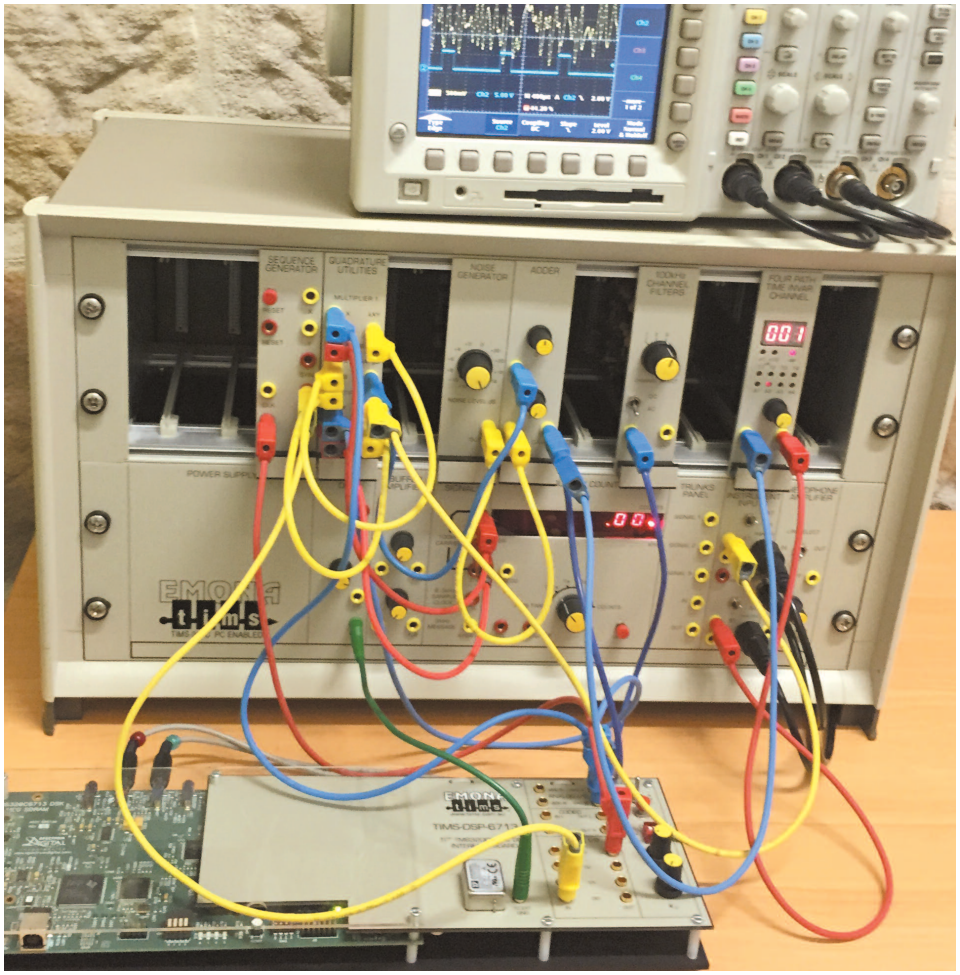
TEACH THE ESSENTIALS OF ADVANCED DIGITAL COMMS

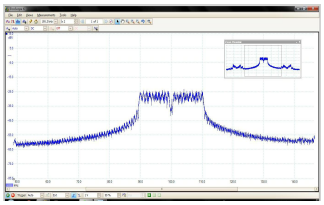
Emona OFDM Experiments

Hands-on hardware experiments teaching the fundamentals of SDR using DSP and real signals

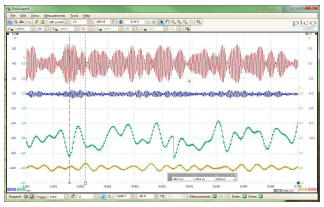


EXPLORE

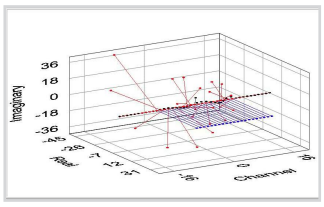
FREQUENCY DOMAIN



TIME DOMAIN



COMPLEX EXPONENTIALS



- ***All "hands-on" experiments***
- ***All with real-time signals***

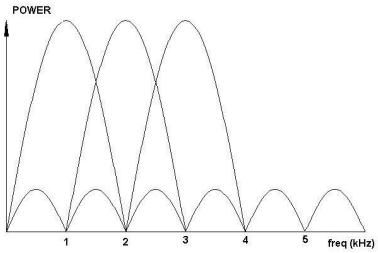
OFDM in the latest technologies:
4G - LTE - WLAN IEEE 802.11a,g,n,ac - Broadband ADSL and VDSL - Digital TV DVB-T - Digital radio DAB/+ - PLC - MoCA - UWB - and more

EMONA INSTRUMENTS
www.emona-tims.com

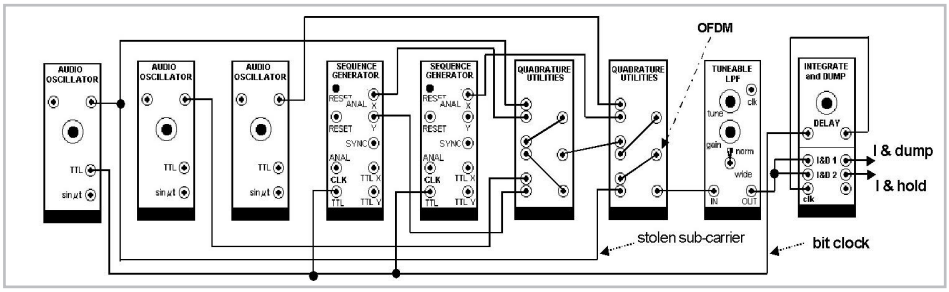
Introduction to OFDM concepts without DSP

With OFDM and its multiple subcarriers implemented in DSP, using IDFT algorithms can be a difficult concept for students to initially understand.

Since TIMS is a true hardware modelling system, TIMS offers an introductory experiment where students actually build a 3-subcarrier OFDM transmitter and receiver using individual oscillator modules. Students manually tune the frequency of each oscillator module to achieve an orthogonal system.



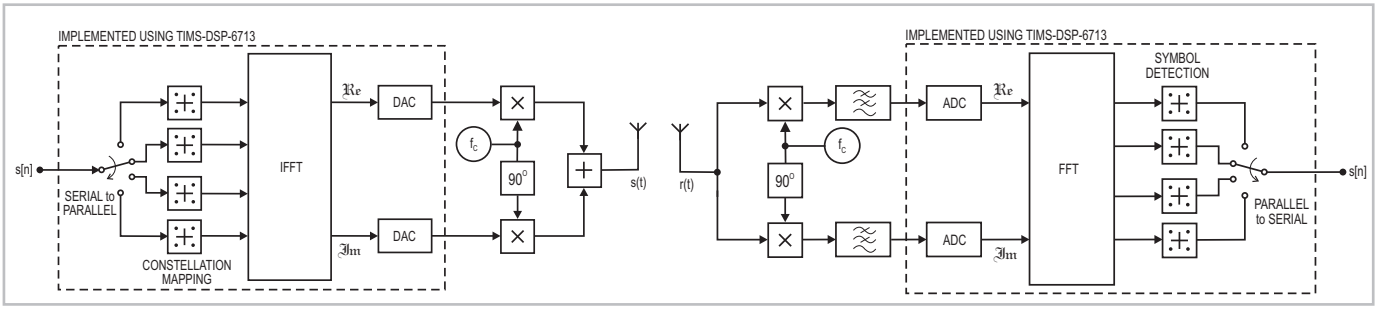
OFDM 3-sub carrier spectrum



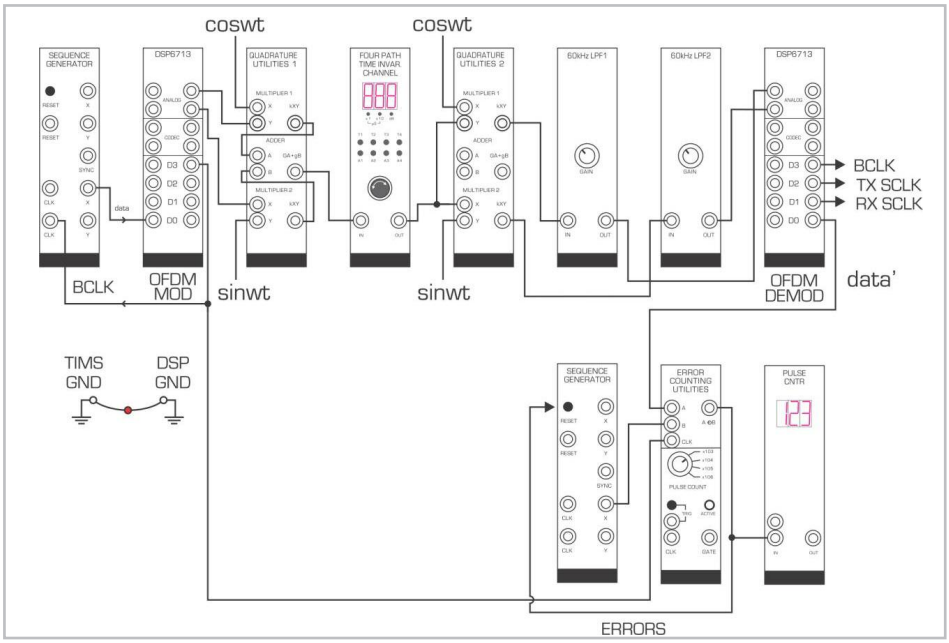
Introduction to OFDM - TIMS discrete subcarrier OFDM implementation

Advanced OFDM experiments with TIMS-DSP-6713

The advanced TIMS OFDM experiments are implemented on the TIMS-DSP-6713 module and used alongside other TIMS modules to build up complete experiments at both baseband and bandpass channels. Up to 20 subcarriers are used with QAM mapping.



TIMS OFDM transmitter and receiver block diagrams using the TIMS-DSP-6713 and discrete modules



TIMS modules implementing an OFDM transmitter, multipath channel and receiver

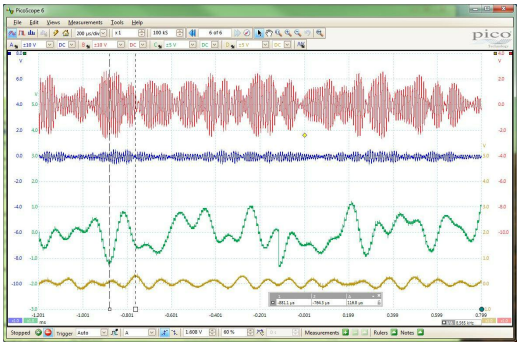
Watch Real time Demo Videos on YouTube CHANNEL
www.youtube.com/EmonaTIMS

Modeling experiments with TIMS clarifies important principles

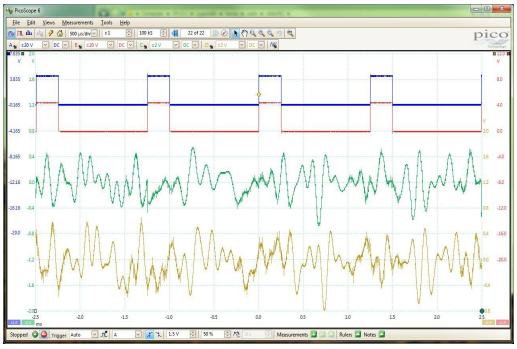
Fully documented OFDM experiments

- IDFT, Complex Exponentials and Complex Quadrature Signals
- OFDM, Cyclic Prefix & PAPR
- OFDM & Channel Equalisation with BER Measurement
- OFDM in band limited, multipath, time-invariant channel with BER measurements
- Comparing QAM to OFDM in a multipath channel
- Multipath effects on OFDM cyclic prefix with BER measurements

Typical TIMS OFDM time domain waveforms

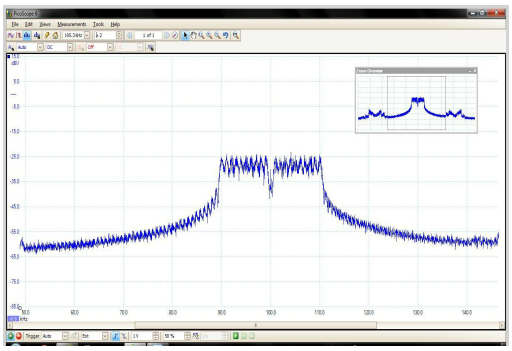


TIMS OFDM signals at baseband and at carrier frequencies

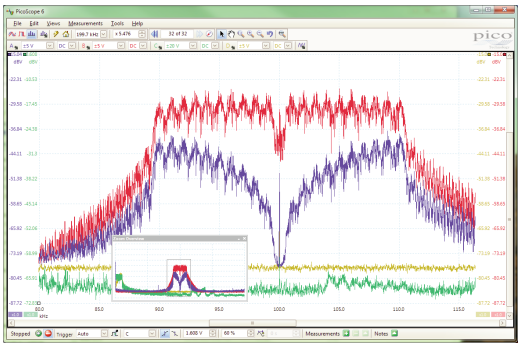


TIMS OFDM I & Q signals at baseband illustrating implementation of Cyclic Prefix

Typical TIMS OFDM spectrum displays



TIMS OFDM spectrum

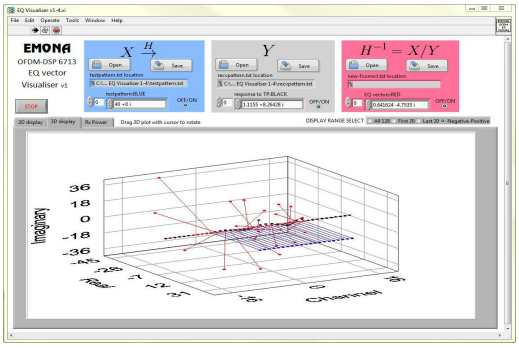


TIMS OFDM signal before and after passing through a multipath channel

TIMS OFDM channel estimation & equalisation displays



2-D amplitude and phase display of OFDM sub-carriers' transmitted/received signals and equalization response



3-D Real & Imaginary vector display of OFDM sub-carriers' transmitted/received signals and equalization response

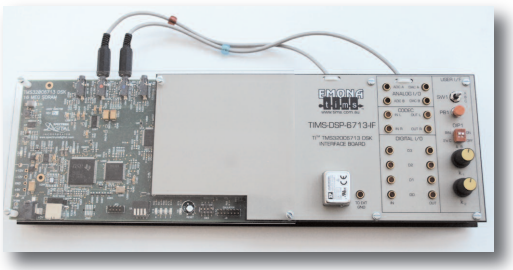
Students engage in the equalisation process reinforcing this essential topic

TIMS OFDM DSP implementation

The TIMS OFDM experiment requires the TIMS-DSP-6713 module and CCS5 software (free academic download) to load the TIMS OFDM software, and a selection of TIMS-100 Series Basic & TIMS-400 Series Advanced TIMS plug-in modules. Oscilloscope and spectrum analyser are essential - as supplied by the TIMS-301C PC-Enabled System.

TIMS-DSP-6713 MODULE

The TIMS-DSP-6713 is based on Texas Instruments' floating point TMS320C6713 processor. The module patches directly into the TIMS-301/C's experiments.



The capabilities include multiple, high speed analog and digital I/O, with physical user controls, allowing students to implement an wide range of telecoms and signals & systems experiments.

The TIMS-DSP-6713 is supplied as a complete package, with all required hardware, links to download software and accessories - ready to run out of the box.

Interface with the host PC is via a USB host interface.

MODES OF OPERATION

TIMS OFDM experiment has three Modes of Operation,

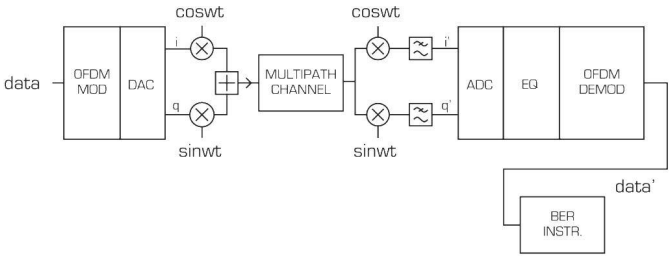
(A) BANDPASS 4-QAM MAPPING
(B) CYCLIC PREFIX MODE ENABLED or DISABLED
(C) TRANSMISSION OF PILOT TEST PATTERN FOR EQUALIZATION TRAINING

Operation Modes are selected via front panel toggle switch and/or program load.

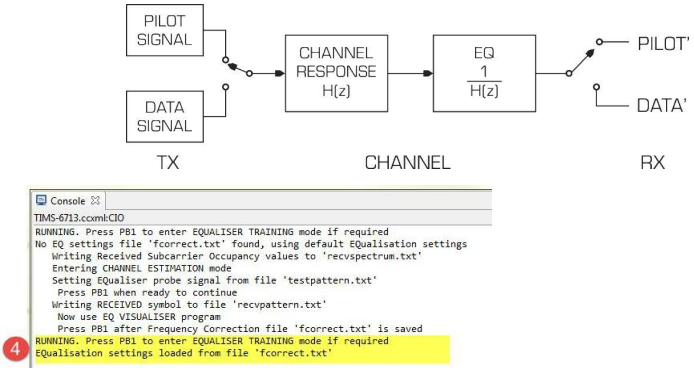
IQ signal sampling delay and amplitude is set by adjusting the front panel knobs.

EQUALIZATION

Equalisation and channel estimation are essential in a phase sensitive scheme such as OFDM. TIMS OFDM enables students to engage fully in developing the equaliser response needed for the many varying bandpass channels that can be implemented, such as multipath, AWGN, etc.



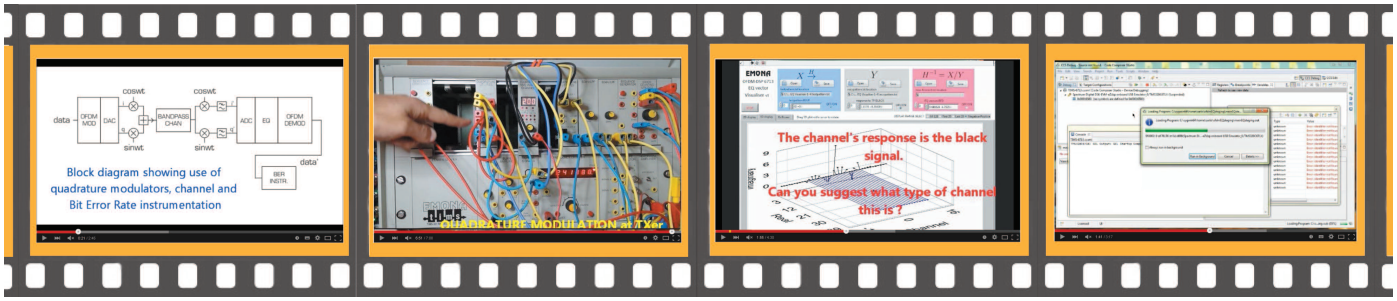
TIMS OFDM system diagram with channel equalization



TIMS OFDM channel equalization block diagram and EQUALIZER code control

The program guides students through channel estimation and equalizer response process with 2D and 3D visualisation.

Watch TIMS OFDM real-time demo videos on youtube.com/emonaTIMS



[OFDM Experiments Overview]

[OFDM in a multipath channel w equalisation]

[Channel estimation & equalisation with OFDM]

[Load and run OFDM on EMONA TIMS 6713 DSP]

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