Since it's founding in 1978, American Microwave Corporation (AMC) has been focused on the design and manufacture of DC to 40 GHz Solid State Control Components, integrated Assemblies and Turn-key Systems.

This is still our niche!
Our Customers Come First!

BOEING

LOCKHEED MARTIN

BAE SYSTEMS

ITT

THALES

TELEPHONICS

CUBIC CORPORATION

GENERAL ATOMICS

L3 communications

NORTHROP GRUMMAN

DEFINING THE FUTURE

GENERAL DYNAMICS

at&t
AMC’s Basic Building Blocks

PIN Diode

Cascadable Monolithic Microwave Integrated Circuit (MMIC) MSA-0686

1 - Input
2 - Ground (GND)
3 - Output
4 - Ground (GND)

3 dB Bandwidth: DC up to 0.8 GHz
Gain: typical 18.5 dB at 0.5 GHz

Microwave/Millimeter-wave Monolithic Integrated Circuit
Building on a solid foundation of Control Components

Solid State Attenuators – standard and custom

Detector Log Video Amplifiers – standard and custom

Solid State Switches – standard and custom

Integration of control components
Solid State Variable Attenuators

AMC’s Electronically Variable Attenuators are available in octave and multi-octave bandwidths to 18 GHz. These linearized voltage variable attenuators are programmable and have attenuation ranges from 30-120 dB.
Products and Capabilities . . .

DLVAs

10 MHz to 40 GHz, narrow and broadband
50 and 70 dB dynamic range
all models are DC coupled
linear detector, high sensitivity and miniature models
CW Immunity circuits are available
Standard, Modified Standard and Custom Switches

- SPST to SP48T SP65T
- DC to 40 GHz, narrow and broadband
- Rectangular and radial outlines
- Hermetic and non-hermetic
- Connectorized and surface mount
- High speed, high isolation, low loss
- Variety of driver options
- Modified Standard or custom performance
- Flexibility in semiconductors/diodes
Solid State Switches

A market leader in PIN Diode and GaAs MMIC switches, AMC offers the industries widest range of standard products and options. With a library of nearly 1000 available designs covering 10 MHz to 40GHz in configurations from SPST to SP48T, AMC has an existing solution for most applications available from stock to 60 days.

In addition, AMC welcomes the opportunity to work with customers on unique requirements for low loss, high isolation, phase matching, custom drivers, special testing and non-standard mechanical configurations.
Building on a solid foundation of Control Components

Medium to High Power Solid-State Switches
50 MHz to 18 GHz, narrow and broadband Designs
Unique mechanical outlines
High speed, high isolation, low loss
Variety of driver options
Up to 2 KW CW

10 W, Ku Band

2 W, X-Band

2 KW, L-Band

10 W, S-Band
Integrated Assemblies

Putting the pieces together

Solid State Switch attenuator Technology

In-house designs for attenuators, couplers, Modulators & phase shifters

In-house machine shop, MIC/MMIC lab & custom digital designs

Established relationships with vendors for contract manufacturing and microwave circuit boards

Specialists in the integration of control products
Integrated Assemblies

Specialists in the integration of control products

- We work closely with our customer’s engineering team
- Incorporating our own designs for switches, attenuators, couplers, splitters, bias Ts, modulators, and phase shifters
- Maximize use of internal digital design capability, our own machine shop and MIC/MMIC clean room
- Extensive experience designing and building products for precision MIL standard applications and highly repeatable, automated assembly applications
Building on a solid foundation of Control Components

Integrated Assemblies
MIC hybrid and MMIC integration
Custom digital/logic control designs
Optimized performance
Special packaging
MIL screening
Problem

- How do you maintain good satellite communications with an Army truck on the move?
Solution

- Make a scanning antenna with a 18 port switch
**SPECIFICATIONS**

- **FREQUENCY RANGE**: C-BAND 4486 - 5108MHz
- **INSERTION LOSS**: 2.7dB MAXIMUM @ +25°C
- **ISOLATION**: 30dB MINIMUM
- **OIP3**: 57dBm MINIMUM
- **OPT**: 40dBm MINIMUM
- **VSWR**: 1.5:1 MAXIMUM, 50 OHMS ALL PORTS
- **SWITCHING TIME**: 1μSEC MAXIMUM
- **CONTROL LOGIC**: 5 BIT BINARY TTL COMPATIBLE (SEE TABLE)
- **“0”**: LOW (-0.3 – +0.8V)
- **“1”**: HIGH (+2.0 – +5.0V)
- **POWER HANDLING**: 10 WATTS CW MAXIMUM
- **SURVIVAL POWER**: 150 WATTS PEAK (1μSEC PULSE WIDTH)
- **CONNECTORS**: RF IN/OUT: SMA FEMALE
- **POWER & CONTROL**: 3 SUBMINIATURE MALE
- **DC POWER**:
  - +5V ±0.5V @ 850mA MAXIMUM
  - -15V ±1.2V @ -200mA MAXIMUM

**ENVIRONMENTAL RATING**

- **TEMPERATURE**: -40°C TO +55°C (OPERATING)
- **HUMIDITY**: MIL-STD-202F, METHOD 103B COND. B
- **SHOCK**: MIL-STD-202F, METHOD 213B COND. B
- **VIBRATION**: MIL-STD-202F, METHOD 204D COND. B
- **ALTITUDE**: MIL-STD-202F, METHOD 105C COND. B
- **TEMPERATURE CYCLE**: MIL-STD-202F, METHOD 1070 COND. A

---

**PRODUCT FEATURE**

**AMERICAN MICROWAVE CORPORATION**

7311 G GROVE ROAD
FREDERICK, MARYLAND 21704 USA
TEL: 301-662-4700 FAX: 301-662-4185
WEBSITE: www.americangroovecorp.com
E-MAIL: sales@americangroovecorp.com
ISO 9001:2000 CERTIFIED

**PRODUCT NUMBER**

SWN-188T-089T-SMA
OPTION 4M4885M108, HPR10W

**PRODUCTS SHOWN**

**A** 100-8173

**SPECIFICATIONS**

- **INPUT**: 3 SUBMINIATURE MALE
- **OUTPUT**: SMA FEMALE
- **SWITCHING**: 1μSEC MAXIMUM
- **CONTROL**: 5 BIT BINARY TTL COMPATIBLE
- **POWER HANDLING**: 10 WATTS CW MAXIMUM
- **SURVIVAL POWER**: 150 WATTS PEAK (1μSEC PULSE WIDTH)
- **DC POWER**: +5V ±0.5V @ 850mA MAXIMUM, -15V ±1.2V @ -200mA MAXIMUM

---

**NOTE**: Schematic, bill of materials, parts list, and other data are available upon request. Dimensions are in inches.
BEAM FORMING NETWORK

Challenge:
Cost and Weight Reduction
• Needed smaller form factor
• Lower cost
• Lower component count
Problem

Design requires 3 devices to control phase and amplitude
Solution
control phase and amplitude with one component

- 0 TO 360°, 0 TO 10 dB
Estimate of Phase Noise based on Phase Invariant Attenuator Blocks

\[
\begin{align*}
\frac{d \Delta \rho}{d R} &= \frac{\rho}{R + \zeta}
\end{align*}
\]

In Vector or phasor sum, \( \rho \) is phase sensitivity when \( \rho_1 = \max \) and \( \rho_2 = 0 \)

\( \rho_1 \text{ Max} = 1 \)

\[
\Delta \phi = \Delta \rho_2 / \rho_1 = \Delta \rho_2 / 1 = \Delta \rho_2
\]

When \( \rho_1 = 0 \text{ then } R = \zeta \)

Max Sensitivity from \( \rho_2 \) at \( R = \zeta \)

\[
\frac{d \rho}{d R} = \frac{2 \zeta}{(2 \zeta)^2} = 1/(2 \zeta)
\]

\[
R_{\text{pin}} = K / 1^* \times \text{close to 1}
\]

\[
R_{\text{pin appx}} = K / 1^* = \zeta / (1/_{0.5})
\]

\[
R = \zeta / _{0.5}^* / 1
\]

\[
R_{\text{pin appx}} = \zeta / _{0.5}^* / 1^*^2
\]

At \( I = _{0.5} \)

\[
\frac{d R}{d I} = -\zeta / _{0.5} \times (1/_{0.5})
\]

\[
\Delta I = _{0.5}
\]

\[
\frac{d R}{d I} = -\zeta / _{0.5} \times (1/_{0.5}) \times \Delta I
\]

\[
\Delta \rho = \frac{d \rho}{d R} \times \Delta I
\]

\[
\Delta \rho_2 = \frac{d \rho_2}{d R} \times \Delta I
\]

\[
\Delta \rho_2 = 1/(2 \zeta) \times (-\zeta / _{0.5} \times \Delta I)
\]

\[
\Delta \rho_2 = 1/(2 _{0.5} \times \Delta I)
\]

\[
\Delta \phi = 1/2 \times \Delta I / _{0.5}
\]

AD9754 output noise at \( I_f = 20 \text{ mA} = 50 \text{ pA/\sqrt{Hz}} \)

\( I_{0.5} \) on phase invariant \( \Delta I \) about 1.5 mA

\[
\Delta \phi = \Delta I / _{0.5} \times 50 \text{ pA} \times 1.5 \text{ mA}
\]

\[
\Delta \phi = \Delta I / _{0.5} \times 5.005 \times 1.500 \times 3.332 \times 10^{-8}
\]

\[
\Delta \phi = \frac{1/2 \times \Delta I / _{0.5}}{1.666 \times 10^{-6} \times 1.38 \times 10^{-10} \times \text{dBC/Hz}}
\]

\[
I_{0.5} \text{ mA} >>> 1.5 \times 0.0015
\]

\[
L(f) = (\Delta \phi \text{ RMS})^2 / 2
\]

pp81 Mw & Wi Synth Rhode

\[
1.3888 \times 10^{-10} \times \text{dBc/Hz}
\]

\[
1.58 \times 10^{-13} \times \text{dBc/Hz}
\]
Phase Invariant Digital Programmable Attenuator

DESCRIPTION
The Phase Invariant Digital Programmable Attenuator offers essentially constant phase, adjustable attenuation over 40 dB in the 6 to 18 GHz range. The attenuator utilizes a unique double balanced arrangement of diodes and quadrature couplers to achieve the phase independent attenuation characteristics.

FEATURES
- Excellent Temperature Stability
- High Speed
- Over 40 dB Dynamic Range
- 0.1 dB Digital Resolution
- Uses the latest in digital technology

MECHANICAL OUTLINE

FUNCTIONAL BLOCK DIAGRAM
# Specifications

## Guaranteed Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attenuation Range</td>
<td>40 dB</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>0.5 dB at 50 kHz</td>
</tr>
<tr>
<td></td>
<td>8.0 dB at 18 GHz</td>
</tr>
<tr>
<td>Return Loss</td>
<td>-9.54 dB (2:1)</td>
</tr>
<tr>
<td>Attenuation Accuracy</td>
<td>-0.75 dB</td>
</tr>
<tr>
<td>Flatness</td>
<td>0.1 dB from 0 to 30 dB</td>
</tr>
<tr>
<td></td>
<td>0.05 dB from 30 to 40 dB</td>
</tr>
<tr>
<td></td>
<td>0.01 dB over temp from 0 to 30 dB</td>
</tr>
<tr>
<td></td>
<td>0.015 dB over temp from 30 to 40 dB</td>
</tr>
<tr>
<td>Phase</td>
<td>+5° max. 0 to 30 dB</td>
</tr>
<tr>
<td></td>
<td>+7° min. 0 to 30 dB</td>
</tr>
<tr>
<td></td>
<td>-5° max. 0 to 30 dB</td>
</tr>
<tr>
<td></td>
<td>-7° min. 0 to 30 dB</td>
</tr>
<tr>
<td></td>
<td>0.5° max. 0 to 60 dB over temp.</td>
</tr>
<tr>
<td></td>
<td>1.0° max. 60 to 80 dB over temp.</td>
</tr>
<tr>
<td>Control</td>
<td>0 Ohms, 0.1 Ohm bias</td>
</tr>
<tr>
<td>Switching Speed</td>
<td>250 microsec</td>
</tr>
<tr>
<td>ESD Surge Power</td>
<td>100 volts (not energized)</td>
</tr>
<tr>
<td>ESD Surge Power</td>
<td>50 volts (energized)</td>
</tr>
<tr>
<td>ESD Surge Power</td>
<td>37 volts (energized)</td>
</tr>
<tr>
<td>Temp. Coefficient</td>
<td>0.016°C from 0 to 30 dB</td>
</tr>
<tr>
<td></td>
<td>0.02°C from 30 to 40 dB</td>
</tr>
<tr>
<td>Power Supply</td>
<td>10 VDC @ 500 mA max</td>
</tr>
<tr>
<td>Size</td>
<td>2.5&quot; (L) x 3.5&quot; (W) x 0.4&quot; (H)</td>
</tr>
</tbody>
</table>

## Typical Performance

### Attenuation

![Graph showing attenuation performance](image)

### Phase Variation

![Graph showing phase variation](image)
Challenge

- Engineer a switch matrix that allows for switching multiple antennas to selected ports quickly in a small form factor
- Eliminate the cable nightmare in their previous solution
- Provide remote control
The Solution

12 x 18 Switch Matrix
Using AMC’s standard switch designs
combined with
AMC standard Bias Tee design and custom
Power Dividers
Providing 5 dB I.L. and >80 dB isolation
Custom RS-232 control and LED driver
Designed for medium volume MIL communications application

• Eliminated cables between switch ports
• Very reliable product in a compact form factor
• Provided excellent repeatability a better reliability
• Has the ability to be remotely controlled by host
And..... Provided a scalable building block

Integrated Surface Mount Technology

Modular Switch Matrix Cards

Rack Mount Solid State Switch Matrix Assemblies
Problem

- Assuring good, constant data links for WIFI service on an airplane
Solution

- Signal strength driven switching for internet access on airplanes

2 x 8 Switch Matrix assembly
8 – 2 Ts and 2 – 8Ts
4 discrete BP filters
Custom logic including fault circuit
Multilayer SMT design
<2 dB I.L., >60 db isolation at 1GHz

FAA/Commercial aircraft application
Designed and built initial units in <120 days
Product Brief

SPECIFICATIONS
- FREQUENCY RANGE: 840 - 905 MHz
- INSERTION LOSS: 2.5 dB MAXIMUM
- ISOLATION: 60 dB MINIMUM
- VSWR (INPUT/OUTPUT): 1.5:1 MAXIMUM
- VSWR (TERMINATION): 2:1 MAXIMUM
- POWER HANDLING: 3 WATT CW INJECTED AT THE COMMON PORT
- SWITCHING SPEED: 300 nSEC MAXIMUM
- CONTROL: \( \leq 0.5V = \text{LOW} = \text{FALSE} \)
  \( \geq 2.0V = \text{HIGH} = \text{TRUE} \)
  SEE LOGIC TABLE ON SHEET 2
- POWER SUPPLY: \(+15V \@ 350 mA\) MAXIMUM

ENVIRONMENTAL RATINGS:
- TEMPERATURE: -40°C TO +85°C (OPERATING)
  -65°C TO +125°C (STORAGE)
- HUMIDITY: MIL-STD-202F, METHOD 103B COND. B
- SHOCK: MIL-STD-202F, METHOD 213B COND. B
- VIBRATION: MIL-STD-202F, METHOD 204D COND. B
- ALTITUDE: MIL-STD-202F, METHOD 105C COND. B
- TEMPERATURE CYCLE: MIL-STD-202F, METHOD 107D COND. A

NOTE: Specifications may vary over operating temperature.

* Units are designed to meet Environmental ratings but not tested. If Environmental Testing is required, please contact Sales Department.
Direction Finding Network for a Electronic Warfare Test station

- **Challenge:**
  - Customer had developed a crude prototype
    - The dynamic range did not meet requirements
    - The signal loss was too high within the unit to meet requirements
    - Customer needed a reliable system which was well engineered to deliver to the end user for a critical program
Solution

- Engineered to have low loss, very high dynamic range and very repeatable performance
American Microwave Corporation (AMC) designed and manufactured a highly complex Electronic Warfare test station. The job was awarded to AMC in June of 2012 with an original ship date of March 2013. The schedule was accelerated to a delivery of 12/21/2012 due to a request to deliver the system to a major customer as soon as possible. AMC supplied 8 each high band (2-18 GHz) and 8 each low band (50-2000 MHz) Direction Finding Assemblies plus 1 each of a high band and low band calibration assembly...a total of 18 separate rack mounted chassis assemblies.
A Case Study

AMC designed and built all components except for the bandpass filters in the switched filter assemblies in a record time of approximately 6 months.

The next few slides contain more information and some photos of rack mounted, switched delay line assemblies in their final stages of assembly and test. The units consist of 14 stages of switched delay line “blocks” mounted on a center web (both sides) that is installed in a 2U height rack mounted chassis. The entire unit is powered through a 15 pin D Type connector and a 68 pin control connector. A 26 pin diagnostic connector is also provided for the convenience of troubleshooting and adjusting the gain of each delay block.
Delay Line Blocks

Mounted Delay Line Blocks

High Band Switched Filter Bank

Very Short Low Band Delays
High Band DFU

Low Band DFU

Back of High Band DFU

Back of Low Band DFU
Bottom Line

- Excellent Quality and Performance
- Well Engineered Innovative Solution
- Accelerated Delivery Date (Cut delivery from 9 to 5 Months)
- On Budget

= Very Happy Customer
Markets supported:

Defense Electronics systems
Satellite & Point to Point communications
Industrial & Scientific applications
Instrumentation & Test equipment
Cellular Infrastructure

Defense programs supported include the following:

<table>
<thead>
<tr>
<th>Airborne / UAV / Missile / EW / Jammers</th>
<th>F-15, B-52, Tiger X, Global Hawk ALQ-188, PDF, USM-464, AAM, ALR-67, Wave Core, Scout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground based radar / Missile Defense / air traffic control / Shipboard radar / Communications</td>
<td>Patriot, MK92, ATNAVICS, AEGIS AEGIS, LAMPS, AN/SPQ-9B, SPS-74, CEC</td>
</tr>
</tbody>
</table>
27 of the last 30 months 100% on-time
(99.7% during that time)

% on time

2009-2011
AMC is growing to meet customer’s needs

- Doubling in size of Assembly, Clean room and Test areas
- Significant increases in size of Quality Assurance, Engineering Lab and Machine Shop
- Plenty of additional space to grow
- Based in Frederick MD (~ 1 hour away)
- ITARS approved

15,000 SQ Ft with options for an additional 10,000 SQ FT

7309 Grove Road, Frederick, MD