Atacama Large Millimeter Array

WCA Data Format for Delivery to the Front End Integration Centers

FEND-40.09.03.00-076-A-DSN

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Approvals:	**Organization**	**Date**

Change Record

Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A01	2008-10-21	All	-	First draft
A02	2009-9-11	All	-	Updated to include changes discussed in meeting with WCA group.
A03	2010-10-15	4.2.1,4.2.2, 4.2.3,4.2.4, 4.3.1	-	Updated file naming convention. Output Power section modified. Updated plot pictures.

Table of Contents

1. Scope

1.1. Identification

This document gives the format and contents of the data to be delivered with each ALMA WCA 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 WCA 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 WCA 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 bias voltage settings, and performance test data. Files containing the data are delivered as part of the WCA delivery and acceptance process at the front end integration center.

1.3. Document overview

This document is intended as a supplement to [AD2], which describes the format expected for WCA operating data and gives examples of how the data is to be delivered. This document follows a format similar to [AD2], but focuses specifically on configuration and test data for Warm Cartridge Assemblies. Some portions of [AD2] are duplicated herein, as necessary. Examples will be provided for how data might appear in various plots.

Items requiring further consideration or editing are shown in highlighted text. Sections left blank are either not applicable or not yet known. Blank sections should be removed from the final document before approval and release.

1.4. Acronyms and abbreviations

ALMA – Atacama Large Millimeter Array

AMC- Active Multiplier Chain
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
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]	Cartridge Data formats for Delivery to the Front end Integration Centers	2007-08-02	ALMA-40.09.03.00-032-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]	First Local Oscillator Assembly For Band 7- Acceptance Report	2008-07-18	FEND-40.10.07.00-108-A-REP

3. Design decisions

3.1. Identification of WCA Configuration Parameters

Table 1 gives the operating parameters for power amplifiers and AMCs 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 1: WCA/LO Operating Parameters				
Signal	**Channel**	**Description**	**Precision**	**Units**
VDPA_0	0	PA channel 0 drain voltage	±XX.XX	V
VDPA_1	1	PA channel 1 drain voltage	±XX.XX	V
VGPA_0	0	PA channel 0 gate voltage	±XX.XX	V
VGPA_1	1	PA channel 1 gate voltage	±XX.XX	V
VGAMC_E	n/a	AMC E gate voltage	+XX.XX	V
VDAMC_B	n/a	AMC B drain voltage	+XX.XX	V
VDAMC_E	n/a	AMC E drain voltage	±XX.XX	V
AMC_MultD	n/a	AMC multiplier D bias	+XXX	0-255

3.2. Identification of WCA Test Data

WCA performance data is to be delivered along with each WCA. The following types of test data are expected, where applicable. Whether or not a given type of data is required for a given WCA 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.

- Amplitude Stability
- Output Power Vs Frequency
- Output Power Vs Drain Voltage
- Output Power Vs Step Size
- Phase Noise
- AM Noise

3.3. Method of Data Delivery

This is described in detail in [AD2], but key elements are revisited here. 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 WCA manufacturer.

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.

3.3.1. Data Records

Files maybe delivered in either CSV of XML format, as described in [AD2].

3.3.2. Transport of a Package

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

3.3.2.1.Alternate Transport

A Web-based interface for uploading and viewing configuration and test data for WCA assemblies is currently in development. Uploading is currently limited to the North American FEIC. To view uploaded configuration and test data, visit this url: http://www.cv.nrao.edu/php-internal/ntc/Tasks/DatabaseUI/www/DBUI/status.php. The data is subdivided by Band, and further subdivided by Cartridge Assembly. This application is still in development.

4. Design of database

4.1. Data Files for WCA Operating Parameters and Configuration

The database schema diagram given in [AD2] may be used as a reference for understanding the parent-child relationships amongst records in the cartridge operating parameters and configuration tables. Figure 8 shows a schema for the WCA-specific portion of the database.

These files contain information which is required to correctly operate the WCAs, such as bias values and temperature sensor offsets. Also they indicate the physical association of the WCA 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 (see [AD2] for conventions).

4.1.1. WCAs

Filename: **BBNNNN_WCAS**

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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.
The fields in WCAs are:
keyBand, keyWCAs, TS, TS_Removed, SN, ESN, FloYIG, FhiYIG, Notes

keyWCAs is required to be unique amongst all WCAs.
FloYIG and FhiYIG are the lower and upper frequency limits of the YiG oscillator integrated with the WCA.

4.1.2. LO Params

Filename: **BBNNNN_LOPARAMS**

The columns in this file are as follows:

keyBand, fkWCA, FreqLO, TS, VDPA_0, VDPA_1, VGPA_0, VGPA_1, VGAMC_B, VGAMC_E, AMC_MultD

FreqLO is in GHz. VDPA_0, VDPA_1, VGPA_0, VGPA_1, VGAMC_B, VGAMC_E, and AMC_MultD are described in Table 1.

4.2. Data Files for WCA Test Data

Test data files contain WCA performance data as-tested by the WCA 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.

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.

The following additional conventions apply:

- **fkWCA**: indicates which WCA in the dataset was used to collect the test data.

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- **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 WCA manufacturer wishes to provide extra or additional test data for a single test. Unique values of this field differentiate between multiple data sets.

- **Pol**: a letter with the value 0 or 1 indicating polarity.

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

4.2.1. Output Power

Filename: **BBNNNN_WCA_OUTPUT_POWER**

There are various plots which use output power- *Output Power Vs. Frequency*, *Output Power Vs. Step Size*, and *Output Power Vs. Drain Voltage*, for example. The format of the file will be the same for each, and data for these plots may all be contained in the same file.

The columns in this file are as follows:

keyBand, keyDataSet, fkWCA, TS, FreqLO, Power, Pol, VD0, VD1, VG0, VG1

FreqLO is in GHz and Power is in mW. VD0 and VD1 are drain voltages for polarization channels 0 and 1, respectively. VG0 and VG1 are gate voltages for polarization channels 0 and 1, respectively. Pol is either 0 or 1. A keyDataSet value of 1 indicates Power vs. Frequency. A keyDataSet value of 2 indicates Power vs. Drain Voltage. A keyDataSet value of 3 indicates Output Power vs. Step Size.

Figures 1-3 shows various plots created from this file. Any of the three plots shown may be created from a single dataset.
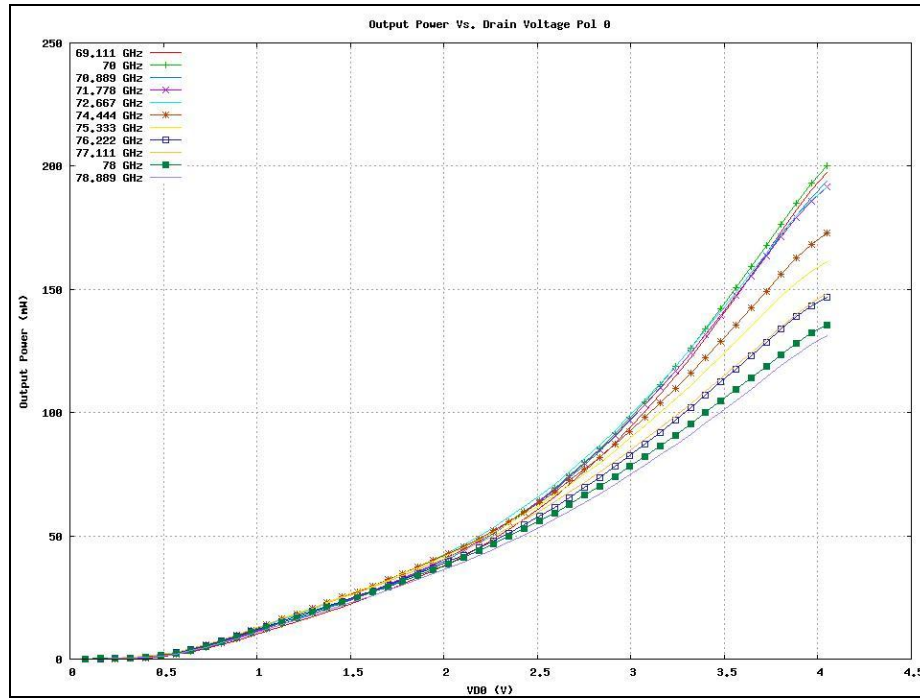
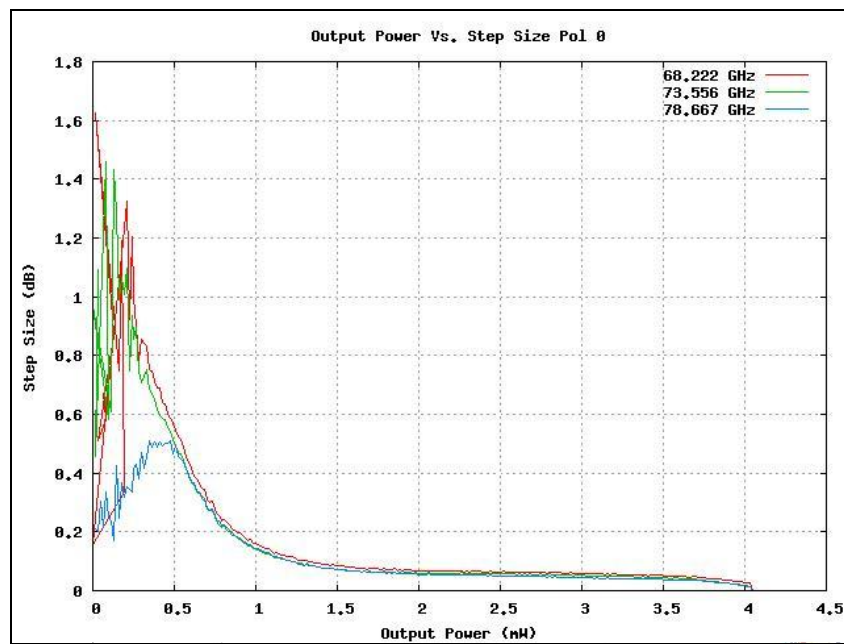**Figure 1- Output Power Vs. Drain Voltage**
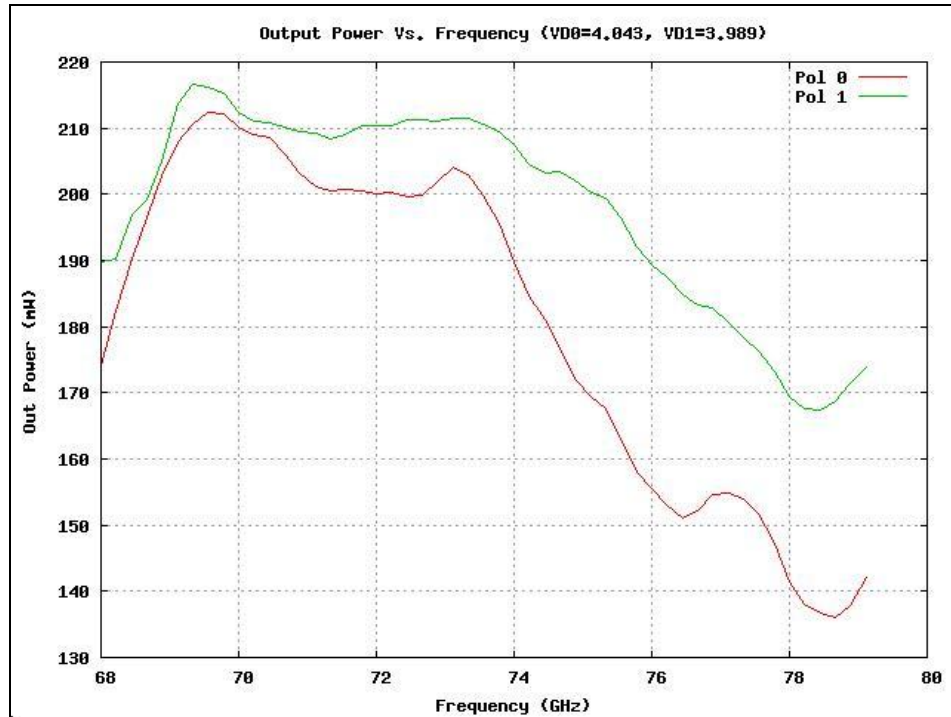

Figure 2- Output Power Vs. Step Size

Figure 3- Output Power Vs Frequency

4.2.2. Amplitude Stability

Filename: **BBNNNN_WCA_AMPLITUDE_STABILITY**

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

keyBand, keyDataSet, fkWCA, TS, FreqLO, Pol, Time, AllanVar

Where SB should be 0 for dual-sideband designs.

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

Error! Reference source not found. gives a sample Amplitude Stability plot for a single LO frequency.
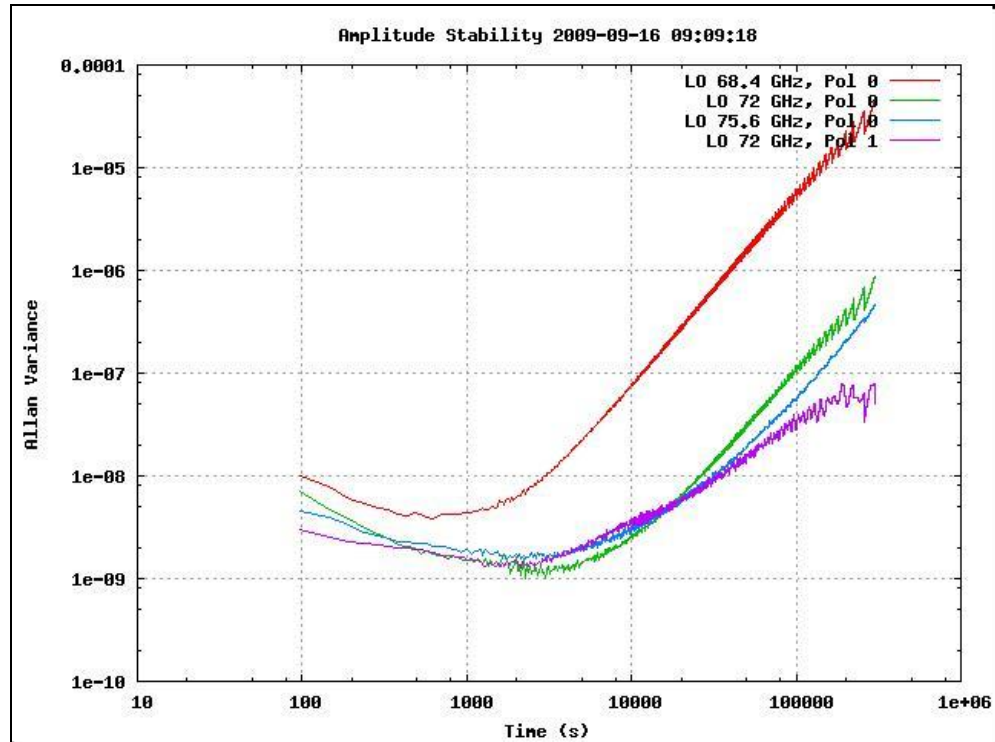
Figure 4- Amplitude Stability

4.2.3. AM Noise

Filename: **BBNNNN_WCA_AM_NOISE**

Plots of AM noise versus Drain Voltage. Format of this file is as follows:

keyBand, keyDataSet, fkWCA, TS, AMNoise, FreqLO, Pol, DrainVoltage

FreqLO is in units of GHz, and forms the X axis values for the plot. AMNoise is the measured noise in units of k/uW.

Figure 5 gives a sample AM noise plot for a specific Drain Voltage.
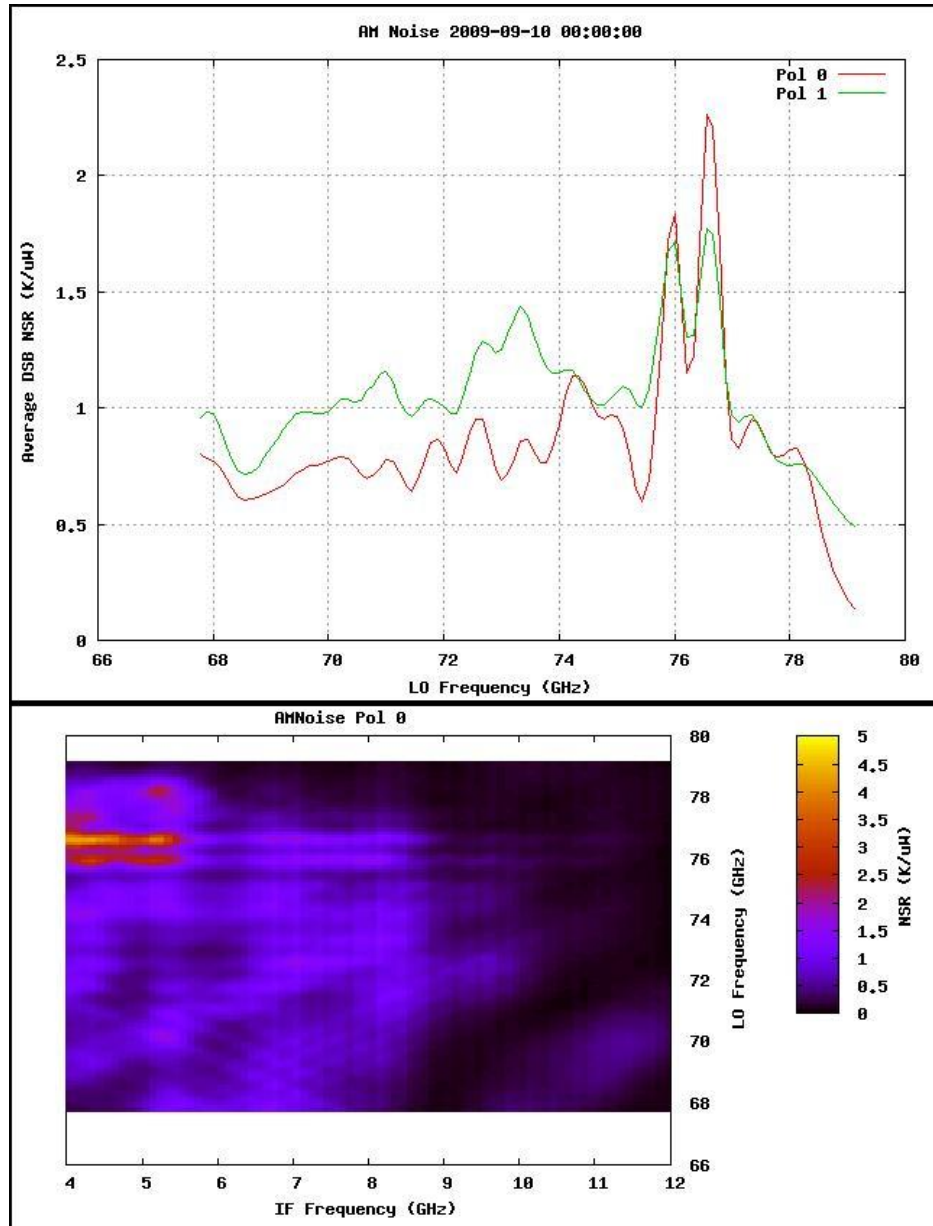
Figure 5- AM Noise

4.2.4. Phase Noise

Filename: **BBNNNN_WCA_PHASE_NOISE**

Plots of phase noise at specific LO frequencies. For each unique value of (FreqLO, Pol) there will be a collection of records:

keyBand, keyDataSet, fkWCA, TS, FreqLO, Pol, CarrierOffset, Lf

FreqLO is in units of GHz. Lf is phase noise, in units of dBc/Hz, and give the phase noise at the specified frequency. CarrierOffset is in Hz, and Pol can be either 0 or 1.

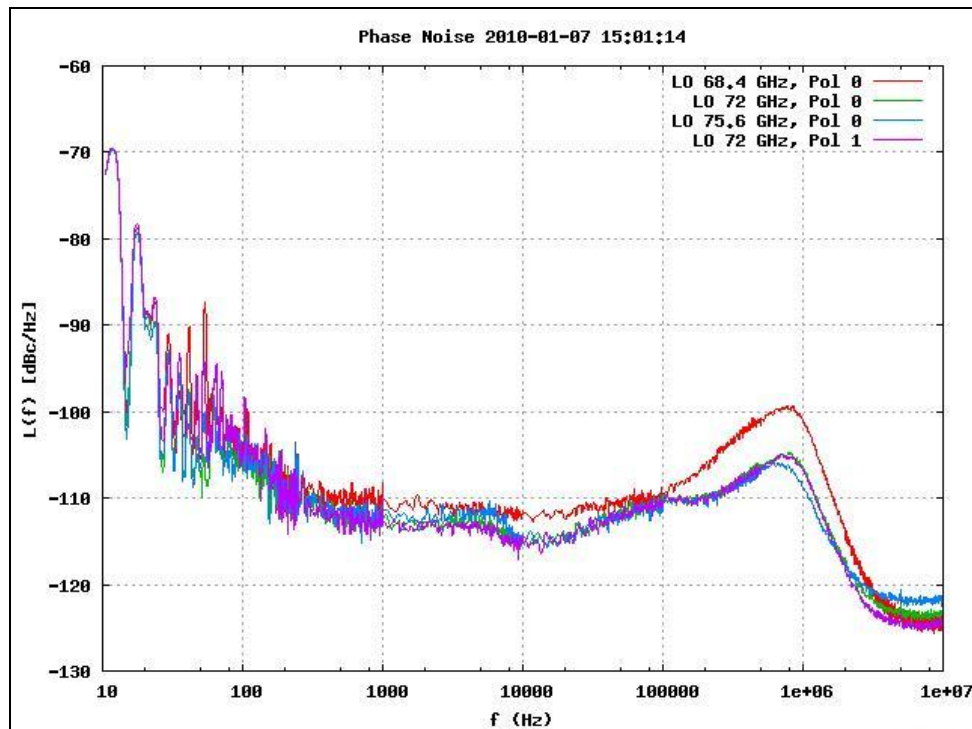Figure 6 gives a sample Phase Noise plot.

Figure 6- Phase noise

4.3. Safety Parameters

4.3.1. PALimits

Filename: **BBNNNN_WCA_PALIMITS**
Fields:
keyBand, fkWCA, FreqLO, TS, max_safe_power, maxVDPA_0, maxVDPA_1,maxVgPA_0,maxVgPA_1

A single record will be interpreted as applying to all frequencies. If there are two or more records, at frequencies outside the range that is covered, the nearest point will be used. At frequencies between two points, the record having the lowest maxVDPA_0 will be used.

4.4. Database Schema

The database functions similarly to that described in [AD2]. Accordingly, any data or configuration files which are in the formats given in [AD2] will be imported correctly. The schema in Figure 8 pertains to the configuration and test data for a WCA, as described in this document.
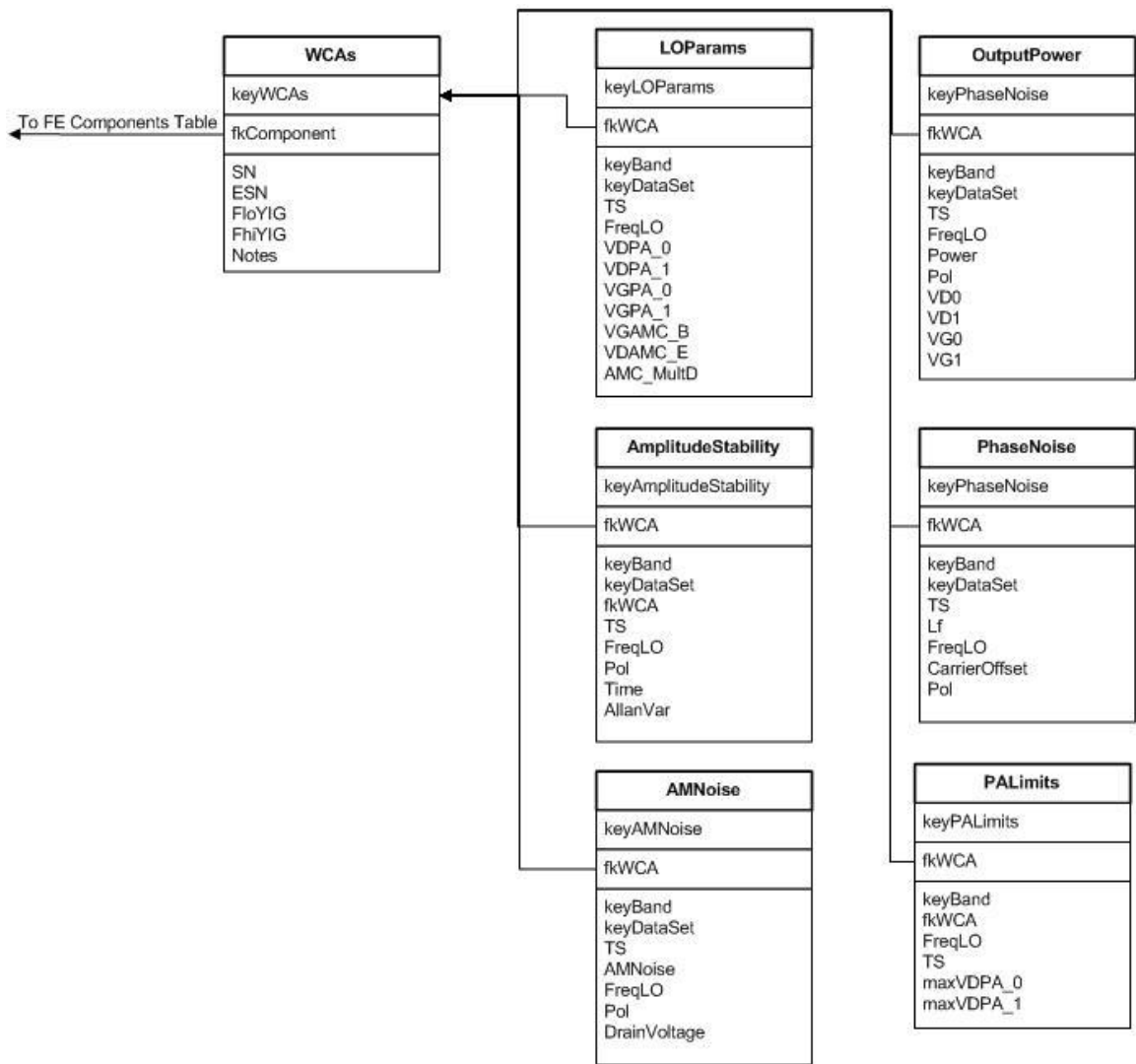
Figure 7- WCA Portion of Database Schema