AN03 Microsemi MMIC Amplifiers with Dynamic Gain Control

Microsemi designs and manufactures GaAs MMIC amplifiers, most of which have 30dB of dynamic gain control. These ICs can be controlled with an opamp circuit, or a microprocessor with a lookup table, to enable real time application-adjustable gain.

This type of amplifier can replace an entire amplifier-attenuator sub-circuit; instead of a fixed-gain amp followed by a voltage-controlled digital or analog attenuator, replace both ICs, the connecting substrate, and at least two sets of wirebonds with a single adjustable-gain IC, shown in *Figure 1*.

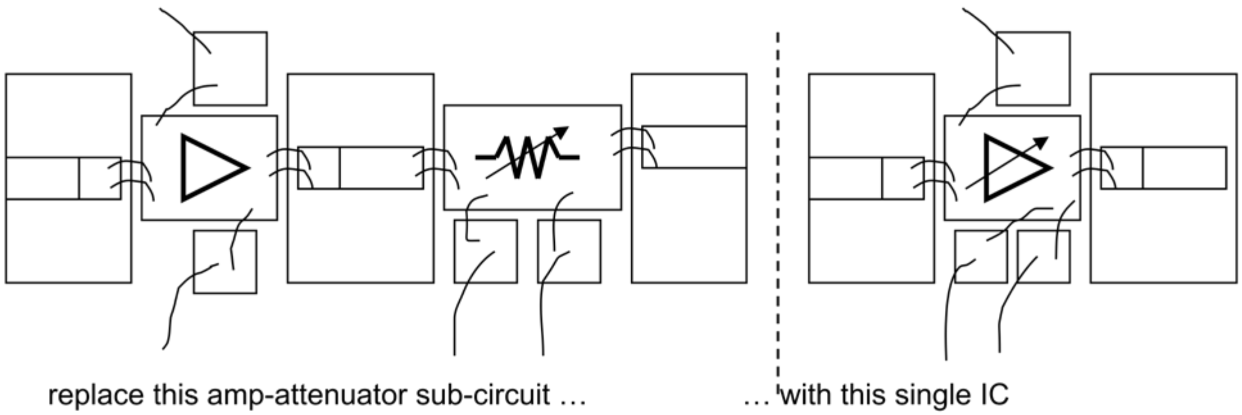

Figure 1. Replacing amp-attenuator sub-circuit with dynamic-gain amp

Benefits of a dynamic gain amplifier versus an amplifier-attenuator sub-circuit:

- Reduced component count, decreased bill of materials
- Reduced assembly time, reduced MMIC variation (one IC vs. two ICs)
- Similar logic requirements to an analog voltage-controlled attenuator

Limitations of dynamic gain control:

- Control voltages are somewhat non-linear and require opamp or microprocessor with lookup table (see *Table 1* and *Table 2*)
- Output power of dynamic-gain amp decreases when gain is decreased
- Not ideally appropriate for power attenuation due to harmonic distortion and nonlinear gain compression (see *Figure 4*)
- Drain voltage and 2nd gate voltage must not exceed the process breakdown voltage; users must adhere to the maximum specifications in the datasheet

Table 1 · Maximum specifications provided in the datasheet

Device	Dynamic range	Max gain (2-20GHz)	Min gain (2-20GHz)	Sensitivity (0-10dB)	Sensitivity (10-30dB)
MMA025AA	~30dB	18dB	-13dB	5mV/dB	3mV/dB

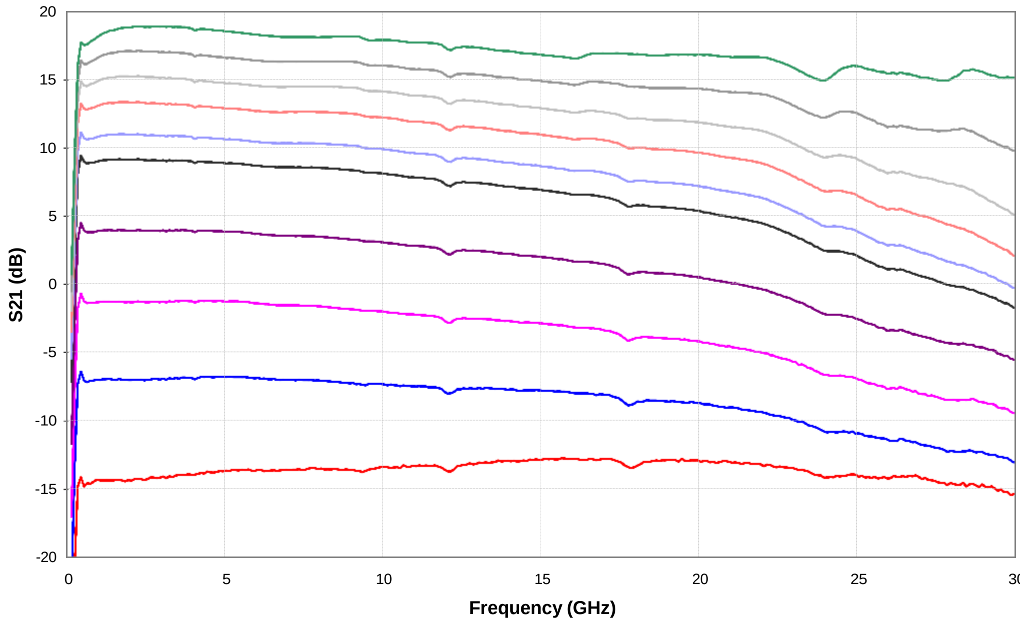

Figure 2. Typical MMA025AA S21; bias values shown in *Table 2*

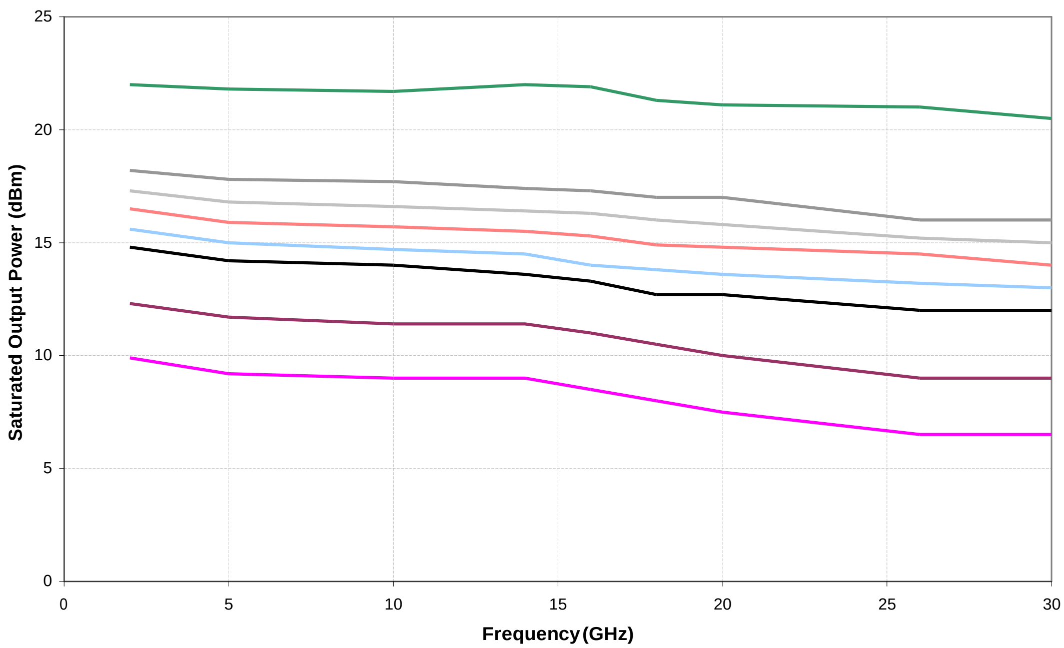

Figure 3. Typical MMA025AA Psat; bias values shown in *Table 2*

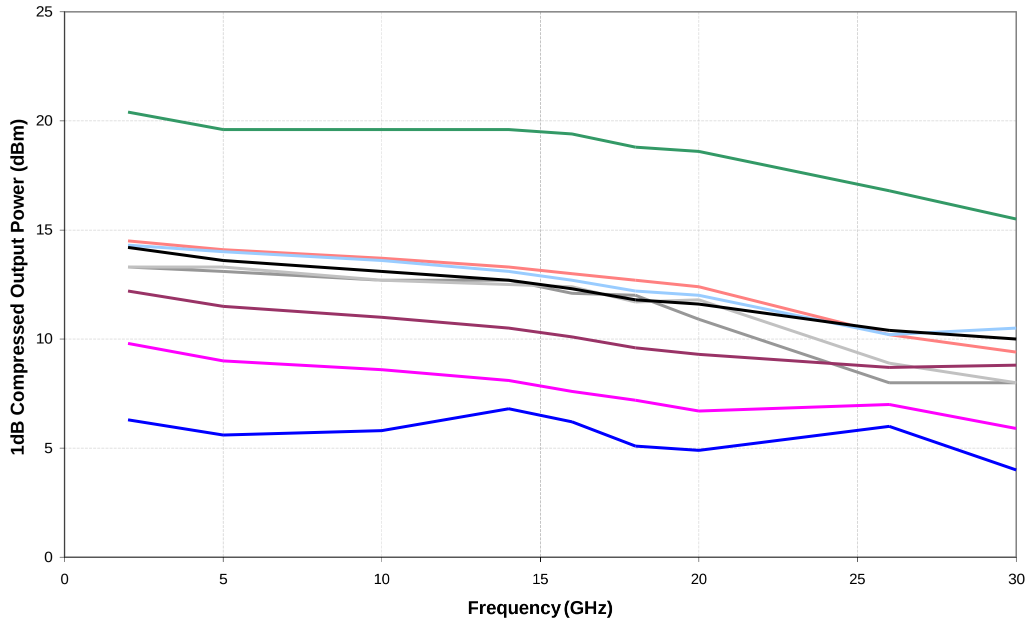

Figure 4. Typical MMA025AA Psat; bias values shown in *Table 2*

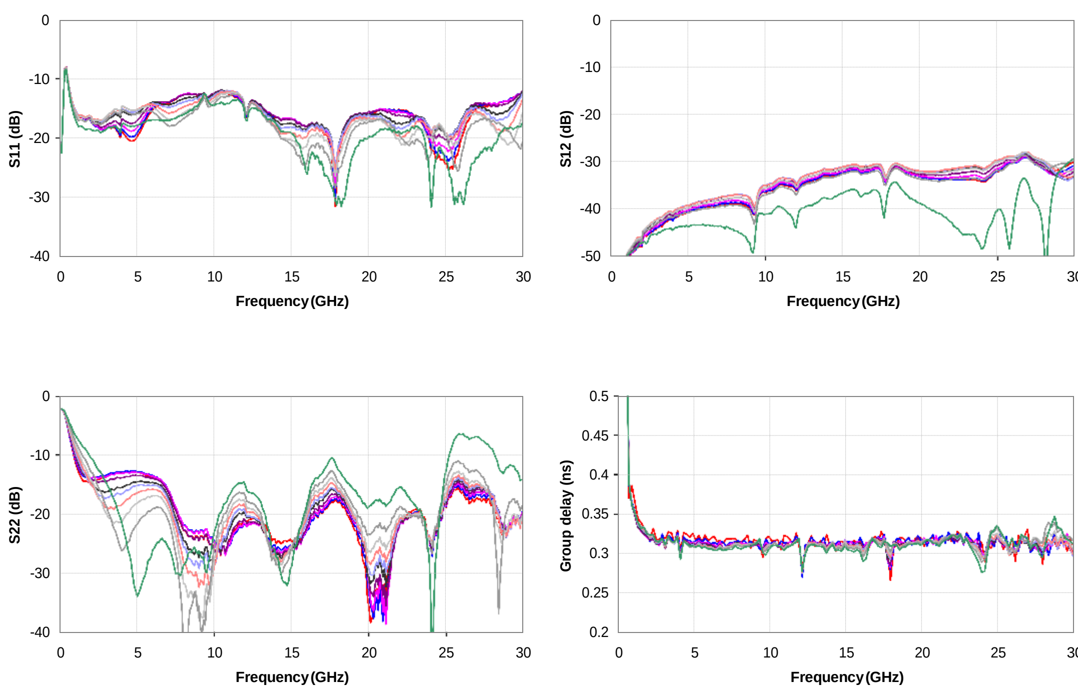

Figure 5. Typical MMA025AA Psat; bias values shown in *Table 2*

Figure 2 through *Figure 5* illustrate the typical dynamic gain performance of the Microsemi MMA025AA, a popular 0.04-30GHz Broadband MMIC Low-Noise Amplifier. The gain was attenuated in 2dB increments from the recommended bias point (no attenuation) to 10dB attenuation, and 5dB increments from that point to 30dB attenuation.

MMA025AA die are mounted in a simple connectorized evaluation module, and assembled according to the 2-30GHz assembly diagram shown in the product library.

The evaluation module is shown in *Figure 6*. A conductive lid was applied for all measurements.

Typical bias voltages for the MMA025AA are shown in *Table 2*.

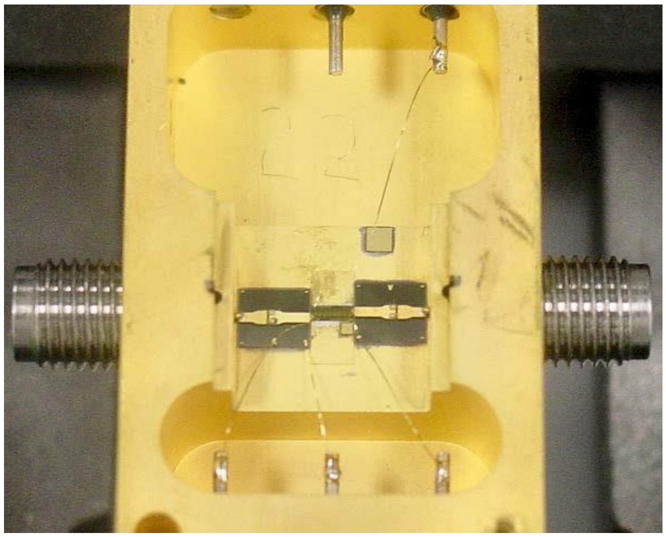

Figure 6. MMA025AA evaluation module

Table 2 · Typical dynamic gain control bias voltages for Microsemi MMA025AA amplifier

Typ Gain (2-20GHz)	Attenuation (dB)	Gate voltage Vg (V)	2nd Gate voltage Vg2 (V)	Drain current Id (mA)
18dB	none	-0.16	none	150
16dB	2	-0.16	+0.09	132
14dB	4	-0.16	-0.03	127
12dB	6	-0.16	-0.12	120
10dB	8	-0.16	-0.20	115
8dB	10	-0.16	-0.27	106
3dB	12	-0.16	-0.44	87
-2dB	20	-0.16	-0.58	67
-7dB	25	-0.16	-0.72	47
-12dB	30	-0.16	-0.86	28

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