EMONA tims

ADVANCED EXPERIMENT PLATFORM FOR TELECOMS EDUCATION

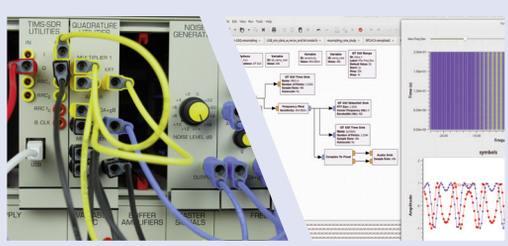
The leading experiment platform for teaching advanced math & theory to telecommunications engineering students

EXPERIMENTS COVERING THE :PRINCIPLES BEHIND

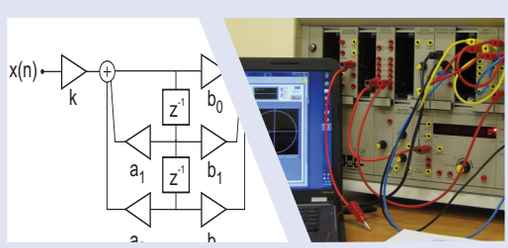
LTE, 4G and 5G
IoT
TETRA
Wideband-CDMA
HSDPA
CDMA2000®
EDGE
cdmaOne (IS-95)
GSM
Wi-Fi
WiMAX
Cordless Telephone
ZigBee™
DECT
Bluetooth®
Near Field Communications
UWB
RFID
Digital Radio DAB
DVB-S
Satellite Modems
Satellite Links
EBEM
Deep Space Telemetry
GPS
RADAR Signals
OFDM (DVB-T, ADSL, WLAN)
Software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

ADVANCED WIRELESS COMMUNICATIONS

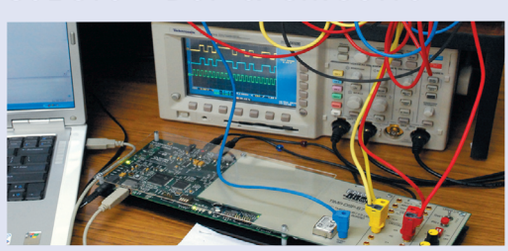
SDR FOR EDUCATION with GNURadio



SIGNALS & SYSTEMS EXPERIMENTS



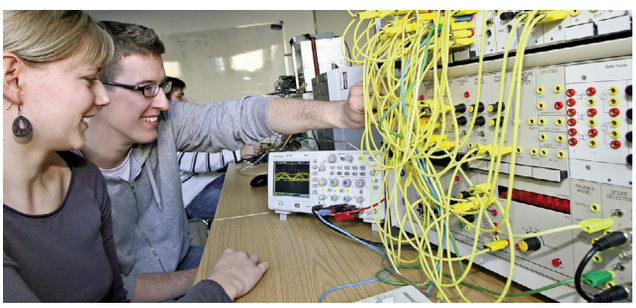
STUDENT PROJECTS - DSP & CIRCUITS

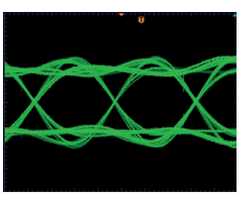


EMONA INSTRUMENTS
www.emona-tims.com

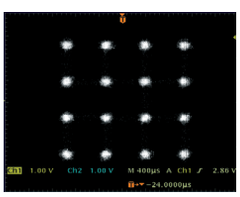
EMONA tims FOR TEACHING

Emona TIMS is laboratory teaching hardware for Wireless, Digital Communications, SDR, Fiber Optics, Signals & Systems and Student Projects.

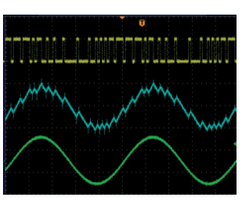




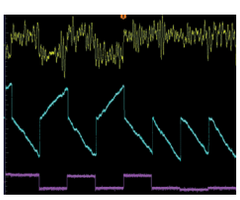
Eye Patterns



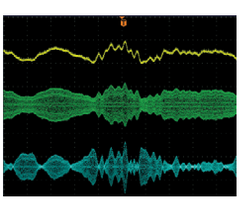
16-QAM



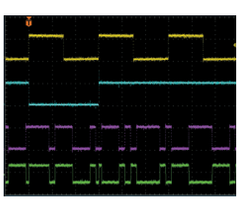
Delta Modulation



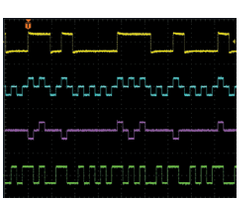
Integrate & Dump



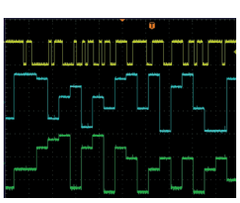
Speech AM & DSB



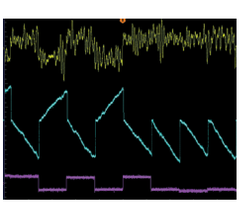
DSSS



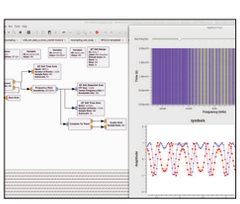
Line Code Encodes



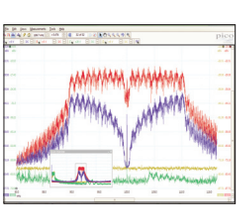
Multi-Level I & Q



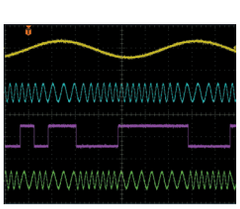
Matched Filter



SDR - GNURadio



OFDM



FM and PM

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 & EASILY EXPANDABLE**
- **ALL-IN-ONE COMPLETE SYSTEM**
- **IN-BUILT PC-INTERFACE INSTRUMENTATION**
- **IDEAL FOR STUDENT CAPSTONE PROJECTS**

"With TIMS you are able to convey reality. I have seen conceptual difficulties virtually vaporize within seconds of a demonstration."

Dr R. Radzyner - Senior Lecturer UNSW Sydney, Australia

COMMUNICATIONS SYSTEMS THEORY

From Theory to Impactful Hands-on Learning .....

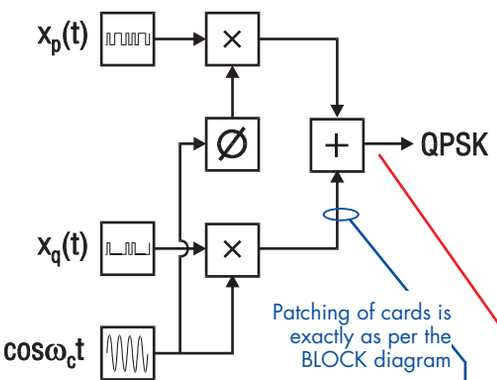
START WITH MATH OR THEORY

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

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

Telecommunications text books are a source of equations and theories.

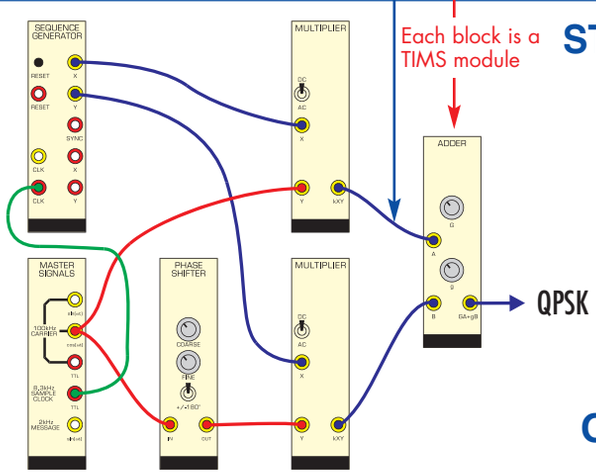
REPRESENT IT AS A BLOCK DIAGRAM



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

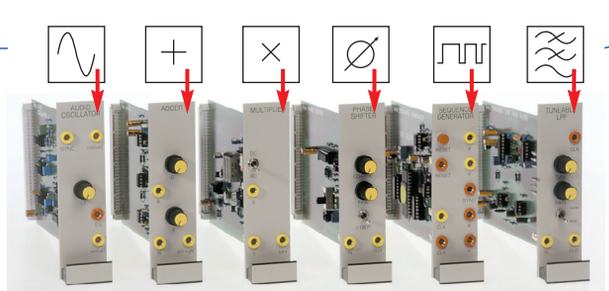
Telecommunications engineers make sense of math and theory through BLOCK DIAGRAMS.

STUDENTS BUILD WITH TIMS "MODULES"



Students follow the BLOCK DIAGRAMS to build experiments to view and measure REAL TIME SIGNALS.

ONE "MODULE" FOR EACH BLOCK



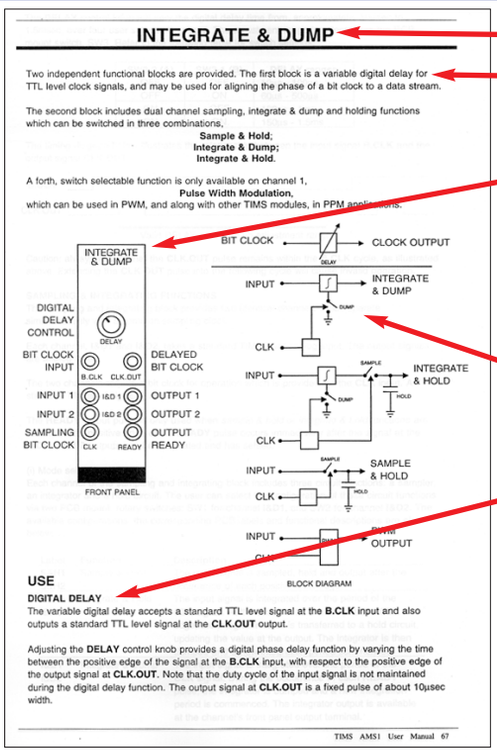
70+ CARDS TO CHOOSE FROM

TIMS "modules", independent electronic circuit cards, are used interchangeably as required by the selected experiment.

Students build each experiment, step-by-step

Easy, turn-key solutions for your lab

• COMPREHENSIVE USER MANUALS



INTEGRATE & DUMP

Two independent functional blocks are provided. The first block is a variable digital delay for TTL level clock signals, and may be used for aligning the phase of a bit clock to a data stream.

The second block includes dual channel sampling, integrate & dump and holding functions which can be switched in three combinations,
Sample & Hold;
Integrate & Dump;
Integrate & Hold.

A forth, switch selectable function is only available on channel 1,
Pulse Width Modulation,
which can be used in PWM, and along with other TIMS modules, in PPM applications.

INTEGRATE & DUMP
DIGITAL DELAY CONTROL
DELAY
BIT CLOCK INPUT
B.CLK
CLK.OUT
DELAYED BIT CLOCK
INPUT 1
I&D 1
OUTPUT 1
INPUT 2
I&D 2
OUTPUT 2
SAMPLING BIT CLOCK
CLK
READY
OUTPUT READY
FRONT PANEL

BIT CLOCK
CLOCK OUTPUT
DELAY
INPUT
INTEGRATE & DUMP
DUMP
CLK
SAMPLE
INTEGRATE & HOLD
HOLD
SAMPLE & HOLD
OUTPUT
BLOCK DIAGRAM

USE

DIGITAL DELAY

The variable digital delay accepts a standard TTL level signal at the **B.CLK** input and also outputs a standard TTL level signal at the **CLK.OUT** output.

Adjusting the **DELAY** control knob provides a digital phase delay function by varying the time between the positive edge of the signal at the **B.CLK** input, with respect to the positive edge of the output signal at **CLK.OUT**. Note that the duty cycle of the input signal is not maintained during the digital delay function. The output signal at **CLK.OUT** is a fixed pulse of about 10µsec width.

TIMS AMS1 User Manual 67

Card name

Concise description of the card's function

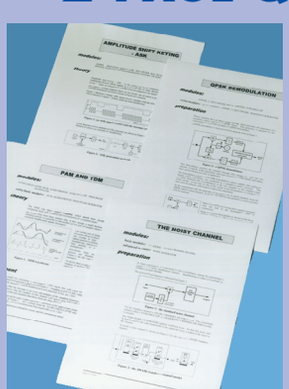
Labelled front panel illustration

Labelled block diagrams

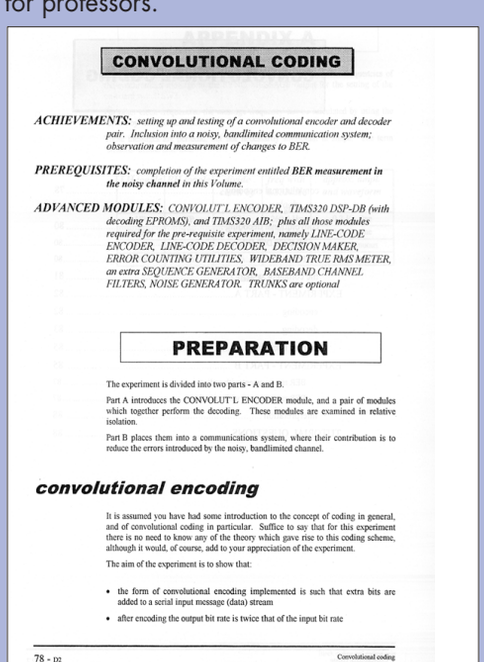
Detailed user information

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

• 2-PAGE QUICK START "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.



CONVOLUTIONAL CODING

ACHIEVEMENTS: setting up and testing of a convolutional encoder and decoder pair. Inclusion into a noisy, bandlimited communication system; observation and measurement of changes to BER.

PREREQUISITES: completion of the experiment entitled ***BER measurement in the noisy channel*** *in this Volume.*

ADVANCED MODULES: CONVOLUT'L ENCODER, TIMS320 DSP-DB (with decoding EPROMS), and TIMS320 AIB; plus all those modules required for the pre-requisite experiment, namely LINE-CODE ENCODER, LINE-CODE DECODER, DECISION MAKER, ERROR COUNTING UTILITIES, WIDEBAND TRUE RMS METER, an extra SEQUENCE GENERATOR, BASEBAND CHANNEL FILTERS, NOISE GENERATOR. TRUNKS are optional

PREPARATION

The experiment is divided into two parts - A and B.

Part A introduces the CONVOLUT'L ENCODER module, and a pair of modules which together perform the decoding. These modules are examined in relative isolation.

Part B places them into a communications system, where their contribution is to reduce the errors introduced by the noisy, bandlimited channel.

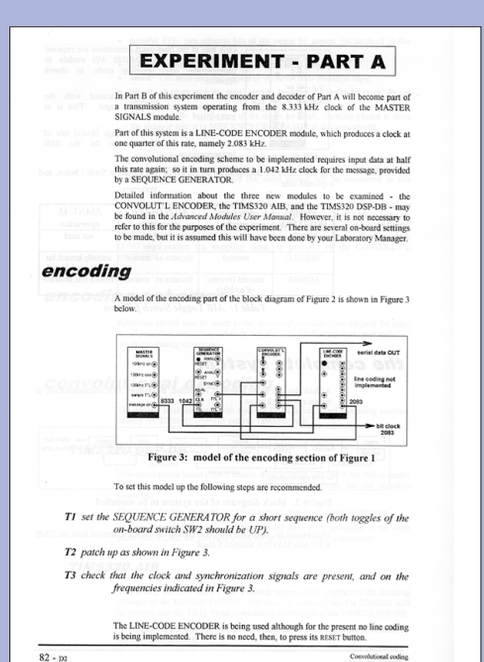
convolutional encoding

It is assumed you have had some introduction to the concept of coding in general, and of convolutional coding in particular. Suffice to say that for this experiment there is no need to know any of the theory which gave rise to this coding scheme, although it would, of course, add to your appreciation of the experiment.

The aim of the experiment is to show that:

- the form of convolutional encoding implemented is such that extra bits are added to a serial input message (data) stream
- after encoding the output bit rate is twice that of the input bit rate

78 - D2 Convolutional coding



EXPERIMENT - PART A

In Part B of this experiment the encoder and decoder of Part A will become part of a transmission system operating from the 8.333 kHz clock of the MASTER SIGNALS module.

Part of this system is a LINE-CODE ENCODER module, which produces a clock at one quarter of this rate, namely 2.083 kHz.

The convolutional encoding scheme to be implemented requires input data at half this rate again; so it in turn produces a 1.042 kHz clock for the message, provided by a SEQUENCE GENERATOR.

Detailed information about the three new modules to be examined - the CONVOLUT'L ENCODER, the TIMS320 AIB, and the TIMS320 DSP-DB - may be found in the *Advanced Modules User Manual*. However, it is not necessary to refer to this for the purposes of the experiment. There are several on-board settings to be made, but it is assumed this will have been done by your Laboratory Manager.

encoding

A model of the encoding part of the block diagram of Figure 2 is shown in Figure 3 below.

serial data OUT
line coding not implemented
8333
1042
2083
bit clock 2083

Figure 3: model of the encoding section of Figure 1

To set this model up the following steps are recommended.

T1 set the SEQUENCE GENERATOR for a short sequence (both toggles of the on-board switch SW2 should be UP).

T2 patch up as shown in Figure 3.

T3 check that the clock and synchronization signals are present, and on the frequencies indicated in Figure 3.

The LINE-CODE ENCODER is being used although for the present no line coding is being implemented. There is no need, then, to press its RESET button.

82 - D2 Convolutional coding

• 16 VOLUMES OF DETAILED "STUDENT TEXT"EXPERIMENTS

Plus another sixteen volumes, across more than 5,500 pages, of **TIMS Student Text Experiments**, providing an in-depth coverage of a broad range of communications theory, wireless, signals & systems, fiber optics and software defined radio experiments. source of experiment ideas and serve to provide an accelerated familiarization for professors.

Mark 'x' to select experiments for your curriculum

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**

THREE TIMS Chassis Options

Choose the Chassis that suits your experiments and budget..... from in-built advanced multi-channel instrumentation through to basic functionality

TIMS-304C/Gen2 - MULTI-INSTRUMENT Chassis

NEW

MODEL TIMS-304C/Gen2 4 Channel System includes:

- **4 Channel PC-based virtual instrument**
  oscilloscope
  spectrum analyzer displays,
  frequency counter
  true RMS voltmeter
- **Function Generator with**
  Arbitrary Waveform Generator

- 12 Slots for PLUG-IN CARDS
- Frequency and Event Counter

- 8 Standard Fixed Cards
- System Power Supply
- 5 Channel TIMS Trunks Lab Network Option

TIMS-301 - STANDARD System Chassis

MODEL TIMS-301 Standard System includes:

- **2-channel switched BNC-4mm scope selector**
  for connection to external oscilloscope

- 12 Slots for PLUG-IN CARDS
- Frequency and Event Counter

- 7 Standard Fixed Cards
- System Power Supply
- 3 Channel TIMS Trunks Lab Network Option

TIMS-801 JUNIOR - Compact Basic System Chassis

MODEL TIMS-801 Junior System includes:

- 8 Slots for PLUG-IN CARDS
- 5 digit Frequency and Event Counter

- 4 Standard Fixed Cards
- System Power Supply

TIMS-300-SERIES and the BASIC "Modules" Bundle

The TIMS-300-Series BASIC BUNDLE includes:

- A **TIMS-304C/Gen2, TIMS-301** or **TIMS-801 System Unit**

PLUS

- **TIMS BASIC Module Bundle**

- Basic and Advanced cards **User Manuals**;
- Detailed **Student Text** experiment manuals;
- Short-cut **LabSheet** experiment manuals;
- Perspex Cards Storage Box
- Standard accessories

13 x TIMS BASIC Modules Bundle (PLUG-IN cards)

- 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 "BASIC BUNDLE" EXPERIMENT CAPABILITES USING THE ABOVE "MODULES":

- 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 Simulation Software OPTION for PreLab Learning at Home

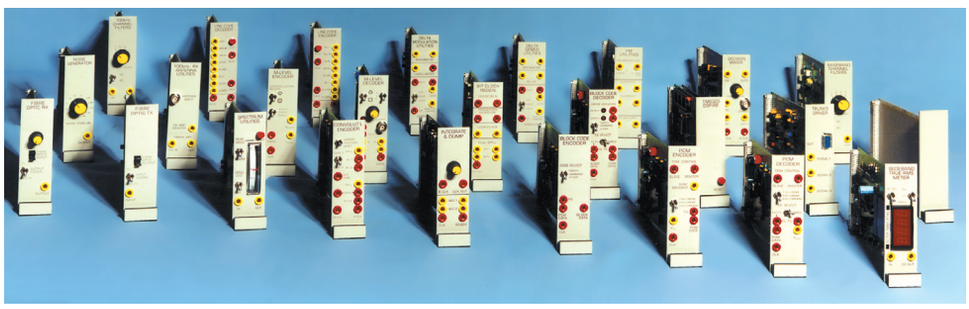
TutorTIMS Simulator for PreLab

A modern graphical, easy to use software simulator to help students prepare at home. Available as **TutorTIMS-BASIC** for "BASIC SYSTEM" experiments.

ADVANCED building blocks to enhance experiment capabilities now and into the future

TIMS ADVANCED modules/cards include over 70 specialised building blocks to expand the range of analog, digital, digital signal processing (DSP) and SDR experiments.

New ADVANCED cards are continuously being developed to enable the implementation of the latest in telecommunications and signal processing theory experiments.



Advanced Cards/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**

The most popular expansion bundle option: "EVAL-16 KIT" to add a range of quantitative, SNR, BER & digital modulation experiments

Add another 16 x BASIC and ADVANCED cards to the TIMS-300 BASIC to build a comprehensive and advanced telecommunications laboratory system

TIMS-300 BASIC BUNDLE

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

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

PLUS

TIMS EVAL-16 BUNDLE

A kit of 16 additional TIMS cards:

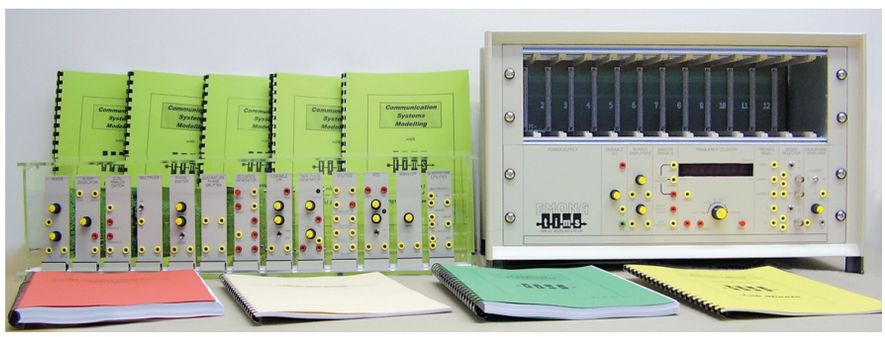
Additional BASIC cards include

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

Additional ADVANCED cards

- 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**

The EVAL-16 KIT includes the complete TIMS-300 BASIC BUNDLE



PLUS the 3 BASIC and 13 ADVANCED modules BUNDLE

TIMS modules (independent electronic circuit cards) are used interchangeably as required by the selected experiment.

Students build telecoms experiments by picking the TIMS modules required to implement the selected experiment, plugging them into the TIMS System rack and patching outputs and inputs to build the experiment.

Additional experiments that can be built using the EVAL-16 BUNDLE:

- **Experiment capabilities include all of the TIMS-300 BASIC Experiments listed on PAGE 7, *PLUS* the following ADVANCED Experiments:**
- 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

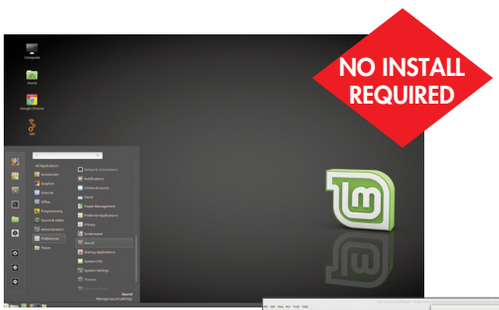
TIMS Software Defined Radio Bundle

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

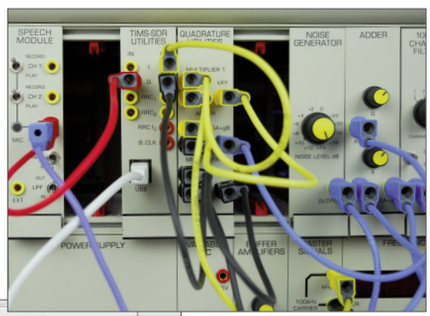
NEW

TIMS-SDR Bundle

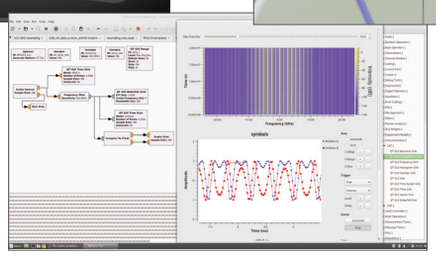
TIMS-SDR Kit is a *zero-install, plug-and-play*, hardware and software package which enables the student to quickly and easily experiment with the graphical GNU Radio Companion software tools in the TIMS telecommunications platform with real signals.



LINUX MINT pre-installed



REAL SDR HARDWARE



GNURadio pre-installed

Requires the TIMS-300 SYSTEM UNIT plus:

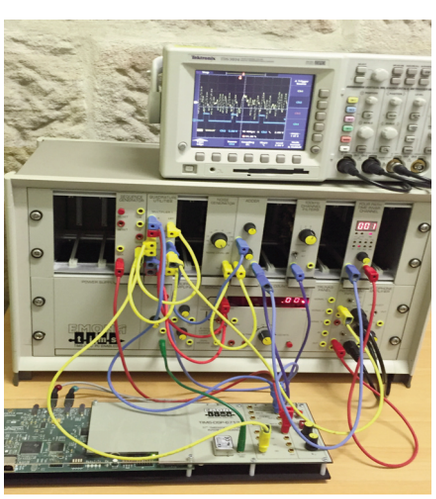
- TIMS-451 **TIMS-SDR Utilities Card** and **TIMS-USB** with **pre-installed LINUX and GNURadio**

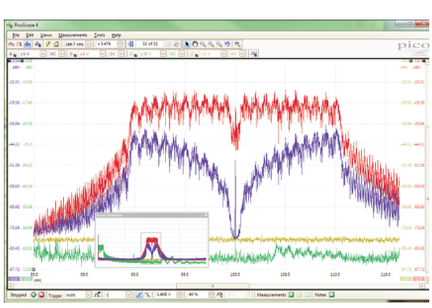
EXPERIMENTS documented in the TIMS Experiment Manuals:

- 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

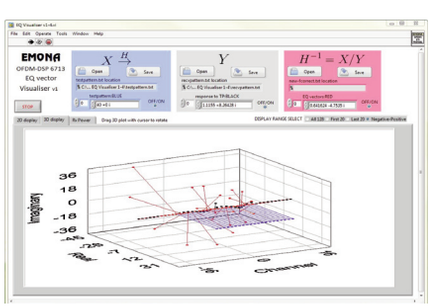
TIMS OFDM Bundle

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-300 SYSTEM UNIT, a TIMS-DSP-6713 DSP card and a selection of TIMS-400 Series Advanced cards.

EXPERIMENTS documented in the TIMS Experiment Manuals:

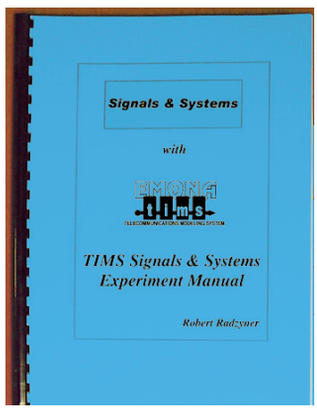
- Introduction to OFDM using discrete cards (non-DSP)

Experiments utilizing the TIMS-DSP-6713 Card

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

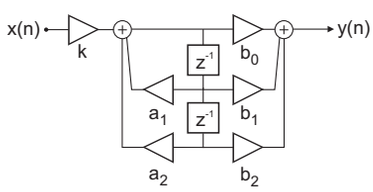
Signals & Systems Bundle

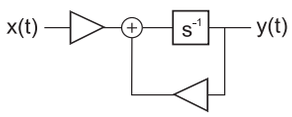
Real signals - No simulation: no DSP. Hardware experiments to help students relate the complex S&S math to the real-world



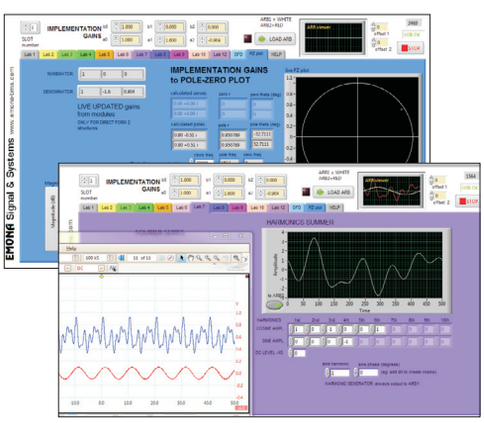
A COMPLETE COURSE OF EXPERIMENTS

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.





PLUS

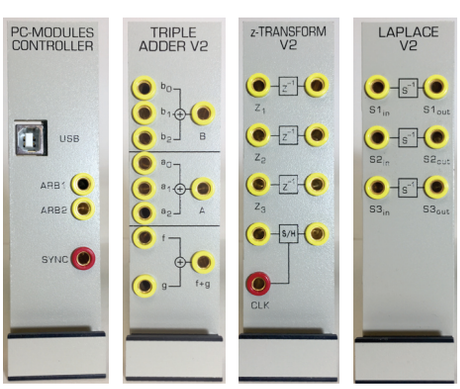


Experiment Control Software

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.

PLUS



Signals & Systems Hardware Bundle

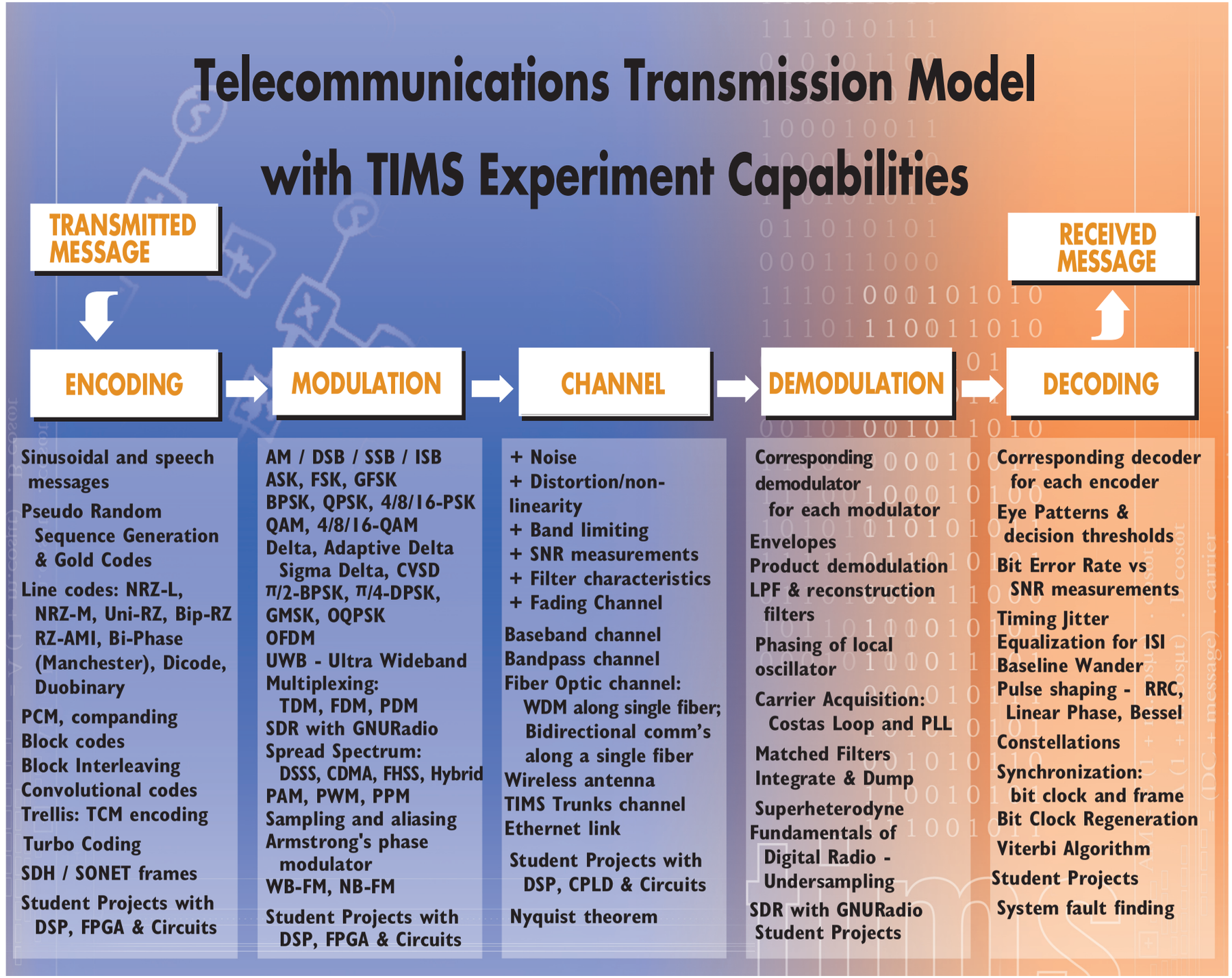
The TIMS Signals & Systems Module Bundle includes four fundamental cards:

- 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.

EXPERIMENTS documented in the TIMS Signals & Systems Experiment Manual:

Lab 1: Intro to the Signals & Systems V2 module bundle
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

Telecommunications Transmission Model with TIMS Experiment Capabilities



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