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X-75525

ENGINEERING REFERENCE DATA

BELL SYSTEM RESISTORS

*BELL TELEPHONE LABORATORIES
INCORPORATED*

Bell Laboratories

subject: Design Standards Manual
for Capacitors (X-75511)
Revision dated March 1975

date: October 1, 1975

from: D. R. Burke

Attached is a revised manual in the Design Standards series entitled Capacitors.

This manual has been developed as part of an ongoing standardization program and contains up to date detail data for those capacitors determined by joint BTL-WE action as being preferred items for use in Bell System products.

If you hold a manual dated July 1973 and receive with this transmittal letter a completely new manual (looseleaf cover with inserts, tabs and pages) please return the manual dated July 1973 to R. I. Forrest, BTL-HO, Room 1B-323. If you do not receive a completely new manual and are a holder of the manual dated July 1973, remove and destroy the present pages, tabs and book inserts. All these items are then replaced by the attached revision.

A "Check List of Pages" is included as part of the manual. This list contains the issue date of each page in this revision and should be used to assure that your copy is complete.

Questions regarding the distribution of this revision should be directed to your local Engineering Records Group or to your local distributor indicated in the front of the manual.

T. J. W. Fonnor 9/12/75

D. R. Burke
Head
Standards and Materials
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HO-8621-RIF-lyp

Att.
As above

DESIGN STANDARDS (X-75525)

resistors

Bell Laboratories
Western Electric

This manual is issued by the Standards and Materials Engineering Department (8621) of Bell Laboratories, Holmdel, New Jersey

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DESIGN STANDARDS
(X-75525)
RESISTORS

COMMENTS

It is the constant aim of the Standards and Materials Engineering Department (8621) to improve these standards wherever practicable. Users of this manual are urged to submit additions, corrections, or note any omissions in the space below.

Return to:

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GENERAL INFORMATION

TECHNICAL INFORMATION

The Design Standards for Bell System products has been extensively revised. This revision, incorporating recommendations from designers and technical consultants, reflects the current nature of Bell System operations and requirements.

The revised standards consists of a series of subject-oriented loose-leaf volumes which replace portions of the existing single-volume Design Standards - Engineering Standards, Book 1, as well as certain Engineering Reference Data Bulletins. Eventually all of these documents will be completely replaced.

The change to subject-oriented volumes will allow the user to order only volumes of specific interest and thus simplify access to essential information. The loose-leaf concept will ease the user's task of maintaining current up-to-date volumes by merely replacing pages as they are received.

The primary purpose of the Design Standards series is to aid the Bell Laboratories designer in the development of products that conform to Bell System standards of reliability, appearance, cost, manufacture, installation, operation, and maintenance.

In addition to providing general design guidelines, the Design Standards volumes also contain specific recommendations for the selection and application of design elements that are preferred for use in Bell System products. These Design Standards have been developed primarily for the physical designer of equipment and certain types of apparatus products. However, most of the information included should also be useful to circuit designers, component designers, and those concerned with design of outside plant products. Design Standards for special products and technologies, such as integrated circuits, printed wiring boards, etc, are currently provided in other documents such as the companion PWB Products series.

The Design Standards series includes:

(a) An overview of the entire design process as it relates to Bell System products.

(b) Specific engineering information (eg, tables of commonly used data) and comprehensive information on preferred Bell System design standards (eg, materials and component selection guides).

(c) An introduction and brief discussion of design elements that are covered in depth elsewhere. In this respect, the Design Standards volumes serve as an entry point and a road map to more detailed information.

(d) General engineering information not readily available elsewhere.

It should be noted that the Design Standards volumes do not replace, but rather supplement and/or interpret existing specifications, practices, etc, which should always be consulted before invoking them on a design.

Design personnel should give serious consideration before using a product design with special requirements that may indicate a need to deviate from these standards. When the deviation is considered necessary, appropriate consultants and the Supervisor of the Design Standards Group (Dept 8621) should be contacted. In this way, ramifications of the proposed deviation can be thoroughly explored and valid changes which may affect other design areas can be introduced into the Design Standards volumes.

Since it is neither possible to produce all planned volumes simultaneously, nor to include complete information in each volume as it is issued, expansion of the series will be done on an evolutionary basis. Suggestions and comments from users are sought and welcomed. Please address all such suggestions and comments to:

Supervisor, Design Standards Group
Bell Laboratories, Department 8621
Holmdel, N.J. 07733
Room 1B-320
CORNET, 8-233-4760
Commercial, (201) 949-4760

A brief description of each volume currently available is included here for reader information. The contents of each volume is described in the INTRODUCTION of each volume. Some volumes, identified with an X-specification number may be invoked as manufacturing requirements by making appropriate references on product drawings and specifications. Volumes not carrying an X-specification number should not be so referenced.

GENERAL ENGINEERING

This volume contains general information and guidance for the designer. It includes: a complete list of engineering consultants, a bibliography of approved engineering reference documents, a description of various Bell System organizations with which the designer is likely to interact, general design guidelines describing the common and peculiar characteristics of major Bell System products and the various aspects of the design processes that produced them, guidance on what is needed to document a design, a brief description of the technical services available to the designer, and a glossary of Bell System terms of particular interest to the designer.

MATERIALS AND FINISHES

This volume aids the designer and design support personnel in the selection, application, and specification of materials and finishes for use in the Bell System. The volume contains lists of all BTL-WE, LRM, WL coded finish, and dash number finish specifications - including specification replacement information, and descriptions of all material and finish specifications that are currently valid. The volume also contains separate material considerations, finish considerations, drawing considerations (bending radii), and consultant directory sections. A comprehensive alphabetical keyword index is also included to facilitate access to the specification descriptions and other pertinent information.

MARKINGS AND MARKING METHODS

This volume aids the designer and associated technical support personnel in the effective selection and application of the recommended elements of marking. It contains information concerning the Why, What, When, How, and Where of marking on Bell System products. It includes guidelines covering the design considerations, the design recommendations, the selection of the type of marking, elements of marking, etc. Graphics, illustrations, tables, charts, etc. are included to further simplify the selection for the user.

CAPACITORS (X-75511)

This volume aids the designer in the selection of capacitors for use in Bell System products. It includes electrical, physical, and related data on capacitors preferred for general use, together with guidelines for their selection and application; a list of capacitor consultants; a list of reference documents; and a glossary related to capacitors.

RESISTORS (X-75525)

This volume aids the designer in the selection of resistors for use in Bell System products. Its scope is similar to the capacitors volume.

This checklist contains a complete list of pages in DESIGN STANDARDS, RESISTORS (X-75525), together with the latest issue date. It is advisable to check the contents of the book against this list. Pages not in agreement with this checklist should be replaced. Current pages may be obtained from one of the following sources depending on the location of the book holder:

(a)	Bell Laboratories	Engineering Records Group, Department 7239, Ext HO-3139
(b)	Western Electric (Except New York)	Local WE Distributor
(c)	Operating Telephone Companies	Indiana Publications Center, WE P.O. Box 26205, Indianapolis, Ind. 46226
(d)	Western Electric (New York)	Head, Standards and Materials Engineering Department 8621 Bell Laboratories Holmdel, N. J. 07733
(e)	Others	

COMPLETE LIST OF PAGES FOR RESISTORS MANUAL (X-75525)

PREFERRED RESISTORS

NUMBER	SECTION	INTENDED USE CATEGORY
KS-8512	5	Power Terminal Lug
KS-13192	3	Precision Wire Wound
KS-13490	1	General Use, Carbon Composition
KS-13491	1	General Use, Carbon Composition
KS-14603	4	Power Axial Lead
KS-16266	4	Power Axial Lead
KS-16311 - KS-16315	2	Precision Metal Film
KS-16645	1	General Use, Carbon Composition (High Reliability)
KS-16764	3	Precision Wire Wound
KS-19077	7	Special Type
KS-19150	1	General Use, Carbon Composition (High Reliability)
KS-19151	1	General Use, Carbon Composition (High Reliability)
→KS-19152	1	General Use, Carbon Composition (High Reliability)
KS-20045	7	Wire Wound, Silicone Coated, Axial Lead
KS-20046	7	Wire Wound, Power, Chassis Mount
KS-20289	1,4	General Use, Metal Film, Power Axial Lead
KS-20616	1	General Use, Metal Film
KS-20810	1	General Use, Metal Film
18 Type	6	18-Type Wire Wound
19 Type	6	19-Type Wire Wound

PREFERRED RESISTORS (Cont)

NUMBER	SECTION	INTENDED USE CATEGORY
254A	7	Special Type, Tantalum Film
257A	7	Special Type, Tantalum Film
259A	7	Special Type
263A	7	Special Type

This manual contains electrical, physical, and related data on various types of discrete resistors that are designated as preferred for use in Bell System products by the cognizant resistor specialists having engineering responsibility. The primary purpose of this manual is to aid engineers and designers select preferred resistors. It also provides assistance with other engineering functions related to the use of resistors such as:

Evaluation - circuit analysis, application, and reliability.

Specifying - method of identification.

Layout and Mounting - physical outline and dimensions.

Interconnection - terminal types and dimensions.

Documentation - apparatus figures and assembly stock lists.

The manual is arranged to provide the user with several alternate paths to the resistor information being sought. The GENERAL GUIDELINES section contains selection parameters to help decide on a particular category of resistor (eg, General Use, Precision, Power, etc.) to satisfy the design requirements. After the category has been determined refer to the individual sections for additional detailed data. If only the KS specification or apparatus code number is known, refer to the numerical index to identify the applicable section for the detail information on the subject item.

Detailed information for nonpreferred resistors is not included in this manual, primarily because nonpreferred items are intended for special applications and generally are more costly than a preferred counterpart. Prospective users of nonpreferred resistors are urged to contact the appropriate consultant named in the CONSULTANTS AND BIBLIOGRAPHY section. The consultants are grouped in the following categories:

Engineering Consultants - Individuals that have engineering design responsibility for the resistor types listed.

Location Consultants - Individuals that have component standardization responsibility for the respective locations indicated.

Location Coordinators - Individuals that have the responsibility to coordinate questions and/or problems concerning component standardization directly related to the respective locations indicated.

The consultants will be pleased to discuss any application problem either by phone or in writing. A RESISTOR CHECKLIST form

is included in the CONSULTANTS AND BIBLIOGRAPHY section for such purposes.

Supplementary information on resistors (such as reliability) can be found in the documents referenced in the BIBLIOGRAPHY contained in the CONSULTANTS AND BIBLIOGRAPHY section. Definitions of terms related to resistors are contained in the GLOSSARY section.

This manual will be revised as changes in the component data and technology require updating the information. Resistor Data Bulletins will be distributed between regular reissues of the manual to assure rapid dissemination of the latest information. These bulletins may not contain complete information but will serve to promptly introduce new or changed resistor data to holders of the manuals.

EXPLANATION OF ILLUSTRATIONS AND TABLES

This manual contains six sections of preferred resistor types, one section of special types, and three sections of basic information in the form of application guides. These three sections include derating curves for the preferred items grouped according to the type of resistive element used. The detail data for specific resistors is contained in tables within each section and for user convenience the tables in the first six sections have the same format. Note that every variation of the item available within either the KS specification or apparatus code, is not listed in these tables. This is a selected listing of only the specific items which the consultants have determined as best suited for most applications. In addition, each section contains configuration outlines and photographs of the various components. The pertinent figure is referenced in the detail table that contains the electrical data and physical dimensions. The dimensional terms used in the tables are also identified in the configuration outlines.

The resistors are listed in order of ascending values of maximum rated power and resistance. The list also includes the following resistor characteristics:

(a) Initial tolerance.

(b) Additional resistance end-of-life tolerance.

(c) Temperature coefficient.

(d) Maximum rated voltage.

(e) Physical characteristics, such as size, terminal type, and terminal size.

NOTE: Refer to GENERAL GUIDELINES section for the method of specifying resistors that have family-type codes, that is, those available in a range of resistance values.

The CARBON COMPOSITION, METAL FILM and WIRE WOUND sections of the manual contain specific application information for those preferred resistors listed in the other six basic categories. However, for user convenience, they have been grouped and identified by the type of resistive element used. These three sections may be used as a point of entry to the more detailed data when a circuit application dictates that a specific type of resistor be used. Each of the three sections consists of a BASIC DATA table that contains a brief description of the item and the overall parameters for the preferred items.

NOTE: These tables are not to be used for selecting a specific component; their purpose is to quickly show the user that the component needed may be found in the detail tabulation within the appropriate category.

Definitions of the table headings used in the six category sections are:

MAXIMUM RATED POWER APPLICATION AT °C (WATTS). This refers to the maximum wattage the resistor should be subjected to under normal circuit operating conditions at the ambient temperature (in degrees celsius) indicated.

RESISTANCE RANGE OR VALUE. This refers to the nominal electrical resistance that the component is designed to provide. The figures are given for the lowest value (MIN) and highest value (MAX) available for the particular code or KS list number. The MIN-MAX resistance range shown in the table is specified in ohms unless followed by K (kilo) or M (mega) as the multipliers of 1000 and 1,000,000, respectively. The actual resistor value chosen should be selected from one of the standard preferred value tables contained in the STANDARD VALUES section of this manual.

INITIAL TOLERANCE. This refers to the variation of resistance value from the nominal that can be expected of the part when it is manufactured and is expressed in plus and minus percent.

ADDITIONAL END-OF-LIFE TOLERANCE (EOL). The resistance tolerance, expressed in plus and minus percent, that should be added to the initial tolerance as a result of operating the resistor for a specified period of time at the maximum recommended power under an approximately 50 percent relative humidity condition. Refer to the GENERAL GUIDELINES section for more detail information on the use of the EOL tolerance.

TEMP COEF (PPM OR %/°C). This is the resistance-temperature coefficient expressed in parts per million or percent per degree celsius. The figure given equates to a percent of rise or fall of resistance value for each degree celsius change from the ambient temperature at which the nominal resistance is measured.

MAX RATED VOLTAGE (RMS or DC). This is the specified maximum continuous voltage to which the resistor should be exposed in normal circuit operation expressed in RMS(ac) or DC volts.

FIG. This is a reference to the numbered illustration showing the configuration outline.

BODY SIZE. This indicates the maximum body dimensions in inches using the same designations L, H, and D as shown on the physical outline drawings. The L (length) dimension is the dimension that lies parallel to a mounting surface. In the case of resistors mounted by axial pigtail leads, the leads are assumed to emanate axially and project at right angles to the axis of the resistor into a mounting surface. The H (height) dimension is the distance the item projects above the mounting surface. The D or depth dimension is the diameter of the unit. The H or D dimensions may be repeated for a tubular resistor depending on the orientation of the component.

TERMINAL TYPE. This identifies the type of terminal used on the resistor and is expressed as follows:

AXIAL PT. The terminals extend axially from opposite ends of the resistor body and are generally tinned copper wire pigtail-type leads.

RADIAL PT. The terminals are pigtail type leads that extend radially from opposite ends of the resistor body.

RADIAL LUG. The terminals extend radially from the resistor body and are relatively short, flat, and tinned surfaces.

TERMINAL SIZE. The terminal dimensions, using the designations (TL for terminal length and TW for terminal width or diameter), that are identified on the configuration outlines.

CODE. This is the KS specification or WE apparatus code identification.

CONSULTANTS

RESISTOR TYPE	ENGINEERING CONSULTANTS*
Composition, Fixed	Christian, Griese
Film, Fixed	Christian, Griese, Yocom
Wire Wound, Fixed	Christian, Griese
18- and 19-Type	Leach
→Potentiometers (WW)	Edwards
All Types	Fuss

LOCATION CONSULTANTS FOR STANDARD RESISTORS*

Columbus	Overholt
Kearny	Davison
Montgomery	Meier

WE LOCATION COORDINATORS FOR STANDARD COMPONENTS		DEPT
Baltimore	L. H. Wise	13BA154860
Buffalo	L. P. Hauck	13BF305230
Columbus		
Mechanical	R. E. Hotze	11CB127600
Electrical	R. E. Overholt	11CB127670
Dallas	B. H. Hobbs	11DJ332360
Denver	W. F. Lewis	14DR421240
Hawthorne	R. A. Agnew	11HW249140
Indianapolis	E. J. Guy	14IN153240
Kansas City	R. N. Hays	15KC115130
Kearny	J. F. Davison	14KY181450
Montgomery	W. L. Brooker	14MG026563
Merrimack Valley		
→ Electric Components	Unassigned	
→ Fasteners	F. J. Schiller	12MV221520
→ Raw Material	J. V. Kiernan	12MV227490
→North Carolina	G. C. Shelton	12WL314520
Northern Illinois	J. F. Bethel	11LE571300
Oklahoma City	D. D. Kemp	11OC313430
Omaha	A. F. Falten	11OH414730
Phoenix	R. E. Streich	13PH402500
→Richmond		
Other than connectors	J. R. Landreth	12RG346760
Connectors	W. M. Chisholm	12RG046130
Shreveport	C. H. Eden	14SP330470

* See Page 2 for complete names, addresses, and telephone numbers.

CONSULTANTS' ADDRESSES	PHONE NO.
Christian, W. A. (Bill) Dept. 53SZ02452-WE-PPE*	8242-7165
Griese, F. C. (Frank) Dept. 53SZ02452-WE-PPE*	8242-7351
Davison, J. F. (Jim) Dept. 81450-WE-KY†	8223-2478
→ Edwards, R. L. (Rick) Dept. 53SZ02452-WE-PPE*	8242-7120
→ Fuss, F. N. Dept. 2162-BTL-AL	8235-7348
Leach, R. F. (Dick) Dept. 2162-BTL-AL	8235-7626
Meier, H. C. (Harry) Dept. 3113-BTL-HO	8233-3270
Overholt, R. E. (Ralph) Dept. 11CB127670	8353-2246
Yocom, W. H. (Willis) Dept. 2162-BTL-AL	8235-6987

* WE, 50 Lawrence Road, Springfield, N. J. 07081

† WE, 100 Central Ave., Kearny, N. J. 07032

WE, 6200 East Broad St., Columbus, Ohio 43213

RESISTOR CHECKLIST EXPLANATION

The following resistor checklist provides a convenient method of organizing and communicating the data that must be provided so that the consultant can properly advise the requestor.

This checklist may be used informally

- for telephone inquiry when speed is important.
- as a mailed inquiry so that the consultant can conduct a more thorough search.
- as the data sheet attachment for an official request for appropriate action.

The checklist is arranged to include pertinent data in the following areas.

- Application.
- Electrical requirements.
- Environmental data.
- Administrative information.

Items calling for data that are not applicable or requiring detailed information not readily available may be ignored. The checklist presented here is to be retained as a master copy and working copies should be reproduced by the user as required.

RESISTOR CHECKLIST

TO:_____ Date_____
(Resistor Consultant)

_____
(Address)

1. APPLICATION

Function in circuit_____

Where used: Equipment_____ Apparatus_____
Reliability: Unspecified___ General___ High reliability_____
Cost considerations:
Primary concern_____ Unit cost limit, if any_____
Quantity expected yearly_____
If cost is secondary, indicate primary reason;
Reliability_____ Size_____ Special reqts_____ (See below)

2. ELECTRICAL REQUIREMENTS

Initial nominal resistance_____ Tolerances_____

Voltage applied to component:
Normal; dc_____ ac_____ frequency_____
Trouble; dc_____ ac_____ frequency_____
Operating frequency range_____ Waveforms_____

Normal expected operating temperature: High_____ Low_____

Current: RMS value_____ Waveform_____

Special requirements: Temperature coefficient_____ Aging_____
Insulation resistance_____ Power factor_____, Q_____
or equivalent series resistance_____

Internal inductance_____ Maximum impedance_____
Other_____

3. ENVIRONMENTAL DATA

Temperature range_____ Humidity_____ Vibration_____
Shock_____ Size and/or shape_____
Terminal: Type_____ Orientation_____
Mounting means_____ Other_____

4. ADMINISTRATIVE INFORMATION

Project_____ Request No._____ SD No._____
Checklist prepared by_____ Loc_____ Phone_____

BIBLIOGRAPHY

BELL SYSTEM DOCUMENTS

A Drawings (for specific resistors); available from BTL Engineering Records.

Design Standards, Bell Telephone Laboratories Engineering Standards, Book 1, Vol. 1; available from BTL Engineering Records.

KS Specifications (for specific resistors); available from BTL Engineering Records for BTL locations and from WE Indianapolis Publications Center (IPC) for WE locations.

Reliability Information (a handbook), January 1976, available from BTL Center 173.

BSP Section 032-140-811, Resistors - 18- and 19-Type - Procedures for Mounting; available from BTL Engineering Records

BELL SYSTEM COMPONENTS MANUALS AND BULLETINS

DOCUMENT TITLE	SPEC NO.	ISSUE DATE
DESIGN STANDARDS		
→ Capacitors	X-75511	Jan 1977
→ Resistors	X-75525	Jan 1977
ENGINEERING REFERENCE DATA BULLETINS		
Connectors	X-75500	June 1965
Cords	X-75517	Mar 1972
Frequency Generators - Power	X-75523	May 1958
Inductors	X-75527	June 1962
Power	X-75523	May 1958
Instruments, Electrical Indicating (Meters)	X-75504	Jan 1965
Jacks	X-75500	June 1965
Jack Mountings	X-75500	June 1965
Keys		
Numerically Coded	X-75507	June 1964
Universal Type for Switchboards	X-75506	Apr 1961
Knobs	X-75526	Feb 1962
Magnetic Amplifiers - Power	X-75523	May 1958
Mounting Plates	X-75505	June 1971
Networks, Transmission	X-75522	June 1961
Plugs	X-75500	June 1965

Relays			
280 Type	X-75305	Aug	1954
B- and G-Type	X-75508	Apr	1955
Meter Type	X-75504	Jan	1965
Multicontact - 286-, 287-, and 288-Type	X-75513	Apr	1963
Sealed Contact	X-75518	Apr	1964
Step-by-Step System - 221-, 222-, 223-, 224-, 225-, 247-, 248-, 251-, and 252-Type	X-75514	Dec	1960
Time Delay - Circuit Arrangements	X-75519	May	1961
U-, UA-, and Y-Type	X-75375	June	1956
Wire Spring - AF-, AG-, AJ-, and AK-Type	X-75509	Dec	1967
Terminals, Hermitically Sealed	X-75521	May	1961
Terminal Strips	X-75510	Apr	1962
Transformers - Power	X-75523	May	1958
Transmission	X-75512	Nov	1964
Voltage Regulators (AC) - Power	X-75523	May	1958

EXTERNAL PUBLICATIONS

IEEE Standard Dictionary of Electrical and Electronics Terms (IEEE Std 100-1972), Wiley-Interscience, N. Y.

Resistance and Resistors, C. L. Wellard, McGraw Hill Book Co., N. Y., 1960.

STANDARDIZATION OF RESISTORS IN THE BELL SYSTEM

The resistors in this manual have been carefully selected with the expectation that they will meet most of the application requirements for the current technology level of Bell System products at a competitive cost. Resistance values and tolerances, other than those listed herein, are available within certain KS specifications or apparatus codes. However, they are not considered preferred components and, therefore, detail data is not included for them. It is recognized that requirements will arise necessitating the use of special resistors not in the preferred listings. The resistor consultants should be contacted for help with the selection of such resistors. The resistor checklist in the CONSULTANTS AND BIBLIOGRAPHY section provides guidance on the information the consultants will want to know about your circuit application.

Information included in this GENERAL GUIDELINES section is intended to assist the designer in making a first-level selection of the resistor type most suitable for a given application. Selection of a specific resistor depends not only on how well it meets the electrical, physical layout and mounting requirements, but more importantly on such factors as:

- The required reliability and circuit end-of-life requirements.
- The environmental operating conditions.
- WE assembly, wiring, and testing techniques.
- The cost of the resistor itself.

Another factor to be considered in the selection of a resistor (or any component) is that a restricted list of components may have been established for application on a particular project. Hopefully, such a list is a subset of the resistors listed herein.

SELECTION PARAMETERS

The selection of a resistor for a given application is generally based on the circuit end-of-life tolerance and the following parameters:

- Rated Wattage.
- Initial Tolerance.
- Temperature Coefficient of Resistance.

- Resistor Add-On End-Of-Life Tolerance.

The circuit end-of-life tolerance is the tolerance limit to which the circuit can change before the circuit operation becomes marginal. In the selection of a resistor, the circuit end-of-life tolerance and the resistor add-on end-of-life tolerance is used to determine the resistor maximum initial tolerance, ie, the circuit end-of-life tolerance less the resistor add-on end-of-life tolerance sets the maximum acceptable initial tolerance for the resistor. Refer to the appropriate section of this manual for the resistors covered by the parameters as shown in Table 1.

TABLE 1

SELECTION PARAMETERS

SECTION	WATTS	INITIAL TOLERANCE (PERCENT)	TEMP COEF OF RESISTANCE (±PPM/°C)	ADDITIONAL END-OF-LIFE TOLERANCE (PERCENT)
General Use	2 and less	±1 and greater	±100 and greater	up to ±15
Precision:				
Metal Film	2 and less	less than ±1	less than ±100	N/S
Wire Wound	2 and less	less than ±1	less than ±130	±0.25
Power:				
Axial Lead	3 to 10	±5 or less	±300 or less	up to ±10
Term. Lug	8 to 215	±5 or less	+125 to ±175	±2.5
18- & 19- Type	5.1	±5 or less	-50 to +300	+3.5, -0

N/S Not Specified

A resistor selection can be made by comparing the resistor rating and characteristics to the circuit requirements, including the circuit end-of-life tolerance. If two or more resistors are found that satisfy the circuit requirements, their physical size and other environmental characteristics will usually determine the best selection. If no resistor can be found, contact the consultant.

Resistors will meet circuit reliability requirements only when they are applied correctly both electrically and environmentally. Power derating, humidity, ambient temperature, waveshape, etc, must all be taken into account. This manual will be helpful in

making a preliminary selection. Final selection may require contact with the consultant and/or the Quality Assurance Center.

In critical applications where long term reliability and stability are essential, it is recommended that a resistor be selected so that the maximum rated power is at least twice the power to be dissipated. In most cases, this will result in a physically larger resistor.

Table 2 lists the most common failure modes for the various resistor types. A more comprehensive discussion of resistors and the impact on reliability is contained in the BTL Reliability Information handbook, particularly the section on part selection and application (refer to the bibliography in the CONSULTANTS AND BIBLIOGRAPHY section of this manual).

The nominal resistance value for family coded resistors shall be selected from the appropriate Recommended Standard Values tables referenced in the detail tabulations. Whenever design requirements and application permit, the broadest initial tolerance should be specified to achieve the lowest cost.

WATTAGE AND DERATING CHARACTERISTICS - NORMAL APPLICATION

For normal applications, the wattage rating should never be exceeded. For operation at higher ambient temperatures, the maximum permissible power should be decreased in accordance with the power-temperature derating curve applicable to the specific resistor. These curves are shown within the appropriate resistor sections identified as CARBON COMPOSITION, METAL FILM, and WIRE WOUND. Maximum permissible power shall be reduced further if air flow is restricted by an enclosure, or if a number of resistors dissipating power are grouped together.

WATTAGE CHARACTERISTICS - TROUBLE CONDITIONS

The trouble wattage should not exceed twice the rated wattage. In the case of vitreous enamel insulated resistors the trouble wattage should not exceed the specified rated wattage.

VOLTAGE RATINGS

The maximum continuous voltage rating (dc or ac rms) shall never be exceeded, regardless of the voltage as calculated from the formula

$$E = \sqrt{RP}$$

where R = Resistance in ohms, and
P = Power in watts.

Caution should be used where any possible peak voltages may exceed the maximum rated voltages regardless of time duration. To avoid possible hazardous conditions to either a resistor or other nearby components, the appropriate consultant should be contacted to assure the suitability of a resistor selected for such conditions.

SPECIFYING RESISTORS

Resistor types are designated by their nominal resistor value. Two types of Bell System identifying codes are used for listed resistors: the apparatus code (App Code) that normally identifies a WE manufactured resistor; and the KS specification (KS Spec) that normally identifies a resistor purchased from an outside supplier. Engineering information on both App Code and KS Spec resistors is available from Bell Laboratories Engineering Records files. The selection of resistors carrying either of these identifying codes provides assurance that they are in accord with Bell System standards. Where possible, only resistors with App Code or KS Spec designations should be specified on drawings for Bell System use.

New resistor types, available from outside suppliers, should be discussed with the resistor consultant prior to using them in circuit applications. Special applications or situations (temperature coefficient, frequency performance, ratings under pulse conditions, cost, stability, etc) should be discussed with the resistor consultant.

Certain App Codes and KS Spec numbers identify a specific resistor with single-valued characteristics. In such cases, the word RESISTOR plus the App Code or KS Spec number represents complete identification of a "unique" resistor. For example:

RESISTOR 18FA

RESISTOR KS-19238,L1

Other App Codes and KS Spec numbers identify family-type resistors in which the same identifying code or number covers a group of resistors where all characteristics are single-valued except one - usually resistance. Thus the same type of resistor is available in a number of different values. The value should be selected from the applicable table provided in the STANDARD VALUES section of this manual. To properly identify a specific resistor of the family type, it is necessary to specify the resistance value along with the word RESISTOR and the App Code or KS Spec number. For example:

RESISTOR 254A 89.8 KOHMS
RESISTOR KS-20810,L1A 100 KOHMS

resistor of the family type, it is necessary to specify the resistance value along with the word RESISTOR and the App Code or KS Spec number. For example:

RESISTOR 254A 89.8 KOHMS
RESISTOR KS-20810,L1A 100 KOHMS

TABLE 2

MOST COMMON RESISTCR FAILURE MODES

RESISTOR TYPE	WHEN SUBJECTED TO				
	NORMAL USE	EXCESS POWER	HIGH TEMPERATURE	HIGH HUMIDITY	SEVERE SHOCK OR VIBRATION
Composition	Drift	Shift	Drift	Drift	-
Film	Open	Open	Drift	Drift Open*	Open
Power Wire Wound	Open	Open	-	-	Open
Precision Wire Wound	Open	Shift-Short‡	Drift	Drift-Open	Open

Note "Drift" indicates a relatively slow change in resistance. It may be temporary or permanent.
"Shift" indicates an abrupt change in resistance.

‡ Dependent on construction.

* Primarily a corrosion effect.

Data Source: Reliability Information, January 1976, courtesy Quality Assurance Center 173.

Conformal Coating - An insulating covering that follows the shape and contours of the coated item.

°C - Degrees Celsius.

Derating - The intentional reduction of stress-strength ratio in the application of an item usually for the purpose of reducing the occurrence of stress-related failures.

Dielectric Withstanding Voltage - (Dielectric Strength) - The potential gradient at which electrical failure or breakdown occurs.

Encapsulated - A method of encasing a resistor base and element by pouring an insulating material in liquid form using a mold and allowing it to set or cure.

Frequency - Cycles per second expressed in Hertz as follows:
kHz - Kilohertz or 1000 hertz.
MHz - Megahertz or 1,000,000 hertz.

Inductance - The property of an electrical circuit by which a varying current flow induces an electromotive force in that or a neighboring circuit.

Inductance, Low, Limited, or Reduced - A specified limit of inductance permitted of certain types of resistors under the specification and is usually achieved by the method of manufacture.

Molded - A method of encasing a resistor base and element within an insulating material generally resulting in a filled cylindrical form.

Nominal Resistance - The resistance value as selected from the standard resistance value tables for the particular resistor and includes the initial tolerance selected.

Precision - The measure of a resistor's ability to maintain a nominal resistance value within a narrow (tight) tolerance. This ability is a function of both initial tolerance and temperature coefficient.

Reliability:

(a) The ability of an item to perform a required function under stated conditions for a stated period of time.

(b) The probability that a device will function without failure over a specified time period or amount of usage.

Stability - The characteristic of a resistor to retain its original nominal resistance value over a specified period of time.

Temperature Coefficient of Resistance - This is a measure of the change of resistance value with temperature as referred to some base temperature.

Watt - The unit of power required to do work at the rate of one joule per second.

STANDARD RESISTANCE VALUES

Certain specific values have been selected as standard values in order to keep the number of orders for odd values of resistance to a minimum and to facilitate manufacture and stocking of the different resistor types. These values are listed in Tables 1 and 2. Table 1 is a list of Recommended Standard Values and Table 2 is a list of EIA Preferred Values for carbon resistors.

Table 1 uses the first three significant figures, and Table 2 uses the first two significant figures. When specifying a resistor value, a decimal point is to be placed where required within the range specified for the desired type of resistor.

TABLE 1

RECOMMENDED STANDARD VALUES

Selection should be made from Column B where possible. For resistance tolerances of less than ±1 percent Column A may be used and a zero should be added before or after the first three significant figures to indicate the resistor value to four significant figures. The decimal point is to be placed as necessary within the range specified for the desired resistor.

COLUMN A NOMINAL VALUES WHEN REQUIRED								COLUMN B PREFERRED NOMINAL VALUES	
100	135	182	246	332	448	597	796	100	332
101	137	184	249	336	453	(1)	806	105	348
102	138	187	252	340	459	604	816	110	365
104	140	189	255	344	464	612	825	115	383
105	142	191	258	348	470	619	835	121	402
106	143	193	261	352	475	626	845	127	422
107	145	196	264	357	481	634	856	133	442
109	147	198	267	361	487	642	866	140	464
110	149	200	271	365	493	649	876	147	487
111	150	203	274	370	499	657	887	154	511
113	152	205	277	374	(1)	665	898	162	536
114	154	208	280	379	505	673	909	169	562
115	156	210	284	383	511	681	920	178	590
117	158	213	287	388	517	690	931	187	619
118	160	215	291	392	523	698	942	196	649
120	162	218	294	397	530	706	953	205	681
121	164	221	298	402	536	715	965	215	715
123	165	223	301	407	542	723	976	226	750
124	167	226	305	412	549	732	988	237	787
126	169	229	309	417	556	741		249	825
127	172	232	312	422	562	750		261	866
129	174	234	316	427	569	759		274	909
130	176	237	320	432	576	768		287	953
132	178	240	324	437	583	777		301	
133	180	243	328	442	590	787		316	

Note (1) A range is not available for these values, only 50- and 600-ohms are standard.

TABLE 2

EIA PREFERRED VALUES

The nominal values given in this table have been selected as standard for carbon composition resistors only having limits of ±5 percent. The table gives the first two significant figures only and the decimal point is to be placed as necessary within the range specified for the desired resistor.

10	18	33	56
11	20	36	62
12	22	39	68
13	24	43	75
15	27	47	82
16	30	51	91

A partial list of resistors that are not intended for general use is provided in Table 1. The list, established by resistor consultants, is based on one or more of the following factors.

(a) The resistors are no longer available.

(b) The resistors were designed for a specific environmental condition and/or application.

(c) The resistors were designed for a critical circuit requirement.

(d) The resistors were designed to meet higher reliability requirements than the general use counterparts could provide.

(e) Current technology makes the use of the resistors in new design unlikely.

(f) In general, the resistors are higher in cost and require longer procurement time.

In some cases a preferred item is indicated as a suggested alternate. If a question arises concerning the use of the items in this list, contact the responsible resistor consultant listed in the CONSULTANTS AND BIBLIOGRAPHY section for assistance.

TABLE 1

NONPREFERRED RESISTORS

SPECIFICATION	TYPE	REMARKS
KS-9913	WW	Similar to KS-8512, Adjustable Tap
KS-9914	WW	Similar to KS-8512, Adjustable Tap
KS-13491	FC	Axial Leads, Suggest Using KS-20289
KS-13492	FC	Axial Leads, Suggest Using KS-20289
KS-13609	WW	Ferrule Terminals, Clip Mounted
KS-13653	WW	Similar to KS-8512, Adjustable Tap
KS-13657	WW	Similar to KS-8512, Low Inductance
KS-13659	WW	Match Pair, Flat, Special Mounting
KS-13660	FC	Axial Leads, Suggest using KS-20616

Legend:
WW = Wire Wound MF = Metal Film MR = Metal Ribbon
FC = Fixed Carbon MS = Metal Strip N/S = Not Specified

TABLE 1

NONPREFERRED RESISTORS (Cont)

SPECIFICATION	TYPE	REMARKS
KS-13712	WW	Flat, Special Terminals
KS-13809	MF	Ferrule Terminals, Clip Mounted
KS-14175	WW	Flat, Bracket Mounting
KS-14272	WW	Similar to KS-8512, Adjustable Tap
KS-15638	MR	High Power, Multiple Taps, Special Mounting
KS-16073	WW	Flat, Tab Terminals
KS-16122	WW	Flat, Lug Terminals
KS-16125	MR	High Power, Heavy Tab Terminals
KS-16340	WW	Bracket Mounting, Adjustable Tap
KS-16489	WW	Single Resistance Value, Circuit Protection
KS-16543	WW	Metal Container, Special Mounting
KS-16645	FC	Axial Leads, Suggest Using KS-20616
KS-16813	FC	Four Nominal Resistance Values Only
KS-16814	WW	Two Nominal Resistance Values Only
KS-16822	WW	Single Power Rating, Noninductive
KS-16896	MF	(Group of Seven Resistor Units with Interrelated Ratios of Resistance Values)
KS-16907	WW	Four or Five Sections Tapped
KS-19020	MF	Ferrule Terminals, Clip Mounted
KS-19021	MF	Ferrule Terminals, Clip Mounted
KS-19022	WW	Ferrule Terminals, Clip Mounted
KS-19111	WW	Precision
KS-19152	FC	Axial Leads, Suggest Using KS-20289
KS-19238	WW	Round, Noninductive, Radial-Tab Terminals
KS-19253	WW	Molded, Replaces KS-8441, KS-8451, and KS-8452
KS-19548	WW	Low Inductance
KS-19756	MF	Single Power Rating
KS-19769	WW	Low Inductance
KS-19799	WW	High Reliability, Lug Terminals

Legend:
WW = Wire Wound MF = Metal Film MR = Metal Ribbon
FC = Fixed Carbon MS = Metal Strip N/S = Not Specified

TABLE 1

NONPREFERRED RESISTORS (Cont)

SPECIFICATION	TYPE	REMARKS
KS-16814	WW	Two Nominal Resistance Values Only
KS-16822	WW	Single Power Rating, Noninductive
KS-16896	MF	(Group of Seven Resistor Units with Interrelated Ratios of Resistance Values)
KS-16907	WW	Four or Five Sections Tapped
KS-19020	MF	Ferrule Terminals, Clip Mounted
KS-19021	MF	Ferrule Terminals, Clip Mounted
KS-19022	WW	Ferrule Terminals, Clip Mounted
KS-19111	WW	Precision
KS-19150,L2,L3	FC	Axial Leads, Suggest using KS-19150,L1
KS-19151,L2,L3	FC	Axial Leads, Suggest using KS-19151,L1
KS-19152,L2,L3	FC	Axial Leads, Suggest using KS-19152,L1
KS-19238	WW	Round, Noninductive, Radial-Tab Terminals
KS-19253	WW	Molded, Replaces KS-8441, KS-8451, and KS-8452
KS-19548	WW	Low Inductance
KS-19756	MF	Single Power Rating
KS-19769	WW	Low Inductance
KS-19799	WW	High Reliability, Lug Terminals
KS-19863	WW	Controlled Inductance
KS-19870	MF	Similar to KS-16312 Except Capacitance Requirement
KS-19949	WW	Single Value, Limited Inductance
KS-20025	WW	Single Value, Radial Lug Terminals
KS-20084	WW	Higher Resistance Values Than KS-8512
KS-20149	WW	Single Value, Special Temperature Coefficient
KS-20200	FC	Axial Leads, Suggest Using KS-20616
KS-20229	WW	Precision, Single Power Rating, Limited Inductance
KS-20289	MF	All tolerances of ±2, and ±10%
KS-20321	WW	Special Temperature Coefficient, Reduced and Noninductive Winding
KS-20344	WW	Special Finned Aluminum Housing

Legend:
WW = Wire Wound MF = Metal Film MR = Metal Ribbon
FC = Fixed Carbon MS = Metal Strip N/S = Not Specified

TABLE 1

NONPREFERRED RESISTORS (Cont)

SPECIFICATION	TYPE	REMARKS
KS-20455	WW	Single Power Rating, Special Temperature Coefficient
KS-20507	MF	Single Power Rating
KS-20510	MF	Special Finned Aluminum Housing
KS-20518	MR	Two Values, Special Mounting
KS-20627	MF	Similar to KS-16312, L3A High Stability With Surges
KS-20656	WW/MF	Matched Pair, High Voltage and Precision
KS-20773	WW	Dual Resistors, Special Finned Aluminum Housing
KS-20791 - KS-20795		High Precision, High Stability, Hermetically Sealed
KS-20828	MF	Chip
KS-20829	MF	High Voltage, High Stability, Precision Shunt
KS-20845	MF	Radial Lead
KS-20846	MF	Radial Lead
KS-20847	MF	Radial Lead
KS-21293	N/S	Hermetically Sealed Oil Filled Can
KS-21311	FC	Single Value, Precision, Noninductive
KS-21321	MF	High Precision, Noninductive
KS-21352	MF	High Precision, Noninductive
KS-21408	MS	High Precision, High Stability, Hermetically Sealed
KS-21465	WW	High Precision, High Stability, High Voltage Divider Network
KS-21477	MF	Dual, High Precision, Noninductive

Legend:
WW = Wire Wound MF = Metal Film MR = Metal Ribbon
FC = Fixed Carbon MS = Metal Strip N/S = Not Specified

TABLE 1-1

ELECTRICAL AND PHYSICAL DATA - GENERAL USE RESISTORS

MAX. RATED PWR APPL AT °C (WATTS)	RESISTANCE RANGE OR VALUE (OHMS)		INITIAL TOLERANCE		ADDITIONAL END-OF-LIFE TOLERANCE		TEMP COEF (PPM OR % /°C)	MAX. RATED VOLTAGE RMS OR DC (VOLTS)	FIG.	MAXIMUM BODY SIZE (IN.)			TERMINAL TYPE	TERMINAL SIZE (IN.)		CODE
	MIN	MAX.	+%	-%	+%	-%				L	H	D		TL	TW	
0.25 @ 70°	2.7*	22M*	5	5	15	15	-2.2 to +11.9%	250	1-2	0.265	0.098	0.098	Axial PT	1.5	0.027	KS-16645,L1
0.25 @ 70°	1.0†	1M†	1	1	2.5	2.5	±100	250	1-1	0.380	0.100	0.100	Axial PT	1.5	0.026	KS-20616,L1A
0.50 @ 70°	2.7*	22M*	5	5	15	15	-7 to +15%	350	1-2	0.406	0.148	0.148	Axial PT	1.5	0.035	KS-13490,L1
0.50 @ 70°	2.7*	22M*	5	5	15	15	-2.2 to +11.9%	350	1-2	0.406	0.148	0.148	Axial PT	1.5	0.035	KS-19150,L1
0.50 @ 70°	0.4†	2.1M†	1**	1**	2	2	±100	350	1-4	0.400	0.150	0.150	Axial PT	1.5	0.034	KS-20810,L1A
1.0 @ 70°	2.7*	22M*	5	5	15	15	-7 to +15%	500	1-2	0.593	0.233	0.233	Axial PT	1.5	0.043	KS-13491,L1
1.0 @ 70°	2.7*	22M*	5	5	15	15	-2.2 to +11.9%	500	1-2	0.593	0.233	0.233	Axial PT	1.5	0.043	KS-19151,L1
2.0 @ 70°	10*	22M*	5	5	15	15	-2.2 to +11.9%	750	1-2	0.719	0.320	0.320	Axial PT	1.5	0.048	KS-19152,L1
3.0 @ 25°	2.6†	2.1M†	1	1	10	10	±200	350	1-3	0.537	0.237	0.237	Axial PT	1.5	0.034	KS-20289,L6C

† From Table 1 - Recommended Standard Values

* From Table 2 - EIA Preferred Values

** For values 9.88 ohms and less, initial tolerance is ±1% ±0.01 ohm

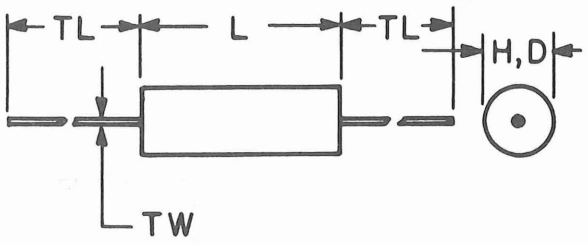
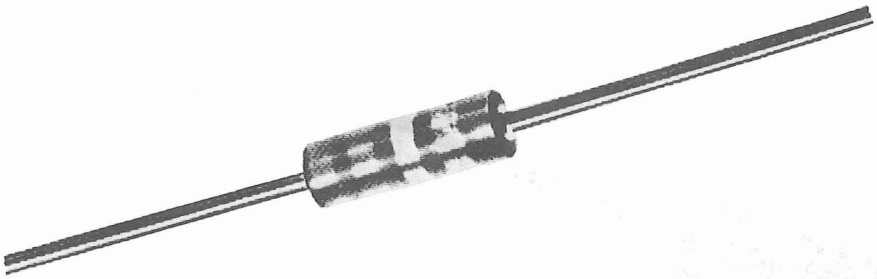


Fig. 1-1



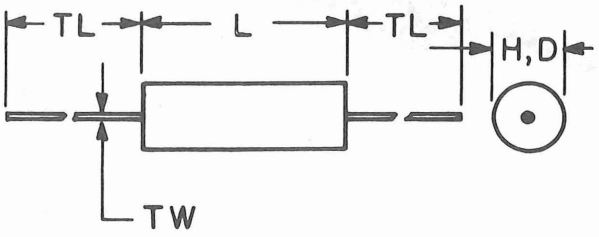


Fig. 1-2

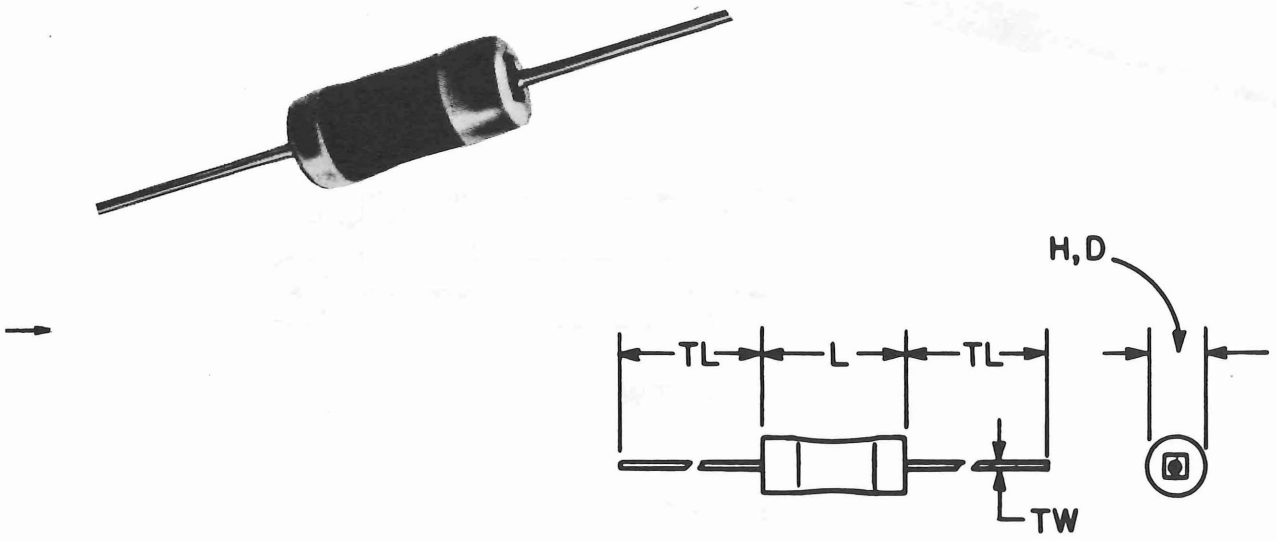


Fig. 1-3

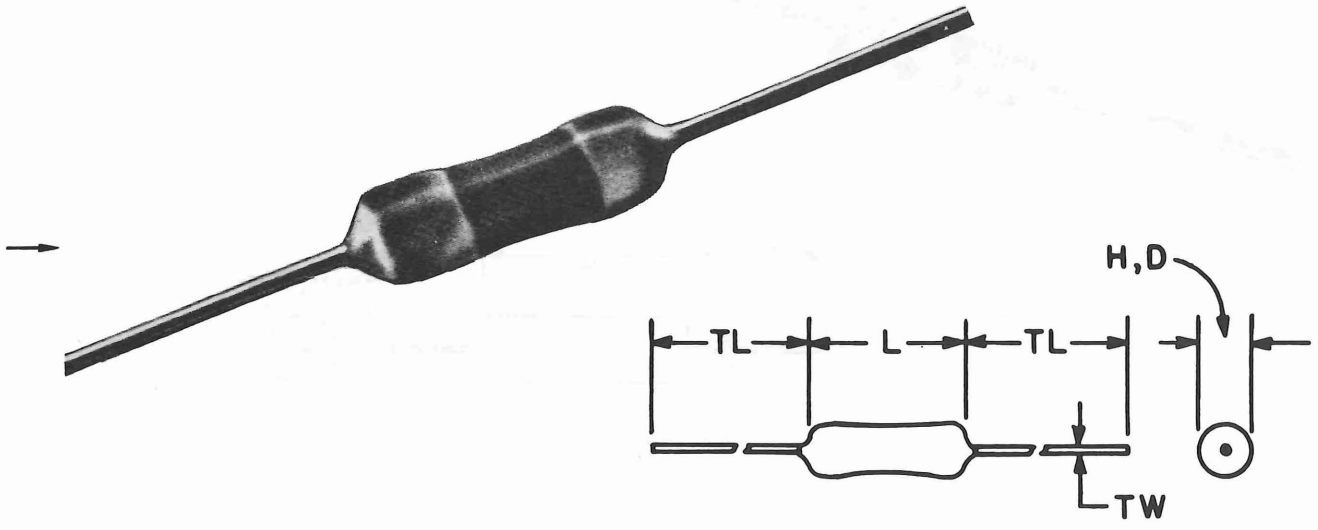


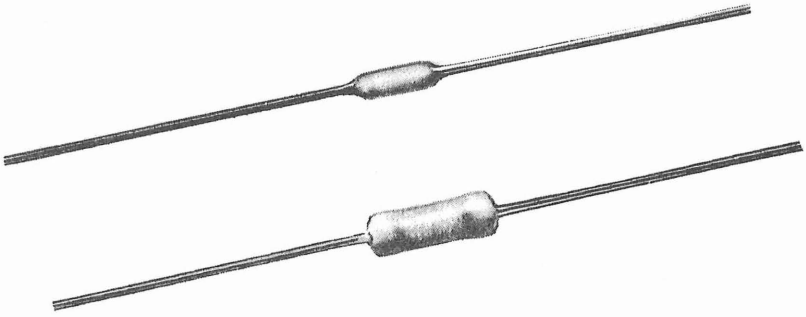
Fig. 1-4

TABLE 2-1

ELECTRICAL AND PHYSICAL DATA - PRECISION METAL FILM RESISTORS

MAX. RATED PWR APPL AT °C) (WATTS)	RESISTANCE RANGE OR VALUE (OHMS)		INITIAL TOLERANCE		ADDITIONAL END-OF-LIFE TOLERANCE		TEMP COEF (PPM/°C)	MAX.RATED VOLTAGE RMS OR DC (VOLTS)	FIG.	MAXIMUM BODY SIZE (IN.)			TERMINAL TYPE	TERMINAL SIZE (IN.)		CODE
	MIN	MAX.	+%	-%	+%	-%				L	H	D		TL	TW	
0.125 @ 70°	100†	200K†	0.1	0.1	2.0	2.0	±50	200	2-1	0.282	0.10	0.10	Axial PT	1.5	0.027	KS-16311,L4F
0.125 @ 70°	100†	200K†	0.1	0.1	2.0	2.0	±25	200	2-1	0.282	0.10	0.10	Axial PT	1.5	0.027	KS-16311,L5F
0.125 @ 70°	20†	200K†	0.5	0.5	2.0	2.0	±50	200	2-1	0.282	0.10	0.10	Axial PT	1.5	0.027	KS-16311,L4D
0.125 @ 70°	20†	200K†	0.5	0.5	2.0	2.0	±25	200	2-1	0.282	0.10	0.10	Axial PT	1.5	0.027	KS-16311,L5D
0.250 @ 70°	10†	500K†	0.1	0.1	2.0	2.0	±50	250	2-1	0.437	0.165	0.165	Axial PT	1.5	0.027	KS-16312,L4F
0.250 @ 70°	10†	500K†	0.1	0.1	2.0	2.0	±25	250	2-1	0.437	0.165	0.165	Axial PT	1.5	0.027	KS-16312,L5F
0.250 @ 70°	10†	500K†	0.5	0.5	2.0	2.0	±50	250	2-1	0.437	0.165	0.165	Axial PT	1.5	0.027	KS-16312,L4D
0.250 @ 70°	10†	500K†	0.5	0.5	2.0	2.0	±25	250	2-1	0.437	0.165	0.165	Axial PT	1.5	0.027	KS-16312,L5D
0.50 @ 70°	1†	1M†	0.1	0.1	2.0	2.0	±50	300	2-1	0.656	0.250	0.250	Axial PT	1.5	0.027	KS-16313,L4F
1.0 @ 70°	100†	2M†	0.1	0.1	2.0	2.0	±50	350	2-2	0.875	0.328	0.328	Axial PT	1.5	0.034	KS-16314,L4F
1.0 @ 70°	10†	2M†	0.5	0.5	2.0	2.0	±100	350	2-2	0.875	0.328	0.328	Axial PT	1.5	0.034	KS-16314,L6D
2.0 @ 70°	20†	14M†	0.1	0.1	2.0	2.0	±50	750	2-2	2.282	0.437	0.437	Axial PT	1.5	0.034	KS-16315,L4F
2.0 @ 70°	20†	14M†	0.5	0.5	2.0	2.0	±100	750	2-2	2.282	0.437	0.437	Axial PT	1.5	0.034	KS-16315,L6D

† From Table 1 - Recommended Standard Values



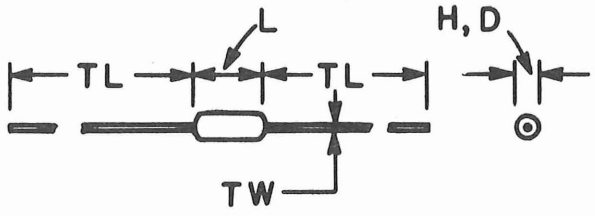


Fig. 2-1

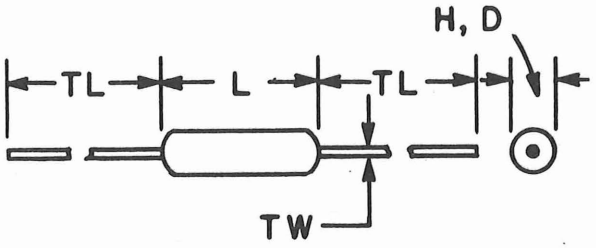


Fig. 2-2

TABLE 3-1

ELECTRICAL AND PHYSICAL DATA - PRECISION WIRE-WOUND RESISTORS

MAX RATED PWR APPL AT °C (WATTS)	RESISTANCE RANGE OR VALUE (OHMS)		INITIAL TOLERANCE		ADDITIONAL END-OF-LIFE TOLERANCE		TEMP COEF (PPM OR % /°C)	MAX RATED VOLTAGE RMS OR DC (VOLTS)	FIG.	MAXIMUM BODY SIZE (IN.)			TERMINAL TYPE	TERMINAL SIZE (IN.)		CODE
	MIN	MAX	+%	-%	+%	-%				L	H	D		TL	TW	
0.50 @ 25°	1†	150K†	0.25	0.25	1.0	1.0	Note 1	200	3-1	0.594	0.594	0.594	Radial Lug	0.375	0.016	KS-13192,L1B_
0.60 @ 66°	2†	165K†	0.1 +0.02	0.1	2.5	2.5	0 ±15	N/S	3-2	0.812	0.406	0.406	Axial PT	2.0	0.034	KS-16764,L1F
0.60 @ 66°	4†	165K†	0.5 +0.02	0.5	2.5	2.5	0 ±15	N/S	3-2	0.812	0.406	0.406	Axial PT	2.0	0.034	KS-16764,L1D
0.75 @ 25°	1†	400K†	0.25	0.25	1.0	1.0	Note 1	400	3-1	1.031	0.594	0.594	Radial Lug	0.375	0.016	KS-13192,L3B_
1.0 @ 25°	1†	1M†	0.25	0.25	1.0	1.0	Note 1	400	3-1	1.281	0.781	0.781	Radial Lug	0.375	0.016	KS-13192,L5B_
1.0 @ 66°	4†	330K†	0.5 +0.02	0.5	2.5	2.5	0 ±15	N/S	3-2	1.062	0.406	0.406	Axial PT	2.0	0.034	KS-16764,L3D
2.0 @ 66°	4†	1.1M†	0.5 +0.02	0.5	2.5	2.5	0 ±15	N/S	3-2	2.062	0.531	0.531	Axial PT	2.0	0.034	KS-16764,L4D

Note 1 Temperature coefficient shall be specified by a 4th suffix letter in the code description as follows: A = 0 ±20 PPM/°C; B = 0 ±130 PPM/°C.

† From Table 1 - Recommended Standard Values

N/S Not Specified

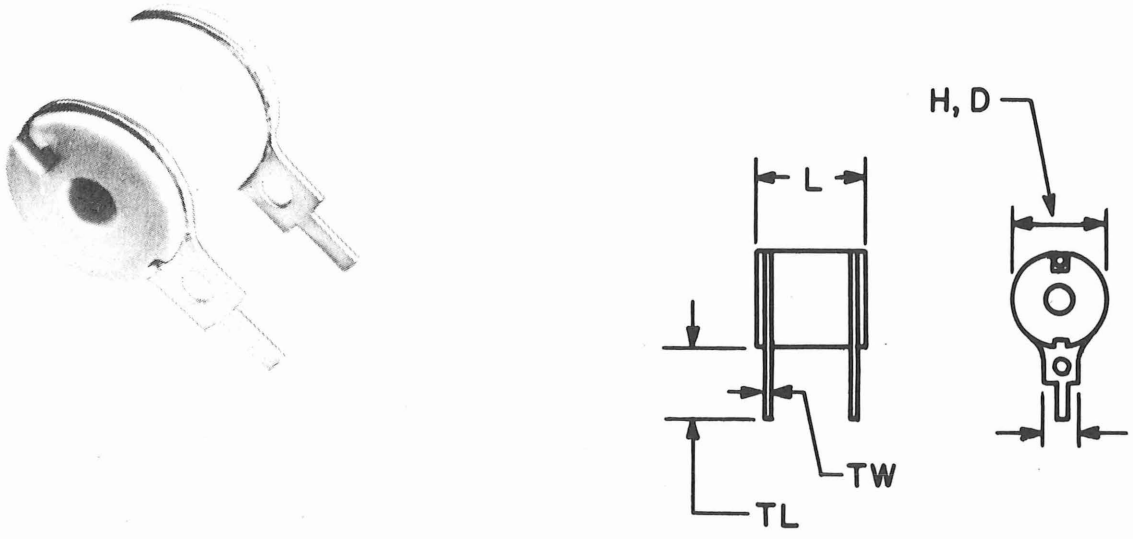


Fig. 3-1

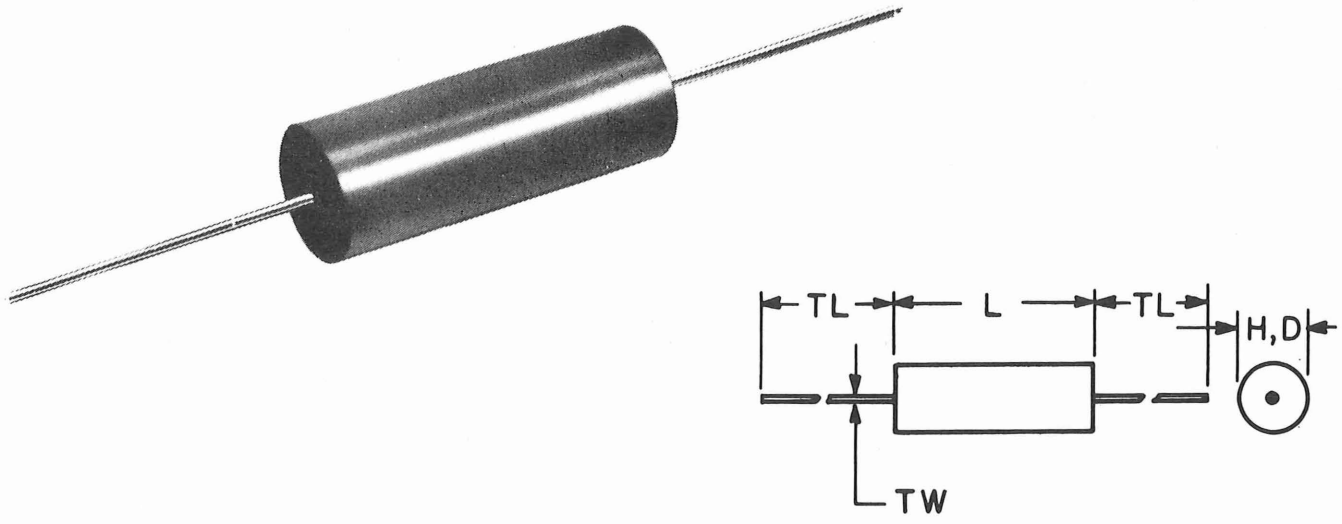


Fig. 3-2

TABLE 4-1

ELECTRICAL AND PHYSICAL DATA - POWER AXIAL LEADS

MAX RATED PWR APPL AT °C (WATTS)	RESISTANCE RANGE OR VALUE (OHMS)		INITIAL TOLERANCE		ADDITIONAL END-OF-LIFE TOLERANCE		TEMP COEF (PPM OR % /°C)	MAX RATED VOLTAGE RMS OR DC (VOLTS)	FIG.	MAXIMUM BODY SIZE (IN.)			TERMINAL TYPE	TERMINAL SIZE (IN.)		CODE
	MIN	MAX	+%	-%	+%	-%				L	H	D		TL	TW	
3.0 @ 25°	0.1†	909†	1.0	1.0	2.5	2.5	Note 1	N/S	4-1	0.563	0.25	0.25	Axial PT	1.5	0.032	KS-14603,L6C_
3.0 @ 25°	0.6†	909†	5.0	5.0	2.5	2.5	Note 1	N/S	4-1	0.563	0.25	0.25	Axial PT	1.5	0.032	KS-14603,L3A_
3.0 @ 25°	2.6†	2.1M†	1.0	1.0	10	10	±200	350	4-3	0.537	0.237	0.237	Axial PT	1.5	0.034	KS-20289,L6C
3.0 @ 25°	12.0†	909†	0.25	0.25	2.5	2.5	Note 1	N/S	4-1	0.563	0.25	0.25	Axial PT	1.5	0.032	KS-14603,L3G_
3.0 @ 25°	920†	1890†	0.25	0.25	2.5	2.5	±150	N/S	4-2	0.563	0.25	0.25	Axial PT	1.5	0.040	KS-16266,L3G
3.0 @ 25°	920†	1980†	1.0	1.0	2.5	2.5	±50	N/S	4-2	0.563	0.25	0.25	Axial PT	1.5	0.040	KS-16266,L6C
3.5 @ 25°	10.0†	89.8K†	1.0	1.0	10	10	±200	500	4-3	0.718	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L3C
4.0 @ 25°	10.0†	89.8K†	1.0	1.0	10	10	±200	500	4-3	0.955	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L4C
5.0 @ 25°	0.14†	2430†	1.0	1.0	2.5	2.5	Note 1	N/S	4-1	1.063	0.406	0.406	Axial PT	1.5	0.040	KS-14603,L4C_
5.0 @ 25°	0.6†	2430†	1.0	1.0	2.5	2.5	Note 1	N/S	4-1	1.063	0.406	0.406	Axial PT	1.5	0.040	KS-14603,L1C_
5.0 @ 25°	0.6†	2430†	5.0	5.0	2.5	2.5	Note 1	N/S	4-1	1.063	0.406	0.406	Axial PT	1.5	0.040	KS-14603,L1A_
5.0 @ 25°	0.6†	2430†	0.25	0.25	2.5	2.5	Note 1	N/S	4-1	1.063	0.406	0.406	Axial PT	1.5	0.040	KS-14603,L1G_
5.0 @ 25°	2460†	6980†	0.25	0.25	2.5	2.5	±50	N/S	4-2	1.063	0.406	0.406	Axial PT	1.5	0.044	KS-16266,L1G
5.0 @ 25°	2460†	6980†	1.0	1.0	2.5	2.5	±50	N/S	4-2	1.063	0.406	0.406	Axial PT	1.5	0.044	KS-16266,L1C
5.0 @ 25°	2460†	6980†	1.0	1.0	2.5	2.5	±50	N/S	4-2	1.063	0.406	0.406	Axial PT	1.5	0.044	KS-16266,L4C
5.0 @ 25°	2460†	6980†	5.0	5.0	2.5	2.5	±50	N/S	4-2	1.063	0.406	0.406	Axial PT	1.5	0.044	KS-16266,L1A
5.5 @ 25°	16.0†	89.8K†	1.0	1.0	10	10	±200	600	4-3	1.565	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L1C
5.5 @ 25°	16.0†	89.8K†	5.0	5.0	10	10	±200	600	4-3	1.565	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L1A
6.5 @ 25°	10.0†	89.8K†	1.0	1.0	10	10	±200	600	4-3	1.745	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L5C
6.5 @ 25°	10.0†	89.8K†	5.0	5.0	10	10	±200	600	4-3	1.745	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L5A
7.5 @ 25°	24.0†	89.8K†	1.0	1.0	10	10	±200	700	4-3	2.075	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L2C
7.5 @ 25°	24.0†	89.8K†	5.0	5.0	10	10	±200	700	4-3	2.075	0.325	0.325	Axial PT	1.5	0.034	KS-20289,L2A
10.0 @ 25°	0.36†	7960†	1.0	1.0	2.5	2.5	Note 1	N/S	4-1	1.813	0.469	0.469	Axial PT	1.5	0.040	KS-14603,L5C_
10.0 @ 25°	0.9†	7960†	5.0	5.0	2.5	2.5	Note 1	N/S	4-1	1.813	0.469	0.469	Axial PT	1.5	0.040	KS-14603,L2A_
10.0 @ 25°	3.0†	7960†	1.0	1.0	2.5	2.5	Note 1	N/S	4-1	1.813	0.469	0.469	Axial PT	1.5	0.040	KS-14603,L2C_
10.0 @ 25°	12.0†	7960†	0.25	0.25	2.5	2.5	Note 1	N/S	4-1	1.813	0.469	0.469	Axial PT	1.5	0.040	KS-14603,L2G_
10.0 @ 25°	8060†	18.9K†	1.0	1.0	2.5	2.5	±300	N/S	4-2	1.813	0.469	0.469	Axial PT	1.5	0.044	KS-16266,L2C
10.0 @ 25°	8060†	16.9K†	1.0	1.0	2.5	2.5	±50	N/S	4-2	1.813	0.469	0.469	Axial PT	1.5	0.044	KS-16266,L5C
10.0 @ 25°	8060†	18.9K†	5.0	5.0	2.5	2.5	±300	N/S	4-2	1.813	0.469	0.469	Axial PT	1.5	0.044	KS-16266,L2A
10.0 @ 25°	8060†	18.9K†	0.25	0.25	2.5	2.5	±50	N/S	4-2	1.813	0.469	0.469	Axial PT	1.5	0.044	KS-16266,L2G

Note 1 Temperature coefficient shall be specified with 4th suffix letter in the code designation as follows:
A = 0 ±30 PPM/°C; B = 0 ±50 PPM/°C; C = 0 ±150 PPM/°C; D = 0 ±300 PPM/°C.

† From Table 1 - Recommended Standard Values

N/S Not Specified

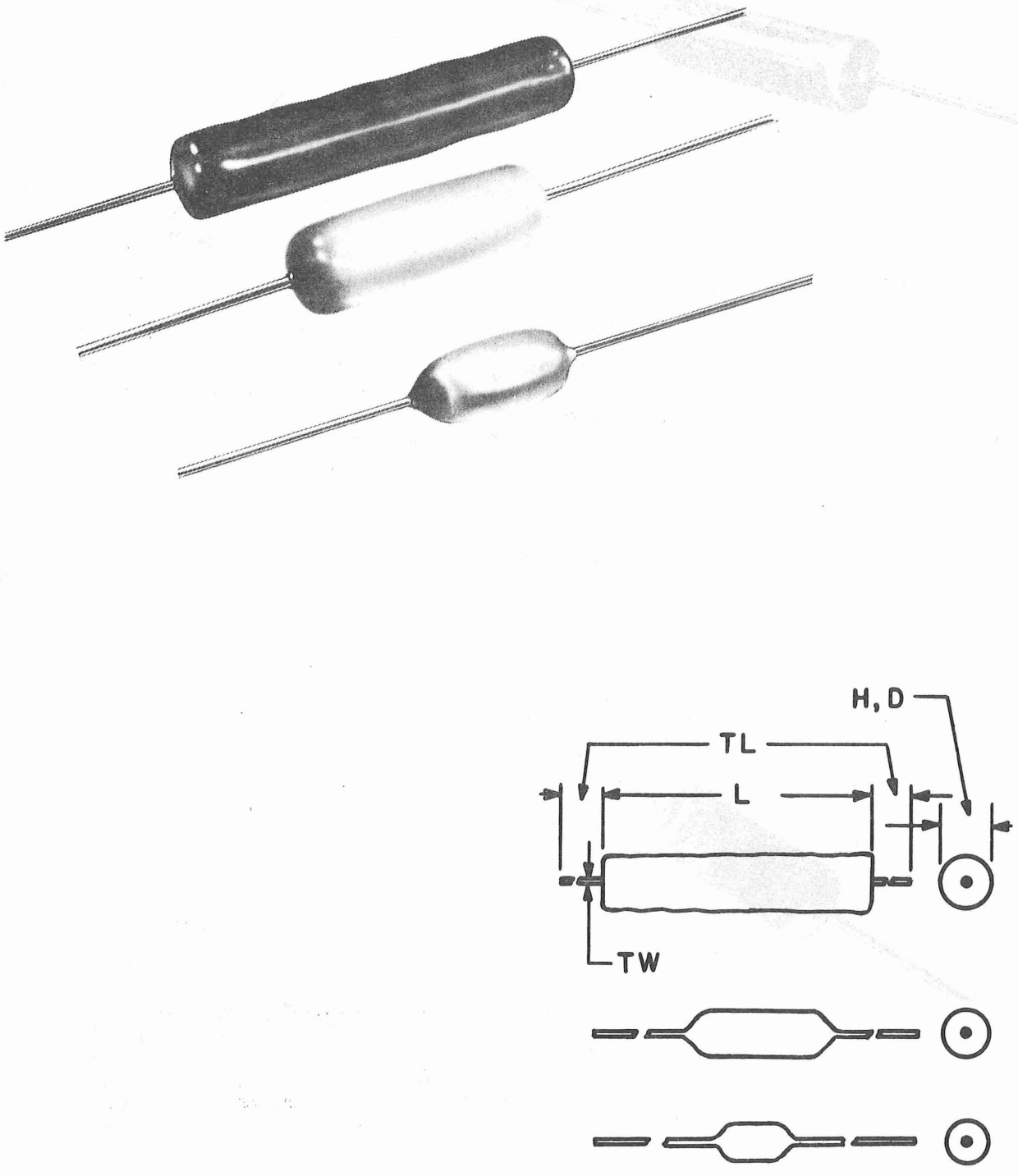


Fig. 4-1

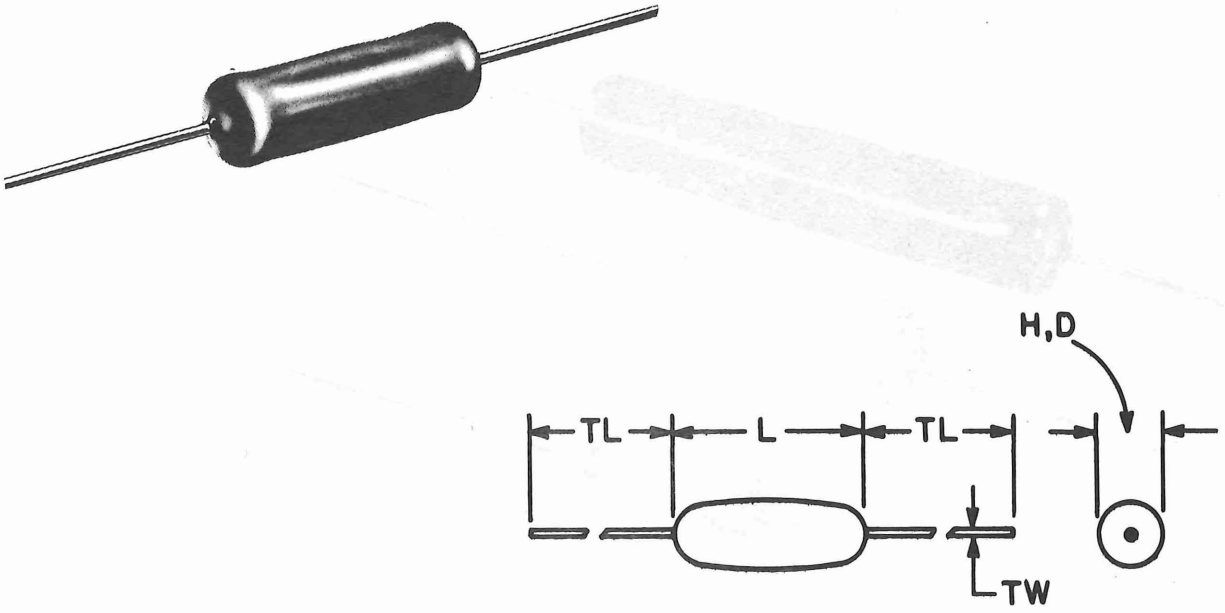


Fig. 4-2

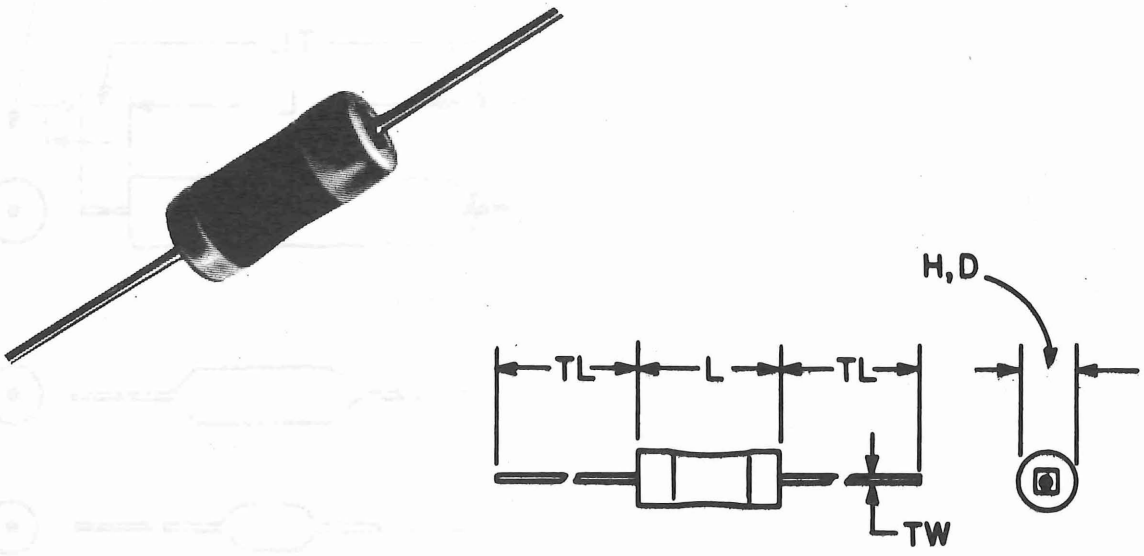


Fig. 4-3

TABLE 5-1

ELECTRICAL AND PHYSICAL DATA - POWER TERMINAL LUG RESISTORS

MAX. RATED PWR APPL AT °C (WATTS)	RESISTANCE RANGE OR VALUE (OHMS)		INITIAL TOLERANCE		ADDITIONAL END-OF-LIFE TOLERANCE		TEMP COEF (PPM/°C)	MAX.RATED VOLTAGE RMS OR DC (VOLTS)	FIG.	MAXIMUM BODY SIZE (IN.)			TERMINAL TYPE	TERMINAL SIZE (IN.)		CODE
	MIN	MAX.	+%	-%	+%	-%				L	H	D		TL	TW	
8 @ 25°	6.5†	2100†	1.0	1.0	3.0	3.0	±150	N/S	5-1	1.031		0.594	Radial Lug	0.438	0.188	KS-8512,L4C
8 @ 25°	1.0†	950†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	1.031		0.594	Radial Lug	0.438	0.188	KS-8512,L4A
10 @ 25°	19.0†	4400†	1.0	1.0	3.0	3.0	±150	N/S	5-1	1.781		0.469	Radial Lug	0.438	0.188	KS-8512,L3C
10 @ 25°	1.0†	2700†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	1.781		0.469	Radial Lug	0.438	0.188	KS-8512,L3A
15 @ 25°	33.0†	7600†	1.0	1.0	3.0	3.0	±150	N/S	5-1	2.031		0.719	Radial Lug	0.438	0.188	KS-8512,L6C
15 @ 25°	1.0†	4800†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	2.031		0.719	Radial Lug	0.438	0.188	KS-8512,L6A
20 @ 25°	48.0†	9800†	1.0	1.0	3.0	3.0	±150	N/S	5-1	2.031		0.719	Radial Lug	0.438	0.188	KS-8512,L8C
20 @ 25°	1.0†	6900†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	2.031		0.719	Radial Lug	0.438	0.188	KS-8512,L8A
30 @ 25°	80.0†	17.8K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	3.156		0.719	Radial Lug	0.438	0.188	KS-8512,L10C
30 @ 25°	1.6†	11.8K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	3.156		0.719	Radial Lug	0.438	0.188	KS-8512,L10A
40 @ 25°	125†	25.6K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	3.531		0.906	Radial Lug	0.563	0.250	KS-8512,L22C
40 @ 25°	2.4†	17.1K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	3.531		0.906	Radial Lug	0.563	0.250	KS-8512,L22A
50 @ 25°	165†	35.1K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	4.563		0.906	Radial Lug	0.563	0.250	KS-8512,L24C
50 @ 25°	3.3†	22.8K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	4.563		0.906	Radial Lug	0.563	0.250	KS-8512,L24A
60 @ 25°	180†	35K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	4.063		1.125	Radial Lug	0.625	0.313	KS-8512,L32C
60 @ 25°	3.6†	23K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	4.063		1.125	Radial Lug	0.625	0.313	KS-8512,L32A

† From Table 1 - Recommended Standard Values

N/S Not Specified

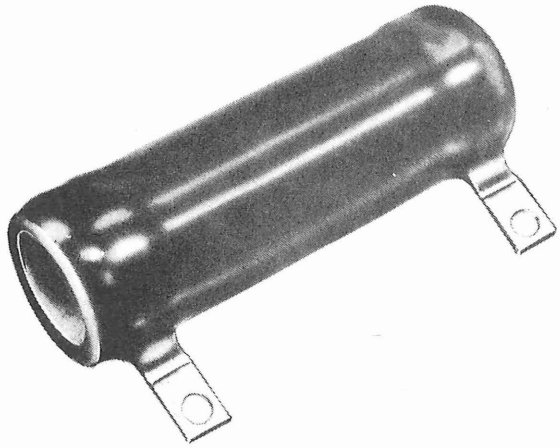
TABLE 5-1 (Cont)

ELECTRICAL AND PHYSICAL DATA - POWER TERMINAL LUG RESISTORS

MAX. RATED PWR APPL AT °C (WATTS)	RESISTANCE RANGE OR VALUE (OHMS)		INITIAL TOLERANCE		ADDITIONAL END-OF-LIFE TOLERANCE		TEMP COEF (PPM/°C)	MAX.RATED VOLTAGE RMS OR DC (VOLTS)	FIG.	MAXIMUM BODY SIZE (IN.)			TERMINAL TYPE	TERMINAL SIZE (IN.)		CODE
	MIN	MAX.	+%	-%	+%	-%				L	H	D		TL	TW	
75 @ 25°	235†	42K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	4.313		1.313	Radial Lug	0.625	0.313	KS-8512,L39C
75 @ 25°	4.5†	27K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	4.313		1.313	Radial Lug	0.625	0.313	KS-8512,L39A
90 @ 25°	300†	60K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	6.062		1.125	Radial Lug	0.625	0.313	KS-8512,L34C
90 @ 25°	5.7†	38K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	6.062		1.125	Radial Lug	0.625	0.313	KS-8512,L34A
115 @ 25°	385†	77K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	6.563		1.313	Radial Lug	0.625	0.313	KS-8512,L41C
115 @ 25°	7.3†	50K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	6.563		1.313	Radial Lug	0.625	0.313	KS-8512,L41A
160 @ 25°	530†	107K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	8.563		1.313	Radial Lug	0.625	0.313	KS-8512,L42C
160 @ 25°	10†	68K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	8.563		1.313	Radial Lug	0.625	0.313	KS-8512,L42A
200 @ 25°	670†	130K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	10.563		1.313	Radial Lug	0.625	0.313	KS-8512,L43C
200 @ 25°	12.7†	87K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	10.563		1.313	Radial Lug	0.625	0.313	KS-8512,L43A
215 @ 25°	750†	153K†	1.0	1.0	3.0	3.0	±150	N/S	5-1	11.813		1.313	Radial Lug	0.625	0.313	KS-8512,L44C
215 @ 25°	14.3†	98K†	5.0	5.0	3.0	3.0	+125±175	N/S	5-1	11.813		1.313	Radial Lug	0.625	0.313	KS-8512,L44A

† From Table 1 - Recommended Standard Values

N/S Not Specified



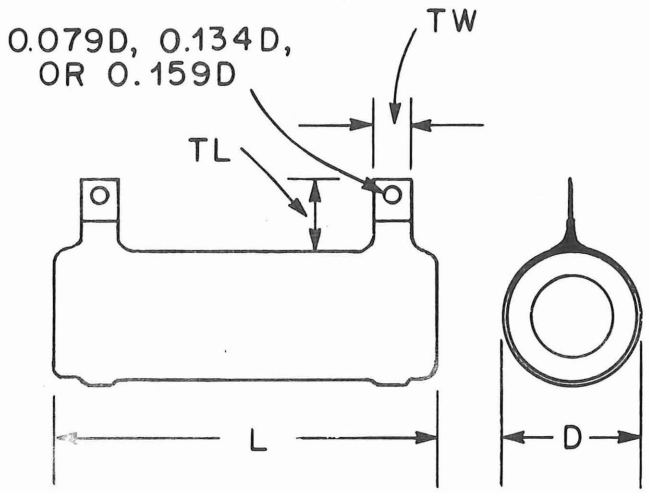


Fig. 5-1

TABLE 6-1

ELECTRICAL AND PHYSICAL DATA - 18-TYPE WIRE WOUND RESISTORS, NOTE 1

All 18-Type resistors have the following characteristics:
Additional EOL Tolerance: +3.5, -0% Max. Body Size (in.): L=1.656, H=3.5, D=0.375
Temperature Coef (PPM/°C): -50 to +300 Terminal Type: End Mechanically Wrapped
Max. Rated Voltage(rms/dc): 350 volts Terminal Size:(in.): TL=1.188
Fig. Reference: 6-1

MAX. RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS)	INITIAL TOLERANCE +%	INITIAL TOLERANCE -%	CODE	MAX. RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS)	INITIAL TOLERANCE +%	INITIAL TOLERANCE -%	CODE
5.1	1.1	1.0	1.0	18KW					
5.1	1.2	1.0	1.0	18CH	5.1	226	5.0	5.0	18AG
5.1	1.8	1.0	1.0	18HK	5.1	294	1.0	1.0	18HY
5.1	2.0	1.0	1.0	18HL	5.1	340	1.0	1.0	18BN
					5.1	422	0.5	0.5	18GK
5.1	10.0	5.0	5.0	18R					
5.1	12.0	0.25	0.25	18HN	5.1	600	0.1	0.1	18JC
5.1	13.5	0.25	0.25	18JT	5.1	600	1.0	1.0	18GH
5.1	15.0	1.0	1.0	18DJ	5.1	750	1.0	1.0	18DR
					5.1	750	5.0	5.0	18BL
5.1	20.0	1.0	1.0	18BE					
5.1	50.0	1.0	1.0	18GB	5.1	887	1.0	1.0	18KR
5.1	75.0	1.0	1.0	18ED	5.1	1000	1.0	1.0	18BM
5.1	100.0	1.0	1.0	18BW	5.1	1000	5.0	5.0	18EH
					5.1	1070	1.0	1.0	18HA
5.1	100.0	5.0	5.0	18U					
5.1	120.0	1.0	1.0	18EP	5.1	1200	1.0	1.0	18KY
5.1	121.0	0.5	0.5	18GJ	5.1	1260	1.0	1.0	18CP
					5.1	1300	1.0	1.0	18PK
5.1	133	1.0	1.0	18ER	5.1	1600	1.0	1.0	18GE
5.1	133	5.0	5.0	18W					
5.1	135	1.0	1.0	18JP	5.1	2000	1.0	1.0	18CR
5.1	140	5.0	5.0	18E	5.1	3050	1.0	1.0	18JE
					5.1	3200	1.0	1.0	18FR
5.1	142	1.0	1.0	18GD	5.1	10K	1.0	1.0	18KF
5.1	200	1.0	1.0	18BT					
5.1	208	1.0	1.0	18GP	5.1	10K	5.0	5.0	18JW
5.1	210	1.0	1.0	18FD					

Note 1. Only codes of standard nominal resistance values and tolerances are shown. Nonstandard values and tolerances are available. If a nonstandard value is required, the consultant should be contacted. For Derating curve see page 10-3.

TABLE 6-2

ELECTRICAL AND PHYSICAL DATA - 19-TYPE WIRE WOUND RESISTORS, NOTE 1

All 19-Type resistors have the following characteristics:
Additional EOL Tolerance: +3.5, -0% Max. Body Size (in.): L=1.656, H=3.5, D=0.375
Temperature Coef (PPM/°C): -50 to +300 Terminal Type: End Mechanically Wrapped
Max. Rated Voltage(rms/dc): 350 volts Terminal Size:(in.): TL=1.188
Fig. Reference: 6-2

MAX. RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE	MAX. RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE
5.1*	0.5	1.0	1.0	1.0	19KW	0.3	37.0		1.0	1.0	19ABH
5.1*	1.0	1.0	1.0	1.0	19BL	4.8		1800.0			
5.1*	1.0	2.0	1.0	1.0	19DR						
5.1*	1.0	0.5	1.0	1.0	19KW	5.1*	47.0	59.0	1.0	1.0	19KC
5.1*	2.0	1.0	1.0	1.0	19DR	5.1*	50.0	50.0	1.0	1.0	19AM
3.8	2.0		1.0	1.0	19UT	0.4	50.0		1.0	1.0	19AY
1.3		6.0				4.7		2000.0			
4.0	3.5		1.0	1.0	19MF	5.1*	53.0	111.0	1.0	1.0	19GT
1.1		10.0				5.1*	59.0	47.0	1.0	1.0	19KC
1.3	6.0		1.0	1.0	19UT	4.6	60.4		1.0	1.0	19ABF
3.8		2.0				0.5		140.0			
5.1*	10.0	10.0	1.0	1.0	19W	5.1*	75.0	110.0	1.0	1.0	19GC
						5.1*	92.0	92.0	1.0	1.0	19YT
1.1	10.0		1.0	1.0	19MF	5.1*	100.0	100.0	5.0	5.0	19K†
4.0		3.5				5.1*	100.0	100.0	1.0	1.0	19DN
5.1*	11.0	11.0	1.0	1.0	19NJ	5.1*	100.0	100.0	1.0	1.0	19FG
5.1*	13.5	15.0	1.0	1.0	19FB	5.1*	100.0	100.0	0.25	0.25	19LC
5.1*	15.0	30.0	1.0	1.0	19EK	5.1*	100.0	200.0	1.0	1.0	19NU
5.1*	15.0	13.5	1.0	1.0	19FB	5.1*	100.0	130.0	1.0	1.0	19FJ
5.1*	17.2	17.2	1.0	1.0	19YP						
						2.2	100.0		1.0	1.0	19RJ
1.0	20.0		1.0	1.0	19HU	2.9		600.0			
4.1		280.0									
						1.4	100.0		5.0	5.0	19DU
1.8	20.0		1.0	1.0	19JB	3.7		1000.0			
3.3		150.0									
						1.1	100.0		1.0	1.0	19RB
5.1*	30.0	15.0	1.0	1.0	19EK	4.0		1300.0			
5.1*	37.0	37.0	1.0	1.0	19LJ						
						5.1*	105.0	105.0	1.0	1.0	19WA

Note 1. Both windings of all codes have standard values per Table 1 in Standard Values Section. Nonstandard values and tolerances are available. If a nonstandard value is required, contact the consultant. For Derating curve see page 10-3.

* Overall rating of resistive element
† The two sections are valanced within 1% of each other

TABLE 6-2

ELECTRICAL AND PHYSICAL DATA - 19-TYPE WIRE WOUND RESISTORS, NOTE 1 (Cont)

All 19-Type resistors have the following characteristics:
Additional EOL Tolerance: +3.5, -0% Max. Body Size (in.). L=1.656, H=3.5, D=0.375
Temperature Coef (PPM/°C): -50 to +300 Terminal Type: End Mechanically Wrapped
Max. Rated Voltage(rms/dc): 350 volts Terminal Size:(in.): TL=1.188
Fig. Reference: 6-2

MAX. RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE	MAX. RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE
5.1*	110.0	75.0	1.0	1.0	19GC	5.1*	182.0	182.0	1.0	1.0	19UP
5.1*	111.0	53.0	1.0	1.0	19GT						
5.1*	115.0	115.0	1.0	1.0	19EA	2.6	191.0		1.0	1.0	19MN
						2.5		920.0			
4.6	120.0		1.0	1.0	19ABE						
0.5		280.0				5.1*	198.0	198.0	1.0	1.0	19UR
						5.1*	200.0	100.0	1.0	1.0	19NU
1.5	120.0		1.0	1.0	19CU	5.1*	200.0	200.0	1.0	1.0	19AAH
3.6		1050.0				5.1*	210.0	210.0	1.0	1.0	19RK
						5.1*	240.0	240.0	1.0	1.0	19LE
5.1*	129.0	129.0	1.0	1.0	19TT						
5.1*	130.0	100.0	1.0	1.0	19FJ	2.0	246.0		1.0	1.0	19AAL
5.1*	130.0	150.0	1.0	1.0	19FY	3.1		1670.0			
5.1*	132.0	158.0	1.0	1.0	19BU						
5.1*	135.0	135.0	1.0	1.0	19TP	1.0	280.0		1.0	1.0	19HU
						4.1		20.0			
0.5	140.0		1.0	1.0	19ABF						
4.6		60.4				0.5	280.0		1.0	1.0	19ABE
						4.6		120.0			
5.1*	140.0	140.0	5.0	5.0	19AF						
5.1*	145.0	145.0	1.0	1.0	19LL	2.7	280.0		1.0	1.0	19DH
5.1*	145.0	150.0	1.0	1.0	19LT	2.4		1330.0			
5.1*	150.0	145.0	1.0	1.0	19LT						
5.1*	150.0	150.0	1.0	1.0	19LB	5.1*	284.0	284.0	1.0	1.0	19UN
3.3	150.0		1.0	1.0	19JB	2.5	291.0		1.0	1.0	19AAM
1.8		20.0				2.6		1470.0			
5.1*	150.0	130.0	1.0	1.0	19FY	5.1*	336.0	336.0	1.0	1.0	19UJ
5.1*	156.0	156.0	1.0	1.0	19NM						
5.1*	156.0	156.0	0.5	0.5	19PL	3.5	370.0		1.0	1.0	19AAN
5.1*	158.0	132.0	1.0	1.0	19BU	1.6		1260.0			
5.1*	165.0	165.0	1.0	1.0	19WF	3.4	370.0		1.0	1.0	19ME
5.1*	180.0	180.0	1.0	1.0	19WE	1.7		1300.0			

Note 1. Both windings of all codes have standard values per Table 1 in Standard Values Section. Nonstandard values and tolerances are available. If a nonstandard value is required, contact the consultant. For Derating curve see page 10-3.

* Overall rating of resistive element

TABLE 6-2

ELECTRICAL AND PHYSICAL DATA - 19-TYPE WIRE WOUND RESISTORS, NOTE 1 (Cont)

All 19-Type resistors have the following characteristics:
Additional EOL Tolerance: +3.5, -0%
Temperature Coef (PPM/°C): -50 to +300
Max. Rated Voltage(rms/dc): 350 volts
Fig. Reference: 6-2
Max. Body Size (in.). L=1.656, H=3.5, D=0.375
Terminal Type: End Mechanically Wrapped
Terminal Size:(in.): TL=1.188

MAX. RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE	MAX.RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE
						5.1*	920.0	825.0	1.0	1.0	19AAT
4.8	493.0		1.0	1.0	19AAP	5.1*	1000.0	1000.0	5.0	5.0	19BM
0.3		1070.0				5.1*	1000.0	750.0	5.0	5.0	19CP
						5.1*	1000.0	1000.0	1.0	1.0	19RN
2.9	600.0		1.0	1.0	19RJ						
2.2		100.0				3.7	1000.0		5.0	5.0	19DU
						1.4		100.0			
5.1*	634.0	634.0	1.0	1.0	19ABG						
						3.6	1050.0		1.0	1.0	19CU
3.1	673.0		1.0	1.0	19ABC	1.5		120.0			
2.0		2670.0									
						0.3	1070.0		1.0	1.0	19AAP
3.4	681.0		1.0	1.0	19ABB	4.8		493.0			
1.7		2370.0									
						4.8	1100.0		1.0	1.0	19SN
4.2	706.0		1.0	1.0	19ABA	0.3		2400.0			
0.9		1870.0									
						5.1*	1150.0	1150.0	1.0	1.0	19TL
4.6	715.0		1.0	1.0	19AAY	5.1*	1170.0	777.0	1.0	1.0	19AAU
0.5		1670.0				5.1*	1200.0	1600.0	1.0	1.0	19PS
5.1*	723.0	898.0	1.0	1.0	19AAR	1.7	1260.0		1.0	1.0	19AAN
5.1*	750.0	750.0	1.0	1.0	19UE	3.4		370.0			
5.1*	750.0	1000.0	5.0	5.0	19CP						
5.1*	750.0	1320.0	1.0	1.0	19AAW	1.7	1300.0		1.0	1.0	19ME
5.1*	777.0	1170.0	1.0	1.0	19AAU	3.4		370.0			
5.1*	816.0	856.0	1.0	1.0	19AAS	4.0	1300.0		1.0	1.0	19RB
5.1*	825.0	920.0	1.0	1.0	19AAT	1.1		100.0			
5.1*	856.0	816.0	1.0	1.0	19AAS						
5.1*	898.0	723.0	1.0	1.0	19AAR	5.1*	1320.0	750.0	1.0	1.0	19AAW
2.5	920.0		1.0	1.0	19MN	2.4	1330.0		1.0	1.0	19DH
2.6		191.0				2.7		280.0			

Note 1. Both windings of all codes have standard values per Table 1 in Standard Values Section. Nonstandard values and tolerances are available. If a nonstandard value is required, contact the consultant. For Derating curve see page 10-3.

* Overall rating of resistive element

TABLE 6-2

ELECTRICAL AND PHYSICAL DATA - 19-TYPE WIRE WOUND RESISTORS, NOTE 1 (Cont)

All 19-Type resistors have the following characteristics:
Additional EOL Tolerance: +3.5, -0%
Temperature Coef (PPM/°C): -50 to +300
Max. Rated Voltage(rms/dc): 350 volts
Fig. Reference: 6-2
Max. Body Size (in.). L=1.656, H=3.5, D=0.375
Terminal Type: End Mechanically Wrapped
Terminal Size:(in.): TL=1.188

MAX.RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE	MAX.RATED PWR APPL AT 56°C (WATTS)	RESISTANCE VALUE (OHMS) WDG	WDG	INITIAL TOLERANCE +%	-%	CODE
5.1*	1350.0	1350.0	1.0	1.0	19RM	3.1		6810.0			
2.6	1470.0		1.0	1.0	19AAM	4.7	2000.0		1.0	1.0	19AY
2.5		291.0				0.4		50.0			
5.1*	1600.0	1200.0	1.0	1.0	19PS	5.1*	2210.0	2610.0	1.0	1.0	19ABD
5.1*	1670.0	2460.0	1.0	1.0	19SD						
						1.7	2370.0		1.0	1.0	19ABB
3.1	1670.0		1.0	1.0	19AAL	3.4		681.0			
2.0		246.0									
						4.8	2400.0		1.0	1.0	19SN
0.5	1670.0		1.0	1.0	19AAY	0.3		1100.0			
4.6		715.0									
						5.1*	2460.0	1670.0	1.0	1.0	19SD
4.8	1800.0		1.0	1.0	19ABH	5.1*	2610.0	2210.0	1.0	1.0	19ABD
0.3		37.0									
						2.0	2670.0		1.0	1.0	19ABC
0.9	1870.0		1.0	1.0	19AbA	3.1		673.0			
4.2		706.0									
						3.1	6810.0		1.0	1.0	19AbL
2.0	1910.0		1.0	1.0	19ABL	2.0		1910.0			

Note 1. Both windings of all codes have standard values per Table 1 in Standard Values Section. Nonstandard values and tolerances are available. If a nonstandard value is required, contact the consultant. For Derating curve see page 10-3.

* Overall rating of resistive element

GENERAL DESCRIPTION

The resistors described in this section are intended for special application ie, where temperature compensation is required or where a high degree of stability and precision with time, temperature, and humidity are essential. The information shown in the following table contains only basic data and is not intended to be used for selecting a particular component.

Table 7-1

BASIC DATA - SPECIAL TYPE RESISTORS

CODE	TYPE CODE (NOTE 1)	DESCRIPTION	MAX POWER RATING (WATTS) AT °C)	NOMINAL RESISTANCE RANGE OHMS FROM	NOMINAL RESISTANCE RANGE OHMS TO	TOLERANCE ±%	MAX RATED VOLTAGE RMS OR DC (VOLTS)	TEMP COEF (PPM/°C)	ADDITIONAL END-OF-LIFE TOLERANCE +%	ADDITIONAL END-OF-LIFE TOLERANCE -%	REMARKS
254A	Family	Rectangular, Flat, Axial PT	1/8 @ 70° 1/4 @ 40°	5†	115K†	1	250	-110 ±50	+1.5	-0	
257A	Family	Rectangular, Flat, Radial PT	1/8 @ 70° 1/4 @ 40°	5†	115K†	1	250	-110 ±50	+1.5	-0	
259A	Family	Tubular, Insulated, Axial PT	1/4 @ 70° 1/8 @ 70°	1† 10†	9.99† 261K†	1 1	250 250	-250 ±250	+4	-2	Temp Comp
263A	Family	Tubular, Insulated, Axial PT	1/2 @ 40°	1†	15M†	1	350	-200 ±500	+4	-2	Temp Comp
KS-19077	Family	Tubular, Insulated, Axial PT	1/4 @ 100°	10	10K	5,10	50	+7000	N/S	N/S	Temp Comp
KS-20045	Family	Tubular, Silicone-Coated, Axial PT	2.5, 4, 8 @ 25°	0.1†	12.4K†	0.25, 0.5, 1, 2, 3, 5, 10	N/S				
KS-20046	Family	Tubular, Finned Aluminum Housing, Axial Solder Type Terminals	4, 8 @ 25°	0.1†	1260†	0.25, 0.5, 1, 2, 3	N/S				Noninductive Power Type

Note 1 Family - range of values per code number.

† From Table 1 - Recommended Standard Values

N/S Not Specified

GENERAL DESCRIPTION

These resistors are fixed, composition, insulated types having axial, wire lead terminals which extend approximately 1-1/2 inches from the body of the resistor.

FEATURES

The preferred carbon resistors are available in nominal resistance values from 2.7 ohms through 22 megohms based on the EIA preferred value system shown in the STANDARD VALUE section, Table 2, and with power ratings of 1/4, 1/2, 1, and 2 watt depending on the specification. Resistors are available in ±5 percent tolerances for all nominal values listed.

RECOMMENDED PRACTICES

The following practices are recommended for Bell System applications:

(a) These resistors are not stable in resistance value with time, with varying atmospheric conditions, and as a result of excessive heating when soldering irons are applied too close to the resistor body or on the terminals for too long a time. It is intended that the failure rate of the KS-16645, KS-19150, KS-19151, and KS-19152 high reliability resistors shall be no more than 10 failure units, or 0.001 percent failure per 1000 hours when operated at 50 percent of rated power in an ambient temperature of 25°C.

(b) It is recommended that, when resistors are tested after shelf aging up to 6 months (either prior to or including aging), permissible deviations from nominal resistance values be in accordance with the following:

Initial Manufacturing Tolerances	±5%
Tolerances After Shelf-Aging and/or Shop Installation	-8 to +11%

(c) The power ratings are contingent upon free air mounting and up to 80 percent of the generated heat being dissipated through the leads. Printed wiring board applications do not satisfy these contingencies. Therefore, when used on printed wiring boards, it is imperative that the 1 and 2 watt ratings of the KS-19151 and KS-19152 resistors be considered as 1/2 and 1 watt respectively if high reliability is to be maintained. For the smaller size KS-16645 and KS-19150 resistors, 1/4 and 1/2 watt respectively, somewhat less heat is required to be dissipated through the leads. Therefore, it is

recommended that the ratings be considered as 1/8 and 1/4 watt respectively. The appropriate consultant should be contacted when the reduced ratings cause mounting space problems.

(d) Resistance value of these resistors changes considerably with frequency depending on the product of megohms and megahertz, ie, a 0.10 megohm resistor at 1 megahertz will decrease approximately 10 percent in value. For further information on this subject, contact the appropriate consultant.

(e) To minimize the effects of humidity, resistors should be operated at a minimum of 10 percent of their rated power.

(f) Where high voltages are present between the resistor circuit and grounded surfaces on which the resistor is mounted, supplementary insulation capable of withstanding the voltage condition should be provided between the resistor and mounting or between the mounting and ground.

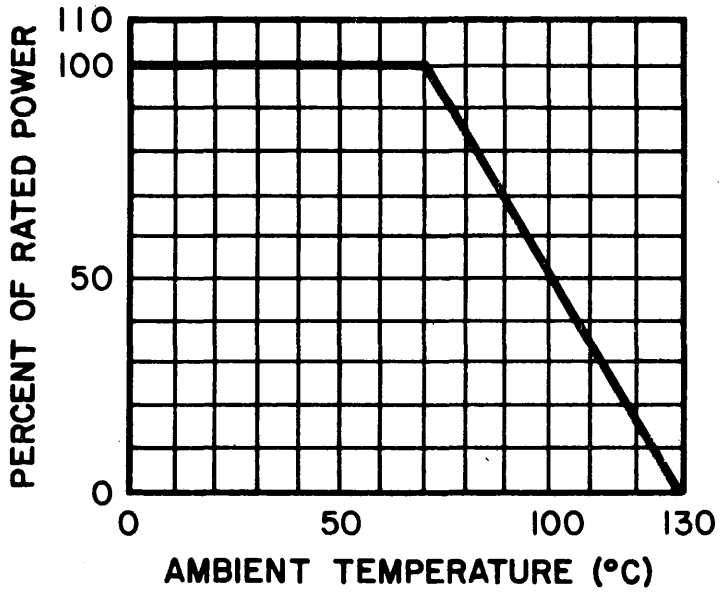


Fig. 8-1 - KS-13490 and KS-13491, Derating Curve

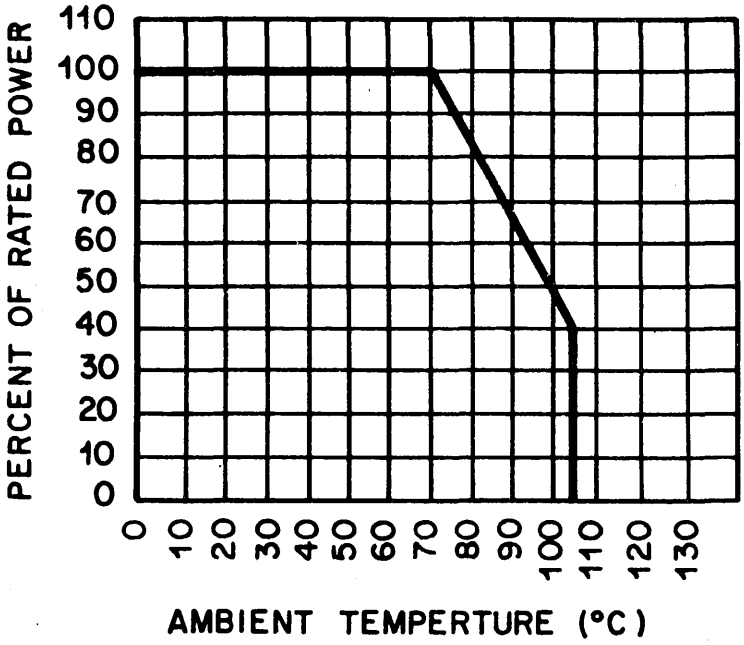


Fig. 8-2 - KS-16645 and KS-19150 through KS-19152, Derating Curve

TABLE 8-1

BASIC DATA - CARBON COMPOSITION RESISTORS

BASIC CODE	TYPE CODE (NOTE 1)	DESCRIPTION	MAX. POWER RATING (WATTS AT 70°C)	NOMINAL RESISTANCE RANGE (OHMS) FROM	TO	TOLERANCE ±%	MAX. VOLTAGE RATING RMS OR DC (VOLTS)	REMARKS
KS-13490	Family	Tubular, Insulated, Axial PT	1/2	2.7	22M	5	350	
KS-13491	Family	Tubular, Insulated, Axial PT	1	2.7	22M	5	500	
* KS-16645	Family	Tubular, Insulated, Axial PT	1/4	2.7	22M	5	250	High Reliability
* KS-19150	Family	Tubular, Insulated, Axial PT	1/2	2.7	22M	5	350	High Reliability
* KS-19151	Family	Tubular, Insulated, Axial PT	1	2.7	22M	5	500	High Reliability
→ * KS-19152	Family	Tubular, Insulated, Axial PT	2	10.	22M	5	750	High Reliability

Note 1 Family - range of values per code number.

* See Recommended Practices, Page 8-1 (c).

GENERAL DESCRIPTION

Metal film resistors are fixed resistors that consist of a metallic film resistive element encased in a molded or conformally coated moisture-resistant flame-proof or flame-retardant enclosure. They are equipped with tinned axial wire lead terminals.

FEATURES

These resistors are available in nominal resistance values from 0.4 ohm to 2.1 megohms inclusive, based on the recommended standard values shown in Table 1 of the STANDARD VALUE section and have power ratings of 1/8, 1/4, 1/2, 1, 2, 3, 3.5, 4, 5.5, 6.5, and 7.5 watts depending on the specification. The preferred KS-16311 through KS-16315 resistors have tolerances of plus or minus 0.1 and 0.5 percent; the KS-20616 and KS-20810 preferred resistors have plus or minus 1 percent tolerance only and the preferred tolerances for KS-20289 are plus or minus 1 and 5 percent.

RECOMMENDED PRACTICES

These resistors have relatively high stability with time, temperature, and humidity, and should be considered for application where such conditions require this characteristic.

Caution should be used where any possible peak voltages may exceed the maximum rated voltage regardless of the time duration. The appropriate consultant should be contacted to assure the suitability of a resistor selected for such applications.

The KS-16311 through KS-16315 resistors may be operated continuously at rated voltage provided the rated power is not exceeded. When voltages in excess of rated values are possible between the resistor and a conductor surface, supplementary insulation should be provided to assure protection against breakdown. It is suggested that mounting straps be used for mounting the KS-16315 resistor. For maximum reliability, these items should be applied in a 50 percent derated condition.

A further consideration in the application of resistors in this group is the environment in which they are to be used. For example, if they are to be used under ambient temperatures in excess of those given in Table 9-1, rated power is reduced as shown on the high-temperature derating curve applicable to the particular code.

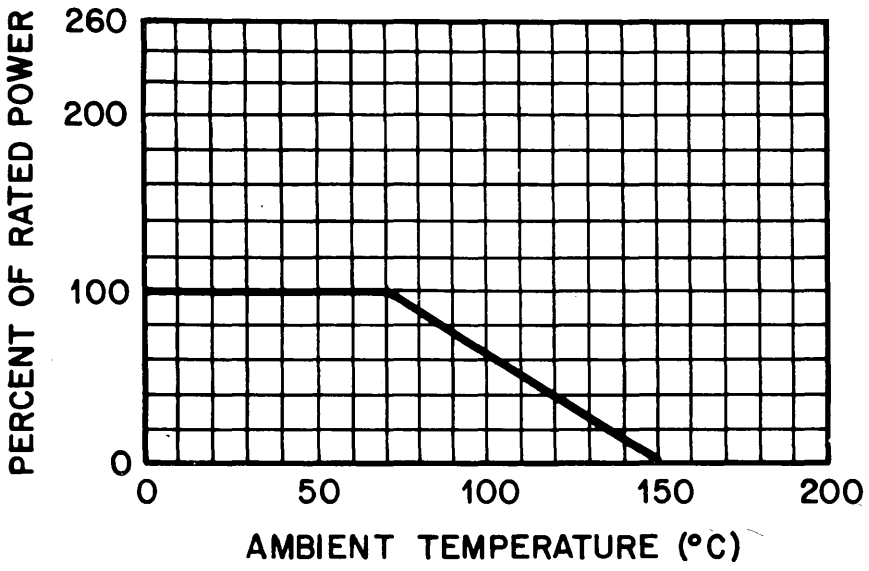


Fig. 9-1 - KS-16311 Through KS-16315 Derating Curve

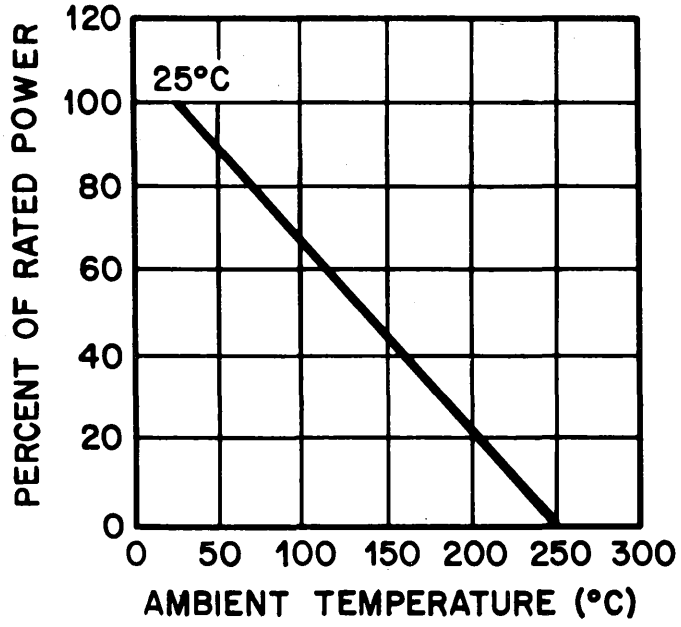


Fig. 9-2 - KS-20289 Derating Curve

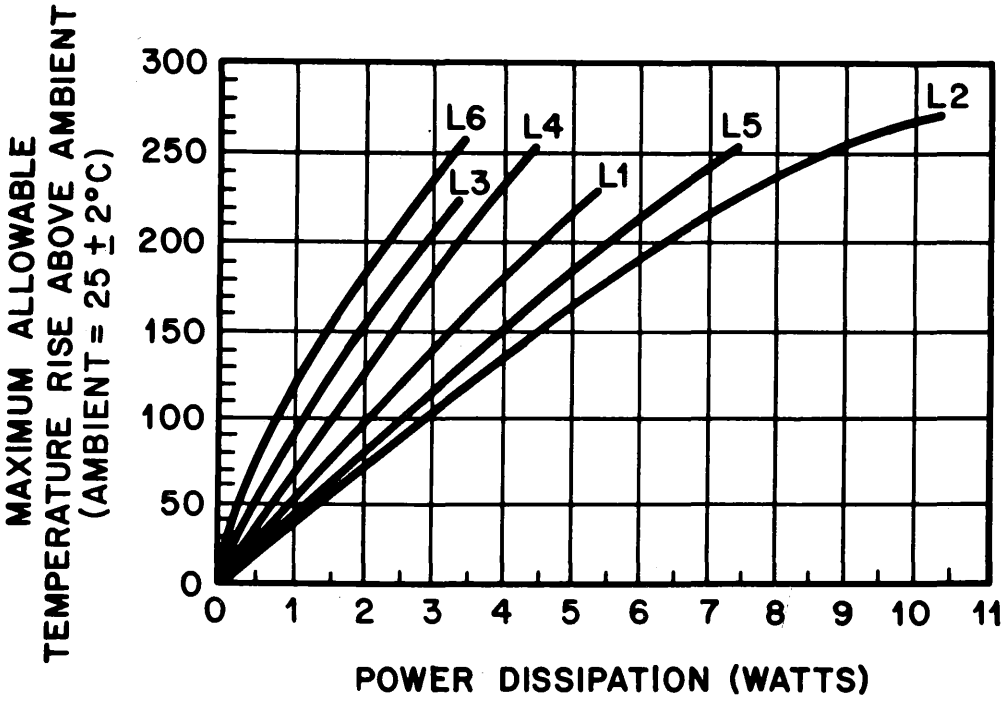


Fig. 9-3 - KS-20289 Temperature Rise Curve

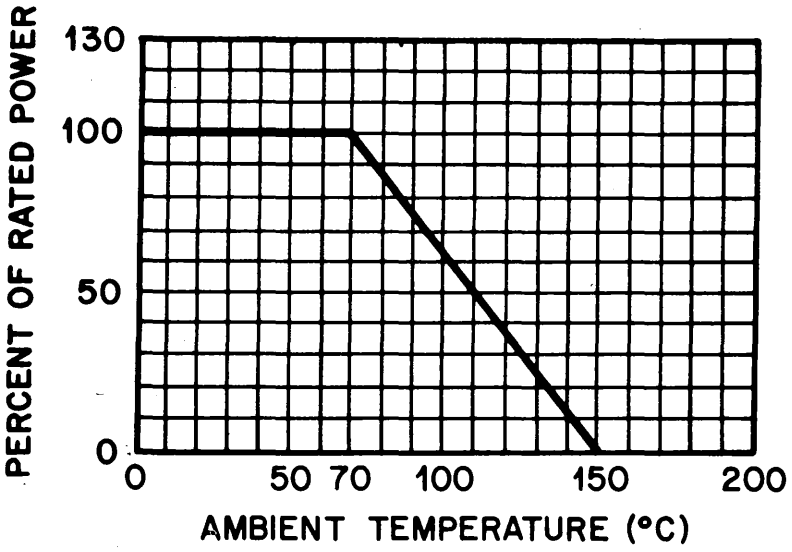


Fig. 9-4 - KS-20616 Derating Curve

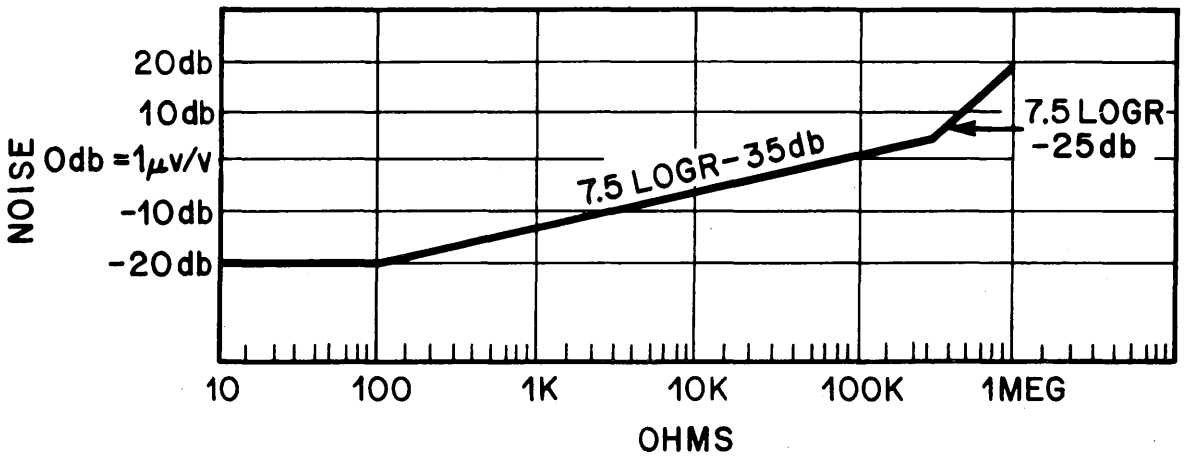


Fig. 9-5 - KS-20616 Current Noise Curve

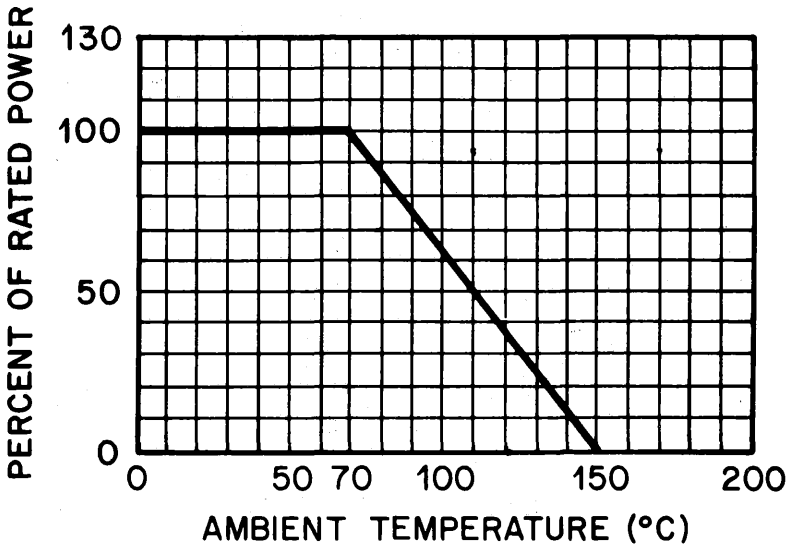


Fig. 9-6 - KS-20810 Derating Curve

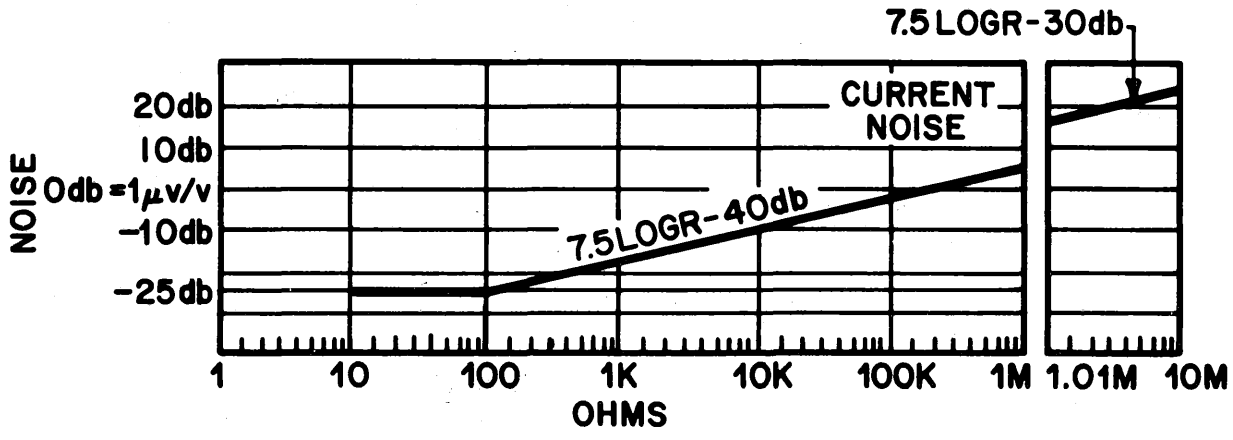


Fig. 9-7 - KS-20810 Current Noise Level Curve

TABLE 9-1

BASIC DATA - METAL FILM RESISTORS

BASIC CODE	TYPE CODE (NOTE 1)	DESCRIPTION	MAX POWER RATING (WATTS AT 70°C)	NOMINAL RESISTANCE RANGE (OHMS) FROM	NOMINAL RESISTANCE RANGE (OHMS) TO	TOLERANCE ±%	MAX VOLTAGE RATING RMS OR DC (VOLTS)	REMARKS
KS-16311	Family	Tubular, Encapsulated, Axial PT	1/8	20	200K	0.1, 0.5	200	Precision
KS-16312	Family	Tubular, Encapsulated, Axial PT	1/4	10	500K	0.1, 0.5	250	Precision
KS-16313	Family	Tubular, Encapsulated, Axial PT	1/2	1.0	1M	0.1, 0.5	300, 350	Precision
KS-16314	Family	Tubular, Encapsulated, Axial PT	1	10	2M	0.1, 0.5	350, 500	Precision
KS-16315	Family	Tubular, Encapsulated, Axial PT	2	20	14M	0.1, 0.5	750	Precision
KS-20289	Family	Tubular, Insulated, Axial PT	3, 3.5, 4, 5-1/2, 6-1/2, 7-1/2 @ 25°C	2.6	2.1M	1, 5	350	Power, Semiprecision
KS-20616	Family	Tubular, Insulated, Axial PT	1/4	1.0	1M	1	250	
KS-20810	Family	Tubular, Insulated, Axial PT	1/2	0.4	2.1M	1	350	

Note 1 Family - range of values per code number.

GENERAL DESCRIPTION

The wire wound resistors are fixed resistors constructed of wire resistance elements wound on a suitable core material and covered with an insulating material. The physical difference between the items listed is their configuration, method of mounting, and type of terminals. Electrically, they cover a broad range of power ratings.

FEATURES

Except for the KS-8512 and the 18- and 19-Types, these resistors are available in nominal resistance values from 0.1 ohm to 1.1 megohms based on the recommended standard resistance values shown in Table 1 of the STANDARD VALUES section and have power ratings of 6/10, 1, 2, 3, 5, and 10 watts depending on the specification. The KS-8512 resistor is available with various power ratings up to 215 watts as shown in Section 5. The 18- and 19-Types are available in unique lettered suffix codes designating specific resistance values at a power rating of 5.1 watts. However, the 19-Type has a dual winding and the power rating is the overall rating of both resistive elements.

RECOMMENDED PRACTICES

The 18- and 19-Type resistors have unique terminal and mounting requirements. The terminals and mounting stud are insulated from the mounting surface by sleeves that are integral parts of the molded terminal head assembly. The terminals are designed for mechanically wrapped connections. Refer to BSP Section 032-140-811 for the 18 and 19-type resistor mounting procedures.

The KS-8512 resistors are generally mounted using mechanical through-bolt vertical or horizontal mounting hardware external to the resistor itself. The electrical connections are made to solder type terminal lugs which extend radially from each end of the resistor body. These resistors are intended for high wattage power applications and, therefore, operate at relatively high temperatures. To avoid a hazard to personnel due to temperature rise in these resistors, it is recommended that they be used at normal power loads not exceeding 50 percent of their rated power.

The KS-14603 and KS-16266 resistors are conventional tubular types with axial wire leads and are adaptable to automatic machine insertion. These resistors are similar except that the KS-16266 items are designed to provide higher resistance values. In critical applications where long-term reliability and/or stability are required, it is recommended that resistors be selected so that the power rating is at least twice the power to be dissipated. The high surface temperature of the 5- and 10-watt resistors could be a possible hazard to personnel or could cause damage to adjacent printed wiring boards and other

apparatus components. For these applications, it is recommended that they be provided with either adequate shielding, spacing, and/or ventilation, or they be used at sufficiently reduced power (see the derating curve in either Fig. 10-1 or 10-3) so as to limit the resistor surface temperature to a tolerable value.

These resistors are available in two forms; molded (lists 4, 5, and 6), and conformally coated (lists 1, 2, and 3). The molded types have a 1000-volt dielectric withstanding voltage requirement; the conformally coated items do not have such a requirement.

The KS-16764 resistors are plastic encapsulated precision items having reduced inductance. They are intended for use where either long term stability or very low signal-to-noise ratio is required.

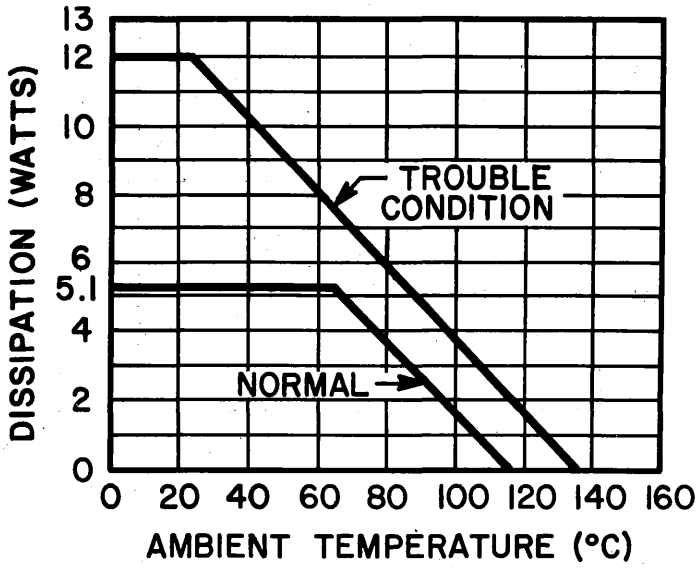


Fig. 10-1 - 18- and 19-Type Derating Curve

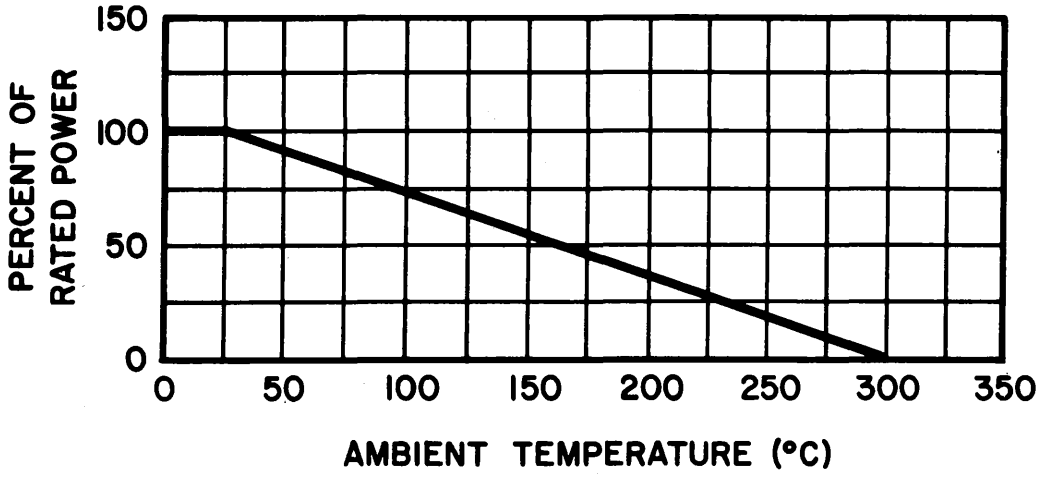


Fig. 10-2 - KS-8512 Derating Curve

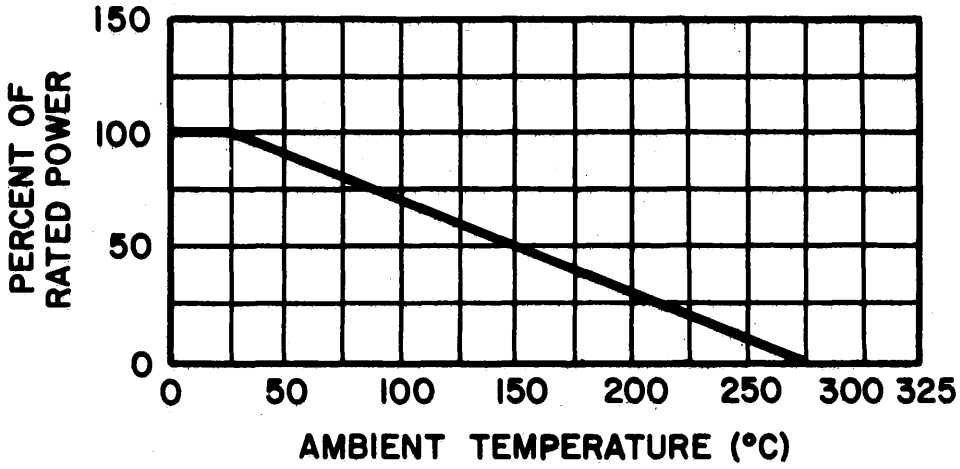


Fig. 10-3 - KS-14603, KS-16266 Derating Curve

TABLE 10-1

BASIC DATA - WIRE WOUND RESISTORS

BASIC CODE	TYPE CODE (NOTE 1)	DESCRIPTION	MAX POWER RATING (WATTS AT °C)	NOMINAL RESISTANCE RANGE (OHMS) FROM	NOMINAL RESISTANCE RANGE (OHMS) TO	TOLERANCE ±%	MAX VOLTAGE RATING RMS OR DC (VOLTS)	REMARKS
18 Type	Unique	Rectangular, Flat, Stud Mounted	5.1 @ 65°	1.1	10K	5.0 Note 2	350	
19 Type	Unique	Rectangular, Flat, Dual Windings, Stud Mounted	5.1**@ 65°	Element A 3.5	3000	5.0 Note 2	350	
				Element B 10.0	6810	5.0 Note 2		
KS-8512	Family	Tubular, Ceramic Core, Single Winding, Radial Lug Terminals	8-215 @ 25°	1.0	153K	1.0, 5.0	200-1500	High Wattage Dissipation
KS-14603	Family	Tubular, Ceramic Core, Axial PT	3, 5, 10 @ 25°	0.1	7960	0.25, 1, 5	N/S	
KS-16266	Family	Tubular, Ceramic Core, Axial PT	3, 5, 10 @ 25°	920	18.9K	0.25, 1, 5	N/S	
KS-16764	Family	Tubular, Plastic Encapsulated, Axial PT	6/10, 1, 2 @ 66°	2.0	1.1M	0.1, 0.5	N/S	Precision, Reduced Inductance

Notes 1 Unique - one value per code number.
Family - range of values per code number.

2 Specific codes are available in lower initial tolerances.

** Overall rating of resistive elements

N/S Not Specified