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Specifications for the AMiBA 4-Lag Correlator

version 080102A

Functional Description: Figure 1 describes the functional block diagram and basic topology of the 4-lag correlator module. This module will consist of 2-way power dividers PD1 – PD6, delay lines T1 – T8, attenuators AT1 – AT8, and mixers MX1 – MX4. The 2 RF inputs will be provided via connectors J1, J2, and the 4 correlated RF outputs will be provided by connector J3.

- Power Dividers: 2 to 18 GHz bandwidth, approximate loss of 4.0 dB each.
- Delay Lines: T1 = T8 = 12.5 psec; T2 = T7 = 25.0 psec; T3 = T6 = 37.5 psec; T4 = T5 = 50 psec.
- Attenuators: 6 dB for impedance matching.
- Mixers: R and L input ports symmetric, responsivity >/= 2500 V_{rms}/W.

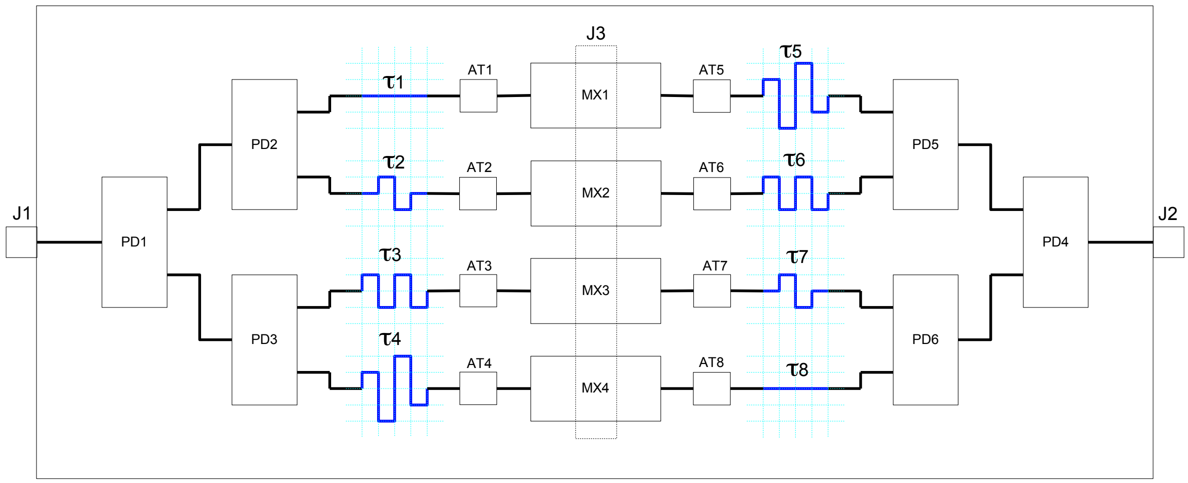

Figure 1 Functional Concept of 4-Lag Correlator

1.0 Electrical Interfaces

1.1 RF Input Connectors: J1 and J2 shall be BMA (female) RF connectors.

Verify by visual inspection.

1.2 RF Input Frequency Range: 2.0 to 18.0 GHz, inclusive. This applies to J1 and J2.

Verify by design inspection.

1.3 RF Input Nominal Impedance: 50 Ohms.

Verify by design inspection.

1.4 RF Input VSWR: 2.0:1 maximum (over 2.0 to 18.0 GHz, inclusive). This applies to J1 and J2.

Verify by test. Use network analyzer to characterize return loss at J1 and J2.

1.5 Correlated Analog Output Connector: 4 individual socket contacts (1 contact per mixer). Sockets shall accept external mating pins. Ground contact shall be provided by the case. Supplier will provide exact interface dimensions. Refer to Figure 4, bottom view.

Verify by visual inspection.

1.6 Correlated Analog Output Format: Single ended signal for each of the 4 mixer outputs. Ground reference for the 4 signals will be established through the case.

Verify by test.

1.7 Correlated Analog Output Frequency Range: DC to 20 kHz, inclusive. Applies to all 4 correlator outputs.

Verify by test. Refer to Figure 2. Set synthesizer 1 and 2 frequencies to 10.000,000 and 10.000,001 GHz, respectively. Set both synthesizer levels to produce -10.0 dBm at end of cables to J1 and J2. Observe MX1 output on oscilloscope (Z_{in} >/= 1 MΩ). Observe MX1 output on oscilloscope (Z_{in} >/= 1 MΩ). Output 1 kHz sinusoid shall have an amplitude >/= 22.5 mV_{pp} (8 mV_{rms}). Increase synthesizer 2 frequency offset to 5 kHz (10.000,005 GHz) and repeat amplitude measurement. Continue for offsets of 10, 15, and 20 kHz. Output sinusoid shall be >/= 22.5 mV_{pp}.

Repeat for MX2, MX3, and MX4.

2.0 Electrical Performance

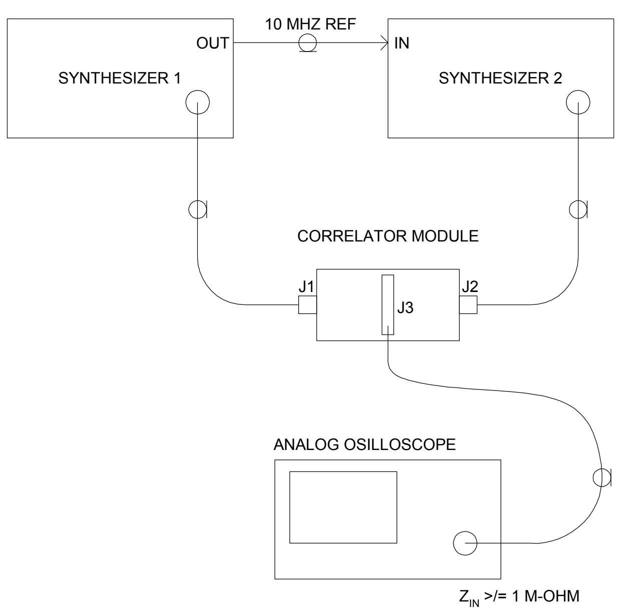

Figure 2 Responsivity Measurement Test Setup

2.1 Module Responsivity: 80 V_{rms}/W[1] minimum at 10 GHz. Applies to all 4 correlator outputs.

Verify by test. Refer to Figure 2. Set synthesizer 1 and 2 frequencies to 10.000,000 and 10.000,001 GHz, respectively. Set both synthesizer levels to produce -10.0 dBm at end of cables to J1 and J2. Observe MX1 output on oscilloscope (Z_{in} >/= 1 MΩ). Output 1 kHz sinusoid shall have an amplitude >/= 22.6 mV_{pp} (8 mV_{rms}). Repeat for MX2, MX3, and MX4.

2.2 Responsivity verses Frequency: </= 3.0 dB peak-to-peak variation in responsivity across 2.0 to 18.0 GHz input range, inclusive. Applies to all 4 correlator outputs.

Verify by test. Refer to Figure 2. Set synthesizer 1 and 2 frequencies to 2.000,000 and 2.000,001 GHz, respectively. Set both synthesizer levels to produce -10.0 dBm at end of cables to J1 and J2.

1) Observe MX1 output on oscilloscope (Z_{in} >/= 1 MΩ). Measure and record output sinusoid amplitudes for MX1, MX2, MX3, and MX4.

2) Increase frequency by 1.0 GHz and repeat measurements up to 18.0 GHz. Always maintain a 1 kHz difference frequency. Calculate and plot responsivity verses frequency. Verify responsivity stays within the bounds of 60 to 120 V_{rms}/W.

2.3 Phase verses Frequency: </= 30 degrees peak-to-peak variation from linear phase across 2.0 to 18.0 GHz input range, inclusive. Applies to all 4 correlator outputs.

Verify by test. Refer to Figure 2. Set synthesizer 1 and 2 frequencies to 2.000,000 and 2.000,001 GHz, respectively. Set both synthesizer levels to produce -10.0 dBm at end of cables to J1 and J2. Use MX1 signal to trigger oscilloscope for the following measurements.

1) Position zero crossing of MX1 output waveform on center graticule of oscilloscope. Using this waveform as reference, measure and record zero crossing positions of MX2, MX3, and MX4 waveforms to within 2.5 μsec accuracy. Convert time to phase using:

$$\phi = 360° \times (T_m/1.0\times10^{-3}\,\text{sec}), \text{ where } T_m = \text{measured time}$$

2) Increase frequency by 1.0 GHz and repeat and record measurements up to 18.0 GHz. Always maintain a 1 kHz difference frequency.

3) Plot relative phase responses of MX2, MX3, and MX4 verses frequency. Calculate best fit line for each mixer and verify relative phase responses stay within +/-15 degrees from linear phase.

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[1] 100 V_{rms}/W at the module corresponds to approximately 2500 V_{rms}/W at the mixer. This assumes the following losses: PD = 3.5 dB each, AT = 6.0 dB each, additional losses = 1.0 dB.

2.4 Delay Increment Accuracy: 25.0 +/- 2.5 psec.

From the previous phase verses frequency measurements, calculate the best fit phase slope (degree/GHz) for MX2, MX3, and MX4. Divide by 360° to obtain differential delays. Verify numbers fall within 2.5 psec of design values.

MX2 - MX1 = 25.0 psec +/- 2.5 psec
MX3 - MX1 = 50.0 psec +/- 2.5 psec
MX4 - MX1 = 75.0 psec +/- 2.5 psec

2.5 Input 1 dB Compression Point: >/= -5.0 dBm at 10 GHz. Applies to all 4 correlator outputs.

Verify by test. Refer to Figure 2. Set synthesizer 1 and 2 frequencies to 10.000,000 and 10.000,001 GHz, respectively. Set both synthesizer levels to produce -15.0 dBm at end of cables to J1 and J2. Record output amplitude of 1 kHz sinusoid for MX1, MX2, MX3, and MX4. Increase input levels to correlator in 1.0 dB increments and record amplitude measurements. Calculate and plot responsivity for each mixer over an input range of -15.0 dBm to -5.0 dBm. Output responsivity shall be reduced by no more than 79.4 % (1 dB) at -5.0 dBm input when compared to responsivity at -15.0 dBm.

2.6 Squared Term Contribution: </= 5.0 %. This quantity is defined as the ratio of undesired DC output (due to input power variation) to the desired DC output (due to correlation). Applies to all 4 correlator outputs.

Verify by test. Refer to Figure 3. Set power profile to produce -10.0 dBm input level at J1 and J2 of the correlator module.

1) Connect MX1 output to a DC voltmeter (mV scale) and adjust phase to produce a maximum positive voltage. Record value. Adjust phase shifter to produce a minimum negative voltage and record value. Obtain desired peak-to-peak response by subtracting the 2 measurements.

2) Disconnect RF signal to J1 and terminate the end of the cable and J1 with 50Ω loads. Measure and record DC output. Reconnect J1 and disconnect J2. Measure and record DC output.

3) Calculate the squared term contribution by taking the ratio of the largest number obtained from 2) to the peak-to-peak number calculated in 1).

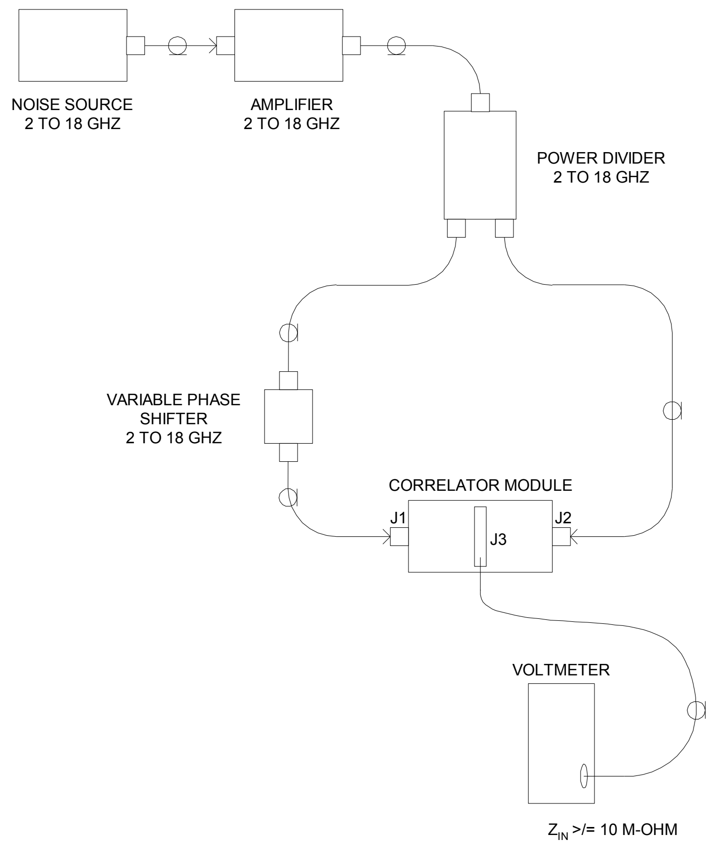

Figure 3 Squared Term Contribution Test Setup

2.7 Output Impedance: </= 100 kΩ when driving module inputs at -10.0 dBm.

Verify by test. Refer to Figure 2. Set synthesizer 1 and 2 frequencies to 10.000,000 and 10.000,001 GHz, respectively. Set both synthesizer levels to produce -10.0 dBm at end of cables to J1 and J2.

1) Observe MX1 output on oscilloscope (Z_{in} >/= 1 MΩ). Measure and record output sinusoid amplitudes for MX1, MX2, MX3, and MX4.

2) Next add a 150KΩ shunt potentiometer across the input signal at the oscilloscope. While observing the MX1 output, adjust the potentiometer to produce exactly ½ the output voltage as obtained in step 1). Using an Ohmmeter, measure and record the resistance of the potentiometer[2]. This is the equivalent output impedance of the mixer. Repeat for MX2, MX3, and MX4.

[2] Remove connection to correlator module and oscilloscope before measuring resistance of potentiometer.

3.0 **Mechanical**

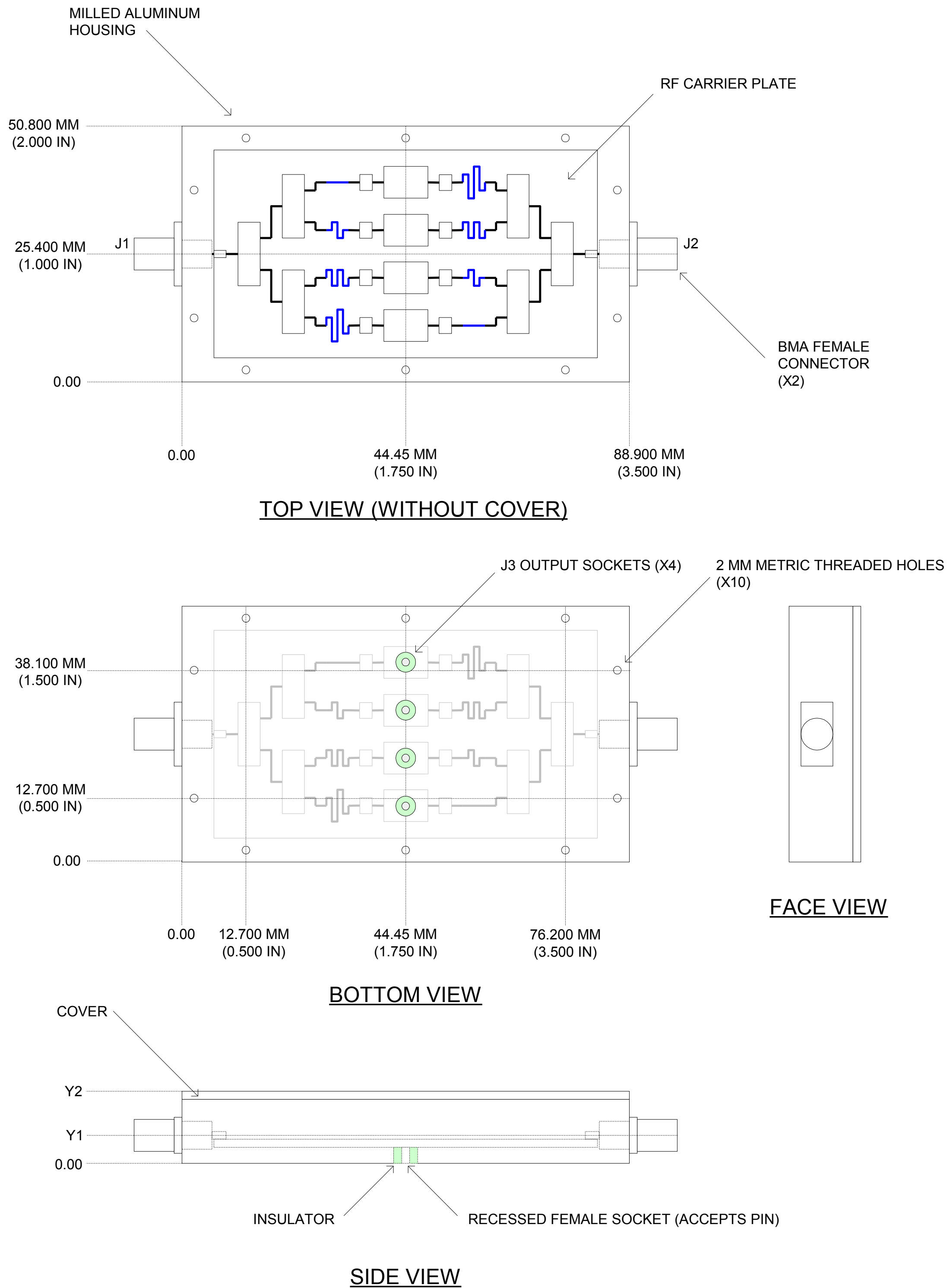

Figure 4 Mechanical Packaging Concept

3.1 Module External Dimensions: Refer to Figure 4.

Length = 88.900 mm (3.500 inches) +/- 0.127 mm (+/- 0.005 inches)

Width = 50.800 mm (2.000 inches) +/- 0.127 mm (+/- 0.005 inches)

Height (with cover) = dimension shall be specified on suppliers outline drawing.

Verify by visual inspection.

3.2 Bottom Mounting Hole Locations: Refer to Figure 4. 10 threaded mounting holes for the mating module shall be provided as described in the figure. Placement of the holes shall be within +/- 0.127 mm (+/- 0.005 inches) of the specified locations.

Verify by visual inspection.

3.3 J1 and J2 Connector Locations: Refer to Figure 4. The J1 and J2 input connectors shall be located symmetrically on opposite faces of the module. The height (Y1 dimension on side view) dimension shall be specified on the suppliers outline drawing. Placement of the connectors shall be within +/- 0.127 mm (+/- 0.005 inches) of the specified locations.

Verify by visual inspection.

3.4 J3 Connector Location: Refer to Figure 4. J3 will consist of 4 individual feed-through sockets. The exact locations and dimensions of these 4 sockets shall be specified relative to the datum on the suppliers outline drawing. Placement of the sockets shall be within +/- 0.127 mm (+/- 0.005 inches) of the suppliers specified locations.

Verify by visual inspection.

4.0 Environmental

4.1 Verification Temperature: All specifications contained in this document pertain to operation at room temperature (20 to 25 degrees C).

4.2 Operating Temperature: The module shall be designed to operate over a temperature range of 0 to 40 degrees C.

4.3 Altitude: The module shall be designed to operate from 0 to 4300 m (14,100 feet).

4.4 Humidity: The module shall be hermetically sealed to avoid moisture from condensing on the internal circuitry.