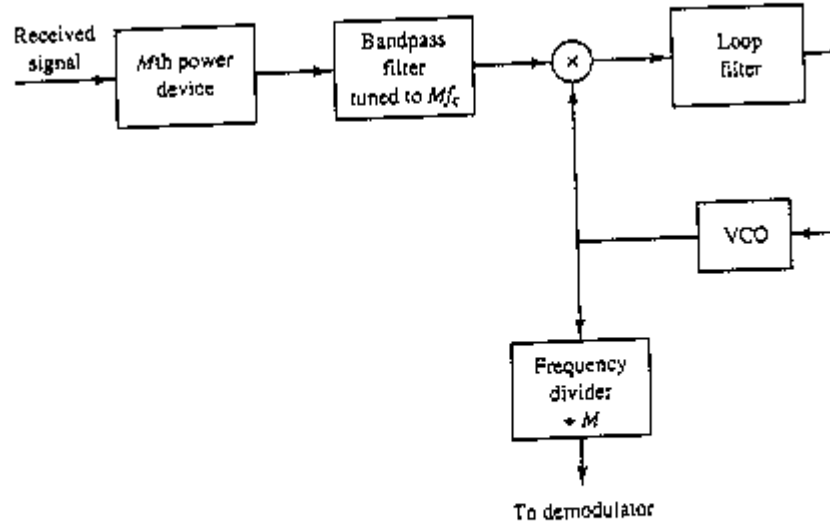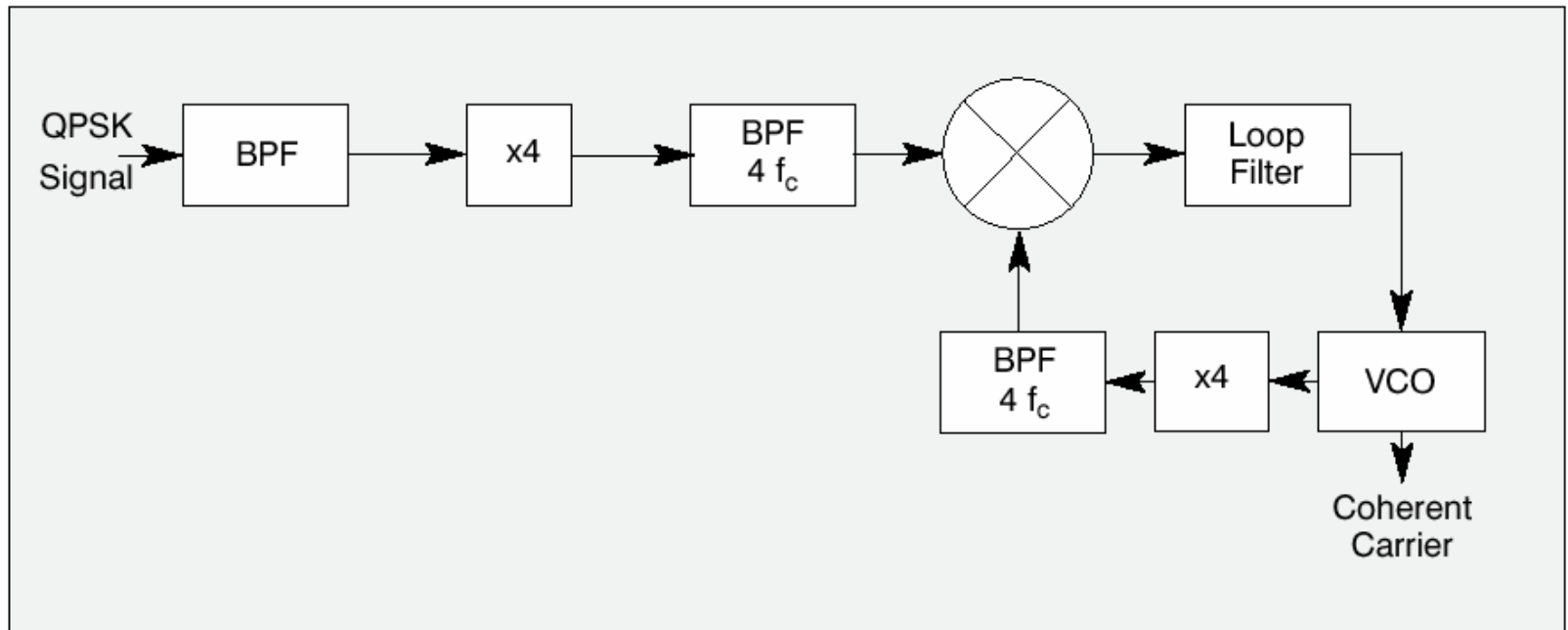# 16.543Notes 8 Supplement

Carrier and Bit Synchronization in Digital Communication Systems
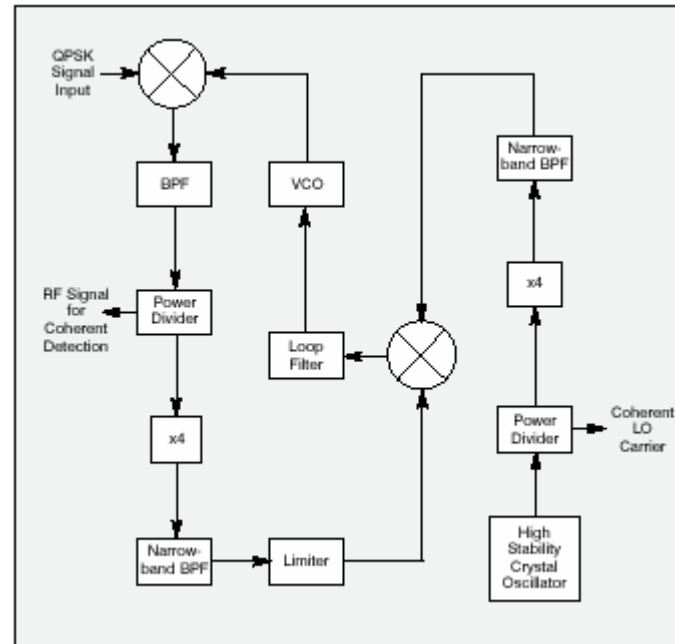
M'th order Carrier Recovery loop

Carrier-phase estimation for M-ary PSK signals.
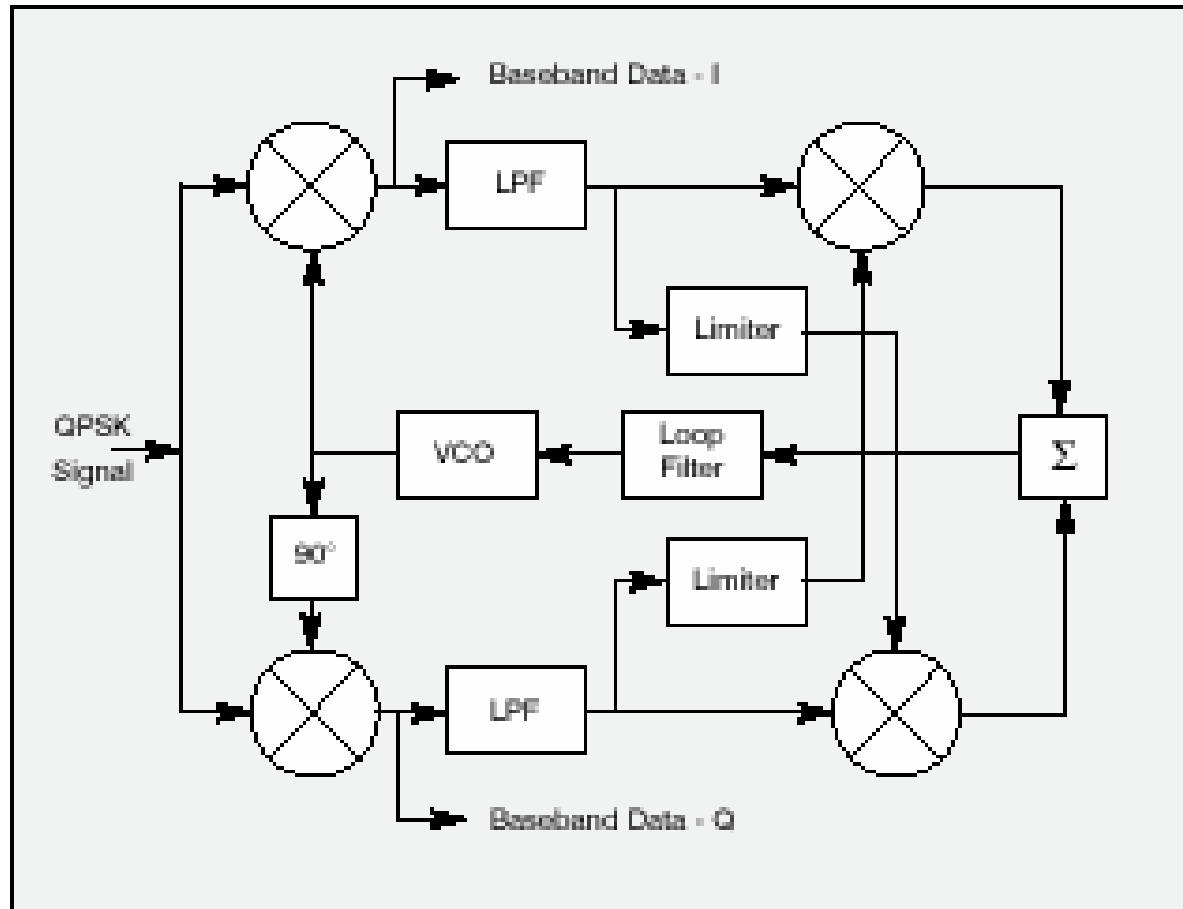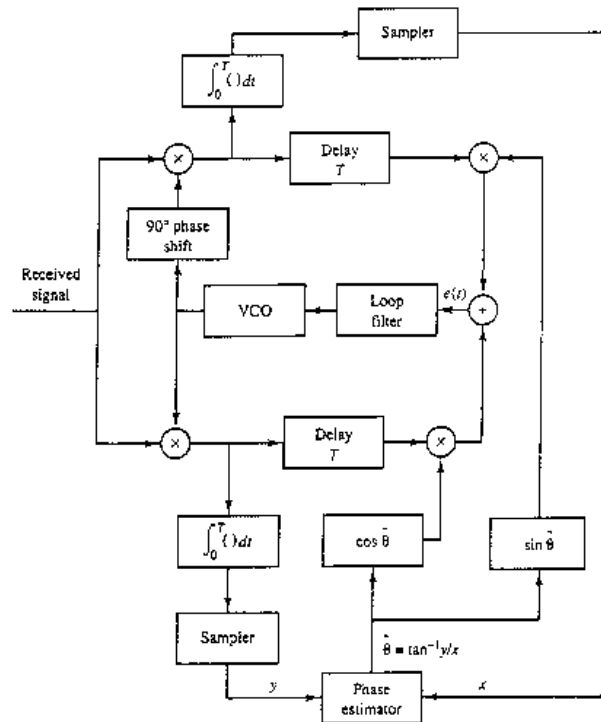
4ᵗʰ order loop for QPSK carrier recovery

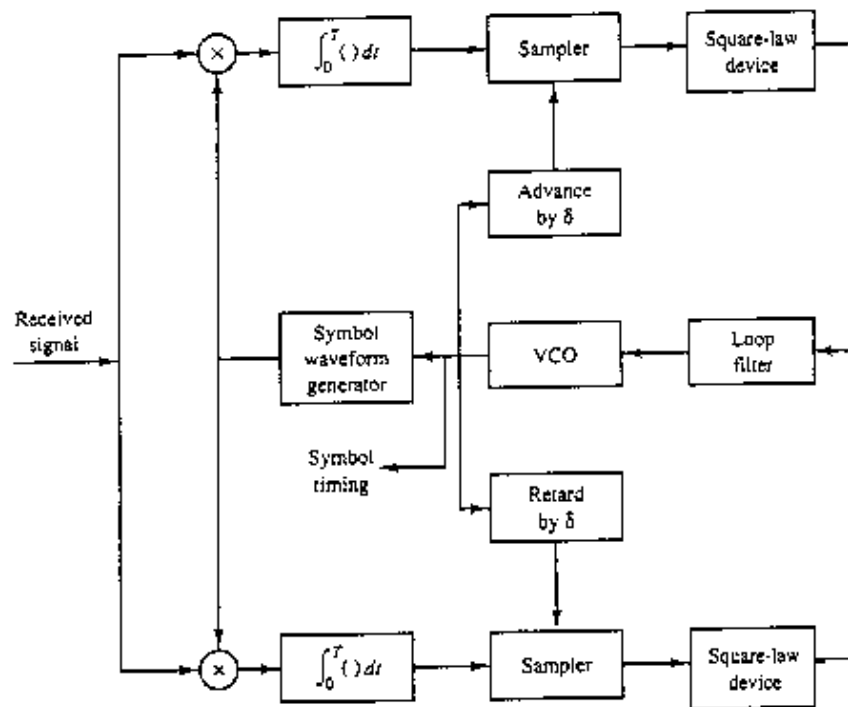# Long Loop Method for QPSK carrier Recovery
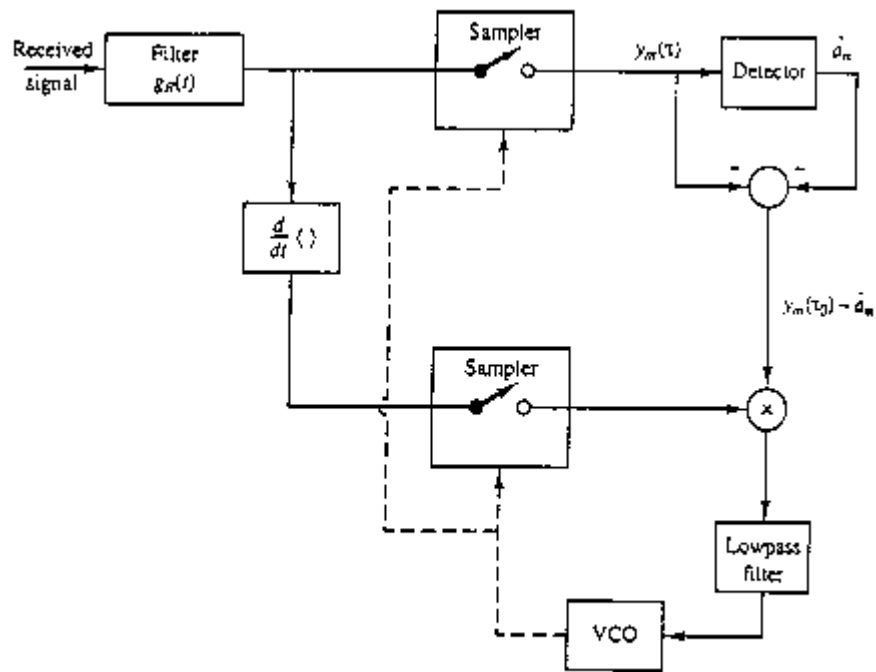
Costas Loop

DFPLL Carrier Recovery

Carrier recovery for *M*-ary PSK using a DFPLL.

Early Late Gate Synchronizer (alternate)

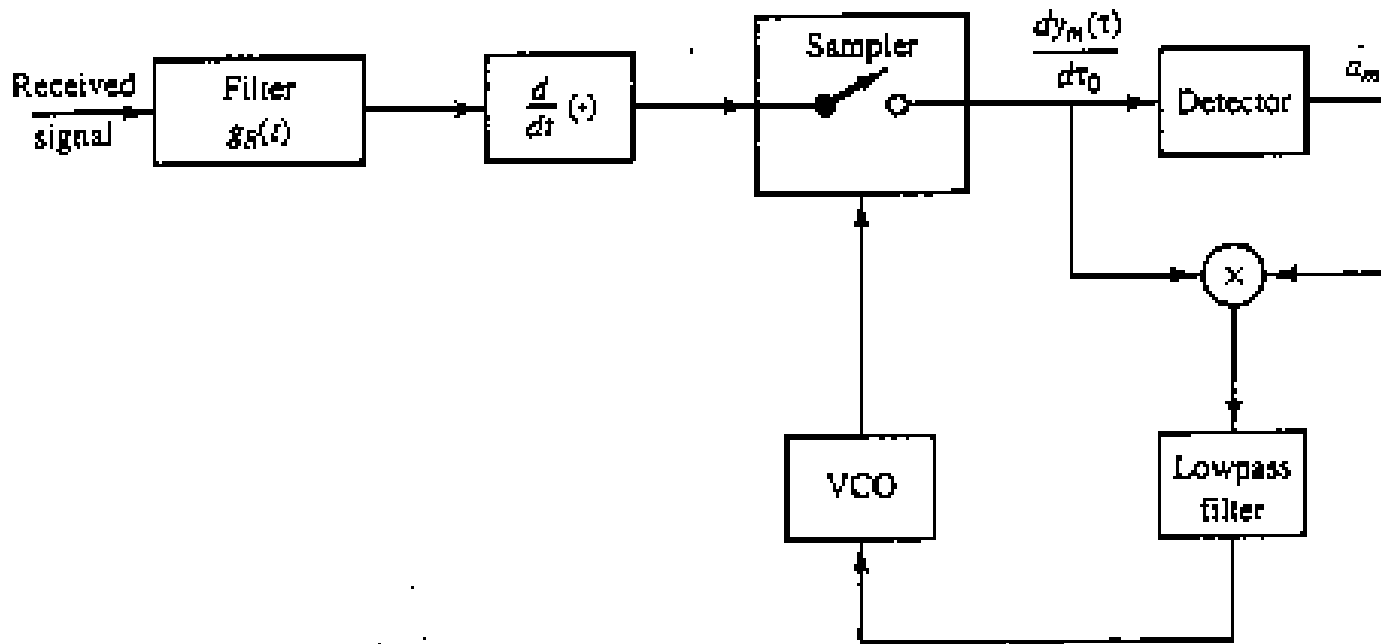Block diagram of early-late gate synchronizer—an alternative form.

MSE Synchronizer

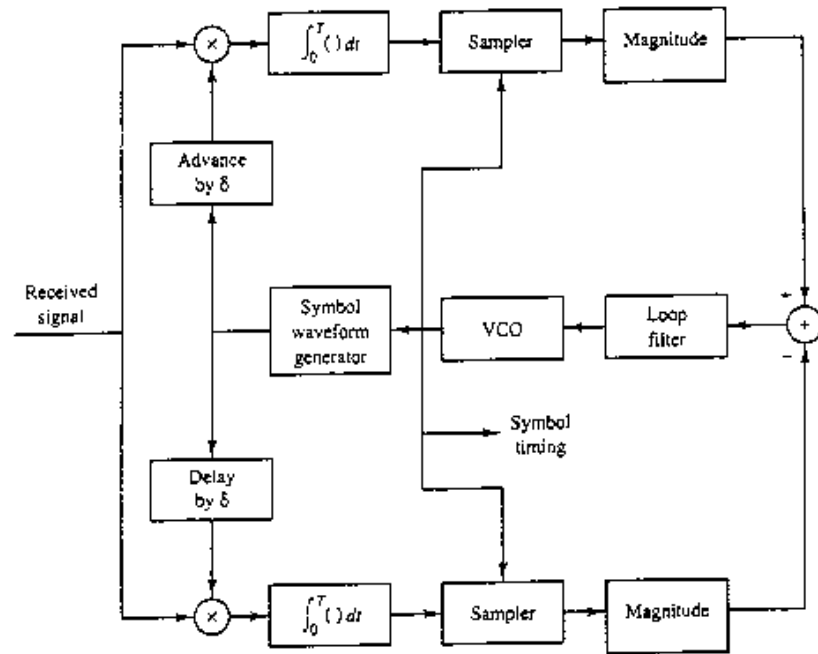Timing recovery based on minimization of MSE.

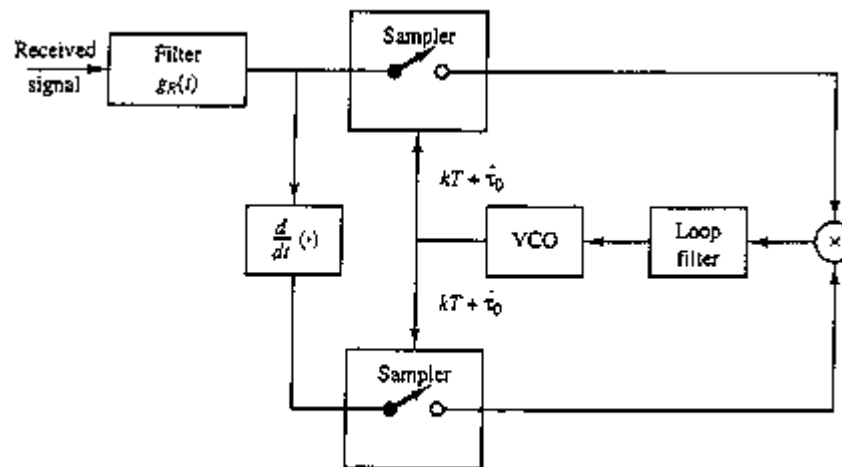# Decision Directed Timing Recovery

Decision-directed ML timing recovery method for baseband PAM.
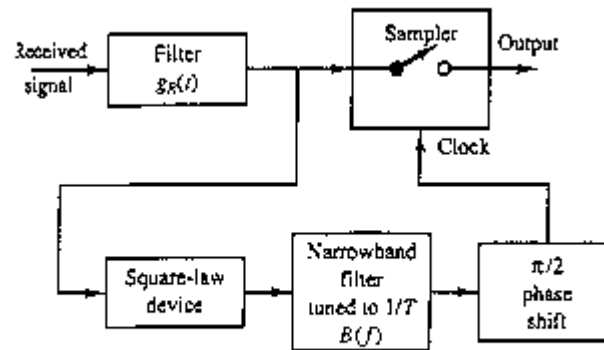
Early Late Synchronizer

Block diagram of early–late gate synchronizer.

Non-DD Timing Estimator

Non-decision-directed estimation of timing for baseband PAM.

Spectral Line Method

Symbol timing based on spectral-line method.