Diagnosys Sales & Support Offices

North America

Diagnosys LLC
Suite 6, 410 Great Road
Littleton, MA, 01460
USA
Phone: (978) 486 9797
Fax: (978) 486 4677
Email: mail@diagnosysllc.com

Europe

Diagnosys UK Ltd
54 Impington Lane
Impington, Cambridge
CB4 9NJ
UK
Phone: +44 1223 520699
Fax: +44 1223 520699
Email: mail@diagnosysuk.co.uk

Web site: WWW.DIAGNOSYSLLC.COM

Stuart Coupland Ph.D.
University of Ottawa Eye Institute
Ottawa Hospital, General Campus
501 Smyth Road, Ottawa,
K1H 8L6
Canada
Phone: (613) 737 8235
Email: scoupland@ottawahospital.on.ca
Web: Www.eyeinstitute.net

ERG Reading & Telemedicine Center

Espion ™

The **Espion** system has been designed to interrogate the visual system layer by layer to provide objective assessment of macular, pan-retinal and optic nerve function. It not only performs all the standard ISCEV clinical vision tests but is also capable of performing new tests as they are developed. Based around a fast PC running Windows and written in conjunction with leading experts in the field, it incorporates into its design many aspects that are very desirable for electrophysiology including a proper client/server SQL database, advanced normal selection, fully programmable protocols, digital filtering, automatic report generation and proper diagnosis facilities. The hardware supports multiple external stimulators with options for expansion as technology changes.

Follow green buttons to select and run a test

Start

Select Patient

Design Philosophy

Housed in a stylish designed case, the system has been designed to cover the following points:

• A product designed especially for the electrophysiology market, not an add-on to another machine
• Easy to use. A hi-tech no knobs technology which doesn't require the user to be a computer wizard or PC expert to understand
• Self contained. (all the major electronics in one box)
• The system is portable can be carried direct to the patient
• Designed to be not only to be the

most accurate, but also the most reproducible system on the market
• Data can be exported/imported easily not only between the system and other software but also between machines world wide for group projects
• Minimum footprint size
• The design is modular, both in hardware and software so further modules can be easily added including customer specific stimuli
• External cables are kept to a minimum and the system does not require a mouse or keyboard
• The system exceeds both American and European clinical safety standards to be one of the safest clinical electrophysiological systems in the world

The software has been designed to allow new hardware and software to be incorporated with minimum change. This means that custom stimuli, hardware stimulators or even new types of tests can be added quickly for research or clinical experiments. Tests consist of a method - VEP, ERG, EOG, FOCAL ERG, a stimulator - Pattern, handheld Ganzfeld, full field

Select Protocol

Ganzfeld or maculoscope and a protocol that contains all the test parameters. Tests may even be combined together such as VEP and ERG to save time. The system has at its heart a very powerful database system which not only
performs all the standard database operations such as entering new patients, protocols, diagnoses and normals it can also be manipulated to select test results for further analysis by simply setting a few filters.
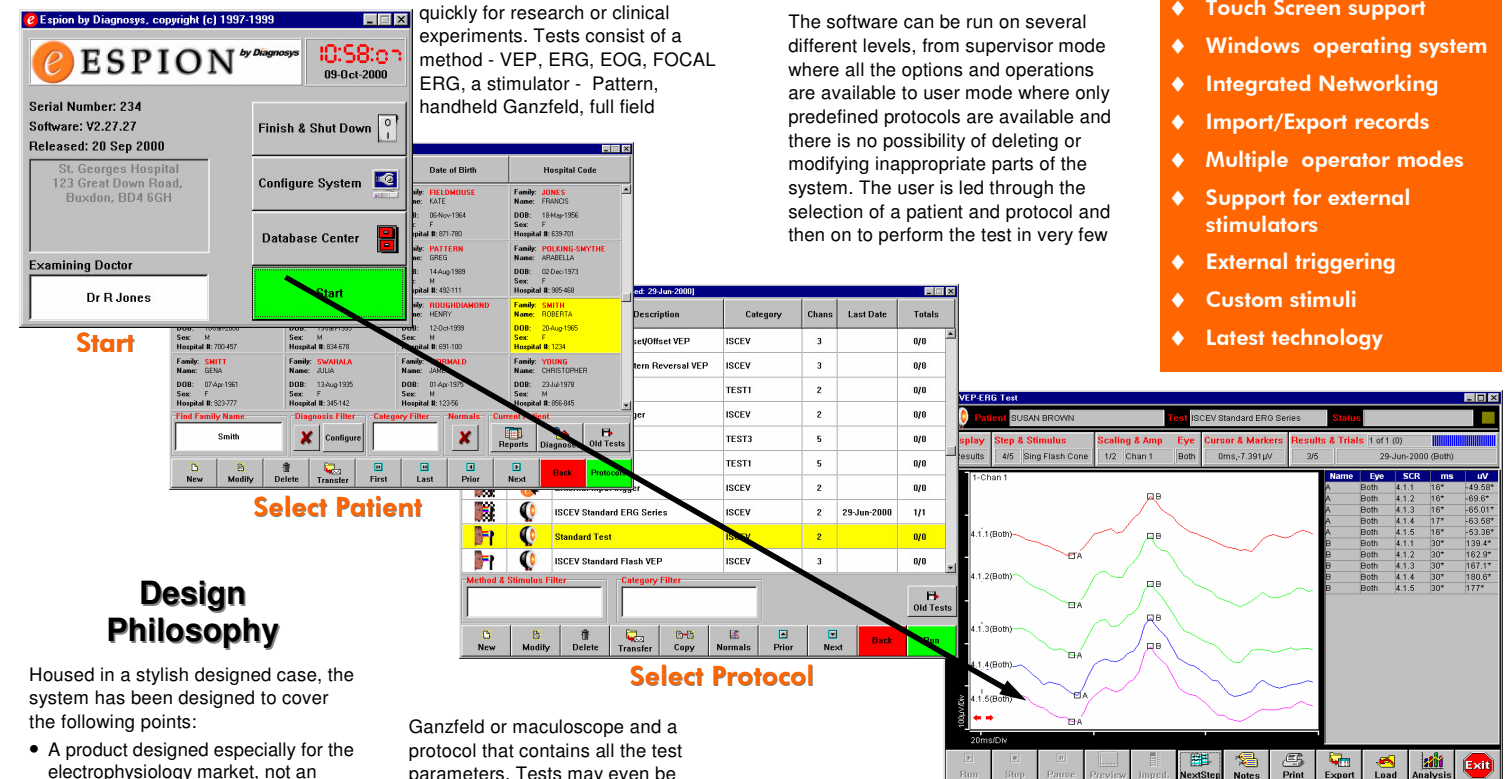
User Controls

The **Espion** console is supplied with an infra-red touch-screen which incorporates a touch keyboard eliminating all need for an external keyboard and mouse.
Most parameters and options can be changed by simply selecting from a drop down list of values speeding up configuration. If required, an external mouse and keyboard may be added and these run in conjunction with the touch screen. Each parameter is supplied with a default list of values which are normally selected from a much larger range. Almost all of these parameters can be configured by the customer and the current list may be changed at any time to cover the values of interest.

Operator modes

The software can be run on several different levels, from supervisor mode where all the options and operations are available to user mode where only predefined protocols are available and there is no possibility of deleting or modifying inappropriate parts of the system. The user is led through the selection of a patient and protocol and then on to perform the test in very few

button pushes making it very straightforward for even a novice to be able to use it. Changing operator modes is password protected to stop unauthorized changes being made to the system configuration.

Run Test

Features

♦ **Performs ISCEV Tests**

• **Pattern VEP**
• **Flash VEP**
• **Pattern ERG**
• **Flash ERG**
• **Focal ERG**
• **EOG**
• **User Defined**

♦ **Fully Configurable**
♦ **Run tests automatically**
♦ **SQL Database**
♦ **Touch Screen support**
♦ **Windows operating system**
♦ **Integrated Networking**
♦ **Import/Export records**
♦ **Multiple operator modes**
♦ **Support for external stimulators**
♦ **External triggering**
♦ **Custom stimuli**
♦ **Latest technology**

Software Updates

Diagnosys has a policy of continuous improvement and make available new features on a regular basis. Bug fixes and minor upgrades are normally available free of charge.

Electrophysiology System
Reinventing Vision Testing

Doc 11794, Rev A, 11-11-03

Database Features

- Industry standard SQL
- Client/Server
- No record limit
- User defined fields
- Automatic sorting
- Group selection
- SQL Query
- Multiple databases
- Sophisticated patient diagnosis
- Password Security
- Automatic backup
- Open data policy

Based around an industry standard SQL database, all patient, tests, protocols and diagnoses are stored in tables as records not flat files which can be accessed by many other 3rd party programs if required. The software supports multiple databases, although only one database can be connected at any one time. New databases may be created anytime.

Client/Server

The standard database is supplied as a local client/server installation (all software resides on the Espion) but with the purchase of the necessary licenses it can be configured as a fully fledged remote client/server system with more than one client connected to the database over the network at the same time. Applications include a clinic with more than one ESPION installed or a customer who wishes to connect the ESPION to their own network and access the data from a PC running another Espion software installation.

Patient Details

Patient details are displayed in a simple grid showing important parameters for easy selection. Records may be sorted by first name, last name, Date of birth and hospital number in both ascending and descending order and found by string lookup using first name or last name. These records can also be filtered by diagnosis, normal, or category to reduce the available subset and produce sets of similar patients for group analysis etc.

Patient Fields

Patient fields include not only name, address, DOB, gender, hospital no. etc but also ethnic origin, eye acuity, eye color, a user defined category and three user definable fields. All fields can be set such that they must be filled in, left blank or even disabled before a new patient is entered into the system.

Patient Reports

The system is capable of storing along with patient details and tests, report files generated by 3rd party programs.

A patient's existing tests or reports may be viewed by a simple button press and a new test started with a further button press.

Patient Diagnoses

Each patient may have one or more diagnoses entered which are stored in a separate database table. This allows patients to be filtered by diagnosis for further analysis. Diagnoses may either be entered manually, or selected from a customer defined set stored in a file and filtered using customer defined categories.

Security

The database may be protected by the addition of User names and passwords to protect access to the stored records. This can be set up from within the program (as well as by the system administrator). By default no password protection is enabled.

Backing Up

For additional safety, a regular backup of the database should be made. The current database can be backed up and restored from within the program using a standard PC ZIP compression

Patient Selection

Patient Fields

Exporting Records

To allow all types of records to be transferred between different databases on the same computer or different computers in different locations, the software supports both single and multiple record extraction. The selected records are stored in a designated file which can emailed to another system as an attachment and then imported into the current database. In this way groups of users can be sent new protocols to run, results can be stored or interpreted centrally and patient normals collected together making it ideal for group trials or shared research.

algorithm. The backed up data may then be saved onto the built–in hard drive, onto the integral ZIP drive, or onto another drive over the network.

Equipment

Console

The console is the heart of the Espion system and is designed to be a hi-tech no knobs self-contained unit that is not only elegant but also extremely easy to use. It is designed to be as small as possible for portability but retain the power of a desktop computer to maximize the available features for stimulus generation, acquisition, printing and analysis. Containing the computer, display and isolated amplifiers, it has connectors for all the external stimulators, the patient headbox and also the pattern generator hardware (if supplied). The console is fully isolated and does not require the PowerBloc for proper operation. This allows the console and one or more handheld stimulators to be carried around in the back of a car or even on normal flights as standard luggage (flight case required).

- Custom design
- Small footprint
- Fast Pentium computer
- Windows operating system
- 128MB RAM
- 40GB hard disc or greater
- 250MB ZIP drive for data backup
- SVGA (800x600) TFT display with 16 million colors
- Infra-red touch panel for fast control and reliability
- Keyboard and mouse supplied
- USB, isolated RS232, Parallel printer, 10baseT network connection (via PowerBloc)
- 5 differential amplifier channels
- Optional Infra-red printer connection
- Integral On/Off switch and power on indicator
- Dimensions 12" x 18.25" x 13.5" (305mm x 465mm x 245mm)
- Weight 20lbs (9kg)

Amplifiers

The five state of the art amplifiers supplied with every system are custom designed to record the very small signals associated with electrophysiology applications. They combine ultra low noise, with a high common mode rejection and extremely high conversion resolution. All amplifiers are DC coupled, opto-isolated and sampled at 10kHz which is reduced to a more manageable 1kHz. Each channel also incorporates an anti-alias filter and impedance checking circuit.

- 5 differential channels
- Fully isolated
- 22 bit resolution producing 100nV, no gain required
- 16 bit ADCs coupled with 12 bit DC offset

- 16 bit ADCs coupled with 12 bit DC offset
- Channel balance better than 1%
- Input voltage range ± 0.5V
- Ultra low noise <0.75 µ V p-p
- 5kHz anti-aliasing filter
- Input impedance greater than $10^9 \Omega$
- Digital filtering (configurable)
- CMRR greater than 100dB at 50/60Hz
- Automatic rejection
- 10KHz internal sample frequency
- Automatic impedance checking

PowerBloc
(Isolation unit)

The PowerBloc houses the isolation transformers required to isolate the pattern stimulator monitor, an inkjet printer and the full-field Ganzfeld if they are located in the patient environment. The PowerBloc also contains all the breakout connections for the console.

- 2.5A isolated output @ 240V
- 5A isolated output @ 110V
- Internal safety fuses
- LPT parallel printer connection
- Single USB connection
- Isolated RS232 connection
- BNC TTL trigger out
- BNC TTL trigger in
- 10baseT Ethernet connection
- Power On indicator
- Dimensions 12.75" x 18.25" x 3" (324mm x 465mm x 76mm)
- Weight 20.5lb (9.3kg)

NOTE: The PowerBloc is not required to isolate the console but actually draw its power from the console.

Trigger Out

The Espion is capable of triggering external equipment with a standard TTL pulse. Output pulses can be configured for both mark and space times as well as being fully isolated for safety.

- TTL Compatible BNC
- Isolated voltage for safety
- On/Off pulse time programmable in ms steps
- Single pulse or pulse train

Trigger In

The Espion system can be triggered by external equipment with a digital negative going TTL pulse or self triggered by monitoring anyone of the analog inputs. Analogue input triggers start the system when either a rising or falling edge is detected on any input. The slope of the edge to be detected can be programmed.

Digital Trigger In

- TTL Compatible BNC
- Isolated voltage for safety
- Edge triggered (negative)
- No minimum pulse width (<100ns)

Analog Trigger In

- Trigger from any channel
- Negative or Positive slope
- Slope slew rate programmable

Printer

The Espion system is designed to couple directly to a color inkjet printer using parallel or USB connections and provide isolated power from the PowerBloc. This is required if the printer is positioned in the patient environment. The software has been written to make full use of the color and high resolution output to produce single sheet quality reports. A laser or other printer may be configured provided it is connected via the network and outside the patient environment. For customers who require a portable solution, the console can be fitted with an infra-red option which removes the need for the PowerBloc entirely.

- Fast color Inkjet printer
- Single sheet output
- Isolated power
- Parallel or USB connection as standard
- Support for more than one printer

NOTE: Printer is not supplied as standard

Photometer
(Calibration)

Diagnosys can provide a high quality photometer to calibrate the entire range of stimulators. It has an RS232 interface for automated calibration and can be purchased or rented as required.

- Calibrated to U.S national institute of standards
- DC and integration measurements
- 5V bias for flash measurement
- Scotopic and Photopic filters
- RS232 interface for automatic operation

NOTE: Photometer is not supplied as standard

Hardware

Safety

- Fully complies with American and European safety standards
- CE$_{0413}$
- EN60601-1:1990,A2:1996
- EN60601-1-1
- EN60601-1-2
- EN60601-2-26:1994
- UL2601 2nd edition; 1997
- CAN/CSA C22.2 no. 601.1-M90,S1:1995

Diagnosys
Reinventing Vision Testing

Contact your local sales office for a quote

Visit WWW.DIAGNOSYSLLC.COM for more information

Stimulators

Designing Protocols

Pattern Stimulator

ColorBurst
Handheld Ganzfeld

ColorDome
Full field Ganzfeld

The ColorBurst is a ultra compact handheld monocular Ganzfeld based on LED technology. It incorporates three rings of ultra bright red, green and blue LEDs which combined together give the whole visible spectrum of colors. High resolution pulse width modulation allows very fine control of the actual luminance and keeps the value constant over time and temperature. Flashes can be created with short or very long time duration for on/off responses unlike standard Xenon flash technology, and superimposed on any color background. It produces all the standard ISCEV flash intensities.

The full field Ganzfeld is a revolutionary advanced design based on the same LED technology as the handheld Ganzfeld and is programmable in a similar way to the ColorBurst. As well as LEDs, however, it also includes several Xenon flash tubes for bright and ultra bright flashes, an nfrared camera for monitoring patient ision and red LED fixation lights for EOG tests.

- Direct connection for multiple stimulators
- Fully Programmable
- Calibrated to international standards
- Custom stimuli
- Support for 3rd party stimulators
- Standalone options
- Latest LED technology

The pattern stimulator has been designed to produce standard ISCEV patterns on a monitor for VEP and ERG tests.

- Configurable monitor timing
- Default: 800*600 @ 100Hz
- 8-15 bit luminance control for accurate contrasts (depending on option).
- Factory calibrated gamma correction built-in
- Supports all standard monitors
- 21" high quality color monitor included
- Luminance > 100cd/m^2 (depending on monitor)

NOTE: The monitor is subject to availability and specification may change.

Maculoscope

The maculoscope is the ophthalmoscope stimulator of the Espion system. It produces the flickering circular stimulus which is the worldwide
standard for focal ERG. The stimulus is projected directly onto the retina where it can be positioned by the examiner. Its unique sensitivity allows it to identify maculopathy even in patients with mild visual loss.

- 4° spot of light flickering at 42Hz
- 100% contrast with a square temporal waveform
- Peak retinal illuminance of 4.8 log-Trolands.
- Stimulus is centered with 12 deg annular surround of 5.5 log-Trolands retinal luminance
- Critical ratio of surround to stimulus illuminance of 0.7 log units is maintained throughout range
- Flicker frequency up to 100Hz
- Incorporates accommodating lenses from –2.5 to 4.0 diopters

- Revolutionary design
- Weighs 7lb (3 Kg) without stand
- No mechanical parts for greater reliability
- All electronic control of color, luminance, and flash duration
- Background and flash luminance created by Red, Green Blue, Amber LEDS with a flash luminance range from 25cd.s/m^2 to around 0.000004cd·s/m^2 (depends on color) and backgrounds in excess of 500cd/m^2
- Integral Xenon flash tube for bright flashes with full electronic control of intensity and luminance range from above 3000cd.s/m^2 down to below 0.009 cd.s/m^2 in over 100,000 steps. Flash durations range automatically from 5us-2ms
- Integrated monochrome camera with infrared LEDs for luminance even in total darkness
- Full color modulation of background LEDs using definable wavetable files
- Built-in dark adaptometer hardware
- Xenon flash auto-calibrating system
- LED auto-calibrating system
- Flexible positioning with optional mounts
- Built in speaker for audio feedback during EOG and ERG tests
- Integral xenon filter holder
- Custom versions available
- Multi-position stand

- Flash duration shorter than 4ms using 250ns PWM control
- Flashes current controlled not voltage controlled for ultra stable luminance and color output.
- Maximum flash duration >1s
- Any color flash
- Any color background
- Dim and Bright LED rings for 6 orders of luminance range
- Max white flash >30cd.s/m^2, 10x ISCEV standard flash
- Luminance linearity <2% deviation over entire range
- Calibrated luminance output in both cd/m^2 and cd.s/m^2
- Very stable output, fully adjusted for temperature
- 3 Red fixation LEDs with adjustable intensity
- On/Off flashes and arbitrary flash waveforms e.g. ramp, sine and exponential possible
- Calibrated in both Scotopic and Photopic luminance ranges
- Sphere diameter is 3.5" and eye viewport diameter is 2.15"
- Colors selectable using standard CIE coordinates
- Color wavelengths typically Red 640nm, Green 530nm, blue 470nm

Calibration

Diagnosys recommends that the ColorBurst is calibrated at least once a year either by returning it to the manufacture or one of its representatives.

Calibration

Diagnosys recommends that the ColorDome is calibrated at least once a year either by returning it to the manufacture or renting/purchasing a suitable photometer.

Protocols are special records which consist of a series of parameters that control how individual tests are performed, displayed, and printed. Any number of

Selecting Protocols

protocols may be setup and categorized for ease of selection such as ISCEV, Prototype etc. Selecting a protocol from the current list is simply a case of touching it and pressing the green button to run the test.

Creating Protocols

Protocols can be created, deleted, copied and modified at will provided the current user has the correct operator status and no data has been saved using that protocol. A protocol encapsulates a test method (VEP,ERG, EOG) a test stimulator (Ganzfeld, Pattern generator, external trigger) and a number of channels to record. Once these are set, then the individual parameters can be modified. Once a protocol has been defined, it may never need to be changed again. Of course new protocols may be based on existing protocols to make configuration even quicker. Most protocol parameters can even be changed when running the test for further refinement on a patient by patient basis.

Defining Steps

Each protocol contains a series of parameters that include acquisition, amplifier, stimulus, timing, and markers which are grouped together into steps. A protocol might consist of one or more steps each of which contains identical parameters except one which varies between steps. An example would be checkerboard spatial size for VEPs or a flash intensity series for ERGs. Conversely the protocol might instead consist of a series of quite different steps. An example might be producing 30Hz flicker, bright and dark adapted flashes for ERGs.

Step Parameters

Result Markers

Each step may define a series of markers which mark specific points on the result e.g. P100, N135, N75 for VEP and A, B for ERG. These markers can be made automatic such they are positioned by the software in the appropriate places after the result has been recorded speeding up diagnosis. Each marker may be set to show absolute periods and amplitudes or relative to other marker values, Marker values are displayed in a table on the screen which can also be printed and copied to the clipboard. These values are saved along with the results in the database and may be included in calculating patient normals.

Input Channels

Channels normally refer to actual amplifier inputs and the system supports 5 differential channels. Channel parameters contain not only the amplifier settings such as filtering and automatic rejection criteria but also graphical display parameters
including the positive direction and initial graph scaling. The system also supports the concept of virtual channels; these are channels whose inputs are actually taken from another channel's. This allows the program to record the same inputs but apply different settings like filtering or produce a channel which is the difference of two other channels.

Filtering

All channels have built in digital filters which cover all the standard ISCEV filter requirements.

- 75,100 to 300Hz
- 0,0.03,0.15,0.6,2.5 to 30Hz
- 0,0.03,0.15,0.6,2.5 to 100Hz
- 0,0.03,0.15,0.6,2.5 to 300Hz
- No filtering
- Line filter 50/60Hz

Amplifier Parameters

Auto-Rejection

The system supports auto-rejection of incoming data if the signal is contaminated with muscle noise, blinks or other extraneous pickup to make data collection as fast as possible. All data is stored after being collected so it can also be manually rejected at a later date.

Data Acquisition

Data is sampled internally at 10kHz and then decimated to 1kHz.

Acquisition Parameters

Acquisition parameters include pre/post trigger periods, auto-zero ranges and various timing delays. Total acquisition periods can stretch from 100ms to greater than 32secs.

- Group by category, stimulator, test type, description
- Easy creation
- All parameters are configurable
- Record 5 channels simultaneously
- Auto-rejection of trials
- 36 Steps per Protocol
- 16 Markers per step
- No limit on number of average per step
- No limit on number of trials in average
- Support for virtual channels
- Acquisition >32secs
- Records all trials for later analysis
- Digital filtering

Diagnosys
Reinventing Vision Testing

Diagnosys
Reinventing Vision Testing

Contact your local sales office for a quote

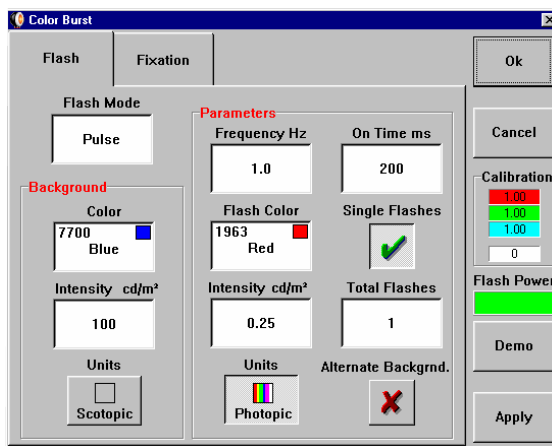**Visit WWW.DIAGNOSYSLLC.COM for more information**

Generating Stimuli

The **Espion** system has been designed to support a range of external and internal stimulators all capable of generating many different types of stimuli. Each stimulator is controlled by a custom set of parameters which are stored as a part of each protocol. Individual steps can have different stimulus parameters making for a very flexible system.

Pattern VEPs

The pattern generator is a very powerful graphics card installed in the console (option) with built-in CPU and memory and incorporating 8-15 bit output DACs for proper luminance correction. It produces the standard ISCEV pattern VEP and ERG stimuli including checkerboards, bars and gratings at various orientations and colors. Because the card is programmable, the range of check sizes, grating spatial frequencies, patch sizes are only limited by the display resolution being used. The program calculates all sizes to the

Flash ERGs

The ColorBurst and ColorDome stimulators are designed to produce output

ERG Parameters

for both ERGs and EOGs and incorporate 4 rings of red, green, blue, (Amber-ColorDome only) LEDs producing at least a 6 log luminance range. Colors can be defined in one of several color spaces including CIE, RGB, LUV and HSV. Luminance values can be set in both Scotopic and Photopic units and are calibrated in cd/m^2 and cd.s/m^2 for flashes. Flash on times can be defined from less than 4 ms to 1 sec for On/Off tests. The software can also be set to produce one or more single flashes in a row with variable timing between them or flash trains for 30Hz flicker type tests. Both stimulators support definable waveform luminance intensities for sinusoidal, ramp, and exponential variation.
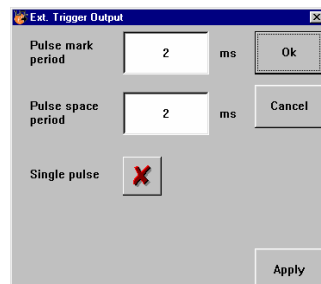
- Scotopic/Photopic units
- User definable flash colors
- 3000cd.s/m^2 down to scotopic threshold
- Multiple (double) flashes with selectable inter-flash timing
- Flashes superimposed on or replacing the background
- On/Off flash timing from 4ms to 10s
- Luminance waveforms supported including ramp, sine, exponential.
- Background color and luminance user definable
- Fixation/EOG LEDs with variable intensity

nearest pixel based on patient viewing distance. This applies equally to temporal frequencies including onset/offset times. Stimuli can be shown full screen or in a window with adjustable shape, size, and position surrounded by mean luminance. Stimulus colors can be adjusted to be anything within the monitor's color gamut and as it is fully calibrated the stimulus luminance control is very precise. This precision allows for iso-luminance stimuli as well as accurate low contrast levels suitable for contrast sensitivity tests.

- 8-15 bit luminance control
- Fully gamma corrected
- User selectable colors with an indication of maximum luminance obtainable
- Mono or iso-luminance stimuli
- High resolution contrast control
- Temporal frequency resolution to 10ms (@100Hz) including variable onset/offset times
- Triggers either frame locked or non-frame locked to reduce any monitor pickup
- Selectable viewing distances
- Fixation points includes cross, square, circle and countdown for patient reference
- Spatial freq. set to nearest pixel
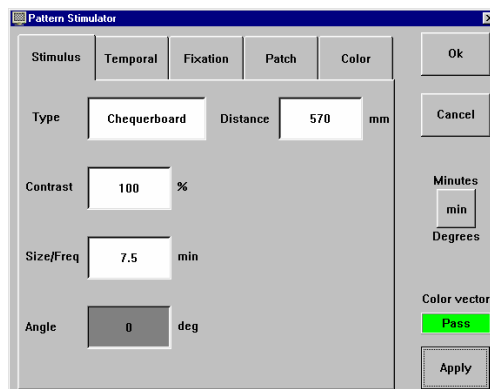- Supports different monitor

External Trigger

The system can trigger external equipment (e.g. Grass PS33) with a TTL pulse or series of pulses. The pulse on (mark) and off (space) times can be configured with ms accuracy.

External Trigger parameters

- TTL pulse
- Pulse mark and space times adjustable with ms accuracy
- Single pulse or pulse train

Pattern Stimulator Parameters

Input Trigger

The system can accept TTL triggers from external equipment to start the acquisition or even trigger when edges are detected on one of the channel inputs.

- Accepts digital TTL triggers from 3rd party equipment
- Trigger from an analog edge on one of the input channels
- Selectable slew rate on analog trigger for positive or negative edge detection
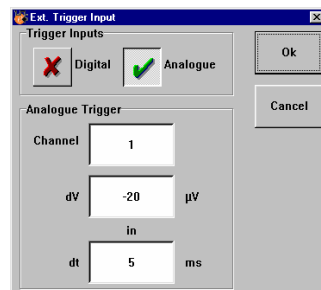
Input Trigger Parameters

Running a Test

Once a patient and protocol have been selected, the next stage is to run the test. The actual screen layout, colors used, printing options are dependent on the type of test being performed. During a test, parameters in individual steps parameters may be changed and even new steps created to extend stimulus sequences etc. The VERP/ERG/EOG display is made up of two sets of buttons; those at the top effect display and normally produce a separate window with additional functionality and those at the bottom control the running of the test. The program not only records the averages or results of each individual stimulus, but also records all the individual trials that make up the average. This facility means trials can be further manually rejected as desired. if more than one result is obtained for any stimulus, an average of averages can be generated to further enhance the record.
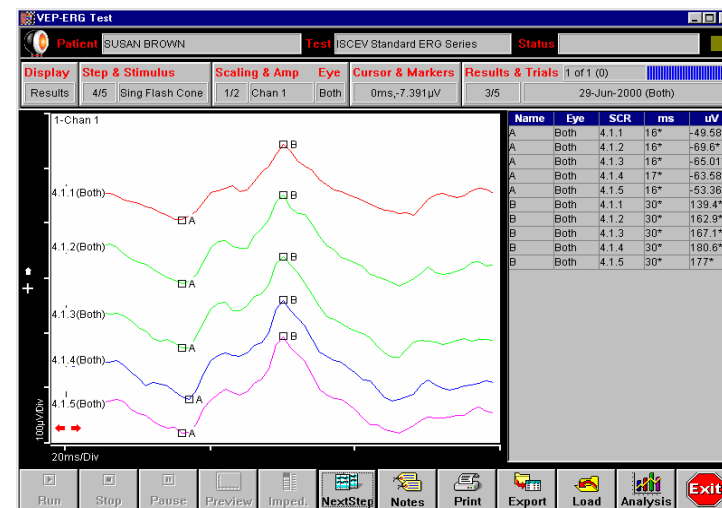
display menu

Displaying Data

Before a result is collected, it is advisable to check the current inputs to make sure they look acceptable. The software not only allows the inputs to be previewed before running, it also allows the test to be paused at anytime whilst still displaying incoming data for real-time feedback. During the test, the current recorded data is superimposed on the building average and the average may be in its turn superimposed on any previous averages already recorded. This gives instant feedback on the quality of the new result before it has finished.

Comparing Results

The software has very powerful overlay and separate facilities. It is possible to overlay one or more results for a particular step to check on reproducibility, to overlay results from different steps to examine trends and also to overlay results from different channels to compare left-right eye results for example. Not only overlaying of results but also automatic separation are built in to spatially separate them for better cross analysis and display. Individual results can be dragged around the screen just by pointing and dragging. To make things even clearer, Individual result colors can be changed and traces turned on and off.

Measuring Impedance

To produce the biggest signals with the least unwanted noise any

amplifier requires both its inputs not only have a low but also equal impedances. This last point is very important as the common mode rejection (CMRR) of the amplifier is reduced significantly when not in balance. A low CMRR means the amplifier is adversely effected by large voltages superimposed on both inputs such as mains pickup. Unlike many other systems, the Espion as well as measuring each electrode's impedance directly, also measures
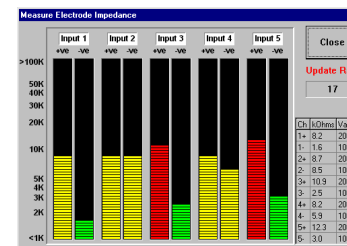
Impedance Measurement

and displays all current electrode impedances simultaneously. This not only pinpoints the electrodes with bad skin contact, it also graphically displays the impedance balance between amplifier inputs allowing the impedance matching to be improved increasing the amplifier's CMRR. All this is achieved with an impedance current of less than 300nA.

Printing Data

The program can print the results of any step or all steps, and the user can select various options to control the actual printed output. These options include:

- Graphs
- The marker values in table form
- Step parameters
- Notes

the graphical output is based on the current display (WYSIWYG) and like most serious programs, a print preview feature is included to

Main VEP/ERG Display

reduce time and paper wastage.

Exporting Data

Once the data has been collected it can be saved into the database for later retrieval or exported to other applications for further analysis e.g. Microsoft Excel or SigmaPlot. This can be achieved by saving the data to a file in ASCII form or using the Windows graphical metafile format via the clipboard for cutting and pasting. Full control is provided in selecting which bits of the data are actually exported including results, trials, marker values and other useful information.

Measurement of Peaks/Troughs

Each protocol can incorporate a complete set of markers which are positioned on each new result automatically. These markers once positioned can easily be moved for more precise alignment as determined by the practitioner and new ones can be created, modified or deleted as required. For quick measurements, a cursor may be positioned on any result indicating period and amplitude either relative to the zero point or to another arbitrary defined position.

Data Analysis

EOG data is displayed as it is recorded, and at the end of the test, the Arden ratio is calculated automatically. Other forms of analysis including RMS voltage are included as standard.

Tests

- Impedance measurement of electrodes simultaneously
- Extremely low impedance current
- Automatic
- Print Preview option
- WYSIWYG printing
- Export of data in ASCII format
- Automatic markers
- Overlaying data for comparative purposes
- Comprehensive analysis
- Ability to attach user notes

Stimuli

- Fully programmable
- External stimulators triggered
- Monochrome and colored stimuli
- Single/multiple flashes
- Pulse, sine, exponential and ramp waveforms
- LED flash technology
- Luminance and color calibrated using international standards
- Luminance entered in standard Units not dB
- Scotopic/Photopic units for luminance selection
- Checkerboards, bars and gratings standard
- Iso-luminance displays
- Custom stimuli
- Dual stimulator control simultaneously