

Qualified High-Precision Resistors for Avionics, Military and Space

Market Solutions



vishayfoilresistors.com

VISHAY FOIL
RESISTORS

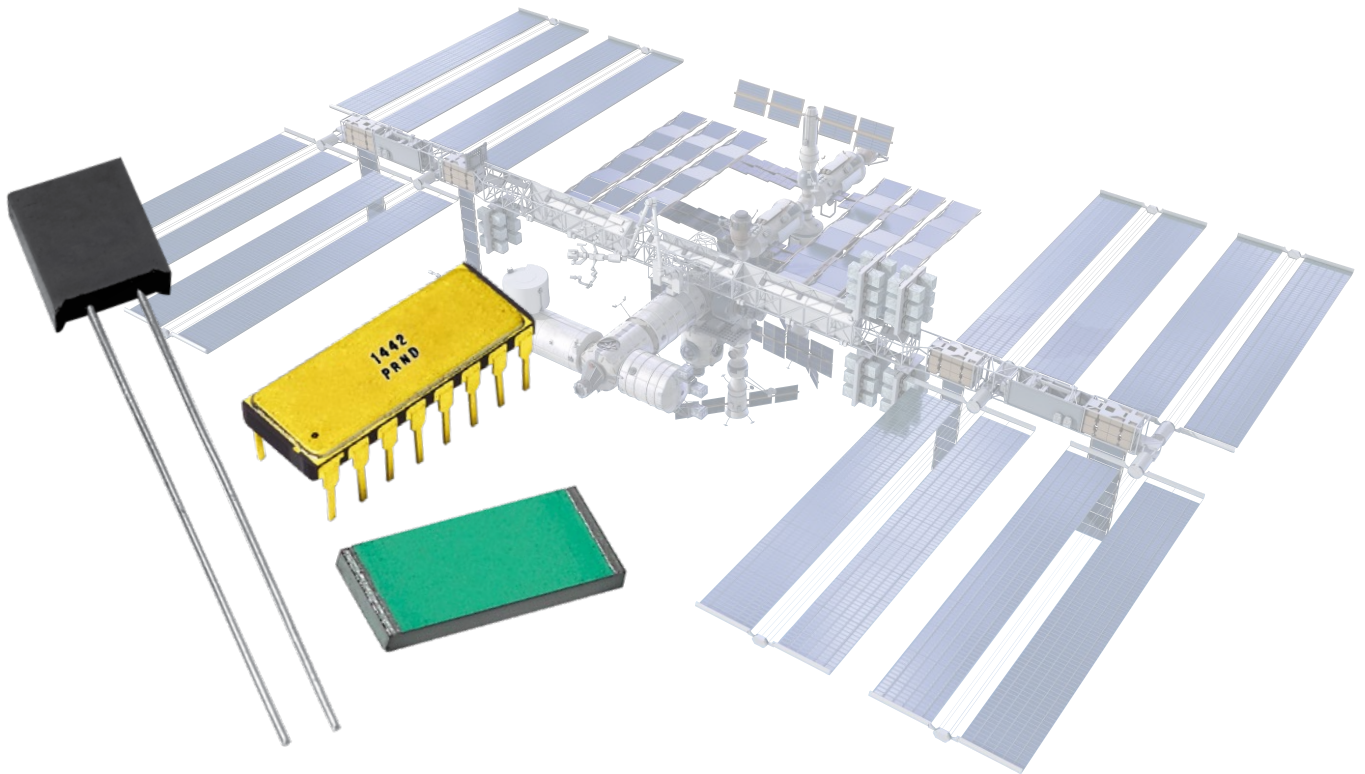
Part of
VPG Foil Resistors

Qualified High-Precision Resistors for AMS

Tested for Outstanding Performance

Reliable. Stable. Precise.

The avionics, military and space (AMS) industry differs from other industries in one essential requirement – its need for continuous reliability. Projects are often mission-critical and every component must perform flawlessly for long periods of time. In order 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 AMS 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.




Mission-Critical Applications Require Bulk Metal® Foil Technology

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 Avionics, Military and Space (EEE-INST-002, DLA, CECC, ER, QPL, etc.) and devices for high-temperature applications. With our technology, we are even able to achieve performance levels superior to the highest military specifications and standards.

Established Reliability (ER)


The RNC90Y established-reliability resistor 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*	4.99 Ω – 121 k Ω	± 5 ppm/°C	0.005%	Lead
			RNC90Z	30.1 Ω – 121 k Ω	± 2 ppm/°C	0.005%	Lead
			RNC90S*	30.1 Ω – 121 k Ω	± 2 ppm/°C	0.005%	Lead


* 0.200" lead spacing

Qualified Products List (QPL)

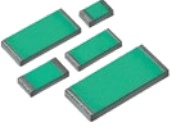


The models 1445Q and 1446Q networks are qualified to MIL-PRF-83401, characteristic C, schematic A. Actual performance exceeds all the requirements of MIL-PRF-83401 characteristic C.

Product	MIL Spec No.	Model	Termination Type	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	100R - 1k 10 ppm/°C
		1446Q	16 pin DIP	100 Ω – 10 k Ω	0.1%	8	1k - 10k 5 ppm/°C

The Vishay Foil Resistors' RJ26 ¼" precision trimming potentiometer is qualified to MIL-PRF-22097.

Product	MIL Spec No.	Model	Termination Type	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)	Leaded	50 Ω , 100 Ω , 200 Ω , 500 Ω , 1 k Ω , 2 k Ω , 5 k Ω	10%	0.05%	± 25 ppm/°C

Wrap Around Surface-Mount and Precision Networks

Product	Type	DLA ⁽¹⁾ and MIL Spec Number	EEE-INST-002 ⁽²⁾ and MIL Spec Number	Nominal TCR MIL Range (ppm/°C)	Typical Load Life Stability 2000h
Wrap Around Surface Mount					
	FRSM0603		303261 MIL-PRF-55342	0.2	
	FRSM0805		303262 MIL-PRF-55342		
	FRSM1206		303263 MIL-PRF-55342		
	FRSM1506		303264 MIL-PRF-55342		
	FRSM2010		303265 MIL-PRF-55342		
	FRSM2512		303266 MIL-PRF-55342		
	VSMP0805	07024 MIL-PRF-55342	303134 MIL-PRF-55342	2	0.005%
	VSMP1206	07025 MIL-PRF-55342	303135 MIL-PRF-55342		
	VSMP1506	03010 MIL-PRF-55342	303136 MIL-PRF-55342		
	VSMP2010	06001 MIL-PRF-55342	303137 MIL-PRF-55342		
	VSMP2512	06002 MIL-PRF-55342	303138 MIL-PRF-55342		
	VSM0805	07024 MIL-PRF-55342			
	VSM1206	07025 MIL-PRF-55342			
	VSM1506	03010 MIL-PRF-55342			
	VSM2010	06001 MIL-PRF-55342			
	VSM2512	06002 MIL-PRF-55342			
	VSM2018	93030 MIL-PRF-55342			
	Custom Hermetically Sealed Precision Resistor Network Device				
	PRND		PRND EEE MIL-PRF-83401	2	0.05%

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 on the shelf as standard products.

Molded, Flexible Terminations, Kelvin Connections, Through Hole and Trimmers

Product	Type	DLA ⁽¹⁾ and MIL Spec Number	EEE-INST-002 ⁽²⁾ and MIL Spec Number	EPPL ⁽³⁾	CECC ⁽⁴⁾	Nominal TCR MIL Range (ppm/°C)	Typical Load Life Stability 2000h
Molded, Flexible Terminations with Robust Construction							
	SMR1DZ	06020 MIL-PRF-55182	303139 MIL-PRF-55182			0.2	0.005%
	SMR1D	06020 MIL-PRF-55182				2	
	SMR3DZ	06021 MIL-PRF-55182	303140 MIL-PRF-55182			0.2	
	SMR3D	06021 MIL-PRF-55182				2	
Current Sense with Kelvin Connections for High Accuracy							
	VCS1625Z	08003 MIL-PRF-55342	303119Z MIL-PRF-55342			0.2	0.02%
	VCS1625	00803 MIL-PRF-55342	303119 MIL-PRF-55342	✓		2	
	CSM2512	07011 MIL-PRF-49465	303144 MIL-PRF-49465			15 Max	0.05%
	CSM3637	07012 MIL-PRF-49465	303145 MIL-PRF-49465				
	CSM3637F		303337 MIL-PRF-49465			10 Max	0.02%
Through-Hole							
	Z201		303143 S-311-P813			0.2	0.005%
	Z201L		303143L S-311-P813				
	RS92N, RS92NA, AN				✓	2	0.005%
	S102	89039 MIL-PRF-89039				2	0.005%
Through-Hole Voltage Divider							
	300144	87026 MIL-PRF-55182				2	0.005%
	300144Z	87026 MIL-PRF-55182				0.2	
Trimmer							
	1240	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 on the shelf as standard products.

Example of Test Flow Surface-Mount Chips

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

Test or Inspection	Result
Pre-cap Visual Inspection	Performed in production flow prior overcoating
RC Record	In tolerance
Thermal Shock	25 x (-65°C to +150°C)
Power Conditioning	70°C, 100 h, 1.5 rated power—not to exceed max. voltage
RC Record	In tolerance $\Delta R = 0.05\%$ for thermal shock and conditioning combined
Final Inspection	5% PDA on ΔR only, 10% PDA on “Out of Final Tolerance”
Visual Inspection	Materials, design, etc.
Mechanical Inspection	Physical dimensions, sample size: 3 units, zero failure

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

Group 2	Sample size: 3, zero failure Solderability		
Group 3	Sample size: 10, zero failure—mounted on FR4 TCR (-55°C/+25°C/+125°C)	Values $\geq 100 \Omega$ 50Ω to $< 100 \Omega$ 10Ω to $< 50 \Omega$	TCR Limits ± 3 ppm/°C ± 4 ppm/°C ± 5 ppm/°C
	Low temperature storage	$\Delta R = 0.02\%$ -65°C no load dwell for 24 h ± 4 h +25°C ambient no load dwell for 2 h to 8 h	
	Low temperature operation	$\Delta R = 0.015\%$ -65°C no load dwell for 1 h Rated power for 45 min +25°C ambient no load dwell for 2 h to 8 h	
	Short time overload	$\Delta R = 0.02\%$ 6.25 x rated power, 5 s—no “I” limitation: not to exceed twice the max. voltage	
Group 4	Sample size: 9, zero failure—mounted on FR4 Resistance to soldering heat	$\Delta R = 0.02\%$ Performed per MIL-PRF-55342 para. 4.8.8.1	
Group 6	Sample size: 12, zero failure—mounted on FR4 Life	$\Delta R = 0.02\%$ 2000 h, +70°C, rated power	
Group 7B	Sample size: 10, zero failure—mounted on FR4 Solder mounting integrity	Performed per MIL-PRF-55342 Force applied: for 0630—1 kg, 30 s / for 0805, 1206, and 1506—2 kg, 30 s For 2010, 2512: force applied: 3 kg, 30 s	
Group 8	Sample size: 5, zero failure—chips not mounted Voltage coefficient	$\Delta R = 3$ ppm/V Applicable resistors $\geq 1k$ Performed per MIL-STD-202 method 309	
Group 9	Sample size: 5, zero failure—mounted on FR4 High temperature exposure	$\Delta R = 0.015\%$ Performed per MIL-PRF-55342 100 h at +150°C $\pm 5^\circ\text{C}$	

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

RC Record	In tolerance
Thermal Shock	25 × (−65°C to +150°C)
RC Record	ΔR = 0.1%
High Temperature Exposure	+170°C, 100 h, no power
RC Record	In tolerance ΔR = 0.2%
Final Inspection	5% PDA on ΔR, 10% PDA on out of tolerance
Visual Inspection	Magnification 30 × to 60 ×
Mechanical Inspection	Dimensions, workmanship, 3 units sample size

Note

⁽¹⁾ Vishay Foil Resistors will perform a pre-cap visual inspection 100% in the production flow prior to overcoating

EEE-INST-002 (Table 3A Film/Foil, Level 1) Destructive Tests – MIL-PRF-49465 and 55342

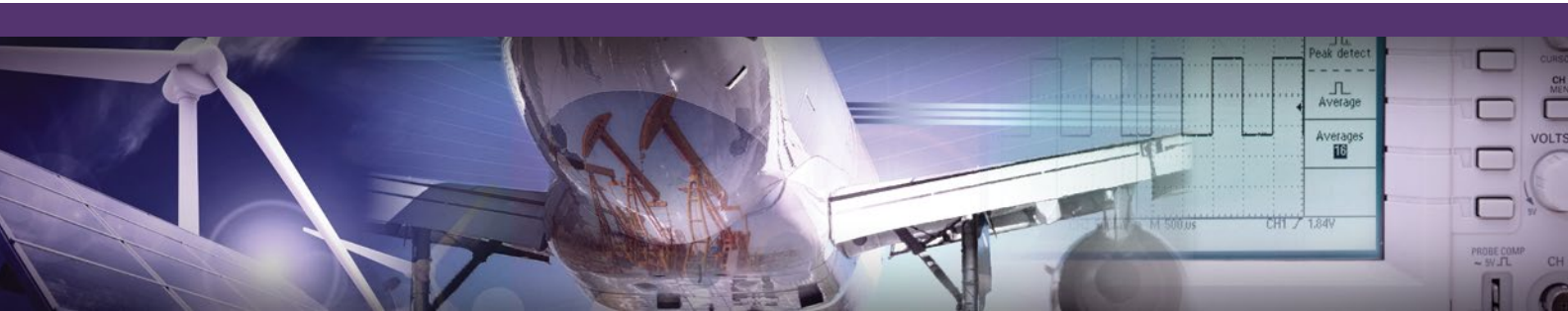
Group 2	Sample size: 3(0) Solderability	MIL-STD-202, method 208
Group 3	Sample size: 10(0) – mounted on FR4 TCR measurement per MIL-STD-202, method 304 Low temperature storage per MIL-PRF-49465 Low temperature operation per MIL-PRF-55342 Short time overload per MIL-STD-49465	±15 ppm/°C, R <100 mΩ; ±10 ppm/°C(3) R ≥100 mΩ (−55°C / +25°C / +125°C) ΔR = 0.02% −55°C ±2°C, 24 h ±4 h ambient no load dwell for 2 h to 8 h at +25°C ΔR = 0.02% −65°C ambient no load dwell for 1 h, rated power for 45 min no load dwell at +25°C for 24 h ±4 h ΔR = 0.05% 5 × rated power at +25°C for 5 s, not to exceed maximum current rating
Group 4	Sample size: 9(0) – mounted on FR4 Resistance to soldering heat Moisture resistance per MIL-STD-202, method 106 (7a and 7b not required)	ΔR = 0.05% performed per MIL-PRF-55342 para. 4.8.8.1 ΔR = 0.02% 240 h, no power
Group 5	Sample size: 9(0) Shock per MIL-STD-202, method 213, condition I Vibration per MIL-STD-202, method 204, condition D	ΔR = 0.05% 100G, 6 ms axes Z and Y, 10 shocks per axis ΔR = 0.05% 10 Hz to 2000 Hz, 20G 2 axes, 6 h per axis
Group 6	Sample size: 12(0) – mounted on FR4 Life test per MIL-PRF-49465	ΔR = 0.1% 2000 h, +70°C, rated power
Group 7B	Sample Size: 10(0) – mounted on FR4 Solder mounting integrity per MIL-PRF-55342	5 kg force, 30 s
Group 9	Sample size: 5(0) – mounted on FR4 High temperature exposure per MIL-PRF-49465	ΔR = 0.3% 1000 h, +170°C ±7°C, no power
Group 10⁽²⁾	Sample size: 4	Per ASTM E595

Notes

⁽¹⁾ Units selected randomly from lots which successfully passed the table 2A testing

⁽²⁾ Optional, per customer request.

Measurement error allowed for ΔR limits: 0.0005 Ω.



Contact

foil@vpgsensors.com

vishayfoilresistors.com

DISCLAIMER: ALL PRODUCTS, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE. Vishay Precision Group, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "VPG"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained herein or in any other disclosure relating to any product. The product specifications do not expand or otherwise modify VPG's terms and conditions of purchase, including but not limited to, the warranty expressed therein. VPG makes no warranty, representation or guarantee other than as set forth in the terms and conditions of purchase. **To the maximum extent permitted by applicable law, VPG disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.** Information provided in datasheets and/or specifications may vary from actual results in different applications and performance may vary over time. Statements regarding the suitability of products for certain types of applications are based on VPG's knowledge of typical requirements that are often placed on VPG products. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. You should ensure you have the current version of the relevant information by contacting VPG prior to performing installation or use of the product, such as on our website at vpgsensors.com. No license, express, implied, or otherwise, to any intellectual property rights is granted by this document, or by any conduct of VPG. The products shown herein are not designed for use in life-saving or life-sustaining applications unless otherwise expressly indicated. Customers using or selling VPG products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify VPG for any damages arising or resulting from such use or sale. Please contact authorized VPG personnel to obtain written terms and conditions regarding products designed for such applications. Product names and markings noted herein may be trademarks of their respective owners.