波形可编程脉冲激光器（MOPAW）

---Pulse Shaping MOPA Laser

上海昊量光电设备有推出一款波形可编程脉冲激光器（MOPAW, **M**aster **O**scillator with **P**rogrammable **A**mplitude **W**aveform ）,其包含具有波形可编程功能的主振荡器，再配合保偏增益光纤，实现较高单脉冲能量以及较高的平均功率。

图 1、MOPAW 激光器图例

波形可编程脉冲激光器（MOPAW）是一款结构紧凑的光纤激光器产品，其采用新型的风冷设计，具有恒定脉冲能量输出，且可在纳秒（ns）、皮秒串（ps burst）以及特定要求皮秒脉冲（ps）等三个不同层面操作。 这种激光器具有独特的时序脉冲波形编辑功能，脉冲宽度可从 2ns（可定制 ps 级）扩展到 17us 或更大。

重复频率也可以调节，从单拍至 500Khz (Mhz 也可以提供)。更具体的说，每一个 1ns 的脉冲时间间隔都可以编程 8192（13-bits）个强度级别,为脉冲时域波形调节提供无与伦比的灵活性。

脉冲波形可以直接通过连接激光器的一台电脑来直接进行编程，用户可以在激光编程电路中记录 64 个不同的脉冲形状，使用时可以直接检索。

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此外，1064nm 的 MOPAW 激光器同样具有频率转换功能，很方便产生 532nm，355nm or 266nm 的转换波长。

（如定制 1560nm/780nm，我们也可以提供）。

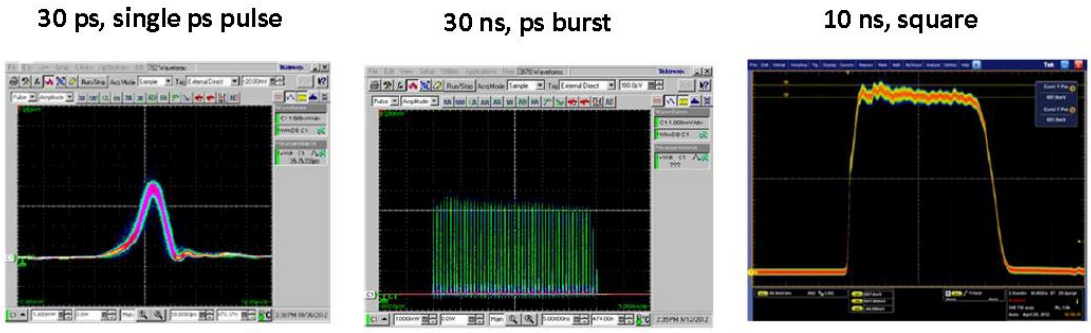

图 2、时域波形展示图例

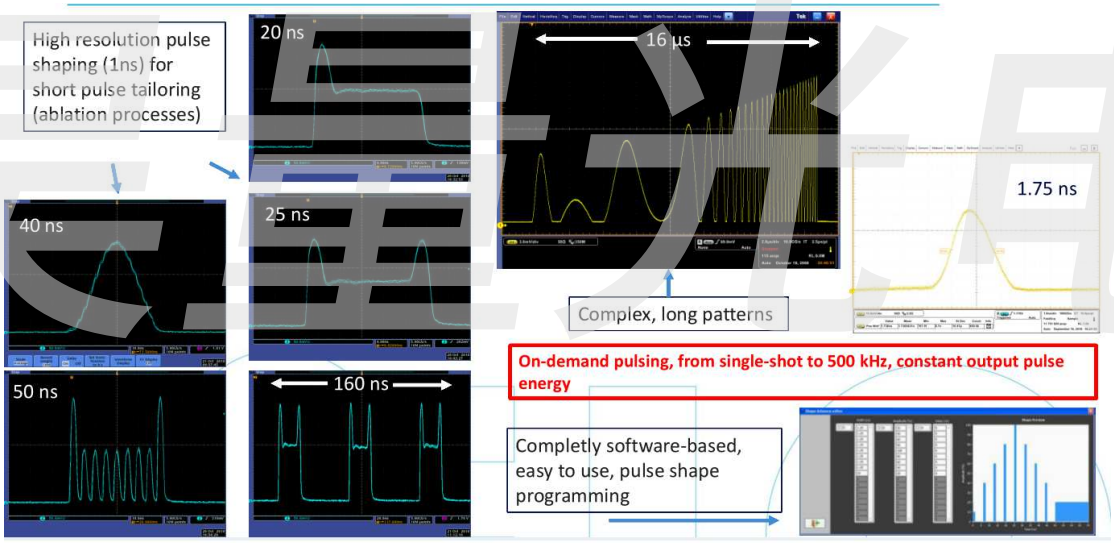

图 3、纳秒（ns）时域波形图实例

MOPAW 主要特点：

- 脉冲时域波形，2ns-17us（ps 级，可定制）；
- 重频可调，Single shot-500KHz（MHz 可定制）；
- 恒定的单脉冲输出能量（可达 mJ 级别）；
- 高峰值功：>50KW（>250KW 可定制）；
- 大功率：>25W 平均功率

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- 增益饱和预补偿功能；
- 近衍射极限光束质量；
- 偏振输出，窄线宽；
- 提供定制方案，如脉宽、能量、功率，波长（1560\780nm）；

MOPAW 主要应用领域（1064nm）：

- **隐形切割；**
- **光伏电池划线；**
- **存储器修复；**
- **精确打标；**
- **微加工（铣削，打孔）；**
- **多层结构材料的处理（加热、切割等）；**
- **共聚焦荧光显微镜、SETD 显微镜等（1560/780nm MOPAW 激光器）；**

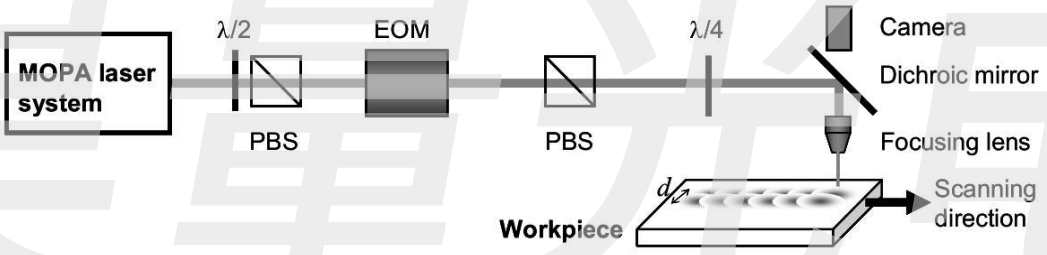

图 4、微加工图例

MOPAW 标准产品规格参数表：

Parameters	Unit	Specifications		Comments
Operating principle		Programmable pulse-shaped nanosecond and picosecond fiber laser operating as a constant pulse energy laser source		Pulse energy and shape will stay constant up to the maximum average output power of the laser independently of the repetition rate
		ns regime	ps regime	
Spectral characteristics				
Wavelength	nm	1064.8 ± 0.2	1064.4 ± 0.2	
Spectral bandwidth	nm	< 1	< 5	Full Width @ -10dB
Out of band optical power	%	< 10		
Temporal characteristics				
Nanosecond envelope risetime	ns	< 2.5		10-90% risetime, gain-switching of the seed diode is completly suppressed Faster risetime possible with gain-switching od the seed diode
Nanosecond envelope duration range	ns	2 to 500		Longer pulse patterns (up to 17 µs) are possible upon request
Single ps pulse duration	ps	NA	< 35	
PS pulse train repetition rate	MHz	NA	240, 480, 960 and 1920	
Pulse shaping time resolution	ns	1.04		
Amplitude and stability characteristics				
Pulse shaping amplitude resolution	levels	8192 (13-bits)		
Nanosecond envelope amplitude stability	% RMS	< 1		Over 30 sec
Nanosecond envelope energy stability	% RMS	< 1		Over 30 sec
Average power stability	% RMS	< 1		Measured over a 20 min.-long period
Power and energy characteristics				
Maximum pulse energy (nanosecond envelope)	µJ	250	250	Higher energy versions are possible upon request
Maximum peak power	kW	50		
Maximum average power	W	25		Higer power versions are possible upon request
Beam characteristics				
Beam quality, M^2		< 1.3		X/Y-axis (D4σ)
Output beam diameter	mm	4.0±0.5		X/Y-axis (D4σ)
Beam divergence (full-angle)	mrad	< 1		X/Y-axis (D4σ)
Beam roundness	%	> 90		0-2m from laser output aperture (numerical beam propagation)
Beam waist astigmatism	%	< 15		
Beam waist asymmetry	%	< 15		
Polarization type		linear, horizontal		
Polarization extinction ratio	dB	> 20		
Output beam height	mm	80		
Operational characteristics				
Allowable pulse repetition range (external trigger)	kHz	single shot up to 500		Higher repetition rates are possible upon request
Allowable pulse repetition range (internal trigger)	kHz	0.029 to 500		Higher repetition rates are possible upon request
System warm-up time	min	< 60		
External trigger to optical output latency	µs	> 90 < 95		

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