

# PGx01 SERIES



Travelling Wave Optical Parametric Generators (TWOPG) are an excellent choice for researchers who need an ultra-fast tunable coherent light source from UV to mid IR.

Ekspla offers four models designed for pumping by up to the 4<sup>th</sup> harmonic of Nd:YAG laser.

## Available models

Model	Features
PG401	Model has a tuning range from 420 to 2300 nm and is optimized for providing highest pulse energy in the visible part of the spectrum. When combined with an optional second harmonic generator (SHG), Sum Frequency Generator (DUV) or Difference Frequency Generator (DFG) stages, it offers the widest possible tuning range – from 193 to 16000 nm. The wide tuning range makes PG401 units suitable for many spectroscopy application.
PG501	Model has a tuning range from 680 to 2300 nm and highest pulse energy in the near-IR spectral range. Optional DFG stages are available for extension of tuning range to the 2300–16000 nm region. The PG501-DFG1P model is the optimal choice for vibrational-SFG spectroscopy setups.
PG701	Model has a tuning range from 1395 to 4500 nm and is targeted for vibrational-SFG or infrared spectroscopy applications.

## High Energy Broadly Tunable OPA

### FEATURES

- ▶ Ultra-wide spectral range from **193 to 16000 nm**
- ▶ High peak power (>**50 MW**) ideal for non-linear spectroscopy applications
- ▶ Narrow linewidth <**6 cm<sup>-1</sup>**
- ▶ Motorized hands-free tuning in **193–2300 nm** or **420–10000 nm** range
- ▶ Remote control via keypad
- ▶ PC control via USB port (RS232 is optional) and LabVIEW™ drivers

### APPLICATIONS

- ▶ Nonlinear spectroscopy: vibrational-SFG, surface-SH, CARS, Z-scan
- ▶ Pump-probe experiments
- ▶ Laser-induced fluorescence (LIF)
- ▶ Other laser spectroscopy applications

**Design**

The units can be divided into several functional modules:

- ▶ optical parametric generator (OPG);
- ▶ diffraction grating based linewidth narrowing system (LNS);
- ▶ optical parametric amplifier (OPA);
- ▶ electronic control unit.

The purpose of the OPG module is to generate parametric superfluorescence (PS). Spectral properties of the PS are determined by the properties of a nonlinear crystal and usually vary with the generated wavelength.

In order to produce narrowband radiation, the output from OPG is narrowed by LNS down to 6 cm<sup>-1</sup> and then used to seed OPA.

Output wavelength tuning is achieved by changing the angle of the nonlinear crystal(s) and grating. To ensure exceptional wavelength reproducibility, computerized control unit driven precise stepper motors rotate the nonlinear crystals and diffraction grating. Nonlinear crystal temperature stabilization ensures long-term stability of the output radiation wavelength.

In order to protect nonlinear crystals from damage, the pump pulse energy is monitored by built-in photodetectors, and the control unit produces an alert signal when pump pulse energy exceeds the preset value.

For customer convenience the system can be controlled through its USB type PC interface (RS232 is optional) with LabView™ drivers or a user-friendly remote control pad. Both options allow easy control of system settings.

**SPECIFICATIONS <sup>1)</sup>**

Model	PG401	PG402	PG501	PG701
<b>Tuning range</b>				
Signal	420–680 nm	410–709 nm	680–1063 nm	1395–2100 nm
Idler	740–2300 nm	710–2300 nm	1065–2300 nm	2200–4500 nm
Output pulse energy <sup>2)</sup>	>1000 μJ at 450 nm	>1000 μJ at 450 nm	>1000 μJ at 800 nm	>600 μJ at 1550 nm >300 μJ at 3700 nm
Linewidth	<6 cm <sup>-1</sup>	<18 cm <sup>-1</sup>	<6 cm <sup>-1</sup>	<6 cm <sup>-1</sup>
Max pulse repetition rate	50 Hz			
<b>Scanning step</b>				
Signal	0.1 nm			
Idler	1 nm			
Typical beam size <sup>3)</sup>	~4 mm			
Beam divergence <sup>4)</sup>	<2 mrad		<2 mrad	<4 mrad
<b>Beam polarization</b>				
Signal	horizontal		vertical	horizontal
Idler	horizontal			

<b>PUMP LASER REQUIREMENTS</b>				
Pump energy	10 mJ at 355 nm	8 mJ at 355 nm	10 mJ at 532 nm	15 mJ at 1064 nm
Recommended pump source <sup>5)</sup>	PL2251A-TH PL2231-50-TH	PL2251-TH PL2231-50-TH	PL2251-SH PL2231-50-SH	PL2251 PL2231-50
Beam divergence	<0.5 mrad			
Beam profile	homogeneous, without hot spots, Gaussian fit >90 %			
Pulse duration <sup>6)</sup>	30±3 ps			

<b>PHYSICAL CHARACTERISTICS</b>	
Size (W × L × H)	450 × 582 × 270 mm

<b>OPERATING REQUIREMENTS</b>	
Room temperature	15–30 °C
Power requirements	100–240 V AC single phase, 47–63 Hz
Power consumption	<100 W

<sup>1)</sup> Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 450 nm for PG401 units, 800 nm for PG501 units and 1550 nm for PG701 units.

<sup>2)</sup> See tuning curves for typical pulse energies at other wavelengths. Higher energies are available, please contact Ekspla for more details.

<sup>3)</sup> Beam diameter is measured at the 1/e<sup>2</sup> level.

<sup>4)</sup> Full angle measured at the FWHM point.

<sup>5)</sup> If a pump laser other than the PL2250 series is used, measured beam profile data should be presented when ordering.

<sup>6)</sup> Should be specified if non-EKSPLA pump laser is used.



**Optional tuning range extensions**

As mentioned above, the tuning range of PGx01 series units can be extended by adding additional nonlinear conversion stages. Optional Second Harmonic Generation (SHG), Sum Frequency Generation (SFG), or Difference Frequency Generation (DFG) stages allow access to spectral ranges that are not accessible by conventional laser sources.

There are many possible ways to add extension stages to the PGx01 series unit, however, the following configurations are most common:

- ▶ **PG401-SH** – second harmonic generator is used to extend the tuning range down to 210 nm resulting in a total tuning range of 210 to 2300 nm.
- ▶ **PG401-SH-DUV** – sum frequency generator is used to extend the tuning range down to 193 nm resulting in a total tuning range of 193 to 2300 nm.
- ▶ **PG401-DFG1P** provides the broadest hands-free tuning range – from 420 to 10000 nm. It can be further extended up to 16000 nm with -DFG2 option, however, it should be noted, that for the 10000–16000 nm range a different

nonlinear crystal is used, and exchange of the crystals needs to be done manually.

- ▶ **PG501-DFG1P** unit has a narrower tuning range of 680–10000 nm and is a cost-effective choice for customers who need only the IR tuning range (for example for vibrational-SFG spectroscopy on surfaces). The tuning range also can be extended to 16000 nm in the same way as for the PG401 unit.

Available standard options are summarized in a table on the page below. Custom configurations are available on request.

**OPTIONAL EXTENSIONS OF TUNING RANGE <sup>1)</sup>**

Extension	DUV	SH	DFG1	DFG1P	DFG2
Available on models	PG401-SH	PG401	PG401 and PG501	PG401 and PG501	PG401 and PG501
Tuning range	193–209.95 nm	210–419 nm	2300–10000 nm	2300–10000 nm	2300–16000 nm <sup>7)</sup>
Output pulse energy <sup>2)</sup>	>30 µJ at 200 nm	>100 µJ	>125 µJ	>250 µJ	>250 µJ at 3700 nm >100 µJ at 10000 nm
Linewidth	<9 cm <sup>-1</sup>		<6 cm <sup>-1</sup>		
Scanning step	0.05 nm		1 nm		
Typical beam size <sup>3)</sup>	~3 mm		~6 mm	~9 mm	~9 mm
Typical beam divergence <sup>4)</sup>	<2 mrad		<3 mrad		
Polarization	vertical		horizontal		

**PUMP LASER REQUIREMENTS**

Pump pulse energy

at 1064 nm	2 mJ	–	5 mJ	10 mJ	15 mJ
at 532 nm <sup>5)</sup>	–		10 mJ		
at 355 nm <sup>6)</sup>	10 mJ		8 mJ		
Recommended pump laser <sup>8)</sup>	PL2251A	PL2251A-TH	PL2251	PL2251A	PL2251B
Recommended harmonics generator module <sup>9)</sup>	H400 / H500		H400 / H500		

**PHYSICAL CHARACTERISTICS**

Size (W × L × H)	456 × 1026 × 273 mm
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**OPERATING REQUIREMENTS**

Room temperature	15–30 °C
Power requirements	100–240 V AC single phase, 47–63 Hz
Power consumption	<100 W

<sup>1)</sup> Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 280 nm for -SH option and at 3700 nm for -DFGx options.  
<sup>2)</sup> See tuning curves for typical pulse energies at other wavelengths.

<sup>3)</sup> Beam diameter is measured at the 1/e<sup>2</sup> point.  
<sup>4)</sup> Full angle measured at the FWHM point.  
<sup>5)</sup> For PG501-DFGx units only.  
<sup>6)</sup> For PG401-DFG units only.  
<sup>7)</sup> 10000–16000 nm range is accessible after manual reconfiguration of DFG stage.  
<sup>8)</sup> If a pump laser other than the PL2251 series is used, measured beam profile data should be presented when ordering.

<sup>9)</sup> H400 is recommended for PG401-DFGx pumping, H500 for PG501-DFGx pumping. See pictures on the last page for recommended arrangement of pumping laser, harmonics generator module and PGx01 units.

TUNING CURVES

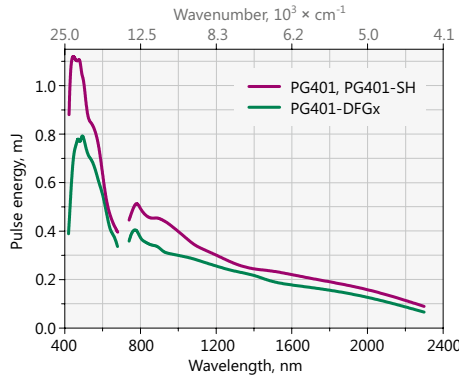


Fig 1. Typical PG401 model tuning curve  
Pump energy: 10 mJ at 355 nm

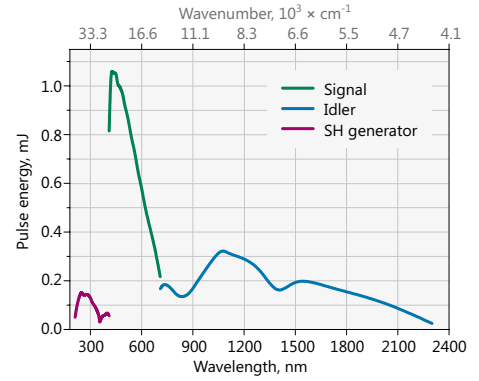


Fig 2. Typical PG401A model tuning curve  
Pump energy: 8 mJ at 355 nm

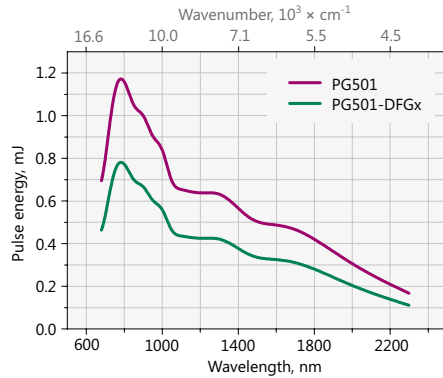


Fig 3. Typical PG501 model tuning curve  
Pump energy: 10 mJ at 532 nm

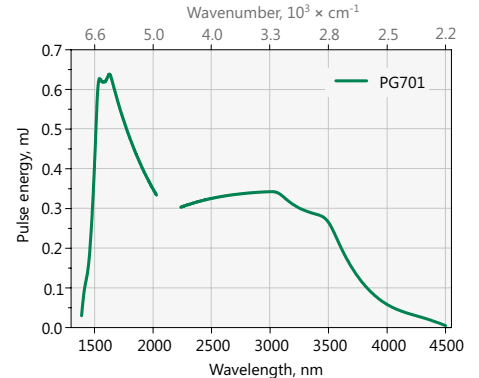


Fig 4. Typical PG701 model tuning curve  
Pump energy: 15 mJ at 1064 nm

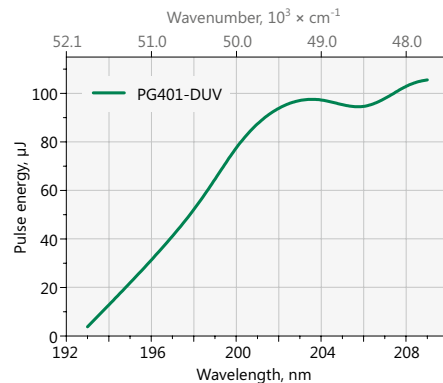


Fig 5. Typical PG401-DUV model tuning curve

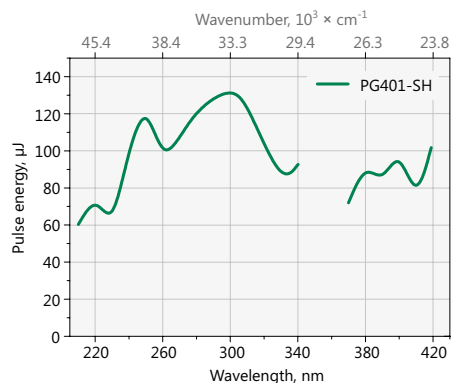


Fig 6. Typical PG401-SH model tuning curve. Pump energy: 10 mJ at 355 nm

Note: The energy tuning curves are affected by air absorption due narrow linewidth. These pictures present pulse energies where air absorption is negligible.

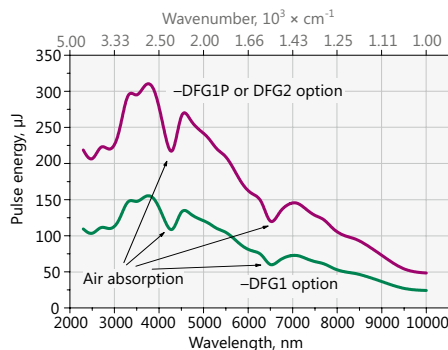


Fig 7. Typical DFGx option tuning curve in 2300–10000 nm range  
Pump energy: 10 mJ at 1064 nm

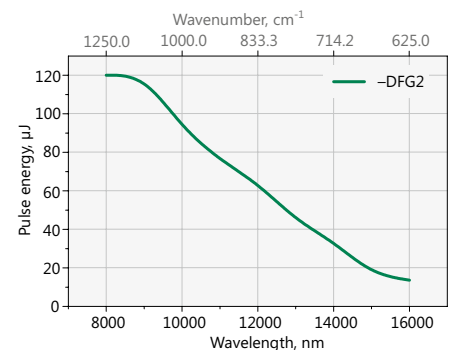


Fig 8. Typical DFG2 option tuning curve in 10000–16000 nm range  
Pump energy: 15 mJ at 1064 nm

**RECOMMENDED UNITS ARRANGEMENT ON OPTICAL TABLE**

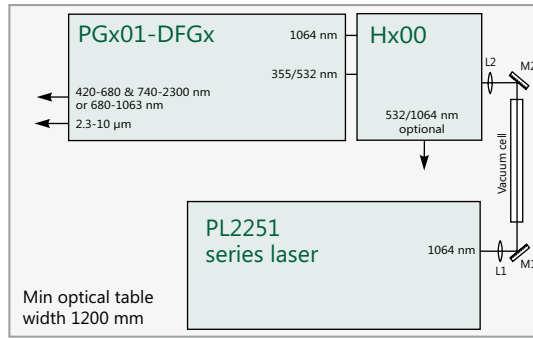


Fig 8. Recommended arrangement of pump laser and PGx01-DFGx unit on optical table

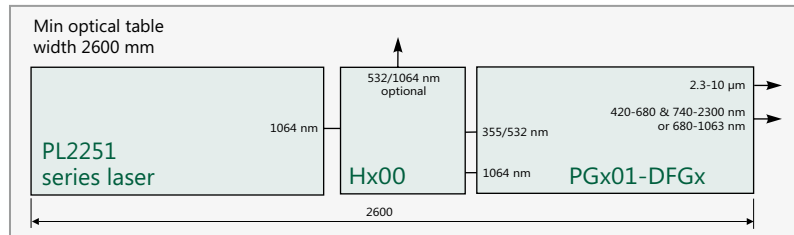


Fig 9. Alternative arrangement of pump laser and PGx01-DFGx unit on optical table

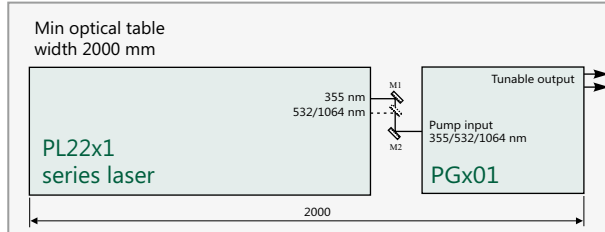


Fig 10. Arrangement of pump laser and PGx01 unit on optical table

**OUTLINE DRAWINGS**

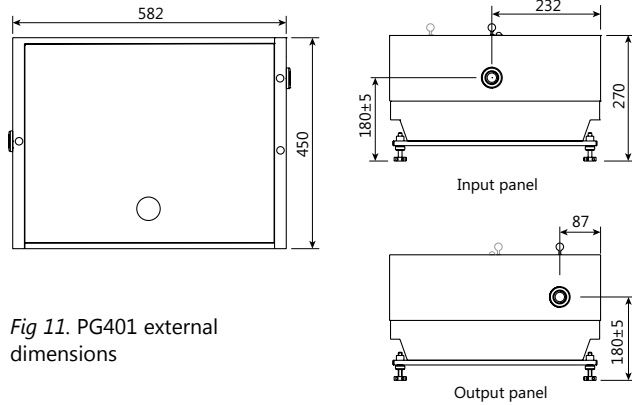


Fig 11. PG401 external dimensions

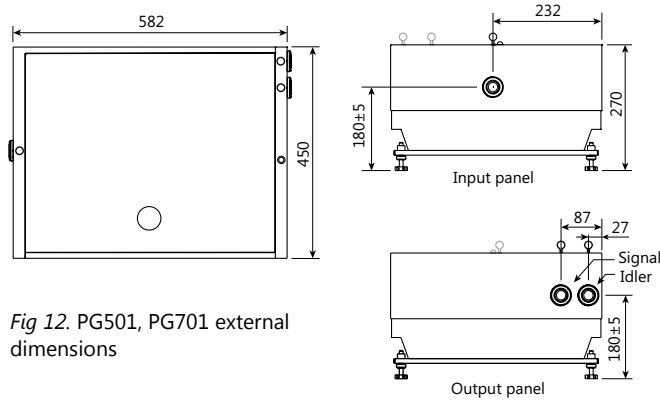


Fig 12. PG501, PG701 external dimensions

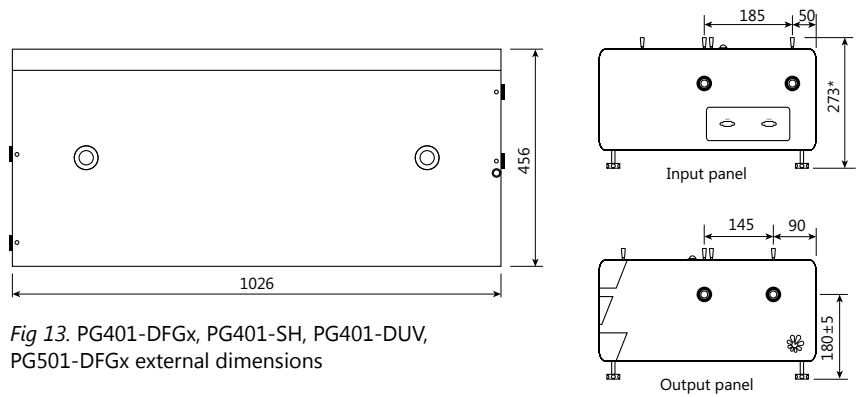


Fig 13. PG401-DFGx, PG401-SH, PG401-DUV, PG501-DFGx external dimensions

**ORDERING INFORMATION**

**PG401-DFG2**

Model	Optional tuning range extension
PG4xx → 355 nm pump	DUV → 193–209.95 nm
PG5xx → 532 nm pump	SH → 210–419 nm
PG7xx → 1064 nm pump	DFG1 → 2300–10000 nm; >125 μJ at 3700 nm
	DFG1P → 2300–10000 nm; >250 μJ at 3700 nm
	DFG2 → 2300–16000 nm

01 → travelling wave, narrowed linewidth
03 → travelling wave, not narrowed
11 → synchronous pumping, narrowed