of same type and you will see a license error when the software is running. Therefore, if you need to replace either of the NI cards, you will need to request a new license file.

The license file must always be placed in the same directory as the SW0002 Microphone Calibration System program. If it is placed elsewhere, the software will display a license error because it cannot find the file.

Note: Do not edit or modify the file in any way or the system will report an error. If the file is modified or deleted, or you receive any errors, contact support at gras@gras.dk

Uncertainty Calculations

The Uncertainty Calculation spreadsheet lists the calculated system uncertainty for each type of microphone and for the individual parameters such as

- Sensitivity
- Noise
- Polarization voltage
- Capacity
- Volume correction
- Pressure
- Humidity
- Temperature

This information can also be compared to the National Physical Laboratory uncertainty.

The following table lists the total uncertainty for each standard microphone. All the uncertainties – the microphone sensitivity uncertainty, the calibration conditions, the AC voltage uncertainty, and the pistonphone – are summed up in the right column.

Type no	Mic Type	Uncertainty (dB)
40AC	WS2F	0.063
40AB	WS2F	0.069
40AD	WS2P	0.072
40AE	WS2F	0.067
40AF	WS2F	0.067
40AG	WS2P	0.063
40AN	WS2F	0.072
40AO	LS2aP	0.063
40AP	WS2P	0.069
40AQ	W2SD	0.072
40AR	W2SD	0.072
40AU	LS2aP	0.063
40BD	P	0.072
40BE	WS3F	0.073
40BF	F	0.073
40BH	P	0.072
40BP	P	0.072
40DP	P	0.073
40EN	WS1P	0.064
40EU	LS1P	0.064

Warranty and Maintenance

The 90CA is assembled and tested by G.R.A.S. before leaving the factory. An individual test certificate is included with each 90CA.

Warranty

All G.R.A.S. products are made of high-quality materials that will ensure life-long stability and robustness. The 90CA is delivered with a 2-year warranty.

Damaged diaphragms in microphones can be replaced.

The warranty does not cover products that are damaged due to negligent use, an incorrect power supply, or an incorrect connection to the equipment.

Calibration

Before leaving the factory, all G.R.A.S. products are calibrated in a controlled laboratory environment using traceable calibration equipment. We recommend a yearly recalibration at minimum, depending on the use, measurement environment, and internal quality control programs.

We recommend a daily check of the 90CA using the 40AG reference microphone to ensure the validity of your calibrations. If you start each calibration session with a level measurement of the 40AG you can verify that the system works properly.

Cleaning

Keep the system in a clean environment; keep the reference pistonphone and microphone in a safe and dry place when not in use.

Store the preamplifiers in a clean and dust-free environment.

Cover the terminal areas with their protection caps to prevent dust and tiny hairs from entering the high-impedant connector area.

Grids and windscreens make an adequate protection, reducing any need to clean microphones.

Avoid touching the diaphragm on any microphone during general use. Never touch the surface with anything that has a point such as a pencil or finger.

If something is spilled on the diaphragm, such as oil, use a clean cloth or cotton ball dipped in alcohol or benzine (for oils) to wipe the surface, using even pressure at all times. Use cleaning solutions that are appropriate, for example, benzine, alcohol, and so on.

The diaphragm is a 2-micron thick metal foil, so any fluid that doesn't damage stainless steel can be used. Be very careful during cleaning because the diaphragm is extra fragile in that situation.

Sometimes you cannot see that the diaphragm is dirty. It is only when connected to the electrostatic actuator that you can measure that something is disturbing the vibration. That happens when the mass of the foreign substance is greater than the mass of the diaphragm.

Before calibrating, always make sure the microphone connector is clean and that no dust is viewable in the connector of the preamplifier. If you see dust, use dry air to blow it away.

How to clean a microphone membrane

- Very gently

- Use alcohol and a cotton ball

- After cleaning, wait an hour before calibration

- Use a mix of water and a little dishwater if the microphone is very dirty

How to clean the gold connector

- Use a very soft foam brush

- Use compressed air

Service and Repairs

All repairs are made at G.R.A.S. International Support Center located in Denmark. Our Support Center is equipped with the newest test equipment and staffed with dedicated and highly skilled engineers. Upon request, we make cost estimates based on fixed repair categories.

If a product covered by warranty is sent for service, it is repaired free of charge, unless the damage is the result of negligent use or other violations of the warranty. All repairs are delivered with a service report, as well as an updated calibration chart.

Manufactured to conform with:

CE marking directive:
93/68/EEC

WEEE directive:
2002/96/EC

RoHS directive:
2002/95/EC

G.R.A.S. Sound & Vibration continually strives to improve the quality of our products for our customers; therefore, the specifications and accessories are subject to change.