

COMMUNICATION SYSTEM TRAINER (Model : XPO-COM)



TECHNICAL SPECIFICATIONS OF MASTER UNIT (MU)

Communication Medium	FM (Wireless)	AM (Wireless)	Fiber Optics
Transmitter	Tunable from 88 Mhz to 108MHz	500KHz to 1.5MHz	TTL BW - 64KHz, Analog BW –Audio, Uses Red LED Emitter.
a) Carrier	with built in FM(VCO)		
b) I/P Ampl	0-5 Vpp (digital)	0-5 Vpp (digital)	0-5 Vpp (digital)
I/p Freq.	Audio range.	Carrier modulated i/p(audio range)	Modulated i/p (audio)
c) Power O/P		50 to 100mW	
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=8μS) Separate Bs5 socket for Digital ,AC coupled & TTL ops.
Controls(Man)	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	SINE/TRG/SQUARE	SINE
O/p Freq	1 Hz to 1MHz in 6 ranges	50 Hz to 5KHz	250/ 500/1000/ 2000 Hz
O/p volt.	0-20Vpp max(sine/TRG) @ 100KHz.	Sine0-2Vpp, Square 0-9 Vpp TRG0-3Vpp	0-10 Vpp
Controls	Freq & Amplitude controls pots	Freq & Amplitude controls pots	Amp. Control pot.
Specification for common Resources			
Power supply	5V / 1A, ± 12V/500mA, 0 to 15V DC (Variable)/100 mA, 0 to 30V DC (Variable)/100 mA		Mechanical Dimensions
Mic with pre-Amp	Hand held Electret / dynamic microphone with preamplifier for audio range		(A) Master Unit : 400mm(W), 125mm(H), 270mm(D)
Audio Amplifier	Variable Gain up to 20 for Audio range, Built in Loudspeaker – 8 ohm/500mW / earphone.		Net weight : 8 Kg.
Pink Noise Gen.	Frequency response of filter for audio range.		Gross Wt : 10 Kg.
Buffer/AC amplifier	NIV gain amplifier 2 Nos, Gain- 0-20, Non sinusoidal Signal Generator cum INV buffer		(B) Panel : 215mm(W), 165mm(H), 40mm(D)
BNC TO Banana	Converts 1 BNC Socket to 2 Banana Sockets (4mm).		Net weight : 700 gm approx.
Low pass filter	4 Nos - 2 pole/4 pole cutoff freq 3.4 KHz Audio range.		
PRBS	Switch settable for on/off fix 15 bit Pseudo Random Binary Sequence generator		

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Specifications subject to change without notice.

✘ Modular experiment panels offered (Atleast select one or more panels)

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

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

- Fiber optic cable (plastic)
 - i. Core material: PMMA (polymethyl methacrylate)
 - ii. Cladding material: fluorinated polymer
 - iii. Fiber structure: step index type
 - iv. Core cladding diameter: 90 micron/1000 microns
 - v. Core refractive index: 1.492
 - vi. Cladding refractive index: 1.405 to 1.417
 - vii. Numerical aperture :0. 5(typically)
 - viii. Acceptance angle: 55 to 60 degrees
 - ix. Attenuation (60nm):0. 3 dB/meter
 - x. Jacket material: polythene (black): 2.2 mm OD
 - xi. LENGTH=1m, 5m
- Transmitter: 4 nos. LASER (780nm), IR (850nm), RED (660nm), BLUE (470nm), I
 - Specifications (SFH 485):
 - Reverse voltage:VR =5V
 - Forward Current: IF=100mA
 - Power dissipation:Ptot =200mW
 - Wave length at peak emission: ?peak = 880nm
- Receiver: PIN photo diode (SFH 213)
 - Max wave length =850 nm
 - Rise time and Fall Time tr & tf=5ns
 - Reverse voltage: 50V
 - Total Power Dissipation: 100mW.
 - Photo Current: 135(>= 100μA)
- Modulation Techniques: Pulse Width Modulation, Frequency Modulation, Amplitude Modulation
- Drivers: analog
- AC Amplifiers: 1 nos
- Comparator: 1 nos
- 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 interfaces
9 pin D – type connector
- Baud Rate: 2400
- Switched faults: 4 in transmitter 4 in receiver
- High Speed Digital Link module (Optional)
- ❖ Digital Band Width: 3MHz
- ❖ 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

List of experiments

- a) DC Characteristics of transmitter diodes
 - b) SENSITIVITY of Optical Fiber
 - c) AC Frequency Response - Analog Link & B.W
 - d) Digital Frequency Response - Digital Link & B.W
 - e) Numerical Aperture
 - f) Losses in cable
 - i) Bending loss
 - ii) Transmission loss
 - iii) Coupling loss
 - g) Immunity to interference of optical fiber
 - h) PC interface: using RS 232
 - i) Signal transmission using Pulse Width Modulation & Demodulation
 - j) VOICE COMMUNICATION using direct transmission as well as modulated using PWM
 - k) Voice transmission using Amplitude Modulation & Demodulation
 - l) Signal transmission using Frequency Modulation & Demodulation
 - m) SWITCHED FAULTS
 - n) High Speed Digital Link (optional)
- 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).
 - Optional expansion modules
 - 1) High speed digital link (B.W.=2MHz) with 1m FO cable.
 - 2) FO emitter detector module
- ### 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: -
 - a) Modulator : Analog i/p channel: - 4 Nos, 10 Vpp, Bipolar. Settable Sampling Freq. (1of 7) : 64 / 32 / 16 / 8 / 4 / 2 / 1 KHz With Settable Duty Cycle 10-90 % in decade steps.
 - b) De-Modulator : Clock Regeneration using PLL, LPF, 1/2/3 Wire Communications.
 - PWM / PPM
 - a) Modulator : I/P freq Audio range (Sine) @ 0-8 Vpp , Carrier Freq - 64KHz (TRG) @ 8 Vpp O/P TTL.
 - b) De-Modulator : LPF (MU), PPM is converter into PWM then Demodulated.
 - PFM
 - a) Modulator : Center Freq (64KHz / TTL) from Function Generator (MU) is FM modulated by audio signal generating PFM pulse train .
 - b) De-Modulator : PLL Detector followed by LPF from MU.
- ### List of experiments
- a) Single channel PAM Sampling [1CH Signal Sampling & Reconstruction (1 CH SSRC)]
 - i) Natural Sampling
 - ii) Flat Top Sampling (Sample Hold)
 - b) 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.]
 - c) 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

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

- Single channel Pulse Code Modulation & Demodulation by various method 3 \ 2 \ 1 wires [mode 1, 2, 3 respectively.]
- Two channel Pulse Code 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 Expt. Panel (CM5)

(Provided with 26 banana)

- 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

- 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)

Consisting of 3Nos. modulators, Ceramic BPF, AM Antenna buffer cum RF amplifier, envelope - diode 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

- 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

- 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.
- Synthesised Superheterodyne Receiver - AM receiver cum tuner (450 to 1450KHz), FM receiver com tuner (88 to 108MHz)

List of Experiment :

- AM receiver: DSB TC demodulation using tuning of AM receiver
Sensitivity of radio receiver,
Selectivity of radio receiver
Signal to noise ratio,
Effect of AGC
Fidelity of Radio Receiver
- FM receiver:
FM demod using tuning of FM receiver.
Sensitivity of radio receiver
Selectivity of radio receiver

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

(Provided with 24 banana + 2TPs.)

Shares common resources like Audio FG microphone / L/S & Amp., pink noise Generator, LPF (2P / 4P) etc. from MU.

- Switched faults: - 8 Nos.
- Mod - Demod: -
 - a) Modulator : (With center frequency 455 KHz).
 - 1) Reactance Modulator using Arm strong oscillator.
 - 2) Varactor Modulator with center frequency adjustment.
 - 3) Phase modulator using varactor
 - b) Demodulator :
 - 1) Detuned resonant circuit detector
 - 2) Quadrature detector.
 - 3) Foster-Seeley discriminators
 - 4) Ratio detector.
 - 5) Phase-locked loop detector and determination of capture and lock range.
 - 6) Phase De modulator using quadrature detector

List of experiments

Frequency modulation using

- 1) Reactance modulator
- 2) Varactor modulator
- 3) Phase modulator using varactor
- 4) Detuned resonant detector
- 5) Foster Seeley/ratio detector
- 6) Study of PLL capture & lock range & its use as FM detector
- 7) Quadrature detector
- 8) Phase demodulation using quadrature detector
- 9) Introduction of noise & its effects on frequency modulation
- 10) Voice communication
- 11) 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 Dabit (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

- a) 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
- b) Study of RZ – AMI [Return To Zero – Alternate Mark Inversion] encoder & decoder
- c) Study of differential DIBIT [MSB /LSB] Encoder & Decoder

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

(Provided with 12 banana + 11 test

points)

- Fundamental frequency 1KHz
- Splits 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

- a) Fourier analysis
- b) Fourier synthesis
- c) Spectrum Analyzer cum Fourier component display on CRO
- d) Study of filters
- e) 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.

List of experiments

- a) Delay using a pulse input
- b) Matching using pulse input
- c) Reactive termination
- d) Noise in communication
- e) Matching & frequency response
- f) Phase relationship
- g) Standing wave ratio & Transformer matching.
- h) Standing waves
- i) Low pass filter effect
- j) 50 ohm line as an oscillator
- k) Time domain reflectometry
- l) Switched Faults
- m) Experiments with actual RG 58 cable used in transmission line (optional)

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 / CPLDs.
- ◆ 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.
- ◆ Connection through sturdy 4mm Banana sockets, patch cord & SMA connectors.
- ◆ Student workbook & instructor's Guide provided with each unit.