

Hello All:

This document will discuss pulse power applications and the design challenges that accompany it. It will address both high voltage and higher power / current pulses and discuss the various solutions that Stackpole offers for the various requirements. The intent is to provide a basis for talking to engineers about their requirements and knowing the key information needed and the important questions to ask.

Pulse Power Requirements

Pulse power requirements usually stem from power electronics turning on or off, or from electric motor start / stop. The pulses are generally much longer in duration than the usual high voltage pulses and as a result, a robust resistive element technology, little or no calibration trimming, and larger resistive element mass are desirable.

For axial leaded resistors the best choices would be the RC series of Carbon Composition resistors, the RSF/RSMF series of metal oxide resistors, and the RSPF / RSPL series of flameproof power resistors. Carbon Comps are well known for their outstanding pulse handling capability and extremely low inductance. The disadvantage of comps is their limited resistance tolerance, poor environmental performance and cost. Metal Oxides provide the lowest cost solution and are the most readily available. The RSPF / RSPL series has a more robust resistive element designed for higher power surges than metal oxides. The RSPF/RSPL series is flameproof, while metal oxides are only flame retardant.

Wirewound resistors such as Stackpole's WW and CB series provide an even greater level of pulse power performance. Because the mass of the wire used for these is significantly more than either of the film elements above, wirewounds will typically provide 5X to 10X the pulse handling of the equivalent size film resistor. In addition, wirewounds have a great deal of flexibility in their design and construction, allowing Stackpole to create a specific resistor with the exact characteristics desired for a particular customer or application. From a pricing standpoint, the wirewound resistor will be a bit more expensive than the equivalent film resistor, so there is a price to be paid for the superior electrical performance. The inherent inductance of a wirewound, even those that are non-inductively wound, mean that wirewounds are not a good choice for high speed switching power supplies.

For SMD resistors the RPC is the surge withstanding thick film chip series designed for high pulse power applications. The use of the entire width of the ceramic for the resistive element coupled with no laser calibration allows the RPC to offer pulse handling that is from 2X to more than 10X higher than a standard thick film chip. Coupled with the relatively low price of the RPC compared to other surge resistor solutions make it the most popular choice for many types of applications where the device will only see a pulse infrequently or at low duty cycle. The smaller mass of the RPC resistive element prevents its use for extremely high pulse power handling or for applications with high pulse repetition rates. For those applications the SM series of surface mount wirewound resistors is ideal. Like the wirewounds discussed previously, the SM product has enough elemental mass to take significantly higher pulsed power and provides the ability to run at higher temperatures. When talking about pulse applications with high repetition rates / duty cycles, this higher temperature capability is critical in maintaining the integrity of the resistor and minimizing the resistance shift due to overload. The SM series also offers the same design and construction flexibility to enable Stackpole to design custom solutions to fit a particular application or customer requirement. In many cases, a custom wirewound can replace solutions using several other resistor types to reduce board space usage and cost.

PULSE POWER HANDLING RESISTORS						
	Carbon Comp (RC)	Metal Oxide (RSF/RSMF)	Flameproof Power (RSPF/RSPL)	Wirewound (WWP)	Thick Film Surge Chip (RPC)	SMD Wirewound (SMP)
SMD or Thru-Hole	Thru-Hole	Thru-Hole	Thru-Hole	Thru-Hole	SMD	SMD
Technology	Composite Carbon	Film on Ceramic	Film on Ceramic	Wire wound around ceramic core	Thick Film on Ceramic	Wirewound on Ceramic core
Pulse Handling	Best	O.K.	Good	Better	Good	Better
Tolerance	5%, 10%	1%, 5%	1%, 5%	Down to 0.05%	5%	0.10%
Resistance Range	1 ohm to 22 Meg ohms	0.1 ohm to 1 Meg ohm	0.1 ohm to 1 Meg ohm	0.1 ohm to 150K ohms	0.27 ohms to 22 Meg ohms	0.01 ohm to 5K ohms
Power Ratings	1/4W, 1/2W, 1W	1/2W, 1W, 2W, 3W, 5W	1W, 2W, 3W	Up to 10W	1/8W, 1/4W, 1/3W, 1/2W, 1W	1W, 2W, 3W, 4W
Cost	Highest	Lowest	Low	Medium	Low	Medium

High Voltage Pulses

High voltage pulses are typically very short in duration. Many times the need for a high pulse voltage resistor is driven by an industry standard requirement for ESD, power line cross, or lightning withstanding. For these requirements, the resistive element needs to be as long as possible. Lengthening the resistive element lowers the effective voltage stress per unit length. This concept is the basis for Stackpole’s film-type high voltage pulse solutions.

For axial leaded resistors, the ASR / SPR series is a power film type resistor designed specifically for high voltage pulse applications. For high voltage pulses and even repetitive pulse conditions, the ASR / SPR will outperform most other technologies. The SPR provides a UL qualified product with values from 1 Mohm to 12 Mohm. For even higher repetitive rate pulses, a product with a higher working voltage such as the MG series is required. The MG series is a metal glaze resistive element with the capability to handle up to 4KV continuously.

For surface mount solutions, Stackpole offers two different products. The RVC series is a lower cost solution for medium voltage applications while the HVC series offers the highest working voltage capability per chip size in the industry. The RVC is a screen printed serpentine resistor element that offers voltage ratings of 2 to 3 times better than the equivalent standard thick film chips. The HVC uses a proprietary deposition method for the resistive element, which allows for finer lines, more uniform resistive traces, and the highest voltage ratings with the highest resistance values. The HVC is capable of tolerances down to 0.5% and 25 ppm, which is the type of precision rarely seen using thick film technology. The price for the HVC is significantly higher than the RVC.

<u>PULSE VOLTAGE HANDLING RESISTORS</u>				
	Anti Surge Film (ASR / SPR)	Metal Glaze (MG / MGM)	Medium Voltage Thick Film (RVC)	High Voltage Thick Film (HVC)
SMD or Thru-Hole	Thru-Hole	Thru-Hole	SMD	SMD
Technology	Power Film on Ceramic Core	Thick Film on Ceramic Core	Thick Film on Ceramic	Fine Line Thick Film on Ceramic
Pulse Handling	Better	Good	Good	Best
Tolerance	5%, 10%	1%, 5%	1%, 5%, 10%	Down to 0.1%
Resistance Range	100 ohms to 33 Meg ohms	100K ohms to 200 Meg ohms	47 ohms to 51 Meg ohms	1 K ohm to 1 Tera Ohm
Power Ratings	1/4W, 1/2W, 1W	1/4W, 1/2W, 1W, 2W, 3W	1/10W, 1/8W, 1/4W, 1/2W, 1.5W	1/10W, 1/8W, 1/4W, 3/4W, 1W
Cost	Low	Medium	Lowest	Highest

Applications

High pulse voltage and pulse power applications are literally in every market. Examples would be all types of power supplies (especially at the inputs and outputs), motor controls, medical applications, instrumentation, measurement, electricity metering and control, power factor monitoring and correction, UPS systems, and refrigerator and HVAC controls.