METHODS TO IMPROVE NOISE PERFORMANCE

TO MINIMIZE INTERNAL NOISE

(1) REDUCE BANDWIDTH TO MINIMUM

(2) KEEP ALL RESISTOR VALUES AS LOW AS POSSIBLE

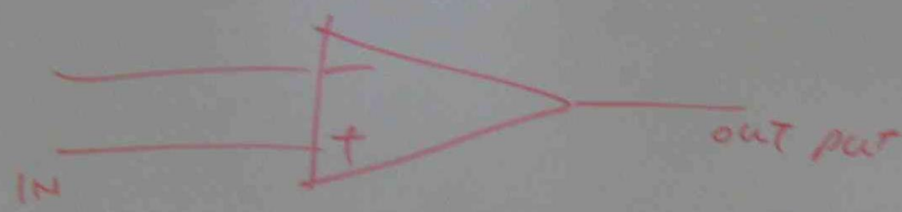
(3) USE LOW NOISE OP-AMPS.

(4) ELIMINATE NOISE AT THE FIRST STAGE OF MULTI STAGE AMPLIFIERS

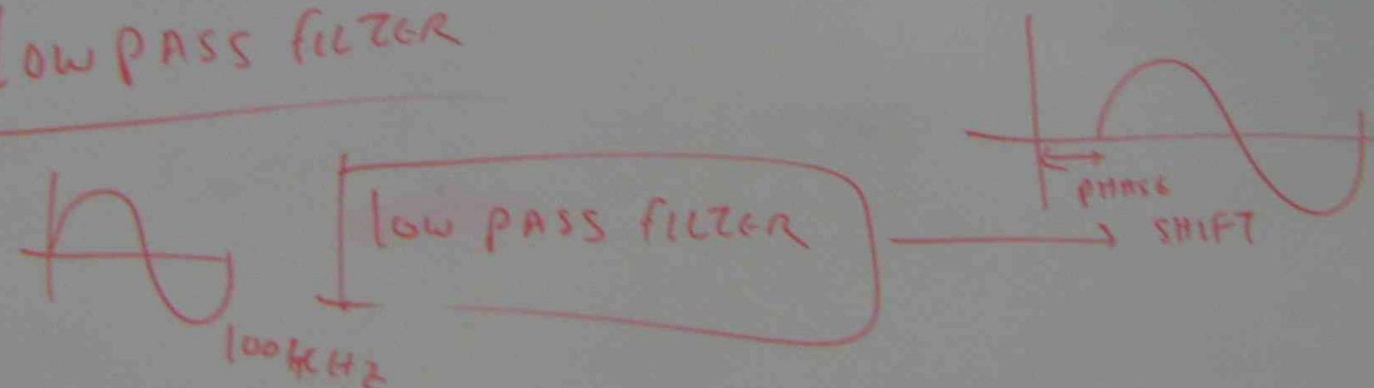
(5) KEEP THE COMPONENTS COOL BY HEAT SINKING OR AIR FLOW

FREQUENCY COMPENSATION

OPEN LOOP FREQUENCY RESPONSE OF OP-AMP



LOW PASS FILTER



THE OPEN LOOP GAIN OF AN OP-AMP STARTS DECREASING FROM A LOW FREQUENCY.

THE LOW PASS FILTERS NOT ONLY ATTENUATE THE OUTPUT, THEY ALSO INTRODUCE A PHASE SHIFT.

TYPICAL GAIN AND PHASE RESPONSE OF AN OP-AMP

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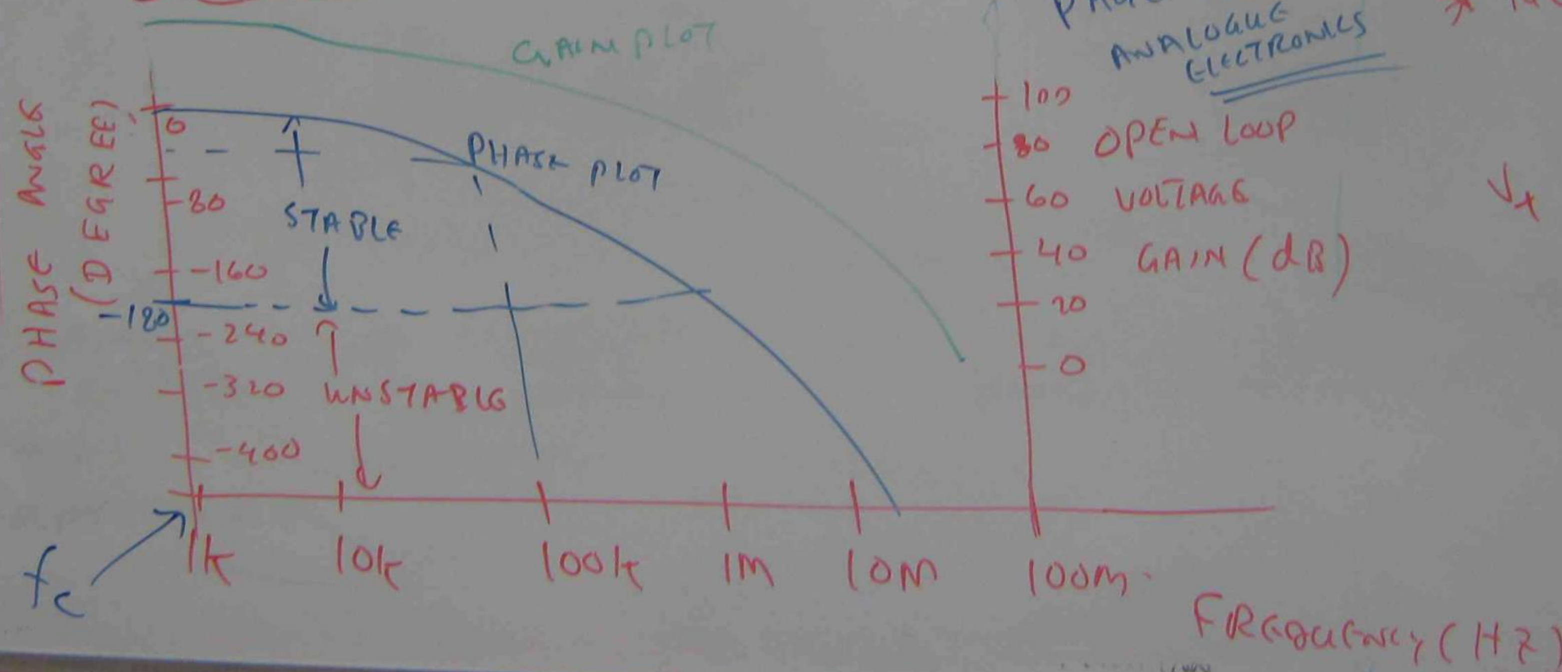
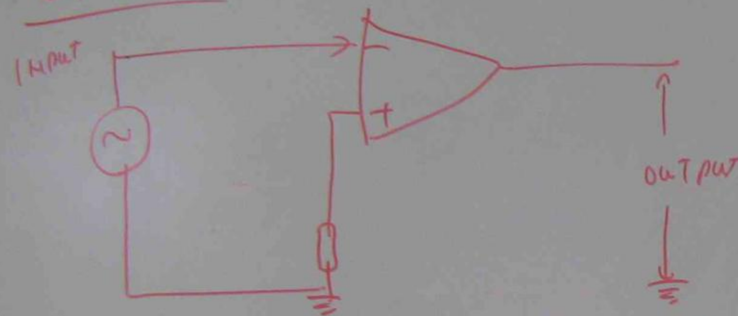


STABILITY OF NEGATIVE FEEDBACK CIRCUITS

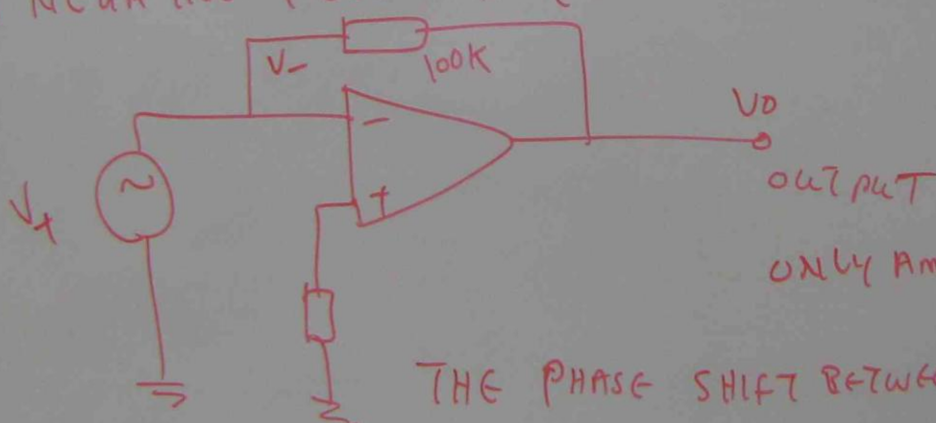
OPEN LOOP



GAIN LARGER & LARGER

UNSTABLE

* NEGATIVE FEEDBACK (NFB) TO REDUCE THE GAIN. SOME PORTION OF OUTPUT VOLTAGE IS FED BACK.



ONLY AMPLIFIES $(V_+ - V_-)$

THE PHASE SHIFT BETWEEN THE OUTPUT AND INPUT CAN CHANGE.

IF PHASE SHIFT IS ≤ -180 & THE AMOUNT OF FEEDBACK IS LARGE, UNSTABLE

(HZ)

IF PHASE SHIFT IS $> -180 \rightarrow$ STABLE.

UNSTABILITY

HIGH FREQUENCY NOISE AT OUTPUT MIXED WITH INPUT SIGNAL

THE CONDITIONS OF UNSTABILITY

- SIGNAL GAIN $\geq$ 0dB
- AMOUNT OF FEED BACK IS LARGE
- PHASE SHIFT $\leq -180^\circ$

(1) C

(2)

(3)

(4

T SIGNAL

GRAPHICAL DETERMINATION OF AMPLIFIER STABILITY

(1) CALCULATE CLOSED LOOP GAIN

$$A_{CL} = 1 + \frac{R_f}{R_1}$$

(2) CHANGE A_{CL} TO dB

(3) ON OPEN LOOP GAIN PLOT, DRAW A HORIZONTAL LINE AT HEIGHT A_{CL} (dB)

(4) NOTE THE FREQUENCY AT WHICH THE LINE CUTS THE OPEN LOOP PLOT.

(5) READ PHASE PLOT AT RELEVANT FREQUENCY

(6) IF THE VALUE IS $< -180 \longrightarrow$ UNSTABLE

$> -180° \longrightarrow$ STABLE

ph

V_{10}

V_{20}

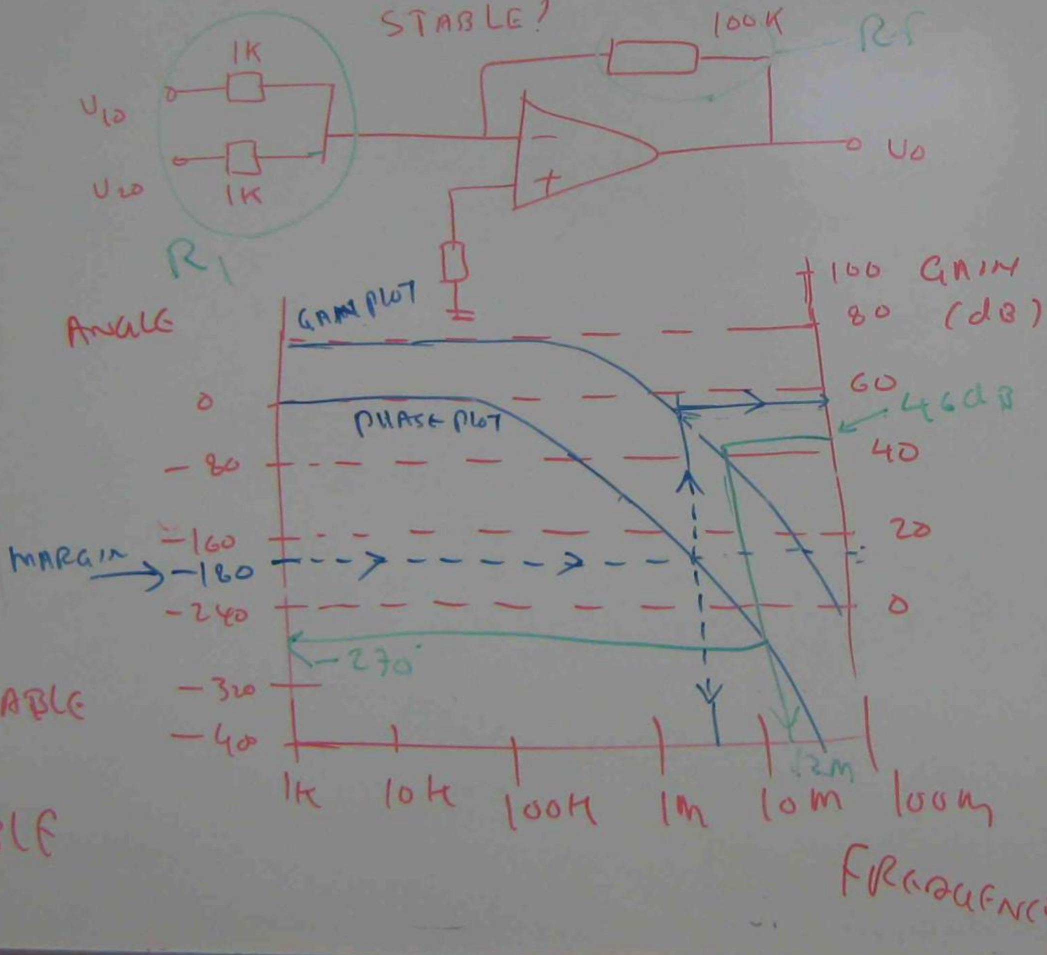
ANGLE

MARGIN $\rightarrow$

pb FOR THE GIVEN OP-AMP, AND IT'S PHASE PLOT ON GRAPH,

(a) IS THIS AMPLIFIER STABLE

(b) WHAT IS THE MINIMUM A_{CL} NEEDED TO MAKE THE AMPLIFIER STABLE?



$R_1 = 1k \| 1k$

$= \frac{1\times 1}{1+1} = 0.5K$

$= 500\Omega$

$R_f = 100k\Omega$

$A_{CL} = 1 + \frac{R_f}{R_1}$

$= 1 + \frac{100\times 1000}{500}$

$= 1 + 200 = 201$

$dB = -20\log_{10} 201$

$= -20 \times 2.303$

$= -46\ dB$

TAKE MAGNITUDE = $\underline{\underline{46dB}}$

46dB → GAIN PLOT → f = 12 MHz

↓

PHASE PLOT

↓

$-270°$

IT IS LESS THAN $-180°$

UNSTABLE

MINIMUM STABLITY

$-180°$ → PHASE PLOT → FREQUENCY → GAIN PLOT → dB

MINIMUM GAIN

60dB

PHASE ANGLE

$dB = -20 \log_{10} 201$

$= -20 \times 2.303$

$= -46\ dB$

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46dB → GAIN PLOT → f = 12 MHz

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PHASE ANGLE

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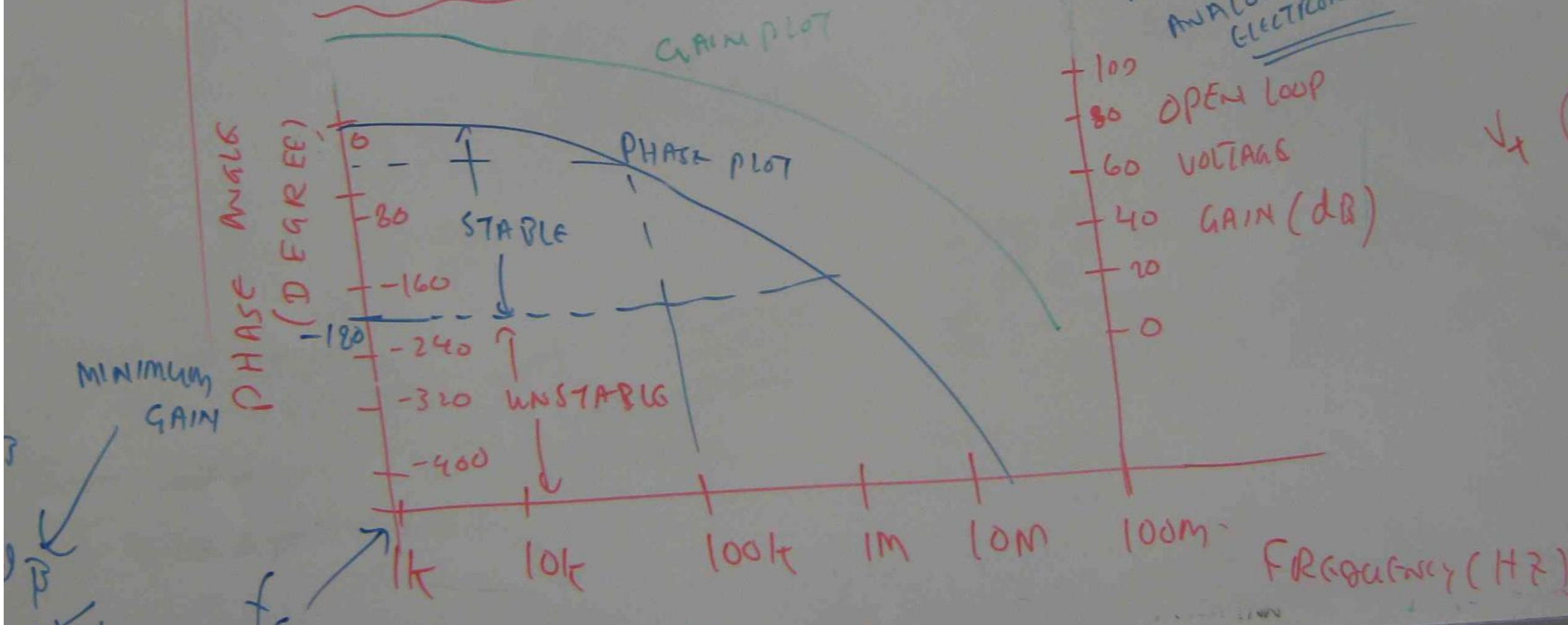

STA

OPEN

INPUT

* NEGA

V_+