MATERION

Tech Brief

Temperature Properties

The Temperature Dependence of Tensile Properties for Alloy 25, Alloy 3, ToughMet® 3 Alloy, PerforMet® Alloy and 10X Rod

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The temperature dependence of the tensile properties for various tempers of ToughMet 3 (C72900) alloy, Alloy 25 (C17200), Alloy 3 (C17510), PreforMet alloy and 10X (C17500) rod were measured from -195 °C (-320 °F) to 345 °C (650 °F) in accordance with ASTM E21. All of these copper alloys showed increased strength at sub-zero temperature and a loss of strength and ductility at elevated temperature.

ELEVATED TEMPERATURE PROPERTIES

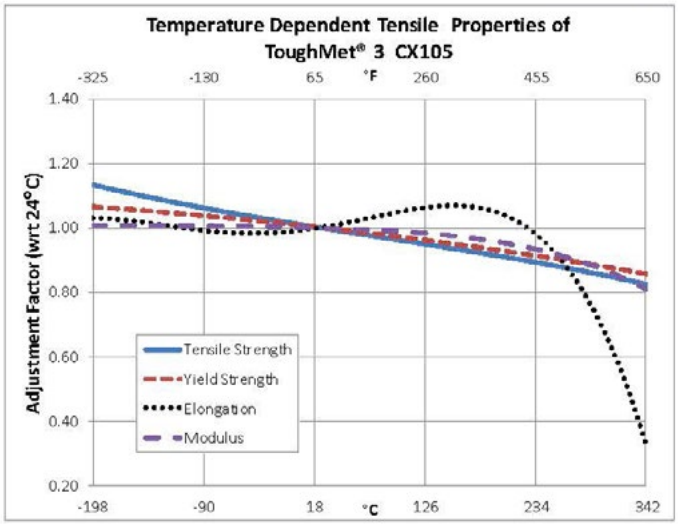
The standard specifications for alloys from Materion Performance Alloys provide tensile properties at "room temperature," about 22 °C (72 °F). When designing with these materials at other temperatures, knowledge of the temperature dependence of the tensile properties may be needed. For this, Materion has measured the temperature dependence of the tensile properties for standard tempers of ToughMet 3 (C72900), Alloy 25 (C7200), Alloy 3 (C17510), PerforMet and 10X rod. Testing was performed in accordance with ASTM E21, "Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials."

When designing below room temperature, these tensile tests with short time exposure at temperature are adequate. At elevated temperature, especially above 200 °C (400 °F), elevated temperature aging effects and creep rupture properties should be considered. Materion Tech Brief AT0061, "The Temperature Stability of Alloy 25, Alloy 3 and ToughMet® 3 Tensile Properties up to 650°F/340°C," details the permanent changes to room temperature tensile properties for Materion alloys exposed to elevated temperature. Documentation on other effects at elevated temperature, such as creep and stress rupture, may be available from the Materion Technical Services.

TEMPERATURE DEPENDENCE GRAPHS

The graphs below show the temperature dependence of the ultimate tensile strength, 0.2% offset yield strength, elongation (4D) and elastic modulus. These are all plotted as the ratio with respect to their value at room temperature. The minimum test temperature was -196 °C (-320 °F), the temperature of liquid nitrogen. The maximum test temperature was 470 °C (875 °F) for 10X, 430 °C (800 °F) for 3HT, and 345 °C (650 °F) for the others. Before testing at elevated temperatures, samples were soaked for 30 minutes.

Each graph represents data from one heat of the material in rod form with diameters ranging from 1.0 to 3.5 inches (25 - 90 mm). They show the general behavior of these alloys but are not guaranteed for use as specific design values. For additional literature, further information, or technical assistance contact Materion.



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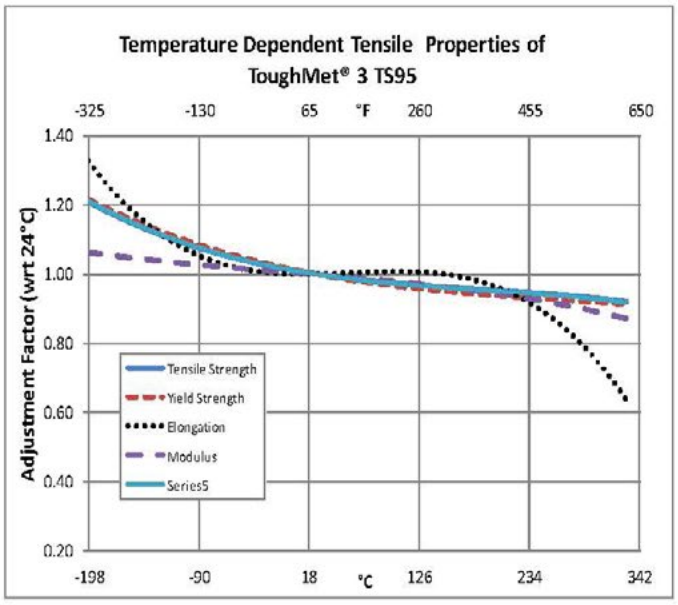
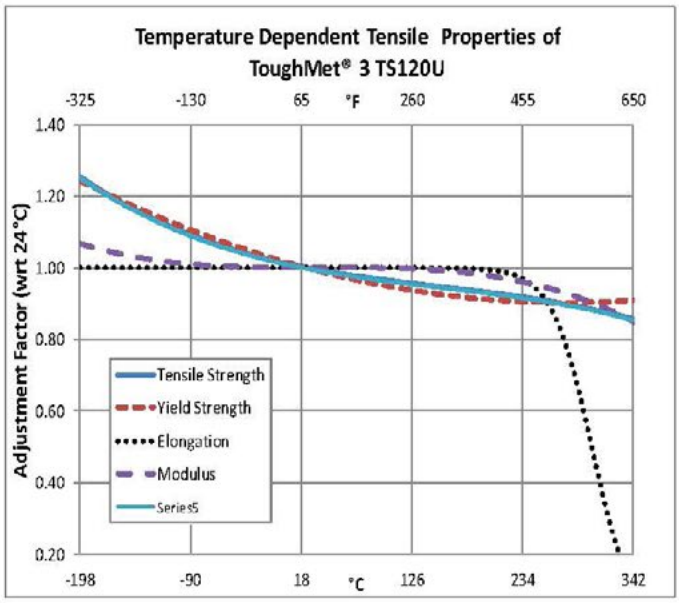
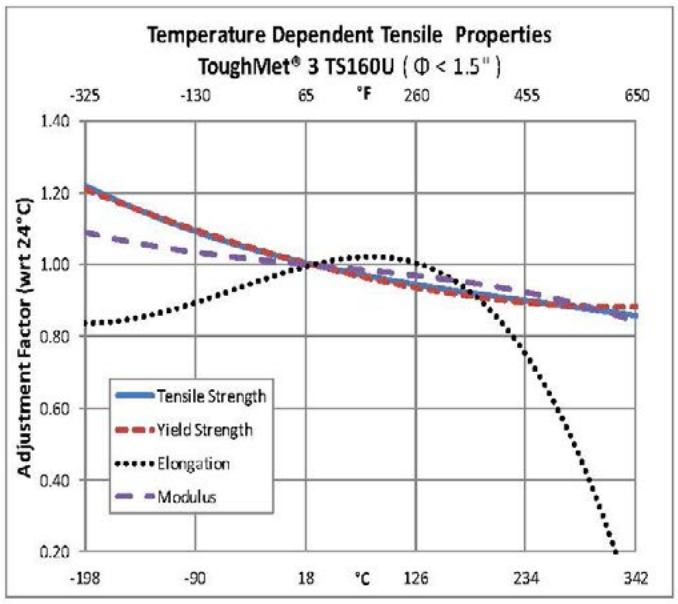
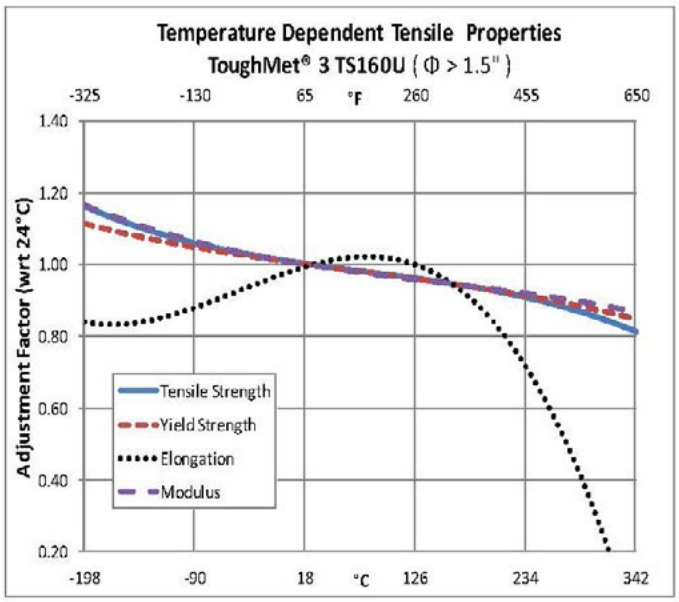
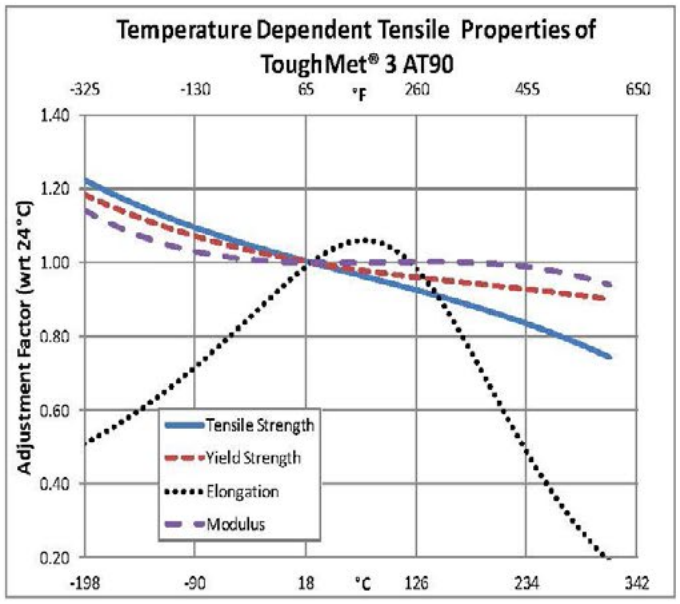
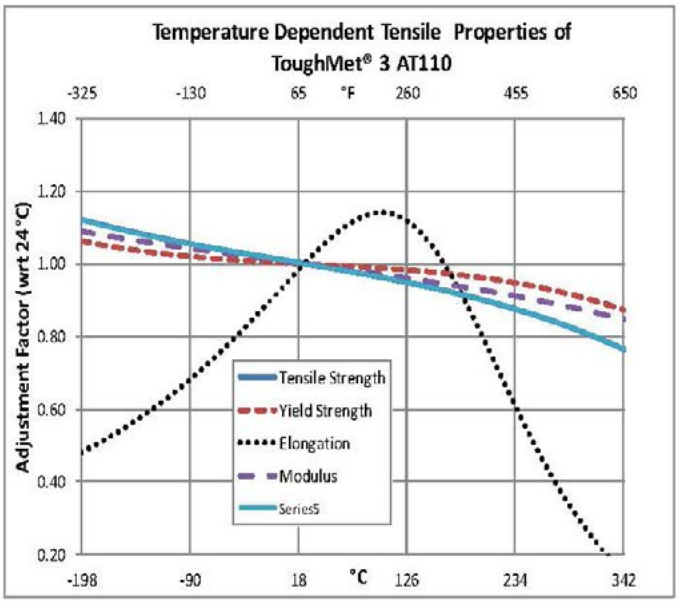

Temperature Dependent Tensile Properties of
ToughMet® 3 TS95
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
Series5
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties of
ToughMet® 3 TS120U
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
Series5
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties
ToughMet® 3 TS160U (Φ < 1.5")
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties
ToughMet® 3 TS160U (Φ > 1.5")
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties of
ToughMet® 3 AT90
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties of
ToughMet® 3 AT110
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
Series5
-198 -90 18 °C 126 234 342

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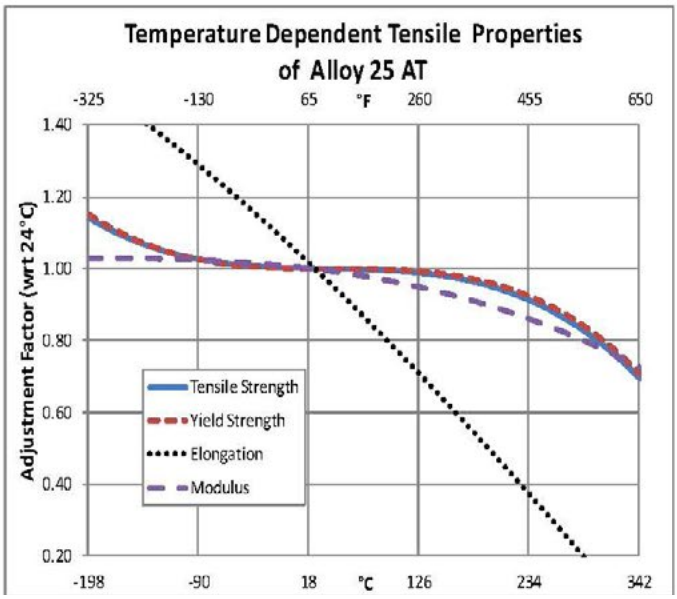
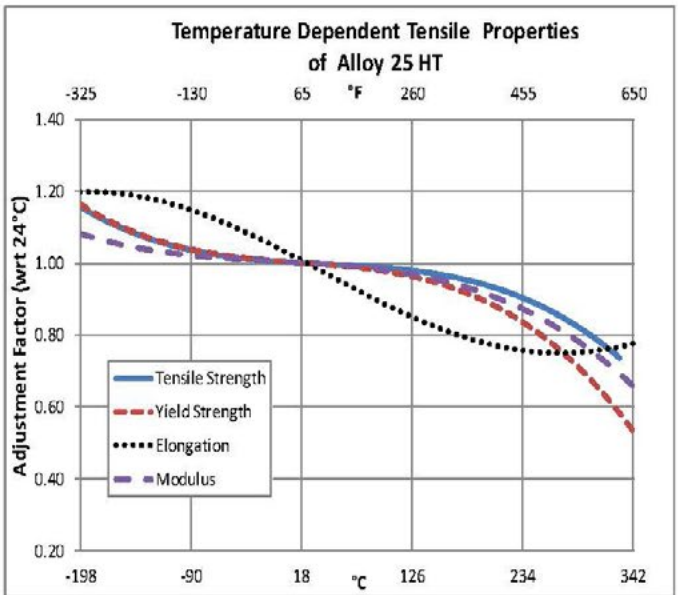
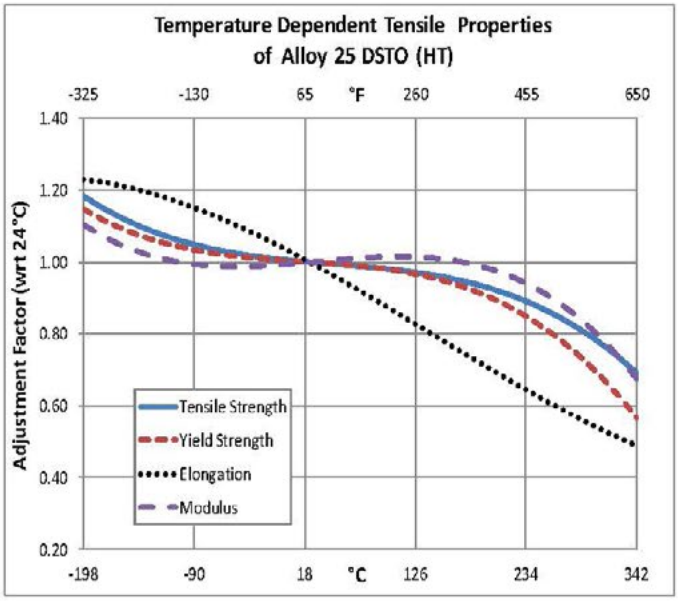
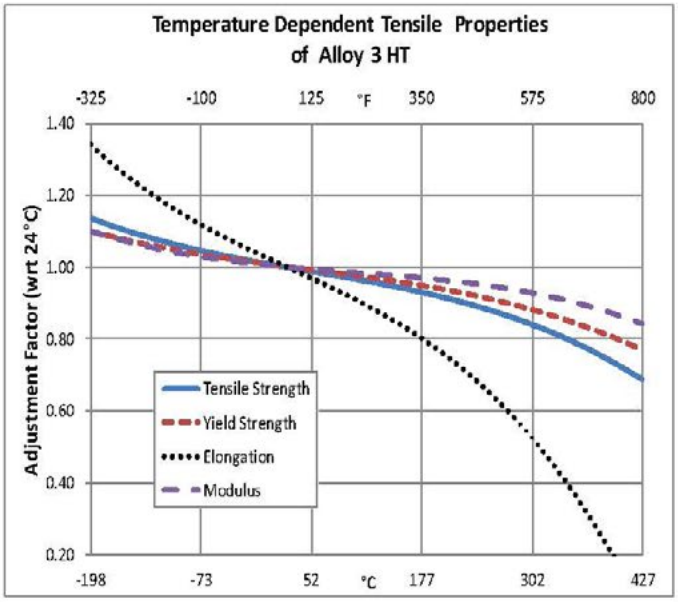
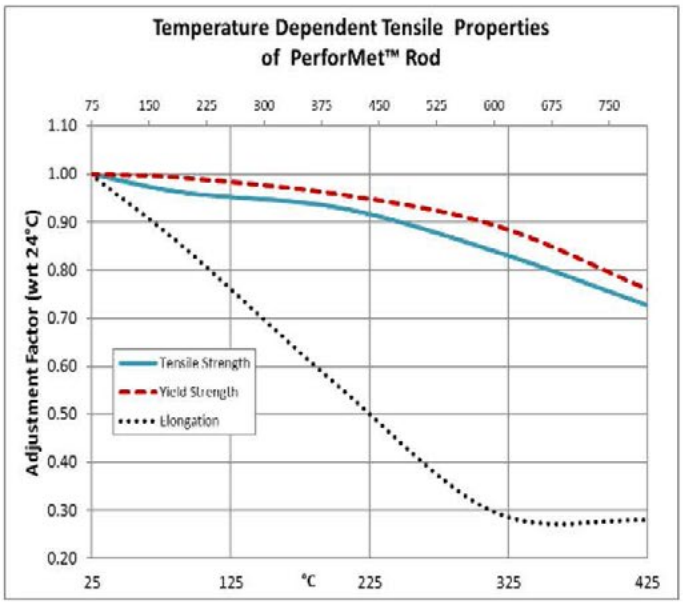
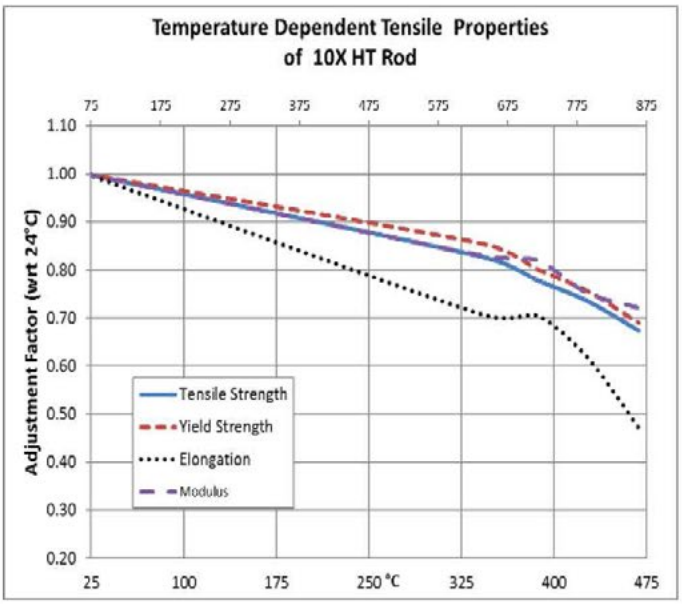

Temperature Dependent Tensile Properties of Alloy 25 AT
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties of Alloy 25 HT
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties of Alloy 25 DSTO (HT)
-325 -130 65 °F 260 455 650
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
-198 -90 18 °C 126 234 342


Temperature Dependent Tensile Properties of Alloy 3 HT
-325 -100 125 °F 350 575 800
1.40 1.20 1.00 0.80 0.60 0.40 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
-198 -73 52 °C 177 302 427


Temperature Dependent Tensile Properties of PerforMet™ Rod
75 150 225 300 375 450 525 600 675 750
1.10 1.00 0.90 0.80 0.70 0.60 0.50 0.40 0.30 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
25 125 °C 225 325 425


Temperature Dependent Tensile Properties of 10X HT Rod
75 175 275 375 475 575 675 775 875
1.10 1.00 0.90 0.80 0.70 0.60 0.50 0.40 0.30 0.20
Adjustment Factor (wrt 24°C)
Tensile Strength
Yield Strength
Elongation
Modulus
25 100 175 250 °C 325 400 475

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Alloy 25 Alloy 3 ToughMet® 3 Alloy PerforMet® Alloy 10X Rod

SAFE HANDLING OF COPPER BERYLLIUM

Processing beryllium-containing alloys poses a health risk if safe practices are not followed. Inhalation of airborne beryllium can cause serious lung diseases in some individuals. Occupational safety and health regulatory agencies worldwide have set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Safety Data Sheet (SDS) before working with this material. The SDS and additional important beryllium health and safety information and guidance can be found at berylliumsafety.com, berylliumsafety.eu and Materion.com. For questions on safe practices for beryllium-containing alloys, contact the Materion Product Stewardship Group at +1.800.862.4118 or contact us by e mail at Materion-PS@Materion.com.

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