



PDV Fringe Recorder Development

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Agenda

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- Interferometry approximation for PDV
- High-Speed PDV systems and costs
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- PDV Fringe Counter Block Diagram
- PDV Fringe Counter Specs
- Conclusion

Motive

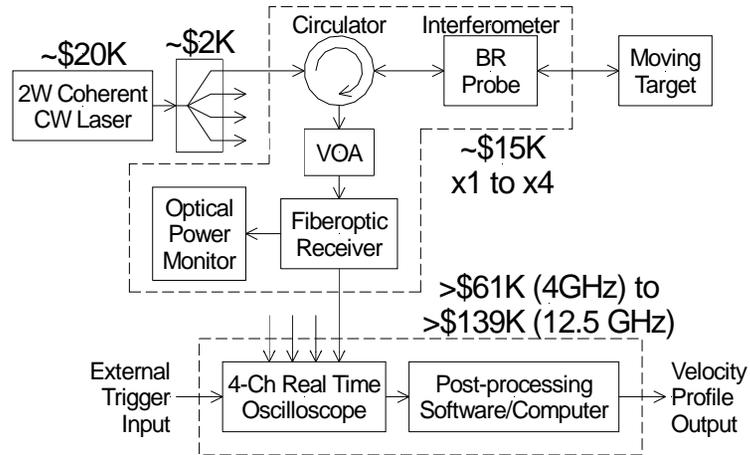
- Nashville SCCM at TME booth
 - Many researchers interested in PDV
 - Kept hearing the ~\$200K entry cost was prohibitive
 - ~\$50K was more like it
 - Often wanted just one channel
- New-comer engineer to PDV community
 - Kept wondering if there was another way to generate PDV velocity profiles
 - The results were usually quite grainy graphs

Interferometry approximation for PDV

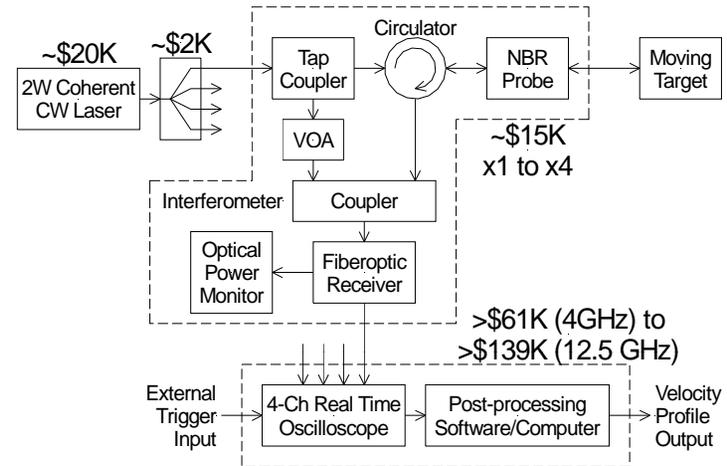
- Interferometer is fundamentally position based
 - Reinforcement or cancellation interference occurs in wavelength increments (1.55 μm)
- PDV interferometer used to measure velocity, not position
 - 1.29 GHz per km/sec is rate of reinforcements and cancellations at receiver output
 - 645 MHz per km/sec is rate of reinforcements or cancellations at receiver output
 - Velocity information is provided by frequency, not amplitude
 - Position resolution several orders of magnitude better than what is needed for velocity
- Final velocity profiles from post-processing software are inherently grainy
 - Velocity profiles typically plotted on a linear scale with no better than 0.1% resolution
 - 0.1% resolution of 10 km/s full scale is 10 m/s resolution
 - 10 m/s is a 6.45 MHz rate of reinforcements or cancellations
- This means that the receiver output rate could be divided down
 - No perceptible resolution loss on the final velocity profile
 - Real time oscilloscope bandwidth could be reduced
- Special fast counter circuit can be used to directly generate position, velocity, acceleration, and jerk profiles (PDV Fringe Recorder)

High-Speed PDV Systems and Costs

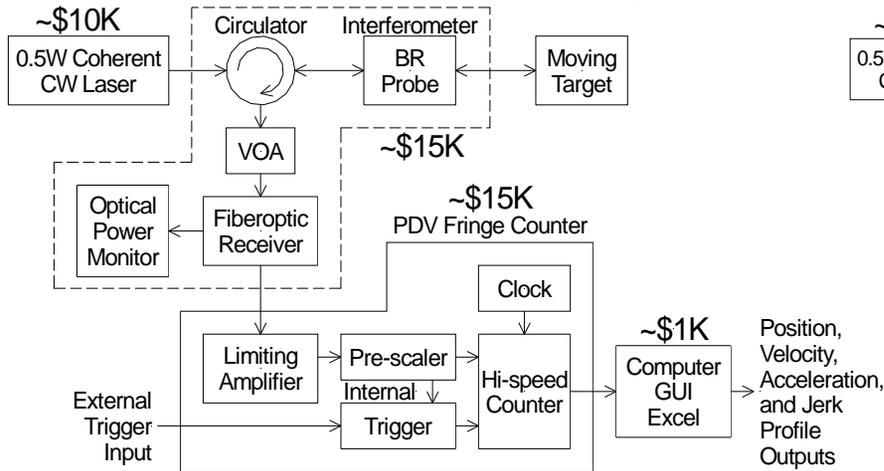
Classical 4-Ch. BR Probe type



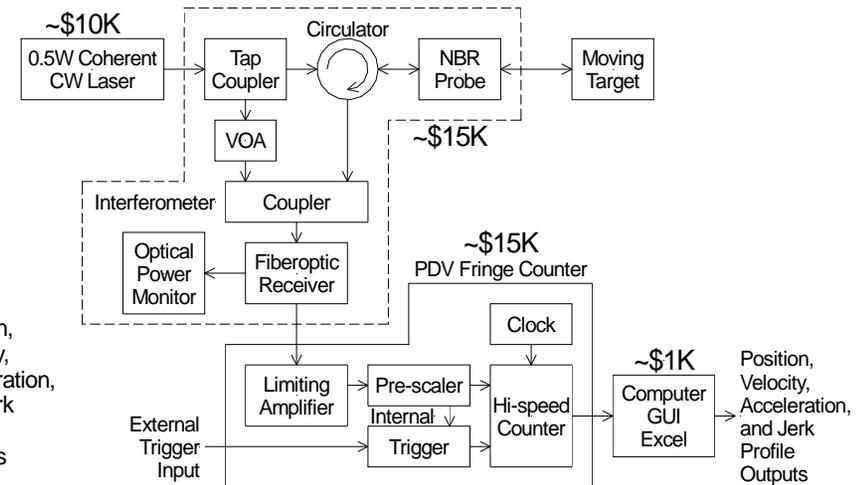
Classical 4-Ch. NBR Probe type



1-Ch. BR Probe type with PDV Fringe Counter



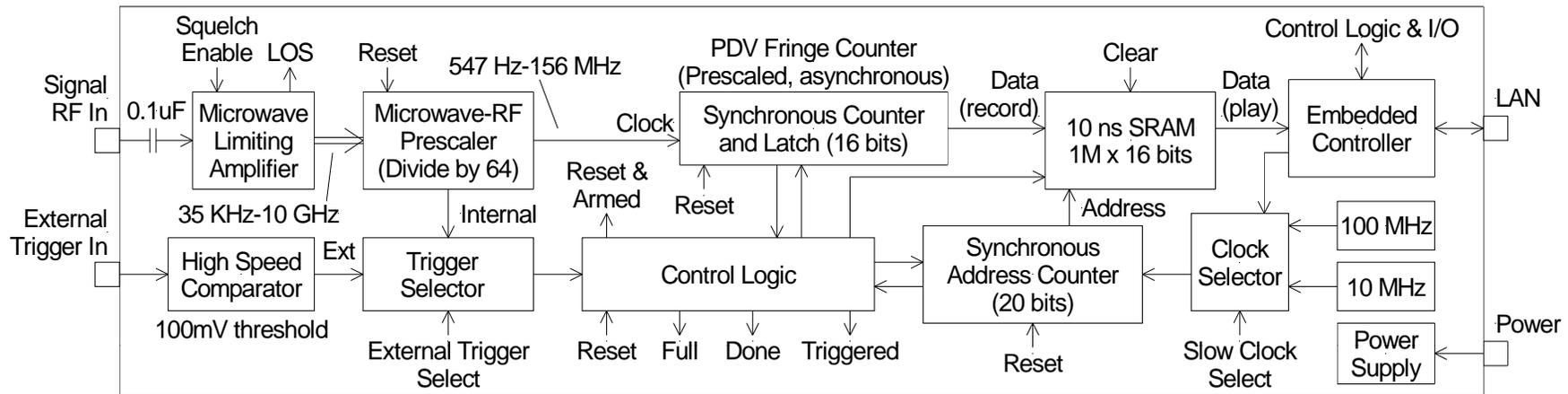
1-Ch. NBR Probe type with PDV Fringe Counter



PDV Fringe Counter Views



PDV Fringe Counter Block Diagram



- Connects to PDV receiver analog RF output
- Connects to optional external trigger source (has internal trigger)
- PDV receiver analog output passes through a microwave limiting amplifier (LA) and produces a digital output for outputs from < 5 mVpp to >900 mVpp
- LA digital output is divided by 64 and enters a 16-bit high-speed "Fringe" counter. Counter output is sampled and stored in a 1M x 16-bit fast static RAM every 10 ns or 100 ns (switch selectable).
- After a PDV run, the RAM time-sliced fringe count data (1M data points) is uploaded to a computer via an Ethernet LAN (takes <10 min), saved as a 10-30MB CSV file (Excel readable)
- The 1M data points represent the target position versus time in 10 or 100 ns steps, which can be smoothed or edited as needed and differentiated to obtain position, velocity, acceleration, jerk
- Clean and quick results due to the hardware processing approach

PDV Fringe Counter Specs

- Target velocity range: ~5 cm/s to ~15.5 km/s
- Target position range: ~6.5 meters with a ~100 um resolution
- Recording duration: ~10 ms (10 ns clock) or ~100 ms (100 ns clock)
- Triggering: external or internal
 - External trigger (50 ohm) occurs when logic input exceeds 100 mV
 - Internal trigger occurs when the velocity exceeds ~5 cm/s, 64 fringes have occurred, and the PDV receiver output signal is >5 mVpp
- Squelch switch for high noise PDV receiver outputs
- Ethernet 10/100Base-T for data upload to computer (10-30MB CSV file)
- Excel used to produce position, velocity, acceleration, and jerk profiles
- Various front panel status LEDs and mode control switches
- 1/4 rack ModBlock (1U x 8" deep), weighs <2 pounds, 12 VDC power
- Model M390A, \$15K

Conclusion – PDV Fringe Counter

- Can replace the 4-channel real-time oscilloscope and post-processing software in many high-speed PDV applications from ~5 cm/s to ~15 km/s
- Can directly provide position, velocity, acceleration, and jerk output profiles from CSV file using Excel
- Implements a single channel, easily expandable to many channels
- PDV system costs, sizes, and power significantly reduced
 - 1 channel PDV Fringe Recorder system costs ~\$41K
 - 4 channel PDV Fringe Recorder system costs ~\$141K, performs faster than 12.5 GHz classical system (to ~15.5 km/s)
 - 4 channel classical PDV system costs start between ~\$143K (4GHz) and ~\$221K (12.5GHz), scope comes in 4-channels only
- Next steps
 - Complete hardware and software tests
 - Verification against classical PDV system (any volunteers?)



Third Millennium Engineering

*Helping customers create and manufacture
advanced technology products for our future*

Can supply any PDV system or equipment required or shown in this paper

- Supplier of high quality custom engineered equipment, products, and systems using fiber optic, microwave, RF, or advanced technologies
- Quantities from 1 to 10+ units in typically 2-3 months
- Simple to complex, typically multi-functional, provided with any features and accessories needed
- Formal specifications not required, verbal specifications and goals adequate to produce quote
- Consulting, Engineering, Manufacturing, Support
- Commercial, Industrial, Defense, Emerging Industries

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- Plano Texas, since 1996, registered Texas engineer, 3CPK6 cage code
- View PDV and other catalogs on website, call or email to receive quote

“Why risk making it or doing without when you can buy exactly what you need?”