The Asteroid Lightcurve Data Exchange Format Standard

(ALCDEF) v 2.1.1 (2015 September 1)

Unlike astrometric observations of asteroids, where a universally accepted format for data submission has been adopted, time-series photometry of asteroids can and is found in any number of formats. This makes it more difficult for archivists of such data and the researchers wanting to use them since each person must write a number of data conversion algorithms to suit their specific wants and needs. Furthermore, many of the commonly found data sets are wanting for critical information that can dramatically reduce the usefulness of archived data.

The Asteroid Lightcurve Data Exchange Format (ALCDEF; Stephens *et al.*, 2010) was created to address these problems by providing a simple data format that not only includes the raw time-series data but a minimum of critical information (i.e., metadata, or data about the data) so that any researcher can use the data correctly in his own investigations. The format also allows including a number of other key metadata values that further enhances the value of the time-series data.

The Minor Planet Center has adopted the ALCDEF standard for asteroid time-series photometry and hosts a web page (*http://www.MinorPlanetCenter.net/light_curve.php*) where these data can be submitted for public use.

In this document, *lightcurve* is used instead of *light curve*.

S-ALCDEF (Simple-ALCDEF)
See Appendix B for the SALCDEF (Simple-ALCDEF) format introduced in v2.1

1. STANDARDIZATION

The issue of standardization has been problematic over the years. Sometimes rigorous requirements and cumbersome procedures resulted in only a small portion of all asteroid lightcurve data obtained in the past decade being readily available.

On the other hand, some core requirements are mandatory if the data are to be useful. This document outlines a proposed standard for asteroid time-series data that, while mandating a core set of information and – to some degree – data formatting, still allows considerable flexibility.

1.1. DATA STRUCTURE

The submitted data files must follow some simple rules so that the data parsing algorithms can store the data in the ALCDEF database

- All files must be standard ASCII format. Extended characters (ASCII > 127) are not allowed.

- The files must consist of multiple lines that are terminated by, preferably, CR/LF pair (ASCII 13/10, Windows) or single LF (ASCII 10, UNIX/LINUX).

- All lines follow a "FITS-like" format of *keyword=value*.

- The total length of any line – including keyword, equals sign, and value – cannot exceed 255 characters.

- There is a fixed set of recognized keywords. Non-standard keywords are not processed when uploading the data to the MPC site but they will not necessarily cause the data to be rejected.

- The fundamental structure for time-series data is a *lightcurve block*. A *lightcurve block* consists of two mandatory blocks:

    Metadata block

    Data block

- A single file can contain one or more *lightcurve blocks* for one or more objects.

- Each subsequent *lightcurve block*, if any, should follow immediately after the data section of the previous block, i.e., there should be no blank lines in the file. However, a blank line between one *lightcurve block* and another will *not* cause the entire file to be rejected. See Appendix A for a sample of a single *lightcurve block*.

1.1.1. METADATA BLOCK

The *metadata block* provides core and supporting information that fully defines the time-series data.

- The first line of this block must be the single word STARTMETADATA. There is no value associated with this keyword.

- The METADATA section must include a set of *required keywords* lines using the format

- *keyword=value*.

- The *required keywords* are used to identify the lightcurve block uniquely during the anti-duplication vetting process during data upload.

- The *metadata block* must be terminated by a line containing the single word ENDMETADATA. There is no value associated with this keyword.

1.1.2. DATA BLOCK

The *data block* contains the time-series data.

- The first line must follow the METADATA section, i.e., the first line after the ENDMETADATA terminating line.

- *There is no STARTDATA keyword*.

- There must be *at least two lines* of data in a lightcurve block.

- The last line of the section must be the single word ENDDATA

- All data must be electronically-obtained, i.e., visual estimates will not be accepted.

1.1.3. DATA LINES

Each data line must be in the format

DATA=JD<Delimiter>MAG[<Delimiter>MagErr<Delimiter>AirMass]

Value	Required	Description
JD	Yes	UT Julian Date of mid-exposure. This field is required. See section 2 for formatting requirements. *Julian Dates must be standard JD, not modified JD.*
MAG	Yes	The magnitude of the object at time JD. This field is required. See section 2 for formatting requirements.
MAGERR	No	The estimated error in the MAG value, in magnitudes.
AIRMASS	No	The air mass of the target at time JD

The fields must be separated by a DELIMITER character. The allowed characters are

TAB   (ASCII   9)
PIPE   (ASCII 124)

The SPACE (ASCII 32) and COMMA (ASCII 44) are not used because they could be inadvertently used within words or values, e.g., it is common for those in many countries to use the comma for the decimal character, something which the ALCDEF standard does not permit but may still occur.

Consecutive delimiters will be interpreted as a NULL value.

1.2. COMPARISON STARS

Comparison star data are not mandatory. If they are included, they are part of the *metadata block*. No more than 10 comparison stars can be defined.

A comp star definition must include, at the minimum, the name (or catalog number, ID, etc.) and magnitude of the star. The color index, and RA/Dec are optional. See section 2 and Appendix A for an example of comp star data.

1.3. ASCPECT DATA

Values such as Earth and Sun distances, phase angle, ecliptic longitude and latitude, and phase angle bisector longitude and latitude are called "aspect data." By choice, only three of these were included as (optional) keyword/value pairs in the ALCDEF standard: Phase angle (PHASE) and Phase Angle Bisector Longitude/Latitude (PABL and PABL).

The point of including phase angle and phase angle bisector values is to serve as a quick guide to the usefulness of a given lightcurve block. For example, to see if data from very low or large phase angles are available or if a given data set would essentially be a duplicate of another because the viewing aspect (phase angle bisector) was about the same.

It is presumed that anyone using ALCDEF data would compute the required aspect data independently, if nothing else as a check of the original values and, more important, to use values based on the latest available orbital elements.

If a data supplier wants to include the other values in his metadata block, they should be in the form of one or more COMMENT lines in the *metadata* block, e.g.,

```
COMMENT=Heliocentric longitude / latitude: +317.11 / +30.80
COMMENT=Sun / Earth Distance (AU): +2.0478 / +1.1324
```

2. KEYWORDS AND DATA FORMATTING

ALCDEF formatting is similar to the FITS standard in that data are expressed as lines of *keyword=value*. The data formatting rules have been deliberately kept to a minimum but there are some minimums to follow.

- Keyword lengths cannot exceed 14 characters and should be in upper case letters.

- Floating point values *must* use the period (ASCII 46) for the decimal character

- Floating point values *must* be in non-exponential form, e.g., 432.5 and *not* 4.325E+02.

- Values that are positive numbers should include a leading plus sign (+) to remove any ambiguity.

- Negative numbers *must* include a leading minus sign (–).

- Floating-point numbers $|x| < 1.0$ *must* include a leading zero. For example: +13.258 or –0.455.

- The keywords below are recognized by the ALCDEF standard and parsing code on the Minor Planet Center site. Any lines containing non-standard keywords will be ignored.

- Boolean values must be expressed as the upper case English words TRUE or FALSE.

3. RECOGNIZED KEYWORDS

Words in **bold italics** must appear in each metadata block or the lightcurve block will be rejected. The DATA keyword must appear at least twice in the *data block* of a *lightcurve block*.

BIBCODE	***CONTACTNAME***	MAGBAND	PHASE
CIBAND	***DATA***	MPCDESIG	PUBLICATION
CICORRECTION	***DELIMITER***	OBJECTDEC	REDUCEDMAGS
CITARGET	DIFFERMAGS	***OBJECTNAME***	REVISEDDATA
COMMENT	***ENDDATA***	***OBJECTNUMBER***	***SESSIONDATE***
COMPCI{X}	***ENDMETADATA***	OBJECTRA	***SESSIONTIME***
COMPDEC{X}	***FILTER***	***OBSERVERS***	STANDARD
COMPNAME{X}	LTCAPP	OBSLATITUDE	***STARTMETADATA***
COMPMAG{X}	LTCDAYS	OBSLONGITUDE	UCORMAG
COMPRA{X}	LTCTYPE	PABB	
CONTACTINFO	MAGADJUST	PABL	

In the keyword descriptions below, the keyword is followed by:

[Required] The keyword *must* be used at least once in a lightcurve block.

[Optional] The keyword *is not required* and can missing entirely

[Optional/Required] The keyword *may be* required to cross-check other keyword/value pairs.

4. DATA VETTING

As each file is uploaded, a number of checks and validations are made to assure that the incoming data as free of errors as possible and to avoid unintended data duplication. *The data vetting checks are done at the lightcurve block level.* If one lightcurve block fails the test, this does not automatically cause the others, if any, in the file to be rejected.

4.1. NUMBER, NAME, DESIGNATION CHECK

The first check is to validate the OBJECTNUMBER, OBJECTNAME, and MPCDESIG values against one another. For example, a *lightcurve block* is rejected assuming the following combinations

Number/Name Mismatch
OBJECTNUMBER=150
OBJECTNAME=Ceres
MPCDESIG= (no entry)

Number/Name vs. Designation Mismatch
OBJECTNUMBER=70030
OBJECTNAME=Margaretmiller
MPCDESIG=2000 AA1

If MPCDESIG is blank or missing from the metadata block and the OBJECTNUMBER-OBJECTNAME combination has been validated, the MPCDESIG value, if available, is automatically assigned.

4.2. DUPLICATE DATA CHECK

The combination of values for some of the required keywords in the *metadata block* is checked to see if that same combination already exists in the database.

If the incoming data appear to be for an existing object (based on OBJECTNUMBER, OBJECTNAME, and/or MPCDESIG) and the CONTACTNAME, SESSIONDATE, SESSIONTIME, and FILTER keyword values are *exactly the same*, the lightcurve block is rejected *unless* the metadata block includes REVISEDDATA=TRUE. In this case, *the existing metadata, comp star, and time-series data are deleted and then replaced by the new data*.

Since the above keywords are used to avoid duplication, it is *vital* that the submitting author use the *exact same entry* for CONTACTNAME for every submission. This can easily be achieved if using a script or program.

For those submitting multiple lightcurve blocks for the same object/filter combination with the same SESSIONDATE, e.g., for a fast-moving near-Earth asteroid or pre- and post-meridian flip of a German Equatorial mount, *it is vital that the SESSIONTIME value be unique for each* lightcurve block.

As of this version, there is no provision to resubmit data that uses a different value for the core keywords covered in this section. To do so would require registration, user accounts, and significantly more involved programming to prevent security breaches.

4.3. KEYWORD DEPENDENCIES CHECK

There are a number of keyword/value pairs that require that another keyword exists and it have a compatible value. For example, if CICORRECTION=TRUE, then CIBAND must be something other than NONE and CITARGET must have a non-zero value. If any one of these cross-checks fails, the *lightcurve block* is rejected. The dependencies are covered under the individual keywords.

5. KEYWORD DEFINITIONS

BIBCODE [Optional]

The 19-character universal BibCode for the publication in which the data were used for analysis or presented. This is different from PUBLICATION, which gives a brief citation, e.g., PUBLICATION=Minor Planet Bul. 37, 169.

Value Type:	String. No surrounding quotes.
Max Length:	25 characters.
Example:	2010MPBu...37..169W
Notes:	The current standard length for a BibCode is 19 characters. The field allows up to 25 characters for future expansion. Trailing blanks beyond 19 characters are dropped.

CIBAND [Optional/Required]

The color index bands for the color index values of the target and comparison stars.

Value Type:	String. No surrounding quotes.
Max Length:	5 characters.
Allowed Values:	BV, VR, VI, SGU, SGR, SRI, SIZ (case-sensitive), NONE (not case-sensitive)
	The BVRI-derived values are on the Johnson-Cousins system. The SXY values are based on the u' g 'r' i' z' magnitudes of the Sloan Digital Sky Survey (SDSS) system.
Example:	CIBAND=VR
Notes:	If CICORRECTION=TRUE, this keyword must be present in the metadata block and assigned a value other than NONE. Otherwise, the *lightcurve block* is rejected.

CICORRECTION [Optional]

Indicates whether or not a color index correction has been applied to the magnitudes in the DATA section.

Value Type:	Boolean
Max Length:	5 characters
Allowed Values:	TRUE, FALSE
Example:	CICORRECTION=TRUE
Notes:	If CICORRECTION=TRUE, then CIBAND must have a value other than

NONE *and* the CITARGET keyword must be in the *metadata block* and have a non-zero value. Otherwise, the *lightcurve block* is rejected.

❖ *This is one of the core keywords used to check for duplicate submissions. See section 4.2.*

CITARGET [Optional/Required]

Indicates the color index of the target.

Value Type:	Floating Point up to 3 decimal places.
Format:	See the numeric formatting guidelines at the start of this section.
Example:	`CITARGET=+0.450`
Notes:	If CICORRECTION=TRUE, then CIBAND must have a value other than NONE *and* the CITARGET keyword must be in the *metadata block* and have a non-zero value. Otherwise, the *lightcurve block* is rejected.

COMMENT [Optional]

Provides additional information that is not covered by one of the recognized keywords.

Value Type:	String. No surrounding quotes.
Max Length:	2048 characters (see Notes)
Example:	`COMMENT=Asteroid was in a very crowded field.`
Notes:	More than one comment lone can be included in a *metadata block*. Each COMMENT line *must* be 255 characters or less, *including* COMMENT=.
	The combined length of all COMMENT *values* must be less than 2048 characters. This includes CR/LF or LF characters but not COMMENT=.

COMPCI{X} [Optional]

The color index of comparison star X.

Value Type:	Floating Point up to 3 decimal places.
Format:	See the numeric formatting guidelines at the start of this section.
Example:	`COMPCI2=+0.319`
Notes:	This value must be the one given by the CIBAND keyword value, e.g., if CIBAND=VR, then this value must be the V-R color index of the comparison star.
	This keyword does not have a dependency on CICORRECTION and so is not part of the cross-checks during the data upload vetting. It is strictly an informational value in the *metadata block*.

COMPDEC{X} [Optional]

The Declination of comparison star X.

Value Type: String. No surrounding quotes.

Max Length: 11 characters.

Format: The value must be in the format: ±dd:mm:ss[.s], i.e., use colons to separate the subfields.

                     Leading zeros must be used to fill each subfield.

Example: COMPDEC2=+05:45:55

                     COMPDEC2=−15:02:01.2

Notes: The Declination is assumed to be J2000. If a different epoch, use a COMMENT line to indicate the epoch.

                     This keyword does not have a dependency on any other keyword and so is not part of the cross-checks during the data upload vetting. It is strictly an informational value in the *metadata block*.

COMPMAG{X} [Optional]

The magnitude for comparison star X.

Value Type: Floating point up to 3 decimal places.

Format: See the numeric formatting guidelines at the start of this section.

Example: COMPMAG2=+12.913

                     COMPMAG2=−0.913

Notes: The value should match the MAGBAND keyword value.

                     For example, if MAGBAND=V, then this value should be the V magnitude of the comparison star.

                     This keyword does not have a dependency on any other keyword and so is not part of the cross-checks during the data upload vetting. It is strictly an informational value in the *metadata block*.

COMPNAME{X} [Optional]

The name for comparison star X.

Value Type: String. No surrounding quotes.

Max Length: 30 characters.

Example: COMPNAME2=UCAC3 102445789

Notes: A maximum of 10 comp stars will be recognized. A minimum of 2 comp stars is recommended when using ensemble differential photometry, although 3 or more is better.

This keyword does not have a dependency on any other keyword and so is not part of the cross-checks during the data upload vetting. It is strictly an informational value in the *metadata block*.

COMPRA{X} [Optional]

The J2000 RA of comparison star X.

Value Type: String. No surrounding quotes.

Max Length: 11 characters.

Format: The value must be in the format: hh:mm:ss[.ss], i.e., use colons to separate the subfields.

Leading zeros must be used to fill each subfield.

Example: COMPRA2=04:05:12

COMPRA2=16:23:03.01

Notes: The RA is assumed to be J2000. If a different epoch, use a COMMENT line to indicate the epoch.

This keyword does not have a dependency on any other keyword and so is not part of the cross-checks during the data upload vetting. It is strictly an informational value in the *metadata block*.

CONTACTINFO [Required]

Contact information for the person submitting the data.

Value Type: String. No surrounding quotes.

Max Length: 120 characters.

Default: None.

Example: CONTACTINFO=[jqastronomer@adomain.com]

Notes: This is usually an email but it can also include a physical mailing address or web site. It is not necessary (but not wrong) to include the name of the submitting author since that is given by the CONTACTNAME keyword.

There are no strict formatting rules but some common conventions are worth considering. For example, surround an email with square brackets as shown above and in Appendix A and put it before a physical (snail mail) address.

CONTACTNAME [Required]

The name of the person submitting the data.

Value Type:	String. No surrounding quotes.
Max Length:	80 characters.
Format:	F i r s t [m i d d l e] initials, surname
Default:	None.
Example:	CONTACTNAME=J.Q. Astronomer
Notes:	This is the person who can provide additional information about the data and contact information for the observers.
	This person and any others listed in the OBSERVERS lines are those to whom credit should be given for the data.
	Do not include contact information, e.g., an email or mailing address. That is given by CONTACTINFO.

❖ *This is one of the core keywords used to check for duplicate submissions. See section 4.2.*

DATA [Required]

Indicates the data for a single observation.

Value Type:	String. No surrounding quotes.
Format:	Multiple floating point values separated by the DELIMITER character.
	The JD should *not* include a leading plus sign (+) and have a precision of at least 5 decimal places (~ 1 s). The MAG, MAGERR, and AIRMASS values should be given to a precision of up to 3 decimal places.
Default:	<blank>
Example:	DATA=2451286.32958|+9.775|+0.012|1.773
Notes:	The value string must contain a minimum of, in order, the full Julian Date (*not* MJD) and a magnitude value in the same band as given in the MAGBAND keyword.
	Additional fields, in order, are the magnitude error and air mass.
	There must be at least two data lines per *lightcurve block*. For non-time series observations, e.g., a single data point for phase curve observations, submit the several observations that were used to derive an average value. This allows independent confirmation.

See the discussion for the DELIMITER keyword. If the DELIMITER value is missing or invalid, the *lightcurve block* will be rejected. See section 1.1 and, in particular, section 1.1.3.

DELIMITER [Required]

Specifies the character used to separate data fields in a DATA line.

Value Type:	String. No surrounding quotes.
Max Length:	10 characters.
Allowed Values:	TAB (ASCII 9) PIPE (ASCII 124)
Default:	PIPE
Example:	`DELIMITER=PIPE`
Notes:	The value is the *name for the character* to be used and not the actual character since, for example, an actual space or tab character may not be correctly interpreted when parsing the *metadata block*.
	Consecutive delimiters will be interpreted as a NULL value. See the discussion for the DATA keyword.
	If the DELIMITER value is missing or invalid, the *lightcurve block* will be rejected.

DIFFERMAGS [Required]

Indicates if the magnitude values for the target are differential or "standard" (or "catalog") magnitudes.

Value Type:	Boolean
Max Length:	5 characters
Allowed Values:	TRUE, FALSE
Default:	FALSE
Example:	`DIFFERMAGS=FALSE`
Notes:	A "Standard" or "catalog" magnitude is defined as the magnitude that would be determined by comparing the brightness of the target against magnitudes from a catalog, e.g., Landolt standards, etc. and assigning a "standard" value, as opposed to a value that is the difference between the target and a comparison star.
	This and the STANDARD keyword are tied to one another. If DIFFERMAGS=TRUE, then STANDARD *must* be set to NONE, i.e., STANDARD=NONE.
	If DIFFERMAGS=FALSE, then STANDARD must be set to one of two values, INTERNAL or TRANSFORMED.
	If this cross-dependency check fails, the *lightcurve block* is rejected.

ENDDATA [Required]

Indicates the end of the data block in a lightcurve block. There is no associated value.

Example: ENDDATA

Notes: See Appendix A for a sample lightcurve block.

                This keyword must appear by itself immediately following the last DATA line in a lightcurve block.

                If any keyword other than ENDDATA or STARTMETADATA follows the last DATA line, the *lightcurve block* is rejected and *may* cause the rest of the file to be rejected.

ENDMETADATA [Required]

Indicates the end of the *metadata block* in a *lightcurve block*.

Value Type: There is no associated value

Example: ENDMETADATA

Notes: See Appendix A for a sample lightcurve block.

                This keyword must appear by itself at the end of a *metadata block* and followed immediately by a DATA line. If it is missing or any other keyword than DATA immediately after ENDMETADATA, the *lightcurve block* is rejected.

FILTER [Required]

The filter used to make the observations.

This is *not* necessarily the same value as given for the MAGBAND keyword. For example, if the data were acquired using a clear (or no) filter but V magnitudes were used to determine the magnitude of the target, this value would be 'C' (without the quotes).

Value Type: String. No surrounding quotes.

Max Length: 5 characters

Allowed Values: B, V, R, I, SU, SG, SR, SI, SZ (case-sensitive) for standard filters

                C (case-sensitive) if no or a clear filter

                The R and I values are understood to be Rc, Ic (Cousins). If not, use a COMMENT line to indicate otherwise. The SX values are the u' g' r' i' z' Sloan (SDSS) magnitudes.

Default: V

Example: FILTER=V

Notes: For legacy purposes, this value can also be 'Clear' or 'None' (case-insensitive). New submissions should use 'C' if no or a clear filter was used.

All observations in a given *lightcurve block* must have been made using the filter specified by this keyword. If multiple filters were used, multiple *lightcurve blocks* should be defined, each with a unique filter in the *metadata block*.

❖ *This is one of the core keywords used to check for duplicate submissions. See section 4.2 for more information*

LTCAPP [Required]

Indicates how light-time corrections, if any, were applied.

Value Type: String. No surrounding quotes.

Max Length: 10 characters. Default: NONE

Allowed Values: NONE, AVERAGE, POINT

NONE	No corrections for asteroid-Earth light-time applied, i.e., the JD are Earth-based.
AVERAGE	A fixed value was applied to all JD values. This is usually the light-time correction for the UT date/time given by SESSIONDATE and SESSIONTIME. If a different time was used, a COMMENT line should be used to indicate the UT date/time used to compute the fixed-value correction.
POINT	Corrections were applied point-by-point, i.e., the light-time correction was computed for the JD of the each observation and applied only to that one observation.

If any correction is applied, it is strongly encouraged that AVERAGE be used instead of POINT. This allows the data user, if he so wants, to remove the fixed light-time correction given by the LTCDAYS value from all observations to obtain the uncorrected JD. If using POINT, the LTCDAYS value is valid only for the SESSIONDATE and SESSIONTIME in the *metadata block*. For near-Earth asteroids, the difference between the AVERAGE and POINT value can be significant.

Example: LTCAPP=AVERAGE

Notes: If this value is AVERAGE or POINT, then LTCDAYS in the *metadata block* and have a non-zero value. In addition, LTCTYPE=LIGHTTIME must be in the *metadata block*.

If the cross-check fails, the *lightcurve block* is rejected.

LTCDAYS [Required/Optional]

The light-time correction at the UT date/time given by SESSIONDATE and SESSIONTIME.

Value Type:	Floating point; the value *must* contain a leading plus or minus sign.
Format:	See the numeric formatting guidelines at the start of this section. The precision of this value should be at least equal to that used for the JD value in a DATA line.
Example:	LTCDAYS=-0.01099
Notes:	If LTCAPP=AVERAGE or POINT, this value is required or the *lightcurve block* is rejected.

The keyword LCTYPE indicates the type of correction, none or light-time. The latter is based on asteroid-Earth distance.

The value must be such that

$$JD(\text{at asteroid}) = JD(\text{at Earth}) + LTCDAYS$$

Therefore,

$$LTCDAYS = -0.005772 * \text{AsteroidDistance (AU)}$$

since the light left the asteroid before it was seen on Earth.

Notes:	If LTCAPP is AVERAGE or POINT, this value must be non-zero and LTCTYPE must be LIGHTTIME. Otherwise, the *lightcurve block* is rejected.

LTCTYPE [Required]

Indicates the type of light-time correction applied to the raw Julian Dates of the observations.

Value Type:	String. No surrounding quotes.
Max Length:	15 characters
Allowed Values:	NONE, LIGHTTIME
Default:	NONE
Example:	LTCTYPE=NONE
Notes:	If LTCTYPE=LIGHTTIME, then the keyword LTCDAYS must be in the *metadata block* and have a non-zero value. In addition, LTCAPP must be in the *metadata block* and be assigned a value of AVERAGE or POINT. Otherwise, the *lightcurve block* is rejected.

MAGADJUST [Optional]

Value to add to the object magnitudes to obtain the correct value.

Value Type: Floating point; the value **must** contain a leading plus or minus sign.

Format: Use up to 3-decimal precision.

Default: 0.000

Example: MAGADJUST=+13.214

                   MAGADJUST=+0.023

Notes: When DIFFERMAGS=TRUE, this would be the value to add to the differential magnitudes in the lightcurve block to put them onto a standard system. For example, if the differential value is referenced against a single comparison star (or average of several), then MAGADJUST would be set to the catalog magnitude of the comparison (or average of the several comparisons) to obtain the target magnitude in the same band as specified by MAGBAND.

                   If DIFFERMAGS=TRUE, this value is strongly suggested, since be impossible to place the data set on a common system without arbitrary offsets for each *lightcurve block*.

                   If DIFFERMAGS=FALSE, then this would be the correction to apply to the magnitudes within each lightcurve block to put them onto a common zero point. For example, the data in a lightcurve block might need to be offset by +0.040 mag to correct for an error in the nightly zero point used in the original measurements.

                   This value should **not** be used to record an arbitrary offset used to force a specific period solution. It is intended strictly for the purpose of referencing all data to a single zero point on a photometric system, be it instrumental (INTERNAL) or, e.g., Johnson-Cousins (STANDARD).

MAGBAND [Required]

Indicates the color band of the magnitudes for the target.

Value Type: String. No surrounding quotes.

Max Length: 5 characters

Allowed Values: B, V, R, I, SU, SG, SR, SI, SZ (case-sensitive)

                   The R and I values are understood to be Rc, Ic (Cousins). If not, use a
                   COMMENT line to indicate otherwise. The SX values are the u' g' r' i' z'
                   Sloan (SDSS) magnitudes.

Default: V

Example: MAGBAND=R

Notes: This is *not* necessarily the same value as for the FILTER keyword. For
                   example, if the data were acquired using a clear (or no) filter but V
                   magnitudes were used to determine the magnitude of the target, then this value
                   would be V.

MPCDESIG [Optional/Required]

This is the original MPC designation for an object that has been subsequently numbered and named.
This is the full designation, not the MPC-packed value, e.g., 1999 CZ1 and not J99C01Z.

For un-numbered objects with no name, this keyword becomes required instead of optional. In this
case, set OBJECTNUMBER=0 and then set MPCDESIG **and** OBJECTNAME to the MPC
designation, i.e., OBJECTNAME must always have a value.

If no designation is available or assigned (as for the first 300 or so numbered asteroids), either
omit the keyword entirely or set the value to an empty string, i.e., MPCDESIG=

Value Type: String. No surrounding quotes.

Max Length: 30 characters.

Example: MPCDESIG=1999 CZ1

❖ *This is one of the core keywords used to check for duplicate submissions and cross-check values.
   See section 4.2 for more information*

OBJECTDEC [Optional]

The approximate Declination of the object at the given SESSIONDATE and SESSIONTIME.

Value Type: String. No surrounding quotes.

Max Length: 3 characters.

Format:	The value should include a leading plus (+) or minus (–) to avoid any uncertainty. Also, use a leading zero when |OBJECTDEC| < 10.
	If the declination rounds to 0 degrees, use +00.
Default:	<BLANK>
Example:	OBJECTDEC=+03

OBJECTNAME [Required]

The name assigned by the IAU.

Value Type:	String. No surrounding quotes.
Max Length:	30 characters.
Default:	None. The *lightcurve block* should be rejected if this keyword and/or value are missing.
Example:	OBJECTNAME=Lucia
Notes:	For un-numbered objects with no name but with an MPC designation, set OBJECTNUMBER=0 and then set OBJECTNAME *and* MPCDEESIG to the MPC designation, i.e., OBJECTNAME must always have a value.

❖ This is one of the core keywords used to check for duplicate submissions and cross-check values. *See section 4.2 for more information.*

OBJECTNUMBER [Required]

The number assigned by the MPC to the asteroid.

Value Type:	Integer. Do not use a leading plus sign since this value is always positive. Maximum Value: 4294967295
Default:	0
Example:	OBJECTNUMBER=222
Notes:	If no number has been assigned, the value should be set to 0, i.e., OBJECTNUMBER=0.

❖ This is one of the core keywords used to check for duplicate submissions and cross-check values. *See section 4.2 for more information.*

OBJECTRA [Optional]

The approximate Right Ascension of the object at the given SESSIONDATE and SESSIONTIME.

Value Type:	String. No surrounding quotes.
Max Length:	5 characters
Format:	hh:mm. 24-hour format. Use leading zeros. Use a colon to separate hours and minutes.
Default:	<BLANK>
Example:	OBJECTRA=03:48

OBSERVERS [Required]

The names of those who acquired the data, usually the person working the telescope and/or who measured the images. These are the persons to whom credit should be given for the data.

Value Type:	String. No surrounding quotes.
Max Length:	1024 (see Notes)
Format:	The names can be given as either initials surname or surname, initials. See the examples below.
Default:	<BLANK>
Example:	OBSERVERS=Astronomer, J.Q; Assistant, H.I.S.
	OBSERVERS=J.Q. Astronomer; H.I.S. Assistant
Notes:	Multiple names *must* be separated by semicolons, not commas, since commas are used when surname is given first.
	The *metadata block* can contain one or more OBSERVERS lines. Each line, including 'OBSERVERS=', *must* be 255 characters or less. The maximum value is for the total number of characters in the *values*.
	Three characters are added internally to the end of each OBSERVERS line value. When retrieving data, these allow parsing the data block into the original lines. These 3 characters per line count against the maximum length.

OBSLATITUDE [Optional]

The latitude from which the observations were made.

Value Type:	Floating point, non-exponential
Format:	See the numeric formatting guidelines at the start of this section. Use up to 0.000001 degree (0.0036 s) precision.

Value Range:	−90.0 to +90.0
Example:	`OBSLATITUDE=+39.083333`
Notes:	Use a negative value for locations in the Southern Hemisphere.
	If a lightcurve block has multiple observers at different longitudes and/or latitudes, the longitude and latitude of the first observer in the list should be given and COMMENT lines added to indicate the locations for the other observers.

OBSLONGITUDE [Optional]

The longitude from which the observations were made.

Value Type:	Floating point, non-exponential
Format:	See the numeric formatting guidelines at the start of this section. Use up to 0.000001 degree (0.0036 s) precision.
Value Range:	−180.0 to +180.0
Example:	`OBSLONGITUDE=−104.757773` (indicates a position in Colorado, USA).
Notes:	ALCDEF uses negative longitudes for positions in the Western Hemisphere.
	If a lightcurve block has multiple observers at different longitudes and/or latitudes, the longitude and latitude of the first observer in the list should be given and COMMENT lines added to indicate the locations for the other observers.

PABB [Optional]

The phase angle bisector (PAB) latitude for the UT date/time given by the SESSIONDATE and SESSIONTIME keywords.

Value Type:	Floating point, non-exponential.
Format:	See the numeric formatting guidelines at the start of this section. Use 0.1 degree precision.
Value Range:	`−90.0 to +90.0`
Example:	`PABB=+2.4`

PABL [Optional]

The phase angle bisector (PAB) longitude for the UT date/time given by the SESSIONDATE and SESSIONTIME keywords.

Value Type: Floating point, non-exponential.

Format: See the numeric formatting guidelines at the start of this section. Use 0.1 degree precision.

Value Range: +0.0 to +359.9

Example: PABL=+193.5

PHASE [Optional]

The solar phase angle (Earth-Sun angle as seen from the asteroid) at the UT date/time given by the SESSIONDATE and SESSIONTIME keywords.

Value Type: Floating point, non-exponential.

Format: See the numeric formatting guidelines at the start of this section. Use no more than 0.01 degree precision.

Value Range: +0.00 to +180.00

Example: PHASE=+5.63

PUBLICATION [Optional]

The citation for the work where the data and/or analysis based on the data appeared. This is different from BIBCODE, which gives the universal 19-character publication reference, e.g., BIBCODE=2010MPBu...37..169W

Value Type: String. No surrounding quotes.

Max Length: 60

Example: PUBLICATION=Minor Planet Bul. 37, 169-171.

REDUCEDMAGS [Required]

Indicates whether or not the target magnitudes have been corrected to "unity distance" using the formula

```
Mag(reduced) = Mag(observed) -5*log(rR)
```

Value Type: String. No surrounding quotes.

Allowed Values: NONE, AVERAGE, POINT

NONE	The magnitudes given the data lines have not been corrected to unity distance.
AVERAGE	The fixed value given by the UCORMAG keyword was applied to all target magnitudes in the data lines.
POINT	The unity correction was computed by finding the Earth-asteroid and Sun-asteroid distance at the JD for each data line and then applied to the observed magnitude.

If any correction is applied, it is strongly encouraged that AVERAGE be used instead of POINT. This allows the data user, if he wants, to remove the fixed UCORMAG value from all observations. For near-Earth asteroids, the difference between the fixed UCORMAG value and the actual (unknown) correction as applied when using POINT can be significant.

Default: NONE

Example: REDUCEDMAGS=AVERAGE

Notes: If REDUCEDMAGS is AVERAGE OR POINT, then the UCORMAG keyword must be present in the *metadata block* and have a non-zero value. Otherwise, the *lightcurve block* is rejected.

If REDUCEDMAGS=NONE, the UCORMAG value can still be included in the *metadata block*. In this case, it should be the value that would be used if REDUCEDMAGS=AVERAGE.

REVISEDDATA [Required/Optional]

Indicates if the data being submitted should replace existing data, if a match can be found.

Value Type:	Boolean
Max Length:	5 characters
Allowed Values:	TRUE, FALSE

TRUE
Replace existing data, if found. If not found, add new *lightcurve block*.

FALSE (or keyword missing)
Add new *lightcurve block* only if an existing *lightcurve block* is not found.

See section 4.2 for the criteria used to check for an existing lightcurve block.

Example: REVISEDDATA=TRUE

❖ This is one of the core keywords used to check for duplicate submissions. See section 4.2 for more information.

SESSIONDATE [Required]

The UT date for the approximate mid-time of the data set in the current lightcurve block.

Value Type:	String. No surrounding quotes.
Format:	yyyy-mm-dd

All digits must be used for year, month, and date. Use leading zeros as required to fill a given subfield.

Default:	None.
Example:	SESSIONDATE=1999-04-17
Notes:	The *lightcurve block* is rejected if this value is missing or has an invalid format.

❖ This is one of the core keywords used to check for duplicate submissions. See section 4.2 for more *information.*

SESSIONTIME [Required]

The UT time for the approximate mid-time of the data set in the current *lightcurve block*.

Value Type:	String. No surrounding quotes.
Format:	hh:mm:ss

Use 24-hour format, e.g., 1 PM = 13:00. All digits must be used for hours, minutes, and seconds. Use leading zeros as required to fill a given subfield.

Default: None.

Example: `SESSIONTIME=07:00:00`

Notes: The *lightcurve block* is rejected if this value is missing or has an invalid format.

❖ This is one of the core keywords used to check for duplicate submissions. See section 4.2 for more information.

STANDARD [Required/Optional]

Defines the system on which the magnitudes are based.

Value Type: String. No surrounding quotes.

Max Length: 12 characters

Allowed Values: NONE, INTERNAL, TRANSFORMED

NONE	The magnitudes are not referenced to a specific system. In this case, it is required that DIFFERMAGS=TRUE. If DIFFERMAGS=FALSE and STANDARD=NONE, the *lightcurve block* is rejected.
INTERNAL	The magnitudes are referenced to catalog magnitudes of the MAGBAND setting but have not been formally transformed to the standard system that defines that magnitude system. If DIFFERMAGS=TRUE and STANDARD=INTERNAL, the *lightcurve block* is rejected.
TRANSFORMED	The magnitudes are referenced to catalog magnitudes of the MAGBAND setting and have been formally transformed to the standard system that defines that magnitude system. If DIFFERMAGS=TRUE and STANDARD=TRANSFORMED, the *lightcurve block* is rejected.

Default Value: NONE (DIFFERMAGS=TRUE) or INTERNAL (DIFFERMAGS=FALSE).

Example: `STANDARD=INTERNAL`

Notes: The specific catalog from which the magnitudes are derived is not given since there are too many combinations, versions within a given catalog, etc.

It is implied that the combination of the values MAGBAND and STANDARD keywords gives the standard system on which the magnitudes are based.

For example, if MAGBAND=V and STANDARD=INTERNAL (or TRANSFORMED), then the magnitudes should be presumed to be Johnson V. If the data provider wants to give more specifics, the COMMENT keyword is available for that purpose.

STARTMETADATA [Required]

This keyword must appear by itself (with no value) on the first line starting a lightcurve block.

Example: STARTMETADATA

Notes: See Appendix A for a sample lightcurve block using this keyword.

UCORMAG [Required/Optional]

Gives the $-5*\log(rR)$ correction at the UT date/time given by the SESSIONDATE and SESSIONTIME keywords.

Value Type: Floating point, non-exponential.

Format: The value must include a leading plus or minus sign. The recommended precision is one decimal place more than the precision of the reported target magnitudes.

Example: UCORMAG=-3.697

                   UCORMAG=+0.044

Notes: If the value for the required keyword REDUCEDMAGS is AVERAGE or POINT, this keyword is required and so, if missing or not assigned a value, the *lightcurve block* is rejected.

APPENDIX A: SAMPLE LIGHTCURVE BLOCK

The following is a sample lightcurve block that uses all required and most optional keywords.

```
STARTMETADATA
REVISEDDATA=FALSE
OBJECTNUMBER=24654
OBJECTNAME=Fossett
MPCDESIG=
CONTACTNAME=B. D. Warner
CONTACTINFO=[brian@MinorPlanetObserver.com] 446 Sycamore Ave., Eaton, CO, USA
OBSERVERS=B. D. Warner
OBSLONGITUDE=-116.383333
OBSLATITUDE=+34.250000
SESSIONDATE=2014-11-04
SESSIONTIME=09:06:00
FILTER=C
MAGBAND=V
STANDARD=INTERNAL
DIFFERMAGS=FALSE
LTCTYPE=NONE
LTCDAYS=-0.006747
LTCAPP=NONE
REDUCEDMAGS=NONE
UCORMAG=-1.9508
OBJECTRA=04:08
OBJECTDEC=+00
PHASE=+12.44
PABL=+55.6
PABB=-15.8
CICORRECTION=FALSE
CIBAND=NONE
CITARGET=+0.000
PUBLICATION=
BIBCODE=
COMPNAME1=040836.38 +001547.2
COMPMAG1=+14.365
COMPCI1=+0.445
COMPRA1=04:08:36.37
COMPDEC1=+00:15:47.1
COMPNAME2=040815.78 +001512.6
COMPMAG2=+14.580
COMPCI2=+0.379
COMPRA2=04:08:15.77
COMPDEC2=+00:15:12.1
COMPNAME3=040829.69 +001901.9
COMPMAG3=+15.109
COMPCI3=+0.407
COMPRA3=04:08:29.70
COMPDEC3=+00:19:01.7
COMPNAME4=040846.74 +000840.3
COMPMAG4=+15.369
COMPCI4=+0.479
COMPRA4=04:08:46.74
COMPDEC4=+00:08:40.1
DELIMITER=PIPE
COMMENT=Heliocentric ecliptic longitude/latitude: +60.02/-20.38
COMMENT=Earth/Sun distances (AU): +2.1007/+1.1689
COMMENT=Observer Instrumentation: 0.30m f/9.6 SCT/ML-1001E
ENDMETADATA
DATA=2456965.735795|+17.521|0.091|1.881
DATA=2456965.738778|+17.491|0.091|1.840
DATA=2456965.741760|+17.332|0.073|1.802
ENDDATA
```

Intentionally Blank

APPENDIX B: Simple-ALCDEF (S-ALCDEF)

B.1   INTRODUCTION

This appendix covers the S-ALCDEF standard and serves as a brief user's guide to the associated upload page on the Minor Planet Center web site.

With the infusion of large amounts of lightcurve data from wide-field surveys, e.g., the Palomar Transit Factory, and the asteroid community in general, a simplified format and submission process were introduced in 2015 August.

The new format is not quite as rigorous as the formal ALCDEF standard, e.g., data from multiple nights for the same object can be submitted in one lightcurve block, assuming that nothing changed such as whether or not the data are light-time corrected, different filters were used, and so on. Several examples are given below to illustrate the flexibility inherent in the new format.

The changes go hand-in-hand with a new submission page on the Minor Planet Center web site. The page can be accessed from the ALCDEF home page

http://www.MinorPlanetCenter.net/light_curve

The screen shot of the upload section of the main page highlights the link to the simple upload page (SUP). The SUP has two sections for data input that, in some cases, apply to all data in the upload file and, in others, can be overridden on a block-by-block basis.

B.1.1   PERMITTED OBJECTS

Data is accepted only for objects that appear in the most recent MPCORB file. Observations of, e.g., NEOCP objects or those with custom designations, can be submitted once the object receives an MPC designation.

B.2 S-ALCDEF PROCESS

When a file is submitted on the S-ALCDEF page, it is converted to a temporary file that is fully ALCDEF-compliant. The temporary file is then passed to the ALCDEF parsing routines that validate the incoming data and, if valid, add them to the ALCDEF database. A message is returned that indicates if all or some of the data were accepted. If there were errors, a link is provided to a text file that details the problems.

In order for this process to work, the file being submitted must also follow the S-ALCDEF standard, which is less stringent than the ALCDEF standard, making it relatively easy to submit existing or archive data without significant editing.

B.2.1 LIGHTCURVE BLOCKS

The format for S-ALCDEF files is similar to that of the ALCDEF standard. Each block of data must have the form that uses four "marker" keywords

    STARTBLOCK
    [metadata overrides]
    STARTDATA
    <data lines>
    ENDDATA
    ENDBLOCK

Immediately after the file is received, it is pre-processed to confirm that for each START marker, there is a corresponding END marker and that the START/ENDDATA markers are between the START/ENDBLOCK markers. If the test fails, an error message is returned. See B.3 for additional information.

B.2.2 METADATA OVERRIDES

Some of the information entered on the page can be overridden on a block-by-block basis. For example, if most of the blocks have observations in the V filter and V magband but one block has observations in the R filter and magband, a metadata override line can be placed between the STARTBLOCK and STARTDATA markers.

The metadata lines must use the same format as the ALCDEF standard, i.e., <keyword>=<value>. With the exception of information regarding exposure time and duration, the keyword used must be one recognized by the ALCDEF standard and its corresponding value must be valid under the standard. The sections below on the data entry sections of the upload page provide more details.

B.2.2.1 KEYWORDS

The following keywords are recognized by the S-ALCDEF standard as those that can be used to override the default metadata values entered on the submission page

ALCDEF Keyword	Page Entry Field	Valid Metadata Values (Field options are in parentheses)
OBJECTNUMBER	Object Number	>= 0
OBJECTNAME	Object Name	Name or MPC designation must be in MPCORB
OBSLONGITUDE	Longitude	Default longitude if all observations from same place
OBSLATITUDE	Latitude	Default latitude if all observations from same place
LTCTYPE	L-T Correction	NONE (No) or AVERAGE (Yes)
REDUCEDMAGS	Reduced Mags	NONE (No) or AVERAGE (Yes)
FILTER	Filter	See FILTER keyword in ALCDEF standard

ALCDEF Keyword	Page Entry Field	Valid Metadata Values (Field options are in parentheses)
MAGBAND	Mag Band	See MAGBAND in Section 5.
STANDARD	Mag System	See STANDARD in Section 5.
DIFFERMAGS	Differ Mags	FALSE or TRUE (See DIFFERMAGS in Section 5)
EXPOSURETIME	Exposure JD	START, MID, END (see note)
EXPOSURE	Exp (sec)	0 for MID, positive number for START or END (see note)

The two exposure keywords are not part of the ALCDEF v2.1 standard, which states that the JD values are for mid-exposure. The EXPOSURETIME value is used to indicate if the JD is for the start-, mid-, or end-time of the exposure. For START and END, a positive value of the exposure (in seconds) must be given in order to allow the JD for each observation to be converted to exposure mid-time. The conversion is *not* made during the upload process in order to preserve the original data. Comment lines that give the exposure information are added to the metadata section of the temporary ALCDEF-compliant file before it is processed.

Section B.3 gives examples of metadata line overrides.

B.2.3.2 ALCDEF KEYWORDS

The section with metadata overrides can also contain lines that use ALCDEF keywords that are not included in the S-ALCDEF standard, e.g., COMPSTAR, OBSLONGITUDE, etc. These lines will pass through unchanged and be included in the temporary ALCDEF file for processing. Just as with an ALCDEF file, if the keywords have invalid values or cross-checks against other keywords fail, the particular lightcurve block will not be added to the ALCDEF database.

B.2.3 DATA LINES

Data lines for S-ALCDEF follow the same rules as under the ALCDEF standard *with one important exception*: the line should begin with the JD and not with 'DATA='. For example:

Yes   2457210.698517|+18.377|+0.121

No   DATA=2457210.698517|+18.377|+0.121

The parsing algorithm does check for non-numeric characters at the beginning of the line and removes them from the line. However, *the resulting line must be at least 7 characters long*, reflecting that it includes at least part of a Julian Date in some form and a magnitude.

B.2.3.1 JULIAN DATES

Unlike the ALCDEF standard, S-ALCDEF does not require that the JD in the data lines be the full Julian Date at mid-exposure, e.g., seven digits before the decimal point and one or more digits after, 2456589.44586 for example.

Modified Julian Dates are allowed as well as partial dates, e.g., those having only the last four significant numbers of the full date plus the decimal part, 6545.3342 for example.

The parsing algorithm converts the given values to full JD for the temporary ALCDEF file for final processing since this is what's stored in the ALCDEF tables. To do this, the upload page includes a "JD Offset" field. If non-zero, that value is added to the one in the data line to get the full JD. See Section B.3 for more information.

B.2.3.2 PARSING DATA FROM MULTIPLE DATES

An important aspect of S-ALCDEF is that data covering multiple dates for a single object can be placed

into a single START/ENDDATA section, providing that *none* of the default or S-ALCDEF keywords change throughout the period.

The parsing algorithm that creates ALCDEF-compliant lightcurve blocks first sorts all the observations within a DATA section in ascending date order. It then compares two succeeding JD in the data lines. If the difference between the first and second observation is greater than 0.25 day, this is considered to be the start of a new lightcurve block.

If this will cause data put into the new DATA block that you intend to be considered part of the existing DATA block, the file being uploaded must be edited so that it contains more than one lightcurve block and places the data lines in each block as required.

B.2.4 COMMENTS

Comments are allowed within the file at any location. The hash symbol '#' is used to mark the start of a comment. All characters after the hash symbol and the symbol itself are removed from the line before any additional handling. Here are some examples:

STARTBLOCK #Lightcurve block for 2929 Harris

2456588.44578|14.150|0.105 # This may be a bad observation

#2456588.44578|14.150|0.105 (comments out a given data line; it will be ignored).

Do not include the hash symbol in any line in the file unless you use it to mark the start of a comment. For example, including it in a COMMENT line to be added to the metadata section will cause the line to be truncated starting with the hash symbol.

B.3   THE S-ALCDEF UPLOAD PAGE

The upload page has an information section that includes a link to this document. It is followed by three sections: Required Data, Base Data, and File Upload. These will be covered in detail in this section.

B.3.1 REQUIRED DATA

Required Data (No override)	
Contact Name	
	e.g., J. Q. Astronomer
Contact Info	
	e.g., email, snail mail (*do not include Contact Name*)
Observers	
	Use semicolon to separate names, e.g., J. Q. Astronomer; H. I. S. Assistant
Delimiter	Pipe (¦) / Tab / Space / Comma — Data columns delimiter
JD Offset	0.0 Value required to get full JD (not MJD). See documentation.
Comment	
	Additional information that applies to all observations. Max chars: 400.
	Text will be split into COMMENT lines of up to 75 characters each.

These are data common to all the data being submitted. *They cannot be overridden*. A separate file must be submitted for each combination of these fields. See Section 5 for more details about the keyword associated with each entry.

Contact Name (ALCDEF keyword: CONTACTNAME)
Enter the name of the person submitting the data or responsible for it.

This field is set to "required" on the input form. The file cannot be submitted if this field is blank.

Contact Info (ALCDEF keyword: CONTACTINFO)
Enter contact information for the person in Contact Name. Do not include the name again but instead, e.g., an email or postal mailing address. Since these data will be archived and maybe used some time in the future, as much as possible this should not be a transient point of contact.

This field is set to "required" on the input form. The file cannot be submitted if this field is blank.

Observers (ALCDEF keyword: OBSERVERS)
Enter the names of observers who collected the data. Separate observers with a semi-colon. A maximum of 150 characters is allowed.

Delimiter (ALCDEF keyword: DELIMITER)
This is single character that separates the elements of the data lines, e.g., here the pipe character (|) is used to separate the JD, magnitude, and estimated magnitude error

    2456783.6740|14.874|0.006

Except when setting is Space, two consecutive delimiters will produce an empty value, which then becomes 0. For example,

    2456783.6740||0.006

would result in a magnitude of 0.0 for the observation. If the setting is 'Space', the parsing algorithm removes extra spaces *within* the line.

The line should not include a delimiter at the end, although a trailing space would be automatically "trimmed" and so not processed.

ALCDEF vs. S-ALCDEF Delimiters
The ALCDEF standard recognizes only two delimiters, the pipe (|) or a tab (ASCII 9). S-ALCDEF also recognizes Space and Comma (with no enclosing quotes around each field).

If including an override line in the file to be uploaded, *use the S-ALCDEF keyword*. For example,

    DELIMITER=SPACE

The parsing algorithm replaces non-ALCDEF delimiters with the pipe (default) delimiter. For example,

    2456783.6740,14.874,0.006

becomes

    2456783.6740|14.874|0.006

in the temporary ALCDEF file so that it will not fail for having an invalid delimiter.

JD Offset (ALCDEF keyword: None)
This field is used only if the data lines do not include the full Julian Date for each observation, e.g., the values are Modified Julian Date (MJD) and/or only partial values containing the last 3 or 4 significant digits of the full date plus the decimal date.

This value will be added to the value in each data line before it is stored in the temporary ALCDEF file. The result *must* be the correct full Julian Date (not MJD). For example, if all data lines include values that are MJD – 2450000.0, e.g., 5689.45774, the JD Offset field would be 2450000.5 (the 0.5 required to convert from MJD to JD).

If the values in the file are full JD, enter 0.0 in the field.

If JD Offset is not 0, a comment line is added to the ALCDEF metadata section(s):

  COMMENT=Original (M)JD values were converted to full JD using: JD = OrgJD + <JD Offset>

Comment (ALCDEF keyword: COMMENT)
This field is applied to all lightcurve blocks. It might include something about the instrumentation or any other information that a future researcher might consider important in order to make proper use of the data.

Enter up to 400 characters in the field. Do not press <RETURN> to create new lines. The entry will be split into as many COMMENT lines of about 75 characters as required. There is no control over where the breaks occur.

The ALCDEF database stores all COMMENT lines in a single field of up to 2040 characters (without 'COMMENT='). Make sure the sum of all the comments, including those added automatically by the S-ALCDEF parsing code, do not exceed this limit.

B.3.2 BASE DATA

These fields contain essential information, almost all required under the ALCDEF standard, but can be overridden in one or more lightcurve blocks in the file being submitted. If the keyword associated with a given entry field is not part of the metadata overrides section (between STARTBLOCK and STARTDATA), the keyword and the value in the field will be written to the temporary ALCDEF file.

Some of the keywords are interactive, i.e., the value for one requires specific values for another keyword. These are covered in the main sections of this document as well as as-needed below.

Base Data (Can override)

Object Number	[ ] Leave blank if not numbered
Object Name	[ ] Enter MPC designation if not named. When a non-zero number and name are given, they must be for the same object, e.g., 5463 Ceres will be rejected.
Default Longitude Latitude	Longitude [ ] ±DDD.dddddd (-180.00 to +180.00) Negative for Western Hemsphere / Latitude [ ] ±DD.dddddd (-90.00 to +90.00) Negative for Southern Hemsphere
L-T Correction	No / Yes — If Yes, the correction at mid-time will be added to the output
Reduced Mags	No / Yes — If Yes, the correction at mid-time will be added to the output
Miscellaneous S'X' = SDSS	Filter: Clear/None, B, **V**, R, I, SU, SG, SR / Mag Band: B, **V**, R, I, SU, SG, SR, SI / Mag System: None, **Internal**, Transformed; Differ Mags: **False**, True; Can't be NONE *and* FALSE / Exposure JD: **Mid**, Start, End; Exp (sec) [0]; Enter 0 if mid-time
Revised	**False** / True — See ALCDEF documentation before submitting revised data

Object Number (ALCDEF keyword: OBJECTNUMBER)
If all, or most, of the data are for one object and that object is numbered, enter the number here. If the object is not numbered or *all* blocks in the file being submitted include OBJECTNUMBER overrides, then leave this field blank.

Do not enter 0 for unnumbered objects when providing a name in Object Name.

Object Name (ALCDEF keyword: OBJECTNAME)
If all, or most, of the data are for one object and that object is named or has an MPC designation, enter the name or designation here. If *all* blocks in the file being submitted include OBJECTNAME overrides, then leave this field blank.

If named, enter the name of the object (case-sensitive). Use the name in preference to an MPC designation. If numbered but not named, enter the currently-used MPC designation.

General Notes about Object Number and Object Name
If Object Number is blank or 0, all the data are for the same object, and there are no metadata override lines in the file as needed, Object Name must have a valid entry.

During the initial processing of the file, a look-up is performed using the number and/or name to find the current MPC designation (even if Object Name is the designation). *The results of this search override Object Number or the Object Name field, depending on which one was used for the search*.

If Object Number is blank or 0, the Object Name field takes precedence in the search. Therefore, if entering one or the other, it's generally better to enter a value in Object Name since searching on the number would the first unnumbered asteroid in the MPCORB file.

If you enter a number, it's better not to enter a value in Object Name as well. In either case, enter the value that you are certain applies to those lightcurve blocks that do not include metadata overrides.

Longitude / Latitude (ALCDEF keyword: OBSLONGITUDE / OBSLATITUDE)

Enter the longitude (±DDD.ddddd) and latitude (±DD.dddddd) of the primary observatory location. This may be different from the position for the person under Contact Info.

Use a leading + for all positive values. Longitude is negative for the Western Hemisphere. Latitude is negative for the Southern Hemisphere. The position should be given to as high a precision as possible, preferably to 1" (~0.0003°) or better.

If either field is blank (empty), its corresponding line will not be included in the ALCDEF database. *It is strongly encouraged that the longitude and latitude be included if at all possible.*

If the data were obtained at multiple locations, use the comments field to note this.

L-T Correction (ALCDEF keyword: LTCTYPE)

Select 'No' if the data are not light-time corrected, which is the preferred value under the ALCDEF standard. In this case, each lightcurve block in the temporary ALCDEF file will include the line

    LTCTYPE=NONE

Select 'Yes' if the data are light-time corrected. In this case, each lightcurve block in the temporary ALCDEF file will include the lines

    LTCTYPE=LIGHTTIME
    LTCAPP=AVERAGE
    LTCDAYS=<value computed for mid-time of data block by parsing algorithm>

Important: If the setting is 'No' (not light-time corrected) but one or more blocks have data that *are* light-time corrected, *all three lines immediately above must be included* with the correct values. For LTCTDAY, the proper correct must be entered. This will be a negative number that is 0.005772 * Earth distance (in AU).

If the field is set to 'Yes' (light-time corrected) but one or more blocks have data are *not* light-time corrected, only one line, LTCTYPE=NONE, should be included.

See the discussion for these keywords in Section 5 for more information.

Reduced Mags (ALCDEF keyword: REDUCEDMAGS)

Select 'No' if the magnitudes in the data blocks have not been corrected to unity distance using $-5*\log_{10}(\text{EarthDist} * \text{SunDist})$. Assuming "Mag System" (see below) is set to Internal or Transformed, the magnitudes would be the sky magnitude, i.e., their apparent brightness. In this case, the temporary ALCDEF file includes the line

    REDUCEDMAGS=NONE

Select 'Yes' if the magnitudes in the data blocks have been corrected to unity distances. In this case, these lines are added to the temporary ALCDEF file:

    REDUCEDMAGS=AVERAGE
    UCORMAG=<value computed for mid-time of data block by parsing algorithm>

Metadata Override Lines

If the setting is 'No' and one or more blocks have reduced magnitudes, include these lines in the metadata overrides section

    REDUCEDMAGS=AVERAGE
    UCORMAG=<value computed for mid-time of data block >

If the setting is 'Yes' and one or more blocks do not have reduced magnitudes, include this line in the metadata overrides section

      REDUCEDMAGS=NONE

Filter (ALCDEF keyword: FILTER)
Select the filter that was used for the observations. The filters starting with 'S' are the Sloan filters, i.e., u', g', r', i', and z'.

If an override line is required, it should be

      FILTER=<filter>

where <filter> is one of the items shown in the list. See the discussion in section 5 for this keyword for more information.

Mag Band (ALCDEF keyword: MAGBAND)
Select the filter that was used for the observations. The filters starting with 'S' are the Sloan filters, i.e., u', g', r', i', and z'. Except when filter is Clear/None, this is almost always the same value as selected for Filter.

If an override line is required, it should be

      MAGBAND=<magband>

where <magband> is one of the items shown in the list. See the discussion in section 5 for this keyword for more information.

Mag System (ALCDEF keyword: STANDARD)
See the discussion for this keyword in Section 5 for information about each option.

If an override line is required, it should be

      STANDARD=<option>

Important: If set to 'None', then Differ Mags (see below) *must* be set to 'True'. Similarly, if Mag System is set to 'Internal' or 'Transformed', Differ Mags *must* be set to 'False'. The parsing algorithm *does not* cross-check these. Such cross-checks are performed on the temporary ALCDEF file.

Differ Mags (ALCDEF keyword: DIFFERMAGS)
Select 'False' if the magnitudes are sky (reduced or not), e.g., 14.233.

Select 'True' if the magnitudes are differentials from a common zero point, e.g., –1.329.

If Differ Mags is set to 'False', the setting for Mag System *must* be 'Internal' or 'Transformed.' If Differ Mags is set to 'True', the setting for Mag System must be 'None.'

If the setting is 'False', the override lines would be

      DIFFERMAGS=TRUE
      STANDARD=NONE

If the setting is 'True', the override lines would be

      DIFFERMAGS=FALSE
      STANDARD=INTERNAL or TRANSFORMED

It is important that *both* lines be included and each has the correct value.

Exposure JD (ALCDEF keyword: None, S-ALCDEF keyword: EXPOSURETIME)
The three options are:

Mid   JD in data section are for mid-exposure (ALCDEF standard)
Start   JD in data section are for the start of the exposure
End   JD in data section are for the end of the exposure

The ALCDEF default is for mid-exposure. If the JD values are not for that time, then Exposure JD must be set to 'Start' or 'End' (there is not an 'other' option) and the exposure time, in seconds, entered in the Exp (sec) field. This allows the end-user to convert the data to mid-time and so make it compatible with other data already in the ALCDEF database.

If Exposure JD is 'Mid' and one or more blocks of data have start or end times, the metadata override lines would be

EXPOSURETIME=START or END
EXPOSURE=360

If Exposure JD is 'Start' or 'End' and one or more blocks of data have mid-times, the metadata override line would be

EXPOSURETIME=MID
EXPOSURE=360   (optional, not required)

- Note that non-numeric values for many keywords in the ALCDEF standard are in all caps. This does not apply to such keywords such as CONTACTNAME/INFO or OBJECTNAME. See Section 5 for specific information about the values for each keyword.

Important: The parsing algorithm does not alter the JD values. Instead, COMMENT lines are added to the temporary ALCDEF file. In the case where the JD are mid-times, the inserted line is

COMMENT=JD are for mid-exposure

even though such a line is not required since mid-times are the default for ALCDEF.

If the JD are start or end times, two comment lines are inserted:

COMMENT=JD are for the exposure <Exposure JD selection> time
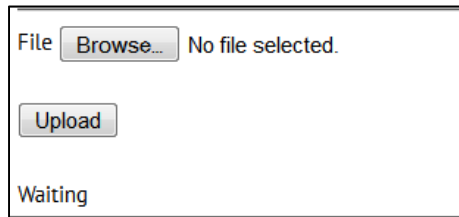COMMENT=Exposure time (seconds) <value in Exp (sec) field>

Revised (ALCDEF keyword: REVISEDDATA)
Select 'False' if submitting data not previously submitted.

Select 'True' if submitting data that is to replace existing data.

The ALCDEF standard allows a limited ability to correct bad entries. However, this mainly applies to the data lines, not the core metadata. See Section 4.2 ("Duplicate Data Check") and the discussions in Section 5 for this keyword and the core keywords that *must be the same as in the original submission*.

B.3.3 FILE UPLOAD

Once the file to be submitted is properly prepared and the entry fields on the upload page are set to the correct values, the data can be submitted for processing and, if valid, inclusion into the ALCDEF database.

Browse
Click the Browse button to display a file selection form. Navigate to the directory where the file to be uploaded is stored and select it per the way your operating system dictates. The name of the file, without path, replaces "No file selected"

Upload
Click the Upload button to upload the file and being processing. If this button is clicked without a file selected, an error message is returned.

Waiting
This label displays the returned message from the upload and parsing process.

If Upload is clicked before a file is selected, the message will say "No file selected."

If there is an error during the initial processing and processing, the label will change to red and display the error message.

After the temporary ALCDEF file is processed, the label will report the final status. It will include lines that indicate how many lightcurve blocks were accepted, how many were rejected, and the name of the file again to make it easier to remember which file was just processed when doing several at a time.

If there was an error, one or more lines will be in red and there will be a link at the bottom of the message. Click on the link ("Click here") to display the error report as a text file loaded into browser.

Use File | Save (or other appropriate commands) in the browser to save the file. It is not possible to retrieve the file later since error report files are deleted approximately five minutes after they are generated.

B.4 SAMPLE S-ALCDEF FILES

Example 1

```
#Assume that all the values on the upload page apply to all the data,
#which are for the same asteroid. In this case, OBJECTNUMBER/NAME
#are not required as metadata overrides
#First night
STARTBLOCK
STARTDATA
2457210.698517|+18.377|+0.121
2457210.700769|+18.489|+0.136
...
2457210.722255|+18.122|+0.100
2457210.723028|+18.067|+0.091
ENDDATA
ENDBLOCK


#Second Night
STARTBLOCK
STARTDATA
2457210.776946|+17.375|+0.055
2457210.777695|+17.419|+0.058
...
2457210.787437|+17.284|+0.055
2457210.789563|+17.197|+0.053
ENDDATA
ENDBLOCK
```

Example 2

```
#Assume that the OBJECTNUMBER and OBJECTNAME entry fields have valid values
#and that all data are for that one asteroid but on night two the FILTER and
#MAGBAND values changed from the upload page settings.
#First night
STARTBLOCK
STARTDATA
2457210.698517|+18.377|+0.121
2457210.700769|+18.489|+0.136
2457210.703026|+18.354|+0.121
...
2457210.720805|+18.309|+0.109
2457210.722255|+18.122|+0.100
2457210.723028|+18.067|+0.091
ENDDATA
ENDBLOCK

#Second Night
STARTBLOCK
FILTER=R
MAGBAND=R
STARTDATA
2457210.776946|+17.375|+0.055
2457210.785932|+17.281|+0.055
...
2457210.787437|+17.284|+0.055
2457210.789563|+17.197|+0.053
ENDDATA
ENDBLOCK
```

Example 3

```
#Data are for different asteroids but all other settings are constant
#First asteroid
STARTBLOCK
OBJECTNUMBER=1
OBJECTNAME=Ceres
STARTDATA
2457210.698517|+18.377|+0.121
2457210.700769|+18.489|+0.136
...
2457210.722255|+18.122|+0.100
2457210.723028|+18.067|+0.091
ENDDATA
ENDBLOCK

#Second asteroid
STARTBLOCK
OBJECTNUMBER=70030
OBJECTNAME=Margaretmiller
STARTDATA
2457210.776946|+17.375|+0.055
2457210.777695|+17.419|+0.058
...
2457210.787437|+17.284|+0.055
2457210.789563|+17.197|+0.053
ENDDATA
ENDBLOCK
```

Example 4

```
#Data are for the same asteroid and all other settings are constant
#but the data for two nights are put into one data block
#The parsing process assume that a jump of 0.25 or more from one JD to
#the next implies observations on a different day, or significantly removed from
#the previous group, and so it would start a new ALCDEF lightcurve block
STARTBLOCK
STARTDATA
2457210.698517|+18.377|+0.121
2457210.700769|+18.489|+0.136
...
2457210.722255|+18.122|+0.100
2457211.739301|+17.810|+0.078    #note change in JD to 1 day later
2457211.740049|+17.975|+0.091
...
2457211.757986|+17.675|+0.068
2457211.758740|+17.599|+0.064
ENDDATA
ENDBLOCK
```

The comment at the end of the first data line for the second night would be ignored. This shows that comments do not have to be at the start of a line.

Do not confuse the comments preceded with the hash symbol with those using the COMMENT keyword. The latter, if placed in the metadata section, will be added to the Comments field in the ALCDEF table for the associated record, i.e., they are a part of the permanent record, while the hash symbol comments are for the submitter's private information and are discarded during the parsing process.