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.

stellar performance

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

dressed up for performance

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 a 15 inch notebook PC
- 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
ready for the clinic

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:
- ECochG
- 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

flexible enough for research needs

Advanced options for SmartEP:
- CLAD for high-rate stimulation
- Notched Noise Masking
- Advanced Auditory Research Module (AARM)
- Complex ABR
- Frequency Following Response
- Acoustic Change Complex
- CHIRP Stimulus Generation Module
- USB Development Kit

Advanced options for SmartOAE:
- Contralateral, ipsilateral, and binaural TEOAE suppression
- Dual OAE probe system
- HF DPOAE for ototoxicity monitoring

designed for an improved clinical experience
SmartEP
The ideal clinical tool for recording ECochG, 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
- Display or hide a subtle vertical grid or horizontal baseline

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, and weighted

The perfect duet for electrocochleography
Our next generation amplifiers combined with the non-invasive IHS Lilly TM-Wick Electrodes produce more robust and repeatable ECochGs.

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

- Change most test parameters with a single click
- Set your own 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
- 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
- Multi-page display and reports
- Easy PDF report generation
- Auto-save reports on program exit

iChirp™ stimuli included

The intelligent Chirp for SmartEP and SmartEP-ASSR is included in the base package.

- 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

![SmartEP-ASSR Diagram]
SmartVEMP
innovative solution for cVEMP and oVEMP

the VEMP solution you’ve been waiting for
The new & improved SmartVEMP option is the only device cleared for oVEMP and cVEMP testing on patients of all ages. (FDA K163326) 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 acceptance amplitudes for each side
• Automatically calculates the acceptance range
• User-defined acceptance and rejection 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
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
The Advanced Auditory Research Module, CBR Research Module, and Ultra-Shielded Insert Earphones are for research use only; they are not for use in diagnostic procedures.

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

Visit the Auditory Neuroscience Lab website (www.brainvolts.northwestern.edu) for information about the research supporting the CBR technology and about upcoming scientific talks by the Lab.
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-fitting check and in-ear calibration for increased 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

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.

SmartTrOAE

Screening and diagnostic transient evoked and spontaneous otoacoustic emissions.

- Fast and easy test setup and data analysis
- Automatic probe-fitting 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
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, 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 selects the best-fitting audiogram from 9 patterns, for fast and efficient screening.

OHTA™
Optimized Hearing Test Algorithm is designed to test four frequencies, non-sequentially in 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.
Specifications

**EP Amplifier**
- Two channels
- A/D Converter: 16-bit
- Sampling rate: 200 to 40000 Hz (adjustable)
- Recording Window: -2.5 s to 2.5 s (max)
- User definable in AARM up to 10 s
- Data points per waveform 1024
- Up to 4096 in AARM
- Adjustable Gain: 5,000 - 200,000
- Adjustable High Pass and Low Pass filters
  - HPF: -6 dB/Oct, -24 dB/Oct @ 70 Hz
  - LPF: -6 dB/Oct, -24 dB/Oct @ 500 Hz
- High Pass: 0.1 - 300 Hz
- Low Pass: 30 - 5000 Hz
- Digital Filters: Finite Impulse Response (FIR/Smoothing), Band Pass, Notch.
- Adjustable artifact rejection level (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 μV RMS
- Input Impedance: > 10 MOhm
- Electrode Impedance: measuring frequency 1000 Hz, measuring range 1 - 25 kOhms

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

**SmartDPOAE**
- Stimulus: 2 Pure Tones, user defined start, end and F2/F1 ratio
  - 375 - 12000 Hz, Standard
  - 375 - 16000 Hz, High Frequency
- Levels: 65/55 (user defined L1, L2, 0-80 dB SPL)
- Response Points per Octave: 1-10 (user defined), up to 41 frequencies per DPGram
- Frequency Analysis (FFT) points: 4096
- FFT Frequency Resolution: 9.8 Hz Standard, 15.6 Hz High Frequency
- Acquisition Time: 102.24 ms
- DP I/O Function

**SmartTrOAE**
- Stimulus: click, 75 us default (adjustable), or tones
- Stimulus Frequency Range: 250 to 6000 Hz
- Presentation: Linear or non-linear train
- Level: 0 - 95 dB SPL (adjustable)
- Stimulus Rate: 1-500/s (user defined)
- Response analysis frequencies: 300 - 6000 Hz
- Frequency Analysis (FFT) points: 1024
- FFT Frequency Resolution: 39.1 Hz
- Acquisition Time: 25.56 ms
- Contralateral, Ipsilateral, and Binaural Suppression
- Dual probe option

**SmartEP**
- Stimulus: Clicks, Tones, Broadband iChirp and Octave Band iChirps, Complex, Speech, and user-defined files
- Stimulus duration in μsec or cycles
  - Click: 100 us default (adjustable)
  - Tones: 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 (Riser/fall time), Gaussian
  - Stimulus presentation:
    - Continuously or only while acquiring
    - Rarefaction, Condensation, Alternating
- Stimulus Rate: 0.1 - 200 per second, (dependent on stimulus duration)
- Rates > 200/s available in CLAD
- Level Accuracy: +/- 1dB
- Attenuation Range: 150 dB
- Frequency Accuracy: +/- 1 percent
- Masking Level: up to 125 dB SPL
  - Masking Frequency Response: Flat to 20kHz (transducer limits determine roll off)
  - Masking Types:
    - Specific level or relative to stimulus level.
    - Contralateral or Ipsilateral
    - White Noise or Notched Noise
    - SAL

**SmartEP-ASSR**
- Stimulus: Clicks, Tones, Broadband iChirp and Octave Band iChirps, and user-defined files
- Frequencies: 250, 500, 1000, 2000, 4000, and 8000 Hz
- Simultaneous testing of both ears
- Test up to four frequencies per ear

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

**Operating Environment**
- Portable Equipment
- Indoors use
- Operating temperature: 15 °C - 35 °C
- Relative humidity: 15% to 90% at 40 °C non-condensing
- Altitude: 0 - 3000 m
- Ambient Pressure: 98kPa - 104 kPa

**Storage**
- Temperature: 0 °C - 50 °C
- Atmospheric Pressure: none specified

**Standards Compliance**
- Safety: IEC 60601-1 Class II, Type BF
- EMC: IEC 60601-1-2
- Medical Device Directive: Class Ila 93/42/EEC
- Protection from Fluids: IPX0 – Ordinary equipment

**Computer Requirements**
- Windows 10 operating system
- Minimum 4 GB RAM
- Minimum 5 GB hard drive space
- Min display vertical resolution of 900 px, Full HD recommended.
- Grounded, 3-prong power supply
- Compliant with IEC 60950
- Mouse or other pointing device
- One available USB Port
- Removable media, network drive, or secure Internet storage site for data backup (recommended)
- Printer (optional)