Laser Marker

Technical Guide

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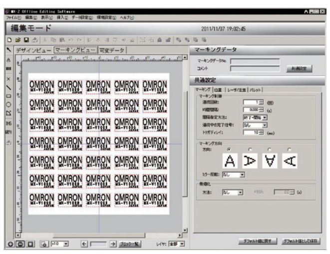
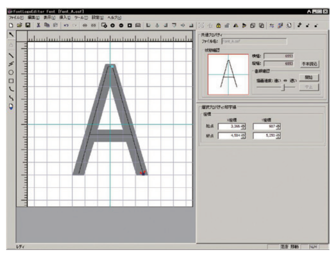
1 Laser Marker Overview

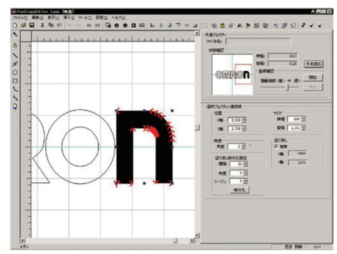
What are laser markers?

A laser marker is a non-contact device for marking physical surfaces using laser energy. Laser marking allows for a unique design and shape for each product since the label data (letters and graphics) can be edited on a computer using template creation software, and it does not wear off or peel off because it is marked directly on the product.
In addition to labeling, laser markers are also used widely for drilling holes, cutting, trimming, and detailed processing.

Template Creation and Editing Software


Creating and editing data


Creating new font data


Creating logo data

Laser marker applications

Laser markers are used in a variety of industrial applications, such as printing 2D codes on automotive parts, logos on electronic components/electrical devices, lot numbers, and many more.


Automotive parts


Electronic components/
electrical devices


Machines/tools

Semiconductors/PCBs


Molded parts


Medical instruments

2 Laser Marker Characteristics

Benefits of using a laser marker

1. Permanent processing and marking

Laser marking is perfect for manufacturing history, process management, and other critical information. It will not wear off or peel off, because it is marked directly on the product.

2. High-quality, fine-detail processing and marking

This no-contact technology minimizes damage to the product, and allows high quality detailed processing and marking.

3. High-speed processing and marking: high productivity

Laser marking is both faster and easier than other kinds of processing or marking.

It contributes more to productivity than other methods.

4. Operating costs of electric usage

There is no need for periodic maintenance, no ink to refill, no cleaning to be done, no blade to change or sharpen.

The electric usage is the primary operating cost.

5. Wide range of materials and processing

Materials which can be marked include metals, plastics, resins, plastic film, and others.

Labeling data can include logos, graphics, model numbers, serial numbers, 2D codes, and more.

6. Environment-friendly processing and marking

There is no ink, and therefore no solvent; no adhesive label, no waste disposal.

Marking comparison table

	Laser Marker	Inkjet	Adhesive Label	Stamping	Press Marking	Chemical marking
Contact/No contact	**No contact**	No contact	Contact	Contact	Contact	Contact
Permanence	**Semi-permanent**	Wears off	Peels off	Wears off	Semi-permanent	Good
Detailed Marking	**Good**	Fair	Fair	No good	Fair	Good
Process	**Easy**	Requires drying	Requires a separate process	Requires drying	Good	No good (requires a separate process)
Label Changes	**Easy**	Easy	Physical label change	No good	Fair	No good
Inventory Management	**No need**	No need	Label stock	No need	No need	Lot production
Waste/Environmental Impact	**Minimal**	Ink	Backing paper	Ink	Minimal	Liquid processing issue
Operating Cost	**Minimal**	Ink refills	Labels	Ink refills	Parts replacement	Liquid processing issue

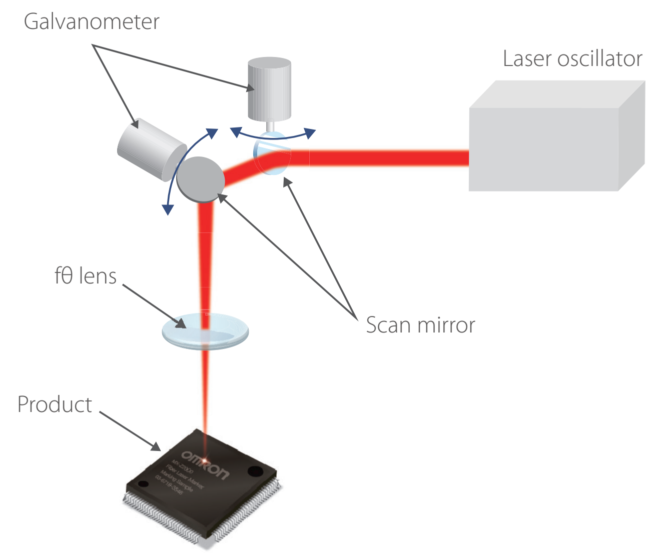
3 Laser Marker Construction

Operating principles and features

Laser markers use laser light to process and mark label data that has been edited using template design software. There are 2-dimensional laser markers for flat surfaces and 3-dimensional laser markers for both flat and shaped surfaces.

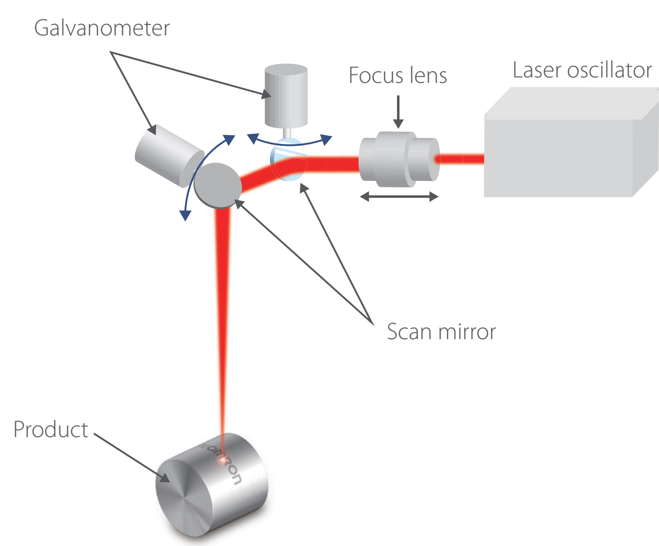
2D Marking (fθ lens)

A galvanometer and scan mirror are used to scan the laser beam and mark the product surface.
An fθ lens is used to concentrate the light on the marking surface.



3D Marking

A galvanometer and scan mirror are used to scan the laser beam and mark the product surface.
Moving the focus lens (used instead of the fθ lens) back and forth makes it possible to adjust the beam not only on the x and y axes, but also on the z axis.



4 Laser Marker Types and Characteristics

Types and characteristics

Laser marker types are classified based on their laser oscillator. Examples of typical laser markers include those with a YAG or YVO_4 solid-state laser oscillator or a fiber laser oscillator generating a 1.06 µm beam, and those with a CO_2 laser oscillator generating a 10.6 µm beam. There are also specialty laser markers used in some applications that have an oscillator that enables SHG and THG by converting the wavelength.

Typical Wavelength	Laser Marker Name	Laser Medium	Characteristics
Fundamental Wave 1.06 µm	Solid-state (YVO_4) laser marker	Nd:YVO_4	The YVO_4 is good for fine print or precision processing; applications that require lower heat levels. The YAG is good for applications that require higher output and heat.
	Solid-state (YAG) laser marker	Nd:YAG	
	Fiber laser marker	Rare-earth-doped fiber	Fiber lasers are compact due to the oscillation principle they use, and are known for generating power efficiently.
Second Harmonic (SHG) 0.53 µm	SHG laser marker	Converts a fundamental laser to half wavelength, using a non-linear optical crystal.	These lasers are effected by wavelength conversions. For materials that have a high absorption rate for these wavelengths, they enable detailed processing with a low thermal effect. However, the operating cost is likely to be high.
Third Harmonic (THG) 0.355 µm	UV (THG) laser marker	Converts a fundamental laser to one-third wavelength, using a non-linear optical crystal.	
10.6 µm	CO_2 laser marker	CO_2	CO_2 lasers have a longer wavelength than solid-state or fiber lasers, so they are more easily absorbed by clear materials. This makes them good for marking glass or other clear materials.

5 Omron's Laser Marker Characteristics

MOPA fiber laser

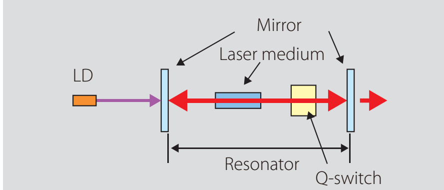
Common fiber lasers and solid-state lasers use mirrors to resonate and amplify the laser. The laser is output by Q-switching. Using this technology, it is difficult to produce a reliable, durable laser with high quality and flexibility. MOPA fiber laser allowed Omron to eliminate the resonator structure and achieve a laser with high flexibility.

Omron's MOPA Fiber Laser

* MOPA: Master Oscillator Power Amplifier

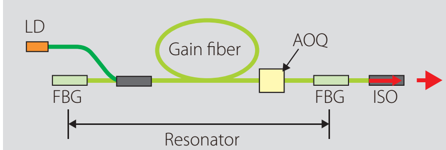
- MOPA fiber laser allows for flexibly setting the pulse width and shape
- Absence of resonator structure allows for highly stable laser output

Common Solid-state Laser



- Pulse width and shape cannot be changed as desired
- Operating life issues with parts such as the Q-switch, mirror, etc.
- Laser output variation due to thermal strain, etc. in optical parts

Common Fiber Laser

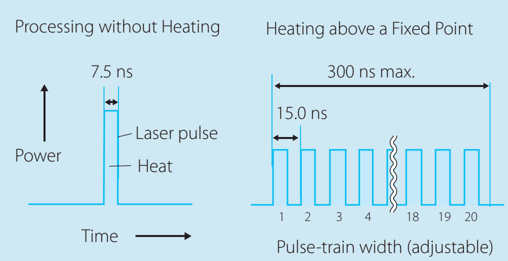


- Pulse width and shape cannot be changed as desired
- Operating life issues with parts such as the AOQ
- Laser output variation due to the characteristics of the AOQ, etc.

Flexible pulse width and shape

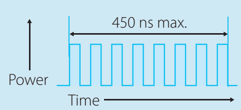
Omron's proprietary flexible pulse control (up to 1 MHz, adjustable 1 to 20 pulses) enables optimum marking and processing for a variety of materials and applications, including both heated and non-heated marking and processing.

Laser Wave Examples

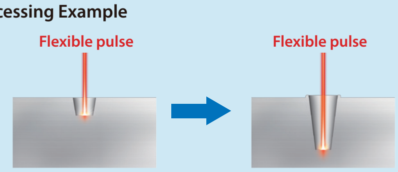


Omron's Laser (EE Mode)

Laser Wave Example

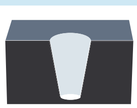


Processing Example



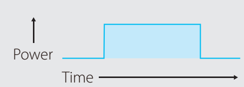
Flexible pulse (divided pulse) laser enables higher output per pulse. Furthermore, continuous irradiation enables deep engraving because it transmits heat also in the depth direction.

Cross section of the processed area

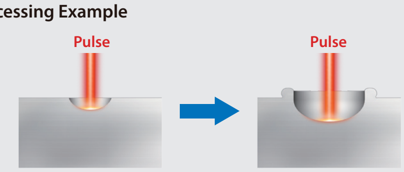


Common Laser

Laser Wave Example

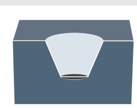


Processing Example



Common laser irradiation, with lower output per pulse than with flexible pulse, results in shallow engraving because it cannot transmit much heat beyond the near surface.

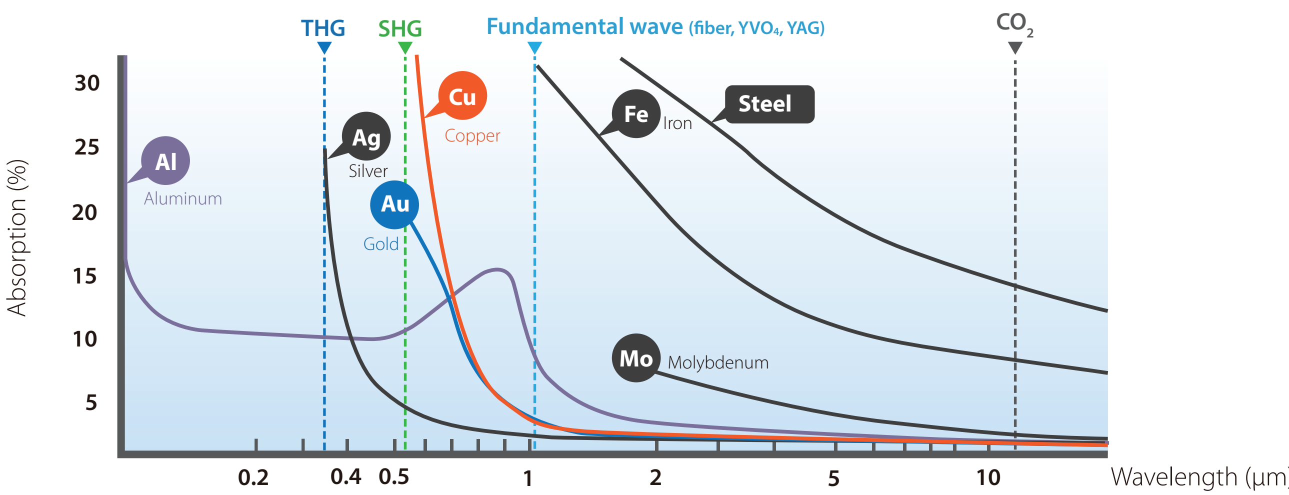
Cross section of the processed area



6 Laser Wavelength and Processing Material

Laser wavelengths and common material absorption

Processing materials with a laser is possible because the surface of the material absorbs the laser beam.
The absorption rate for each wavelength depends on the material.
Fiber, YAG and YVO_4 lasers are better suited for processing metals than CO_2 lasers. They have shorter wavelengths, and are better absorbed by metals.



Materials and laser marker processing characteristics

The following table shows the marking suitability of laser markers with different wavelengths for various common materials, such as metals, plastics, resins, and other materials.
Choose the most appropriate laser marker based on the materials being marked.
While SHG laser markers are well suited for marking copper, gold, and so on (due to the high absorption rates), their cost is also high and achieving high output is difficult. As a result, fundamental wave laser markers are often used instead.

Material		Fundamental Wave Laser Marker (Fiber, YVO_4, YAG)	SHG Laser Marker	CO_2 Laser Marker
Material	Iron	Very good	Good	No good
	Aluminum	Very good	Good	No good
	Stainless steel	Very good	Good	No good
	Copper	Very good	Very good	No good
	Gold	Good	Very good	No good
	Silver	Fair	Very good	No good
Plastic/Resin	ABS (acrylonitrile butadiene styrene)	Very good	Very good	Good
	PBT (polybutylene terephthalate)	Very good	Very good	Good
	POM (polyoxymethylene)	Very good	Very good	Good
	PC (polycarbonate)	Good	Very good	Good
	PP (polypropylene)	Good	Very good	Good
	PVC (polyvinyl chloride)	Very good	Very good	Very good
	PET (polyethylene terephthalate)	No good	No good	Good
Other	Silicon	Good	Very good	No good
	Ceramic	Good	Good	Fair
	Paper	Fair	Fair	Very good
	Rubber	Fair	Fair	Very good
	Glass	No good	No good	Very good
	Wood	Fair	Fair	Very good
	Transparent electrode	Very good	Fair	No good

7 Operational Notes

Observe the following points to prevent the product from becoming inoperative or malfunctioning, or to avoid adverse effects on its performance or device.

1. Power supply, connection and wiring

- Never bundle the marker head control cable and the marker head power supply cable together with 200/100 [VAC] power wires or the power wire or control wire of AC motors, AC servo motors, or electromagnetic valves, etc. being used in your system. Bundling them together will cause noise to enter the galvanometer control cable and the I/O cable for the external control device, which may result in laser marker malfunction.
- If there are surges on the power supply line, connect a surge suppressor as appropriate for the operating environment.
- Do not step on the cables.

2. Operating environment

- To prevent power supply noise or radiation noise from occurring, be sure to implement measures against noise, such as a surge protector at locations where a surge can occur, such as the point of contact with the motor used for surrounding devices.
- Reflected light may damage the marker head. When using, ensure that the specular reflection beam is not reflected back into the marker head.

3. Maintenance inspection

- If the cover glass of the marker head laser irradiation port gets dirty, the laser output may drop or failure may occur.
  Do not use the product with a dirty cover glass.
- Do not use paint thinners, benzene, acetone or kerosene items to clean the marker head or the controller.
  Carefully remove dirt or dust on the cover glass with a soft cloth moistened with ethanol, without scratching the cover glass.

8 Glossary

Galvanometer/ Scan mirror	A galvanometer adjusts the rotation angle in accordance with the current that flows through the drive coil. A scan mirror is a type of mirror that adjusts the direction of the laser beam.
fθ lens	A laser scanning lens that enables marking or processing at a position (Y) proportional to the rotation angle (θ) of the galvanometer/scan mirror.
YAG	A solid-state laser using Yttrium Aluminum Garnet as the oscillation medium. The center wavelength is 1,064 nm.
YVO_4	A solid-state laser using Yttrium Vanadate as the oscillation medium. The center wavelength is 1,064 nm.
CO_2 laser	A gas laser using carbon dioxide (CO_2) in gas form as the oscillation medium. The center wavelength is 9.6 μm or 10.6 μm.
Fundamental wave	A laser light with a wavelength as generated by the crystal medium. The wavelength is 1,064 nm when a Nd:YVO_4 or Nd:YAG crystal is used.
Second harmonic (SHG)	Also known as green laser. A laser light with a wavelength that is half that of the fundamental wave. What characterizes this laser light is its green color. (SHG: Abbreviation for Second-Harmonic Generation)
Third harmonic (THG)	Also known as UV laser. A laser light with a wavelength that is one-third that of the fundamental wave. (THG: Abbreviation for Third-Harmonic Generation)
Non-linear optical crystal	A crystal used to convert the laser light wavelength.
Nd:YVO_4	A YVO_4 crystal doped with small amounts of neodymium (Nd). YVO_4 laser medium. (YVO_4: Abbreviation for Yttrium Orthovanadate)
Nd:YAG	A YAG crystal doped with small amounts of neodymium (Nd) to change the physical properties of the crystal. YAG laser medium. (YAG: Abbreviation for Yttrium Aluminum Garnet)
MOPA	A method to separately control the beam-generating master oscillator (or seed light) and the high-output optical amplifier. (MOPA: Abbreviation for Master Oscillator Power Amplifier)
Resonator structure	An optical structure with a mirror as its main element to form a stationary light (laser) wave by using resonance.
LD	Abbreviation for Laser Diode. Its light is used as the source of the laser light (seed light) or the light to amplify.
SEED	Abbreviation for Seed LD. Laser diode that creates the light that will become the source of the laser light (seed light).
ISO	Abbreviation for Isolator. It is used to attenuate unnecessary light coming from the reflection on the optical path or the marked or processed object, and protect the laser amplifier from being damaged or becoming unstable.
AOQ	Abbreviation for Acousto-Optic Q-switch. Placed inside the resonator, it uses the acousto-optic effect to change the refraction index of the light by adding an ultrasound wave and create narrow, high-peak power laser pulses.
FBG	Abbreviation for Fiber Bragg Grating. The diffraction grating (slits) on the optical fiber is used as resonator mirrors that reflect specific wavelength component.
Q-switch	An optical component that suppresses lasing by keeping the Q factor low until a large number of atoms are excited, and allows lasing by increasing the Q factor again after the number of excited atoms becomes large enough.

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