Sensor Accessories

EasySense Laser module with Optical slides

(Product No. 3285)

DATA HARVEST

Data Harvest Group Ltd.
1 Eden Court, Leighton Buzzard,
Beds, LU7 4FY
Tel: 01525 373666
Fax: 01525 851638
e-mail: sales@data-harvest.co.uk
www.data-harvest.co.uk

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Contents

Introduction

The EASYSENSE Laser is a solid-state laser module that produces a red light of 645 – 665 nm wavelength. It is designed to be used in optic investigations that require a coherent light source e.g. Young's slits experiments or single ray optic investigations.

There are two optical slides supplied with the Laser, one is a set of slits and the other a set of diffraction gratings. Both are suitable for wavelength of light investigations.

The Laser module is not a *Smart Q* Sensor. The EASYSENSE unit is used to supply power for the Laser but will not be able to identify it. The Laser module has a push-button switch to prevent the Laser being turned on by accident.

The Laser module can be used with *Smart Q* Sensors, such as the Light level or Rotary Motion Sensor, to provide accurate data collection for optics experiments. It can also be used as an alternative infrared transmitter for the *Smart Q* Light Gate to record across a wider area.

Connecting

- Push one end of the sensor cable (supplied with the EASYSENSE unit) into the hooded socket on the Laser.
- Connect the other end of the sensor cable to a socket on the EASYSENSE unit.
- Set up your investigation. Clamp the Laser module securely and check that the potential path of the laser beam is not directed to any individual (including you) or into an area where individuals may wander.

  Note: The Laser will not operate until the small push button on the Laser housing has been pressed
- Check the EASYSENSE unit is powered.

  Note: If the EasySense unit is in 'sleep' mode (LCD blank), the Laser will not be powered. Press a button on the unit to 'wake it up' and therefore power the Laser.
- Complete all safety checks and press the push switch to activate the laser beam.
- Once activated the push switch can be used to turn off the laser beam.

Safety

The cardinal rule of all work with lasers is "never stare into the beam".

ALWAYS MAKE SURE THE LASER IS POINTING AWAY FROM YOU AND NOT TOWARDS ANYONE ELSE BEFORE PRESSING THE SWITCH.

Code of practice

The EASYSENSE Laser has been designed to comply with the recommendations made by The *Use of Lasers in Schools, Colleges of Education and Further Education Establishments*, Circular No.766, SED (now SOED), 1970 with regards to:

1. Laser diodes should only be used in laser diode modules and not as discrete devices.
2. The radiation from the laser module must be visible.
3. The optical power of the laser diode module should not exceed 1mw.
4. The laser should be rated Class 1 or Class 2.

Relevant parts of this code of practice should be explained orally and given in writing to pupils before allowing them to work with laser diode modules.

1. Under no circumstances view (look into) the laser directly.
2. Do not allow the laser to be directed towards another person. Clamping the laser into a jig or clamp is good practice.
3. The Laser module should not be switched on until it is safe to proceed, i.e. the Laser is clamped securely in a jig and the potential path of the laser beam is not directed to an individual or into an area where individuals may wander.
4. Laser beams should be prevented from leaving the workbench area. An optical stop should be used to terminate the beam. A piece of matt black card or paper will suffice. If the beam cannot be contained in this manner then some form of barrier to prevent accidental viewing should be considered.
5. Whenever possible the laser beam should be restricted to a horizontal plane of 20cm above the bench top height.
6. A laser warning sign should be positioned in the area where lasers are being used.
7. When the system is being set up a piece of white paper should be used as a screen to track the whereabouts of the radiation when arranging equipment e.g. optical apparatus.
8. Normal classroom lighting should be used whenever possible; blackout conditions should only be used if essential to the experiment. Back reflections should be identified and stopped.
9. When using a fibre optic cable, a screen should be placed over the emerging end to make the laser light visible.

Note: The lens should **never** be removed from the laser diode module. If the lens becomes damaged the module should be discarded or returned to Data Harvest for repair. Removal of the lens will raise the power output of the laser.

Reference:

1. *The Use of Lasers in Schools, Colleges of Education and Further Education Establishments*, Circular No.766, SED (now SOED), 1970
2. BS EN 60825: 1992 *Radiation safety of laser products, equipment classification, requirements and user's guide*, British Standards Institution,

Information

- Neither the EASYSENSE unit nor software will identify the Laser module when it's connected.
- The Laser will not operate if the EASYSENSE unit is not powered. If the unit goes into 'sleep' mode' press a button to 'wake it up' and therefore power the Laser. When the unit is re-awakened the Laser will need to be switched back on by pressing the small button switch on the module housing.
- The Laser is not suitable for use when data is being collected remote from the computer e.g. in EasyLog mode, for more than six minutes. After six minutes the

EASYSENSE unit will automatically go into sleep mode between readings so the power supply to the Laser module will be interrupted and the Laser will switch off.

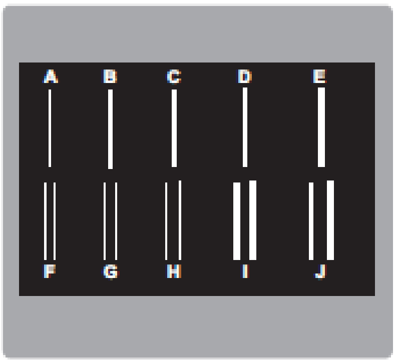
- The Laser diode produces a fixed focus oval beam of light. When conducting a Young's slit investigation the beam of light should be orientated to match the slit.

Laser Diode specifications

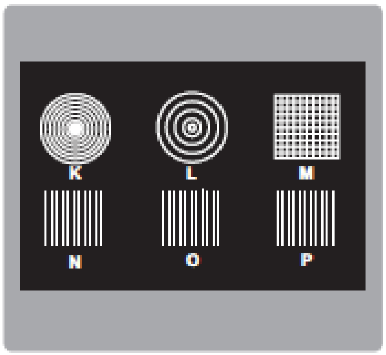
Operating voltage	3 – 5 V
Output power	<= 1.0 mW
Laser class	Class II
Wavelength at peak emission	645 – 665 nm (visible red)
Spot size at 5m	6 mm ±2 mm
Divergence	1.6 mrad
Operating temperature range	10 - 30ºC
Storage temperature range	-20 - 65ºC

Optical Slide information

There are two optical slides supplied with the Laser module.



Set of slits (front image)



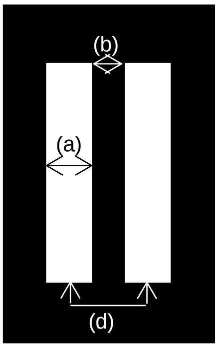
Set of Diffraction Gratings/Patterns (front image)

- The slides should be used with the front image facing towards the Laser module to reduce back scattering of the laser beam.

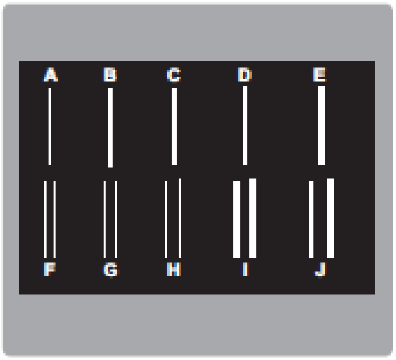
  Note: If the letters appear reversed the slide is the wrong way round.
- The Laser module should be set up within 5cm of the optical slides surface for the best results.
- Handle the slide by its mount only. Mishandling will damage the film.

1. The set of slits

This optical slide has clear slits on a black film labelled from A to J.



A double slit

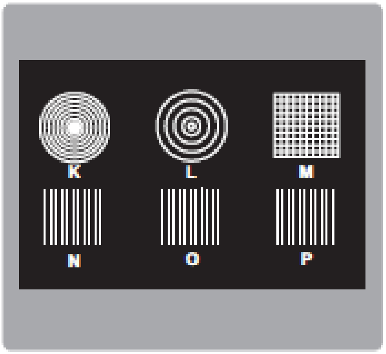


Single slit specifications	
Slit	Width Size **(a)** (microns)
A	25
B	36
C	43
D	51
E	61

Double slit specifications			
Double slits	Slit Width **(a)** (microns)	Width of slit separator **(b)** (microns)	Distance **(d)** between centres of slits (microns)
F	25	25	25 + 25 = 50
G	25	36	25 + 36 = 61
H	25	51	25 + 51 = 76
I	51	51	51 + 51 = 102
J	61	61	61 + 61 = 122

2. The Diffraction gratings/patterns slide

This optical slide has three diffraction gratings (labelled N, O, and P) and three diffraction patterns (K, L and M) on a black film.



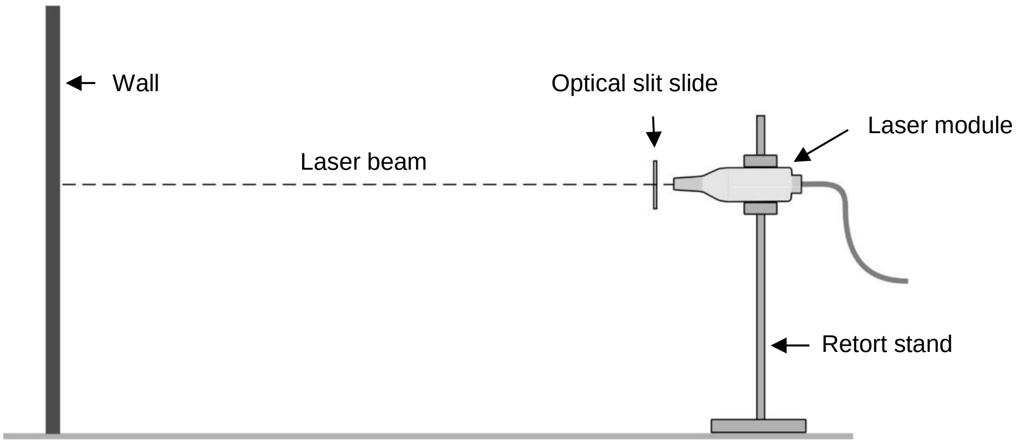
Diffraction pattern specifications						
Pattern	Description of pattern	Line width (microns)	Lines spacing (microns)	Distance between slits (microns)	Lines per mm	Lines per inch
K	Target	10	10	10 + 10 = 20	50	1270
L	Target	10	10	10 + 10 = 20	50	1270
M	Checker board	10	10	10 + 10 = 20	50	1270

Diffraction grating specifications					
Grating	Line width (microns)	Lines spacing (microns)	Distance between slits (microns)	Lines per mm	Lines per inch
N	8	8	8 + 8 = 16	62.5	1587.5
O	10	10	10 + 10 = 20	50	1270
P	20	20	20 + 20 = 40	25	635

Investigations

- *Young's single and double slit experiment: Finding the wavelength of the light passing through the slit.*
- *Young's single slit experiment: Finding the width of a slit that the student has produced using a pair of sharp edges (razor blades).*
- *Finding the wavelength of light using a diffraction grating.*
- *Finding the spacing of the slits in a diffraction grating.*
- *Optics experiments that need a single slit e.g. angle of incidence of a refracted beam through a glass block*.
- *Demonstrate X-ray diffraction of crystals using the M grating (two diffraction gratings crossed at right angles).*
- *Using the Laser module directed to the infrared receiver on a Smart Q Light Gate to record data from an object interrupting the infrared beam.*

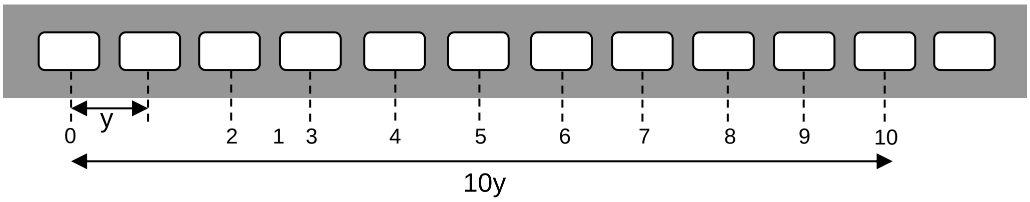
Young's single slit experiment



1. Set up the experiment in a darkened (but not blacked out) room. The Laser module should be held in a clamp and positioned so the laser beam can be pointed to a sheet of paper fixed on a wall or screen approximately 1 meter away.
2. Clamp the Laser module so it points towards the wall; the laser beam should be positioned 20 cm above the surface of the bench.
3. Make sure no one can casually walk into the path of the laser; if necessary place a temporary barrier to restrict access.
4. Clamp the optical slit slide (A – J) with the front of slide facing towards the Laser and place in front of the Laser module so when the laser is activated its beam will pass through the slide.

   Note: When the slide is viewed from behind the Laser module the lettering on the slide should be the correct way round.
5. Connect the Laser module to an input on the EASYSENSE unit; make sure the unit is powered. Check that no one is in the path of the laser. Press the button switch on the Laser module to switch on the laser beam. The beam will appear as a red spot on the wall.
6. Stand behind the Laser module (so you do not view the laser directly), and adjust the slide so it is less than 5 cm from the Laser module. Move the slide so the laser beam is directed through the centre point one of the slits (A – J) and a pattern of alternating bright and dark bands is visible on the wall (try different slits to get the clearest pattern). Make any further adjustments to the laser position or slide position to get the bands as sharp as possible.

7. Face the wall (do not look back at the laser), mark and then measure as accurately as possible the distance across as many bands as possible using the middle of a bright band as a start and end point. Count the total number of dark/bright band spacings that you have measure across.



8. Press the switch to deactivate the Laser and measure the distance from the optical slide to the wall.

Calculate wavelength λ of the light from the Laser using the following equation: $\lambda = \frac{yd}{x}$

Where y = the band spacing on the wall (measure across as many bands as possible and divide the measurement by the number of band spacings)

d = distance between the double slits (from centre to centre)

x = distance from the optical slide to the wall

Example from results using double slit (I)

Measurement across 10 bright band spacings (10y) = 51mm, so y = 5.1mm = 5.1×10^{-3}m

Distance between the double slits = d = 102microns = 102×10^{-6}m. (This value is listed in the slide specification table)

Distance from slide to wall (x) = 800mm = 800×10^{-3}m

$$\frac{5.1 \times 10^{-3} \times 102 \times 10^{-6}}{800 \times 10^{-3}} = \frac{520.2 \times 10^{-9}}{800 \times 10^{-3}}$$

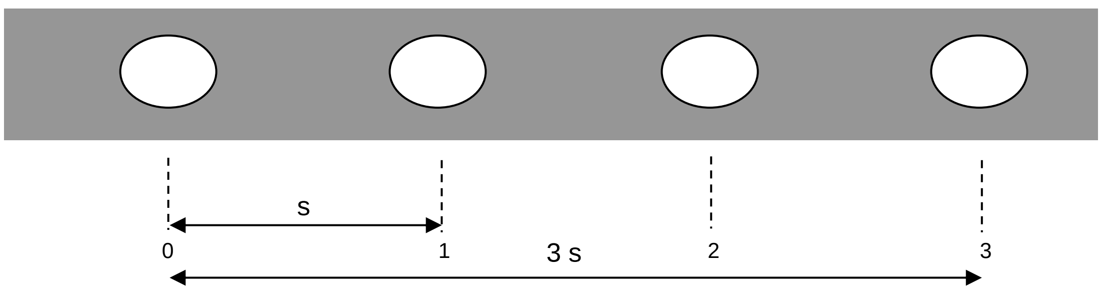
$= 0.65025 \times 10^{-6}$m $= 650.25 \times 10^{-9}$m

= 650.25nm

Prefix Help Chart		
Prefix	**Name**	**Meaning**
m	milli	Divide by 1 000 i.e. 10^{-3}
μ	micro	Divide by 1 000 000 i.e. 10^{-6}
n	nano	Divide by 1 000 000 000 i.e. 10^{-9}

Finding the spacing of slits in a diffraction grating

1. Setup the experiment again following steps 1 – 5 but use the diffraction grating slide.
2. Move the slide so the laser beam is directed through the centre point one of the diffraction gratings (N, O or P) and a pattern of bright spots is visible on the wall.
3. Face the wall (do not look back at the laser), mark and then measure as accurately as possible the separation (s) across as many spots as possible using the centre of a spot as a start and end point. Count the total number of dark/bright spot spacings that you have measured across.



4. Press the switch to deactivate the Laser and measure the distance from the optical slide to the wall.

5. Record the information in a table as shown below.

Gratings (lines/mm)	Distance from slide to wall (r)	Separation (s)	Calculated distance between slits (d)
N 62.5			
O 50			
P 25			

Calculate the distance between the slits (d) on the diffraction grating using the formula

$$d = \frac{\lambda}{\sin \phi}$$

λ = the wavelength of the Laser.

Sin ϕ = (s/r) = the separation between the fringes on the screen (s) divided by the distance from the optical slide to the wall (r).

Example from results using diffraction grating (N)

Wavelength of Laser = λ = 650 nm = 650×10^{-9} m (as calculated in the previous investigation).

Measurement across 10 bright spot spacings (10 s) = 428 mm, so s = 42.8 mm = 42.8×10^{-3} m

Distance from slide to wall (r) = 1158 mm = 1158×10^{-3} m

So $\sin \phi = \frac{42.8 \times 10^{-3}}{1158 \times 10^{-3}} = 0.0369$

Prefix Help Chart		
Prefix	**Name**	**Meaning**
m	milli	Divide by 1 000 i.e. 10^{-3}
µ	micro	Divide by 1 000 000 i.e. 10^{-6}
n	nano	Divide by 1 000 000 000 i.e. 10^{-9}

$$d = \frac{\lambda}{\sin \phi}$$

$d = \frac{650 \times 10^{-9}}{0.0369} = 17547 \times 10^{-9} = 17.5 \times 10^{-6}$

Note: The stated value of the distance between slit set N = 16.0×10^{-6}

Limited warranty

For information about the terms of the product warranty, see the Data Harvest website at: https://data-harvest.co.uk/warranty.

Note: Data Harvest products are designed for **educational** use and are not intended for use in industrial, medical or commercial applications.

WEEE (**W**aste **E**lectrical and **E**lectronic **E**quipment) Legislation

Data Harvest Group Ltd are fully compliant with WEEE legislation and are pleased to provide a disposal service for any of our products when their life expires. Simply return them to us clearly identified as 'life expired' and we will dispose of them for you.