Cycle

BOMPD

Balanced Optical Microwave Phase Detector

Lowest noise synchronization between lasers and microwaves

APPLICATIONS

- Synchronization between ultrafast lasers and microwave signals
- Photonic microwave generation
- Synchronization between ultrafast lasers and relativistic electron beams
- Electron bunch timing in free-electron lasers

BENEFITS

- More than 0.2 mV/fs sensitivity
- Lower than 5 fs RMS noise floor
- Less than 20 fs RMS timing jitter and timing drift
- Attosecond-level timing jitter resolution

DESCRIPTION

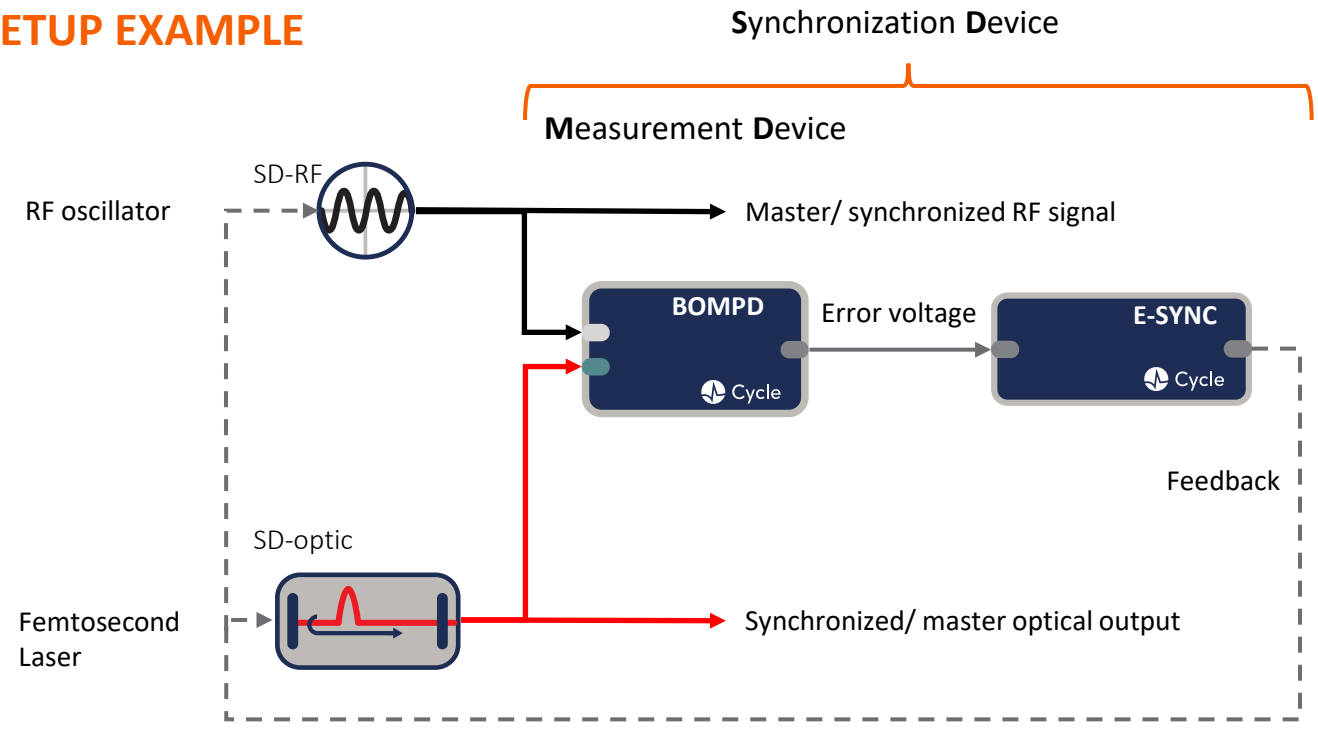
BOMPD allows ultra-precise measurement of timing jitter between an optical pulse train and the phase of a microwave signal.

BOMPD detection is amplitude invariant and bias-drift free.

BOMPD output is a baseband voltage signal that is proportional to the relative timing jitter between the input sources. It can be implemented as:

- **measurement device (MD)** for measuring the timing jitter and drift,
- **synchronization device (SD)** including necessary controllers and drivers to synchronize either
  - a femtosecond laser (SD-optic), or
  - a voltage-controlled oscillator (VCO) (SD-RF).

SETUP EXAMPLE



Cycle GmbH, Hamburg, Germany | +49 40 298486-10 | contact@cyclelasers.com | cyclelasers.com

Cycle

contact@cyclelasers.com

Contact us to discuss your timing and synchronization requirements

SPECIFICATIONS

Parameter	Specification	Comment
Detector specifications		
Timing jitter	< 20 fs RMS	integrated residual noise [35 µHz – 100 kHz], i.e., for 8 hours[1]
Timing sensitivity	> 0.2 mV/fs	main balanced output with 1 MΩ load impedance
Timing noise floor	< 5 fs RMS	integrated noise floor [1 Hz - 100 kHz]
Timing resolution	< 0.1 fs RMS	integrated noise floor within 1 Hz bandwidth above 100 Hz
Detector bandwidth	> 100 kHz	3-dB signal bandwidth
Dimensions (H x W x L)	420×300×171 mm^3	dimensions of the optical detector head
Synchronization Device (SD) option specifications		
Control unit type	Cycle E-SYNC	additional electronic synchronization unit to control the lock
Control unit dimensions	3 U	19” rack module
Control system interface	EPICS	via TCP/IP
Integrated feedback	included	applied either to a VCO or a slave laser’s actuators
Auto lock	included	via graphical user interface on a computer
Input requirements		
Optical input wavelength	800 ± 30 nm 1030 ± 30 nm 1550 ± 40 nm	center wavelength
Optical input type	PM fiber	collimator included
Optical input power	< 5 mW	coupled in fiber
Pulse repetition rate	10 MHz – 1.3 GHz	
Laser RF input power	-20 to -10 dBm	photodetected laser output
Fund. RF input frequency	10 MHz – 1.3 GHz	shall be equal to pulse repetition rate
Fund. RF input power	0 to +7 dBm	required for fundamental lock
Harm. RF input frequency	200 MHz – 20 GHz	shall be a harmonic of pulse repetition rate, contact Cycle for frequencies higher than 20 GHz.
Harm. RF input power	+13 to +18 dBm	contact Cycle for lower input power.

[1] with appropriate laser inputs, in a thermally controlled environment (temperature +18 to +24°C, with slope < 0.4°C/h and variation < 1°C pk-pk; humidity < 60 %RH with variation < 10 %RH pk-pk).

MEASUREMENT DATA

Out-of-loop timing jitter and drift a Ti:Sa laser locked to a RF master oscillator at 5712 MHz.