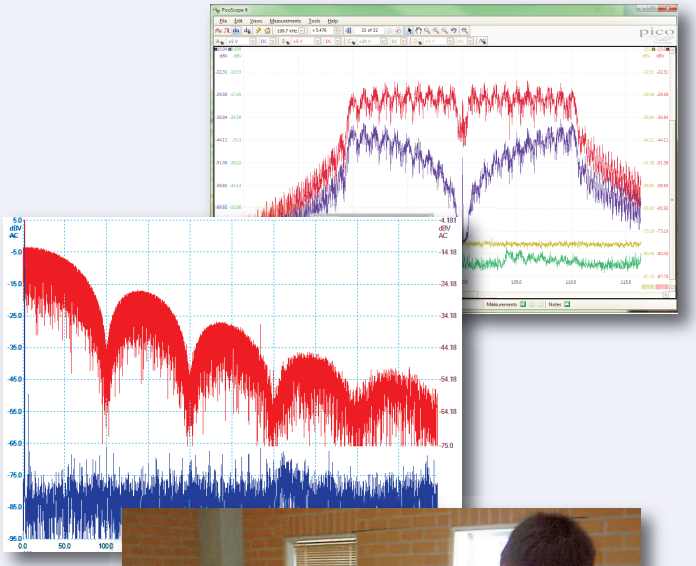
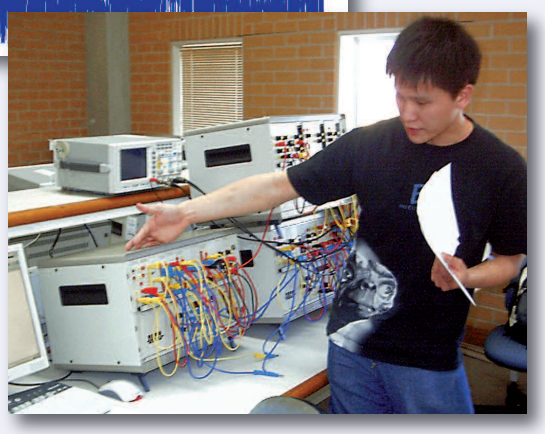
UPDATED

Exploring Wireless Communications Standards with Emona TIMS

Telecommunications, SDR and Signals & Systems Hands-on Lab Experiments for University and College Students

- LTE
- 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
- and much more . . .





Exploring Wireless Communications Standards with Emona TIMS

TIMS is used by students to implement modulation and coding schemes at the block diagram level. These schemes are **modelled** often partially and not implemented fully or at commercial RF frequencies. All measurements obtained with TIMS are mathematically correct and correspond to theory. Note that with TIMS, expensive commercial RF test instruments are **not** required.

APPLICATION	MODULATION SCHEME	TIMS EXPERIMENTS
REMOTE CONTROL APPLICATIONS		
ZigBee™	BPSK	L-28, L-29, L-50, L-118; D1-08, D7-03
also	O-QPSK	D4-05, D4-06
Remote Keyless Entry	BFSK	D7-01, D7-02, L-32, L-33
Tire Pressure Monitoring System	OOK	L-26, L-27
CORDLESS RADIOTELEPHONE		
Cordless Telephone	FM	L-12, L-13, L-14, L-84, L-85
Personal Handy System	pi/4 DQPSK	D4-06
Digital European Cordless Telephone (DECT)	MSK, GFSK	D4-04, D4-06
CELLULAR TELEPHONE		
GSM / GPRS	MSK	D4-04, D4-06
also	BFSK	L-32, L-33; D1-07, D7-02
EDGE	8-PSK	L-115, L-34
Wideband-CDMA	QPSK: DS-SS	L-62 to L-65, L-67; D5-01, D6-02, L-30, L-31
HSDPA	QPSK, QAM, 16QAM: CDMA	L-48, L-49
HSUPA	QPSK, QAM: CDMA	L-48, L-49, L-30, L-31, L-62 to L65, L-67
CDMA2000®	CDMA	D5-01, D6-01, L-62 to L-65, L-67
with	QPSK or OQPSK	D2-13, L-30, L-31, D4-05, D4-06
Long Term Evolution (LTE)	OFDM	D3-06, L-103, D8-03, L-151 to 156
with	QPSK,16QAM	D2-13, L-30, L-31, L-115
cdmaOne (IS-95)	O-QPSK: CDMA	D4-05, D4-06
EV-DO	QAM: CDMA	L-48, L-49, L-62 to L-65, L-67
TETRA	pi/4-DQPSK, QAM, 16QAM	D4-06, L-48, L-49, L-115
WIRELESS DATA		
IEEE 802.11 Wireless LAN	DBPSK: DS-SS	D6-01, D6-02, L-57, D7-03
also	GFSK: FH-SS	D3-09 to D3-12, D5-02, D3-18, D7-03
Wi-Fi 1 (802.11b)	QPSK: DS-SS	L-30, L-31, L-115, L-62 to L-65, D5-01, D6-01
Wi-Fi 2 (802.11a/g)	OFDM/DS-SS with	D3-06, L-103, L-48, L-49, D5-01, D8-03
	BPSK, QPSK, 16QAM	L-30, L-31, L-28, L-29, L-115
WiMAX	OFDM	D3-06, L-103; D8-03, L-151 to 156
with	BPSK, QPSK, QAM, 16QAM	L-30, L-31, L-28, L-29

APPLICATION	MODULATION SCHEME	TIMS EXPERIMENTS
PERSONAL AREA NETWORK		
Bluetooth® 1.0	BFSK	D7-01, D7-02, L-32, L-33
also	FH-SS with GFSK	D3-09 (FH-SS), D3-18 (GFSK)
Bluetooth® 2.0 - Enhanced Data Rate	pi/4-DQPSK	D4-06
Near Field Communication (NFC)	ASK (Manchester)	L-26, L-27, L-42 (line codes); D1-06
RFID	PWM, FSK, ASK, BPSK	D1-06, D1-07, D1-08, L-28, L-29, L-27, L-26
also	AM, FM	A1-04, A2-09, A2-10, A2-11 to 15, D2-11
UWB	PAM, OOK, PSM (MHP,	D4-08, D4-12, D4-13, D4-15
	gaussian), BPSK/QPSK	A1-11, D1-08
DIGITAL COMMERCIAL BROADCASTING		
Digital Radio DAB	OFDM with DQPSK	D3-06; L-103, D4-06, D8-03, L-151 to 156
Digital Video Broadcasting-Satellite (DVB-S)	QPSK, 16QAM	L-30, L-31, L-115, L48, L-49
Digital Video Broadcasting-Satellite (DVB-S2)	QPSK, 8PSK	L-30, L-31, L-115, L-34
Digital Video Broadcasting-Terrestrial (DVB-T)	OFDM with QPSK, 16QAM	D3-06, L-30, L-31; L-115, L-151 to 156
SATELLITE COMMUNICATIONS		
Satellite Modems	BPSK,QPSK,OQPSK,	L-28/29,L-50, L-118; D4-03 to D4-06
	8PSK, 16QAM	L-115
also	Convolutional Coding	L-86, L-87; D2-09
Satellite Links	QPSK, pi/4-QPSK, MSK	L-28/29, D4-04, D4-06, L-31, L-31
with a combination of any of the following:	TCM Trellis Coding	L-59, L-61; D2-10
	PCM	D1-11, D1-12; L-24, L-25
	Delta Mod/Adaptive Delta Mod	L-43 to 46; D1-13 to 15
	FDM	L-17, A2-07
	CDMA	L-62, L-64, L-65; D6-01
	TDMA	D5-03 (TH-SS); A1-11 (PAM & TDM)
Enhanced Bandwidth Efficient Modem (EBEM)	8PSK	L-115, L-34
Deep Space Telemetry	BPSK	L-28, L-29, L-50, L-118; D1-08, D4-03
NAVIGATION		
GPS	BPSK	L-28, L-29, L-50, L-118; D1-08, D4-03

KEY

L-xxx : TIMS LabSheet Experiment number. LabSheet experiments are concise 2 page experiment descriptions.
Dx-xx : TIMS Student Text Volume (Dx) and Experiment number (-xx). Student text are detailed experiments.

NOTES

The information in this document is provided as an overview and summary of the typical modulation and coding schemes implemented. Actual data as well as information regarding current standards may differ from the statements contained in the above. Error and Omissions Excepted.

Emona TIMS Experiments Listing

Below is a listing of the contents pages of the 11 volumes of TIMS detailed "Student Text" Experiment Manuals, the TIMS Signals & Systems Lab Manual and the unique TIMS "LabSheet" Experiments Manual.

New TIMS experiments are published regularly. All professors using TIMS have free web access to all TIMS experiment documents including the latest experiments and latest user manual chapters.

Emona TIMS Student Text Lab Manual
Volume A1 - Fundamental Analog Experiments
186 pages

Emona TIMS Student Text Lab Manual
Volume D1 - Fundamental Digital Experiments
178 pages

Emona TIMS Student Text Lab Manual
Volume A2 - Further & Advanced Analog Expts
172 pages

Emona TIMS Student Text Lab Manual
Volume D2 - Further & Advanced Digital Experiments
162 pages

Emona TIMS Student Text Lab Manual
Volume D3 - Advanced Digital Experiments
168 pages

Emona TIMS Student Text Lab Manual
Volume D4 – Further Advanced Digital Experiments
452 pages

Emona TIMS Student Text Lab Manual
Volume D5 – Basic Spread Spectrum Experiments
168 pages

Emona TIMS Student Text Lab Manual
Volume D6 – Advanced Spread Spectrum Experiments
168 pages

Emona TIMS Student Text Lab Manual
Volume D7 – Advanced BER Experiments
154 pages

▶ NEW:

Emona TIMS Student Text Lab Manual
Volume D8 – Multipath and OFDM Experiments
102 pages

▶ NEW:

Emona TIMS Student Text Lab Manual
Volume D9 – RADAR Signals Experiments
66 pages

Emona TIMS Experiments Listing - continued

Emona TIMS Student Text Lab Manual
TIMS Signals & Systems-V1 Experiments
(The S&S V1 experiments utilize the manually controlled LAPLACE-V1 and z-TRANSFORM-V1 plug-in modules.)

192 pages

Introduction
Special signals – characteristics and applications . . . S1-01
Modeling linear and nonlinear systems with TIMS . . . S1-02
Unraveling convolution . . . S1-03
Comparing responses in the time and frequ domains S1-04
A Fourier series analyzer . . . S1-05
Spectrum analysis of various signal types . . . S1-06
Getting started with poles and zeros in the Laplace domain S1-07
Sampling and Aliasing . . . S1-08
Getting started with analog-digital conversion . . . S1-09
Discrete-time filters – Finite Impulse Response . . . S1-10
Using poles and zeros in the z plane: discrete-time filters . . . S1-11
Discrete-time filters – practical applications . . . S1-12
Parseval's Theorem- Relationship between time & frequency domain . . . S1-13
Random Signal Analysis: AWGN and erfc . . . S1-14

▶ **NEW:**

Emona TIMS Student Text Lab Manual
TIMS Signals & Systems-V2 Experiments
(The S&S V2 experiments utilize the PC controlled LAPLACE-V2, z-TRANSFORM-V2, TRIPLE ADDER-V2 and PC-MODULES CONTROLLER plug-in module set.)

210 pages

Introduction
Introduction to the Signals & Systems V2 module set . S2-01
Special signals – characteristics and applications . . . S2-02
Systems: linear and nonlinear . . . S2-03
Unraveling convolution . . . S2-04
Integration, correlation & matched filters . . . S2-05
Exploring complex numbers and exponentials . . . S2-06
Build a Fourier series analyzer . . . S2-07
Spectrum analysis of various signal types . . . S2-08
Poles and zeros in the Laplace domain . . . S2-09
Sampling and Aliasing . . . S2-10
Getting started with analog-digital conversion . . . S2-11
Discrete-time structures – Finite Impulse Response . . . S2-12
Poles and zeros in the z plane with IIR systems . . . S2-13

▶ **EXPANDED:**

Emona TIMS LabSheet Experiments

394 pages

Emona TIMS LabSheets are concise, 2 page, quick-start experiment guides

Introduction to TIMS . . . L-01
Modelling equations . . . L-02
DSB - generation . . . L-03
Product demodulation . . . L-04
Amplitude modulation - 1 . . . L-05
Amplitude modulation - 2 . . . L-06
Envelope detection . . . L-07
SSB generation . . . L-08
SSB demodulation . . . L-09
ISB - independent sideband . . . L-10
Armstrongs phase modulator . . . L-11
FM generation by VCO . . . L-12
FM demodulation by PLL . . . L-13
FM demodulation by ZX counter . . . L-14
Sampling . . . L-15
PAM & TDM . . . L-16
FDM - frequency division multiplex . . . L-17
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▶ THE LATEST ADDITIONS:

HOW STUDENTS FOLLOW THEORY TO BUILD TIMS COMMUNICATIONS EXPERIMENTS

Students use exactly the same approach to building telecommunications experiments in both Emona TIMS hardware and Emona TutorTIMS pre-lab learning software.

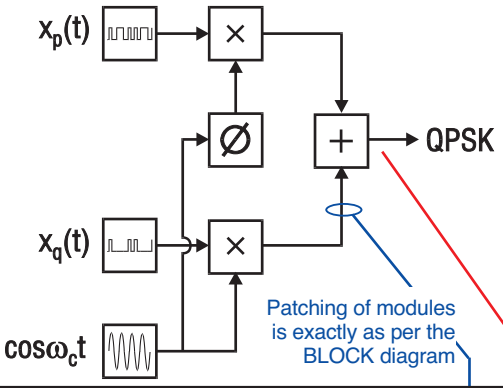
$$x_p(t).\cos \omega_c t + x_q(t).\sin \omega_c t = QPSK$$

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 & TutorTIMS experiment.

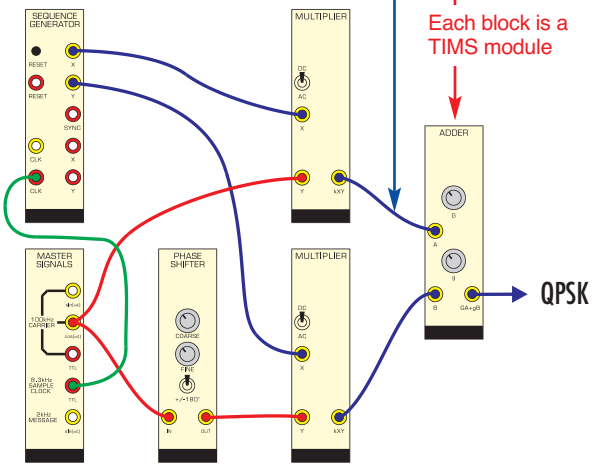
REPRESENT IT AS A BLOCK DIAGRAM



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 & TutorTIMS MODULES



TIMS & TutorTIMS both realise telecommunications BLOCK DIAGRAMS. TIMS realises block diagrams with real circuits. TutorTIMS realises block diagrams with on-screen graphical blocks, which run simulation code in the background.

References

A non-exhaustive list of sources includes: Digital Communications, Kamilo Feher; Digital Communications with Fiber Optics & Satellite Applications, Harold B. Killen; Practical Digital Wireless Signals, Earl McCune. IEEE, industry Fora and Alliances. All registered trademarks, including ZigBee™, CDMA2000™, Bluetooth™ and others are acknowledged as the property of their registered owners.

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