ESL ELECTROSCIENCE
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CERMET RESISTOR SYSTEM 3900 Series

The 3900 Series is a ruthenium-based resistor system for use in hybrid micro-electronic circuits and discrete components. It is used for the most demanding telecommunications, aerospace and medical applications and combines high performance, low cost, and ease of processing. The resistors exhibit good voltage and thermal stability.

The 3900 Series has the following characteristics:

- Wide range of resistivities: 0.1Ω/sq. to 1 MΩ/sq.
- Temperature Coefficient of Resistance (TCR): less than 50 ppm/°C for the 100 Ω, 1 kΩ, and 10 kΩ resistivity ranges.
- TCR tracking within 10 ppm/°C when the same size and termination are used with an individual resistivity.
- Low sensitivity of TCR and resistivity to printing and firing cycles.
- Good power load stability, up to 1000 mW/mm^2 (650 W/in^2) - with or without overglaze as long as hot spot temperatures are limited to 150°C. Heat stabilization may be used to permit stable operation at significantly higher power loading.
- Excellent stability after laser trimming.
- Specially blended intermediate resistor values are available on request.
- All members of the 3900 Series are co-fireable.

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See Caution and Disclaimer on page 2.

PASTE DATA

Rheology:	Thixotropic, screen-printable paste

PROCESSING

Screen Mesh, Emulsion:		200 / 12.5 µm
Levelling Time (at 20°C):		5 - 10 min
Drying Time (at 125°C):		10 - 15 min
Firing Temperature Range:		850°C in air
	Optimum:	850°C
	Time at peak:	10 min
Total Firing Cycle:		1 hour
Substrate for Calibration:		96% alumina*

*** - NOTE:** Beryllia substrates may also be used but resistivity and TCR changes will occur. Similarly, small shifts in resistivity and TCR may occur with 99% alumina substrates or substrates containing substantial amounts of calcium and barium silicates.

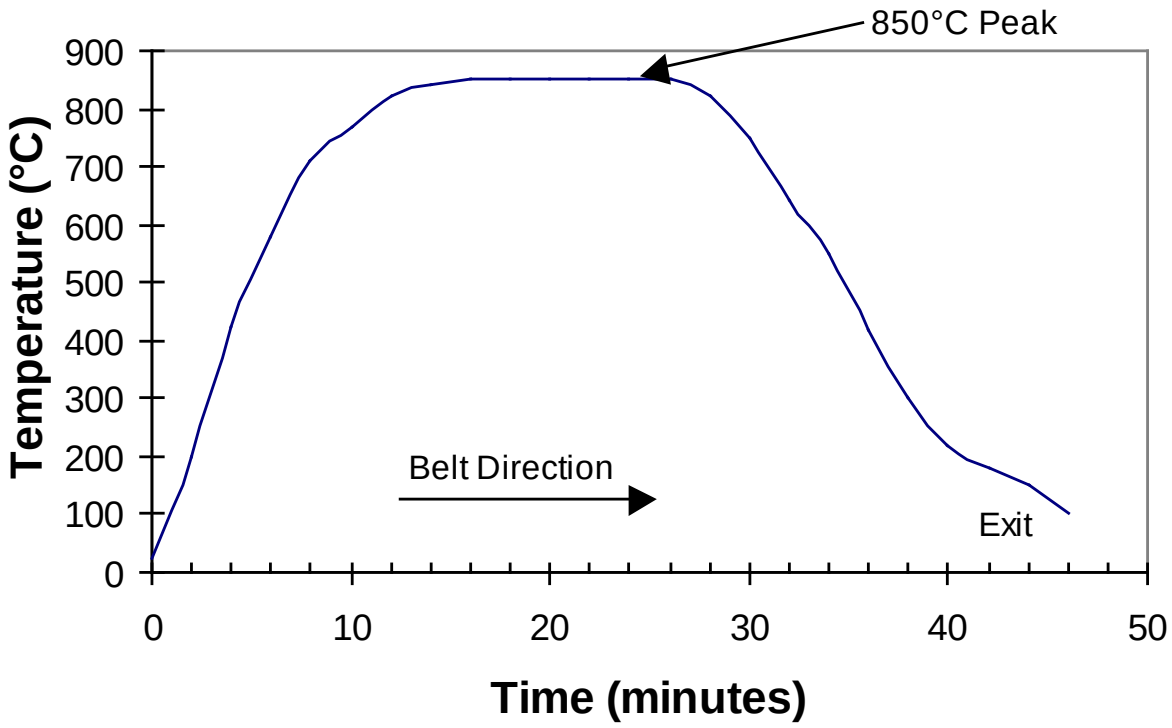
Stabilization:

If required, post-fire stabilization, such as overglazing with 4770-BCG (fired at 500°C - 525°C) and/or 240-SB (modified silicone resin, cured at 200°C - 250°C), may be used. For high precision applications, or tight tolerance resistors the following procedure may be used: overglaze with 4770-BCG, trim to 1% of nominal value, anneal at 200°C for 24 hours before fine trimming to the desired tolerance. Laser cuts may be protected with a low temperature polymer coating such as 240-SB.

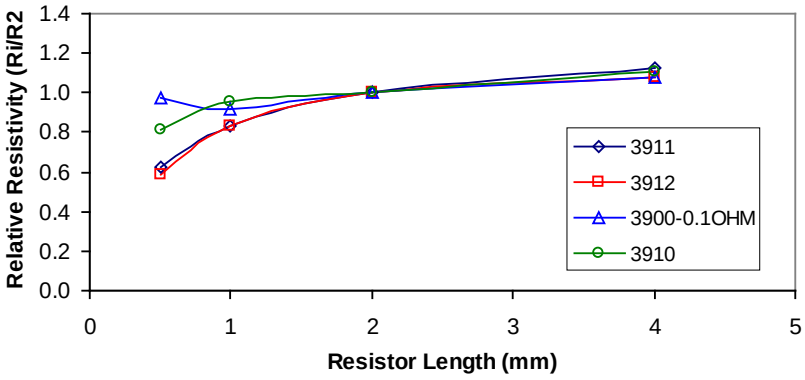
PROPERTIES	3900-0.1OHM	3910	3911	3912	3913	3914	3915	3916
Resistivity (Ω/square)[1]	0.1	1	10	100	1 k	10 k	100 k	1 M
Tolerance (%)	±50	±30	±10	±10	±10	±10	±10	±10
Viscosity (Pa·s)[2]	300±25	225 ± 25						
Dried Thickness (µm)	22.5 ± 2.5							
Thinner	ESL 401							
Average TCR (ppm/°C)[3]	75 ± 75	50 ± 100	0 ± 100	0 ± 50	0 ± 50	0 ± 50	0 ± 100	-100 ± 100
STOL (V/mm)[4]	-	-	8.07	24.6	70.9	64.0	128	-
Std. Working Voltage (V/mm)[5]	-	-	3.22	9.84	28.3	25.6	51.2	-
Max Rated Power (mW/mm^2)[6]	-	-	974	970	1001	60.6	27.0	-
Quan-Tech Noise (dB)	N/A	N/A	N/A	≤-10	≤-10	≤+10	≤+25	≤+35
Average VCR (ppm/V/cm)	-	-	-	-	-	≤-100	≤100	≤-450
Laser Trim Stability (%ΔR) (1,000 hours at 150°C)	-	-	±0.3%	±0.3%	±0.3%	±0.3%	±0.3%	±0.3%
Termination Conductor	8835-1B	9635-B						
Shelf Life (25°C)	6 months							

[1] CALIBRATION: Resistor size: 1.25 mm x 1.25 mm.
[2] VISCOSITY: Brookfield RVT, ABZ Spindle, 10 rpm, 25.5°C±0.5°C.
[3] CTCR: -55°C to +25°C. HTCR: +25°C to +125°C. Resistor size measured for TCR: 3900-0.1 OHM & 3910 - 20 mm x 2 mm; all others - 1.25 mm x 1.25 mm.
[4] STOL: Voltage required, 5 second duration, to induce a resistance change of ±0.1% at 25°C.
[5] STANDARD WORKING VOLTAGE: 0.4 x STOL Voltage.
[6] MAXIMUM RATED POWER: (Standard Working Voltage)^2/Resistance.

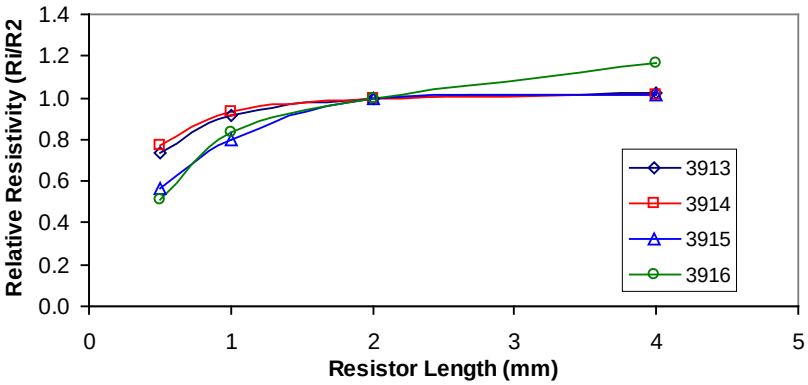
Typical 850°C Firing Profile



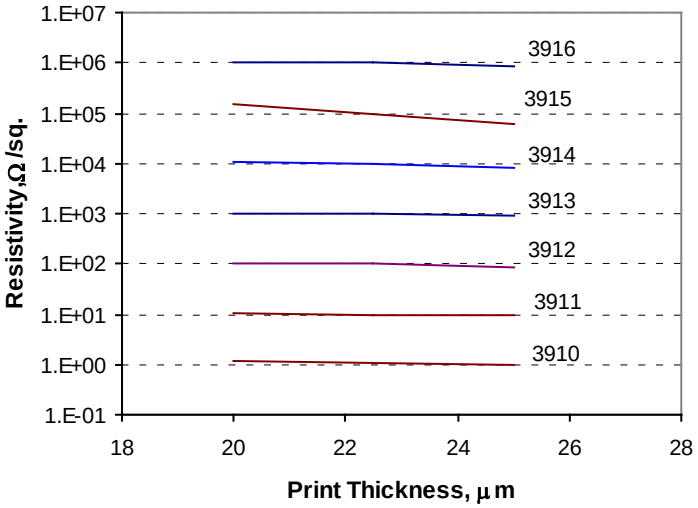
3900-Series Resistivity vs Resistor Length



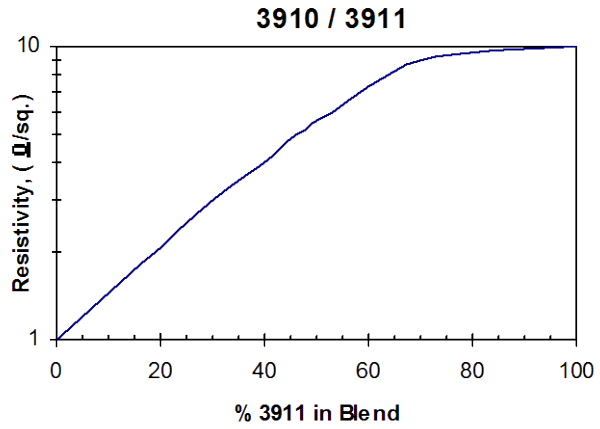
3900-Series Resistivity vs Resistor Length

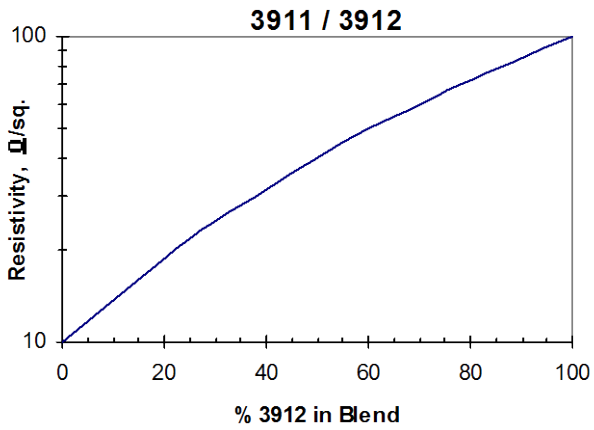


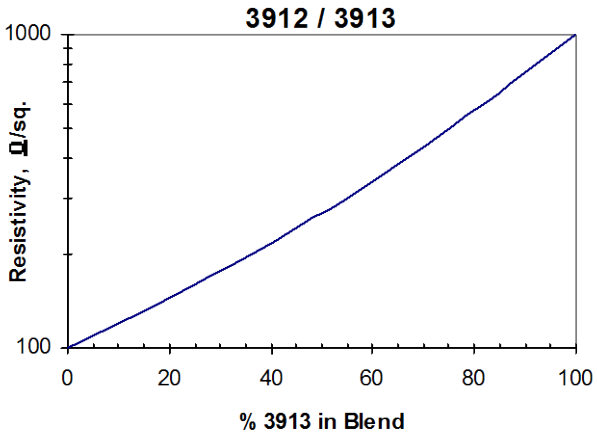
3900 Series Resistivity vs. Print Thickness

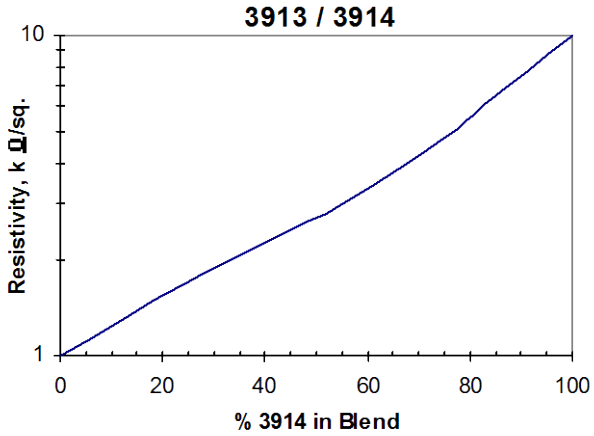


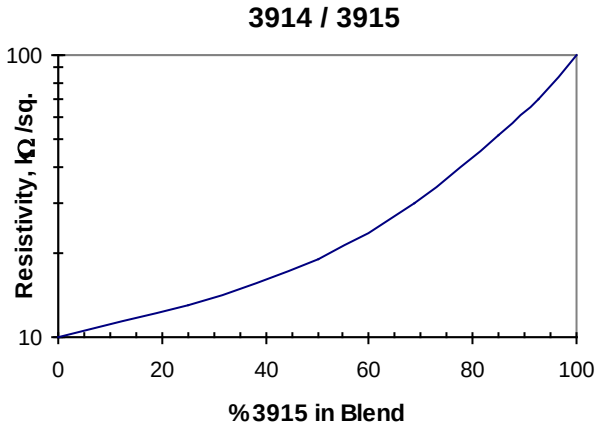
Blending Curves for Adjacent Members of the 3900 Series Resistors



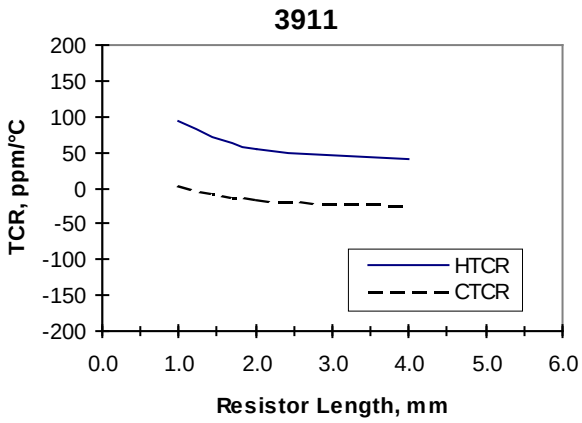


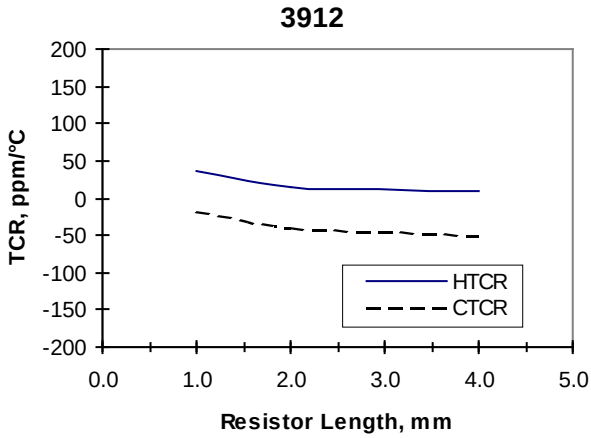


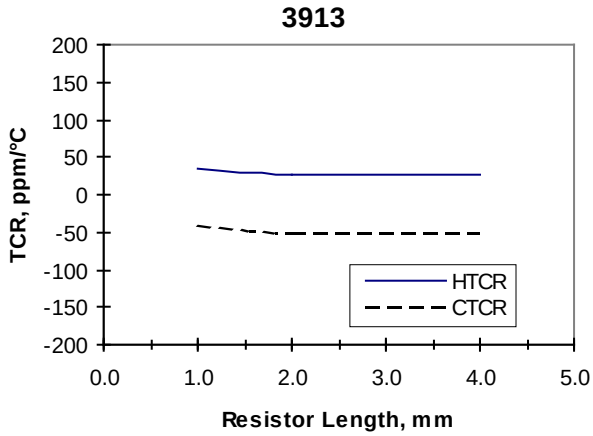


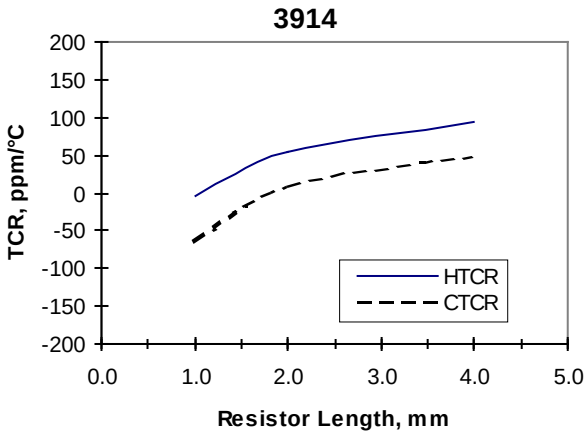


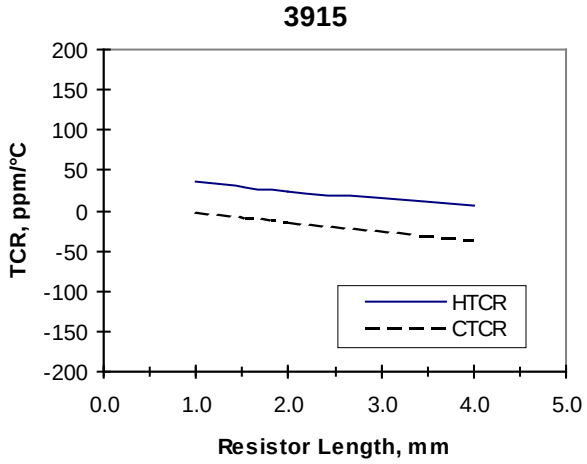
TCR (ppm/°C) vs. Resistor Length (mm) for the 3900 Series Resistors

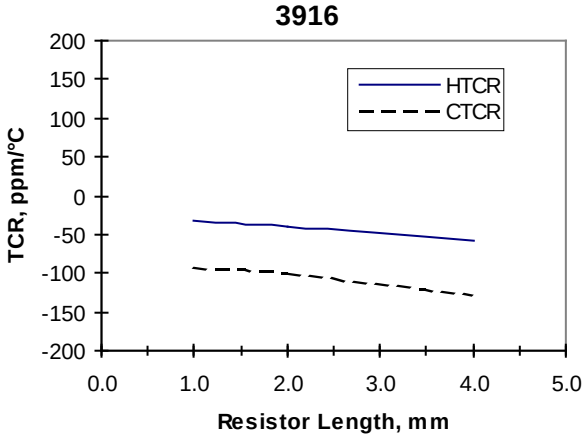












NOTE: HTCR: +25°C to +125°C
CTCR: -55°C to +25°C