

The following reference material is reprinted from the *Engineer's Relay Handbook*, 5<sup>th</sup> edition, published by the Relay and Switch Industry Association (RSIA) formerly NARM.

For information on the association or how to obtain the complete handbook, contact:

Relay and Switch Industry Association (RSIA)  
2500 Wilson Boulevard  
Arlington, VA 22201  
(703) 907-8025 (703) 907-8025 FREE  
Fax: (703) 875-8908  
Email: narm@eca.us.org

The following definitions do not include terms peculiar to mathematical formula, statistical analysis, relay reliability studies, and the like. Such terms are defined in the appropriate chapter. When cross-references are made, the preferred terminology is the one under which the definition appears.

There is a sequence of events in relay pick up (operate) and dropout (release) with respect to current rise and decay. The events are defined in terms of duration of coil current, armature motion, and contact actuation.

Fig. 1.1 Time traces typical of relay pickup.

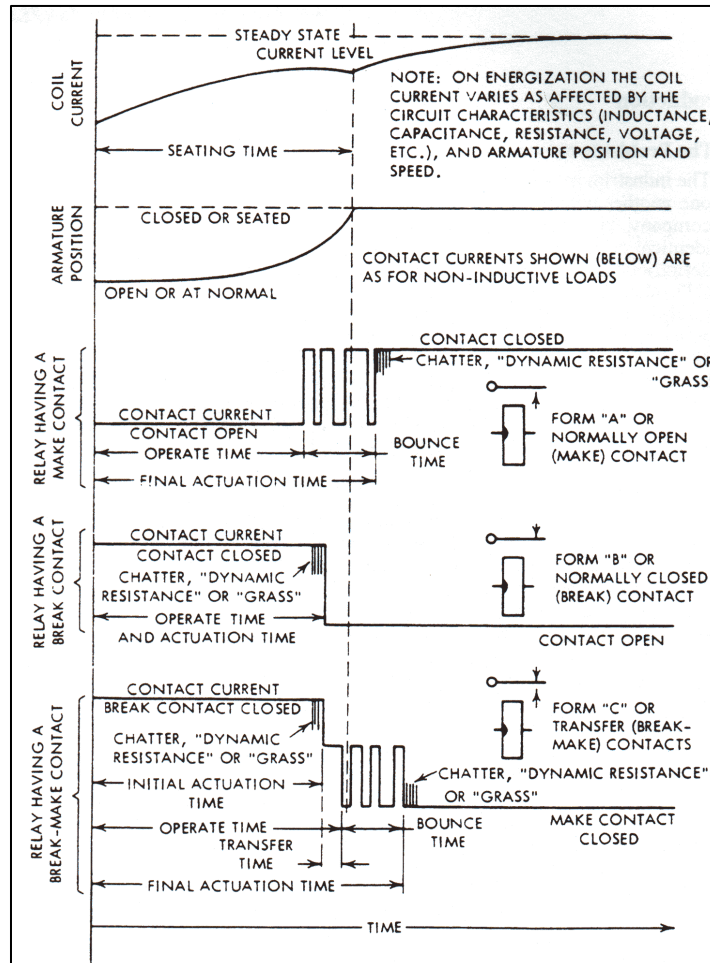
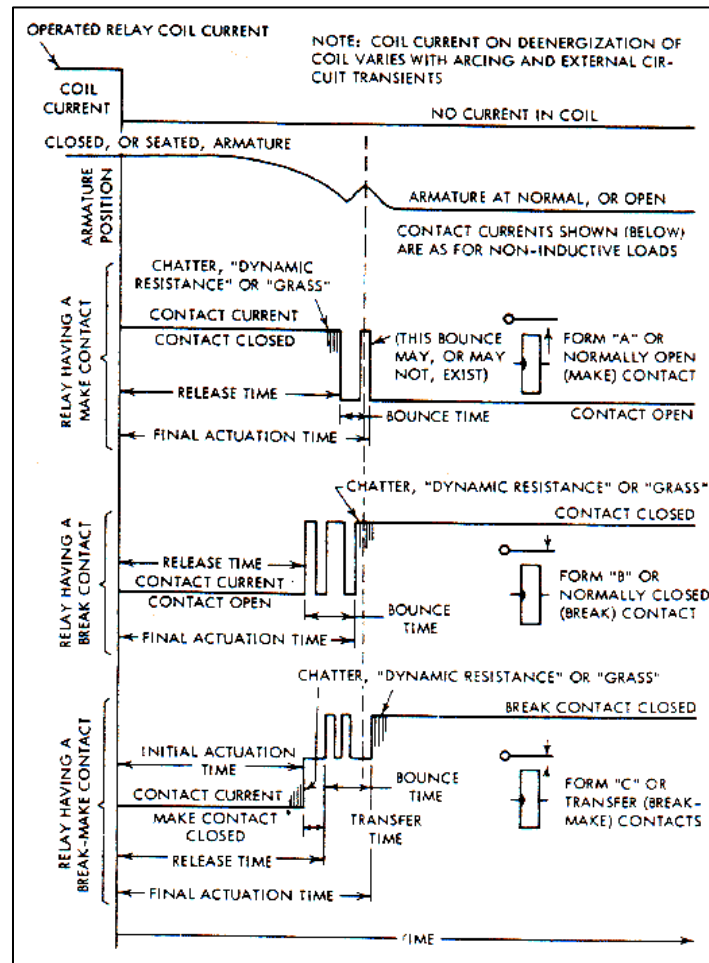


Fig. 1.2 Time traces typical of relay dropout.



Figures 1.1 and 1.2 show contact performance-as a series of oscillograms – for relay with a normally open contact, a normally closed contact, and a transfer (break-make) contact.

**Pick Up** (Figure 1.1) Upon coil energization, current begins to rise at a decreasing rate, but no armature movement occurs until the power develops sufficiently to operate the contact spring load. This period is sometimes referred to as waiting time. Contact actuation occurs during the armature movement. The final actuation time exceeds the initial actuation time by the amount of the contact bounce. For normally closed contacts, operate time and initial operate time are identical. On break-make contacts, the time interval between initial opening of the normally closed contact and closure of the normally open contact is called transfer time.

**Dropout** (Figure 1.2) On de-energization of the coil, the magnetic flux does not die out immediately. The length of time it persists depends upon the release characteristics of the coil (fast-to-release, slow-to-release, and the like). The sequence of events described under pickup is essentially reversed under dropout. It will be seen that a normally open contact may be momentarily reclosed as a result of armature rebound off the backstop. This effect, which is not always present, depends on many factors, such as contact spacing, contact spring load, backstop design, and the like.

Fig. 1.6 Symbols for Relay Contact Combinations established by the American National Standards Institute (ANSI).

Form	Description	ANSI Symbol	Form	Description	ANSI Symbol
A	Make or SPSTNO		L	Break, Make, Make, or SPDT (B-M-M)	
B	Break or SPSTNC		M	Single pole, Double throw, Closed Neutral. SP DT NC (This is peculiar to MIL-SPECS.)	
C	Break, Make, or SPDT (B-M), or Transfer		U	Double make, Contact on Arm. SP ST NO DM	
D	Make, Break or Make-Before-Break, or SPDT (M-B), or "Continuity transfer"		V	Double break, Contact on Arm. SP ST NC DB	
E	Break, Make, Break, or Break-Make-Before-Break, or SPDT (B-M-B)		W	Double break, Double make, Contact on Arm. ST DT NC-NO (DB-DM)	
F	Make, Make SPST (M-M)		X*	Double make or SP ST NO DM	
G	Break, Break or SPST (B-B)		Y**	Double break or SP ST NC DB	
H	Break, Break, Make, or SPDT (B-B-M)		Z	Double break, Double make SP DT NC-NO (DB-DM)	
I	Make, Break, Make, or SPDT (M-B-M)		* Not to be confused with preliminary ("X") make ** Not to be confused with a late ("Y") break		
J	Make, Make, Break, or SPDT (M-M-B)		Special A	Timed close	
K	Single pole, Double throw Center off, or SPDTNO		Special B	Timed open	
Multi-point selector switch					

The heavy arrow indicates the direction of operation. Contact chatter may cause some electrical discontinuity in forms D and E. Symbols taken from ANSI C83.16-1971 and Y32.2-1975.

The proper polarization for a polarized relay is shown by the use of plus (+) and (-) designations applied to the winding leads. The current in the direction indicated is to be interpreted to move, or tend to move, the armature toward the contact shown nearest the coil on the diagram. If the relay is equipped with numbered terminals proper numbers should be shown.

**Bounce, contact.** Internally caused intermittent and undesired opening of closed contacts, or closing of open contacts, of a relay, caused by one or more of the following: (1) Impingement of mating contacts; (2) Impact of the armature against the coil core on pickup or against the backstop on dropout; (3) Momentary hesitation or reversal of the armature motion during the pickup or dropout stroke (See Figures 1.1 and 1.2).

**Bounce time.** See *time, contact bounce*.

**Break.** The opening of closed contacts to interrupt an electric circuit.

**Buffer, armature or bushing, armature of lifter, armature or pusher, or stud armature.** A normally insulating member that transmits the motion of the armature from one movable contact spring to another in the same pileup.

### **Contact.**

- (1)The portion of current-carrying members at which electrical circuits are opened or closed.
- (2)The current carrying parts of a relay that engages or disengages to open or close electrical circuits.
- (3)Used to denote a combination or set. (Contacts also used)

**Contact bounce.** See *bounce, contact*.

**Contact, break.** See *contact, normally closed*.

**Contact, break-before-make.** A contact combination in which one contact opens its connection to another contact and then closes its connection to a third contact. (See "C" contact combination in Figure 1.6.)

**Contact, break-make.** See *contact, break-before-make*.

**Contact, continuity transfer.** A contact combination in which contact closes connection to another contact and then opens its prior connection to a third contact. (See "D" contact combination in Figure 1.6.)

**Contact, dynamic resistance.** See *dynamic contact resistance*.

**Contact final actuation time.** Total time from beginning of coil energization or de-energization to the end of bounce; i.e., contacts mechanically in final resting position. (See Figures 1.1 and 1.2.)

**Contact, initial actuation time.** Time from beginning of coil energization or de-energization to first opening of closed contact; i.e., at beginning of bounce. (See Figures 1.1 and 1.2)

**Contact, make.** See *contact, normally open*.

**Contact, make-before-break.** See *contact, continuity transfer*.

**Contact, make-break** See *contact, continuity transfer*.

**Contact, normally closed.** A contact combination which is closed when the armature is in its unoperated position. (See "B" contact combination in Figure 1.6.)

**Contact, normally open.** A contact combination that is open when the armature is in its unoperated position. (Generally applies to monostable relays.) (See "A" contact combination in Figure 1.6.)

**Contact, operate time.** Time from initial energization to the first opening of closed contact or first closing of open contact, prior to bounce. (See Figure 1.1 and 1.2)

### **Contact, reed.**

- (1)A glass-enclosed, magnetically operated contact using thin, flexible, magnetic conducting strips as the contacting members.
- (2)Contact assembly, the contact members of which are blades either fully or partly of magnetic material and which are moved directly by a magnetic force. (IEC)

**Contact release time.** Time from initial de-energization of the relay coil to the first opening of a closed contact prior to bounce. (See Figures 1.1 and 1.2.)

**Contact, transfer.** Either a contact, break-make or contact, continuity transfer.

**Contact transfer time.** Time during which the moving contact first opens from a closed position and first makes with the opposite throw of the contact. It is floating in a non-contacting position prior to bounce and after energizing or de-energizing the coil. (See Figure 1.1 and 1.2.)

**Contact weld.** A contact failure due to fusing of contacting surfaces to the extent that the contacts fail to separate when intended.

**Contacteur.** See *relay, power*.

**Current, intermediate.** The range of current (milliamperes) at which formation of carbonaceous material may significantly affect contact resistance.

**Current, leakage.** (Maximum off-state current) $T_D$  (rms)-The parameter is an effective current and is specified at maximum-load voltage. In solid-state relays, it is the current that flows through the load when the relay is in the off-state. Does not apply to electromechanical relays where contacts are open and current cannot flow.

**Current, minimum load.**  $I_{TMIN}(rms)$ -The minimum current required to maintain the relay in the on-state (nominal load voltage applies). Applies mainly to solid-state relays.

**Current, non-repetitive surge**- $I_{TSM}$ . The maximum allowable, non-repetitive, peak, sinusoidal current that may be applied to the output for one full cycle at nominal line frequency. Relay control may be lost during and following the surge until the junction temperature falls below the maximum rated temperature.

**Current rated contact.** The current which the contacts are designed to handle for their rated life. See *rating, contact*.

**Current, maximum rate of rise on state (di/dt).** The maximum non-repetitive rate of current rise the output can withstand without being damaged.

(1) With the relay output(s) turned on by the application or removal of the control voltage and/or current.

(2) With the relay output(s) driven into break-over with the input at non-operate level. **Current, repetitive overload**- $I_{TO}$  (rms)-The maximum allowable repetitive rms overload current that may be applied to the output for a specific duration and duty cycle while still maintaining output control. Applies mainly to solid state relays.

**De-energize.** To remove power from a relay coil.

**Dielectric strength.**  $V_{ISO}$ -The maximum allowable ac rms voltage (50/60Hz) which may be applied between two specified test points such as input-output, input-case, output-case in solid state relays, and between current-carrying and non-current-carrying metal members in electromechanical relays.

**Dropout, to drop out.** A monostable relay drops out when it changes from an energized to an unenergized condition. (IEC)

**Dropout, time.** See *time, release*.

**Dropout value, measured.** As the current or voltage on an operated relay is decreased, the value at which all contacts restore to their unoperated positions.

**Dropout value, specified.** As the current or voltage on an operated relay is decreased, the value at or above which all relay contacts must restore to their unoperated positions.

**Duty cycle.** A statement of energized and de-energized time in repetitious operation; for example, 2 seconds on, 6 seconds off. Often expressed as the energized percentage of total cycle time.

**Dynamic contact resistance.** A change in contact electrical resistance due to a variation in contact pressure on a contacts mechanically closed (see Figures 1.1 and 1.2); occurrence is during non-bounce condition.

**Energization.** The application of power to a coil winding of a relay. With respect to an operating coil winding, use of the word commonly assumes enough power to operate the fully unless otherwise stated.

**Frame.** The main supporting portion of a relay, which may include parts of the magnetic structure.

**Hold value specified.** As the current or voltage on an operated relay is decreased, the value at or above which all relay contacts must restore to their unoperated positions.

**Housing.** An enclosure or cover for one or more relays, with or without accessories; usually provides access to the terminals.

**Initial actuation time.** See *contact initial actuation time*.

**Insulation resistance.**  $R_{ISO}$  The minimum allowable dc resistance between input and output of solid state relays and between contacts and coil for electromechanical and reed relays.

**Isolation.** The value of insulation resistance, dielectric strength, and capacitance measured between the input and outputs, input to case, output to case, and output to output when applicable.

**Leakage (max.off state current  $I_D(rms)$ ).** The rms current conducted by the output circuit of the relay at maximum load voltage with zero input voltage/current.

**Make.** The closure of open contacts to complete an electric circuit.

**Minimum current.** See *current, intermediate*.

**Miss, contact.** Failure of a contact mating pair to establish the intended circuit. This may be a contact resistance in excess of a specified maximum value.

**Normal condition.** The de-energized condition of the relay.

**Normal position.** The de-energized position of contacts, open or closed, due to spring tension, gravity, or magnetic polarity. The term is also used for the home position of a stepping switch.

**Normal sequence of operation.** The intended contact operation sequence built into a relay unaffected by wear or dimensional change. See *gaging, relay contact*.

**Offstate dv/dt.** The application of both position and negative voltages with maximum specified rate of rise to the output terminals.

**Operate.** A relay operates when sequentially it starts, it passes from an initial condition towards the prescribed operated condition, and it switches.(IEC)

**Operate time.** See *contact operate time*.

**Operate value.** See *operating characteristics, pickup value*.

**Operate value, just.** See *operating characteristics, pickup value, measured*.

**Operate value, must.** See *operating characteristics, pickup value, specified*.

**Operating characteristics.** Pickup, nonpickup, hold and dropout, voltage and current.

**Output circuit.** The whole of the electrically conductive parts within a relay connected to the terminals between which the predetermined change is produced. (IEC)

**Pickup, to pick up.** A monostable relay picks up when it changes from the unenergized condition to an energized condition.(IEC)

**Pickup value, measured.** As the current or voltage on an unoperated relay is increased, the value at or below which all contacts function.

**Pickup pulse.** A short, high-level pulse applied to a relay; usually employed to obtain fast-operate time.

**Pickup value, specified.** As the current or voltage on an unoperated relay is increased, the value at or below which all contacts must function.

**Pickup (or pull-in) time.** See *time, operate*.

**Pull-in time.** See *time, operate*.

**Pull-in (or pull-on) value measured** See *operating characteristics, pickup value, measured*.

**Pull-in (or pull-on) value specified** See *operating characteristics, pickup value, specified*. **Pusher** See *buffer, armature*.

**Relay.** An electric device that is designed to interpret input conditions in a prescribed manner and after specified conditions are met to respond to cause contact operation or similar abrupt change in an associated electric control circuit. Notes: (a) Inputs are usually electric, but may be mechanical, thermal or other quantities. (b) A relay may consist of several units, when responsive to specified inputs, the combination providing the desired performance characteristic.

**Relay, close.** differential-A relay having its dropout value specified close to its pickup value.

**Relay, coaxial.** A special RF relay that opens or closes a coaxial cable or line. It is generally a low impedance device.

**Relay, current-sensing.** A relay that functions as a predetermined value of current; an overcurrent or an undercurrent relay, or a combination of both.

**Relay, direct current (dc).** A relay designed for operation from a direct-current source.

**Relay, electrical.** A device designed to produce sudden, predetermined changes in one or more electrical output circuits, when certain conditions are fulfilled in the electrical input circuits controlling the device. (IEC)

Note 1-The term relay shall be restricted to a relay unit having a single relaying function between its input circuits and its output circuits.

Note 2-The term relay includes all the components which are necessary for its specified operation.

Note 3-The adjective "electrical" can be deleted when no ambiguity may occur.

**Relay, electromagnetic.** A relay whose operation depends upon the electromagnetic effects of current flowing in an energizing winding.

**Relay, electromechanical power controller (EMPC).** An electromechanical relay which contains electronic circuitry that monitors electrical characteristics of its containing system and causes the EMPC to open or close based upon its specified parameters. An EMPC combines the traditional function of a relay and a circuit breaker or fuse.

**Relay, electromagnetic time delay.** A relay in which the actuation of the contacts is delayed by the inductive effect of a conducting sleeve or slug (usually nonmagnetic) or a short-circuited winding over the core.

**Relay, electromechanical** An electrical relay in which the designed response is developed by the relative movement of mechanical elements under the action of a current in the input circuits. (IEC)

**Relay, latching.** A relay that maintains its contacts in the last position assumed without the need of maintaining coil energization.

(1)Magnetic latching- A relay that remains operated, held either by remanent magnetism in the structure or by the influence of a permanent magnet, until reset.

(2)Mechanical latching- A relay in which the armature or contacts may be latched mechanically in the operated or unoperated position until reset manually or electrically.

**Relay, measuring.** An electrical relay intended to switch when its characteristics quantity, under specified conditions and with a specified accuracy, attains its operating value. (IEC)

**Relay, mechanical time delay.** A relay in which operate or release action is delayed by a clockwork, escapement, bellows, dashpot, or other mechanical device.

**Relay, multiposition.** A relay that has more than one operate or nonoperate position; e.g., a stepping relay.

**Relay, neutral.** A relay whose operation is independent of the direction of the coil current, in contrast to a polarized relay.

**Relay, power.** A relay with heavy-duty contacts; usually rated 25 amperes or higher. Sometimes called a contactor.

**Relay, reed.** A relay using glass-enclosed, magnetic reeds as the contact members.

**Relay, specified time.** An electrical relay in which one or more of the times which characterize it (e.g., operating time) are subject to specified requirements; in particular, accuracy. (IEC)

**Relay, undercurrent.** A relay specifically designed to function when its energizing current falls below a predetermined value. (See *relay, current sensing*.)

**Relay, undervoltage.** A relay specifically designed to function when its energizing voltage falls below a predetermined value.

**Release, measured.** See *operating characteristics, dropout measured*.

**Release specified.** See *operating characteristics, dropout specified*.

**Release time.** See *contact, release time*.

**Release value.** See *operating characteristics, dropout value*.

**Reset.** The return of contacts or a mechanism to the normal state (initial conditions).

**Reset, automatic.** A qualifying term applied to:

(1) A stepping relay that returns to its home position either when it reaches a predetermined contact position or when a pulsing circuit fails to energize the driving coil within a given time. May either pulse forward or be spring reset to the home position.

(2)An overload relay that restores the circuit as soon as an over-current situation is corrected.

**Reset, electrical.** A qualifying term applied to a relay to indicate the it may be reset electrically after operation.

**Reset, manual.** A qualifying term applied to a relay to indicate that it may be reset manually after operation.

**Resistance, contact.** The electrical resistance of closed contacts measured at their associated contact terminals.

**Resistance, dynamic contact.** Variation in contact resistance due to changes in contact pressure during the period in which contacts are motion, before opening or after closing (See Figures 1.1 and 1.2).

**Self de-energize.** The removal of power from a relay coil by an auxiliary switch or contact within the relay itself. Usually applies to latching relays only.

**Self de-energizing switch.** A secondary relay or auxiliary contact usually enclosed within the primary relay which removes power from the primary relay coil after it has transferred position. Usually applies to latching relays only.

**Shield, electrostatic.** Grounded conducting member located between two or more mutually insulated elements to minimize electrostatic coupling.

**Shield, magnetic.** A ferromagnetic member used to reduce magnetic coupling.

**Slow-release time characteristic.** See *characteristic, slow release time*.

**Switch.** A relay switches at the instant it completes its designated function in a given output circuit. (IEC)

**Thermal resistance maximum, junction to ambient ( $R_{\theta JA}$ ).** The maximum thermal resistance between the semiconductor junction and still air ambient. (Expressed in C/watt).

**Thermal resistance maximum, junction to case ( $R_{\theta JC}$ ).** The maximum thermal resistance between the output switch semiconductor(s) junction to point of measurement on the relay case (expressed in C/watt). **Thermal shock non-operating.** These temperature extremes between which the relay may be rapidly cycled without permanent electrical or mechanical damage.

**Time, actuation.** The time interval from coil energization or de-energization to the functioning of a specified contact; same as time, contact actuation, subdivided as follows:

(1) *Time, final actuation*-The sum of the initial actuation time and the contact bounce intervals following such actuation.

(2) *Time, initial actuation*-The time from coil energization or de-energization to the first closing of a previously open contact or the first opening of a previously closed contact. (See *time, operate; time, release*.)

**Time, contact bounce.** The time interval from initial actuation of a contact to the end of bounce.

**Time, operate.** (1) The time interval from coil energization to the functioning of the last contact to function. Where not otherwise stated, the functioning time of the contact in question is taken as its initial actuation time (that is, it does not include contact bounce time). (See Figures 1.01 and 1.02.) (2) For a solid state or hybrid relay in a non-operated state, the time from the application of the pickup voltage to the change of state of the output.

**Time, release.** (1) The time interval from coil de-energization to the functioning of the last contact to function. Where not otherwise stated, the functioning time of the contact in question is taken as its initial actuation time (that is, it does not include contact bounce time). (2) For a solid state or hybrid relay in an operated state, the time from the application of the dropout voltage to the change of state of the output.

**Voltage, nominal** A single value of voltage (or a narrow voltage range) intended to be applied to the coil or input. See *voltage, rated coil*.

**Voltage, off state.** In solid state relay, the following determine whether the relay will stay off under each load voltage condition:

(1) Critical rate of rise of commutation voltage,  $dv/dt$ . The maximum value of the rate of rise of principal voltage which will cause switching from the off state to the on state.

(2) Maximum off state voltage ( $V_{DMAX}$ )(RMS). The maximum effective steady state voltage that the output is capable of withstanding when in off state.

(3) Maximum rate of rise of off state voltage,  $dv/dt$ . The rate of rise of the off-state voltage which the output can withstand without false operation.

(4) Minimum off state voltage ( $V_{DMIN}$ )(RMS). The minimum effective voltage which the relay will switch.

(5) Non-repetitive peak voltage ( $V_{DSM}$ ). The maximum off-state voltage that the output terminals are capable of withstanding without breakover or damage.



**Voltage, on state.** In solid state relays, the output terminal wave form at rated current consists of repetitive half-cycles (+and-) of distinctive voltage drops. Each voltage state is necessary for load current conduction and may be specified for specific applications, as follows:

- (1) Instantaneous on state voltage ( $V_T$ ) The instantaneous voltage across the output when in the on condition.
- (2) Maximum RMS on state voltage ( $V_T$ )(RMS). Maximum RMS voltage drop across the relay output at maximum load current  $I_{TRMS}$ .
- (3) Minimum power factor load ( $PF_{MIN}$ ). The minimum power factor load the relay will switch and still meet all of its electrical specifications.
- (4) Peak on state voltage ( $V_{TM}$ ). The maximum value of  $V_T$  excluding 20 of zero crossing of the voltage wave form.

**Voltage, rated coil.** The coil voltage at which the relay is intended to operate for the prescribed duty cycle. Note: The use of any coil voltage less than rated may compromise the performance of the relay.

**Voltage, reverse polarity.** The maximum allowable reverse voltage which may be applied to the input of a solid state relay without permanent damage.

**Zero-voltage-turn-on voltage (zero synchronous turn-on) ( $V_{TO}$ ).** The maximum voltage across the output terminals following initial turn-on.

For more information, contact



972-783-8100 • 888-SEMITEK • info@semitek.com • www.semitek.com

870 N Dorothy Drive, Suite 714 • Richardson, Texas USA 75081