Product Catalog 2006

Tucker-Davis Technologies

Contents

A history of practical experience and exceptional performance...

In the mid 1980s, no commercial signal processing system could fully support laboratories and their diverse research interests. The methods in each laboratory were unique, and each was forced to hire software and hardware engineers to design and construct purpose-built systems or modify lesser products to meet their specifications. These methods were costly, time consuming, and impractical. While the need for a better approach was clear, instrumentation companies showed little interest in this small but growing market.

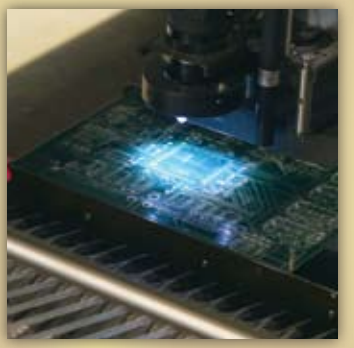
While an undergraduate electronics technician in Dave Green's psychoacoustics laboratory at the University of Florida, I noticed this opportunity and began working toward a solution. Using my laboratory and engineering experience, I designed and produced the first TDT research products. These initial designs were more affordable off-the-shelf and more cost effective in the long run than anything else on the market. The time to get a lab up and running was dramatically reduced and the modular design allowed researchers to start small and expand their lab as the research demanded.

From these early efforts, Tucker-Davis Technologies was born. Today, I'm proud to head a fully vertical instrumentation manufacturing company capable of all stages of product development from inception and design through manufacturing and support. After nearly 20 years of continuing innovation, TDT systems can be found on all seven continents, with systems ranging in complexity from a simple audio stimulator to a complete multichannel sensory and behavioral neurophysiology system for awake, behaving subjects.

Flexible, powerful, and *integrated* are words often used to describe our research systems. Similar words also describe our company. As you'll learn in the following pages, all departments and individuals at TDT work closely to achieve our common goal: to offer the most powerful research instrumentation that we can imagine and back it up with the best customer support in the business.

Tim Tucker

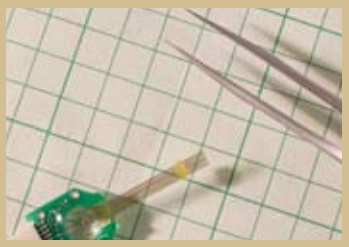
In-House =



...An Integrated Approach

At TDT, we recognize the benefits of promoting close ties between every department of our company.

Our goal is to supply you with the highest quality, most up-to-date technology available, and at an affordable price. We believe we can best meet this goal when all areas of our business work together in a cooperative and collaborative environment. This belief is typified by the integrated nature of our facility, which brings together our team of scientists, on-site laboratory, engineering staff, and manufacturing floor all under one roof.

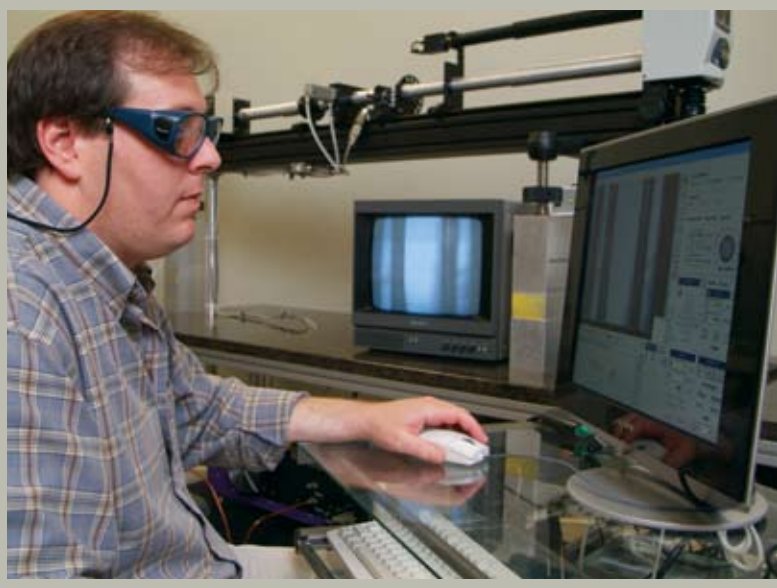


In-House R&D=

From R&D...

DIRECTOR OF R&D, WILLARD WILSON *earned his PhD in neuroscience from the University of Rochester, where he studied the influence of sound motion on the spatial receptive fields of auditory neurons. After postdoctoral research focused on dynamic auditory processing, Dr. Wilson accepted a position at Tucker-Davis Technologies in 1999. As director of Research and Development, he is responsible for identifying target markets and devices, securing funding for research and development, and directing software and hardware engineers in product development. He maintains an active basic research program and continues to collaborate with academic scientists.*

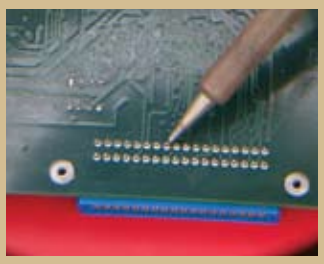
...Informed Innovation



In keeping with our commitment to innovative product development, TDT has built a Research and Development Department with a full-time staff of scientists and engineers focused exclusively on inventing new devices and methods for bioscience research. Their mission is to identify target products, design and fabricate prototypes, evaluate these in real-world situations, and use the results to inform commercial product design. Our imaginative team of R&D engineers is currently focused on creating novel electrode solutions for chronic multichannel recording and developing new digital signal processing techniques for spike detection, sorting, and noise reduction.

...to Engineering

To help us fully appreciate the research needs of our customers, we maintain a complete on-site neurophysiology research facility approved for vertebrate research. The laboratory affords us a unique perspective, allowing us to develop, and test *in vivo*, novel solutions for neuroscience research.



In-House Engineering =

From Engineering...

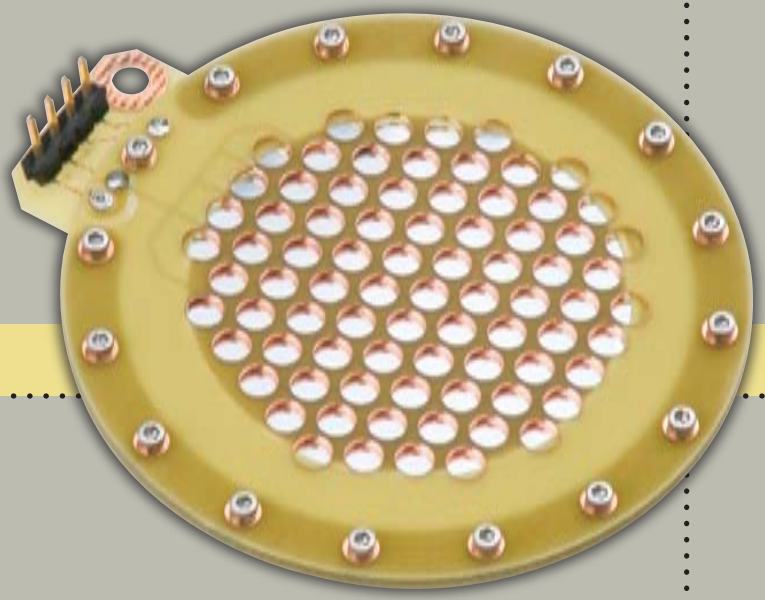
AT THE UNIVERSITY OF FLORIDA, THE NEUROPROSTHETICS RESEARCH GROUP *operates at the interface between basic neural engineering research and clinical care. Their research is motivated by the potential for direct neural interfaces to deliver therapy and restore functionality to disabled individuals. With the help of TDT System 3 hardware and software, researchers are developing neuroprosthetics (Brain-Machine Interfaces) for individuals with motor disabilities and epilepsy. Their approach is to use distributed microelectrode arrays to gather information from the brain for either direct communication with external devices or for micro-control of neural systems.*

DR. JUSTIN SANCHEZ *attributes System 3's flexibility with making real-time brain-machine interface experiments easier to conduct. "With the streamlined architecture, I can use one computer and one [RX5 Pentusa Base Station] to handle the whole experiment. TDT is always willing to help me get the job done as well as propose innovative and effective solutions."*

...Elegant Design

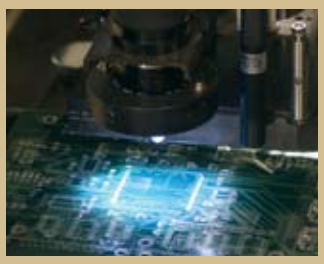
The principal task of engineering is to turn ideas into products. We have some of the best engineers in the business and they design with quality and performance in mind. However, having our production facility and research lab 'in house' allows them to design for usability and ease-of-manufacturing as well, ensuring you get a high quality product that is both user friendly and cost effective.

Our R&D team plays a critical role in the engineering process, providing valuable information concerning the feasibility and usability of new features before they are implemented. As new products are designed and tested, our scientists put our equipment to use, just as it would be utilized in a research laboratory.



...to Manufacturing

With our manufacturing department just steps away from the offices of our design engineers, we're able to streamline the entire product development process, from concept to delivery. With immediate feedback from production staff, the reaction time for product improvements and upgrades is very fast. When the design cycle is minimized, the cost of each new product roll-out is vastly reduced.



In-House Manufacturing =

From Manufacturing...

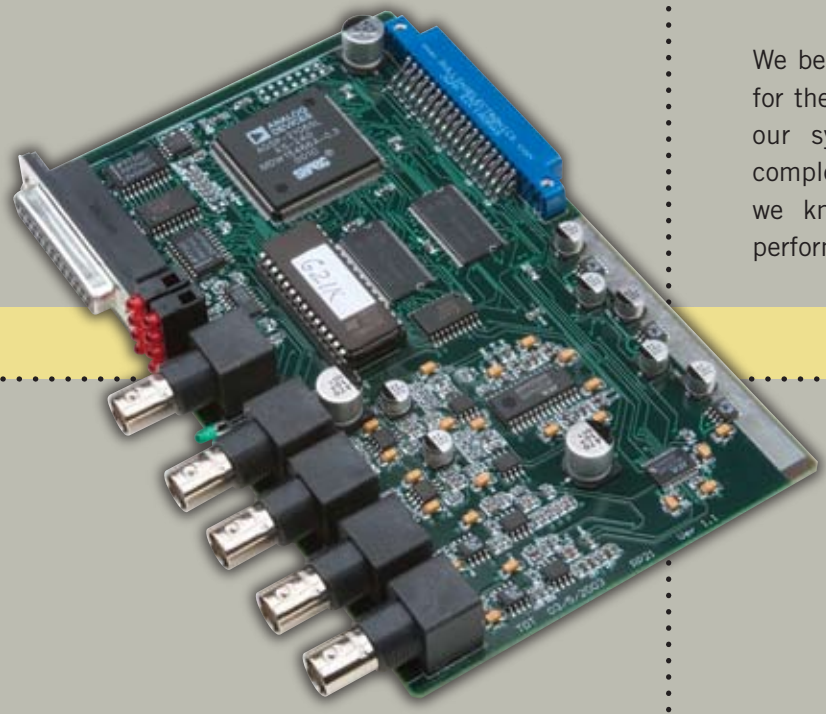
IN THE DEPARTMENT OF BIOPHYSICS, RADBOUD UNIVERSITY NIJMEGEN *in the Netherlands, TDT System 3 equipment is being used to investigate primate sound localization and audio-visual integration in the sensorimotor system. Using TDT Medusa Preamplifiers, chronic headstages and RP2.1 Enhanced Real-Time Processors, researchers present stimuli and simultaneously record single-unit and behavioral responses in monkeys. An RP2.1 is used to deliver stimuli via a small mobile speaker. While collecting data from search coils to measure the orienting response to the stimulus, researchers also use the Medusa PreAmps to perform electrophysiological recordings in different areas of the brain.*

Principal Investigator **AJ van OPSTAL** *says TDT's "System 3 provides the integrated hardware and flexible software control we needed for multichannel recording at high sampling rates."*

...Affordable Quality

Our commitment to affordable quality continues when the manufacturing process begins. We use the most modern production methods and put our products through a series of rigorous tests before shipping them to your lab. At TDT, delivering a product means taking it from concept to production. Each phase, including development, testing, board layout, component assembly and systems integration, is performed by highly trained and dedicated TDT team members. This eliminates the unreliability and increased turn-around time introduced by outsourcing parts of the process to contract engineering or manufacturing firms.

We believe the best solution is the one that is designed for the task at hand from the beginning. We don't build our systems around off-the-shelf boards; we build complete systems from the ground up. It is the only way we know to deliver the reliability, affordability, and performance you deserve.



...to Customer Support

Five Year Warranty
Any defects in materials or workmanship are promptly repaired or replaced.

"Customer support has been excellent, especially considering the physical distance between Australia and the US. Equipment faults, although rare, have been fixed with little or no down time."

— *Dr Antonio Paolini, La Trobe University*

In-House Customer Support =

From Customer Support...

CUSTOMER SUPPORT DIRECTOR, VICTOR RUSH *oversees the support staff and works with them to resolve even the toughest cases. He earned his PhD in Ecology and Evolution from UC Santa Barbara where he studied fish vision. After postdoctoral research in Victoria BC and Kentucky, Dr. Rush was headed toward a career in academia before TDT offered him the deal of a lifetime: playing with electronic toys and helping scientists.*

CUSTOMER ADVOCATE, MICHELLE MALLARD *acts as your main point of contact. Putting over five years of project management experience to work for you, Michelle ensures any support issues that arise are resolved to your satisfaction.*

...Knowledgeable Assistance

Our Technical Support Engineers and Application Specialists have Bachelors and Masters degrees in Biomedical Engineering from topflight schools and many have research experience in neuroscience and physiology. This real world experience means that the people who work with you not only have an intimate knowledge of our equipment, but also understand your needs and your research. Each support team member has access to a wide variety of hardware, software, and test equipment and when necessary, they'll replicate your set-up to provide you with practical solutions.

It is our goal to have the best customer support in the business.

...to Results

Real-Time Technical Support
Our qualified and experienced support engineers are dedicated to only one job: to ensure that you get the help you need—when you need it.

Online Tools For After-Hours Help
Searchable database of technical notes, online help files, and downloadable software updates.

TDT Premium Support Program (PSP)
A premium support program for busy labs requiring an extra level of service. PSP includes a No Downtime Guarantee and access to a toll-free support line.

Product Overview

TDT System 3 Innovation

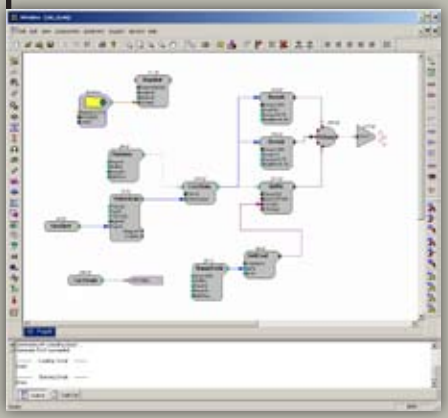
System 3 is TDT's latest generation of integrated hardware/software research platforms. Continuing a long tradition of modular, programmable hardware systems, System 3 adds a new level of usability through a powerful set of software tools and run-time software applications.

The System 3 architecture moves most of the burden of data processing and transfer to dedicated hardware modules specifically designed for this purpose. Time-critical processes are performed on autonomous hardware, keeping processing and timing delays to a minimum and freeing your PC for display, analysis and other non time-critical tasks.

Our modular platform is built around a powerful group of digital signal processors (DSPs), specifically designed to perform complex signal processing algorithms *in real time*. The processors are controlled using a common configuration tool, our Real-time Processor Visual Design Studio (RPvds). This graphical design interface gives you unparalleled control over signal presentation and data acquisition, allowing you to customize the function of each signal-processing module in your system.

DSPs are essentially a blank slate that can be programmed to perform almost any signal processing or number crunching task. Because programming DSPs is typically complex and tedious, most DSP implementations are limited to the programs that were embedded at the factory. The end-user cannot modify the DSP's program and the flexibility that is often critical for research applications is lost. RPvds gives you the power to reclaim that flexibility, allowing you to customize the function of your DSP using a visual point-and-click programming interface.

RPvds includes a powerful library of over 300 components, representing a variety of fundamental processing tasks. You can combine components to create exactly the processing function you require, and these processing chains can be loaded and controlled from TDT software applications. By allowing run-time access to these processing chains, RPvds gives you a level of real-time control not available in other systems.

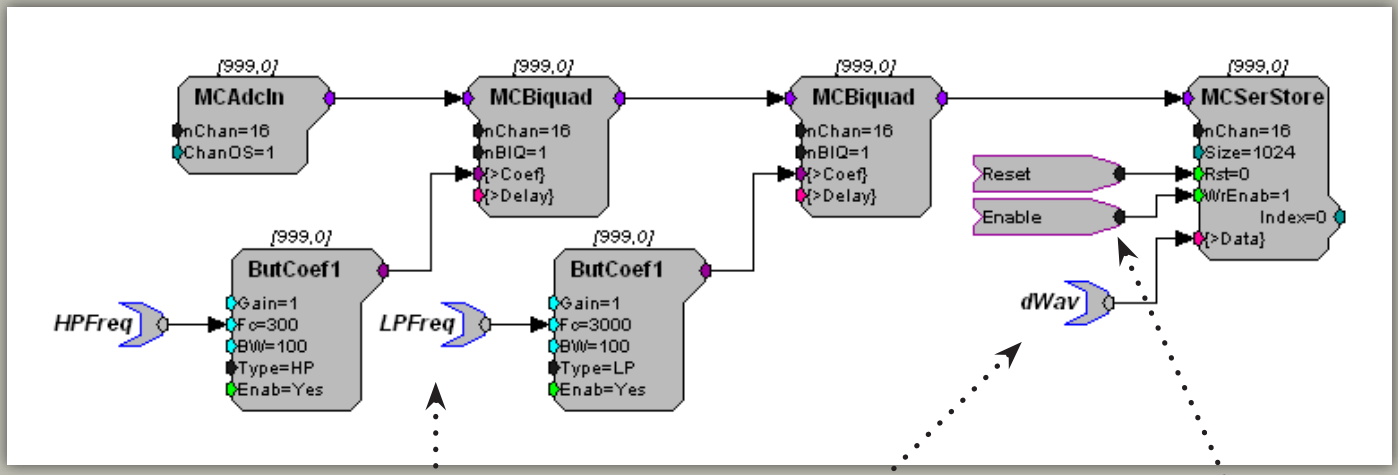


While it's true that RPvds provides you with unprecedented DSP control, that doesn't mean you have to configure every complex experiment at this level. TDT offers a wide variety of run-time applications supplied with pre-configured processing chains that can be used "as is" or modified by the user. Whether you use our standard processing chains or build your own, RPvds is the foundation for System 3's unique flexibility, allowing you to configure your System 3 hardware for virtually any signal processing task.

This example RPvds circuit acquires, filters, and stores multi-channel data.

This component "acquires" 16 channels of data from a preamplifier.

All 16 channels are routed through a series of Biquad filter components to implement highpass and lowpass filters that you can control dynamically during acquisition.



Data is stored when the enable line goes high. This could be triggered by stimulus onset or spike detection.

"Parameter Tags" allow you to access or change parameters, such as filter settings, from your own software or from programs like OpenEx.

System Examples

Typical Neurophysiology Workstations

TDT's Neurophysiology Workstations each include a powerful real-time processor and one or more multi-channel preamplifiers. This combination delivers the low noise of an optically isolated, battery-powered preamplifier and the flexibility of a user programmable real-time DSP. Every channel is simultaneously sampled and user-specific processing is performed *on the fly*. Our OpenEx software suite is included to provide flexible, real-time control of multi-channel experiments from a graphical software interface.

Z-Series Multi-Channel Neurophysiology Workstation

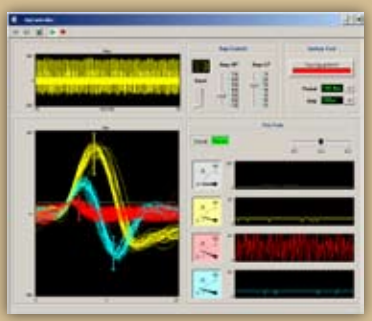
Z-Series Neurophysiology Workstations represent our highest channel count recording systems to date. Offering to up to 256 channels, this system features a new fast fiber optic connection supporting sampling rates up to ~50 kHz. This sample system includes two 64-channel acute headstages and a 128-channel Z-Series Preamplifier to create a complete 128 channel recording solution (NN64ACs not shown).

Qty	Part #	Page #
1	RZ2-4	32
1	PZ2-4	44
2	NN64AC	47
1	OpenEx	24
1	OpenDeveloper	27
1	OpenExplorer	26

OpenEx Software features:
- Simultaneous sweep-based and continuous data recording
- Local field potentials and neural spike recording from the same recording electrode - without decreasing overall channel count
- Record time stamped waveforms, stimulus parameters, and external digital events into a single synchronized data set
- Export data to Neuroshare, ASCII , PLX, or NEX format

OpenEx gives you real-time control:
- Change filter settings dynamically
- Sort spikes in a real-time visual environment
- Auto-thresholding and auto-sorting features

OpenExplorer gives you powerful online and offline data mining tools:
- Animate playback of stored data for dynamic visualization of neural activity
- Select and sort data *on the fly* during acquisition



The modular and flexible nature of TDT System 3 Processors makes it easy to expand or completely change the functionality of your workstation—often with little or no additional equipment.

Multi-Channel Neurophysiology Workstation

TDT's Multi-Channel Neurophysiology Workstation acquires, processes, and analyzes neural spikes on our Pentusa multiprocessor base station. Pentusa-compatible preamplifiers digitize incoming signals at ~25 kHz with 16-bit precision. Our modular BioAmp design provides unprecedented system scalability (from 4 to 64 channels). This sample system includes two 16-channel acute headstages and two 16-channel Medusa PreAmps to create a complete 32-channel recording solution.

Qty	Part #	Page #
1	RX5BA-5	34
2	RA16PA	45
2	RA16AC	48
2	MW16	50
1	PO5	59
1	FO5	59
1	ZB1	60
1	PS25F	60
1	OpenEx	24
1	OpenDeveloper	27
1	OpenExplorer	26

Integrated Stimulus Generation
Neurophysiology workstations can easily be expanded to add complete integrated stimulus production capabilities. System 3 devices can be used to generate acoustic, vibrotactile, or vestibular stimulus waveforms; control visual stimulus generators or olfactometers; or generate electrical microstimulation waveforms.

Integrated Auditory Stimulus Generation
When added to an existing workstation, the components listed below offer two channels of synchronized very high-fidelity, wide bandwidth, acoustic stimulation complete with programmable attenuation and ultrasonic transducers.

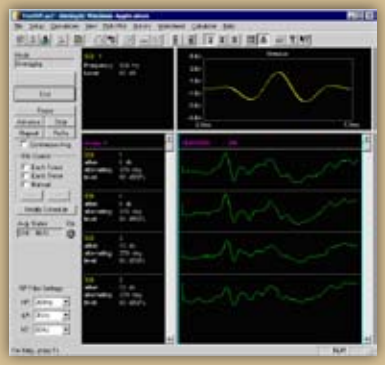
Qty	Part #	Page #
1	RX6-A2	36
2	PA5	52
1	ED1	55
2	ES1	54
2	FO5	59
3	ZB1	60
3	PS25F	60

Integrated Microstimulation
Add the components listed below for 16 channels of synchronized microstimulation based on our flexible System 3 DSP platform and featuring our 16 channel switching headstage.

Qty	Part #	Page #
1	RX7G	38
1	SH16	49
1	FO5	59
1	ZB1	60
1	PS25F	60

Typical Evoked Potentials and EEG Workstations

TDT Evoked Potential and EEG Workstations have been used to record an almost endless variety of bioelectric potentials including ABRs, VEPs, ERGs, EMGs, DPOAEs, and EEGs. Evoked potentials are transduced in our low impedance headstage, which features differential amplification, onboard impedance testing, and the low noise of an optically isolated, battery powered front end. Waveforms are digitized at 16-bit precision and sampling rates up to ~25 kHz, and transmitted to a DSP base station for further processing over a noiseless fiber optic link. Synchronized stimulus generation can be added by connecting additional device caddies in our modular zBus format. Systems are available with our powerful and time-tested turn-key BioSigRP software or the power and flexibility of our OpenEx software suite.



Auditory Evoked Potentials Workstation

Combined with our powerful low-noise hardware platform, a pair of flexible turn-key software packages, SigGenRP and BioSigRP, give you complete control over your ABR recording setup. SigGenRP provides complete control over the stimulus waveform, level, timing, and calibration and provides a means for systematically varying stimulus parameters from one interval to another. BioSigRP includes full signal averaging and analysis capabilities including waveform display, comparison, and measurement in the time or frequency domain, filtering, waveform math (such as: add, subtract, or average selected waveforms), aligning or shifting waveforms in time, and automatic peak finding. Both are easy to use, with the power and flexibility needed for basic research applications.

Qty	Part#	Page#
1	RP2.1	42
1	RA16BA	43
1	RA4PA	45
1	RA4LI	46
1	PO5	59
1	FO5	59
1	ZB1	60
1	PS25F	60
1	SigGenRP	28
1	BioSigRP	28

SigGenRP features:

- Build signals in time or frequency domain
- Dozens of built-in signal types
- Design and control simple, complex, and nested variables

BioSigRP features:

- Artifact rejection
- Peak, latency and comparison overlay analysis
- Auto-cursoring
- Dozens of built in mathematical function for manipulating data
- Instant access to up to 100 records
- Easy report generation

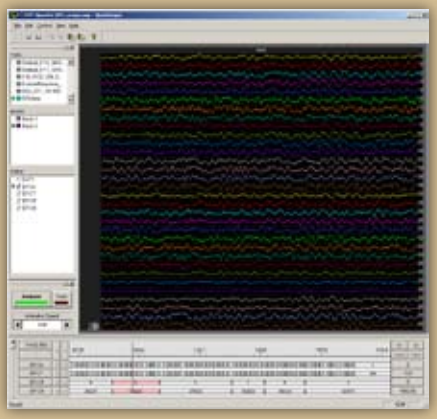
EEG, EMG, and Evoked Potentials Workstation

Ideal for EEG, EMG, and high-count evoked potential recording, this system offers two channels of 24-bit D/A for stimulus generation and 16 channels of 16-bit A/D for data acquisition. The system can easily be expanded for higher channel counts. OpenEx, a customizable software suite for experimental design and control confers maximum flexibility. With its powerful data server that stores, indexes, time stamps, and serves up data quickly, OpenEx easily handles data storage, transfer, and visualization for large or high-count data sets.

OpenEx features:

- Time stamped waveforms, stimulus parameters, and external events stored into a single data set
- Easy to configure, multi-channel plots
- Built-in access to RPvds for custom processing
- Specialized RPvds signal averaging components for evoked potential recording
- Export data to popular formats

Qty	Part#	Page#
1	RX6-A2	36
1	RX5BA-2	34
1	RA16PA	45
1	RA16LI	46
2	PA5	52
1	PO5	59
3	FO5	59
3	ZB1	60
3	PS25F	60
1	OpenEx	24
1	OD1	27



Adding Transducers

TDT's System 3 is a modular system that can be customized for a given application by selecting the necessary components from over 20 signal processing and conditioning devices. The above systems can easily be expanded to include a headphone buffer and transducers (pgs 54-58) for complete stimulus production. A microphone amplifier (pg 57) and microphone can be added for DPOAEs or add a FlashLamp (pg 55) for visual stimulus and VEP and ERG recordings. Contact us to discuss a configuration for your lab.

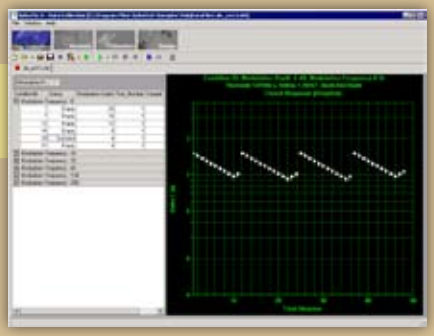
Typical Psychoacoustics and Speech Workstations

TDT has been developing products for psychoacoustics research for more than 20 years. This experience allows us to create flexible platforms for stimulus generation and data acquisition that can be customized for your research. With TDT psychoacoustic workstations, you can design and present virtually any waveform, from simple to complex, without scripting or coding. Our modular hardware design allows us to configure systems that contain all of the equipment you need for your experiments and none that you don't. The systems listed here are typical configurations available for psychoacoustics and speech. For high-count free-field stimulation, consider the RX8 (pg 40). Please contact us to determine the right configuration for your lab.

Basic Psychoacoustic Workstation

This basic system includes hardware and software tools for common psychoacoustic experiments. Two channels of 24-bit Sigma-Delta D/A and A/D provide signal generation and acquisition. The system also includes 16-bits of programmable digital I/O and a four-button response box for implementing subject response interfaces. PsychRP software features an easy-to-use interface and can perform a wide range of experiments out-of-the-box, including: Bekesy-Type Tracking, Modified Method of Limits, and Multiple Interval-Forced Choice.

Qty	Part#	Page#
1	RP2.1	42
1	HB7	58
1	RBOX	-
1	PO5	59
1	FO5	59
1	ZB1	60
1	PS25F	60
1	PsychRP	29



Psychoacoustics & Speech Workstation

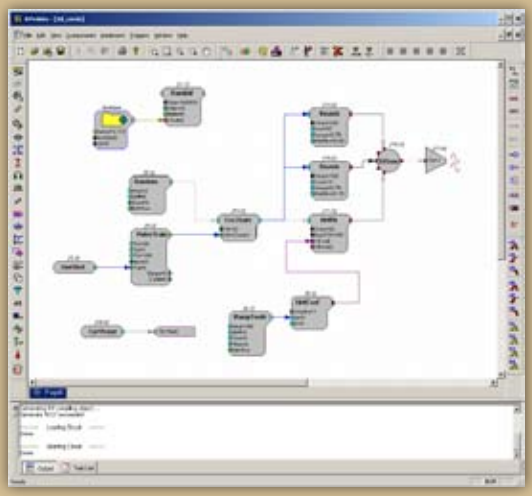
This system includes a comprehensive set of hardware and software tools for animal and human psychophysics. Two channels of 24-bit Sigma-Delta D/A and A/D provide signal generation and acquisition that extends from DC into the ultrasonic range. A microphone amplifier is provided for acoustic recordings and system output can be monitored with headphones or a monitor speaker. The system also includes two channels of programmable attenuation and 24-bits of programmable digital I/O for controlling external devices or implementing subject response interfaces. SykofizX software offers a large collection of experimental paradigms and customization options for computer control of your experiments. With onboard wizards and an extensive library of examples, the software guides you through your experimental setup and allows for customization of the experimental paradigm, hardware configuration, and subject interfaces.

Qty	Part#	Page#
1	RX6-A2	36
2	PA5	52
1	HB7	58
1	MS2	56
1	MA3	57
1	PO5	59
2	F05	59
3	ZB1	60
3	PS25F	60
1	SykofizX	29

Notable SykofizX features include:

- Multiple presentation and independent variable manipulation methods
- Support for .wav and other stimulus file formats
- Fully integrated and easy-to-use calibration mode
- Convenient evaluation utilities available for preview and subject training
- Support for interleaved tracking
- Powerful XML data storage format and flexible data export for offline analysis

Typical Data Acquisition & Stimulus Generation Workstations



TDT offers a number of versatile, user-programmable DSP-based systems for real-time stimulus generation and data acquisition featuring our System 3 line of real-time processors. Systems with 24-bit Sigma-Delta A/D and D/A converters offer unparalleled precision and signal-to-noise ratios while those with 16-bit PCM converters are best-suited for applications that require minimal group delay. You can customize the DSP function using circuits designed with TDT's RPvds Visual Design Studio. These circuits can be controlled directly through RPvds, TDT applications software, or through custom code written using MATLAB, Visual C++, Visual Basic, or any language that supports ActiveX controls.

Use TDT's Real-Time Processors to:

- Acquire signals from virtually any analog source: from DC to 120 kHz, up to 20 Vp-p.
- Generate stimuli onboard or download and play existing stimulus files.
- Acquire and generate TTL signals using digital inputs, trigger inputs, and digital outputs.
- Store acquired data or buffer stimuli using up to 128 MB of onboard memory or stream data to the PC over a high-speed interface.
- Custom configure virtually any experimental paradigm using the flexible design studio interface and System 3 modular hardware configurations.

Low Channel Count Data Acquisition

This economical and flexible data acquisition and signal generation system features the powerful RP2.1 real-time processor with a 50 MHz Sharc 21065 DSP (150 MFLOPS Peak), 32MB of onboard memory, and two channels each of 24-bit Sigma-Delta A/D and D/A at sampling rates up to ~200 kHz. Consider the RX6 (pg 36) for higher sampling rates.

Qty	Part#	Page#
1	RP2.1	42
1	P05	59
1	FO5	59
1	ZB1	60
1	PS25F	60
1	ACTX	23

High Channel Count Data Acquisition

This system features the RX8 with five 100 MHz Sharc ADSP 21161 DSPs (600 MFLOPS Peak), 128 MB of onboard memory and up to 24 channels of analog I/O. You can select either 16-bit PCM or 24-bit Sigma-Delta A/D and D/As (with sampling rates up to ~100 kHz) in a variety of configurations.

Qty	Part#	Page#
1	RX8	40
1	PP16	60
1	P05	59
1	FO5	59
1	ZB1	60
1	PS25F	60
1	ACTX	23

Software

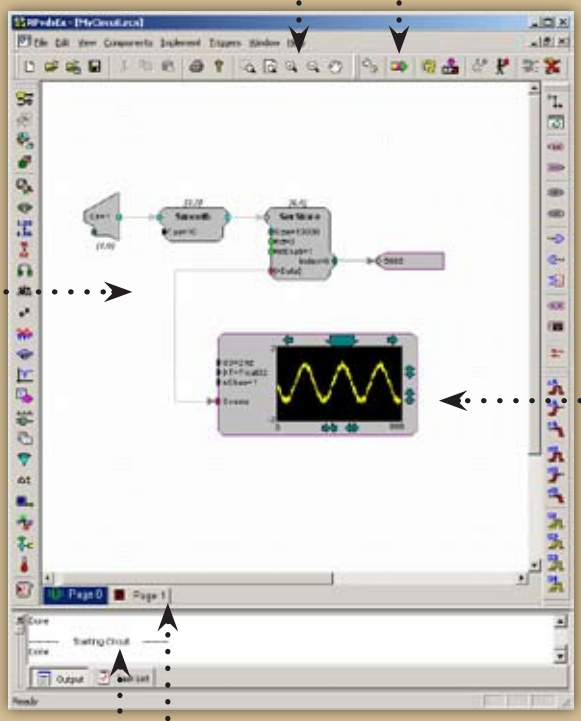
RPvds – The Heart of System 3

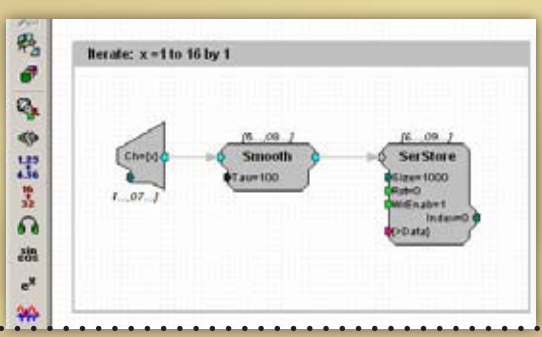
TDT's Real-Time Processor Visual Design Studio is a flexible and easy-to-use environment that allows users to create powerful, custom, DSP programs without writing complex DSP code. Processing chains are built and debugged in an intuitive point-and-click environment. Simply select and link components to create custom processing circuits. You can run the circuit within RPvds to test and debug your design, then save the completed circuit as a control object that can be used with run-time applications.

Using the RPvds real time design studio you can turn our powerful real-time processing devices into custom lab instruments solving your specific set of problems.

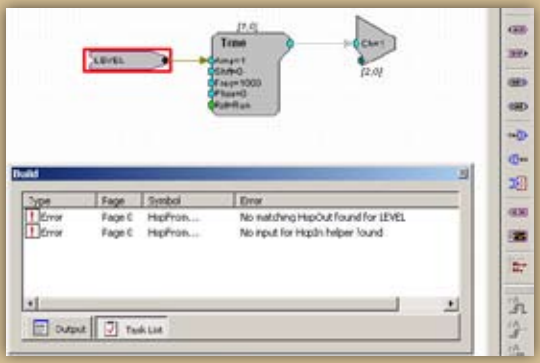
Some typical RPvds applications:

- Simultaneous Single Unit and LFP Data Processing
- Spike Fired Averaging
- Artifact Rejection
- Cross Channel Noise Reduction
- Instantaneous Rate Derivation
- Behavioral Control
- Complex Stimulus Design
- Locked Averaging
- Complex Filtering

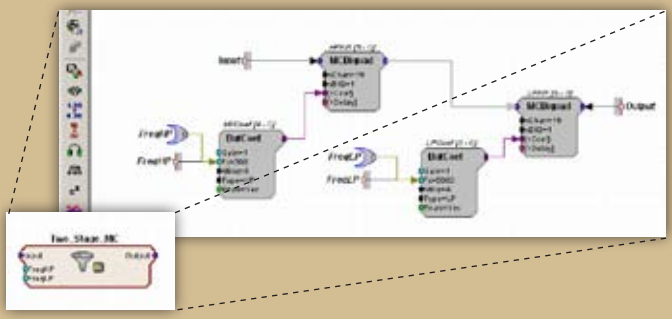




Handy iterate capability simplifies multi-channel circuit design.



Concise error reporting helps you find and fix circuit errors.



Powerful "Macros" feature allows complex circuit details and high-level functions to be condensed into easy-to-use Macro components.

ActiveX Controls—
Custom Software Development Tools

TDT's ActiveX Controls are simple and powerful tools for writing custom applications for System 3 hardware. Just like other TDT applications, custom code developed using ActiveX controls can load and run RPvds circuits, update variables within processing chains, or read data from buffers in real-time. Any programming environment that supports ActiveX controls can be used, including common languages like: Visual C++, Visual Basic, Delphi, MATLAB, LabView, and VEE. Programs that allow scripts for implementing ActiveX controls such as Microsoft Access and Excel are also supported.

Software for Extracellular Neurophysiology

OpenEx Suite—Multi-Channel Data Acquisition

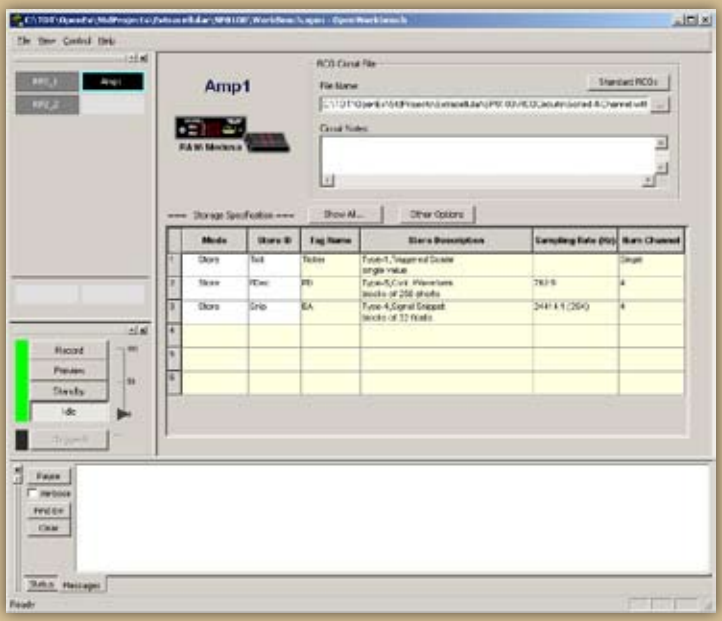
OpenEx is a user extensible software platform that taps into the speed, flexibility, and real-time control of our System 3 hardware. An open architecture and customizable, visual interface make it flexible enough to address a wide range of research applications, ranging from behavioral training paradigms to multi-channel neurophysiology.

The core suite of programs includes configuration, control, display, and analysis applications. Because OpenEx is built on a distributed client/server architecture, all OpenEx applications can run in parallel, organized under a single workspace manager. This allows you to configure any number of custom client windows for your specific application, each able to access data as it's acquired and stored.

OpenEx Suite includes:

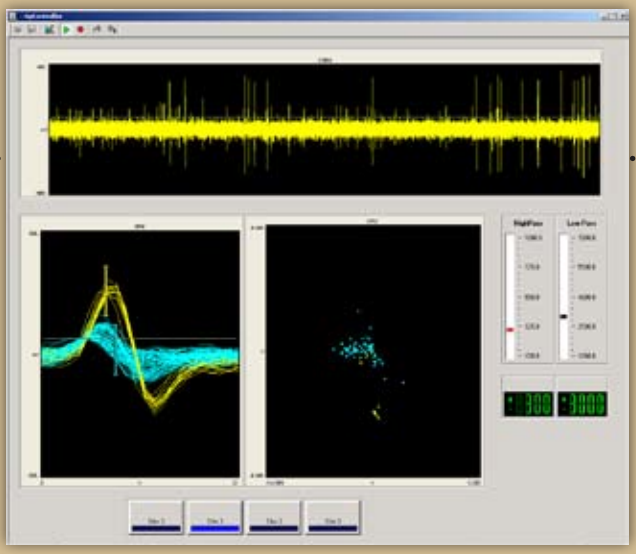
TTank Engine

TTank is a data server that operates behind the scenes to provide fast, reliable data storage and retrieval. Response waveforms as well as behavioral and stimulus events can be time stamped with microsecond accuracy and stored to our unique DataTank format. This format allows TTank to save large amounts of data and efficiently serve data up to client applications for real-time display and analysis.



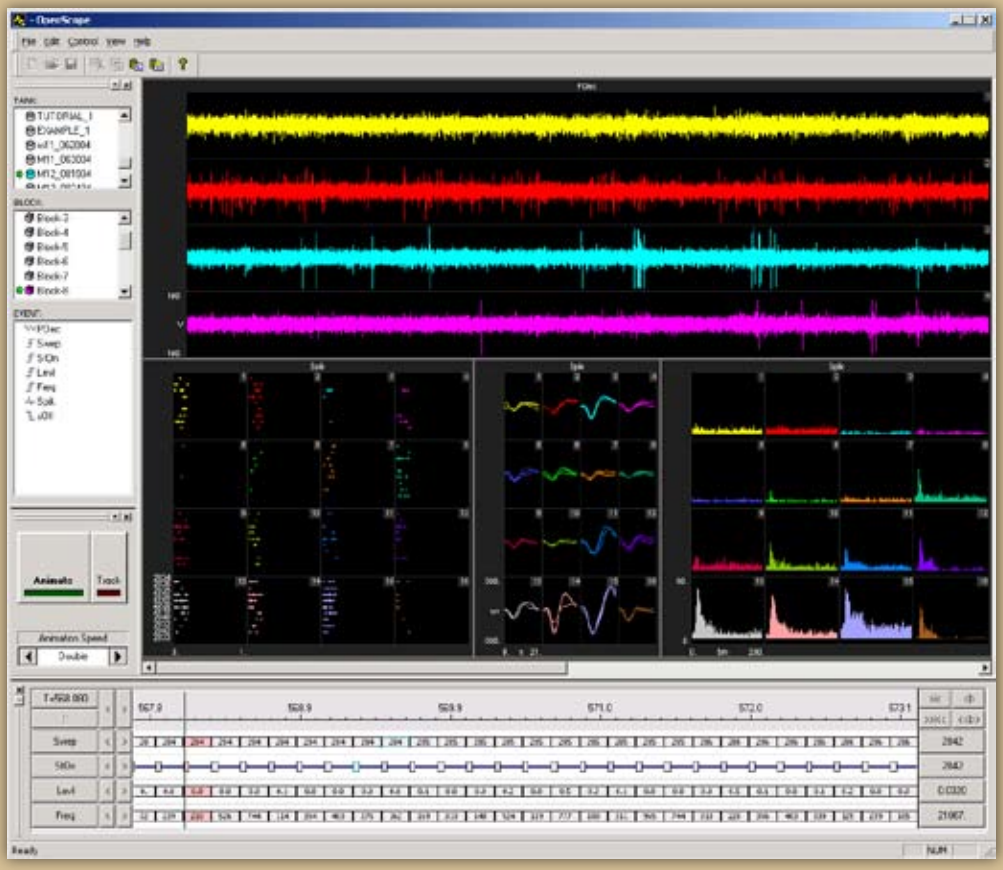
OpenWorkbench

OpenWorkbench is the interface between OpenEx applications and the System 3 hardware. Through OpenWorkbench's graphical user interface, you can select which devices will be used in an experiment, specify which functions each will perform, select which data to store, and control the general flow of the experiment.



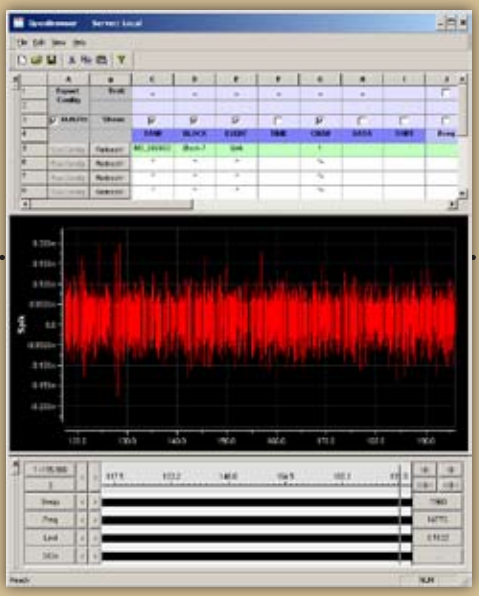
OpenController

OpenController gives you real-time control of your experiment. Parameters such as filter settings, single-unit thresholds, and stimulus variables, can all be modified *on the fly*. You can combine built-in components to create your own visual interfaces for parameter control and data display. OpenController includes over twenty customizable controls including gauges, switches, sliders, manual and automated spike sorting controls, and data displays.



OpenScope

OpenScope is a user-customizable application developed to visualize neural spike data and other bioelectric waveforms (e.g. EEGs or local field potentials) in real-time and offline. A number of plot types allow viewing of raw data in several ways including: continuous time base, spike shape overlay and feature space, PSTH and raster plots.



OpenBrowser

OpenBrowser is a data export and viewing application that accesses data through the TTank data server. Data from one or more data tanks can be selected, filtered, previewed, and exported. OpenBrowser supports *Neuroshare*, and a variety of export formats including a standard ASCII file and formats for *NeuroExplorer®* or Plexon's *Offline Sorter*.

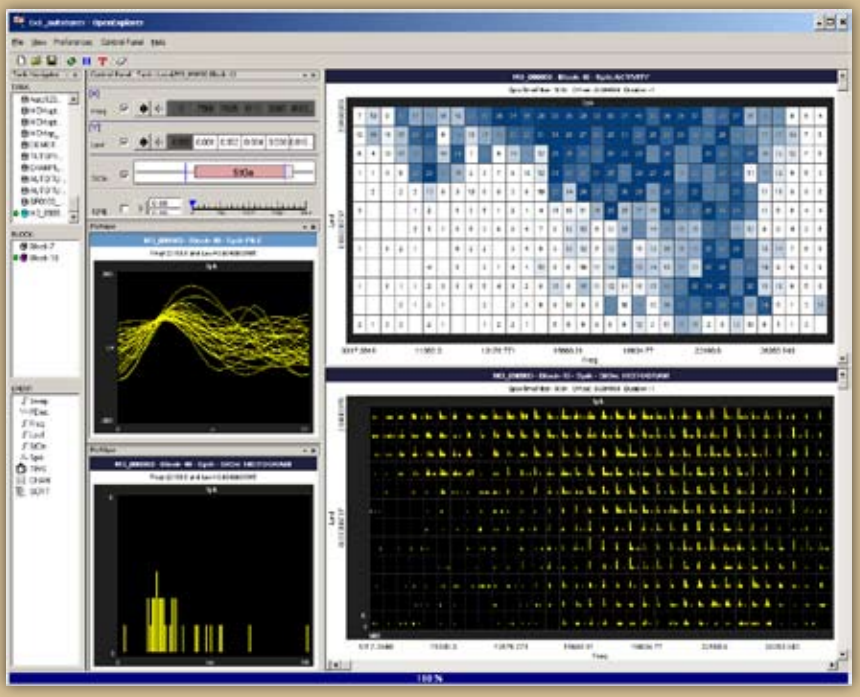
OpenProject

OpenProject acts as the essential environment integration tool, greatly simplifying the system's ease of use. With OpenProject, all OpenEx programs are brought under the control of a single management tool and all of the files related to a given experiment are managed automatically under a single directory structure.

More OpenEx Software:

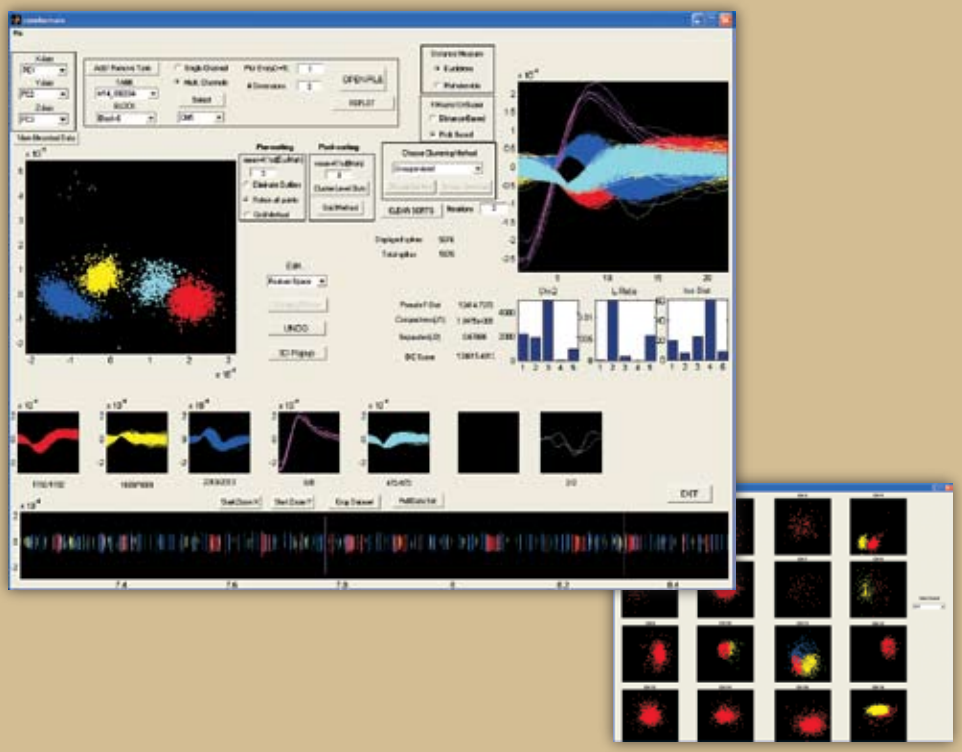
OpenExplorer—Data Mining

OpenExplorer is a powerful data mining tool for the OpenEx software suite. Flexible plotting features allow you to explore the relationships between recorded data, stimulus parameters, and other defined events. With OpenExplorer you can quickly sort through complex data sets and display these relationships dynamically. A graphical interface makes it easy to select the data and plot type for each cell in a grid display. Simply drag any stored parameter to the control area to plot it or filter other data based on that parameter. After your plots are configured, OpenExplorer allows you to view snap shots of activity or an animated display across an array of data over time. With OpenExplorer you'll be able to explore a single data set using virtually any combination of stimulus, behavioral, or environmental data stored to the data tank.



OpenDeveloper—Development Tools

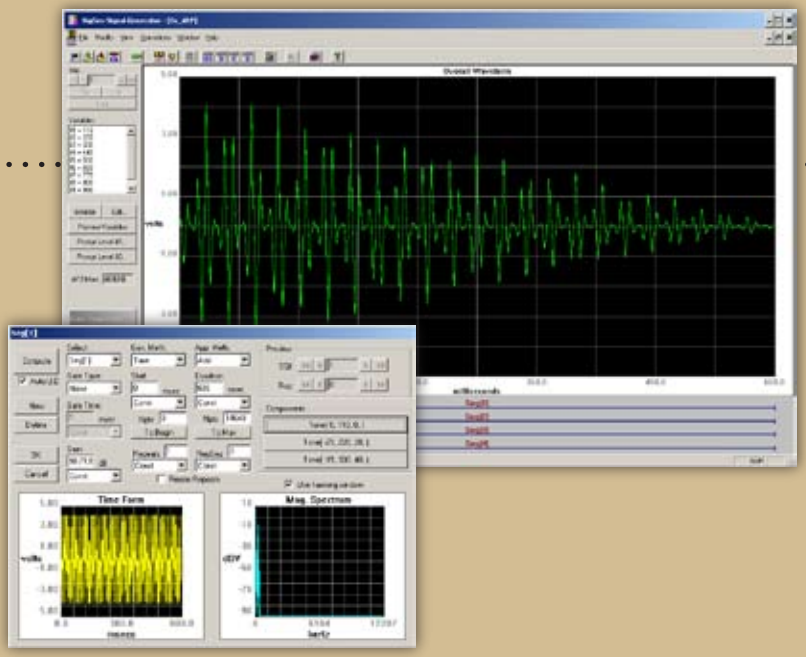
OpenDeveloper is a application program interface that can be used with programming languages such as MATLAB, Visual Basic, and Visual C++ to generate client applications that access the OpenEx servers. OpenDeveloper provides access to the same set of server interfaces used by OpenEx applications such as OpenScope and OpenController.



OpenSorter—Spike Sorting

OpenSorter is stand-alone neurophysiological spike sorting software for TDT's OpenEx software suite. It offers fully automated and unsupervised sorting of multiple electrode channels using expectation-maximization analysis of Bayesian probabilities. Sorting is based on principal components feature space, waveform parameter feature space, or waveform shape. Semi-automated K-Means and manual sorting methods are also supported. Offline results can be used to train a real-time, hardware-based, principal components sorting mode. Sorting results can be edited and spikes re-assigned using a manual feature space or waveform space editor. Sorting analyses such as Pseudo-F and J statistics, isolation distances, and L-ratios display sort quality and help to guide manual resorting and editing. Available 2006.

Software for Evoked Potentials

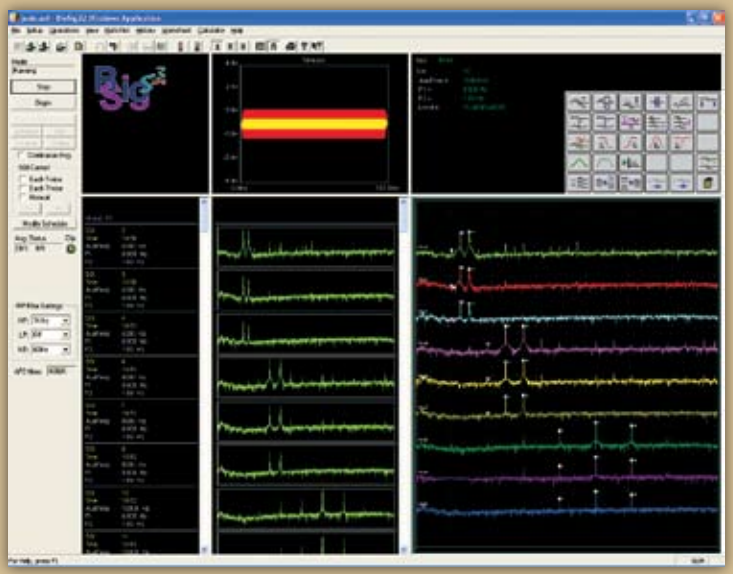


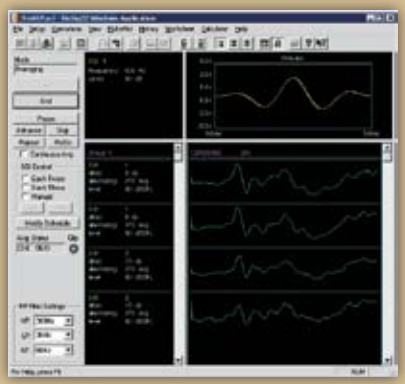
SigGenRP—Signal Design

SigGenRP is a powerful stimulus design package that provides systematic control of stimulus variables across a range of experimental conditions. The intuitive graphical interface makes it easy to build a variety of complex signal waveforms from basic building blocks such as clicks, noise, sweeps, and sine waves. You control all aspects of the signal, such as duration, frequency, intensity, and filter settings. Stimulus parameters and complex variable schedules are saved in a file and used to generate stimuli from compatible applications such as BioSigRP (below) or OpenEx (pg 24). SigGenRP also includes a versatile signal calibration tool that you can use to calibrate and normalize transducers, determine total harmonic distortion and produce normalization files.

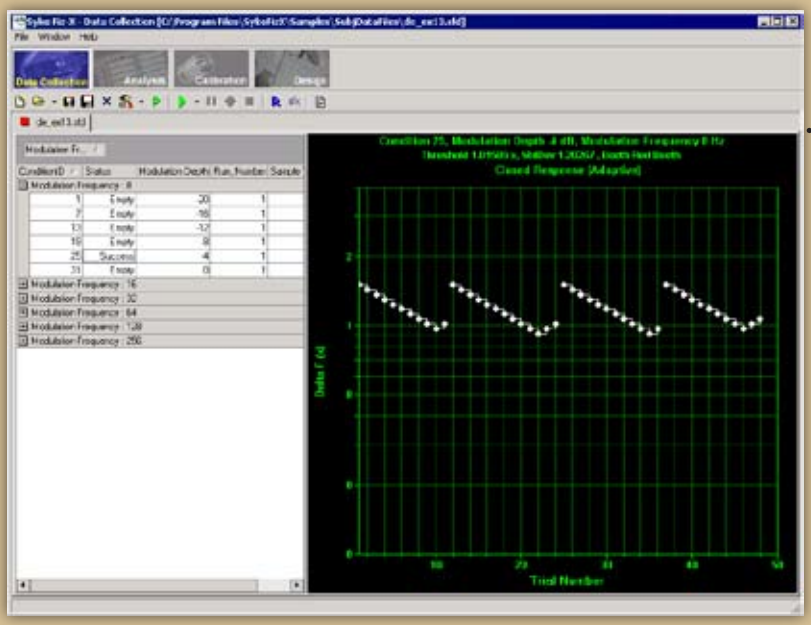
BioSigRP—Signal Averaging for Evoked Potentials

BioSigRP is a comprehensive program for presenting stimuli as well as capturing and analyzing evoked potentials such as ABRs, VEPs, and otoacoustic emissions. BioSigRP uses the signal parameters stored in SigGenRP files to generate stimulus signals that vary across successive presentations according to your design. You can present dual-channel stimuli and acquire up to four channels of response data. With the powerful BioSigRP signal averaging software, you'll have control over timing of stimulus and recording windows, plus a built-in worksheet where you can work with data records and generate detailed, hard-copy reports even while acquiring evoked responses. An auto-cursoring function applies predefined cursor points to averaged waveforms and a comprehensive Cursor Edit window provides peak, latency and waveform comparison overlay analysis. BioSigRP also provides powerful data and record management tools, for instantly accessing up to 100 records, and dozens of built-in mathematical functions, for working with data. **SigGenRP required.**





Software for Psychophysics

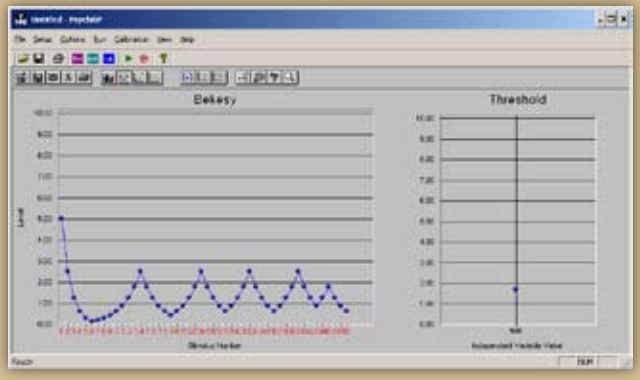


SykofizX—Psychophysics for Human and Animal Studies

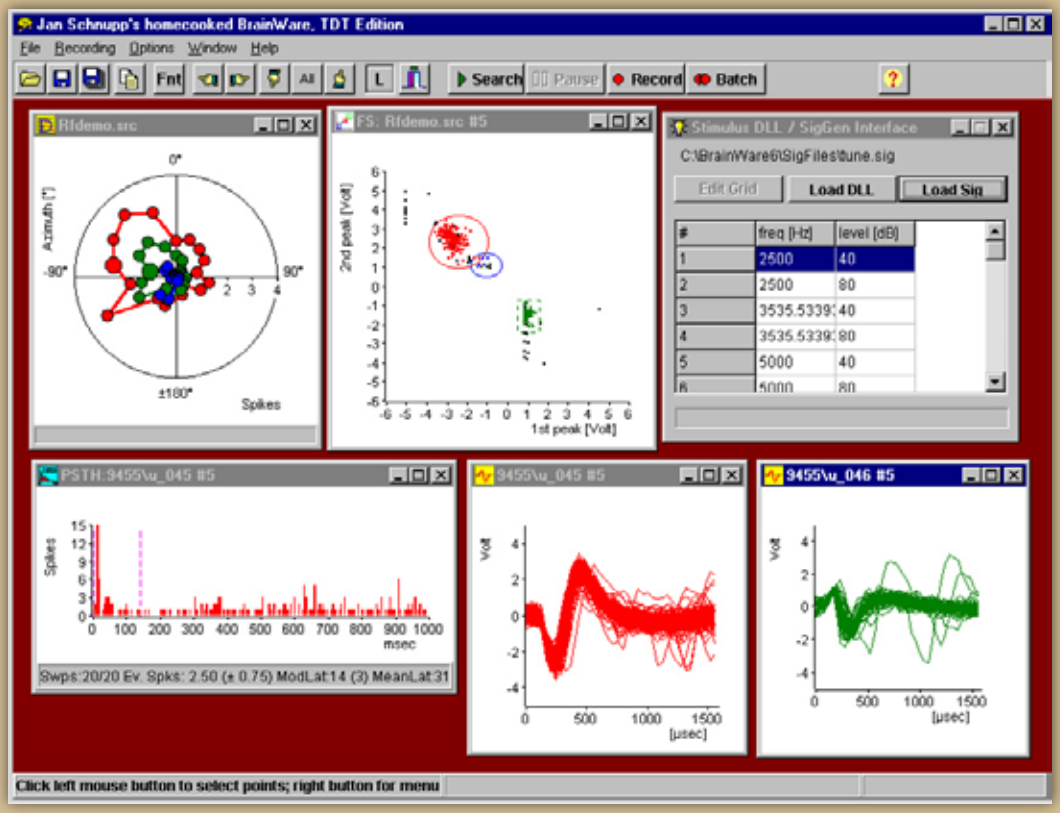
SykofizX is a powerful tool for designing and running psychophysical experiments. Signal presentation and control are integrated into a single package that supports most standard paradigms. With its onboard wizards and extensive library of examples, the software guides you through your experimental setup. Each experiment is divided into common elements, allowing you to mix and match various functional units, with varying degrees of customization. System calibration is also integrated for accurate control of stimulus level. Data can be displayed as it is collected or viewed after data collection is complete. Flexible data export options facilitate offline analysis. SykofizX is supported by all TDT hardware and supports a variety of flexible subject interfaces ranging from a simple response box to a full touch screen.

PsychRP—Psychoacoustic Testing

PsychRP is an affordable and easy to use program for Bekesy-Type Tracking, Modified Method of Limits, and Multiple Interval Forced Choice testing. Pre-programmed calibration routines and standard experiments minimize configuration and set-up time while still allowing you to customize stimuli using the full flexibility of the RPvds programming interface. PsychRP supports the RP2.1 Real-Time Processor for signal generation and the RBOX response box for collection of user responses.



Third-Party Software



BrainWare—Extracellular Recording and Data Analysis

BrainWare software is a versatile package for stimulus presentation, extracellular recording, and analysis. BrainWare plots neural responses versus stimulus parameters online, providing immediate feedback about the responsiveness of cells. With BrainWare you can acquire data on up to 16 channels, sort spikes, view data online, and use built-in analysis tools.

A "feature space" representation of action potential candidates allows you to "cut clusters" in a visual interface and PSTHs are automatically generated for each cluster. Once clusters are defined, cross-correlation, auto-correlation, ISI, and period histograms can be generated to provide further analysis.

Real-time Processors

Comparing Processor Modules

System 3 Real-time Processors are the foundation of every TDT system. We offer several designs with a range of possessor speeds, onboard memory, and input/output. The input/output configurations of each device have been tailored to support specific target applications. The table below provides a quick comparison of the digital and analog input/output configurations available. For more information about the processing power and onboard memory, see the technical specifications for each device.

Part #:	Target Application:	MIPS (Max)	Max Typical Sampling Rate:	D/A Channels:	A/D Channels:	Fiber Optic Ports:	Digital I/O:	Pg
RZ2	neurophysiology and evoked potentials up to 256 channels	19200	~50 kHz	Up to 16 24-bit Sigma-Delta or 16-bit PCM	Up to 16 24-bit Sigma-Delta, or 16-bit PCM, *	one 256-channel input two 16-channel inputs	24 bits programmable	32
RX5	neurophysiology up to 32 channels and evoked potentials up to 64 channels	3000	~50 kHz	four 16-bit PCM	*	two or four 16-channel inputs	40 bits programmable	34
RX6	ultrasonic signal generation, 3D auditory display	3000	~260 kHz	two 24-bit Sigma-Delta	two 24-bit Sigma-Delta	one 16-channel input (optional)	24 bits programmable	36
RX7	electrical stimulation and neurophysiology	3000	~25 kHz	four 16-bit PCM	*	one or two 16-channel inputs one 16-channel output	40 bits programmable	38
RX8	multi-channel audio display and feedback, multi-channel control of external devices, multi-channel data acquisition	3000	~100 kHz	up to 24^ 16-bit PCM or 24-bit Sigma-Delta	up to 16^ 16-bit PCM or 24-bit Sigma-Delta	none	24 bits programmable	40
RA16BA	neurophysiology and evoked potentials up to four channels	150	~25 kHz	eight 18-bit Sigma-Delta	*	one 16-channel input	16 bits output 1 trigger input	43
RP2.1	general signal generation, general data acquisition	150	~200 kHz	two 24-bit Sigma-Delta	two 24-bit Sigma-Delta	none	8 bits output 8 bits input 1 trigger input	42
RM1	circuit debug or training	150	~100 kHz	two 24-bit sigma-delta	two 24-bit Sigma-Delta	none	8 bits programmable	42
RM2	circuit debug or training	150	~100 kHz	two 24-bit Sigma-Delta	two 24-bit Sigma-Delta, *	one 16-channel input	8 bits programmable	42

** These devices can acquire digitized analog signals from a preamplifier (pgs 44-45) via fiber optic input*
^The RX8 can be configured with up to 24 total channels of analog I/O

RZ2 Z-Series Base Station

Designed for up to 256-channel data acquisition, the RZ2 is the first in TDT's Z-Series line of ultra high performance processors. Z-Series processors feature four or eight ultra fast digital signal processors networked on a novel bus architecture that speeds both onboard communication and memory access. Faster clock speeds and enhanced processing power not only improve channel count, but also allow for simultaneous acquisition on all 256 channels at sampling rates up to ~50 kHz. High bandwidth data is streamed from a Z-Series PreAmp (pg 44) to the RZ2 over a fast fiber optic connection. Our innovative Optibit optical PC interface ensures fast and reliable data transfer from the RZ2 to the PC. The RZ2 also features 16 channels of analog I/O, 24 bits of digital I/O, two legacy optical inputs for Medusa PreAmps (pg 45), and an onboard LCD for system status display.

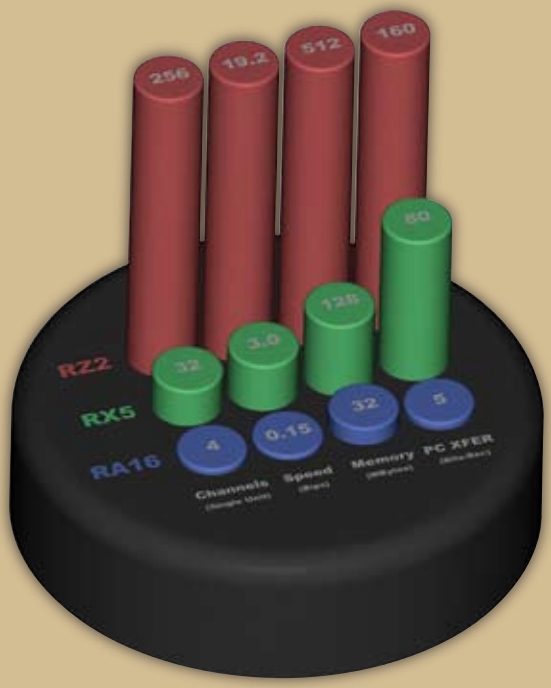
RZ2 Base Station Part Numbers:

RZ2-4 Four DSPs
RZ2-8 Eight DSPs

Technical Specifications:

DSPs:	four or eight 400 MHz DSPs, 2.4 GFLOPS peak
Memory:	64 MB SDRAM per DSP
Max sampling rate:	~50 kHz
D/A:	8 channels, 24-bit Sigma-Delta or 16-bit PCM
A/D:	8 channels, 24-bit Sigma-Delta or 16-bit PCM
Digital I/O:	24 bits
Fiber optic ports (new):	one 256-channel input (~50 kHz maximum sample rate)
Fiber optic ports (legacy):	two 16-channel inputs (~25 kHz maximum sample rate)

TDT systems are compatible with a wide variety of electrode types, including stereotrodes and tetrodes, microwire arrays, metal microelectrodes, acute and chronic NeuroNexus probes, surface electrodes, multi-electrode caps, and needle electrodes.



The RZ2 is a highly optimized version of our very successful RA16 and RX5 BioAmp processors. The RZ2 has been engineered to offer more processing, more throughput and more input channels. The numbers speak for themselves…

OR

RZ2 Base Station (RZ2)
The RZ2 processes and filters acquired signals and can be used to control digital I/O and/or generate analog signals.

The RZ2's new all-in-one form factor includes onboard power and communications without sacrificing compatibility. The standard DB-25 digital I/O connector and Legacy fiber optic ports make the RZ2 100% compatible with all other System 3 devices.

PZ2 PreAmp
The Z-Series PreAmps are used exclusively with Z-Series base stations and digitize neural signals at sampling rates up to ~50 kHz. See page 44 for more on these latest generation preamplifiers.

NN64 (not shown)
High channel count systems typically use the TDT 64-channel acute, high impedance headstages. Chronic heastages (pg 47) and microwire arrays (pg 50) are also available.

RX5 Pentusa Base Station

The Pentusa's fast clock speeds and distributed architecture deliver the processing power and transfer rates you need to process multi-channel neurophysiology data in real-time. This means you'll get excellent performance in applications that require fast data transfer for real-time control and data visualization or for high volume data transfer tasks such as streaming data to disk. PCM analog outputs support a wide variety of signal production tasks, including control of motors, electrical stimulation, and monitoring analog signals during acquisition.

Used with the Medusa battery powered preamplifiers (pg 45), the Pentusa is a biological amplifier system that provides simultaneous ~25 kHz acquisition on every channel, fiber optic isolation, and the power of user-programmable real-time DSPs. The system's versatile design allows you to switch from extracellular recording to EEGs simply by changing headstages. Programming and control of as many as 32 single-unit channels or 64 EEG channels can be accomplished on a single device. For systems with up to 256 channels, consider our RZ2 base station (pgs 32-33) and PZ2 preamplifiers (pg 44).

Part Numbers:

RX5BA-2 Two DSPs and one fiber optic input port
RX5BA-5 Five DSPs and four fiber optic input ports

Technical Specifications:

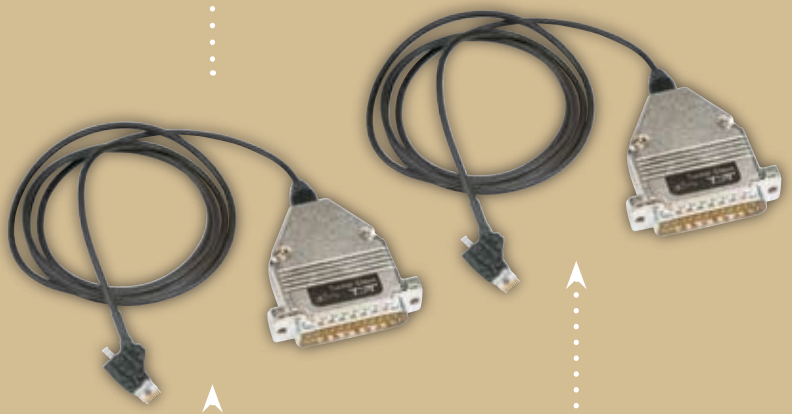
DSPs:	two or five 100 MHz Sharc ADSP 21161, 600 MFLOPS peak
Memory:	128 MB SDRAM
Max sampling rate:	~50 kHz
D/A:	4 channels, 16-bit PCM
S/N (typical):	82 dB (20 Hz to 20 kHz at 9.9 V)
THD (typical):	-74 dB for 1 kHz output at 5 Vrms
Frequency response:	DC-Nyquist (~1/2 sample rate)
Sample delay:	4 samples
Digital I/O:	40 bits programmable
Fiber optic ports:	two or four 16-channel inputs
Power and communication:	zBus required

MS2 Monitor Speaker
The monitor speaker can be used to monitor neural activity on any channel. For more transducers, see pages 54-58.

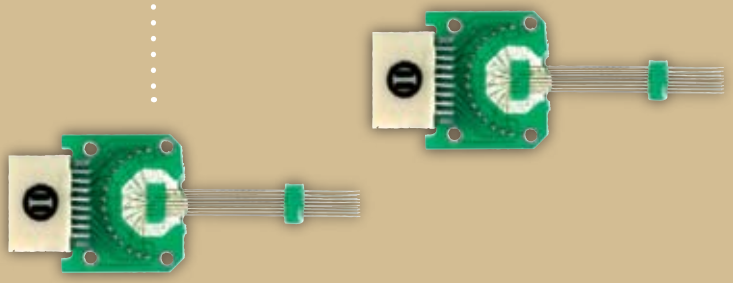
TDT systems are compatible with a wide variety of electrode types, including stereotrodes and tetrodes, microwire arrays, metal microelectrodes, acute and chronic NeuroNexus probes, surface electrodes, multi-electrode caps, and needle electrodes.

Pentusa Base Station (RX5)
The Pentusa processes and filters acquired signals and can be used to control digital I/O and/or generate analog signals.

RA16PA
Each PreAmp digitizes up to 16 channels of neural signals at up to ~25 kHz. For PreAmps, see pages 44-45.

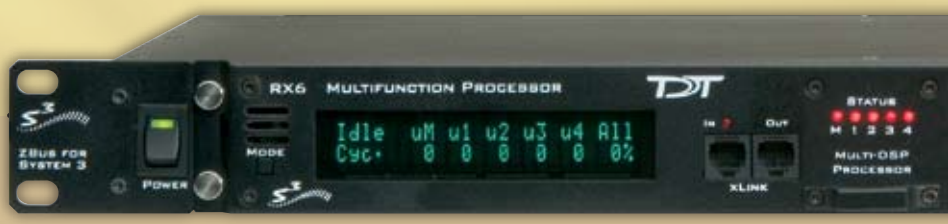


RA16CH
The Medusa PreAmp can be used with either high or low impedance headstages. For a complete list of headstages, see pages 46-49.



MW16
Microwire arrays deliver excellent recording characteristics for chronic multi-channel neurophysiology applications. For available array configurations, see page 50.

RX6 MultiFunction Processor



The RX6 Multifunction Processor has been designed with high quality, wideband audio signals in mind. Superior analog input/output and a novel multi-DSP architecture combine to provide exceptional processing power, fast data transfer rates, and a realizable bandwidth of 120 kHz. This processor is supported by a complete line of audio signal processing accessories (pgs 52-58), and can be used with our electrostatic speakers (pg 54) to generate ultrasonic acoustic stimuli for animal studies. Used with our headtracker interface (pg 53), the RX6 becomes a powerful 3-D platform for complex real-time audio presentation, HRTF filtering, multiple virtual sound and many tap FIRs.

Technical Specifications:

DSPs:	two or five 100 MHz Sharc ADSP 21161, 600 MFLOPS peak
Memory:	128 MB SDRAM
Max sampling rate:	~260 kHz
D/A:	2 channels, 24-bit Sigma-Delta
S/N (typical):	105 dB (20 Hz - 20 kHz at 9.9 V)
THD (typical):	-92 dB for 1 kHz output at 5 Vrms
Frequency response:	DC-Nyquist (~1/2 sample rate)
Sample delay:	43 samples
A/D:	2 channels, 24-bit Sigma-Delta
Max sampling rate:	~260 kHz
S/N (typical):	105 dB (20 Hz - 20 kHz at 9.9 V)
THD (typical):	-95 dB for 1 kHz input at 5 Vrms
Frequency response:	DC-Nyquist (~1/2 sample rate)
Sample delay:	70 samples
Voltage range:	+/- 10.0 V
Digital I/O:	24 bits programmable
Fiber optic ports:	optional 16 channel input
Power and communication	zBus required

Part Numbers:

RX6-A2	Two DSPs
RX6-2	Two DSPs and one fiber optic input
RX6-A5	Five DSPs
RX6-5	Five DSPs with one fiber optic input

Supported Sampling Rates

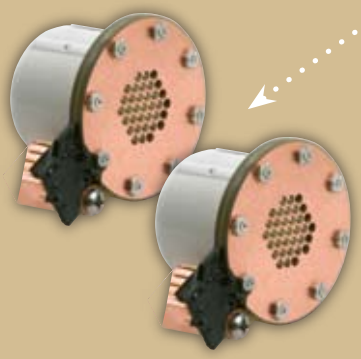
The RX6 supports a broad range of sampling rates with analog I/O rates up to ~260 kHz and digital I/O rates up to ~390 kHz. The list below shows the realizable analog sampling rates available on the RX6.

6103.52	**12207.03**	**24414.06**	**48828.13**	**97656.25**	**195312.50**
6975.45	13950.89	27901.79	55803.57	111607.14	223214.29
8138.025	16276.04	32552.08	65104.17	130208.33	260416.67
9765.63	19531.25	39062.50	78125.00	156250.00	

Multifunction Processor (RX6)
Filter and play out high quality auditory signals in real-time.

ED1
The broadband electrostatic speaker driver has an incredibly flat frequency response far into the ultrasonic range and can drive two ES or EC series speakers. *See page 54. For other amplifier/ transducer options, see pages 54-58.*

HTI3
Acquire 3-D spatial information using a Polhemus FASTRAK® or Ascension Flock of Birds® motion tracker. *See page 53.*



ES1
These lightweight speakers deliver ultrasonic stimuli with very low distortion. *See page 54.*

RX7 Stimulator Base Station

The RX7G Multichannel Microstimulator System is a programmable current stimulator capable of delivering complex microstimulation patterns simultaneously across multiple microelectrode channels. The system also incorporates a user-programmable DSP and multi-channel A/D input (via one of our preamplifiers) for dynamic, real-time stimulus control based on analog control signals from virtually any signal source. You can generate complex arbitrary waveforms with a bandwidth of up to 10 kHz or design and deliver complex patterns of biphasic pulses with phase durations of less than 50 microseconds. A proven digital communication system optically isolates the electrical stimulator from the waveform generators to eliminate AC power surges and noise, ensuring superior safety and performance. This system can be used with our switching headstage (pg 49) and a medusa preamplifier (pg 45), creating a complete stimulate and record solution. To add multi-channel data acquisition, consider the RX5 Pentusa Base Station (pg 34).

Base Station Technical Specifications

DSPs:	two or five 100 MHz Sharc ADSP 21161, 600 MFLOPS peak
Memory:	128 MB SDRAM
Max sampling rate:	~25 kHz
D/A:	4 channels, 16-bit PCM
S/N (typical):	82 dB (20 Hz to 20 kHz at 9.9 V)
THD (typical):	-74 dB for 1 kHz output at 5 Vrms
Frequency response:	DC-Nyquist(~1/2 sample rate)
Sample delay:	4 samples
Digital I/O:	40 bits programmable
Fiber optic ports:	one or two 16-channel inputs and one 16-channel output
Power and communication:	zBus required

Stimulus Isolator Technical Specifications

Stimulus output channels:	4 or 16 PCM D/A
Stimulus output voltage (max):	+/- 135 V
Stimulus output current (max):	+/- 100 µA up to 1MΩ load
Digital output:	16 bits
Selectable reference:	channel or global
Power:	HV250 battery pack with carbon zinc batteries
Device power:	Rechargeable Li-Ion battery

System Part Numbers

To order as a system:

RX7G-4 Two DSP Base Station, four channel Stimulus Isolator and battery pack
RX7G-16 Five DSP Base Station, 16 channel Stimulus Isolator and battery pack

To order components:

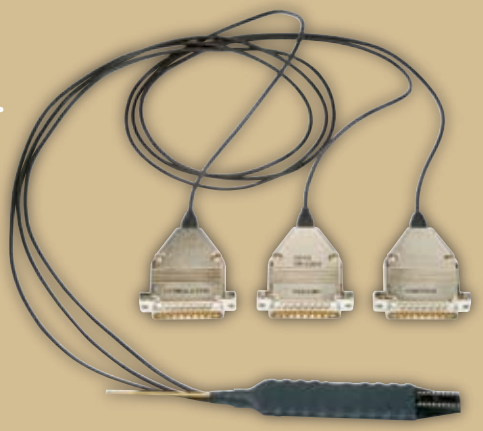
RX7-2 Two DSPs and one fiber optic input port
RX7-5 Five DSPs and two fiber optic input ports
MS4 Four-Channel Stimulus Isolator
MS16 16-Channel Stimulus Isolator
HV250 Battery Pack
HV250-R Rechargeable Battery Pack

RA8GA
Signals from external devices, such as a light sensor or microphone, are digitized and transferred to the base station where they can be processed and used to control stimulus output with delays as small as 8 samples or 200 microseconds.
For PreAmps, see page 45.

Microstimulator Base Station (RX7)
The base station transfers control information and digital stimulation waveforms from the base station to the stimulus isolator via fiber optics and can also filter and process digitized signals acquired via an amplifier.

MS16
Current limiting circuitry, a self-contained high voltage battery, and fiber optic communication combine to produce complete electrical isolation between the waveform generator and stimulus delivery system, for ultimate stimulator safety.

RA16PA Medusa PreAmp
The PreAmp digitizes up to 16 channels of neural signals at up to ~25 kHz. For PreAmps, see page 45.



SH16
The system is designed for use with up to 1MΩ electrodes. This 16-channel switching headstage receives stimuli and control information from the Stimulus Isolator and can also transfer neural signals to the preamplifer. For more headstages, see page 46.

RX8 Multi I/O Processor

The Multi I/O Processor (RX8) is a high channel count analog input/output system. Available with either 12 or 24 analog channels, the RX8 can be configured to your specifications at the factory. Combine PCM or Sigma-Delta A/Ds and D/As to create a system matched to your application. The Sigma-Delta converters have a dynamic range of over 100 dB with a maximum bandwidth of 50 kHz, making them ideal for audio applications. The PCM converters, with almost no group delay, are excellent for controlling external devices such as microstimulators or motors in real-time. Combine the RX8 with the RX5 (pg 34) for a complete physiology workstation or consider the RX6 (pg 36) for auditory applications that require higher sampling rates. A complete line of transducers and amplifiers are available to round out the system (pgs 54-58).

Technical Specifications

DSPs:	two or five 100 MHz Sharc ADSP 21161, 600 MFLOPS Peak
Memory:	128 MB SDRAM
Max Sampling Rate:	~100 kHz
D/A:	up to 24 channels
Frequency response:	DC-Nyquist (~1/2 sample rate)
PCM:	16-bit
S/N (typical):	80 dB (20 Hz - 20 kHz at 9.9 V)
THD (typical):	70 dB for 1 kHz output at 5 Vrms
Sample delay:	4 samples
Sigma-Delta:	24-bit
S/N (typical):	97 dB (20 Hz - 20 kHz at 9.9 V)
THD (typical) delay:	84 dB for 1 kHz output at 5 Vrms
Sample delay:	20 samples
A/D:	up to 16 channels
Frequency response:	DC-Nyquist (~1/2 sample rate)
PCM:	16-Bit
S/N (typical):	80 dB (20 Hz - 20 kHz at 9.9 V)
Sample Delay:	4 samples
Sigma-Delta:	24-bit
S/N (typical):	97 dB (20 Hz - 20 kHz at 9.9 V)
Distortion (typical):	84 dB for 1 kHz input at 5 Vrms
Sample delay:	44 samples
Digital I/O:	24 bits programmable

Part Numbers

RX8-2 Two DSPs and 12 I/O
RX8-2-24 Two DSPs and 24 I/O
RX8-5 Five DSPs and 24 I/O
RX8-5-12 Five DSPs and 12 I/O

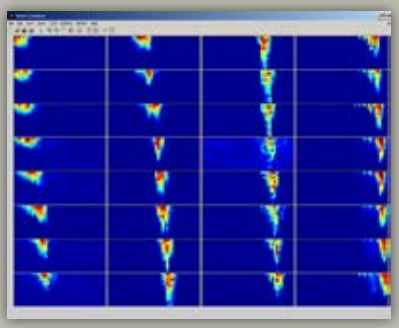
Multi I/O Processor (RX8)
Load stimulus waveforms from the PC to the processor. Transfer signals for play out to the PP16 Patch Panel via 25 pin ribbon cable.

PP16 Patch Panel
The patch panel provides convenient BNC connections for easy access to component input and output channels. See page 60.

Dr. John Middlebrooks *and his colleagues at the* KRESGE HEARING RESEARCH INSTITUTE AT THE UNIVERSITY OF MICHIGAN *use TDT systems to study the psychophysics and physiology of spatial hearing and cochlear prosthetics. A TDT customer for over fifteen years, Dr. Middlebrooks uses both System 3 (our latest hardware line) and its predecessor, System II. In the process of upgrading, the lab currently uses System II for human psychophysical studies involving measurements of head-related transfer functions and behavioral tests of sound localization. The lab's physiological experiments rely on System 3 for studies on sound localization in the auditory cortex as well as for experiments studying responses of the inferior colliculus and auditory cortex to electrical stimulation of the auditory nerve. Physiological studies make extensive use of multi-site silicon-substrate thin-film electrodes ("Michigan probes").*

"Our first use of the Michigan probes required custom multi-channel headstages and amplifiers that were built in-house, but we soon went to TDT equipment for data acquisition. RX5s give us easy 32-channel acquisition with filters and artifact rejection programmed into the DSPs. RP2.1s give us flexibility in design and presentation of audio signals, and an RX8 is used to generate voltage control signals for a current source that stimulates the cochlear implant.

We have been very pleased with the TDT hardware. We generally write our own software, using the TDT drivers, simply because we can tailor the software precisely to our experiments. The visual design software for the System 3 devices (RPvds) makes it easy to design the circuits for the DSPs."



Frequency response areas recorded simultaneously from 32 sites along the tonotopic axis of the inferior colliculus. Individual panels represent mean spike rates (colors) as a function of frequency (horizontal axis) and sound level (vertical axis). The display shows the orderly tonotopic progression of frequency tuning. These data were acquired using an RP2.1 for acoustic stimulus generation and calibration and an RX5 for simultaneous acquisition of neural waveforms from 32 sites of a Michigan electrode.

Single DSP Processors

RP2.1 Real Time Processor

With high-quality analog I/O and a 90 kHz bandwidth, the RP2.1 Real Time Processor is a time tested solution for audio signal generation and acquisition. Sixteen digital I/O bits also make this workhorse processor an affordable solution for experiment control tasks. A complete line of transducers and amplifiers (pgs 54-58) are also available to complete your system. Consider the RX6 Multifunction Processor (pg 36) for audio applications that require more processing power or bandwidth, or the RX8 Multi I/O Processor (pg 40) for applications requiring higher channel counts.

Part Number: RP2.1

Technical Specifications:

DSP:	50 MHz Sharc 21065, 150 MFLOPS
Memory:	32 MB SDRAM
Max sampling rate:	~200 kHz
D/A:	2 channels, 24-bit Sigma-Delta
S/N (typical):	105 dB (20 Hz to 20 kHz at 9.9 V), 95 dB (20 Hz to 50 kHz at 9.9 V)
THD (typical):	-95 dB for 1 kHz output at 5 Vrms
Frequency response:	DC-Nyquist (~1/2 sample rate)
Sample delay:	30 samples
A/D	2 channels, 24-bit Sigma-Delta
S/N (typical):	105 dB (20 Hz to 20 kHz at 9.9 V), 95 dB (20 Hz to 50 kHz at 9.9 V)
THD (typical):	-95 dB for 1 kHz input at 5 Vrms
Frequency response:	DC-Nyquist (~1/2 sample rate)
Sample delay:	65 samples
Voltage range:	+/- 10.0 V
Digital inputs:	8 bits + 1 trigger
Digital outputs:	8 bits
Power and communication:	zBus required

Medusa Base Station

Recommended for single or dual channel extracellular recordings and low channel count EEG's, EMG's and evoked potential recordings (such as ABRs), the Medusa Base Station is a versatile signal processor designed to acquire, filter, and process data digitized on one of our preamplifiers (pg 45). PCM analog outputs can be used for a wide variety of signal production tasks, including control of motors, electrical stimulation, and monitoring analog signals during acquisition. See page 56 for our monitor speaker and page 60 for our patch panel for easier access to output channels. For multi-channel neurophysiology and higher channel count EEG, consider the RX5 or RZ2 base stations (pgs 32-35). For a complete multi-channel microstimulation system, see page 38.

Part Number: RA16BA

Technical Specifications:

DSP:	50 MHz Sharc 21065, 150 MFLOPS
Memory:	32 MB SDRAM
Max sampling rate:	~25 kHz
D/A: (AC coupled)	8 channels, 18-bit Sigma-Delta
S/N (typical):	90 dB (20 Hz to 20 kHz at 9.9V)
THD (typical):	-80 dB for 1 kHz output at 5 Vrms
Frequency response:	3 Hz - Nyquist (~1/2 sample rate)
Sample delay:	30 samples
Voltage out:	+/- 10.0 V
Fiber optic ports:	one 16-channel input
Digital outputs:	16 bits
Digital input:	external trigger
Power and communication:	zBus required

Mini and Mobile Real-Time Processors

The System 3 platform includes two self-contained real-time processors: the Mini Processor and the Mobile Processor. Designed as an affordable test-bed system for designing and debugging RPvds circuits, each device includes stereo A/D and D/A (45 kHz bandwidth), an adjustable onboard speaker, and can drive headphones at up to 100 dB SPL. The devices draw power from the USB interface of the computer and work well with laptop computers for maximum portability. While these devices can be used for basic mobile psychoacoustics testing, we recommend the RP2.1 or RX6 (pgs 42, 36) for most psychophysical studies. For neurophysiology or evoked potentials we recommend the RA16BA or RX5 (pgs 43, 34) with one of our preamplifiers (pg 45).

Part Numbers:
RM1 Mini Processor
RM2 Mobile Processor (with fiber optic input)

Technical Specifications:

DSP:	50 MHz Sharc 21065, 150 MFLOPS
Memory:	32 MB SDRAM
Max sampling rate:	~100 kHz
D/A:	2 channels, 24-bit Sigma-Delta
S/N (typical):	85 dB (20 Hz to 20 kHz at 900mV)
THD (typical):	-80 dB for 1 kHz input at 630 mV rms
A/D:	2 channels, 24-bit Sigma-Delta
S/N (typical):	85 dB (20 Hz to 20 kHz at 900mV)
THD (typical):	-80 dB for 1 kHz input at 630 mV rms
Voltage range:	+/- 1.0 V
Highpass filter:	0.16 Hz
Fiber optic port:	one 16-channel input (RM2 only)
Digital inputs/outputs:	8 user selectable
Power and communication:	built-in interface to any PC's USB port AC adapter optional

Preamplifiers

Since TDT developed the first digital biological amplifier in the mid 1990's, our battery-powered, optically isolated, direct digital designs have become an industry standard. From headstage to base station, acquired signals flow through an optimized path designed to provide the best signal-to-noise and dynamic range possible. By digitizing biological signals at the headstage and transmitting them over a lossless fiber optic cable, we avoid the noise inherent in a traditional wired cable. Our innovative design also allows us to use low-voltage, low-noise OpAmps in the headstage and preamplifier, creating an efficient, safe, and low-noise front end.

Z-Series Preamplifiers

TDT's high-count Z-Series preamplifiers feature a fast new fiber optic connection capable of simultaneously transferring up to 256 channels at full precision. This extended bandwidth supports sampling rates up to ~50 kHz and improves signal fidelity, spike discrimination, sorting, and analysis. Used exclusively with Z-Series base stations (pgs 32-33), preamps are available in 64, 128 or 256-channel models. Our custom 18-bit hybrid A/D architecture offers the advantages of Sigma-Delta converters at significantly lower power. Dual-battery architecture allows one battery to power the preamp while its backup is charged over an isolated charging circuit. LEDs indicate battery status as well as spike detection and clipping on each channel.

Specifications:

A/D:	Up to 256 channels 18-bit hybrid
A/D Sampling Rate	up to ~50 kHz
Maximum voltage in:	10 mV
Battery:	two banks, each with eight hours battery life between charges, four hours to charge
Indicator LEDs:	256 status, 256 clipping, battery life, active battery bank
Input referred noise:	~2uV rms 300-7000Hz

Part Numbers:

PZ2-2 64-Channel PreAmp
PZ2-4 128-Channel PreAmp
PZ2-8 256-Channel PreAmp

Medusa PreAmps

Medusa PreAmps feature TDT's unique preamplifier design in a smaller, lower-count package. Signals are digitized at up to ~25 kHz on the preamplifier and sent over a fiber optic link to a DSP device such as the Pentusa (pg 34) or Medusa (pg 43) base station, where they are filtered and processed in real-time. A standard DB25 input connects the preamp directly to any of TDT's headstage designs (pgs 45-49). Multiple preamplifiers can be connected in parallel for higher channel count acquisition.

Preamplifiers are available with either PCM or Sigma-Delta A/Ds. Typical applications use PCM A/Ds to acquire bioelectric signals with minimal delay. Choose Sigma-Delta A/Ds to record near high frequency electric or magnetic noise sources (e.g. eye-coils, wireless motion detectors, or touch screens).

Technical Specifications:

S/N (typical):	rms 3 µV bandwidth 300- 3000 Hz; 6 µV bandwidth 30-7500 Hz
A/D sampling rate:	~ 6, 12, or 25 kHz
Input Impedance:	1 MΩ
Frequency response:	3 dB 2 Hz-7.5 kHz
Highpass filter:	1.6 Hz (3 dB corner, 1st order, 6 dB per octave)
Power requirements:	500 mA while charging, 50 mA once charged
Battery:	Li-ion Battery 1500 mAh, 20-30 hours battery life between charges
Charger:	6-9 V DC 500 mA, center negative
Fiber optic cable:	5 meters, maximum cable length 20 meters

RA4PA and RA16PA:

A/D:	4 or 16 channels, 16-bit PCM
Maximum voltage in:	+/- 4 mV
Lowpass filter:	7.5 kHz (3 dB corner, 1st order, 6 dB per octave)

RA16SD:

A/D:	16 channels, 16-bit Sigma-Delta
Maximum voltage in:	+/- 5 mV
Lowpass filter:	7.5 kHz (3 dB corner, 2nd order, 12 dB per octave)
Group delay:	20 samples

Part Numbers:

RA4PA 4-Channel PreAmp
RA16PA 16-Channel PreAmp
RA16SD 16-Channel Sigma-Delta PreAmp

Adjustable Gain PreAmp (General-Purpose Digitizer)

The Adjustable Gain PreAmp is a general-purpose digitizer that acquires and digitizes multi-channel data from a variety of analog voltage sources including eye-trackers, intracellular or extracellular amplifiers, pH meters, and temperature sensors. The operating range on all channels is controlled by manually setting the maximum input range to ± 0.1V, 1.0V, or 10.0Vp. The preamp uses a 25-pin connector for analog input and can be used with our patch panel (pg 60) to streamline connection. Digitized signals are sent over a fiber optic cable to a DSP base station, such as the Pentusa (pg 34) or Medusa (pg 43), where they are filtered and processed in real-time. For a complete high-count, general-purpose solution, consider the RX8 (pg 40).

Part Number: **RA8GA-2**

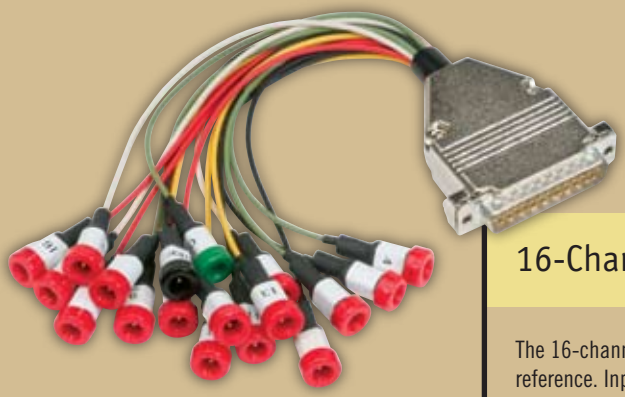
Technical Specifications:

A/D:	8-channels 16-bit PCM
Maximum voltage in:	Variable gain settings allow +/-10 V, +/-1 V or +/- 100 mV
A/D sampling rates:	~ 6, 12, or 25 kHz
S/N (typical):	70 dB for 1 kHz output at +/- 9.9 V
THD (typical):	< -70 dB for 1 kHz output at +/- 9.9 V and +/- 900mV
Crosstalk:	< -70 dB (DC - Nyquist)
DC offset:	< 5 mV at +/- 10 V < 3 mV at +/- 1 V and +/- 100 mV
Frequency response:	DC - 7.5 kHz
Lowpass filter:	7.5 kHz (3dB corner, 2nd order, 12 dB per octave)
Input impedance:	> 10KΩ
Power and communication:	zBus required

Headstages

Low Impedance Headstages

TDT's low impedance headstages are designed for evoked potentials, EMG, and EEG recordings using needle electrodes, surface electrodes and electrode caps. Headstages connect directly to the Medusa preamplifiers via a standard 25-pin connector.



16-Channel Headstage

The 16-channel low impedance headstage includes a built-in impedance tester for each channel and the reference. Inputs are accessed via a 25-pin input connector or a set of standard low impedance 1.5 mm safety connectors (LI-CONN) that streamline connection to commonly used electrode types.

Part Numbers: **RA16LI**

16-Channel Headstage with Full Differential

This version of our 16-channel low impedance headstage provides differential inputs for each channel, improving common mode rejection on all channels and making it ideal for EMG recordings. The headstage uses a DB44 input connector.

Part Numbers: **RA16LI-D**

Four-Channel Headstage

The four-channel low impedance headstage provides standard 1.5 mm safety connectors for easy direct connection to electrodes. A built in impedance tester can be used to test each channel and the reference with respect to ground.

Part Numbers: **RA4LI**

High Impedance Headstages

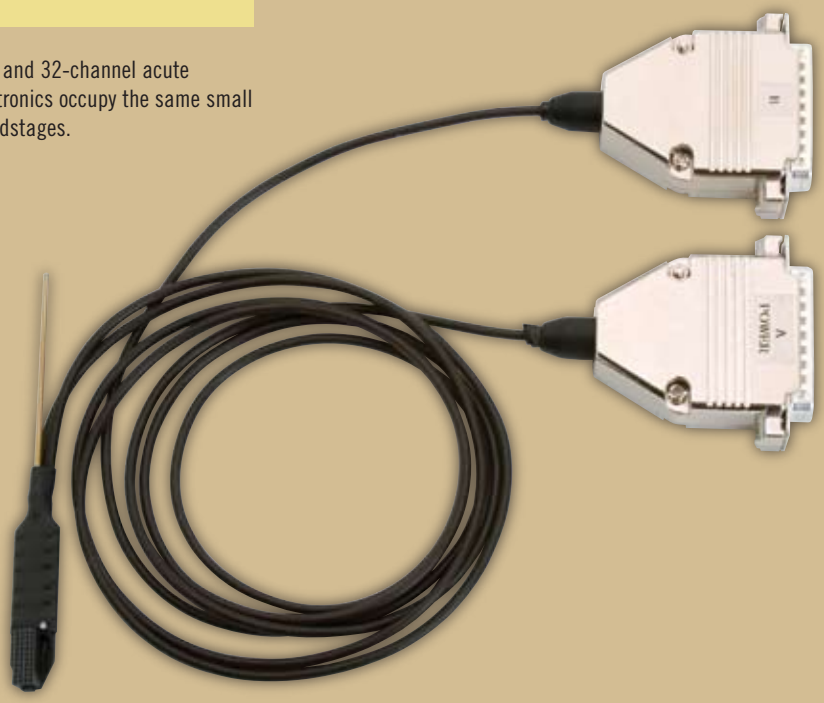
TDT's high impedance headstages are designed for extracellular neurophysiology using silicon electrodes, metal microelectrodes or microwire arrays. Each headstage offers excellent signal-to-noise (~5 uV rms noise floor) and connects directly to a Medusa preamplifier using a standard 25-pin connector. Acute headstages include a holding rod allowing them to be attached to a micromanipulator. Chronic headstages are designed to attach directly to implanted electrodes in awake, behaving preparations.

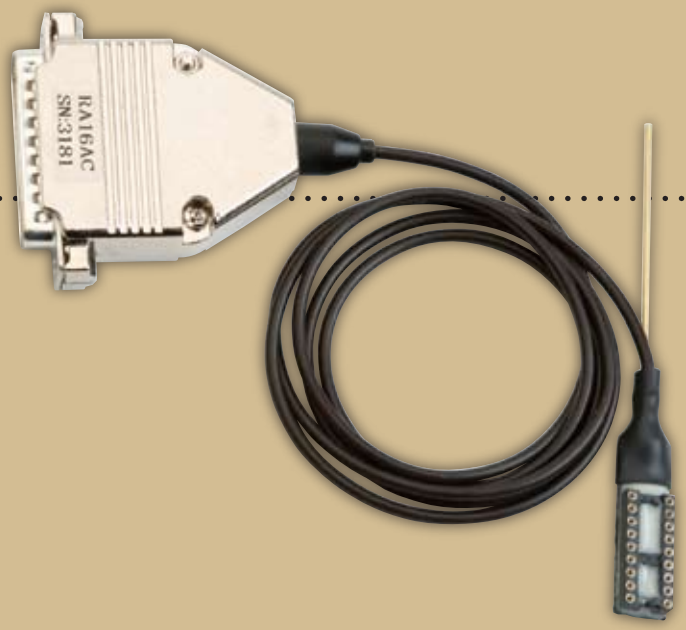
Number of Channels	Part #	Preparations	Gain	Input Connector	Mates with…
64	NN64AC	Acute	1x	40-pin	2x Samtec MOLC header
32	NN32AC	Acute	1x	40-pin	Samtec MOLC header
16	RA16AC	Acute	1x	18-pin DIP	0.5 mm pins
16	RA16AC4	Acute	4x	18-pin DIP	0.5 mm pins
16	RA16CH	Chronic	1x	18-pin Nano	Omnetics Nano-Pin connector
16	SH16	Acute (Switchable)	1x	18-pin DIP	0.5 mm pins
4	RA4AC1	Acute	1x	6-pin	0.76 mm pins
4	RA4AC4	Acute	4x	6-pin	0.76 mm pins

64 and 32-Channel Acute Headstages

This headstage is designed for the 64 and 32-channel acute NeuroNexus probes. Its miniature electronics occupy the same small footprint as our 16-channel acute headstages.

Part Numbers: **NN32AC**
NN64AC





16-Channel Acute Headstages

Connect this headstage directly to NeuroNexus acute 16-channel electrodes or use it with metal microelectrodes via a 0.5 mm adaptor. This small form factor is also available with 4x gain.

Part Numbers: **RA16AC (unity gain)**
RA16AC4 (4x gain)

Four-Channel Acute Headstages

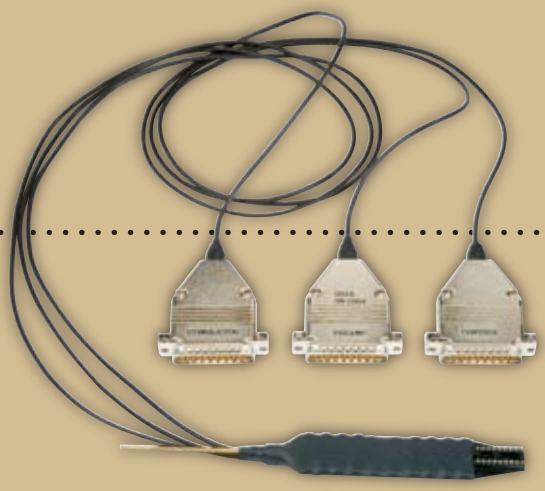
The four channel acute headstages use a low-profile connector for a slim form factor and are available with a unity or 4x gain. This economical 6-pin design provides easy connection to metal microelectrodes for lower channel count systems.

Part Numbers: **RA4AC1 (low-profile, unity gain)**
RA4AC4 (low-profile, 4x gain)

16-Channel Chronic Headstage

The chronic headstage features a low-profile female Omnetics nano connector, and is compatible with TDT microwire arrays as well as NeuroNexus chronic electrodes. The headstage weighs 1.2 g and connects to the preamplifier over a custom cable designed to maximize freedom of movement. The headstage can be used to record from subjects as small as the rat or mouse.

Part Number: **RA16CH**



16-Channel Switchable Acute Headstage

The switchable headstage features high-voltage, low-leakage solid-state relays to allow remote switching between stimulation and recording on each channel. Relay switching time is 2 ms. The ground line is also switchable, allowing an input channel to instead be used as a reference. The pinout of the SH16 matches the NeuroNexus 16-channel acute electrode, allowing direct connection to the headstage.

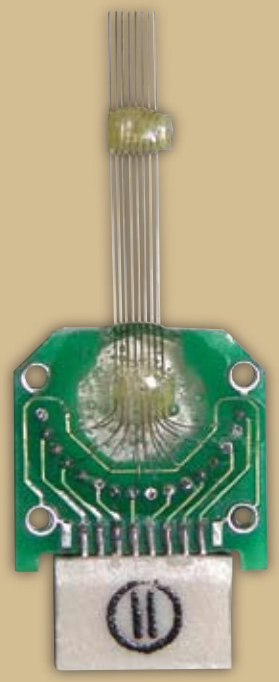
Part Number: **SH16**

Dr. Antonio Paolini *and his colleagues in the* AUDITORY NEUROSCIENCE LABORATORY AT LA TROBE UNIVERSITY *are using TDT System 3 equipment to examine neural mechanisms underlying auditory information processing in the cochlear nucleus. In particular, they use multi-channel neurophysiological techniques and intracellular recordings to investigate the role of inhibition in neural timing and how this may play a role in frequency coding. The Auditory Neuroscience Laboratory incorporates the latest TDT hardware and software including multi-DSP modules, microwire electrodes, microstimulators and the OpenEx software suite.*

"The power of the TDT system is realized when conducting multi-channel recordings, especially with the five-DSP RX series of components. Stimulus delivery is also made easy through development of a custom front end within the OpenEx environment incorporating the flexible RPvds circuit design," remarks Dr. Paolini, "No additional programming outside the OpenEx environment is necessary." The ease of use and flexibility of the OpenEx Software was a deciding factor for Dr. Paolini. OpenEx allows him to change stimulus parameters on the fly and stores response waveforms along with all the appropriate Epoch information, maximizing the amount of data that can be recorded from a given cell.

Dr. Paolini will soon move his laboratory and head the Auditory Clinical Neuroscience Unit at the Bionic Ear Institute in Melbourne, Australia. According to Dr. Paolini, "TDT System 3 will be the preferred platform, increasing the research scope to include chronic neurophysiological recording and high speed 64 channel human EEG, all powered by TDT hardware and software."

Microwire Arrays



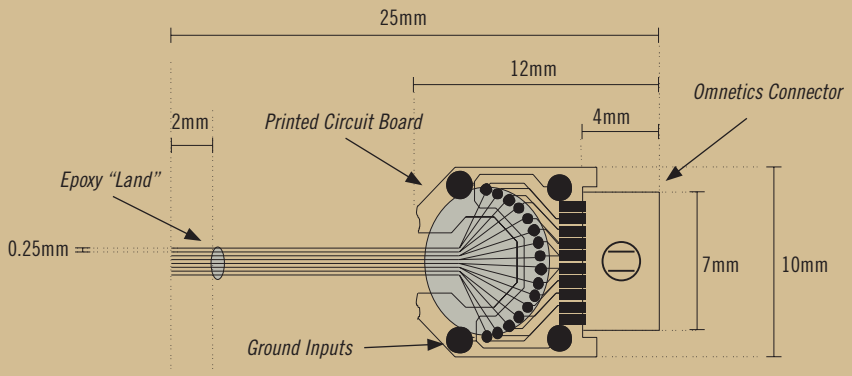
Microwire Arrays

TDT has applied modern manufacturing techniques to this simple and reliable technology for chronic multi-channel neurophysiology. This allows us to add innovative new design features while delivering dependable and consistent microwire arrays and keeping lead time to a minimum. Standard 50 µm polyimide-insulated tungsten microwire gives the arrays excellent recording characteristics and the rigidity of tungsten facilitates insertion. The overall length of the standard array is 2.5 cm, but can be customized simply by adjusting the length to which the microwire is cut. An optional epoxy "land" near the recording end of the array maintains electrode spacing. Using laser-cutting techniques, we can sharpen each wire in the array, easing insertion and minimizing tissue damage. Since each wire is individually cut to length, you can specify an array profile that matches the geometry of your target tissue. The standard MW16 array consists of sixteen channels configured in two rows of eight electrodes each. Arrays with more than two rows are constructed by stacking and bonding together standard two-row arrays. These are accessed via multiple 16-channel connectors and headstages. Stereotrode and tetrode configurations are also available. Contact TDT for information on additional array types and customizations available.

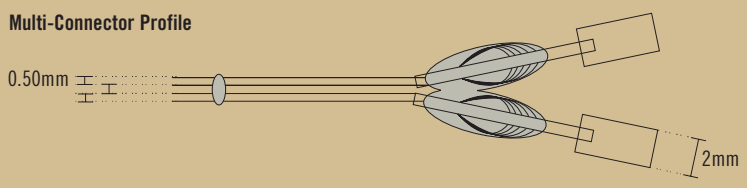
Part Number: MW16

Technical Specifications:

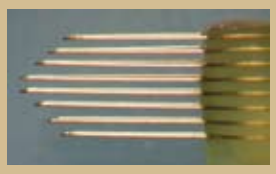
- Overall array size: 2 x 9 x 25mm; ~0.3 g (standard array)
- Omnetics dual row 18-pin nano connector(s) (0.025 mil pitch; <2x7x4mm)
- Up to 96 channels (16 per connector)
- Standard 2 x 8 configuration can be adjusted to user's specifications
- Standard 50 µm polyimide-insulated tungsten microwire
- Electrode separation is 250 µm within rows, with 500 µm separation between rows
- Standard impedances of 50 - 100 kΩ across the entire array
- Configuration can be adjusted to user's specifications



Multi-Connector Profile



Single Connector Profile



With over 15 years of experience in manufacturing hardware for scientific applications, TDT has the resources to reliably deliver the arrays you depend on for your research. Our manufacturing methods produce consistent, dependable, and affordable arrays while maintaining the flexibility to build custom arrays to your specifications. With TDT microwire arrays you can design your own electrodes without the time and labor intensive task of building arrays by hand.

Ordering Information:

n Rows X n Electrodes (default: 2X8)	OPTIONS: Max channels per connector = 16
Metal (default: Tungsten)	
Electrode Diameter (default: 0.050 mm)	
Insulation (default: Polyimide]	OPTIONS: Polyimide or Formvar
Row Pitch (default: 0.250 mm)	OPTIONS: 0.250, 0.300, 0.450 mm + multiples
Row Distance (default: 0.500 mm)	OPTIONS: distances at 0.05mm intervals from 0.05 - 0.8mm
Total Length (default: 25 mm)	OPTIONS: 15 - 120 mm
Tip-to-Land (default: 2mm)	OPTIONS: 2 - 4 mm

Motorized Commutator

As part of a complete solution for research with awake, behaving subjects, TDT has developed a series of 16 and 32-channel motorized commutators. Our lightweight cables, connectors, and ultra quiet motorized design minimize the torque caused by subject motion relative to a fixed cable.

Sensors on the commutator continuously measure the rotational angle applied to the headstage cable, and spin the motor to compensate, eliminating the turn-induced torque at the subject's end of the cable. Pushbuttons allow optional manual control, and an input BNC can be used to inhibit the commutator motor during critical recording periods. The motorized commutators are powered by a rechargable Li-Ion battery.

Part Number: **AC16 - 16 channels**
AC32 - 32 channels

Signal Conditioning

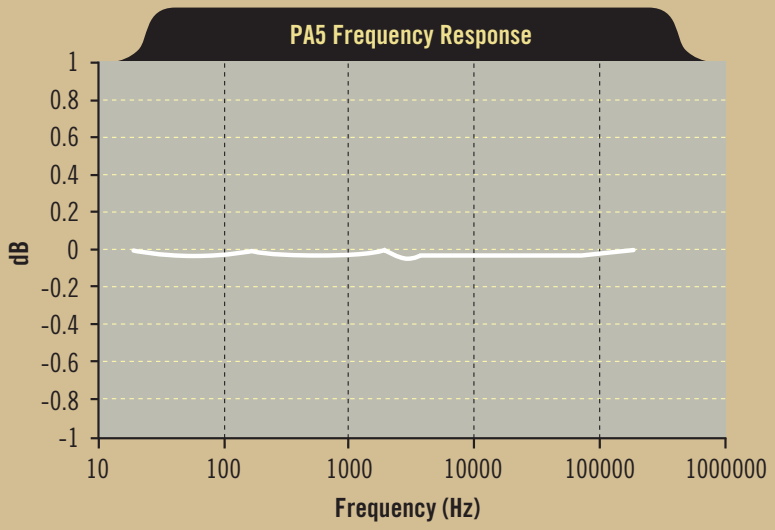
Programmable Attenuator

TDT has built more than 2000 programmable attenuators over the last 20 years, improving and perfecting the design with each new hardware generation. Our latest version, the PA5 Programmable Attenuator is a precision device for controlling signal levels over a wide dynamic range. The device is fully programmable; however, simple manual operation is also available using front panel controls.

Part Number: PA5

Technical Specifications:

Attenuation range:	0.0 to 120.0 dB
Resolution:	0.1 dB
Attenuation accuracy:	0.05 dB
Attenuation switching time:	5 ms
Switching transient:	< 8 mV
S/N (typical):	113 dB (20 Hz to 80 kHz at 9.9V)
Noise floor:	16 µV rms (20 Hz to 80 kHz)
THD (typical):	< 0.003% (1 kHz tone +/-7 V peak @ 0 dB attenuation)
Spectral variation:	< 0.04 dB (20 Hz to 80 kHz)
DC offset:	< 10 mV
Input signal range:	+/-10 V peak
Input impedance:	10 kΩ
Output impedance:	10 Ω
Power and communication:	zBus required



Signal Mixer

The Signal Mixer is a versatile three-channel signal mixer with input weighting and channel inversion on two of the three input channels. Input channels A and B are independently scaled then summed along with input C to produce the final output. A precision active summing circuit is used to give the SM5 quiet and accurate adding performance. The SM5 has very low noise and a flat frequency response up to 200 kHz.

Part Number: SM5

Technical Specifications:

Bandwidth:	200 kHz
Weighting range:	-20.0 to +20.0 dB
S/N (typical):	111 dB (20 Hz to 80 kHz at 9.9V)
Noise floor:	19 µV rms
THD (typical):	<0.002% (1 kHz tone +/-7 V peak)
Spectral variation:	<0.1 dB (10 Hz to 200 kHz)
Input signal range:	+/- 10 V peak
Max output:	+/-10 V
Input impedance:	10 kΩ
Output impedance:	20 Ω
Inversion:	channels A & B
Power and communication:	zBus required

Power Multiplexer

The Power Multiplexer delivers an analog signal to multiple output devices. Ideal for switching your high quality audio signal to one of sixteen speakers, this device provides rapid transitions when switching channels, excellent channel separation, and a high signal-to-noise ratio. A BNC connection is provided for signal input and outputs are accessed via a front panel 25-pin connector. A Patch Panel can also be used to provide easier access to outputs. A second 25-pin connector provides a connection to a control device, such as our RP2.1 Real-time Processor (pg 42).

Part Number: PM2R

Technical Specifications:

Switching mode:	Single 1-to-16 or 16-to-1
Switching time:	2 ms
Input/output level:	+/-15 V
Channel crosstalk:	< -80 dB
S/N (typical):	90 dB
Maximum allowable current:	2 A continuous
Power and communication:	zBus required

Headtracker Interface

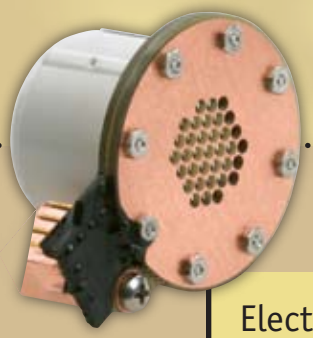
The Headtracker Interface simplifies acquisition of movement and positional information from motion tracking hardware. Acting as an interface between your System 3 processor and the Polhemus FASTRAK® or Ascension Flock of Birds® motion tracker systems, the HTI3 can acquire X, Y, Z coordinates, azimuth, elevation or pitch data from two receivers/sensors. Data can be transferred directly to any TDT real-time processor module with a fiber optic input (such as the RX6, pg 36), bypassing the host computer and avoiding any increase in latency. You'll be able to use tracker data to control 3D audio signal presentation in real-time or incorporate subject movement data into physiological studies of awake, behaving subjects. For information on processor modules see pages 31-43.

Part Number: HTI3

Technical Specifications:

Max update rate:	120 Hz
Boresight trigger:	external
RS232 acquisition rate:	115 kbaud
Fiber optic port:	one output
Power and communication:	zBus required

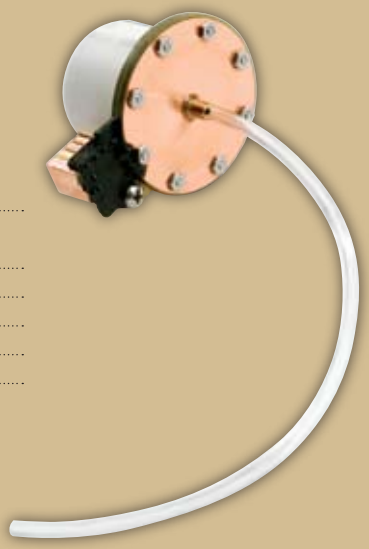
Transducers & Amplifiers



Electrostatic Speakers

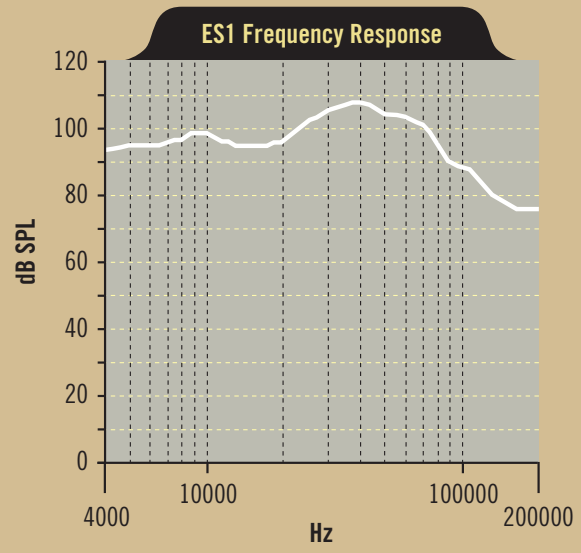
TDT Electrostatic Speakers are designed specifically for ultrasonic signal production. Our patented electrostatic design utilizes a thin, flexible membrane with an extremely low moving mass. Unlike conventional speakers, these speakers distribute the driving signal homogeneously over the surface of the membrane. These special features produce a small, lightweight speaker with an excellent ultrasonic response and low distortion. Available with or without a coupler, both models are easy to position and are particularly well suited for studies with small animals that have hearing in the ultrasonic range. The speakers are driven by the ED1 Electrostatic Speaker Driver and are provided with a 6 m connection cable.

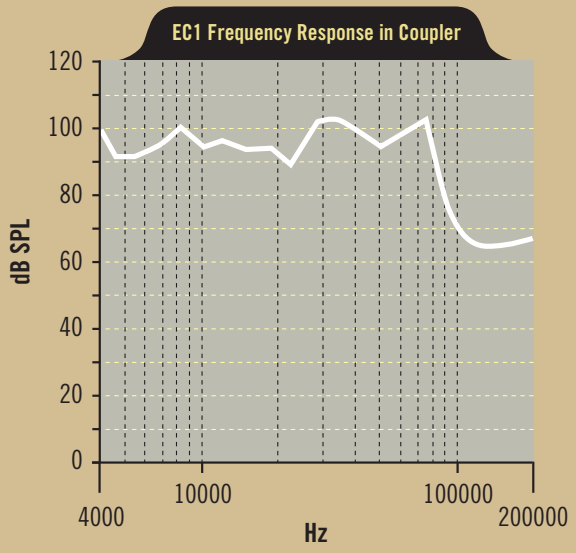
Part Numbers:
ES1 Free Field Electrostatic Speaker
EC1 Electrostatic Speaker – Coupler Model



Technical Specifications:

Frequency response:	ES1	+/-11 dB from 4 kHz to 110 kHz
	EC1	+/-9 dB from 4kHz to 110 kHz
Weight:		22 g
Dimensions:		3.8 cm outside diameter x 2.6 cm deep
Typical output (9.9V peak input):	ES1	95 dB SPL at 10 cm, +/- 9.9V 5 kHz signal
	EC1	90 dB SPL, +/- 9.9V 5 kHz signal
Maximum output:		110 dB SPL at 10cm
THD (ES1 typical):		< 3% at +/- 4 V input





Electrostatic Speaker Driver

The Electrostatic Speaker Driver is a broadband electrostatic driver that produces incredibly flat frequency responses reaching far into the ultrasonic range. Two input BNCs accept signals up to 10 V peak. The front panel gain control can be used to control the overall signal level of both channels from 0 to -27 dB in 3 dB steps. Output is via two 4-pin, mini-DIN connectors, which carry both bias and signal voltages. This driver is designed to work exclusively with TDT Electrostatic Speakers and can drive two speakers for stereo operation.

Part Number: ED1

Technical Specifications:

Input signal range:	+/-10 V peak
Bias voltage:	> 700 V
Input impedance:	10 kΩ
Output impedance:	NA
Power and communication:	zBus required

Flashlamp System

The Flashlamp system includes a high intensity photic stimulator and driver and is ideal for ERG, Visual Evoked Potential, and Visual Neurophysiology applications. The Flashlamp driver (FD1) takes a variable voltage input and TTL pulses to control the intensity and rate of photic stimulation. The system features rapid flash rates, variable intensity control, high output, and a spectral range from UV to long red. The modular design allows for precise positioning of the lamp and a fiber optic guide (FO1) can give additional positioning and focusing ability.

Part Number: FLSYS

Technical Specifications:

Flash rates:	up to 200 Hz
Input signal (Vref):	4 – 10 V
Trigger:	TTL
Flash intensity (max):	0.235 mJ
Spectrum:	350 – 800 nm
Flash rate:	0.1 - 200 Hz
Life:	10^9 flashes
Power and communication:	zBus required for FD1

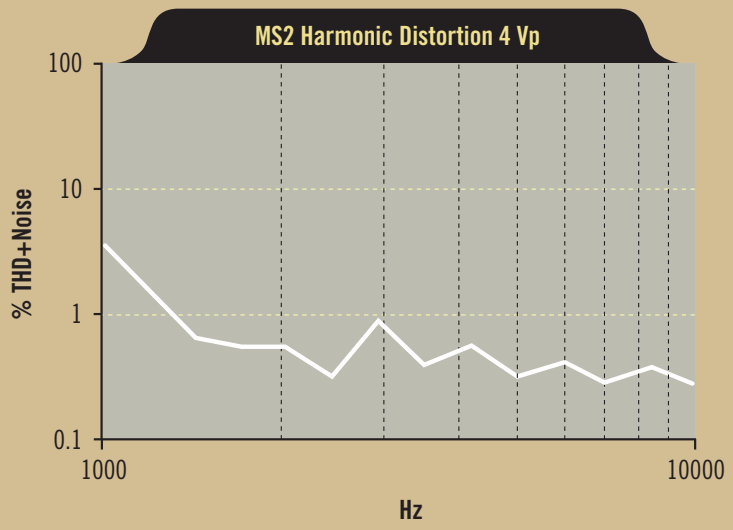
Monitor Speaker

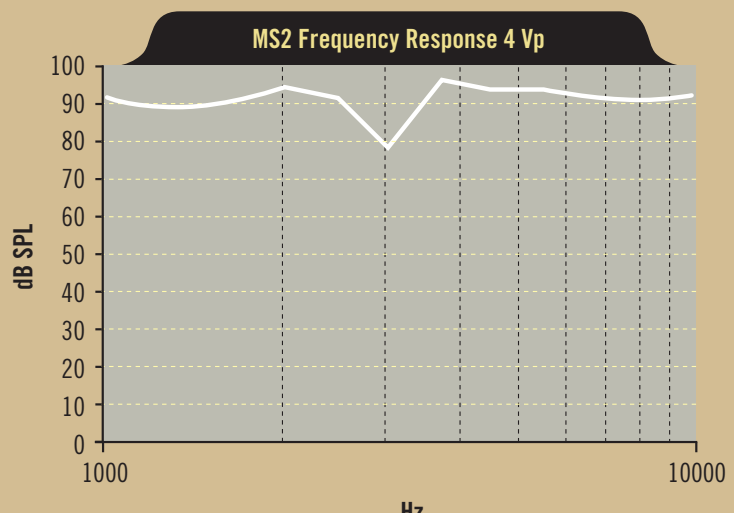
The Monitor Speaker is a versatile powered speaker useful for monitoring auditory stimulus or physiological signals. The built-in power amplifier is capable of driving the onboard speaker at up to 90 dB SPL. The Monitor Speaker has an adjustable output level and a frequency response range from 300 Hz to 20 kHz.

Part Number: MS2

Technical Specifications:

Input signal range:	+/-10 V peak
Max output:	> 90 dB SPL at 10 cm
Input impedance:	10 kΩ
Power and communication:	zBus required





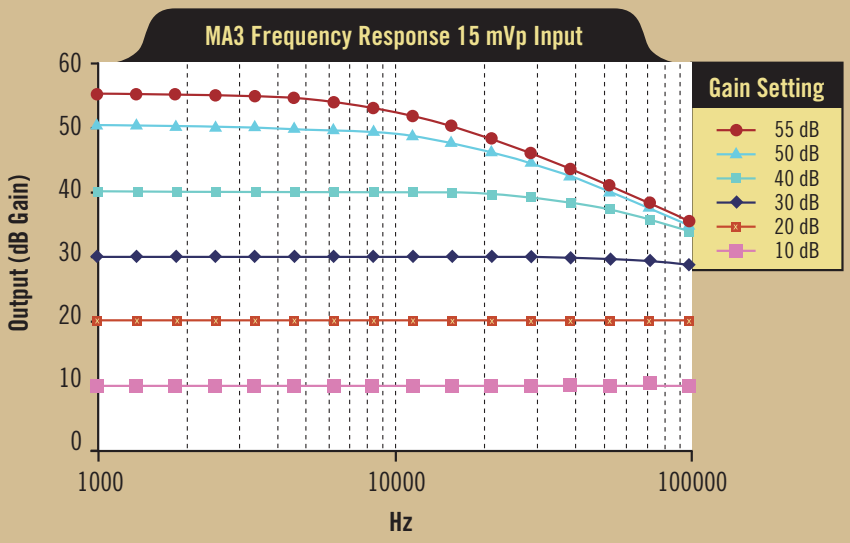
Microphone Amplifier

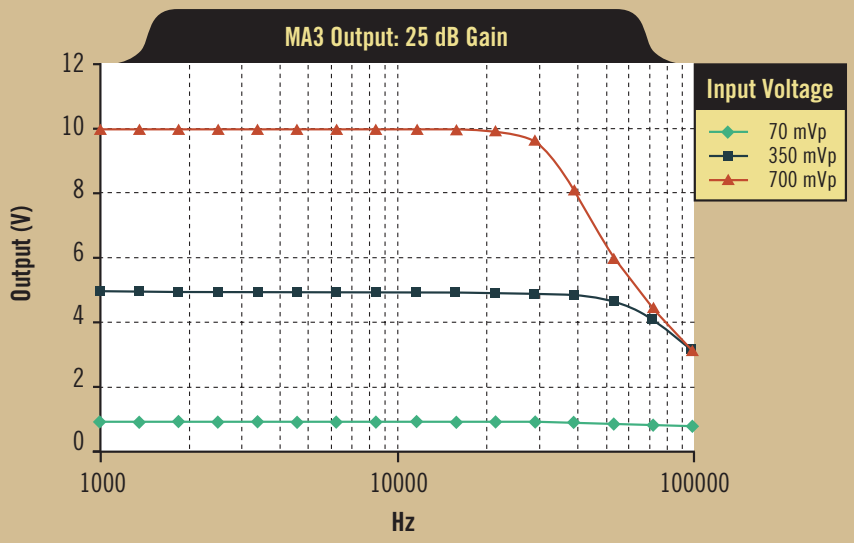
The Microphone Amplifier is a two-channel high gain, low noise preamplifier with both phono and balanced XLR microphone inputs for optimum impedance and noise characteristics. The Microphone Amplifier features variable gain from 10 dB to 55 dB in 5 dB steps, a toggle switch providing 20 dB of additional gain (maximum amplification of 5600x), and a bias switch for microphones requiring a bias voltage. Two BNC outputs provide easy connection to any TDT System 3 device.

Part Number: MA3

Technical Specifications:

Input signal range:	+/-10 V peak
-3dB bandwidth:	100 kHz @ 30 dB gain
Gain accuracy:	+/-1 dB
S/N (typical):	110 dB (20 Hz to 30 kHz at 9.9V)
Noise floor:	9.2 µV rms
THD (typical):	< 0.002% (1 kHz tone, +/-7 V peak)
Spectral variation:	3 dB (20 Hz to 30 kHz, 45 dB gain)
Input impedance:	600 Ω
Output signal range:	+/-10 V peak
Output impedance:	5 Ω
Bias voltage:	10 V, 150 mA max (XLR input)
Power and communication:	zBus required





Headphone Buffer

The Headphone Buffer is a precision power amplifier capable of delivering up to 1 Watt of power to headphones or other transducers. Capable of driving both high and low impedance loads; this stereo device has a flat frequency response up to 200 kHz, excellent channel separation, and low signal distortion and noise. The inputs feature an AC/DC coupling switch to allow for optional removal of DC offset. The output gain can be set between 0 and -27 dB in 3 dB steps. The outputs include both a stereo headphone jack and Left and Right BNC connectors. A special differential mode of operation provides an additional 6 dB of gain for mono signals.

Part Number: HB7

Technical Specifications:

Input signal range:	+/-10 V peak
Power output:	0.12 W into 4 Ω
	0.25 W into 8 Ω
	1.0 W into 32 Ω
S/N (typical):	117 dB (20 Hz to 80 kHz at 9.9V)
Noise floor:	9.2 µV rms
THD (typical):	< 0.0002% (1 kHz tone, +/-7 V peak)
Spectral variation:	< 0.1 dB (10 Hz to 200 kHz)
Input impedance:	10 kΩ
Output impedance:	5 Ω
Crosstalk:	<-94 dB (10 Hz - 5 kHz)
Power and communication:	zBus required

Eight Channel Power Amplifier

The Eight Channel Power Amplifier is capable of delivering up to 1.5 watts of power per speaker to up to eight speakers simultaneously. The unit features high channel separation with low crosstalk combined with low noise and distortion. The gain for all eight channels can be set to 0, -6, -10 or –13 dB using front panel toggle switches. The outputs are arranged for optional direct connection to a PP16 Patch Panel.

Part Number: SA8

Technical Specifications:

Input signal range:	+/-10 V peak
Typical output:	94 dB SPL at 1 m (white noise, 3 V rms into 4Ω)
Power output:	1.5 W/channel into 8 Ω
S/N (typical):	116 dB (20 Hz to 80 kHz at 9.9V)
Noise floor:	10.5 µV rms
THD (typical):	< 0.02% at 1 Watt from 50 Hz to 100 kHz
Spectral variation:	< 0.1 dB (50 Hz to 200 kHz)
Input impedance:	10 kΩ
Output impedance:	2 Ω
Crosstalk	< -60 dB
Power and communication:	zBus required

Stereo Power Amp

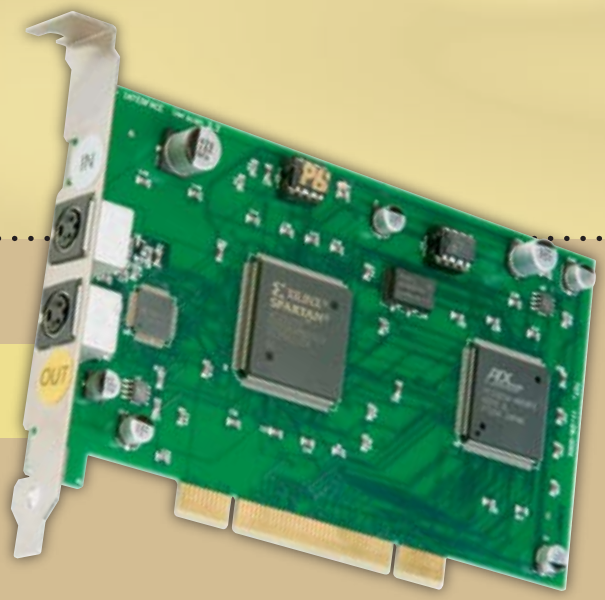
The Stereo Power Amp is a precision power amplifier capable of delivering up to 1.5 Watts per channel to a pair of speakers or 3.0 Watts to a single speaker in ganged output mode. The SA1 is a stereo device with excellent channel separation and low signal distortion and noise. It has a flat frequency response from 50 Hz to 200 kHz. The output gain can be set between 0 and -27 dB in 3 dB steps.

Part Number: SA1

Technical Specifications:

Input signal range:	+/-10 V peak
Power output:	1.5 W/channel into 8 Ω, 3.0 W ganged output
Typical output:	94 dB SPL at 1 m
	(white noise, 3 V rms into 4 Ω speaker)
S/N (typical):	116 dB (20 Hz to 80 kHz at 9.9V)
Noise floor:	10.5 µV rms
THD (typical):	< 0.02% at 1 W from 50 Hz to 100 kHz
Spectral variation:	< 0.1 dB (50 Hz to 200 kHz)
Input impedance:	10 kΩ
Output impedance:	2 Ω, 1 Ω ganged
Power and communication:	zBus required

Interfaces



PC Interfaces

OPTIBIT/GIGABIT INTERFACE: Our high-speed interfaces provide communication between your PC and System 3, zBus-based, hardware components. Designed for users requiring real-time control of System 3 devices, each consists of a PCI card for your computer and one or more interface modules that mount in zBus device caddies. These interfaces also provide automatic device identification, system initialization and a single clock that phase-locks all devices across all caddies. The Optibit version, featuring fiber optic data transmission and improved throughput, is also available. This design minimizes the potential for communication errors caused by electromagnetic interference and allows lossless data transmission over longer distances.

Part Numbers:

PI5 PCI Interface Card
FI5 PI5-to-zBus Interface module
PO5 PCI Interface Card w/optics
FO5 PO5-to-zBus Interface module w/optics

Technical Specifications:

Maximum cable length:	30 meters
Computer interface:	2.2 compliant (3.3V) PCI card

Transfer rates depend on system module accessed.

USB INTERFACE: The USB interface provides a convenient connection to your computer via the USB port, allowing programmable modules to communicate across the zBUS. The latest USB v2.0 version provides precise system-wide device synchronization and a significant improvement in speed for large and small data transfers.

Part Number:

UZ2 USB2 Interface module

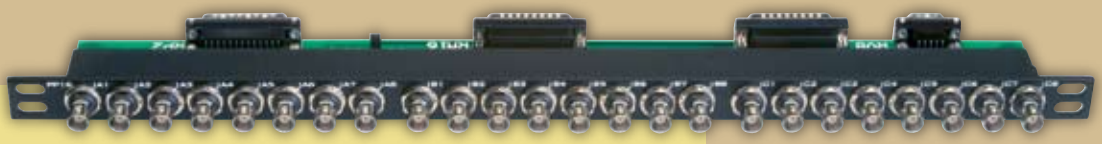
Interface Performance Comparison

The table below illustrates the typical transfer rates for the UZ2 and Gigabit interfaces with the available processors:

Interface	*Transfer Type*	*RP*	*RX Devices*	*RZ Devices*
UZ2	Read	1.5	2.5	NS
	Write	1.5	2.5	NS
PI5FI5	Read	1.5	2.5	NS
	Write	1.5	2.5	NS
PO5/FO5	Read	1.5	10.0	20.0
	Write	1.5	2.5	20.0

Transfer rates are in MBytes/s. *NS – Not supported*

Accessories



Patch Panel

The Patch Panel eliminates the need for specialized adapter cables to connect to the I/O ports on TDT's Real-time Processor modules, Power Multiplexer, Adjustable Gain PreAmp, and Eight-Channel Power Amplifier. Clearly marked front panel BNC connectors give you complete, convenient access to channel inputs, digital I/O and channel outputs on these devices.

Part Number: PP16

Technical Specifications:

Front panel connectors:	24 BNC
Back panel connectors:	3 DB25
	1 DB9
Width:	Standard 19" rack mount
Height:	1/2 U

zBus Accessories

Most System 3 modules must be mounted in a zBUS Device Caddie for operation. The zBus, built into each 1U (1 ¾" tall) device caddie, provides power and communication to each module. One or two modular devices can be mounted in the caddie's front bays, providing easy access to front panel connections. The zBus power and interface modules mount in the rear bays. Multiple caddies can be interfaced for custom system configurations and individual modules can be added or removed as needed. The device caddie's sturdy design and 19" width provide portability and an easy fit in standard equipment racks. The power supply can be switched to either 110 V or 220V.

Part Numbers:

ZB1 zBUS Device Caddie
PS25F 25 W Power Supply
PS40 40 W Power Supply

Other Products and Services

TDT can help you complete your system. We offer a range of reseller items minimizing the number of places you'll have to shop when setting up your lab. Here is a short list of other products and services we offer.

Workstation Grade Computers
Minimize setup time by adding a fully-configured PC to any TDT system. TDT will install interface cards and configure software on a System 3 compatible PC to ship a fully functional workstation with your order. Multi-monitor configurations available for use with display intensive applications.

Motorized Microdrives
TDT offers motorized hydraulic microdrives and controllers from FHC, Inc. Control electrode position from a pushbutton remote control or control, display, and record position from your computer using TDT's OpenEx software and hardware for a complete integrated positioning solution.

Needle and Surface Electrodes
We can complete your evoked response system with cup or needle electrodes.

Polhemus FASTTRAK® and Ascension Flock of Birds® Motion Tracking Systems
These multi-axis tracking systems can be used to transduce the physical position of nearly any part of your subject. Either system can be connected directly to TDT hardware via the HTI3 tracker interface.

CRS Visual Stimulation System
CRS's latest top-of-the-range system, the ViSaGe Visual Stimulus Generator, is based on 15 years of VSG development. Accurate timing guarantees no dropped or inserted frames. Use CRS's Stimulus Description Language and TDT's OpenEx software to directly control the CRS system.

Etymotic Research,Inc. Speakers (Insert Earphones) and Microphones
Used for closed field or occluded ear canal auditory work and DPOAEs, we can help you get the best speaker/microphone system for your application.

ACO Pacific Type 1 Calibration Microphones
ACO Pacific offers high quality, cost effective free-field or pressure calibration systems for closed and open field audio work at up to 120 kHz.

Oscilloscopes and Multimeters
We can add oscilloscopes, multimeters, or spectrum analyzers to your order to ensure your lab has reliable troubleshooting and test equipment on hand.

BNC Wiring Kits and Table Top Racks
TDT provides BNC cables and relay racks tough enough to stand up to everyday use in the lab. Kits combine a variety of commonly used cable lengths and racks are available in several sizes to fit your system.

TDT Premium Support Program
PSP is designed to help you make the most of your valuable research time. With TDT's No Downtime Guarantee, you won't lose valuable research time. If any TDT hardware should fail, regardless of the cause, we'll send a replacement module by next day service (to US customers, expedited service to international customers).

Part Number Index

Areas of Interest

Notes

Notes

Contact Us

If you're considering purchasing a TDT system, we encourage you to give us a call. You'll speak to a knowledgeable technical sales person who'll answer all your questions and might ask you some as well. Questions like which signals and subjects you work with, how many channels of I/O you need and what type of stimulus you plan to use. We'll use this information to determine the best TDT system for your application – a system that's been customized to include everything you'll need, and nothing you don't. And after you purchase your system, our full-time support staff will be there to help with any questions or problems you might have.

At TDT we're committed to providing you with the right research system, backed by support that is second to none. Call us today to discuss a TDT configuration for your lab.

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