Electroretinography Measuring Position with Variable Stimulation Programs

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Figure 1: ERG Measuring Position

Category:
Biomedical

Products Used:
LabVIEW™
DAQCard™ 516

The Challenge:
Measuring ERG-potentials in time determined stimulation.

The Solution:
Using LabVIEW 5.0.1 and PCMCIA DAQCard 516 with multithreading technology.

Introduction
The electroretinography (ERG) is one of the most frequently used visual electrodiagnostic tests of retinal function. The ERG is easily measured, but there are many engineering difficulties in processing the signal data because the response amplitudes are relatively small, and the relevant signals are buried in electromagnetic and biologic noise. Therefore it is important that the responses are displayed promptly in a virtual instrument so the operator can continuously monitor stability, and make adjustments during the test procedure. The described system is used to detect retinal alteration (side effects) after drug application in laboratory animals.

System Hardware
The measuring position (Figure 1) consists of:
- Manipulator for reliable application of electrodes to the eyes of a laboratory animal
- Physiological amplifier
- Pentium 166 notebook with 16 Mbyte of RAM
- PC Card 516 for analogue DAQ and control of stimulators (flash apparatus or LED0

- Testing apparatus to check all system function without laboratory animals – it consists of a photocell with integrated linear amplifier, battery and resistors, connected to the input of the physiological amplifier

The ERG was recorded at the surface of the cornea via the loop of a platinum wire (diameter 0.25 mm) and a reference needle platinum electrode between the eyes. The ground was placed at the ear. The electrodes are shortly connected with the differential input of the physiological amplifier.

      Input voltage; 0.1- 1.0 mV
      Band-Pass: 0.03 – 1,000Hz
      Input impedance: 1 Mohm
      Gain: 100, 1,000, 10,000

System Software
Windows 95
LabVIEW 5.0.1
Application Builder

There are two independent stand-alone programs for data acquisition and analysis. Features of acquisition software:
- Controls to select the gain of physiological amplifier and to select the stimulation program
- Start the acquisition and display the recorded ERG
- Save the recorded ERG with predefined names to spreadsheet file

Features of analysis software:
- Read and display the spreadsheet file in a graph
- Detect character points
- Send the results to Excel

Figure 2 shows a typical example for the ERG recording over 1,000 scans equal to 1,000 ms. The acquisition time depends on the selected stimulation program (1-40 sec.). 50 ms delay between start of analogue in and digital out (plus width 1 ms) triggers flash.

The response signal (A-wave of the ERG) is delayed 5ms to the flash. Therefore it is essential to have a deterministic control for the execution of In/Out operations to keep the stimulation times.
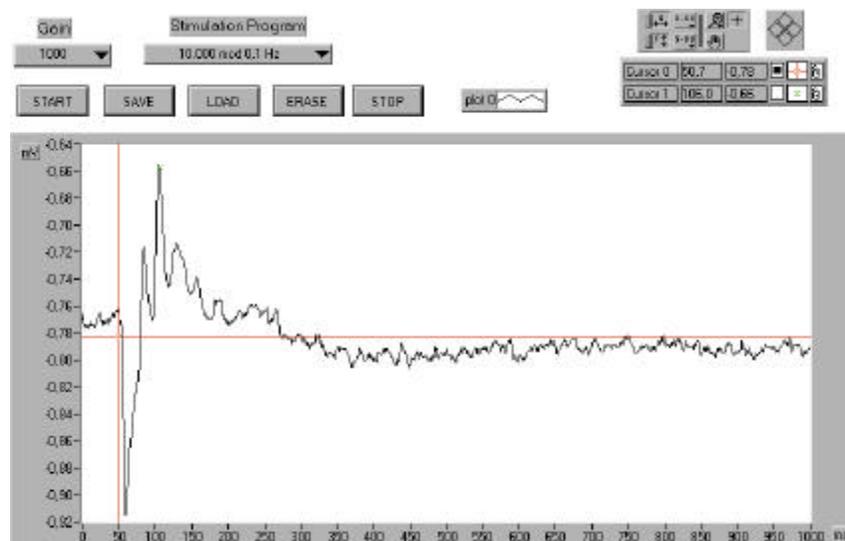

Figure 2: Example for an ERG Recording

Figure 3: Sequence to Create Pulse Trains and Delays in ms-Range

Software Methods

To generate pulse trains in Windows Operating Systems, hardware counter/timers are generally required. The presented example solves the problem by deterministic control of subVIs in ms-range using multi threading technology in LabVIEW 5.0.1.

Figure 3: Basic Example:

Sequence 1 – delay between start of DAQ and digital out trigger
Sequence 3 – delay to generate pulse width

As a result the complicated programming of the hardware counter (82C54) on DAQ Card 516 is cancelled. The structure of the program becomes simpler and is arranged more clearly. The compliance with the given times is realized if the time-critical VIs are allocated with high priority (time critical/data acquisition) by the use of the VI setup panel. On the other hand Wait functions are used to make less important tasks execute less frequently. A wait of 300 ms to poll the user interface frees up the application to handle the time-critical I/O operations by the demanded precision. In addition, it frees up the operating system so it has more time to devote to other applications for example Dynamic Data Exchange to EXCEL.

Conclusion and Preview

The transparency of programming by LabVIEW and the serviceability result in a high acceptance by the physicians. The demands on the ERG system are constantly changing, but with LabVIEW we can easily modify the measuring position. For example: using a full-field (ganzfeld) dome stimulator makes it necessary to add a second PCMCIA card (Dio-24). The possible stimulation of both eyes leads to 2-channel analogue DAQ. Because of the modular nature of LabVIEW-based software, we can quickly develop variable stimulation programs with new features.

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