



COMMUNICATION SYSTEM TRAINER (Model : XPO-COM)

Fiber Optic Communication Trainer



TECHNICAL SPECIFICATIONS OF MASTER UNIT (MU)

Communication Medium	FM (Wireless)	AM (Wireless)	Fiber Optics
Transmitter Carrier	Tunable from 88 MHz to 108 MHz with built in FM(VCO)	500 kHz to 1.5 MHz	TTL BW - 64 kHz, Analog BW - Audio, Uses Red LED Emitter.
a) I/P Amplitude		5 Vpp	
b) I/P Frequency	Audio range.	Carrier modulated I/P (audio range)	Modulated I/P (audio)
c) Power O/P		50 to 100 mW	
Receiver	External 5 BS5 to connect to antenna, 2 nd IF I/P, 2 nd IF O/P, speaker & Audio amplifier, AM/FM Select switch, L/S impedance 8 ohm / 0.5 W		Detector (tr=8 S) Separate BS5 socket for Digital, AC coupled & TTL ops.
Controls (Manually)	Settable 88 MHz to 108 MHz.	Gain control Settable from 0 to 4.5V	Transmitter bias Control.
Antenna / Transmission	Telescopic antenna (3 branch antenna) (optional)		1m plastic fiber cable, CRT-1.492, NA- 0.5, - 660nm, step index, terminated with SMA connector.
Waveform Gen.	Function Generator	Audio Oscillator	Sync. Sine Wave Gen.
I/P	AM (std) -I/P volt - +5V, 0V-No modulation AM (DSBSC)-I/P volt. 0-9.8 Vpp, o/p volt. 0- 2.7. FM I/P volt. 400mV (+50% modulation) ASK - I/P upto 500Hz, +5V Square wave FSK -I/P upto 500Hz, +4.5V Square wave	Selection of Sine / Square / Triangle	32 KHz TTL I/P to Generate 4 nos. of sync. sine O/P
Waveform	SINE/TRG/TTL / CMOS (settable)	SINE/TRG/SQUARE	SINE
O/p Freq	1 Hz to 1 MHz in 6 ranges	50 Hz to 5 kHz	250/ 500/1000/ 2000 Hz
O/p volt.	0-20Vpp max(sine/TRG) @ 100 kHz.	Sine 0-2Vpp, Square 0-9 Vpp TRG 0-3Vpp	0-10 Vpp
Controls	Freq & Amplitude controls pots	Freq & Amplitude controls pots	Amplitude Control pot.
Specification for common Resources			Mechanical Dimensions
Power supply	5V / 1A, ± 12V/500mA, 0 to 15V DC (Variable)/100 mA, 0 to 30V DC (Variable)/100 mA		(A) Master Unit : 460mm(W), 160mm(H), 350mm(D)
Mic with Pre-Amp.	Hand held Electret / dynamic microphone with preamplifier for audio range		Net weight : 5 Kg.
Audio Amplifier	Variable Gain upto 20 for Audio range, Built in Loudspeaker - 8 ohm/500mW / earphone.		Gross Wt. : 7 Kg.
Pink Noise Gen.	Frequency response of filter for audio range.		(B) Panel : 215mm(W), 165mm(H), 40mm(D)
Buffer/AC amplifier	NIV gain amplifier 2 Nos, Gain- 0-20, Non sinusoidal Signal Generator cum INV buffer		Net weight : 700 gm approx.
BNC TO Banana	Converts 1 BNC Socket to 2 Banana Sockets (4mm).		(C) Operating Voltage : 220/240Vac switch settable ±10%, 50Hz/72VA.
BW Filter [LPF]	4 Nos - 2 pole/4 pole butter worth filter cutoff freq 3.4 KHz Audio range.		
PRBS	Switch settable for on/off fix 15 bit Pseudo Random Binary Sequence generator		

- ◆ **Modular experiment panels offered (Atleast select one or more panels). Needs MU for common shared resources like PS, Sync Sin Waves, Carrier Audio generators etc.**

1) Fiber Optic/ Led / Laser Expt. Panel/CM1

(Provided with 16 banana + 2 TPs + 1 Led.)

- ◆ **Fiber optic cable (plastic)**

Core material: PMMA (polymethyl methacrylate), Cladding material: fluorinated polymer, Fiber structure: step index type, Core cladding diameter: 90 micron/1000 microns, v.Core refractive index: 1.492, Cladding refractive index: 1.405 to 1.417, Numerical aperture :0.5 (typically), Acceptance angle: 55 to 60 degrees, Attenuation (60nm):0.3 dB/meter, Jacket material: polythene (black): 2.2 mm OD, LENGTH=1m, 5m

- ◆ **Transmitter: 4 nos. LASER (780nm), RED (660nm), BLUE (470nm), IR SFH 485 (850nm),** Reverse voltage: VR =5V, Forward Current: IF=100mA, Power dissipation: P_{tot} =200mW, Wave length at peak emission: λ_{peak} = 880nm

Reverse voltage: VR =5V, Forward Current: IF=100mA, Power dissipation: P_{tot} =200mW, Wave length at peak emission: λ_{peak} = 880nm

- ◆ **Receiver 1 No. PIN photo diode (SFH 213):** Max wave length =850 nm, Rise time and Fall Time t_r & t_f =5ns, Reverse voltage: 50V, Total Power Dissipation: 100mW, Photo Current: 135(>= 100 μ A).

- ◆ **Function Blocks:**

- AC Amplifiers: 1 nos,
- Comparator: 1 nos
- Fibre Optic Driver with : Analog Bandwidth: 500KHz(except LASER) & 1MHz for LASER, Digital Bandwidth: 1 MHz (except LASER) & 2MHz for LASER
- Voice link: established using microphone & speaker (Master unit [MU])
- PC -PC Communication: Using RS -232 interface 9 pin D - connector, Baud Rate: 2400
- Switched faults: 4 in transmitter 4 in receiver

- ◆ **Accessories**

N.A. APPARATUS, Bending radii stack (BR), fiber optic cable: 1m, 5m with SMA CONNECTOR, Electrical Interference Experiment Apparatus, Coupling loss apparatus, Speaker and MIC (from MU).

List of experiments (14) : DC Characteristics of transmitter diodes, SENSITIVITY of Optical Fiber, AC Frequency Response - Analog Link & BW, Digital Frequency Response - Digital Link & B.W, Numerical Aperture, Losses in cable- i) Bending loss ii) Transmission loss iii) Coupling loss. Immunity to Electrical Noise interference of optical fiber PC interface : Using RS 232, Signal transmission using Pulse Width Modulation & Demodulation, VOICE COMMUNICATION using direct transmission as well as modulated using PWM, Voice transmission using Amplitude Modulation & Demodulation, Signal transmission using Frequency Modulation & Demodulation, SWITCHED FAULTS, High Speed Digital Link (optional).

- ◆ **Optional expansion module**

High speed digital link (B.W.=2MHz) with 1m FO cable.

- **Transmitter**

Forward input current (IFPK): 1000 mA (IFdc)=80 mA, Reverse input voltage: VBR= 5V, Peak wavelength emission: 660 nm, N.A.:0.5, Rise time: 80 ns, Fall time: 40 ns.

- **Receiver**

Supply voltage: (max) 7V, O/p collector current: 25 mA, O/p collector power dissipation: 40 mW, O/P VOLTAGE: 18v, Fan out (TTL): 5

2) 1 channel Sampling & Reconstruction, 4 Channel TDM/PAM & PPM, PWM, PFM Expt. panel (CM2)

(Provided with 20 banana + 10 TPs + 10 Leds)

- Crystal Freq.-10 MHz, Shares common resources like sync sine wave 4 nos, microphone / loudspeaker Amplifier, Low Pass Filter (LPF 2P / 4P) etc from Master unit (MU)
- Switched faults : - 4 Nos.

- **1 channel Sampling/ Reconstruction & 4 Channel TDM/PAM & demodulation:-**

- Modulator :** Analog i/p channel: - 4 Nos, 10 Vpp, Bipolar. Settable Sampling Freq. (1 of 7) : 64 / 32 / 16 / 8 / 4 / 2 / 1 KHz With Settable Duty Cycle 10-90 % in decade steps.
- De-Modulator :** Clock Regeneration using PLL, LPF, 1/2/3 Wire Communications

- ◆ **PWM / PPM**

- Modulator :** I/P freq Audio range (Sine) @ 0-8 Vpp , Carrier Freq - 64KHz (TRG) @ 8Vpp O/P TTL.
- De-Modulator :** LPF (MU), PPM is converter into PWM then Demodulated.

- ◆ **PFM**

- Modulator :** Center Freq (64KHz / TTL) from Function Generator (MU) is FM modulated by audio signal generating PFM pulse train.
- De-Modulator :** PLL Detector followed by LPF from MU.

List of experiments (3) : Single channel PAM Sampling [1CH Signal Sampling & Reconstruction (1 CH SSRC)] i) Natural Sampling, ii) Flat Top Sampling (Sample Hold), Multichannel [4 CH] PAM Sampling, multiplexing of data over single wire & demultiplexing of data at receiver to reconstruct 4 channels by various method 3 \ 2 \ 1 wires [mode 1, 2, 3 respectively., PWM \ PFM \ PPM Pulse modulation & demodulation as a methods of digital communication

3) Carrier modulation/ Demodulation Expt. Panel (CM3)

(Provided with 38 banana + 3 Tps)

Shares common resources like Data Bit Stream (PRBS), FSK Demodulated etc from Master unit (MU).

- **Carrier Sine wave**-500KHz, 250KHz(0° phase) & 250KHz(90° phase) with settable amplitude 0 to 2Vpp.
- 4 MHz Crystal Stabilized Clock.
- **On board Unipolar to Bi polar Converter, Data Squaring.**
- **Carrier Modulation Techniques** ASK, FSK, PSK & QPSK.
- **Carrier De-Modulation Techniques** ASK (Rectifier Detector), FSK (Phase Lock Loop Detector), PSK (Squaring loop Detector) and QPSK (Fourth power loop detector).
- **Low Pass Filter** 2 Nos with Cut off Frequency 340KHz.

List of experiments (4) : Amplitude Shift Keying [ASK] Modulation / Demodulation, Frequency Shift Keying [FSK] Modulation / Demodulation, Phase Shift Keying [PSK] Modulation / Demodulation, Quadrature Phase Shift Keying [QPSK] Modulation / Demodulation.

4) 2 Channel Pulse Code [TDM/ PCM] Modulation [PCM]/ Demodulation with frame & bit Error Detection & synchronization & Correction Expt. Panel (CM4)

(Provided with 22 banana + 6 TPs + 20 Leds)

Shares common resources like sync sine wave 4 nos, microphone / loudspeaker Amplifier, Pseudo Random Binary Sequence Generator, Low Pass Filter (LPF 2P / 4P) etc from Master unit (MU)

- Switched faults: - 4 Nos. + 2 No Switches for bit error simulation
- 1 & 2 Ch TDM / PCM Mod - Demod: - 1/2/3 Wire Communications
- **Modulator :** Analog i/p : - 2 Nos, 10 Vpp , onboard Two adjustable variable DC source, Sampling Freq. 16KHz per Channel for Fast mode & 0.106 Hz per Channel for Slow Mode, use of PRBs to generate frame marker useful to establish sync. in receiver during 1/2 wire communications.
- **De-Modulator :** Synchronization is established by using Pseudo Random Binary Sequence, Clock Regeneration using PLL.

c) Frame & bit Error Detection :Use of PRBs for synchronization,selectable for OFF, Even , Odd parity &Hamming check code.

d) Error Correction :Single or Double Data bit error correction using Hamming code

- Voice communication using wired PCM.
- Voice communication using Fiber optics (CM1) & PCM

List of experiments (7) : Single channel Pulse Code Modulation & Demodulation by various method 3 \ 2 \ 1 wires [mode 1, 2, 3 respectively, Two channel TDM, PCM Modulation & Demodulation by various method 3 \ 2 \ 1 wires [mode 1, 2, 3 respectively], Use of PRBS for frame synchronization by adding a Bit (Marker) in 2 / 1 Wire (Mode 2, 3 respectively), Study of Error Code Check Such as Even Parity, Odd Parity and 1 bit / 2 bit error simulation & correction by Hamming Code, Voice and Radio communication using PCM, Study of ADC / DAC [CODEC] by observing on Leds & by applying DC Levels at single or both i/ps, Switched Faults

5) Delta, adaptive delta, sigma delta modulation and demodulation Experiment Panel (CM5)

(Provided with 26 banana)

- Shares common resources like sync sine wave 4 nos., Microphone / Loudspeaker Amplifier low pass filter, LPF (2P/4P) etc. from master unit [MU]
- Consisting of Voltage comparator, differential amplifier, TTL to Bipolar Converter.
- Switched faults. (4 Nos.)
- Delta, adaptive delta (CVSD), sigma modulation & demodulation, Adaptive control circuits 2Nos. each, provides 2 bit binary code, used to control gain of an integrator for adaptive delta modulation.
- **Companding** : Using compressor and expander function blocks.
List of experiments (6) : Delta mod-demod, Adaptive (CVSD) delta mod demod, Sigma delta mod demod, Voice communication, Effect of companding on delta mod-demod, Switched faults.

6) AM modulation & demodulation Expt. panel (CM6)

(Provided with 26 banana)

- Shares common resources like audio frequency generator, function generator, Microphone / Loudspeaker Amplifier, low pass filter, LPF (2P/4P) etc. from master unit [MU]
- Consisting of 3Nos. modulators, Ceramic BPF, envelope - diode detector, product detector.
- Switched faults - 4 Nos.
- **Modulator**: Balanced modulator (DSB SC) - 2Nos. and DSB - TC - 1 No., SSB - SC - 1No.
- **Demodulator**: Envelope detector 1 No., Product detector 1 No.
- Frequency division multiplexing with 2 Nos. of DSB - SC AM channels (Use P19 for demod of FDM - AM)
List of experiments (12) : DSB modulation with transmitted carrier (TC), DSB modulation with suppressed carrier (SC), Ceramic filter (BPF), SSB SC modulation (for upper/lower side band), DSB TC demodulation, DSB SC demodulation, SSB SC demodulation,

ASK demodulation using synchronous detector, QAM mod demod, FDM-AM using P19(AM/FM receiver kit), Voice communication, Switched faults, Switched faults.

- **CBT (Optional)** - Proving theory of AM (DSB-SC, SSB-SC, FDM, QAM) using numerical method on PC (Excel Graphs)

7) AM demodulator cum AM-FM Receiver Expt. Panel (P19)

(Provided with 3 banana + 20TPs)

Consisting of antenna, RF amplifier, IF amplifier, Local oscillator (455KHz), Mixer, Audio amplifier with L/S

- AM demodulator - Diode Detector for DSB
- Switched faults 16 Nos.
- Determination of Selectivity, Sensitivity.
- Synthesized Superheterodyne Receiver - AM receiver cum tuner (450 to 1450KHz), FM receiver com tuner (88 to 108MHz)

List of Experiment (8): AM receiver (5) : DSB TC demodulation using tuning of AM receiver, Sensitivity of radio receiver, Signal to noise ratio, Effect of AGC, Fidelity of Radio Receiver.

FM receiver(3): FM demod using tuning of FM receiver, Sensitivity of radio receiver, Selectivity of radio receiver

8) FM Modulation & Demodulation Expt. Panel (CM7)

(Provided with 26 banana + 2TPs.)

Shares common resources like audio function generator, microphone / L/S Amp., pink noise Generator, LPF (2P / 4P) etc. from MU.

- Switched faults: - 8 Nos.
- **a) Modulator** : (With center freq 455 KHz). Reactance Modulator, Varactor Modulator with center frequency adjustment, Phase modulator using varactor, Armstrong Modulator using PLL.
- **b) Demodulator** : Detuned resonant circuit detector, Quadrature detector, Foster-Seeley discriminators, Ratio detector, Phase-locked loop detector and determination of capture and lock range, Phase Demodulator using quadrature detector

List of experiments (12) : Frequency modulation using : Reactance modulator, Varactor modulator, Phase modulator using varactor, Frequency demodulation using, Detuned resonant detector, Foster Seeley/ratio detector, Study of PLL capture & lock range & its use as FM detector, Use of PLL as Armstrong Modulator, Quadrature detector, Phase demodulation using quadrature detector, Introduction of noise & its effects on frequency modulation, Voice communication, Preemphasis & deemphasis for flat frequency response, Switched faults.

- **CBT (Optional)** - Proving theory of FM, PM (using numerical method on PC (Excel Graphs)

9) Data Formatting / Reformatting Expt. Panel (CM8)

(Provided with 18 banana.)

Shares common resources like Data Bit Stream (PRBS), FSK Demodulator etc from Master unit (MU)

- **Data Formatting and Reformatting Option** NRZ (L), NRZ (M), Polar RZ (AMI) & NRZ, Bipolar RZ & NRZ, Bi-phase Manchester, Bi-phase Mark, Differential Encoded Dibit (For use with QPSK).] -8 Nos. of encoders & 3 Nos. of bit decoders & 1 No. of dibit decoders.
- **Bi phase Clock Recovery** - By using Phase Lock Loop (PLL) with center frequency 250KHz & 32KHz selectable.

List of experiments (3) : Study of RZ, NRZ-L [Non Return To Zero – Level], NRZ-M [Non Return To Zero – Mark], Bi phase Mark, NRZ-S, Bi phase Manchester encoders & decoders,)Study of RZ – AMI [Return To Zero – Alternate Mark Inversion] encoder & decoder, S t u d y o f differential DIBIT [MSB /LSB] Encoder & Decoder

10) Fourier analysis cum synthesis expt. panel (FAS) (CM 9)

(Provided with 12 banana + 11 test points)

- Shares common resources like LPF (2P/4P) HPF, audio frequency generator, function generator.
- Fundamental frequency 1KHz
- **Analysis** by Splitting 1KHz square wave into fundamental sin and 9 harmonics including DC component if any.
- **Synthesis** of 10 above components to generate original signal.
- Display frequency components on CRO using spectrum display controller in external trigger mode.
- Study of filters (LPF, HPF, BPF) and display characteristics curve on CRO (XY Mode) using FM sweep display.

List of experiments (5) : Fourier analysis, Fourier synthesis, Spectrum Analyzer cum Fourier component display on CRO, Study of filters, Switched faults.

- **CBT (Optional) -** Proving theory of Fourier Analysis & Synthesis (using numerical method on PC (Excel Graphs))

11) Transmission Line Expt. Panel (CM10)

(Provided with 27 banana.)

- Consisting of 50 ohm, 70 ohm simulated line, pulse generator, 50 ohm line driver, BNC to banana adaptor-2nos, Impedance matching variable resistors 2nos.
- Effect of pulse input, reactive termination, match termination, noise.
- Standing wave display on CRO in external trigger mode & VSWR determination.
- **Optional Coaxial cable (RG58)** x 55 meters & terminating BNC, Calculation of delay, impedance, speed of light, standing wave ratio (VSWR).

List of experiments (13) : Delay using a pulse input, Matching using pulse input, Reactive termination, Noise in communication, Matching and frequency response, Phase relationship, Standing wave ratio and Transformer matching, Standing waves, Low pass filter effect, 50 ohm line as an oscillator, Time domain reflectometry, Switched Faults, Experiments with actual RG 58 cable used in transmission line (optional).

12) DPCM / ADPCM Modulation / Demodulation Expt. Panel (CM11)

(Provided with 13 banana + 3 test points+20LEDs + 6 switches)

Shares common resources like Audio Frequency Oscillator /Signal source DTFFG-III, 2-P/4-P Low Pass filter from NLPF Card, MIC Pre-Amplifier, Audio Amplifier from Master Unit (MU).

- Operation mode : Switch selectable - DPCM OR ADPCM
- Number of data bits in data frame switch selectable 3/4/5 bits.
- On-board Clock source @ 660 KHz.
- a) **Modulator Function Blocks** : - 1 Analog Input- 10Vpp & Audio upto 2KHz, Onboard adjustable DC signal source, ADC Sampling Frequency @8.5 KHz, 7 Bit Comparator, Subtractor, Signed Adder, Parallel to Serial Converter.
- b) **Demodulator Function Blocks** : - 1 Analog Output- 10Vpp & Audio upto 2KHz, Demodulated DPCM / ADPCM signal reconstructed using 7-bit DAC followed by passing through 2P/4P Butterworth filter on NGLPF Panel (MU), Serial to Parallel Converter, 7 Bit Signed Adder,

List of experiments (5) : DPCM - Modulation - Demodulation, ADPCM - Modulation - Demodulation, Slope Overload Error, Voice Communication using DPCM / ADPCM, Study of Eye Diagram.

13)16 QAM Modulation / Demodulation Expt. Panel (CM12)

(Provided with 12 banana + 2 test points+ 5 LEDs)

Shares common resources like Audio Frequency Oscillator /Signal source DTFFG-III, 2-P/4-P Low Pass filter from NLPF Card, MIC Pre-Amplifier, Audio Amplifier from Master Unit (MU).

- On-board Clock source @ 660 KHz.
- a) **Modulator Function Blocks**:- 1 Analog Input- 10Vpp & Audio upto 800Hz [2KHz], Onboard adjustable DC signal source, ADC Sampling Frequency @8.5 KHz, 7 Bit ADC, Signed Adder, Quadrature sine generator I, Q @ 55KHz, Mux and Latch.
- b) **Demodulator Function Blocks** :- 1 Analog Output- 10Vpp & Audio upto 800Hz [2KHz], switch selectable DAC O/P either 16 QAM O/P or Demod O/P, original signal recovered by passing through 2P/4P Butterworth filter on NGLPF Panel (MU), 7 Bit DAC, Signed Adder, 7 Bit Amplitude & Phase comparator, Latch & Mux.

List of experiments (5) : Generate 16 QAM modulated sin output, Verify constancy of frequency but only phase angle and amplitude varies depending upon modulation bits, Draw constellation diagram for 16 QAM, Determine upper limit of data rate given a particular carrier frequency, Send and receive voice using 16 QAM.

14) 4 Channel CDMA Modulation / Demodulation Expt. Panel (CM13)

(Provided with banana sockets & leds & test points)

Shares common resources like Audio Frequency Oscillator /Signal source DTFFG-III, 2-P/4-P Low Pass filter from NGLPF Card, MIC Pre-Amplifier, Audio Amplifier from Master Unit (MU).

- On-board Clock source @1. 2 MHz.
- a) **Modulator Function Blocks** : High speed 7 bit ADC & logic blocks 4 station data (sequence generator), 4 parallel in serial out (PISO) converter, 4 chip sequence (m=8) generators, signed digital adder, modulation control mode select switches, CDMA clock control logic.
- b) **Demodulator Function Blocks** : Signed synchronous multiplier, station select mux, bipolar to unipolar convertor, serial in parallel out (SIPO) and 7 bit DAC.

List of experiments (6) : Verification of CDMA modulation algorithm at o/p of DAC, Recovery of selected station data out of 4 stations, Upper frequency limit for recovery of voice frequency (Bandwidth determination), Voice communication, Study of ADC & DAC (Codec), Eye Diagram.

15) WDM Expt. Panel (CM14)

- Transmitter (2 Nos) : Laser 1310 nm & 1550 nm
- Receiver / Detector (2 Nos.) : 1310 nm & 1550 nm
- 9 pin D connector (2 Nos.) : For bidirectional communication / PC link

SALIENT FEATURES :

- ◆ Can learn and experiment about variety of communication mediums (AM, FM, FO Wired) & methods (Modulation / Demodulation Analog/Digital).
- ◆ Covers Analog communication, Digital communication, Fiber optics characteristics as well as communication, Wired communication through various modular experiment panels implemented using latest state of arts VLSI/CPLD's.
- ◆ Aesthetically designed injection molded electronic desk (master unit) carrying useful experiment resources like power supplies, Multi Function generators, FM/AM/FO/ X'mitter/receiver, MIC & L/S amplifier, Butterworth Filter (BWF), Sync sine waves etc while central slot will hold various replaceable experiment panels. Order 10 MUs + 10 Panels sets or mu multiples.
- ◆ Connection through sturdy 4mm Banana sockets, patch cord & SMA connectors.
- ◆ Student workbook & instructor's Guide provided with each unit. connectors

ANSHUMAN Tech Pvt Ltd.

Plot 13, Sthairya Society, Behind Tol Hospital
Nr .Nav-Sahyadri Society, Karve Nagar
Pune - 411 052 (Maharashtra)INDIA
Email : anshumanelectronics@vsnl.com
anshumantech@yahoo.in

Tel : (0091)(020) 25460892 /
25463052
Fax : (020) 25463052
Visit us at : www.anshumantech.com/
www.anshumantech.net

Specifications subject to change without notice