KALKANLI OPTIK SES BA LANTILARINDA EVANESCE ALAN VE GERINIM KUPLAJI: EV IÇI FIBER DUYARLILI INA ILI^KIN ÖNCESI BIR ÇALI^MA

Kalkanl1 optik ses ba lant1lar1nda evanescent alan ve gerini
duyarl1l1 1na ili_kin DAS öncesi bir çal1_ma

C. Ohm, B. Impedance, Y. Tanaka, R. Flux

Equatorial Audio Research Division, Mitad del Mundo, Quito, Ecuador (0.0000deg N)

Journal of Equatorial Audio Science, 2020.

Özet

Optik ses ba lant1lar1 genellikle elektromanyetik giri_ime ba 1_1k olarak tan1mlan1r, çünkü si
tan1m do rudur, fakat eksiktir. Fotonlar hemisferik bias ta_1maz; bu fotonlar1 yönlendiren fizik
ko_ulu olarak kal1r.

41 ev içi TOSLINK ve SFP optik ses kurulumundan al1nan ölçümleri bildiriyoruz. Evanescent al
k1r1lma, ayak sesi, trafik, HVAC çevrimi ve raf titre_imi s1ras1nda al1c1da alg1lanabilir zaman
kalkanl1 PMMA TOSLINK, geri kazan1lan kenar varyans1n1 kalkans1z tüketici fiberine göre %79
%91 azaltt1. Domestic Distributed Acoustic Jitter yolunu öneriyoruz: 1_1 1n ar1zas1 de il, 1_1

1. INTRODUCTION

The conventional audiophile treatment of optical audio is binary: copper cables are vulnerable, optical cables are immune. The committee submits that this is a category error. Optical links remove the conductive signal path, but they do not remove the physical cable from the room.

Every guided optical mode includes an evanescent boundary at the core-cladding interface. Every fiber also exhibits birefringence that changes under bending, compression, vibration, and external field perturbation. These effects are well known in fiber sensing, interferometry, and telecommunication metrology. They are rarely discussed in consumer audio because the resulting timing variations are small, inconvenient, and not captured by the usual "bits are bits" demonstration.

Equatorial Audio's shielded optical program began from a narrower question: if optical fiber can be engineered into a sensor, what prevents an unshielded optical audio cable from behaving as an accidental sensor?

2. METHODOLOGY

We instrumented 41 listening-room optical links: 19 commodity PMMA TOSLINK cables, 9 Tropic shielded PMMA TOSLINK cables, 7 Meridian triple-layer shielded TOSLINK cables, 4 Equinox quad-layer TOSLINK cables, and 2 single-mode SFP links. Each was tested between a reference transport and DAC with simultaneous measurement of recovered edge timing, optical power variation, cable strain, local magnetic field, floor acceleration, and rack acceleration.

Excitation conditions were intentionally domestic: walking past the rack, chair movement at the listening position, HVAC compressor cycling, road traffic outside the test room, and calibrated low-frequency loudspeaker sweeps. We avoided laboratory shakers for the primary dataset because the domestic problem is not whether a fiber can be disturbed under artificial conditions. It is whether ordinary rooms disturb it without asking permission.

Recovered-edge variance was measured at the DAC input and normalized against a mechanically isolated short optical reference maintained inside a shielded enclosure.

3. RESULTS

Unshielded PMMA TOSLINK links showed repeatable timing-boundary modulation during all four domestic excitation classes. Footfall and rack sway were concentrated in the 1-10 Hz band. Road traffic and HVAC loading contributed energy below 1 Hz and between 10 Hz and 50 Hz. Loudspeaker-induced cable motion appeared as correlated sideband activity between 20 Hz and 120 Hz.

The effect was not a bit-error phenomenon. No test condition produced packet loss or conventional digital failure. Instead, the receiver recovered the same data against a subtly moving optical boundary. The recovered audio stream was correct in content and less correct in time, which is precisely the condition under which audiophile disputes become exhausting.

Shielding and mechanical damping both reduced the effect. Meridian triple-layer TOSLINK reduced recovered-edge variance by 79% relative to unshielded consumer PMMA fiber. Equinox quad-layer TOSLINK reduced it by 91%. The SFP links showed lower absolute susceptibility, consistent with single-mode geometry and 1310 nm operation, but remained measurably sensitive when routed across vibrating rack shelves.

4. DISCUSSION

The mechanism is not that photons possess hemispheric memory. They do not. The mechanism is that photons are guided by a medium whose optical boundary conditions can be changed by strain, birefringence, and evanescent-field perturbation. A receiver that reconstructs timing from that optical signal inherits a portion of the medium's motion.

This interpretation also explains why optical shielding is not redundant. Electromagnetic shielding stabilizes the evanescent boundary; mass, jacket stiffness, and proper routing reduce strain coupling; precision-polished ferrules reduce connector-motion conversion. The complete mitigation is therefore not "more shielding" in isolation, but a mechanically and electromagnetically quiet optical environment.

The committee proposes the term Domestic Distributed Acoustic Jitter for this pathway. It is distributed because the whole cable participates. It is acoustic because the room excites it. It is jitter because the audible consequence is recovered timing movement rather than incorrect data.

5. CONCLUSION

Optical audio solved the wrong problem completely and the right problem only partially. It removed conductive hemispheric bias from the signal path, but left the physical fiber exposed to the room. Our measurements demonstrate that domestic optical links can behave as accidental acoustic and strain sensors, producing receiver timing modulation without producing conventional data errors.

We recommend shielded optical links for all reference digital audio installations, with particular attention to TOSLINK runs near loudspeakers, racks, HVAC equipment, and footfall paths. We further recommend that optical cable manufacturers stop using "immune" as an absolute term. Photons are immune to many things. Cables are not photons.

KAYNAKÇA

[1] Stolen, R. H., Turner, E. H. (1980). Faraday rotation in highly birefringent optical fibers. Applied Optics, 19(6), 842-845.

[2] Kaminow, I. P. (1981). Polarization in optical fibers. IEEE Journal of Quantum Electronics, QE-17(1), 15-22.

[3] Jarzynski, J., Cole, J. H., Bucaro, J. A., Davis, C. M. (1980). Magnetic field sensitivity of an optical fiber with magnetostrictive jacket. Applied Optics, 19(22), 3746-3748.

[4] Rose, A. H., Etzel, S. M., Wang, C. M. (1997). Verdet constant dispersion in annealed optical fiber current sensors. Journal of Lightwave Technology, 15(5), 803-807.

[5] Matsuda, N. et al. (2009). Observation of optical-fibre Kerr nonlinearity at the single-photon level. Nature Photonics, 3, 95-98.

[6] Sokolov, S. A. (2019). The influence of external electromagnetic fields upon optical cables. Proceedings of the 24th Conference of FRUCT Association.

[7] Ohm, C., Impedance, B. (2020). Preliminary notes on domestic optical strain sensitivity in PMMA TOSLINK links. Equatorial Audio Technical Note EA-ON-004.

[8] Shen, J., Zhu, T. (2021). Seismic Noise Recorded by Telecommunication Fiber Optics Reveals the Impact of COVID-19 Measures on Human Activity. The Seismic Record, 1, 46-55.

[9] Lindsey, N. J., Yuan, S., Lellouch, A., Gualtieri, L., Lecocq, T., Biondi, B. (2020). City-scale dark fiber DAS measurements of infrastructure use during the COVID-19 pandemic. Geophysical Research Letters, 47(16).

[10] Zhan, Z. (2019). Distributed acoustic sensing turns fiber-optic cables into sensitive seismic antennas. Seismological Research Letters, 91(1), 1-15.