DISC INTRODUCTION

Metrosil discs introduction

Metrosil discs are available in sizes from 25mm to 150mm diameter. They can be supplied as plain unmounted discs or mounted on central studs either as single discs or as multidisc assemblies arranged in series or parallel. The smallest size can be supplied with suitable wire terminations and encapsulated in PVC or other materials as required.

Metrosil characteristics

The voltage-current relationship of Metrosil resistors is generally as indicated in figure 1: the characteristic is symmetrical. Traditionally, the relationship is expressed by:

$V=KI^{\beta}$

$I=HV^{\alpha}$

where K (or H) and β ($=1/\alpha$) are constants for any resistor. The value of K (or H) depends on the physical dimensions of the resistor, its composition and the manufacturing process. Actual values of K may vary from less than 30 to 100,000.

The value of β also depends on the composition and manufacturing process and can be made to have a value form 0.14 to 0.5 (α=7 to 2).

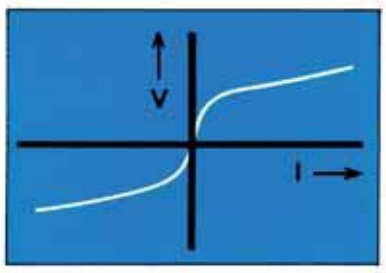


Fig 1

V-I relationship for Metrosil resistors

Specification

Varying the composition and processing conditions involved in the manufacture of Metrosil discs can achieve a broad spectrum of electrical characteristics. A large number of electrical specifications are available as standard items and others can be manufactured on request.

Metrosil applications

Most of the applications of Metrosil make use of its non-linear properties to provide an "electrical safety valve" for protecting equipment and insulation from the effects of over voltages.

Protection of field coils, contactor coils, relay coils and solenoids.

When an inductive dc current is broken suddenly, there is a transient rise in voltage across the inductance, which can be 10 to 20 times the supply voltage and may damage insulation or circuit components. The source of this overvoltage is the energy that is stored in the magnetic field of the inductance at the moment of switching off.

It is therefore essential to provide some means for this energy to dissipate itself harmlessly.

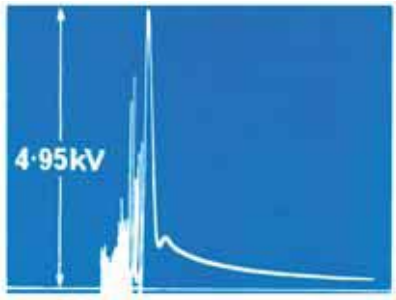
This can be achieved by connecting a discharge resistor across the inductive coil. At the instant when the circuit is broken, the current briefly held constant by the inductance of the coil is diverted through the resistor and rapidly decays to zero. The voltage across the coil is therefore limited to the voltage necessary to pass the coil current through the resistor, the value of which is so chosen that the voltage is a safe one. The transient voltage reduction is illustrated by the oscillograms.

If an ordinary linear resistor is used and it is permanently connected across the coil, there will be a continuous waste of power at normal voltage. If the resistor is inserted just before the circuit is broken, additional contacts and wiring will be required. A Metrosil resistor on the other hand, can be permanently connected across the coil and yet will consume at normal voltages only a small fraction of the power taken by the ordinary resistor.

Metrosil discharge resistors can be supplied for all ac and dc voltages and for use with almost any inductive device such as contactor, clutch and brake coils, relay coils and solenoids, electromagnets and the fields of motors, generators and alternators of all sizes.

Other applications

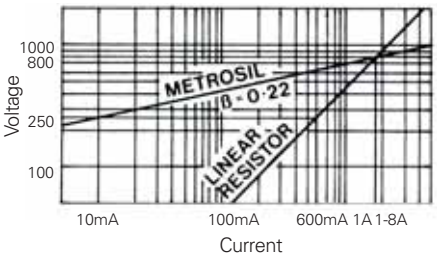
- Current and voltage transformer protection
- Telecommunication equipment protection
- Improving the sensitivity and protection of high impedance relays
- Telephone line protection
- EMP protection
- Traction units
- Rotor protection

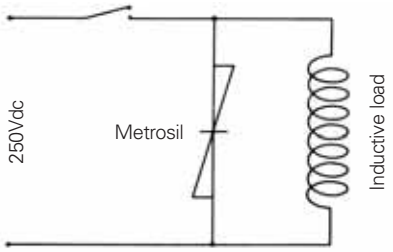


Without Metrosil protection

With Metrosil (type 300A/S1) passing 10mA connected across the coil

Typical oscillograms of voltage surges across a 600 amp contactor coil taking 1.8A at 250V dc, produced in interrupting the supply.





Both the linear resistor and Metrosil limit the overvoltage to 800V at 1.8 amps. The use of Metrosil reduces the power losses at 250V to 2.5 watts compared to 150 watts in the linear resistor.

DISC ORDERING GUIDE

Metrosil Properties

Metrosil has a negative temperature coefficient of resistance. Between 0°C and 100°C, the current at a constant voltage increases by about 0.6% per degree and the voltage at a constant current falls by about 0.12% per degree.

The specific heat of the material is about 0.84 J/gK and the density is about 2.35g/cm^3 with slight variations depending on the specification.

The maximum permissible continuous temperature of a mounted disc is limited to 100°C by the type of insulation used. Other grades of insulation can permit higher running temperatures and forced air-cooling or immersion in insulating oil can be used to increase the disc rating.

Rated voltage

Rated voltage is the maximum continuous operating voltage for which the device is suitable. Users must allow for any possible variations in the supply voltage. This is particularly important since an increase of 10% in the supply voltage will cause an increase of some 60% in the continuous power dissipation in the Metrosil.

Rated power dissipation

Rated power dissipation is the maximum recommended time-averaged power dissipation in the device. The actual dissipation consists of the continuous power dissipation under normal operating conditions plus the time-averaged effect of repeated surges.

Rated energy absorption

Rated energy absorption is the maximum energy in a single surge that the device will admit without overheating. The quoted energy figures will in fact cause a temperature rise of 75°C. This surge may be absorbed repeatedly without any deterioration of the device provided that sufficient time elapses between surges for the device to cool. Otherwise, such surges should be included in the continuous power dissipation.

Both the dissipation and the energy absorption assume an ambient temperature of 20°C. These ratings should be decreased by 10% for every 10°C rise in ambient.

Peak surge current capability

The ability of the disc to pass the surge current varies with the size of the disc. A general guide is given in the following table.

Metrosil type No	100	175	300	600
Peak current A	0-3	2-7	5-15	>10

Metrosil identification for ordering purposes

Each Metrosil resistor type is identified by a series of letters and numbers in the format:

A-B/C/D/E

Where:

- A refers to the nominal disc diameter in inches

  100 = 1.00 in (25mm)
  175 = 1.75 in (45mm)
  300 = 3.00 in (75mm)
  600 = 6.00 in (150mm)

- B refers to the type of disc

  A = annular
  P = plain

- C refers to the type of mounting and number of discs per assembly

  S = standard stud mounting
  US = unspaced stud mounting
  ES = stud mounting electronic type (100-A and 175-A)
  W = wired disc

- D indicates the type of connection in the assembly

  S = all discs in series
  P = all discs in parallel
  I = all discs insulated from each other
  CT = centre tapped

- E is the electrical specification number.

NB item D may be omitted for single disc assemblies and items C and D will not be needed for loose discs.

Example: 300-A/S3/P/3080

Specifies three 3in (75mm) diameter annular discs stud mounted in parallel. The material specification number =3080.

Selection guide

Selection of an appropriate Metrosil unit for a particular application is achieved by using the V-I curves and tabulated data to choose an electrical characteristic which gives the required level of protection and then checking that the Metrosil unit is capable of coping with the power and energy levels involved. In case of any doubt, please contact the Metrosil sales engineers, who are always ready to advise and assist.