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A WIDE-BAND FIBER OPTIC FREQUENCY DISTRIBUTION SYSTEM EMPLOYING THERMALLY CONTROLLED PHASE COMPENSATION

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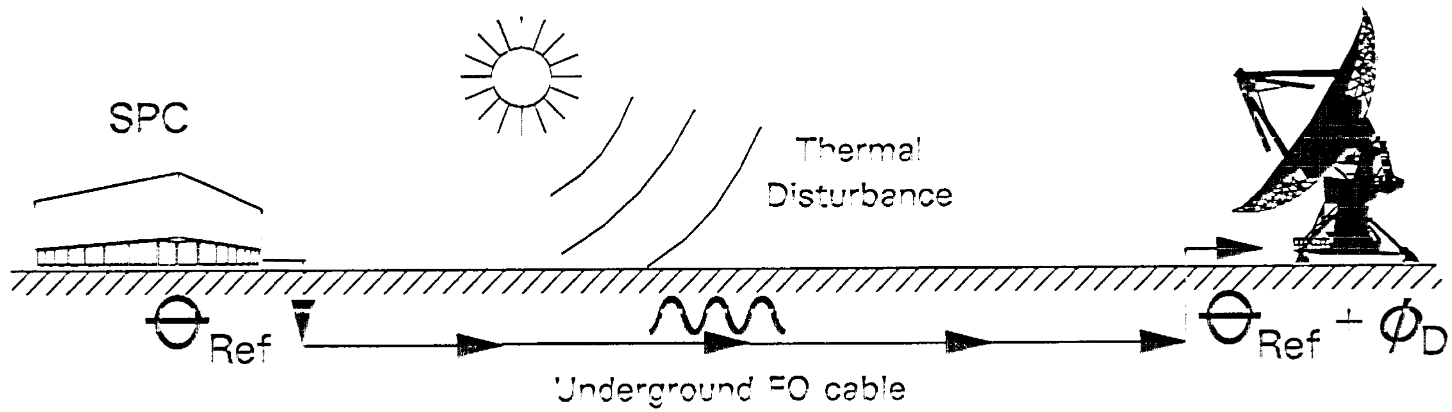
WIDE-BAND FO FREQUENCY DISTRIBUTION SYSTEM WITH THERMALLY-CONTROLLED PHASE COMPENSATION

OUTLINE

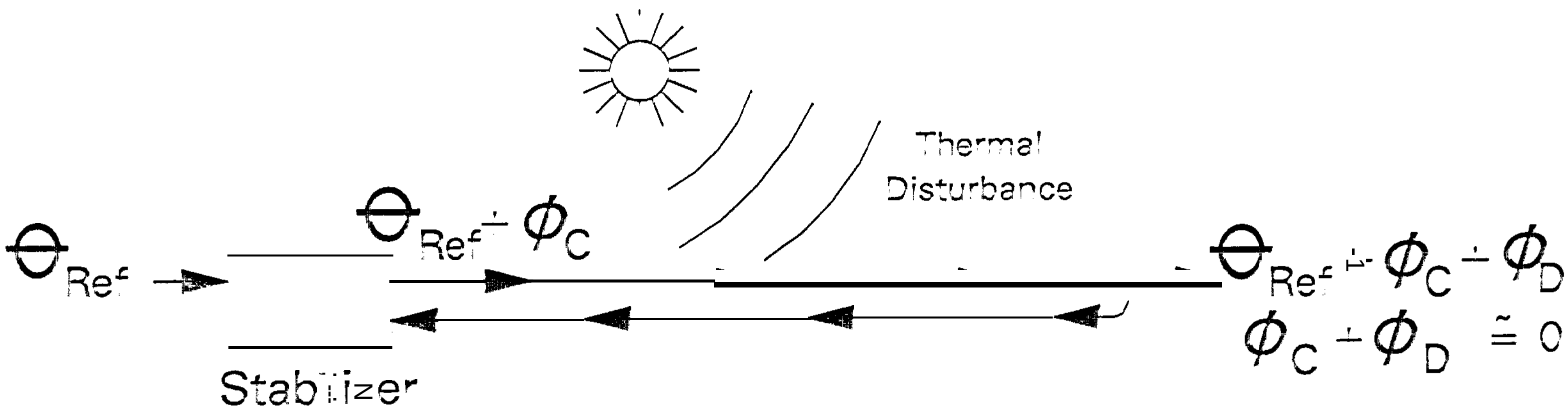
- *Passive vs Active FO Frequency Distribution Systems*
- *Thermally Controlled RF Phase Stabilization Scheme Block Diagram*
- *Signal Analysis of Active Distribution System*
- *Theoretical Allan Deviation resulting from a Diurnal Temperature Cycle.*
- *Experimental Allan Curve, 24 hr Cycling, Passive System*
- *Experimental Allan Curve, 24 hr Cycling, Active System*
- *Conclusions*

COMPARISON OF PASSIVE AND ACTIVE FIBER OPTIC FREQUENCY DISTRIBUTION SYSTEMS

Passive Fiber Optic Frequency Distribution System



Frequency Distribution System with Active Phase Compensation



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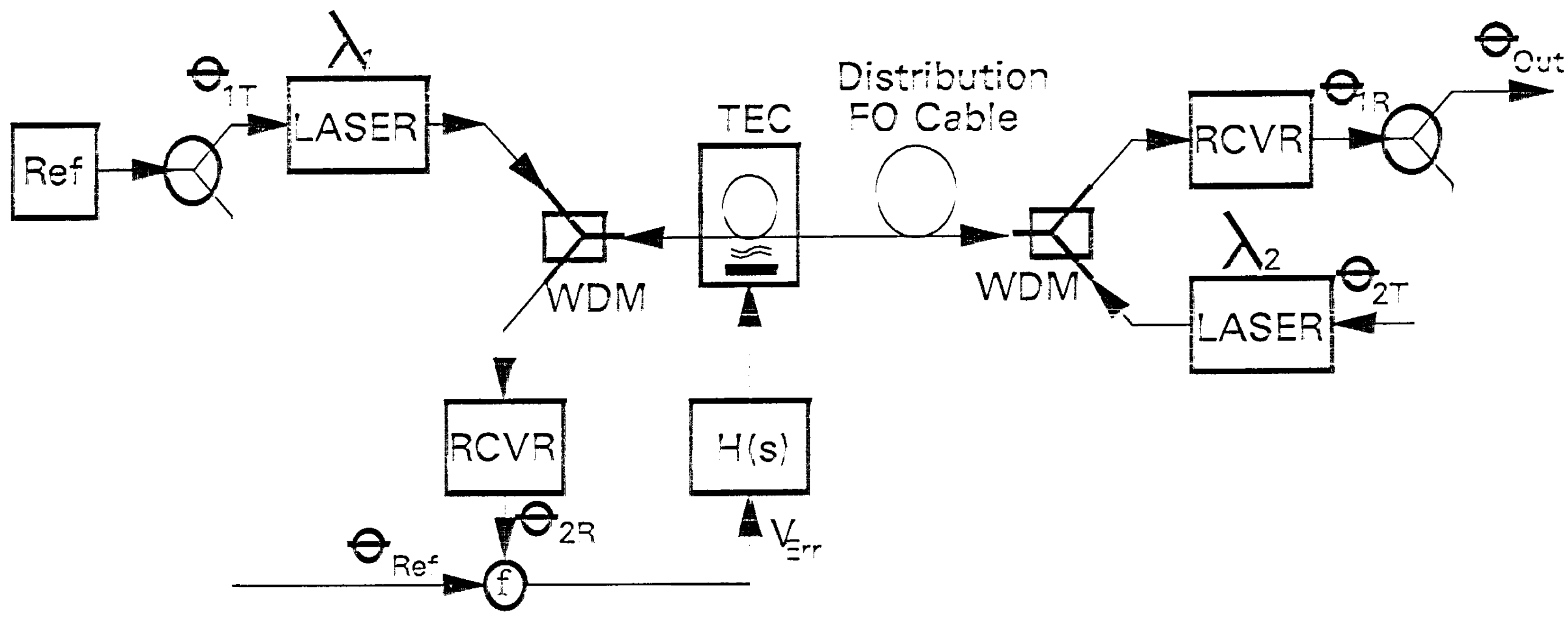
BLOCK DIAGRAM



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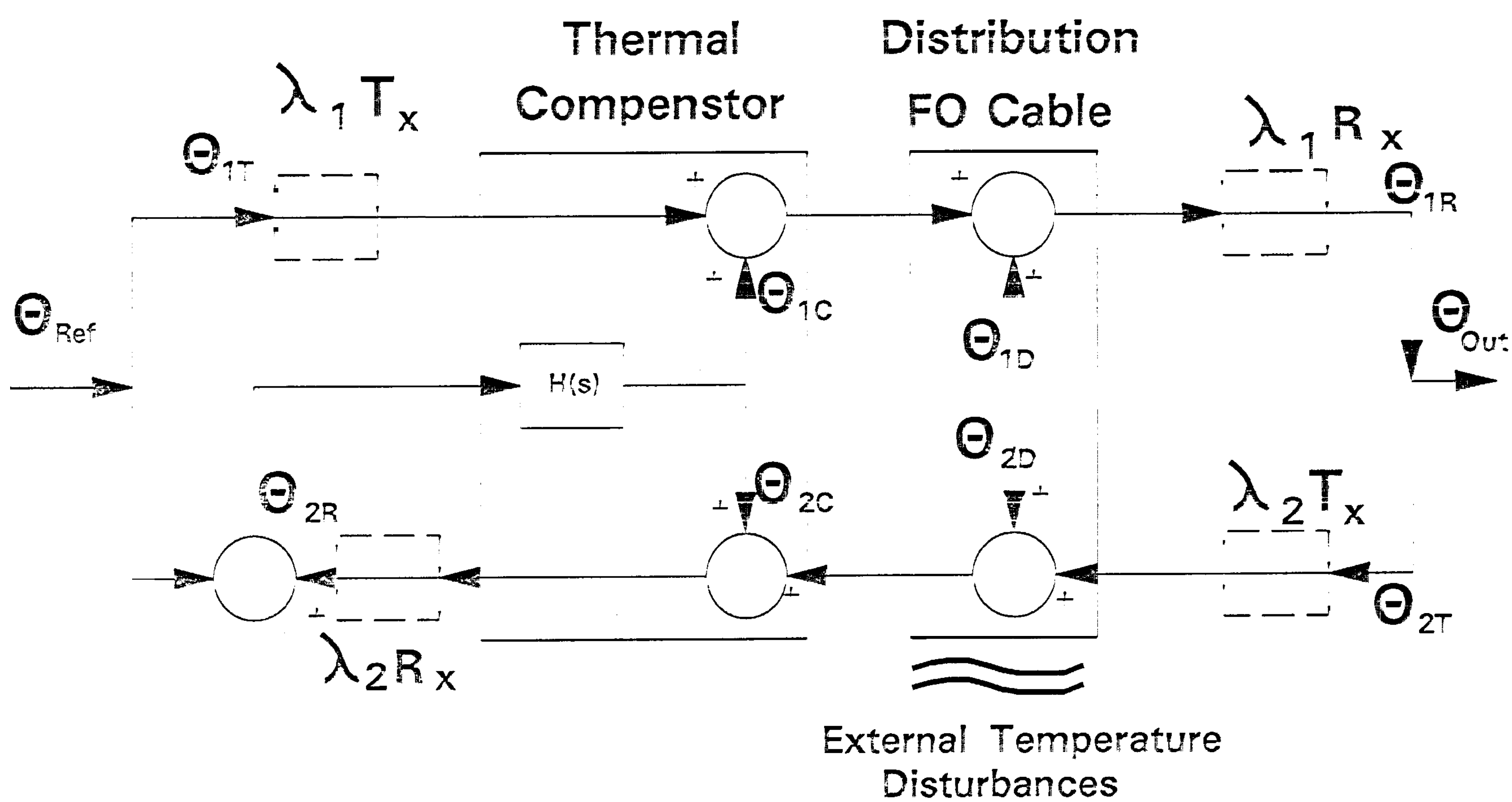
SIGNAL FLOW DIAGRAM



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THEORETICAL ALLAN DEVIATION CURVE FOR A DIURNAL PHASE VARIATION

- Diurna ime Residual:

  $x(t) = X \cos(2\pi\nu t)$

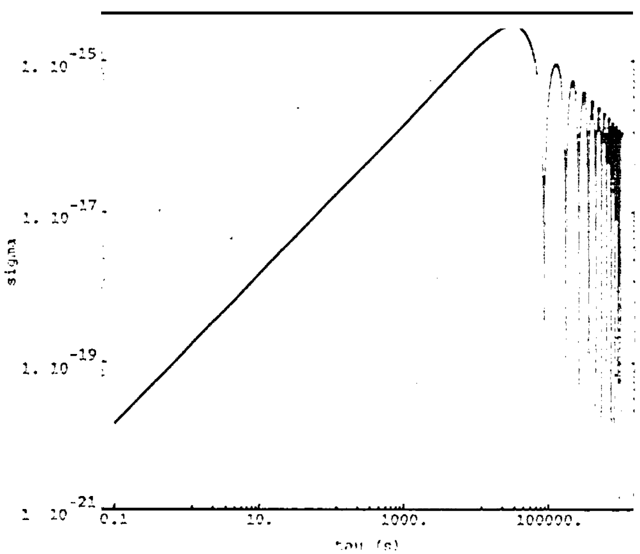
- Allan Deviation:

  $\sigma(\tau) = 2X^2/\tau \sin(\pi\nu\tau)$

- For our case:

  $\nu = 1/86400$ Hz

  $2X = 115$ psec



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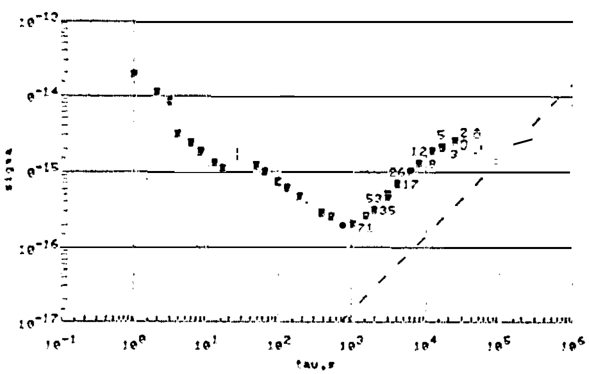
EXPERIMENTAL ALLAN DEVIATION CURVE 24 HOUR CYCLING, NO COMPENSATION

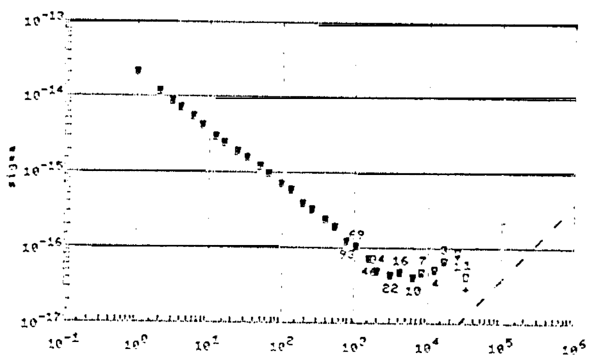
- 3.8 km, 100 MHz passive FO system (1×10^{-16} @1000s), thermally cycled 1 °C
- External 200 m compensation fiber, not actively controlled
- RF phase shift induced was 4.14° (115 ps)



EXPERIMENTAL ALLAN DEVIATION CURVE

24 HOUR CYCLING, WITH COMPENSATION

- Active FO system, 3.8 km cable varying 1°C
- 200 m compensation fiber, varying ~ 20°C
- Residual RF phase shift remaining after compensation = .104° (2.9 ps)



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WIDE-BAND FO FREQUENCY DISTRIBUTION SYSTEM WITH THERMALLY CONTROLLED PHASE COMPENSATION

CONCLUSIONS

- *Active stabilization method reduces diurnal phase variations and Allan deviation over equivalent passive distribution system by approximately a factor of 40*
- *RF phase compensation range (100 MHz) is about 4 degrees (200 m delay coil and 20 degree TEC temp range)*
- *Adds no significant amount of additional instability for small τ's.*
- *Stabilizing method is low loss, and has inherent low phase noise*
- *Stabilizer was prone to drift over period of several days, which degraded stability.*
- *Cannot compensate for fast phase variations (10s of seconds or ess)*