



How to Use Liquid Lens Zemax Models

Overview

This document provides some tips on how to use Corning® Varioptic® Lens models in Zemax® OpticStudio® software.

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1. General Presentation

A typical Zemax model of an adjustable lens is composed of six surfaces, namely the two glass windows (shown below: a Schott glass D263T eco, Surface 3 and 7), the conductive phase (Surface 4), the oil phase in the conical part of the liquid lens (Surface 5) and the oil phase in the cylindrical part (Surface 6).

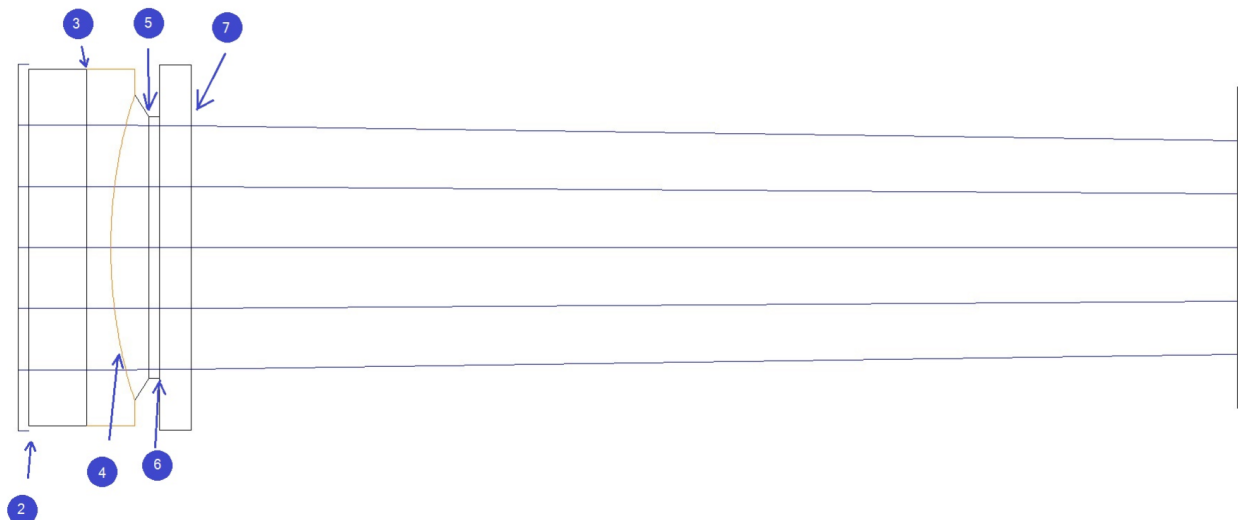


Figure 1

Corning uses ZPL macros to fully describe the liquid lens behavior as function of voltage.

This is achieved via three different macros giving the radius of curvature, the conductive phase thickness and the semi-diameter (Figure 2: number 1). Oil thickness calculation is given by performing a thickness solve (a subtraction) based on the value from previous surface. This last value is given by the macro and the total thickness between the windows.

	Surf.Type	Comment	Radius	Thickness	Material	Coating	Clear Semi-Dia	Chip Zc	Mech Serr	Conic	TCE x 1E-6
0	OBJECT	Standard ▾	Working distance	Infinity			0,000 U	0,0...	0,000	0,0...	0,000
1	Standard ▾	Lens voltage: 40.4500 Volts	Infinity	0,000			1,750	0,0...	1,750	0,0...	0,000
2	Standard ▾	Cap thickness	Infinity	0,100			1,700 U	0,0...	1,700	0,0...	3,000
3	(aper)	Standard ▾	Cap Glass Window	Infinity	0,550	D263TECO	1,700 U	0,0...	1,700	0,0...	-
4	(aper)	Standard ▾	Conductive phase	Infinity	0,356 Z	PC427A	1,700 U	0,0...	1,700	0,0...	-
5	(aper)	Standard ▾	Oil bodycone	1,448E+04 Z	0,244 T	H572A	1,554 Z	0,0...	1,554	0,0...	-
6	(aper)	Standard ▾	Oil cylinder	Infinity	0,100	H572A P	1,250 U	0,0...	1,250	0,0...	-
7	(aper)	Standard ▾	Bodycone Glass Window	Infinity	0,300	D263TECO	1,250 P	0,0...	1,250	0,0...	-
8	STOP (aper)	Standard ▾		Infinity	10,000		1,750	0,0...	1,750	0,0...	0,000
9	IMAGE	Standard ▾		Infinity	-		1,750	0,0...	1,750	0,0...	0,000

Figure 2

1.1. Changing Adjustable Lens Optical Power

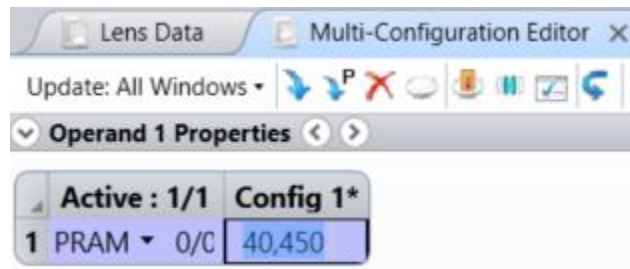


Figure 3

In order to change optical power, the designer must change the voltage used by the macros which is set by the Multi Configuration Editor (MCE, Figure 3). Voltage set in MCE is displayed in the “Comments” cell of surface 2 (Figure 2: number 2). After changing the value and pressing enter, the four variables described in the model will be updated along with the optical power.

1.2. ZPL macro

Each of the macro names can be found by right clicking on the Z letter next to the numerical value (Figure 4 below). In the example below, the macro name for radius of curvature is “C_A25H0”.

This macro has been extracted and copied to the Zemax Macro folder when opening the .zar file provided by Corning.

Surf.Type	Comment	Radius	Thickness	Material	Coating	Clear Semi-Dia	Chip Zc	Mech Semi-Dia	Conic	TCE x 1E-6
0 OBJEC	Standard ▾	Working distance Infinity	Infinity			0,000	0,0...	0,000	0,0...	0,000
1	Standard ▾	BAFFLE Infinity	2,080			3,400 U	0,0...	3,400	0,0...	0,000
2	Standard ▾	Cap thickness Infinity	0,100			1,850 U	0,0...	1,850	0,0...	0,000
3	Standard ▾	Lens voltage: 40.4500 Volts Infinity	0,000			1,850 P	0,0...	1,850	0,0...	0,000
4 (aper)	Standard ▾	Cap glass window Infinity	0,550	D263TECO		1,850 P	0,0...	1,850	0,0...	-
5 (aper)	Standard ▾	Conductive phase Infinity	0,356 Z	PC427A		1,850 P	0,0...	1,850	0,0...	-
6 (aper)	Standard ▾	Oil bodycone 1,44... Z	0,244 T	H572A		1,554 Z	0,0...	1,554	0,0...	-
7 (aper)	Standard ▾	Curvature solve on surface 6	0,100	H572A P		1,250 U	0,0...	1,250	0,0...	-
8 (aper)	Standard ▾	Solve Type: ZPL Macro	0,300	D263TECO		1,250 P	0,0...	1,250	0,0...	-
9 STOP	Standard ▾	Macro: C_A25H0	0,800			1,250 U	0,0...	1,250	0,0...	0,000
10 (aper)	Black Box Lens ▾		<7,715>			3,601 U	-	-	-	0,000
11	Standard ▾	Optical last surface to flange Infinity	1,800			3,601 P	0,0...	3,601	0,0...	0,000
12	Standard ▾	MBFL thickness value Infinity	6,120			3,601 P	0,0...	3,601	0,0...	0,000
13 IMAGI	Standard ▾	Infinity	-			3,601 P	0,0...	3,601	0,0...	0,000

Figure 4

Each macro is in fact a second order fit of the parameter variation function of the voltage.

Surf.Type	Comment	Radius	Thickness	Material	Coating	Clear Semi-Dia	Chip Zc	Mech Semi-Dia	Conic	TCE x 1E-6
0 OBJEC	Standard ▾	Working distance Infinity	Infinity			0,000	0,0...	0,000	0,0...	0,000
1	Standard ▾	BAFFLE Infinity	2,080			3,400 U	0,0...	3,400	0,0...	0,000
2	Standard ▾	Cap thickness Infinity	0,100			1,850 U	0,0...	1,850	0,0...	0,000
3	Standard ▾	Lens voltage: 40.4500 Volts Infinity	0,000			1,850 P	0,0...	1,850	0,0...	0,000
4 (aper)	Standard ▾	Cap glass window Infinity	0,550	D263TECO		1,850 P	0,0...	1,850	0,0...	-
5 (aper)	Standard ▾	Conductive phase Infinity	0,356 Z	PC427A		1,850 P	0,0...	1,850	0,0...	-
6 (aper)	Standard ▾	Oil bodycone 1,44... Z	0,244 T	H572A		1,554 Z	0,0...	1,554	0,0...	-

C_A25H0.ZPL

```

1 SOLVEBEFORESTOP
2 p=param(0,0)
3 b5="Lens voltage: "+$str(p)+" Volts"
4 SURF 3,1,b5
5 q=(p/24)*(0.00009304*p+p+0.005504*p-0.3748)-(p<=24)*0.186
6 Solvereturn (q)
7
8

```

Zemax Programming Language

Active File: C_A25H0.ZPL

☒ Close After Execution ☐ Quiet Mode ☐ Check Obsolete Syntax

Status: Idle

Execute Terminate Cancel Edit

Figure 5

Note: Two additional lines of code are present in the curvature macro. Their purpose is to paste the voltage value set from the Multi Configuration Editor into one of the “Comment” cells.

2. .Zar File and Potential Version Compatibility Issue

Corning uses OpticStudio version 2018 and generates Zemax archive files for its customers. This archive includes (in addition to the .zmx file) all the macros, and glass cat used to model the lens.

The previous version of Zemax might not support ZPL macros or may have problems when placing the optical system stop. Zemax demo version also does not support ZPL macros.

3. Corning® Varioptic® Lenses C-Series Module Zemax Model

Corning also provides Zemax models for all C-Series modules. These include a black box model of the fixed lens and liquid lens all in one so that customers can simulate directly the full optical stack.

Please note that those models include additional surfaces representing the front and rear end of the lens. This allows the user to directly change the module working distance and/or Mechanical Back Focal Length (MBFL), to correlate simulation with measurement.

Those models also allow a quick evaluation of the module resolution.

	Surf.Type	Comment	Radius	Thickness	Material	Coating	Clear Semi-Dia	Chip Zt	Mech Semi-Dia	Conic	TCE x 1E-6
0	OBJEC	Standard ▾	Working distance	Infinity			0,000	0,0...	0,000	0,0...	0,000
1		Standard ▾	BAFFLE	Infinity			3,400 U	0,0...	3,400	0,0...	0,000
2		Standard ▾	Cap thickness	Infinity			1,850 U	0,0...	1,850	0,0...	0,000
3		Standard ▾	Lens voltage: 40.4500 Volts	Infinity			1,850 P	0,0...	1,850	0,0...	0,000
4	(aper)	Standard ▾	Cap glass window	Infinity			1,850 P	0,0...	1,850	0,0...	-
5	(aper)	Standard ▾	Conductive phase	Infinity			1,850 P	0,0...	1,850	0,0...	-
6	(aper)	Standard ▾	Oil bodycone 1,44...	Z	0,244 T	H572A	1,554 Z	0,0...	1,554	0,0...	-
7	(aper)	Standard ▾	Oil cylinder	Infinity			1,250 U	0,0...	1,250	0,0...	-
8	(aper)	Standard ▾	Bodycone Glass Window	Infinity			1,250 P	0,0...	1,250	0,0...	-
9	STOP	Standard ▾		Infinity			1,250 U	0,0...	1,250	0,0...	0,000
10	(aper) Black Box Lens		fix_lens_9-6.ZBB		<7,715>		3,601 U	-	-		0,000
11		Standard ▾	Optical last surface to flange	Infinity			3,601 P	0,0...	3,601	0,0...	0,000
12		Standard ▾	MBFL thickness value	Infinity			3,601 P	0,0...	3,601	0,0...	0,000
13	IMAGI	Standard ▾		Infinity			3,601 P	0,0...	3,601	0,0...	0,000

Figure 1

Note(s):

1. In some modules, the so called “Optical last surface to flange” value is adjusted to match with the Zemax black box thickness with MBFL value and are therefore not consistent with values measured on the module parts (they can even be negative values in Zemax).
2. Corning does not provide Zemax model data to simulate optical variation with temperature.
3. In the case of microscopy modules, the Zemax model present three different configurations corresponding to the three available module magnifications (config 1=X2; config2= X3; config3= X5).

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