New Model 3708 8-Channel Preamp and Scanner

MAKING ULTRA-LOW NOISE RESISTANCE MEASUREMENTS JUST GOT EASIER

For many years, the Linear Research Model LR-700 AC resistance bridge has been revered as the industry standard for ultra-low noise AC resistance measurements. Since Linear Research ceased operations in 2005, there has not been a commercially available instrument able to parallel the real-world, low noise measurement performance of the Model LR-700. That is, until now!

Lake Shore obtained the remaining stock of field-effect transistors (FETs) used in the Model LR-700 that were selected for their unique, low-voltage noise characteristics. These FETs enabled us to develop the Model 3708 8-channel preamp and scanner. When combined with the exclusive design attributes of our Model 370 AC resistance bridge, the Model 3708 offers an exceptionally low voltage noise floor specification of just 2 $\text{nV}_{\text{RMS}}/\sqrt{\text{Hz}}$. This is equivalent to the low noise measurement performance previously only available with the Model LR-700.

How Good is the Model 3708 Preamp and Scanner?

The noise specification across a single FET used in the Model 3708 preamp and scanner is 0.62 $\text{nV}_{\text{RMS}}/\sqrt{\text{Hz}}$. Sixteen of these FETs, along with additional instrument circuitry, contribute to the overall instrument voltage noise floor performance. The practical measure of voltage noise is given by the resolution of the instrument, which is a function of the specified resistance range and excitation level.

The following table compares the Model LR-700 directly with the Model 370/3708 as each is observed using a digital readout or computer interface. The Model LR-700 specifications were compiled using mid-scale, room temperature resistors and a 10 second filter, while the Model 370/3708 specifications were compiled using an 18 second filter. The Model 370/3708 specifications were, however, normalized to 10 second filtering by multiplying the 18 second noise figure by $\sqrt{(18/10)}$, or 1.34.

Comparison of Linear Research LR-700 and Lake Shore Model 370/3708 instrument specifications for measurements performed under equivalent conditions

Resistance range (Ω)	Linear Research Model LR-700		Lake Shore Model 370/3708	
	Resolution	Excitation	Resolution	Excitation
0.002	10 nΩ	30 μV	10 nΩ	30 μV
0.02	100 nΩ	300 μV	54 nΩ	300 μV
0.2	1 μΩ	300 μV	540 nΩ	300 μV
2	10 μΩ	300 μV	5.4 μΩ	300 μV
20	100 μΩ	300 μV	54 μΩ	300 μV
200	1 mΩ	10 mV	270 μΩ	3 mV
2,000	10 mΩ	10 mV	2.7 mΩ	3 mV
20,000	100 mΩ	10 mV	27 mΩ	3 mV
200,000	1 Ω	10 mV	540 mΩ	3 mV
2,000,000	10 Ω	10 mV	7.3 Ω	3 mV

Which Lake Shore Scanner is Best for Your Particular Requirements?

At Lake Shore, we are committed to offering instrumentation optimized for your particular needs. As such, we offer three different scanner options for use with the Model 370 AC resistance bridge, each customized for particular measurement requirements. These include the Models 3708, 3716L, and 3716. The scanners allow the single channel Model 370 to multiplex up to either 8 or 16 channels. The input gain of the Model 370 is set to unity whenever a scanner option is used. Beyond these common features, the scanners are differentiated by their respective input voltage noise and DC bias current.

Some consideration must be given to ensure you choose the best scanner option to meet your needs. Ultra-low resistance measurement applications that demand the very best in low noise performance require the **Model 3708** preamp and scanner. While at just 2 $nV_{RMS}/\sqrt{Hz}$, the Model 3708 offers the lowest input voltage noise, it is not recommended for ultra-low temperature measurements. These measurements require very low DC bias current to prevent measurement errors as a result of self heating.

The **Model 3716L** scanner is the best option for most resistance measurement applications. This scanner offers a voltage noise floor of 4 $nV_{RMS}/\sqrt{Hz}$ and bias current of 30 pA. While the Model 3716L is excellent for basic AC resistance measurements, depending on the temperature sensor used, the DC bias current limits the scanner's utility for applications below 50 mK.

At just 4 pA, the original **Model 3716** scanner offers exceptionally low DC bias current. It is designed to provide femtowatt excitation levels, so it is the best choice for applications below 50 mK. The relatively high input voltage noise floor of 33 $nV_{RMS}/\sqrt{Hz}$ is not optimal for AC resistance measurements, but is a surmountable factor for sub-Kelvin measurement applications.

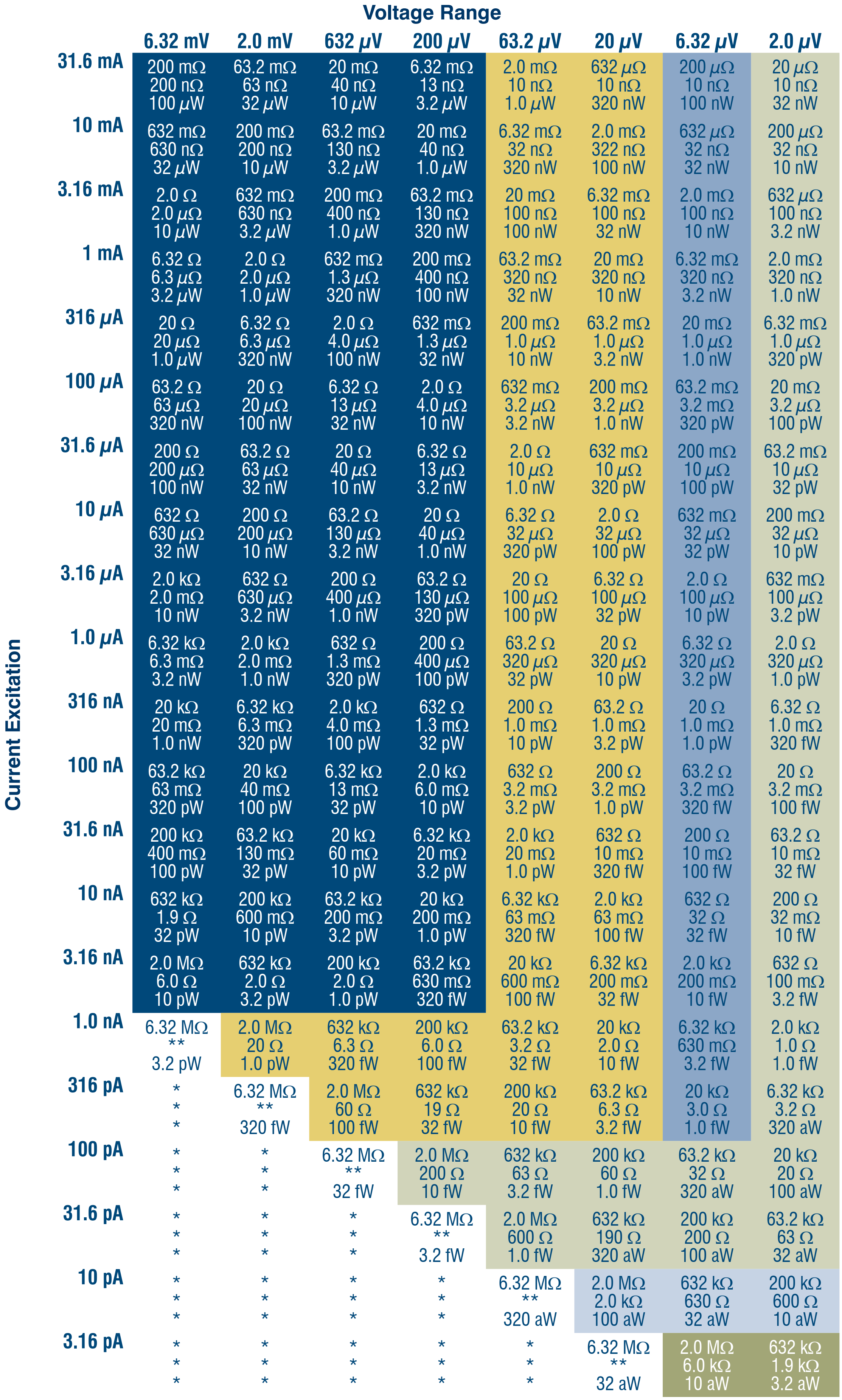
Comparison of noise, DC bias current, and number of channels for all Lake Shore scanners

	Model 3708	**Model 3616L**	**Model 3716**
Noise	2 $nV_{RMS}/\sqrt{Hz}$	4 $nV_{RMS}/\sqrt{Hz}$	33 $nV_{RMS}/\sqrt{Hz}$
DC bias current	55 pA + 1% I_{EXC}	30 pA + 1% I_{EXC}	4 pA + 1% I_{EXC}
Number of channels	8	16	16

Ordering Information

Part number	**Description**
370S	AC resistance bridge with 3716 scanner
370L	AC resistance bridge with 3716L scanner
370U	AC resistance bridge with 3708 scanner
370N	AC resistance bridge only
3716	16-channel scanner for Model 370
3716L	Low resistance 16-channel scanner for Model 370
3708	Ultra-low resistance 8-channel preamp/scanner for Model 370
3708-ARW	Ultra-low resistance 8-channel scanner for Model 370, includes 370 upgrade for instruments with main version 9/27/2005 and input version 1.3 or earlier firmware

Model 3708 Performance Specification Table



Voltage Range

Current Excitation	6.32 mV	2.0 mV	632 µV	200 µV	63.2 µV	20 µV	6.32 µV	2.0 µV
31.6 mA	200 mΩ 200 nΩ 100 µW	63.2 mΩ 63 nΩ 32 µW	20 mΩ 40 nΩ 10 µW	6.32 mΩ 13 nΩ 3.2 µW	2.0 mΩ 10 nΩ 1.0 µW	632 µΩ 10 nΩ 320 nW	200 µΩ 10 nΩ 100 nW	20 µΩ 10 nΩ 32 nW
10 mA	632 mΩ 630 nΩ 32 µW	200 mΩ 200 nΩ 10 µW	63.2 mΩ 130 nΩ 3.2 µW	20 mΩ 40 nΩ 1.0 µW	6.32 mΩ 32 nΩ 320 nW	2.0 mΩ 322 nΩ 100 nW	632 µΩ 32 nΩ 32 nW	200 µΩ 32 nΩ 10 nW
3.16 mA	2.0 Ω 2.0 µΩ 10 µW	632 mΩ 630 nΩ 3.2 µW	200 mΩ 400 nΩ 1.0 µW	63.2 mΩ 130 nΩ 320 nW	20 mΩ 100 nΩ 100 nW	6.32 mΩ 100 nΩ 32 nW	2.0 mΩ 100 nΩ 10 nW	632 µΩ 100 nΩ 3.2 nW
1 mA	6.32 Ω 6.3 µΩ 3.2 µW	2.0 Ω 2.0 µΩ 1.0 µW	632 mΩ 1.3 µΩ 320 nW	200 mΩ 400 nΩ 100 nW	63.2 mΩ 320 nΩ 32 nW	20 mΩ 320 nΩ 10 nW	6.32 mΩ 320 nΩ 3.2 nW	2.0 mΩ 320 nΩ 1.0 nW
316 µA	20 Ω 20 µΩ 1.0 µW	6.32 Ω 6.3 µΩ 320 nW	2.0 Ω 4.0 µΩ 100 nW	632 mΩ 1.3 µΩ 32 nW	200 mΩ 1.0 µΩ 10 nW	63.2 mΩ 1.0 µΩ 3.2 nW	20 mΩ 1.0 µΩ 1.0 nW	6.32 mΩ 1.0 µΩ 320 pW
100 µA	63.2 Ω 63 µΩ 320 nW	20 Ω 20 µΩ 100 nW	6.32 Ω 13 µΩ 32 nW	2.0 Ω 4.0 µΩ 10 nW	632 mΩ 3.2 µΩ 3.2 nW	200 mΩ 3.2 µΩ 1.0 nW	63.2 mΩ 3.2 mΩ 320 pW	20 mΩ 3.2 µΩ 100 pW
31.6 µA	200 Ω 200 µΩ 100 nW	63.2 Ω 63 µΩ 32 nW	20 Ω 40 µΩ 10 nW	6.32 Ω 13 µΩ 3.2 nW	2.0 Ω 10 µΩ 1.0 nW	632 mΩ 10 µΩ 320 pW	200 mΩ 10 µΩ 100 pW	63.2 mΩ 10 µΩ 32 pW
10 µA	632 Ω 630 µΩ 32 nW	200 Ω 200 µΩ 10 nW	63.2 Ω 130 µΩ 3.2 nW	20 Ω 40 µΩ 1.0 nW	6.32 Ω 32 µΩ 320 pW	2.0 Ω 32 µΩ 100 pW	632 mΩ 32 µΩ 32 pW	200 mΩ 32 µΩ 10 pW
3.16 µA	2.0 kΩ 2.0 mΩ 10 nW	632 Ω 630 µΩ 3.2 nW	200 Ω 400 µΩ 1.0 nW	63.2 Ω 130 µΩ 320 pW	20 Ω 100 µΩ 100 pW	6.32 Ω 100 µΩ 32 pW	2.0 Ω 100 µΩ 10 pW	632 mΩ 100 µΩ 3.2 pW
1.0 µA	6.32 kΩ 6.3 mΩ 3.2 nW	2.0 kΩ 2.0 mΩ 1.0 nW	632 Ω 1.3 mΩ 320 pW	200 Ω 400 µΩ 100 pW	63.2 Ω 320 µΩ 32 pW	20 Ω 320 µΩ 10 pW	6.32 Ω 320 µΩ 3.2 pW	2.0 Ω 320 µΩ 1.0 pW
316 nA	20 kΩ 20 mΩ 1.0 nW	6.32 kΩ 6.3 mΩ 320 pW	2.0 kΩ 4.0 mΩ 100 pW	632 Ω 1.3 mΩ 32 pW	200 Ω 1.0 mΩ 10 pW	63.2 Ω 1.0 mΩ 3.2 pW	20 Ω 1.0 mΩ 1.0 pW	6.32 Ω 1.0 mΩ 320 fW
100 nA	63.2 kΩ 63 mΩ 320 pW	20 kΩ 40 mΩ 100 pW	6.32 kΩ 13 mΩ 32 pW	2.0 kΩ 6.0 mΩ 10 pW	632 Ω 3.2 mΩ 3.2 pW	200 Ω 3.2 mΩ 1.0 pW	63.2 Ω 3.2 mΩ 320 fW	20 Ω 3.2 mΩ 100 fW
31.6 nA	200 kΩ 400 mΩ 100 pW	63.2 kΩ 130 mΩ 32 pW	20 kΩ 60 mΩ 10 pW	6.32 kΩ 20 mΩ 3.2 pW	2.0 kΩ 20 mΩ 1.0 pW	632 Ω 10 mΩ 320 fW	200 Ω 10 mΩ 100 fW	63.2 Ω 10 mΩ 32 fW
10 nA	632 kΩ 1.9 Ω 32 pW	200 kΩ 600 mΩ 10 pW	63.2 kΩ 200 mΩ 3.2 pW	20 kΩ 200 mΩ 1.0 pW	6.32 kΩ 63 mΩ 320 fW	2.0 kΩ 63 mΩ 100 fW	632 Ω 32 Ω 32 fW	200 Ω 32 mΩ 10 fW
3.16 nA	2.0 MΩ 6.0 Ω 10 pW	632 kΩ 2.0 Ω 3.2 pW	200 kΩ 2.0 Ω 1.0 pW	63.2 kΩ 630 mΩ 320 fW	20 kΩ 600 mΩ 100 fW	6.32 kΩ 200 mΩ 32 fW	2.0 kΩ 200 mΩ 10 fW	632 Ω 100 mΩ 3.2 fW
1.0 nA	6.32 MΩ ** 3.2 pW	2.0 MΩ 20 Ω 1.0 pW	632 kΩ 6.3 Ω 320 fW	200 kΩ 6.0 Ω 100 fW	63.2 kΩ 3.2 Ω 32 fW	20 kΩ 2.0 Ω 10 fW	6.32 kΩ 630 mΩ 3.2 fW	2.0 kΩ 1.0 Ω 1.0 fW
316 pA	* * *	6.32 MΩ ** 320 fW	2.0 MΩ 60 Ω 100 fW	632 kΩ 19 Ω 32 fW	200 kΩ 20 Ω 10 fW	63.2 kΩ 6.3 Ω 3.2 fW	20 kΩ 3.0 Ω 1.0 fW	6.32 kΩ 3.2 Ω 320 aW
100 pA	* * *	* * *	6.32 MΩ ** 32 fW	2.0 MΩ 200 Ω 10 fW	632 kΩ 63 Ω 3.2 fW	200 kΩ 60 Ω 1.0 fW	63.2 kΩ 32 Ω 320 aW	20 kΩ 20 Ω 100 aW
31.6 pA	* * *	* * *	* * *	6.32 MΩ ** 3.2 fW	2.0 MΩ 600 Ω 1.0 fW	632 kΩ 190 Ω 320 aW	200 kΩ 200 Ω 100 aW	63.2 kΩ 63 Ω 32 aW
10 pA	* * *	* * *	* * *	* * *	6.32 MΩ ** 320 aW	2.0 MΩ 2.0 kΩ 100 aW	632 kΩ 630 Ω 32 aW	200 kΩ 600 Ω 10 aW
3.16 pA	* * *	* * *	* * *	* * *	* * *	6.32 MΩ ** 32 aW	2.0 MΩ 6.0 kΩ 10 aW	632 kΩ 1.9 kΩ 3.2 aW

■ ±0.03%
■ ±0.05%
■ ±0.1%
■ ±0.3%
■ ±0.5%
■ ±1.0%

Accuracy:
% reading +
0.005% of range

* Range not available

** Range available,
not specified

200 kΩ — resistance range
100 Ω — resolution
1.0 fW — power

Resistance Range: Full scale resistance range, nominal 20% over range

Resolution: RMS noise with 18 s filter settling time (approximates 3 s analog time constant)

Power: Excitation power at one-half full scale resistance

Precision: Dominated by measurement temperature coefficient (±0.0015% of reading ±0.0002% of range)/°C

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Established in 1968, Lake Shore Cryotronics, Inc. is an international leader in developing innovative measurement and control solutions. Founded by Dr. John M. Swartz, a former professor of electrical engineering at the Ohio State University, and his brother David, Lake Shore produces equipment for the measurement of cryogenic temperatures, magnetic fields, and the characterization of the physical properties of materials in temperature and magnetic environments.