

# Q2 series

## FEATURES

Up to **80 mJ** pulse energy and up to **2 W** average power

Up to **100 Hz** pulse repetition rate

Air cooled (**water-free**)

**5 – 10 ns** pulse duration

Smoothly variable pulse repetition rate for 1053 nm output wavelength models

Weight **< 9 kg** incl. heatsink, controller & AC/DC adapter

**> 2 G shot** lifetime of pump diodes

Built-in sync pulse generator for triggering of user equipment

Remote monitoring and control via built-in **Ethernet** interface

Optional **2 – 3 ns** pulse duration at up to **60 mJ** pulse energy (short cavity version)

Optional attachable attenuator for fundamental wavelength

Optional attachable pulse energy monitor

Optional attachable 2<sup>nd</sup> harmonic generator

Optional stand-alone 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup> harmonic generator

Optional two-channel pulse generator

Optional attachable beam guiding module

Optional stand-alone air-purging unit for long lifetime of UV optics

## APPLICATIONS

Light Induced Breakdown Spectroscopy (LIBS)

Light Detection And Ranging (LIDAR)

LCD repair

Laser ablation/cleaning

Time-of-Flight Spectroscopy (TOFS)

Light Induced Fluorescence (LIF) Spectroscopy

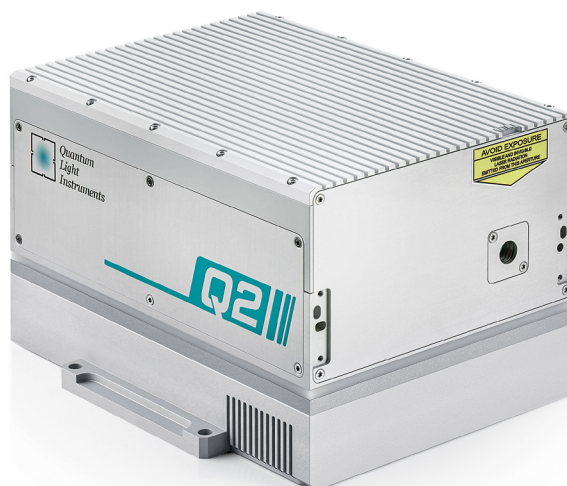
Flash photolysis

Pulsed Light Deposition (PLD)

Ophthalmology

Time-domain thermorefectance (TDTR)

## DIODE PUMPED AIR-COOLED Q-SWITCHED LASER



Q2 series diode pumped, fully air-cooled, Q-switched laser designed for wide range of applications that require high peak power pulses.

Our innovative water-free laser crystal end-pumping technology allows to produce Gaussian-like, low divergence laser beam. At the same time, Q2 is versatile platform that can be configured in many ways.

It can be configured for 80 mJ pulse energy at 10 Hz pulse repetition rate. For high repetition rate configuration laser can produce up to 20 mJ at 100 Hz.

The laser can configured to emit 1053 nm or 1064 nm wavelength from Nd:YLF or Nd:YAG laser crystals respectively. Due to thermal properties of Nd:YLF crystal, at 1053 nm the laser can operate from single shot to maximum pulse repetition rate without changes in beam divergence or profile.

In short cavity configuration pulse duration can be reduced by 50% in comparison to standard configuration. Peak power of pulse can reach more than 30 MW at pulse energy up to 60 mJ.

Thermo-electric cooler based temperature control system eliminate risks associated with water cooling (leaks, organic contamination etc.) and reduce maintenance costs. If requested, standard fan-cooled heatsink can be detached from the laser body and laser can be mounted on user-supplied cold plate or other cooling system.

Innovative laser design resulted in compact, user-friendly turnkey system that requires little maintenance.

There are no chillers or bulky power supplies that one needs fit under the table. All laser electronics are integrated into Q2 housing and the only external modules are lightweight controller box that provides laser control interfaces and mains adapter that provides 12 or 28 VDC, 30 – 100 W powering (depending on model).

Laser is controlled through Ethernet port via build-in web-server. There is no need to install control software – any computer or even cell phone with modern web-browser will be able to control Q2. API is also provided for integration with user devices.

Low jitter triggering pulses for user equipment are available with up to 300 or 450  $\mu$ s lead in internal triggering mode, depending on lasing wavelength. In external triggering mode, laser pulsing can be externally triggered from delay generator.

Laser functionality can be further extended by wide range of auxiliary equipment:

- Attachable second harmonic generator, model SHG.
- Stand-alone up to fifth harmonic generators of H-SMART series.
- Attachable motorized attenuator for fundamental wavelength.
- Attachable pulse energy monitor with analog and/or digital output.
- Stand-alone two-channel pulse generator for smoothly variable pulse repetition rate, burst, double-pulse and other user-configurable modes of operation.
- Attachable low power laser beam guiding module.
- Stand-alone air purging unit for long lifetime of UV optics, when used together with HSMART harmonics generator.

## SPECIFICATIONS AT 10 Hz PULSE REPETITION RATE <sup>1)</sup>

MODEL	Q2				
	-B10	-C10	-D10	-E10	-F10
Wavelength	1064 / 1053 nm				1053 nm
Pulse repetition rate <sup>2)</sup>	10 Hz				
Pulse energy <sup>3)</sup>	10 mJ	20 mJ	35 / 40 mJ	60 / 65 mJ	80 mJ
Typical pulse duration <sup>4)</sup>	< 8 ns		< 7 ns		< 5 ns
Pulse energy stability <sup>5)</sup>	< 0.5 % RMS				
Power drift <sup>6)</sup>	± 3.0 %				
Beam profile	bell-shaped, >80% fit to Gaussian				
Beam divergence <sup>7)</sup>	< 1.5 mrad		< 1 mrad		
Polarization	linear, horizontal				
Typical beam diameter <sup>8)</sup>	1.5 mm		2.0 mm	3.0 mm	4.0 mm
Jitter <sup>9)</sup>	< 0.5 ns RMS				

### OPTIONAL HARMONICS GENERATOR <sup>3)</sup>

Pulse energy <sup>3)</sup>					
532 / 526.5 nm	4 / 5 mJ	8 / 10 mJ	16 / 20 mJ	30 / 32 mJ	40 mJ
355 / 351 nm	2.4 / 3 mJ	4.5 / 6 mJ	9 / 12 mJ	18 / 20 mJ	24 mJ
266 / 263 nm	1.2 / 1.5 mJ	2.4 / 3 mJ	5 / 6 mJ	9 / 10 mJ	12 mJ
213 / 211 nm	0.5 mJ	1 mJ	2 mJ	3.5 mJ	5 mJ

### OPTIONAL ATTENUATOR <sup>11)</sup>

Transmission range	0.5 – 95 %
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### DIMENSIONS

Laser head ( W×L×H)	160 × 230 × 141 mm <sup>3</sup>
Controller unit (W×L×H)	108 × 191 × 59 mm <sup>3</sup>
Power adapter (W×L×H) <sup>12)</sup>	50 × 125 × 31 mm <sup>3</sup> typical

### OPERATING REQUIREMENTS

Cooling requirements	air cooled
Ambient temperature	15 – 30 °C
Relative humidity	10 – 80 % (non-condensing)
Mains voltage	90 – 230 VAC, single phase, 47 – 63 Hz <sup>13)</sup>
Average power consumption	30 W      40 W      50 W      60 W



<sup>1)</sup> Due to continuous improvements all specifications are subject to change. Unless stated otherwise all specifications are measured at fundamental wavelength and maximum pulse repetition rate. The parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture.

<sup>2)</sup> Factory-set pulse repetition rate is fixed at max repetition rate shown in the table. In internal triggering mode repetition rate can be divided by integer number down to f/2, f/3, f/4, ... 1 Hz.

<sup>3)</sup> When pulse energy is presented in xx/yy format, first number is for 1064 nm wavelength version, second – for 1053 nm version.

<sup>4)</sup> At FWHM level at fundamental wavelength, measured with 350 ps rise time photodiode. Short pulse duration version is available, with pulse duration shorter by approx 50%. Inquire for detailed specifications.

<sup>5)</sup> Measured during 30 seconds operation after warm-up.

<sup>6)</sup> Over 8 hour period after 20 minutes of warm-up when ambient temperature variation is less than  $\pm$ 2 °C.

<sup>7)</sup> Full angle measured at the 4 $\sigma$  level.

<sup>8)</sup> Beam diameter is measured 20 cm from laser output at the 4 $\sigma$  level.

<sup>9)</sup> In respect to falling edge of pump diode triggering pulse.

<sup>10)</sup> Q2 is compatible with our attachable second harmonic generator (model SHG) and all models of stand-alone H-SMART harmonics generator. Pulse energies presented here are maximum values. Please refer to harmonic generator datasheets for detailed specifications.

<sup>11)</sup> Motorized attenuator intended to be attached to the laser housing. Transmission can be changed remotely through laser web-server control interface.

<sup>12)</sup> Power adapter dimensions might differ from indicated here, depending on model.

<sup>13)</sup> Laser can be powered from appropriate 12 or 28 VDC power source. Please inquire for details.

## SPECIFICATIONS AT 20 –50 Hz PULSE REPETITION RATE <sup>1)</sup>

MODEL	Q2								
	-B20	-C20	-D20	-E20	-D33	-E33	-B50	-C50	-D50
Wavelength	1064 / 1053 nm					1064 nm	1064 / 1053 nm		1064 nm
Pulse repetition rate <sup>2)</sup>	20 Hz				33.3 Hz		50 Hz		
Pulse energy <sup>3)</sup>	8 / 10 mJ	16 / 20 mJ	32 / 40 mJ	60 / 65 mJ	40 mJ	60 mJ	8 / 10 mJ	16 / 20 mJ	40 mJ
Typical pulse duration <sup>4)</sup>	< 7 ns		< 5 ns				< 7 ns	< 6 ns	< 5 ns
Pulse energy stability <sup>5)</sup>	< 0.5 % RMS								
Power drift <sup>6)</sup>	± 3.0 %								
Beam profile	bell-shaped, >80% fit to Gaussian								
Beam divergence <sup>7)</sup>	<1.5 mrad		<1 mrad						
Polarization	linear, horizontal								
Typical beam diameter <sup>8)</sup>	1.5 mm		3.0 mm	4.0 mm			1.5 mm	2.5 mm	3.5 mm
Jitter <sup>9)</sup>	< 0.5 ns RMS								

### OPTIONAL HARMONICS GENERATOR <sup>10)</sup>

Pulse energy									
532 / 526.5 nm	4 / 5 mJ	8 / 10 mJ	16 / 20 mJ	30 / 32 mJ	20 mJ	30 mJ	4 / 5 mJ	8 / 10 mJ	20 mJ
355 / 351 nm	2.4 / 3 mJ	4.5 / 6 mJ	9 / 12 mJ	18 / 20 mJ	12 mJ	18 mJ	2.4 / 3 mJ	4.5 / 6 mJ	12 mJ
266 / 263 nm	1.2 / 1.5 mJ	2.4 / 3 mJ	5 / 6 mJ	9 / 10 mJ	6 mJ	9 mJ	1.2 / 1.5 mJ	2.4 / 3 mJ	6 mJ
213 / 211 nm	0.5 mJ	1 mJ	2 mJ	3 mJ	2 mJ	2.5 mJ	0.4 mJ	0.8 mJ	1.5 mJ

### OPTIONAL ATTENUATOR <sup>11)</sup>

Transmission range	1 – 95 %								
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### DIMENSIONS

Laser head ( W×L×H)	160 × 230 × 141 mm <sup>3</sup>								
Controller unit (W×L×H)	108 × 191 × 59 mm <sup>3</sup>								
Power adapter (W×L×H) <sup>12)</sup>	192 × 178 × 46 mm <sup>3</sup> typical								

### OPERATING REQUIREMENTS

Cooling requirements	air cooled								
Ambient temperature	15 – 30 °C								
Relative humidity	10 – 80 % (non-condensing)								
Mains voltage	90 – 230 VAC, single phase, 47 – 63 Hz <sup>13)</sup>								
Average power consumption	30 W	40 W	70 W	80 W		100 W	50 W	80 W	100 W



<sup>1)</sup> Due to continuous improvements all specifications are subject to change. Unless stated otherwise all specifications are measured at fundamental wavelength and maximum pulse repetition rate. The parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture.

<sup>2)</sup> Factory-set pulse repetition rate is fixed at max repetition rate shown in the table. In internal triggering mode repetition rate can be divided by integer number down to f/2, f/3, f/4, .. 1 Hz.

<sup>3)</sup> When pul se energy is presented in xx/yy format, first number is for 1064 nm wavelength version, second – for 1053 nm version.

<sup>4)</sup> At FWHM level at fundamental wavelength, measured with 350 ps rise time photodiode. Short pulse duration version is available, with pulse duration shorter by approx 50%. Inquire for detailed specifications.

<sup>5)</sup> Measured during 30 seconds operation after warm-up.

<sup>6)</sup> Over 8 hour period after 20 minutes of warm-up when ambient temperature variation is less than ±2 °C.

<sup>7)</sup> Full angle measured at the 4σ level.

<sup>8)</sup> Beam diameter is measured 20 cm from laser output at the 4σ level.

<sup>9)</sup> In respect to falling edge of pump diode triggering pulse.

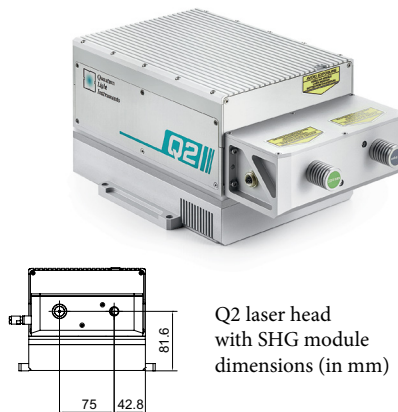
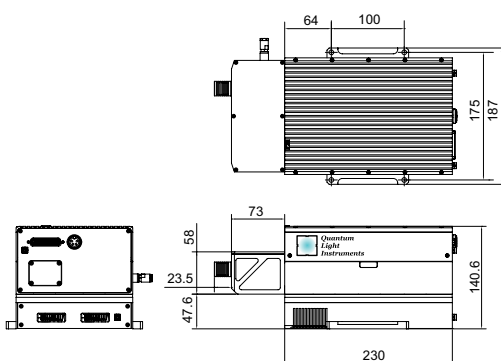
<sup>10)</sup> Q2 is compatible with our attachable second harmonic generator (model SHG) and all models of stand-alone H-SMART harmonics generator. Pulse energies presented here are maximum values. Please refer to harmonic generator datasheets for detailed specifications.

<sup>11)</sup> Motorized attenuator intended to be attached to the laser housing. Transmission can be changed remotely trough laser web-server control interface.

<sup>12)</sup> Power adapter dimensions might differ from indicated here, depending on model.

<sup>13)</sup> Laser can be powered from appropriate 12 or 28 VDC power source. Please inquire for details.

### DRAWINGS



Q2 laser head with SHG module dimensions (in mm)

## SPECIFICATIONS AT 100 / 200 Hz PULSE REPETITION RATE <sup>1)</sup>

MODEL	Q2				
	-200	-100	-A100	-B100	-C100
Wavelength	1064 nm				
Pulse repetition rate <sup>2)</sup>	200 Hz	100 Hz			
Pulse energy <sup>3)</sup>	1 mJ	2.5 mJ	5 mJ	10 mJ	20 mJ
Typical pulse duration <sup>4)</sup>	< 10 ns		< 8 ns		< 7 ns
Pulse energy stability <sup>5)</sup>	< 0.5 % RMS				
Power drift <sup>6)</sup>	± 3.0 %				
Beam profile	bell-shaped, >80% fit to Gaussian				
Beam divergence <sup>7)</sup>	<2 mrad		<1.5 mrad		<1 mrad
Polarization	linear, horizontal				
Typical beam diameter <sup>8)</sup>	1.5 mm		2.0 mm	2.5 mm	3.5 mm
Jitter <sup>9)</sup>	< 0.5 ns RMS				

### OPTIONAL HARMONICS GENERATOR <sup>10)</sup>

Pulse energy					
532 nm	0.5 mJ	1.25 mJ	2.5 mJ	5 mJ	10 mJ
355 nm	0.25 mJ	0.7 mJ	1.5 mJ	3 mJ	6 mJ
266 nm	0.1 mJ	0.3 mJ	0.7 mJ	1.5 mJ	3 mJ
213 nm	0.02 mJ	0.1 mJ	0.25 mJ	0.5 mJ	1 mJ

### OPTIONAL ATTENUATOR <sup>11)</sup>

Transmission range	1 – 95 %				
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### DIMENSIONS

Laser head (W×L×H)	160 × 230 × 141 mm <sup>3</sup>				
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### OPERATING REQUIREMENTS

Cooling requirements	air cooled				
Ambient temperature	15 – 30 °C				
Relative humidity	10 – 80 % (non-condensing)				
Mains voltage	90 – 230 VAC, single phase, 47 – 63 Hz <sup>13)</sup>				
Average power consumption	40 W	50 W	70 W	80 W	100 W



## AUXILIARY EQUIPMENT

Compatible with our attachable 2<sup>nd</sup> harmonic generator, model SHG

Compatible with all our H-SMART series harmonic generators

Attachable motorized attenuator for fundamental wavelength beam

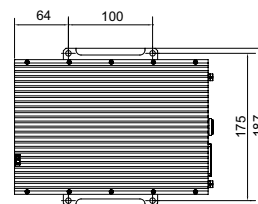
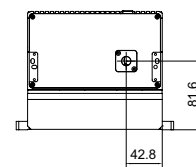
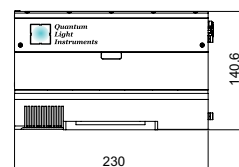
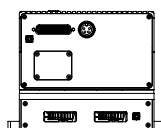
Attachable pulse energy monitor with analog and/or digital output

Stand-alone two-channel pulse generator

Attachable beam guiding module

Optional stand-alone air-purging unit for long lifetime of UV optics

## DRAWINGS



Q2 laser head dimensions (in mm)

<sup>1)</sup> Due to continuous improvements all specifications are subject to change. Unless stated otherwise all specifications are measured at fundamental wavelength and maximum pulse repetition rate. The parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture.

<sup>2)</sup> Factory-set pulse repetition rate is fixed at max repetition rate shown in the table. In internal triggering mode repetition rate can be divided by integer number down to f/2, f/3, f/4... 1 Hz.

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<sup>4)</sup> At FWHM level at fundamental wavelength, measured with 350 ps rise time photodiode. Short pulse duration version is available, with pulse duration shorter by approx 50%. Inquire for detailed specifications.

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<sup>7)</sup> Full angle measured at the 4σ level.

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<sup>11)</sup> Motorized attenuator intended to be attached to the laser housing. Transmission can be changed remotely through laser web-server control interface.

<sup>12)</sup> Power adapter dimensions might differ from indicated here, depending on model.

<sup>13)</sup> Laser can be powered from appropriate 12 or 28 VDC power source. Please inquire for details.

# MOTORIZED ATTENUATORS & PULSE ENERGY MONITORS

## ATTENUATOR FEATURES

Drop-in attachable to the laser body attenuators for **1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup>** harmonics of Nd:YAG or Nd:YLF lasers

Up to **98%** maximum transmission

Precise transmission control by stepper motor in microstepping mode (12800 steps/rotation)

Transmission adjustment resolution **<0.15 %**

Remote control via common with laser **Ethernet** interface

Optional stand-alone version for mounting on optical table

Optional side port transforms attenuator to variable beam splitter

## PULSE ENERGY MONITOR FEATURES

Drop-in laser pulse energy or power monitoring (up to **100 samples/second**)

Less than **2 %** insertion losses

**12-bit** resolution

Average pulse energy and pulse-to-pulse stability calculation

Sample&Hold analog output from BNC socket on the rear panel of laser controller

Digital readout through laser **Ethernet** interface

Optional broadband version for 210 – 2300 nm range

## ATTENUATOR SPECIFICATIONS <sup>1)</sup>

MODEL	ATTENUATORS				
	AT1	AT2	AT3	AT4	AT5
Design wavelength	1064 nm	532 nm	355 nm	266 nm	213 nm
Typical max transmission <sup>2)</sup>	98 %	95 %	90 %	75 %	65 %
Typical min transmission <sup>2)</sup>	1 %			0.5 %	
Output polarization <sup>3)</sup>	linear, horizontal			linear, rotating	
Resolution	< 0.15 %				
Accuracy	± 0.5 %				
Clear aperture	6 mm				
Stepper motor	12800 steps / 360 deg, 4-phase, 1A				
Dimensions (W×L×H)	42 × 54 × 77 mm <sup>3</sup>				
Weight	< 0.4 kg				

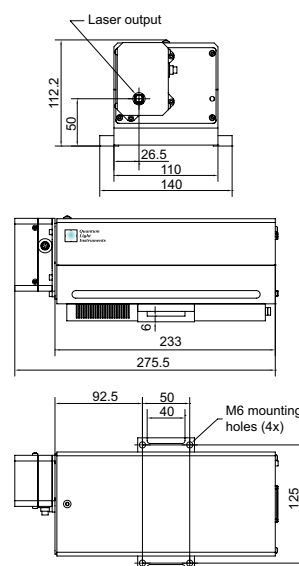
## PULSE ENERGY MONITOR SPECIFICATIONS <sup>1)</sup>

MODEL	PULSE ENERGY MONITOR					
	EM1	EM2	EM3	EM4	EM5	EM/BB
Design wavelength	1064 nm	532 nm	355 nm	266 nm	213 nm	210 – 2600 nm
Insertion loss	< 2 %					
Detector type	photodiode					pyroelectric
Resolution	12 bit					
Accuracy	± 3 %					
Clear aperture	6 mm					
Dimensions (W×L×H)	24 × 28 × 48 mm <sup>3</sup>					
Weight	< 0.1 kg					

<sup>1)</sup> Due to continuous improvements all specifications are subject to change. The parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture.

<sup>2)</sup> Depends on polarization state of laser. Depolarization of laser beam might affect values provided here.

<sup>3)</sup> For some models polarization plane depends on angular position of polarizer.



Dimensions (in mm) of Q1 laser with attenuator attached



Attenuator and pulse energy monitor attached to the laser head