Agilent
RF and Microwave Amplifiers

Selection Guide

High efficiency broadband signal amplification

- Broadband performance up to 50 GHz, optimizes the operating range of your test systems
- Excellent noise figure and high gain, significantly reduce overall test system noise figure
- High output power, boosts available power for measurements

Anticipate __Accelerate __Achieve

Agilent Technologies

Introduction

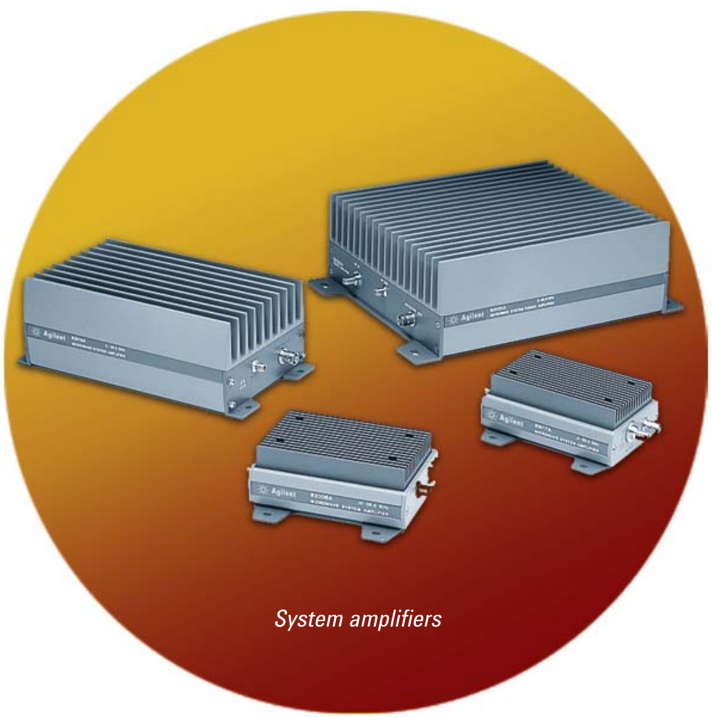
The Agilent 83006/017/018/020/050/051A and N4985A test system amplifiers offer ultra broadband performance up to 50 GHz. With excellent noise figure relative to their broad bandwidth and high gain, these products can be used to significantly reduce test system noise figure. By replacing several amplifiers with a single broadband product, test setups can be greatly simplified. You can place this amplification power where you need it by using remotely-locatable Agilent power supplies. In addition, the Agilent 87415A provides octave band performance from 2 to 8 GHz.

N4985A system amplifier

Agilent 87405B/C and N4985A-S30/S50 preamplifiers provide exceptional gain and flatness. The 87405B/C preamplifiers are very portable and come with a convenient probe-power bias connection which eliminates the need for an additional DC power supply, making them an ideal front-end preamplifier for a variety of Agilent instruments.

The N4985A-S30/50 system amplifiers are a high-performance broadband amplifier featuring baseband RF (< 100 kHz) through millimeter wave (> 30 GHz) frequency coverage. These amplifiers are designed to be a multi-use laboratory RF amplifier as a gain block for frequency domain applications, or as a time domain pulse amplifier. Its small size and versatile performance make it an excellent choice for general purpose gain block with moderate power output in a single package, potentially replacing two or three narrower-band amplifiers.

87405B/C preamplifier


System amplifiers

Power Supply

With excellent noise figure relative to their broad bandwidth and high gain, Agilent system amplifiers significantly improve system noise figure and dynamic range. These products come equipped with a low profile heat sink, an integral mounting bracket, and a two-meter DC power supply cable. Thermal and power supply design allows fast, easy integration into most measurement systems.

The Agilent 83006/017/018/020/050/051A amplifiers are supplied with a 2-meter bias cable that has a connector on one end and bare wires on the other. This bias cable can be used to interface with a power supply provided by the user. Or, for a complete solution, Agilent offers the 87421 /422A remotely locatable power supplies. The 87421A power supply is furnished with one 2-meter cable (87422A, two 2-meter cables) for direct connection to an Agilent amplifier as shown in the amplifier power cable cross reference table below.

The N4985A system amplifier is a series of high-performance broadband amplifiers with excellent power and gain from 0.00001 to 50 GHz. The amplifier is designed to be easily used in lab and test applications. It features an integrated cooling and temperature-referenced power detector outputs, and is completely self-contained with a standard AC power supply.

Power cable cross reference[1]

Model	Cable part number[2] (supplied with amplifier)	Power supply recommended	Cable part number[3] (supplied with power supply)
83006A	83006-60004	87421A	83006-60005
83017A	83006-60004	87421A	83006-60005
83018A	83006-60004	87421A	83006-60005
83050A	83006-60004	87421A	83006-60005
83051A	83006-60004	87421A	83006-60005
87415A	83006-60004	87421A	83006-60005
83020A	83020-60004	87422A[2]	87422-60001 83006-60005
87405B	Integral cable	Spectrum analyzer	
87405C[4]			
87405C-101	87405-20006	E3631A	No cable supplied
87405C-102	87405-20007	Spectrum analyzer	No cable supplied
87405C-103	87405-20010	87422A	87422-60001 83006-60005

1. *See outline drawings for connector types*
2. *For use with available power supply*
3. *For use with power supply for direct connection*
4. *Must order one of cable options*

Power supply specifications

Model	AC input voltage	DC output (nom)	Ouput power	Size (H, W, D)
87421A	100 to 240 VAC 50/60 Hz	+12 V at 2.0 A, –12 V at 200 mA	25 W max	57, 114, 176 mm 2.3, 4.5, 6.9 in
87422A[1]	100 to 240 VAC 50/60 Hz	+15 V at 3.3 A, –15 V at 50 mA +12 V at 2.0 A, –12 V at 200 mA	70 W max	86, 202, 276 mm 3.4, 8.0, 10.9 in

1. *The ± 15 V output is designed to power the Agilent 83020A; the ± 12 V output can be used to power an additional amplifier.*

What Selection Criteria Do I Consider?

Today's engineers are constantly seeking for amplifiers of exceptional gain and power performance over a broad bandwidth.

There exists a very large number of potential electrical specifications that can be applied to a microwave power amplifier selection. These elements are defined by the following characteristics:

Frequency range

RF and microwave applications range in frequency from 100 MHz for semiconductor to 60 GHz for satellite communications. Broadband accessories increase test system flexibility by extending frequency coverage. However, frequency is always application dependent and a broad operating frequency may need to be sacrificed to meet other critical parameters.

Noise figure

Noise figure is the primary specification for a typical microwave power amplifier selection. The noise figure is defined as the ratio of the signal-to-noise power ratio at the input to the signal-to-noise power ratio at the output. The noise factor is thus the ratio of actual output noise to that which would remain if the device itself did not introduce noise, or the ratio of input SNR to output SNR.

Low noise amplifiers are always preferred as the noise figure of the system is dominated by the noise figure of the preamplifier. By adding a preamplifier to noise figure measurement systems, the total system noise figure can also be reduced.

$$F_{new} = F_{pa} + \frac{F_{sys} - 1}{F_{pa}}$$

Where F and G are noise figure and preamplifier gain, both in linear terms.

$$NF_{sys} = 10 \log (F_{sys}) \text{ in dB}$$

For systems with a single preamplifier, where the gain of the preamplifier is greater than or equal to the spectrum analyzer noise figure, the system noise figure is approximately equal to the noise figure of the preamplifier.

Output power (P_{sat} & P_{1dB})

Among the key specifications for microwave amplifiers are their power output specifications. Output power at P_{sat} refers to the saturated output power, or maximum output power from the amplifier. This is the output power where the P_{in}/P_{out} curve slope goes to zero. Output power at P_{1dB} refers to the output power during 1dB compression point. Unlike the gain specification, implicitly it is assumed that the specification is at an operating point where the amplifier is exhibiting some degree of non-linear behavior. With an inherently broadband amplifier, power output as a function of power input does not vary discontinuously as a function of frequency. Typically, a wideband microwave power amplifier that could deliver in excess of several watts required a solution where numerous narrowband amplifiers were either multiplexed or switched; often introducing undesired issues, such as power curve discontinuities, at frequency cross-over points.

Gain

Gain usually is specified within the context of power output. Often, if no context for power output is given, then this is assumed to be small signal gain. Conditions for small signals at the input and output are usually easy to reproduce and verify, whereas gain and gain flatness can vary significantly when an amplifier approaches compression. Gain flatness for an amplifier with a significant frequency range is often specified over subsets of the entire frequency range. Gain and gain flatness typically include an implicit assumption that the reverse gain from the output to the input is negligible; i.e. the amplifier is unilateral.

Typically, gain flatness could only be achieved over narrow bandwidths with classic reactive matching techniques, such as those used for internally matched devices. Attempts to broaden the gain bandwidth of a high-power microwave amplifier requires trade-offs with resistive matching, or feedback techniques that take power output. The spatially combined topology overcomes these limitations.

Input and output return loss (VSWR)

The standing wave ratio, often referred to interchangeably as VSWR, is the result of wave interference. Peaks and troughs in a given field pattern remain in a static position as long as the sources of interference do not change with respect to each other. Return loss, expressed in dB, is a measure of voltage standing wave ratio (VSWR). Return loss is caused by impedance mismatch between circuits. At microwave frequencies, the material properties as well as the dimensions of a network element play a significant role in determining the impedance match or mismatch caused by the distributed effect. Agilent amplifiers guarantee excellent return loss performance by incorporating appropriate matching circuits to ensure optimum power transfer through the amplifier and the entire network.

Isolation

Isolation is the degree of attenuation from an unwanted signal detected at the port of interest. Isolation becomes more important at higher frequencies. High isolation reduces the influence of signals from other channels, sustains the integrity of the measured signal, and reduces system measurement uncertainties.

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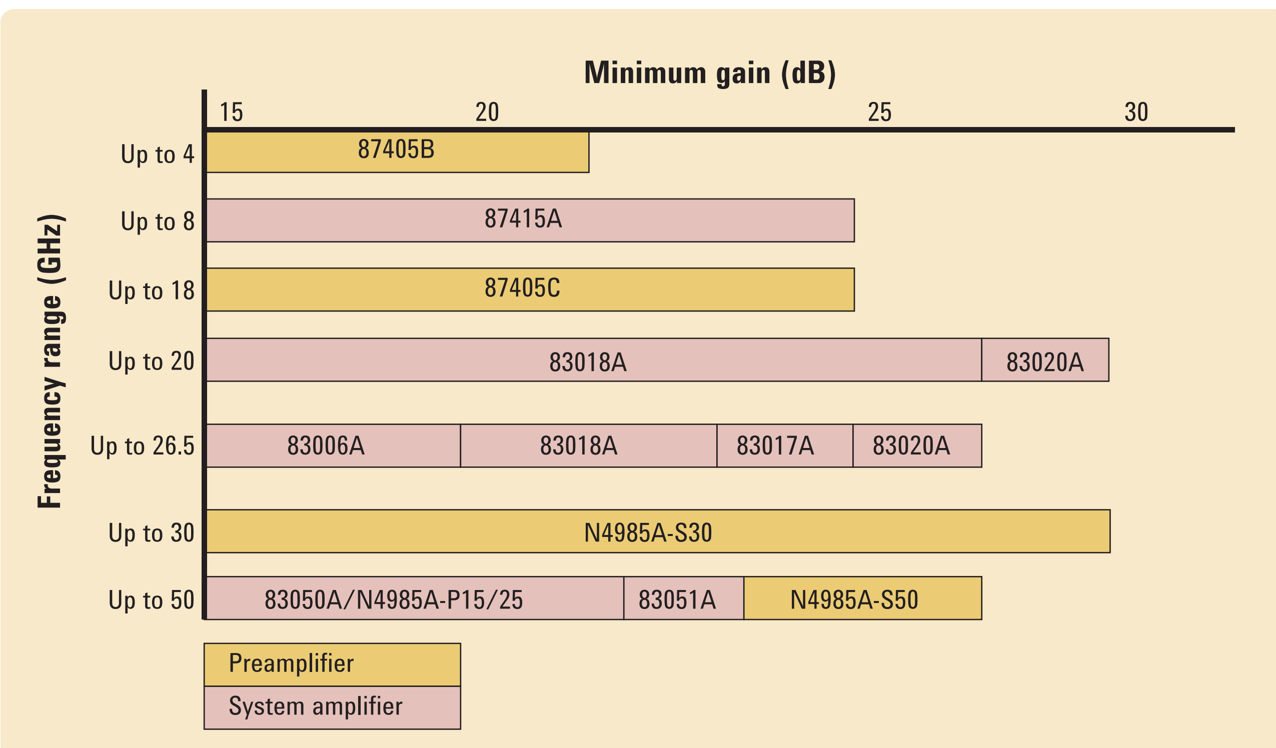
RF & Microwave Amplifiers Selection Guide



RF & Microwave Amplifiers Specification Table

Model	Frequency range (GHz)	Noise figure (dB) (typical)	Output power at P_{sat} (dBm)	Output power at P_{1dB} (dBm)	Gain (dB) (min)	VSWR	Isolation (dB)	Bias (nom)	RF connectors (input/ output)	Recommended power supply
Preamplifiers										
87405B	0.01 to 4 GHz	5 at 4 GHz	8 at 4 GHz	8 at 4 GHz	22	1.9	40	+15 V at 105 mA	Type N (m.f)	87422A
87405C	0.1 to 18 GHz	6 at 4 GHz 4.5 at 18 GHz	17 at 18 GHz	15 at 4 GHz 14 at 18 GHz	25	1.92	50	+15 V at 140 mA –15 V at 3 mA	Type N (m.f)	87422A
N4985A -S30[1]	0.00001 to 30 GHz	5 at 2 to 30 GHz	22 at 26 GHz	N/A	30 at 26 GHz	1.92	N/A	AC power supply included	2.92 mm (f)	included
N4985A -S50[2]	0.00001 to 50 GHz	5 at 2 to 30 GHz 6 at 20 to 40 GHz	17 at 50 GHz	N/A	27 at 45 GHz	2.32	N/A	AC power supply included	2.92 mm (f)	included
System amplifiers										
87415A	2 to 8 GHz	13 at 8 GHz	26 at 8 GHz	23 at 8 GHz	25	3	60	+12 V at 900 mA	SMA (f)	87421A
83006A	0.01 to 26.5 GHz	13 at 0.1 GHz 8 at 18 GHz 13 at 26.5 GHz	18 at 10 GHz 16 at 20 GHz 14 at 26.5 GHz	13 at 20 GHz 10 at 26.5 GHz	20	3.2	65	+12 V at 450 mA –12 V at 50 mA	3.5 mm (f)	87421A or 87422A
83017A[3]	0.5 to 26.5 GHz	8 at 20 GHz 13 at 26.5 GHz	20 at 20 GHz 15 at 26.5 GHz	18 at 20 GHz 13 at 26.5 GHz	25	2.6	65	+12 V at 700 mA –12 V at 50 mA	3.5 mm (f)	87421A or 87422A
83018A[3]	2 to 26.5 GHz	10 at 20 GHz 13 at 26.5 GHz	24 at 20 GHz 21 at 26.5 GHz	22 at 20 GHz 17 at 26.5 GHz	27 dB at 20 GHz 23 dB at 26.5 GHz	2.2	55	+12 V at 2 A –12 V at 50 mA	3.5 mm (f)	87421A or 87422A
83020A[3]	2 to 26.5 GHz	10 at 20 GHz 13 at 26.5 GHz	30 at 20 GHz 25 at 26.5 GHz	27 at 20 GHz 23 at 26.5 GHz	30 dB at 20 GHz 27 dB at 26.5 GHz	2.2	55	+15 V at 3.2 A –15 V at 50 mA	3.5 mm (f)	87422A
N4985A -P15	0.01 to 50 GHz	12 at 50 GHz	25 at 26.5 GHz 20 at 50 GHz	23 at 26.5 GHz 17 at 50 GHz	22 at 50 GHz	3.01	50	AC power supply included	2.4 mm (f)	included
83050A	2 to 50 GHz	6 at 26.5 GHz 10 at 50 GHz	20 at 40 GHz 17 at 50 GHz	15 at 40 GHz 13 at 50 GHz	21	2.1	50	+12 V at 830 mA –12 V at 50 mA	2.4 mm (f)	87421A or 87422A
N4985A -P25	2 to 50 GHz	12 at 50 GHz	25 at 26.5 GHz 20 at 50 GHz	23 at 26.5 GHz 17 at 50 GHz	22 at 50 GHz	3.01	50	AC power supply included	2.4 mm (f)	included
83051A	0.045 to 50 GHz	12 at 2 GHz 6 at 26.5 GHz 10 at 50 GHz	12 at 45 GHz 10 at 50 GHz	8 at 45 GHz 6 at 50 GHz	23	2.2	50	+12 V at 425 mA –12 V at 50 mA	2.4 mm (f)	87421A or 87422A

1. *Option OA3 is available for optical application tuning.*
2. *Option OA5 is available for optical application tuning.*
3. *83017A, 83018A and 83020A include internal directional detectors with BNC (f), DC connectors for external leveling applications.*

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Application Examples

Adding preamplifiers to measurement systems as shown in Figure 2 can improve sensitivity and reduce the noise floor when measuring low-level signals. By adding a preamplifier to noise figure measurement systems, the total system noise figure can also be reduced. The noise figure of the system is dominated by the noise figure of the preamplifier. For systems with a single preamplifier, where the gain of the preamplifier is greater than or equal to the spectrum analyzer noise figure, the system noise figure is approximately equal to the noise figure of the preamplifier.

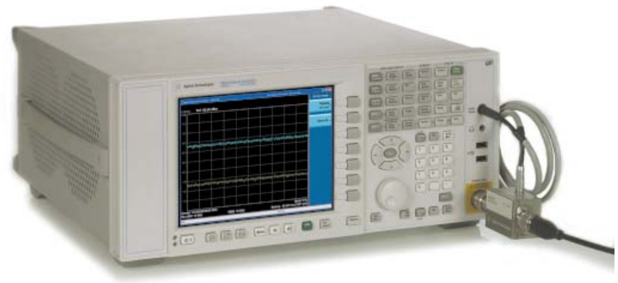


Figure 1. Low level signal measurement test setup

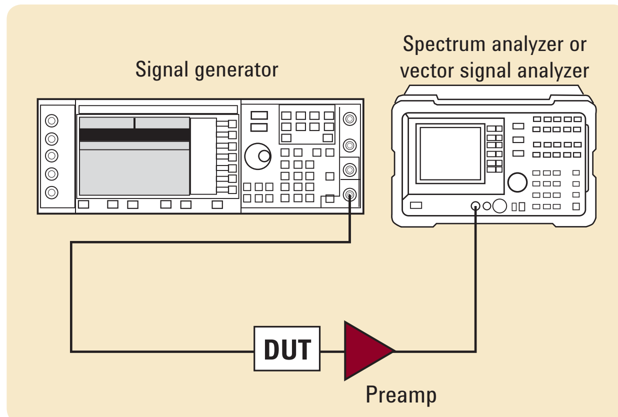


Figure 2. Preamplifier with spectrum analyzer setup

System Amplifiers

The small envelope size of Agilent Technologies family of microwave system amplifiers make them ideal for automated test and benchtop applications, offering the flexibility to place power where you need it.

Boost source output power

Increase output power from microwave sources to increase test system dynamic range. Drive high input power devices such as TWTs, mixers, power amps, or optical modulators. Drive test devices into compression for device characterization.

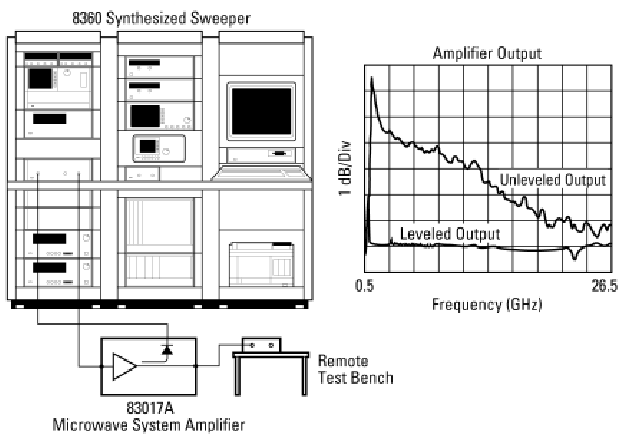
Recover systematic losses

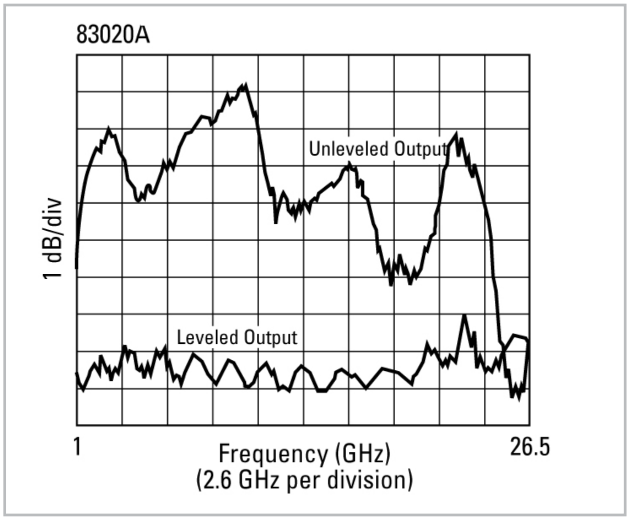
The microwave system amplifiers help solve the power loss from connectors, cables, switches, and signal routing components which consume valuable source power. Long transmission paths, common in antenna applications, are particularly susceptible to such losses.

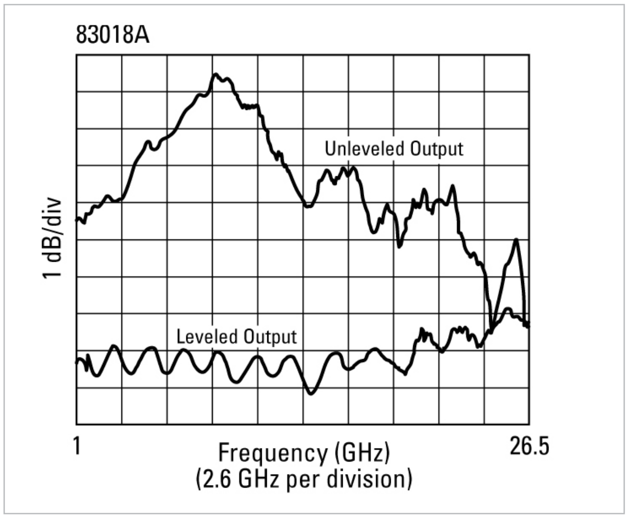
Level source power

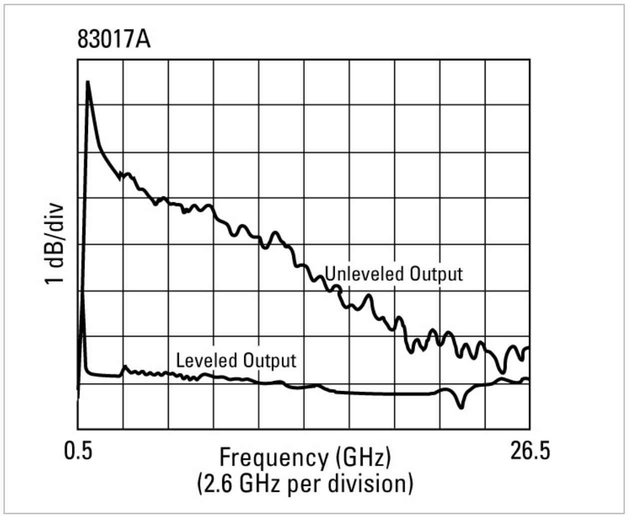
By using feedback to an external source ALC input, system designers can level output power at the test port, negating the effects of postsweeper reflections and losses. Simply route the directional detector output to the source external ALC input connector. The figures at right show typical results.

The 83017A, 83018A, and 83020A feature an integral directional detector to supply feedback. To level an 83006A amplifier, use the 0.01 to 26.5 GHz 83036C directional detector or the 1 to 26.5 GHz 87300C coupler with an 8474C detector.









Improve measurements

The 83006A, 83017A, and 83051A preamplifiers increase the sensitivity and dynamic range of spectrum analyzers. Add a preamplifier to noise figure measurement systems to significantly lower system noise figure. The table below shows typical system noise figure reduction achievable with these amplifiers. Note that the reduced system noise figure is dominated by the preamplifier noise figure. See Noise Figure Measurement Accuracy - The Y-Factor Method Application Note 57-2, literature number 5952-3706E.

Benchtop gain block

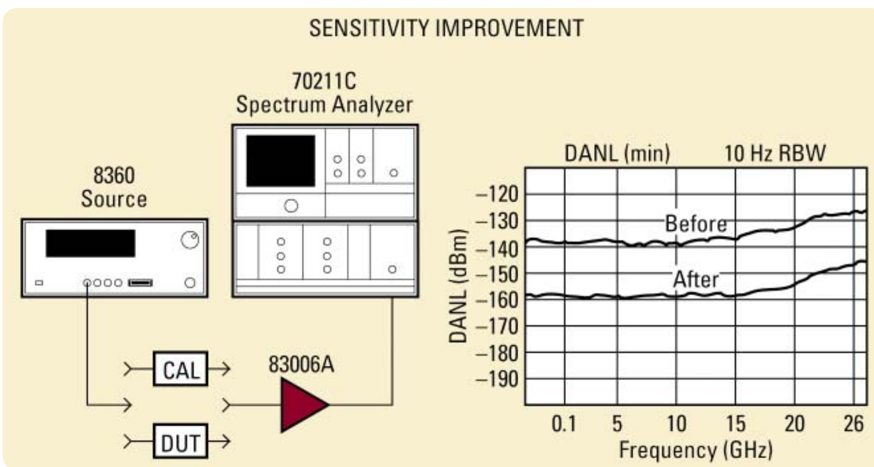
Benchtop microwave design tasks often require amplification to measure low level output characteristics, improve system dynamic range, perform saturation tests, or boost power levels. The Agilent family of system amplifiers offers small size and immediate, off-the-shelf solutions to microwave design, production, or test engineers.

Pulse parameter measurements

Fast rise time and multi-octave bandwidth make these amplifiers attractive for fast pulse parameter measurements. The 0.01, 0.5, and 2 GHz cutoff frequencies make them more useful for RF or impulse measurements with low duration times.

$$F_{new} = F_{pa} + \frac{F_{sys} - 1}{G_{pa}}$$

Figure 3. All terms linear



Typical noise fgure improvement

Amp model	Freq (GHz)	Max NF(dB)	Min gain (dB)	System noise figure (Fsys) without preamp (dB)						
				13	15	18	20	23	25	30
83006A	0.01–0.2	13	20	—	13.1	13.1	13.2	13.4	13.6	14.8
	0.2–18	8		8.1	8.2	8.4	8.6	9.2	9.8	12.1
	18–26.5	13		—	13.1	13.1	13.2	13.4	13.6	14.8
83017A	0.5–18	8	25	8.0	8.1	8.1	8.2	8.4	8.6	9.8
	18–26.5	13		—	13.0	13.0	13.1	13.1	13.2	13.6
83018A	1–2	10	23	10.0	10.1	10.1	10.2	10.4	10.6	11.8
	2–20	10	27	10.0	10.0	10.1	10.1	10.2	10.3	10.8
	20–26.5	13	23	—	13.0	13.1	13.1	13.2	13.3	14.0
83020A	1–20	10	30	10.0	10.0	10.0	10.0	10.1	10.1	10.4
	20–26.5	13	27	—	13.0	13.1	13.1	13.1	13.1	13.4
83050A	2–26.5	6	21	6.1	6.2	6.3	6.5	7.0	7.5	9.5
	26.5–50	10		10.0	10.1	10.1	10.2	10.4	10.6	11.8
83051A	0.045–2	12	23	12.0	12.0	12.1	12.1	12.3	12.4	13.2
	2–26.5	6		6.1	6.2	6.3	6.5	7.0	7.5	9.5
	26.5–50	10		10.0	10.1	10.1	10.2	10.4	10.6	11.8

Mechanical Dimensions

Net Weights	
Model	**Net weight**
83006A	0.64 kg (1.4 lbs)
83017A	0.64 kg (1.4 lbs)
83050A	0.64 kg (1.4 lbs)
83051A	0.64 kg (1.4 lbs)
83018A	1.8 kg (4 lbs)
83020A	3.9 kg (8.5 lbs)
87415A	0.64 kg (1.4 lbs)
87405B	0.23 kg (0.5 lbs)
87405C	0.22 kg (0.485 lbs)

Ordering Information

Model	Notes
87405B	Preamplifier, 0.01 to 4 GHz, 22 dB gain, type-N (m) output to type-N (f)
87405B-001	Power probe connector to banana plug
87405C	Preamplifier, 0.1 to 18 GHz, type N(M) output to type N(F)
87405C-101	Cable assembly – banana plug
87405C-102	Cable assembly – power probe cable
87405C-103	Cable assembly – 15 pin bias cable
87415A	2 to 8 GHz remote system amplifier
83006A	Amplifier, 0.01 to 26.5 GHz, 20 dB gain
83017A	Amplifier, 0.5 to 26.5 GHz; 25 dB gain
83018A	Microwave system amplifier, 2 to 26 GHz, 22 dBm
83020A	Power amplifier; 2 to 26.5 GHz, 27 dB gain
83050A	Amplifier; 2 to 50 GHz, 20 dBm at 40 GHz
83051A	Preamplifier; 0.045 to 50 GHz, 23 dB gain
N4985A	System amplifiers
N4985A-P15	10 MHz to 50 GHz
N4985A-P25	2 to 50 GHz
N4985A-S30	100 kHz to 30 GHz
N4985A-S50	100 kHz to 50 GHz
N4985A-0A3	Optical application tuning for Option S30
N4985A-0A5	Optical application tuning for Option S50

Related Literature

Preamplifiers

87405B *(http://cp.literature.agilent.com/litweb/pdf/5988-8452EN.pdf)*

87405C (*http://cp.literature.agilent.com/litweb/pdf/5989-5743EN.pdf)*

N4985A-S30 *(http://cp.literature.agilent.com/litweb/pdf/5991-0713EN.pdf)*

N4985A-S50 *(http://cp.literature.agilent.com/litweb/pdf/5991-0713EN.pdf)*

System amplifiers

87415A *(http://cp.literature.agilent.com/litweb/pdf/5091-1358E.pdf)*

83006A *(http://cp.literature.agilent.com/litweb/pdf/5963-5110E.pdf)*

83017A *(http://cp.literature.agilent.com/litweb/pdf/5963-5110E.pdf)*

83018A *(http://cp.literature.agilent.com/litweb/pdf/5963-5110E.pdf)*

83020A *(http://cp.literature.agilent.com/litweb/pdf/5963-5110E.pdf)*

N4985A-P15 *(http://cp.literature.agilent.com/litweb/pdf/5991-0713EN.pdf)*

83050A *(http://cp.literature.agilent.com/litweb/pdf/5963-5110E.pdf)*

N4985A-P25 *(http://cp.literature.agilent.com/litweb/pdf/5991-0713EN.pdf)*

83051A *(http://cp.literature.agilent.com/litweb/pdf/5963-5110E.pdf)*

For more on Agilent amplifiers and ordering information see the Agilent RF and Microwave Amplifiers, Brochure, literature number 5989-6949EN

To order our complimentary Agilent RF & Microwave Test Accessories Catalog 2012/13

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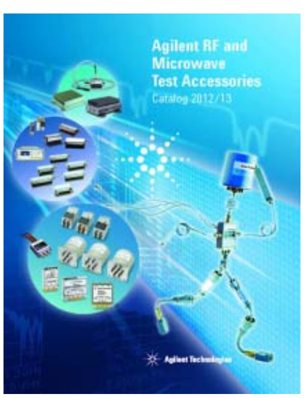

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