Micromax™ 8039R

Electronic Inks and Pastes

High Stability Resistors System Compositions

Micromax™ HS80-Series screen printable resistor compositions are specially formulated and tested for use on Ag/Pd conductor terminations. These compositions range from 10 Ω/sq to 1 MΩ/sq. They offer high stability after trimming and ageing.

Product benefits

• Qualified and tested on Ag/Pd conductor
• TCR's of less than 100 ppm/°C
• Excellent encapsulated and unencapsulated post laser trim stability after laser trimming and long term storage
• Optimised for 60 minute 850°C firing profile
• Two subseries with blendable resistor members
• Phthalate, Cadmium, Nickel oxide free*

* Phthalate, Cadmium and Nickel oxide 'free' as used herein means that cadmium, phthalate and nickel oxide are not intentional ingredients in and are not intentionally added to the referenced product. Trace amounts however may be present.

Product information

Solvent or thinner	Micromax™ 4036
Blend member or series	HS80srs[1]

[1]: Blendable srs B

Rheological properties

Viscosity	145 - 210[2]	Pa.s

[2]: Brookfield HAT, UC&SP, SC4-14/6R, 10 rpm, 25°C ± 0.2°C

Application technique

Mask mesh	200[3]	
Mask emulsion	12 - 18	µm
Drying time	10 - 15	min
Drying temperature	150	°C
Theoretical coverage	80 - 110[4]	cm^2/g
Recommended film thickness, dried	22 - 28	µm
Leveling time	≥10	min

[3]: Screen Types: Stainless steel

[4]: based on wet thickness of 50µm

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Electrical properties

Surface resistivity	9E6 - 1.1E7[5]	mOhm per square
Hot Temperature Coefficient Resistance	-20 - 50[6]	ppm/K
Cold Temperature Coefficient Resistance	-100 - 100[7]	ppm/K
Noise	-6[8]	dB
Short Term Overload Voltage	≥250[9]	V/mm
Standard Working Voltage	100[10]	V/mm
Maximum Rated Power Dissipation	1000[11]	m/(W.mm^2)
Voltage Coefficient of Resistance	-30[12]	ppm

[5]: resistor geometry 1.5mm x 1.5mm, resistivity values are reported to a dried thickness of 25µm

[6]: from +25 to +125°C for Hot TCR, resistivity values are reported to a dried thickness of 25µm

[7]: from -55 to +25°C for Cold TCR, resistivity values are reported to a dried thickness of 25µm

[8]: resistor geometry : 1mm x 1mm; firing cycle : 60 min cycle to peak temperature of 850°C for 10 min

[9]: short term overload voltage : required (5 sec duration) to induce a resistance change of 0.25% in a 1mm x 1mm resistor at 25°C

[10]: standard working voltage : 0.4 x short term overload voltage

[11]: maximum rated power dissipation = (standard working voltage)^2 / resistance

[12]: ppm/°C, Resistor geometry 1mm x 1mm laser trimmed with P-cut to 1.5x average fired value. VCR measured from 5-50 VDC.

Storage and stability

Shelf life	6[13]	months

[13]: in unopened containers, from date of shipment, at temperature between 5-30°C

Additional information

How to use

Design & compatibility

- Compatibility
  - See paragraph on Terminations.
  - Dielectric compatibility : Micromax™ HS80 compositions are compatible with Micromax™ dielectric composition 5704 although the resistivity and TCR values will shift compared to the values quoted on alumina. Whilst Micromax™ has tested this composition with the materials specified above and the recommended processing conditions, it is impossible or impractical to cover every combination of materials, customer processing conditions and circuit layouts. It is therefore essential that customers thoroughly evaluate the material in their specific situations in order to completely satisfy themselves with the overall quality and suitability of the composition for its intended application(s).

Processing

- Terminations
  - Use of a different termination material may cause a shift of TCR and resistivity values from those stated. Low resistivity members (Micromax™ 8011 - 8021 - 8031) of the Series are not recommended with high Ag content conductor such as Micromax™ 6160 due to interaction between conductors and resistors at the overlap (cosmetics, solderability loss, possible power stability).
- Blendability
  - Adjacent Members Micromax™ HS80-Series, as presented in this document, consists of two blendable subseries:
    - A : 10 Ohm/sq through 1 KOhm/sq : Micromax™ 8011, 8021 and 8031
    - B : 1 KOhm/sq through 1 MOhm/sq : Micromax™ 8029, 8039R, 8049R and 8059.
  - Blending adjacent members for the two sub-series (A and B) is not recommended as it may result in abnormal resistance blend curves and TCR values outside the specification range.
  - The Series also include 3 additional low resistivity members (Micromax™ 8004, 8009 and 8019) that are blendable. Micromax™ 8019 is blendable with 8029, so that these added compositions form with Micromax™ 8029, 8039R, 8049R and 8059 a complete series without blend brake. These additional members are described in a dedicated datasheet available on request and are recommended versus Micromax™ 8011 - 8021 - 8031.
- Substrates
  - Substrates of different compositions and from various manufacturers may result in variations in performance properties.
- Screen types
  - 200 mesh stainless steel screen with a 12-18µm emulsion build up. Nylon or polyester screens my be used in some applications. A 150-175 mesh screen will usually be required to achieve equivalent print thickness. Recommended dried thickness 25+/-3µm.
- Printing
  - The composition should be thoroughly mixed before use. This is best achieved by slow, gentle hand stirring with a clean burr-free spatula (flexible plastic or stainless steel) for about 1-2 minutes. Care must be taken to avoid air entrapment. Printing should be performed in a well ventilated area.
  - Note : Optimum printing characteristics are generally achieved in the room temperature range of 20°C - 23°C. It is therefor e important that the material, in its container, is at the temperature prior to commencement of printing. Class 10,000 printing area is

recommended for building complex hybrids and multilayer circuits, otherwise severe yield losses could occur.

- Thickness effects
  - Micromax™ HS80-Series compositions are recommended to be printed at dried thickness between 23 and 28µm.
- Thinning
  - Micromax™ HS80-Series compositions are optimized for screen printing and thinning is not normally required. Use the Micromax™ recommended thinner for slight adjustments to viscosity or to replace evaporation losses. The use of too much thinner or the use of a non recommended thinner may affect the rheological behaviour of the material and its printing characteristics.
- Drying
  - Allow prints to level for over 10 minutes at room temperature, then dry for ≥ 10-15 minutes at 150°C.
  - Dry in a well ventilated oven or conveyor dryer.
- Firing
  - 850°C peak held for 10 minutes on 60 minute cycle in an air atmosphere. Micromax™ HS80-Series resistivity and TCR specifications are based on a 60-min firing cycle with a 10 min peak at 850°C, 20 min above 800°C and 30 min above 600°C.
  - Variations in the peak temperature or the time at peak may result in variation in resistivity and TCRs. This is illustrated in figures 13 to 16. Fire in well ventilated belt, conveyor furnace or static furnace. Air flows and extraction rates should be optimized to ensure that oxidizing conditions exist within the muffle and that no exhaust gases enter the room.
- Refire sensitivity
  - Refiring results in changes in resistivity and TCRs.
- Encapsulant
  - In general, glass encapsulation is not required. However, in applications which require mechanical protection or protection from extreme environments such as high temperature nitrogen or forming gas, Micromax™ encapsulant compositions QQ550 or QQ620 are recommended.
- Resistor geometry
  - Micromax™ HS80-Series compositions are quality Assured tested using a 1.5mm x 1.5mm resistor with prefired Micromax™ Ag/Pd termination. Variations in resistor geometry will result in slight variations of resistivity and TCR values.
- Laser trimming
  - To ensure long term stability of the resistors and to achieve maximum trimming accuracy, it is necessary to optimize resistor geometry, cut geometry and trimming parameters. Parameters should be selected to achieve a clean laser cut (kerf) and it is

    recommended to cut into the substrate or dielectric by 6-8µm.
  - For the best results, the extent of trim should be limited to 2x the fired value and/or kerf should be a minimum of 300µm from the edge of the resistor.
  - While adequate stability may be achieved with single plunge cut, double plunge cuts, L-cuts or J-cuts generally offer superior accuracy and stability.
- Stability after laser trimming
  - Series Micromax™ HS80 was developed to give optimum stability of laser trimmed resistors from the time immediately after completion of the laser trim. through the further process and storage steps required in the production of a hybrid circuit or resistor network and on to the power loaded functional use of the resistor.
  - All stability data were produced using 1 mm X 1 mm (40 mil X 40 mil) resistors terminated with Palladium/Silver Conductor Composition Micromax™ 9308 preferred at 850°C unless otherwise stated. The resistors were fired using a 60-min cycle with 10 min at a peak temperature of 850°C and laser trimmed 1.5-2x their fired value with a plunge cut using a production-type YAG laser trimming system. Initial measurements were taken 15-50 ms after completion of the laser trim.
  - Load life
    - Resistors were stored at 70°C ambient and power loaded with a duty cycle of 1.5 hours on, 0.5 hour off. Resistor changes have been measured after 1000 hrs.
  - Stability after solder dipping
    - The resistors were dipped for 5 seconds into 62Sn/36¨Pb/2Ag solder at 255+/-5°C. The flux used was Alpha 611.
  - Stability after thermal shock
    - The resistors were subjected to a thermal shock test which consisted of 5 cycles of 5 minutes at −65°C, transfer within 10 seconds to +150° C and a dwell of 5 minutes before transfer back to −65°C. Average changes in resistivity are within +/- 0.1%.
  - No load stability
    - The resistors were stored for 1000 hours at various environmental conditions including: -25°C, 150°C and 40°C/90% relative humidity.
  - Resistor stability is dependent on many factors including termination material, substrate, processing conditions, and laser trim parameters. Under controlled conditions, Series HS80 compositions are capable of 0.25% end of life tolerances.

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Properties

- Typical resistor properties based on laboratory tests using recommended processing conditions :
    - Terminations : Micromax™ palladium/silver Conductor Composition Micromax™ 9308 prefired at 850°C
    - Substrate : 96% alumina
    - Printing : 200 mesh stainless steel screen (8-12µm emulsion thickness) to a dried thickness of 25 ± 3µm
    - Firing : 60 min cycle to peak temperature of 850°C for 10 minutes
- All values reported here are results of experiments in our laboratories intended to illustrate product performance potential with a given experimental design. They are not intended to represent the product's specifications, details of which are available upon demand.

Other low resistivity members

- The Series also include 3 additional low resistivity members : Micromax™ 8004 (a 4 Ohm/sq composition), Micromax™ 8009 (10 Ohm/sq) and 8019 (100 Ohm/ sq). Micromax™ 8019 composition is blendable with Micromax™ 8029 so that Micromax™ 8004, 8009 and 8019 form with Micromax™ 8029 - 8059 a complete continuous blendable Series. These additional members are described in a dedicated datasheet (available on request) and are not reported in the present document. Micromax™ 8004, 8009, 8019 and 8029 offer improved stability over the low resistivity members Micromax™ 8011, 8021 and 8031 and, for that reason, are the recommended compositions to use to get low resistivity values.

General

Performance will depend to a large degree on care exercised in screen printing. Scrupulous care should be taken to keep the composition, printing screens and other tools free of metal contamination. Dust, lint and other particulate matter may also contribute to poor yields.

Storage and shelf life

Containers may be stored in a clean, stable environment at room temperature (between 5°C – 30°C) with their lids tightly sealed. Storage in high temperature (>30°C) or in freezers (temperature <0°C) is NOT recommended as this could cause irreversible changes in the material. The shelf life of compositions in factory-

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sealed (unopened) containers between (5 °C – 30 °C) is 6 months from date of shipment.

Safety and handling

For safety and handling information pertaining to this product, read Safety Data Sheet (SDS).

Figures

Figure 1

HS 80 STABILITY AFTER LASER TRIMMING

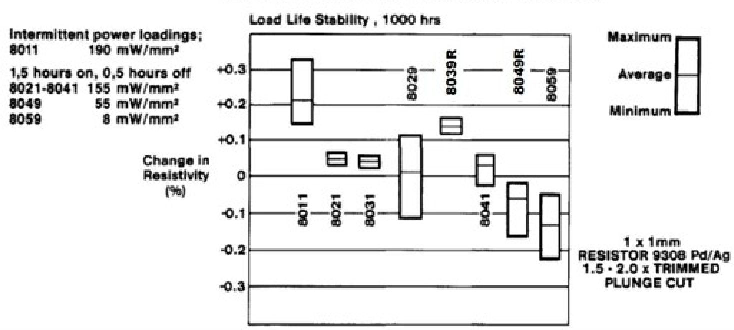

Figure 2

HS 80 STABILITY AFTER LASER TRIMMING

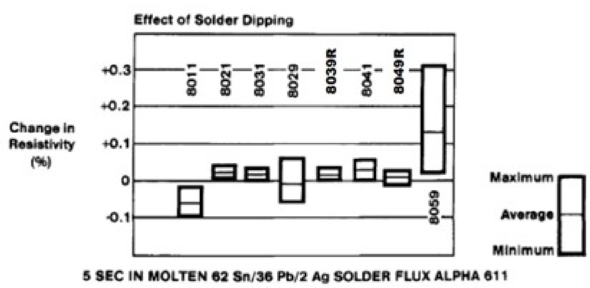

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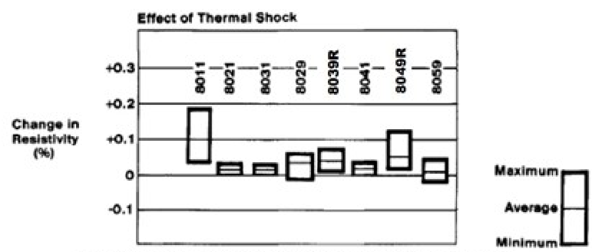
Figure 3

HS 80 STABILITY AFTER LASER TRIMMING



5 CYCLES WITH 5 MIN AT -65°C, 10 SEC TRANSFER TO +150°C A DWELL OF 5 MIN BEFORE TRANSFER BACK

Figure 4

HS80 ENVIRONMENTAL STABILITY AFTER LASER TRIMMING

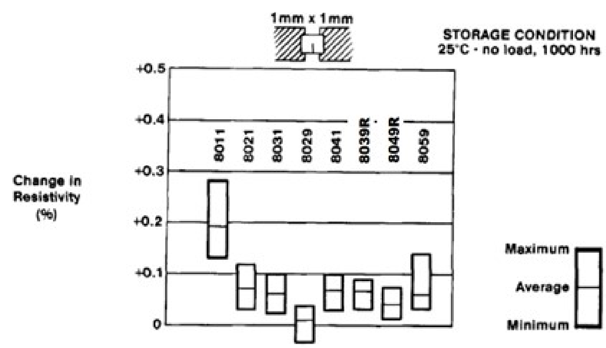
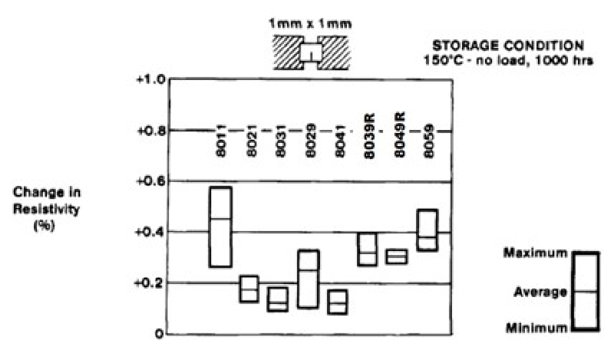


Figure 5

HS 80 ENVIRONMENTAL STABILITY AFTER LASER TRIMMING



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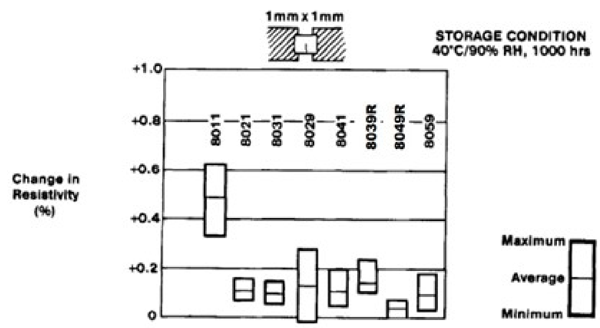

Figure 6
HS 80 ENVIRONMENTAL STABILITY AFTER LASER TRIMMING

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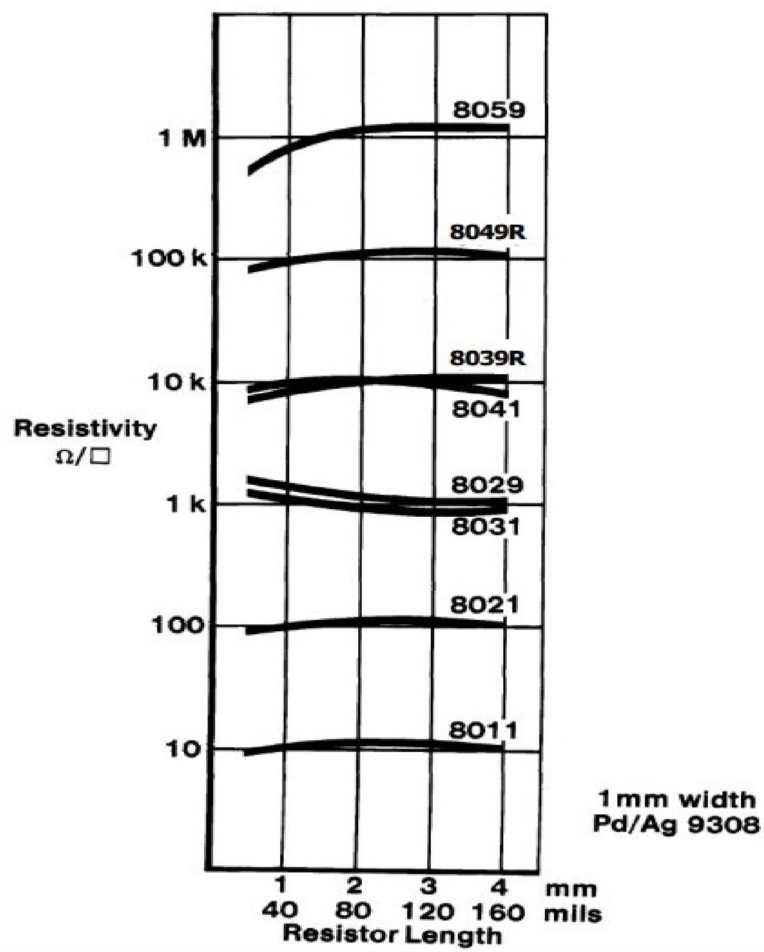
Figure 7
HS 80 EFFECT OF RESISTOR LENGTH ON RESISTIVITY



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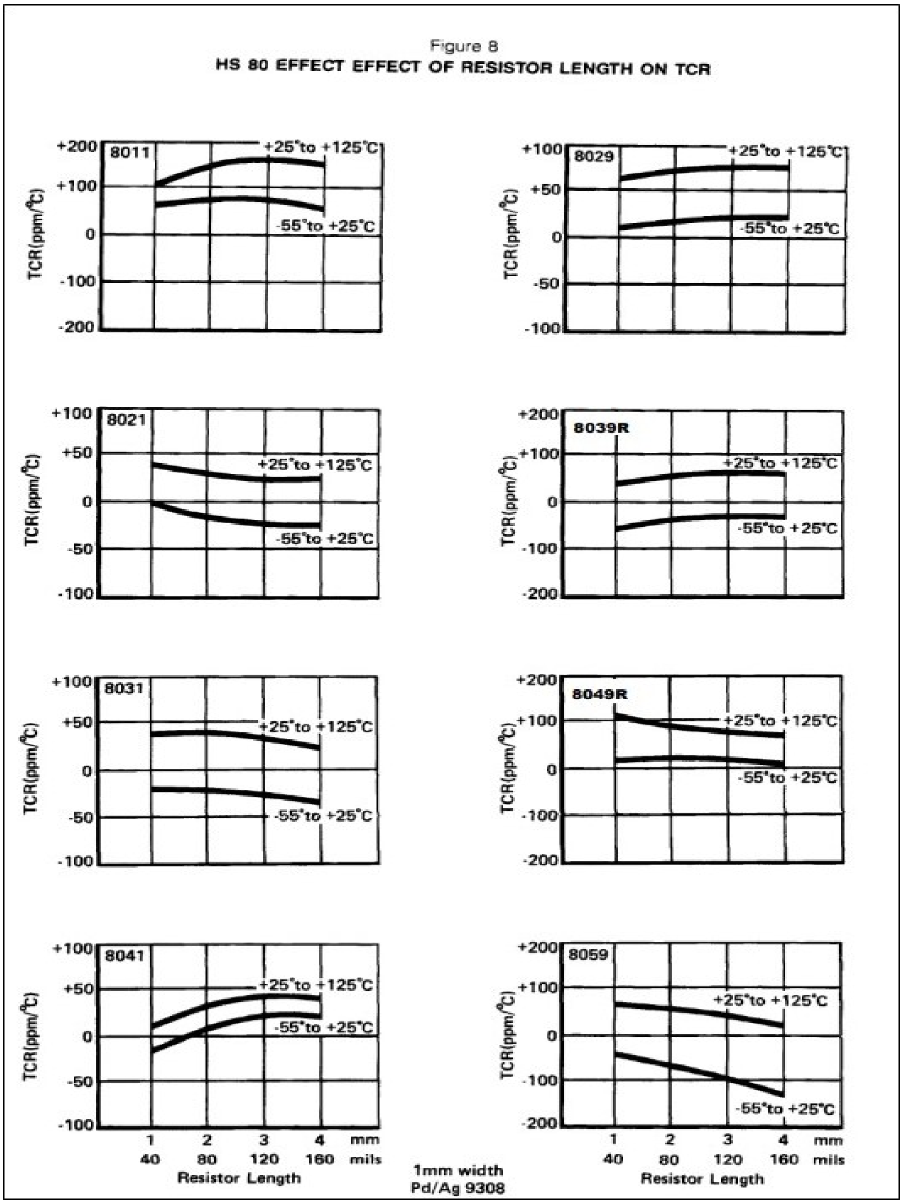

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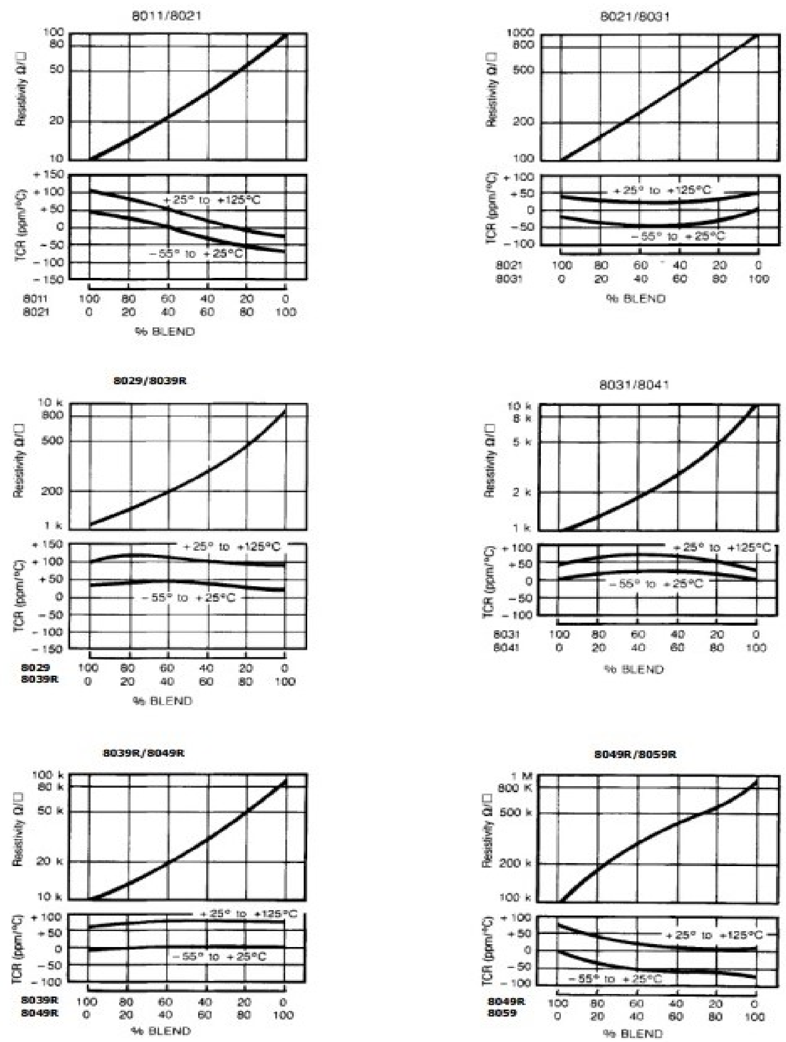
Figure 9

BLEND CURVES



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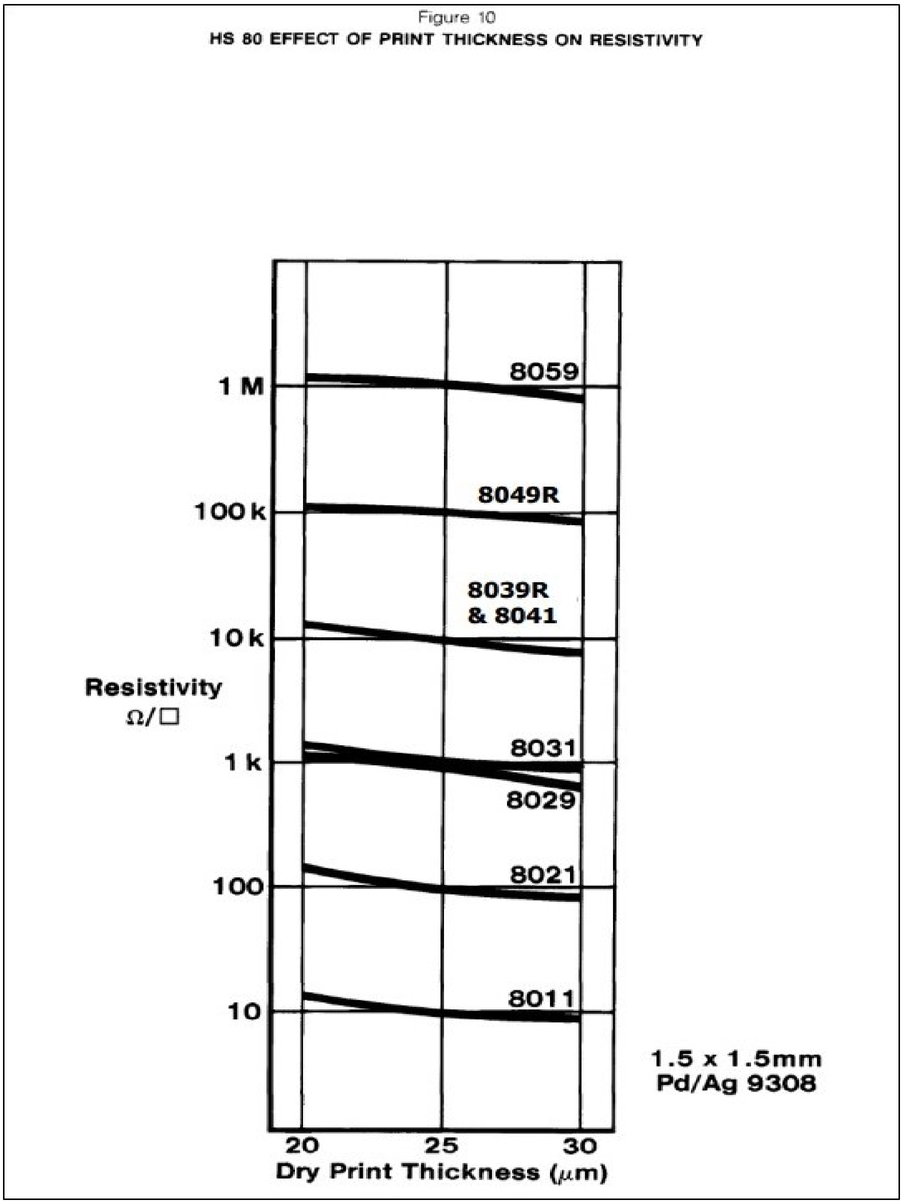

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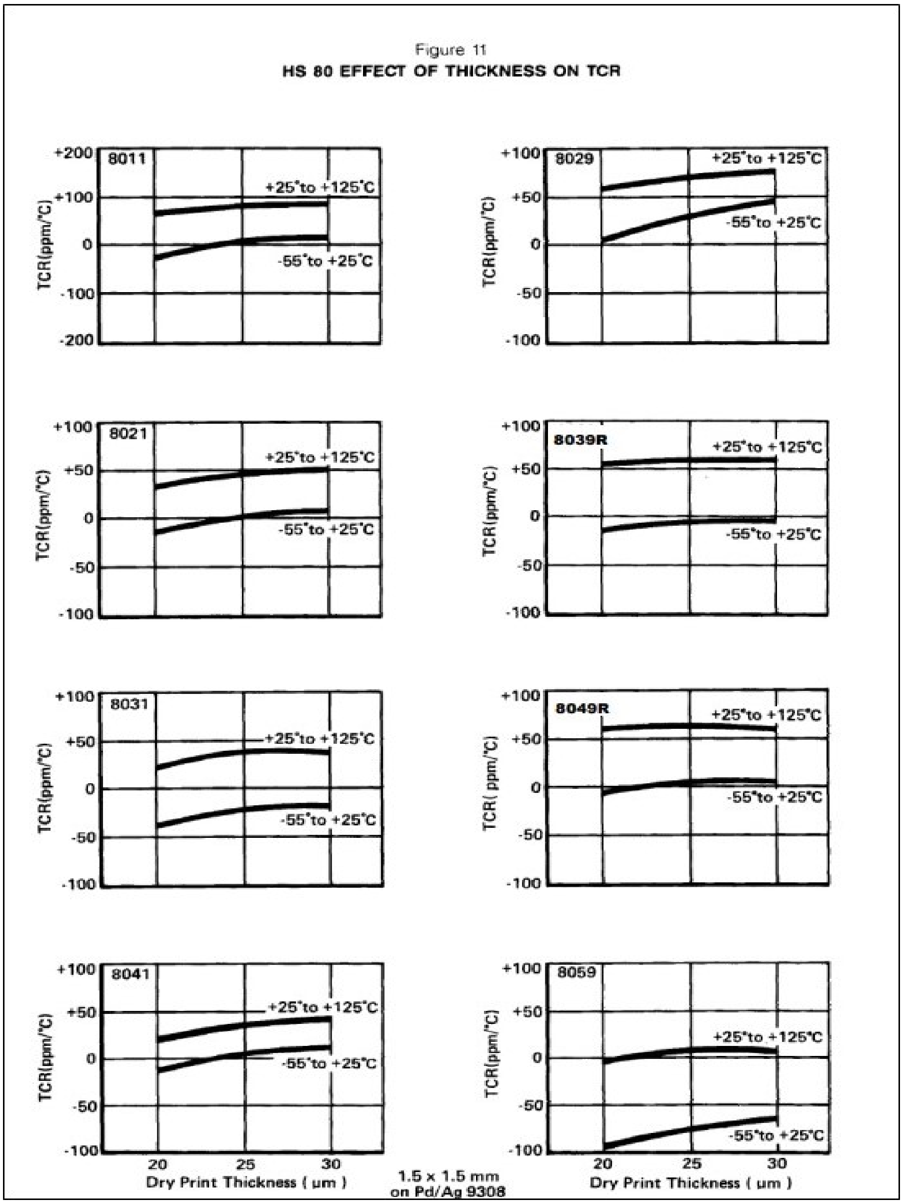

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Figure 12. FIRING PROFILE

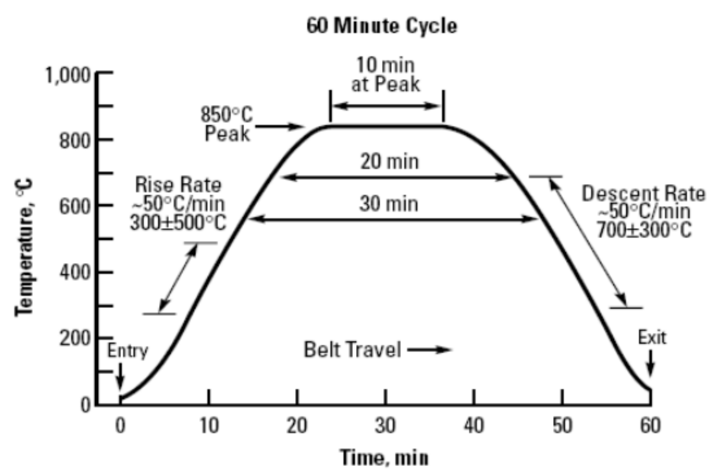

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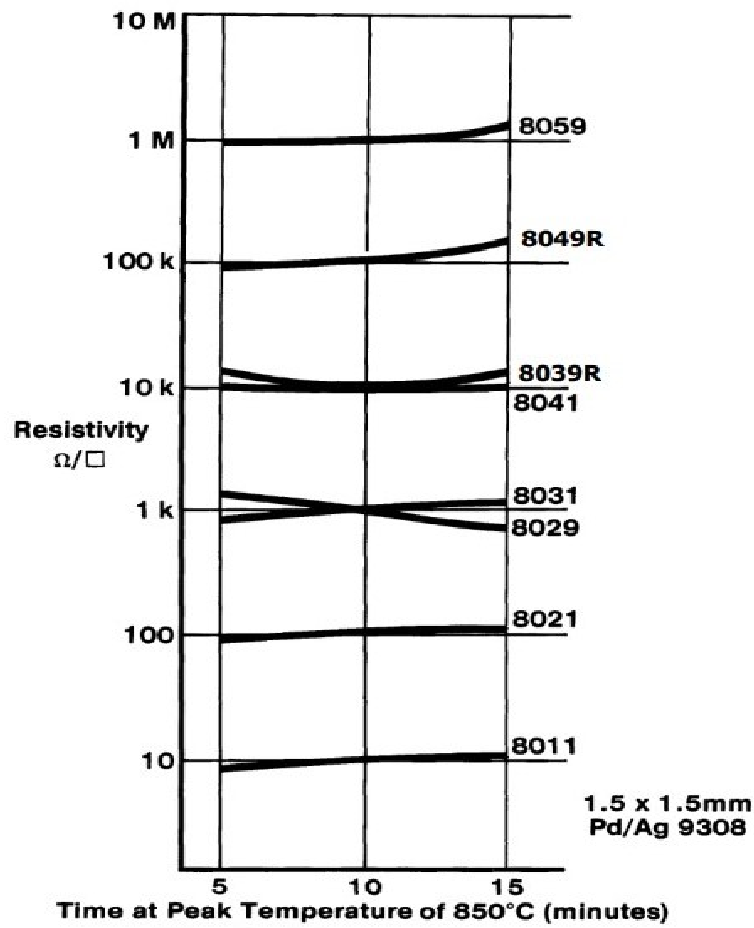
Figure 13

HS 80 EFFECT OF TIME AT PEAK TEMPERATURE ON RESISTIVITY



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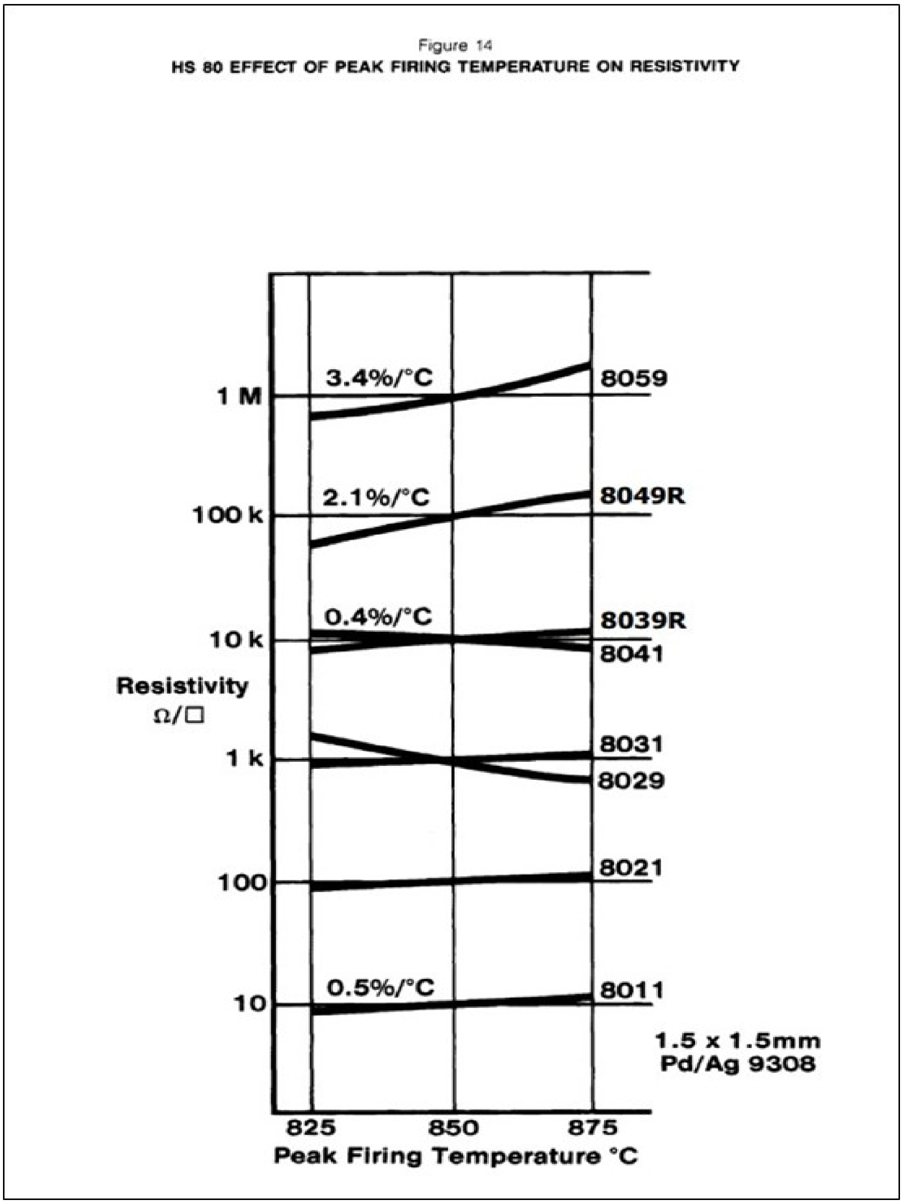

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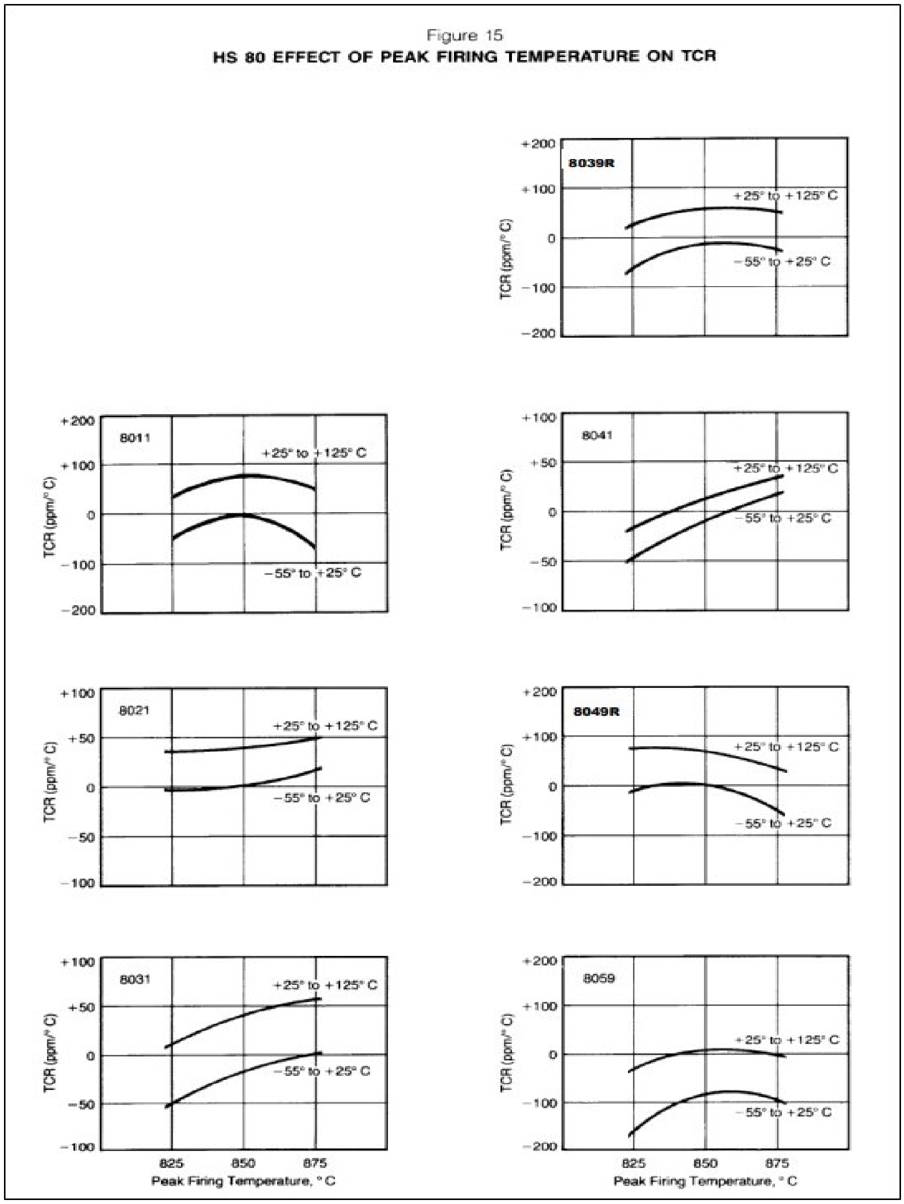

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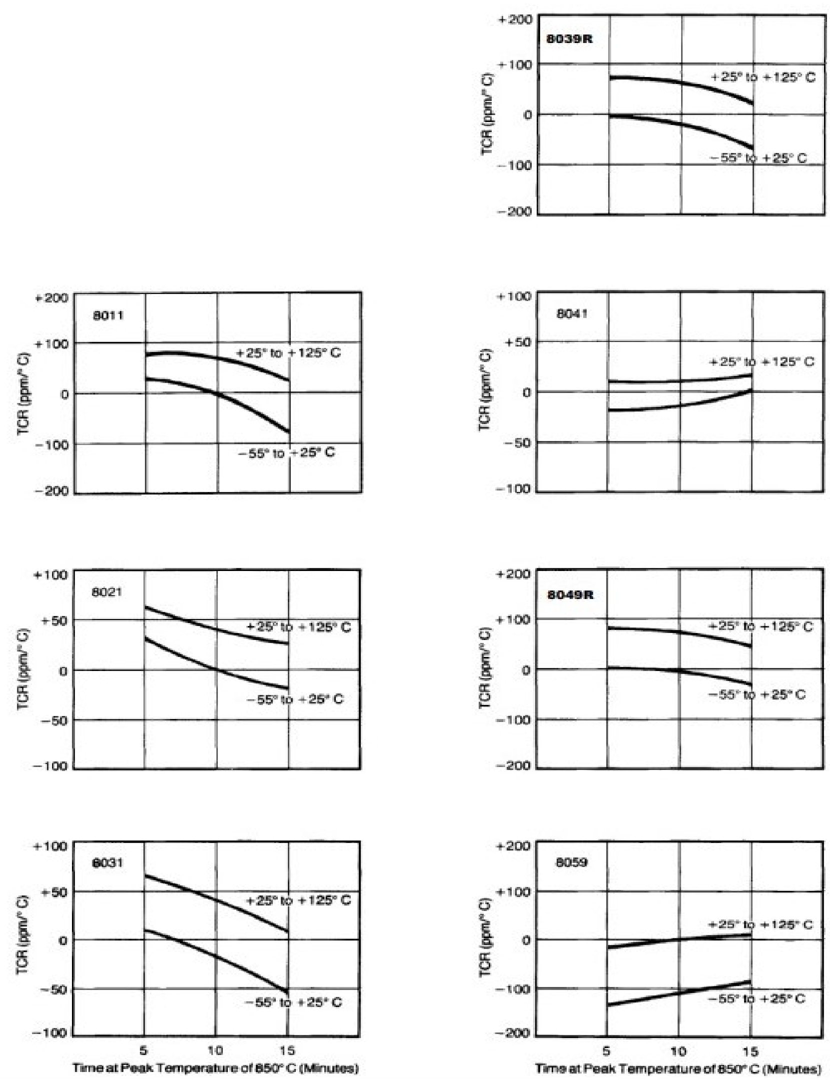
Figure 16
HS 80 EFFECT OF TIME AT PEAK TEMPERATURE ON TCR



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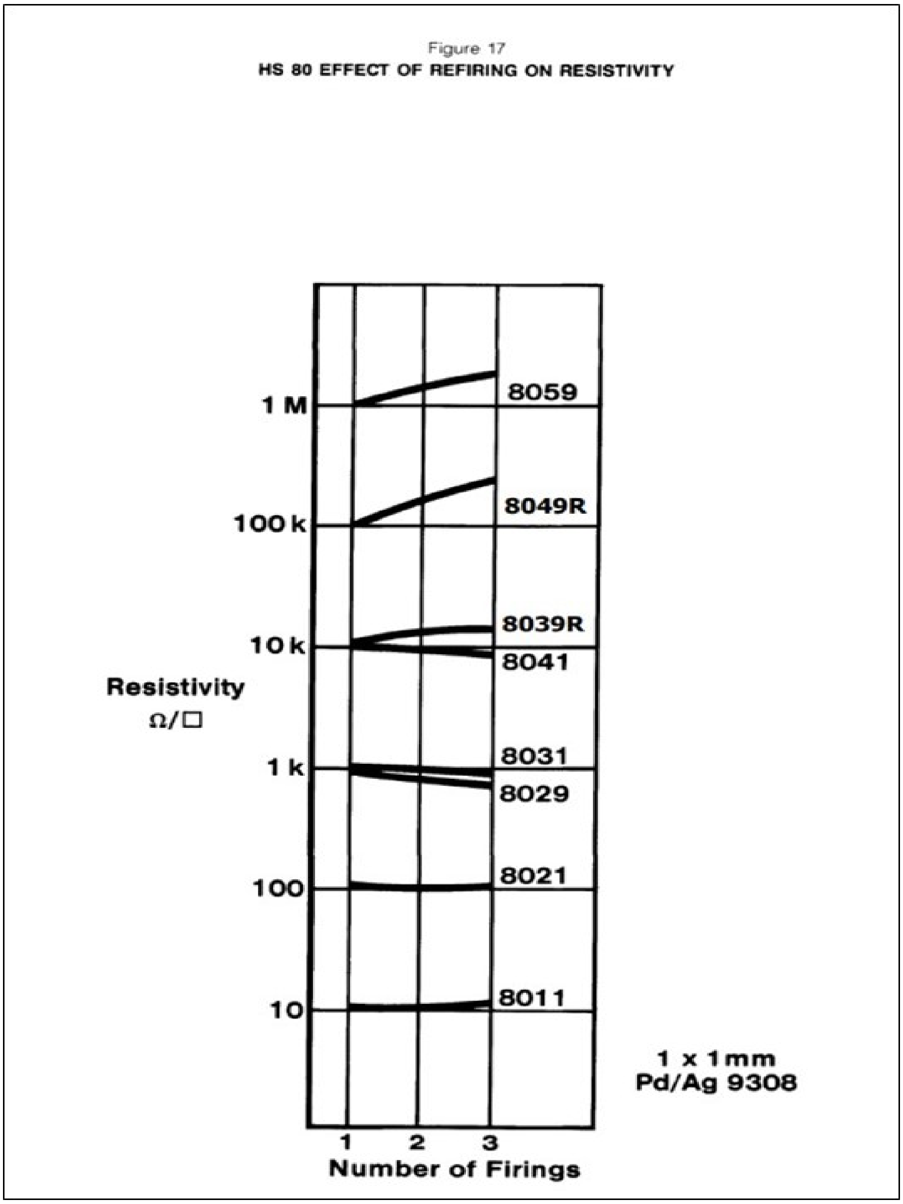

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