

Test Report 126-MOPA #107

by

Tom Kane

Glen Truong

Lightwave Electronics Corporation

2400 Charleston Road

Mountain View, CA 94043

January 7, 1999

1. Performance

1.1. Performance Target Specifications as per LIGO-E970055-02-D

<i>Parameter</i>	<i>Specification</i>
1. Power in circular TEM ₀₀ mode	> 10 W
2. Total power in all non-TEM ₀₀ modes	< 1 W ($M_{\text{horizontal}} \times M_{\text{vertical}} < 1.1$)
Relative Power Fluctuations, $\delta P(f)/P$:	
3. Drift over 24 hours	< 1 % peak-to-peak
4. Drift over 500 hours (126 laser only)	< 3 % peak-to-peak
5. 1-100 Hz	< 0.5% RMS
6. 100 Hz - 10 kHz	< 0.5% RMS
7. 10 kHz - 3 MHz	< 0.5% RMS
Relative Power Fluctuations, $\delta P(f)/P$, at 60 Hz Line Frequency and Harmonics:	
8. 60 Hz and 120 Hz	< 1×10^{-5} rms
9. Between 150 Hz and 10 kHz	< 1×10^{-5} rms
10. Between 10 kHz and 3 MHz	< 2.4×10^{-6} rms
11. Relative power fluctuations, $\delta P(f)/P$, at Model 126 power supply switching frequency (~80 kHz) and power amplifier power supply switching frequency	< 2×10^{-5} rms

1.2. 126-MOPA #107 Measured Performance

Parameter	Measured Performance	Meets Specification ?		
		Yes	No	Comment
1. Power in circular TEM ₀₀ mode	10.7 W	x		beam not circular
2. Total power in all non-TEM ₀₀ modes	0.9 W ($M_{\text{horizontal}} = 1.03$, $M_{\text{vertical}} = 1.05$)	x		
Relative Power Fluctuations, $\delta P(f)/P$:				
3. Drift over 24 hours	0.7 ± 1.0 % peak-to-peak	x		
4. Drift over 500 hours (126 laser only)	0.5 ± 1.0 % peak-to-peak	x		
5. 1-100 Hz	0.027% RMS	x		
6. 100 Hz - 10 kHz	0.026% RMS	x		
7. 10 kHz - 3 MHz	0.013% RMS	x		
Relative Power Fluctuations, $\delta P(f)/P$, at 60 Hz Line Frequency and Harmonics:				
8. 60 Hz and 120 Hz	2.73×10^{-6} & 5.75×10^{-6} rms	x		
9. Between 150 Hz and 10 kHz	1.64×10^{-6} rms at 180 Hz 1.97×10^{-5} rms at 789 Hz 1.27×10^{-5} rms at 987 Hz	(x)		except at 789 Hz & 987 Hz
10. Between 10 kHz and 3 MHz	undetectable (at 0.3 Hz bandwidth) 60 Hz harmonics above 180 Hz	x		
11. Relative power fluctuations, $\delta P(f)/P$, at Model 126 power supply switching frequency (~80 kHz) and power amplifier power supply switching frequency	6.18×10^{-6} rms near 78 kHz	x		

2. Configuration

2.1. Configuration Target Specification as per LIGO-E970055-02-D

<i>Parameter</i>	<i>Specification</i>
12. Type of laser	Nd ³⁺ :YAG
13. Wavelength	1064 nm
14. Optical scheme	Master Oscillator Power Amplifier, double-pass
15. Amplifier pumping	8 x 20-W diode bar, direct-coupled, side pumped
Frequency Control:	
16. Thermal tuning range, continuous	10 GHz
17. Thermal tuning range, total	30 GHz
18. Thermal tuning rate	1 GHz/ sec
19. Piezo tuning range, ±15 V	30 MHz
20. Piezo response bandwidth, small signal	> 30 kHz
21. Warm-up time	< 1 hour
Laser head, mechanical:	
22. Support structure	2 ft. x 2 ft., ¼ in.-20 tapped holes on 1 in. square grid
23. Modules/ components	a. Model 126-1064-700 master oscillator b. Power amplifier, sealed c. Coupling and beam control optics
24. Beam height above support structure	TBD ±0.05 in.
25. Cover	Removable dust protective cover, metal
26. Total laser height	< 1 ft.
27. Distance from laser head to power supplies	Up to 50 ft.

Test Report 126 MOPA #107

<i>Parameter</i>	<i>Specification</i>
Laser head, optical:	
28. Output beam waist spot size, w_0	0.25 mm TBD \pm 0.1 mm
29. Output beam waist location	TBD \pm 50 mm from output aperture
Laser chiller:	
30. Type	Low-temperature, bath circulator
31. Manufacturer, Model	Neslab, RTE-140M
32. Cooling capacity	600 W at 10 °C, at ambient temp. of 20 °C
33. Pumping capacity	0.9 gpm through 100 ft. length of 3/8 in. ID hose
34. Dimensions (h x w x d)	66.0 cm x 31.4 cm x 48.3 cm (> 12 in. clearance at front and rear for ventilation)
35. Distance from laser head to chiller	Up to 50 ft.
36. Distance from chiller microprocessor controller to chiller	Up to 50 ft.
37. Laser safety	In compliance with federal register 21 CFR 1040.10 & 1040.11 laser safety standard
38. Transportability	Transportable by commercial carrier without performance degradation

2.2. 126-MOPA #107 Configuration

Parameter	Configuration	Meets Specification ?		
		Yes	No	Comment
12. Type of laser	Nd ³⁺ :YAG	x		
13. Wavelength	1064 nm	x		
14. Optical scheme	Master Oscillator Power Amplifier, double-pass	x		
15. Amplifier pumping	8 x 20-W diode bar, direct-coupled, side pumped	x		
Frequency Control:				
16. Thermal tuning range, continuous	10 GHz	x		
17. Thermal tuning range, total	30 GHz	x		
18. Thermal tuning rate	1 GHz/ sec	x		
19. Piezo tuning range, ±10 V	DC: 6.1 MHz/V AC: 5.9 MHz/V	x		
20. Piezo response bandwidth, small signal	> 30 kHz	x		
21. Warm-up time	< 1 hour	x		
Laser head, mechanical:				
22. Support structure	2 ft. x 2 ft., ¼ in.-20 tapped holes on 1 in. square grid	x		
23. Modules/ components	a. Model 126-1064-700 master oscillator b. Power amplifier, sealed c. Coupling and beam control optics	x		
24. Beam height above support structure	2.35 in. ±0.05 in.	x		
25. Cover	Removable dust protective cover, metal	x		
26. Total laser height	8.2 in. ±0.2 in.	x		
27. Distance from laser head to power supplies	Up to 50 ft.	x		

Test Report 126 MOPA #107

Parameter	Configuration	Meets Specification ?		
		Yes	No	Comment
Laser head, optical:				
28. Output beam waist spot size, w_0	horizontal: 0.15 mm \pm 0.1 mm vertical: 0.23 mm \pm 0.1 mm	x		
29. Output beam waist location	horizontal: +12 mm \pm 20 mm from output aperture (outside laser) vertical: -78 mm \pm 20 mm from output aperture (inside laser)	x		
Laser chiller:				
30. Type	Low-temperature, bath circulator	x		
31. Manufacturer, Model	Neslab, RTE-140M	x		
32. Cooling capacity	600 W at 10 °C, at ambient temp. of 20 °C	x		
33. Pumping capacity	0.9 gpm through 100 ft. length of 3/8 in. ID hose	x		
34. Dimensions (h x w x d)	66.0 cm x 31.4 cm x 48.3 cm (> 12 in. clearance at front and rear for ventilation)	x		
35. Distance from laser head to chiller	Up to 50 ft.	x		
36. Distance from chiller microprocessor controller to chiller	Up to 50 ft.	x		
37. Laser safety	In compliance with federal register 21 CFR 1040.10 & 1040.11 laser safety standard	x		
38. Transportability	May require minor realignment when transported by commercial carrier	x		



Sample 206 - Jan 8, 99 - 09:58:19 AM

Centroid (X,Y) [mm]	(1.925, 2.444) 3.111
Peak % Resp. [%]	97.6
Eff. Diameter 86.5% [mm]	1.341
Ellipticity	
Major, Minor 86.5% [mm]	1.332, 1.330
Angle [degrees]	94.786
Circularity	0.998
Gaussian Fit	
Coefficient	0.974, 0.958
Centroid [mm]	1.920, 2.448
Diameter [mm]	1.322, 1.359