

4.4.2.6. Extension keywords

The next three keywords were originally defined for use within the header of a conforming extension, however they also may appear in the primary header with an analogous meaning. If these keywords are present, it is recommended that they have a unique combination of values in each HDU of the FITS file.

EXTNAME keyword. The value field shall contain a character string to be used to distinguish among different extensions of the same type, i.e., with the same value of XTENSION, in a FITS file. Within this context, the primary array should be considered as equivalent to an IMAGE extension.

EXTVER keyword. The value field shall contain an integer to be used to distinguish among different extensions in a FITS file with the same type and name, i.e., the same values for XTENSION and EXTNAME. The values need not start with 1 for the first extension with a particular value of EXTNAME and need not be in sequence for subsequent values. If the EXTVER keyword is absent, the file should be treated as if the value were 1.

EXTLEVEL keyword. The value field shall contain an integer specifying the level in a hierarchy of extension levels of the extension header containing it. The value shall be 1 for the highest level; levels with a higher value of this keyword shall be subordinate to levels with a lower value. If the EXTLEVEL keyword is absent, the file should be treated as if the value were 1.

The following keyword is optional, but is reserved for use by the convention described in App.K. If present it shall appear in the extension header immediately after the mandatory keywords, and be used as described in the Appendix.

INHERIT keyword. The value field shall contain a logical value of T or F to indicate whether or not the current extension should inherit the keywords in the primary header of the FITS file.

4.4.2.7 Data Integrity Keywords

The two keywords described here provide an integrity check on the information contained in FITS HDUs.

DATASUM Keyword. The value field of the DATASUM keyword shall consist of a character string that should contain the unsigned integer value of the 32-bit 1's complement checksum of the data records in the HDU (i.e., excluding the header records). For this purpose, each 2880-byte FITS logical record should be

interpreted as consisting of 720 32-bit unsigned integers. The 4 bytes in each integer must be interpreted in order of decreasing significance where the most significant byte is first, and the least significant byte is last. Accumulate the sum of these integers using 1's complement arithmetic in which any overflow of the most significant bit is propagated back into the least significant bit of the sum.

The DATASUM value is expressed as a character string (i.e., enclosed in single quote characters) because support for the full range of 32-bit unsigned integer keyword values is problematic in some software systems. This string may be padded with non-significant leading or trailing blank characters or leading zeros. A string containing only one or more consecutive ASCII blanks may be used to represent an undefined or unknown value for the DATASUM keyword. The DATASUM keyword may be omitted in HDUs that have no data records, but it is preferable to include the keyword with a value of 0. Otherwise, a missing DATASUM keyword asserts no knowledge of the checksum of the data records. Recording in the comment field the ISO-8601-formatted Datetime when the value of this keyword record is created or updated is recommended.

CHECKSUM Keyword. The value field of the CHECKSUM keyword shall consist of an ASCII character string whose value forces the 32-bit 1's complement checksum accumulated over the entire FITS HDU to equal negative 0. (Note that 1's complement arithmetic has both positive and negative zero elements). It is recommended that the particular 16-character string generated by the algorithm described in Appendix J be used. A string containing only one or more consecutive ASCII blanks may be used to represent an undefined or unknown value for the CHECKSUM keyword.

The CHECKSUM keyword value must be expressed in fixed format, when the algorithm in Appendix J is used, otherwise the usage of fixed format is recommended. Recording in the comment field the ISO-8601-formatted Datetime when the value of this keyword record is created or updated is recommended.

If the CHECKSUM keyword exists in the header of the HDU and the accumulated checksum is not equal to -0, or if the DATASUM keyword exists in the header of the HDU and its value does not match the data checksum then this provides a strong indication that the content of the HDU has changed subsequent to the time that the respective keyword value was computed. Such an invalid checksum may indicate corruption during a prior file copy or transfer operation, or a corruption of the physical media on which the file was stored. It may alternatively reflect an intentional change to the data file by subsequent data processing if the CHECKSUM value was not also updated.

Normally both keywords will be present in the header if either is present, but this is not required. These keywords apply only to the HDU in which they are contained. If these keywords are written in one HDU of a multi-HDU FITS file then it is strongly recommended that they also be written to every other HDU in the file with values appropriate to each HDU in turn; in that case the checksum accumulated over the entire file will equal -0 as well. The DATASUM keyword must be updated before the CHECKSUM keyword. In general updating the two checksum keywords should be the final step of any update to either data or header records in a FITS HDU. It is highly recommended that if

4. The INHERIT keyword described in Sect. 4.4.2.6 was originally introduced as a *FITS* convention since 1995, and registered in 2007. The text of the original convention is reported at <http://fits.gsfc.nasa.gov/registry/inherit.html>. See also references and practical considerations therein.

DRAFT

Appendix K: Header inheritance convention

This Appendix is not part of the FITS standard, but is included for informational purposes.

The reserved boolean INHERIT keyword described in Sect.4.4.2.6 is optional, but if present it *shall* appear in the extension header immediately after the mandatory keywords. Keyword inheritance provides a mechanism to store keywords in the primary HDU, and have them be shared by one or more extensions in the file. This mechanism minimizes duplication (and maintenance) of metadata in multi-extension FITS files.

It *should* only be used in *FITS* files that have a null primary array (e.g., with NAXIS = 0). to avoid possible confusion if array-specific keywords (e.g., BSCALE and BZERO) were to be inherited.

When an application reads an extension header with INHERIT = T, it should merge the keywords in the current extension with the primary header keywords. The exact merging mechanism is left up to the application. The mandatory primary array keywords (e.g., BITPIX, NAXIS, and NAXISn) and any COMMENT, HISTORY, and blank keywords in the primary header are *never* inherited. It is assumed also that the table-specific keywords described in Sect. 7.2 and 7.3, and the table-specific WCS keywords described in Sect. 8, cannot be inherited since they will never appear in the primary header. If the same keyword is present in both the primary header and the extension header, the value in the extension header *shall* take precedence. If INHERIT = F in an extension header, the keywords from the primary header *should* not be inherited.

An application which merely reads a FITS file is authorized by INHERIT = T to look up in the primary HDU for an expected keyword not found in the current HDU. However if the application writes out a modified file, it has to be very careful to avoid unwanted duplication of keywords, and preserve the separation of primary and extension headers, namely if an application modifies the value of an inherited keyword while processing an extension HDU, then it is recommended to write the modified value of that keyword into the extension header, leaving the value of the keyword in the primary header unchanged. The primary array keywords should only be modified when the intent is to explicitly change the value that will subsequently be inherited in the extensions.

Also if the FITS file is read in sequentially (e.g., from tape or Internet downloads), the reader would need to cache the primary header in case it turns out that a later extension in the file uses the INHERIT keyword.