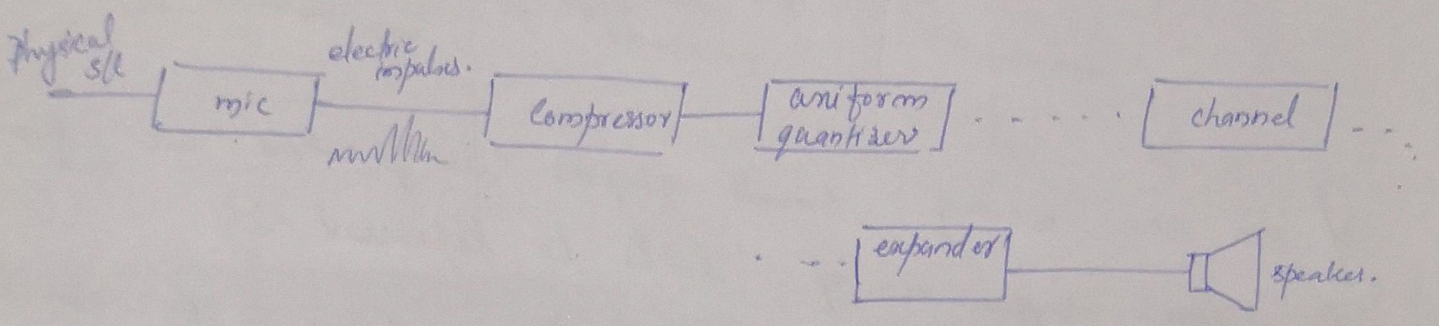
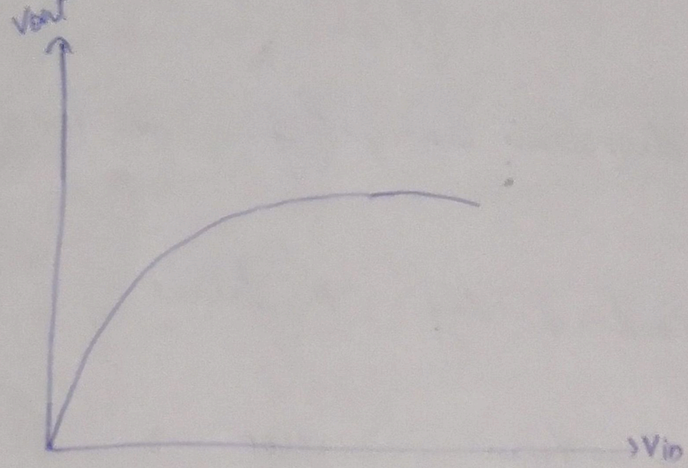
Companding

In nonuniform quantization we have variable stepsize which is according to the amplitude of the message signal.
Companding means at the transmitter we are compressing the s/g and at the reciever we are expanding the s/g.
→ compressing it and passed to the uniform quantizer and at the reciever we are expanding it.

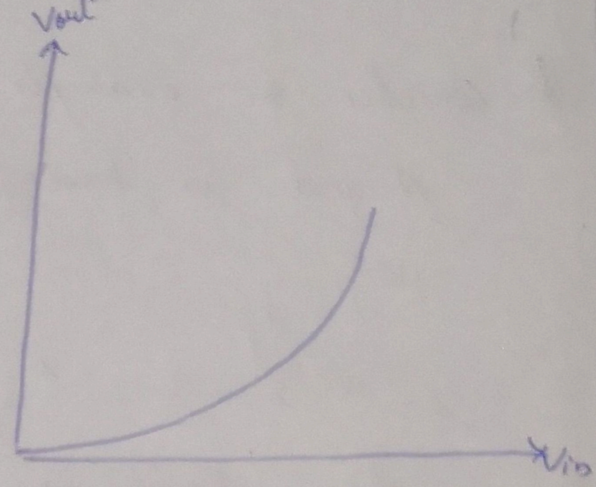


electric impulses from the mic is with variable amplitudes when it passed through a compressor; lower amplitude will get amplify and higher amplitude will attenuated.
By compressing the higher amplitude levels dynamic range (max - to - min) have reduced in the s/g.
After compressing it is subjected to uniform quantization.
This quantized value (s/g) is encoded and transmit through the channel. At the reciever after decoding process it will expand. ie; reverse process of compression
→ higher amplitude s/g will get amplify and lower amplitude s/g will get attenuate. The speaker will convert the electrical s/g. in to speech signal.

Characteristics of Companding



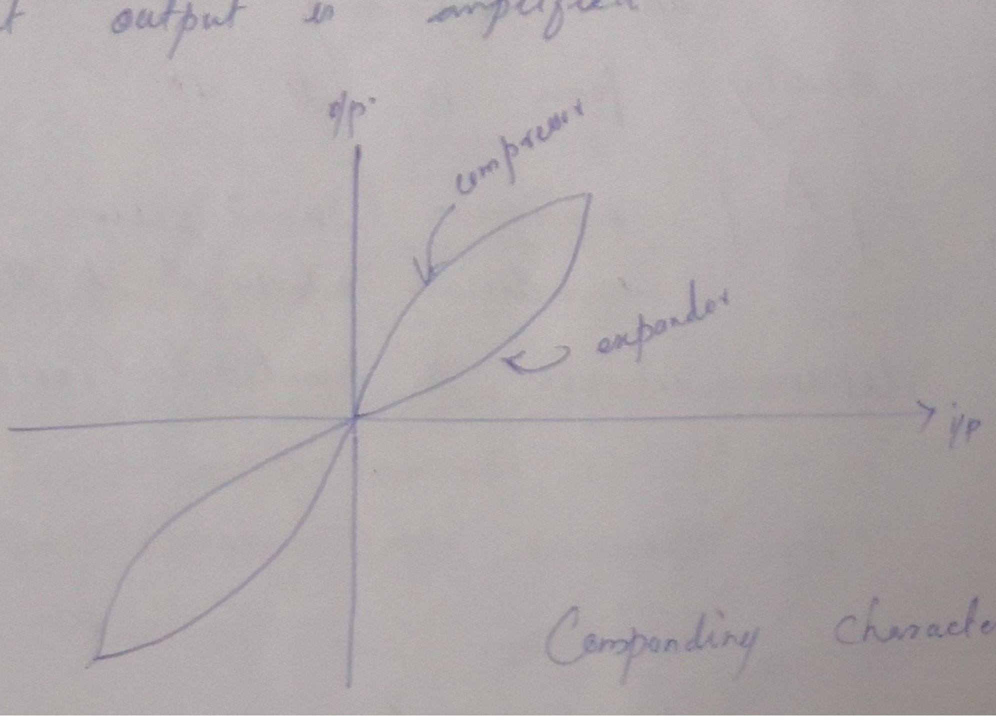
compressor



expander

From the graph we can see that for the compressor for lower value of i/p (lowamplitude) o/p is increasing fastly and for higher value of input o/p is lowering.

In the expander diagram things are happening inversely; i.e; for low value of i/p o/p is lowered and for higher value of input output is amplified.



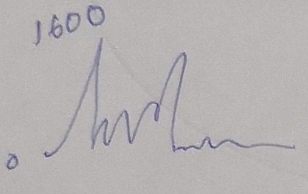
Companding Characteristics.

Advantage of Companding

1) Dynamic range is reduced
(2) stepsize is reduced so quantization error will reduce.

Consider the example.

A signal is having a dynamic range of 0V - 1600 V

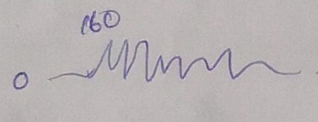


it is quantized by 16 levels

then stepsize $(\Delta) = \dfrac{V_{max} - V_{min}}{L} = \dfrac{1600 - 0}{16}$

$$\Delta = \underline{100}$$

After companding the dynamic range is reduced to 0V to 160V



Then step size $(\Delta) = \dfrac{160 - 0}{16} = \underline{10}$.

We can see that after companding the step size is reduced tremendously from 100 to 10.

$|Q_e|_{max} = \left|\dfrac{\Delta}{2}\right|$ maximum quantization error is directly proportional to step size

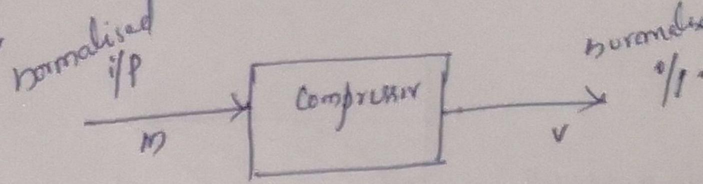
So when the stepsize decreases the quantization error will decrease.
when quantization error decreases SNR increases & efficiency increases; the gain also increases.

μ - law Companding

μ - law compressor is a standard for companding which is used in America & Japan.

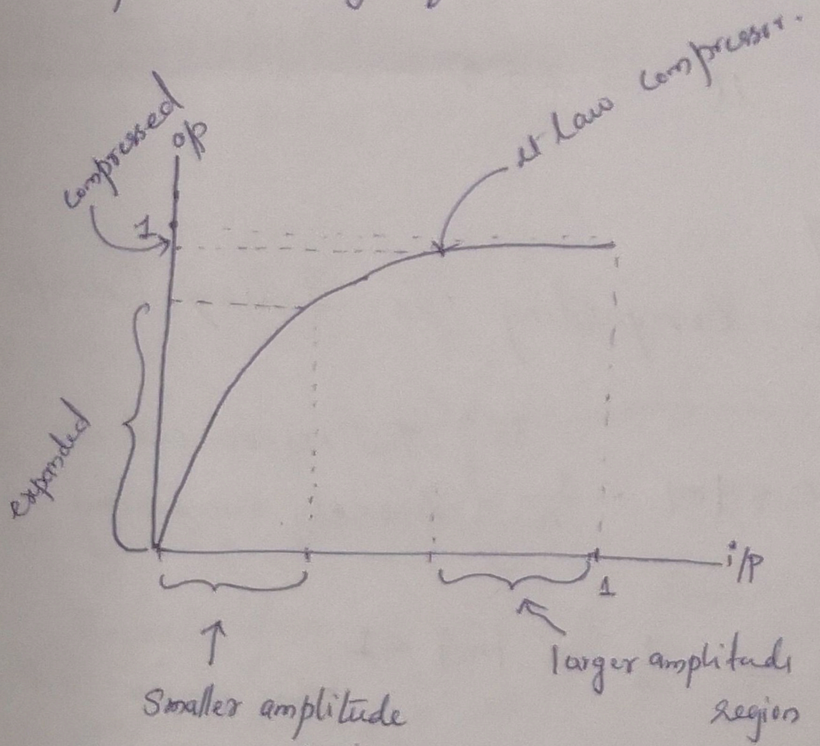
μ is the compression parameter.

$$m = \frac{x \rightarrow \text{amplitude of s/l at particular instant}}{x_{max} \rightarrow \text{max amplitude of s/l.}}$$



$$V = \frac{\log(1+\mu|m|)}{\log(1+\mu)} \quad \text{where } 0 \leq |m| \leq 1$$

The value of m is normalised to one; ie; the dynamic range of m is limited in b/w 0 and 1.



μ-law compressor is a concave function. Smaller amplitude regions of input is get expanded at the o/p side; and larger amplitude region get compressed at the o/p side.

$\Rightarrow$ Smaller amplitude region get expanded means it contains larger no: of quantization intervals ie; it is finely quantized.

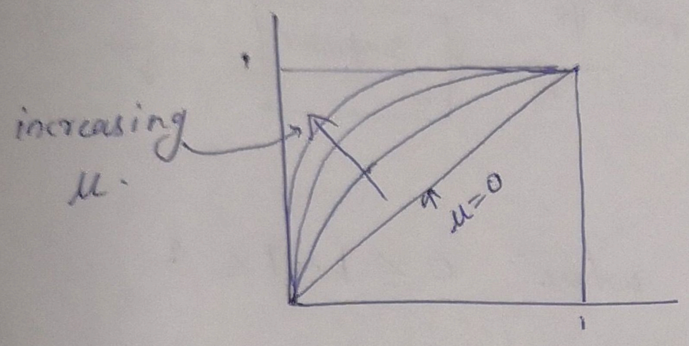
$\Rightarrow$ larger amplitude region get compressed means it contains less no: of quantization intervals ie; it is coarsely quantized.

when $\mu \to 0$ in the eqn $v = \frac{\log(1+\mu|m|)}{\log(1+\mu)} = \frac{\log 1}{\log 1}$.

at $\mu = 0$

there is no compression which means output = input.

So at $\mu = 0$ it will be a linear characteristics.



As μ increases the chara becomes more concave means μ increases more compression happens at larger amplitude region and also more expansion happens for lower amplitude region

(μ increases $\to$ more companding).

Practical value of $\mu = 255$.

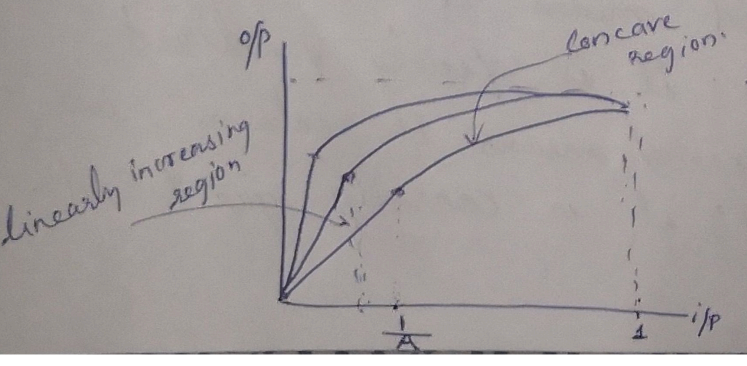
A - law Companding

This is a standard used for Companding in India & Europe.

$$V = \begin{cases} \dfrac{A|m|}{1+\log A} & \Rightarrow 0 < |m| < \frac{1}{A} \\[2ex] \dfrac{1+\log A|m|}{1+\log A} & \Rightarrow \frac{1}{A} \le |m| < 1 \end{cases}$$

This region will be a linearly increasing

This region will be concave.



As the value of $A \uparrow \Rightarrow \frac{1}{A}$ shift to left and linear portion will change

for $A = 1 \Rightarrow$ no compression

Practical value of $A = 87.6$