Introduction

ZEMAX saves and loads lens files using the ZMX file format. The ZMX format has been designed to be easy to maintain, modify, and understand. ZMX can be easily incorporated into other programs using the information in this chapter. For example, you may want to write a program to convert lens data from another lens design program to ZMX format, or you may want to read in ZMX files to perform additional analysis outside of ZEMAX. ZMX uses simple ASCII four letter mnemonic commands.

ZMX commands

The following table defines each ZMX keyword and syntax.

ZMX FORMAT COMMANDS

Command and syntax	Description
APLA	Curvature aplanatic solve.
CHIA val	Curvature chief ray angle solve value.
CHZH hgt	Thickness chief ray height solve.
CLAP min max	Circular aperture min max.
CNOR	Curvature chief ray normal.
COAT	The name of the coating used by the surface, if any.
COMM	Comment for the current surface.
CONI val	Conic constant.
CURV val solvetype param1 param2	The curvature value of a surface. The solvetype is an integer code that indicates the type of solve, and the two following parameters are the solve parameters. See the chapter "Solves" for details.
DIAM val solvecode pusurf	The semi-diameter of a surface. The solvecode is 0 for automatic, 1 for fixed, 2 for pickup and 3 for maximum. The pusurf value is only required for solvecode = 2.
DISZ val	The Z thickness of a surface.
EDGE thi rad	Thickness edge thickness solve.
ELAP xwid ywid	Elliptical aperture.
ELOB xwid ywid	Elliptical obscuration.
ENPD val	Entrance pupil diameter value.
ENVD temp pres	Environment data. The temp and pres values are in degrees c and atmospheres, respectively.
FLAP	Floating aperture.
FLOA val	Float by stop size. The val argument is ignored.
FNUM val	Image space F/# value.

Command and syntax	Description
FTYP i	Field type. The integer i is 0, 1, or 2 for field angle, object height, or image height.
FWGT val1 val2 val3...	The field weights. See XFLD.
GARR i sag dx dy dxdy	Used for defining the grid surface data. "i" is the array index, starting at 0. The other values are the sag, the derivative of the sag in the x direction, the derivative of the sag in the y direction, and the second cross derivative. Must follow after the GDAT command.
GCAT name1 name2 name3 ...	Indicates which glass catalogs are used by the lens.
GDAT ix iy dx dy	Defines the grid data header for the surface. The values are the number of x and y pixels, and the delta x increment and delta y increment.
GFAC val type	Apodization factor value and type. The type code is 0 for none, 1 for Gaussian, and 2 for tangential.
GLAS name code pu nd vd pd vnd vvd vpd io ao	The glass of the surface. Name is the glass name, such as BK7. Code is 0 for fixed, 1 for model, 2 for pickup. Pu is the pickup surface, which must be supplied even if the solve is not a pickup. nd, vd, and pd are the index, abbe, and partial dispersion values, which are only used if the glass is a model. The vnd, vvd, and vpd codes are 0 if that parameter is variable, else they are unity. The io and ao values are the index and Abbe offsets respectively, which are used primarily for tolerancing. A glass name must be supplied, even if the glass is a model glass.
GLRS surf	Global coordinate reference surface.
HIDE	Hide rays to/from surface flag.
MARA val	Curvature marginal ray angle solve value.
MAZH hgt zone	Thickness marginal ray height solve.
MNOR	Curvature marginal ray normal.
MNUM n	Number of configurations.
NAME string...	Indicates the "lens name" description.
NOTE i string	Lens notes. "i" should be between 1 and 3, inclusive, and the string can be any text.
OBDC xdec ydec	Obscuration and aperture decenter x and decenter y.
OBNA val	Object space numerical aperture value.
OBSC min max	Circular obscuration min max.
OPDZ opd zone	Thickness OPD solve.
PARM n val	Parameter n is the value of "val".
PCUP n val	Curvature pickup solve from surface n times val
PICB i	Paraxial Ignore Coordinate Breaks, i = 0 is false, i = 1 is true. Default is true.

Command and syntax	Description
PKUP n val	Conic pickup from surface n times val.
POLS nUnpol Ex Ey Phax Phay	Default polarization state data.
PPAR i n val	Parameter i pickup from n times val.
PUSH val	Pupil Shift. Used only if ray aiming is on. The "val" is in lens units.
PWAV n	The primary wavelength indicator.
PZUP n val	Thickness pickup from n times val.
RADI val	The radius of curvature. Now obsolete, use CURV.
RAIM tol type fastasphere usecache grinaper robust	The ray aiming and a few other settings on the advanced box are controlled by this command. Tol is no longer used, but some value (such as zero) must be present as a placeholder. Type is 0, 1, or 2 for None, Paraxial, or Real ray aiming. Fastasphere is 1 if the "Fast Asphere Trace" is selected, otherwise it is 0. Usecache is 1 if "Use Ray Aiming Cache" is selected, otherwise it is 0. Grinaper is 1 if "Check Grin Aper" is selected, otherwise it is 0. Robust is 1 if "Robust Ray Aiming" is selected, otherwise it is 0.
ROPD i	Reference OPD setting. For i = 0, 1, and 2, the reference point is Absolute, Infinity, and Exit Pupil, respectively. Use Exit Pupil as the default.
SDMA margin fast_semi_diameters	Semi-diameter margin, and fast semi-diameter mode flag.
SLAB int	Surface label. This is a unique integer ZEMAX assigns to each surface to identify the surface as new surfaces are inserted or old ones deleted. Some features that depend upon knowing where a surface has moved to in the list of surfaces use this label to keep track of the renumbered surfaces.
SPID numarms width	Spider aperture.
SQAP xwid ywid	Rectangular aperture.
SQOB xwid ywid	Rectangular obscuration.
STOP	Indicates the current surface is the stop surface.
SURF	Increments the surface counter.
TCED val v	TCE value of surface. v is unity if variable, else 0.
TCOC surf	Thickness center of curvature solve.
TCOM surf thickness	Thickness compensator solve.
TOLE n length	Thickness position solve.
TYPE codename	Indicates the current surface type. The codenames are listed in a following section.
UDAD x y	User defined aperture data x and y.

Command and syntax	Description
UNIT code	Specifies the lens units. The "code" must be either MM, CM, IN, or METER.
USAP min max	User defined aperture min max.
USOB min max	User defined obscuration min max.
VCON	Conic is variable.
VCUR	Curvature is variable.
VDSZ	Thickness is variable.
VERS n	The version number of ZEMAX that created the file.
VPAR n	Parameter n is variable
WAVL val1 val2 val3...	The wavelength values in microns.
WWGT val1 val2 val3...	The wavelength weights.
XDAT n val v pus sca	Extra Data Parameter n has value val. If v is unity, then the value is variable. If v is 2, then there is a pickup solve on the extra data parameter. The pickup surface number is pus and the scale factor is sca.
XFLD val1 val2 val3...	The x-field values. There are from 1 to 12 values separated by spaces. The units depend upon the field type, either degrees or lens units.
YFLD val1 val2 val3...	The y-field values. See XFLD.
ZVCX val1 val2 val3...	The VCX vignetting factors.
ZVCY val1 val2 val3...	The VCY vignetting factors.
ZVDX val1 val2 val3...	The VDX vignetting factors.
ZVDY val1 val2 val3...	The VDY vignetting factors.

ZMX format for optimization merit functions

ZEMAX simply appends the optimization merit function to the end of the ZMX file. After the lens data is all defined, the optimization operands follow in the following format:

```
NAME int1 int2 hx hy px py target weight
```

Note the arguments are all separated by spaces, and that the value of the operand is not stored. All operands use this format, even if not all data fields are used by the operand. Unused values are ignored, but must be present. ZEMAX will keep track of the number of operands as the file is loaded again. There is no need to write out how many operands are present. For a list of optimization operands, see the chapter "Optimization".

ZMX format for multi-configuration operands

ZEMAX also appends all multi-configuration data to the lens file. There are two formats used. If the multi-configuration operand is GLSS, then this format is used:

```
GLSS surface config name
```

Otherwise the more general format is used:

```
NAME surface config value variable_status
```

The variable_status is 0 for not variable, and 1 for variable. For a list of multi-configuration operand names, see the chapter "Multi-configurations".

Minimum ZMX file

The simplest "minimum" ZMX file looks like this:

```
NAME Lens has no title.
UNIT MM
ENPD 0
GFAC 0
GCAT schott misc
FTYP 0
ROPD 2
PICB 1
XFLD 0
YFLD 0
FWGT 1
WAVL 0.55
WWGT 1
PWAV 1
SURF 0
   TYPE STANDARD
   CURV 0
   DISZ INFINITY
SURF 1
   STOP
   TYPE STANDARD
   CURV 0
   DISZ 0
SURF 2
   TYPE STANDARD
   CURV 0
   DISZ 0
MNUM 1
```

The data consists of a header block, starting with the NAME keyword, and ending with the PWAV keyword. The header block defines all of the system parameters, such as fields, wavelengths, units, and other data not associated with any surface. Note also the keyword "INFINITY" can be used for infinite distances.

After the header block, the SURF 0 command indicates that all data following refers to surface 0, the object surface. When the next SURF command is reached, the surface counter is incremented and then data for the next surface is defined. Note that the number following the SURF command is ignored! It is only printed by ZEMAX to make the file easier to read. Each SURF command increments the surface counter, and the counter cannot be reset to add data for an earlier surface.

The tabs which indent the data between SURF commands are also added by ZEMAX simply to make the file easier to read, and are not required.

Surface type codes

The surface type codes are 8 character names which define the surface type. The names are similar to the names of the surface types, as defined in the Chapter "Surface Types":

```
STANDARD,EVENASPH,ODDASPHE,ALTERNAO,PARAXIAL,PARAX_XY,TOROIDAL,BICONICX,TOROGRAT
CUSPLINE,HOLOGRM1,HOLOGRM2,COORDBRK,POLYNOMI,FRESNELS,ABCDSURF,ALTERNAT,DGRATING,
CONJUGAT,TILTSURF,IRREGULA,GRINSUR1,GRINSUR2,GRINSUR3,GRINSUR4,GRINSUR5,GRINSUR6,
GRINSUR7,GRINSUR8,GRINSUR9,GRINSU10,FZERNSAG,FZERNPHA,SZERNSAG,XPOLYNOM,BINARY_1,
BINARY_2,XCUSPLIN,XASPHERE,XOSPHERE,VARLSGRT,ELLIGRAT,ELLIGRA2,SUPERCON,XFRESNEL,
GRID_SAG,GRID_PHA,GEN_FRES,PERIODIC,TOROHOLO,JONESMAT,ATMOSPHR,ZONEPLAT,USERSURF,
BIRE__IN,BIRE_OUT,OFABHOL1,NONSEQCO.
```

Additional examples

For additional ZMX example files, see any of the sample files that come with ZEMAX.