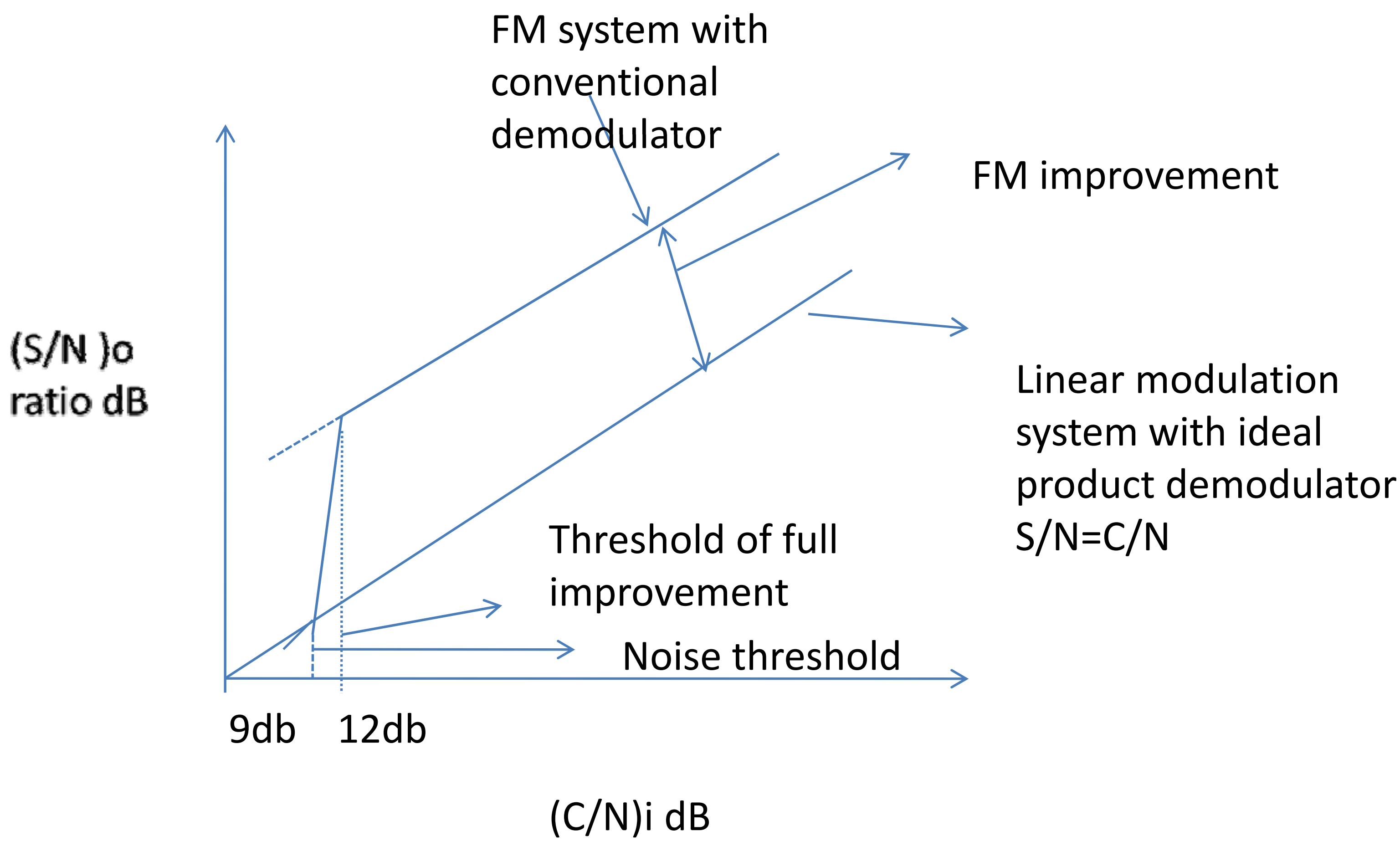
Relation between S/N &C/N

- Performance of FM receiver is judged on the basis of variation of output (S/N)o as function of (C/N) is measured at the input to the limiter.

$$\left(\frac{S}{N}\right)_O = \left(\frac{C}{N}\right)_i \frac{3}{2} m^2$$

$$\left(\frac{S}{N}\right)_{OdB} = \left(\frac{C}{N}\right)_{idB} + 10 \log \frac{3}{2} m^2$$

- The second term on RHS gives improvement by FM in return for BW sacrifice
- As (C/N)i decreases (S/N)o falls more sharply than (C/N)i as seen in the figure below.



Threshold (C/N)i for FM detector

Contt---

- With phase detector

$$\frac{\left(\frac{S}{N}\right)_O}{\left(\frac{C}{N}\right)_i} = (\Delta\phi)^2$$

- Δϕ=peak phase deviation
- For non-sinusoidal modulating signal spectrum (0 to fmax Hz)

$$\left(\frac{S}{N}\right)_0 = \left(\frac{C}{N}\right)_i \frac{3B}{2f_{\max}}\left(\frac{\Delta f_{peak}}{f_{\max}}\right)^2$$

Contt---

$$B = 2 f_{\max} (1 + m)$$

$$m = \frac{\Delta f_{peak}}{f_{\max}}$$

$$\left(\frac{S}{N}\right)_0 = \left(\frac{C}{N}\right)_i * 3(1 + m) m^2$$

- For large m,$3(1+m)m^2 \approx 3m^2$
- $m \ll 1$,$3(1+m)m^2 \approx 3m^2$

S/N CAN BE IMPROVED

- The above eqn. shows that S/N can be improved by INCREASING THE CARRIER POWER (by increasing level of modulating baseband signal)
- Pre-emphasis at the transmitting system
- De-emphasis at the demodulating network

Power Spectral density

- In audio baseband signal power spectral density is relatively high in low frequency range and falls of rapidly at higher frequencies

- Thus in carrier modulated by audio signal , power spectral density of side bands near the carrier is highest and relatively small near the limits of allocated transmission band

S/N RATIO IN FREQUENCY MODULATION WITH MULTIPLEXED TELEPHONE SIGNAL IN SATELLITE LINK

- CHANNEL IS LOCATED AT THE HIGH FREQUENCY END OF THE MULTIPLEXED SIGNAL

$$\left(\frac{S}{N}\right)_{wc} = \left(\frac{C}{N}\right)_{i} * \left(\frac{B}{b}\right)\left(\frac{\Delta f_{rms}}{f_{\max}}\right)^{2}$$

- Where wc represents worst channel , b is voice channel BW (3100 Hz usually) , B is rf BW .

Contt---

- Since the frequency response of the telephone receiver or the human ear is not flat, listener will respond differently to noise in different parts of audio spectrum.
- So some noise will go unnoticed and effective SNR will be higher than that given by above eqn. by a certain factor called ***weighting factor.***
- Value depends upon the frequency of the telephone receiver and of the user ear
- 1-78(25 db) by CCITT

Modified (S/N)wc

$$\left(\frac{S}{N}\right)_{wc} = \left(\frac{C}{N}\right)_{i} * \left(\frac{B}{b}\right)\left(\frac{\Delta f_{rms}}{f_{\max}}\right)^{2} pq$$

$$\left(\frac{S}{N}\right)_{wc} = \left(\frac{C}{N}\right)_{i} + 10 \log_{10}\left(\frac{B}{b}\right) + 20 \log_{10}\left(\frac{\Delta f_{rms}}{f_{\max}}\right) + p + q$$

- P is 2.5 db and q is 4db
- P is psophometric weighting factor
- q Pre-emphasis improvement factor

Contt---

- Δfrms and B are usd to calculate no. of channels N carried by a multiplexed telephone signal and to the available transponder bandwidth
- Δfrms is the rms carrier deviation that a single 1KHz 0dBm sine wave called test tone would produce when supplied to modulator input
- Loading factor-(total rms deviation caused by a multiplexed signal is called loading factor)
- For N voice channel loading factor

$$20\log(l) = -1 + 4\log_{10}(N), 12 \leq N \leq 240$$

$$= 15 + \log_{10}(N), N > 240$$

Contt---

- l Δfrms – rms multicarrier deviation

$$g = \frac{\Delta f_p}{l \Delta f_{rms}}$$

- Where Δfp is peak frequency deviation
- N>24 g is3.16
- N<24 g 6.5
- 7500pwp (psophometircally weighted power) is the noise allowed for up and down links

Contt---

$$B = 2(\Delta f_p + f_{\max})$$

$$B = 2(gl\,\Delta f_{rms} + 2 f_{\max})$$

$$\Delta f_{rms} = \frac{\left(\frac{B}{2} - f_{\max}\right)}{gl}$$

$$S/N = \frac{10^{-3}}{7500\ x10^{-12}} = 1.33\ x10^{5}$$

$$S/N = 51.25\ dB$$