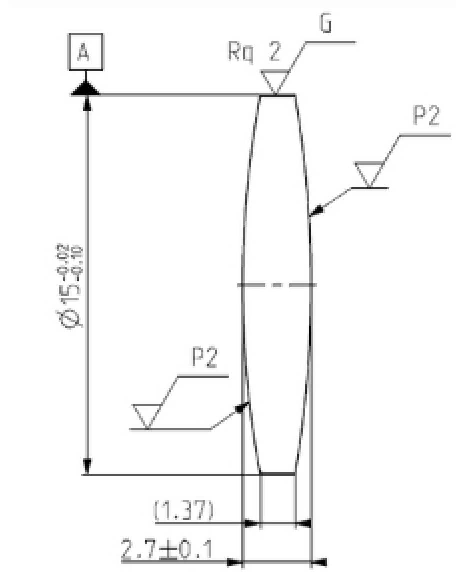
How To Read An Optics Production Drawing

The most commonly used standard for optics manufacturing is ISO 10110, which was first created in 1927. Below we will describe some of the key parameters called out in the standard.

The image below is of a typical lens drawing.

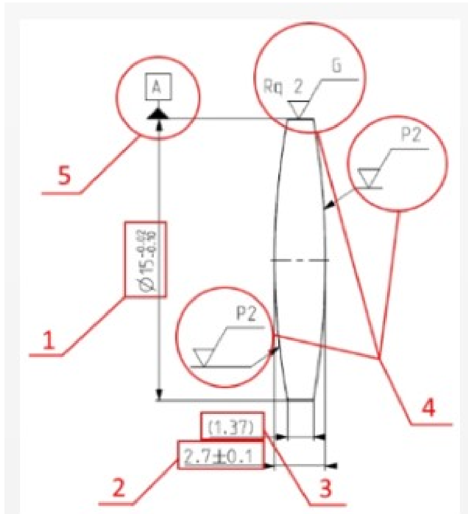


LEFT SURFACE	MATERIAL	RIGHT SURFACE
R 41.0129 CX	GLASS: S-PHM52	R 44.7075 CX
Øe 13±0.1	Nd=1.618000±0.001	Øe 13±0.1
CHAMFER: 0.1-0.2	Vd=63.33±0.5	CHAMFER: 0.1-0.2
(λ) ARC R<0.5% for 1050-1400 nm		(λ) ARC R<0.5% for 1050-1400 nm
3/ 5.0 (1.00) @ 0.6328 µm	0/ 10	3/ 5.0 (1.00) @ 0.6328 µm
4/ 6'	1/ 5x0.1	4/ 6'
5/ 5x0.3; L3x0.004	2/ 1:2	5/ 5x0.3; L3x0.004
6/ -		6/ -

The drawing can be divided into two areas – **Drawing Area** and **Table of Parameters**.

Drawing area

Let’s review the drawing area of the biconvex lens seen above.



You can see a set of numbered parameters and conventional signs which are described below.

1. Lens diameter – full lens diameter.
2. Lens thickness – thickness of a lens along axis of the base surface.
3. Lens edge thickness. This parameter is given for reference. Its value depends on set of defined (with tolerances) parameters.
4. Surface texture – composite conventional sign with set of parameters which defines quality of surface processing.
5. Datum surface – surface which define datum axis of the lens. It is possible to see more than one datum surface on different drawings

Table of parameters area

Table of lens parameters is divided into columns.

LEFT SURFACE	MATERIAL	RIGHT SURFACE
R 41.0129 CX	GLASS: S-PHM52	R 44.7075 CX
Øe 13±0.1	Nd=1.618000±0.001	Øe 13±0.1
CHAMFER: 0.1-0.2	Vd=63.33±0.5	CHAMFER: 0.1-0.2
(λ) ARC R<0.5% for 1050-1400 nm		(λ) ARC R<0.5% for 1050-1400 nm
3/ 5.0 (1.00) @ 0.6328 μm	0/ 10	3/ 5.0 (1.00) @ 0.6328 μm
4/ 6'	1/ 5x0.1	4/ 6'
5/ 5x0.3; L3x0.004	2/ 1;2	5/ 5x0.3; L3x0.004
6/ -		6/ -

We can see two columns with requirements for the surface and one column with requirements for the optical element material in example drawing.

Column with surface parameters

	LEFT SURFACE
1	R 41.0129 CX
2	Øe 13±0.1
3	CHAMFER: 0.1-0.2
4	(λ) ARC R<0.5% for 1050-1400 nm
5	3/ 5.0 (1.00) @ 0.6328 µm
6	4/ 6'
7	5/ 5x0.3; L3x0.004
8	6/ -

1. Radius of curvature value. Convex (CX) or concave (CC).
2. Effective (clear) diameter – diameter is meant for light propagation. An optical coating is overlaid only in border of effective diameter.
3. Protective bevel.
4. Optical coating of the surface – should be meant working wavelength or set of wavelength or spectral range and coefficient of transmitting efficiency in percent.
5. Tolerances on surface form (figure error). First number is the power difference in fringes. Second number (in brackets) is irregularity in fringes. Also wavelength for measurements should be defined.
6. Centering – tilt angle of a surface defined as angle between the datum axis and the surface normal. Units – angle minutes and angle seconds.
7. Scratch and dig specifications – there is defined all possible surface imperfections.
8. Damage threshold of laser irradiation. Generally speaking, this parameter is critical for optical elements which work with high power laser irradiation. This is why this cell often is empty.

Column with material requirements

Column with material requirements is placed between columns with surface parameters.

	MATERIAL
1	GLASS: S-PHM52
2	Nd=1.618000±0.001
3	Vd=63.33±0.5
4	0/ 10
5	1/ 5x0.1
6	2/ 1;2

It includes the following items.

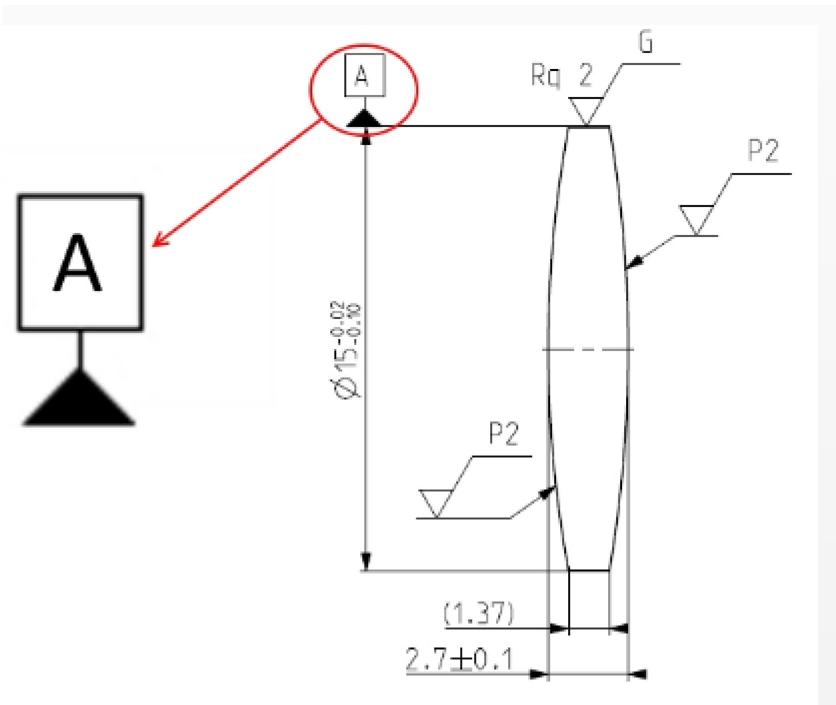
1. Optical material Name.
2. Refractive Index.
3. Abbe Number.
4. Stress Birefringence – defines maximum allowable stress in nm/cm of optical path length.
5. Bubbles and Inclusions – defines number and size of bubbles and inclusions in the optical element.
6. Inhomogeneity and Striae – defines homogeneity class number and striae class number.

All requirements and properties of optical elements are defined by optical and mechanical engineers in the course of preparing an optical design.

Even with a published standard there can be confusion and different interpretations, so a best practice is to check with your lens manufacturer about their definitions and questions. For more information, one of the best and most complete online documents to understand this subject is available here.

Datum Surface In Optical Drawings

The datum surface symbol looks like black triangle with letter inside square near triangle apex (see image below).



The key function of the **datum surface** is to define "reference point" for all other geometrical requirements for the lens (or for another mechanical or optical element which was drawn on the drawing).

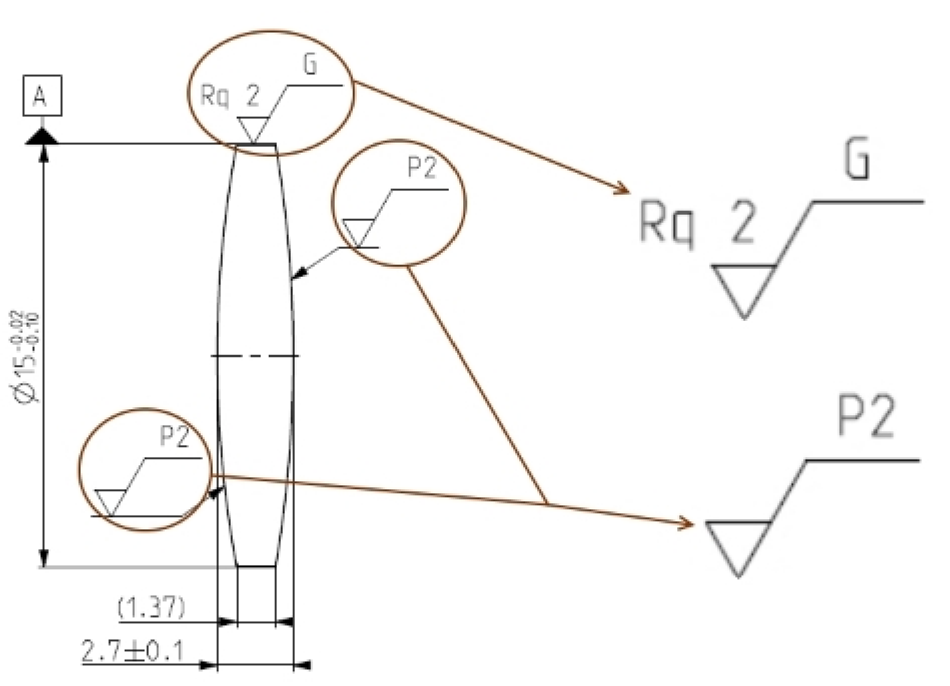
In the drawing above the front face and back face of the lens are spherical surfaces. The side face is cylindrical surface. The axis of cylinder formation is datum axis. All other geometrical requirements are defined relative to this datum axis. In our case this is centering of the surfaces (see "How To Read An Optics Production Drawing" - "Table of parameters area" - "Column with surface parameters").

There are many ways of defining of the **datum surfaces** - on spherical surface, on chamfer surface, many more complex variants are possible. Only optical engineer in cooperation with mechanical engineer can estimate requirements for optical system or optical element and define the right method of datum surface assignment.

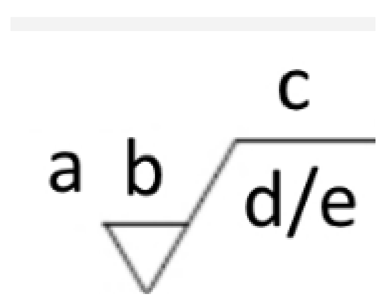
Using the wrong **datum surface** can impact the cost of the optical element production and on optical system quality. So we advise you to check your drawings definitions with your lenses producer.

Surface Texture Requirement In Optical Drawings

In the example drawing below you can see three marks related to **surface texture**. Two identical marks for the front face and back face. And one for side face.



The ISO standard allows to define this parameter more exactly. In many cases this is level of detail may not be required, but in some applications **surface texture** is crucial. Look at the picture below.



The meaning of these letters is as follows:

a is type of roughness measurement. Possible conventional signs are Rq (Root mean square (RMS) height variance) and PSD (Power spectral density (PSD) of surface height).

b is the value of Rq or PSD. Unit of measurement is micrometer (µm).

c is the method and level of the surface treatment. Possible conventional signs are G, P1, P2, P3, P4. Ground method is used if matte surface needed. P1, P2, P3, P4 methods are used for getting of polished surfaces. P level defines quality of polishing. These levels are described in the table.

Level of the polishing	Number of the defects	Approximate roughness (in nm)
P1	80 < N < 400	< 8
P2	16 < N < 80	< 4
P3	3 < N < 16	< 2
P4	N < 3	< 1

d\e parameter defines conditions for surface sampling. **d** is the value of minimum resolution for scanning of the profile surface. **e** is the value of the scan length. Here it is necessary be very careful with units of measurement. As opposed to Rq and PSD values which are measured in micrometer these values are measured in millimeters (mm).

A best practice is to ensure you and your production vendor are using the same definitions related to lens quality.