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# High Performance 2-50 GHz System Power Amplifier

## *Operating Manual*



**TA2U50HA**

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**CENTELLAX**



SPEED INNOVATION

3843 Brickway Blvd, Suite 100  
Santa Rosa, CA 95403  
Tel: 707.568.5900  
Fax: 707.568.7647

**Email:**  
sales@centellax.com  
support@centellax.com  
**www.centellax.com**



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Note: This product contains no user or factory adjustments. There is no calibration cycle or certificate.

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3843 Brickway Blvd, Suite 100  
 Santa Rosa, CA 95403  
**Tel:** 707.568.5900  
**Fax:** 707.568.7647



**Email:**  
[sales@centellax.com](mailto:sales@centellax.com)  
[support@centellax.com](mailto:support@centellax.com)  
**www.centellax.com**

# High Performance Broadband RF Amplifier

## TA2U50HA Operating Manual

### Section 1:      *Introduction*

The TA2U50HA is a versatile 1W RF System Amplifier, which has many uses in research, development, or production-line environments. This amplifier is a useful addition to the laboratory where RF, microwave, or millimeter wave measurements are made. Typical applications include:

- Driver for high power amplifiers e.g. TWT or linear power amplifiers.
- Overcome system losses such as long transmission lines, power dividers, etc.
- Antenna research and development; Antenna characterization systems.
- Broadband RF characterization of systems and components.

#### NOTE

Source-driven RF power amplifiers should always be terminated in an absorbing load. Unterminated outputs will radiate RF energy; this can be dangerous to the operator, may violate FCC laws. Unterminated RF amplifiers reflect most of their energy back into the final amplifier stage; this can result in damage or destruction of the amplifier.

Centellax is committed to providing amplifiers that have exceptional performance, are unconditionally stable, and will survive accidental laboratory misuse, such as a fully-saturated unterminated output. TA2U50HA System Amplifiers have passed rigorous RF tests which include an RF burnout test. RF burnout test conditions are:  $P_{out} = 30\text{dBm @ } 2\text{ GHz}$ ; open output (unterminated).

**Internal Power Detector:** The TA2U50HA Power System Amplifier incorporates a power detection feature.

Two matched on-chip GaAs diodes are used:

One of the diodes is RF coupled to the final output stage of the amplifier.

The second is a matched diode, in close proximity to the detector diode, which is not RF coupled but provides a reference voltage that is a function of temperature and biasing.

A differential measurement of these diodes provides a voltage proportional to the amplifier output power level independent of temperature and bias level of the output amplifier chip.

The two diode voltages are provided on the rear panel of the TA2U50HA System Amplifier and can be used to determine the amplifier output power level (as shown in Figure 9).

An application note details the use of these diodes and is available from the Centellax website.

For additional questions, please email: [support@centellax.com](mailto:support@centellax.com) or call **707-568-5900x7**.

The detector diode is frequency dependant and must be calibrated for each test frequency. The diode is a nonlinear device and its output voltage varies with power. This must also be characterized.

In an ATE environment, calibration of the detector diode is not complicated and may be as simple as measuring the differential voltage at each test frequency and power level. A look up table or curve fit can be used to provide a measure of power delivered.

### External ALC Leveling

Establishing a desired power level at the amplified DUT “*Reference Plane*” with power request to the source is often desirable. Many modern sources support “*External Power Leveling*”. This technique involves power leveling using feedback from external sensors (e.g. power meters or detector diodes). Properly configured, these sensors provide feedback to the source that can be used by the source to level the amplified power level at a remote reference plane.

## Rear Panel

**Input:** A 2.4 mm input connector is provided on the rear panel of the TA2U50HA.

**Power in:** 9 Vdc @ ~1.5 A, supplied by the included AC supply.

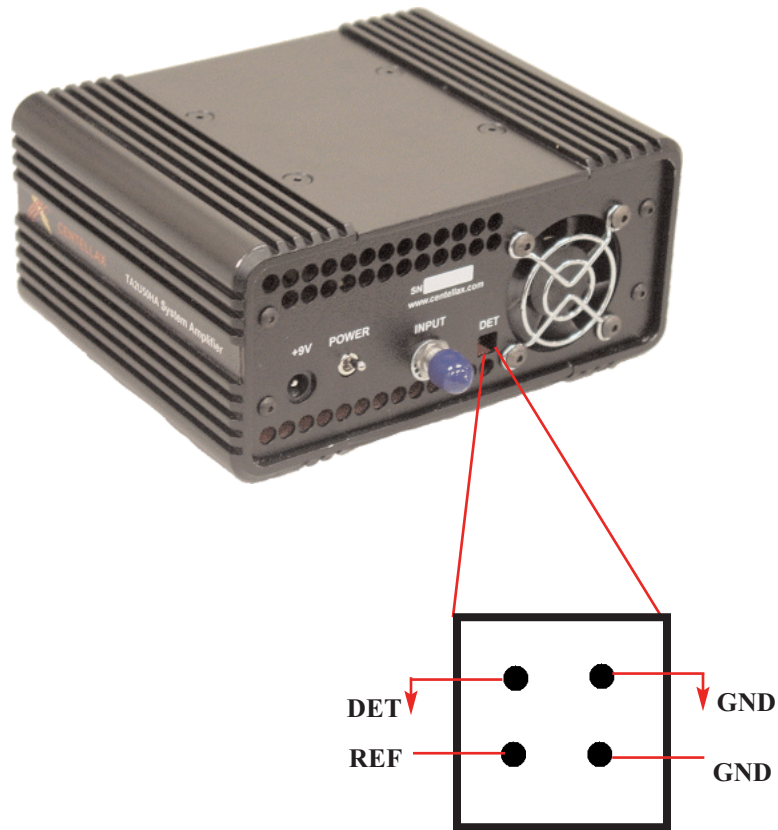
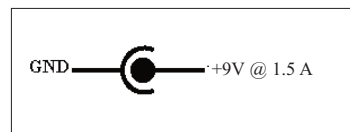


Figure 9: Rear panel of TA2U50HA



## Section 2: Description

The Centellax TA2U50HA Power System Amplifier is a high performance, 1W broadband amplifier featuring 6 octaves of RF coverage from 2 GHz to greater than 50 GHz.

The TA2U50HA is designed to be a useful general purpose RF Power System Amplifier for laboratory or test system applications where higher broadband RF power is needed. The amplifiers small size (5.5x4.5x2.5 inch) and built in bias power supplies allows close placement to the measurement or source reference plane. It's high gain helps make up for system losses such as long transmission lines and system components.

The TA2U50HA features 2.4mm 50GHz female connector at the amplifier's input and 1.85mm(V) connector at output. V connector is compatible with 2.4mm. Adapters to lower frequency connectors e.g. 2.9mm, 3.5mm and SMA are readily available.

The TA2U50HA is self contained and plugs into standard AC power sources.

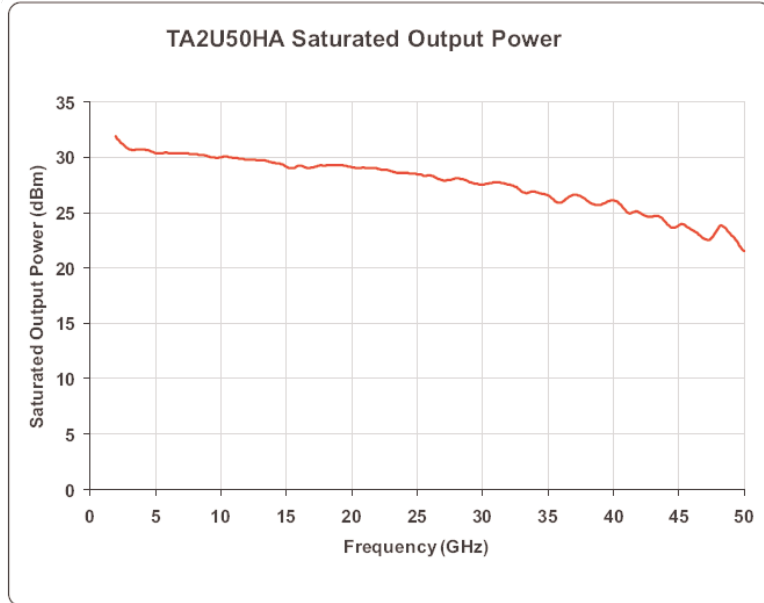
### Features

- 1W (30dBm)  $P_{sat}$  to 10 GHz
- Excellent performance at 20 GHz:
  - High gain (27dB, +2dB flatness)
  - 26dBm  $P_{-1dB}$ , 29dBm  $P_{sat}$
- Easy to integrate into your lab:
  - Built-in cooling fan
  - AC power supply
- Power detector outputs
- Size: 5.5 x 4.5 x 2.75 inch

### Section 3: Specifications

**Table 1: Performance Specification**

Parameter	Description	2 - 10 GHz			10-30 GHz			30 - 40 GHz			40 - 50 GHz		
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
P <sub>sat</sub> (dBm)	Saturated Output Power	26	30	-	25	29	-	23	27	-	20	24	-
P-1 (dBm)	1 dB Compressed Power	24	28	-	23	27	-	21	25	-	17	22	-
S <sub>21</sub> (dB)	Small Signal Gain	25	29	-	24	28	-	21	25	-	17	24	-
S <sub>11</sub> (dB)	Input Match	-	-15	-	-	-15	-	-	-10	-	-	-8	-
S <sub>22</sub> (dB)	Output Match	-	-15	-	-	-10	-	-	-6	-	-	-6	-
S <sub>12</sub> (dB)	Reverse Isolation	-	-60	-	-	-60	-	-	-50	-	-	-50	-
NF (dBm)	Noise Figure	-	9	-	-	9	-	-	10.5	-	-	12	-
H <sub>2</sub> (dBc)	2nd Harmonic @P-1	-	-40	-	-	-40	-	-	-35	-	-	-30	-
H <sub>3</sub> (dBc)	3rd Harmonic @P-1	-	-20	-	-	-20	-	-	-	-	-	-	-



*Figure 1:* TA2U50HA Saturated Output Power Typical Module Performance

### Front Panel

**Output:** The TA2U50HA features a 1.85mm(V) 50GHz female connector at the amplifier’s output.

**Led Indicator:** One LED annunciator on the front panel indicates the System Amplifier is powered.



*Figure 8:* Front panel of TA2U50HA

**Note: Always terminate the RF driven amplifier output !**

When the system is calibrated the actual power delivered to the input "Reference Plane" is read on the power meter display for power sensor A. Sensor A is used to monitor and provide feedback to the user or an ATE system in order to set the "Reference Plane" power level. The power level is set by adjusting the RF Source power level control.

Calibration of the system is accomplished by removing the DUT and connecting sensor B to the input "Reference Plane" in order to determine the coupler's coupling coefficient and the other losses to the reference plane.

These losses are: **PmB - PmA**. These losses are frequency dependant and must be measured at each test frequency.

Coupler through losses and their coupling coefficients are very linear over their rated power range and therefore only need to be measured at one power level.

The frequency dependant losses (**PmB-PmA**) are then provided to the power meter in the form of a display offset for **PmA**.

The calibration is complete and the DUT input power level is displayed directly on the power meter sensor A display.

This setup is quick and easy to calibrate and represents a good test bench for the R&D laboratory, where a manual control system is sufficient to evaluate performance.

Understanding the compression characteristics of the TA2U50HA System Amplifier is important in these situations and can often be compensated for in the Automated Test Environment (ATE) by using an iterative set and measure routine to set the input reference plane power level close to the desired level.

Since the incident power is always accurately provided by a **PmA** measurement, the requested incident power level does not always need to be exact for accurate characterization of a DUT.

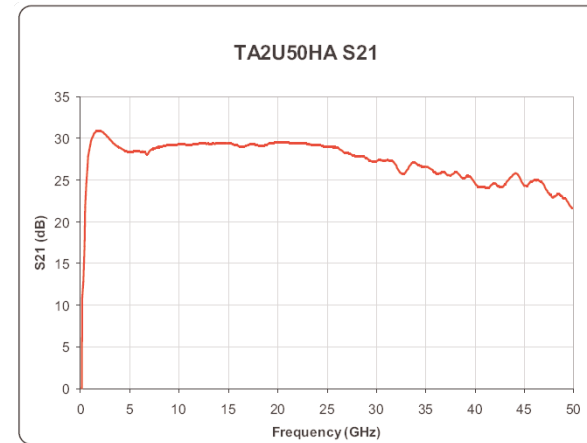


Figure 2: Typical Gain Performance

Figure 3: Typical Reflection Performance

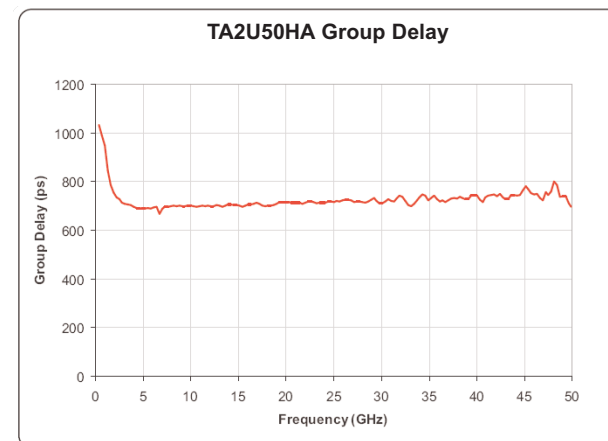
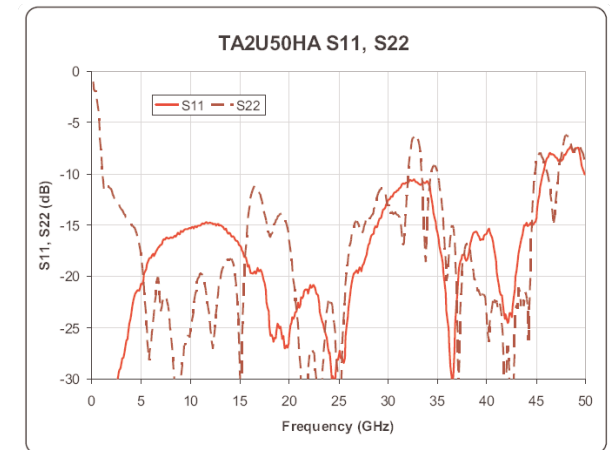


Figure 4: Typical Group Delay Performance



## Section 4: Performance Verification

The Figures below show the setup used to verify the performance of the TA2U50HA System Amplifier.

A calibrated power splitter (or calibrated coupler) connected to the amplifier input reference plane and to power sensor A, as shown, establishes the input power level. The output power is measured on power sensor B. Measurements of gain vs output power at frequencies of interest establish the amplifier performance.

**CAUTION:** Use of an attenuator may be required on the output in the sensor B is rated for less than 1W. Applies to fixtures 5,6,7.

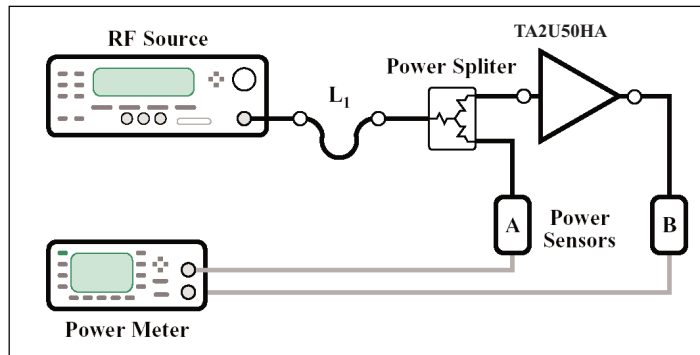


Figure 5: Verification setup with a power splitter

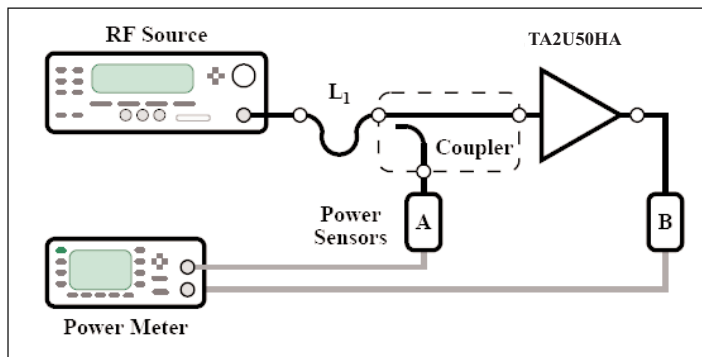


Figure 6: Verification setup with a calibrated coupler

## Section 5: Operation

### Example Application:

The TA2U50HA System Amplifier amplifies the RF Source output power to the level needed to characterize DUT performance.

The small size of TA2U50HA System Amplifier is easy to place close to the DUT input “Reference Plane”. The high gain of the System Amplifier easily overcomes the cable losses from the remote RF Source.

The Figure 7 shows an amplified RF power measurement system using the TA2U50HA System Amplifier.

The DUT is characterized by setting the power level at the DUT input

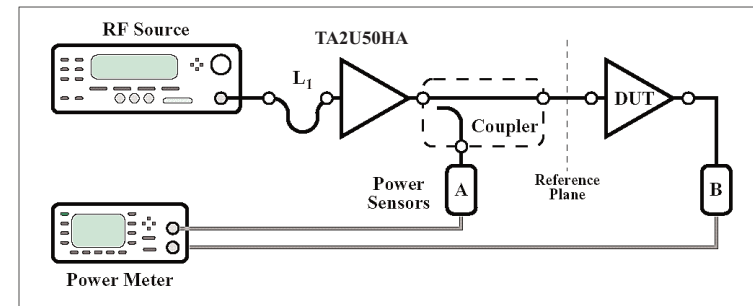


Figure 7: Example of an Amplified RF Power Measurement System

“Reference Plane” and measuring the output power at various input power levels for each test frequency.

The RF Source, used in this example, is a laboratory grade Synthesized Source or Signal Generator with precise amplitude control, (e.g. Agilent 83650L RF Source, or Anritsu MG3694A). The power levels are measured using a power meter with two measurement port sensors (A and B), (e.g. Agilent E4419B).

An RF power coupler provides a small, proportional amount of the amplified power to power sensor A as shown in Figure 7.