Atacama
Large
Millimeter
Array

Cartridge Data Formats for Delivery to the Front End Integration Centers

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Change Record

Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A01	2006-03-20	All	-	Initial draft, combining content from FEND-40.09.03.00-008-A-DSN and FEND-40.02.00.00-016-A-STD
A02	2007-04-03	4.1.9, 4.2.7, Figure 15	-	MM: fixes including comments from A. Koops.
A03	2007-06-26	1.1, 4.2.10, 4.2.13	-	Separated co-polar from cross-polar beam patterns. Clarification in intro. Preparation for release.
A04	2007-07-16	4.2.13, 4.2.14	-	Minor wording fixes.
A05	2007-08-02	-	-	Prepared for submittal to release.

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1. Scope

1.1. Identification

This document gives the format and contents of the data to be delivered with each ALMA cartridge to the front end integration center. This document does not specify what data must be delivered, only the format in which to provide it. The individual cartridge test plans are the authorities for what data is required. We treat the data to be delivered as though it were a database, so when the term database is used here, it refers to the collection of cartridge operating and test data as it is prepared, delivered, and archived at the integration center.

1.2. Database overview

The data consists of operating parameters, such as optimum mixer and preamplifier bias values, and performance test data. Files containing the data are delivered as part of the cartridge delivery and acceptance process at the front end integration center.

1.3. Document overview

The design given here is the culmination of effort on two different documents: [RD2] by John Effland, giving the format expected for cartridge operating data and [RD3] by Morgan McLeod giving examples of how the data is to be delivered. This document contains all of the information from both of those documents and is intended to replace both of them. Also given are examples and rationale for how the data might appear when rendered as plots in a report.

Table 1 lists mixer parameters and Table 2 lists preamp parameters. Table 3 lists WCA parameters. Table 4 gives temperature sensor calibration offsets. The tables include specifications for the precision required to store each parameter. Note that these tables define all required cartridge parameters, but aren't necessarily consistent with the database schema.

Section 3 gives an overview of the cartridge configuration and operating data and how it is prepared, delivered, and used. Section 4.1 gives the formats for configuration and operating data. Section 4.2 gives the formats and examples for cartridge test data.

The database schema, shown in Figure 14, gives the database design for the required operating parameters to be delivered with each cartridge.

There are no security or privacy considerations related to the use of this document.

1.4. Acronyms and abbreviations

ALMA – Atacama Large Millimeter Array
CSV – Comma Separated Values, a common text file format.
DSB – Dual Sideband
ESN – Electronic Serial Number
FE – Front End
FEIC – Front End Integration Center
NA – Not applicable
LHe – Liquid Helium
IF – Intermediate Frequency
LO – Local Oscillator
Pol. – Polarization
SB – Sideband
SN – Serial Number
SQL – Structured Query Language
TS – Time Stamp
WCA – Warm Cartridge Assembly
XML – Extensible Markup Language

2. Referenced documents

2.1. Applicable documents

The following documents are included as part of this document to the extent specified herein. If not explicitly stated differently, the latest issue of the document is valid.

Reference	*Document title*	*Date*	*Document ID*
[AD1]	ALMA Product Tree	2004-03-02	SYSE-80.03.00.00-001-M-LIS
[AD2]	Procedures for In-House and On-Site Acceptance of Band 6 Cartridges	2006-09-06	FEND-40.02.06.00-104-A-PRO
[AD3]	Front End Integration Center Database Design Description	2006-05-12	FEND-40.09.03.00-007-A-DSN

2.2. Reference documents

The following documents contain additional information and are referenced in this document.

In the event of a conflict between one of the applicable documents referenced above and the contents of this document, the contents of the applicable document shall be considered as a superseding requirement.

Reference	*Document title*	*Date*	*Document ID*
[RD1]	Interface Control Document Between Front End And Control Software	2007-02-19	ALMA-40.00.00.00-70.35.25.00-B-ICD
[RD2]	Data Formats for Cartridge Operating Parameters	2006-10-18	FEND-40.02.00.00-016-A-STD
[RD3]	Cartridge Data Delivery Data File Templates Design	2006-10-18	FEND-40.09.03.00-008-A-DSN
[RD4]	ICD Between Cartridges and Warm Cartridge Assembly	2005-06-03	FEND-40.02.00.00-40.11.00.00-A-ICD
[RD5]	ALMA System Technical Requirements for 12m Array	2006-09-21	ALMA-80.04.00.00-005-B-SPE

3. Database-wide design decisions

3.1. Identification of Cartridge Operating Parameters

The details for how cartridge operating parameters are to be provided are given in section 4.1. The tables in this section give the signal names, definitions, units, and precision.

Table 1 gives the operating parameters for SIS mixers. Because these parameters are often a function of LO frequency, there is a separate parameter set for each LO frequency.

Table 2 shows the operating parameters for the cold preamplifiers that follow the mixer and are located in the cartridge vacuum space. These parameters may vary with LO frequency and therefore there is a parameter set for each LO frequency.

In cases where the cartridge does not use some of the parameters given in the tables, the values for the not-applicable parameters shall be assumed to be zero. One example of this is band 9, a DSB design, so any parameter referring to mixer 2 or sideband 2 is not applicable. Another example is band 6, where the magnet current control for mixer 1 controls the coils in both sidebands.

Table 3 gives the power amplifier operating parameters which are stored for each WCA. These parameters may vary with LO frequency and therefore there is a parameter set for each LO frequency.

Table 4 gives temperature offsets for each of the temperature sensors integrated into the cartridge assembly. Because the diode sensors have a steep voltage vs. temperature characteristic at the low end of the temperature scale, the offsets are to be given as an absolute temperature offset in Kelvin, to be applied at the specified temperature.

Table 1: Mixer Operating Parameters

Signal	Pol	Comp. Mixer	Description	Precision	Units
VJM1P0	0	1	Mixer junction bias voltage	±XX.XX	mV
IJM1P0	0	1	Mixer junction bias current	±XXXX.X	µA
IMAGM1P0	0	1	Mixer magnet current[1]	±XXX.X	mA
VJM2P0	0	2	Mixer junction bias voltage	±XX.XX	mV
IJM2P0	0	2	Mixer junction bias current	±XXXX.X	µA
IMAGM2P0	0	2	Mixer magnet current[2]	±XXX.X	mA
VJM1P1	1	1	Mixer junction bias voltage	±XX.XX	mV
IJM1P1	1	1	Mixer junction bias current	±XXXX.X	µA
IMAGM1P1	1	1	Mixer magnet current	±XXX.X	mA
VJM2P1	1	2	Mixer junction bias voltage	±XX.XX	mV
IJM2P1	1	2	Mixer junction bias current	±XXXX.X	µA
IMAGM2P1	1	2	Mixer magnet current	±XXX.X	mA

[1] For Band 6, mixer magnet current is common for component mixers 1 and 2.
[2] IMAGM2Px not used for Band 6 because it's included in IMAGM1Px.

Table 2: Preamp Operating Parameters

Signal	Pol	Comp. Mixer	Description	Precision	Units
VD1_A1P0	0	1	Drain voltage, HFET stage 1	±XX.XX	V
VD2_A1P0	0	1	Drain voltage, HFET stage 2	±XX.XX	V
VD3_A1P0	0	1	Drain voltage, HFET stage 3	±XX.XX	V
ID1_A1P0	0	1	Drain current, HFET stage 1	±XX.XX	mA
ID2_A1P0	0	1	Drain current, HFET stage 2	±XX.XX	mA
ID3_A1P0	0	1	Drain current, HFET stage 3	±XX.XX	mA
VG1_A1P0	0	1	Gate voltage, HFET stage 1	±XX.XX	V
VG2_A1P0	0	1	Gate voltage, HFET stage 2	±XX.XX	V
VG3_A1P0	0	1	Gate voltage, HFET stage 3	±XX.XX	V
VD1_A2P0	0	2	Drain voltage, HFET stage 1	±XX.XX	V
VD2_A2P0	0	2	Drain voltage, HFET stage 2	±XX.XX	V
VD3_A2P0	0	2	Drain voltage, HFET stage 3	±XX.XX	V
ID1_A2P0	0	2	Drain current, HFET stage 1	±XX.XX	mA
ID2_A2P0	0	2	Drain current, HFET stage 2	±XX.XX	mA
ID3_A2P0	0	2	Drain current, HFET stage 3	±XX.XX	mA
VG1_A2P0	0	2	Gate voltage, HFET stage 1	±XX.XX	V
VG2_A2P0	0	2	Gate voltage, HFET stage 2	±XX.XX	V
VG3_A2P0	0	2	Gate voltage, HFET stage 3	±XX.XX	V
ILEDP0	0	-	LED current	±XX.X	mA
VD1_A1P1	1	1	Drain voltage, HFET stage 1	±XX.XX	V
VD2_A1P1	1	1	Drain voltage, HFET stage 2	±XX.XX	V
VD3_A1P1	1	1	Drain voltage, HFET stage 3	±XX.XX	V
ID1_A1P1	1	1	Drain current, HFET stage 1	±XX.XX	mA
ID2_A1P1	1	1	Drain current, HFET stage 2	±XX.XX	mA
ID3_A1P1	1	1	Drain current, HFET stage 3	±XX.XX	mA
VG1_A1P1	1	1	Gate voltage, HFET stage 1	±XX.XX	V
VG2_A1P1	1	1	Gate voltage, HFET stage 2	±XX.XX	V
VG3_A1P1	1	1	Gate voltage, HFET stage 3	±XX.XX	V
VD1_A2P1	1	2	Drain voltage, HFET stage 1	±XX.XX	V
VD2_A2P1	1	2	Drain voltage, HFET stage 2	±XX.XX	V
VD3_A2P1	1	2	Drain voltage, HFET stage 3	±XX.XX	V
ID1_A2P1	1	2	Drain current, HFET stage 1	±XX.XX	mA
ID2_A2P1	1	2	Drain current, HFET stage 2	±XX.XX	mA
ID3_A2P1	1	2	Drain current, HFET stage 3	±XX.XX	mA
VG1_A2P1	1	2	Gate voltage, HFET stage 1	±XX.XX	V
VG2_A2P1	1	2	Gate voltage, HFET stage 2	±XX.XX	V
VG3_A2P1	1	2	Gate voltage, HFET stage 3	±XX.XX	V
ILEDP1	1	-	LED current	±XX.X	mA

Table 3: WCA/LO Operating Parameters

Signal	Pol	Description	Precision	Units
VDP0	0	Power Amplifier Drain Bias	±XX.XX	V
VDP1	1	Power Amplifier Drain Bias	±XX.XX	V
VGP0	0	Power Amplifier Gate Bias	±XX.XX	V
VGP1	1	Power Amplifier Gate Bias	±XX.XX	V
AttenP0	0	Power Amplifier Attenuation	+XX.X	dB
AttenP1	1	Power Amplifier Attenuation	+XX.X	dB
VDAMC	n/a	AMC control drain for prototype carts	±XX.XX	V

Table 4: Temperature Sensor Calibration

Symbol	Pol	Description	Precision	Units
DT110K	n/a	Temperature offset for 110K stage	±X.XX	K
DT20K	n/a	Temperature offset for 15K stage	±X.XX	K
DT4K	n/a	Temperature offset for 4K stage	±X.XX	K
DTM0	0	Temperature offset for Pol. 0 mixer/preamp	±X.XX	K
DTM1	1	Temperature offset for Pol. 1 mixer/preamp	+X.XX	K

3.2. Identification of Cartridge Configuration Parameters

A number of tables are required to represent the physical configuration of a cartridge, WCA, and cartridge bias module, and their respective sub-assemblies, at the time of testing and of delivery. The following sub-assemblies are tracked as part of every cartridge data package. The details for how these data items are to be provided are given in 4.1.

- ColdCarts – cold cartridge assemblies.
- ColdMults – cold LO multipliers installed within the cold cartridge.
- WCAs – Warm Cartridge Assemblies
- Mixers
- Preamps – may or may not be physically integrated with Mixers.
- TempSensors – temperature sensor diodes installed within the cold cartridge.
- WarmIFPlates – the plate and its two or four warm IF amplifiers installed within the WCA.
- BiasMods – cartridge bias modules.
- CartAssemblies – a configuration of a cold cartridge, a WCA, a bias module, and a warm IF plate, as delivered or tested at some point in time.

3.3. Identification of Cartridge Test Data

Cartridge performance data is to be delivered along with each cartridge. The following types of test data are expected, where applicable. Whether or not a given type of data is required for a given cartridge band is specified in each band's acceptance test plan. The details for how these data items are to be provided are given in their respective detailed design under section 4.2.

- Noise Temperature
- Image Suppression – for sideband separating mixer types.
- Sideband Ratio – for dual sideband mixer types.
- In-Band Power
- Total Power
- Power Variation
- Gain Compression
- Amplitude Stability
- Phase Drift
- Beam Pattern
- IF Spectrum
- Polarization Accuracy
- Cross-Polarized Beam Pattern
- Integrated Cross-Polarization Level
- I-V Curves

3.4. Timing of Data Delivery

Operating, configuration, and test data are to be delivered to the FEIC concurrent with the delivery of each cartridge. Successful transfer of operating and test data shall be considered a condition of cartridge acceptance by the FEIC.

3.5. Method of Data Delivery

We identify five layers of the data transfer process:

3.5.1. Data Records

Every record or row in a data file is identified by one or more numeric "key" fields. Key fields are always the first items in a valid record. Where the key fields are used to establish relationships amongst records in multiple files, the assignment of the keys and ensuring their uniqueness is the responsibility of the cartridge manufacturer. Future software and database developments may partially shift the burden of key management onto the FEIC database.

Header and comment rows are acceptable but not required. Initial comment characters such as # or ! may be used. Any row which cannot be interpreted as a legal record for import into a parameter or test data table will be ignored as though it were a comment. The import script shall ignore any lines not starting with numeric keys and shall discard any records where the key fields are zero or non-numeric.

3.5.2. Individual Files

For each of the data items identified in section 3.1, 3.2, and 3.3 a delivery will include at most one corresponding file. Each file shall contain the data for one cartridge assembly only. For example, the records for four component mixers may be combined in a file if all four mixers are installed in the same cartridge, but the records for two different WCAs must be in separate files.

The files shall be plain ASCII text and shall be formatted as either comma-separated text or XML. File names shall be constructed according to the naming conventions given in the detailed design sections under sections 4.1 and 4.2. The rules for each file type are given here:

3.5.2.1. Comma-Separated Text

MS Excel's text export format is acceptable. Also acceptable is the export format from MS Access and MySQL. However in all cases the following restrictions apply:

- Dates must have the format YYYY-MM-DD with left-padding of zeros.
- Times must be 24-hour format as HH:MM:SS with left-padding of zeros.
- Therefore timestamps strings (TS) which are used throughout the database have a date followed by a space, followed by a time.
- Since strings are unquoted in MS Excel CSV format, text fields may not contain any commas as these might be misinterpreted as field delimiters.
- Text and timestamp fields may be optionally quoted with double-quotation marks.

3.5.2.2. XML

MS Excel's native XML export format is acceptable. Additionally, the XML files must comply with the following restrictions:

- **One top-level element** – Each XML file may have a single top-level element, within which is the collection of elements corresponding to records.
- **Each element beneath the top-level element represents a record.**

- **Top-level and record element names are unimportant** – The import script will not depend on the top-level or record element names having any particular value.
- **Field element names are specified exactly and are case-sensitive.**
- **Field values follow the same rules as for plain text** – except that the restrictions on commas and quotes are relaxed.

An example:

```
<?xml version="1.0" encoding="UTF-8" ?>
<dataroot xmlns:od="urn:schemas-microsoft-
com:officedata"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="Mixers.xsd"
generated="2006-10-06 11:57:44">
      <Mixers>
            <keyBand>6</keyBand>
            <keyMixers>7</keyMixers>
            <TS>2006-10-05 14:50:26</TS>
            <SN>103</SN>
      </Mixers>
      <Mixers>
            <keyBand>6</keyBand>
            <keyMixers>8</keyMixers>
            <TS>2006-10-05 19:19:54</TS>
            <SN>109</SN>
      </Mixers>
</dataroot>
```

In this example, the top-level element is called “dataroot” and the record-level elements are called “Mixers.” Neither of these names is significant to the import script. However the field Names keyBand, keyMixers, TS and SN must exactly match the names as given in this document and are case-sensitive.

3.5.2.3. Text Files Naming Convention

The text files will be named according to the kind of data contained. The name includes information about the band and assembly to which the data applies.

Files shall be named like: BBNNNN_TESTNAME.CSV or .XML. Note that the section headings describing the files in sections 4.1 and 4.2 do not show the XML or CSV extension.

Where BB indicates the cartridge band: 01 through 10 and NNNN indicates the lowest key value to which the file data applies. Each file details section below under sections 4.1 and 4.2 gives the usage of the

NNNN portion of the name. While NNNN as shown here indicates four digits are called for, it really can be any number of digits up to the maximum allowable for a 32-bit unsigned integer (10 digits).

The file names are given as all-uppercase in this document, however lowercase or mixed-case names are acceptable for data delivery.

3.5.3. Collections of Files

The text files as specified above shall be collected together to form one coherent data set corresponding to a cartridge as-delivered. The naming conventions are sufficient to ensure that when one or more collections are placed in the single directory on a MS Windows computer or a file server, no two files will have the same name, and a user can distinguish the contents of each file from the file names.

3.5.4. Packaging of a Collection

Each collection of files, corresponding to a single cartridge in a single configuration (as-tested or as-delivered) shall be packaged as a standard ZIP file, readable natively by MS Windows XP (not requiring software such as WinZIP or GNU archive manipulation tools.)

The archive should be named like: BBNNNN_CARTRIDGE.ZIP.

Where BB indicates the cartridge band: 01 through 10 and NNNN indicates the lowest-numbered key value for keyCarts from COLDCARTS.

3.5.5. Transport of a Package

Packages should be uploaded to ALMA EDM in the cartridge developer's workspace area. An email message to mmcleod@nrao.edu and ksaini@nrao.edu or their counterparts at the European FEIC is appreciated but not strictly required.

3.5.5.1. Alternate Transport

As software and database development progresses at the FEICs, alternate methods of transport may be provided which allow for the delivery of a package or of individual files directly through a web interfaces to the FEIC database.

3.6. Duplicate Data

Every data record in every file includes key fields which either uniquely identify an assembly, or uniquely identify the assembly to which a data set pertains. Therefore, it is possible to determine at the time of data import into the FEIC database whether a record or file is a duplicate of one delivered and imported earlier.

If a file contains data which duplicates data from an earlier delivered file, it will replace the prior data on import into the database. The prior data will be saved as a historical record of what has been delivered but will not be used for operating the cartridge.

3.7. Providing Updates to Data

It may become necessary to provide updated data for a given assembly. For example if a cartridge is delivered to the FEIC and then is later returned for repair, some of the data items associated with the cartridge will change when the cartridge is redelivered. This section gives the procedures for providing updates while maintaining a useful history.

Where these procedures say to update a record, it means that the cartridge manufacturer delivers a record which is the same as the previous one except with the specified changes. Where these say to create a record, it means that a new record, with new unique keys, is delivered.

The burden of providing these updates is on the cartridge manufacturer. However as software and database development continues, this burden may be partially shifted to the FEIC database.

3.7.1. Replacement of a Mixer

Replacement of a mixer is expected to invalidate existing operating data. Therefore replacement of a mixer “cascades” up to ColdCarts and CartAssemblies, forcing the creation of new records in those tables as well. The old records may be kept for historical purposes. Note that in cases where two mixers are integrated into a single unit these steps may require creating or updating more than one record.

Procedure:

- Update the TS_Removed fields in one or more MIXERS records with the date and time the old mixer(s) were removed.
- Create one or more a new records in MIXERS having unique values of keyMixers and having the date and time the old mixer(s) were removed as the value of TS.
- Create one or more new collections of records in MIXERPARAMS having new, unique values of keyMixerParams and having the new value(s) of keyMixers as fkMixers.
- Update the TS_Removed field in COLDCARTS with the date and time the cold cartridge was actually removed from available stock.

- Create a new record in COLDCARTS having a new unique value of keyColdCarts and having all the same values as the old record except: The new value of keyMixers is stored in fkMixerN; the date and them the old mixer was removed as TS.

- Update the TS_Removed field in CARTASSEMBLIES with the date and time the cold cartridge (and therefore, old mixer) was removed.

- Create a new record in CARTASSEMBLIES having a new unique value of keyCartAssys and having all the same values as the old record except: The new value of keyColdCarts is stored in fkColdCarts; the date and time the old mixer was removed as TS.

3.7.2. Replacement of a Cold Preamplifier

Like replacement of a mixer above, replacement of a preamplifier "cascades" up to CartAssemblies. Note that in cases where two or more preamps are integrated into a single unit or are integrated with a mixer assembly, these steps may requiring creating or updating more than one record.

Procedure:

- Update the TS_Removed fields in one or more PREAMPS record(s) with the date and time when the preamp(s) were removed.

- Create one or more new record(s) in PREAMPS having unique values of keyPreamps and having the date and time the old preamp(s) were removed as the value of TS.

- Create one or more new collections of records in PREAMPPARAMS having new, unique values of keyPreampParams and having the new value(s) of keyPreamps as fkPreamps.

- Update the TS_Removed field in COLDCARTS with the date and time the old preamp was removed.

- Create a new record in COLDCARTS having a new unique value of keyColdCarts and having all the same values as the old record except: The new value of keyPreamps as fkPreampN; the date and time the old preamp was removed as TS.

- Update the TS_Removed field in CARTASSEMBLIES with the date and time the old preamp was removed.

- Create a new record in CARTASSEMBLIES having a new unique value of keyCartAssys and having all the same values as the old record except: The new value of keyColdCarts as fkColdCarts; the date and time the old preamp was removed as TS.

3.7.3. Replacement of a Cold Multiplier

Like replacement of a mixer or preamplifier above, replacement of a cold multiplier "cascades" up to CartAssemblies.

Procedure:

- Update the TS_Removed fields in a COLDMULTS record with the date and time when the multiplier was removed.
- Create a new record in COLDMULTS having a unique values keyColdMults and having the date and time the old multiplier was removed as the value of TS.
- Update the TS_Removed field in COLDCARTS with the date and time the old multiplier was removed.
- Create a new record in COLDCARTS having a new unique value of keyColdCarts and having all the same values as the old record except: The new value of keyColdMults as fkColdMults0 or fkColdMults1.
- Update the TS_Removed field in CARTASSEMBLIES with the date and time the old multiplier was removed.
- Create a new record in CARTASSEMBLIES having a new unique value of keyCartAssys and having all the same values as the old record except: The new value of keyColdCarts as fkColdCarts; the date and time the old multiplier was removed as TS.

3.7.4. Replacement of a Temperature Sensor

The replacement of a temperature sensor does "cascade" up the dependency tree because. Procedure:

- Update TS_Removed in TEMPSENSORS with the date and time the sensor was removed.
- Create a new record in TEMPSENSORS having a unique value of keyTempSensors and having the date and time the old sensor was removed as TS.
- Create a new record in COLDCARTS having a new unique value of keyColdCarts and having all the same values as the old record except: The new value of keyTempSensors as one of fkTempSensor0...5
- Update the TS_Removed field in CARTASSEMBLIES with the date and time the old sensor was removed.

- Create a new record in CARTASSEMBLIES having a new unique value of keyCartAssys and having all the same values as the old record except: The new value of keyColdCarts as fkColdCarts; the date and time the old sensor was removed as TS.

3.7.5. Replacement of a Cold Cartridge Bias Module

While it is anticipated that bias modules may be replaced without significantly altering mixer and preamp bias parameters, it is important to keep a historical record of bias module changes, therefore the change must "cascade" up to the CartAssemblies level. Procedure:

- Update the record in BIASMODS so that TS_Removed contains the date and time the module was removed.

- Create a new record in BIASMODS having a unique value of keyBiasMods and having the date and time the old module was removed as the value of TS.

- Update the record in CartAssemblies so that TS_Removed contains the date and time the module was removed.

- Create a new record in CartAssemblies with a unique value of keyCartAssys and having the new value of keyWCAs or keyWarmIFPlates and the same values as the previous record for fkColdCarts and (if applicable) fkBiasMods. Set TS equal to the date and time the old module was removed.

- Produce test data referencing the new keyCartAssys as fkCartAssys.

3.7.6. Replacement of a WCA or one or more Warm IF Amplifiers

Replacement of a WCA or its sub-assemblies may have a significant effect on the mixer and preamp bias values. Therefore it may "cascade" up to the CartAssemblies level. Procedure:

- Update the record in WCAs or WarmIFPlates so that the TS_Removed contains the date and time the WCA or IF plate was removed.

- Create a new record in WCAs or WarmIFPlates having a unique value of its respective key and having the date and time the module was removed as the value of TS.

- Update the record in CartAssemblies so that TS_Removed contains the date and time the module was removed.

- Create a new record in CartAssemblies with a unique value of keyCartAssys and having the new value of keyWCAs or keyWarmIFPlates and the same values as the previous record for fkColdCarts and (if applicable) fkBiasMods. Set TS equal to the date and time the old module was removed.

- Create a new collection of records for LOPARAMS corresponding to the LO-dependent parameters of the new WCA.
- Produce test data referencing the new keyCartAssys as fkCartAssys.

3.7.7. Replacement of a Photomixer

Since all of the test data delivered by cartridge manufacturers is taken without a photomixer installed, there really is no provision at this time for the possibility of test data or bias values being invalidated by the installation and use of a photomixer at the FEIC and thereafter. So for the time being, only the SN_Photomixer field in the CartAssemblies table needs to be updated when a photomixer is installed or changed.

4. Detailed design of database

4.1. Data Files for Cartridge Operating Parameters and Configuration

The database schema diagram given in Figure 14 may be used as a reference for understanding the parent-child relationships amongst records in the cartridge operating parameters and configuration tables.

These files contain information which is required to correctly operate the cartridges, such as bias values and temperature sensor offsets. Also they indicate the physical association of the cartridge and its sub-assemblies as tested and delivered.

Certain conventions are followed in the names, types, and usage of the columns in the configuration and operating parameter tables:

- **numeric fields**: all numeric fields for operation and test data are single-precision floating point. The expected width and precision are given in section 3.1 and/or are given with each file description below.
- **NULL values**: wherever a value is optional it may be provided as a NULL. This may be represented as either nothing at all between a pair of commas, as the value 0 in a foreign key field, or as an empty string for fields accepting a string. In XML files the attribute may be left out of the record altogether.

Examples of NULL:

```
!keyBand,keyPreamps,TS,TS_Removed,SN,ILED,Notes
3,2,2007-03-17 21:45:00,,3001,0.02,””
```

```
<Preamps>
      <keyBand>3</keyBand>
      <keyMixers>2</keyMixers>
      <TS>2007-03-17 21:45:00</TS>
      <SN>3001</SN>
      <ILED>0.02</ILED>
</Preamps>
```

In both examples, SN_Removed and Notes are NULL.

- **keyBand**: integer (1-10) indicating which band is providing the data.
- **keyXxx**: unsigned 32-bit integer uniquely identifying the record amongst similar records, that is within the same table. These numbers must be unique over time: When the second and subsequent cartridges are delivered they must not reuse the numbers associated with the first. In the case of tables containing operating parameters, this is a unique record identifier. The assignment of these numeric keys is required and is the responsibility of the cartridge manufacturer. Taken together with the keyBand, these keys uniquely identify a data point on a curve, a cartridge, or another assembly. That is, they uniquely identify a record in the conceptual database table which spans data delivered in different parcels and at different times.
- **fkXxx**: “foreign key” unsigned 32-bit integer which establishes a parent-child or cross-reference relationship with a record in some other table. Corresponds to a value of keyXxx in the other table.
- **TS**: timestamp string of the format YYYY-MM-DD HH:MM:SS. 24-hour time with zero-filled fields. Double quotation marks are optional. Intended to contain the time that a test was performed or an item was created. If no timestamp is known for a given record, use the current time when the record is generated for delivery.
- **TS_Removed**: timestamp string of the same format as TS. Intended to contain the time that a sub-assembly module was removed the cartridge assembly. This field allows the database to maintain a history of which components were assembled together at various points in time. The usage of this column is detailed in section 3.7 above. For cartridge data delivery to the FEIC, the use of this column is optional.

- **SN**: string up to 20 characters in length. No quotation marks or commas. This is the manufacturer or project-assigned serial number for the assembly.
- **ESN**: hexadecimal string exactly 16 characters long. Double quotation marks optional. This is the electronic serial number as reported by the ESN chip or FPGA in the assembly.
- **Notes**: string of arbitrary length. No quotation marks or commas allowed. May be an empty string or NULL.
- **FreqLO, FreqIF, FloYIG, FhiYIG**: LO, IF, and YiG oscillator frequencies are expressed in GHz with six decimal places of precision after the decimal point, therefore allowing steps as small as 1 kHz to be distinguished. Single-precision floating point is not accurate enough to represent these numbers so double-precision is used for these fields.

4.1.1. Table ColdCarts

Filename: **BBNNNN_COLDCARTS**

The NNNN portion of the file name should match the value of keyColdCarts for the single record contained in the file.

Table ColdCarts contains the ALMA band number, serial number, and other relevant information about each cold cartridge. ColdCarts contains cross-references to child tables Mixers, Preamps, ColdMults, and TempSensors, indicating the sub-assemblies installed within each cold cartridge.

This file contains the serial numbers and notes for each cold cartridge assembly, as delivered. One record per cold cartridge assembly:

keyBand, keyColdCarts, fkMixer01, fkMixer02, fkMixer11, fkMixer12, fkPreamp01, fkPreamp02, fkPreamp11, fkPreamp12, fkColdMult0, fkColdMult1, fkTempSensor0…5, TS, TS_Removed, SN, ESN, Notes

keyColdCarts is unique amongst all cartridges.

fkColdMult0 and fkColdMult1 are foreign keys into the ColdMults table, indicating which cold multipliers are installed. They reference the multipliers for polarization 0 and 1, respectively. For cartridges which lack cold multipliers, these fields shall be NULL or 0.

fkTempSensor0…fkTempSensor5 are foreign keys into the TempSensors table, indicating which temperature sensors are installed. While only 5 sensors are expected, the monitor and control hardware has a sixth port for a spare. The positions 0…5 correspond to the FE M&C port numbers for connection to the temperature sensor. They do not indicate physical location in the cartridge – information which is given in the corresponding

TempSensors record. If a temperature sensor is not installed on a given port, the value provided for fkTempSensorsN for that port shall be NULL or 0.

fkMixer01, fkMixer02, fkMixer11, and fkMixer12 are foreign keys into the MIXERS table, indicating which mixers are installed. For cartridges having only 2 mixers, only two of the foreign keys are used and the other two shall be NULL or 0. Details are given in Table 5.

Table 5: Mixer/Polarization Mapping

Number of Mixers in Cartridge	Mixer foreign key Field	Polarization	Sideband
2	fkMixer01	0	NA
	fkMixer11	1	NA
2 mixer bodies with 2 component mixers per body	fkMixer01	0	1
	fkMixer02	0	2
	fkMixer11	1	1
	fkMixer12	1	2
4	fkMixer01	0	1
	fkMixer02	0	2
	fkMixer11	1	1
	fkMixer12	1	2

fkPreamp01, fkPreamp02, fkPreamp11, fkPreamp12 are foreign keys into the PREAMPS table, indicating which cold preamps are installed. For cartridges having only 2 preamps, only two of the foreign keys are used and the other two shall be NULL or 0. Details are given in Table 6.

Table 6: Preamp/Polarization Mapping			
Number of Preamps in Cartridge	**Preamp foreign key Field**	**Polarization**	**Sideband**
2	fkPreamp01	0	NA
	fkPreamp11	1	NA
4	fkPreamp01	0	1
	fkPreamp02	0	2
	fkPreamp11	1	1
	fkPreamp12	1	2

4.1.2. Table Mixers

Filename: **BBNNNN_MIXERS**

The NNNN portion of the file name should match the lowest value of keyMixers contained in the file.

Table Mixers contains the serial number and notes pertaining to an individual or component mixer and holds the relationship between mixers and the cartridges in which they are installed. This allows for the properties of a given mixer to be determined before it is assigned to a particular cartridge. The data identifying the mixer is stored in the Mixers table and the data which varies with LO is stored in the MixerParams table. Each row in the latter table contains a foreign key with values for (keyBand, fkMixers) which matches the corresponding (keyBand, keyMixers) values in the Mixers table.

The fields in Mixers are:

keyBand, keyMixers, TS, TS_Removed, SN, Notes

keyMixers should be unique amongst all mixers delivered by the cartridge manufacturer.

Band 6, which uses integrated mixer-preamps, requires a separate table (not documented here) that maps their mixers to the matching preamp pairs.

4.1.3. Table MixerParams

Filename: **BBNNNN_MIXERPARAMS**

The NNNN portion of the file name should match the lowest value of fkMixers contained in the file.

MixerParams holds the operating parameters for the mixers. The relational characteristics of the database allow for an indeterminate number of MixerParams records per mixer, with one record in MixerParams corresponding to each LO frequency. The FE Control software will use linear interpolation to select mixer operating values for frequencies between those provided. For frequencies outside the range provided, the values corresponding to the lowest or highest LO frequency will be used.

MixerParams has one record per LO frequency per Mixer:

keyBand, keyMixerParams, fkMixers, Temperature, FreqLO, TS, VJ, IJ, IMAG

Where fkMixers has the same value as keyMixers for a record in table Mixers.

And keyMixerParams is a globally-unique record identifier. No two MixerParams records during the entire production run shall have the same value of (keyBand, keyMixerParams). The FEIC database shall enforce this requirement.

VJ, IJ, and IMAG are the individual mixer operating parameters for each of the four component mixers. The definitions of these fields and their precisions are given in Table 1, using terminology which includes the mixer position and polarization, like VJM1P0, IJM1P0, IMAGM1P0, etc.

Temperature gives the temperature in degrees Kelvin at which the mixer bias values apply. This is expected to always be 4K, but the format provides for the possibility that the bias values might be different at, for example, 3.5K.

4.1.4. Table Preamps

Filename: **BBNNNN_PREAMPS**

The NNNN portion of the file name should match the lowest value of keyPreamps contained in the file.

Table Preamps holds the relationship between cold amplifiers and the cartridges in which they are installed. Each record in PreampParams contains foreign key field data in fkPreamps that matches Preamps. When a cold amplifier is assigned to a cartridge, each of the fkPreampN fields in table ColdCarts should match the key field keyPreamps for one record in Preamps.

The fields in Preamps are:

keyBand, keyPreamps, TS, TS_Removed, SN, ILED, Notes

keyPreamps is required to be unique amongst all preamps.

ILED is the preamplifier's LED current, if applicable. Table 2 gives this as ILEDP0 or ILEDP1 depending on polarity.

4.1.5. Table PreampParams

Filename: **BBNNNN_PREAMPPARAMS**

The NNNN portion of the file name should match the lowest value of fkPreamps contained in the file.

PreampParams holds the operating parameters for the cold amplifiers. The relational characteristics of the database allow for an indeterminate number of PreampParams records per preamp, with one record in PreampParams corresponding to each LO frequency. The FE Control software will use linear interpolation to select preamp operating values for frequencies between those provided. For frequencies outside the range provided, the values corresponding to the lowest or highest LO frequency will be used. If the amplifier parameters do not vary with frequency, then simply provide a single record for each preamp, using the lowest frequency in the band.

PreampParams has one record per LO frequency per Preamp:

keyBand, keyPreampParams, fkPreamps, Temperature, FreqLO, TS, VD1, VD2, VD3, ID1, ID2, ID3, VG1, VG2, VG3

Where fkPreamps has the same value as keyPreamps for a record in PREAMPS.

And keyPreampParams is a globally-unique record identifier. No two PREAMPPARAMS records during the entire production run shall have the same value of (keyBand, keyPreampParams). The FEIC database shall enforce this requirement.

VD1…VG3 are the individual preamp operating parameters for each of the two or four preamplifiers. The definitions of these fields and their precisions are given in Table 2 using terminology which includes the preamp position and polarization, like VD1_A1P0, VD2_A1P0, etc.

Temperature gives the temperature in degrees Kelvin at which the preamp bias values apply. This is expected to always be 4K, but the format provides for the possibility that the bias values might be different at, for example, 3.5K.

4.1.6. Table ColdMults

Filename: **BBNNNN_COLDMULTS**

The NNNN portion of the file name should match the lowest value of keyColdMults contained in the file.

Child table ColdMults hold details about the two cold multipliers installed in each cartridge, where applicable. No data need be delivered for this table if the cartridge does not contain cold multipliers.

The fields in ColdMults are:

keyBand, keyColdMults, TS, TS_Removed, SN, Notes

keyColdMults is required to be unique amongst all cold multipliers. Note that this key value is distinct from the cold multiplier serial number to allow for removal, repair, and replacement of the same multiplier. A new record is generated in that case with a new key value but the same multiplier serial number, as described in section 3.7.3.

4.1.7. Table TempSensors

Filename: **BBNNNN_TEMPSENSORS**

The NNNN portion of the file name should match the lowest value of keyTempSensors contained in the file.

Table TempSensors contains the temperature offsets at the liquid Helium boiling point (4.2K) to be applied to each temperature sensor integrated into a given cartridge. That is, when the sensor is dipped in LHe, if the indicated temperature is 4.3K, then +0.1K is entered as the offset for that sensor. ColdCarts contains six foreign keys into TempSensors because there are 5 (or more) temperature sensors installed in each cartridge. Temperature sensor calibration data is located in its own table because it is generally measured separately from mixer and preamp data.

The fields in TempSensors are:

keyBand, keyTempSensors, TS, TS_Removed, Location, Model, SN, OffsetK, Notes

keyTempSensors is required to be unique amongst all temperature sensors. Note that this key value is distinct from the temperature sensor serial number to allow for removal, repair, and replacement of the same temperature sensor. A new record is generated in that case with a new key value but the same sensor serial number, as described in section 3.7.4.

Model is an integer with one of the following values:

- 1 = DT-670C.
- 2 = DT-670A-SD.
- Other values may be added if needed.

SN is the sensor manufacturer assigned serial number string.

Location is a numeric code indicating where the sensor is installed in the cartridge. Possible values are:

- 0 = Spare
- 1 = 110K stage
- 2 = 15K stage
- 3 = 4K stage
- 4 = Pol. 0 mixer
- 5 = Pol. 1 mixer

OffsetK is the amount of calibration offset, in degrees Kelvin, to be applied to the nominal temperature sensor curve for the specified Model. It is assumed this will be specified at the temperature of highest interest (e.g. 4K for a probe at that stage), and allow the offset error to be somewhat larger at other parts of the sensor curve.

4.1.8. Table BiasMods

Filename: **BBNNNN_BIASMODULES**

The NNNN portion of the file name should match the value of keyBiasMods for the single record contained in the file.

Table BiasMods gives the serial numbers and notes about the cold cartridge bias module. These are also associated with a record in table CartAssemblies. If a bias module is removed, the date and time removed is put in the TS_Removed field of tables BiasMods and CartAssemblies, as described in section 3.7.5.

The fields in BiasMods are:

keyBand, keyBiasMods, TS, TS_Removed, SN, Notes

keyBiasMods is required to be unique amongst all bias modules.

4.1.9. Table WCAs

Filename: **BBNNNN_WCAS**

The NNNN portion of the file name should match the lowest value of keyWCAs contained in the file.

The child table WCAs contains information about each Warm Cartridge Assembly that doesn't vary with LO frequency. Each record in WCAs corresponds to a unique Warm Cartridge Assembly. When a WCA is removed, the date and time removed is put in the TS_Removed field of table WCAs and Table CartAssemblies also is given a new record with the TS_Removed field in that table likewise updated, as explained in section 3.7.6.

The fields in WCAs are:

keyBand, keyWCAs, TS, TS_Removed, SN, ESN, SN_PwrAmp, FloYIG, FhiYIG, Notes

keyWCAs is required to be unique amongst all WCAs.

SN_PwrAmp is the serial number given to the power amp integrated with the WCA. It is a string of up to 20 characters containing no quotes or commas.

FloYIG and FhiYIG are the lower and upper frequency limits of the YiG oscillator integrated with the WCA.

4.1.10. Table LOParams

Filename: **BBNNNN_LOPARAMS**

The NNNN portion of the file name should match the value of fkWCAs for the records contained in the file.

LOParams is a child table to WCAs. It holds frequency-dependent information about the WCA, such as the nominal power amplifier drain voltages and the attenuation settings. The foreign key fkWCAs provides the necessary mapping of many records in LOParams to a single record in WCAs.

The fields in LOParams are:

keyBand, keyLOParams, fkWCAs, FreqLO, TS, VDP0, VDP1, VGP0, VGP1, AttenP0, AttenP1, VDAMC

Where fkWCAs has the same value as keyWCAs for some record in table WCAs.

And keyLOParams is a globally-unique record identifier. No two LOParams records during the entire production run shall have the same value of (keyBand, keyLOParams). The FEIC database shall enforce this requirement.

The definitions of the fields and their precisions are given in Table 3.

4.1.11. Table WarmIFPlates

Filename: **BBNNNN_WARMIFPLATES**

The NNNN portion of the file name should match the value of fkWCAs for the records contained in the file.

Table WarmIFPlates gives the configuration of a warm IF amplifiers installed in a warm IF amplifier assembly. Though these are installed in the WCA it makes more sense from the point of view of configuration history maintenance and test data delivery to associate them with the CartAssemblies. If a warm IF plate is removed or modified, the date and time removed is put in the TS_Removed field in tables WarmIFPlates and table CartAssemblies, as described in section 3.7.6.

The fields in WarmIFPlates are:

keyBand, keyWIFPlates, TS, TS_Removed, SN, SN_WIF0, SN_WIF1, SN_WIF2, SN_WIF3, Notes

keyWIFPlates must be unique amongst all warm IF plates.

SN_WIF0 through SN_WIF3 are the serial numbers of the warm IF amplifiers integrated with the WCA by the cartridge manufacturer. They are strings of up to 20 characters. [RD4] Table 1 gives the numbering conventions for the WIF amplifiers with respect to sideband and polarity.

4.1.12. Table CartAssemblies

Filename: **BBNNNN_CARTASSEMBLIES**

The NNNN portion of the file name should match the value of keyCartAssemblies for the single record contained in the file.

Table CartAssemblies contains the configuration of which cold cartridge, WCA, bias module, warm IF plate, and photomixer are matched up with one another as tested and delivered. The record with the most recent time stamp (TS) shall be interpreted as the full cartridge assembly as-delivered.

Every item of test data described in section **Error! Reference source not found.** contains a reference to a configuration as given in this file and in the records of other files which it references.

One record per cartridge assembly:

keyBand, keyCartAssys, fkColdCarts, fkWCAs, fkBiasMods, fkWarmIFPlates, TS, TS_Removed, SN_Photomixer, Notes

Where keyCartAssys must be unique amongst all cartridge assemblies delivered.

fkColdCarts has the same value as keyCarts for a record in ColdCarts.

fkBiasMods has the same value as keyBiasMods for a record in BiasMods.

fkWCAs has the same value as keyWCAs for some record in WCAs.

SN_Photomixer is the serial number given to the photomixer integrated with the WCA. It is a string of up to 20 characters containing no quotes or commas. Since this is expected to be installed at the integration center, it may be left blank or NULL when cartridge data is delivered.

4.2. Data Files for Cartridge Test Data

Test data files contain cartridge performance data as-tested by the cartridge builder prior to delivery. In most cases they are sufficient to illustrate compliance with a specification. In some cases they provide utility value which may assist later analysis at the FEIC. Samples plots are given in this section to clarify the intent of the data requirement. In most cases the samples were lifted from cartridge data which has been delivered to the North American FEIC.

Note that for test data there is no record-level unique identifier "keyXxx" field. That is because none is needed for the purposes of transferring test data. When the test data is imported into the FEIC database it will be automatically assigned unique keys but since nothing in the as-delivered data references individual records of test data, there is no need for unique keys. Contrast this with the CartAssembly configuration records which are referenced from test data sets via the fkCartAssys field.

In addition to the conventions for names, types, and usage of columns given at the beginning of section 4.1, the following additional conventions apply:

- **fkCartAssys**: has the same value as a keyCartAssys for a record in CartAssemblies indicating which configuration was tested.
- **keyDataSet**: an integer distinguishing different sets of data delivered for the same test. While generally we expect only one set of test data for each test, the database supports the storage of multiple data sets, and there may arise a situation where the cartridge manufacturer wishes to provide extra or additional test data for a single test. Unique values of this field differentiate between multiple data sets.
- **Pol**: an integer with the value 0 or 1 indicating polarity.
- **SB**: an integer where 1=USB and 2=LSB. For DSB designs, this should be given as 0.
- **CenterIF, BWIF**: in many cases, the test procedure involves measuring IF power or the like in bands having various center frequencies and bandwidths. These two fields specify the center frequency and bandwidth for a measurement. In the case of broadband measurements, CenterIF may be zero and BWIF should accurately reflect the resolution bandwidth actually

measured. Like FreqLO and the other frequency values described in section 4.1, these frequencies are given in GHz, double-precision with 6 places after the decimal point.

- The **NNNN** portion of the file name should match the value of fkCartAssys referenced in each file.

4.2.1. Noise Temperature

Filename: **BBNNNN_NOISE_TEMPERATURE**

One row per combination of (FreqLO, CenterIF, BWIF, Pol, SB):

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, CenterIF, BWIF, Pol, SB, Treceiver

Where Treceiver is single-precision floating point, given in degrees Kelvin.

To indicate broadband noise temperature, CenterIF shall be zero and BWIF shall be a large number indicating the actual broadband width.

Figure 1 gives a sample Noise Temperature plot, where the X axis values are obtained by adding CenterIF to FreqLO (or subtracting, if in the LSB of a sideband separating design.)

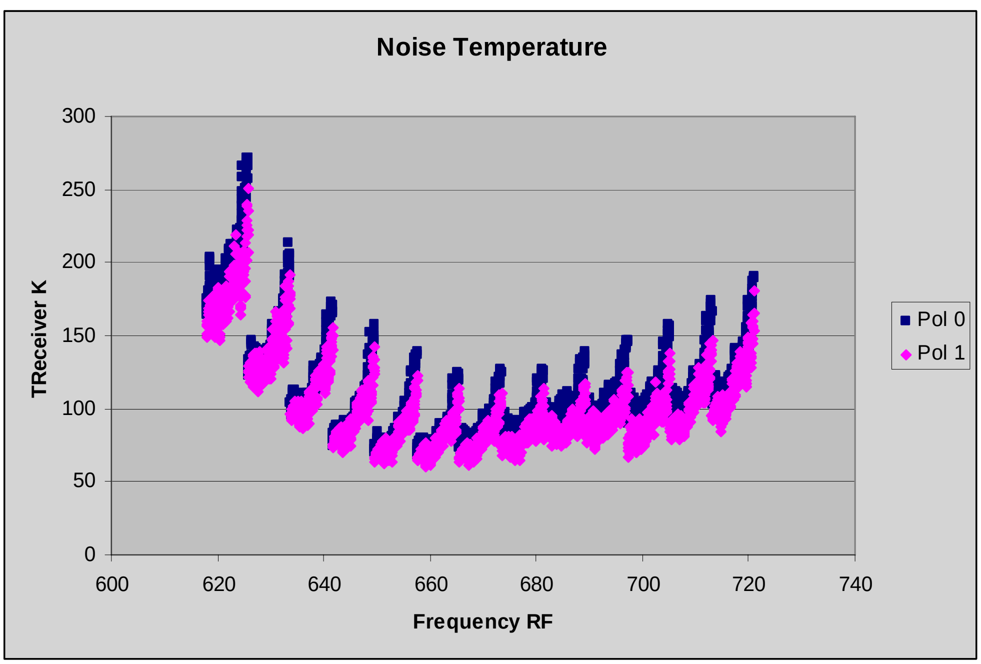


Figure 1: Sample Noise Temperature plot

4.2.2. Image Suppression

Filename: **BBNNNN_IMAGE_SUPPRESSION**

Applies only to sideband-separating designs.

One row per combination of (FreqLO, CenterIF, BWIF, Pol, SB):

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, CenterIF, BWIF, Pol, SB, R

Where R is given in dB of image suppression.

Figure 2 gives a sample Noise Temperature plot for a single polarization, where the X axis values are obtained by adding CenterIF to FreqLO (or subtracting, if in the LSB of a sideband separating design.)

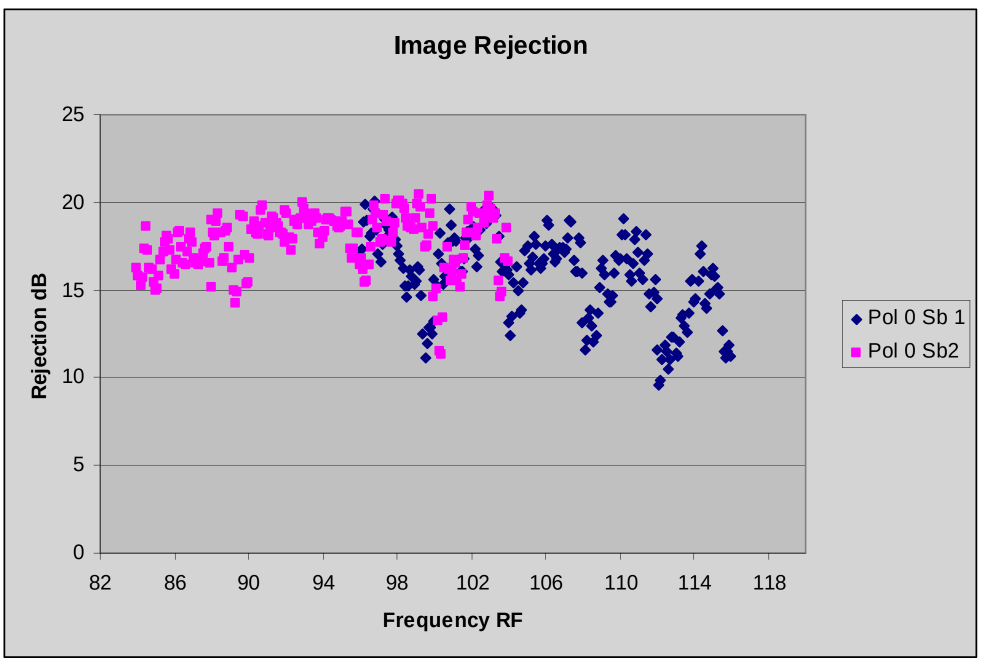


Figure 2: Sample Image Rejection plot

4.2.3. Sideband Ratio

Filename: **BBNNNN_SIDEBAND_RATIO**

Applies only to dual-sideband designs.

One row per combination of (FreqLO, CenterIF, BWIF, Pol):

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, CenterIF, BWIF, Pol, R

Where R is the ratio of a signal appearing in the upper sideband versus a signal appearing at the same IF frequency in the lower sideband, expressed in dB.

Figure 3 gives a sample Sideband ratio plot where the X axis values are obtained by adding CenterIF to FreqLO.

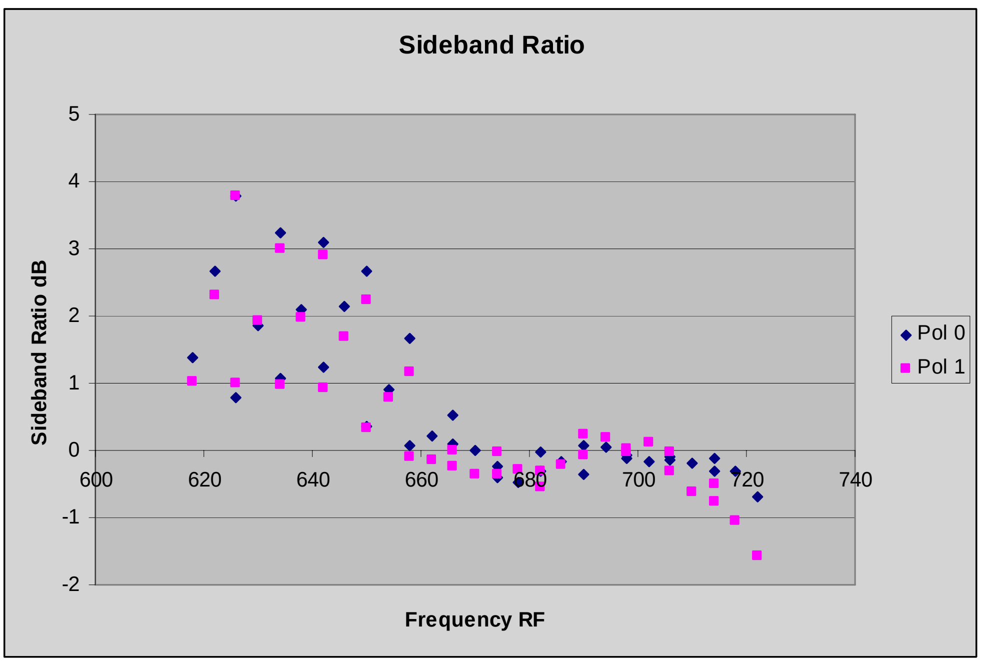


Figure 3: sample Sideband Ratio plot

4.2.4. In-Band Power

Filename: **BBNNNN_INBAND_POWER**

One row per combination of (FreqLO, Pol, SB):

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, SB, Power

Where SB should be 0 for dual-sideband designs.

Power is given in dBm.

Figure 4 gives a sample In-Band Power plot.

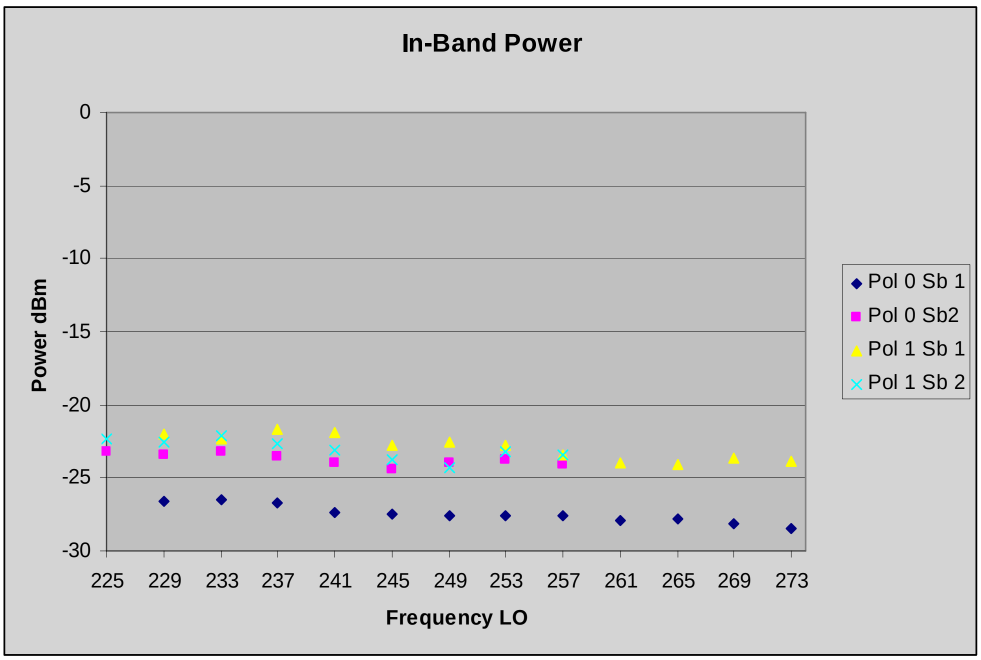


Figure 4: sample In-Band Power plot

4.2.5. Total Power

Filename: **BBNNNN_TOTAL_POWER**

One row per combination of (FreqLO, Pol, SB):

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, SB, Power

Where SB should be 0 for dual-sideband designs.

Power is given in dBm.

Figure 5 gives a sample Total Power plot.

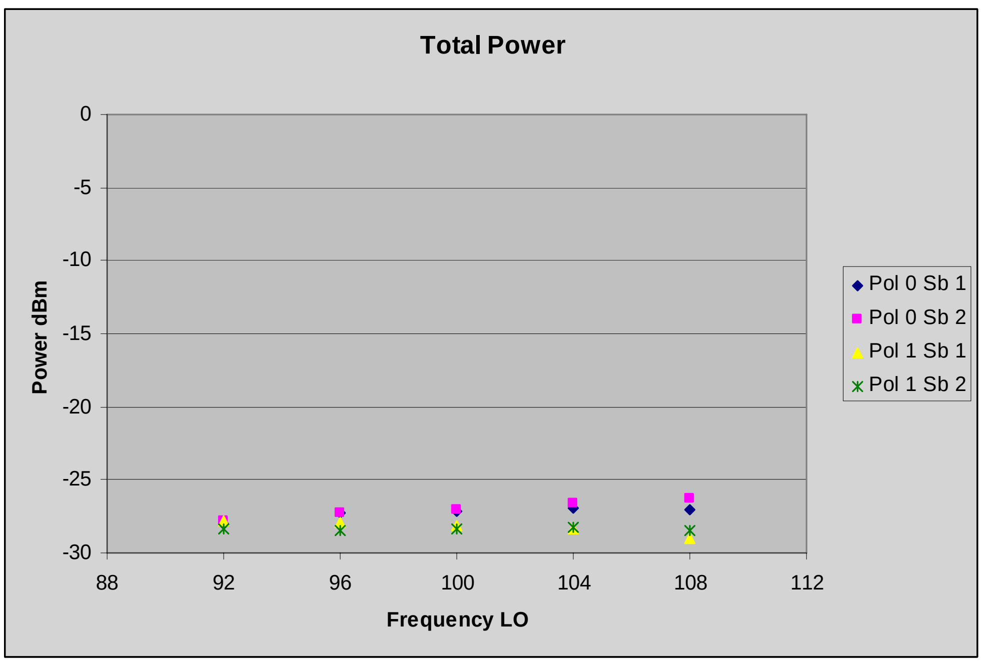


Figure 5: sample Total Power plot

4.2.6. Power Variation

Filename: **BBNNNN_POWER_VARIATION**

Total and 2 GHz sub-band power variation of the IF output LO frequencies. These values, which indicate compliance with the IF power variation specifications are derivable from the spectrum data provided for IF Spectrum, as described in section 4.2.11. For each unique value of (FreqLO, Pol, SB, CenterIF) there will be record:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, SB, CenterIF, BWIF, PowerVar

Where SB should be 0 for dual-sideband designs.

CenterIF gives the band centers for the sub-band power variation values. If CenterIF is non-zero then BWIF shall be 2.0.

For the full-band power variation measurement CenterIF shall be zero and BWIF shall be the receiver's full bandwidth.

PowerVar gives the power variation for the specified sub-band or for the full band in dB difference between the maximum and minimum power values.

Table 7 gives sample Power Variation data for a single polarization and sideband. This may be interpreted as follows: The first 5 rows give the power variation across the full IF band at the given LO frequencies. The subsequent 5 give the variation of the worst 2 GHz sub-band, at the specified CenterIF frequency.

FreqLO	Pol	SB	CenterIF	PowerVar
92	0	1	0	5.08
96	0	1	0	4.91
100	0	1	0	5.56
104	0	1	0	5.6
108	0	1	0	6.05
92	0	1	7	3.65
96	0	1	7.05	3.84
100	0	1	7	3.8
104	0	1	7	4.04
108	0	1	7.05	4.06

Table 7: sample Power Variation data

4.2.7. Gain Compression

Filename: **BBNNNN_GAIN_COMPRESSION**

One row per combination of (FreqLO, Pol, SB):

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, SB, Compression

Where SB should be 0 for dual-sideband designs.

Compression is given as percentage.

Figure 6 gives a sample Gain Compression plot.

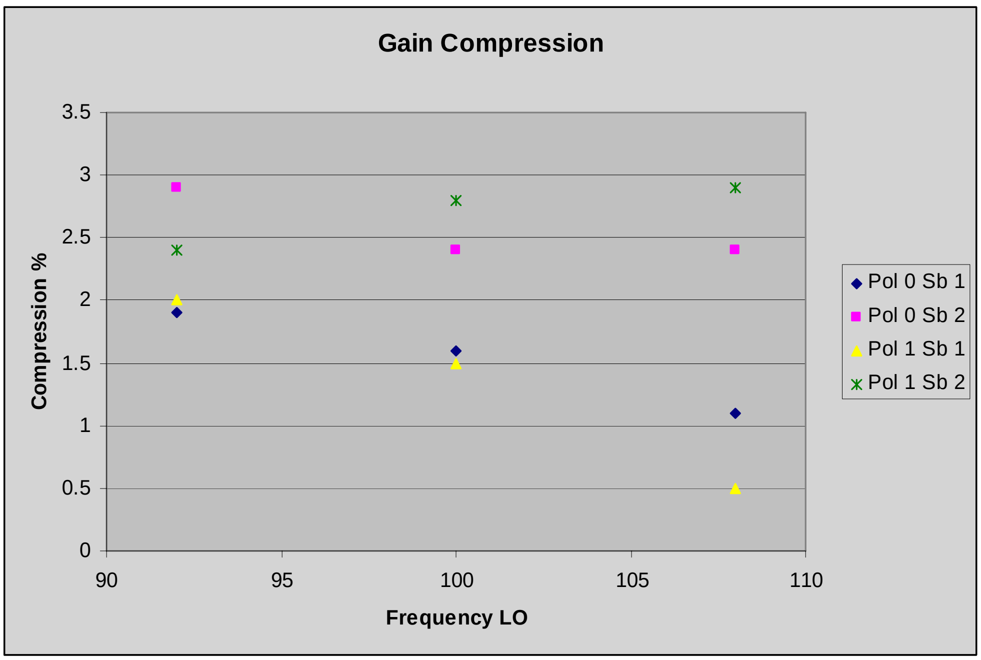


Figure 6: sample Gain Compression plot

4.2.8. Amplitude Stability

Filename: **BBNNNN_AMPLITUDE_STABILITY**

Allen variance plots of IF power at specific LO frequencies. For each unique value of (FreqLO, Pol, SB) there will be a collection of records:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, SB, Time, AllanVar

Where SB should be 0 for dual-sideband designs.

Time is in seconds, giving the X-axis values for the plot and AllenVar gives the Allan variance at the specified time scale.

Figure 7 gives a sample Amplitude Stability plot for a single LO frequency.

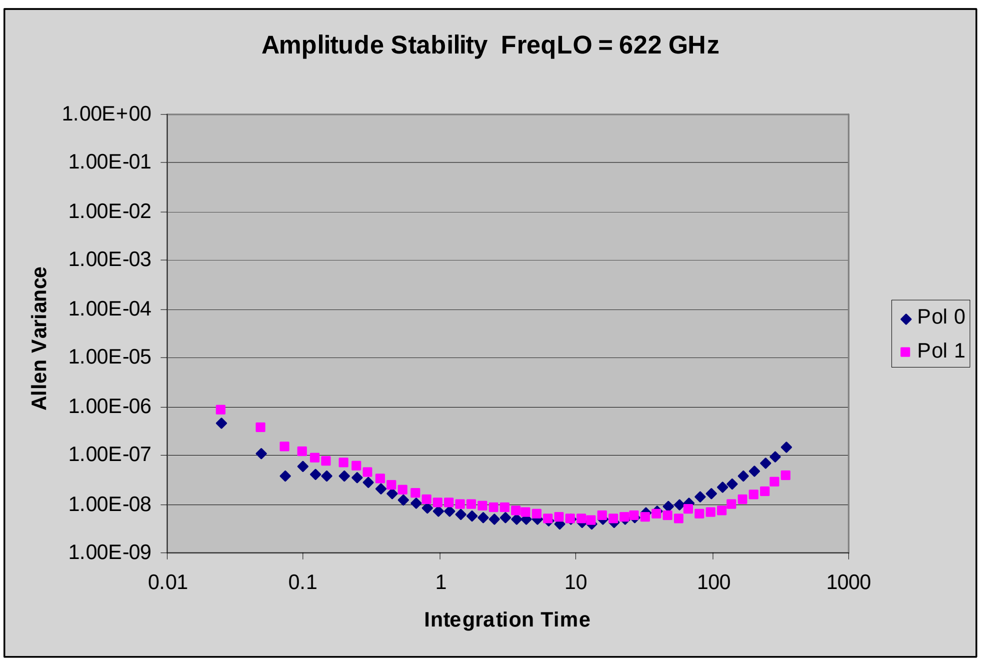


Figure 7: sample Amplitude Stability plot

4.2.9. Phase Drift

Filename: **BBNNNN_PHASE_DRIFT**

Allan deviation plots of phase for specified values of LO and RF source frequency. Allen deviation is to be computed as given in [RD5] section 1.3 with $\tau = 10$s and T = 300s. The sample size should be at least 10 x T seconds.

For each unique value of (FreqLO, FreqCarrier, Pol, SB) there will be a collection of records:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, FreqCarrier, Pol, SB, Time, AllanDev

Where SB should be 0 for dual-sideband designs.

Time is in seconds, giving the X-axis values for the plot and AllanDev gives the Allan deviation of phase at the specified time scale.

Figure 8 gives a sample Phase Drift plot for a single LO frequency.

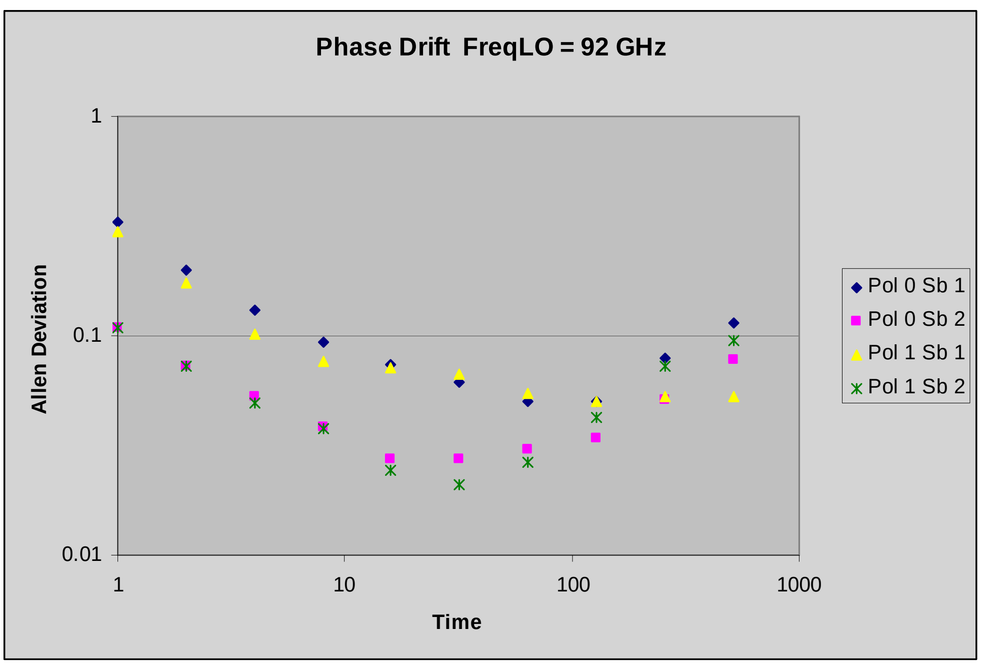


Figure 8: sample Phase Drift plot

4.2.10. Beam Pattern

Filename: **BBNNNN_BEAM_PATTERN**

Two-dimensional far-field angular co-polarized power and phase plots for specified values of LO and RF source frequency. For each unique value of (FreqLO, FreqCarrier) there will be a collection of records:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, FreqCarrier, Theta, Phi, Power, Phase

Where Theta and Phi give the pointing angle, Power gives the co-polarized power in dB below the maximum for each given Polarization.

Phase gives the phase angle relative to the maximum. If phase is not measured, its value may be given as 0.

If far-field patterns are not available, near-field patterns may be substituted.

Figure 9 gives a sample Far-Field beam pattern plot for a single LO frequency and a single carrier frequency.

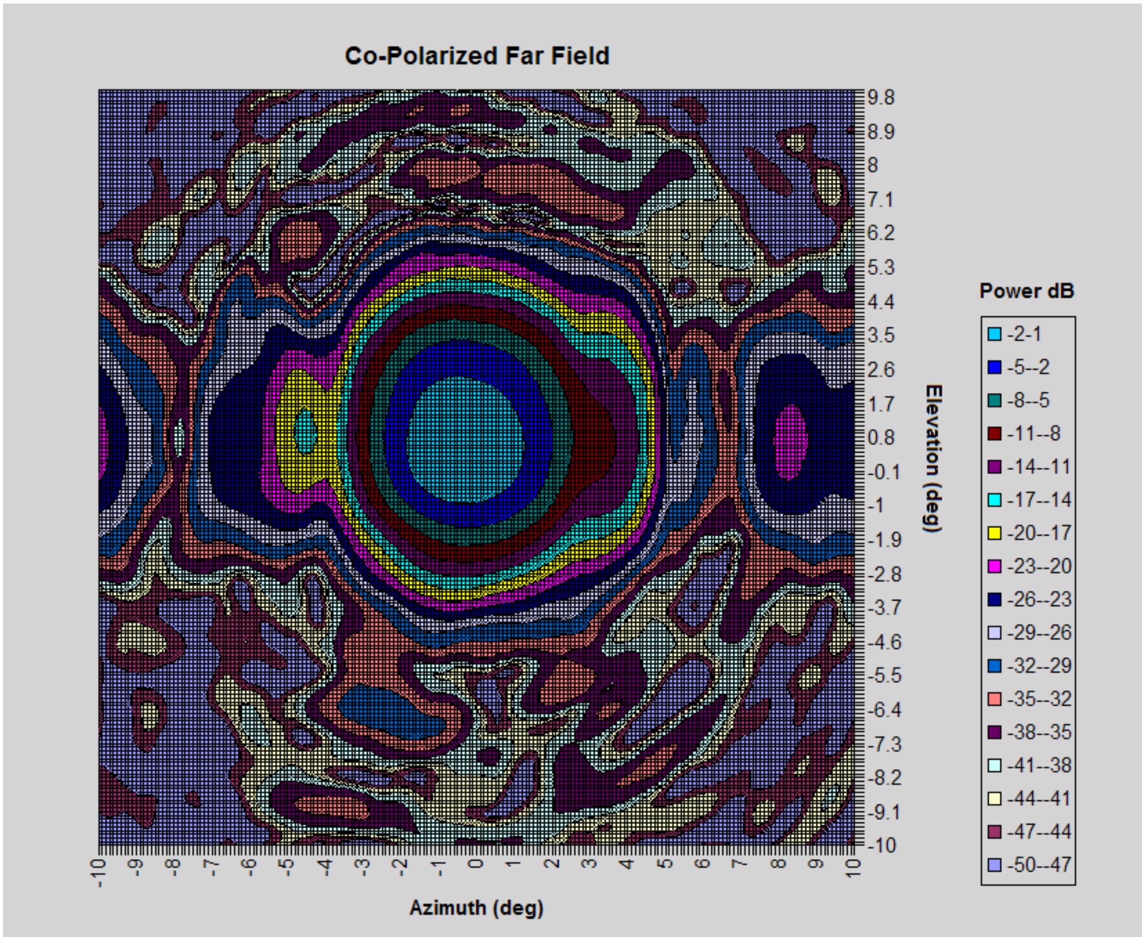


Figure 9: sample Far-Field Beam Pattern

4.2.11. IF Spectrum

Filename: **BBNNNN_IF_SPECTRUM**

IF Spectrum data should be provided with 100 MHz steps or smaller. BWIF should equal the step size.

IF spectrum at specific LO frequencies. For each unique value of (FreqLO, Pol, SB) there will be a collection of records:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, SB, CenterIF, BWIF, Power

Where SB should be 0 for dual-sideband designs.

Where CenterIF gives the X-axis values of the spectrum and Power gives the IF sub-band power in dBm at the specified frequency.

Figure 10 gives a sample plot of IF Spectrum data for a single LO frequency.

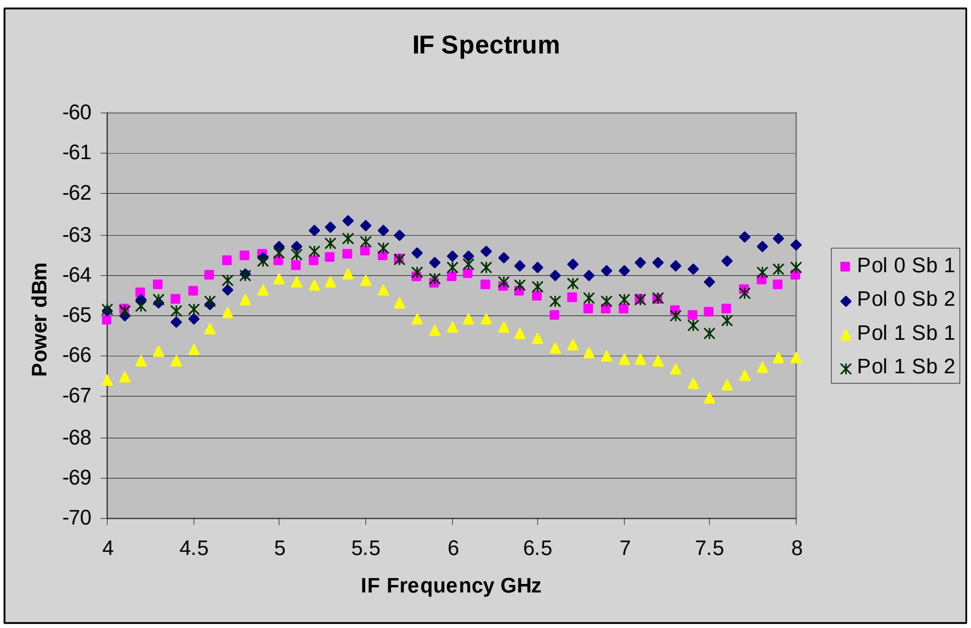


Figure 10: sample IF Spectrum plot

4.2.12. Polarization Accuracy

Filename: **BBNNNN_POLARIZATION_ACCURACY**

The amount of angular error of both polarizations for specified values of LO and RF source frequency. For each unique value of (FreqLO, Pol) there will be one record:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, AngleError

Where AngleError is the error in degrees relative to the nominal polarization angle. For Pol0 the nominal angle is radial to the cryostat and for pol1 it is tangential.

Figure 11 gives a sample plot of Polarization Accuracy data.

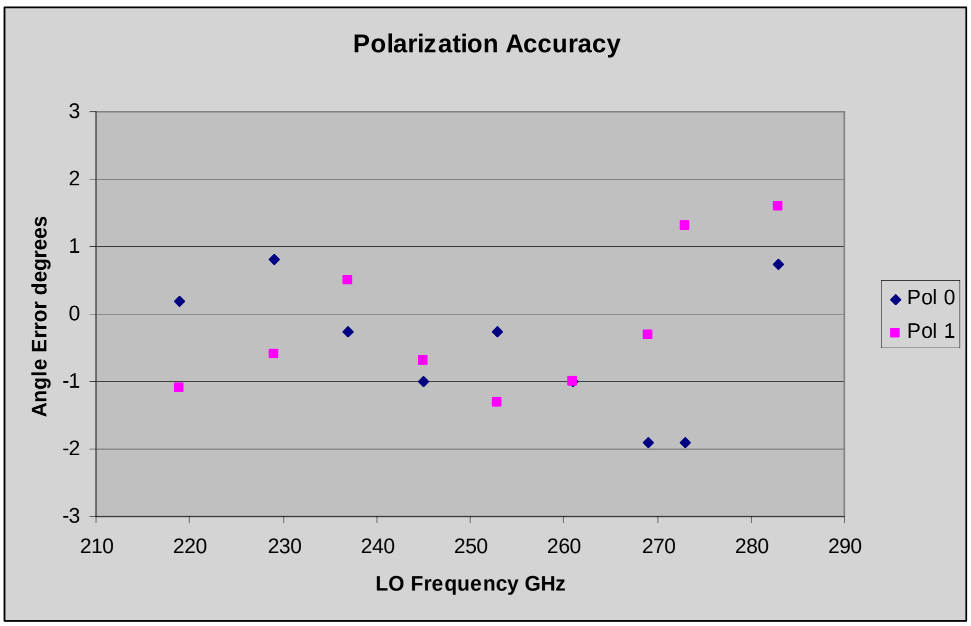


Figure 11: sample Polarization Accuracy data plot

4.2.13. Cross-Polarized Beam Pattern

Filename: **BBNNNN_CROSS_POLAR_BEAM_PATTERN**

Two-dimensional far-field angular plots of co-polarized and cross-polarized power for specified values of LO and RF source frequency. For each unique value of (FreqLO, FreqCarrier, Pol) there will be a collection of records:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, FreqCarrier, Pol, Theta, Phi, XPolPower, Phase

Where Theta and Phi give the pointing angle, XPolPower gives the cross-polarizated power at the specified angle, in dB normalized to the CoPolPower peak.

Figure 12 gives a sample Cross-Polarized beam pattern plot. Note that the cross-polarized power is normalized to the co-polarized peak.

Phase gives the phase angle relative to the maximum. If phase is not measured, its value may be given as 0.

If far-field patterns are not available, near-field patterns may be substituted.

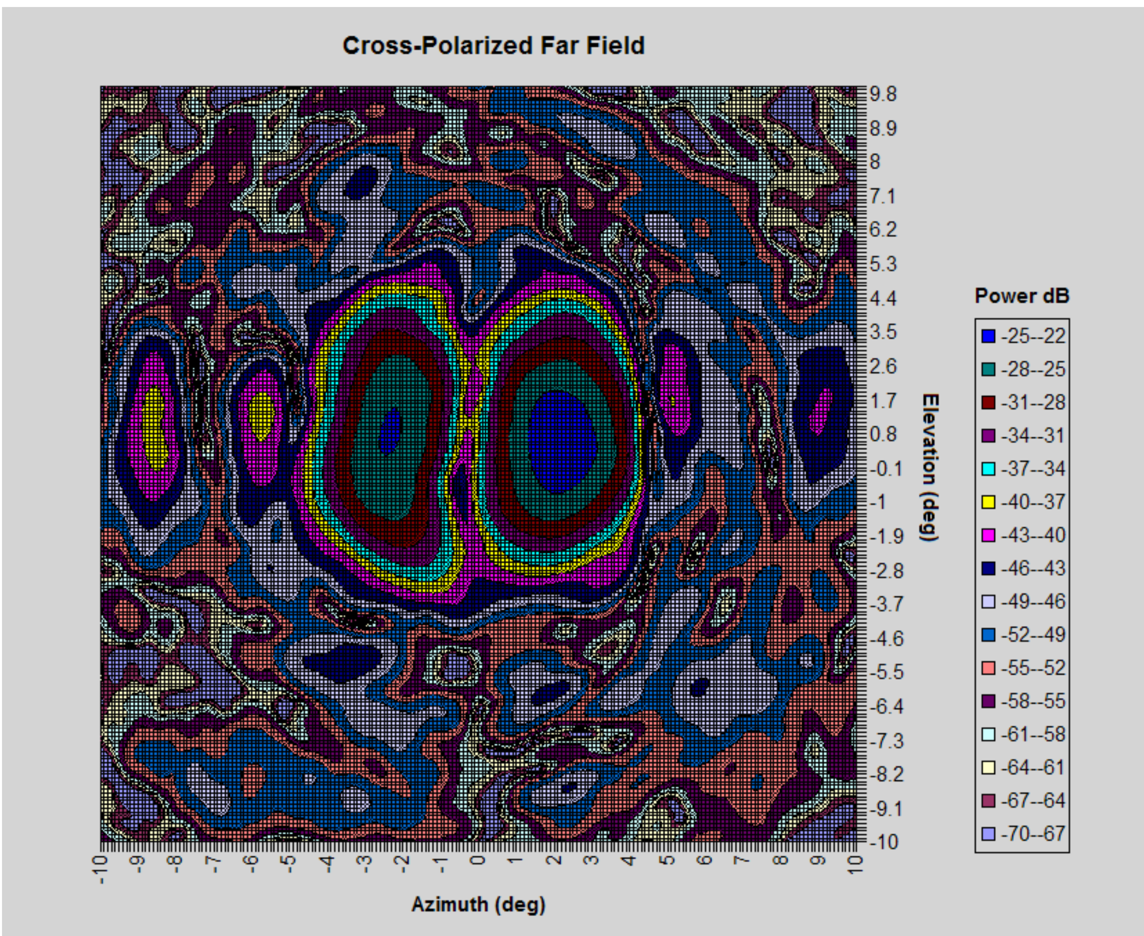


Figure 12: sample Cross-Polarized Beam Pattern plot

4.2.14. Integrated Cross-Polarization Level

Filename: **BBNNNN_CROSS_POLARIZATION**

Total cross-polarized power for specified values of LO frequency. For each unique value of (FreqLO, Pol) there will be a collection of records:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, XPolPower

XPolPower (integrated) is in dB and normalized to the co-polarized integrated power.

Table 8 gives sample Integrated Cross-Polarization Level data.

FreqLO	Pol	XPolPower
622	0	-16.35
622	1	-18.38
670	0	-16.40
670	1	-16.77
694	0	-16.69
694	1	-18.87

Table 8: sample Integrated Cross-Polarization Level data

4.2.15. I-V Curve

Filename: **BBNNNN_IV_CURVE**

SIS mixer I-V Curves may be provided either pumped or un-pumped with LO power. For each unique value of (FreqLO, Pol, SB) a collection of records:

keyBand, keyDataSet, fkCartAssys, TS, FreqLO, Pol, SB, VJ, IJ

Where SB should be 0 for dual-sideband designs.

FreqLO is 0 if the mixer is un-pumped. If FreqLO is nonzero, then it is assumed that the mixer is pumped with the optimal LO power, sufficient to give the junction current given for the specified LO frequency in the MixerParams table, section 4.1.3.

VJ is given in mV, IJ is in µA per section 3.1.

Figure 13 gives sample I-V Curve plots for a single LO frequency, polarization and sideband, both pumped and un-pumped.

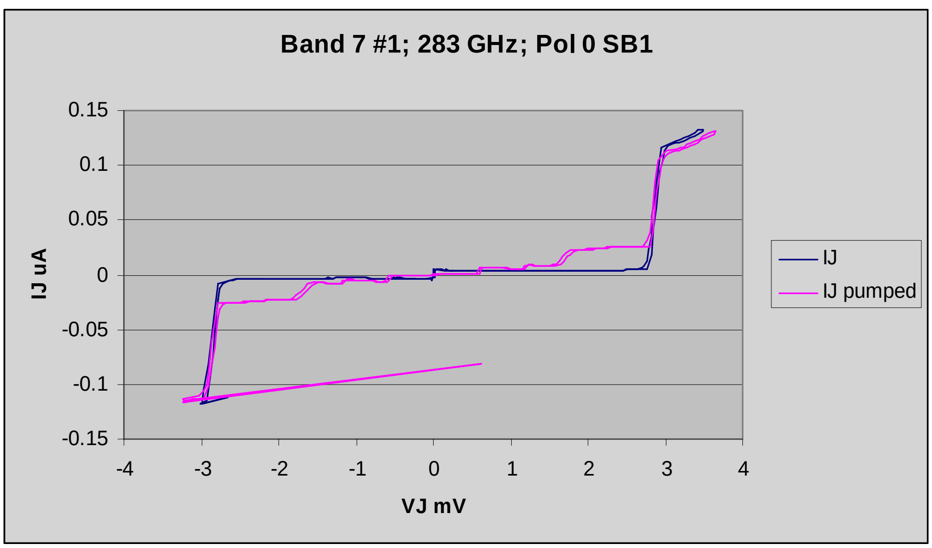


Figure 13: sample I-V Curve data plot

4.3. Database Schema

This section presents the database schema, shown in Figure 14, for the tables that hold cartridge, mixer, preamplifier, and LO operating parameters, as described in sections 3.1, 3.2, and 4.1. Database schemas describe the relationship between the various tables in the database. Note that each table can be considered as defining a row in a spreadsheet, with each field description representing one column in the spreadsheet. "Keys" are simply record numbers and are generally assigned to each new record in the table. "Foreign keys" are fields in a table that contain the key value of another table which is a way of relating the data.

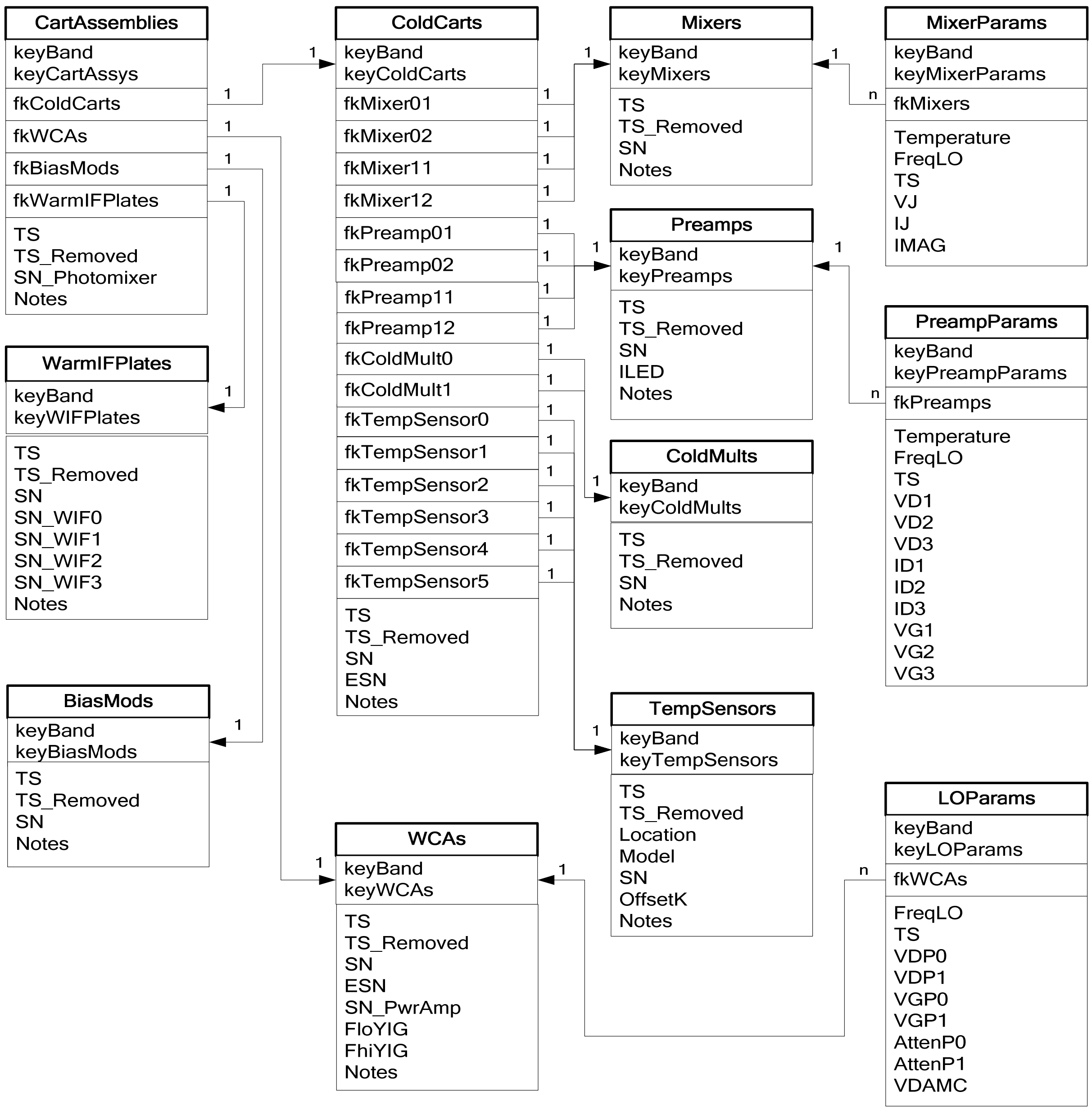
Each table in the database has a two-part primary key, always consisting of the Band number as an integer, plus an additional unique integer for each record. The database is defined such that this second unique integer is auto-incrementing and therefore is never specified when putting data into a table.

Additionally each table contains a timestamp column called "TS." This name was chosen because "timestamp" in any capitalization is a reserved word in some SQL implementations, notably MS Access.

Each table which corresponds to a physical assembly in the cartridge has a "Notes" column where any notes relevant to a given assembly may be placed.

Other common abbreviations in the column names are "SN" for serial number and "ESN" for electronic serial number. The former is the number assigned by the project and/or cartridge manufacturer. The latter is an 8-byte hexadecimal number as read from the ESN chip embedded in the applicable assemblies. Both Cartridge and WCA designs include ESN capability.

Several of the tables include a field called TS_Removed. This field is for recording the date and time when a record no longer represents the components actually installed in the cartridge or its subassembly. Rather than delete or change that record, the TS_Removed field contains the timestamp when the record became historical. For example, when a particular configuration of ColdCarts is no longer used for active testing because a mixer has been replaced, a new record will be created containing the new configuration and the old record will be retained for historical purposes. The old record's TS_Removed field will contain the date and time that the record became historical and the Notes field in the relevant table should also be updated with information about why the mixer was replaced. Procedures for the usage of TS_Removed are given in section 3.7.



Note: File stored as Visio OLE in document

Revisions:
2006-06-02 jee added ColdMults table
2006-06-08 jee removed “Location” from coldMults Table
2006-10-05 jee added SN to WarmIFPlates table
2006-10-16 jee removed back links in CartAssemblies, WarmIFPlates, BiasMods, TempSensors, and ColdMults
2007-04-03 mm renamed fkMixerNN and fkPrempNN fields to be consistent with tables in text.

Figure 14: Database Schema for Configuration and Operation Parameters