BOC - TCBOC

Balanced Optical Cross Correlator

Drift-free, attosecond-resolution optical pulse timing detection

DESCRIPTION

BOC enables ultra-precise measurement of timing between optical pulse trains using nonlinear optical cross-correlation. Its balanced detection suppresses amplitude noise (RIN), providing a pure timing signal independent of intensity fluctuations.

Operating entirely in the optical domain, BOC generates a baseband signal proportional to pulse timing, enabling highest-resolution timing characterization beyond the limits of electronic phase detection.

With the optional ESYNC module, the system evolves from a measurement tool into a complete synchronization solution, actively locking one laser oscillator to another with residual timing jitter below 15 fs RMS.

BENEFITS

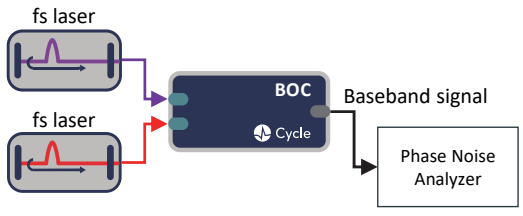
- Attosecond-level timing jitter resolution
- Exceptional long-term stability & ultra-low drift
- High timing sensitivity (> 1 mV/fs) for precise measurement and control
- Intrinsic rejection of RIN and < 15 fs RMS timing jitter & drift with ESYNC

APPLICATIONS

- Timing jitter & drift characterization of femtosecond lasers
- Femtosecond laser synchronization & repetition rate locking
- Fiber link stabilization & optical path length control
- Synchronization for pump-probe experiments

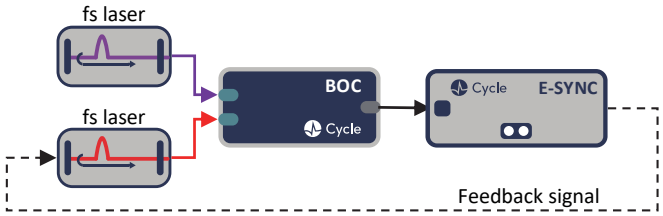
SETUP EXAMPLES

Timing jitter characterization



BOC inputs/outputs	
Input 1	fs laser (PM fiber or free space)
Input 2	fs laser (PM fiber or free space)
Output	Baseband signal proportional to relative timing jitter

Femtosecond laser synchronization



ESYNC inputs/outputs	
Input	Baseband signal proportional to relative timing jitter
Output	Feedback signal for laser intracavity actuators

SPECIFICATIONS

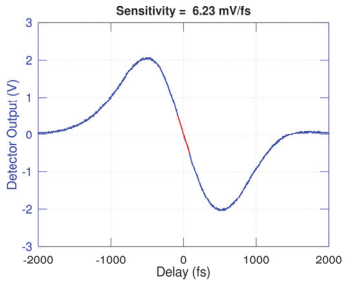
Parameter	Specification	Comment
Detector specifications		
Timing sensitivity	> 1 mV/fs	main balanced output with 1 MΩ load impedance
Timing noise floor	< 0.5 fs RMS	integrated noise floor [1 Hz - 100 kHz]
Timing resolution	< 0.05 fs RMS	integrated noise floor within 1 Hz bandwidth above 100 Hz
Detector bandwidth	> 100 kHz	3-dB signal bandwidth
Dimensions (H x W x L)	240×190×70 mm^3	dimensions of the optical detector head
Option ESYNC: Electronic Synchronization Unit		
Timing jitter	< 15 fs RMS	integrated residual noise [35 µHz – 100 kHz], i.e., for 8 hours[1]
Control unit type	Cycle ESYNC	provides auto search, lock and feedback control functions
Control unit dimensions	3 U	19” rack module
Control system interface	EPICS	via TCP/IP
Integrated feedback	included	applied to a slave laser’s actuators
Auto lock	included	via graphical user interface on a computer
Option A: Low repetition rate integrator		
Integrator electronics for low repetition-rate lasers		
Input specifications		
Optical input wavelength	800 ± 20 nm 1030 ± 10 nm 1555 ± 10 nm	standard center wavelengths with one-color (BOC) or two-color input (TCBOC). Contact Cycle for other wavelengths.
Optical input type	PM fiber or free-space	depending on the pulse peak power
Optical input power	< 30 mW	depending on the wavelength and other laser parameters
Pulse peak power	> 2.5 kW	per pulse with uniform temporal shape
Pulse repetition rate	1 kHz – 10 GHz	tailored for the repetition rate of interest

[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).

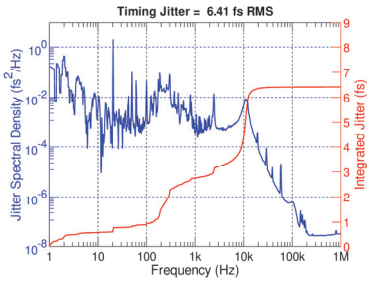
MEASUREMENT DATA

TCBOC and ESYNC performance locking an 800-nm mode-locked laser (Ti:Sa) to a 1550-nm mode-locked laser (Er):

Timing sensitivity



Out-of-loop timing jitter



Out-of-loop timing drift