Frequency stabilized Nd:YAG/I₂ system at 1064/532 nm
(Model ILP I₂/532-1)
Main features

- **High frequency stability**
- **Big choice of the reference frequencies**
- **Simultaneous operation at two wavelengths 1064 nm and 532 nm**
- **Compact design**
- **Computer control**

The ILP I₂/532-1 system consists of the Nd:YAG ring laser (TimeBase, model ILP 1064/532-XX/XX), frequency stabilized to a saturated absorption resonance in the molecular iodine. High frequency stability, compact design and advanced automatic control make the ILP I₂/532-1 an attractive tool for a wide range of applications including interferometry, holography and high-precision metrology. As a proven example, the ILP I₂/532-1 can be used as a reference for optical wavemeters and sophisticated ballistic gravimeters [1].

The frequency stabilization scheme of the ILP I₂/532-1 system is shown in Fig. 1. The frequency stabilization to a hyperfine structure component (HFS) in the molecular iodine is based on the Doppler-free modulation transfer spectroscopy. The phase of the strong saturated beam is modulated by the electro-optical modulator (EOM) and the Doppler-free saturated absorption resonances in the iodine cell are detected by the photo detector (PD) in the weak counter-propagation beam at the frequency of the probe modulation. The signal of the first harmonic signal from the saturated absorption resonance in I₂ is used as an error signal for an automatic frequency control (AFC), the output signal of which is applied to the piezoelectric transducers (PZT-1 and PZT-2) of the ILP 1064/532-XX/XX laser, thus accomplishing the frequency lock to a HFS resonance. In this way the ILP I₂/532-1 system can be stabilized to any HFS resonance of the molecular iodine within the tuning range of the ILP 1064/532-XX/XX laser (typically about 400 GHz). This tuning range includes a big number of strong absorption lines as well as the R56(32-0) line, accurately measured by several groups and recommended by the BIPM as a secondary frequency standard in the visible range [2-4].

The ILP I₂/532-1 system consists of the optical unit and the electronic unit. The optical unit includes the Nd:YAG laser, the iodine cell and the optical setup for the Doppler-free spectroscopy (Fig. 2). The electronic unit includes power suppliers, laser diode driver, TEC controllers for temperature stabilizations (of the Nd:YAG laser, laser diode and the iodine cell), AFC and the computer control interface with the USB port. The ILP I₂/532-1 system can be operated in the manual or in the computer controlled modes. In the computer controlled operation the system is connected using the USB port to a computer (≥ Pentium II/ 256 RAM, operation system Windows NT/2000/XP). The graphical interface (Fig. 3) includes the digital oscilloscope regime with the possibility of selection of an iodine absorption line and a HFS component, and the lock mode for the automatic stabilization to the HFS components.

Fig. 1. The scheme of the ILP I₂/532-1 system.
Fig. 2. Inside of the optical unit of the *ILP I₂/532-1* system.

Fig. 3. Computer controlled operation mode of the *ILP I₂/532-1* system.
The ILP $I_2$/532-1 system characteristics:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
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<tbody>
<tr>
<td>Output power at 532 nm*</td>
<td>$\geq 5$ mW</td>
</tr>
<tr>
<td>Output power at 1064 nm**</td>
<td>$\geq 5$ mW</td>
</tr>
<tr>
<td>Polarization</td>
<td>Linear</td>
</tr>
<tr>
<td>Tuning range at 1064 nm/532 nm</td>
<td>$\sim 200/400$ GHz</td>
</tr>
<tr>
<td>Relative frequency instability $\Delta\nu/\nu$</td>
<td>$\sim 10^{-10}$</td>
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<tr>
<td>Relative frequency reproducibility $\Delta\nu/\nu$</td>
<td>$\sim 2 \times 10^{-10}$</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>+10 ... + 40 $^\circ$C</td>
</tr>
<tr>
<td>Power consumption</td>
<td>150 W (max)</td>
</tr>
<tr>
<td>Size of the electronic unit (L × W × H)</td>
<td>320 × 330 × 140 (mm)</td>
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<tr>
<td>Size of the optical unit (L × W × H)</td>
<td>320 × 210 × 140 (mm)</td>
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<tr>
<td>Weight (total)</td>
<td>12.5 kg</td>
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* fiber coupled output available  
** optional

For more detailed information please contact:

**TimeBase**
Birkenhof 26  
40225 Düsseldorf  
Germany  
Tel: +49 (211) 310-20-48  
Fax: +49 (211) 310-20-47  
info@time-base.de  
www.time-base.de

References

1. 7-th International comparison of the absolute gravimeters ICAG-2005, BIPM, France, 5-17 September (2005).

