

Duet

Evoked Potentials and
Otoacoustic Emissions
in perfect harmony



many options, one smart system

the clinical solution you've been waiting for

We've listened to you and have integrated your feedback into a powerful platform for EP and OAE. We are excited to introduce the Duet: a sleek, portable, and versatile clinical evoked potential and otoacoustic emissions system.

outstanding production

Over 30 years of engineering design experience, combined with unsurpassed expertise in evoked responses, have culminated in the **next generation bio-amplifier** to bring you **superior data quality** for evoked potentials and otoacoustic emissions.

Repeatable, reliable data you can count on

- High definition responses
- Cleaner, more robust responses
- Increased signal-to-noise ratio (SNR)
- Lower residual noise

Reduced test times without compromising data quality



all dressed up

The newest member of the Universal Smart Box family, the Duet's sleek design is both ergonomic and portable.

- It is lightweight, at less than 4 lbs (2 kg)
- Fits perfectly under most laptop computers
- Maximize your workspace by using it with its companion stand
- Built-in isolation and shielding: it can be used in any location, including the NICU and OR

Test in more places without sacrificing flexibility

stellar clinical performance

The Duet is available in two base packages: Duet 2 Channel AEP, or Duet 2 Channel AEP & OAE. Choose from a variety of add-on modules for the ultimate in flexibility and versatility. Upgrade anytime with minimal or no down time.

Standard SmartEP modules:

- ECoG
- ABR (click, tone burst, iChirp)
- MLR
- LLR/CAEP

Optional SmartEP modules:

- P300/MMN
- eABR
- Chained-Stimuli ABR
- cVEMP, oVEMP
- ASSR

Standard SmartOAE modules:

- DPOAE
- TEOAE
- SOAE

Optional EP/OAE:

- Simultaneous ABR/TEOAE

powerful research features

Advanced options for SmartEP:

- CLAD for high-rate stimulation
- Notched-Noise Masking
- Advanced Auditory Research Module (AARM)
- Frequency Following Response (FFR)
- Complex ABR (cABR)
- Acoustic Change Complex (ACC)
- Binaural Interaction Research Module (BI)
- SmartEP-CAM Continuous Acquisition Module
- Chirp Stimulus Generation Module
- DLL Development Kit

Advanced options for SmartOAE:

- TEOAE suppression: contralateral, ipsilateral, and binaural
- Dual OAE probe system
- High Frequency DPOAE for ototoxicity monitoring



designed for an
improved clinical experience

SmartEP

The ideal clinical tool for recording ECoG, ABR, and more.

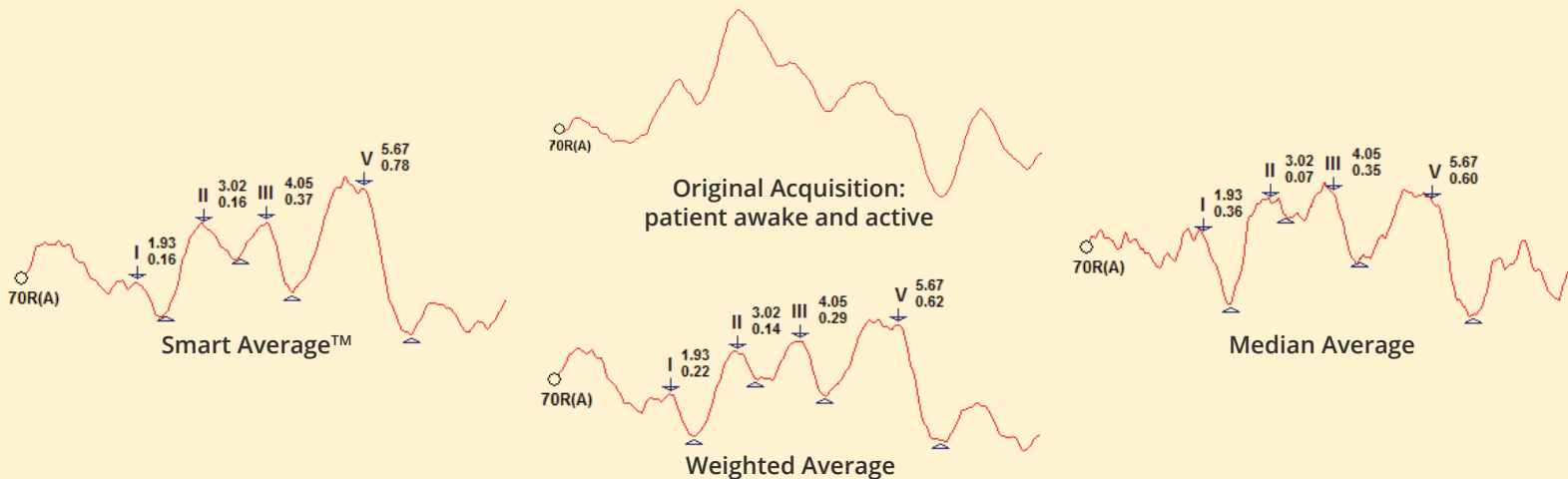
new and improved user interface simplifies acquisition

- Improved toolbar and button design for fast access to key features
- Easy access to all parameters from a simplified control panel and streamlined menus
- Quickly load your own or preset protocols
- Easily view ongoing EEG display for quick assessment of patient state during testing
- Great variety of options allow you to perform the tests the way you want
- Choose from a variety of stimuli, or generate or import your own custom stimuli
- On-screen and remote impedance checking using patient response alert box



smarter averaging display options

- Option to automatically acquire and store data in sweep blocks for more powerful processing
- Easily analyze acquired waveforms using additional averaging techniques for further noise reduction
- Averaging techniques includes traditional (linear), median, weighted, and Smart Average

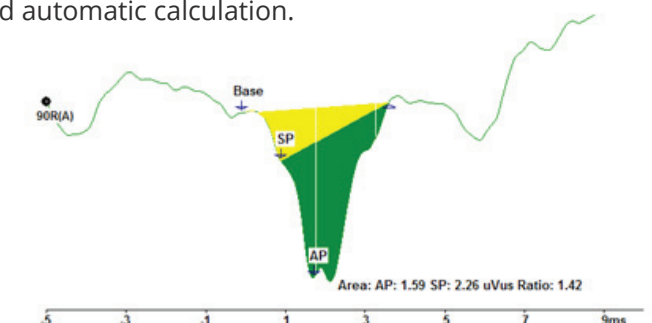
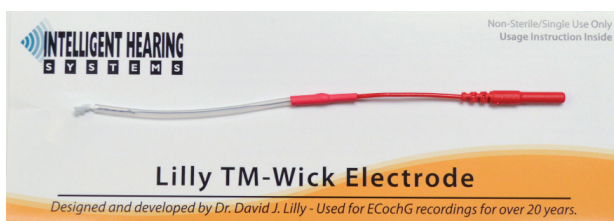


- Objective response measurements provide indicators of recording quality, including SNR, RN, Fsp, and Fmp
- Automated averaging stopping rules using residual noise measures allow data to be acquired automatically with consistent quality and noise level criteria

the perfect duet for electrocochleography

Our next generation amplifiers combined with the non-invasive IHS Lilly TM-Wick Electrodes produce more robust and repeatable ECoG.

Improved SP/AP amplitude and area curve ratio analysis and automatic calculation.



smart features

- Dual channel system, with ability to use as a single channel, including automatic polarity switching
- Change most test parameters with a single click
- Adjustable display scale
- Latency-Intensity graphs indicating normative data ranges are automatically generated from marked waveforms
- Quickly add, subtract, invert, time shift, or cross-correlate recordings
- Display or hide a subtle grid or baseline
- Split-sweep view to visualize single recording repeatability
- 2D and 3D Spectral Analysis

streamlined workflow

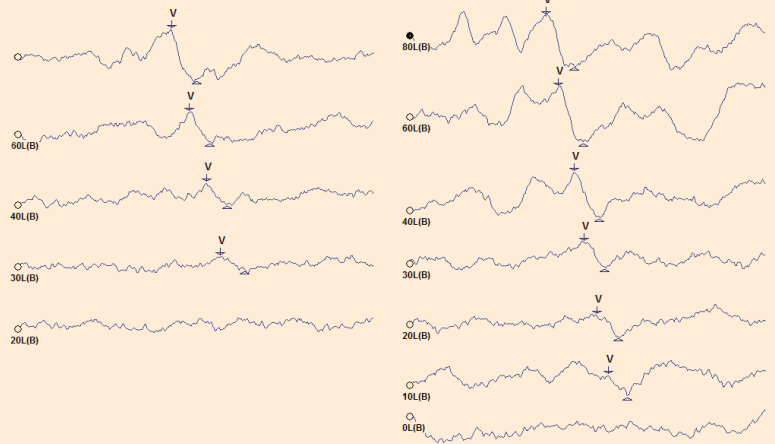
- Easily mark waveforms using over thirty pre-defined peak labels, or create your own custom labels. Easily adjust them using a mouse or keyboard
- View latencies and amplitudes of peaks directly on waveforms and in newly embedded recording information panel.
- Automatically arrange recordings by intensity, acquisition order, stimulus frequency, or rate
- Quickly resize the waveforms using the zoom in/out buttons
- Customizable page labels and attributes
- Multi-page display and reports with easy PDF reports
- Auto-save reports on program exit

iChirp™ stimuli included

The intelligent Chirp for SmartEP and SmartEP-ASSR is included with all packages.

- Broad and narrow band (500, 1000, 2000, 4000 Hz)
- Improved threshold detection
- Robust amplitude responses
- Optimized wave V identification
- Optional, innovative custom chirp design utility

Beneficial for recording ABR in awake and active patients.

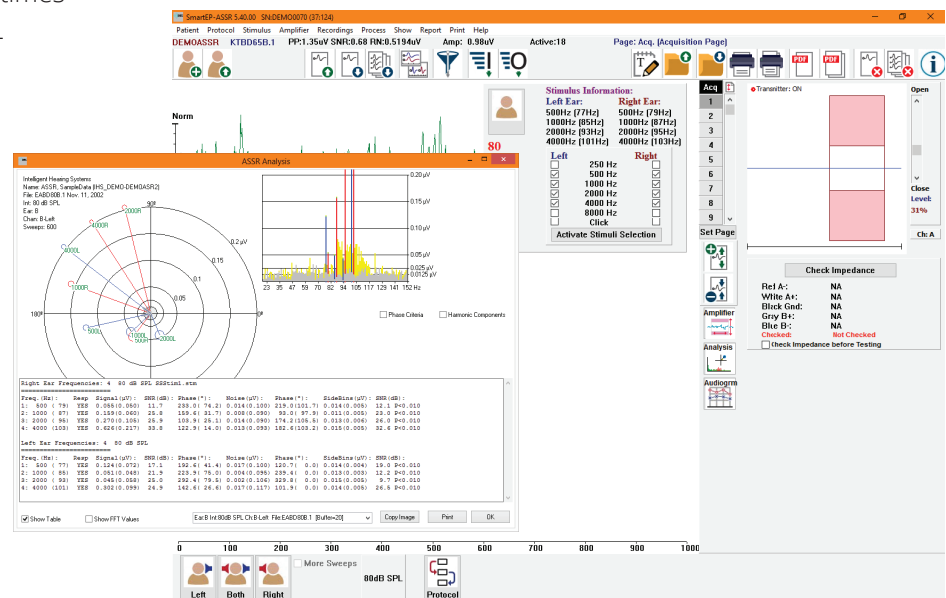


2000 Hz tone burst ABR (left) vs 2000 Hz iChirp ABR (right)

SmartEP-ASSR

Full-featured screening and diagnostic Auditory Steady State Response System.

- Provides quick, accurate threshold detection using automated statistical analysis
- Test both ears at the same time, four frequencies per ear
- iChirp (broadband & frequency specific) for robust amplitudes and harmonic component analysis for improved threshold detection and reduced test times
- Automated audiogram generation in SPL and HL
- Cost effective add-on to SmartEP

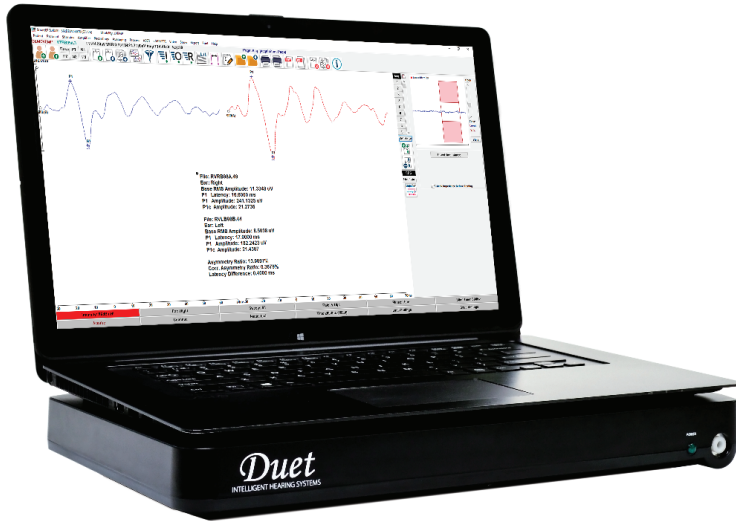


SmartVEMP

Innovative solution for cVEMP and oVEMP

the VEMP solution you've been waiting for

The new & improved SmartVEMP option is cleared by the U.S. FDA for oVEMP and cVEMP testing on patients of all ages. The most advanced VEMP module in the market has been enhanced to become the ideal clinical tool for recording oVEMP and cVEMP responses.



integrated EMG monitoring

SmartVEMP includes the ability to monitor EMG activity with the same recording electrodes: no need for additional EMG monitoring electrodes.

The module also features a user-friendly interface to easily choose the target EMG levels for your patient.

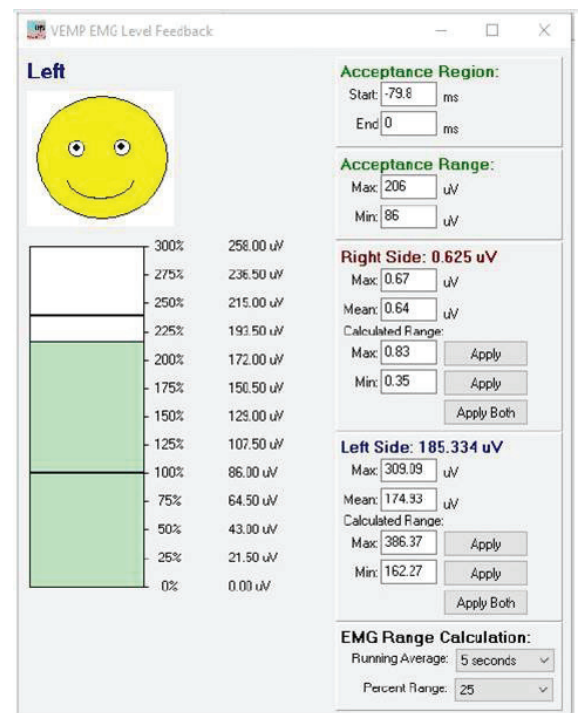
- Choose patient-specific EMG level acceptance amplitudes for each side
- Automatically calculates the EMG acceptance range
- User-defined acceptance and rejection time regions
- Only averages sweeps with adequate EMG activity

On-screen EMG for easy viewing and monitoring patient state during testing

improved bio-feedback options

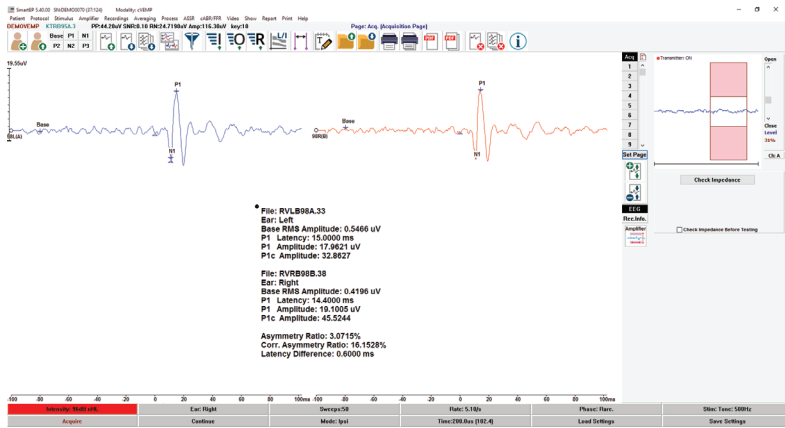
Patient-friendly options for visual bio-feedback:

- Feedback box with LED indicators
- On-screen EMG level display with happy/sad face
- Animated videos for pediatric testing

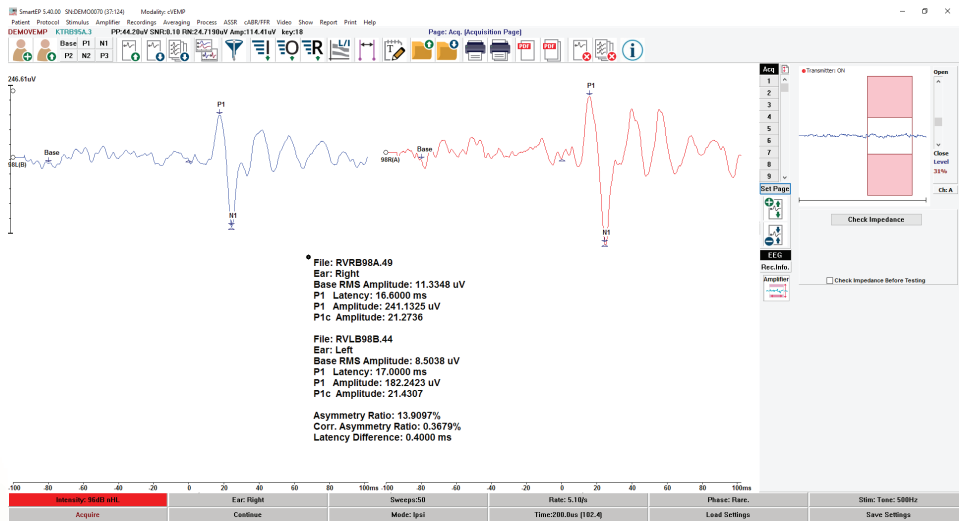


smarter VEMP features

- Quickly load preset cVEMP and oVEMP protocols
- Easy to mark peak labels using mouse or keyboard
- Baseline automatically marked to the user-defined acceptance region
- Integrated baseline EMG response normalization
- Create a grand average using multiple recordings
- Easily compare left and right VEMP responses
- Automatic calculation of corrected amplitude and asymmetry ratios
- Amplitude corrections based on pre-stimulus EMG activity



Sample oVEMP Recordings



Sample cVEMP Recordings



AAR/FFR

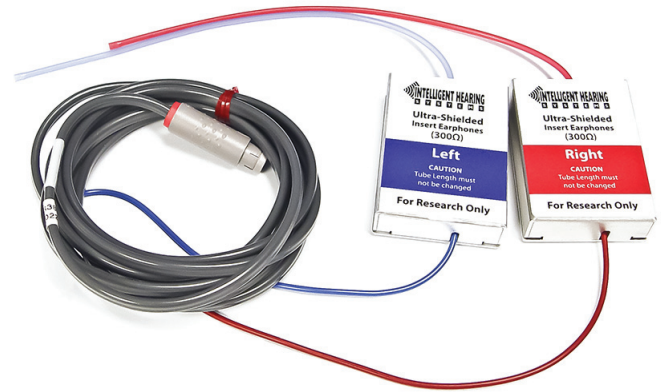
Advanced Auditory Research Module for Frequency Following Response and Acoustic Change Complex*

complete control of stimulus and acquisition timeline

This add-on module for SmartEP allows users to customize every aspect of acquisition and stimulation, using an advanced and easy to understand interface; making it an ideal tool for the acquisition of Frequency Following Responses (FFR).

It permits the mixing of stimuli when the Notch-Noise masking hardware is installed and provides the user access to define times of acquisition by specifying delays and offsets for each stimuli selected.

- Use simple or complex stimuli, including tones, iChirps, speech stimuli, and noise
- Define custom stimuli using the built-in conversion utility
- Adjustable stimulus sampling rate: 40kHz, 20kHz, 10kHz, 5kHz
- Use stimulus files up to 8 seconds in duration
- Set stimuli to be presented at a specific time, or to be output continuously
- Combine up to 2 stimuli per ear or present ipsilateral masking



Optional ultra-shielded ER3 or ER2 insert earphones

SmartEP Advanced Auditory Research Module

		170.05ms	
1024		2048	500.00ms
	Zero Time		
		ArtRej	
			476.19 ms

System Base Sampling Rate: 40 kHz

File Stim Info: BA.STM
Comment:

Right Ear - Channel 1 (Stimulus 1):
☒ ON File: BA.STM Browse Intensity: 80 Time Offset (us): 50000 ☐ Continuous ☐ Condensation ☐ Rarefaction ☒ Alternating

Right Ear - Channel 2 (Stimulus 2):
☐ ON File: Browse Intensity: 0 Time Offset (us): 0 ☐ Continuous ☐ Condensation ☐ Rarefaction ☒ Alternating

Left Ear - Channel 1 (Stimulus 3):
☒ ON File: White_40K.STM Browse Intensity: 70 Time Offset (us): 0 ☒ Continuous ☒ Condensation ☐ Rarefaction ☐ Alternating

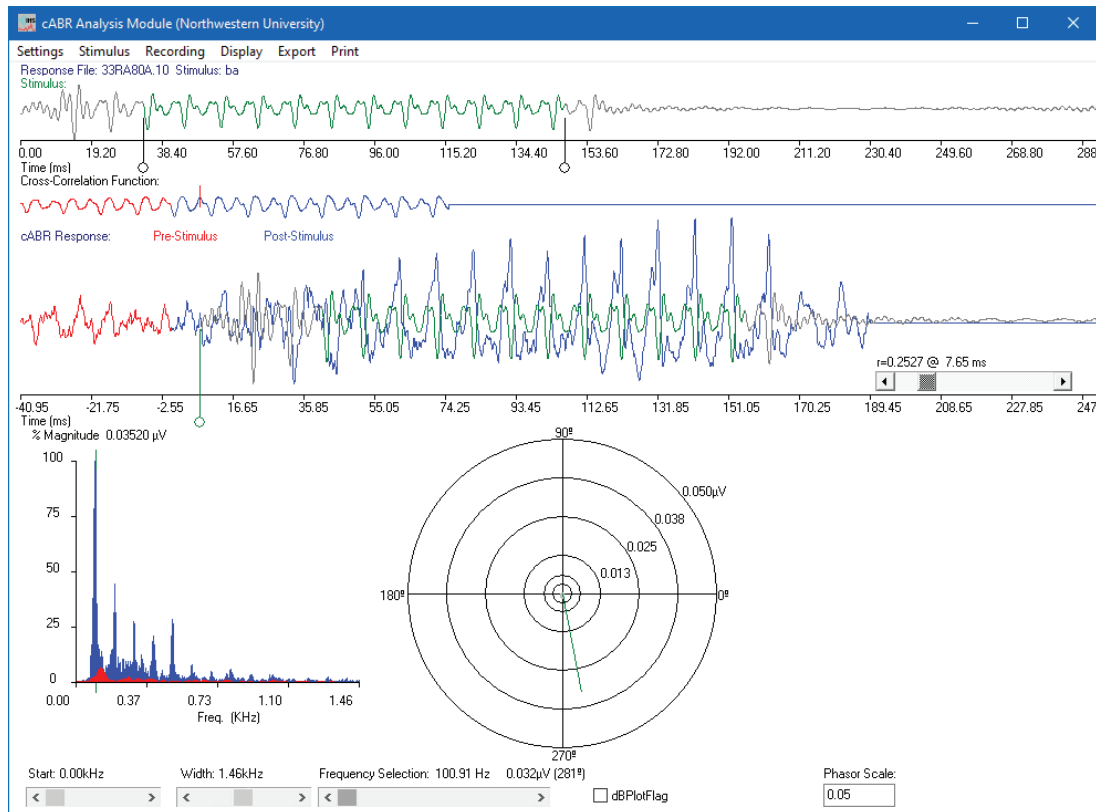
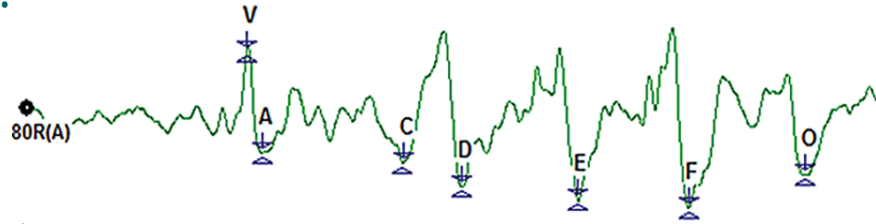
Left Ear - Channel 2 (Stimulus 4):
☐ ON File: Browse Intensity: 0 Time Offset (us): 0 ☐ Continuous ☐ Condensation ☐ Rarefaction ☒ Alternating

Data Buffer 1:
☒ ON Zero Time (us): 50000 Start Time (us): 0 Sampling Rate (us): 150 (25us intervals) Data Points: 2048

Main:
☐ Right-Left Control Panel
Rate: 2.10 /s
Period: 19048 pnts
Period: 476.19 ms
EP Type: A-ABR
☐ OAE Enabled
Artifact Rejection (us):
Start: 55000
End: 200000
Load
Save
Save as Default
Note: Advanced Settings will also be saved when saving System Settings.
OK

Acquisition and Analysis of cABR:

- Includes pre-defined settings for complex stimuli, including speech syllables BA, DA, GA, and more
- Users can create customized settings and stimuli
- cABR specific label markers
- Easy comparison of marked recordings
- Includes cABR analysis, spectrogram, and phaseogram tools
- Analysis module includes a cross-correlation function, overlapping stimulus and response, and response power spectrum
- Users can define the response analysis region, high pass, and low pass filters
- Display of filtered and unfiltered spectrogram
- Export data, cross correlation information, or power spectrum of recording for additional external analysis
- Interfaces with MATLAB® modules for further analysis possibilities



*The Advanced Auditory Research Module, cABR Research Module, and Ultra-Shielded Insert Earphones are intended for research use only; they are not intended for use in diagnostic procedures.

Full functionality requires the Auxiliary Output Channel hardware and the Notched Noise Masking software option.

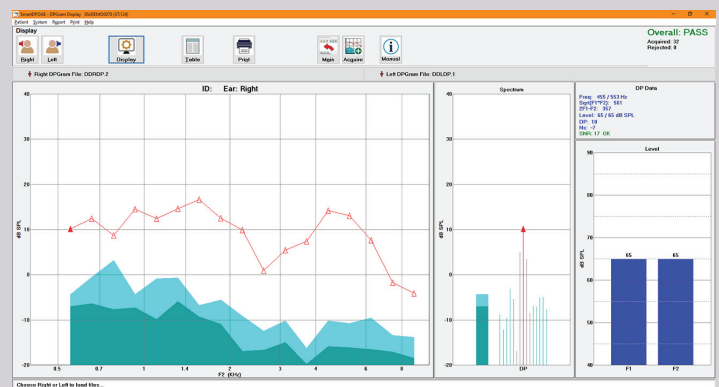
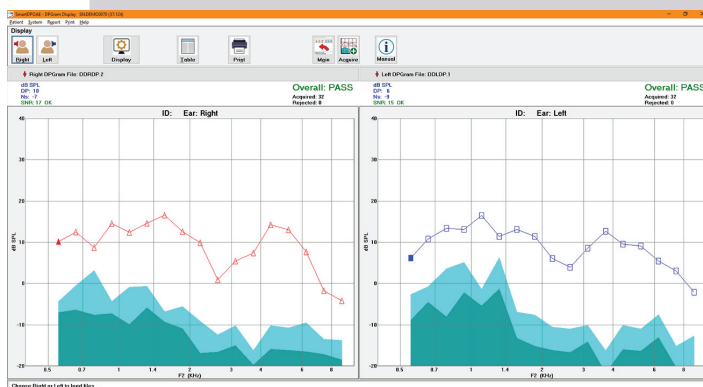
Research supporting this technology was developed by Dr. Nina Kraus and colleagues at Northwestern University.

Visit the Auditory Neuroscience Lab website (www.brainvolts.northwestern.edu), directed by Dr. Nina Kraus, for information about the research supporting the cABR technology and about upcoming scientific talks by Dr. Kraus.

SmartDPOAE

Screening and diagnostic distortion product otoacoustic emissions.

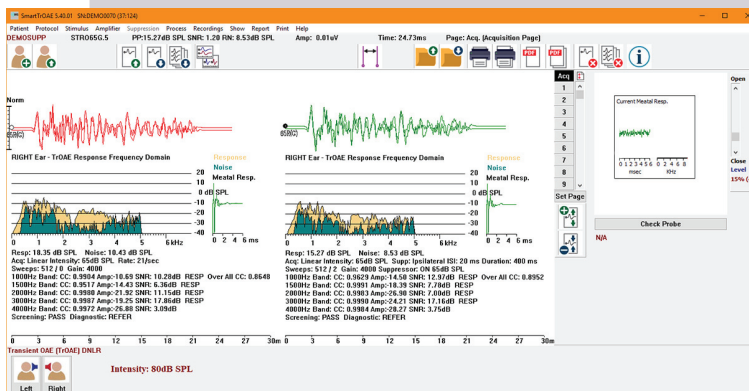
- Fast and easy setup with up to 41 frequencies per ear in a single test
- Automatic probe-fit check and in-ear calibration for increased test accuracy
- Easy-to-interpret colorful DPGrams and detailed information for each frequency tested
- Clear Pass or Refer indications based on user-selected passing criteria
- User-customizable display of normative ranges on the DPGram facilitates response analysis
- High frequency option for ototoxicity monitoring
- Built-in scripting feature allows you to define sequences of frequencies and intensities for automated data collection
- Optional graphical display of noise standard deviation for improved interpretation



SmartTrOAE

Screening and diagnostic transient evoked and spontaneous otoacoustic emissions.

- Fast and easy test setup and data analysis
- Automatic probe-fit check and in-ear calibration
- Clear Pass or Refer indications based on user-selected passing criteria
- Displays of the OAE time signal, frequency analysis and the ear canal response
- Use clicks, tones, or user-defined stimulus files
- Time-Frequency plots can be used to illustrate how the frequency composition of transient OAE responses, Noise, and SNR change over time



Available in the Duet is a dual-probe option that allows for the acquisition of contralateral, ipsilateral, and binaural TEOAE suppression recordings.

This option includes a Suppression Analysis module for temporal and spectral comparison of control and suppression data.

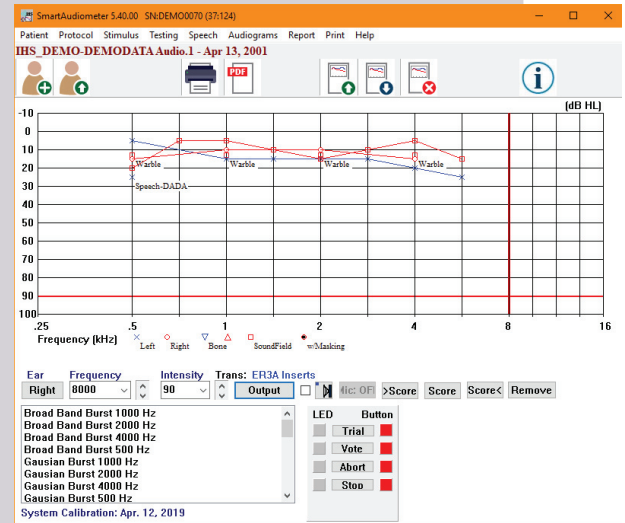
complement your Duet

Expand your capabilities by adding either of the following audiometry options to your Duet.

Smart Audiometer

PC-based screening audiometer.

- Automatic generation of pure tones from 250 Hz to 16 kHz, depending on stimulator used
- Includes a wide array of stimulus files at 500, 1000, 2000, and 4000 Hz: warble tone, narrowband burst, small band burst, broadband burst, Gaussian burst, and pure tones
- Ability to use custom stimuli
- Includes standard clinical '5-up/5-down' Adult Self-Test automated routine using the response box accessory
- Print detailed reports with sequence information, frequency tables, and threshold information
- Built in audiogram markers for different stimulator types
- Optional speech discrimination module



Intelligent VRA

Automated visual reinforcement audiometry.

- Increased reliability & accuracy by a single examiner
- Choose from our variety of 4 and 10 second colorful, animated wide-screen video clips, or use your own video clips
- Use one of our three automated test routines, administer a speech discrimination paradigm (IVRISD), or run a VRA test manually
- Probe Trials maintain patient attention while testing near threshold
- Control Trials allow you to determine the reliability of a test
- Trial-by-trial reports include detailed information for each test sequence
- Final report includes audiogram and threshold for each frequency tested

CAST™

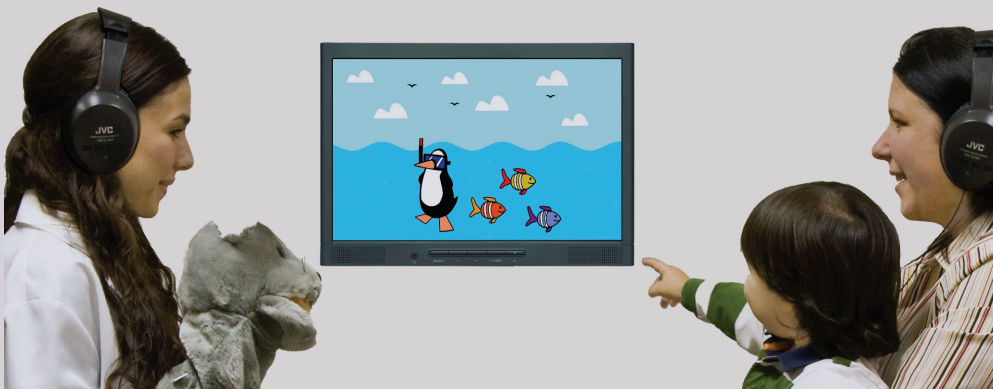
Classification of Audiograms by Sequential Testing quickly selects the best-fitting audiogram from 9 common patterns, for fast and efficient screening.

OHTA™

Optimized Hearing Test Algorithm is designed to test four frequencies, non-sequentially using an intensity staircase fashion.

5-up/5-down

Automated 'step-up, step-down' intensity staircase procedure for testing thresholds at up to four selected frequencies.



Duet Technical Specifications

Duet is a sleek, portable, and versatile clinical evoked potential and otoacoustic emission device.

GENERAL SPECIFICATIONS

Evoked Potentials: ECoG, ABR, MLR, LLR/CAEP, SN10, Chained Stimuli ABR, eABR, P300, MMN, FFR, cABR, cVEMP, oVEMP, ASSR

Otoacoustic Emissions: DPOAE, TEOAE, SPOAE, TEOAE Suppression

Audiometry: Audiometer, VRA, VRISD

EP AMPLIFIER

Channels: Two channels. Single channel operation with automatic polarity switching and single channel electrode cable

Gain: 5,000 - 200,000 (adjustable)

High Pass Filter:

0.1 - 300 Hz, (adjustable)
-6 dB/Oct, -24 dB/Oct @ 70 Hz

Low Pass Filter:

30 - 5,000 Hz (adjustable)
-6 dB/Oct, -24 dB/Oct @ 500 Hz

Digital Filters:

Finite Impulse Response (FIR/
Smoothing), Band Pass, Notch

A/D Converter: 16-bit

Sampling rate:

200 to 40,000 Hz (adjustable)

Recording Window:

-2.5 s to 2.5 s (max)
User definable in AARM up to 10s

Data points:

1024 per waveform
Up to 4096 in AARM

Artifact Rejection Level: Adjustable:
0-100%, and any region within the
analysis time window

Line Frequency Notch Filter:

50 or 60 Hz (-12 dB/Oct)

Common Mode Rejection:

≥ 110 dB @ 1 kHz
≥ 110 dB @ 60/50 Hz, notch filter off

Noise Level: ≤ 0.27 μ V RMS

Input Impedance: > 10 MOhms

Electrode Impedance:

Measuring frequency: 1,000 Hz
Measuring range: 1 - 25 kOhms

EP STIMULUS

Stimulus:

Clicks, Tones, Broadband iChirp
and Octave Band iChirps, Complex,
Speech, and user-defined files

Stimulus duration:

Defined in μ sec or cycles
Click: 100 μ s default (adjustable)
Tones and user files:
up to 500 ms (adjustable),
up to 4 seconds using AARM

Stimulus Envelopes:

Rectangular, Blackman, Exact
Blackman, Cosine, Cosine Squared
(Hanning), Cosine Cubed, Extended
Cosine (Rise/fall time), Triangular
(Bartlett), Trapezoidal (Rise/fall time),
Gaussian

Stimulus presentation:

Continuously or only while acquiring
Rarefaction, Condensation, or
Alternating polarity

Stimulus Rate:

0.1 - 200 per second,
(dependent on stimulus duration)
Rates > 200/s available in CLAD

Stimulus Output:

Up to 132 dB SPL
(transducer dependent)
Attenuation Range: 150 dB
Level Accuracy: \pm 1 dB
D/A: 16-bit

Frequency:

Range: up to 32 kHz
(transducer dependent)
Frequency Accuracy: \pm 1 percent

Masking:

Level: up to 125 dB SPL
Frequency Response: Flat to 20kHz
(transducer limits determine roll off)
Types: Specific or relative to stimulus
level. Contralateral or Ipsilateral. White
Noise or Notched Noise. SAL

VEMP

Integrated Patient Feedback:

Video Monitor
LED Feedback Box (optional)

ASSR

Gain: 100,000

High Pass Filter: 30 Hz

Low Pass Filter: 300 Hz

Stimulus:

Clicks, Tones, Broadband iChirp and
Octave Band iChirps, and user-defined
files
Simultaneous testing of both ears
Test up to four frequencies per ear

Frequencies: 250, 500, 1000, 2000,
4000, and 8000 Hz

TRANSDUCERS

ER-3C Insert Earphones:

Intensity: up to 132 dB SPL
Frequency Range: 125 - 10,000 Hz
Total Harmonic Distortion: <1% @1kHz

ER-2 Insert Earphones:

Intensity: up to 120 dB SPL
Frequency Range: 125 - 16,000 Hz

DD45 Headphones:

Intensity: up to 120 dB SPL
Frequency Range: 125 - 8,000 Hz
Total Harmonic Distortion: <1% @1kHz

B71 Bone Conductor:

Intensity: up to 69 dB HL (96 dB SPL)
Frequency Range: 250 - 4,000 Hz
Total Harmonic Distortion: <2% @1kHz

B81 Bone Conductor:

Intensity: up to 82 dB HL (109 dB SPL)
Frequency Range: 250 - 8,000 Hz
Total Harmonic Distortion: <1% @1kHz

ER-10D OAE Probe:

Intensity: up to 100 dB SPL
Frequency Range: 125 - 16,000 Hz

High Frequency Transducers:

Intensity: up to 100 dB SPL (up to
140 dB SPL at some frequencies)
Frequency Range: 2,500 - 32,000 Hz

Sound Field:

Amplifier and speakers intensity and
frequency range dependent on sound
field components

Auxiliary:

Output channel for ipsilateral masking
and stimulus mixing

Duet Technical Specifications

OAE AMPLIFIER

Sampling Rate: 40 kHz
A/D Converter: 16-bit
Frequency Accuracy:
0.01% from selected

DPOAE

Modes: DP OAE, DP I/O Function
Stimulus: 2 Pure Tones, user defined start, end and F2/F1 ratio
375 - 12,000 Hz, Standard
375 - 16,000 Hz, High Frequency
Levels: 65/55 SPL
(user defined L1, L2, 0-80 dB SPL)
Response Points per Octave:
1-10 (user defined), up to 41 frequencies per DP Gram
Frequency Analysis (FFT) points:
4096
FFT Frequency Resolution:
9.8 Hz Standard,
15.6 Hz High Frequency
Acquisition Time: 102.24 ms

TEOAE

Probe: Single or Dual
Stimulus: Click, 75 µs default (adjustable); or tones
Stimulus Frequency Range:
250 to 6,000 Hz
Presentation:
Linear or non-linear train
Level: 0 - 95 dB SPL (adjustable)
Stimulus Rate: 1-50/s (adjustable)
Response analysis frequencies:
300 - 6,000 Hz
Frequency Analysis (FFT): 1024 points
FFT Frequency Resolution: 39.1 Hz
Acquisition Time: 25.56 ms
Suppression: Contralateral, Ipsilateral, and Binaural Suppression

DATA AND SECURITY

Encryption: Advanced Encryption Standard (AES) to encrypt patient demographic information (PHI), using a 256-bit key

Data Export: Ability to export to external patient databases such as Oz-eSP, HiTrack and other hospital systems using HL7 protocols (customization fee may apply)

PHYSICAL CHARACTERISTICS:

Dimensions:
38.2 x 25 x 4.76 cm (15 x 9.8 x 1.9 in)
Weight:
1.36 Kg (3 lbs)

POWER REQUIREMENTS

Internal Power Supply:
115-230 VAC, 560-350 mA
30W, 50/60 Hz
Fuse Type:
Time Lag (Slow-Blow) Fuses
2A, 250V~ (IEC 60127-2 compliant)

ENVIRONMENT

Degree of Mobility:
Portable Equipment
Location:
Indoor use
Temperature:
Operating: 15°C - 35°C (59°F - 95°F)
Transport: -20°C - 50°C (-4°F - 122°F)
Storage: 0°C - 50°C (32°F - 122°F)
Relative humidity:
Operating: 15% to 90%
at 40 °C non-condensing
Max Altitude:
3000 m above sea level
Ambient Pressure:
Operating: 98 kPa -104 kPa
Storage: None Specified
Warm-up Time:
None at room/operating temperature

QUALITY SYSTEM

ISO 13485: Manufactured, designed, developed, and marketed under ISO 13485 certified quality systems

STANDARDS COMPLIANCE

Safety and Electromagnetic Compatibility:
IEC 60601-1 Class II, Type BF (Safety)
IEC 60601-1-2 (EMC)
IEC 60601-2-40 (EP)

Calibration and Test Signals:
IEC 60645-3

Medical Device Directive:
93/42/EEC Class IIa

Protection from Fluids:
IPX0 – Ordinary equipment

COMPUTER REQUIREMENTS

Operating System:
Windows 10
Hardware Required:
Minimum 4 GB RAM
Minimum 5 GB hard drive space
Mouse or other pointing device
1 USB Port
Display:
900 pixels minimum vertical resolution, Full HD recommended
Power Supply:
Grounded, 3-prong power supply, Compliant with IEC 60950
External Storage:
Removable media, network drive, or secure Internet storage site for data backup (recommended)
Printer:
Software includes PDF printing capabilities, hardware printer optional

