



# HIGH POWER

## Tunable Laser and Amplifier Systems in the Watt Regime

Single-mode diode lasers often do not meet the power requirements of applications. With tapered amplifiers (TAs, see page 11) the power can easily increase to the Watt level without impairing the spectral quality of the seed laser. Besides, TAs offer excellent beam quality ( $M^2 < 1.5$  or 2).

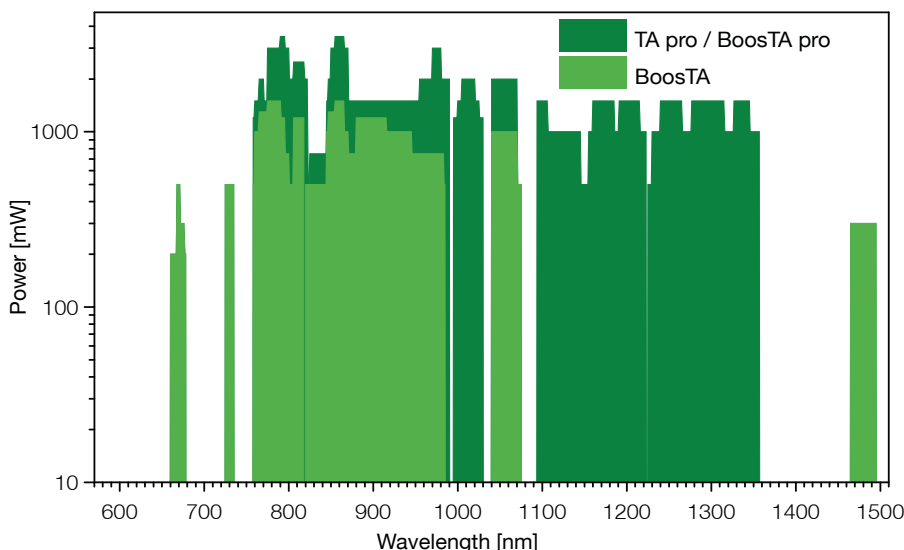
TOPTICA offers complete and integrated Master Oscillator Power Amplifier (MOPA) systems with stable beam pointing and

output power (TA pro) as well as amplifier only solutions (BoostTA pro). Both offer power levels up to 3.5 W, while the BoostTA is the most cost efficient solution providing up to 1.5 W output power.

The **TA pro** is a member of TOPTICA's pro series and consistently follows the concept of maximum stability and ease of use. This product consists of a grating stabilized diode laser and a tapered semiconductor

amplifier. The Master-Oscillator Power-Amplifier (MOPA) concept combines the tunability and linewidth of the DL pro seed laser with the high power and excellent beam quality available from tapered amplifiers. Master oscillator and power amplifier are independently driven by a pair of temperature and current controllers. Patented, highly stable, flexure based mirror mounts ensure easy coupling of the master laser into the tapered amplifier and prevent intensity fluctuations caused by beam pointing variations. For beam shaping, TOPTICA uses custom-made optical components, achieving an excellent beam profile and highest single-mode fiber-coupling efficiencies.

The DLC TA pro comes with TOPTICA's new all digital laser driver DLC pro. The digital control electronics delivers the highest currents (powers), lowest noise and drift (narrow linewidth) and the most convenient user interfaces. SYST TA pro is the more cost efficient alternative with analog double stage SYS DC series electronics.



### Integrated system with high-quality components

The TA pro consists of a grating-stabilized diode laser and a tapered semiconductor amplifier. A high-quality optical isolator placed between master laser and amplifier eliminates spurious back-reflections and thus guarantees spectrally robust operation.

Between isolator and tapered amplifier a probe beam is tapped off and made available for spectral stabilization and monitoring purposes. All mechanical and optical components are integrated in a housing that is machined from one solid block. The complete system has proven its stability in numerous tests both in TOPTICA's laboratories and in many customers' experiments.

### Active power stabilization included

DLC TA pro systems feature integrated photo diodes that monitor the seed and output powers to prevent damage to and premature aging of the amplifier chip. With the free DLC pro firmware update to version 1.4 or higher we have added active power stabilization. Not only can the power be stabilized at the integrated photo diodes, but also on external photo diodes in your experiment – exactly where you need it.

### Key advantages

The integrated MOPA (Master-Oscillator Power-Amplifier) system provides unmatched stability against acoustic noise, vibrations and ambient temperature

changes. The TA pro is easy to align, very stable when aligned, and it offers the best possible beam quality available from tapered amplifiers. The TA pro comes in five standard wavelengths, but further wavelengths between 632 nm and 1495 nm are available as well. The output power at a specific wavelength depends on available TA chips and master laser diodes. Thanks to a new high-current laser driver, the most powerful TA pro systems now achieve power levels up to 3.5 W.

### Prepared for high bandwidth locking

The TA pro system is ideally prepared for high bandwidth power and frequency stabilization as well as linewidth reduction by acting on the laser and/or amplifier current through several high bandwidth modulation inputs. TOPTICA offers various solutions for stabilization tasks, e.g. Pound-Drever-Hall or phase locking.

DLC TA pro systems come with TOPTICA's all digital DLC pro. It delivers lowest drift and noise and at the same time highest amplifier currents: 5 A with CC-5000 and with the optional surcharge SUR TA / HP up to 10 A. DLC pro is conveniently controlled via touch display, knobs or remotely via TCP/IP or USB. More information on DLC pro can be found on pages 39 & 40. Alternatively, the TA pro is still available with TOPTICA's proven analog electronics SYS DC 110 as SYST TA pro.

Please inquire.

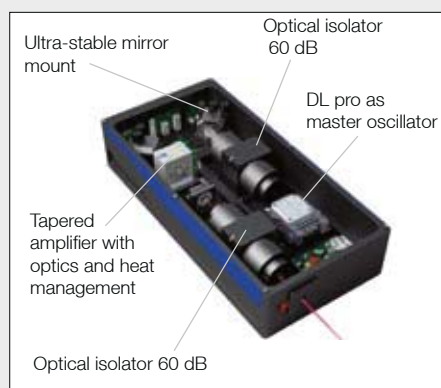


DLC TA pro - next generation of amplified tunable diode lasers - with the all digital DLC pro driving electronics.

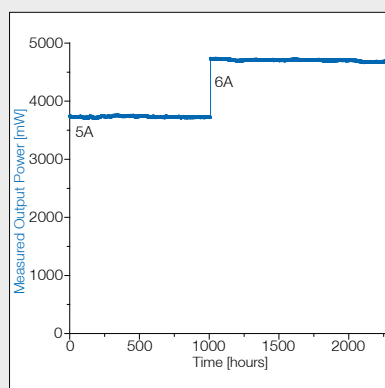
### Key Features

- MOPA concept with DL pro master and tapered amplifier
- Powers up to 3.5 W
- Amplifier currents up to 5 A / 10 A
- Excellent beam quality: typ.  $M^2 < 1.5$
- DC & AC-coupled modulation ports for both master laser and amplifier
- Probe-beam output
- Output power stabilization

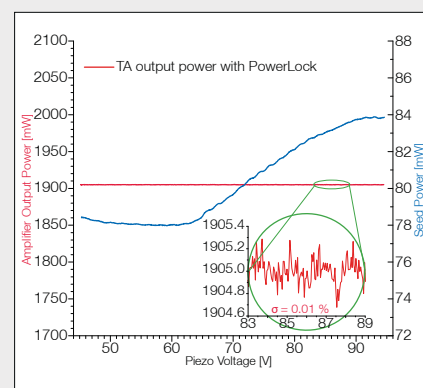
Check our regularly updated diode and TA chip stock list: [www.laser-diodes.com](http://www.laser-diodes.com)



TA pro laser head with integrated 60 dB output isolator.



Excellent output power stability (example of testing a new chip at two different amplifier currents).



DLC TA pro system master and amplifier powers with PowerLock during a 10 Hz piezo scan. While the master fluctuates approx. 8%, the TA output is stable ( $\sigma=0,01\%$ ).

# TA pro TOPSeller and Customized Versions

## Optimized Systems for Selected Applications

### Optimized Systems for Selected Applications

Pre-configured TA pro systems have proven themselves as workhorses in numerous quantum optics laboratories around the world. TOPTICA's TA pro TOPSellers are value priced and can be combined with multiple options. Optical Isolation of the output beam is highly recommended.

### Customized Solutions

Based on more than 30 different TA-Chips a very broad range of wavelengths and powers can be realized with customized versions of TA pro systems (graph on page 24, see also tapered amplifier stock list at [www.toptica.com/laser-diodes](http://www.toptica.com/laser-diodes)). They are open and flexible systems, and can be modified according to individual needs (see options). In case you don't find your preferred features please don't hesitate to contact us. We are happy to discuss your individual needs and are prepared to create flexible solutions. There are many more possibilities not listed here.

### Options

- Optical isolator for TA output (recommended)
- Surcharge SUR TA / HP for higher currents (DLC pro: 10 A, SYST: 5 A)
- Fiber-coupling of TA output and/or probe beam (output FiberDock requires optical isolation)
- Narrow linewidth resonator
- DFB master laser
- Motorized wavelength selection
- Bias-T for high bandwidth frequency modulation
- Locking option DLC pro Lock and DigiLock 110, PDD 110, FALC 110, etc.

<b>H</b> DLC 2 x Lyman $\alpha$					
<b>Li</b> DLC Lithium cooling <b>DLC TA pro 670</b> DLC DL pro 670	<b>Be</b> DLC Be <sup>+</sup> cooling				
<b>Na</b> DLC Sodium cooling	<b>Mg</b> DLC Mg <sup>+</sup> cooling				
<b>K</b> <b>DLC TA pro 765</b> DLC DL pro 780	<b>Ca</b> DLC Ca <sup>+</sup> cooling DLC DL pro 850 DLC DL pro HP 420 DLC DL pro HP 397 DLC DL pro 850				
<b>Rb</b> DLC Ryberg Rb I DLC Ryberg Rb II <b>DLC TA pro 780</b> <b>DLC TA pro 795</b> DLC DL pro 780 DLC DL pro HP 420	<b>Sr</b> DLC Sr cooling DLC DL pro 461 HP DLC DL pro 670 DLC DL pro HP 420		<b>Pr</b> DLC Pr Storage		
<b>Cs</b> <b>DLC TA pro 850</b> DLC DL pro 850 DLC DL pro HP 461	<b>Ba</b>		<b>Yb</b> DLC Yb cooling DLC Yb <sup>+</sup> cooling DLC DL pro 369 DLC DL pro HP 637	<b>Dy</b> DLC Dy cooling	<b>Hg</b> DLC Mercury Cooling



Magneto-optical trap of lithium atoms.  
T. Esslinger, ETH Zürich, Switzerland.

A number of TOPSeller systems are available, e.g. for laser cooling or excitation of specific transitions. Listed in this cut-out of the periodic table are all TOPTICA TOPSeller solutions for each element. Amplified diode lasers are marked in bold letters. TOPSellers based on direct diode lasers (see page 19) or frequency-converted NLO systems (see page 34) are mentioned for completeness.

DLC TA pro TOPSeller	670	765	780	795	850
Wavelength range [nm]	664 .. 674	760 .. 775	765 .. 795	780 .. 800	850 .. 870
Max. output power [W]	0.5	2	3	3.5	3.5
Beam quality [M <sup>2</sup> ]	< 1.5	< 1.5	< 2	< 2	< 2
Mode-hop-free tuning [GHz]	30 - 50	30 - 50	30 - 50	30 - 50	30 - 50

For customers who wish to boost the power of existing lasers, coherent stand-alone amplifiers offer an attractive solution.

TOPTICA's BoostTA product line provides efficient optical amplification without compromising the high spectral and spatial beam quality of the master laser.

### Semiconductor optical amplifier for more laser power

TOPTICA's new stand-alone optical amplifier BoostTA pro increases the output power of a DL pro or any other linearly polarized master laser by up to 20 dB.

Following TOPTICA's well-established pro-technology, the TA chip is mounted in a compact unit with optimized heat management and beam-shaping optics.

### Options

- Optical output isolator, 30 or 60 dB (integrated in amplifier head)
- Fiber-coupled input
- Fiber-coupled output (requires optical isolation)
- Operation with standard rack SYS DC 110

A compact, external power supply (DC HP) drives the amplifier head and allows effortless operation - even of current-hungry TA chips at wavelengths with lower gain. Researchers thus benefit from output power levels up to 3.5 W with currents up to 7 A.

The BoostTA pro head also includes a high-bandwidth current modulation board, which - when used in a closed feedback loop - allows compensating power fluctuations of the master laser by adjusting the amplifier gain. The board features a protective circuit to avoid the risk of chip damage. The beam management of the seed laser can be greatly simplified by fiber input coupling, which is optionally available as well as fiber-output coupling. Optical output isolation is provided by TOPTICA. The BoostTA pro head has sufficient space for a 60 dB isolator to protect the TA chip from back reflections.

To determine the available tuning range and output power for your desired wavelength, please contact TOPTICA. For an overview, please see the table on page 28, the graph on page 24 and check our regularly updated tapered amplifier stock list on [www.laser-diodes.com](http://www.laser-diodes.com). The stock list shows the required amplifier current for achieving the maximum specified output power. BoostTA pro offers a maximum current of 7 A.



BoostTA pro — High-power optical amplifier.

### Key Features

- Compact amplifier module
- Gain up to 20 dB (x 100)
- Output power up to 3.5 W
- Amplifier currents up to 7 A
- External control electronics (DC HP)
- Maintains spectral properties of master oscillator
- Many wavelengths available (660 .. 1495 nm)

Check our regularly updated TA chip stock list: [www.laser-diodes.com](http://www.laser-diodes.com)



BoostTA pro with DC HP.



BoostTA pro laser head with Fiber-in, Fiber-out (FiFo).

# BoosTA

## Semiconductor Optical Amplifier



BoosTA — Economic optical amplifier.

### Key Features

- Compact amplifier module
- Gain up to 20 dB (x 100)
- Output power up to 1.5 W
- Amplifier currents up to 2.5 A
- Integrated, compact control electronics
- Maintains spectral properties of master oscillator
- Many wavelengths available (660 .. 1495 nm)

Check our regularly updated TA chip stock list:  
[www.laser-diodes.com](http://www.laser-diodes.com)

### Compact and cost efficient semiconductor optical amplifier

For customers with moderate power requirements, the BoosTA offers a cost efficient alternative to the BoostA pro while still being superior to self-built solutions. It comes pre-aligned and tested with a suitable seed laser, and users can readily insert it into their experimental set-up.

The BoosTA comprises a selected tapered amplifier chip as well as proprietary collimation optics, which help to achieve the best possible output beam profile. Control electronics for TA chip temperature and driver current is integrated into the laser head. The current can either be set manually via a rotary potentiometer, or remotely via an RS 232 interface. An external power supply minimizes the impact of thermal and electronic radiation (EMC) on the amplifier head.

Fiber input and output coupling as well as integration of an optical output isolator in the amplifier head are optionally available like for the BoostA pro. The fiber-coupled system provides high flexibility in the optical beam path, reduces complexity on the optical

table and increases the long-term stability of the experimental set-up. It is even possible to combine two different seed lasers, e.g. in a polarization-maintaining fiber array, and amplify both wavelengths simultaneously in a single BoosTA system. This concept is widely used for the generation of tunable, continuous-wave terahertz radiation.

Available BoosTA power levels depend on the particular TA chip and the available current. The BoosTA offers a maximum current of 2.5 A - sufficient for output powers up to 1.5 W.

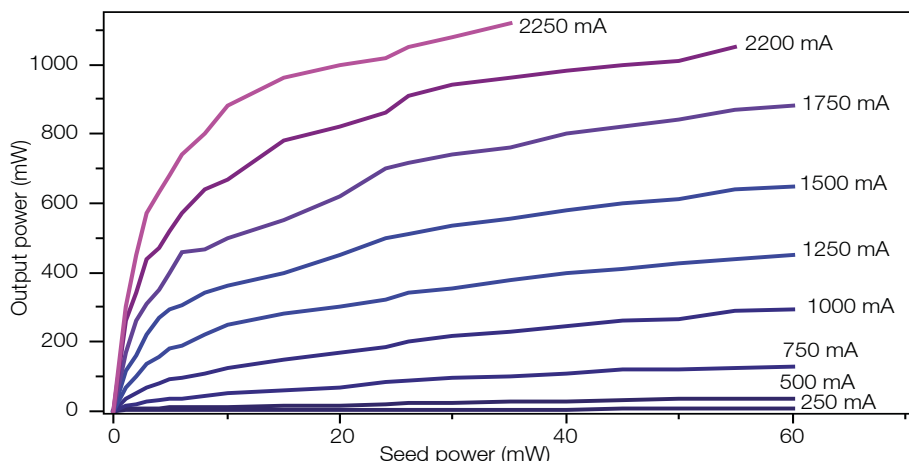
The table below lists common wavelengths and available powers from BoosTA and BoostA pro with typical required amplifier currents.

### Options

- Optical output isolator, 30 or 60 dB (integrated into amplifier head)
- Fiber-coupled input
- Fiber-coupled output (requires optical isolation)

### BoosTA vs. BoostA pro - Power at selected wavelengths

Wavelength [nm]	670	735	765	780	795	850	915	970	1010	1060	1100..1360	1480
Max. Power [W] <b>BoostA pro</b>	0.5	0.5	2	3	3.5	3	1.5	3	2	2	1.5	0.3
Max. Power [W] <b>BoosTA</b>	0.5	0.5	1.3	1.5	1.2	1.3	1.2	0.75	-	1	-	0.25
Max. required Current [A]	1.1	1.5	3	4	4	5	3	5	5	4	7	3



Typical saturation behavior of tapered amplifier chips at different amplifier currents (seed power levels exceeding 40 mW are not recommended).



Class 4 Laser Product EN 60825-1:2007. Visible or invisible laser radiation. Avoid eye or skin exposure to direct or scattered radiation. Caution - Class 4 visible and/or invisible laser radiation when open. Avoid exposure to the beam, avoid eye or skin exposure to direct or scattered radiation. Magnetic fields may be present which may affect the operation of certain pacemakers.

## Specifications

### High power laser and amplifier systems

Specifications			
	DLC TA pro	BoosTA pro	BoosTA
Configuration	MOPA	Amplifier	
Master laser	DL pro (integrated), DL DFB on request	External	
Wavelengths	660 .. 1495 nm*		
Max. power	3.5 W		1.5 W
Coarse tuning	10 .. 50 nm		
Typical mode-hop-free tuning	20 - 50 GHz	Depends on master laser	
Typical linewidth (5 μs)	10 kHz .. 300 kHz	Depends on master laser	
Polarization	Linear > 100 : 1		
ASE background, typ.	< -40 dB	Depends on master laser	
Beam quality M <sup>2</sup>	< 1.5 (< 2.0 for some higher-power chips)	< 1.5 (< 2.0 for some higher-power chips)**	
Divergence	< 1 mrad		
Beam height	50 ± 1 mm		53.9 mm
Optical isolators	Internal: 60 dB included, Output: optional 30 or 60 dB	Input: none, Output: optional 30 or 60 dB	
Fiber-coupling	Output and probe beam: optional	Input*** and Output: optional	
Fiber-coupling efficiency****: min. (typ.)	50 % (60 %)	50 % (60 %)**	
Monitor photo diodes	For seed and output	-	
Intensity modulation option	TA-Mod included		-
Control electronics	DLC pro, digital	DC HP	Integrated + power supply
Maximum TA current (HP)	5 A (10 A)	7 A	2.5 A
Frequency modulation option	Included	-	
Locking options	DLC pro Lock, DLC ext	Depends on master laser	
Environment temperature / humidity	operating: 15 - 30 °C, transport: 0 - 40 °C / Non condensing		
Operating voltage	100 - 120 V / 220 - 240 V AC, 50 - 60 Hz (auto detect)		
Power consumption	Typ. 70 W	Typ. 40 W	Typ. 35 W
Size head (H x W x D)	90 x 192 x 400 mm <sup>3</sup>	90 x 115 x 275 mm <sup>3</sup>	85 x 100 x 312 mm <sup>3</sup>
Size electronics (H x W x D)	154 x 450 x 348 mm <sup>3</sup>	85 x 105 x 200 mm <sup>3</sup>	70 x 175 x 179 mm <sup>3</sup>
Weight head / electronics	9.5 kg / 8.5 kg	3.9 kg / 2.3 kg	4.5 kg / 2.4 kg
*With gaps **With TOPTICA master laser ***Requires PM fiber FC/APC ****With TOPTICA's FiberDock, isolation required.			