

Timing Recovery in Low SNR

[Research Interests](#)

As data storage densities are pushed towards Tb/in^2 and beyond, advanced signal detection algorithms such as iterative soft decoding (e.g., using low density parity check (LDPC) codes) are being suggested to cope with the lower signal-to-noise ratios (SNRs) and higher inter-symbol interference (ISI) inevitable at these extremely high densities. However, at low SNRs, current phase-locked loop (PLL) based timing recovery schemes exhibit a large residual **timing jitter** (timing jitter refers to the residual timing error after the timing recovery system does its job). Large timing jitter leads to frequent **loss of lock** (the event where the recovered clock differs significantly from the actual clock for a long duration leading to error bursts). SNR gains achieved by advanced signal detection methods will be eroded by such frequent loss of lock. Loss of lock rate, defined as the fraction of sectors suffering from loss of lock, can be used to measure how often loss of lock happens in a data storage system.

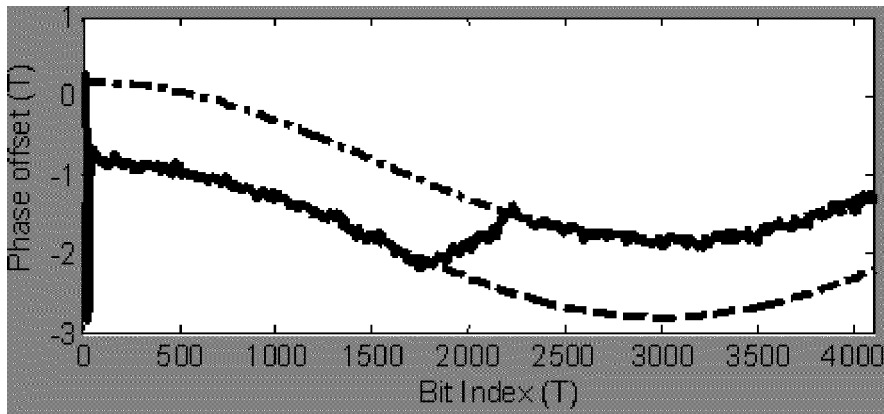


Figure 1 Example phase trajectory with loss of lock. Note that the estimated phase slips by a full cycle causing mis-indexing of bits leading to a burst of bit errors.

We are developing new timing recovery methods that can achieve acceptably low (e.g., 10^{-5}) loss of lock rate in low SNR (e.g., about 8 dB). Based on the piecewise linear phase drift approximation, we have developed new **acquisition** and **tracking** algorithms, which are suitable for high data rate applications.

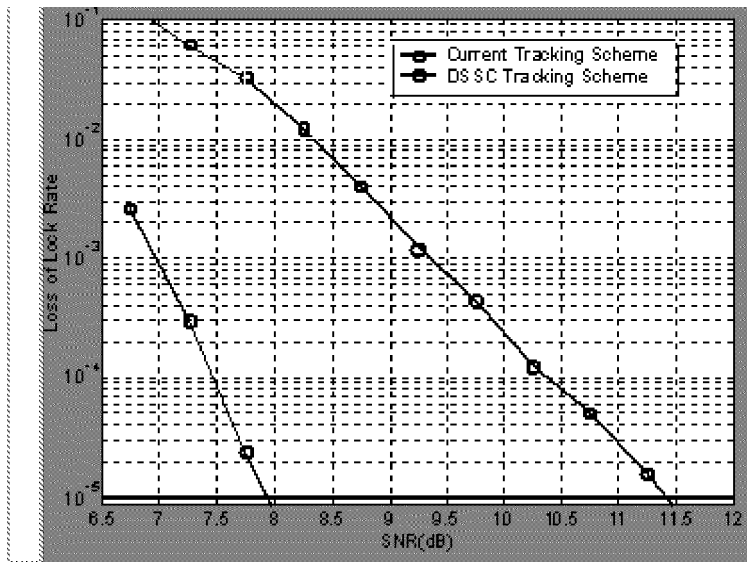


Figure 2 Loss of lock rate as a function of SNR for a longitudinal magnetic recording channel

Figure shows that our new tracking scheme can achieve 3.5 dB SNR gain over the current timing recovery scheme for a target loss of lock rate of 10^{-5} (i.e., one sector out of 100,000 sectors suffering from loss of lock) in a longitudinal magnetic recording channel. Although the example used for simulation is that of a longitudinal magnetic recording channel, this timing recovery method should be applicable to other data storage systems (e.g., perpendicular magnetic recording, optical recording, etc.).

References:

- J. Liu, H. Song and B. V. K. Vijaya Kumar, "[Bound for loss of lock rate in partial response recording channels](#)," Electronics Letters, Vol. 38, No. 16, pp. 928-930, 2002.
- J. Liu, H. Song and B. V. K. Vijaya Kumar, "[Symbol timing recovery for low-SNR partial response channels](#)," **Globecom'2002**, Taipei, Taiwan, November 2002.