

## GB . Projects . CcbFitsSpec

# CCB FITS File Specification -- DRAFT

## 1 Introduction

This wiki page specifies the CCB FITS file format. The CCB FITS file will conform with GBT FITS standards laid out in GBT SPN/004 (<http://www.gb.nrao.edu/GBT/MC/doc/dataproc/gbtFits/gbtFits/gbtFits.html>) which should be consulted in parallel with this specification.

## 2 Primary Header

The primary header will contain all required GBT FITS keywords, for example:

```
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= 'CCB' / device or program of origin
GBTCVER= '4.6' / telescope control software release
FITSVER = '1.2' / FITS definition version for this device
DATEBLD = 'Mon Sep 20 20:58:25 UTC 2004' / time program was linked
SIMULATE= 0 / Is the instrument in simulate mode?
DATE-OBS= '2004-10-09T07:50:01' / Manager parameter startTime
TIMESYS = 'UTC' / time scale specification for DATE-OBS
TELESCOP= 'NRAO_GBT' / Green Bank Telescope (Robert C. Byrd 100m)
OBJECT = '2230+114' / Manager parameter source
PROJID = 'AGBT04C_018_04' / Manager parameter projectId
OBSID = 'lineFSW' / Manager parameter scanId
SCAN = 305 / Manager parameter scanNumber
END
```

In addition to the above standard keyword/value pairs, the following instrument-specific keyword/value pairs will be recorded:

<u>Keyword</u>	<u>Values</u>	<u>Related CCB Library Call</u>	<u>Units</u>	<u>Notes</u>
ACTPSW	A,B,Both,None	ccb_set_phase_switch_cnf.active_switches		Designate active phase switches
INPSWSTA	0,1	".closed_switches		Important if one switch is held constant so you know what it was
INPSWSTB	0,1	".closed_switches		Important if one switch is held constant so you know what it was
SMPPERST	integer	".samp_per_state	100 ns	number of ADC samples per phase switch state
CALCYCLN	integer	ccb_set_cal_diode_cnf.ncal		number of integrations in the calibration cycle
CALOFFIG	integer	".diode_times		duration of the cal off step, integrations
				duration of the left cal on step

LCALONIG	integer	".diode_times		duration of the left cal on step, integrations
BCALONIG	integer	".diode_times		duration of the both cal on step, integrations
RCALONIG	integer	".diode_times		duration of the right cal on step, integrations
INTGPD	integer	ccb_set_timing_cnf.integ_period		number of phase switch cycles which go into one integration
PSWDT	integer	ccb_set_timing_cnf.phase_switch_dt	100 ns	phase switch transition blanking interval
CRISED	integer	".diode_rise_dt	100 ns	Cal diode settling time after being switched on (determines # blanked integ)
CFALLDT	integer	".diode_fall_dt	100 ns	Cal diode settling time after being switched off determines # blanked integ)
RNDTRPDT	integer	".roundtrip_dt	100 ns	Internal hardware round trip delay
HOLDOFF	integer	".holdoff_dt	100 ns	minimum interval between hardware interrupts
INTEGRAT	integer	ccb_integration_time()	100 ns	integration time per phase after blanking

**DELETED** (29apr05 -- deltas)

CALSUSED	A,B,Both,None	".driven_diodes	Designate CAL diodes to be used
NTGPERCL	integer	".diode_times	duration of each calibration cycle step, in integrations

The "Units" and "Notes" in the above table will be recorded in COMMENT fields and/or in subcomments ("/") after the keyword/value. Consistent with GBT conventions the primary header contains no data array, only keyword/value pairs.

**COMMENTS**

- While the CCB supports a variable step size in the calibration cycle, the manager will fill the diode\_times array uniformly so this configuration information isn't needed in the FITS file.

**3 PORT Table**

A standard (SPN/004) PORT binary table extension will be recorded in order to allow the CCB inputs to be cross-indexed with the physical descriptions provided in the IF manager IF table. There will be two columns: BANK (a character), and PORT (a non-zero integer). A given value of PORT uniquely identifies a physical input to the CCB, and may be used to index physical descriptions (frequency, feed, polarization ,etc) in the IF manager IF table. It also uniquely defines a row in the PORT table. The BANK column is retained for compliance with GBT SPN/004 and will be set to a fiducial value of 'A'.

Additionally there will be a SLAVE column indicating which daughter card a given input port is associated with. Data will be unsigned 8-bit integers with valid values 0,1,2,3.

The order of the rows of the PORT table will correspond to the ordering of PORT columns in the DATA table. The number of rows NPORTS of the PORT table is equal to the number of valid connections to the CCB input ports.

## Comments

- The "number of valid connections to the CCB input ports" is defined in the usual way. I think this means: the number of input ports for which the IF manager can find a valid feed and polarization in the SIG state, although for the CCB this can be determined trivially by looking at the cabling file which will directly show CCB to RX connections as there is no intervening IF hardware.
- The input port/daughter card mapping should be a static property of the hardware once it's built and labelled.

## 4 CCBSTATE Table

A binary table extension called CCBSTATE will record the physical definitions of the phases of the data. There will be a number of rows equal to the number of phases NPHASES returned for each CCB input port for each integration.

Columns PHIA and PHIB will record the values of the phase switches A & B at each phase state. Valid values are 0 or 1. Data type of each entry in the column is an unsigned byte.

The ordering of rows in the CCBSTATE table will correspond to ordering of the phase columns in the DATA table. The number of rows in the CCBSTATE table is equal to the number of phases in the phase switch cycle (which is in turn equal to 2 to the power of the number of active phase switches-- hence 1,2, or 4). The number of phases in the phase switch cycle is referred to as NPHASES elsewhere in this document.

### Comments

- NPHASES is equal to  $2^{NACTPSW}$  where NACTPSW is the number of active phase switches. Since NACTPSW has valid values of 0, 1, and 2, NPHASES can be 1, 2, or 4.
- This table is analagous to GBT Backends' STATE tables but differs due to the different implementations of CALs (individual integrations are Cal On or Cal off, rather than having sub-integrations or "phases" be Cal On or Cal Off as for other GBT backends) and SIGREF (next bullet point) for this backend.
- A REF state corresponds to "PHIA XOR PHIB". A SIG state is "NOT(PHIA XOR PHIB)". With two phase switches active there will be two physically distinct rows of the CCBSTATE table that correspond to SIG and two that correspond to REF.

## 5 DATA Table

The DATA binary table extension contains raw accumulated total power integrations for each phase of each CCB input port that was used for a given scan.

The first (DMJD) column of the data array contains the MJD of the integration start.

The DATA column is a multidimensional column with dimensions (NPORTS,NPHASES). Each datum will be recorded as a 32 bit two's complement integer; subsequent transformation to unsigned values will be facilitated by recording a TZERO keyword with a value of  $2^{31}$ . The order of the PORT and PHASE sub-columns should correspond to the order of the rows in the PORT and CCBSTATE tables respectively. The number of phases NPHASES is determined by the number of active switches and will be 1, 2, or 4. The number of ports NPORTS is the number of valid connections to a frontend from the CCB.

A second multi-dimensional OVRFLOW column, of the same dimensions as the DATA column, will comprise LOGICAL data with "T" indicating integrations that overflowed and "F" indicating integrations that did not. The value at subcolumn M row N in the OVRFLOW column will denote the overflow status of the integration datum at subcolumn M row N of the DATA column.

Four further LOGICAL columns will contain the SLAVEOK flags. Two further LOGICAL columns will contain CAL

A and CAL B ON flags.

## COMMENTS

- Integration data are returned by the CCB as unsigned 32 bit integers.
- Conversion from signed 32 bit two's complements values, to unsigned 32 bit values, may require use of double precision on the data processing end.
- Overflow information is conveyed by the CCB in the raw (unsigned 32 bit) integration data by a magic value of  $2^{32} - 1$ .

## Appendix: Format of integration data Received by the Manager from the CCB

There are 16 input ports to the CCB (only 12 are used with 3mm), and each integration comprises up to 4 separate phase switch states (each state iterated many times and accumulated over the integration). The bundle of integration data will **always** return

$16 \times 4 = 64$  numbers,

ordered as

J1(00) J1(01) J1(10) J1(11) J2(00) ... J16(11)

where J1..16 denote CCB input ports (map to Rx outputs as per the cabling file), and the parentheses indicate the phase switch state. "0" is **off** , "1" is **on** (I think **on** means phase switch current **positive** but need to check this).

- When less than 2 switches are active some of the columns are empty. The columns will be filled in as determined by the actual driven state of both switches however. So say switchA is driven, switchB is held at **on**, then the filled columns would be numbers two, four, six...
- For 3mm, only 12 input ports will be used, though which twelve is determined by the cabling file.

For more information on the low-level device configuration see pages 23 – 30 of "The Network Interface between the YGOR manager and the CCB server" by Martin Shepherd (v13jun03) at [http://www.astro.caltech.edu/~tjp/GBT/ccb\\_network\\_interface.pdf](http://www.astro.caltech.edu/~tjp/GBT/ccb_network_interface.pdf)

### Still to Do

- mapping of cal A and cal B to L and R or some other physical identifier
- try simulating and reading the FITS file for a few configs.

-- [BrianMason](#)

## Revision History

Date	Who	Notes
11feb05	BSM	Original Draft
23feb05	BSM	Substantial Revisions based circulation of draft on mailinglist:
		added multi-D overflow column; specified data types; added SLAVE column
		to PORT table; changed FLAG column to a single all-inclusive byte; other minor changes

----- Revision r1.12 - 07 Jun 2005 - 15:06 GMT - [BrianMason](#)

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