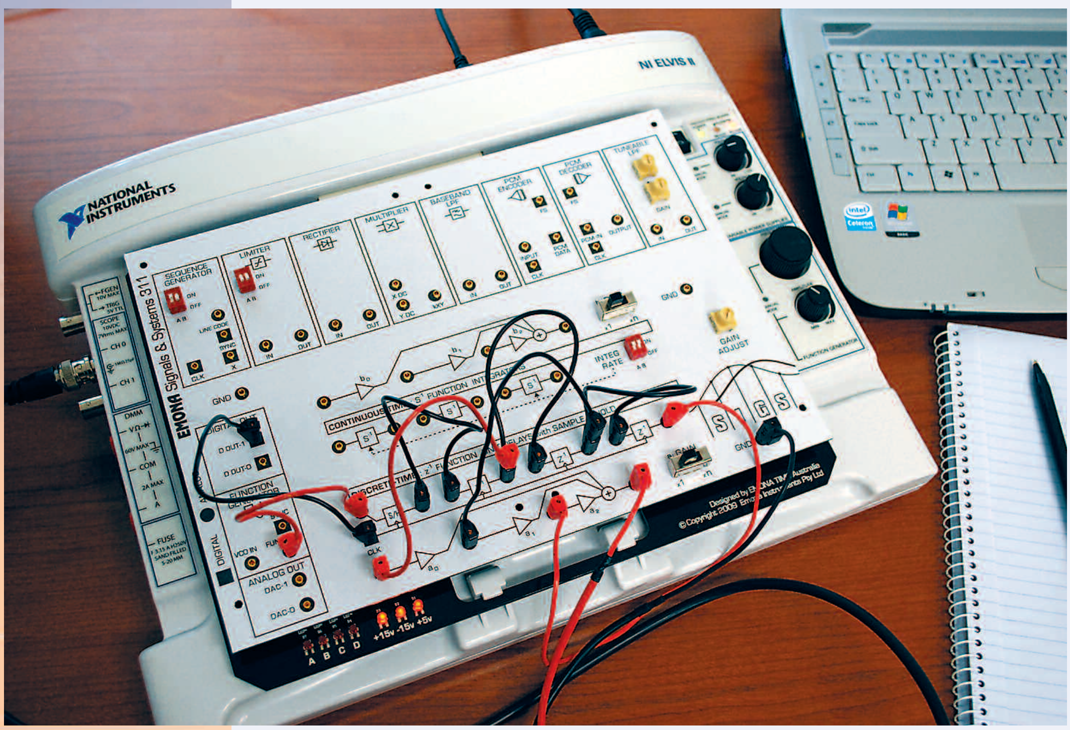
EMONA SIGNAL PROCESSING EXPERIMENTER FOR NI ELVIS™

Hands-on Signal Processing
and Signals & Systems Experiments
for the NI ELVIS™, fully integrated with NI LabVIEW™



EMONA SIGEx

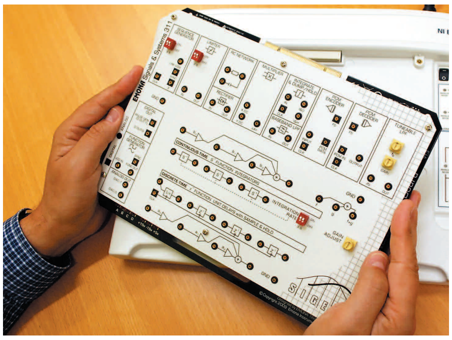
EMONA INSTRUMENTS
www.emona-tims.com

SHOW STUDENTS LAPLACE & Z-TRANSFORM MATH IN THE REAL WORLD

The Emona SIGEx-311 add-on board for the NI ELVIS II/+ enables students to patch together continuous time and discrete-time systems in real hardware, for circuit theory, digital signal processing and signals & systems courses.

The Emona SIGEx-311 Signal Systems Experimenter for NI ELVIS II/+ makes it possible for students to experience at first hand the **interaction between the theory and mathematics** of the digital signal processing, circuit analysis and signals and systems textbooks, with the real world of hardware and of signals in wires and waves.

The accompanying 16 experiment Lab Manual covers introductory level experiments, designed to provide hands on exercises covering most of the key concepts and challenges in an **undergraduate Signal Processing and Signals & Systems courses**.



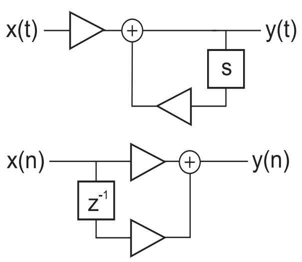
SIGEx-311 Lab Manual Experiments

The SIGEx experiment manual is designed to provide a practical "**hands-on**", **experiential, lab-based component** to the theoretical work presented in lectures on the topics typically covered in introductory signals courses for engineering students.

Whilst the experiments are predominantly focused on all electrical engineering students, this material is not only for electrical engineers. With an understanding of differential equations, algebra of complex numbers and basic systems theory, engineering students in general can reinforce their understanding of these important foundational principles through practical laboratory course work where they see the **"math come alive" in real circuit based signals**. This provides a foundation for further study of communications, control, and systems engineering in general.

Students take responsibility for the construction of the experiments and "learning by doing" to consolidate their knowledge of the underpinning theory, which at times is particularly **abstract and hard to grasp** for these early engineering students. They are not constrained by the software and need to be systematic in debugging their own systems when results do not meet their expectations.

The common reaction of early students when confronted with "Complex Analysis" is one of confusion and regression to "rote-learning" in order to survive the examination process. This manual has as its predominant aim to create real, "hands-on" implementation of the theory, in such a way that the student can directly articulate and **connect the mathematical abstractions with real world implementations**. It is a journey of personal discovery where the motto is "why is it so ?"



Examples of 1st order filters. 2nd order filters are also investigated.

SIGEx-311 Lab Manual Experiments- Vol.1*

Lab 1: Introduction to the NI ELVIS II/+
Lab 2: Introduction to the SIGEx board
Lab 3: Special signals – characteristics and applications
Lab 4: Systems: Linear and non-linear
Lab 5: Unraveling convolution
Lab 6: Integration, convolution, correlation & matched filters
Lab 7: Exploring complex numbers and exponentials
Lab 8: Build a Fourier series analyzer
Lab 9: Spectrum analysis of various signals
Lab 10: Time domain analysis of RC networks
Lab 11: Poles and zeros in Laplace domain
Lab 12: Sampling and Aliasing
Lab 13: Getting started with analog-to-digital conversion
Lab 14: Discrete-time filters – FIR
Lab 15: Poles and zeros in the z-plane: IIR forms
Lab 16: Discrete-time filters – practical applications
App A: SIGEx Lab to Textbook chapter table

Students implement experiments by patching together functional blocks - such as samplers, filters, independent adders, integrators, unit delays, etc. Therefore, the SIGEx-311 hardware, and lab manual experiments, can easily be integrated or adapted to suit your current signals and systems courses and text books.

* Volume 2 to be released in due course.

REAL HARDWARE FUNCTIONAL BLOCKS - FULLY INTEGRATED WITH NI ELVIS™

A Complete Suite of Signals & Systems Functional Blocks

The SIGEx-311 board includes all of the functional blocks - integrators, sample-and-hold, unit delays and supporting blocks - required for all experiments, as well as access to powerful instruments from NI ELVIS™.

A selection of independent functional SYSTEM blocks

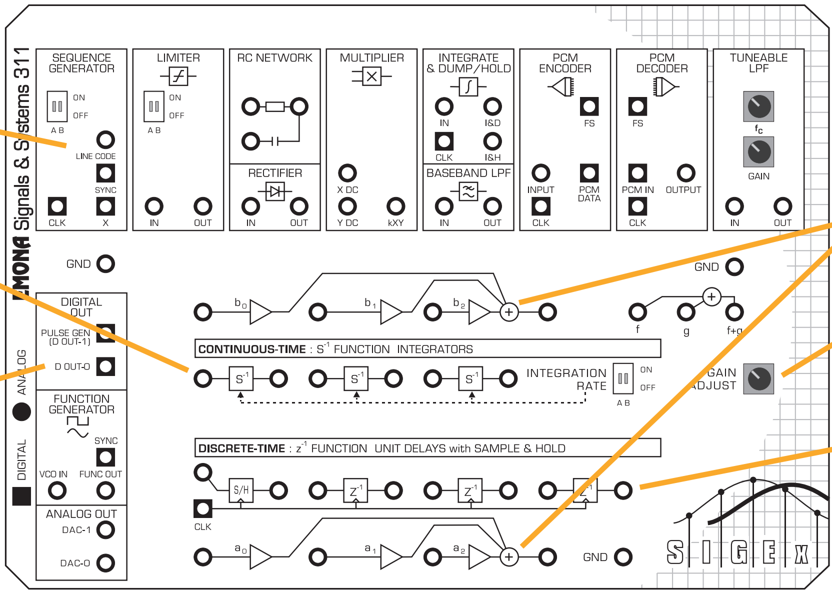
Three 1/s functions

Access to NI ELVIS instruments, including
- Clock generator
- Function generator
- Dual ARB generator

Three input ADDERS with user adjustable gains

Manual adjustment of on-screen ADDER gain values

Three UNIT DELAYS, preceded by a SAMPLE & HOLD



SIGEx add-on board for the NI ELVIS™ platform

SIGEx SOFT FRONT PANEL

Complete Signals & Systems Experiment Integration with NI ELVIS™ and NI LabVIEW™

The SIGEx-311 utilizes the virtual instrumentation and programmable functionality of NI ELVIS™ II/+. Students actually build each experiment by patching together the experiment structures, and set gains and parameters via the SIGEx-311 Soft Front Panel, running under NI LabVIEW™.

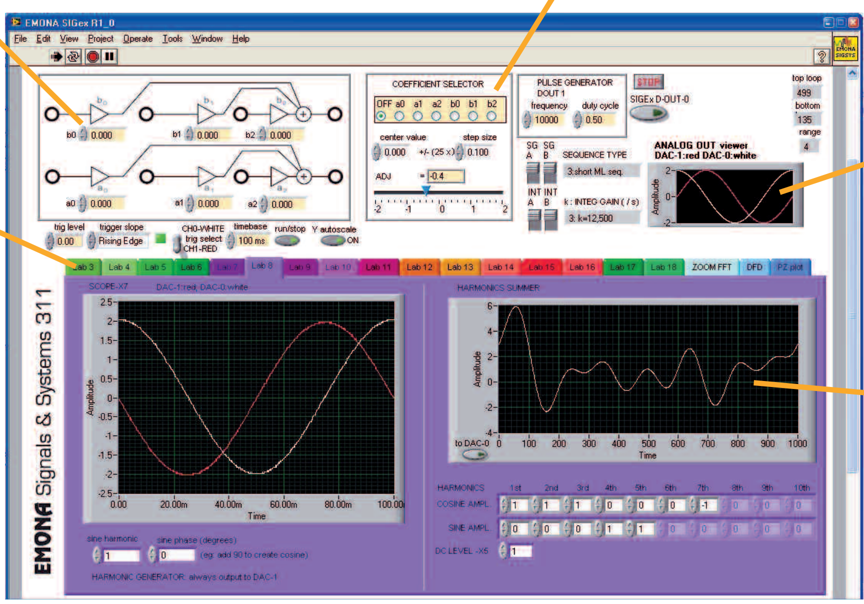
Adjustable gains of the hardware ADDERS

Fine tune control of the manual GAIN ADJUST

Custom experiment instrumentation is selected via each TAB

Handy viewer displays the ARB generator output waveforms

Time and Frequency displays built-in for viewing real signals



SIGEx Soft Front Panel

SIGEx Experiments-to-Textbooks Comparison

This table aims to direct users to sections of commonly available text books which contain theory and exercises related to experiments currently documented and implemented with the SIGEx/NI ELVIS bundle. Given that SIGEx is by design an open-ended modeling system it is possible to build many more experiments than is currently documented.

SIGEx Lab Manual Experiments	Lathi.B.P., "Signal Processing & Linear Systems", Oxford University Press	Oppenheim.A.V., Wilsky.A.S., "Signals & Systems", Prentice Hall, 2nd edition	Ziemer.R.E, Tranter.W.H, Fannin.D.R, "Signals & Systems : Continuous & Discrete", Prentice Hall, 4th edition	McClellan.J.H, Schafer, R.W., Yoder.M.A.: "DSP First", Prentice Hall
Lab 03: Special signals – characteristics and applications	1 Introduction to Signals and Systems B.2 Sinusoids 2.4 System response to external input: zero-state response	1 Signals and Systems	1-3 Signal models	1 Mathematical representation of signals
Lab 04: Systems: Linear and non-linear	1 Introduction to Signals and Systems	1 Signals and Systems 2 Linear time-invariant systems	2-2 Properties of systems	2 Thinking about systems
Lab 05: Unraveling convolution	9.4-1 Graphical procedure for the convolution sum	2.1 Discrete-time LTI systems: The convolution sum	8-4 Difference equations and discrete-time systems; Example 8-12 Discrete convolution; 10-6 Convolution	5.3.3 Convolution and FIR filters
Lab 06: Integration, convolution, correlation & matched filters	2.4-1 The convolution integral 3.2 Signal comparison: Correlation	2.2 Continuous-time LTI systems: The convolution integral 2 Linear time-invariant systems;	10-6 Energy spectral density and autocorrelation function	5.6 Convolution and LTI systems
Lab 07: Exploring complex numbers and exponentials	B.1 Complex numbers B.3-1 Monotonic exponentials B.3-2 The exponentially varying sinusoid	1 Signal and systems: Math review 1.3 Exponentials and sinusoidals	1-3 Phasor signals and spectra	2.5 Complex exponentials and phasors
Lab 08: Build a Fourier series analyzer	3.4 Trigonometric fourier series	3.3 Fourier series representation of continuous-time periodic signals	3-3 Trigonometric Fourier series representations for periodic signals 3-4 The complex exponential Fourier series	3.4.1 Fourier series analysis
Lab 09: Spectrum analysis of various signal types	4 Continuous-time signal analysis: The fourier transform	4.1.3 Examples of Continuous-Time Fourier transforms	4.5 Fourier transform theorems	3 Spectrum representation
Lab 10: Time domain analysis of an RC circuit	1.8 System model: Input-output description	3.10.1 A simple RC lowpass filter 3.10.2 A simple RC highpass filter	2-2:2-7 System modeling concepts 6-2 Network analysis using the Laplace transform	-
Lab 11: Poles and zeros in the Laplace domain	6 Continuous-time system analysis using the Laplace transform	9 The Laplace transform 9.4 Geometric evaluation of the Fourier trans. from the pole-zero plot	6-4 Transfer functions	-
Lab 12: Sampling and Aliasing	5 Sampling 8.3 Sampling continuous-time sinusoid and aliasing	7 Sampling	8-2 Sampling 8-2 Impulse-train sampling model	4 Sampling and aliasing
Lab 13: Getting started with analog-digital conversion	5.1-3 Applications of the sampling theorem (Pulse code modulation PCM)	8.6.3 Digital Pulse-Amplitude (PAM) and Pulse-Code modulation (PCM)	8-2 Quantizing and encoding	4.4 Discrete to continuous conversion
Lab 14: Discrete-time filters with FIR systems	11 Discrete-time system analysis using the z-transform; 12.1 Freq response of discrete-time systems; 12.2 Freq response from pole-zero location	6.6 First-order and second-order discrete time systems 6.7.2 Examples of discrete-time nonrecursive filters	9-5 Design of finite-duration impulse response (FIR) digital filters	5 FIR filters
Lab 15: Poles and zeros in the z plane with IIR systems	12 Frequency response and digital filters	10.4 Geometric eval. of the Fourier transform from the pole-zero plot	9-4 Infinite Impulse Response (IIR) filter design	8 IIR filters
Lab 16: Discrete-time filters – issues in practical applications	-	-	9-2 Structures of digital processors	8 IIR filters

ERRORS and OMISSIONS EXCEPTED. The above comparison table is intended as an approximate guide and does not imply endorsement of the authors or publishers.

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