Section A - General Purpose Equipment

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This section briefly describes the functions and operating techniques of most commonly used Electronic Equipment, devices and components in Electronics, Communication and other related Laboratories. The necessary precautions to be taken while handling such equipment, in order to avoid erroneous measurements and to obtain optimum performance from them are also briefly discussed. The equipment discussed in the following text are classified as follows: -

II-1 BASIC MEASURING INSTRUMENTS

II-2 POWER SUPPLIES

II-3 WAVEFORM MEASURING INSTRUMENTS

II-4 SIGNAL GENERATORS

II-5 ELECTRONIC COMPONENTS AND DEVICES

II-1 Basic Measuring Instruments : The Basic measuring instruments commonly used in the laboratories are the instruments needed to measure the basic electrical quantities such as currents and voltages and include ammeters, voltmeters and multimeters.

Ammeters and Voltmeters : The ammeters, used to measure electric currents, are the meters having very low internal resistance and are used in series with the load whereas the voltmeters, used to measure voltages, have high internal impedance and are used in parallel with the load. The ammeters and voltmeters used to measure the corresponding DC quantities have their terminals marked with + & - polarities and should be carefully used with correct polarities. These instruments are available in different ranges and are accordingly named e.g., micro-ammeters, milli-ammeters, milli-voltmeters etc. The voltmeters draw negligible amount of current from the circuit under measurement and its sensitivity is expressed in ohms per volt. Typically a meter movement having a 1 ma full-scale current has a sensitivity of 1000 ohms/volt whereas if the full-scale current is 100 micro-ampere , the sensitivity is designated as 10,000 OHMS/VOLT. The higher the ohms-per-volt rating, the more sensitive is the meter and the smaller is the loading effect on the circuit. A good voltmeter has a sensitivity between 20,000 to 100,000 ohms/V.

Precautions

(i) Higher voltages/currents should never be measured on low-range meters.
(ii) The meters must always be connected to the circuits with correct polarities.
(iii) For accurate measurements, the meters must be kept stationary in horizontal position.

Multimeters : The Multimeter (MM) incorporates several instruments such as voltmeter, ammeter and ohmmeter into one case, and they all utilize the same meter movement. It usually has three switches--**the function switch** which selects the type of measurement viz. current, voltage or resistance, **the range switch** which selects different ranges, and **the**

mode switch which selects the AC or DC mode of operation. It contains one jack usually black to which the ground point of the circuit is connected and one or more jacks where the other points of the circuit are to be connected. Two kinds of multi-meters are available in the laboratories- **Analog** and **Digital**. In digital multimeters (**DMM**) the meter movement is replaced by digital panel meter consisting of LCD or LED display with A-to-D convertor and some processing circuitry. Most solid-state MM use batteries as a power supply.

Analog Multimeter : A typical analog multimeter (**AMM**) which is widely used in the laboratories is SIMPSON Model 260-6M and is shown in Fig. 2.1.

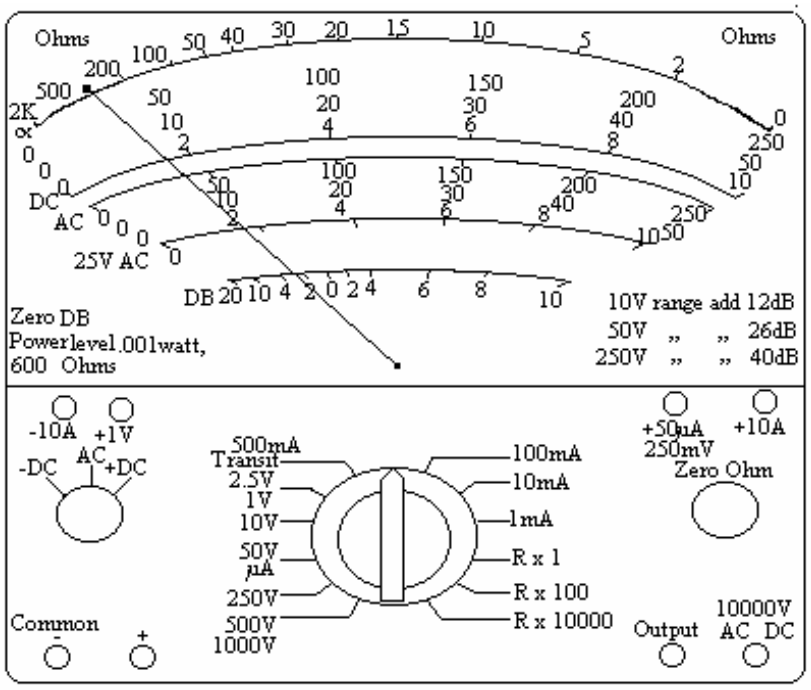


Fig..2.1 DIGITRONIX ANALOG MULTI-METER

It has 8 ranges for DC voltage measurement, 6 ranges for AC Voltage measurement, 5 ranges for DC Current, 3 ranges for resistance measurement, and 1 for power measurement in dBs. as marked on the front panel. It has a single switch serving the functions of both mode and function switches.

Operating Instructions :

For DC Voltage Measurement -

1. Set the mode switch to +DC.
2. Plug the black test lead in the -common jack and the red lead in---250 MV jack while using 250mv range, +1V jack while using 1 V range , + Jack when the ranges above 1 V are used.
3. Set the range sw in the required range.
4. Connect the black lead to the Negative side of the circuit being measured and the red test lead to the positive side .
5. Read the voltage on the black scale marked D.C. and use the appropriate figure.

For Measuring A.C. Voltage -This meter responds to the average value of an A.C waveform. It is caliberated in terms of the R.M.S. value of a pure sine wave. If the

waveform is nonsinusoidal, the reading may be either higher or lower than the true R.M.S. value of the measured voltage, depending upon its waveform.

1. Set the mode/Function switch at AC.
2. Select an appropriate range by the range switch.
3. Connect the test leads across the voltage source to be measured.
4. Read the red scale marked AC and use the red figures immediately below the scale, except for the ranges 2.5V and 500V, which should be directly read on the scales marked 2.5V& 50V respectively.
5. For the measurement of the voltage in 1000V range, plug the red lead into the 1000 V jack.. and read the voltage on the red scale marked AC using the 0-10 figures and multiply by 100.

For Measuring Output Voltage and Decibels -

1. Set the function switch at AC.
2. Plug the red test lead in the OUTPUT jack and the black one in the COMMON jack.
3. Connect the test leads across the circuit being measured with the black lead to the ground side.
4. Read the output voltage on the appropriate AC scale. This output voltage of the circuit actually contains both AC & DC components as usually occuring in amplifiers circuits, the DC component is blocked by a 0.1 MFD/400V capicitor connected in series with the OUTPUT jack. The blocking capacitor may alter the AC response at low frequencies but is actually ignored at audio frequencies.
5. To measure decibels, read the dB scale at the bottom of the dial marked from -20 to +10 dBs, in accordance with instructions for measuring A.C. Voltage. The dB readings on the scale are referenced to zero dB power level of .001 watt in 600 ohms, or 0.775 V AC across the 600 ohms. For 2.5 V range, read the dB scale directly, but for other ranges, add +12 dB to 10 V, +26 dB to 50 V and +40 dB to 250 V ranges.

For Measuring Direct Current

1. Set the function switch at +DC.
2. Plug the black test lead in the COMMON jack and the red test lead in the + jack for the current ranges of 1 ma, 10 ma, 100 ma, or 500 ma. For measuring the current in the 50 microamps range and 1000 amps ranges, the red test lead is to be plugged in the jacks marked 50 microamps & 1000 amps respectively.
3. Select the proper range for measurement and read the appropriate scale as explained earlier.

For Measuring Resistance

1. Adjust the zero ohm of the meter by rotating the ZERO OHM control of the meter while the test leads connected to jacks COM & + are shorted. If the pointer can't be adjusted to zero, replace the batteries of the meter.
2. Connect the test lead across the component and select the proper range of resistance.
3. Read directly the scale for R = 0 to 200 ohms, & multiply by 100 for R = 200 to 20,000, & by 1,000 for R above 20,000 ohms.
4. The function switch should be set at either +DC or -DC position.

Precautions :

1. When in doubt as to the actual voltage present, always use the highest voltage range as a protection to the instrument. If the voltage is within a lower range, the switch may be set for the lower range to obtain a more accurate reading.
2. Before making measurements, turn off the power to the circuit being measured. Discharge any capacitors in the circuit under measurement. Connect test leads to the circuit and turn on the power.
3. When measuring high voltages, never touch the meter, the test leads or the test probes with the power supply turned on. After making measurements, turn off power to the circuit being measured before disconnecting the test leads.
4. The range or function switches should be turned only when the power to the circuit is turned off or when the leads are disconnected.
5. Before measuring the resistance of a circuit, the power to the circuit should be turned off and the component be disconnected from the circuit.
6. Extreme care must be taken in using correct polarity of the meter while measuring DC voltage or current. When the function switch of the meter is at +DC, the COMMON and the +jacks of the meter have - & + polarities respectively, but when the function switch is turned to - DC, the polarity of the jacks is reversed.

Digital Multimeters : The most of the DMMs available in the laboratories are hand-held and auto-ranging having a power ON/OFF switch and separate jacks for measurements and are so simple to use that needs no explanation. DMMs are becoming more common and are replacing the analog MMs. in the laboratories today.

II-2 Power Supplies : The electronic circuits employing active devices need DC voltages for their operation which are derived from AC mains and should be free from ripples and independent of any variation in the AC mains voltage or in the load current drawn by the circuit itself. The Equipment providing such voltages are called Regulated Power Supply (RPS) Units. Fixed, Variable and Dual RPS are needed in the laboratories and therefore, Multi-output RPS are commonly available in various laboratories. As a sample RPS, the APLAB Transistorised RPS Unit (shown in Fig. 2.2) is described as follows:-

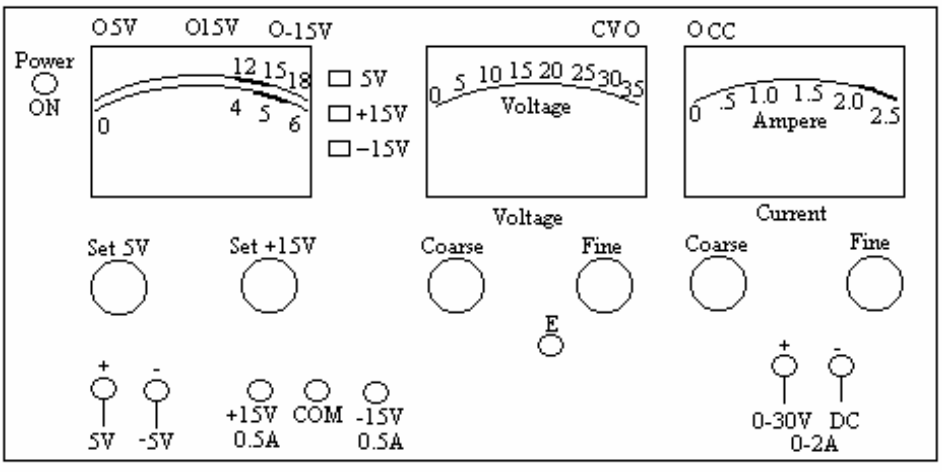


Fig.2.2 MULTI OUTPUT DC POWER SUPPLY (APLAB -7711)

The APLAB MultiOutput RPS Model 7711 : This power supply delivers three outputs.

(i) 0-30V DC output continuously variable with 2 Amps capacity. This output is suitable for general purpose.

(ii) 5V pre-set dc output with 5 Amps capacity suitable for Digital Integrated Circuits.

(iii) A symmetrical dual supply +15v, 0, -15v pre-set dc output with 500mA capacity, suitable for liniar IC circuits. All the outputs of Model 7711 are floating (i.e., neither any of the +ve o/p terminals nor any of the -Ve output terminals nor any point within the regulator circuitry is connected to ground).

Description :

Input & output termination - The unit works from 230V AC supply through a mains cable with a 3-pin plug. All the output terminations are provided on the front panel and are marked clearly.

Metering & panel controls -

+30 V/2A Section : Two separate front panel meters continuously monitor the output voltage & load current. The least count of the voltmeter is 0.5V on the scale 0-30V and that of the ammeter is 50 mA on 0-2.5 A scale. Coarse and Fine controls are provided on the front panel for setting the output voltage & current within the specified ranges.

Symmetrical Dual PS & +5V Sections: A single panel meter monitor either +15V or -15V or +5V section output with the help of selector push switch provided on the front panel. Meter has two scales. One is 4 to 6V and the other is 12-18V. The least count of the 4-6V scale is 0.2V and that of 12 to 18V scale is 0.5V. One separate control is provided to adjust the output voltage of +5V SECTION from 4.5V to 5.5V and another one to adjust output voltage of +&-15V SUPPLY SECTION from +&-12V to +&-18V. The maximum load current supplied by 5V section is 5.0 Amps. and that for Sym. Dual supply section is 500mA.

Protection & Indication :

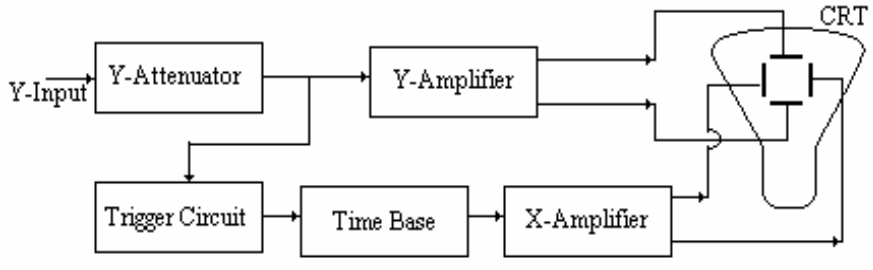
The outputs of all the three sections are fully protected against over loads & short circuits by means of fold back characteristics. The outputs automatically reset after removal of over load. A built-in "Crowbar Circuit" operates and reduces the output voltage below 2V in case output voltage tends to exceed the crowbar limit (approx. 6.2V) to protect the supply from over voltage.

The availability of the output voltages are indicated by the three red LEDs marked 5V, +15V & -15V provided on the front panel.

The regulation is less than 0.1% and the ripples are less than 1 mV. This supply can be used as CV or CC Supply. For settings the current limit of the 30V section, short circuit the output terminals and adjust the CURRENT COARSE & FINE controls until the panel meter reads the desired current. Leave the pots in this adjusted mode, the supply will now operate in within the set voltage & current limits and will cross-over from voltage mode to current mode when the load increases or vice-versa. The current limit of the other sections is pre-set, both output voltage & load current will start falling simultaneously.

II-3 Waveform Measuring Instruments : The most widely used wave form measuring instrument in the laboratories is an OSCILLOSCOPE, which displays rapidly changing voltages against "time" in the form of a graph seen as a bright trace on the screen of a Cathode Ray Tube (CRT), hence it is more frequently called a Cathode Ray.

Oscilloscope (CRO). In its simplest form, a CRO consists of the sections shown in the following Block Diagram :



Block Diagram

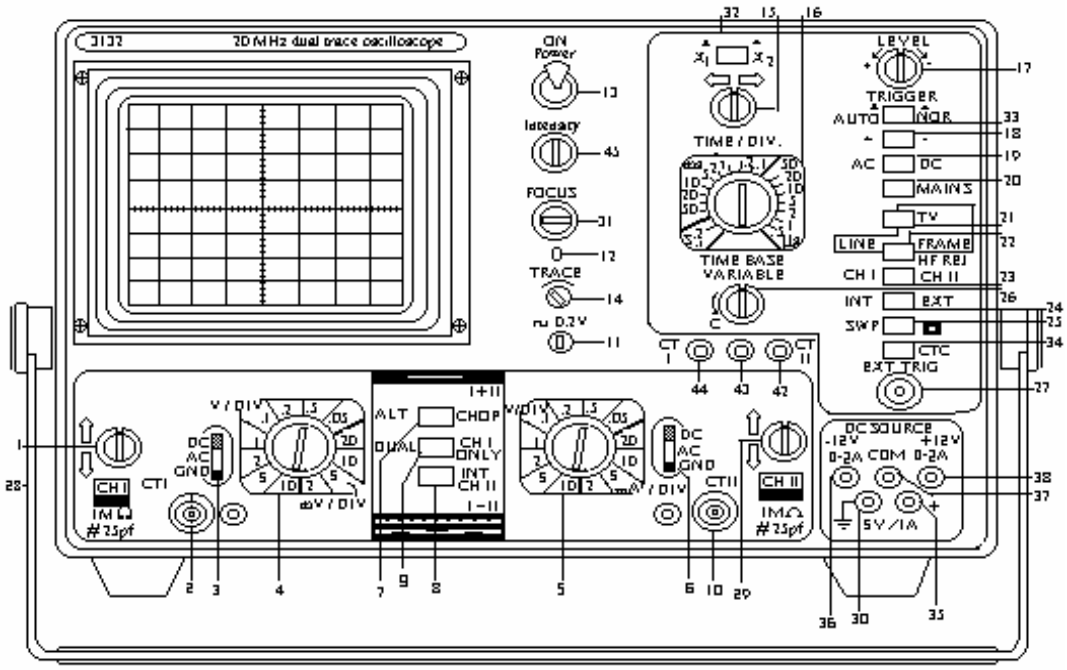


Fig. 2.3 FRONT PANEL VIEW OF AN OSCILLOSCOPE APLAB MODEL 3132

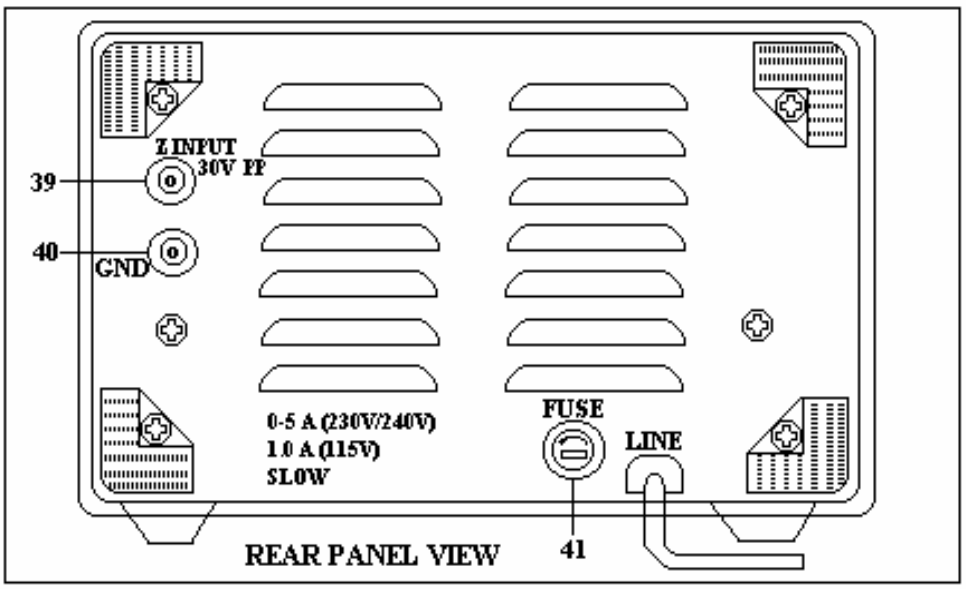


Fig. 2.4 REAR PANEL VIEW OF AN OSCILLOSCOPE APLAB MODEL 3132

The test signal is applied to the input of the vertical amplifier (Y), through an attenuator and hence to the vertical deflection plates of the CRT, at the same time the test signal is fed from the pre-amplifier stage of the vertical system to trigger circuit which process the signal and supplies a pulse which initiates the time base circuit. The time base generates a very accurate and linear ramp wave form, as accuracy is essential, this ramp is a low voltage signal and is therefore fed into an amplifier (X-amplifier) which applies the amplified ramp to the horizontal deflection plates (X plates) of the CRT. It can now be seen that with the test signal being applied to the Y-axis, and an internally generated signal varying with time being applied to the X axis, the scope is indeed plotting a graph of voltage against time. To enable measurements to be made, the CRT display area is divided into equal divisions on both the X & Y axis like a normal graph paper.

To make the best selection and use of a CRO, the following terms should be clearly understood .

(i) Sensitivity :-It is the minimum voltage applied to the vertical input of the CRO producing a vertical deflection of one division (cm) on the CRO screen. To measure small voltage level signals , the CRO of high sensitivity should be used.

(ii) Bandwidth :-It is the BW of the vertical amplifiers of the CRO. To display the high frequency non-sinusoidal signals with minimum distortion, the CRO of larger BW should be used. The BW of the CRO to be used should be greater than atleast ten times of the highest frequency of the signal to be displayed.

(iii) Input Coupling :- A three way selector switch is used to select either AC or DC coupling or ground. In DC coupling, the input signal is fed directly into the amplifier while AC coupling enables the CRO to block the DC component of the input signal and passes only the AC component of the signal to the Y amplifier. In the ground position, the input of the Y amplifier is grounded. It is important to know here that the input signal is not grounded in the ground position.

(iv) Maximum Input Voltage :- It is the maximum voltage that can be safely applied to the Y input of the CRO. For example, the Aplab Model 3132 specifies the maximum input voltage to be 400 Volts (DC + peak AC).

(v) Display Modes :- This term is normally given, while specifying a Dual Trace Oscilloscope in which there are two vertical channels - CH1 & CH2, each having a separate but identical Y-amplifier. The Display mode refers to the different possibilities of switching on the signals from the two channels. In CH1 or CH2 Mode, only signals fed into the CH1 or CH2 INPUT SOCKETS will be displayed on the screen. In the ALTERNATE mode, the signals from the two channels are displayed alternatively on the screen. But in the CHOPE mode, the two signals are displayed simultaneously at a chopped frequency (e.g.,250 KHz in case of Aplab Model 3132). In the ADDITION mode, the two signals are algebraically added, while in the INV mode, the difference of the signals fed to the two channels is displayed. In the X-Y mode, the CRO is used as an X-Y Plotter, wherein CH1 = Y-axis and CH2 = X-axis.

(vi) Time Base :- This circuit provides an accurate signal varying directly with time, which is applied to the X-plates of the CRT. The ramp generator is designed to be compatible with the BW of the vertical amplifier, so that at the fastest sweep, several cycles of the BW frequency can be displayed. The sweep speed is selected on the timebase control which is marked in seconds per division, in the 1, 2, 5 sequence. A variable control is also incorporated to increase the sweep speed on any setting and enables the waveform to be expanded so that a particular point can be investigated in more detail. Some CROs also incorporates a x5 expansion control to enable 5 times expansion for further detailed investigations.

(vii) Triggering :- As mentioned earlier the trigger circuit initiates the timebase so that the X- deflection sweeps in synchronism with the test signal applied at Y- input. Therefore all the modern models of CROs are having a combination of trigger circuit. & timebase (TB).

Two trigger modes called AUTO & NORMAL are incorporated in almost all CROs. In AUTO mode, the TB will trigger automatically on the mean level of the input signal. This is used for signals having frequencies above 50 Hz but it is not suitable for triggering at fast pulses with a relatively low repetition rate. For these applications the NORMAL mode of triggering is used. In this mode the trigger circuit is only initiated when a voltage selected by the trigger level control is present.

Trigger Source:- It is selected either internally from CH1 or CH2, or from external signal applied at EXT. TRIG. SOCKET, which should be in synchronism with the signal to be displayed.

Triggering from either +ve or -ve edge of the waveform can also be selected.

Some additional modes of triggering such as TV & MAINS are also incorporated in many CROs to get the stable display of the TV LINE & FRAME signals respectively.

(viii) LF & HF Rejection :- These are used for triggering the signal containing both high & low frequencies such as an A.M. Signal. To display a low modulation index signal, the TB is trigger with HF, so LF REJ is selected to reject the low frequency, likewise for the high mod. index AM signal HF REJ. is selected.

Measurement of amplitudes & frequencies etc. are explained in the experiments on CROs, however, as a sample, the functions of various controls of the APLAB DUAL TRACE CRO Model 3132 are given below.

FRONT PANEL CONTROL & THEIR FUNCTIONS (See Fig. 2.3 for control location)

POWER ON	(31)	Turns the Line input `ON'
INTENSITY	(45)	Controls the brightness of the display
FOCUS	(13)	Controls the sharpness of the display
TIME BASE	(16)	18 Step switch, to enable selection of 18 calibrated sweep speeds from 0.5 microsec/div to 0.2 sec/div in the 1-2-5 sequence.
TIME BASE VARIABLE	(26)	In C position (fully anticlockwise) the selected sweep holds indicated calibration. Clockwise rotation of the control increases the sweep speed. The fully Clockwise position increases the speed to approximately 2.5 times.
SWEEP MAGNIFIER	(32)	Magnifies sweep 5 times in X5 position
LEVEL	(17)	Variable control selects the trigger point on the displayed waveform.
AUTO/NORM	(33)	In **AUTO** mode, a trace is displayed in the absence of an input signal. The display is then automatically triggered for signals above 50 Hz depending upon correct setting of Trigger LEVEL control. In **NORMAL** mode, the trigger display appears only on correct setting of Trigger LEVEL control.

INT/EXT	(24)	In **INT** mode, the display triggers from signals derived from CH1 or Mains. In EXT mode, the display triggers from any other external source fed through EXT TRIG BNC SOCKET (27).
MAINS	(20)	Triggers from power Line frequency.
TV	(21)	Triggers from LF component of TV signal (TV frame) or TV line in combination with HF-Rej.
+/-	(18)	Selects trigger point on either +ve or -ve slope of the displayed wave form.
CH I / CH II	(23)	Selects trigger signal in INT mode derived from either CHI or CH II inputs.
AC/DC	(19)	Chooses trigger signal coupling.
HF Rej.	(22)	Introduces Low pass filter (20 KHz) in trigger coupling.
SWP/X-Y	(25)	Converts CH II input into X-channel and enables use of the scope as an X-Y scope (Y-input Via CH I)
CTC	(34)	Converts scope into a Dual component tester (with X-Y mode)
CTI	(42/43)	Input terminals for CHI of component tester-comparater.
CT II	(43/44)	Input terminals for CH II of component tester-comparater.
EXT TRIG /CT BNC	(27)	Input terminal for EXT TRIG signal and CT.
HOR Position	(15)	Controls the horizontal position of Control the display.
0.2V 	(11)	200 mV p-p, 1 KHz square wave calibration signal.
VERT POS Control	(1/29)	Controls vertical position of the display.
DC/AC/GND	(3/6)	Selects input coupling / grounding (grounds the amplifier input but the input signal is not grounded).
INPUT BNC CHI/Y	(2/10)	Input terminals to CHI/Y, CHII/X inputs.
TRACE ROTATION	(14)	Screw driver control to adjust horizontal tilt of the trace.
CH I /CHII(Attenuator)	(4/5)	12 Step compensated attenuator from 2mV/div to 10 V/div in 1-2-5 sequence.
DUAL / CH I	(8)	In CHI mode, CRO operates as single channel scope while in DUAL mode, it operates as dual trace CRO.
ALT / CHOP	(7)	Selects switching mode for the two channels while in DUAL operation. CHOP position is preferably used for signals upto 1 KHz.
INVERT CH II	(9)	The polarity of the signal to CHII is inverted.
ADD	(7/8)	Signals to CHI & CH II are algebraically added.
SUBS	(7/8/9)	Signal to CHII is subtracted from CHI.
GND	(30)	Ground terminal.

LED	(12)	Lights when Power is ON.
DC POWER SOURCE		
+5V	(30 & 35)	Gives +5V o/p (-ve grounded)
+12V	(38 & 37)	Gives +12V o/p on (38)
-12V	(37 & 36)	Gives -12V o/p on (36)
HANDLE	(28)	Used to mount scope in slant position.

REAR PANEL (Refer to Fig. 2.4)

Z-Modulation	(39)	Signal to this input modulates the brightness of the trace.30Vp-p signal is required for full blanking.
LINE FUSE	(41)	(5 X 20mm) , 500mA slow blow fuse.

Precautions

1. Avoid using the CRO in high temperature.
3. For using the CRO , select a location free from humidity, mechanical vibrations, strong magnetic fields and generation of impulse voltages .
4. Do not apply input voltage exceeding the maximum ratings. The input voltage to the vertical amplifier is upto 400V (DC+AC peak), the input for EXT. TRIG is upto 5V AC peak, or 5V DC, and the input to Z AXIS is upto 50V (DC+AC peak).
4. Do not increase the brightness of the CRO unnecessary.
5. Do not place any object on the CRO or cover the ventilation holes of the case.

FIRST TIME OPERATION OF THE CRO -Set controls as follows:-

POWER ON	Switch in OFF position
INTENSITY	Mid position
FOCUS	Mid position
ATTENUATOR I/II	50 mV/cm
CH I/CH II POSITION	Mid position
dc-ac-gnd	gnd
ALT / CHOP	ALT
DUAL / CH I	CH I (Pressed position)
NORMAL / INV II	Released position
TIME / DIV	1 ms/div
VARIABLE	CAL position(Fully anticlockwise)
x1 / x5	x1 position (Released position)
LEVEL	Mid position
AUTO / NORMAL	AUTO (Released position)
CH I/CH II	CH I (Released position)
INT / EXT	INT (Released position)
+ / -	+ (Released position)
ac / dc	ac (Released position)
TV	Released position
LINE/FRAME HF REJ	LINE (Released position)
MAINS	Released position
SWP / X-Y	SWP (Released position)
CTC	Released position
Horizontal Position	Mid position

Single Trace Operation : **Connect** the power cord to the correct AC supply and switch the instrument ON. **Set** the INTENSITY to mid position. After 30 seconds when the trace

appears, **adjust** FOCUS to get a sharp trace. Now **connect** a lead from square wave 0.2 V p-p socket to CHI amplifier input socket and **switch** input selector to AC. A square wave of 4 div. amplitude will be displayed. Now **put** input coupling switch to GND position. The signal is disconnected leaving a reference base line.

Dual Trace Operation . Now **feed** the square wave signal to CH I and CH II inputs and **set** DUAL/CHI, to DUAL position. **Switch** the input selectors to AC. The same signals will be displayed on both channels. **Press** ALT/CHOP switch to CHOP position. The two traces are now chopped at a frequency of approximately 120 KHz.

II-4 Signal Generators: The widely used test signals in the laboratories are Sine wave, square wave, positive and negative pulses, triangular and saw-tooth waves. The instruments used to generate these signals are usually called Function Generators.
In the following lines, the APLAB 3 MHz Function / Sweep generator (Fig. 2.5) is described:-

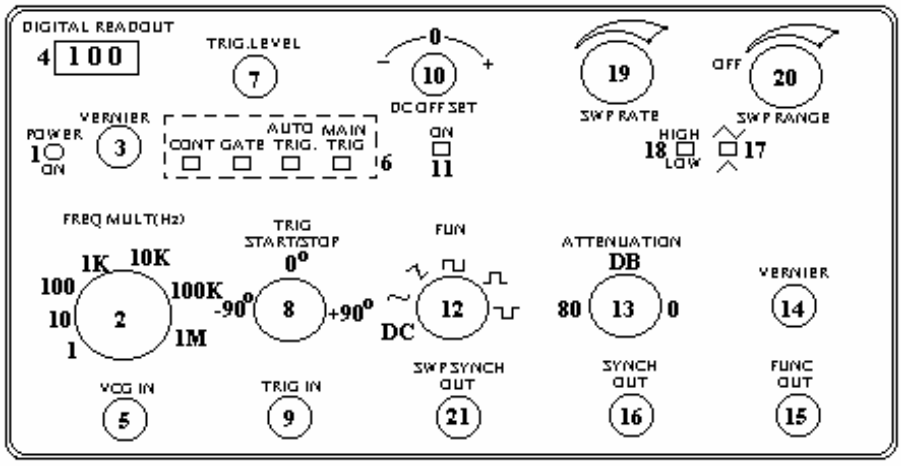


Fig. 2.5 APLAB 3 MHz Function/Sweep Generator Model 2054

MAIN FEATURES OF THE EQUIPMENT (Fig. 2.5)

* Wide range of frequencies from 0.02 Hz (i.e. 50 Secs.) to 3 MHz.
* Choice of six selectable waveforms.
* Digital readout for the output frequency.
* All outputs can drive 50 ohms terminations.
* Trigger and gate modes with adjustable Start/Stop controls.
* Bi-directional (i.e. Triangular) and unidirectional (i.e.Ramp) sweep.
- Swept-frequency sine wave output available on feeding an external triangular/saw-tooth waveform to the VCG IN input.

*Controlled pulses of precise rise & fall times are available.

OPERATING INSTRUCTIONS

FRONT PANEL CONTROLS & THEIR FUNCTIONS

1. POWER ON — Turns generator ON & OFF.
2. FREQ. MULTIPLIER — Selects one of the ten Freq. range settings in steps.
3. FREQ. VERNIER — A fine adjustment of the frequency.

4. VCG IN	Accepts 0 to 3V AC or DC voltages to vary the freq. of the outputs. When vernier is at min., span obtainable is 100 : 1.
5. MODE SELECTOR	
(a) CONT	Continuous output at FUNCTION OUT/SYNC OUT
(b)GATE	Continuous output at FUNCTION OUT/SYNC OUT for the duration of trigger signal at TRIG IN
(c) AUTO TRIG	DC Level output until generator is triggered by a signal at TRIG IN.
(d) MAN TRIG	Output is available only when this switch is pushed
6. TRIGG LEVEL	Sets the level of the signal at TRIG IN
7. TRIGG IN	Accepts 1V p-p to 10V p-p Ext.signal to trigger the generator.
8. DC OFFSET ON/OFF	Introduces DC offset in the output waveforms in ON position.
9. FN. SELECTOR	Selects one of the six output functions e.g. DC, Wave forms.
10. ATTENUATOR	Attenuates the o/p in 20 dB/Step
11. ATTEN. VERNIER	Gives fine control of attenuation.
12. FN. OUT	O/P connector
13. SYNC OUT	A TTL pulse for each cycle of generator is available
14. SWP MODE	Selects triangular or Ramp for sweeping the o/p freq.
15. SWEEP RATE	Selects the freq. of sweep signal
16. SWEEP ON/OFF	It is kept OFF when the Instt. is to be used as Function generator, and ON when used as sweep generator.
17. SWEEP SYNC	Gives signal for synchronising other equipment.

REAR PANEL

LINE FUSE/SOCKET	3-pin socket to feed line voltage to generator.This has an in-built fuse arrangement.

Precautions:

1. Select a location, free from high temperature, humidity, mechanical vibrations and dust.
2. Do not operate the equipment near strong magnetic fields or where impulse voltages are present.
3. Do not force any control of the generator, operate it smoothly.

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