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│         Instructions LASNIX Infrared Attenuator          │
│                    Models 302, 305                       │
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1.   HANDLING.   LASNIX infrared attenuators operate on light diffraction. The active optical elements consist of fine metal screen.

> WARNING:
> The metal screen is mechanically fragile.
> It may be touched with great care only.

2.   INSTALLATION.   The attenuator can be operated both in vertical and horizontal position. The motion of the attenuator elements should be in horizontal direction to avoid unintended slip. The end flanges provide four mounting holes spaced 94 mm, 9 mm in diameter.

Model 305
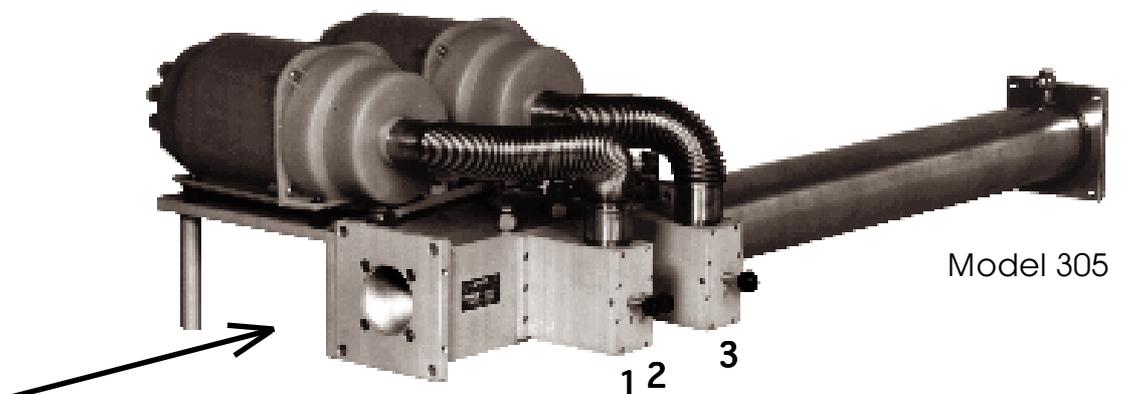
The laser beam must enter from the end marked by the arrow. Exit is after passage through the long absorber tube. The attenuator function does not depend on the angular alignment within the clear aperture.

3.   CONNECTIONS.   The attenuator is cooled both by air blowers and cooling water. Power requirements are 8 A @ 120 V (50 or 60 Hz) for each motor. Be sure to leave intake and exhaust openings unobstructed. The water connections can be made using plastic tubing with 8 mm o.d. and 6 mm i.d.

4.   MOTOR WEAR.   The blowers contain carbon contacts which wear out so that after about 1000 hours of service the motor shuts off automatically. In this case the screens are no longer cooled and can be damaged by the laser beam. Therefore we recommend to install new contacts after 500 hours of service. A set of contacts (Type 70616 supplied by Metronic, 78628 Rottweil, F.R. Germany) is included.

5.   OPERATION.   Attenuation is instantly achieved by inserting one or more attenuator elements. The individual metal screen is designed for an attenuation of 5 db nom. Each blower connects to two screens which can be moved either together only or independently. It is essential to have the motor running **before** inserting an element into the laser beam.

6.   UNITS.   The attenuation of individual elements in decibels (db) is additive. The following table may facilitate the interconversion of units. We have $T = 10^{-A/10} = 1/F$, where T is the power transmittance,   A is the attenuation in decibels, and F is the attenuation factor:

A(db)	T(%)	F	A(db)	T(%)	F
0	100	1.00	6	25.1	3.98
0.01	99.97	1.0023	7	20.0	5.01
0.1	97.7	1.023	8	15.9	6.31
1	79.4	1.26	9	12.6	7.94
2	63.1	1.59	10	10	10
3	50.1	2.00	20	1.0	100
4	39.8	2.51	30	0.1	1000
5	31.6	3.16	40	0.01	10000

7.   POWER HANDLING.   The attenuator is specified for a maximum incident c.w. laser power density of 3000 W/cm² .*
      This power limit assumes optimum cooling from the air blowers, attained

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* Above a power density of 3500 W/cm² c.w. or quasi-c.w. the metal screen starts to glow; permanent damage occurs above 7000 W/cm² .

at an applied voltage of 120 VAC.**

<u>using repetitive pulses:</u>
With repetitively pulsed beams the time-averaged (quasi-c.w.) power density limit is likewise 3000 W/cm², with the added requirement that the energy density of the individual pulse may not exceed 22 J/cm² .

<u>using short pulses:</u>
The attenuator is specified for a maximum incident laser pulse energy density of 22 J/cm², with the added requirement that the power density does not exceed the plasma breakdown threshold. The latter is near 500 MW/cm². Therefore, the pulse energy density limit is reduced when the pulse length becomes shorter than 50 ns.

8.   HIGH POWER SPECIAL REQUIREMENTS.   When using laser intensities above 2000 W/cm² the attenuation element #1 must be included in any combination of active elements.

Check the water flow when using high power; a flow rate of 4 liter/min. is recommended per 10 kW.

The total power may not exceed 30 kW.

9.   USE WITH CO LASER BEAMS.   All power and energy limits given apply to use of the attenuator with CO_2 laser beams. For the use with CO laser beams these limits are reduced to 67%. Furthermore, the operation at shorter wavelengths requires extending the device length.

10. REFLECTION FROM A TARGET.   The attenuated beam when reflected from a target can pass through the attenuator a second time, whereby it is attenuated again by the same factor. Both direction and polarisation are fully preserved. In addition, however, diffracted beams are excited which propagate under small angles from the axis (>3° for CO_2 lasers) towards the laser. These beams can be intercepted by an absorbing dia-phragm e.g. with an aperture diameter of 50 mm located 70 cm from the attenuator. When operating with shorter wavelength the angles are accord-ingly smaller and thus require a longer distance of the diaphragm.

** The blower motors may be operated at a reduced voltage in order to reduce noise and heat output; this will however reduce the power limit. Specifically, operation at 60 V reduces the power limit by 20%, i.e. from 3000 W/cm² to 2400 W/cm².

11. OPTION "P" OPERATION.
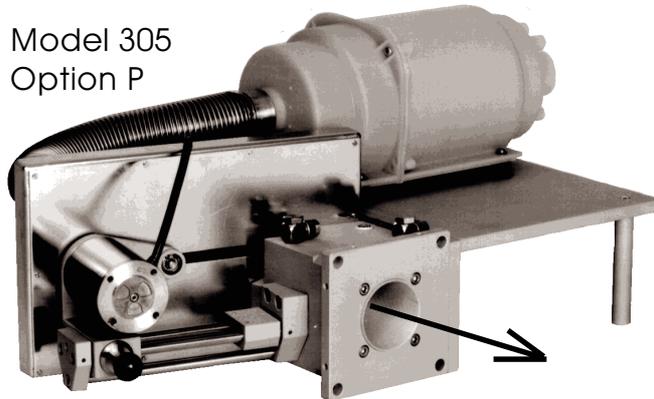
A rotating screen element is used to enhance the power density limit of the attenuator by a factor of three.

Option P has to be attached to the <u>input</u> side of the attenuator Mod. 302/305, since its rotating element can take the highest power density. Mounting screws are supplied.

Model 305
Option P

CONNECTIONS. Option P is cooled both by an air blower and cooling water. Power requirement is 8 A @ 120 V (50 or 60 Hz) for the blower motor. Be sure to leave intake and exhaust openings unobstructed. The water connections can be made using plastic tubing with 8 mm o.d. and 6 mm i.d.

MOTOR WEAR. The blower contains carbon contacts which wear out so that after about 1000 hours of service the motor shuts off automatically. In this case the screen is no longer cooled and can be damaged by the laser beam. Therefore we recommend to install new contacts after 500 hours of service. A set of contacts (Type 70616 supplied by Metronic, 78628 Rottweil, F.R. Germany) is included.

OPERATION. Attenuation is instantly achieved by inserting the rotating attenuator element attached to its motor. This element has an attenuation of 5 db nom. It is essential to have the motor and the blower running <u>before</u> inserting the element into the laser beam.

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POWER HANDLING. The attenuator is specified for a maximum incident c.w. laser power density of 10 000 W/cm^2. This power density limit assumes optimum rotation and cooling from the air blower.

<u>using repetitive pulses:</u>

With repetitively pulsed beams the time-averaged (quasi-c.w.) power density limit is likewise 10 000 W/cm^2, with the added requirement that the energy density of the individual pulse may not exceed 22 J/cm^2.

<u>using short pulses:</u>

The attenuator is specified for a maximum incident laser pulse energy density of 22 J/cm^2, with the added requirement that the power density does not exceed the plasma breakdown threshold. The latter is near 500 MW/cm^2. Therefore, the pulse energy density limit is reduced when the pulse length becomes shorter than 50 ns. ☐