HIGH VOLTAGE RELAY APPLICATIONS

THE PHYSICS OF VACUUM & GAS FILLED HIGH VOLTAGE RELAYS

Normally we do not encourage users of GIGAVAC relays to understand the physics of our relay technology. However, when it comes to contact loads, some understanding can make the relay selection a lot easier and can result in a much better selection for your application. The chart at the end of this article provides a comparison that indicates the best dielectric and contact materials for specific applications. GIGAVAC's "How to Pick a Relay - Quick Pick" makes the selection easy. But if you want to know why we recommend specific relays for particular applications, you may find this article of interest and you may want to look at High Voltage Relay Designs to become better acquainted with the designs of different GIGAVAC high voltage relays. And remember, if you ever have questions always feel free to contact Today's Experts at GIGAVAC or our Sales Representative in your area.

Please note, this article does not apply to our Reed Relays.

Some history: Vacuum as a dielectric - a new generation of relays is born

GIGAVAC sealed high voltage relays were first developed for aerospace RF applications. The relays were to be as small as possible, have low RF losses, have good dielectric isolation at the rated RF voltage, and be able to operate at various altitudes and in harsh environments. To meet this requirement, a new generation of relays were developed using advanced sealing methods so that vacuum could be used as the dielectric inside the relay. The dielectric strength of vacuum is about 8 times greater than air. And because there is no oxidation in a vacuum, low resistance copper contacts (rhodium for our reed relays) are used that allows the relay to carry significantly more current than traditional open-air relays. GIGAVAC calls these vacuum relays with copper contacts "carry only" relays.

These new small vacuum relays quickly gained acceptance and new applications for "hot switching" (make and break load switching) soon developed. However, because soft contact materials like copper and rhodium vaporize easily as the contacts switch and deposit on the inner walls of a vacuum relay, a "plating out" of the walls occurs over time and there is a dielectric breakdown. To increase the life of the relay, harder contact materials such as tungsten and/or molybdenum were used. GIGAVAC has identified these vacuum relays as "make & break".

SF6 Gas filled relays for high in-rush switching and long periods of non-operation

As the new sealed high voltage relays became more popular, other applications developed which took advantage of the hard contact materials. These applications include high in-rush capacitive make and capacitive discharge such as those found in ESD test equipment, cable test equipment, heart defibrillators, and for applications where no high voltage is applied for long periods of time where low and or stable leakage current is needed. Because GIGAVAC had mastered the sealing processes for vacuum relays, GIGAVAC back-filled and pressurized with SF6 gas the "make & break" relays with hard contacts mentioned above.

Under special circumstances, GIGAVAC also back-fills with pressurized SF6 gas "carry only" relays mentioned above for applications where the inrush is not too high and where higher carry current is required. We do not normally recommend these relays without knowing the specific application.

SF6 under pressure has many advantages over vacuum because the leakage current is stable over long periods of non-operation and because of the way the gas performs during switching. SF6 is an excellent insulator but once the switch is closed if the relay bounces the SF6 becomes easily ionized and carries the arc current. This makes the relay electronically bounceless and dramatically reduces contact wear. GIGAVAC calls these SF-6 gas filled relays with hard contact materials "make only" relays.

Another advantage of SF6 gas filled relays is that they do not emit hazardous X-rays because the electrons collide with the gas molecules and are unable to accumulate sufficient energy to make significant radiation.

Recommendation - SF6 Gas filled relays are recommended for many non-RF high voltage applications

For non-RF applications and for relays over 10kV, SF6 gas filled relays are the most forgiving of all the high voltage relays. Because they have SF6 gas inside rather than vacuum, the leakage current is generally lower and more repeatable over long periods of non-operation. And because of the gas, they are the most forgiving should the contacts have to make an abnormal load in case of equipment failure. So ... if your load is not RF, we recommend you first take a look at the relays rated for "make only". The exception is our reed relays and G81 rated about 10 kV that are the best relays for these voltages where space and cost are important.

High Voltage Relay* Performance Comparison with different dielectric and contact materials

Application	SF6 Gas	SF6 Gas	Vacuum	Vacuum
	Tungsten/Moly(2)	**Copper** (Special Applications)	**Tungsten/Moly(2)**	**Copper**
Carry Only (DC)	**GOOD** But the gas increases the contact resistance resulting is less current being carried than in vacuum	**BETTER** than hard contacts but the gas increases the contact resistance resulting is less current being carried than in vacuum	**GOOD** But not as much current as copper contacts	**BEST**
Carry Only (RF)	**N0** The gas will interfere with the RF carry capabilities	**N0** The gas will interfere with the RF carry capabilities	**GOOD** But not as much current as copper contacts	**BEST**
Make & Break*	**GOOD** for make but only low currents on break	**GOOD** for make but only low currents on break	**BEST**	**FAIR** Extremely low currents only
Make Only**	**BEST**	**BETTER** But not as good as hard contacts	**GOOD** But not as much current as copper contacts	**FAIR** Extremely low currents only
Long Periods of Non-Use Or where Low and Stable Leakage Current Is Needed	**BEST** Only relays listed "Make only"	**BETTER** than hard contacts but the gas increases the contact resistance resulting is less current being carried than in vacuum	**GOOD** Generally will "burp" when HV is applied	**GOOD** Generally will "burp" when HV is applied

*Does not apply to GIGAVAC reed relays
**Contact GIGAVAC for specific make and break relay ratings in your application

04/02/08