

## ADVANCE DIGITAL COMMUNICATION EDUCATIONAL SYSTEM

Digital communication has emerged to augment or replace the conventional analog systems, which has been widely used till recently. Digital communication has demonstrated more effective techniques to conserve the radio spectrum by providing new, more efficient modulation and coding methods and a wide variety of analog digital conversion techniques. Those techniques are made possible by the parallel development of solid state technology.

The main functions performed by Digital Encoders are :

### SAMPLING - QUANTIZING - ENCODING.

**We** provide a package of Lab Trainers that give practical ways to understand implement "**Digital Communication Techniques**". **We** offer the 'hands on' trainer systems in a series of ten modules, which act as an aid to practically see, experiment learn the digital techniques applied to communication. These modules, when used with frequency Spectrum Analyser, can show the waveform in **Frequency Domain Pattern's** to understand aliasing, signal drops etc. The System is very useful Engineering colleges, Polytechnics, ITI's and Defence and communication Staff Training Centers to impart practical aspects of "**Digital Communication Techniques**".

The modules now available are:

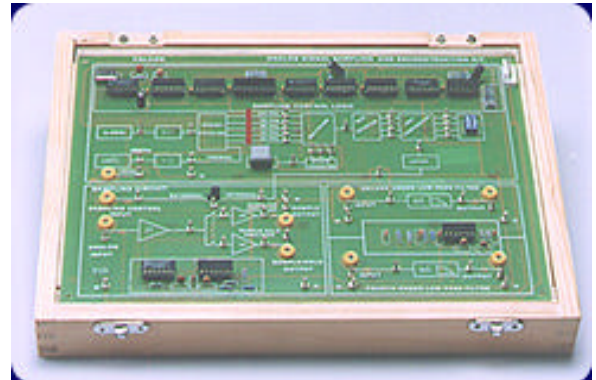
- **TLD-01: ANALOG SIGNAL SAMPLING AND RECONSTRUCTION**
- **TLD-02: TDM PULSE AMPLITUDE MODULATION / DEMODULATION**
- **TLD-03: PULSE CODE MODULATION TRANSMITTER**
- **TLD-04: PULSE CODE DEMODULATION RECEIVER**
- **TLD-05: DATA CONDITIONING AND CARRIER MODULATION TRANSMITTER**
- **TLD-06: DATA RECONDITIONING AND CARRIER DEMODULATION RECEIVER**
- **TLD-07: DELTA, ADAPTIVE DELTA AND SIGMA DELTA MODULATION AND DEMODULATION**
- **TLD-08: PULSE AMPLITUDE MODULATION / PULSE WIDTH MODULATION PULSE POSITION MODULATION TRAINER**
- **TLD-09: STUDY OF FRAMING AND MARKER WITH VOICE CODING**
- **TLD-10: AUDIO INPUT / OUTPUT**

On the next pages the detailed features of each module.

## TLD-01: ANALOG SIGNAL SAMPLING AND RECONSTRUCTION

Sampling theorem - If the frequency spectral component of a magnitude time function -  $m(t)$  - is ' $f_m$ ' then the instantaneous samples taken at a rate  $f_s > 2f_m$  contains all information of the original message. '

This module enables the students to study the theory of Signal Sampling and Signal Reconstruction as an introduction to Digital Communication studies. This kit provides practical training to the students involved in learning the 'Sampling Theorem'.



### Features :

- Analog sampled outputs and sampled 'hold' outputs
- Active low pass filters, 'Butter worth' type of 2nd and 4th order
- On-board 5 different sampling frequencies
- Duty cycle variation in steps of 10% up to 90%
- 1KHz onboard sine wave generator
- Provision for external analog input & sampling signal
- Various test/monitoring points provided on board

### Technical Specifications :

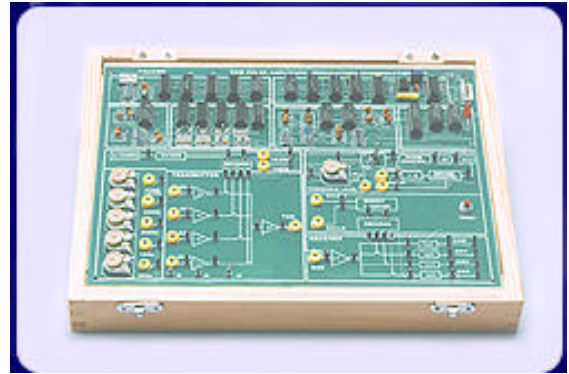
- Onboard Sampling frequencies : 2 kHz, 4 kHz, 8 kHz, 16 kHz, 32 kHz
- Duty cycle : 10% to 90% in 10% steps
- Low pass filter type : Butter worth 2nd and 4th order
- Cut - off frequency : 3.4KHz
- Onboard Sine wave signal : 1 kHz at 5V p-p synchronized
- Interconnection : 2mm banana socket
- Power Supply : +5V, +/-12V

### List of Experiments :

- Study of analog signal sampling & sample-hold and its re-construction
- low pass filter.
- Study of effect of different sampling frequency.
- Study of effect of variation of duty cycle.
- Study of 2nd and 4th Order 'Buterworth' low pass filter for reconstruction.

## TLD-02: TDM PULSE AMPLITUDE MODULATION / DEMODULATION

This module provides facilities to students for experimentation in the areas of Pulse Amplitude Modulation, Demodulation and Time Division Multiplexing of those signals. It provides the students a facility to examine Sampling, Multiplexing, Demultiplexing and Signal Re-construction.



### Features :

- 4 channel analog samplers and multiplexing.
- 4th order Butterworth filter for reconstruction.
- Transmitter and receiver synchronized through PLL.
- On board variable sinewave & DC level generator.
- Various test points provided on board

### Technical Specifications :

- Input channels : 4 numbers
- Switching : Time Division Multiplexing
- Modulation : Pulse Amplitude Modulation
- Sampling rate : 16 KHz
- Maximum signal BW : 2 KHz
- Onboard sinewaves : 2 kHz, 1 kHz, 500 Hz, 250 Hz
- Synchronization pulse : Using (variable) DC level generation
- Phase lock loop : Generates receiver clock and channel information
- Low Pass Filter Type : 4th order Butterworth Filter
- Cut Off frequency : 3.4 KHz
- Interconnection : 2mm standard banana socket
- Power Supply : +5V, +/-12V

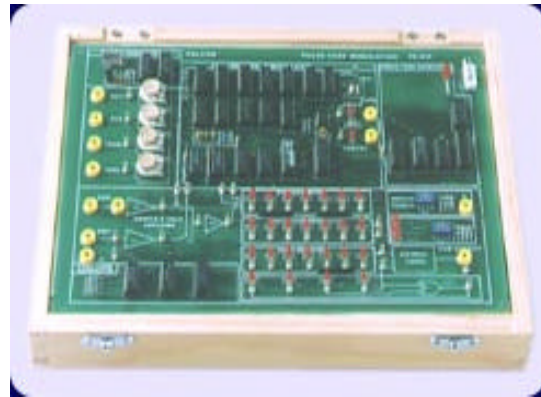
### List of Experiments :

- Study of 4 Channel Division Multiplexing and Demultiplexing.
- Study of TDM Pulse Amplitude Modulation and Demodulation with Transmitter Clock, Channel Identification Information and data connected directly to the Receiver.
- Study of TDM Pulse Amplitude Modulation and Demodulation with Channel Identification Information and data connected directly to the Receiver using Phase Locked Loop Circuiting.
- Study of TDM Pulse Amplitude Modulation and Demodulation with data connected directly to the receiver using the Threshold Level Comparator and Phase Locked Loop Circuiting.

### **TLD-03: PULSE CODE MODULATION TRANSMITTER**

This module allows students to learn and experiment Pulse Code Modulation (PCM) techniques.

Provided are two channel Time Division Multiplexed Pulse Code Modulation kits. It enables students to learn the basics of timing synchronisation between the transmitter and receiver. PCM receiver is a separate kit.



#### **Features :**

- 2 channel TDM Pulse Code Modulation transmitter section.
- Real-time operation using fast mode or Examination of data and control signal using LED's in slow mode.
- Parity selection - None, Even, Odd, Hamming.
- 4 Single Bit error option using switched fault mode.
- On-Board sinewave and two variable amplitude DC Level.
- Various test points provided on-board.

#### **Technical Specifications :**

- Input channels : 2 Nos. Time-division Multiplexed pulse modulated
- Onboard signals : 1KHz, 500Hz variable amplitude
- Synhronised sinewaves; Two Avariable amplitude DC levels
- Synchronization signal : Pseudo random code generation.
- Parity code facility : Even, Odd, Hamming, no Parity.
- Modes of Operation : Fast/Slow.
- Interconnection : 2mm standard banana socket.
- Power Supply : +5V, +/-12V

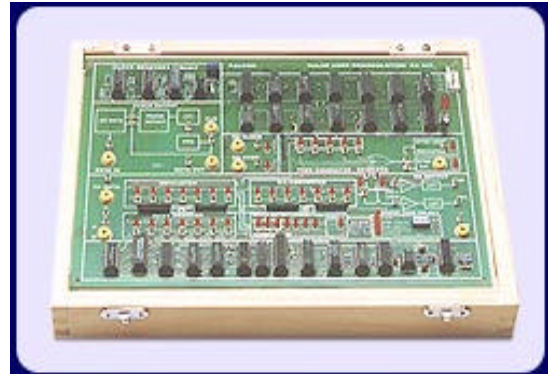
#### **List of Experiments :**

- Study of 2 channel Time Division Multiplexing and its Pulse Code Modulation.
- Study of Analog to Digital Principles
- Study of Pseudo Random sequences Generation.
- Study of Error Generation Code Logic using Odd parity, Even parity and Hamming Parity.
- Study of effect of single bit error using switch faults.

### **TLD-04: PULSE CODE DEMODULATION RECEIVER**

This module has been designed to allow the students to see the decoding of original encoded signal sent through PCM transmitter kit. The receiver kit "phase locks" to the input pulse stream to derive the clock information.

Moreover, by the use of pseudo-random binary sequence, the synchronization between transmitter and receiver is established.



#### **Features :**

- 2 channel Time Division Demultiplexed PCM receiver.
- Real-time operation using fast mode or examination of data and control signals decoding on LED's.
- Low pass filters allow original signals to be reconstructed.
- Single bit error detection, when odd or even parity is selected in the transmitter.
- Single bit error detection, when odd or even parity is selected in the transmitter.
- Various test points provided on-board.

#### **Technical Specifications :**

- Input channels : 2 numbers TDM pulse code modulated data.
- Receiver clock : Generated by phase-lock loop
- Parity check facility : Even, Odd, Hamming
- Low pass filter : 3.4 KHz (cut-off)
- Power Supply : +5V, +/-12V

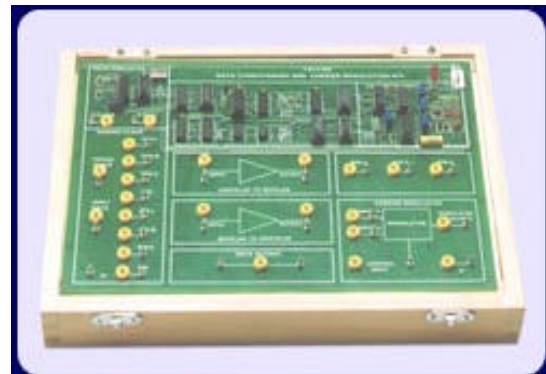
#### **List of Experiments :**

- Study of 2 - channel Time Division Demultiplexing and pulse code demodulation.
- Study of Error Check Code Logic using Odd parity, Even parity and Hamming parity.
- Study of effect of single bit error detection in Odd parity and Even parity mode and single bit error correction in Hamming Parity mode.
- To learn the function of phase lock loop (PLL) to a receiver clock generator and frequency synthesiser.

## TLD-05: DATA CONDITIONING AND CARRIER MODULATION TRANSMITTER

This module allows students to learn the different types of data formats such as Non-Return to Zero, Phase Encoded, Return to Zero and Multilevel binary format which are used in digital transmission systems. It also covers the study of Carrier Modulation techniques.

TLS-05 is a transmitter module where as TLD-06 is receiver kit.



### Features :

- Data conditioning format : NRZ(L), NRZ(M), NRZ(S) Biphase (Manchester), Biphase (Mark), Biphase (Space), RZ, Alternate Mark Inversion (AMI).
- ASK, FSK, PSK Carrier modulation techniques.
- On-Board Data Simulator generates NRZ - L pattern.
- On-Board synchronised three carrier sine waves.
- Various test points provided on-board.

### Technical Specifications :

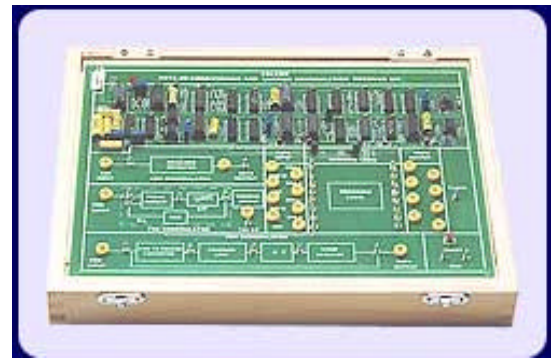
- On board Data simulator : NRZ-L pattern (Onboard)
- Data format (coding) : NRZ(L), NRZ(M), NRZ(S), Biphase (Manchester), Biphase (Mark), Biphase (Space), RZ, AMI.
- Onboard Carrier sinewaves : 2 MHz (0 Deg.), 1 MHz (0 Deg.),
- Carrier Modulation : ASK, FSK, PSK
- Interconnection : 2mm standard banana socket
- Power Supply : +5V, +/-12V

### List of Experiments :

- Data Coding Techniques for Non-Return to Zero format
- Data Coding Techniques for Phase Encoded format
- Data Coding Techniques for return to Zero format and multilevel binary format
- Amplitude Shift Keying Modulation Technique (ASK)
- Frequency Shift Keying Modulation Technique (FSK)
- Frequency Shift Keying Modulation Technique (FSK)
- Phase Shift Keying Modulation Technique (PSK)

## TLD-06 : DATA RE-CONDITIONING AND CARRIER DEMODULATION RECEIVER

This module takes the data streams from TLD-05 as input and does the Reconditioning and Demodulation. This kit enable the students to learns the different types of data format decoding to get the original NRZ-L data. It also covers the study of carrier demodulation techniques.



### Features :

- Data Re-conditioning format : Return to Zero-NRZ(L), NRZ(M), NRZ(S); Phase Encoded-Biphase (Manchester), Biphase (Mark), Biphase (Space), Return to (RZ), Alternate Mark Inversion (AMI).
- ASK, FSK, PSK Carrier modulation techniques.
- Receiver Clock generated by Phase-lock loop.
- Various test points provided on-board.

### Technical Specifications :

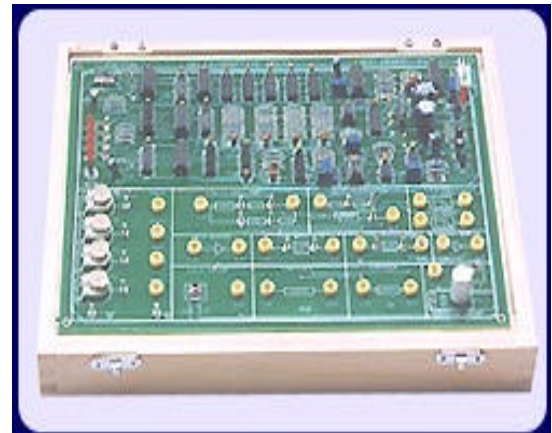
- Data format (coding): NRZ(L), NRZ(M), NRZ(S), Biphase (Manchester), Biphase (Mark), Biphase (Space), RZ, AMI.
- Carrier Modulation : ASK, FSK, PSK
- Receiver Clock : Generated by Phase-lock loop.
- Interconnection : 2mm standard banana socket
- Power Supply : +5V, +/-12V

### List of Experiments :

- Data Coding Techniques for Non-Return to Zero format.
- Data Coding Techniques for Phase Encoded format.
- Data Decoding Techniques for Return to Zero format and multilevel binary format.
- Amplitude Shift Keying Modulation Technique.
- Frequency Shift Keying Modulation Technique.
- Phase Shift Keying Modulation Technique.

### **TLD-07: DELTA, ADAPTIVE DELTA AND SIGMA DELTA MODULATION AND DEMODULATION**

This module provides facilities to students for experimentation in the area of Delta Modulation techniques. It provides the students a facility to examine Delta, Adaptive Delta and Sigma Delta Modulation and Demodulation. An exhaustive manual has been provided with the system, which provides detailed experimental procedure and complete circuit diagram of the system.



#### **Features :**

- Linear Delta Modulation and Demodulation
- Adaptive Delta Modulation and Demodulation
- CVSD Modulation & Demodulation
- Voice Communication using dynamic mic and speaker
- Compressor and Expander
- Selectable Four different Sampling frequencies.
- Four different on board sine wave generator.
- Facility for interfacing external signals
- 2nd and 4th order Low Pass Butterworth Filter
- Unipolar to Bipolar conversion on board
- Integrator Gain setting by variable pot
- Various test and monitoring points provided on-board.

#### **Technical Specifications :**

- Modulation Techniques : Linear Delta Modulation Adaptive Delta Modulation and
- Sampling Frequency : 8KHz, 16KHz, 32 KHz, 64 KHz,
- Onboard SineWave : 250KHz, 500KHz, 1KHz, 2KHz
- Voice communication : using dynamic mic and speaker.
- Low Pass Filter Type : 2nd & 4th Order Butterworth Filter
- Cut-Off Frequency : 3.4 KHz
- Interconnection : 2mm standard banana socket
- Power Supply : +5V, +/-12V
- Cut-Off Frequency

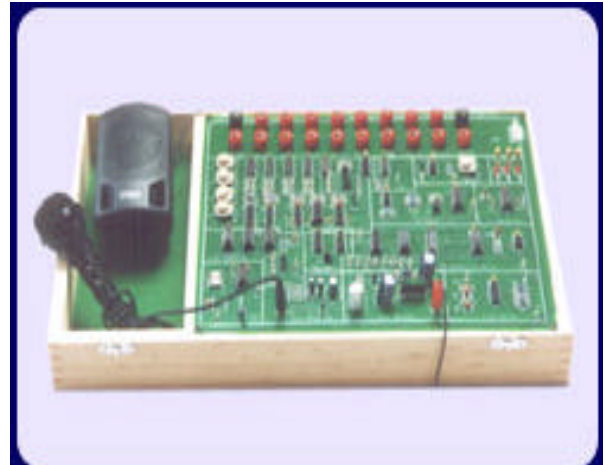
#### **List of Experiments :**

- Study of Delta Modulation and Demodulation
- Study of effect of slope overload and increased integrator gain in Delta Modulation
- Study of Adaptive Delta Modulation and Demodulation
- Study of Sigma Delta Modulation and Demodulation
- Study of Compressor and Expander
- Study of voice communication.



### **TLD-08: PULSE AMPLITUDE MODULATION / PULSE WIDTH MODULATION PULSE POSITION - MODULATION TRAINER -**

This module provides facility to students for experimentation in the area of Pulse Modulation Techniques such as Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM). It provides the students a facility to examine Sampling Modulation, Demodulation and Signal Reconstruction. An exhaustive manual has been provided with the system which provides detailed experimental procedure and complete circuit diagram of the systems.



#### **Features :**

- All type of Modulation & Demodulation techniques using natural & flat top sampling
- Pulse Amplitude Modulation
- Pulse Width Modulation
- Pulse Position Modulation
- Analog sampled outputs & sampled 'hold' outputs.
- Selectable four different Sampling frequency from on-board Pulse Generator.
- Four different on-board sinewave generator.
- Voice Communication using dynamic mic and speaker.
- 4th order Butterworth filter
- Various test/monitoring points provided in-board

#### **Technical Specifications :**

- Pulse Modulation Techniques :: Pulse Amplitude Modulation, Pulse Width Modulation, Position Modulation
- On board Sampling
- Frequency : 4KHz, 8KHz, 16KHz, 32KHz
- On board Sine Wave Generator : 250KHz, 500KHz, 1KHz, 2KHz (Variable amplitude Vpp)
- Voice communication : using dynamic mike and speaker.
- Low Pass Filter Type : 4th Order Butter worth Filter
- Cut-Off Frequency: 3.4 KHz
- Interconnection: 4 mm standard banana socket
- Power Supply +5V, +/-12V
- Cut-Off Frequency

#### **List of Experiments :**

- Study of Pulse Amplitude Modulation and Demodulation using natural Sampling
- Study of Pulse Amplitude Modulation and Demodulation using flat top sampling
- Study of Pulse Width Modulation and Demodulation using natural sampling and top sampling
- Study of Pulse Position Modulation and Demodulation using natural sampling
- Study of Voice Communication Using PAM and PWM Techniques.

## TLD-09: STUDY OF FRAMING AND MARKER WITH VOICE CODING

This module provides to students for experimentation in the area of Framing and Marker time division multiplexing, PCM voice coding using telephone handset, and frequency response of CODEC.

An exhaustive manual has been provided with the system provides detailed experimental procedure and complete circuit diagram of the system.

### Features :

- 32 channel time division multiplexing
- Framing and Marker concept
- PCM Voice coding and decoding
- CODEC Response

### Technical Specifications :

- Data Clock : 2.048MHz
- Switching : Time Division Multiplexing
- No. of Channels : 32-One for marker channel, One for Audio Channel, 30 Channel for Data Switch with LED indication.
- Voice communication : using dynamic mike and speaker.
- Frame Maker : Two 8 bit user selectable markers in alternate frames
- Frame Frequency : 8 KHz
- Modulation Technique : Pulse code modulation using CODEC chip Motorola MC145502
- Voice communication : Using Telephone handsets or External analog signal
- Interconnection : 4mm standard banana socket
- Power Supply : +/-5V
- Cut-Off Frequency

### List of Experiments :

- Study of 32-channel time division multiplexing
- Study of framing in time division multiplexing
- Study of marker in time division multiplexing
- Study of PCM voice coding
- Frequency response of CODEC

## TLD-10: AUDIO INPUT / OUTPUT

This module provides facility for interfacing audio signal to any of the TLD-00 series Digital Communication Trainer modules. The input module accepts audio input signal microphone. The signal after amplification is connected to Digital Communication Trainer module (TLD-00 Series) which accepts external analog signal.

The output module accepts analog input signal from Digital Communication Trainer modules. The built in power amplifier output drives a speaker providing the output. A volume control knob is provided to adjust the volume.

### Technical Specifications :

#### Audio Input Module :

- Input Impedance : 600 Ohms
- Voltage Gain : 1 to 100
- RC Filter : 3.4 KHz Cut-off
- Max. Output Voltage : 5 Volts
- Power Supply : 9 V

#### Audio Output Module :

- Input Impedance : 47 Kohm
- Output Voltage : Adjustable
- Sound Speakers : 8 Ohms, 0.3 W
- Power Supply : 9V