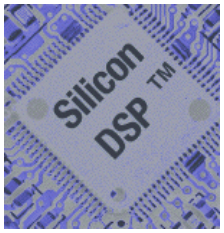
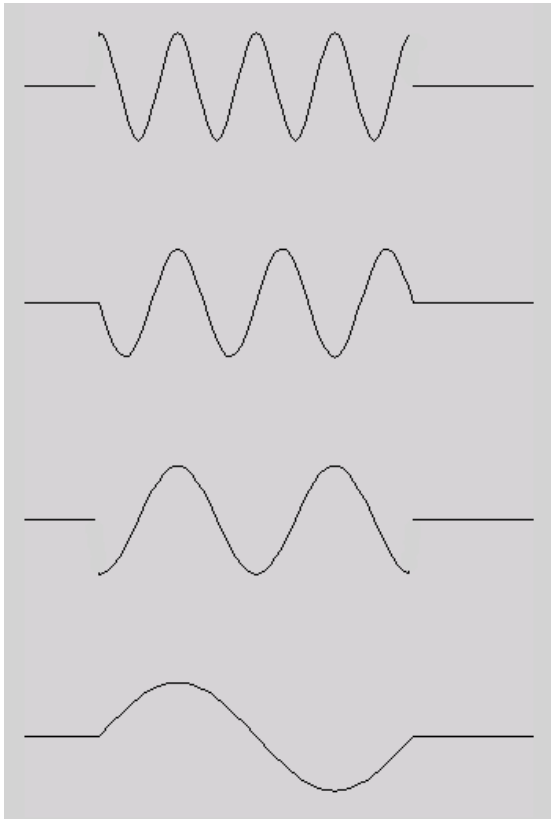
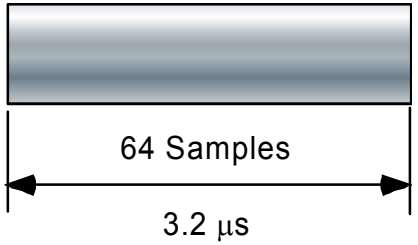
Intersymbol Interference
OFDM Modulation

Cyclic Prefix
(Guard Interval)

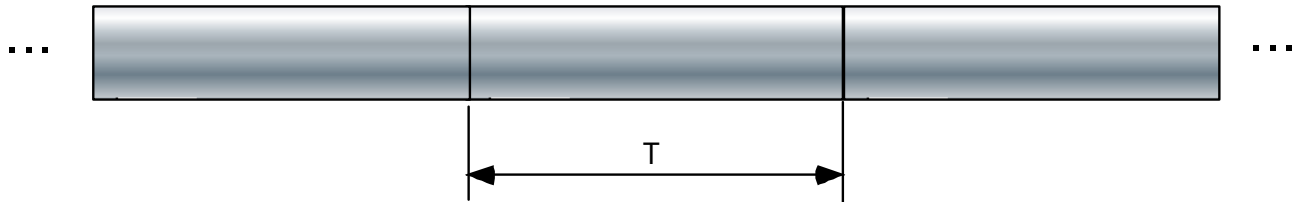


Silicon DSP Corporation

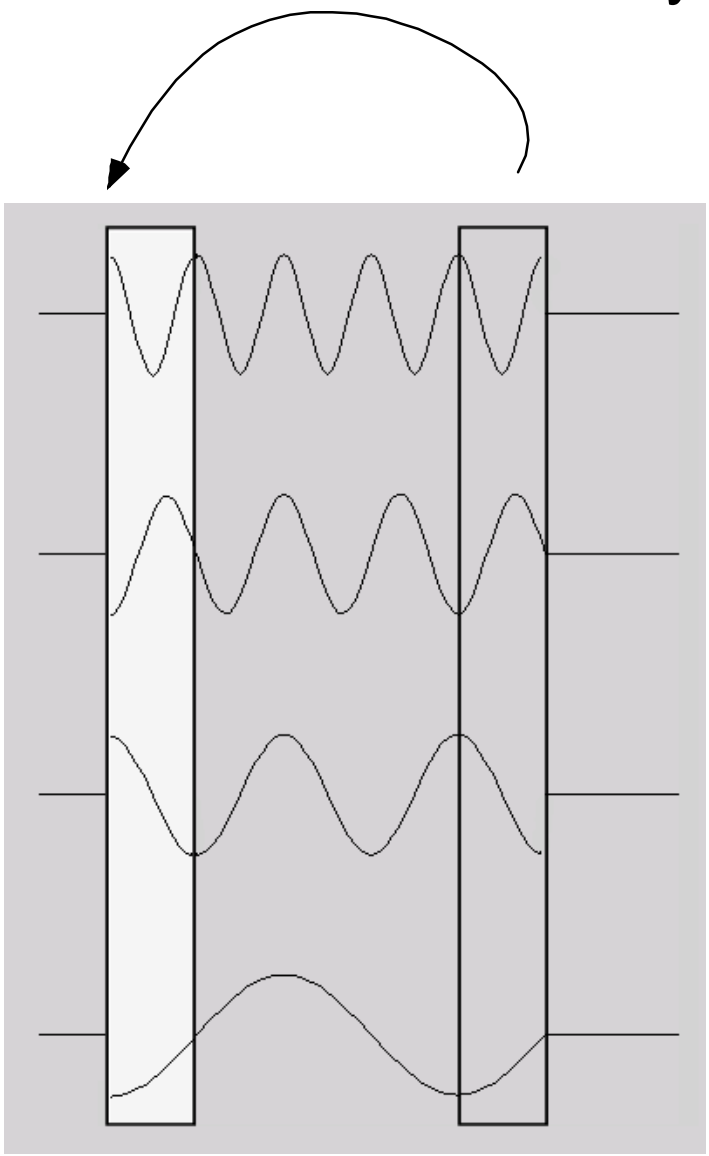


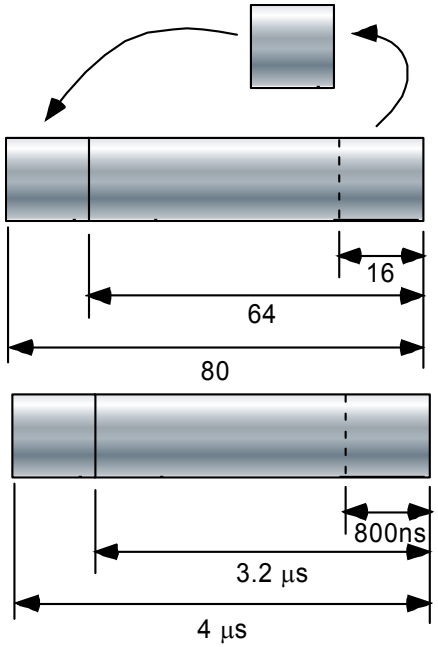


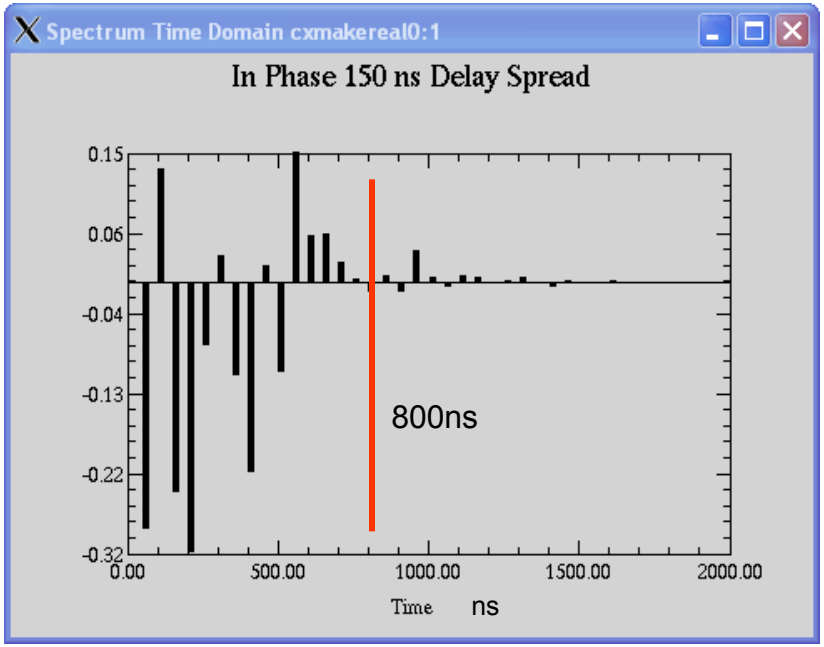
$\Delta f = 312.5$ kHz



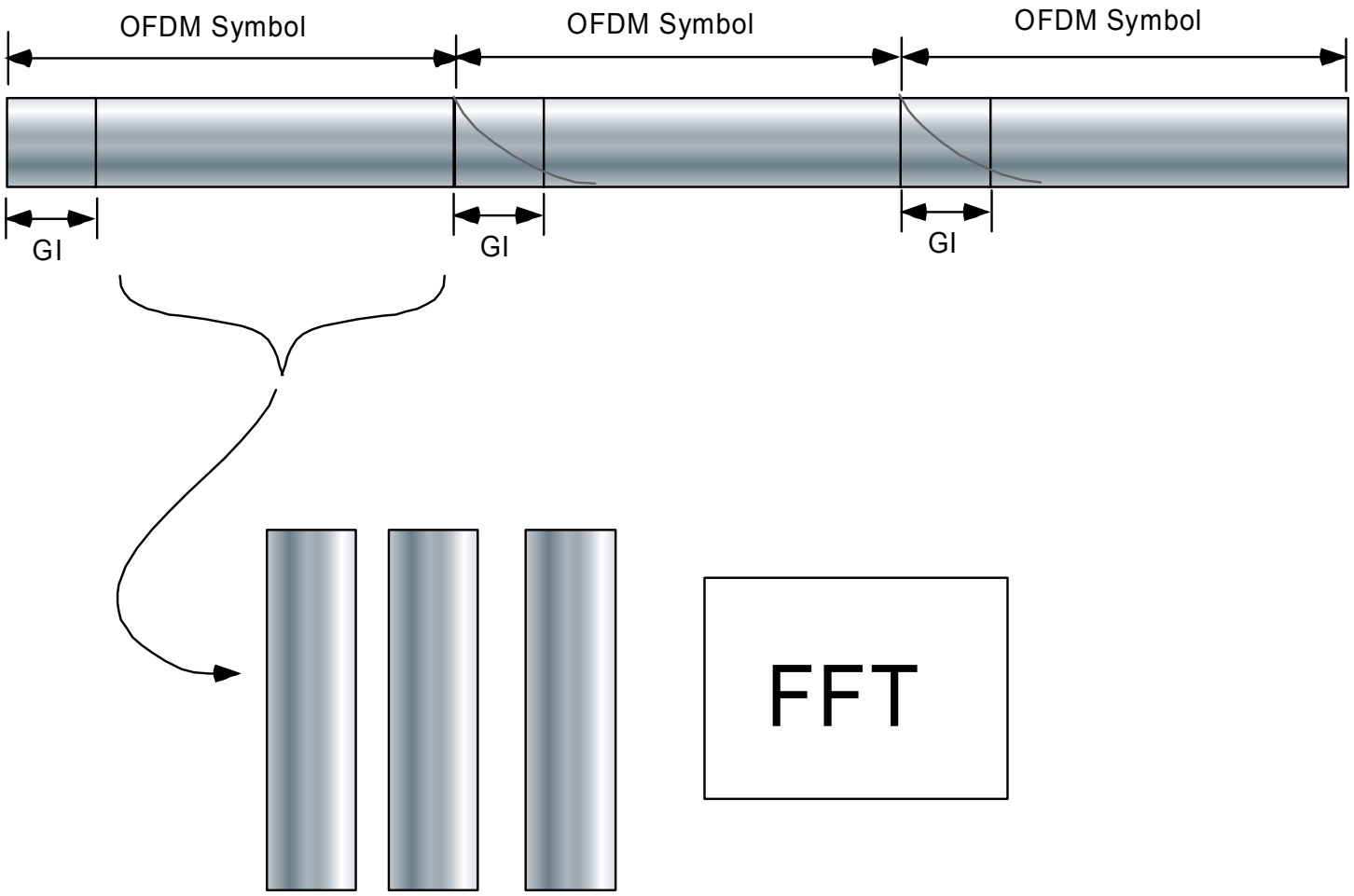
Cyclic Prefix



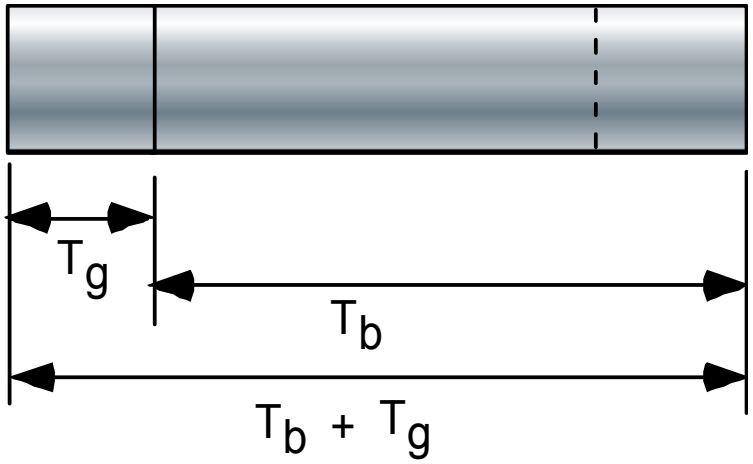




Cyclic Prefix (Guard Interval)



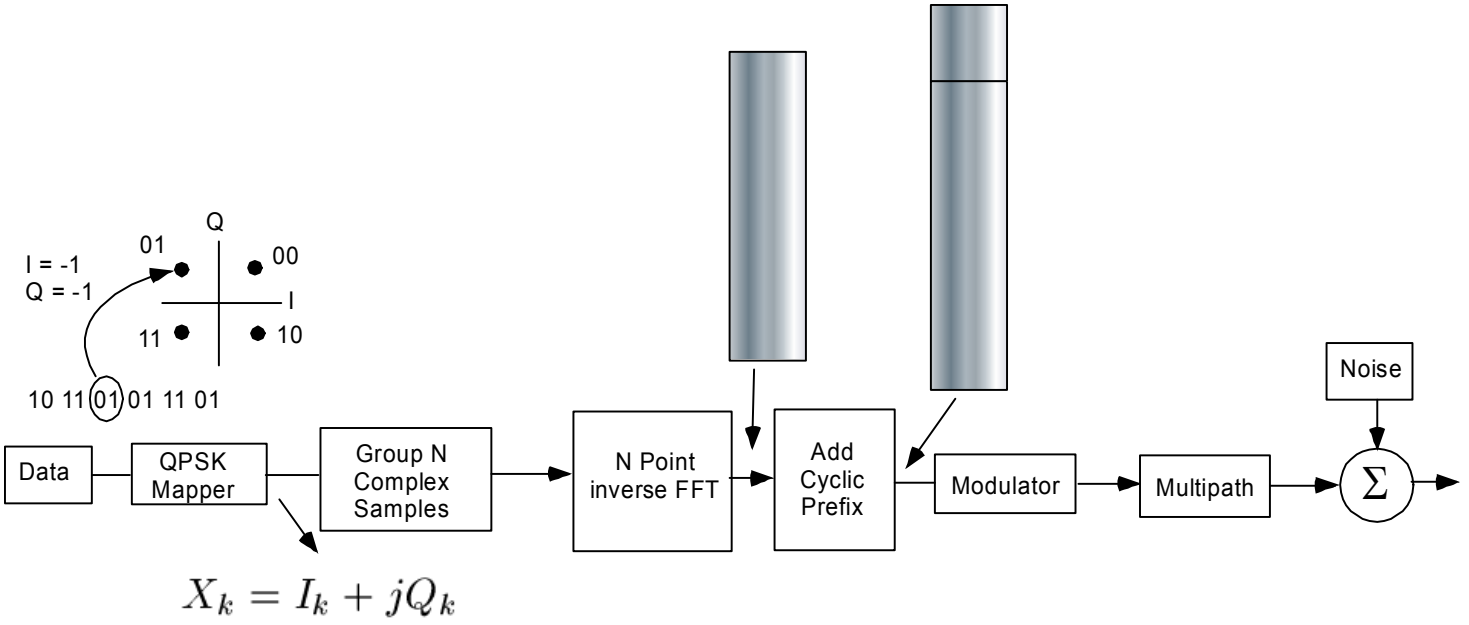
SNR Loss Due to Cyclic Prefix



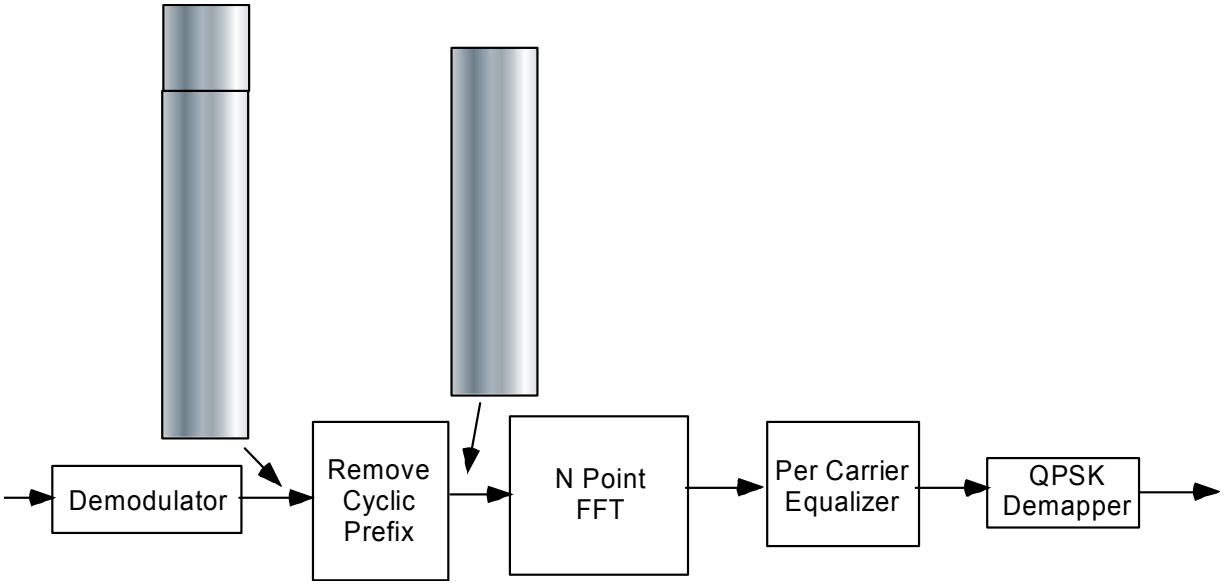
$$10\log_{10}(1-\frac{T_g}{T_b+T_g})\quad dB$$

For IEEE802.11a the loss is 0.97 dB or close to 1 dB

OFDM Modulation/Demodulation

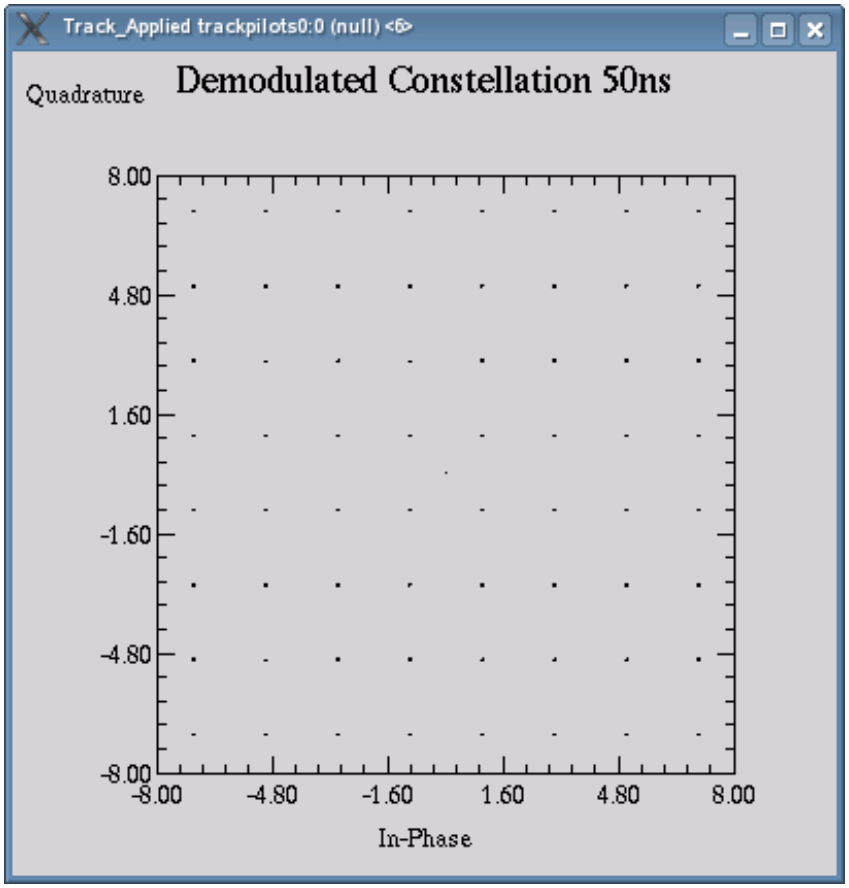


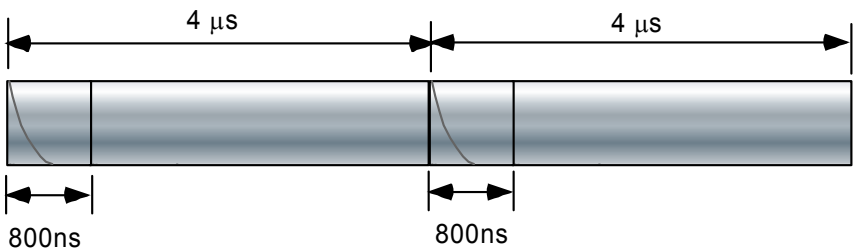
$$X_k = I_k + jQ_k$$



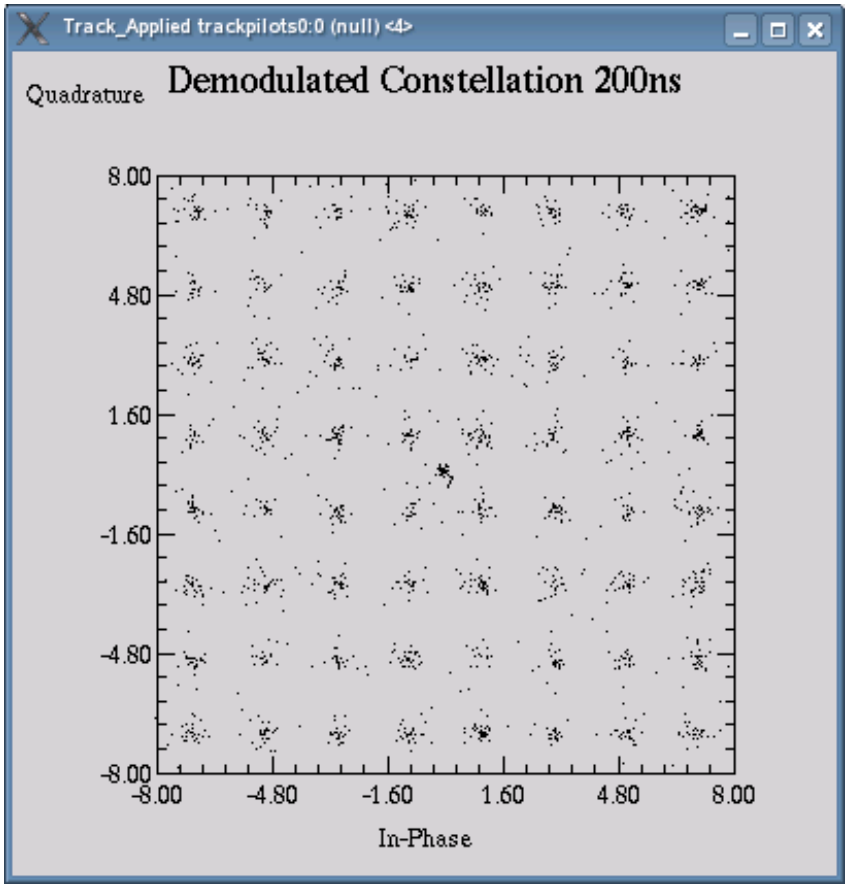
Examples of ISI with Cyclic Prefix

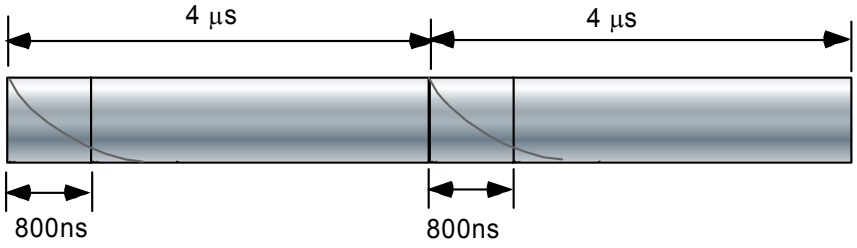
50ns Delay Spread



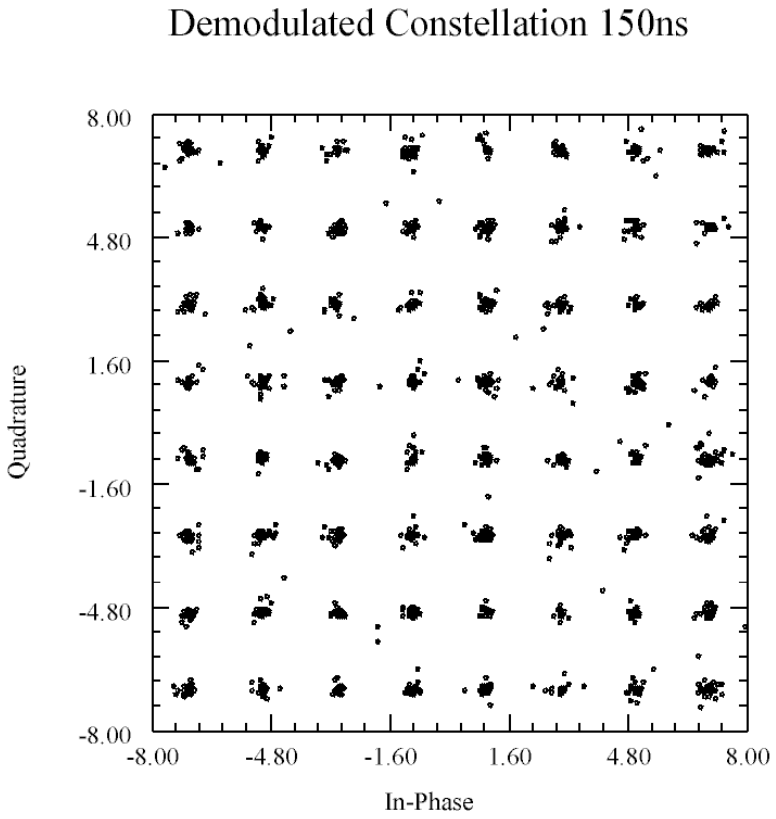


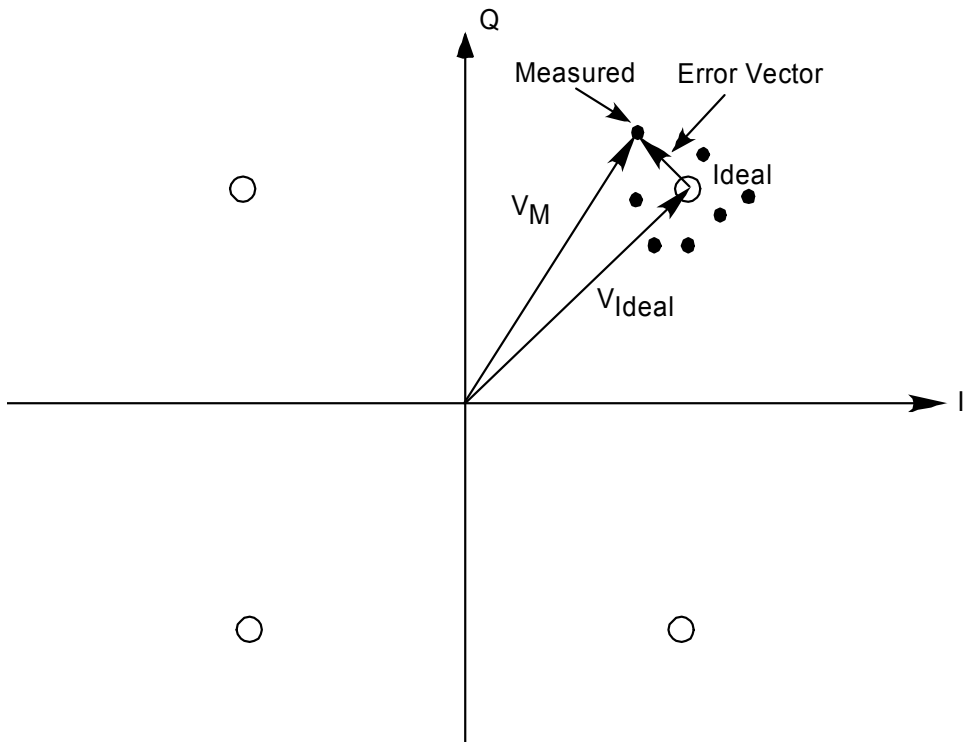
200ns Delay Spread



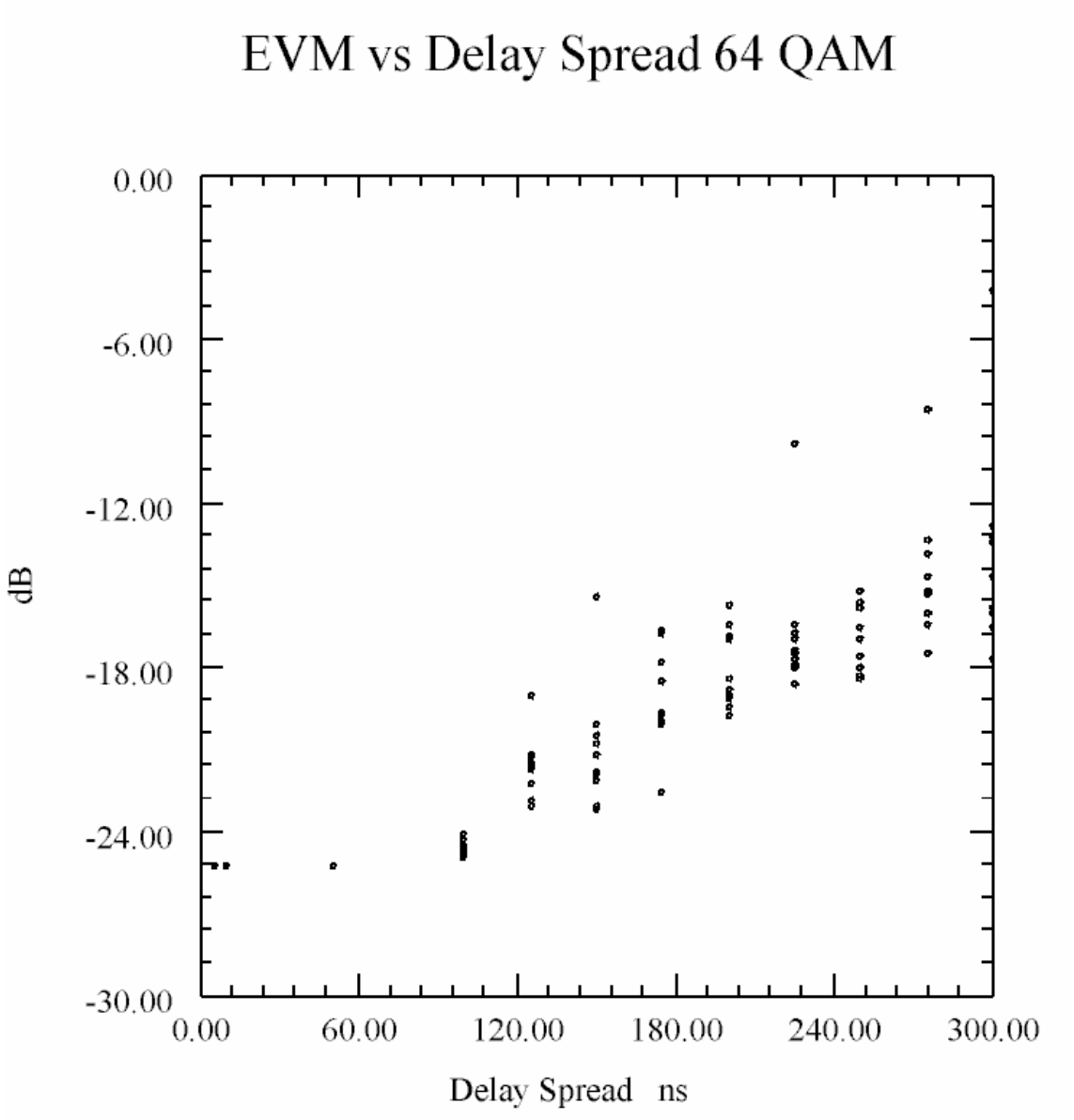


Error Vector Magnitude
EVM

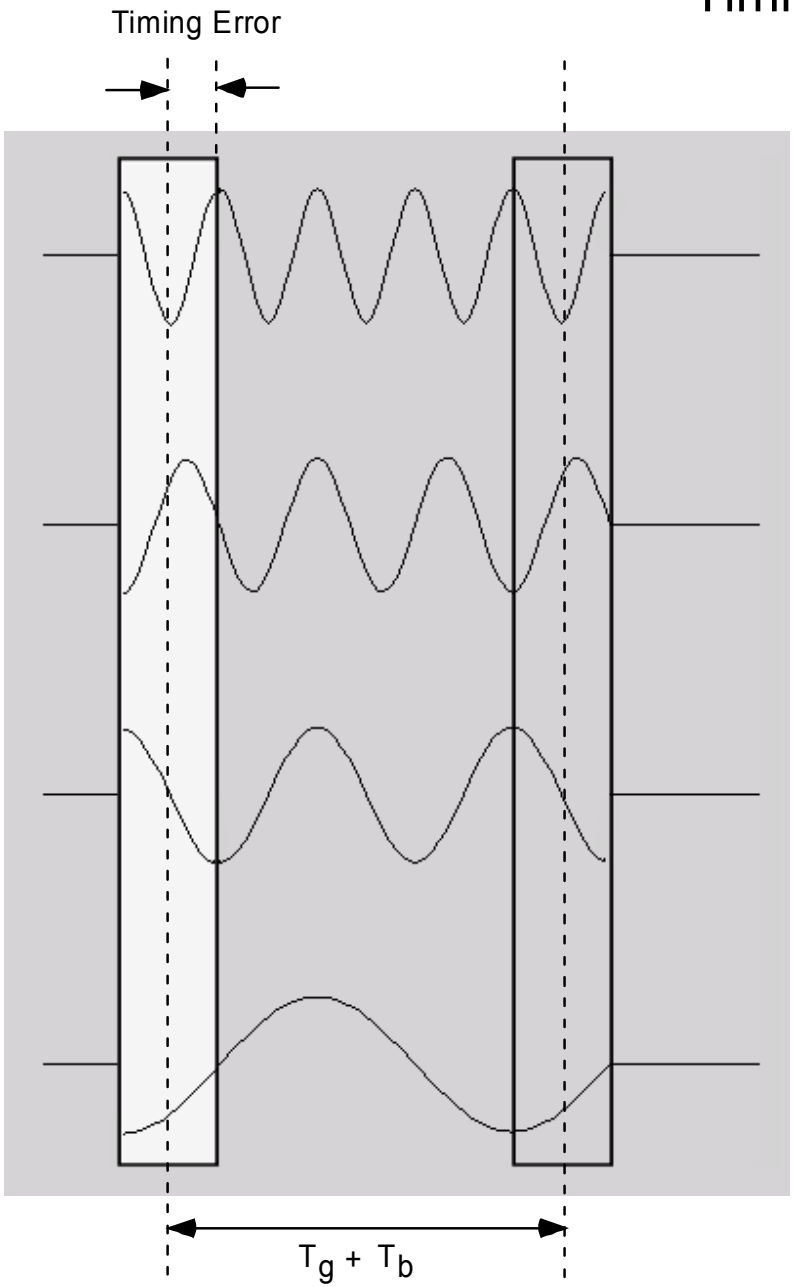


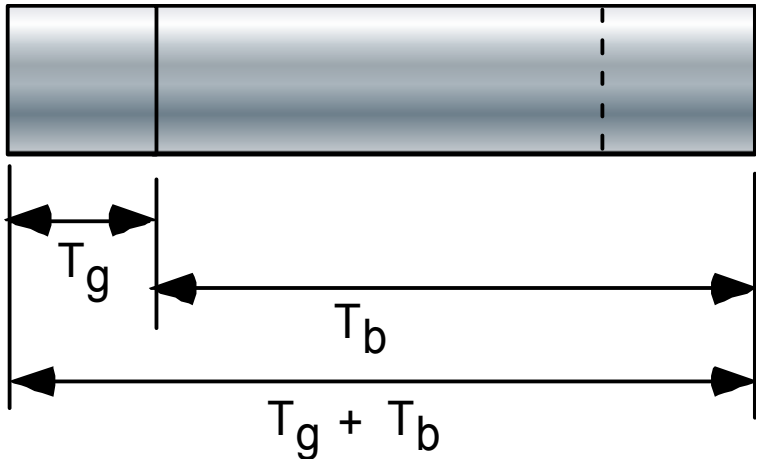


$$EVM = \frac{\frac{1}{N}\sum_{i=1}^{N} |V_{Measured} - V_{Ideal}|^2}{\frac{1}{M}\sum_{j=1}^{M} |V_{Ideal}|^2}$$



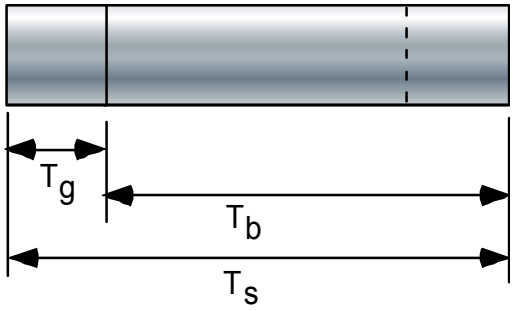
Timing Error





Rate Dependence on Cyclic Prefix

$$\text{DataRate} = \frac{N_{Data} b_m c_r}{T_s}$$



b_m is the number of bits per modulation symbol

c_r is the coding rate

Tg		Rate
ns	*Samples*	*Mbps*
400	8	60
800	16	54
1600	32	45

b_m = 6

c_r = 3/4

N_{Data} = 48

Original Paper Introducing Cyclic Prefix

DIGITAL SOUND BROADCASTING TO MOBILE RECEIVERS

Bernard Le Floch, Roselyne Halbert-Lassalle, Damien Castelain
CCETT (Centre Commun d'Etudes de Télédiffusion et Télécommunications)
35512 Cesson Sévigné, France

IEEE Transactions on Consumer Electronics, Aug. 1989.

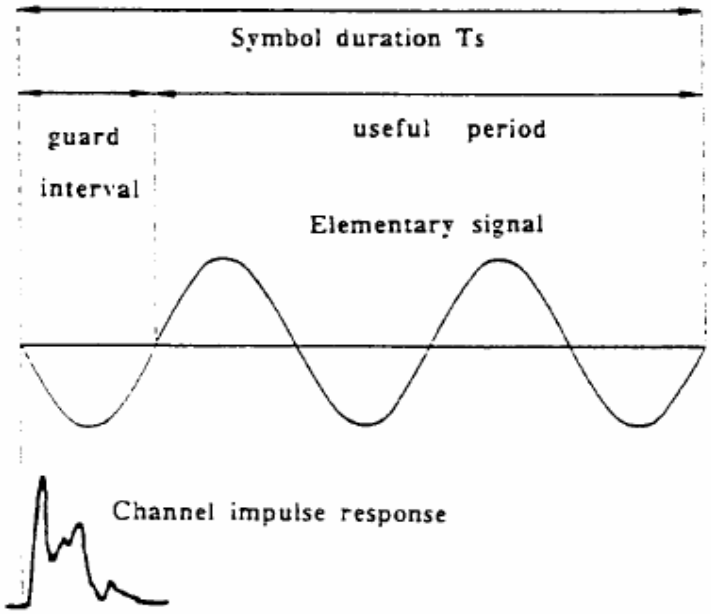


Figure 3

Use of a guard interval to suppress the intersymbol interference