Department of Electronics Engineering,

Communication Systems Laboratory

Laboratory Manual

for

B. Tech. (Electronics), III Year (VI – Semester)

Lab Course EL 394 (Communication Lab. – II)

List Of Experiments for the Session 2010 – 2011

1. Selectivity Characteristics of AM Radio Receiver (Scientech model ST-2202)
2. Study of PLL Characteristics and its use as the FM Demodulator
3. Study of Optical Fiber Communication
4. Study of Micro-strip Circuits and their characteristics using AMTK-100 kit
5. Study of various Data Formats and their transmission & reception by FSK
6. Study of Digital Modulation Schemes – ASK, PSK, OOK, APSK
7. Study of TDM & PCM using Scientech kits ST-2103 & ST-2104
8. Study of Delta Modulation and condition of slope over-loading using ST-2105 kit

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Compiled by

Engr M. Hadi Ali Khan

B. Sc. Engg (AMU), MIETE (India), Ex-MIEEE (USA), Ex-MSSI (India)

Department of Electronics Engineering,

AMU, Aligarh – 202 002

Email:- engineer_amu@ymail.com

Note:- This laboratory manual is also available on the internet at the following URL :-

http://mhakhan.tripod.com/lab.html

Experiment No. 1

Object:- **Plot the Selectitivity Characteristics of AM Radio Receiver at 1200 KHz.**

Apparatus Used:-

1. Scientech AM Receiver Trainer Kit Model ST2202
2. Scientech 2 MHz AM/FM/Function Generator Model ST4062 (used as AM signal Generator)
3. Pacific AF Signal Generator Model FG18 (used as a message signal generator)
4. 20 MHz CRO Model ………….

Procedure:-

1. Obtain an AM signal from the Function Output socket of Scientech 2MHzAM/FM/ Function Generator Model ST4062 by selecting its function switch to “Sine” & its Modulation switch to “AM Standard” positions and feed an AF Sinusoidal signal from another signal generator to its “Modulation Input” socket.
2. View the AM signal obtained as above, on the CRO screen and adjust the relevant controls to keep the AM Level within 800 mV range, audio frequency in 400 Hz to 2 KHz, carrier frequency in the Medium wave broadcast range (say at 900 KHz) and set its modulation index to 30 %.
3. Now turn ON the AM receiver and make the following setting on it:-

(a) Set the detector switch in diode mode.

(b) Set the AGC switch to “out”

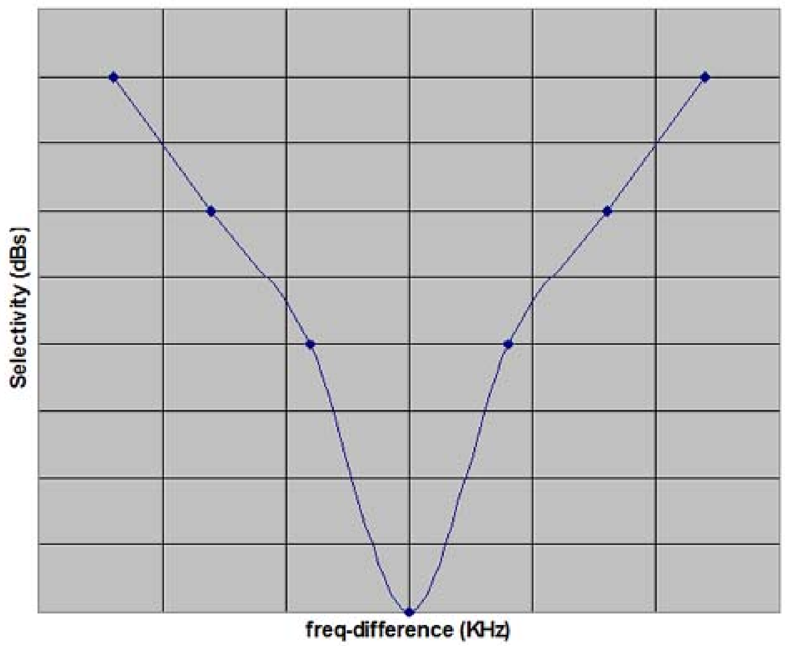
(c) Set the volume control fully clockwise

4. Apply the AM signal as adjusted above in step 2, to the Rx input socket of the AM receiver ST2202.
5. Tune the receiver to the carrier frequency of the input AM signal and adjust “Gain” potentiometer potentiometer provided in the RF section of **ST2202** so as to get unclipped demodulated signal at detector’s output **(t_p38)**. (The maximum level of the unclipped demodulated signal at detector’s output will ensure the correct tuning of the receiver.)
6. Note the voltage level at receiver’s final output stage i.e., audio amplifier’s output **(t_p39)** on CRO (this is the voltage at resonance, **V_R**).
7. Now gradually offset the carrier frequency in suitable steps of 2 or 5 KHz below and above the carrier frequency adjusted in step 2 above, without changing the tuning of receiver while maintaining the input signal level constant.
8. Now record the signal at audio amplifier’s output **(t_p39)** on CRO for different input carrier frequencies (this is the voltage OFF-resonance, **V_{OFF}**).
9. Tabulate the readings as under:- Receiver tuned to frequency, f_c = 1200 KHz

S. No.	**Carrier frequency of the transmitted AM signal (KHz)**	**Receiver Output (mV)**	**Ratio = $20\log_{10}(V_R / V_{OFF})$ dB**
1.	1190		
2.	1195		
3.	1200	(V_R)	
4.	1205		

10. Plot the curve between the ratio and the carrier frequency, which gives the selectivity characteristics of AM Radio receiver. Also record the settings made for modulation frequency, signal level at the receiver input terminal (in mV) and the modulation index of the input AM signal, as follws:-
    (a) AM Level = ………………………. Volts $_{p-p}$
    (b) Message frequency in the AM signal = ………….. Hz
    (c) Modulation index = ………….. %
    (d) Carrier frequency - ………………. KHz

Selectivity Characteristics



Reference:- 1. Kennedy : Electronics Communication
2. Terman, F. E. : Electronics and Radio Engineering
3. User Manual of the kit ST-2202
4. website :- http://mhakhan.tripod.com/lab.html

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Experiment No.2

PLL as the FM Demodulator

Object:- (a) Determine the lock-range and the Capture-range of the given PLL kit.

(b) Plot the demodulation characteristics **(V_D vs Δf)** and verify that the given PLL circuit is working as the Demodulator. Of the FM signal.

Apparatus Used :-
1. The PLL Kit,
2. A Function generator with digital frequency display (1 MHz)
3. A Dual Trace CRO (20 MHz)

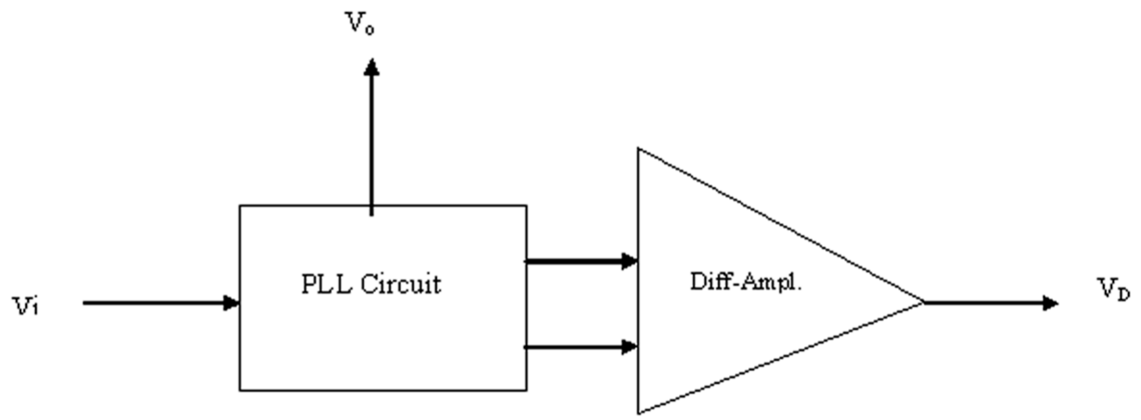

Figure 1

Experimental Setup

Figure 1 shows the experimental set-up & fig. 2 shows the Block-diagram of a PLL chip

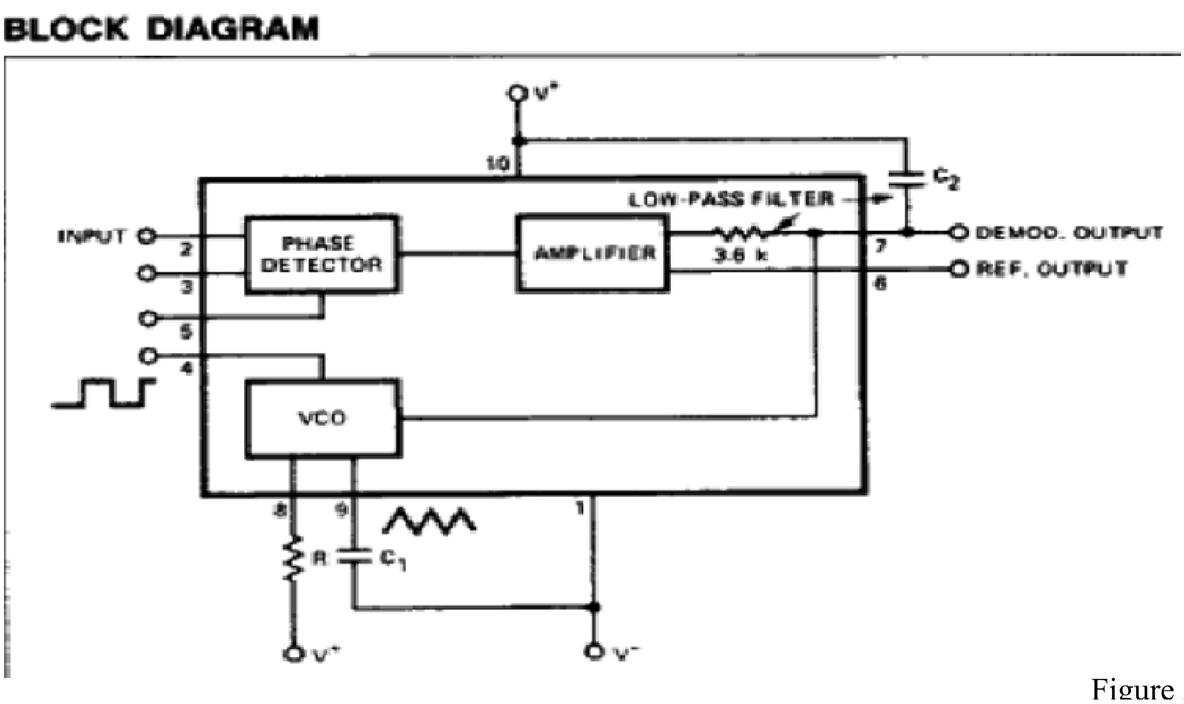

Figure 2

Theory :- The functional characteristics of the PLL are described in the Data-sheet supplied by the manufacturer of PLL chip NE565. Refer to the data-sheet of NE565.

Observations:- (a) Free-running frequency, f_o = ------- KHz ; ($f_o = 1/T_o$,)

f_1 = ………………KHz ; (L -- UL)

f_2 = …………… KHz ; (UL -- L)

f_3 = ………………KHz ; (L -- UL)

f_4 = ………………KHz ; (UL -- L)

(b) Lock-range (f_L) = ($f_1 - f_3$) = KHz

(c) Capture-range (f_c) = ($f_2 - f_4$) = KHz ; (Verify that $f_L > f_c$)

(d) Readings for Demodulation Characteristics:

S. No.	Incoming signal frequency (f_i)	DC Level of the Differential output (V_D)	$\Delta f = (f_i - f_o)$

Vi = a sinusoidal signal having variable frequency & amplitude around 8 volts p-p (obtained from an external signal generator) to be connected at input of the PLL marked V_i ; for the purpose of determination of the lock-range, capture-range & the Demodulation characteristics of the PLL circuit.

Result:-

A curve between V_D versus Δf shows the Demodulation characteristics of the PLL and is linear, which justifies that the given circuit of the PLL (NE565) is working as a demodulator of a FM signal having maximum frequency deviation less than the lock-range of the PLL..

Report:-

1. Draw the circuit diagram of the PLL and give an expression for its free-running frequency.
2. Discuss the applications of the PLL in actual practice.

Circuit diagram of FM Demodulator using PLL NE565 / LM565

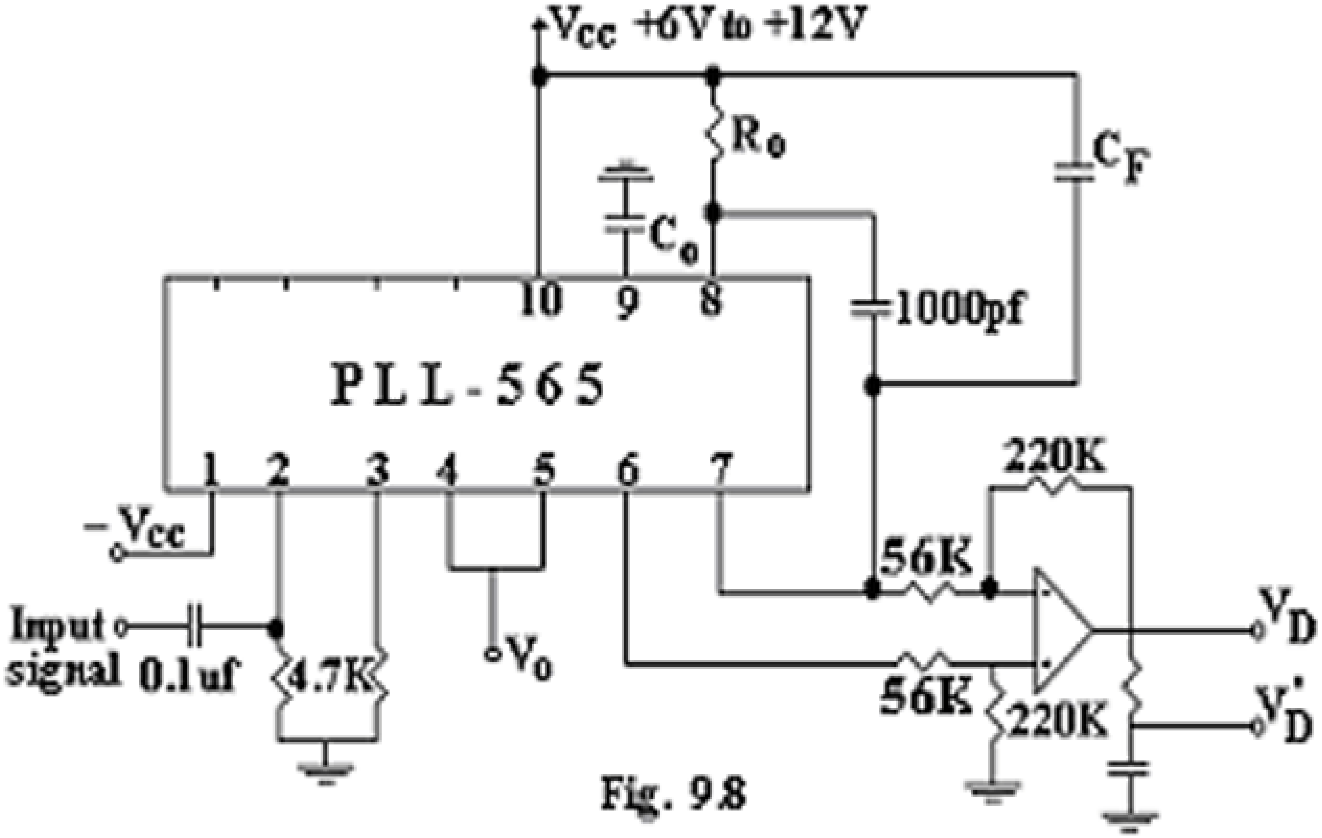

Fig. 9.8

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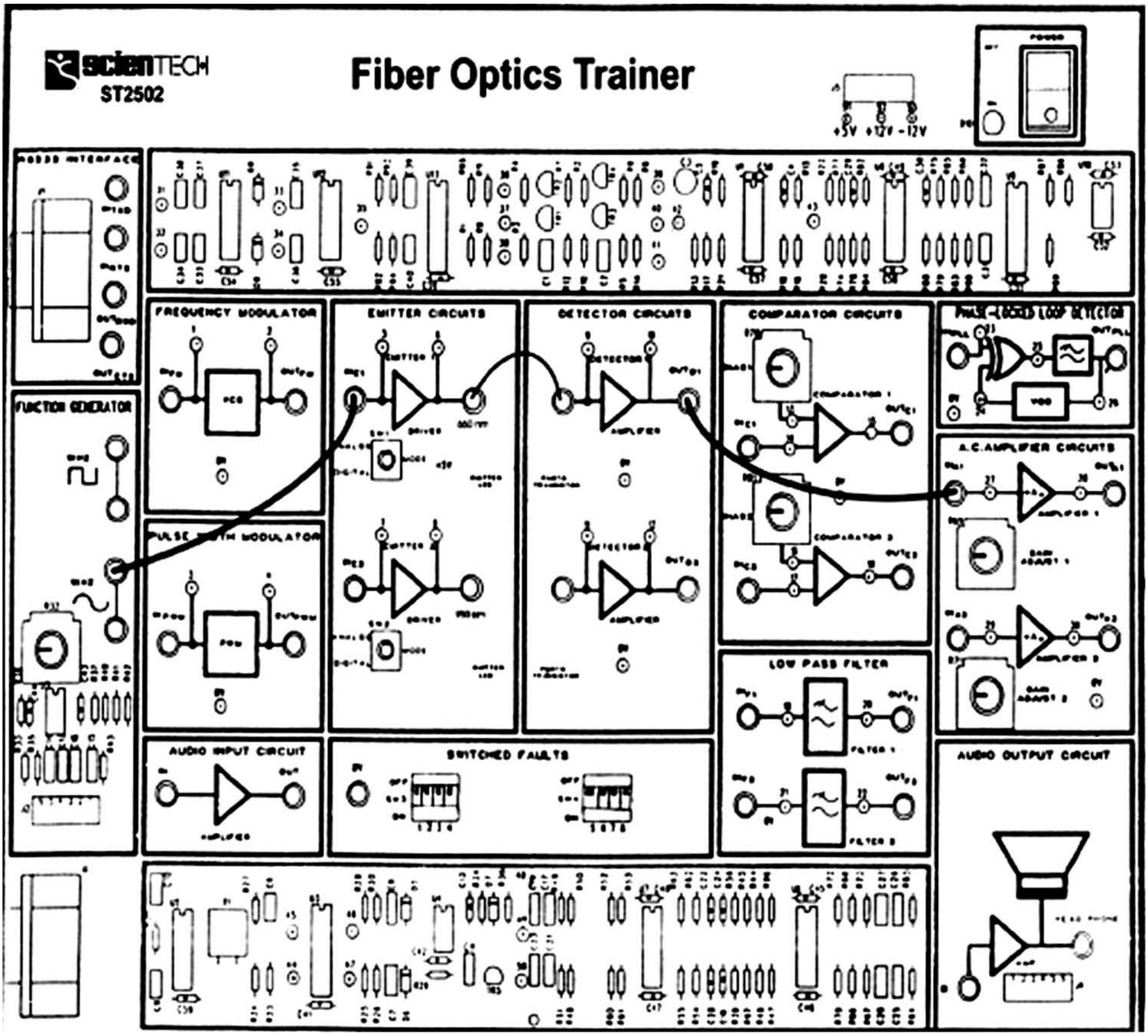
Experiment 3 : Study of Optical Fiber Communication

3(a) Objective: Setting up Fiber Optic Analog Link
Study of a 650nm fiber optic analog link in this experiment you will study the relationship between the input signal and received signal.

Equipments Required:
1. ST2502 trainer with power supply cord
2. Optical Fibre cable
3. Cathode ray oscilloscope with necessary connecting probe

Connection diagram:-



Procedure:

1. Connect the power supply cord to the main power plug & to trainer ST2502.
2. Ensure that all switched faults are ‘Off’.
3. Make the following connections as shown in figure 1.1

a. Connect the 1 KHz sine wave output to emitter l's input.
b. Connect the Fiber Optics cable between emitter output and detectors input.
c. Detector l's output to AC amplifier 1 input.

4. On the board, switch emitter l's driver to analog mode.
5. Switch ON the power supply of trainer and oscilloscope.
6. Observe the input to emitter 1 (TP5) with the output from AC amplifier 1 (TP28) and note that the two signals are same.

Questions:

1. What is meant by index profile?
2. What is the drawback of multimode fibres?
3. What is fibre optics?

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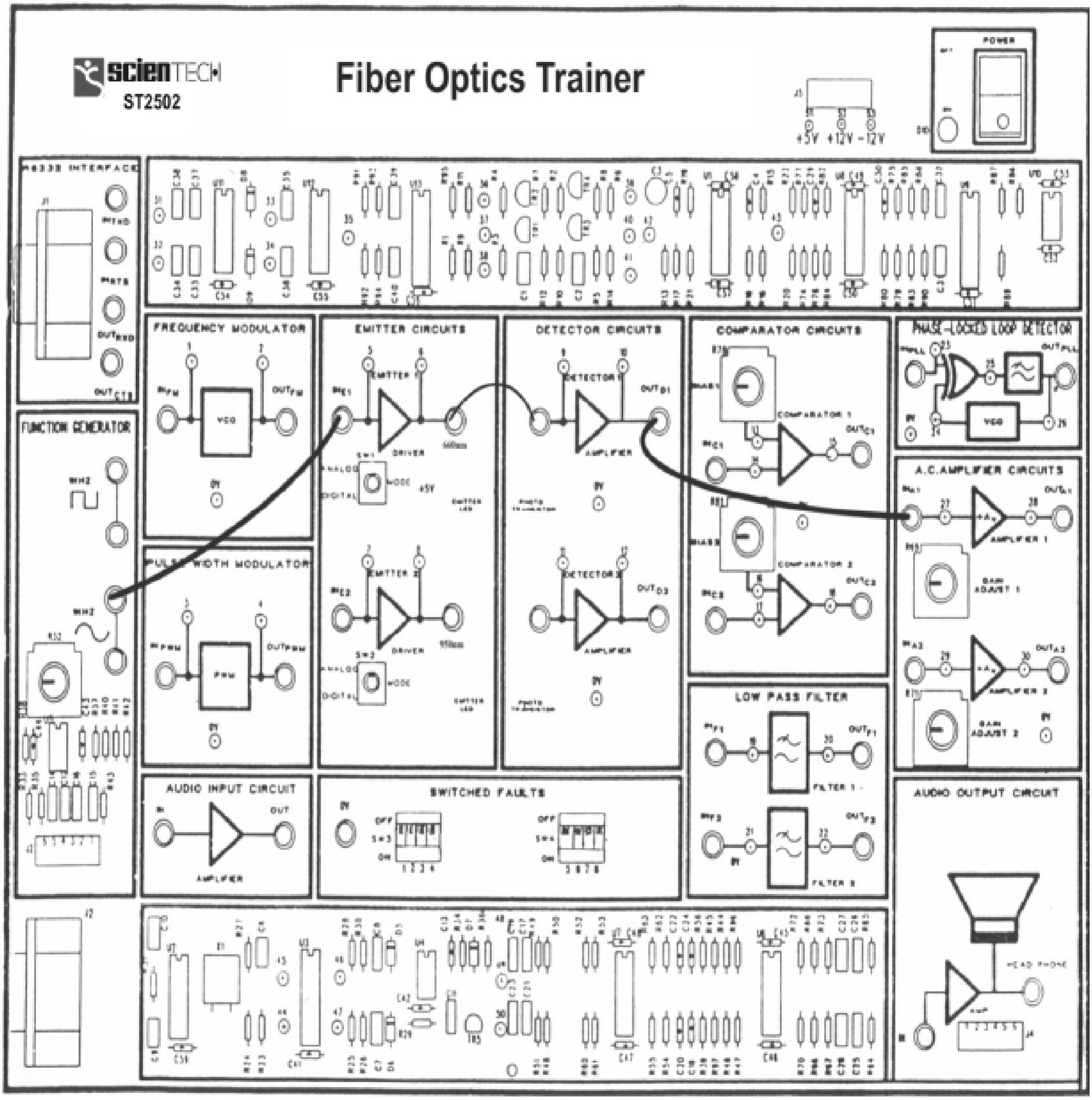
Object 3 (a) :- To measure propagation or attenuation loss in optical fiber
Equipments Required:

1. ST2502 trainer with power supply cord
2. Optical Fibre cable
3. Cathode ray oscilloscope with necessary connecting probe

Connection Diagram:



Procedure:-

1. Connect power supply cord to the main power plug & to trainer ST2502.
2. Make the following connections as shown in the above connection diagram (on page-3).

a. Function generator’s 1 KHz sine wave output to Input 1 socket of emitter 1 circuit via 4 mm lead.

b. Connect 0.5 m optic fiber between emitter 1 output and detector l's input.
c. Connect detector 1 output to amplifier 1 input socket via 4mm lead.
3. Switch ON the Power Supply of the trainer and oscilloscope.
4. Set the Oscilloscope channel 1 to 0.5 V / Div and adjust 4 - 6 div amplitude by using X 1 probe with the help of variable pot in function generator block at input 1 of Emitter 1.
5. Observe the output signal from detector TP10 on CRO.
6. Adjust the amplitude of the received signal same as that of transmitted one with the help of gain adjust potentiometer in AC amplifier block. Note this amplitude and name it V_1.
7. Now replace the previous FG cable with 1 m cable without disturbing any previous setting.
8. Measure the amplitude at the receiver side again at output of amplifier 1 socket TP 28. Note this value end name it V_2.

Calculate the propagation (attenuation) loss with the help of following formula:-

$$V_1 / V_2 = e^{-\alpha (L_1 + L_2)}$$

Where α is the attenuation loss in nepers / meter

Note that, 1 neper = 8. 686 dB
L_1 = length of shorter cable (0.5 m)
L_2 = Length of longer cable (1 m)

Questions:
1. How to measure propagation losses?
2. By what optical cable is made up of?
3. What is step index fibre?

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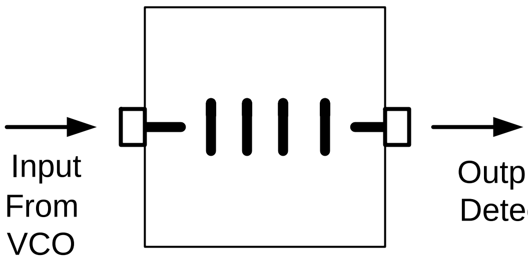
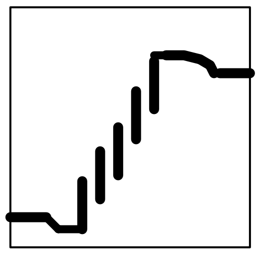
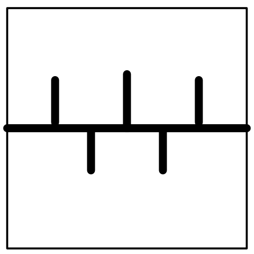
Experiment No. 4 (Micro strip Components)

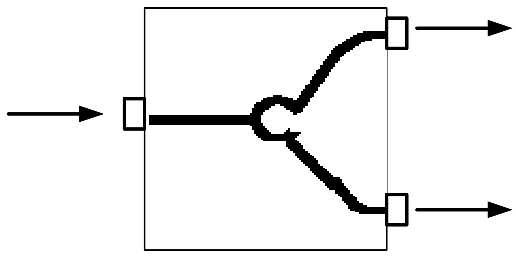
<u>Introduction</u>:- The objective of this experiment is to get the knowledge about the Microwave Integrated Circuits (MICs), fabricated using standard micro strip technology and available in the form of "Advanced Micro-strip Trainer Kit (AMTK). By using this kit, the students can study the Characteristics of some Micro strip components such as Low-pass filters, band-pass filters, band-stop filters and the power dividers. These micro strip components have been designed to operate in the C-band (having a center frequency = 5 GHz) and are available in the form of printed circuit boards, which can be mounted on a "Universal Test Jig" with the help of its spring-loaded mechanism for the testing-purpose. The following figures show the printed circuit boards of some of the individual micro strip components included in the AMT kit :-

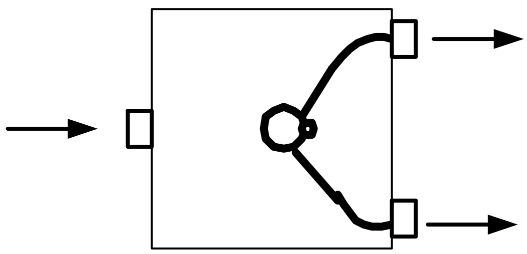


LPF


BPF


Band Stop Filter


Power Devider without
Isolation Resistor

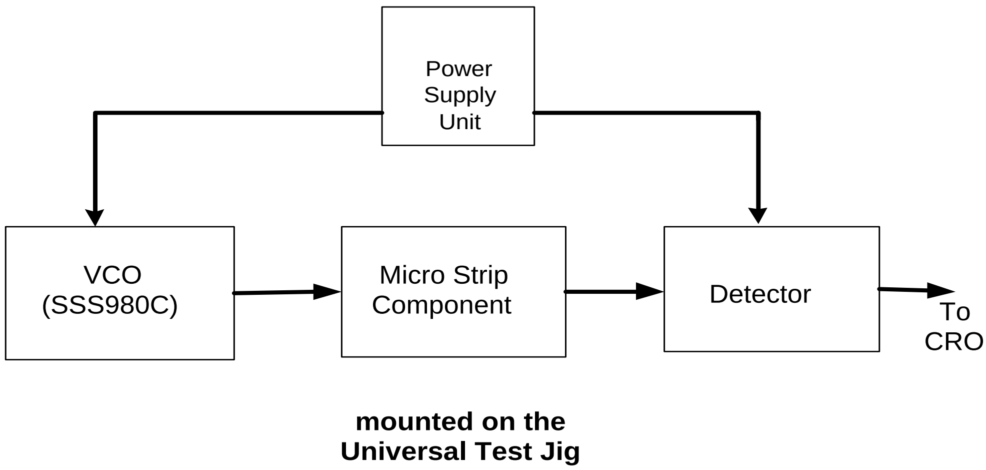

Power Devider with
Isolation Resistor

About the Apparatus:-

The AMTK setup contains a Power-supply unit, a C-band solid-state source model SSS980C (VCO) operating in the frequency-range of 4.7 GHz to 5.7 GHz, a Universal Test Jig with six co-axial connectors, three 50 Ω matched loads required for terminating ports while testing, a microwave detector, the stands for mounting the Universal Test Jig & detector, and a CRO.

Experimental Setup :-

The following figure shows the layout and the interconnections of various items of the AMTK to carry out testing and taking observations for the determination of the Characteristics of the Micro strip components:-



Experimental Setup Diagram

Procedure: -

1. Make the experimental setup as shown in figure above.
2. Insert the micro strip component to be tested into the Universal Test Jig by turning its lever anti-clockwise and after placing the component inside the jig, again turn the lever in clockwise direction to lock the 2”X2” substrate of the microstrip component in position. In this position the input and output microstrip line conductors make a perfect contact with the co-axial connector tab. The circuit is now ready for testing.
3. Now, turn ON the Power Supply Unit and adjust its voltage such that the VCO (a C-band solid-state source model SSS980C) displays a frequency of 4.7 GHz.
4. Adjust the required controls of the CRO to display properly a signal at the output of the detector, having the waveform like square-wave.

5. Measure the amplitude of the signal displayed on the CRO screen corresponding to the VCO frequency of 4.7 GHz.
6. Keep on changing the VCO frequency by turning the voltage control knob of the power supply unit and take measurements at discrete frequencies and record your observations in the form of the table shown under the observations, and plot the characteristics (gain versus frequency) over a specified frequency band.
7. For Power Dividers, measure the amplitudes at both the output ports.
8. Record your observations in a tabular form as shown under the heading of observations.

OBSERVATIONS:-

(a) For low-pass filters:-

S. No.	**VCO frequency (GHz)**	**Amplitude (volts$_{p-p}$)**
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Similarly, record your observations for the following microstrip components:-

1. Band Pass Filter (BPF),
2. Band Stop Filter (BSF),
3. Power Divider without isolation resistor
4. Power Divider with isolation resistor.

Result:- Plot the characteristics (amplitude versus frequency) over a specified frequency band (4.7 GHz to 5.7 GHz) for the microstrip components used above.

Report:-

1. How can you realize Microwave Filters?
2. Discuss the applications of Microwave filters.

References:-

1. User Manual of Advanced Microstrip Trainer Kit.; SICO, India.
2. Matthaei, Young and Jones : Microwave Filters, Impedance Matching Networks and Coupling Structures, Artek House, Dedhan, Mass, 1980.
3. T. C. Edwards : Foundations for Microstrip Engineering, John Wiley, New York, 1981

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EXPERIMENT - 5

Coding Techniques for different Data Formats and FSK - Modulation and Demodulation

Object:- (a) Encode the given binary data into the following Formats using the given Trinity kit model CS-1223Tx :-

1) Non-Return to Zero Formats: NRZ-L, NRZ-M and NRZ-S
2) Phase Encoded Formats : Biphase-L, Biphase-M and Biphase-S
3) Alternate Mark Inversion Format : AMI

(b) Use the encoded data format NRZ-L as the modulating signal, generate the FSK signal.

(c) Recover the Data from the FSK signal generated above by demodulation using the Trinity CS-1223 Rx kit.

Apparatus Used :- 1. Trinity Data Format Trainer Kits model 1223 Tx and Rx.
2. A Dual Trace CRO (20 MHz)

Brief Description of the Kit, CS-1223 Tx :-

The kit CS-1223 Tx consists of the following six sections:-

1 **Clock and Data Generator Section**, providing Clock-S and Data-S at its outputs.
2 **Data Formats Generator Section** having two inputs CLK-In and DATA-In, and six outputs for different Data formats. (NRZ-M & NRZ-S are available at NRZ-M/S output, selected by the two-way switch SW-1).
3 **Carrier Generator Section**, providing three sinusoidal signals:2 MHz, 1 MHz (0^o) and 1 MHz (180^o), to be used as carrier signals for different modulation schemes such as FSK, etc.
4 **Carrier Modulation Section** having three inputs (control input for modulating signal, Input-1 and Input-2 for carrier) and one output providing the modulated signal.
5 **Unipolar to Bipolar converter**, and
6 **Bipolar to Unipolar converter**

The kit **CS-1223 Rx** is for decoding of the encoded formats and demodulation of the FSK .

THEORY:-

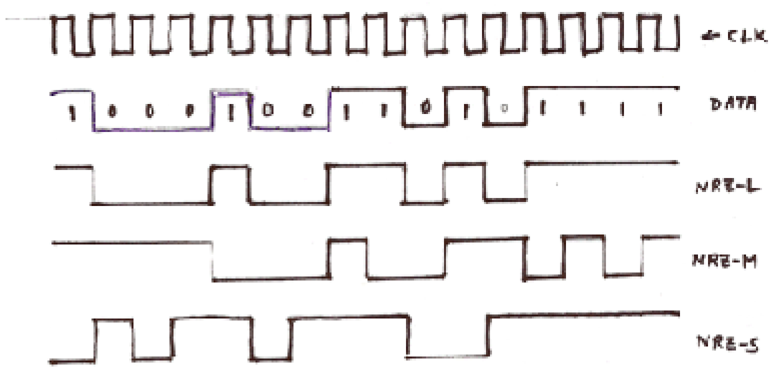
1. The Non-Return to Zero Formats:

a) NRZ-L :- Here all 'ones' are represented by high and all 'zeroes' by low levels.

b) NRZ-M :- All 'ones' are marked by the change in level, and all zeroes by no transition.

c) NRZ-S :- All 'ones' by no transition, and all zeroes by change in level.

The above encoded signals in Non Return to Zero Formats are shown in the following figure:-



NON-RETURN TO ZERO DATA FORMAT

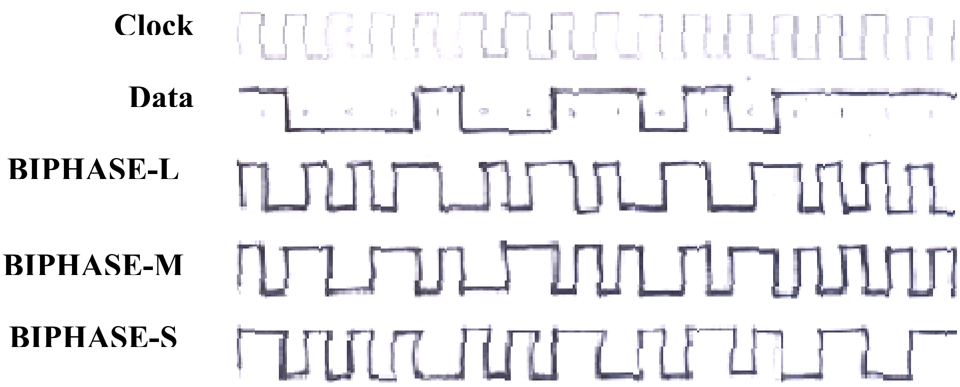
2. Phase Encoded Formats :-

Biphase-L:- 'One is represented by half bit wide pulse positioned during the first half of the bit interval and a 'zero' by half bit wide pulse positioned during the second half of the bit interval. This type of coding is also known as Manchester coding.

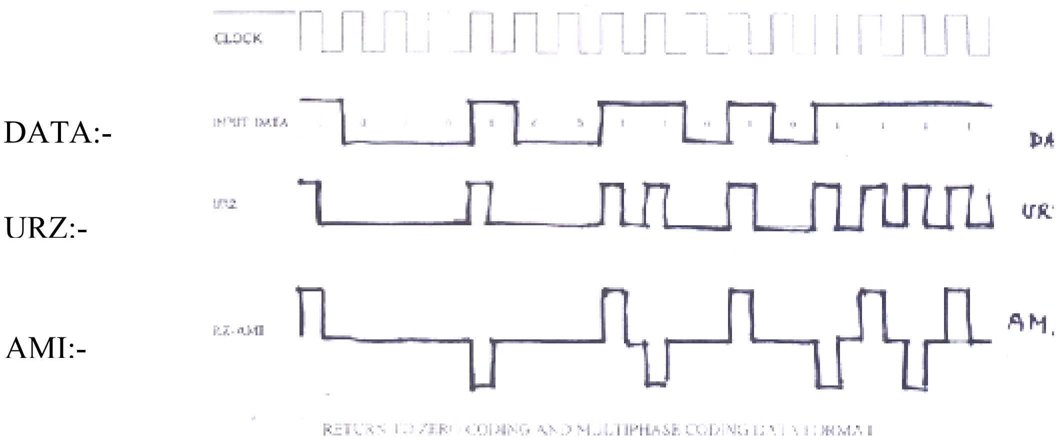
Biphase-M:- In this type of coding, a transition occurs at beginning of every bit interval, and a 'one' is represented by a second transition at half bit later, whereas a 'zero' has no second transition.

Biphase-S :- Here also, a transition occurs at beginning of every bit interval, but a 'zero' is marked by a second transition occurring at one half bit later and 'one' has no second transition.

The waveforms for this type of coding are shown in the following figure:-

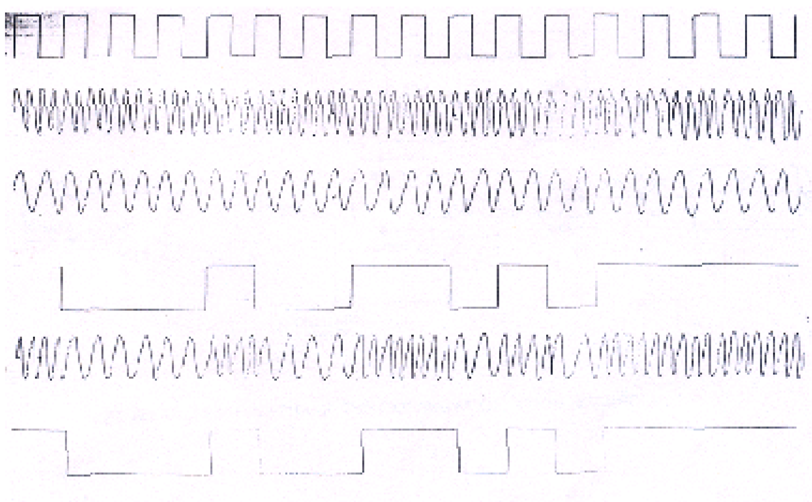


3. Alternate Mark Inversion Format, AMI :- This is a multi-level coding technique, in which the binary digits 'ones' and 'zeroes' are represented by three or more voltage levels, instead of the normal two levels 'High' and 'Low'. In this technique 'ones' are represented by equal amplitudes of alternating pulses, which alternate between a +5 V and -5V. These alternating pulses return to 0 volt, after every half bit interval. The 'zeroes' are represented by absence of pulses. This technique of data encoding finds its application in Telemetry. The following figure shows the waveforms for AMI :-



4. FSK and its Demodulation:-

FSK (frequency shift keying), is a technique of modulation in which the frequency of the carrier shifts to some other value on the occurrence of the 'High' level of binary modulating signal, and returns to its original value on the occurrence of the 'Low' level of the binary modulating signal. By demodulation, the data is recovered. The FSK waveforms are shown in the following figure:-



<u>PROCEDURE</u> :-

(a) For Data coding techniques:-

After turning ON the kit, Observe the Clock and the data on CRO, connect them to their corresponding inputs in "Data Formats Generator Section".

Observe NRZ-L, AMI, Biphase-L at the terminals marked with their names.

Observe NRZ-M and NRZ-S at the terminal marked NRZ-M/S and select M & S by the switch, SW-1.

Similarly observe Biphase-M and Biphase-S at the terminal marked Biphase-M/S and select M & S by the switch, SW-1.

(b) For FSK:-

Connect NRZ-L to the control input of Carrier modulation section, and view it on one-channel of CRO.

Connect 2 MHz carrier to Input-1 and 1 MHz (0^o) carrier to Input-2 of the Carrier modulation section.

Observe FSK signal at the FSK output, and note the appearance of the two frequencies corresponding to the High and Low levels on the CRO screen. Trace the FSK waveform.

(b) Recovery of Data from FSK:-

Use another kit CS-1223 Rx and connect the grounds of both the kits together.

Connect the FSK from Tx kit to FSK IN input terminal in the FSK Demodulator section on the Rx kit.

Observe the recovered Data (NRZ-L) at the demodulator output terminal and view it on one channel of the CRO, whereas view the modulating signal (NRZ-L on Tx kit) on the other channel of the CRO..

Trace the two signals.

Note that a small phase lag exists between the modulating data and the recovered data because of the limitation of the tracking ability and the time response of the PLL (used in the demodulator section in the Rx kit).

Report:- Discuss the decoding techniques for different coded data formats. Comment on your results and give reasons for justification of any assumption or argument.

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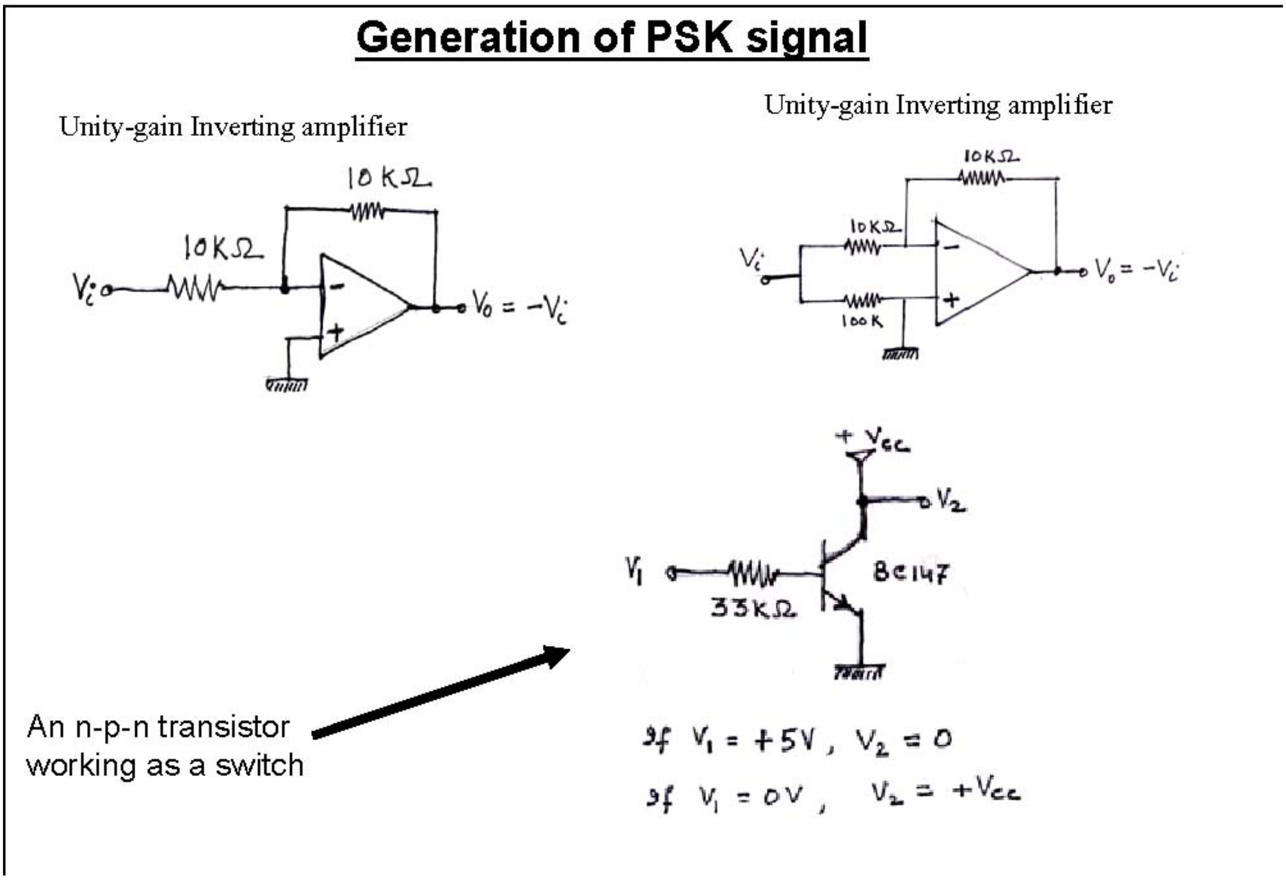
Experiment No. 6 (Digital Modulation Schemes)

Object:- Study the various Digital Modulation Schemes (ASK, PSK, OOK, APSK)



$b_1 = 0,\ v_o = +v_{in}$
$b_1 = 1,\ v_o = -v_{in}$

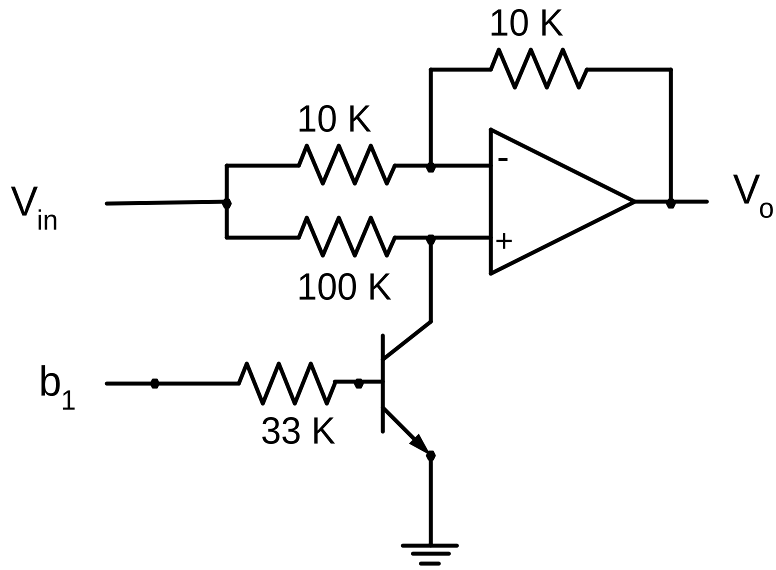


Figure 1:- PSK Circuit

OOK:- By shorting the 10 K resistor connected between pin # 2 & 6 of the PSK circuit shown in Figure 1 above, it will now work as an OOK (ON-OFF Keying) circuit.

$b_2 = 0$, $v_o = v_{in}$
$b_2 = 1$, $v_o = 3v_{in}$

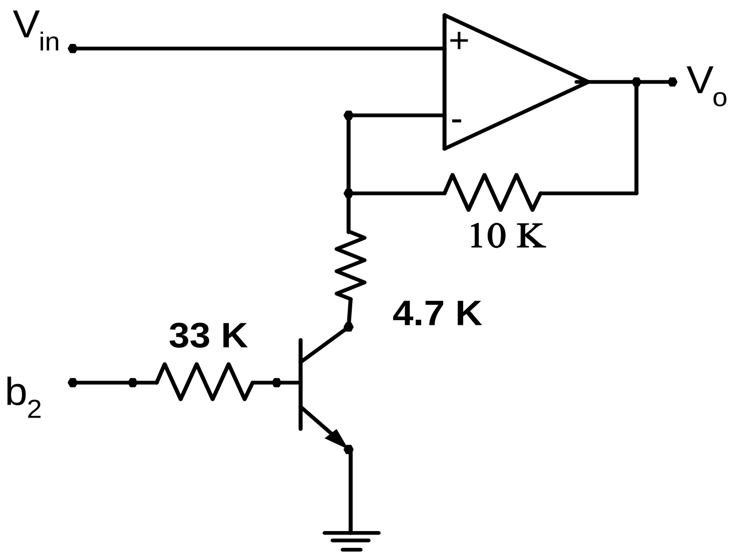


Figure 2 :- ASK Circuit

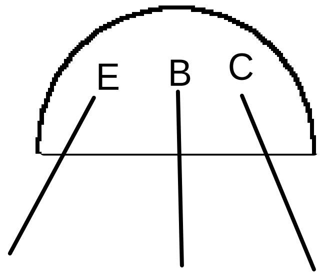


Figure 3 :- Bottom View of NPN Transistor (BC 147)

Apparatus Used:-

1. Breadboard PDC-20 (having symmetrical dual DC power supply)
2. Components:- Opamps (741) = 02 nos.
   NPN Transistors (BC 147) = 02 nos
   Resistors :- 100K = 1, 33K = 2, 10K = 3, 4.7K = 1
3. Function Generator Model ST-4062 = 1 (for carrier)
4. Function Generator (Pacific) Model FG-18 = 1 (for TTL Clock)
5. 20 MHz Dual Trace Oscilloscope = 1

Procedure:-

1. Construct the PSK circuit (as shown in Figure 1 above) on the Breadboard.
2. Keeping the DC power supply OFF, connect the +15 V terminal of the supply to pin # 7, and –15 V terminal to pin # 4 of the opamp, 741, and the GND terminal to a common point on the Breadboard, and turn ON the power supply now.
3. Obtain a sinusoidal signal from Function Generator Model ST-4062 and adjust its amplitude around 0.5 V p-p and frequency around 8 KHz (by connecting it directly to CRO), and connect it to the carrier input, $\mathbf{V_{in}}$ of the PSK circuit.
4. Obtain a TTL clock from the TTL output of the Function generator model FG-18, and adjust its frequency around 1 to 2 KHz (by connecting it directly to CRO), and connect it to modulating signal input $\mathbf{b_1}$ of the PSK circuit. [Note that a TTL clock is a binary pulse-train (unipolar) of amplitude = +5-volts$_{p-p}$]

5. Ensure that all the GND terminals of both Function generators and the CRO are connected together and are also connected to the common point made on the Breadboard.
6. Now, connect the TTL clock to one channel, and the output of the PSK circuit to the other channel of the CRO, and adjust the triggering and the gain controls of the CRO properly to obtain a clear wave shape of the PSK signal on the CRO screen. Note the shifting of the phase at every transition point of the binary TTL clock.
7. Now, short circuit the 10K resistor connected between pin 2 & 6 of opamp in the PSK Circuit, to get an **OOK signal** on the CRO screen.
8. Similarly, construct the ASK circuit (as shown in Figure 2 above) on the bread board, connect biasing power supply and connect the previously adjusted sinusoidal carrier to the **V_{in} input of** the ASK circuit, and a TTL clock to its b_2 input and display b_2 on one channel and the output, Vo of the ASK, on another channel of the CRO, and note the shifting of the amplitudes at the transition points of the binary TTL clock.
9. The APSK signal can be studied by connecting the output of the ASK to the carrier input **V_{in}** , of the PSK circuit, (the sinusoidal carrier signal being connected to the carrier-input of the ASK circuit), and connecting '1' and '0' to the binary inputs b_1 and b_2. For '1', connect +15 Volts DC supply and for '0', connect Ground (0 Volt DC).
10. Measure and record the high and low values of the amplitudes of the APSK signal and the phase difference of the APSK output with the carrier-input in a tabular form as shown under observations and verify the truth-table for the APSK signal.
11. Draw all the above signals (PSK, OOK, ASK & APSK) clearly on a graph paper and mark the shifting of phase and amplitude in the modulated signals corresponding to b_1 and b_2.

Continued to next page ---

Observations

Amplitude of the carrier = -------- Volts p-p

frequency of the carrier = -------- KHz

frequency of the TTL clock = -------- KHz

For ASK, high amplitude = ------- volts p-p, and low amplitude = ------- volts p-p

b_1	b_2	Amplitude	Phase-diff
0	0		
0	1		
1	0		
1	1		

NB:- For verifying truth table of the APSK, connect +15 V DC for logical '1' and GND for '0'. Care must be taken for proper grounding of the circuits and for proper triggering of the CRO.

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Experiment No. 7 - PCM

OBJECT:- (a) Study of TDM.
(b) Study of the Transmission and reception of two signals by PCM.
(c) Study of error- check codes: -
(i) Even and Odd parity codes
(ii) Hamming codes

EQUIPMENTS REQUIRED:-

1. PCM Transmitter kit, Scientech model ST2103 - Tx
2. PCM Receiver kit, Scientech model ST2104 - Rx
3. 20 MHz Dual Trace CRO / DSO
4. Patch cords

PROCEDURE:-

(a) For TDM:-

1. Set up the following initial conditions on the PCM Transmitter kit, ST2103:-

a) Mode Switch in 'FAST' position

b) DC 1 & DC2 Controls in function generator block fully clockwise.

c) Set ~ 1 KHz and ~2 KHz control levels to give 10 Vpp.

d) Pseudo - random sync code generator ON/'OFF' switch in 'OFF' Position.

e) Error check code generator switch A & B in A=0 & B=0 position ('Off' Mode)

f) All switched faults to 'Off'.

2. First, connect only the ~1 KHz output to CH 0

3. Turn ON the power. Check that the PAM output of 1 KHz sine wave is available at TP15 of the ST2103.

4. Connect channel 1 of the oscilloscope to TP10 & channel 2 of the oscilloscope to TP15, and observe the timing & phase relation between the sampling signal TP10 & the sampled waveform at TP15.

5. Turn 'Off' the power supply. Now connect also the 2 KHz supply to CH 1.

6. Connect channel 1 of the oscilloscope to TP12 & channel 2 of the oscilloscope to TP15.

7. Observe & explain the timing relation between the signals at TP10, 5, 6, 12 &15.

8. Draw the wave-shape of TDM signal on a graph paper and record all concerned parameters in your observations.

(b) For PCM:-

1. Using the same setup of initial conditions as already done in step 1 above, make the following connections:-

(a) Connect the Ground of the Tx-kit (2103) to the Ground of the Rx-kit (2104),

(b) Connect the Tx Clock (3) of Tx-kit (2103) to the Rx-Clock (46) on the Rx-kit (2104),

c) Connect the Tx Sync (4) of Tx-kit (2103) to the Rx-Sync (47) on the Rx-kit (2104),

d) Connect the PCM Output (44) on Tx-kit (2103) to the PCM Data input (1) on the Rx-kit.

e) Connect the message signals of ~1KHz to CH-0 (10) and ~2 KHz to CH-1 (12) on the Tx-kit

2. Now, observe the PCM Output at (44), on one channel of the oscilloscope.

3. Observe the effect of amplitude variation of the above message signals on the PCM output.

4. Draw the wave-shape of PCM signal on a graph paper.

Now, observe the recovered message signals at CH0 (33) & at CH1 (36) in the Rx-kit, on CRO, and compare them with the transmitted message signals connected on the Tx-kit, note their parameters and report the result of your comparisons.

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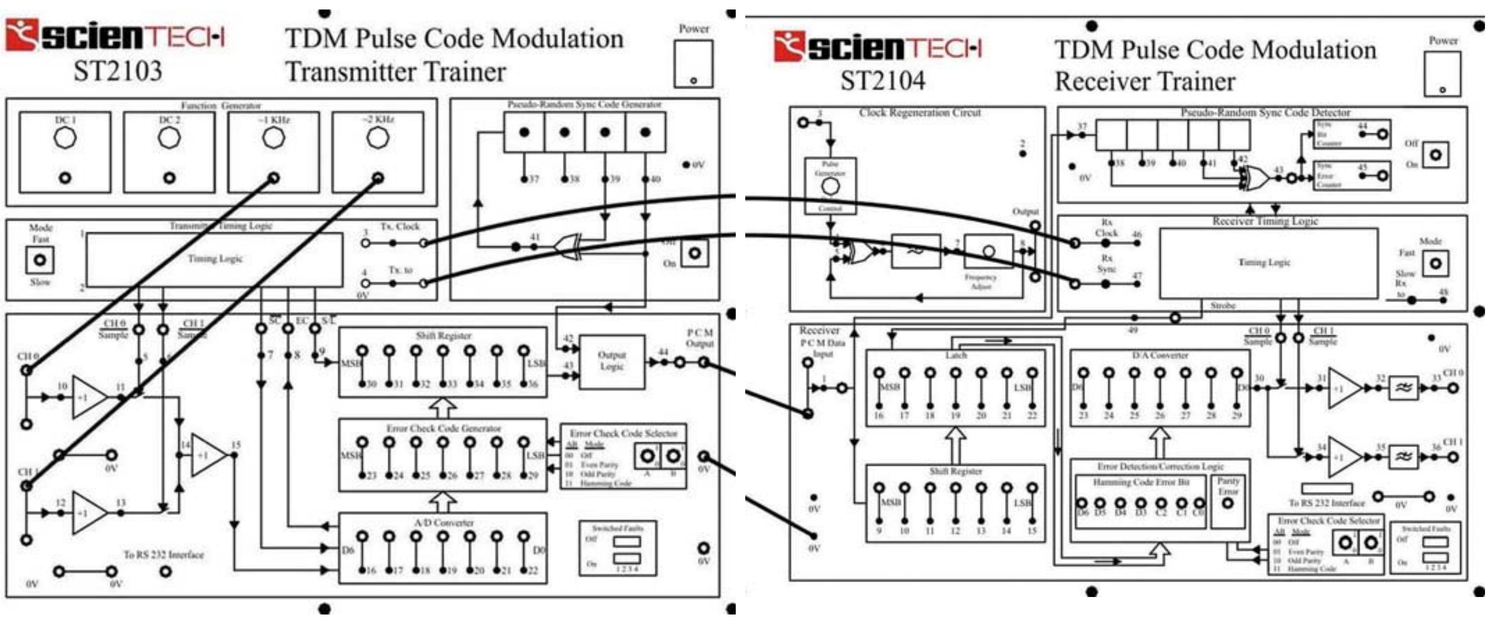
PCM Transmitter and Receiver Layout diagrams



Connections for TDM and PCM

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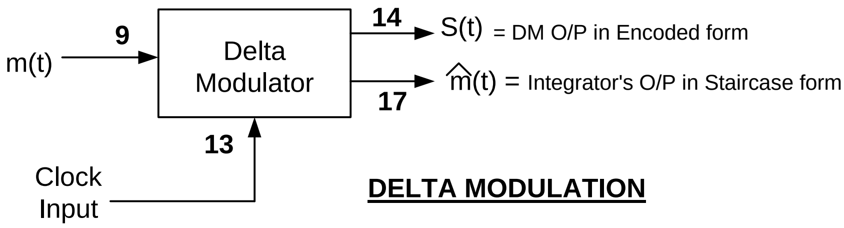
Experimemt No. 8 : Delta Modulation

Object:- a) **Generate Delta modulated signal using the given Scientech kit model ST-2105.**
b) **Determine the conditions for slope-overloading.**
c) **Study the elimination of the slope-overloading by adjusting various parameters**.

APPARATUS USED:-

1. Scientech Delta Modulation Trainer kit Model ST-2105
2. 20 MHz Dual Channel Oscilloscope

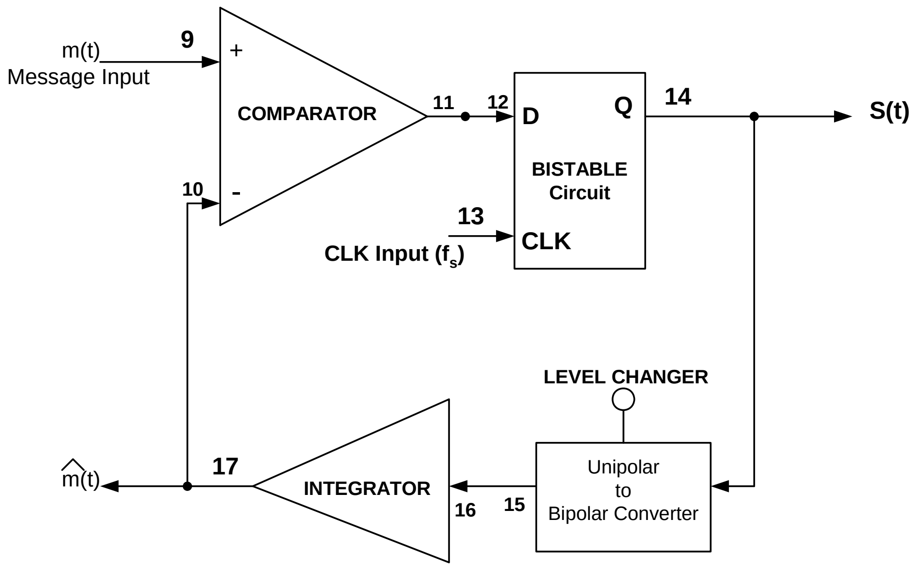


Schematic Diagram for Delta modulation:-

The following sections of the given kit are to be used for this experiment on Delta Modulation:-

1. Function Generator section providing sinusoidal signals (to be used as modulating signals) of adjustable amplitudes and of 250 Hz, 500 Hz, 1 KHz and 2 KHz frequencies.
2. CLOCK Generator section providing clocks of adjustable frequencies of 32 KHz, 64 KHz, 128 KHz and 256 KHz (to be used as a carrier of given sampling rates).
3. A COMPARATOR Circuit (in the Transmitter Part of the kit).
4. A BISTABLE Circuit (in the Transmitter Part of the kit) with "LEVEL CHANGER" control.
5. An INTEGRATOR Circuit (in the Transmitter Part of the kit) with adjustable gain control.
6. A Unipolar to Bipolar Converter section (in the Transmitter Part of the kit).

The above sections of the kit are to be inter-connected according to the following Schematic diagram:-



<u>PROCEDURE</u>:-

1. Adjust the Clock frequency (sampling rate) to 32 KHz (by setting the switches A = 0, B = 0).and connect it to socket number (13) in the "BISTABLE Circuit (in the Transmitter Part of the kit)".
2. Adjust the "Step size", by connecting 0-volt to the positive-input (9) of the COMPARATOR Circuit and monitor on an Oscilloscope, the output of Integrator 1 (t.p.17) and the output of the transmitter's LEVEL CHANGER (t.p15).
3. Ensure that integrator 1 block's switches are in following position:

(A) Gain control switch in left-hand position (towards switch A & B).

(B) Switches A & B in A=0 and B=0 positions, corresponding to the minimum gain.

4. Adjust the transmitter's LEVEL CHANGER preset until the output of INTEGRATOR 1 (t.p. 17) is a triangle wave centered around 0 Volts. The peak-to-peak amplitude of the triangle wave at the integrator's output should be 0.5V (approx), this amplitude is known as the **integrator STEP SIZE Δ**. The output from the Transmitter's BISTABLE Circuit (t.p. 14) will now be a stream of alternate '1' and '0', this is also the output of the delta modulator itself. The Delta Modulator is now said to be 'balanced' for correct operation.
5. Now remove the 0-volt from the positive-input (9) of the COMPARATOR Circuit and connect a Sine-wave (as a message signal) of 500 Hz (obtained from the Function Generator section) to the positive-input terminal (9) of the COMPARATOR Circuit.
6. Observe the **"Integrator's output" m(t)** at (17) on one channel of the CRO.
7. Adjust the "TRANSMITTER LEVEL ADJ Preset" (provided in the BISTABLE Circuit) in order to obtain a stable trace of "Integrator's output" m(t) at (17).
8. Now observe the sinusoidal message signal of 500 Hz connected at (9) of the Comparator on the other channel of the CRO, and after adjusting the CRO controls, observe that the "Integrator's output" m(t) at (17), is following the message signal m(t) on the CRO screen. This ensures the correct operation of Delta modulation; and the "**encoded Delta modulated signal S(t)**" is now available at the output of the BISTABLE Circuit at socket (14). View it on the CRO and observe that it is a stream of '1s' and '0s'.
9. Record all the parameters adjusted for this setting in your observations. This completes the first part (a) of this experiment.

Now proceed for taking **observations for slope-overloading** as required for **part (b)** of the experiment in the following way:-

1. Increase the frequency of the message signal m(t) by connecting a 1 KHz and then a 2 KHz sine-wave to the Comparator's input (one by one), and record the maximum frequency of the m(t) in your observations, at which the "Integrator's output" m(t) ceases to follow the message signal m(t) on the

CRO. The condition in which the "Integrator's output" is no longer following the message is called **"slope over-loading"**. This gives the first condition of slope over-loading.

2. Now restore the message frequency and start increasing the message amplitude, until you again observe the slope-overloading. Record the maximum message amplitude in your observations at which the slope-overloading is occurring, which is the **second condition** of slope-overloading.

Next, **for part (c)** of the experiment, proceed as follows:-

1. First observe the slope-overloading at the maximum message frequency (as already done in part b), then, increase the step-size Δ, by increasing the integrator's gain by setting the integrator switches A & B accordingly, and observe that, at what setting of integrator's gain switches, the slope-overloading is eliminated and the "Integrator's output" m(t) again starts to follow the message signal m(t). Record the value of the step-size Δ (in volt) in your observations, at which the slope-overloading is eliminated.

2. Similarly, get the slope-overloading at the maximum message amplitude (as already done in part b) and eliminate it by again increasing the step-size Δ (as done in the above step) and record it in your observations.

3. Also, try to eliminate the slope-overloading by increasing the sampling frequency.

OBSERVATIONS:-

(a) For the proper occurrence of Delta Modulation (no slope-overloading) :-

Amplitude of the sinusoidal (message) signal, A_m = ………… Volts $_{p-p}$
Frequency of the sinusoidal (message) signal, f_m = ………… KHz
Sampling frequency, f_s = ………….. KHz,
Step-size. Δ = …………….. volts, $_{p-p}$

(b) Conditions for slope-overloading :-

Maximum frequency of the message, causing slope-overloading = …………… KHz
Maximum amplitude of the message, causing slope-overloading = …………… Volts $_{p-p}$

(c) For elimination of slope-overloading:-

(i) Step-size (for eliminating slope-overloading at maximum message freq. of …. KHz) = …. Volt
(ii) Step-size (for eliminating slope-overloading at max. message amplitude of …. volts $_{p-p}$) = …. Volt
(iii) Sampling frequency (for eliminating slope-overloading at max. message freq. of . KHz) = … KHz

References:- 1. For understanding the operations of the various sections of the kit, refer to the "**Manual of the Scientech Delta modulation Trainer kit, model ST-2105**".
2. For theory of the Delta Modulation, refer to the Textbooks prescribed on Digital Communication.

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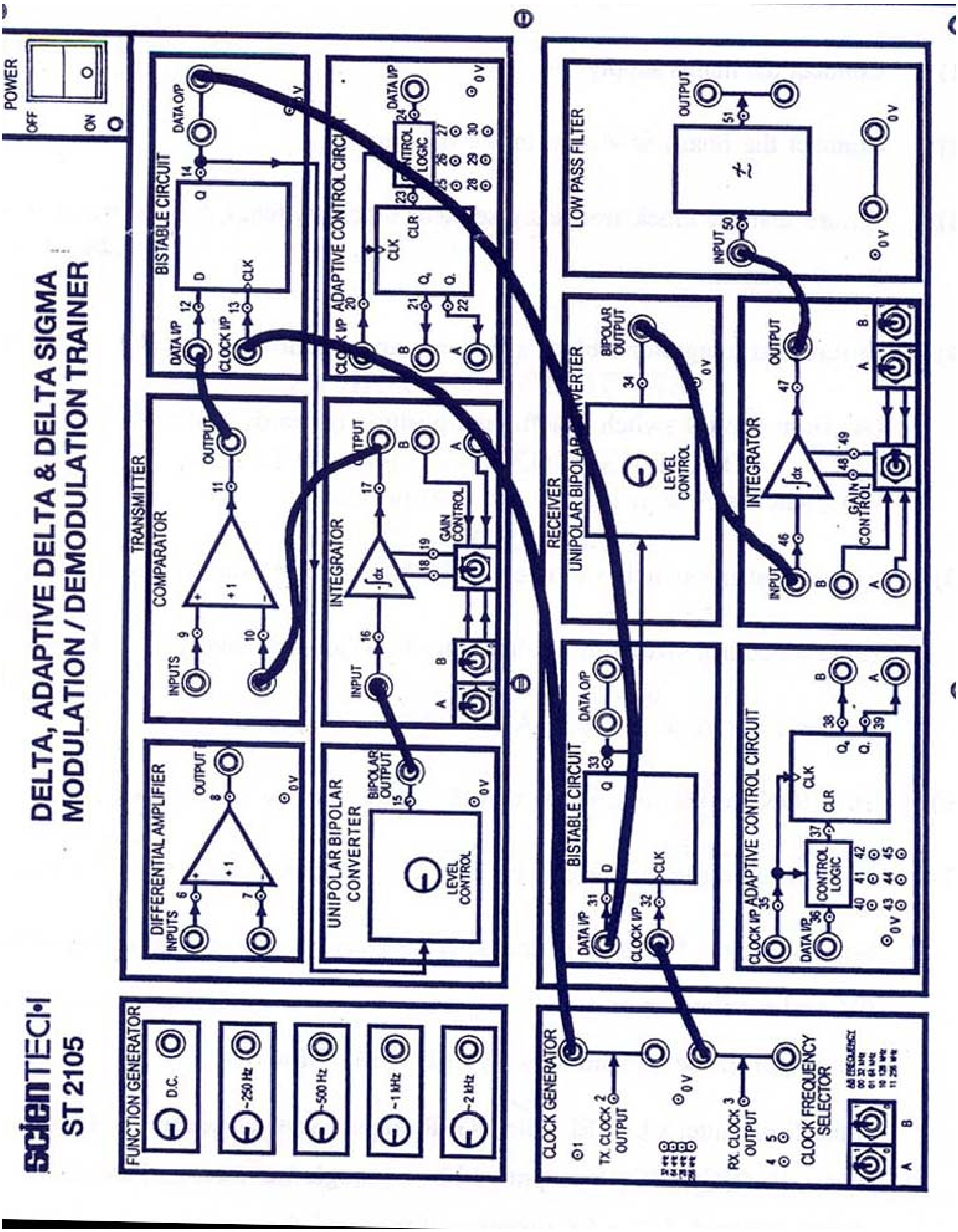
Experimental kit model ST-2105 Layout



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