

DuPont 7400 Series Resistors

100mΩ/sq – 500mΩ/sq Surge Protection Resistors

Technical Data Sheet

Product Description

DuPont 7400 Series resistor composition are intended to be applied to ceramic substrates by screen printing and fired in a conveyor furnace in an air (oxidising) atmosphere, to form specific resistive elements. DuPont 7400 series resistors have been developed for applications where high voltage pulses must be dissipated. These materials have low resistivity and are intended for use in serpentine patterns.

Product Benefits

- Outstanding stability to high voltage pulses
- Lead, nickel and cadmium free
- Small changes in resistivity after encapsulation
- Compatible 850°C firing encapsulant, suitable for laser trimming
- Suitable for encapsulation with low temperature overglaze
- Qualified at 20 µm dried thickness
- Excellent stability after storage at 150°C and 85°C/85% rel humidity

Processing Substrates

Properties are based on test on 96% alumina substrates. Substrates of other compositions and from various manufacturers may result in variations in performance properties, as may different lots of substrates, and any subsequent processing of substrates (e.g. laser scribing or drilling) prior to printing. It is the responsibility of users to determine the effects of any of the above variables in their particular situations.

Terminations

DuPont 7400 series can be used with a wide range of terminations. The reported properties are based on test using DuPont QM21R palladium/silver conductor composition as the termination material, prefired at 850°C.

Printing

DuPont 7400 series resistor compositions should be thoroughly mixed before use. This is best achieved by slow, gentle hand stirring with a clean, burr-free spatula (flexible plastic) for 1 - 2 minute. Care must be taken to avoid air-bubble entrapment. Printing should be carried out in a clean, well-ventilated area.

Note: optimum printing characteristics of DuPont 7400 Series resistors are generally achieved in the temperature range 20°C-23°C. It is therefore important that the material, in its container, is at this temperature prior to commencement of printing.

Specified properties are based on resistor printed to 20 ± 2µm dried print thickness. This is generally achieved using a 325 mesh stainless steel screen with 8-12 µm emulsion thickness. Print speeds of 10 to 20 cm/s may be used.

Control and reproducibility of print thickness is essential to obtain predictable, reproducible fired resistor properties.

Drying

Allow print to level for 5-10 minutes at room temperature, followed by drying for 10-15 minutes in a well ventilated oven or conveyor dryer.

Firing

Care must be taken to ensure that any gases/vapors from other chemicals/materials (e.g. halogenated solvents) do not enter the furnace muffle. It is also essential that the air supply to the furnace is clean, dry and free of contaminants. Air flows and extraction rates should be optimized to ensure that oxidizing conditions exist within the muffle, and that no furnace exhaust gases enter the room. DuPont 7400 series resistors are fired in a 30 minutes firing cycle to a peak of 850°C held for 10 minutes. See Figure 1

Variations in the peak firing temperature and/or time at the peak temperature may result in variations in the final fired properties.

Resistor compositions must be fired in clean air. Insufficient airflow or pollution of the air in the furnace may result in shifts of resistivity or TCR.

Encapsulation

Encapsulation composition DuPont 7401 has been specifically designed for compatibility with DuPont 7400 Series resistors and is recommended to obtain optimum pulse stability. DuPont 7401 is fired at a peak temperature of 850°C using a 30 minute firing profile. Low temperature (500°C) firing encapsulant DuPont 5415A or DuPont QQ550 can also be used.

Laser Trimming

DuPont 7400 Series resistors can be trimmed successfully using a wide range of trimming conditions. When trimming through DuPont 7401 encapsulant relatively high power should be used. The following range of trim parameters have been used on production type YAG laser: bite size 4-5µm, pulse frequency 4-5kHz; average power 4.0 - 5.0 W, giving trim speeds of up to 25mm/s.

General

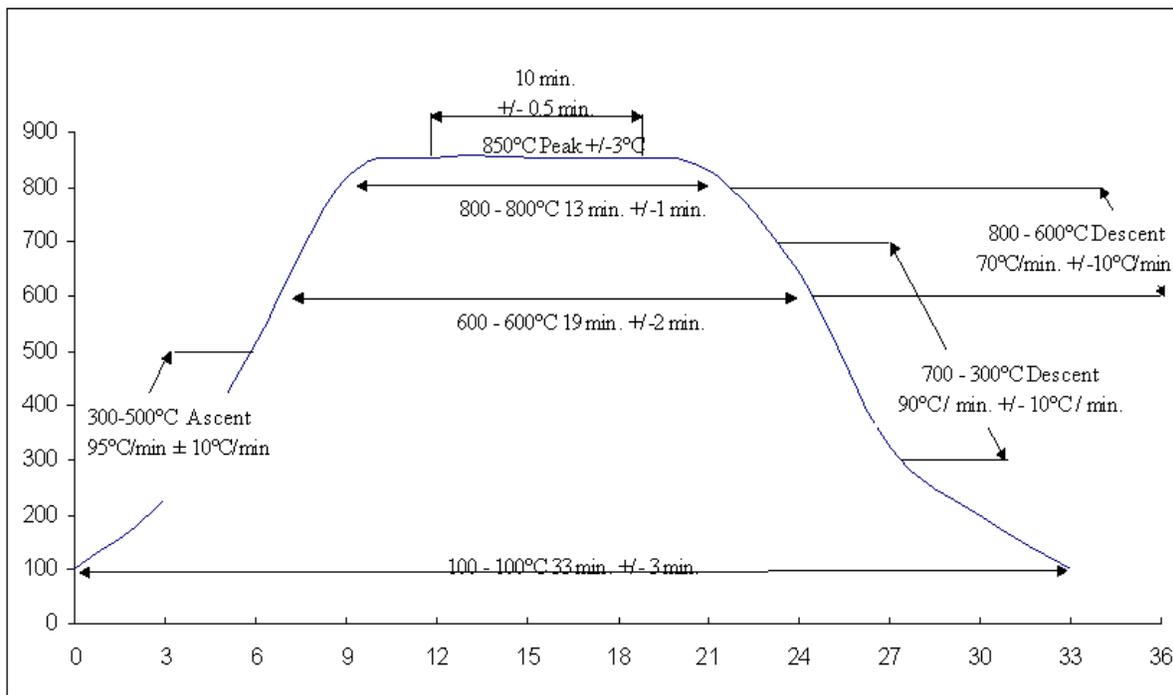
Yields and performance will depend to a large degree on the care exercised during processing, particularly in screen printing. Scrupulous care should be taken to keep the conductor composition, printing screens and other tools free of metal contamination.

Dust, lint and other particulate matter may also contribute to poor yields.

Blend behavior

DuPont 7400 series resistivity and TCR blend characteristics are shown in Table 1.

Figure 1 - Typical 30 minute Furnace Profile



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Table 1

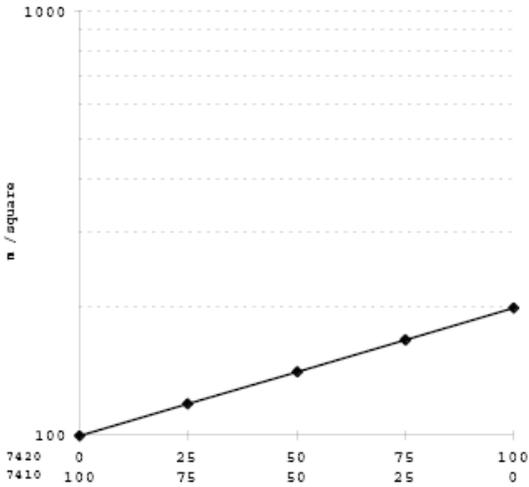
Shrinkage (for guidance only)			
	7410	7420	7450
Wet/Dry (%)	50	49	44
Dry/Fired (%)	55	47	43
Typical Fired Properties¹			
Resistivity, mΩ/sq ²	100	200	500
Resistivity shipping specifications	± 10%	± 10%	± 10%
HTCR ppm/°C ³	50 ± 25	0 ± 25	0 ± 25
CTCR ppm/°C ⁴	75 ± 25	50 ± 25	50 ± 25
Resistance change after encapsulation			
7401 (850°C firing)	<5%	<5%	<5%
5415A (620°C firing)	<0.1%	<0.1%	<0.1%
QQ550 (500°C firing)	<0.1%	<0.1%	<0.1%
Resistant change after pulse test ^{1,5}			
7401 encapsulant	<0.1%	<0.1%	<0.1%
5415A encapsulant	<0.1%	<0.1%	<0.1%
QQ550 encapsulant	<0.1%	<0.1%	<0.5%
Resistance of test parts, Ω	20	40	100
Pulse peak voltage kV	1.5	1.9	2.6
Time to half peak voltage, μ s	340	400	500
Pulse energy, Joules	28	26	24
Resistance change after 1000 hours storage⁶			
150°C		0.02%	0.03%
85°C/85% RH		0.01%	0.1%
<p>¹ Typical resistor properties based on laboratory tests using procedures as follows:</p> <p>Pattern: 200 square serpentine with 0.9mm line width and 0.6mm spaces; Corners on pattern reinforced with DuPont QM21R conductor.</p> <p>Printing: 325 mesh stainless steel screen, 8-12μm emulsion thickness to a dried resistor thickness of 20±3μm.</p> <p>Firing: 30 minutes profile with a peak temperature of 850°C held for 10 minutes.</p> <p>Substrate: All tests performed on 96% alumina.</p> <p>Termination: DuPont QM21R Pd/Ag conductor</p> <p>² Resistivity values are normalized to 20μm dried thickness.</p> <p>³ HTCR measured in the range +25 °C to 125 °C.</p> <p>⁴ CTCR measured in the range -55 °C to 25 °C.</p> <p>⁵ Resistors encapsulated at a fired encapsulant thickness of 10-12mm. Test equipment: Haefely P6T pulse tester with nominal 10/700ms pulse setting, (actual time to half peak shown in table). Resistance shift recorded after 10 pulses with 30 seconds between each pulse, at the pulse voltage indicated.</p> <p>⁶ Resistors protected with DuPont 7401 encapsulant.</p>			



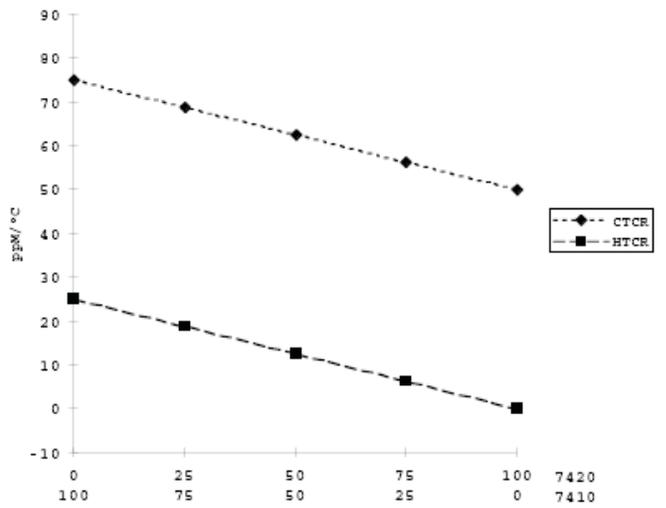
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Table 1 shows anticipated typical physical properties for DuPont 7400 Series based on specific controlled experiments in our labs and are not intended to represent the product specifications, details of which are available upon request.

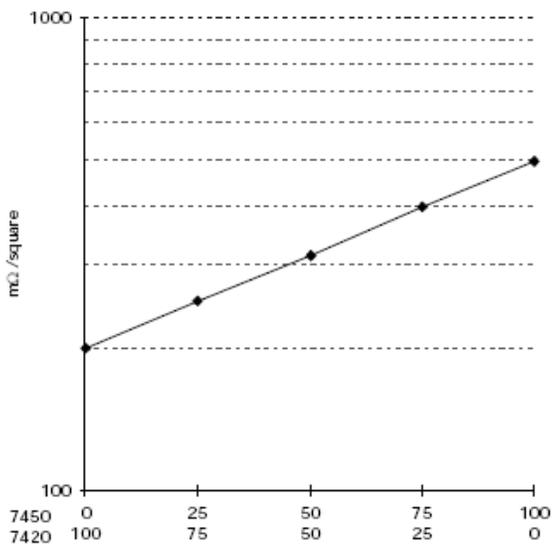
DuPont 7401 / DuPont 7420 Resistivity



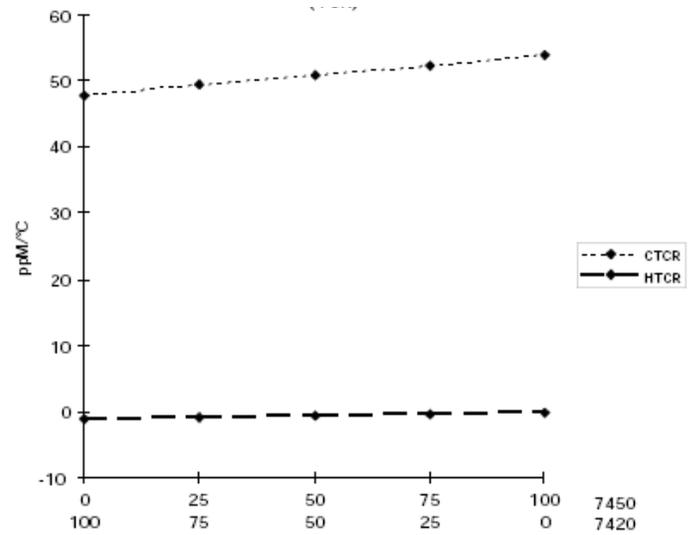
DuPont 7410 / DuPont 7420 Temperature Coefficient of Resistance (TCR)



DuPont 7420 / DuPont 7450 Resistivity



DuPont 7420 / DuPont 7450 Temperature Coefficient of Resistance (TCR)



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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 the Material Safety Data Sheet (MSDS).

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