Atacama Large Millimeter Array

ALMA Back End IPT IFDC
Production Bandpass Filter Specification

BEND-52.06.04.00-001-A-SPE

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Change Record

Version	Date	Affected section(s)	ICO #	Reason/Initiation/Remarks
A	2006-02-16	All		Procurement of production filters

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1 PURPOSE

This document defines all specifications of the IF Downconverter replaceable bandpass filter (IFDC BPF). The IFDC BPF is as an anti-aliasing filter whose function is to reduce the presence of aliased signals in the passband to less than or equal to 1% (-20dB). The two folding frequencies are 2 GHz and 4 GHz.

2 SCOPE

This specification establishes the performance, design, manufacture, quality assurance, qualification and acceptance criteria for the Back End IF Downconverter bandpass filter (IFDC BPF). The IFDC BPF shall be referred to herein as the *unit*.

3 APPLICABLE DOCUMENTS

3.1 Compliance Documents

The Vendor shall comply with the requirements of the following documents of the exact issue shown to the extent specified herein. In the event of conflict between the documents listed and the contents of this specification, this specification shall be the superseding document.

BEND-52.05.04.00-001-A-SPE, ALMA Back End IPT IF Downconverter Production Bandpass Filter Statement of Work

3.2 Reference Documents

The following documents are listed as reference documents and shall be used for guidance only. This specification does not require compliance to the requirements of these documents. Vendors should note instances where internal specifications and standards are substituted for these reference documents.

ANSI/ASQC Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes.

4 REQUIREMENTS

4.1 Item Description

The unit shall consist of a bandpass filter. The goal is to cover the maximum bandwidth possible of the 2-4 GHz band while maintaining less than 1% aliased signals from 2 and 4 GHz folding frequencies. Figure 1 illustrates the basic functionality of the bandpass filter.

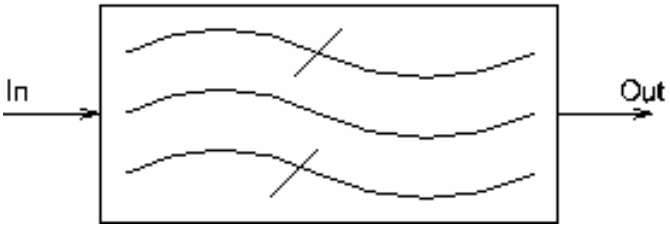

Figure 1: IFDC Bandpass Filter Functional Block Diagram

4.2 Specifications

The following subsections detail the RF, physical, interface, lifetime, environmental and safety specifications that the IFDC Bandpass filter must satisfy.

4.2.1 RF Performance

The folding frequencies of the design are at 2 and 4 GHz. The frequency difference between the equi-ripple pass band frequency (F1) and 2 GHz must be equal to the difference between 2 GHz and the low side -20 dB frequency (FL). The frequency difference between the equi-ripple pass band frequency (F2) and 4 GHz must be equal to the difference between 4 GHz and the high side -20 dB frequency (FH) as illustrated in Figure 2.

The characteristic impedance of all ports shall be 50 ohms.

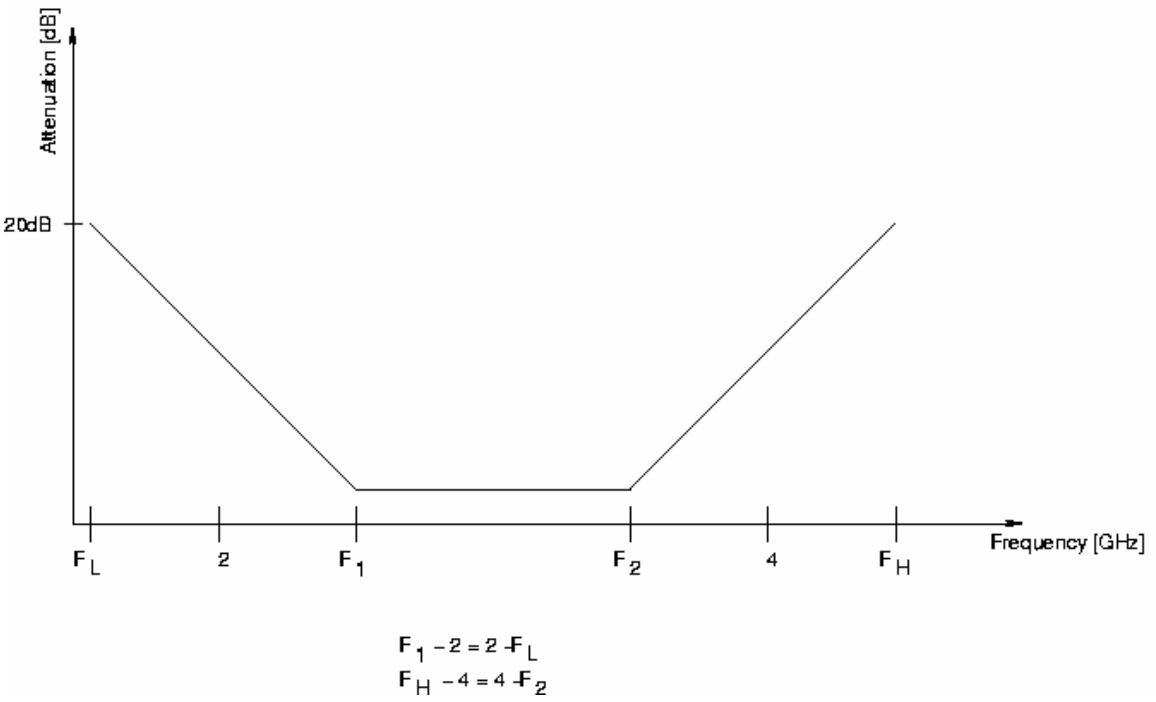

Figure 2: IFDC BPF Filter Mask

Example

If an eight section combline has equi-ripple band edges at 2.13 GHz and 3.95 GHz, then the -20dB frequencies must be >1.87 and <4.05 GHz. The bandwidth is 1820 MHz meeting the minimum bandwidth requirement.

4.2.1.1 Passband Frequency Range

The unit shall operate over the approximate range of 2130 MHz to 3950 MHz.

The filter shall have a minimum bandwidth of 1800 MHz independent of the exact filter band edge frequencies.

The exact filter band edge frequencies shall be proposed by the Vendor. The Vendor shall present the proposed filter band edges to the Buyer for approval.

4.2.1.2 Stop Band

The filter will hold a -40 dB stop band from 5000 MHz to 14000 MHz, minimum.

4.2.1.3 Return Loss

The unit return loss shall be 14 dB minimum over the frequency range defined in Section 4.2.1.1.

4.2.1.4 Phase Matching (Changed 2006-02-16, was 3dB Frequencies)

Filter to filter phase matching is required to within ± 4 degrees over any 1800 MHz of the 2120-3930 MHz equi-ripple band (Vendor to specify the 1800 MHz).

Phase matching is for room ambient temperature only and DOES NOT have to be guaranteed over the full operating temperature range.

The requirement allows removal of the least squares best fit straight line phase slope across the equi-ripple passband, defined in paragraph 4.2.1. That is, the requirement will be for phase variation after the slope is removed.

A "golden" unit may be kept by the Vendor and used as a reference for matching all the filters to that one. It can be one of the 55 on order now, and can be the last filter delivered on our last production order.

4.2.1.5 Power Handling

The unit shall be capable of receiving an input RF power of +24dBm with no degradation to any performance specification. The unit shall not electrically breakdown (corona discharge) at the specified operating altitude. The unit shall not use hermetic sealing to meet the power handling requirement without the approval of the Buyer.

4.2.1.6 Insertion Loss

The unit insertion loss goal shall be 1.0 dB maximum over the frequency range defined in Section 4.2.1.1. Maximum allowable insertion loss is 0.8 dB {**GOAL**}.

The unit insertion loss variation shall be 0.8 dB maximum over the frequency range defined in Section 4.2.1.1 and under all environmental conditions. Maximum allowable insertion loss variation is 0.6 dB {**GOAL**}.

4.2.2 Lifetime Requirements

4.2.2.1 Reliability

The unit shall have a calculated MTBF of 150,000 hours.

4.2.2.2 Failure Modes and Effects Analysis (FMEA)

The Vendor shall perform a Failure Modes and Effects Analysis (FMEA) and provide the results to the Buyer.

4.2.2.3 Root Cause Analyses

For each device failure within the warranty period, the Vendor shall perform a root cause analysis on the failed unit. The results of the failure analysis shall be provided to the Buyer. For unit failure beyond the warranty period, the Buyer may request a root cause analysis to be performed at the Buyer's expense.

4.2.2.4 Maintainability

The Vendor shall design the unit such that there is no need for scheduled or preventive maintenance.

The Vendor shall identify repair turnaround times for failed units.

4.2.2.5 Operating Life

The unit is used in a large scale scientific application with an expected operational life of 30 years. Vendor should provide feedback in regards to this level of operating life requirement.

4.2.2.6 Storage Life

The unit shall meet the operational life requirements following a storage life of up to three years. The Vendor shall identify any procedures that are necessary to meet this requirement.

4.2.2.7 Age Sensitivity

The Vendor shall identify age sensitive parts including criteria for age sensitivity and procedures for periodic servicing and/or life extension as applicable. Each unit shall include a list of age sensitive items, date of manufacture, and schedule date for maintenance or replacement action.

4.2.3 Interface Definition

The unit shall comply with the following interface definitions.

4.2.3.1 Physical Mounting Interface

The unit shall be capable of being mounted from the top either through the body of the filter itself or through outboard mounting feet with through holes. In either case, the through holes must provide clearance for M2.5 screws. Vendor shall provide an outline drawing.

4.2.3.2 RF Signal Interface

The RF signal interface shall consist of SMA Jack coaxial connectors for the signal input and signal output.

4.2.4 Physical Characteristics

The unit shall meet the following physical requirements.

4.2.4.1 Envelope

The dimensions of the unit shall be 66mm (L) **{GOAL}** x 23mm (W) **{GOAL}** x 18mm (H) **{GOAL}** not including connectors and outboard mounting feet. The Vendor is encouraged to define an envelope size that will result in improved performance and/or reduced cost.

4.2.4.2 Weight

The unit shall have a maximum weight of 250 grams {**GOAL**}.

4.2.4.3 Mounting Surface

The mounting surface of the unit shall be machined with a surface finish of 2µm or better, Mounting surface scratches equal to or less than 0.15mm deep are acceptable with the provision that no material protrude outward from the mounting surface (in order to maintain baseplate flatness). The unit mounting surface shall be flat within 0.05mm.

4.2.5 Environmental Conditions

The unit shall meet the requirements of this specification during and after exposure to any combination of the following environments.

4.2.5.1 Temperature

4.2.5.1.1 Operating Range

The unit shall meet all performance requirements of this specification when operating over the temperature range of 0°C minimum to +65° maximum.

4.2.5.1.2 Stability

The filter shall be designed to minimize frequency drift with temperature variation. The maximum allowable temperature drift is 12 ppm/°C over the operating temperature range. The maximum allowable temperature drift is 10 ppm/°C {**GOAL**}.

4.2.5.1.3 Storage Range

The unit shall be capable of meeting all performance requirements of this specification after it has been stored for extended periods of time over the temperature range of -40°C minimum to +75° maximum.

4.2.5.2 Altitude

The unit shall be capable of meeting all performance requirements when operating from sea level barometric pressure level through to the barometric pressure level of approximately 5000 m (on average, 557 mb ±3 mb).

4.2.5.3 Acceleration

The unit shall be capable of meeting all performance requirements after being exposed to a constant acceleration of 1 G around any axis.

4.2.5.4 Humidity

The unit shall be capable of meeting all performance requirements when the relative humidity (RH) is in the range of 1% to 95%. Vendor shall inform Buyer if the unit has any sensitivity to extremely low RH levels.

4.3 Design and Construction

The design process shall consider material, tolerancing, processes, methods, and techniques that will achieve the lowest cost consistent with acceptable performance.

4.3.1 Parts, Materials and Processes

The Vendor shall utilize a control system for parts, materials, and processes consistent with the requirements of ISO 9001.

4.3.1.1 Cleanliness

All internal and external surfaces of the unit shall be clean. The surfaces shall be free of oil and other contaminants.

4.3.2 Workmanship

The unit will be built using workmanship standards that meet or exceed MIL-STD-454 Requirement 9.

4.3.3 Interchangeability

All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable and replaceable. Units shall be uniformly characterized to accommodate interchangeability without re-characterization or adjustment in the subsystem or system.

4.3.4 Safety

4.3.4.1 Environmental, Health, and Disposal

The Vendor shall comply with the safety, environmental, health and disposal requirements established in federal, state, and local rules and regulations.

4.3.4.2 Electrostatic Discharge Sensitive Devices

The unit shall include the proper protection of any ESD sensitive electronics. The unit will have an ESD warning label if it is ESD sensitive.

Tests in addition to other Vendor suggested and Buyer approved tests. It is highly recommended parts be tested in an altitude simulation chamber to verify performance at 5000m altitude. Vendor may substitute or provide altitude data on similar devices to satisfy this requirement, with the approval of the Buyer.