



Title:

**Copper/Tungsten vs.
Copper Flange Construction**

Document No.:

BTR-030

Revision:

A

Introduction:

Barry Industries set out to compare the two different construction methods of their Flanged and leaded Resistors. Construction "A" consists of a Copper/Tungsten (Cu/W) flange with Gold/Germanium (Au/Ge) preforms and .060" thick BeO, 270-ohm chip resistor with leads. Construction "B" consists of a Copper (Cu) flange with Lead/Silver preforms and .060" thick BeO, 270-ohm chip resistor with leads. Four resistors of each type construction were cycled for a period of 9 seconds on and 9 seconds off. Each resistor had 150 Watts of applied power for the 9 second on cycle.

Data:

Construction "A" (Cu/W)

Initial Data:	Final Data	Delta	% Delta	# Cycles
#1 =270.82 ohms	#1 = 271.00	+0.18	+.066%	494,000
#2 =270.91 ohms	#2 = 271.09	+0.18	+.066%	494,000
#3 =270.48 ohms	#3 = 270.67	+0.19	+.070%	494,000
#4 =271.27 ohms	#4 =271.00	+0.18	+.066%	494,000

Construction "B" (Cu)

Initial Data:	Failure Mode	# Cycles completed
#5 = 271.39	Detached from flange and lead fell off	3,550
#6 = 271.22	Detached from flange and resistor failed	3,833
#7 = 271.39	Detached from flange and lead fell off	2,567
#8 = 271.23	Detached from flange and resistor failed	3,192

Results:

Construction "A" Cu/W Flange:

After 494,000 cycles on all four resistors for a total of a 1.976 million cycles, all the resistors survived. By monitoring the current in the loop that was still set to 2.98 Amps, we could see that all the resistors were performing as when they were originally setup.

Construction "B" Cu Flange:

The chips all broke away from the flange. Once the chip broke away from the flange it was no longer in contact with the heat sink and one of two things happened. The resistor would heat up and the resistor would fail by arcing open or the lead would fall off from overheating. Resistors failed after an average of 3,286 cycles.

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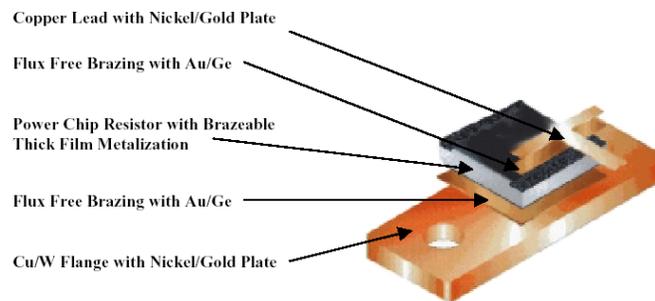
A

Conclusion:

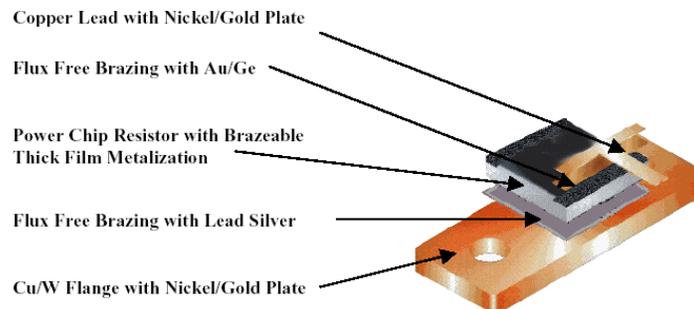
While Resistors built on Copper flanges may be good for CW power applications, they do not survive in applications where the power is constantly being cycled. The main reason for this is the disparity in the Thermal Coefficient of Expansion (TCE) between the Copper flange and the substrate material. The construction "B" type resistors are not recommended for Pulsed Power Applications.

The Resistors built on Copper/tungsten flanges have a TCE that is matched to that of the BeO Substrate. This matching forms a bond that moves in unison as the Assembly is heated and cooled by the applied power. The Construction "A" samples are greatly Superior when the application requires the power to be pulsed or cycled. The Copper/Tungsten flanged resistors lasted an average of 150 Times longer.

Construction "A" (CU/W)



Construction "B" (Cu)



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