Penta ht optics

Application Note **Penta** ht optics Collimating Lenses

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General

Since 1985, in Philips plastic aspherical collimating lenses have been manufactured, primarily for use in CD and later DVD and BluRay optical storage systems. From these lenses general purpose collimation lenses for laser diode have been derived. In this way, users of these lenses benefit of the well designed and rigorous quality approach needed for a mass manufactured product. Because of the High Quality / Low-Cost necessity, the manufacturing method of choice has been injection molding of optical plastic in high precision molds with optical finish. With this approach an exceptionally high degree of uniformity is created between lenses of one delivery batch.
Over time, many millions of these lenses have found there way to the respective users, in Optical Storage industries, Barcode scanning, Laser pointing and many other applications. Since 2008, the manufacturing lines for these lenses were brought outside of Philips with **Penta** ht optics being responsible for worldwide sales of the collimation lenses.

Lenstypes and Specifications

	CAY033/40	CAY046	CAY046/55	CAW100
Outer diameter D [mm]	4.0	7.4	5.50	5.20
Thickness lens h [mm]	3.00	3,05	3.05	2.44
N.A.	.354	.373	.347	.192
Clear Aperture CA [mm]	2.5	3.9	3.2	3.9
Design Wavelength [nm]	**670**	**670**	**670**	**785**
Effective Focal Length EFL [mm]	3.30	4.60	4.60	9.85
Back Focal Length BFL [mm]	2.08	3.18	3.18	8.40
Free Working Distance FWD [mm]	1.97	3.08	2.98	8.30
RMS Wavefront [ml] *on axis*	40	40	40	40
total	65	70	70	50
Storage Temperature [°C]	-25 to 90	-25 to 90	-25 to 90	-25 to 100
Operating Temp. [°C]	5 to 75	5 to 75	5 to 75	-10 to 85

Table 1: Lenstypes and Specifications

All lenses are 100% Rohs compliant and fulfill all requirements under REACH.

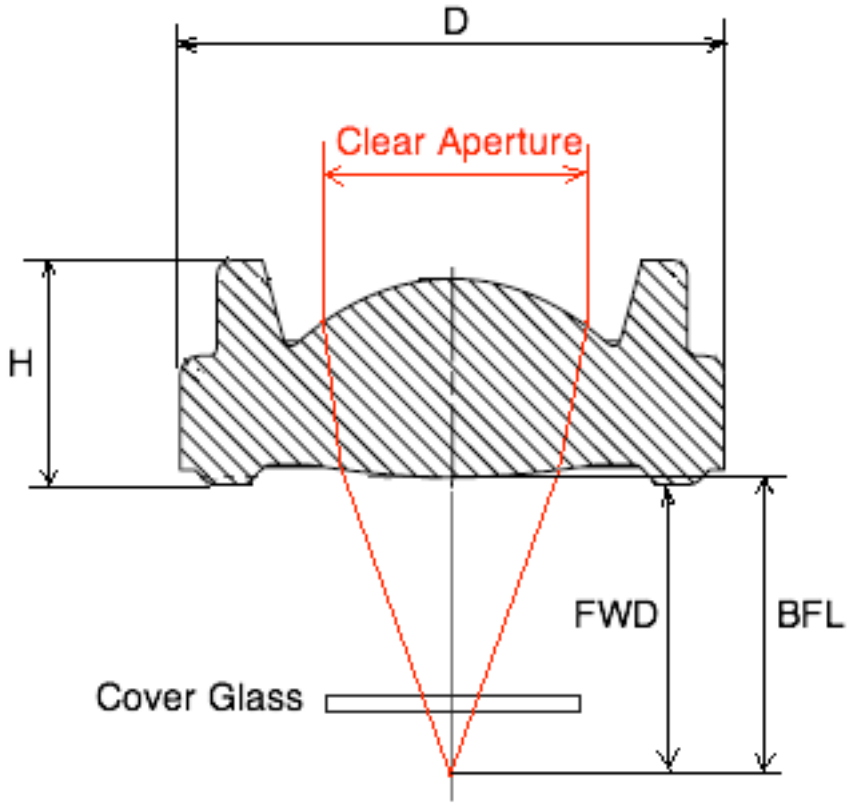

Fig. 1 Lens-Laser layout.

The design with its aspherical corrections is optimized for 670 nm, but the lenses can be used in a wide variety of wavelengths from 400 to 950 nm. Within this whole spectrum the aberrations will be lower than the specified limit. Take care that the BFL changes when the lens is used at another wavelength. Consult us for the right value.
The laser cover glass considered in the design is 0.25 mm BK7, distance 0.55 mm from the laser. In case no cover glass, or another glass type and/or thickness is used, the BFL will change accordingly. When this is taken into account when focusing the lens, this will not harm the function of the lens. Consult us in case of doubt.

The diameter D is the mechanical outside diameter of the lens and should be used for axial reference of the lens toward the laser beam. Please note that the lens type CAY033/40 has a gate protrusion, outside this diameter D.

The design in Zemax (as .ZMX file) and the drawing for opto-mechanical in-design can be made available on request.

The stated focal length is a nominal value and delivered parts typically will show a variation of the focal length of ± 50 micron.

Environmental specifications. Lenses have been tested under various conditions and been found to be stable under storage conditions in general from -25 C to 90 C. Tests have been done under IEC 60068-2. Apart from abrasion resistance all tests are passed. For abrasion resistance the nature of the plastic poses limitations: this is a relatively soft

material and should be cleaned with non-mechanical means, like cleaning by blowing antistatic air or in an ultra-sonic fluid bath.

Manufacturing and Packaging

The lenses are manufactured under clean room conditions on precision injection molding machines. Also, necessary secondary operations and packaging is done under clean room conditions, class 100k. Materials used are optical plastics of renowned manufacturers, guaranteeing the index of refraction of the material within strict tolerances.
Parts are manufactured in large series of 20.000 lenses minimum and the quality is monitored with Statistical Process Control. Under SPC are: EFL and RMS wave front aberrations. This will guarantee the quality of the spot shape as well as the size. Wavefront is tested on an interferometer.

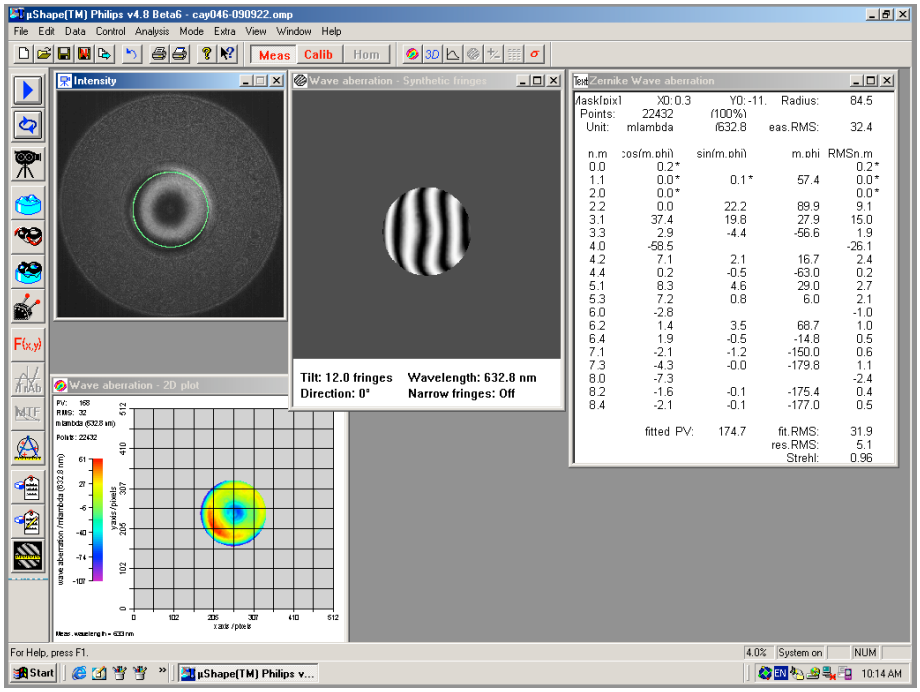

Fig. 2 Interferometric measurement of lenses

For transport package the choice is a tray or stick. For the CAY033/40 and CAW100 only tray is available. The number of lenses in the smallest packaging unit is given in the table below. So, orders are best issued in multiples thereof, with a minimum of 1,000 pcs. In case this rule is not possible, additional cost may occur.

	CAY033/40	CAY046	CAY046/55	CAW100
Number of lenses per tray	180	130	180	266
Number of lenses per stick	NA	60	250	NA

Table2: Number of lenses per package

Fig 3: Transport package possibilities for CAY046/55 are stick (on top) and tray

Temperature Behavior

As our lenses are manufactured from plastic, they show different material characteristics as compared to glass. One of these characteristics is the change of the index of refraction with the temperature. This coefficient is called dn/dT and has a value of $-1x10^{-4}$ (or -0,0001) /°C. Which means that an n=1.531 would decrease to 1.530 with a temperature increase of 10 °C. Needless to say, that this effect must be taken into consideration when doing a design with plastic optics. The designer must make sure that the spot size is still within the limits at lowest and highest use temperature.
It helps when the index used for the design is corrected for this effect and has the value of the center temperature of the use temperature window. Eg. in an application which is used from 10-60 °C, recalculate the value of n to 35 °C.
Refocusing after temperature change also takes away the problem. When plastic lenses are used in an Autofocus system the problem virtually disappears.

The maximum storage temperature is the temperature until which all changes in the material are fully reversible: essentially the characteristics of the lens fully return to the original, when temperature is restored to original.
One can also consider this as the maximum use temperature, as long as the index change influence is verified.

Anti-Reflex Coating

As an option the lenses can be coated to minimize reflections on the surfaces: the so-called AR-coating. This coating is a stack of dielectric layers on the surface of the lens. The working of the coating is wavelength dependent, so we specify the coating at a certain wavelength. Coatings are available for 420, 650 and 800 nm design wavelength.
Note from fig. 3 that the coating has wider use, depending the type of coating and the wavelength range.

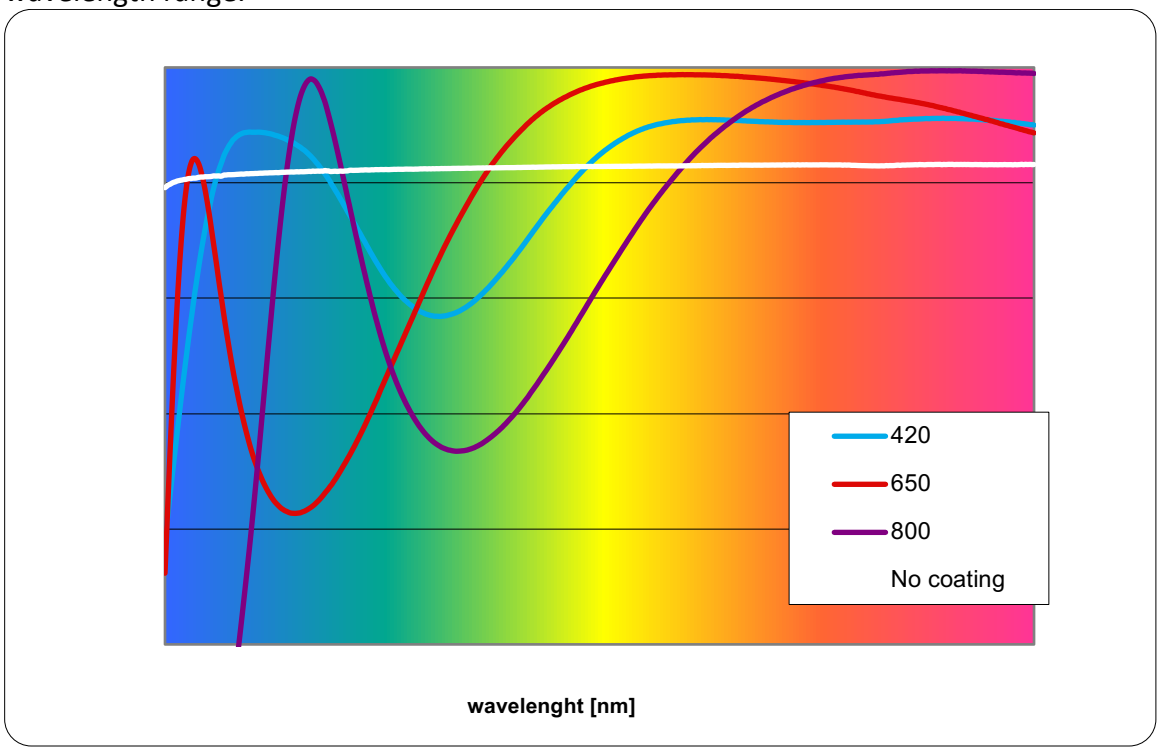

Fig. 3 Transmission of a 1.2 mm thick plastic disk, AR coated two sides, angle of incidence 90 degrees.

Ordering a coated lens means specifying the wavelength for which the coating is designed: the value is added behind the type of the lens. In this way the CAW100 becomes CAW100C800, when coated for 800 nm.

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Mounting instructions

It is advisable that the lens is focused with the laser before the distance is fixed in the assembly. Due to lens tolerances and other tolerances in the system a focusing option of ± 70 micron towards the nominal calculated value is advisable.
The preferred way of mounting is to glue the lens into a non-reinforced plastic housing. There are two reasons for that:

1. The expansion of the plastic housing is the same as the lens, which prevents stress build-up at elevated temperatures. Which occur with a metal housing.
2. Mechanical lock also can introduce stress in the lens.

UV curing glue is a good option. When heat-curing glue is used, observe the maximum temperatures of 90 and 100 degrees respectively.
Make sure that the gate vestige of the lens CAY033/40 is allowed for in the housing.
In general, the gate position can be used for orientation of the lens in the application.

To prevent stray light and halo-effects around the spot it is advisable to use an iris (diaphragm) between laser and lens, preventing rays hitting the lens outside the clear aperture.

FAQ

1. What is the meaning of CAY or CAW?
   Collimator-Aspheric-Type of plastic indicator (W or Y).

2. Can the lens be used for other purposes than collimation of a laser?
   Yes, although the aspherical optimization will be lost

3. Can the lens be used up-side down?
   Yes, but the aberration correction will not be optical anymore and the working distance changes.

4. Can the mechanical shape of the lens be changed for making the lens fit into our application?
   Yes, at the cost of so-called customization of the lens: we will make a special version of the lens fully adapted to your needs. Tool costs will be charged.

5. Does the lens get cheaper when we only order one side coated?
   Basically coating is two-sided.

6. Where is more information obtainable?
   Mail to: penta@me.com
   Visit: www.pentaoptics.com