EVLA Front-End CDR

C-Band (4-8 GHz)
EVLA Receiver
# EVLA C-BAND PERFORMANCE PROJECT BOOK REQUIREMENTS

## 5.0 Receiver Parameters (Summary)

<table>
<thead>
<tr>
<th>TABLE 5.1 : EVLA RECEIVER PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (GHz)</td>
</tr>
<tr>
<td>Band$^2$</td>
</tr>
<tr>
<td>Tsyst ($^\circ$K)</td>
</tr>
<tr>
<td>Tsky$^3$ ($^\circ$K)</td>
</tr>
<tr>
<td>Tcrrv$^4$ ($^\circ$K)</td>
</tr>
<tr>
<td>Feed Type$^5$</td>
</tr>
<tr>
<td>Efficiency$^6$</td>
</tr>
<tr>
<td>Location$^7$</td>
</tr>
<tr>
<td>Polarizer Type$^8$</td>
</tr>
<tr>
<td>LO Frequency (GHz)</td>
</tr>
<tr>
<td>LO Multiplier$^{10}$ (GHz)</td>
</tr>
<tr>
<td>Frequency Output</td>
</tr>
<tr>
<td>Output Power$^{11}$ (dBm)</td>
</tr>
<tr>
<td>Est. Headroom$^{12}$ (dB)</td>
</tr>
<tr>
<td>Output to Module$^{13}$</td>
</tr>
<tr>
<td>Refrigerator Model$^{14}$</td>
</tr>
<tr>
<td>Details: 5.1.7.</td>
</tr>
</tbody>
</table>

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April 24, 2006

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$^1$ Frequency range: 1.2 - 2 GHz.


$^3$ Temperature range: 12°C.

$^4$ Temperature range: 14°C.

$^5$ Feed types: Compact, Conical.

$^6$ Efficiency range: 0.45 - 0.62.

$^7$ Location coordinates: -84.1°, 101.6°.

$^8$ Polarizer types: QR, Hyb., note.

$^9$ Polarizer note: PS, W-B.

$^{10}$ LO multiplier: NA.

$^{11}$ Output power range: -33 dBm.

$^{12}$ Est. headroom: 35 dB.

$^{13}$ Output to module: T302, T304.

$^{14}$ Refrigerator model: 1020.
C-band Block Diagram
## Estimated EVLA C-Band $T_{Rx}$, Output Power & Headroom

<table>
<thead>
<tr>
<th>EVLA C-Band Rx (RHH : 28 March 2006)</th>
<th>P (1dB) (dBm)</th>
<th>P (1%) (dBm)</th>
<th>Temp (K)</th>
<th>NF/C (dB)</th>
<th>Loss/Gain (linear)</th>
<th>Delta T (K)</th>
<th>Trx BW (MHz)</th>
<th>$P_{noise}$ (dBm)</th>
<th>$P_{noise}$ (dBm/GHz)</th>
<th>Headroom (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Window</td>
<td>6000</td>
<td>-90.8</td>
<td>-98.6</td>
<td>10.0</td>
<td>0.9954</td>
<td>1.385</td>
<td>1.0000</td>
<td>0.300</td>
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<tr>
<td>Feed Horn</td>
<td>-90.3</td>
<td>-90.2</td>
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<tr>
<td>Vacuum Window</td>
<td>-90.3</td>
<td>-90.2</td>
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<td>Quad-Ridge OMT</td>
<td>-90.3</td>
<td>-90.2</td>
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<tr>
<td>Coax Cable</td>
<td>-90.3</td>
<td>-90.2</td>
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<td>Hybrid Phase Shifter</td>
<td>-90.3</td>
<td>-90.2</td>
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<tr>
<td>Coax Cable</td>
<td>-90.3</td>
<td>-90.2</td>
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<tr>
<td>Cal Coupler (IL)</td>
<td>-90.3</td>
<td>-90.2</td>
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<tr>
<td>Cal Coupler (Branch)</td>
<td>-90.3</td>
<td>-90.2</td>
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<tr>
<td>Isolator</td>
<td>-90.3</td>
<td>-90.2</td>
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<tr>
<td>LNA</td>
<td>-53.0</td>
<td>3.10</td>
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<td>Stainless Steel Coax</td>
<td>-55.0</td>
<td>3.50</td>
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<tr>
<td>Coax Cable</td>
<td>-56.0</td>
<td>3.50</td>
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<tr>
<td>Switch</td>
<td>-56.0</td>
<td>3.50</td>
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<tr>
<td>Isolator</td>
<td>-56.0</td>
<td>3.50</td>
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<tr>
<td>Filter (3.8-8.2 GHz)</td>
<td>-58.8</td>
<td>-65.3</td>
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<tr>
<td>Post-Amp</td>
<td>-30.8</td>
<td>33.8</td>
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<tr>
<td>Isolator</td>
<td>-31.3</td>
<td>15.93</td>
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</table>
Vacuum/RF Window

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EVL A Front-End CDR – C-Band Receiver  
April 24, 2006
Interim AMC (narrow band) Polarizer #1

Note length, vs. Production OMT

<table>
<thead>
<tr>
<th>FULL FREQUENCY:</th>
<th>4.6 - 5.1 GHz</th>
<th>PRIME FREQUENCY:</th>
<th>4.8 - 5.0 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSWR:</td>
<td>1.21 Max.</td>
<td>VSWR:</td>
<td>1.15 Max.</td>
</tr>
<tr>
<td>ELLIPTICITY:</td>
<td>0.6 dB Max.</td>
<td>ELLIPTICITY:</td>
<td>0.25 Max.</td>
</tr>
<tr>
<td>ISOLATION:</td>
<td>25 dB Min.</td>
<td>ISOLATION:</td>
<td>28 dB Min.</td>
</tr>
<tr>
<td>MATERIAL:</td>
<td>Aluminum</td>
<td>MATERIAL:</td>
<td>Aluminum</td>
</tr>
<tr>
<td>FINISH:</td>
<td>Gold plated</td>
<td>FINISH:</td>
<td>Gold plated</td>
</tr>
</tbody>
</table>

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EVLÁ Front-End CDR – C-Band Receiver
April 24, 2006
Interim VLA (salvaged), modified AMC Polarizer

Salvaged VLA polarizer—modified:
- 4.5 – 5 GHz only.
- Cut-off flanges
- Add new flanges
- Add PAL coax adapters
- Add PAL sq → circ adapter
NRAO (wide-band) Production OMT
Dewar components 1

<table>
<thead>
<tr>
<th>Component</th>
<th>FQ</th>
<th>VSWR</th>
<th>ISO</th>
<th>COUPL</th>
<th>INS LOSS</th>
<th>AMP BAL</th>
<th>PH BAL</th>
<th>FQ SENS</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 deg hybrid</td>
<td>4-8 GHz</td>
<td>1.30</td>
<td>18 dB</td>
<td>3.2+-1.7</td>
<td>TBD dB</td>
<td>+/-0.2 dB</td>
<td>+/-2.0 Deg</td>
<td>+/-0.75 dB</td>
</tr>
<tr>
<td>Cal Coupler</td>
<td>4-8 GHz</td>
<td>1.25/1.25</td>
<td>20 dB</td>
<td>30+-1.25</td>
<td>0.25 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cal Splitter</td>
<td>4-8 GHz</td>
<td>1.35/1.25</td>
<td>20 dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryo Isolator</td>
<td>4-8 GHz</td>
<td>1.25</td>
<td>20 dB</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cryo LNA</td>
<td>4-8 GHz</td>
<td>/*</td>
<td></td>
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</tr>
</tbody>
</table>

ATM H915
ATM C115-0/MI
ATM P215
DORADO 31CC60-1
NRAO: “C” LNA

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April 24, 2006
### Dewar components 2

<table>
<thead>
<tr>
<th>SS Coax</th>
<th>Re-formable Coax</th>
<th>SMA Bulkhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>![SS Coax Image]</td>
<td>![Re-formable Coax Image]</td>
<td>![SMA Bulkhead Image]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RF-COAX</th>
<th>RF-Connection</th>
<th>AMP/TYCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>S086MMSS-22</td>
<td>SMA-M/SMA-M .141</td>
<td>1054874-1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SS Coax</th>
<th>Re-formable Coax</th>
<th>SMA Bulkhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (FQ)</td>
<td>&lt; 18 GHz</td>
<td>&lt; 18 GHz</td>
<td>&lt; 18 GHz</td>
</tr>
<tr>
<td>VSWR</td>
<td>1.29</td>
<td>&lt; 18 GHz</td>
<td>1.18</td>
</tr>
<tr>
<td>Length</td>
<td>18-22 IN</td>
<td>4, 6 IN</td>
<td></td>
</tr>
<tr>
<td>Insertion Loss (INS LOSS)</td>
<td>2 dB (est)</td>
<td>&lt; 0.35 dB</td>
<td>0.42 dB</td>
</tr>
</tbody>
</table>

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EVL A Front-End CDR – C-Band Receiver
April 24, 2006
DEWAR PACKAGING 2

AC CONTROL BOX
RF POST DEWAR BOX
OMT ASSEMBLY SUPPORT ROD

ZOTEFoAM WINDOW
THERMAL GAP
COLD PLATE (15K)
AMC POLARIZER
RAD SHIELD (50K)

CTI 350 FRIG
### RF Box Components

#### Isolator
- **Type**: MICA 604-S39
- **FQ**: 4-8 GHz
- **VSWR**: 1.3:1
- **ISO**: 18 dB
- **COUPL**: 3.2+/-0.7
- **INS LOSS**: < 0.5 dB
- **NF**: < 4 dB, 2 typ
- **AMP FLAT**: 0.5 dB

#### BPF
- **Type**: TTE K5221-4/8-G-A
- **FQ**: 4-8 GHz
- **VSWR**: 1.5/1.5
- **GAIN**: 28+/-2 dB
- **INS LOSS**: < 1 dB
- **NF**: < 4 dB, 2 typ

#### Post-amp
- **Type**: ALC ALS04--149
- **FQ**: 4-8 GHz
- **VSWR**: 2.0/2.0
- **ENR**: 31 dB
- **INS LOSS**: < 1 dB
- **P1dB**: >+10dBm, 15 typ

#### Noise Source
- **Type**: NORDEN NO3-2086
- **FQ**: 4-8 GHz
- **ENR**: 31 dB
- **INS LOSS**: < 1 dB
- **P1dB**: >+10dBm, 15 typ

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EVL A Front-End CDR – C-Band Receiver  
April 24, 2006
RF Box Packaging

- Space for Solar Cal Var Attn
- Digital control & Cal Drive PCB
- Noise Source
- Bandpass Filters
- Output Isolators
- Input Isolators
Common Dewar Design
DEWAR PACKAGING: THE COLD PLATE

Au PLATED, OFC COLD PLATE
AL RAD SHIELD
BOTTOM PLATE

CHARCOAL CANISTER
SS COAX OUT
LNA
ISO
CAL COUP
REFORM COAX IN
CAL SPLITTER
EVLA C-BAND
NARROW-BAND PERFORMANCE

C Band XN-5 Final SOIDA results
Trx

Trx spec = 16K, incl feed and radome

OTHER RESULTS:
SN  R  L
-----------------
2  14  15
3  15  18
4  19  14

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TEST CONDITIONS:
• RCP LNA=3-13 GHz, SN18, not 4 – 8 GHz optimized.
• Dewar cool (12/50 K)
• SOIDA signal injected via cal port (after the 4.5-5.0 GHz AMC pol)
• .086 SS coax, 22 in long used to inject test CW has 2+ dB loss, not calibrated out.
• Test demonstrates flatness, not absolute Trx.
EVLA C-BAND
Preliminary Conclusions

• Interim (4.6 – 5.1 GHz) receivers meet noise temp and amp/phase stability goals.
• Full EVLA BW (4 – 8 GHz) tests show no BW limiting factors after polarizer.
• Interim receiver production keeping pace with antenna refurbishment schedule.
• EVLA full-bandwidth version awaits only the 4 – 8 GHz OMT design completion.
• 4 – 8 GHz OMT design completion will follow 1 – 2 GHz OMT design evaluation (in-progress).
• No technical or production problems anticipated.
Summary

• M&S Budget - $237.3K already spent out of $603.0K allotment
  – Remaining large ticket items - Quad-ridge OMT’s
  - LNA’s
  - Cables
  - New Card Cages

• Many of the significant components have already been ordered and received for the entire build with component prices at or below our original estimates.

• To keep within the EVLA Project spend profile, it was felt that the upgraded design was low risk and that we could confidently proceed with mass production.

• **We hope the FE CDR Panel agrees with this action…**