



**Robert C. Byrd Green Bank Telescope
NRAO Green Bank**

Joe Brandt

5th June 2007

GBT SOFTWARE PROJECT NOTE 9.0

GBT Holography Backend FITS File Specification

HTML version Available¹

Contents

1 Background	3
2 Primary HDU keywords	3
3 Binary Image	4
4 Modification History	6
5 SUMMARY	6

Abstract

The FITS format structure is presented for the Holography Backend scan data files. The scan data FITS files are permanently archived after each observation, and together with the scan data files from other devices provide the complete record of each observation.

The scan data FITS files contain one or more binary FITS images obtained by the holography backend over the course of the observation.

¹<http://www.gb.nrao.edu/GBT/MC/doc/dataproc/gbtHoloFits/gbtHoloFits/gbtHoloFits.html>

History

5th June 2007 Initial version (Joe Brandt).

1 Background

All GBT scan data FITS files should conform to the standards specified in the GBT Software Project Note 4.0, “Device and Log FITS Files for the GBT.”

The holography backend will be used for engineering observations related to the performance of the antenna, by recording the phase difference between the main and reference beam. GBT memo 101 describes the holography backend hardware.

The details of the holography backend FITS files are described in the following sections.

2 Primary HDU keywords

The holography backend FITS keywords for the primary HDU conforms to the definition for common FITS headers as described in GBT Software Project Note 4.0 “Device and Log FITS Files for the GBT.”

An example primary header is shown below:

```
SIMPLE = T / file does conform to FITS standard
BITPIX = 8 / number of bits per data pixel
NAXIS = 0 / number of data axes
EXTEND = T / FITS dataset may contain extensions
COMMENT FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
ORIGIN = 'NRAO Green Bank' /
INSTRUME= 'Holography' / device or program of origin
GBTMCMVER= 'integration' / telescope control software release
FITSVER = '2.2' / FITS definition version for this device
DATEBLD = 'DATEBLD goes here' / time program was linked
SIMULATE= 1 / Is the instrument in simulate mode?
DATE-OBS= '2008-03-19T00:00:04' / Manager parameter startTime
TIMESYS = 'UTC' / time scale specification for DATE-OBS
TELESCOP= 'NRAO_GBT' / Green Bank Telescope (Robert C. Byrd 100m)
OBJECT = '1800+7828' / Manager parameter source
PROJID = 'TREG' / Manager parameter projectId
OBSID = 'unit_test' / Manager parameter scanId
SCAN = 34 / Manager parameter scanNumber
UTDATE = 54544 / MJD of start time
UTCSTART= 3.6000000000000E+00 / Start time
CYCLETIM= 1.0000000000000E-01 / Switching period in seconds
CYCLES = 1 / Switching periods per Integration
DURATION= 1.0000000000000E-01 / Integration time
TESTATTN= 5 / Test input attenuation db's (0-31)
REFATTEN= 2 / Reference input attenuation db's (0-31)
END
```

The primary header keywords for the holography backend FITS files are as follows:

The first four items are mandatory FITS keywords.

ORIGIN is a reserved FITS standard keyword.

INSTRUME is the FITS standard keyword used to specify the “instrument” responsible for producing the data in the file. This will be set to the string Holography for all holography FITS files.

GBTMCVER, FITSVER, DATEBLD, and SIMULATE are GBT-specific keywords.

GBTMCVER refers to the version of the M&C system in use at the time the file was created.

FITSVER refers to the version of the GBT FITS definition the file conforms to. The leading number refers to the global definition version (i.e. this document), while the trailing number refers to a revision specific to this specific type of FITS file. For example, a value of 2.5 in a Spectrometer FITS file would imply the fifth revision of the Spectrometer FITS file definition conforming to the second revision of the global GBT FITS standards.

DATEBLD is generated automatically via the Unix command “date -u +whenever the program which actually writes the FITS file is linked.

SIMULATE specifies whether the program was running in simulation mode when the file was written.

DATE-OBS is the FITS standard keyword to specify the date and time of the start of an observation. As recommended in the standard, the UTC time scale is explicitly specified using the TIMESYS keyword. This time in GBT Device files represents the nominal scheduled time and is therefore represented only to the nearest second.

TELESCOP is a reserved FITS standard keyword.

OBJECT is the FITS standard, and PROJID, OBSID and SCAN pre-existing FITS keywords used to define these quantities, and so are used here. The corresponding GBT M&C base manager parameters are indicated in the comments.

The following are additional header keywords added for the holography manager:

UTDATE is the modified Julian Day (MJD) of the start of the observation.

UTCSTART is the number of seconds since midnight UTC of the start of the observation.

CYCLETIM is the duration of the sub-integration time, in seconds.

CYCLES is the integer number of sub-integrations accumulated before passing the data onto the manager. Therefore the typical integration time is CYCLETIM*CYCLES in seconds.

DURATION is the length in seconds of the each integration time. This should be equal to the cycletime times the number of cycles per integration.

TESTATTN is the amount of input attenuation of the main (i.e. GBT) signal input.

REFATTEN is the amount of input attenuation in db of the reference signal input.

3 Binary Image

The holography FITS file contains a binary image which represents the data acquired by the holography backend for the purpose of assisting in the determination of GBT surface features.

The header keywords for the binary image is as follows:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                8 / 8-bit bytes
NAXIS   =                2 / 2-dimensional binary table
NAXIS1  =               60 / width of table in bytes
NAXIS2  =               99 / number of rows in table
PCOUNT  =                0 / size of special data area
GCOUNT  =                1 / one data group (required keyword)
TFIELDS =                8 / number of fields in each row
TTYPE1  = 'DMJD'          / label for field 1
TFORM1  = '1D'           / data format of field: 8-byte DOUBLE
TUNIT1  = 'd'            / physical unit of field
```

```

TTYPE2 = 'IFFLAG ' / label for field 2
TFORM2 = '1J ' / data format of field: 4-byte INTEGER
TUNIT2 = 'CODE ' / physical unit of field
TTYPE3 = 'TESTxTEST' / label for field 3
TFORM3 = '1D ' / data format of field: 8-byte DOUBLE
TUNIT3 = 'COUNTS ' / physical unit of field
TTYPE4 = 'QTESTxQTEST' / label for field 4
More? [Yes]
TFORM4 = '1D ' / data format of field: 8-byte DOUBLE
TUNIT4 = 'COUNTS ' / physical unit of field
TTYPE5 = 'REFxREF ' / label for field 5
TFORM5 = '1D ' / data format of field: 8-byte DOUBLE
TUNIT5 = 'COUNTS ' / physical unit of field
TTYPE6 = 'TESTxQTEST' / label for field 6
TFORM6 = '1D ' / data format of field: 8-byte DOUBLE
TUNIT6 = 'COUNTS ' / physical unit of field
TTYPE7 = 'TESTxREF' / label for field 7
TFORM7 = '1D ' / data format of field: 8-byte DOUBLE
TUNIT7 = 'COUNTS ' / physical unit of field
TTYPE8 = 'REFxQTEST' / label for field 8
TFORM8 = '1D ' / data format of field: 8-byte DOUBLE
TUNIT8 = 'COUNTS ' / physical unit of field
EXTNAME = 'DATA ' / name of this binary table extension
SCAN = 34 / Scan number
UTDATE = 54544 / MJD start of integration
UTCSTART= 3.600000000000000E+00 / start time in sec since midnight
BACKEND = 'Holo ' / Holography Receiver
END

```

DMJD	IFFLAG	TESTxTEST
d	CODE	COUNTS
5.454400004166667E+04	1	1.000000000000000E+00
QTESTxQTEST	REFxREF	TESTxQTEST
COUNTS	COUNTS	COUNTS
1.000000000000000E+01	1.000000000000000E+02	1.000000000000000E+03
TESTxREF	REFxQTEST	
COUNTS	COUNTS	
1.000000000000000E+04	1.000000000000000E+05	

The columns are described below:

DMJD is the time-stamp in modified Julian days and fractions of a day of the end of integration. (TBD)

IFFLAG is a flag which if non-zero, indicates the data in the associated row is invalid, contaminated by RFI, or for some other reason is questionable. This flag is currently always zero. (Unimplemented.)

The columns TESTxTEST, QTESTxQTEST, REFxREF, TESTxQTEST, TESTxREF, REFxQTEST represent the magnitudes of the cross-correlations of the signals in the column name. (e.g. TESTxREF is the cross-correlation of the test signal with the reference signal.) Each of these columns is in terms of counts, which are unitless.

It is questionable of whether or not the keyword values of SCAN, UTDATE, UTCSTART and BACKEND are useful in the data table, since by default there will always only be one binary table per scan. I leave this as an item for discussion.

4 Modification History

This section describes the modification history of the holography FITS file.

- FITSVER 0.0 - Initial version used for testing

- FITSVER 2.2 - Updated version of manager ported to linux.
 - PROJECT keyword changed to PROJID

 - BACKEND keyword removed

 - SCANID keyword changed to OBSID

 - FITSVER value changed to 2.2

5 SUMMARY

The definition of FITS file keywords and table columns conforms to the standard for the GBT project as a whole. However, the holography backend FITS files do not contain the standard STATE or PORT tables.