Atacama
Large
Millimeter
Array

Band 6 Cartridge
Database Design Description

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Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A00	2007-04-02	All	–	Initial draft.
A01	2007-04-11	Many	–	jee: reviewed
A02	2007-05-15	Schema, Section 3.1, and Figure 2	–	jee: Added Table 2 showing mapping to FEIC database.
A03	2007-06-12	Few	–	jee: final editing

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1. Introduction

1.1. Purpose

This document describes the design for the Band 6 Cartridge Configuration Database. This database holds information about the particular parts used to construct each Band 6 cartridge along with the electrical settings required to operate the cartridge.

1.2. Scope

Band 6 Test Systems measure data and format it according to [AD01]. That test and configuration data are delivered along with Band 6 Cartridge assemblies to the Front End Integration Center. The mixer and amplifier test systems measure and characterize cartridge components which are then integrated into a cartridge assembly and measured on the Band 6 Cartridge Test System. The result is variety of data items, each of which is keyed to a particular component or cartridge assembly.

For a given cartridge, the relevant data falls into the following broad categories:

1. **Parts used during assembly:** The part numbers and serial numbers of subassemblies that comprise each complete Band 6 Cartridge.
2. **Operational parameters:** The information needed to operate the cartridge and its subassemblies within the context of the ALMA installation. This information will be duplicated in the ALMA Archive area for operational parameters when that portion of the Archive becomes available.
3. **Amplifier test results:** The results of Cold IF Amplifier testing on the Band 6 Amplifier Test System.
4. **Mixer test results:** The results of SIS Mixer-Preamp block testing on the Band 6 Mixer Test System.
5. **Cartridge test results:** The full results of testing a cartridge assembly on the Band 6 Cartridge Test System, including items required for the cartridge acceptance report and additional data not required for the report, giving a full history of the testing performed on the cartridge test system.

1.3. Applicable documents

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

Table 1: Applicable Document List

Reference	Document Title	ALMA Doc. Number
[AD01]	Cartridge Data Formats for Delivery to the Front End Integration Centers	FEND-40.09.03.00-032-A-DSN

1.4. Reference documents

The following documents contain additional information.

Table 2: Reference Document List		
Reference	**Document Title**	**ALMA Doc. Number**

1.5. Acronyms

A list of the acronyms used in this document is given below.

ALMA	Atacama Large Millimeter Array
DB	Database
DBMS	Database Management System
FE	Front End
FEIC	Front End Integration Center
FETMS	Front End Test and Measurement System
IF	Intermediate Frequency
LO	Local Oscillator
NRAO	National Radio Astronomy Observatory
RF	Radio Frequency
TMS	Test and Measurement System
WCA	Warm Cartridge Assembly

2. Database Design Decisions

2.1. An instance of MySQL server will be the main repository at each site.

The Band 6 Cartridge Database will reside on the same MySQL server as the North American FEIC database. This server is operated and maintained by the CV-Computing group. Backup and other maintenance of the server will be carried out by that group.

The target server version is to be MySQL 4.1, revision 18 or later. MySQL 5.0 may be considered if it is shown to possess a clear advantage.

2.2. Especially high performance is not required.

The database will ultimately contain millions of test data records, but will only require simultaneous use by less than 10 users. This is firmly within the capabilities of a modern medium-performance DBMS and does not call for dedicated hardware.

2.3. Moderate concurrency of access is required

The tasks which will access the database simultaneously are discussed in the detailed design section of this document. Essentially they are:

1. inserting cartridge configuration and operational parameter data;
2. creating test data at the Band6 Amplifier, Mixer, or Cartridge Test Systems; and
3. up to about 5 users viewing and occasionally modifying data from workstations.

2.4. Data will be inserted and used by the test system software.

The most active creator and consumer of data in the database will be the Band 6 test system software. There may be two or more test system applications operating simultaneously.

2.5. Raw data will be stored with no calibration or post-processing applied.

All data measured by the test systems will be stored as returned from the instrument. The stored data shall include the result of any calibrations applied by the instrument to the data. Separate procedures, either automatic or initiated by client workstation software, will perform any additional calibration or post-processing on the data. Thus transformed, the data may be stored again in the database for subsequent display, reporting, or export. Data stored after such transformation does not replace the original raw data.

2.6. Data may be viewed and modified by workstation client software.

Data shall be gathered, tagged by the test system software, and then scanned for exceptions or anomalies away from the main test system, as needed.

2.7. Data format will be consistant with format required for data delivery.

Operation and test data required with cartridge delivery will be inserted into the FEIC Database as specified in [AD01]. An important requirement is that the data not require excessive transformation to conform to data delivery requirements described in [AD01]. It shall be a straightforward matter to match up the data as-delivered with its copy in the Band 6 Cartridge database.

3. Detailed design of the database

3.1. Relational schema for Cartridge assembly configuration

Figure 1 shows the database tables that hold assembly configuration and operating parameters for cartridges, mixers, and preamplifiers. A subset of the information contained in these tables is deliverable as specified in [AD01]. To simplify the delivery process, the database configuration established for the FEIC is used as the template for this design, although some modifications and additions have been made to allow for tracking of more information required within the Band 6 group.

All tables include a primary key value defined as a unique auto-incrementing integer. 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). Common field abbreviations are "SN" for serial number and "PO" for purchase order number. The former is the number assigned by the project and/or cartridge manufacturer. The latter is purchase order number assigned to the item when it was purchased. 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.

Several of the tables include a field called `TS_Removed`. This field is used 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 deprecated. 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.

The FEIC database doesn't include a separate mixer-preamp table and Figure 2 shows the mapping between the `ColdCarts` table in the FEIC database [AD01] and the `MxrPreampAssys` table in Figure 1.

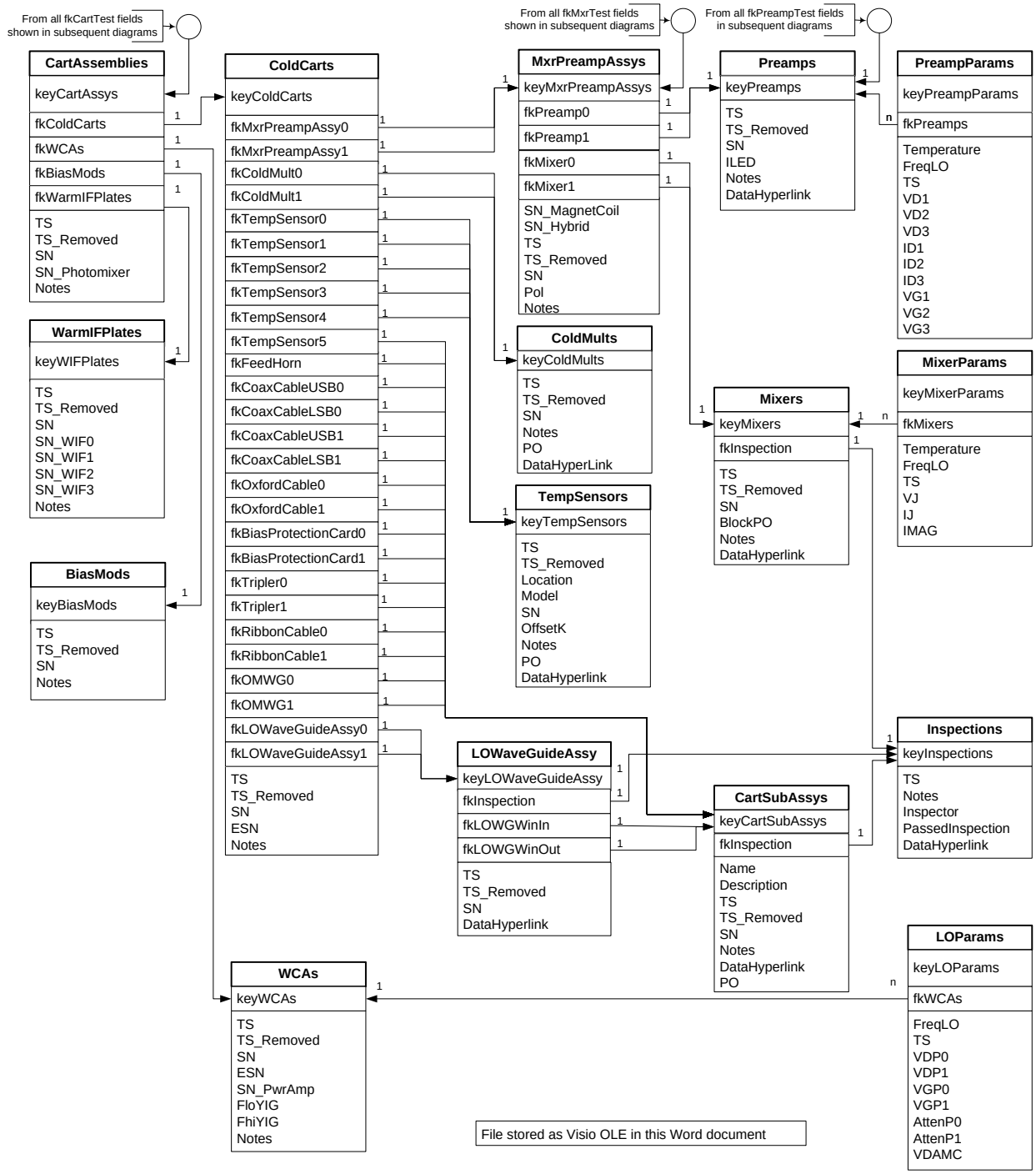

Figure 1: Cartridge Assembly Configuration Database Schema

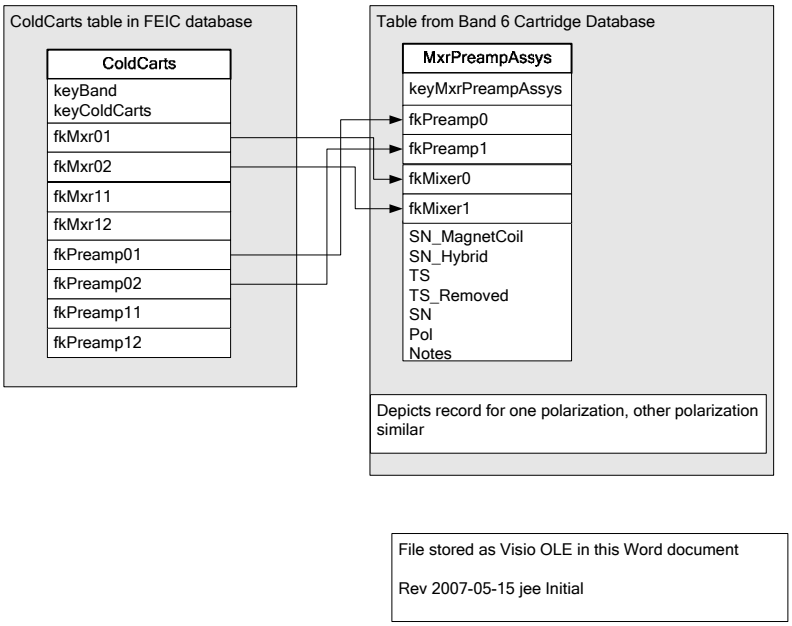

Figure 2: Mapping between `ColdCarts` table in the FEIC database and `MxrPreapAssys` table in Figure 1

3.1.1. Table CartAssemblies

Table `CartAssemblies` contains the configuration of which cold cartridges, WCAs, bias modules, warm IF plates, and photo-mixers are matched up with one another. The record with the most recent time stamp (TS) shall be interpreted as the full cartridge assembly as-delivered.

3.1.2. Table WarmIFPlates

Table `WarmIFPlates` gives the configuration of warm IF amplifiers and cables 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`.

3.1.3. Table BiasMods

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`.

3.1.4. Table WCAs

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

3.1.5. Table ColdCarts

Table `ColdCarts` in Figure 1 contains the serial number assigned to a cold cartridge and the configuration of which mixer-preamp assemblies, cold multipliers, temperature sensors, LO Waveguide assemblies, and other various subassemblies are matched up in a cold cartridge.

When a cold cartridge subassembly is removed, the `TS_Removed` field in `ColdCarts` as well as the `TS_Removed` field in `CartAssemblies` must be updated. When a cold cartridge subassembly is replaced, a new `ColdCarts` record will be inserted that has the same serial number and same foreign keys of unchanged items, but an updated foreign key referencing the newly-installed subassembly. A new record in the `CartAssemblies` table will also have to be inserted that has an updated foreign key referencing the most recent `ColdCarts` record. This method of updating records preserves the entire history of a cartridge assembly and all its components.

3.1.6. Table ColdMults

Child table `ColdMults` holds details about the two cold multipliers installed in each cartridge.

3.1.7. Table MxrPreampAssys

The table `MxrPreampAssys` provides the relationship between a cold cartridge and a mixer-preamp block, which includes two component mixers in each mixer block, two preamps, a hybrid and a magnet coil. A mixer-preamp assembly is designed for a particular polarization, and therefore the table contains a `Pol` field. The polarization on which a block is installed is also

evident from in the `ColdCarts` table where `fkMxrPreampAssy0` refers to the block on `Pol 0` and `fkMxrPreampAssy1` refers to the block on `Pol 1`. This table allows for the properties of a given mixer-preamp block to be determined even before it is assigned to a cold cartridge.

3.1.8. Table Mixers

A. The table `Mixers` holds information about component mixers and the blocks in which they are installed. It also links a set of pumped and un-pumped component mixer I-V parameters. Pumped I-V parameters vary with LO frequency and physical temperature and are used in cartridge configuration and operation. 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 `fkMixers` which matches a corresponding `keyMixers` value in the `Mixers` table.

B. This table includes a foreign key referencing a record in the `Inspections` table. This links each mixer to information about when it was inspected, by whom, whether or not it passed inspection and a hyperlink to any inspection data recorded.

3.1.9. Table Preamps

Similarly, table `Preamps` holds the relationship between cold amplifiers and the mixer-preamp block in which they are installed. Each record in `PreampParams` contains foreign key field data in `fkPreamps` that matches `Preamps`. Each record in `Preamps` may be associated with a set of `PreampParams` records that define the preamp parameters.

This table includes a foreign key referencing a record in the `Inspections` table. This links each amplifier to valuable information about when it was inspected, by whom, whether or not it passed inspection and a hyperlink to any inspection data recorded.

3.1.10. Table TempSensors

Table `TempSensors` contains the temperature offsets at the liquid Helium boiling point (4.2K) which are 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 five foreign keys into `TempSensors` because there are 5 temperature sensors installed in each cartridge. The locations assigned to `fkTempSensor0` … `fkTempSensor4` are 110K stage, 15K stage, 4K stage, Pol 0 mixer, and Pol 1 mixer, respectively.

Temperature sensor calibration data is located in its own table because it is measured separately from mixer and preamp data.

This table also includes a `PO` field to store the purchase order number under which a temperature sensor was ordered.

3.1.11. Table LOWaveGuideAssys

The table `LOWaveGuideAssys` documents the relationship between a cold cartridge and the LO waveguide assembly which includes two LO waveguide windows. A LO waveguide assembly is designed for a particular polarization in the cold cartridge and therefore, polarization information is stored in the `ColdCarts` table where `fkLOWaveGuideAssy0` refers to LO waveguide installed on Polarization 0 and `fkLOWaveGuideAssy1` refers to Polarization 1.

Waveguide window details are handled with foreign keys `fkLOWGWinIn` for the inner waveguide window and `fkLOWGWinOut` for the outer waveguide window in the `CartSubAssys` table.

This table allows for the properties of a given mixer-preamp block to be determined even before it is assigned to a cold cartridge.

3.1.12. Table CartSubAssys

The table `CartSubAssys` gives the relationship between a cold cartridge and its various subassemblies and provides the necessary fields to store records for the following types of components:

1. Feed Horns
2. Coax Cables
3. Triplers
4. Waveguide windows
5. Ribbon Cables
6. Over-Moded Wave Guides

The `Name` and `Description` field identify the type of component and its description or model number. For example: `Name` = 'Temperature Sensor' `Description` = 'Lakeshore DT-670C-SD'.

This table includes a foreign key referencing a record in the `Inspections` table. This links each subassembly to valuable information about when it was inspected, by whom, whether or not it passed inspection and a hyperlink to any inspection data recorded.

This table allows for the properties of a given subassembly to be determined even before it is assigned to a cold cartridge.

This table also includes a `PO` field to store the purchase order number under which a component was ordered or to identify a batch to which it belongs.

3.2. Relational schema for test data

3.2.1. Tracking software versions

Software programs and versions used to collect or transform test data will be tracked using two tables, `SoftwareVersions` and `SoftwarePrograms`. For each software program used on a test system to collect or manipulate data in the database, a record will be placed in the `SoftwarePrograms` table. For each new version of a program released a new record will be placed in the `SoftwareVersions` table. The `SoftwareVersions` table contains a reference to the `SoftwareProgram` to which it applies. Sets of measurement data can use these tables to link a set of measured data to the software used to collect it.

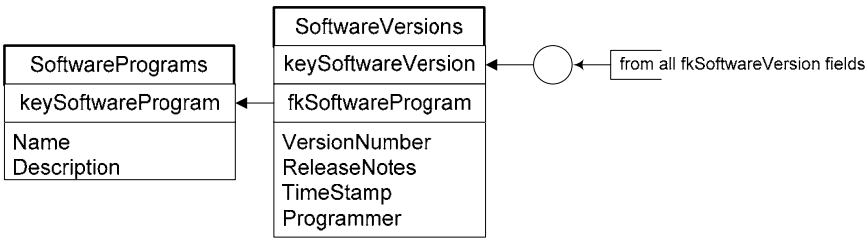

Figure 3: Software Version Tacking

3.2.2. Cartridge Assembly Test Data

Figure 4 illustrates the `CartTests` table, along with helper tables `TestTypes`, `CartTestErrors`, `EnvConditions`, and `NotesCartTests`. These tables provide the structure for recording the information gathered for any of a variety of tests performed on a cartridge assembly. Prior to data collection, test system software will insert a new record in `CartTests`. During a measurement, data records will be stored in other tables specific to the measurement being performing, but linked back to the `CartTests` record to which the data set belongs. Test system software can use the helper tables to record errors that occur during a measurement and log environmental conditions before, during, and/or after a measurement. The `NotesCartTests` table allows multiple notes to be associated with a particular `CartTest`.

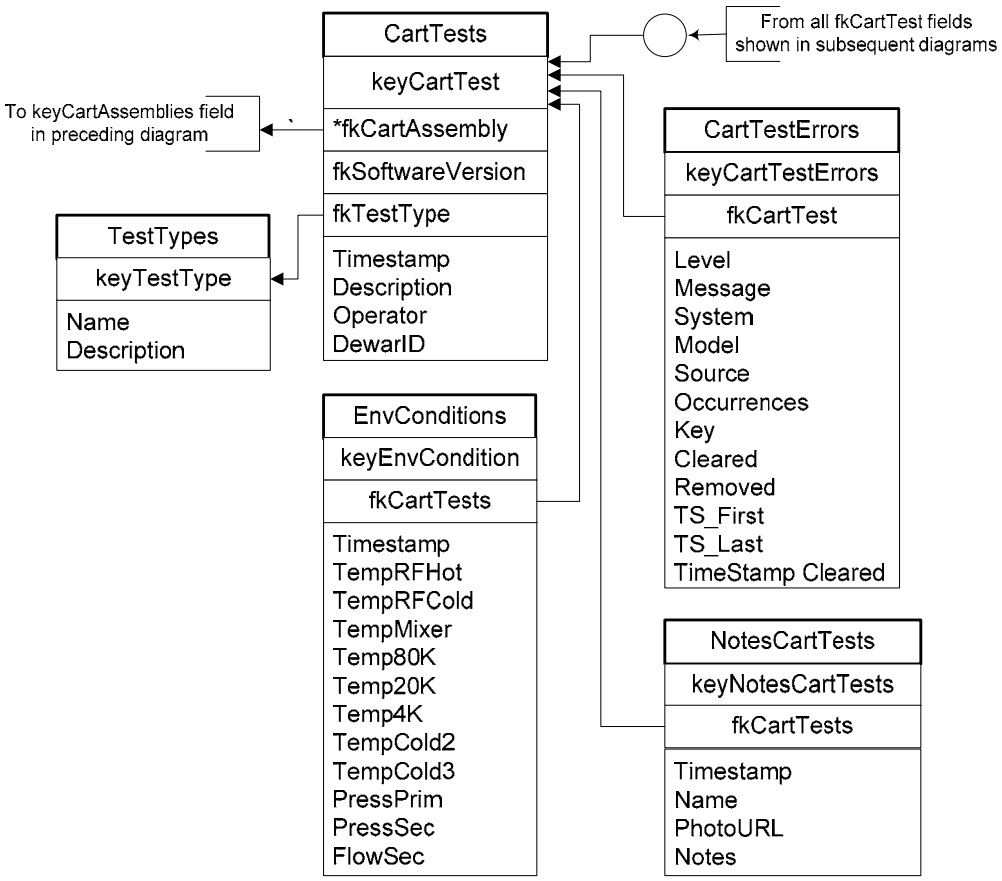

Figure 4: Cartridge Assembly Test Data

3.2.2.1. Cartridge Assembly Noise Temperature Test Data

Raw data collected during a noise temperature test on a cartridge assembly will be stored in the `NT_Data` table. It contains a reference to the `NT_Calc_Data` table which houses all calculated values. Records in the `NT_Calc_Data` table will be inserted as a post-processing procedure rather than during a measurement. These tables are illustrated in Figure 5 with an asterisk '*' indicating the fields required for data delivery to the FEIC database for noise temperature measurements.

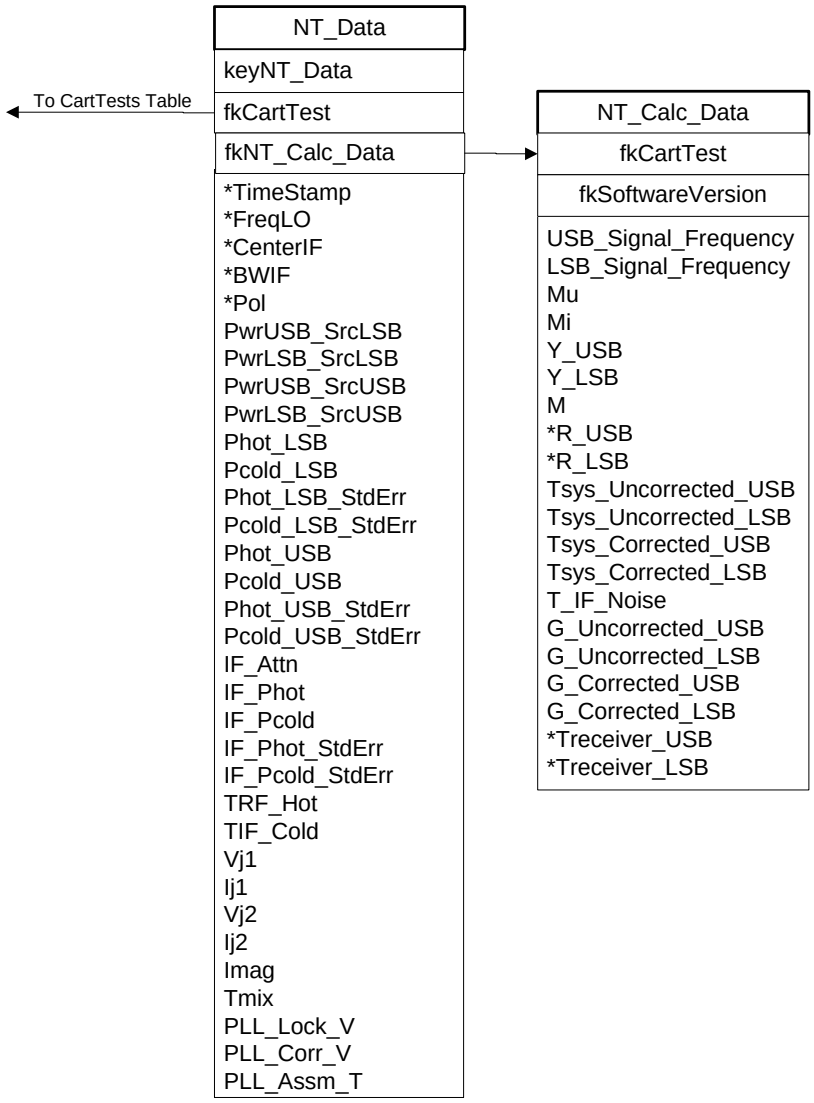

Figure 5: Cartridge Assembly Noise Temperature Test Data

3.2.2.2. Cartridge Assembly Beam Pattern Test Data

Raw data collected during a beam pattern scan on a cartridge assembly will be stored in the `BeamPatterns` and `BP_Data` tables. The `BeamPatterns` table contains general information for a single scan, while the `BP_Data` table contains a record for each data point at a particular XY position in a scan. Each `BP_Data` record contains a reference to a record in the `BP_Calc_Data` table, which stores the calculated values for normalized power, theta, and phi. Records in the `BP_Calc_Data` table will be inserted as a post-processing procedure rather than during a

measurement. These tables are illustrated in Figure 6 with an asterisk '*' indicating the fields required for data delivery to the FEIC database for beam pattern measurements.

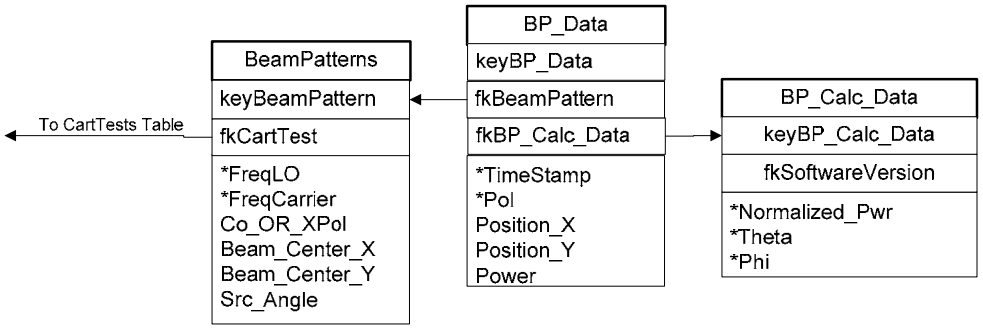

Figure 6: Cartridge Assembly Beam Pattern Data

3.2.2.3. Cartridge Assembly Gain Compression Test Data

Data collected during a measure of gain compression on a cartridge assembly will be stored in the `GainCompression` tables. This tables is illustrated in Figure 7 with an asterisk '*' indicating the fields required for data delivery to the FEIC database.

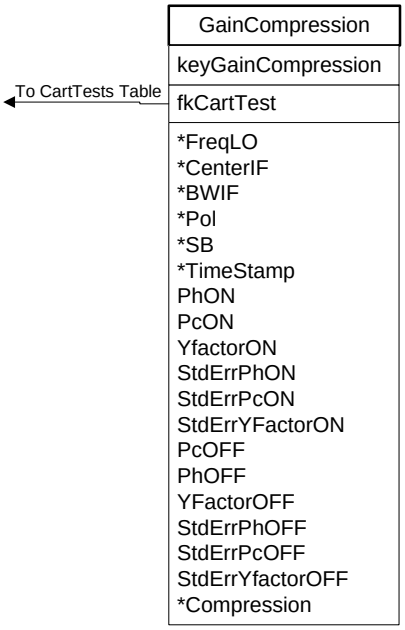

Figure 7: Cartridge Assembly Gain Compression Data

3.3. Data format of test data delivered with cartridges.

The data format of operating and test data delivered with cartridges is given in [AD01]. SQL queries or software programs will be developed that extract data from the tables in the Band 6 database and format it for delivery to the FEIC database.