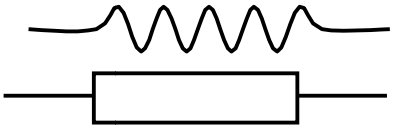
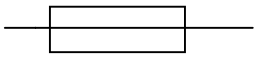
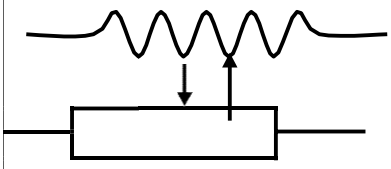
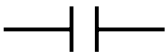
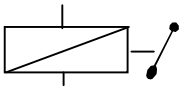
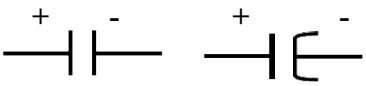
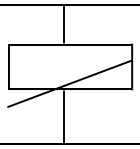
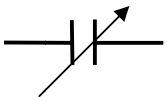
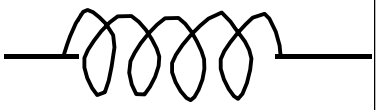
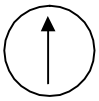
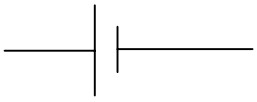
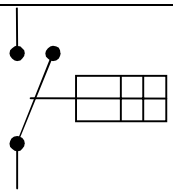
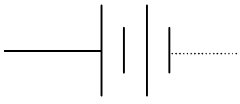
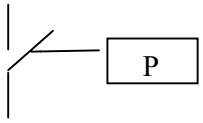
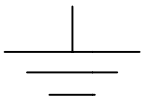
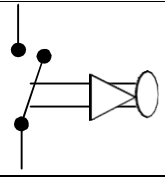
SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson-I: Fundamentals of Electricity **Session-1:** Symbols, Basic Concept of voltage and current, Ohm's law, Power law

ELECTRIC SYMBOLS			
Name & Letter Notation	**Symbol**	**Name & Letter Notation**	**Symbol**
Resistor R or r		Fuse Si or e	
Variable resistor or Potentiometer P or f		Circuit Breaker e	
Capacitor(Non-Polarised) C or K		Relay Re	
Polarize Capacitor or Electrolyte Capacitor C or K		Solenoid or Shut down coil (s)	
Variable Capacitor C		Speaker	
Inductor **L**		Galvanometer (g)	
Cell		Ignition Switch (b)	
Battery		Pressure Switch (b)	
Earth OD(OA)		Limit Switch Ls	

GENERAL :

Electricity cannot be weighed on a scale or measured into a container. But, certain electrical "actions" can be measured.These actions or "terms" are used to describe electricity; **voltage, current, resistance,** and **power**.

VOLTAGE:

Voltage is electrical pressure, a **potential force** or difference in electrical charge between two points. It can push electrical current through a wire, but not through its insulation.Voltage is measured in **volts**. One volt can push a certain amount of current, two volts twice as much, and so on. A **voltmeter** measures the difference in electrical pressure between two points in volts. A **voltmeter** is used in parallel.

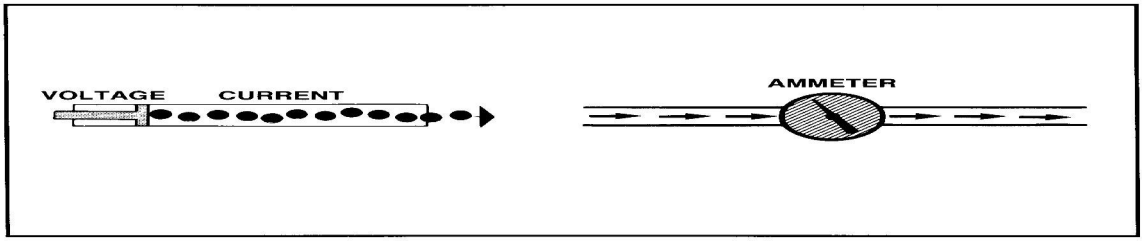
Voltage is pressure

Voltage	Basic Unit	Units for Very Small Amounts		Units for Very Large Amounts	
Symbol	V	μV	mV	kV	MV
Pronounced As	Volt	Micro-volt	Milli-volt	Kilo-volt	Mega-volt
Multiplier	1	0.000001	0.001	1,000	1,000,000

CURRENT:

Current is electrical flow moving through a wire. Current flows in a wire pushed by voltage. Current is measured in amperes, or amps, for short. An ammeter measures current flow in amps. It is inserted into the path of current flow, or in series, in a circuit.

Current is flow.



Current	Basic Unit	Units for Very Small Amounts		Units for Very Large Amounts	
Symbol	A	μA	mA	kA	MA
Pronounced As	Ampere (Amp)	Micro-ampere	Milli-ampere	Kilo-ampere	Mega-ampere
Multiplier	1	0.000001	0.001	1,000	1,000,000

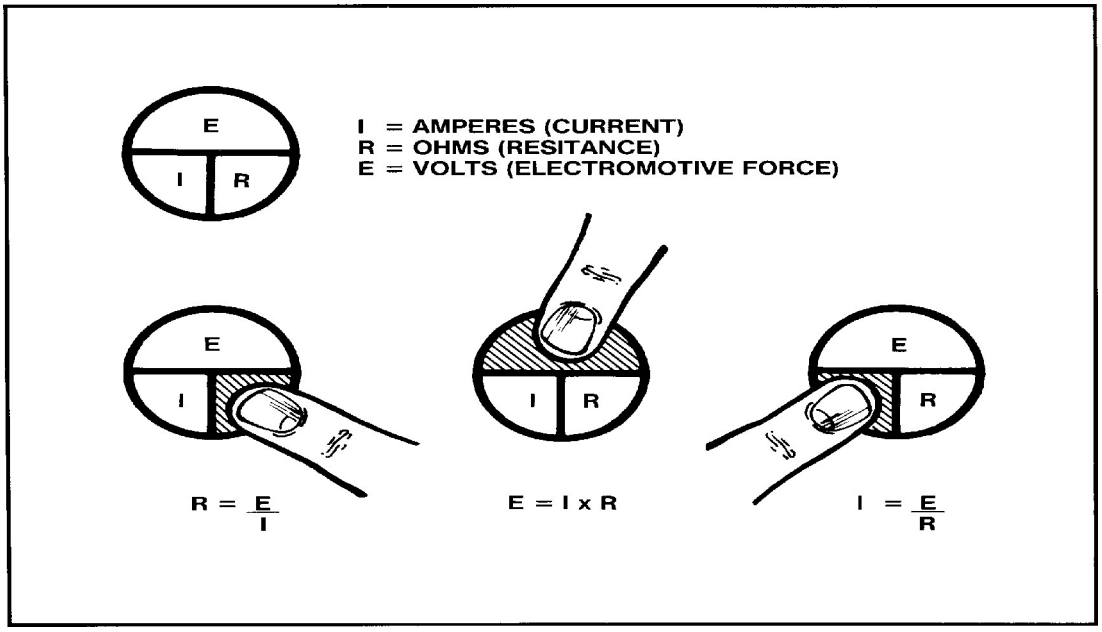
A simple relationship exists between voltage, current, and resistance in electrical circuits.Which can be explain with the help of Ohm's Law.

OHM'S LAW

The current in a circuit is directly proportional to the applied voltage and inversely proportional to the amount of resistance.

This means that if the voltage goes up, the current flow will go up, and vice versa. Also, as

the resistance goes up, the current goes down, and vice versa.



ELECTRIC POWER AND WORK:
Voltage and current are not measurements of electric power and work. Power, in watts, is a measure of electrical energy ... power (P) equals current in amps (1) times voltage in volts (E), P = I x E. Work, in watt seconds or watt-hours, is a measure of the energy used in a period of time ... work equals power in wafts (W) times time in seconds (s) or hours (h), W = P x time. Electrical energy performs work when it is changed into thermal (heat) energy, radiant (light) energy, audio(sound) energy, mechanical (motive) energy, and chemical energy. It can be measured with a waft- hour meter.

Power	Basic Unit	Units for Very Small Values	Units for Very Large Values	
Symbol	W	mW	kW	MW
Pronounced As	Watt	Milliwatt	Kilowatt	Megawatt
Multiplier	1	0.001	1,000	1,000,000

Power is the amount of work performed. It depends on the amount of pressure and the volume of flow.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–II: Electrical Components Session-2: Resistor: Definition, Unit,Symbol, Types ,Power Rating, Tolerance,

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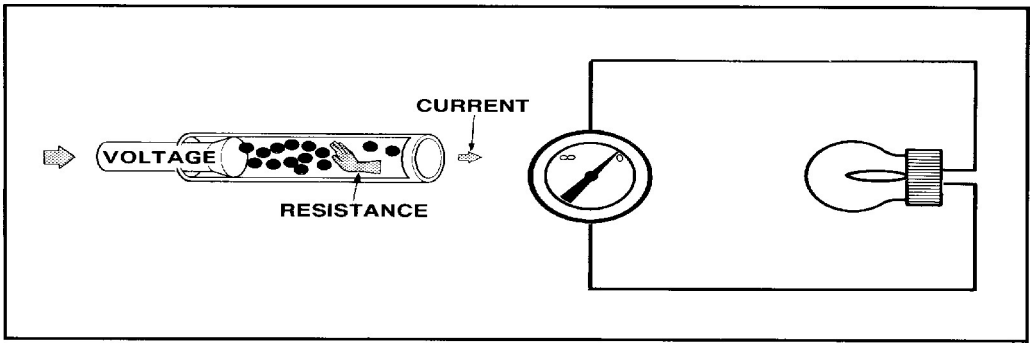
RESISTANCE:

Resistance opposes current flow. It is like electrical "friction." This resistance slows the flow of current. Every electrical component or circuit has resistance. And, this resistance changes electrical energy into another form of energy - heat, light, motion. This property of the component is called resistance, it's unit is "Ohm" Ω.

1 Kilo Ohms(KΩ) = 1000 Ohms

1 Mega. Ohms(MΩ) = 1,000,000 Ohms = 10^6 Ohms =1,000 KΩ

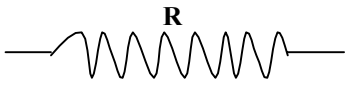
Resistance opposes flow.

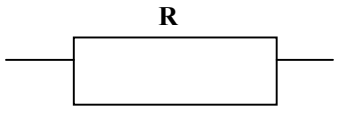


Resistance is measured in ohms. A special meter, called an **ohmmeter**, can measure the resistance of a device in ohms when no current is flowing.

Resistance	Basic Unit	Units for Very Small Amounts		Units for Very Large Amounts	
Symbol	Ω	μΩ	mΩ	kΩ	MΩ
Pronounced As	Ohm	Micro-ohm	Milli-ohm	Kilo-ohm	Mega-ohm
Multiplier	1	0.000001	0.001	1,000	1,000,000

Symbol:





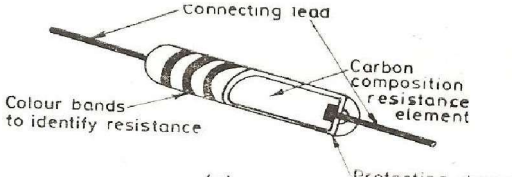
TYPES OF RESISTOR

Fixed type resistor

Variable type resistor (Potentiometer) value of Resistance can be varied

Carbon composition Resistor

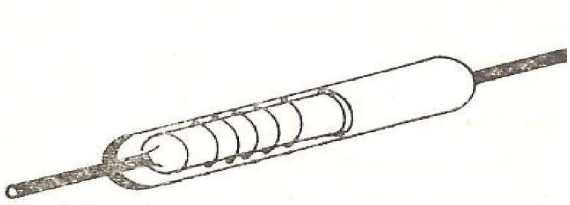
The resistive material is of carbon-clay composition. The leads are made of tinned copper. Resistors of this types are readily available in values ranging from few ohms to about 22MΩ



Wire wound resistor

In wire wound resistor a length of resistance wire such as nichrome is used, which is wound on to a round hollow porcelain core

The ends of winding are attached to there metal pieces inserted in the core. These resistors are available from 1Ω to 100 KΩ with wattage rating upto 200W



Properties of Resistor:

(1) Resistance is directly proportional to the length of conductor & inversely proportional to cross-sectional area of conductor.

$R \propto l/a$ or $R = \rho l/a$

Where l = Length of conductor

a = Cross sectional area.

ρ = Resistivity.

(2) Resistance depends upon nature of material & rises with rise in temp. in case of conductors & metals. In case of insulators, resistance decreases with the increase in temp.

(3) Resistance has no polarity. It can be used in any direction.

POWER RATING :

The power rating of a resistor is given by the maximum wattage it can dissipate without excessive heat. They are available in 1/8, 1/4 , 1/2, 1, 2, watt. The size of resistos varies with

wattage rating. The size of resistor increases as wattage rating increases.

$\mathbf{P = I^2 R}$ Where P = Power in Watt

I = Current in Amps

R = Resistance in Ohms

Resistor of appropriate wattage should be selected. Resistors of ¼ watt are widely used .

TOLERANCE:

The tolerance of resistor is a measure of the precision with which the resistor was made. It is the value in percentage, which may be less or more than the manufactured value of resistor. Resistors are available in following tolerances 0.1%, 1%, 2%, 5%, 10% and 20%. Generally resistors of 5% tolerance are used. Where accuracy is required, resistors of .1% to 1% are used.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–II: Electrical Components **Session-3:** Resistor: Colour coding, Combination, Application, Faults & Troubleshooting

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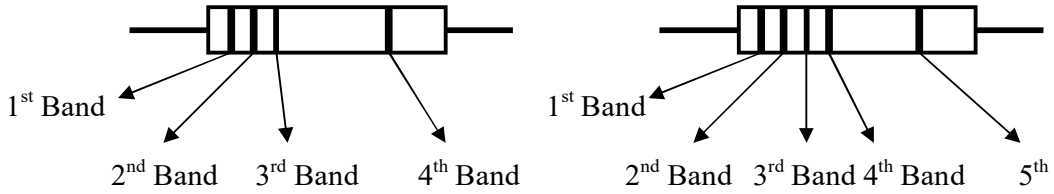
COLOUR CODING OF RESISTORS:

To indicate value of resistors colour coding technique is used instead of printing value directly on resistors which is followed by all manufacturers. In this technique bands of colours are printed on resistors generally 4-band and 5-band techniques are used to indicate value of resistors. 4-band colour coding is explain below.

4-band colour resistor **5-band colour resistor**



4-Band colour code Table

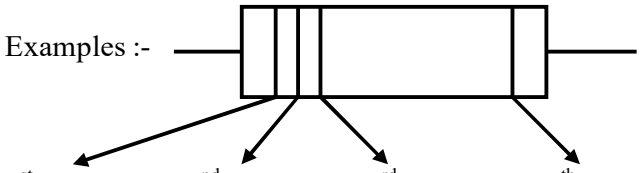
Colour	Ist & 2nd Band	3rd Band	4th Band
	Digit	Multiplier	Tolerance
Black	0	$10^0=1$	
Brown	1	$10^1=10$	1%
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	.1%
Gray	8	10^8	
White	9	10^9	
Gold	-	$0.1 = 10^{-1}$	±5%
Silver	-	$0.01 = 10^{-2}$	±10%
No colour	-	-	±20%

Mnemonics: As an aid to memory in remembering the sequence of colour codes given above, the Trainees can remember the following sentence (all the capital letters stand for colours):

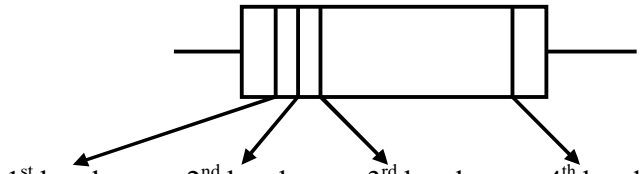
(a) B. B. R O Y in Grate Britain has a Very Good Wife.
0 1 2 3 4 5 6 7 8 9

(b) Bill Brown Realized Only Yesterday Good Boys Value Good Work.
© Bye Bye Rosie Off You Go Bristol Via Great Western.

Examples :-



1st band	2nd band	3rd band	4th band		
Yellow	Violet	Orange	Gold		
4	7	10^3	±5%	=	47 kΩ ±5%



1st band	2nd band	3rd band	4th band		
Blue	Gray	Brown	Gold		
6	8	10^1	±5%	=	680Ω ±5%

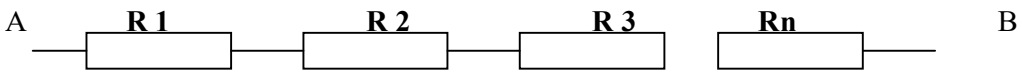
In practical electronic circuits, the values of the resistors required may lie within a very wide range (say, from few ohms to about 20 MΩ). In most of the circuits, it is not necessary to use resistors of exact values. Even if a resistor in a circuit has a value which differs from the desired (designed) value by as much as 20%, the circuit still works quite satisfactorily. Therefore, it is not necessary to manufacture resistors of all the possible values. A list of readily available standard values of resistors are given in Table .

Standard values of commercially available resistors:

Ohms (Ω)			**Kilohms (kΩ)**			**Megaohms(MΩ)**	
1.0	10	100	1.0	10	100	1.0	10
1.2	12	120	1.2	12	120	1.2	12
1.5	15	150	1.5	15	150	1.5	15
1.8	18	180	1.8	18	180	1.8	18
2.2	22	220	2.2	22	220	2.2	22
2.7	27	270	2.7	27	270	2.7	
3.3	33	330	3.3	33	330	3.3	
3.9	39	390	3.9	39	390	3.9	
4.7	47	470	4.7	47	470	4.7	
5.6	56	560	5.6	56	560	5.6	
6.8	68	680	6.8	68	680	6.8	
8.2	82	820	8.2	82	820	8.2	

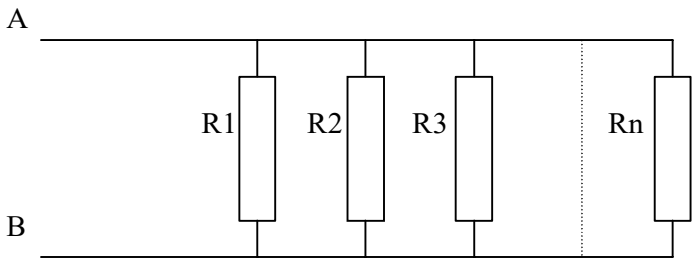
COMBINATION OF RESISTORS :

a) Series Connection :-



$$R_{total} = R1 + R2 + R3 + \ldots\ldots\ldots\ldots\ldots + Rn$$

b) Parallel Connection :-



$$1/Rt = 1/R1 + 1/R2 + 1/R3 + \ldots\ldots\ldots\ldots + 1/Rn$$

APPLICATION :

1. It apposes the current so it is used to reduce current in the circuit.
2. To drop the voltage (V = I.R.) and as potentiometer.
3. In timer circuit to set time (T=RC).
4. To set the gain of operational amplifiers.
5. In bulb and heaters.

TROUBLES:

General trouble in resistor is open circuit and it get short rarely.

How to check the Resistor in PCBs:

1. Select higher Ohmic(MΩ) range in Multi meter.
2. At least one terminal of the resistor should be taken out from PCB with the help of desoldering.
3. If Multi meter indicates open or short, it is faulty. If it indicates printed value then resistor is correct.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–II: Electrical Components **Session-4:** Capacitor: Definition, Unit, Symbol Types, Combinations, Application, Faults and Troubleshooting

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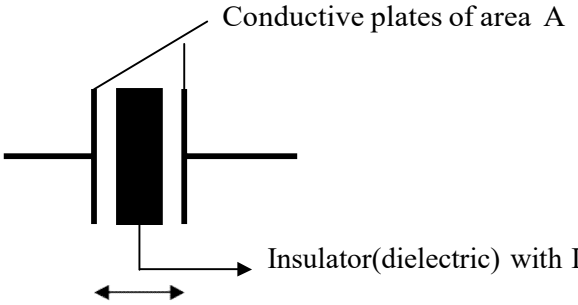
CAPACITOR:

Capacitor is a passive component, which can store electrical energy in the form of charge (Electrons) and release them whenever required .Capacitor's ability to store electrical charge is called **Capacitance** . It is represented by "C"and it's unit is Farad(F) but practically its small units are used like Micro farad(μF), Pico farad (pF) Nano Farad (nF).

1 Farad = 10^6 Micro farad(μF)	1 Micro farad(μF) = 10^{-6} Farad
1 Farad = 10^9 Nano farad(nF)	1 Nanofarad(nF = 10^{-9} Farad
1 Farad = 10^{12} Pico farad(pF)	1 Pico farad(pF) = 10^{-12} Farad

Construction :-Capacitor consists of two plates of conductive material separated by insulating material which is called **dielectric.**



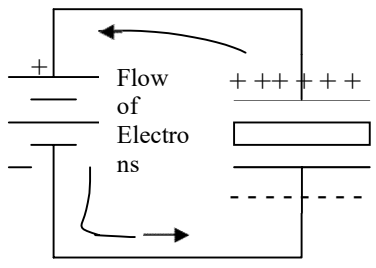
Material	Dielectric Constant $€_0$
Air	1.0
Mica	4.2
Paper	4.7
Ceramic	80

Capacitance of capacitor C a $\frac{A}{d}$

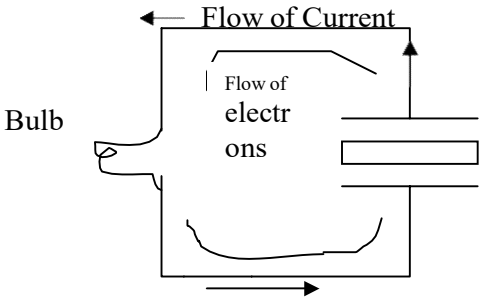
$$C = \frac{€_0 A}{d}$$

Capicitance of capacitor can be increased by increasing area of plates, decreasing distance between plates.

Charging and discharging of capacitor :-**The process of storing electrical charge(electrons) is called charging of capacitor. When capacitor release stored energy it is called discharging of capacitor.**



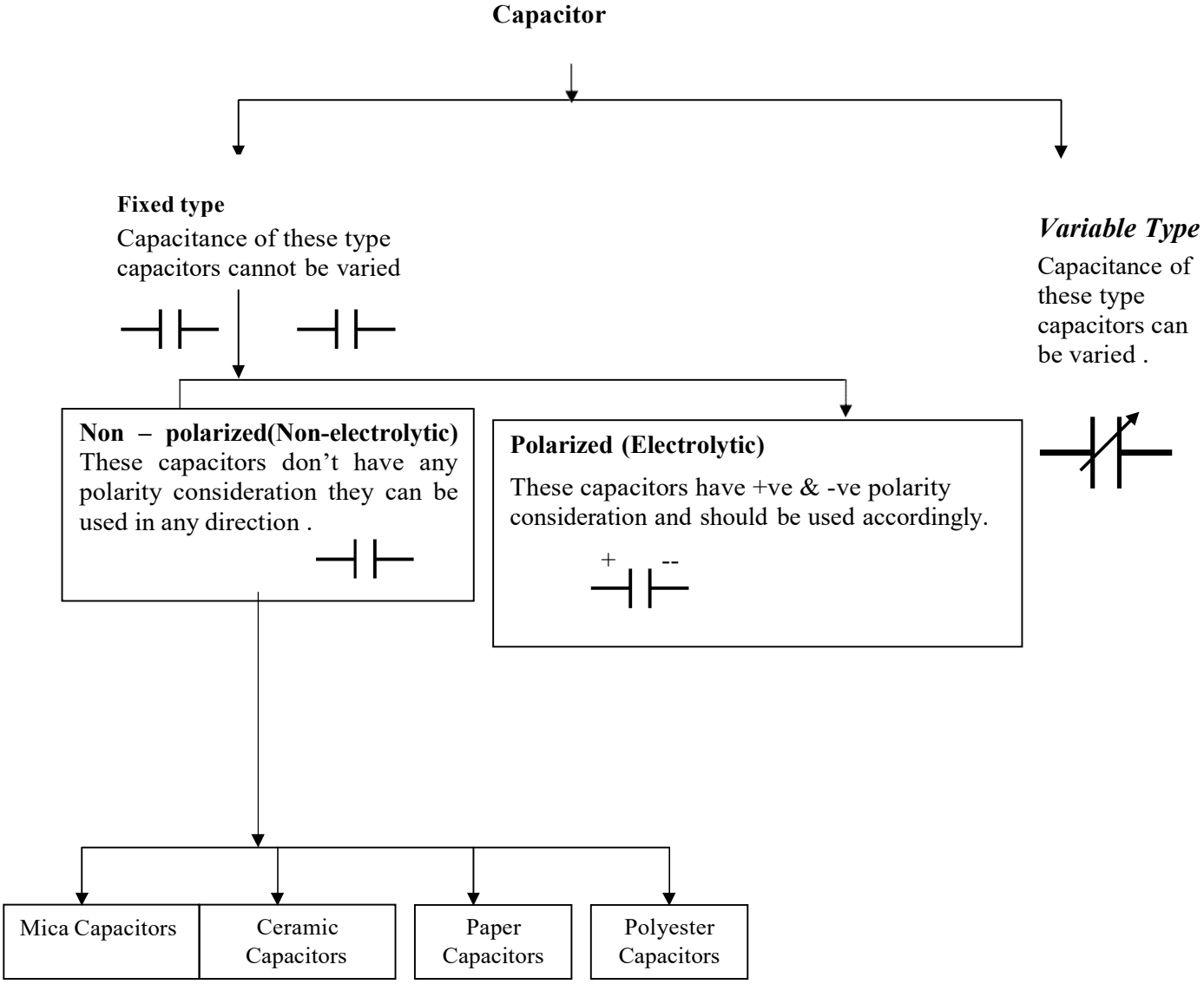
Charging of Capacitor



Discharging of Capacitor

TYPES:

Like resistors, capacitors are also fixed type and variable type. Fixed type capacitors are again of two types, non – polarized(Non electrolytic) and polarized (Electrolytic) . Some of the most commonly used non – polarized capacitors are mica, ceramic , paper capacitors . Polarized capacitors are electrolytic and tantalum capacitors . Variable capacitors are air-gang and trimmer capacitors .



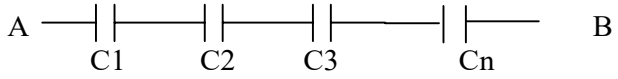
APPLICATIONS:

1. To store charge and discharge when required.
2. To pass A.C. signal and block D.C. signals.
3. To pass UN wanted signals.
4. In time delay circuits.
5. In tuned circuits.

COMBINATION OF CAPACITOR:

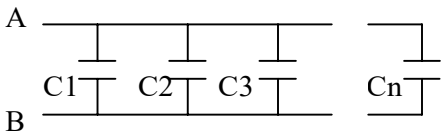
1. Series Combination :

Suppose C_1, C_2, C_3, C_n capacitors connected in series, then effective capacitance across the combination will be-



$$1/C \text{ total} = 1/C1 + 1/C2 + 1/C3 + \ldots.. + 1/Cn$$

2. Parallel Combination :



$$C \text{ total} = C1 + C2 + C3 + \ldots\ldots\ldots + Cn$$

APPLICATION:

(i) It is used in filter circuit.
(ii) It is used in timer circuit.
(iii) It is used as a memory.

TROUBLES IN CAPACITORS:

(1) Short circuiting
(2) Open circuiting
(3) Leakage

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–II: Electrical Components **Session-5:** Inductor: Definition, Unit, Symbol Types, Combinations, Application, Faults and Troubleshooting

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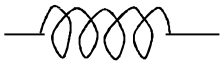
INDUCTOR :

When current flows through a coil of conductor wire then it generates a magnetic field. The magnetic field reacts so as to oppose the change in current. This reaction of magnetic field is called inductance, and the force it develops is called induced emf, and component producing inductance is called inductor. It is a fine length of wire wound on a core, frame or air core. Unit of inductance is Henry .

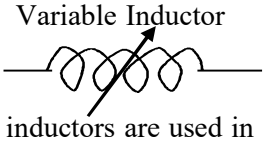
Mili Henry mH = 10^{-3} Henry
Micro Henry µH = 10^{-6} Henry

Types of Inductor

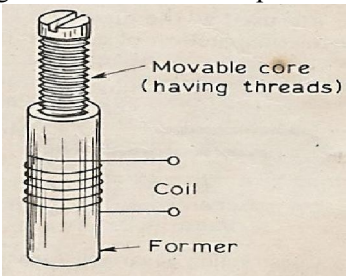
Fixed type Inductor



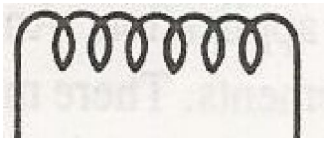
Variable Inductor



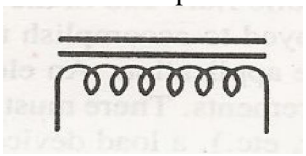
Variable inductors are used in tuning circuits of radio frequencies.



AirCore Inductor: When a coil is wound on a hollow insulting tube, this is called air core inductor. These are used where small inductance required .



IronCoreInductor: When Coil is wound on iron base, it is called iron core inductor.These are used where large inductance required.



APPLICATIONS: -

1.It is used as solenoid in hydraulic and pneumatic valves to shift spools.

2.In electromagnetic relay to change positions of contacts.

3.It is used as shut down coil in engines.

4. In filter circuits.

5. In oscillator circuits.

6. In tuning circuits.

7. In transformers to step down or step the A.C. voltage.

8. It is used as choke in florescent tubes.

9. It is used in motors and generators.

COMBINATION OF INDUCTORS:

a) Series Combination :

$L_t = L_1 + L_2 + L_3 + \ldots\ldots + L_n$

b) Parallel Combination :

$1/L_t = 1/L_1 + 1/L_2 + 1/L_3 + \ldots\ldots + 1/L_n$

TROUBLES OF INDUCTOR :-

(1) Short circuit.
(2) Open circuit.

Session-6: Electronics Model Room for demonstration, checking of Resistor, Capacitor and Inductor

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In Electronic model room these components are shown and checked with the help of Multimeters

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical **Session-7 :** Battery: Definition of Cell & Battery, Types, Construction, Specific Gravity, Rating

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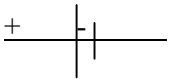
BATTERY :

The battery is the primary "source" of electrical energy on Automotives. It stores chemicals, not electricity. Two different types of lead in an acid mixture react to produce an electrical pressure. This **electrochemical reaction** changes chemical energy to electrical energy. Battery is the Combination of cells .

CELL:

It converts chemical energy to electrical energy. In cell electrical energy is store in the form of chemical energy. When battery is connected to any circuit then chemical energy is converted to electrical energy current flows from +ve to –ve terminal.

Symbol Cell: 

Battery

TYPES :

1. **PRIMARY CELL:** Non rechargeable cell is called Primary Cell.The chemical reaction totally destroys one of the metals after a period of time. Small batteries for Torch and radios are primary cells.

2. **SECONDARY CELL:** Rechargeable cell is called Secondary Cell .The metals and acid mixture change as the battery supplies voltage. The metals become similar, the acid strength weakens. This is called **discharging**. By applying current to the battery in the opposite direction, the battery materials can be restored. This is called **charging** . Automotive lead-acid batteries are secondary cells

CONSTRUCTION :

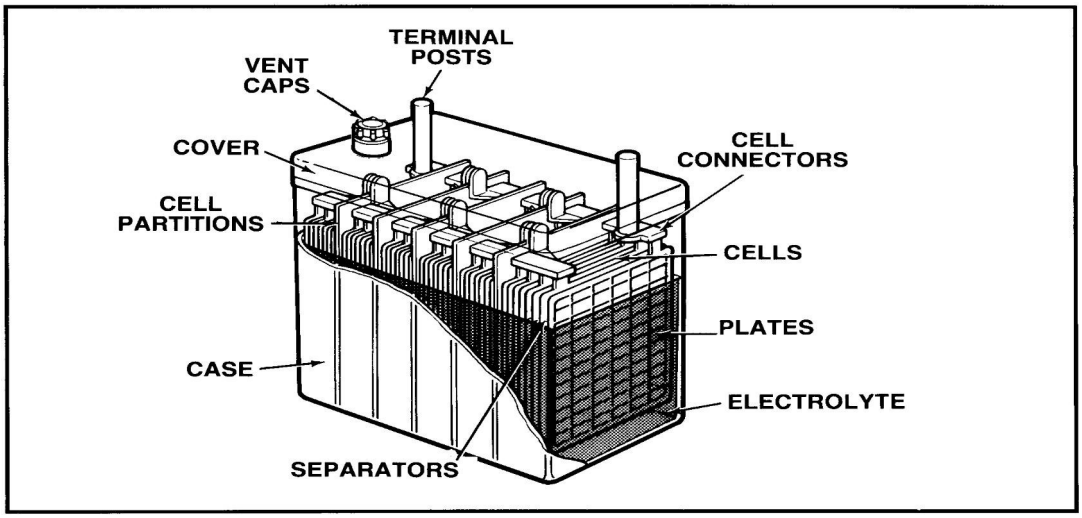
1. **Case:** Container which holds and protects all battery components and electrolyte, separates cells, and provides space at the bottom for sediment (active materials washed off plates) Translucent plastic cases allow checking .

2. **Cover:** Permanently sealed to the top of the case; provides outlets for terminal posts, vent holes for venting of gases and for battery maintenance (checking electrolyte, adding water).

3. **Plates:** Positive and negative plates have a grid framework of antimony and lead alloy. Active material is pasted to the grid ... brown-colored lead dioxide (Pb02) on positive plates, gray- colored sponge lead (Pb) on negative plates. The number and size of the plates determine current capability ... batteries with large plates or many plates produce more current than batteries with small plates or few plates.

4. **Separators:** Thin, porous insulators (woven glass or plastic envelopes) are placed between positive and negative plates. They allow passage of electrolyte, yet prevent the plates from touching and shorting out.

5. **Cells:** An assembly of connected positive and negative plates with separators in between is called a cell or element. When immersed in electrolyte, a cell produces about 2.1 volts (regardless of the number or size of plates). Battery cells are connected in series, so the number of cells determines the battery voltage. A"1 2 - volt" battery has six cells.



6. **Cell Connectors:** Heavy, cast alloy metal straps are welded to the negative terminal of one cell and the positive terminal of the adjoining cell until all six cells are connected in series.

7. **Cell Partitions:** Part of the case, the partitions separate each cell.

8. **Terminal Posts:** Positive and negative posts(terminals) on the case top have thick, heavy cables connected to them. These cables connect the battery to the vehicle's electrical system (positive) and to ground (negative).

9. **Vent Caps:** Types include individual filler plugs, strip-type, or box-type. They allow controlled release of hydrogen gas during charging (vehicle operation). Removed, they permit checking electrolyte and, if necessary, adding water.

10. **Electrolyte:** A mixture of sulfuric acid (H2SO4) and water (H2O). It reacts chemically with the active materials in the plates to create an electrical pressure (voltage). And, it conducts the electrical current produced by that pressure from plate to plate. A fully charged battery will have about 36% acid and 64% water.

SPECIFIC GRAVITY:-

Specific gravity means exact weight. The hydrometer compares the exact weight of electrolyte with that of water. **Strong electrolyte in a charged battery is heavier than weak electrolyte in a discharged battery.**

By weight, the electrolyte in a fully charged battery is about 36% acid and 64% water. The specific gravity of water is 1.000. The acid is 1.835 times heavier than water, so its specific gravity is 1.835. The electrolyte mixture of water and acid has a specific gravity of 1.270 is usually stated as "twelve and seventy."By measuring the specific gravity of the electrolyte, you can tell if the battery is fully charged, requires charging, or must be replaced. It can tell you if the battery is charged enough for the capacity, or heavy- load test.

CAPACITY RATINGS:

The battery must be capable of cranking the engine and providing adequate reserve capacity. Its capacity is the amount of electrical energy the battery can deliver when fully charged. Capacity is determined by the size and number of plates, the number of cells, and the strength and volume of electrolyte.

AMP-HOURS (AH) RATING :

The battery must maintain active materials on its plates and adequate lasting power under light-load conditions. This method of rating batteries is also called the 20-hour discharge rating. Original equipment batteries are rated in amp-hours. The ratings of these batteries are listed in the parts microfiche. The **Amp-Hour Rating** specifies, in amp-hours, the current the battery can provide for 20 hours at 80˚F (26.7˚C) while maintaining a voltage of at least 1.75 volts per cell (10.5 volts total for a 12- volt battery). For example, a battery that can deliver 4 amps for 20 hours is rated at 80 amp-hours (4 x 20 =80A).

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical Maintenance, **Session-8 :** Working of Lead-acid Cell & Battery. Testing by Hydrometer and Load tester

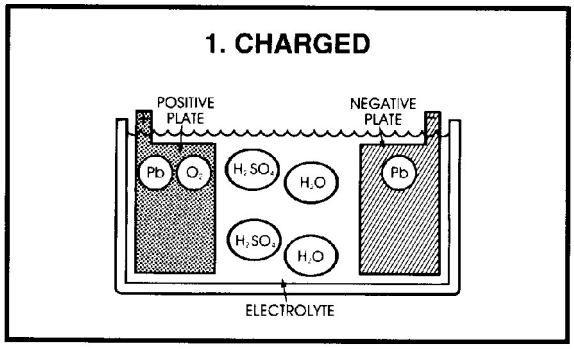
WORKING OF LEAD-ACID CELL & BATTERY :

A lead-acid cell works by a simple principle: when two different metals are immersed in an acid solution, a chemical reaction creates an electrical pressure.One metal is brown-colored lead dioxide (Pb02). It has a positive electrical charge. The other metal is gray colored sponge lead (Pb). It has a negative electrical charge. The acid solution is a mixture of sulfuric acid (H2SO4) and water (H20). It is called electrolyte.If a conductor and a load are connected between the two metals, current will flow. This **discharging** will continue until the metals become alike and the acid is used up. The action can be reversed by sending current into the cell in the opposite direction. This **charging** will continue until the cell materials are restored to their original condition.

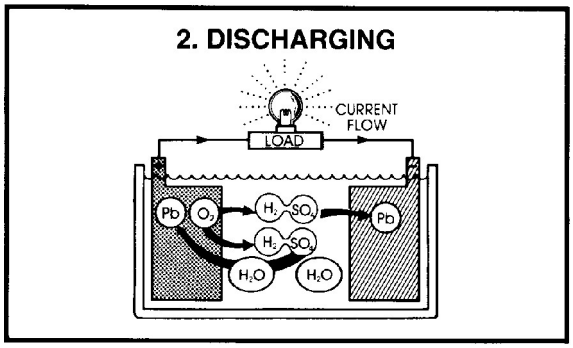
ELECTROCHEMICAL REACTION:

A lead-acid storage battery can be partially discharged and recharged many times. There are four stages in this discharging/charging cycle.

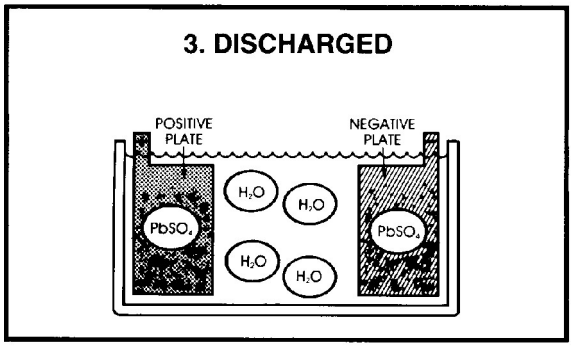
1. Charged: A fully charged battery contains a negative plate of sponge lead (Pb), a positive plate of lead dioxide (Pb02), and electrolyte of sulfuric acid(H2SO4) and water (H20).



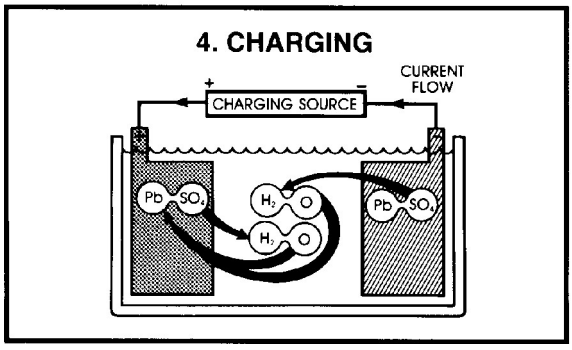
2. Discharging : As the battery is discharging, the electrolyte becomes diluted and the plates become sulfated. The electrolyte divides into hydrogen (H2) and sulfate(S04) . The hydrogen (H2) combines with oxygen (0) from the positive plate to form more water(H20). The sulfate combines with the lead (Pb) in both plates to form lead sulfate (PbS04)



3. Discharged: In a fully discharged battery, both plates are covered with lead sulfate (PbSO4) and the electrolyte is diluted to mostly water (H2O).



4. Charging: During charging, the chemical action is reversed. Sulfate (S04) leaves the plates and combines with hydrogen (H2) to become sulfuric acid (H2SO4). Free oxygen (02) combines with lead (Pb) on the positive plate to form lead dioxide (Pb02). Gassing occurs as the battery nears full charge, and hydrogen bubbles out at the negative plates, oxygen at the positive.



TEST PROCEDURE BY HYDROMETER:

The following steps outline a typical procedure for performing a state-of-charge test:

1 . Remove vent caps or covers from the battery cells.

2. Squeeze the hydrometer bulb and insert the pickup tube into the cell closest to the battery's positive (+) terminal.

3. Slowly release the bulb to draw in only enough electrolyte to cause the float to rise. Do not remove the tube from the cell.

4. Read the specific gravity indicated on the float. Be sure the float is drifting free, not in contact with the sides of top of the barrel. Bend down to read the hydrometer a eye level. Disregard the slight curvature of liquid on the float.

5. Read the reading of the electrolyte.

6. Record your readings and repeat the procedure for the remaining cells.

LOAD TESTING :

While an open circuit voltage test determines the battery's state of charge, it does not measure the battery's ability to deliver adequate cranking power.A **capacity**, or **heavy-load**, test does. A Sun VAT-40 tester is used. If another type of tester is used, follow the manufacturer's recommended procedure.

The following steps outline a typical procedure for load testing a battery:

1. Test the open circuit voltage. The battery must be at least half charged. If the open circuit voltage is less than 12.4v, charge the battery.

2. Disconnect the battery cables, **ground cable first**

3. Prepare the tester:
   - Rotate the Load Increase control to OFF.
   - Check each meter's mechanical zero. Adjust, if necessary.
   - Connect the tester Load Leads to the battery terminals; RED to positive, BLACK to negative.
   - Set Volt Selector to INT 18V. Tester voltmeter should indicate battery open-circuit voltage.
   - Set Test Selector to #2 CHARGING.
   - Adjust ammeter to read ZERO using the electrical Zero Adjust control.

4. Connect the clamp-on Amps Pickup around either tester load cable (disregard polarity).

5. Set the Test Selector Switch to #1 STARTING.

6. Load the battery by turning the Load Increase control until the ammeter reads **3 times the amp- hour (AH) rating or one-half the cold-cranking ampere (CCA) rating.**

7. Maintain the load for **no more than 15 seconds** and note the voltmeter reading.

8. Immediately turn the Load Increase control OFF.

9. If the voltmeter reading was 10.0 volts or more, the battery is good. If the reading is 9.6 to 9.9 volts, the battery is serviceable, but requires further testing. Charge and re-test. If the reading was **below 9.6 volts, the battery is either discharged or defective.**

NOTE: Test results will vary with temperature. Low temperatures will reduce the reading. The battery should be at operating temperature.

MAINTENANCE OF BATTERY:

Maintenance of battery of battery is done in 50-hour schedule. Which is as under.

1. Check the electrolyte level in each cell of the battery (daily). The level should be 10-15 mm above the plates. If not then top up with distilled water.
2. Check the specific gravity of each cell. It should be 1.180-1.280.
3. The connection should be tight and clean.
4. Put petroleum jelly on the terminal.
5. The vent hole should be cleaned.
6. The Voltage of battery should be checked by multi meter. It should be 2.1 volt in full charge condition.
7. Clean the battery with water.
8. Check the rubber pad , if found damaged then replace it.

PRECAUTIONS:-

1. While removing the connections of battery remove the negative terminal first and then the positive terminal.
2. Use proper tools.
3. Don’t take any lighted articles near to the battery.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical Working, **Session-9 :** Alternator, Regulator, Construction, Maintenance and Trouble-shooting

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ALTERNATOR :

The Alternator converts mechanical energy into electrical energy when the engine is running. This energy is needed to operate the loads in the vehicle's electrical system as well as charging the Batteries., it sends current into the battery to maintain the battery's state of charge. Mechanical energy is transferred from the engine to the alternator by a grooved drive belt on a pulley arrangement. Through electromagnetic induction, the alternator changes this mechanical energy into electrical energy. The alternating current generated is converted into direct current by the rectifier, a set of diodes which allow current to pass in only one direction.

AC5R ALTERNATOR: AC5R alternators with inbuilt 440 Regulators are designed and matched as battery charging systems for Road Vehicles, Marine and Stationary engines. All models are basically the same but with minor variations to provide different voltages, cutting-in-speeds, methods of mounting etc. to suit individual requirements. Special finish is given to machines for Marine application.

General: The Alternator is a 3 phase machine of the revolving field and stationary armature type. Its output from the stator windings is rectified by means of built-in-silicon diodes in heat sinks mounted within the slip ring end shield. Output control is effected by varying the rotor excitation. The machine is self limiting in terms of output current. Cooling is provided by a radial fan mounted on the drive end of the rotor shaft. The standard machine is insulated return version. The Regulator is housed in the Alternator itself.

Terminal Arrangement: The alternator has three terminals i.e. positive terminal, negative terminal and warning lamp terminal 'WL'.

Rectifier: The rectifier pack comprises of nine silicon diodes, six main out put diodes and three field diodes mounted on suitable heat-sinks.

Rotor: Forged claw or pressed claw rotors are used. A pair of four fingered claws envelope the field coil and when finally assembled to the main shaft from the 8 pole imbricated rotor. The ends of the windings are brought out and connected to two slip rings at the end of the rotor assembly. The rotor is supported by ball bearings housed on the two end brackets.

Stator: The stator assembly comprises of a pack of laminations housing a three phase winding in the slots. The stator is held in position by the drive end (D.E.) and slip ring end (SRE) shields.

In-built Regulator:This is a fully transistorized device with no moving parts, requiring no service attention. The transistors, diodes and resistors are fixed on a printed circuit base and then encapsulated. No cutout relay is necessary as the diodes in the alternator prevent reverse currents from the battery flowing through the stator when the machine is stationary or when generating less than the battery voltage. As the alternator is self limiting in current output the regulator has only to control voltage which it does by regulating the alternator field current.The regulator is housed in the Alternator in between SRE shield and cowl by means of three studs.

OPERATION OF THE ALTERNATOR:

Initial excitation: When the ignition switch (or equivalent control switch for diesel engines) is switched 'ON' a small current flows from the battery through the warning lamp to the rotor field winding. At this stage the warning light is illuminated and the rotor is partially

magnetized.When the engine is started and the partially magnetized rotor rotates within the stator windings 3 phase alternating current (a.c.) and rapidly rising voltage is generated.

Self excitation:A portion of generated alternating current (A.C.) is rectified to direct current (D.C.) by the three field diodes incorporated in the rectifier pack. Output current from the field (auxiliary) diodes supplement the initial current flowing through the rotor field winding from the battery, causing an increase in the magnetic influence of the rotor and resulting in self excitation of the alternator. As the rotor speeds and generated until the Alternator becomes fully excited.

Charge indication: During the rise in generated output voltage (reflected at WL terminal) the warning lamp is extinguished as the generated voltage applied to one side of the warning lamp rises above the battery voltage applied to the other side of warning lamp. This normally indicates that the alternator is the developing its main battery-charging current.

Output Control: The main battery charging current is rectified from a.c. to d.c. by the six main output diodes in the rectifier pack which function as a full-wave bridge rectifier circuit.The Alternator output is controlled by the in-built 440 regulator. The regulator functions as an electronic control switch of the rotor field winding circuit switching the circuit 'OFF' and 'ON' at a very high frequency to maintain the alternator output voltage (and so the current) at a predetermined and safe working limit.

MAINTENANCE:

i) **General:** Keep the alternator reasonably clean and ensure that ventilation slots or air spaces are clear are unobstructed. Check mounting bolts for tightness.

ii) Belt: Ensure that the driving belt on the alternator is in good condition and is neither too slack nor too tight. If necessary the fan belt tension should be adjusted to obtain approximately 1|2"-3|4" deflection of the belt when pressed at midway of the longest point between pulleys.

NOTE: A slack belt will rapidly wear and because of slip may not drive the alternator at the required speed. Too tight a belt will impose severed side thrust on the bearings and seriously shorten their life.

iii) **Battery:** Check with a hydrometer the specific gravity of the electrolyte in each of the battery cells to ensure that the battery is in good condition. Check for the tightness of its terminals. The specific gravity of the electrolyte should be uniform in all the cells. If the battery is found to be discharged it should be independently recharged or substituted before proceeding to further checks.

iv) **Brush Gear:** Check brushes once in 20000 kms. Renew the brush and spring assemblies if the overall length of the brushes are worn to or less than 7.9 mm (0.312"). If brushes are satisfactory but require cleaning use a petrol moistened cloth.

v) **Rotor slip rings:** The slip ring surfaces should be clean and smooth. If the rings are burnt or unclean and require refinishing the surfaces may be cleaned with a piece of very fine emery paper.

vi) **Bearings:** Check bearing for every 20,000 kms. And renew if worn.

PRECAUTIONS:

i) Ensure all connections are secure and clean.

ii) Ensure that no connection in the charging circuit, including battery, is broken while the engine is running.

iii) Observe correct polarity when refitting the vehicle battery or when using a slave battery to start the engine.

iv) Do not flash the alternator output leads to check its working

v) Disconnect all alternator terminals while carrying out any welding on the vehicle.

vi) Ensure that the alternator is not mounted close to the exhaust manifold without any protection.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical **Session-10 :** Self starter: Construction, Working, Maintenance and Troubleshooting

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SELF STARTER :

Starting the engine is possibly the most important function of the Machine's electrical system. The starting system performs this function by changing electrical energy from the battery to mechanical energy in the starting motor. This motor then transfers the mechanical energy, through gears, to the flywheel on the engine's crankshaft. During cranking, the flywheel rotates and the air-fuel mixture is drawn into the cylinders, compressed, and ignited to start the engine. Most engines require a cranking speed of about 200 rpm.

Self starter are designed for use on the larger types of engine, where because of the high inertia of flywheel and crankshaft, it is necessary for the starter pinion to engage the engine flywheel before the starter develops full torque, thus avoiding heavy engagement shock and excessive wear on gear teeth. Engagement between starter and engine is effected by an axial movement of the complete armature assembly and it is from this movement that the term 'Axial' starter is derived.

Construction :

The field windings of the machines consist of a main series winding, an auxiliary series winding and shunt winding. A solenoid operated two stage switch forms an integral part of the starter and is used to control the starting cycle, so that only a small switch to handle the solenoid current is required externally.

Working:

When starter switch is operated, the first stage contacts on the solenoid switch close and a small current passes through the auxiliary field windings, causing the armature rotate slowly. Simultaneously the complete armature assembly is drawn towards the driving end of the machine by the magnetic field set up in the winding and the pinion is brought into mesh with the engine flywheel gear. As the armature nears the end of its axial travel, a tripping disc operates the trigger on the solenoid switch, causing the second stage contacts to close and complete the circuit to the main series winding. The starter then exerts its full torque on the engine. When the starter button is released, the armature is return to its disengaged position by the coiled spring on the armature plunger.

The auxiliary shunt windings are arranged so as to hold the pinion in mesh until the starter push button is released; this reduces the number of engagements used to start heavy engines as the pinion will remain in mesh despite irregular engine firing. The starter is fitted with an overload clutch interposed in the drive between armature and pinion. The clutch has a slipping torque of about twice the lock torque of the starter but below the shearing strength of the pinion teeth and is thus an effective safeguard against the teeth of the pinion being sheared due to excessive load.Where required oil sealing precautions are taken comprising an oil seal in the driving end shield and a rubber sealing ring inside the pinion.

Maintenance :

Examine starter to ensure that the mounting bolts are securely fastened and all electrical connections are clean and tight. The cable should be examined for fractures particularly at the point where the cables enter the terminal lugs. The cable insulations must be free from signs of chafing and deterioration due to oil, etc.

Brush Gear- Check that the brush leads are clear of any obstruction likely to impede movement and see that the brushes are free in their holders by first lifting brush spring and gently pulling on the brush leads. If a brush is inclined to 'stick' clean the inside of the brush holder with a clean cloth moistened in petrol. Be sure to replace the brush in its original position so that the curvature of its contact surface conforms accurately with commutator periphery.Always ensure that a minimum of .045" clearance is there between the brush holder throughout. If necessary this can be achieved by rubbing down the brushes using 400 grade emery and a sheet of glass. However, it is emphasized that no attempt should be made to file the brush boxes to obtain the recommended clearance.

The brush should be well bedded i.e. worn to the commutator periphery over at least 80 percent of their contact area. If not, lift each brush from commutator and wedge in position with spring. Wrap a strip of very fine glass paper (do not use emery cloth) or caborundum paper around the commutator with abrasive side outwards. Lower the brush (or brushes) in one brush gear arm on to the glass paper and bed to the correct shape by drawing the glass paper backwards and forwards over the commutator. Raise the finished brushes and repeat the bedding procedure for the brushes on the other brush gear arms in turn. After bedding, each brush must be removed from its holder and all traces of dust and abrasive cleared away, preferably using compressed air or some form of hand bellows. Examine the brushes to ensure that no particles of abrasive are embedded in their contact surfaces.The brushes must be renewed if they are worn to approximately 13 m which is half of the original length or to a point where springs no longer provide effective pressure. It is essential that brushes are fitted in complete sets and under no circumstances should brushes of different grade be used together. To be sure of obtaining the correct grade brush, always specify Lucas-TVS Spares (Brush Part No. 9030-698A). This can be bought from any authorized Lucas-TVS Agent. Replacement brushes must be always bedded before use as described earlier.

Commutator

The commutator surface should be clean and entirely free from oil any trace of which should be removed by pressing a dry clean fluff less cloth against the commutator while the armature is hand rotated. On starters fitted to engines with wet flywheel an excessive amount of oil may indicate a defective oil seal, in which case the starter must be removed from the engine and completely overhauled.If the commutator is dirty or badly discoloured, lift the brushes and wedge in position with their springs. Wrap a strip of very fine glass paper around the commutator with the abrasive side inwards and draw the glass paper backwards and forwards over the commutator while slowly rotating ar4mature until surface is clean. Remove all traces of dust and abrasive using compressed air or hand bellows.Finally, lower the brushes on the commutator and carefully replace the commutator cover.

Lubrication

The drive end bearing is lubricated by oil (Telluse 33) from a large reservoir contained in the drive end shield. Refilling can be done when the starter is dismantled during overhaul periods. Lubrication of starter components which can be done at overhaul period is as follows.

LOCATION	LUBRICATION	INSTRUCTION
DE Bearing	Shell Tellus 33	Wick and felt pad saturate before assy. Top up with 8 ccs. Oil. Light oil.
Pinion Sleeve & Helix	Shell Telluse 33	Light oil.
Mating inner race	Shell Telluse 33	Saturate before assy.
Felt seal in trip plate	Shell Telluse 33	
Clutch plate	Caltex Marfax 3HD or Shell Nerita 3 Grease	Grease both sides of plates before assy.
Return spring on armature plunger assy		Strongly grease the spring and smear the plunger shaft. Smear with grease.
Inner race fiber thrust washer	Shell Retinax or Shell Alvania 3 grease	Lightly grease the surface.
DE shaft & pinion bore		Smear with grease.
CE Brg. Bush, Pin and thrust washer		

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical Operation, **Session-11 :** Relay: Definition, Construction & Types, Pindiagrams, Testing

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RELAY : - Relay is an electromagnetic device which operation is controlled by electrical signal when relay operates it provides switching of other electrical & and electro-hydraulic components i.e relay & solenoids. It works on electromagnetic induction principle ie when current flows in a conductor in the form of coil it becomes magnet and when current stops it demagnetizes .

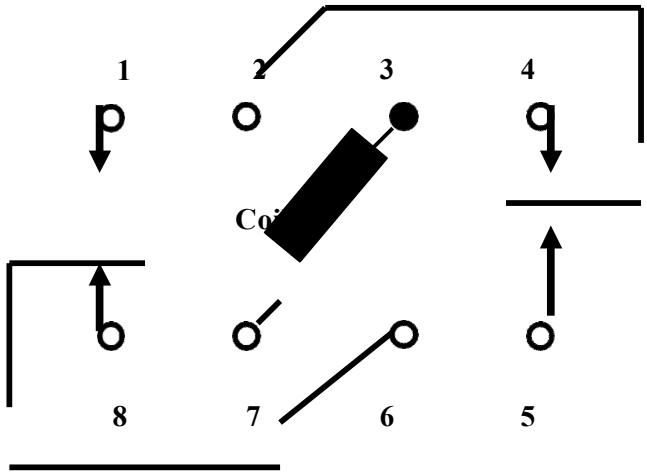
Generally relay have multi contacts. Which are of two types NC (Normally close) and NO (Normally Open) when relay is "OFF" some contacts are close which are called normally closed**(NC).** Open contacts are called normally open **(NO).** When relay operates NC contacts become open and NO contacts become close.

Different Types of Relays & their Pin Diagrams used in Machines :-

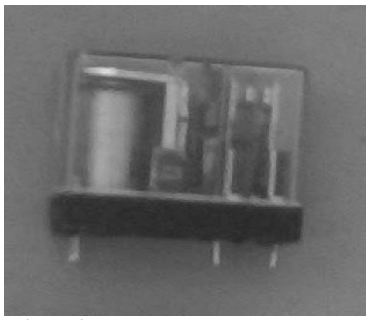
ELT - 663:

This relay is 8-Pin relay operated by 24V. This relay has two NC and two NO contacts. This relay is used in Lining PCB, lifting PCB, Tamping Unit control PCB etc of CSM, Duomatic & Unimat.

Pin Diagram

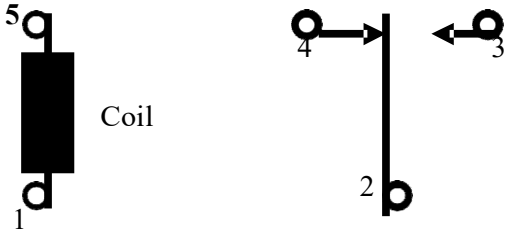


ELT - 1218:



This relay is 5-Pin relay operated by 24V. This relay has one NC and one NO contact. This relay is used in Lighting and horn circuit of CSM, Duomatic & Unimat.

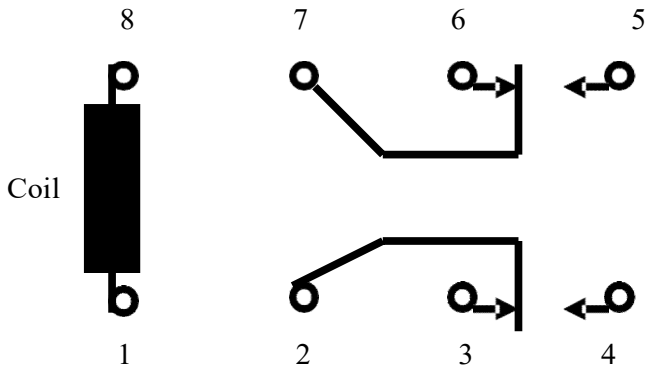
Pin Diagram



ELT – 7045:

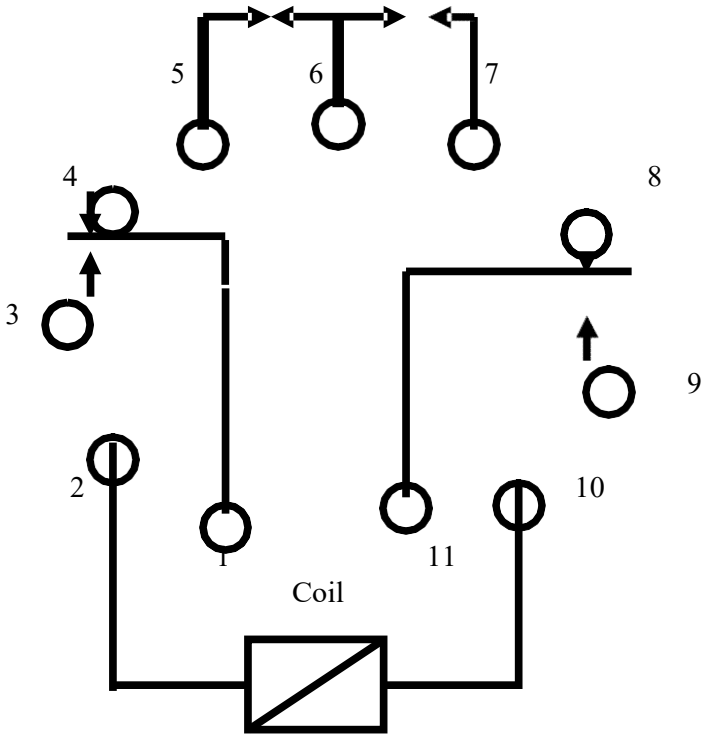
This relay is 8-Pin relay. There are two types of 7045 relays are available one operates on 24V and other on 12V. These relays have two NC and two NO contacts. These relay are used in CSM , 09-3X and Unimat .

Pin Diagram



ELT – 7010:

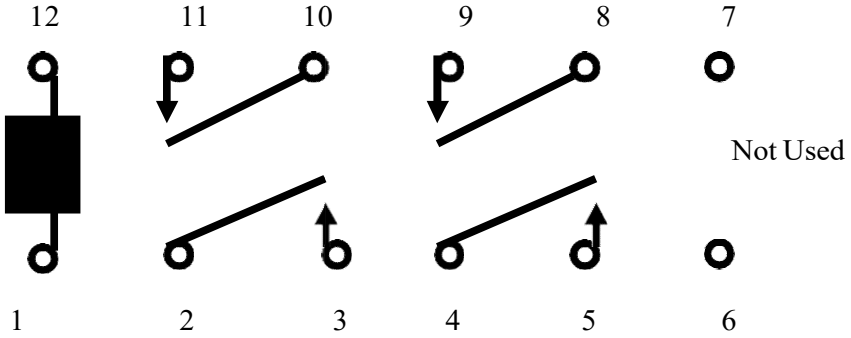
This relay is 11 Pin relay operated by 24V. This relay has three NC contacts & three NO contacts. This relay is used in Engine panel of CSM, Unimat & Duomatic.

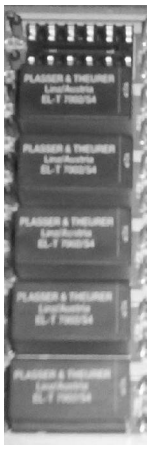


ELT – 7002/S4:

This relay is 12 Pin relay operated by 24V. This relay has all NO contacts. This relay is used as QL (Load relay) to operate solenoids in CSM, 09-3X , Unimat & DGS.

Pin Diagram

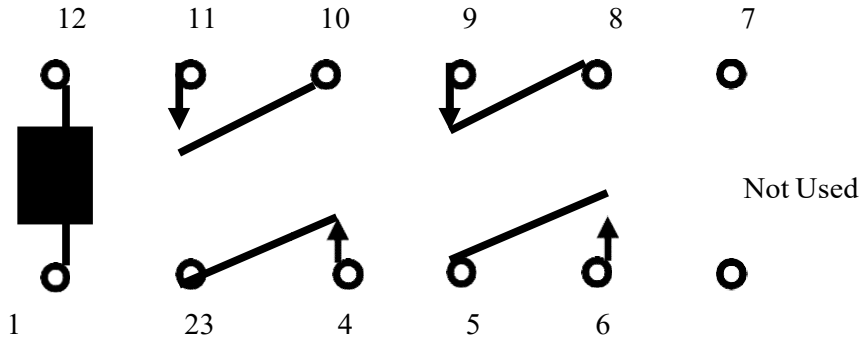




ELT – 7002/S2:

This relay is 12-Pin relay operated by 24V. This relay has two NC contacts and two NO-contacts. This relay is used in CSM & Unimat.

Pin Diagram



ELT – 7002/S2-L2:

This relay is 12-Pin relay operated by 24V. This relay has two NC and two NO-contacts opposite of contacts of ELT-7002/S2 . In This relay pin 6 & 7 are also used for Coil. It is used in Overslew PCB in CSM & Unimat & Duomatic.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical **Session-12 :** Electronics Model Room for demonstration, checking and testing of Relays

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In electronic model room different types of relays are shown to the trainees and relays are checked with the help of multimeters.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical **Session-13:** Engine Circuit: Description, Function and Types

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ENGINE CIRCUIT:

In the machine operation and safety of Engine is controlled through an electrical circuit which is called engine circuit. Engine circuit is mainly consists of batteries, selfstarter, shutdown coil alternator ,safety components(Pressure switch and temperature switch),stopper switch. Engine starts when it is cranked by selfstarter with the help of batteries and fuel is supplied by shutdowncoil. During running of engine lub oil pressure and tempreture are ensured .

FUNCTIONS:

Functions of engine circuit are as under:-

a) To start the engine.
b) To shut down the engine.
c) To charge the battery.
d) Safety of engine from high water temperature and low lub. Oil pressure.

Operation to start the engine.

a) Cranking the engine.

b) Fuel supply system should be ON.

c) Safety of engine is to be ensured.

- Against low lube oil pressure (1.5 bar)
- Against high temperature.
- Emergency stop switch.
- If ZF switch is ON then engine will not start.

Types of engine circuit:

1. Latch type
2. Non latch type

Latch type:

In these circuits hold relays are used as a multi stage safety device. These circuits gives better performance in terms of better safety.These circuits are provided in Unimat 2S &3S,09-3X,DGS,WST,BCM.

Non-latch type:

The circuit other than latch circuit is known as Non-Latch circuit. These circuits are provided in Unomatic, Duomatic and CSM

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical **Session-14:** Working, Safety Components, Faults & Troubleshooting

---

WORKING OF ENGINE CIRCUIT(CSM):-

1. For starting the engine 24V/180AH is required, two batteries of 12V/180Ah/25 plates are connected in series. Self starter type B55-24/SL5-24 of 6 BHP is provided to crank the engine.

2. After performing daily maintenance of engine battery main key should be ON.

3. Engine can be started from both the cabins starter switch are provided in both cabins working(rear) cabin and front cabin but ignition key(5b9) is provided only in the working cabin only, which should be ON.

4. Bypass switches no. 5b 58 or 11 b 22 has to be pressed while starting the engine .Before pulling starter switch(5b8) for cranking bypass switch should be pressed to switch on shutdown coil(1s6) for fuel supply. By pass switches No. 5b 58 or 11 b 22 has to be pressed till the lub. oil pressure builds up to 1.5 Kg/cm^2 & above after that it can be released. If lub.oil pressure falls below this level engine will stop because electrical supply of shutdown coil stops.

5. 7 nos. engine stopping switches are provided scattered all over the machine which cuts off fuel supply. These can be used in emergency.

6. Two nos. alternators are provided with the engine each of 24V/ 40 Amp. These are used to supply 24V DC to the indication & lighting system and charging of batteries. Also these supply power to recorder and GVA.

Safety Components of engine

- Against low lube oil pressure switch is provided (1.5 bar)
- Against high temperature switch is provided
- Emergency stop switch.
- If ZF switch is ON then engine will not start by relay 5u5 .

FAULTS & TROUBLESHOOTING :

S.no.	Fault	Probable Causes	Remedial Actions
1.	Engine does not start	1. Batteries	1. Check batteries : Terminals should be tight and clean , Voltage& gravity . Over-aged batteries should be replaced.
		2.Selfstarter	2.Check connections and solenoid.
		3. Emergency stop switch is pressed.	3.All emergency stop switch should be in release position.
		4. Shut down mechanism stuck	4. Check the electrical supply at coil if it is ok, then lubricate the piston of shut down coil mechanism with lub oil and operate it manually. If still not working, then coil may be defective. Replace it with new one.
		5. Misconnection of starting switch.	5. Check starting switch and if any misconnection is noticed, rectify it.
2.	Engine stops	1. Shut down circuit fails.	. 1 Check shutdown coil,relay13d1`fuse,emergency stopper switch lub oil pressure switch, temperature switch replace if found defective.

SUB: ELECTRICAL & ELECTRONICS SYSTEM

Lesson–III: Auto Electrical Components, **Session-15:** Z.F. Circuit: Description, Working, Safety Sensors, Faults & Troubleshooting

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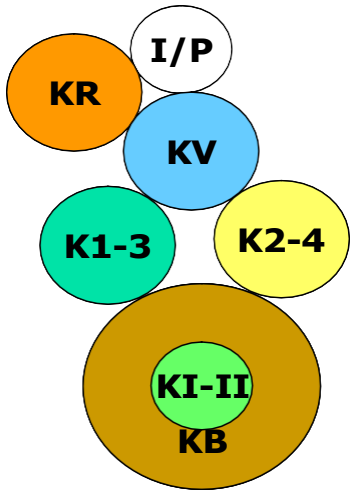
ZF GEARBOX ELECTRICAL CIRCUIT:

ZF Gearbox is the hydrodynamic gearbox which is provided in CSM,09-3X,Unimat2S&3S,DGS and WST machines. In this gearbox shifting of gears and safety is controlled by electrical circuit.This circuit mainly consists of relays, shifter assembly, lockup device and inductive transducer.

Shifter assembly:- It is brain of the gearbox.Hydraulic fluid is pressurised & supplied from this unit.Four solenoid valves are provided for various clutch operation.Measuring points are available for testing.

Gear Train

S.N.	Clutches	Speed	Solenoid	Position
1	KV	Forward	M1	On
2	KR	Reverse	M4	On
3	K1-3	1st &3rd	M2	On
4	K2-4	2nd &4th	M2	Off
5	KB	FD Slower	M3	On
6	KI-II	FD Higher	M3	Off



Working of ZF Circuit :

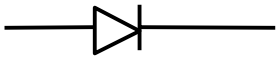
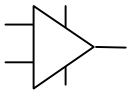
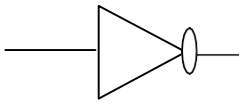
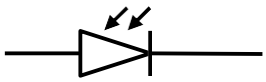
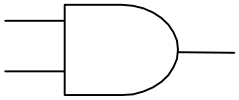
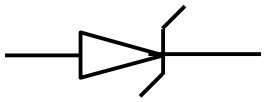
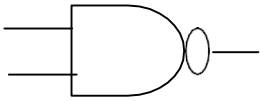
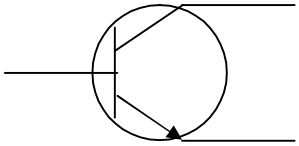
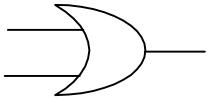
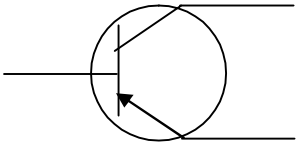
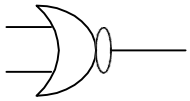
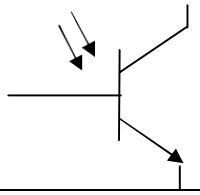
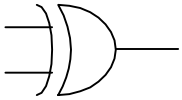
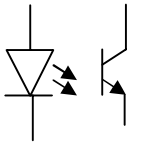
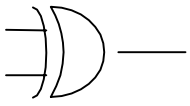
1. There are two main switches 5b34 an 11b24 which are responsible for selecting direction of movement. 5b34 is provided in the rear cabin where as 11b24 is provided in the front cabin. When we switch on one, it cuts off the other through relays 28d1 and 28d2.
2. Direction selector relays 28d1 and 28d2 get earth through relay28u2A. Which gets earth through 1(Working pneumatic, 2) Satellite gear if engaged, 3) Machine working gear is engaged, trailer gear engaged, 4) ZF filter is choked. 5) ZF temp. is more than 100^0C and 6) ZF pressure less than 10 from 1 to 4 all these action are indicated by LED if not locked or engaged combined effect of these is indicated by indicator lamp 11 h3.
   Mal functioning of any of above seven items will not allow driving which can be achieved by pressing push button 5b26 or 11b26 which gives direct earth to direction selecting relays 28d1 and 28d2.
3. When brake pressure of 3 Kg. or more is applied it acts through a pressure switch and cuts off earth from gear solenoids M_1 and M_4. One of which is invariably used either in forward or in reverse direction.
4. If any of the gear is engaged and engine is shut off, the engine can only be started after taking out gear. This action is achieved by providing + from M_1 & M_4 through terminal No. G-32 which is connected to starting relay.
5. Lock up position is achieved through RPM sensing transducer provided on turbine shaft it is achieved when turbine achieves 80% of the engine speed.

FAULT AND TROUBLE SHOOTING:

S.no.	Fault	Probable Causes	Remedial Actions
1.	No drive Transmission in all speed	1.Electrical supply cut off	1.If pressure at 65 no. point is 12-14 bar, current will be checked with the help of Pr.49 test kit - i) If no current in above, 5 Amp fuse may be damaged. Replace the fuse. ii) If fuse is Ok, then with the help of Pr. 78 Test Kit, current on switch output will be checked. If no current is found, controller is defective. Replace the controller. iii) If current is found on switch, output cable may be burst which should be replaced
2.	No function in 1st & 2nd speed.	1.Cut off switch in 'ON' position.	1. Cut off switch should not be in operated condition
		2.Current not supplied on corresponding solenoid.	2. Current at solenoids M1, M2, M3 and M5 will be checked with Pr.49 Test Kit. Prescribed current is 0.25 to 0.5 Amp.
		2. 3.Control valve assembly gets defective.	3. If current input is OK, control valve assembly needs repairing.
		4.Pressure switch of brake circuit defective.	4. If current on solenoids as per coding is not available, it indicate wrong coding, then pressure cut off switch will be checked by pressure 49. If there is no reaction, pressure switch of brake circuit is defective.
		5. Solenoid defective.	5. If coding is OK but signal is not coming, then change defective solenoid.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-I: Fundamentals of Electronics **Session-1:**Electronics Symbols and Nomenclatures

ELECTRONIC SYMBOLS			
Name & Letter Notation	**Symbol**	**Name & Letter Notation**	**Symbol**
Diode D or n		Operational amplifier IC	
LED		NOT Gate	
Photo Diode		AND Gate	
Zener Diode Zd or Tz		NAND Gate	
N-P-N Transistor		OR Gate	
P-N-P Transister		NOR Gate	
Photo Transister		EXOR	
Opto Coupler OC		EX-NOR	

NOMENCLATURES OF PCBS		NOMINCLATURES OF DRAWINGS	
EK	Plug In Type PCB	X	Input To Programmer (Yellow Led Indication)
ELT	Connection Type PCB	Q	Out Put From Programmer (Red LEd Indication)
SV	Power Supply PCB	Q^1	Time Delay Out Put Of Programmer
LV	Analog Control PCB	QL	Load Relay Output
V	Digital Control PCB	∀	OR
P	Programmer PCB	M	AND
A	D.C. Motor Control PCB	--	Not Allowed
MC	Micro Controller PCB	P	Proportional Circuit(Tamping And Satellite Circuit)
DV	Data Sender And Receiveer PCB	R	Lining Control Circuit
E	Relay PCB	N	Levelling Control Circuit (Niv)
00,0a, 02	Modifications In PCB	E	Front Input Control Circuit
d,b,z	Connectors of PCB	D	Driving Control Circuit
		Z	Hook Control Circuit
		F	Multicheck Address
		ALC	Automatic Guiding Computer
		*ALC	Connectors Of Computer ALC
		GVA	Geometric Value Adjustment
		Tele	Laser System
		PCB	Printed Circuit Board (U)

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-I: Fundamentals of Electronics **Session-2:** Fundamentals of Electronics and Applications, Active components & Passive components

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Introduction to Electronics

(i) Electronics Engineering

Electronic engineering is the branch of engineering in which we study operation and application of electronic components and devices.

Electronics = Electron + Mechanics

(ii) Electronic devices

A device in which conduction(flow of current) takes place due to movement of electrons and holes through semiconductors.

Difference between Electrical and Electronics.

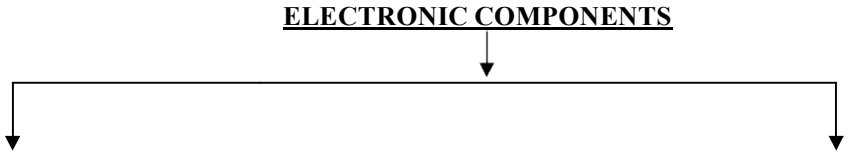
	Electrical		Electronics
1	Electrons are charge carriers. Current is the flow of electrons. The direction of current is in opposite direction of flow of electrons	1	There are two charge carriers Electron and Hole. Current flows due to movement of electrons and holes. Electron is negative charged and the hole is positive charged .
2	Medium isconductive materials .Current flows through conductors like copper, aluminum etc.	2	Current flows through semi conductors like Silicon and germanium etc.
3	Mainly A.C supply. is used Generally supply voltage is 220V,440V and in KV A.C.	3	Mainly D.C.supply is used. Generally supply voltage is 1.5V to 24V D.C.
4	The supply voltage are single phase, multi phase or Polly phase.	4	The supply voltage are Positive or Negative.
5	The electrical equipment are bulky and heavy.	5	The Electronic equipment are light and small in size.

Applications of Electronics

1. Communication & Entertainment
2. Consumer Electronics
3. Defence Applications
4. Industrial Application
5. Medical Sciences
6. Space Exploration

TYPES OF ELECTRONIC COMPONENTS:

There are various types of electronic components but they are divided into two categories**.**



Passive Components
These components are not able to amplify
Or process the electrical signal themselves
e.g. resistor, capacitor, inductor.

Active components
These components can amplify and
process the electrical signal.
Transistors, Diode, lc.. etc.

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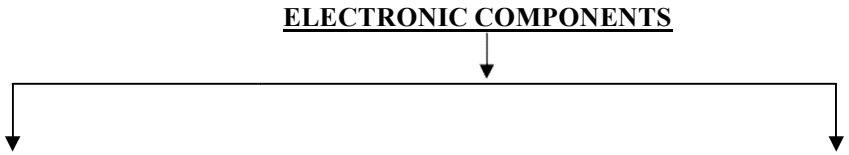


Passive Components
These components are not able to amplify
Or process the electrical signal themselves
e.g. resistor, capacitor, inductor.

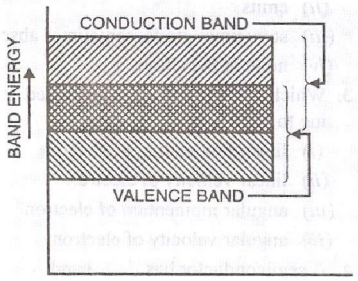
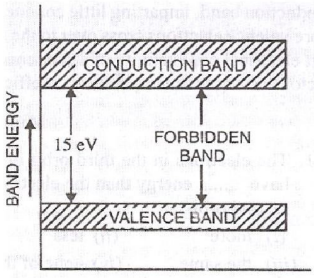
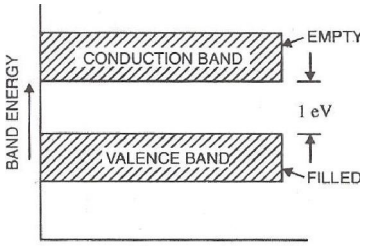
Active components
These components can amplify and
process the electrical signal.
Transistors, Diode, lc.. etc.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-II: Semiconductor Theory

Session-3: Difference between Conductor, Semiconductor & Insulator. Properties of Semiconductor, Covalent Bonds, Energy Bands, Types of semiconductor, i.e. Intrinsic, extrinsic, (P-Type, N-Type).

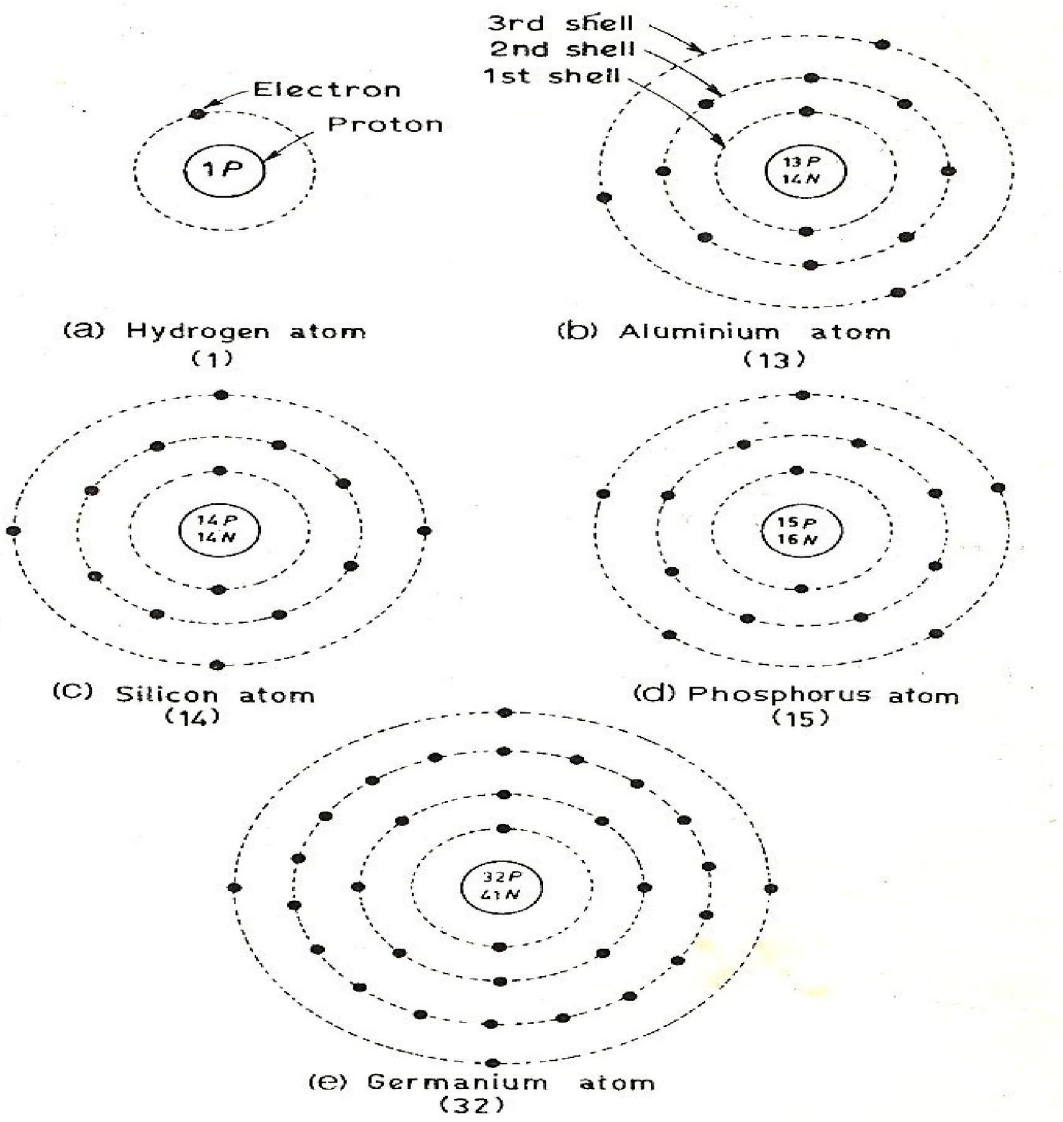
Difference between conductor, Insulator and Semi-Conductor

	Conductor(Metal)	Insulator	Semi-Conductor
1	Conductors consist of large numbers of free electrons. The free electrons move randomly inside a solid, and can carry charge from one point to another. In fact, there is no forbidden-energy gap between the valence band and conduction bands. The two bands actually overlap. The valence-band energies are the same as the conduction-band energies in the metal. It is very easy for a valence electron to become a conduction (free) electron. Therefore, without supplying any additional energy such as heat or light. A metal already contains a large number of free electrons ,there fore they are good conductors of electricity. 	Insulators do not consist of free electrons. It has a very wide Energy gap (15eV or more). Because of this, it is practically impossible for an electron in the valence band to jump the gap, to reach the conduction band. Only at very high temperatures or under very stressed (electrically) conditions, can an electron jump the gap. At room temperature, an insulator does not conduct because there are no conduction electrons in it. Therefore electric current does not pass through insulators. However, it may conduct if its temperature is very high or if a high voltage is applied across it. This is termed as the breakdown of the insulator. 	Semi-Conductors have numbers of free electrons less than conductors and more than insulators. In this case, the forbidden energy gap is not wide. It is of the order of 1 eV (for germanium, E_G = 0.72 eV; and for silicon E_G = 1.12 eV). The energy provided by the heat at room temperature is sufficient to lift electrons from the valence band to the conduction band. Some electrons do jump the gap and go into the conduction band. Therefore, at room temperature, semiconductors are capable of conducting some electric current. 
2	Conductors have minimum resistance and positive temperature co efficient ie resistance increases as temperature is increased.	Insulators have maximum resistance. There is no effect of normal temperature range. But at high temp they get break down.	Semi-Conductors have resistance more than conductors and less than insulators. They have negative temperature co-efficient. ie resistance decreases as temperature is increased.
3	Example: Gold, Silver, copper & Aluminum.	Example: Mica, Rubber, Asbestos, Porcelain & dry wood.	Example: Silicon & Germanium

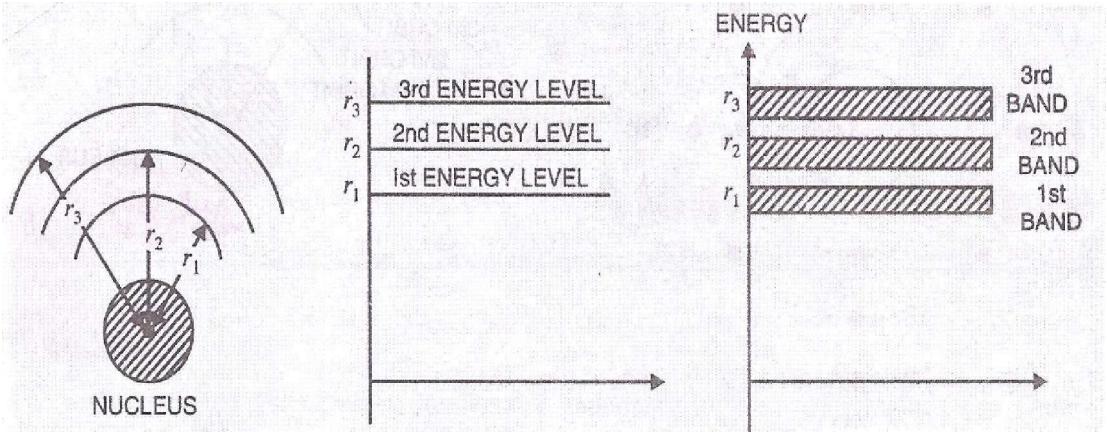
SEMICONDUCTOR THEORY:

The most fundamental unit of metal is atom. An atom consists of protons, electrons and neutrons. Protons and neutrons lie in a nucleus while electrons move around the nucleus in elliptical orbit.Electrons have – Ve charge (-- 1.6 x 10^{-19} Culombs). Protons have same positive charge. Neutrons have no charge, it is neutral. Properties of material depends upon number of electrons and protons in atom. Electrons are arranged in orbital shell around nucleus.

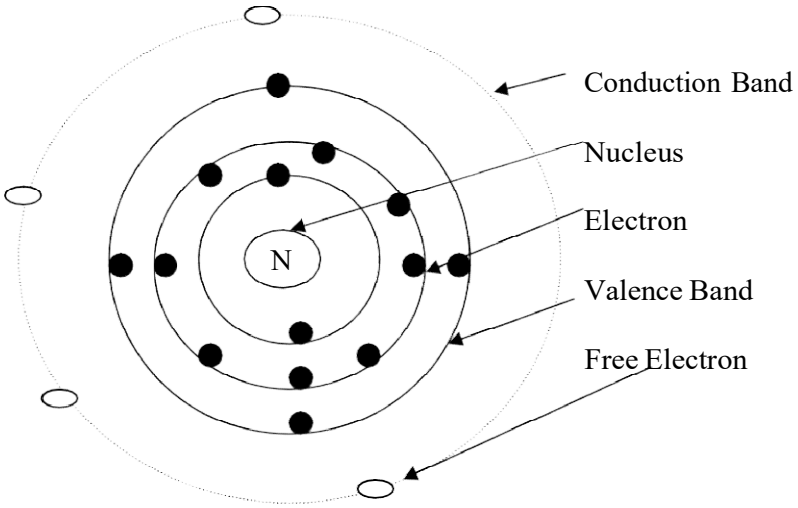
Atomic Structures of different materials



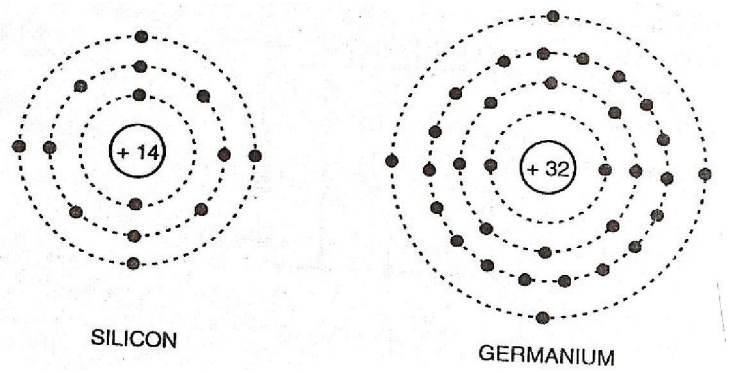
ENERGY LEVELS/ BANDS: Since we know that electrons revolve around the nucleus in different orbits, these orbits have different energy levels, as per their position. Electrons near to the nucleus have lower energy and tightly bound with nucleus in first shell. Electrons in outermost orbit have greater energy and they can be easily knocked out of its orbit. Energy Band Diagram is shown in fig.

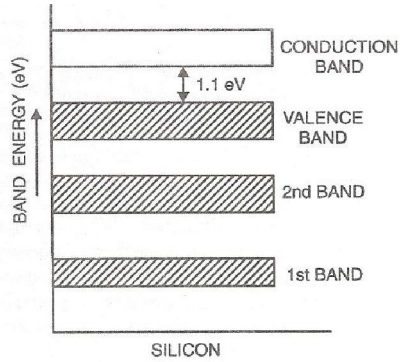


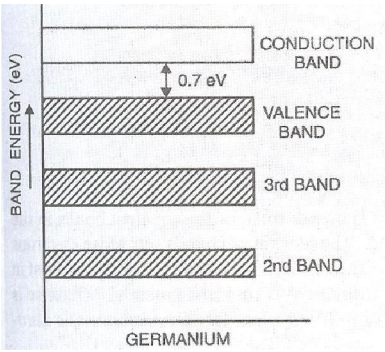
Above valency band, there is another band which is called conduction band. In semiconductors, normally electrons remain in valency band. When an external energy like temp. & light given to atom, then electrons of valency band gain more energy or we can say that they are excited. If this energy becomes more than Egenergy Gap (for silicon EG = 1.121eV, and germanium EG = 0.72ev) electron go to the conduction band. In this band, electrons do not feel any attraction force of nucleus. **They can move freely in Conduction Band work as charge carriers and constitute electrical current. These electrons are called free electrons. Larger the number of free electrons, larger is the conductivity of that material.**



Semiconductors:- Semi-Conductors have four electrons in valence shell. In Semi-conductors numbers of free electrons are less than conductors and more than insulators. Because the forbidden energy gap is not wide. The energy provided by the heat at room temperature is sufficient to lift electrons from the valence band to the conduction band. Semi-Conductors have resistance more than conductors and less than insulators. They have negative temperature co-efficient. ie resistance decreases as temperature is increased. **Example: Silicon (Si) & Germanium(Ge) are the semiconductor materials which are used in electronic components ie diodes, transistors and Ics .**



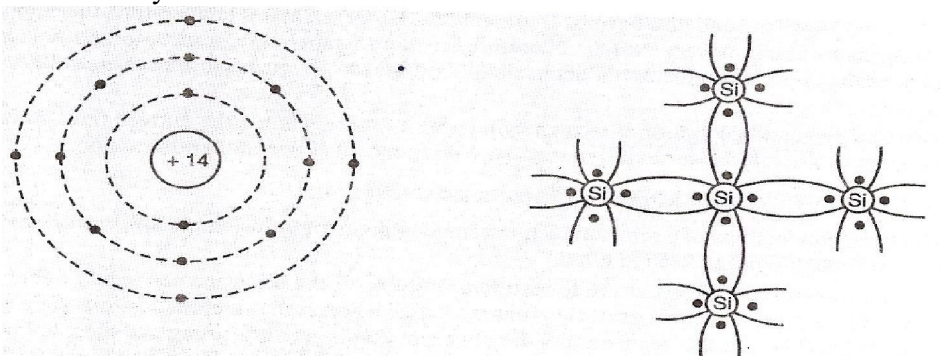




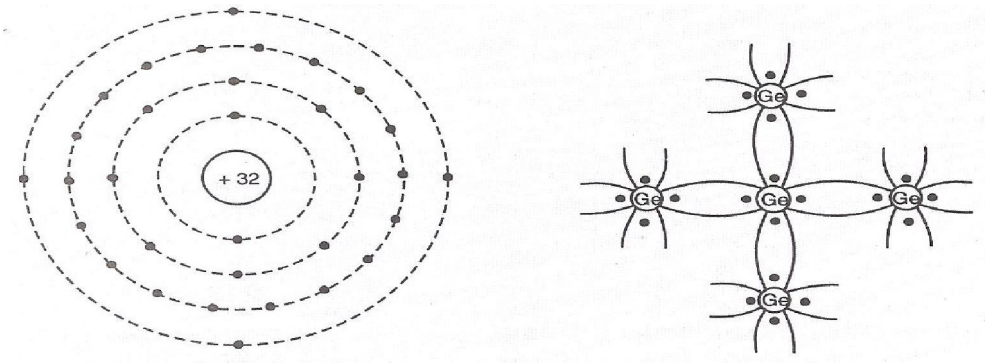
Covalent Bond in Semiconductors :

There should be eight electrons in outermost orbit of an atom. If it is not complete, then outermost orbit is called valence shell and electrons are called valence electrons. Atoms have tendency to complete the outermost orbit by sharing of electrons of other atoms of same element or that of the other element. Atoms of Silicon(Si) and Germanium(Ge) have four valence electrons in its valence shell. So to complete its outermost orbit, each atom shares electron from four neighboring atoms and complete its last orbit and forms covalent bond.

Each co-valent bond consists of two electrons, one from each adjacent atom. Both electrons are shared by two atoms.



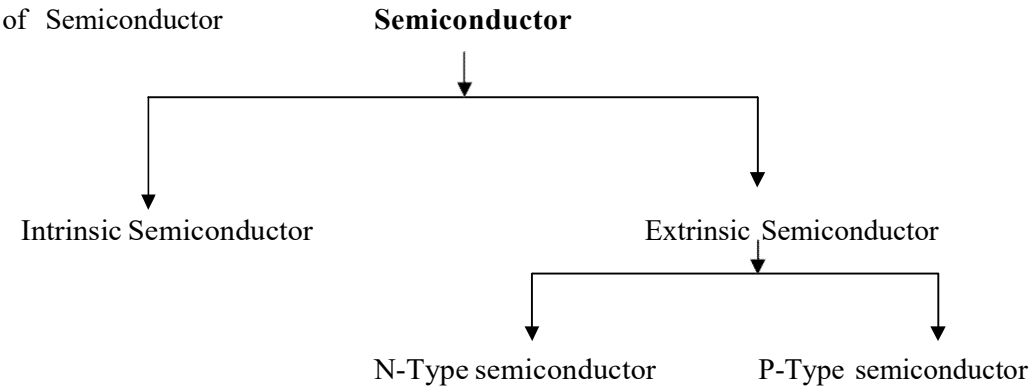
Covalent Bonds in Silicon Atoms



Covalent Bonds in Germanium Atoms

At absolute zero temp. (-273^{0}C), all the valance electrons are tightly bound to the parent atoms. No free electrons are available for electrical conduction. So semiconductor behaves as a perfect insulator at absolute zero.

Types of Semiconductor

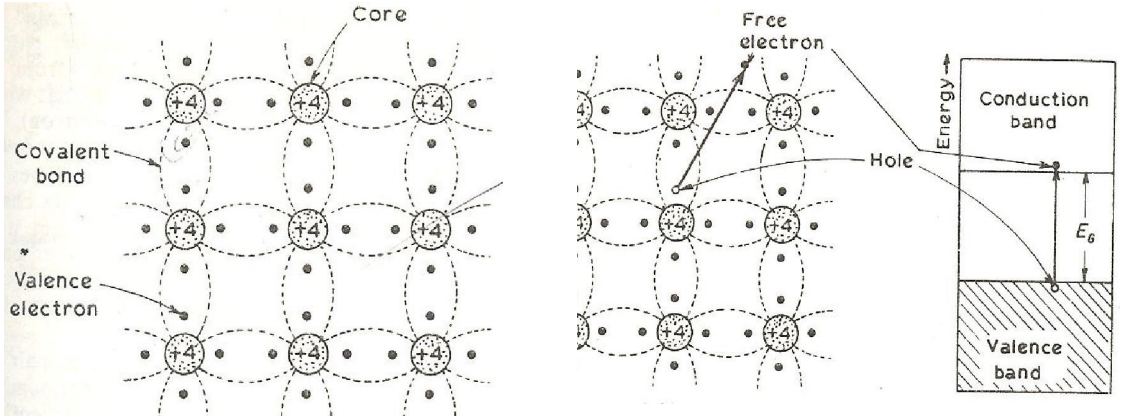


Intrinsic Semiconductor

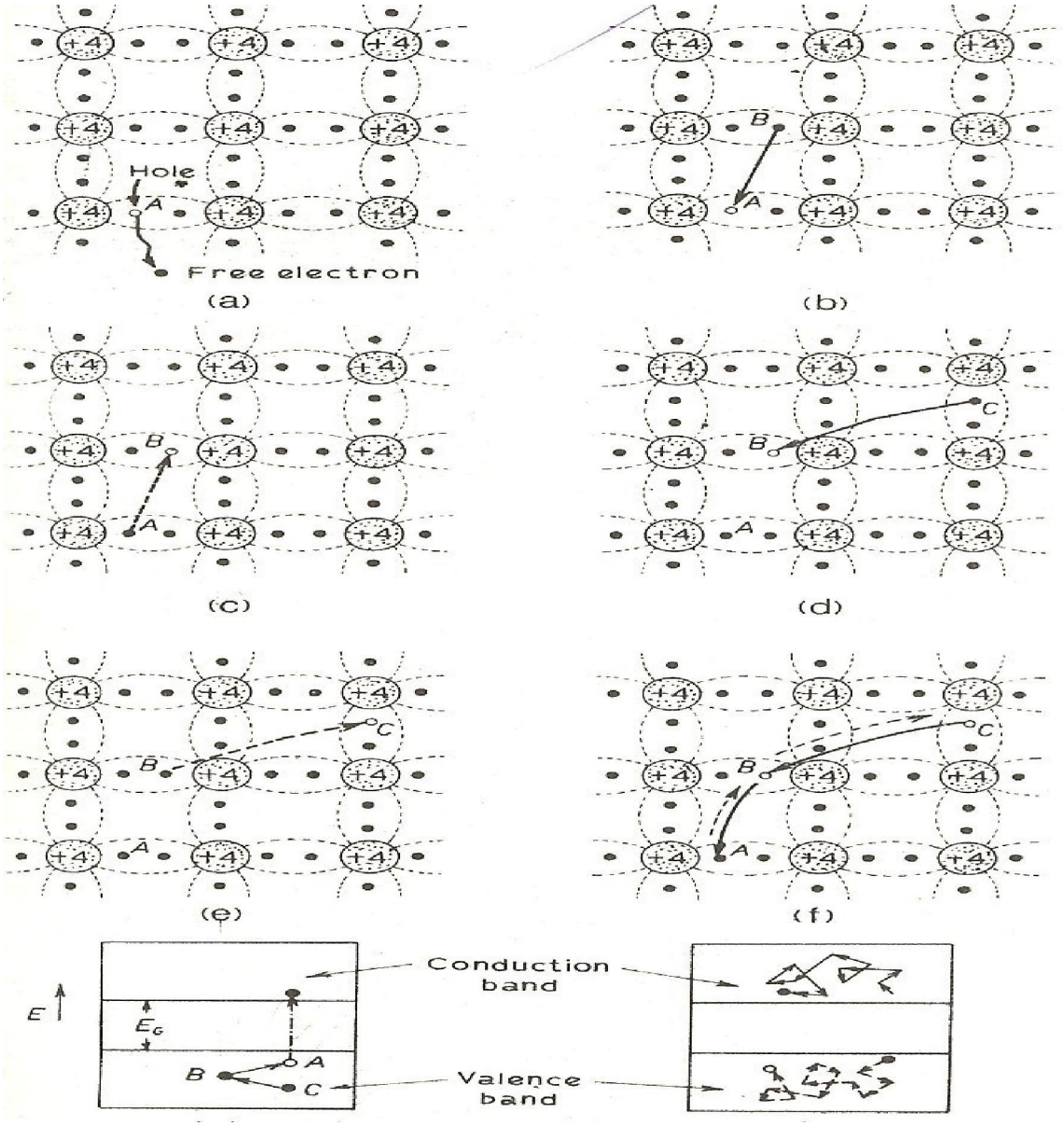
Semi conductor materials Silicon & Germanium in its purest form are called intrinsic semi-conductor.

CHARGE CARRIERS IN INTRINSIC SEMI CONDUCTOR:

At absolute zero temp. (-273^{0}C), intrinsic semiconductors behave like insulators because all electrons are tightly bound to atoms. So there are no free electrons. At room temp(25^{0}C), electrons in valance band acquire sufficient energy to jump from valance band to conduction band. Electrons move away from covalent bonds, thus a covalent bond is broken. When an electron moves away from covalent bond then a vacancy is created which is called '**Hole**'.When a free electron is generated, a hole is also created which has +Ve charge equal to that of electrons. In other words, holes & electrons are always generated in pairs. The concentration of holes & free electrons will be equal in intrinsic semiconductors.



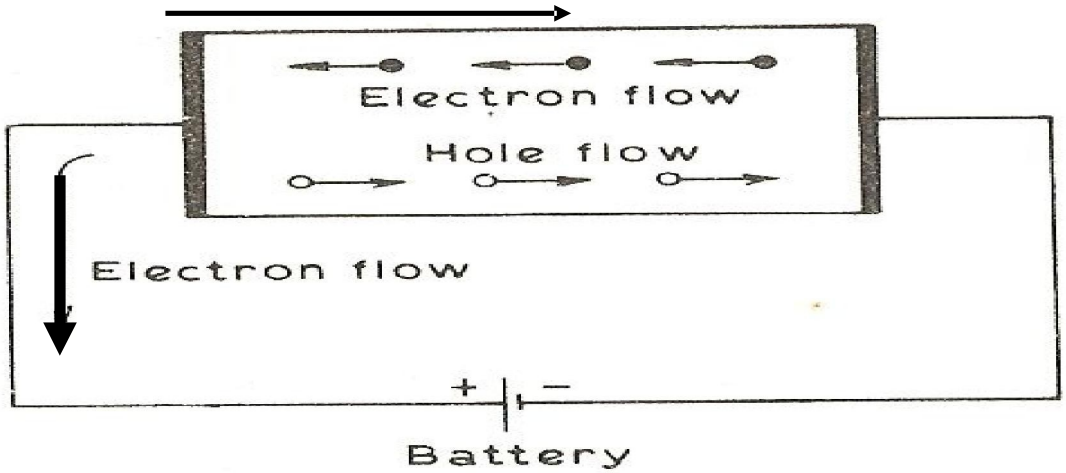
Movement of Hole and electron in Intrinsic Semiconductor



CONDUCTION IN INTRINSIC SEMICONDUCTOR

Semiconductors have two types of charge carriers electron & hole. Electron is –ve charge particle and hole is +ve charge particle.When battery is connected across semiconductor material i.e. silicon or germanium , the electrons experience attraction force towards the positive terminal of battery and holes toward negative terminal of battery. The free electrons move towards positive terminal and holes move towards –ve terminal of battery. The electric current flows through the semiconductor in the same direction as in which the holes are moving and opposite to the direction of electron movement.

Total current $I = I_e + I_h$



Although two types of charge carriers move in opposite directions, but current due to hole I_h & current due to electron. Ie are in same direction i.e. they add together and constitutes current I .

EXTRINSIC SEMICONDUCTORS: When some other material is added with intrinsic semiconductor as an impurity, then the semiconductor is called extrinsic semiconductor. The process of deliberately adding the impurities to semiconductor is called doping. So doped semiconductors are called Extrinsic Semiconductors.

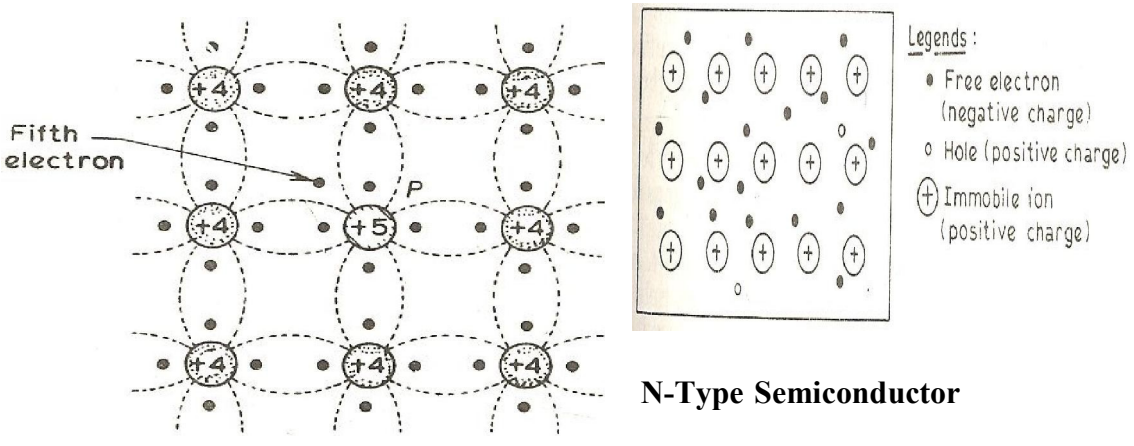
There are two types of extrinsic semiconductors:

(1) N-Type Semiconductor **(2) P-Type Semiconductor**

(1) N-Type Semiconductor:-When elements of Vth group (Pentavelent elements i.e. phosphorus(15), Arsenic(33),Antemony(51)) are added or doped to semiconductors, then they are called N-Type Semiconductors.

Since impurity added to semiconductor is very small. So each impurity atom is surrounded by semiconductor atom . Suppose impurity of phosphorus is added to silicon, which is shown in fig. atom of phosphorus is surrounded by four atoms of silicon. Phosphorus has five electrons in its valency band. While silicon has four electrons in its valency band. Four electrons of phosphorus atom form **co-valent bonds** with four neighbouring electrons of silicon atoms. The fifth electron of phosphorus has no chance of forming a covalent bond , it remains free. this electron acquire energy at normal room temp. and becomes free from valency band & reaches to conduction band. In other words at room temperature each impurity atom donates one electron to the conduction band that s why this type of impurity js called **Donar type impurity .**

At room temp. electrons of covalent bond also get energy and they break covalent bonds, pairs of free electrons and holes are generated. There fore nos of free electrons will be more than the nos of holes . **In N-Type semiconductors, electrons are in majority and holes are in minority**. **Electrons are called majority charge carriers and holes are called minority charge carries.** It also consists of +ve immobile ions .



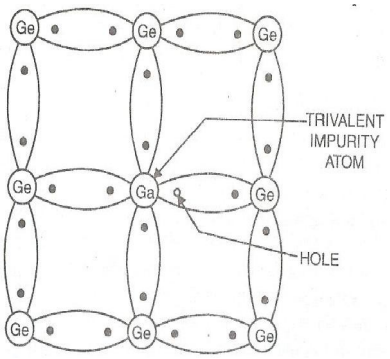
N-Type Semiconductor

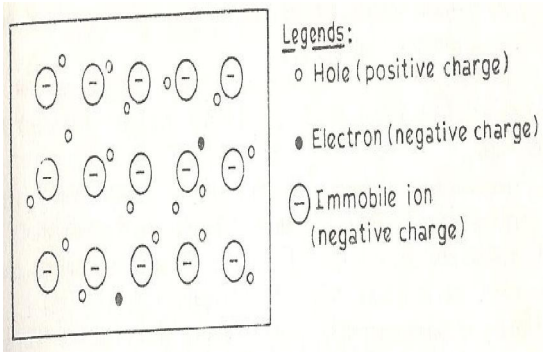
P-Type Semiconductor: When elements of IIIrd group (Trivalent elements i.e.Boron(5), Aluminium(13),Gallium(31) Indium(49)) are added as impurity to semiconductors, such type of semiconductors are called P-type semiconductors.

Suppose impurity of Gallium is added to silicon. Atom of Gallium is surrounded by silicon atoms. Gallium atom has three electrons in valency band. These electrons form covalent bonds with neighbouring electrons of silicon atoms. The fourth covalent bond remains incomplete because Gallium does not have fourth electron in valency band . So there is a deficiency of electron in bond. **The single electron in incomplete bond has the greater tendency to snatch the electron from the neighbouring atom.** This tendency is so great that an electron from an adjacent bond having additional energy can jump to occupy vacant position in incomplete bond.

When electrons jump to fill incomplete bond, A vacancy is created from where electron had jumped, which has +Ve charge called **Hole.** The bond in which electron jump to fill vacant position, it becomes –Ve charge ion which is immobile because it is held tightly in the crystal structure by covalent bond.Since the Gallium atom accepts the electron to complete covalent bond, so it is called acceptor impurity.

P-Type semiconductors have excess holes which are created due to the addition of acceptor type impurity , in addition with electron – holes pair generated due to breaking of covalent bonds. There fore nos of holes will be more than the electrons. **So P-Type semiconductors have holes in majority and electrons in minority**. It also consists of -ve immobile ions .

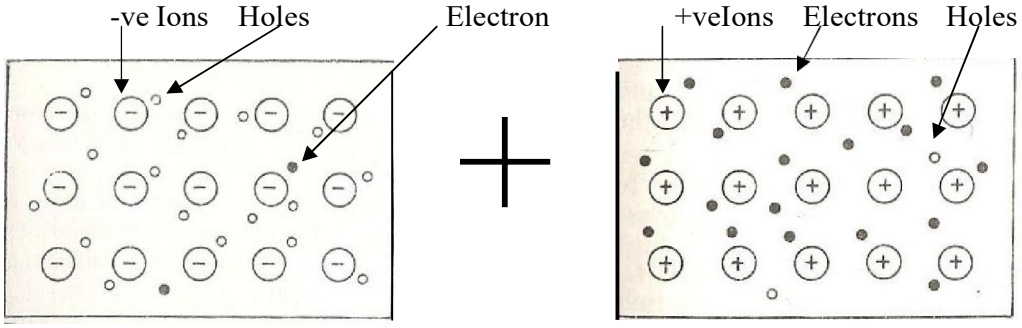




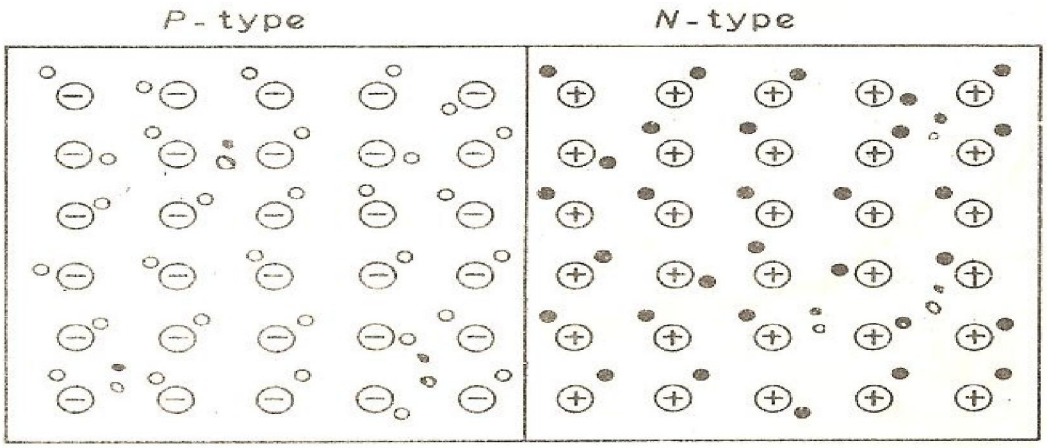
P- Type semiconductor

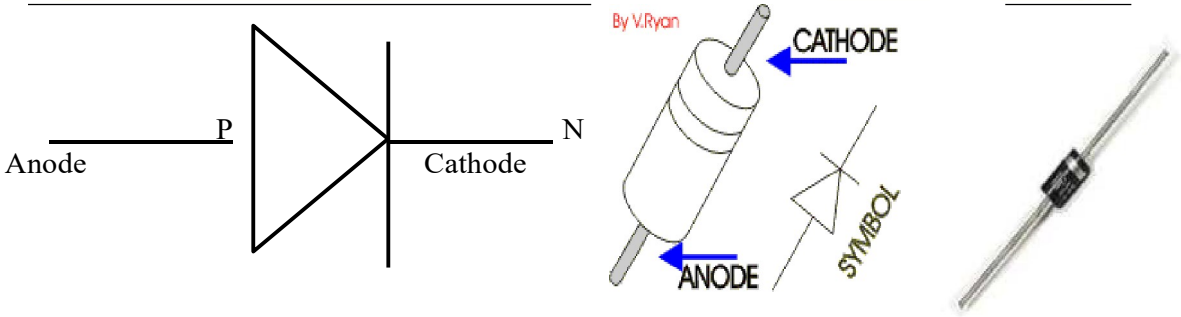
SEMICONDUCTOR DIODE:

P-N junction diode: When we join a piece of P-type semiconductor to a piece of N-type semiconductor with the help of special technique, A P-N junction is formed. Such a P-N junction makes a very useful device. It is called a P-N junction Diode or Semiconductor Diode. The most important characteristics of a P-N junction is its ability to conduct current in one direction only. In other direction, it offers very high resistance. It is a unidirectional device.



P- Type N-Type

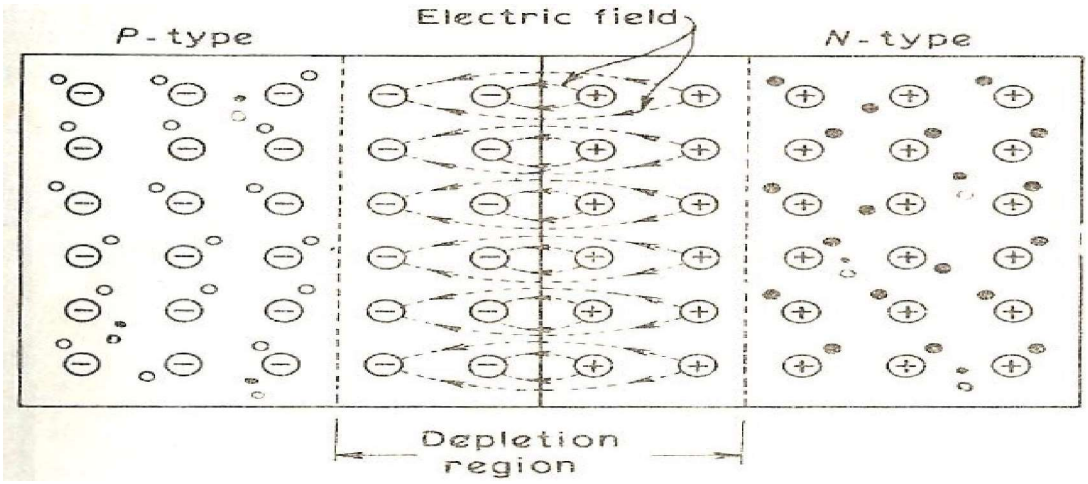




P-N Junction

P-N JUNCTION WITH NO EXTERNAL VOLTAGE:

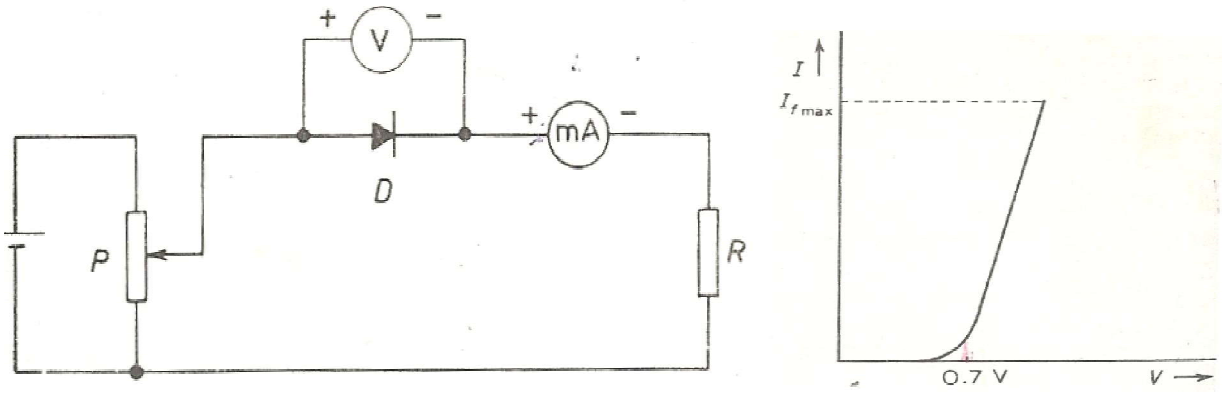
A P.N.-Junction just immediately after it is formed is shown in fig. Its left half is P-type and right half is N-type. The P- region has Holes in majority , Electrons in minority and negatively charged immobile ions. The N- region has Electrons in majority , Holes in minority and positively charged ions. Holes and electrons are the mobile charge carriers, but the ions are immobile.



As soon as the PN-junction is formed, the following processes are initiated:

(i) Due to difference in concentration of charge carriers in P and N regions , Holes near the junction in P- region diffuse into the N region. Where they recombine with free Electrons in the N- region near the junction.
(ii) Free Electrons from N- region near the junction diffuse into the P- region. These Electrons recombine with the holes.
(iii) The diffusion of Holes (from P- region to N- region) and Electrons (from N region to P- region) occurs for a very short time. After a few recombinations of Holes and Electrons near the junction, a restraining force is set up automatically. This force is called a Barrier. Further diffusion of holes and electrons from one side to the other is stopped by this barrier. For a Silicon PN-junction, the barrier potential is about 0.7V, whereas for a Germanium PN-junction it is approximately 0.3V.

PN-JUNCTION WITH FORWARD BIAS: When battery or DC supply is connected to the PN-junction diode such a way that the positive terminal of the battery is connected to the P-side (Anode) and the negative terminal to the N-side(Cathode) , as shown in (Fig…). Inthis condition the PN-junction diode is said to be in forward-biased.

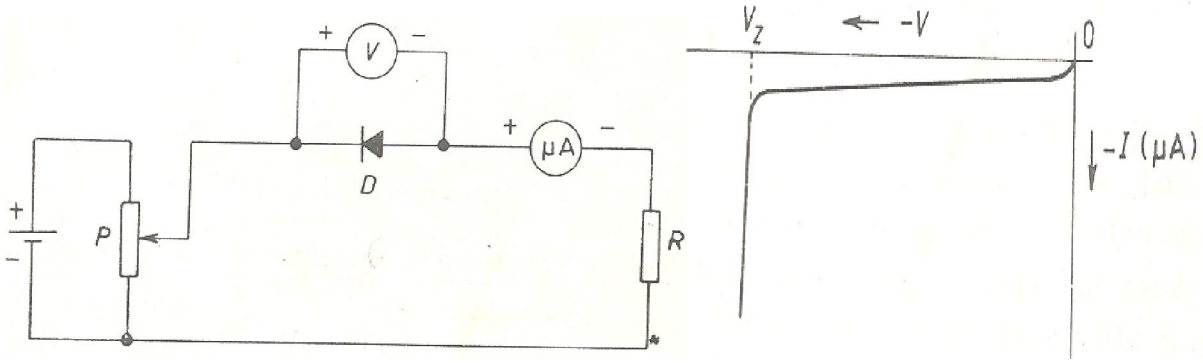


When the PN-junction is forward-biased, the holes are repelled from the positive terminal of the battery and are compelled to move towards the junction. The electrons are repelled from the negative terminal of the battery and drift towards the junction. Because of their acquired energy, some of the holes and the free electrons penetrate the depletion region. This reduces the potential barrier. The width of the depletion region reduces and so does the barrier height. As a result of this, more majority carriers diffuse across the junction. These carriers recombine and cause movement of charge carriers in the space-charge region.

For each recombination of free electron and hole that occurs, an electron from the negative terminal of the battery enters the N-type material near the positive terminal of the battery, an electron breaks a bond in the crystal and enters the positive terminal of the battery. For each electron that breaks its bond, a hole is created. This hole drifts towards the junction. Note that there is a continuous electron current in the external circuit. The current in the P-type material is due to the movement of holes. The current in the N-type material is due to the movement of electrons. The current continues as long as the battery is in the circuit. If the battery voltage is

increased, the barrier potential is further reduced. More majority carriers diffuse across the junction. This results in an increased current through the PN-junction.

PN-JUNCTION WITH REVERSE BIAS: When battery or DC supply is connected to the PN-junction diode such a way that the positive terminal of the battery is connected to the N-side (Cathode) and the negative terminal to the P-side(Anode) , as shown in Fig. In this condition the PN-junction diode is said to be in reverse biased.The holes in the P region are attracted towards the negative terminal of the battery. The electrons in the N region are attracted to the positive terminal of the battery. Thus the majority carriers are drawn away from the junction. This action widens the depletion region and increases the barrier potential .



The increased barrier potential makes it more difficult for the majority carriers to diffuse across the junction. However, this barrier potential is helpful to the minority carriers in crossing the junction. In fact, as soon as a minority carrier is generated, it is swept (or drifted) across the junction because of the barrier potential. The rate of generation of minority carriers depends upon temperature. If the temperature is fixed, the rate of generation of minority carriers remains constant. Therefore, the current due to the flow of minority carriers remains the same whether the battery voltage is low or high. For this reason, this current is called reverse saturation current. This current is very small as the number of minority carriers is small. It is of the order of nano-amperes in silicon diodes and microamperes in germanium diodes.

Reverse Breakdown - We have seen that a PN-junction allows a very small current to flow when it is reverse-biased. This current is due to the movement of minority carriers. It is almost independent of the voltage applied. However, if the reverse bias is made too high, the current through the PN-junction increases abruptly, the voltage at which this phenomenon occurs is called breakdown voltage. At this voltage, the crystal structure breaks down .In normal applications, this condition is avoided. The crystal structure will return to normal when the excess reverse bias is removed, provided that overheating has not permanently damaged the crystal.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-III: Semiconductor Diode **Session-5:** Application of P.N. Junction Diode as Rectifier - Half wave & Full wave Rectifiers (Centre Tape and Bridge Rectifier), Polarity Protection Device

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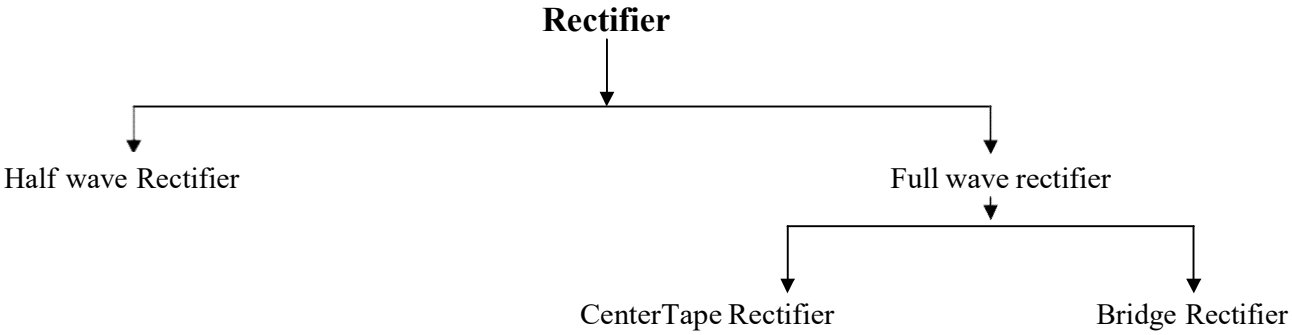
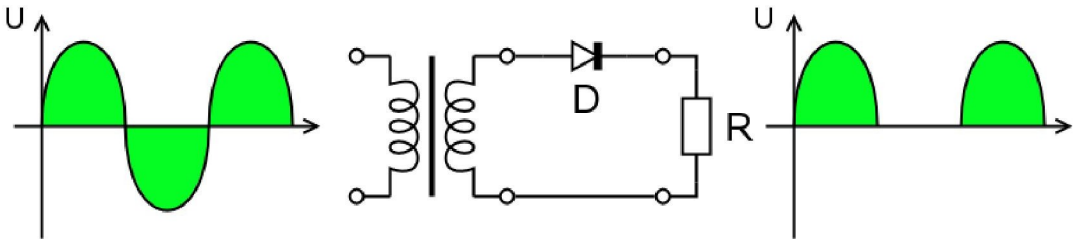
RECTIFIERS: Since Diode is an unidirectional device it operates or conducts only in one direction so it is used to convert AC to DC. AC to DC converters using diodes are called rectifiers. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC . Rectifiers are of following types.



Half wave Rectifer:



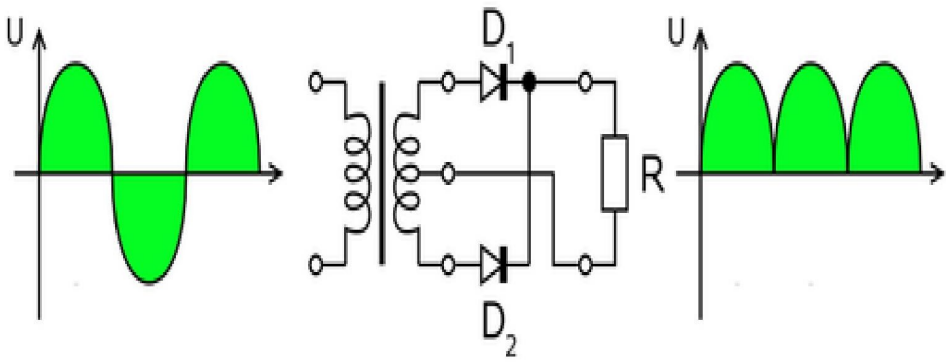
In this type of Rectifier only one diode is used, which converts only half cycle of DC, so it is called Half Wave Rectifier.

As shown in figure during positive half cycle diode D is forward biased. It operates and passes the positive half cycle in the output. During negative half cycle the diode is in reverse bias. It does not operate and does not pass negative half cycle to the output.

The diode in this rectifier passes the positive half cycle (only half cycle)or rectify only halfcycle , so it is called half wave rectifier.It's efficiency is 40.6%.

To get smooth D.C. in output electrolyte capacitor can be connected in parallel as a filter in the output.

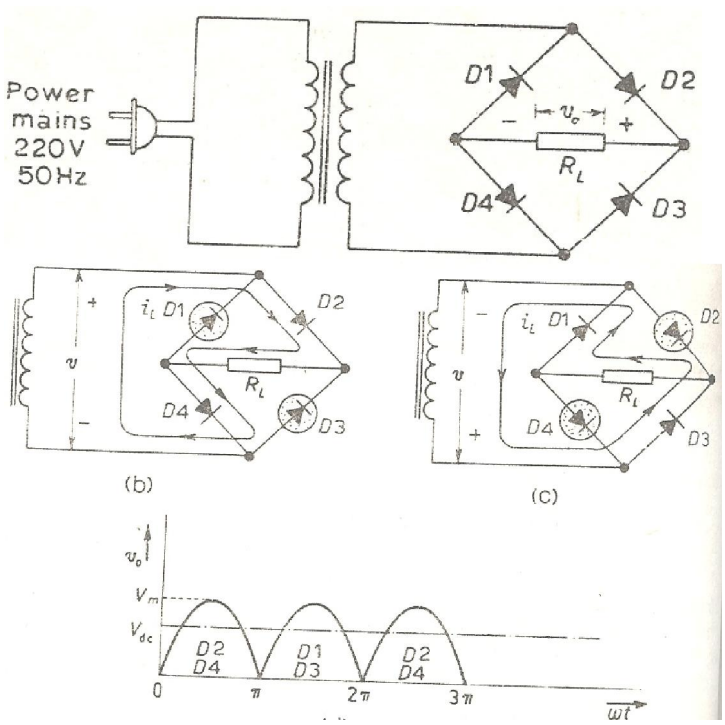
Full wave rectifier: Center Tape Rectifier:



In this rectifier center tape transfer and two diodes D1 & D2 are used. As shown in figure in positive half cycle diode D1 is in forward bias and diode D2 is in reverse bias. At this time D1 operates and D2 does not operate. Positive half cycle is passed on in the output.

During negative half cycle diode D2 is in forward bias and diode D1 is in reverse bias, D2 operates and D1 does not operate. Therefore diode D2 rectify the negative half cycle. By connecting a capacitor as filter in out put we get smooth D.C.
Efficiency = 81.2%.

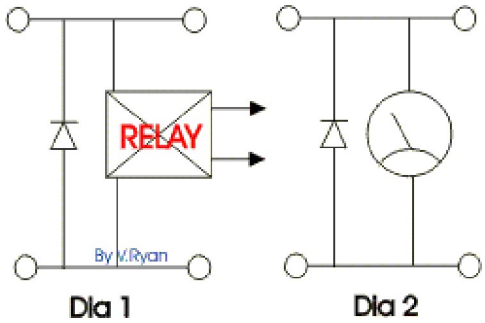
Bridge Rectifier:



This rectifier consists of four diodes D1,D2,D3 and D4 as shown in figure . During positive half cycle diode D2 and D4 are in forward bias , D1 and D3 are in reverse bias. So diode D2 and D4 operate and pass positive half cycle in the out put.
During negative half cycle diode D1 and D3 are in forward bias and D2 and D4 are in reverse bias. So diode D1 and D3 operate and pass the negative half cycle in the out put. By connecting a capacitor as filter in the output we get smooth D.C.Efficiency is 81.2%

1. Half wave - For general purpose.
2. Center tape - For high current use.
3. Bridge rectifier - For Audio Vidio use.

Polarity Protection Device



Since diode is unidirectional device so it is use as polarity protection device in analog meters ,relays and solenoids,

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

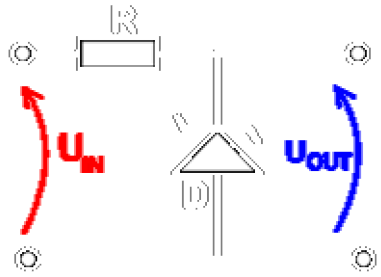
Lesson-III: Semiconductor Diode **Session-6:**Types of Diodes, Construction, Working Symbol and Application of Zener Diode, LED, Photo Diode, Opto-coupler.

Types of diode: -

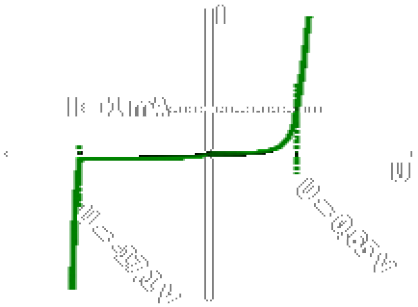
1. Zener Diode:

Zener diode is a special kind of diode which is made to work in reverse bias without damage. It is heavily doped to working in reverse bias.

In reverse bias, it is made to conduct at certain voltage V_Z called reverse breakdown voltage. When reverse voltage reaches to Vz, zener diode conducts. Before this voltage, it does not conduct. The breakdown occurs due to zener effect, and avalanche effect. When reverse bias is When reverse bias is increased, the electric field at the junction also increases. High electric field causes covalent bonds to break. Thus a large number of carriers are generated. This causes a large current to flow. This mechanism of breakdown is called zener breakdown.



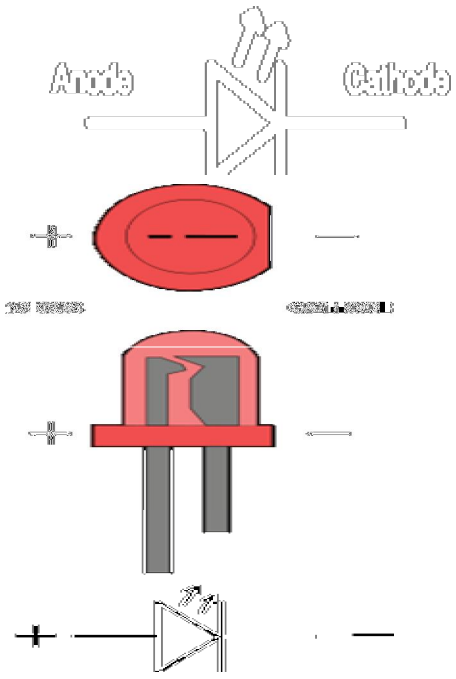
In case of avalanche breakdown, the increased electric field a uses increase in the velocities of minority carriers. These high energy carriers break covalent bonds, thereby generating more carriers. Again, these generated carriers are accelerated by the electric field. They break more covalent bonds during their travel. A chain reaction is thus established, creating a large number of carriers. This gives rise to a high reverse current. This mechanism of breakdown is called avalanche breakdown.



Characteristics are same as the characteristics of diode in reverse bias.

The most common application of a zener diode is in voltage stabiliser or regulator circuit.

2.Light Emitting Diode (LED) :



This is a special kind of diode. When it is operated it emits light. It is used in forward bias. In LEDs photo conductive materials such as gallium phosphate (GaP), gallium Arsenate (GaAs), Gallium Arsenate Phosphate (GaAsP) etc are used to emit lights of different colours

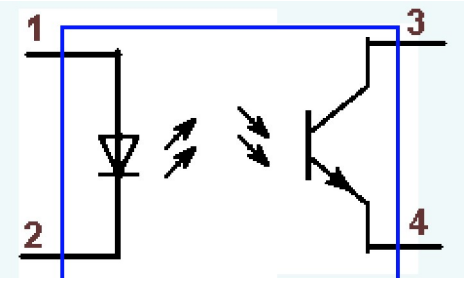
The operating voltage of LEDs is 1 Volt to 3 Volt and maximum current rating is 5 to 10 mA. These are used as indicators, calculators, and watches and intercom.

LED's have a number of advantages over ordinary incandescent lamps. They work on low voltages and currents and thus consumers less power. They require no heating, no warm up time and hence are very fast in action. Small in size & light in weight.

3. Photo Diodes:-

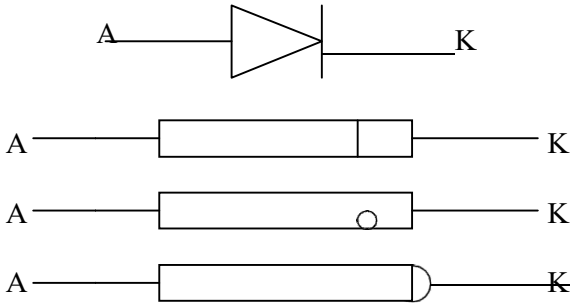
This is a special kind of diodes, which are made of photoconductive material (Cadmium sulfide). It operates when light falls on its junction. It is used in reverse bias. In reverse bias connection in the absence of light it does not operate but when light falls on its junction it starts conduction till the light falls on its junction. Photo diode is used in alarm system (Fire alarm, Burglar alarm etc).

Opto Isolator (Opto- Coupler:-



This is the combination of LED and Photo diode or photo transistor. When LED glows ,it's light falls on junction of photo diode or photo transistor then it also operates it is used for isolation of analog and digital circuit.

Identification and testing of diode.



Note: The marked side of diode is always Cathode side.

Checking of Diode:

Connect the diode to a multi tester in the Ohms Range. The following reading should be observed.

Forward Bias	- Low resistance
Reverse Bias	- High resistance

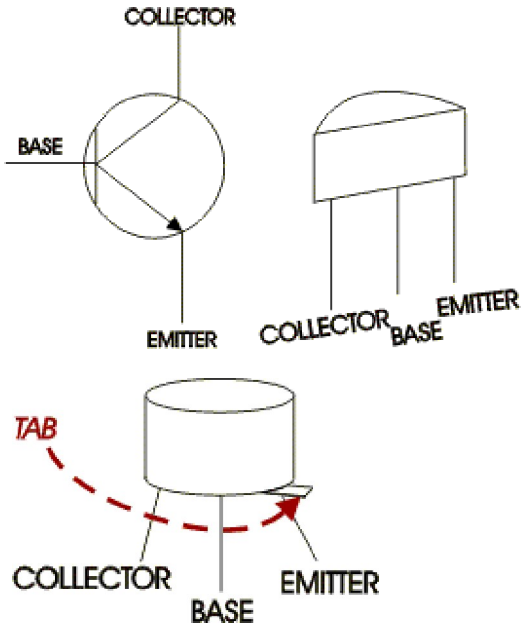
If the above condition is satisfied then the diode is in good condition otherwise change that.

TRANSISTOR: When a third doped element is added to PN junction in such a way that two PN junction are formed, the resulting device is known as transistor.A transistor has three sections of doped semiconductors. The section on one side is emitter, middle section is base and 3rd section is collector. These three sections form two junction emitter-base junction and collector-base junction.

1. **EMITTER:**Emitter is heavily doped than base and collector. It is heavily doped so that it can supply large no. of holes and electrons. It's area is kept between that of base and collector.

2 **BASE:**Base is very lightly doped than emitter and collector. Its area is also less than that of emitter and collector.

3. **COLLECTOR:**Doping of collector is kept larger than base and less than emitter but its area is larger than base and emitter. The junction is always reverse bias with respect to base.



TRANSISTOR WORKING:

- NPN Transistor is shown in figure with electrical connection.
- Emitter base junction is forward biased by battery V_E and collector base junction is reverse biased by battery V_C.
- Since emitter-base junction is forward biased, so electron from emitter junction diffuse towards base and holes diffuse towards emitter.
- Suppose 100 electrons enter from emitter to base. These electrons constitutes emitter current.
- Since base is very thin and very lightly doped so assume that only two electrons recombines with holes.
- To compensate deficiency of two holes in base, new two holes electrons pair generate due to battery V_E
- Two electrons come out from base terminal towards +ve terminal of V_E battery and constitute I_E current.
- 98 electrons diffuse from base to collector. These electrons experience an attractive force due to positive terminal of battery Vc.
- They travel out of the collector terminal and reach the +ve terminal of battery Vc- and thus constitute collector current. I_c

$$I_E = I_B + I_c$$

$$\beta = \frac{I_c}{I_E}$$

Lesson-IV: Transistor **Session-8:** Mode of Connections, Amplifying function, Applications as Switch and Amplifier, Testing

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THREE CONFIGURATION OF TRANSISTOR:

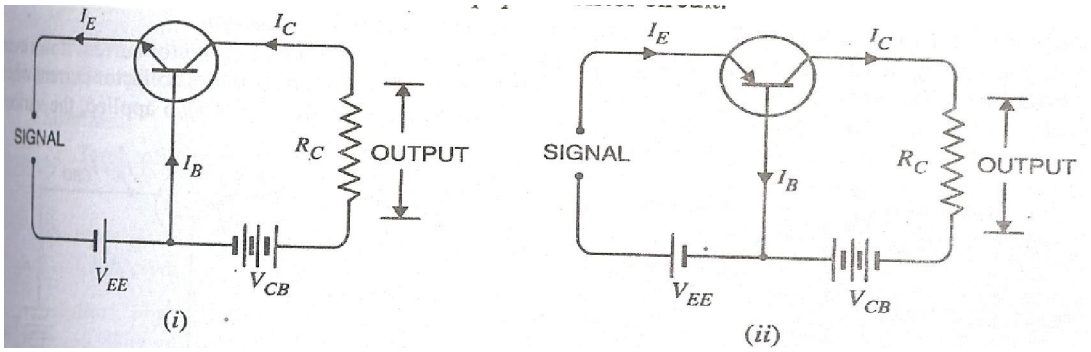
There are three modes of connections of transistor to use in the circuit.

(1) Common Base Configuration (C.B)

(2) Common Emitter Configuration (C.E)

(3) Common Collector Configuration (C.C)

1. COMMON BASE CONFIGURATION (C.B):



In this configuration base terminal is made common between emitter and collector. Input signal is applied between emitter-base terminal and output is taken across collector-base terminal.

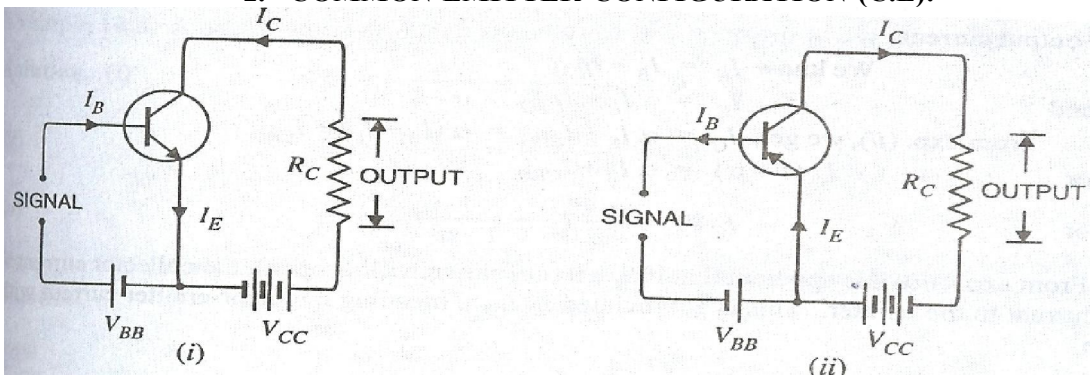
Input resistance = very low (20Ω)

Output resistance = very high (1MΩ)

Gain = $\alpha = \frac{I_c}{I_E}$ = Less than 1

USE: Voltage & power amplifier.

2. COMMON EMITTER CONFIGURATION (C.E):



In this configuration emitter terminal is made common between base and collector. Input signal is applied between base and emitter terminal and output is taken across collector emitter terminal.

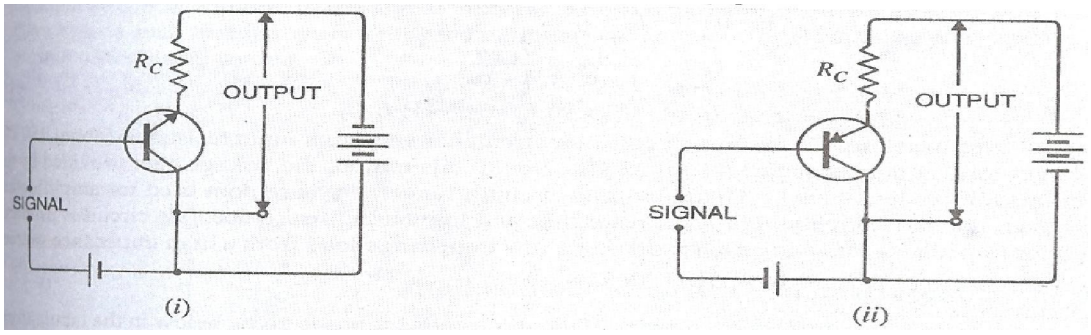
Input Resistance = 1 KΩ (approx.)

Output Resistance = approx 10 KΩ

Gain $\beta = \frac{Ic}{I_B}$ = approx 100

Use: A good amplifier.

3. COMMON COLLECTOR CONFIGURATION (C.C):

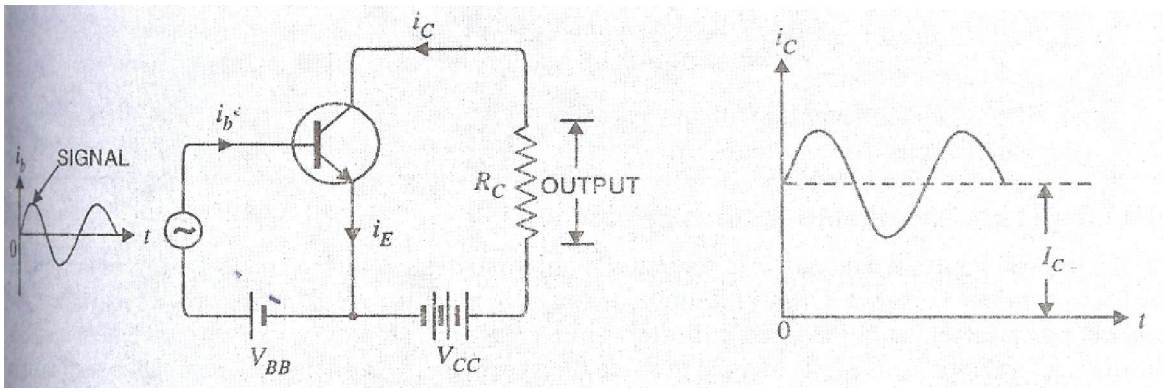


In this configuration collector is made common between base and emitted input signal is applied between base and collector terminal and output is taken across emitter and collector terminal.

Input Resistance = approx 150KΩ
Output Resistance = approx 800Ω
Gain $\gamma = \frac{1_E}{1_B}$ = less than 1

Use: In impedance matching and buffers.

TRANSISTOR AS AN AMMPLIFIER IN CE CONFIGURATION:



Transistor as an amplifier in C.E. configuration is shown in Fig… Input signal Vs is applied between base and emitter, output is taken across load resistor RL. During (+) ve half cycle of the signal the forward voltage across the emitter base junction is increased. Therefore more electrons flow from emitter to the collector via base. This cause increase in collector current. This collector current cause greater voltage drop across load resistor R_L

During (-) ve half cycle of the signal the forward bias voltage across the emitter-base junction decreases. Which cause collector current decrease. This results in the decreased output voltage. Hence an amplified output is obtained across load.

APPLICATION OF TRANSISTOR:

1. As an amplifier to amplify weak signal.
2. It is used in oscillator circuit.
3. It is used as a switch

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-IV: Transistor **Session-9:** Electronics Model Room for demonstration, checking and testing of Diodes and Transistors.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

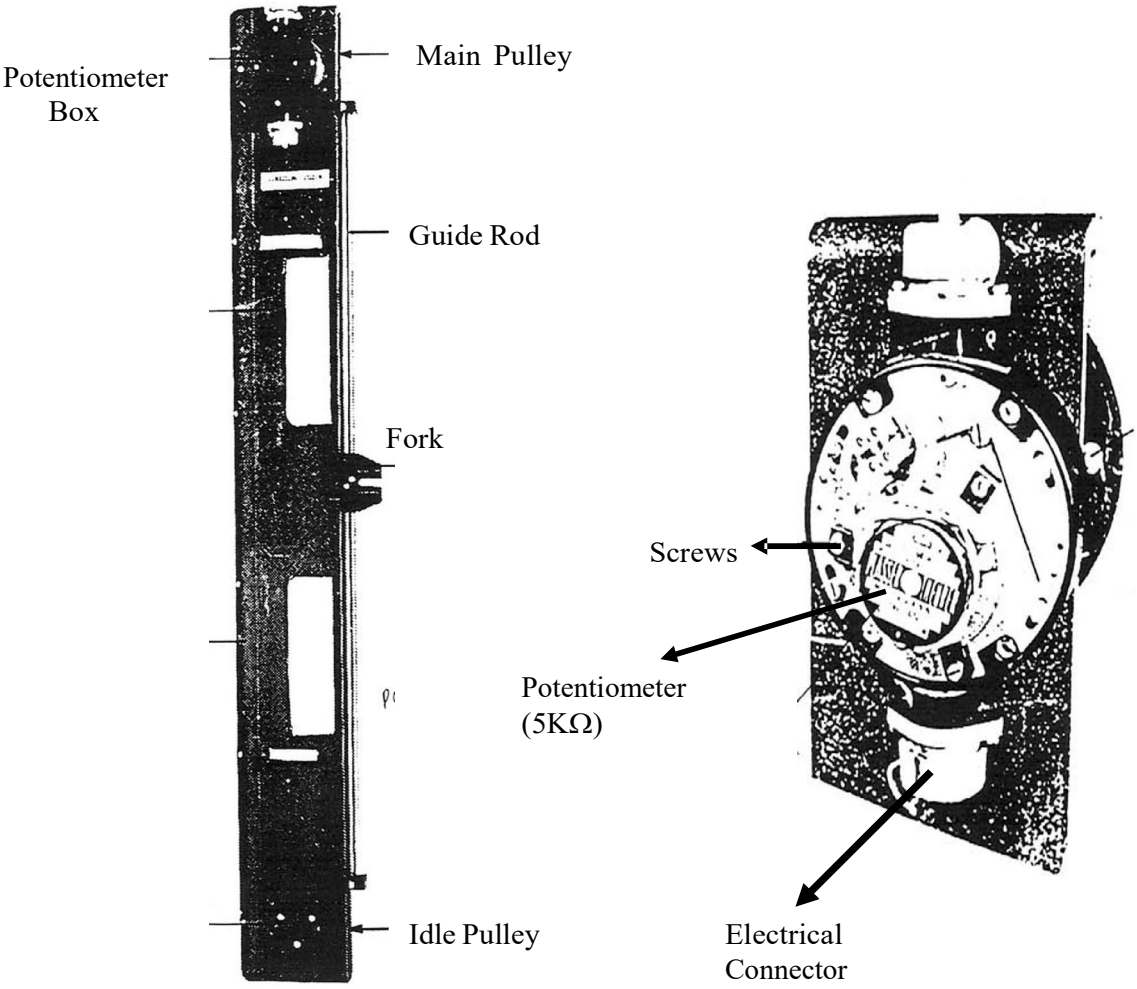
Lesson-V: Transducer **Session-10:** Definition, Principle, Classification, Types, Tamping Depth Transducer, Function and Calibration

Transducer:

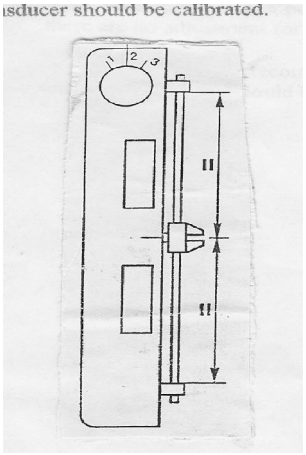
- Transducer is a device which converts mechanical energy into electrical energy.
- In Track Machines Transducers are used to convert track parameters (Cross Level, Long. level, versine) and Mechanical linear displacement (Tamping Unit, Satellites, Hook etc.) to electrical signal.

- In machines transducers are potentiometer type which is basically a variable resistance which shaft is rotated by mechanical arrangement and it generates electrical signal as per deflection.

TAMPING DEPTH TRANSUDCER: Tamping depth transducer converts displacement of taping unit to electrical signal at the rate of 19mv/mm. Output signal of this transducer is –ve if fork is above centre mark of the transducer and it will be +ve if fork is below centre mark. Multicheck address of transducers are F14 (for LH side) and F15 (for RH side). By using these address we can check output of LH or RH transducer.

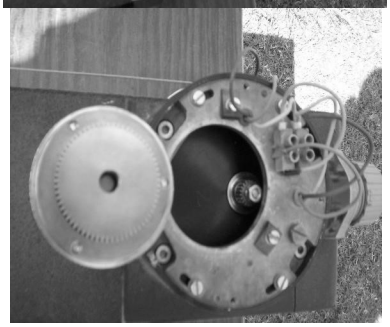


<u>CALIBRATION OF TAMPING DEPTH TRANSDUCER</u>: During working when transducer chord wire breaks we have to replace the chord wire. Detach transducer from machine replace the wire. After replacing wire check stroke of fork it should be equal both side of center mark of transducer .



Now keep fork of transducer at center mark of transducer for calibration. Then measure resistance between 1 & 2 or 2 & 3 terminal of potentiometer with the help of multimeter. It should be 2.5 KΩ (half of full value 5 KΩ). If resistance is not 2.5 KΩ then loose the screw of potentiometer and rotate potentiometer to get the 2.5KΩ resistance or value should be equal between 1 & 2 or 2 & 3 terminals of potentiometer.

If value 2.5KΩ is obtained. Tighten the screw of potentiometer keeping precautions that terminals of potentiometer should not touch with screws.



If value 2.5 KΩ is not obtained by rotating the potentiometer. Then loose the other three screws of potentiometer base plate and pullout potentiometer with gear. Now rotate the gear until same resistance is obtained between 1 & 2 and 2 & 3. After adjustment fit the potentiometer with base and tightened the screws.

NOTE: Three core cable is used for Transducers which has three wires Red(+10V), Blue(-10V) and yellow (output).

There is a 2KΩ resistance near potentiometer which comes in series with output 2nd terminal (centre) of potentiometer that should be properly

CALIBRATION OF PORTABLE TAMPING DEPTRH TRANSDUCER

After Replacement of wire fit the transducer in the machine , tamping unit should be locked .

Multi check address should be selected (F14 or F15),Tamping unit circuit should be on.

In this position output voltage of transducer should be -7.5V, if it is not loose the three screws of potentiometer ,turn it to get required voltage .after adjustment tight the screws and fit the cover .

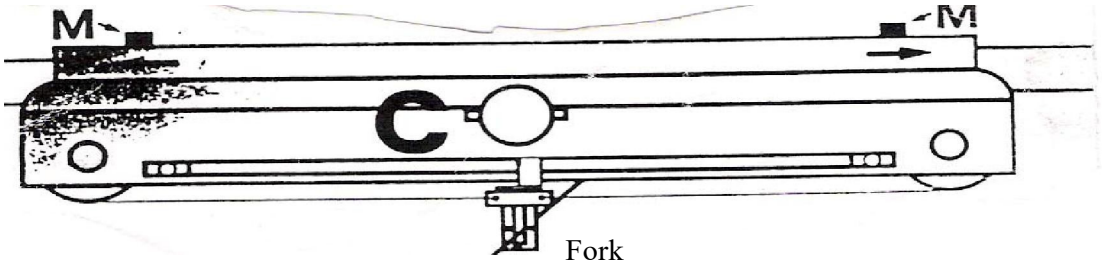
CALIBRATION OF PORTABLE TAMPING DEPTRH TRANSDUCER IN CSM-3X

In CSM-3X output voltage of transducer in lock condition should be –4.6 Volt, if it is not loose the three screws of potentiometer ,turn it to get required voltage .after adjustment tight the screws and fit the cover .

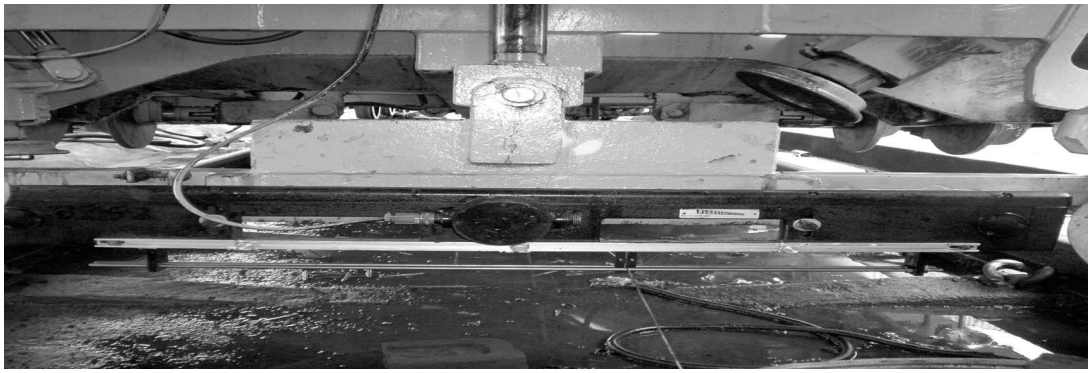
Note:- Before calibration of transducers, supply to potentiometers +10V and –10V from PCB EK813SV should be checked with the help of multi position selector switch It's output voltage should be +15V , –15V, + 10V and –10V . If there is variation in +10V, it should be adjusted by potentiometer P1 and -10V can be adjusted by P2 in same PCB.

LINING TRANSDUCER:

Lining Transducer measures $\mathbf{H_1}$ value of versine and converts it to electrical signal at the rate of **23.1 mv/mm –ve if fork is deflected to right side & +ve if fork is deflected to left side**. It is mounted on lining trolley . It's multicheck address is **F01**.



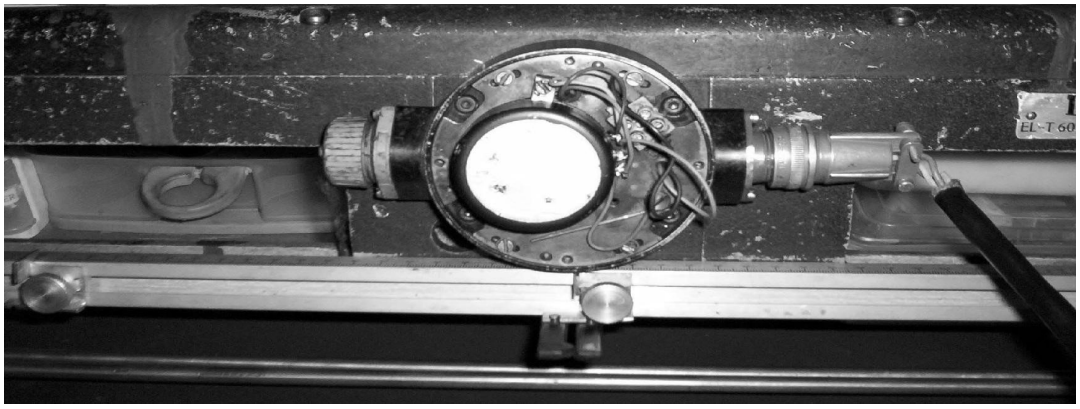
Fork



CALIBRATION OF LINING TRANSDUCER:

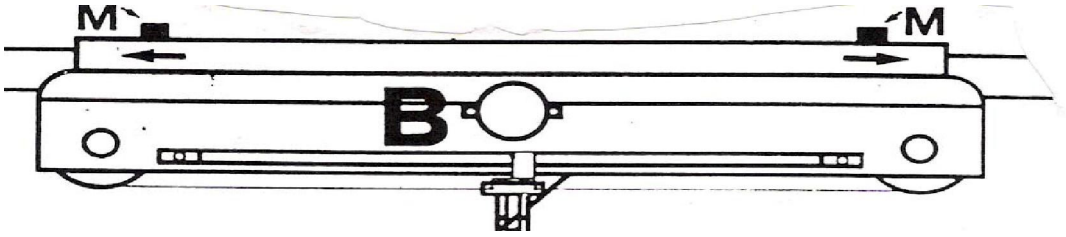
For calibration of lining transducer fix the fork of lining transducer at zero lock position, select multicheck address **F01** in multicheck PCB then display of multicheck should show 0v, if it is not showing zero volt then loose three screws of potentiometer and turn it to get zero volt . After adjustment tight the screws of potentiometer.

Before calibration of transducer voltage of potentiometer should be checked .It should be +10V and –10V. If there is any variation, then adjust +10v and –10v in EK813SV of lining circuit.



MEASURING TRANSDUCER:

Measuring transducer measures $\mathbf{H_2}$ value of versine and convert it to electrical signal at the rate of 23.1 mv/mm **+ ve if fork is deflected to right side** and **-ve if fork is deflected to left side**. It is mounted on measuring trolley .It's multicheck address is **F02**.It is used in 4-pt. lining.



CALIBRATION OF MEASURING TRANSDUCER:

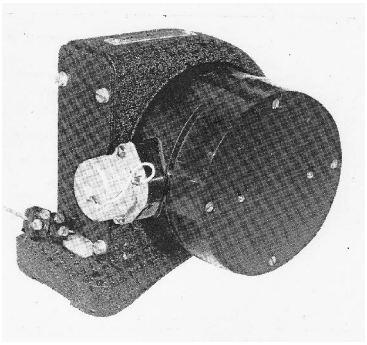
Measuring transducer converts **H2** value of versine to electrical signal at the rate of **23.1 mv/mm +ve for RH side and –ve for LH side.**

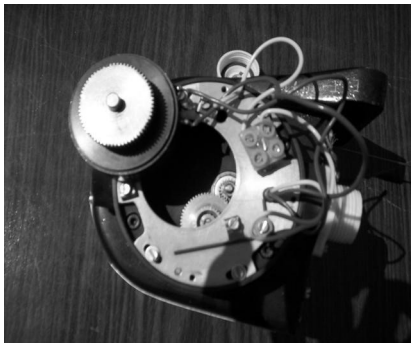
Calibration procedure of measuring transducer is same as lining transducer but for calibration of measuring transducer,4-pt lining and multicheck address F02 should be selected.

SATELLITE TRANSDUCER:

Satellite transducer converts displacement of satellite to electrical signal at the rate of **11mv/mm.**

This transducer is used in CSM and CSM-3X .Output of this transducer goes to satellite control PCB EK24V**(in CSM)** and EK202V(09-3X) at **6d** terminal of these PCBs.





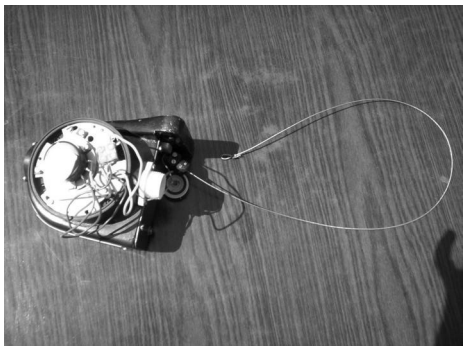
CALIBRATION OF SATELLITE TRANSDUCER IN CSM:

For calibration of Satellite Transducer. Put Machine in working mode, lock the satellite unit in front zero position. Measure output voltage of transducer or at 6d terminal of EK24V, it should be +8.2V.If it is not +8.2v, then open the cover of transducer and loose three screws of potentiometer and adjust it to get +8.2V . After adjustment tight the screws and fit the cover of transducer and release the satellite from front zero position.

Calibration of Satellite Transducer in CSM-3X

For calibration of satellite transducer in CSM-3X Satellite should be locked in rear position , in this position output voltage of transducer should be -8.6 V. If it is not then open the cover of transducer and loose the screw of potentiometer and adjust potentiometer to get -8.6V at 6d terminal of EK 202V.

HOOK DEPTH TRANSDUCER:



This transducer is provided in points and crossing machines Unimate-2S &3S in hook control circuit. This transducer converts displacement of hook to electrical signal at the rate of 23mv/mm .Multicheck address of hook Transducers are F18(L)and F19(R).

CALIBRATION OF HOOK DEPTH TRANSDUCER

For calibration of hook transducer hook should be in up position ,select multicheck address of hook transducer F18 or F19, in this position output voltage of hook transducer should be -2.2 Volt. If output is not -2.2 V then open the cover of transducer and loose three screws of potentiometer and adjust it to get -2.2 V.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-V: Transducer **Session-12:** Pendulum, Height Transducer, Encoder.

PENDULUM:

Pendulum is a transducer which converts cross level error to electrical signal at the rate of **25 mv/mm –ve for LH rail high and +ve for RH rail high .**

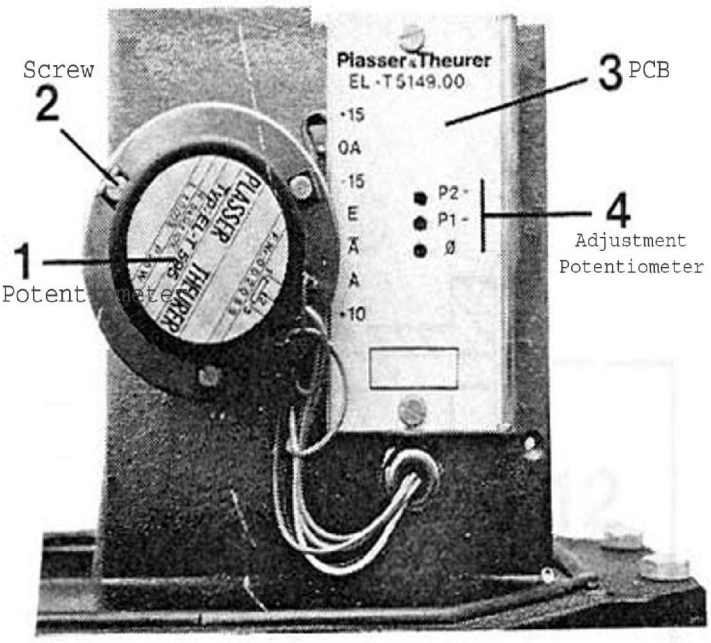
Pendulum consists of a potentiometer which shaft is attached with pendulum weight . Pendulum weight swings as per cross level difference therefore potentiometer's shaft also rotates and potentiometer generates electrical signal . Pendulum also consists of PCB. Potentiometer generates electrical signal at the rate of **2mv/mm**

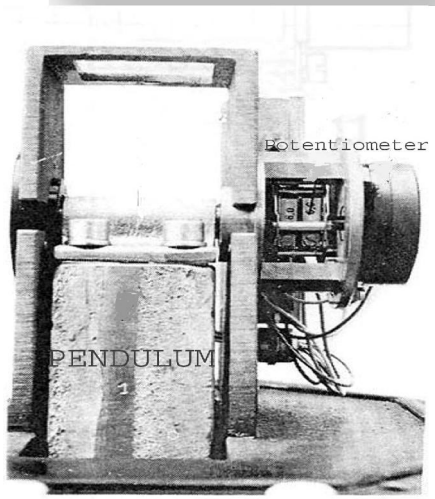
then PCB amplifies it at the rate of 25mv/mm This PCB consists of adjustment **potentiometers P1 , P2 and P3 .**

P1 --- Rigtht Side Cant Adjustment .

P2 -- Left Side Cant Adjustment.

P3 -- Zero Adjustment .





There are three pendulums used in CSM and CSM -3X , in other tamping machines only two pendulums are used .

Front Pendulum: This pendulum is mounted on front trolley . It measures cross level of front area before tamping.
Middle Pendulum: This pendulum is mounted on middle feeler rod . It measures cross level of tamping area .
Rear Pendulum: This pendulum is mounted on measuring trolley . It measures cross level after tamping .This pendulum participates in twist correction.

CALIBRATION OF FRONT PENDULUM:

Mechanical Adjustment: Lower the front trolley on track where cross level should be zero. Now check spirit level it should be on zero, if it is not zero then adjust check nut of front pendulum to get spirit level on zero.

Electrical Zero Adjustment: After mechanical adjustment check output of pendulum at 12b terminal of front input PCB EK345LV with the help of multimeter if output of pendulum is not zero then adjust potentiometer P3 in pendulum PCB to get zero volt at 12b.

Right Side Cant Adjustment: Place 100mm thick shim (Iron piece or wooden piece) under RH wheel of front trolley. Now measure voltage at 12b with respect to 32 db with the help of multimeter . It should be +2.5V, if it is not +2.5V then adjust P1 in pendulum PCB. After adjustment remove 100mm shim from wheel.

Left Side Cant Adjustment: Now place 100mm thick shim under LH wheel of front trolley. Measure voltage at 12b with respect to 32 db(OA) with the help of multimeter. It should be –2.5V. If it is not –2.5V then adjust P2 in pendulum PCB.

CALIBRATION OF MIDDLE PENDULUM:

Mechanical Adjustment: Lower the middle feeler rod on track where cross level is zero, check the spirit level of pendulum it should be on zero. If it is not in zero position then adjust check nut of middle pendulum to bring spirit level in zero position .

Electrical Zero Adjustment: Select Multicheck address F07, selector switch should be on 2nd position. Display should show zero volt ,if it is not zero volt then adjust potentiometer P3 in pendulum PCB to get zero volt on display.

Right Side Cant Adjustment: Place 100mm shim under RH side feeler rod and check output of pendulum on display . It should be +2.5V, if it is not +2.5V then adjust potentiometer P1 in pendulum PCB to get +2.5V.After adjustment remove shim.

Left Side Cant Adjustment: Place 100mm shim under LH feeler rod and check output of pendulum on display . It should be –2.5V, if it is not –2.5V then adjust potentiometer P2 in pendulum PCB to get –2.5V.

Rear Pendulum: Rear pendulum is fitted on rear feeler rod (Measuring trolley). It measures cross level after tamping and converts it to electrical signal at the rate of 25mv/mm(-ve if Left rail high).

Mechanical Zero Adjustment of Rear Pendulum: Lower the measuring trolley on track where cross level is zero. Check spirit level of rear pendulum. It should be in centre(zero position). if it is not in centre then adjust check nut of mounting of rear pendulum to bring spirit level at centre.

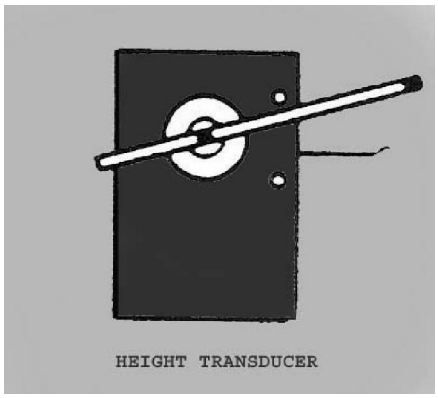
Electrical Zero Adjustment: After mechanical adjustment electrical output voltage of pendulum should be checked. Select multicheck address FO9 , check voltage on display ,it

should be zero volt on zero track, if it is not zero volt then adjust potentiometer P3 in pendulum PCB to get zero volt on display.

Right Side Cant Adjustment: Place 100mm shim under RH side wheel of measuring trolley and select multicheck address F09. Output of pendulum should be +2.5V if it is not +2.5V (less or more) then adjust potentiometer P1 in pendulum PCB to get +2.5V. After adjustment remove shim.

Left Side Cant Adjustment: Now place 100mm shim under LH side wheel of measuring trolley and check output voltage of pendulum it should be -2.5V if not adjust potentiometer P2 in pendulum PCB.

HEIGHT TRANSDUCER:



Height transducer converts longitudinal level to electrical signal at the rate of 90mv/mm +ve for lifting .There are two height transducers used in tamping machines one for left side and other for right side rail. Height transducers are mounted on middle feeler rod. Multicheck address of Height Transducers are F0D(LH) and F0E(RH)

CALIBRATION OF HEIGHT TRANSDUCER:

Arrange to make at least 30m track longitudinal & cross level free and provide shim if necessary to get zero longitudinal level track under all three feeler rods (Front, middle and rear.

- Switch on lifting circuit.
- Keep all input potentiometers (General lift,Cant and Cross level correction potentiometer etc.) at zero.
- Satellite should be in zero position.
- Apply levelling chord tension.
- select multicheck address of height transducers F0D or F0E

  Arm of height transducer should be parallel to track in horizontal and output signal should be 0V, pointer of lift indicator should in midlle position.

- If arm is not horizontal then adjust height transducer mechanically UP or DN as required.

- If arm is parallel to track and electrical signal is not zero then adjust potentiometer of height transducer by loosing screw. Signal should be checked on F0D for Left height transducer and on F0E for Right height transducer.

ENCODER:

This transducer is used in CSM, 09-3X, and DGS. This transducer converts displacement of machine to Digital signal at the rate of 1000 Pulse/meter. This is

PART NO. OF TRANSDUCERS AND POTENTIOMETERS USED IN CSM

SNO.	Name of Transducers	PART NO.
1.	Lining Transducer	ELT-609.00
2.	Measuring Transducer	ELT-609.00
3.	Front Pendulum	ELT 2021.00A
4.	Middle Pendulum	ELT-2036.00A
5.	Rear Pendulum	ELT-2036.00A
6.	Height Transducer	ELT-2013.00
7.	Tamping Depth Transducer	ELT-1330.00/ ELT-750.00
8	Satellite Transducer	ELT-1041.00
9.	Distance Measuring wheel	ELT-7055/700AF
	POTENTIOMETERS	
1.	Slew Potentiometer	ELT-1044
2.	Versine Potentiometer	ELT-1044
3.	Over Slew Potentiometer	20 KΩ +10 SKALA/200G
4.	Zero Adjustment Potentiometer	20KΩ +5 S KALA/200G
5.	Super Elevation Potentiometer	ELT-1044
6.	General Lift Potentiometer	ELT-1044
8.	±5mm correction Potentiometer	ELT-5140
9.	± 10mm Correction Potentiometer	ELT-1044
10.	Depth Selector Potentiometer	ELT-5016

PART NO. OF TRANSDUCERS AND POTENTIOMETERS USED IN DUOMATIC

SNO.	Name of Transducers	PART NO.
1.	Lining Transducer	ELT-609.00
2.	Measuring Transducer	ELT-609.00
3.	Pendulum	ELT 133.00
4.	Height Transducer	ELT-213.00
5.	Tamping Depth Transducer	ELT-1330.00
	POTENTIOMETERS	
1.	Slew Potentiometer	ELT-1044
2.	Versine Potentiometer	ELT-1044

3.	Over Slew Potentiometer	20 KΩ +10 SKALA/200G
4.	Zero Adjustment Potentiometer	20KΩ +5 SKALA/200G
5.	Super Elevation Potentiometer	ELT-1044
6.	General Lift Potentiometer	ELT-1062

PART NO. OF TRANSDUCERS AND POTENTIOMETERS USED IN UNIMAT2S&3S

Sl.NO.	TRANSDUCER	PART NO.
1.	Lining Transducer	ELT-609.00
2.	Measuring Transducer	ELT-609.00
3.	Pendulum	ELT 2036.00
4.	Height Transducer	ELT-2044.00
5.	Tamping Depth Transducer	ELT01330.00/ELT-750.00
6.	Hook depth Transducer	ELT-750.00
	POTENTIOMETERS	
1.	Slew Potentiometer	ELT-1044
2.	Versine Potentiometer	ELT-1044
3.	Over Slew Potentiometer	20 KΩ +10 SKALA/200G
4.	Zero Adjustment Potentiometer	20KΩ +5 SKALA/200G
5.	Super Elevation Potentiometer	ELT-1044
6.	General Lift Potentiometer	ELT-1044

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-V: Transducer **Session-13:** Electronics model room for demonstration of checking and calibration of Transducers..

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-VI: Operational Amplifier **Session-14:** Definition of Operational Amplifier, Symbol, Function of each terminal, Open loop, Close loop, +ve feed back,–ve feed back, Characteristics

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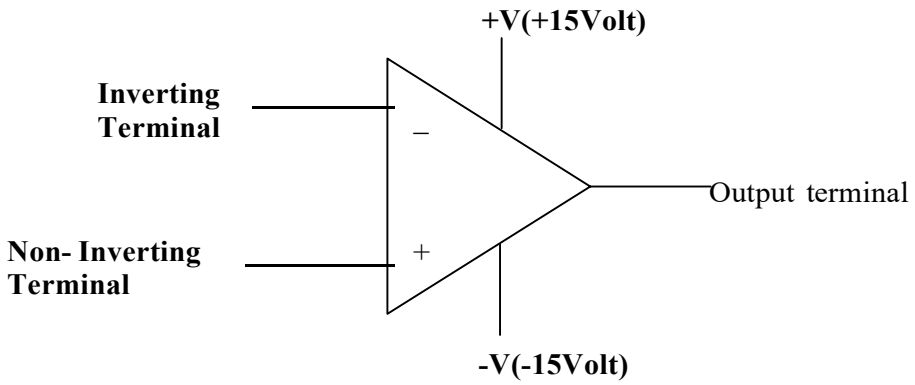
OPERATIONAL AMPLIFIER:

Operational amplifier is a direct coupled high gain amplifier usually consists of one or more stage of differential amplifier. It can amplify AC as well as DC input signals. Operational amplifier also can do mathematical operations such as addition ,subtraction ,multiplication , integration and differentiation etc. Commonly it is abbreviated to Op- amp .

SCHEMATIC SYMBOL:

The basic operational amplifier has two input and one output terminal input terminals are called inverting terminal and non-inverting terminal.



Characteristics Of Ideal Operational Amplifier:

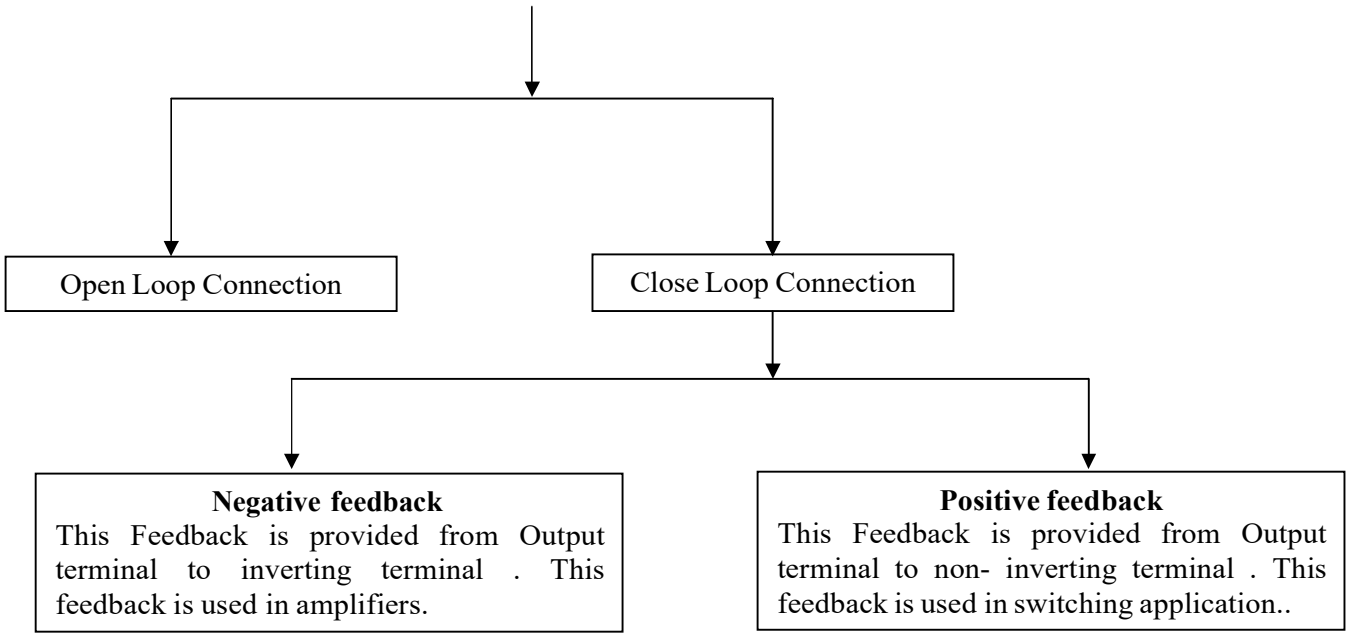
Input impedance	=	Infinite
Output impedance	=	Zero (0)
Gain	=	Infinite
Band width	=	Flat

Characteristics Of Practical Operational Apmlifier:

Practical operational amplifier has following characteristics:

- Input impedance = 10^6 (MΩ)
- Output impedance = 75Ω
- Gain = 10^6
- Band width = Almost flat

Modes of Connections of Operational Amplifier



SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-VI: Operational Amplifier **Session-15:** Application of Operational Amplifier as Buffer, Inverter, Non Inverter, Adder, Sub-tractor, Integrator etc.

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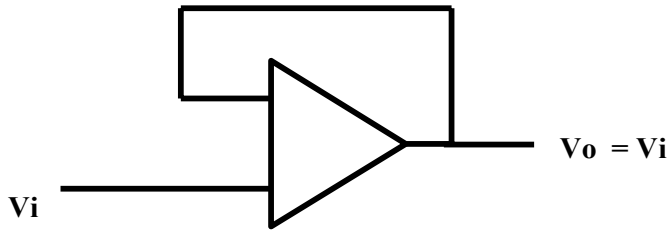
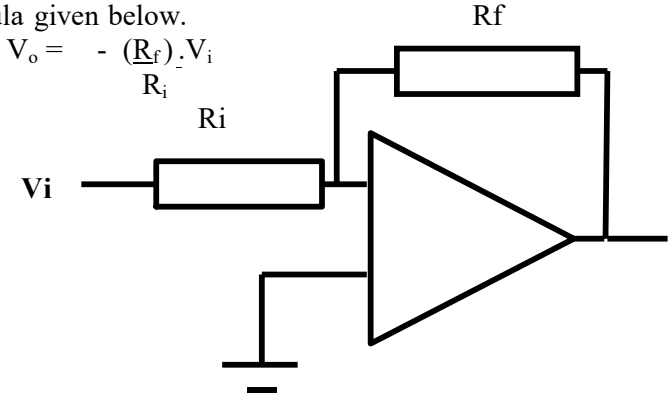
1. **Buffer Amp :-** It is an unity gain Amplifier, which output is equal to Input. This Op-Amp is used for isolation and impedance matching. In PCBs output of transducers are received through this amplifier



2. **Inverting Amp :-**This Amplifier Inverts the polarity of the input signaland amplifies as per formula given below.

$$V_o = -\frac{R_f}{R_i} V_i$$



$$V_o = -\frac{Rf \cdot Vi}{Ri}$$

Ri = Input Resistor
Rf= Feedback Resistor
Vi = Input voltage
Vo = Output voltage

Ex: (i) If R_f = 100KΩ
R = 10 KΩ
e_i = 1V

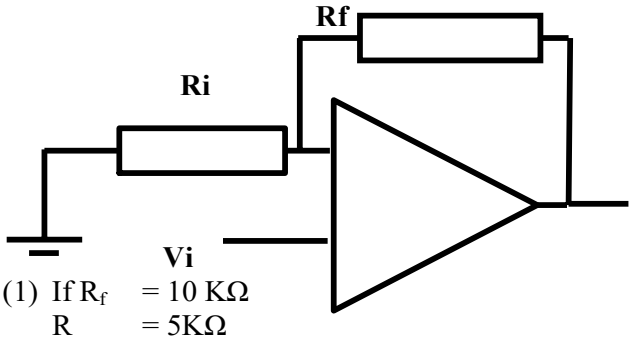
$e_0 = -1 \times \frac{100}{10} = -10V$

(ii) R_f = 4KΩ

R = 2KΩ
e_i = -3V
C_0 = -(-3) x ($\frac{4}{2}$) = - (-3) x 2 = 6V

3. Non-Inverting Amp :-This Amplifier does not Inverts the polarity of the input signals and amplifies as per formula given below.

$$V_o = (1+\frac{R_f}{R_i}).V_i$$



$V_o = (1+\frac{R_f}{R_i}).V_i$
Ri = Input Resistor
Rf= Feedback Resistor
Vi = Input voltage
Vo = Output voltage

Ex. (1) If R_f = 10 KΩ
R = 5KΩ
e_i = + 2V

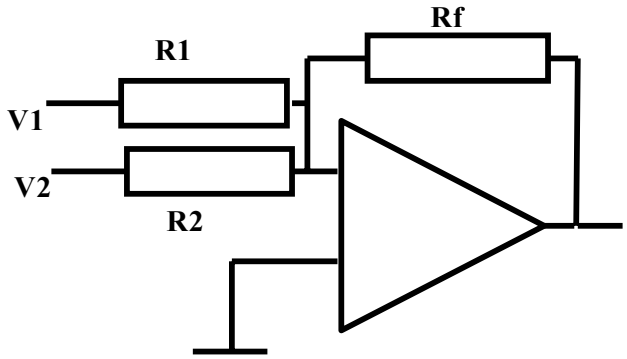
e_0 = +2 (1 + $\frac{10}{5}$) = + 6V

(2) R_f = 200KΩ
R1 = 100KΩ
e_i = -4V

e_0 = - 4 (1+ $\frac{200}{100}$) = -12V

4.Summing Amp :-This Amplifier add the input signals and amplifies as per formula given below.

$$V_o = -(\frac{R_f}{R_1}.V_1 + \frac{R_f}{R_2}.V_2)$$



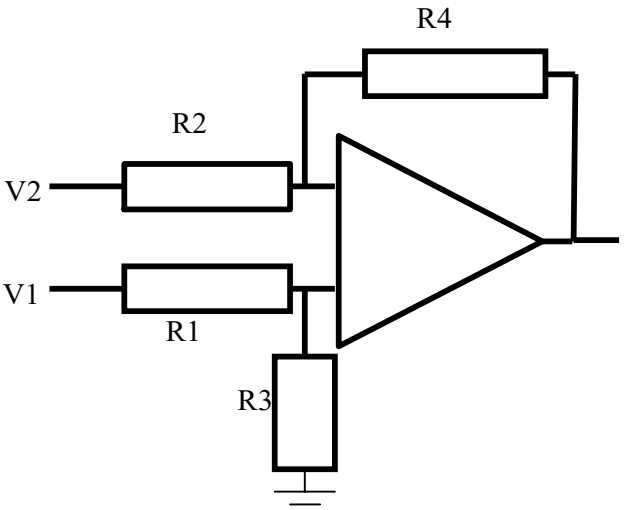
$V_o = -(\frac{R_f}{R_1}.V_1 + \frac{R_f}{R_2}.V_2)$
R1&R2 = Input Resistor
Rf = Feedback Resistor
V1&V2 = Input voltage
Vo = Output voltage

: (1) R_f= 10KΩ
R_1 = 5KΩ
R_2 = 5KΩ
e_1 = 1V,C_2 = 2V

e_o = $-\frac{RF}{R}(e_1 + e_2) = -\frac{10}{5}(1+2)$
= $-\frac{30}{5}$ = -6V

5. Subtractor :-This Amplifier subtracts the input signals and amplifies as per formula given below.

$$V_o = - \frac{R_4}{R_1} .(V_1 - V_2) \qquad (R1 = R2 : R4=R3)$$



$V_o = - \frac{R_4}{R_1} .(V_1 - V_2)$

R1&R2 = Input Resistor

R4 = Feedback Resistor

V1&V2 = Input voltage

Vo = Output voltage

6 INTEGRATOR:

Output of this amplifier is integral of input voltage .This amplifier is also called ramp generator. This amplifier is used in signal generators to convert square wave to triangle wave or ramp signal .

7 DIFFERENTIATOR:

This amplifier perform the differentiation operation . Output of this amplifier is derivative of input signal . This amplifier is used in signal generators to convert triangle wave or ramp signal to square wave .

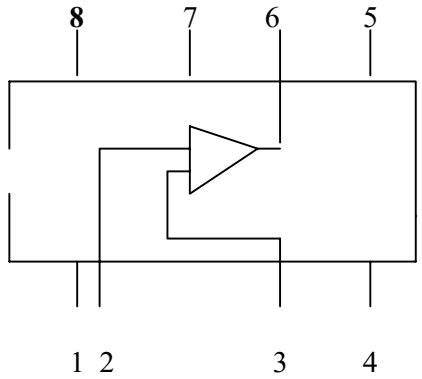
Lesson-VI: Operational Amplifier **Session-16:** Operational Amplifier ICs used in different PCBs in machines and their Pin diagrams

OPERATIONAL AMPLIFIER ICs USED IN DIFFERENT PCB's OF MACHINES

SINGLE OP – AMP:

OP02
741
OP50
LH0041 C G

PIN DIAGRAM OF OP – AMP – 02:



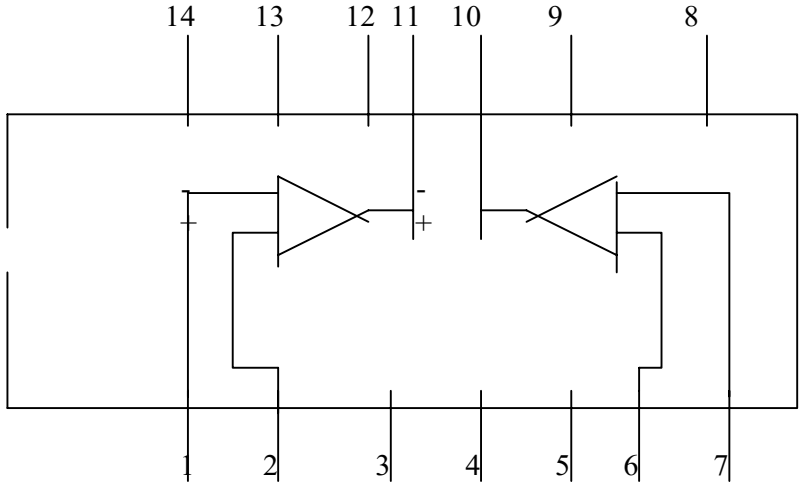
PIN-1 → For null adjustment
PIN-2 → For Inverting terminal
PIN-3 → Non Inverting terminal
PIN-4 → For Negative Supply
PIN-5 → Null adjustment
PIN-6 → For Output
PIN-7 → For +Ve supply
and PIN-8 → No connection

OP-AMP ICs USED IN DIFFERENT PCBs OF MACHINES

DUAL OPERATIONAL AMPLIFIER

OP04
747

Pin Diagram of OP04



PIN – 1 →& 2 Input for Op Amp. –'A'

PIN – 3 →Null Adjustment of 'A'

PIN – 4 →VE supply

PIN – 5 →Null Adjustment of 'B'

PIN - 6 & 7 →Input For 'B'

PIN – 8 →Null Adjustment of 'B'

PIN – 9 →X Ve Supply

PIN – 10→ Output of 'B'

PIN – 11→ No connection.

PIN – 12→ Output For ‘A

PIN – 13 →X Ve supply

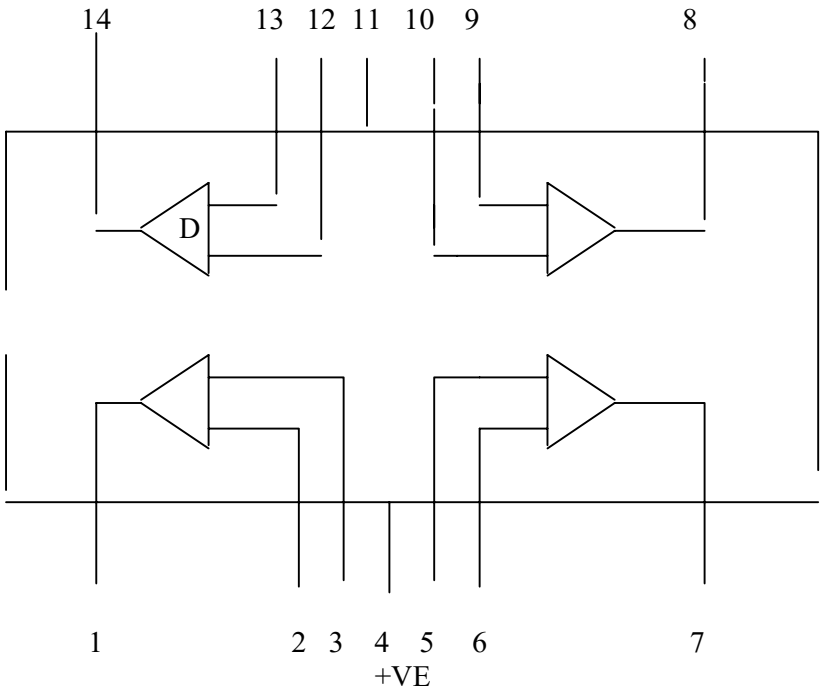
And PIN – 14 →Null Adjustment for ‘A’

OPERATIONAL AMPLIFIER ICs USED IN DIFFERENT PCB’s OF MACHINE

SINGLE OP – AMP:

OP 02
741
OP50
LH0041 CG

PIN DIAGRAM OF OP – AMP – 02:



PIN – 1→ OUTPUT OF ‘A’

PIN – 2 → INPUT OF ‘A’

PIN – 3 → + VE supply

PIN – 5& 6 → INPUT OF ‘B’

PIN - 7 → OUTPUT OF ‘B’

PIN – 8 → OUTPUT OF ‘C’

PIN – 9 & 10 → INPUT OF ‘C’

PIN – 11→ VE SUPPLY

PIN – 12 & 13 → INPUT OF ‘D’

And PIN – 14 → OUTPUT OF ‘D’

Session-17: Electronics Model Room for demonstration of working of Operational Amplifiers in different applications

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-VII: Digital Electronics **Session-18:** Number system i.e. Binary, Decimal, Hexadecimal,Logic Gates and Flip-Flop

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Digital Electronics

Number Systems: There are four system which are often used in digital circuits. These systems are-

1. **Decimal –** It has a base (or radix) of 10 i.e. It uses 10 different symbols to represent numbers (0,1,2,3,4,5,6,7,8,9)

2. **Binary –** It has a base of 2 i.e. It uses only two different symbols – (0,1)

3. **Octal –** It has a base of 8 i.e. It was 8 different symbols – (0,1,2,3,4,5,6,7)

4. **Hexadecimal –** It has a base of 16 i.e. It uses sixteen different symbols – (0,1,2,3,4,5,6,7,8,9, A, B, C, D, E, F)

Binary system is extensively used by digital system like digital computer.
Hexa decimal number system is particularly suited for Micro Computer/Microprocessor based system.

LOGIC CIRCUITS

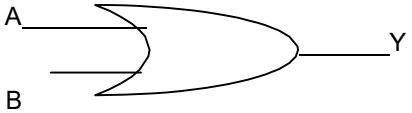
Logic Gates. Are logic circuits which process two or more signals logically. In essence, they are switches. Depending on the input voltage, the gate or switch will be either on or off. Inputs and output have only two stage "o"(Off) or "1"(On).
The first thing to learn about the different gates is their symbols. A logic gate symbol is simply a shorthand way of representing an electronic circuit that operates in a certain way. Understanding the logic symbols can make understanding the operation of a circuit much quicker and easier than if the circuit were represented by showing all the transistors, diodes and resistors .

Name of Gate:-

1. OR GATE.
2. AND GATE
3. NOT GATE
4. EX-OR GATE
5. NOR GATE
6. NAND GATE

1. **OR GATE:-** It has two or more than two inputs and one outputs. If any input is high (1) the output is high.

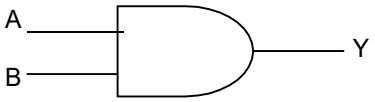
SYMBOL



TRUTH TABLE

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

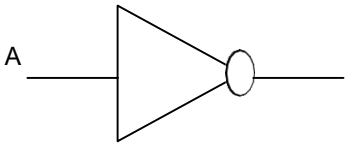
2. **AND GATE:-** It has two or more than two inputs and one out puts. If both the input are high then only the out put is high.



A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

3. **NOT GATE:** - It has only one input and only one out put. If the input is high then the out put is low and vise versa.

SYMBOL:-



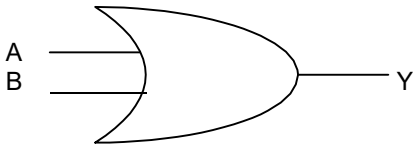
$\overline{Y=A}$

TRUTH TABLE

A	Y
0	1
1	0

4EX-OR GATE: It has two in put and only one out put. If input is different then output is high.

SYMBOL:

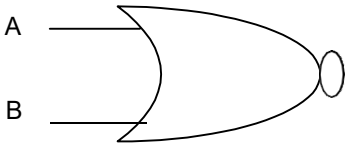


TRUTH TABLE

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

5. **NOR GATE: -** It has two or more then two inputs and one out put. If any input or all input is high then out put is low.

SYMBOL

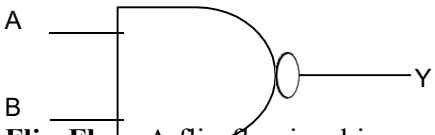


TRUTH TABLE

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

6. **NAND GATE: -** It has two or more than two in puts and one out put. If any or all the input are low then output is high.

SYMBOL

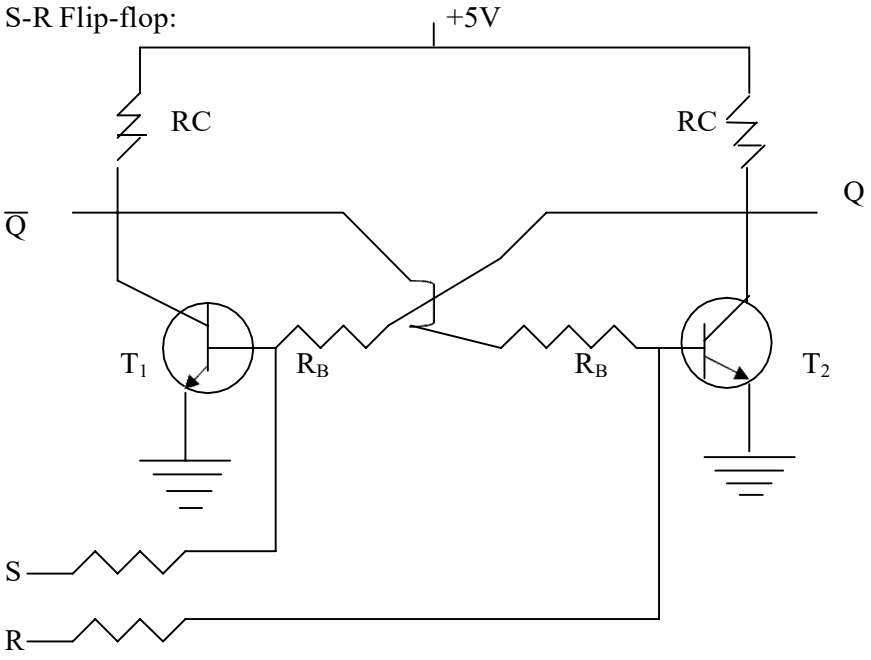


TRUTH TABLE

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Flip-Flop: A flip-flop is a binary storage device. It can store binary bit either 0 or 1. It has two stable states: high and low i.e. 1 and 0. It has the property to remain in one state indefinitely until it is directed by an input signal to switch over to the other state. It is a basic memory element.

S-R Flip-flop:



Truth Table

R	S	Q	Comment
0	0	NC	No change
0	1	1	Set
1	0	1	ReSet
1	1	-	Racing

In this ckt only of transistor is saturated and other is cut-off-suppose that transistor T1 is saturated and hence its collector voltage is approximately 0 volt. Now there is no base drive for transistor T2 so T2 is cut off and its collector voltage is approx +5V. The high collector voltage of T2 produces sufficient base current for T1 therefore T1 remains in saturation. The output is equal to +5V. Thus the circuit stores a binary bit. Similarly when T2 is saturate and T1 is cut off. The output is approx OV. In this condition the circuit stores a binary bit 0.

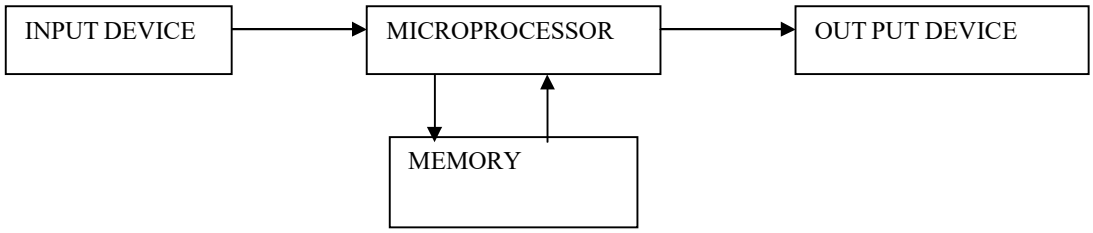
SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-VII: Digital Electronics **Session-19:** Electronics model room for demonstration of working of Logic Gates

Lesson-VII: Digital Electronics **Session-20:** Basic Idea of Microprocessor, Semiconductor memories, Multiplexer

MICROPROCESSOR:-

A CPU built into single chip is called a micro processor. It is latest development in the yield of computer technology. Digital computer whose CPU is microprocessor is called microcomputer. A microprocessor combined with memorial input out put devices forms a micro computer. The micro indicates its physical size, not its computing power.



The first microprocessor was introduced in 1971 by INTEL CO. USA. It was a 4bit microprocessor. 4 bit microprocessor means that the processor makes processing of 4bit data in parallel at a time. The first INDIAN microprocessor is SCL 6502. it is an 8bit Microprocessor Manufactured by Semiconductor Complex Ltd. The Number of bit that a digital computer can process in parallel at a time is called its word length. The Memory addressing capacity of Microprocessor depends on the width of its address Bus. If a Microprocessor has n-bit wide address bus it can directly address 2^n memory locations. Example of Microprocessor such that 8085, 8086, 80186,80286,80486, PENTIUM.

Memory:

The function of memories is to store program data and results. There are two kinds of memory:

1. Semiconductor memories
2. Magnetic Memory

Semiconductor memories are faster, smaller, lighter and consume less power. Semiconductor memories are used as the main memory of a computer.

Magnetic memories are slow but they are cheaper than semiconductor memories. Magnetic memories are used as secondary memory of computer for bulk storage data and information.

1. Semiconductor Memory:

(i) **RAM:** The read and write memory of a computer is popularly known as RAM. It is also called R/W memory. Information's can be read from and written into it during normal operation. It has random access property. RAM stands for random access memory. The RAM is a volatile memory i.e.. It is contents are lost when supply is interrupted.

(ii) **ROM:** It is a read only memory. It is non volatiles. It is used for permanent storage. It has also a random access property. The contents of ROM are decided by manufacturer. Contents are permanently stored in a ROM at the time of manufacturing.

(iii) **PROM:** It is programmable ROM. The contents of PROM are decided by the user. A special equipment for the programming of PROM is called PROM programmer.

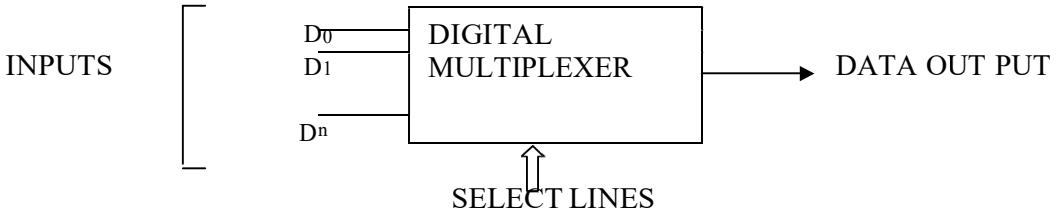
(iv) **EPROM:** It is an erasable PROM. The contents are erased by exposing EPROM to high intensity short were ultra violet light for 10 to 20 minutes. The user can not erase the content of a single memory location. The entire contents are erased.

(v) **E^2PROM:** It is electrically erasable PROM. They need not to be removed from Microcomputer board for erasing. A single byte of data or the entire device can not be erased in about 10MS. Erasing and Programming of E^2PROM is much easier.

2. Magnetic Memory:

Magnetic memories are non volatile. They are slower than semiconductor memory. They are used in computer system mostly for bulk storage. The important types of magnetic memories are: Magnetic Tape, floppy disc, hard disc and magnetic bubble type memory.

DIGITAL MULTIPLEXER/DATA SELECTORS:- A digital Multiplexer has N inputs and only one output. It selects one out of N inputs and makes it available at the out put. It also called data selectors. There are a select logic which decides which input is to be selected.



SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-VIII: Electronic Circuits and PCBs: Session-21: Discrete Circuit & Integrated Circuit, Advantage & Disadvantage ,PCBs used in different machines, Description, Name Quantity and their Functions

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CIRCUITS:- There are two types of circuits :-

(i) Discrete circuit.
(ii) Integrated circuit.

DESCRET CIRCUIT:- In this circuit Electronic Components like resistor, capacitor, diode and Transistors are connected with conductor plate (track) on Printed Plates by soldering.

Advantages:-
(i) Rectification of fault is easy.
(ii) Power rating of ckt is high.
(iii) Manufacturing is easy.

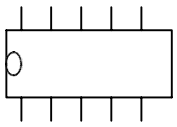
Dis-advantages:-
(i) Costlier than I.C.
(ii) Bulky
(iii) Occupied more space.
(iv) Soldering problem may arise (dry solder).

2. **INTREGRATED CIRCUIT**:- In this circuit all the electronic component except Inductor is connected(constructed) on a silicon chip. The size of component is very small, so this is done with the help of magnifying lens and computer.

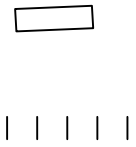
Advantages:-
(i) Cheaper than Discrete circuits
(ii) Light weight.
(iii) Occupied very less space.
(iv) No problem of dry soldering.

Dis advantages:
(i) it is non repairable.
(ii) If any component of an I.C is damaged then I.C has to be replaced.
(iii) Less power carrying capacity.

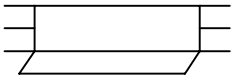
I.C PAKAGING:
(I) dip type(Dual in line pakage) used in our Machine.
(ii) TO TYPE(Top-Hat)
(iii) FLAT TYPE.



(1)

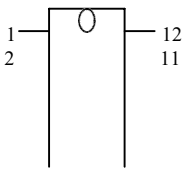


(2)



(3)

I.C SYMBOL: There are consists of either a triangle or a rectangle.



3	10
4	9
5	8
6	7

TERMINAL NUMBERING:-
Anticlockwise from mark position , grooved or nose.

PCBs used in Unomatic/Duomatic

Sl. No.	PCB Part NO.	Function of PCB	Quantity	Location Panel Box No.
1.	EK813 SV00	DC to DC convertor Power supply 24V→ ±15 & ±10V	4 Nos	B4 B7 B2 1 2 1
2.	EK 16 V 00	Tamping unit UP/DN control.	2 Nos	B2
3.	EK277 LV00	Middle pendulum control	1 No.	B7
4.	EK229 LV00	Track lifting	2 Nos.	B7
5.	EK 79 V00	3- stage lifting Regulator	1 No	B7
6.	EK255 LV00	Auto levelling	1 No	B4
7.	EK217 LV00	Front pendulum control	1 No.	B4
8.	EK 708 A00 or EK 715 A00	DC Marli Motor control For levelling Control	2Nos.	B4
9.	EK335 LV00	Lining control	1 No.	B7
10.	EK290 LV00	Over slew control	1 No	B7
11.	EK 80 LV00	3-stage lining Regulator	1 No.	B7
12.	EK275 LV00	Design lining	1 No.	B4
13.	ELT 631 00	Inter com.	1No.	B4
14.	ELT 1116.00	Semi-auto work	1 No.	B2

P.C.Bs used in 09– CSM

Sl. No.	PCB Part No.	Function of PCB	Quantity	Location Panel Box No.

1.	EK812 SV00	DC to DC convertor 27V→ 24V and 12V	1 No.	B20
2.	EK 813SV00	DC to DC Convertor Power Supply 24V → ±15V & ±10V	5 Nos.	B4, B6, B10 1 2 2
3.	EK 851SV00	DC to DC converter 24V→ 12 V and 5 V	1 No.	B 19
4.	EK 16 V00	Tamping unit UP /DN control	2 Nos.	B10
5.	EK 24 V00	Satellite control	1No	B10
6.	EK 28 LV00	Multiplexer	1 No.	B6
7.	EK 99V00	Distance simulator	1 No.	B19
8.	EK 100 V00	Auto Positioning	1 No.	B10
9.	EK110 LV00	Pendulum Compensation	1 No.	B6
10.	EK290 LV00	Over slew Control	1No.	B10
11.	EK 319 LV00	Work drive control	1No.	B6
12.	EK 345LV00	Front input	1 No.	B4
13.	EK346 LV00	Pendulum control	1 No.	B6
14.	EK347 LV00	Track lifting	2 Nos.	B6
15.	EK348 LV00	Satellite compensation	1 No.	B10
16.	EK349 LV00	Lining control	1 No.	B10
17.	EK 501 P00	Programmer PCB	1 No.	B20
18.	EK 552 P00	Time Delay	1 No.	B20
19.	EK 553 P00	Programmer input/output	9 Nos.	B20
20	EL-T 631.00	Intercom	1No	B40
21.	VT 3005	Work drive amplifier	1No	On Chasis

LIST OF PCBs USED IN CSM-3X

Sl. No.	PCB Part No.	Function	Quantity	Location Panel Box No.
1.	EK 805 SV00	DC to DC Convertor 24V → +5V	1 No	B20

2.	EK812SV00	DC to DC Convertor 27V→ +24V & +12 V	1 No	B 10
3.	EK 813SV00	DC to DC Convertor 24V → ±15V,±10V	2 Nos	B6 B10 1 1
4.	EK 816SV00	DC to DC Convertor 24V → ±15V,±10V & +5V	4 Nos.	B4, B6, B10, B20 1 1 1 1
5.	EL-T7155	DC to DC Convertor 24V → +16V	1 No.	B7
6.	EK2343LV00	Front input	1 No.	B4
7.	EK 2361 LV00	Lining input	1 No.	B10
8.	EK 2140 LV00	Lining output and Over slew	1No.	B10
9.	EK 3069LV00	Track lifting	2 Nos.	B6
10.	EK 2351LV00	Pendulum Control	2 Nos.	B6
11.	EK 526MC00	Micro controller for Satellite compensation	2 Nos	B10 B6 1 1
12.	EK 1AP7	Tamping Unit Control	4 Nos	B6
13.	EK 140V00	Squeezing Control	1 No.	B10
14.	EK 202V	Proportional satellite control	1No	B10
15.	EK2360L00	Drive pump control	1 No	B10
16.	EK 2349LV00	Drive speed display of machine	1 No .	B10
17.	EK 193V	Drive control	1No.	B10
18.	EK 207V00	Multiplexer	2 No.	B10
9.	EK 650 P00	Programmer	1 No	B20
20	EK 651P00	Subroutine	5 No.	B20
21	EK 652 P00	Time Delay	6 No.	B20
22	EK 653 P00	Programmer input/output	28Nos	B30 B31 16 12 17
23	EK654P00	QL (Load Relay)	2Nos	B20
24	EK 658P00	Watch Dog	1 No.	B20
25.	EK 602E 00	Relay Plate	3Nos	B6 B10 2 1
26	EK150V00	Auto Positioning 65cm sleeper	1No	B6

27	EK 2324 LV00	Satellite Lateral Movement	1 No.	B10

PCBs used in Unimat-2S

Sl. No.	PCB Part No.	Function	Quantity	Location Panel Box No.
1.	EK 812 SV00	DC to DC Convertor 24V → + 24V and + 12V	1 No.	B20
2.	EK 813 SV00	DC to DC Convertor 24V → ±15V&,±10V	4 Nos	B4 B6 B10 1 1 2
3.	EK 132 LV00	Tamping unit UP/DN control	2 Nos	B6
4.	EK 2072 LV00	Front input	1 No.	B4
5.	EK 2038 LV00	Lining control	1 No.	B10
6.	EK 719 A00	D.C Motor Control for Lining chord follow up	1 No.	B10
7.	EK 144 LV00	Hook and 3-stage lining & lifting control	1 No.	B6
8.	EK 2041 LV00	Track lifting (Leveling control)	2 No.	B6
9.	EK 2042 LV00	Pendulum control	1No.	B6
10.	EK 28 LV00	Multiplexer	1 No.	B6
11.	EK 290 LV00	Over-slew Control	1 No.	B10
12.	EK 502 P00	Programmer	1 No.	B20
13.	EK 552 P00	Time Delay	1 No.	B20
14.	EK 553 P00	Input/Output of Programmer	12 No.	B20
15.	EK 554 P00	QL-Relay	5 Nos.	B10
16.	EL-T 631.00	Intercom	1 No.	B40

PCB's used in Unimat - 3S

Sl. No.	PCB Part No.	Function	Quantity	Location Panel Box No
1.	EK 813 SV 00	DC to DC Convertor 24V→ ±15 V and ±10V	4 Nos	B4, B6, B10 1 2 1
2.	EK 812 SV00	DC to DC Convertor 24V→ +24V and + 12V	1 No.	B20
3.	EK 2072 LV00	Front input	1 No.	B4

4.	EK 2173 LV00	Lining Inputs control	1 No.	B10
5.	EK 2140 LV00	Lining Output& Over Slew control	1 No.	B10
6.	EK 2041 LV00	Track lifting	2 Nos.	B6
7.	EK 2042 LV00	Pendulum control	1 No.	B6
8.	EK 120 V00	Hook Control	1 No	B6
9.	EK 140 A00	Proportional squeezing	1 No.	B6
10.	EK 132 V02	Tamping Unit UP/DN control	2 Nos.	B6
11.	EK 28 V02	Multiplexer	1 No.	B6
12.	EK 502 P00	Programmer PCB	1 No.	B20
13.	EK 552 P00	Time Delay	1 No.	B20
14.	EK 553 P00	Programmer Input/output	13 Nos.	B20
15.	EK 554 P00	QL-relay	5 Nos.	B10
16.	EL-T 631.00	Inter com.	1 No.	B40

Lesson-IX: Power Supply: Session-22: Need of Power supply, Types of power supply, DC to DC Converter & Regulator

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POWER SUPPLY PCBs:

Power supply source on machine are batteries . Battery give 12 volt output .By connecting two batteries in series we get 24 volt .This 24v is used for starting of engine , to operate the solenoids, to operate the relay, for programmer .These batteries are not capable to supply voltage to all above circuit at same time for longer period . Battery get discharge in short period .It need charging during working for that purpose alternators are provided in machines.

Besides 24volt , ±15V, ±10V,+12V,+5V are also used .

±15V need for operational amplifier supply and calibration potentiometers in PCBs .

±10V is used for transducers and potentiometers in panel box .

+12V is used in programmer PCB .

+5V is used for digital display .

It is not possible to provide separate battery and it' charging arrangement for each supply voltage .

So 24 volt is converted to ±15V , +12v and +5v by DC to DC converters

.DC to DC converters which are used in machine are regulated power supply PCBs .

POWER SUPPLY PCBs USED IN DIFFERENT MACHINES

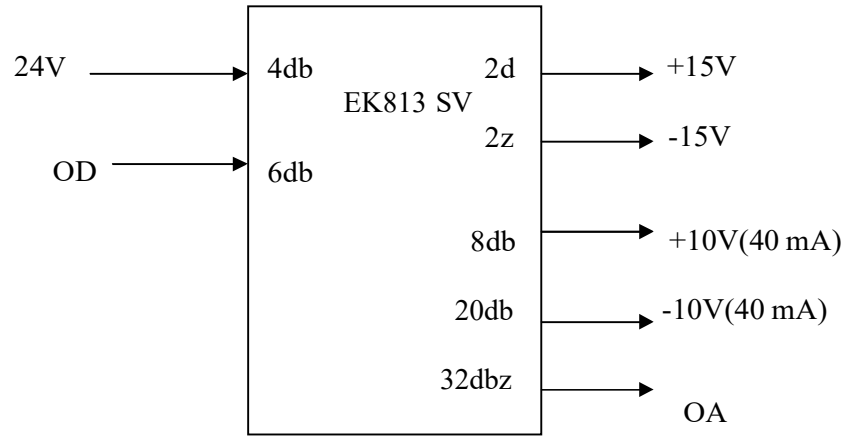
- **PCB EK813SV** :This PCB converts 24v to ±15v &±10v. This PCB is used in Uno/Duo. CSM, Unimat2S/3S,09-3X machines.
- **EK816SV :**This PCB converts 24v to ±15v, ±10v &5v.This PCB is used only in 09-3X machine.
- **EK812SV :**This PCB converts 24v to24v &12v.This is used in CSM/UNIMAT/09-3X/DGS etc.
- **EK851SV :**This PCB converts 24v to 12v & 5v.This PCB is used in CSM.
- **EK805SV :** This PCB converts 24v to 5v.This PCB is used in 09-3X.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-IX: Power Supply: Session-23: Functional description of Power supply PCBs EK813SV, EK816SV, EK851SV, Calibration, Testing & Troubleshooting

---

1. **EK813SV:** This PCB converts +24V DC to ±15V DC and ±10V DC. ± 15V is used for operational amplifier supply and calibration potentiometers in PCBs . ±10V is used for transducers and potentiometers .This PCB mainly consists of a power pack which converts +24v to ± 15v .Then + 15v is converted to 10v by regulator Ic REF 01.Output of REF 01 Ic has less current capacity ie 15mA . So to increase this current to 40 mA current booster circuit is used which has output of +10 v with current capacity of 40mA. Output of REF 01 Ic is converted to --10v(40mA) by inverter and current booster .This PCB consists of two adjustment potentiometers P1 and P2. P1is used to adjust +10v and P2 is used to adjust -10v.There are no arrangement for adjustment of +15v and -15v .
   Note --- As per plasser variation in output of EK813SV is permissible upto ± 150mv .



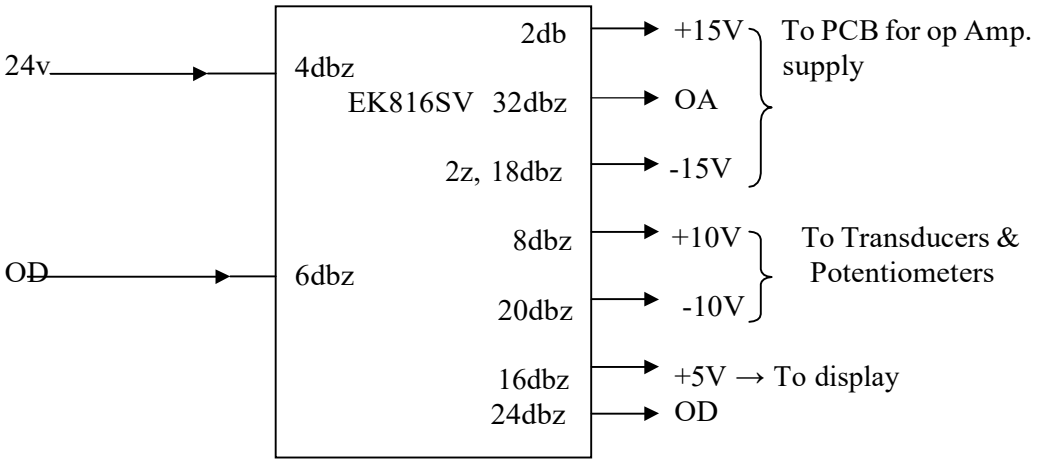
Nos of power supply PCB EK813SV used in CSM
In lining control circuit ---------- 1no
In leveling control circuit ---------- 1no
In front input circuit ---------- 1no
In tamping unit and satellite control circuit ---- 1no
In work drive control circuit ---------- 1no
Total---------- 5nos

EK813SV used in CSM-3X --- 2nos
EK813SV used in Duomatic ---4 nos
EK813SV used in Unimate-----4nos

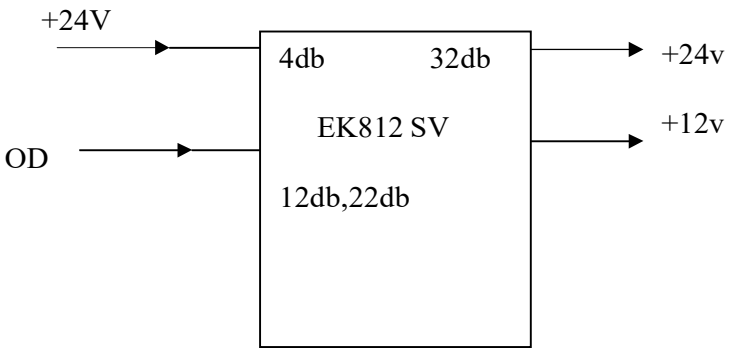
2. **EK 816 SV**: This PCB converts +24V DC to ±15V, ±10V, and +5V. Difference between EK 816 SV and EK 813 SV is that EK 816 SV has an additional output of + 5V for that two power pack are provided in this PCB one power pack converts +24V to ±15V, other power pack converts +24V to +5V . This PCB also has same circuit as in EK813SV.There are also two adjustment potentiometers P1 and P2 in this PCB.P1 for +10v adjustment and P2 for -10v adjustment .There are no adjustment for +15v and -15v.

There are four EK816 SV in CSM-3X.

(1) 20U15 → In Driving control circuit .
(2) 6U1 → In Leveling + pendulum control circuit .
(3) 10U3 → In Lining control circuit.
(4) 4U1 → In Front Input circuit



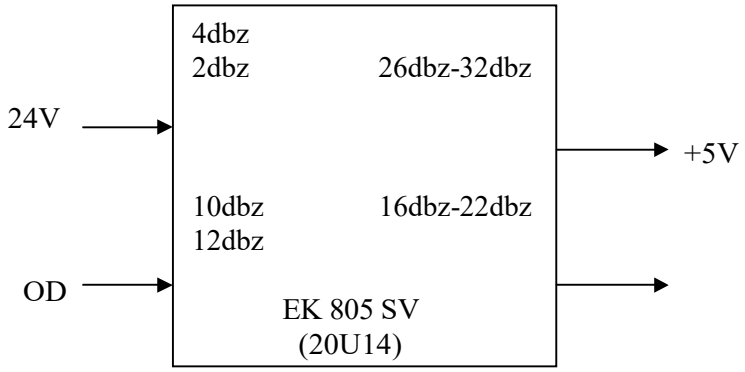
EK 812 SV: This PCB converts + 24V dc to 24V & +12V. This PCB is used for programmer in CSM, Unimat, & DGS. This circuit, supplies the power to Microprocessor at a constant rate of 24V and 12V.The main supply of battery ranges between 24V to 27V, of DC.When battery is fully charged its voltaged goes up to 27V. Also this battery is connected to Alternator when RPM of alternator is 2000, then its output is 27V.But Microprocessor requires + 24V DC at constant rate. The fluctuation in voltage can cause damage to microprocessor IC and other IC's also get affected, for the function of microprocessor +12V is supplied for microprocessor/input/output circuit. This is also done by DC to DC convertor.This circuit is different from EK813SV00 EK851SV00 etc.
Its drawings have not been supplied by the manufacturer.



EK 851 SV:
This PCB converts + 24V dc to +12 & +5V this PCB is used in CSM and unimate.

EK851SV00. This PCB is also DC-TO-DC converter to 12V and 5V. 12V is used for Recorder circuit and 5V is used for digital display. The circuit design of this PCB is different from EK 813SV00. When P type and N type layer is formed in a chip of semiconductor, they form a barrier potential of 0.7v for Si and .3v for Ge. When an external power supply is applied in forward bias then this chip of semiconductor (diode) conducts only when applied voltage overcome this barier voltage. This barrier potential acts as a resistance to drop .7v or.3v depending on semi conductor material. This draw back of PN junction is used to our advantage, in the D.C. to D.C conversion. Because each crystal diode drops .7v (Si). So adding a No. of diodes back to back we can drop the applied voltage to our required voltage. This EK 851SV00 is designed on this principle. In put voltage is 24V DC to 27V DC.
IC's 7812 &7805 are voltage Regulator (+Ve voltage regulator). These IC's keeps the output a constant rated voltage. The input for these IC's 7812 &7805 is max.Volt of 1.5 x rated voltage. Suppose IC No. is 7812,it means, that output of this IC is + 12V.Then input for this IC shout not exceed 12 ×1.5 = 18V. This 18V.input for 7812. + 18V is achieved by dropping the battery voltage by means of connecting back to back of silicon diodes.

EK 805 SV: This PCB converts +24V DC to +5V. This PCB is used in programmer circuit of CSM-3X. There is only one EK 805SV used in CSM-3X .



Lesson-IX: Power Supply: **Session-24:** Electronics Model Room for demonstration, checking and calibration of PCB EK813SV

There is a 24 position selector switch (18b4) provided along with digital display (18g4). By selecting different position we can do different measurement.
Detail of different positions of selector switch are given below:

Position 1 →DISPL → To use display as volt meter.

With the help of this display we can measure upto ±15V. We can check signals in side the PCB using test prob.

Position 2 →Multiplex→ If we want to use multiplexer PCB EK28V to check output of transducers, input and output of PCBs then selector switch should be on 2nd position.

Position 3 →N51 (-15V)
Position 4 →N50 (+15V)
(-10V)
Position 6 →N52 (+10V)

Output of power supply PCB EK813SV of Position 5 →N53 leveling circuit.

Position 7 →D51 (-15V)
Position 8 →D50 (+15V)
Position 9 →D53 (-10V)
Position 10 →D52 (+10V)

Output of power supply PCB EK813SV of driving circuit.

Position 11→ R51 (-15V)
Position 12 →R50 (+15V)
Position 13 →R53 (-10V)
Position 14 →R52 (+10V)

Output of power supply PCB EK813SV of lining circuit.

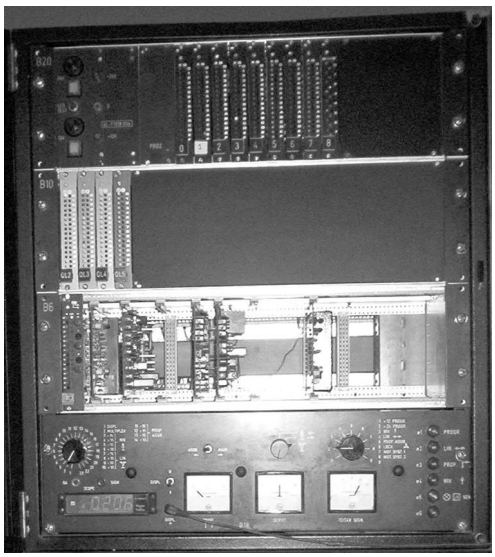
Position 15 →P51 (-15V)
Position 16 →P50 (+15V)
→P53 (-10V)
Position 18 →P52 (+10V)

Output of power supply PCB EK813SV of Position 17 Tamping control circuit.

Position 19 to 24 → Spare

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-X: Programmer unit and Logic Plan. Session-25: Function and Description of Programmer Unit, Description of different PCBs of Programmer Unit i.e. EK 501P, EK553P



Programmer Unit :

Programmer Unit is the microprocessor based system which is provided in 09-series machines & Unimat, DGS for measuring the various electrical signals and monitoring input and output of microprocessor.

- This unit controls functions of machines.
- This unit consists of Programmer PCB which has Processor & Memory(EPROM). Program of machine is stored in memory
- This PCB receives inputs X(yellow LED),when inputs are same as in Program then outputs command Q(Red LED) are generated to allow the functions.

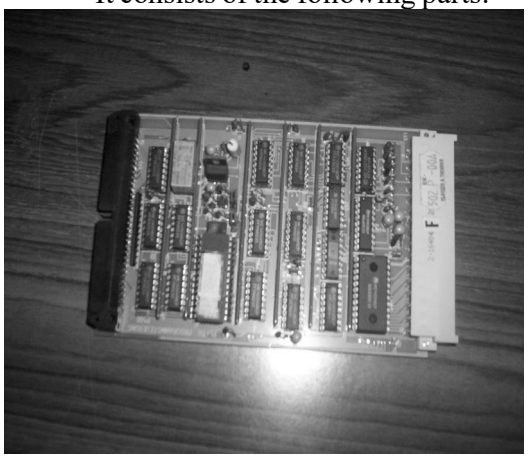
With the help of multi-check we can do-

(i) Monitoring of power supplies of different units.

(ii) Measuring analogue electrical signals coming from different transducers and PCBs.

(iii) Indication of all inputs and outputs of microprocessor in the form of coloured LEDs.

It consists of the following parts:



1. Logic controller or Programmer PCB :

This PCB consists of Processor & EPROM (memory IC). Program of particular machine as per functions is stored in EPROM, this program is different for different machine i.e CSM, CSM-3X, Unimat, DGS,

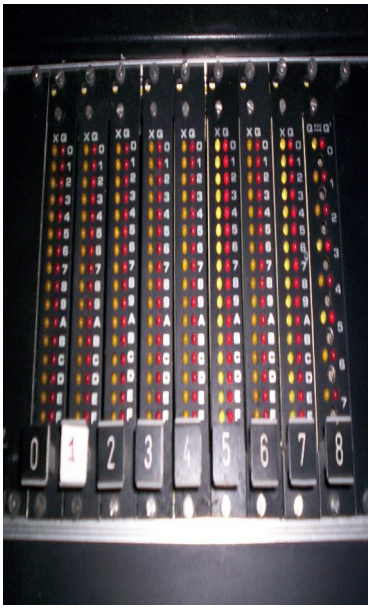
- Programmer PCBs used in different machines

CSM	Unimat	DGS	CSM-3X
EK501P	EK502P	EK503P	EK650P

This programmer is EK 501(CSM) P/EK 502P (UNIMAT) or control unit in the machine which is programmed as per machine functions. It receives input signals and generates output signals as per conditions of Input signal. It consists of mainly microprocessor and EPROM.

Input output PCB (I/0 PCB) EK553P:

X	Q	
O	O	0
O	O	1
O	O	2
O	O	3
O	O	4
O	O	5
O	O	6
O	O	7
O	O	8
O	O	9
O	O	A
O	O	B
O	O	C
O	O	D
O	O	E
O	O	F



EK553P PCB is Input-Output PCB. This PCB indicates Inputs & Outputs of Processor. I/0 PCB has yellow LEDs with **X** mark which indicates input to Processor and red LED with **Q** mark which indicates output from Processor. Each PCB consists of 16 nos. of yellow & Red LEDs (0 to F).When any input goes to Processor from switch, pedal switch , relay ,sensor, limit switch, transistor then concerning yellow LED glows. When output comes from Processor then red LED glows.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-X: Programmer unit and Logic Plan. **Session-26:** Description of EK554P, EK552P, Different Parts of Logic Plan

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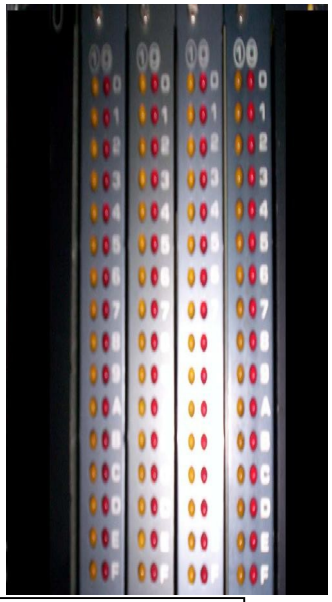
O	O	
O	O	0
O	O	1
O	O	2
O	O	3
O	O	4
O	O	5
O	O	6
O	O	7
O	O	8
O	O	9
O	O	A
O	O	B
O	O	C
O	O	D
O	O	E
O	O	F



Q		Q^I
O	O	O 0
O	O	O 1
O	O	O 2
O	O	O 3
O	O	O 4
O	O	O 5
O	O	O 6
O	O	O 7

QL Relay PCB EK554P:-

The outputs of I/0 PCB EK553P are only capable to operate small loads i.e. transistors, LEDs. EK553P can not operate solenoids directly.To operate solenoid load relays(QL relay) are used which are provided on PCBs. These PCBs are called QL PCBs EK554P. Output of EK553P operates QL relay in EK554P and QL relay operates solenoids .

Each PCB consists of 16 Nos. of load relays (0 to F) and 8 fuses. Two relays are connected with one fuse. QL PCB also consists of yellow & red LEDs. In normal condition when relay is de-energized then red LED will glow, yellow LED remain off. When relay is energized then yellow LED will glow, red LED becomes OFF. If solenoid connections are open or no connection to QL relay then both yellow and red LED will glow simultaneously.

Time Delay PCB EK 552 P

In the machine in different functions (tamping cycle) certain time delay is required which are provided by time delay PCB EK552P .

Time delay outputs are denoted by Q^1 . This PCB has Eight nos of yellow & red LEDs.

When time starts yellow LED glows, and when time is over then red LED glows. This PCB consists of 8 nos of potentiometers by which time can be adjusted .

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-X: Programmer unit and Logic Plan. **Session-27:** Electronics Model Room for demonstration, checking and testing of Programmer unit

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SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-X: Programmer unit and Logic Plan. **Session-28:** Reading of Logic Plan and Input & Output of Programmer with the help of Logic Plan

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MEANING OF MARKS PRINT ON LOGIC PLAN:

X	-	INPUT TO MICROPROCESSOR (YELLOW LED INDICATION)
Q	-	OUT PUT FROM MICROPROCESSOR (RED LED INDICATION)
Q^1	-	TIME DELAY OUT PUT OF MICROPROCESSOR
QL	-	LOAD RELAY OUTPUT
٧	-	OR
M	-	AND
___	-	NOT ALLOWED

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-X: Programmer unit and Logic Plan. **Session-29:** Electronics Model Room for demonstration of Logic Plan .

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XI: Multi-check/ Multiplexer PCB. **Session-30:** Description of Multi-check PCB EK28V, Different measurements taken by Multi- check PCB.

MULTIPLEXER/Multicheck PCB EK28V:

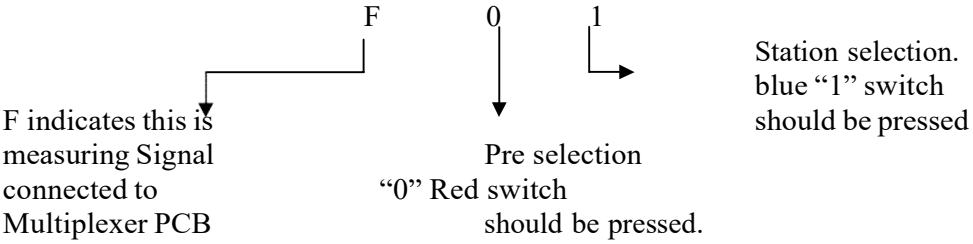
This PCB is used to check, signals of transducers, potentiometers, inputs and outputs of PCBs. This PCBs receives around 28 measuring signals. But this PCB is connected with only one digital display (18g4). Each signal has it's address by feeding address in this PCB we can see that signal in digital voltmeter. For feeding address this PCB consists of three red switch designated as 0, 1, 2. 1 and 2 switch have red LED indication. It also consists 16 small blue switch with yellow LEDs designated as 0 to 9 and A to F.

Signals which are connected with multiplexer PCBs are designated by "F"

METHOD OF USE OF MULTIPLEXER PCB:

If we want to use the multiplexer PCB EK28V to check signal of transducer or PCB. Multiposition selector switch (18b4) should be on 2nd position, display should be "ON".

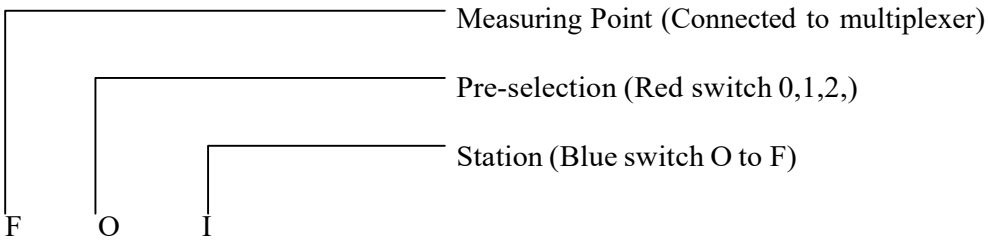
Suppose we want to check the signal of lining transducer which address is F01.



(i) First press "0" red switch
(ii) Now press "1" blue switch.

Now signal of lining transducer will appear in digital voltmeter.

MULTICHECK ADDRESS OF DIFFERENT SIGNALS IN CSM



For using multi check, keep selector switch in Panel No. 18 on 2nd position and then feed the address of Transducer signal then signal will display on digital indicator.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XI: Multi-check/ Multiplexer PCB. **Session-31:** Electronics Model Room for demonstration of Multi-check PCB.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XII: Tamping Unit Control Circuit UNO/DUO/ CSM/3X /Unimat

Session-32: Functional Description of Tamping Unit Control Circuit, Function and Calibration of Depth Selector and Depth Transducer

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Functions of tamping Unit Control Circuit :

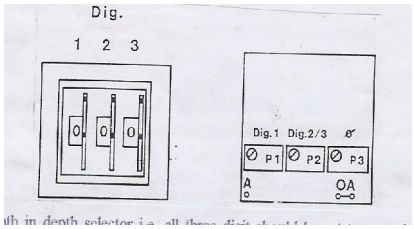
- This circuit controls the UP/DN movement of tamping unit.
- It controls the lowering & lifting speed of tamping unit.
- It controls the target depth of tamping tools.
- It controls the squeezing time.

Tamping Unit Control PCBs in Different Machines

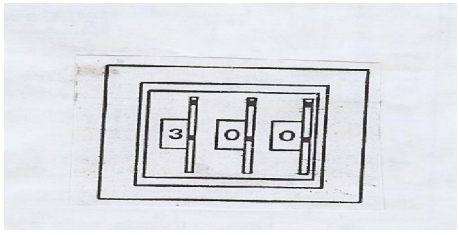
- In UNO/DUO/CSM :-EK 16 V 00.
- In UNIMAT2S/3S :-EK 132V00.
- In 09-3X :-EK 1AP700.
- In New Duo/MPT :-EK 176V00

DEPTH SELECTOR: Before tamping proper tamping depth should be selected. This depth depends upon types of sleepers and rail. Tamping depth is fed in depth selector. Depth selector converts depth to electrical signal at the rate of 25mv/m. This depth selector consists of small PCB. There are three potentiometers in depth selector PCB.P1.P2 and P3. Signal of depth selector can be checked at multicheck address F13.

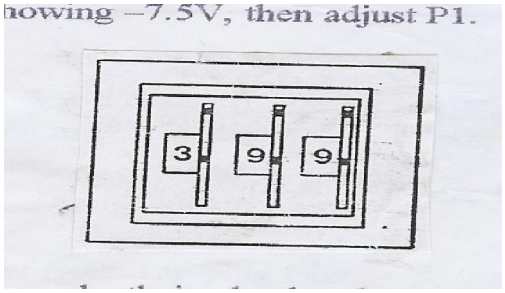
DEPTH SELECTOR CALIBRATION:



(1) Select Zero depth in depth selector i.e. all three digit should be set to zero. Now select multicheck address F13 in multiplex PCB and keep selector switch in 2nd position Now display should read OV. If it is showing some value then adjust potentiometer P3 to get zero volt.



(2) Now select 300 MM depth in depth selector then. Output of selector will be –7.5V if it is not6 showing –7.5V, then adjust P1.



(3) Now select 399m depth in depth selector output of depth selector in display should be –9.975V if it is not, adjust potentiometer P2.

TAMPING DEPTH TRANSUDCER: Tamping depth transducer converts displacement of taping unit to electrical signal at the rate of 19mv/mm. Output signal of this transducer will be –ve if fork is above centre mark of the transducer and it will be +ve if fork is below centre mark. Multicheck address of transducer is F14 (for LH side) and F15 (for RH side). By using these address we can check output of LH or RH transducer.

Lesson-XII: Tamping Unit Control Circuit UNO/DUO/ CSM/09-3X /Unimat2S&3S

Session-33: Different Positions of Tamping Unit & their Description, Current of Proportional valve

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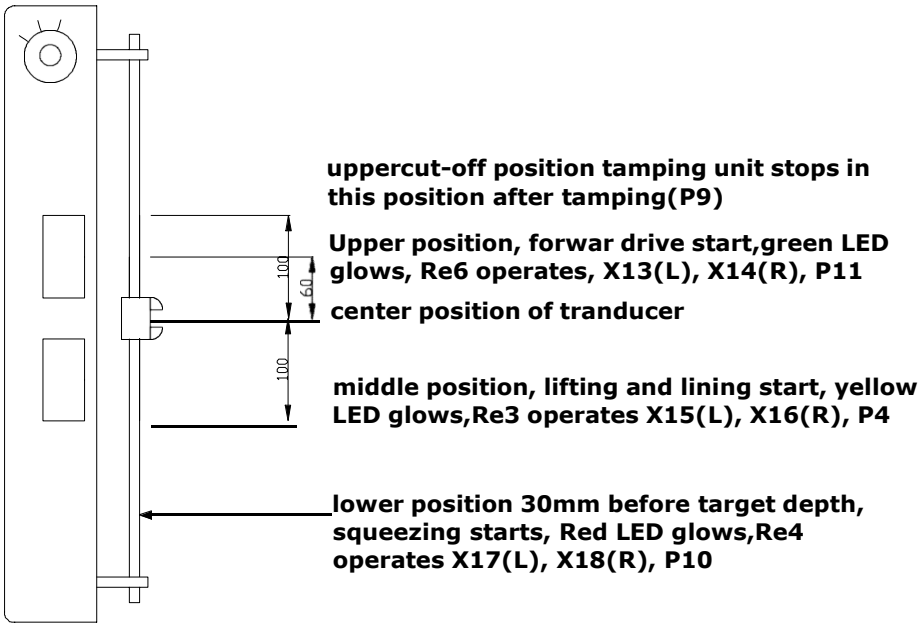
Different Positions of Tamping Unit :-



1. Upper Working Position:

The upper break point should be set at approximately 40mm before the upper working position (120mm above the zero point), which and be adjusted by P11 if necessary. At this point, the comparator OP5B switches from high to low illuminating the green LED and energizing relay Re6.

2. Middle Position:

When the tamping banks reaches approximately 100mm below the zero point, the comparator OP10 switches from high to 1cw, energizing relay Re3 and illuminating the yellow L.E.D. contact Re3/2 closes, connecting an earth to input x15 (x16 for the r.h.s.) which can be used to initiate lift and lining.

The point where Re3 energizes can be adjusted by P4, which allows adjustment of ± 260mm about the zero point.

3. Lower Position:

When the tamping banks reach approximately 30mm before the lower position (top of tamping tools 15mm below sleeper), the comparator OP5A switches from low to high

illuminating the red L.E.D. and energizing relay Re4. This point can be adjusted by P10. Contact Re4/2 closes connecting an earth to input x17 (x18 for the r.h.s.) This input is used for automatic squeeze.

Current of Proportional Valve:

To monitor the current drawn by the tamping bank solenoids, there is a gauge fitted with a switch on box 18. By turning the switch 18b3 to position 1, the left hand tamping bank solenoid current is displayed on gauge 18g3. By turning the switch to position 2 the right hand side in monitored position 3 monitors the, satellite proportional current.

by turning switch 18b3 to position 1 or 2, connects the gauge to terminal 10bof 10u6 or 10u7; the other side of the gauge connects to earth. This places the gauge across a 1 ohm resistor (R76) which is measured by the gauge 18g3 which is a voltmeter. Therefore with 750 mA following through the resistor, there will be a volt drop of 750 mV across if which is displayed as a percentage on the gauge 18g3, i.e. 750 mV = 750 mA = 100%.

Current of Proportional Valve in Different Machines

Machines	Lowering Current	Lifting Current	Basic Current
Duomatic/WST/CSM	650mA	600mA	250mA
Uno/Unimat/09-3X/MPT	600mA	550mA	250mA
Calibration Potentiometer	P7	P12	P8

Lesson-XII: Tamping Unit Control Circuit UNO/DUO/ CSM/09-3X /Unimat2S&3S

Session-34: Functional Description of Tamping Unit control PCBs EK16V, EK132V

TAMPING UNIT (PROPORTIONAL) CONTROL CIRCUIT OF CSM

PRINTED CIRCUIT BOARDS:

10u5	-	power supply board	-	EK 813 SV 002
10u6	-	proportional control 1.h.s.	-	EK 16V-00 (02)
10u7	-	Proportional control r.h.s.	-	EK-16V-00 (02)

TRANSDUCERS:

1f14	-	Depth transducer 1.h.s.
1f15	-	Depth transducer r.h.s.

Switches:

1x10	Tamping bank lowering pedal.
1x11	Working drive pedal
2x19	Tamping system ON
2x1A	Penetration assist OFF
2x27	Auto cycle 1 x position.
2x28	Auto cycle 2 x position.
2b43	Both tamping units manual lift.
51x1D	Only left hand tamping unit.
51x1E	Only right hand handing unit.

FUNCTIONAL DESCRIPTION OF TAMPING UNIT CONTROL PCBS EK16V/ EK132V

The control of the tamping unit with proportional valves should result in:

a) a smooth start of lifting and lowering and
b) an accurate and smooth positioning at the pre-selected top and bottom end position.

1. **Description of the Proportional Valve:**The valve is variable between approx. 250-750 mA. 750 mA means a full deflection, at approx. 250 mA the valve main piston moves to the overlapping zone and the flow becomes zero.
2. **Zero Adjustment:** For the basic adjustment a preset current is set with the potentiometer "P8" which deflects the valve over the overlapping zone a little (approx. 250 mA). With the instruction "tamping and lowering" this full current is immediately available. The returning of the proportional valve to zero (approx. 250 mA) always takes place immediately from any position of the piston when the pre-selected theoretical value is achieved.
3. **Tamping Unit Lowering:** The "theoretical value – tamping depth" is selected with a preset-potentiometer (2f13). A voltage is applied at connection "8b" which corresponds with the required depth. This voltage is also available at output "28z" for a digital instrument.The tamping depth is specified in "mm" below DRL. The zero point is located approx. 1mm below DRL.The signal of the "actual value of the tamping depth transducer" is adjusted with potentiometer "P13" in such a way, that at the output of the amplifier "OP1B(10)" the same voltage (reversed polarity) as at the operational amplifier "OP2B(10)" depth preset (theoretical value) is apparent if the pre-selected depth is reached. 10V represents generally "425mm". The relays Re1, Re2 and Re3 on the printed circuit are always energized if the instruction "tamping unit lowering" (Q11) is received. Because the relay "Re5" is now energized, the theoretical pre-selected depth value is applied to the input of the "OP3B" via "OP2B(10)". Because the tamping unit and therefore the signal "actual value" of the depth transducer corresponds with the top position, a different signal is available at the input of the "OP3B" (R32, R34).This difference signal is transferred to "OP4B" and amplified according to the resistor wiring. By bridging the resistor "R40" the amplification can be changed to the second stage by an external activation (Connection "8d").(First stage, short of the braking reduction of approx. 110mm before 0)

(Second stage, short of the braking reduction of approx. 80 mm before 0)

Therefore a voltage of approx. "-14V" (full deflection) is available at "OP4B(10)", if the instruction "tamping unit lowering" Q11 is received, which drops linear to zero if it approximates the pre-selected depth.

Ramping in: If the proportional valve is de-energized (limit is reached or exceeded) the OP-amplifier "OP6A(12)" is at + 13V. Therefore the amplifier OP7B(10) is at +12V. Together with the instruction "tamping unit lowering" the OP6A(12) is swept back to approx. -14V. Via OP7A acting as a time delay, (time adjustment with P3) there is still a positive voltage (+12V) available at OP7B(10) which is counteracting to the "tamping unit lowering voltage" (-14V) at OP4B(10). Therefore there is no voltage available at the output of OP8A(12) if the instruction "tamping unit lowering" is given… Via OP7A delayed, the counteracting voltage at OP7B is gradually reduced to zero.

In the same way the signal at OP8A(12) is increasing (start of the ramp)

As the preset pre-conduction current, which is adjusted by P8 has already pulled the valve out of the overlapping zone, and increases the deflection of OP8B via the shorting ramp OP8A to maximum.The deflection voltage is converted into a corresponding current via the OP8B(10) and the transistor T1.For this, the current measuring resistor R76 is used. Because this resistor has 1 OHM, the measured voltage corresponds accurately with the according current 0,75V = 0,75A = 750 mA.

Via the relay contact Re2 (energized when "lowering") the current output signal is supplied to the corresponding solenoid valve via the output 28d, tamping banks down.

4. **"Tamping Unit Lowering" Cut Off:**Approaching the pre-selected theoretical depth value, the voltage at OP4B(10) is decreasing gradually and reaches "zero" if the theoretical value and the actual value are balanced. Exactly at zero the OP6A(12) sweeps to positive.
5. **Tamping Unit Lifting:** The procedure when "Lifting" is analogue to the procedure when "Lowering". Instead of the externally adjustable theoretical value (input 6b), a fixed top end theoretical value is preset with the potentiometer P9 at the operational amplifier OP3A(12). At the end of the instruction "Lowering" (="lifting" start) the relay Re5 releases again and transfers the theoretical value for "lifting" to the input of OP3B. Again, the resulting difference voltage to the actual value is amplified at OP4A and in the same way as with lowering transferred to transistor T1. Also the starting ramp is released again.

   But now the proportional valve "lifting" is supplied via the released relay Re2 and connection 28b. The diodes D16 and D17 are damping the peak voltages which occur when the proportional valve is deenergized.
6. **General Notes:** The signal at the output of the OP8(12) is transferred via P7 when lowering, but when lifting via P12. Therefore the maximum deflection during lifting and lowering can be specified individually and individually adjusted.

   Also, by bridging the resistor Re64 during lowering, a second maximum speed can be selected with switch "2b41".The amplification (specification of the start in the decreasing of the speed near the end position) is specified separately by the resistor wiring of the OP4A or OP4B respectively. (B = lowering, A= lifting)

   The adjusting sequence of the starting ramp (integration circuit OP7A) is already carried out in a basic adjustment in the E-workshop, but is also described on the corresponding functional diagram. For this adjustment the toggle switch b1 is required.

   The ramp at the start of "lifting" or "lowering" is preset generally to "200ms" with the potentiometer P3, but it can be adapted to the individual circumstances at any time on the machine. The lifting and lowering of the tamping units should take place smoothly.

Lesson-XII: Tamping Unit Control Circuit UNO/DUO/ CSM/09-3X /Unimat2S&3S

Session-35: Functional Description of Tamping Unit Control PCBs EK1AP7/EK176V,

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TAMPING UNIT CONTROL CIRCUIT OF 09-3X:CSM-3X can tamp 3-sleeper at a time. CSM-3X is equipped with four tamping units. Two for LH side, two for RH side Movement of tamping unit is controlled through electronic PCB and proportional valve for smooth lowering and lifting of tamping unit and to achieve required target depth . PCB EK1AP7 is provided for each tamping unit. It's mean there are four tamping unit control PCB EK1AP7 and four tamping depth transducer . But there is only one target depth selector which provide target depth to each PCB.Each tamping unit consists of 12 tamping tools so there are 48 Tamping tools in this machine. Tamping unit is mounted in satellite unit .In working mode the machine move continuously whereas satellite unit move in cyclic manner by way of hydraulic travel mechanism of the satellite frame axle bogie. Tamping can be done either fully automatic , semiautomatic or through an operator .When working in curves the tamping units are automatically centred over the rails .

Although there are 4 tamping unit which can tamp. 3-sleepers at a time but we can also tamp one sleeper at a time by stopping movement of two tamping units .There is also a selection for tamping cycle 1X , 2X and 3X(triple tamping in one cycle) .

PCB USED IN TAMPING UNIT CONTROL CIRCUIT.

Tamping unit control PCB - EK1AP7 - 4 nos (6u8 to 6u11)

Squeezing Pressure control PCB - EK 140V - 1no (10u12)
Power Supply PCB - EK 813 SV – 1no (6u12)

TAMPING DEPTH TRANSDUCER: Tamping depth transducer converts displacement of tamping unit to electrical signal at the rate of 11.5mv/mm. This signal will be –ve if tamping unit is above centre position and +ve if tamping unit is below centre position of this transducer **. When tamping unit is lock the output of tamping depth transducer at multicheck address should be –4 v.**

There are four tamping depth transducers one for each tamping Unit.

(i) For LH front tamping unit – 1f14 - Multicheck address **F14**
(ii) For LH rear tamping unit – 1f15 - Multicheck address **F15**
(iii) For RH front tamping unit – 1f16 - Multicheck address **F16**
(iv) For RH rear tamping unit – 1f17 - Multicheck address **F17**

.

TAMPING DEPTH SELECTOR : 2 f 10

Prior to work target tamping depth is selected which depend on rail height and sleeper height . This target depth is fed in depth selector which converts it to electrical signal at the rate of 25mv/mm(-ve).

Multicheck address of depth selector is **F13** where we can check output of depth selector.

PROPORTIONAL VALVE : There are four tamping unit in CSM-3X .One protional valve is used for one tamping unit UP and Down control. So there are four proportional valves used for tamping unit movement . One proportional valve is used for squeezing .

TAMPING UNIT CONTROL PCB IN CS-3X: In CSM-3X for tamping depth control PCB EK 1AP7 is provided. Since there are four tamping units in CSM-3X so for each tamping unit separate PCB and transducer is provided This PCB has different circuit from PCB EK16V(CSM) and EK132V(Unimat).

This PCB is used for smooth lowering and lifting of tamping units and to achieve desired target depth of tamping tools . When target depth is selected and tamping unit is lowered then top of tool blade should go 10-12mm below bottom of PRC sleeper .

Tamping Unit control PCB EK 1AP7 – 4 Nos. (6u8 to 6 u 11)

6u8 – LH Front	6u 9- LH Rear
6u 10- RH Front	6 u 11- RH Rear

FUNCTIONAL DESCRIPTION OF TAMPING UNIT CONTROL PCB EK 1AP7:

This PCB consists of different circuit s which are explain below.

INPUTS TO PCB:-

Tamping depth transducer: This PCB receive signal from tamping depth transducer at 6d terminal at the rate of 11.5mv/mm. This signal will be –ve if tamping unit is above zero position and +ve if tamping unit is below centre position. This signal goes to operational amplifier OP1-A (3) via resistance R1. OP1-A is a buffer, output of OPIA (1) will be same as input. Output of OPI-A(1) is going to OPI-B(6) via R3. OP1-B is the inverting amplifier with gain 2. It will amplify input signal two time. So out put of OP1-B(7) will be at the rate of 23mv/mm.

Output of OP1-B(7) is going to OP1-C (10), which is buffer so output will be same as input. Output of OP1-C(8) is going to OP1-D(13) via R7. OP1-D is inverting amplifier with gain one OP1-D only inverts the polarity of input signal .Output of OP1-D(14) is applied to OP2-A(2) via R10. OP2-A is inverting amplifier which amplify the input signal at the rate of 25 mv/mm**. P13** is used to adjust the gain of this amplifier by which we can adjust output of this amplifier at the rate of 25mv/mm. This is the main input amplifier which gain is adjusted to get target depth of tamping tools. **P1** is for zero adjustment by which we can adjust zero depth position. So output of OP2-A(1) will be at the rate of 25mv/mm, +ve if tamping unit is above zero position of transducer and –ve if tamping unit is below zero position .Output of OP2A(1) is going to different position circuits and to lowering and lifting control circuit of tamping unit. This output is also connected to 6z for display of depth of tamping unit.

Depth selector: Depth selector converts selected depth to electrical signal at the rate of 25mv/mm(-ve).Output of depth selector is applied at 6b terminal of EK 1AP7. From 6b terminal this signal goes to Op3-A via potentiometer **P21** and resistance R34 .OP3-A is the inverting amplifier with gain one, gain is adjusted by P21. If 300mm depth is selected in depth selector then Output of depth selector will be – 7.5V which will apply at 6b. Then output of OP3 -A (1) should be + 7.5V if it is not then it should be adjusted by P21. Output of OP3-A goes to adder OP3-D via resistance R36, relay contact 8&4 of Re8 and resistance R40.Relay Re8 operates during lowering of tamping unit.

THREE POSITIONS OF TAMPING UNIT: During lowering of tamping unit PCB sense three position of it.These three positions are explain below .

Upper working position : After tamping when tamping unit move upwards then it stops at upper working position .There are two upper working position in CSM-3X .Psition-1 and position –2 which are selected by toggle switch .Position –1 is set at 150mm and position-2

is set at 80 mm above zero position of transducer . In PCB OP3-B is used for upper working position.OP3-B is the inverting amplifier . Output of this amplifier is set **to -3.75v** for position-1 by potentiometer **P22** . **–3.75v is equivalent of 150mm at the rate of 25mv/mm**. Output of this amplifier is set to **–2v** for position-2 by potentiometer **P23**. **–2v is equivalent of 80 mm at the rate of 25mv/mm** .Normally P22 is connected to OP3-B through contact 10 &7 of relay Re9 .When toggle switch is shifted to position –2 then microprocessor generate output Q11F which ground the 24d terminal thus Re9 operates ,now contact 7 connects to 12 there for P23 is connected to OP3-B. Output of this amplifier is applied to adder OP3-D via resistance R37 ,contact 6&4 of relay Re8 and resistanceR40.

Upper position indication : Although tamping unit stops at upper working position but PCB sense upper position at 60mm above centre position of transducer .In this position PCB give input to microprocessor for upper position which means that tamping unit has reach in upper position now next tamping cycle should start. A green LED glows in this position in PCB EK1AP7 . This circuit consists of OP2-D, transistor TA-2 and green LED.OP2-D is a comparater

Summing(adder) amplifier : Operational amplifier OP3-D is summing amplifier .During lowering of tamping unit it add signal of tamping depth transducer and signal of depth selector. During lifting of tamping it add signal of transducer and output of OP3-B for upper working position .This is the inverting adder. Output of this adder is going to OP5-D which is the non– inverting amplifier .Gain of this amplifier is adjusted by **P18** for lowering speed and gain is adjusted by **P19** for lifting speed . Selection of these potentiometers is done by Re8 which operate during lowering of tamping unit in this case P18 will be connected to OP5-D through 9 &13 contact. During lifting of tamping unit Re8 will off then P19 is connected to OP5-D through 11 &13 contact .

There is five speed selection provided by selector switch on panel B2 .This switch is connected to different resistance(PCB EL-T6109 2u5) by selecting these resistance which are connected to 8d terminal of this PCB we are changing the gain of OP5-D . When tamping unit is lowered then Output of OP5-D will go to ramp circuit (OP4-A,OP4- B and OP4-C) through 12 &7 contact of Relay Re5 which operate during lowering . During lifting of tamping unit output of OP5-D goes to ramp circuit through OP3-C and contact 4 &8 of relay Re4 which operate during lifting of tamping unit .OP3-C is the inverting amplifier with gain one .

Electrical ramp circuit : For smooth lowering and lifting of tamping unit an electrical ramp generator circuit is provided in this PCB which generate electrical ramp of 200ms in starting of lowering and lifting of tamping unit .In PCB OP4-A ,OP4-B and OP4-C form the ramp circuit .OP4-B is the integrator circuit which has capacitor K14 and two zenor diode ZD1 and ZD2 in feedback. Charging and discharging of K14 form the electrical ramp .Zenor diode ZD1 and ZD2 limit the output of OP4-B(7) to ±10.6v .When tamping unit is in upper working position before starting of lowering of tamping unit , output of OP4-A(1) will be +Vsat(+14v). Integrater OP4-B will be charge it's output voltage will be –10.6v and output voltage of OP4-C(8) will be + 12.2V(set by P5).

When tamping unit lowering command is given by microprocessor then relay Re1,Re3 ,Re5, Re7 and Re8 operate which set lowering circuit in PCB .When PCB receive lowering command then output of OP5-D will be –14v which is available at input of OP4-D(13) and counteracts with the output voltage of OP4-C(8) which is +12.2V. Output of OP4-D (14) is set to zero volt with help of P6 initially when lowering command is given .Therefore initially no voltage is available at the output of OP5-A(1) and OP5-B(7) to operate the transistor T1.Same time output of OP4-A (1) is reversed to –Vsat(-14v) there for integratorOP4-B start discharging(time is set

by P3) and output of OP4-C (+12.2 v) start reducing gradually and output of OP4-D(14) start increasing in same manner . When 12.2v become zero volt then output of OP4-D(14) will be +14v . Reducing time of +12.2 v to 0v is called the ramp which time is set by P3. Output voltage of OP4-D(14) is applied to OP5-B via OP5-A(Inv. Amplifier) and contact

4&8 of Re7 ,R58,R60 and P7.Voltage to OP5-B(6) is converted to appropriate current via transistor by means of current measuring resistor R68. Sice this resistor has a value of 1 Ω ,the voltage measured across it will be equal to current . .75v =.75A =750 mA.

The current output signal is then fed to proportional valve for lowering via relay contact 13 &9 of Re3 , and to proportional for lifting via relay contact 9 & 13 of Re2 during lifting of tamping unit .

Lesson-XII: Tamping Unit Control Circuit UNO/DUO/ CSM/09-3X /Unimat2S&3S

Session-36: Calibration, Testing and Troubleshooting

Calibration/Adjustment Potentiometers in PCB EK16V & EK132V

P1 → Zero depth Adjustment

P4 → Middle position adjustment

P7 → Lowering speed adjustment (Max. lowering current adjustment)

P8 → Basic current adjustment (33% = 250mA)

P9 → Upper cut off point adjustment

P10→ Lower position adjustment

P11→ Upper position adjustment

P12→ Max lifting current adjustment (Lifting speed adjustment)

P13→ Target depth adjustment

Note: P3, P5, P6 potentiometers are used in ramp generator circuit to adjust the ramp. These potentiometers should not be adjusted at site.

Adjustment Potentiometers in PCB EK1AP7 /EK176V

P1 - Zero depth adjustment potentiometer .
P4 - Middle position adjustment (Starting of lifting and lining).
P7 – Maximum current(600mA) adjustment of proportional valve for lowering (Lowering speed adjustment of tamping unit) .
P8 – Minimum current (250mA) adjustment of proportional valve for lowering of tamping unit.
P10 –Lower position adjustment (starting of Squeezing).
P11 – Upper position indication adjustment .
P12 - Maximum current(550mA) adjustment of proportional valve for lifting(Lifting speed adjustment of tamping unit) .
P13 – Target depth adjustment .
P17 - Minimum current (250mA) adjustment of proportional valve for lifting of tamping unit.
P18 – Amplification for tamping unit lowering .
P19 – Amplification for tamping unit lifting .
P21 –Target depth value adjustment .
P22 – Tamping unit upper working position –1 (150mm) adjustment .
P23 - Tamping unit upper working position –2 (80mm) adjustment .

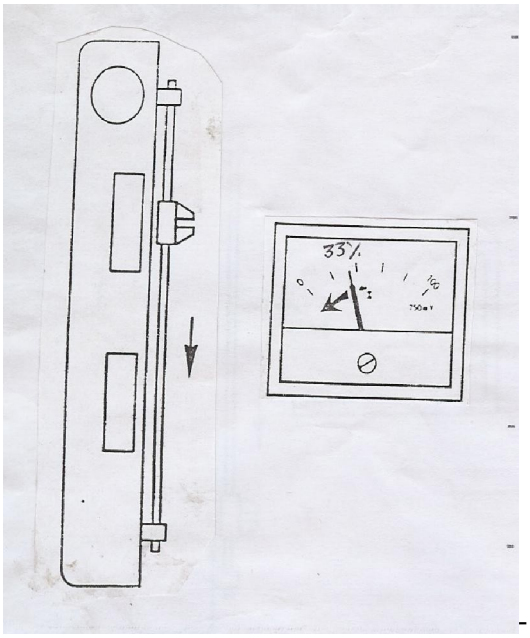
Calibration Procedure Of tamping Unit Circuit of CSM :

For calibration of tamping depth control circuit PCB EK16V. Bring machine on good track. Put machine in working mode i.e. apply Hyd. Pressure, switch on working system.

- Lower the Tamping Unit, and release hydraulic pressure let the Tamping Unit remain in lower position.
- Release the fork of transducer from Tamping Unit.

NOTE: This procedure refers to calibration of the RH Tamping Unit, for LH Tamping Unit same procedure should be adopted.

Basic Current Adjustment:



This current of proportional valve is set at 33% of full scale deflection current i.e. 250mA.

Select 200 mm depth in depth selector select the proportional valve current indicator for RH side tamping unit

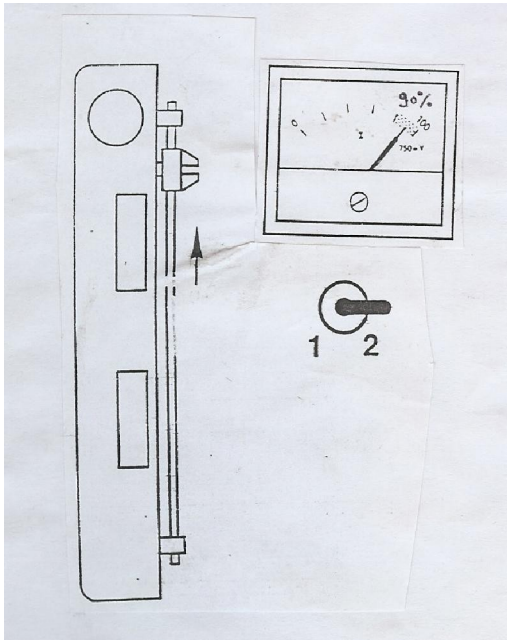
Keep the Taping Unit lowering pedal press

Move fork of Transducer top to down side and watch the deflection of pointer of current indicator. Pointer of proportional current indicator will ove fro Max. to Min. This pointer should drop suddenly at 33% of full scale deflection i.e. 250mA.

If pointer of current indicator is a not dropping suddenly at 33% then adjust P8 in EK 16V.

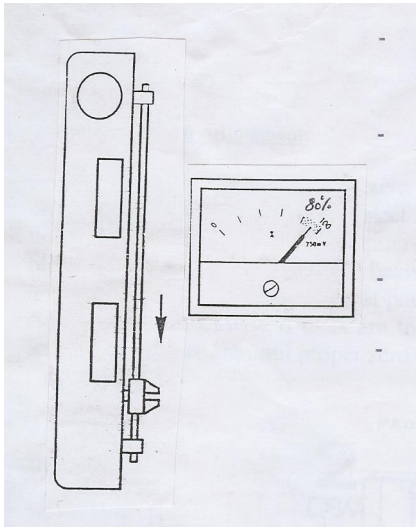
Maximum Taping Unit Lowering Current (Lowering Speed Adjustment:

Maximum current of Proportional valve for Tamping Unit Lowering is set at 67mA or 90% of full scale deflection current.



- Select depth 300mm in depth selector.
- Set toggle switch (High speed) to position.2.
- Keep fork of Tamping depth Transducer fully up.
- Keep lowering pedal press. And watch deflection of current indicator.
- Pointer of current indicator should be at 90% of full deflection.
- If pointer of current indicator is not at 90% then bring pointer at 90% (67mA) by adjusting potentiometer P7 in PCB EK 16V.
- Release Tamping Unit pedal.
- Shift toggle switch to position-I

Maximum Tamping Unit Lifting Current (Lifting Speed) Adjustment:



- Maximum current of proportional valve for Tamping Unit lifting is set at 600mAor 80% of full scale deflection current.
- Tamping pedal should be released (not pressed)
- Keep fork fully down. Watch deflection of current indicator.
- Pointer of current indicator should be at 80% (600mA) of full scale deflection.
- If pointer of current indicator is not at 80% (600mA) then adjust P12 in PCB EK16 to bring pointer at 80% of scale.

Zero Depth Adjustment: For zero depth adjustment, attach fork with tamping unit. Apply hydraulic pressure. Select zero depth in selector. Press tamping unit lowering pedal, lower the tamping unit and measure the tool depth. Top of tool blade should go 10mm to 12mm below rail head as shown in fig. If tool blade is not going at such depth then adjust potentiometer P1 to get 10mm to 12 mm depth. Adjust P1 anticlockwise if tools are too high and clockwise if tools are too low. Repeat this procedure until proper zero depth is achieved.

Target Depth Adjustment: Before tamping, target depth should be Selected. It depends upon type of sleeper and rail. Total depth is calculated by adding rail height, sleeper height and rubber packing. Suppose 60kg. Rail is used where machine is placed for calibration. Total target depth will be 392mm {rail height (176mm)+sleeper height (210mm)+rubber packing (6mm)}.

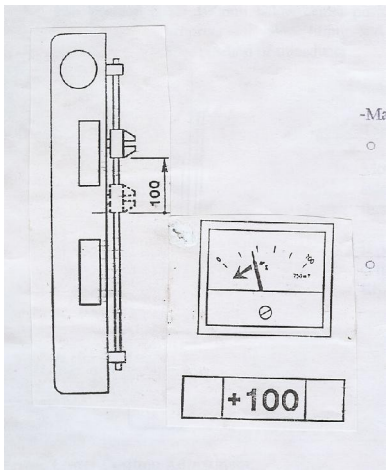
Select 392mm depth in depth selector.

Remove the ballast from sides of sleeper up to bottom.

Lower the tamping Unit by pressing the tamping pedal. Keep it press.

Measure the tool depth below bottom of sleeper. Top of tool blade should go 10mm to 12mm below sleeper bottom as shown in figure. If tool blade is not going at such depth then release the tamping pedal. Adjust potentiometer P13 in PCB EK 16V clockwise if tool blade is too high and adjust P13 anticlockwise if tool blade is too low from sleeper bottom. Again press the tamping pedal and measure the tool depth, repeat this procedure until proper depth is achieved.

Upper Position "Cut Off" Point Adjustment:



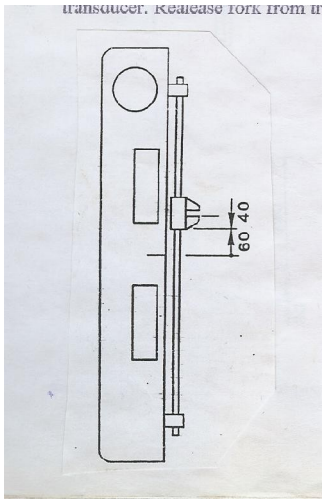
Upper "Cut Off" point is set 100mm above centre position. After Tamping when Tamping Unit comes up it should stop 100mm above centre position of Transducer.

- Mark 100mm above centre position of transducer.

o Press the tamping unit Lowering pedal, lower the tamping unit, when tamping unit Comes up after taping cycle fork should stop at 100mm mark.

o If fork does not stop at 100mm mark then adjust potentiometer P9 in EK16V.

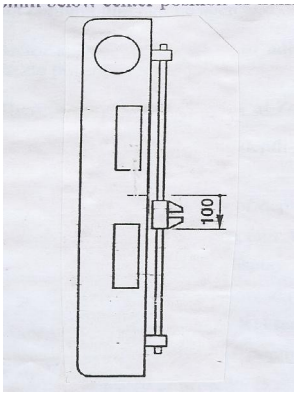
Upper Position Indication Adjustment:Although upper "Cut Off" point is set 100mm above centre position, but PCB EK16V senses upper position of Tamping Unit 60mm above centre position. In this position green LED glows in PCB EK 16V. For calibration of upper position indication, mark 60mm above centre mark of transducer. Release fork from transducer.



- Pedal should be released.

- Move fork of transducer fro centre position to up side when fork reach at 60mm, green LED in PCB EK16V should glow. If it is glowing before or after 60mm then adjust it by potentiometer P11 in PCB Ek16V.

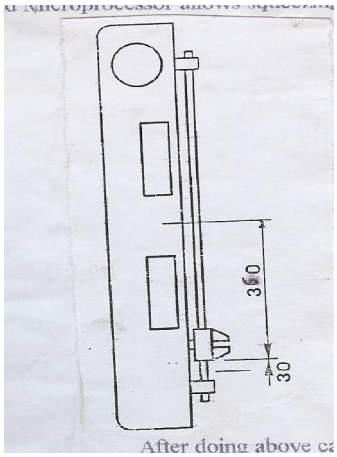
Middle Position Adjustment: This position is set 100mm below centre position. In the position yellow LED glows in PCB EK16V and microprocessor allow lifting and lining. For calibration of this position mark 100mm below centre of transducer.



- Select 300mm depth in depth selector.
- Tamping pedal should be released.
- Move fork of transducer centre position to
  down side as fork reach at 100mm below centre position then yellow LED should glow in PCB EK 16V.

- If yellow LED is glowing before or after 100mm centre position then adjust potentiometer P4 in PCB EK16V.

Lower Position Adjustment: This position is set 30mm before target depth. In this position Red LED glows in PCB EK16V and Microprocessor allows squeezing in this position.



- For calibration of this position select 390mm depth in depth selector and mark 360mm on transducer below centre position.
- Tamping pedal should be released.
- Move fork of transducer fro centre position to down side as fork reach at 360mm, red LED should glow in PCB EK 16V, if Red LED glows before or after 360mm then adjust P10 in PCB EK 16 to glow Red LED at 360mm.

fix fork of Transducer with Tamping Unit.

Calibration of Depth Display: There is a depth display in panel No. 19 in which we can see the depth achieved by Tamping Unit. This display consists of five position selector switch. Selecting 3rd position depth of left hand tamping unit can be seen and on 4th position depth of RH Tamping Unit can be seen.
Selector switch PCB consists of adjustment potentiometer by which we can adjust the display to indicate proper depth.

Adjustment of Depth Display at Zero Depth: For calibration of depth display, Apply hydraulic pressure, select zero depth in depth selector.

- Select 4th position of depth display (for RH tamping unit).
- Lower the tamping unit by pressing the tamping pedal.
- Watch the depth display.
- Display should show zero depth. If it is showing some value then adjust P7 (in depth selector PCB) for RH tamping unit.
- For calibration of depth display for LH tamping unit potentiometer P8 should be adjusted in same PCB.

Adjustment of Depth Display at Target Depth: Select 300mm depth in depth selector. Lower the tamping unit by pressing the tamping pedal and watch display. It should show 300mm. If depth display is not showing 300mm then adjust potentiometer P2 (For RH tamping unit) in depth selector PCB. Potentiometer P3 should be adjusted in same PCB for LH tamping unit.

- Release the Tamping pedal.

After Calibration:

After calibration of RH tamping unit, movement of both tamping unit should be checked during tamping (lowering and lifting of both tamping unit simultaneously). Since there are separate circuit for each tamping unit so it is very difficult that both tamping unit will behave in same manner. So we try to synchronize lowering and lifting movement of both tamping unit as near as possible.

TROUBLE SHOOTING FLOW CHART OF TAMPING UNIT CONTROL CIRCUIT OF CSM.

In starting when tamping cycle 1X is selected and pressing tamping pedal both tamping unit are not going down.

Check lowering command of tamping unit Q10 for (LH) and Q11for (RH) in programmer coming or not when pressing pedal.

Q 10 and Q11 are coming

Check hydraulic system pressure.

Select proportional valve current indicator in panel B18 for LH or RH side and press the pedal if there is no deflection in current indicator then check fuse 2A in EK16V replace it if blown . If fuse is ok then check relay Re-1, Re-2 & Re-5 and replace one by one. Relay Re 2 should be replaced first.

Check voltage +24V at coupler of proportional valve. If there is no +24V on proportional valve then check resistance 7r3 (LH) and 7r4 for RH side.

If +24V is coming on proportional valve now operate proportional valve manually then T /Unit should go down if it is not going down then prop. Valve is defective repair or replace it.

Transistor(BDW 63) in PCB may be defective If this transistor is in spare replace it other wise replace PCB EK16V.

Q10 and Q11 are not coming.

Check circuit breaker (18e3) of tamping unit circuit .check 24v. check power supply pcb EK813SV it's voltage ±15v and ±10v . If output voltage are not coming then check fuse in this pcb replace if blown . if fuse is ok , out put voltage are not coming then replace this PCB .

Check X19 should come in programmer it is tamping system "ON" input .If switch 2X19 is ON but X19 is not coming then this switch may be defective replace it switch.

Check coupler of transducer and slipping of wire replace if broken and calibrate the transducer.

Check 2kΩ resistance in transducer replace it if defective .

Check X10 while pressing the pedal, if X10 is not coming then check pedal switch replace if defective.

B

B

Check X3E should not come in programmer.

It is lining without tamping switch . 2X3E should not "ON"

Check X5A and X5B should not come.These are Tamping Unit lock indication if coming then check limit switch of tamping unit lock , these should be repaired/replaced.

Check X13 for LH side and X14 for RH side coming or not these are upper position indication, if not coming then calibrate upper position in PCB EK16V by potentiometer P11.If no effect of calibration then replace relay Re6 in same PCB

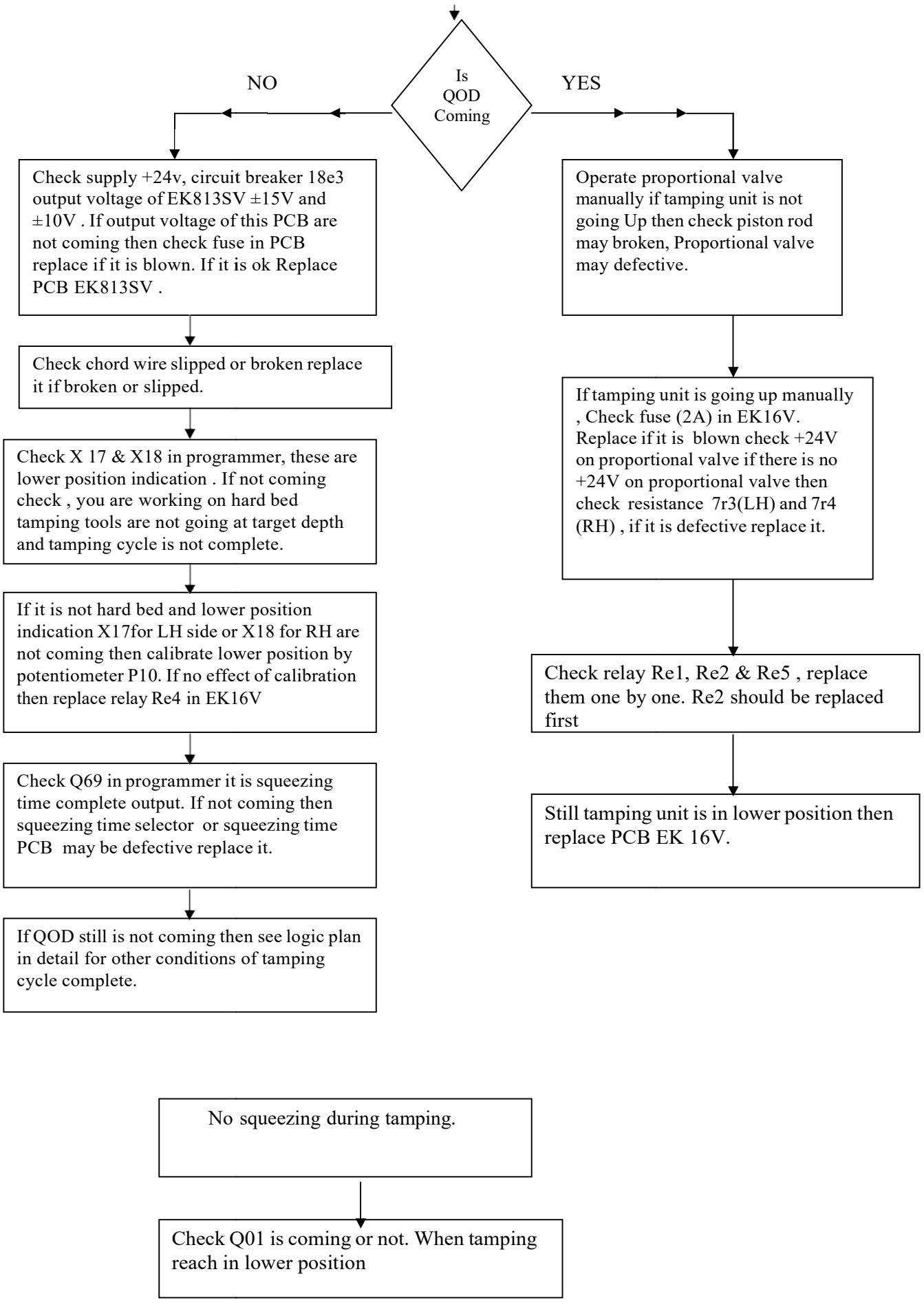
Check X22 should not come in programmer. This is the satellite rear position indication, if it is coming even satellite in front position then repair or replace rear position limit switch.

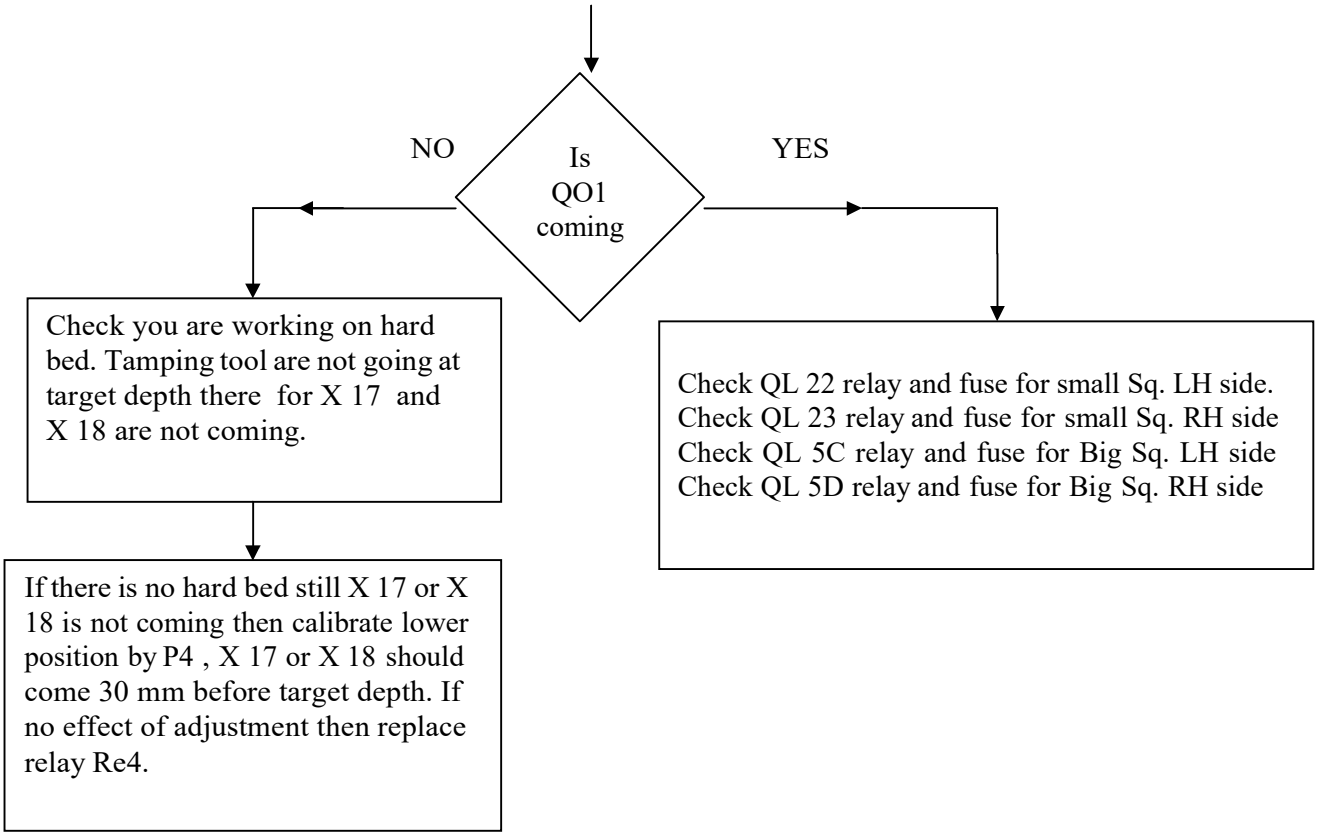
Check X1B, this is satellite middle position indication .If it is not coming then calibrate it at 340mm by potentiometer P4 in EK24V. If noeffect of calibration then replace relay Re3 in same PCB

If Q10 and Q11 are still not coming then see Logic plan in detail and check all condition of lowering of tamping unit.

During Tamping , Tamping Unit remain in lower position.

Check **QOD** in programmer , this is tamping cycle complete out put .


Is QOD Coming
NO
YES
Check supply +24v, circuit breaker 18e3 output voltage of EK813SV ±15V and ±10V . If output voltage of this PCB are not coming then check fuse in PCB replace if it is blown. If it is ok Replace PCB EK813SV .
Check chord wire slipped or broken replace it if broken or slipped.
Check X 17 & X18 in programmer, these are lower position indication . If not coming check , you are working on hard bed tamping tools are not going at target depth and tamping cycle is not complete.
If it is not hard bed and lower position indication X17for LH side or X18 for RH are not coming then calibrate lower position by potentiometer P10. If no effect of calibration then replace relay Re4 in EK16V
Check Q69 in programmer it is squeezing time complete output. If not coming then squeezing time selector or squeezing time PCB may be defective replace it.
If QOD still is not coming then see logic plan in detail for other conditions of tamping cycle complete.
Operate proportional valve manually if tamping unit is not going Up then check piston rod may broken, Proportional valve may defective.
If tamping unit is going up manually , Check fuse (2A) in EK16V. Replace if it is blown check +24V on proportional valve if there is no +24V on proportional valve then check resistance 7r3(LH) and 7r4 (RH) , if it is defective replace it.
Check relay Re1, Re2 & Re5 , replace them one by one. Re2 should be replaced first
Still tamping unit is in lower position then replace PCB EK 16V.
No squeezing during tamping.
Check Q01 is coming or not. When tamping reach in lower position



FAULT	CAUSES	REMIDIAL SECTION
Tamping tools are not going at proper depth.	Calibration out.	Calibrate depth transducer calibrate PCB EK16V for zero depth by P1 and for target depth by P13.
Lowering speed slow	Check current of proportional valve for lowering, it should be 650mA.	Calibrate lowering current of proportional valve by P7 in PCB EK16V.
Slow lifting speed.	Check current of proportional valve for lifting, it should be 600mA.	Calibrate lifting current of proportional valve by P12 in PCB EK 16V.

Session-37: Electronics Model Room for demonstration, testing and calibration of Tamping unit PCB

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XIII: Lining Control Circuit, UNO/DUO/ CSM/3X /Unimat

Session-38: Functional Description of Lining Control Circuit and Input Potentiometer (Slew & Versine)

LINING CONTROL PCBs OF DIFFERENT MACHINES

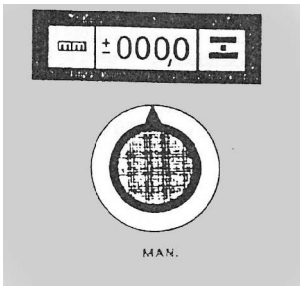
PCBs which are used in lining control circuit in different machines are given below:

CSM:			**UNIMATE 2S:**		
Lining PCB	-	EK 349 LV	Lining PCB	-	EK 2038 LV
Front Input PCB	-	EK 345 LV	Over slew	-	EK 290 LV
Over slew PCB	-	EK 290 LV	Front input	-	EK 2072LV
Power supply PCB	-	EK 813 SV	3-stage Lining	-	EK 144V
Satellite compensation PCB	-	EK348 LV	Power supply	-	EK 813 SV
CSM-3X:			**UNIMATE-3S:**		
Lining input PCB	-	EK 2361 LV	Input Lining PCB	-	EK 2173LV
Lining Output	-	EK 2140LV	Output & overslew PCB	-	EK 2140 LV
& Overslew PCB			Front input PCB	-	EK 2072 LV
Front Input PCB	-	EK 2343 LV	Power supply	-	EK 813 SV
Satellite compensation PCB	-	EK 526 MC	**UNIMAT COMPACT:**		
Power supply PCB	-	EK 816SV	Input Lining PCB	-	EK 1.1/17 LV
DUOMATIC:			Output & over slew PCB	-	EK 2140 LV
Lining PCB	-	EK 335 LV	Front input PCB	-	EK 3049 LV
Overslew PCB	-	EK 290 LV	Power supply	-	EK 813 SV
Front input	-	EK 275 LV			
3-stage Lining	-	EK 80V			
Power Supply	-	EK 813 SV			

(i) VERSINE POTENTIOMETER:

This potentiometer is provided in front cabin in panel B4 .This potentiometer is used to feed versine value in 3-pt lining and Vm value in 4-pt lining . This potentiometer converts versine value to electrical signal at the rate of 50 mv/mm, + vc for RH side, -ve for LH side.

(ii) SLEW POTENTIOMETER :



This potentiometer is also provided in front cabin in panel B4 .This potentiometer is used to feed slew value . It converts slew(Offset value in design lining) value into electrical signal at the rate of 50 mv/mm +ve for RH side and –ve for LH side.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XIII: Lining Control Circuit, UNO/DUO/ CSM/3X /Unimat

Session-39: Functional Description of Lining PCB EK349LV, EK335LV, Basic concept of 3 Point Regulator / 3 Stage Regulator

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LINING SYSTEM of CSM

Printed Circuit Boards:

4u5	.....	Front Input PCB	.....	EK-345LV-00-(02)
10u1	.....	Satellite Compensation PCB	.....	EK-348LV-00(02)
10u2	.....	Lining Control PCB	.....	EK-349LV-00(02)
10u3	.....	Overslew Control PCB	.....	EK-290LV-00 (02a)
10u4	.....	Power Supply PCB	.....	EK-813SV-002

Transducers:

1f01..... Lining Transducers

1f02..... Measuring Transducers

Potentiometers:

2f05	.....	Overslew value	.....	20k Ohms
2f24	.....	0 Point Correction	.....	20k Ohms
4f1	.....	Versine Adjustment	.....	10k Ohms
4f4	.....	Slew	.....	10k Ohms

Switches:

2b10	.....	Overslew ON-OFF
2b12	.....	2 Step Lining
2x39	.....	3 Point Lining ON
2x3B/3C	.....	Manual Lining – Left or Right.
2x4E/4F	.....	Datum Left or Rights
4b4	.....	Positive or Negative for Versine Correction.

Description of Lining Control PCB EK-349LV 02:

The inputs from the front system and the transducers on the measuring and lining trolleys are passed to the lining control board 10u2.

Inputs:

Input 1. Satellite Compensation: Due to the machine constantly moving, the relationship between the trolleys will vary and therefore a satellite compensation signal is required. The output of the compensation card at 50 mV/mm (negative for right hand adjustment) from terminal 6z, is fed to 10u2 on terminal 30z (a more detailed explanation is provided later). This signal at 50 mV/mm is passed to the summing line via R14, R18 and P2C.

Input 2. Lining Versine: Not used in 4 point lining, therefore Ov at terminal 20d.

Input 3. Zero Adjustment : In order to correct minor errors in the lining system, a potentiometer 2f24 is provided. The potentiometer is supplied with + and –10 volts from R52

and R53, the signal from the potentiometer is at 2V/mm (negative to the right) can be checked on multiplex F24. This pot is used to do a daily check before work takes place.

The signal passes to 10u2 on terminal 20z to amplifier OP1B (buffer) onto the summing line via P16, R60 and R59.

Input 4. Front Cord Displacement (3 Point): Not used in 4 point, therefore input at terminal 22z – 0v.

Input 5. Front Cord Displacement (4 Point): As previously explained, the offset in the tower by potentiometer 4f4 is fed into P.C.B. 4u5 and onto the compensation board 10u1 on terminal 28b which links to 10u2on terminal 24b. The signal at –50mV (to the right) passes to OP1D (buffer) and onto the summing line via P18 and R56.

Input 6. Curve Correction: When the machine is on a curve, the lining cord is offset downhill due to mechanical forces and therefore needs to the corrected. On a curve with 150mm difference between the high and low rail, the cord is offset by 2mm.

The rear pendulum 1f09, feeds in a signal of 25 mV/mm negative left hand high rail) to P.C.E. 6u5 on terminal 30z which is amplified by OP1D to – 50 mV/mm at terminal 30b. This signal passes to 10u2 on terminal 26d, therefore on a curve of 150mm with left hand rail high, there will be 50 mV x 150 mm = 7.5 volts = 2mm offset correction, which can be checked on multiplex F1E. The signal at 26d passes to OP2A(2) where it is inverted and attenuated by 0.035, and onto the summing line via P19 and R45.

Input 7. Measuring Transducer: The measuring transducer 1fo2 feeds in a signal at terminal 28b of 10u2 at 23.1 mV/mm (positive for movement to the right) which can be checked on multiplex F02. The signal passes to OP2B and OP3A.

With a positive at 28b, the signal passes to OP2B(5) and once the summing line via D13, R37 and P14.With a negative at 28b (movement to the left), the signal passes to OP3A and onto the summing line via 09, R16 and P13.

Input 8. Lining Transducer: The lining transducer 1f01 feeds in a signal at terminal 28d of 10u2 at 23.1mV/mm (negative for movement to the right), which can be checked on multiplex F01. be checked on multiplex F01. The signal passes to OP2D (buffer) and onto OP3C and OP3D. With a positive at terminal 28d (to the left) passes to OP3C and onto the summing line, via D6, R15 and P10. With a negative at terminal 28d, passes to OP3D, and onto the summing line via D5, R20, and P9.

Summing Line: The various signals are adjusted due to the differing value of resistors, and are added together at the summing line. The summing line forms an input to amplifier OP4C (inverting adder) on pin 9. If the track alignment is correct, no slew is required, the signals balance out and the input voltage is zero. Therefore the output voltage from amplifier OP4C is zero.Due to slight errors in the mechanical components in the system, the input signals could contain errors. Therefore two additional signals are connected to the summing line.

1) + 15 volt signal to the summing line via R6 and R7.
2) – 15-volt signal which is adjusted by a fixed resistor and a potentiometer depending on left or right hand pre-load. This is controlled by relay Re3 as follows:

Mode	**Relay Re1**	**Pre-Load**
4 Point	De-energized	Left
4 Point	De-energized	Right

Relay Re3	**Resistor/POT**
De-energized	R13/P8
Energized	R5/P7

The appropriate potentiometer is used to trim the summing line to zero in the respective direction of pre-load to balance the +15 volt signal. This is known as the Dynamic Zero.

Output of OP4C: When the machine moves onto mis-aligned track there will be an input to amplifier OP4C on pin 9 via the summing line. The output of amplifier OP4C pin 8 at 0.5 V/mm (positive for sew to the right) passes to terminal 12d and enters the over slew board 10-u3 (EK-290LV-00) on terminal 30dbz. The signal is inverted and kept at the same magnitude by amplifier OP4B, leaving 10u3 at terminal 4dbz and re-entering 10u2 on terminal 10z. (See recent modes at rear of book).The signal at –0;5 V/mm (for slew to the right), passes to earth via R9(14K) and contact earth via R9(14k) and contact Re4/2. this prevents the signal from passing to the lining servo circuit until it is required, i.e. at start lining signal.

The output of amplifier OP4C at +0.5 V/mm on pin 8, also passes to OP4D(13) which inverts the signal to- 0.5 V/mm (slew to the right) which passes to the galvo 9g2 via R26, R27 and terminal 4z, which indicates the required slew.

Daily Check: The daily check is now carried out, and adjustments made using the 0 point correction pot 2f24 until an even deflection either way on the galvonometer is obtained. The machine is ready to line the track.

Automatic Lining: To start automatic lining, an output Q0A is required which needs the following to be complete:

05^3D[(24^25)vs2F)^(4Ev4F)].

05 = Lifting & Lining enable (20^OB)v(30^OB^15)v(30^OB^16)
3D = Auto Lining on, and
24^25 = Sensors on, or
2F = Sensors off, and
4Ev4F = Pre-load to the left, or right.

If all of these inputs are made, the program will be complete for output QOA which earths terminals 28dbz and 16d on the overlsew board 10u3 (EK-290LV-02a).

With the machine selected to line every sleeper, the earth at terminal 28dbz does not affect this circuit. The earth at terminal 16d passes to terminal 18d via the closed contact Re3/1, which links to terminal 16d of the lining control card 10u2. The earth at this terminal connects to the coil of relay Re4, which has a positive supply via terminal 14z, and therefore energizes.

Contact Re4/1 reverses, completing an earth path to relay Rez, which has a positive supply via terminal 4d, causing Re7 to energies. Contact Re7/1 closes, passing the 24 volt supply from terminal 4d volt supply from terminal 4d to terminal 4b which connects to tank bypass solenoid 1s56. Solenoid 1s56 energizes moving the tank bypass valve to the blocked port position hydraulically. The second contact of relay Re4 opens, removing the earth between resistors R9 and R17, allowing the lining signal to pass to the servo valve. The lining signal at 0.5v/mm (negative for slew to the right) is inverted by amplifier OP4B (1:1) and the output passed to the servo amplifier OP4A via the combination of R39 and R32 in parallel with D11 and R33. The signal at +0.5V/mm (for slew to the right), is inverted by OP4A and amplified by approximately 7:1. The output of pin 1 is passed to a potential divider network, which consists of"- P1 (20K), R42 (16K), R52 and due to Re4 being energized R53 (Re4/2 open).

When the slew required is 4m or more, the output of OP4A will be –14 volts (i.e. saturated), which results in –3 volts at pin 2 of OP5. The output of OP5 at pin 5 is approximately – 6 volts which results in a current of 15mA's flowing through the circuit of R44 (100µ), 1s15 (100µ) and returning through R68 (200µ). With 15 mA flowing through the servo valve, the valve allows maximum flow of oil to the lining cylinders which moves the track to the right. As the track moves, the lining trolley which is pre-loaded to the rail, moves with it, reducing the input from the lining transducer. The signal at the summing line reduces and when under 4mm of track movement is required, amplifier OP4A comes out of

saturation. Therefore the current through the servo valve 1s15 reduces.Due to the current reducing in the servo valve, the oil to the lining rams is reduced, slowing down the movement of the track.

When the track has been slewed to the correct position, the summing line will be balanced, resulting in no current flowing through the servo valve. The valve is now, in the null position, i.e. blocked, trapping oil between the servo valve and the lining rams. This maintains the track in the correct position as seen on the lining galvo 9g2, which shows zero slew.

When squeeze has finished, output QOD breaks the program of QOE which in turn breaks the program of QOE which in turn breaks the program of QOB. The loss of output QOB results in breaking the program of QOA. Due to the loss of output QOA, the earth is removed from 10u3, terminals 16d and 28dbz. Therefore removing the earth at terminal 18d, which connects to 10u2.

The loss of the earth at terminal 16d, causes relay Re4 to de-energies, causing relay Re7 to de-energize, ad the tank valve solenoid to de-energize, moving the valve to the parallel port position. With Re4/2 returning to the de-energized position, an earth is placed again between R9 and R17, blocking any signal from passing to the servo circuit.

08-275 POINTs AND CROSSING TAMPING MACHINE

LINING SYSTEM:PCBs:

10u1	Power Supply	EK-813SV-002
10u2	Analogue Circuit	EK-2039LV-00(02)
10u3	Overslew Circuit	EK-290LV-00a(02a)
10u4	Rear Cord Follow Up	K-719A-00(02)
4u5	Front Input Interface	EK-2039-LV-00(02)
4u7	Laser Lining Control	EK-715A-00(02)

Switches:

22b1	Overslew On-Iff
22x10	Lining System on & Automatic Start
23x2F	Manual lining to left
23x30	Manual lining to right
22x4B	2 step lining on
22x11	3 point lining on
4b4	Lining versine director

INPUTS:

1f21	Lining versine transducer
1f22	Measuring versine transducer
1f1	Rear cord follow up transducer
22f4	O-correction potentiometer (±5mm)
4f1	Lining adjusting value
4f4	Front cord displacement
22f05	Overslew value

Circuit Description: When the working main switch is turned on terminal 2 is fed at 24 volts. Via circuit breaker 18e2 and terminal R2 printed circuit 10u1 is fed with 24 volts at terminal 4db. The output terminals of 10u1 will be at the following voltages:

8db(R52) + 10 volts
20db(R53) – 10 volts
2d + 15 volts
2z - 15 volts
32db OA earth

From these five terminals the printed circuits 10u2, 10u3 & 10u4, transducers 1f1, 1f21 & 1f22 and potentiometer 22f24 are fed with the correct voltage.

Six analogue inputs are fed into the analogue control circuit 10u2:

1. Lining Versine: The signal from the lining transducer 1f21 is fed in via terminal 28d at 23mV/mm of displacement, the signal is negative when the transducer is deflected to the right. The voltage can be checked using Multi check F01. From terminal 28d the signal is taken to OP2D(12) via R51, OP2D is wired as a high impedance buffer of gain 1, the signal leaves the output OP2D(14) and passes to amplifiers OP3C(10) and OP3D(12). Due to the use of diodes D5 & D6 OP3C will only accept positive signals and OP3D negative signals. The output from OP3C(10) passes via R5 and P10 to the summing line. The output from OP3D(14) passes via R20 and P9 to the summing line. P9 is used to calibrate the signal to the summing line when the transducer is deflected to the right and P10 when deflected to the lift.

The output from OP2D(14) via terminal 23z is taken to printed circuit 10u4 to control the automatic follow up of the lining cord.

Switch S2 on printed circuit 1pu3 can be used to connect terminal 30b to earth effectively feeding a "zero" into OP2D for calibration purposes.

2. Measuring Versine: The signal from the measuring transducer 1f22 is fed in via terminal 28b at 23mV/mm of displacement, the signal is positive when the transducer is deflected to the right. The voltage can be checked using Multi check F02. From terminal 28b the signal is fed via R49 to OP2B(5) and OP3A(3). Due to the use of diodes D7 & D10 OP2B will only accept negative signals and OP3A positive signals. The output from OP2B(7) passes via R37 and P14 to the summing line. The output from OP3A(1) passes via R16 and P13 to the summing line.When the 4 lining trolleys are in perfect alignment on either straight or curved track and all other inputs are at zero the signals from OP2B and OP3D or OP3A and OP3C balance each other out at the summing line. However, due to the relationship of the trolleys the signal from the measuring trolley will always be smaller than the signal from the measuring trolley will always be smaller than the signal from the lining trolley. Therefore P13 is used to calibrate the correct ratio when the transducers are deflated to the left and P14 when they are deflected to the right.

3. Compensation Input: In order to keep the lining cord in the centre of the machine (see cord follow up) a compensation transducer is fitted to the rear lightening trolley to compensate for the reduced input signal from the lining transducer when the cord has been displaced at the rear.The signal from the compensation transducer 1f1 is fed in via terminal 26z at 23mVm/mm (negative when displaced to right). The voltage can be checked using multicheck F03. The terminal 26z the signal is fed via R50 to OP2C(10) and OP3B(5). Due to the use of diodes D7 & D10 OP2C will only accept positive signals and OP3B negative signals.The output OP2C(8) passes to the summing line via R8 and P12 whilst the output OP3B(7) passes via R19 & P11. P11 is used to calibrate the signal whilst deflected to the right and P12 when deflected to the left.When 3 point lining is selected Re2 will be energized and the inputs to OP2C and OP3B earthed.

4. Zero Correction: Due to the possibility of slight inaccuracies in the lining system a zero correction potentiometer 22f4 is fitted. This can adjust the input signals by upto ±5mm.

The signal from the potentiometer is fed into printed circuit 10u2 at terminal 20z. The signal then goes via R71 to OP1B(5). The output OP1B(7) is fed into the summing line via P16, R60 and R59.Potentiometer P16 is used to calibrate the signal to the summing line.

5. Digital Versine Value: When the machine is sued in the 3 points Lining mode the inputs from the measuring transducer and compensation transducer are grounded by connecting OP2B(5) and OP2C(10) to earth via contacts Re2/1 and Re2/2 which are now closed. The signal from the lining transducer is compared directly with required versine, set by potentiometer 4f1 (see description of front tower).

The signal is fed into printed circuit 102 at terminal 20d at 50mV/mm and can be measured using multicheck F00.From terminal 20d the signal passes to OP1A(3) via R70. The output OP1A(1) goes to the summing line via R63.

6. **Front Card Displacement:** Unlike previous machines the front end of the lining cord is fixed. Fixed point slews are still made in the same manner but the signal is fed into printed circuit 10u2 directly.For4-point lining the displacement signal at terminal E48 is fed into the printed circuit at terminal 24b via the normally closed contact of relay 7u1/B. From terminal 24b the signal passes through R58 to OP1D(12). The output OP1D(14) goes via P18 & R56 to the summing line.

Due to a difference reduction factor for 3 point lining the signal from terminal E48 is fed into printed circuit 10u2 at terminal 22z via the normally open contact of relay 7u1/B (which is energized when 3 point lining is selected).The output OP1C(8) passes via P17 and R55 to the summing line.The values of P18 & R56 (4 point lining) and P17 and R55 (3 point lining) are difference and alter the input of 50mV/m to 311. 5mV/mm (4 point lining) and 159 mV/mm (3 point lining) at the summing line.

Summing Line: The six inputs previously described are connected together at the summing line which forms the input to OP4C(9) which is wired as an "inverting adder".If the track is correctly aligned and no slew is required the inputs balance out and the input voltage is zero. Therefore the output voltage OP4C(8) will be zero.The system can be worked in 3 point or 4 point modes with the trollies preloaded to left or right. Slight errors in the mechanical system will mean that input signals could contain slight errors. Therefore an additional input is fed into the summing line via the contact of Relay Re1. Relay Re1 is energized from program output Q18 when 3 point lining is selected. When right hand preload is selected relay Re3 is energized.

A-15 volt signal is fed to the summing line via the resistors shown in the table below.

Mode	Relay Re1	Preload	Relay Re3	Resistors
3 Point	Energized	Left	De-energized	P6, R3
4 Point	De-energized	Right	Energized	P7, R5
3 Point	Energized	Right	De-energized	P5, R4
4 Point	De-energized	Left	De-energized	P8, E13

The potentiometers are used to trim the summing line to zero in the respective mode. The signal is balanced by a +15 volt signal via R6 & R7.

Output Stage: The output OP4C(8) is taken to terminal 12d and OP4D(13). The signal is now 0.5V/mm (set with P21). The output of oP4D(14) passes through resistors R26 & R2 to terminal 4z and finally to the lining indicators. This signal is negative for a slew to the right.

From terminal 12d the output signal at 0.5mV/mm (slew to right positive) enters the overslew printed circuit 10u3 at terminal 30d. From terminal 30d the signal passes via R33 to OP4B(7). The overslew value enters 10u3 at terminal 6d and via R31 to OP4B(7). If overslew is not selected terminal 6d is connected to earth via switch 22b2. The signal is inverted and the output OP4B(10) is connected to terminal 4d. This terminal is connected to terminal 10z on printed circuit 10u2. This terminal is connected to terminal 10z on printed circuit 10u2. The signal (now negative for slew to right) passes to E9. Unless automatic lining has been selected and the machine is in the correct stage of the working cycle Re4 will be de-energized and the junction of R9 and R17 connected to earth via Re4/2.

If automatic lining has been selected and the machine is in the correct stage of the working cycle program output QOA will be fed to terminals 28d and 16d of 10u3. For normal slew every cycle QPA at terminal 16d passes via the normally contact of Re3 to terminal 18d. This terminal is connected to terminal 16d of 10u2, thus providing an earth path for relay Re4 which no energies contact Re4/2 opens removing the earth from R9/R17.

The signal now passes to OP4B(6) where the signal is inverted again (1:1 ratio slew to right positive). The output OP4B(7) goes via R38 to R39, R32 to OP4A(2). Each side of R38 is connected to terminals 10d & 10b and can be shorted out by switch 22b/1 in order to increase the gain of OP4A. The output OP4A(1) is taken via P1 & R42 to OP5 which is the output amplifier The servo value Is15 is connected in the feed back loop via terminals 6z and 8z. Terminal 6z is negative for a slew to the right.Contact Re4/1 changes over and switches R53 into circuit to increase the servo value current for automatic lining.

Manual Slew to Left: Switch 2x30 is closed, connecting terminal 14d to earth. Relay Re5 now energizes and its contacts reverse. Re5/2 connects a-15 volt signal via Re34 to OP4B(6). The output path from OP4B(7) is the same as for automatic slew.

Lining By Pass Value: The lining by pass value is operated directly from the programme output QL20 which is available providing the conditions for track slew are met.

Over Slew PCB EK290LV: The input to the overslew printed circuit 10u3 at terminal 30d additional charges capacitor K8 via normally closed contact Re5/4. The voltage on K8 is equal to the input voltage (including polarity).

The output voltage at terminal 4d is also used as an input voltage for the two comparators OP3A & OP3B. The reference voltage is determined by R21, R22, R25 and R26 and is approximately – 0.65v for OP3A and + 0.65v for OP3B (approx 1mm of slew required). Should the output from OP4B(10) lie outside – 0.65v and + 0.65v either OP3A or OP3B will switch to an output of +15 volts and in turn will switch TI on.When the automatic lining signal QOA is received at terminal 28d the earth to Re6 will be completed and Re6 will energize and its contact close.

A 24 volt feed is now passed to Re4 coil and contact Re4/1. Due to capacitor K11 Re4 does not energize immediately and Re4/1 stays closed long enough for Re5 to energize – contact Re5/1 closes and retains Re5.The charge on K8 is now connected to OP4A(2) via Re5/3. The output OP4A(12) is connected to terminal 8d. If the overslew is switched on terminal 8d is switched on terminal 8d is connected to terminal 6d via 22f05 and 22b2. When the lining indicator shows zero the overslew value from K8 and OP4A is still present at OP4B(7) . The track is therefore slewed past the zero point until the new signal at 30db cancels the overslew value at 6d and output OP4B(10) is zero.

When the output OP4B(10) approaches zero the comparator OP3A or OP3B switches to –15 volts. Therefore T1 is switched off and Re5 deenergises. OP4A(2) is now fed at zero voltage and hence the input is now zero. Because the track has been overslewed the input 30d is reversed polarity. This causes OP4B(10) to be reversed polarity and the track is slewed back to the zero point.

Two step Lining: The machine has the facility for lining every second working cycle. To enable the machine to line every second cycle switch 22 x 4B must be turned on. The output from the programmer Q19 is made every cycle. When Q19 is on terminal 20d is earthed and relays Re2 & Re3 are energized. At each automatic start signal “Q19” relay Re6 energises (see overslew) and the 24V is also taken to Re1 (1 & 6) and SB1(3). SB1 operates as a flip flap on the first pulse Re1 coil (1 & 12) energises and all contacts reverse. The signal Q19 passes via Re1/3 to terminal 18b. Automatic lining now takes place. As the state of SB1 has now changed the next signal QOA allows Re1 coil (6 & 7) to energise which reverts all contacts to the original state. As Re1/3 is now open QOA signal cannot pass to terminal 22d and automatic lining does not take place. On the next cycle Re1 coil (1 & 12) energises again.

Front Tower Lining:

Digital Input: The direction switch 4b4 has to be correctly set for the direction of the curve. For right hand curves 4b4 connects the digital potentiometer 4f1 to the +10 volt supply and the –10 volt supply for left hand curves. A signal of 50mV/mm (positive for right hand curves) is taken from 4f1 to terminal 8b of 4u5. The signal passes via R72 to OP6C(10). The output OP6C(8) is taken via R31 to OP4D(13) where the inverted signal from OP4D(14) passes to terminal 30d. This terminal is connected to the lining display (4u2) to show the set versine and 10u2 terminal 20d to feed the desired versine into the lining control board.

If the GVA computer is used the output versine from the computer is fed to terminal 20z of 4u5 and via R22 to OP3A(3). The output OP3A(1) passes via R23 to inverter OP3B(6). The zero point of this inverter is set by P7 and the gain by P8. The output OP3B(7) passes via R73 and P21 to OP4D(13) where it is added to the signal from 4f1.

Front Cord Displacement: The front cord displacement is carried out electrically on these machines either by the manual potentiometer 4f4 or the laser potentiometer 1f27. (Laser equipment is not completely fitted but the machine are wired for laser equipment.

The manual signal from 4f4 (50mV/mm positive for displacement to right) is fed into printed circuit 4u5 at terminal 6b via R54 the signal goes to OP5A(3). The output OP5A(1) is taken to terminal 8, and display 4u2(1) to show manual displacement and via R55 to OP5B(6).
The laser input from, 1f27 (23, 1mV/mm, negative for displacement to right) is fed into terminal 10d and via R64 to OP6A(3). The output OP6A(1) is taken via R65 to OP6B(6) where the signal is amplified and inverted to 50mV/mm positive for displacement to right. The gain is set by P16 and the zero point by P15. If the laser lining is switched on a 24 volt feed via 4b1 is connected to terminal 2b and energizes Re3. The contact Re3/1 closes and connects output OP6B(7) to input OP5B(6) via R56 thus adding the manual and laser

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XIII: Lining Control Circuit, UNO/DUO/ CSM/3X /Unimat

Session-41: Calibration of Servo Valve, Transducers & Input Potentiometer.

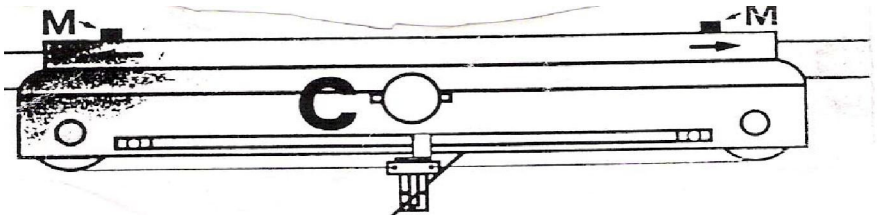
Calibration of Servo Valve: Put machine in working mode.For null adjustment of servo valve remove coupler of servo valve used in lining circuit . Then operate manual lining switch to LH side. In this condition there should be no movement in lining cylinder i.e. lining cylinder should not operate if there is any movement in lining cylinder it's mean null of servo valve is disturb.

To calibrate the servo adjust Allen bolt of servo until movement of cylinder stops.

Now operate the manual lining switch RH side and watch movement of lining cylinder and there should be no movement if there is movement then adjust Allen bolt of servo valve until movement stops.
After null adjustment fit the coupler of servo valve.

Electrical Null adjustment of Servovalve: Put machine in working mode and keep deflection of lining galvanometer on zero keeping fork of lining transducer and measuring transducer at zero lining potentiometer and slew potentiometer should be at zero now operate lining without tamping by pedal switch and watch movement of lining cylinder there should be no movement if there is any movement then adjust P3 in EK349LV until movement stop.

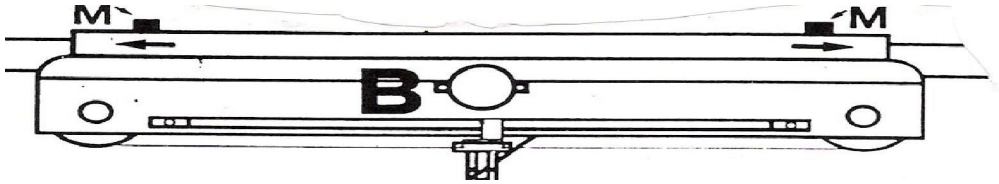
Calibration of Lining Transducer: Lining transducer converts actual versine H1 of track to electrical signal at the rate of 23.1 mv/mm –ve if cord is deflected to RH side and +ve for LH side.



For calibration of lining transducer keep fork of lining transducer at zero lock select **F01** in multicheck then display of multicheck should show 0v, if it is not showing zero volt then loosen the screw of potentiometer and rotate potentiometer to get zero volt . After adjustment tightened the screws of potentiometer.
Before calibration of transducer voltage applied to potentiometer should be checked .It should be +10V and –10V. If there is any variation, then adjust +10v and –10v in EK813SV.

Calibration of Measuring Transducer: Measuring transducer converts **H2** value of versine to electrical signal at the rate of **23.1 mv/mm +ve for RH side and –ve for LH side.**

Calibration procedure of measuring transducer is same as lining transducer but for checking of signal of measuring transducer, multicheck address F02 should be selected and 4 Pt. lining should be ON.



Calibration of Versine Potentiometer(4f1): This potentiometer converts versine value to electrical signal at the rate of 50mv/mm +ve for RH side and –ve for LH side.
For calibration of versine potentiometer select Multicheck address **F00**. Select "0" value in versine potentiometer then output voltage of versine potentiometer should be zero on display. If not , loose the screw of digital counter and take out the counter and now rotate shaft of potentiometer to get zero volt on display. Now set all digits to zero of counter then fit counter on shaft of potentiometer.When voltage of versine potentiometer is checked at multicheck address F00 then polarity will be –ve for RH and +ve for LH side.
Before starting calibration +10V & -10V to this potentiometer should be checked and adjusted by potentiometer P1 & P2 in EK 813SV of front input .

Calibration of Slew Potentiometer(4f4): This potentiometer is provided in front cabin on panel B4.This potentiometer converts slew value to electrical signal at the rate of **50mv/mm** +ve for RH side and –ve for LH side. For calibration of this potentiometer , keep slew potentiometer at zero position then output voltage should be zero, if not then take out the knob of potentiometer then rotate the shaft of potentiometer to get zero volt. Then by matching the knob at zero position fit on shaft of potentiometer. When voltage of slew potentiometer is checked at multichecked address **F06** then polarity will be –ve for RH and +ve for LH side.
Before starting calibration +10V and –10V should be checked . If there is any variation then adjust by P1 & P2 in EK813SV of front input .

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XIII: Lining Control Circuit, UNO/DUO/ CSM/3X /Unimat

Session-42: Calibration of Lining PCB, Troubleshooting & Fault finding

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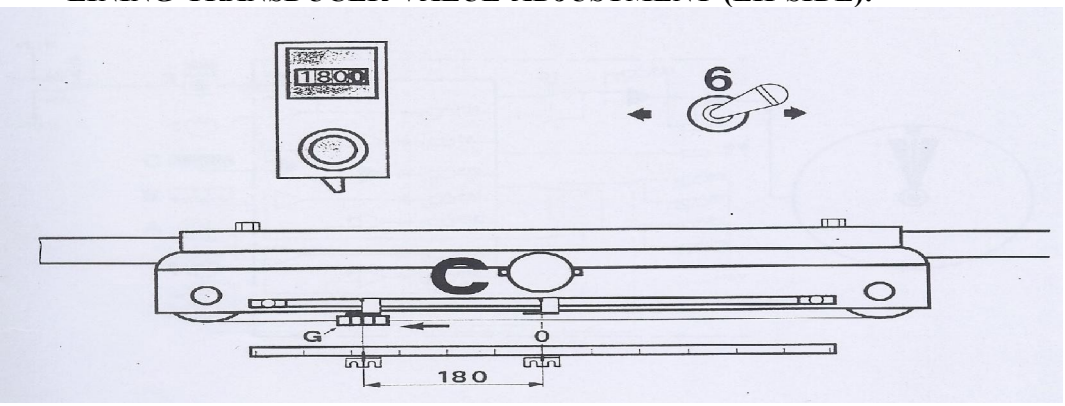
CALIBRATION OF LINING PCB EK349LV:

The calibration procedure of EK349LV is explained below:

- Before starting calibration inputs in front cabin slew and versine potentiometer should be kept on zero.
- Zero adjustment potentiometer should keep on zero.
- Satellite should be locked at front zero position.
- Datum potentiometers P5 to P8 should keep at center.

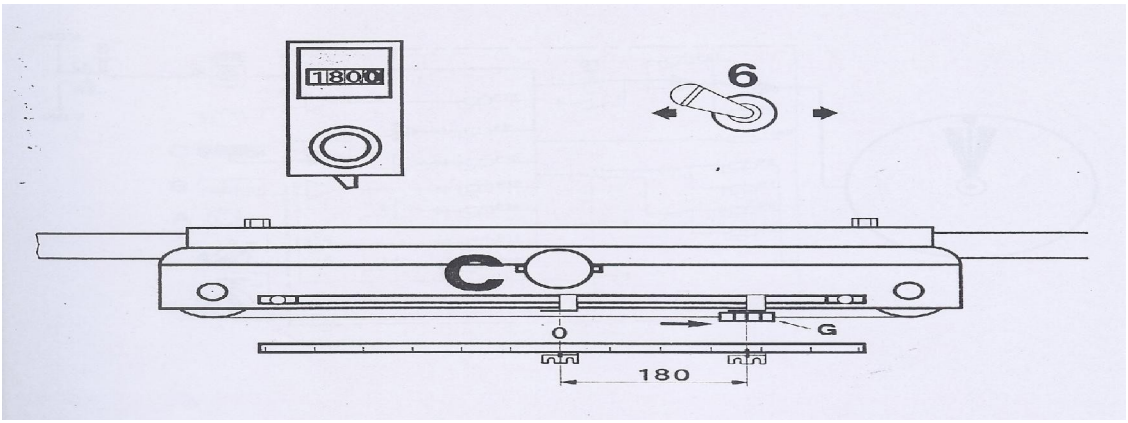
1. LINING TRANSDUCER VALUE ADJUSTMENT (LH SIDE):



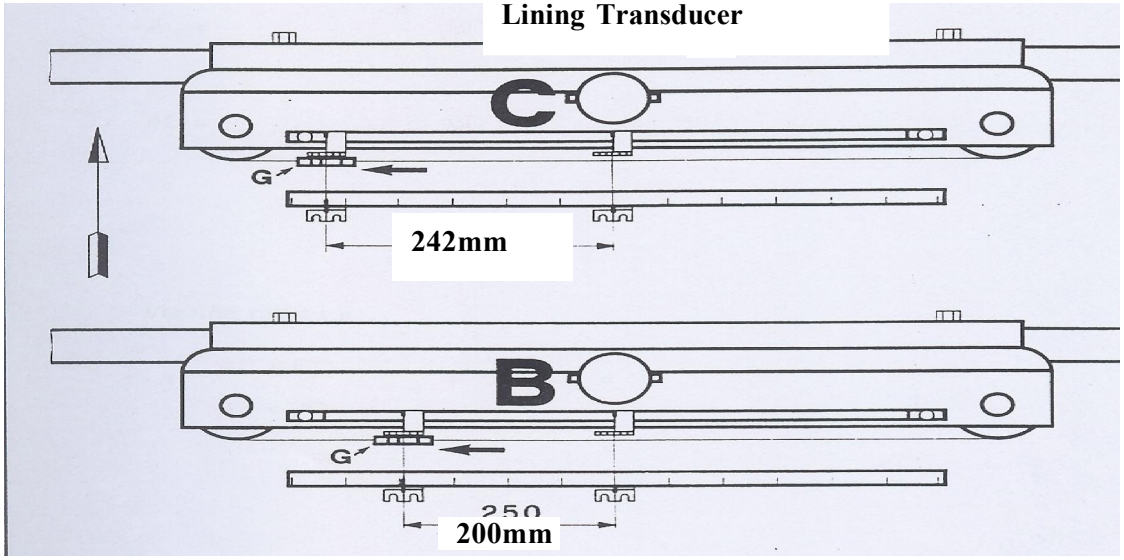
3-point lining should be ON.Set 180 mm Value in versine potentiometer and turn toggle switch to RH side in front cabin.Now keep the fork of lining transducer at 180mm in LH direction. Deflection of lining galvanometer should be zero if not then adjust potentiometer P10 to get pointer of galvanometer at center(zero).

2. LINING TRANSDUCER VALUE ADJUSTMENT (RH SIDE):

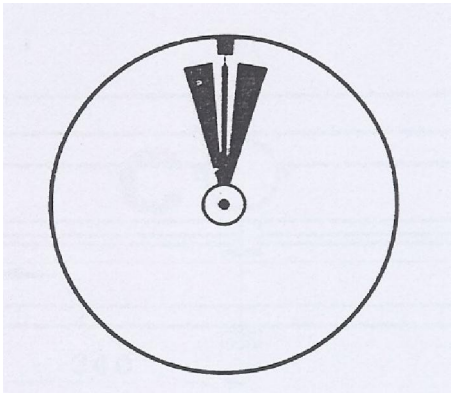
Now turn direction of toggle switch of versine potentiometer towards LH side. Keep fork at 180mm in RH direction then deflection of pointer should be zero if pointer is not at zero then adjust by P9 to get deflection of pointer at center(zero)



3. VERSINE RATIO ADJUSTMENT (LH SIDE):



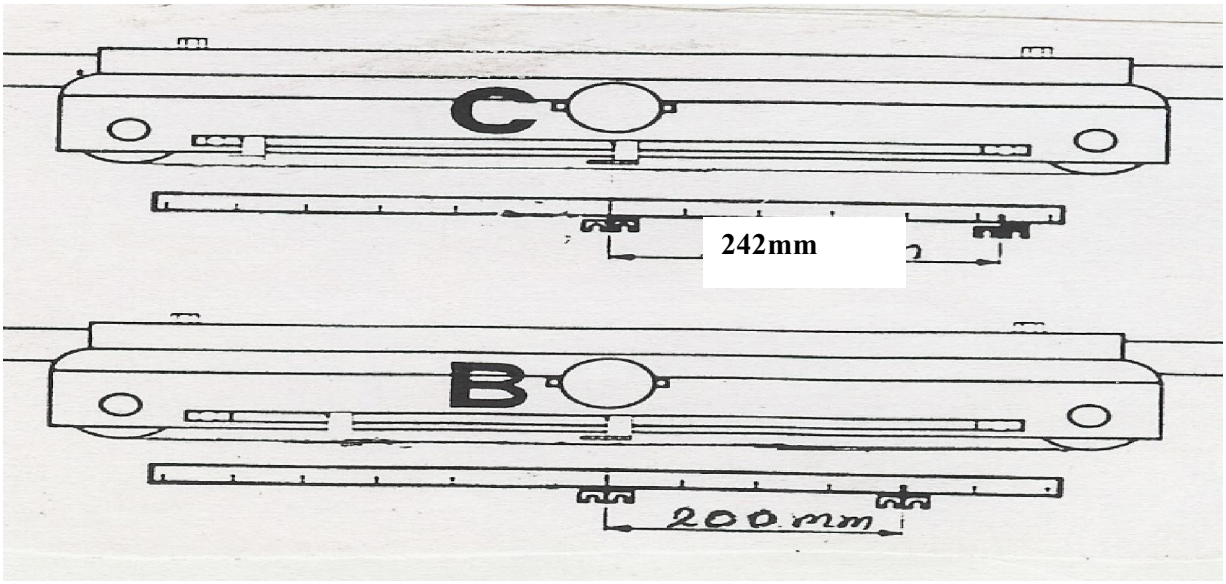
Meas



VERSINE RATIO ADJUSTMENT (RH SIDE):

Select 4- point lining.

- Move fork of measuring transducer LH side and keep at 200mm
- (H_2 = 200mm)
- Now keep fork of lining transducer at 242mm in same direction .
- (H1 = ixH2)
- (H_1 = 1,21 x 200 = 242mm)

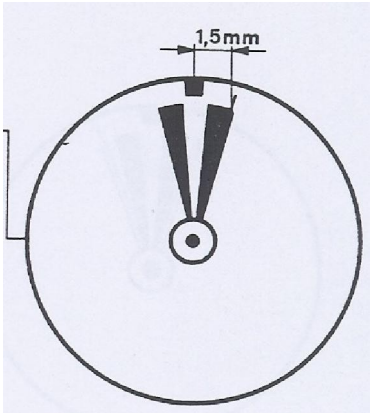


- Move fork of measuring transducer RH side and keep at 200mm.
- Now move fork of lining transducer and keep at 242mm in same direction.
- In this condition deflection of galvanometer should be at center, if not adjust P14 to get deflection at center.

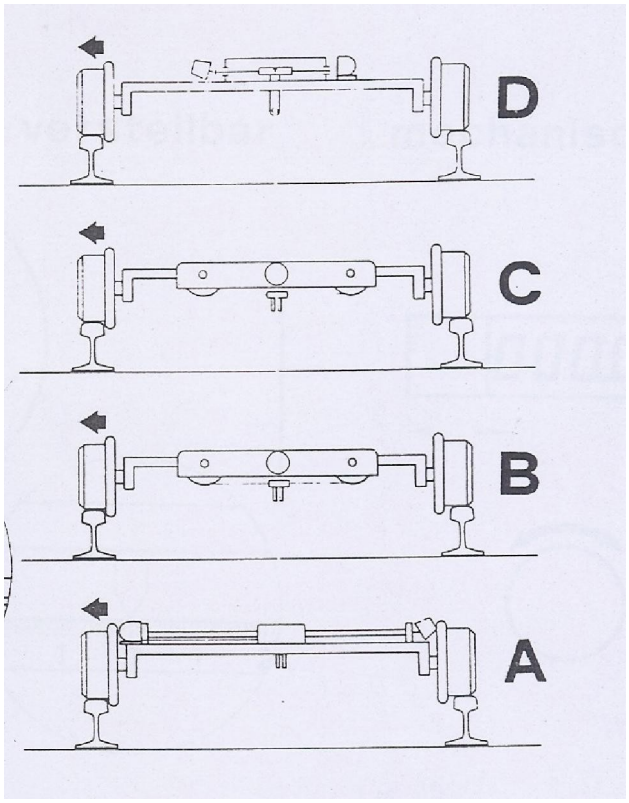
ZERO ADJUSTMENT POTENTIOMETER CALIBRATION: For calibration of zero adjustment potentiometer (2f24) turn it anti clock wise (Red zone) upto 5mm. Now feed 5mm in versine potentiometer and turn toggle switch to left side. Lining galvanometer should indicate zero. If pointer is not at center then adjust **P16**. Untill galvanometer indicate zero.

LINING GALVANOMETER POINTER DEFLECTION ADJUSTMENT:

Feed 1.5mm in versine digital potentiometer and turn toggle switch to LH direction. Now adjust potentiometer **P4** to move pointer to the end of the right side red zone.

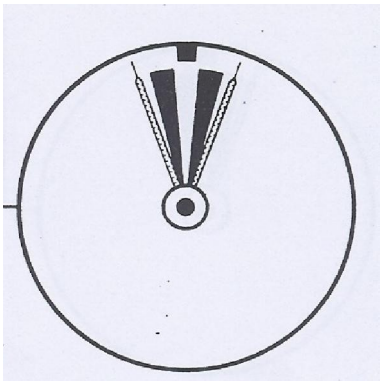


DATUM ADJUSTMENT:



After above all calibration datum adjustment should be done. In which we compensate the small error due to wear & tear of wheels of different trolleys, i.e. lining trolley measuring trolley etc.

During working datum has to be applied LH side or RH side. So both side datum adjustment should be done one by one in 3- point and 4 -point lining.



LH DATUM ADJUSTMENT: For datum adjustment machine should be bring on good track put machine in working mode in 4- point lining and apply LH side datum and move machine forward and watch deflection of lining galvanometers. Pointer of galvanometer should be deflect around zero. If there is only one side deflection then potentiometer **P8** in PCB EK 349LV should be adjusted to get proper deflection of pointer around zero.

Now select 3- point lining in same datum and move machine then in this case pointer should deflect around zero if it is one side deflection then adjust **P6** to get proper deflection of pointer around zero.

RH DATUM ADJUSTMENT: Now apply RH datum and select 4 point lining. Now move machine and watch deflection of pointer. It should deflect l around zero if not adjust **P7** to get proper deflection around zero.Now select 3-point lining. Now move machine and watch deflection of pointer. It should deflect around zero if not adjust **P5** to get proper deflection around zero.

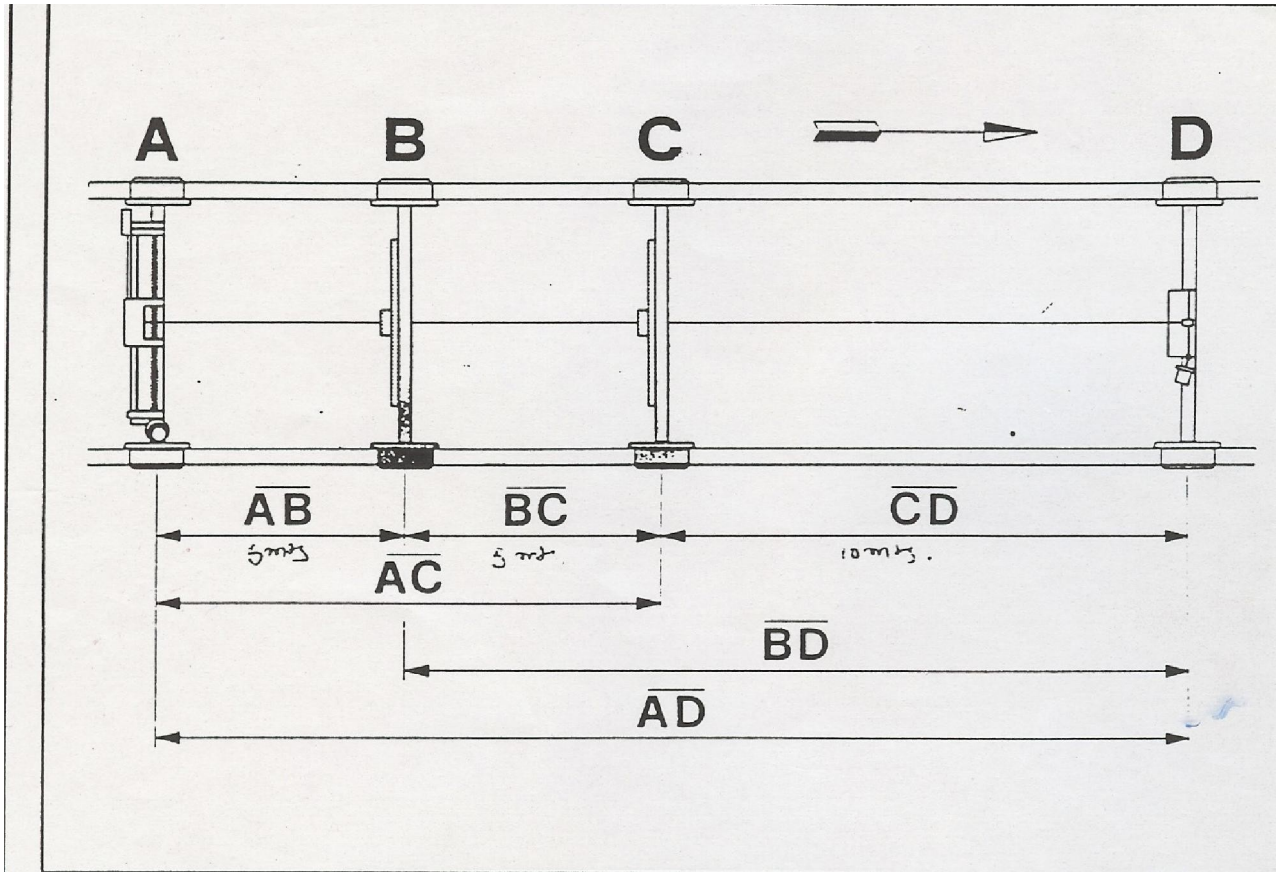
CURVE CORRECTION: For curve correction adjustment machine should be bring on high cant curve i.e. 150mm. (LH high) select-3-point lining. Apply Datum accordingly and feed value in versine potentiometer to get zero deflection of lining galvanometer . Now feed 2mm in zero adjustment potentiometer anti clock wise (Red zero) in this case pointer of lining galvanometer will deflect. Now bring it to zero by adjusting potentiometer **P19** in EK349LV.

MECHANICAL ADJUSTMENT OF BOGIES:

08-series and 09-series Machines are equipped with single cord lining system. Machine can work in 3-point mode and 4 point mode.

In CSM and 08-series machines in 3-point lining. three trolleys are used and in 4 -point lining 4 trolleys are used.

DISTANCE BETWEEN DIFFERENT TROLLIES OF CSM:



CSM:

AD	=	$20.75M_1$	CD	=	10.15M
AC	=	10.5M	BC	=	4M
AB	=	6M	BD	=	14.75M

$$H_1 = \frac{AC \times CD}{2R}$$

$$H_2 = \frac{AB \times BD}{2R}$$

$$\text{Versine Ratio } i = \frac{H_1}{H_2} = \frac{AC \times CD}{AB \times BD} = \frac{10.6 \times 10.15}{6 \times 14.75}$$

i = 1.2157

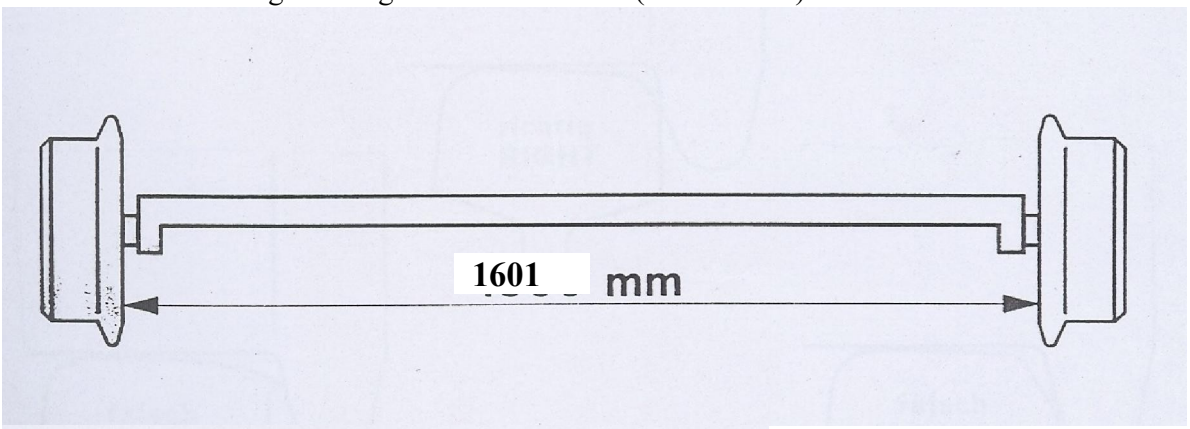
Versine ratio depends upon distance between bogies since these.
Distance are different for different machine therefore versine ratio is also different for different machines.

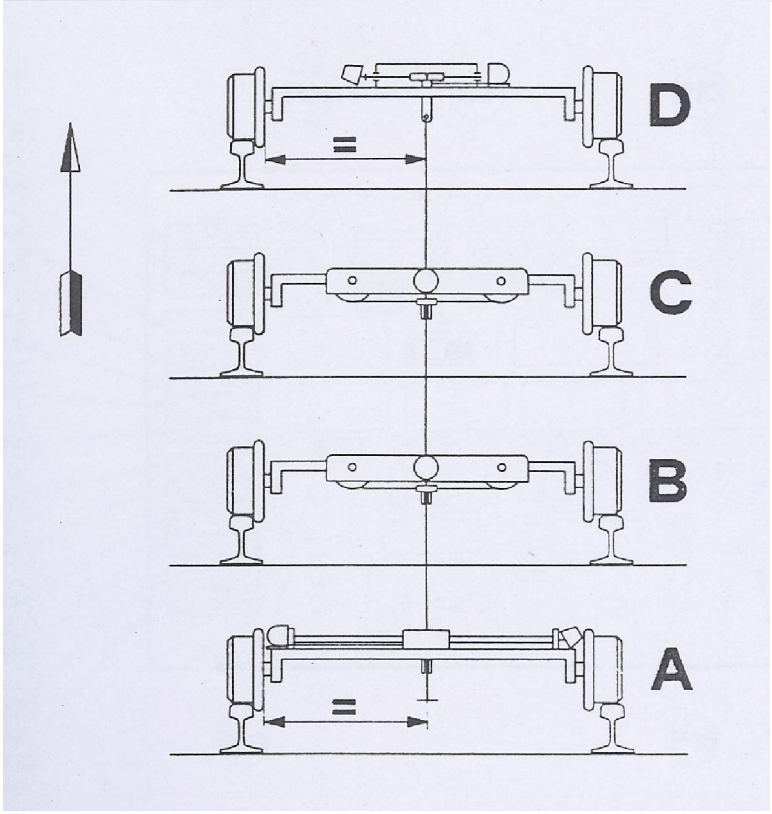
UNOMATIC/DUOMATIC: i = 1.33

UNIMAT 2S: i = 1.33
UNIMAT – 3S : i = 1.6
CSM-3X: i = 1.49

DISTANCE BETWEEN FLANGES OF WHEELS OF BOGIES:

Distance between flanges should be gauge-75mm since broad gauge is 1676mm. Therefore distance between flanges of bogies Should be 1601 (1676-75mm).





Since distance between flanges of bogies Should is1601 (So Centre of these bogies should be at 800.5mm .

So in front bogie and rear bogie lining chord should be fix at 800.1mm from flange . Centre position of lining transducer and measuring transducer should be at 800.5mm from flange of bogies .

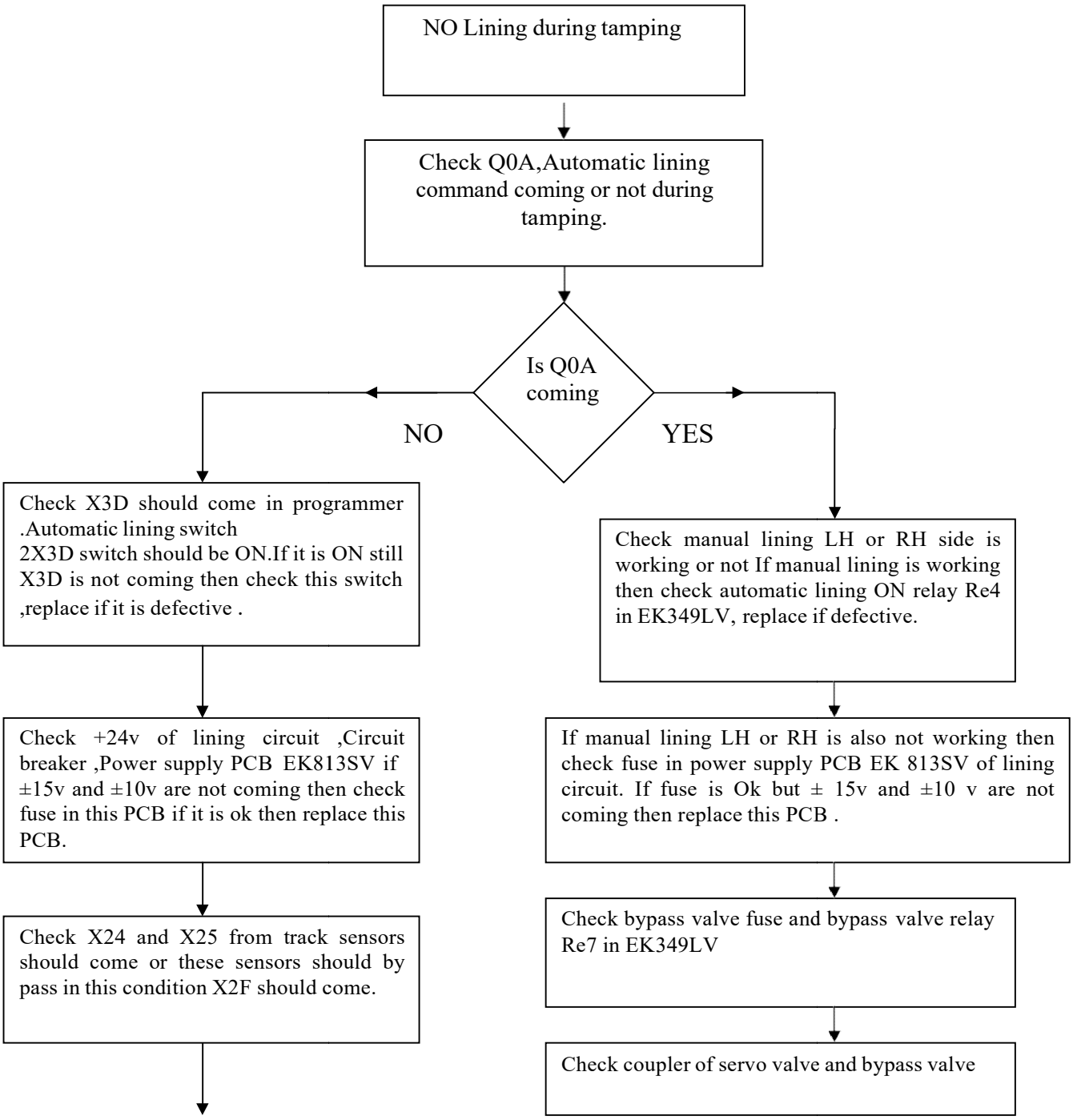
If there is variation in distance (1601)mm between flange of wheels then shim should be provided in wheels two maintain this distance.

This distance should be maintain in all bogies.

.

MECHANICAL ADJUSTMENT OF LINING TRANSDUCER AND MEASURING TRANSDUCER: Transducers should be mounted in such way that centre position clamp of transducer should be at centre(800.5mm). There is a scale in mm mounted on lining transducer and measuring transducer which has range 400mm-0-400mm. This scale should be fitted in such a way that it's 0-mark should be at centre of distance between flange of wheel i.e at (800.5mm). If transducer is not at centre then loose the mounting bolts of transducers and shift until correct distance is achieved from flange, tighten the screw after adjustment. If scale also is not at centre then loose the bolt of scale and shift to achieve correct centre position.

TROUBLE SHOOTING FLOW CHART OF LINING CONTROL CIRCUIT OF CSM



Check X30 should come. This is from switch 2X30 which enable lining and leveling in middle position of tamping unit.

Check X4E or X4F left side datum or right side datum should applied.

1. Manual lining Lh side is not working

Check X3B in programmer when operating manual lining switch, if not coming then replace this switch

Check manual lining LH relay Re5 in Ek349LV replace if defective

2. Manual lining RH side is not working

Check X3C in programmer when operating manual lining switch, if not coming then replace this switch

Check manual lining LH relay Re6 in Ek349LV replace if defective

3 . Left side datum not working .

Check X4E in programmer if not coming then check datum switch , replace if defective .

If X4E is coming then check Relay QL38 and fuse ,replace which is defective

If Relay QL38(7002/S4) and fuse is OK then check coupler of datum pneumatic solenoid (1s270), if coupler is ok then check solenoid , repair/replace if defective .

Check deflection in servo indicator if pointer is not deflecting during tamping then PCB EK349LV may be defective replace it. If pointer is deflecting but no lining then servo valve may be defective replace it.

4 . Right side datum not working .

Check X4F in programmer if not coming then check datum switch , replace if defective .

If X4F is coming then check Relay QL39 and fuse ,replace which is defective

If Relay QL39(7002/S4) and fuse is OK then check coupler of datum pneumatic solenoid (1s271), if coupler is ok then check solenoid , repair/replace if defective .

5. No deflection in lining galvanometer when switch

ON the lining system and giving deflection to lining

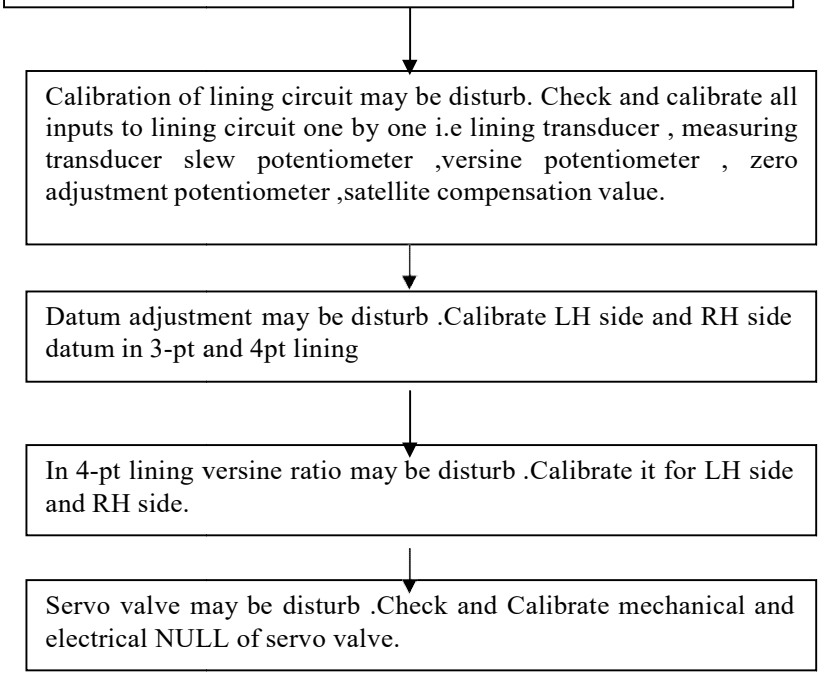
Check +24v of lining circuit ,Circuit breaker Power supply PCB EK813SV if ±15v and ±10v
are not coming then check fuse in this PCB if it is ok then replace this PCB.

Check somebody has shifted the position of switch S1in the PCB EK349LV which is used to isolate the output circuit from input .

Check somebody has shifted position of switch S1 in over slew PCB EK290LV, which is used to ground the signal of lining transducer .

Check connection of lining galvanometer if it is OK then lining galvanometer may be defective replace it.

6. In 3-pt. and 4pt. Lining machine is not doing lining



SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XIV: Front Input Circuit: UNO/DUO/ CSM/3X /Unimat

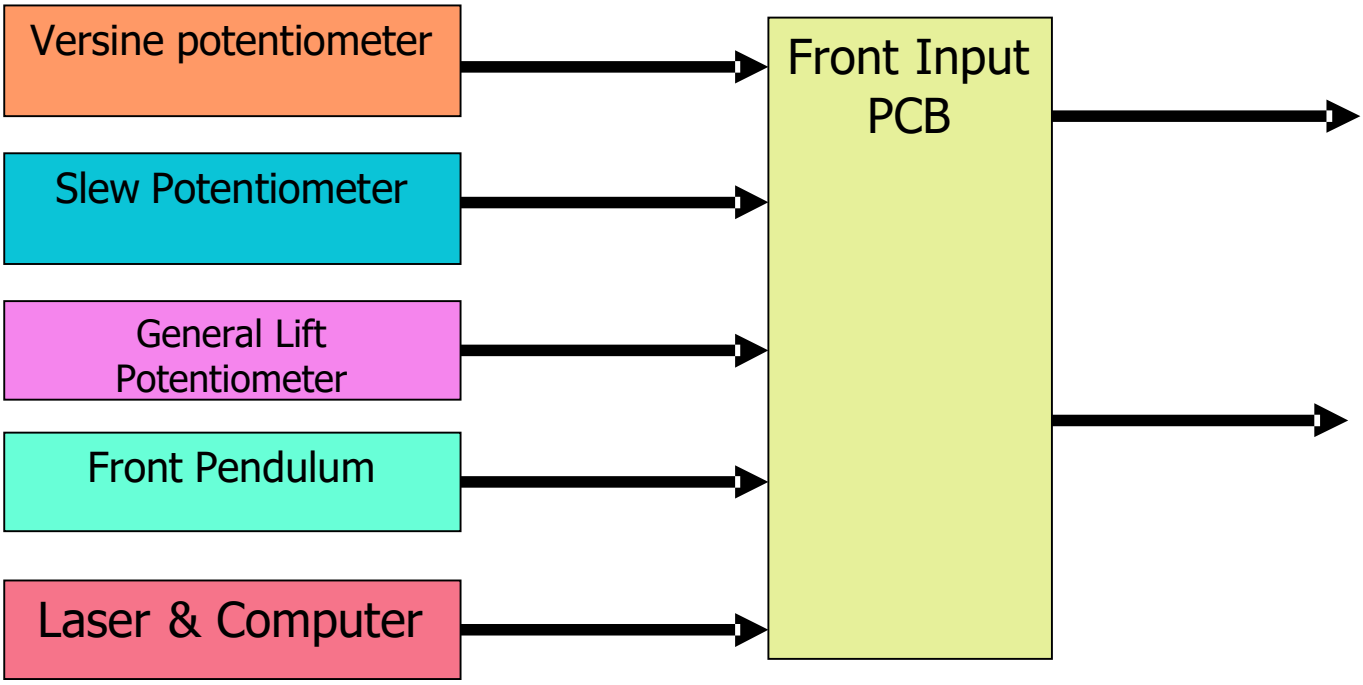
Session-43: Functional Description of Front Input Circuit, Front Input Potentiometer, Slew, Versine, General Lift etc.

Front Input Circuit :-This circuit receive inputs from front cabin and transmits to lining & levelling circuit.The parts of front input circuits are as under:-

- Input potentiometers :-Versine,Slew,General lift potentiometers.
- Front Pendulum.
- Front Input PCB.
- Laser lining.
- Computer(ALC, GVA)

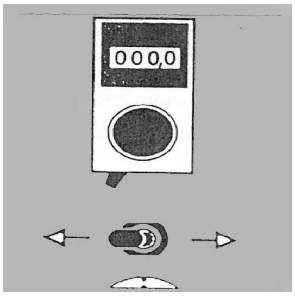
Front-input PCBs :

- UNO/DUO/ :-EK 17/255/275LV00
- CSM :-EK 345LV00.
- UNIMAT2S/3S :-EK 2072LV00
- 09-3X :-EK 2343LV00



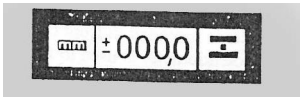
INPUT POTENTIOMETERS IN FRONT INPUT CIRCUIT:

(i) VERSINE POTENTIOMETER:



This potentiometer is provided in front cabin in panel B4 .This potentiometer is used to feed versine value in 3-pt lining and Vm value in 4-pt lining . This potentiometer converts versine value to electrical signal at the rate of 50 mv/mm, + vc for RH side, -ve for LH side.

(ii) SLEW POTENTIOMETER :



This potentiometer is also provided in front cabin in panel B4 .This potentiometer is used to feed slew value . It converts slew(Offset value in design lining) value into electrical signal at the rate of 50 mv/mm +ve for RH side and –ve for LH side.

(iii) GENERAL LIFT POTENTIOMETER:

GENRALLIFT POTENTIOMETWER

This potentiometer is provided in front cabin in panel B4. It is used to feed genral lift value. It converts general lift value to electrical signal at the rate of 50 mv/mm +ve for lifting.

Lesson-XIV: Front Input Circuit: UNO/DUO/ CSM/3X /Unimat

Session-44: Basic idea of ALC, GVA and Laser Lining

ALC:INTRODUCTION:-

Win ALC is the next generation of the well proven Plasser "ALC" track alignment computers. Since the first Plasser PC MSDOS based "ALC" was introduced in 1992 approximately 300 units have been fitted to machines world wide. The program is not tailor made for one specific country but contains all the main elements for world wide applications. The program for the "ALC" has constantly been updated from the first edition with new features being added as an ongoing situation. The PC based "ALC" program had been taken to the limit of the MASDOS operating system so it is a natural progression to change the operating environment to WINDOWS 95, this removing the restrictions of the MSDOS memory limitations and enabling a multi tasking environment that will be already familiar to the majority of people today.

The "Win ALC" system is designed as an addition to enhance and improve the existing PLASSER tamping machines lining and lifting systems. It can be fitted as a bolt on to an older machine or normally is fitted when the machine is built.

TECHNICAL DESCRIPTION OF SYSTEM:

The WIN-ALC system comprises of 4 distinct main parts:

1. The Computer or PC
2. The Display or Monitor
3. The keyboard (also fitted with the pointing device, the mouse)
4. The distance measuring wheel or encoder

Technical data:

System unit
PLASSER Built Dedicated PC :Intel Pentium 100 MHZ
16 Mbytes Memory
70 Ns Starting time
3 ½'1.44MB Floppy Disc drive
959 MB IDE-BUS

WORKING IN GEOMETRY, MEASURING RUN.

The "ALC" has two methods of enhancing the tampers track alignment systems. "Geometry" method and the "Measuring and compensation" method. In the geometry method the target track geometry is entered into the computer along with design data. For this method of working the exact design and geometry information must be known. A measuring run is not carried out as the computer will automatically input the correct lining and lift information calculated from the data entered.

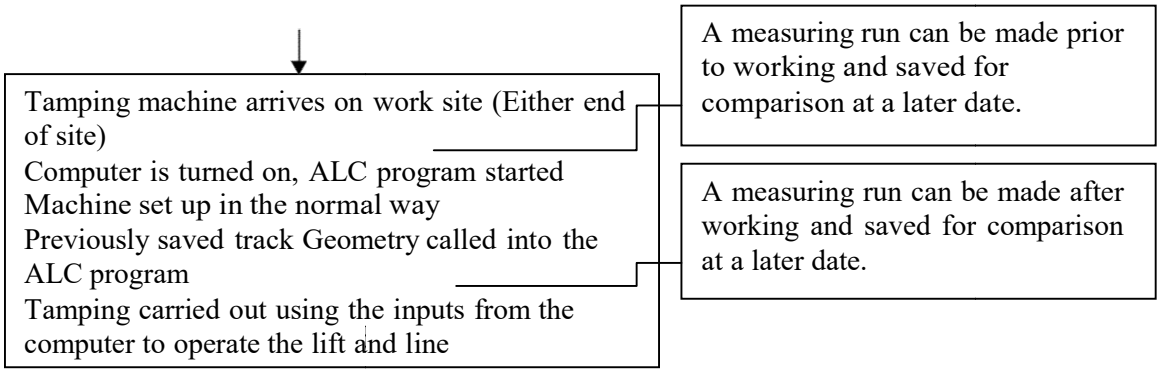
The "Measuring" method is used where the track data is not known.The data for the track is obtained via a measurement run using the machines measuring system prior to working. During or after the measurement any data that is known can be entered e.g. fixed points, cant, radii, etc. After computation by the "ALC" computer the tamper is set to work with the "ALC" automatically entering the computed lift and line data.

ALC Geometry Method: The geometry method of operating the "ALC" is used when all of the target data for a section of track is known. The data is loaded into the computer at any time prior to work. A measuring run is not used in calculations as all data has been entered, although measuring runs can be made before and after work as a benchmark.

Sequence of Operation

BEFORE ARRIVING AT WORK SITE (preferable) Obtain site details, geometry, location etc. Enter site geometry into a computer running the

Win ALC program



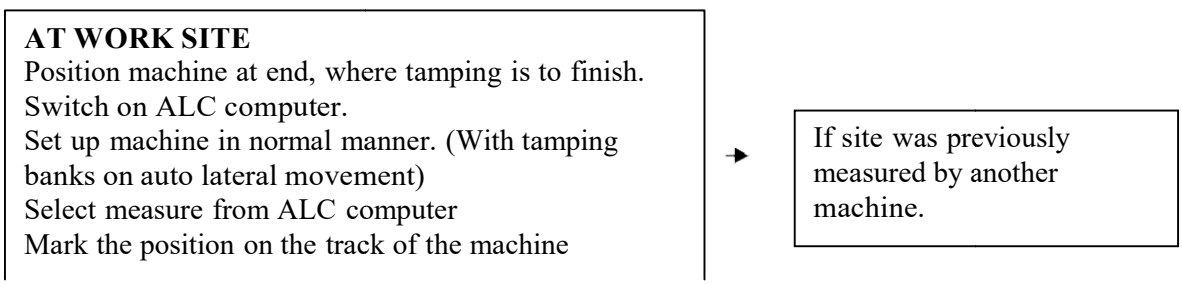
THE "MEASURING" METHOD : The measuring method is used where the track data is not known. The data for the track is obtained via measurement run using the machines measuring system prior to working. During or after the measurement any data that is known can be entered e.g. fixed points, cant, radius, etc. After computation by the "ALC" the tamper is set to work with the "ALC" automatically entering the computed lift and line data.

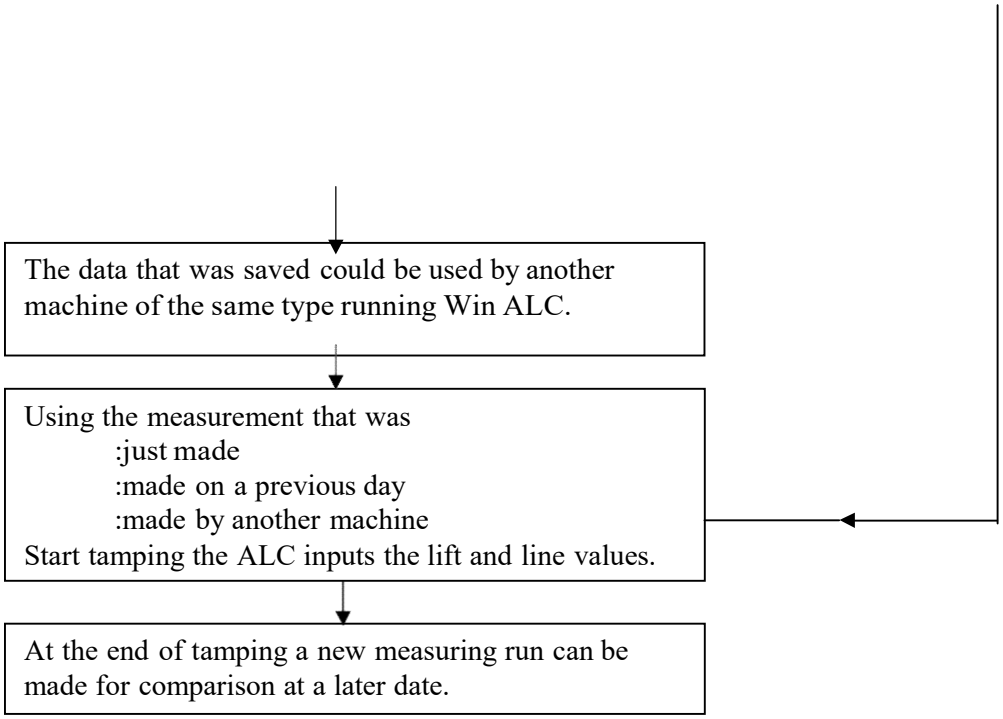
Sequence of Operation: The machine can either measure in the working direction or in the reverse. If the track is measured in the working direction, the tamping machine must reverse back to the start of the work site before commencing tamping. There is a "fast measuring drive" key switch on the front and rear driving desks. These enable the machine to use the second gear of the main drive to make the measuring run.

Performing a Measuring Run: The machine is set up for normal working, although this is not necessary to have the tamping banks running. The tamping banks slew switch on the B2 panel should be set to automatic. If it is on manual the fast measuring function will be disabled. It is advisable to drive the machine for a short distance using the normal working drive. Thus checking that the lifting and lining system is in working order before the start of the measuring run by avoiding errors at the start of the measuring run, due to poor bogie alignment or incorrect pre-loading. It is important to select the correct float rail. If the wrong rail is selected, the design for the lift will not be correct. It is also a good idea to mark the position of the machine on the rail before the start of the measuring run, so that the machine can be repositioned accurately at the start position after the measuring run has been completed (Forward measuring run). The lining system has to be set to 3-point. Use the can switch to select the datum rail for the longitudinal height recording. The reference rail for the versine recording is selected by turning on the lining system and selecting the required pre-load.

End of Measuring Run: At the end of the measuring run return the key switch to the normal position. The computer will automatically produce a "run in from" the old track geometry to the new target geometry at the beginning and end of the measuring run. The measuring run should therefore only cover the length of rail on which the work has to be carried out.

Sequence of Operation





Laser Lining System in CSM & 09-3X:

09-3X machine is provided with a laser lining system that can be used to extend the measuring system on straight track. Laser lining is used on straight track in 3-Pt mode to remove long misalignment or false curve. The laser system consists of laser gun and laser receiver. The laser trolley which consists of laser gun is placed in front of the machine up to 300 meter(200m in CSM) away. The receiver on the machine is adjustable so that it follows the laser beam and the position is detected by a transducer that provides an input to the lining system equivalent to the off set of the front end of the cord. As the machine is working it moves up to the laser trolley until the distance is a minimum of 20 meters away

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XIV: Front Input Circuit: UNO/DUO/ CSM/3X /Unimat

Session-45: Functional description of Front Input PCB EK345LV, EK2072LV etc. Calibration, Troubleshooting & Fault finding

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PCB EK345LV: Lining Cord Displacement: The lining cord on this machine is fixed at the front and rear tightening trolleys. To simulate the movement of the cord, a potentiometer 4f4 (IOK) is fitted, which is operated by a knob mounted on a disc. The potentiometer is supplied with + 10 volts (E52) on terminal 1. Turning 4f4 to the right, simulates movement of the

cord to the right feeding in a signal of +50 mV/mm (-50 mV/mm for the left) into P.C.B. 4u5 on terminal 6b. The input is buffered by amplifier OP5A, and is passed to terminal 8z at +50 mV/mm (for the right) which passes to P.C.B. 4u2 on terminal B. Moving the switch to position 4, passes the signal to gauge 4g2 where it is displayed. The output of OP5A also passes to OP5B (inverter), the output of which at – 50 mV/mm (to the right) passes to the input of OP5C(9). The output of OP5C(8) at + 50 mV/mm is fed to OP5D(13) which inverts the signal to –50 mV/mm (to the right) which connects to terminal 8b. Terminal 8b connects two ways:

1) To terminal E of 4u5, which is displayed on 4g2 with the switch in position 1.
2) To terminal E48, which can be seen on the multiplex F06, From E48, the signal at – 50 V/mm (to the right) passes to the satellite compensation card 10u1 (EK-3.48-LV-00) on terminal 28b which passes to terminal 28z via Re3/1 contact. Terminal 28z of 10u1 is connected to the lining analogue control P.C.B. 10u2 on terminal 24b.

Cross Level and General lift Setting: Terminal E26 connects to the front analogue input interface 4u5 on terminal 16z (EK-345LV-02) which passes the +50 mV/mm signal to OP8B which inverts it to –50 mV/mm. The output of OP8B(7) passes to terminal 28d, and onto E23 which connects to PCB 33u1; by turning the switch to position 2, the signal is passed to display 33g5 which shows the theoretical cross level.The output of OP8B(7) at –50 mV/mm also passes to OP8C(9) and to the contact of Re5. As switch 2b32 is set to the left hand high rail position, the 24 supply at N13 connects to terminal 18z of 4u5; relays Re5 and Re4 are energized. Therefore the contact Re5/2 contact is closed and Re5/1 is open, and so the –50 mV/mm output of OP8D(7) passes to OP8D(13) via Re5/2 contact.The front pendulum 1f13 feed in a signal of –25 mV/mm (left hand high rail) to PCB 4u5 on terminal 12b, which is inverted by OP6D and amplified, to +50 mV/mm. The signal passes to OP8D(13) where it joins the signal from the cross level digital, which is –50 mV/mm. Therefore if the theoretical cross level set by the digital is the same as the cross level under the tower, the two inputs cancel each other out.The output of OP8D(14) will depend on the input; if the inputs cancel each other out the output is 0 volts, which passes to the display via terminal 16d, -E28 – 33u1 position 1 – to 33g5.The output of OP8D(14) also passes to pin 4 of relay Re4, which is energized, and therefore passes through Re4/2 to OP4B, which is negative if the rail is too high. OP4B inverts the signal and passes it to amplifier OP4A which inverts it again. The output of OP4A(1) connects to terminal 28z, and then onto the left hand levelling PCB 6u2 via terminal E47.As the machine is set up, terminal 28z is negative, i.e. in the no lift position as shown on the lift gauge 19g3 and 33g2, ready to run in the lift for the left hand side (floating rail).The basic lift is set using potentiometer 4f3 which feeds in a signal of 50mv/mm into PCB 4u5 (EK-345LV-02). This signal is positive for lift, and as the previous shift the lift would have been run out, to bring the lift gauge towards the centre, the potentiometer is turned passing a more positive signal into the PCB.This signal passes to OP1A (buffer) and to OP13, where it is inverted and passed to OP1C where it is inverted back to 50 mV/mm. The output of OP1C(8) connects to terminal 22b which connects to terminal E55; this terminal connects to both lifting PCB i.. 6u2 for the left (floating rail) and 6u3 for the right (datum rail).
The tower end is now set, with the lift gauges just past the centre in the no lift position ready to run in the lift.

PCB EK2072 LV-02: Cross Level:

Pendulum:
The cross level at the front tower is measured by the pendulum 1f13 and the signal at 25mV/mm of cross level (negative for left hand high rail) is fed into printed circuit 4u5 at terminal 12b and is taken via R42 to OP6D(13) and added to the offset from P25 (used for zero calibration) and R41. The output OP6D(14) is inverted and the signal increased to 50mV/mm of cross level (left hand high rail now positive). The output OP6D(14) is taken via terminal 12z to the display 33u1 and via R45 to OP8D(13).

Required Cross Level: The required cross level is set with potentiometer 4f5 and the signal of 50mV/mm (positive for positive cant) is fed into 4u5 at terminal 14b and viaR53 to OP8A(3). The output OP8A(1) signal passes via P22 and R52 to OP8B(6) where it is added to the signal from the GVA output via terminal 16z, R51 and P24 (normally only one is used). The input OP8B(6) can be zeroed using P23.The output OP8B(7) is inverted and fed to display 33u1 via terminal 28d, R35/2 and OP8C(9) via R48.If switch 23b3 is set to left hand high rail terminal 18z will be connected to 24V and Re5 energized. Therefore Re5/2 is closed and the output from OP8B is taken directly to OP8D(13) via R46 (signal strength 50mV/mm negative for position cant).

Cross Level Error: At OP8D the signals from the pendulum and required cross level are added together.If the actual cant and required cant are equal the two signals will be of the same voltage but of different polarity. Therefore the output will be zero.

Should the actual cant and required cant be different (cross level error) there will be an output at OP8D(14) of signal strength 50mV/mm (negative if the left rail is too high) and this is displayed on 33u1 via terminal 16d.The output also passes to Re4/1 and Re4/2.

Basic Lift Setting: Unlike previous machines the front end of the front end of the card is fixed and basic lift is applied proportionally to the lift transducer.The basic lift set on potentiometer 4f3 is fed into 4u5 at terminal 20d (50mV/mm, positive for lift) and via R1 to OP1A(3) the output OP1A(1) is taken to display 4u1 via terminal 20b (where the manual lift can be displayed) and OP1B(7) is inverted and is taken to display 4u1 via terminal 22d to display manual and laser lift, at a strength of 50mV/mm negative for lift, and via R6 to OP1C(9).

At this point the GVA lift from terminal 24d R5 and P2 is added to the output of OP1B. P1 can be used to zero the input of OP1C. The output OP1C(8) is inverted (now 50mV/mm positive for lift) and is taken via terminal 22b to 4u1 to indicate complete lift and via R10 to OP1D(13). Output OP1D(14) is again inverted and the signal taken to terminal 22z, which is connected to terminals 28b and 32z.From terminal 28b this signal passes via R30 to OP4A(2). If left hand high rail is selected Re4 will be energized and the cross level error signal from OP8D(14) will pass via Re4/2, and Re5 to OP4B where the signal is inverted. The output passes via R33 to OP4A(2) where it is added to the basic lift signal. The inverted output OP4A(1) is taken via terminal 28z to the left hand lift circuit 10u6 at 50mV/mm positive for lift.

The signal from terminal 32z is taken via R36 to OP4C(9). The output OP4C(8) is inverted. Because Re4/1 is open the cross level error does not affect this signal. The output passes via terminal 30z to the right hand lift circuit10u7. Basic lift is therefore put onto the opposite rail to that selected as the high rail and the cross level error appears on the high rail.

If right hand high rail is selected Re4 will be de-energized and the cross level error is taken via Re4/1 and R39 to OP4C and is added to the basic lift. The output is taken to the right hand lift circuit. The signal to the left hand lift circuit is not affected by the cross level error.

Front Tower Lining:Digital Input:

The direction switch 4b4 has to be correctly set for the direction of the curve. For right hand curves 4b4 connects the digital potentiometer 4f1 to the +10 volt supply and the –10 volt supply for left hand curves. A signal of 50mV/mm (positive for right hand curves) is taken from 4f1 to terminal 8b of 4u5. The signal passes via R72 to OP6C(10). The output OP6C(8) is taken via R31 to OP4D(13) where the inverted signal from OP4D(14) passes to terminal 30d. This terminal is connected to the lining display (4u2) to show the set versine and 10u2 terminal 20d to feed the desired versine into the lining control board.

If the GVA computer is used the output versine from the computer is fed to terminal 20z of 4u5 and via R22 to OP3A(3). The output OP3A(1) passes via R23 to inverter OP3B(6). The zero point of this inverter is set by P7 and the gain by P8. The output OP3B(7) passes via R73 and P21 to OP4D(13) where it is added to the signal from 4f1.

Front Cord Displacement: The front cord displacement is carried out electrically on these machines either by the manual potentiometer 4f4 or the laser potentiometer 1f27. (Laser equipment is not completely fitted but the machine are wired for laser equipment.

The manual signal from 4f4 (50mV/mm positive for displacement to right) is fed into printed circuit 4u5 at terminal 6b via R54 the signal goes to OP5A(3). The output OP5A(1) is taken to terminal 8, and display 4u2(1) to show manual displacement and via R55 to OP5B(6).

The laser input from, 1f27 (23, 1mV/mm, negative for displacement to right) is fed into terminal 10d and via R64 to OP6A(3). The output OP6A(1) is taken via R65 to OP6B(6) where the signal is amplified and inverted to 50mV/mm positive for displacement to right. The gain is set by P16 and the zero point by P15. If the laser lining is switched on a 24 volt feed via 4b1 is connected to terminal 2b and energizes Re3. The contact Re3/1 closes and connects output OP6B(7) to input OP5B(6) via R56 thus adding the manual and laser inputs together

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XV :Leveling & Lifting Control Circuit of UNO/DUO/ CSM/3X /Unimat

Session-46: Functional Description of Leveling Control Circuit, Transducers and Input Potentiometers

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LEVELLING SYSTEM

PCBs which are used in leveling circuit of different machine are given below:

CSM:			**UNIMAT – 2S:**		
Lifting PCB	-	EK 347 LV	Lifting PCB	-	EK 2041 LV
Front input PCB	-	EK 345 LV	Front input PCB	-	EK 2072 LV
Pendulum Control PCB	-	EK 346 LV	Pendulum Control PCB	-	EK 2042 LV
Satellite compensation PCB	-	EK 348 LV	3-Stage Lifting	-	EK 144 V
Power supply PCB	-	EK 813 SV	Power supply PCB	-	EK 813 SV
CSM-3X:			**UNIMAT – 3S:**		
Lifting PCB	-	EK 3069 LV	Lifting PCB	-	EK 2041 LV
Front input PCB	-	EK 2343 LV	Pendulum Control PCB	-	EK 2042 LV
Pendulum Control PCB	-	EK 2351 LV	Front input PCB	-	EK 2072 LV
Satellite compensation PCB	-	EK 526 MC	Power supply PCB	-	EK 813 SV
Power supply PCB	-	EK 816SV	**UNIMAT COMPACT:**		
DUOMATIC:			Lifting PCB	-	EK 2041 LV
Lifting PCB	-	EK 229 LV	Front input PCB	-	EK 3049 LV
Front input PCB	-	EK 255 LV	Pendulum Control PCB	-	EK 2042 LV
Front pendulum PCB	-	EK 217 LV	Power supply PCB	-	EK 813 SV
Middle pendulum PCB	-	EK 277 LV			
3-Stage lifting PCB	-	EK 79 V			
Power supply PCB	-	EK 813 SV			

Transducers used in leveling control circuit:

PENDULUM: Pendulum is a transducer which converts cross level error to electrical signal at the rate of 25 mv/mm –ve for LH rail high and +ve for RH rail high **.**There are three pendulums are used in CSM ,unimat 2Sand 09-3X.In other tampingmachines only two pendulums are used

Front Pendulum: This pendulum is mounted on front trolley . It measures cross level of front area before tamping.

Middle Pendulum: This pendulum is mounted on middle feeler rod . It measures cross level of tamping area .

Rear Pendulum: This pendulum is mounted on measuring trolley . It measures cross level after tamping .This pendulum participates in twist correction.

GENERAL LIFT POTENTIOMETER (4F3): This potentiometer is provided in panel no. B4 in front cabin. This potentiometer converts given general lift value to electrical signal at the rate of 50MV/MM output of this potentiometer can be checked at multicheck address F.

For calibration of this potentiometer keep general lift potentiometer on zero and check output of this potentiometer with the help of multi meter it should be OV. If there is some signal on zero position first take out knob of potentiometer now rotate shaft of potentiometer to get zero volt. Now fit knob on shaft by matching zero position.

Now feed 100mm general lift now output of this potentiometer should be +5V if it is more than +SV then supply voltage to this potentiometer should be checked it should be +10V if it is not +10V (less or more) than adjust P1 potentiometer in EK 813 in panel No. B4.

SUPER ELEVATION POTENTIOMETER: This potentiometer is provided in B2 panel in working cabin this potentiometer is used do provide SE. Values on curves. This converts cant values to electrical signal at the rate of 50MV/mm.output of this potentiometer can be checked at multicheck address F08.

Leveling & Lifting Control Circuit of CSM:

PRINTED CIRCUIT BOARDS:

1u48	-	Distance Measuring – Encoder	-	EL–T5034.002
4u1	-	Board for Lift Indication (To 4g1)	-	EL–T5103.00(02)
4u4	-	Power Supply for the Tower	-	EK-813SV-002
4u5	-	Front Analogue Input Interface	-	EK-345LV-00(02)
6u2	-	L.H. Levelling Control	-	EK-347LV-00(02)a
6u3	-	R.H. Levelling Control	-	EK-347LV-00(02)a
6u4	-	Power Supply, Main cab	-	EK-813SV-002
6u5	-	Pendulum Control	-	EK-346LV-(02)b
6u6	-	Distance Shift	-	EK-110V-00(02)a
10u1	-	Compensation Card	-	EK-348V-00(02)
19u2	-	Encoder Power Supply	-	EK-851SV-002
19u3	-	Distance Measuring	-	EK-99V-002
33u1	-	Board for Cross Level Indication (33g5)	-	EL-T5105.00(02)a

TRANSDUCERS:

1fOD	-	Levelling Transducer L.H.S.	-	5 k ohms
1fOE	-	Levelling Transducer R.H.S.	-	5 k ohms

POTENTIOMETERS:

1f07	-	Middle Pendulum
1f09	-	Rear Pendulum
1f13	-	Front Pendulum
4f3	-	Basic Lift Setting
4f5	-	Cross Level Adjustment – Tower
19f31	-	Settlement Compensation
88f1	-	Cross Level Digital

Levelling Control Board 6u2 or 6u3 (EK-347LV-02a)

On the levelling control boards 6u2 and 6u3 are seven inputs to a summing line. The following description is for the left hand side (6u2).

Input-1. Proportional Levelling Transducer: The levelling transducer 1FOD is supplied with + and –10 volts on terminals N52 and N53 (see power supply circuits 6u4). The signal from the transducer at 90 mV/mm is fed into 6u2 on terminal 26b (positive for lift), and can be checked using multiplex 7OD. The signal is passed to the summing line via amplifier OP1A (buffer), P1 and R7, remaining positive.

Input-2. Lift Correction: The 11 position switch on 51u1 (ED-T)= 5140.022) can be used to correct cross level errors, but only on one side (floating rail) at a time. This switch can be used to apply up to 5mm of lift in 1m steps, which connects to 6u2 on terminal 30b. This signal of 2 v/mm can be checked on multiplex F11. The signal passes to the summing line via amplifier OP13 (buffer), P3 and R8, remaining positive.

Input-3. Cross Level Error: Any difference between the pendulum at the tower, and the cross level digital, produces a signal from 4u5 terminal 28z (E47) which connects to 6u2 on terminal 26d which can be checked on multiplex F21. This will be positive for lift, which passes to amplifier OP2A and onto the summing line via f5 and R9.

Input-4. Satellite Displacement Compensation: On the 09 machine, the centre reference point is attached to the satellite; as this is the only part of the machine that stops during the tamping cycle, the relationship between the front, rear and centre reference point varies dependent on the satellite position. Therefore errors will occur in the longitudinal level.

To compensate for the satellite position, PCB 10u1 (EK-348LV-03) is fitted. The satellite length transducer1f1D feeds in a signal to 10u1 on terminal 20d, which is –10.2 volts in the 0 position, which passes to OP1A (buffer) The output of OP1B(7) is zero. This passes

through OP2A and OP2D so that the input to the multiplier MUL4 on pin 7= 0. Therefore the output at terminal 22z is 0 volts. Terminal 22z connects to PCB 6u2 and 6u3 on terminal 24z which can be checked on multiplex FOC.With the machine moving and the satellite stationary, the input from the length transducer becomes less negative so that pin 6 of OP13 becomes more positive. Therefore the output of OP1B(7) is negative at a maximum of –1.5 volts/m. This is inverted by OP2A to +1.6 volts/m and amplified to +8 volts, i.e. gain = 1 + R36/R35 x V in 5 x 1.5 = 8 volts.

With +8 volts on pin 7 of MUL4 and 10 volts on pin 13 (200mm max. lift x 50 mV = 10 volts)] the output of MUL4 on pins 1 and 2 = Input 13 x Input 7/10. This equals 10 x 8/10 = 8 volts, which connects to terminal 22z. Terminal 22z connects to terminal 24z of levelling PCB's 6u2 and 6u3 to compensate for the satellite position at –187 mV/mm of lift, which passes to the summing, line via o2B, P4 and R10.

Note:200mm = max lift and 1 metre max distance of satellite therefore 1.6 v/m and –3.12 volts are maximum values.

Input 5. Cross Level Error Rear: The input of the digital 88f1 and the input of the rear pendulum 1f09 are compared by pendulum PCB 6u5 [EK-346LV-(02)] and with the left hand rail as the high rail, the error signal is passed to terminal 24z. This terminal connects to terminal 8z on levelling board 6u2; the signal at 200 mV/mm (negative for L.H. rail too low) is passed onto the summing line via the inverter OP3A P6 and R11. Therefore this signal is now positive.

Note: This will only occur if the rear automatic cross level correction switch 19b1 is in the "outer position, i.e. not lit (site operator's manual page 41, item7). If this switch is in the 24 volt supply to terminal 26d of 6u5 is removed, de-energizing Re4 and Re5, connecting 24z and 24b to earth. This prevents any cross level correction.

Input 6. Settlement Compensation: The lifting value for the L.H.S. from 6u2 and the lifting valve for the R.H.S. from 6u3 are compared and displayed. A potentiometer is fitted to select a percentage of the difference from 0 to 100% and a signal is passed to the side requiring the most lift, i.e. to 6u2 or 6u3.The signal at terminal 6z at 6u2 is 2V/mm, negative for lift, is inverted by OP3B and passes to the summing line via P7 and R12. (This will be explained further under settlement compensation).

Input 7. Basic Lift Setting: The basic lift is set by 4f3 which produces a signal from 4u5 at terminal 22b to terminal E55 (tower end). This connects to 6u2 and 6u3 on terminal 4z; the signal at 50mV/mm is positive for lift, and passes onto the summing line via P11 and R13.

Summing Line: At the summing line, the various signals are added together, and adjusted due to their differing value of resistors. The final signal is passed to amplifier OP4A (inverting adder), the output will be negative for lift. At this time as the machine is ready to run in the lift, the output will be negative for lift. At this time as the machine is ready to run in the lift, the output will be positive.

Lift Indication: Amplifier OP4A(12) feeds the positive signal to OP5A and OP4B. At OP5A, the positive signal of 1 v/m is inverted and doubled by OP5A which connects to terminal 10b, and passes to the lift gauges 19g3 and 33g2 (19g4 and 33g3 for R.H.S.) This causes the gauges to deflect to the right i.e. no lift.At OP4B (Comparator), the output is low, therefore Re1 remains de-energized.

Starting to Work: Before work takes place the rear cross level circuit has to be reset, as the machine's memory circuit provides incorrect indication on the rear galvo 19g2. To correct the indication, press the green start button 19b13, (see operator's manual page 40, item 1), press and hold the yellow simulation button 19b15, untill the display 19g2 reads ub excess if 80. The red stop button is then depressed, 19b14. (This will be explained under rear cross level, distance measuring)

The lifting method is now selected using either the "lining down" switch 2x20 or the "lining and levelling start with tamping units middle position" 2x30. In this case 2x20 is operated.

Automatic Lift:

To obtain automatic lift, an output Q06 for the left hand side and Q07 for the right hand side.To achieve an output for the left hand side Q06, the program needs to be complete, i.e. 2E^05^6E^32^48^49^(24v2F)^02^93^94.

2E = Auto levelling on using switch 2x2E.
05 = 20^OB, e.g. 2x20 made and tamping down signal.
6E = Right hand bank not latched.
32 = Left hand over lift transistor not on.
48 = Front trolley not in the upper position.
49 = Rear trolley not in the upper position.
24v2F = Track sensor L.H.S. made, or track sensors switched off.
02 = Left clamp lift and stop not made.
93 = Levelling transducer not in the upper position.
94 = Satellite not in the travel position.

With the tamping system on (19) and the drive (11) and tamping pedals (10) depressed the machine now drives, and due to the output QOB the tamping banks descend. Output QOB completes the program of QO5 (20^OB), which in turn completes the program of QO6 and QO7.

Outputs Q06 or Q07 complete the program of Q4C which connects to PCB 1-0u1 on terminal 24z energizing relay Re5. Relay R energizing results in 1 contact changing over removing the input from terminal 10z which is the value from the cross level digital theoretical value) via terminal 4z of 5u5. With the contacts of Re5 having changed over, connects the capacitor K20, which had been charged to the value set by the digital, to amplifier OP5B. The capacitor discharges via OP5B and OP5D, ensuring that the value at terminal 14b remains the same as before tamping. Terminal 14b links to terminal 6b of PCB 6u5 ensuring the cross level indication remains a true reflection at that point, even though the machine has continued to move.Output Q06 and Q07 complete the programs of QL2E(06) and QL2F (07) and due their positive outputs, energize 1s3 and 1s4 which are the lifting solenoids, moving the C.S.V's into the lift position.Output Q06 completes an earth path to terminal 16b of 5u2 and Q07 completes an earth path to terminal 16b of 6u3. The earth at 1sb passes to the coil of Re2 (automatic lift relay) via Re4/1 contact, Re3/2 contact and DIL. As terminal 14d is connected to PR (+24 volts), relay Re2 energizes reversing its two contacts. Re2/1 contact changing over doesn't affect the over lift of T1 circuit due to the link between earth and R33, i.e. shorting out Re2/1 contact. By changing over, however, the earth is removed between R40 and R41 which had previously blocked the output from OP4A(12) passing to the servo circuit.

Servo Circuit: As the machine has started to work, the basic lift has been increased by 4f3 in the tower to run in the lift. Therefore terminal 4z of 6u2 and 6u3, each mm of lift applied increases the signal by +180 mV. The summing line now becomes positive resulting in the output of OP4A turning negative at –1 V/mm of lift. This output signal is inverted and doubled to 2 v/mm by OP5A which connects 10b, indicating lift, i.e. deflecting to the left.The output of OP4A passes to OP6A where it is inverted to +1 V/mm and passes on to amplifier OP6B where it is inverted and amplified 5:1 up to a maximum of 14 volts, (negative for lift). The output of OP6B passes to terminal 22b which links to terminal 20b. As R63 is now in circuit, with –14 volts at terminal 20b, there will be –3 volts a pin 6 of OP7, which results in an output of approximately –4.5 volts at pin 10 of OP7.Connected in the feedback loop is the servo valve, which form a potential divider circuit with R65(200Ω). If the servo valve resistance is taken as a nominal figure of 100Ω, the voltage across it = 100/300 vin = 1/3 of –4.5 volts, i.e. –1.5 volts. By Ohms Law, the current through the servo valve = 1.5 V/100Ω = 15 mA.

The servo gauge 18g2 is connected to terminal 22d, with switch 18b2 in position 1 for 6u2 (L.H.S.) and earth (see drawing E1-09-1.929-0). Therefore the gauge will read 100% due to measuring the –3volts across R65, i.e. –4.5 volts – the volt drop across the servo valve (-volts) = -3 volts (15 mAs). With 15 mAs flowing through the servo valves, oil is passed

to the clamp frame lift/lower cylinders via the C.S.V.'s and lift takes place both sides. As the rail lifts, the centre feeler rods lift with it, changing the input from the levelling transducer towards the zero position. Therefore the lifting signal on the summing line becomes less positive, resulting in the output of OP4A(12) becoming less negative.When the lifting signal is less than 3mm, amplifier OP6B comes out of saturation, reducing the voltage at terminal 22b to below –14 volts and therefore the current through the servo valve coils drops below 15 mA. The flow of oil to the lift/lower cylinder decreases, reducing the speed of lift.When the inputs on the summing line are balanced, the output of OP4A being zero, results in the servo valve moving to the null position trapping the oil between it and the cylinder, i.e. maintaining the lift.

As the output of OP4A is zero the input and output of OP5A has reduced to O which can be seen on the lift gauges which are connected to terminal 10b. The gauges having been in the lift position (to the left) move towards the centre of the gauge, and when the output is zero from OP5A, the pointer of the gauge will be in the centre, i.e. lift achieved position.

Lift Light: When the output of OP4A is negative (for lift to take place) by 0.5 volt, the output of comparator OP4B swaps to + 14 volts. Therefore relay Re1 energizes, reversing its contact, which passes the 24 volt supply at terminal R6 to 12z. Terminal 12z connects to the lift light 19h4 (19h5 for the right), which illuminates, showing lift is required.

When lift is achieved, the output of OP4A is below 0.5v, therefore comparator OP4B switches to low (-14 volts) de-energizing Re1. Therefore the lift light goes out.

Lift Correction: As explained on the levelling board write up, the lift correction switch mounted on panel 51 (left hand armrest) can correct errors in the lifting circuit. The switch can be used to increase the lift by 5mm in 1 mm steps on the floating rail only. Therefore in this example of L.H. high rail (floating), if the working cross level gauge pointer does not reach the centre position and hangs to the left, more lift is required on the left hand rail. Therefore the switch is used to correct the lift by feeding in a signal of +2/MA volts which increases the summing line voltage and therefore the output signal.To check the input from the switch on 51u1, the multiplex F11 for the L.H.S. ad F12 for the R.H.S. can be used.

Overlift: Should a fault cause the track to be overliefted by 4mm, the summing line turns negative, resulting in the output OP4A turning positive. The output of OP4A passes to OP5A which inverts and doubles the signal to –2V/mm which passes to the lift gauges via terminal 10b, and comparator OP5B. This reduces the input at pin 7 of OP5B below pin 6 and therefore the output switches high (+15 volts), turning "On" the base of transistor T1. The transistor connects the earth at terminal 6db to terminal 8d which connects an input to the PLC x 32 for the L.H.S. and x 33 for the R.H.S.Input X32 breaks the program of Q06, which removes, the lifting circuit for the L.H.S. and makes the lowering circuit, i.e. Q16 and QL2B. Input x33 breaks the program of Q07 , removing the lifting circuit for the R.H.S. end completes the program for lowering i.e. Q17 and QL2C.

Lift and Hold: With the machine set for double tamping, i.e. 2 x position (2x28) and the lift and hold switch 2x31 made, the tamping banks descend when foot pedal 1 x10 is pressed. When the bank reach the middle position (15-16), output Q05 is latched by (31^15v16)^OF, and geld on by 04v(28^CC)^OF. Therefore when the banks raise for the first time, even though OB is lost, Q05 output remaining ensures Q06 & Q07 are retained, i.e. machine still lifting.

When the banks are lowered for the second time, output Q00 is removed (see tamping section, and the hold program of Q0C is lost when the banks raise for the second time. The loss of Q0C results in the loss of Q05 which breaks the lifting cycle.

Cross Level Correction & Display Tower End: The cross level at the tamping position is also displayed in the power on gauge 33g4 (see modification No. 17) which is fed on terminal N45 from terminal 8d of PCB 6u5. Therefore the operator at the tower can see if the cross level is correct after lift has taken place.If correction is required, there used to be a + or – 10mm adjustment potentiometer 4f5 fitted, which has since been modified to 100mm. This is

achieved by operating a switch to either connect +10 volts (E52) or –10 volts (E53) to the potentiometer, which is also connected to earth. By moving the digital, a signal at 100 mV/mm is fed into PCB 4u5 on terminal 14b, which is buffered by OP8A. The output from OP8A(1) at 1`00 mV/mm is passed to the summing line of OP8B via P22 and R52.Potentiometer P22 and R52 originally were 47k and 255k respectively, but were reduced to 4.7 k and 24.9 k. This was carried out because the input signal was reduced from 1 V/mm to 100 mV/mm due to the mod, i.e. $1/10^{th}$ of the original signal. Therefore the resistors were reduced by approximately $1/10^{th}$.

At the input of OP8B, the signal from the main cab digital, and the cross level correction digital are added together, increasing the output of OP8B at –50 mV/mm. The output from OP6D (pendulum 1f13) at +50 mV/mm no longer balances the signal from from OP8D (the two digitals) at pin 13 of OP8D and therefore the input to OP8D is negative.

The output of OP8D at +50 mV/mm, passes to OP4B via Re4/2 where it is inverted to –50 mV/mm. Which is again inverted to +50 mV/mm by OP4A. OP4A's output at pin 1 is connected to terminal 28z, which passes to terminal E47 and then onto PCB 6u2 on terminal 26d, and can be checked on multiplex F21. This positive input to the levelling board results in the summing line increasing positively, resulting in a stronger negative output of OP4A, which increases the servo current. Therefore the lift is increased on the L.H.S. correcting the cross level fault.

PCB EK-346LV(Cross Level – Working Area):

The middle pendulum 1f07feeds in a signal of 25 mV/mm into PCB 6u5 (EK-346LV-02B) on terminal 22b, which is negative for the L.H. high rail selection. The signal is passed to OP4C where it is doubled in strength to –50 mV/mm which is inverted by OP3B. The output of OP3B is passed to a sub actor OP3C(9) at +50 mV/mm, where it is compared with the +50 mV/mm signal from the cross level digital (terminal 6b) at pin 10 of OP3C, which is held due to the memory from 10u1 terminal 14b.The input from the pendulum is taken away from the input from the digital and the output is passed to Re2/1 contact. With the left hand rail as the high rail, switch 2b32 is turned to the left closing contacts 2b32/1, 2b32/3 and 2b32/5. Contact 2b32/3 closed, connects an earth to terminal 6d and 28d, energizing relays Re1 and Re2 on 6u5. Therefore the output of OP3C passes through Re2/1 contact at 200 mV/mm (positive if the left hand rail is too low).The 200 mV/mm signal is inverted by OP6D and passed to terminal 8d via P13, R71 and R72 and onto the display 9g2. When tamping takes place, if the correct amount of lift has been applied, due to the rail lifting, the pendulum input should balance the input from the digital. Therefore the output of OP3C is) volts, and the galvo 9g2 shows no cross level error.

Settlement Compensation: If large cross level, errors exist, there is a problem with the settlement of the ballast, which can be overcome if required by the 09-32. The output of the left hand levelling board 6u2 on terminal 22z is passed to the pendulum board 6u5 on terminal 18z and can be checked on the multiplex F16. The output of the fight hand levelling board 6u3 on terminal 22z is also passed to the pendulum board 6u5 on terminal 20d and can be checked on multiplex F17. The two lifting signals at –1V/mm of lift are compared by amplifier OP4B on 6u5 (EK346LV-02B). If the left hand side requires the greater lift, the output of OP4B(7) will be positive.

The output of OP4B (+5 Volts) charges capacitor K15 via Re /2 contact. When the machine start lifting output is given, i.e. Q06 or Q07, there is an output Q4C which earths terminal 18b, resulting in relay Re3 energizing. Therefore both contacts reverse; Re3/2 passes the +5 volts from the capacitor K15 to Re3/2 contact which passes the signal to OP4A(3). The output of OP4A(1) at 5 v (i.e. 1 v/mm of lift = 5 mm of lift) passes to the lift difference gauge 19g8, showing which side requires the most lift. The output of OP4A(1) also passes to the settlement compensation potentiometer 19f31 which can select from 0% (system off) to 100% (all of the signal). With the potentiometer 19g8 set to 20%, the reduced value is connected to terminal 12b of 6u5 (positive for left hand rail low), which in this case is 20% of 5 = + 1 v *1mm of lift). This signal is inverted to – 1 v/mm of lift by OP6A; as the output is negative, this results in the comparator OP6C's output being low, therefore Re6 remains in the de-energized state.The – 1 v signal from the output of OP6A(1) therefore passes to

terminal 16z of 6u5 via Re6/1 contact. This signal passes to PCB 6u2 (levelling board for the L.H.S.) which at –1 v is inverted by OP3B (on 6u2) to 1 v which is passed onto the summing line to give 1 mm of extra lift. As relay Re6 remained de-energized on PCB 6u5, Re5/2 contact maintains an earth at terminal 16b, which passes to PCB 6u3 (levelling board R.H.S.). Therefore no extra lift signal is passed to the R.H.S. With this system the total lift on the left hand side equals 7 mm and the right hand side equals 1 mm of lift (figures only used as an example). This results in an over lift on the L.H.S. of 1 mm to compensate for the ballast settling after tamping has taken place. If the circuit remained as explained, the 1 mm of overlift would cause the middle cross level galvo 9g1 to pass the centre point (0 cross level error) and finish to the right of centre due to the pendulum's new level. This could cause problems as the operator might try to correct this indication.

Leveling & Lifting Control Circuit of Unimat2S

Levelling System:

Printed Circuit:

10u5	Levelling System Power Supply	EK-813SV-002
10u6	Levelling Control Left	EK-2041LV-00(02)
10u7	Levelling Control Right	EK-2041LV-00(02)
10u8	Pendulum Control Rear	EK-2042LV-00(02)
4u4	Power Supply Tower	EK-813SV-002
4u5	Front Analogue Interface	EK-2039LV-00(02)

Transducers:

1f00 Levelling Transducer Left.
1f0E Levelling Transducer Right
1f07 Pendulum Rear
1f13 Pendulum Tower
1f25 Laser (Lift right) not fitted at present
1f26 Laser Lift left
232f11 Zero adjuster left
22f12 Zero adjuster right
23f08 Required cross level rear
22f09 Settlement Compensation value
23f0B Zero correction left (plain line)
52f0B Zero correction left (S & C)
51f0C Zero correction right
4f3 Lift Setting Tower
4f5 Required cross level tower

Switches:

23b3 High Rail selector rear
22b6 Gain control right
22b7 Gain control left
23b4 Cross level direction rear
4b7 Cross level direction front

Front Tower:Cross Level:

Pendulum: The cross level at the front tower is measured by the pendulum 1f13 and the signal at 25mV/mm of cross level (negative for left hand high rail) is fed into printed circuit 4u5 at terminal 12b and is taken via R42 to OP6D(13) and added to the offset from P25 (used for zero calibration) and R41. The output OP6D(14) is inverted and the signal increased to 50mV/mm of cross level (left hand high rail now positive). The output OP6D(14) is taken via terminal 12z to the display 33u1 and via R45 to OP8D(13).

Required Cross Level: The required cross level is set with potentiometer 4f5 and the signal of 50mV/mm (positive for positive cant) is fed into 4u5 at terminal 14b and viaR53 to OP8A(3). The output OP8A(1) signal passes via P22 and R52 to OP8B(6) where it is added to the signal from the GVA output via terminal 16z, R51 and P24 (normally only one is used). The input OP8B(6) can be zeroed using P23.

The output OP8B(7) is inverted and fed to display 33u1 via terminal 28d, R35/2 and OP8C(9) via R48.

If switch 23b3 is set to left hand high rail terminal 18z will be connected to 24V and Re5 energized. Therefore Re5/2 is closed and the output from OP8B is taken directly to OP8D(13) via R46 (signal strength 50mV/mm negative for position cant).

Cross Level Error: At OP8D the signals from the pendulum and required cross level are added together.If the actual cant and required cant are equal the two signals will be of the same voltage but of different polarity. Therefore the output will be zero.Should the actual cant and required cant be different (cross level error) there will be an output at OP8D(14) of signal strength 50mV/mm (negative if the left rail is too high) and this is displayed on 33u1 via terminal 16d.
The output also passes to Re4/1 and Re4/2.
Basic Lift Setting: Unlike previous machines the front end of the front end of the card is fixed and basic lift is applied proportionally to the lift transducer.
The basic lift set on potentiometer 4f3 is fed into 4u5 at terminal 20d (50mV/mm, positive for lift) and via R1 to OP1A(3) the output OP1A(1) is taken to display 4u1 via terminal 20b (where the manual lift can be displayed) and OP1B(7) is inverted and is taken to display 4u1 via terminal 22d to display manual and laser lift, at a strength of 50mV/mm negative for lift, and via R6 to OP1C(9).
At this point the GVA lift from terminal 24d R5 and P2 is added to the output of OP1B. P1 can be used to zero the input of OP1C. The output OP1C(8) is inverted (now 50mV/mm positive for lift) and is taken via terminal 22b to 4u1 to indicate complete lift and via R10 to OP1D(13). Output OP1D(14) is again inverted and the signal taken to terminal 22z, which is connected to terminals 28b and 32z.
From terminal 28b this signal passes via R30 to OP4A(2). If left hand high rail is selected Re4 will be energized and the cross level error signal from OP8D(14) will pass via Re4/2, and Re5 to OP4B where the signal is inverted. The output passes via R33 to OP4A(2) where it is added to the basic lift signal. The inverted output OP4A(1) is taken via terminal 28z to the left hand lift circuit 10u6 at 50mV/mm positive for lift.
The signal from terminal 32z is taken via R36 to OP4C(9). The output OP4C(8) is inverted. Because Re4/1 is open the cross level error does not affect this signal. The output passes via terminal 30z to the right hand lift circuit10u7. Basic lift is therefore put onto the opposite rail to that selected as the high rail and the cross level error appears on the high rail.
If right hand high rail is selected Re4 will be de-energized and the cross level error is taken via Re4/1 and R39 to OP4C and is added to the basic lift. The output is taken to the right hand lift circuit. The signal to the left hand lift circuit is not affected by the cross level error.
Rear Pendulum: The rear pendulum is used purely as an indicator circuit. The required cross level is set with 23f08. The signal of 50mV/m (positive for positive cant) is fed into 10u8 at terminal 28z and passes via R22 to OP1A(3). P4 is used to adjust the zero point. The output OP4C(1) is amplified by 1.33, set with P16. The signal passes via R27 and R28 to OP2C(9). When the GVA is used the required cross level enters at terminal 6z and passes via P5 and R30 to OP2C(9).When the GVA is used the required cross level enters at terminal 6z and passes via P5 and R30 to OP2C(9).
The gain of OP2C is 0.7 and the signal is reduced and inverted to 50mV/mm (negative for positive cant). The signal then passes R32 to OP2D(13). The output OP2D(14) is again inverted and passes to terminal 4z and the display 23g5. Terminal 4z is connected to terminal 6b and is taken via R44 to OP3C(10) and R47 to OP3D(13).
The pendulum, input 1f07 is taken to terminal 22b at 25mV/mm (negative for left hand rail high) and via R35 to OP4C(10).)7 is used to set the zero point. The output OP4C(8) is amplified 2:1 and the signal is now t0mV/mm and passes via R39 to OP3B(6). The output OP3B(7) is inverted and P8 can be used to accurately calibrate the signal. The output OP4C(8) also passes via R40 to OP3A(3). The output OP3A(1) is not inverted and P9 can be used to calibrate the output. This output passes vua R46 to OP3D(12) where it is compared with the signal from 23f0B via terminal 6b and amplified. The resultant output OP3D(14) passes to Re2/2 at 200mV/mm (negative if the lift hand rail is high).

The output OP3B(7) via R45 to OP3C(9) where it is compared with the signal from 23f08. The output OP3C(8) is also amplified to 200mV/mm (negative if the left hand rail is high) and passes to R32/1.If left hand high rail is selected switch 23b3 will connect terminal 6d to earth and Re2 will energize. Therefore R32/1 will close and the signal from OPP3C(8) will

pass via R68 to OP6D(13). The output OP6D(14) is inverted but still at 200mV/mm (now positive for left hand rail high) and passes via P13, R71 and R72 to terminal 8d and the cross level indicators.
If right hand high rail is selected Re2 is de-energized and Re2/2 is closed. Therefore the signal from OP3D(14) passes via R68 to OP6D(13). The output is the same as for left hand high rail.

Track Lift (Only left side described):Inputs:

Proportional Levelling Transducer: The signal from the levelling transducer IfOD t 90m/V/mm (positive for lift) is fed into printed circuit 10u6 at terminal 26z and passes via R1 to OP1A(2). The output OP1A(12) is the same as the input and passes via P1 and R7 to the summing line.
Front Tower (Lift Value): The output from the front tower 4u5 terminal 28z is fed into 10u6 at terminal 24z at 50mV/mm (positive for lift). From terminal 26z the signal passes via R4 to OP2B(6). The output OP2B(10) is the same as the input and passes via P4 and R10 to the summing line.
Cross Level Correction: In order to correct minor cross level errors additional lift can be made by using 23fOB in plain line mode or 52fOB in switch mode. A signal of 600mV/mm (positive for lift) is fed into 10u6 at terminal 26d and passes via R3 to OP2A(2). The output OP2A(12) is the same as the input and passes via P5 and R9 to the summing line. A maximum of 3mm of lift can be applied.
Zero Correction: Minor errors in the levelling system (±5mm) can be made using 22f11. The signal is fed into 10u6 at terminal 30b and passes via R2 to OP1B(6). The output OP1B(10) is the same as the input (2V/mm positive for lift) and passes via R8 to the summing lien
Lift Reduction: In curves it is necessary to reduce lift and if the machine is fitted with GVA this is carried out automatically. The signal from the GVA at 100mV/mm (negative for lift) is fed into 10u6 at terminal 8z and passes via R5 to OP3A(1). The output OP3A(12), be amplified and inverted to 200mC/mm (positive for lift), passes via P6 and R10 to the summing line.

Summing Line: At the summing line the various signals from the inputs are added together. Due to differing values of resistors the signals at the summing line are adjusted e.g. the lift value from the front tower of 50mV/mm passes via P4 and R10 (= 19k) whereas the value from the levelling transducer of 90m/V/mm passes via P1 and R7 (= 9.5k). Therefore only half of the lift value is used compared with the error value. As they are in the ratio 1:1.8 only a small part of the lift value is ued (1:3.6).From the summing line the total signal passes to OP4A(1). P2 can be used to trim any minor errors when all inputs are zero.

The output OP4A(12) is now 1V/mm and is inverted (negative for lift) and passes:

1) via R40 and R41 to OP6A(1)
2) via R22 to OP4B(7)
3) via R27 to OP5A(1)
4) to terminal 16d

Output Stage:OP4B is used as a comparator and if the input OP4B(7) is negative the output OP4B(10) will be +15 volts ands relay Re1 will be energized. Re1/1 will close and connect the 24 volt feed at terminal 12b to terminal 12z and the lift indicator lamp 23h5 which will illuminate for positive inputs the output OP4B(10) will be –15 volts and Re1 will be de-energized.

OP5A is used to invert the signal via R27 and increase it by a factor of 2.5:1. The output OP5A(12) is positive for lift, passes via R29 to terminal 10b and the lift indicator 23g3. The output also passes via R30 to the over lift protection circuit.
OP6A is used to invert the signal via R40 and R41 and the output OP6A(12), now positive for lift, passes via R51 and R44 to OP6B(7). The output OP6B(10) is inverted and increased by approx 7:1. An input of 2mm will saturate the amplifier to an output of 14v (= 15mA

servo value current) which is fed into OP7 via terminals 22b and R62. The servo valve is connected in the feedback loop of OP7 via terminals 22d and 20z. The current will be 15mA when more than 2mm of lift is required. (Cut off point set with P8).
When automatic lift is required and the machine is in the correct part of the working cycle the processor output for automatic lift will be made, connecting terminal 16b to earth. If Re4 and Re3 are de-energized terminal 16b is connected to Re2 via Re4/1, Re3/2 and D11. The Re2 will now energize as the other side of the coil is connected to 24 Volts via terminal 14d Re2/1 will open removing the earth from R41 and allow signal from OP4B to pass to OP6A and give the servo valve a signal as described above.
Lift Unit Lowering: Under normal working conditions the lift unit is in the lowering condition unless lift is required. To lower the unit the processor give an output connecting terminal 18d to earth allowing Re4 to energize. As Re4/1 is open Re2 cannot energize and Re2/1 connects R41 to earth. A positive 15 volt signal via R47 is connected to OP6A(1). The output OP6A(12) is negative and gives the servo valve a lowering signal via OP6B and OP7.
Manual Lift: Under certain circumstances it is necessary to apply track lift manually. Push button 23X7A is depressed and if the program is complete the processor output Q1C connects terminal 4b to earth allowing Re3 to energize. The lowering signal is cancelled and as Re3/2 is open Re2 is de-energized. As Re2/1 is closed R41 is earth. Re3/1 closes and gives OP6A(1) a negative 15 volt signal via R46. OP6A(12) is positive and gives the servo valve a lift signal.
Over lift Protection: Should a fault occur in the lift system and cause the track to be over lifted the proportional transducer will give a lowering input and OP4A will have a positive output. Therefore OP5A will have a negative output. When the output reaches negative 10v (= 4mm) the comparator output OP5B(10) will change to positive 15 volts which will switch T1 on connecting terminal 8d to the earth at terminal 6db. Terminal 8d gives an input to the processor and prevents further track lift.
Settlement Compensation: The output at terminal 16d of 10u6 (L.H. Levelling) and 10u7 (R.H. Levelling) at 1V/mm, negative for lift are fed into the pendulum printed circuit at terminals 18z and 20d respectively. The inputs are taken via R53 and R55 to OP4B(6) and OP4B(5). The output OP4B(7) is the difference in the total lift value for each side (positive if L.H. side larger lift) and through V5, R33/2 and R57 charges K15.
When the processor gives a start lifting signal terminal 18b is earthed and Re3 energizes. Re3/1 changes over and removes the earth from R58. Re3/2 also changes over and connects K15 to OP4A(3) via R57, R3/2 and R58. This is to ensure that the lift difference does not change as track lift takes place. The output OP4A(1) goes to terminal 20b at 1V/mm of lift difference positive if L.H. side has larger lift) is taken to 22f09 and 22g2. 22f09 is used to set the percentage of lift difference used and this value is fed into 10u8 at terminal 12b. The signal passes via R78 to OP6A(2). The output OP6A(1) is now negative if the left side has the larger lift (too low) and passes to Re6/2, to comparator OP6C and via R79 to OP6B(6), the output OP6B(7) is inverted (positive for more lift L.H. side) and is taken to Re6/1 and terminal 12z which is connected to terminal 20z..
If the output OP6A(1) is positive (R.H. side has larger lift) the comparator output OP6C(8) will be +15 volts and Re6 will energize. Both contacts will change over, Re6/2 will earth terminal 16z and in turn earth terminal 6z of 10u6 (L.H. side). The negative signal from OP6B(7) will pass via Re6/1 to terminal 16b and in turn to terminal 6z of 10u7 (R.H. side).

From terminal 6z (10u6) the signal will pass via R6 to OP3B(7). The output OP13B(10) will be inverted and will pass to the summing line via R12 increasing lift on this side. At the same time the negative signal at terminal 12z (10u8) will pass to OP6D(13) via terminal 10z, R70 and P14 (10u8) to modify the cross level error signal from Re2 i.e. an extra lift of 2mm on the right hand side will cause this side to be over lift by 2mm. The resultant cross level error will be adjusted to zero.
If the larger lift is on the left side OP6C(8) will be –15 volts and Re6 will be de-energized. Re6/1 will earth terminal 16b and therefore terminal 6z of 10u7. The output OP6AZ(1) will give a negative signal to terminal 16z via Re6/2. Therefore a negative signal will be fed to

terminal 6z (10u6) which will be fed as a positive signal to the summing line of 10u6 via OP3B. At the same time a positive signal via terminals 12z and 10z will be fed to OP6D(13) again modifying the cross level error signal.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XV :Leveling & Lifting Control Circuit of UNO/DUO/ CSM/3X /Unimat

Session-49: Calibration of Lifting PCB, Troubleshooting & Fault finding.

CALIBRATION OF INPUT POTENTIOMETERS IN LEVELLING CIRCUIT:

CALIBRATION OF GENERAL LIFT POTENTIOMETER (4f3): This potentiometer is provided in panel no. B4 in front cabin. This potentiometer converts given general lift value to electrical signal at the rate of 50MV/MM output of this potentiometer can be checked by multimeter.For calibration of this potentiometer keep general lift potentiometer on zero and check output of this potentiometer with the help of multi meter it should be OV. If there is some signal on zero position first take out knob of potentiometer now rotate shaft of potentiometer to get zero volt. Now fit knob on shaft by matching zero position.
Now feed 100mm general lift now output of this potentiometer should be +5V if it is more than +SV then supply voltage to this potentiometer should be checked it should be +10V if it is not +10V (less or more) than adjust P1 potentiometer in EK 813 in panel No. B4.

CALIBRATION OF SUPER ELEVATION POTENTIOMETER: This potentiometer is provided in B2 panel in working cabin this potentiometer is used do provide SE. Values on curves. This converts cant values to electrical signal at the rate of 50MV/mm.output of this potentiometer can be checked at multicheck address F08.For calibration of this potentiometer. Set zero value in this potentiometer. Set zero value in this potentiometer. Select multicheck address F08 then check voltage on display. It should be OV if there is some value then remove digital counter set it to zero and also set shaft of potentiometer to get zero volt on display then refit digital counter on shaft.
Feed 180mm in S.E. potentiometer and select multi check address F08 keeping selector switch on position 2 display should show +9v. If this voltage in less or more then check +10V supply of EK813SV (6U4) if it is not exact +10V then adjust by potentiometer P1 (-10V by P2).
Now feed 5mm in S.E. potentiometer. Select LH rail high with cant selector. Measure voltage at 24Z it should be –1 volt if not adjust P11 in EK 346QV. Now select RH rail high with the help of cant selector. Now measure voltage at 24b it should be –1V if not adjust P12 in EK 346LV.

CALIBRATION OF FRONT INPUT PCB EK345LV:

For calibration of this PCB:

- Front bogie should be on zero cross level track.
- Measure voltage with the help of multimeter
- Measure voltage with the help of multimeter between terminals 12Z and 32 dbz. It should be zero volt if it is not zero then adjust P2S potentiometer in EK 345 LV. Front input PCB 4U5 to get zero volt.
- Place 100mm shim under LH wheel of front bogie. Measure voltage between 12Z and 32dbz it should be 5V if not adjust potentiometer P26 in EK345LV.
- Select LH rail high with the help of cant selector in working cabin measure voltage between 282 and 32 dbz of EK 345LV it should be –SV if not adjust P11 in EK 345LV.

- Place 100mm shim under RH wheel of front bogie and select RH rail high cant selector. Now measure voltage between 30z and 32 dbz of multimeter it should be – SV if not adjust P12 in EK 345 LV.

CALIBRATION OF MIDDLE PENDULUM IN EK 346LV:

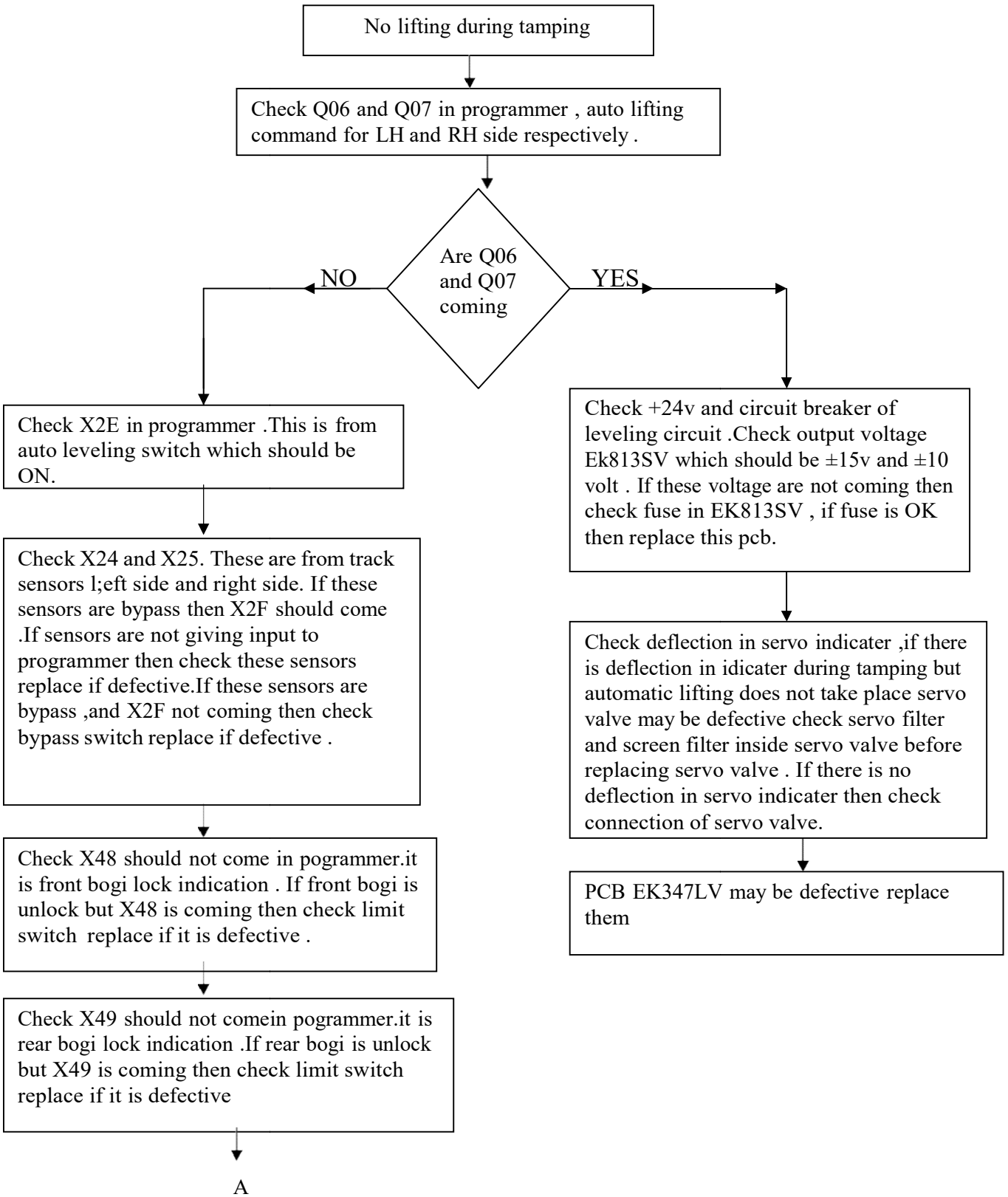
- Place 100mm shim under LH feeler rod of middle pendulum. Select LH rail high by cant selector.
- Feed 100mm in S.E. potentiometer cross level galvanometer should be at centre if it is not on centre then adjust P9 in PCB EK 346LV.
- Now place 100mm shim under RH feeler rod and feed 100mm in S.E. potentiometer. Select RH rail high. Galvanometer working area) should be at centre if not adjust P9 in EK 346LV to bring deflection.

- Select multicheck address F1E. Display should show OV if not zero then adjust pot P1 in EK 346LV.

CALIBRATION OF EK 346 FOR REAR PENDULUM:

- When rear pendulum on zero track then select F1E and check signal on zero it should be 0V if not then adjust P1 in EK346LV.
- Place 100mm shim under LH wheel. Select LH rail high with cant selector and feed 100mm in super elevation potentiometer. Now measure voltage at 26b terminal with the help of voltmeter (display) keeping selector switch on Ist position or with the help of multimeter. Voltage at 26b should be zero if it is not zero then adjust P2 in EK 346LV.
- Place 100mm shim under RH wheel of rear pendulum select RH rail with cant selector. Now feed 100mm in S.E. potentiometer. Now measure voltage at 26b with the help of voltmeter or multimeter it should be zero volt if not adjust P3 in EK 346LV to get zero volt.

TROUBLE SHOOTING OF LEVELLING CIRCUIT OF CSM



SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVI : Satellite Control Circuit:

Session-50: Functional Description of Satellite Control Circuit, Description of different positions of Satellite, Satellite Transducer, PCBs.

SATELLITE CONTROL CIRCUIT:

- Satellite Control circuit controls movement of Satellite This circuit is used only in CSM & CSM-3X for control of satellite movement. PCB EK 24V in CSM,& EK 202V in CSM-3X. are used for satellite movement control .

SATELLITE TRANSDUCER: Satellite transducer converts displacement of satellite to electrical signal at the rate of **11mv/mm.**This transducer is used in CSM and CSM-3X .Output of this transducer goes to satellite control PCB EK24V**(in CSM)** and EK202V(09-3X) at **6d** terminal of these PCBs.

CALIBRATION OF SATELLITE TRANSDUCER: For calibration of Satellite Transducer. Put Machine in working mode, lock the satellite unit in front zero position. Measure output voltage of transducer or at 6d terminal of EK24V, it should be +8.2V.If it is not +8.2v, then open the cover of transducer and loose three screws of potentiometer and adjust it to get +8.2V . After adjustment tight the screws and fit the cover of transducer and release the satellite from front zero position.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVI : Satellite Control Circuit:

Session-51: Functional Description of Satellite Control PCBs EK24V & EK202V

Explation of Satellite Control PCBs PCBs EK24V & EK202V

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVI : Satellite Control Circuit:

Session-52: Calibration of Satellite Control PCB Troubleshooting & Fault finding.

CALIBRATION OF SATELLITE CONTROL PCB EK24V:

For calibration of EK24V (10U8) Put machine in working mode select multicheck address F1D. and keep selector switch (18b4) on 2nd position. Now move satellite forward until display (18g4) indicate zero. If necessary adjust P1 in EK24V to get zero on display.

Mark position of Satellite wheel on rail. Now move satellite 300mm forward. Now check. Voltage on display (F1D) it should be **–6.9V,** if it is not –6.9v then adjust **P13** in EK24V to get –6.9V.

ZERO POSITION OF SATELLITE: Now move satellite forward by Joy stic (2X12) until satellite stops lower the lock for of satellite and lock satellite in zero position.

Now selector switch 18b4 on position 1 and check voltage at 6d terminal of EK24V it should be +8.2V if it is not adjust potentiometer of transducer . Select address F1D keep selector switch 18b4 on position 2. Voltage on display should be –10.2V if necessary adjust **P1** in EK24V.

Now turn 24 position switch 18b4 to position 1`and check voltage at out put of OP3 (10) it should be 0V if it is not 0V then adjust P9 to get zero volt on display.

ADJUSTMENT OF SATELLITE DISPLACEMENT DISPLAY: 19g6:

Displacement of satellite can be seen on display 19g6 . Keeping 5-position selector switch 19b6 on position-5th, when satellite is locked in zero position it should show 0mmif it is not showing 0mm then adjust potentiometer **P6** in display PCB to get zero display.

FRONT POSITION ADJUSTMENT: Select multicheck address F1D and keep multi position switch 18b4 to position 2. Check displacement of satellite on display 19g6, Keeping multi position switch 19b6 on 5th position. Now move satellite forward until display 19g6 indicate 120mm in this position Red LED in EK24V should glow and input to microprocessor **X1C** should go for **2 bar** brake of satellite. If red LED is glowing before or after 120mm then adjust **P10** to glow Red LED at 120mm.

MIDDLE POSITION ADJUSTMENT:
Move satellite backward until 19g6 display indicating 340mm in this position yellow LED in EK24V should glow and input to Microprocessor **X1B** should go for 5 bar satellite brake. If yellow LED is glowing before or after 340mm then adjust **P4** in EK24V.

BASIC CURRENT ADJUSTMENT OF PROPORTIONAL VALVE:
Select satellite proportional valve current Indicator using multi position switch 18b3 on position 3. Now move satellite front side when satellite stops in front then needle of current indicator should drop at **33%** of scale of current indicator (**250mA**) if this current is not 250mAthen adjust **P8** in EK24V to set minimum current or basic current at 250mA.

MAXIMUM FORWARD CURRENT: Bring satellite in rear position and release Hydraulic pressure. Now operate joy stick to drive satellite forward and watch deflection of satellite proportional valve current indicator it should be at **650mA (90%)** if it is not at 650mA then adjust **P7** in EK24V to get deflection of indicator at 650mA.

SATELITE CONTROL CIRCUIT OF CSM-3X: In CSM-3X satellite movement is controlled by PCB EK 202 V (10U11). Power supply PCB EK813SV is used.

SATELLITE TRANSDUCER: Satellite transducer converts displacement of satellite to electrical signal at the rate of 1.5 mv/mm. Signal of satellite can be checked at 6d terminal of EK202V.For calibration of satellite transducer lock satellite in rear lock position then measure the output of satellite transducer at 6d terminal of EK202V. It should be –8.6V. If it is not –8.6V then loose the screw of potentiometer and adjust it to get –8.6V.After adjustment tightened the screw of potentiometer. Now move satellite full forward output of satellite transducer should be +8.6V.

- Position the satellite in such position where output of satellite transducer at 6d terminal is 0v.

  In this condition output of Op-IB(7) should be OV. If not adjust P2 in EK202V to get OV. Now check voltage at 6Z it should be OV. If not adjust pot. P1 in such a way to get OV at 6Z.

- Mark this position and move satellite towards rear around 1000MM. Now check output of OP-1B(7). It should be +8V. because gain of OP1B(7) is set at the rate of 8mv/mm. If output of Op-1B(7).

  In some position check voltage at 6Z. It should be +10V because gain of OP2A is set at the rate of 10mv/mm. If voltage at 6z is not +10V then adjust pot.P13 to get +10V at 6z.

- Now move satellite in rear position and lock it satellite should be in such position that damper cylinder should press satellite in front position.

- Voltage at 6z or at (F11) should be +10V if not adjust P1 to get +10V at 6Z.

- Now move satellite in front position, keep the gap 30 to 50mm between damping cylinder and main chassis frame press the paddle and measure

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVII Work Drive Control Circuit:

Session-53: Functional Description of Work Drive Control Circuit, Encoder, PCB ELT-5034.

Work drive of CSM machine is controlled through PCB EK319LV.

There is a variable pump in driving circuit which is operated by proportional valve. Proportional valve is operated by PCB VT3005. VT 3005 receives signal from EK319LV it controls current to proportional valve of variable pump which is responsible for increase or decrease of speed of machine.

Working drive speed is synchronized with the satellite by a distance measuring wheel. This distance measuring wheel converts distance traveled by machine to pulses at the rate of 1000 imp/meter which frequency is 277.7 Hzs at 1 Km/hrs speed and EK319LV converts it to voltage (1km/hr = 1v.).Speed can be seen on bar type display. Maximum working speed can be set at 2km/hr.

PCB USED IN DRIVING CIRCUIT:

(1) Driving PCB-EK 319LV (6U8)

(2) Power supply PCB-EK813SV (6U7)

(3) Encoder PCB ELT-5034

(4) Variable pump proportional valve amplifier-VT 3005

ENCODER:

This transducer is used in CSM ,09-3X and DGS. This transducer converts displacement of machine to Digital signal at the rate of 1000 Pulse/meter. This is mounted on front trolley.out of this transducer is used for speed display.

Encoder PCB ELT-5034:-This PCB is mounted on Front trolley which receives inputs from encoder and sends to Workdrive PCB EK319LV and EK99V.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVII Work Drive Control Circuit:

Session-54: Functional Description of Work Drive PCB EK319LV& VT-3005

Functional Description of Work Drive PCB EK319LV):-

For the drive control of 09-machines the frequency/voltage transformation, the OP amplifier IC3Aand IC3B and the servo amplifier IC4 are used from this board.

1. Frequency – voltage transformation
   This stage is used by supplying a speed indicator.
   To input"12" the frequency signal is supplided(it is generated by the
   Distance measuring wheel withan incremental transducer-1000imp/m)
   The ICI is an integrated frequency/voltage transformer(VFC42) which
   Supplies at its output +10 V if the input frequency is 10Khz. With 1000
   Imp/m a voltage of 277,7Mv is generated by 1Kmph.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVII Work Drive Control Circuit:

Session-55: Calibration of Work Drive PCB, Troubleshooting & Fault finding .

CALIBRATION OF WORK DRIVE CIRCUIT OF CSM MACHINE:

Speed Adjustment Potentiometer:

There are two potentiometer for speed adjustment 19f40 and 19f40A.Selection of second potentiometer is done by toggle switch in B19 panel , by which we can reduce the speed to half .

Calibration procedure of work drive circuit:

Bring the machine on track. Where there should be sufficient space to drive machine at 1 Km/hr. speed in working mode.

- Now put machine in working mode for working drive. Lower the front trolley and front measuring wheel.

- Remove EK319LV PCB from it's slot and fit it again with extension card. When removing and inserting PCB supply of driving circuit should be off.

- Keep multi position selector switch 18b4 on position 1(displ)

- Now set machine for working drive and move the machine. Increase the speed with the help of speed adjustment potentiometer. Now measure voltage in PCB EK319LV on pin no1 of IC1 and increase speed until display shows .277V.

- ICI is the frequency to voltage converter IC. Pulses from distance measuring wheel encoder is applied at 12db terminal which frequency is 277.7Hz. ICI convert it to 277mV or . 277V at 1 Km/hr. speed.

- Now let the machine move at 1Km/hr. speed.

- Now select multicheck address F1B. Keep multi position selector switch on 2nd position. Display should show +1V. If display is not showing +1v then adjust potentiometer P1 in EK319LV.

- Now keep multi position selector switch on position 1 and measure voltage at 26db terminal of EK 319LV with the help of test prob it should be .62V , if not adjust P3 in same PCB.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVIII Hook Control circuit

Session-56: Functional Description of Hook Control Circuit and Transducer

Hook Control Circuit

Hook Control Circuit: Hooks are used only in Unimat machines to lift the track on switch & crossings where rollers clamp can not be used.Hook Control Circuit is used only in point and crossing tamping machines to control depth of Hook.. Two different depths may be selected by a theoretical value potentiometer. The actual value is monitored by Hook control PCB with the help of Hook depth transducer , There are two positions where Hook can be applied PosI (Rail Head) and PosII (Rail Foot)

Printed Circuit Board PCB: In Unimat 2S, PCB 144V and in Unimat 3S PCB EK 120V is used for Hook Control.

Transducers:

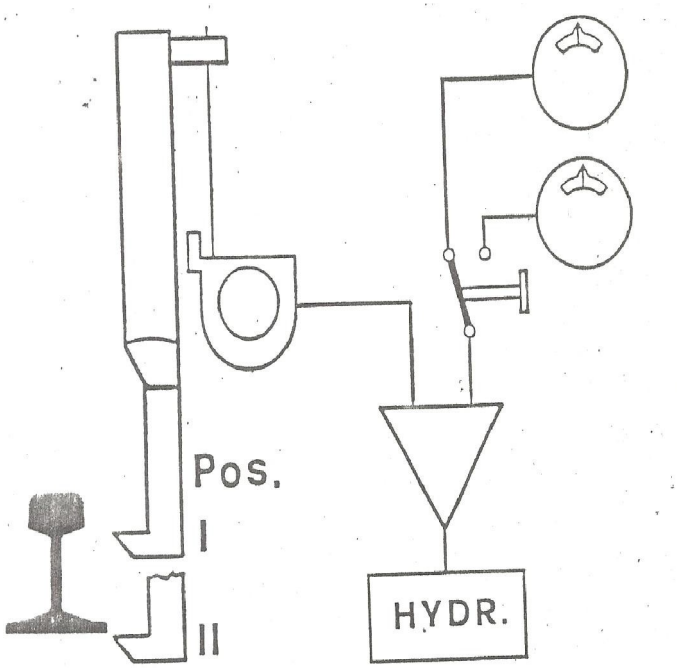
1f50 Hook depth Transducer Left

1f51 Hook depth Transducer Right

23f1 Required Depth L.H. side Rail head
23f2 Required Depth L.H. side Rail foot
23f3 Required Depth R.H. side Rail head
23f4 Required Depth R.H. side Rail foot

Switches:

23b1 Rail head/Rail foot L.H. side
23b2 Rail head/Rail foot R.H. side



Hook depth Transducer 1f50(Left) ,1f51 (Right) :

This transducer converts displacement of hook to electrical signal at the rate of 23mv/mm .Multicheck address of hook Transducers are F18(Left) and F19(Right).

Calibration :-For calibration of hook transducer hook should be in up position ,select multicheck address of hook transducer **F18 or F19**, in this position output voltage of hook transducer should be **-2.2 Volt**. If output is not -2.2 V then open the cover of transducer and loose three screws of potentiometer and adjust it to get -2.2 V.

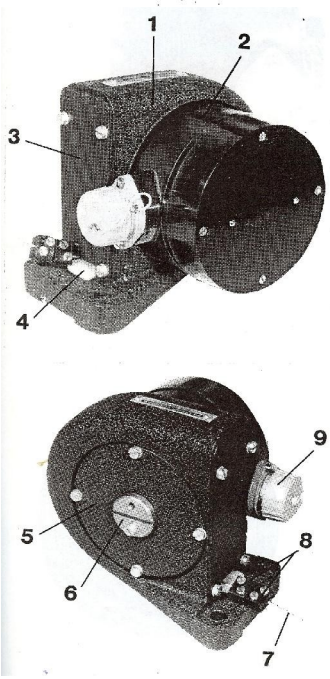
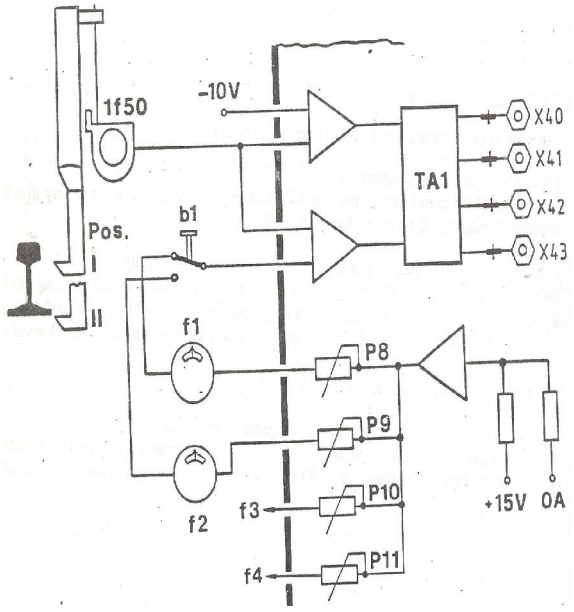


Fig. 1
1 = Housing
2 = Transmission
3 = Assembly Cover
4 = Chord Guide Strips
5 = Cover
6 = Spring Fixing Bolt
7 = Potentiometer Chord
8 = Chord Clamps
9 = Socket

Circuit Description of PCB EK-120V-00(6U5) in Unimat 3S
Lowering of Hook:

The hook can be lowered to either rail head or rail foot, selected with 23b1(LH)and 23b2(RH).

The theoretical depth is set with potentiometer 23f1 (for rail head). This is supplied with **+3 volts** set from 6u5 terminal 30b and adjusted using **P8.**



The required depth is set and the resulting voltage (between 1.5V and 3V) is fed into 6u5 at terminal 32z and via R40 to OP2C(10). The output OP2C(8) is identical to the input and provides a reference voltage for the comparator OP2B(5). The actual depth is fed in at terminal 26b and passes via R41 to OP2B(6).

If the voltage at OP2B(6) is less than OP2B(5) the output OP2B(7) will be +14 volts. This is fed into the transistor array TA1 pin 1 and connects terminal 18b to earth, This becomes an input to the processor. If the program to lower the hook is complete the processor will effectively earth erminal 10z and through R50 and D11 switch on the LED 3/4 of OC1. This will switch on the transistor 5/6 which will turn on T2, connecting terminal 4z to terminal 6z (earth). The lowering solenoid will now energies and the hook will lower. The actual depth voltage will become more positive and when equal to the theoretical voltage OP2B(7) will switch to –14 volts switching off TA1 1/18 and removing the input to the processor and therefore to terminal 10z . OC1 3/4 will now switch off and T2 will rapidly de-energies the lowering solenoid, stopping and hook in the required position.

If the hook is required to apply at rail foot switch 23b1 is changed to the rail foot position and 23f2 will feed in the reference voltage (between 2.5 & 5 volts) to terminal 32z. A higher voltage therefore a greater depth. The hook will now lower until the actual depth voltage equals this greater reference voltage.

Lifting of Hook: A -10 volt signal is fed in at terminal 24d and passes via R30 to OP3D(12). R61 connects this terminal to earth and set the voltage at –2 volts. The output OP3D(14) will –2 volts. This forms the reference voltage for the comparator OP3A. Terminal 20b is connected to terminal 26b and the actual depth signal is fed to OP3A.

If the hook is lowered the voltage at terminal 20b will be more positive than the reference voltage and OP3A(1) will be –15 volts switching off TA1 5/24 and ensuring that the processor input via terminal 18z is not made.To lift the hook the processor output connects terminal 12d to earth which switches on LED ½ of OC1 and therefore transistor 7/8. This will turn on T1 connecting terminal 8z to earth and energizing the lifting solenoid.As the hook raises the actual depth voltage decreases and when equal to –2 volts OP3A(10) switches to +15 volts TA1 5/14 is switched on connecting terminal 18z to earth giving an input to the processor for the drive safe routine. The hook is stopped in its upper position physically.

Circuit Description of PCB EK-144V-00 in Unimat 2S

In Unimat-2S EK144V-00 PCB is used in hook control circuit .Theoretical depth value (+ polarity) is applied at connection “32z” which is fed to Operational Amplifier “OP2C” via resistor ”R40” and capacitor “K12”. K12 represent a low pass filter to avoid eventual high interfering frequency. Operational Amplifier “OP2C” is a buffer which output is applied to “OP2B (5)” via resistor “R 32”. OP2B is a comparator which compare signals applied at pin no 5 and 6 .At the pin no 6 of the OP2B via “R41” the left depth-actual value of the hook depth transducer is available (+ polarity).

As long as the theoretical signal at pin no 5 of OP2B is more positive than the actual value signal at pin no6, the output at pin no 7 will be on full level (approx + 14 volts) which is applied at base of transistor in transistor array T A1 at pin no1 via diode D4.Transistor supplies an earth signal via pin no 18 of TA1 to the output connector 18b of PCB. This signal is used as input X40 (left hook lowering) by processor for the further control .In the same way the other four theoretical-actual-comparison circuits are operating with “OP2A”,”OP3A”, and “OP3B”.

With the OP1D a voltage of +7.5 V is generated at output pin no 1 by means of the potentiometers P8, P9,P10 and P11 this voltage can be set at 3V by P8 & P10 for rail head and at 5.5V by P9 & P11 for rail foot.

Four FET(Field effect transistor)-power transistors are also used in this PCB. These field effect transistors can operate solenoid directly. The output signal is an earth signal and therefore at the other end of the coil of solenoid +24V is applied.

The parallel diodes “D18” to “D 21” serve as transistor protection in case of negative back voltages by solenoids. The terminals of FET are: S (SOURCE), D(DRAIN) and G (GATE).

Via the gate ”G” the control voltage which connects the connection from “S” to “D” is supplied .Via a dropping resistor R49 with diode D10 an earth signal supplied by the programmer energizes an optical coupler OC1.In OC1 the internal LED illuminates which light energizes photo transistor. The photo transistor transfers then a plus-signal applied at collector to emitter then to the gate “G”of the corresponding FET transistors(T1) through OC1(8) and resistor R45.Because FET transistors have a very high gate resistance ,a leak resistor R53 is provided against earth .

For protection against voltage peaks when the solenoid of valves cut off a protection combination is provided which consists of a resistor R60 and a free wheeling diode D14

The + 24V power supply for the Solenoids of hook DC valves should be supplied via the fuse Si1(6,3A).

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XVIII Hook Control circuit

Session-58: Calibration of Hook Control PCB, Troubleshooting & Fault finding

Calibration potentiometers in Hook Control PCB:-

P8 :- Required Depth LH Side Rail head.
P9 :- Required Depth LH Side Rail foot.
P10:- Required Depth RH Side Rail head.
P11:- Required Depth LH Side Rail foot.

S.No.	Faults	Causes and Remedial Actions
1.	L.H. hook is not getting lower	i) Switch for LH hook down should be in ON position and signal should come on multi check or subroutine Q00→X00 should come on multi check and following conditions should also be fulfilled.
		a) Preselector switch for LH hook should be in ON position
		b) Switch for LH lining unit unlock should be in ON position and indication should come on multi check.
		c) Switch for LH hook always down should be in ON position and indication should come on multi check.
		d) If indication for all above conditions are not coming on multi check then check the lifting circuit.
2	R.H. hook is not getting lower	If hydraulic circuit is found Ok then problem is in electrical circuit. Check it as follows. i) Switch for RH hook down should be in ON position and signal should come on multi check or subroutine Q01→X01 should come on multi check and following conditions should also be fulfilled. a) Preselector switch for RH hook should be in ON position b) Switch for RH lining unit unlock should be in ON position and indication should come on multi check. c) Switch for RH hook always down should be in ON position and indication should come on multi check. d) If indication for all above conditions are not coming on multi check then check electrical circuit.
3	R.H. hook is not going outward	If hydraulic circuit is found Ok then problem is in electrical circuit. Check it as follows. i) Condition Q63→X63 should be fulfilled and indication should come on multi check. ii) Condition Q06→X06 should not come on multi check. iii) Condition Q07→X07 should not come on multi check. iv) Preselector switch for RH hook should be in ON position and indication should come on multi check. v) RH lining unit should be in unlock condition and indication should come on multi check. vi) If any one of the above condition is not fulfilling, the relay QL72 may be defective. Check and do the needful. vii) Fuse for QL72 may also be blown. Check and do the needful.
4	L.H. hook is not going outward	If hydraulic circuit is found Ok then problem is in electrical circuit. Check it as follows. i) Condition Q63→X63 should be fulfilled and indication should come on

		multi check. ii) Condition Q06→X06 should not come on multi check. iii) Condition Q07→X07 should not come on multi check. iv) Preselector switch for LH hook should be in ON position and indication should come on multi check. v) LH lining unit should be in unlock condition and indication should come on multi check. vi) If any one of the above condition is not fulfilling, the relay QL74 may be defective. Check and do the needful. vii) Fuse for QL74 may also be blown. Check and do the needful.
5.	R.H. hook is not coming inward	If hydraulic circuit is found Ok then problem is in electrical circuit. Check it as follows. i) Check the signal X43 on multi check .If not coming then check output at terminal no. 12 of Transistor TA 1 of PCB EK144V-02. If it is not found there then transistor may be defective. Replace it. ii) Switch for lifting unit fully up should be in ON position. iii) Signal for QL73 should come on multi check. If not coming then relay may be defective. iv) Fuse for QL73 may also be blown. Check and do the needful.
6.	L.H. hook is not coming inward	If hydraulic circuit is found Ok then problem is in electrical circuit. Check it as follows. i) Check the signal X42 on multi check .If not coming then check output at terminal no. 14 of Transistor TA 1 of PCB EK144V-02. If it is not found there then transistor may be defective replace it. ii) Switch for lifting unit fully up should be in ON position. iii) Signal for QL75 should come on multi check. If not c coming then relay may be defective. iv) Fuse for QL75 may also be blown. Check and do the needful.

SUB-DISCIPLINE:- ELECTRONIC SYSTEM(LESSONS:19 SESSIONS:59)

Lesson-XIX Panel Boxes & Cable List

Session-59: Main Panel Boxes i.e Working & Engine Panel boxes, Cable List

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Panel Boxes :-In the machines switches, relays , PCBs and wiring connectors are fitted in Panel Boxes provided in cabins and machines chasis.list of panel boxes is as under.

Panel Boxes in Unomatic & Duomatic

S.No.	Panel Box No.	Description
1.	B2	Working control panel R.H.S.in working cabin.
2.	B4	Front inputs panel in front cabin.
3.	B5	Engine control panel in working cabin.
4.	B7	Levelling and lining control Panel
5.	B11	Engine control panel in front cabin
6.	B13	Engine electrical circuit junction box
7.	B19	Galvanometers box
8.	B33	Galvanometer (cross level and lining)Box in front cabin.
9.	B50	Electrical terminals box outside on machine chassis for solenoids.
10.	B51	Manual cross level correction on working chair handrest LHS
11.	B52	Manual cross level correction on working chair handrest RHS

Panel Boxes in CSM

S.No.	Panel Box No.	Description
1.	B2	Working control panel R.H.S.in working cabin.
2.	B4	Front inputs panel in front cabin.
3.	B5	Engine control panel in working cabin.
4.	B6	PCBs slide module
5.	B7	Base plate for logistic cabinet
6.	B9	Galvanometer (cross level and lining)Box outside machine chassis
7.	B10	PCBs slide module
8.	B11	Engine control panel in front cabin
9.	B13	Engine electrical circuit junction box
10.	B18	Measuring and multicheck Panel
11.	B19	Working control panel L.H.S.in working cabin.
12.	B20	Programmer PCBs slide module
13.	B26	Electrical terminals box outside on machine chassis.
14.	B28	ZF gearbox electrical circuit junction box
15.	B29	Fault indication box
16.	B33	Galvanometer (cross level and lining)Box in front cabin.
17.	B40	Intercom Box
18.	B45	Electrical terminals box outside on machine chassis.
19.	B47	Electrical terminals box outside on machine chassis.
20.	B48	Electrical terminals box outside on machine chassis.
21.	B50	Electrical terminals box outside on machine chassis.
22.	B51	Manual control box on working chair handrest LHS
23.	B52	Manual control box on working chair handrest RHS
24.	B53	Working light electrical terminals box outside on machine chassis.
25.	B55	Fault indicater electrical terminals box outside on machine chassis.
26.	B77	Laser battery charger box

27.	B79	Engine throttle control box front cabin
28.	B80	Engine throttle control box working cabin
29.	B81	Engine throttle control box

Panel Boxes in Unimat 2S & 3S

S.No.	Panel Box No.	Description
1.	B4	Front inputs panel in front cabin.
2.	B5	Engine control panel in rear cabin.
3.	B6	PCBs slide module
4.	B7	Base plate for logistic cabinet
5.	B10	PCBs slide module
6.	B11	Engine control panel in front cabin
7.	B13	Engine electrical circuit junction box
8.	B18	Measuring and multicheck Panel
9.	B20	Programmer PCBs slide module
10.	B22	Working control panel R.H.S.in working cabin.
11.	B23	Working control panel middle.in working cabin.
12.	B24	Working control panel L.H.S.in working cabin.
13.	B26	Electrical terminals box outside on machine chassis.
14.	B28	ZF gearbox electrical circuit junction box
15.	B29	Fault indication box
16.	B33	Galvanometer (cross level and lining)Box in front cabin.
17.	B40	Intercom Box
18.	B51	Lifting correction and tamping tool slew , outside R.H.S.
19.	B52	Lifting correction and tamping tool slew , outside LH.S.
20.	B53	Working light electrical terminals box outside on machine chassis.
21.	B55	Limit switch connector box.
22.	B69	Terminal box clamp.
23.	B94	Recorder panel box rear