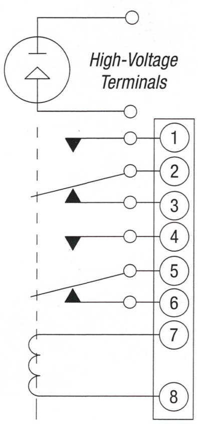
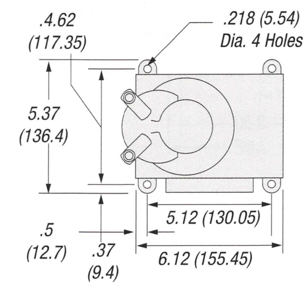
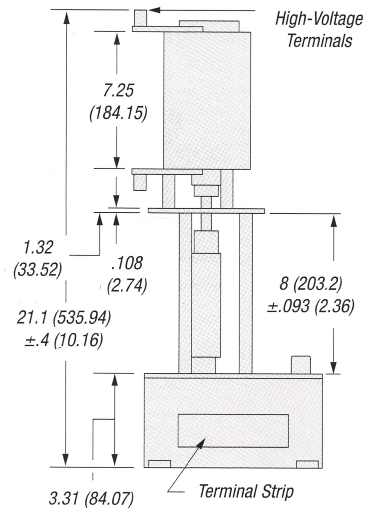
RP101F, RP901K and RP900K SPST High-Voltage AC/DC Contactors

These contactors feature a vacuum interrupter and an actuator linked together by an insulated actuating rod. The contactors provide all of the operating advantages of vacuum interrupting plus the benefits of a matching actuator-solenoid motor. They offer a minimum of 100,000 operations and are ideal for use in high-power broadcast transmitters.



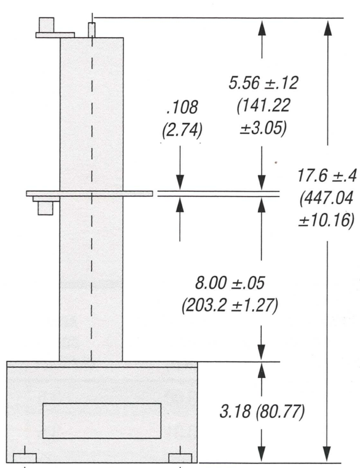




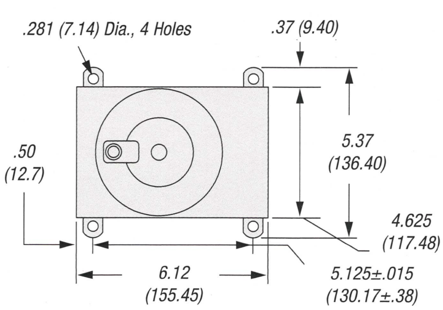
RP900K

VOLTAGE RATINGS	RP101F	RP901K	RP900K
Test Voltage (kV Peak)	50	70	70
Rated Voltage (kV Peak)*	30	50	50
Current Rating			
Continuous (Amps RMS)	100 DC	200 DC	200 RMS
Maximum Interrupting Current (Amps)	—	—	4000
Maximum Interrupt DC Power (kW)	500 (10 amps max.)	500 (10 amps max.)	—
Specifications			
Capacitor Discharge Decaying to 0 in 200μs (kA)	50	100	100
Contact Resistance (Micro Ohms)	200	500	200
Contact Capacity (pF)	4.5	5.5	5.5
Contact Inductance (nH)	32	45	45
Mechanical Life (operations)	100,000	100,000	100,000
Auxiliary Contacts	DPDT	DPDT	DPDT
Auxiliary Contact (Volts AC RMS)	230	230	230
Auxiliary Contact Current (Amps RMS)	15	15	15

* Derate to 15.5kV RMS for 50/60 Hz Cycle Power.



RP101F



RP101F, RP901K and RP900K SPST High-Voltage AC/DC Contactors

CAT. NO.	CONTACT ARRANGEMENT	INSULATOR LENGTH	ACTUATOR (VOLTS)	PULL-IN CURRENT (AMPS)	HOLD CURRENT (AMPS)	HOLD POWER (WATTS)	TIME TO CLOSE (MSEC)	BREAK TIME (MSEC)
RP101F4903D21B20	N/O	6	115VAC	5.20 RMS	0.54 RMS	18.0	46	26
RP101F4304D26B20	N/C	6	100VDC	15.00 DC	0.07 DC	7.0	36	30
RP101F4903A21B20	N/O	2	115VAC	5.20 RMS	0.54 RMS	18.0	46	26
RP101F4903D2KB20	N/O	6	110VAC/50 Hz	3.00 RMS	0.30 RMS	17.0	46	26
RP901K4903D21B30	N/O	6	115VAC/60 Hz	5.20 RMS	0.54 RMS	18.0	60	50
RP900K4903D21B30	N/O	6	115VAC	5.20 RMS	0.54 RMS	18.0	25	46
RP900K4904D21B30	N/C	6	115VAC	5.20 RMS	0.54 RMS	18.0	40	70
RP900K4903D2LB30	N/C	6	220VAC/50 Hz	2.50 RMS	0.35 RMS	12.0	40	70
RP900K4601D26B3C	N/O	6	100VDC	3.75 DC	0.14 DC	14.3	18	7
RP900K4602D26B30	N/C	6	100VDC	3.75 DC	0.20 DC	20.0	23	14
RP900K4315E26B30	N/O	8	100VDC	1.50 DC	0.07 DC	7.0	80	10
RP900K4665XX6B30	N/C	NA	100VDC	3.75 DC	0.20 DC	20.0	40	12
RP900K4667DX6B30	N/O	6	100VDC	5.20 DC	0.14 DC	15.9	18	7
RP900K4803D25B30	N/O	6	48VDC	2.00 DC	0.14 DC	7.0	40	100
RP900K4803D26B30	N/O	6	100VDC	1.60 DC	0.07 DC	7.0	40	100
RP900K4903C2KB20	N/C	4	115VAC/50 Hz	5.10 RMS	0.70 RMS	19.0	26	46

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Contactors Overview

Jennings vacuum contactors offer one of the most reliable means available for remotely controlling electric power.

Jennings vacuum contactors provide all the operating advantages of a vacuum interrupter plus the benefits of a matching actuator to meet specific application requirements. These low and medium voltage contactors offer the most reliable means of remotely controlling electric power.

Maintenance-Free Vacuum Contactors Provide Fast Arc Extinction and Rapid Recovery of Dielectric Strength.

Jennings contactors consist of a vacuum interrupter and an actuator linked together by an insulated actuating rod. Linkage and stand-off posts that isolate the high voltage from ground are made of epoxy glass laminate for DC switching. Heavy-duty connectors are provided for the high voltage connection.

Figure 1 illustrates a solenoid-operated vacuum contactor. Its interrupter consists of an evacuated ceramic insulating envelope in which there are two contacts, one stationary and one movable. The movable contact is operated from the outside through a metallic bellows that provides a vacuum-tight seal.

A vacuum has an extremely high dielectric strength — as high as 1000 volts per mil. When the contacts are opened to interrupt current flow, metal vapor is generated by the passage of current through the contacts. The vapor sustains the arc that is created, maintaining it down to or near current zero.

The small arc drawn on the contact opening is quickly extinguished because there are no gases, and there is only a small voltage drop across it. As the arc extinguishes, the metallic vapor rapidly diffuses outward and condenses on the cool surface of the vapor shields. The vapor shields prevent the metallic vapor from depositing on the ceramic insulating surfaces.

Fast arc extinction and rapid recovery of dielectric strength after contact opening are characteristics of vacuum interrupters. A phenomenon with these interrupters is the auto-maintenance of the vacuum. The metallic ions released from the contacts provide a gettering action. Tests have shown that frequent operation of the contacts produces a steady improvement in vacuum level because the released metallic ions actually remove gas molecules from the evacuated space. This ion-pumping action tends to maintain the vacuum near the high initial value.

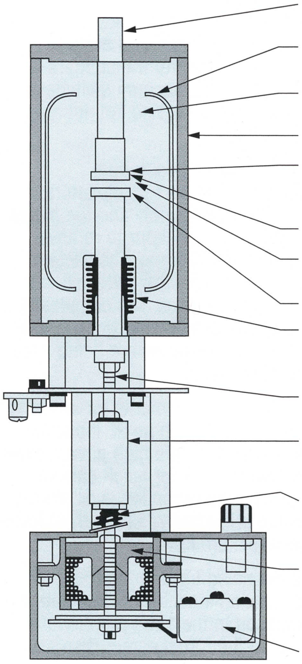


Figure 1 — Typical Jennings Solenoid-Operated Vacuum Contactor

Contactors Overview

Typical Applications

Jennings vacuum power contactors are used for controlling DC and 50/60/400 Hz circuits. Principal use is in high power electrical equipment requiring long contact life without maintenance, low-cost, high voltage control or sealed contacts because of environmental conditions.

Switching and protecting transformers used in DC power supplies is one of the most common power frequency applications for contactors. Most transformer switching is done on the primary side for off-on control or to switch out current-limiting resistors or reactors used for reduced-voltage starting of power tubes. It may be necessary to use additional backup fault protection to take care of primary line-side faults. This is sometimes accomplished using a current-limiting fuse or coordinating with a high capacity system breaker already located in the primary side. However, where frequent faults are anticipated, contactors offer a much longer life with no contact maintenance, and they are often less expensive.

Contactors Eliminate Most Chopping Problems

The metal ion plasma in a vacuum interrupter permits current to flow in the circuit for a short period of time after the contacts have been opened. The metallic plasma stabilizes the arc, maintaining it as the current follows the sine wave pattern down to or near current zero.

In highly inductive circuits, this action is essential in preventing a phenomenon known as chopping, which happens with oil, air and vacuum breakers.

Chopping occurs when the arc is suddenly extinguished and the current drops immediately to zero. At high currents, a large amount of energy is stored in the circuit inductance and will resonate at high frequency with the distributed capacitance until dissipated by resistive circuit elements. The transient voltage surges caused by this chopping action can seriously damage the insulation of circuit components. This consideration is especially important in electric power switching because the magnitude of the transient is a function of the rate of change of current across the inductive load.

Because suppression of transient voltages depends on maintaining a stable arc, various steps can be taken to reduce the possibility of chopping. Factors affecting chopping include contact material, contact size, current levels, contact opening speed and external circuitry.

Advantages of Jennings Vacuum Contactors

By employing proven Jennings vacuum interrupter* technology, Jennings contactors provide reliable, maintenance-free operation in industrial motor controls and other systems using a wide range of currents and voltages. The operation of contacts within a vacuum offers several inherent advantages:

- **No required contact maintenance** — Contacts are sealed within a very high vacuum and remain clean permanently. There is no contact oxidation or possibility of foreign matter forming on the contacts and leaving contaminating residues.
- **Long life** — The arc that results as the contact is made or broken is quickly extinguished within a vacuum. The special contact material utilized erodes at an extremely slow rate to provide reliable operation for tens of thousands of operations.
- **Environmental safety factor** — Vacuum contactors can be used in environments involving corrosive atmospheres because there is no exposed arcing during interruption.
- **Compact, reliable operating mechanism** — The high dielectric strength of a vacuum minimizes the contact-to-contact gap required to interrupt current. This short contact stroke not only provides high operating speed, but also reduces the size and weight of the operating mechanism used.
- **No arc chute replacement** — Ordinary air-break contactors require fragile arc chutes to extinguish the arc that forms when the contact is broken. Arc chutes are damaged with use and ultimately require replacement. The manner in which vacuum contactors operate causes the arc to be extinguished rapidly with minimal damage or wear.
- **Proven operation** — Jennings vacuum interrupters have been supplied for several decades for use in electrical power generation and distribution systems operating at all voltage levels. The long life and reliability of these devices is such that many of the original units are still in operation!
- **Low contact resistance** — This resistance remains low and stable for the life of the contactor.

Contactors Overview

AC Current Ratings

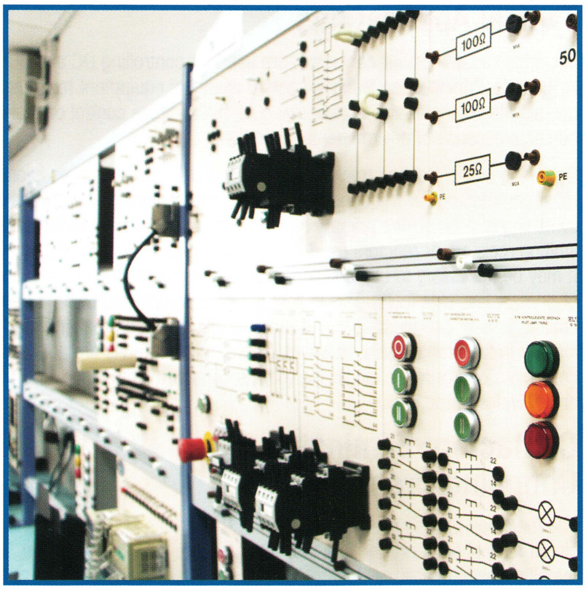
Continuous current and maximum interrupting current ratings are all RMS values and should all be considered in selecting the proper contactor. Continuous line current can be calculated by dividing the total three-phase kVA by 3 and then by the line-to-line voltage.

When calculating maximum fault currents, consider that the first loops of current flow can always be asymmetrical (see Figure 2) by as much as 2.7 times peak instantaneous value or 1.7 times RMS value of the steady state for the first loop. The asymmetry factor (RMS ratio) decays in most practical cases to almost the steady-state value 1 in approximately four cycles (for more information, contact Jennings). Therefore, the faster the contactor opens after the initiation of the short circuit (consider the sum of minimum tripping delay plus contact opening time), the higher the asymmetrical current it has to interrupt. Maximum interrupting currents used in the rating charts assume an asymmetry factor of 1.0.

Maximum steady-state fault current depends upon circuit impedance. In a primary bus fault, the fault current is limited only by course impedance, which may be 2% to 5%, depending on the distance from the power source and the impedance of transformers and line between. Primary bus faults can therefore be as high as 20 to 50 times rated kVA line current of source.

In calculating maximum short circuit currents due to faults in or beyond the transformer secondaries, a knowledge of transformer impedance is necessary, because a transformer with 5% impedance will limit the maximum fault current to a value of 20 times normal line current. Most transformers have impedance of less than 5%, although source impedance and other impedances in the equipment being protected may increase the total impedance to as high as 10%.

Example — A typical 100kVA three-phase transformer in a DC power supply with 12kV secondaries and 440V primaries would have rated kVA line currents of 131 amps RMS in the primaries and 5 amps RMS in the secondaries. If total circuit impedance is 8% (5% in the power supply and 3% in the source and line), the maximum primary fault current due to a short circuit in the high voltage secondaries would be 1640 amps RMS. If interruption occurs within two cycles of fault initiation, this value could be offset by a factor as high as 1.2 times 1640 amps, for a total fault current of 1970 amps RMS. Of course, most fault currents would be less than this value, because maximum offset doesn't always occur, and faults often occur farther along in the circuit, where the impedance of rectifiers and other circuit components help limit the fault current to lower values. (Corresponding fault current in the high voltage secondaries is only 96 amps, which is why the high voltage secondaries are often a desirable place for fault protection when you anticipate a large number of fault operations.)



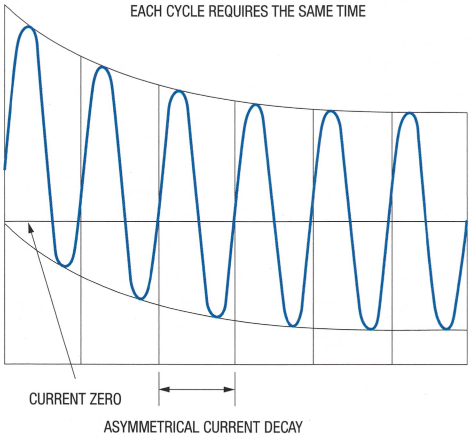


Figure 2

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DC Switching

High voltage vacuum contactors can help the circuit designer solve complex DC switching problems that are otherwise difficult to handle. They can be used to interrupt high voltage, capacitive, resistive or inductive loads without the damaging electrical breakdown so frequently displayed by conventional DC switches.

Vacuum contactors are frequently used in charging capacitor banks, isolating charge banks and safety grounding of power supplies. They are also used to discharge high-energy storage capacitors and for the generation of high current pulses for plasma study, shock waves and metal forming.

DC Switching of Pulse Networks — Vacuum contactors are rated in continuous DC amps. They are used in a broad range of high power radar systems where the peak current is considerably above the continuous current rating of the switch, but where the effective current may be within the switch rating. The effective current in a square pulse = the peak current X duty cycle. For example, a typical radar square wave pulse of 2000 amps peak with a .01 duty cycle = 2000 amps X .01 = 200 DC amps effective, which is within the continuous rating of most vacuum contacts.

DC Switching of Power Supplies — Vacuum contactors are used for switching current-limiting reactor resistors, switching DC power directly to tubes and modulator loads, interrupting DC currents and isolating DC loads from one common power supply that feeds more than one load. They are also used for DC transfer switching. In switching DC inductive loads, suppression networks are required across the inductances when breaking the circuit and may be required when making the circuit to avoid possible overvoltages. At high voltages, a ⅛ to 1 MFD capacitor in series with 1 ohm per kV makes an effective suppression network across an inductance. The suppression circuit should be critically damped.

DC Load Switching — In DC load switching, current zeros do not exist as they do in AC circuits. Extremely rapid arc extinction in vacuum switches due to the high velocity radial diffusion of vaporized metal permits vacuum switches to interrupt DC loads more effectively than other types of switchgear.

1. Vacuum switches are rated up to 20 amps at 30kV DC and 10 amps at up to 50kV DC resistive loads without arc suppression. (See Figure 3.)
2. Vacuum switches using an R-C suppression across the contacts can interrupt slightly higher currents with less arcing time, which increases contact life. (See Figure 4.)
3. Vacuum switches using a charged capacitor suppression circuit that causes ringing and creates artificial current zeros have been used to interrupt up to 35kV DC at 150 amps DC resistive loads. (See Figures 5A and 5B.)
4. Inductive loads can be switched like resistive loads when a diode is used in parallel to the load. (See Figure 6.)

Please discuss your high current DC interrupting applications with Jennings application engineers, who will be happy to review your application and make recommendations. Contact us today at **jenningssales@tnb.com**.

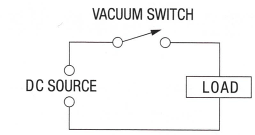

Figure 3 — No Arc Suppression

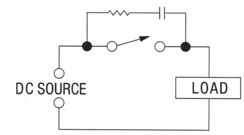

Figure 4 — R-C Suppression (1 Ω / kV; 0.125–1 MFD)

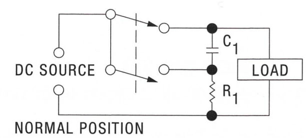

Figure 5A — Charged Capacitor Suppression Circuit in Normal Position

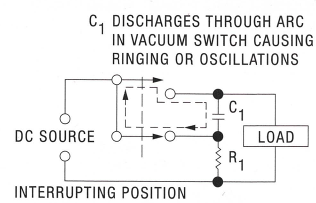

Figure 5B — Charged Capacitor Suppression Circuit in Interrupting Position

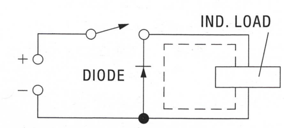

Figure 6 — Inductive Load Switching

Safety Information

Vacuum contactors may be used to switch high power circuits. All power sources connecting to the vacuum contactor must be isolated to avoid the possibility of electrical shock during inspection and servicing.

⚠ WARNING

DISCONNECT POWER BEFORE SERVICING. HAZARDOUS VOLTAGE CAN SHOCK, BURN OR CAUSE DEATH.