SKEW AND CURVATURE IN HEAT ASSISTED MAGNETIC RECORDING

Zengyuan LIU[1], Ian GILBERT[1], Stephanie HERNANDEZ[1], Chris REA[2], Steven GRANZ[1], Hua ZHOU[2], Martin BLABER[2], Pin-Wei HUANG[3], Chubing PENG[2], Ganping JU[3], and Tim RAUSCH[1]

1) Seagate Research Group, Seagate Technology, Shakopee, MN, USA
2) Recording Head Operations, Seagate Technology, Bloomington, MN, USA
3) Recording Media Operations, Seagate Technology, Fremont, CA, USA

I. INTRODUCTION

The contributions of transition curvature and skew are known to negatively impact the areal density capability (ADC) of Heat Assisted Magnetic Recording (HAMR) systems in addition to normal media noise [1]. The near field transducer (NFT) in HAMR generates a circular thermal profile, thereby producing curved transitions. Skewed patterns are observed at disk locations where both magnetic writer and temperature profiles become asymmetric due to rotation of head. Recording performance degradation caused by skew are also shown to be related to facts of worse curvature at track center. With increasing of HAMR areal density capacity (ADC), it is critical to understand effects from curvature and skew, and seek possible solutions to mitigate the resulting noise.

II. RECORDING CURVATURE

It has been demonstrated that cross-track field gradient provided by parabola-like profile can help correcting the curvature [2]. In figure 1, the general field profile characteristics are shown as inset A. By using this technique, we obtained straight transitions under different H_min and a cross track field gradient of 200 Oe/nm. The data points show the signal to noise (SNR) ratio as a function of the minimum field H_min. For comparison, inset B shows curved transitions when a uniform field of 10 kOe is applied. The dotted line represents the SNR at this condition (around 11dB). Inset C shows straight patterns under H_min=10 kOe. Compared to the curved transitions, over 1.5 dB SNR improvement is obtained. Although largely due to curvature reduction, this SNR gain may be partially from the increased field at track edges. However, SNR decreases with decreasing H_min. For example, inset D demonstrates how the remanence regions are degraded when H_min=4 kOe. This is expected given insufficient minimum field at track center. Therefore, minimum field of the parabola-like profile are required to be large enough to preserve any SNR gains by curvature reduction.

To make systematic comparisons with curved transitions, recording performance of HAMR conventional magnetic recording techniques (CMR) are evaluated at same track pitch density and linear density. Laser power are optimized for each case. By achieving same magnitude of SNR, straight transitions are shown to have 20% PW50 reduction. PW50 is the width of the derivative of the reader response to a transition at the 50% amplitude point, which is a measure of transition sharpness and down-track reader resolution. These improvements on PW50 can provide higher linear density capability.

III. RECORDING SKEW

Figure 2 shows the SNR at different skew angles. The skew angle is defined at the rotation angle of field and thermal profiles to the relative to the cross track direction. The linear velocity is kept constant ~20 m/s. SNR decreases by approximately 1 dB as the skew angle is varied by 15 degree. To reveal the underlying causes, the recording patterns, and a schematic view of pattern asymmetry are shown in figure 3. Compared to recording patterns under zero skew, the yellow arrows show that we may attribute the SNR loss at non-zero skew angle to curvature effects caused by pattern asymmetry.

Zengyuan Liu
E-mail: zengyuan.liu@seagate.com
tel: (612) 562-3141

REFERENCES

1) G. Ju et. al., "High Density Heat-Assisted Magnetic Recording Media and Advanced Characterization-Progress and Challenges," *IEEE Trans. Magn.*, vol. 51, no. 11, (2015).
2) J.-G. Zhu and H. Li, "Correcting Transition Curvature in Heat-Assisted Magnetic Recording," *IEEE Trans. Magn.* vol. 53, no. 2 (2017).

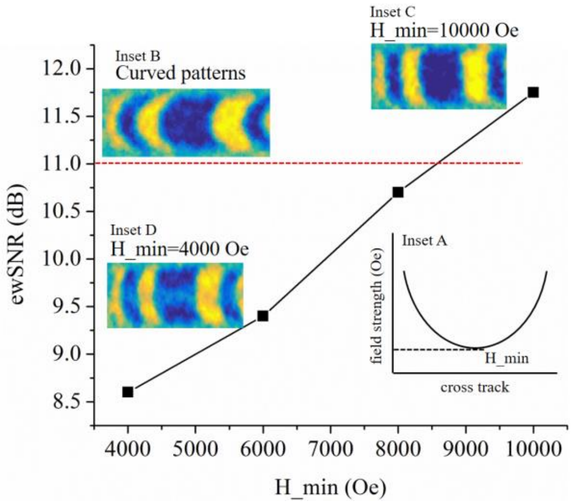

Figure 1 SNR performance under different minimum field in the cross track field gradient technique

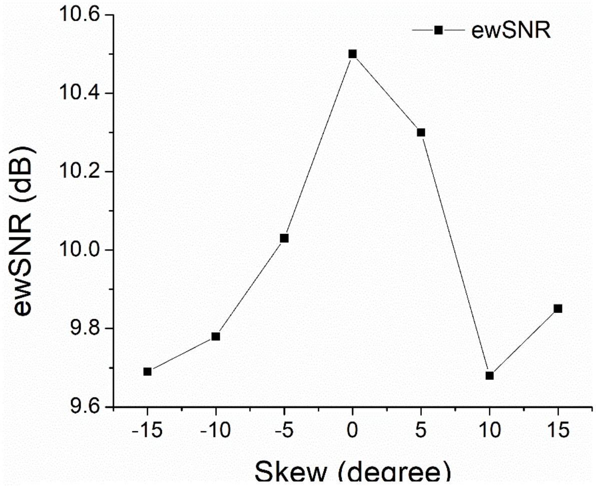

Figure 2 SNR under different skew angle of head

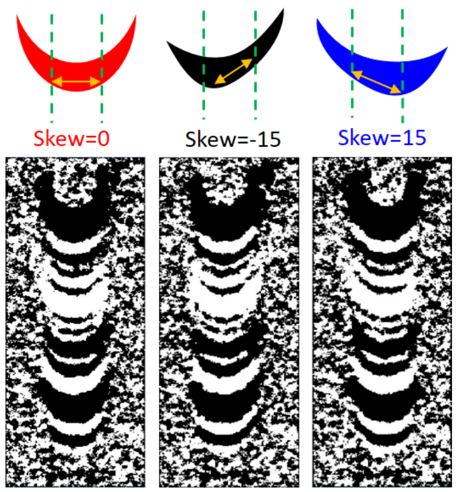

Figure 3 Recording patterns under different skew. Dashed green line marks the reader location.