

GUILDLINE 6530 - TRACEABLE CALIBRATION OF RADIATION METERS



THE CHALLENGE

APPLICATION: CALIBRATION OF RADIATION METERS

Radiation Monitoring principle:

In nuclear power generation facilities, the accurate monitoring of radiation is critical. This is typically accomplished through a radiation monitor based on a sensor which produces very small currents with respect to the detected radiation. This current is typically in the range of **0.33pA - 100μA**. Detected current levels are then converted to mR/hr (MilliRoentgen Per Hour). A commonly used device to detect such a low current is a Femto / PicoAmmeter. (A Keithley model 6430 for example).

The Calibration Challenge:

The challenge is to provide sufficiently accurate and traceable low value currents to support the Femto / Picoammeter calibration. One simple method that can be used to generate such low currents is to use a readily available commercial voltage standard and high value resistance standards such as the Guildline model 9336 & 9337. This method, although simple in principle, still presents some challenges due to the availability of traceable, appropriate voltage source and resistance value combinations.

THE SOLUTION

THE GUILDLINE 6530 TERAOHMMETER-BRIDGE

The Guildline 6530 Teraohmmeter is an instrument which can calibrate very high resistance values 100 kΩ to 10 PetaΩ to very high accuracy levels. It is also very well suited to perform this calibration at different voltages, to obtain the voltage characteristics of the resistor. These voltage characteristics are crucial, as they directly affect the resulting current value when these resistors are used with different voltages to create a current source. Additionally, the Guildline 9336 and 9337 series resistance standards offer the accuracies and stabilities required to generate the necessary stable, low current value.

The method described in this application is an example for calibration of the Keithley 6430 Femto / PicoAmmeter using the Guildline 6530 Teraohmmeter, 9336/9337 Resistance standards and a commercial voltage standard.

First it is necessary to determine the effective currents that are needed to calibrate the current measurement capabilities of the Femto / PicoAmmeter. The Keithley 6430 is used to measure the output current for the effective ranges outlined in the table below. The selection of resistances used to generate the reference currents is based on use of 1 Volt and 10Volts which are the two most common voltage standard values available.

Effective Calibration Points for Support of Keithley 6430.

Measurement Range on Keithley 6430	9336/9337 Standard Resistor	6520 Test Voltage	Effective Current Drive	6520 Calibration Range	Actual 6520 Calibration 1 Year Spec.	6430 Current 1 Year Spec.	
10 uA	200k	100 k	1 V	10 uA	standard cal	0.025 %	0.05 % + 2 nA
1 uA	2M	1 M	1 V	1 uA	standard cal	0.025 %	0.05 % + 300 pA
1 uA	20M	10 M	10 V	1 uA	custom cal	* 0.025 %	0.05 % + 300 pA
100 nA	200M	100 M	10 V	100 nA	standard cal	0.015 %	0.05 % + 20 pA
10 nA	2G	1 G	10 V	10 nA	standard cal	0.02 %	0.05 % + 2 pA
1 nA	20G	10 G	10 V	1 nA	standard cal	0.06 %	0.05 % + 200 fA
100 pA	200G	100 G	10 V	100 pA	standard cal	0.08 %	0.15 % + 30 fA
10 pA	2T	1 T	10 V	10 pA	custom cal	* 0.2 %	0.5 % + 7 fA
1 pA	20T	10 T	10 V	1 pA	custom cal	* 0.3 %	1.0 % + 7 fA

**These points are not normally specified or included in the standard calibration procedures for a 6530 or 6520 (previous model to 6530) Teraohmmeter. Specifications shown are based on the 6520 one-year drift and the wider traceability uncertainty associated with the non-standard voltage points.*

THE SOLUTION (CONTINUED)

As indicated in the preceding table, only three non-standard calibration points are needed for the 6530 or 6520 to support the Keithley 6430 meter with respect to calibrating radiation meters. It is also strongly recommended that the 10 TΩ at 100 Volt point be calibrated to increase integrity and confidence in the 10 TΩ at 10 Volt point. This recommendation is based on the lack of a traceable calibration available at 10 Volts for 10 TΩ resistance standard.

As can be seen in the above table a Guildline 6530 (Previous model 6520) with additional calibration points can now be used to directly calibrate the Guildline 9336 and 9337 resistance standards at the voltages needed to generate the low current source. The 6530 reduces the uncertainty from the specifications listed in the preceding table. The 6530 Teraohmmeter can be used to assign traceable resistance values at 1 Volt and 10 volts, as outlined in the table, which gives a total uncertainty ratio of 2:1 (Not accounting for the voltage standard).

These resistors can now be used with an easy to obtain, sufficiently accurate, voltage standard of traceable value. The end-result is a traceable reference current generation from 1pA to 10μA suitable for calibration of the Keithley 6430, and subsequently radiation meters.



For more information

Or talk to us about your requirements

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