# Tunnel Valve Sensors in Contact Recording



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**Abstract:**
Results of experiments in which hard-disk drive (HDD) tunnel valve (TV) sensors were run in continuous contact with magnetic recording tape are presented. In one mode, suspended HDD sliders were run against tape backed by a supporting air film in a novel configuration. In another, tape was run in an air-skiving mode over HDD rowbars mounted on support beams, similar to the way tape wraps a conventional tape head. The data indicate that HDD TV sensors can successfully operate in continuous contact with running tape media. Measurements show that roughness of older generation metal particle tape limits the signal-to-noise ratio achievable using existing narrow HDD TV sensors. However, TV sensors optimized for running on smoother barium ferrite tape are now a viable candidate for future high areal density tape recording platforms.

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Digital tape storage areal density continues to grow at a rapid, steady pace. For example, tape areal density grew 150-fold over the last 18 years, or an average of 33% annually, with cartridge capacity often doubling every product cycle. While hard-disk drive (HDD) areal density grew simultaneously at a higher average rate, this dropped to 38% per year in 2004 and is only $\sim 20$ % today [1]. Tape, on the other hand, is projected to maintain its historical growth rate for at least the next 8–10 years, in part through continued aggressive scaling of track density. This is reflected in the Information Storage Industry Consortium 2012–2022 International Magnetic Tape Storage Roadmap [2], which shows track density increasing from 6.5 kilo-tracks per inch (ktpi) in 2012 to 52.8 ktpi in 2022, during which track pitch is projected to be 0.5 $\mu$ m or less. Accordingly, aggressive read sensor width scaling will need to follow suite. In today's sixth generation Linear Tape Open (LTO) [3] products, for which track pitch is $\sim 5.3$ ktpi, read sensor width is between approximately 3–4 $\mu$ m. Giant magnetoresistive (GMR) technology sensors are used in LTO-6 tape heads. Future reader widths of $\sim 1$ $\mu$ m will mandate a transition from GMR to tunnel valve (TV), or tunnel magnetoresistive (TMR), technology, as happened in the HDD industry in the early 2000s. But unlike in HDD, heads in tape drives run in continuous contact with the magnetic

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