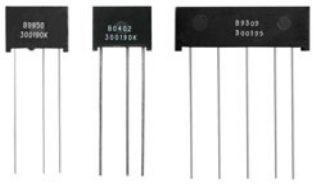
High Precision Bulk Metal® Foil Voltage Divider and Network Resistor with TCR Tracking to 0.5 ppm/°C and Resistance Match to ± 0.005% (50 ppm)



INTRODUCTION

Unitized Resistor Networks are comprised of Vishay Foil Resistors' S102C elements combined and molded into single units. This method of making networks yields some important advantages that should be considered where space is not a limitation and maximizing performance is important. To begin with, the leads that emerge from the package go directly to the resistance element (or an internal PC board), so the possibility of thermal EMFs is very low. Next, the value range of the elements is large (1 Ω to 150 kΩ in a single foil element) and they can be combined for even higher values. Finally, these elements possess all the good features of discrete Bulk Metal® Foil resistors, plus the ability to be further sorted for TCR track and absolute match before encapsulation. These networks make excellent voltage dividers, bridges, and attenuators where performance and stability are important.

These four fundamental factors determine how "ideal" a precision divider resistor will be:

1. Initial absolute resistance value or how closely the absolute resistance value can be achieved,
2. How precisely the value of individual resistors can be controlled,
3. How precisely the end of life tolerance is maintained under a wide range of operating conditions and stress factors (temperature, humidity, load, etc.),
4. Fast response without ringing and fast thermal stabilization - and the ability of the resistor to react to rapid switching without adversely affecting the circuit function.

Until the development of Vishay Foil resistors, precise control of all four factors was virtually impossible. Vishay Foil resistors are designed and manufactured to eliminate the inter-parameter compromise inherent in all other types of resistors. All important characteristics: tolerance, long term stability, temperature coefficient, power coefficient, ESD, noise, capacitance and inductance – are optimized, approaching the theoretical ideal in total performance. Resistor technologies before the development of the Bulk Metal® Foil resistors all compromised the theoretical ideal performance in one or more ways. For example, the winding of wire and the evaporation or the sputtering of extremely thin metal each produce metallurgical changes in the resistance materials and these noticeably deteriorate the electrical characteristics. Such changes are not predictable, and thus randomly alter performance parameters. The form factor of other units also introduces losses in high frequency performance, limits power dissipation and prohibits size reduction.

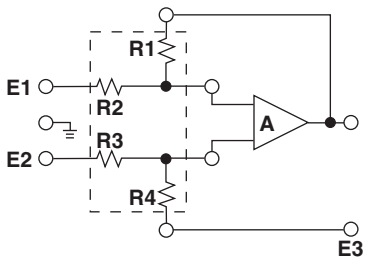
VPG's Application Engineering Department is available to advise and to make recommendations for non-standard technical requirements and special applications.

FEATURES

- Resistance range: 1 Ω to 150 kΩ
- Temperature coefficient of resistance (TCR): 2 ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref.)
- TCR Tracking: to ± 0.5 ppm/°C
- Resistance tolerance: absolute and match to 0.005% (50 ppm)
- Power rating: to + 125°C: 0.3W (up to 100K) 0.2W (>100K)
- Electrostatic discharge (ESD) at least to 25 kV
- Thermal EMF: 0.05μV/°C
- Non hot spot design
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)
- Current noise: 0.010 μVRMS/V of applied voltage (< - 40dB)
- Rise time: 1ns without ringing
- Non-inductive: 0.08μH
- Voltage coefficient: 0.1 ppm/V
- Prototype quantities available in just 5 working days or sooner. For more information, please contact foil@vpgsensors.com
- Terminal finishes available: lead (Pb)-free, tin/lead alloy(1)

FIGURE 1 - MODEL 300198 NETWORK

APPLICATION EXAMPLE

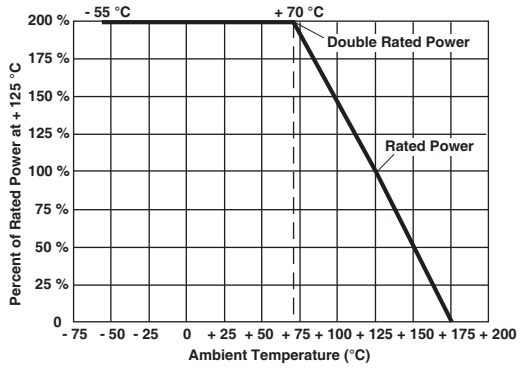


(1) Pb containing terminations are not RoHS compliant, exemptions may apply.

APPLICATIONS

- Differential amplifiers
- Gain defining resistors in digital voltmeters
- Ratio arms in bridge circuits
- Fuel metering systems
- Heads up displays
- Fire control systems
- Spacecraft instrumentation
- Naval weapons systems
- Binary Coded Decimal Ladder Networks
- Binary Ladders (A-D, D-A conversion, current and voltage summing)
- Ratio and Ratio-matching Networks
- Bridge Networks
- Synchro Input and Summing Networks
- Resolver Networks
- Linear and Linear-summing Networks
- Decoder Networks
- Quadrature Bridge Networks
- Resistive Summing Networks

FIGURE 2 - POWER DERATING CURVE



ENHANCE THE NETWORK PERFORMANCES

Ratio stability under load life conditions and other specifications improve considerably after a special “burn in” - a preconditioning of the network. The Vishay Foil Resistors Post Manufacture Operation (PMO) department provides a “burn in” service. For further details please contact our application engineering department.

TABLE 1 - TYPICAL[1] PERFORMANCE CHARACTERISTICS

Resistance Temp Characteristic (TCR) **TCR Tracking To Reference Element**		see Table 2
Max Ambient Temp at Rated Wattage		+ 125 °C
Max Ambient Temp at Zero Power		+ 175 °C
Thermal Shock	**ΔR**[2] **ΔRatio**[3]	0.002 % (20 ppm) 0.002 % (20 ppm)
Low Temperature Operation	**ΔR** **ΔRatio**	0.005 % (50 ppm) 0.002 % (20 ppm)
Short Time Overload	**ΔR** **ΔRatio**	0.002 % (20 ppm) 0.002 % (20 ppm)
Terminal Strength	**ΔR** **ΔRatio**	0.001 % (10 ppm) 0.001 % (10 ppm)
Resistance to Soldering Heat	**ΔR** **ΔRatio**	0.002 % (20 ppm) 0.001 % (10 ppm)
Moisture Resistance	**ΔR** **ΔRatio**	0.003 % (30 ppm) 0.003 % (30 ppm)
Shock	**ΔR** **ΔRatio**	0.001 % (10 ppm) 0.001 % (10 ppm)
Vibration, High Frequency	**ΔR** **ΔRatio**	0.001 % (10 ppm) 0.001 % (10 ppm)
Life 0.3 W at + 125 °C	**ΔR** **ΔRatio**	0.01 % (100 ppm) 0.01 % (100 ppm)
0.02 W at + 60 °C	**ΔR** **ΔRatio**	0.003 % (30 ppm) 0.001 % (10 ppm)
0.05 W at + 25 °C	**ΔR** **ΔRatio**	0.002 % (20 ppm) 0.001 % (10 ppm)
High Temperature Exposure	**ΔR** **ΔRatio**	0.01 % (100 ppm) 0.01 % (100 ppm)
Low Temperature Storage	**ΔR** **ΔRatio**	0.002 % (20 ppm) 0.002 % (20 ppm)
Insulation Resistance		> 500 000 MΩ
Dielectric Withstanding Voltage		No Change
Voltage Coefficient[4]	**ΔR** **ΔRatio**	< 0.1 ppm/V[4] < 0.1 ppm/V[4]
Noise		0.010 μV$_{RMS}$/V of applied voltage (< - 40dB)
Inductance		0.08 μH
Capacitance		0.5 pf
Rise Time		1 ns at 1 kΩ
Thermal EMF lead to lead		0.05 μV°C
Thermal EMF air circulation		0.02 μV/°C
Thermal EMF power		0.1 μV for 20 mW

NOTES:
1. Typical is a designer's reference that represents 85% of production. Most of the DR's shown are maximums. To ensure that all typical values are maximums a "burn-in" is required. Measurement error 0.001 R.
2. ΔR: absolute resistance change.
3. ΔRatio: change in ratio between resistors within the network package from before to after the specified test
4. Measured < 0.1 ppm/V and within the measurement capability of the equipment. Voltage coefficient is “essentially zero”

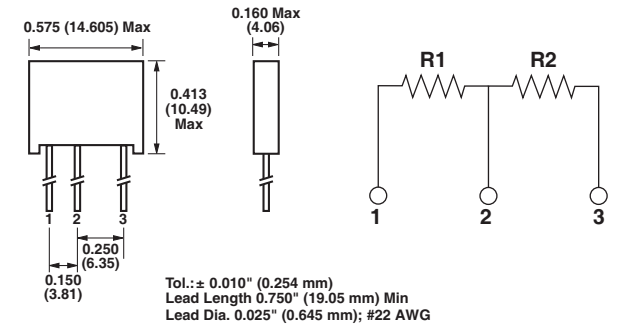
TABLE 2 - MODEL 2R, 3R, 4R SPECIFICATIONS

MODEL	RESISTANCE VALUES	ABSOLUTE TCR (- 55 °C to + 125 °C, + 25 °C ref.)	TOLERANCE		TCR TRACKING (MAX.)*	
		TYPICAL AND MAX. SPREAD	ABSOLUTE	MATCH	SAME VALUES	DIFFERENT VALUES
2R, 3R, 4R	500 Ω to 150 kΩ	± 2 ppm/°C ± 2.5 ppm/°C	± 0.005 %	0.005 %	1 ppm/°C	2 ppm/°C
	100 Ω to 500 Ω		± 0.005 %	0.01 %	1.5 ppm/°C	2.5 ppm/°C
	50 Ω to 100 Ω	± 2 ppm/°C ± 3.5 ppm/°C	± 0.01 %	0.02 %	2 ppm/°C	3 ppm/°C
	25 Ω to 50 Ω	± 2 ppm/°C ± 4.0 ppm/°C	± 0.01 %	0.02 %	2.5 ppm/°C	3.5 ppm/°C
	10 Ω to 25 Ω		± 0.02 %	0.04 %	3 ppm/°C	4 ppm/°C
	5 Ω to 10 Ω	± 2 ppm/°C ± 4.5 ppm/°C	± 0.05 %	0.05 %	3.5 ppm/°C	4.5 ppm/°C
	2 Ω to 5 Ω	± 2 ppm/°C ± 5.0 ppm/°C	± 0.1 %	0.1 %	4 ppm/°C	5 ppm/°C
	1 Ω to 2 Ω	± 2 ppm/°C ± 6.0 ppm/°C	± 0.5 %	0.2 %	4.5 ppm/°C	5.5 ppm/°C

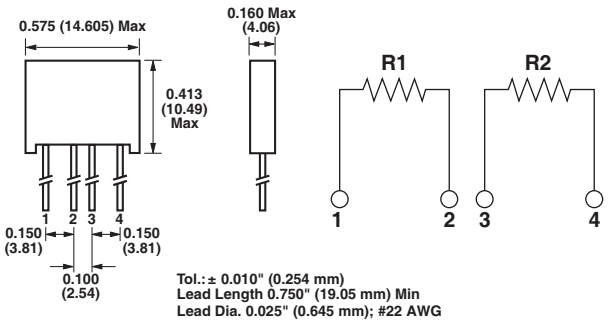
* For better TCR tracking please refer to 2R,3R,4R with Z-Foil technology.

FIGURE 3 - MOLDED 2R, 3R, 4R RESISTOR NETWORK DIMENSIONS AND CIRCUIT DESIGN in inches (millimeters)

MODEL 300190



MODEL 300191



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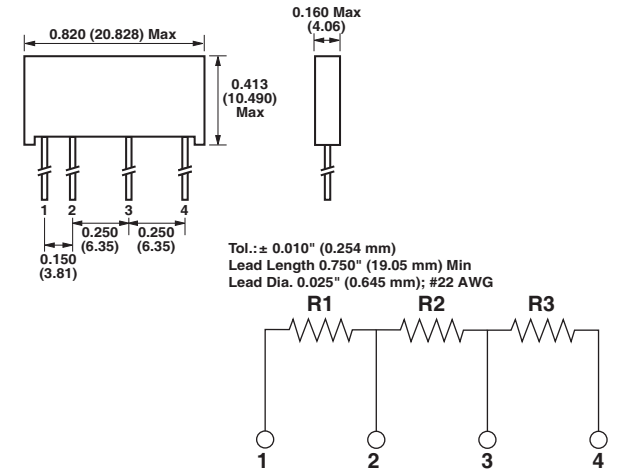
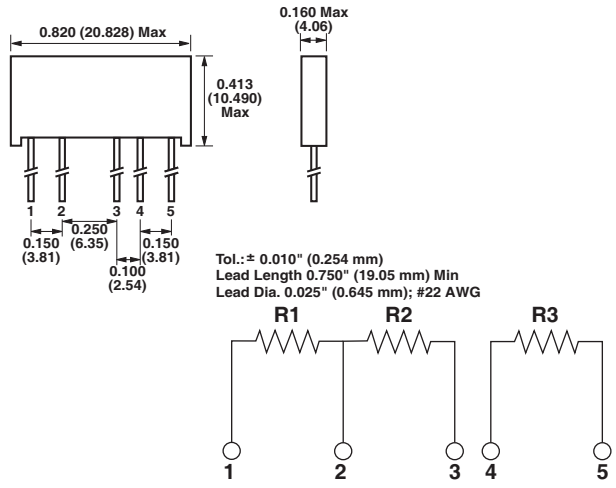


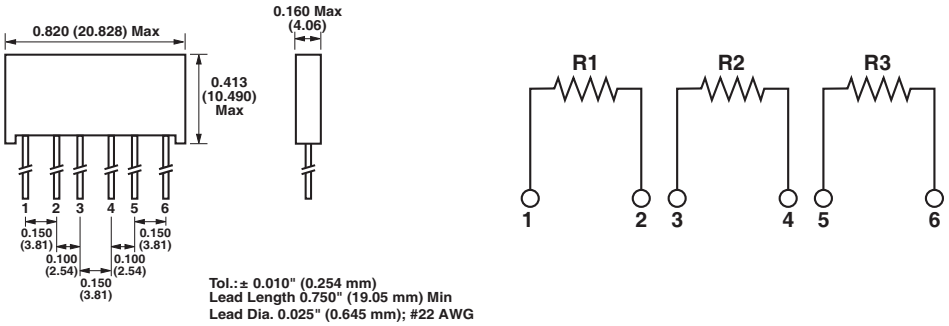
MODEL 300193



VISHAY FOIL RESISTORS A VPG Brand

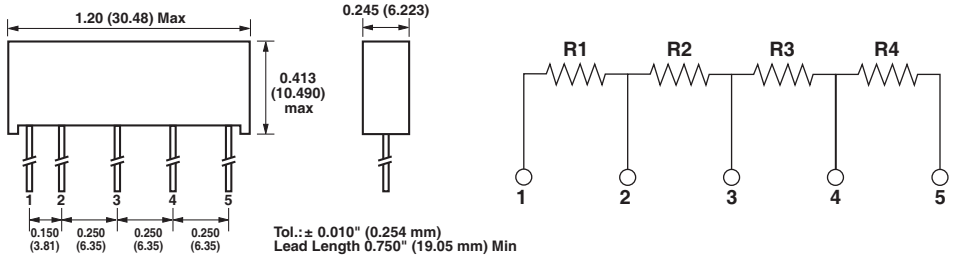
FIGURE 4 - MOLDED 2R, 3R, 4R RESISTOR NETWORK DIMENSIONS AND CIRCUIT DESIGN in inches (millimeters)

MODEL 300194



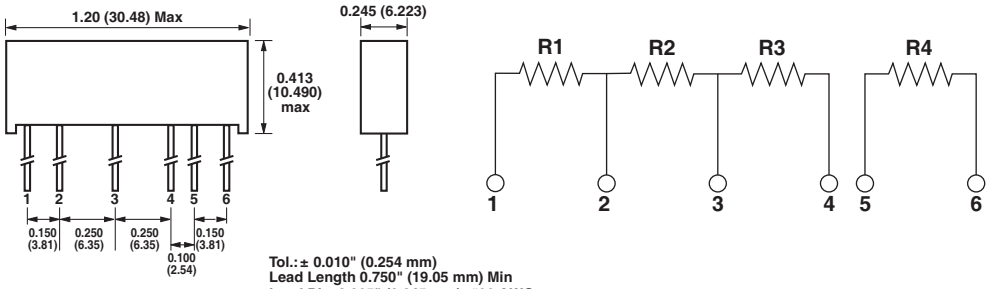
Tol.: ± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

MODEL 300195



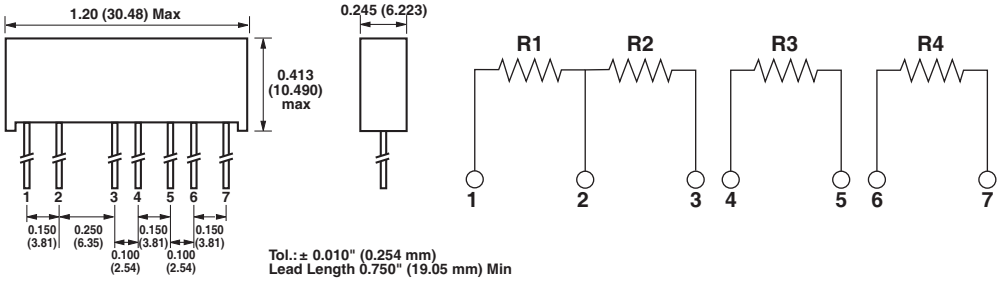
Tol.: ± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

MODEL 300196



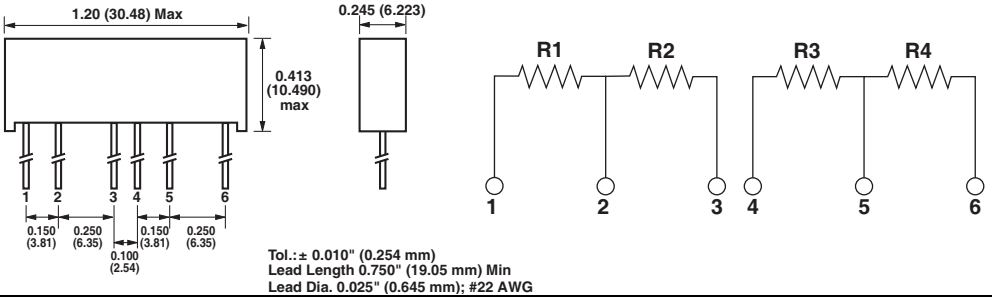
Tol.: ± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

MODEL 300197



Tol.: ± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

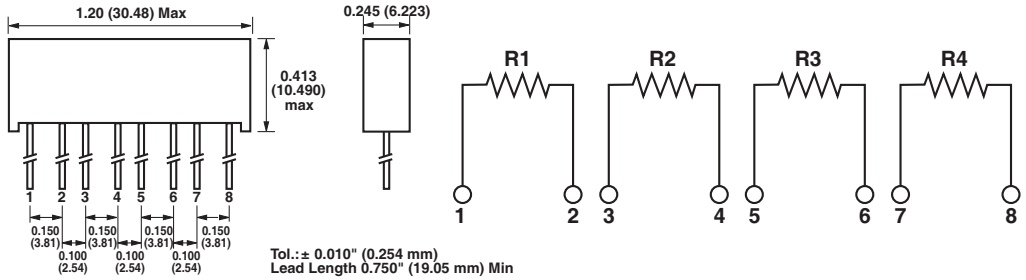
MODEL 300198



Tol.: ± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

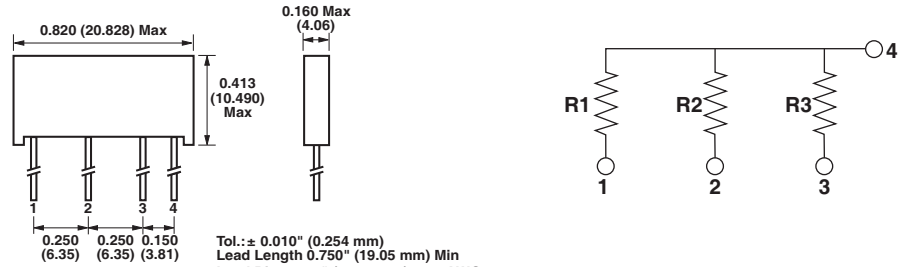
FIGURE 5 - MOLDED 2R, 3R, 4R RESISTOR NETWORK DIMENSIONS AND CIRCUIT DESIGN in inches (millimeters)

MODEL 300199



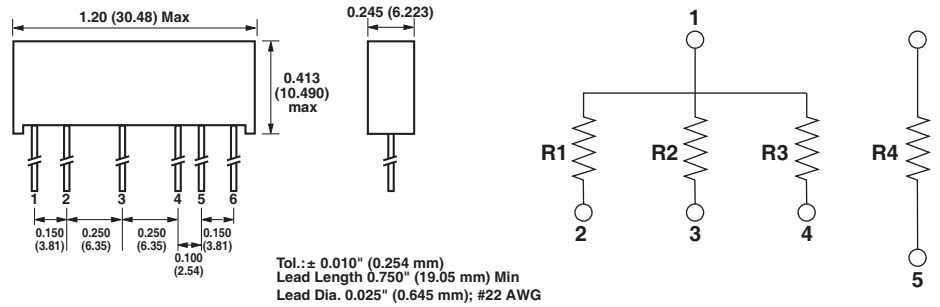
Tol.:± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

MODEL 300210



Tol.:± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

MODEL 300211



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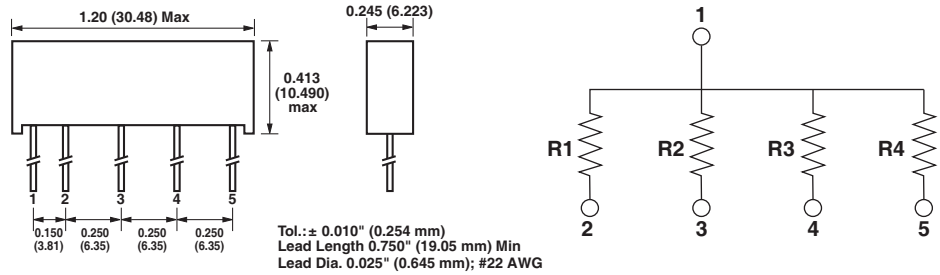
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

MODEL 300212



Tol.:± 0.010" (0.254 mm)
Lead Length 0.750" (19.05 mm) Min
Lead Dia. 0.025" (0.645 mm); #22 AWG

ORDERING INFORMATION - MOLDED 2R, 3R AND 4R RESISTOR NETWORKS

Networks are built to your requirements. Send your schematic and electrical requirements to the Applications Engineering Department by contacting foil@vpgsensors.com. A unique part number will be assigned which defines all aspects of your network.

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