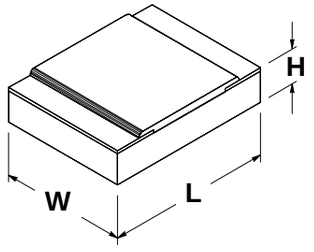
ELTECdata # 111
High Megohm Thick Film Chip Resistors

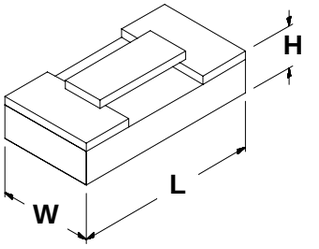
ELTEC INSTRUMENTS, INC.

Model 114 - - High Megohm Micro Miniature Chip Resistor

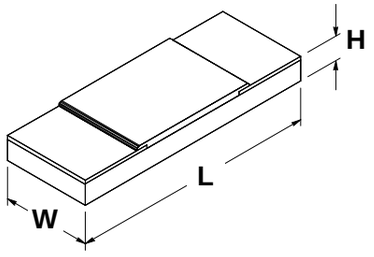


Dimensions:	L	W	H
Inches	0.055	0.028	0.015
(Tolerance +/-)	0.005	0.003	0.003
Millimeters	1.40	0.71	0.38
(Tolerance +/-)	0.13	0.08	0.08

Model 114M50 - - High Megohm Micro Miniature Chip Resistor with Modified Glass Geometry

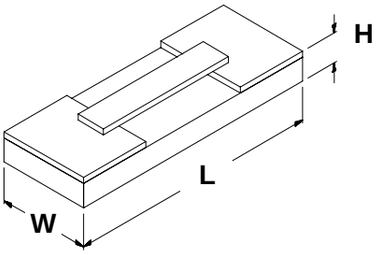


Model 112 - - High Megohm Miniature Chip Resistor



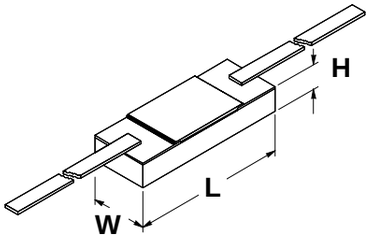
Dimensions	L	W	H
Inches	0.105	0.038	0.015
(Tolerance +/-)	0.005	0.003	0.003
Millimeters	2.67	0.97	0.38
(Tolerance +/-)	0.13	0.08	0.08

Model 112M50 - - High Megohm Miniature Chip Resistor with Modified Glass Geometry



ELTEC has been manufacturing miniature resistors in values to 1 x 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.

Model 102 - - High Megohm Chip Resistor With Leads

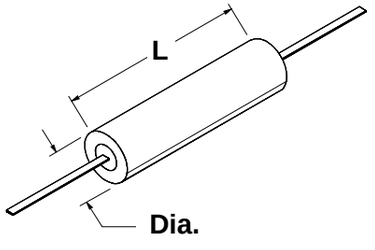


Resistor:	L(Max)	W(Max)	H(Max)
Inches	0.125	0.048	0.045
Millmeters	3.18	1.22	1.14

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 104 - - High Megohm Tubular Resistor With Leads



Resistor:	L(Max)	Dia(Max)
Inches	0.265	0.070
Millmeters	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

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 112, 112M50 (0.105" long by 0.038" wide) and the Model 114, 114M50 (0.055" long by 0.028" wide). The Models 112M50 and 114M50 have a modified glass geometry. The smaller glass are (located nearer to the center of the substrate) reduces the possibility of chipping/damaging the glass during handling which can cause a permanent value change. For those who do not have hybrid bonding equipment, ELTEC attaches nickel leads to the Model 112 which then becomes the Model 102. If the Model 102 is placed within a ceramic sleeve and the ends sealed with epoxy, it is then called the Model 104. Thus, product differences are generally restricted to size and mounting convenience.

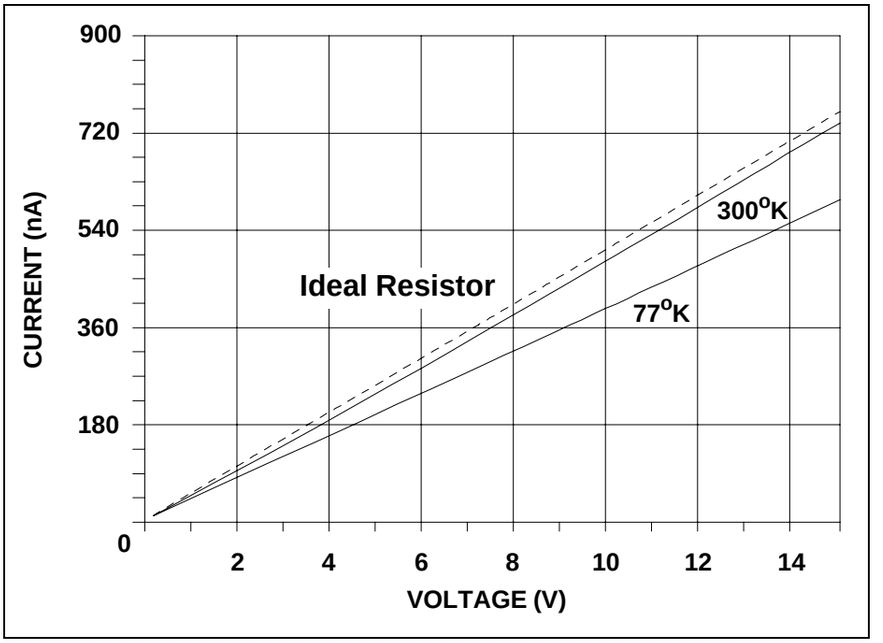
Resistor Values

Resistors are available from regular production runs in values of 1 megohm ($1X10^6$) to 1 teraohm ($1X10^{12}$). The most requested values are in 1X, 2X and 5X multiples of the appropriate base exponent. Incremental values are also available.

Nonstandard Values

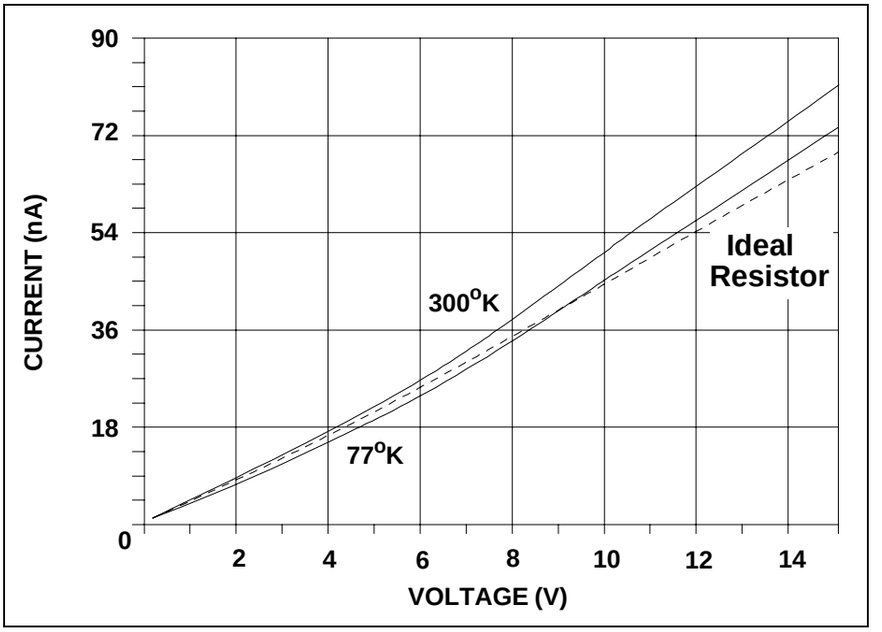
Resistor values from 100k ohms to 1 megohm and above 1 teraohm are available on special order. Special orders may require additional leadtime.

Model 114
Resistor Value
$1.95X10^7$ Ohms at 1 Volt



Resistance of ELTEC Model 114 Chip Resistor as a function of Temperature and Applied Voltage. (Customer supplied data)

Model 114
Resistor Value
$2.15X10^8$ Ohms at 1 Volt



Resistance of ELTEC Model 114 Chip Resistor as a function of Temperature and Applied Voltage. (Customer supplied data)

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 77ºK to 4ºK 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.

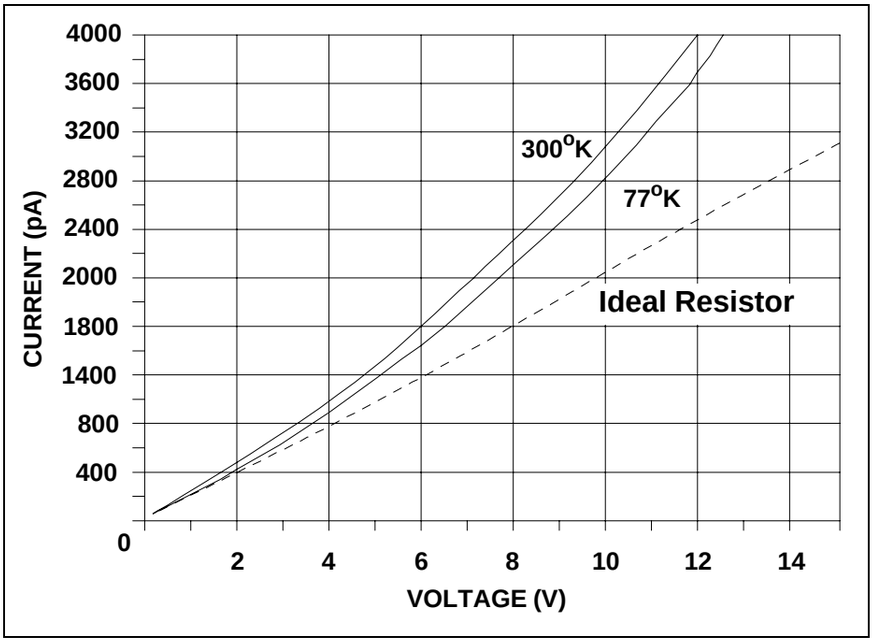
Resistor Tolerances

ELTEC recommends the choice of the widest possible tolerance commensurate with the performance needs of any particular circuit. 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.

Model 114
Resistor Value
$4.81X10^9$ Ohms at 1 Volt



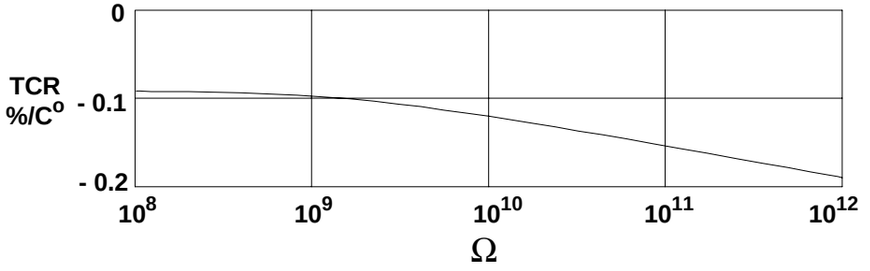
Resistance of ELTEC Model 114 Chip Resistor as a function of Temperature and Applied Voltage. (Customer supplied data)

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.**

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 (77ºK) have values 25% greater than at room temperature. Thus, order resistors 80% of desired value for 77ºK applications. For applications at liquid helium temperatures (4ºK), 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.

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.

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 10^{12} 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.

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.

ELTEC Instruments, Inc. P.O. Box 9610 Daytona Beach, Florida 32120-9610 U.S.A.
Tel (USA and Canada): (800) 874-7780 Tel (Outside USA): (386) 252-0411 Fax: (386) 258-3791
Web: www.eltecinstruments.com E-Mail: Sales@eltecinstruments.com