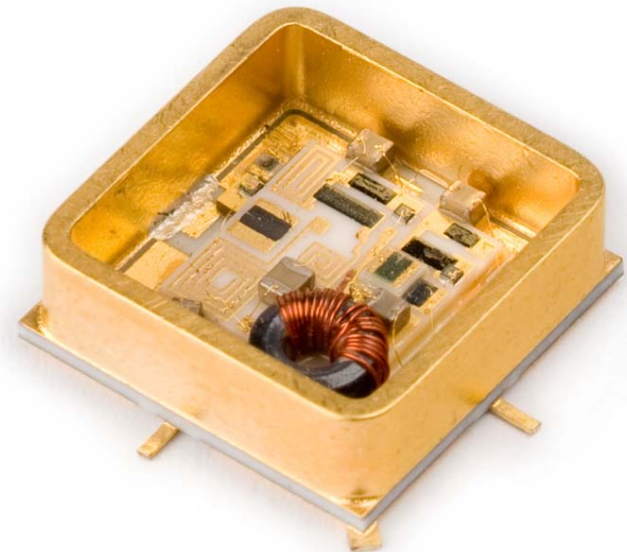


Amplifiers | Packages-Hybrid

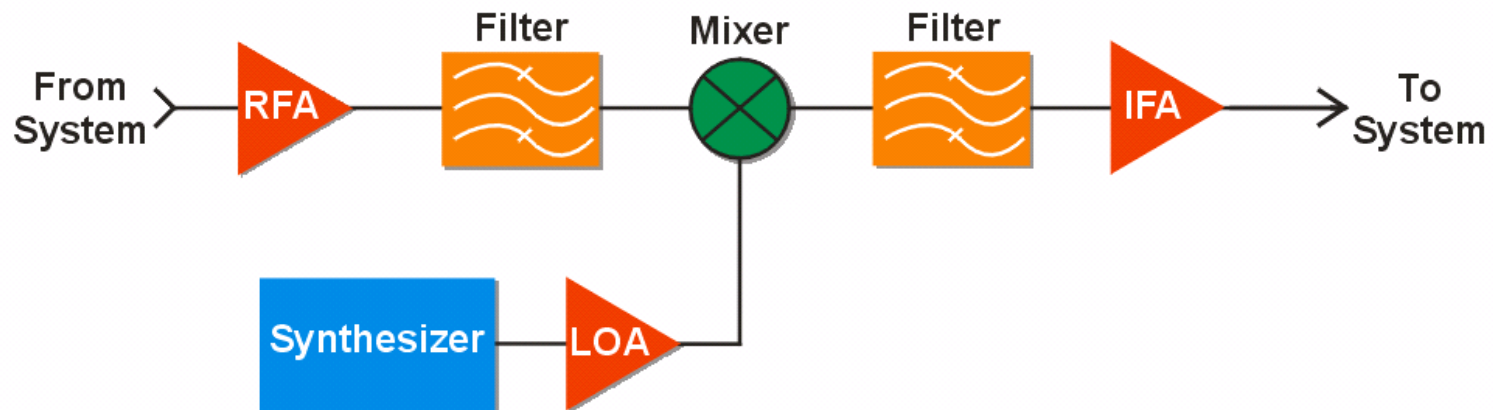
- **Hermetically Sealed**
 - 100% testing over temperature extremes
 - Gross and fine leak
 - Constant acceleration up to 10,000 g
 - 160 hour burn-in at 125°C
- **Ceramic Surface Mount (QBH-8000 series)**
 - Alumina substrate and cover
 - Thick film metallization
 - Utilize both chip & wire, and SMT components
 - 100% testing at 125°C
- **Generation II (QBH-2000 series)**
 - Soft substrate (PTFE) designs
 - Strictly surface mount components
 - Assembled with Sn96
- **Standard Commercial**
 - Developed by large manufacturers (i.e. Motorola, Philips)



Amplifiers | Performance

• Gain Blocks

- Frequency Range: 1 MHz to 18 GHz
- RF/IF drivers and LO buffer amps in Integrated Microwave Assemblies (IMAs)
- Transistor die - extended operating temperature range, -55°C to +125°C
- Power feedback below 1.5 GHz - high reverse isolation reducing load sensitivity (QBH-1401)
- Frequency selective matching circuits reduces “out-of-band” gain
- Improved efficiency with autotransformers and current sharing
- Low phase noise
- LCA package for cost sensitive programs (< \$35)



Amplifiers | Hi-Reverse Isolation

- **Palm Bay (previously Q-bit) Hi-Reverse Isolation designs are typically 10-15 dB better than general RF amplifiers**
- **Excellent in Synthesizers, Exciters and Oscillator Assemblies**
- **Often saves customer the price and real estate of an isolator**



Amplifiers | Low Noise Performance

- **Low Noise Amplifiers**

- 10 MHz to 6000 MHz
- Low frequency (<500 MHz) designs generally use silicon bipolar transistors and incorporate the low loss benefits of power feedback to adjust gain and VSWR
- High frequency (>500 MHz) designs based on GaAs MESFET and PHEMT technology
- Integrate high Q components (i.e. air coils, low ESR caps)
- Discrete first stage followed by MMICs



- **QBH-920**

- 30-200 MHz
- 1.4 dB typical noise figure
- 8.0 dB gain
- 3rd/2nd order IP: 42/59 dBm
- +15.0 Vdc/29 mA

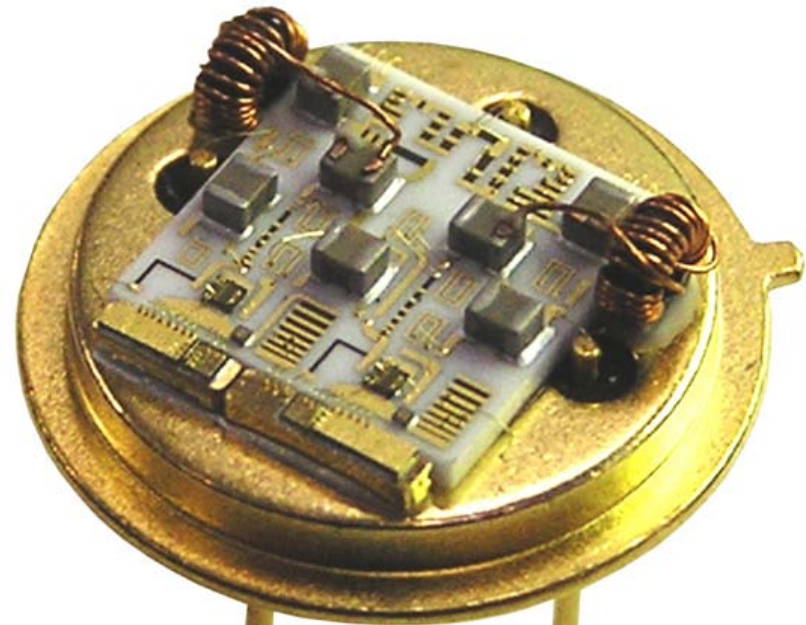
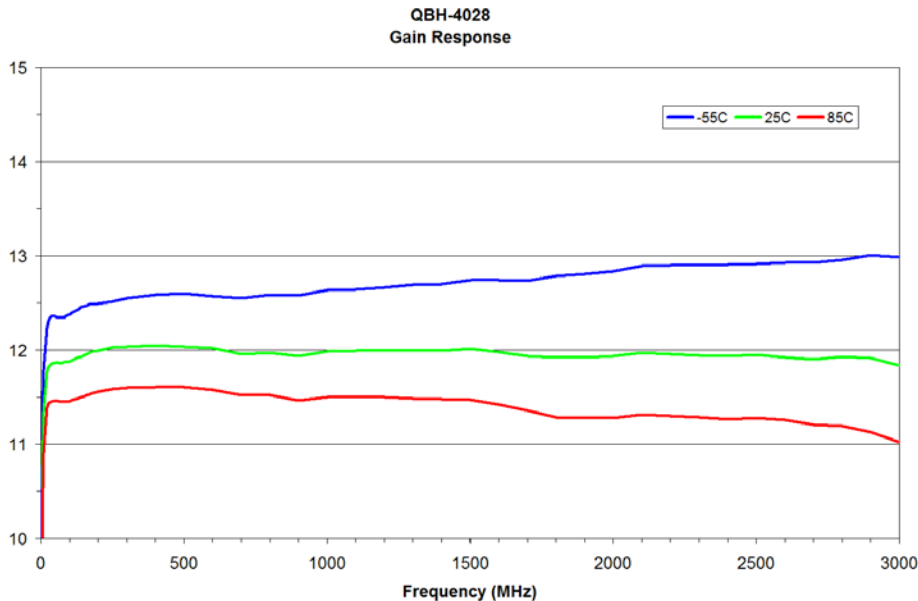
- **QBH-2001**

- 1200-1600 MHz
- 0.85 dB noise figure
- 22.0 dB gain
- +3.0 dBm P1dB
- +5.0 Vdc/40 mA

Amplifiers | Broadband Performance

• Broadband

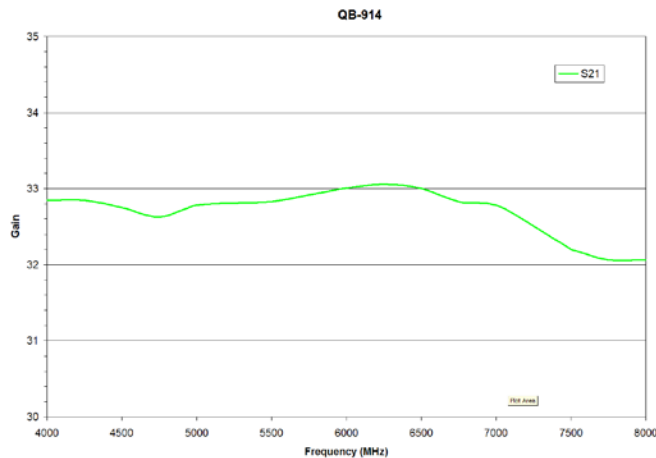
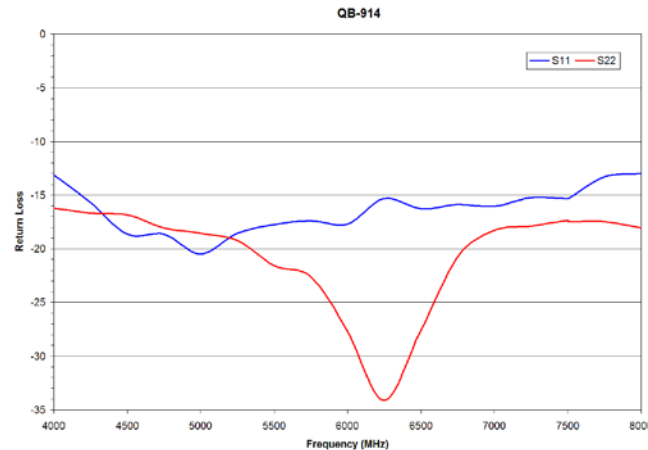
- Combine low Q resistive feedback networks, voltage shunt and current series, to establish gain window and input/output VSWR
- Use discrete Silicon Bipolar or GaAs MESFET/PHEMPT devices in die form to tightly control the parasitic inductance of wire bonds



Amplifiers | Low Noise Amplifiers

• QB-914

- 4.0-8.0 GHz
- Gain: 32 dB typical
- NF: 1.8 dB
- P1dB: 17 dBm
- 3rd order IP: 23 dBm
- +12 Vdc/125 mA



Amplifiers | High Dynamic Range Performance

- **High Dynamic Range**

- Relatively low noise with excellent linearity (low distortion)
- Bias medium power transistors (<4 watts) at 10-20% loss to achieve an optimum tradeoff between noise figure and distortion
- Low frequency (<200 MHz) designs - push-pull configuration using Si bipolar devices in a patented feedback topology (QB-101)
- Used as the input stage in multi-carrier receivers. Allows reception of large input signals without distorting the amplifier output.



- **QB-101**

- IF Amplifier
- 2-70 MHz
- 22.0 dB gain
- 4.0 dB Noise Figure
- 3rd/2nd Order
 - Output IP3 +54 dBm
 - Output IP2 +110 dBm
- +24 Vdc/400 mA

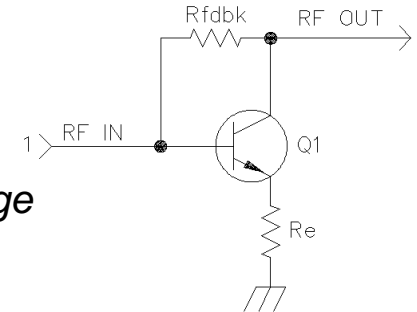
- **QBH-5674B**

- Military/Space
- 3.0-4.0 GHz
- 15.0 dB gain
- 1.7 dB Noise Figure
- +36.0 dBm 3rd Order OIP

Amplifiers | Architecture/Topologies

• Resistive Feedback

- Ultra wideband with performance over multiple octaves
- Reverse isolation is typically 6 dB higher than the gain
- Easy to integrate making it ideal for multiple gain stages in a small package



• Resistive Feedback

- Use twisted-wire transformers, printed 3 dB hybrids, or Lange couplers to combine parallel stages, 90° out of phase
- Maintain excellent input/output VSWR while intentionally mismatching the RF transistor to optimize noise figure, output power, and distortion
- Redundant design - if a branch fails, noise figure increases 3 dB and gain drops about 6 dB

• Push-Pull

- Baluns (**balanced** to **unbalanced**) connect parallel cascode stages 180° out of phase
- Broadband with excellent gain stability and linearity, especially the 2nd Order OIP. Configuration theoretically cancels even-harmonic distortion products

Amplifiers | Ultra Low Phase Noise Performance

• Ultra Low Phase Noise

- We achieve **guaranteed** (100% tested) performance using high performance silicon bipolar transistors in unique circuits up to 2 GHz

• Benefits

- Improves error rate in telemetry apps
- Improved sub-clutter visibility in radar apps
- Better signal to noise ratio in receivers

TM9119PM

Frequency	Typical	Guaranteed
100 Hz	-165	-160 dBc/Hz
1 kHz	-172	-167 dBc/Hz
10 kHz	-177	-172 dBc/Hz
100 kHz	-179	-174 dBc/Hz
1 MHz	-180	-175 dBc/Hz



Spectrum is the **only hybrid amp manufacturer** that guarantees low-phase noise performance on its standard line of parts. We've invested heavily in high-performance test equipment including Agilent network analyzers, low-phase noise signal generators, an enhanced Agilent ES5500 phase noise measurement system, and additional in-house environmental test equipment

Amplifiers | Ultra Low Phase Noise Performance

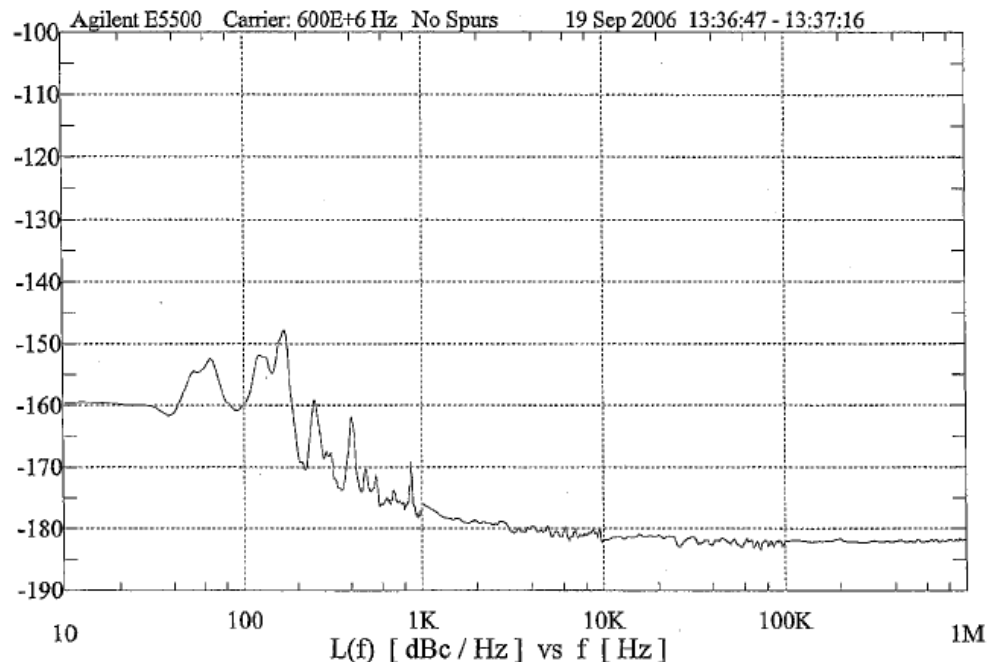
- Ultra Low Phase Noise

- **Guaranteed performance** (100% lot testing) up to 6.0 GHz

- Frequency <2 GHz

- Use silicon **bipolar transistors**. Combine multiple die with high f_t in parallel to achieve bandwidth and power

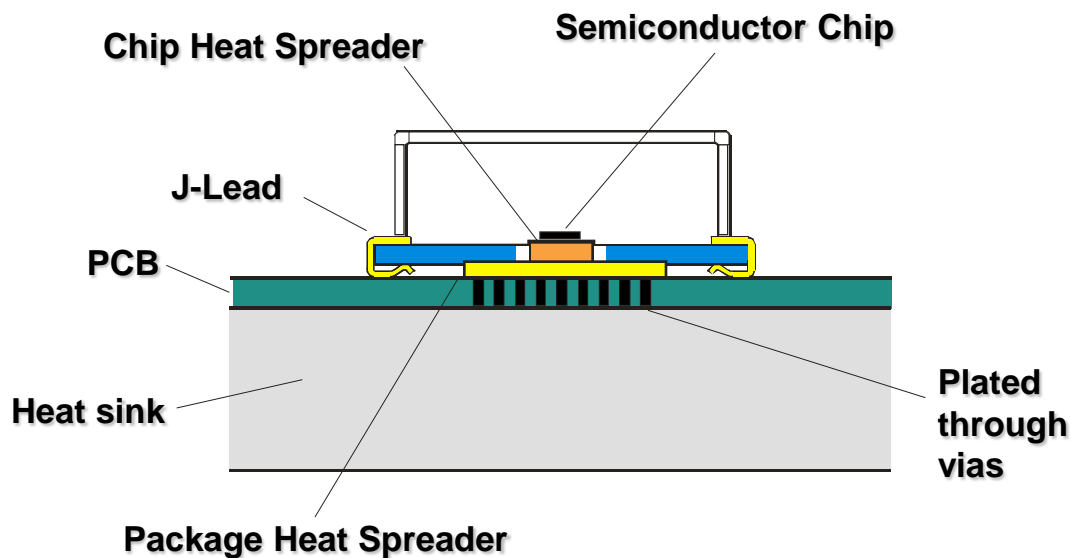
600 MHz @ Pout = +24 dBm



Amplifiers | Ceramic Lower Cost Amplifiers

• Ceramic Surface Mount Hybrid

- Units shipped in feeder tubes, or tape & reel for automated PCB assembly
- Able to convert designs in hermetic packages into cost-effective surface mount solutions for the customer without performance degradation
- Excellent thermal characteristics - RF transistor is eutectically attached to a copper carrier, which is soldered directly to the package heat spreader



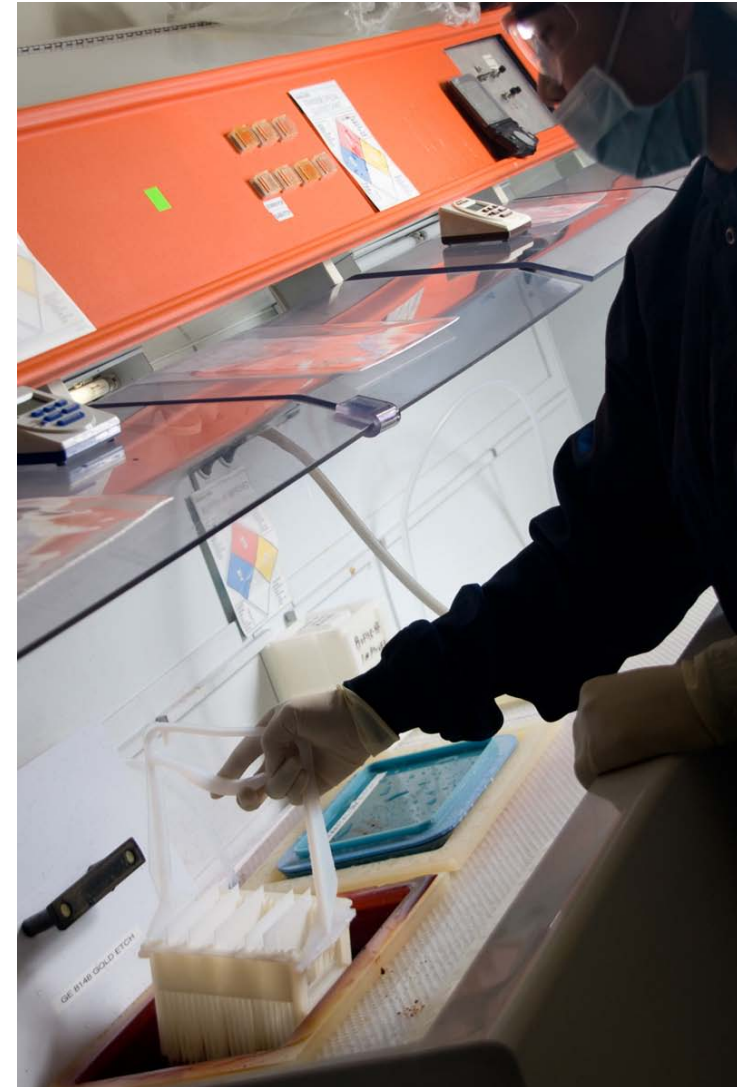
Amplifiers | Ceramic Lower Cost Amplifiers

- **PCB Materials: Thin Film**

- High circuit density with fine line geometries
- Purchase metallized substrates - Alumina (99.5%), BeO and AlN
- State College facility capable of etching circuit patterns with an accuracy of 2.0 mil wide lines and 2.0 mil spacing

- **PCB Materials: Thick Film**

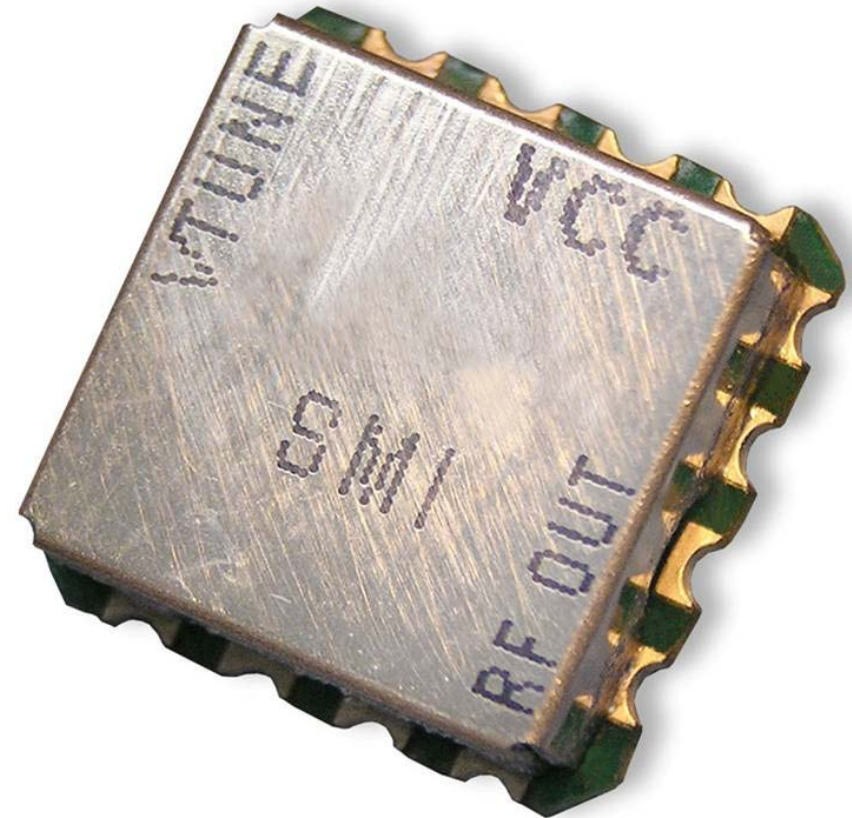
- Purchase Alumina (96%) substrates with machined vias and/or slots for transistor carriers
- Screen print and fire the circuit pattern with the following pastes:
 - Gold - wire bonding
 - Palladium silver - solder chip components, thermocompression (TC) welding
 - Resistive pastes - bias networks/attenuators
- Thick film copper available for high volume applications



Amplifiers | Generation II Package

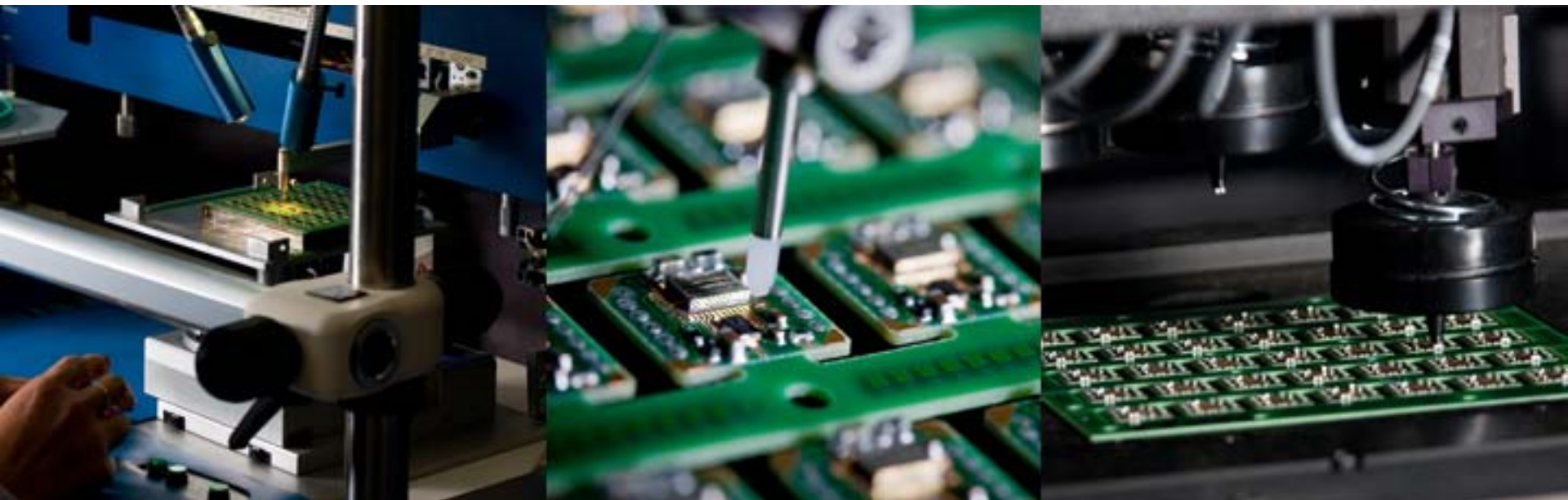
- **Generation II Product**

- *Packaged in tape & reel for pick and place applications.*
- *Completely automated assembly with a single reflow to attach components and cover*
- *No tuning / alignment*
- *Metal cover provides circuit isolation*
- *LNA and lower power ($P_{1dB} < 26 \text{ dBm}$) designs*
- *Intended for high volume applications; price < \$15*



Amplifiers | Ceramic Lower Cost Amplifiers

- **LCA assembled with high volume processes**
 - *Extensive use of fixtures*
 - *Screen print solder paste in the array*
 - *Align and reflow backside heat spreader in the array*
 - *Eutectic attach transistor in SST (vacuum reflow) using carbon “boats” to align die on copper carrier, 20x20 matrix or larger*
 - *Automated pick & place of chip components in the array*
 - *Autobonder*



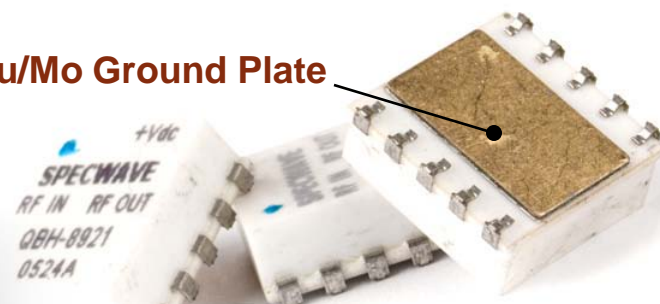
Amplifiers | Ceramic Lower Cost Amplifiers

• Provides Cost Effective Solution

Customer's needs	Spectrum's LCA	MMICs
Never Obsolete	✓	End-of-life / Next generation forces system redesign.
True 50 Ohm Match	✓	Additional components means additional design time and Real Estate.
Superior Phase Noise	✓	Not tested or guaranteed in production.
Guaranteed Performance -55°C to +85°C	✓	Always Typical Values / Graphs.
No External Components Needed	✓	Blocking caps are just the beginning...
Low Cost	✓	✓

- Frequencies to 4000 MHz
- Output power to 4 watts
- Noise as low as 0.8 dB
- No external biasing or RF matching circuits required
- Available in tape & reel

Large Cu/Mo Ground Plate



Amplifiers | Broadband Power Amplifiers

• QB-904

- Class AB, 3 stage design
- +24 VDC/900 mA @ Pout
- Balanced architecture for good VSWR
- Combination of PHEMPT and GaN device technologies in die form
- 35 dB gain with 4 watts Pout



Specifications

Parameters (Typical at 25°C)

Power Amplifier Models

Amplifier Series	QB-904 (4 watt)	QB-910 (1/2 watt)	QB-909 (Medium Gain)
Frequency Range (MHz)	2,000-6,000	2,000-6,000	2,000-6,000
Gain (dB)	35	27	17
Gain Flatness (dB)	+/- 2.5	+/- 2.0	+/- 1.0
Power Output (dBm)	+36	+28	+19
DC Voltage (Vdc)	23-29	23-29	8
DC Current (mA Quiescent)	285	185	100
Noise Figure (dB)	8	7	5.5
RF Input/RF Output Connector	SMA Female or Gold Plated 0.015 pin		
DC Input	SMA Female or Gold Plated 0.015 pin		

Amplifiers | Performance

- **Medium Power**

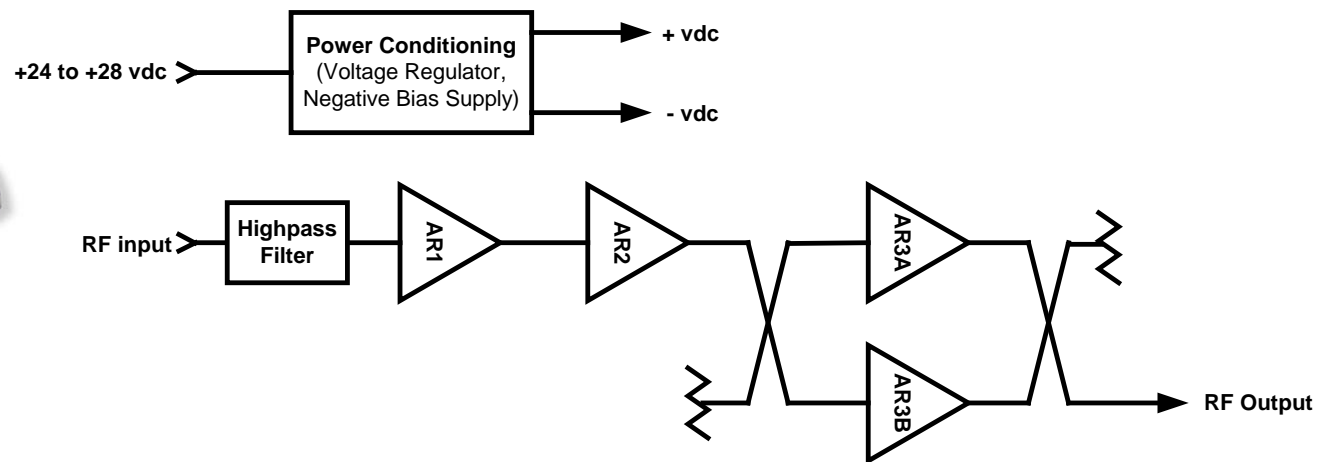
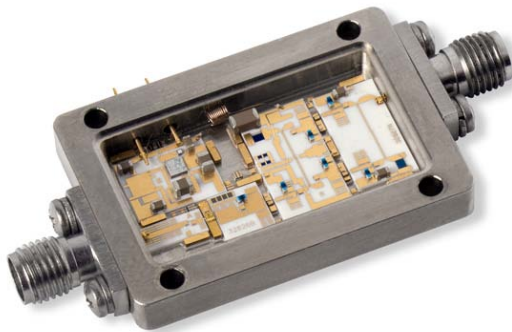
- Frequency range - 1 MHz to 6 GHz
- Hybrids are class A with output powers up to 4 watts @ P1dB
- Connect parallel stages in a push-pull or balanced configuration
 - Design miniature 90° hybrid couplers and baluns - adjust the windings to optimize parameters
 - Topology distributes heat throughout the package



Amplifiers | QB-904 Performance, 4 watts 2-6 GHz

• QB-904

- 3 Stage Amplifier with Internal Voltage Regulation
- Class AB Biased for Radar, Jammers, Communications Transmit Applications
- Balanced Output Stage for Good Broadband Output Return Loss
- 4 watts Output Power over 2 to 6 GHz Band
- Filtered Input (18 dB/Octave filter roll-off)
- Latest Gallium Nitride (GaN) device Technology
- 38 dB Small Signal Gain
- Connectorized or Printed Wiring Board Mount (solder attach 0.015" pins)
- Small Size
- Optional Heat Sink Available



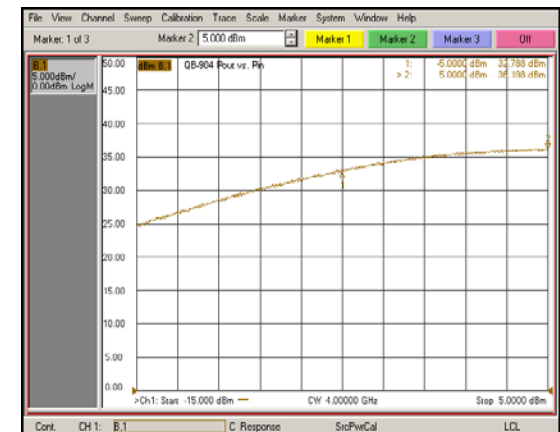
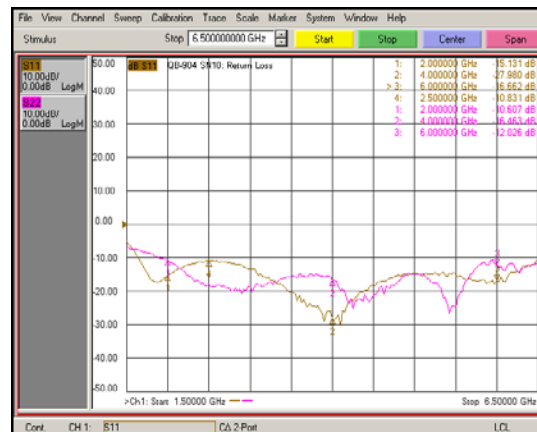
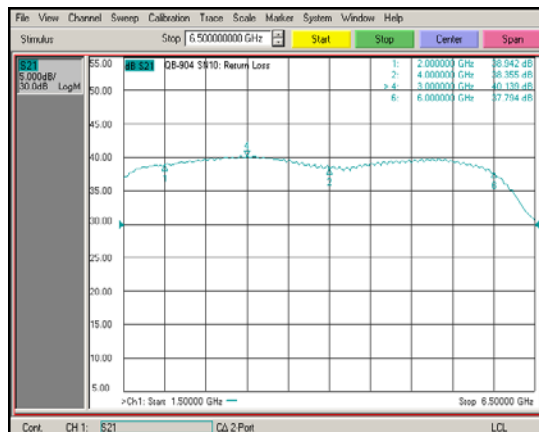
Amplifiers | QB-904 Performance, 4 watts 2-6 GHz

Specifications

Parameters (Typical at 25°C)

Typical Specifications

Frequency Range	2.0 to 6.0 GHz
Small Signal Gain	38 dB
Gain Flatness	+/- 3.0 dB
Input Loss Return	10 dB
Output Return Loss	12 dB
Output Power (Psat)	+36 dBm
DC Voltage (Vdc)	+23 to +29 VDC
DC Current (mA Quiescent)	285 mA
Noise Figure (dB)	8 dB
RF Input/Output Connector	SMA Female or Gold Plated 0.015 pin
DC Input Connector	SMA Female or Gold Plated 0.015 pin



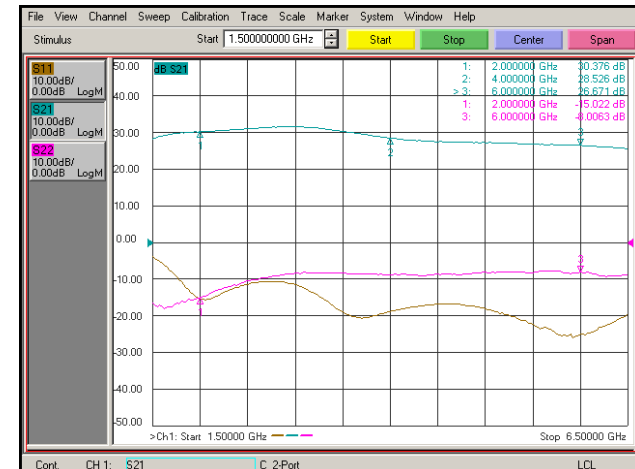
Amplifiers | QB-910 Performance, 0.5 watts 2-6 GHz

Specifications

Parameters (Typical at 25°C)

Typical Specifications

Frequency Range	2.0 to 6.0 GHz
Small Signal Gain	27 dB
Gain Flatness	+/- 2.0 dB
Input Loss Return	10 dB
Output Return Loss	8 dB
Output Power (Psat)	+28 dBm
DC Voltage (Vdc)	+23 to +29 VDC
DC Current (mA Quiescent)	185 mA
Noise Figure (dB)	8 dB
RF Input/Output Connector	SMA Female or Gold Plated 0.015 pin
DC Input Connector	SMA Female or Gold Plated 0.015 pin



Amplifiers | QB-909 Performance 19 dBm, 2-6 GHz

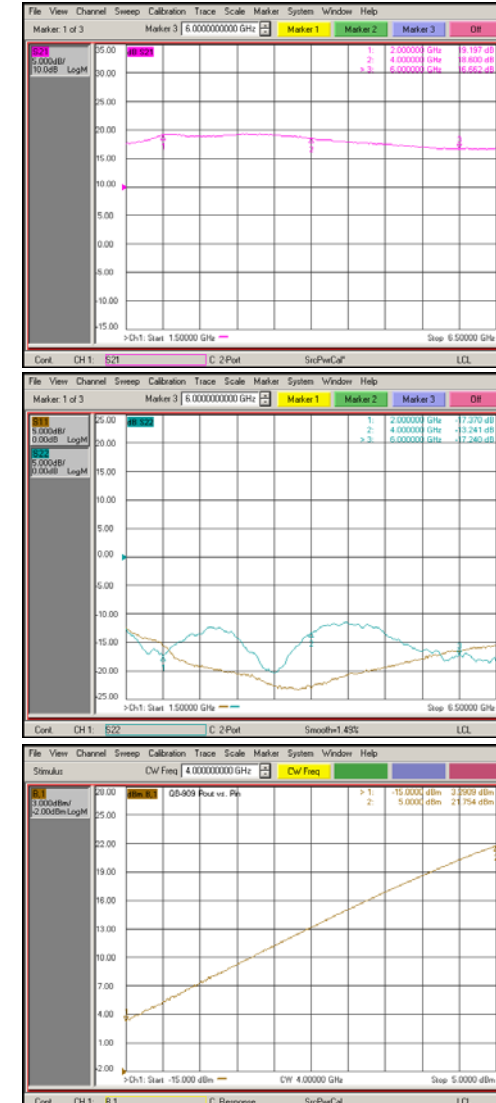
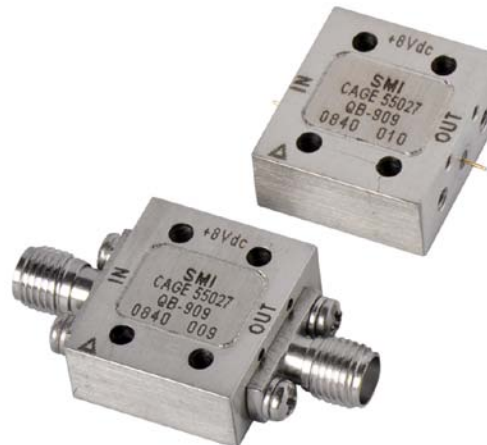
Specifications

Parameters (Typical at 25°C)

Typical Specifications

Frequency Range	2.0 to 6.0 GHz
Small Signal Gain	17 dB
Gain Flatness	+/- 1.0 dB
Input Loss Return	12 dB
Output Return Loss	12 dB
Output Power (Psat)	+19 dBm
DC Voltage (Vdc)	+8 VDC
DC Current (mA Quiescent)	100 mA
Noise Figure (dB)	5.5 dB
RF Input/Output Connector	SMA Female or Gold Plated 0.015 pin
DC Input Connector	SMA Female or Gold Plated 0.015 pin

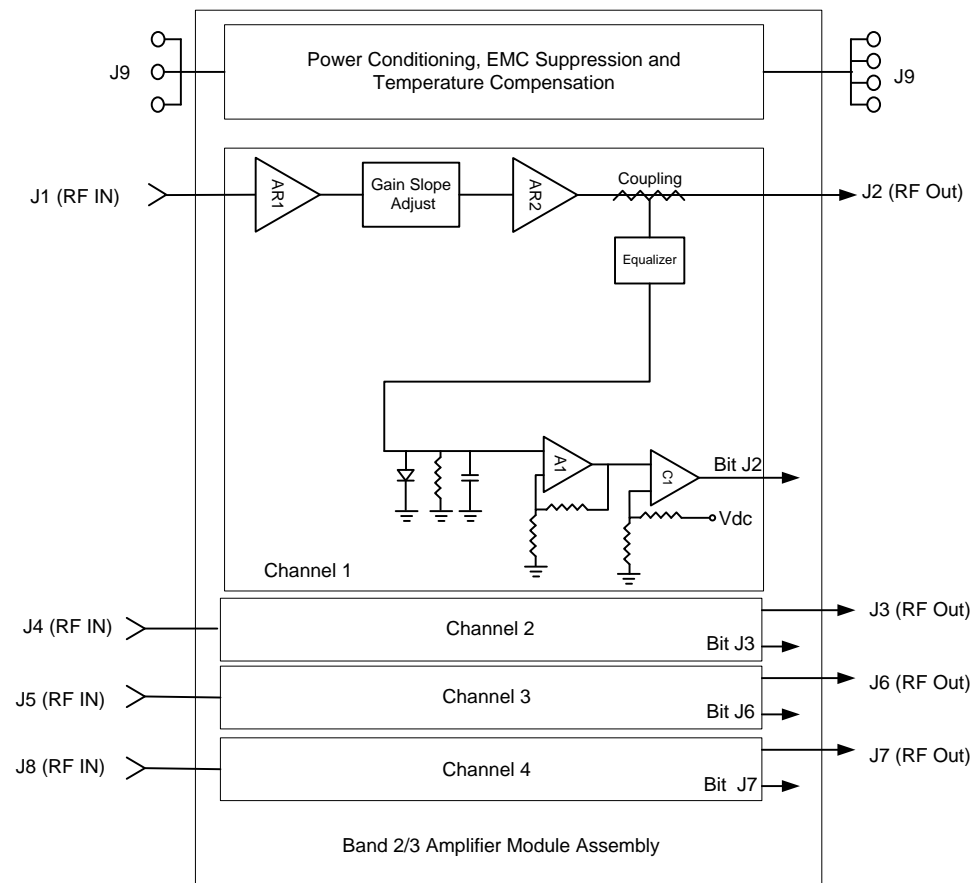
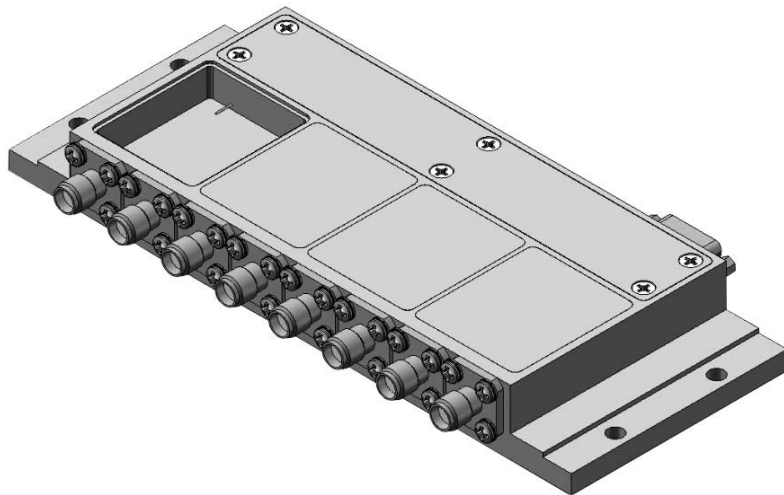
- Single stage amplifier
- Class A biased for radar, jammers, communications transmit applications
- P1dB +18 dBm over 2-6 GHz band
- 18 dB small signal gain
- Connectorized or printed wiring board mount (solder attach 0.015" pins)
- Small size, hermetically sealed



Amplifiers | High Frequency Integrated Amplifiers

• QB-911

- Frequency 2-18 GHz (4 phase tracked amplifier assemblies)
- Consists of...
 - 2 stage amplifier (4 channels)
 - Broadband detector
 - Gain compensator
 - Digital fault circuits
 - Power conditioning
 - Complex packaging



ISO 9001:2000 Quality Operating System

- **MIL-PRF-38534 Product Screening and qualification capability**
 - Device screening and groups A, B, C, and D qualification (when required by order)
 - Environment testing per MIL-STD-883 test methods
- **Other specifications guidelines**
 - J-STD-001 Class 3 and IPC-A-610, for eutectic attach and general soldering processes
 - IPC-7711 and IPC-7721, for rework and authorized repair operations
- **Quality assurance programs**
 - Calibration recall program for test and measurement equipment
 - Facility ESD program
 - Failure analysis and corrective action system
 - Internal ISO audit program
 - Operator training program

