

RF High Power Precision Calorimeters

Models: 1314 - 250 W, from 50 Hz to 3000 MHz
 1316A – Up to 10,000 W¹, from 50 Hz to 500 MHz

High-power, high-accuracy calorimetric measurements for calibrating RF transfer standards, RF Power Meters, plasma generators, amplifiers, and other precision applications. The lowest uncertainties available for your high-power measurements, from the RF experts at TEGAM.

1314 & 1316A RF Calorimeters

- Calibrate High-Power RF sensing devices up to 10,000 W
 - Working standards: TEGAM 2601A and 2602A
 - Through devices: Bird wattmeters, 402x
- 50 Hz to 3000 MHz¹ frequency range
- National Lab traceable through an AC Power Standard

TRUST is an essential feature in any measurement system and TEGAM's 1314 and 1316A RF Calorimeters are instruments you can rely on every day with confidence.

Counted on by primary labs and industry-leading manufacturers around the world, TEGAM's line of RF power calorimeters provide highly accurate RF power measurements up to 10,000 W in the 50 Hz to 3000 MHz¹ range.

The 1314 and 1316A combine TEGAM's innovations in calorimetric measurement technology with precision Peltier chillers to precisely measure input power in the form of RF energy

known as the *calorie*. A *calorie* is defined as the amount of energy, in the form of heat, required to raise the temperature of a certain mass of liquid by a given amount.

By accurately measuring temperature and mass we can determine the amount of heat and therefore, the amount of energy applied to the liquid. This process results in **unprecedented uncertainties for high-power RF measurements**.

TEGAM's calorimeters can self-calibrate with National Lab traceability through an AC power standard using the included calorimeter calibration software. They can also be configured to calibrate working standards, through meters, and terminating devices. By combining either calorimeter with TEGAM's **low-pass filter banks**, **high-power switching systems**, and **workload calibration software**, the entire measurement process can be automated.

Turnkey Systems Available

TEGAM has condensed its experience with high-power RF calibration into convenient and accurate automated systems that operate from 50 Hz up to 3000 MHz, at power levels up to 10,000 W¹. Each turnkey package is designed and built according to your requirements, and may include a calorimeter, filter banks, RF switches, signal sources, transfer standards, and amplifiers as appropriate. Our package components have been tested and verified by TEGAM to produce accurate and repeatable automated calibrations. Onsite installation and training are available for a fast and trouble-free start up. Due to the wide range of configuration options, turnkey packages are quoted on an as-requested basis. Contact us to learn more.



Figure 1: 1316A Calorimeter Measurement System

¹ See Specifications for model-specific power and frequency ranges.



Figure 2: 1316A Calorimeter Front Panel

Applications

- **RF Source Measurement:** Measure RF power output from plasma generators and other high-power sourcing devices.
- **RF Transfer Standards:** Reduce the time required to make precision RF measurements while maintaining high accuracy by calibrating transfer standards. Use the 1314 or 1316A to calibrate transfer standards such as the TEGAM **2601A** and **2602A** for faster verification of your daily workload.
- **In Situ Power Meters:** Where process accuracy matters, calibrate in situ devices directly on the calorimeter for the best-possible uncertainty.
- **Amplifiers:** Calibrate RF amplifier outputs up to 10,000 W with unparalleled measurement uncertainty. Note that source harmonics must be < -40 dBc to maintain best measurement uncertainties.

For over 30 years, TEGAM has been building RF measurement instruments for challenging applications. The TEGAM High Power Precision Calorimeter family - [experience and innovation](#) realized.

When your measurement matters...

Be Certain with TEGAM

Specifications

Measurement Ranges	1314	1316A
Frequency (MHz)	50 Hz to 3000 MHz	50 Hz to 500 MHz
Power (W)	10 W to 250 W	Connector/Frequency Dependent: With standard HN connector: 10 W to 10,000 W: 50 Hz to 2 MHz 10 W to 8,900 W: >2 MHz to 13.56 MHz 10 W to 6,200 W: >13.56 MHz to 27.12 MHz 10W to 5,000 W: >27.12 MHz to 40.68 MHz 10W to 4,100 W: >40.68 MHz to 60 MHz 10 W to 2,200 W: >60 MHz to 200 MHz 10 W to 1,300 W: >200 MHz to 500 MHz With optional 3-1/8" connector⁶: 10 W to 10,000 W: 50 to 500 MHz
Connector Type	Type N (female)	HN (female) standard, 3-1/8" optional ⁶

Basic Accuracy	0.3 W + 0.3% Rdg ^{2, 3}	1.5 W + 0.3% Rdg ^{2, 3, 6}
Power Requirements		
Calorimeter	100 – 240 VAC, 1.5 A	220 – 240 VAC, 20 A
Chiller	100 – 240 VAC, 9.4 A	220 – 240 VAC, 20 A
Chiller (coarse control)	N/A	208 VAC, 3-Phase, 16.5 A
AC Power Source	104 to 127 VAC, 10 A ⁴	208 VAC, 3-Phase, 42 A
AC Power Standard	100 – 240 VAC, 10 A	100 – 240 VAC, 10 A

Specifications (cont...)

Physical Dimensions		
Calorimeter Cabinet	46 x 22.5 x 56 in (117 x 57 x 142 cm) ⁷	46 x 22.5 x 56 in (117 x 57 x 142 cm) ⁷
Chiller (coarse control)	N/A	29.25 x 28.5 x 62 in (74 x 72.4 x 157.5 cm) ⁷
AC Power Source	16.75 x 5.25 x 22.6 in (42.5 x 13.3 x 57.5 cm) ⁷	32 x 25 x 56 in (81.3 x 63.5 x 142.24 cm) ⁷
Coolant Flow Rate	1 gallon (3.75 Liters) per minute nominal	4 gallons (15.2 Liters) per minute nominal
Common Specifications		
Drift	< 50% of uncertainty over 48 hours	
Input Impedance	50 Ω nominal	
S11 Linear Magnitude	Typical < 0.025 at $f < 100$ MHz, and < 0.1 at $f \geq 100$ MHz	
	<p style="text-align: center;">Figure 3: Typical S₁₁ Linear Mag Performance</p>	
Communication	Ethernet	
Cooling Fluid	25% DOW-Therm SR-1, 75% deionized water	
Operating Temperature	68 to 86 °F (20 to 30 °C)	
Storage Temperature	14 to +122 °F (-10 to +50 °C) ⁵	

² Average of ten (10) consecutive points taken 25 seconds apart, where the standard deviation of those points is < 0.05 W.

³ The 1314 and 1316A are intended for use as primary standards. Measurement repeatability and uncertainties will vary among laboratories depending upon various factors, including ambient environment, user experience, and elapsed time since the most recent system calibration. TEGAM will provide guidance where possible, but users are ultimately responsible for establishing their own measurement uncertainties consistent with the laboratory's capabilities.

⁴ Other AC Input voltage ratings available as appropriate for the end-user's local power specifications.

⁵ Assumes proper preparations are followed prior to storage, including draining the coolant system. See manual for details.

⁶ Optional 3-1/8" connector may increase transfer uncertainties if using adaptors to calibrate non-3-1/8" devices.

⁷ Optional items. Specifications listed are with a typical configuration.



Warranty	1-year Parts & Workmanship for TEGAM-manufactured components
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Optional System Components (contact your TEGAM representative for more information).

AC Source	For routine calibration of the Calorimeter.
AC Power Meter	For routine calibration of the calorimeter.
Rack (Single/Dual Bay)	Options available based on specific configurations.
P/C	For control of calorimeter and ancillary equipment.
Other	Contact TEGAM for further details and options.