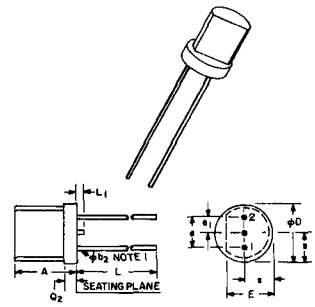
Silicon
Asymmetrical AC Trigger

ST4

The ST4 is an asymmetrical AC trigger integrated circuit for use in triac phase controls. This device greatly reduces the snap-on effects that are present in symmetrical trigger circuits and minimizes control circuit hysteresis. This performance is possible with a single RC time constant, whereas a symmetrical circuit of comparable performance would require at least three additional passive components.

The ST4 is available in a two leaded TO98 type in-line epoxy package.



SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.170	.265	4.32	6.73
ϕb2	.016	.019	.406	.483
ϕD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e1	.045	.055	1.14	1.40
L	.500		12.70	
Q2	.055	.075	1.40	1.90
s	.080	.115	2.03	2.92
L1	.031	.094	.794	2.38

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

FEATURES

- Reduces Circuit Complexity (Minimum Parts Count)
- Hysteresis–Free Control
- Low Switching Current (80μA)
- Wide Range of Control
- Low Cost Packaging

PERFORMANCE

A typical triac phase-control circuit is shown in figure 1 along with the symmetrical trigger characteristics.

Its main disadvantage is the snap-on hysteresis exhibited in figure 2.

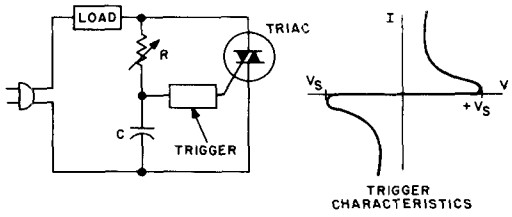


Figure 1. Typical triac phase-control circuit with hysteresis.

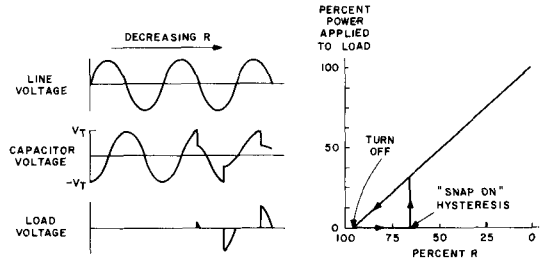


Figure 2. Typical waveforms illustrating hysteresis effect.

Using a lamp dimmer as an example, the light "snaps on" to moderate brightness, although a gradual increase in brightness is both expected and desired. During each half-cycle of AC voltage, the capacitor C is charged through the resistor R and while the trigger is not firing, the capacitor voltage lags line voltage by approximately 90°. However, once the trigger device fires, the capacitor voltage drops as it is discharged into the triac gate. During the next half-cycle, the capacitor voltage will now exceed the breakover voltage sooner since it started charging from a lower voltage. This action results in a large step in the transfer function of figure 2. This snap-on effect can be eliminated with additional circuit components, usually 2 resistors and a capacitor.

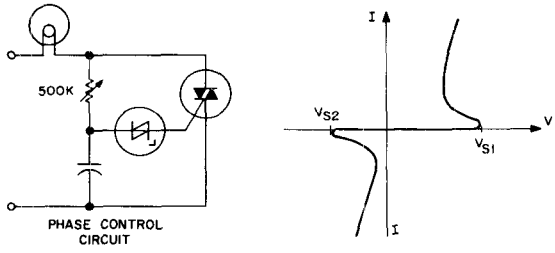


Figure 3. Typical triac phase-control circuit with an asymmetrical switch.

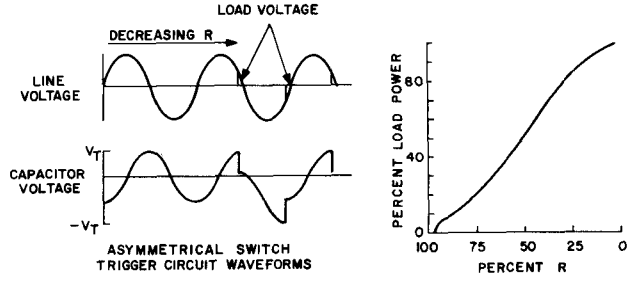


Figure 4. Hysteresis-free, cost-optimized, circuit performance.

A superior and more economical way to eliminate this hysteresis is to use the ST4 trigger device. The ST4 is constructed such that when the device triggers for the first time, the triggering voltage on the next half-cycle is equal to the original breakover voltage plus the voltage decrease due to the capacitor discharge into the triac gate. This allows the capacitor voltage to maintain the same time relationship with line voltage and thus the same firing angle. These concepts are shown graphically in figures 3 and 4.

Further discussion of hysteresis, device operation, and light dimming can be found in:

1. *GE SCR Manual,* chapters 7 & 9. **2.** 200.35 *Using the Triac for the Control of AC Power.* **3.** 200.53 *Solid State Incandescent Lighting Control.*

absolute maximum ratings: (25°C)

ST4

CURRENT

I_{21} Continuous . . . . . 200 ma
I_{21} Pulsed (PW = 2μs, Duty Cycle ≤ 10%). . . . . 500 ma
I_{12} Pulsed (PW = 2μs, Duty Cycle ≤ 10%). . . . . 175 ma

POWER

Total Average*. . . . . 350 mW

*Derate power 3.5 mW/°C above 25°C

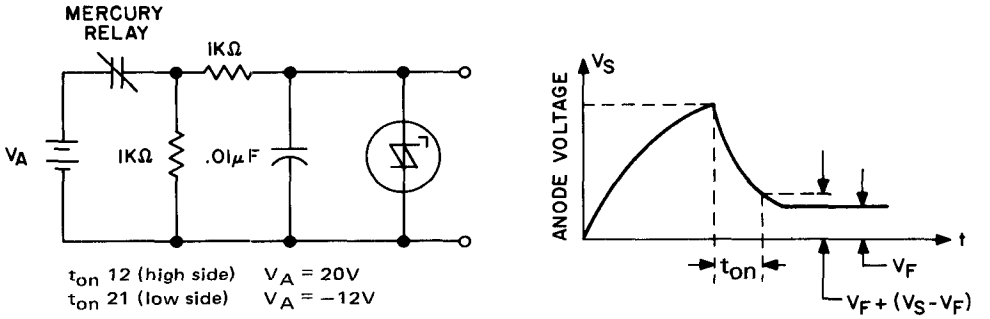
TEMPERATURE

Operating junction temperature range . . . . . −55°C to +125°C
Storage temperature range . . . . . −55°C to +150°C
Lead temperature (during soldering) at distance ≥ 1/16 ins. (1.59 mm) from case for 10 sec. max. . . . . 260°C

electrical characteristics: (25°C)

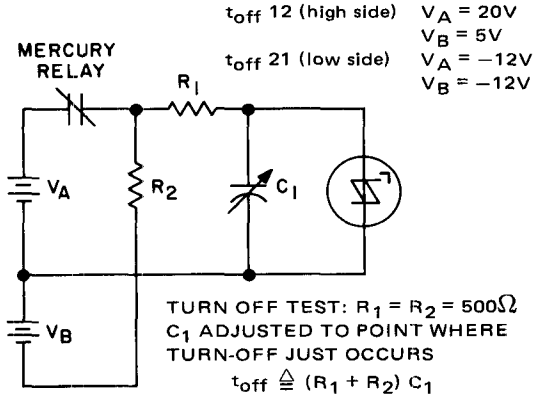
Test	Symbol	Min.	Max.	Units	Test Conditions
Switching Voltage	V_{S1}	14	18	Volts	
	V_{S2}	7	9	Volts	
Switching Current	I_{S1}, I_{S2}	–	80	μA	
	I_{S1}, I_{S2}	–	160	μA	T_A = −55°C
Voltage Drop	V_{F1}	7	10	Volts	I_{12} = 100 mA
	V_{F2}	–	1.6	Volts	I_{21} = 100 mA
Off-State Current	I_{12}	–	100	nA	V_{12} = 10 Volts
	I_{21}	–	100	nA	V_{21} = 5 Volts
Switching Voltage Temperature Coefficient	T.C.	–	.05	%/°C	T_J = −55°C to +125°C
Turn-on Time	t_{on}	–	1	μsec	See Circuit 1
Turn-off Time	t_{off}	–	30	μsec	See Circuit 2
Output Pulse	V_o	3.5	–	Volts	See Circuit 3

Circuit 1
Turn-on Time, t_{on}



t_{on} 12 (high side) V_A = 20V
t_{on} 21 (low side) V_A = −12V

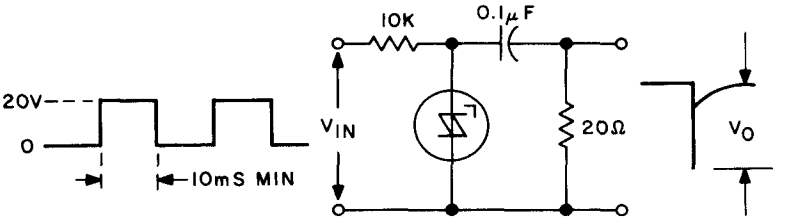
Circuit 2
Turn-off Time, t_{off}



t_{off} 12 (high side) V_A = 20V, V_B = 5V
t_{off} 21 (low side) V_A = −12V, V_B = −12V

TURN OFF TEST: $R_1 = R_2 = 500\Omega$
C_1 ADJUSTED TO POINT WHERE TURN-OFF JUST OCCURS
$t_{off} \triangleq (R_1 + R_2)\, C_1$

Circuit 3
Peak Pulse Amplitude, V_o (Both Directions)



ST4

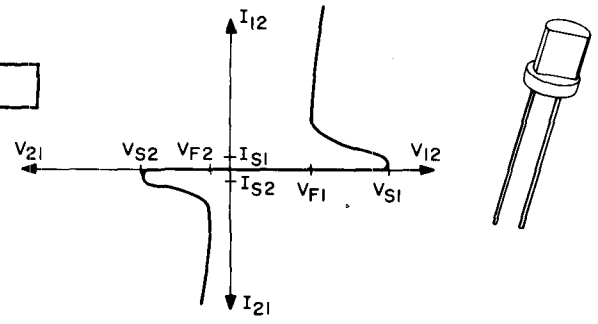


FIGURE 5. ST4 ELECTRICAL CHARACTERISTICS

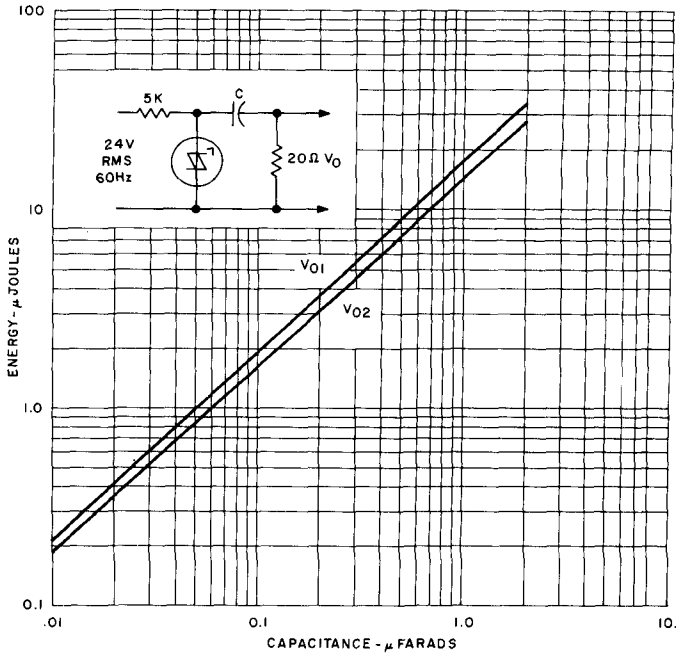


FIGURE 6. CAPACITIVE DISCHARGE ENERGY (PER PULSE) VS. CAPACITANCE (TYPICAL)

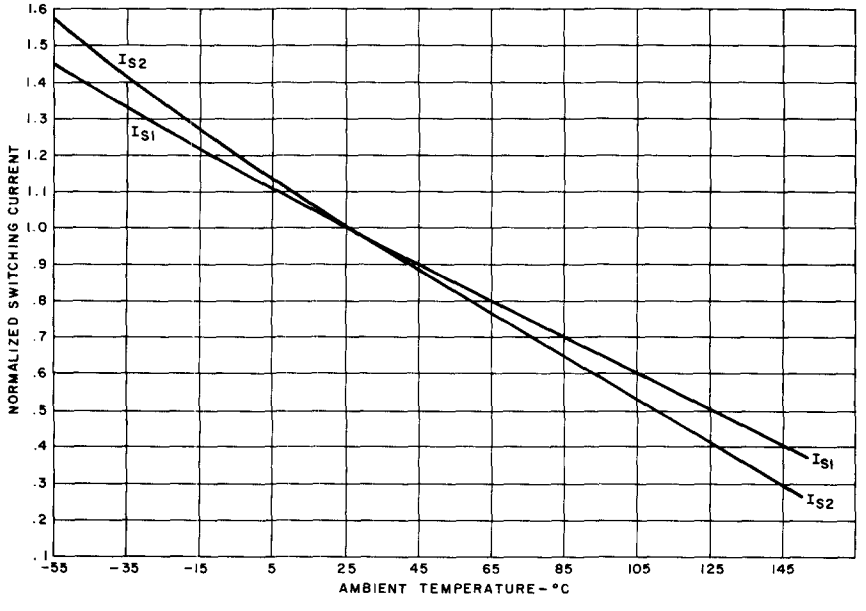


FIGURE 7. SWITCHING CURRENT VARIATION WITH TEMPERATURE (TYPICAL)

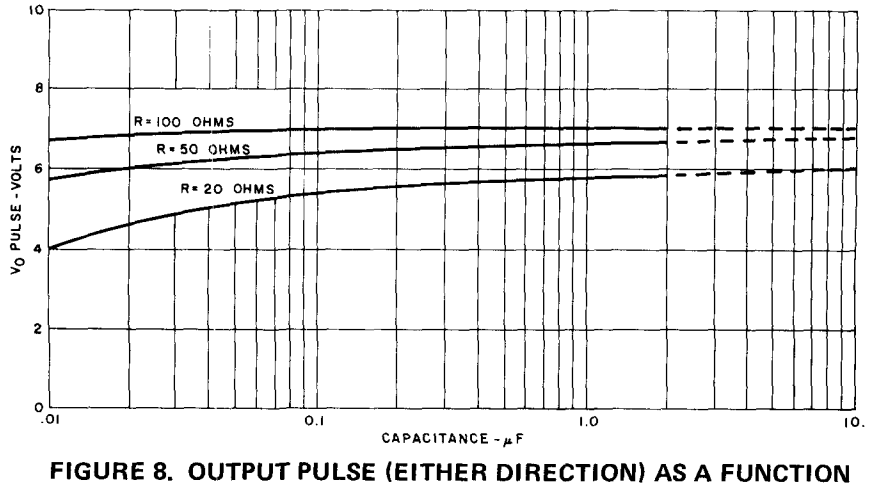


FIGURE 8. OUTPUT PULSE (EITHER DIRECTION) AS A FUNCTION OF LOAD RESISTANCE AND CHARGING CAPACITANCE (TYPICAL)

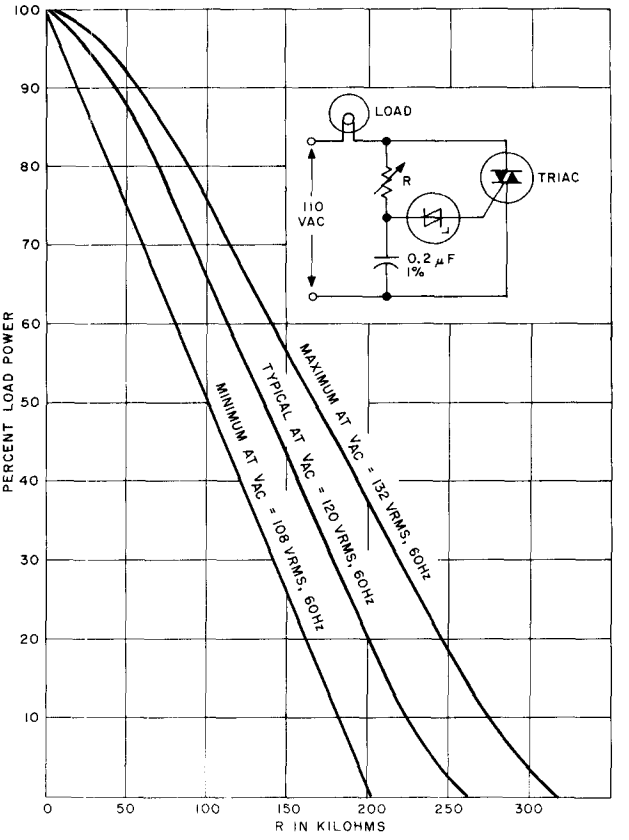


FIGURE 9. OUTPUT POWER TO LOAD VS. CONTROL RESISTOR VALUE (25°C)

USE THE ST4 ASYMMETRICAL AC TRIGGER WITH A TRIAC SELECTED FROM GE'S COMPREHENSIVE LINE.		
Current Rating	**GE Type**	***Specification Sheet No.***
3A	SC35/36	175.24
6A	SC40/41	175.25
6A	SC240/241	175.16
6/10A	SC141/146	175.15
10A	SC45/46	175.26
10A	SC245/246	175.17
15A	SC50/51	175.27
15A	SC250/251	175.18
25A	SC60/61	175.21