DSP sinusoidal oscillator

Digital oscillators can be used anywhere that a sinusoidal signal is required such as in:

- Mixers
- Down-converters
- Modulators
- Demodulators

A DSP sinusoidal oscillator can be designed by taking the z-transform of the output signal, *cos(nΘ).*
We had previously (or taken directly from the table of Z-transforms):

$$\boxed{\begin{aligned}
& b^n\cos(na) \Leftrightarrow \frac{z\left(z-b\cos(a)\right)}{\left(z^2-2bz\cos(a)+b^2\right)}\\
& Let\ b=1:\\
& \cos(na) \Leftrightarrow \frac{z\left(z-\cos(a)\right)}{\left(z^2-2z\cos(a)+1\right)}\\
& \therefore\quad \cos(n\theta) \Leftrightarrow \frac{z\left(z-\cos(\theta)\right)}{\left(z^2-2z\cos(\theta)+1\right)} = \frac{\left(1-z^{-1}\cos(\theta)\right)}{\left(1-2z^{-1}\cos(\theta)+z^{-2}\right)}
\end{aligned}}$$

The system transfer function is:

$$\boxed{\begin{aligned}
& H(z)=\frac{Y(z)}{X(z)}=\frac{\left(1-z^{-1}\cos(\theta)\right)}{\left(1-2z^{-1}\cos(\theta)+z^{-2}\right)}\\
& \Rightarrow Y(z)\left(1-2z^{-1}\cos(\theta)+z^{-2}\right)=\left(1-z^{-1}\cos(\theta)\right)X(z)\\
& Y(z)=X(z)-z^{-1}\cos(\theta)X(z)+2z^{-1}\cos(\theta)Y(z)-z^{-2}Y(z)\\
& y(n)=x(n)-\cos(\theta)x(n-1)+2\cos(\theta)y(n-1)-y(n-2)
\end{aligned}}$$

Since it is an oscillator, we can set the input x(n) to zero.

$$\boxed{y(n)=2\cos(\theta)y(n-1)-y(n-2)}$$

The system below uses *y(n-2)=0* and *y(n-1)=Acos(Θ).* Visualise a *cosine* function and if the previous value is 0, the next value must be *Acos(Θ*).

DIGITAL CONVOLUTION, OSCILLATORS, AND WINDOWING 49

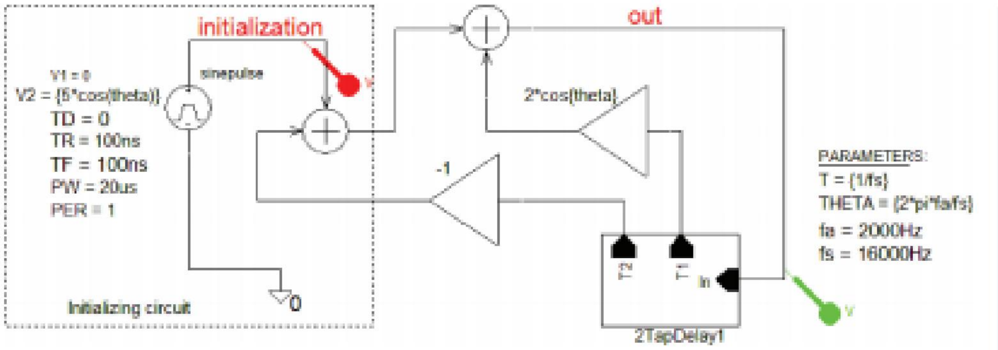

FIGURE 3.9: Digital oscillator.

For a sampling frequency of 16 kHz and an oscillation frequency of 2 kHz:

$$\theta_0 = \frac{2\pi f_0}{f_s} = \frac{2\pi(2)}{16} = \frac{\pi}{4}$$