Digital LaseLock

Digital LaseLock®

Fully digital stand-alone 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
- Lock point validity detection and automatic "search" function
- Built-in oscilloscope functionality
- User interface with touch screen and colored signal display

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Principle of Operation

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

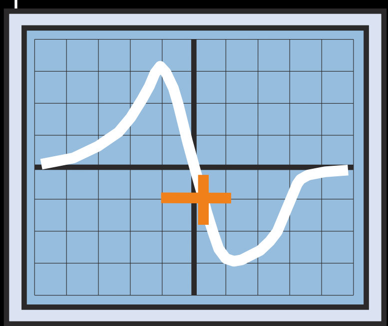
2) top-of-fringe stabilization (to maximum or minimum, 'lock-in'-technique)

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

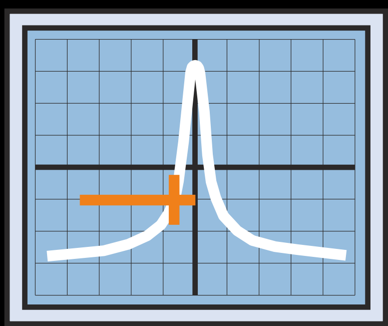
In contrast, **top-of-fringe stabilization** uses a modulation technique and phase-synchronous detection. For this, the laser frequency (or a different physical measure like the resonator length) is modulated, a detector signal is multiplied with the modulation signal, and then the product signal is 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.

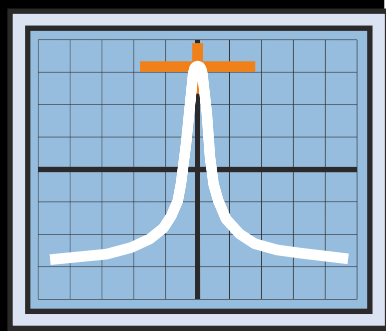
The zero-crossing of the derivative represents a maximum (or minimum) of the detected signal structure. For stabilization of a laser or resonator towards such an extremum, the 'lock-in' signal is processed by a regulator, which generates a suitable control signal that is fed back (either directly, or 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

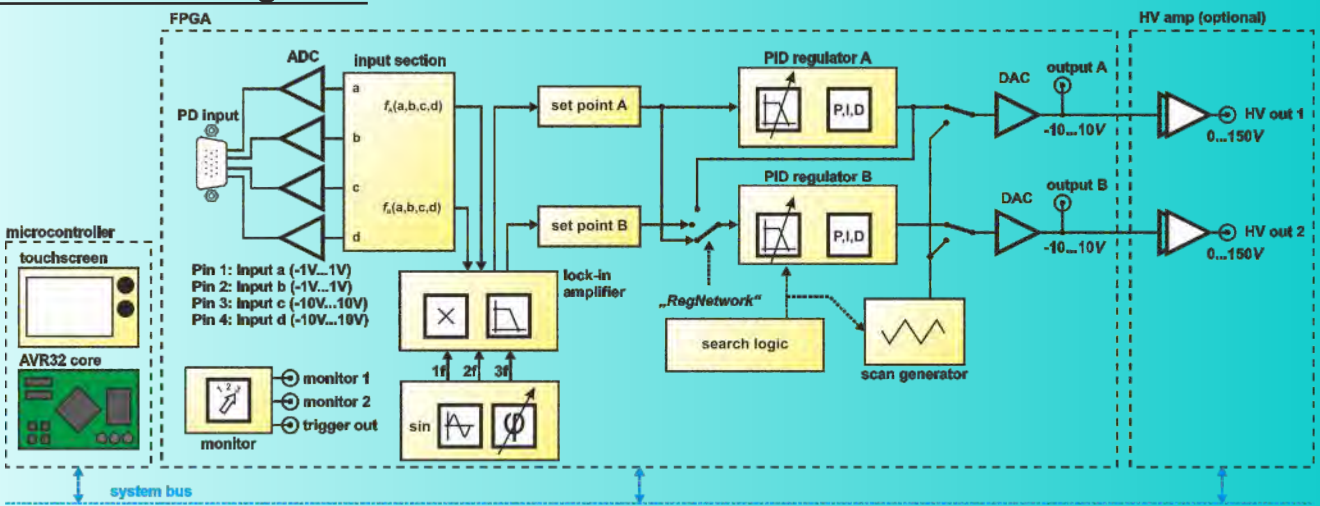


side-of-fringe



top-of-fringe

Block Diagram



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Components of LaseLock®

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

Input section
Two separate fast input channels (2.5 MS/s)
Up to 16 additional input channels (200 kS/s)
Generation of input signal difference and/or ratio
Optional: External preamplifier with supply and remote control from the lockbox

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

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

Output section
Two high-bandwidth regulator output channels (2.5 MS/s)
Up to 16 additional output channels (200 kS/s)

PID regulator section
Two PID regulators for simultaneous control of two laser tuning elements (e.g. grating piezo and laser current in an ECDL)
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
User-selectable action upon loss of regulator input signal: Automatic search scan / regulator hold / reset

Monitor outputs
Analog output of relevant internal signals and levels for display on a scope screen

Drivers (optional):

HV AMP: High-voltage amplifier for piezo actuators
HC AMP: High-current amplifier for galvo scanners
CCTC: TEC/current drivers for diode lasers

Suitable sensors:

CoSy®: Compact saturation spectroscopy module (Rb, Cs, K cells)
Fabry-Pérot interferometer with detection after Hänsch-Couillaud (*PDR-HC*)
Fabry-Pérot interferometer with detection after Pound-Drever-Hall (*PDH*)

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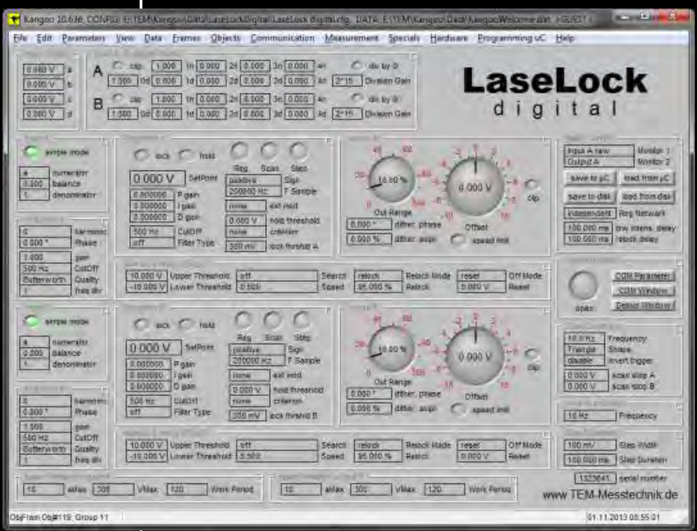
Colored TFT touch screen

Laselock® scans the laser frequency.
The user can search the absorption lines and select the desired line peak for regulation using two threshold values (red and blue line).

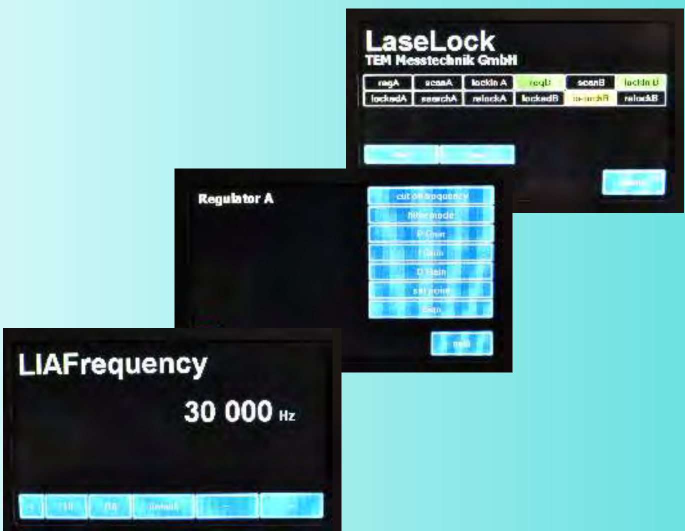
The built-in dither generator modulates the output voltage. The demodulated input signal is used for the regulation. The yellow line defines the set point level.

After switching from “scan“ to “lock“, *LaseLock* stabilizes the frequency to the desired absorption peak. The input signal is always compared with user defined thresholds. If the signal exseeds these thresholds, the regulator will start a search scan and then relock automatically.



PC interface (USB, RS232, optional: Ethernet)
Full remote control of all parameters
Read-out of measurement data

Control and visualization software *Kangoo*
Free LabView drivers



- 4.3" TFT touch screen with adjustable backlight brightness
- full control of all parameters
- relevant parameters and system status on the home screen
- graphical user interface
- visualization of signal and parameter levelson screen
- selection wheel for parameter setting and menu scrolling

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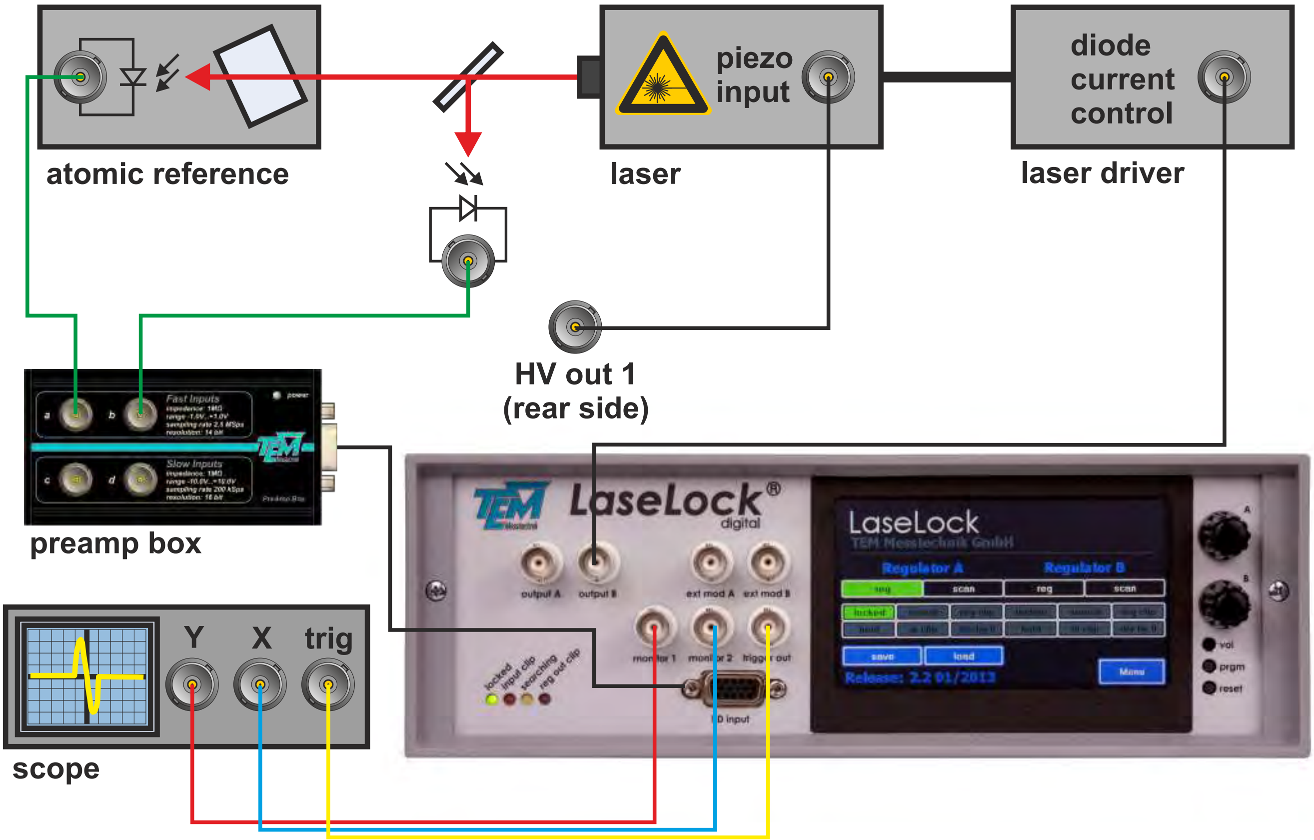
Application Example

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



This application requires the following components:

- one *digital LaseLock*® with HV option
- 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

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 for which 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.

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Technical Data

Signal input	Impedance	1 MOhm
	Voltage range	+/- 1.0 V (fast inputs)
		+/- 10.0 V (slow inputs) (others on request)
	Bandwidth	300 kHz (higher BW on request)
	Sampling Rate	2.5 MSps (fast inputs)
		200 kSps (slow inputs)
Outputs	Voltage range	+/- 10.0 V at 1 kOhm load
	Impedance	50 Ohm
	Sampling Rate	2.5 MSps
Lock-In amplifier	Modulation frequency	0.1 Hz ... 1 MHz
	Phase adjustment	0 ... 360°
	Cut-off frequency	25 Hz ... 850 kHz
Twin PID regulator	Combinations	independent / parallel / series
	Over-all delay	approx. 2 µs
Scan generator	Output frequency	100 mHz ... 20 kHz (triangular or saw tooth shape, TTL trigger output)
Supply	Voltage range	100...240 V AC, 50...60 Hz (auto detect)
	Power consumption	Typ. < 10 W, (20 W with HV option, max. 100 W @ full load)
Housing	Dimensions H x W x D	88mm x 260mm x 373mm
Display	Size	4.3" (11 cm)
	Resolution	480 x 272, 16-bit color
	Technology	resistive touchscreen, LED backlight

Subject to change without notice

Development, Manufacturing and Distribution

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