NIC COMPONENTS CORP.
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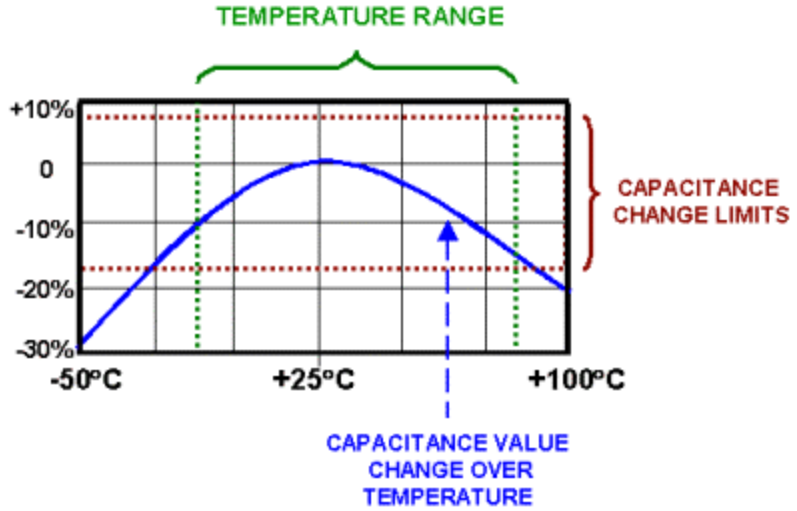
Technical Inquiries: tpmg@niccomp.com

EIA TEMPERATURE COEFFICIENTS: CERAMIC CAPACITORS

All ceramic capacitors are specified (and guaranteed) with regards to their capacitance value and tolerance at +25°C (Room Temperature; 77°F)

All capacitors will change in capacitance value if their temperature departs from room temperature, as normally will occur through heating or cooling within an electronic circuit.

THE GRAPH BELOW, SHOWS EXAMPLE OF CAPACITANCE VALUE CHANGE OVER TEMPERATURE



The maximum allowable change in capacitance value over a specified operating temperature range is the Temperature Coefficient (**TC**) of the capacitor

THE TABLE BELOW, SHOWS THE BREAKDOWN OF THE EIA THREE DIGIT "**TC**" CODES

Low Temperature Limit	High Temperature Limit	Maximum Allowable Capacitance Change From +25°C (0 VDC)
X = -55°C	5 = +85°C	F = ±7.5%
Y = -30°C	6 = +105°C	P = ±10%
Z = +10°C	7 = +125°C	R = ±15%
	8 = +150°C *(SPECIAL)*	S = ±22%
		T = +22% / -33%
		U = +22% / -56%
		V = +22% / -82%

X7R = ±15% ΔC over -55°C ~ + 125°C

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EIA Temperature Coefficients: Ceramic Capacitors

Common "**TC**" desiginations include:

X5R = ±15% change over -55°C~+85°C Standard Tolerance: K = ±10%

X7R = ±15% change over -55°C~+125°C Standard Tolerance: K = ±10%

Y5V = +22%/-82% change over -30°C~+85°C Standard Tolerance: Z = -20%/+80%

Z5U = +22%/-56% change over -10°C~+85°C Standard Tolerance: M = ± 20%

Exception to the above system is Ultra-Stable "TC": **COG** = **NPO**

NPO = 0±30PPM/°C over -55°C ~ + 125°C ...Standard Tolerance: J = ±5%

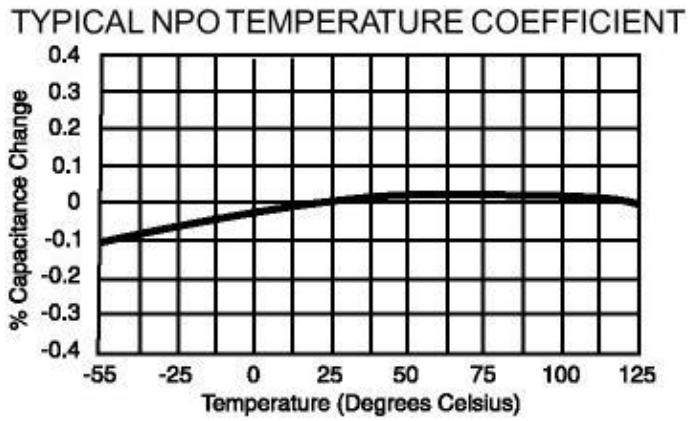
NPO = Negative Positive Zero [Originated from Military Standards]

Component Characteristics Substitution Guide:

"**TC**" - Temperature Coefficient : (Ceramic Capacitors)
Substitution Rule: A component with a more stable (better) temperature coefficient (**TC**) can replace a less temperature stable **TC** component.
i.e...an **X7R** ceramic can replace **X5R**, **Z5U** or **Y5V** ceramic part
i.e...an **NPO** ceramic can replace a **X5R**, **X7R, Z5U** or **Y5V** ceramic

Temperature Characteristic Curves:

NPO (COG) = 0±30PPM/ºC over -55ºC ~ +125ºC



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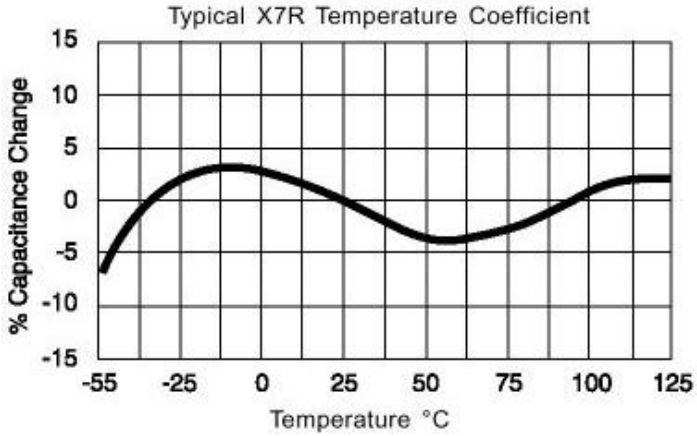
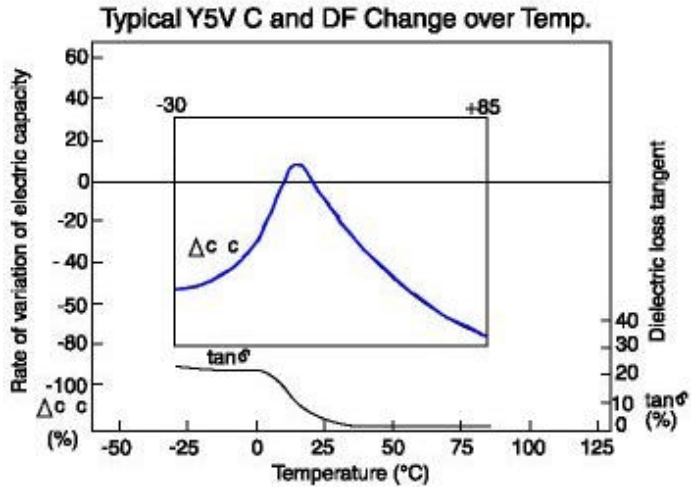
EIA Temperature Coefficients: Ceramic Capacitors

X7R = ±15% over -55ºC ~ +125ºC



Y5V = +22%/-82% change over -30°C ~ +85°C



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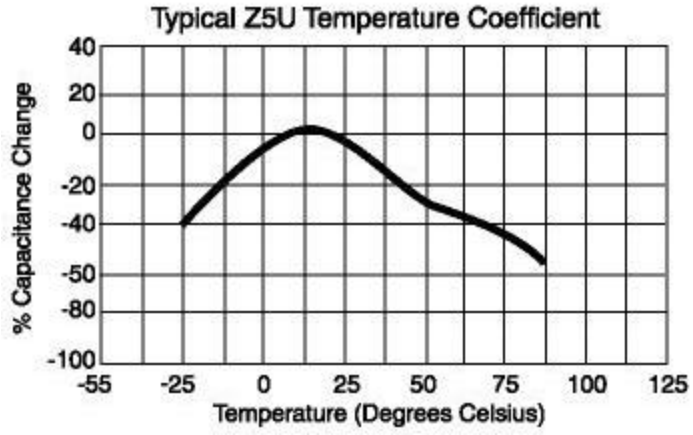
EIA Temperature Coefficients: Ceramic Capacitors

Z5U = +22%/-56% change over -10°C ~ +85°C



Additional Information & Resources:

- EIA-521… APPLICATION GUIDE FOR MULTILAYER CERAMIC CAPACITORS - ELECTRICAL
- EIA-198-2-E … TEST METHODS CERAMIC CAPACITORS
- NIC MLCC GUIDELINES:
    - Measurement of High Capacitance MLCC
    - Voltage Coefficients: NPO , X7R , Y5V
    - Aging Characteristics
    - Test Conditions