Amplifiers

Magdy Michael,
Director, Business Developments and Key Accounts

This presentation consists of L-3 Communications Corporation general capabilities and administrative information that does not contain controlled technical data as defined within the International Traffic in Arms (ITAR) Part 120.10 or Export Administration Regulations (EAR) Part 734.7 – 734.11.
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Block Diagram

GENERIC BLOCK DIAGRAM

AMPLIFIERS

DOWN-CONVERTER

UP-CONVERTER
Low Noise Amplifier (LNA)

• Definition:
  – An electronic amplifier used to amplify very weak signals (for example, captured by an antenna). It is usually located close to the detection device to reduce losses in the feed line.
  – Its noise figure adds directly to the system noise.
    \[
    SiNi = \text{Signal to Noise Ratio at the amplifier input}
    \]
    \[
    SoNo = \text{Signal to Noise Ratio at the amplifier output}
    \]
  – Typically high gain (40-60 dB). This reduces noise contribution (Second stage contribution) from other components in the chain.

\[
T_{eq} = T_1 + \frac{T_2}{G_1} + \frac{T_3}{G_1G_2} + \ldots
\]
Amplifiers

• Narda-MITEQ’s largest Component product offering catalogue amplifiers and special designed to application amplifiers to the OEM market.

• Product Groups: **LNA**: Low Noise/Medium Power

  **AMFW**: Low Noise/Medium Power Waveguide
LNA and LNAs Series

- 10 MHz to 50 GHz with output powers up to +25 dBm
- Very broadband models (0.1 to 40 GHz)
- Small, lightweight, and can be utilized as drop-in or connectorized
- Surface mount designs to 20 GHz NSM, AFSM [SMT08]
- Ideal for High-Rel/Space applications (Hermetic packages)
- Waveguide Models (JS Series) available up to V-Band [55-67 GHz]
- Optional One Watt CW input limiters available!

AFS/JS
AFSM/TSM
NSM
AMFW (Satcom LNAs)

- Low Noise Waveguide packages
- Standard Satcom and Radar bands
- L-Band through Q-Band
- Noise Temperatures as low as 30 Kelvin
AMFW (Satcom LNAs)

• Noise performance specified in Noise Temperature
  – Noise Figure =\(10 \log_{10} \left\{ \frac{\text{Noise Temp (K)}}{290 \text{ K}} + 1 \right\} \)
• Our Best Noise Temperatures a +23°C
  – L Band: 30K
  – S and C-Band: 28K
  – X-Band: 65K
  – Ka (K): 110K

<table>
<thead>
<tr>
<th>Band</th>
<th>Waveguide</th>
<th>Frequency</th>
<th>Dimensions (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>WR-284</td>
<td>2.60 to 3.95 GHz</td>
<td>2.840 x 1.340</td>
</tr>
<tr>
<td>C</td>
<td>WR-137</td>
<td>5.85 to 8.20 GHz</td>
<td>1.372 x 0.622</td>
</tr>
<tr>
<td>X</td>
<td>WR-90</td>
<td>8.2 to 12.4 GHz</td>
<td>0.900 x 0.400</td>
</tr>
<tr>
<td>X-Ku</td>
<td>WR-75</td>
<td>10.0 to 15.0 GHz</td>
<td>0.750 x 0.375</td>
</tr>
<tr>
<td>Ku</td>
<td>WR-62</td>
<td>12.4 to 18.0 GHz</td>
<td>0.622 x 0.311</td>
</tr>
<tr>
<td>K</td>
<td>WR-51</td>
<td>15.0 to 22.0 GHz</td>
<td>0.510 x 0.255</td>
</tr>
<tr>
<td>K</td>
<td>WR-42</td>
<td>18.0 to 26.5 GHz</td>
<td>0.420 x 0.170</td>
</tr>
<tr>
<td>Ka</td>
<td>WR-28</td>
<td>26.5 to 40.0 GHz</td>
<td>0.280 x 0.140</td>
</tr>
<tr>
<td>Q</td>
<td>WR-22</td>
<td>33 to 50 GHz</td>
<td>0.224 x 0.112</td>
</tr>
</tbody>
</table>
## Amplifiers

- **Model Number Key:**

### Ordering Information

**Specify by part number: xxx-**

### Example: 1 to 2 GHz, 30 dB gain, 0.6 dB noise figure, +10 dBm

**LNA-30-01000200-06-10P**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Gain dB</th>
<th>Frequency GHz</th>
<th>Noise Figure dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-01000200-06-10P</td>
<td>30</td>
<td>0.6</td>
<td>10</td>
</tr>
</tbody>
</table>

### Example: 1 to 2 GHz, 30 dB gain, 1.0 dB noise figure, +15 dBm

**LNA-30-01000200-10-15P**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Gain dB</th>
<th>Frequency GHz</th>
<th>Noise Figure dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-01000200-10-15P</td>
<td>30</td>
<td>1.0</td>
<td>15</td>
</tr>
</tbody>
</table>

### Example: 1 to 2 GHz, 40 dB gain, 3.0 dB noise figure, +25 dBm

**LNA-40-01000200-30-25P**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Gain dB</th>
<th>Frequency GHz</th>
<th>Noise Figure dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-01000200-30-25P</td>
<td>40</td>
<td>3.0</td>
<td>25</td>
</tr>
</tbody>
</table>
Amplifier Options [AFS/JS/AMF]

- **Standard Options**
  - *Some options may affect other parameters.*

<table>
<thead>
<tr>
<th>Standard Performance Options</th>
<th>Suffix</th>
<th>Standard Connector Options</th>
<th>Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Limiter</td>
<td>-L</td>
<td>SMA Male Connector</td>
<td>-M</td>
</tr>
<tr>
<td>Gain Window</td>
<td>-GW</td>
<td>K Type Connector</td>
<td>-K</td>
</tr>
<tr>
<td>Temperature Compensation</td>
<td>-TC</td>
<td>V Type Connector</td>
<td>-V</td>
</tr>
<tr>
<td>Phase Match</td>
<td>-PM</td>
<td>Waveguide Input</td>
<td>-WG</td>
</tr>
<tr>
<td>Amplitude Match</td>
<td>-AM</td>
<td>NPC Connector</td>
<td>-NP</td>
</tr>
<tr>
<td>Amplitude/Phase Match</td>
<td>-APM</td>
<td>N Type Connector</td>
<td>-N</td>
</tr>
<tr>
<td>Gain Control</td>
<td>-GC</td>
<td>TNC Type Connector</td>
<td>-T</td>
</tr>
<tr>
<td>Gain Slope</td>
<td>-GS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hermetic</td>
<td>-H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kovar Chassis</td>
<td>-KC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias Through Output</td>
<td>-BTO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias Through Input</td>
<td>-BTI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Operating Voltage</td>
<td>-XXDC*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain Slope</td>
<td>-GS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase and Gain Tracking</td>
<td>-PG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>-PS or -AS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination of three or more standard options</td>
<td>-S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
*XX is the DC operating voltage. When specifying these options, please include applicable detailed information.*
Amplifiers Technology/Construction

• GaAs FET/GAN/MMIC [Chip & Wire Hybrid]
  – Narda-MITEQ is not a foundry. We procure the best parts available for the customer specific application.
• KOVAR and Aluminum housings
• Hermetic and Non Hermetic designs.
The Ins and Outs of MITEQ

Offering a Wide Variety of input and output options Today!

Surface Mount
- Mixers
- Amplifiers
- PLL Oscillators

Coaxial
- Standard
- Blind Mate
- 90 Degree

Standard and Custom Waveguide
- Mixers
- Amplifiers
- Converters

Optical
- Broadband RF Fiber Optic
- Amplifiers with FO outputs

Drop in/open Substrate
- Mixers
- Amplifiers

PC Mount
- Flat Pack Loggs
- Hybrid Couplers

Let MITEQ help you process your signals!
Amplifiers

• In-house Screening per MIL-STD-883 and 202
  • Hermetic sealing
  • Leak Testing
  • Temp. Cycling
  • Mechanical Shock
  • PIND
  • Burn-in
  • Vibration
Low Noise Amplifiers

- **Key Specifications/Attributes [What to ask the customer]**
- Frequency Range
- Noise Figure/Noise Temperature @ +23°C
  - *NF varies as a function of temp at a rate of ±0.01dB per °C typ.*
- Gain [Min & Max] & Flatness across Frequency
  - *Gain vs. Temp. (±0.01dB per °C per stage typ.)*
- Operating temperature Range
  - *Most AFS and JS products will operate from -54 to +85°C*
  - *Catalog specifications are at +23°C*
- Linearity [Input & Output IP3]
  - *Most of Narda-MITEQ amplifiers are specified at output*
  - *IP3 not always 10 dB above P1dB*
- Operating Environment [Hermetic?]
- When do they need it!
- Narda-MITEQ web site search engine is a good starting point
Web Site Search Engine

• Start Here!
Applications [LNA]

- Military communications
- Data links [UAV]
- Satellite Communications/In Flight Entertainment
- Space borne Communications [Satellite]
- Radar Front Ends
- Scientific and Research labs
- Radio astronomy, Cryogenic
- EMI/Compliance Testing
In-Flight Broadband

Row 44 offers commercial airlines—anywhere in the world—the most robust and scalable satellite-based in-flight broadband platform.
In Flight Communications/Entertainment

Ka-Band Inflight Communication Solutions

MITEQ offers a wide range of flight proven (RTCA DO-160 E/F) components and subsystems at Ka-Band

Low Noise Amplifiers
- 17.7-21.2 GHz with Noise Figures as low as 1.25 dB
- Lightweight/Hermetic
- Waveguide or Coaxial
- Low Voltage (+5 VDC)

Modular Frequency Converters
- Small Efficient Up/Downconverters
- Wideband IF coverage
- High Linearity

Power Amplifiers
- 26.5-31 GHz
- Power levels to 10 watts
- Adjustable Gain

PIN Diode Switches
- 5P2T-5P4T Coaxial Absorptive type
- High Isolation

Frequency Sources
- Ultra low Phase Noise vibration insensitive
- Stop sizes down to 1 kHz (synthesizer)
KA-Band LNA

- Freq Band: 18-21 GHz
- Noise Figure: 1.25 dB @ +23C
- Hermetic [Electronics]
- DO-160 Qualified
- Optional Integral transmit reject filter 60 dBc @ 30 GHz
- Optional +5 VDC operation
- Optional One watt input limiter
- DC bias through RF output connector [EMI immunity]

SAFSW5-18002100-13-8P
Ku-Band LNA Airborne Direct TV

- 12.2-12.7 GHz
- 0.9 dB NF Typ.
- 23 dB +/- 3 dB
- 1.5 VSWR Max
- 70 mA Typ.
- -50 to +70 deg-C
- Phase matched
- 1/2 Height Waveguide Flange
- RTCA/DO-160 F
- 1700 pcs currently flying

AMFW-3F-12201270-10-15P-APM
UAV Applications
UAV Applications

• Use of UAV’s continues to grow within DOD
• UAV’s have RF applications for Spectrum Surveillance, Radar & Electronic Attack [Jamming].
• UAV’s utilize X/KU/KA bands for Communications [Data Links] and Control back to the ground control Hub. Many of the ground command hubs being deployed use multiple bands for a variety of UAV’s and missions.
• The Frequency bands used for the data links are almost identical to many existing Satcom Bands [existing Narda-MITEQ products]!
• Applications for Narda-MITEQ amplifiers on both ends of the Data Link [Ground & Airborne].
UAV KA-Band LNA’s

Waveguide Low Noise AMPLIFIERS

Airborne Ka-Band Low Noise Amplifier

- Small size at 1.18” X 0.97” square
- Lightweight (less than 23 grams)
- Hermetically sealed
- Operating temperature range of -30 to +65°C
- Noise temperature of 97K (1.25 dB NF)
- Low power dissipation of less than a watt
- Optional RF input limiters, DC power connections and waveguide flanges are also available

Ka-Band

- Weather tight enclosure with hermetically sealed hybrid MIC
- Pressure windows available
- Various waveguide flanges available
- Optimizable narrow band performance
- Adaptable for cryogenic applications
- Space qualifiable

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Compliance Testing Application
Compliance Testing Applications

- Semiconductor Manufacturer/Designer
- Computer Manufacturers
- Third Party Test labs
- T & M Equipment Manufacturers [OEM]
- Automotive Test Labs
- Medical Equipment Manufacturers
- Cellular Phone Industry
Amplifier Strengths

• Large Diverse Catalog Offering [Over 5,000 models]
• Excellent starting point for custom applications
  – *Low or no NRE in many cases*
• Wide Freq Coverage: 1 KHz-67 GHz
• Commercial & Hi-Rel Grades
  – *Hybrid assemblies use the same MIL-STD-883 Inspection criteria and assembly processes*
• Wide range of mechanical outlines [Surface mount, Coax, Waveguide, etc]
• Wide range of Standard options
• More Multipurpose amplifiers being built for stock
• Web Store [shows what is in stock and price]
• Make it easy for the customer to buy from Narda-MITEQ!
• Three Year Warranty for all indoor application!*
What we need from the field force

• Customers sometimes ask for a specific model amplifier.
• Please ask the basic performance requirements about Freq.Band, NF, Package Etc. as covered earlier!
• The customer may be able to use an alternative amplifier model.
• Always ask how soon the customer needs his parts and if there are tradeoffs between his specs vs Schedule!
• Use the web portal to help your customer find an amplifier model and quote it. You will have that capability!
• Know the customers price points also!
• This will help us decide on which way to proceed!