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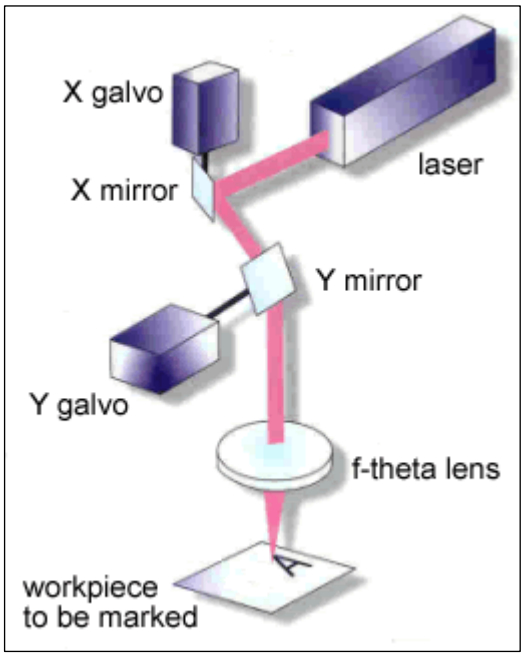
Laser Marking Head (Laser Scanner)

A whole laser marking head (or called laser scanner) consists of two scan mirrors, two galvanometers (or called galvo-scanner motor) & drive cards, a XY mount, a scanning lens (f-theta lens), an interface card (or called D/A card), a set of marking software and a DC power supply. Two types of scanning optics for CO2 and Nd:YAG lasers are available.

Basics of 2-axis laser scanners

A laser beam is reflected from two scan mirrors in turn, and directed through a focusing lens. The mirrors are capable of high speed deflection about a rotation axis, being driven by a galvo-scanner motor. In most cases the maximum deflection angle of the mirror is ±12.5° (often ±10° is a safer limit) either side of the non-deflected incidence angle of 45°.

Note that, for best performance, the lens will appear to be 'the wrong way round' when compared with a standard meniscus lens used in conventional focusing of a laser beam.



Some of the design objectives in specification of 2-axis laser scanners are:

- Achievement of desired scanned field size
- Maximization of scan speeds
- Minimizing focused spot sizes
- Lowest cost solutions

Some of the limitations to be considered are:

- Quality factor **Q** ($Q = M^2$) of the laser beam
- Scan angle limitations
- Loss of power due to beam-clipping
- Physical aperture of the scanner head

Field of scan

The laser beam will be scanned over an angle θ, equal to twice the mirror deflection angle. So, the typical scanned field might be $\theta=\pm20°$ in both X and Y directions. ($\theta=\pm25°$ would be the usual maximum scanned field). The field size is then approximately $2F\tan\theta$ in both X and Y.

The approximation arises because:

1) it is usually desirable to have a deliberate *distortion characteristic* in the scanner lens design so that the field position is proportional to θ, not $\tan\theta$.
2) scanning in two axes produces a geometrical distortion which is unrelated to the lens properties.

Focused spot size

The lower limit on spot size 'd' ($1/e^2$ intensity diameter) for a laser beam of diameter 'D' ($1/e^2$) is:

$d = 13.5QF/D\ \mu m$

Example: A TEM_{00} beam (Q=1) of 13.5mm ($1/e^2$) diameter, focused by a perfect lens of 100mm focal length, will form a focused spot of 100μm diameter. (Taking a more realistic value of Q=1.5, the spot size would be 150μm).

Beam clipping and optical aberrations can lead to focused spot sizes which are larger than the minimum *diffraction limited* value found from the equation above.

Large field sizes demand the use of lenses of long focal length. In turn, this leads to increased focused spot size unless the beam diameter, mirror sizes, and lens diameter are all increased.

Spot sizes are given in the form of an average spot size over the whole, maximum, field-of-scan. A second figure, the standard deviation from average spot size, gives a measure of variation of the spot size to be expected over the field.

Beam clipping

The physical aperture of a laser scanner is often limited by a circular aperture of the scanner head, of diameter 'A' mm, say.

Beam clipping can occur at a circular aperture, even for a well-centred beam, when the 'tails' of the beam energy distribution is blocked by the metalwork. The percentage power loss at a circular aperture, for a TEM_{00} beam (Q=1) is shown in the following table:

Table: Power Loss

A/D	0.8	1	1.2	1.4	1.6	1.8	2
Loss %	27.8	13.5	5.6	1.98	0.6	0.15	0.03

The table indicates that, where the physical aperture of the scanner is limited to A mm diameter, the laser beam diameter D ($1/e^2$) must be selected by a compromise between reduced spot size and power loss due to beam clipping. A value of D = A/1.4 would probably be acceptable for most laser scanner systems. Power loss due to beam clipping increases for de-centred beams.

Mirror design

Mirror (1) (or called Scan Mirror X)

The width of mirror (1) is determined by the beam diameter. It is easier to discuss this in terms of a 'full beam diameter' D_F, where the definition of full diameter is, to some extent, arbitrary.

For example, a system designer might define D_F as the measured diameter of a beam print in perspex [plexiglass]. Alternatively, D_F may be the measured 99% power points, or perhaps a value chosen in the range 1.4D to 1.6D.

The mirror width W1 is slightly larger than the selected value of D_F, sufficient to allow for minor misalignment. The length of mirror (1) is determined by the maximum angle of incidence i_{max} on the mirror. Let $\alpha = (90° - i_{max})$. Then the mirror length is L1, where $L1 = W1/\sin\alpha$. The large shape 'chamfers' on scanner mirrors are determined by the separation, S1, between mirrors (1) and (2); the scan angles, and the need that the mirrors should not collide during scanning.

Mirror (2) (or called Scan Mirror Y)

The width of mirror (2), W2, should be identical to the length of mirror (1). The length, L2, of mirror (2) is found from projection of the beam onto the second mirror at a distance of S1, and at maximum scan angle θ. These mirrors are built and coated *specifically for use with CO2 or YAG lasers*. They have a very high laser damage threshold, measured at 1000W/mm of $1/e^2$ beam diameter (D).

F-theta characteristic

Lenses described as being 'F-theta', or 'Fθ', type are designed so as to produce an off-axis spot at a location proportional to the scan angle. In turn, this may be directly proportional to a voltage applied to the galvo scanner motor. (A lens with zero distortion would form a spot at a field location of Ftanθ). No 2-axis galvo scanner can have a true F-theta characteristic, due to distortion from use of two mirrors. Single-element lenses are designed to be the best compromise between smallest spot size and F-theta characteristic. Errors in F-theta characteristic are usually 2% - 3% for these single element lenses. Multi-element lenses allow design freedom enabling a closer approach to F-theta performance. Fθ errors <0.36% are typical for this range, with only the 75mm FL type having a slightly greater value.

Lens design

All scanning lens designs are based on factors described above. For typical small scanner systems, limited to perhaps 10mm or 15mm full beam diameter, lenses of 48mm diameter have been found to be suitable. For 15mm beams, this lens size is only possible by minimizing the distances S1 and M2L. Each class of lens is designed for use with a specific range of beam diameters, and, more importantly, *for a specific set of values S1 and M2L.*

In each case the lens is designed to provide the best compromise performance for flat field, spot size and F-theta characteristic for the specified beam diameter and mirror locations, while avoiding beam-clipping at the lens mount.

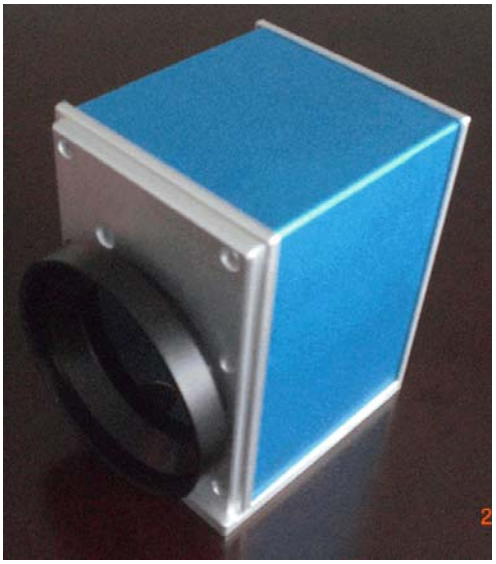
For certain (longer focal length, single-element) lenses it is possible to obtain an improvement in performance by increasing the distance M2L. This necessitates the design/use of lenses of larger diameter (to avoid beam clipping).

Marking software

The Window-based marking software supports various fonts, pictures (PLT, DXF, BMP), automated series numbers, barcodes & DataMatrix. The users can easily use AutoCAD or CorelDraw to design their patterns. They also can scan photos or logos and then use marking software to mark.

Options
Beam expander

LSST series marking heads (F1 outline)
dimension A: 128X98X92mm



LSST series marking heads (F2 outline),
dimension A: 128X98X92mm
dimension B: 155X118X128mm or
dimension C:205X162X178mm

LSST series marking heads (F3 outline)
dimension A: 155X118X128mm or
dimension B: 180X145X148mm

LSCT series marking heads

Description of Part Number: LSCT-xxxx-yy-zzz-AAAA-BB
LSCT, LSST: LSCT or LSST series marking heads.
xxxx: laser wavelength.
yy: maximum input laser beam diameter.
zzz: marking field, which depends on the used f-theta lens.
AAAA: galvo model number
BB: outlines and dimensions

CO2 laser marking heads at 10.6um

Part number	Wave-length um	Max input beam dia. mm	Mark area mm	Focused beam dia. um	Model of galvo	Out line	Dimension LxWxH,mm
LSST-10.6-08-105-8161-1A	10.6	8	105x105	171	OSST8161	F1	128X98X92
LSST-10.6-08-105-8161-2A	10.6	8	105x105	171	OSST8161	F2	128X98X92
LSST-10.6-10-105-8161-1A	10.6	10	105x105	171	OSST8161	F1	128X98X92
LSST-10.6-10-105-8161-2A	10.6	10	105x105	171	OSST8161	F2	128X98X92
LSST-10.6-12-105-8062-2B	10.6	12	105x105	171	OSST8062	F2	155X118X128
LSST-10.6-12-105-8062-3A	10.6	12	105x105	171	OSST8062	F3	155X118X128
LSST-10.6-15-105-8061-3B	10.6	15	105x105	171	OSST8061	F3	180X145X148
LSST-10.6-20-105-8061-3B	10.6	20	105x105	171	OSST8061	F3	180X145X148
LSST-10.6-25-105-3808-2C	10.6	25	105x105	171	OSST3808	F2	205X162X178
LSST-10.6-32-105-3808-2C	10.6	32	105x105	171	OSST3808	F2	205X162X178
LSCT-10.6-12-110-6231	10.6	12	105x105	171	6231		184x176x124

F-theta lens STSL-10.6-105-150 is used in above specifications.

Nd:YAG laser and fiber laser marking heads at 1064nm

Part number	Wave-length um	Max input beam dia. mm	Mark area mm	Focused beam dia. um	Model of galvo	Out line	Dimension （LxWxH,mm）
LSST-1064-08-110-8161-1A	1064	8	110x110	18	OSST8161	F1	128X98X92
LSST-1064-08-110-8161-2A	1064	8	110x110	18	OSST8161	F2	128X98X92
LSST-1064-10-110-8161-1A	1064	10	110x110	18	OSST8161	F1	128X98X92
LSST-1064-10-110-8161-2A	1064	10	110x110	18	OSST8161	F2	128X98X92
LSST-1064-12-110-8062-2B	1064	12	110x110	18	OSST8062	F2	155X118X128
LSST-1064-12-110-8062-3A	1064	12	110x110	18	OSST8062	F3	155X118X128
LSST-1064-15-110-8061-3B	1064	15	110x110	18	OSST8061	F3	180X145X148
LSST-1064-20-110-8061-3B	1064	20	110x110	18	OSST8061	F3	180X145X148
LSST-1064-25-110-3808-2C	1064	25	110x110	18	OSST3808	F2	205X162X178
LSST-1064-32-110-3808-2C	1064	32	110x110	18	OSST3808	F2	205X162X178
LSCT-1064-12-110-6231	1064	12	110x110	18	6231		184x176x124

F-theta lens STY-1064-110-160 is used in above specifications.

Nd:YAG laser marking heads at 532nm

Part number	Wave-length um	Max input beam dia. mm	Mark area mm	Focused beam dia. um	Model of galvo	Out line	Dimension（LxWxH,mm）
LSST-532-08-110-8161-1A	532	8	110x110	15	OSST8161	F1	128X98X92
LSST-532-08-110-8161-2A	532	8	110x110	15	OSST8161	F2	128X98X92
LSST-532-10-110-8161-1A	532	10	110x110	15	OSST8161	F1	128X98X92
LSST-532-10-110-8161-2A	532	10	110x110	15	OSST8161	F2	128X98X92
LSST-532-12-110-8062-2B	532	12	110x110	15	OSST8062	F2	155X118X128
LSST-532-12-110-8062-3A	532	12	110x110	15	OSST8062	F3	155X118X128
LSST-532-15-110-8061-3B	532	15	110x110	15	OSST8061	F3	180X145X148
LSST-532-20-110-8061-3B	532	20	110x110	15	OSST8061	F3	180X145X148
LSST-532-25-110-3808-2C	532	25	110x110	15	OSST3808	F2	205X162X178
LSST-532-32-110-3808-2C	532	32	110x110	15	OSST3808	F2	205X162X178
LSCT-532-12-110-6231	532	12	110x110	15	6231		184x176x124

F-theta lens STY-532-110-160 is used in above specifications.

Remark:

- The marking field of our standard marking head is 105x105mm (CO2 laser) or 110x110mm (Nd:YAG laser). Other mark fields are available upon request. In fact, the marking field depends on the f-theta lens. Thus you may prepare a few f-theta lenses with different marking fields for your various applications.
- The focused beam diameter is theoretical calculation for reference only and actual focused beam diameter depends on beam expander, f-theta lens and laser.
- The DC power supply for the above marking heads is DCBJ-80-25-2 (+/-25VDC).

In order to meet the experienced customers' requirement on cost, we also supply BASIC laser marking head which just includes the basic parts such as galvanometers and drivers, scan mirrors, DC power supply and all mechanical parts. BASIC marking heads are integrated and aligned for use. The model numbers will be LSCT-xxxx-yy-AAAA-BASIC or LSST-xxxx-yy-AAAA-BASIC.

- Whole marking head, including (1) integrated marking head (galvanometer & its driver, scan mirror, f-theta lens and all mechanical parts. Aligned for use. (2) D/A card LMX-1 & marking software and (3) DC power supply.
- BASIC marking head, including integrated marking head (galvanometer & its driver, scan mirror), DC power supply & all mechanical parts. Aligned for use.

Flying Laser Mark Head

A whole flying laser mark head consists of two scan mirrors, two galvanometers (or called galvo-scanner motor) & drive cards, a XY mount, a scanning lens (f-theta lens), an interface card (or called D/A card), encoder, and a set of marking software and a DC power supply.

The flying marker is widely used in production line to mark brand, date, batch numbers, series number, warranty period, producer name etc. It is similar to ink jet printer to mark the flying products. The products are moving/flying when the laser marks the patterns on the products. The marks are permanent and there is no consumable such as ink.

The maximum flying speed is 100m/min. It suits the applications in medicine, cosmetics, foods, wine, cloth, semiconductor, chemical industries.

In most cases the flying marking is done with a CO2 laser and thus the suitable materials to be marked are paper, leather, acrylic, plastic, wood, painted metal, PCB board etc.

Description of part number: LSF-xxxx-yy-zzz-AAAA-BB
LSF: LSF series flying mark heads
xxxx: laser wavelength
yy: maximum input laser beam diameter
zzz: marking area zzz x zzz in mm.
AAAA: model of galvos
BB: outline and dimension

CO2 laser flying mar heads

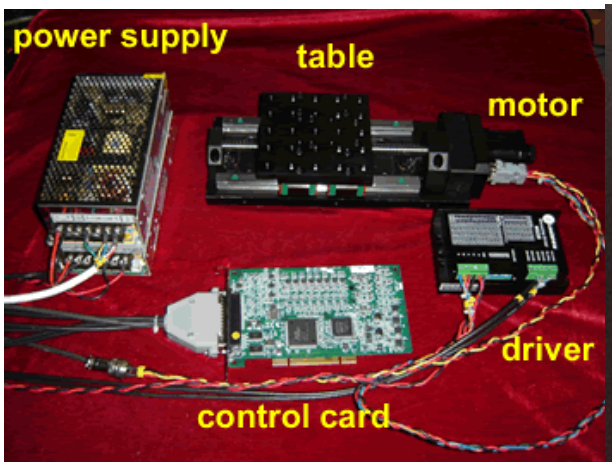
Part number	Wave-length um	Max input beam dia. mm	Mark area mm	Focused beam dia. um	Model of galvo	Out line	Dimension（LxWxH,mm）
LSST-10.6-08-105-8161-1A	10.6	8	105x105	171	OSST8161	F1	128X98X92
LSST-10.6-08-105-8161-2A	10.6	8	105x105	171	OSST8161	F2	128X98X92
LSST-10.6-10-105-8161-1A	10.6	10	105x105	171	OSST8161	F1	128X98X92
LSST-10.6-10-105-8161-2A	10.6	10	105x105	171	OSST8161	F2	128X98X92
LSST-10.6-12-105-8062-2B	10.6	12	105x105	171	OSST8062	F2	155X118X128
LSST-10.6-12-105-8062-3A	10.6	12	105x105	171	OSST8062	F3	155X118X128
LSST-10.6-15-105-8061-3B	10.6	15	105x105	171	OSST8061	F3	180X145X148
LSST-10.6-20-105-8061-3B	10.6	20	105x105	171	OSST8061	F3	180X145X148
LSST-10.6-25-105-3808-2C	10.6	25	105x105	171	OSST3808	F2	205X162X178
LSST-10.6-32-105-3808-2C	10.6	32	105x105	171	OSST3808	F2	205X162X178
LSCT-10.6-12-110-6231	10.6	12	105x105	171	6231		184x176x124

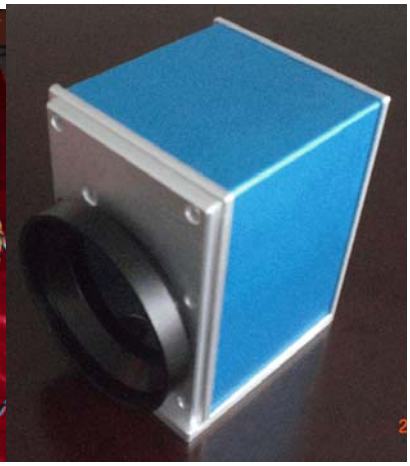
Remark:

- F-theta lens STSL-10.6-105-150 is used in above specifications. Other mark areas available upon request.
- The focused beam diameter is theoretical calculation for reference only and actual focused beam diameter depends on beam expander, f-theta lens and laser.
- The marking software is LMC-1F.
- Other laser wavelengths available upon request.

3D Laser Engraving Head

We can provide OEMs and system integrators with a range of high performance components and sub-assemblies of 3D laser engraving heads at more attractive prices. The engraving head includes a control card, a table with driver, a 2D marking head and DC power supplies.





The control card is used to control the table (step motor), position limits of the table, marking head and laser beam on/off. It is inserted onto the mother board of a computer. The drive software and laser engraving software comes with the control card.

The dimension of the table is 365x120x55mm. The length of the screw is 230mm and the travel range is 120mm. There is a position limit on both ends. The signals are given via DB9.

How to Properly Select Marking Head, Beam Expander, Scan Mirror, F-theta Lens and Laser

Here laser beam diameter is D1, beam diameter after beam expander is D2, beam expansion ratio is T, maximum allowed input beam diameter of scan mirrors is D3, maximum allowed input beam diameter of marking head is D4, Entrance pupil of f-theta lens is EP.

$$D3 \geq D1 * T \text{ or } D4 \geq D1 * T \text{ or } EP \geq D1 * T$$

Marking field is proportional to focal length (or working distance) and focused beam diameter is also proportional to focal length (or working distance).

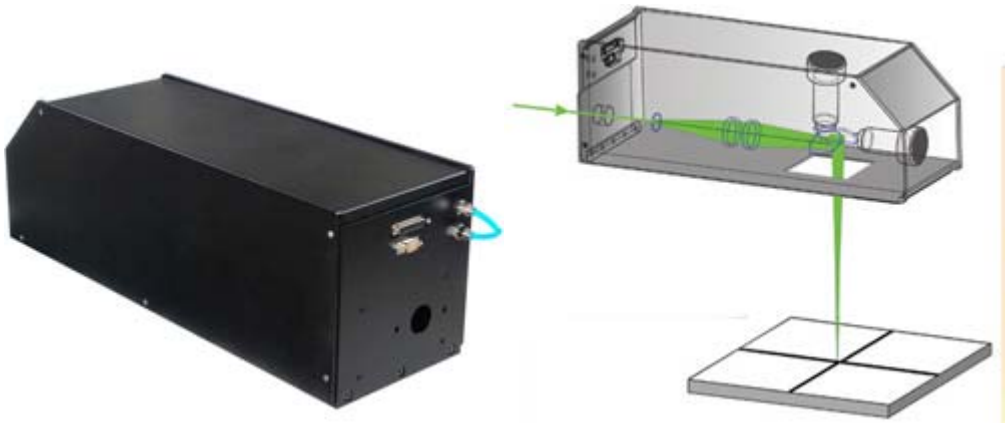
3-Axis Laser Scan System (Dynamic-Focusing Scan Head)

3-axis laser scanning system is designed to meet with the requirement of laser scanning with extreme small beam size and large scanning field as well as high scanning flexibility. The applicable lasers are YAG, CO2 and fiber. It consists of a scan head, linear translator modules, a group of dynamic focusing mirrors, XY scanners, deflection mirrors and a protection window. It takes digital signal and supports XY_2-100 standard protocol. The optimum input aperture designed is 15mm. There are six options of marking fields that can be adjusted manually: 300x300, 400x400, 500x500, 600x600, 750x750, 1000x1000mm. It is characterized by compact and tight structure with dust proof design and installation at ease as well as high anti-interference. Heat sinking of galvo scanners and drivers have been fully taken into consideration during design to secure high long-term stability of the system.

Different from the pre-objective scanning system, in a 3-Axis dynamic scanning system, the scanning mirrors are placed after the objective lens. This lens system is made of a movable expanding lens and focusing lens unit. The laser beam first enters an expander lens; the expanded beam will enter the focusing lens unit, then go through the scanning mirrors and reach the focal plane finally. Moving the expander lens with a motorized translator induces the change of the distance between the expander lens and the focusing lens, which makes the focused laser spot move within a two or three-dimensional space, so called “3-Axis scanning”.

A 3-Axis dynamic scanning system normally offers the following advantages:

- Adjustable range of scanning field size from 100mmX100mm to 2000mmX2000mm;
- Achieve smaller focused spot size compared to the pre-object scanning systems;
- Enhanced uniformity of the focused spot size from the center to the edge of the scanning field.



Applications:
Large scale laser marking, laser cutting, laser welding, laser drilling, micro machining, 3D applications, laser rapid prototyping, etc.

1. Parameter of Linear Translator Modules

Filed Size (mm)	300x300	400x400	500x500	600x600	750x750	1000x1000
Average Focusing Spot Diameter(μm)	190	260	320	380	500	690
Response time	<4ms	<4ms	<4ms	<4ms	<4ms	<4ms

2. Parameters of XY Scanners and Driver Board

（All angles are in mechanical degree, and all parameters apply after 1-minute warm up period）

Input Voltage Requirement	±24V
Small Step Response（±0.5V waveform）	1.5ms
Effective Scan Angle	±12°
Position Signal Input Scale Factor	0.5V/°
Position Signal Output Scale Factor	0.5V/°
Analog Position Signal input range	±5V（Max.）
Linearity	99.9%，range±20°

Scale Drift	<40PPM/℃
Zero Drift	<10μRad./℃
Repeatability	8μRad.
Long Time Drift Over 8 Hours	<0.5mRad.
Average Current	2A
Ambient Temperature	25℃±10℃