For an AM receiver with RF amplifier loaded to an antenna, the coupling circuit is 100. If IF is 455 kHz, find the image frequency and its rejection ratio at 1000 kHz and at 25 MHz. Also, find the IF to make the image rejection as good as 25 MHz as it would be at 1000 kHz.

At 1000 kHz:

To find the image frequency:

$$\text{Image frequency } f_{im} = f_{RF} + 2f_{IF}$$

$$= 1000 \times 10^3 + 2\,(455 \times 10^3) = 1.91 \text{ MHz}$$

To find the image frequency rejection ratio:

$$\rho = \frac{1.91 \times 10^6}{1000 \times 10^3} - \frac{1000 \times 10^3}{1.91 \times 10^6}$$

$$= 1.91 - 0.523 = 1.3864$$

$$\text{IFRR} = \sqrt{1 + Q^2 \rho^2}$$

$$= \sqrt{1 + (100)^2\,(1.3864)^2} = 138.64$$

At 25 MHz:

To find the image frequency:

$$\text{Image frequency } f_{im} = f_{RF} + 2f_{IF}$$

$$= 25 \times 10^6 + 2(455 \times 10^3) = 25.91 \text{ MHz}$$

To find the image frequency rejection ratio:

$$\rho = \frac{25.91\times10^6}{25\times10^6} - \frac{25\times10^6}{25.91\times10^6}$$

$$= 1.0364 - 0.9648 = 0.0715$$

$$\text{IFRR} = \sqrt{1+Q^2\rho^2}$$

$$= \sqrt{1+(100)^2\ (0.0715)^2} = 7.219$$

To find the IF to make IFRR as good at 25 MHz as it would be at 1000 kHz:

$$\text{IFRR} = \sqrt{1+Q^2\rho^2} = 138.64$$

$$\sqrt{1+(100)^2\,\rho^2} = 138.64$$

$$1 + 100\,\rho^2 = 19209.96$$

$$\rho = 1.386$$

We know that,

$$\rho = \left(f_{\text{im}} / f_{\text{RF}} \right) - \left(f_{\text{RF}} / f_{\text{im}} \right)$$

$$\therefore \qquad \left(f_{\text{im}} / f_{\text{RF}} \right) - \left(f_{\text{RF}} / f_{\text{im}} \right) = 1.386$$

$$f_{\text{im}}{}^2 - f_{\text{RF}}{}^2 = 1.386 \times f_{\text{im}} \cdot f_{\text{RF}}$$

$$f_{\text{im}}{}^2 - (25 \times 10^6)^2 - (1.386 \times 25 \times 10^6)\, f_{\text{im}} = 0$$

$$f_{\text{im}}{}^2 - (34.65 \times 10^6)\, f_{\text{im}} - (6.25 \times 10^{14}) = 0$$

By solving the equation,

$$f_{\text{im}} = \frac{34.65\times10^6 \pm \sqrt{(34.65\times10^6)^2 - 4\times1\times6.25\times10^{14}}}{2} = 95.483\text{ MHz}$$

$$\therefore \quad f_{\text{im}} = f_{\text{RF}} + 2f_{\text{IF}} = 95.483\text{ MHz}$$

$$25\times10^6 + 2f_{\text{IF}} = 95.483\times10^6$$

$$2f_{\text{IF}} = 95.483\times10^6 - 25\times10^6 = 70.483\times10^6$$

$$\therefore \quad f_{\text{IF}} = \frac{70.483\times10^6}{2} = 35.24\text{ MHz}$$

BW & Frequency spectrum of FM Wave

Frequency spectrum of FM Wave –

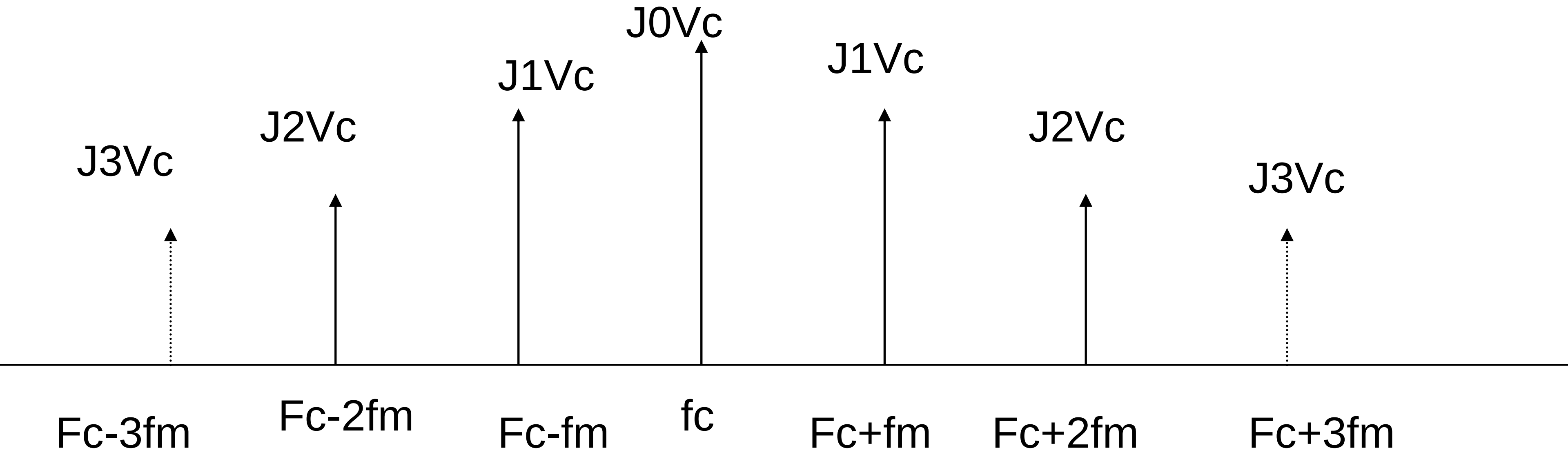
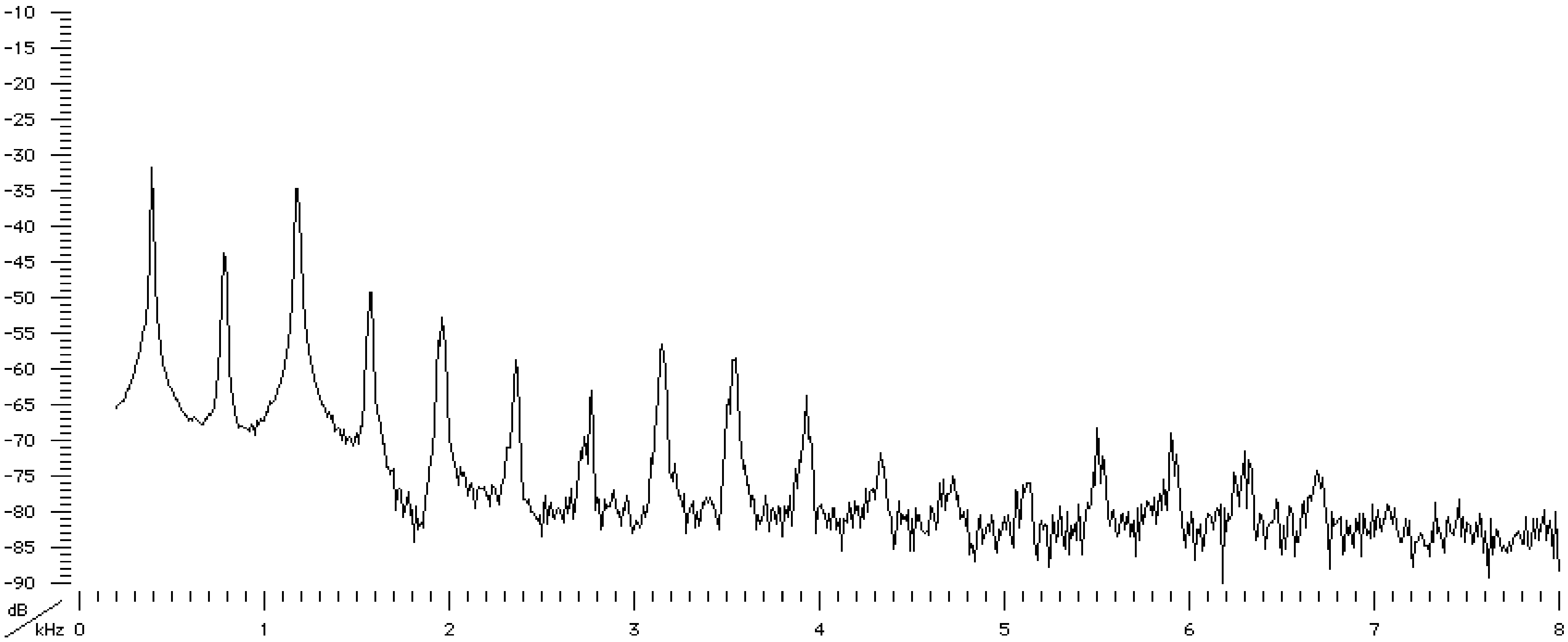


Table of Bessel functions of the first kind

Modulation index	Carrier	Side frequency pairs								
β_f	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9
0.00	1.00	---	---	---	---	---	---	---	---	---
0.25	0.98	0.12	---	---	---	---	---	---	---	---
0.5	0.94	0.24	0.03	---	---	---	---	---	---	---
1.0	0.77	0.44	0.11	0.02	---	---	---	---	---	---
1.5	0.51	0.56	0.23	0.06	0.01	---	---	---	---	---
2.0	0.22	0.58	0.35	0.13	0.03	---	---	---	---	---
2.4	0	0.52	0.43	0.20	0.06	0.02	---	---	---	---
2.5	-0.05	0.50	0.45	0.22	0.07	0.02	0.01	---	---	---
3.0	-0.26	0.34	0.49	0.31	0.13	0.04	0.01	---	---	---
4.0	-0.40	-0.07	0.36	0.43	0.28	0.13	0.05	0.02	---	---
5.0	-0.18	-0.13	0.05	0.36	0.39	0.26	0.13	0.05	0.02	---
5.45	0	-0.34	-0.12	0.26	0.40	0.32	0.19	0.09	0.03	0.01
6.0	0.15	-0.28	-0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02

Pre Emphasis & De Emphasis

Spectrum of Voice Signal



PRE-EMPHASIS:

Pre-emphasis refers to boosting the relative amplitudes of the modulating voltage for higher audio frequencies from 2 KHz to approximately 15 KHz.

DE-EMPHASIS:

De-emphasis means attenuating those frequencies by the amount by which they are boosted.

Pre-emphasis is done at the transmitter and the de-emphasis is done in the receiver. The purpose is to improve the signal-to-noise ratio for FM reception.