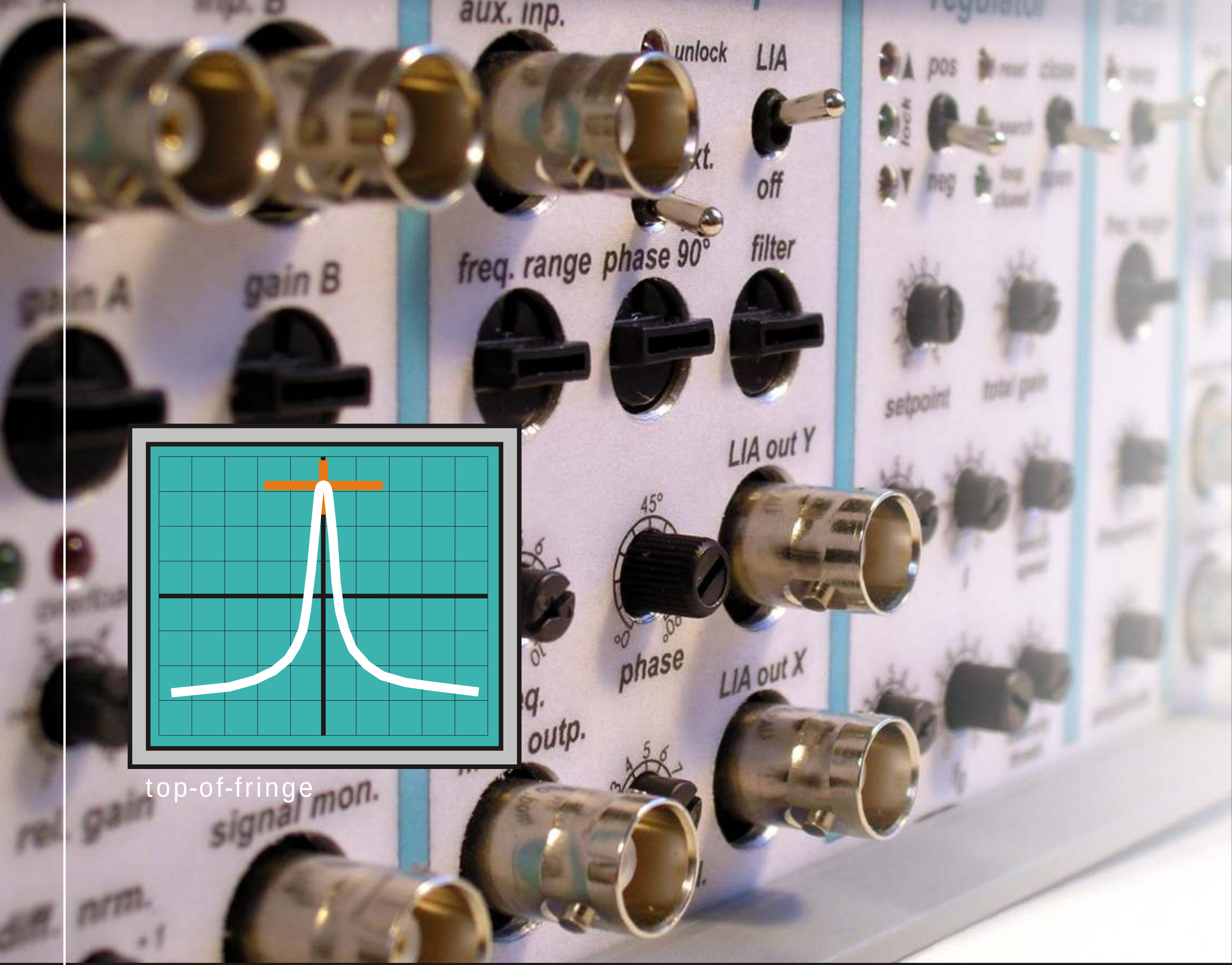
LaseLock



top-of-fringe

LaseLock®

Universal and compact laser stabilization electronics

- Compact, stand-alone locking electronics for diode lasers, dye lasers, Ti:Sa lasers, or optical resonators
- Side-of-fringe and top-of-fringe stabilization
- 2 independent PID regulators
- High-voltage output
- Lock point validity detection and automatic "search" function
- Multi-channel monitor for display of regulator signals

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Principle of Operation

Two different methods can be applied: **1) side-of-fringe stabilization**

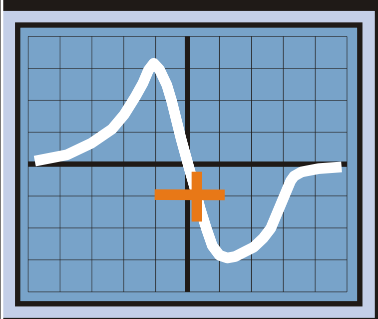
2) top-of-fringe stabilization (to maximum or minimum, 'lock-in'-technique)

Side-of-fringe stabilization is used when a direct discriminator signal can be derived from the measurement signal.

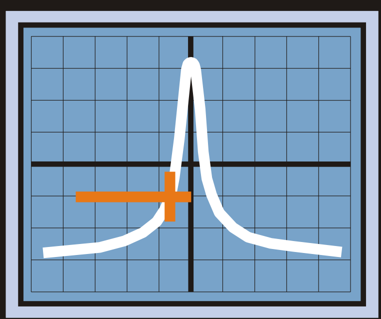
In contrast, **top-of-fringe stabilization** uses a modulation technique and phase-synchronous detection. For this, the laser frequency (or a different physical measure like the resonator length) is modulated, a detector signal is multiplied with the modulation signal, and then the product signal is averaged by a low pass filter. The resulting 'lock-in'-signal represents the derivative of the signal with respect to the laser frequency (or the respective varied physical measure).

This signal can be used directly for physical examinations, because in most cases it contains less disturbing signal parts (noise, offsets) than the directly measured signal.

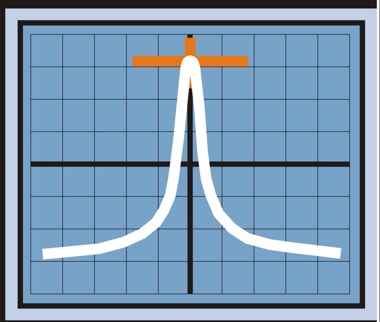
The zero-crossing of the derivative represents a maximum (or minimum) of the detected signal structure. For stabilization of a laser or resonator towards such an extremum, the 'lock-in' signal is processed by a regulator, which generates a suitable control signal that is fed back (either directly, or for piezo actuators via a high-voltage amplifier) to the frequency-determining element of the laser (or resonator). In this way the control loop is closed and the laser (or resonator) is locked actively to the maximum (or minimum).



side-of-fringe

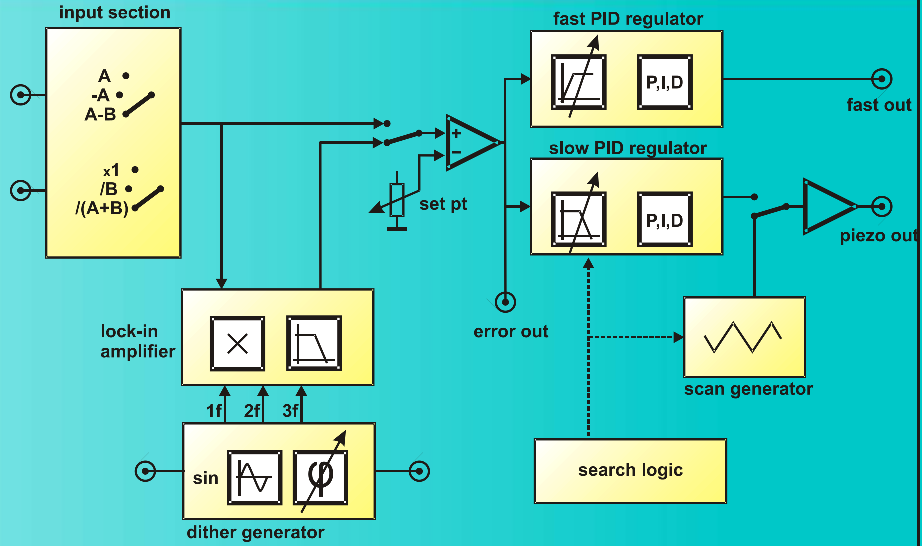


side-of-fringe



top-of-fringe

Block Diagram



LaseLock® combines all components required for or beneficial to this purpose in a user-friendly compact device:

Input amplifier section
Two separate inputs with adjustable sensitivity
Generation of input signal difference and/or ratio
Input signals available at monitor output

Lock-in-amplifier section
Sine/cosine oscillator with adjustable frequency
Modulation output with variable amplitude
Complex phase-synchronous detection
2f / 3f demodulation, user selectable
Adjustable detection phase (0 - 360°)
Selectable filter cut-off frequency
Synchronisation input

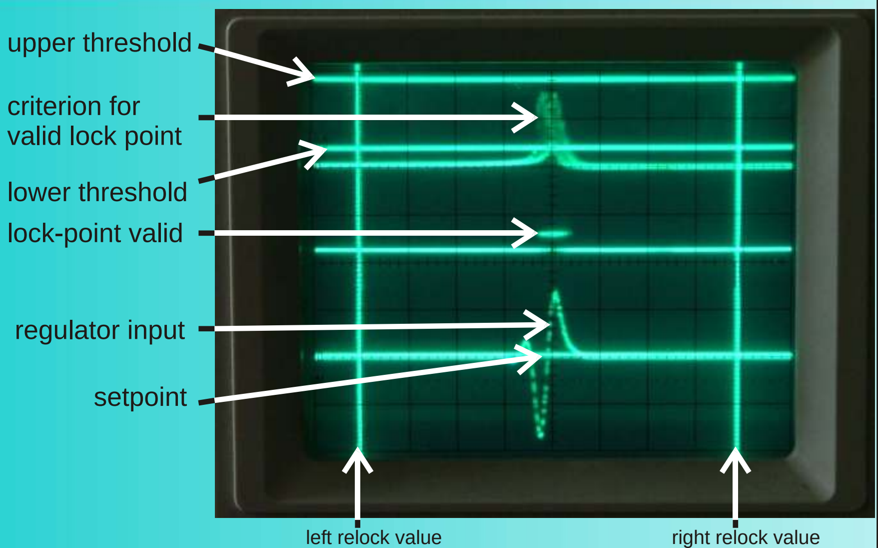
Scan generator section
Triangular-shaped scan signal for system adjustment
Scan range equal to the regulator output span
Adjustable scan frequency and amplitude
Scan signal available at monitor output

Output amplifier
High-voltage (HV) amplifier for piezo actuators
High-bandwidth regulator output with current entrainment signal for driving an external cavity diode laser oscilloscope recommended)

PID regulator section
Two independent PID regulators for simultaneous control of grating piezo and laser current
Individually adjustable proportional, integral and differential regulator coefficients
Second order low pass filter for resonance suppression in mechanical systems
Modulation input, e.g. for set point and/or output modulation

Search logic
Discriminator logic for recognition of valid and invalid regulation ranges
Automatic search start upon loss of regulator input signal
Multi-channel monitor for display of all relevant regulator signals (analog oscilloscope recommended)
Digital control input

Monitor section
for multi-channel simultaneous display of all relevant regulator signals and levels on a single oscilloscope screen (analog oscilloscope strongly recommended)



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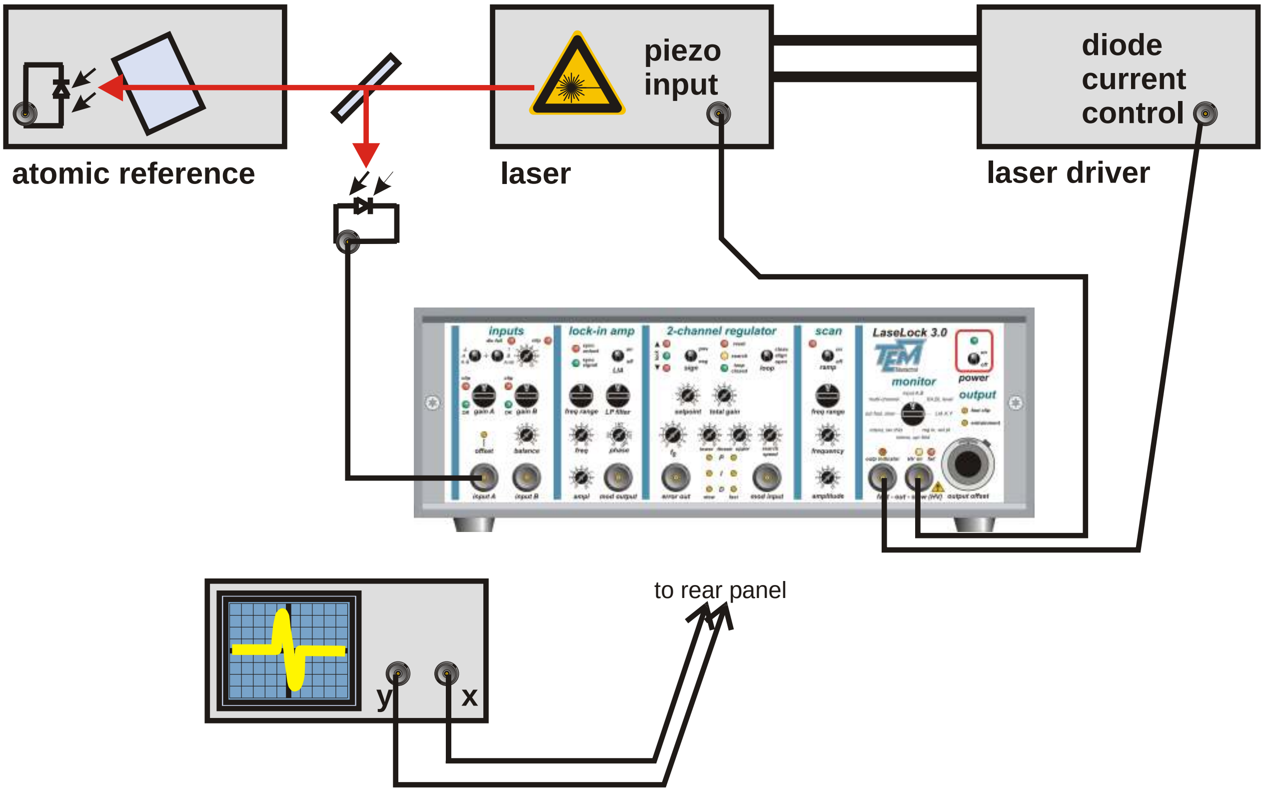
Application Example 1

Stabilization of the frequency of an external cavity diode laser to an atomic absorption line



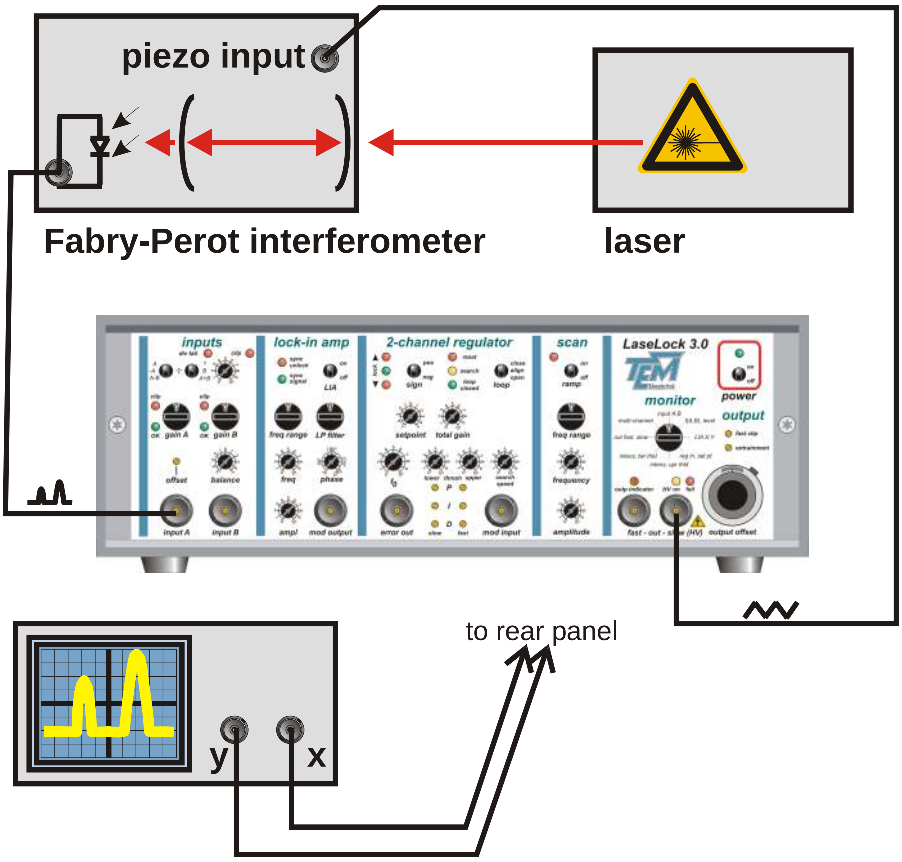
This application requires the following components:

- one *LaseLock*®
- one laser the frequency of which can be tuned via a piezo-actuator (e.g., a TOPTICA *DL100* diode laser)
- one spectroscopic absorption cell*
- one beam splitter
- two photo detectors
- one analog oscilloscope with XY-mode and an analog bandwidth Of minimum 20 Mhz

In this application, the frequency of a tunable laser (e.g., a diode laser, Ti: Sapphire- or dye laser) is stabilised with the help of a reference cell. The aim is to regulate the laser frequency to a value where the sample shows maximum or minimum absorption.

*We recommend to use TEM Messtechnik´s compact spectroscopy module *CoSy*, which includes a complete setup for Doppler-free saturation absorption spectroscopy.

Stabilization of an optical cavity (Fabry-Perot interferometer or ring cavity for frequency doubling) to the laser frequency



This application requires the following components:

- one *LaseLock*®
- one laser
- one optical cavity with one mirror moveable by a piezo actuator
- one photo detector (optional: one reference photo detector)
- one (analog) oscilloscope with XY-mode and a minimum analog bandwidth of minimum 20 MHz

In this application an optical cavity is stabilized with respect to the laser frequency by the help of the built-in piezo of the interferometer. The aim is to regulate the cavity in resonance to the actual laser frequency.

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Technical Data

Signal input	Impedance: Amplifier gain: Bandwidth Gain-bandwidth-product	user selectable (10kOhm standard) 1..3000 up to 5MHz 50MHz
Outputs	HV output Fast output Scan trigger output Scan monitor output Multichannel monitor	150V, 150mA, BNC 1MHz, 50Ohm, BNC TTL +/-10V@1kOhm +/-10V@1kOhm, +/-5V@50Ohm
Lock-In amplifier	Modulation frequency Phase adjustment Cut-off frequency	33Hz…1MHz 0..360° 33Hz..100kHz
Twin PID regulator	Bandwidth cross-over frequency slow/fast regulator	1MHz adjustable from 150 to 8kHz (range is user selectable)
Scan generator	Output frequency	10mHz..10kHz (triangular shape)
Supply	Voltage range	100..120V / 220..240V AC, 50..60Hz
Housing	Dimensions HxWxD	88mmx260mmx373mm

Costumer specific values on request. Subject to change without notice.

Development, Manufacturing and Distribution

TEM Messtechnik

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