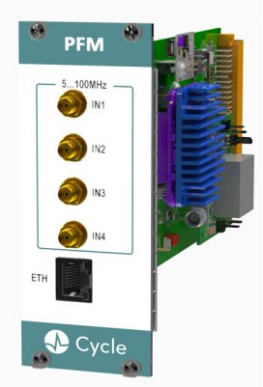
PFM

Phase/frequency meter module

High-resolution phase comparison for atomic clocks and timing systems



DESCRIPTION

PFM is a compact phase and frequency meter module developed for the characterization and comparison of ultra-stable atomic clock signals.

It enables precise, real-time measurement of phase, frequency offset, and stability over a continuous 5 MHz – 100 MHz input frequency range.

PFM is based on a fully digital architecture, directly sampling each input signal and processing data in an FPGA to extract phase and frequency information without analog mixing.

Software-defined virtual channel pairing enables flexible real-time comparison of all input signals, including non-harmonically related frequencies. The underlying technology is field-proven in operational frequency and timing systems deployed in deep-space ground-station infrastructures.

BENEFITS

- Femtosecond-level phase resolution
- Fully digital architecture
- Continuous 5 - 100 MHz input frequency range
- Real-time comparison between any selected input channels
- OEM 3U Eurocard module for seamless system integration

APPLICATIONS

- GNSS and satellite ground-segment timing diagnostics
- Atomic clock monitoring and diagnostics
- F&T system monitoring and diagnostics
- UTC laboratory clock comparison and validation
- Radio astronomy and VLBI timing backends

SPECIFICATIONS

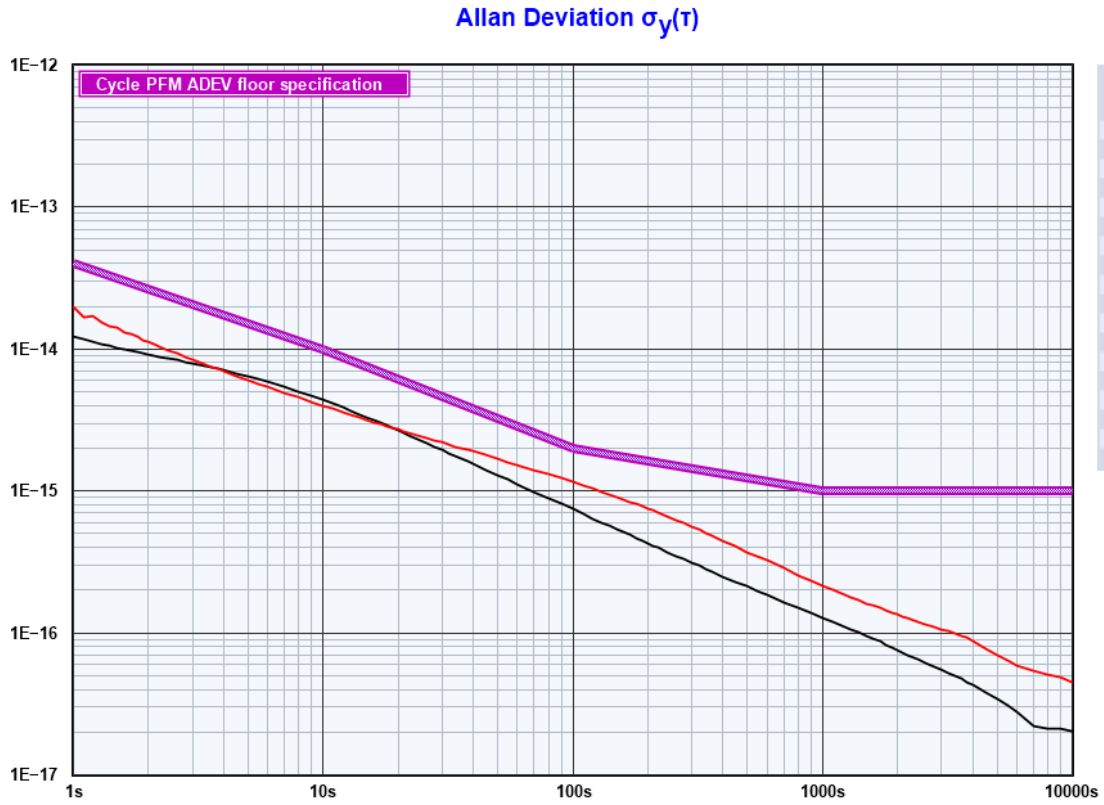
Parameter	Specification	Comment	
Input channels	4 x SMA type	channel 1 is reference	
Input signal frequency	[5 MHz – 100 MHz]	sine wave, any frequency in this range	
Input signal level	[6 – 11 dBm]	nominal	
Virtual channels	6	any combination of two out of four input channels is reported	
Phase resolution	13 fs	at 100 MHz input with 100 Hz ramp frequency	
ADEV measurement floor[1]	**Tau** 1 s 10 s 100 s 1 000 s 10 000 s	**Specification** < 4.0E-14 < 1.0E-14 < 2.0E-15 < 1.0E-15 < 1.0E-15	**Typically** 2.0E-14 5.0E-15 1.0E-15 2.0E-16 5.0E-17
Measurement outputs	Phase, frequency and ADEV	for any combination of two out of four input channels	
Measurement rate	1 Hz 10 Hz	ADEV, real-time Phase, real-time	
Control system interface	EPICS	via TCP/IP	
Form factor	3U Eurocard	plug-in module for 19-inch rack-mounted units	

[1]Module temperature from +15 to +30°C, with slope < 0.4°C/h & variation < 1°C pk-pk; humidity < 60 %RH with variation < 10 %RH pk-pk.

MEASUREMENT DATA

PFM performance at 10 MHz and 100 MHz:

ADEV measurement floor at 10 MHz and 100 MHz:



Tau	Sigma(Tau)
1s	1.22E−14
2s	9.19E−15
4s	7.07E−15
8s	5.01E−15
10s	4.38E−15
20s	2.66E−15
40s	1.56E−15
80s	8.89E−16
100s	7.44E−16
200s	4.29E−16
400s	2.49E−16
800s	1.51E−16
1000s	1.28E−16
2000s	7.56E−17
4000s	4.27E−17
8000s	2.13E−17
10000s	2.04E−17
20000s	2.04E−17

Trace	Input Freq	Duration	Elapsed	Acquired	Instrument
PFM Residual ADEV @ 100 MHz	100 MHz	1d 5h 7m 38s	1d 5h 7m 38s	1048576 pts	Cycle PFM
PFM Residual ADEV @ 10 MHz	10 MHz	2d 17h 1m 30s	2d 17h 1m 30s	2340901 pts	Cycle PFM