Two samples of an AM signal with carrier frequency ω_c.

$$\begin{cases} x[0] = f(t_0)\sin(\omega_c t_0 + \alpha) \\ x[1] = f(t_1)\sin(\omega_c t_1 + \alpha) \end{cases}$$

If the samples were taken Δt seconds apart, then the sampling frequency f_s is $1/\Delta t$.

$$\begin{cases} x[0] = f(t_0)\sin(\omega_c t_0 + \alpha) \\ x[1] = f(t_0 + \Delta t)\sin(\omega_c (t_0 + \Delta t) + \alpha) \end{cases}$$

If Δt is quite small, $f(t_0) = f(t_0 + \Delta t) = A$:

$$\begin{cases} x[0] = A\sin(\omega_c t_0 + \alpha) \\ x[1] = A\sin(\omega_c (t_0 + \Delta t) + \alpha) \end{cases}$$

If $t_0 = 0$:

$$\begin{cases} x[0] = A\sin(\alpha) \\ x[1] = A\sin(\omega_c \Delta t + \alpha) \end{cases}$$

We define ϕ as $\omega_c \Delta t = \omega_c / f_s = 2\pi f_c / f_s$.

$$\begin{cases} x[0] = A\sin(\alpha) \\ x[1] = A\sin(\phi + \alpha) \end{cases}$$

$$\begin{cases} \alpha = \arcsin\left(\frac{x[0]}{A}\right) \\ \alpha = \arcsin\left(\frac{x[1]}{A}\right) - \phi \end{cases}$$

$$\arcsin\left(\frac{x[0]}{A}\right) = \arcsin\left(\frac{x[1]}{A}\right) - \phi$$

$$\frac{x[0]}{A} = \sin\left(\arcsin\left(\frac{x[1]}{A}\right) - \phi\right)$$

$$\frac{x[0]}{A} = \frac{x[1]}{A}\cos\phi - \cos\left(\arcsin\left(\frac{x[1]}{A}\right)\right)\sin\phi$$

$$\frac{x[0]}{A} = \frac{x[1]}{A}\cos\phi - \sqrt{1 - \frac{x[1]^2}{A^2}}\sin\phi$$

$$x[0] = x[1]\cos\phi - \sqrt{A^2 - x[1]^2}\sin\phi$$

$$A^2 - x[1]^2 = \left(\frac{x[1]\cos\phi - x[0]}{\sin\phi}\right)^2$$

$$A^2 - x[1]^2 = \frac{x[1]^2\cos^2\phi + x[0]^2 - 2x[1]x[0]\cos\phi}{\sin^2\phi}$$

$$A^2 = \frac{x[1]^2\cos^2\phi + x[1]^2\sin^2\phi + x[0]^2 - 2x[1]x[0]\cos\phi}{\sin^2\phi}$$

$$A = \frac{\sqrt{x[1]^2 + x[0]^2 - 2x[1]x[0]\cos\phi}}{\sin\phi}$$

Then:

$$y[i] = \frac{\sqrt{x[i]^2 + x[i-1]^2 - 2x[i]x[i-1]\cos\phi}}{\sin\phi}$$

Where $\phi = 2\pi f_c/f_s$