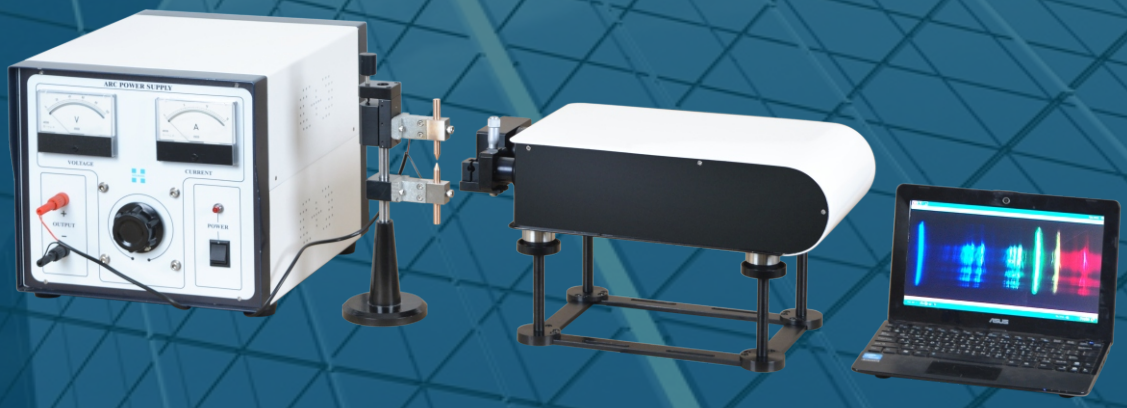
HOLMARC
OPTO-MECHATRONICS PVT. LTD

CCD Based Constant Deviation Spectrometer (For Arc emission and Absorption Measurements)



INSTRUCTION MANUAL

HOLMARC

Instruction Manual

CCD Based Constant Deviation Spectrometer

(For Arc emission and Absorption Measurements)

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Product Features

HOLMARC's constant deviation spectrometer uses CCD imaging of spectrum instead of photographic silver halide films. It is used to analyze emission and absorption spectra by comparing with the predetermined chart of elements. Modern and user friendly design of the spectrometer with constant deviation prism produces sharp and clear spectra. We make use of Hartmann's equations to calibrate the spectrometer with Mercury lamp. Also we find the wavelength of absorption bands of $KMnO_4$, and the wavelength of emission spectra of copper, brass and iron.

Getting Started

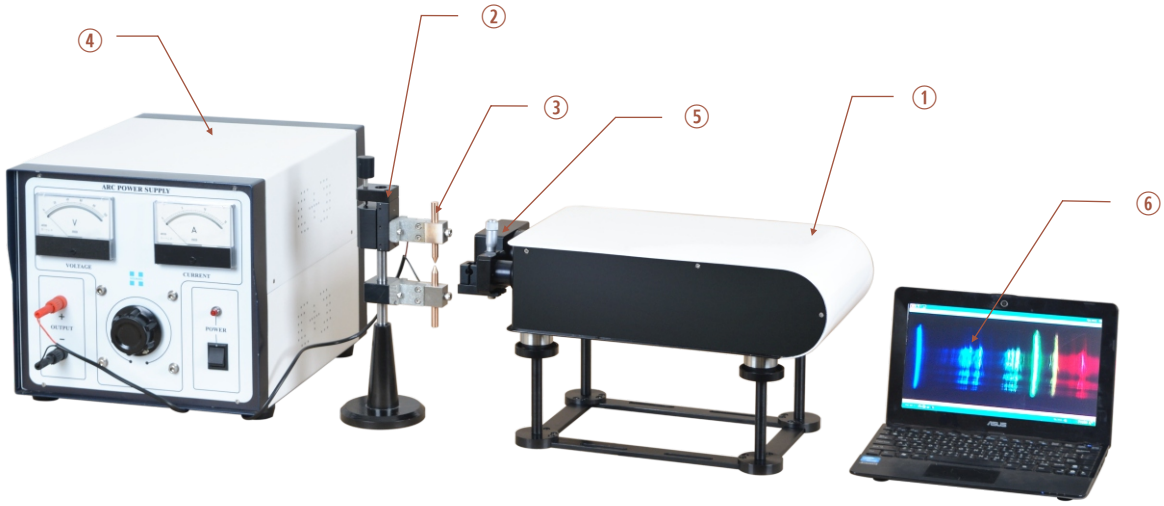
a. Safety Instructions

1. Mercury light is not good for eyes. Avoid direct exposure from Hg. It contains UV light.
2. It is best that students work in low light and dust free atmosphere.
3. Take care while doing Arc emission experiment since it uses high voltage source.

Please check if the following items are present while the instrument package is delivered.

1.	Prism Spectrometer With CCD Camera	-	1 No
2.	Halogen Lamp	-	1 No
3.	Arc Power supply	-	1 No
4.	Arc Stand	-	1 No
5.	Iron, Copper & Brass rods	-	10 No's each
6.	KMnO4 powder	-	1 Pack
7.	Cuvette	-	2 No's
8.	Low pressure Mercury lamp	-	1 No

b. Parts Listing



1. Constant Deviation Spectrometer
2. Metal Arc stand
3. Metal rods
4. Arc power supply
5. CCD sensor
6. PC connected to sensor via USB cable

c. Components Included

1. Constant Deviation Spectrometer

Prism type	:	Pellin Broca prism
Design	:	constant deviation 120F
Spectrometer Input	:	Micrometer controlled slit(1Rev : 0.25m ,1Div : 0.005 mm)
Spectrometer output	:	CCD electronic output through USB connected to a PC
Wavelength Range	:	400 - 800 nm
Wavelength Accuracy	:	+ / - 2 nm
Abs/Emission accuracy	:	+ / - 2 nm

Camera Specifications :

CCD detector	:	Sensitive linear array 0-3647 pixels
Pixel size	:	800 x 200 micron
A/D Resolution	:	16 Bits
Exposure Time	:	0.1 - 6500 ms
Frame rate	:	138 scans / second
Compatibility	:	Any windows platform OS
Interface	:	USB 2.0

2. Mercury vapour Lamp

Input	:	230 V / 50 Hz
Output	:	4KV

3. Halogen Lamp With Power supply

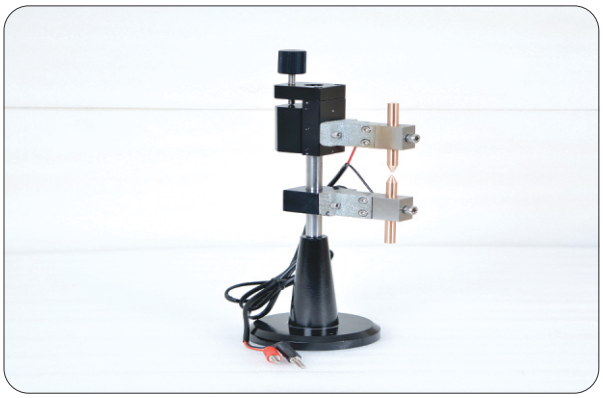
Input : 230V, 50Hz

Output Power : 10W

4. Metal Arc stand

Substance holder type : ceramic

Arc cavity : 25 mm



5. Copper, Iron and Brass rods

Length : 75 mm

Diameter : 8 mm

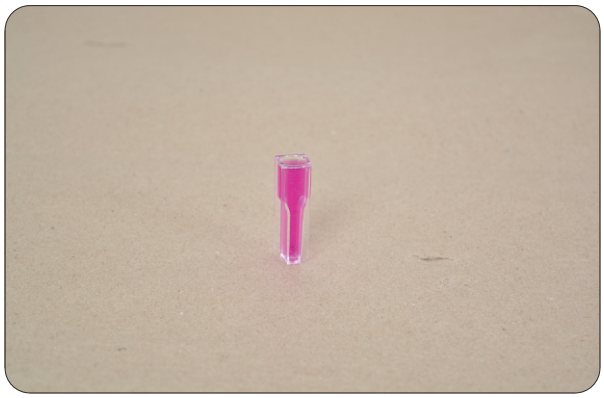
6. Arc Power Supply

Input : 230V AC / 50 Hz

Output voltage : 0-100 V

Output current : 0-15 A

7. Cuvette



Quantity : 2 no’s

8. $KMnO_4$ Powder

1 Pack

Fundamentals

Aim

1. To calibrate the prism spectrometer using mercury (Hg) lamp, using Hartmann equations.
2. To measure the wavelength of absorption bands of KMnO4 solution using Hartmann's equations.
3. To calculate the wavelength of emission spectra emitted by copper iron and brass.

1. Calibrating spectrometer with low pressure Hg

Theory

Every element emits a characteristic spectrum of its own. To find the wavelength of light emitted usually the spectrum of a standard source is measured and compared. The unknown wavelength is determined by using Hartmann equations.

The wavelength of the prominent lines in the arc spectrum of different substances are studied by using the Hartmann's formula,

$$\lambda(d) = \lambda_0 + C / d - d_0$$

where λ_0, C and d_0 are Hartmann's constants that must be evaluated experimentally. This is done by substituting the comparator scale readings d of three known lines (in the mercury spectrum) from an arbitrary point and their wavelengths λ in the above equation and solving the three equations . If we could find three lines with scale readings d_1, d_2 and d_3 corresponding to known wavelengths λ_1, λ_2 and λ_3 respectively, then we can find Hartmann's constants using the following relations:

$$A = (\lambda_2 - \lambda_1) / (\lambda_3 - \lambda_1)$$

$$B = (d_2 - d_1) / (d_3 - d_1)$$

$$\lambda_0 = ((A \times \lambda_3) - (B \times \lambda_2)) / (A - B)$$

$$d_0 = ((B \times d_3) - (A \times d_2)) / (B - A)$$

$$C = ((\lambda_2 - \lambda_1) \times (d_0 - d_1) \times (d_0 - d_1) \times (d_0 - d_2)) / (d_2 - d_1)$$

a. Place the spectrometer on a rigid table.

b. Install the spectrometer software in a suitable PC(HOLMARC spectra analyzer).

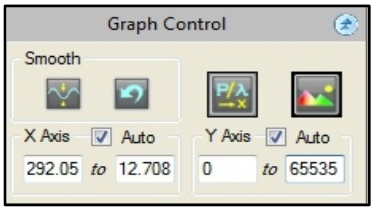
c. You could see  icon after the successful installation of the software on your computer screen. Connect CCD detector to the PC via provided USB cable.

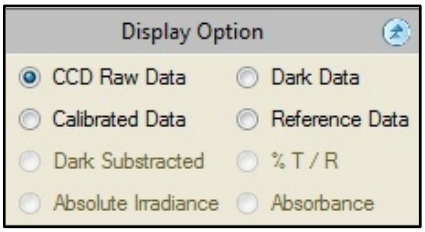
d. Now click on the icon and open the software. On the screen you could find a window for logging into the software. Login as a user.

e. Switch on the mercury lamp and Place it in front of the spectrometer. To observe the discrete spectrum of mercury click on the run icon 

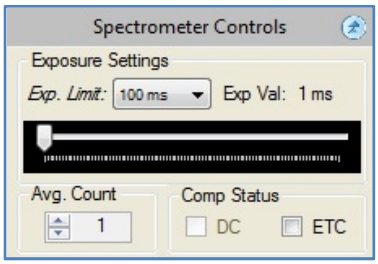
, to start live spectrum view. (adjust the slit width using the micrometer screw provided to get a precise accurate spectrum.). You will have a plot with pixel values on X - axis and Y - axis shows intensity.  icon gives you the graph mode of spectrum, you can change it to table mode by clicking  icon. Also you can record live spectrum by clicking the next icon on tool bar (). View the spectrum image at the bottom of the window by clicking  icon.

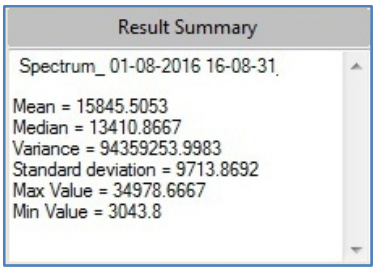
There is a control panel on the left side of the window which helps you to change the range of X - axis as well as Y - axis. Also you can have smooth curve using the smoothening option in the graph control panel. There is also a redo option which helps you to redo the smoothening.





Next option in the control panel is the display option through which you could change the displaying data. (User can only view the CCD Raw Data).





The next two options in the control panel are spectrometer control and result summery. **Spectrometer control** includes;

Exposure Time : This is the integration time for each frame, the minimum exposure time and the exposure time step is 100µs, which means the set exposure time is a multiple of 100µs.

Avg. Frame Number : Set the frame number for each acquiring action.

Compensation Status : Set the auto dark status (DC) and ETC status of the grabbed frame.

Note : Setting new spectrometer control parameters will affect next grabbed frame, and have no effect on the current or previous frames.

The **Result summery** displays statistical values of the acquired spectral intensities over the specified wavelength range.

Also remind to check the status bar below the window to know whether the applied exposure is oversaturated or not.

1. Current calibrated wavelength range in nm.
2. Dark Data Status: 'Dark: ON' means dark data has been loaded; 'Dark: OFF' means dark data has not been loaded.
3. Reference Data Status: 'Ref: ON' or 'Ref: OFF' status means reference data is loaded or is NOT loaded.
4. Exposure Time of current frame, in millisecond.
5. The grabbing information.
6. Saturation status of current frame. 'Normal' or 'Over Saturated'. If it is 'Over Saturated' , reduce the exposure time.

f. If all is well click stop (

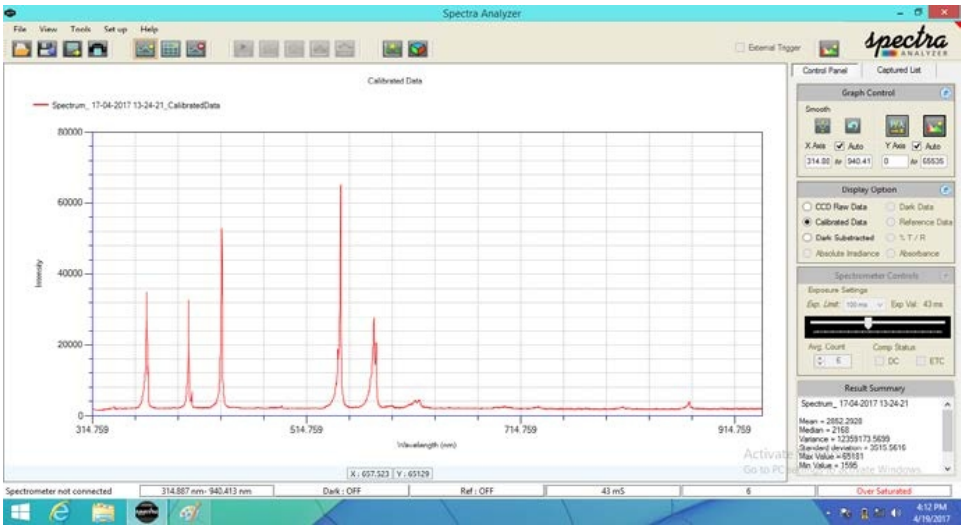
) and click on Acquire single spectrum icon  and have a stable spectrum. Save the spectrum in your desired location using the save icon () provided in the window.

g. Find the pixel values of the peaks obtained by zooming the graph. To zoom right click on the graph and drag a rectangle around the point whose values need to be measured.

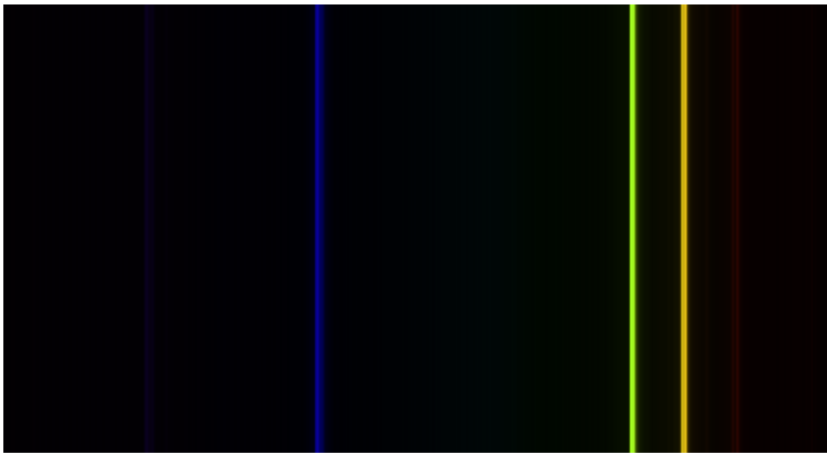
h. Using the values obtained and the known wavelengths find the Hartmann's constant. Take any three known wavelengths and find the Hartmann's constant. (To ensure that the obtained constants are correct try to find out the wavelengths in the mercury spectrum itself and compare it with the theoretical values).

(Someone who is logging in as administrator can calibrate the spectrometer using the software itself.)

Observations



Colour of spectral lines	Known Wavelength (nm)	Corresponding Pixel values (X - axis)
Violet	λ1 = 404.656	P1 =
Blue	λ2 = 435.833	P2 =
Green	λ3 = 546.096	P3 =
Yellow	λ4 = 579.066	P4 =

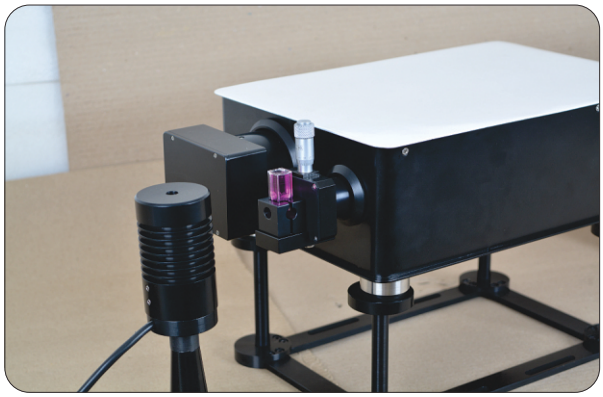


2. Measure absorption bands of KMnO4 Using Hartmann's constant

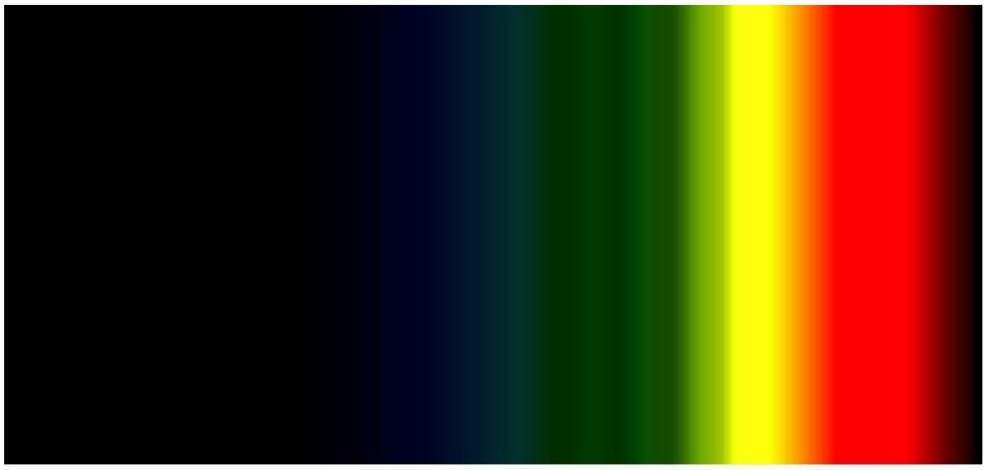
After calibrating the spectrometer replace the mercury lamp with the halogen lamp and its power supply. You will see a continuous spectrum on your PC now(As you run the live spectrum as before).

Now prepare $KMnO_4$ solution, at a particular concentration, take it in a cuvette provided and place it on the cuvette holder on the spectrometer. Then you will have 3 or 4 dark bands in the continuous spectrum. Measure the pixel values of the band from the graph. (Measure the pixel value at the starting point of the band and at the ending point).

Use the Hartmann's constants obtained before to find out the wavelength of absorption bands of $KMnO_4$.



Observations



Width of the absorption band	Calculated wavelength $\lambda = \lambda_0 + [\ C / (d_0 - d)\ ]$ nm

Result

Absorption spectrum of the $KMnO_4$ solution is recorded.

3. Wavelength of prominent lines in emission spectra of copper, iron and brass

To find the wavelength of emission spectra of certain materials replace the halogen lamp by the arc stand and its power supply.

Fix the rods provided in the arc stand so that minimum space exists between the tips of the rods, so that arcing occurs (You can adjust the spacing between the rods using the fine adjustment screw provided on the arc stand).

Now connect the wires to the power supply and switch it on, apply suitable voltage (35V-40V) and the arcing occurs. Make sure that the arcing occurs exactly in front of the slit of the spectrometer.

View the spectrum on PC as before and adjust the arc stand and also the micrometer slit so that a clear spectrum is obtained. (You must adjust all these before the arcing ends, arcing lasts only up to a few minutes and to view it again you must sharpen the ends of the rods).
As before find the pixel values corresponding to each line and find the wavelength using the Hartmann's constants.

Use video mode or graph mode for easy pixel selection.

Observations

Iron spectrum

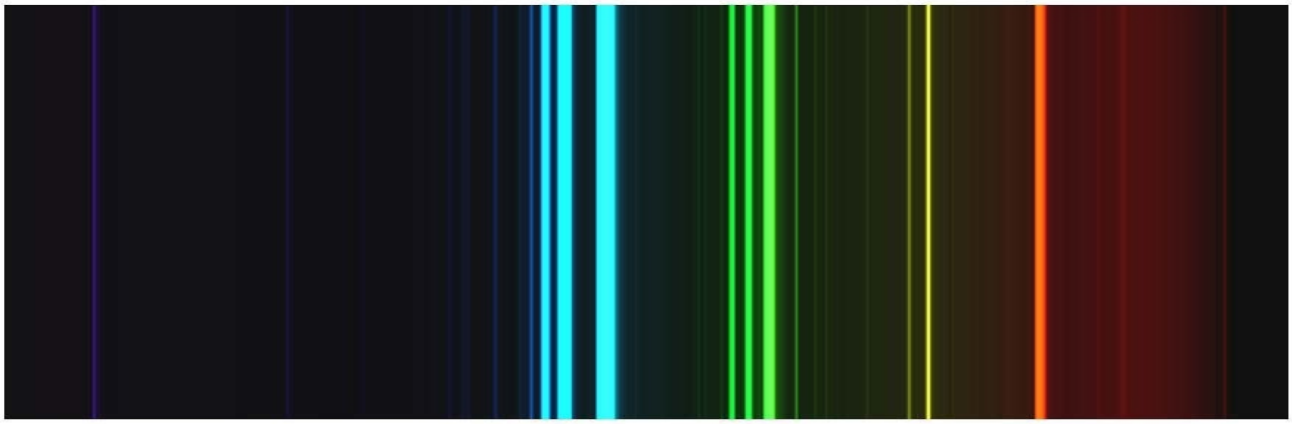
Distance of line from zero d, (Pixel values)	Calculated wavelength $\lambda = \lambda_0 + [C / (d_0 - d)]$ nm	Theoretical wavelength
		438.355
		440.475
		441.512
		485.975
		484.132
		489.1
		492
		495.7
		513.368
		516.749
		520.234
		522.688
		527.180
		532.418
		538.946
		544.692

Copper spectrum

Distance of line from zero d, (Pixel values)	Calculated wavelength $\lambda = \lambda_0 + [C / (d_0 - d)]$ nm	Theoretical wavelength
		453.9
		458.7
		465.112
		510.554
		515.324
		531.641
		529.252
		570.024
		578.213

Brass spectrum

Distance of line from zero, d (pixel values)	Calculated wavelength $\lambda = \lambda_0 + [\ C / (d_0 - d)\ ]\ nm$	Theoretical wavelength nm	Element
		465.112	Cu
		468.014	Zn
		472.01	Zn
		481.053	Zn
		515.324	Cu
		518.199	Zn
		521.641	Cu
		578.213	Cu
		633.893	Zn



Material Rod	Arc Light Colour	Prominent Wavelength
Copper	Green	Green triplet
Brass	Cyan	Cyan
Iron	White	Vibgyor colors

Results

Wavelength of the prominent lines of the emission spectra of copper, iron and brass are recorded.

Technical Support

Before you call the HOLMARC Technical Support staff, kindly gather the following information:

- Title and model number (usually listed on the label)
- Approximate age of apparatus
- Detailed description of the problem/sequence of events
- Have the manual in hand to discuss your query

Feedback

If you have any comments regarding our product or manual, please let us know. If you have any suggestions on alternate experiments or find a problem in the manual, kindly inform us. HOLMARC appreciates any customer feedback. Your inputs help us evaluate and improve our product.

For technical support, contact us at
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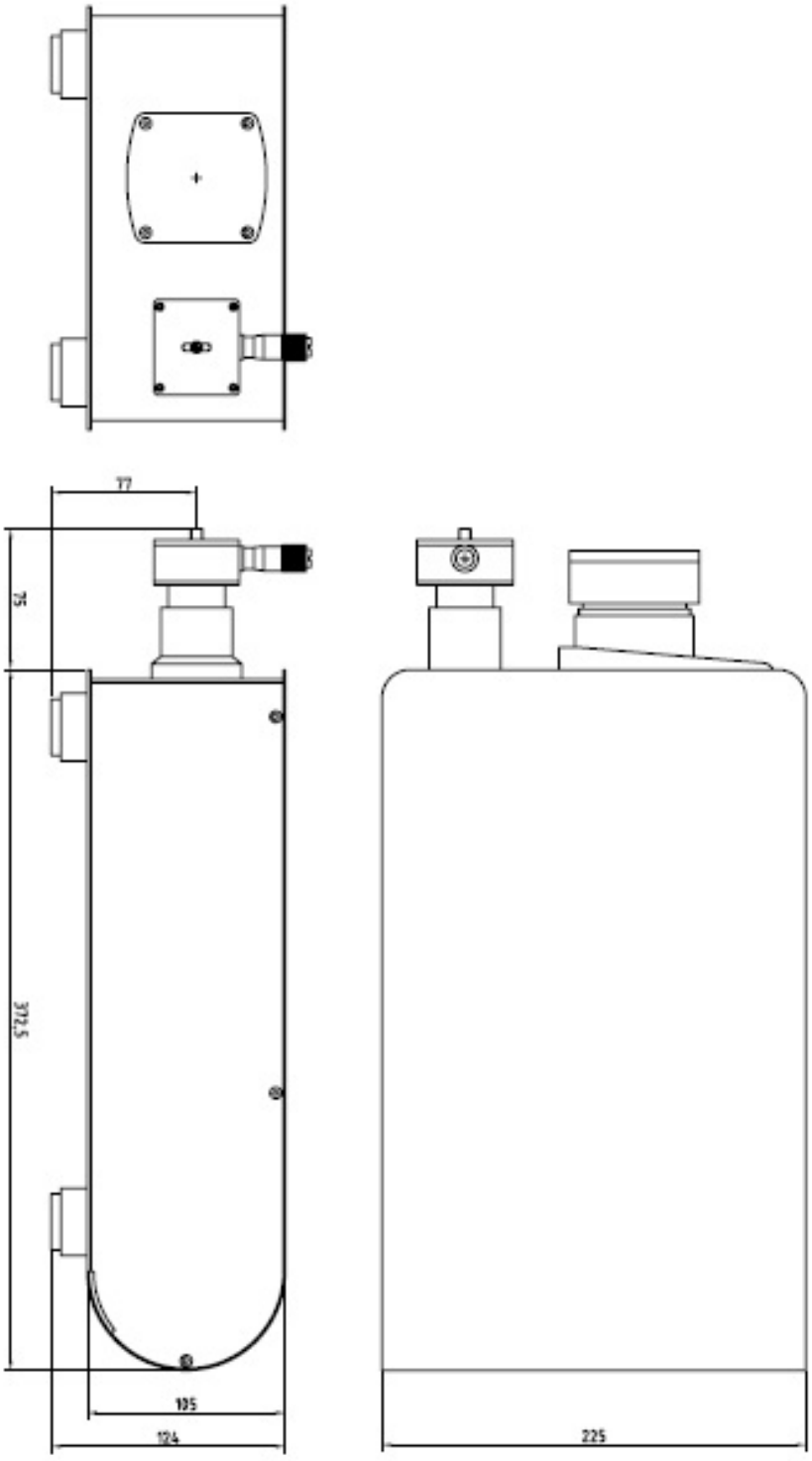
Web: www.holmarc.com

Mechanical Drawing



Holmarc Limited Warranty

Every Holmarc Instruments and its accessories are warranted by HOLMARC OPTO-MECHATRONICS P LTD for a period of ONE YEAR from the date of original purchase.

Holmarc will repair or replace a product, or part thereof, found by Holmarc to be defective, provided the defective part is returned to Holmarc, with proof of purchase.

This warranty applies to the original purchaser and our distributors and is non-transferable.

Each returned part or product must include a written statement detailing the nature of the claimed defect, as well as the end user's name, address, and phone number.

This warranty is not valid in cases where the product has been abused or mishandled, where unauthorized repairs have been attempted or performed, or where depreciation of the product is due to normal wear-and-tear.

Holmarc specifically disclaims special, indirect, or consequential damages or lost profit which may result from a breach of this warranty. Any implied warranties which cannot be disclaimed are hereby limited to a term of one year from the date of original retail purchase.

Holmarc reserves the right to change product specifications or to discontinue products without notice.

Please refer our commercial invoice for warranty claim.

(Authorized Signatory)

HOLMARC
OPTO-MECHATRONICS PVT. LTD

Holmarc Opto-Mechatronics P Ltd has been organized as a provide of engineering tools for scientific research. Our company is equipped to meet most challenging and demanding requirements of scientific community with our manufacturing and development capabilities in optics, mechanics, electronics & software. At Holmarc, experienced engineers, designers & technicians work hand in hand to deliver state of the art engineering solutions to our clients.

All of us at Holmarc stay tuned to absorb changes in technology as fast as possible. We deliberately keep our technical skills as well as manufacturing infrastructure flexible and maintain a dynamic work culture throughout our operations.

We have distributors and collaborators in all parts of the world and are well equipped to serve world scientific community. We welcome queries irrespective of geographical and political boundaries.

HOLMARC

www.holmarc.com

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