tims

Telecommunications Signals & Systems Lab Equipment

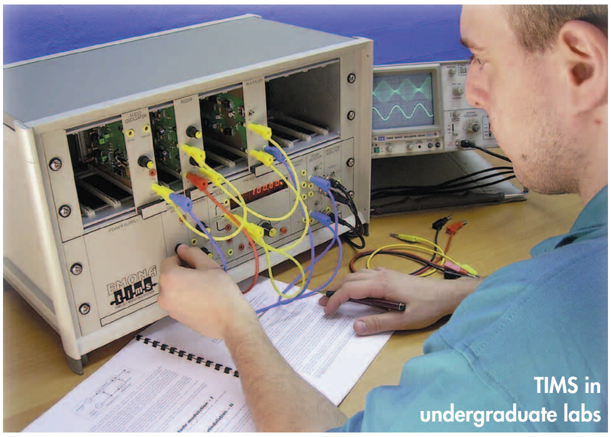
FIBER OPTICS
SIGNALS & SYSTEMS
TELECOMMUNICATIONS LAB EXPERIMENTS
SOFTWARE
STUDENT PROJECTS
DSP

Telecommunications Theory and Math by Building Experiments at the Block Diagram Level

EMONA INSTRUMENTS
www.tims.com.au

TIMS is laboratory teaching hardware for courses in - Wireless, Digital Communications, Fiber Optics and Signals & Systems.

TIMS, Telecommunications Instructional Modeling System, is laboratory teaching equipment for EE and EET students in wireless, telecommunications and signal processing courses.

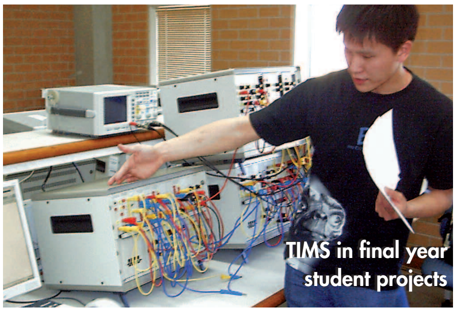

TIMS in undergraduate labs

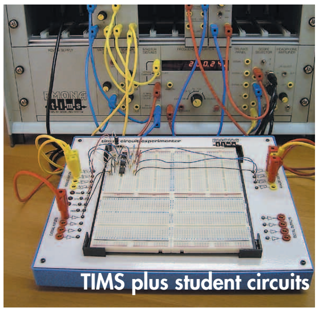
TIMS has the distinction of being the only telecommunications lab equipment that can implement practically any form of modulation or coding - keeping pace with the rapid development of telecommunications theory.

• OPEN ENDED ARCHITECTURE
As TIMS is an open-ended architecture system, it has always and will continue to have the capacity to implement the very latest developments in digital and analog modulation and coding.

• SELF CONTAINED
TIMS is self contained requiring only an additional oscilloscope.

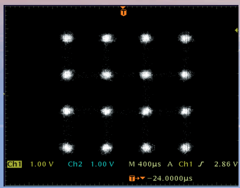
• PC-INTERFACE - INSTRUMENTATION, LabVIEW™ and MATLAB™
As well, TIMS can interface to a PC providing data acquisition and spectrum analysis facilities and a range of supporting math applications.

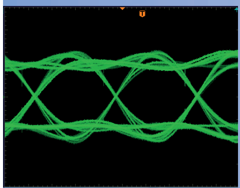

TIMS in final year student projects

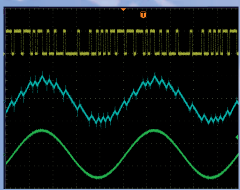

TIMS plus student circuits

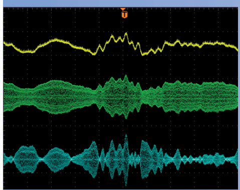
TIMS is a 'hands-on' lab system where engineering students learn mathematics "by-doing" - through practical experience.

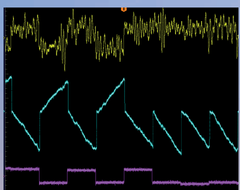
EXAMPLES OF ACTUAL TIMS WAVEFORMS

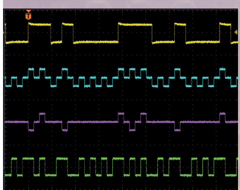

16-QAM

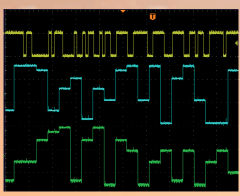

Eye Patterns

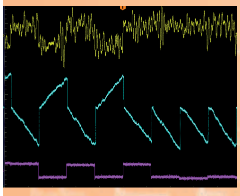

Delta Modulation

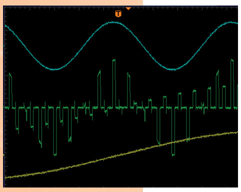

Speech AM & DSB

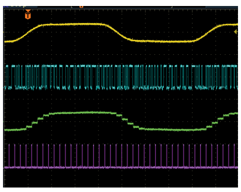

Integrate & Dump

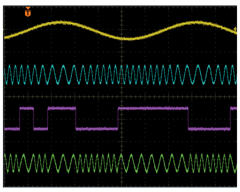

Line Code Encodes

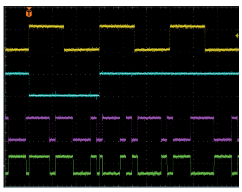

Multi-Level I & Q Signals


Matched Filter


PAM & TDM


PCM


FM and PM


DSSS

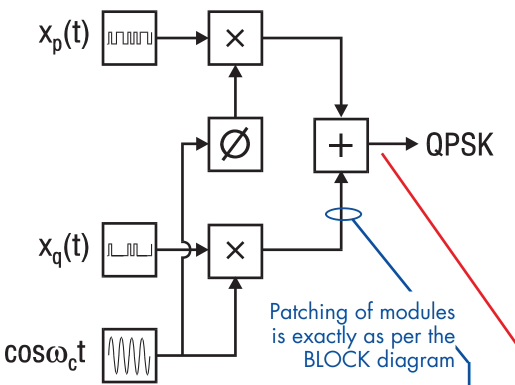
TIMS can implement practically any modulation or coding technique with its modeling approach.

$$x_p\,(t).\cos\omega_c\,t + x_q\,(t).\sin\omega_c\,t = QPSK$$

where $x_p\,(t)$ and $x_q\,(t)$ are alternate elements of a digital sequence.

START WITH MATH OR THEORY

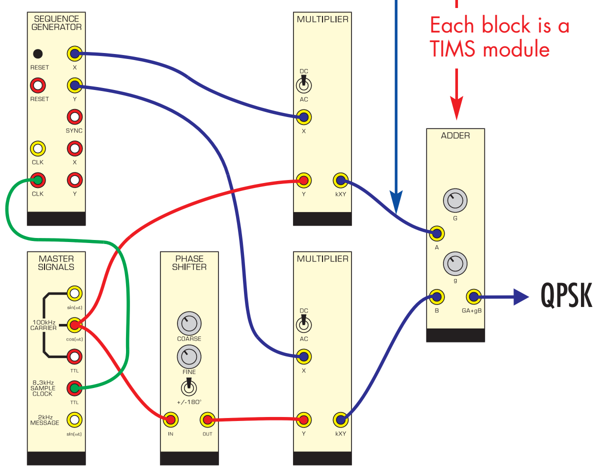
Telecommunications text books are a source of equations and theories. This is the starting point for a TIMS experiment.



REPRESENT IT AS A BLOCK DIAGRAM

In telecommunications, Math and Theory is always expressed in the universal language of BLOCK DIAGRAMS.

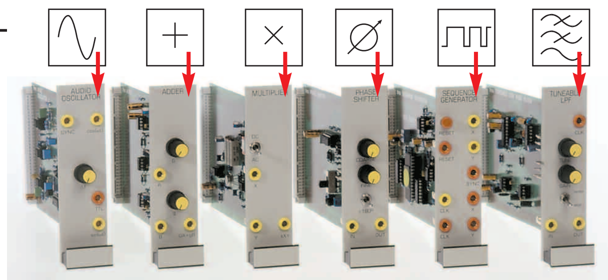
Telecommunications engineers make sense of math and theory through BLOCK DIAGRAMS.



BUILD IT USING TIMS MODULES

TIMS realises telecommunications BLOCK DIAGRAMS with real circuits - and provides students with **real time signals**.

ONE MODULE FOR EACH BLOCK



TIMS is a true hardware math modeling system

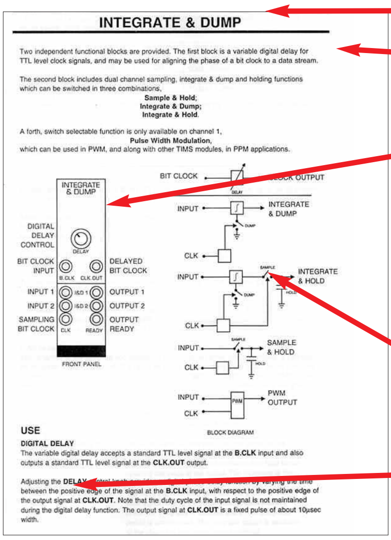
TIMS USER & EXPERIMENT MANUALS

Fully documented, turn-key solutions for your lab.

The experiment manuals supplied with TIMS provide a rich source of teaching resources, from introductory to advanced laboratory coursework. **TIMS includes five types of manuals.**

• USER MANUALS

All module capabilities and specifications are outlined in the TIMS User Manuals. Module descriptions are presented in a common format making it very easy for students to quickly grasp the use of any module.



Module name

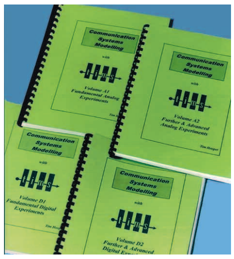
Concise description of module's function

Labelled front panel illustration

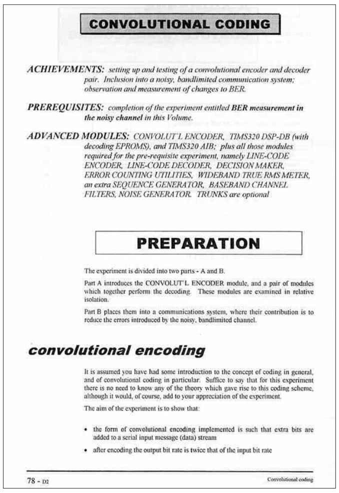
Labelled block diagrams

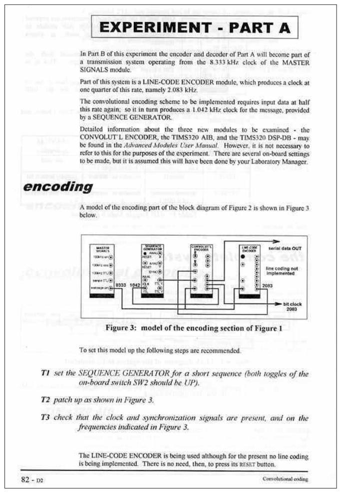
Detailed user information

• STUDENT TEXT EXPERIMENTS

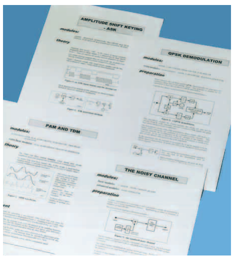


The five volume **TIMS Student Texts**, over 1,000 pages in total, provide an in-depth coverage of a broad range of wireless and telecom-munications experiments. Included is supporting theoretical information, detailed experimental instructions and challenging questions. Each chapter also includes a tutorial section.

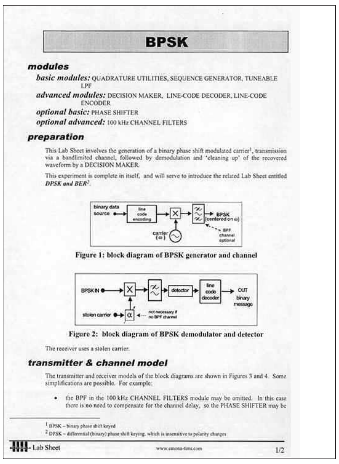


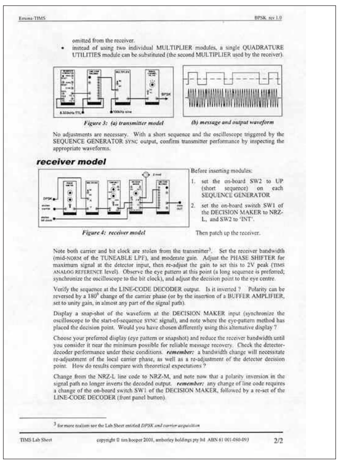


• LABSHEET EXPERIMENTS



TIMS LabSheet Experiments are a massive library of concise, single sheet experiments which provide a rich source of experiment ideas and serve to provide an accelerated familiarization for newcomers to the TIMS modeling environment.

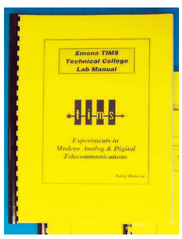




• SIGNALS & SYSTEMS EXPERIMENTS MANUAL

The **TIMS Signals & Systems Experiments Manual** makes it possible for students to experience at first hand the interaction between the theory and mathematics of the signals and systems textbook with the real world of hardware and of signals in wires and waves. In this first volume, catering for the introductory level, experiments have been designed to provide hands-on exercises covering most of the key concepts and challenges.

• TECHNICAL COLLEGE LAB MANUAL



The Emona TIMS **Technical College Lab Manual** presents TIMS telecommunications systems experiments in a carefully paced manner, aimed at younger students who do not have a university-level grounding in mathematics.

19 chapters range in topics from introduction to modelling equations, analog & digital modulation, through to CDMA fundamentals.

TIMS IMPLEMENTS ALL OF THIS AND MORE

Select your curriculum from the experiment list below.

TIMS DOCUMENTED EXPERIMENTS:

- ❒ Adaptive Delta Modulation
- ❒ AM - Amplitude Modulation
- ❒ AM - Amplitude Modulation II
- ❒ Amplifier Overload
- ❒ Armstrong's Phase Modulator
- ❒ ASK - Introduction
- ❒ ASK - Demodulation Advanced
- ❒ ASK - Generation Advanced

- ❒ Baseline Wander and Line Coding
- ❒ BER Instrumentation
- ❒ BER Measurement - Introduction
- ❒ Bit Clock Regeneration
- ❒ Block Coding and Decoding
- ❒ Block Coding Gain
- ❒ Block Coding - error correcting
- ❒ BPSK - Introduction
- ❒ BPSK - Demodulation Advanced
- ❒ BPSK - Modulation Advanced
- ❒ BPSK and BER
- ❒ Broadcasting

- ❒ Carrier Acquisition - PLL
- ❒ CDMA - 2 Channel
- ❒ CDMA - Introduction
- ❒ CDMA - Multichannel
- ❒ CDMA - Processing Gain
- ❒ CDMA at Carrier Frequencies
- ❒ Complex Analog Messages
- ❒ Convolutional Coding
- ❒ Costas Loop

- ❒ Delta Demodulation
- ❒ Delta Modulation
- ❒ Delta-sigma Modulation
- ❒ Digital Signal Recovery with the Decision Maker
- ❒ Digital Noise in Baseband & Block Coded Channels
- ❒ DPSK and BER
- ❒ DPSK and Carrier Acquisition
- ❒ DSBSC - Generation
- ❒ DSSS - Spread Spectrum

- ❒ Envelope Detection
- ❒ Envelopes
- ❒ Equalization for ISI
- ❒ Eye Patterns
- ❒ Eye Patterns & BER

- ❒ FDM - Frequency Division Multiplex
- ❒ FHSS: Fast & Slow Hopping
- ❒ FHSS and Bit Error Rate Performance
- ❒ FHSS: Hybrid DSSS/FHSS System
- ❒ Fiber Optic Transmission, Splitting and Combining
- ❒ Fiber Optic - Bidirectional Transmission
- ❒ Fiber Optic - WDM Transmission
- ❒ FM - Demodulation by PLL
- ❒ FM - Demodulation by Zero Crossing Counting
- ❒ FM - Deviation Multiplication
- ❒ FM, Wideband - Generation by VCO
- ❒ FM - Synchronous Demodulation
- ❒ FM and Bessel Zeros
- ❒ Frequency Synthesis with the PLL
- ❒ FSK - Envelope Demodulation
- ❒ FSK - Generation

- ❒ Intro to DSP: Analog & Digital Implementations
- ❒ Introduction to TIMS
- ❒ GFSK - Gaussian FSK
- ❒ ISB - Independent Sideband
- ❒ ISI: PAM & ASK over band-limited channels

- ❒ Line-Coding & Decoding

- ❒ Matched Filter Detection
- ❒ MSK, OQPSK, π/4-QPSK,π/4-DQPSK
- ❒ Modeling Equations
- ❒ Modem: Binary Data via Voiceband
- ❒ Modem: Multi-Level Data via Voiceband
- ❒ Modem: Data Rates & Voiceband Modems -TX
- ❒ Modem: Data Rates & Voiceband Modems -RX
- ❒ Multi-channel Digital Fiber Link
- ❒ Multi-level QAM & PSK

- ❒ Noisy Channel
- ❒ Noise Generation using Binary Sequences

- ❒ OFDM Principles - Introduction

- ❒ PAM & TDM
- ❒ PCM & Bit Clock Regeneration
- ❒ PCM Decoding
- ❒ PCM Encoding
- ❒ PCM TDM
- ❒ PCM-TDM 'T1' Implementation
- ❒ PDM - Phase Division Multiplex - Demodulation
- ❒ PDM - Phase Division Multiplex - Generation
- ❒ PLL - Phase Lock Loop
- ❒ Power Measurements
- ❒ PPM - Pulse Position Modulation
- ❒ PRBS Messages & Sequence Synchronization
- ❒ Product Demodulation
- ❒ Pulse Shaping - Introduction
- ❒ Pulse shaping for band-limited channels
- ❒ PWM - Pulse Width Modulation

- ❒ QAM - Demodulation
- ❒ QAM - Generation
- ❒ QAM and 4-PSK
- ❒ QASK - Modulation
- ❒ QASK - Demodulation
- ❒ QPSK - Generation
- ❒ QPSK - Demodulation

- ❒ Sampling & Reconstruction
- ❒ Sampling with Sample-&-Hold
- ❒ Signal Constellations 4/8/16QAM and 4/8/16PSK
- ❒ SNR in AM Demodulated Signals
- ❒ SNR performance of SSB and DSBSC
- ❒ SONET - TDM and Byte Interleave Mux
- ❒ SONET Data Frame
- ❒ SONET transmission via an optical link
- ❒ Spread Spectrum Principles
- ❒ Speech in Telecommunications
- ❒ SSB Demodulation
- ❒ SSB Generation
- ❒ SSB Linear Amplifier Measurements
- ❒ Superheterodyne
- ❒ System fault finding

- ❒ TCM - Coding Gain
- ❒ TCM - Trellis Coding
- ❒ TDM
- ❒ Timing jitter in Band Limited Channels
- ❒ Ultra Wide Band - Introduction to UWB Principles
- ❒ Unknown Signals - 1
- ❒ Wave Analyzer - Spectrum Analysis
- ❒ Weaver's SSB Demodulator
- ❒ Weaver's SSB Generator

SIGNALS & SYSTEMS EXPERIMENTS MANUAL:

- ❒ Special Signals - characteristics and applications
- ❒ Modeling Linear and Non-linear Systems with TIMS
- ❒ Unraveling Convolution
- ❒ Comparing Responses in the Time and Frequency Domains
- ❒ A Fourier Series Analyzer
- ❒ Spectrum Analysis of Various Signal Types
- ❒ Getting Started with Poles and Zeros in the Laplace Domain
- ❒ Sampling and Aliasing
- ❒ Getting Started with Analog-Digital Conversion
- ❒ Discrete-Time Filters - Finite Impulse Response
- ❒ Using Poles and Zeros in the z plane: Discrete-time Filters
- ❒ Discrete-time Filters - Practical

STUDENT PROJECT CAPABILITIES:

- ❒ Building electronic circuits with the **TIMS-820 Wire-wrapping Project Module**
- ❒ Implementing functions in a CPLD with the **TIMS-830 Programmable Digital Project Module**
- ❒ Solderless breadboarding of electronic circuits with the **TIMS-840 Circuit Experimenter**
- ❒ Programming DSP implementation with the **TIMS-DSP Module Set**

NOTE: This list is constantly expanding as new modules are released and new experiments are written.

TIMS PRODUCT RANGE

The TIMS block-diagram approach is implemented in TIMS hardware, software & via the internet hardware.

1. Emona TIMS Lab Hardware

TIMS-301 Hands-on lab hardware experiments

The **TIMS-301 System** is a true, real-time, hardware mathematical modeling system. TIMS is similar in concept to traditional "analog computers" with a high degree of specialisation to easily implement almost any analog or digital modulation, coding or signal processing scheme.

TIMS has the unique capacity to be continuously and inexpensively expanded to implement the very latest developments in telecommunications and signal theory.

The TIMS System is made up of different plug-in and fixed modules. The fixed modules are the most commonly used and are built into the TIMS-301 System Unit. The plug-in modules slide into the System Unit's rack (the top half of the System) and are selected according to the experiment you wish to implement.

Each TIMS plug-in module realises a fundamental telecommunications/signals building block and these blocks are used and re-used in different experiments. No single TIMS module is a complete experiment. TIMS modules include a wide variety of analog, digital and DSP building block functions.

Students quickly become familiar with the TIMS front panel conventions and are able to easily incorporate different modules into their experiments. This enables students to focus on learning and experiencing the mathematical and theoretical concepts which are often difficult to comprehend without actual hands-on experience through manipulation of real-world signals.

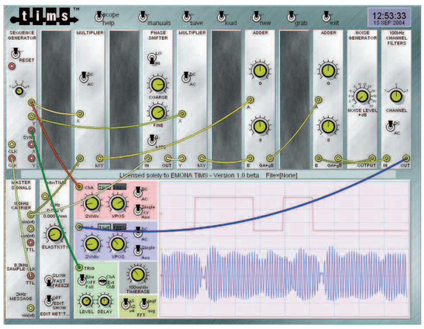
2. TutorTIMS - Simulation Software

TIMS Simulator for pre-lab learning

TutorTIMS is a TIMS telecommunications experiments simulator which looks just like the TIMS lab equipment.

All front panel controls *mimic* the TIMS lab hardware system, with true point-and-click technology. No programming or syntax entry is required. So students can start patching telecommunications experiments in minutes.

TutorTIMS is ideal for helping students prepare at home before attending hands-on labs at college.



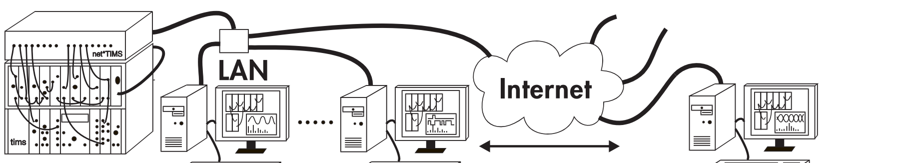
Three versions of TutorTIMS are available:

- **TutorTIMS-Advanced**
  Unlimited User, 25-User, 15-User, 5-User, 1-User, Annual 30-User via Internet access.
- **TutorTIMS-Basic** Unlimited User, and
- **TutorTIMS-FreeWare**
  Available as a free download at www.webtims.com

3. net*TIMS - TIMS Experiments via the Internet

Distance-learning hardware experiments

net*TIMS allows professors to set-up real TIMS telecommunications experiments in their own laboratory which many students can simultaneously access and control from within the lab and *at a distance* to carry out the experiments.



net*TIMS hardware experiment in the lab

Each student PC on the **LAN** has a unique student experiment session

Each student on the **INTERNET** has a unique student experiment session

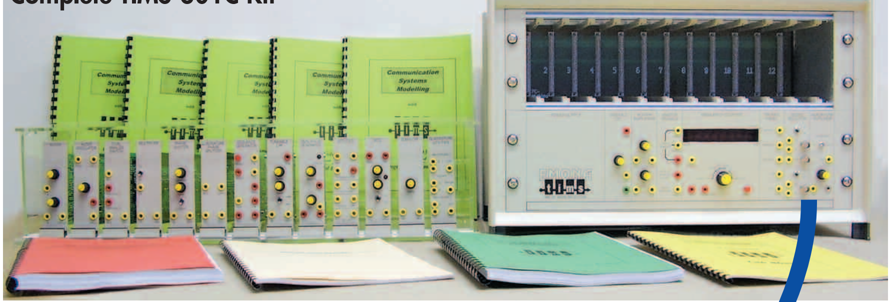
TIMS-301 SYSTEM UNIT and BASIC MODULE SET

TIMS-301/C BASIC SYSTEM

A convenient starting point. Includes the System Unit (FIXED modules) and the most useful set of multi-useable plug-in modules (BASIC Module Set)

The TIMS-301 and TIMS-301C kit includes:

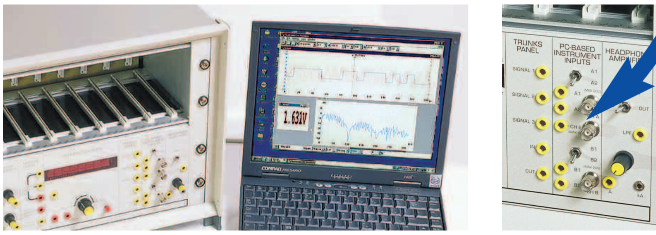
- The TIMS-301/C System Unit
- 13 plug-in modules of the BASIC Module SET (see BASIC module list below)
- User Manuals;
- Student Text experiment manuals
- LabSheet experiment manuals;
- Modules Storage Box
- Standard accessories



Complete TIMS-301C Kit

TIMS-301 and TIMS-301C

TIMS-301C has an in-built PC-Based, 2 channel scope and spectrum display (FFT) multi-instrument. Complete with PC software and cables. Requires an external PC (not included in TIMS-301C price).



TIMS-301C with built-in PC Instrumentation: LabVIEW™ and MATLAB™compatible

TIMS-301 SYSTEM UNIT with FIXED Modules

The FIXED MODULES are the most commonly used modules.

The TIMS-301 and 301C both include:

- **12-Slot Rack for plug-in modules**
- **Master Oscillators**
- **Buffer Amplifiers**
- **Frequency and Event Counter**
- **Variable DC Voltage Output**
- **Oscilloscope Display Selectors**
- **TIMS Trunks Outputs**
- **Power Supply**

The TIMS-301C also includes:

- **PC-based virtual instrument -** 2 channels plus trigger input, with wide bandwidth scope and spectrum analyzer displays, true RMS voltmeter and frequency counter.

TIMS-301 BASIC Module Set (PLUG-IN modules)

- TIMS-147 **Adder**
- TIMS-148 **Audio Oscillator**
- TIMS-149 **Dual Analog Switch**
- TIMS-150 **Multiplier**
- TIMS-151 **Phase Shifter**
- TIMS-152 **Quadrature Phase Splitter**
- TIMS-153 **Pseudorandom Sequence Generator**
- TIMS-154 **Tuneable Low Pass Filter**
- TIMS-155 **Twin Pulse Generator**
- TIMS-156 **Utilities**
- TIMS-157 **Voltage Controlled Oscillator**
- TIMS-158 **60kHz Low Pass Filter**
- TIMS-425 **Quadrature Utilities**

TIMS-301C EXPERIMENTS documented in the TIMS Experiment Manuals:

- Introduction to TIMS
- Modeling of math equations
- AM modulation (2 methods)
- Envelopes/envelope recovery
- DSBSC mod and demod
- SSB mod - phasing method
- SSB demod - phasing method
- Product demodulation
- Phase lock loop
- FM modulation & demod
- Armstrong's Phase modulator
- PAM generation
- TDM generation
- FDM generation or recovery
- PDM generation or recovery
- PWM mod and recovery
- Eye diagrams
- Introduction to Pulse shaping
- Noise generation
- Sampling Theorem and reconstruction
- QAM generation or demod
- BPSK mod and demodulation
- QPSK mod or demodulation
- ASK mod and demodulation
- QASK mod or demodulation
- FSK modulation (2 methods)
- Carrier acquisition - PLL
- Complex analog messages
- Spread spectrum generation

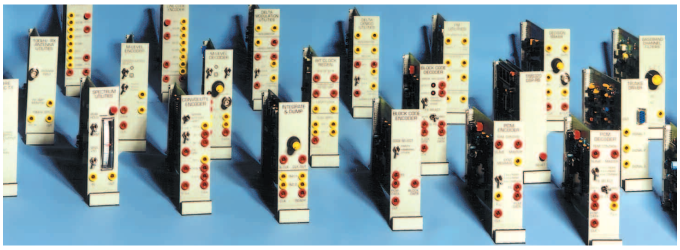
ORDERING INFORMATION:
TIMS-301 Standard System
or TIMS-301C PC-Enabled System

TIMS ADVANCED PLUG-IN MODULES (options)

A broad and growing range of additional TIMS Modules used for implementing any modulation or coding scheme.

TIMS ADVANCED modules include over 50 specialised building blocks to expand the range of analog, digital and digital signal processing (DSP) experiments. Student Project modules are also available for students to experiment with discrete electronic circuits and CPLD-based digital electronic implementation within telecommunications.

New ADVANCED modules are continuously being developed to include the latest developments in telecommunications and signal processing theory.



Advanced Modules Alphabetical List

- TIMS-410 **100kHz Channel Filters**
- TIMS-401 **Baseband Channel Filters**
- TIMS-420 **Bit Clock Regeneration**
- TIMS-414 **Block Code Encoder**
- TIMS-415 **Block Code Decoder**

- TIMS-427 **CDMA Encoder (Multi-Sequences Source)**
- TIMS-428 **CDMA Decoder**
- TIMS-840 **Circuit Experimenter**
- TIMS-416 **Convolutional Code Encoder**
- TIMS-417 **Convolutional Decoder Firmware**

- TIMS-402 **Decision-Maker Module**
- TIMS-403 **Delta Modulation Utilities**
- TIMS-404 **Delta Demodulation Utilities**
- TIMS-435 **Digital Channel Error Generator**
- TIMS-424 **Digital Utilities**
- TIMS-1050 **DSP-HS DSP Development Module**

- TIMS-405 **Error Counting Utilities**
- TIMS-240 **Expansion Rack**
- TIMS-210 **Extender Card**

- TIMS-505 **Fiber Optic Coupler**
- TIMS-503R **Fibre Optics Transmitter (red)**
- TIMS-503G **Fibre Optics Transmitter (green)**
- TIMS-504 **Fibre Optics Receiver**
- TIMS-506 **Fiber Optic WDM Filters**
- TIMS-421 **FM Utilities**
- TIMS-434 **Frequency Hop Spread Spectrum**

- TIMS-418 **Integrate & Dump, Sample & Hold**

- TIMS-436 **Laplace**
- TIMS-406 **Line-Code Encoder**
- TIMS-407 **Line-Code Decoder**

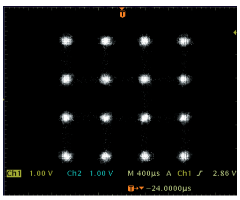
- TIMS-422 **M-Level Encoder**
- TIMS-423 **M-Level Decoder**
- NEW TIMS-438 **MSK,π/4-DQPSK,OQPSK Encoder** (& RRC)
- NEW TIMS-439 **MSK,π/4-DQPSK,OQPSK Decoder**
- TIMS-408 **Noise Generator**

- TIMS-412 **PCM Encoder**
- TIMS-413 **PCM Decoder**
- TIMS-250 **Perspex Module Storage Box**
- TIMS-830 **Programmable CPLD Project Module**
- TIMS-820 **Project Module (Wire-wrapping)**
- TIMS-425 **Quadrature Utilities**

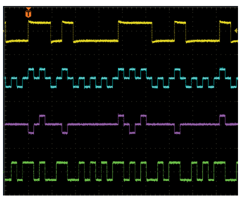
- TIMS-429 **SONET/SDH STS-1 Multiplexer**
- TIMS-430 **SONET/SDH STS-1 Demultiplexer**
- TIMS-431 **SONET/SDH STS-3 Multiplexer**
- TIMS-432 **SONET/SDH STS-3 Demultiplexer**
- TIMS-433 **SONET/SDH STS-1/3 Clock Regenerator**
- TIMS-411 **Spectrum Utilities**
- TIMS-426 **Speech Module**

- TIMS-419 **Trellis-Coded Modulation Firmware**
- TIMS-409 **True RMS Voltmeter**
- TIMS-201 **Trunks Driver**
- TIMS-202 **Trunks Receiver and TIMS-BUS**
- NEW TIMS-440 **Tuneable Data Comms Filters** (dual lin.phase)
- NEW TIMS-441 **Ultra Wideband**
- TIMS-437 **z-Transform**

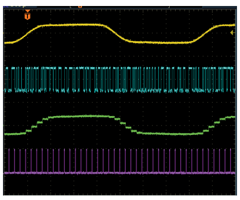
- TIMS-501/502 **100kHz Tx & 100kHz Rx Antenna Set**



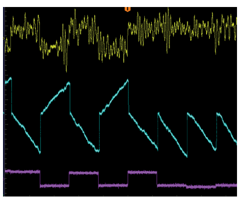
16-QAM



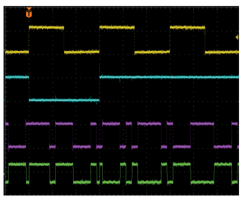
Line Code Encoding



PCM



Matched Filter



DSSS

ENHANCING THE TIMS-301/C BASIC KIT

To add to the TIMS-301/C experiment capabilities, either -

- **Choose from predefined kits listed here, or**
- **Choose from a list of TIMS experiments and Emona will prepare a custom proposal.**

(A) EVAL-16 KIT : adding a range of quantitative, SNR, BER & digital experiments

Add another 4 x BASIC and 12 x ADVANCED modules to the TIMS-301/C to build a comprehensive and advanced telecommunications laboratory system

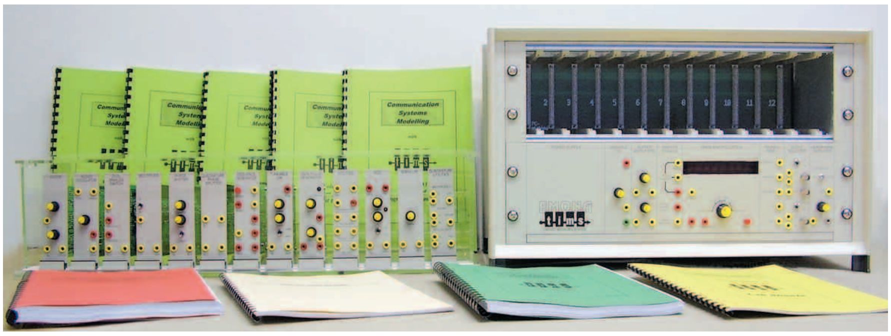
TIMS-301/C KIT
The Basic TIMS-301 System which includes -.
- TIMS-301/C **System Unit** and 13 x BASIC modules

PLUS

TIMS EVAL-16 KIT
A kit of 16 additional TIMS modules:

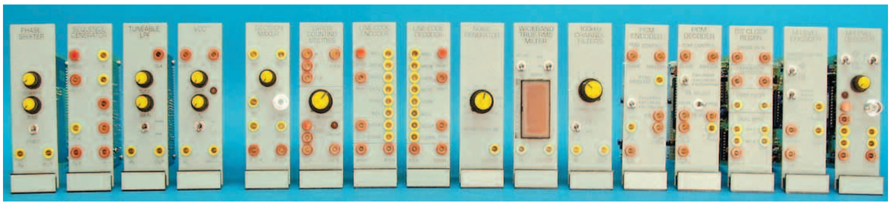
Additional BASIC modules include
- TIMS-151 **Phase Shifter**
- TIMS-153 **Sequence Generator**
- TIMS-154 **Tuneable LPF**
- TIMS-157 **VCO**

Additional ADVANCED modules
- TIMS-402 **Decision Maker**
- TIMS-405 **Error Counting Utilities**
- TIMS-406 **Line-Code Encoder**
- TIMS-407 **Line-Code Decoder**
- TIMS-408 **Noise Generator**
- TIMS-409 **TRMS Volt Meter**
- TIMS-410 **100kHz Channel Filters**
- TIMS-412 **PCM Encoder**
- TIMS-413 **PCM Decoder**
- TIMS-420 **Bit Clock Regeneration**
- TIMS-422 **M-Level Encoder**
- TIMS-423 **M-Level Decoder**



Complete TIMS-301 Kit

PLUS



PLUS the additional BASIC and ADVANCED modules

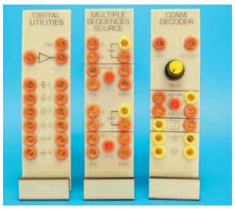
Additional EVAL-16 KIT EXPERIMENTS documented in the TIMS Experiment Manuals:

- **Experiment capabilities include all of the TIMS-301/C Experiments listed on PAGE 7, plus all of the following:**
- Carrier acquisition - PLL
- The noisy channel
- BER instrumentation
- Bit clock regeneration
- Signal Constellations - 4/8/16-QAM and 4/8/16-PSK
- Eye diagrams & BER
- FM demodulation - PLL
- Detection with the Decision Maker
- BER measurement
- QAM and 4-PSK detailed
- FSK - envelope demodulation
- BPSK and BER
- PRBS Sequence Synchronization
- Line Coding and Decoding
- PCM Encoding and Decoding
- ASK - advanced experiments
- BPSK - advanced experiments
- DPSK and BER

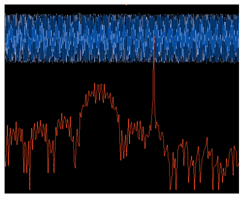
ORDERING INFORMATION:
TIMS-301/301C Basic System
+ (A) TIMS-EVAL-16 KIT
or TIMS-301/301C Basic System
+ Custom selection to suit your requirements

(B) TIMS-CDMA Spread Spectrum Module Option

Add the 3 modules listed here to the TIMS-301 and EVAL-16 KIT for Direct Sequence Spread Spectrum (DSSS) and CDMA experiments



Additional ADVANCED modules include
- TIMS-424 **Digital Utilities**
- TIMS-427 **Multi Sequences Source**
- TIMS-428 **CDMA Decoder**



CDMA + JAMMING

EXPERIMENTS[1] documented in the TIMS Experiment Manuals:

- CDMA - Introduction
- CDMA - Processing Gain
- CDMA - 2 Channel with BER Measurement

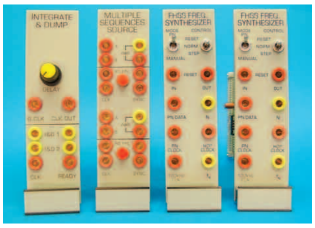
[1] More advanced CDMA experiments are also available as an additional option.

ORDERING INFORMATION:
TIMS-301/301C Basic System
+ (A) TIMS-EVAL-16 KIT
+ (B) TIMS-CDMA KIT

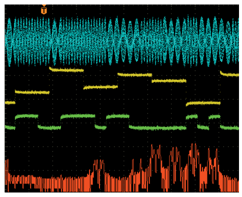
or TIMS-301/301C Basic System
+ Custom selection to suit your requirements

(C) TIMS-FHSS Frequency Hop Module Option

Add the 4 modules listed here to TIMS-301 + EVAL-16 + TIMS-CDMA KITS for Frequency Hop Spread Spectrum (FHSS) experiments



Additional ADVANCED modules
- TIMS-418 **Integrate & Dump**
- TIMS-427 **Multi Sequences Source**
- TIMS-434 **Frequency Hop Synthesizer module x 2**



FHSS

EXPERIMENTS[2] documented in the TIMS Experiment Manuals:

- Introduction to FHSS using FSK
- FHSS: Fast and Slow Hopping
- FHSS and BER Performance

Additional experiments which can be implemented using modules sets A to D:
- Sampling with the Sample & Hold
- PPM and PWM - advanced
- Matched filter detection with BER
- Binary data tx via voiceband channel

More advanced FHSS experiments are also available as an option.

ORDERING INFORMATION:
TIMS-301/301C Basic System
+ (A) TIMS-EVAL-16 KIT
+ (B) TIMS-CDMA KIT
+ (C) TIMS-FHSS KIT

or (A) TIMS-301/301C Basic System
+ Custom selection to suit your requirements

(D) TIMS-AdvFO Advanced Fiber Optics Option

Add the 8 modules listed here to TIMS-301 to demonstrate the underlying principles of fiber optics links - WDM and bi-directional

Additional ADVANCED modules include
- TIMS-503R **FO Transmitter (RED) x 2**
- TIMS-504G **FO Transmitter (GREEN) x 1**
- TIMS-504N **FO Receiver x 2**
- TIMS-505 **Fiber Optic Coupler x 2**
- TIMS-506 **WDM Filters x 1**
- TIMS-510S **Fiber Optic Cable Set x 1**

EXPERIMENTS documented in the TIMS Experiment Manuals:

- Fiber Optic Transmission
- Optical Losses
- Optical Signal Splitting and Combining
- Bi-directional (same wavelength) communication via a single fiber
- WDM - Wave Division Multiplex
- SONET via an Optical Link

ORDERING INFORMATION:
TIMS-301/301C Basic System
+ (D) TIMS-AFO KIT
+ TIMS-SONET module set (optional)

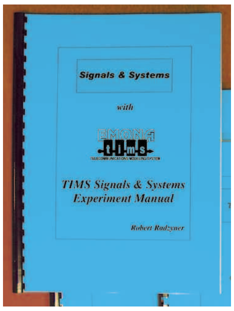
or TIMS-301/301C Basic System
+ Custom selection to suit your requirements

NOTE: The TIMS fiber optics modules can be used with any TIMS digital or analog signal, for example, SONET, PCM, CDMA, Delta Modulation, etc.

TIMS SIGNALS & SYSTEMS

SIGNALS & SYSTEMS EXPERIMENTS MANUAL

A new volume of experiments that help students to relate the complex math of Signals & Systems to the real-world



OVERVIEW

The TIMS Signals & Systems Experiments Manual makes it possible for students to experience at first hand the interaction between the theory and mathematics of the signals and systems textbook with the real world of hardware and of signals in wires and waves. In this first volume, catering for the introductory level, experiments have been designed to provide hands on exercises covering most of the key concepts and challenges, including:

VOLUME 1 TIMS Signals & Systems Experiments:

SECTION 1 -

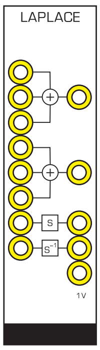
Lab 1: Special signals - characteristics and applications
Lab 2: Modeling linear and nonlinear systems with TIMS
Lab 3: Unraveling convolution
Lab 4: Comparing responses in the time and frequency domains
Lab 5: A Fourier series analyzer
Lab 6: Spectrum analysis of various signal types

SECTION 2 -

Lab 7: Getting Started with Poles and Zeros in the Laplace Domain
Lab 8: Sampling and aliasing
Lab 9: Getting started with analog-digital conversion
Lab 10: Discrete-Time Filters - Finite Impulse Response
Lab 11: Using poles and zeros in the z plane: Discrete-time filters
Lab 12: Discrete-time filters - practical

TIMS LAPLACE & z-TRANSFORM MODULES

The LAPLACE and z-TRANSFORM are two specialised TIMS modules. They are used to implement continuous-time and discrete-time filters and structures, designed in the s-plane and z-plane respectively.

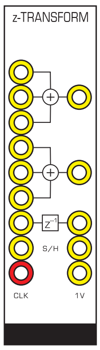


TIMS-436

LAPLACE Module

The implementation of continuous-time system equations and transfer functions using Laplace transform operators is an essential part of system design and analysis. These elements are the basis of active filters which are common in everyday electronic systems design. Applications include:

- Filters: Lowpass, Highpass, Notch, Allpass, Bandpass
- Integrator- Differentiator phase shifter

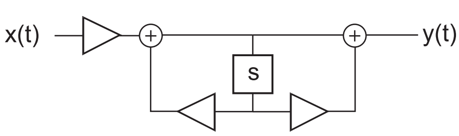


TIMS-437

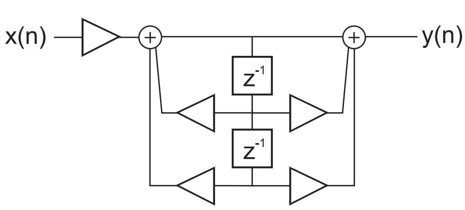
z-TRANSFORM Module

The z-transform provides the essential tools for the analysis and implementation of discrete-time systems represented by recursive equations. The delay operator (z^{-1}) is the basis of DSP digital filter implementations and also switched capacitor filters, common in everyday electronic systems design. Applications include:

- FIR Filters
- IIR Filters
- Convolution
- Sample & Hold
- Analog Unit Delay



- **First Order LTI System with Differentiator**



- **Second Order Section - Direct Form II Biquad Stage** (requires two z-TRANSFORM modules)

TIMS EXPERIMENTS AND THE TRANSMISSION MODEL

A simplified block diagram of a telecommunications system is shown below as five elements:
ENCODING - MODULATION - CHANNEL - DEMODULATION - DECODING

This diagram is a summary of the schemes which TIMS currently implements.

Let us tailor the selection of TIMS modules to suit your course needs.

TRANSMITTED MESSAGE → ENCODING → MODULATION → CHANNEL → DEMODULATION → DECODING → RECEIVED MESSAGE

ENCODING	MODULATION	CHANNEL	DEMODULATION	DECODING
Sinusoidal and speech messages Pseudo Random Sequence Generation & Gold Codes Line codes: NRZ-L, NRZ-M, Uni-RZ, Bip-RZ RZ-AMI, Bi-Phase (Manchester), Dicode, Duobinary PCM,ADPCM,companding Block codes Block Interleaving Convolutional codes Trellis: TCM encoding SDH / SONET frames Student Projects with DSP, CPLD & Circuits	AM / DSB / SSB / ISB ASK, FSK, GFSK BPSK, QPSK, 4/8/16-PSK QAM, 4/8/16-QAM Delta, Adaptive Delta Sigma Delta, CVSD π/4-DPSK, GMSK, OQPSK OFDM UWB - Ultra Wideband Multiplexing: TDM, FDM, PDM Spread Spectrum: DSSS, CDMA, FHSS, Hybrid PAM, PWM, PPM Sampling and aliasing Armstrong's phase modulator WB-FM, NB-FM Student Projects with DSP, CPLD & Circuits	+ Noise + Distortion/non-linearity + Band limiting + SNR measurements + Filter characteristics Baseband channel Bandpass channel Fiber Optic channel: WDM along single fiber; Bidirectional FO link Wireless antenna TIMS Trunks channel Student Projects with DSP, CPLD & Circuits Nyquist theorem Shannon theorem	Corresponding demodulator for each modulator Envelopes Product demodulation LPF & reconstruction filters Phasing of local oscillator Carrier Acquisition: Costas Loop and PLL Matched Filters Integrate & Dump Superheterodyne Fundamentals of Digital Radio - Undersampling Student Projects with DSP, CPLD & Circuits	Corresponding decoder for each encoder Eye Patterns & decision thresholds Bit Error Rate vs SNR measurements Timing Jitter Equalization for ISI Baseline Wander Pulse shaping - RRC, Linear Phase, Bessel Constellations Synchronization: bit clock and frame Bit Clock Regeneration Viterbi Algorithm Student Projects with DSP, CPLD & Circuits System fault finding

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