

# Atacama Large Millimeter Array

## Interface Control Document

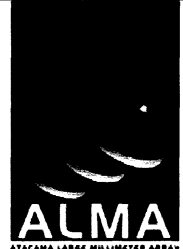
*between Cartridges  
and Warm Cartridge Assembly*

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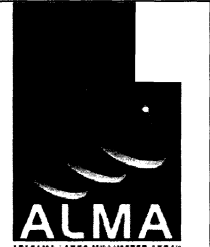
2004-10-07

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### Change Record

Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A	2004-10-07	All	None	First issue

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## 1 Description

### 1.1 Purpose

This document specifies the mechanical and thermal interfaces between the cold cartridges and the Warm Cartridge Assembly (WCA).

### 1.2 Items remaining “To Be Determined”

The following are items to be determined for this ICD:

- The thermal environment of the Warm Cartridge Assembly shall be such that the warm IF amplifiers are maintained at a constant temperature within  $\pm 20$  mK over a 1 second interval (TBC).


### 1.3 Scope

The cartridge to WCA interface includes the following:

1. Mechanical interface between the 300K cartridge base plate and the frame of the WCA,
2. mechanical interfaces between the first LO waveguides located in the WCA and the waveguides located on the 300K cartridge base plate,
3. mechanical interface of coax between cold cartridge and warm IF amps,
4. mechanical interface of coax between harness plate and warm IF amps,
5. mounting details for warm IF amps,
6. mechanical interface of WCA to mixer bias module, and
7. thermal interfaces for the WCA to cartridge base plate and WCA to warm IF amplifiers.

These interface specifications are all included in this ICD. The same WCA frame is used for both the 140-mm diameter and 170-mm diameter cartridges, therefore the interface specifications are identical for all cartridges unless otherwise noted.

The bias module is a separate deliverable item and mates independently to the cold cartridge. Therefore, it has a separate interface, specified in the individual cartridge to bias module ICDs. The electrical specification for the IF signals, as they leave the warm cartridge assembly, are given in the individual cartridge to IF Switch ICDs. Likewise, the electrical interfaces for the LO signals in the WCA waveguides are specified in the individual cartridge to first LO ICDs.

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## 2 Related Documents and Drawings

### 2.1 Applicable documents and drawings

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

<i>Ref</i>	<i>Document title</i>	<i>Document ID</i>
[AD1]	ALMA System: Electromagnetic Compatibility (EMC) Requirements	ALMA-80.05.01.00-001-B-SPE

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

### 2.2 References


The following documents contain additional information and are referenced in this document. The following documents are for reference only. Locations and tolerances specified in this document take precedence over any reference documents. For future modifications of this ICD, the source drawings for the figures in this ICD are located in ALMAEDM in the Front End workspace under Documentation/40.11 Warm Cartridge Assembly.

<i>Ref.</i>	<i>Document title</i>	<i>Document ID</i>
[RD1]	ALMA Project Book	
[RD2]	ALMA Product Tree	ALMA-80.03.00.00.001-M-LIS
[RD3]	WCA Frame Assembly	FEND-40.10.00.00-019-A-DWG
[RD4]	WCA PLL mounting Base Plate	FEND-40.10.05.00-019-A-DWG

### 2.3 Abbreviations and Acronyms

A limited set of basic acronyms used in this document is given below.

ALMA- Atacama Large Millimetre Array  
 DSB - Double Side Band  
 ICD - Interface Control Document  
 IF - Intermediate Frequency  
 IO - Input / Output  
 LO - Local Oscillator  
 LSB - Lower Side Band  
 M&C - Monitor and Control  
 NRAO - National Radio Astronomy Observatory

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OVC - Outer vacuum container  
SIS - Superconductor-Insulator-Superconductor  
SSB - Single Side Band  
TBD - To be determined  
USB - Upper Side Band  
VSWR-Voltage Standing Wave Ratio  
WCA - Warm Cartridge Assembly  
2SB - Side Band Separating

### **3 Mechanical Interfaces**

#### **3.1 WCA Frame to Cartridge 300K Plate Mechanical Interface**

The Warm Cartridge Assembly framework, housing parts of the first LO and IF subsystems, is detailed in [RD3]. Fig. 1 shows an exploded rendering of the WCA, the 300K cartridge base plate, the cartridge bias module, and the harness plate which provides the bias, M&C, and IF connections between the WCA and the Front End auxiliary electronics. The WCA is attached to the 300 K cartridge base plate using three M6 x 16 mm screws and three Ø6 mm dowel alignment pins, as shown in Fig. 3. The same WCA frame is used for both sizes of cartridges. The WCA to cartridge interface is fully contained within the 144-mm diameter bolt circle, as shown in Fig. 3.

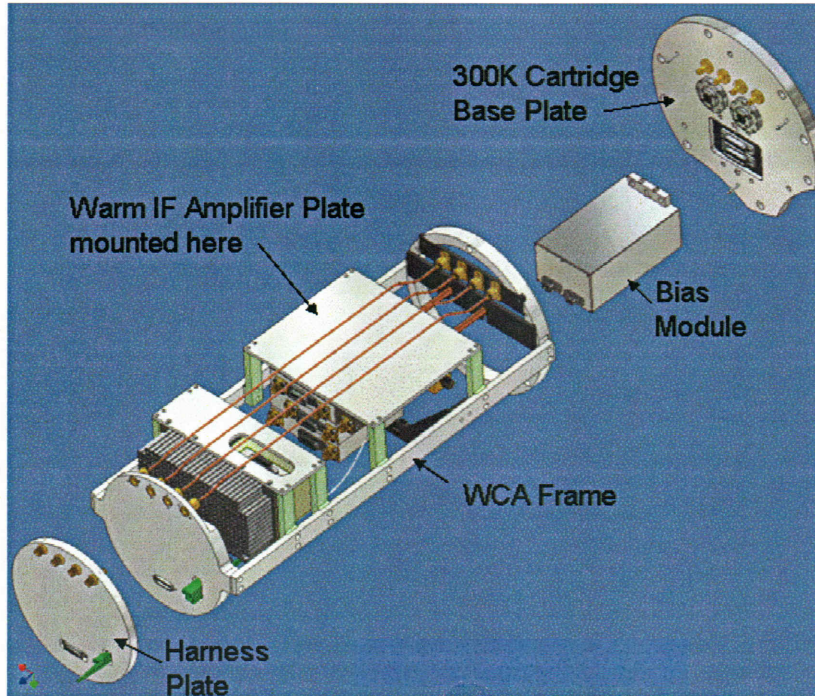



Figure 1: Exploded rendering of warm cartridge assembly (WCA), harness plate, bias module, and 300K cartridge base plate.

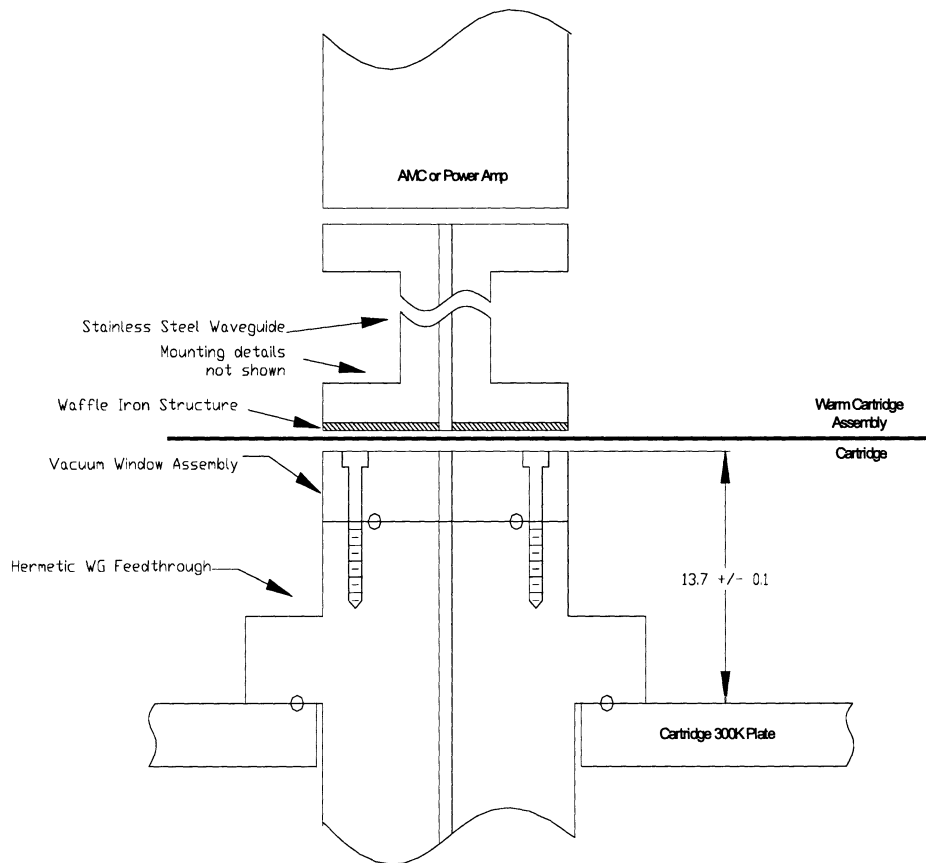
### 3.2 WCA First LO Waveguide to Cartridge Waveguide Feedthrough Mechanical Interface

The LO signals enter the cartridge through two UG-387 flange waveguide vacuum feedthroughs. The feedthroughs are part of the cold cartridge structure. The Warm Cartridge Assembly shall be removable from the 300 K cartridge base plate without breaking the vacuum seal.

The two LO waveguide connections at the vacuum feedthrough shall be blind mate. The waveguide flanges shall be pinned but not screwed together. Instead, there shall be a pre-loaded pressure fit between the flanges. This approach allows removal of the WCA when all cartridges and their respective WCAs are installed in the OVC. Since imperfections in this waveguide physical interface are unavoidable, this interface shall be designed such that performance specifications will be met without the waveguides being screwed together. As of the writing of this document, this requirement will be met by machining a "waffle-iron" filter into the output waveguide flanges of the Warm Cartridge Assembly to make this interface much less sensitive to waveguide misalignment or cocking. In addition, the input flange of the waveguide feedthrough in the cartridge 300K plate shall

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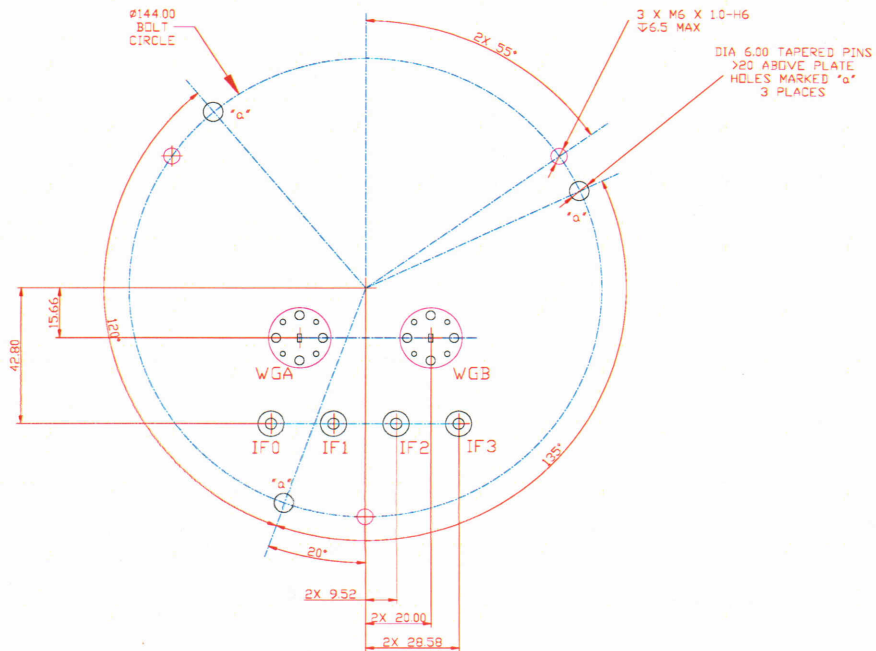
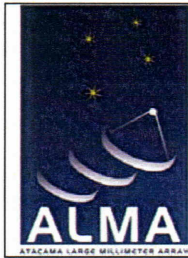
be compatible with standard UG 387/U flanges to allow operation with alternate LO sources for electrical testing.



**Figure 2: Waveguide Interface from WCA to 300K Plate**

The input flange of the waveguide feedthrough will be  $13.7 \pm 0.1$  mm above the ambient side of the cartridge 300K baseplate, as shown in Fig. 2. The orientation of the assembled feedthrough must match the orientation of the waveguides on the warm cartridge assembly, and is shown in Figure 3 below. The location of the input flange of the waveguide feedthrough is specified in Fig. 3. The waveguides corresponding to polarization 0 and 1 are specified in Table 1.






**Figure 3: 300K cartridge base plate. For dowel pin centers, tolerances are true position +/- 0.025 mm. For everything else, tolerances are true position +/- 0.1 mm.**

Connector	Band 3	Band 6	Band 7	Band 9
WGA	Pol 0	Pol 1	Pol 1	Pol 0
WGB	Pol 1	Pol 0	Pol 0	Pol 1
IF0	Pol 0 USB	Pol 0 USB	Pol 0 USB	Pol 0
IF1	Pol 0 LSB	Pol 0 LSB	Pol 0 LSB	Reserved for Pol 0 LSB
IF2	Pol 1 USB	Pol 1 USB	Pol 1 USB	Pol 1
IF3	Pol 1 LSB	Pol 1 LSB	Pol 1 LSB	Reserved for Pol 1 LSB

**Table 1. List of connectors on 300 K cartridge base plate with corresponding polarization and sideband for each band.**

### 3.3 WCA Frame to IF Connectors Mechanical Interface

The four IF signals exit the 300-K cartridge interface via male (plug) blind-mate SMA connectors (Dynawave #1110-2899-6289 Rev AA). The location of the centre of these

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connectors is specified in Fig. 3. The polarization and sideband of each IF connector is specified in Table 1. Mating connectors on the WCA for the 300K cartridge interface shall be female (Jack) connectors (Dynawave # 2962-4121-6256 for RG-141 cable or for RG-085 cable #2962-8521-6256).

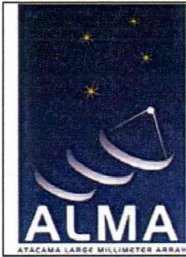
The IF connectors on the WCA at the harness plate interface shall also be female (Jack) connectors. (Dynawave # 2962-4121-6256 for RG-141 cable or for RG-085 cable #2962-8521-6256).

### 3.4 Mounting of Warm IF Amplifiers

The warm IF amplifiers are specified by the cold cartridge manufacturer and will not be delivered with the Warm Cartridge Assembly. These amplifiers will be added by the cold cartridge manufacturer, as well as the coax cables which connect them to the cold cartridge interface and IF switch interface. The wiring for the dc bias of the IF amplifiers will be supplied, however, as part of the WCA wiring harness.

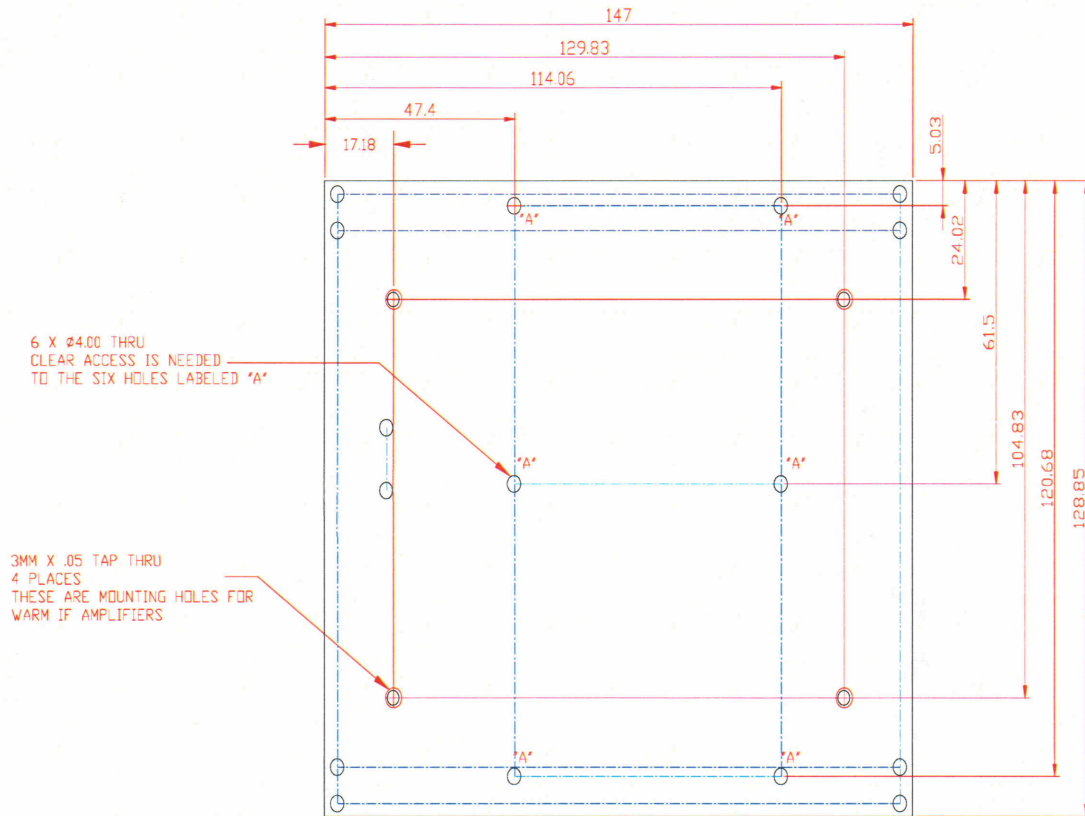
The four warm IF amplifiers shall be mounted to the warm cartridge assembly using a sub-plate. The mounting interface on the warm cartridge assembly is specified in Fig. 4. Clear access is needed to the six M3 socket head PLL mounting screws labelled "A" in Fig. 4 so that the PLL assembly can be removed without disturbing either the warm IF amplifiers or associated coaxial cables. For more details on the PLL mounting plate, see [RD4]. The available volume for the warm IF amplifiers and any heat sinks is represented by the hatched area in Fig. 6.

The volume available for IF cabling between the warm IF amplifiers and 300K base plate and between the warm IF amplifiers and harness plate is specified in Figs. 5-7.

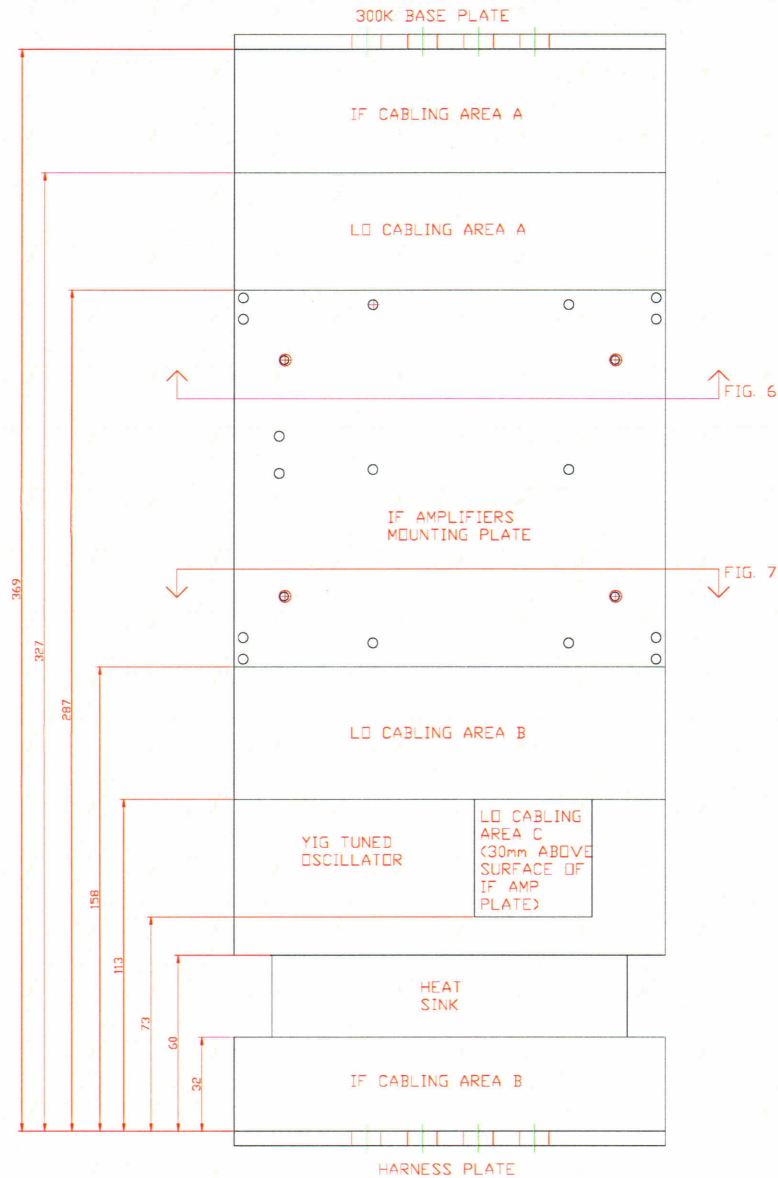
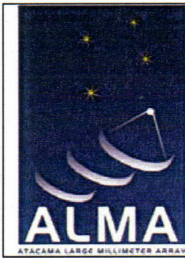


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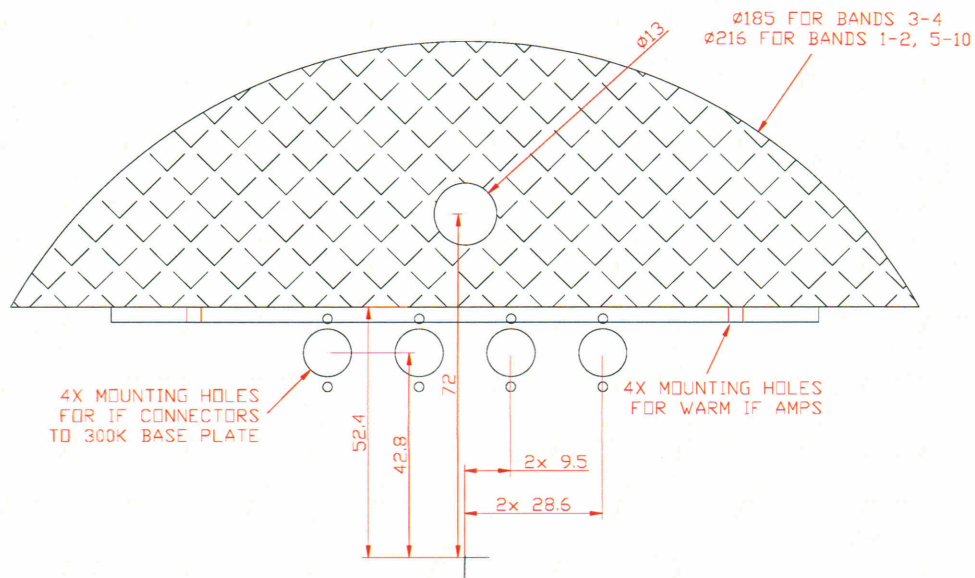
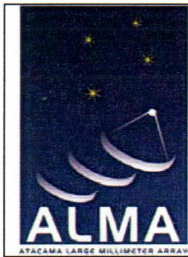
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**Figure 4 Mounting interface for warm IF amplifiers on WCA. M3 socket head screws are used in the holes marked "A" to mount first LO components to the other side of this plate. The four M3 screws used to mount the warm IF amplifiers are allowed to protrude slightly on the other side of the plate.**

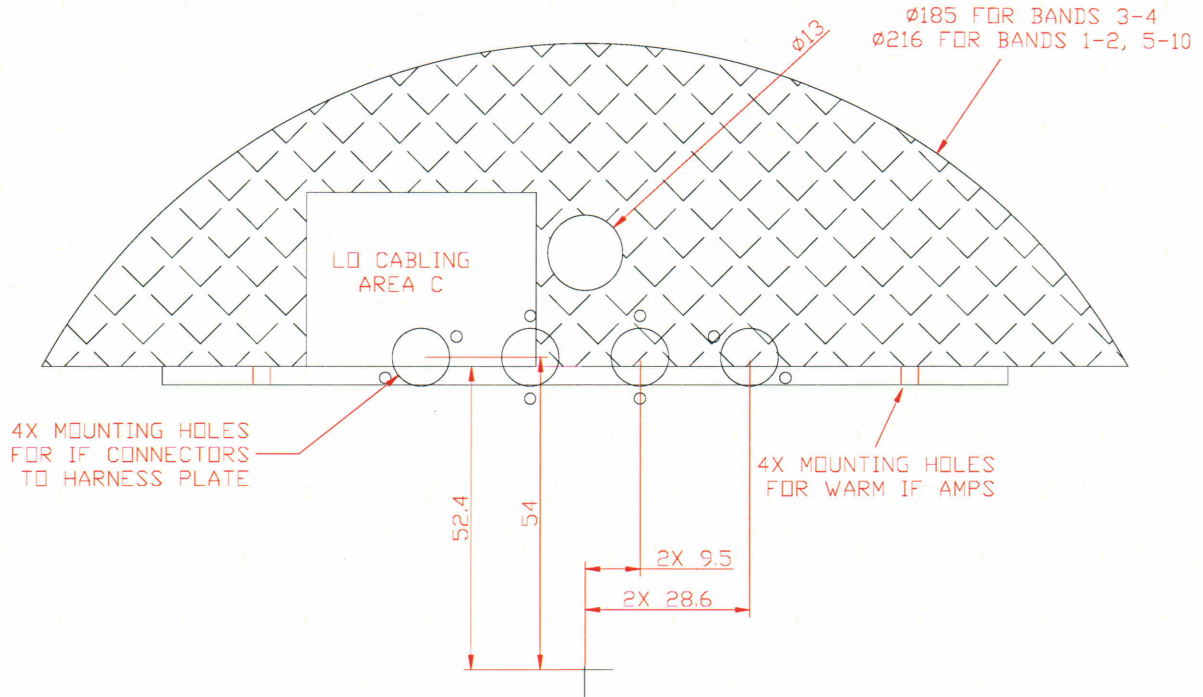
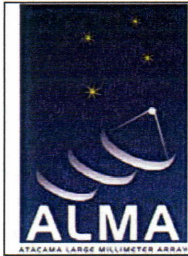


**Figure 5 Sketch of WCA looking down onto IF amplifier mounting plate. In areas labelled “IF Cabling Area A” and “IF Cabling Area B”, IF cabling may be routed below plane of amplifier mounting surface. Everywhere else, IF cables must remain above plane of amplifier mounting surface. IF cabling in area labelled “LO Cabling Area C” must be at least 30 mm above amplifier mounting plane (see Fig. 7)**



**Figure 6** Cross-section of available volume above warm IF amplifier mounting surface looking toward 300K cartridge base plate. 13-mm clearance hole is needed to connect and disconnect WCA from 300 K plate. The location of the four IF connectors to the 300K base plate is also shown. Hatched area is allowed area for IF cabling. IF cabling below the surface of the mounting plate (necessary to mate with connectors on 300K base plate) is allowed only in the areas defined in Fig. 5. Note that available volume is smaller for bands 3-4.





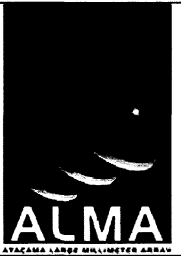
**Figure 7** Cross-section of available volume above warm IF amplifier mounting surface looking toward harness plate (away from dewar). 13-mm clearance hole is needed to connect and disconnect WCA from 300 K plate. The location of the four IF connectors to the harness plate is also shown. Hatched area is allowed area for IF cabling. IF cabling below the surface of the mounting plate is allowed only in the areas defined in Fig. 5. Note that available volume is smaller for bands 3-4.

### 3.5 WCA to Bias Module Mechanical Interface

The bias module is first installed on the 300 K cartridge base plate. Then, when the WCA is connected to the 300 K plate, the WCA wiring harness will blind mate to the bias module connector. The design and integrity of this interface are not the responsibility of the cartridge manufacturer.

## 4 Thermal Interfaces

### 4.1 WCA to 300K Cartridge Base Plate Thermal Interface

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The WCA is mounted and thermally tied to the bottom vacuum flange of the cartridge body, which is at ambient temperature (nominally 300 K). The addition of the WCA shall not raise the nominal temperature of the cold cartridge vacuum flange by more than 10 K under operational conditions.

#### **4.2 Warm IF Amplifier to WCA Frame Thermal Interface**

During operation, each of the four amplifiers shall output no more than 1200 mW of heat. This heat will be conducted into the warm cartridge assembly frame through the amplifier mounting interface.

#### **4.3 Thermal Stability**

The thermal environment of the Warm Cartridge Assembly shall be such that the warm IF amplifier mounting plate is maintained at a constant temperature within  $\pm 20$  mK over a 1 second interval (TBC).