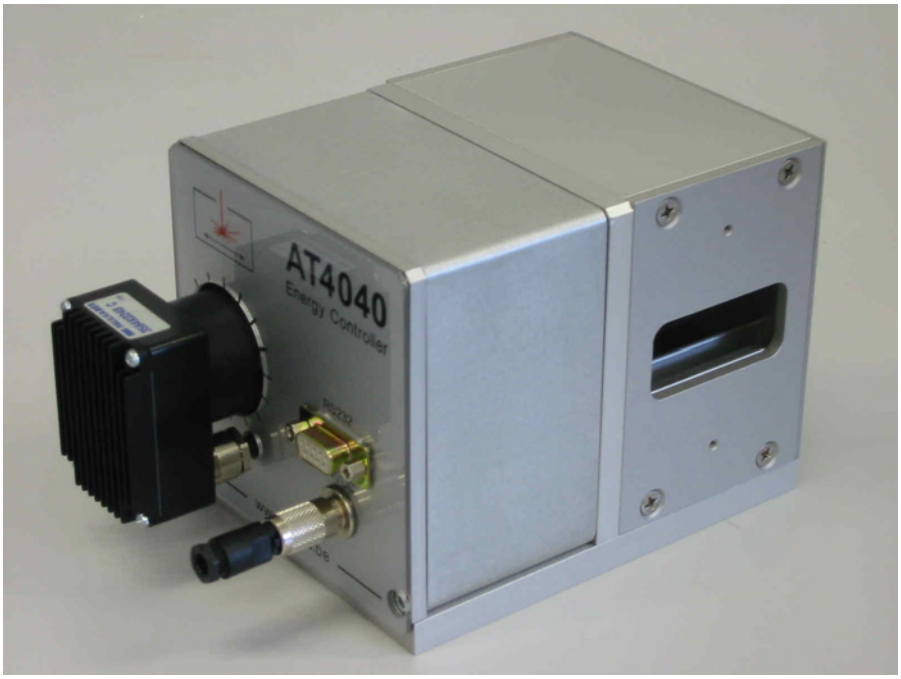
AT4040 Energy Controller

-USER INTRUCTIONS-

Optec AT4040 is a programmable laser beam attenuator controlled by RS232, particularly suitable for use with high power excimer lasers. For those lasers, internal control over o/p energy from within the laser source generally has an unwanted side-effect on beam profile. AT4040 can also be used with Nd-YAG lasers including harmonics.



The fundamental principle of the AT4040 is the shift in cut-off wavelength which occurs when a multilayer dielectric high-pass edge filter is tilted w.r.t. the beam. Fig.1. The shift is towards a lower cut-off wavelength, and the coating is made so that the highest transmission, approx. 95%, occurs with the attenuator plate perpendicular to the beam (0° position); %T reduces progressively with tilt angle in a non-linear fashion, (Fig. 2) to a low value typically <5% at 45° tilt. The exact angular relation of %T depends on the individual coating run, and the device must be recalibrated if the attenuator plate is changed.

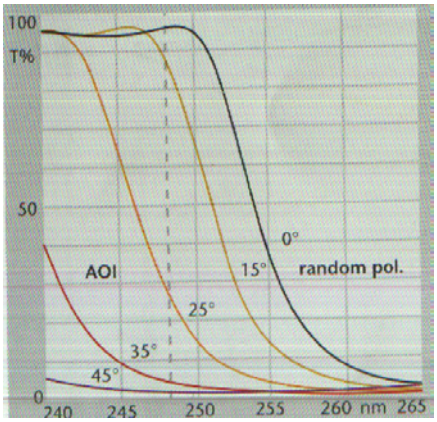


Fig.1

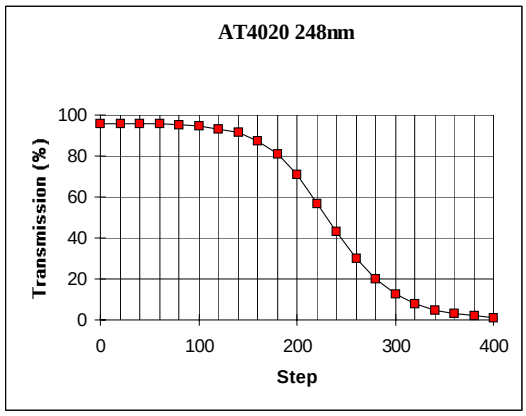


Fig.2

The part of the beam which is not transmitted is reflected, at twice the tilt angle, or 90° for minimum transmission. In the AT4040 this reflected component is scattered/absorbed in a light trap/heat sink surrounding the optics.

The attenuator element is a fused silica plate 65x30x2mm, for use at wavelengths down to <200nm, whilst the dielectric coating is MIL spec, with damage threshold on the order of 1J/cm². The reverse side of the plate is AR coated at the operating wavelength for maximum peak %T. Note that, as with all such optical components, the orientation of the plate in the beam(i.e. filter coating towards or away from the beam) make no difference to overall transmission.(See stability) Attenuator plates are specific to a particular wavelength and cannot be used at other wavelengths.

The tilt of the 2mm thick attenuator plate produces a lateral beam shift by double refraction. That shift is compensated by a second FS plate with AR/AR coating; the plates are geared together to tilt at equal/opposite angles,-Fig.3. The order of the two plates(i.e. which is encountered first by the beam) makes no difference to overall transmission of the combination. However, it is generally desirable to place the attenuator plate in the downstream position in AT4040, since the reflected component is thus more efficiently intercepted by the light trap heat sink at low tilt angle.

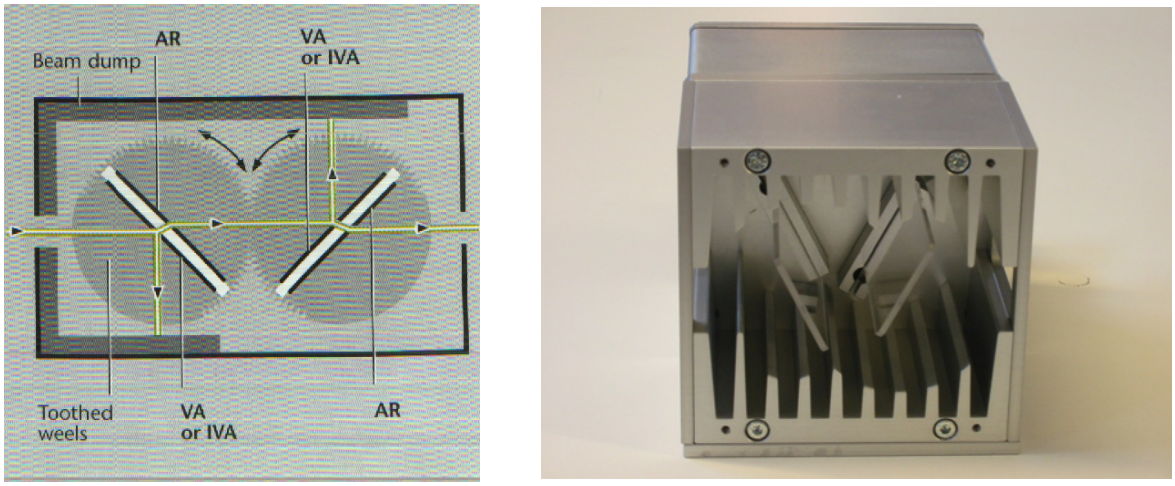
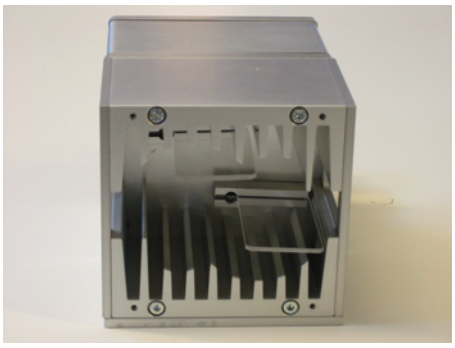


Fig.3

The gearing on the AT4040 is 8:1, so that one complete turn = 45° plate tilt. The internal dc servo motor is used like a stepping motor and has 750 steps/turn. The motor is controlled by the specific software through RS232 port.

The AT4040 incorporates an ‘open gate’’ feature, whereby the plates can be removed entirely from the beam path for 100% transmission.



Access to the Optics

- Remove rear light trap cover,- 4xM3 screws.

- Remove light trap complete,- 4x M4 screws with heads embedded in heat sink extrusion, normally hidden by rear cover. **Take care** when the screws are released to withdraw the heat sink squarely, without contacting the optics.

- Check condition of optical plates,- clean as necessary. **CAUTION** - dust on optics can cause irreversible damage when irradiated with a high energy laser beam.

- Check that the attenuator plate, marked VA on corner, is preferably in the downstream position w.r.t. the laser beam.

- Check the tilting mechanism. It should be possible to tilt the plates from the 0° position, to the 45° position. In either position, on further tilting beyond this range the 'click' of the limit switch will be heard. **DO NOT** force the mechanism beyond these limits.

- In the O° position, the plates should be parallel, and the control knob aligned with the zero indication on the control dial.

- If all is correct, replace and fix the light trap to protect the optics from accidental damage. Do not replace the rear cover yet if control/calibration checks have to be carried out.

Stability

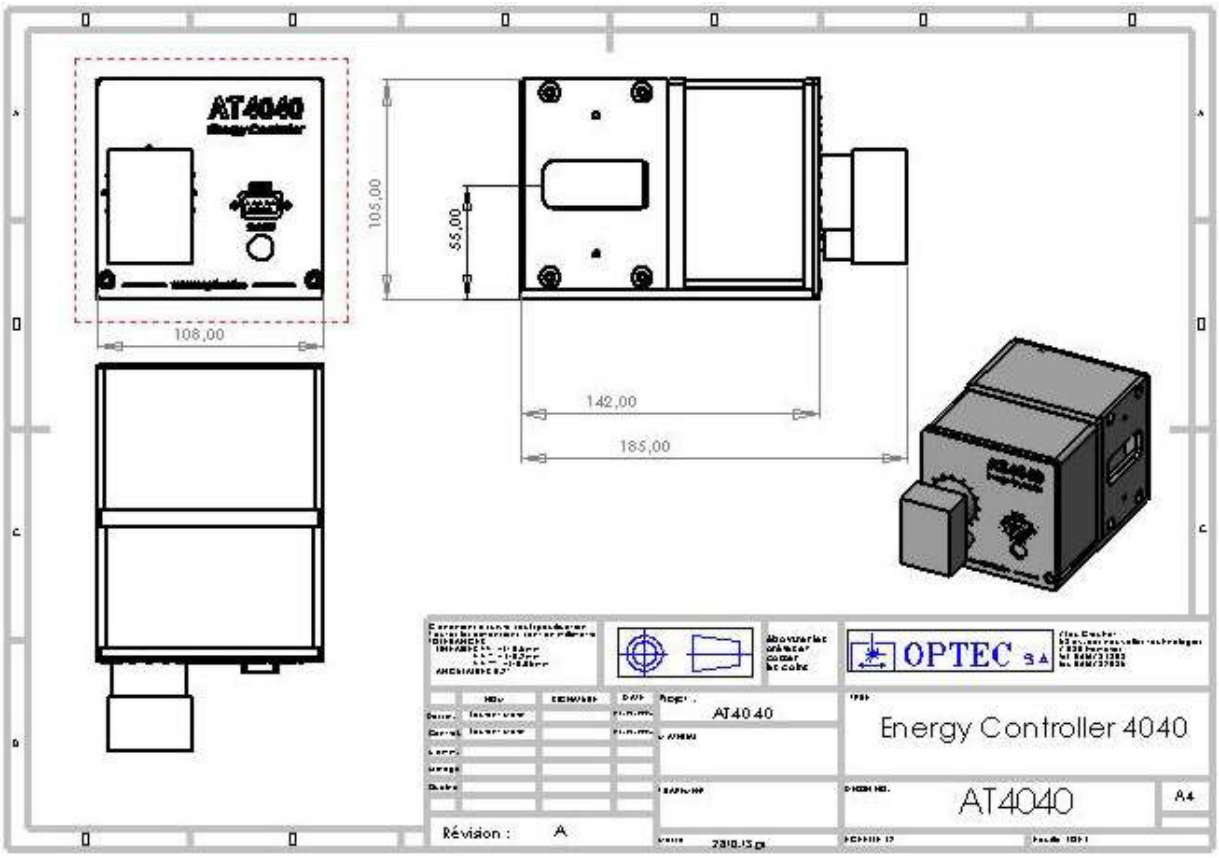
The attenuation of the edge filter depends on interference effects within the dielectric stack, which in turn depend on the refractive index and thickness of each layer. Both index and thickness are temperature-dependent, whilst the temperature of the plate can increase at high powers, depending on the %T setting, since a part of the heating mechanism is due to absorption of a small fraction of the transmitted beam in the FS. Thus at low %T values the effect can be minimized by having the filter coating towards the beam, so that the(large) reflected component light does not need to traverse the FS plate twice.

However this effect is commonly masked by a bigger effect due to temp/humidity. The dielectric layers are porous on a microscopic scale, so that moisture can accumulate in the pores, resulting in a reversible shift in cut-off wavelength as water vapour is driven off or reabsorbed after use. The steep slope of the %T-wavelength curve means that observable effects on %T can be produced, though it is virtually impossible to quantify the effect in any particular case since it depends on both environment and irradiation parameters, including duty cycle. Where temp./humidity effects are thought to be important the calibration procedure should be carried out after a typical warm-up period, or operated with dry N2 flush.

In other specific cases, a 'reverse attenuator' plate may be considered. Although with a somewhat more limited attenuation range, those elements, based on a low-pass filter, have denser oxide layers in the stack, and thus are less prone to the humidity effect. High %T is given with the plate tilted at 45°, whilst low %T results with the plate nearly normal to the beam. This means the light trap/heat sink is inefficient, and damage to external components, or potential injury to operators, could result from a high energy beam reflected from the AT4040. For that reason, the option is not fitted as standard..

Attenuation ratio depends principally on the tilt angle of the filter coating. Note that dust particles burnt by high power laser irradiation may present either opaque on clear spots in the coating. If the total projected area of those damaged zones becomes appreciable there will be a measurable and irreversible shift in the attenuation curve, and the device should be recalibrated.

External Dimensions



Software Installation

Insert the CD-ROM into the CD reader and run *setup.exe, f*ollowing the instructions.

Remark : The recommended screen resolution is 1024x768. Cosmetic problems may appear if other screen resolution is used.

1. Connect the AT4040 to the RS232 port (selected in the INI file) of the control PC using a pin to pin Sub-D9 cable male –female(supplied).

2. Connect the AT4040 to 24Vdc power supply with the 2-pin connector. Voltage : 80-250Vac, 50/60Hz, 30W.

3. Switch on and boot the computer.

4. Switch on the Power Supply. Check for red LED light (24Vdc present).

5. Start the program by clicking on the appropriate icon.

After clicking on the desktop icon, the following window appears. Click OK to continue.

The software will first start an auto-test procedure for detection of possible hardware problems, then begins the homing procedure of the AT4040. If there is any hardware error, messages prompting the possible problems will appear in the window.

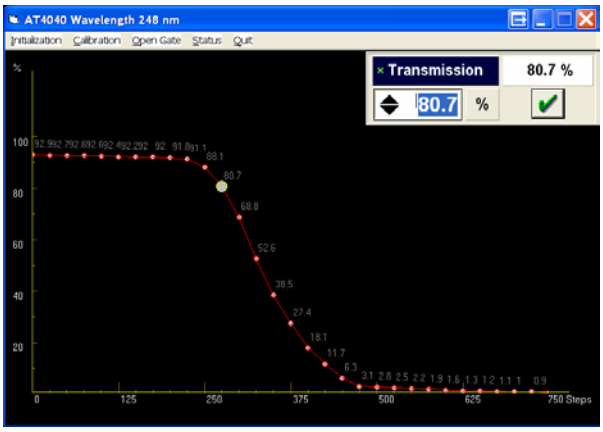
Status : The hex address of the parallel port is incorrectly set in the .INI file. Check for info about the computer and set the correct value (see annexe).

Serial Cable : No cable connected between the computer and the AT4040.

Interface Power: If the neon lamp next to the power plug is not on either no mains power is present or the mains fuse is blown. If the red LED next to the 7 pins connector is not lit, either the 5Vdc power supply is out or the protection fuse is blown. Act accordingly.

Interface : Check the integrity of the parallel port with Windows utilities

Operation



When everything is OK, and homing procedure complete, the main control window appears.

The window title indicates the current wavelength (setting in .INI file), meaning that the corresponding calibration file has been loaded and the data will be used to set the attenuator at the desired transmission.

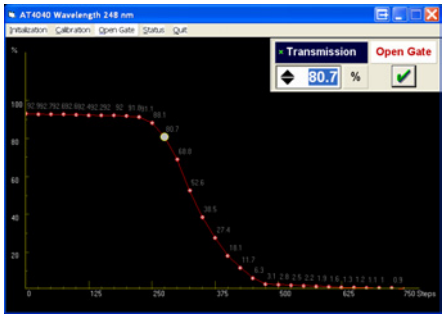
The graphic displays the current calibration curve, %T versus motor steps. Dots represent calibration measurements; the larger dot is the current setting.

To change the transmission, step up/down or type in the new setting in the RQ window and click on the green tag. Requested transmission beyond the useful range will highlight in red.

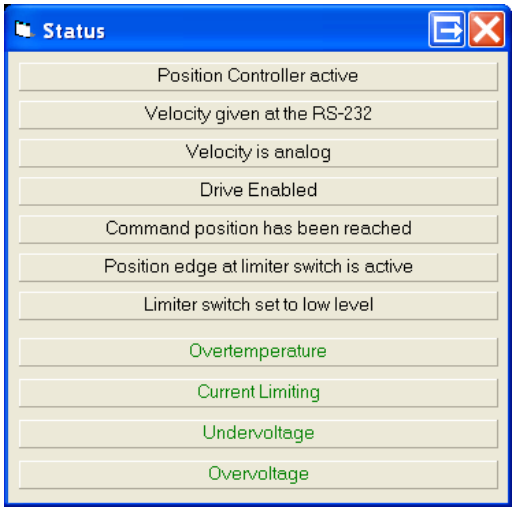
Initialization : Performs a homing procedure, with default transmission ratio set to minimum value.

Calibration : Allows tuning & calibration of the AT4040 (see below).

Open Gate : Removes optics completely from the beam path for 100% transmission.



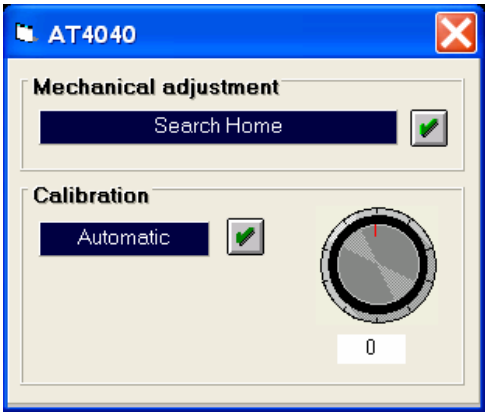
Status : Displays current status of the controller (for troubleshooting).



Quit : Exit the program.

Tuning & Calibration

- Click on **Calibration**, this window will appear.



- Select **Mechanical Adjustment,** the AT4040 will seek and stop against the designated home limit contact and offset to maximum transmission. Check that both plate are in vertical position

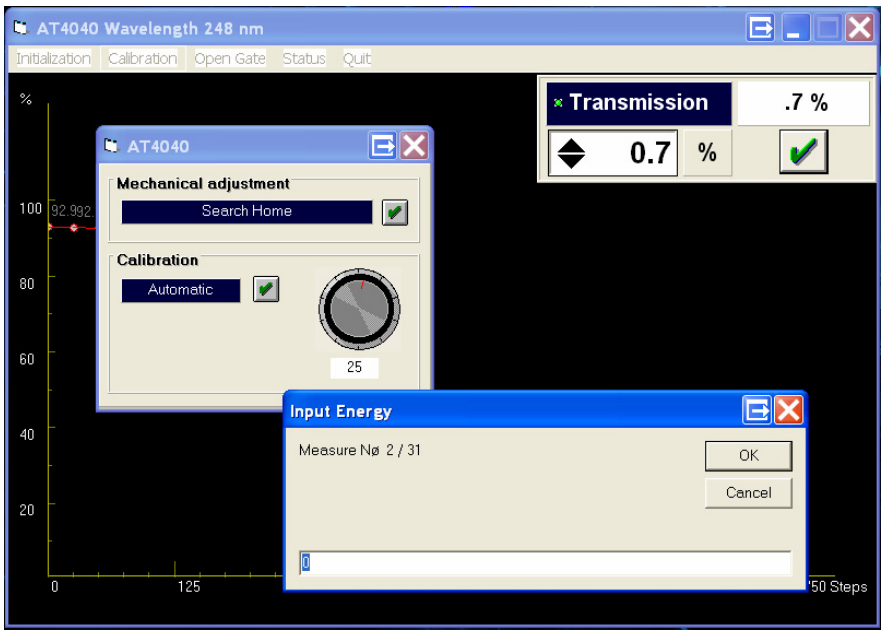
- N.B. During **Initialization** the AT4040 first moves to home contact, corrects offset to 0°AOI position, then moves to the defined default position which is minimum transmission 45°AOI

- For **Calibration**, an energy meter will be required. The energy meter should be capable of measuring relative energy values in the range of interest to sufficient precision, absolute values are not required.

- Care should be taken about the geometrical set-up used to measure AT4040 transmission to ensure that energy is not lost by geometrical effects. A defining aperture not larger than approx. 20mm dia., or 15x30mm rectangle, should be placed in the laser beam just upstream of the AT4040 position. Check that the beam defined by this aperture falls centrally in the AT4040 i/p aperture, and exits cleanly at the o/p without loss of energy. Place the energy meter a short distance downstream of the AT4040. Check the minimum and maximum values of energy/power to be measured (5-100%) fall within the range of measurement, and that repetition rate is set at an appropriate low value (see temp. effects in stability). **(WEAR SAFETY EYEWARE)**

- Ensure that laser emission is stable. Click on **Automatic**. After initialization, measure the energy delivered by the laser. At that stage the AT4040 is in Open Gate configuration. Enter this value in the window.

- Click on OK, the AT4040 is now set to maximum transmission AOI 0°. Proceed with the energy measurements as requested; values entered in the field are automatically converted to %T values.



- When the message **Calibration Successful** appears click on OK to save new data in the ATT.nnn file in c :\at4040\ (nnn = wavelength in nm). Previous data are saved in a .bak file.

- Data in ATT.nnn can always be edited using a text editor.

Step Position	Transmission (%)
0	94.70
25	94.30
50	92.80
75	91.50
100	90.70
125	89.45

.INI File

AT4040.INI file is located in the directory c:\program Files\at4040\

AT4040.INI

```
[DATA]
Wavelength=248          'Working Wavelength
HomeSpeed=50
NormalSpeed=60
WaitTime=1000000        'Serial port timeout (in ms)
CommPort=1              'RS232 port number
```