



ELTEC INSTRUMENTS, INC.

ELTECdata # 111

High Megohm Thick Film Chip Resistors RoHS Compliant

ELTEC has been manufacturing miniature resistors in values to 1×10^{12} Ohms (one million, million Ohms) since 1969. These resistors have been used in many satellites, deep-space probes and Mars landing missions. High stability and low noise quality has led to use in hydrophone preamplifiers, piezoelectric accelerometers and in low current medical and scientific experiments, even in circuits measuring currents through individual cells. Of course, ELTEC uses millions of our own resistors in our major product - pyroelectric infrared detectors.

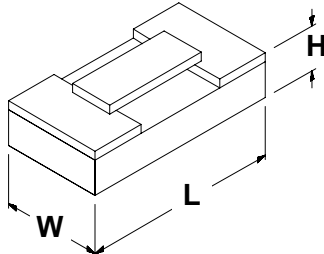
General Description

ELTEC resistors have an alumina ceramic base (substrate) upon which are fired either gold or platinum/gold contacts. A resistive "paste" is applied between the contacts and then fired in a tunnel oven. Although the exact ingredients are proprietary, the paste consists of glass and metal oxide particles in a fluid that is driven off during firing. The result is a glass containing the metal oxide in suspension. In crystallographic physics, the resistors can be regarded as amorphous semiconductors or glassy colloids.

Product Mix

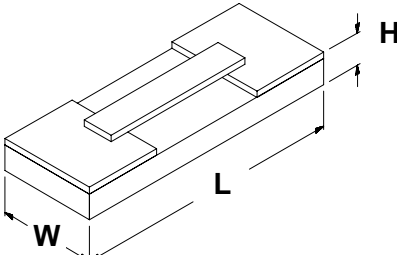
Essentially, two sizes of chips are manufactured by ELTEC; the Model 112M50R (0.105" long by 0.038" wide) and the Model 114M50R (0.055" long by 0.028" wide). Both of these models have a modified glass geometry. The smaller glass (located nearer to the center of the substrate) reduces the possibility of chipping/damaging the glass during

Model 114M50R -- High Megohm Micro Miniature Chip Resistor with Modified Glass Geometry



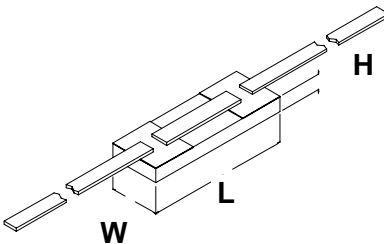
Dimensions:	L	W	H
Inches	0.055	0.028	0.015
(Tolerance +/-)	0.005	0.003	0.003
Millimeters	1.40	0.71	0.38
(Tolerance +/-)	0.13	0.08	0.08

Model 112M50R -- High Megohm Miniature Chip Resistor with Modified Glass Geometry



Dimensions	L	W	H
Inches	0.105	0.038	0.015
(Tolerance +/-)	0.005	0.003	0.003
Millimeters	2.67	0.97	0.38
(Tolerance +/-)	0.13	0.08	0.08

Model 102M50R -- High Megohm Chip Resistor With Leads

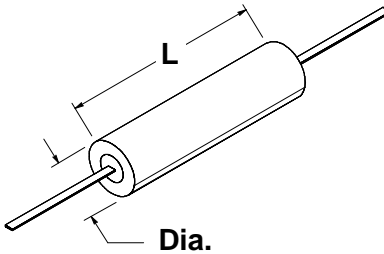


Resistor:	L(Max)	W(Max)	H(Max)
Inches	0.125	0.048	0.045
Millimeters	3.18	1.22	1.14

Nickel Leads:	L(Min)	W(Max)	H(Max)
Inches	0.500	0.012	0.004
Millimeters	12.7	0.305	0.102

Dimensions include epoxy encapsulation

Model 104M50R -- High Megohm Tubular Resistor With Leads



Resistor:	L(Max)	Dia(Max)
Inches	0.265	0.070
Millimeters	6.73	1.78

Nickel Leads:	L(Min)	W(Max)	H(Max)
Inches	0.500	0.012	0.004
Millimeters	12.7	0.305	0.102

handling which can cause a permanent value change. For those who do not have hybrid bonding equipment, ELTEC attaches nickel leads to the Model 112M50R which then becomes the Model 102M50R. If the Model 102M50R is placed within a ceramic sleeve and the ends sealed with epoxy, it is then called the Model 104M50R. Thus, product differences are generally restricted to size and mounting convenience.

Resistor Values

Resistors are available from regular production runs in values of 1 megohm (1×10^6) to 1 teraohm (1×10^{12}). The most requested values are in 1X, 2X and 5X multiples of the appropriate base exponent. Incremental values are also available.

Nonstandard Values

Resistor values from 100k ohms to 1 megohm and above 1 teraohm are available on special order. Special orders may require additional leadtime.

Technical Applications

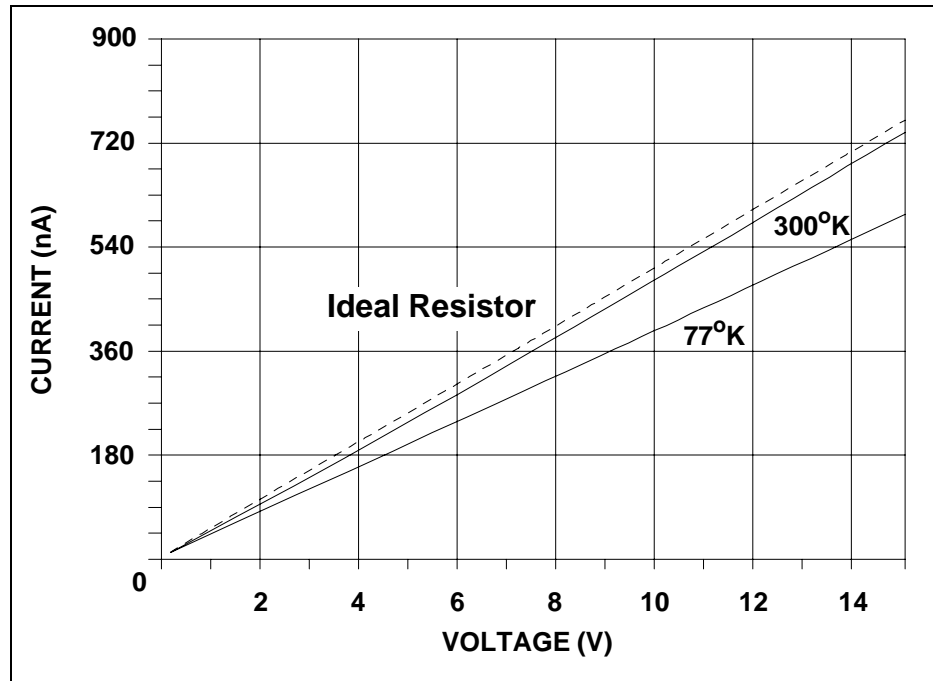
ELTEC resistors are primarily used in high impedance, low voltage hybrid circuits where a very small resistor is specified.

ELTEC resistors have a very low capacitance, and operate with very low noise. The small size, low capacitance and low noise make ELTEC resistors ideal for medical research involving in vitro applications. In many aerospace applications, the resistors are cooled from 77°K to 4°K and become the ultra low noise first stage in extremely low current/voltage detection stages as in photon infrared detectors. They are also used for very low noise, high gain feedback resistors with specially selected op amps.

Resistor Tolerances

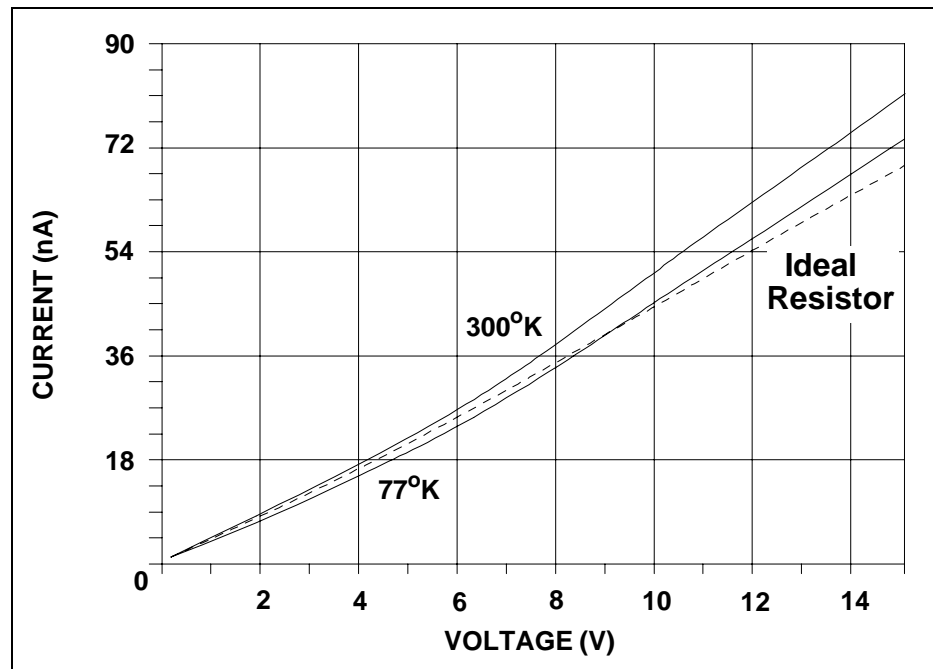
ELTEC recommends the choice of the widest possible tolerance commensurate with the performance needs of any particular cir-

Resistor Value 1.95×10^7 Ohms at 1 Volt



Resistance of ELTEC Chip Resistor as a function of Temperature and Applied Voltage. (Customer supplied data)

Resistor Value 2.15×10^8 Ohms at 1 Volt



Resistance of ELTEC Chip Resistor as a function of Temperature and Applied Voltage. (Customer supplied data)

cuit. All resistors are extremely stable regardless of the tolerance chosen. Wider tolerance values cost less and can be shipped faster. Standard tolerances are 5%, 10%, 20% and 30%. Please request a special quotation for volume applications in circuits accepting wide tolerance resistors (i.e. charge-bleed protective circuits).

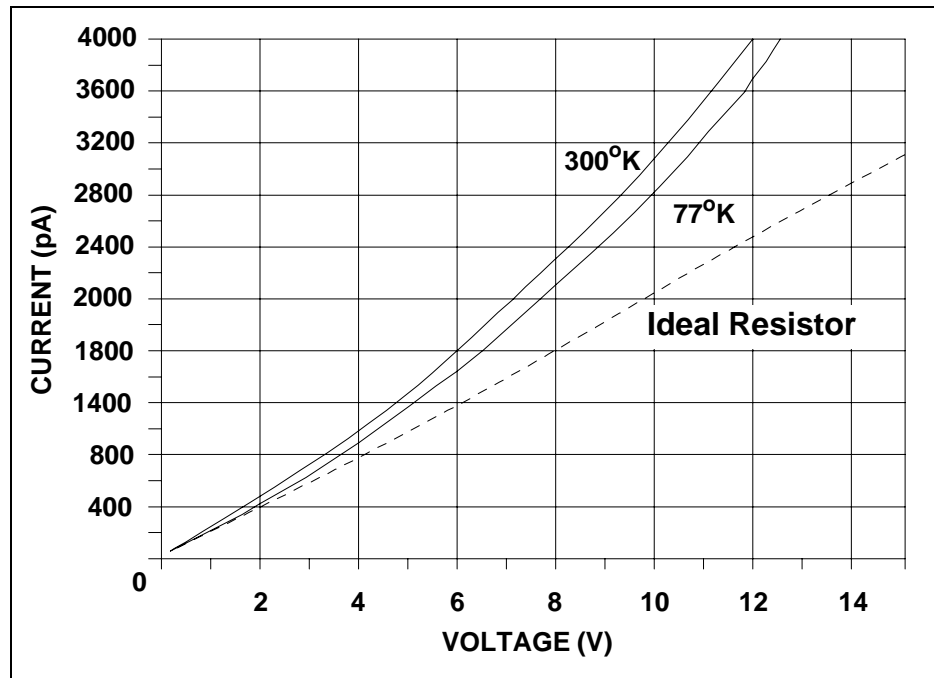
Stability

The materials and manufacturing techniques used to create ELTEC thick film resistors give them unsurpassed stability. The charge-carrying mechanism within the resistor is a chemically stable, fully oxidized metal atom within a silicate (glass) matrix. The "noble" metal (gold or platinum/gold) terminals are fired onto a substrate made of highly stable electronic-grade sintered aluminum oxide.

Precautionary Data

ELTEC resistors are primarily designed for low voltage operation. The resistors have a negative voltage coefficient of resistance (VCR) of typically 4% to 6% from 1 to 10 Volts — primarily due to the small number of charge carriers available. This VCR should be considered in any application up to the maximum rating of 60 Volts. Use of these resistors beyond 60 Volts generally produces a permanent lowering of resistor value. **Maximum recommended operating voltage is 60 VDC.**

Resistor Value 4.81X10⁹ Ohms at 1 Volt



Resistance of ELTEC Chip Resistor as a function of Temperature and Applied Voltage. (Customer supplied data)

ELTEC thick film resistors have a negative temperature coefficient of resistance. The graph gives approximate values of this TCR as a function of resistance magnitude. In general, resistors operated at the temperature of liquid nitrogen (77°K) have values 25% greater than at room temperature. Thus, order resistors 80% of desired value for

77°K applications. For applications at liquid helium temperatures (4°K), resistance will be 2 to 3 times the room temperature value. NOTE: If there is a need for resistors operating at cryogenic temperatures, please contact an ELTEC Applications Engineer.

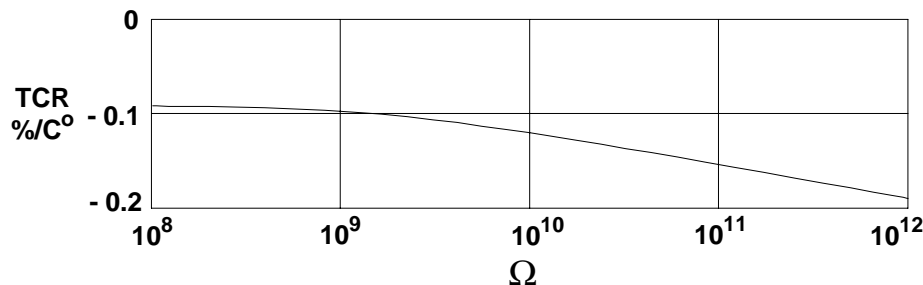
Power Rating (Watts)

ELTEC specifies that resistors not be used with voltages exceeding 60 volts because overvoltages may produce a permanent change in resistance value.

Thus, with a 60 volt maximum, the most power that can be put through a 1 megohm resistor is 3.6 milliwatts (3.6X10⁻³). For a resistor of 10¹² ohms, the power maximum would be 3.6 nanowatts (3.6X10⁻⁹).

Manipulating $E = IR$ to more convenient forms of $W = E^2/R = I^2R$, putting 1/4 Watt through a 1 meg resistor would take 500 Volts; for a 1/2 Watt, 707 Volts.

Temperature Coefficient of Resistance



Negative temperature coefficient of resistance (TCR) as a function of resistor value. Note: Typical data; user should verify TCR of specific lots as required. TCR and VCR percentages are typical. Both are unspecified parameters of ELTEC resistors.

To put a quarter Watt through the highest value resistor, 10^{12} Ohm would take 500,000 Volts - for 1/2 watt, 707,100 Volts.

Often, resistor users must meet a "blanket" specification stating ... "all resistors used in this device shall have power ratings of at least 1/4 Watt." To this it can be said that thick film resistors - as a class - can meet traditional power ratings. One customer completed his specification form stating that the ... manufacturer rated thick film resistors at 1/2 Watt as long as the voltage applied did not exceed 60 Volts.

Metallization Option

To reduce the parallel capacitance, ELTEC can metallize the **back** of the resistor (extra charge). Mounting with conductive epoxy may accomplish the same result. In leaded resistors with a metallized back, the back is made accessible with a third lead. This lead (or the back) can be grounded which causes the reduction in capacitance.

Single Lot Option

Orders can be filled with all resistors coming from a single manufacturing lot if required. Also, a Certificate of Compliance attesting

to the single lot source will be supplied if so requested.

Cleaning

ELTEC resistors can be cleaned with most agents recommended for electronic components, with the exception of alcohol and acetone. After cleaning, a final rinse in deionized water followed by a 24 hour bake out at 110°C is suggested.

Testing

All resistors are individually tested at 1 Volt DC @ 25°C. Testing at other voltages is available on special order.

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