

Radio Frequency 20 GHz Thin Film Chip Resistors



TNPR e3 precision thin film chip resistors are the perfect choice for RF circuits where reduced parasitic impedance as well as highest reliability and stability is of major concern. Typical applications include 5G technology, industrial, test and measuring equipment, and medical equipment.

FEATURES

- Operating frequency range: up to 20 GHz
- Superior moisture resistivity (85 °C; 85 % RH)
- Excellent overall stability at different environmental conditions 0.05 % (1000 h rated power at 70 °C)
- Advanced sulfur resistance verified according to ASTM B 809
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS
COMPLIANT
HALOGEN
FREE
GREEN
(5-2008)

APPLICATIONS

- 5G technology
- Industrial and medical equipment
- Test and measuring equipment

TECHNICAL SPECIFICATIONS	
DESCRIPTION	TNPR0201 e3
Imperial size	0201
Metric size code	RR0603M
Resistance range	50 Ω
Resistance tolerance	± 1 %; ± 0.5 %
Temperature coefficient	± 25 ppm/K
Rated dissipation, P_{70} ⁽¹⁾	0.075 W
Operating voltage, U_{max} , AC _{RMS} or DC	$\sqrt{P \times R}$
Permissible film temperature, $\vartheta_{F max}$ ⁽¹⁾	155 °C
Operating temperature range	-55 °C to 155 °C
Failure rate: FIT _{observed}	≤ 0.1 x 10 ⁻⁹ /h

Notes

- Other R-values, TCRs, and tolerances on request
- ⁽¹⁾ Please refer to APPLICATION INFORMATION

APPLICATION INFORMATION

When the resistor dissipates power, a temperature rise above the ambient temperature occurs, dependent on the thermal resistance of the assembled resistor together with the printed circuit board. The rated dissipation applies only if the permitted film temperature is not exceeded.

Please consider the application note “Thermal Management in Surface-Mounted Resistor Applications” (www.vishay.com/doc?28844) for information on the general nature of thermal resistance.

These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.

MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION		
OPERATION MODE	STANDARD	POWER
Rated dissipation, P_{70}	0.050 W	0.075 W
Operating temperature range	-55 °C to 125 °C	-55 °C to 155 °C
Permissible film temperature, ϑ_F max.	125 °C	155 °C
Max. resistance change at P_{70} for resistance range, $ \Delta R/R $ after:	50 Ω	50 Ω
	1000 h	≤ 0.05 %
	8000 h	≤ 0.10 %

Note

- The presented operation modes do not refer to different types of resistors, but actually show examples of different loads, that lead to different film temperatures and different achievable load-life stability (drift) of the resistance value. A suitable low thermal resistance of the circuit board assembly must be safeguarded in order to maintain the film temperature of the resistors within the specified limits. Please consider the application note "Thermal Management in Surface-Mounted Resistor Applications" (www.vishay.com/doc?28844) for information on the general nature of thermal resistance

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
TNPR0201 e3	± 25 ppm/K	± 1 %; ± 0.5 %	50 Ω	-

PACKAGING						
TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
TNPR0201 e3	ET7 = ED	10 000	Paper tape according IEC 60286-3, Type 1a	8 mm	2 mm	$\varnothing$ 180 mm / 7"

PART NUMBER AND PRODUCT DESCRIPTION					
Part Number: TNPR020150R0FEED					
T	N	P	R	0	2
0	1	5	0	R	0
F	E	E	D		
TYPE / SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	SPECIAL
TNPR0201	R = decimal (4 digits)	D = ± 0.5 % F = ± 1 %	E = ± 25 ppm/K	ED (E.. = lead (Pb)-free)	Up to 2 digits Blank = standard
Product Description: TNPR0201 50R0 1 % T-9 ET7 e3					
TNPR0201	50R0	1 %	T-9	ET7	e3
TYPE / SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	LEAD (Pb)-FREE
TNPR0201	50R0 = 50 Ω	± 0.5 % ± 1 %	T-9 = ± 25 ppm/K	ET7 (E.. = lead (Pb)-free)	e3 = pure matte tin termination finish

Note

- The product can be ordered using either the PART NUMBER or the PRODUCT DESCRIPTION



DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of special metal alloy is deposited on a high grade ceramic substrate (Al_2O_3) and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly fine trimming the resistive layer without damaging the ceramics. A further conditioning is applied in order to stabilize the trimming result. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure matte tin on nickel plating. The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. This includes full screening for the elimination of products with a potential risk of early life failures. Only accepted products are laid directly into the tape in accordance with **IEC 60286-3, Type 1a** ⁽¹⁾.

ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using reflow or vapour phase as shown in **IEC 61760-1** ⁽¹⁾. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The suitability of conformal coatings, potting compounds and their processes, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.

The resistors are RoHS-compliant, the pure matte tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years. The immunity of the plating against tin whisker growth has been proven under extensive testing.

MATERIALS

Vishay acknowledges the following systems for the regulation of hazardous substances:

- IEC 62474, Material Declaration for Products of and for the Electrotechnical Industry, with the list of declarable substances given therein ⁽²⁾
- The Global Automotive Declarable Substance List (GADSL) ⁽³⁾
- The REACH regulation (1907/2006/EC) and the related list of substances with very high concern (SVHC) ⁽⁴⁾ for its supply chain

The products do not contain any of the banned substances as per IEC 62474, GADSL, or the SVHC list, see www.vishay.com/how/leadfree.

Hence the products fully comply with the following directives:

- 2000/53/EC End-of-Life Vehicle Directive (ELV) and Annex II (ELV II)
- 2011/65/EU Restriction of the Use of Hazardous Substances Directive (RoHS) with amendment 2015/863/EU
- 2012/19/EU Waste Electrical and Electronic Equipment Directive (WEEE)

Vishay pursues the elimination of conflict minerals from its supply chain, see the Conflict Minerals Policy at www.vishay.com/doc?49037.

Notes

⁽¹⁾ The quoted IEC standards are also released as EN standards with the same number and identical contents

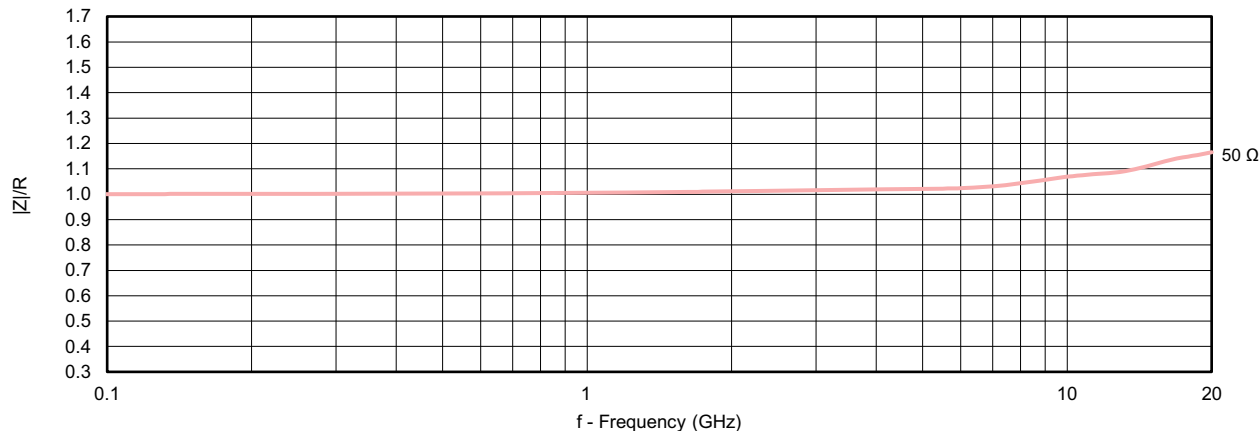
⁽²⁾ The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at <http://std.iec.ch/iec62474>

⁽³⁾ The Global Automotive Declarable Substance List (GADSL) is maintained by the American Chemistry Council and available at www.gadsl.org

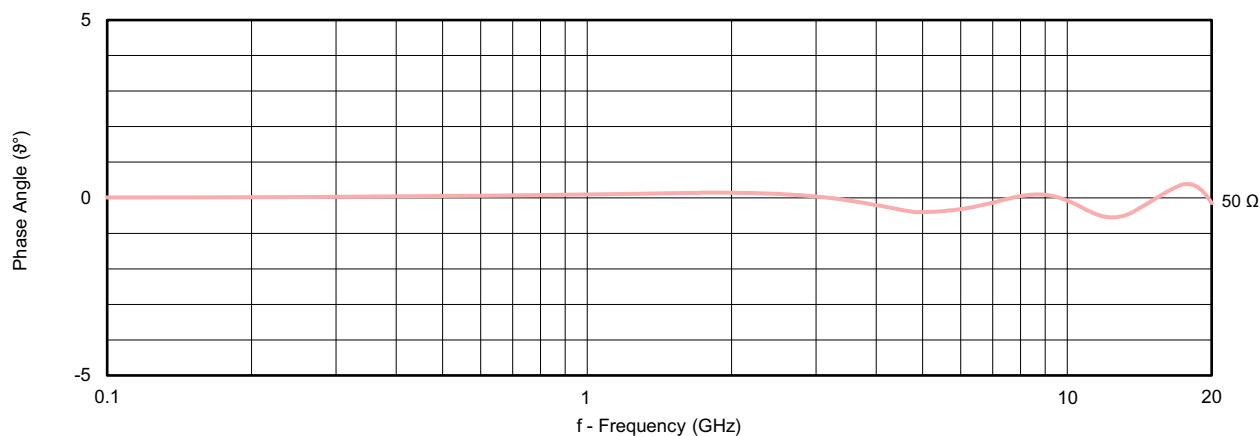
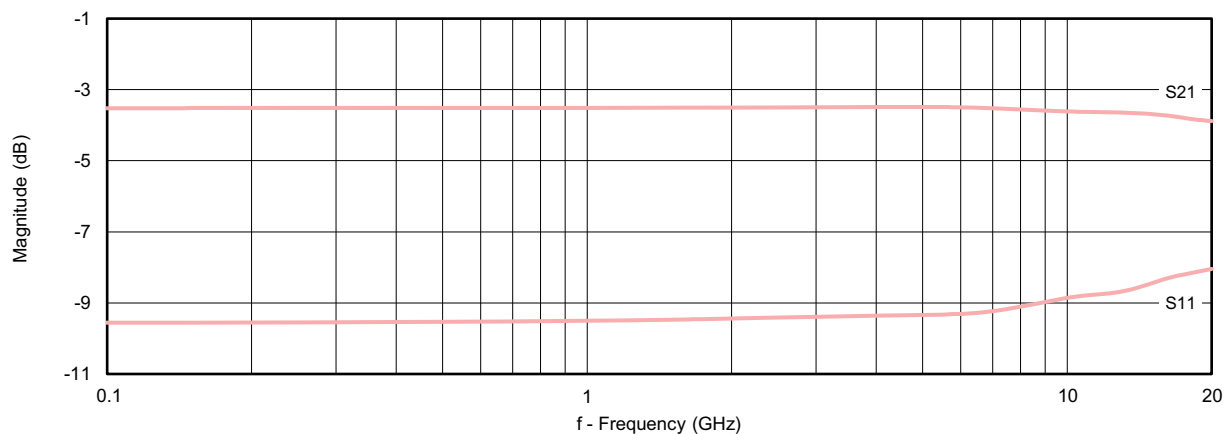
⁽⁴⁾ The SVHC list is maintained by the European Chemical Agency (ECHA) and available at <http://echa.europa.eu/candidate-list-table>



IMPEDANCE CURVE



S-PARAMETER

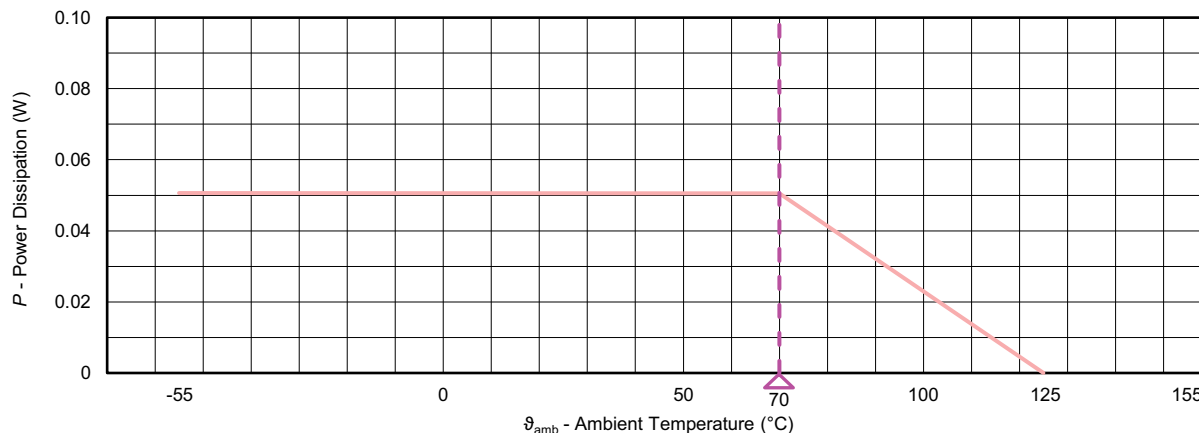


Note

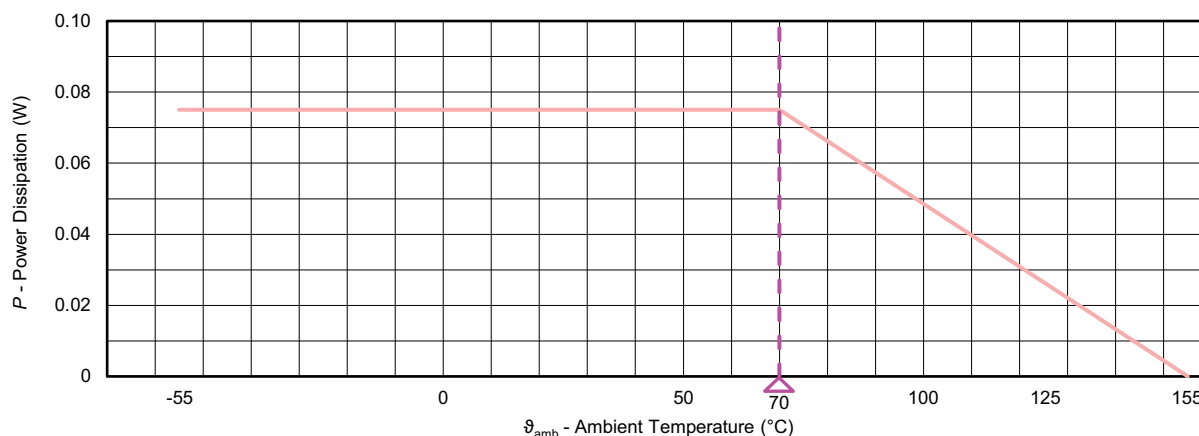
- ⁽¹⁾ 2-port S-parameter measurements on 10 mil RO4350B substrate with $Z = 50 \Omega$ microstrip.
Typical figures. HF-characteristic also depends on termination and circuit design



FUNCTIONAL PERFORMANCE



Derating - Standard Operation



Derating - Power Operation

**TEST AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification

EN 60115-8, sectional specification

EN 140401-801, detail specification

IEC 60068-2-xx, test methods

The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-801. The detail specification EN 140401-801 does not cover case size 0201. The table presents only the most important tests, for the full test schedule refer to the documents listed above. However, some additional tests and a number of improvements against those minimum requirements have been included.

The testing also covers most of the requirements specified by EIA / ECA-703 and JIS-C-5201-1.

The tests are carried out under standard atmospheric conditions in accordance with IEC 60068-1, 4.3, whereupon the following values are applied:

Temperature: 15 °C to 35 °C

Relative humidity: 25 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar)

A climatic category LCT / UCT / 56 is applied, defined by the lower category temperature (LCT), the upper category temperature (UCT), and the duration of exposure in the damp heat, steady state test (56 days).

The components are mounted for testing on printed circuit boards in accordance with EN 60115-8, 2.4.2, unless otherwise specified.

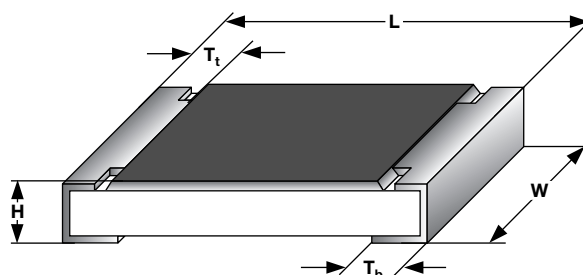
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 ⁽¹⁾ TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			TNPR0201 e3	50 Ω
4.5	-	Resistance	-	$\pm 1 \%$; $\pm 0.5 \%$
4.8	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	± 25 ppm/K
4.25.1	-	Endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.05 \% R + 0.01 \Omega)$ $\pm (0.1 \% R + 0.02 \Omega)$
		Endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.1 \% R + 0.01 \Omega)$ $\pm (0.2 \% R + 0.02 \Omega)$
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm (0.05 \% R + 0.01 \Omega)$ $\pm (0.1 \% R + 0.02 \Omega)$
4.24	78 (Cab)	Damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.1 \% R + 0.01 \Omega)$
4.37	67 (Cy)	Damp heat, steady state accelerated: Standard operation mode	(85 $\pm$ 2) °C (85 $\pm$ 5) % RH $U = \sqrt{0.1 \times P_{70} \times R}$; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$
4.38	-	Electro static discharge (human body model)	IEC 61340-3-1 ⁽¹⁾ ; 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015); 200 V	$\pm (0.5 \% R + 0.05 \Omega)$

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 ⁽¹⁾ TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			TNPR0201 e3	50 Ω
4.22	6 (Fc)	Vibration	Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s ² ; 7.5 h	$\pm (0.05 \% R + 0.01 \Omega)$ no visible damage
4.17	58 (Td)	Solderability ⁽²⁾	Solder bath method; SnPb40; non-activated flux (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	Good tinning (≥ 95 % covered); no visible damage
			Solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux (235 $\pm$ 3) °C; (2 $\pm$ 0.2) s	
4.18	58 (Td)	Resistance to soldering heat	Solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.02 \% R + 0.01 \Omega)$
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol + 50 °C; method 2	No visible damage
4.32	21 (Ue ₃)	Shear (adhesion)	2 N	No visible damage
4.33	21 (Ue ₁)	Substrate bending	Depth 2 mm, 3 times	$\pm (0.05 \% R + 0.01 \Omega)$ no visible damage, no open circuit in bent position
4.35	-	Flammability	IEC 60695-11-5 ⁽¹⁾ , needle flame test; 10 s	No burning after 30 s

Notes

⁽¹⁾ The quoted IEC standards are also released as EN standards with the same number and identical contents

⁽²⁾ For 0201 case size only similar to DIN EN 60115-8 test procedure. Due to the components small size they were fixed by glue previous to testing instead of applying tweezers

DIMENSIONS


DIMENSIONS AND MASS					
TYPE / SIZE	L (mm)	W (mm)	H (mm)	T _t / T _b (mm)	MASS (mg)
TNPR0201 e3	0.6 $\pm$ 0.05	0.3 $\pm$ 0.05	0.23 $\pm$ 0.03	0.12 $\pm$ 0.05	0.14

SOLDERING RECOMMENDATIONS

For recommended solder pad dimensions please refer to www.vishay.com/doc?28950.

For recommended soldering profiles please refer to www.vishay.com/doc?31090.



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