Bandpass Sampling (2B)

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1/27/12

Please send corrections (or suggestions) to youngwlim@hotmail.com.

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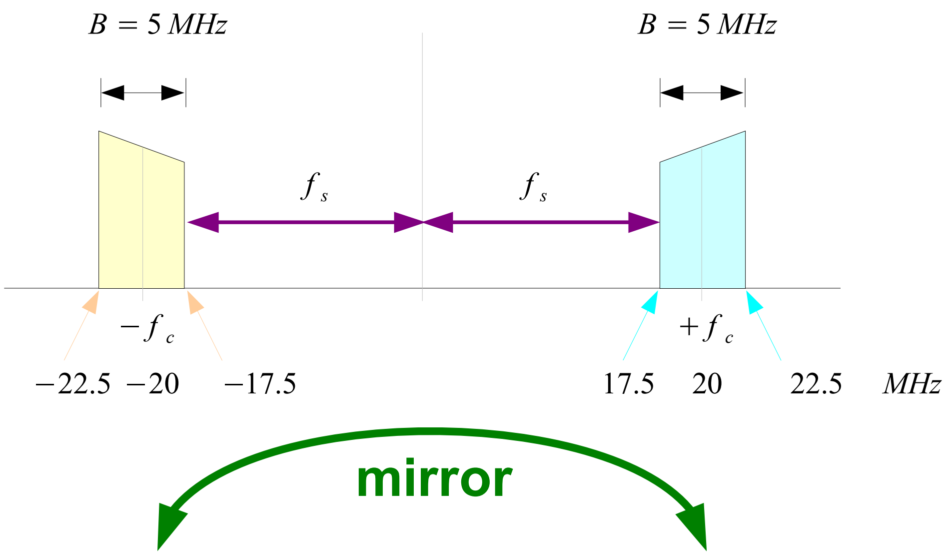
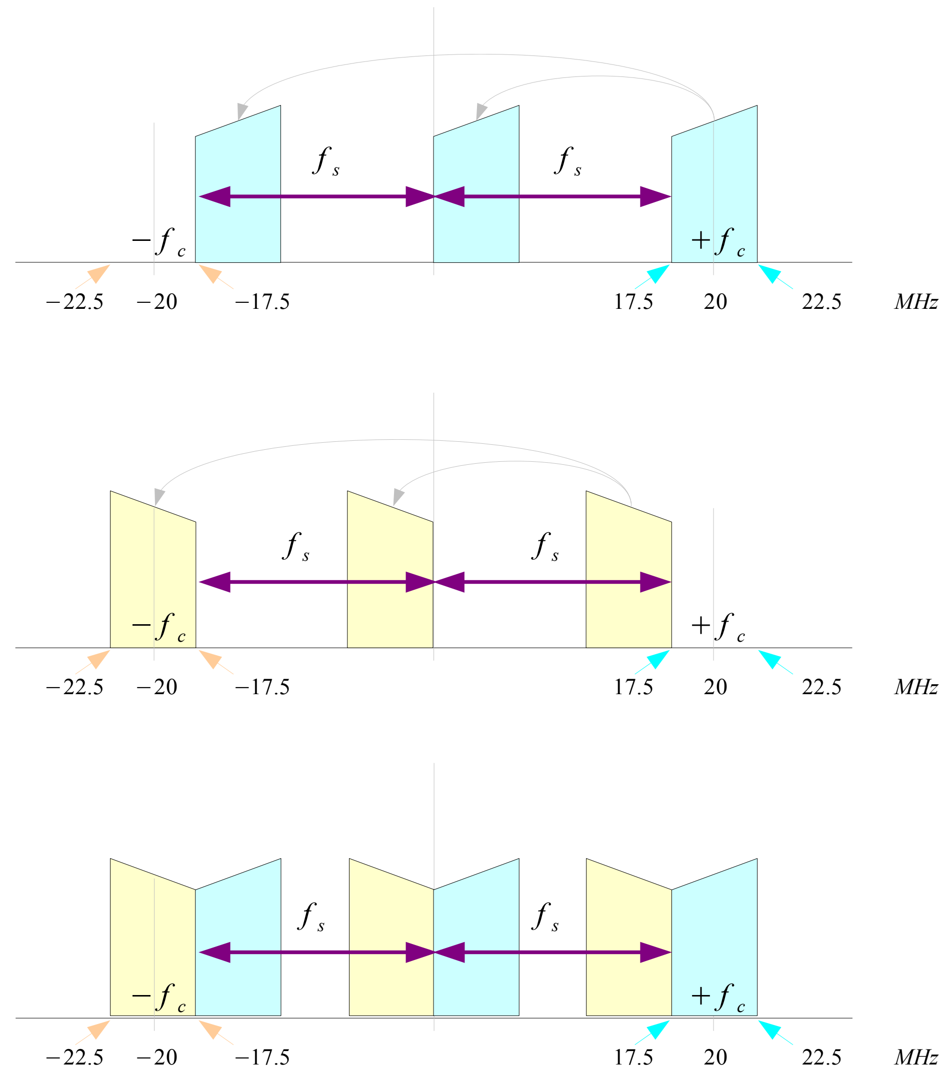
Band-limited Signal





- **Bandpass Sampling**
- **IF filtering**
- **Harmonic Sampling**
- **Sub-Nyquist Sampling**

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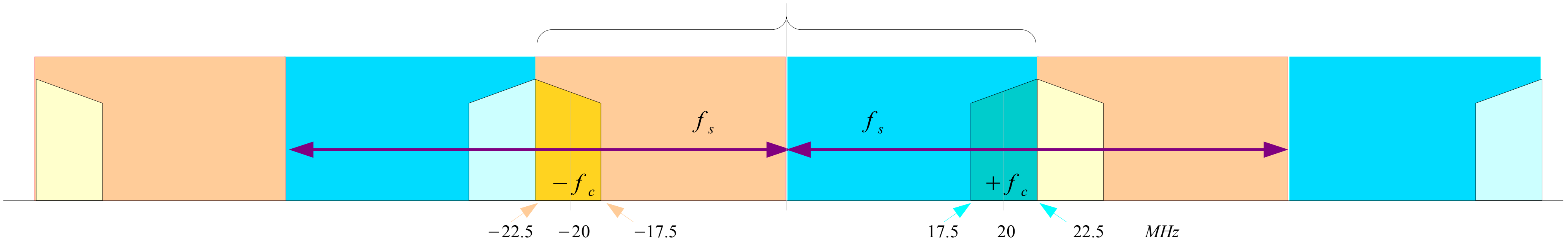
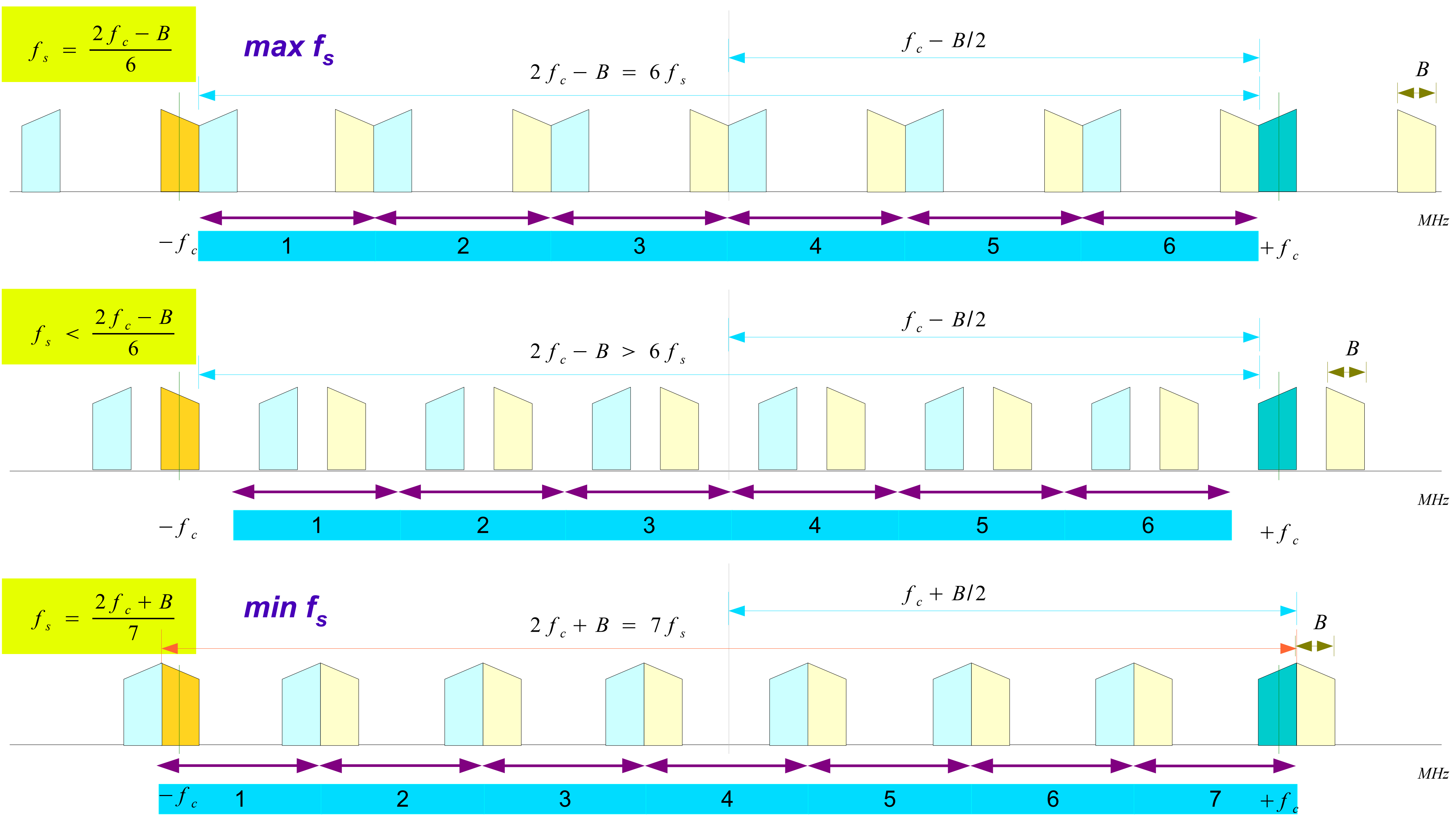
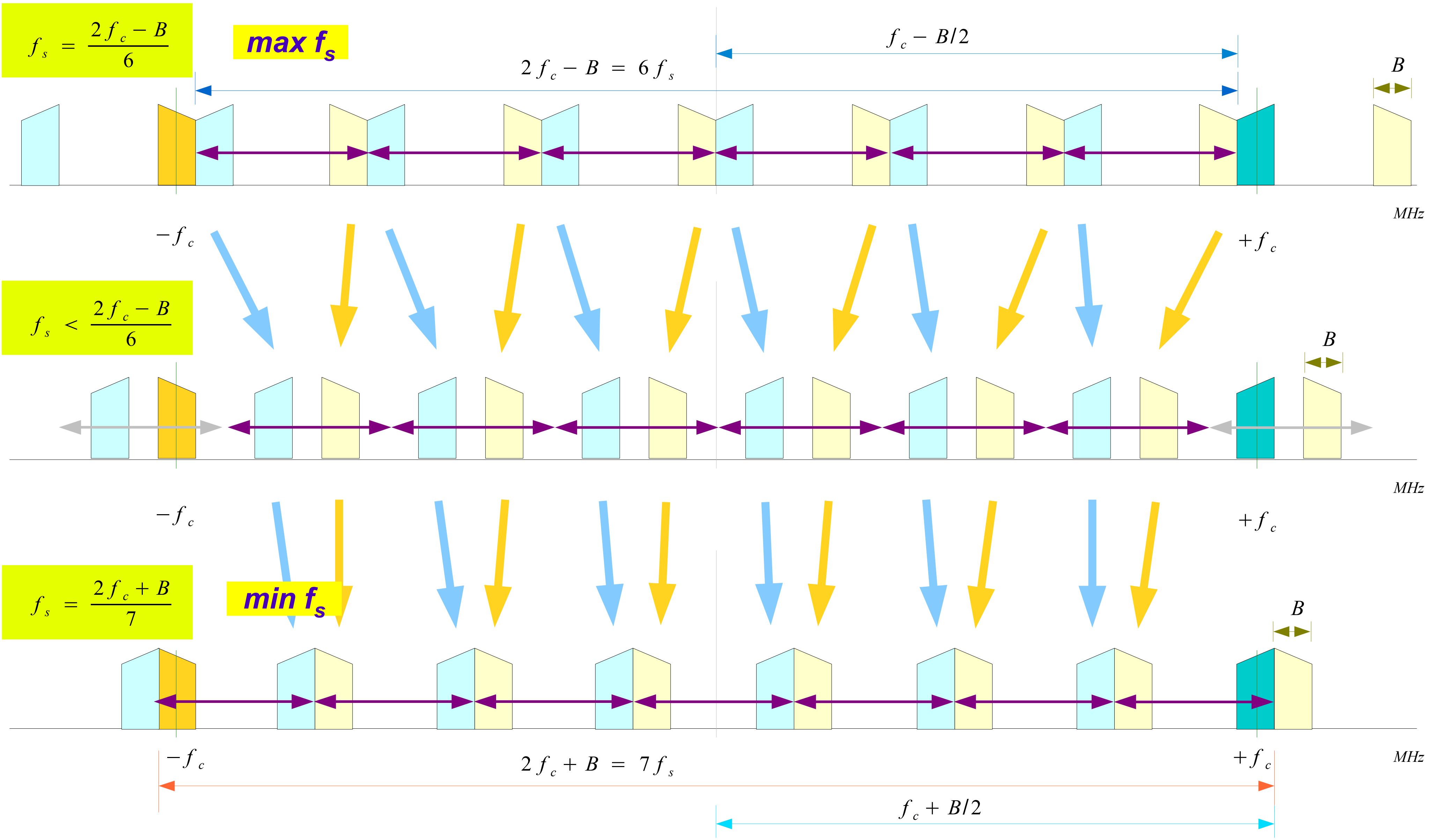
Low-pass Signal Sampling



Band-pass Signal Sampling



Band-pass Signal Sampling



$$\frac{2f_c + B}{m+1} \le f_s \le \frac{2f_c - B}{m}$$

$$f_c = 20\,MHz$$
$$B = 5\,MHz$$

$$2B \le f_s$$

$$\frac{2\cdot 20 + 5}{1+1} = 22.5 \le f_s \le \frac{2\cdot 20 - 5}{1} = 35 \Rightarrow f_s = 22.5\,MHz \quad (10 \le f_s)$$

$$\frac{2\cdot 20 + 5}{2+1} = 15 \le f_s \le \frac{2\cdot 20 - 5}{2} = 17.5 \Rightarrow f_s = 17.5\,MHz \quad (10 \le f_s)$$

$$\frac{2\cdot 20 + 5}{3+1} = 11.25 \le f_s \le \frac{2\cdot 20 - 5}{3} = 11.67 \Rightarrow f_s = 11.25\,MHz \quad (10 \le f_s)$$

$$\frac{2\cdot 20 + 5}{4+1} = 9 \ge \frac{2\cdot 20 - 5}{4} = 8.75 \Rightarrow$$ X

$$\frac{2\cdot 20 + 5}{5+1} = 7.5 \ge \frac{2\cdot 20 - 5}{5} = 7.0 \Rightarrow$$ X

$$\frac{2f_c + B}{m+1} \le f_s \le \frac{2f_c - B}{m}$$

$$f_c = 20\,MHz$$
$$B = 5\,MHz$$

$$2B \le f_s$$

$$\frac{f_c + B/2}{B} = R$$

highest signal frequency / bandwidth

$$\frac{2f_c + B}{(m+1)B} = f(m, R)$$

minimum sampling rate / bandwidth

$$\frac{2(f_c + B/2)}{(m+1)B} = \frac{2R}{m+1} = f(m, R)$$

$m = 1$	$f(1,R) = R$	$m = 5$	$f(5,R) = \frac{1}{3}R$
$m = 2$	$f(2,R) = \frac{2}{3}R$	$m = 6$	$f(6,R) = \frac{2}{7}R$
$m = 3$	$f(3,R) = \frac{1}{2}R$	$m = 7$	$f(7,R) = \frac{1}{4}R$
$m = 4$	$f(4,R) = \frac{2}{5}R$	$m = 8$	$f(8,R) = \frac{2}{9}R$

References

[1] http://en.wikipedia.org/
[2] J.H. McClellan, et al., Signal Processing First, Pearson Prentice Hall, 2003
[3] A “graphical interpretation” of the DFT and FFT, by Steve Mann
[4] R. G. Lyons, Understanding Digital Signal Processing, 1997