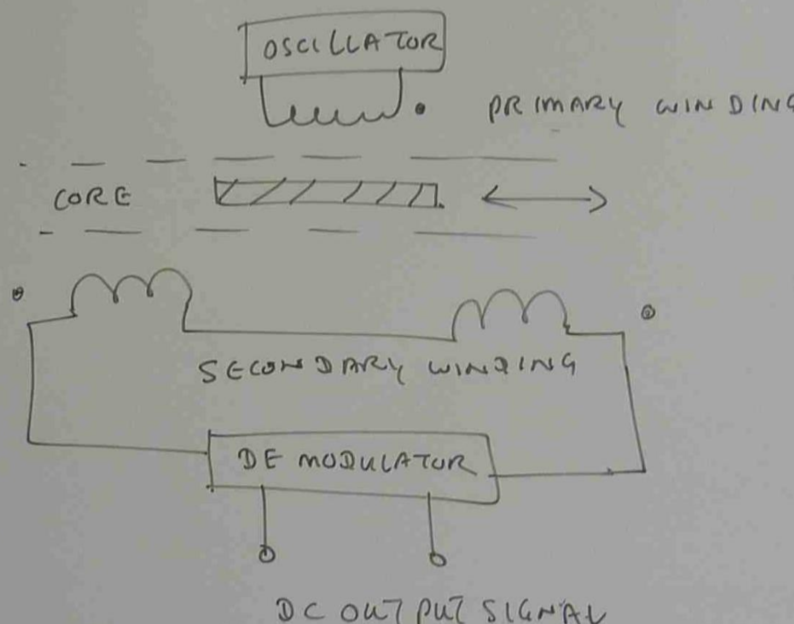
TYPES OF TRANSDUCERS

LINEAR VARIABLE DIFFERENTIAL TRANSDUCER (LVDT)

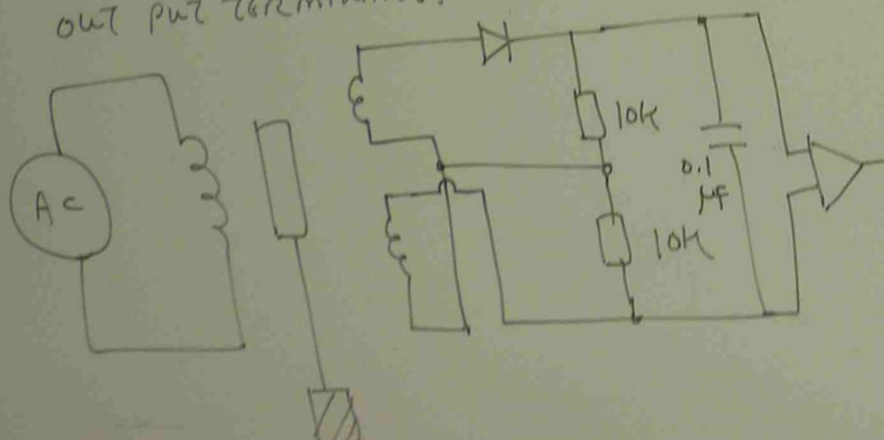


THE L.V.D.T HAS THREE WINDINGS ARRANGED SIDE BY SIDE ON A TUBULAR FORMER. THE CORE IS AN IRON FERRITE SLUG THAT CAN BE MOVED BACK AND FORTH IN THE FORMER.

THE SECONDARY WINDINGS ARE CONNECTED OPPOSITE TO EACH OTHER.

THIS INDUCES EQUAL BUT OPPOSITES VOLTAGES IN THE SECONDARY WINDING WHEN THE SLUG IS IN THE CENTRE OF FORMER.

IF THE SLUG IS MOVED LEFT (OR) RIGHT, THE PHASOR SUM OF VOLTAGES INDUCES IN TWO SECONDARY WINDINGS IS PRODUCED AT OUT PUT TERMINALS.



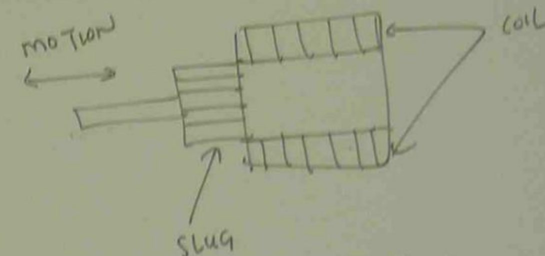
APPLICATIONS

GAUGING METAL SIZES

TENSIONING OF PAPER ROLLS

LIQUID LEVELS.

THE VARIABLE INDUCTANCE LINEAR POSITION TRANSDUCER



MOTION OF THE IRON SLUG PRODUCES VARIABLE INDUCTANCE

$$L = \frac{\mu N^2 A}{l}$$

N = NO. OF TURNS

L = INDUCTANCE

μ = PERMEABILITY

A = C.S.A

l = LENGTH OF COIL

$X_L = 2\pi f L$

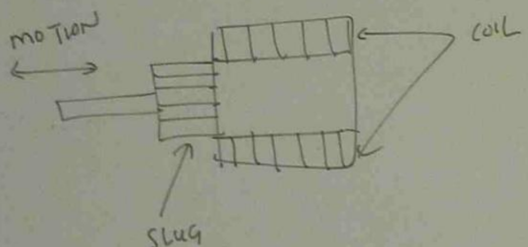
APPLICATIONS

GAUGING METAL SIZES

TENSIONING OF PAPER ROLLS

LIQUID LEVELS.

THE VARIABLE INDUCTANCE LINEAR POSITION TRANSDUCER



MOTION OF THE IRON SLUG PRODUCES VARIABLE INDUCTANCE

$$L = \frac{\mu N^2 A}{l}$$

N = NO. OF TURNS

L = INDUCTANCE

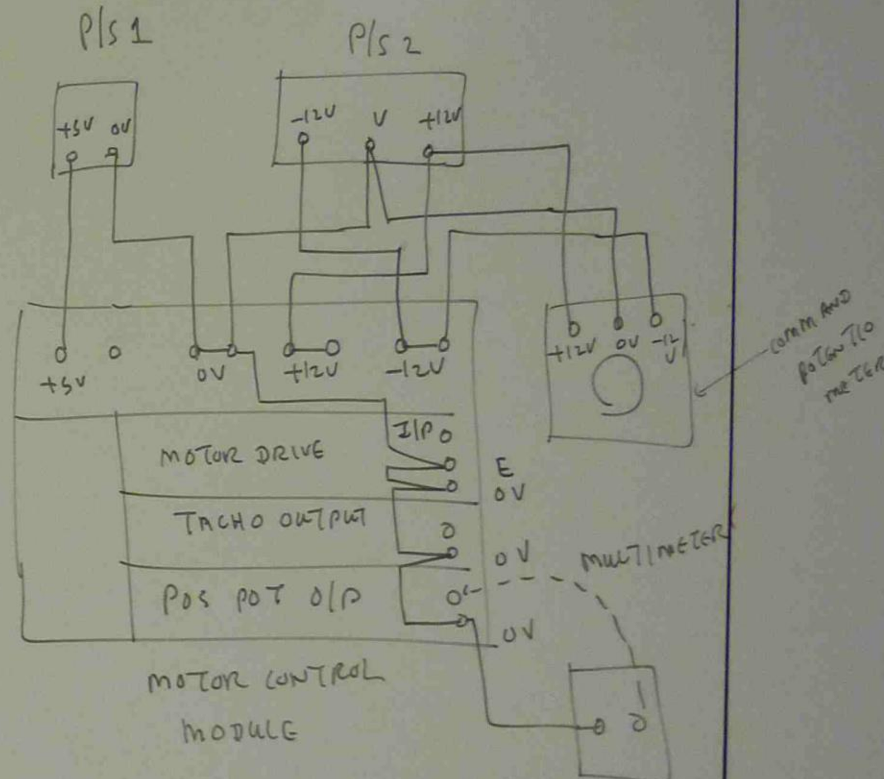
μ = PERMEABILITY

A = C.S.A

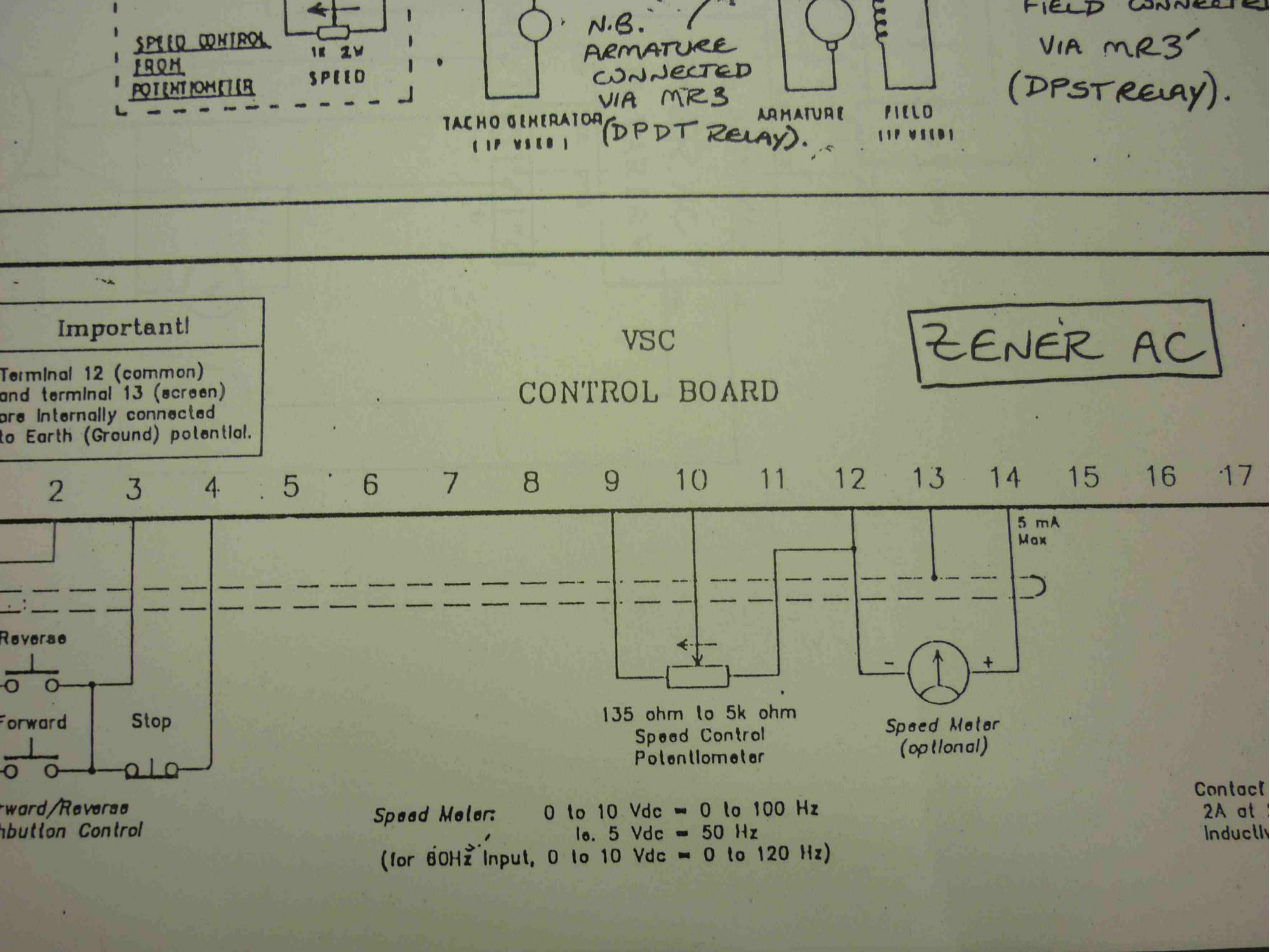
l = LENGTH OF COIL

$$X_L = 2\pi f L$$

POSITION MEASUREMENT



P/S POWER SUPPLY


SPEED CONTROL FROM POTENTIOMETER
1K 2W
SPEED
TACHO GENERATOR (IF USED)
N.B. ARMATURE CONNECTED VIA MR3 (DPDT RELAY).
ARMATURE
FIELD (IF USED)
FIELD CONNECTE
VIA MR3' (DPST RELAY).
Important!
Terminal 12 (common) and terminal 13 (screen) are internally connected to Earth (Ground) potential.
VSC
CONTROL BOARD
ZENER AC
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
5 mA Max
Reverse
Forward
Stop
rward/Reverse
hbutton Control
135 ohm to 5k ohm Speed Control Potentiometer
Speed Meter (optional)
Speed Meter: 0 to 10 Vdc = 0 to 100 Hz
ie. 5 Vdc = 50 Hz
(for 60Hz input, 0 to 10 Vdc = 0 to 120 Hz)
Contact
2A at
Inducti

ELECTRONIC FIELD (PROXIMITY) SENSORS

PROXIMITY SENSORS MAY BE CLASSIFIED EITHER AS

- CONTACT SENSORS : THOSE THAT ESTABLISH A PHYSICAL CONTACT
- NON CONTACT SENSORS : THOSE THAT DO NOT OPERATE MECHANICALLY.

THEY MAY BE CLASSIFIED AS

- DIGITAL : THOSE THAT ARE EASIER TO USE AND LESS EXPENSIVE (TWO STATES ON/OFF)
- ANALOG : MORE COMPLEX (CALLED LINEAR OUTPUT SENSORS)

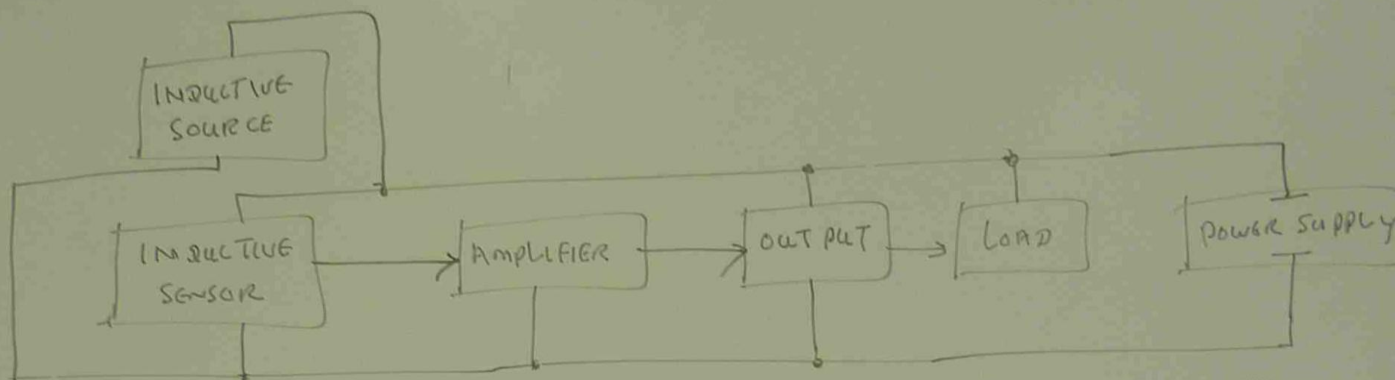
INDUCTIVE PROXIMITY DETECTORS

THEY CAN SENSE METALLIC OBJECTS BY ELECTROMAGNETIC INDUCTION.

THE INDUCTIVE FIELD SOURCE CONSISTS OF AN OSCILLATOR AND A COIL THAT PRODUCES A WEAK MAGNETIC FIELD.

WHEN A METALLIC OBJECT IS INTRODUCED WITH IN THE MAGNETIC FIELD, EDDY CURRENTS ARE INDUCED ON THE OBJECT SURFACE WHICH WILL DRAW ENERGY FROM THE OSCILLATOR CAUSING THE AMPLITUDE OF THE SIGNAL FROM THE OSCILLATOR TO BE REDUCED. THIS REDUCTION IN AMPLITUDE (VOLTAGE DROP) IS PICKED UP BY THE SENSOR

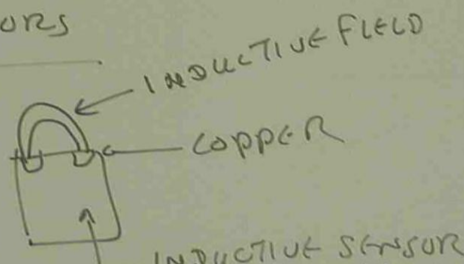
CAUSING THE OUT PUT STATE TO BE CHANGED



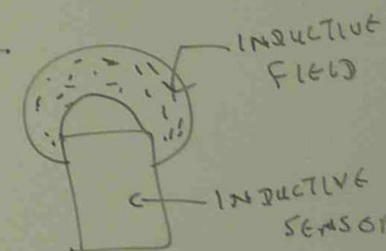
— ELECTRO MAGNETIC INDUCTION SENSORS ARE ALL OBJECT ACTUATED.
THE OUT PUT IS ENERGIZED WHEN THE METAL OBJECT MOVES IN TO THE FIELD.

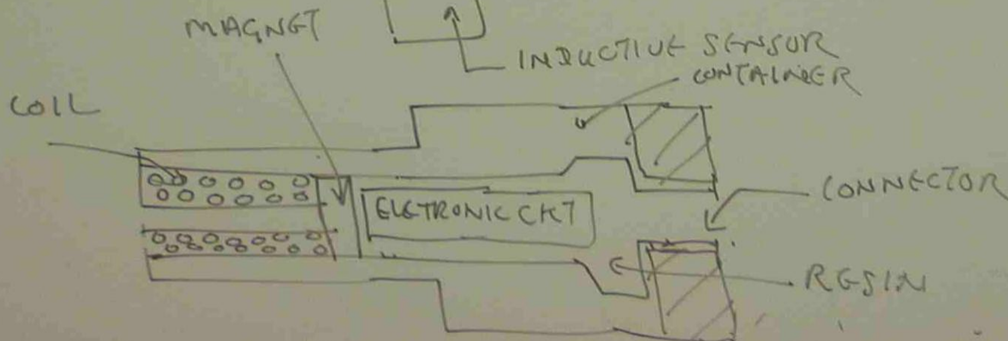
INDUCTIVE SENSORS

SHIELD



UNSHIELD





SENSING DEVICE

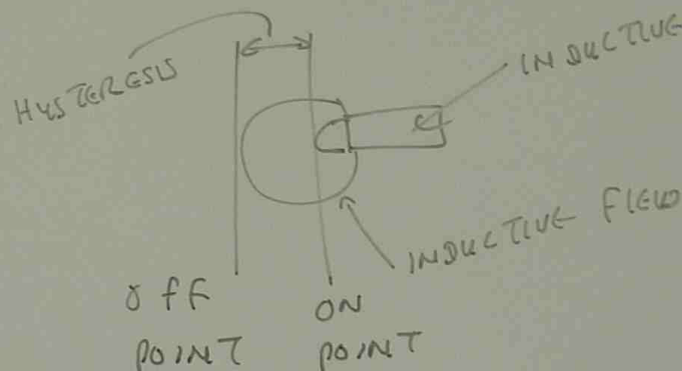
AFFECTED BY TEMPERATURE 5% SENSING DISTANCE

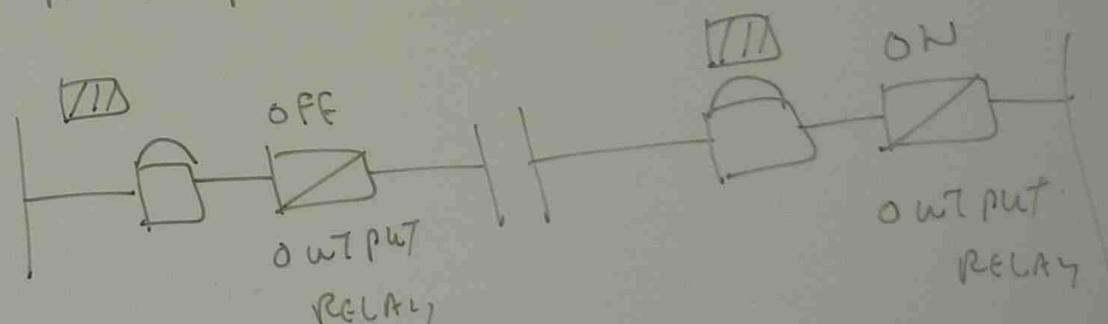
HYSTERESIS

IMPORTANT TO PREVENT TEASING.

METAL OBJECT MUST BE CLOSER TO TURN ON THE SENSOR

(GAP BETWEEN ON & OFF POINTS)





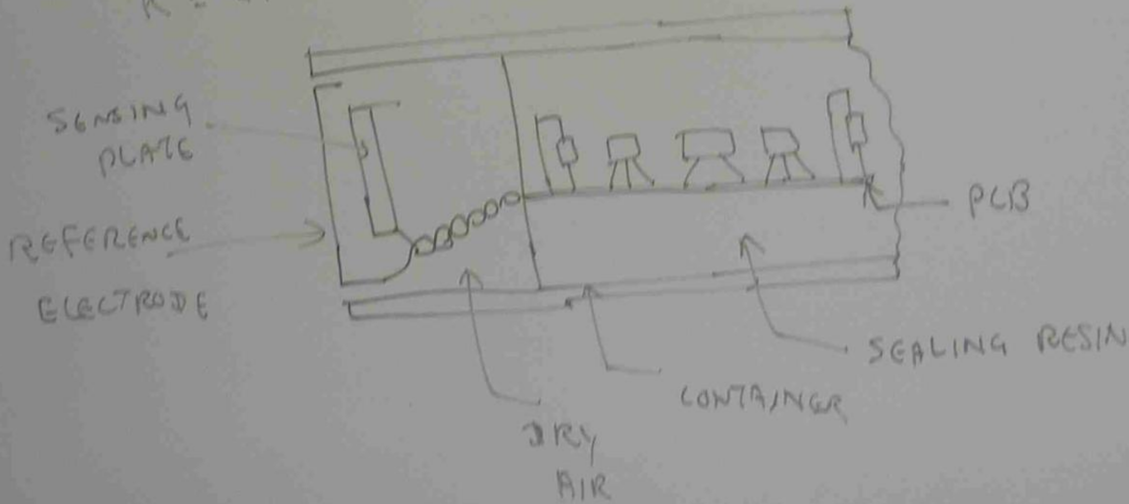
CAPACITANCE PROXIMITY SENSOR

CAPACITIVE SENSORS CAN BE USED WITH METALLIC AND NON METALLIC MATERIALS EITHER SOLID (OR) NON SOLID.
THEY ARE WIDELY USED IN FOOD INDUSTRY TO DETECT A PRODUCT INSIDE NON METALLIC CONTAINERS.
CAPACITIVE SENSOR CAN MEASURE LEVEL THROUGH CAPACITANCE CHANGES DETECTED BY THE SENSOR.

$$C \propto \frac{AK}{d}$$

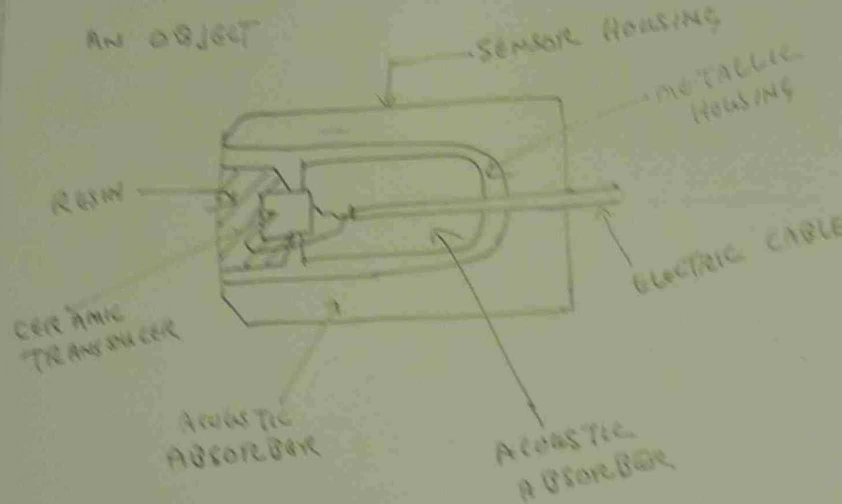
C = CAPACITANCE, A = AREA OF PLATES, d = DISTANCE BETWEEN PLATES

K = DIELECTRIC CONSTANT.



ULTRA SONIC SENSORS

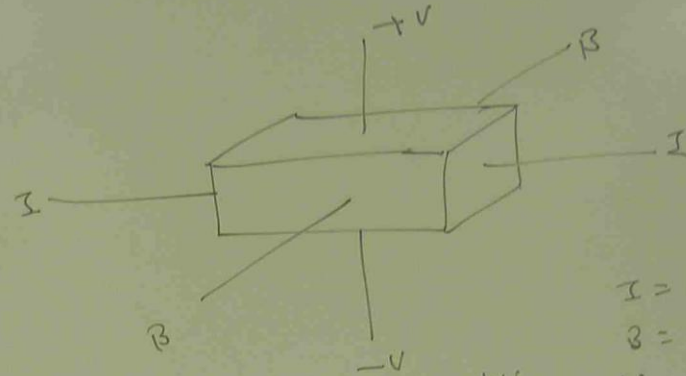
ULTRA SONIC SENSORS FUNCTION LIKE A RADAR.
THEY USE A NARROW ULTRASONIC BEAM TO DETECT AN OBJECT



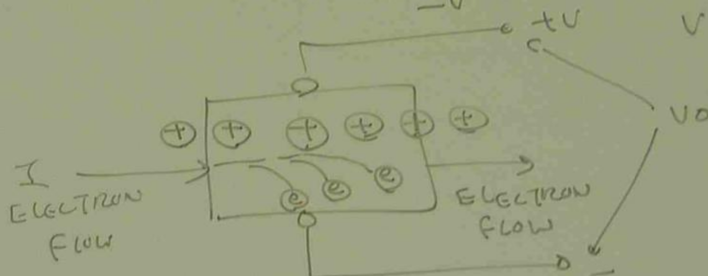
THE ELEMENT USED FOR PROXIMITY SENSING IS AN ELECTRO ACOUSTIC TRANSDUCER, PIEZO-ELECTRIC CERAMIC TYPE. THE SENSOR EMITS A 5mm ACOUSTIC BEAM WHICH IS BOUNCED BACK BY OBJECT AND RECEIVED BY SENSOR.

HALL EFFECT SWITCH

To



I = CURRENT
B = MAGNETIC FIELD
V = VOLTAGE



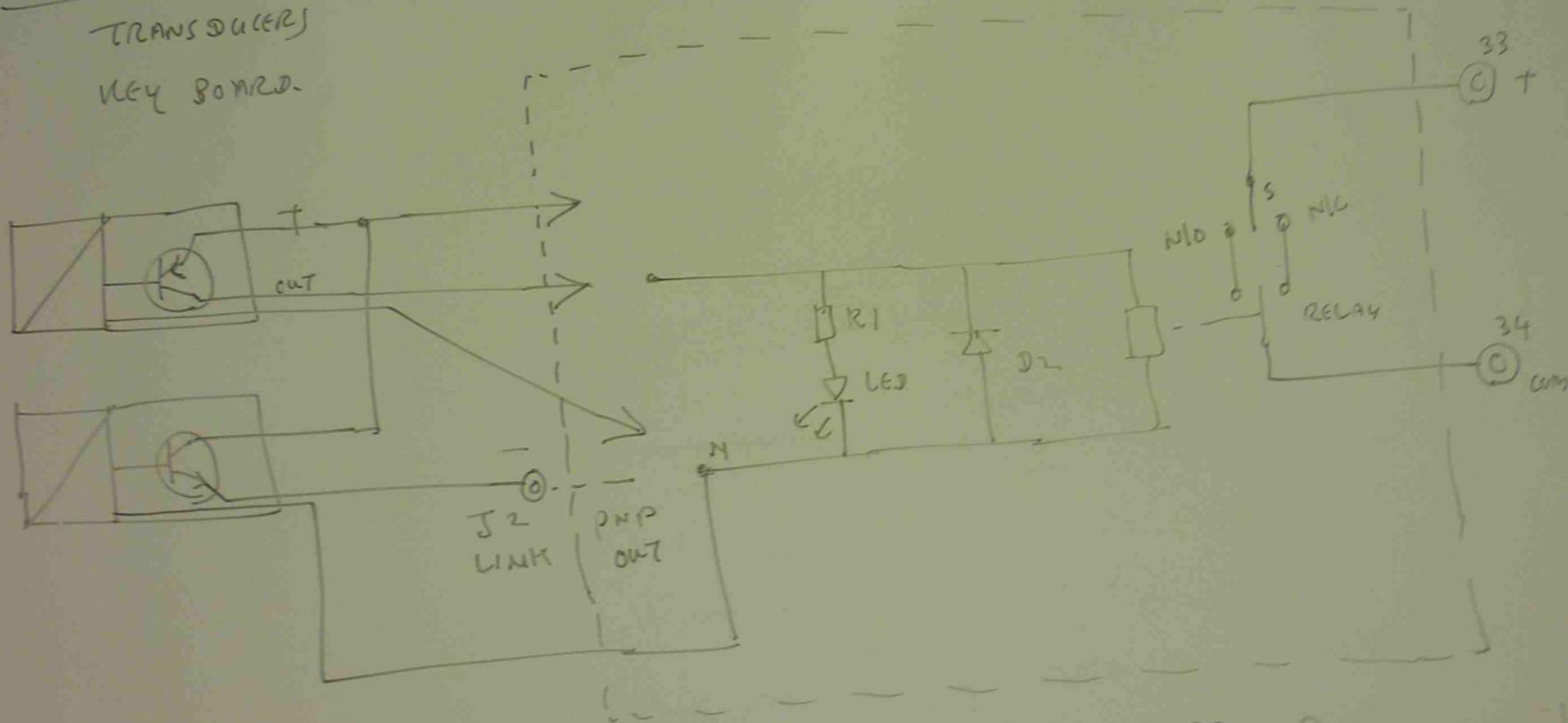
WHEN A CURRENT I OF CHARGE CARRIE (ELECTRONS) PASSES THROUGH A SMALL, THIN, FLAT SLAB OF SEMI CONDUCTOR MATERIAL THAT HAS A MAGNETIC FIELD (B) PASSING THROUGH IT, A VOLTAGE WILL BE PRODUCED THAT IS PERPENDICULAR

TO THE DIRECTION OF CURRENT FLOW AND PERPENDICULAR TO THE DIRECTION OF MAGNETIC FIELD.

APPLICATION

TRANSDUCERS

KEY BOARD.



SENSOR RELAY BUFFER BOX

Q/ EXPLAIN THE METHOD OF TUNING P AND D CONTROLLER, USING THE SYSTEMATIC TRIAL METHOD.

PRELIMINARY

DERIVATIVE OFF
GAIN LOW (Eg 0.3)
CONTROLLER ON AUTO

TUNING PROCEDURE

- PROGRESSIVELY INCREASE THE CONTROLLER GAIN AND MAKE A SMALL STEP CHANGE TO THE SET POINT WITH EACH INCREASE IN GAIN.
- OBSERVE THE RESPONSE OF THE P.V TO EACH SET POINT CHANGE
- CONTINUE THE ABOVE PROCEDURE UNTIL RESPONSE IS OBTAINED.
- INCREASE DERIVATIVE TIME
- INCREASE THE GAIN SO THAT CYCLE AMPLITUDE INCREASES AGAIN.
- INCREASE DERIVATIVE TIME
- REPEAT THE STEP

Q. EXPLAIN THE TUNING OF PID CONTROLLER

PRELIMINARY

DERIVATIVE OFF + INTEGRAL IS
GAIN LOW TURNED OFF
CONTROLLER ON AUTO

TUNING PROCEDURE

- AS ABOVE

+

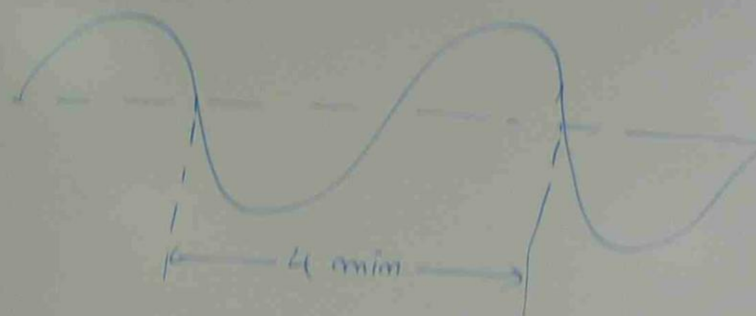
GRADUALLY DECREASE THE INTEGRAL TIME

MAKE A SMALL SET POINT CHANGE WITH

DECREASE IN INTEGRATION TIME.

OBSERVE THE RESPONSE.

Q



PERIOD + VALUE

THE P.U CYCLE SHOWN ABOVE WAS OBTAINED WHEN TUNING A CONTROLLER USING THE ULTIMATE CYCLING METHOD (CONTROLLER GAIN $K_u = 1.8$). DETERMINE THE CONTROLLER SETTINGS FOR A PID CONTROLLER.

CONTROLLER GAIN FOR PID CONTROLLER $= \frac{K_u}{2} = \frac{1.8}{2} = 0.9$

INTEGRAL TIME $= \frac{P_u}{3} = \frac{4 \text{ min}}{3} = 1.3 \text{ min}$

DERIVATIVE TIME $= \frac{P_u}{6} = \frac{4}{6} = 0.7 \text{ min}$

Q EXPLAIN THE PROCEDURE INVOLVED IN TUNING A CONTROLLER USING THE ULTIMATE CYCLING METHOD.

- INTEGRAL & DERIVATIVE OFF
- CONTROLLER IS GRADUALLY INCREASED
- SMALL SET POINT CHANGES ARE MADE UNTIL P.V STARTS TO CYCLE WITH A CONSTANT AMPLITUDE

(THIS IS CALLED ULTIMATE CYCLE)

THIS GAIN IS ULTIMATE GAIN (Ku)

THE PERIOD OF CYCLE IS ULTIMATE PERIOD P.u

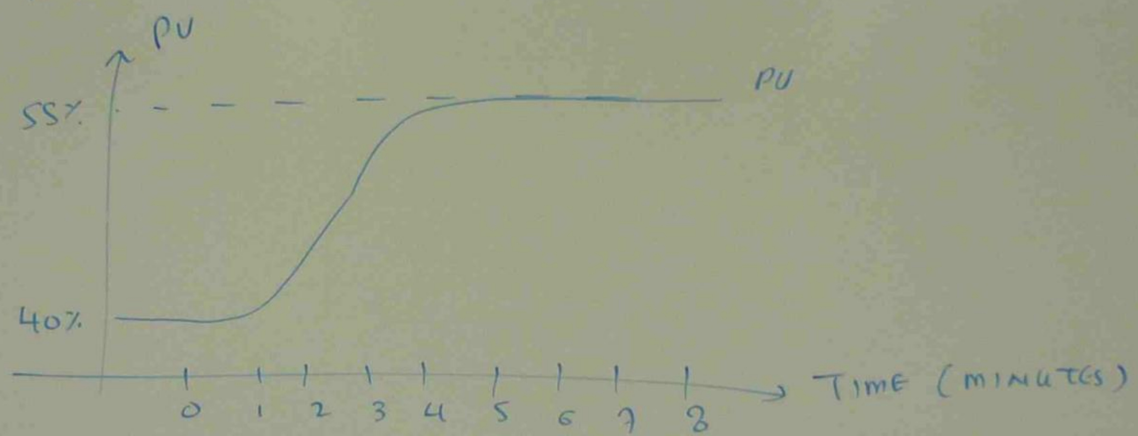
TROLLER

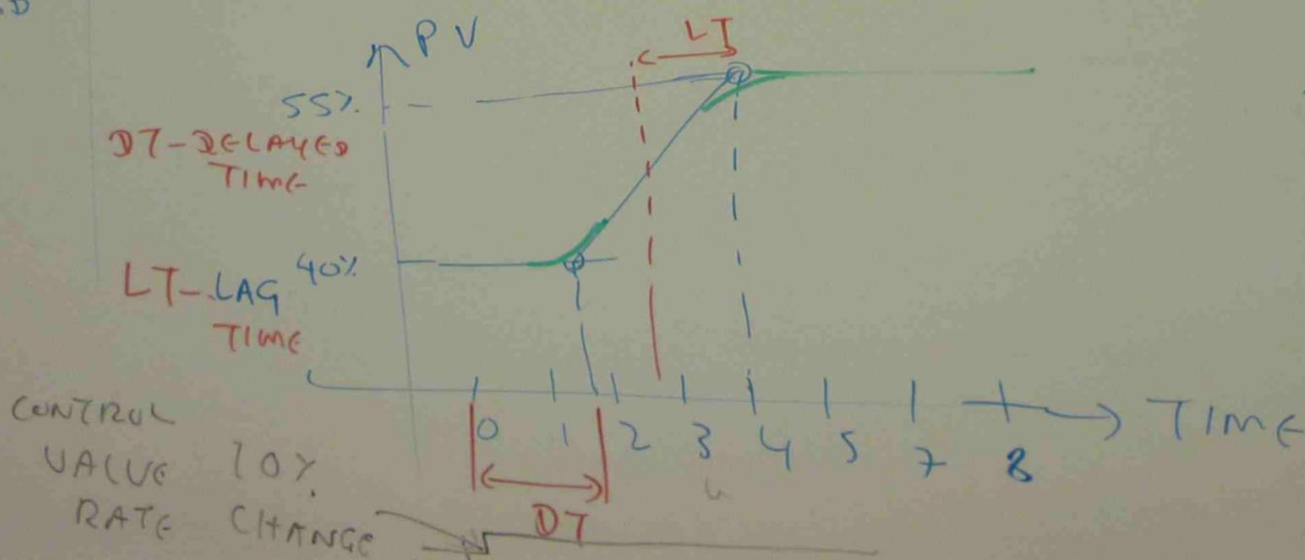
P.U

DE

RIOD

Q/ THE FOLLOWING GRAPH SHOWS THE PROCESS RESPONSE OBTAINED FROM A STEP RESPONSE (OPEN LOOP) TUNING PROCEDURE. CALCULATE P AND I SETTING REQUIRED FOR THIS LOOP.





DT = 1.6 min

LT = 2.4 min

LAG RATIO (R) = $\frac{LT}{DT} = \frac{2.4}{1.6} = 1.5$

PLANT GAIN (C) = $\frac{\text{\% CHANGE OF PV}}{\text{\% CHANGE OF VALVE STROKE}} = \frac{15\%}{10\%} = 1.5$

PID SETTING

% PROPORTIONAL BAND = $(100\% - \text{\% CHANGE PV}) \times \frac{C}{R}$

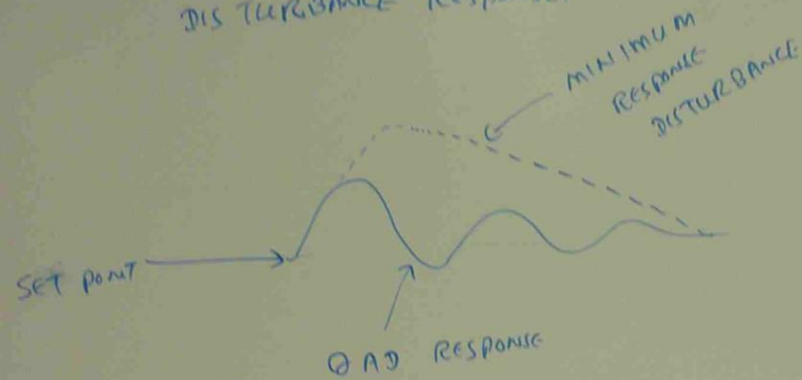
$= (100 - 15) \times \frac{1.5}{1.5} = 85\%$

INTEGRAL TIME (RESET TIME) = $\frac{1.5 \times DT \times C}{R} = \frac{1.5 \times 1.6\,min \times 1.5}{1.5} = 2.4\,min$

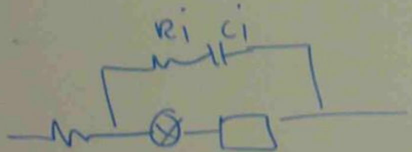
DERIVATIVE TIME = $\frac{0.5 \times DT \times R}{C} = \frac{0.5 \times 1.6 \times 1.5}{1.5} = 0.8\,min$

Q SE
SET POINT
Q EX

Q. SKETCH THE GRAPH SHOWING QAD (QUARTER AMPLITUDE DAMPED) AND MINIMUM DISTURBANCE RESPONSE.



Q. EXPLAIN THE PROCEDURE REQUIRED TO TUNE A CONTROLLER USING THE OPEN LOOP (STEP RESPONSE) METHOD



$T_i = R_i C_i$

(INTEGRAL CONTROL)

THE CONTROLLER IS PLACED ON MANUAL.

A RECORDER IS REQUIRED TO RECORD THE P.V RESPONSE.

A STEP CHANGE IS APPLIED TO THE CONTROL VALVE (5% TO 10%). P.V RESPONSE IS RECORDED

P. V GRAPH IS PLOTTED

DELAY TIME (DT) AND LAG TIME

(LT) AND PLANT GAIN (C) ARE

CALCULATED.

BASED ON LT, DT & C

INTEGRAL TIME, DERIVATIVE TIME

ARE CALCULATED

THEN REQUIRED VALUES OF R, C

IN PID CONTROL ARE DETERMINED.