RF Components and Subsystems

NANOWAVE Technologies Inc. is a privately owned Canadian manufacturer of advanced high reliability RF and microwave components, modules and subsystems for the Aerospace, Avionics, Defense, Industrial and Medical markets.

At NANOWAVE all critical processes are conducted in-house to provide a controlled supply chain to the end customer over product life spans up to and beyond 20 years. In house processes include:

- Packaging and Housing Technology
- Thin-Film Technology
- Semiconductor Device and MMIC Design
- RF Circuit Engineering
- RF Filter Design
- Circuit Card Design and Manufacturing
- Assembly and Integration
- Electrical and Environmental testing
- Quality Assurance

The foundation of the NANOWAVE product is a proprietary, high reliability, hybrid monolithic integrated circuit (HMIC) process. The HMIC process integrates bare die with in-house thin film circuits which are then hermetically sealed within a modular assembly. The resultant circuits can be sustained over product lifetimes of up to and beyond 20 years without change in module function or physical form fit making NANOWAVE product ideally suited to the high reliability long duration product requirements of aerospace and defense applications.

The RF subassemblies comprise Solid-State Power amplifiers, Up-/Down-Converters, Filters, Synthesizers, Low-Noise Receivers, and Limiters. All RF blocks can be complemented by sophisticated Digital Control Interfaces, which allow interrogation from supervision systems, enabling remote status reporting on all major subsystem parameters, such as voltages, currents, or RF power levels.

NANOWAVE uses the following integrated circuit processes in its HMIC modules and is continuously reviewing and assessing the potential of new technologies to address customer requirements:

- Gallium Nitrid (GaN)
- Gallium Arsenid (GaAs)
- Silicon Germanium (SiGe)
- Bi-polar CMOS (BiCMOS)
- High Power Silicon (LDMOS)
- Indium Phosphide (InP)
Product Overview

NANOWAVE's product portfolio covers a wide range of RF modules, components, subsystems, systems and sophisticated assemblies for the following Markets

- Commercial Aerospace
- Defense
- Communications
- Industrial
- Medical

NANOWAVE RF products can be found in applications such as

- Airborne and Ground-based RADAR
- SatCom
- Terrestrial Communication

NANOWAVE’s Aerospace products can be found on the following platforms

- A380
- B787
- A320
- B737
- F-18
- P-3

Fig. 1: Overview on NANOWAVE’s Product Portfolio and Markets

<table>
<thead>
<tr>
<th>Category</th>
<th>Market</th>
<th>GaAs / GaN</th>
<th>Thin Film</th>
<th>Transmitter &lt; 400 W</th>
<th>Transmitter &gt; 400 W</th>
<th>Signal Sources</th>
<th>Frequency Converter</th>
<th>High-Power Transceiver</th>
<th>Broadband SSPA</th>
<th>Active Array</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Aerospace (CA)</td>
<td></td>
<td>GaAs/GaN</td>
<td>rF Capacitor</td>
<td>100/200 W Gann</td>
<td></td>
<td>Miniature Tx / Rx</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defense</td>
<td></td>
<td>Thick Copper substitute</td>
<td>400 W X-Band Tx</td>
<td>4 kW L-Band (Pulsed)</td>
<td></td>
<td>Data Link Tx/Rx</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SatCom &amp; Fiber Optics</td>
<td></td>
<td>LASER Mount</td>
<td>200 W INMARSAT Tx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
<td>4-pole SAW Filter</td>
<td>600 W X-Band (Pulsed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td></td>
<td>Quartz Capacitor</td>
<td></td>
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</tbody>
</table>

Fig. 1: Overview on NANOWAVE’s Product Portfolio and Markets
FACTS ON THE TECHNOLOGY

ACTIVE DEVICE TECHNOLOGY

NANOWAVE uses GaN, GaAs, SiGe, BiCMOS, LDMOS, and InP bare die active devices in its RF subassemblies in order to obtain:

- Best possible thermal management
- High efficiency
- Lowest parasitics
- Smallest size
- Multi-octave matching
- Multi-decade obsolescence mitigation

All RF subassemblies are packaged into hermetically sealed housings to achieve high reliability and high MTBF performance.

KEY TECHNOLOGIES

NANOWAVE has all manufacturing technologies in-house to produce high volumes of complex assemblies. This comprises:

- Engineering
- Chip Design
- Thin Film Technology
- Packaging Technologies (Machining, Reflow)
- Surface Mount Technology (PCB and Ceramic)
- Hybrid Module Assembly (Pick & Place, Eutectic Pick & Place, Automated Wire Bonding)
- Integration
- Test & Tune
- Quality Assurance (Electrical and Environmental testing)

FREQUENCY BAND DEFINITION

<table>
<thead>
<tr>
<th>Band</th>
<th>Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>S</td>
<td>2.0 - 4.0</td>
</tr>
<tr>
<td>C</td>
<td>4.0 - 8.0</td>
</tr>
<tr>
<td>X</td>
<td>8.0 - 12.0</td>
</tr>
<tr>
<td>Ku</td>
<td>12.0 - 18.0</td>
</tr>
<tr>
<td>Ka</td>
<td>28.0 - 32.0</td>
</tr>
<tr>
<td>BB</td>
<td>Broad band (multi octave)</td>
</tr>
</tbody>
</table>

QUALITY ASSURANCE

NANOWAVE Technologies Inc. is certified to the following standards:

- ISO 9001:2008
- AS 9100

The products are qualified and tested according to the following standards:

- DO-160
- MIL-STD-883
- MIL-C-9858A
- MIL-PRF-38534C
MINIATURIZED T/R MODULES

Based on NANOWAVE's Thin Film and Package Manufacturing capabilities, very compact and light-weight transceiver modules can be realized. These miniaturized Tx and Rx modules comprise the listed features. A full Transceiver subsystem is obtained by complementing these T/R modules by a SSPA module.

Special Features

Rx Module
- Input signal Limiter
- LNA
- Image Rejection Mixer
- Low-Pass Filter
- Gain stages
- Multiplier
- Band-Pass Filter

Tx Module
- Driver SSPA
- Gain Stages
- Band Pass Filter
- Multiplier

Fig. 2: Miniaturized X-Band Tx and Rx Modules
(size: 2.51 sq.in., weight: < 1 oz)

Rx Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Band</th>
<th>Input Frequency GHz</th>
<th>IF Frequency MHz</th>
<th>Conversion Gain dB</th>
<th>Input 1dB Compression Point dBm</th>
<th>Image Rejection dB</th>
<th>Spurious dBc</th>
<th>Operating Temperature ºC</th>
<th>Size inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWRX0812-00</td>
<td>X/L</td>
<td>8.0 - 12.0</td>
<td>L-Band</td>
<td>29.0</td>
<td>-25.0</td>
<td>&gt; 25</td>
<td>-60</td>
<td>-55 - +85</td>
<td>1.75 x 1.6 x 0.215</td>
</tr>
</tbody>
</table>

Tx Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Band</th>
<th>Output Frequency GHz</th>
<th>IF Frequency MHz</th>
<th>Output Power dBm</th>
<th>Carrier Supression dBc</th>
<th>Carrier Leakage dBc</th>
<th>Spurious dBc</th>
<th>Operating Temperature ºC</th>
<th>Size inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWTX0812-33</td>
<td>L/X</td>
<td>8.0 - 12.0</td>
<td>L-Band</td>
<td>+9.0</td>
<td>36.0</td>
<td>22.0</td>
<td>-70</td>
<td>-55 - +85</td>
<td>1.75 x 1.6 x 0.215</td>
</tr>
</tbody>
</table>

All specifications are subject to change without notice. Full Data Sheets of NANOWAVE products are available on request at sales@nanowavetech.com.
ABOUT NANOWAVE

NANOWAVE Technologies Inc. was founded in 1992 and is a leading Canadian Designer and Manufacturer of Advanced Microwave and Millimeter Wave Components and Sub-Systems for the Radar, Communications, Industrial and Medical markets.

The company’s products can be found on the most advanced commercial and defense aircrafts, as well as ground based Radar and Communication Systems.

NANOWAVE’s commitment to annual investments in R&D combined with in-house control of critical design, manufacturing and test processes results in rapid response to our customers’ demands for:

- Customization
- Obsolescence Mitigation
- Demanding Technical Specifications
- On-time Delivery
- High Reliability
- Traceability

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