

# Micromax™ LF01A

## Electronic Inks and Pastes

### Lead Free Resistor Compositions

The Micromax™ LFX0A resistor series has been proven to have excellent performance properties for hybrid applications. Designed to give an ideal balance of properties, this lead-free(Pb)\* and cadmium(Cd)-free\* resistor series is fully blendable between adjacent members.

### Product benefits

- Resistors are compatible with Pb-free conductors
- Lead free\* and Cadmium free\*
- Excellent ESD Stability
- Good power handling stability
- Reach compliant

### Processing features

- Thin printing 12µm dried thickness
- Fast firing - 850°C/30 minute profile
- Narrow TCR gaps
- Linear blend behavior

\*Lead and Cadmium 'free' as used herein means that these are not intentionally added to the referenced product. Trace amounts however may be present.

### Product information

|                        |                |
|------------------------|----------------|
| Solvent or thinner     | Micromax™ 8250 |
| Blend member or series | LFX0A srs      |

### Rheological properties

|                                                             |                               |
|-------------------------------------------------------------|-------------------------------|
| Viscosity                                                   | 150 - 240 <sup>[1]</sup> Pa.s |
| [1]: Brookfield HAT, UC&SP, SC4-14/6R, 10 rpm, 25°C ± 0.2°C |                               |

### Application technique

|                                   |             |
|-----------------------------------|-------------|
| Mask mesh                         | 325         |
| Mask emulsion                     | 10 - 15 µm  |
| Drying time                       | 10 - 15 min |
| Drying temperature                | 150 °C      |
| Recommended film thickness, dried | 10 - 14 µm  |
| Leveling time                     | 5 - 10 min  |

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### Electrical properties

|                                         |                                             |
|-----------------------------------------|---------------------------------------------|
| Surface resistivity                     | 1000 <sup>[2]</sup> mOhm per square         |
| Hot Temperature Coefficient Resistance  | -100 - 100 <sup>[3]</sup> ppm/K             |
| Cold Temperature Coefficient Resistance | -100 - 100 <sup>[4]</sup> ppm/K             |
| Electrostatic discharge, 5kV            | -0.21 <sup>[5]</sup> (avgDeltaR)(%)         |
| Noise                                   | -14.7 <sup>[6]</sup> dB                     |
| Short Term Overload Voltage             | 15 <sup>[7]</sup> V/mm                      |
| Standard Working Voltage                | 6 <sup>[8]</sup> V/mm                       |
| Maximum Rated Power Dissipation         | 20721 <sup>[9]</sup> m/(W.mm <sup>2</sup> ) |

[2]: Glazed with Micromax™ QQ620, in the case of unglazed 0.8 - 1.20 Ω/sq.

[3]: Glazed with Micromax™ QQ620 and unglazed are the same. Hot TCR in PPM/°C measured 25°C to 125°C. Note : To obtain ±100 ppm/C, measured using 8 squares.

[4]: Glazed with Micromax™ QQ620 and unglazed are the same. Cold TCR in PPM/°C measured 25°C to -55°C. Note : To obtain ±100 ppm/C, measured using 8 squares.

[5]: Unglazed (in the case of glazed with Micromax™ QQ620 N/A), after 1x5kV pulse. ESD measured on 1mm x 1mm resistors untrimmed pulsed 1x2kV and 1x5kV on same resistor.

[6]: Glazed with Micromax™ QQ620, in the case of unglazed -14.5 dB.

[7]: Glazed with Micromax™ QQ620, in the case of unglazed 2 V/mm. STOL : Short Time Overload Voltage (V/mm); Voltage required in a 5 second duration to induce a resistance change of 0.25%, at 25°C, in a 1mm x 1mm resistor trimmed to 1.5x fired value with a single plunge cut. Note : 630 volts is the equipment limit.

[8]: Glazed with Micromax™ QQ620, in the case of unglazed 0.8 V/mm. SWV : Standard Working Voltage = 0.4x short term overload voltage.

[9]: Glazed with Micromax™ QQ620, in the case of unglazed 371 mW/mm<sup>2</sup>. MRPD : Maximum Rated Power Dissipation = (standard working voltage)<sup>2</sup>/trimmed resistance

### Storage and stability

|            |                          |
|------------|--------------------------|
| Shelf life | 6 <sup>[10]</sup> months |
|------------|--------------------------|

[10]: in unopened containers, from date of shipment, at temperature <25°C

### Additional information

How to use

### Processing

#### • Terminations

- Micromax™ LFx0A resistors were designed for use with high silver-containing Pb-free terminations. Reported properties are based on tests using Micromax™ LF171 Ag/Pt and Micromax™ LF121 Ag/Pd conductor terminating materials. Similar performance properties have been observed with other Micromax™ gold and silver-bearing conductors, however using different terminations may result in a shift of resistance and TCR values.

#### • Blendability

- There are two 10K ohm blend members. Composition Micromax™ LF40A is to be blended with the lower 1K ohm member

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Micromax™ LF30A, while composition Micromax™ LF49A is to be blended with the higher 100K ohm member Micromax™ LF59A. Only adjacent members are blendable.

- **Substrates**
  - Reported properties are based on tests with 96% alumina substrates. Substrates of other compositions may yield variation in performance properties.
- **Printing**
  - Properties are based on resistors printed to 12±2µm dried thickness. A 325 mesh stainless steel screen with 10-15µm emulsion is recommended. Each composition must be thoroughly mixed before use. This is best achieved by slow, gentle, hand-stirring with a clean flexible burr-free spatula (plastic) for 0.5-1 minute.
- **Thinning**
  - Micromax™ LFx0A Series has been optimized for screen printing and thinning is not normally required or recommended. Micromax™ 8250 thinner may be added sparingly to compensate for evaporative losses.
- **Drying**
  - Allow prints to level at room temperature for 5-10 minutes, then dry at 150 °C for 10-15 minutes in a well-ventilated oven.
- **Firing**
  - Properties are based on a 30 minute firing cycle (100°C - 100°C) with 10 minutes at a peak temperature of 850°C.
- **Encapsulant**
  - Micromax™ QQ620 is the recommended Pb-free encapsulant material that may be used to provide mechanical protection from extreme environments. Micromax™ QQ620 is recommended to be screen printed and fired over the pre-fired resistor prior to laser trimming.
- **Laser trimming**
  - Please see the table for recommended laser trim parameters. Use of encapsulant will improve trim stability performance of certain decade members.

### Properties

#### Laser Trimming

| Resistor | Power   | Q-Rate  | Bite Size |
|----------|---------|---------|-----------|
| 1Ω       | P=2.0 W | QR=3000 | BS=150    |
| 10Ω      | P=2.0 W | QR=3000 | BS=150    |

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|       |         |         |        |
|-------|---------|---------|--------|
| 100Ω  | P=2.0 W | QR=3000 | BS=200 |
| 1kΩ   | P=2.0 W | QR=4000 | BS=200 |
| 10kΩ  | P=2.0 W | QR=3000 | BS=150 |
| 10kΩ  | P=2.0 W | QR=3000 | BS=150 |
| 100kΩ | P=2.0 W | QR=3000 | BS=200 |
| 1MΩ   | P=2.0 W | QR=5000 | BS=200 |
| 10MΩ  | P=2.0 W | QR=3000 | BS=150 |

Fired Properties - Glazed with QQ620 & Unglazed (preliminary)

- Test Procedure
  - Typical fired properties and Preliminary fired properties are based on the following :
  - Termination : LF171 Ag/Pt
  - Dry Thickness : 12±2μm
  - Resistor geometry : 1.0 x 1.0mm
  - Firing : 30 minute cycle 850 °C peak for 10 minutes.
  - Substrate : 96% alumina
  - Resistance and TCR, Quan-tech Noise, and ESD are measured on untrimmed resistors.
  - Preliminary fired properties are based on the following : No encapsulation
- 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.

### Storage and shelf life

Containers should be stored, tightly sealed, in a clean, stable environment at room temperature (<25 °C). Shelf life of material in unopened containers is six months from date of shipment. Some settling of solids may occur and compositions should be thoroughly mixed prior to use.

### Safety and handling

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

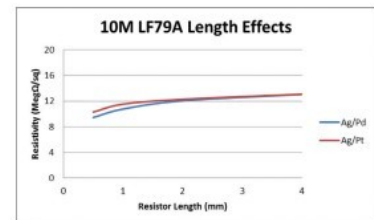
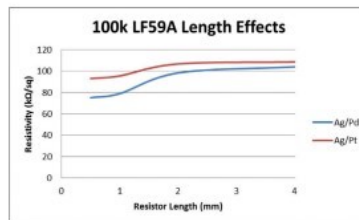
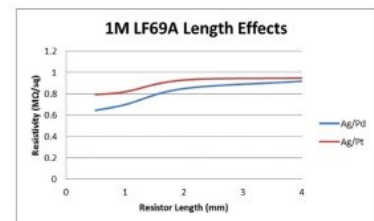
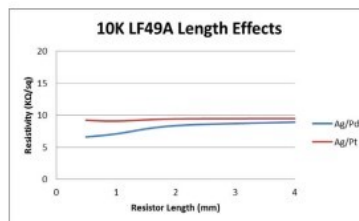
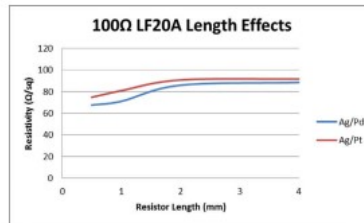
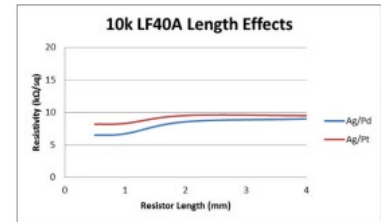
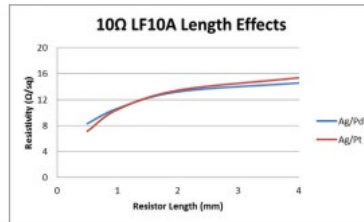
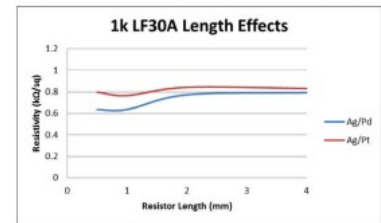
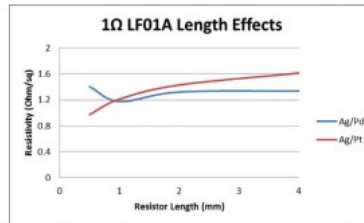
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## Electronic Inks and Pastes

### Resistor Termination Dependence

#### (Length Effect Curves) Resistivity

Data based on 1.0 mm width resistors with DuPont LF121 3:1 Ag/Pd and DuPont LF171 Ag/Pt Pb-free terminations



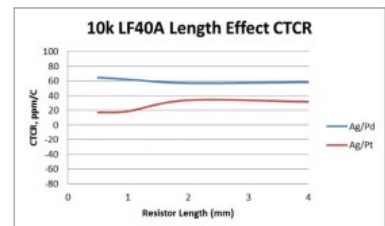
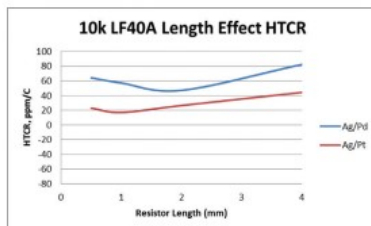
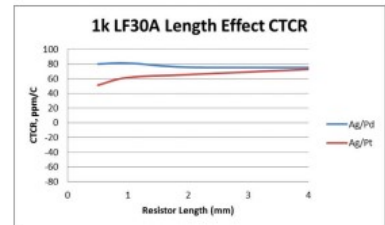
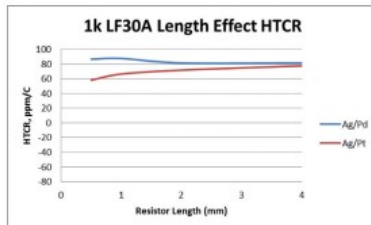
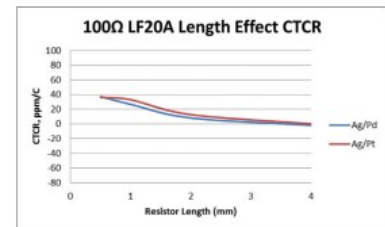
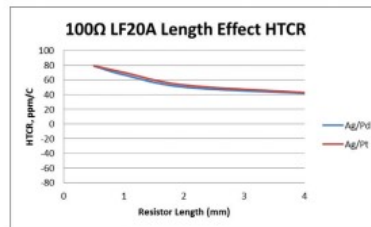
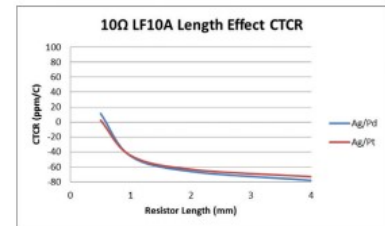
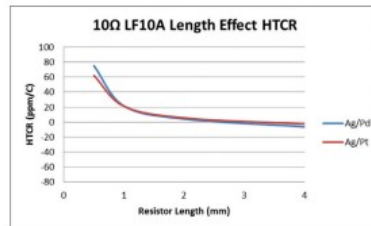
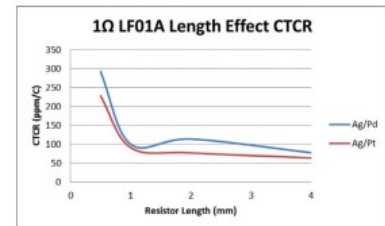
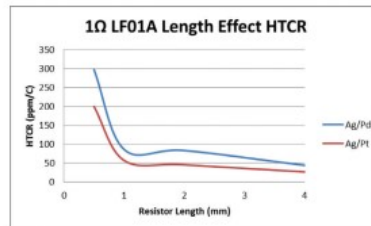
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Electronic Inks and Pastes

## Resistor Termination Dependence

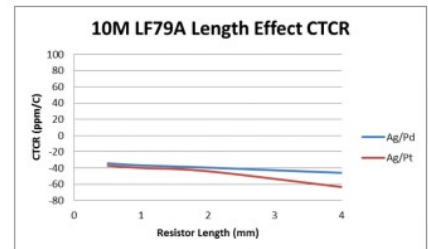
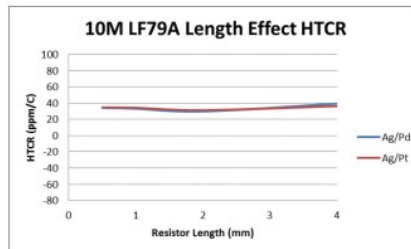
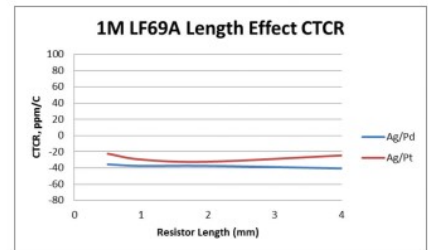
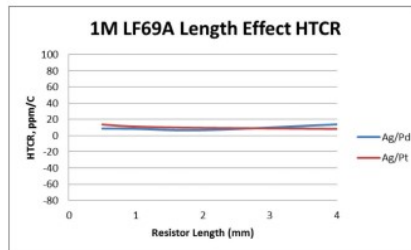
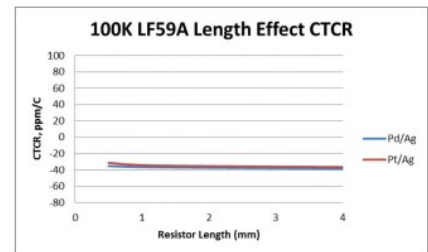
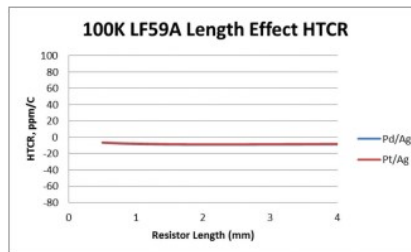
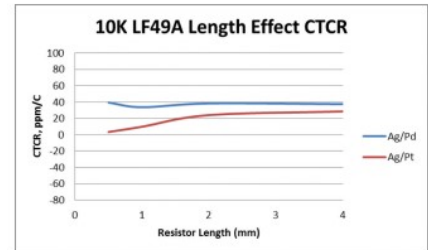
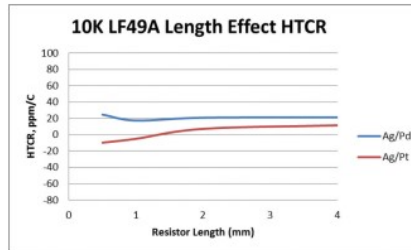
(Length Effect Curves) Hot & Cold TCR

Data based on 1.0 mm width resistors with LF121 Ag/Pd and LF171 Ag/Pt Pb-free terminations



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Electronic Inks and Pastes

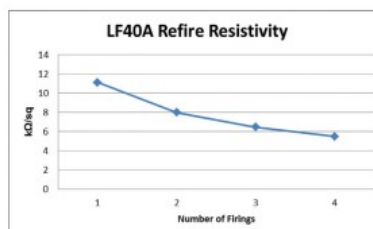
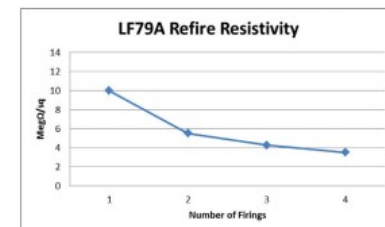
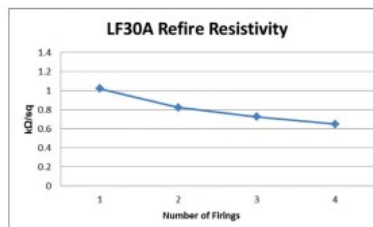
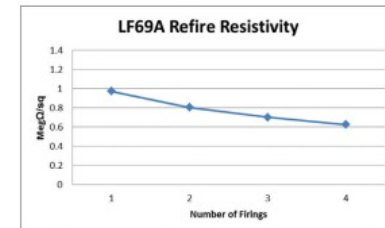
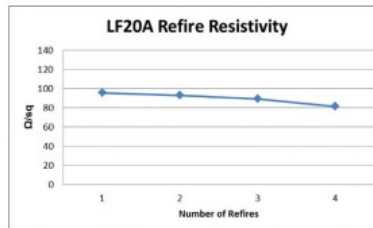
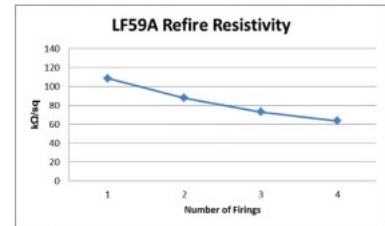
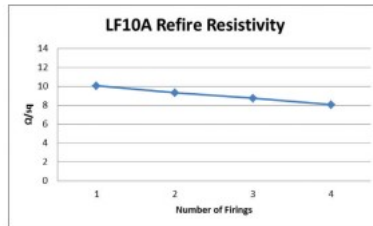
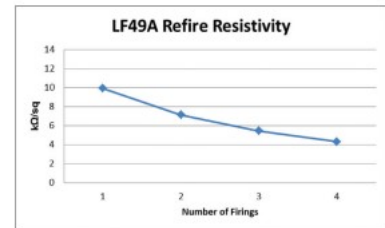
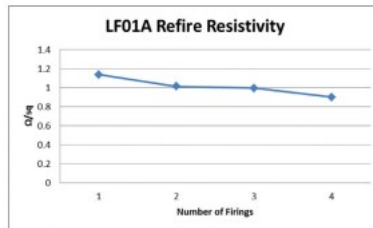


# Micromax™ LF01A

## Electronic Inks and Pastes

### Refire Behavior

Data measured on 1.0x1.0 mm resistors on LF171 Ag/Pt Pb-free conductor terminations

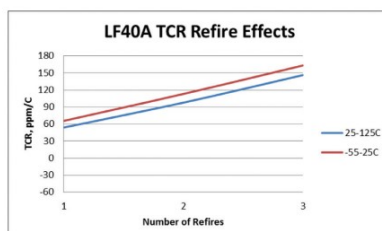
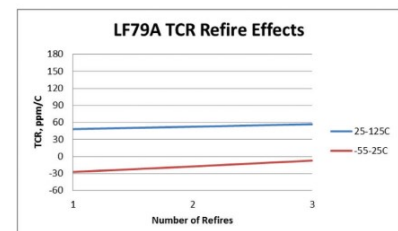
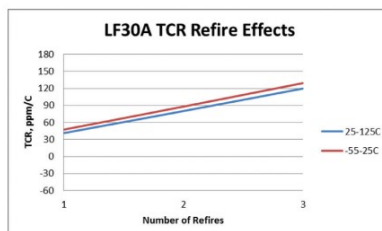
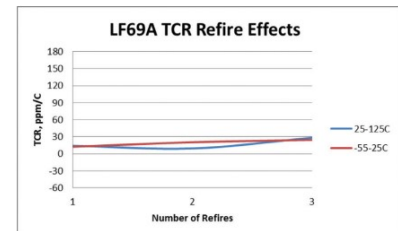
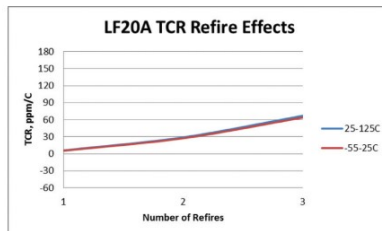
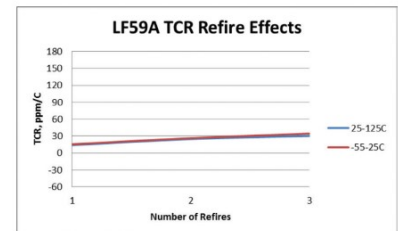
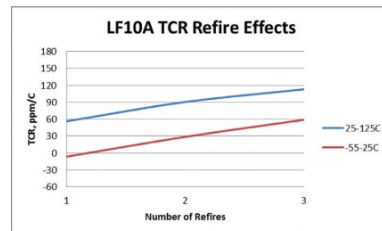
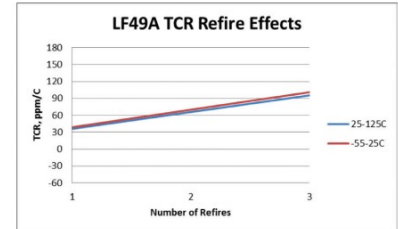
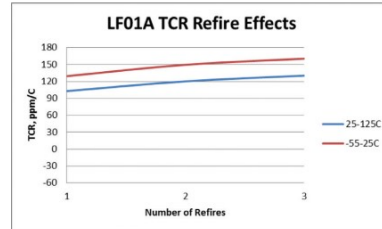


# Micromax™ LF01A

## Electronic Inks and Pastes

### TCR Refire Effects

Data measured on 1.0x1.0 mm resistors with Pb-free LF171 Ag/Pt terminations

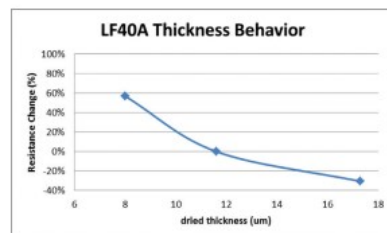
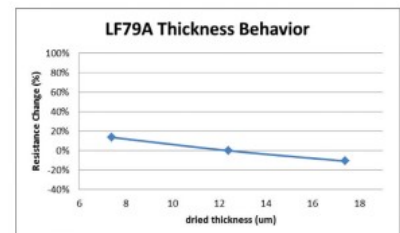
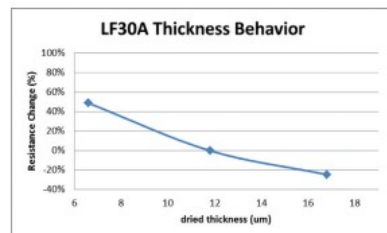
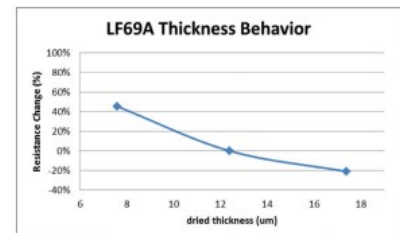
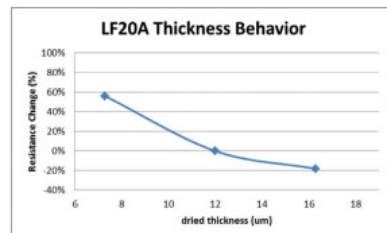
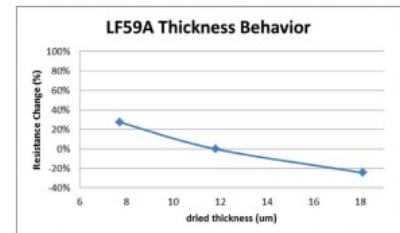
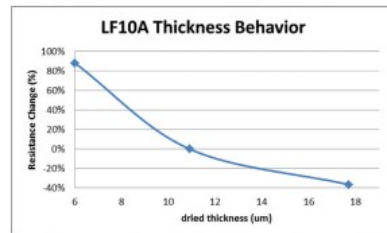
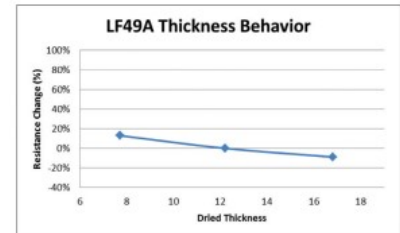
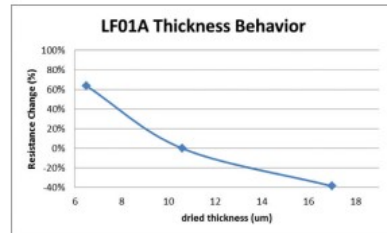


# Micromax™ LF01A

Electronic Inks and Pastes

## Thickness Behavior – Resistivity

Data measured on 1.5x1.5 mm resistors with Pb-free Ag/Pt terminations

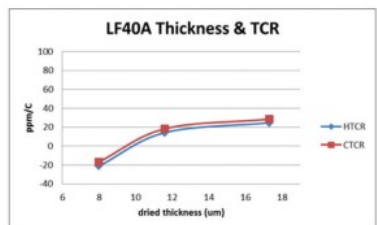
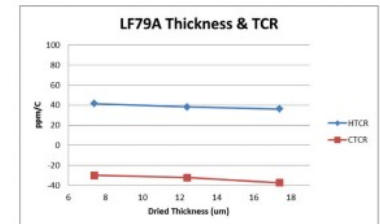
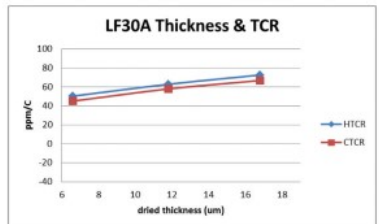
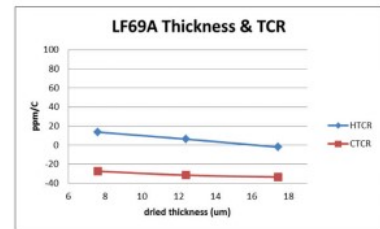
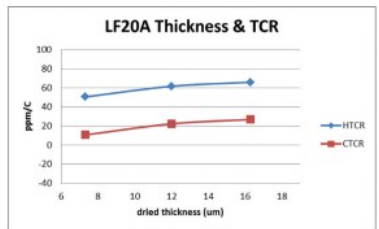
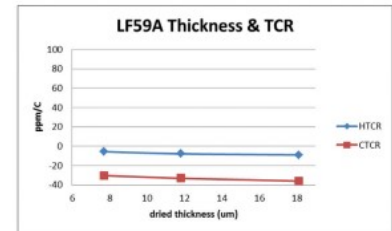
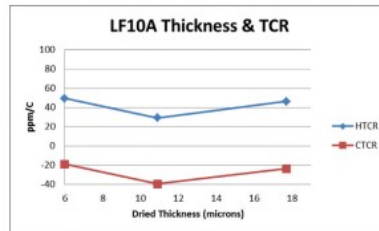
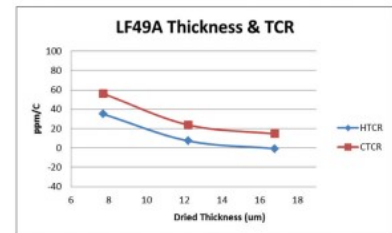
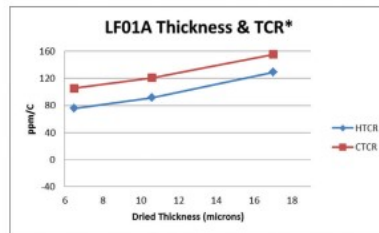


# Micromax™ LF01A

## Electronic Inks and Pastes

### Thickness Behavior – TCR

Data measured on 1.5x1.5 mm resistors with Pb-free Ag/Pt terminations



\*LF01A charted data measured using 1 square resistor. QC is tested using 8 squares pattern to compensate for termination influence.

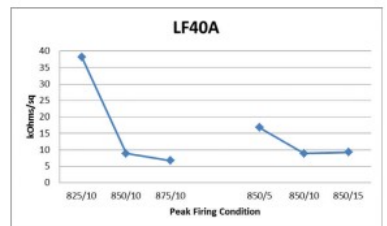
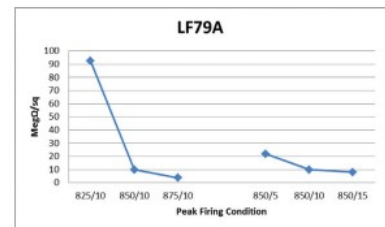
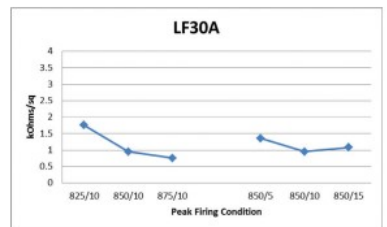
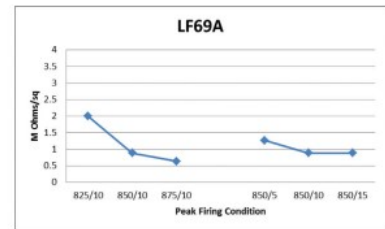
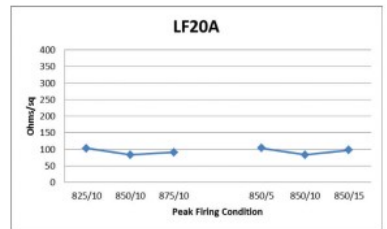
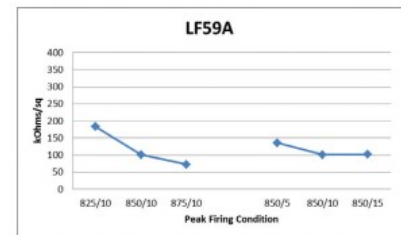
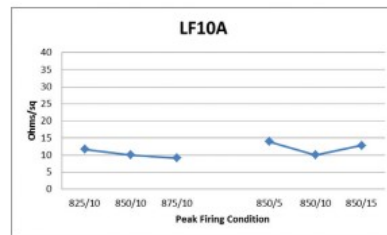
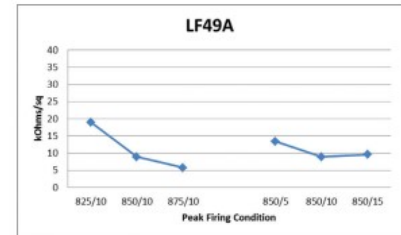
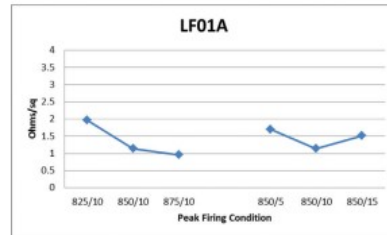
# Micromax™ LF01A

## Electronic Inks and Pastes

### Sensitivity to Firing Conditions

(Resistivity VS Peak Temperature and Time at Peak)

Data based on 1.0x1.0 mm resistors with Pb-free LF171 Ag/Pt terminations

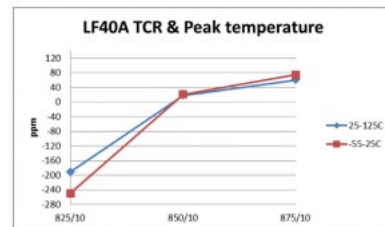
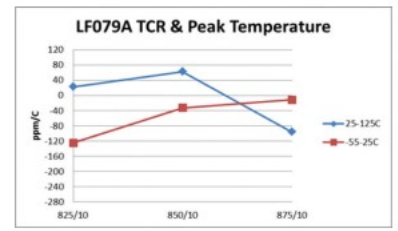
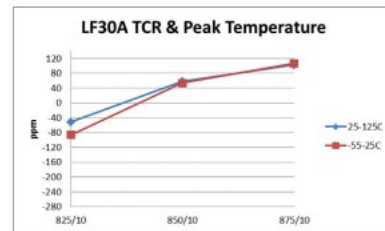
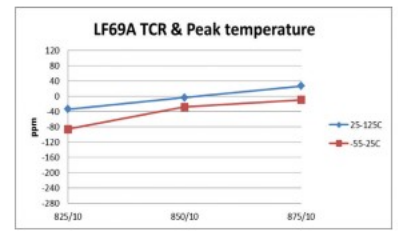
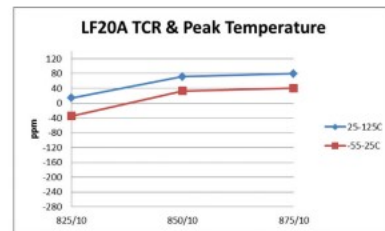
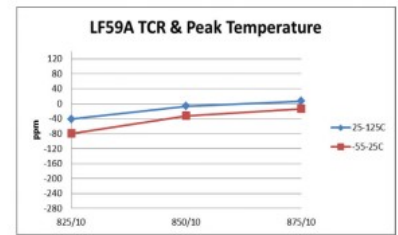
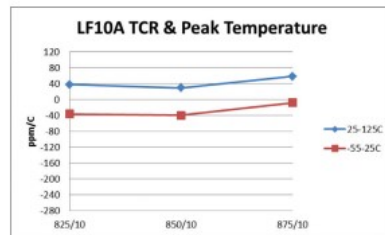
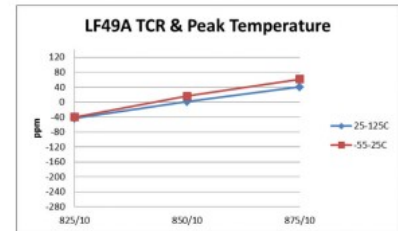
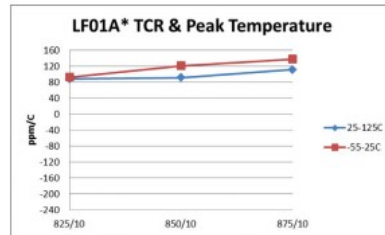


# Micromax™ LF01A

## Electronic Inks and Pastes

### TCR Sensitivity to Firing Conditions (Peak Temperature)

Data based on 1.0x1.0 mm resistors with Pb-free LF171 Ag/Pt terminations.



\*LF01A data based on 1mm x 1mm resistor.

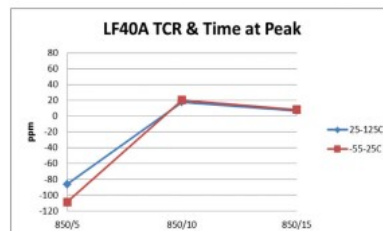
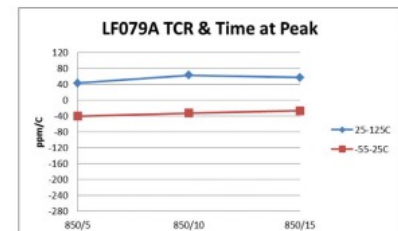
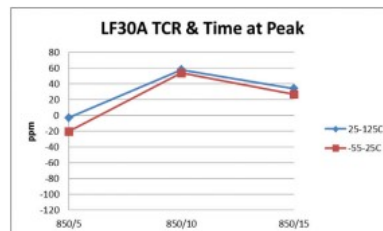
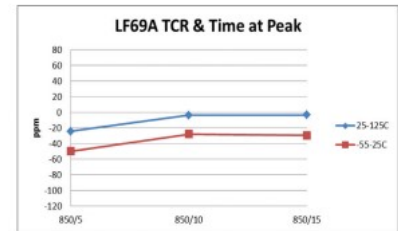
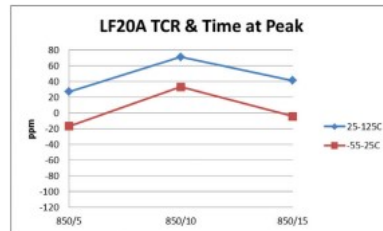
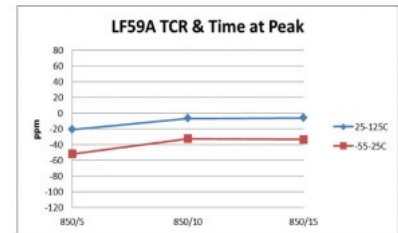
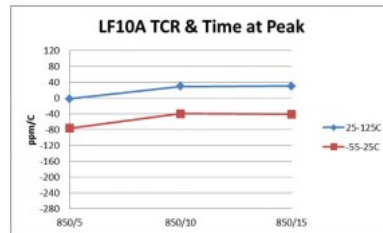
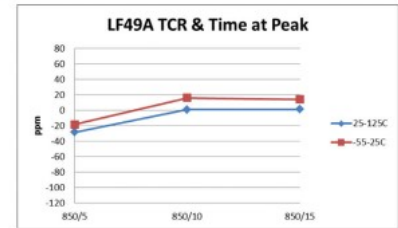
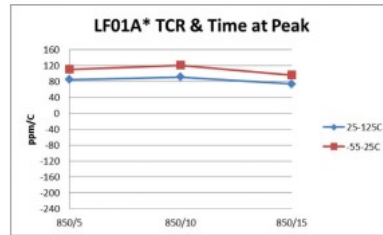
# Micromax™ LF01A

## Electronic Inks and Pastes

### TCR Sensitivity to Firing Conditions

(Time at Peak)

Data based on 1.0x1.0 mm resistors with Pb-free LF171 Ag/Pt terminations.



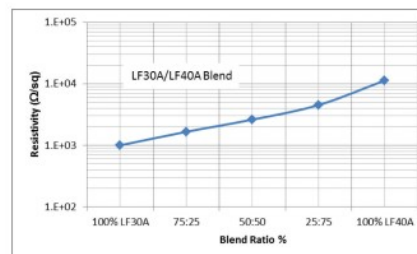
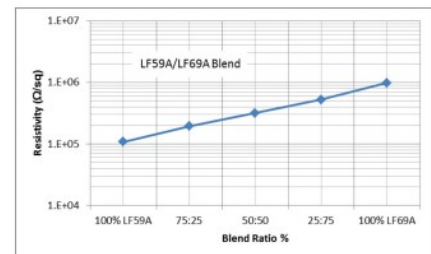
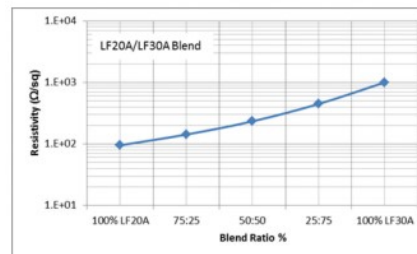
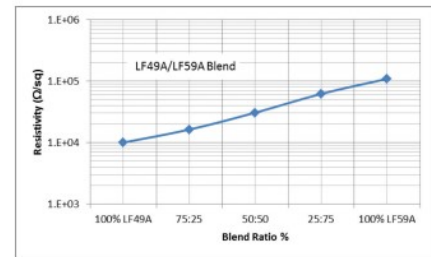
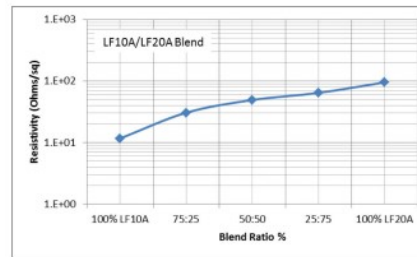
\*LF01A data based on 1mm x 1mm resistor.

# Micromax™ LF01A

## Electronic Inks and Pastes

### Blend Behavior – Resistivity

Data based on 1.0x1.0 mm resistors with Pb-free LF171 Ag/Pt terminations



# Micromax™ LF01A

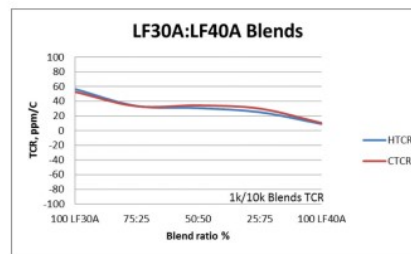
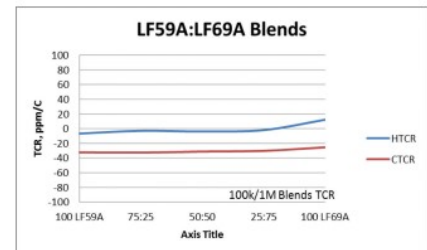
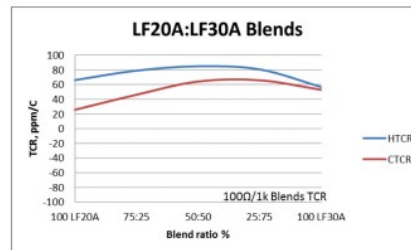
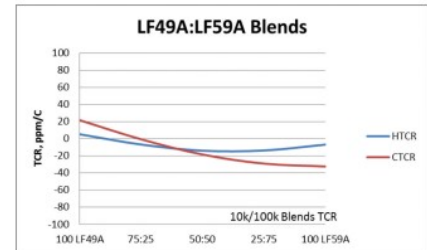
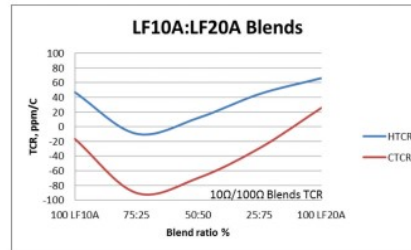
## Electronic Inks and Pastes

### Blend Behavior – TCR

Data based on 1.0x1.0 mm

HTCR = 25°C - 125°C, CTCR = -55°C - 25°C

Data based on 1.0x1.0 mm resistors with Pb-free LF171 Ag/Pt terminations



# Micromax™ LF01A

## Electronic Inks and Pastes

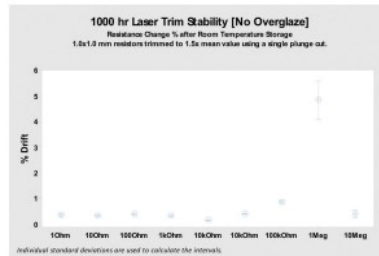
### Laser Trim Stability – 1000 hours

Unglazed

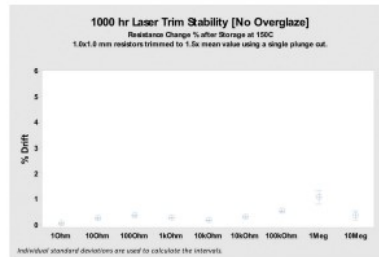
VS

Glazed with QQ620

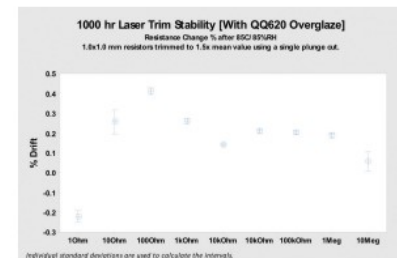
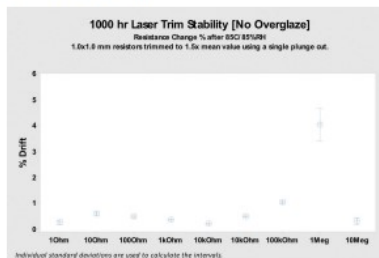
#### Room Temperature Storage



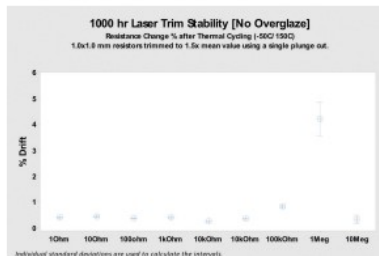
#### Storage at 150°C



#### Storage at 85°C/85%RH



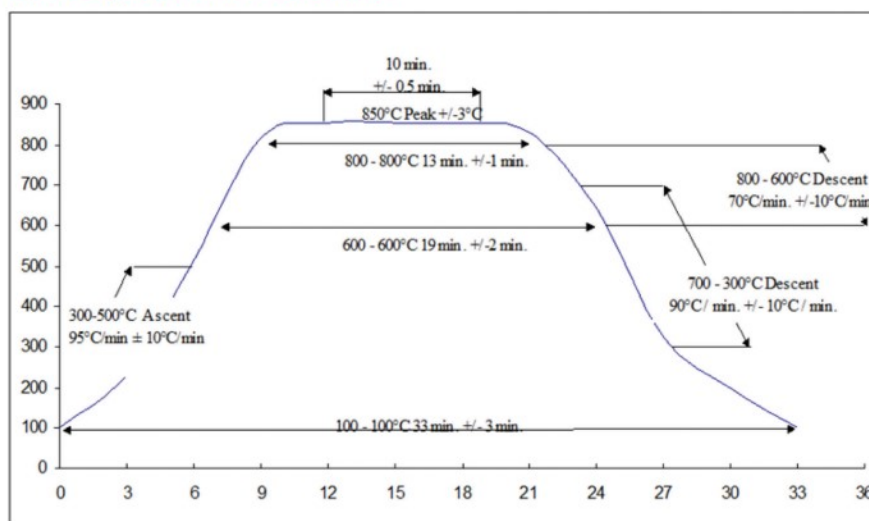
#### After Thermal Cycling –50°C/150°C



# Micromax™ LF01A

## Electronic Inks and Pastes

**Figure 1 – Typical 30 minute Furnace Profile**



**NOTICE TO USERS:** Values shown are based on testing of laboratory test specimens and represent data that fall within the standard range of properties for natural material. These values alone do not represent a sufficient basis for any part design and are not intended for use in establishing maximum, minimum, or ranges of values for specification purposes. Colourants or other additives may cause significant variations in data values. Properties of moulded parts can be influenced by a wide variety of factors including, but not limited to, material selection, additives, part design, processing conditions and environmental exposure. Other than those products expressly identified as medical grade (including by MT® product designation or otherwise), Celanese's products are not intended for use in medical or dental implants. Regardless of any such product designation, any determination of the suitability of a particular material and part design for any use contemplated by the users and the manner of such use is the sole responsibility of the users, who must assure themselves that the material as subsequently processed meets the needs of their particular product or use. To the best of our knowledge, the information contained in this publication is accurate; however, we do not assume any liability whatsoever for the accuracy and completeness of such information. The information contained in this publication should not be construed as a promise or guarantee of specific properties of our products. It is the sole responsibility of the users to investigate whether any existing patents are infringed by the use of the materials mentioned in this publication. Moreover, there is a need to reduce human exposure to many materials to the lowest practical limits in view of possible adverse effects. To the extent that any hazards may have been mentioned in this publication, we neither suggest nor guarantee that such hazards are the only ones that exist. We recommend that persons intending to rely on any recommendation or to use any equipment, processing technique or material mentioned in this publication should satisfy themselves that they can meet all applicable safety and health standards. We strongly recommend that users seek and adhere to the manufacturer's current instructions for handling each material they use, and entrust the handling of such material to adequately trained personnel only. Please call the telephone numbers listed for additional technical information. Call Customer Services for the appropriate Materials Safety Data Sheets (MSDS) before attempting to process our products.

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