Asteroid Lightcurve Data Exchange Format (ALCDEF)

Definition and Standards

v. 2.3.0

2021 September 1

Table of Contents

The Asteroid Lightcurve Data Exchange Format Standard

ALCDEF v 2.3.0 (2021 September 1)

Unlike astrometric observations of asteroids, where a universally accepted format for data submission has long been adopted, time-series photometry of asteroids can and is found in any number of formats. This makes it more difficult for archivists and researchers since they 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 without which the usefulness of archived data can be dramatically reduced.

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.

ALCDEF data can be freely uploaded and retrieved via the website *https://minplanobs.org/alcdef* or, once final transfer of domain hosting is made, *https://alcdef.org*.

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

ALCDEF and NASA PDS
Starting with ALCDEF version 2.2, new keywords were added to satisfy requirements of NASA's Planetary Data System. This was in preparation of having all ALCDEF data submitted prior to v2.2 and, starting with v2.2 those with explicit permission, transferred to the PDS in a single archive that would be periodically updated.

The advantages are 1) it saves having to prepare different data files for submission to the PDS and 2) the data will undergo review and will be indexed by the SAO/NASA Astrophysics Data System (ADS).

✎ Please review this revised document carefully. To be as compliant as possible with PDS standards, new keywords, some required have been added and some pre-existing keywords have been changed from optional to required.

Every effort has been made to assure that ALCDEF files created before this version of the standard will be compatible when uploading data. Some data will not be available in those older files and so default values will be assigned as needed. Those retrieving data should be aware of the changes and, if necessary, revise any parsing programs.

One of the new keywords is SUBMITPDS. This is an "opt-in" feature. The submitter *must give explicit permission* by putting this keyword in the *metadata block*. The *alcdef.org* page includes a field to give general permission to all *lightcurve blocks* in the file being uploaded. The option must be specified before the file upload is allowed.

If the SUBMITPDS keyword is found in the file being uploaded, its value supersedes the general permission settings. If the keyword is not found, the general permission setting will apply.

If SUBMITPDS=TRUE, the data *will be* submitted to the PDS *regardless of the general permission setting.*

If SUBMITPDS=FALSE, the data **will not** be submitted to PDS *regardless of the general permission setting.*

This does not apply to legacy data, which is all ALCDEF data submitted on or before the earlier of 2018 September 1 and the date ALCDEF 2.2 was officially released.

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 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 process and store the data into the ALCDEF database

- All files must use standard ASCII format or UTF-8 encoding. The file **must not** include a BOM (byte order mark) that precedes the first character of the text.

- When submitting a UTF-8 file, do not include text markups, e.g., bold, italics, etc. The reason for allowing UTF-8 is to include characters with diacritical marks.

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

- All lines follow the format of *keyword=value.*

- All data must use a period (.) for the decimal character, a dash (-) for the date separator, and a colon (:) for the time separator.

- 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 ignored when uploading the data to the ALCDEF site and, generally, will not cause a *lightcurve block* to be rejected.

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

  Metadata
  Data

- 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 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 immediately follow the METADATA section, which is terminated by the ENDMETADATA line.

- *There is no STARTDATA keyword*.

- There must be *at least two lines* of data in a lightcurve block. It is *strongly* recommended that there be at least five data lines.

- 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]

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 and, preferably, *without* light-time correction.
MAG	Yes	The magnitude of the object at time JD. This field is required. See section 2 for formatting requirements.
MAGERR	Strongly encouraged	The estimated error in the MAG value, in magnitudes.
AIRMASS	Deprecated	The air mass of the target at time JD. This field has been deprecated. Files including the air mass will not fail, but the data will no longer be stored.

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

PIPE   (ASCII 124)
SEMICOLON   (ASCII 59)
TAB   (ASCII 9)

The SPACE (ASCII 32) and COMMA (ASCII 44) are not used because they could be inadvertently included within words or values, e.g., it is common for those in many countries to use the comma for the decimal character.

Consecutive delimiters are interpreted as a NULL value.

✧ Submissions to the Simple ALCDEF (S-ALCDEF) do allow commas and spaces. Those are automatically converted to the PIPE character in a temporary file that is then processed as if it were a "regular" ALCDEF file.

1.2   COMPARISON STARS

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

A compstar 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   ASPECT 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 aspect 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 uses name-value pairs, i.e., *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.
- All data must use a period (.) for the decimal character, a dash (-) for the date separator, and a colon (:) for the time separator.
- String values, e.g., "This is a comment line", should not include the surrounding quotes.
- 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.
- When appropriate, positive numbers should include a leading plus sign (+) in cases where there might be any ambiguity. Two examples are color index and magnitude (a must if reporting differential values). The JD in the Data section do not and should not include the + sign, but it is not a fatal error to do so.
- Negative numbers *must* include a leading minus sign (–).
- Floating-point numbers $|x| < 1.0$ *must* include a leading zero. For example: +0.258 or –0.455.

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

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

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*, i.e., there must be at least two time-series observations.

Keywords in blue text are new or have been revised in this version.

BIBCODE	**CONTACTNAME**	LTCDAYS	PABB
CIBAND	**DATA**	LTCTYPE	PABL
CICORRECTION	DELIMITER	**MAGBAND**	PHASE
CITARGET	DETECTOR	MPCCODE	PUBLICATION
COMMENT	DIFFERMAGS	MPCDESIG	REDUCEDMAGS
COMPCI{X}	DIFFZEROMAG	OBJECTDEC	REVISEDDATA
COMPCIBAND{X}	**ENDDATA**	**OBJECTNAME**	**SESSIONDATE**
COMPDEC{X}	**ENDMETADATA**	**OBJECTNUMBER**	**SESSIONTIME**
COMPMAG{X}	EQUINOX	OBJECTRA	STANDARD
COMPMAGBAND{X}	EXPJD	**OBSERVERS**	**STARTMETADATA**
COMPNAME{X}	EXPOSURE	OBSLATITUDE	SUBMITPDS
COMPRA{X}	**FACILITY**	OBSLONGITUDE	TELESCOPE
CONTACTINFO	**FILTER**		UCORMAG

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 be missing entirely.

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

2.2   PDS KEYWORDS

Given on a separate line is the PDS keyword equivalent, which is not always the same. On the same line is the Default value that will be used for the PDS submission.

All PDS keywords are *required*, using at least the default value. If there are no data for the field or the keyword is missing from the ALCDEF file, the default value is written to the PDS file being submitted.

✬ **Always use the ALCDEF keywords and default values and follow ALCDEF data crosschecking rules when preparing files for submission to the ALCDEF site. The site will do the necessary ALCDEF to PDS conversions when/if the data are submitted to the PDS.**

As discussed in section 4.3 below, some keywords and their values have dependencies on other keywords and their values. If a keyword is not required to meet the "crosscheck", it can be excluded from the metadata section, *unless it is a required keyword*.

3.   PRIVACY CONCERNS

Privacy rules are constantly changing. In many cases, it is not clear how the rules apply to submissions of scientific research. For example, if publishing in a journal, it is universally accepted that such personal information as the names of the authors and, for some, either an

email and/or postal address. Here the uncertainty is if, by submitting the paper, the authors are giving explicit permission to have the identifying information stored and distributed within the scope of what appears in the journal.

The ALCDEF standard includes some mandatory information along these lines, i.e., names and an email and/or postal address. Other identifying information could be the observatory name, the MPC observatory code, or information in the COMMENT lines.

The information in a standard or simple ALCDEF file is stored in database tables so that the *metadata* and *data blocks* can be redistributed as ALCDEF-compliant text files. This is the only means and format that the information is stored and distributed.

Personal information is never distributed to third parties other than those downloading the data from the ALCDEF site for scientific research.

3.1 REQUIRED OPT-IN KEYWORDS

Every submission under v2.2 and beyond must include the SUBMITPDS keyword. This is used to indicate explicit permission to have the data automatically be submitted to the NASA PDS within an ALCDEF archive file.

The value can be TRUE or FALSE (default). If FALSE, the data will not be sent to the PDS.

> **By virtue of uploading data to the ALCDEF database, the submitter gives implicit permission to store and distribute data as described above and the setting of the SUBMITPDS keyword.**

3.2 CONSTANT KEYWORDS

Some keywords carry the same data for every metadata block submitted by a given contributor. This usually involves the CONTACTNAME, CONTACTINFO, FACILITY, TELESCOPE, DETECTOR, OBSERVERS, PUBLICATION, and COMMENTS keywords. It is inefficient database and storage management to store the repetitive information when a contributor submits thousands of lightcurve blocks.

To help manage repetitive data, the ALCDEF standard recognizes and uses "constant keywords." Instead of the full contact information for a contributor, a ***preapproved*** constant can be used instead. A table in the ALCDEF database stores the constant keywords and up to 8 lines, each < 256 characters, that replace the constant keyword when data are retrieved from the web site.

A simple sample of this approach is

>   Constant keyword: {CCNI-SAMPLE-1}
>   Data Lines:
>   CONTACTNAME=J. Q. Astronomer
>   CONTACTINFO=[jqastronomer@observatory.com] 123 Main St., Anytown, CO 80600

Note that the constant keyword is always surrounded by curly braces, i.e., { }.

Each constant keyword consists of three sections separated by a dash (-), e.g.,

>   {CCNI-SAMPLE-1}

The first section follows a naming convention that defines the purpose:

CCOM	Comment line	COBS	Observers
CCNI	Contact Name/information.	CPUB	Publication (not Bibcode)
CDET	Camera description	CTEL	Telescope description
CFAC	Facility (observatory name)		

The second section is a unique identifier, usually the last name of the contributor. The same identifier should be used for **all** constant keywords for the same contributor. The third section is a unique number, starting with 1, to allow multiple constants with the same first two sections.

✎ Constant keywords should be used only when the replacement data value is significantly longer than the constant keyword length. For example, there is no significant gain using

> {CTEL-SAMPLE-1} => 0.35-m f/10 SCT

An exception to this is the set of CCNI keywords, those that store the CONTACTNAME and CONTACTINFO. The CONTANTNAME line may be about the same length as the keyword itself, but the CONTACTINFO line will almost certainly be significantly longer than the keyword.

✎ If using a CCNI constant keyword, it should be used in CONTACTNAME **and** CONTACTINFO.

Using a constant CCNI keyword in lieu of the actual values makes it possible to have data downloads use the most recent information, e.g., the email and/or mailing address changes, without having to change thousands of entries. More important, the critical keyword CONTACTNAME keyword will always have the same value, which is required as part of submitting revised data.

3.2.1 MANAGING CONSTANT KEYWORDS

Constant keywords are defined by the site manager *only*, not by contributors. This assures consistency and avoids duplication. Only predefined keywords will be accepted during data upload. Using an ill-formed or undefined constant will cause a lightcurve block to be rejected during data upload.

The current list of predefined constant keywords is available on the [ALCDEF site constant keywords page](#).

To apply for a constant keyword definition, send an email to brian@MinPlanObs.org specifying the constant keyword name and up to 8 "data lines". For example:

> {CCNI-SMITH-X}
> John Q. Astronomer
> [jqastronomer@observatory.com] 123 Main St., Anytown, CO 80600
>
> {CFAC-SMITH-X}
> The Very Big Observatory Complex (Another Place, CO)

The 'X' will be assigned a number > 0.

✎ Do not start using the constant keywords until they have been approved. Data should not be submitted to the ALCDEF site pending approval, which will usually be given in less than 24 hours.

4. DATA VALIDATION

As each file is uploaded, a number of validations are made to assure that the incoming data are as free of errors as possible and to avoid unintended data duplication.

The validation is done at the lightcurve block level. If one *lightcurve block* fails the test, this does not automatically cause the others in the file, if any, to be rejected.

4.1 NUMBER, NAME, DESIGNATION CHECK

The first validation is to have agreement among the OBJECTNUMBER, OBJECTNAME, and MPCDESIG values. For example, a *lightcurve block* is rejected assuming the following combinations

    Number/Name Mismatch
    OBJECTNUMBER=150   (should be 1 based on the name)
    OBJECTNAME=Ceres
    MPCDESIG= (no entry)

    Number/Name vs. Designation Mismatch
    OBJECTNUMBER=70030
    OBJECTNAME=Margaretmiller
    MPCDESIG=2000 AA1   (should be 1999 CZ1 based on number/name)

If MPCDESIG is blank or missing from the *metadata block* and the OBJECTNUMBER-OBJECTNAME combination is valid, the MPCDESIG value, if available, is automatically assigned. However, the opposite is not true, i.e. if the MPCDESIG is valid but there is no entry for OBJECTNAME, the *lightcurve* block is rejected.

4.2 DUPLICATE DATA CHECK

A combination of values for some required keywords in the *metadata block* is used to prevent duplicate entries of the same *lightcurve block*. The keywords are:

        OBJECTNUMBER   CONTACTNAME   FILTER
        OBJECTNAME   SESSIONDATE
        MPCDESIG   SESSIONTIME

If the values for these keywords are all the same as an existing *lightcurve block*, then regardless of any other differences, the *lightcurve block* is rejected *unless* REVISEDDATA=TRUE is found within the *metadata block*. In this case, the original *lightcurve block* (*metadata*, *compstars*, and *data blocks*) is deleted and the new *lightcurve block* is added to the database tables.

Since the above keywords are used to avoid duplication, submitting authors should the *exact same entry* for CONTACTNAME for every submission. For example, J. Q. Adams and J. Adams are considered to be different people. Keeping the value the same 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, the SESSIONTIME value *must be unique* for each *lightcurve block*.

4.2.1 REVISING EXISTING DATA WITH CHANGED CORE DATA

The REVISEDDATA keyword is meant to be used to correct values not associated with the core keywords, e.g., a correction to the JD values in the *data block*. If the value for one or more of the core keywords changes, e.g., FILTER=R should have been FILTER=V, presents a problem.

For security reasons, end users are not allowed to edit or delete records directly. At some future date, a secure method will be developed. In the meantime, an email outlining the problems should be sent to the website manager.

4.3   KEYWORD DATA STARDARDIZATION AND DEPENDENCIES CHECKS

To help those looking for data from specific locations, observers, etc., it is strongly encouraged that the date for at least the keywords be consistent. For example, if initial data were submitted with CONTACTNAME=J. Q. Astronomer, all future submissions should have the same line. Using a script or custom program can provide the means of assuring data consistency whenever possible. Constant keywords (see section 3.2) are another means of assuring consistency for repetitive values for some keywords.

This is not a requirement of the ALCDEF standard, but it helps follow general database management procedures.

4.3.1 UPLOAD DATA PREPARATION AND VALIDATION

To provide some consistency in the presentation of the data in the ALCDEF files, the web site confirms the data for a number of keywords. The first element assures that the data formatting and/or values follow the ALCDEF standard. During this process, some keyword values may be set during file parsing (before final validation) to avoid having the lightcurve block rejected. If any value is altered, a new COMMENT line is added giving the details. The second element cross-checks some keyword values, i.e., that a specific value for a keyword agrees with the values for other keywords tied to the first keyword.

This is a summary of the validations done during the initial parsing and subsequent validation of each *lightcurve block*. Additional information is available in Section 5, "Keyword Definitions."

CompStar keywords are in a separate table below.

Keyword	Validation
ALL KEYWORDS	• **Cannot contain what appears to be a URL (web or ftp address).** • **Unless a predefined constant keyword, should not be all upper/lower case.**

GENERAL AND OBJECT-SPECIFIC KEYWORDS	
CONSTANT {Cx-y-n}	• Keyword is surrounded by curly braces { } • Keyword is in the "Common Constants" table • Keyword has at least one "data line" associated with it
BIBCODE	• Cannot be blank. • Is current Bibcode standard maximum length (currently 19 characters) • Bibcode validity not confirmed.

CIBAND	**Version 2.2+ Handling** • Can be excluded if CICORRECTION=FALSE, otherwise: • Has value of BV, VR, VI, BR, SGU, SGR, SRI, SIZ, ATco, GBG, GGR, JK, JH **Pre Version 2.2 Handling** (deprecated, should not be used in new files). • Can be blank or excluded if CICORRECTION=NONE, otherwise forces CITARGET=–99.9.
CICORRECTION	• Can be excluded if CICORRECTION=FALSE, otherwise: • CIBAND and CITARGET must have non-default values.
CITARGET	• Can be excluded if CICORRECTION=FALSE, otherwise: • Must be a valid numerical string, i.e., include only (– + . 0-9, no spaces) • Cannot be default "bad value" –99.9 (see CIBAND).
COMMENT	• Can be excluded, otherwise: • Can use a predefined constant keyword • If a word is surrounded by curly braces, it must be among the defined constant keywords on the ALCDEF website. • Each line should be < 254 characters (not including COMMENT=) • Total number of characters for all COMMENT lines must be < 2000 characters.
CONTACTNAME	• Cannot be blank • Can use a constant keyword • Does not appear to have email (@, .com, .net, .edu, .org, gmail) • Cannot be in CONTACTINFO, *unless it is the same predefined constant keyword.*
CONTACTINFO	• Cannot be blank • Can use a predefined constant keyword • If a constant keyword, it must match the entry in CONTACTNAME. • Cannot be all upper case *unless it is a predefined constant keyword* • Can be all lower case only if the entry is an email, e.g. CONTACTINFO=[myemail@adomain.com]. *Note the square brackets enclosing email.*
DATA	• Must be a valid numerical string, i.e., include only (– + . 0-9, no spaces) • Must include DATADELIMITER character at least once (separating JD and Mag)
DELIMITER	• Cannot be blank. • Must have value of PIPE, SEMIC, or TAB (not literal characters). The simple-ALCDEF standard allows COMMA and SPACE, but these are converted to PIPE during parsing.
DETECTOR	• Cannot be blank. • Can use constant keyword. • If blank, set to default DETECTOR=CCD.
DIFFERMAGS	• Must be TRUE or FALSE • See 4.3.2, "Differential vs. Sky Magnitudes" below.
DIFFZEROMAG	• Must be a valid numerical string, i.e., include only (– + . 0-9, no spaces) • See 4.3.2, "Differential vs. Sky Magnitudes" below.
ENDDATA	• Must be standalone line (no value) immediately after the last DATA line in a *lightcurve block*.
ENDMETADATA	• Must be standalone line (no value) immediately after the last line in the *metadata block* and immediately before the first DATA line in the *lightcurve block*.
EQUINOX	• Cannot be blank. • If initially blank, set to J2000.0 during parsing.
EXPJD	• Cannot be blank. • If START or END, EXPOSURE must be a valid positive integer string (0-9).
EXPOSURE	• Cannot be blank. • Must be a valid positive, non-zero integer string, i.e., include only (0-9, no spaces) if EXPJD has a value of START or END. • Forced to –99 during parsing and replaced by line in *metadata block*.

FACILITY	• Should not be blank. This or MPCCODE are required for submission to PDS. • Maximum length: 80 characters. • Can use predefined constant keyword.
FILTER	• Has value of C, B, V, R, I, SU, SG, SR, SI, SZ, J, K, H, AC, AO, GB, GG, GR (case-sensitive), or Clear, None (case-insensitive). Clear and None are deprecated and should not be used in new ALCDEF files. • J, H, and K are 2MASS, Ax is ATLAS cyan, orange, or t. Gx are GAIA Blue, Green, and Red.
LTCAPP	• Can be excluded if line would be LTCAPP=NONE, otherwise: • If LTCAPP= AVERAGE or POINT, LTCDAYS must be valid numeric string, i.e., include only (+ − . 0-9, no spaces) *and* LTCTYPE must be LTCTYPE=LIGHTTIME.
LTCDAYS	• Can be excluded if LTCAPP=NONE (or not included), otherwise: • Must be valid numeric string, i.e., include only (+ − . 0-9, no spaces) *and* LTCTYPE must be LTCTYPE=LIGHTTIME.
LTCTYPE	• Can be excluded if LTCAPP=NONE (or not included), otherwise: • Must be LTCTYPE=LIGHTTIME • LTCAPP must be AVERAGE or POINT and LTCDAYS must be valid numeric string, i.e., include only (+ − . 0-9, no spaces)
MAGBAND	• Has value of B, V, R, I, SU, SG, SR, SI, SZ, GB, GG, GR, J, K, H, AC, AO (same meaning as Filter values).
MPCCODE	• Can be blank but PDS requires this or FACILITY value. • Must be code issued by the Minor Planet Center. A user-defined code is not allowed. • Maximum length: 10 characters.
MPCDESIG	• Can be blank, but only if OBJECTNAME is not blank. • Must be the full, not packed, MPC designation. • OBJECTNUMBER, OBJECTNAME, and MPCDESIG (if set) must all be for the same object. • Parsing (pre-validation) attempts to match OBJECTNUMBER, OBJECTNAME, and MPCDESIG to latest MPCORB file. If one value is missing, its value is set based on the successful cross-match of the other two.
OBJECTDEC	• Can be blank. • Must be ±DD MM format using valid numeric characters, i.e., include only (+ − 0-9, space between fields). Use leading zero for deg/min < 10. • Parsing replaces blank entry with one computed using the object and date/time information in the *metadata block*. • Original OBJECTDEC and OBJECTRA must agree to within 2° of computed position.
OBJECTNAME	• Cannot be blank. • Must use MPCDESIG if not named. MPCDESIG must be full, not packed, designation. • Must be for same object indicated by OBJECTNUMBER and MPCDESIG. • Parsing sets to MPC assigned name/designation based on successful match of OBJECTNUMBER and MPCDESIG.
OBJECTNUMBER	• Cannot be blank. • Must be 0 if object unnumbered. • Must be valid integer numeric string, i.e., include only (0-9) • Must be for same object indicated by OBJECTNAME and/or MPCDESIG.
OBJECTRA	• Can be blank. • Must use colon (:) as the time separator. • Must include only (: 0-9, no spaces). • Must use 24-hour format: HH:MM[.m], leading 0 for hour/minute < 10. • Valid 24-hour time (00:00.0 to 23:59.9). • Set to RA/Dec computer during parsing based on object and date/time information. • Original OBJECTDEC and OBJECTRA must agree to within 2° of computed position.

OBSERVERS	• Cannot be blank. • Can use constant keyword. • Can be all upper case *if using a constant keyword*. • No validation for use of semicolon (;) to separate different observers but ending semicolon is removed.
OBSLATITUDE	• Can be blank, but strongly recommended. • Must be a valid numerical string, i.e., include only (+ − . 0-9, no spaces). • Must be in the range of −90 to +90. • Must be negative for Southern Hemisphere.
OBSLONGITUDE	• Can be blank, but strongly recommended. • Must be a valid numerical string, i.e., include only (+ − . 0-9, no spaces). • Must be in the range of −180 to +180. • Must be negative for Western Hemisphere.
PABB	• Can be blank, but strongly recommended. • Must be a valid numerical string, i.e., include only (+ − . 0-9, no spaces). • Must be in the range of −90 to +90. • If blank, replaced by value computed during parsing based on object and date/time.
PABL	• Can be blank, but strongly recommended. • Must be a valid numerical string, i.e., include only (+ . 0-9, no spaces). Despite always being positive, the plus sign (+) is recommended. • Must be in the range of 0 to +359.9. • If blank, replaced by value computed during parsing based on object and date/time.
PHASE	• Can be blank, but strongly recommended. • Must be a valid numerical string, i.e., include only (+ − . 0-9, no spaces). • Must be in the range of −180 to +180. • If blank, replaced by value computed during parsing based on object and date/time.
PUBLICATION	• Can be blank. • Can use constant keyword. • Maximum length: 60 characters.
REDUCEDMAGS	• Must have value of NONE, AVERAGE, or POINT. • Can be excluded if value is NONE, otherwise: • UCORMAG must be a valid, non-zero numerical string, i.e., include only (+ − . 0-9, no spaces).
REVISEDDATA	• Cannot be blank. • If value is FALSE, the new core data cannot match the core data of an existing *metadata block*. • If value is TRUE, then if a matching *metadata block* is found, the entire *lightcurve block* is deleted and the new *lightcurve block* is added. If a matching *metadata block* is not found, a new *lightcurve block* is added.
SESSIONDATE	• Uses dash (-) as the date separator • Uses yyyy-mm-dd format: all four digits of year, leading 0 for month/date < 10. • Valid date (between 1600-01-01 and 3999-12-31) • Must include only (− 0-9, no spaces). • The Julian Date found from SESSIONDATE and SESSIONTIME must be within 15 minutes of the average Julian Date of the values in the *data block*. The average JD is computed with $((JD_{EARLIEST} + JD_{LATEST}) / 2.0)$.
SESSIONTIME	• Uses colon (:) as the time separator. • Must include only (: 0-9, no spaces). • Must use 24-hour format: hh:mm:ss, leading 0 for hour/minute/second < 10 • Valid 24-hour time (00:00:00 to 23:59:59) • The Julian Date found from SESSIONDATE and SESSIONTIME must be within 15 minutes of the average Julian Date of the values in the *data block*. The average JD is computed with $((JD_{EARLIEST} + JD_{LATEST}) / 2.0)$.

STANDARD	• Can be blank (or excluded) if DIFFERMAGS=TRUE • Must have value of NONE, INTERNAL, or TRANSFORMED. • See section 4.3.2 for additional information.
STARTMETADATA	• Must be a standalone line (no value) immediately preceding the first line in a *metadata block*.
SUMBITPDS	• Cannot be blank. • Must have value of TRUE or FALSE.
TELESCOPE	• If blank, set to TELESCOPE=VARGBTEL (PDS: various ground-based telescopes) • Can use constant keyword
UCORMAG	• Can be excluded if REDUCEDMAGS=FALSE, otherwise: • Must be a valid numerical string, i.e., include only (+ – . 0-9, no spaces). • Cannot be 0 (that would place it in a physically impossible position).

COMPSTAR KEYWORDS	
NAME	• Cannot be blank. Subsequent validations for given compstar are bypassed if blank.
RA	• Cannot be blank. If initially blank, set to OBJECTRA value during parsing.
DEC	• Cannot be blank. If initially blank, set to OBJECTDEC value during parsing.
MAG	• Cannot be blank. Not altered during parsing. • Must be a valid numerical string (– + . 0-9)
MAGBAND	• If blank, set to required object MAGBAND value.
CI	• Cannot be blank if object CICORRECTION=TRUE. No default set during parsing.
CIBAND	• Cannot be blank if CICORRECTION=TRUE. No default set during parsing.

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-default value (–99.9). If any one of these crosschecks fails, the *lightcurve block* is rejected. The dependencies are covered under the individual keywords.

4.3.2 DIFFERENTIAL VS. "SKY" MAGNITUDES

There is a complex cross-referencing among the DIFFERMAGS, DIFFZEROMAG, and STANDARD keywords that changed starting with v2.2 of the ALCDEF standard.

The first main difference is that the DIFFZEROMAG keyword was added starting with version 2.2. It is used in conjunction with DIFFERMAGS to convert the magnitudes in the *data block* to "sky" (catalog) magnitudes that are on an internal or standard system, or differential magnitudes based on the difference of raw instrumental magnitudes as defined by the STANDARD keyword.

Prior to v2.2
Requirements for lightcurve block to be accepted:
DIFFERMAGS=TRUE, STANDARD=FALSE
DIFFERMAGS=FALSE, STARDARD=[INTERNAL/TRANSFORMED].

Legacy data, i.e. without the DIFFZEROMAG keyword, will be handled based on these rules.

Post v2.2

The table below outlines the crosschecking requirements. Any combination not found in the table will cause the *lightcurve block* to be rejected.

DIFFERMAGS = FALSE				
Keyword	**Value**	**Keyword**	**Value(s)**	**Note**
DIFFZEROMAG	−99.9	STANDARD	INTERNAL TRANSFORMED	Data magnitudes are on an internal or standard system.

DIFFERMAGS = TRUE				
Keyword	**Value**	**Keyword**	**Value(s)**	**Note**
DIFFZEROMAG	−99.9	STANDARD	NONE	The sky magnitude zero point is undefined, i.e., the values are differenced against a value of 0.0.
DIFFZEROMAG	>>0.0	STANDARD	INTERNAL TRANSFORMED	The zero point is a sky magnitude on either an internal or standard system, or an arbitrary offset, e.g., 25.0, so that the differential magnitudes become values that are always positive.
The default of −99.9 allows handling legacy data where DIFFZEROMAG did not exist.				

Intentionally Blank

5. KEYWORD DEFINITIONS

String values should not be enclosed by quotes, double quotes, or other character.

BIBCODE [Optional]

PDS: BibCode [Required]   Default: - (dash)

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

Value Type:	String.
Max Length:	25 characters.
Example:	`BIBCODE=2010MPBu...37..169W`
Notes:	The current standard length for a BibCode is 19 characters. The field allows up to 25 characters for future expansion. Leading and trailing blanks are removed.

CIBAND [Optional/Required]

PDS: CIBand [Required]   Default: - (dash)

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

Value Type:	String
Max Length:	5 characters.
Allowed Values:	BV, VR, VI, BR, SGU, SGR, SRI, SIZ, ATco, GBG, GGR, JK, JH (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. The JK, JH bands are based on 2MASS J, K, H bands. The ATco is based on ATLAS c(yan) and o(range).
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.
	If CICORRECTION=FALSE, or it is not included in the file, then this keyword and CITARGET can be excluded from the file.

CICORRECTION [Optional]

PDS: CICorr [Required]   Default: N (= FALSE)

Indicates whether or not a color index correction has been applied to the magnitudes in the *data block*.

Value Type:	Boolean
Max Length:	5 characters
Allowed Values:	TRUE, FALSE
Example:	`CICORRECTION=TRUE`
Notes:	If not included in the metadata block, the value is assumed to be FALSE.
	If CICORRECTION=TRUE, then CIBAND must have a value other than NONE <u>and</u> 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 page 9*.

CITARGET [Optional/Required]

PDS: CIObject [Required]   Default: –99.9

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 <u>and</u> the CITARGET keyword must be in the *metadata block* and have a non-zero value. Otherwise, the *lightcurve block* is rejected.
	If CICORRECTION=FALSE or is not in the *metadata block*, then CICORRECTION and CIBAND keywords can be excluded from the *metadata block*.

COMMENT [Optional]

PDS: Comments [Required]   Default: - (dash)

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

Value Type:	String
Max Length:	2048 characters (see Notes)
Example:	`COMMENT=Asteroid was in a crowded field.` `COMMENT={CCOM-SMITH-1}  (using a constant keyword)`
Notes:	More than one comment line can be included in a *metadata block*. Each COMMENT line must be 255 characters or less, *including* COMMENT=. Can include a constant keyword plus other comment lines. It's preferred that6 any constant keywords be listed before any "supplemental" lines. The combined length of all COMMENT *values* must be less than 2048 characters. This includes CR/LF characters but not COMMENT=.

COMPCI{X} [Optional/Required]

PDS: CI [Required, if COMPNAME{X} is included in ALCDEF]   Default: - (dash)

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 correspond to 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 field is required if COMPNAMEX is included.

COMPCIBAND{X} [Optional/Required]

PDS: CI [Required, if COMPNAME{X} is included in ALCDEF]   Default: - (dash)

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:	`COMPCIBAND2=+0.319`

Notes: This value must correspond to 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 field is required if COMPNAMEX is included

COMPDEC{X} [Optional]

PDS: Dec [Required, if COMPNAME{X} is included in ALCDEF]   Default: - (dash)

The Declination of comparison star X in EQUINOX equatorial coordinates.

Value Type: String.

Max Length: 11 characters.

Format: The value must be in the format: ±DD:MM:SS[.s], i.e., use colons to separate the subfields and a period for decimal seconds.

Leading zeros must be used to fill each subfield.

Example: `COMPDEC2=+15:02:01.2`
Notes: The Declination is assumed to be in the equinox given by the `EQUINOX` keyword.

This field is required if COMPNAMEX is included.

COMPMAG{X} [Optional]

PDS: Mag [Required, if COMPNAME{X} is included in ALCDEF]   Default: –99.9

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`

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 field is required if COMPNAMEX is included.

COMPMAGBAND{X} [Required]

PDS: MagBand [Required]   Default: V

Indicates the color band of the magnitudes for the comp star. In almost all cases, this will be the same as MAGBAND in the main part of the metadata header. It is included to facilitate easier translation to/from the PDS data format.

Value Type:	String.
Max Length:	5 characters
Allowed Values:	B, V, R, I, SU, SG, SR, SI, SZ, AT, AC, AO, GB, GG, GR, J, K, H (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. The J, K, and H are the 2MASS magnitudes.

GG refers to the Gaia G magnitudes. Using just G could be confused with the Sloan g′ mag band.

Default:	V
Example:	COMPGMAGBAND2=V
Notes:	This is *usually* the same value as FILTER. One obvious exception is if FILTER=C. There is no "C" color band.

COMPNAME{X} [Optional]

PDS: Name [Required, if COMPNAME{X} is included in ALCDEF]   Default: - (dash)

The name for comparison star X.

Value Type:	String.
Max Length:	30 characters.
Example:	COMPNAME2=UCAC4 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.
	If this keyword is included, then it cannot be blank and the other COMP{X} values for the star must be included.

COMPRA{X} [Optional]

PDS: RA [Required, if COMPNAME{X} is included in ALCDEF]   Default: - (dash)

The Right Ascension of comparison star X in EQUINOX equatorial coordinates.

Value Type:	String.
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:	This value is assumed to be in the equinox given by the EQUINOX keyword.
	This field is required if COMPNAMEX is included.

CONTACTINFO [Required]

PDS: Not included. However, this ALCDEF field may be added as a COMMENT during migration and future submissions to the PDS.

Contact information for the person submitting the data.

✎ See page 6 regarding data storage and distribution policies for personal information.

Value Type:	String.
Max Length:	120 characters.
Default:	None.
Example:	CONTACTINFO=[jqastronomer@adomain.com] 123 Main St., Anytown, State USA 01234.
	CONTACTINFO={CCNI-SMITH-1} (using constant keyword)
Notes:	This is usually an email but it can also include a physical mailing address or web site.
	Can use a predefined constant keyword.
	Do not include the CONTACTNAME is this field, *unless CONTACTNAME is a predefined constant keyword*. In this case, this and CONTACTNAME must use the same constant 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 postal address.

CONTACTNAME [Required]

PDS: Submitter [Required]   Default: - (dash).
Since this is a required ALCDEF field, this field should always have a valid entry and not the default.

The name of the person submitting the data.

↳ See page 6 regarding data storage and distribution policies for personal information.

Value Type: String. No surrounding quotes.

Max Length: 80 characters.

Format: First [middle] initials, surname
                   First middle initial surname

Default: None.

Example: CONTACTNAME=J. Q. Astronomer
                   CONTACTNAME=John Q. Astronomer
                   CONTACTNAME={CCNI-SMITH-1} (using constant keyword)

Notes: This is the person who submitted the data and can provide additional
                   information about them and any contact information for the observers.

                   Can use a predefined constant keyword, which must match the one in
                   CONTACTINFO.

                   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 page 9.*

DATA [Required]

PDS: Not included. Each line in the PDS lcdata table is written with the unique ID for the
metadata block along with the required fields for the ALCDEF data lines.

Indicates the data for a single observation.

Value Type: String.

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 JD should not include light-time correction. If so, then LTCAPP,
                   LTCDAYS, and LTCTYPE must be included and have the appropriate
                   values.

                   The MAG and MAGERR values should be given to a precision of up to 3
                   decimal places.

Default: None.

Example: DATA=2451286.32958|+9.775|+0.012

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.

The third field is the magnitude error, in magnitudes and not, e.g., SNR.

There must be at least two data lines per *lightcurve block*, but five or more is ***strongly*** encouraged.

For non-time series observations, e.g., a single data point for phase curve observations, submit the several (preferably three or more) observations that were used to derive an average value. This allows independent confirmation.

✎ The optional air mass value that could end the DATA line prior to v2.2 has been deprecated. If it is included in a DATA line, it will be ignored.

See the discussion for the DELIMITER keyword. If the DELIMITER value is missing or invalid, the *lightcurve block* will be rejected. See page 2 ff.

DELIMITER [Required]

PDS: Not included.   Default: empty string (forces file to have correct value)

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

Value Type: String.

Max Length: 5 characters.

Allowed Values: PIPE   (ASCII 124)
                 SEMIC (semicolon) (ASCII 5 9)
                 TAB   (ASCII 9)

Default: PIPE

Example: DELIMITER=PIPE

Notes: The value is the *name for the character* to be used and *not the actual character* itself.

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.

DETECTOR [Optional/Required]

PDS: Detector [Required]   Default: - (dash)

Indicates the detector (camera) used for the observations. This is a new keyword introduced to facilitate migration to the PDS.

Value Type: String.

Max Length: 40 characters

Default: CCD

Example: `DETECTOR=CCD`
                   `DETECTOR=FLI-1001E, 1024x1024, 1x binning`
                   `DETECTOR={CDET-SMITH-1} (using constant keyword)`

Notes: Legacy ALCDEF data will not have this specific field and so it will be set to default values in the ALCDEF and PDS tables.

                   Can use a predefined constant keyword, but only if the description is noticeably longer than the constant keyword. The second example would be a good candidate for a constant keyword.

                   If more than one facility contributed data for the *same lightcurve block*, use VARGBDET (various ground-based detectors) or use comment lines to give the more relevant information for each location.

DIFFERMAGS [Required]

PDS: DiffMags [Required]   Default: FALSE

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

Value Type: Boolean

Max Length: 5 characters

Allowed Values: TRUE, FALSE

Default: FALSE

Example: `DIFFERMAGS=FALSE`

Notes: A differential magnitude is the difference between the target and a comparison star magnitude or some arbitrary value. A "sky" magnitude is the direct measure of the target's brightness based on a catalog, e.g., Landolt standards, etc.

There is a complex cross-relationship among DIFFERMAGS, DIFFZEROMAG, and STANDARD. See page 14.

DIFFZEROMAG [Optional/Required]

PDS: DiffZeroMag [Required]   Default –99.9

Indicates the zero point for differential magnitudes.

Value type: Floating point up to 3 decimal places.

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

Example: DIFFZEROMAG=+12.913

Notes: This value is needed only if DIFFERMAGS=TRUE.

There is a complex cross-relationship among DIFFERMAGS, DIFFZEROMAG, and STANDARD. See page 14.

ENDDATA [Required]

PDS: Not included.

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

Value Type: 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]

PDS: Not included.

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 these conditions are not meta, the *lightcurve block* is rejected.

EQUINOX [Optional]

PDS: Equinox [Required]   Default: J2000.0

Indicates the equinox (coordinate system origin points) of the equatorial Right Ascension and Declination values in the *metadata block*. Generally, the RA/Dec for the comp stars will be of the same equinox, but allowance is made where that is not always the case.

Value Type: String.

Max Length: 10 characters

Allowed Values: J2000.0, B1950.0 (others may be added)

Default: J2000.0

Example: `EQUINOX=J2000.0`

Notes: If missing, as in legacy ALCDEF data, J2000.0 is assumed.

This value should be written as EQUINOX=<equinox> for each compstar{x}. It's duplicated to facilitate translation to/from the PDS format.

EXPJD [Optional]

PDS: ExpJD [Required]   Default: MID

Indicates if the JD values in the data section are for the start, middle, or end of exposures.

Value Type: String.

Max Length: 5 characters

Allowed Values: START, MID, END

Default: MID

Example: `EXPJD=MID`

Notes: If this keyword is not included, MID is assumed.

If EXPJD=[START/END], then the EXPOSURE keyword *must* be included and assigned a *positive, non-zero* value. Otherwise, the *lightcurve block* will be rejected.

EXPOSURE [Optional/Required]

PDS: Exposure [Required]   Default: 0

The exposure time, in seconds.

Value Type: Integer.

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

Allowed Values:	0 to 65535 (~ 0.76 days)

Default:	0

Example:	EXPOSURE=200

Notes:	If EXPJD=[START/END], this keyword is required and **must** be >0. Otherwise the *lightcurve block* will be rejected.
	If EXPJD=MID, this keyword is not required or, if included, it will be ignored.

The ALCDEF standard uses mid-exposure JD. The combination of EXPJD and EXPOSURE allows the end user, if necessary, to compute the mid-exposure JD values.

FACILITY [Optional, but strongly encouraged]

PDS: Facility [Required]   Default: - (dash)

The name of the facility or observatory where the observations were made or to which the person in CONTACTNAME/INFO belongs.

Value Type:	String.

Max Length:	80 characters

Default:	None

Example:	FACILITY=Center for Solar System Studies-Palmer Divide Station.
	FACILITY={CFAC-SMITH-1} (using a constant keyword)

Notes:	The PDS requires this keyword and/or a value for MPCCODE.
	✎ If both are missing or have empty values, the *lightcurve block* will not be submitted to the PDS, even if requested.
	If more than one facility contributed data for the same *lightcurve block*, use the data submitter's location and amplify using COMMENT lines.

FILTER [Required]

PDS: Filter [Required]   Default: V

The filter used to make the observations in the given *lightcurve block*.

Value Type:	String.

Max Length:	5 characters

Allowed Values:	B, V, R, I, SU, SG, SR, SI, SZ, J, K, H, AC, AO, GB, GG, and GR (case-sensitive) for standard filters (GAIA magbands and filters are considered one in the same).

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

NONE, CLEAR (case-insensitive)

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. The J, K, and H values are 2MASS magnitudes. The AX filters are ATLAS c or o.

Default:	V
Example:	`FILTER=V`
Notes:	For legacy data, 'Clear' or 'None' (case-insensitive) were used. New submissions should use 'C' if no or a clear filter was used.

This is usually the same value as MAGBAND. The obvious exception is if FILTER=C. There is no "C" color band.

❖ *This is one of the core keywords used to check for duplicate submissions. See page 9 for more information*

LTCAPP [Required]

PDS: LTCApplied [Required]   Default: empty string (forces file to have correct value)

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

Value Type:	String.
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 for the UT given by SESSIONDATE and SESSIONTIME. Use a COMMENT line if a different UT date/time was used.
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 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 *must* be in the *metadata block* and have a non-zero value. In addition, LTCTYPE=LIGHTTIME *must* be in the *metadata block*.

If the crosscheck fails, the *lightcurve block* is rejected.

See Notes under LTCDAYS.

LTCDAYS [Required/Optional]

PDS: LTCDays [Required]   Default: –99.9

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

Value Type: Floating point. Precision of 1 sec (~0.000 01 d) or higher preferred.

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

Default: 0.0

Example: `LTCDAYS=-0.01099`

Notes: If LTCAPP=[AVERAGE/POINT], this value must be non-zero and LTCTYPE=LIGHTTIME must be in the *metadata block*. Otherwise, the *lightcurve block* is rejected.

The ALCDEF standard *strongly urges* that the JD values in the data block be geocentric (or topocentric, which differs by ~0.01 s), i.e. without light-time correction to asteroidcentric. If LTCAPP=LIGHTTIME, this value can be used to reverse the correction and so get the original geocentric values.

The value of LTCDAYS must be such that

$$JD_{asteroid} = JD_{Earth} + LTCDAYS$$

Therefore,

$$LTCDAYS = -0.005772 * ED$$

where   ED is the Earth-asteroid distance in AU.

LTCTYPE [Required]

PDS: LTCType [Required]   Default: empty string (forces file to have correct value)

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

Value Type: String.

Max Length: 15 characters

Allowed Values: NONE, LIGHTTIME

Default: NONE

Example: `LTCTYPE=NONE`

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

                   See Notes under LTCDAYS.

MAGADJUST [Deprecated]

PDS: Not used.

This keyword has been replaced by DIFFZEROMAG, which has a somewhat different function starting with v2.2.

MAGBAND [Required]

PDS: MagBand [Required]   Default: V

Indicates the color band of the magnitudes for the target.

Value Type: String.

Max Length: 5 characters

Allowed Values: B, V, R, I, SU, SG, SR, SI, SZ, AC, AO, GB, GG, GR, J, K, H (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. The J, K, and H values are 2MASS magnitudes.

                   GX refers to the GAIA BGR magnitudes. AC and AO are the two primary ATLAS magbands.

Default: V

Example: `MAGBAND=R`

Notes: This is *usually* the same value as FILTER. One obvious exception is if FILTER=C. There is no "C" color band.

MPCCODE [Optional]

PDS: MPCCode [Optional] Default: - (dash)

This is the observatory code assigned by the Minor Planet Center.

Value Type: String.

Max Length: 10 characters

Example: MPCCODE=U82

To comply with PDS requirements, either this or the FACILITY keyword should have a value that identifies the observatory.

MPCDESIG [Optional]

PDS: Desig [Required] Default: - (dash)

This is the adopted MPC designation for the object.

Value Type: String.

Max Length: 30 characters.

Example: `MPCDESIG=1999 CZ1`

Notes: Use the full, not packed, designation, e.g., 1999 CZ1, not J99C01Z.

For un-numbered objects, Set OBJECTNUMBER=0 and MPCDESIG **and** OBJECTNAME to the MPC designation.

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=

❖ *This is one of the core keywords used to check for duplicate submissions and crosscheck values.*

OBJECTDEC [Optional]

PDS: ObjDec [Required] Default: - (dash)

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

Value Type: String.

Max Length: 6 characters.

Format:	±DD MM. If needed, use a leading zero to pad each field with two characters. Use a space to separate degrees and minutes
	If the declination rounds to 0 degrees, use +00 00.
Default:	None
Example:	OBJECTDEC=+03 06
Notes:	The Dec must use equatorial coordinates of the same equinox as given by the EQUINOX keyword. The default is EQUINOX=J2000.0
	Files from earlier versions having only degrees (e.g., +10) are still compatible, but they will be appended with ' 00' for the minutes.

OBJECTNAME [Required]

PDS: ObjName [Required]   Default: - (dash)

The name assigned by the IAU. See Notes below.

Value Type:	String.
Max Length:	30 characters.
Default:	None. The *lightcurve block* will be rejected if this keyword and/or value are missing.
Example:	OBJECTNAME=Lucia OBJECTNAME=1999 CZ1
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 crosscheck values. *See section 3.2 for more information.*

OBJECTNUMBER [Required]

PDS: ObjNumber [Required]   Default: –9

The number assigned by the MPC.

Value Type:	Integer. Do not use a leading plus sign since this value is always positive for ALCDEF submission.
Maximum Value:	4294967295
Default:	0
Example:	OBJECTNUMBER=222 OBJECTNUMBER=0

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 crosscheck values. See section 3.2 for more information.*

OBJECTRA [Optional]

PDS: ObjRA [Required]   Default: - (dash)

The approximate Right Ascension (HH:MM.m) of the object at the given SESSIONDATE and SESSIONTIME.

Value Type: String.

Max Length: 7 characters

Format: HH:MM[.m]. 24-hour format. Use leading zeros. Use a colon to separate hours and minutes.

Default: <BLANK>

Example: `OBJECTRA=03:48.4`

Notes: The RA must use equatorial coordinates of the same equinox as given by the EQUINOX keyword. The default is EQUINOX=J2000.0

                    Files from earlier versions having only HH:MM (e.g., 18:32) are still compatible, but they will be appended with '.0' for the decimal minutes.

OBSERVERS [Required]

PDS: Observers [Required]   Default: - (dash)

The names of those who contributed to obtaining and deriving the data. These are the persons to whom credit should be given for the data.

Value Type: String.

Max Length: 1024 (see Notes)

Format: The names can be given as either initials surname or surname, initials. See the examples below.

Default: None.

Example: `OBSERVERS=Astronomer, J. Q.; Assistant, H. I. S.`
                    `OBSERVERS=J. Q. Astronomer; H. I. S. Assistant`
                    `OBSERVERS=John Q. Astronomer; Herbert Assistant`
                    `OBSERVERS=S. I. R. Henry VIII`
                    `OBSERVERS=Henry VIII, Steve`
                    `OBSERVERS={COBS-SMITH-1} (using constant keyword)`

Notes: In broad terms, all observers are at the same location as defined by MPCCODE or FACILITY. See page 43 if the observers and/or observing location are not the same for every *lightcurve block* in a file.

Can use a constant keyword, alone or combined with "supplemental" observers. The constant keyword should be first.

Add a space after every initial (see examples above).

Multiple names *must* be separated by semicolons, not commas, since commas are used when surname is given first.

The fourth example above shows how to include suffixes with surnames, i.e. do not include a comma between the surname and suffix. This differs from the SAO/NASA ADS entries, which follow the format in the first example but add the suffix *after the first (middle) initial without a comma*.

The *metadata block* can contain one or more OBSERVERS lines. Each line, including 'OBSERVERS=', *must* be 255 characters or less. The maximum number of characters does not include OBSERVER=.

OBSLATITUDE [Optional]

PDS: ObsLat [Required]   Default: –99.9

The latitude of the observatory defined by the MPCCODE or FACILITY keywords.

Value Type: Floating point.

Format: ±DD.ddddd. Use up to 0.00001 degree (0.036 s) precision.

Value Range: –90.0 to +90.0

Example: OBSLATITUDE=+39.083333 (11 character max for value)

Notes: Use a negative value for locations in the Southern Hemisphere.
See page 43 if the observing location is not the same for every *lightcurve block* in a file.

OBSLONGITUDE [Optional]

PDS: ObsLong [Required]   Default: –999

The longitude of the observatory defined by the MPCCODE or FACILITY keywords.

Value Type: Floating point.

Format: ±DDD.dddddd. Use up to 0.000001 degree (0.0036 s) precision. Leading zeros should not be used. See the examples.

Value Range: −180.0 to +180.0

Example: OBSLONGITUDE=−104.757773 (in U.S.; 11 character max for value).
                    OBSLONGITUDE=+34.22544

Notes: ALCDEF uses negative longitudes for positions in the Western
                    Hemisphere.

                    See page 43 if the observing location is not the same for every
                    lightcurve block in a file.

PABB [Optional]

PDS: PABB [Required]   Default: −99.9

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

Value Type: Floating point.

Format: Use 0.1 degree precision. (6 character max for value)

Value Range: −90.0 to +90.0

Example: PABB=+2.4

PABL [Optional]

PDS: PABL [Required]   Default: −9.9

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

Value Type: Floating point.

Format: Use 0.1 degree precision.

Value Range: +0.0 to +359.9

Example: PABL=+43.5 (6 character max for value)

Notes: Only positive values are allowed, i.e. 0 to 359.9.

PHASE [Optional]

PDS: Phase [Required]   Default: −9.9

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.

Format:	Use no more than 0.01 degree precision.

Value Range:	+0.00 to +180.00

Example:	`PHASE=+5.63` (7 character max for value)

Notes:	ALCDEF does not recognize using negative phases for pre-opposition and positive values for post-opposition.

PUBLICATION [Optional]

PDS: Publication [Required]   Default: - (dash)

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.

Value Type:	String.

Max Length:	60

Example:	`PUBLICATION=Minor Planet Bull. 37, 169-171.` `PUBLICATION={CPUB-SMITH-1}`

Notes:	Can use constant keyword. This is recommended only if submitting a large number of *lightcurve blocks* that are all part of a single publication. An example would be several *lightcurve blocks* for each of several hundred unique objects, such the case of a large wide-field survey.

REDUCEDMAGS [Required]

PDS: ReducedMags [Required]   Default: empty string (forces file to have correct value)

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

`Mag(reduced) = Mag(observed) - 5*log10(rR)`

Value Type:	String.

Allowed Values: NONE, AVERAGE, POINT

NONE	The magnitudes were not corrected to unity distance.
AVERAGE	All magnitudes corrected using the value for the UCORMAG keyword.
POINT	Each magnitude was corrected using value computed for the JD of the observation.

✤ If any correction is applied, it is *strongly encouraged* that AVERAGE method be used. This allows the data user, if he wants, to remove a known value from all observations.

Default:	NONE

Example: REDUCEDMAGS=AVERAGE

Notes: If REDUCEDMAGS is AVERAGE OR POINT, then the UCORMAG keyword *must* be in the *metadata block* and have a valid 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 when using the AVERAGE method.

REVISEDDATA [Required/Optional]

PDS: Not included.

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.

Example: REVISEDDATA=TRUE

❖ This is one of the core keywords used to check for duplicate submissions. See page 9 for more information.

SESSIONDATE [Required]

PDS: SessionDateTime [Required]   Default: 1899-12-30T00:00:00 (see Notes below)

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

Value Type: String.

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.

The UT Julian Date derived from SESSIONDATE and SESSIONTIME *must* agree with the average JD of the *data block* (($JD_{EARLIEST}$ + JD_{LATEST}) / 2) to within 15 minutes (~0.0141 d). Otherwise the *lightcurve block* will be rejected.

For PDS submission via the ALCDEF site, the SESSIONDATE and SESSIONTIME values are concatenated with a 'T' between the two. The 'T' indicates the values are Universal Date/Time. As with ALCDEF, any submission without a valid date and time will not be submitted to PDS.

❖ This is one of the core keywords used to check for duplicate submissions. See page 9 for more *information.*

SESSIONTIME [Required]

PDS: SessionDateTime [Required]   Default: 1899-12-30T00:00:00 (see Notes below)

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

Value Type: String.

Format: hh:mm:ss

Use 24-hour format, e.g., 1 PM = 13:00:00. 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.

The UT Julian Date derived from SESSIONDATE and SESSIONTIME *must* agree with the average JD of the *data block* (($JD_{EARLIEST}$ + JD_{LATEST}) / 2) to within 15 minutes (~0.0141 d). Otherwise the *lightcurve block* will be rejected.

For PDS submission via the ALCDEF site, the SESSIONDATE and SESSIONTIME values are concatenated with a 'T' between the two. The 'T' indicates the values are Universal Date/Time. As with ALCDEF, any submission without a valid date and time will not be submitted to PDS.

❖ This is one of the core keywords used to check for duplicate submissions. See section 3.2 for more information.

STANDARD [Required]

PDS: MagStd [Required]   Default: empty string (forces file to have correct value)

Defines the system on which the magnitudes are based.

Value Type: String.

Max Length: 12 characters

Allowed Values: NONE, INTERNAL, TRANSFORMED

                   See page 14 to see how this keyword interacts with DIFFERMAGS

Default Value: INTERNAL (DIFFERMAGS=FALSE).

Example: STANDARD=INTERNAL

Notes: NONE (DIFFERMAGS=TRUE)
                   If DIFFZEROMAG=0, the zero point for the values is arbitrary.

                   If DIFFZEROMAG=<Sky/Catalog magnitude>, then the zero point is the value given for DIFFZEROMAG, which should be in the same photometry band as MAGBAND.

                   INTERNAL (DIFFERMAGS=FALSE)
                   Magnitudes are "sky" or "catalog" values but they are on an internal system,
                   e.g., there may be a systematic shift of zero point and/or color correction.

                   TRANSFORMED (DIFFERMAGS=FALSE)
                   Magnitudes have been corrected to match a standard system, e.g., Johnson V.

                   The specific catalog from which the magnitudes are derived is not given since there are too many possibilities. Use a COMMENT to provide this information if it seems necessary.

                   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, when STANDARD=[INTERNAL/TRANSFORMED] and MAGBAND=V and, then the magnitudes must be Johnson V.

                   When converting to PDS format from ALCDEF, the value assigned to MagStd will follow the Default Value settings given above.

STARTMETADATA [Required]

PDS: Not included.

Defines the start of a *metadata block*.

Example: `STARTMETADATA`

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

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

SUBMITPDS [Optional]

PDS: Not included

Indicates if permission is given to submit the *lightcurve block* to the PDS archives.

Value Type: Boolean

Max Length: 5 characters

Allowed Values: TRUE, FALSE

Default: FALSE

Example: `SUBMITPDS=TRUE`

Notes: Submitting to the PDS archives requires an "opt-in", meaning that unless specific permission is given to do so, data will not be sent to the PDS archives.

The ALCDEF site allows indicating the default value to be used. The setting is used if only if SUBMITPDS is not found in the *metadata block*.

If SUBMITPDS is found in the *metadata block*, its value takes precedence over the default setting on the ALCDEF site.

SUBMITPDS=TRUE allows the *lightcurve block* to be submitted to the PDS archive.

SUBMITPDS=FALSE prevents the *lightcurve block* from being submitted to the PDS.

TELESCOPE [Optional]

PDS: Telescope [Required]   Default: VARGBTEL

This describes the instrument used to make the observations.

Value Type:	String.
Max Length:	40 characters
Default:	VARGBTEL (PDS approved value; various ground based telescope)

Example:	`TELESCOPE=0.35-m f/10 SCT`
	`TELESCOPE=The George Smith 2.5-m Memorial Telescope`
	`TELESCOPE={CTEL-SMITH-1}`

Notes:	Do not include the camera (detector). Use the DETECTOR keyword instead. A constant keyword should be used only if the description is noticeably longer than the keyword.

UCORMAG [Required/Optional]

PDS: UnityCor [Required]   Default: –99.9

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

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

Example:	`UCORMAG=-3.697`
	
	`UCORMAG=+0.044`

Notes:	If REDUCEDMAGS=AVERAGE/POINT, this keyword is required. If missing or not assigned a value, the *lightcurve block* is rejected. If REDUCEDMAGS=NONE, this keyword is not required and should probably be excluded to prevent any confusion. If UCORMAG is defined, the value should be for the date/time of the *lightcurve block* given by SESSIONDATE and SESSIONTIME *even if the corrections were applied point-by-point*.

6. HANDLING DATA FROM MULTIPLE SUBMITTERS/OBSERVERS

When submitting a file to the ALCDEF site, the file can include any number of *lightcurve blocks* (to a reasonable limit, preferably < 1 MB). The blocks may all be for the same or multiple objects and/or from the same or multiple *submitters* or *observers*.

The importance of this comes into play when giving values to certain, sometimes core, keywords. Specifically, these would be

CONTATNAME	OBSERVERS
CONTACTINFO	OBSLATITUDE
FACILITY	OBSLONGITUDE
INSTRUMENT	FILTER
OBSERVERS	MAGBAND

6.1 SINGLE SUBMITTER/OBSERVER

Consider the simple example where the submitter was J. Q. Astronomer, who was the only observer and all observations, regardless of object, were made from his location. He uses software that reads a configuration file that describes only his information as part of the automatic construction of the ALCDEF file from his data tables.

In this case, the 10 keywords given would be the same for every lightcurve block.

6.1.1 SINGLE SUBMITTER, MULTIPLE OBSERVERS AT SAME LOCATION

Assuming this was a gaggle of people tied to one telescope's observations, the only change here from above is that the OBSERVERS value would have more than one name. If each person used a different set of equipment, then this should be handled as in section 6.2

6.2 SINGLE SUBMITTER, MULTIPLE OBSERVERS

Suppose now that J. Q. Astronomer coordinated an observing campaign for an asteroid that included F. A. Smith and S. M. Jones, who were at different locations and sent their data to J. Q. Astronomer. There are several possibilities, some requiring additional effort on the part of the data submitter but which assure the most accurate information.

6.2.1 INDIVIDUAL SUBMISSION

The simplest approach is that each observer submits his own data as a single submitter/observer to the ALCDEF site using his information. The campaign coordinator should try to assure that each person submits his data. This reduces the work load on the person conducting the coordinated effort.

6.2.2 ISOLATING DATA BY OBSERVER

Even if they all observed on the same night, the data in a given *lightcurve block* would be from one observer. The values for the 10 keywords would be changed to reflect the person who provided the data. For example, using his software, J. Q. Astronomer might generate a separate file for each person's data, using a different configuration for each observer. He could submit the files individually or merge them into a single file.

6.2.3 A COMBINATION OF METHODS

If tying a specific *lightcurve block* to a specific observer is not important but the location and equipment used by each observer is important, then a series of COMMENT lines can be used. For example:

```
CONTACTNAME=J. Q. Astronomer
CONTACTINFO=[jq@astronomer.net]
FACILITY=Into Darkness Observatory
INSTRUMENT=0.50-m f/8 Ritchey-Chretien
DETECTOR=FLI PL=1001E
OBSLONGITDUE=-116.55435
OBSLATITUDE=+39.015411
OBSERVERS=J. Q. Astronomer; F. A. Smith; S. M. Jones
COMMENT=Smith: The Smith Observatory; -104.21121, +23.88945
COMMENT=Smith: 0.35-m SCT, SBIG STL-1001E
COMMENT=Jones: No Place Like Dome Observatory
COMMENT=Jones: MPCCode: A22
COMMENT=Jones: 0.40-m SCT, Apogee U47
```

The OBSLONGITUDE/LATITUDE/FACILITY keywords are for J. Q. Astronomer. For Smith, his longitude and latitude are given while Jones uses his MPCCode ID (which can be converted to longitude and latitude using the many lists available on the Internet).

6.3.4 GENERIC VALUES

Here all the *lightcurve blocks* are in one or more files and no distinction is made for the source of the data for each *lightcurve block*. In this case, eight of the keywords in each *metadata block* would look something like:

```
CONTACTNAME=J. Q. Astronomer
CONTACTINFO=[jq@astronomer.net]
FACILITY=MULTIPLE
INSTRUMENT=VARGBTEL
DETECTOR=VARGBDET
OBSLONGITDUE=MULTIPLE
OBSLATITUDE=MULTIPLE
OBSERVERS=J. Q. Astronomer; F. A. Smith; S. M. Jones
```

"VARGB" is from the PDS and stands for "various ground-based."

This is the least desirable option and should be used as a last resort.

6.3.4 FILTER AND MAGBAND

These two keywords require special attention since, for one, FILTER is one of the core keywords used to allow submitting revised data.

Regardless of the considerations above, every lightcurve block must specify the actual values. If submitting files with generic data (sect 6.3.3), the *metadata block* in each *lightcurve block* must somehow be edited to give the correct values.

APPENDIX A: SAMPLE LIGHTCURVE BLOCK

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

```
STARTMETADATA
REVISEDDATA=FALSE
SUBMITPDS=TRUE
OBJECTNUMBER=18736
OBJECTNAME=1998 NU
MPCDESIG=
SESSIONDATE=2018-11-15
SESSIONTIME=09:58:00
CONTACTNAME=B. D. Warner
CONTACTINFO=[brian@MinorPlanetObserver.com] 446 Sycamore Ave., Eaton, CO, USA
OBSERVERS=B. D. Warner
FACILITY=Center for Solar System Studies - Palmer Divide Station
MPCCODE=U82
OBSLONGITUDE=-116.38483
OBSLATITUDE=+34.27247
TELESCOPE=0.35m f/9.1 SCT
DETECTOR=STL-1001E
EXPOSURE=240
EXPJD=MID
OBJECTRA=07:14.9
OBJECTDEC=+25 40
EQUINOX=J2000.0
PHASE=+28.51
PABL=+92.6
PABB=+2.6
FILTER=C
MAGBAND=V
DIFFERMAGS=FALSE
STANDARD=INTERNAL
CICORRECTION=FALSE
CIBAND=VR
LTCAPP=NONE
REDUCEDMAGS=NONE
DELIMITER=PIPE
COMPNAME1=071454.96 +253744.9
COMPRA1=07:14:54.92
COMPDEC1=+25:37:44.9
EQUINOX=J2000.0
COMPMAG1=+16.199
COMPMAGBAND1=V
COMPCI1=+16.199
COMPMAGBAND1=VR
COMPNAME3=071451.62 +254205.8
COMPRA3=07:14:51.61
COMPDEC3=+25:42:05.7
EQUINOX=J2000.0
COMPMAG3=+15.524
COMPMAGBAND3=V
COMPCI3=+0.434
COMPMAGBAND3=VR
COMMENT=Image measurer: B. D. Warner
ENDMETADATA
DATA=2458437.787825|+18.318|+0.055
DATA=2458437.790736|+18.368|+0.052
DATA=2458437.793644|+18.354|+0.052
DATA=2458437.799479|+18.229|+0.046
DATA=2458437.802401|+18.315|+0.050
ENDDATA
```

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 *alcdef.org* 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 else 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 of the new format.

The changes go hand-in-hand with a new submission page on the *alcdef.org* web site. The page can be accessed from the ALCDEF home page or directly using

> *https://minplanobs.org/alcdef*
> *https://minplanobs.org/alcdef/PHP/alcdef_SimpleUpload.php*

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: one applies to all data in the upload file and the other can overwrite data on a block-by-block basis. The two are combined into a single setup that affects the files being uploaded.

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 cannot be submitted until 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.2.0.1 GIVING EXPLICT PERMISSIONS

The S-ALCDEF format follows the same rules governing the storage and subsequent redistribution of data. The web page provides the Submit to PDS option to govern how data are redistributed. See page 6 for more information.

The keywords are in the Required Data section of the S-ALCDEF input form. In other words, you must set the value for both keywords to YES or NO. Unlike the other settings in the section, which apply to all *lightcurve blocks*, the values for these two keywords can be altered with a metadata override (see below).

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 a START/ENDDATA pair are found between the START/ENDBLOCK markers. If the test fails, an error message is returned. See section 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 mag band but one block has observations in the R filter and R mag band, metadata override lines 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>. 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
DIFFERMAGS	Differ Mags	FALSE or TRUE (See DIFFERMAGS in Section 5)
EXPJD	Exposure JD	START, MID, END (see note)
EXPOSURE	Exp (sec)	–99 for MID, *positive* number for START or END
FILTER	Filter	See FILTER keyword in ALCDEF standard
LTCTYPE	L-T Correction	NONE (No) or AVERAGE (Yes)
MAGBAND	Mag Band	See MAGBAND in Section 5.
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
REDUCEDMAGS	Reduced Mags	NONE (No) or AVERAGE (Yes)
STANDARD	Mag System	See STANDARD in Section 5.
SUBMITPDS	Submit to PDS	Must be set to TRUE to allow submitting to PDS.

The two exposure keywords are part of the ALCDEF v2.2 standard, which states that the JD values are presumed to be for mid-exposure. The EXPJD 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* non-zero 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.

Section B.3 gives examples of metadata line overrides.

B2.3.2 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 crosschecks 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 checks for non-numeric characters at the beginning of the line and removes them from the line. However, the resulting line must still pass the data checks assumed for a data line.

All floating point numbers must use a period for the decimal character and cannot use exponential notation.

B.2.3.1 JULIAN DATES

This is one of the few times that the original data are not preserved. This is because the odds for errors increase considerably if the JD values are a mix of full/partial and/or JD/MJD.

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, e.g., 2456589.44586.

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 value 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 to be put into the wrong *lightcurve block*, the file 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 data line; it is 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 the hash symbol in a COMMENT line for 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. This section covers each one in detail.

B.3.1 REQUIRED DATA

These are data common to all *lightcurve blocks* in the file, with the exception of *Allow Sharing and Submit to PDS*. All other entries are applied to every *lightcurve block* in the file. A separate file must be submitted for each combination of those other fields. See Section 5 for more details about the keyword associated with each entry.

Allow Sharing (ALCDEF keyword: ALLOWSHARING)
This option must be set to YES or NO (ALCDEF values TRUE or FALSE) before submitting a file. If not set, the page is returned with an error message in the File Upload section.

If set to NO, the entire file will be rejected unless one or more lightcurve blocks has a metadata override of ALLOWSHING=TRUE.

Submit to PDS (ALCDEF keyword: SUBMITPDS)
This option must be set to YES or NO (ALCDEF values TRUE or FALSE) before submitting a file. If not set, the page is returned with an error message in the File Upload section.

Assuming ALLOWSHARING=TRUE, if set to NO, the data will be stored and redistributed via the ALCDEF site, but they will not be part of an archive submitted to NASA's Planetary Data System (PDS).

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 CONTACTNAME. This field is intended to be an email or postal mailing address. Since these data will be archived and may be 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 *from the same location as the CONTACTNAME*. Separate observers with a semi-colon. A maximum of 150 characters is allowed.

✥ If data are from multiple locations, a separate submission should be made for each location with only the obtained at that location in the file.

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
```

will 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 three delimiters, the pipe (|), semicolon (;), or 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.

*All floating point numbers **must** use the period for the decimal character* to avoid problems is the data delimiter is a comma.

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, heliocentric, barycentric, etc.). 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 converted to full JD using: JD = OrgJD + <JD Offset>
```

Comment (ALCDEF keyword: COMMENT)

This field is applied to all *lightcurve blocks*. It might include 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 70 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.

✥ Do not include "basic" instrumentation information. The Base Data section includes the Telescope and Camera fields to provide that information. These can be changed with metadata overrides within *lightcurve blocks*.

B.3.2 BASE DATA

Base Data (Can override)		
Object Number	0	
	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.	
Facility		
	Observatory/Facility name, e.g., Center for Solar System Studies - Palmer Divide Station	
MPC Code		MPC observatory code, e.g., U82
Tools	Telescope VARGBTEL	Detector CCD
	e.g., 0.5-m f/8.1 Ritchey-Chretien	e.g., CCD or FLI-1001E or Apogee Alta
Default Longitude Latitude	Longitude	Latitude
	±DDD.dddddd (-180.00 to +180.00)	±DD.dddddd (-90.00 to +90.00)
	Negative for Western Hemsphere	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 — Diff Zero Mag -99.9	Exposure JD: Mid, Start, End — Exp (sec) -99 — Enter 0 if mid-time
Revised	False / True	See ALCDEF documentation before submitting revised 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 submitted file. 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.

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 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. This is to avoid problems when the number and name/designation are not for the same object.

Regardless of other considerations, enter the appropriate value that applies to *all lightcurve blocks* that do not include metadata overrides.

Facility / MPC Code (ALCDEF keyword: FACILITY / MPCCODE)
These are new keywords that were added to facilitate submissions to the PDS. Both are not required but one or the other is **very strongly** urged and both would be better.

✎ Do not use a user-defined MPC Code, e.g., a temporary one pending MPC action.

Telescope / Detector (ALCDEF keyword: TELESCOPE / DETECTOR)
These are new keywords that were added to facilitate submissions to the PDS. Both are **very strongly** urged.

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, submit a separate file with the appropriate settings and that includes only data from the location.

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=<mid-time value of data block computed during parsing>
```

Important: If the setting is NO (not light-time corrected) but one or more *lightcurve blocks* have data that *are* light-time corrected, then *all three lines immediately above must be included* with the correct values. For LTCTDAYS, the value will be a negative number that is 0.005772 * Earth distance (in AU), e.g., if the asteroid was 1.0 AU from Earth,

```
LTCDAYS=−0.005772
```

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

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, e.g., +13.443. 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=<mid-time value computed during parsing>
```

If the setting is NO and one or more *lightcurve blocks* have reduced magnitudes then, assuming that a constant value was used for the unity distance correction, 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 *lightcurve blocks* do not have reduced magnitudes, include only 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 magband (photometric band) of the reported magnitudes, e.g, V. The options starting with 'S' are the Sloan filters, i.e., u', g', r', i', and z'.

Not seen in the screen shot is the option GG. This should be used when g magnitudes from the Gaia catalog were used, *unless* those were converted to another band, e.g., V. In that case, select V and add a comment line

COMMENT=Gaia g magnitudes converted to <magband> using <formula>

Where <magband> is the chosen magband setting and <formula> is the formula used to convert from g to <magband>. Use single-line notation for the formulae, e.g., *sqr* for x^2 or *sqrt* for $\sqrt{x}$.

Except when filter is Clear/None, this is usually the same value as selected for Filter. There is no "C", "Clear", or "None" band.

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=<NONE/INTERNAL/TRANSFORMED>
```

See 4.3.2   DIFFERENTIAL VS. "SKY" MAGNITUDES on page 14 in the main part of this manual.

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, given by DIFFZEROMAG. An override line would be

```
DIFFERMAGS=<TRUE/FALSE>
```

See 4.3.2   DIFFERENTIAL VS. "SKY" MAGNITUDES on page 14 in the main part of this manual.

Diff 0 (ALCDEF keyword: DIFFZEROMAG)
Enter the value to be added to differential magnitudes to derive a "sky" magnitude.

An override line would be

```
DIFFZEROMAG=+13.000
```

See 4.3.2   DIFFERENTIAL VS. "SKY" MAGNITUDES on page 14 in the main part of this manual.

Exposure JD (ALCDEF keyword: EXPJD)
The options are:

Mid	JD values in *data block* are for mid-exposure (ALCDEF standard).
Start	JD values in *data block* are for the start of the exposure.
End	JD values in *data block* 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

```
EXPJD=<START/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

```
EXPJD=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. If the JD are start or end times, two comment lines are inserted:
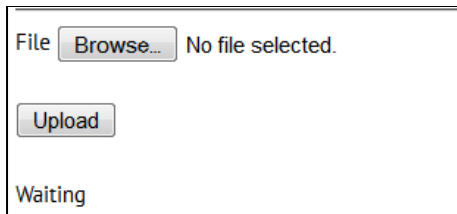
```
COMMENT=JD are for the exposure <Exposure JD selection> time
COMMENT=Exposure time (seconds) <value in Exp (sec) field>
```

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 entries. However, this mainly applies to the data lines or other lines that are not in the core metadata. See 4.2 DUPLICATE DATA CHECK on page 9 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.

REVISION HISTORY

This history begins with the changes starting with version 2.2.6 (2019 March 24).

DEFAULT VALUES REMOVED

Default values are no longer automatically provided in ALCDEFSubmit for the following keywords:

Keyword	Old Default	New Default
DATADELIMITER	NONE	Empty string
LTCAPPLIED	NONE	Empty string
LTCTYPE	NONE	Empty string
STANDARD	NONE	Empty string
REDUCEDMAGS	NONE	Empty string

The changes were made to assure that the allowed keyword names and value were being used by third-party sources of ALCDEF files. With the defaults, some invalid values, e.g., INSTRUMENTAL instead of INTERNAL for the STANDARD keyword, were passing validation when they should not. It would not be realistic to write validation routines when any number of variations for keyword names and/or values were allowed.

ADDITION OF "CONSTANT KEYWORDS" (2.2.6)

Constant keywords (see section 3.2) were added to help reduce data storage and provide greater flexibility by letting a single word take the place of many. The full text tied to the constant keyword is seen only when exporting data from the ALCDEF web site. A list of the most recent constant keyword definitions can be found on the ALCDEF website.

ALCDEFVERIFY (2.2.6)

ALCDEFVerify is no longer provided as a Windows-based program. Instead, submitters should use the link on the ALCDEF home page to submit files for verification only. This change allows for a single version of the validation code on the website, i.e., the same code is used to when using the ALCDEFVerify tool and uploading data to the database.

ADDED MISSING COMPCIBAND DESCRIPTION IN KEYWORD SECTION (2.2.7)

The keyword COMPCIBAND was included in the table of keywords but its definition and usage were not.

REMOVED ALLOWSHARING KEYWORD. (2.3.0)

The ALLOWSHARING value was moot. By virtue of uploading the data, the supplier is giving implicit permission to allow distribution, with the main limit base on the SUBMITPDS keyword.

Update documentation to reflect changes and several corrigenda.

Intentionally Blank