Wiz

by Pocket Neurobics
Bio-Signal Acquisition since 2000

USER MANUAL

1   Quick Start

- Install PC Application (BioExplorer, BioEra etc) - needs to be latest version, see copy on CD
- plug Q/E/H-wiz into USN port and allow Windows to search for Pocket Neurobics driver in it's on-line repository
- or, for W/N-wiz, plug PN wireless dongle into USB port
- as part of the Windows driver installation procedure, note the COM port number assigned to the Pocket Neurobics device by Windows
- only if driver installation fails, try the manual driver executable on the PN CD under 'utilities'
- transfer illustrative BioExplorer and BioEra designs into respective directories on your PC
- transfer media resources, video and audio files, into respective directories on your PC
- open the PC Application, go to Device Configuration, enable the "PN Wiz" driver, and configure it for the COM port assigned by Windows
- open the illustrative design "Wiz_Test"

With successful installation, the Application should show the Wiz's start-up test sequence for the seconds immediately after it is powered on. This is, for ExG channels, four tones, each of one second duration, of 4, 8, 16 and 32Hz., and for HEG channels values alternating about the nominal value of 100, namely 99.0 and 101.0, each for 1 second duration.

2 Sections

Table of Contents

3   Summary

The Wiz suite of products support EEG, ECG, EMG, SCP, HEG (nIR & pIR) and Pulse Oximetry bio-signal acquisition. They require software such as BioExplorer (PC) and BioEra (Tablet), together with sensors – electrodes for ExG, headbands for HEG, or a Pulse Oximeter – to complete a biofeedback system.

All products in the suite utilise the latest 24-bit precision technology. All ExG products feature user selection of DC or AC coupling, linking of reference electrodes, electrode impedance measurement, and individual electrode-off indications. Electrode impedance measurement can be real-time, concurrent with training. All HEG products feature auto base-lining to a common, nominal value of 100. This allows swapping easily between the various HEG modalities without the need for changing protocols and feedback presentation settings. For the oximetry based modalities, the constituent IR and Red signals are separately available.

The Wiz product suite has been designed to allow the common, simple tasks such as one-channel EEG or HEG training to be initiated with a minimum of fuss. Few buttons, no menus. If a HEG headband is plugged in then the Wiz will automatically recognise what type of headband it is and adjust accordingly. With no HEG headbands connected, the Wiz defaults to EEG. For single channel training, irrespective of the modality, the signal will appear at the software as channel 1.

The Wiz products can function as simple bio-signal sources for biofeedback software. However increasingly the binding between the hardware and the software is becoming stronger. For example, some functions on Wiz products are instigated only by commands from the PC application, they cannot be access through the buttons on the device itself. Moreover the U-wiz and X-wiz products have no buttons, so basic functions like Power on/off appear as buttons on the biofeedback software. This binding with the software extends to managing different modalities: changes in the use of a channel, from say EEG to HEG are advised to the software which can reconfigure automatically – no changes in driver, indeed a single design can be created to handle multiple modalities.

Most Wiz devices can connect to a PC or tablet via USB or wireless – and some can do both concurrently. However in general products are designed to operate principally with one or other transport mechanism. Products that can transmit over USB and wireless concurrently allow for multi-seat training room situations: training can occur over a robust USB link to a PC or Tablet, and a central Monitoring point can monitor the signals from the multiple seats over a wireless link. Up to 8 seats can be supported in this fashion.

The Q-wiz is capable of 4 bio-signal channels. These can be 4 ExG signals or a combination of ExG and HEG, or HEG only. It is the preferred product when both ExG and HEG modalities are required. It can also interface to a 19 or 21-ch eeg cap, where a mix of 4 eeg channels is selected from the 21 available. The

selection of eeg channels can be adjusted on the fly. This makes it particularly suited to speedy assessment procedures like the Van Deusen TLC assessment.

The E-wiz and the H-wiz are 2 channel devices for ExG and HEG respectively. They are the robust workhorses of the suite. They feature a battery compartment for 2x AA batteries, although they operate equally well from direct USB power. This powering arrangement is particularly advantageous for Tablet based systems where the Wiz will only draw power from the Tablet once it's own internal batteries have expired. If batteries are used, these units are equally at home being used wirelessly. The range is up to 5 meters.

The U-wiz and the X-wiz are miniature, low cost, USB centric devices - although both can also operate wirelessly. They do not have buttons, relying on the software to supply commands to change modes etc. They are the product of choice where cost matters, and are particularly suited to multi-seat training room applications or home-training programs. They can sit neatly along-side a Tablet and derive their power from that tablet. Although miniature, they have most of the features of the larger products including, for ExG, EIM, AC/DC coupling, and linking of references, and for HEG, both nIR and pIR modalities with auto-baselining.

The R-wiz and the N-wiz are miniature, wearable units for ExG and nIR HEG respectively. They are wireless only, operating from a single AAA battery. They are the product of choice where the electronics need to be integrated into the headband such as in some sports performance applications.

More information can be found on the accompanying CD or alternatively on the website. Look for sample designs, help on using products for assessment, and other resources like videos for feedback presentation etc.. There are also introductory video tutorials.

4   Important Information

Wiz products attach to the body. In the case of ExG modalities they attach to the body with electrical conductance. All Wiz products are isolated from mains electrical power in accordance with standards. However caution needs to be exercised that electrode leads cannot come into contact with any electrical power source.

Should sensors be shared amongst individuals then steps need to be taken to ensure there cannot be transference of communicable diseases. Users should acquaint themselves with any Best Practice statements accompanying the specific sensor. There is an article on the accompanying PN CD that describes the potential risks and suitable ameliorating procedures. If the equipment is to be shared, please read that article.

Precautions need to be commensurate with risk. HEG sensors are generally not high risk, and an occasional wipe-down with an alcohol rub is sufficient. The nIR HEG sensor can be used with tissues between the headband and forehead. Electrodes on the other hand can be high risk in some circumstances and specific precautions are required. There are two standards of care to apply depending on whether "prepping" of the skin is done or not. Prepping is a process of abraiding the skin to improve electrical connection of the electrode to the skin. With modern amplifiers this is rarely needed - we specifically recommend that no prepping be done. If prepping is done, and the skin barrier is compromised, then a much higher standard of care is required.

No Prepping

- electrodes should be thoroughly washed in hot, soapy water between uses
- alternatively disposable Ag/AgCl electrodes should be used

Prepping

- Electrodes are to be autoclaved between uses. Users need to acquaint themselves with standards that apply to this process
- alternatively one-time use disposable Ag/AgCl electrodes are to be used

In the case of EEG caps, the manufacturer supplies a plastic syringe to apply conductive gel to the electrodes. This syringe is not to be brought into contact with the scalp in an effort to improve electrical connection. If it is, then the standard of care under Prepping above is to apply.

Should use of Wiz products induce head-aches or dizziness, please cease use and consult a qualified biofeedback practitioner before resuming training.

5   Feature Set

Feature Set	Wiz Model:	Q	E	H	U	X	R	N
Modes		4	4	4	4	4	4	4
Maximum sampling rate per slot		512sps	512sps	128sps	512sps	128sps	512sps	128sps
4 bio-signal channels		X						
2 bio-signal channels + 2 status channels		X	X	X	X	X	X	X
EEG/ECG/EMG/SCP		X	X		X		X	
NIR/PIR/Pulse		X		X		X		
NIR		X		X		X		X
Wireless &/or USB		X	X	X	X	X		
Wireless only (8 wireless channels, 5m range)							X	X
EEG 21-ch Cap Interface & Control		X						
Real-time 8-LED display of signal on Slot 1		X	X	X				
24-bit resolution		X	X		X		X	
16-bit resolution				X		X		X
DC-coupled (under User control)		X	X		X		X	
Linking of Reference electrodes (user control)		X	X		X		X	
Auto-baselining of HEG		X		X		X		X
Auto detection of Headband connection		X		X		X		X
Auto configuration of Slots for AC, DC signals		X	X		X		X	
Detection of electrode lead-off		X	X		X		X	
Electrode Impedance Measurement		X	X		X		X	
Detection of poor signal		X	X	X	X	X	X	X
Vibration to signify system warning			X					
Vibration when HEG baseline achieved				X				
Most functions under PC control		X	X	X	X	X	X	X
Remembers configuration		X	X	X	X	X	X	X
Self-test at startup		X	X	X	X	X	X	X
Signal Generator Mode		X	X	X	X	X	X	X
Firmware Upgradeable		X	X	X	X	X	X	X
Failsafe Mode		X	X	X	X	X	X	X

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6 Overview

The Wiz is a bio-signal acquisition device. The devices in the series capture bio-signals such as eeg and blood oxygenation measures and forward them via USB or wireless to an Application running on a PC which has a Wiz driver to correctly interpret the signals being sent. The Wiz will typically be used as an element in a bio-feedback training system.

In this manual, the following terms are used:
      - "Modality": the type of bio-signal being acquired - eeg, emg, ecg, scp, nIR, pIR, and pulse oximetry are modalities
      - "Channels": the number of channels of each modality. For example 2 channel nIR can be carriedover 4 transport slots of the Q-wiz.
      - "Transport Slot": the total number of Channels of various modalities that can be transported from the Device to the PC.
      - "Mode": the Mode of a device indicates its current configuration - the number of slots transported, the sampling rate of those slots, and gain or amplification of each slot.

- "sps": samples per second, or how fast the bio-signal is samples. EMG needs a fast sampling rate, whereas the blood oxygenation modalities can use a much slower sampling rate and thus use less of the PC's processing resources
- "EIM": electrode impedance measurement.

There are seven products currently defined in the Wiz product suite:
- Q-wiz: 2/4ch EEG/HEG, usb/wireless, with 21-ch eeg cap interface
  - Q for mini-Quantitative Assessment
- E-wiz: 2ch EEG, usb/wireless, 2xAA battery option
  - E for EEG
- H-wiz: 2ch HEG, usb/wireless, 2xAA battery option
  - H for HEG
- U-wiz: 2ch EEG usb/wireless, miniature button-less
  - U for USB eeg
- X-wiz: 2ch HEG usb/wireless, miniature button-less
  - X for xray
- W-wiz: 2ch EEG wireless, 1xAAA battery
  - R for Radio
- N-wiz: 2ch HEG wireless, 1xAAA battery
  - N for nIR HEG

Applications supporting the Wiz suite are:
- BioExplorer (www.cyberevolution.com)
- BioEra (www.bioera.net - future)

The Wiz suite flexibly supports 1 to 4 transport slots to the application. The modalities in those slots fall into two categories:

(i)AC (alternatibg current) signals:
- EEG, elecroencephalography, 1 to 4 chanels
- SCP, slow cortical potentials, 1 to 4 channels
- ECG, electrocardiography, 1 to 4 chanels, and
- EMG, elecromyography. 1 to 4 channels.

(ii) DC (slowly varying Direct Current) signals:
- nIR HEG, near infrared hemoencephalography , one or two channels
- pIR HEG, passive infrared hemoencephalography, one channel
- pulse oximeter sensing the pulse rate

EEG, SCP, ECG, and EMG all use the same silver or silver/silver-chloride electrode interface, whereas nIR and pIR HEG blood oxygenation sensors use special headbands. The nIR HEG sensor input can also accept a pulse oximeter input.

The Q-Wiz supports all modalities and up to 4 bio-signal channels, whereas the E/U/R-wiz support two AC bio-signal channels, and the H/X/N-wiz support two DC bio-signal modalities.

Wiz devices automatically detect when a headband or finger sensor is connected and reconfigure accordingly. When only one bio-signal is used, it will appear on slot 1. For devices that support both AC and DC modalities, namely the Q-wiz, when no headbands or finger sensors are connected, slots will default to AC - ie 2 or 4 channels of EEG etc.

The PC Application will automatically detect which modality is assigned to which slot and adjust accordingly.

The mapping of Modality into transport slot changes according to which headband or finger sensor is connected, and which Mode is selected. The Mode switch on the Wiz supports 4 Modes. Additonal Modes (that is, Modes 4a and 4b below) are accessible only by a command sent from the PC/Tablet Application.

Mode	Slot:	Slot1	Slot2	Slot3	Slot4

<Mode 1> 32sps - used for HEG (and EEG protocol processing - future)
<Mode 2> 128sps - Hi resolution EEG and HEG
<Mode 3> 512sps - EMG, ECG and SCP (and EEG if mixed modalities)

```
-----------------------------------------------
no headband sensed          EEG1  EEG2
nIR sensed                  NIR1  NIR2*
nIR & pIR sensed            NIR1  PIR1
pIR sensed                  PIR1  EEG1
PULS sensed                 PULS1 EEG1
pIR & PULS1 sensed          PULS1 PIR1
```

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```
<Mode 4/a/b> 256sps 4ch - mixed modes - **Q-wiz**
```
-----------------------------------------------
no headband sensed(Mode 4)  EEG1  EEG2  EEG3    EEG4
no headband sensed(Mode 4a) EEG1  EEG2  EIM1    EIM2    (by PC Command only)
no headband sensed(Mode 4b) EEG1  EEG2  Offset1 Offset2 (by PC Command only)
nIR sensed                  EEG1  EEG2  NIR1    NIR2
nIR & pIR sensed            EEG1  EEG2  NIR1    PIR1
pIR sensed                  EEG1  EEG2  EEG3    PIR1
PULS sensed                 EEG1  EEG2  EEG3    Oxi1
pIR & PULS sensed           EEG1  EEG3! Oxi1    PIR1
        * for ch3 & ch4, precedence is: HEG, EIM/Offset, EEG
```

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```
<Mode 4a/b> 256sps 4ch - mixed modes - **E/H/U//X/R-wiz**
```
-----------------------------------------------
```
E/U/Rwiz (Mode 4)   EEG1 EEG2 EIM1   EIM2
E/U/Rwiz (Mode 4b)   EEG1 EEG2 Offset1 Offset2 (by PC Command only)

H/Xwiz (Mode 4)
```
nIR & pIR sensed            NIR1  PIR1  IR      Red
pIR sensed                  pIR1
PULS sensed                 Oxi1        IR      Red
pIR & PULS sensed           Oxi1  PIR1  IR      Red
```

All devices also have a Mode 0, or Program Mode, which is selected to allow firmware updates, or, in the case of wireless operation. to allow the PC to send Commands to the device (see section on Commanding the device).

Wireless operation requires a PN wireless dongle connected to a USB port. Products that operate either wirelessly or by direct USB connection will automatically choose direct USB connection when a direct USB connection is recognised ("enumerated"). Products that can be powered by USB or battery, choose battery when it is available. Partcularly in the case of Table-based systems, this can increase the operating time of the system.

7 Buttons

The U-wiz and theX-wiz do not have buttons. Refer to the section of PC Control for a description.

All other units have a Mode button. A short press sequences thru the available Modes. Mode is indicated by a blinking green light. For Mode 1, the light blinks once. For Mode 0, or Program Mode, the light does not blink.

Modes are consistent across models. Mode 2 on the Q-wiz has the same attributes as Mode 2 on the E-wiz. The Mode button also serves as a 'Signal Good' indication. This indication is an assessment of the quality of signal on all active slots. When the signal is judged as good then the Green light is mostly on and blinks off. If the signal cannot be judged Good, then the green light is off and blinks on.

On the Q-wiz, a long press of the Mode button activates the EEG Cap interface at which time the 8-LED indicator reports the status of the Cap multiplexer.

All models have a second button which controls key functions of the active modality. For

EEG/ECG/EMG/SCP modalities, the Link/Freeze button toggles a link between the two reference electrodes and also toggles whether the DC (direct current) component of the signal is removed or not. A short press of the button toggles the link action, with a green light indicating that the references are currently linked. A long press (>2sec) toggles whether the DC component is removed from the signal or whether the DC is not removed ("frozen") which is indicated with a blue light. DC-coupling is preferred for ECG and SCP signal sampling and should be used with Ag/AgCl electrodes.

Models that have battery power have a Power-On button. If there is not a Power-On button, then the unit can be de-powered by removing the USB cable (or switching off at a USB mini-hub with a power switch), or by placing the unit in Program Mode (Mode 0). The Application might also support control of Power On/Off.
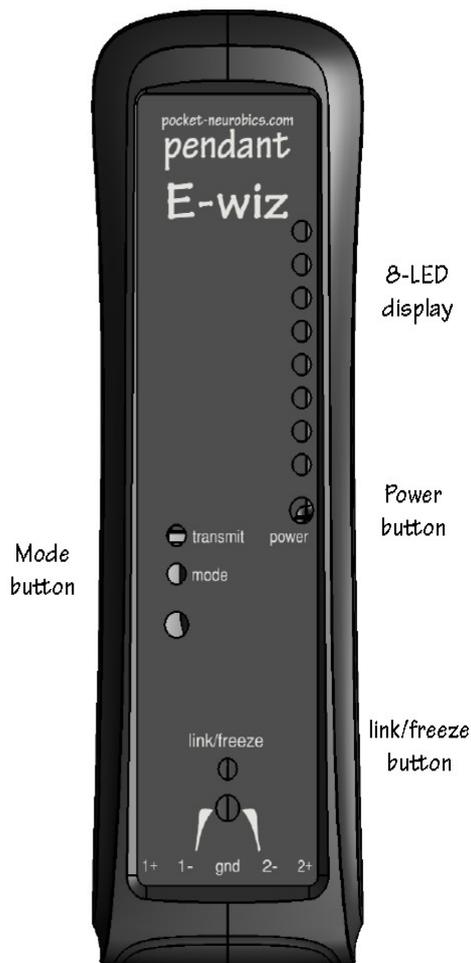

Mode button

8-LED/ Q-menu

link/ freeze button

Q-wiz:
- Mode button (green):
  - short press, sequences thru Modes
  - long press, activates the Q-menu and the Cap interface
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.
- Link (green) & Freeze (blue) button:
  - short press, controls linking of EEG references, and initiates nIR/pIR/pulse HEG baseline search.
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)
  - long press, controls freezing and unfreezing EEG DC removal
  - pressed at power-up: initiates Signal Generator mode
- there is no Power On button for the Q-wiz.
- both Mode & Link Buttons together
  - to exit Signal Generator Mode (or simply remove the power from the unit & re-start)
  - when in Q-menu mode, @ "Program Mode", pressing the Link and Mode button enters/exits programming of the User-defined switching of the Cap (see section of the Q-menu).

E-wiz:
- Mode button (green):
  - short press, sequences thru Modes
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.

- Link (green) & Freeze (blue) button:
  - short press, controls linking of EEG references
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)
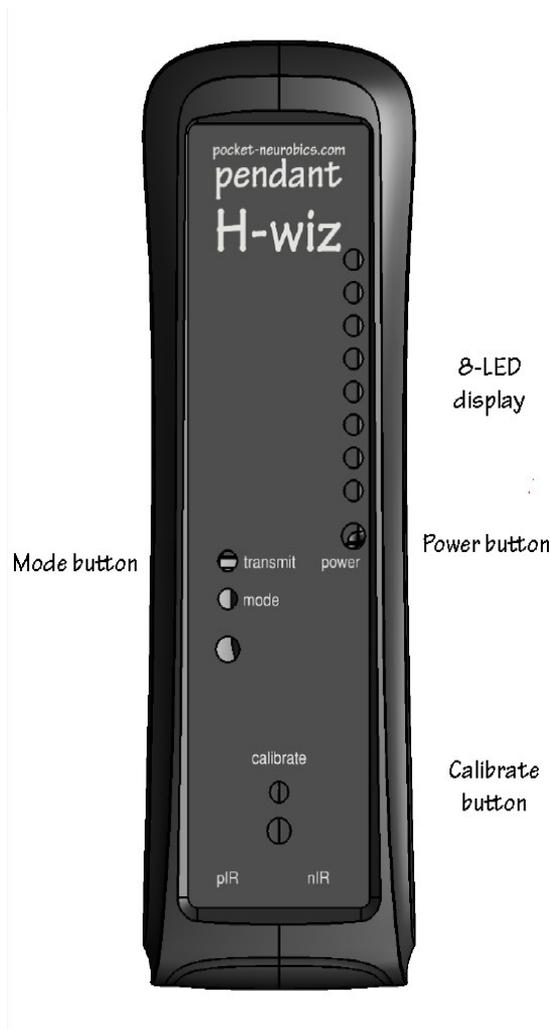
- long press, controls freezing and unfreezing EEG DC removal
- pressed at power-up: initiates Signal Generator mode

- Power On Button
  - toggles normal operation and power off

H-wiz:
- Mode button (green):
  - short press, sequences thru Modes
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted
- Calibrate (green) button:
  - short press, initiates nIR/pIR/pulse HEG baseline search for nominal value of 100
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)
- pressed at power-up: initiates Signal Generator mode
- Power On Button
  - toggles normal operation / power off

Labels on device image:
- 8-LED display
- Power button
- Mode button
- link/freeze button

pocket-neurobics.com
pendant
E-wiz

transmit   power
mode

link/freeze

1+   1-   gnd   2-   2+

W-wiz:
- Mode button (green):
  - short press, sequences thru Modes
  - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.
- Link (green) & Freeze (blue) button:
  - short press, controls linking of EEG references
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)

  - long press, controls freezing and unfreezing EEG DC removal
  - pressed at power-up: initiates Signal Generator mode

- Wireless Channel button:
  - increments wireless channel number when in Mode 0 (Program Mode). Sequences thru channels 1..8

- Power On Button
  - toggles normal operation and power off

- Mode button (green):
  - short press, sequences thru Modes
    - pressed at power-up: enter fail-safe mode. Operates with base feature set. Mode for recovery should firmware become corrupted.

- Calibrate (green) button:
  - short press, initiates nIR/pIR/pulse HEG baseline search for nominal value of 100
    - in Mode 0 and wireless transport, increments rf channel (in USB Transport, use Application to change wireless channel if required)
    - in Mode 0 and USB transport, toggles between USB transport only and USB and wireless transport concurrently (Transport LED blinks with wireless channel number when wireless is active)
  - pressed at power-up: initiates Signal Generator mode

- Wireless Channel button:
  - increments wireless channel number when in Mode 0 (Program Mode). Sequences thru channels 1..8

- Power On Button
  - toggles normal operation and power off

8-LED display

Mode button

Power button

Calibrate button

pocket-neurobics.com
pendant
H-wiz

transmit   power

mode

calibrate

pIR   nIR

8 LED Indicators

Q-wiz:

TRANSMIT {blue):
- On Steady: sending to Application via USB
- On Blink: sending wirelessly
- Off Blink: not transmitting to Application (ie Program Mode)
- 4 blinks: acknowledging command received for Application
- Blink: wireless channel number

MODE/GOOD (green):
- On: no EEG lead off, and/or nIR full signal strength, and/or pIR valid reading
- Off: EEG pair off, or nIR not full strength, or pIR reading out of range
- Fast flash: EEG single electrode off
- Blink: Mode 0/1/2/3/4 = Program/32sps(2ch)/128sps(2ch)/512sps(2ch)/256sps(4ch)

LINK (blue/green):
- Blue On: EEG baseline frozen (DC coupled)
- Blue Off: DC removal - EEG low frequency response ~0.2Hz
- Green On: EEG References linked - only one Reference electrode required
- Green Off: EEG References independent - two References required for 2 eeg channel operation

HEG (yellow):
- On: when nIR, pIR or Oxi headband sensed
- Off: no headband sensed, all 2/4 channels used for EEG
- Blink: when nIR/pIR/pulse baseline search for nominal value of 100 is under way
- Fast Flash: indicates that User Defined configuration of the Cap is currently being programmed

E-wiz:

TRANSMIT {blue):
- On Steady: sending to Application via USB
- On Blink: sending wirelessly
- Off Blink: not transmitting to Application (ie Program Mode)
- Blink: wireless channel number
- 4 blinks: acknowledging command received for Application
- Fast blink: low battery

MODE/GOOD (green):
- On: no EEG lead off
- Off: EEG lead off
- Blink: Mode 0/1/2/3 = Program/32sps(2ch)/128sps(2ch)/512sps(2ch)
- Fast flash: EEG single electrode off

LINK (blue/green):
- Blue On: EEG baseline frozen (DC coupled)
- Blue Off: DC removal - EEG low frequency response ~0.2Hz
- Green On: EEG References linked - only one Reference electrode required
- Green Off: EEG References independent - two References required for 2 eeg channel operation

H-wiz:

TRANSMIT {blue):
- On Steady: sending to Application via USB
- On Blink: sending wirelessly
- Off Blink: not transmitting to Application (ie Program Mode)
- 4 blinks: acknowledging command received for Application
- Blink: wireless channel number

MODE/GOOD (green):
- On: nIR full signal strength, and/or pIR valid reading
- Off: nIR not full strength, or pIR reading out of range
- Blink: Mode 0/1/2 = Program/32sps(2ch)/128sps(2ch)

CALIBRATE (blue):
- On: when nIR, pIR or Oxi headband sensed
- Off: no headband sensed, sends test signal to PC Application
- Blink: when nIR/pIR/pulse baseline search for nominal value of 100 is under way

W-wiz:

BLUE:
- On: EEG baseline frozen (DC coupled)
- Off: DC removal - EEG low frequency response ~0.2Hz
- Blink(Mode 0 only): wireless channel number

GREEN:
- On: EEG References linked - only one Reference electrode required
- Off: EEG References independent - two References required for 2 eeg channel operation
- Blink: Mode 0/1/2/3 = Program/32sps(2ch)/128sps(2ch)/512sps(2ch)

N-wiz:

BLUE:

- On: when nIR, pIR or Oxi headband sensed
- Off: no headband sensed, sends test signal to PC Application
- Blink: when nIR/pIR/pulse baseline search for nominal value of 100 is under way
- Blink (Mode 0): wireless channel number

GREEN:
- On: nIR full signal strength, and/or pIR valid reading
- Off: nIR not full strength, or pIR reading out of range
- Blink: Mode 0/1/2 = Program/32sps(2ch)/128sps(2ch)

9 Connecting to PC: Wireless and USB Transport

All models can transmit wirelessly. The W-wiz and the N-wiz are exclusively wireless. The Q/E/H/U/X-wiz can transmit either wirelessly or directly via USB cable. They can also transmit concurrently both directly via USB cable and wirelessly.

The Q-wiz can be powered from a normal USB port or by a "USB Portable Power" battery. In the case of the latter, the Q-Wiz will automatically recognise that it does not have a USB connection and start to transmit wirelessly. A PN proprietary dongle is required to receive the wireless signal.

The E-wiz and the H-wiz can be powered from either a USB port or 2x AA batteries placed inside the unit. The batteries are not needed for USB operation, however note that if batteries are used whilst connected to a USB port, the unit will draw power from the batteries, not the USB port. This means that if the USB port belongs to a tablet, the E/H wiz will not draw power from the tablet's battery thus extending the 'on" time for the tablet.

The Q/E/H/U/X-wiz will default to direct USB communication if it is sensed that the power is derived from a USB port. If not, they will transmit wirelessly. No manual intervention is required.

The R-wiz and the N-wiz operate from a single AAA battery inside the unit.

In cases where the computer is slow to enumerate the Q-wiz when connected, then the Q-Wiz may decide that it is not connected to a USB port and begin transmitting wirelessly. Unplugging the unit and re-inserting should have it enumerate correctly. If this happens persistently then the Q-wiz can be started in fail-safe mode (see below) which grants a longer period for USB enumeration.

Concurrent Wireless and USB Transport

For the Q/E/H-wiz, when in USB Transport and Program Mode, a short press of the "Link" button will toggle between having USB Transport only (the blue "Transmit" LED will be on steady), and having both USB and Wireless Transport concurrently (signified by the blue "Transmit" LED being mostly on and blinking off). For the button-less U/Xwiz, this capability can be commanded from the Application. This dual mode allows "training room" scenarios whereby USB connection is used to communicate with the PC at each training seat, and wireless communication is used to a central control position which can scan the progress of each training seat, or select one for closer monitoring. This setting is remembered from session to session, but note that wireless operation can cause interference to other devices operating wirelessly - each device will need its own wireless channel.

Changing Wireless Channels

When multiple Wiz's are operating in close proximity, each must have a separate wireless channel. There are eight wireless channels available.

When in Wireless Transport (ie battery powered)
- the wireless channel number is incremented by choosing Mode 0 (Program Mode), then a _short_ press of the "Link" button
- the PC Application cannot command a change to the wireless channel

In USB transport mode

- the Application may have the ability to change wireless channels of the Wiz, and if so,
- the wireless channel number can be changed either in Program Mode (Mode 0) or in the Operating Modes.

A new wireless channel number is remembered from session to session.

Separately, the PN wireless dongle needs to be set to the same wireless channel as that of the Wiz. That is, the wireless dongle needs to be blinking at a rate the same as the Wiz. When the PN wireless dongle is successfully receiving a signal, it's green LED is on and blinks off. The wireless channel of the dongle can be changed either by _short_ presses of its button, or by commands from the PC Application if the Application has that ability.

10   Modes

A _short_ press of the Mode button will change modes.

There are five Modes:
- Mode 0
  - Program Mode, for uploading upgrades, interrogating version numbers etc
- Mode 1
  - two transport slots at 32sps sampling rate: low transmission rates to minimise burden on PC processor
  - recommended for HEG & SCP only, not suited for use with EEG, EMG or ECG
- Mode 2
  - two slots at 128sps sampling rate: most sensitive and low rates to minimise burden on PC processor
  - recommended for EEG and SCP
- Mode 3
  - two slots at 512sps sampling rate for high bandwidth, 4x lower sensitivity
  - recommended for ECG/EMG/SCP
- Mode 4
  - four slots at 256sps sampling rate, high sensitivity (Q-wiz only)
  - 4a: 2 bio-signal channels + 2 EIM status channels (Q/E/U/Rwiz)
  - 4a: 2 bio-signal channels + 2 IR/Red constituents (H/X/N wiz)
  - 4b: 2 bio-signal channels + 2 Offset status channels (Q/E/U/Rwiz)

 Mode changes are signified to the PC Application automatically, and the Application's interface will reconfigure in sympathy. For some changes, like changing from 2-slot modes to 4-slot mode, the Application's input may need to be manually reconfigured. Note that the Source Objects of the BioExplorer Application have the ability to auto detect the modality of incoming signals such that if there is one Source Object configured for EEG and another for HEG, then BioExplorer will automatically connect the correct Source object to correct incoming stream. It does this on the fly.

 Further, where there is a single channel of a single modality, then it will always appear on on the first input to the Application, that is, Slot 1. Thus single channel protocol designs can assume the input is always the first input.

11   EEG Electrode Interface

The Q-Wiz can operate as a single channel eeg, 2-channel eeg, 3-channel eeg, or 4-channel eeg. The E/U/R-wiz can operate as single or two channel eeg. If using EEG, EEG Channel 1 must be one of the channels being used, however there are no constraints on which other channels are used. A Ground connection ("gnd") is also required for all EEG configurations. Thus the minimum arrangement for EEG use is three elecrodes: 1+, 1-, and gnd.

The Wiz is a 24-bit resolution, directly coupled device. However the default mode of operation is to slowly

remove the DC component of the EEG so the signal does not wander and potentially move out of range of the PC Application. This virtual High Pass Filter is set at about 0.2Hz. A _long_ press of the "Link/Freeze" button will override DC removal, and a blue LED will light to signify that the DC-removal is now frozen (_blue_ for _frozen_) and the amplifier will then act as a true DC-coupled device. Freezing the DC removal operation is used with SCP and ultra-low frequency EEG modalities. Another long press will re-activate DC-removal and extinguish the blue LED. Freeze state is not remembered and will need to be set each time the unit is powered on.

The amount of DC-offset removal can be remembered by the Wiz, allowing the eeg to settle faster when next powered on. Offsets are grabbed at the time of freezing the eeg with a long press of the Freeze button.

A _short_ press of the "Link" button will electrically join the two Reference electrodes (1- and 2-) adjacent to the Link button and a Green LED will light to signify that the references are linked. Another short press will unlink and extinguish the Green LED. (_green_ for _link_). Linking of electrodes is typically used for assessment procedures. Link state is remembered - the device will power-up in the state previously set.

For the Q-wiz, EEG channels 3 and 4 do not have their own separate reference electrode. EEG Channel 3 uses 1- as its reference and EEG Channel 4 uses 2- as its reference. If the green "Link" light is on, then all four electrodes are sharing a common reference and only one reference electrode need be connected to the body, although typically two reference electrodes are still used, one to each ear-lobe.

12   HEG Interface

The Q/H/X/N-wiz senses when a HEG (either nIR, pIR, or pulse) headband is connected. The "HEG" LED will begin to flash, signifying that the unit is adjusting the signal to it's nominal value of 100. Once the nominal value is found, the device automatically Freezes the baseline and the "HEG" LED stops flashing and becomes steady on. The Wiz is then ready for training. If the headband is unplugged, then in the case of the Q-wiz the slot reverts to the default EEG use, whilst in the case of the H-wiz and the N-wiz, absent a headband, a test signal (values of 99 & 101 alternating every second) is sent on the slots.

Note that the Wiz will attempt to find the nominal value whether the headband is on the head or not, so if a false nominal value has been set, then a _short_ press of the "Calibrate" or "Link" button will initiate a new search. Nominal values are found after 5 to 15 seconds of searching.

The Wiz remembers the offset required to establish the nominal value of 100, allowing HEG to settle faster next time it is powered-on. Offsets are stored at the time a nominal value of 100 is achieved. These offset values will then be saved to memory when there is either a mode change or a short press of the Link/Freeze button. For both nIR and pIR HEG, should the limits of the range of reading be exceeded, then a search for the nominal value of 100 is automatically re-started.

If in a 2-slot mode (ie Mode 1, 2, or 3) and just one headband is in use, either pIR or nIR, then the signal will appear on Slot 1. This means that changing from pIR to nIR modality is as simple as changing headbands - no reconfiguration of the Wiz or PC Application is required.

The Wiz supports 2-ch nIR Headbands. If the Wiz senses that the current headband supports only one nIR channel, then it substitutes the Infrared component of the nIR1 signal on the nIR2 slot. This IR signal can be used to gauge the quality of the nIR1 signal, and can be used by the application to derive the Pulse Rate from the nIR signal, for say HRV training.

13   Other Sensors

Nellcor compatible SpO2/Pulse Oximeters can interface to the Q/H/X-wiz via an adaptor. The adaptor allows the sensor to be plugged into the nIR HEG socket on the Wiz. Pulse Oximeters would generally be used to obtain the pulse bioSignal. Pulse Rate and Heart Rate Variability training can be based on this signal.

Thermocouples can be used to measure skin temperature. In particular, thermocouples which can be grasped are available for the Q/H-wiz for use in training hand-warming. They are connected to the pIR HEG

socket.

14   8-LED Display (Q/E/H-wiz)

The Q/E/H-wiz have an array of eight green LED's to feedback state information to the user. The 8-LED display serves two functions:
- Signal Display mode: real-time display of the signal on transport Slot 1, either EEG (AC) or HEG (DC) depending on mode and whether headbands are connected or not
- Q-menu mode(Q-wiz only): displaying the status of the 21-ch EEG Cap interface (to be described later)

On power-up, the Signal Display mode appears. It can be recognised by flickering of the LEDs, reflecting the real-time nature of the signal being displayed. To enter the Q-menu mode, _long_ press of the Mode button. Q-menu mode can be recognised by a non-flickering LED display, with initially only the top LED lit. Once in Q-menu mode, Signal Display Mode can be re-entered with a _short_ press of the Mode button.

Without headbands connected, the Signal Display shows the real-time display of the EEG signal on transport Slot 1 (ie EEG Channel 1). With "Freeze" off (ie no blue "Link" LED), then the EEG signal should be centered on the display and the magnitude of the EEG will excite LEDs around the center LED. With "Freeze" on (ie blue "Link" LED is on), then the display will reflect DC shifts of the EEG signal. If the display exceeds the LED display range, indicated by the upper-most or lowest LEDs slowly flashing, then this might indicate that the DC level is exceeding safe limits, although the operating range of the EEG signal is considerably greater than the range of the 8-LED display. The EEG signal can be re-centered by a _long_ press of the "Link" button to un-Freeze the baseline. Once centered, the baseline can be re-Frozen with another _long_ press of the "Link" button.

With only one of nIR or pIR HEG headbands connected, the 8-LED display will refect the amplitude of the respective slowly varying DC signal, with the nominal value of 100 being centered on the display. If both pIR and nIR HEG headbands are connected, then the nIR signal appears on transport Slot 1 and is displayed. In nIR HEG mode, the LED display range covers 80 to 120, and in pIR HEG mode the range is 95 to 105. Again, if the 8-LED display range is exceeded, this may or may not be an issue since the operating range of the Wiz is greater than this.

Dithering of the 8-LED display allows for a sensitive, continuously varying signal. Thus the Wiz can be used as a standalone biofeedback trainer for slowly varying DC bio-signals, such as HEG.

15   EEG Cap Interface (Q-wiz only)

The Q-wiz features an interface to a 21 channel EEG cap. Electrocap and Deymed caps are compatible, altho the latter is compatible for 19-ch montages only. The Cap can be used for assessment or training, and the multiplexing of the 21 channels of the Cap onto the 4 slots of the Q-wiz, can be controlled by the PC Application, if it is so capable.

Since there are 21 EEG sites available to the CAP and just 4 slots to the PC Application, there is a choice of which site is to go to which slot. Each Slot can accept one or more of 8 possible Cap sites. Thus we speak of "multiplexing" Cap sites onto available slots, and of a "mapping" of sites onto slots.

The EEG Cap and it's 25-pin D-connector are active and connected whilst the Q-menu is active. The Q-menu is activated by a _long_ press of the Mode button, and is de-activated by a _short_ press of the Mode button. The Cap interface sits across the normal electrode inputs, so both the Cap interface and the normal electrodes can be used at the same time, however in general one should use either the Cap interface or the normal electrode interface but not both. Linking of electrode references by toggling the "Link" button applies equally to the normal electrode input and the references provided by the EEG Cap.

Pre-configured mappings of EEG Cap locations to Slots

A long press of the Mode button will activate the Cap interface. The current Mode is maintained, such that if

the unit was in Mode 2 (2ch/128sps) prior to entering in Cap Assessment, then only two of the four slots are available to the Cap. Similarly, if a HEG headband is plugged-in, one or more slots are lost to the Cap interface. In general, select Mode 4 (4ch/256sps) and remove headbands prior to a long press of the Mode button to activate the Cap interface. Once activated, a short press will de-activate the Cap.

There are five pre-configured mappings of selected Cap locations to the four slots which are sent to the Application. These mappings are listed on the _left_ of the 8-LEDs for, left-to-right, Slot 1..4. These five settings sequence through as the result of holding down the Mode button continuously or through a series of long presses.

These five pre-defined mappings accord with 'The Learning Curve' four channel Assessment Procedure (refer www.brain-trainer.com).

User Defined mappings of EEG Cap locations to Slots

A sixth configuration, called User Defined, is programmable. To program the User Defined mapping of EEG Cap locations to slots, scroll down to "Program". In a moment, the 8-LEDs will start to sequence through the currently stored mappings of EEG Cap locations to slots. The 8-LEDs indicate the Cap location listed to the _right_ of the LED. Again, left-to-right, Slot 1..4. The current EEG Cap site identified by the 8-LEDs applies to the Slot indicated by the "Mode" LED, which blinks with the current slot number (one blink for Slot 1 etc). Note that this display is for user information only - so the user can readily see how the User Defined mapping is configured - the Cap interface itself remains fully activated with all slots configured according to the User Defined setting.

Scan Mode

Using _long_ presses of the Mode button to scroll to Scan will cause the EEG Cap locations to sequence through the five pre-set configurations and the User Defined configuration. Dwell time is about 8 seconds, meaning that to sequence through all six mappings takes 48 seconds. Prior to commencement of assessment, Scanning can be used to check that there is a valid eeg signal on each of the Cap locations of interest, both by visual inspection of the eeg trace and Lead-off reporting to the PC Application.

Programming the User Defined Mapping

With the unit sequencing through the current User defined mapping, as described above, pressing _first_ the "Link" button and then, momentarily, the Mode button, enters a mode for Programming the User Defined mapping. To signify this, the "HEG" LED flashes rapidly. This process erases previous User defined mapping.

The "Mode" LED will begin blinking _once_ to indicate that we are currently programming the mapping of EEG Cap locations to Slot 1. The first of the 8-LEDs is lit. In this Programming Mode, _short_ presses of the Mode button will sequence through the choices of Cap location available, whilst momentarily pressing the "Link" button will save that Cap location to the current Slot.

Multiple EEG Cap sites can be selected for a single Slot. The default User Defined mapping maps each quadrant of the scalp to the four slots. Note that not all Cap locations are available to all slots. The possible choices are those listed to the _right_ of the respective 8-LED and in the table below.

By cycling through programming the four slots and returning to a previously programmed slot, re-selecting a particular Cap site will erase that site. Similarly, if a location is accidentally selected, selecting it again will un-select. This happens in real-time,
so selections appear instantly on the Cap interface. To exit and save the new mapping as a new User Defined mapping, press the "Link" button followed by and together with a momentary press of the Mode button. The rapid flashing "HEG" LED will extinguish. To exit Program Mode without saving the new configuration, that is to keep the previous User Defined mapping, simply _long_ press the Mode button. The rapid flashing "HEG" LED will extinguish. This latter method allows individual locations on the EEG Cap to be chosen and observed, without changing the User defined mapping. A _short_ press of the Mode button will then exit the Q-menu entirely and disconnect the EEG Cap interface.

Mappings

	Ch1	Ch2	Ch3	Ch4
Pre-defined Sequence 1		T3	T4	C3	C4
Pre-defined Sequence 2		F3	F4	P3	P4
Pre-defined Sequence 3		Fz	Pz	Cz	Oz
Pre-defined Sequence 4		F7	F8	T5	T6
Pre-defined Sequence 5	Fp1	Fp2	O1	O2
Default User Defined Ch1	Fp1/F3/F7
Default User Defined Ch2	Fp2/F4/F8
Default User Defined Ch3	T5/O1/P3
Default User Defined Ch4	T6/O2/P4

(these default locations are quadrants of the brain - this configuration can be re-programmed)

User Defined Mapping Choices

Choices:	Ch1	Ch2	Ch3	Ch4
	Fp1	Fp2	F7	F8
	F3	F4	T3	T4
	C3	C4	T5	T6
	P3	P4	O1	O2
	F7	F8	C3	C4
	T3	T4	P3	P4
	Fpz	Cz	Cz	Fz
	Fz	Pz	Pz	Oz

Note that sites should not be shared across slots as that will act to short the two eeg channels.

Controlling the Cap's User Defined Mapping from the PC Application

Some supporting Applications include the ability to control the mapping of the EEG Cap onto the 4 slots. If the Q-Wiz is directly connected via USB then the Application can command mapping of the EEG Cap sites on the fly - commands sent from the application will instantaneously configure the EEG Cap and the chosen sites will be conveyed to the Application over the four slots.

If the Q-menu is not active at the time that the Q-Wiz receives a command to map the cap sites, the Q-Wiz will automatically activate the multiplexer and save the new mapping as the User Defined mapping. Also, if not already in Mode 4 (256sps/4ch), the Q-wiz will change to that mode.

If the Q-Wiz is connected via wireless, then select Mode 0 (Program Mode) to allow the PC Application to command mapping of cap sites.

16   Poor Signal Detection

The Wiz monitors
- electrodes for Lead-off condition
- nIR HEG for signal strength
- pIR for values out of range

If any test fails, the "Good" LED is extinguished. This information, on a slot by slot basis, is also sent to the PC Application. That is, each slot is separately reported as Good or not.

ExG Lead off information is extended to the Status Bar of the PC Application. If one of a pair of electrodes is detected to be off, the status for that channel rapidly flashes as a warning. If both electrodes are detected to be off, the status is "bad" but not flashing, since that channel may not be in use. Should the ground electrode be detected as off, then all channels (2 or 4) status indication rapidly flashes.

To determine whether it is the active or reference electrode that has fallen off, link the references. If the rapid flashing persists then it is the active electrode that has fallen off.

Electrode pair impedances can also be measured. Initiated by the PC application, EIM values for each

channel (2 or 4, depending on the Mode) are sent back to the Application for display. Values up to 128kOhm are reported. Accuracy is better than 10%.

17   Test Signals

At power-up, a brief self-test sequence of test signals is sent to the transport slots and to the nIR HEG headband. If the transport slot is configured for EEG use("AC"), then the test signal is a 4, 8, 16, and 32Hz tone, each for one second at a level of 30uVpp. If the transport slot is configured for HEG use ("DC"), then the brief test signal is values 99 and 101, each for 1 second.

Additionally, during this power-up self-test phase, control signals to the nIR HEG headband interface separately pulse the Red and the IR LEDs, so that both can be seen with the naked eye. [In normal use, the brightness of the Red LED makes it impossible to see whether the IR is functioning.]

If power is applied to the Wiz with the "Link"/"Calibrate" button pressed, then it will power-up in Signal Generator Mode. In this mode the above test signals are applied indefinitely, or until power to the unit is removed, or both the "Link" button and the "Mode" button a pressed simultaneously to exit Signal Generator Mode. Note that external controls can configure the EEG test signal to be a swept tone of 0..30Hz with a 4 second sweep time, rather than the default pulsed tones. EEG Test signals are at a level of 30uVpp.

8 sec Self-Test on normal Power-up

EEG - 4/8/16/32Hz, at 1 second intervals
NIR - 99/101 at 1 sec intervals

18   Saving Configurations

When changing Modes, the new Mode is remembered. When the unit is next powered, it will come up in that Mode. After a signal has settled, be it eeg or heg, pressing the Freeze button for 2sec will save the current baseline so that the signal can settle more quickly when that modality is next selected. Functions that get remembered:
   • Mode: 32/128/512/256sps, 2ch/4ch
   • Baseline offset values
   • EEG Reference Link Status (linked or un-linked)
   • wireless channel number
   • User Defined Cap Mapping

19   Fail-safe Mode

Fail-safe Mode is entered by powering-up with the Mode button pressed. Fail-safe Mode offers base functionality (ie is usable for most functions), and the ability to upload or re-load firmware upgrade packages to restore full functionality. Fail-safe Mode comes up in Mode 2 (128sps/2ch), but other modes can then be selected. Firmware upgrades are restored by placing the unit in Program Mode then using the PC Application Software to upload the latest firmware package available from the pocket-neurobics.com website.

Functions that may not work in Fail-safe mode (model dependant):
   • commanding of the Wiz by the PC Application
   • pulse oximeter interface

Safety functions in Fail-safe Mode:
   • extra time for USB enumeration (for slow PCs)
   • freeze button locks current sensor configuration (to stop possible jitter on sensor detection in noisy

environments)

20 Commanding the Wiz – BioExplorer

Most functions on the Wiz can be commanded from the special Wiz window that appears when in BioExplorer, the Wiz driver is selected. If multiple Wiz devices are active, then there will be multiple Wiz command windows open.

Some functions are specific to a particular model, such as buzzer being relevant to the E-wiz and H-wiz only. Commands that are not relevant to your model will be simply ignored.
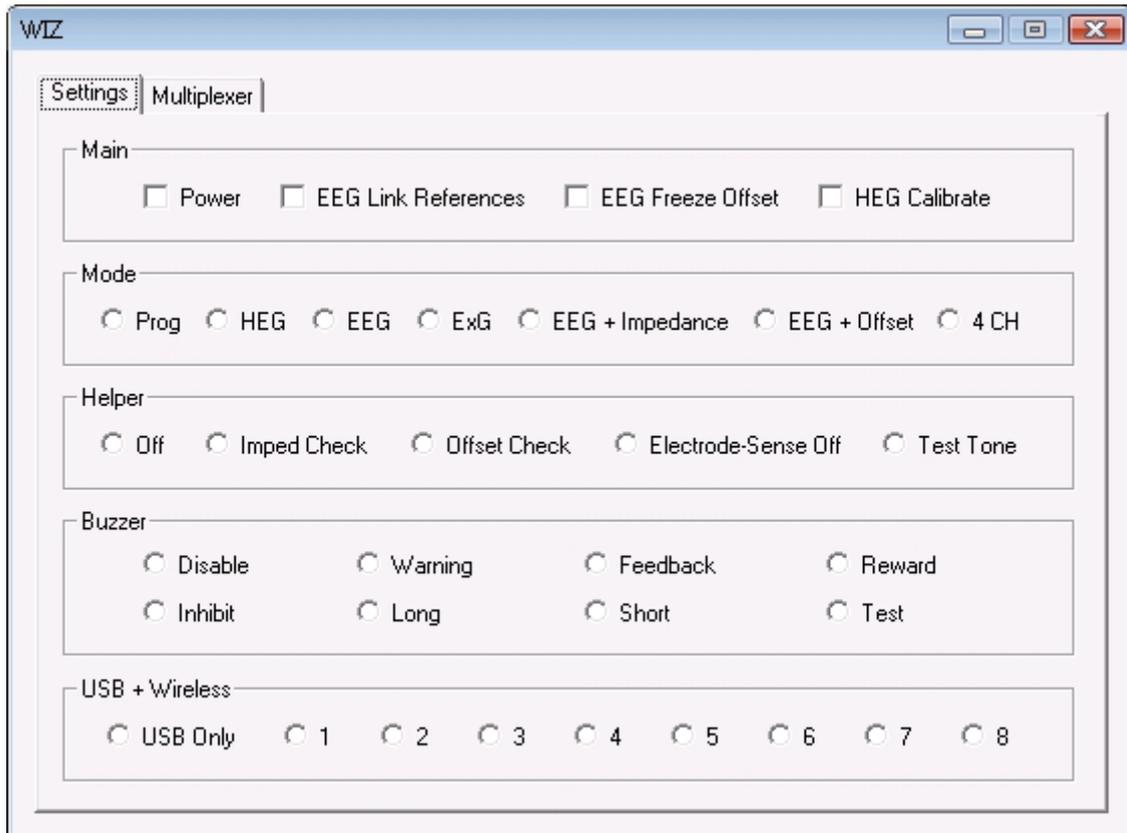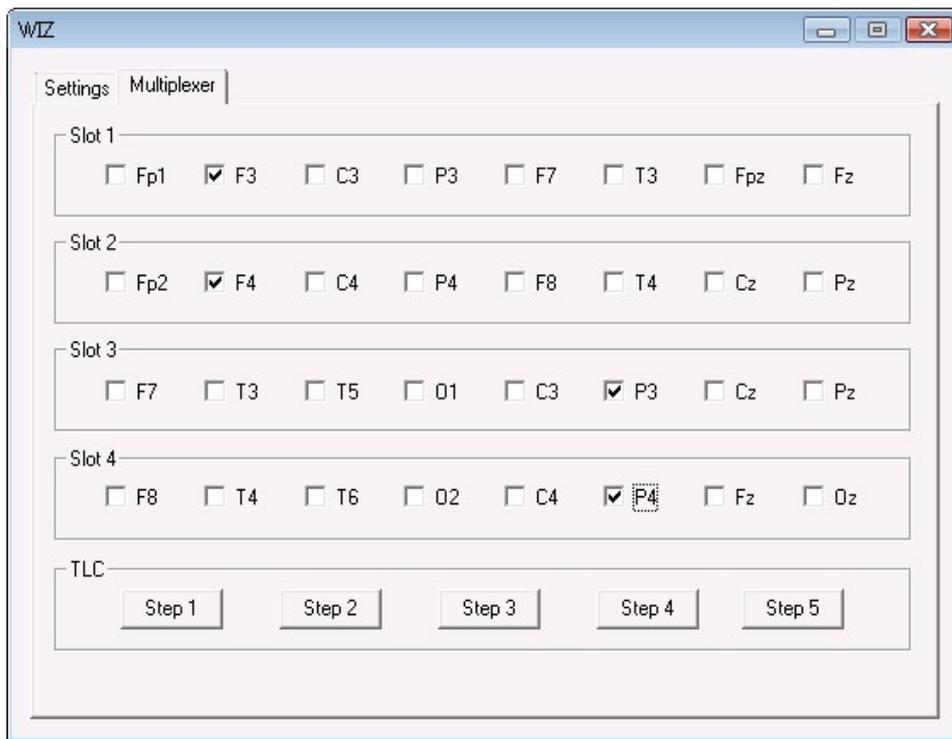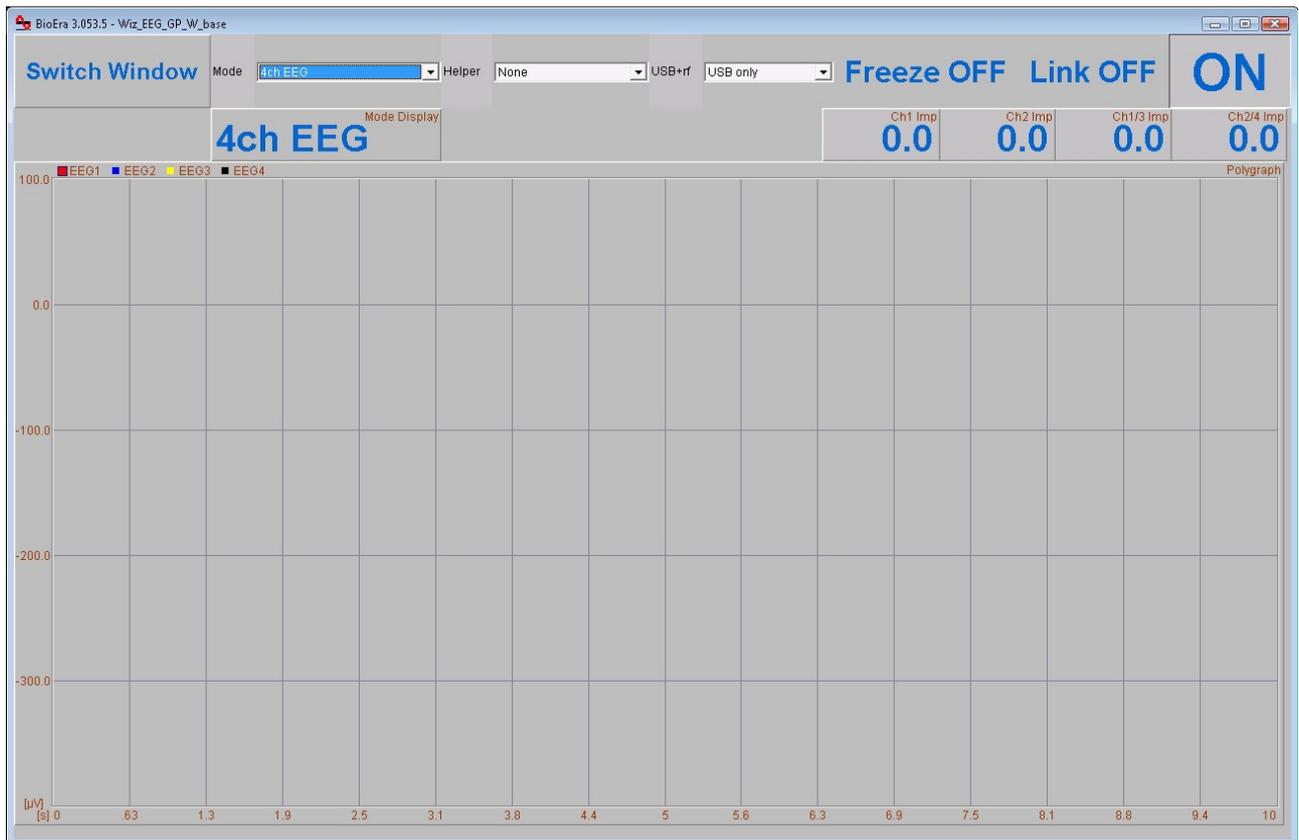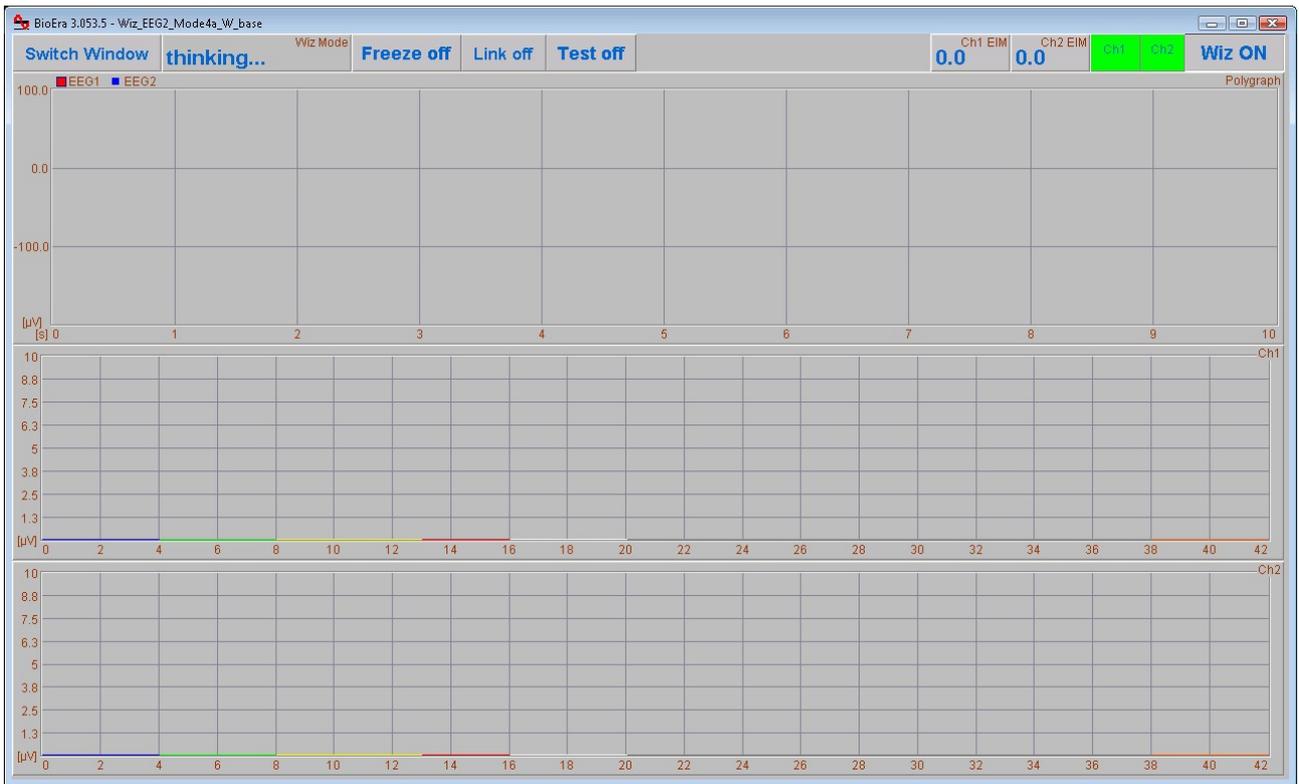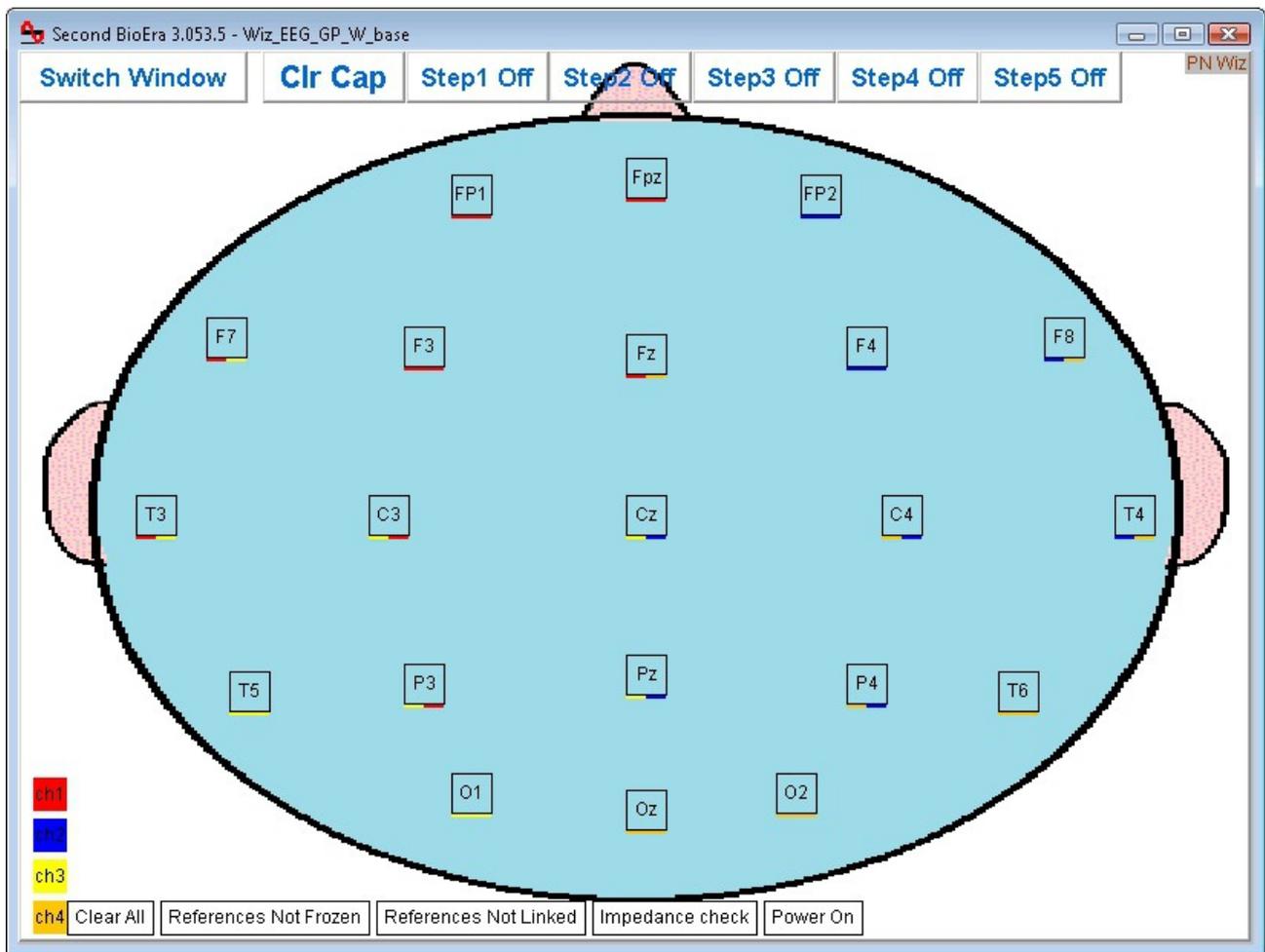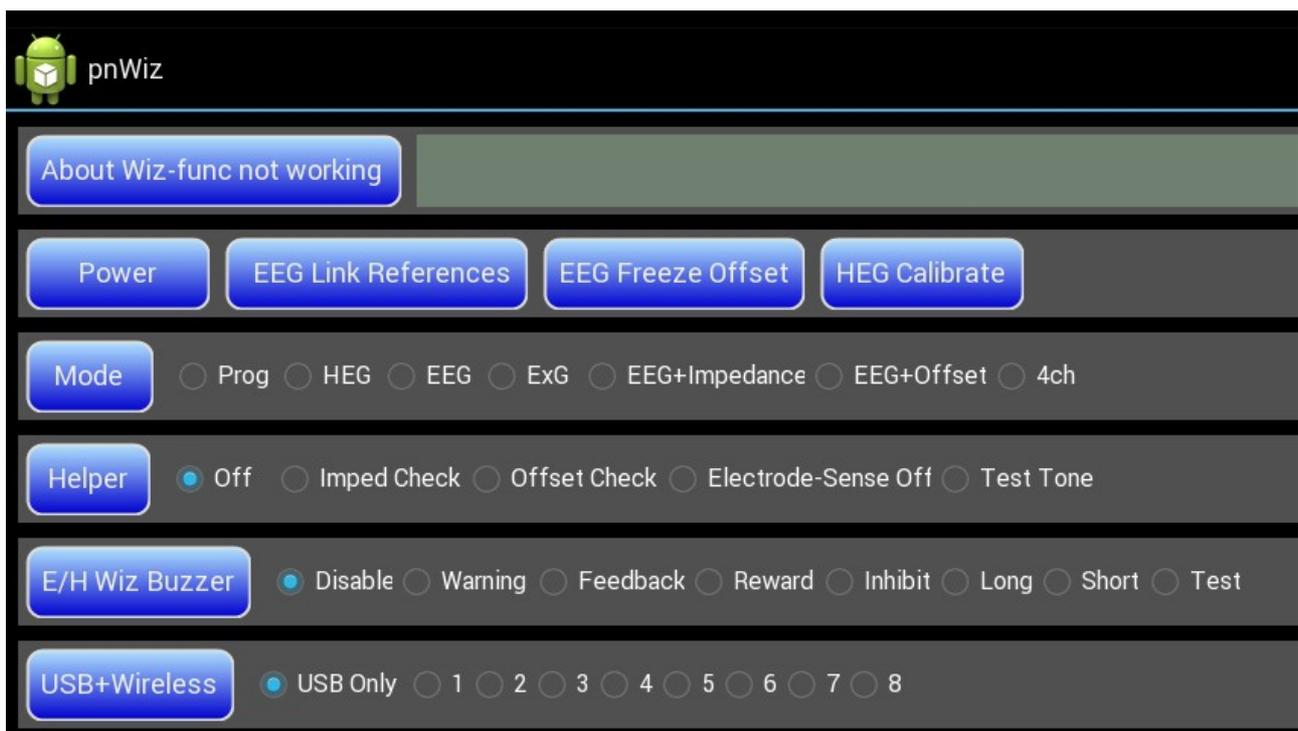
21 Commanding the Wiz – BioEra

BioEra allows changing many parameters at runtime, granting increased flexibility, but conceding increased complexity. This architecture allows designs to configure the Wiz at start-up so that the Mode matches the intent of the design.
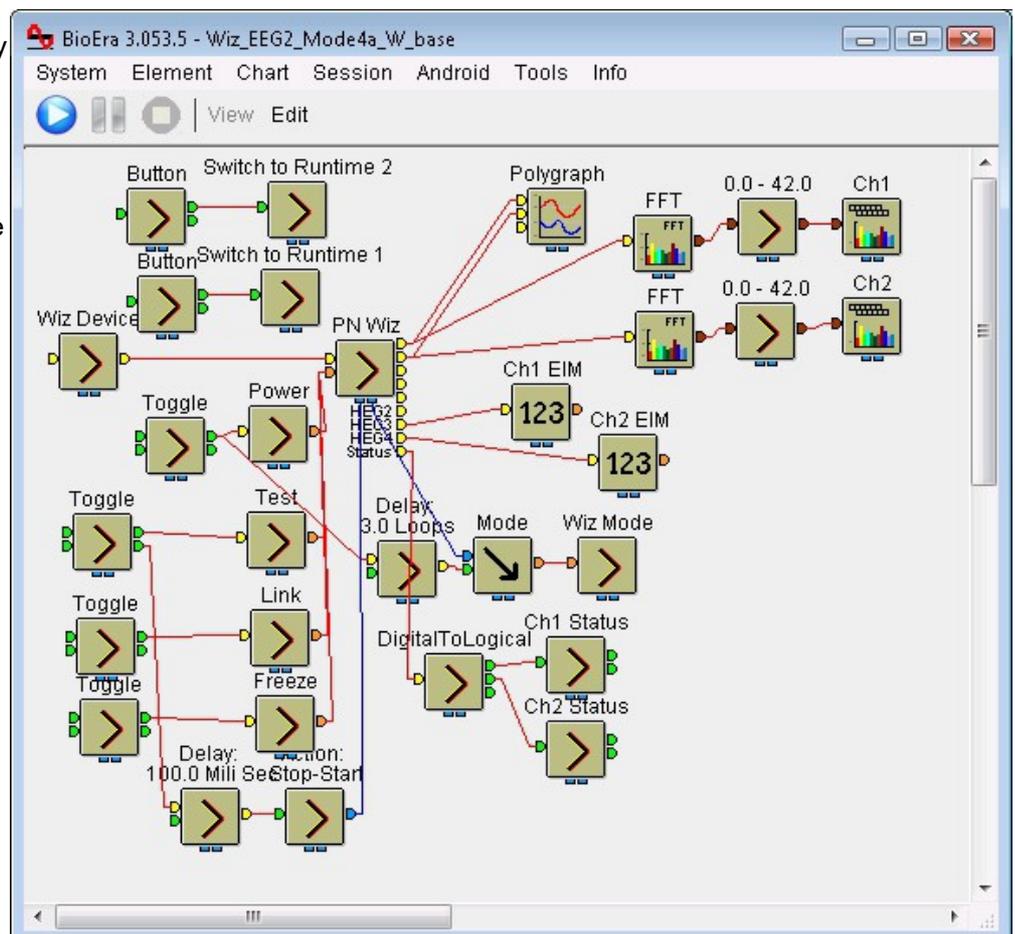
## 22 Commanding the Wiz – Wiz Central App (in development)

Wiz units that connect to a PC Application via a direct USB Connection, namely the Q/E/H/U/X-wiz, can have all functions controlled by the PC Application. These functions include:

- power on/off
- change Mode
- change Qwiz 21-ch EEG cap configuration on the fly
- change Linked references – Q/Ewiz
- change Freeze - Q/Ewiz
- start HEG Baseline search – Q/Hwiz
- set USB or USB+RF Transport Mode
- measure electrode impedance
- set RF Ch No

Receiipt of commands are acknowledged by four flashes of the "Transmit" Indicator and four flashes of the slot status indicators sent to the Application. Not all commands will be relevant to all models (for example Buzzer commands are only relevant to the E/H-wiz), but all commands will be acknowledged.

An example of Graphical Control of the Q-wiz's 21-ch EEG Cap interface:
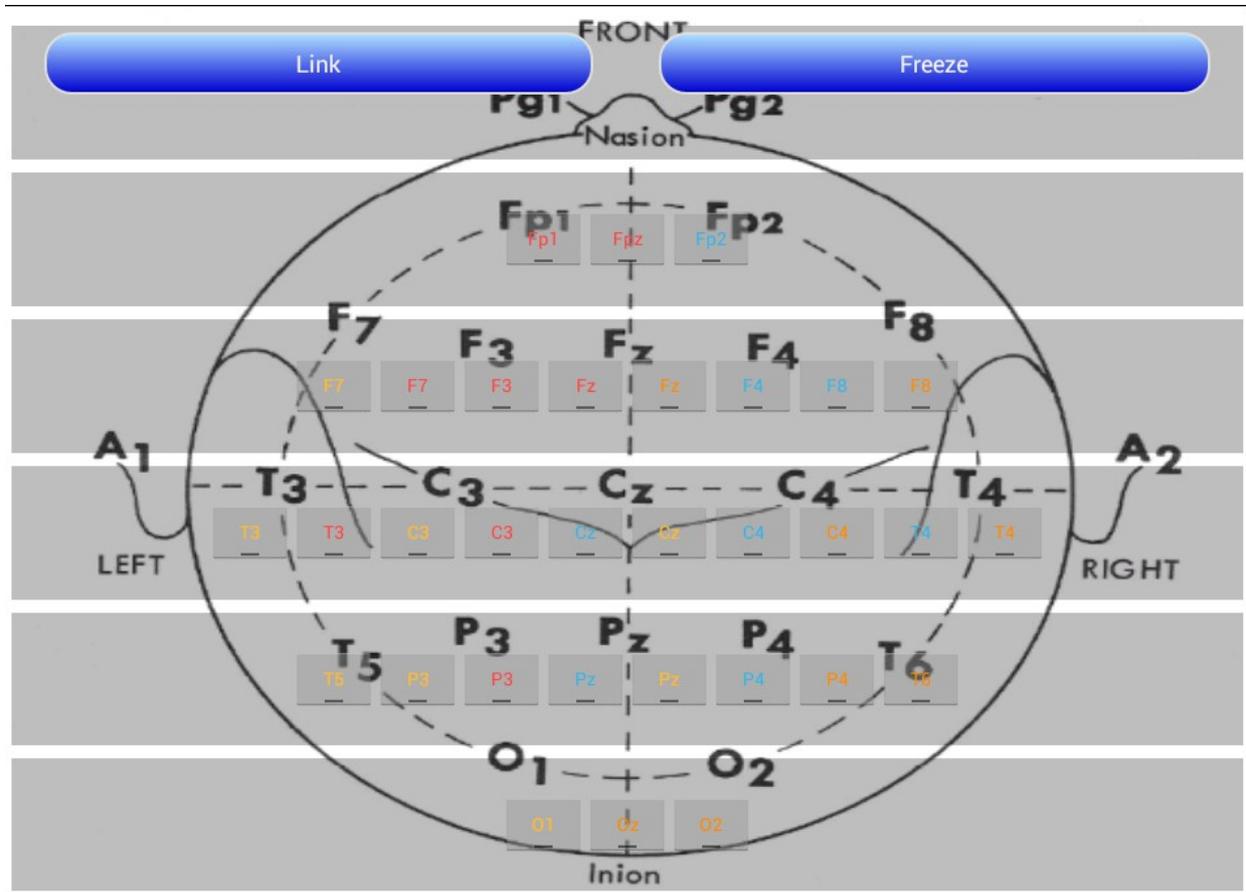
23 Fault Finding

There are a few things in the Wiz to enable you to check it's health. Let's discuss EEG first, with the discussion more generally applicable to EEG, ECG, EMG and SCP. We will discuss HEG later.

EEG

First item is the "Test Tone" Helper function. This is available in the Wiz window in BioExplorer under Helper functions: Test Tone, and in most BioEra designs there will be a button "Test".

If EEG is active the Test Helper function injects a tone at the input of the Wiz. Thus the device is fully tested – in general, if the Test function is working then the Wiz is working and users need to check whether the electrodes

themselves are behaving.

If the Test signal is fine, but the EEG is flat-lined, then the first thing to check is that "Freeze" is off. Freeze is switched on for working with SCP (& ERPs), Othmer low frequency protocols, and possibly ECG. Activating the Freeze function puts the Wiz into its DC-coupled mode. This means that the offset removal that is normally in place, acting to return the EEG signal to an average of 0uVolt is de-activated. If Freeze is switched-on whilst the EEG is out of range, not yet having fully restored itself to an average of 0uV, then it will stay out of range indefinitely. That is, the EEG will be flat-lined. For this reason the Freeze state is not remembered – each time the Wiz is started, it starts with Freeze off.

Also, if using one-channel EEG designs, you must use Channel 1 (aks 1+/1-, aka Left). If you use Channel 2 (or 3 or 4) without using Channel 1, then the feature of actively suppressing 50/60Hz interference is lost.

In relation to electrode performance there are several layers of defense.

First, the Red/Green information in the Statua Bar of BioExplorer, and also generally brough out to Lamps in BioEra designs, give "electrode off" indications. This will actually identify which electrode has fallen off using the following code

•steady red light – both electrodes are off (or that channel is not in use)
•flashing red light – one of the pair of electrodes is dislodged

Linking reference electrodes can then distinguish which of the pair of electrodes is dislodged

•if the flashing red light persists when electrodes are linked, then it is the active electrode that has dislodged
•if the flashing red light goes steady green, then it is the reference electrode that has dislodged.

Second, there are two Helper functions related to checking electrodes: in BioExplorer, "Impedance Check" and "Offset Check". BioEra designs will generally have an electrode impedance check ("EIM" button) but may or may not have an offset check. Electrode impedance is a measure of the goodness of the contact of the electrode with the skin. Poor contact will result in a noisy EEG and quite possibly a large increase in 50/60Hz power line interference which too can lead to flat-lining. EIM is a measure of the impedance of the electrode pair, not a single electrode. So values under 20kOhm can be considered good and up to 50kOhm is quite serviceable. Offset Check is a measure of the voltage generated by the metal electrode together with an electrolyte (the paste) onto the skin. All metals will generate this voltage with Ag/AgCl electrodes having the lowest voltage. EEG systems are designed to tolerate this relatively large voltage, however gold-plated electrodes, when the gold plating wears or is otherwise compromised, exposing a different base metal, produces a particularly severe offset voltage that can cause the EEG to intermittently flat-line. Gold electrodes are not recommended. The Wiz can tolerate offset voltages +-250mV and so should not be an issue if gold electrodes are not used.

Finally, Wiz units have multiple processors which exchange messages. It is possible that from time to time these messages get corrupted and the Wiz enters a wrong state. Pressing the Wiz on/off button in the design will reset the device and correct any problem. If it occurs at all it should be rare, and repeated occurrences would indicate a problem with the device.

HEG

In relation to HEG, the Test Helper function puts out a test tone of approximately 99.5 and 100.5, alternating every second. This is not as complete a test as the Test Helper for EEG, but does check most of the HEG circuitry to send data to the computer.

In relation nIR HEG, the Helper Test Tone also tests the signal sent to the nIR headband. In normal use, the Red and Infrared lights on the headband are switched rapidly making it impossible to see whether the infrared light (being largely outside the visible spectrum, and so very dim) is lighting or not. With the Test Helper, the signals sent to the headband are a slow flash of the Red and Infrared light so that it becomes possible to perceive that the infrared light is illuminating. If either light is not working, then a return-to-factory repair is required.

OTHER

Further possible failure modes include:

(i)   USB enumeration (Q-wiz only):

for the Q-wiz, the decision to transmit over USB or wirelessly is made shortly after power is applied to the unit

(ie shortly after it is plugged into a USB port). If in this period of a couple of seconds it is not "enumerated" by the USB protocol it assumes that the power is coming from a "portable USB power" source (ie a battery) and therefore starts to transmit wirelessly. If the computer is older and perhaps abused in the number of USB devices attached (Windows can choose to assign this a low priority when it has other things to do) then it may be that enumeration is slow and the Q-wiz starts to transmit wirelessly even though it is connected to a real USB port.

The solution is

> •un-plug the Wiz and re-plug, with enumeration likely to be faster on the second attempt
> •if the problem is chronic, then the Wiz cab be started in Safe Mode (by powering it with the Mode button depressed) which gives extra time for enumeration. Note that some functions may be lost in Safe mode.

One can tell when the Wiz is transmitting wirelessly by the "Transmit" light – if transmitting wirelessly the Transmit light will blink, if not transmitting wirelessly it will be steady. The number of blinks indicate the wireless channel number. [But remember that most Wiz devices can transmit over USB & wireless concurrently, in which case the Transmit light blinks whilst communicating over USB.]

Wiz devices other than the Q-wiz can switch between wireless & USB at any time, so a late enumeration is not a problem.

(ii)   Failure to recognise a HEG headband (Q-wiz, H-wiz & X-wiz):

When a nIR/pIR/oximeter is plugged into the Wiz, the "HEG" light should come on. If it does not then the Wiz is unlikely to work correctly

(iii)   Corruption of firmware (all Wiz models):

If the Wiz unit is not working or behaves erratically when started normally, but works fine when started in Safe Mode (see above) then this would strongly indicate that the firmware of the Wiz has been corrupted. This (rare event) may occur from a failed firmware update, or it may occur should there be a power surge or lightning strike whilst the Wiz is saving parameters. Recovery is by using Safe Mode to place the Wiz in Program Mode, then to upload the firmware file from the "Update" tab on the website.

Note that some functions may not be available in Safe Mode, depending on the Wiz model, however Program Mode will always be accessible. For the U-wiz and the X-wiz, which are nominally "button-less", a paper-clip is used to press the mode button accessible on the side of the unit.

24 Summary Specification

EEG (Mode 2)

Bandwidth	0 - 46Hz
Resolution	0.06uV
Dynamic Range (Freeze)	4mVpp
Dynamic Range (no Freeze)	1Vpp
Noise (electrodes in tub of paste)	0.025uV/Hz typ. (0.5-40Hz)

ECG/EMG/SCP (Mode 3)

Bandwidth	0 - 190Hz, with stop band 50-60Hz
Resolution	0.24uV
Dynamic Range (Freeze)	16mVpp
Dynamic Range (no Freeze)	1Vpp
Noise (electrodes in tub of paste)	0.015uV/Hz typ. (0.5-150Hz)