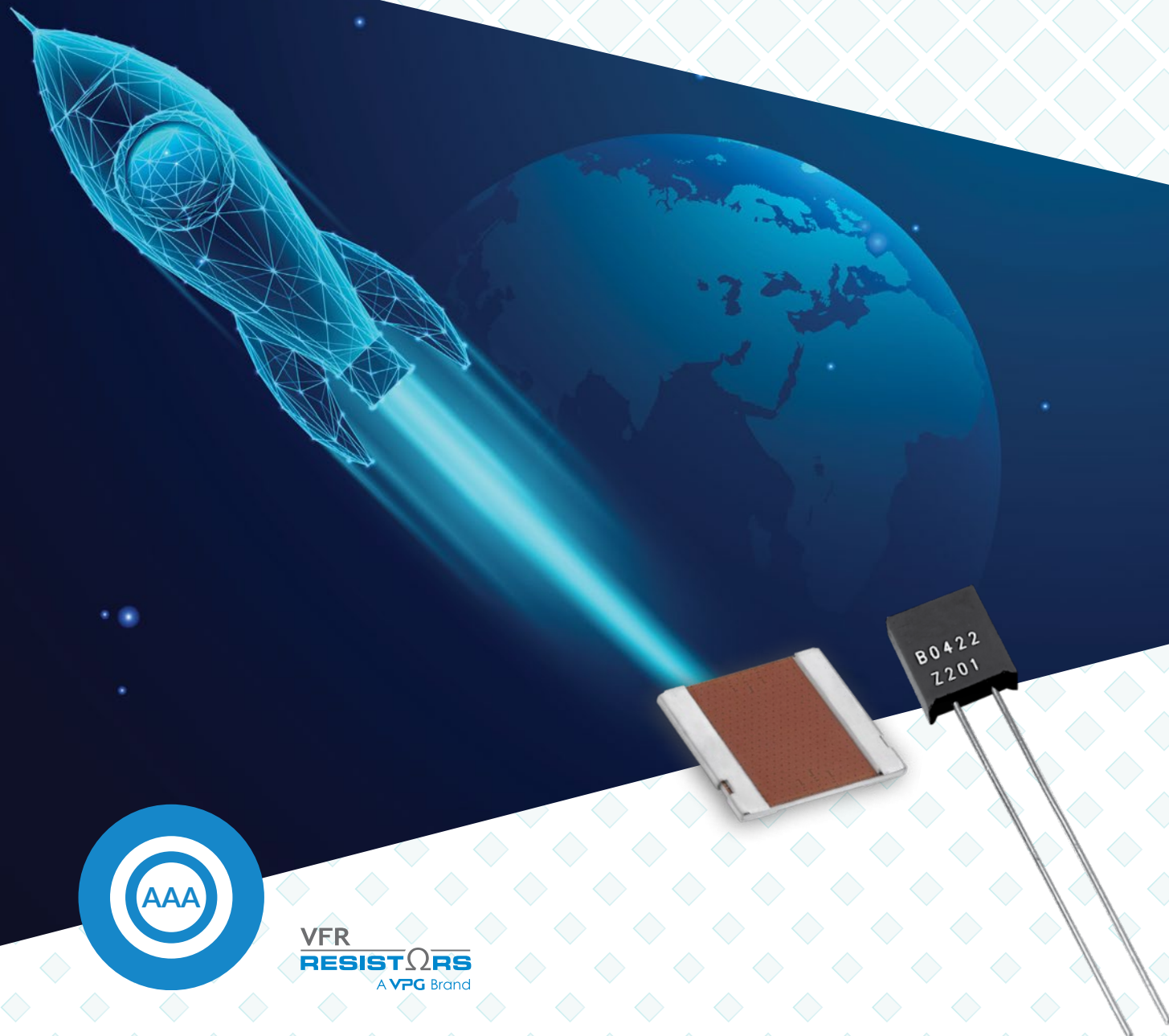


VPG Foil Resistors

VFR • ALPHA ELEC. • POWERTRON • APR

**Consistent Precision
& Reliability**



VFR
RESISTORS
A VPG Brand

**Qualified High-Precision Resistors
for Aerospace and Defense**

Market Solutions

Unparalleled Stability-

Even in the Harshest Operating Conditions

Our unique Bulk Metal® Foil technology outperforms all other resistor technologies. Continuously refined since its introduction in 1962, this ultra-precision technology provides extremely low Temperature Coefficient of Resistance (TCR) and exceptional long-term stability even when subjected to temperature extremes. Our product portfolio includes discrete resistors and resistor networks in surface-mount and through-hole (leaded) configurations, precision trimming potentiometers, and discrete chips for use in hybrid circuits, with customized chip resistor networks and arrays available.

We continue to develop, manufacture and market new types of Bulk Metal® Foil resistors, including military-established reliability components for Aerospace and Defense (EEE-INST-002, DLA, CECC, ER, QPL, etc.) and devices for high-temperature applications.

Tested for Outstanding Performance

Projects in the Aerospace and Defense industries are often mission-critical and every component must perform flawlessly for long periods of time. To ensure optimal functionality, screening and testing of our resistors is performed in accordance to NASA Goddard EEE-INST-002 and DLA MIL guidelines. These guidelines are followed as our baseline to develop and ensure our resistors achieve the high level of reliability that engineers expect and count on. Additionally, our advanced engineering services provide tailored solutions that can significantly expand the already superior capabilities of Bulk Metal® Foil technology, such as improved temperature performance, resistor matching/ tracking and enhanced stabilization.



Established Reliability (ER)

The RNC90Y has been the benchmark for high-precision established-reliability discrete resistors since 1982. In 2000, the Z201 resistor achieved a technological breakthrough with a TCR of 0.2 ppm/°C, enabling the introduction of the RNC90Z, an established-reliability “R” level resistor with a TCR limit of ± 2 ppm/°C over the extended range of -55°C to $+175^{\circ}\text{C}$. This is a significant improvement over the existing RNC90Y’s ± 5 ppm/°C TCR specification.

Product	Failure Rate	MIL Spec No.	Model	Resistance Range (Ω)	TCR (MIL Range)	Absolute Tolerance	Termination Type
	Level R	MIL-PRF-55182/9	RNC90Y	4.99 Ω – 121 k Ω	± 5 ppm/°C	0.005%	Lead
			RNC90T ⁽¹⁾	4.99 Ω – 121 k Ω	± 5 ppm/°C	0.005%	Lead
			RNC90Z	4.99 Ω – 30 Ω	± 3 ppm/°C	0.005%	Lead
				30.1 Ω – 121 k Ω	± 2 ppm/°C		
			RNC90S ⁽¹⁾	4.99 Ω – 30 Ω	± 3 ppm/°C	0.005%	Lead
				30.1 Ω – 121 k Ω	± 2 ppm/°C		

Notes:

⁽¹⁾ 0.200" lead spacing

Qualified Products List (QPL)

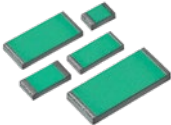
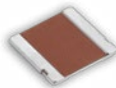
The models 1445Q and 1446Q networks are qualified to MIL-PRF-83401, characteristic C, schematic A. Actual performance exceeds all the requirements of MIL-PRF-83401 characteristic C.

Product	MIL Spec No.	Model	Termination Style	Resistance Range (Ω)	Absolute Tolerance	Number of Resistors	Absolute TCR (-55°C to $+125^{\circ}\text{C}$, $+25^{\circ}\text{C}$ ref.)
	MIL-PRF-83401	1445Q	14 pin DIP	100 Ω – 10 k Ω	0.1%	7	100 Ω – 1 k Ω 10 ppm/°C
		1446Q	16 pin DIP	100 Ω – 10 k Ω	0.1%	8	1 k Ω – 10 k Ω 5 ppm/°C

The RJ26 $\frac{1}{4}$ " precision trimming potentiometer is qualified to MIL-PRF-22097.

Product	MIL Spec No.	Model	Termination Style	Resistance Range (Ω)	Absolute Tolerance	Setability	TCR Through the Wiper (-55°C to $+125^{\circ}\text{C}$, $+25^{\circ}\text{C}$ ref.)
	MIL-PRF-22097	RJ26 (Trimmer)	W-edge mount	50 Ω , 100 Ω , 200 Ω , 500 Ω , 1 k Ω , 2 k Ω , 5 k Ω	10%	0.05%	± 25 ppm/°C
			X-edge mount				

Surface-Mount Resistors

Product	Type	DLA ⁽¹⁾ and MIL Spec Number	EEE-INST-002 ⁽²⁾ and MIL Spec Number	Maximum TCR MIL Range (ppm/°C)	Typical Load Life Stability 2000h
Surface Mount Chip Resistors					
	FRSM0603	07024 MIL-PRF-32663	303261 MIL-PRF-32663	±3	0.005%
	FRSM0805	07024 MIL-PRF-32663	303262 MIL-PRF-32663		
	FRSM1206	07025 MIL-PRF-32663	303263 MIL-PRF-32663		
	FRSM1506	03010 MIL-PRF-32663	303264 MIL-PRF-32663		
	FRSM2010	06001 MIL-PRF-32663	303265 MIL-PRF-32663		
	FRSM2018	93030 MIL-PRF-32663	303265 MIL-PRF-32663		
	FRSM2512	06002 MIL-PRF-32663	303266 MIL-PRF-32663		
Surface Mount Molded Resistor					
	SMR1DZ	06020 MIL-PRF-55182	303139 MIL-PRF-55182	±2	0.005%
	SMR3DZ	06021 MIL-PRF-55182	303140 MIL-PRF-55182	±2	
Current Sensing Surface Mount Resistors with Kelvin Connections					
	VCS1625Z	08003 MIL-PRF-55342	303119Z MIL-PRF-55342	±3	0.02%
	VCS1625	00803 MIL-PRF-55342	303119 MIL-PRF-55342	±5	
	CSM2512	07011	303144 / 303415	±20	0.05%
	CSM2512F		303336	±10	
	CSM3637	07012	303145 / 303416	±20	0.02%
	CSM3637F		303337 MIL-PRF-49465	±10	

Notes:

⁽¹⁾ DLA (Defense Logistics Agency, formerly known as DSCC)⁽²⁾ EEE-INST-002 (Instruction for EEE Parts Selection, Screening, Qualification, and Derating)

All the above resistors are also available off-the-shelf as standard products.

Through-Hole Resistor and Precision Networks

Product	Type	DLA ⁽¹⁾ and MIL Spec Number	EEE-INST-002 ⁽²⁾ and MIL Spec Number	EPPL ⁽³⁾	CECC ⁽⁴⁾	Maximum TCR MIL Range (ppm/°C)	Typical Load Life Stability 2000h
Custom Hermetically Sealed Precision Resistor Network Device							
	PRND		PRND EEE MIL-PRF-83401			±5	0.05%
Through-Hole Discrete Resistors							
	Z201		303143 S-311-P813			±2	0.005%
	Z201L		303143L S-311-P813				
	RS92N, RS92NA, AN				3	±5	0.005%
	S102	89039 / MIL-PRF-55182 301807 97010 / MIL-PRF-55182				±5	0.005%
Through-Hole Voltage Divider							
	300144	87026 MIL-PRF-55182				±5	0.005%
	300144Z	87026 MIL-PRF-55182				±2	
Through-Hole Variable Resistor							
	1240 P, W, X Mount	87126 MIL-PRF-39035				±10	0.1%

Notes:

⁽¹⁾ DLA (Defense Logistics Agency, formerly known as DSCC)

⁽²⁾ EEE-INST-002 (Instruction for EEE Parts Selection, Screening, Qualification, and Derating)

⁽³⁾ EPPL (European Preferred Parts List)

⁽⁴⁾ CENELEC Electronic Components Committee-European Committee for Electrotechnical Standardization

All the above resistors are also available off-the-shelf as standard products.

Example of Test Flow Surface-Mount Molded Resistor Data sheet 303139/303140

EEE-INST-002 (Table 2A Film/Foil, Level 1) 100% Tests/Inspections

Pre-cap Visual Inspection	Performed in production flow on welded chip on strip
RC Record	In tolerance
Thermal Shock	25 × (−65°C to +150°C)
Short Time Overload	6.25 × rated power (at +125°C), 5 s, not to exceed 70.5 V for 303139, 190 V for 303140
RC Record	In tolerance, $\Delta R = 0.02\%$ for values higher than 100 Ω , $\Delta R = 0.03\%$ for values between 5 Ω to 100 Ω
Power Conditioning	Rated power, 100 h, +125°C
RC Record	In tolerance $\Delta R \leq 200$ ppm for $R > 100 \Omega$, $\Delta R \leq 500$ ppm for $R \leq 100 \Omega$
Final Inspection	PDA 3% on $\Delta R > 0.05\%$ only
Visual Inspection	Materials, design, marking, etc.
Mechanical Inspection	Physical dimensions sample size: 3 units. For a min. of one failure –100% inspection

EEE-INST-002 (Table 3A Film/Foil, Level 1) Destructive Tests

Group 2	Sample size: 3(0) Solderability Resistance to solvents	MIL-STD-202, method 208 MIL-STD-202, method 215												
Group 3	Sample size: 10(0) Thermal shock	25 × (−65°C to +150°C) ΔR = 0.02% for values higher than 100 Ω ΔR = 0.03% for values between 5 Ω to 100 Ω												
	MIL-STD-202, method 107	<table><tr><th colspan="2">303139, 303140</th></tr><tr><th>Values</th><th>TCR limits</th></tr><tr><td>100 Ω to 40 kΩ</td><td>±2 ppm/°C</td></tr><tr><td>20 Ω to <100 Ω</td><td>±3 ppm/°C</td></tr><tr><td>10 Ω to <20 Ω</td><td>±5 ppm/°C</td></tr><tr><td>5 Ω to <10 Ω</td><td>±7ppm/°C</td></tr></table>	303139, 303140		Values	TCR limits	100 Ω to 40 kΩ	±2 ppm/°C	20 Ω to <100 Ω	±3 ppm/°C	10 Ω to <20 Ω	±5 ppm/°C	5 Ω to <10 Ω	±7ppm/°C
	303139, 303140													
	Values	TCR limits												
	100 Ω to 40 kΩ	±2 ppm/°C												
	20 Ω to <100 Ω	±3 ppm/°C												
	10 Ω to <20 Ω	±5 ppm/°C												
	5 Ω to <10 Ω	±7ppm/°C												
TCR – mounted on FR4	Temperature range: −55°C/+25°C/+125°C													
Low temperature storage	−65°C no load dwell for 24 h ±4 h +25°C ambient no load dwell for 2 h to 8 h ΔR = 0.01%													
Low temperature operation	−65°C no load dwell for 1 h rated power (at +125°C) for 45 min +25°C ambient no load dwell for 24 h ±4 h													
Short time overload	ΔR = 0.01% 6.25 × rated power (at +125°C), not to exceed 70.5 V for 303139, 190 V for 303140													
Group 4	Sample size: 9(0) DWV MIL-STD-202, method Insulation resistance MIL-STD-202, method 302 Resistance to soldering heat – mounted on FR4 MIL-STD-202, method 210 condition B Moisture resistance	ΔR = 0.01% 301 Atmospheric pressure, 200 VAC, 1 min 100 VDC IR ≥ 104 MΩ ΔR = 0.03% performed per MIL-PRF-55342 para. 4.8.8.1 ΔR = 0.03%												
	MIL-STD-202, method 106 DWV, at 200 VAC, 1 min atmospheric pressure Insulation resistance, at 100 VDC	ΔR = 0.01% IR ≥ 100 MΩ												

EEE-INST-002 (Table 3A Film/Foil, Level 1) Destructive Tests

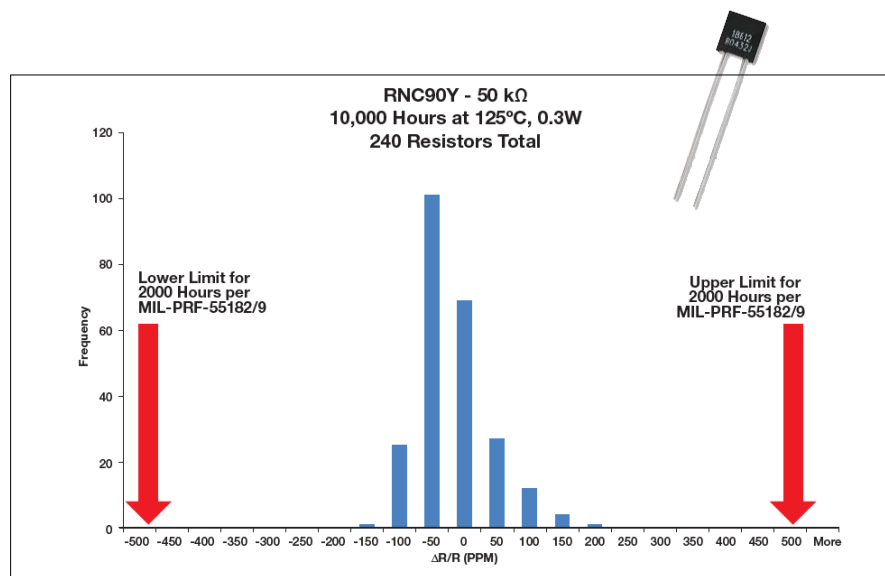
Group 5	Sample size: 9(0) – mounted on FR4	
	Shock MIL-PRF-55182 and MIL-STD-202, method 213, condition I 10 shocks in each of two mutually perpendicular planes (Y, Z) 100 G, 6 ms, sawtooth	$\Delta R = 0.01\%$
Group 6	Vibration MIL-PRF-55182 and MIL-STD-202, method 204, condition D 10 Hz –2000 Hz –10 Hz, 20 G, planes Y, Z In each of two mutually perpendicular planes (Y, Z), 20 G, 4 h in each plane	$\Delta R = 0.01\%$
	Life MIL-STD-202, method 108 1.5 h on, 0.5 h off, 125°C, rated power (at +125°C), 2000 h	$\Delta R = 0.05\%$
Group 7	Sample Size: 5(0) – not mounted Voltage coefficient MIL-PRF-55182 and MIL-STD-202, method 309	5 ppm/V Working voltage Resistance range >1 K
Group 9	Sample size: 5(0) High temperature exposure	$\Delta R = 0.1\% + 175^\circ\text{C}$, 2000 h, no load
Group 10	Thermal outgassing	Contact VPG Foil Resistors application engineering for review

Notes:

- (1) For prototype units, append a "U" to the model number (example: 303139U). These units have all of the table 2A 100% tests performed, with no destructive qualification testing required.
- (2) Measurement error allowed for ΔR limits: 0.01 Ω .

Example of Load Life Results (10,000 h)

RNC90Y is a QPL product with established reliability (ER). It meets the requirements of MIL-PRF-55182/9.





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