



**ALMA Project  
First Local Oscillator Driver  
For Band 6 – Technical  
Specifications**

Doc #: FEND-40.10.06.00-001-C-SPE  
Date: 2008-04-28  
Status: (Released)  
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## **First Local Oscillator Driver for Band 6 Technical Specifications**

FEND-40.10.06.00-001-C-SPE

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<b>Prepared By: Name(s) and Signature(s)</b>	<b>Organization</b>	<b>Date</b>
K. S. Saini E. W. Bryerton D. L. Thacker	NRAO NRAO NRAO	2008-04-28
<b>Approved By: Name and Signature</b>	<b>Organization</b>	<b>Date</b>
D. L. Thacker	NRAO	
J. Effland	NRAO	
<b>Approved By FE System Engineer Name and Signature</b>	<b>Organization</b>	<b>Date</b>
K. S. Saini	NRAO	
H. Rudolf	ESO	
<b>Approved By FE IPT Leads Name and Signature</b>	<b>Organization</b>	<b>Date</b>
G. H. Tan	ESO	
J. Webber	NRAO	
<b>Released By JAO Name and Signature</b>	<b>Organization</b>	<b>Date</b>
R. Murowinski	JAO	

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## Change Record

Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A01	2004-12-27	All	–	Initial draft based on the corresponding Band 3 document.
A02	2005-04-08	All	–	Saini – Modified based on comments received for the corresponding Band 9 document. Eric updated Figure-1.
A03	2006-06-28	4.1	–	Saini – Updated the frequency range. Revised spurious specifications. Other minor editorial changes.
A04	2006-07-14	4.2	–	EWB – Updated output power range.
B01	2006-07-21	None	–	Saini – Rev A03 should really have been called Version B, since everybody signed off on Rev A02 which became the final Rev A document.
C01	2008-04-16	1.3, 1.4, 4.3, 4.5, 4.6, 4.9	ALMA-40.10.00.00-088-A-CRE and others	Saini – Reconciled with the FE System Specifications based on the new “Rev B” ALMA Tech Specs. Applied changes arising out of various ALMA CREs
C02	2008-04-28	3.6.1.3, 3.6.1.4, 3.6.1.5, 3.6.2.3, 3.6.2.9, 4.6	–	Saini – Corrections


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# 1 Introduction

	<b>ALMA Project</b> <b>First Local Oscillator Driver</b> <b>For Band 6 – Technical</b> <b>Specifications</b>	Doc #: FEND-40.10.06.00-001-C-SPE Date: 2008-04-28 Status: (Released) Page: Page 6 of 18
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The Atacama Large Millimeter Array (ALMA) is an international astronomy facility. ALMA is an equal partnership between Europe and North America, in cooperation with the Republic of Chile, and is funded in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC), and in Europe by the European Southern Observatory (ESO) and Spain. ALMA construction and operations are led on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI) under a cooperative agreement with the NSF, and on behalf of Europe by ESO.

The North American ALMA Project Office (NAAPO) is responsible for the delivery of North American work-packages to the ALMA project. Within the NRAO, the North American Front-end Group (NAFEG) is responsible for the delivery of the Band 6 local oscillator driver to the NAAPO.

ALMA will be located in the Altiplano of northern Chile at an elevation of 5000 meters above sea level. The ALMA site is the highest, permanent, astronomical observing site in the world. On this remote site super-conducting receivers that are cryogenically cooled to less than 4 degrees above absolute zero will operate on each the 64 12-meter diameter antennas.

The Band 6 local oscillator driver provides local oscillator power for the Band 6 cartridge and is comprised of the following components integrated into an assembly: YIG tuned oscillator, integrated active multiplier chain, phase lock module, monitor and control/power module, support structure, waveguides and wiring harness.

### 1.1 Purpose

This document details the specifications and requirements for the ALMA Band 6 first local oscillator driver.

### 1.2 Scope

This document is applicable to the following Level-3 work elements:

WBS#	Work Element Name
4.145.1106	Band 6 local oscillator driver
4.145.1100	Pre-prototype and prototype local oscillator chains


The following product tree items are covered by this document:

40.11.06.00 Band 6 Warm cartridge assembly

40.10.06.00 Band 6 first local oscillator

The product tree is described in [RD2].

Note that the scope of this document does not extend to the local oscillator reference photo-mixer or its bias supply or to the cold multiplier.

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### 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.

Reference	Document Title	ALMA Doc. Number
[AD1]	ICD: Band 6 cartridge – Band 6 local oscillator driver	<a href="#">FEND-40.02.06.00-40.10.06.00-C-ICD</a>
[AD2]	ICD: WCA connector plate and FE-WCA Harness Plate	<a href="#">FEND-40.11.00.00-40.04.00.00-A-ICD</a>
[AD3]	ICD: Front-end assembly monitor and control – First local oscillator	<a href="#">FEND-40.04.03.03-007-A-DSN</a>
[AD4]	ICD: Front-end first local oscillator – Back End LO and time reference	<a href="#">ALMA-40.10.00.00-50.03.00.00-A-ICD</a>
[AD5]	ICD: Cartridges – Warm cartridge assembly	<a href="#">FEND-40.02.00.00-40.11.00.00-A-ICD</a>
[AD6]	ALMA System: Electromagnetic Compatibility Requirements	<a href="#">ALMA-80.05.01.00-001-B-SPE</a>
[AD7]	ALMA Environmental Specification	<a href="#">ALMA-80.05.02.00-001-B-SPE</a>

In the event of a conflict between the applicable documents mentioned above and the contents of this specifications and requirements document, the contents of this document shall take precedence.

### 1.4 Reference documents


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

Reference	Document Title	ALMA Doc. Number
[RD1]	First local oscillator driver for Band 6 – Statement of Work	FEND-40.10.06.00-002-A-SOW
[RD2]	ALMA Product Tree	<a href="#">ALMA-80.03.00.00-001-M-LIS</a>

### 1.5 Acronyms

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

<b>ALMA</b>	<u>A</u> tacama <u>L</u> arge <u>M</u> illimeter <u>A</u> rray
<b>AM</b>	<u>A</u> mplitude <u>M</u> odulation
<b>AMC</b>	<u>A</u> ctive <u>M</u> ultiplier <u>C</u> hain
<b>CDR</b>	<u>C</u> ritical <u>D</u> esign <u>R</u> evue
<b>EMC</b>	<u>E</u> lectromagnetic <u>C</u> ompatibility
<b>ESO</b>	<u>E</u> uropean <u>S</u> outhern <u>O</u> bservatory
<b>FE</b>	<u>F</u> ront- <u>E</u> nd

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<b>FLOOG</b>	<u>F</u> irst <u>L</u> ocal <u>O</u> scillator <u>O</u> ffset <u>G</u> enerator
<b>ICD</b>	<u>I</u> nterface <u>C</u> ontrol <u>D</u> ocument
<b>IF</b>	<u>I</u> ntermediate <u>F</u> requency
<b>IPT</b>	<u>I</u> ntegrated <u>P</u> roduct <u>T</u> eam
<b>LO</b>	<u>L</u> ocal <u>O</u> scillator
<b>M&amp;C</b>	<u>M</u> onitor & <u>C</u> ontrol
<b>MMIC</b>	<u>M</u> onolithic <u>M</u> icrowave <u>I</u> ntegrated <u>C</u> ircuit
<b>MTTF</b>	<u>M</u> ean <u>T</u> ime <u>T</u> o <u>F</u> ailures
<b>NAAPO</b>	<u>N</u> orth <u>A</u> merican <u>A</u> LM <u>A</u> <u>P</u> roject <u>O</u> ffice
<b>NAFEG</b>	<u>N</u> orth <u>A</u> merican <u>F</u> ront-end <u>G</u> roup
<b>NRAO</b>	<u>N</u> ational <u>R</u> adio <u>A</u> stronomy <u>O</u> bservatory
<b>PA</b>	<u>P</u> ower <u>A</u> mplifier
<b>PDR</b>	<u>P</u> reliminary <u>D</u> esign <u>R</u> evue
<b>PLL</b>	<u>P</u> hase <u>L</u> ocked <u>L</u> oop
<b>RF</b>	<u>R</u> adio <u>F</u> requency
<b>WCA</b>	<u>W</u> arm <u>C</u> artridge <u>A</u> ssembly
<b>YTO</b>	<u>Y</u> IG <u>T</u> uned <u>O</u> scillator

## 1.6 Verb Convention

"Shall" and "must" are used when a specification or provision is mandatory. The verbs "should" and "may" indicate a specification or provision that is discretionary.

## 1.7 Requirements numbering

The requirements are numbered according to the following code:

**[FEND-40.10.06.00-XXXXX-YY / Z]**

Where:

**FEND-40.10.06.00** identifies the 'Front-end /Local oscillator/Band 6' as in [AD1];

**XXXXX** is a consecutive number 00010, 00020, ... (the nine intermediate numbers remaining available for future revisions of this document);

**YY** describes the requirement revision. It starts with 00 and is incremented by one with every requirement revision;

**Z** describes the requirement verification method(s), where T stands for Test, I for Inspection, R for Revue of design and A for Analysis. Multiple verification methods are allowed.

Details of the verification methods are contained in the Band 6 local oscillator driver acceptance test plan.

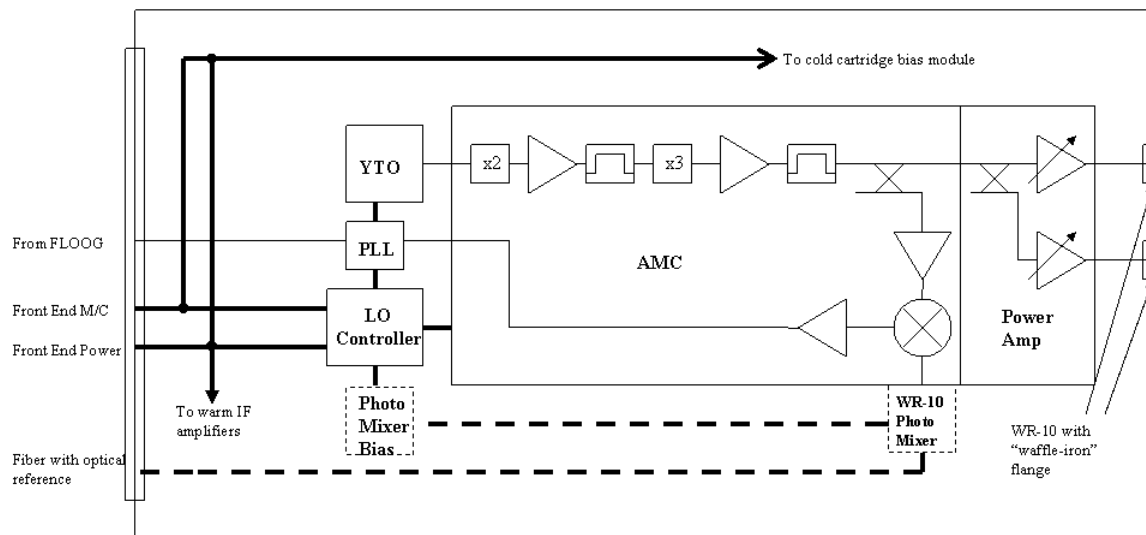
## 2 Description

### 2.1 Equipment Definition

The Band 6 first local oscillator driver components that were mentioned in the introduction are located within the Band 6 warm cartridge assembly (WCA) that bolts directly onto the bottom of




## 2.2 Block Diagram



**Figure 1**  
**Block diagram for the Band 6 First LO driver assembly<sup>1</sup>.**

<sup>1</sup> Back-end components essential to the operation of the ALMA system but not covered by this document are shown with dotted lines.

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### 3 General Requirements

#### 3.1 Operation modes

The Band 6 local oscillator driver will be used in the following modes.

##### 3.1.1 Operational

[FEND-40.10.06.00-00010-00 / I]

This mode applies during normal observations with the front-end sub-system. In this mode, all the specifications and requirements described in this document apply.

##### 3.1.2 Non-Operational

[FEND-40.10.06.00-00020-00 / I]

This mode applies when electrical power is not applied to the Band 6 local oscillator driver.

##### 3.1.3 Stand-by

[FEND-40.10.06.00-00030-00 / I]

This mode applies when electrical power is applied to the Band 6 local oscillator driver but the optical and FLOOG reference signal levels are not at their nominal values.

##### 3.1.4 Transport with the antenna or service vehicle

[FEND-40.10.06.00-00040-00 / I]

This mode applies when the Band 6 local oscillator driver, integrated into the front-end sub-system, is transported with the antenna on the antenna transport vehicle or in the front-end service vehicle.

#### 3.2 Compatibility with the ALMA front-end sub-system

[FEND-40.10.06.00-00050-00 / I]


The Band 6 local oscillator driver design shall be compatible with other parts of the ALMA front-end sub-system. Details are given in the applicable ICDs [AD1 – AD5].

#### 3.3 Design for production

##### 3.3.1 Technology

[FEND-40.10.06.00-00060-00 / R]

The Band 6 local oscillator driver design should use mature technologies whenever possible.

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### 3.3.2 Series production

[FEND-40.10.06.00-00070-00 / R]

The Band 6 local oscillator driver design should be compatible with low production and assembly costs. The design should be as simple as possible.

### 3.3.3 Standard parts

[FEND-40.10.06.00-00080-00 / R]

Standard, unmodified commercially available components should be used in the Band 6 local oscillator driver whenever possible.

## 3.4 Mechanical tuning

[FEND-40.10.06.00-0090-00 / R]

Operation of the Band 6 local oscillator driver shall not require the use of mechanical tuners.

## 3.5 Metric dimensioning

[FEND-40.10.06.00-00100-00 / R]

In general, metric dimensioning shall be used in the Band 6 local oscillator driver. This includes items such as fasteners and tapped holes. However the internal details of components may use imperial dimensioning and fasteners. Standard wave-guide flanges (using imperial dimensions) may be used.

## 3.6 Monitor and control

### 3.6.1 Remotely controlled functions

It shall be possible to control the following functions of the Band 6 local oscillator driver via the front-end local oscillator monitor and control system:

#### 3.6.1.1 Set frequency

[FEND-40.10.06.00-00110-00 / T]

This control shall be executed via digital control bits to set the coarse tune coil on the YTO. See [AD3].


#### 3.6.1.2 Sweep to acquire lock

[FEND-40.10.06.00-00120-00 / T]

This shall be a software function based on other remotely executable functions as described in [AD3].

#### 3.6.1.3 Set PLL IF attenuators

[FEND-40.10.06.00-00130-00 / T]

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This control shall be executed via digital control bits to set the programmable attenuator. See [AD3]. These control points are not applicable to the LO drivers incorporating the “digital” PLL circuitry as well as the integrated M&C and “digital” PLL circuitry.

#### **3.6.1.4 Set Loop Gain**

[FEND-40.10.06.00-00132-00 / T]

This control shall be executed via digital control bits to set the appropriate loop gain depending on the multiplication factor in the AMC of the band selected. See [AD3]. This is only applicable to the LO drivers incorporating the “digital” PLL circuitry as well as the integrated M&C and “digital” PLL circuitry.

#### **3.6.1.5 Zero Integrator**

[FEND-40.10.06.00-00134-00 / T]

This control shall be executed via digital control bit to open the loop and dump/zero the loop filter. See [AD3]. This is only applicable to the LO drivers incorporating the “digital” PLL circuitry as well as the integrated M&C and “digital” PLL circuitry.

#### **3.6.1.6 Set power level**

[FEND-40.10.06.00-00140-00 / T]

This output power level shall be adjusted by programming the driver amplifier drain bias voltages in the power amplifier sub-assembly.

### **3.6.2 Operating parameters to be monitored**

The following operating parameters of the Band 6 local oscillator driver shall be monitored via the front-end local oscillator monitor and control system:

#### **3.6.2.1 PLL IF power**


[FEND-40.10.06.00-00150-00 / T]

This shall be derived from the output voltage level of the IF total power detector. The detected voltage, suitably amplified and buffered, shall be available to the front-end first local oscillator monitor and control system as an analog monitor point. See [AD3]. This monitored value will be used in conjunction with the quadrature phase detector voltage to assess whether the PLL is locked to the reference signals.

#### **3.6.2.2 PLL reference signal power**

[FEND-40.10.06.00-00160-00 / T]

This shall be derived from the output voltage level of the FLOOG total power detector. The detected voltage, suitably amplified and buffered, shall be available to the front-end first local oscillator monitor and control system as an analog monitor point. See [AD3].

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### **3.6.2.3 PLL +5 V power**

[FEND-40.10.06.00-00170-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3]. This monitor point is not applicable to the LO drivers incorporating the integrated M&C and “digital” PLL circuitry.

### **3.6.2.4 PLL temperature**

[FEND-40.10.06.00-00180-00 / T]

The buffered sensor voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.5 AMC amplifier gate and drain voltages**

[FEND-40.10.06.00-00190-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.6 AMC amplifier drain currents**

[FEND-40.10.06.00-00200-00 / T]

This shall be calculated from measurements of the voltage drop across a known resistor inserted in series. The voltage shall be monitored as an analog monitor point.

### **3.6.2.7 AMC tripler bias voltage**

[FEND-40.10.06.00-00210-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.8 AMC +5 V**

[FEND-40.10.06.00-00220-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.9 AMC -3 V**

[FEND-40.10.06.00-00225-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3]. This monitor point is not applicable to the LO drivers incorporating the integrated M&C and “digital” PLL circuitry.

### **3.6.2.10 PLL correction voltage**


[FEND-40.10.06.00-00230-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.11 Quadrature phase detector voltage**

[FEND-40.10.06.00-00240-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3]. This monitor point is not applicable to the LO drivers incorporating the “digital” PLL circuitry.

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### **3.6.2.12 PA -3 V**

[FEND-40.10.06.00-00250-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.13 PA +5 V**

[FEND-40.10.06.00-00260-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.14 PA gate and drain voltages**

[FEND-40.10.06.00-00270-00 / T]

This voltage shall be monitored as an analog monitor point. See [AD3].

### **3.6.2.15 PA drain currents**

[FEND-40.10.06.00-00280-00 / T]

This shall be calculated from measurements of the voltage drop across a known resistor inserted in series. The voltage shall be monitored as an analog monitor point.

## **3.7 Channels**

[FEND-40.10.06.00-00290-00 / R]

The Band 6 local oscillator driver shall service both Band 6 channels.

## **3.8 Mass**

[FEND-40.10.06.00-00300-00 / T]

The mass of all Band 6 local oscillator driver components and their support structure shall not exceed 5 kg. Details can be found in the applicable Interface Control Document [AD1].

## **3.9 Eigen-frequency**

[FEND-40.10.06.00-00310-00 / A]

The Band 6 local oscillator driver assembly shall have a first eigen-frequency of 70 Hz or greater.

## **3.10 Volume**


[FEND-40.10.06.00-00320-00 / I]

The Band 6 local oscillator driver components described in section 2.1 shall be contained within a volume of Ø140 mm x 400 mm, measured from the cartridge 300K plate to the top of the WCA assembly. Note that this does not include the harness plate or allowance for cable clearance. Further details can be found in the applicable Interface Control Document [AD5].

## **3.11 Orientation**

[FEND-40.10.06.00-00330-00 / A, R, T]

The Band 6 local oscillator driver shall meet all performance requirements over a range of gravity vectors from 0 to 90 degrees. This rotation occurs about the axis of the antenna elevation-bearing.

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### 3.12 Thermal Load

[FEND-40.10.06.00-00340-00 / A]

During operation the maximum allowable thermal load imposed on the cryostat by the local oscillator driver during operation or stand-by is detailed in [AD5].

### 3.13 First local oscillator reference signal requirements

[FEND-40.10.06.00-00350-00 / R]

Details can be found in the applicable Interface Control Document [AD4].

### 3.14 DC Power requirements

[FEND-40.10.06.00-00360-00 / R]

Details can be found in the applicable Interface Control Document [AD2].

### 3.15 Connectors and RF ports

#### 3.15.1 First local oscillator reference input port

[FEND-40.10.06.00-00370-00 / R, I]

The LO reference input port shall be rectangular waveguide.

Details can be found in the applicable Interface Control Document [AD4].

#### 3.15.2 First local oscillator driver output RF ports

[FEND-40.10.06.00-00380-00 / R, I]

Both RF output ports shall be waveguide, the flanges being UG-387 modified to include a non-contacting design. Details can be found in the applicable Interface Control Document [AD5].

#### 3.15.3 First local oscillator offset generator input port

[FEND-40.10.06.00-00390-00 / R, I]

Details can be found in the applicable Interface Control Document [AD4].

#### 3.15.3 DC bias connectors

[FEND-40.10.06.00-00400-00 / R, I]


Details for the bias connector(s) can be found in the applicable Interface Control Document [AD2].

## 4 Performance requirements

### 4.1 Output tuning range

[FEND-40.02.07.00-00410-00 / T]

The Band 6 local oscillator driver output shall tune from a frequency of 73.7 to 88.3 GHz inclusive.

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## 4.2 Output power

[FEND-40.10.06.00-00420-00 / T]

At all frequencies specified in section 4.1, the output power of either channel shall be adjustable from 5 mW to 20 mW in less than 0.5 dB steps.

## 4.3 Stability of output power

[FEND-40.10.06.00-00430-00 / T]

The Allan variance,  $\sigma^2(2, T, 0.9 \cdot T)$ , of the Band 3 first local oscillator output power shall be less than  $9.0 \times 10^{-8}$  for  $0.05 \text{ s} \leq T \leq 100 \text{ s}$  and less than  $1.0 \times 10^{-6}$  for  $T = 300 \text{ s}$ .

## 4.4 Sideband noise

[FEND-40.10.06.00-00440-00 / T]

The AM sideband noise on the output signal of the Band 6 local oscillator driver shall not exceed 10K/ $\mu$ W of power absorbed in the SIS device(s).

## 4.5 Phase stability

[FEND-40.10.06.00-00460-00 / A, R, T]

The short term phase stability ( $T < 1 \text{ s}$ ) of the phase locked Band 3 first local oscillator output signal shall be less than 38 fs. The long-term phase stability ( $20 \text{ s} \leq T \leq 300 \text{ s}$ ) shall be less than 12.5 fs. The long term phase stability (delay drift) requirement refers to the 2-point standard deviation with a fixed averaging time,  $\tau$ , of 10 seconds and intervals,  $T$ , between 20 and 300 seconds. Note that these specifications apply to the first local oscillator alone and do not include a contribution from the reference signal.

## 4.6 Spurious signals

[FEND-40.10.06.00-00470-00 / R, T]

Spurious Signals (coherent or incoherent) on the outputs of the LO drivers in the WCAs shall be  $< -40 \text{ dBc}$  over the range of offset frequencies from the carrier from 500 Hz to 500 kHz and  $< -50 \text{ dBc}$  from 500 kHz to 12 GHz. The components harmonically related to the YTO frequency shall not exceed -20 dBc.

## 4.7 Stabilization time

### 4.9.1 Stabilization time from non-operational mode

[FEND-40.10.06.00-00480-00 / T]


The transition from the non-operational to the operational mode shall take no longer than 15 minutes.

### 4.9.2 Stabilization time from stand-by mode

[FEND-40.10.06.00-00490-00 / T]

The transition from the stand-by mode to the operational mode shall take no longer than 1.5 seconds.



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#### **4.8 Phase locking**

[FEND-40.10.06.00-00500-00 / T]

The Band 6 first local oscillator driver shall reliably phase lock within 1 second to the first local oscillator reference signal over the tuning range and output power as specified in sections 4.1 and 4.2, and without phase ambiguity in any of the LO outputs.

#### **4.9 Time to phase-switch**

[FEND-40.10.06.00-00505-00 / R, T]

The Band 6 first local oscillator hardware shall be designed so that it could be configured to phase-switch ( $90^\circ$  or  $180^\circ$ ) and reach within  $60^\circ$  of the final phase in 1  $\mu\text{s}$ .

#### **4.10 Time for frequency-switching**

[FEND-40.10.06.00-00506-00 / R, T]

The Band 6 first local oscillator driver hardware shall be designed so that it could be configured to track frequency changes resulting from a frequency sweep of the FLOOG signal or the reference laser signals of 25 MHz within 10 ms.

#### **4.11 Isolation between channels**

[FEND-40.10.06.00-00507-00 / R, A]

The isolation between the two channels of the Band 6 first local oscillator driver shall be better than 10 dB.

### **5 Operating Conditions**

#### **5.1 Thermal Environment**

[FEND-40.10.06.00-00510-00 / A, R, T]

(Note that this subsection only applies to the operational mode.)

The Band 6 local oscillator driver shall meet its performance requirements with an air flow of  $15 \text{ l s}^{-1}$  or greater across the unit, in a thermal environment whose temperature is maintained in the  $16 - 22^\circ\text{C}$  range and in which the maximum temperature variation is  $1^\circ\text{C}$  in one hour.

#### **5.2 Vibration**

[FEND-40.10.06.00-00520-00 / R, T]


The Band 6 local oscillator driver must survive vibration levels as specified in Appendix 1 of [AD7]. The vertical direction is defined as being perpendicular to the 300 K plate at the bottom of the cryostat.

#### **5.3 Acceleration**

[FEND-40.10.06.00-00530-00 / R, T]

The Band 6 local oscillator driver must survive the following:

- 3 g shock load in the vertical direction.
- 2 g shock load in the horizontal direction.

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The vertical direction is defined as being perpendicular to the 300 K plate at the bottom of the cryostat.

#### **5.4 Storage and shipping**

[FEND-40.10.06.00-00540-00 / R]

(Note that this section only applies to the storage mode)

The Band 6 local oscillator driver must comply with [AD7].

#### **5.5 Electro-Magnetic Compatibility**

[FEND-40.10.06.00-00550-00 / R]

The Band 6 local oscillator driver must comply with [AD6].

### **6 Reliability Requirements**

#### **6.1 Continuous operation**

[FEND-40.10.06.00-00560-00 / R]

The Band 6 local oscillator driver shall be designed for continuous use.

#### **6.2 Mean time to failure**

[FEND-40.10.06.00-00570-00 / A]

The calculated MTTF of the Band 6 local oscillator driver shall exceed 5 years.

#### **6.3 Mean time to repair**

[FEND-40.10.06.00-00580-00 / A]

At the ALMA operational support facility the mean time to repair of the Band 6 local oscillator driver shall be less than eight hours.

#### **6.4 Lifetime**

[FEND-40.10.06.00-00590-00 / R]

The Band 6 local oscillator driver shall have a minimum lifetime of 15 years.