

# An Introduction to Carbon Composition Resistors

## CCR Series



The new CCR Series of Carbon Composition Resistors offers designers a solution for applications involving high voltages and high-energy pulses. In the past designers would have turned to the trusted Hot Moulded Carbon Composition resistor. However, with the demise of this technology, designers are often forced to use less than ideal technologies and oversized components to handle their pulse requirements.

Many resistor manufacturers claim to offer Carbon Composition replacements. However, these wirewound or thick film alternatives do not fully match the pulse performance and low inductance of Carbon Composition. The CCR series offers a true replacement technology based on a bulk resistive element comprising carbon in a ceramic filler.

- **Bulk resistive element**
- **Very high energy withstand capability**
- **High voltage withstand**
- **Direct Replacement for Hot Moulded Carbon Composition Resistors**



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## What is a CCR Carbon Composition Resistor?

The CCR resistor is made up of a solid rod of conductive composite material, the chemical composition of which is altered to produce different resistance values.

The general composition consists of the following materials:

- Conductor - Carbon
- Filler – Ceramic

By altering the ratio of filler to conductor it is possible to change the resistance value.

Interference-fit end caps are attached to the rods, leads are welded onto these caps, and the resistor body is then protected with a specially formulated epoxy coating. The resistors are then colour code marked.

### CCR Carbon Composition Resistor



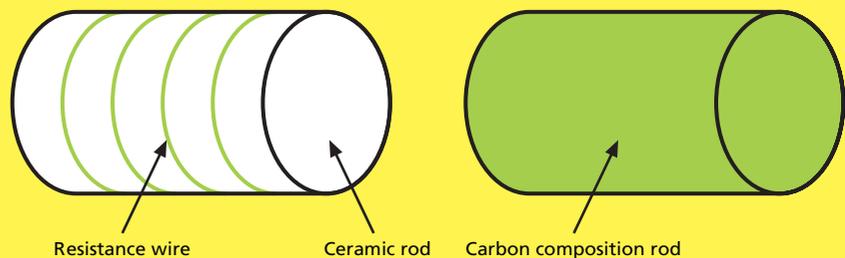
## Advantages of CCR Carbon Composition Resistors

The main advantage of Carbon Comps is their pulse handling capability. This is due to the fact that the entire rod conducts.

For example in applications applying a fast (<100ms), high-energy pulse, the conductive element is required to withstand all of the energy and to absorb all of the heat generated. This is because it takes a finite time for this heat to be transferred from the conductor into the surrounding materials and the air. Therefore, with a film or wirewound resistor, the film or wire is required to handle the pulse energy. As the mass of wire or film is low, the energy handling capability is low.

However, in the case of Carbon Composition, the entire rod conducts, and so the thermal mass is far higher, which results in a higher energy capability. This is illustrated in the following diagram.

### Energy Capability



#### Wirewound

Only the wire around the ceramic rod conducts, therefore in the case of fast pulses, the wire is required to withstand all of the energy. Due to the low mass of wire the energy capability is limited.

#### Carbon Composition

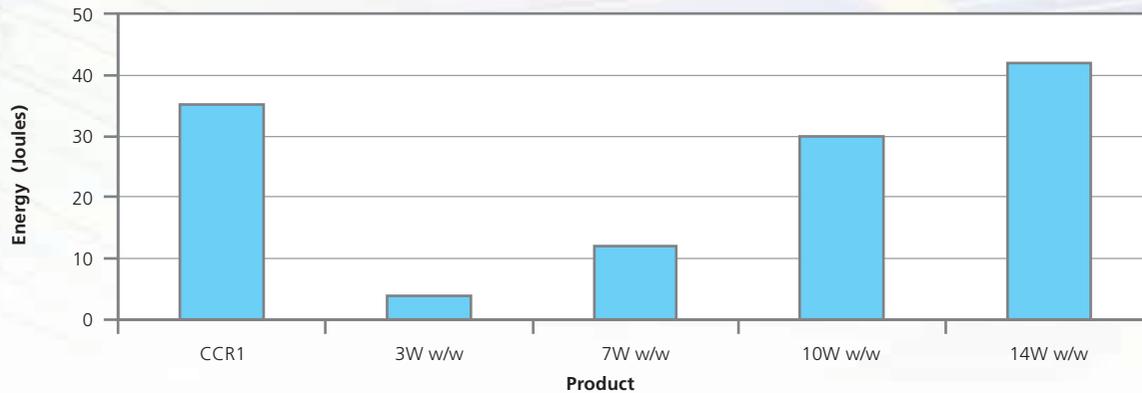
The entire rod conducts, therefore due to the higher mass of material the energy capability is increased.

Typically the 1W CCR1 can handle 35J. This is in contrast to 4J for a wirewound resistor of similar dimensions. In addition

to this, the voltage capability is also higher. The chart below shows a comparison between the CCR1 and

typical wirewound products. This is based upon the maximum energy capability for a 1ms pulse.

### Carbon Composition Vs Wirewound Pulse Capability



## Applications of CCR Carbon Composition Resistors

CCR Carbon Composition Resistors are suitable for any application involving high-energy pulses, where small size is important. They are particularly suitable as a replacement for Hot Moulded Carbon Composition resistors.

Although many Carbon Composition Resistors have now been replaced by other technologies (wirewound in particular), these solutions tend to be less than ideal, and there are still applications where Carbon Compositions are needed owing to high pulse performance requirements.

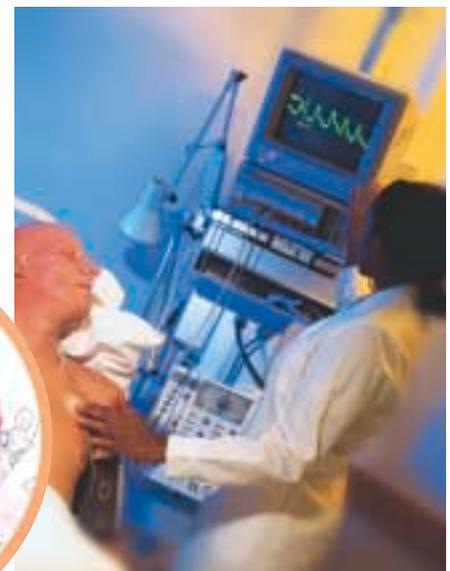
Examples of some specialist applications for Carbon Composition Resistors are given below:

### Medical

Carbon Compositions are used as surge protection resistors in medical monitoring equipment and as output resistors in defibrillators.

For example in an emergency situation where monitoring equipment is attached to a patient (e.g. ECG) it may be necessary to apply a defibrillator pulse, in the case of cardiac arrest. In such circumstances there would not be time to disconnect all of the sensitive monitoring equipment and therefore this equipment must be protected.

Carbon Composition Resistors, either mounted inside the equipment or molded into the leads of the monitoring equipment, provide protection. These resistors are required to withstand all of the pulse energy – typically around 30J but could be as high as 100J at 3000V.



## Applications of CCR Carbon Composition Resistors *Continued*

### Automotive

Advances in engine management systems and engine efficiency have led to changes in the way a vehicle ignition system operates. New electronic management systems have replaced the old mechanically driven ignition system, with digital systems employing microprocessor control capable of varying the ignition timing according to specific engine conditions. In addition to this, new emission laws mean that engine efficiency is critical.

Instead of using one ignition coil to ignite all the spark plugs (with a mechanically driven distributor to

connect each spark plug in turn to the coil), new direct ignition systems use one coil mounted directly above each spark plug driven directly from the engine management system.

This has several advantages, which are beyond this note, however it has the effect that higher voltages are produced at the spark plugs. Each coil / lead assembly incorporates a resistor for suppression purposes. In the past metal oxide parts were used, but, owing to the higher peak voltages used, these are no longer suitable. Carbon Comps are now used for this application.



### Other Applications:

There are many more applications for Carbon Composition resistors; a general list of possible application areas is given below:

- Strobe Lighting
- High Power Lighting
- High Voltage Power Supplies
- Protection (e.g. Discharge Circuits, Surge Protection)
- Welding
- Automotive
- Inrush Current Limiting
- And many more...

For more information or to discuss your specific requirements, please contact the Resistor Application Engineer Team using the contact information below.

**TT electronics has over 60 years experience in designing and manufacturing resistive components.**

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