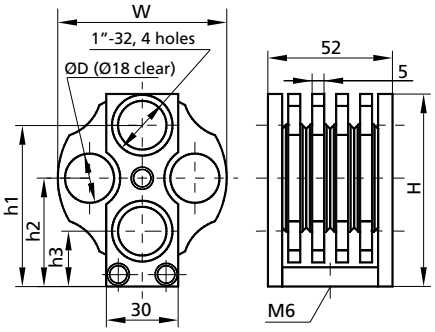
990-0604 VARIABLE WHEEL ATTENUATOR

990-0604-01

- **4 wheels**
- **3 filter per wheel (12 filters in total)**
- **Filter diameter 20 or 25.4 mm**
- **Maximum deviation 0.09 mm**
- **Clear aperture Ø18/Ø20 mm**
- **C-mount threads on both ends**
- **Connecting adapters available**



Variable Wheel Attenuator 990-0604 is a basic model with 4 filter-set wheels. Each wheel contains 4 filter slots each for Ø20 mm with clear aperture of Ø18 mm.

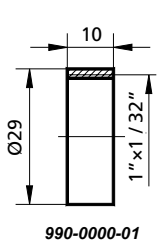
Each filter slot is inclined by 4°to avoid retroreflections.

Each wheel has 4 fixed positions. You can use any of these 4 filter positions as an optical axis. The back and front panels do not to obscure.

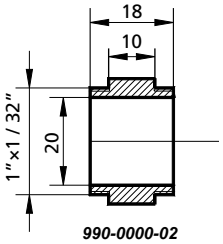
Both panels have 1"–32 threaded holes (C-Mounts). Separately you may order standard connecting adapters 990-0000-01, 990-0000-02 and 990-0000-03. Custom adapters are available.

M6 mounting hole is provided in the bottom plate.

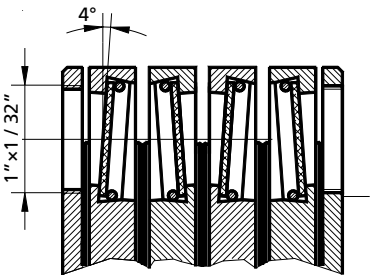
990-0604-02 model is designed to accept 1" (25.4 mm) filters with maximum thickness of 3 mm. This model comes without filters.

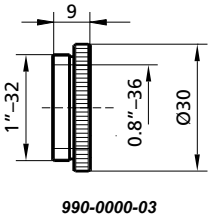


990-0000-01



990-0000-02





990-0000-03

Model	H, mm	W, mm	h1, mm	h2, mm	h3, mm	D, mm	Weight, kg	Price, EUR
990-0604-01	84	70	67	45	23	Ø20	0.35	457
990-0604-02	95	80	75	50	25	Ø25.4	0.40	297

Note:
960-0604-01 is with filters Ø20 mm.
990-0604-02 is without filters. 960-0604-02 is suitable for Neutral Density and Colour Glass filters Ø25.4 mm that should be ordered seperately.

RELATED PRODUCTS

Neutral Density Filters Ø25.4 mm
See page 1.14

Colour Glass Filters Ø25.4 mm
See page 1.16

990-0704 CLOSED VARIABLE WHEEL ATTENUATOR

990-0704

***991-0704** with a CCD camera*

Close Variable Wheel Attenuator 991-0704
ideally suits for use with CCD cameras.
Adapters 990-0000-01 or 990-0000-02
are used for connection.

- **4 wheels, each containing 3 filters & 1 empty space**
- **4 fixed positions per wheel**
- **C-mount threads on both ends**
- **Connecting adapters available**
- **Stray light fully eliminated**
- **Variable height of the optical axis**
- **Three mounting holes**

SPECIFICATIONS

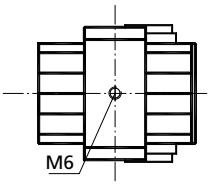
Diameter NDF	20 mm
Maximum thickness	3 mm
Non-parallel filters	(inclined by 4°)
Maximum deviation	0.09 mm
Clear aperture	Ø18 mm

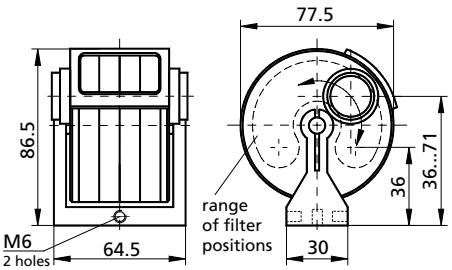
Code	Weight, kg	Price, EUR
990-0704	0.55	549

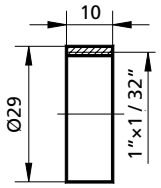
Close Variable Wheel Attenuator is used when it is necessary to fully eliminate the side background lighting when using photodetectors with high sensitivity (e.g. CCD, photomultiplier, etc.). You may order standard connecting adapters 990-0000-01 and 990-0000-02 separately. Custom adapters are available too.

Loosen the central axis and rotate the whole body of the filter to set the desired position of an optical axis at a height between 36–71 mm.

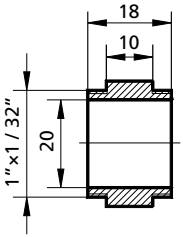
The base of the attenuator has M6 holes on 3 sides for mounting versatility.



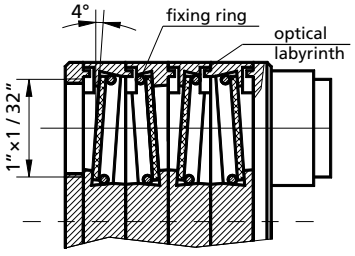




990-0000-01



990-0000-02



SOME APPLICATIONS OF OPTICAL FILTERS

- **In systems for laser beam diagnostics with CCD-cameras**
- **Measurement of laser power, pulse energy and pulse duration**
- **Spectroscopy**
- **We can offer a set of bandpass filters for mercury lamp, laser lines, and for your other needs**

A choice of filters is available for our standard 4-wheel attenuators, allowing 256 relative positions of wheels, rendering 99 different transmission values, of which you can find a very close match to the desired value. Discrete filters permit to establish accurate optical density.

Also we can offer designs with 1, 2, 3 and more wheels.

Variable wheel attenuators come with a standard, most popular, set of filters listed in Table 1. The standard filters are made of neutral grey glass with spectral characteristics according to Figure 3.

Alternatively, attenuators (wheels and optics) can be manufactured according individual orders. We can also supply variable wheel attenuators without filters, which you can fit by yourself.

In most cases detectors (CCDs, photodiodes, photomultipliers, etc.), used for diagnostics of laser radiations, are too delicate for direct measurement of high powers, such as from ion lasers or pulsed solid-state lasers. An attenuator may be required to reduce laser power density at the surface of detector. Optical attenuators must be used when the laser output-power or power density exceeds working (linear) range or damage threshold of a detector. (Draft International Standard ISO/TC172/SC9/WG1)

For example, the damage threshold for a typical commercially available CCD is about 100 mW/cm², for the ultra high speed photodetectors series AR-S (Antel Optronic Inc.) it is about 200 mW/cm². On the other hand, laser power must be adjusted to the optimum point, which is typically just below the saturation level of the detector. For example, a typical commercially available CCD saturates at only 0.05 mW/cm² at 632.8 nm and at 5.5 mW/cm² at 1.06 mm (see R. Rypma "Dimming the Light ...", in Photonics Spectra N.10, 1995, p.145).

For preliminary attenuation of very high power lasers the simplest approach is to use just the first surface reflection of an uncoated laser-grade substrate.

It is useful to have an intensity adjustment range of at least 1000:1 or more in this final stage. Even when working with a single-wavelength laser, operated at one power level, this range may be encountered when making measurements at different points in the optical train.

After major reduction in intensity by reflection off an uncoated substrate is achieved, some of the low-power neutral density filters of the high optical quality can bring the beam power to the exact level necessary for optimum measurement by detection system.

RELATED PRODUCTS

990-0604 Variable Wheel Attenuator

See page 7.30

Table 1. *List of a standard filter-set*

Transmission		Filter #1	Filter #2	Filter #3	Filter #4
Wheel #1	T	1.00	0.90	0.80	0.50
	dB	0.00	0.46	0.97	3.00
Wheel #2	T	1.00	0.30	0.10	0.03
	dB	0.00	5.20	10.00	15.20
Wheel #3	T	1.00	0.01	0.003	0.001
	dB	0.00	20.00	25.00	30.00
Wheel #4	T	1.00	0.0003	0.0001	0.00003
	dB	0.00	35.00	40.00	45.00

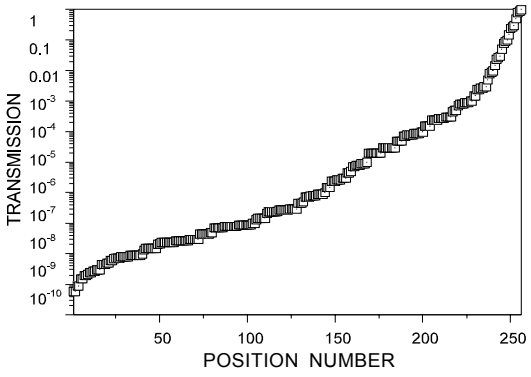


Figure 1

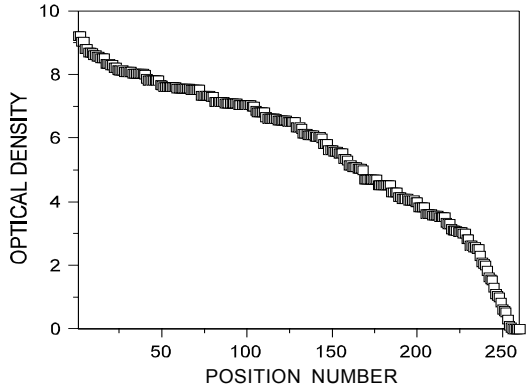


Figure 2

Charts for the standard filter-set: possible filter positions versus resulting transmission/density.

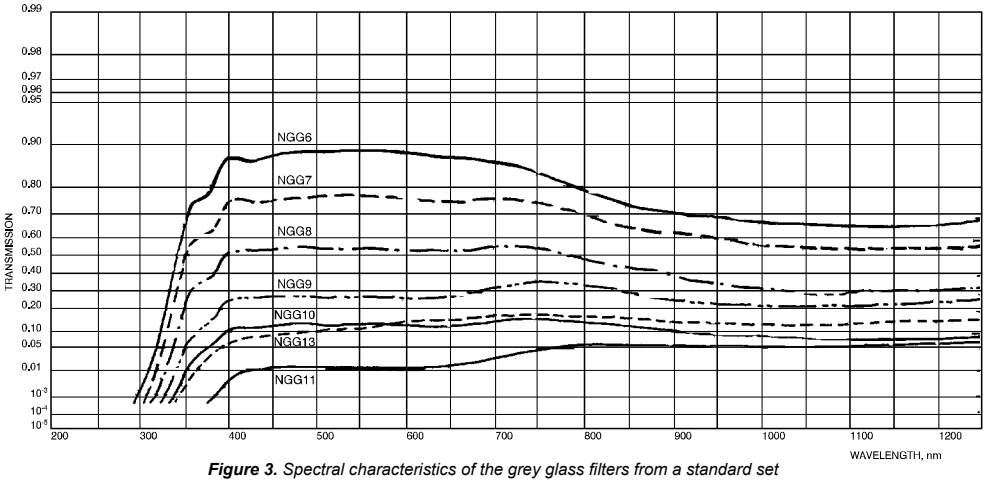


Figure 3. *Spectral characteristics of the grey glass filters from a standard set*

990-0400 FILTERS HOLDER WITH 90° FLIP

990-0415

990-0423

The holder of 1 inch filters **990-0415** allows the fixation of up to 5 filters into 1 inch optics ring holders. The thickness of optical filters (or any other optical elements) to be held is from 0.5 mm to 8.0 mm. Filters can be easily replaced in ring holders. This filter holder allows fast filter removal from beam path flipping it at 90° position. Any position of filters can be fixed with fixing screw. The firm 0° position can be fixed with the second brass screw (included).

The holder of 2 inch filters 990-0423 allows the fixation of up to 3 filters into 2 inch optics ring holders. The thickness of optical filters (or any other optical elements) to be held is from 0.5 mm to 14.0 mm.

The holder 990-0415ND is the same holder 990-0415 but with Neutral Density filters that operates as step energy attenuator and allows adjusting transmission from 100% (all 5 filters are at 90° position) till 0.015% (all 5 filters are at 0° position) at visible region. If you need other adjustment you can choose any other Neutral Density filter Ø25.4 mm.

Using the holder **990-0415** with various color glass or dielectric filters various transmitted band pass regions can be achieved. The Filters Holder with 90° Flip is made of black anodized aluminium and brass screws.

Catalogue number	Acceptable filters number	Suitable filters diameter, mm	Clear aperture diameter, mm	Weight, kg	Price, EUR
990-0415	5	25.4	23	0.16	155
990-0415ND	5	25.4	23	0.19	250
990-0423	3	50.8	48	0.22	145

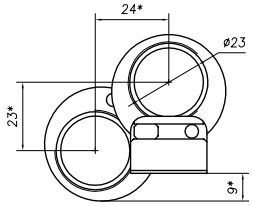
- **Allows stacking of 5 filters of Ø25,4 mm (1"), or 3 filters of Ø50,8 (2")**
- **Fast flipping in and out of beam path**
- **Available to be used in 90° position**
- **Has one M4, two M6 and two holes Ø 6.4mm for mounting on posts or table bases**
- **Large aperture allows to attenuate large diameter laser beam**
- **Black Anodized Aluminium and Brass screws**

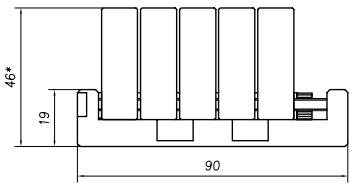
***990-0415** at 0° position*

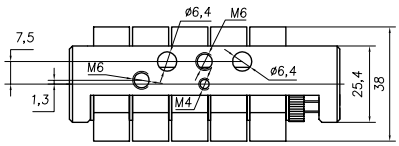
(Note: Solid base height extender 820-0210 should be ordered seperately)

***990-0423** at 0° position*

(Note: Solid base height extender 820-0210 should be ordered seperately)







***990-0415** at 0° or 90° position*

(Note: Solid base height extender 820-0210 should be ordered seperately)

RELATED PRODUCTS

Neutral Density Filters Ø25.4 mm

See page 1.14

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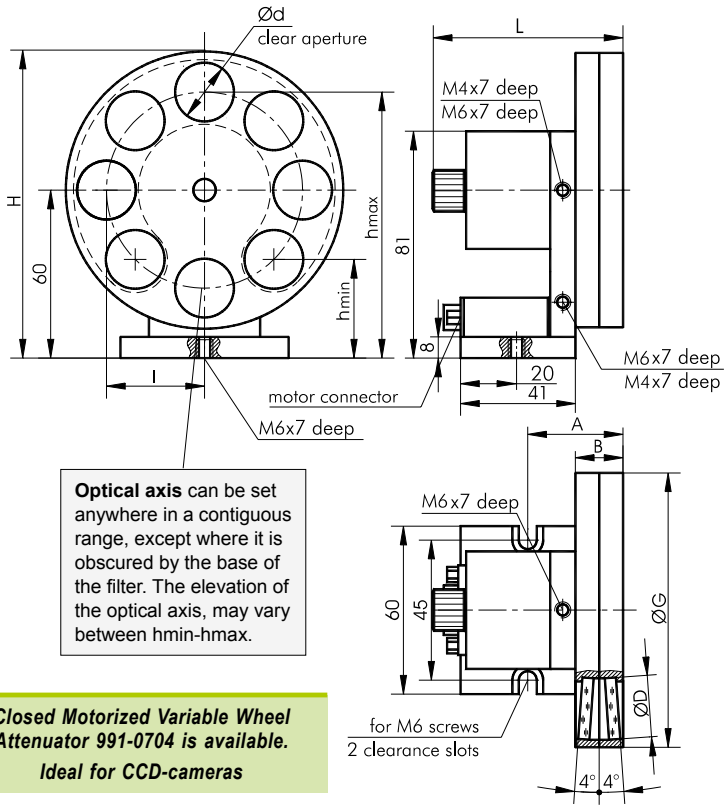
991-0602 MOTORIZED VARIABLE TWO WHEELS ATTENUATORS

991-0602-01

- **Filter diameter – Ø20/Ø25.4 mm**
- **Clear aperture Ø18/Ø23 mm**
- **Non parallel filters (inclined by 4°)**
- **Maximum thickness of filters – 2 mm**
- **Custom design available**



Optical axis can be set anywhere in a contiguous range, except where it is obscured by the base of the filter. The elevation of the optical axis, may vary between hmin-hmax.

Closed Motorized Variable Wheel Attenuator 991-0704 is available.
Ideal for CCD-cameras

Motorized Variable Two Wheel Attenuator 991-0602 consists of two filter wheels. Each wheel contains eight filter mounts of ØD mm with clear aperture Ød mm. Each mount is inclined by 4° to prevent mutual reflections between filters.

We supply the attenuators 991-0602-01 with a standard, most popular, set of filters. *(See the table below.)* Alternatively, optics can be manufactured according individual orders. Or we can supply the attenuators without filters, which you can fit by yourself.

Bring a filter of each wheel into the optical path easily by hand or using automation.

Two wheels are driven by a single step motor. A computer can operate it via a controller. The Step Motor Controller Card 980-0030F-USB / 980-0030-RS232 and Position Control Software come separately.

For fastening, attenuator has clearance slots for M6 and M4 screws. There are also two M6 holes, and one M4 hole (opposite to one of the M6 holes).

Material: black anodized aluminium.

Model	D, mm	d, mm	H, mm	G, mm	A, mm	B, mm	L, mm	h_{min}, mm	h_{max}, mm	l, mm	Price, EUR
991-0602-01	Ø20	Ø18	110	Ø100	35	16.5	73.5	34	97	37	918
991-0602-02	Ø25.4	Ø23	115	Ø110	39	20.5	78	32	99.5	39.5	738

Note:
991-0602-01 is with filters dia 20 mm.

991-0602-02 is without filters. 991-0602-02 is suitable for Neutral Density and Colour Glass Filters Ø25.4 mm that should be ordered seperately.

RELATED PRODUCTS

Neutral Density Filters Ø25.4 mm
See page 1.14

Colour Glass Filters Ø25.4 mm
See page 1.16

Stepper & DC Motor Controller 980-1045
see page 8.183

Standard set filters transmittance

Wheel N1	Wheel N2
1	1
0	0
0.9	0.8
0.5	0.3
0.1	0.03
0.01	0.003
0.001	0.0003
0.0001	0.00003

Stepping motor specifications

Rated Current	0.4 A
Resistance	33 Ω
Inductance	52 mH
Holding torque	0.12 N·m
Step angle	1.8 °
Step angle accuracy	5 minutes
Required electrical powe	5.6 W

Motors of other types are available.

991-0702 MOTORIZED CLOSED VARIABLE TWO WHEELS ATTENUATORS

991-0702-01

Motorized Closed Variable Two Wheel Attenuator 991-0702 consists of two filter wheels. Each wheel contains eight filter mounts of ØD mm with clear aperture of Ød mm. Each mount is inclined by 4 degrees to prevent mutual reflections between filters.

We supply the attenuator 991-0702-01 with a standard, most popular, set of filters. See the table below. Alternatively, optics could be manufactured to individual orders. Or we could supply the attenuator without filters, which you can fit by yourself.

You bring a filter of each wheel into the optical path easily by hand or using automation. The two wheels are driven by a single step motor. A computer can operate it via a controller and Computer Software which come separately.

For fastening, the attenuator has clearance slots for M6 and M4 screws. There are also two M6 holes, and one M4 hole (opposite to one of the M6 holes).

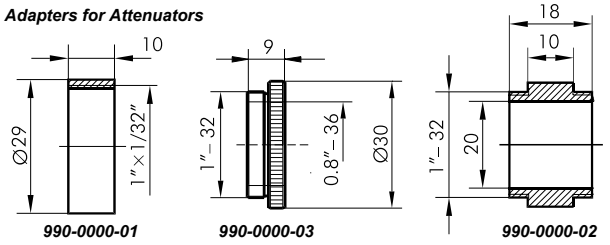
Material: black anodized aluminium.

SPECIFICATIONS

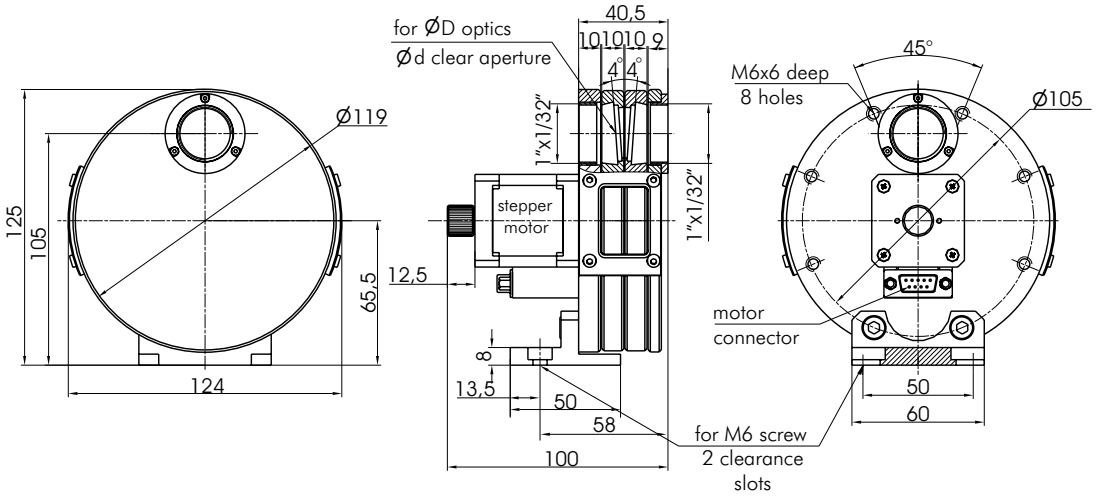
Step angle	1.8°
Step angle accuracy	5 minutes
Required electrical power	5.6 W
Weight	0,75 kg
Motor	4247
Mechanical reference switch	1
Switch polarity	pushed is closed

- **Filter diameter – Ø20/Ø25.4 mm**
- **Clear aperture Ø18/Ø23 mm**
- **Non parallel filters (inclined by 4°)**
- **Maximum thickness of filters – 4 mm**
- **C-mount threads on both ends**

Adapters for Attenuators



990-0000-01 ***990-0000-03*** ***990-0000-02***



Model	D, mm	d, mm	Weight, kg	Price, EUR
991-0702-01	Ø20	Ø18	0.7	1118
991-0702-02	Ø25.4	Ø23	0.75	938

Note:

991-0702-01 is with filters Ø20 mm.

991-0702-02 is without filters. 991-0702-02 is suitable for Neutral Density and Colour Glass Filters Ø25.4 mm that should be ordered seperately.

RELATED PRODUCTS

Neutral Density Filters Ø25.4 mm
See page 1.14

Colour Glass Filters Ø25.4 mm
See page 1.16

Stepper & DC Motor Controller 980-1045
see page 8.183

Standard set filters transmittance

Wheel N1	Wheel N2
1	1
0	0
0.9	0.8
0.5	0.3
0.1	0.03
0.01	0.003
0.001	0.0003
0.0001	0.00003

Stepping motor specifications

Rated Current	0.4 A
Resistance	33 Ω
Inductance	52 mH
Holding torque	0.12 N·m
Step angle	1.8 °
Step angle accuracy	5 minutes
Required electrical powe	5.6 W

Motors of other types are available.

COMPUTER SOFTWARE FOR MOTORIZED ATTENUATORS

- **Control of single stepper motor with two wheels and up to 8 filters in every wheel**
- **Three different transmittance tables can be configured for three different wavelengths**
- **Operation in transmittance and optical density modes**
- **Program can choose the best combination for required transmittance or optical density, or filters defined by user can be set**
- **Different speed and step division options**

Computer Software is designed to control motorized attenuator unit with our stepper motor controller 980-0045-USB (page 8.183).

Motorized attenuator together with program can be applied in all kinds of optical circuitry where variable transmittance has to be achieved.

Program allows to change easily transmittance or optical density of an attenuator **991-0602** and **991-0702**. Just enter transmittance or optical density values, and the program will select the closest two filters. Or you can select the filters directly.

The simple interface allows to use the program right away. For each of the three different wavelengths it stores a set of filter transmittance values, which a user can modify. "**Density/Transmittance**" button switches between these modes at any time.

All system configuration information and current state of an attenuator is stored in a file and is automatically reloaded after the program starts.

Any of our software works only with our controllers.

Standard set filters transmittance

Wheel N1	Wheel N2
1	1
0	0
0.9	0.8
0.5	0.3
0.1	0.03
0.01	0.003
0.001	0.0003
0.0001	0.00003

REQUIREMENTS

PC compatible computer with any minimal Windows 95/98/ME/2000/XP installation
Display
Step Motor Controllers

Stepper Motor Controlers for MOTORIZED VARIABLE TWO WHEELS ATTENUATORS

*Motorized Variable Two Wheels Attenuator **991-0602***
see page 7.34

*Stepper & DC Motor Controllers **980-0045-USB***
see page 8.183

*Motorized Closed Variable Two Wheels Attenuators **991-0702***
see page 7.35