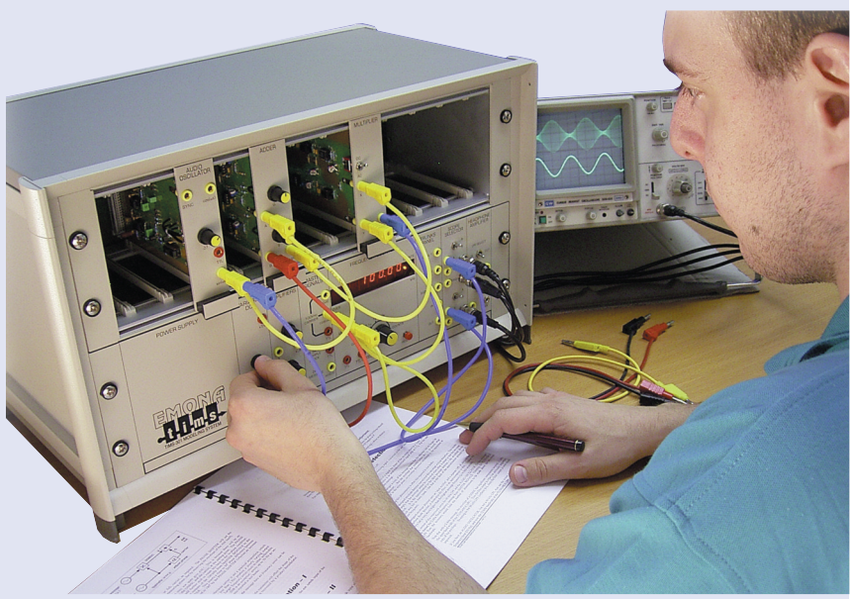
tims

Telecommunications
Signals & Systems
Lab Equipment

EXPERIMENTS COVERING THE PRINCIPLES BEHIND:

- LTE, 4G and 5G
- IoT
- TETRA
- Wideband-CDMA
- HSDPA
- CDMA2000®
- EDGE
- cdmaOne (IS-95)
- GSM
- Wi-Fi
- WiMAX
- Cordless Telephone
- ZigBee™
- DECT
- Bluetooth®
- Near Field Communications
- UWB
- RFID
- Digital Radio DAB
- DVB-S
- Satellite Modems
- Satellite Links
- EBEM
- Deep Space Telemetry
- GPS
- RADAR Signals
- OFDM (DVB-T, ADSL, WLAN)
- Software Defined Radio

and much more . . .



University Level Experiments in

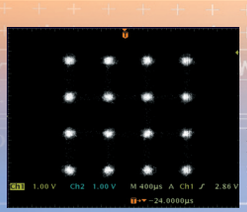
- Wireless Communications
- SDR running GNURadio **NEW**
- Signals & Systems & DSP
- Fiber Optics
- Student Projects

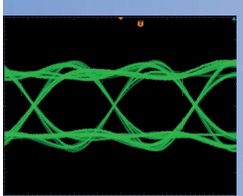
EMONA INSTRUMENTS

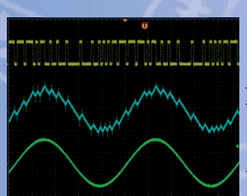
www.emona-tims.com

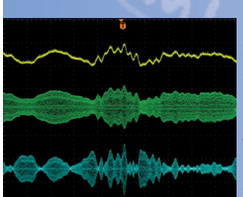
EMONA tims™ FOR TEACHING

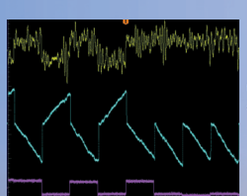
ACTUAL TIMS WAVEFORMS

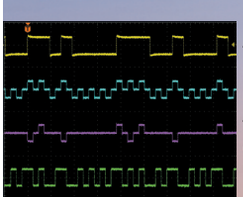

16-QAM

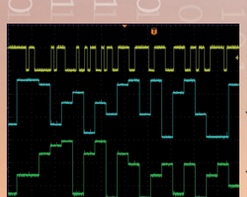

Eye Patterns

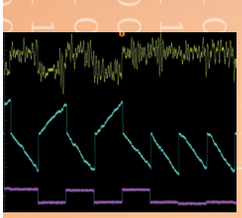

Delta Modulation

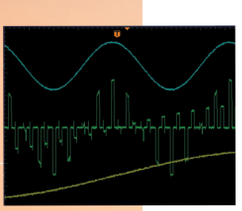

Speech AM & DSB

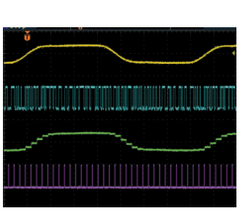

Integrate & Dump

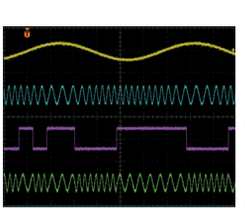

Line Code Encodes

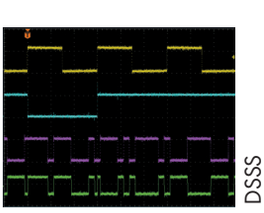

Multi-Level I & Q Signals


Matched Filter

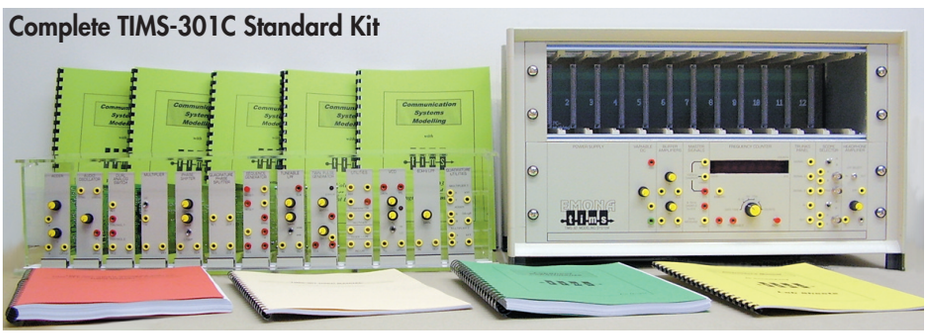

PAM & TDM


PCM


FM and PM


DSSS

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


Complete TIMS-301C Standard Kit

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

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 & EXPANDABLE ARCHITECTURE

As TIMS is an open-ended architecture system, TIMS can implement from the most basic communications systems theory, through to the very latest in coding and modulation.

• SELF CONTAINED

TIMS is self contained requiring only an additional oscilloscope for waveform display and PC for detailed spectrum display and measurements.

• PC-INTERFACE - INSTRUMENTATION, LabVIEW™ & MATLAB™

As well, TIMS can interface to a PC providing data acquisition and spectrum analysis facilities and a range of supporting math applications.

• STUDENT CAPSTONE PROJECTS

TIMS is the ideal system to allow students to conveniently develop, built and analyse the performance of their thesis projects.

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

COMMUNICATIONS SYSTEMS THEORY

TIMS is a True Hardware Math Modeling System . . . . . almost infinitely expandable

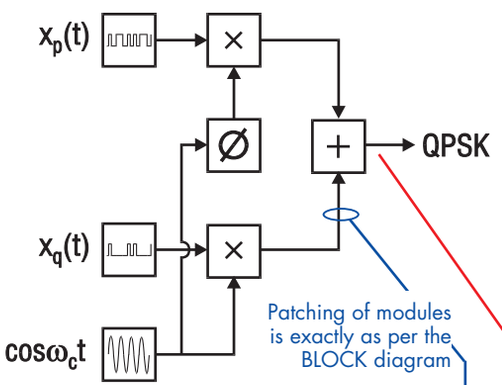
START WITH MATH OR THEORY

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

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

Telecommunications text books are a source of equations and theories.

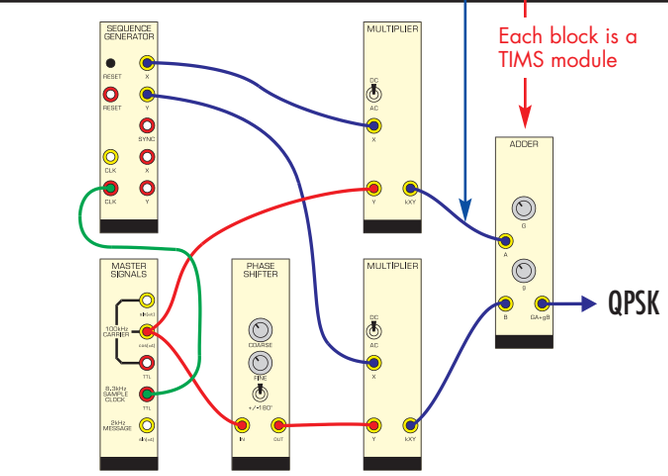
REPRESENT IT AS A BLOCK DIAGRAM



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

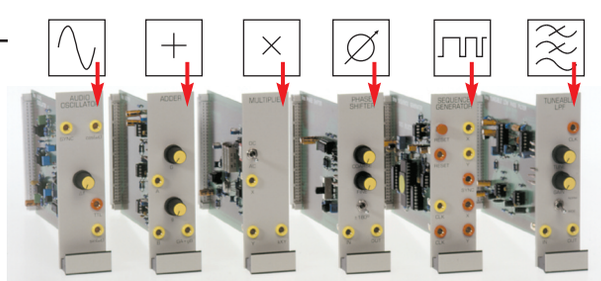
Telecommunications engineers make sense of math and theory through BLOCK DIAGRAMS.

STUDENTS BUILD IT USING MODULES



Students patch the BLOCK DIAGRAMS based on communications theory - then view and measure **real time signals**.

ONE MODULE FOR EACH BLOCK



70+ MODULES TO CHOOSE FROM

STUDENTS PATCH OUTPUTS TO INPUTS TO BUILD THE MODULATION SCHEME and HAND ADJUST EACH PARAMETER: gain, phase, frequency, coupling, alignment, synchronization....

Students build each experiment, step-by-step

TIMS PRODUCT RANGE

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

1. Emona TIMS-301, 301C & 304C Lab Hardware

TIMS-300 Hands-on, communications theory experiments

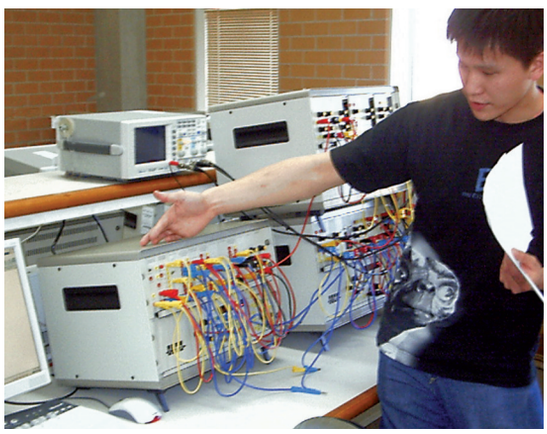
The **TIMS-300 System** is a true, real-time, hardware mathematical modeling system.

TIMS can 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. Each TIMS plug-in module realises a fundamental communications/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.



2. TutorTIMS-R2 - PreLab Simulation Software

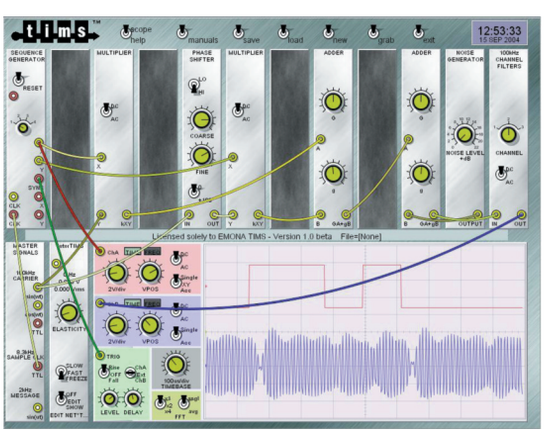
TIMS Simulator for pre-lab learning with Signals & Systems Experiments

TutorTIMS-R2 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.

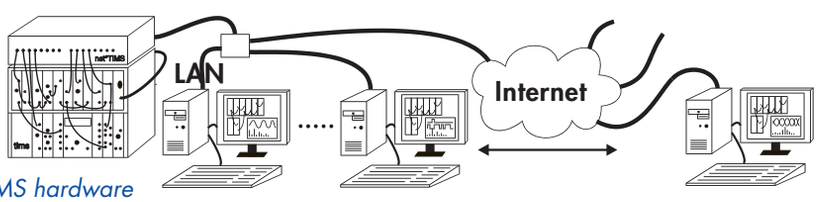
TutorTIMS-R2 is ideal for helping students **prepare at home** before attending hands-on labs at college.



3. net*TIMS - Simultaneous, multi-user lab-in a box

Simultaneously serves 30+ students, each running their own experiment

net*TIMS allows professors to set-up **real TIMS telecommunications experiments** in their own laboratory. Many students can **simultaneously access** and control from within the lab or from any location (from campus or from home) to carry out these hardware 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 IMPLEMENTS ALL OF THIS AND MORE

Select your curriculum from the experiment list below.

TIMS DOCUMENTED EXPERIMENTS:

- ❒ Adaptive Delta Modulation
- ❒ AM - Amplitude Modulation
- ❒ Amplifier Overload
- ❒ Armstrong's Phase Modulator
- ❒ ASK - Modulation & Demodulation
- ❒ Baseline Wander and Line Coding
- ❒ BER Instrumentation & measurement
- NEW ❒ **Binary signal detection in Gaussian noise**
- ❒ Bit Clock Regeneration
- ❒ Block Coding and Decoding
- ❒ Block Coding Gain
- ❒ Block Coding - error correcting
- NEW ❒ **π/2-BPSK used in 5G mobile**
- ❒ BPSK - Introduction
- ❒ BPSK and BER
- ❒ Broadcasting - AM and FM
- ❒ 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
- ❒ Digital Noise in Baseband & Block Coded Channels
- ❒ DPSK and BER
- ❒ DPSK and Carrier Acquisition
- ❒ DSP Intro and Applications
- ❒ DSBSC - Generation & Demodulation
- ❒ DSSS - Spread Spectrum
- ❒ Envelopes and Envelope Detection
- ❒ Equalization for ISI
- ❒ Eye Patterns & BER
- ❒ Fading, Multi-path Channel
- ❒ 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 - Generation & Envelope Demodulation
- NEW ❒ **BFSK - coherent signalling & BER**
- NEW ❒ **BFSK - non-coherent signalling & BER**
- ❒ GFSK - Gaussian FSK
- NEW ❒ **IoT - ASK+DSSS Physical Layer**
- NEW ❒ **IoT - Chirp Spread Spectrum Application**
- NEW ❒ **IoT - Ultra Wide Band Application**
- ❒ ISB - Independent Sideband
- ❒ ISI: PAM & ASK in band-limited ch
- ❒ 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
- ❒ Multi-channel Digital Fiber Link
- ❒ Multi-level QAM & PSK
- NEW ❒ **Multi-path - Time-invariant fading channel characteristics**
- NEW ❒ **Multi-path - ISI rejection in DS SS**
- ❒ Noisy Channel
- ❒ Noise Generation - Binary Sequences
- ❒ OFDM Principles - Introduction
- NEW ❒ **OFDM, Cyclic Prefix & PAPR**
- NEW ❒ **OFDM & Channel Equalisation with BER Measurement**
- NEW ❒ **OFDM in band limited, multipath, time-invariant channel with BER measurements**
- NEW ❒ **OFDM - IDFT, Complex Exponent & Complex Quad Signals**
- ❒ PAM & TDM
- ❒ Parseval's Theorem: Harmonic & Non-harmonic Signals
- ❒ PCM & Bit Clock Regeneration
- ❒ PCM Encoding &Decoding
- ❒ PCM TDM
- ❒ PCM-TDM 'T1' Implementation
- ❒ PDM - Phase Division Multiplex
- ❒ 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
- ❒ Random Variables & AWGN
- NEW ❒ **Radar signals:**
  Constant-frequency pulse
  Linear-frequency modulated pulse
  Coherent train of LFM pulses
  Phase-coded pulse
  Coherent train of identical Unmodulated pulses
  Stepped-frequency pulse
- NEW ❒ **16-QAM - as used in 4G and 5G LTE**
- NEW ❒ **16-QAM - LTE BER measurement**
- ❒ QAM - Generation &Demodulation
- ❒ QAM and 4-PSK
- ❒ QASK - Modulation & Demodulation
- ❒ QPSK - Modulation & Demodulation
- NEW ❒ **QPSK - BER of Coherent QPSK in distortionless channel**
- ❒ Sampling & Reconstruction
- ❒ Sampling with Sample-&-Hold
- ❒ Signal Analysis: relationship between time and frequency domains
- NEW ❒ **SDR - Intro to GNURadio**
- NEW ❒ **SDR - Exploring sampling & resampling**
- NEW ❒ **SDR - Software Defined Radio in TX**
- NEW ❒ **SDR - Software Defined Radio in RX**
- ❒ 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
- ❒ Spread Spectrum: Direct Sequence, Frequency Hop, Time Hop Hybrid FH-DS, FH-CDMA,
- ❒ Speech in Telecommunications
- ❒ SSB Generation and Demodulation
- ❒ SSB Linear Amplifier Measurements
- ❒ Superheterodyne
- ❒ System fault finding
- ❒ TCM - Coding Gain
- ❒ TCM - Trellis Coding
- ❒ TDM
- ❒ Timing jitter in Band Limited Channels
- NEW ❒ **Turbo coding**
- ❒ UWB - Pulse Shapes & Spectra
- ❒ UWB - with BER
- ❒ UWB - Multiband Modulation
- ❒ UWB - Multiple Access Orthogonal Pulse Modulation with MHP
- ❒ UWB - OOK, PPM, BPM & OPM
- ❒ Wave Analyzer - Spectrum Analysis
- ❒ Weaver's SSB Mod and Demodulator

SIGNALS & SYSTEMS EXPERIMENTS MANUALS:

- ❒ Special Signals - characteristics and applications
- ❒ Modeling Linear and Non-linear Systems
- ❒ Unraveling Convolution
- ❒ Integration, correlation & matched filters
- ❒ Exploring complex numbers and exponentials
- ❒ Comparing Responses in the Time and Frequency Domains
- ❒ A Fourier Series Analyzer
- ❒ Spectrum Analysis of Various Signals
- ❒ Poles and Zeros in the Laplace Domain
- ❒ Sampling and Aliasing
- ❒ Analog-Digital Conversion
- ❒ Discrete-Time Filters - Finite Impulse Response
- ❒ 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**
- ❒ Solderless breadboarding of electronic circuits with the **TIMS-840 Experimenter**
- ❒ Programming DSP implementations with the **TIMS-DSP-6713 Module**

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

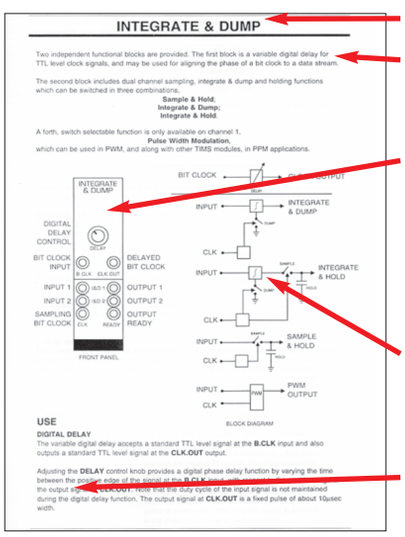
TIMS USER & EXPERIMENT MANUALS

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.

• 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

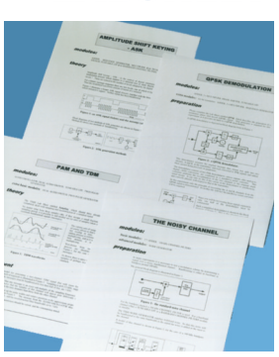
Concise description of module's function

Labelled front panel illustration

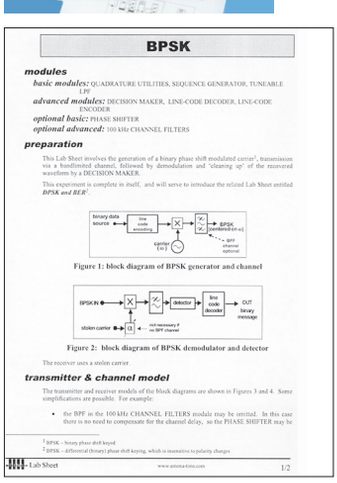
Labelled block diagrams

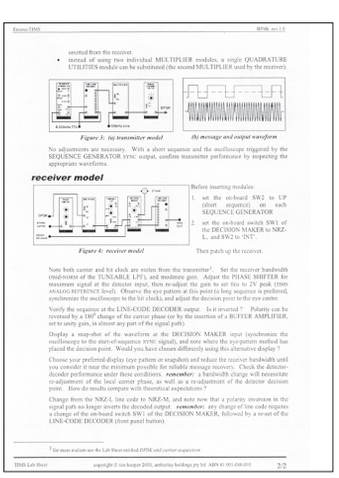
Detailed user information

• LABSHEET EXPERIMENTS



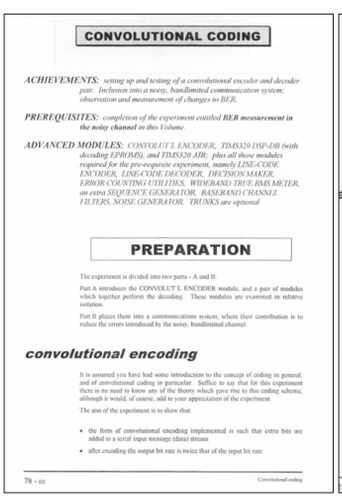
TIMS LabSheet Experiments are a massive library of OVER 160 concise, **single sheet experiments** which provide a rich source of experiment ideas and serve to provide an accelerated familiarization for professors.

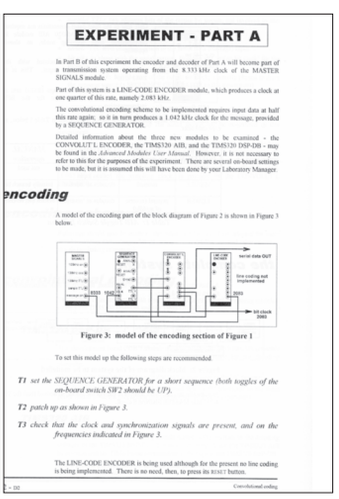




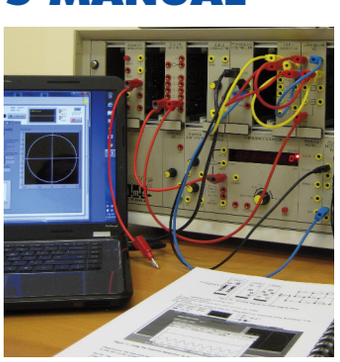
• 14 DETAILED LAB MANUALS

The seven volume **TIMS Student Texts**, over 4,500 pages in total, provide an in-depth coverage of a broad range of wireless and telecommunications experiments. I





• SIGNALS & SYSTEMS V2 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.

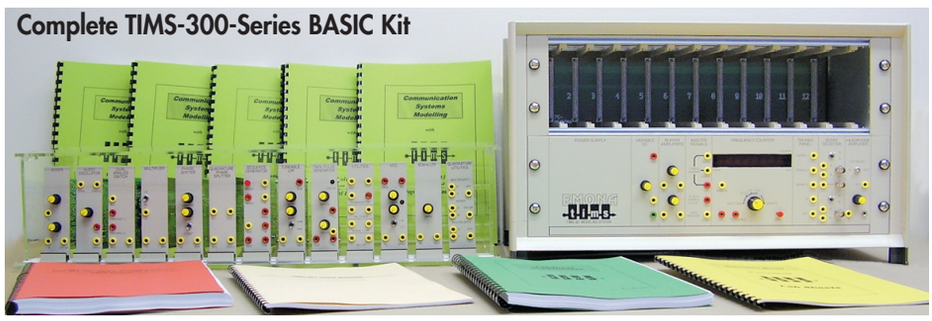
TIMS-300 SYSTEM UNITS and BASIC MODULE SET

TIMS-301, 301C and 304C SYSTEM UNITS

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

The TIMS-300-Series kit includes:

- The TIMS-300 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-300-Series BASIC Kit

• 3 VERSIONS OF THE TIMS-300-SERIES SYSTEM UNIT


TIMS-301 Standard System


TIMS-301C with 2 channel Instrument

TIMS-304C with 4 channel Instrument, Function and Arbitrary generator

TIMS-300-Series SYSTEM UNITS

The FIXED MODULES are the most commonly used modules.

MODEL TIMS-301 Standard System includes:

- **Master Oscillators**
- **Buffer Amplifiers**
- **Frequency and Event Counter**
- **Variable DC Voltage Output**
- **Oscilloscope Display Selectors**
- **TIMS Trunks Outputs**
- **Power Supply**

MODEL TIMS-301C PC-ENABLED also includes:

- **PC-based virtual instrument -** 2 channel oscilloscope and spectrum analyzer displays, true RMS voltmeter.

NEW MODEL TIMS-304C PC-ENHANCED also includes:

- **PC-based virtual instrument & ARB generator -** 4 channel oscilloscope and spectrum analyzer displays, true RMS voltmeter and single channel function/arbitrary generator.

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-300 EXPERIMENTS documented in the TIMS Experiment Manuals:

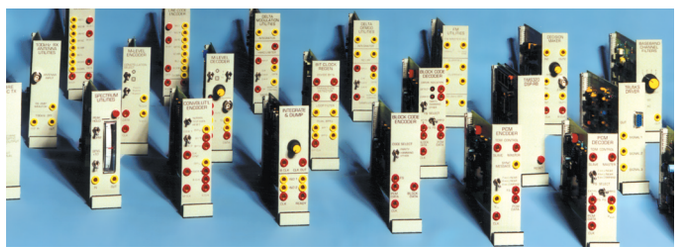
- Introduction to TIMS
- Modeling of math equations
- AM modulation (2 methods)
- Envelopes/envelope recovery
- DSBSC mod and demod
- SSB mod - phasing method
- SSB demod - phasing method
- Product demodulation
- Phase lock loop
- FM modulation & demod
- Armstrong's Phase modulator
- PAM generation
- 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

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 70 specialised building blocks to expand the range of analog, digital , digital signal processing (DSP) and SDR experiments.

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**

- NEW TIMS-447 **Carrier Acquisition PLL/Costas**
- 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-DSP-6713 **Floating Point 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**
- NEW TIMS-442 **Laplace V2** (used with TIMS-445)
- TIMS-406 **Line-Code Encoder**
- TIMS-407 **Line-Code Decoder**

- TIMS-422 **M-Level Encoder**
- TIMS-423 **M-Level Decoder**

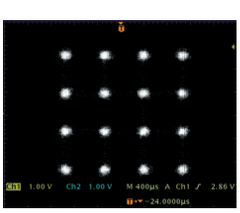
- TIMS-438 **MSK,π/4-DQPSK,OQPSK Encoder** (& RRC)
- TIMS-439 **MSK,π/4-DQPSK,OQPSK Decoder**
- NEW TIMS-446 **Multi-Path Channel Module**
- TIMS-408 **Noise Generator**

- NEW TIMS-449 **OFDM for DSP-6713 Module**

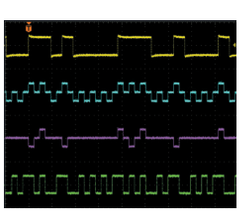
- NEW TIMS-445 **PC Modules Controller**
- TIMS-412 **PCM Encoder**
- TIMS-413 **PCM Decoder**
- TIMS-250 **Perspex Module Storage Box**
- TIMS-830 **Programmable CPLD Project Module**
- TIMS-820 **Project Module (Wire-wrapping)**
- TIMS-425 **Quadrature Utilities**

- TIMS-429 **SONET/SDH STS-1 Multiplexer**
- NEW TIMS-451 **SDR with GNURadio**
- 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**
- NEW TIMS-448 **SSB Filters for DSP-6713 Module**
- TIMS-426 **Speech Module**

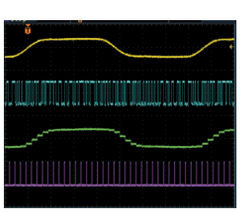
- TIMS-419 **Trellis-Coded Modulation Firmware**
- NEW TIMS-444 **Triple Adder** (requires PC Modules Controller)
- TIMS-409 **True RMS Voltmeter**
- TIMS-201 **Trunks Driver**
- TIMS-202 **Trunks Receiver and TIMS-BUS**
- TIMS-440 **Tuneable Data Comms Filters** (dual lin.phase)
- NEW TIMS-450 **Turbo Coding**
- TIMS-441 **Ultra Wideband**
- TIMS-437 **z-Transform**
- NEW TIMS-443 **z-Transform V2** (used with TIMS-445)
- TIMS-501/502 **100kHz Tx & 100kHz Rx Antenna Set**



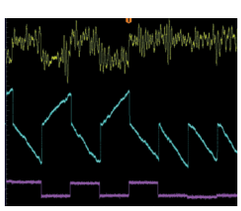
16-QAM



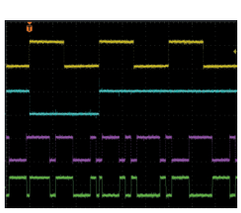
Line Code Encoding



PCM



Matched Filter



DSSS

EXPANDING THE TIMS-300 BASIC KIT

To add to the TIMS-300 experiment capabilities, either -

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

EVAL-16 KIT: adds a range of quantitative, SNR, BER & digital modulation experiments

Add another 3 x BASIC and 13 x ADVANCED modules to the TIMS-301/C to build a comprehensive and advanced telecommunications laboratory system

TIMS-300 KIT
The Basic TIMS-30X/C System which includes -.

- TIMS-30X/C **System Unit** and 13 x BASIC modules

and ADD

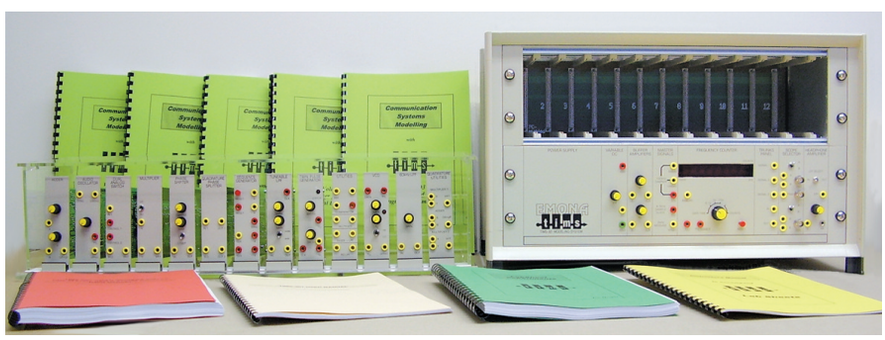
TIMS EVAL-16 KIT
A kit of 16 additional TIMS modules:

Additional BASIC modules include

- TIMS-153 **Sequence Generator**
- TIMS-154 **Tuneable LPF**
- TIMS-157 **VCO**

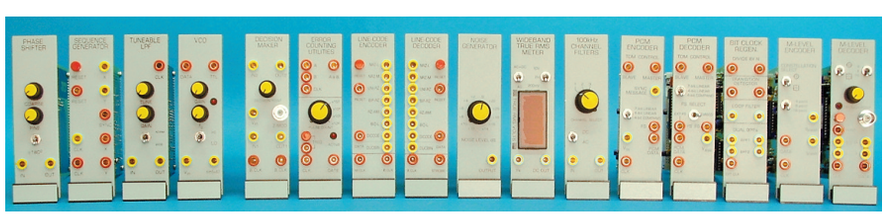
Additional ADVANCED modules

- 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**
- TIMS-425 **Quadrature Utilities**



Complete TIMS-300 Kit

PLUS



PLUS these 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

EXPANDING THE TIMS-300 BASIC KIT - expansion examples

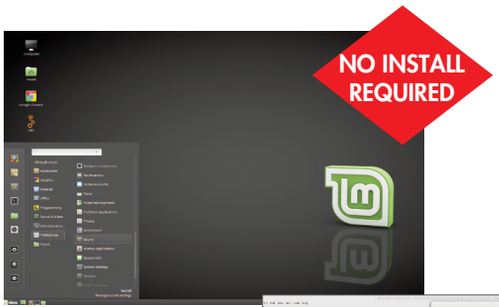
TIMS Software Defined Radio Experiments

With LINUX and GNURadio pre-installed, run TIMS-SDR in minutes

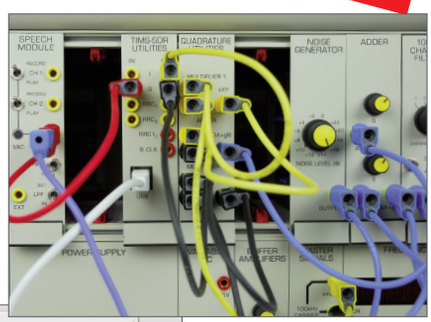
NEW

TIMS-SDR & plug-and-play USB Stick

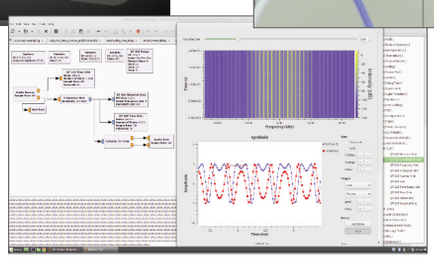
TIMS-SDR Kit is a zero-install, plug-and-play, hardware and software package which enables the student to quickly and easily experiment with the graphical GNU Radio Companion software tools in the TIMS telecommunications platform with real signals.



LINUX MINT pre-installed



REAL SDR HARDWARE



GNURadio pre-installed

Requires the TIMS-301C/304C BASIC System plus:

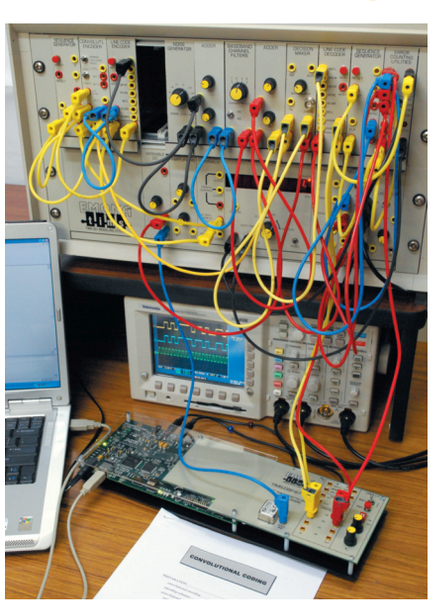
- TIMS-451 **TIMS-SDR Utilities Module** and **TIMS-USB** with **pre-installed LINUX and GNURadio**

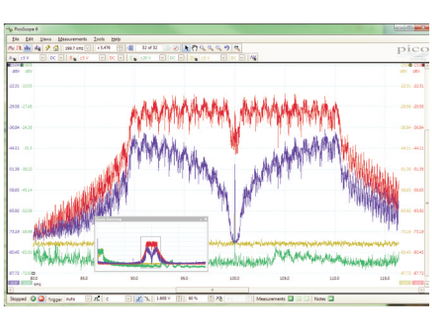
EXPERIMENTS documented in the TIMS Experiment Manuals:

- Familiarization with GNURadio
- Exploring Sampling and Resampling in SDR
- TX with SDR and RX with Hardware: FM applications
- TX with hardware, RX with SDR: QAM applications
- TX and RX with SDR: BPSK, QPSK, MSK, FSK, OFDM, and more

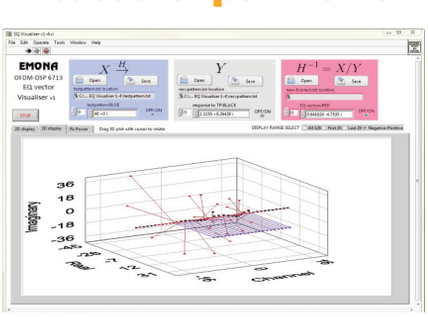
TIMS OFDM Experiments

TIMS offers both introductory experiments to demonstrate the principles of OFDM without DSP, as well as a suite of advanced DSP-based experiments





TIMS OFDM spectrum at channel input (red) and at output of a multipath channel (blue)



TIMS Visualiser Software, shows students 2D and 3D vector displays of each sub-carrier, at channel input and at receiver.

TIMS OFDM requires the TIMS-301C/304C Basic System, a TIMS-DSP-6713 DSP module and a selection of TIMS-400 Series Advanced modules.

EXPERIMENTS documented in the TIMS Experiment Manuals:

- Introduction to OFDM using discrete modules (non-DSP)

Experiments utilizing the TIMS-DSP-6713 Module

- IDFT, Complex Exponent & Complex Quadrature Signals
- OFDM, Cyclic Prefix & PAPR
- OFDM & Channel Equalisation with BER
- OFDM in band limited, multipath with BER

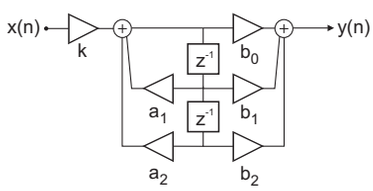
TIMS SIGNALS & SYSTEMS - expansion examples

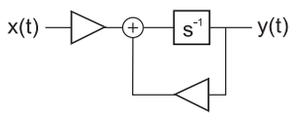
SIGNALS & SYSTEMS EXPERIMENTS

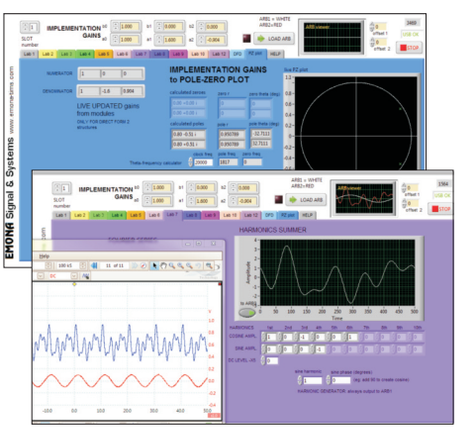
Real signals - No simulation. Hardware experiments to help students to relate the complex math of Signals & Systems to the real-world

A COMPLETE LAB MANUAL - pick the labs for your course

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.



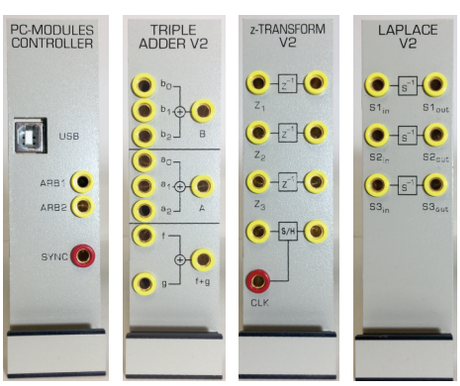




EXPERIMENT CONTROL SOFTWARE

The TIMS Signals & Systems Experiments Manual includes graphical software with all the control instrumentation and data presentation tools required.

- Immediate, on-screen control of ADDER gains (coefficients) and arbitrary waveform GENERATOR.
- Interactive digital filter design tools with z-plane presentation of poles & zeros.
- In-built instrumentation display with time domain, frequency domain & tables.



SIGNALS & SYSTEMS REAL EXPERIMENT HARDWARE

The TIMS Signals & Systems Module Set includes four fundamental modules:

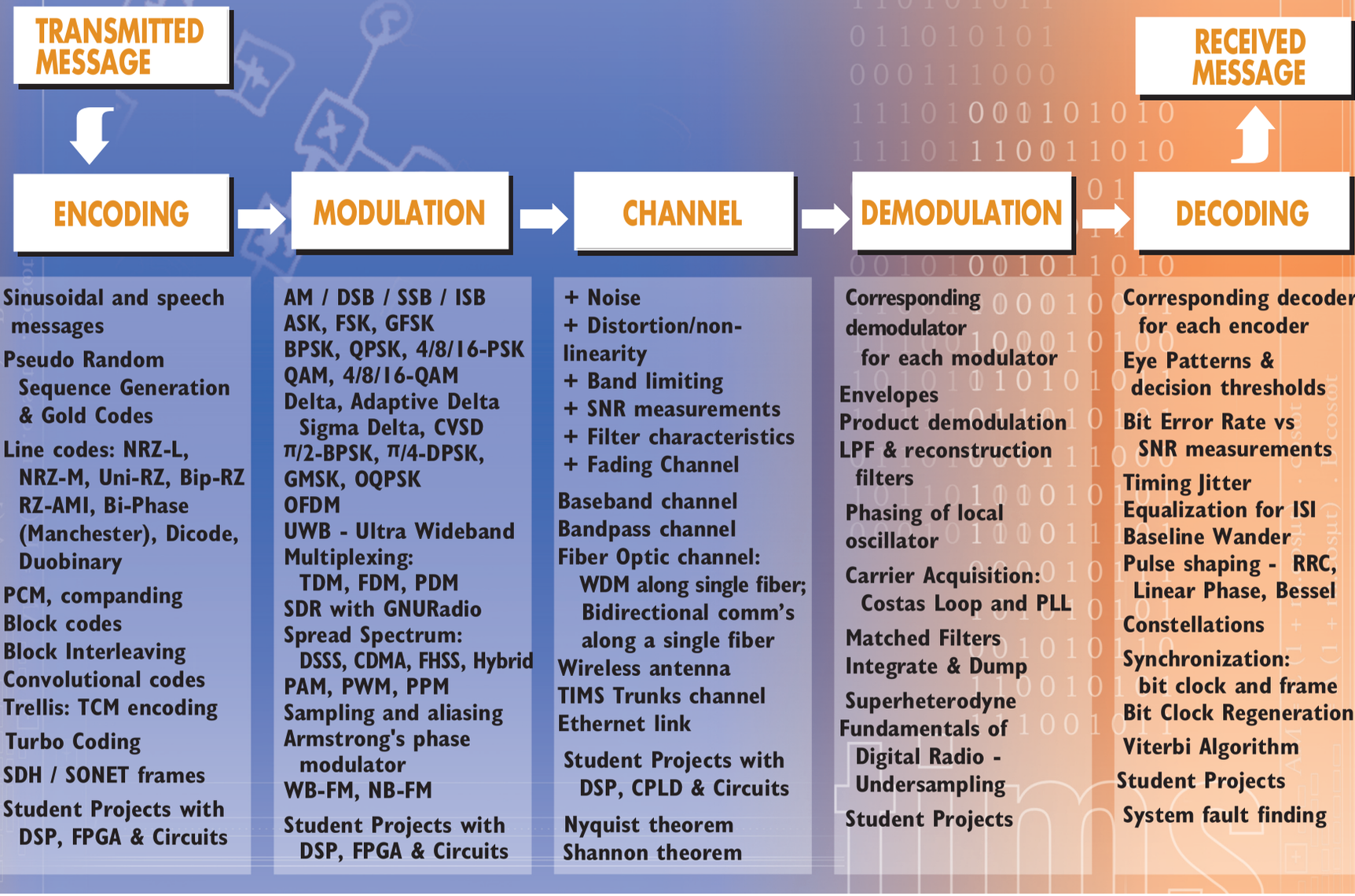
- TIMS-445 **PC-Modules Controller**
  USB interface to control coefficient plus 2 channel Arb waveform generator.
- TIMS-444 **Triple Adder**
  Three independent, software controlled summing junctions.
- TIMS-443 **z-Transform-V2**
  For implementing IIR an FIR discrete time structures.
- TIMS-442 **Laplace-V2**
  For implementing continuous-time structures.

TIMS SIGNALS & SYSTEMS EXPERIMENTS

Lab 1: Intro to the Signals & Systems V2 module set
Lab 2: Special signals - characteristics & applications
Lab 3: Systems: Linear and non-linear systems
Lab 4: Unraveling convolution
Lab 5: Integration, correlation & matched filters
Lab 6: Exploring complex numbers and exponentials
Lab 7: Build a Fourier series analyzer
Lab 8: Spectrum analysis of various signal types
Lab 9: Poles and zeros in the Laplace domain
Lab 10: Sampling and aliasing
Lab 11: Getting started with analog-digital conversion
Lab 12: Discrete-time structures: FIR
Lab 13: Poles and zeros in the z plane with IIR systems

TIMS EXPERIMENTS AND THE TRANSMISSION MODEL

A summary of TIMS experiment capabilities



Emona Instruments Pty Ltd
78 Parramatta Road
Camperdown NSW 2050 AUSTRALIA
Tel: +61-2-9519-3933 Fax: +61-2-9550-1378
URL: www.tims.com.au
Email: sales@emona-tims.com

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