LASER CLEANING PARAMETERS

LC-CLEAN 1500W CW

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1. INTRODUCTION

The system used is a **1500 W continuous wave (CW) fiber laser**, air-cooled, with adjustable power and modulation capability.

Unlike pulsed lasers:

- There is no pulse width (ns).
- The emission is continuous or modulated.
- The process is primarily thermal.

Process control is based on:

- Power
- Frequency (modulation)
- Duty cycle
- Speed
- Scan width
- Pattern
- Lens (Try to avoid)

2. GENERAL PARAMETER EXPLANATION

2.1 POWER

Power defines the thermal energy delivered to the material.

- Range: 0–100%
- Typical use:
  - 100% → standard working condition
  - Reduced only to control aggressiveness or heat input

In CW operation, power directly determines the thermal effect.

2.2 FREQUENCY (MODULATION)

The laser allows modulation up to approximately 10 kHz.

Practical working range:

- 2,000 – 8,000 Hz

Interpretation:

- Low frequency (2–4 kHz) → more aggressive, higher energy per interaction
- High frequency (6–8 kHz) → smoother, better control, less aggressive

There is no cut-off concept as in pulsed lasers.

2.3 DUTY CYCLE

The duty cycle defines the percentage of time the laser is active during each modulation cycle.

- Range: 10–100%

Interpretation:

- 100% duty → continuous emission, maximum energy
- Reduced duty → lower thermal accumulation

Reducing the duty cycle can improve effective cleaning speed by avoiding material overheating and re-burning.

2.4 SPEED

- Working range: 20,000 – 35,000 mm/s

In CW operation:

- High speeds improve thermal control
- Low speeds should be avoided due to excessive heat input

2.5 SCAN WIDTH

Scan width controls the energy distribution on the surface.

- 40–50 mm → higher energy density, more aggressive
- 50–60 mm → standard
- 80–100 mm → lower density, higher productivity

Reducing scan width increases energy density without changing power.

2.6 LENSES

Frequent lens changes are not recommended due to:

- Risk of contamination
- Optical damage

- System reliability issues

Available lenses:

- F500 → higher energy density, more aggressive
- F800 → lower energy density, smoother cleaning

The recommended approach is to keep the same lens and adjust parameters instead.

3. KEY DIFFERENCE COMPARED TO PULSED LASER

- Pulsed laser → controlled ablation
- CW laser → continuous thermal process

This results in:

- Higher thermal input
- Greater aggressiveness
- Less precise control

In thick coatings:

The process is a controlled burning effect rather than clean ablation.

4. PATTERNS USED

4.1 SINUSOIDAL (STANDARD)

- Uniform energy distribution
- Stable process
- Good surface finish

This is the default pattern for most applications.

4.2 PETAL (FINISHING)

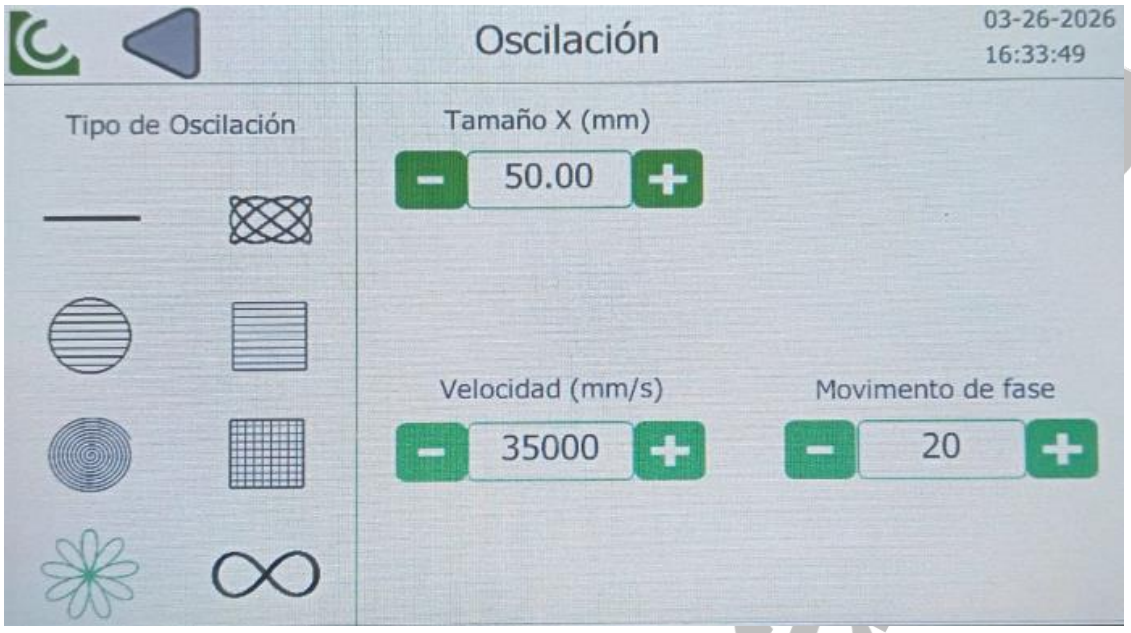
- More distributed energy
- Reduced visible marks
- Smoother appearance

Recommended use:

- After sinusoidal
- With the same parameters
- To improve surface finish

This is especially useful for:

- Paint
- Visible surfaces
- Finishing operations



4.3 LINE (AGGRESSIVE)

- Concentrated energy
- Maximum removal capability

Used for:

- Heavy rust
- Thick coatings
- Difficult areas

Pattern Selection Order

1. Sinusoidal (base process)
2. Petal (finish improvement)
3. Line (if more aggressiveness is required)

5. PARAMETER TABLE (1500W CW)

General Conditions

- Power: 100% (adjustable if needed)
- Frequency: 2,000 – 8,000 Hz
- Duty cycle: 10–100%
- Speed: 20,000 – 35,000 mm/s
- Lens: F500 or F800

Operating Table

Application	Pattern	Power	Duty	Frequency	Speed	Scan Width	Notes
Light rust	Sinusoidal	100%	100%	4,000–8,000 Hz	25,000–35,000	50–60 mm	Base setup
Medium rust	Sinusoidal	100%	100%	3,000–6,000 Hz	22,000–30,000	50–60 mm	Standard
Heavy rust	Line	100%	100%	2,000–4,000 Hz	20,000–25,000	40–50 mm	Maximum aggressiveness
Surface paint	Sinusoidal → Petal	100%	80–100%	4,000–6,000 Hz	22,000–30,000	50–60 mm	Improved finish
Thick paint	Line	100%	60–100%	2,000–4,000 Hz	20,000–25,000	40–60 mm	Avoid re-burning

Multi-layer paint	Line	100%	50–80%	2,000–4,000 Hz	20,000–25,000	40–50 mm	Multiple passes
Light cleaning	Sinusoidal / Petal	100%	80–100%	6,000–8,000 Hz	28,000–35,000	80–100 mm	High productivity

6. KEY OPERATING RULES

6.1 GENERAL RULES

- Use 100% power in most applications
- Maintain speed between 20,000 and 35,000 mm/s
- Work within 2–8 kHz frequency range
- Use:
    - Sinusoidal as standard
    - Petal for finishing
    - Line for aggressive cleaning

6.2 DUTY CYCLE USAGE

- 100% duty provides maximum performance
- Reducing duty improves thermal control

Reduce duty when:

- Material shows signs of burning
- Carbonization appears
- Cleaning efficiency decreases

6.3 KEY PRINCIPLE

Reducing the duty cycle can improve effective cleaning speed by preventing overheating and re-burning.

6.4 ADJUSTMENT PRIORITY

1. Scan width
2. Speed
3. Duty cycle

4. Frequency
5. Pattern
6. Power

6.5 IF CLEANING IS INSUFFICIENT

- Reduce scan width
- Reduce speed within range
- Lower frequency (more aggressive)
- Increase duty
- Switch to line pattern

6.6 IF THE PROCESS IS TOO AGGRESSIVE

- Reduce duty cycle
- Increase frequency
- Increase scan width
- Increase speed
- Switch to petal pattern

7. CONCLUSION

The 1500W CW laser is:

- Simple in parameter control
- Highly thermal
- Very productive

Process control relies mainly on:

- Duty cycle
- Frequency
- Scan width
- Speed