A **line code** is a code selected for use within a communications system for transmitting a digital signal over the channel.
Mixing in the Frequency Domain

Known as Frequency translation.

Review:

\[ g_1(t) \cdot g_2(t) \text{ and } G_1(f) \star G_2(f) \]

\[ g_2(t) = \cos(\omega_c t) \]

\[ \cos(\omega_c t) \]
Sampling Function in the Time Domain

$$\mathcal{H}(t) f(t) = \sum_{n=-\infty}^{\infty} f(n) \delta(t - nT_0)$$

**Review:**

- $f(t)$
- $\delta(t - nT_0)$
- $f(0), f(T_0), f(2T_0)$
Sampling Theorem and Nyquist Rate

**Sampling Theorem:** A band-limited signal with no spectral components beyond $f_m$ can be uniquely determined by values sampled at uniform intervals of

$$T_s \leq \frac{1}{2f_m}$$

This sampling rate is the **Nyquist Rate** $f_S$ and is given by

$$f_S = \frac{1}{T_s} = 2f_m$$

Usually we sample at a rate above $f_S$.
Sampling Function in Frequency Domain

\[ G(f) = \text{III}(f) \star M(f) \]

*Time domain:*
\[ g(t) = \text{III}(t) \cdot m(t) \]
Nyquist Rate and Aliasing Effect

Sampled at Nyquist Rate

$|G(f)|$

$f_s = 2f_m$

Greater than Nyquist Rate

$|G(f)|$

$f_s > 2f_m$

Less than Nyquist Rate

$|G(f)|$

$f_s < 2f_m$

“Aliasing”
Aliasing From Sub-Nyquist Rate Sampling

When the input signal frequency is faster than half the sampling frequency, the sampled result will appear to be a low-frequency wave.

Red is the original waveform $m(t)$ and Blue appears to be the output.

https://en.wikibooks.org/wiki/Analog_and_Digital_Conversion/Nyquist_Sampling_Rate