CMR

INTERNAL ASSESSMENT TEST - II.

(Q2)

$$T = RC \ln\left(\frac{1}{1-\eta}\right).$$

$$T = \frac{1}{f} = \frac{1}{2\times10^3} = 5\times10^{-3}\, s.$$

$$5\times10^{-3} = R\times0.047\times10^{-6}\ln\left(\frac{1}{1-0.66}\right)$$

$$R = \frac{5\times10^{-3}}{4.315\times10^{-8}}.$$

$$= ~~116.86~~ \; 11.6\,K\Omega.$$

$$V_P = \eta V_{BB} + V_D.$$

$$V_{BB} = \frac{V_P - V_D}{\eta}$$

$$= \frac{14 - 0.8}{0.66}.$$

$$= 20V.$$

$$R_2 = \frac{0.7(R_{B1}+R_{B2})}{\eta V_{BB}}$$

$$= \frac{0.7(5\times10^3)}{0.66\times20} = 265.15\,\Omega.$$

$V_{BB} = I_{leakage}(R_1 + R_2 + R_{B1} + R_{B2})$

$20 = 3.2 \times 10^{-3} (R_1 + 265.15 + 5 \times 10^3)$

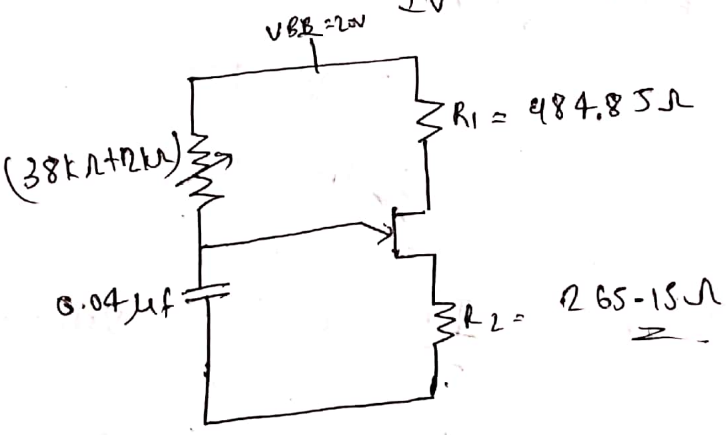
$R_1 = \left(\frac{20}{3.2 \times 10^{-3}}\right) - (5265.15)$

$R_1 = 984.85\ \Omega$

$R_{min} = \frac{V_{BB} - V_P}{I_P}$

$= \frac{20 - 14}{3 \times 10^{-3}} = 2\ k\Omega$

$R_{max} = \frac{V_{BB} - V_V}{I_V} = \frac{20 - 1}{0.5 \times 10^{-3}} = 38\ k\Omega$



(3)

$n = 30;\ m = 40;\ V_s = 230;\ f = 50\ Hz;\ R = 50\ \Omega.$

$K = \frac{n}{n+m} = \frac{30}{30+40} = 0.4285.$

$T = \frac{1}{f} = 20\ ms$

$V_m = \sqrt{2}\, V_s = \sqrt{2} \times 230 = 325.26\ V$

(i) $T_{ON} = 20 \times 10^{-3} \times n$

$= 20 \times 10^{-3} \times 30.$

$= 0.6s = 600ms$

$T_{OFF} = 20 \times 10^{-3} \times m$

$= 20 \times 10^{-3} \times 40.$

$= 0.8s = 800ms$

(ii) $(V_o)_{rms} = \sqrt{K}\, V_s$

$= \sqrt{0.4285} \times 230.$

$= 150.55\,V$

(iii) Input power factor $= \sqrt{K}$

$= \sqrt{0.4285}$

$= 0.6545$

(iv) ~~RMS~~ $(I_T)_{rms} = \frac{I_m}{\pi} K$ $\quad$ ~~VMA~~ $= \cdot\; I_m = \frac{V_m}{R}$

$= \frac{6.5052}{\pi} \times 0.4285$ $\quad$ $= \frac{325.26}{\pi} \times 0.4285$ $\quad$ $= \frac{325.26}{50.}$

$= 0.881A$ $\quad$ $= 44.36A$ $\quad$ $= 6.505$

$(I_T)_{avg} = \frac{I_m}{2} \sqrt{K}.$

$\frac{6.5052}{2} \times 0.6545 = \frac{325.26}{2} \times 0.6545.$

$= 2.12A$ $\quad$ $= 106.44A$

(5) $P_o = 5\,kW$; $R = 5\,\Omega$.

$V_m = \sqrt{2} V_s$

$= \sqrt{2} \times 230 = 325.26\,V$

(i) ~~$P_o = \sqrt{V_o R}$~~

~~$= \sqrt{325.26 \times 5\,\Omega}$~~

$(V_o)_{rms} = \sqrt{P_o R}$

$= \sqrt{5 \times 10^3 \times 5}$

$= 158.11\,V$

$(I_o)_{rms} = \frac{(V_o)_{rms}}{R}$

$= \frac{158.11}{5} = 31.62\,A$

(ii) Duty cycle $K = \left(\frac{(V_o)_{rms}}{V_s}\right)^2$

$= \left(\frac{158.11}{230}\right)^2$

$= 0.4725\,V$

(iii) Power factor $= \sqrt{K} = \sqrt{0.4725}$

$= 0.6874$

(iv) $(I_T)_{rms} = \frac{I_m}{\pi} K$

$= \frac{65.052}{\pi} \times 0.4725$

$= 9.78\,A$

$I_m = \frac{V_m}{R}$

$= \frac{325.26}{5}$

$= 65.052\,A$

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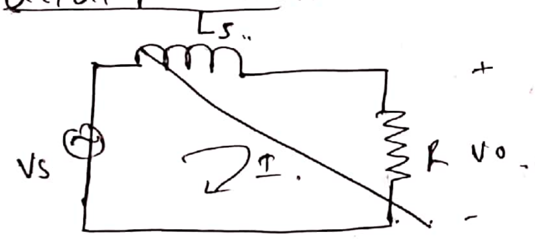
$(I_T)_{Avg} = \frac{I_m}{2} \sqrt{K}$.

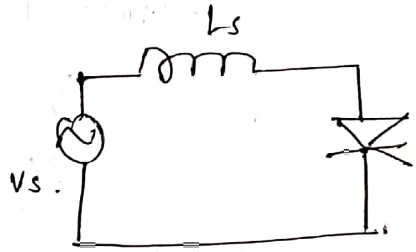
$= \frac{65.062}{2} \sqrt{0.4725}$.

$= 21.33 A$

di/dt protection:-

(4)





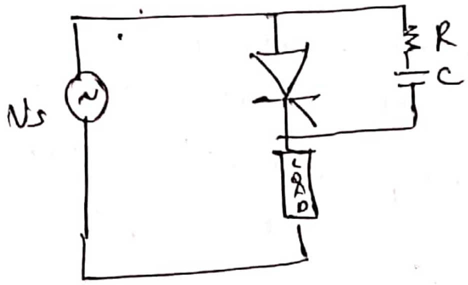
- When the SCR turns ON rapidly, anode current varies and hence this variation in current is non uniform across SCR, which creates hot spots, the temperatures exceeds permissible value thus damaging the circuit.
- di/dt protection is therefore required for protection against high temperature.

$di/dt = \frac{V_s}{L_s}$

$\therefore L_s = \frac{V_s}{di/dt}$

dv/dt protection

When positive voltage is applied the Junction J_1 & J_3 are forward biased and junction J_2 is reverse



biased thus capacitor is connected in parallel to SCR.

- When positive voltage exceeds certain value even when gate voltage is zero the gate SCR turns ON this leads to false operation of SCR and dv/dt protection is needed to protect the operation of SCR.

- $i = dq/dt$

$$q = C_j V_s$$

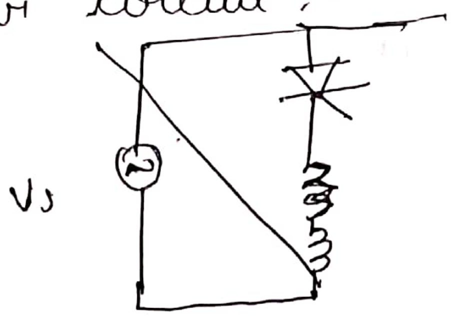
$$i = \frac{d}{dt}(C_j V_s)$$

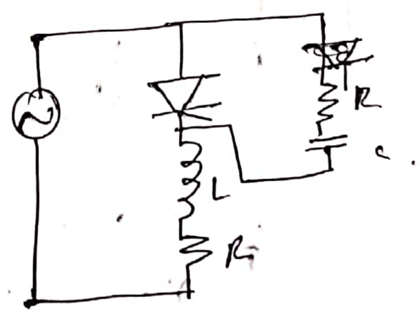
$$i = \left(\frac{dC_j}{dt}\right)V_s + C_j \frac{dV_s}{dt}$$

C_j is almost constant.

$$i = C_j \frac{dV_s}{dt}$$

- Snubber circuit :-



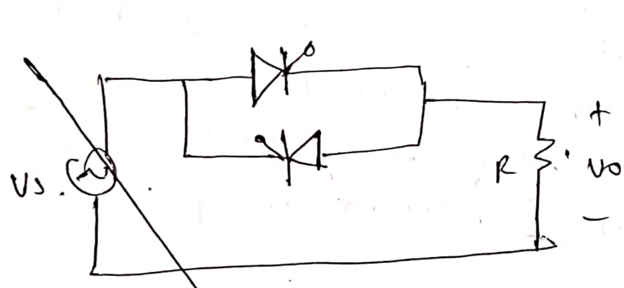


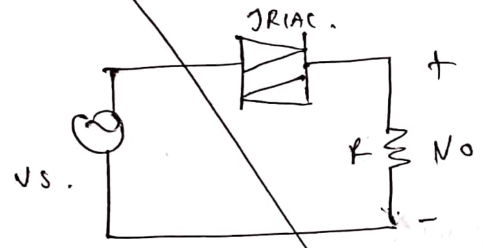
The capacitor is added in parallel so that it charges slowly when positive voltage is applied, and when SCR turns OFF, the excess current

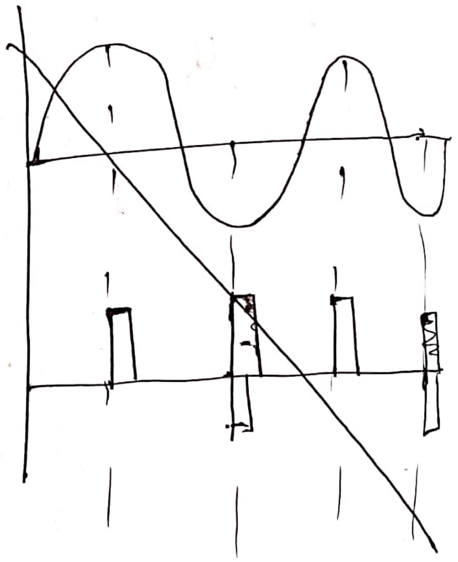
(8)

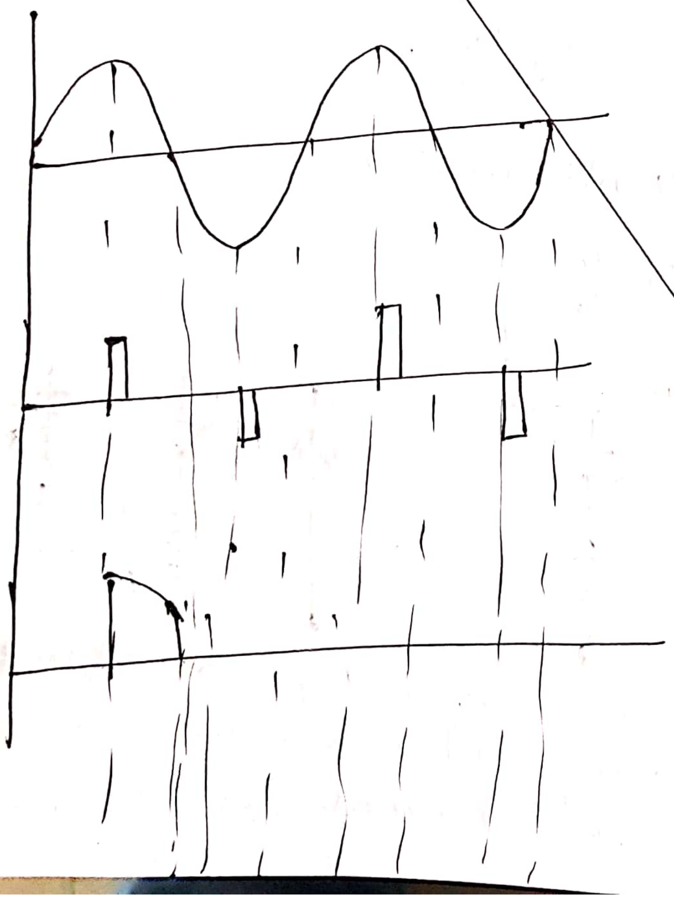
is ~~discho~~ passage to SCR during discharging of capacitor, this will ~~dano~~ damage SCR, in order the limit the current passing thorough SCR resistor is connected in series with capacitor.

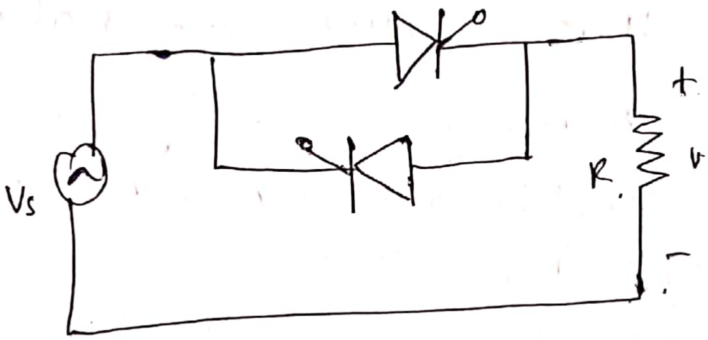
(6)

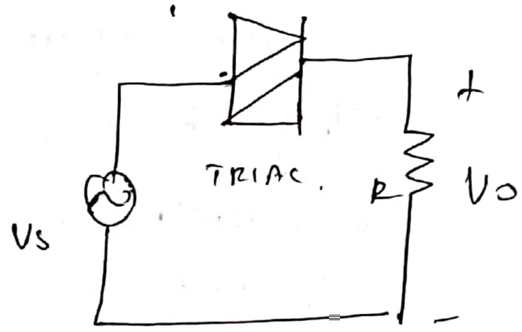


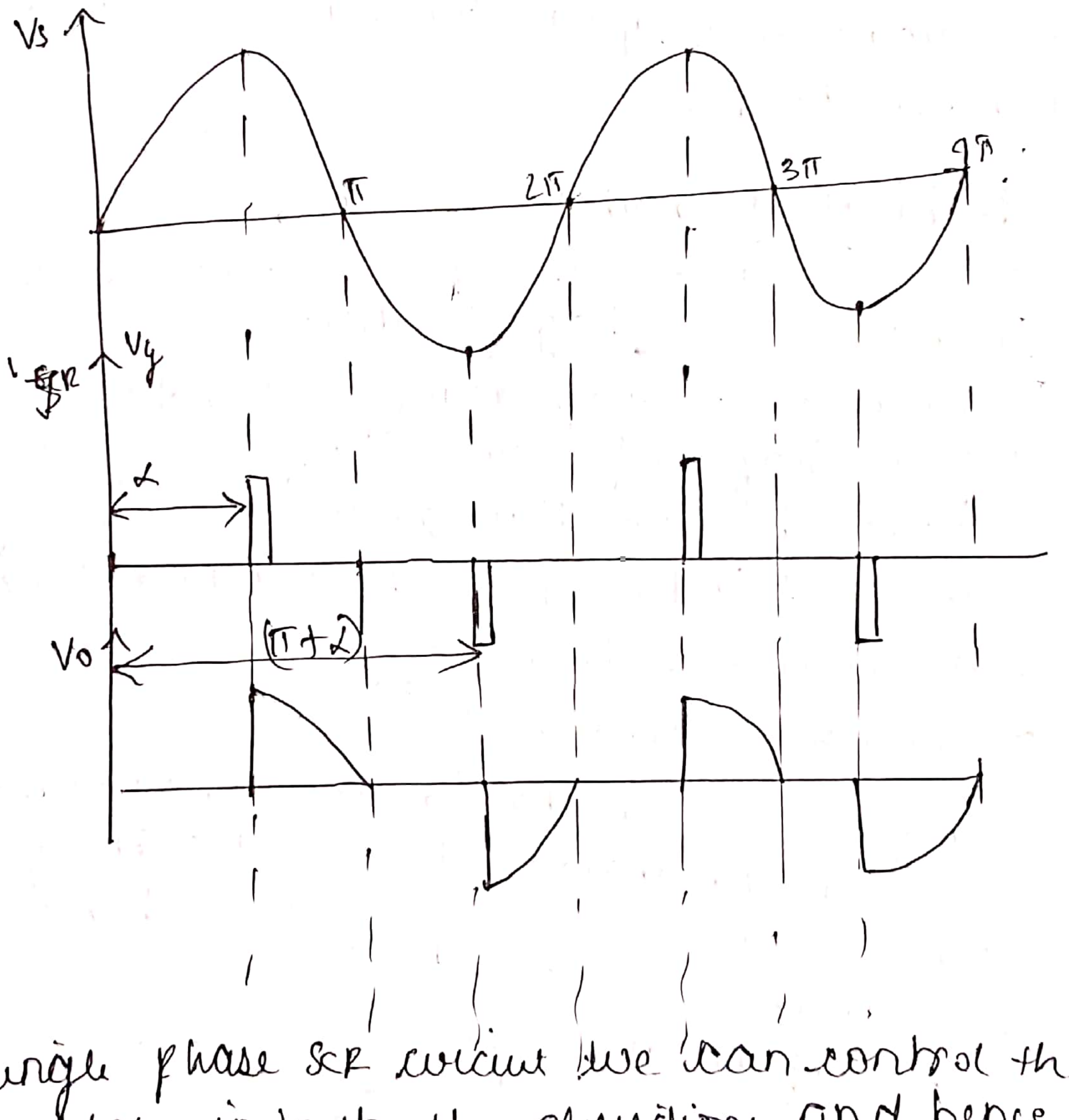












- In single phase SCR circuit we can control the power flow in both the directions and hence it is called bidirectional controller.
- The power can be controlled in both half cycle.
- In positive half cycle thyristor T_1 is ON, and T_2 is off after triggering angle α, the T_1 conducts between α to π radians, when v_s crosses ~~positive~~ zero towards.

negative cycle the thyristor T_1 turns Off naturally.

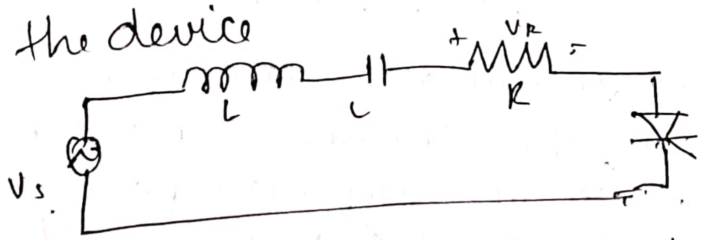
- Thyristor T_2 turns ON in negative half cycle and conducts between $(\pi+\alpha)$ to 2π radians and it turns Off naturally after in positive cycle.
- Both the triggering angles of T_1 and T_2 are π radians or 180° apart, ~~hen~~ hence conduction happens in both half cycles.

(7) Natural commutation :-

- In natural commutation the reverse voltage nature of AC voltage is utilised.
- When AC voltage crosses zero ~~the~~ towards negative ~~haf~~ half cycle, the forward current reduces to zero, thus ~~turing~~ turning off the device, this does not need any external ~~curr~~ circuit to turn off the device.

Forced ~~com~~ commutation :-

- In forced commutation the external ~~sort~~ circuit is connected inorder to reduce the forward current to zero forcefully and hence turn off the device



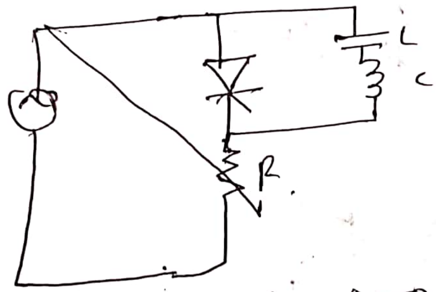
Class A commutation.

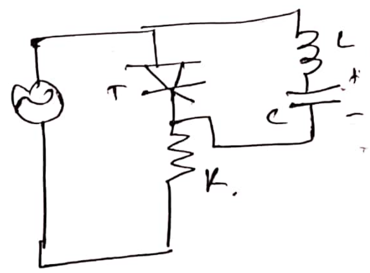
(i) class A commutation :-

- In class A commutation it is also called resonating commutation with LC component connected in series.

- The current through SCR is made lower than holding current to turn off device, even when voltage is positive the ~~H~~ current is made to resonate, when the current goes to zero, the ~~hold voltag~~ forward current reduces, then commutation on current reduces, and resonating frequency is determined by the LC component present in the circuit.

(ii) Class B commutation :-





- The LC component is connected in parallel and it is called pulse resonant ~~or~~ commutation circuit.
- When positive voltage is applied the capacitor gets charged and the device turns on, when the voltage goes negative the polarity gets reversed and capacitor starts discharging through C- T - L - C+ and hence forwards current reduces and goes to zero turning off the SCR.
- ~~The SCR turns on i.e~~ The capacitor turns ON again when after discharging which in turn turns on SCR with same polarity.

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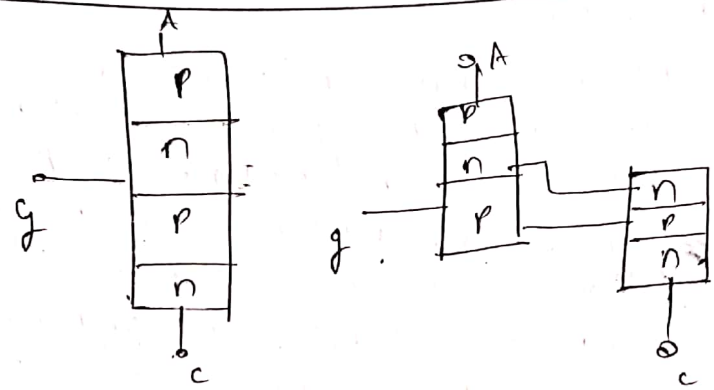
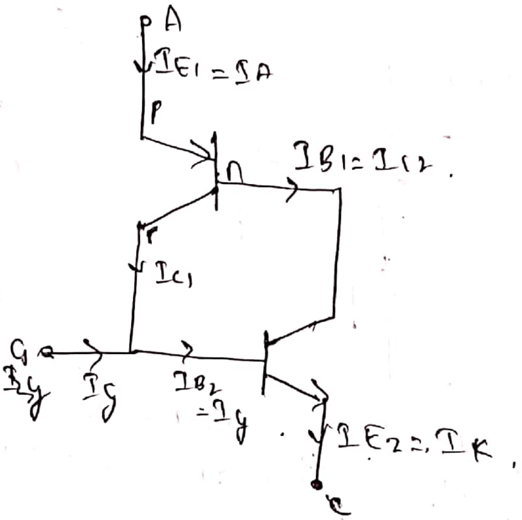
(1)





$I_{A1} = I_{E1}\alpha_1 + I_{CBO_1}$

$I_{E1} = I_A$

~~$I_{A1} = I_A\alpha_1\ I_{A1}\alpha$~~

$I_{A1} = I_A\alpha_1 + I_{CBO_1}$ — (1)

$I_{A2} = I_{E2}\alpha_2 + I_{CBO_2}$

$I_{E2} = I_K$.

$I_{A2} = I_K\alpha_2 + I_{CBO_2}$ — (2)

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From ① & ②.

$I_A = I_{A1} + I_{A2}$

$I_A = I_A \alpha_1 + I_{CBO_1} + I_K \alpha_2 + I_{CBO_2}$.

$I_K = I_A + I_g$

$I_A = I_A \alpha_1 + I_{CBO_1} + I_A \alpha_2 + I_{CBO_2} + I_g \alpha_2$.

$I_A = I_A(\alpha_1 + \alpha_2) + I_{CBO} + I_{CBO} + I_g \alpha_2$.

$I_A(1 - (\alpha_1 + \alpha_2)) = I_{CBO_1} + I_{CBO_2} + I_g \alpha_2$

$$I_A = \frac{I_{CBO_1} + I_{CBO_2} + I_g \alpha_2}{1 - (\alpha_1 + \alpha_2)}$$