Closes the Data Base window.

## 7.1.2 File format

This section describes the format of an XEphem database file. The file name extension is .edb. See the next section for files containing two-line Earth satellite elements.

### 7.1.2.1 General format rules

- Each object occupies one line in the file.
- The order of objects in a file does not matter.
- Lines beginning with anything other than a-z, A-Z or 0-9 are ignored and may be used for comments.
- Lines are separated into Fields using commas (,).
- Fields may be further subdivided into Subfields with vertical bars (|).
- All date fields may be in either of two forms:

    1. month/day/year, where day may contain a fractional portion. examples: 1/1/1993 and 1/1.234/1993 . Note the format of dates in database files is always M/D/Y, regardless of the current XEphem Date format Preference setting; or

    2. the year as real number as indicated by the presence of a decimal point, such as 1993.123.

### 7.1.2.2 Format Details

The first two fields are required and are always Name and Type. Remaining fields depend on Type.

**Field 1** One or more object names, each separated by the Subfield separator, |. Any number of characters may be present in the file but XEphem only uses the first 20 characters of each name and only the first 20 names.

**Field 2** Type designation. Consists of a single letter designation from the following set (case *is* significant):

- **f** fixed (or at most exhibits constant curvilinear proper motion)
- **e** heliocentric elliptical orbit
- **h** heliocentric hyperbolic orbit
- **p** heliocentric parabolic orbit
- **E** geocentric elliptical orbit, *i.e.*, Earth satellite
- **P** built-in planet or natural satellite name

If **Field 2** is **f** the object is fixed and the following fields and subfields are defined:

**SubField 2A** An optional SubField 2A can be added to further define an object class code, consisting of one character from the following list:

A Cluster of galaxies

- B Star, binary. Deprecated as of version 3.6, gets turned into D internally. Use Field 2 type **B** if more than one position angle and separation or orbital elements are known.
- C Cluster, globular
- D Star, visual double
- F Nebula, diffuse
- G Galaxy, spiral
- H Galaxy, spherical
- J Radio
- K Nebula, dark
- L Pulsar
- M Star, multiple
- N Nebula, bright
- O Cluster, open
- P Nebula, planetary
- Q Quasar
- R Supernova remnant
- S Star
- T Stellar object
- U Cluster, with nebulosity
- Y Supernova
- V Star, variable

**SubField 2B** If SubField 2A is one of T, B, D, S or V, optional SubField 2B may consist of up to two spectral designation characters, typically one letter followed by one numerical subclass designator. Two examples are O and G3.

If SubField 2A is any other class code, optional SubField 2B may consist of up to two additional characters to further describe the type.

**Field 3** Astrometric RA position coordinate in equinox given by Field 6 always at epoch 2000, given as H:M:S.

**SubField 3A** This optional subfield may specify a proper motion in RA. It is in milliarcseconds per year on the sky, *i.e.*, `ΔRA*cos(dec)`.

**Field 4** Astrometric Declination position coordinate in equinox given by Field 6 always at epoch 2000, given as D:M:S.

**SubField 4A** This optional subfield may specify a proper motion in Dec. It is in milliarcseconds per year on the sky

**Field 5** Magnitude of the object.

**Field 6** This optional field is the reference epoch. It is assumed to be 2000 if absent

**Field 7** depends on SubField 2A

If SubField 2A is **G** or **H**

| | | |
|---|---|---|
| **Field 7** | Galaxy major axis, in arcseconds | |
| | **SubField 7A** | Galaxy minor axis, in arcseconds |
| | **SubField 7B** | Major axis position angle, in degrees East of North |

If Subfield 2A is **B** or **D**

| | | |
|---|---|---|
| **Field 7** | star pair separation, in arcseconds | |
| | **SubField 7A** | reserved, set to 0 |
| | **SubField 7B** | position angle, in degrees East of North |

Otherwise Field 7 is optional but if present

| | |
|---|---|
| **Field 7** | size of the object, in arcseconds. It is assumed to be 0 if absent. |

If **Field 2** is **B** the object is a true binary pair and the following fields and subfields are defined.

**SubField 2A** An optional SubField 2A can be added to further define an binary class code, consisting of one character from the following list. This scheme is taken from the Washington Multiplicity catalog for compliance with the IAU 2003 recommendation.

| | |
|---|---|
| a | Astrometric binary |
| c | Cataclysmic variable |
| e | Eclipsing binary |
| x | High-mass X-ray binary |
| y | Low-mass X-ray binary |
| o | Occultation binary |
| s | Spectroscopic binary |
| t | Single-line spectroscopic binary |
| u | Double-line spectroscopic binary |
| v | Spectrum binary |
| b | Visual binary |
| d | Visual binary with common proper motion |
| q | Visual binary - optical |
| r | Visual binary - physical |
| p | Exoplanet |

**SubField 2B** Up to two characters to specify the spectral class of the primary star, typically one letter followed by one numerical subclass designator. Two examples are O and G3.

| | | |
|---|---|---|
| | **SubField 2C** | Up to two characters to specify the spectral class of the secondary star, typically one letter followed by one numerical subclass designator. Two examples are O and G3. |
| **Field 3** | RA position coordinate, given as H:M:S. | |
| | **SubField 3A** | This optional subfield may specify a proper motion in RA. It is in milliarcseconds per year on the sky, *i.e.*, `ΔRA*cos(dec)`. |
| **Field 4** | Declination position coordinate, given as D:M:S. | |
| | **SubField 4A** | This optional subfield may specify a proper motion in Dec. It is in milliarcseconds per year on the sky |
| **Field 5** | Magnitude of each star in the pair. | |
| | **SubField 5A** | Magnitude of the primary star |
| | **SubField 5B** | Magnitude of the secondary star |
| **Field 6** | This optional field is the reference equinox year. It is assumed to be 2000 if absent | |
| **Field 7** | This field may contain either 3 or 6 subfields (one or two triples of year/separation/position angle) or 7 subfields (orbital elements).<br>If 3 or 6 subfields, they define positions grouped as the following triplets: | |
| | **SubField 7A/D** | Year of the separation and position angle given in the next two fields, decimal year or month/day/year |
| | **SubField 7B/E** | Separation, arc seconds |
| | **SubField 7C/F** | Position angle, degrees E of N, referenced to equinox in field 6 |
| | If 7 subfields, they define a true orbit: | |
| | **SubField 7A** | Semi-major axis, arcseconds |
| | **SubField 7B** | Inclination from plane of sky, degrees |
| | **SubField 7C** | Longitude of node, degrees |
| | **SubField 7D** | Eccentricity |
| | **SubField 7E** | Epoch of periastron, decimal year or month/day/year |
| | **SubField 7F** | Argument of periastron, degrees |
| | **SubField 7G** | Period. Units are designated by suffix **y** for years, **d** for days, or **h** for hours. If no designation the default is years. |

If **Field 2** is **e** the object type is elliptical heliocentric (eccentricity < 1) and the remaining fields are defined as follows:

| | | |
|---|---|---|
| **Field 3** | i = inclination, degrees | |
| **Field 4** | O = longitude of ascending node, degrees | |
| **Field 5** | o = argument of perihelion, degrees | |
| **Field 6** | a = mean distance (aka semi-major axis), AU | |
| **Field 7** | n = mean daily motion, degrees per day (computed from a**3/2 if omitted) | |
| **Field 8** | e = eccentricity, must be < 1 | |
| **Field 9** | M = mean anomaly, i.e., degrees from perihelion | |
| **Field 10** | E = epoch date, i.e., time of M | |
| | **SubField 10A** | First date these elements are valid, optional |
| | **SubField 10B** | Last date these elements are valid, optional |
| **Field 11** | D = the equinox year, i.e., time of i, O and o | |
| **Field 12** | First component of magnitude model, either g from (g,k) or H from (H,G). Specify which by preceding the number with a "g" or an "H". In absence of either specifier the default is (H,G) model. See Magnitude models. | |
| **Field 13** | Second component of magnitude model, either k or G | |
| **Field 14** | s = angular size at 1 AU, arc seconds, optional | |

You may have other parameters available for elliptical orbits that can be converted into these. The following relationships might be useful:

```
P = sqrt(a*a*a)
p = O + o
n = 0.9856076686/P
T = E - M/n
q = a*(1-e)
```

AU = 149,597,870 km = 92,955,621 U.S. statute miles

where

`P` = the orbital period, years;
`p` = longitude of perihelion, degrees
`T` = epoch of perihelion (add multiples of P for desired range)
`q` = perihelion distance, AU

Note that if you know T you can then set E = T and M = 0.

If **Field 2** is **h** the object type is hyperbolic heliocentric (eccentricity > 1) and the remaining fields are defined as follows:

| | | |
|---|---|---|
| **Field 3** | T = date of the epoch of perihelion | |
| | **SubField 3A** | First date these elements are valid, optional |
| | **SubField 3B** | Last date these elements are valid, optional |
| **Field 4** | i = inclination of orbital plane to ecliptic, degrees | |

| | |
|---|---|
| **Field 5** | O = longitude of ascending node, degrees |
| **Field 6** | o = argument of perihelion, degrees |
| **Field 7** | e = eccentricity, must be > 1 |
| **Field 8** | q = perihelion distance, AU |
| **Field 9** | D = the equinox year (i.e., time of i/O/o) |
| **Field 10** | g component of magnitude model. See Magnitude models. |
| **Field 11** | k component of magnitude model |
| **Field 12** | s = angular size at 1 AU, arc seconds, optional |

As with elliptical elements, other parameters might be available. The relationships are generally the same, except:

```
q = a*(e-1)
```

If **Field 2** is **p** the object type is parabolic heliocentric (eccentricity exactly equal to 1) and the remaining fields are defined as follows:

| | | |
|---|---|---|
| **Field 3** | T = date of epoch of perihelion | |
| | **SubField 3A** | First date these elements are valid, optional |
| | **SubField 3B** | Last date these elements are valid, optional |
| **Field 4** | i = inclination, degrees | |
| **Field 5** | o = argument of perihelion, degrees | |
| **Field 6** | q = perihelion distance, AU | |
| **Field 7** | O = longitude of ascending node, degrees | |
| **Field 8** | D = the equinox year (i.e., time of i/O/o). | |
| **Field 9** | g component of magnitude model. See Magnitude models. | |
| **Field 10** | k component of magnitude model | |
| **Field 11** | s = angular size at 1 AU, arc seconds, optional | |

If **Field 2** is **E** (note upper case) the object type is Earth satellite and the remaining fields are defined as follows:

| | | |
|---|---|---|
| **Field 3** | Epoch of the other fields | |
| | **SubField 3A** | First date these elements are valid, optional |
| | **SubField 3B** | Last date these elements are valid, optional |
| **Field 4** | inclination, degrees | |
| **Field 5** | RA of ascending node, degrees | |
| **Field 6** | eccentricity, must be < 1 | |
| **Field 7** | argument of perigee, degrees | |
| **Field 8** | mean anomaly, degrees | |
| **Field 9** | mean motion, revs/day | |
| **Field 10** | orbit decay rate, revolutions/day^2 | |

| | |
|---|---|
| **Field 11** | integral reference orbit number at Epoch |
| **Field 12** | drag coefficient, 1/(earth radii); optional |

XEphem arbitrarily assigns all Earth satellites a visual magnitude of 2.0.

XEphem can also read files directly containing the venerable Two-Line-Element (TLE) format. See next section for details.

If not specified explicitly in the edb entry, XEphem assigns the valid range of dates for satellite elements to the greater of 100 days or the time required for the mean motion to change by one percent either side of the element epoch.

If **Field 2** is **P** (note upper case) then **Field 1** must be the name of a built-in object for XEphem and no other fields are defined. The following names are recognized:

- Sun
- Moon
- Mercury
- Venus
- Mars
  - Phobos
  - Deimos
- Jupiter
  - Io
  - Europa
  - Ganymede
  - Callisto
- Saturn
  - Mimas
  - Enceladus
  - Tethys
  - Dione
  - Rhea
  - Titan
  - Hyperion
  - Iapetus
- Uranus
  - Ariel
  - Umbriel
  - Titania
  - Oberon
  - Miranda
- Neptune
- Pluto

#### 7.1.2.3 Magnitude models

The **g,k** magnitude model requires two parameters to be specified. One, the absolute magnitude, g, is the visual magnitude of the object if it were one AU from both the Sun and the Earth. The other, the luminosity index, k, characterizes the brightness change of the object as a function of its distance from the Sun. This is generally zero, or very small, for inactive objects like asteroids. The model may be expressed as:

```
m = g + 5*log10(D) + 2.5*k*log10(r)
```

where:

`m` = resulting visual magnitude
`g` = absolute visual magnitude
`D` = comet-earth distance, in AU
`k` = luminosity index
`r` = comet-sun distance.

The **H,G** model also requires two parameters. The first, H, is the magnitude of the object when one AU from the Sun and the Earth. The other, G, attempts to model the reflection characteristics of a passive surface, such as an asteroid. The model may be expressed with the following code fragment:

```
beta = acos((rp*rp + rho*rho - rsn*rsn)/ (2*rp*rho));
psi_t = exp(log(tan(beta/2.0))*0.63);
Psi_1 = exp(-3.33*psi_t);
psi_t = exp(log(tan(beta/2.0))*1.22);
Psi_2 = exp(-1.87*psi_t);
m = H + 5.0*log10(rp*rho) - 2.5*log10((1-G)*Psi_1 + G*Psi_2);
```

where:

`m` = resulting visual magnitude
`rp` = distance from sun to object
`rho` = distance from earth to object
`rsn` = distance from sun to earth

Note that neither model takes into account the phase angle of sun light.

### 7.1.3 Notes

XEphem uses a different window to manage Field star catalogs.

XEphem ships with a few perl scripts which might be helpful for converting databases in other formats into XEphem format. These scripts are in the tools/ directory of the source distribution tree.

### 7.1.4 Two-line Earth satellite element sets

XEphem supports reading files which contain Earth satellites defined using the the NORAD "two-line element" set format, or TLE. Because the TLE format is quite rigid and includes a checksum within each line, XEphem is able to search files containing other arbitrary text and find each properly formatted TLE contained therein. Follows is a description of the TLE. Note the line immediately preceding the TLE, line "0", is assumed to contain a common name for the satellite, this line is only used if the following two lines conform to TLE.

Data for each satellite consists of three lines in the following format:

```
AAAAAAAAAAAAAAAAAAAAAAAA
1 NNNNNU NNNNNAAA NNNNN.NNNNNNNN +.NNNNNNNN +NNNNN-N +NNNNN-N N NNNNN
2 NNNNN NNN.NNNN NNN.NNNN NNNNNNN NNN.NNNN NNN.NNNN NN.NNNNNNNNNNNNNN
```

Line 0 is a twenty-four character name.

Lines 1 and 2 are the standard Two-Line Orbital Element Set Format identical to that used by NORAD and NASA. The format description is:

**Line 1**

| Column | Description |
|---|---|
| 01 | Line Number of Element Data |
| 03-07 | Satellite Number |
| 08 | Classification (U=Unclassified) |
| 10-11 | International Designator, last two digits of launch year, 2000+ if < 57. |
| 12-14 | International Designator, launch number of the year |
| 15-17 | International Designator, piece of the launch |
| 19-20 | Epoch Year, last two digits of year,  2000+ if < 57 |
| 21-32 | Epoch Day of the year and fractional portion of the day |
| 34-43 | First Time Derivative of the Mean Motion |
| 45-52 | Second Time Derivative of Mean Motion (decimal point assumed) |
| 54-61 | BSTAR drag term (decimal point assumed) |
| 63 | Ephemeris type |
| 65-68 | Element number |
| 69 | Checksum (Modulo 10)<br>(Letters, blanks, periods, plus signs = 0; minus signs = 1) |

**Line 2**

| Column | Description |
|---|---|
| 01 | Line Number of Element Data |
| 03-07 | Satellite Number |
| 09-16 | Inclination [Degrees] |
| 18-25 | Right Ascension of the Ascending Node [Degrees] |
| 27-33 | Eccentricity (decimal point assumed) |
| 35-42 | Argument of Perigee [Degrees] |
| 44-51 | Mean Anomaly [Degrees] |
| 53-63 | Mean Motion [Revs per day] |
| 64-68 | Revolution number at epoch [Revs] |
| 69 | Checksum (Modulo 10) |

When reading a TLE entry, XEphem assigns the valid range of dates for a set of elements to the greater of 100 days or the time required for the mean motion to change by one percent either side of the element epoch.

## 7.2 Index

This window shows a list of all objects currently loaded into memory sorted by name. Or, by chosing a toggle button across the top, the list can be restricted to just deep sky, stellar, binary systems,