

Resistors

R 8900 Series

Air Fired Resistor System

Description

The Heraeus resistor system shows the following key advantages :

R 8900 series offers a range of $1 \Omega / \square$ - $1 \text{ M}\Omega / \square$

- Excellent noise and STOL values
- Cofiring with C 4412 H conductor paste
- Compatible with C 2000 series (Ni and Cd-free)

Typical Fired Resistor Properties ¹⁾

R 8900 Series ^{2,3}	R 8911	R 8921	R 8931	R 8935 L	R 8935 HN ¹⁰	R 8941 N ¹⁰	R 8951 N ¹⁰	R 8961 N ¹⁰
Resistivity ⁴ [Ω/\square]	$10 \pm 10\%$	$100 \pm 10\%$	$1 \text{ k} \pm 10\%$	$5 \text{ k} \pm 10\%$	$5 \text{ k} \pm 10\%$	$10 \text{ k} \pm 10\%$	$100 \text{ k} \pm 10\%$	$1 \text{ M} \pm 10\%$
Temperature coefficient of resistance ⁴ TCR [ppm/K]	± 100	± 100	± 100	± 100	± 100	± 100	± 100	± 100
Voltage coefficient of resistance ⁵ VCR [ppm/V/mm]	-	-	-	-	-	-50	-	-
Short term overload voltage ⁶ [V/mm]	9	28	87	155	180	238	497	524
Standard working voltage ⁷ [V/mm]	3.6	11	35	62	72	95	199	209
Maximum rated power dissipation ⁸ [mW/mm ²]	1300	1280	1220	770	1040	910	395	44
Quan tech noise ⁹ [dB]	-	-32	-21	-10	-13	-10	-3	-

1 Typical properties based on laboratory test methods. For optimum results all materials should be fired in a profiled furnace supplied by dried, hydrocarbon-free and other contaminant-free air (PP-1).

2 Also available: R 8901 (Resistivity: $1 \Omega / \square \pm 20\%$; TCR : ± 250 ppm / K) ³; other resistivity values available on request.

3 Processing conditions: termination: Heraeus Silver / Palladium conductor composition C 1214, prefired at 850 °C; substrate: 96% alumina (Ceramec, Rubalit 708 S); printing: 200 mesh stainless steel screen with 30 μm emulsion, to a dried thickness of $25 \pm 3 \mu\text{m}$ (resistivity $\leq 10 \Omega / \square$: $22 \pm 3 \mu\text{m}$); firing: 60 minute cycle (furnace entry to exit) to a peak temperature of 850 °C for 10 minutes.

4 Shipping specifications: Resistor geometry: 1.5 x 1.5 mm. Temperature coefficient of resistance: -55 °C to +25 °C and +25 °C to +125 °C.

5 Voltage coefficient of resistance: Resistor geometry 1 x 1 mm laser trimmed with P-cut to 1.5 x fired value. VCR measured from 5 - 50 VDC.

6 Short term overload voltage: voltage required (5 second duration) to induce a resistance change of 0.1% in a 1 x 1 mm resistor at 25 °C.

7 Standard working voltage: 0.4 x short term overload voltage.

8 Maximum rated power dissipation =

$$\frac{(\text{standard working voltage})^2}{\text{resistance}}$$

9 Resistor geometry: 1 x 1 mm

10 Improved pastes with decreased firing sensitivities

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Processing:

1. Stir well prior to processing. When stored in a refrigerator allow paste to come to room temperature to avoid condensation.
2. Print through a 200 mesh stainless steel screen, 30 μm emulsion. Total screen thickness: 90 – 110 μm .
3. Level at room temperature for 5 – 10 minutes.
4. Dry at 150 °C for 10 minutes. Dried film thickness should be $25 \pm 3 \mu\text{m}$.
5. The electrical performance given in this data sheet refers to a 60 minute firing cycle, with a peak temperature of 850 °C for 10 minutes. Conformance to R 8900 Series specifications may also be obtained using a 30 minute cycle, with 10 minutes at 850 °C (R 8900 E Series).

Properties:

Form:	Thixotropic paste
Viscosity:	25 – 50 Pas ($D = 100 \text{ s}^{-1}$, 25 °C)
Coverage:	80 – 110 cm^2 / g
Shelf life:	12 months with correct storage. Store in a dark, cool and dry place (2 °C – 23 °C and with container tightly shut).

Compatibility:

- Conductors, various standard terminations:

Ag	C 1075 SD
AgPd	C 2000 series, C 1214
AgPt	C 1076 SD
Au	C 5754 B, C 5007
- Overglaze:

IP 9025 ST	(500 °C)
IP 9029 H	(600 °C)
TO 7003	(600°C)
- Dielectric: IP 9117 series

Thinner: Heraprint 100

Blend-Break:

Adjacent decades may be blended to yield intermediate values that conform to R 8900 series specifications. A blend-break exists between R 8931 and R 8941 N; these are not directly blendable but, for blending, two 5 $\text{k}\Omega/\square$ pastes are available instead: R 8935 L (compatible with the low-ohmic end) and R 8935 HN (compatible with the high-ohmic end).

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Laser Trim Stability:

All tests were performed on 1 x 1 mm resistors, not overglazed, and terminated with C 1214 (Ag/Pd).

Trimming Parameters:

trimming to 1.5 times the fired value with a Nd-YAG-laser with a single plunge cut

Trim Speed: 10 - 30 mm/s

Q-Rate: 2 - 5 kHz

Average power: 0.8 - 1.5 W

Trim Performance ¹¹:

Initial accuracy: $\pm 0.1 \%$

Long term stability (1000 hrs):

85 °C/ 85% RH : $\pm 0.2 \%$

150 °C aging: $\pm 0.2 \%$

power aging: $\pm 0.2 \%$
 $\pm 0.3 \%$ @ R 8911

¹¹ Test conditions and accurate values available on request

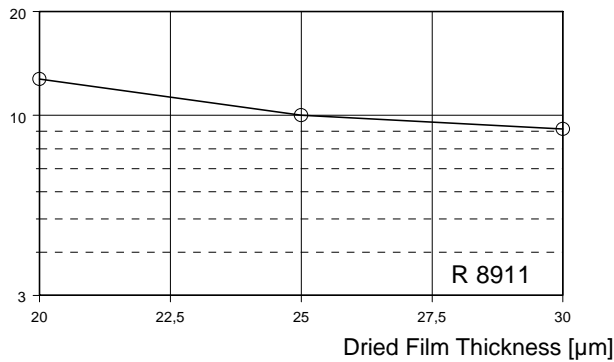
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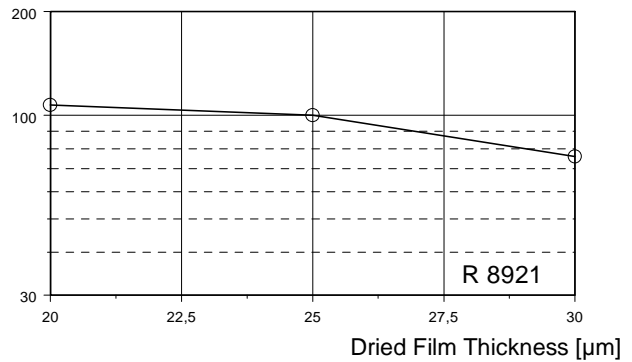
Air Fired Resistor System

Effect of Film Thickness on Resistivity:

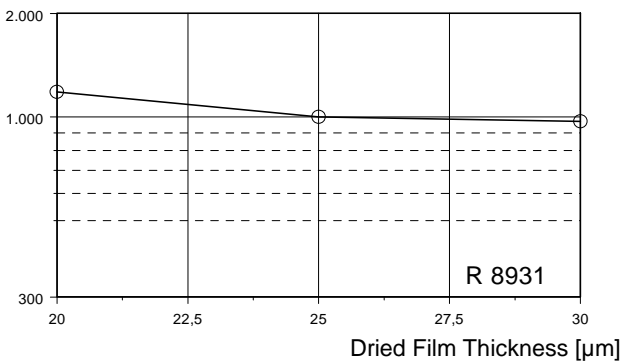
Resistivity [Ω/\square]



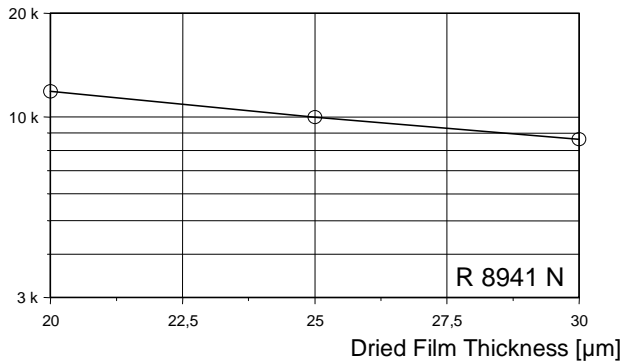
Resistivity [Ω/\square]



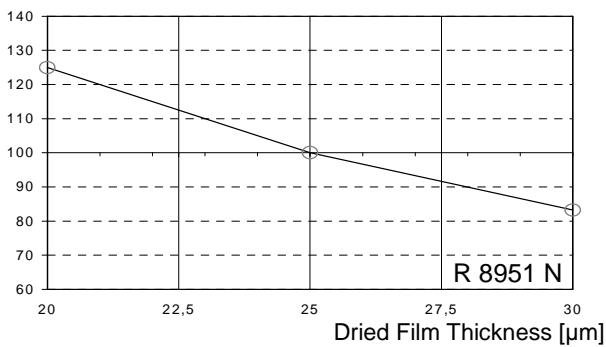
Resistivity [Ω/\square]



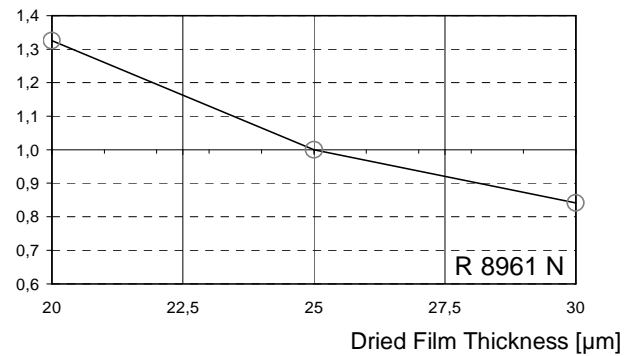
Resistivity [Ω/\square]



Resistivity [$\text{k}\Omega/\square$]



Resistivity [$\text{M}\Omega/\square$]



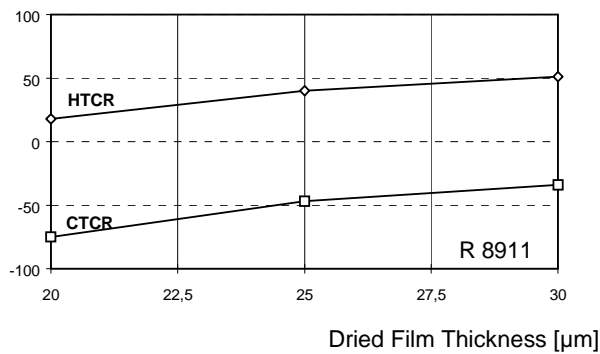
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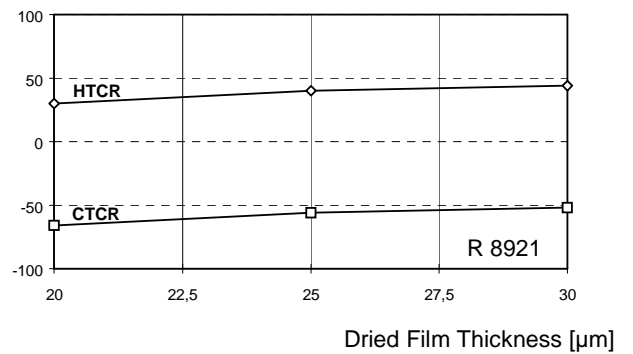
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Effect of Film Thickness on TCR:

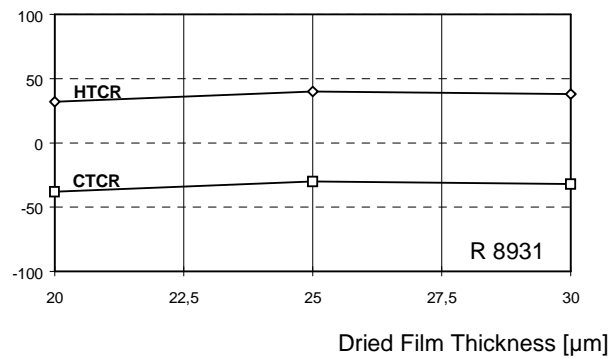
TCR [ppm/K]



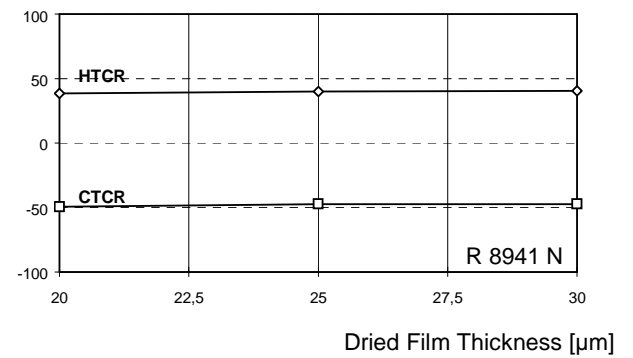
TCR [ppm/K]



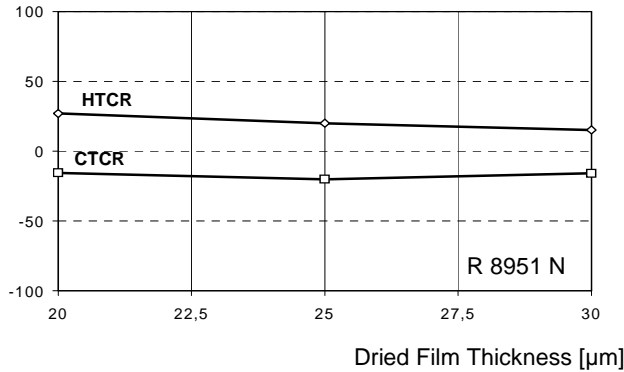
TCR [ppm/K]



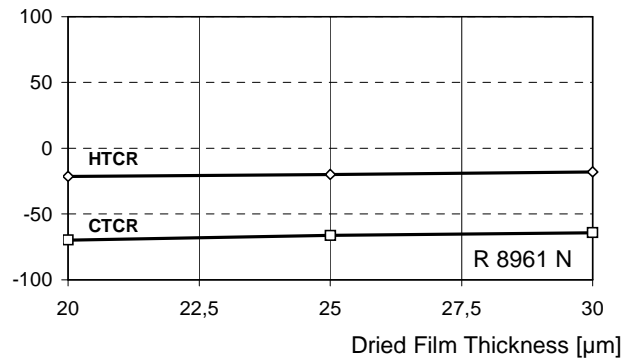
TCR [ppm/K]



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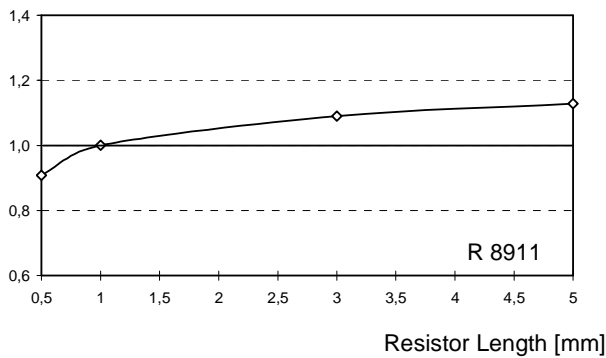
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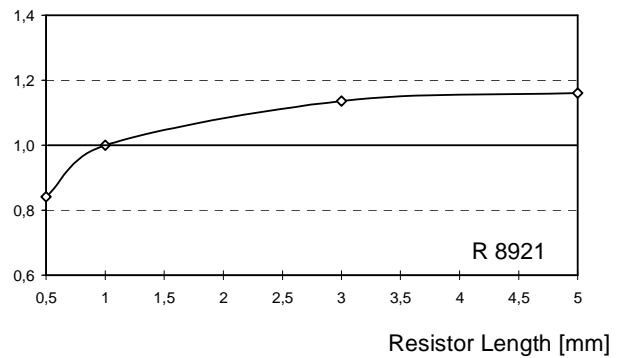
Effect of Resistor Length on Resistivity:

Termination : C1214 Ag/Pd ; Resistor width : 1.0 mm

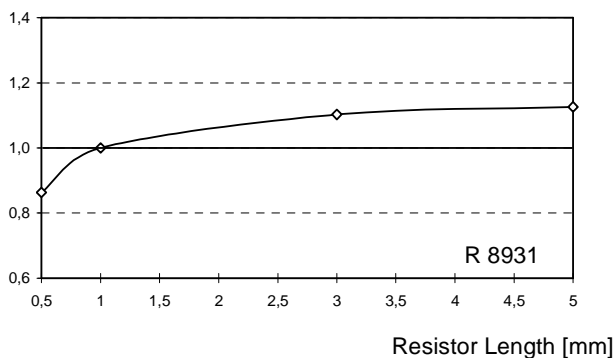
Rel. Resistivity



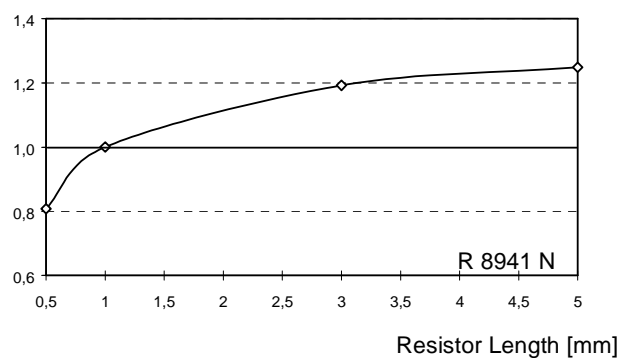
Rel. Resistivity



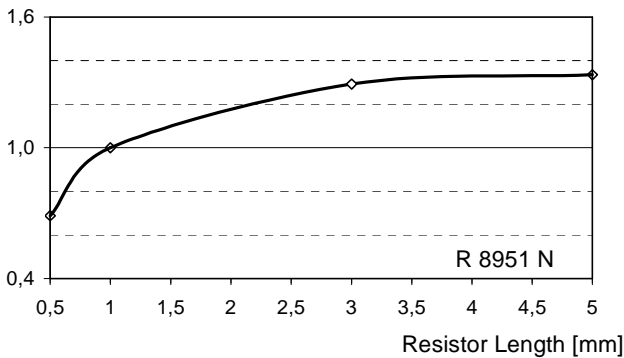
Rel. Resistivity



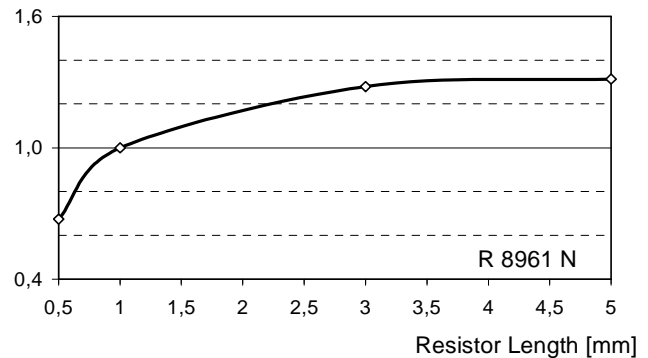
Rel. Resistivity



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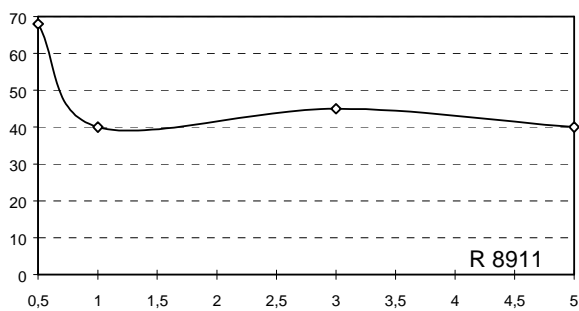
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Effect of Resistor Length on HTCR:

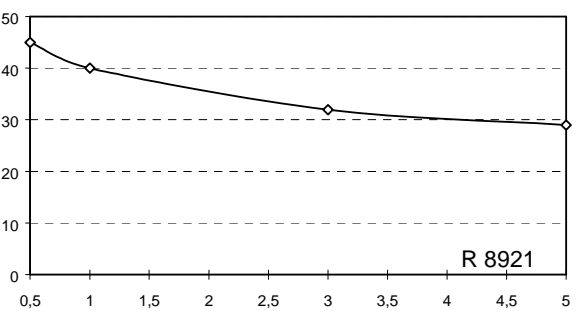
Termination : C1214 Ag/Pd ; Resistor width : 1.0 mm

TCR [ppm/K]



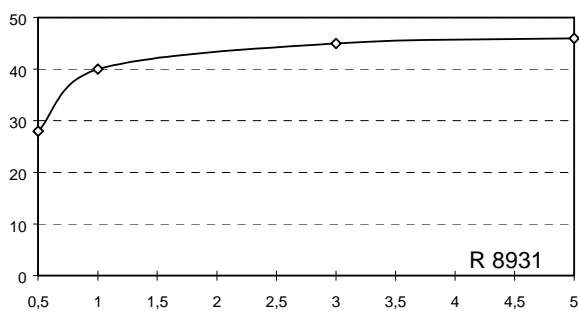
Resistor Length [mm]

TCR [ppm/K]



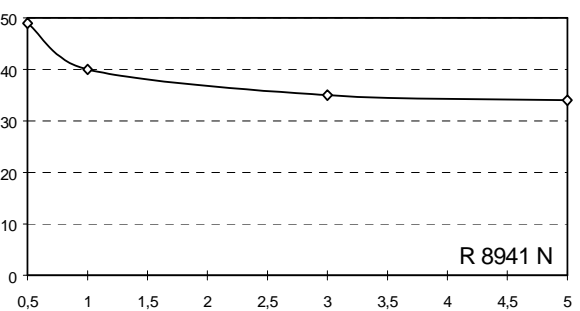
Resistor Length [mm]

TCR [ppm/K]



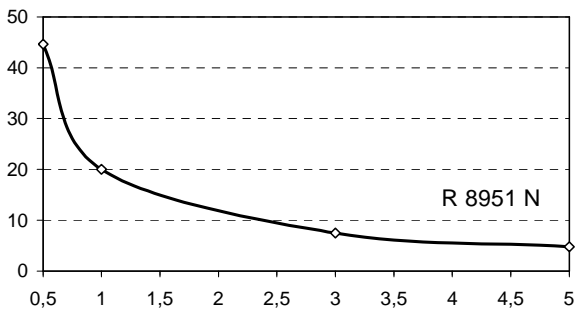
Resistor Length [mm]

TCR [ppm/K]



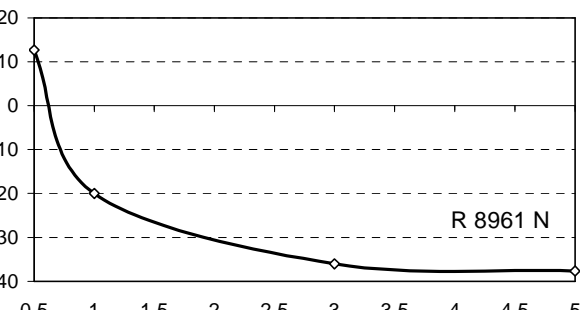
Resistor Length [mm]

TCR [ppm/K]



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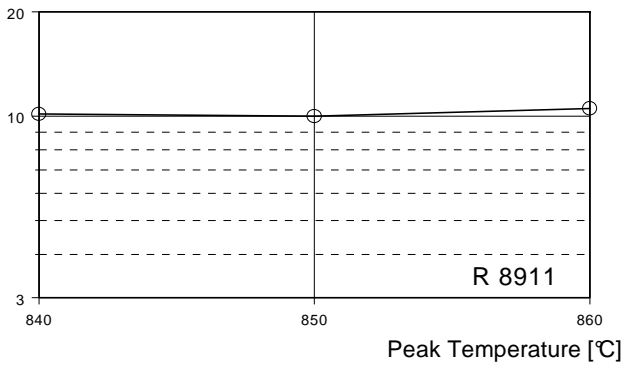
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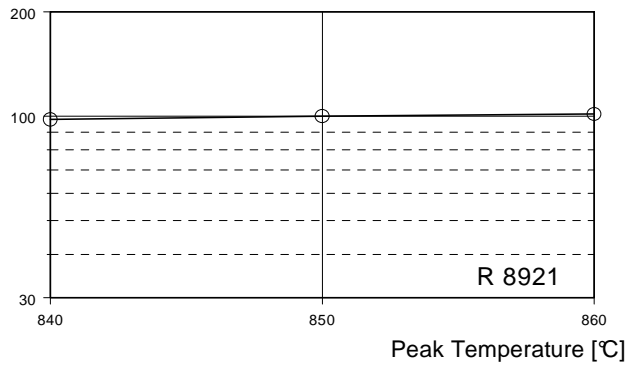
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Effect of Peak Temperature on Resistivity:

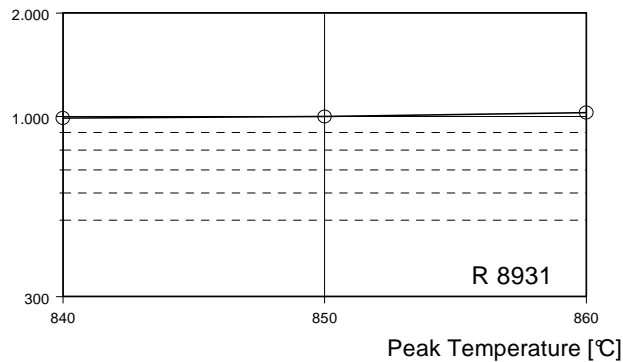
Resistivity [Ω/\square]



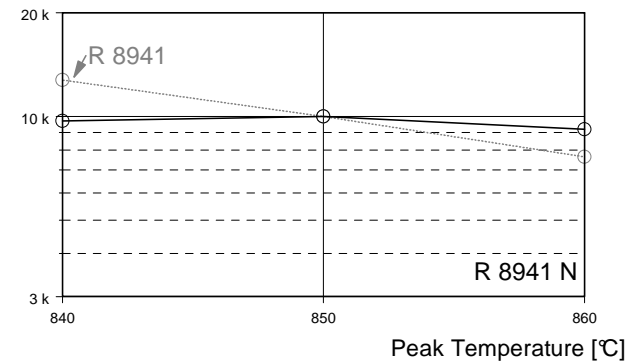
Resistivity [Ω/\square]



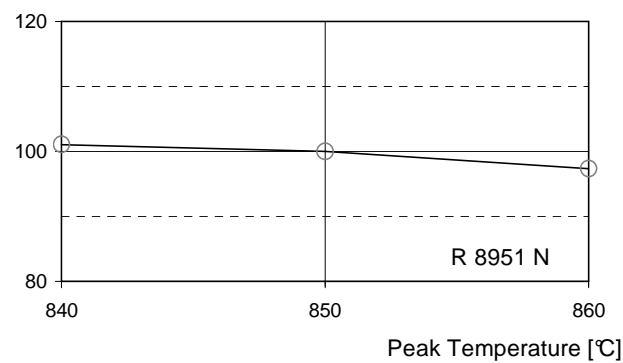
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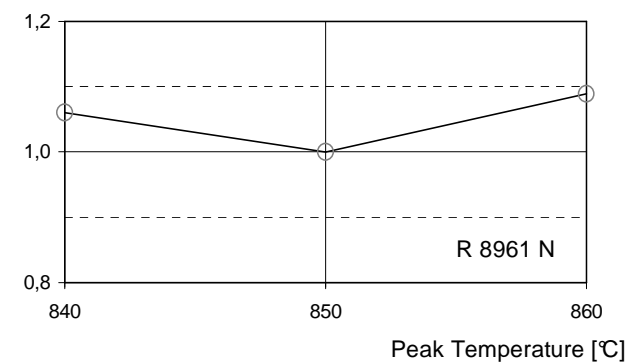
Resistivity [Ω/\square]



Resistivity [$\text{k}\Omega/\square$]



Resistivity [$\text{M}\Omega/\square$]



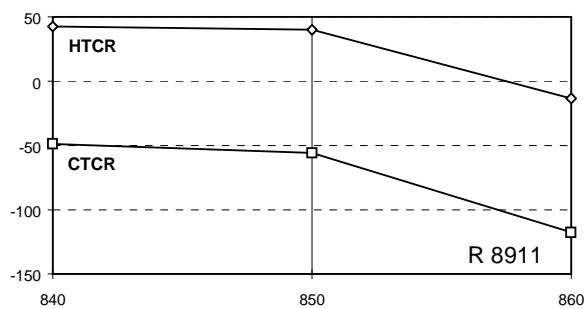
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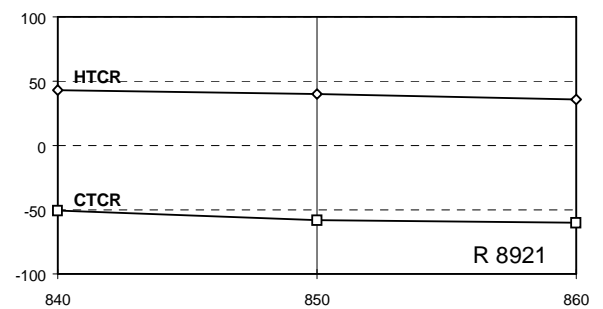
Effect of Peak Temperature on TCR:

TCR [ppm/K]



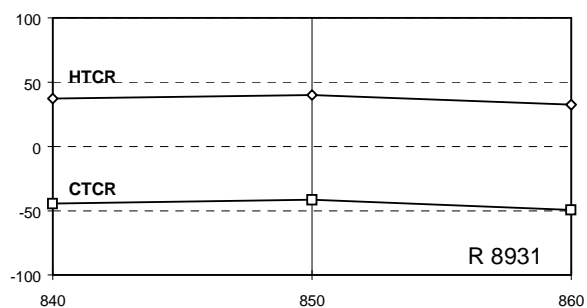
Peak Temperature [°C]

TCR [ppm/K]



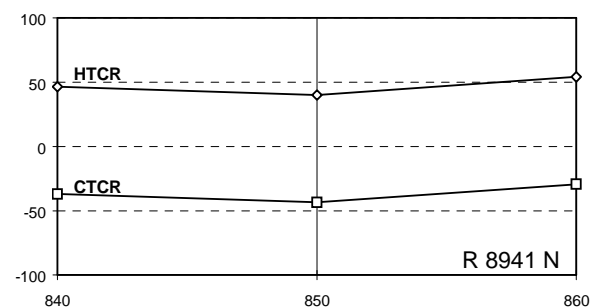
Peak Temperature [°C]

TCR [ppm/K]



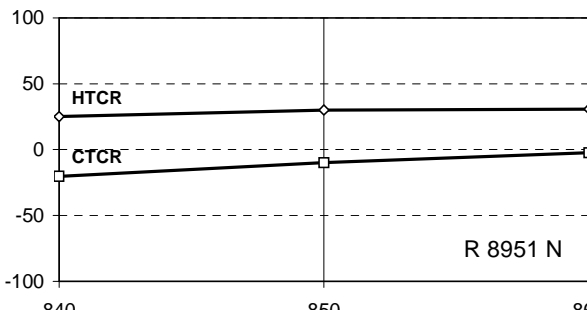
Peak Temperature [°C]

TCR [ppm/K]



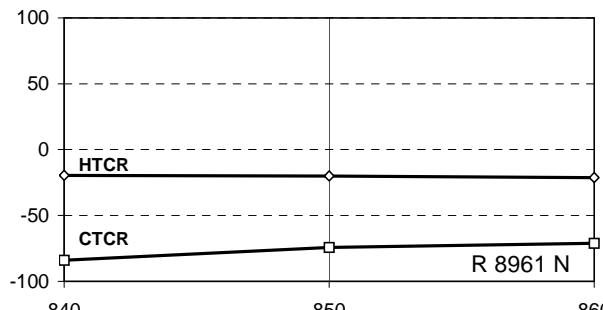
Peak Temperature [°C]

TCR [ppm/K]



Peak Temperature [°C]

TCR [ppm/K]

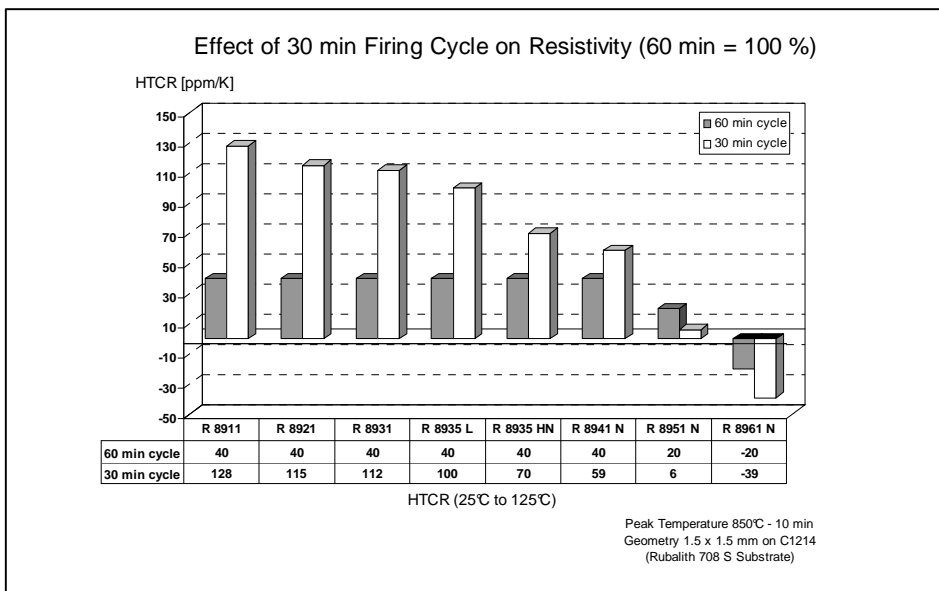
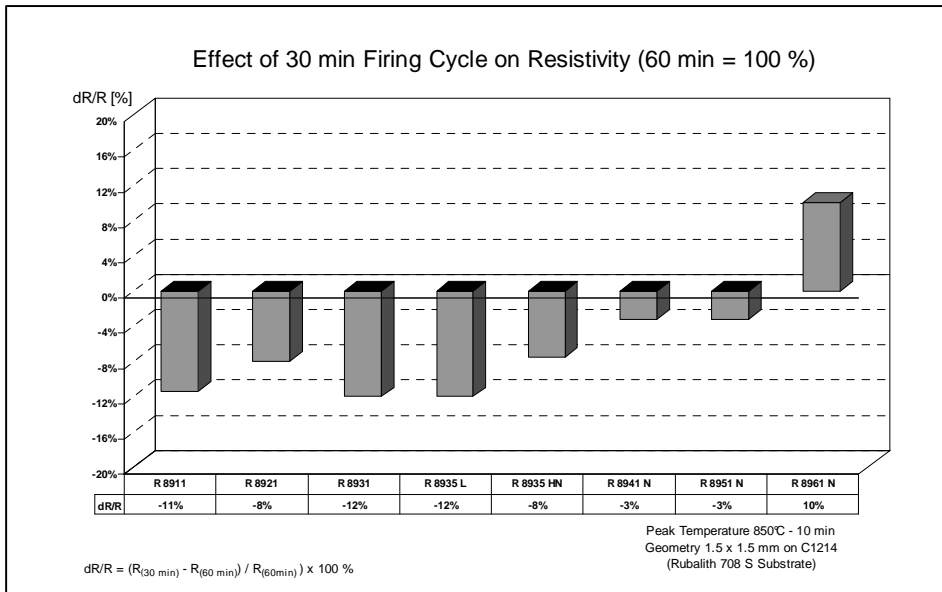


Peak Temperature [°C]

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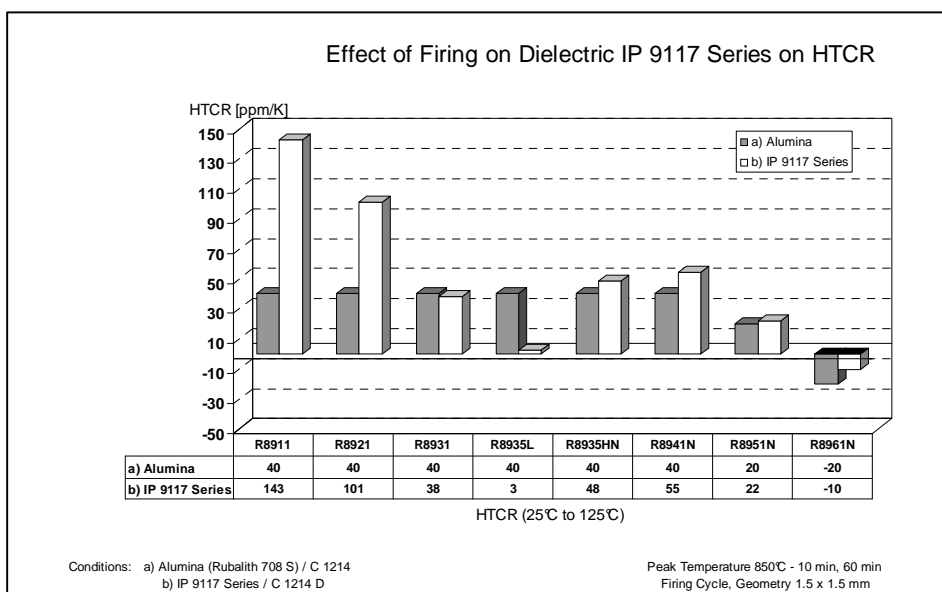
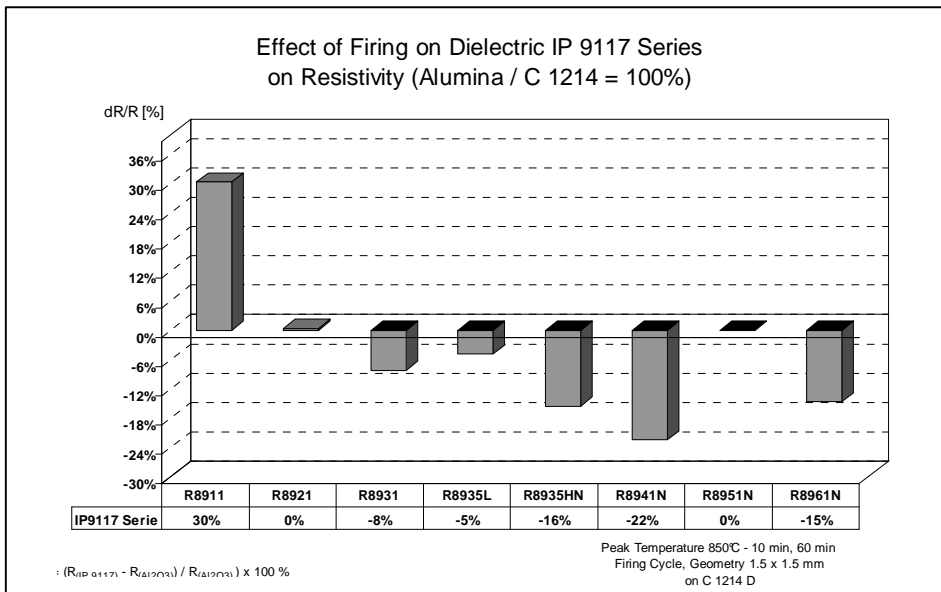
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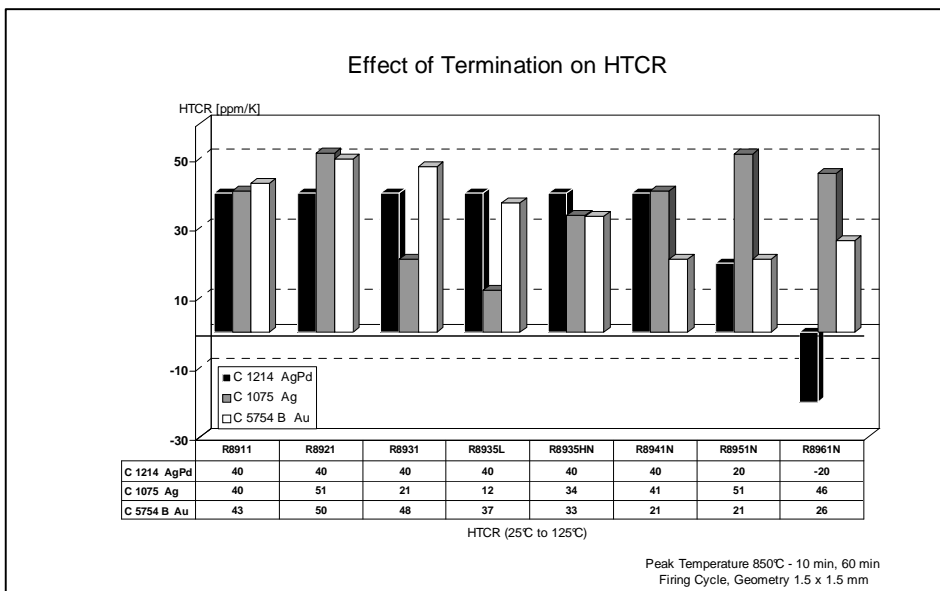
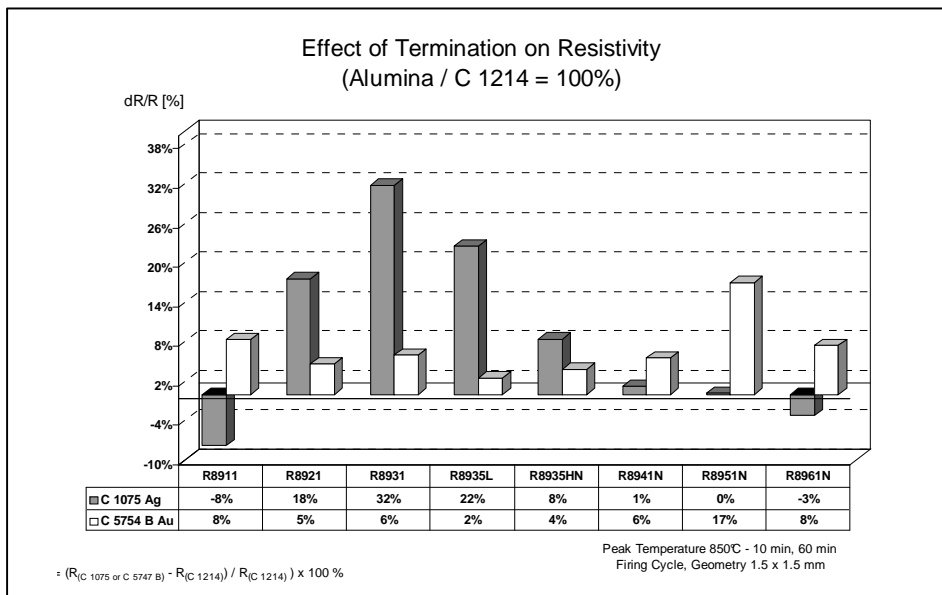
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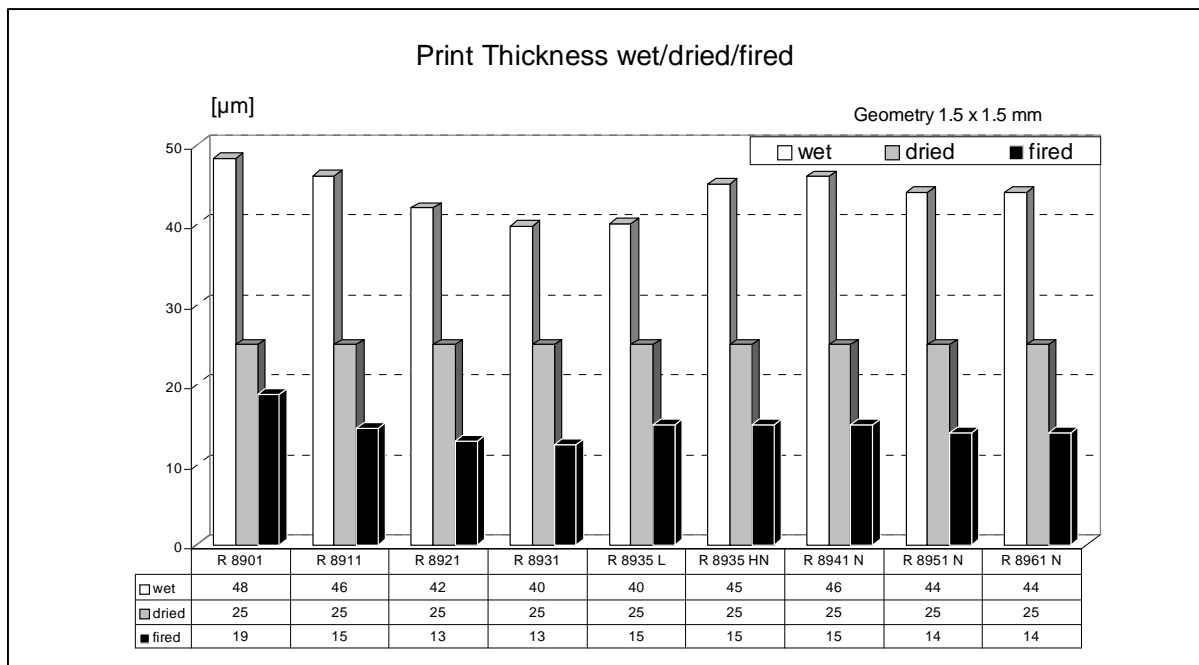
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The descriptions and engineering data shown here have been compiled by Heraeus using commonly-accepted procedures, in conjunction with modern testing equipment, and have been compiled as according to the latest factual knowledge in our possession. The information was up-to date on the date this document was printed (latest versions can always be supplied upon request). Although the data is considered accurate, we cannot guarantee accuracy, the results obtained from its use, or any patent infringement resulting from its use (unless this is contractually and explicitly agreed in writing, in advance). The data is supplied on the condition that the user shall conduct tests to determine materials suitability for a particular application.

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