ELECTRONIC MECHANIC

NSQF LEVEL - 5

2nd Year (Volume I of II)

TRADE PRACTICAL

SECTOR: Electronics & Hardware

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : Electronics & Hardware

Duration : 2 - Year

Trades : Electronic Mechanic 2nd Year (Volume I of II) - Trade Practical - NSQF LEVEL 5

First Edition: November 2018 Copies: 1000
First Reprint: February 2019 Copies: 2000

Rs.140/-

Published by:

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE
P. B. No.3142, CTI Campus, Guindy Industrial Estate,
Guindy, Chennai - 600 032.
Phone: 044 - 2250 0248, 2250 0657, 2250 2421
Fax : 91 - 44 - 2250 0791
email : chennai-nimi@nic.in , nimi_bsnl@dataone.in
Website: www.nimi.gov.in

FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Electronic Mechanic, 2nd Year (Volume I of II) Trade Practical NSQF Level - 5 in Electronics & Hardware Sector under Semester Pattern.** The NSQF Level - 5 Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 5 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 5 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

RAJESH AGGARWAL
Director General/ Addl.Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of Federal Republic of Germany. The prime objective of this Institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

R. P. DHINGRA
EXECUTIVE DIRECTOR

Chennai - 600 032

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP **(Trade Practical)** for the trade of **Electronic Mechanic** under the **Electronics & Hardware** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. N.P Bannibagi	-	Asst. Director of Training NSTI Ramanthapur campus Hyderabad.
Smt. K. Arul Selvi	-	Training Officer NSTI (W) Trichy.
Shri. K. Hemalatha	-	Vocational Instructor NSTI Chennai.
Shri. C. Anand	-	Vocational Instructor Govt. ITI for women, Puducherry.
Shri. S. Usha	-	Junior Training Officer, Govt. Model ITI, Hosur Road, Bangalore.
Shri. G. Ravishankar	-	Junior Training Officer, Govt. ITI, NR. Mohalla, Mysore.
Shri. Vineet Kumar Mudgal	-	Training Officer Govt. Model ITI, Govindpura Bhopal, Madhya Pradesh
Shri. A. Jayaraman	-	Training Officer (Rtd), Govt. of India CTI, Guindy Chennai - 32.
Shri. R.N. Krishnasamy	-	Vocational Instructor (Rtd) Govt. of India (VRC) Guindy, Chennai -32.
Shri. S. Gopalakrishnan	_	Assistant Manager, Co-ordinator, NIMI, Chennai - 32

NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the Fourth Semester course of the Electronic Mechanic trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 5

The manual is divided into Eight modules. The distribution of time for the practical in the Eight modules are given below.

Module 1	Digital storage oscillocope	25 Hrs
Module 2	Basic SMD (2,3,4 terminal components)	125 Hrs
Module 3	Protection devices	25 Hrs
Module 4	Electrical control circuits	25 Hrs
Module 5	Electronic cables & connectors	50 Hrs
Module 6	Communication Electronics	75 Hrs
Module 7	Microcontroller (8051)	75 Hrs
Module 8	Sensors, transducers and applications	75 Hrs
	Projects - Analog IC applications	50 Hrs
	Project work/ Industrial visit	50 Hrs
	Total	575 Hrs

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. However, there are few instances where the individual exercise does not from a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the Fourth Semester course of the Electronic Mechanic Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theortical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercises atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Measure the various parameters by DSO and execute the result wiith standard one**
- **Rework on PCB after identifying defects from SMD soldering and desoldering**
- **Construct different electrical control circuits and test for their proper functioning with due care and safety**
- **Prepare, crimp, terminate and test various cables used in different electronics industries**
- **Assemble and test a commercial AM/FM receiver and evaluate performance**
- **Test, service and troubleshoot the various components of different domestic/industrial programmable systems.**
- **Execute the operation of different process sensors, identify wire & test various sensors of different industrial processes by selecting appropriate test instruments.**
- **Plan and carry out the selection of a project, assembly the project and evaluate performance for a domestic/commercial applications.**

Week No.	Learning Outcome Reference	Professional Skills (Trade Practical) with Indicative hrs.	Professional Knowledge (Trade Practical)
53	• Measure the various parameters by DSO and execute the result with standard one.	Digital Storage Oscilloscope 180. Identify the different front panel control of a DSO. (5 hrs) 181. Measure the Amplitude, Frequency and time period of typical electronic signals using DSO. (7 hrs) 182. Take a print of a signal from DSO by connecting it to a printer and tally with applied signal. (6 hrs) 183. Construct and test function generator using IC 8038. (7 hrs)	Advantages and features of DSO. Block diagram of Digital storage oscilloscope (DSO)/ CRO and applications. Applications of digital CRO. Block diagram of function generator. Differentiate a CRO with DSO.
54	• Identify, place, solder and desolder and test different SMD discrete components and IC,s package with due care and following safety norms using proper tools/setup.	Basic SMD (2, 3, 4 terminal components) 184. Identification of 2, 3, 4 terminal SMD components. (5 hrs) 185. De-solder the SMD components from the given PCB. (5 hrs) 186. Solder the SMD components in the same PCB. (5 hrs) 187. Check for cold continuity of PCB. (3 hrs) 188. Identification of loose /dry solder, broken tracks on printed wired assemblies. (7 hrs)	Introduction to SMD technology Identification of 2, 3, 4 terminal SMD components. Advantages of SMD components over conventional lead components. Soldering of SM assemblies - Reflow soldering. Tips for selection of hardware, Inspection of SM.
55-56	• Identify, place, solder and desolder and test different SMD discrete components and IC,s package with due care and following safety norms using proper tools/setup.	SMD Soldering and De-soldering 189. Identify various connections and setup required for SMD Soldering station. (5 hrs) 190. Identify crimping tools for various IC packages. (3 hrs) 191. Make the necessary settings on SMD soldering station to de-solder various ICs of different packages (at least four) by choosing proper crimping tools (14 hrs) 192. Make the necessary settings on SMD soldering station to solder various ICs of different packages (at least four) by choosing proper crimping tools	Introduction to Surface Mount Technology (SMT). Advantages, Surface Mount components and packages. Introduction to solder paste (flux). Soldering of SM assemblies, reflow soldering. Tips for selection of hardware, Inspection of SM. Identification of Programmable Gate array (PGA) packages. Specification of various tracks, calculation of track width for different current ratings. Cold/ Continuity check of PCBs. Identification of lose / dry solders, broken tracks on printed wiring assemblies.

		(14 hrs) 193. Make the necessary setting rework of defective surface mount component used soldering / de-soldering method. (14 hrs)	Introduction to Pick place Machine, Reflow Oven, Preparing stencil,& stencil printer
57-58	• Rework on PCB after identifying defects from SMD soldering and desoldering.	PCB Rework 194. Checked and Repair Printed Circuit Boards single, Double layer, and important tests for PCBs. (12 hrs) 195. Inspect soldered joints, detect the defects and test the PCB for rework. (8 hrs) 196. Remove the conformal coatings by different methods. (8 hrs) 197. Perform replacement of coating. (8 hrs) 198. Perform baking and preheating. (8 hrs) 199. Repair solder mask and damage pad. (6 hrs)	Introduction to Static charges, prevention, handling of static sensitive devices, various standards for ESD. Introduction to non soldering interconnections. Construction of Printed Circuit Boards (single, Double, multilayer), Important tests for PCBs. Introduction to rework and repair concepts. Repair of damaged track. Repair of damaged pad and plated through hole. Repair of solder mask.
59	• Construct different electrical control circuits and test for their proper functioning with due care and safety.	Protection devices 200. Identify different types of fuses along with fuse holders, overload (no volt coil), current adjust (Biometric strips to set the current). (9 hrs) 201. Test the given MCBs. (8 hrs) 202. Connect an ELCB and test the leakage of an electrical motor control circuit. (8 hrs)	Necessity of fuse, fuse ratings, types of fuses, fuse bases. Single/ three phase MCBs, single phase ELCBs. Types of contactors, relays and working voltages. Contact currents, protection to contactors and high current applications.
60	• Construct different electrical control circuits and test for their proper functioning with due care and safety	Electrical control circuits 203. Measure the coil winding resistance of the given motor. (6 hrs.) 204. Prepare the setup of DOL starter and Control an induction motor. (7 hrs) 205. Construct a direction control circuit to change direction of an induction motor. (6 hrs.) 206. Connect an overload relay and test for its proper functioning. (6 hrs)	Fundamentals of single phase Induction motors, synchronous speed, slip, rotor frequency. Torque-speed characteristics, Starters used for Induction motors.
61-62	• Prepare, crimp, terminate and test various cables used in different electronics industries.	Electronic Cables & Connectors 207. Identify various types of cables viz. RF coxial feeder, screened cable, ribbon cable, RCA connector cable, digital optical audio, video cable, RJ45, RJ11,	Cable signal diagram conventions Classification of electronic cables as per the application w.r.t. insulation, gauge, current capacity, flexibility etc. Different types of

		Ethernet cable, fiber optic cable splicing, fiber optic cable mechanical splices, insulation, gauge, current capacity, flexibility etc. used in various electronics products, different input output sockets (15 hrs) 208. Identify suitable connectors, solder/crimp /terminate & test the cable sets. (10 hrs) 209. Check the continuity as per the marking on the connector for preparing the cable set. (10 hrs) 210. Identify and select various connectors and cables inside the CPU cabinet of PC. (10 hrs) 211. Identify the suitable connector and cable to connect a computer with a network switch and prepare a cross over cable to connect two network computers. (5 hrs)	connector & their terminations to the cables. Male / Female type DB connectors. Ethernet 10 Base cross over cables and pin out assignments, UTP and STP, SCTP, TPC, coxoial, types of fibre optical Cables and Cable trays. Different types of connectors Servo 0.1" connectors, FTP, RCA,BNC,HDMI Audio/video connectors like XLR, RCA (phono), 6.3 mm PHONO, 3.5 / 2.5 mm PHONO, BANTAM, SPEAKON, DIN, mini DIN, RF connectors, USB, Fire wire, SATA Connectors, VGA, DVI connectors, MIDI and RJ45,RJ11 etc.
63-65	• Assemble and test a commercial AM/ FM receiver and evaluate performance.	Communication electronics 212. Modulate and Demodulate various signals using AM and FM on the trainer kit and observe waveforms (10 hrs) 213. Construct and test IC based AM Receiver (10 hrs) 214. Construct and test IC based FM transmitter (10 hrs) 215. Construct and test IC based AM transmitter and test the transmitter power. Calculate the modulation index. (10 hrs) 216. Dismantle the given FM receiver set and identify different stages (AM section, audio amplifier section etc) (10 hrs) 217. Modulate two signals using AM kit draw the way from and calculate percent (%) of modulation. (10 hrs) 218. Modulate and Demodulate a signal using PAM, PPM, PWM Techniques (15 hrs)	Radio Wave Propagation – principle, fading. Need for Modulation, types of modulation and demodulation. Fundamentals of Antenna, various parameters, types of Antennas & application. Introduction to AM, FM & PM, SSB-SC & DSB-SC. Block diagram of AM and FM transmitter. FM Generation & Detection. Digital modulation and demodulation techniques, sampling, quantization & encoding. Concept of multiplexing and de multiplexing of AM/ FM/ PAM/ PPM /PWM signals. A simple block diagram approach to be adopted for explaining the above mod/ demod. techniques
66-68	• Test, service and troubleshoot the various components of different domestic/ industrial programmable systems.	Microcontroller (8051) 219. Identify various ICs & their functions on the given Microcontroller Kit. (5 hrs) 220. Identify the address range of RAM & ROM. (5 hrs) 221. Measure the crystal frequency, connect it to the controller. (5 hrs)	Introduction Microprocessor & 8051Microcontroller, architecture, pin details & the bus system. Function of different ICs used in the Microcontroller Kit. Differentiate microcontroller with microprocessor. Interfacing of memory to the

		222. Identify the port pins of the controller & configure the ports for Input & Output operation. (7 hrs) 223. Use 8051 microcontroller, connect 8 LED to the port, blink the LED with a switch. (10 hrs) 224. Perform the initialization, load & turn on a LED with delay using Timer. (8 hrs) 225. Perform the use of a Timer as an Event counter to count external events. (10 hrs) 226. Demonstrate entering of simple programs, execute & monitor the results. (10 hrs) 227. Perform with 8051 microcontroller assembling language program, check the reading of an input port and sending the received bytes to the output port of the microcontroller, used switches and LCD for the input and output. (15 hrs)	microcontroller. Internal hardware resources of microcontroller. I/O port pin configuration. Different variants of 8051 & their resources. Register banks & their functioning. SFRs & their configuration for different applications. Comparative study of 8051 with 8052. Introduction to PIC Architecture.
69-71	• Execute the operation of different process sensors, identify, wire & test various sensors of different industrial processes by selecting appropriate test instruments.	Sensors, Transducers and Applications 228. Identify sensors used in process industries such as RTDs, Temperature ICs, Thermocouples, proximity switches (inductive, capacitive and photo electric), load cells, strain gauge. LVDT PT 100 (platinum resistance sensor), water level sensor, thermostat float switch, float valve by their appearance (15 hrs) 229. Measure temperature of a lit fire using a Thermocouple and record the readings referring to data chart. (15 hrs) 230. Measure temperature of a lit fire using RTD and record the readings referring to data chart (15 hrs.) 231. Measure the DC voltage of a LVDT (15 hrs) 232. Detect different objectives using capacitive, inductive and photoelectric proximity sensors (15 hrs)	Basics of passive and active transducers. Role, selection and characteristics. Sensor voltage and current formats. Thermistors / Thermocouples - Basic principle, salient features, operating range, composition, advantages and disadvantages. Strain gauges/ Load cell – principle, gauge factor, types of strain gauges. Inductive/ capacitive transducers - Principle of operation, advantages and disadvantages. Principle of operation of LVDT, advantages and disadvantages. Proximity sensors – applications, working principles of eddy current, capacitive and inductive proximity sensors

72-73	• Plan and carry out the Selection of a project, assemble the project and evaluate performance for a domestic/commer cial applications.	Analog IC Applications 233-237 Make simple projects/ Applications using ICs 741, 723, 555, 7106, 7107 Sample projects: • Laptop protector • Mobile cell phone charger • Battery monitor • Metal detector • Mains detector • Lead acid battery charger • Smoke detector • Solar charger • Emergency light • Water level controller • Door watcher (Instructor will pick up any five of the projects for implementation) (50 Hrs)	Discussion on the identified projects with respect to data of the concerned ICs. Components used in the project.
74-75	• Plan and carry out the Selection of a project, assemble the project and evaluate performance for a domestic/commer cial applications	Digital IC Applications 238-242 Make simple projects/Applications using various digital ICs (digital display, event counter, stepper motor driver etc) Duty cycle selector • Frequency Multiplier • Digital Mains Resumption Alarm • Digital Lucky Random number generator • Dancing LEDs • Count down timer • Clap switch • Stepper motor control • Digital clock • Event counter • Remote jammer (Instructor will pick up any five of the projects for implementation) (50 Hrs)	Discussion on the identified projects with respect to data of the concerned ICs. Components used in the project.
76-77	Revision		
78	Examination		

Identify the different controls on the front panel of a Digital Storage Oscilloscope

Objectives: At the end of this exercise you shall be able to
- **Identify different controls on the front panel of a DSO**
- **to operate the front panel controls on the DSO.**

Requirements

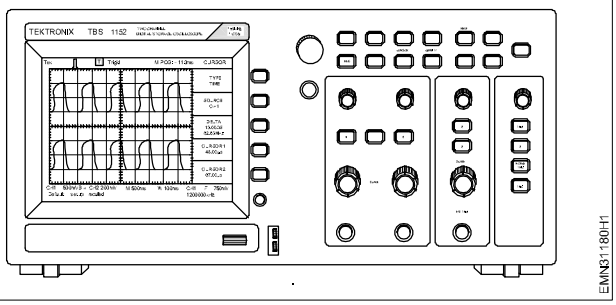
Tools/Equipments/Instruments

• DSO	- 1 No.
• Manual	- 1 No.

PROCEDURE

The Fig 1 shows the front panel of a digital storage oscilloscope for 2-channel models. Here TDS 2002 tektronix oscilloscope as taken as reference. Other DSO will also have the same features. If it differs from this, you may refer manual to understand the functions.

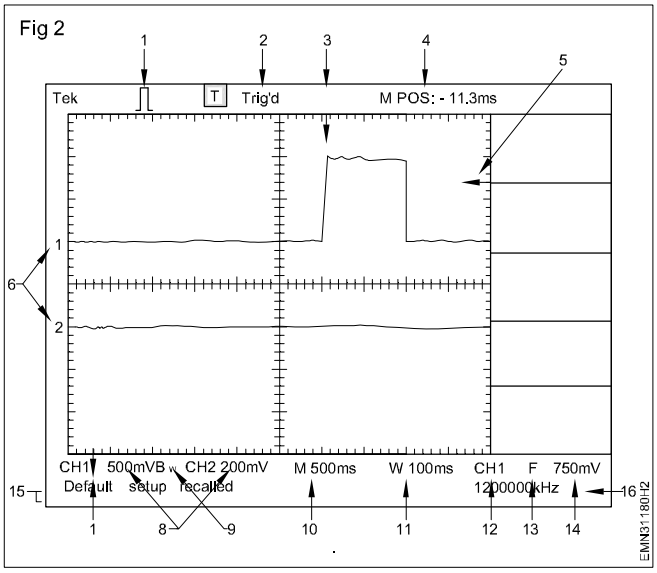
Fig 1



Display Area

In addition to displaying waveforms, the display is filled with many details about the waveform and the oscilloscope control settings. (refer Fig 2)

Fig 2



1 Icon display shows acquisition mode.

Sample mode

Peak detect mode

Average mode

2 Trigger status indicates the following:

Armed : The oscilloscope is acquiring pretrigger data. All triggers are ignored in this state.

Ready: All pretrigger data has been acquired and the oscilloscope is ready to accept a trigger.

Trig'd: The oscilloscope has seen a trigger and is acquiring the post trigger data.

Stop: The oscilloscope has stopped acquiring waveform data.

Acq. Complete : The oscilloscope has completed a single sequence acquisition.

Auto: The oscilloscope is in auto mode and is acquiring waveforms in the absence of triggers.

Scan: The oscilloscope is acquiring and displaying waveform data continuously in scan mode.

3 Marker shows horizontal trigger position. Turn the HORIZONTAL POSITION knob to adjust the position of the marker.

4 Readout shows the time at the center graticule. The trigger time is zero.

5 Marker shows Edge or Pulse Width trigger level.

6 On-screen markers show the ground reference points of the displayed waveforms. If there is no marker, the channel is not displayed

7 An arrow icon indicates that the waveform is inverted.

8 Readouts shows the vertical scale factors of the channels.

9 A BW icon indicates that the channel is bandwidth limited.

10 Readout shows main time base setting

11 Readout shows window time base setting if it is in use.

12 Readout shows trigger source used for triggering.

13 Icon shows selected trigger type as follows


Edge trigger for the rising edge


Edge trigger for the falling edge


Video trigger for line sync.


Video trigger for field sync.


Pulse width trigger, positive polarity.


Pulse width trigger, negative polarity.

14 Readout shows Edge or Pulse Width trigger level.

15 Display area shows helpful messages; some messages display for only three seconds.

16 Readout shows trigger frequency

Message Area

The oscilloscope displays a message area (item number 15 in the previous figure) at the bottom of the screen that conveys the following types of helpful information:

- Directions to access another menu, such as when you push the TRIG MENU button:

For TRIGGER HOLDOFF, go to HORIZONTAL Menu

- Suggestion of what you might want to do next, such as when you push the MEASURE button:

Push an option button to change its measurement

- Information about the action the oscilloscope performed, such as when you push the DEFAULT SETUP button:

Default setup recalled

- Information about the waveform, such as when you push the AUTOSET button:

Square wave or pulse detected on CH1

Using the Menu System

The oscilloscope uses four methods to display menu options:

- **Page (Submenu) Selection:** For some menus, you can use the top option button to choose two or three submenus. Each time you push the top button, the options change. For example, when you push the top button in the SAVE/REC Menu, the oscilloscope cycles through the Setups and Waveforms submenus.
- **Circular List:** The oscilloscope sets the parameter to a different value each time you push the option button. For example, you can push the CH 1 MENU button and then push the top option button to cycle through the Vertical (channel) Coupling options.
- **Action:** The oscilloscope displays the type of action that will immediately occur when you push an Action option button. For example, when you push the DISPLAY Menu button and then push the Contrast Increase option button, the oscilloscope changes the contrast immediately.
- **Radio:** The oscilloscope uses a different button for each option. The currently-selected option is highlighted. For example, the oscilloscope displays various acquisition mode options when you push the ACQUIRE Menu button. To select an option, push the corresponding button.

Vertical Controls

CH 1, CH 2, Cursor 1 and Cursor 2 position: Positions the waveform vertically. When you display and use cursors, an LED lights to indicate the alternative function of the knobs to move the cursors.

CH 1 & CH 2 Menu: Displays the vertical menu selections and toggles the display of the channel waveform on and off.

VOLTS/DIV (CH 1 & CH 2): Selects calibrated scale factors.

Horizontal Controls

HORI MENU: Displays the Horizontal Menu.

SET TO ZERO: Sets the horizontal position to zero.

SEC/DIV: Selects the horizontal time/div (scale factor) for the main or the window time base. When Window Zone is enabled, it changes the width of the window zone by changing the window time base.

Trigger Controls

LEVEL and USER SELECT: When you use an Edge trigger, the primary function of the LEVEL knob is to set the amplitude level the signal must cross to cause an acquisition. You can also use the knob to perform USER SELECT alternative functions. The LED lights below the knob to indicate an alternative function

TRIG MENU: Displays the Trigger Menu.

SET TO 50%: The trigger level is set to the vertical midpoint between the peaks of the trigger signal.

FORCE TRIG: Completes an acquisition regardless of an adequate trigger signal. This button has no effect if the acquisition is already stopped.

TRIG VIEW: Displays the trigger waveform in place of the channel waveform while the TRIG VIEW button is held down. You can use this to see how the trigger settings affect the trigger signal, such as trigger coupling.

Menu and Control Buttons

SAVE/RECALL: Displays the Save/Recall Menu for setups and waveforms.

MEASURE: Displays the automated measurements menu.

ACQUIRE: Displays the Acquire Menu.

DISPLAY: Displays the Display Menu.

CURSOR: Displays the Cursor Menu. Vertical Position controls adjust cursor position while displaying the Cursor Menu and the cursors are activated. Cursors remain displayed (unless the Type option is set to off) after leaving the Cursor Menu but are not adjustable.

UTILITY: Displays the Utility Menu.

HELP: Displays the Help Menu.

DEFAULT SETUP: Recalls the factory setup.

AUTOSET: Automatically sets the oscilloscope controls to produce a usable display of the input signals.

SINGLE SEQ: Acquires a single waveform and then stops.

RUN/STOP: Continuously acquires waveforms or stops the acquisition.

PRINT: Starts print operations..

Connectors

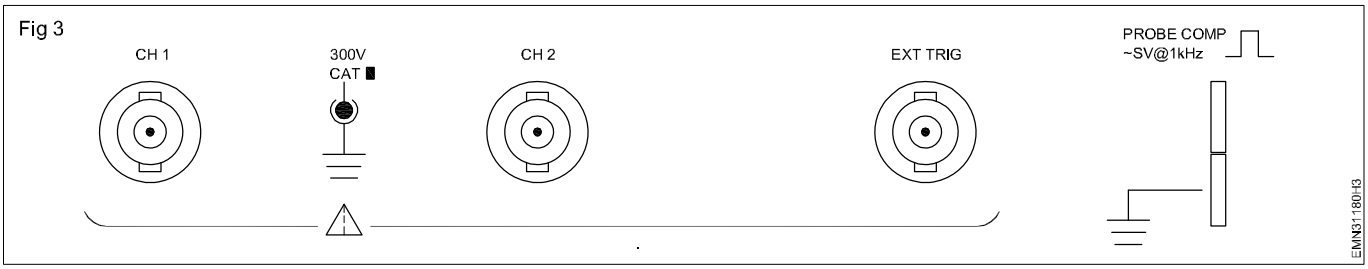
PROBE COMP: Voltage probe compensation output and ground. Use to electrically match the probe to the oscilloscope input circuit. Refer to ex no 1. The probe compensation ground and BNC shields connect to earth ground and are considered to be ground terminals

CAUTION : If you connect a voltage source to a ground terminal, you may damage the oscilloscope or the circuit under test. To avoid this, do not connect a voltage source to any ground terminals

CH 1, CH 2: Input connectors for waveform display. (Fig 3)

EXT TRIG: Input connector for an external trigger source. Use the Trigger Menu to select the Ext or INT trigger source

Fig 3



Measure the Amplitude, frequency and time period of typical electronic signal using DSO

Objectives: At the end of this exercise you shall be able to
- **measure the time, frequency and amplitude of a square/ rectangular waveform**
- **measure the time, frequency and amplitude of a sine waveform.**
- **measure the time, frequency and amplitude of a two signals to compare the phase shift.**

Requirements

Tools/Equipments/Instruments

- DSO with instruction manual and probe kit - 1 No
- Analog trainer kit with manual - 1 No
- Signal generator with manual - 1 No

PROCEDURE

TASK 1: **Taking Automatic Measurements of square wave forms**

The oscilloscope can take automatic measurements of most displayed signals, to measure signal frequency, period, and peak-to-peak amplitude. The following steps may be followed.

1 Connect a signal generator to a DSO and switch on the DSO and signal generator. Set signal generator frequency at 1kHz and amplitude at 5V as in Fig 1.

2 Push the **MEASURE** button to see the Measure Menu.

3 Push the top option button; the **Measure 1** Menu appears. Push the Type option button and select Freq. The Value readout displays the measurement and updates.

NOTE: If a question mark (?) displays in the Value readout, turn the VOLTS/DIV knob for the appropriate channel to increase the sensitivity or change the SEC/DIV setting.

4 Push the **Back** option button.

5 Push the second option button from the top; the **Measure 2** Menu appears.

6 Push the Type option button and select **Period**. The Value readout displays the measurement and updates.

7 Push the **Back** option button.

8 Push the middle option button; the **Measure 3** Menu appears.

9 Push the Type option button and select Pk-Pk. The Value readout displays the measurement and updates.(*Pk-Pk= Peak - Peak)

10 Push the **Back** option button.

11 Push the second option button from the bottom; the **Measure 4** Menu appears.

12 Push the Type option button and select **Rise Time**. The Value readout displays the measurement and updates.

13 Push the **Back** option button.

14 Push the bottom option button; the **Measure 5** Menu appears.

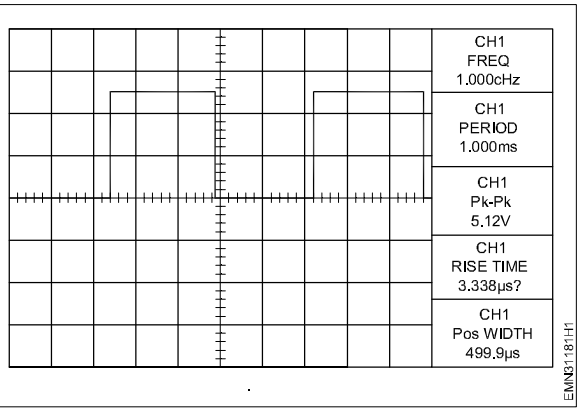
15 Push the Type option button and select PosWidth. The Value readout displays the measurement and updates.

16 Push the **Back** option button.

17 Repeat steps 2 to 15 by varying amplitude and frequency.

18 The steps 2 to 11 may be followed by connecting other type of waveforms (sine wave and triangular wave).

Fig 1



TASK 2: **Measure the time, frequency and amplitude of a two signals to compare the phase shift**

To activate and display the signals connected to channel 1 and to channel 2,

1 Construct the amplifier as shown in Fig 2 using the trainer kit. If trainer kit is not available in the lab, construct the circuit using discrete components on breadboard/PCB.

2 Connect two oscilloscope channels to the amplifier input and output as shown.

3 If the channels are not displayed, push the **CH 1 MENU** and **CH 2 MENU** buttons.

4 Push the **AUTOSET** button.

5 Push the Measure button to see the **Measure Menu**

Note: Any amplifier circuit may be used to perform this experiment.

6 Push the top option button; the **Measure 1** Menu appears.

7 Push the Source option button and select **CH1.**

8 Push the Type option button and select **Pk-Pk**.

9 Push the **Back** option button.

10 Push the second option button from the top; the **Measure 2** Menu appears

11 Push the Source option button and select **CH2.**

12 Push the Type option button and select **Pk-Pk**.

13 Push the **Back** option button

14 Read the displayed peak-to-peak amplitudes for both channels and observe the phase differences between the wave forms. It may appear as shown in Fig 2.

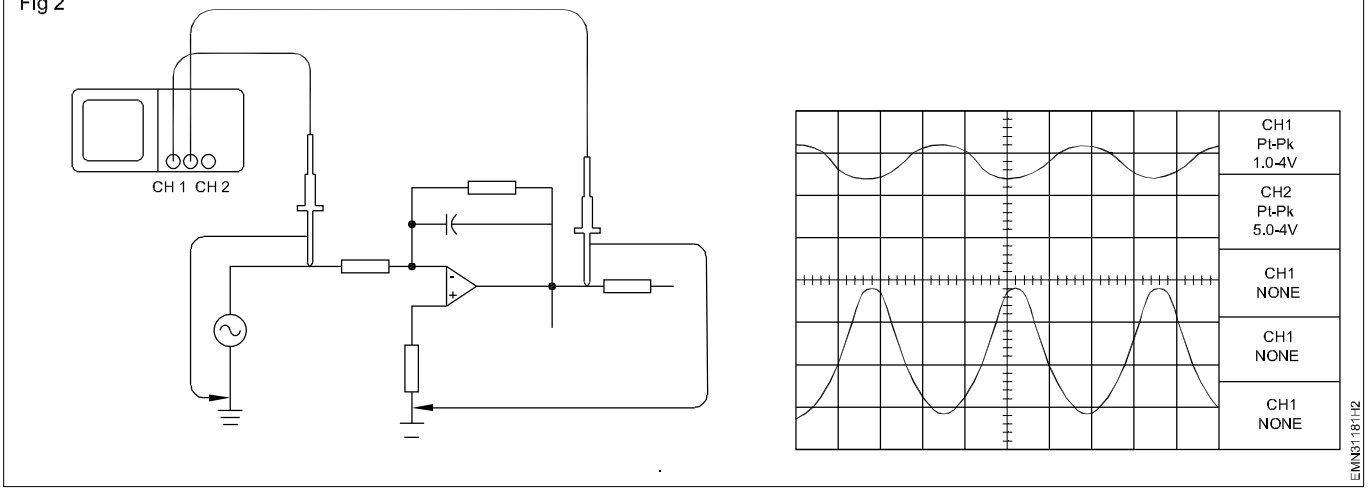
15 Vary the frequency and amplitude one by one and repeat the step 14 record your reading in the table 1.

16 Performs step 15 till you can read the values thoroughly.

17 Get the work checked by the instructor.

Sl No	Frequency	V_{in}	V_{out}	Gain=V_{out}/V_{in}

Fig 2



TASK 3: **Measure the Ring Frequency**

1 To measure the ring frequency at the rising edge of a signal, push the CURSOR button to see the Cursor Menu as in Fig 1.

2 Push the Type option button and select Time.

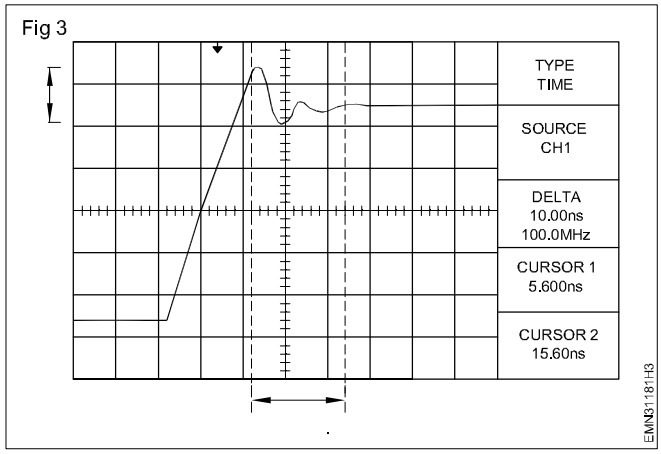
3 Push the Source option button and select CH1.

4 Turn the CURSOR 1 knob to place a cursor on the first peak of the ring.

5 Turn the CURSOR 2 knob to place a cursor on the second peak of the ring.

6 Observe that the delta time and frequency (the measured ring frequency) in the Cursor Menu.

Fig 3



TASK 4: **Measure the ring amplitude**

1 To measure the amplitude of the ringing. To measure the amplitude, push the CURSOR button to see the Cursor Menu as in Fig 2.

2 Push the Type option button and select Voltage.

3 Push the Source option button and select CH1.3.

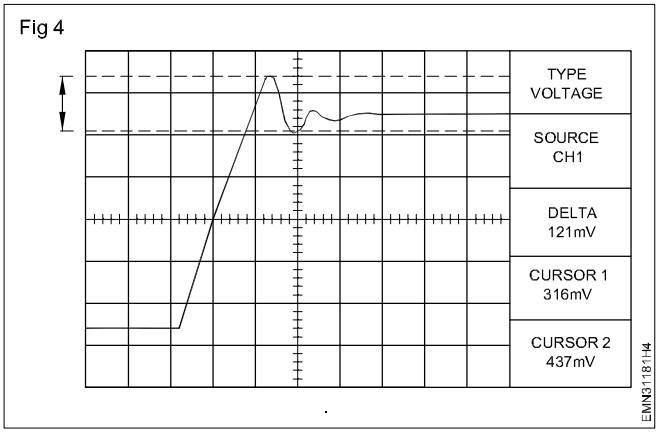
4 Turn the CURSOR 1 knob to place a cursor on the highest peak of the ring.

5 Turn the CURSOR 2 knob to place a cursor on the lowest point of the ring.

6 You can see the following measurements in the Cursor Menu:

- The delta voltage (peak-to-peak voltage of the ringing)
- The voltage at Cursor 1.
- The voltage at Cursor 2

Fig 4



— — — — — — — —

TASK 5 : **Measure the pulse width**

1 To measure the width of a pulse using the time cursors, push the CURSOR button to see the Cursor Menu as in Fig 3

2 LEDs light under the VERTICAL POSITION knobs to indicate the alternative CURSOR 1 and CURSOR 2 functions

3 Push the Source option button and select CH1.

4 Push the Type option button and select Time.

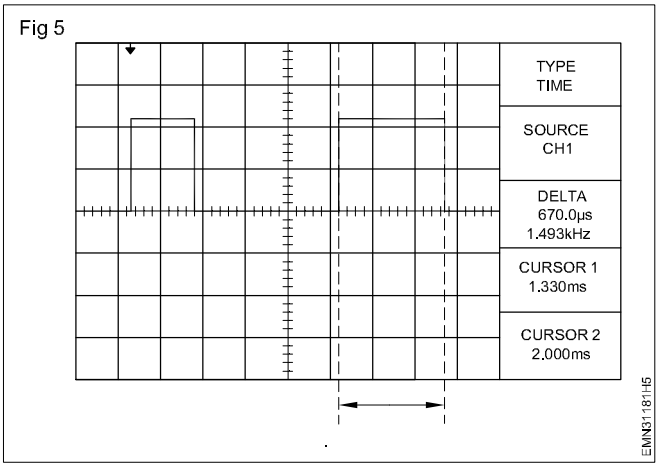
5 Turn the CURSOR 1 knob to place a cursor on the rising edge of the pulse.

6 Turn the CURSOR 2 knob to place the remaining cursor on the falling edge of the pulse.

7 Observe the following measurements in the Cursor Menu:

- The time at Cursor 1, relative to the trigger.
- The time at Cursor 2, relative to the trigger.
- The delta time, which is the pulse width measurement

Fig 5



Note:

The Positive Width measurement is available as an automatic measurement in the Measure Menu.

The Positive Width measurement also displays when you select the Single-Cycle Square option in the AUTOSET

— — — — — — — —

TASK 6: **Measuring rise time**

1 Turn the SEC/DIV knob to display the rising edge of the waveform.

2 Turn the VOLTS/DIV and VERTICAL POSITION knobs to set the waveform amplitude to about five divisions.

3 Push the CH 1 MENU button to see the CH1 Menu if it is not displayed.

4 Push the Volts/Div option button and select Fine.

5 Turn the VOLTS/DIV knob to set the waveform amplitude to exactly five divisions..

6 Turn the VERTICAL POSITION knob to center the waveform position the baseline of the waveform 2.5 divisions below the center graticule.

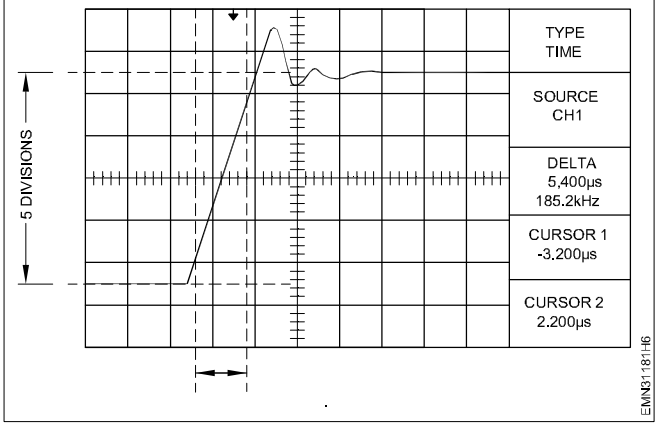
7 Push the CURSOR button to see the Cursor Menu.

8 Push the Type option button and select Time.

9 Turn the CURSOR 1 knob to place the cursor at the point where the waveform crosses the second graticule line below center screen. This is the 10% level of the waveform as in Fig. 4.

10 Turn the CURSOR 2 knob to place the second cursor at the point where the waveform crosses the second graticule line above center screen. This is the 90% level of the waveform.

Fig 6



11 The Delta readout in the Cursor Menu is the rise time of the waveform.

Note :

The Rise Time measurement is available as an automatic measurement in the Measure Menu.

The Rise Time measurement also displays when you select the Rising Edge option in the AUTOSET Menu.

Take a print of a signal from DSO by connecting a printer and tally with applied signal

Objectives: At the end of this exercise you shall be able to
- **connect a printer to a DSO and print the screen data**
- **connect a computer to a DSO and save the screen data**
- **connect a USB flash device and save the screen data**
- **recall the saved data from the USB flash drive.**

Requirements

Tools/Equipments/Instruments

• DSO	- 1 No.
• Manual	- 1 No.
• Analog trainer kit	- 1 Set
• Signal generator	- 1 No.
• Power supply 0-30 V/2A	- 1 No.

Materials/Components

• IC -555	- 1 No.
• Resistor ¼ W/CR25	- 1 No.
• 47 kΩ	- 1 No.
• 68 kΩ	- 1 No.
• 330Ω	- 1 No.
• Diode 1N 4007	- 1 No.
• Capacitor	
• 0.01µF	- 2 Nos.
• 10µF	- 1 No.
• LED	- 1 No.

PROCEDURE

TASK 1: **Connect a printer to a DSO and print the screen data**

1 Assemble an analog circuit using the analog trainer kit. E.g assemble a astable multivibrator circuit as shown in Fig 1.

2 Connect a power supply to the circuit and switch on the power supply and connect the output to the DSO.

3 Switch on the Digital storage oscilloscope

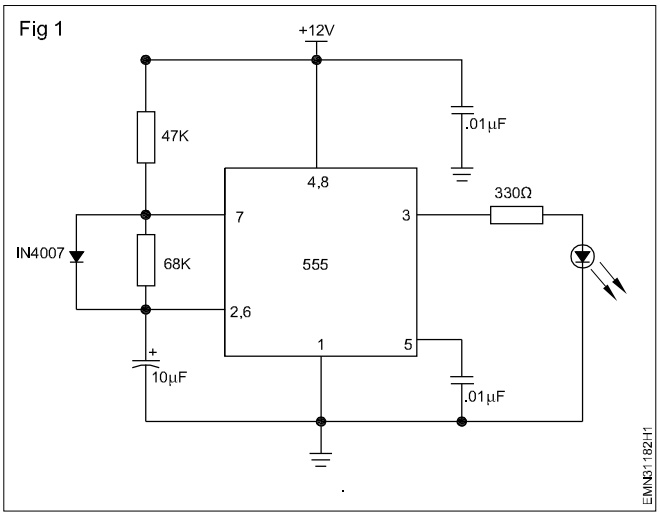
4 Press **AUTOSET**

5 Connect the printer using a USB cable to the rear panel of the DSO

6 Select the **UTILITY** → **OPTIONS** → **Rear USB Port** → **Printer**→ **Printer setup**

7 Push the option button labeled **PRINT Button** to select prints. The oscilloscope takes a snapshot of the screen and begins to send the image to the printer.

Fig 1



— — — — — — — —

TASK 2: **Connect a computer to a DSO and save the screen data**

1 Repeat the steps from 1 to 4 of task 1

2 Connect the computer using a USB cable to the rear panel of the DSO

3 Select the **UTILITY** → **OPTIONS** → **Rear USB Port** → **computer** → **Printer setup**

4 Push the option button labeled **PRINT Button** to save the image. The oscilloscope takes a snapshot of the screen and begins to send the image to the computer.

— — — — — — — —

TASK 3: **Save a screen data in a USB flash drive**

1 Repeat steps 1 to 3 of task 1

2 Connect a USB flash drive to the DSO on the front panel

You can use the **PRINT button** or the **SAVE/RECALL** menu **Save Image Action** option to save the current screen image to a file on a USB flash drive, the **PRINT** button is more versatile than the option button , because it can be used with any menu

3 Press **SAVE/RECALL** menu button.

4 Push the action button to select **Save all.**

5 Push the option button labeled Print button to select saves all to files.

6 Push <select Folder> to set a different folder as the current folder, if you desire to store at different folder. The oscilloscope will create a new folder within the current folder with and automatically generated name. every time you much push the print button

7 Access the screen you want to save

8 Push the Print button, the oscilloscope creates screen image in the new folder, with automatically generates file names

9 To see al list of the files created by Save All To Files, use < File Utilities>.

The save LED near the print button lights, to indicate that pushing the button will save the data to USB flash drive.

— — — — — — — —

TASK 4: **To recall a setup from a USB flash drive**

- Check that a USB flash drive is inserted in the oscilloscope
- Push the SAVE/RECALL menu button
- Push the Action option button to select Recall setup
- Push the Recall From option button to display the Recall setup menu
- Use the multipurpose knob to select a file or folder
- If desired, use the Change folder option button to navigate to a different folder
- Push the Recall option button, This causes the oscilloscope to recall the selected setup from the USB flash drive and change to the recalled settings.

Note: If the analog trainer kit is not available. The above circuit or any amplifier or oscillator circuit may be constructed using discrete components and the waveforms may be printed or saved.

Help System

The oscilloscope has a Help system with topics that cover all the features of the oscilloscope. You can use the Help system to display several kinds of information:

General information about understanding and using the oscilloscope, such as Using the Menu System.

Information about specific menus and controls, such as the Vertical Position Control.

Advice about problems you may face while using an oscilloscope, such as Reducing Noise.

Push the Exit option button or any menu button to remove the Help text from the screen and return to displaying waveforms.

— — — — — — — —

Construct and test function generator using IC 8038

Objectives: At the end of this exercise you shall be able to
- **construct a Function generator using IC 8038**
- **connect a DSO to various output points and trace the waveforms**
- **measure the amplitude and frequency.**

Requirements

Tools/Equipments/Instruments

- Regulated Power supply 0-30 VDC/2A - 1 No.
- DSO with probe kit - 1 No.
- Trainees tool kit - 1 Set.

Materials/Components

- IC 8038 - 1 No.
- Resistor 2.2k, 10k ¼ W - 1 No. each
- Potentiometer 10k - 1 No.
- Capacitors 1 µF, 0.1 µF, 0.01µF, 0.001 µF - 1 No. each
- IC Socket - 1 No.
- GPPCB Board/bread board - 1 No.

PROCEDURE

1 Construct the Function generator circuit by referring to the circuit as shown in Fig 1

2 Connect a power supply to the circuit, set the voltage at 15V and switch on the power supply

3 Switch on the DSO and perform quick check

4 Connect the DSO probes at any one of the output terminal and ground, trace the waveform

5 Measure the frequency and record the reading in Table 1.

6 Repeat the step 4 and 5 for other output terminals.

7 Calculate the frequency using the formula (f)= 0.15/ $(VR_1+R_1)C_1$

8 Vary the C_1 as shown in the table 2 and repeat steps 5 to 8

9 Compare the measured frequency and calculated frequency.

10 Get the work checked by the instructor.

Note : to get different frequencies the capacitor c_1 may be varied, the Table 1 shown below gives the different frequency range for the different capacitor values

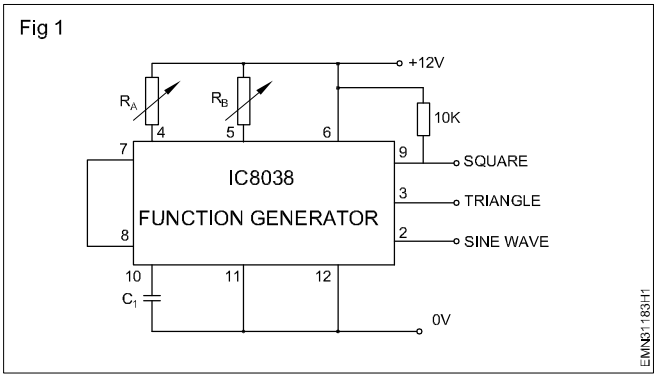
Table 1

Type of wave form	Calculated frequency	Measured frequency	Amplitude (P-P)
Sine wave			
Square wave			
Triangular wave			

Table 2

Frequency rane	C_1 value
1Hz - 100Hz	1µF
100Hz-1kHz	0.1µF
1kHz-10kHz	0.01µF
10kHz-100kHz	0.001µF

Fig 1



Identification of 2,3,4 terminal SMD components

Objectives : At the end of this exercise you shall be able to
- **identifiy the 2,3,4 terminal SMD components**
- **decode the printed code letters and record the values of SMD components.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- ESD table with wrist strap - 1 Set
- Digital multimeter with probes - 1 No.
  Aids: SMD components chart - 1 No.

Materials/Components

- Assorted 2,3 & 4 terminal SMD components (Resistors capacitors, transistors, ICS) - as reqd.
- SMD data sheet - 1 No
- Magnifying glass - 1 No

PROCEDURE

TASK 1 : **Identification of 2,3,4 terminal SMD components**

NOTE: The instructor has to provide different SMD resistors, capacitors, diodes, transistors

SAFETY PRECAUTION: Wear the wrist strap and ensure that the ESD belt is properly grounded before touching any SMD components

1 Identify 2,3 or 4 terminal SMD components from the assorted group of SMD components.

2 Separate the SMD components as per the number of terminals (i.e. 2,3 or 4 terminals).

3 Record the code marked on it in Table 1.

4 Identify the component & its value specifications using reference Chart -1.

5 Repeat the above steps for all the SMD components provided.

6 Get the work checked by the Instructor.

Table 1

Sl.No	No.of terminals	Code No. marking	Identified component	Remarks

Chart 1

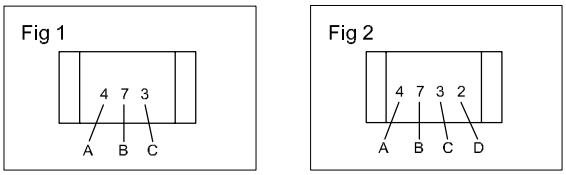
Shape and markings of some common SMDs

Component	Shape	Makings
Chip resistor		Labeled with value
Chip capacitor		Not marked
Diode		Cathode end marked with notch or band
SOT (Small outline Transistor)	 	May be marked, unmarked, or house numbered, pin one marked with beveled side, dot, band or notch

TASK 2: **Idenfification of value of SMD resister**

1 Pick one of the SMD resistor and refer to the Fig 1 and Fig 2 identify the coding marked on the component

Fig 1 & Fig 2



2 Decode the value refering to the Chart 2 & Chart 3

3 Record the observations in Table 2

Registors are frequently marked with a three digit number and some typical values are shown in chart 4. The first two numbers are the significant digits of the value, and the last digit is the multiplier (the number of zeros to add to te first two digits). For example, a chip resistor labeled 102 has a value of 1000 Ohms, or 1k Ohms.

Marking on the SMD resistors

A = 1st digit of the resistors value

B = 2nd digit of the resistors value

C = number of zeros

Chart - 2

Code letters printed	Resistance value
101	100 Ω
471	470 Ω
102	1k Ω
122	1.2k Ω
103	10k Ω
123	12k Ω
104	100k Ω
124	120k Ω
474	470k Ω

Typical resistor markings and corresponding values

A = 1st digit of the resistor value

B = 2nd digit of the resistor value

C = 3rd digit of the resistor value

D = number of zeros

4 By using the above technique, find values of resistors for those components whose values are printed as below and record in Table 2

Chart 3

Printed code letters	Resistance Value
100R	100 Ω
634R	634 Ω
909R	909 Ω
1001	1k Ω
4701	4.7k Ω
1002	10k Ω
1502	15k Ω
5493	549k Ω
1004	1M Ω

Table - 2

Code letter printed	Resistance Value
102	--- Ω
470	--- Ω
103	--- Ω
222	--- Ω
101	--- Ω
232	--- Ω
333	--- Ω
1243	--- Ω
4743	--- Ω

TASK 3: **Identification of SMD capacitors**

NOTE: Ceramic multilayer chip capacitors are available with a very wide range of values, from 0.47 pF to 1uF. These values are covered by seven cases forms. The forms depends on the capacitors values. The most popular case are 0805 and 1206.

PRECAUTION: Be very careful with non-marked components Avoid mixing them. SMD tantalum capacitors are available in different case forms, partly without printed values. The + polarity is marked by white line, or white "M". The case forms depend on capacitance value and nominal voltage.

1 Coding with digits

1 Pick one of the SMD capacitor, refer to the Fig. 3,4,5 & 6 and identify the type, coding marked on the capacitor.

2 Decode the values refering to Chart - 4 find the value.

3 Record the observed calculated value in Table 3.

4 Get the work checked by the instructor.

Example

Description "224" means 220 000 pF=220nF=0.22µF

2 Coding with alphanumerical characters

Chart 4

Capacitance pF	1	1.5	2.2	3.3	4.7	6.8
Code	A	E	J	N	S	W
Multiplicator	10^5	10^6	10^4	10^3	10^2	10^1
Code	5	6	4	3	2	1

Nominal voltage code (first digit from left)

Volt 4	6.3	10	16	20	25	35
Code G	J	A	C	D	E	V

Example 1

1 1.0 pF, 16V ... CA

2 2.2 pF, 6.3V ... JJ

Example 2

A6..... 1.0 x 10^6 pF=1..0 µF

J5..... 2.2 x 10^5 pF=0.22 µF

FJ6..... 2.2 x 10^6 pF=2.2 µF

Fig 3

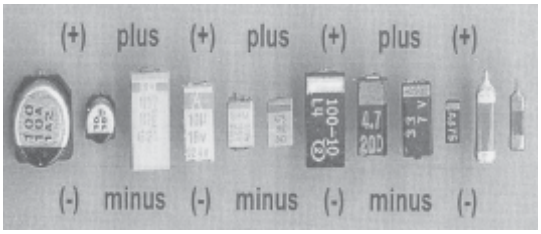


Fig 4

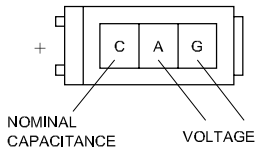


Fig 5

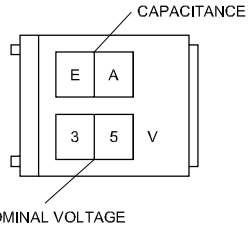


Fig 6

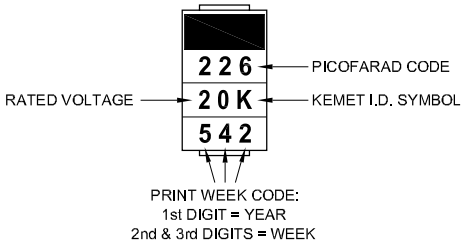


Table 3 - Capacitor Values

Package	Code on capacitor SMD	Calculated Value
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF
		..... µF

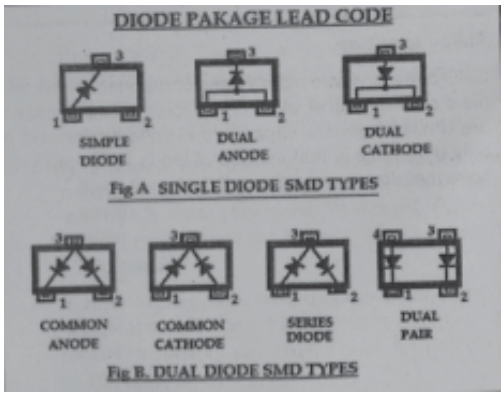
— — — — — — — —

TASK 4: **Identification of SMD Diodes and Transistor**

1 Pick one of the SMD diode, from the sorted SMD components using marking provided on the surface.

2 Refer Fig 7 and identify the type. Write down the code in Table 4.

Fig 7



Almost all standard diodes are available as SMD components in SOT-23, SOT-89 and SOT-143 cases, In general electrical parameters of SMD diodes are the sme as comparable standard types in coventional cases. SOT -23 and SOT - 143 cases are used for components with power dissipation 200 to 400 mW. SOT - 89 cases are used for power dissipation 500mW to 1W

SMD LEDs are available in SOT - 23 cases.

By using above package types separate the diode and test it by using multimeter.

3 Select the diode testing mode on the digital multimeter, check the diode in forward and reverse directions.

4 Enter the observation on Table 4.

Table - 4

Sl.No.	Package Type	Forward Resistance Value	Reverse Resistance Value

10 Get the work checked by the instructor.

5 Repeat the above steps for all the remaining diodes.

6 Get the work checked by the instructor.

7 Pick one of the SMD transistor and with the help of Fig.8 identify the terminals.

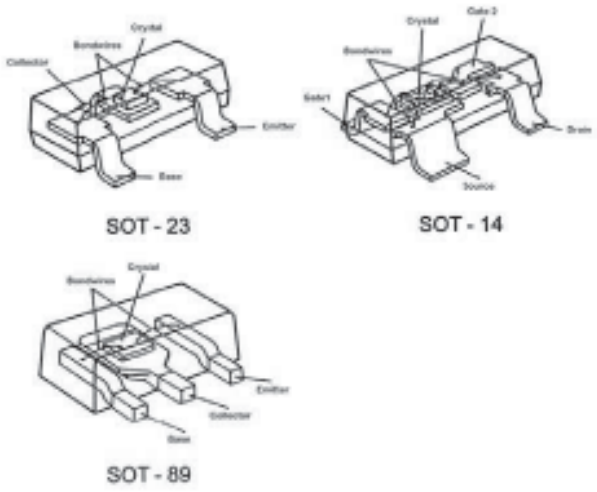
8 Record the package type and the observations in Table-5

Table - 5.

Sl. No.	Package	Types of component	Test carried out	Remarks

9 Repeat the above steps for all the remaining.

Fig 8



Desolder the SMD Components from the given PCB

Objectives : At the end of this exercise you shall be able to
- **desolder the SMD Components from the PCB following different methods.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No
- SMD rework station with hot air nozzles/temperature/flow controller with Instruction Manual - 1 Set
- DMM with Probes - 1 No.

Materials/Components

- Desoldering wick - as reqd.
- Solder flux pen/Liquid flux - as reqd.
- IPA Cleaning solution - 1 bottle
- Piece of Medium Density Fiberborad (MDF) - 1 No

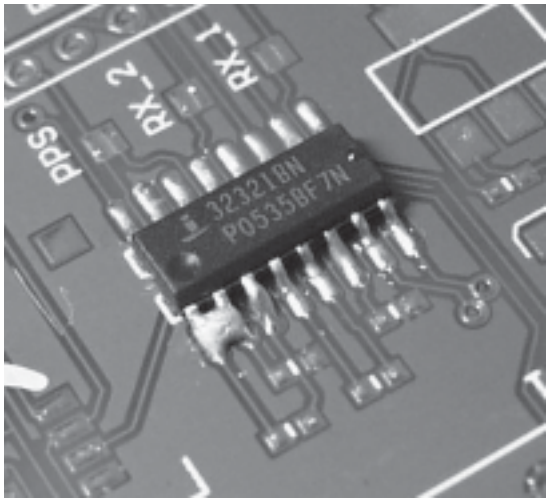
PROCEDURE

TASK 1 : **Desolder the SMD component from the PCB**

1 Collect the defective SMD-PCB from the Instructor and identify the components to be removed.

2 Use magnifying glass and inspect the size of solder joints on the components to be removed as shown in the Fig 1

Fig 1

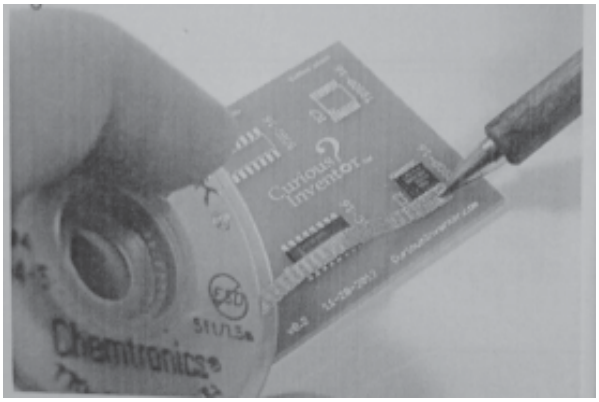


3 Apply a small quantity of flux and solder to the joints of the surface mount components to be removed.

4 Place one end of solder wicking braid on the component lead side and the tip of the soldering iron over it as shown in Fig 2

5 Allow time for the solder to melt and the solder wick to draw the molten solder into the braid by capillary action.

Fig 2



6 After the molten solder has been extracted from the joint, remove the wick and the soldering iron tip from the component lead.

7 Use the unused portion of the wick for removing excess solder.

8 Repeat the steps 3 to 7 for removing other terminals of the surface mount components.

9 Remove the components from the PCB and clean the surface, using IPA solution.

10 Get the work checked by the Instructor.

TASK 2 : **Desolder SMD components using hot air**

Note: Use the MDF board to avoid damage to the Workbench or any surface made of plastic by the hot air.

1 Choose the appropriate hot air nozzle tip for the desoldering work attach and tighten it using screw driver.

2 Power ON the soldering rework station and adjust the hot air and temperature knobs to suit the work.

Note: It is recommended to set the air flow and temperature knobs at the middle and test on a small component, then readjust them to the required level around 275°C.

3 Aim the hot air nozzle at the SMD component and move it slightly back and forth until the solder begins to melt.

4 Use tweezers and carefully grab/lift the SMD component from the board.

Caution:

1 Aim the hot air gun at the same point will melt the board after a certain period of time

2 Make sure to keep the hot air gun moving to prevent any damage to the heat sensitive component/PCB burning.

5 Adjust the air flow and temperature setting knobs back to zero position after finished the SMD component desoldering work.

6 Switch OFF the soldering rework station and allow it to cool down.

7 Clean the board using IPA solution with brush.

8 Get the work checked by the Instructor.

Solder the SMD components in the same PCB

Objectives : At the end of this exercise you shall be able to
- **solder the SMD components on the PCB.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No.
- SMD soldering work station (hot air temperature/flow controller) with all accessories (and instruction manual) - 1 Set
- Vacuum pick up tool - 1 No.

Materials/Components

- Rosin cored solder wire - as reqd.
- Flux pen/Liquid flux - as reqd.
- IFA cleaning solution - 1 bottle
- Piece of medium density fiber board - 1 No.
- Crocodile clips holder (MDF borad) - 2 Nos.
- Solder paste tube/syringe - 1 No.
- Cleaning brush - 1 No.

PROCEDURE

1 Choose and fit the appropriate tip for the soldering iron suitable to the SMD component onto the PCB.

2 Use crocodile clips to hold the PCB firmly on the work-bench.

3 Select the SMD components and note down the location/direction on the PCB to be soldered.

4 Switch ON the soldering workstation and adjust the temperature setting knob around 275°C.

5 Keep the SMD component over the pads on the printed circuit at its position correctly.

6 Use flux pen and apply a little quantity on the places where soldering has to be done.

7 Cut the solder wire into small pieces and place them on SMD component leads.

8 Hold the component using tweezers and apply the hot soldering iron tip over the solder pieces to melt.

9 Remove the soldering iron tip and allow the molten solder to set on the pin.

Caution: To avoid thermal buildup, solder the terminals alternately with little time interval between pins

10 Repeat steps to solder the other end of the SMD component .

11 Use magnifier and inspect the soldered joints are free from any solder bridges

12 Clean the board using IPA solution with brush

13 Get the work checked by the Instructor.

— — — — — — — —

Check for cold continuity of PCB

Objectives: At the end of this exercise you shall be able to
- **inspect and identify any probable defect on the given circuit board**
- **record the observed defect/fault on the given circuit board.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No
- Digital multimeter with probes - 1 No.
- Soldering workstation/hot air temperature/flow controller (with instruction manual) - 1 Set

Materials/Components

- Rosin cored solder and flux - as reqd.
- IPA cleaning solution - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No

PROCEDURE

TASK 1: **Identification of any defect/dry solder/short circuit on the given circuit board.**

Note: The instructor has to simulate faults necessary in the circuit board to be given for this exercise/task.

1 Collect the defective circuit board from the Instructor.

2 Clean the board using the brush (Use IPA solution if needed).

3 Visually inspect for any physical damages like cracks/ burnt/dry soldered leads of all the major components on the PCB.

4 Use magnifier and carefully observe for any broken tracks on the board.

5 Use Ohm meter and check for any short/open circuit between tracks.

6 Record the observations in Table 1.

7 Get the work checked by the Instructor

Table - 1

Sl.No	Details of fault/defect identified		Types of defect Open/short circuit	Remarks
	Dry Solder	Loose connecion		
1				
2				
3				
4				
5				
6				
7				

— — — — — — — —

Identification of loose / dry solder / broken tracks on printed wired assemblies

Objectives : At the end of this exercise you shall be able to
- **identify any loose/dry solder/broken tracks on the given circuit board**
- **record the observed defect/faults on the given circuit board.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No
- Digital multimeter with probes - 1 No.
- Soldering workstation/hot air temperature/flow controller (with instruction manual) - 1 Set

Materials/Components

- Rosin cored solder and flux - as reqd.
- IPA cleaning solution - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.
- jumper wire/multistranded flexible wire pieces - as reqd.

PROCEDURE

TASK 1: **Identification of any defect/dry solder/short circuit on the given circuit board**

Note: The Instructor has to simulate faults necessary in the circuit board to be given for this exercise/task

1 Collect the defective circuit board from the Instructor.

2 Clean the board using the brush (Use IPA solution if needed)

3 Visually inspect and identify any loose/dry soldered components.

4 Use magnifier and carefully observe for any broken tracks on the board.

5 Record the observations in Table 1.

6 Resolder the identified loose or dry-soldered component; use jumper wire and join the broken track.

7 Get the work checked by the instructor.

Table - 1

Sl.No	Details of fault/defect identified		Types of defect Open/short circuit	Remarks
	Dry Solder	Loose connecion		
1				
2				
3				
4				
5				
6				
7				

— — — — — — — —

Identify various connections and setup required for SMD soldering station

Objectives: At the end of this exercise you shall be able to
- **identify various controls/ connections on the soldering work station**
- **prepare the soldering work station for soldering SMD components.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No.
- SMD Soldering workstation with all accessories and operating manual - 1 Set

  Aids: Chart showing panel controls of soldering workstation - 1 No.

Materials/Components

- Solder wire 60/40 rosin core - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.

PROCEDURE

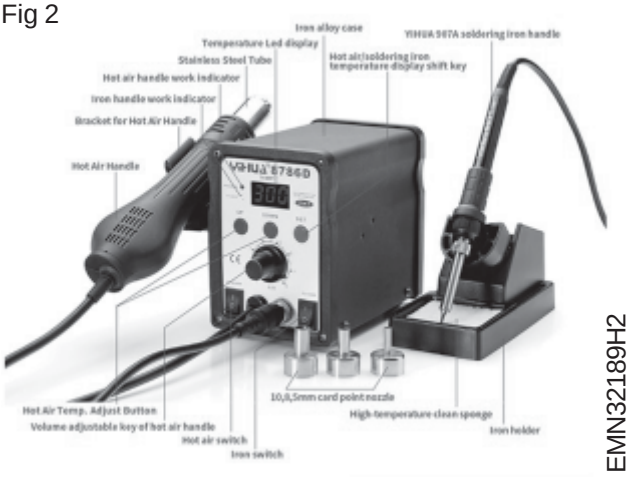
TASK 1: **Identification of Panel Controls/ Switches**

1 Refer to the operating manual Fig 1 and Fig 2 Identify the front panel controls/switches on the soldering workstation, with reference to the operating manual.

Fig 1

EMN32189H1

Fig 2



EMN32189H2

2 Record the name of the control/switch and its function on the Table -1.

3 Identify the accessories used with the soldering workstation and record them in Table - 1.

4 Get the work checked by the Instructor.

Table 1

Sl. No.	Name of the control/Switch/ accessory	Functions/Uses Specifications	Remarks

— — — — — — — —

TASK 2: **Setting the soldering station for SMD Component Soldering work**

Note: The Instructor has to ensure that all the controls/switches on the panel are kept in zero position before given to trainees.

1 Select and fix the suitable bit/ tip onto the soldering iron for the SMD Component soldering work.

2 Select and fix appropriate size of hot air nozzle suitable for the soldering work.

3 Switch ON the soldering work station and set the temperature at 275°C.

4 Adjust the hot air pressure control knob to the mid position.

5 Test the soldering iron heat by keeping the solder wire on the tip for melting.

Note: At the time of soldering SMD components, the controls may be re-adjusted for required temperature/air pressure actually needed for the soldering work.

6 Record the settings control position, temperature observations on the Table-2.

7 Get the work checked by the Instructor and switch OFF the soldering workstation.

4 Refer to adjust controls on the trent the operating manual panel of the soldering workstation for 275° c temperature and record it in the Table-2 turn on soldering station

6 Set proper tip temperature

7 Now adjust the soldering workstation is ready to work for soldering / desolering

8 Get the worm checked by the instructor Table 2

Sl.No	Name of the Control/Switch	Setting/Position	Temperature/Air pressure	Remarks

— — — — — — — —

Identify crimping tools for various IC packages

Objectives: At the end of this exercise you shall be able to
- **identify the crimping tools used for holding the ICs**
- **use the crimping tool during the soldering/desoldering processes of IC on the PCBs.**

Requirements

Tools/Equipments/Instruments

- Crimping tools - 1 Set
- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No.
- Digital multimeter with probes - 1 No.
- Soldering workstation/hot air temperature/flow controller (with instruction manual) - 1 Set

  Aids: Wall chart showing all the special tools used for the SMD IC soldering/ desoldering of SMD components - 1 No.

Materials/Components

- Rosin cored solder and flux - as reqd.
- IPA cleaning solution - as reqd.
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.

PROCEDURE

Note:

1 The Instructor has to label the tool utilized for this exercise

2 Demonstrate the special tools used for the SMD components/ICs soldering/desoldering in the SMD PCBs along with safety precautions to handle the special tools

3 Provide some sample SMD PCBs for this exercise

1 Refer to the WallCharts showing all the special tools used for the SMD IC soldering/desoldering of SMD components as provided by the instructor and identify the name of the tool

2 Record the observations on the Table 1.

3 Pick one of the labelled special tool displayed by the instructor in the table.

4 Use the tools, hold and grip SMD components ICs on the assembled PCBs.

5 Get the work checked by the instructor

Table 1

Sl.No.	Label No	Name of the special tool	Use/application	Remarks

— — — — — — — —

Make the necssary settings on the SMD soldering workstation to desolder various ICs of different packages

Objectives: At the end of this exercise you shall be able to
- **make necessary settings on the SMD soldering workstation for desoldering of ICs (different packages)**
- **desolder SMD ICs using wicking braid method**
- **desolder SMD ICs using hot air method.**

Requirements

Tools/Equipments/Instruments

• Trainees tool kit	- 1 Set
• Crimping tools	- 1 Set
• Magnifier with lamp	- 1 No.
• Digital multimeter with probes	- 1 No.
• SMD Soldering workstation with operating manual	- 1 Set

Materials/Components

• Rosin cored solder and flux	- as reqd.
• IPA cleaning solution	- as reqd.
• Solder flux pen/liquid flux	- as reqd.
• Cleaning brush	- 1 No.

PROCEDURE

Note:

1 The instructor may use a portable stand/ fixture with crocodile clips to hold the PCB during soldering/desoldering work.

2 Guide the trainees to carryout this desoldering task with soldering iron/wicking braid or hot air for SMD IC assembled PCB given for this task.

TASK 1 : **Making necessary settings on the SMD soldering workstation for desoldering of ICs (different Packages)**

1 Identify the SMD IC on the PCB/ assembled board.

2 Use magnifying glass and inspect the size of the soldered joints of the IC to be removed/ desoldered.

3 Select the appropriate tip/bit and fix it on to the soldering iron to be used for desoldering work.

4 Apply solder flux over the SMD IC pins using the 5ml syringe as shown in Fig 1

Fig 1

EMN32191H1

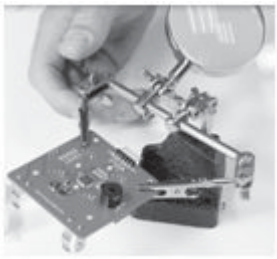
5 Use the fixure with crocodile clips as shown in Fig 2 to hold the board firmly on the workbench.

6 Switch ON the SMD soldering workstation, adjust the temperature setting knob to 275°C and keep the soldering iron ready for desoldering the SMD IC.

7 Use the crimping tool bent tip tweezers and hold the SMD IC.

8 Apply the hot soldering iron tip on the IC pins and desolder the SMD IC.

Fig 2



EMN32191H2

— — — — — — — —

TASK 2 : **Desoldering using wicking braid**

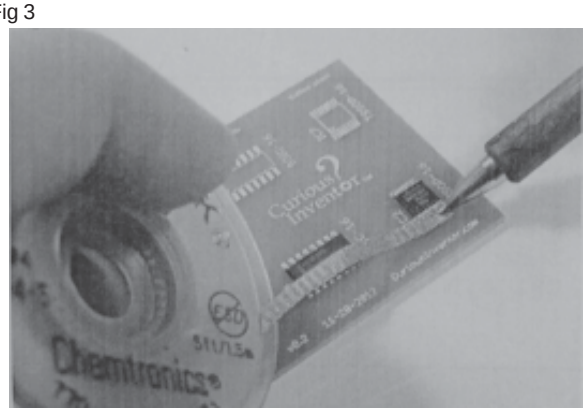
1 Repeat Steps 1 to 6 of Task-1.

2 Use the desoldering wicking braid one end over the SMD IC pins as shown in Fig 3.

3 Keep the tip of the hot soldering iron over the wicking braid and allow time to melt the solder for few seconds.

4 After the molten solder completely sucked by the wicking braid lift the soldering iron and wick quickly.

Fig 3



EMN32191H3

5 Use the crimping tool/bent tweezers, lift the SMD IC from the PCB.

6 Clean the PCB with IPA solution using brush.

7 Get the work checked by the Instructor

— — — — — — — —

TASK 3 : **Desoldering using hot air**

1 Repeat steps 1 to 6 of Task -1.

2 Select the nozzle size suitable to the SMD IC and fix it on the tip of the hot air gun.

4 Switch ON the SMD workstation and re- adjust the hot air/ soldering iron temperature according to the desoldering work.

5 Get the work checked by the Instructor and switch OFF the SMD workstation with both control knobs brought back to zero position and soldering iron/ hot air gun kept in their holders.

— — — — — — — —

Make necessary settings on SMD soldering station to solder various ICs

Objectives : At the end of this exercise you shall be able to
- **identify the suitable SMD printed circuit board to solder the SMD ICs**
- **solder SMD IC using soldering workstation (soldering iron type)**
- **solder SMD IC using soldering workstation using hot air and solder paste.**

Requirements

Tools/Equipments/Instruments

- ESD mat or table top and ESD wrist strap (both grounded) - 1 Set
- SMD soldering workstation with tempe rature controller/hot air flow controller with all accessories - 1 Set
- Magnifier with lamp - 1 No
- Vacuum pen - 1 No
- Tweezers with bent/pointed tips (ESD safe tips) - 1 No

Materials/Components

- Solder flux pen/liquid flux, solder wick, IPA solutions cleaning cotton bud - as reqd
- Solder paste - as reqd
- Prototype SMD PCB suitable to assemble SMD leaded IC and lead leadless IC - as reqd
- SMD IC - as reqd
- Flexible PCB tape - as reqd

PROCEDURE

Precautions:

1 Keep the workbench neat and clean.

2 Use ESD proof bins or trays to store the components.

3 Wear the ESD wrist strap to discharge the buildup of body static charge to ground.

TASK 1: **Selecting the suitable PCB for soldering leaded SMD ICs and leadless SMD ICs**

1 Use the vacuum pen and pick the given leaded SMD IC for soldering work.

2 Check the pitch of the IC and select the suitable SMD PCB.

3 Place the selected SMD IC on the pads of the PCB.

4 Get the work checked by the Instructor, label the PCB as 1 and keep it seperately.

5 Repeat above steps for the leadless SMD IC and label the PCB as 2 and keep it also seperately.

Note:

1. Use the pencil bit for the soldering iron to solder the SMD IC on the PCB.

2. Select and fix the appropriate size of hot air nozzle suitable for the soldering work.

— — — — — — — —

TASK 2: **Soldering leaded SMD IC using temperature controlled soldering workstation**

1 Switch ON the soldering workstation and set the temperature of the soldering iron in the range of 250° - 280°C.

2 Apply the flux on the pads of PCB 1 as shown in the Fig 1.

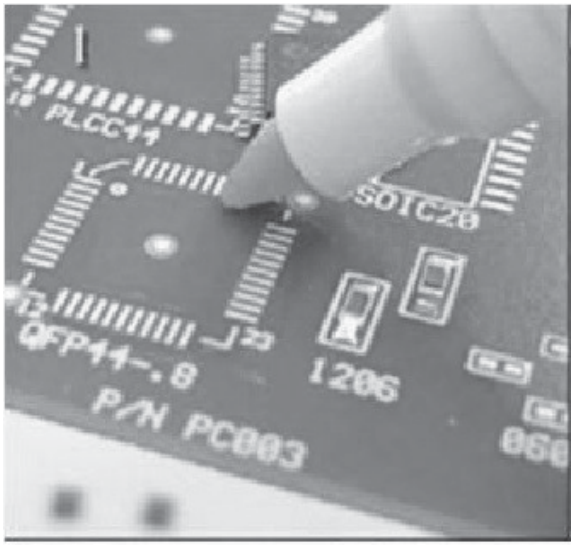
3 Identify the pin no 1 of the leaded SMD IC and pick the vacuum pen and of place it correctly on the pick pad as shown in Fig 2.

4 Align/adjust the chip as shown in Fig 3 using tweezers if necessary

Note: Once multiple pins are soldered, it's very difficult to make adjustments without removing the chip.

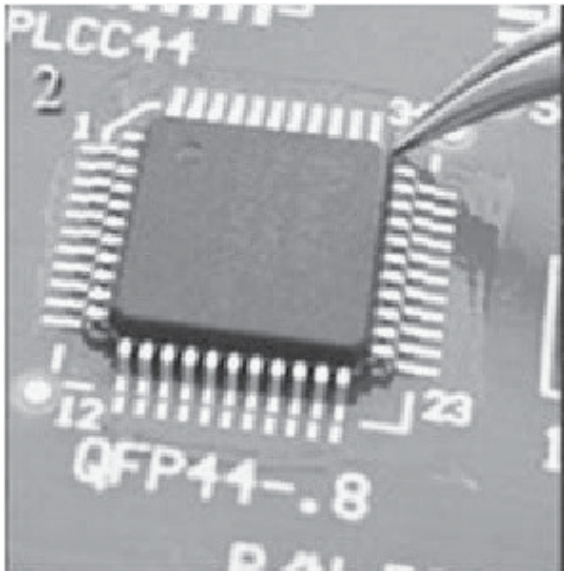
5 Use the soldering iron with a little solder on the tip solder the first pin of the IC as shown in Fig 4.

Fig 1



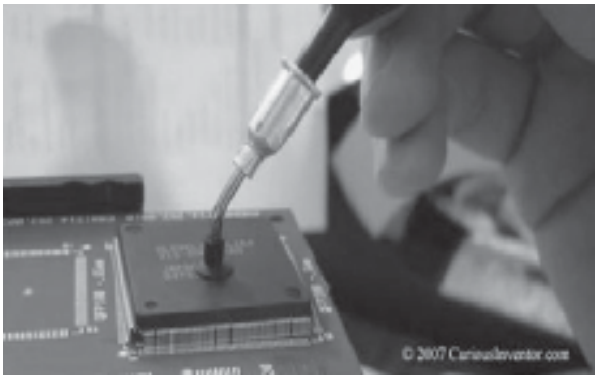
EMN32192H1

Fig 3



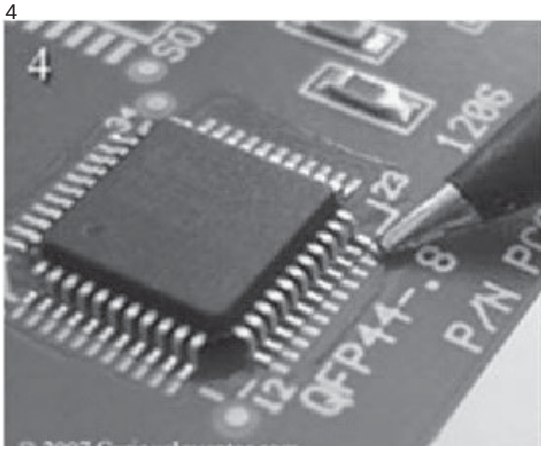
EMN32192H3

Fig 2



EMN32192H2

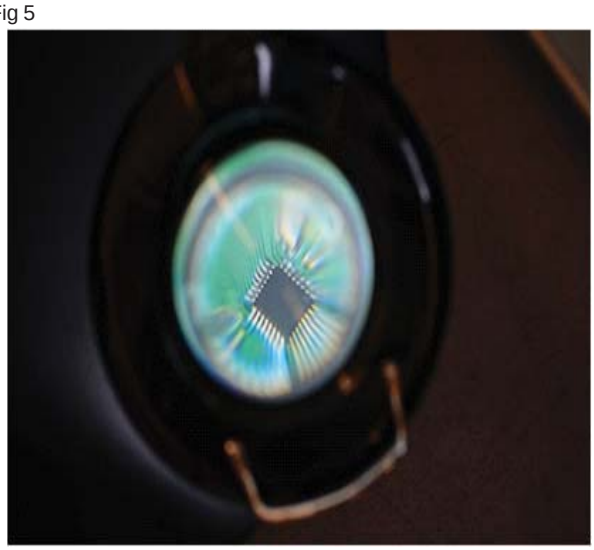
Fig 4



EMN32192H4

6 Check the alignment is correct through the magnifier as shown in Fig 5.

Fig 5



EMN32192H5

7 Solder the diagonal corner pin of the IC, recheck and confirm the alignment.

8 Apply the liquid flux over all the pins of the IC and solder the remaining pins.

9 Check IC terminals are perfectly soldered. If any solder bridges are formed remove them using solder wick.

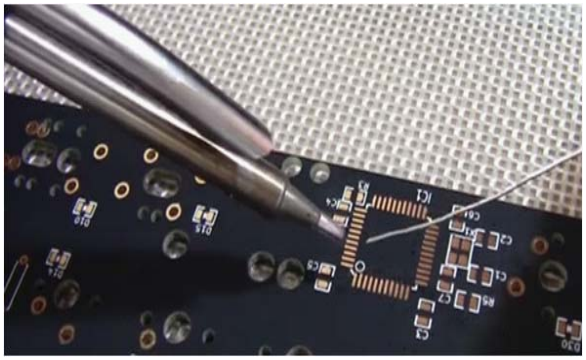
10 Verify the solder joint using magnifier and clean the PCB with IPA solution.

11 Get the work checked by the Instructor.

TASK 3: **Soldering leaded SMD IC using soldering workstation hot air and solder paste**

1 Pick the SMD IC and the PCB-2; Identify the pin-1 mark on the land pattern of the PCB as shown in Fig 6.

Fig 6



EMN32192H6

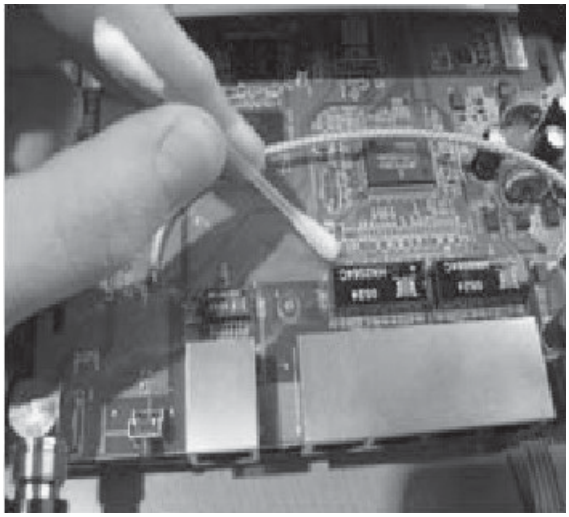
2 Clean the solder pad with IPA solution and tin the 1st pin, diagonally opposite pin pads.

3 Use holding device with crocodile clips to fix the PCB firmly on the work bench.

4 Switch ON the soldering workstation, adjust the temperature setting knob to 275°C.

5 Use the ESD safe tweezers and place the SMD IC on the pads of the PCB at its position correctly as shown in Fig 7.

Fig 7

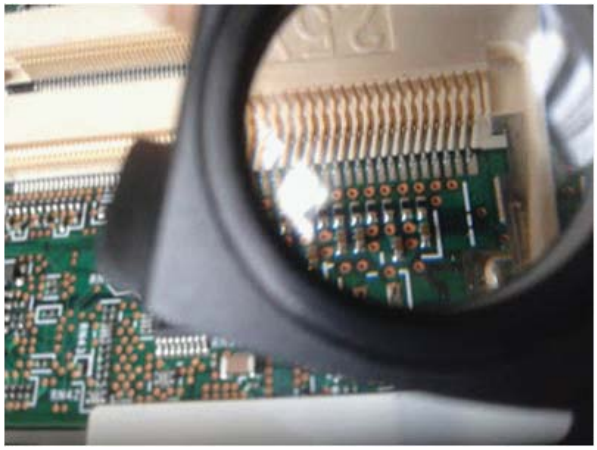


EMN32192H7

6 Hold the IC firmly and solder the pin-1 using pencil tip soldering iron and solder the diagonally opposite pin; switch OFF power.

7 Check the alignment using magnifier and confirm the SMD ICs correct position on the PCB as shown in Fig 8.

Fig 8



EMN32192H8

8 Apply the solder paste over the pins on all the four sides of the SMD IC.

9 Power ON the soldering workstation and adjust the air and temperature knobs to 280°C.

10 Apply the hot air nozzle over the SMD IC leads on all the four sides.

11 Keep the hot air nozzle moved around till the solder paste slowly melts and the solder joints formed on the pads of PCB.

Caution: To avoid damage do not keep the hot air nozzle over the device and adjacent components for a longer period of time and burning of the PCB. Don't blow air by mouth; it may cause dry solder.

12 Use magnifier and check all the pins of the SMD IC are correctly soldered to the pads on the PCB as shown in Fig 8.

Note: Solder the pins using soldering iron with pencil tip if needed

13 Clean the soldered PCB using IPA solution with brush

14 Get the work checked by the Instructor

Repeat the above steps for various SMD IC packages like SOP, SSOP, TSOP, TSSOP, SOIC, SOT packages

Make necessary setting for rework of defective Surface Mount Components using soldering/desoldering method

Objectives: At the end of this exercise you shall be able to
- **desolder the surface mount solder joint using solder wick**
- **desolder/solder the surface mount component using soldering workstation**
- **desolder the SMD IC using soldering workstation/hot air**
- **desolder the SMD components using vacuum pump.**

Requirements

Tools/Equipments/Instruments

• Trainees tool kit	- 1 Set
• Magnifier with lamp	- 1 No
• ESD table/Surface with wrist strap	- 1 No
• Soldering workstation/hot air temperature/flow controller (with instruction manual)	- 1 Set
• Digital Multimeter with probes	- 1 No.
• Desoldering tool with vacuum pump	- 1 Set

Materials/Components

• Solder wick	- as reqd.
• IPA cleaning solution	- as reqd.
• Solder flux pen/liquid flux	- as reqd.
• Cleaning brush	- 1 No
• Vacuum pen	- 1 No
• Kapton tape	- 1 No
• Syringe - 5 ml	- 1 No
• SMD leaded IC assembled PCB	- 1 No

Note: The Instructor has to ensure that the trainees are wearing the ESD strap before handling the electronic components of the PCB

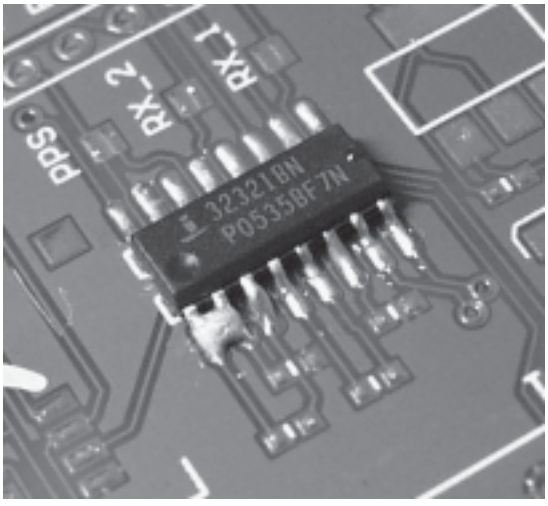
PROCEDURE

TASK 1: **Removal of surface mount solder joint using solder wick**

1 Collect the defective SMD-PCB from the Instructor and identify the component to be removed.

2 Use magnifying glass and inspect the size of the solder joints on the components to be removed as shown in the Fig 1

Fig 1

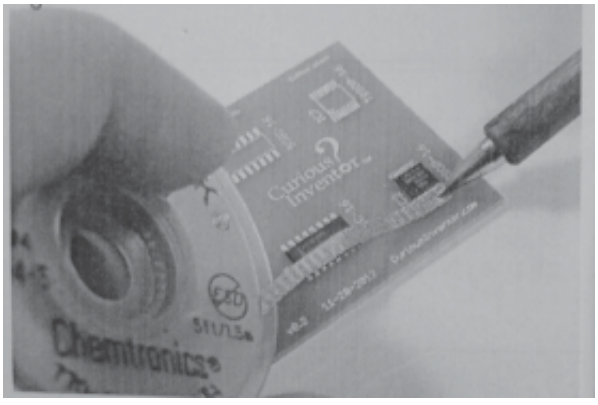


EMN32193H1

3 Apply a small quantity of flux and solder to the joints of the surface mount components to be removed.

4 Place the end of solder wicking braid on the component lead side and the tip of the hot soldering iron over it as shown in Fig 2

Fig 2



EMN32193H2

5 Allow time for the solder to melt and the solder wick to draw the molten solder into the braid by capillary action.

6 After the molten solder has been extracted from the joint, remove the wick and the soldering iron tip from the Component lead.

7 Use the unused portion of the wick for removing excess solder.

8 Repeat the steps 3 to 7 for removing other terminals of the surface mount components.

9 Remove the components from the PCB and clean the surface with IPA solution.

10 Get the work checked by the Instructor.

— — — — — — — —

TASK 2 : **Desoldering of SMD - IC using soldering workstation/hot air**

Note: The Instructor has to ensure that the masking of the other components using Kapton tape is done before starting the desoldering of SMD - IC.

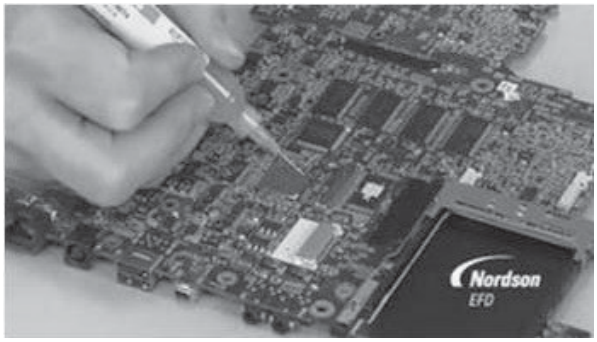
1 Select the blower tip of the Soldering workstation as shown in Fig 3 suitable to the SMD - IC to be removed.

Fig 3

EMN32193H3

2 Apply solder flux over the SMD - IC or chip using the 5ml syringe as shown in Fig 4

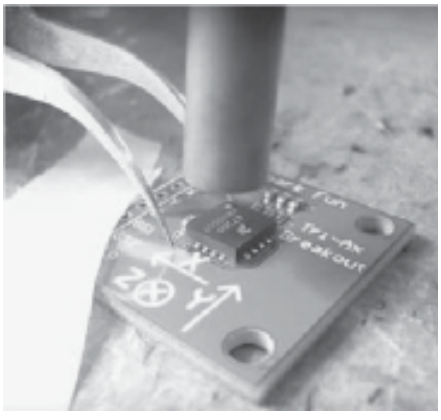
Fig 4



EMN32193H4

3 Adjust and set the temperature and apply the hot air over the SMD - IC to be removed as shown in Fig 5

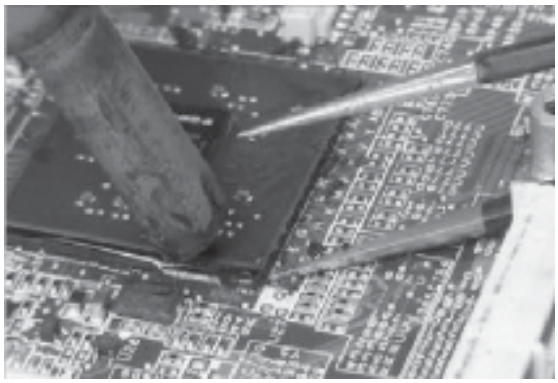
Fig 5



EMN32193H5

4 Slowly try to insert the tweezers to lift from one side and remove the SMD - IC from the PCB as shown in Fig 6

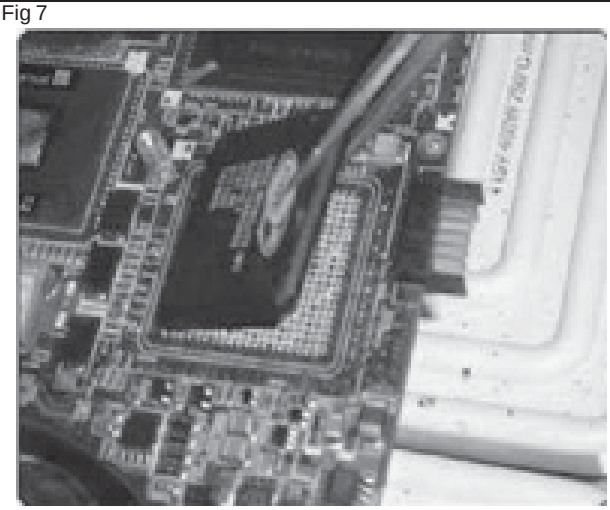
Fig 6



EMN32193H6

5 Take away the SMD - IC using tweezers as shown in Fig 7

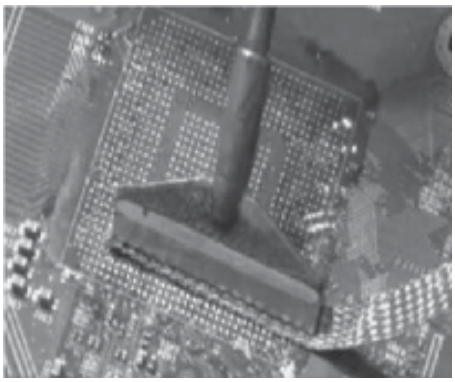
Fig 7



EMN32193H7

6 Remove any excess solder over the pads using solder wick as shown in Fig 8

Fig 8

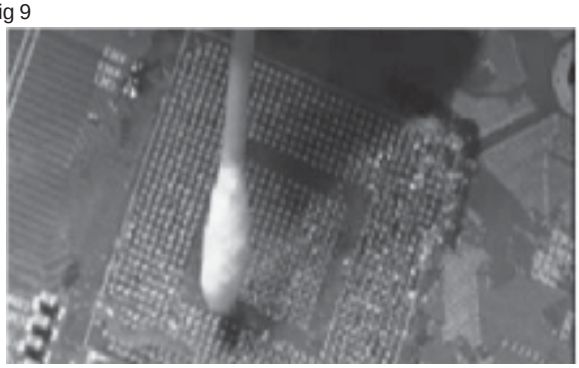


EMN32193H8

7 Clean the solder pads using IPA solution with cotton buds/brush as shown in Fig 9

8 Check the pad of the SMD - IC using magnifier lens is cleaned.

Fig 9



EMN32193H9

9 Verify no pad is damaged as shown in Fig 10

10 Get the work checked by the Instructor.

Fig 10

EMN32193HA

— — — — — — — —

TASK 3: **Removal of SMD components using desoldering pump**

1 Collect the defective SMD circuit board from the Instructor and identify the components to be removed.

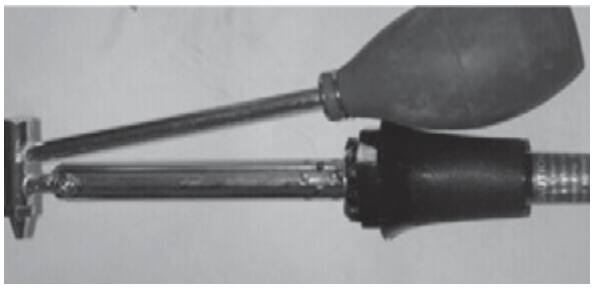
2 Inspect the size of the solder joints on the component to be removed using magnifying glass.

Note: If the size of the solder joint is small apply additional solder to form an excess solder joint.

3 Apply a small quantity of the flux to the solder joint of the component to be removed.

4 Use the Vaccum desoldering tool as shown in Fig 11 and align the desoldering tool tip contact the solder joint.

Fig 11



EMN32193HB

5 Place the soldering iron tip on the joint to melt solder.

6 Activate the Vaccum bulb immediately to extract the molten solder completely from the joint as shown in Fig 12

Fig 12

EMN32193HC

7 Remove the desoldering tool tip and then turn OFF the Vacuum pump.

Note: To avoid thermal build up on the adjacent components, desolder the joints alternatively.

8 Use tweezers to remove the SMD component from the PCB and clean the surface using cleaning solution.

9 Get the work checked by the Instructor.

10 Pad of SMD - IC removes check the cleaner are using magnifier lens.

11 Get the work checked by the Instructor.

— — — — — — — —

Check and repair PCBs single, double layer and important test for PCBs

Objectives : At the end of this exercise you shall be able to
- **identify the single and double layer PCB**
- **check the possible faults in the PCB**
- **repair the identified defect crack in the PCB/track on the PCB.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No.
- ESD table/surface with wrist strap - 1 No.
- Soldering workstation/hot air temperature/flow controller (with instruction manual) - 1 Set
- Watchmaker's screw driver - 1 Set
- Digital multimeter with probes - 1 No.
- PCB repair kit with bonding tip, bonding system - 1 Set
- Small 'C' / 'G clamp - 1 No.

Materials/Components

- Rosin cored solder - as reqd
- IPA cleaning solution - as reqd
- Solder flux pen/liquid flux - as reqd.
- Cleaning brush - 1 No.
- Cotton swab/wipes - as reqd
- Epoxy tube - as reqd
- Emery cloth / paper - 1 No.
- Kapton tape - 1 No.
- Adhesive bonding tape - 1 No.
- Single/double layer PCB - 1 No.

PROCEDURE

TASK 1: **Checking the single and double layer PCB**

1 Collect the required materials from the Instructor.

2 Identify the single and double layer PCB.

3 Physically check the PCB for any damage.

4 Use magnifying glass and observe for crack in any of the tracks on the PCB.

5 Record the observations in the Table 1.

Table 1

Sl.No	Types of PCB Single/Double layer	Physical damages noticed Crack on track	Crack on PCB	Remarks

— — — — — — — —

TASK 2: **Repair the identified defect in the single/double layer PCB**

Note:

1 Mix the epoxy as per the manufacturer's instruction to use on the PCB.

2 Arrange a vibration free space to keep the PCB for the setting time

1 Apply a little quantity of epoxy on both the cracked portions of PCB (avoid excessive quantity of epoxy).

2 Hold the two sides of the cracked PCB pressed together.

3 Keep the PCB for 15 to 30 seconds time for setting without any shake.

Note: Allow 30 minutes setting time for the PCB before proceeding to the next step.

4 Follow the above steps for double sided PCB also.

5 Get the work checked by the Instructor.

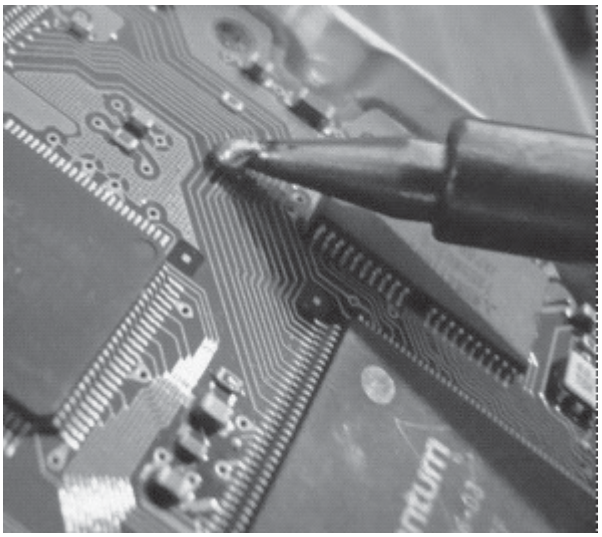
— — — — — — — —

Task 3: **Repair the cracked track on the PCB**

1 Scrape both sides on the cracked track and clean the surface.

2 Use soldering iron and tin both the sides on the cracked track as shown in Fig 1.

Fig 1

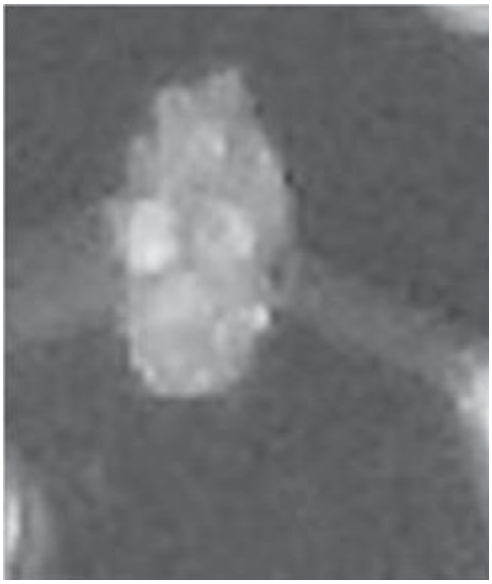


EMN32194H1

3 Select a small piece of a thin wire suitable to the width of the track.

4 Use tweezers, tin the wire piece and position correctly bridging over the crack as shown in Fig 2.

Fig 2



EMN32194H2

5 Solder the tinned copper wire piece over the track completely covering the crack.

6 Use magnifying glass and check for any solder bridge around the repair area.

7 Check the continuity of the repaired track using Ohm meter.

8 Get the work checked by the Instructor.

— — — — — — — —

Inspect soldered joints, detect the defects and test the PCB for rework

Objectives : At the end of this exercise you shall be able to
- **inspect the soldered joint for any defects**
- **detect the type of defect in the soldered joint**
- **test the given PCB for rework.**

Requirements

Tools/Equipments/Instruments/Raw materials

- Trainees tool kit - 1 Set
- Magnifier with lamp - 1 No.
- Soldering Iron 25W/ 240 VAC - 1 No.
- Safety glass/ gogles - 1 No.

AIDS: Chart showing images on different types soldering defects in the PCB assemblies using electronic component -1 No.

Materials/Components

- IPA Solution - 1 bottle
- Cleaning Brush - 1 No.
- Cleaning Cloth - as reqd.

PRODECURE

TASK 1: **Inspection of the soldered joints**

Note: The Instructor has to show some samples of PCB with defective soldered joints and explain to the trainees.

1 Collect the defective PCB for the inspection.

2 Make visual inspection on the board for any physical damage/defect.

3 Clean the residual flux on the solder joint using IPA solution with brush.

4 Use magnifier with bright white light, carefully observe the shape of the joint formation, surface texture, mechanical bonding and any browny wax like material.

5 Refer to the Chart - 1 showing types of defects on the soldered PCB.

Chart - 1

Chart showing various types of soldered joint defects

Sl.No.	Name of the defect	Visual Observation	Remarks
1	Dry Joint / Cracked joint/Lifted Component		
2	Poor solder joint/ Cracked joint/Lifted Component		
3	Excess solder on joints		
4	Wetting defects/ Pin or blow holes		
5	Temperature defects/ overheating		
6	Lumps of charred flux.		

6 Record the detected/ observed defect on the Table-1.

7 Get the work checked by the Instructor and record the remarks for rework on the PCB.

Table 1

Sl.No.	Obervation on the soldered joint	Name of the defect	Remarks

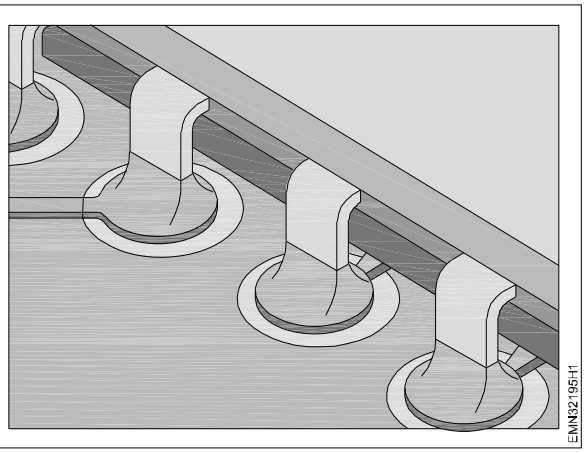
— — — — — — — —

TASK 2 : **Removal of through hole solder joint using vacuum desoldering tool**

1 Collect the defective board from the Instructor and indentify the component to be removed.

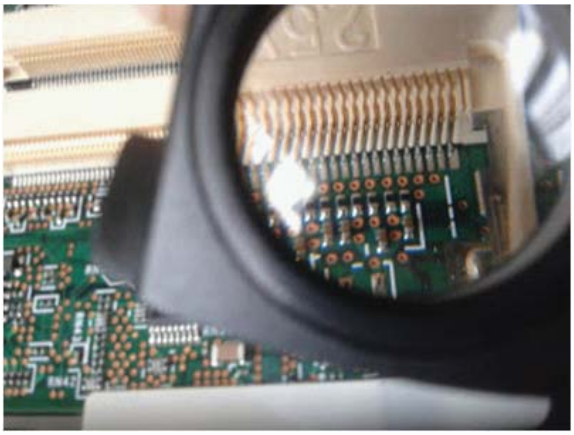
2 Inspect the size of the solder joints on the component to be removed using magnifying glass as shown in Fig 1, 2 & 3.

Fig 1



EMN32195H1

Fig 2



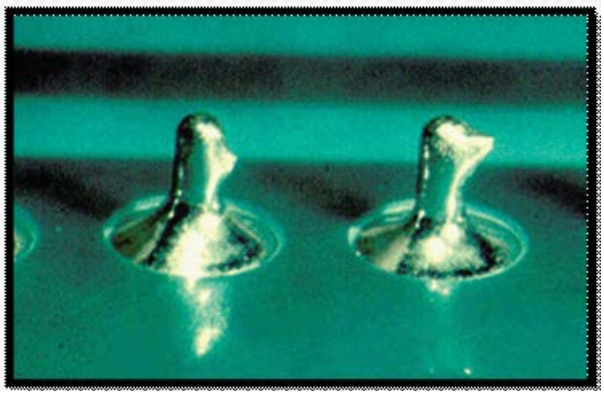
EMN32195H2

Fig 3

EMN32195H3

3 If the sizes of the solder joints are minimal, apply additional solder to form an "excess solder" joint as shown in Fig 4.

Fig 4



EMN32195H4

4 Apply a small amount of flux to the solder joints of the component to be removed.

5 Take the vacuum desoldering tool as shown in Fig 5 and align the desolder tip with a component lead end and lightly make contact with the solder joint.

Fig 5

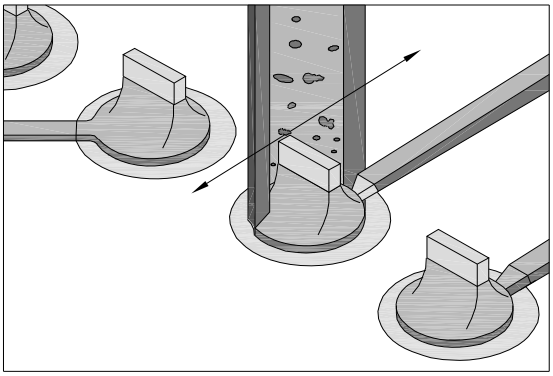
EMN32195H5

6 Keep the desolder tip off the pad by allowing it to slide around on a film of solder as shown in Fig 6 & 7.

Caution : Do not apply pressure with the solder extractor tip to the leads or other conductive patterns.

Wear Safety Glass. The molten solder may hit the eye.

Fig 6



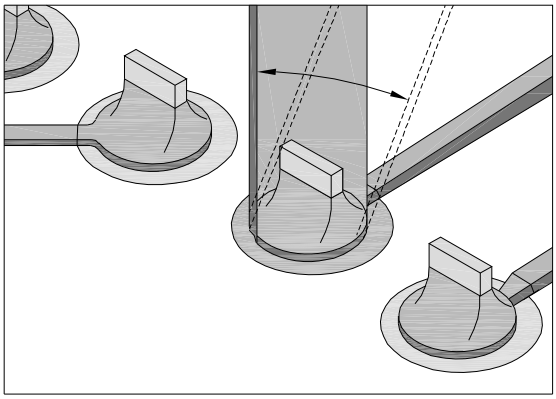
EMN32195H6

Fig 7

EMN32195H7

6 After the solder has melted, start a rotating or oscillating motion with the desolder tip. Continue the rotating motion until a change in the "feel" of the rotating motion occurs as shown in Fig 8 & 9.

Fig 8



EMN32195H8

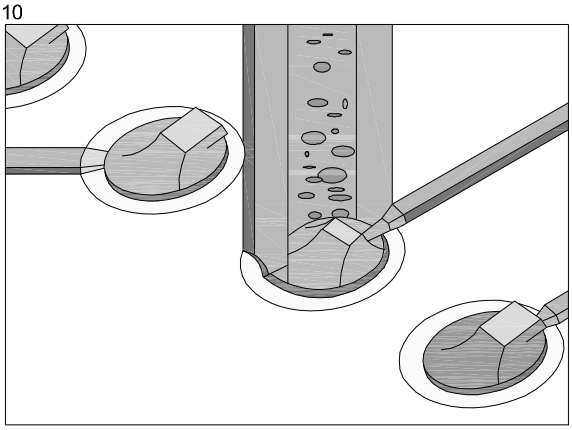
Fig 9

EMN32195H9

7 When the solder in the solder joint is completely molten, immediately activate the vacuum tool extracting the solder from the solder joint as shown in Fig 10 & 11.

Maintain rotation of the desolder tip while continuous vacuum is being applied. This allows air to cool both the component lead and the plated-through hole.

Fig 10



EMN32195HA

Fig 11

EMN32195HB

8 After the solder has been extracted from the solder joint, remove the desolder tip from the component lead.

9 Maintain continuous vacuum for a few seconds to clear the desolder tip.

10 Turn off the vacuum.

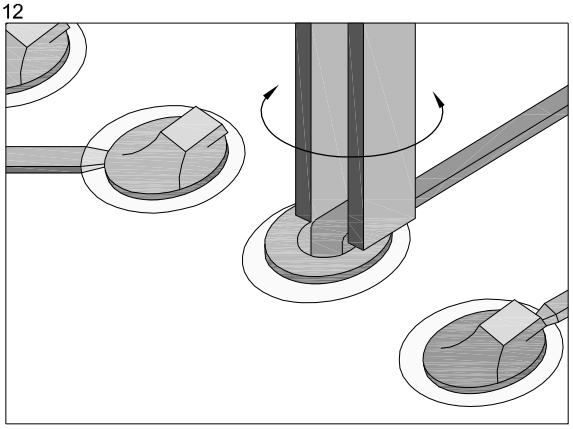
11 Use a flat nose pliers to gently rotate the lead laterally break any remaining solder joints as shown in Fig 12.

12 Desolder each of the remaining component leads individually using a skipping method to reduce thermal buildup at adjacent hole locations.

13 Check each component lead that they are not soldered to the side of the plated hole as shown in Fig. 13 and then remove component using tweezer.

Note: If each lead is not completely free, resolder the joint and repeat steps 2 - 12.

Fig 12



EMN32195HC

13 Clean the surface using cleaning solution and get the work checked by the Instructor.

14 Practice this process to remove few more components

15 Get the work checked by Instructor.

Fig 13

EMN32195HD

— — — — — — — —

Remove the conformal coatings by different methods

Objectives: At the end of this exercise you shall be able to
- **identify conformal coating on the SMD PCBs**
- **remove conformal coating on SMD PCBS, follwing different methods.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Acrylic resin with Spray gun - 1 No.
- Hot air gun - 1 No.
- ESD safe surface - 1 No.
- ESD wrist strap - 1 No.

Materials / Components

- Foam swab - as reqd.
- Cleaning Brush - 1 No.
- Gloves - 1 Set
- Scraper - 1 No.
- IPA solution - as reqd.
- Marker pen - 1 No.
- General purpose PCB (or) SMD PCB - 1 No.
- Cleaning Wipes - as reqd.
- High temperature tape (50 mm x 100 mm Kapton tape) - 1 No

Note:

1 The instructor has to select the PCB with conformal coating and explain about the type of coating to the trainees.

2 To determine the appropriate coating removal procedure, first the coating must be identified, whether the coating is harder or softer, or the coating is transparent.

TASK 1: **Identification of conformal coating**

1 Check the coating physically and record the observation in the Table 1.

2 Use the hot air gun, apply the heat over the coating for a short duration and record the observation.

3 Use foam swab, apply IPA solution on the coating and record the observation.

4 Check the hardness of the coating surface bonding and record your observation.

5 Get the work checked by the Instructor.

Table 1

S. No.	Test	Yes	No
1	Does the coating feel soft, rubbery, spongy or glossy?		
2	Does the coating have a noticeable reaction to heat?		
3	Is there a reaction to solvent?		
4	Is the coating hard?		
5	Is the coating have very strong surface bonding?		

— — — — — — — —

TASK 2: **Removal of conformal coating using solvent by local spot removal method**

1 Use the maker pen and draw outline for the coating removal area as shown in Fig 1.

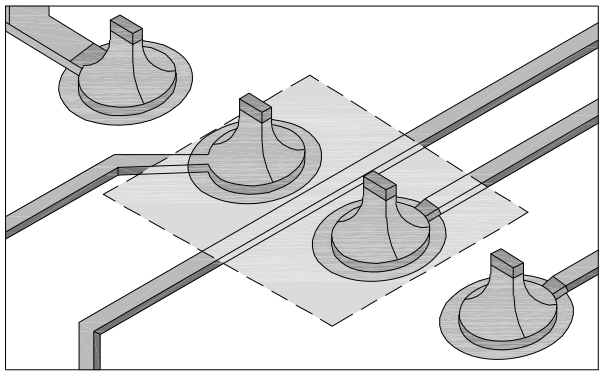
2 Apply High Temperature (Kapton Tape to outline the area on all the four sides where the coating to be removed.

3 Dip one end of a foam swab in stripping solution and apply a small quantity of the solution on the coating to be removed as shown in Fig 2.

Note: Since various substances are used for coating removal, their time required to dissolve will vary. Therefore, re apply several times even after evaporation.

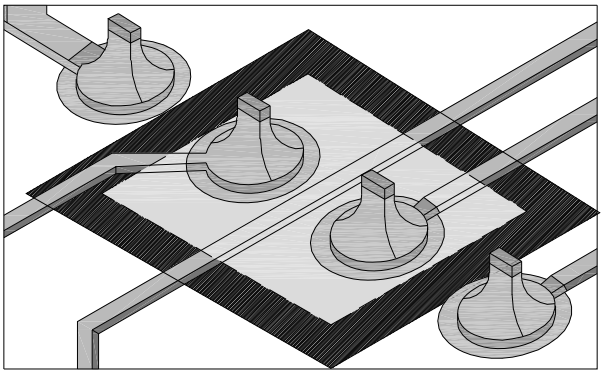
4 Rub the solution applied surface carefully with a brush or wood stick to remove the coating as shown in Fig 3 & 4.

Fig 1



EMN32196H1

Fig 2

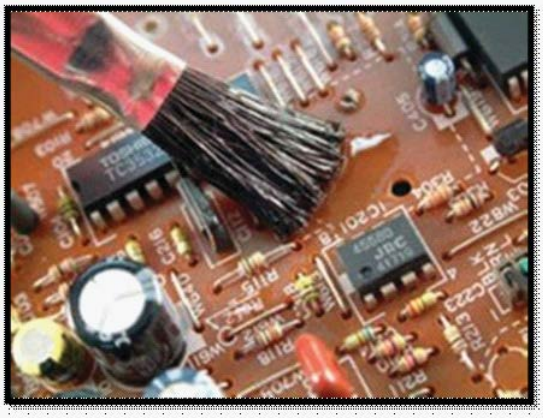


EMN32196H2

5 Clean the conformal coating removed area using IPA solution.

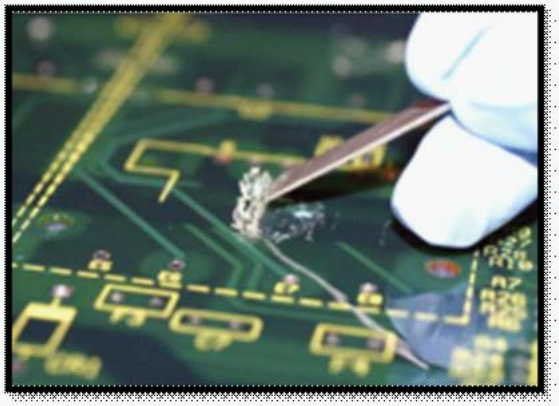
6 Get the Work checked by the Instructor.

Fig 3



EMN32196H3

Fig 4



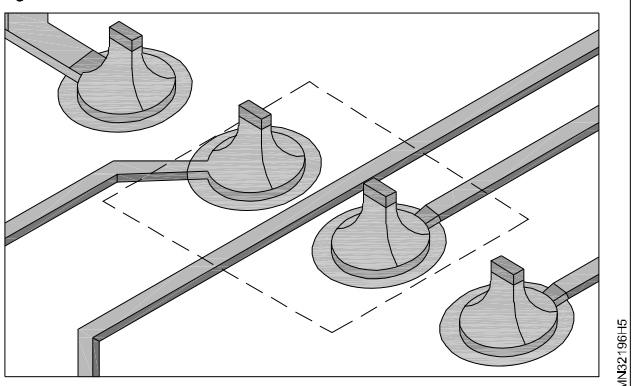
EMN32196H4

— — — — — — — —

TASK 3: **Removal of conformal coating by peeling method**

1 Use marker pen, draw outline for a coating removal area as shown in Fig 5.

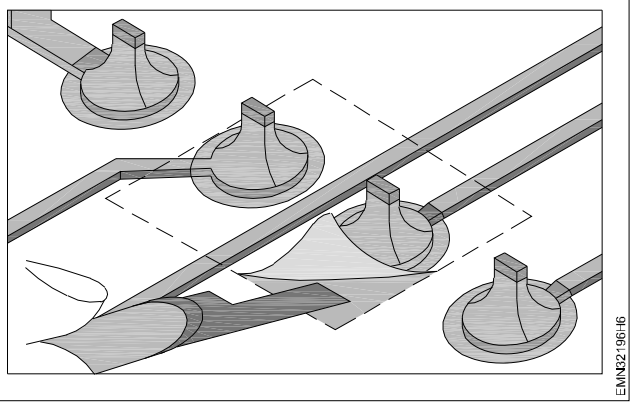
Fig 5



EMN32196H5

2 Use electricians knife, slit and peel off the coating material as shown in Fig 6 & 7.

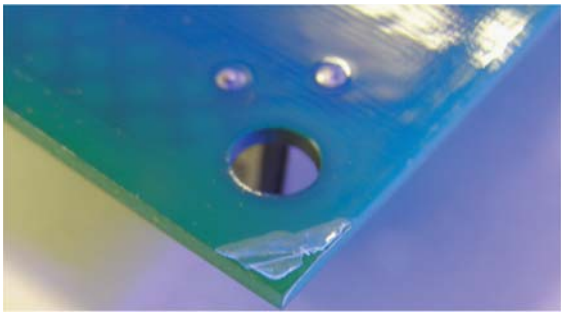
Fig 6



EMN32196H6

3 Repeat the above step until all the coating material is removed.

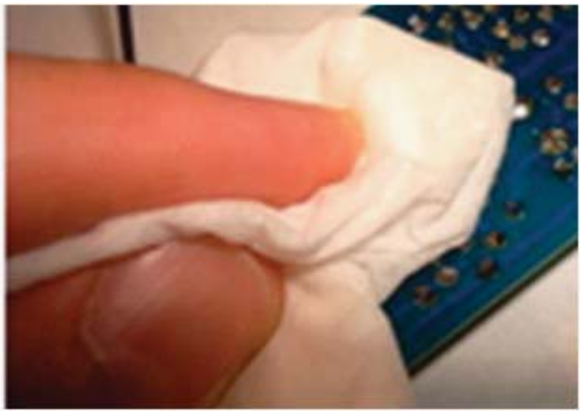
Fig 7



EMN32196H7

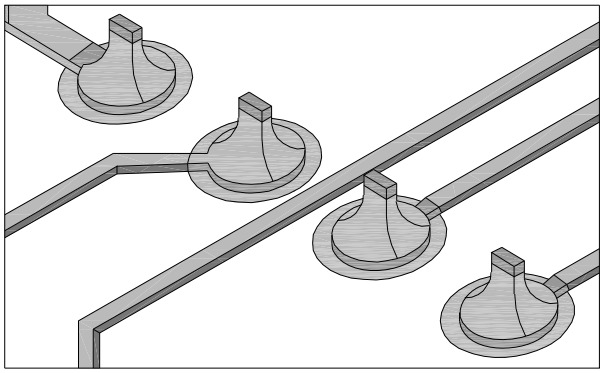
4 Clean the stripped area using cleaning solvent and cleaning wipes as shown in Fig 8 and 9.

Fig 8



EMN32196H8

Fig 9



EMN32196H9

5 Get the work checked by the Instructor

Perform replacement of coating

Objectives : At the end of this exercise you shall be able to
- **replace the conformal coating on PCB.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Acrylic resin with Spray gun - 1 No.
- Scraper - 1 No.
- Hot air gun - 1 No.
- ESD safe surface with ESD wrist strap - 1 Set

Materials/Components

- Cleaning brush - 1 No.
- Foam swab - as reqd.
- IPA Cleaning solution - 1 bottle
- Marker pen - 1 No.
- General purpose PCB (or) SMD PCB - 1 No.
- Cleaning Wipes - as reqd.
- High temperature tape (50 mm x 100 mm Kapton tape) - 1 No.
- Gloves - 1 Set

PROCEDURE

TASK 1: **Conformal coating on local spot area of PCB**

Caution: Use the ESD safe surface/wrist strap to prevent the board from eletrostatic charges.

1 Wear wrist strap and connect it on the ESD-safe surface mat as shown in Fig 1 & 2.

Fig 1

Fig 2

2 Use foam swab/cleaning brush and clean the selected area on the given SMD PCB for any dust particles.

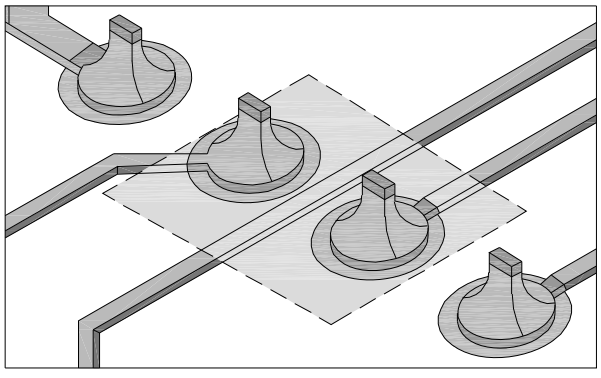
Note: PCB must be thoroughly cleaned and dried eight hours before applying conformal coating.

3 Use IPA solution, clean the selected area throughly and allow it to dry.

Note: Keep the cleaned board to dry completely for a minimum of one hour to 2 hours duration.

4 Mark the outline area using marker pen where the coating to be applied as shown in Fig 3.

Fig 3

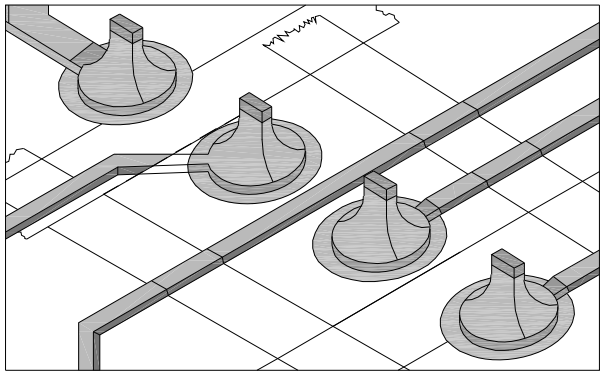


5 Use the high temperature kapton tape, apply the tape on all the four sides of the outlined area as shown in Fig 4 and 5.

Fig 4

EMN32197H4

Fig 5



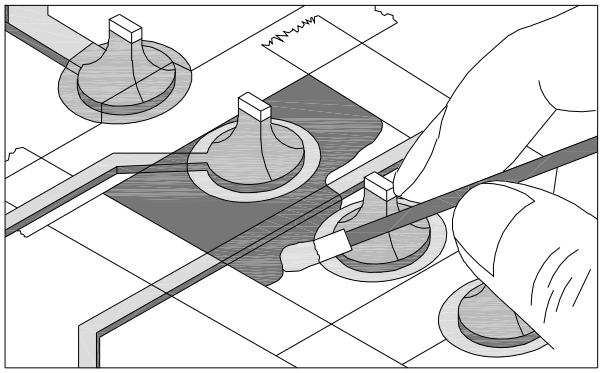
EMN32197H5

6 Use a brush or foam swab and apply the conformal coating on the board surface as shown in Fig 6 & 7.

Fig 6

EMN32197H6

Fig 7



EMN32197H7

Note:

1 **Alternatively two types of spray guns used for conformal coating.**

2 **Use any one type of spray gun as shown in Fig 8 & 9.**

Fig 8

EMN32197H8

Fig 9

EMN32197H9

7 Keep the board for curing and drying under a fan or in a ventilated area.

8 Get the work checked by the Instructor.

Perform baking and preheating of PCB

Objectives : At the end of this exercise you shall be able to
- **perform the baking process of PCB for soldering**
- **perform the preheating of PCB prior to desoldering/soldering.**

Requirements

Tools/Equipments/Instruments

- PCB baking oven with preheating plate and operating manual - 1 Set
- Magnifying lens with light - 1 No.

Materials/Components

- Cleaning brush - 1 No.
- IPA solution - 1 bottle
- Cleaning cloth - as reqd.
- PCB/Assembly for baking and preheating process - as reqd.

Precaution:

1 **Clean the PCB/assembly prior to baking or preheating to prevent flux and contaminations being baked to the board surface.**

2 **Packing & preheating procedures must be carefully selected to ensure that temperatre, time cycles and vapors, gases etc. generated during the heating process do not contaminate the PCB surface.**

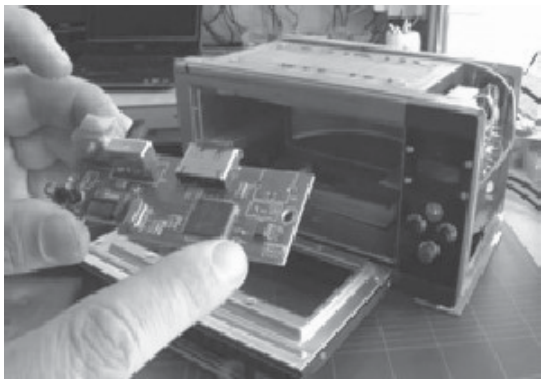
PROCEDURE

TASK 1 : **Baking the PCB for soldering**

1 Collect the PCB/assembled board from the Instructor.

2 Refer to the operating manual of PCB baking oven switch 'ON' and adjust the oven temperature to 125°C.

Fig 1



EMN32198H1

3 Open the door and keep the PCB/assembled board vertically and close the door as show in Fig 1

4 Press the "Start button' and allow it for 4 hours

5 Observe for the alarm sound and check the oven is switched OFF automatically after 4 hours time.

6 Get the permission from the Instructor, open the oven take out the PCB/assembled board.

7 Inspect the PCB board visually for any physical damages.

8 Get the work checked by the Instructor.

— — — — — — — —

TASK 2: **Preheating the PCB/assembled board for desoldering components**

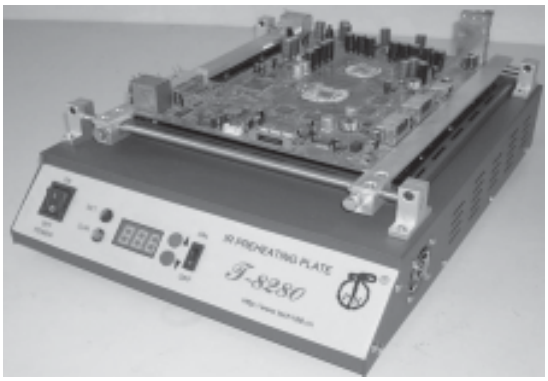
Note: The instructor has to ensure that the pre heat temperature of the oven should not exceed 2 to 4°C per second, and the bake-out temperature at 125°C.

1 Repeat steps 1 and 2 of task 1.

2 Fix the PCB/assembled board on the preheating plate as shown in Fig 2.

3 Switch ON and adjust the temperature setting around 125°C at the rate of 2 to 4°C per second.

Fig 2



EMN32198H2

4 Press the ‘start button’ for temperature to increase till the completion of set time.

5 Observe the alarm sound for automatic switch OFF.

6 Remove the PCB/assembled board, inspect visually for any physical damages.

7 Get the work checked by the Instructor.

Repair solder mask and damaged pad

Objectives : At the end of this exercise you shall be able to
- **repair the damaged pad on the PCB**
- **repair the solder mask on circuit board.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Soldering workstation - 1 Set

Materials/Components

- IPA cleaning solution - 1 Bottle
- Cleaning brushes - 1 No.
- Copper oil - as reqd.
- Circuit bond packs (2 gram prepackaged Epoxy containers) syringe type - as reqd
- Wipes/Foam swabs - as reqd.
- Glass/plastic bowls to mix the epoxy - 1 No.
- Kapton tape - as reqd.
- PCB with damage - as reqd.
- PCB repair Kit - 1 Set

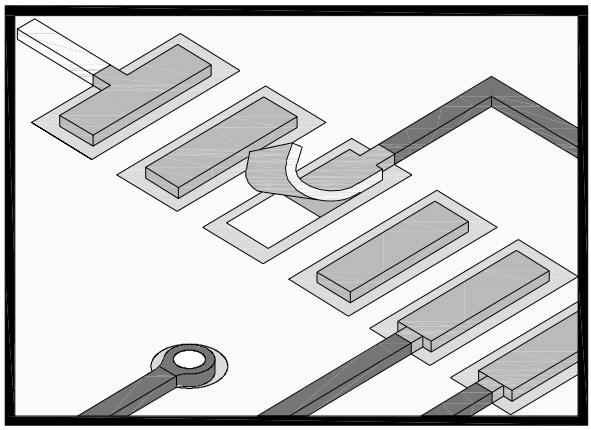
PROCEDURE

TASK 1 : **Repair the damaged pads on the circuit board**

1 Identify the damaged pad and clean the surface with cleaning solvent using a brush.

2 Use a dull knife and remove the damaged surface mount pad and a short length of the connecting track as shown in Fig 1.

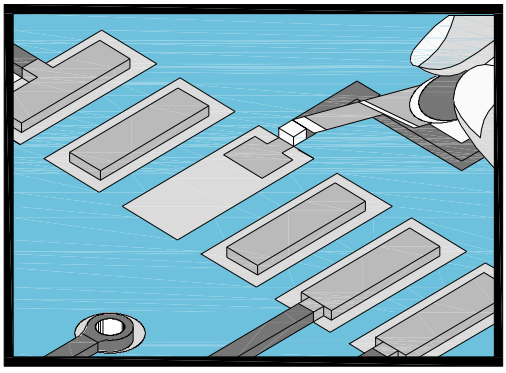
Fig 1



3 Use a Knife to scrape any epoxy residue, contamination or burnt material from the board surface as shown in Fig 2.

4 Tin the connecting track on the board surface using liquid flux and solder & clean the area.

Fig 2

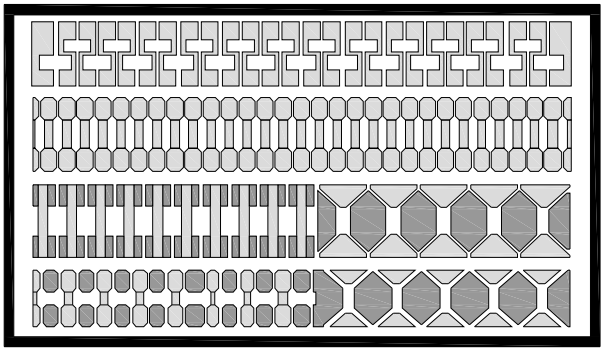


The length of the overlap solder connection should be minimum 2 times of the circuit width. The area for the new pad on the board surface must be smooth and flat.

5 Select a new surface mount pad from a new strip as shown in Fig 3, which closely matches the surface mount pad to be replaced.

Note: PCB repair hit for circuit boards must contain eyelets & setting tools, pads, lands, tracks, tracks for damaged circuit traces, adhesive, and colour agents for solder mask and board repair, dry film, adhesive backed circuit frames.

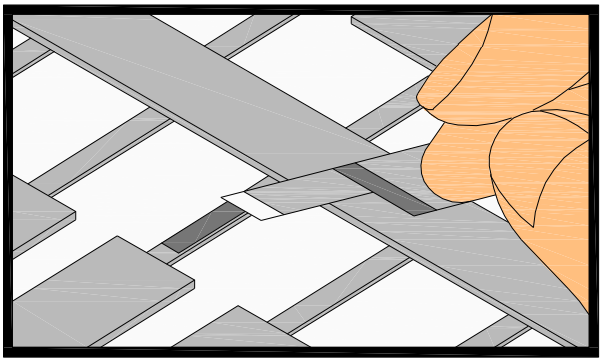
Fig 3



Note: New surface mount pads are fabricated from copper foil. The foil is plated on the top side with solder, and an adhesive bonding film is on the bottom side.

6 Before trimming out a new pad, carefully scrape the adhesive bonding film from the connecting track as shown in Fig 4.

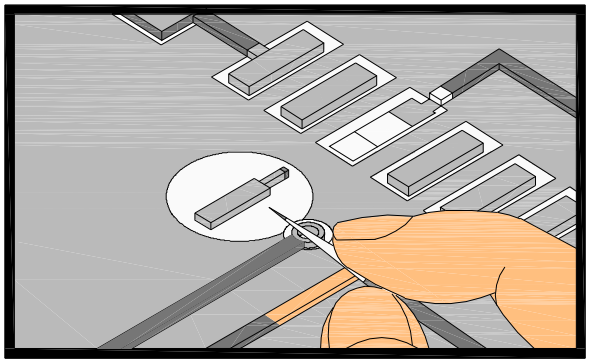
Fig 4



Precaution : Scrape off the epoxy backing only from the joint connection area. When handling the replacement contact, avoid touching the epoxy backing with your fingers or other materials that may contaminate the surface and reduce the bond strength.

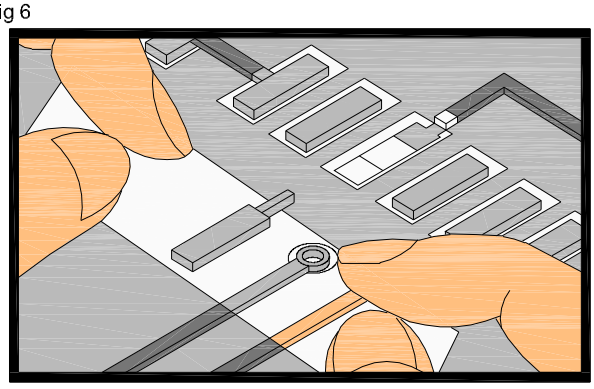
7 Cut out and trim the new pad. Cut the length to provide the maximum allowable circuit overlap for soldering. Minimum 2 times the track width. (Fig 5)

Fig 5



8 Place a piece of High Temperature Tape over the top surface of the new pad. Place the new pad in correct position on the circuit board surface using the tape to proper alignment. (Fig 6).

Fig 6

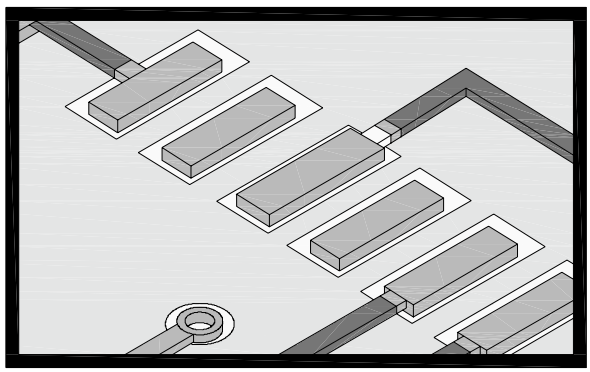


9 Select a bonding tip to match the shape of the new pad. (See bonding tip manual provided with the repair kit).

The tip used for bonding should be as small as possible but should completely cover the entire surface of the new pad.

10 Position the circuit board flat and stable. Gently place the hot bonding tip onto the High Temperature Tape covering the new pad. Apply pressure as recommended in the manual of the repair kit for 5 seconds to tack the new pad in place. Carefully peel off the tape.

Fig 7



Precaution : Excessive bonding pressure may cause measling in the circuit board surface or may cause the new pad to slide out of position.

11 Gently place the bonding tip directly onto the new pad and apply pressure as recommended in the manual of the repair kit for an additional 30 seconds to fully bond the pad.

Note: After the bonding cycle, remove the tape used for alignment. The new pad is fully cured. Carefully clean the area and inspect the new pad for proper alignment.

12 Use minimum flux and solder to ensure a reliable connection. Tape may be placed over the top of the new pad to prevent excess solder.

Note: The overlap solder joint connection should be a minimum of 3 mm.

13 Mix Epoxy and coat the overlap solder joint connection. Cure the Epoxy coating as shown in Fig 7.

14 Get the completed work checked by the Instructor.

— — — — — — — —

TASK 2: **Apply solder mask on the PCBs**

Precaution: Work on the board under ESD-Safe surface to prevent from electrostatic charges.

1 Inspect and remove the damaged solder mask on the board completely using knife by gentle scraping.

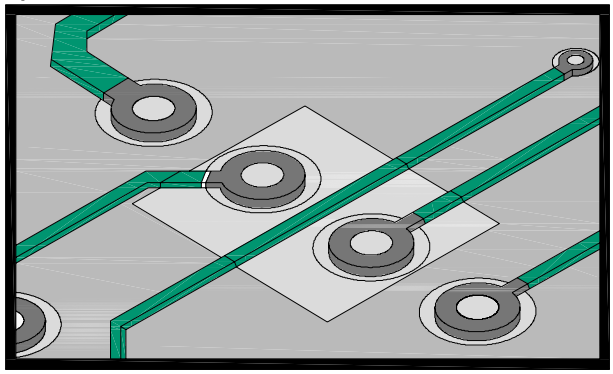
2 Clean the area using cleaner and brush.

Caution: Surface to be coated must be throughly cleaned priror to coating to ensure adequate adhesion, minimised corrosion, and optimised electrical properties.

3 Apply high temperature tape to four sides to expose the area where the solder mask to be applied as shown in Fig 8.

Note: The Instructor has to guide the trainees to prepare the epoxy bond

Fig 8



4 For syringe type, remove the caps of syringe that contains two separate compartments as shown in Fig 9. Press slowly the contents into the mixing cup. Use the mixing stick, slowly stir the mixture for 2 minutes to ensure the resin and hardener have completely mixed without bubbles.

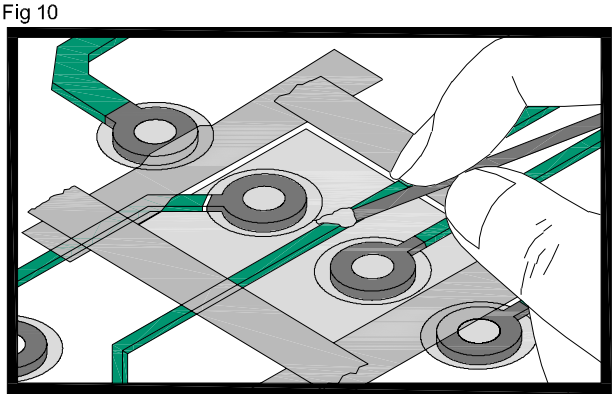
Fig 9

Note: For packaged type, remove the clip and press the resin and hardener into the Mixing cup both halves together with your fingers. Mix for at least one minute to ensure a complete mix of the resin and hardener.

5 Add color agent to the mixed epoxy to match the circuit board colour. Stir slowly to prevent bubbles.

6 Apply the Solder mask to the board surface as required. Use a brush or foam swab to apply and spread the epoxy as shown in Fig 10.

Fig 10



7 Get the work checked by the Instructor and keep the epoxy coated board for 24 hours at room temperature for curing.

— — — — — — — —

Identify different types of fuses along with fuse holders, over load relay, (no volt coil) current adjust bimetallic strips to set the current

Objectives : At the end of this exercise you shall be able to
- **identify different fuses and fuse holders**
- **identify the bimetallic type overload relay parts to adjust the tripping current.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital/multimeter with probes - 1 No.

Aids: Chart showing all types of fuses and fuse holders along with their uses/application - 1 No.

Materials/Components

Different types of fuses:

- Kit kat, glass cartridge type open and closed types - as reqd.
- Ferrule contact type - as reqd.
- HRC fuse - as reqd.
- Diazed screw type - as reqd.
- Blade fuse - as reqd.

PROCEDURE

TASK 1: **Identification of fuses and fuse holders**

Note:

1 The Instructor has to demonstrate all types of fuses and fuse holders with their uses/ application

2 Label the fuses and fuse holders separately with suitable code numbers

1 Pick any one of the fuses from the lot.

2 Refer to the Chart 1, identify the type of fuse and note down the coding for the type /rating etc.

3 Record the observations in Table 1.

4 Pick one of the fuse holder and repeat above steps.

5 Follow steps 1 to 4 for all the remaining fuses and fuse holders, record the observations.

6 Get the work checked by the Instructor.

Table 1

Sl.No	Label with Alphabet	Name of the type		Rating in Amps	Application
		Fuses	Fuse Holder		
1	A				
2	B				
3	C				
4	D				
5	E				
6	F				
7	G				
8	H				
9	I				
10	J				

— — — — — — — —

TASK 2: **Identification of bimetallic type thermal overload relay**

1 Collect the thermal overload relay from the Instructor along with the instruction leaflet (Example given in Fig 1).

2 Refer to the instruction manual and identify the make/ manufacturer/model no/parts and controls on the thermal overload relay.

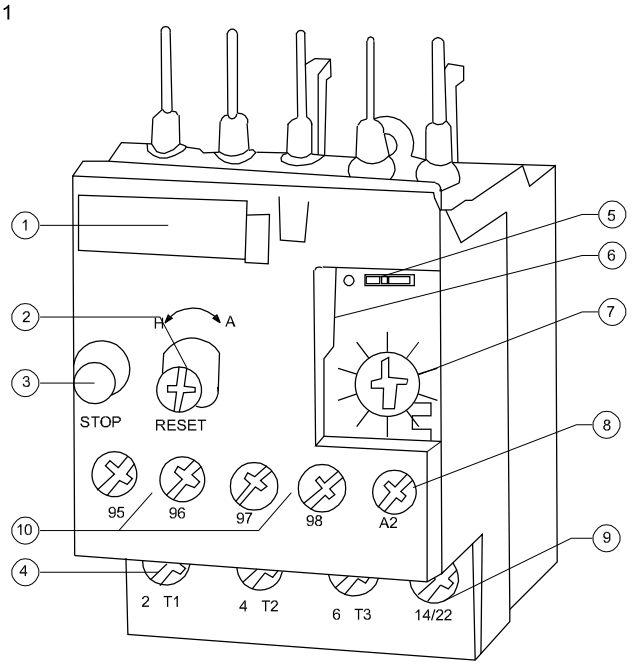
3 Identify the load current adjustment setting and markings on the dial.

4 Record the observations in Table 2.

5 Use Ohm meter and identify/check the Normally Open and Closed contacts.

6 Measure the no-volt coil resistance and note down the observed value in Table 3.

Fig 1



1. EQUIPMENT DESIGNATION LABEL
2. MANUAL/AUTOMATIC RESET SELECTOR SWITCH
3. STOP BUTTON
4. COMPLETE ORDER NUMBER ON THE FRONT OF THE DEVICE
5. SWITCHING POSITION INDICATION AND TEST FUNCTION
6. TRANSPERANT COVER, SEALABE (SECURES ADJUSTER KNOB FOR RATED MOTOR CURRENT, TEST FUNCTION AND MANUAL/AUTOMATIC RESET SRETTING)
7. ADJUSTER KNOB FOR FOR RATED MOTOR CURRENT
8. REPEAT COIL TERMINAL
9. AUXILIARY SWITCH REPEAT TERMINAL
10. 1NO+1NC

EMN33200H1

Table 2

Sl.No.	Name of the part Control/Switch	Description	Remaks

Table 3

Sl.No.	Identified item/terminal	Description/colour code/code Numbers	Remaks
1	Normally open contact		
2	Noramlly closed contact		
3	No volt coil resistance		
4	Minimum current adjustment		
5	maximum current adjustment		
6	Trip time in seconds as per the manufacturer		

Test the given MCBs

Objectives : At the end of this exercise you shall be able to
- **identify the terminals of MCB**
- **connect the MCB in an electrical circuit**
- **check the operation of MCB and ensure its function.**

Requirements

Tools/Equipments/Instruments

- Trainees tools kit - 1 No.
- Combination plier 150 mm - 1 No.
- Screw driver 150 mm - 1 No.
- Electrician knife 100 mm - 1 No.
- Miniature circuit breaker single pole 240V/6A - 1 No.
- Single phase motor 1 HP, 240V/50Hz - 1 No.
- MI Ammeter (0-10A) - 3 Nos.
- Connecting wires - as reqd.
- SPDT switch 240V/6A - 1 No.
- MCB (3P + N) 415V/6A - 1 No.
- Three phase lamp load - 1 No.

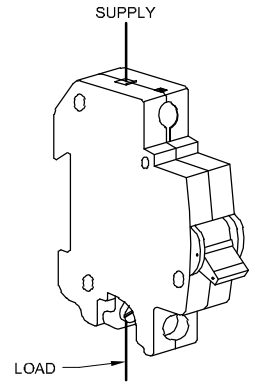
PROCEDURE

TASK 1: **Identify the terminals of the MCB**

1 Identify the supply and load terminals of a single pole MCB referring to the actual given MCB . (Fig 1).

2 Check the continuity between source and load terminals to ascertain healthiness of MCB.

Fig 1



SINGLE POLE MCB

— — — — — — — —

TASK 2: **Connect a single pole MCB to the load and test it**

1 Collect the miniature circuit breaker and read the specification of given MCB.

2 Connect the circuit elements as per the circuit diagram shown in Fig 2.

3 Keep the MCB in ON condition (up) and switch ON the main power supply.

4 Close the SPT switch S_1 and operate the single phase motor with load.

5 Operate the motor and note down the reading of the ammeter in Table 1.

6 Increase the motor load, till the MCB trips.

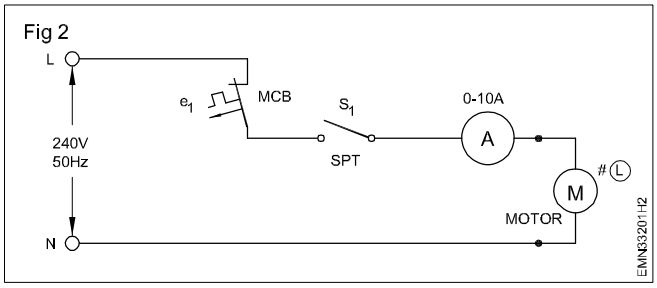
7 Note down the value of current at which the circuit breaker trips in the circuit.

8 Check whether the MCB trips at 1.3 x I_n where I_n is the normal rated current of the MCB.

Table 1

Sl.No	Load current	MCB Status
1	0.5 A	ON
2	1.0 A	ON
3		
4		
5		
6		

Fig 2

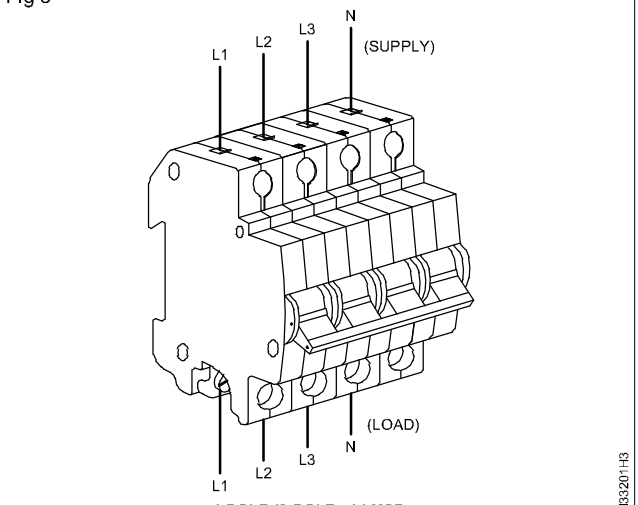


TASK 3: **Connect a 4 pole MCB to the load and test it.**

1 Collect the 4 pole MCB and read its specifications

2 Identify the supply and load Terminal connection of a four pole MCB by referring the Fig 3.

Fig 3



3 Complete the circuit, as shown in circuit diagram (Fig 4) .

4 Keep the MCB in ON position and switch ON the mains supply.

5 Switch on the lamp load step by step and note down the readings of the ammeter in the Table 2

While switching the load check that the load on each phase should be equal.

6 Increase the load current in steps of 0.5 amp and observe the MCB till it trips off.

7 Note down the current at which the MCB trips off.

Fig 4

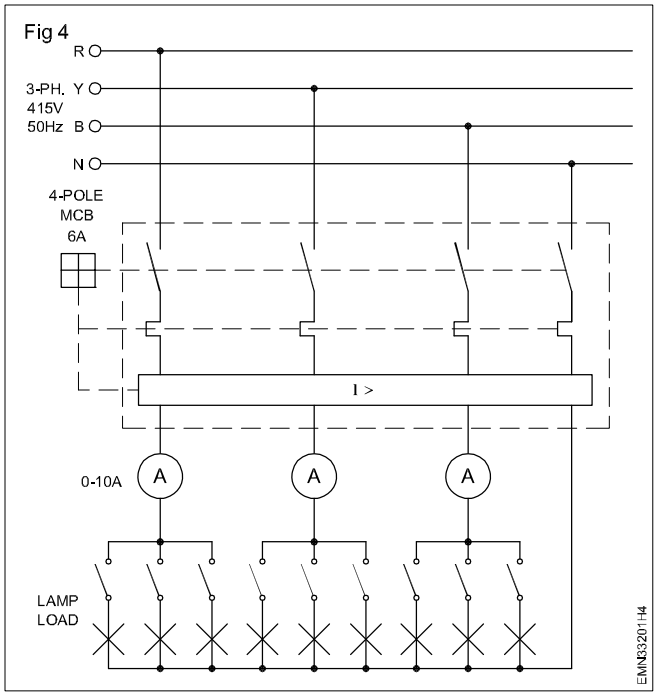


Table 2

Sl. No	Load current	MCB Status
1	0.5 A	ON
2	1.0 A	ON
3		
4		
5		
6		

Connect an ELCB and test the leakage of an electrical motor control circuit

Objectives: At the end of this exercise you shall be able to
- **identify the terminals of ELCB**
- **connect the ELCB in an electrical circuit and test its functioning**
- **measure the leakage current at which ELCB trips off.**

Requirements

Tools/Instruments/Equipments

- Trainees tool kit - 1 No.
- Cutting plier 150mm - 1 No.
- Screw driver 150mm - 1 No.
- Electrician knife 100mm - 1 No.
- Wire stripper 150 mm - 1 No.
- Ammeter MI (0 - 10A) - 1 No.
- Ammeter MI (0 - 100mA) - 1 No.

Materials/Components

- ELCB 240V/25A, 2 pole with Tripping leakage current 30mA - 1 No.
- MCB 240V/10A, 2 pole - 1 No.
- 10kΩ 1W wire wound variable resistor - 1 No.
- 5kΩ 1W fixed resistor - 1 No.
- Pushbutton switch 240V, 6A - 1 No.
- Water rheostat - 1 No.

PROCEDURE

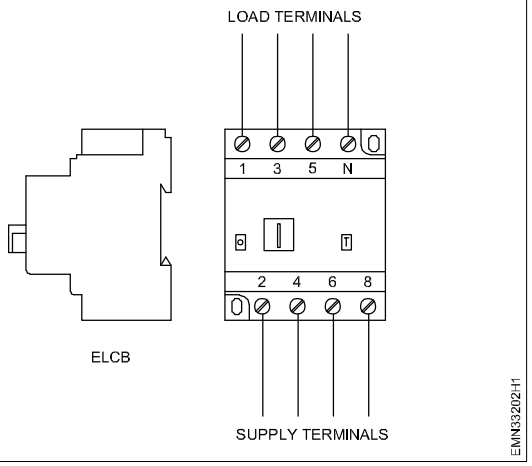
TASK 1: **Identify the terminals of ELCB**

1 Collect the ELCB, read the specification given on it and record them in Table - 1.

2 Identify the supply terminals and load terminals referring to marking on the unit as given in Fig 1.

3 Check the continuity between source and load terminals by actuating manually.

Fig 1



TASK 2: **Connect and test the operation of ELCB**

1 Wire up the circuit as shown in the circuit diagram (Fig 2).

2 Switch on the main supply keeping the MCB and ELCB in ON position.

3 Close switch S_1 and operate the water rheostat till the ammeter 'A' reads about 5 A current.

Keep variable resistance 'Rs' in full cut in position.

4 Press the test switch and vary the variable resistance and note the leakage current and record in Table 1.

5 Record the leakage current at which the ELCB trips off in Table 1.

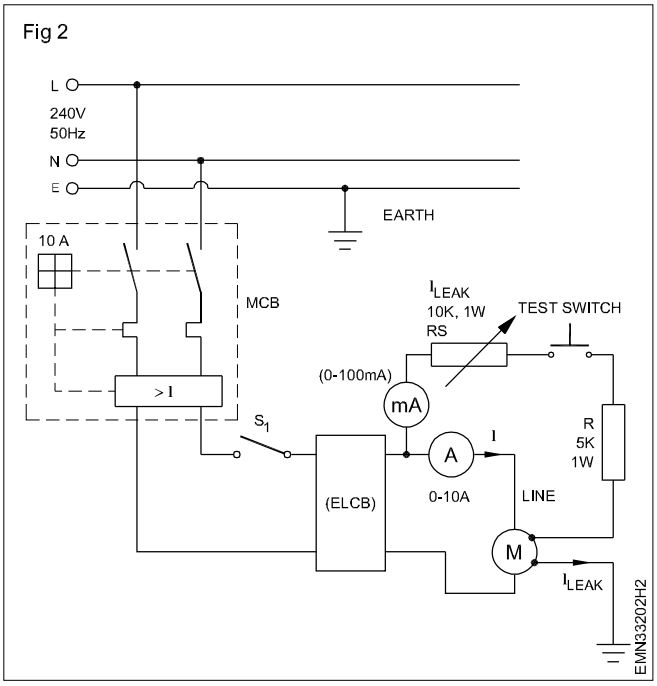
6 Open the external test switch and reset the ELCB.

7 Test ELCB for 'Trip function' by operating the 'Test button'. In this case the ELCB must trip off when the button is pressed.

Table 1

Sl.No.	Leakage current in mA	ELCB Status
1	5	ON
2	10	ON
3		
4		
5		

Fig 2



Measure the coil winding resistance of the given motor

Objectives: At the end of this exercise you shall be able to
- **identify the pairs of the two windings**
- **measure the resistance of each winding by an Ohmmeter (or Ohms range of multimeter).**

Requirements

Tools/Instruments/Equipments

- Trainees tool kit - 1 Set.
- Multimeter with probes - 1 No.
- Single phase induction motor 0.5 HP, 230V/240V - 1 No

Materials/Components

- Nil

PROCEDURE

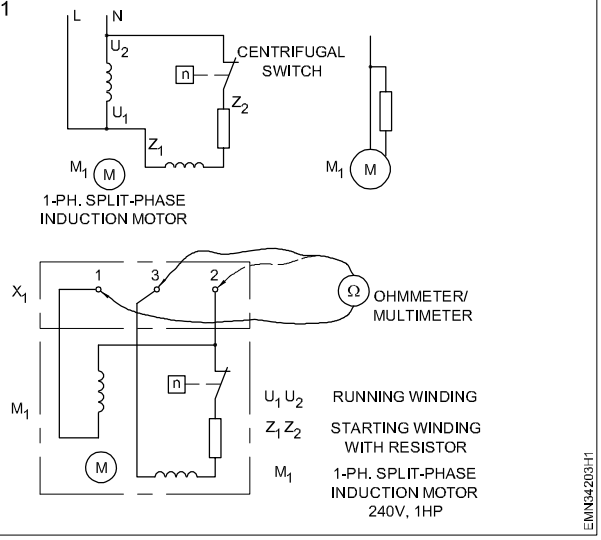
TASK 1: **Measure the coil winding resistance of a single phase capacitor induction run motor (3 terminals)**

1 Remove the terminal cover. Make connection using a piece of cable and short circuit two terminals at a time to discharge the capacitor.

Remove the capacitor and test the capacitor for insulation and leakage.

2 Measure the resistance in between pairs of termianls by an ohmmeter (Fig 1)

Fig 1



3 Mark the terminals between which you get maximum reading as 1 and 3. Mark the unmarked terminal as 2.

4 Record the resistance values in table 1 according to your terminals markings made.

The reading between the pair of terminals 1 & 2 and 1 & 3, whichever is greater is considered as the terminals of starting winding and the other is considered as terminal of running winding.

Table 1

Resistance between 1 & 2	Resistance between 2 & 3	Resistance between 1 & 3

TASK 2: **Split phase induction motor (4 terminals)**

1 Repeat the steps 1 and 2 of Task 1 for Fig 2.

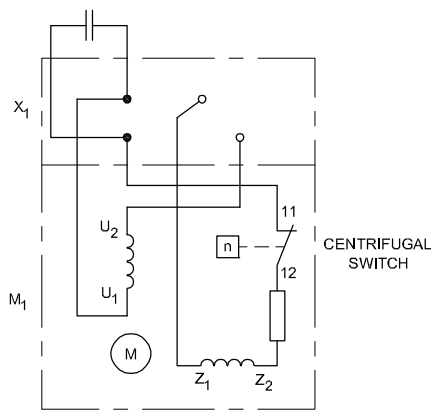
2 Find out the pairs of terminals and number one pair of terminals as 1 and 2. The other pair is numbered as 3 and 4 (Fig 3)

3 Measure the resistance between 1 and 2 and 3 & 4 .

Resistance between 1 & 2 = _____ ohms

Resistance between 3 & 4 = _____ ohms

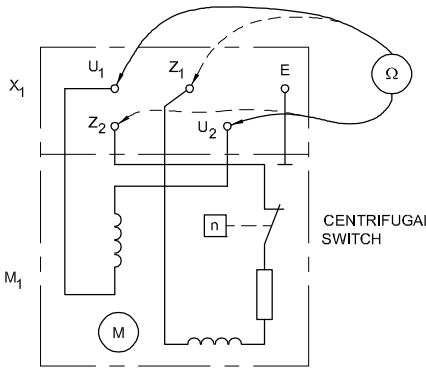
Fig 2



X_1 – TERMINAL BOX
M_1 – 1-PH. SPLIT-PHASE INDUCTION MOTOR 230V, 1HP

EMN34203H2

Fig 3



Ω – OHMMETER/MULTIMETER
X_1 – TERMINAL BOX
M_1 – 1-PH. SPLIT-PHASE INDUCTION MOTOR 230V, 1HP

EMN34203H3

Conclusion

Higher resistance is between _____ terminals. Lower resistance is between the terminals marked as ____

Therefore the starting winding is connected between _____?

Prepare the set up of D.O.L. starter and control an induction motor

Objectives: At the end of this exercise you shall be able to

- **identify and collect the parts of a D.O.L starter**
- **assemble the D.O.L starter when contactor overload relay, push-button stations and single-strand cables are given in semi-knocked out condition**
- **connect and harness the hook-up cable for control circuit**
- **mount the D.O.L starter, the main ICTP switch and connect the 3-phase induction motor**
- **earth the motor, the starter and the switch**
- **set the overload relay (R)**
- **replace correct capacity backup fuses**
- **start and stop the 3-phase induction motor through D.O.L starter**
- **measure the starting and the running currents of the 3-phase squirrel cage motor**
- **measure the actual speed of the 3-phase squirrel cage motor**
- **determine synchronous speed.**

Requirements

Tools/Instruments/Equipments

- Trainees tool kit - 1 Set
- Combination pliers 200mm - 1 No.
- Screwdriver 300mm with 4mm blade - 1 No.
- Connector screwdriver 100mm - 1 No.
- Side cutting pliers 200mm - 1 No.
- Electricians knife - 1 No.
- Ammeter MI 0-20 amp - 1 No.
- Voltmeter MI 0-500V - 1 No.
- Plumb bob with thread - 1 No.
- Spirit level - 1 No.
- Tachometer 0-3000 rpm - 1 No.
- 3-phase squirrel cage motor 2 HP 415V/ 50Hz - 1 No.
- D.O.L starter 10 amp 415V with overload relay, no-volt coil & push-button station - 1 No. (The instructor is requested to dismantle the contactor, overload relay and the internal connecting hook-up cables before giving the equipment to the trainees)

Materials/Components

- PVC insulated, single strand copper cable 16 SWG - 0.5m
- PVC insulated, single strand copper cable 18 SWG - 0.5m
- Machine screws 2 BA, 30mm long with 2 washers and one nut - 4 Nos.
- I.C.T.P switch 415V/16A - 1 No.

PROCEDURE

1 Note down the name-plate details of the given AC 3-phase squirrel cage induction motor in Table 1.

2 Collect the contactor unit, overload relay unit, start/stop push-button unit, the necessary fixing screws, hookup cables, I.C.T.P switch and D.O.L starter base and cover.

Table 1

Name-plate details			
Manufacturer, Trade Mark	:	Rated frequency	: .....
Type, model or list number	:	Rated power	: .....k.w/HP
Type of current	:	Rating class	: .....
Function	:	Insulation class	: .....
Fabrication or serial number	:	Rated current	: ..... amps
Type of connection shunt/series/compound	: ..... sep/	Rated speed	: .....r.p.m
Rated voltage	: ..... volts	Protection class	: .....

3 List the items you received from your instructor in Table 2.

Table 2

List of items
1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____
8 _____
9 _____
10 _____

4 Record the name plate details of the contactor and overload relay in your record respectively.

5 Investigate and check the contactor input and output terminals, auxiliary and main terminals, movable and fixed contacts, no-volt coil, overload relay, their rating, normally closed relay contacts and their operation.

6 Identify the connecting terminals for interconnecting no-volt coil, main supply to control circuit, normally open auxiliary contacts.

7 Identify the mounting screw holes in the contactor, overload relay and the corresponding holes in the starter base box.

8 Draw the complete circuit diagram for the given D.O.L starter with overload relay, no-volt coil, 'ON' and 'OFF' push-buttons.

For your guidance the following diagrams are given for a starter of a particular make.

Fig 1 shows Base and cover of D.O.L starter.

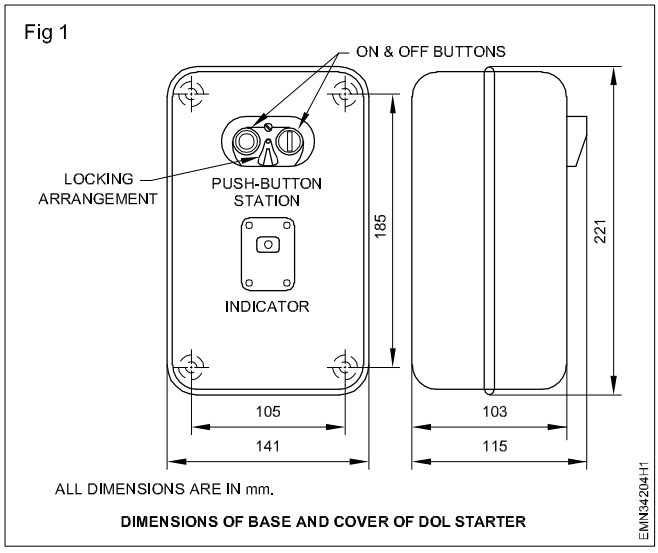


Fig 2 shows Push-buttons only.

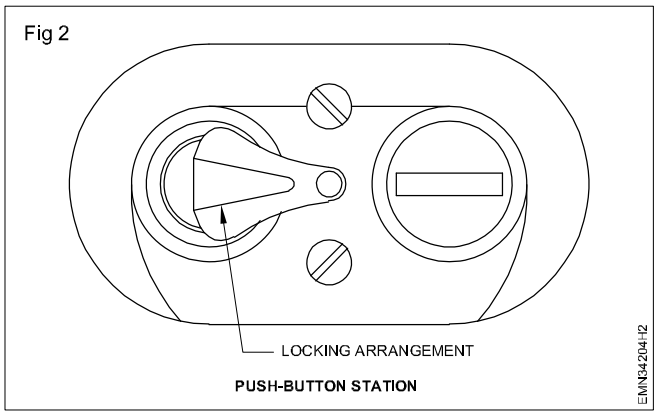


Fig 3 shows Overload relay package with push-button strips in the foreground which will get actuated when the push-buttons are pushed.

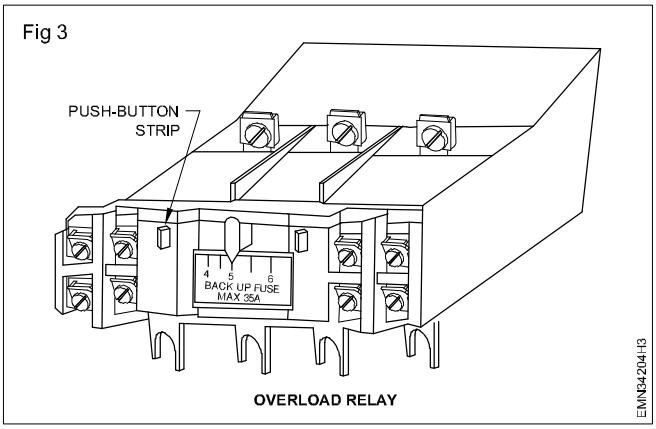
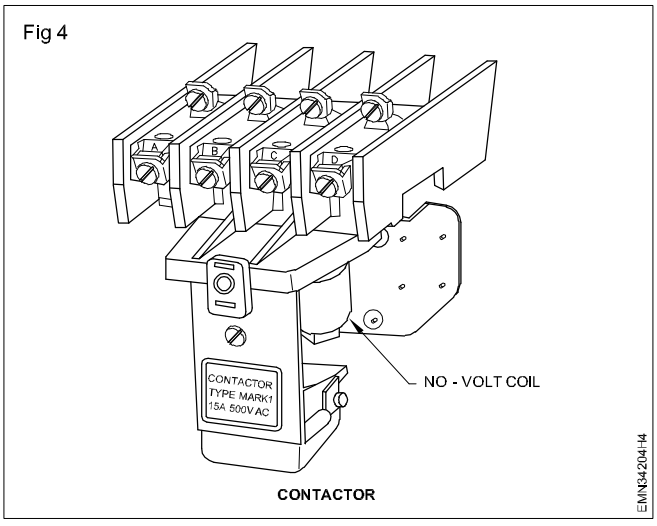


Fig 4 shows Contactor with no-volt coil.



9 Get the diagram approved by the instructor.

10 Mount the accessories in the starter base box with the help of mounting screws.

Do not tighten the screws more than necessary as too much tightening of screws will break the PVC casing of the contactor and OL relay.

11 Identify the place of connection of the hook-up cables with the help of the approved diagram. Measure and cut the hook-up cables leaving allowance for harnessing.

12 Connect the hook-up cables according to the approved diagram.

13 Harness the hook-up cables such that the cables do not interfere with any moving mechanism of the starter.

14 Check up once again the complete connection of the D.O.L starter internal wiring.

15 Get the wiring approved by your instructor.

16 Identify the holes in the starter base box for mounting the starter on the wall/frame.

17 Mount the starter vertically on the wall/frame.

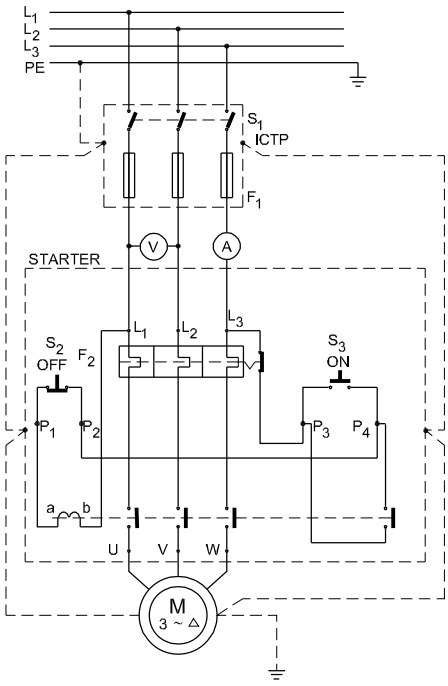
The position of the starter should be such that the no-volt coil mechanism works properly, taking advantage of the gravitational pull while disengaging.

Use a plumb bob or spirit level to check the verticality.

18 Connect the main supply to the starter incoming terminals through the I.C.T.P switch. (Fig 5)

A complete diagram showing the internal diagram of a starter of a particular make along with I.C.T.P and motor is given for your guidance. You can replace the internal diagram of the given starter in the place of the starter diagram shown in Fig 5.

Fig 5



CIRCUIT DIAGRAM OF DOL STARTER WITH PROTECTIVE DEVICE

EMN342204H5

19 Connect the starter outgoing terminals to the 3-phase squirrel cage induction motor alongwith the ammeter and voltmeter as shown in Fig 5.

Before connecting the 3-phase squirrel cage motor, test it for continuity and insulation.

20 Connect the protective earthing continuity conductors (two separate PE connections) to the motor and starter case, ICTP switch, and connect securely the protection earth continuity conductors to the main earth. (Fig 5)

21 Investigate the full load current of the motor and set the overload relay of the starter to that rating.

22 Provide a backup fuse as recommended by the manufacturer of the starter considering the horse-power rating of the motor.

For your guidance the backup fuse rating for a specified horse power/kw rating is given in the information section of Theory Ex. 3.3.08

Preferably check for the backup fuse rating in the pamphlet supplied alongwith your starter.

23 Get the main connections, earth connections, overload setting and the backup fuse rating approved by your instructor.

24 Switch on the ICTP.

25 Start the motor by the start (S_3) button of the starter.

26 Read the ammeter for the starting current at the time of starting.

27 Read the voltmeter and ammeter values when the motor shows normal runnings.

28 Measure the actual speed of the rotor with the help of a tachometer.

29 Switch OFF the motor using stop (S_2) button of the starter.

30 Switch OFF the mains, remove the fuses and disconnect the connections.

31 Determine the synchronous speed.

32 Get the work checked by the Instructor.

Construct a direction control circuit to change the direction of an induction motor

Objectives : At the end of this exercise you shall be able to
- **connect the manual forward and reverse switch to a 3-phase squirrel cage induction motor and D.O.L starter**
- **run and reverse the direction of rotation of the 3-phase squirrel cage induction motor through the D.O.L starter and the manual reversing switch.**

Requirements

Tools and Instruments/Equipments

- Trainees tool kit - 1 Set
- Insulated cutting pliers 150mm - 1 No.
- Screwdriver 150mm - 1 No.
- D.E spanner set 5mm to 20mm - 1 set
- Multimeter with probes - 1 No.
- 3-phase 415V, 5HP squirrel cage induction motor - 1 No.

Materials/Components

- 2.5 sq.mm PVC multi-strand aluminium cable 600V -15 m
- Manual drum type forward and reverse switch, three-pole, three positions, 16 amp sheet metal front plate, front mounting, metal lever handle having bakelite ball grip - 20 operations per hour - 1 No.
- D.O.L starter, 16/20 amp, 3-phase 415V - 1 No.
- ICTP switch, 415V/15amp - 1 No.

PROCEDURE

1 Read and interpret the name-plate details and enter in Table 1.

Table 1

Name-plate details	
Manufacturer, Trade Mark	: .....
Type, model or list number	: .....
Type of current	: .....
Function	: .....
Fabrication or serial number	: .....
Type of connection (sep/shunt/series/compound)	: .....
Rated voltage	: ..... volts
Rated frequency	: .....
Rated power	: .....k.w/HP
Rating class	: .....
Insulation class	: .....
Rated current	: ..... amps
Rated speed	: .....r.p.m
Protection class	: .....

2 Ascertain the terminals of the squirrel cage induction motor.

3 Test the 3-phase squirrel cage induction motor for insulation resistance and ground fault between (1) windings (2) windings & body, and enter the results in Table 2.

Table 2

Sl. No.	Terminals	Insulation resistance	Remarks
1	U_1 to V_1		
2	V_1 to W_1		
3	W_1 to U_1		
4	U_2 to body		
5	V_2 to body		
6	W_2 to body		

If the test results are lower than 1 megohm, inform the instructor immediately.

4 Select a suitable size of ICTP., D.O.L starter, rotary type forward and reverse switch, cables and fuse etc. according to the available 3-phase squirrel cage induction motor.

Inclusion of D.O.L starter is to facilitate safety. In certain industrial connections the D.O.L starter is not used. The motor is left with fuse protection only.

5 Trace out the connection of the given D.O.L starter and forwarding/reversing switch with the help of a multimeter and draw the diagrams.

6 Show the traced connections and get the approval of the instructor.

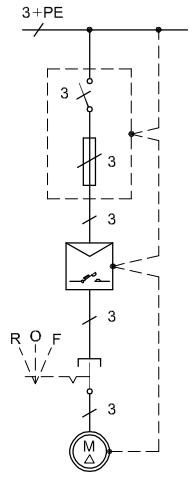
7 Draw the complete diagram showing ICTP D.O.L starter, forward and reversing switch connections to the motor.

The layout diagram given in Fig 1, the schematic diagram given in Fig 2 and the wiring diagram in Fig 3 are for your guidance. Make necessary changes in your diagram to suit the requirements of the given D.O.L starter and forward/reversing switch.

8 Keep the forward reversing switch in the 'OFF' position.

9 Show the connections to the instructor and get his permission to switch 'ON'.

Fig 1



LAYOUT DIAGRAM FOR FORWARD/REVERSE SWITCH CONNECTION TO A MOTOR

EMN34205-H1

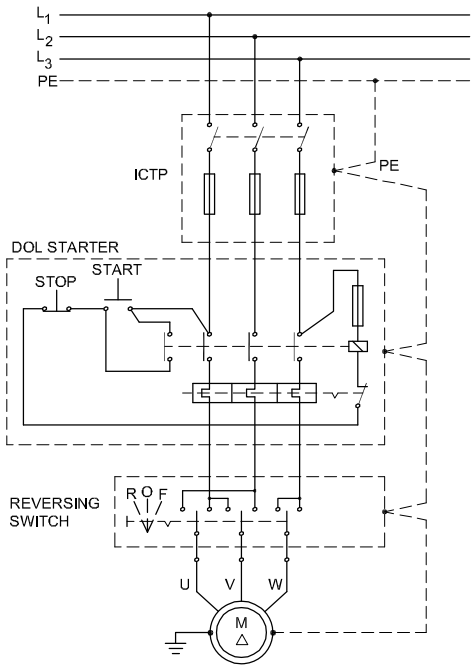
10 Switch 'ON' the ICTP and switch 'ON' the D.O.L starter by pushing the 'ON' button.

11 Move the forward reversing switch handle to forward position and watch the direction of rotation of the motor. D.O.R of the motor is..... .

12 Bring the reversing switch to 'OFF' position and wait until the motor comes to rest.

When reversing a motor, we should allow it to come to a standstill position before attempting to operate in the opposite direction. This is to avoid strain to the motor.

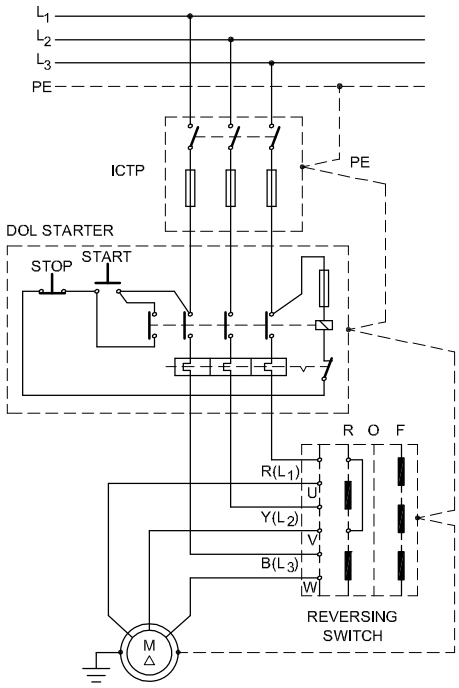
Fig 2



COMPLETE SCHEMATIC DIAGRAM

EMN34205-H2

Fig 3



COMPLETE SCHEMATIC DIAGRAM

EMN34205-H3

Move the reversing switch to reverse position for changing the direction of rotation and note the direction of rotation. D.O.R of the motor is..... .

13 Stop the motor, switch off the mains, remove the fuse-carriers, disconnect the supply leads, main switch, starter and the forward and reversing switch.

Connect an overload relay and check its performance

Objectives : At the end of this exercise you shall be able to
- **identify the type of relay**
- **identify the parts of a relay**
- **trace the circuit diagram of the relay and draw its wiring diagram**
- **ascertain the operation of the magnetic and thermal relays.**

Requirements

Tools/Instruments/Equipments

- Trainees tool kit - 1 Set
- Multimeter or ohmmeter with probes - 1 No.
- Ammeter MI 0-30A - 1 No.
- Stop-watch - 1 No.
- Milliammeter MI 100 mA - 1 No.
- Variac input 240V, output 0-270V, 5 amp - 1 No.
- DC magnetic relay 6V or 12V - 1 No.
- Variable DC power supply 0-30V/ 2A - 1 No.
- Overload relay - thermal relay (LT make, relay type ML 2-3, relay range 13 or similar) - 1 No.

Materials

- PVC flexible cable 14/0.2 mm - 5 m
- Resistor 5 w 470 ohm - 1 No.
- PVC insulated copper cable 4 sq.mm. 250V grade - 4 m

PROCEDURE

TASK 1: **Identify the type of relay.**

1 Collect the relays along with the instruction booklet.

Table 1

Data of the relay	
Type of relay	
Coil Voltage	
Relay range	
Back up fuse rating	

2 Determine by inspection the terminal connection of the coil and the number of contacts.

3 Also identify the normally open and closed contacts by using ohmmeter or multimeter.

4 Record the relay and contact terminal number in Table 2.

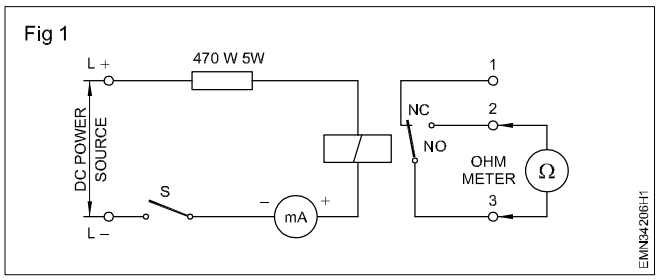
5 Draw the connection diagram of the relay in your record.

6 Measure the coil resistance and record in Table 2.

7 Connect the relay as per diagram shown in Fig 1.

8 Adjust the power supply voltage to minimum.

Fig 1



9 Switch ON the switch 'S'.

10 Slowly increase the DC voltage till the ohmmeter/ multimeter connected across the normally open contact shows deflection.

11 Observe the minimum current (pick up current) required to activate the relay and enter the value in Table 2.

12 Slowly reduce the voltage of the power supply till the ohmmeter/multimeter connected across the normally open contact shows infinity deflection.

13 Observe the minimum current (reset current) required to reactivate the relay and enter the value in Table 2.

14 Repeat steps 8 and 13 and verify the previous pick up and reset reading.

15 Repeat the working steps if necessary until the readings are constant.

Table 2 - Relay characteristics

Function	Terminal connection	Relay characteristics
Relay coil		Coil resistance _____ ohm
Normally open contacts		Pickup current, _____ mA
Normally closed contacts		Reset current, _____ mA

— — — — — — — —

TASK 2: **Test the thermal overload relay and check its performance**

1 Fill up the following data of the relay under test.

a Relay type _____

b Relay range _____

c Back up fuse rating _____

2 Check continuity of auxiliary contacts and main poles. (mention ok or not ok)

a Normally open _____

b Normally closed _____

c R pole _____

d Y pole _____

e B pole _____

If the answer is ok to all the above points then only take the relay for overload testing.

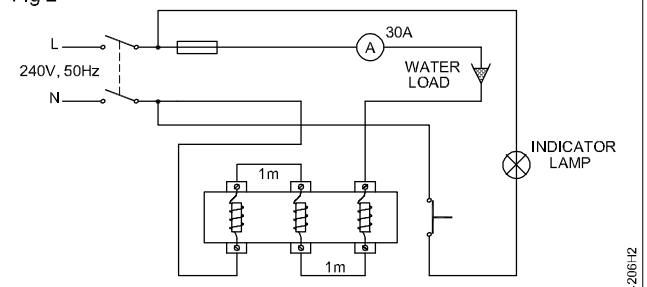
3 Select a proper size of cable for connection.

In the case of a smaller size of cable or improper termination, the relay may trip early.

4 Connect all the three poles of relay in series as shown in Fig 2 to the supply. Use a proper size of cable. The length of cable should be one metre.

5 Connect the normally close (NC) contact of relay in series with an indicator lamp to the power supply. (Fig 2). (This will give the relay trip signal to the test panel.)

Fig 2



CONNECTIONS OF THERMAL OVERLOAD RELAY FOR O/L TESTING

6 Set the relay, calculate the test current and enter the values in Table 3.

7 Find out the minimum and maximum trip time with respect to multiples of the set current you have selected from the manufacturer's data and note down the values in Table 4.

8 Switch on the supply and adjust the test current through the water load. Immediately switch off the current. Keep the water load at the adjusted position. Reset the time counter. Cool the relay for about 10 minutes.

9 Switch on the test current as well as the stop-watch and check trip time of the relay.

10 Compare the trip time between the manufacturer's data and the actual.

11 Discuss the result with your instructor.

Table 3

Relay Setting	X	Multiples of set (% of overload)	=	Test current amp.
Ex 10 amp.	X	2(200%)	=	20 amp.
1	X	2(200%)	=	
2	X	3(300%)	=	

Table 4

Sl.No	Relay setting	Test current amp	Trip time in seconds As per manufacturer		Actual	Remarks
			Min.	Max.		

Cable size with respect to test current

Test Current Amp.	0 to 8	8 to 16	16 to 22	22 to 30	30 to 40	40 to 51	51 to 70	0 to 86	86 to 105
For Copper Cables Sq.mm.	1	1.5	2.5	4	6	10	16	16	25

Caution: After each test, cool the relay for a minimum of 10 minutes. Otherwise, the relay will trip fast and may not get correct results.

— — — — — — — —

Identify various types of cables used for Audio, Video and RF signal with different input output socket

Objectives : At the end of this exercise you shall be able to
- **identify different types of cables used for audio, video and RF signal**
- **note the details of identified audio, video and RF cables and sockets**
- **record the observations in the table.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No.
- Magnifier with lamp - 1 No.
- **Aids:** Diagram/chart showing all the details of types of audio/video socket/ connectors and cables - 1 No.

Materials/Components

- Different types of cables used for audio/video/RF, shielded/coaxial, ribbon, CAT 6,RG 6/RG59, telephone cable-markedwith labels - 1m each
- RCA plug and socket, phono jack, BNC - as reqd.
  XLR, F-connector, RJ45, RJ11 plug & socket - 1No each

Note: The instructor has to label the cables utilized for this practical with alphabets and sockets/ connectors with numbers

PROCEDURE

TASK 1: **Identification of cables used for audio/video/RF signal**

1 Pick one of the labelled cables displayed by the Instructor.

2 Record the details of the identified cables in Table 1.

3 Repeat the above steps for all remaining labelled cables.

4 Get the recorded information checked by the Instructor.

Table 1

Sl.No.	Details of cables		Name	Remarks
	No.of cores	No.of insulating layer		
1			Shielded wire	
2			Screened wire	
3			Coaxial cable	
4			Ribbon cable	
5			RG 6 / RG 59	
6			Optical fiber cable	
7			CAT 6 cable	
8			RJ11 telephone cable	
9			Two core speaker wire	

— — — — — — — —

TASK 2: **Identification of different input / output sockets**

1 Pick one of the labelled connector / plug / socket from the selected lot displayed by the Instructor

2 Record the name and other details of identified audio/ video/ RF socket/connector/plug in Table-2.

3 Repeat the steps for all the remaining labelled sockets/ connectors/plug.

4 Get the recorded information checked by the Instructor.

Table 2 - Details of audio / video / RF sockets/plugs

Sl.No.	Label number	Name of the plug / socket	Application
1	RCA plug		
2	RCA socket		
3	Phono jack		
4	Phono jack socket		
5	XLR - plug - socket		
6	BNC - plug - socket		
7	F - connector plug - socket		
8	RJ 45 plug / socket		
9	RJ 11 plug / socket		

— — — — — — — —

Identify suitable connectors, solder / crimp/ terminate and test the cable sets

Objectives : At the end of this exercise you shall be able to
- **pick the required connector/ plug and cable for a specific application**
- **prepare cable by soldering onto a socket / connector/plug and test it**
- **crimp a cable onto the selected socket/connector/plug and test it.**

Requirements

Tools/Equipments/Instruments

- Trainees tool Kit - 1 Set
- Magnifier with lamp - 1 No
- Digital Multimeter with probes - 1 No
- Crimping tool (HT 301 A/ 301C) - 1 No
- Rotary cable stripper - 1 No
- Soldering iron-25watt/240v - 1 No
- **Aids:** Chart showing all types of audio/video sockets and connectors - 1 No

Materials/Components

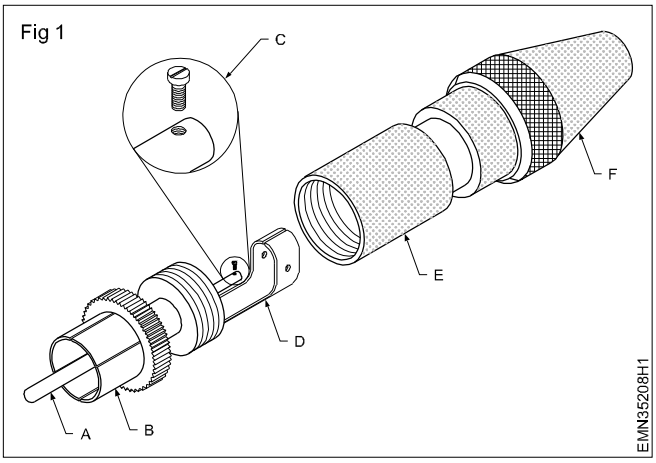
- RCA plug and socket, phono jack-stereo (6.5mm/3.5mm),BNC / XLR socket and plug, F-connector - as reqd
- Single/Two core shielded wire - 2m
- Coaxial cable-RG 6/ RG59 - as reqd
- Rosin cored solder and flux - as reqd
- PVC sleeves -2 mm dia - as reqd

PROCEDURE

TASK 1: **Preparation of audio cable using RCA plug to RCA plug**

1 Pick a RCA plug, visually check and remove the rear portion of the housing by unscrewing it; Refer the exploded view as shown in Fig 1.

Fig 1



2 Scrape/ clean any oxide layer on the terminal lug using knife and tin the terminal.

3 Take the single core shielded cable, skin the outer insulation for 2cm length and dress the leads/screen terminals.

4 Apply a thin layer of flux on the core and shield leads and tin these terminals.

5 Insert a piece of PVC sleeve onto the tinned portion of the inner conductor (over the exposed portion to avoid any accidental contacts or shorts) and screw/solder it to the plug terminal-C.

6 Solder the screen lead (outer conductor) to the other terminal-D, on the plug as shown in Fig 1.

7 Inspect the soldered joint and ensure continuity from the socket end to the cable end using ohmmeter.

8 Insert the outer housing of the plug (E to F) through the cable, pull and tighten it.

9 Prepare the other end of the cable, tin the terminals of the RCA plug and solder as shown in Fig.2.

Fig 2

10 Check the continuty and ensure that there is no short circuit between the core and the screen lead terminals.

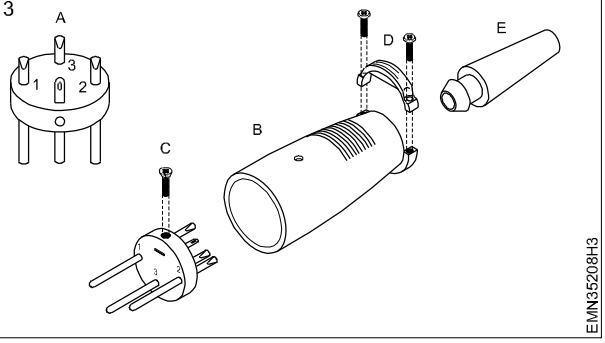
11 Get the prepared RCA to RCA cable checked by the Instructor.

— — — — — — — —

TASK 2 : **Preparation of audio cable using XLR to Phono jack (6.5 mm / 3.5 mm)**

1 Pick the XLR plug connector, identify the terminals with reference to Fig 3

Fig 3



2 Scrape / clean the terminals and tin them.

3 Take the two core shielded cable, skin the outer insulation for 2 cm length using cable stripper.

4 Open the copper braid/shield, separate the two cores, and twist the bunch of shield conductors into one.

5 Tin the end fof all three (two cores and shield) terminals.

6 Solder the screen lead of the prepared cable to the pin No.3 of the XLR connector.

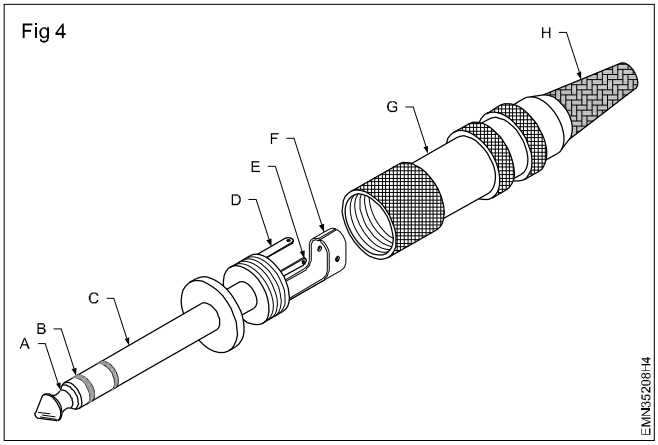
7 Solder the two cores to pin 1 and 2.

8 Inspect and test the soldered terminals with the cable has no short circuit.

9 Pick the phono jack plug and solder the signal leads correctly as shown in Fig 4

7 Get the work checked by the Instructor.

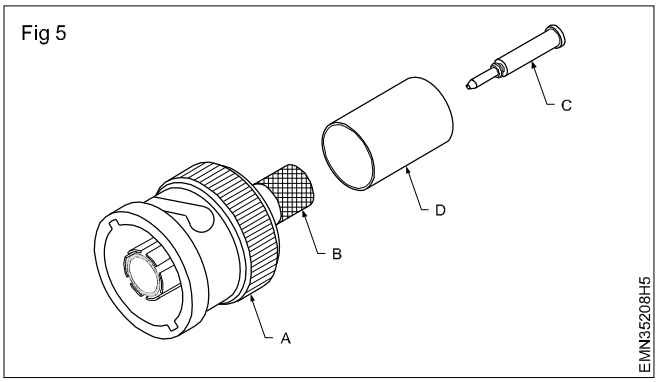
Fig 4



TASK 3 : **Preparation of BNC to RCA cable**

1 Select a BNC male type plug, refer to the Fig 5 and remove the inner parts from the housing.

Fig 5



Note: Keep the removed parts safely to re-assemble them after crimping the cable.

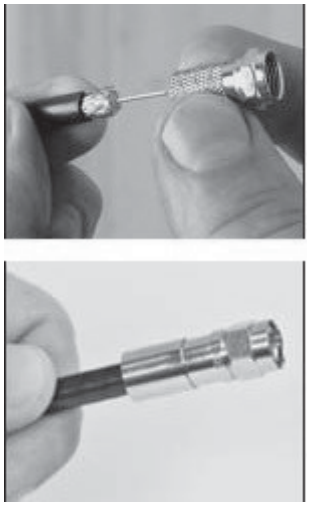
2 Take the coaxial cable, mark 1.5 cm length and using cable stripper, skin the outer PVC insulation.

3 Insert the coaxial cable into the ferrule (D) and fold the shielding without disturbing the mesh formation. Push the shielding backwards over the sheath so that the inner insulation and core is visible as shown in Fig 6 (a) & (b).

4 Remove the styroflex insulation for 5mm length from the tip using blade; refer to Fig 6, insert the core into the center pin (C) of the BNC plug and crimp this connection using crimping tool.

5 Get the crimped pin checked by the Instructor.

Fig 6



6 Insert the crimped pin into the connector housing (A) till the center pin comes out to the level position and the styroflex insulation fits tightly in the connector.

7 Push the shield and spread it over the knurled outer portion (B) of the rear end on the connector.

8 Pull the ferrule (D) alrady inserted, move it on the shield spread over the knurling.

9 Make the ferrule (D) sit over the shield uniformly and crimp this portion using correct slot hole on the crimping tool.

10 Use multimeter and test for any short circuit between the pin and the body of the BNC connector.

11 Get the work checked by the Instructor.

12 Take a RCA plug and solder it on the other end of the coaxial cable following steps 1 to 7 of Task 1.

13 Get the BNC to RCA cable checked by the Instructor.

— — — — — — — —

Check the continuity as per the marking on the connector for preparing the cable set

Objectives : At the end of this exercise you shall be able to
- **identify the marking on the HDMI cable terminals**
- **check the continuity of the wires in the cable**
- **check the continuity of the SPDIF optical cable.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No
- LED torch light -3 volt - 1 No
- Magnifier with lamp - 1 No
- **Aids:** HDMI type-A socket and plug, SPDIF optical cable terminal diagram - 1 No

Materials/Components

- Rosin cored solder - as reqd
- HDMI type-A cable - 1 No
- HDMI type-A socker and plug - 1 No
- SPDIF optical cable Hook-up wire 0.5m - 1 No
- Hookup wire - 0.5 m

PROCEDURE

TASK 1 : **Checking the HDMI cable**

Note: Cut the hook-up wire into two pieces and skin both the ends. Attach one end of the hook-up-wire by twisting on the pin of DMM test probe and leave the other end open. Do this for the other probe also.

1 Mark both the terminals of HDMI cable as A and B.

2 Pick the HDMI cable end-A and keep the plug terminal in horizontal position.

3 Refer to the Fig 1 (a) and (b), identify the pin no 1.

4 Select the ohmmeter range on the DMM, use the common lead, and insert the hook up wire end contact Pin No. 1

5 Use the other lead of the DMM with hook-up wire, touch the pin no 1 on the B end of the HDMI cable

6 Observe the reading on the DMM and record the readings in the Table-1

7 Repeat the steps for all the remaining pins of the HDMI cable.

8 Cross check any short circuit with other pin connections.

9 Get the work checked by the Instructor.

Fig 1

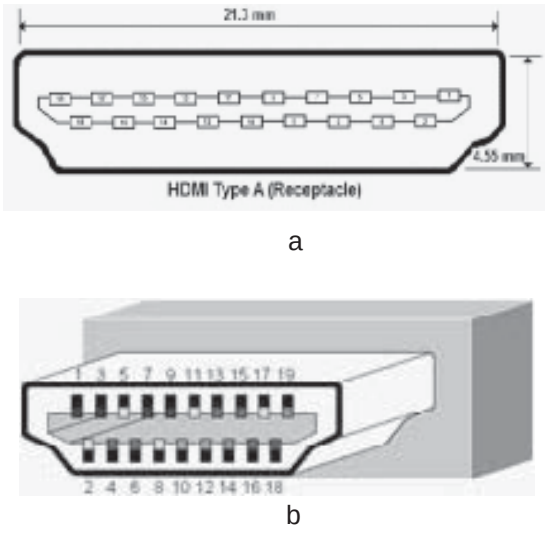


Table 1

Sl.No	Pin no of the HDMI cable (end A-B)	Ohm meter reading in Ohms	Result	Remaks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				

— — — — — — — —

TASK 2 : **Checking the SPDIF cable**

Note:
1. **Ensure that there is no physical damage to the SPDIF cable used for this Task.**
2. **Remove the cap if any on the optical fiber cable end before proceeding the step**

1 Mark one end of the SPDIF (optical fiber cable) as terminal-A and other end as terminal B.

2 Arrange a small pointed light beam from LED torch.

3 Keep the optical fiber cable end point on the terminal - A of SPDIF cable under the LED light rays as shown in Fig 2 a,b.

4 Observe the other end of the cable for any visible light spot penetrated through the cable.

5 Record the observation in Table - 2.

Fig 2

a

b

EMN35209H2

Table 2

Sl.No	LED light applied on	Result	Remarks
1	Terminal - A		
2	Terminal - B		

6 Reverse the SPDIF cable terminals under the LED light and repeat steps 3 to 5.

7 Get the work checked by the Instructor.

Identify and select various connectors and cables inside the CPU of PC

Objectives : At the end of this exercise you shall be able to
- **identify different types of external ports / connectors used in computer system**
- **identify different types of cables / connectors used inside the computer system**
- **identify different ports / slots on the motherboard of computer.**

Requirements

Tools/Equipments/Instruments

- Multimedia computer system - 1 Set
- Digital multimeter with probes - 1 Set
- Trainees tool kit - 1 Set
- **Aids:** Charts - 1 showing all types of internal & external ports, cables & connectors used in computer system- 1 No
- Chart 2 showing all types of slots and ports on computer mother board - 1 No

Materials/Components

- Set of cables used to connect peripheral devices to a computer- externally - 1 Set
- Set of cables used to connect ports and slots on a mother board - internally - 1 No

Note: The instructor has to sequentially label all the external ports/sockets on the front panel of the CPU using numbers.

Task 1 : Identification of external ports of multimedia computer system

1 Select and identify the first labelled external port on the CPU with reference to Fig 1.

2 Refer to the chart - 1 and record and application/ uses details of the identified item in Table 1.

3 Repeat the above step for all the remaining labelled ports on the rear panel and front panel of the CPU.

4 Identify the labelled ports on the monitor, record the details in Table 1.

5 Get recorded information checked by the instructor.

Task 2 : Identification of ports /slots on mother board

Note: 1 The intructor has to label all the cables from SMPS, CPU cooler, optical drive, HDD, front panel USB socket, Mic, Speaker, Status LED indicators, POwer ON switch etc sequentially using alphabets. 2. Mark all the sockets/slots on the mother board other than the parts of rear panel of CPU

1 Remove the fixing screws of CPU; open the side cover of the CPU and keep aside carefully.

Note: keep the removed screws and cover safely to re-assemble them after identification of internal ports.

2 Identify all the labelled internal ports on the mother board as shown in Fig 2.

Fig 1

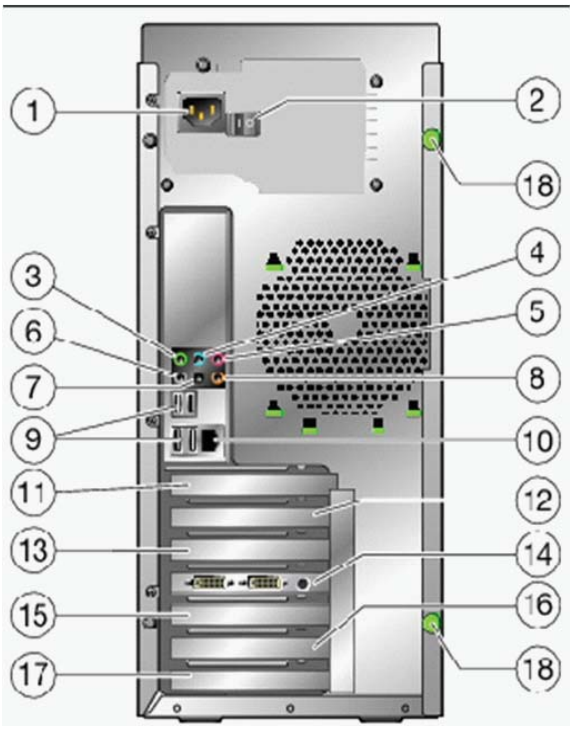


Table - 1 Showing internal & external ports of computer system.

Label No.	Name of the Port/ Socket	Location of the port/ Type No	CPU/Monitor	Application/ Uses	Remarks
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Note: Draw additional rows and coloumns as per requirement/ the computer system

3 Select the first labelled port/ slot, refer to the chart-2, identify the name, type etc. and record them in Table-2.

4 Repeat step 3 for all the remaining ports/ slots on the mother board.

5 Get the recorded observations checked by the instructor.

Fig 2

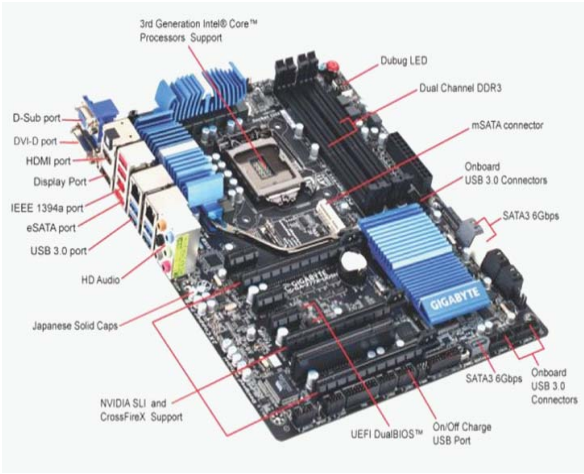


Table - 2

Label No.	Name of the Port/slot	Type of cable/ Code No/	No of Pins	Application Use	Remarks
1	2	3	4	5	6
2					
3					
4					
5					
6					
7					
8					
9					
10					

Identify the suitable connector and cable to connect computer with a network switch and prepare a cross-over cable to connect two computers

Objectives : At the end of this exercise you shall be able to
- **identify connector/ports used in network switch**
- **select the connector and cable required for the network switch**
- **prepare the cross-over network cable using CAT6 cable to connect two computers in network**

Requirements

Tools/Equipments/Instruments

- RJ45 Crimping tool - 1 No
- Network cable tester - 1 No
- Digital Multimeter with probes - 1 No
- Trainees tool kit - 1 Set
- Working personal computer - 2 Nos
- 8 port network switch - 1 No
- Cable stripper - 1 No

Materials/Components

- CAT6 cable - 2 mtr
- RJ45 plug - 4 No
- Strain relief cable boot (optional) - 4 Nos

PROCEDURE

TASK 1: **Identification of connector/ports used on network switch**

1 Collect the 8 port network switch from the Instructor

2 Observe the front panel controls, ON/OFF switch, ports/ sockets and their types of network switch unit as shown in Fig 1

Fig 1

8 Port Network Switch

3 Record the observation in Table - 1

4. Get the work checked by the Instructor

Note: The Instructor has to provide the 8 port network switch and guide the trainees to handle the electronic device

Table - 1

S. No.	Controls No. of Ports/ Sockets/Types	Cable

TASK 2: **Preparation of straight cable to connect computer with network switch**

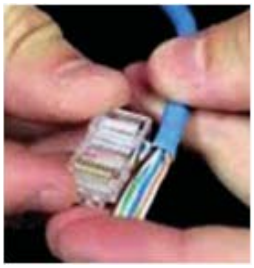
Note: Instructor has to arrange the required lenth of CAT6 cable for straight cable and cross-over cable, the tool for crimping the RJ45 plug/ jacks.

Ensure the correct working of crimping tool.

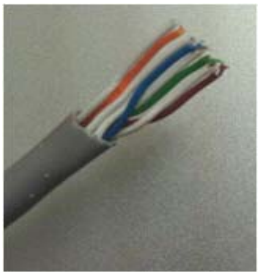
1 Collect and check all the tools and RJ45 connectors required for making network cables.

2 Take the CAT6 cable, mark 2.5 cm from one end of the cable as shown in Fig 2 a,b and remove the cable jacket/ insulation using cable stripper / crimping tool.

Fig 2



a



b

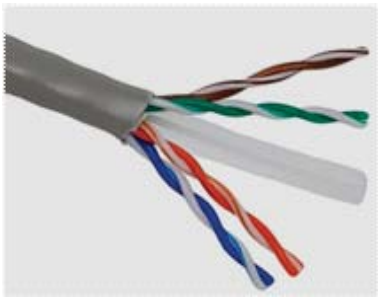
EMN35211H2

Note:

1. **If strain relief boot is to be used, insert and slide on the strain, relief boot into the CAT6 cable before crimping.**
2. **Do not remove any insulation from the conductors of the cable pairs.**

3 Bend each twisted pairs on four sides and cut-off the soft supporting member-spleen and the string as shown in Fig 3.

Fig 3

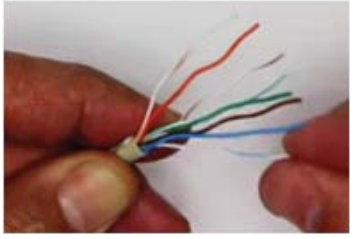


EMN35211H3

4 Untwist the wire pairs and separate all the wires as shown in Fig 4 (a) and (b).

Fig 4

a



b

EMN35211H4

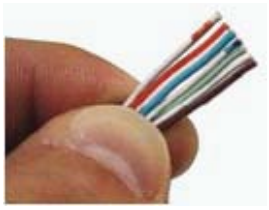
5 Straighten the wires and arrange them from left to right in the order as shown in cable colour Chart-1 for straight cable crimping.

Wire colour Chart-1 for straight cable

Pin no.	Cable end-A Wire colour	Cable end-B Wire colour
1	white-green	white-green
2	green	green
3	white-orange	white-orange
4	blue	blue
5	white-blue	white-blue
6	orange	orange
7	white-brown	white-brown
8	brown	brown

6 Grasp the wires firmly between your fingers flatly and cut a few mm so that all the wires are of the same length as shown in Fig 5.

Fig 5

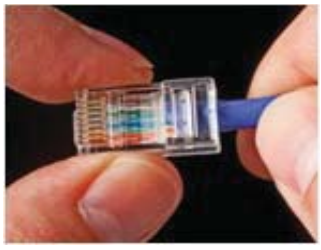


EMN35211H5

7 Insert the prepared wires into the RJ45 plug as shown in Fig 6 (a) and (b).

Fig 6

a



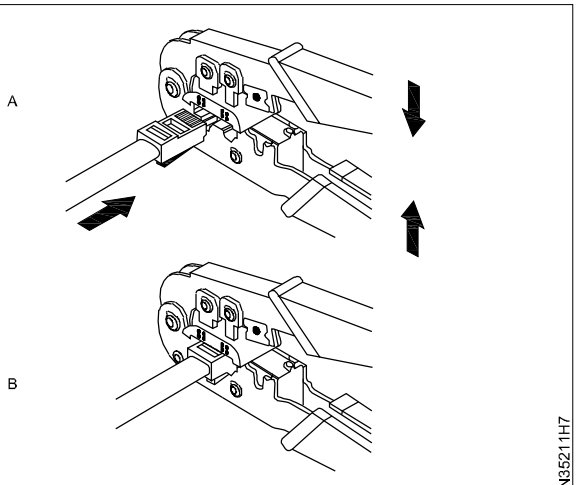
b

EMN35211H5

8 Get the colours of wires inserted into RJ45 plug for crimping straight cable checked by the Instructor.

9 Insert the jack and wire combo into RJ45 slot of the crimping tool as shown in Fig 7.

Fig 7



CRIMPING

Note: The crimping tool may come with additional slots for crimping RJ11-telephone wires also.

10 Press the crimping tool a bit harder so that the pins of the jack go inside and contacting the core of each wire simultaneously.

Note: Pins should not be protruding after crimping.

11 Get the crimped RJ45 plug checked by the Instructor.

12 Take the other end of the CAT6 cable, follow steps 2 to 10 and crimp the RJ45 plug.

13 Connect the prepared straight cable into the Network cable tester, switch ON and record the observation of the LEDs glowing in Table-1.

Observation Table -1

Pin no.	Status of LED	Remarks
1		
2		
3		
4		
5		
6		
7		
8		

14 Get the crimped straight cable checked by the Instructor.

— — — — — — — —

TASK 3: **Preparation of cross-over cable to connect two computers**

1 Take the CAT6 cable and repeat step 2 to 4 of Task 2.

2 Straighten the wires and arrange them from left to right in the order as shown in wire colour Chart-2 for cross-over cable.

Wire colour Chart-2 for cross-over cable

Pin No.	Cable end-A Wire colour	Cable end-B Wire colour
1	white-green	white-orange
2	green	orange
3	white-orange	white-green
4	blue	white-brown
5	white-blue	brown
6	orange	green
7	white-brown	blue
8	brown	white-blue

Note: If strain relief boot is to be used, slide on the strain relief boot into the CAT6 cable.

3 Grasp the wires firmly between the fingers flatly and cut a few mm so that all the wires are of the same length as shown in Fig 5 of Task 2.

4 Repeat steps 7 to 10 of Task 2 and get the crimped RJ45 plug checked by the Instructor.

5 Take the other end of CAT6 cable, follow above steps 2 to 4 and crimp the RJ45 plug.

6 Connect the prepared cross-over cable into the network cable tester, switch ON and record the observations in Table 2.

Observation Table -2

Pin no.	Status of LED	Remarks
1		
2		
3		
4		
5		
6		
7		
8		

7 Get the work checked by the Instructor.

Modulate and demodulate various signals using AM and FM on the trainer kit and observe the waveforms

Objectives : At the end of this exercise you shall be able to
- **modulate the amplitude of audio signal using trainer kit**
- **demodulate the AM signal and measure the waveforms**
- **modulate the frequency of audio signal**
- **demodulate the FM signal and measure the waveforms.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- DMM with probes - 1 No
- AM/FM trainer kit with instruction manual and patch cards - 1 Set
- CRO-20 MHz-Dual trace with probe kit & instruction manual - 1 Set

PROCEDURE

Note: The instructor has to check and verify the output signal of the built in audio generator terminal and also the carrier wave generator on the AM trainer kit.

TASK 1 : **Amplitude modulation of audio signal**

1 Collect the AM trainer kit and identify the signal input - output terminals.

2 Prepare the CRO for measurement and connect the channel-1 with the direct probes.

3 Switch ON the AM trainer kit, connect the output of audio generator to channel -1 of CRO and measure the output signal waveform; calculate frequency of audio generator.

4 Repeat the step-3 for carrier wave generator.

5 Record the observations in Table 1A and 1B.

6 Use patch card, connect the output of audio generator to the input of AM modulator section.

7 Connect the output signal of the AM modulator to the CRO and measure the modulated waveform/frequency.

8 Record the observations in Table-2.

9 Get the work checked by the Instructor.

Table-1 A

Sl.No	Audio signal	
1	Waveform	
2	Amplitude	
3	Frequency	

Table-1 B

Sl.No	Carrier wave signal	
1	Waveform	
2	Amplitude	
3	Frequency	

Table-2

Sl.No	AM Modulator output	
1	Waveform	
2	Amplitude	

— — — — — — — —

TASK 2 : **Demodulation of AM signal**

1 Identify the input and output terminals of the demodulator (detector) circuit.

2 Use patch cord and connect the output signal from AM modulator section to the input of AM Demodulator section.

3 Connect the output of AM demodulator to the Channel -1 of CRO input.

4 Switch ON the set up and measure the waveform at the input/output of demodulator circuit.

5 Record the observations in Table -3

Table - 3

Sl.No	Demodulated signal	
	Input waveform	Output waveform
1		

— — — — — — — —

TASK 3: **Frequency modulation and demodulation of audio signal**

1 Identify the input and output terminals of FM modulator section on the trainer kit.

2 Use patch cord, connect the output of audio signal and carrier signals to the input of FM modulator section.

3 Switch ON the set-up, prepare the CRO for measurement and connect the ch-1 input to the FM modulator section output.

4 Measure the waveform, calculate the amplitude and record the observations in Table-4.

5 Connect the output of FM modulator section to the input of FM demodulator section.

6 Switch ON the setup and measure the input / output of FM demodulator circuit.

7 Record the observations in the Table-4.

8 Get the work checked by the Instructor.

Table - 4

Sl. No.	Parameter	FM Modulator Output	FM demodulator Output
1	Waveform		
2	Amplitude		

— — — — — — — —

Construct and test IC based AM receiver

Objectives : At the end of this exercise you shall be able to
- **construct and test IC MK 484 based AM receiver.**

Requirements

Tools/Equipments/Instruments

- Trainees took kit - 1 Set
- Variable DC power supply (0-30V/2A) - 1 No
- Digital multimeter with probes - 1 Set
- FM radio receiver (working condition) - 1 No.

Materials / Components

- L1 make 55 turns of 30SWG enamelled copper wire on a 1 cm diameter card board former. - 1 No
  Capacitors
  - 0.1 µF/10 V - 2 Nos
  - 0.01 µF/10 V - 1 No
  - 47 µF/10 V - 1 No
- Head phone jack (female & male) - 1 Set
- Insulation tape PVC - as reqd
- Variable capacitor (ganged) 125 pF - 1 No
  Resistors
  -100 kΩ ¼ W - 2 Nos
  -1 kΩ ¼ W - 2 Nos
  -270 Ω ¼ W - 1 No
- IC MK 484 (with data sheet) - 1 No
- Transistor BC 548 - 1 No
- Head phone 32Ω (impedence) - 1 No
- Bread board/GP-PCB - 1 No.
- Cell 1.5V - 1 No
- Ferrite rod-100mm length - 1 No
- 30 SWG Enamelled copper wire - 5 m
- card board piece (10 cm x 15 cm) - 1 No

TASK 1 : **Construction of IC based AM receiver**

1 Collect all the materials/components required for the circuit as shown in Fig 1

2 Plan the layout of components on the Gen.purpose PCB suitably.

Note: Refer to the data sheet of the ICMK 484, identify terminals.

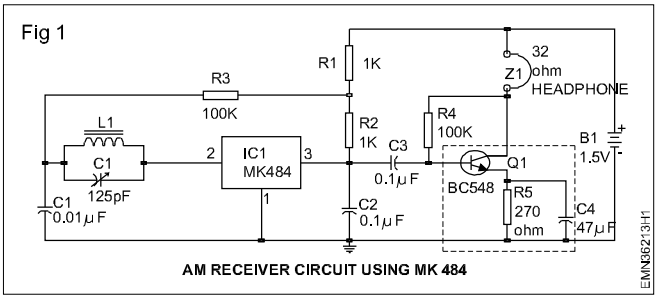
3 Insert all the components on the PCB as per the circuit and solder them.

4 Make a bobbin using the cardboard piece, roll around the ferrite rod tightly with insulation tape.

5 Wind 55 turns of the coil L1 using 30 SWG enemelled copper wire over the cardboard bobin.

6 Cut two pieces of insulation tape and use them on the starting and end terminals on the coil L1.

Fig 1



AM RECEIVER CIRCUIT USING MK 484

7 Scrape the terminals of the coil, check continuity and solder at correct positions.

Caution: Keep the coil with ferrite rod fixed on the board suitably

8 Fix the PVC gang capacitor, phono jack-female socket suitably and solder it on the PCB.

9 Verify the soldered connections with the circuit diagram.

10 Connect the headphone and switch ON the circuit.

11 Observe the sound signal, verify the gang capacitor tuned to the local AM radio station.

12 Get the work checked by the Instructor.

Construct and test IC based FM transmitter

Objective : At the end of this exercise you shall be able to
- **construct & test an IC UPC 1651 based FM transmitter.**

Requirements

Tools/Equipments/Instruments

- Variable DC power supply 5 V - 1 No.
- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No.
- FM radio receiver (working condition) - 1 No.

Materials / Components

- L1 make 05 turns of 26 SWG enamelled copper wire on a 4 mm diameter card board former.
  Capacitors
- 15 pF - 2 Nos.
- 100 pF - 1 No.
- 3.3 μ F/10 V - 1 No.
  Variable capacitor (ganged) 15 pF - 1 No.
  Resistor 4.7 kΩ, 1/4 W - 1 No.
- IC UPC 1651 - 1 No.
- 3/4 m insulated copper wire antenna - 1 No.
- DC power supply (0-30V/2A) - 1 No.
- Condenser microphone - 1 No.
- GP PCB/Bread board - 1 No.

PROCEDURE

1 The circuit can be assembed on a GP-PCB board. (Fig.1)

Inductor L1 can be made by making 5 turns of 26 SWG enamelled copper wire on a 4 mm diameter plastic former.

2 Connect 3/4 m insulated Cu wire as antenna

Do not give more than 6V to the IC.

Mic M1 can be a condenser microphone

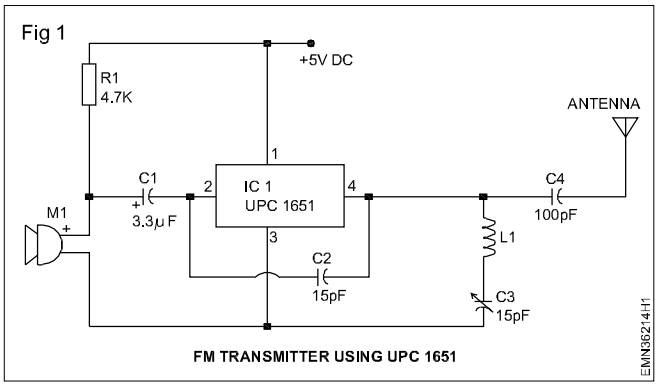
3 Connect the power supply to the circuit

4 Make some sound in the mic (song or speak or buzzer sound etc) connected to the FM Transmitter.

5 Use the FM radio receiver and tune it to test the transmitted sound/signal.

Note: The Instructor has to guide the trainees to adjust the variable capacitor in the FM transmitter or the tuning of the FM receiver, one at a time, so as to receive good sound reception of the transmitted signal

Fig 1



FM TRANSMITTER USING UPC 1651

6 Gradually increase the distance between the transmitter and receiver and observe the range of the transmitter.

This setup can be used on a cordless mic

Construct and test IC based AM transmitter and test the transmitter power. Calculate the modulation index

Objectives : At the end of this exercise you shall be able to
- **construct and test the IC based AM transmitter**
- **measure waveform and calculate percentage of modulation.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set.
- Variable DC power supply (0 - 30 V/2A) - 1 No.
- RF power meter - 1 No.
- DMM with probes - 1 No.
- CRO (0 - 20 MHz; Dual trace with probe kit) - 1 Set

Materials/Components

- Bread board - 1 No.
- IC 555 - 1 No.
- Condenser mic - 1 No.
- Resistor CR 25, 1kΩ, 390 Ω - 1 No. each
- Ceramic Capaictor 0.001 µF - 1 No.
- Electrolytic capacitor 1000µF/25V - 1 No.
- Hook up wire - 4 m
- Linear graph sheet - 1 No.

TASK 1: **Construction of IC based AM transmitter and test the power**

1 Collect all the components / materials required for the circuit as shown in Fig 1.

2 Plan the layout of the components on the bread board, insert all the components and interconnect using hookup wire jumpers and assemble the AM transmitter.

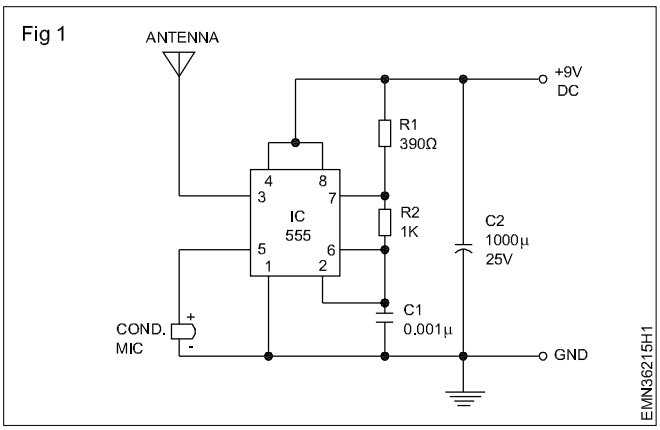
Note: Refer to the pin out of IC 555 and carefully insert onto the breadboard

3 Verify the connection with correct polarity and pin number of IC 555.

4 Connect 3 m long hookup wire at pin no. 3 as antenna.

5 Prepare the CRO for output measurement, connect across the AM transmitter circuit pin no. 3 and ground.

Fig 1



6 Switch ON 9VDC to the circuit and observe the waveform on the CRO

7 Speak through the condenser mic continuously and observe the maximum amplitude and minimum amplitude on the CRO.

8 Record the observations in Table - 1.

9 Connect the RF power meter across pin no. 3 of IC 555 and ground. Repeat step 7 and 8 above.

10 Get the work checked by the Instructor.

Table - 1

Mnimum Amplitude	.....
Maximum Amplitude	.....
RF Power Meter Reading	.....

TASK 2: **Calculation of modulation index**

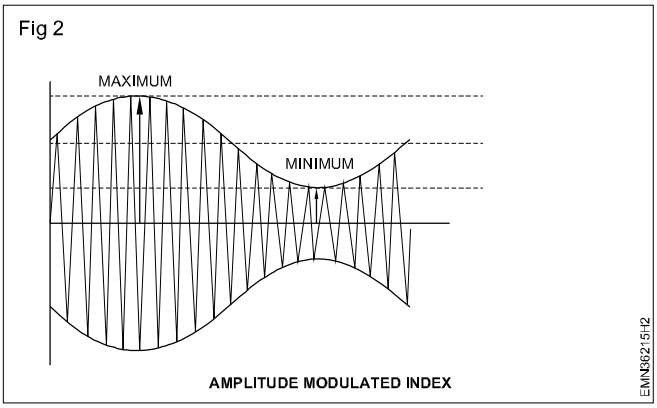
1 Connect the CRO across the AM transmitter circuit at pin no.3 and ground

2 Switch ON the 9VDC and repeat step 7 of TASK - 1.

3 Draw the waveform on the graph sheet and mark the maximum and the minimum amplitude as shown in Fig - 2

4 Use the following formula to calculate the modulation index

Fig 2



$$\text{Modulation Index } (m) = \frac{\{\text{Maximum amplitude} - \text{Minumum amplitude}\}}{\{\text{Maximum amplitude} + \text{Minumum amplitude}\}}$$

5 Substitute the maximum and minimum amplitude values observed and find the modulation index

6 Get the work checked by the instructor

Dismantle the given FM receiver set and identify different stages (AM section, audio amplifier section etc.)

Objectives : At the end of this exercise you shall be able to
- **dismantle the given FM receiver using IC TEA5591A**
- **identify the stages of the FM receiver on the circuit board.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- DMM with probes - 1 No.
- FM receiver using ICTEA5591 A - 1 No.

Aids: Chart showing the print out diagram / data sheet of the IC TEA 5591 A and the PCB layout of AM/FM radio receiver

Note:

1 **The Instructor has to guide the trainees to open and dismantle the circuit board from the FM receiver without any damage to the windings/components**

2 **Keep the screws, washer / nut & bolt etc. separately**

PROCEDURE

1 Refer to the chart showing the FM receiver circuit diagram

2 Identify the major components on the layout of circuit board

3 Identify the stages and location of different stages of FM receiver by tracing the PCB, from speaker side towards input side.

4 Record the observations in the Table - 1

Fig 1

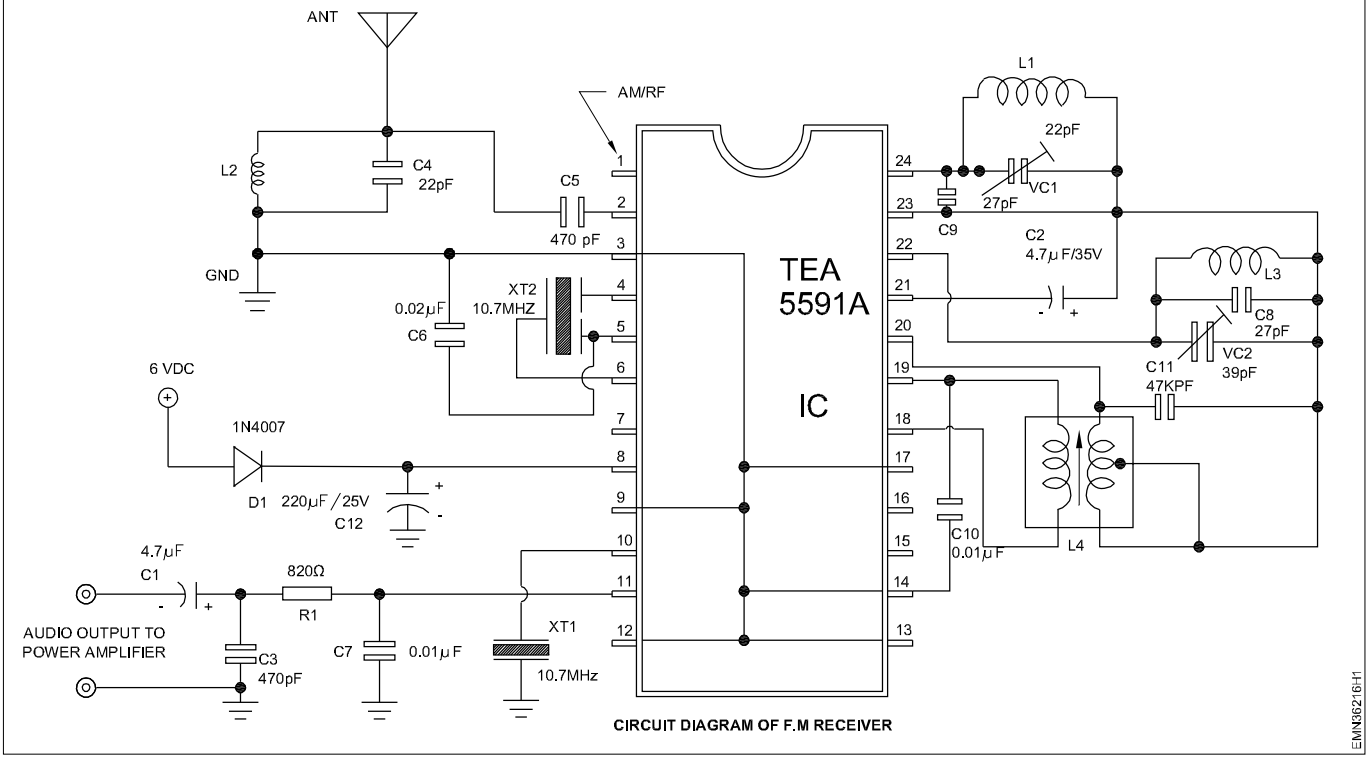


Table - 1

S. No.	Name of the stage	Active devices in each stage	Remarks
1	Power supply +ve		
2	Ground terminal -ve		
3	FM RF input		
4	Mixer output		
5	FM oscillator		
6	IF amp (1^{st}) input		
7	IF amp (1^{st}) Output		
8	2nd IF amp. output		
9	FM Demodulator		
10	AF Output		

Modulate two signals using AM kit, draw the waveform and calculate percentage (%) of modulation

Objectives : At the end of this exercise you shall be able to
- **modulate two signals using AM trainer kit/circuit**
- **measure waveform and calculate percentage of modulation.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- AM trainer kit with operating manual - 1 No
- DMM with probes - 1 Set
- CRO dual trace 0-20MHz with probe kit - 1 Set
- Audio generator - 1 No
- RF generator - 1 No
- Soldering iron -25W/240V - 1 No
- Regulated power supply 0-30VDC/2A - 1 No

Materials/Components

- Gen purpose PCB - 1 No
- Transistor BF 195C or equivalent - 1 No
- Resistor -CR25/¼ W
- 10 kΩ - 3 Nos
- 20 kΩ - 1 No
- 100 kΩ - 1 No
- Capacitor ceramic 0.01µF, 0.1 µF, 0.001µF/25 VDC - 1 No each
- Resin cored solder - as reqd
- Flexible wire - as reqd

PROCEDURE

TASK 1: **Amplitude Modulation of two signals.**

Note: The instructor has to use the AM trainer kit for this exercise. In case, the kit is not available, assemble the given Amplitude Modulator circuit using transistor for this task as shown in Fig 1.

1 Refer to the operating manual of the AM trainer kit and follow the steps for modulating the built in audio signal as moudulating signal (fm).

2 Use RF carrier signal generator with 500 KHz frequency as carrier signal.

3 Prepare the CRO for measurement and connect the Ch-1 input with direct probes/crocodile clips.

4 Switch ON the AM trainer kit and connect the output of audio signal, carrier signal to the modulator section.

5 Connect the output of modulator section to CRO.

6 Adjust CRO and observe the stable waveform of modulated signal.

7 Measure the amplitude and record the observations in Table 1.

8 Get the work checked by the Instructor.

Fig 1

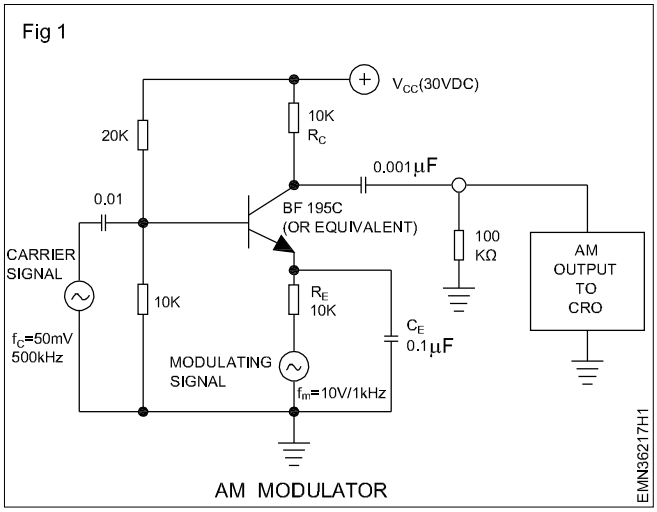


Table 1

Sl.No	Signal	Waveform	Amplitude	Frequency	Remarks
1	Audio signal				
2	Carrier signal				
3	Modulator output				

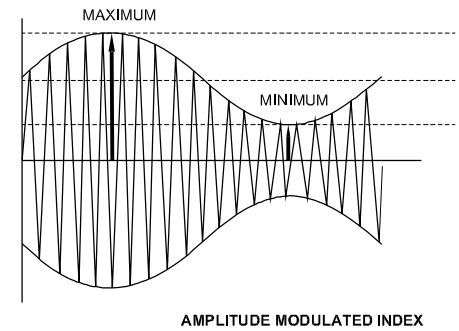
— — — — — — — —

TASK 2: **Calculate the modulation index**

1 Refer to the amplitude modulated wave form draw the graph separately.

2 Notedown the maximum amplitude and minimum amplitude as shown in Fig 2.

Fig 2



AMPLITUDE MODULATED INDEX

3 Use the following formula to calculated the modulation index.

$$\text{Modulation Index } (m) = \frac{\{\text{Maximum amplitude} - \text{Minumum amplitude}\}}{\{\text{Maximum amplitude} + \text{Minumum amplitude}\}} \times 100$$

4 Substitute the maximum amplitude and minimum amplitude values.

5 Find the modulation index.

6 Get the work checked by the Instructor.

Modulate and demodulate signal using PAM, PPM, PWM techniques

Objectives : At the end of this exercise you shall be able to
- **construct and test PAM modulator**
- **construct and test PAM demodulator**
- **construct and test PPM modulator**
- **construct and test PPM demodulator**
- **construct and test PWM modulator**
- **construct and test PWM demodulator.**

Requirements

Tools/Equipments/Instruments

- Variable DC power supply 0-30V/2A - 1 No.
- Digital multimeter with probes - 1 No.
- CRO 20 MHz with instruction manual probe kit - 1 No.
- Audio frequency generator - 1 No.
- Trainees tool kit - 1 Set
- Function generator - 1 No.

Materials/Components

- **Capacitors:**
  - 10 µF/35V - 2 Nos.
  - 10 µF/25V - 1 No.
  - 220 µF/ 25V - 1 No.
  - 10 µF/25V - 1 No.
  - 0.01 µF /25 V - 2 Nos.
- **Resistors CR 25/ ¼ W**
  - 9.1 kΩ - 1 No.
  - 4.7 kΩ - 2 Nos.
  - 10 kΩ - 1 No.
  - 330 Ω - 1 No.
  - 1 kΩ - 1 No.
  - 3.9 kΩ - 1 No.
  - 10 kΩ - 3 Nos.
- IC 555 - 3 Nos.
- Diode 1N 4001 - 1 No.
- Diode 1N 4007 - 1 No.
- GP-PCB - 2 Nos.
- Transistor 2N2222A or equivalent - 1 No.

PROCEDURE

TASK 1 : **Construtions and testing of PAM modulator**

1 Collect all the components, check them and assemble the astable multivibrator circuit as shown in Fig 1.

2 Prepare CRO for measurements with Ch-1 input.

3 Connect 5VDC power supply to astable multivibrator; Switch ON and measure the output at pin -3 of IC 555.

4 Switch ON the audio signal generator, adjust the output to 1 kHz and verify the waveform.

5 Connect the CRO probes across the collector and ground terminals of transistor Q1.

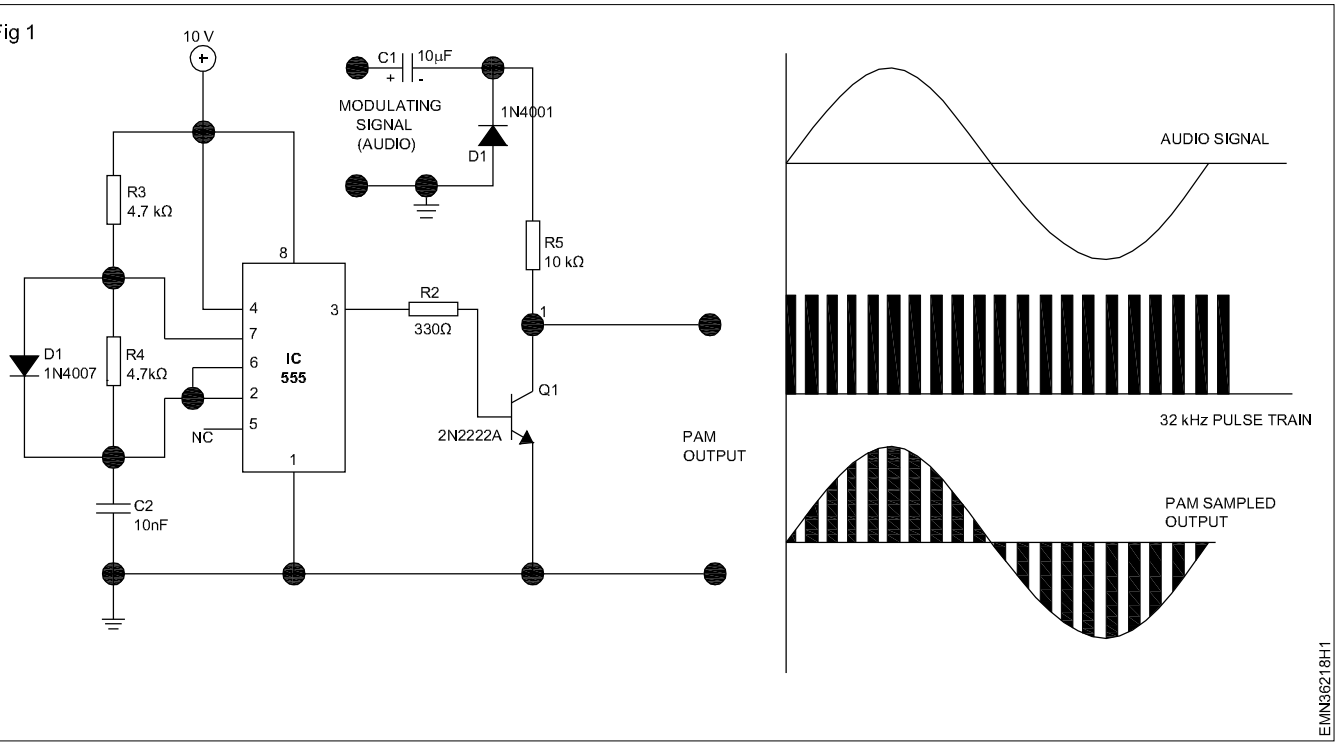
6 Measure the waveform and record the observations in Table-1.

7 Get the work checked by the Instructor.

Table - 1

Sl.No.	Measured wave form	Frequency	Remarks
1	Pin no 3 of IC 555		
2	Audio generator output		
3	Collector of transistor Q1		

Fig 1



TASK 2 : **Construction and testing of PAM demodulator**

1 Assemble the RC circuit as shown in Fig 2 for the PAM demodulator stage.

2 Connect the output signal from the transistor Q1 of the circuit shown in Task 1 as input to the demodulator.

3 Switch ON the PAM modulator set up.

4 Measure the output signal across capacitor 'C' of PAM demodulator stage on the CRO.

5 Record the observation in Table 2.

6 Get the work checked by the instructor

Fig 2

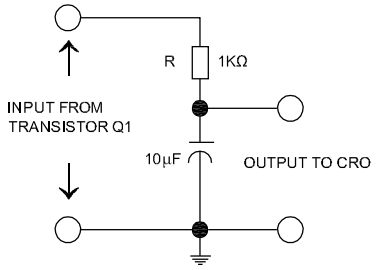


Table- 2

Sl.No	Description	Waveform	Remarks
1	Input waveform at Pin No.3 of IC555		
2	Output waveform across capacitor 'C'		

TASK 3 : **Construction and testing PPM modulator**

1 Collect all the components, check them and assemble the PPM modulator circuit as shown in Fig 3.

2 Connect the function generator output set at 1 KHz and 1 Vp-p, with triangular waveform to the pin no 5 of IC555.

3 Prepare CRO for measurement and connect Ch-1 with input signal (Pin-5).

4 Connect Ch-2 of CRO to the output Pin No 3 of IC555.

5 Switch ON the 5VDC supply to the PPM circuit.

6 Measure the waveform on the CRO and record the observations on Table-3.

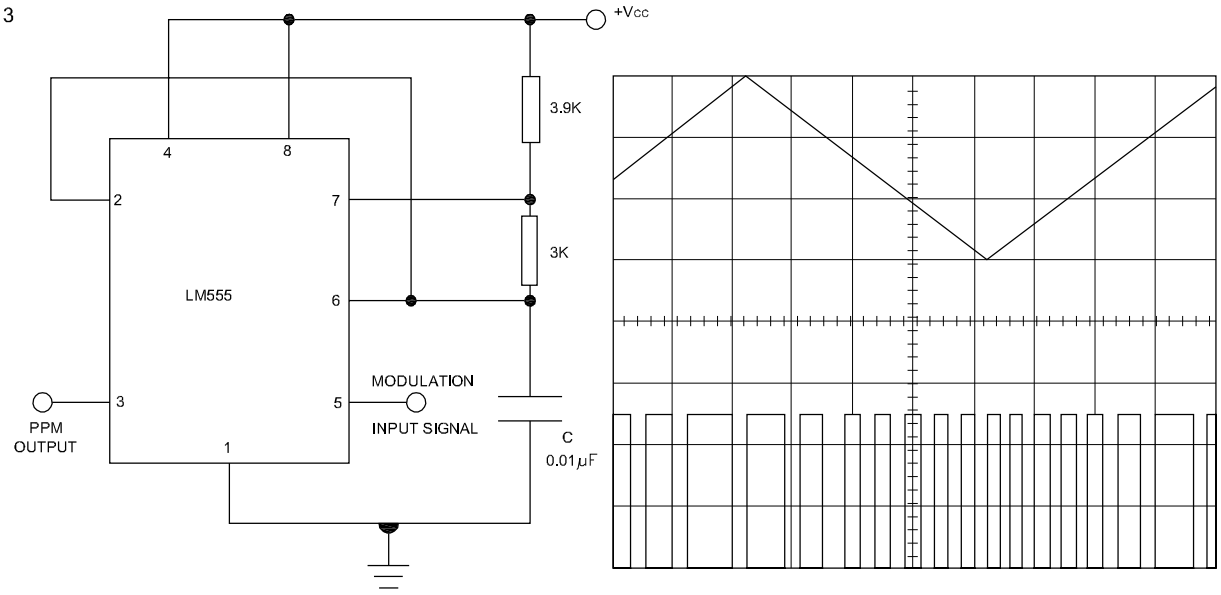
Table 3

Sl.No	Input / Output	Waveform	Remarks
1	Pin No. 5		
2	Pin No. 3		

7 Vary the triangular signal frequency and observe the effect on the output waveform.

8 Get the effet on the modulated output waveform checked by the Instructor.

Fig 3



CONSTRUCTION OF PPM MODULATOR

EMN36218H3

— — — — — — — —

TASK 4 : **Construction and testing PPM demodulator**

1 Use the assembled demodulator circuit of Task 2 (Fig 2) as the PPM demodulator.

2 Connect the output pin No 3 of PPM modulator circuit of Task 3 (Fig 3) as input signal to the above demodulator circuit.

3 Connect the function generator with sinewave set at 1 kHz -1 Vp-p output to the Pin No-5 of IC 555 as modulation signal input.

4 Switch ON the 5 VDC to the IC 555 and function generator, observe the waveform at Pin No 3.

5 Use CRO, measure the waveform across capacitor 'C' of PPM demodulator stage and record the observations on Table 4.

6 Get the effect on the demodulated waveform checked by the Instructor.

Table - 4

Sl.No	Description	Waveform	Remarks
1	Input Waveform across PPM demodulator		
2	Output Waveform across capacitor 'C' of PPM demodulator output		

— — — — — — — —

TASK 5 : **Construction and testing PWM modulator**

1 Modify the assembled board of Task 3 as per the circuit shown in Fig 4.

2 Connect sine wave signal from the function generator with 1 KHz, 1 Vp-p to the Pin No 5 of IC 555.

3 Switch ON the 5VDC supply and observe the output wareform at Pin No 3 of PWM modulator circuit.

4 Observe the effect on the output waveform by varying the sine wave signal.

5 Record the observations in Table-5.

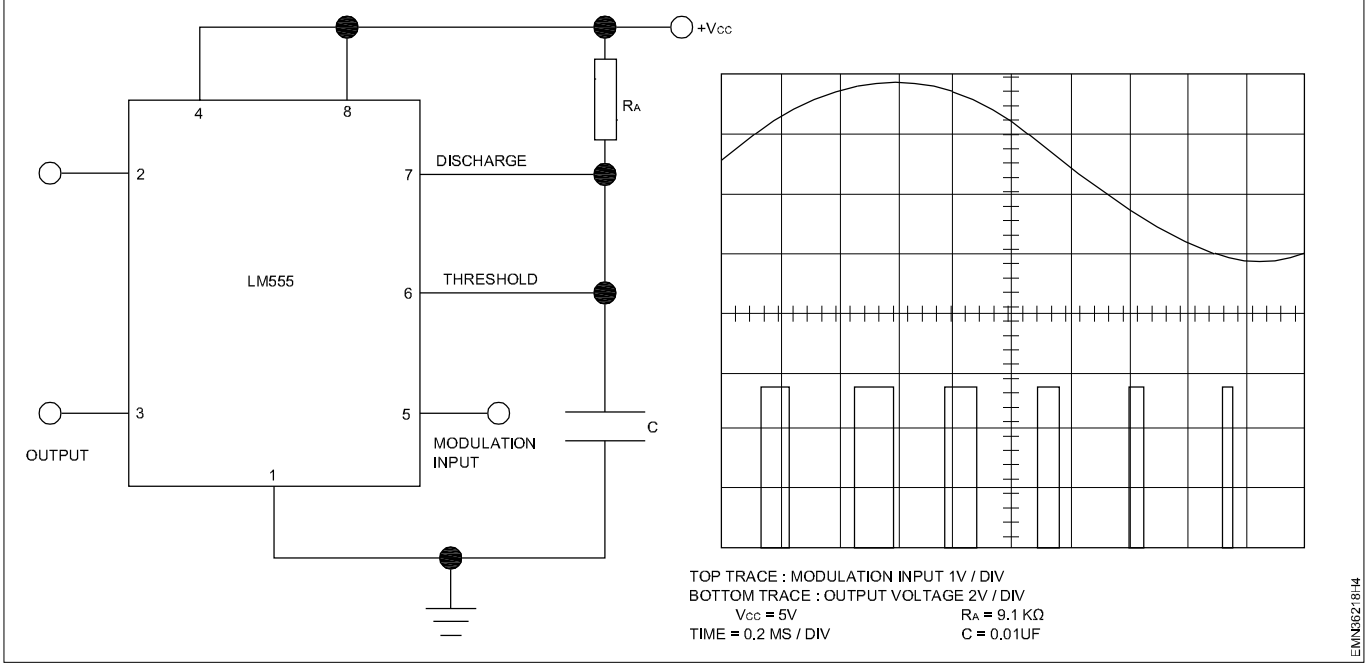
6 Get the effect on the modulated output waveform checked by the Instructor.

Table - 5

Sl.No	Description	Waveform	Remarks
1	Input Waveform at Pin No 5 of IC555		
2	Output Waveform at Pin No 3 of IC555		

Fig 4

PWM MODULATOR CIRCUIT



— — — — — — — —

TASK 6 : **Construction and testing PWM demodulator**

1 Use the assembled demodulator circuit of Task 2 (Fig 2 as the PWM demodulator.

2 Connect the output of PWM modulator Pin No 3 of IC555 of Task - 5 as the input signal to the PWM demodulator stage.

3 Connect the sinewave from the function generator with 1 KHz frequency, 1 Vp-p to Pin No 5 of IC 555.

4 Measure the output waveform across the PWM demodulator stage using CRO.

5 Record the observed waveforms across the input and output of PWM demodulator stage in Table - 6.

6 Get the effect on the demodulated waveform checked by the Instructor.

Table - 6

Sl.No	Description	Waveform	Remarks
1	Input Waveform across PWM demodulator		
2	Output Waveform across capacitor 'C"		

— — — — — — — —

Identify various ICs and their function on the given microcontroller kit

Objectives : At the end of this exercise you shall be able to
- **note down various ICs on the microcontroller trainer kit**
- **identify the function of ICs on the microcontroller trainer kit.**

Requirements

Tools/Equipments/Instruments

- 8051 Microcontroller Trainer kit with manual - 1 Set
- Trainees tool kit - 1 Set.
- Digital Multimeter with probes - 1 No.

Materials/Components

- **Aids:** Layout diagram of ICs on the 8051 microcontroller kit - as reqd

PROCEDURE

Note:

1. **The Instrument has to prepare the layout diagram of ICs in the 8051 microcontroller trainer kit.**
2. **Label the main ICs for the functions like interfacing, RAM EPROM latch, buffer, keyboard controller, peripheral control etc. according to the microcontroller trainer kit available in the lab, to be provided along with the trainer kit for this exercise.**

1 Collect the microcontroller trainer kit with its operating instructions manual.

Table - 1

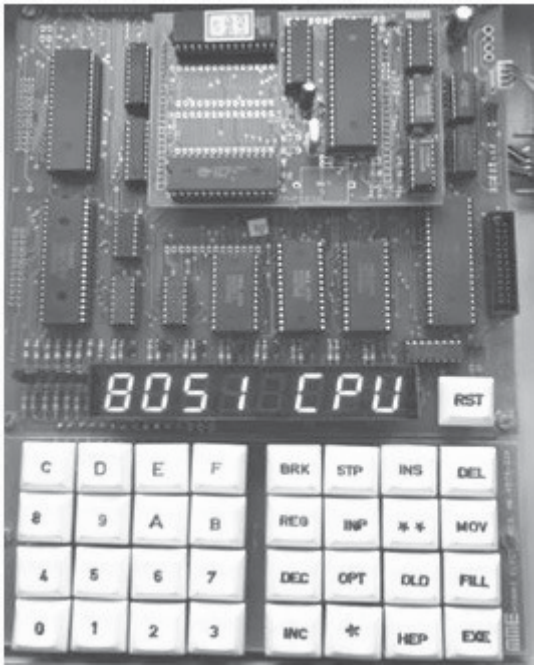
S. No.	Function	IC No.	No.of Pins	Function/ Purpose of IC	Remarks
1	IC 1				
2	IC2				
3	IC3				
4	IC4				
5	IC5				

2 Open the top cover of the microcontroller trainer kit, and observe the ICs on the board with reference to the layout diagram.

3 Note down the code number/marking on each IC, number of pins and record the observations in Table - 1

4 Get the work checked by the Instructor

Fig 1



EMN37219H1.jpg

— — — — — — — — —

Identify the address range of RAM & ROM of 8051 microcontroller

Objectives : At the end of this exercise you shall be able to
- **identify address range of RAM of the 8051 microcontroller trainer kit**
- **identify address range of ROM of the 8051 microcontroller trainer kit**

Requirements

Tools/Equipments/Instruments

- 8051 microcontroller Trainer kit with manual - 1 Set

Materials/Components

- Nil

PROCEDURE

The Instructor has to refer the Instruction Manual of the 8051 microcontroller trainer kit and prepare the memory location of the RAM and ROM address range for the user programs in the trainer kit available in the lab

1 Refer to the instruction manual of the microcontroller trainer kit, read the RAM address which is used to load user program

2 Refer to the instruction manual of the microcontroller trainer kit,read the ROM address which is used to load user program

3 Record the address of RAM and ROM used in the microcontroller trainer kit in the given tabular form

4 Calculate the memory capacity by subracting the starting address from the end address (using hexadecimal number) and record in Table - 1.

5 Get the work checked by the instructor

Table - 1

Memory Type	Starting Address	End Address	Memory Capacity
RAM			
ROM			

— — — — — — — —

Measure the crystal frequency, connect it to the controller

Objectives : At the end of this exercise you shall be able to
- **identify the crystal oscillator in the given microcontroller kit**
- **measure the clock frequency of the given microcontroller kit.**

Requirements

Tools/Equipments/Instruments

- 8051 Microcontroller Trainer kit with manual - 1 Set
- DMM with probes - 1 No.
- Digital frequency meter - 1 No.
- Oscilloscope (0-20 MHz) with manual and probes - 1 No.

Materials/Components

- Nil

PROCEDURE

1 Collect the microcontroller kit from the instructor.

2 Identify the crystal oscillator in the microcontroller kit.

3 Refer to the operating manual note down the freq and locate the pin number 18 and 19 of the microcontroller IC 8051 (refer Fig 1).

Note: Use DMM and measure the clock frquency by selecting the Hz range if available.

4 Prepare the CRO for measurements with Ch-1 input.

5 Switch ON the microcontroller and measure the crystal signal waveform at pin 18 with respect to ground and calculate the frequency.

6 Repeat step 5 at pin no. 19.

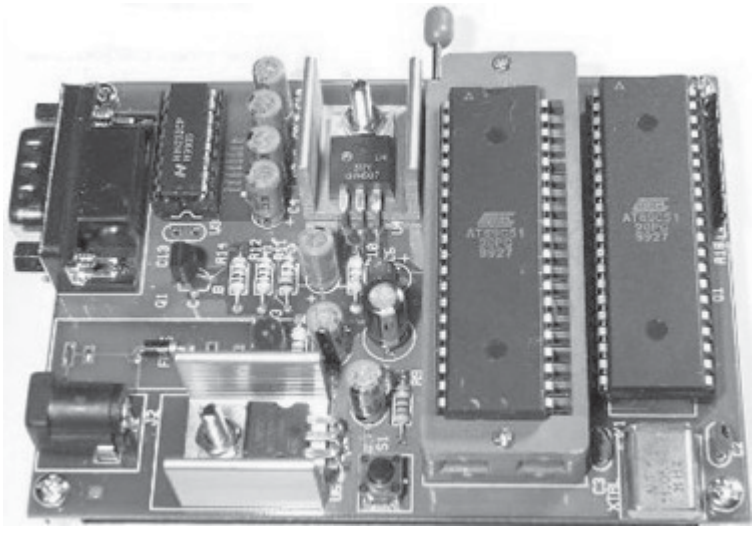
7 Record the observed readings in the Table 1.

8 Get the work checked by the Instructor.

Table - 1

Clock frequency as per manual	CRO waveform/ frequency		Remarks
	Pin No. 18	Pin No. 19	

Fig 1



EMN37221H1.jpg

— — — — — — — —

Identify the port pins of the microcontroller and configure the ports for input & output operation

Objectives : At the end of this exercise you shall be able to
- **identify the port pins in 8051 microcontroller**
- **enter the program in the microcontroller kit and execute it.**

Requirements

Tools/Equipments/Instruments

- 8051 Microcontroller Trainer kit with manual - 1 Set
- DMM with probes - 1 No.
- Logic probes - 1 No.

Materials /Components

- Program to operate the I/O port - as reqd.

PROCEDURE

TASK 1: **Identification of port pins in 8051 microcontroller**

1 Collect the 8051 microcontroller kit and identify the sections using instruction manual

2 Identify the pin connection used for different ports on the microcontroller IC 8051

3 Notedown the pin number of ports in Table - 1, and mark the ports with dual function.

4 Note down the alternative pins of the ports in Table - 1

5 Get the work checked by the instructor

Table - 1

S. No.	Port Number	Pin Number	Alternative

— — — — — — — —

TASK 2: **Entering the program into the microcontroller**

1 Refer to the instruction manual and identify all the operating controls and switches.

2 Connect the switch to port - 1

3 Configure the port - 1 as input port

4 Connect the output port to LEDs

5 Enter the given program and execute it on the trainer kit.

Note: In the given program LED port address (FF13) is designed and tested as per the manufacturer of the microcontroller kit. It may vary for kits of different manufacturer / models.

6. Operate the switches one by one and verify the output by using LEDs

Program

```
LOOP    MOV A, P1
MOV     DPTR, #FF13
MOV  X @ DPTR, A
SJMP LOOP
```

Note: The instructor has to explain about the given program and its working. The above program can be repeated for different Input/ Output ports.

— — — — — — — —

Use 8051 microcontroller, connect 8 LEDs to the port and blink the LEDs with switch

Objectives : At the end of this exercise you shall be able to
- **enter the program to blink 8 LEDs using switch and run it on the microcontroller trainer kit**
- **check the result through the port - 1 and record the observation.**

Requirements

Tools/Equipments/Instruments

- 8051 Microcontroller trainer kit with instructional manual - 1 Set.
- Trainees tool kit - 1 Set
- Digital multimeter with probes - 1 No.
- Logic probe - 1 No.

Materials/Components

- 8 LEDs interface module (available on board) - 1 No.
- Program to blink the 8 LEDs through switch - as reqd.

PROCEDURE

Note:

1. **The instructor has to enter the program, execute and ensure that the 8051 microcontroller trainer kit is functioning correctly before given to the trainees for this exercise / task**
2. **Make necessary modifications in steps / program according to the microcontroller trainer kit available in the section**

1 Collect the 8051 microcontroller trainer kit from the instructor

2 Refer to the instruction manual and identify all the operating controls / switches

3 Configure the port - 1 of 8051 microcontroller kit as input port

The onboard 8 LED interface module connected internallly is used for this task.

4 Enter the given program to blink the 8 LEDs through switch into the microcontroller trainer kit

5 Execute the program and observe the blinking of LEDs

6 Get the work checked by the instructor

Program

```
LOOP   START   JNB 90, START
               MOV DPTR, #FF13
               MOV A, #FF
               MOV X, @DPTR, A
               LCALL DELAY
               MOV A, #00
               MOV X @DPTR, A
               LCALL DELAY
               SJMP LOOP
               DELAY LOOP
               MOV RO, #FF
       LOOP 2  MOV R1, #FF
       LOOP 1  DJNZ R1, LOOP 1
               DJNZ RO, LOOP 2
               RET
```

— — — — — — — —

Perform the initialization, load and turn ON a LED with dealy using timer

Objectives : At the end of this exercise you shall be able to
- **enter the program to turn ON a LED with delay using timer in 8051 microcontroller trainer kit**
- **execute the program on the 8051 microcontroller trainer kit.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- 8051 microcontroller trainer kit with instructional manual - 1 Set
- Logic probe - 1 No.

Materials/Components

- Push-to-on switch - 1 No.
- Bread board - 1 No.
- Hook up wire - as reqd.
- Program to turn ON a LED with delay using timer - as reqd.

PROCEDURE

Note:

1 The instructor has to make necessary modification in steps according to the microcontroller kit available in the lab

2 Enter the program and test it before giving to the trainees

1 Collect the 8051 microcontroller kit from the instructor

2 Refer to the instructional manual and identify all the operating controls / switches

3 Configure the port - 1 as output port

4 Enter the given program to turn ON the LED with delay using timer into the microcontroller kit

5 Execute the program and verify the result

6 Get the work checked by the instructor

Main Program

```
        MOV TMOD, #10
HERE    MOV TH1, #0F
        MOV TL1, #F0
        MOV A, #55
        MOV 90, A
        ACALL DELAY
        ACALL DELAY
        MOV A, #00
        MOV P1, A
        ACALL DELAY
        ACALL DELAY
        SJMP HERE
```

Delay Program

```
        SET B TR1 (8E)
AGAIN   JNB TF1 (8F), AGAIN
        CLR TR1
        CLR TF1
        RET
```

— — — — — — — —

Perform the use of timer as an event counter to count external events

Objectives : At the end of this exercise you shall be able to
- **enter the program to count external events into the microcontroller kit**
- **observe the output using LED**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- 8051 microcontroller trainer kit with instructional manual - 1 Set
- Digital multimeter with probes - 1 No.
- Logic probe - 1 No.

Materials/Components

- Push-to-on switch - 1 No.
- Bread board - 1 No.
- Hook up wire - as reqd.
- Program to count external events - as reqd.

PROCEDURE

Note:

1. The instructor has to enter the program, execute that the 8051 microcontroller trainer kit is functioning corretly before given to the trainees for this exercise / task

2 Connect the push button switch at pin No. 15 and ground using bread board and hook up wire

3 Make necessary modifications in steps / program according to the microcontroller trainer kit available in the section

1 Collect the 8051 microcontroller trainer kit from the instructor

2 Refer to the instructional manual and identify all the operating controls / switches

The Instructor has to explain about the program and its working

3 Enter the given program into the microcontroller kit

All the datas and address are specified in Hexadecimal format only

Program to count external events

```
        MOV TMOD, #60
        MOV TH1, #00
        SET B BO
AGAIN   SET  B TR1
LOOP    MOV A, TL1
        MOV DPTR, #FF13
        MOV X @DPTR, A
        JNB TF1, LOOP
        CLR TR1
        CLR TF1
        SJMP AGAIN
```

4 Execute the program, press the push button and observe the output port LED

5 Repeat the above step for counting

6 Get the work checked by the instructor.

— — — — — — — —

Demonstrate entering of simple program, execute and monitor the result

Objectives : At the end of this exercise you shall be able to
- **enter the program in the 8051 microcontroller kit**
- **execute the program to operate two 8 bit addition.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- 8051 microcontroller trainer kit with instruction manual - 1 Set
- Logic probe - 1 No.

Materials/Components

- Program to operate two 8 bit addition - as reqd.

PROCEDURE

TASK 1: **Entering the program to operate two 8 bit addition**

Note:

1 The Instructor has to make necessary modifications in steps according to the microcontroller trainer kit available in the lab

2 Enter the program and test it before giving to the trainees

1 Collect the 8051 microcontroller kit from the instructor

2 Refer to the instruction manual and identify all the operating controls and switches

3 Enter the simple assembly language program to operate two 8 bit addition into the microcontroller

4 Execute the given program and verify the result

5 Record the datas and result in Table - 1

6 Repeat the steps 3 and 4 for different values and record it in Table - 1

7 Get the work checked by the Instructor

Note: The Instructor has to explain about the program and its working

Program

```
        MOV RO, #00
        MOV A, #data 1
        ADD A, #data 2
        JNC Label
        INC RO
        MOV DPTR, #address
        MOV X @ DPTR, A
        INC DPTR
        MOV A, RO
        MOV X @DPTR, A
HERE    SUMP    HERE
```

— — — — — — — —

TASK 2: **Writing the program to operate two 8 bit subraction**

Note: The instructor should guide the trainees to write the program to operate two 8 bit subraction, multiplication and division also

1 Write the porgram to operate two 8 bit subraction

2 Get the program checked by the instructor

3 Enter the program into the microcontroller kit and execute it

4 Verify the result and record it in Table - 1

Table - 1

S. No.	Mathematical	Data-1	Data-2	Result
1	Addition			
2	Subraction			
3	Multiplication			
4	Division			

5 Get the work checked by the instructor

Note: The Instructor my guide the trainees to write logical programs like AND, OR, NOT operations for practice.

Perform with 8051 microcontroller assembly language program to check the reading of an input port and send the received bytes to the output port of the microcontroller, using switches and LCD for the input and output.

Objectives : At the end of this exercise you shall be able to
- **enter the program in the 8051 microcontroller kit using switches and LCD display**
- **execute the program and observe the result.**

Requirements

Tools/Equipments/Instruments

- 8051 Microcontroller with instruction manual - 1 Set
- Trainees tool kit - 1 Set
- Logic probes - 1 No.

Materials/Components

- Program to operate the I/O ports using switches and LCD display - as reqd.

PROCEDURE

Note:

1 **The Instructor has to make necessary modifications in steps according to the microcontroller trainer kit available in the lab**

2 **Entre the program and test it before giving to the trainees**

1 Collect the 8051 microcontroller kit from the Instructor

2 Refer to the instruction mannual and identify all the operating controls, swithches and LCD display

3 Configure the port - 1 as Input port

4 Set the switch position before executing the program

5 Entre the given program using swithces and LCD display using Input/Output ports

Program

LOOP MOV A, P1

MOV DPTR, # address

MOV X @DPTR, A

SJMP LOOP

6 Execute the program and verify the result

Note: The instructor has to explain about the given program and its working so that the above program can be repeated for different input / output ports.

7 Get the work checked by the instructor.

Identification of different sensors used in process industries

Objectives : At the end of this exercise you shall be able to
- **identify the type of sensor used in process industries**
- **select suitable sensor for a specific purpose/application.**

Requirements

Tools/Equipments/Instruments

- Magnifier lamp - 1 No
- **Aids:** Chart showing the image of all the sensors with colour code, physical appearance and other details - 1 No

Materials/Components

- All types of sensors with instruction leaflet brouchure - 1 No each (RTD, Temperature IC i.e., Thermocouple, Proximity switch (inductive capacitive photo electric) Load cells, Strain gauge, LVDT, PT100 thermostat, float switch, float valve).

PROCEDURE

Note:

1 The instructor has to label the RTD temperature IC, thermocouple, proximity switches (Inductive, capacitive and photoelectric), Loadcell, strain gauge, LVDT float switch and float valve for water level.

2 Prepare technical data chart providing the type, code number and use/application for all the above sensors for this exercise.

1 Pick one of the labeled sensor from the lot.

2 Observe the physical shape and contructional detail, refer to the chart -1 and identify the name of the sensor.

3 Use magnifier for viewing small/delicate details of the sensor.

4 Refer to the technical details of the selected sensor on the data chart, record the observations in Table -1.

5 Repeat the steps 1 to 4 for remaining sensing devices.

6 Get the work checked by the Instructor.

Table -1

Sl.No	Label No.	Name of the Sensor	Type/Colour Code/Number	Sensing Criteria	Using Application	Remarks
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

— — — — — — — —

Measurement temperature of lit fire using thermocouple and record the readings referring to data chart

Objectives : At the end of this exercise you shall be able to
- **identify and test the thermocouple using millivoltmeter (DMM) by quick test**
- **measure the output DC millivolt of Thermocouple at different temperatures and compare with standard values of data sheet.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital Multimeter/millivolt meter with probes - 1 Set
- Steel rule 300mm and vernier - 1 No

Aids:

- Thermocouple Leads colour chart - 1 No
- Thermocouple temperature table - 1 No
- Thermocouple specification data sheet - 1 No

Materials/Components

- Temperature sensors (assorted types) - as reqd
- Thermocouple J & K type sensor - as reqd
- Hot bath or water bath or heating source or Candle with match box - 1 No

PROCEDURE

Note: The instructor has to demonstrate the procedure to identify and test the thermocouple used for this exercise and label them serially.

TASK 1 : **Identification of thermocouple from the assorted temperature sensors by quick test**

1 Take the digital multimeter and select low DC millivolts range.

2 Connect the DMM across the Thermocouple leads and observe the DC millivolts reading.

3 Heat the end of the thermowell bulb by using lit fire from candle or by using Hot bath or water bath or heating source.

4 Observe the DC millivolt reading on the meter and record the observations in Table-1.

5 Separate the temperature sensors into two groups which are changing DC millivolts and which are not changing DC millivolts for heating.

6 Mark the temperature sensor as "THERMOCOUPLE" that produced DC millivolts variation for change in temperature.

Note: The sensors not responded for temperature change may be defective or RTDs.

Table 1

Sl. No.	Label No.	Millivoltmeter reading		Remarks
		Before heating	After heating	
1				
2				
3				

7 Repeat steps 2 to 6 for the remaining sensors.

8 Get the work checked by the Instructor.

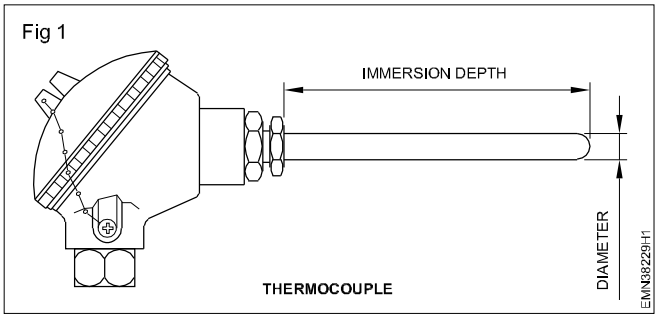
TASK 2: **Testing of thermocouple with millivoltmeter and confirmation of correctness**

1 Collect the Thermocouple sensor from the Instructor.

2 Use the specification data sheet and note down type of sensor, material or element of sensor, and range of sensor calibrated, output of sensor in Table 2.

3 Note down physically observed data like thermowell length, thickness (dia), number of lead wires and their colours in Table 2 as shown in Fig 1.

Fig 1



4 Select the millvolt range in DMM and connect the probes across the thermocouple leads.

5 Observe the DC millivolt reading at room temperature and record in Table 2.

6 Refer to the specification data sheet and verify the reading with above recorded observation for correctness of thermocouple.

7 Get the work checked by the Instructor.

Table 2

Specification of the thermocouple

Sl. No.	Description of Item	Details
1	Type of sensor	
2	Sensor element material	
3	Number of wires	
4	Lead colours	
5	Sensor output (if available)	
6	Sensor calibrated range (if available)	
7	Thermowell length (in mm)	
8	Thermowell dia (in mm)	
9	Thermowell material	
10	Thermowell thickness	
11	DC mV measured at room temperature	
12	DC mV recorded from thermocouple temperature data table at room temperature	

— — — — — — — —

TASK 3: **Measuring the output DC millivolt of thermocouple at different temperatures**

1 Collect the tested thermocouple from the instructor and fix it on the stand as shown in Fig 2.

2 Keep the steel rule by the side of stand and mark 5 divisions of 10 mm height from the bottom upto 50mm height.

3 Connect the millivoltmeter across thermocouple leads as shown in Fig 2, observe and record the reading as measurement at room temperature in Table 3.

Note: Refer to the data sheet of the thermocouple and record the value in Table-2.

4 Light the candle and keep the flame under the bulb of thermocouple at Level-1 (10 mm height).

5 Note down the millivoltmeter readings and reacord in Table-3.

Fig 2

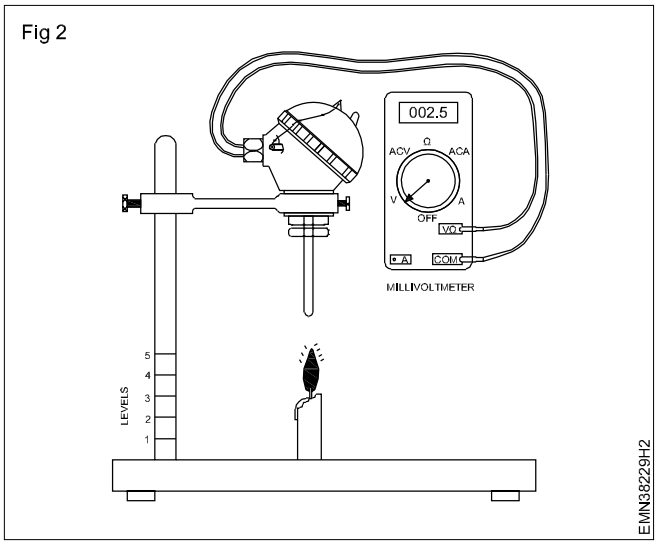


Table 3

Sl. No.	Description	Millivoltmeter reading	Remarks
1	Room temperature		
2	Level - 1 (10 mm)		
3	Level - 2 (20 mm)		
4	Level - 3 (30 mm)		
5	Level - 4 (40 mm)		
6	Level - 5 (50 mm)		

6 Increase the height of the candle to Level-2 (20mm height), note down the readings and record it.

7 Repeat the steps next Levels upto 50mm height and record readings in Table-3.

8 Get the readings checked by the Instructor and put out the candle fire.

Measurement of temperature of a lit fire using RTD and record the readings referring to data chart

Objectives : At the end of this exercise you shall be able to
- **identify and check the RTD at room temperature**
- **measure the resistance value at different temperature levels.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Digital Multimeter with probes - 1 No.
- Steel rule 300 mm - 1 No.
- RTD Leads colour chart - 1 Set
- RTD temperature data sheet table - 1 No.
- RTD specifications data sheet - 1 No.
- **Aids:** Wall chart showing the types of temperature sensors. - 1 No.

Materials / Components

- Temperature sensors assorted - as reqd.
- RTD PT - 100 sensor - as reqd
- Candle with match box - 1 No.

PROCEDURE

TASK 1: **Identification of RTD from the assorted temperature sensors by quick test**

Note: The instructor has to demonstrate the procedure to identify and test the RTD used for this exercise.

1 Identify the RTD by physical appearance along with lead colours from the chart 1.

2 Use the DMM, select low resistance range and connect the ohm meter across the temperature sensor leads, observe the resistance value and record the readings in Table -1.

3 Lit the candle using match box.

4 Heat the end of the thermo well bulb by using the flame from candle.

5 Observe the variation of resistance value on Ohm meter and confirm the device under test is RTD.

6 Get the work checked by the Instructor.

Note: The sensors not responded for temperature change may be defective or thermocouple.

7 Use the RTD specification data sheet and note down the available name plate data like type of sensor, material of the sensor, resistance of sensor, calibrated, output of sensor and thermowell material in Table - 1.

8 Note down and record the physically observed, length, thickness, (dia), number of lead wires and their colours in Table - 1.

Table 1

Reistance value of RTD at room temperature = ... Ohms (as per data sheet)

Sl. No.	Description of Item	Details
1	Type of sensor	
2	Sensor element material	
3	Number of wires	
4	Lead colours	
5	Sensor output (if available)	
6	Sensor calibrated range (if available)	
7	Thermowell length (in mm)	
8	Thermowell dia (in mm)	
9	Thermowell material	
10	Resistance measured at room temperature	

9 Use the DMM select low resistance range, connect the ohm meter across the RTD leads, measure the resistance value at room temperature and record the reading in Table - 1.

10 Verify the resistance reading at room temperature from the RTD specification data sheet table and record in Table-1.

Note: Compare the DMM reading with above observation for correctness of RTD.

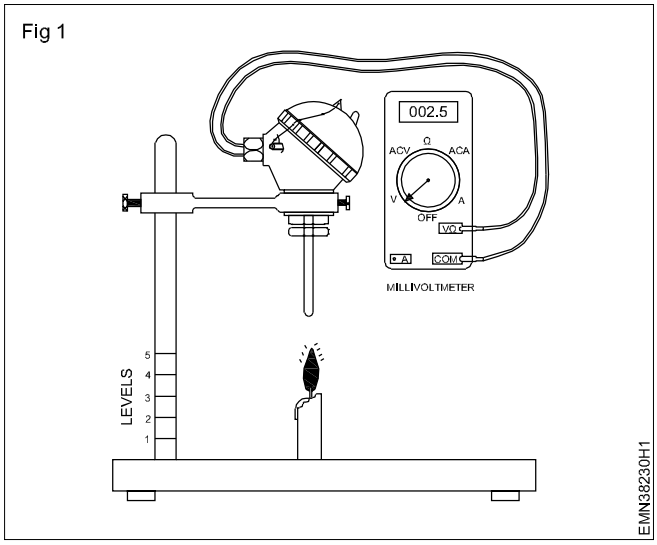
11 Get the work checked by the Instructor.

— — — — — — — —

TASK 2 : **Measuring the output DC millivolt of RTD at different temperature**

1 Collect the tested RTD from the Instructor and fix it on the stand as shown in Fig 1.

Fig 1



2 Keep the steel rule by the side of stand and mark 5 divisions of 10 mm height from the bottom upto 50 mm height.

3 Connect the millvoltmeter across RTD Leads as shown in Fig 1, observe and record the reading as measurement at room temperature in Table - 2.

Note: Refer to the data sheet of the RTD and record the value in Table - 2.

Table 2

Sl. No.	Description	Millivoltmeter reading	Remarks
1	Room temperature		
2	Level - 1 (10 mm)		
3	Level - 2 (20 mm)		
4	Level - 3 (30 mm)		
5	Level - 4 (40 mm)		
6	Level - 5 (50 mm)		

4 Light the candle and keep the flame under the bulb of RTD at Level - 1 (10mm height).

5 Note down the millvoltmeter reading and record in Table - 2,

6 Increase the height of the candle to Level -2 (20mm height), note down the readings and record it.

7 Repeat the steps next levels upto 50mm height and record readings in Table - 2.

8 Get the readings checked by the Instructor and put out the candle fire.

— — — — — — — —

Measure the DC voltage of a LVDT

Objectives : At the end of this exercise you shall be able to
- **test LVDT coils using multimeter**
- **measure the output voltages using CRO**
- **measure displacement using LVDT.**

Requirements

Tools/Equipments/Instruments

- Digital Multimeter with probes - 1 No.
- Dual trace CRO (20 MHz) - 1 No.
- Function generator - 1 No.
- BNC cord for CRO - 1 No.
- LVDT trainer kit with manual - 1 No.

Materials / Components

- Connecting wires - 1 Set

PROCEDURE

TASK 1: **Testing of LVDT coils using multimeter (Ohm meter)**

1 Collect the required tools and equipments

2 Take the LVDT and identify the primary and secondary coils by using its markings and positions. as shown in Fig 1.

3 Take multimeter and select low resistance range.

4 Measure the resistance across primary and secondary coils using ohms range. Note the readings in Table 1.

5 Get the work checked by instructor.

Fig 1

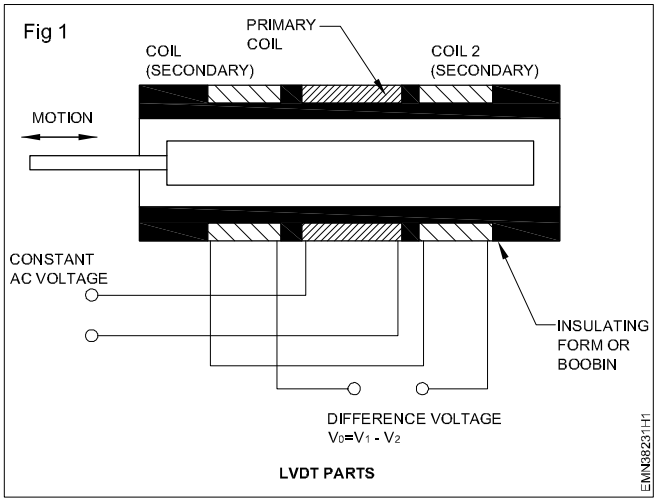


Table 1 : Strain gauge resistances

Coil	Resistance in ohms
Primary coil	
Secondary coil 1	
Secondary coil 2	

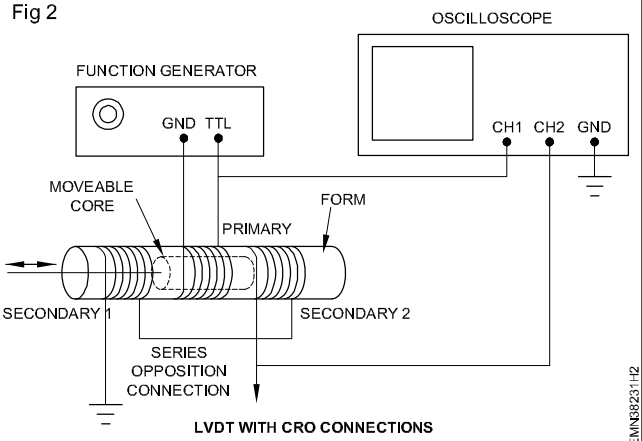
TASK 2: **Measurement of output voltages using CRO**

- Connect the primary coil of LVDT to the trainer kit / function generator refer Fig 2 for all connection.

Note: primary coil can also be tested using function generator by selecting 1 KHz sign wave frequency.

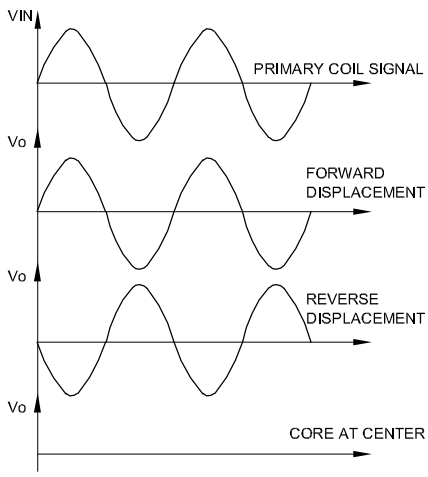
- Connect the Channel 1 of CRO across to the primary coil of LVDT.
- Connect the secondary of LVDT to the channel 2 of CRO.
- Switch on the trainer power supply.
- Place the core in centre of LVDT and observe the wave forms. Plot wave form in observations.
- Move the core forward direction and observe the wave form phase and magnitude. Draw the wave forms at maximum displacement.
- Bring back the core in centre and move the core in reverse direction. Observe the wave form phase changing and magnitude variation. Draw the wave form at maximum displacement as shown in Fig 3

Fig 2



LVDT WITH CRO CONNECTIONS

Fig 3



LVDT DISPLACEMENT WAVE FORM

— — — — — — — —

TASK 3: **Displacement measurement using LVDT with indicator**

1 Connect the LVDT coils to LVDT signal conditioner (indicator) or trainer kit.

2 Place the Core in middle of the LVDT or zero position in indicated scale.

3 Adjust the zero knob and make display zero.

4 Move the LVDT in forward movement at maximum i.e. 20 mm.

5 Adjust the span knob and make display 20 mm read out.

6 Repeat steps 1 to 5 up to system gets stable readings.

7 Move the LVDT core in steps of 5 mm upto 20 mm in forward and reverse movement.

8 Note down the reading in Table 2, for each 5 mm change.

9 Compare the readings and confirm.

10 Get the work checked by the instructor.

Table 2 : Displacement vs Voltage

S.No	Core displacement in (mm)	Output voltage with polarity
1		
2		
3		
4		
5		
6		

— — — — — — — —

Detect different objects using capacitive, inductive and photo electric proximity sensors

Objectives : At the end of this exercise you shall be able to
- **construct capacitive proximity sensor circuit and test it**
- **construct inductive proximity sensor circuit and test it**
- **construct photo electric proximity sensor circuit and test it**
- **defect different objects using proximity sensors.**

Requirements

Tools/Equipments/Instruments

- Trainees tool kit - 1 Set
- Soldering iron 25 watts/240 V - 1 No.
- Regulated power supply 0-30V/2A - 1 No.
- DMM with probes - 1 No.

Materials / Components

- IC CD 4026 - 2 Nos.
- 7 Segment display common cathode - 2 Nos.
- Resistor CR 25-2k2, 3k9, 4k7 - 1 No.each
- Resistor 150 Ohm/ ¼ W/CR25 - 2 Nos.
- PC 817 Optocoupler - 1 No.
- Bread board - 1 No.
- Proximity sensor PNP type - 1 No.
- Photo electric sensor - 1 No.
- Microswitch - 2 Nos.
- LM 7805 - 1 No.
- PSA - 6B inductive sensor - 1 No.
- Hook up wire - 2m
- Rosin cored solder - as reqd.

PROCEDURE

TASK 1: **Construction and testing the inductive type proximity sensors**

Note: The instructor has to guide the trainees to fix the proximity sensor (inductive/photo electric sensors) and adjust the distance detection sensitivity to detect the objects

1 Collect all the components, plan the layout of the display device, counter IC and all other components on the bread board / PCB

2 Check all the components and assemble the counter circuit as per the schematic diagram shown in Fig 1 except the proximity sensor

3 Switch on the 12V DC power supply, press the reset switch1 and abserve the seven segment display shows zero

4 Pick and identify the terminals of the inductive proximity sensor, connect it on the circuit as input.

5 Bring a piece of iron object and move it in front of the sensor such that it detect the object and the display changed to show the number '1'.

6 Repeat the object number of times and observe the display shows incremental numbers confirming the detection of the object.

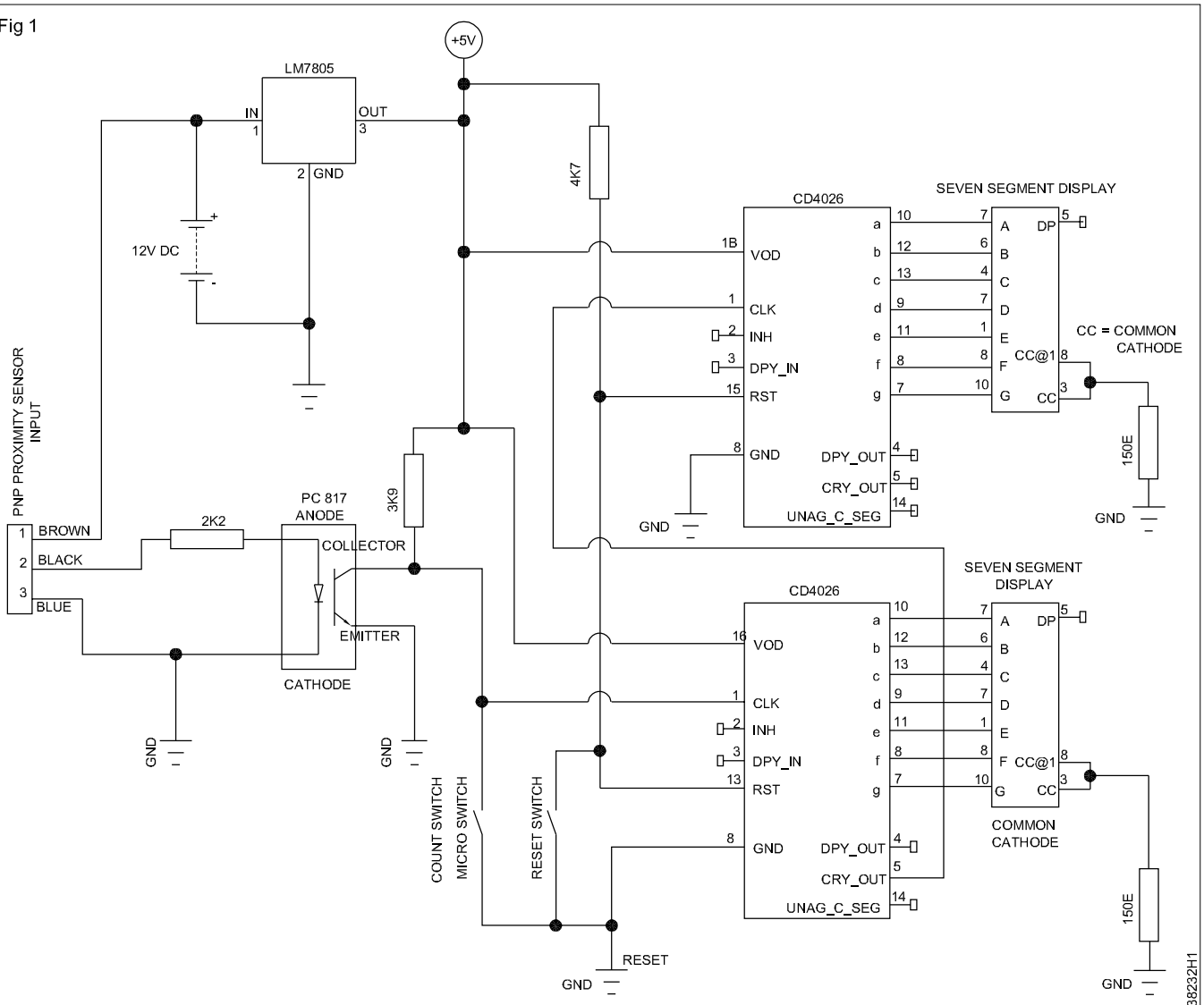
7 Record the number observed in Table - 1

Table - 1

S. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	.....		
	.....		

8 Get the work checked by the Instructor and switch off the circuit

Fig 1



CIRCUIT CONNECTION AND ITS COMPONENTS

— — — — — — — —

TASK 2: **Construction and testing of photo electric type of proximity sensor**

1 Use the asembled counter circuit as per the step 1 to 3 of Task -1

2 Pick the photoelectric proximity sensor, identify the terminals and connect it to the counter circuit input.

3 Switch ON the 12 V DC power supply and observe the display.

4 Pick any item/object, bring it closer to the proximity sensor and observe for any changes in the display

5 Repeat the above step with any ferrous or non-ferrous objects and observe the change in display to confirm the detection of the object.

6 Record the number observed in Table - 2

7 Get the work checked by the instructor and switch OFF the circuit

Table - 2

S. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	.....		
	.....		

— — — — — — — —

TASK 3: **Construction and testing of capacitive proximity sensor**

1 Use the counter circuit assembled as per the step 1 to 3 of Task - 1

2 Pick the three wire capacitive proximity sensor and identify the terminals, connect it to the input of counter circuit

3 Switch ON the 12V DC power supply and observe the display

4 Pick any object and bring it very closer to the proximity sensor input and observe the display for any change

5 Repeat the above step number of times and observe the increment of number in the display to confirm the detection of the object

6 Record the number observed in Table - 3

7 Get the work checked by the instructor and switch off the circuit

Table - 3

S. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	.....		
	.....		

Note: The circuit will display upto the number 99. Exceeding this limit another set of IC CD 4026 and seven segment display may be added.

— — — — — — — —