Design and Development of ultra wide band 8-50 GHz LNA

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Outline

• Motivation
• Modeling
• MMIC measurements
• LNA measurement results
• MMIC design iteration
Motivation

• Increase DSN downlink data rate by 10x at X and KA bands
• Decrease system cost of NGVLA
• Open doors for wideband science
• Challenge old design assumptions
DC – 50 GHz Probe station

Probe station

MMIC under microscope
Transistors under Test

OMMIC Transistors

NGC Transistors
HSC2120 First Stage NGC transistor Measurement and model comparison

Frequency (GHz)
The Next Generation Very Large Array
How better models effect LNA predictions

MMIC simulation using NGC vs JPL model

NGC APRA3 Run 50GHz LNA Candidate - 100% in

Solid - NGC

Dashed - JPL

Gain

Input Ref Coeff

Output Ref Coeff

Microwave + IMN

Microwave only

DB(s[1,1])

8_50GHz LNA 50LN2 1

DB(s[2,1])

8_50GHz LNA 50LN2 1

DB(s[2,2])

8_50GHz LNA 50LN2 1

TE(s)

8_50GHz LNA 50LN2 1
50 GHz LNA Module Development
LNA assembly - OMMIC

LNA layout

Zoom in on MMIC
50 GHz Test bed
Enables Hot/cold, noise source, S parameters to 50 GHz
OMMIC MMIC probe measurement 300K and 15K

- 0.3537 GHz, 29.82 dB
- 33.76 GHz, 32.81 dB

Frequency (GHz)
Ommic Wideband LNA Housing #002 Thru Measurement with inductor and bias network
Design iteration

- NGC MMIC redesign
- Used four finger device on first stage
- Changed device sizes
- Decoupled first stage bias network from subsequent stages
- Removed input bias network on first stage
Changes to the input transistor, 2\textsuperscript{nd} transistor, and input gate bias resistor.

Changing out 3\textsuperscript{rd} FET flattens gain.
The Next Generation Very Large Array

Gain and Noise of MMIC 50LN4

| Frequency (GHz) | DB(|S(1,1)|) | DB(|S(2,1)|) | DB(|S(2,2)|) |
|----------------|-------------|-------------|-------------|
| 8 GHz          | 6.43        |             |             |
| 50 GHz         | 10.5        |             |             |

Output Equations

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<tr>
<th>Equation</th>
<th>Description</th>
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<tbody>
<tr>
<td>Tmin_NGC</td>
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<tr>
<td>Tmin_50LN4</td>
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Graph showing gain and noise for MMIC 50LN4 at different frequencies.
Confusions, Confessions, Conclusions

• Development complete on a set of testbeds to 50 GHz
• Improved models to 50 GHz achieved for NGC
• Improved MMIC design nearly complete for NGC
• Current testing in progress of OMMIC prototype LNA
• Current work progressing on improved module design