IF Subsystem

Specs & Measured Test Data
EVLA Converter Modules

Module

T301  4/P-Band Converter
T302  L/S/C-Band Converter
T303  UX Converter (coaxial version)
M301  Converter Interface Module
A-SW  Receiver Band Switches (p/o T303)
B-SW  B-Rack System Switches
## Converter Frequencies

<table>
<thead>
<tr>
<th></th>
<th>RF</th>
<th>1st IF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T301</strong></td>
<td>(4) 73 - 75 MHz (P) 308-348 MHz</td>
<td>1097-1099 MHz (L) 1332-1372 MHz (L)</td>
</tr>
<tr>
<td><strong>T302</strong></td>
<td>(L) 1 - 2 GHz (S) 2 - 4 GHz (C) 4 - 8 GHz</td>
<td>12-11 GHz (X) 11 - 9 GHz (X) 12 - 8 GHz (X)</td>
</tr>
<tr>
<td><strong>T303</strong></td>
<td>(Ku-Q) 8 -12 GHz 12 -18 GHz</td>
<td>12- 8 GHz (X) 12- 8 GHz (X)</td>
</tr>
</tbody>
</table>
EVLA Converters
RF/IF Signal Flow

74 MHz
327 MHz

4/P BAND CONVERTER

(L-BAND IF)

L/S/C CONVERTER

UX CONVERTER

T304 DOWN CONVERTERS

SWITCHES

SWITCHES

SWITCHES

K-Band
Ka-Band
Q-Band

L-Band
C-Band
S-Band

Ku-Band
K-Band
System Specifications

• System Phase Stability spec 200fs/min over 30 min
• Converter spec is 1/3 of this spec
• Not yet measured
• Have not determined exactly how much will be allocated to each converter
T301 4/P Converter
Design Notes

- 2-wide module in LO/IF Rack
- Internal Solar Attenuators
- Simultaneous 74 MHz & P-band observing
- Bandwidth can be changed at a later time by changing filters.
- LCP/RCP transfer switches (added 3-2004) to allow simultaneous 4/P and L band observing
T301 4/P Converter
Block Diagram

74 MHz

P-Band
308–348 MHz

20dB Solar Attenuators

BW Compensation Amplifiers

4/P Band Combiner

1024 MHz Notch

1090–1450 MHz BPF

RCP

1024 MHz L.O.

IF-A

RCP IF-A/IF-B

LCP IF-C/IF-D

IF-B
T301 4/P-Band Converter Specs

- Input Frequencies: 74 MHz (73-75 MHz)  
  P-Band (308-348 MHz)  

- Bandwidths: 2 MHz (74 MHz)  
  Narrow Band 40 MHz (P-band)  

- Input Power: -35 dBm/BW  
- P1dB of Converter: +12 dBm  
- Headroom: ~74 dB
T301 4/P-Band Converter

Specs

• LO: 1024 MHz @ +3dBm
• IF Frequency: 1097-1099 MHz
  Narrow Band
• IF Output Power: -45 dBm/BW
  (To be compatible with L-Band Converter input)
• IF flatness: <1 dB/2 MHz
• IF-IF Isolation: >65 dB
T301 4/P-Band Converter Specs

IF distribution was recently changed to allow simultaneous 4/P and L–band observing, and to reduce the number of system switches by:

- *Adding L/S/C or 4/P selector switches to the T302 L/S/C Converter* (completed)
- *Adding RCP/LCP normal/reverse transfer switches to the T301 4/P converter* (not yet completed – preventing full T301 testing)
T302

L/S/C Converter
T302 L/S/C Converter
Design Notes

• 2-wide module in LO/IF Rack
• System band switches selects L, S or C band
• Internal Solar Attenuators
• Internal switches selects L/S/C or 4/P band to allow simultaneous 4/P and L-band observing
## T302 L/S/C Converter

### RF Input Specs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>1–8 GHz</td>
<td>1–8 GHz</td>
</tr>
<tr>
<td>Input power level</td>
<td>-50 dBm</td>
<td>-45 dBm</td>
</tr>
<tr>
<td>1dB compression</td>
<td>+10 dBm</td>
<td>+3 dBm</td>
</tr>
<tr>
<td>Headroom (-50dBm in)</td>
<td>60dB</td>
<td>53 dB</td>
</tr>
<tr>
<td>Headroom (-45dBm in)</td>
<td></td>
<td>48 dB</td>
</tr>
<tr>
<td>Input VSWR</td>
<td>1.35:1 max</td>
<td>1.08-1.12</td>
</tr>
</tbody>
</table>
## T302 L/S/C Converter

### LO Specs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO frequency range</td>
<td>12–20 GHz</td>
<td>(L301)</td>
</tr>
<tr>
<td>LO input power level</td>
<td>+3dBm</td>
<td>See note</td>
</tr>
<tr>
<td>LO 2\textsuperscript{nd} harmonic</td>
<td>&lt;-40 dBc</td>
<td>(L301)</td>
</tr>
<tr>
<td>LO spurious levels</td>
<td>&lt;-70 dBc</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** +17dBm LO mixer injection achieved with LO input power >0dBm.
# T302 L/S/C Converter

**IF Specs**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF frequency range</td>
<td>8–12 GHz</td>
<td>8-12 GHz</td>
</tr>
<tr>
<td>IF output power</td>
<td>≥–50 dBm</td>
<td>-38 dBm</td>
</tr>
<tr>
<td>Conversion Gain</td>
<td>not specified</td>
<td>12-13 dB</td>
</tr>
<tr>
<td>Image rejection</td>
<td>–30 dBc</td>
<td>.</td>
</tr>
<tr>
<td>Overall flatness</td>
<td>1.5 dB/2 GHz</td>
<td>~1.2 dB</td>
</tr>
<tr>
<td>Passband ripple</td>
<td>.2 dB/2 MHz</td>
<td>~.2 dB</td>
</tr>
</tbody>
</table>

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Paul Harden  
EVLA LO-IF CDR • May 17, 2004  
17
T302 L/S/C Converter

IF Output

Overall flatness & ripple
RF: 3.1–4.1 GHz
LO: 13.0 GHz
Spec: <1.5dB/2 GHz
Meas: ~1.2dB/2 GHz
2 GHz sweep not shown
Spec: 0.2dB/2 MHz
Meas: ~0.2dB/2 MHz
SWR 1.08–1.14
(25-29dB reflected)

SWR: 0.1/div  IF Response 2dB/div
T302 L/S/C Converter

IF Output

Overall flatness & ripple
Miteq Mixer

*Does not meet spec*

RF: 3.1–4.1 GHz
LO: 13.0 GHz
Spec: <1.5dB/2 GHz
Meas: ~7dB/2 GHz
~3.5dB/1 GHz

1 GHz Sweep shown

SWR: 0.1/div  IF Response: 2dB/div
T303 UX Converter (Coaxial Version)
T303 UX Converter (MMIC Version)

Norden Millimeter Prototype #1
T303 UX Converter
Design Notes

- Located in feed cone – custom enclosure
- Contains receiver band switches
- MIB interface via M301 wire & fiber optics
- Powered from front end power supplies
- Coaxial & MMIC versions being tested simultaneously
T303 UX Converter Block Diagram

RCP Converter

12–14 GHz  24–28 GHz
X2

LO-1
Ku-Band Only
8–18 GHz Input

Ku-Band
K-Band
Ka-Band
Q-Band

8–12 GHz
BPF

PO

12–18 GHz

Ku-BAND PATH (Converted Path)

IF-A
IF-B

TO LCP

X2

X-BAND PATH (X-Direct Path)

BPF
T303 UX Converter Specs

- RF input frequency: 8 – 18 GHz
  - 8–12 GHz Portion: X-band direct IF
  - 12–18 GHz portion: converted to X-band IF
- LO input frequency: 12–14 GHz
  - Doubled internally to 24–28 GHz
  - (Only 24–26 GHz portion used)
## RF Input Specs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input power level</td>
<td>-53dBm/GHz</td>
<td>-47 dBm†</td>
</tr>
<tr>
<td>1dB compression</td>
<td>(X/Ku paths)</td>
<td>+2/-4</td>
</tr>
<tr>
<td>Headroom (X-direct)</td>
<td>38 dB</td>
<td>49 dB†</td>
</tr>
<tr>
<td>Headroom (Ku path)</td>
<td>25 dB</td>
<td>43 dB†</td>
</tr>
<tr>
<td>Input VSWR</td>
<td>1.35:1 max</td>
<td>1.08-1.18</td>
</tr>
<tr>
<td>Input Noise Figure</td>
<td>5.2 dB max</td>
<td>Not meas</td>
</tr>
</tbody>
</table>

† Measured values are typically used for calibration purposes.
# T303 UX Converter

## LO Specs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO input frequency</td>
<td>12–14 GHz</td>
<td>(L301)</td>
</tr>
<tr>
<td>LO input power level</td>
<td>+10 dBm</td>
<td>+10dBm</td>
</tr>
<tr>
<td>LO doubled frequency</td>
<td>24–28 GHz</td>
<td>24-27.5†</td>
</tr>
<tr>
<td>LO 2(^{nd}) harmonic</td>
<td>&lt;–40 dBC</td>
<td></td>
</tr>
<tr>
<td>LO spurious levels</td>
<td>&lt;–70 dBC</td>
<td></td>
</tr>
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† Power reduced –3dB 27.5–28.0 GHz
# T303 UX Converter

## IF Specs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Measured</th>
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</thead>
<tbody>
<tr>
<td>IF frequency range</td>
<td>8–12 GHz</td>
<td>8-12 GHz</td>
</tr>
<tr>
<td>IF output power</td>
<td>&gt;–48 dBm</td>
<td>-43 dBm</td>
</tr>
<tr>
<td>Conversion Gain</td>
<td>not specified</td>
<td>12-13 dB</td>
</tr>
<tr>
<td>Image rejection</td>
<td>–30 dBc</td>
<td>.</td>
</tr>
<tr>
<td>Overall flatness</td>
<td>2dB/2 GHz</td>
<td>1.5dB</td>
</tr>
<tr>
<td>Passband ripple</td>
<td>.2dB/2MHz</td>
<td>.2dB max</td>
</tr>
</tbody>
</table>
T303

X-Direct Path

Overall flatness & ripple

MMIC Version

X-Direct Path

RF: 8–12 GHz

LO: Not used

Spec: 2dB/2 GHz

Meas: ~1.5dB/4 GHz

4 GHz sweep shown

SWR 1.08–1.12

SWR 0.1/div  IF OUT 2dB/div
T303

Ku Conversion Path

Overall flatness & ripple
MMIC Version
Ku-converted Path
RF: 12–18 GHz
LO: 12.0 GHz
Spec: 2dB/2 GHz
Meas: 3.8dB/6 GHz
6 GHz sweep shown
Meas. SWR 1.08–1.12

SWR 0.1/div IF OUT 2dB/div
Ku-converted Path
12–18 GHz @ +5dBm
LO: 12.0 GHz
Spec: 32dB headroom from P1dB
-40dBm+32=–8dBm
Meas P1dB= –2dBm
Spec: IMD <<30dB
LO spurs <-60dBc
IMD product –65dBc
T303 UX Converter

IF Output

When things go wrong...
M301 Converter Interface Module

- One MIB services all three converters and controls all system switches
- M301 to reduce MIB RFI in converters
- Uses MIB SPI bus for all monitor/control
- Fiber Optics used for feed cone SPI lines
M301 Converter Interface Block Diagram