



### Example of Fourier Series in the Limit of a Long Period

Signal  $x(t)$  is a square wave with period  $T$  and pulse width  $2T_s$ .

Fourier series representation:  $x(t) = \sum_{k=-\infty}^{\infty} X[k] e^{jk\omega_0 t}$ , where  $X[k] = \frac{2T_s}{T} \text{sinc}\left(k \frac{2T_s}{T}\right)$  and  $\omega_0 = \frac{2\pi}{T}$ .

Note that as  $T \rightarrow \infty$ , we obtain an isolated pulse, which is an aperiodic signal. In this limit,  $\omega_0 \rightarrow 0$ , and, although  $k$  is a discrete variable,  $k\omega_0$  approaches a continuous variable. In this limit, a plot of  $2\pi X[k]/\omega_0$  versus  $k\omega_0$  approaches a continuous curve.

In the plots below, the Fourier series representations of  $x(t)$  include terms for  $-64 \leq k \leq 64$ .



