MOTOROLA
Semiconductors
BOX 20912 • PHOENIX, ARIZONA 85036

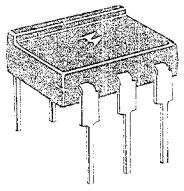
4N29
4N30
4N31
4N32
4N33

NPN PHOTOTRANSISTOR AND PN INFRARED EMITTING DIODE

. . . Gallium Arsenide LED optically coupled to a Silicon Photo Darlington Transistor designed for applications requiring electrical isolation, high-current transfer ratios, small package size and low cost; such as interfacing and coupling systems, phase and feedback controls, solid-state relays and general-purpose switching circuits.

- High Isolation Voltage — V_{ISO} = 2500 V (Min) — 4N29,32; 1500 V (Min) — 4N30,31,33
- High Collector Output Current @ I_F = 10 mA — I_C = 50 mA (Min) — 4N32,33; 10 mA (Min) — 4N29,30; 5.0 mA (Min) — 4N31
- Economical, Compact, Dual-In-Line Package
- Excellent Frequency Response — 30 kHz (Typ)
- Fast Switching Times @ I_C = 50 mA — t_{on} = 0.6 μs (Typ); t_{off} = 17 μs (Typ) — 4N29,30,31; 45 μs (Typ) — 4N32,33

INFRARED LIGHT EMITTING DIODE
PHOTO DARLINGTON TRANSISTOR
COUPLED PAIR



MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
INFRARED-EMITTING DIODE MAXIMUM RATINGS			
Reverse Voltage	V_R	3.0	Volts
Forward Current — Continuous	I_F	80	mA
Forward Current — Peak (Pulse Width = 300 μs, 2.0% Duty Cycle)	I_F	3.0	Amp
Total Power Dissipation @ T_A = 25°C; Negligible Power in Transistor	P_D	150	mW
Derate above 25°C		2.0	mW/°C
PHOTOTRANSISTOR MAXIMUM RATINGS			
Collector-Emitter Voltage	V_{CEO}	30	Volts
Emitter-Collector Voltage	V_{ECO}	5.0	Volts
Collector-Base Voltage	V_{CBO}	30	Volts
Total Power Dissipation @ T_A = 25°C; Negligible Power in Diode	P_D	150	mW
Derate above 25°C		2.0	mW/°C
TOTAL DEVICE RATINGS			
Total Device Dissipation @ T_A = 25°C; Equal Power Dissipation in Each Element	P_D	250	mW
Derate above 25°C		3.3	mW/°C
Operating Junction Temperature Range	T_J	-55 to +100	°C
Storage Temperature Range	T_{stg}	-55 to +150	°C
Soldering Temperature (10 s)	—	260	°C

FIGURE 1 — MAXIMUM POWER DISSIPATION

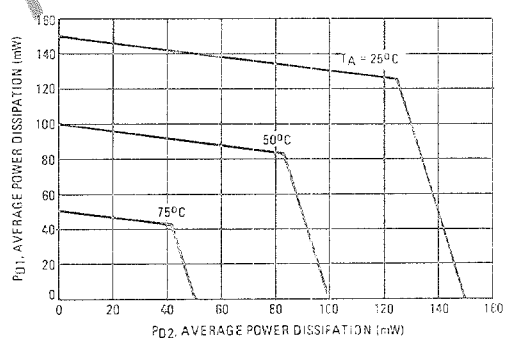


Figure 1 is based upon using limit values in the equation:

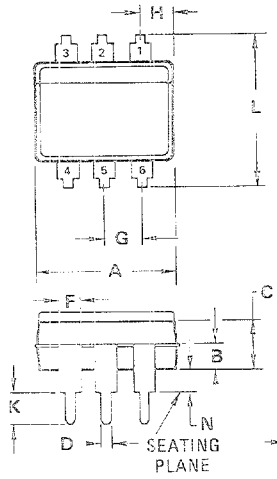
$T_{J1} - T_A = R_{\theta JA} (P_{D1} + K_\theta P_{D2})$

where:

- T_{J1} Junction Temperature (100°C)
- T_A Ambient Temperature
- $R_{\theta JA}$ Junction to Ambient Thermal Resistance (500°C/W)
- P_{D1} Power Dissipation in One Chip
- P_{D2} Power Dissipation in Other Chip
- K_θ Thermal Coupling Coefficient (20%)

Example:

With P_{D1} = 90 mW in the LED @ T_A = 50°C, the Darlington P_D (P_{D2}) must be less than 50 mW.



STYLE 2
PIN 1. ANODE
2. CATHODE
3. N.C.
4. EMITTER
5. COLLECTOR
6. BASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.38	8.89	0.330	0.350
B	1.40	1.65	0.055	0.065
C	2.92	3.18	0.115	0.125
D	0.41	0.51	0.016	0.020
E	0.64	0.89	0.025	0.035
F	1.14	1.40	0.045	0.055
G	2.54 BSC		0.100 BSC	
H	1.57	1.83	0.062	0.072
J	0.23	0.28	0.009	0.011
K	2.54	3.30	0.100	0.130
L	7.37	7.87	0.290	0.310
M	—	5°	—	5°
N	—	1.27	—	0.050
R	1.52	1.78	0.060	0.070

CASE 673-03

LED CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
*Reverse Leakage Current (V_R = 3.0 V, R_L = 1.0 M ohms)	I_R	—	0.05	100	μA
*Forward Voltage (I_F = 50 mA)	V_F	—	1.2	1.5	Volts
Capacitance (V_R = 0 V, f = 1.0 MHz)	C	—	150	—	pF

PHOTOTRANSISTOR CHARACTERISTICS (T_A = 25°C and I_F = 0 unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
*Collector-Emitter Dark Current (V_{CE} = 10 V, Base Open)	I_{CEO}	—	—	100	nA
*Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	BV_{CBO}	30	—	—	Volts
*Collector-Emitter Breakdown Voltage (I_C = 100 μA, I_B = 0)	BV_{CEO}	30	—	—	Volts
*Emitter-Collector Breakdown Voltage (I_E = 100 μA, I_B = 0)	BV_{ECO}	5.0	—	—	Volts
DC Current Gain (V_{CE} = 5.0 V, I_C = 500 μA)	h_{FE}	—	5000	—	—

COUPLED CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
*Collector Output Current (1) (V_{CE} = 10 V, I_F = 10 mA, I_B = 0)	4N32, 4N33	I_C	50	—	—	mA
	4N29, 4N30		10	—	—	
	4N31		6.0	—	—	
*Isolation Voltage (2)	4N29, 4N32	V_{ISO}	2500	—	—	Volts
	4N30, 4N31, 4N33		1500	—	—	
Isolation Resistance (2) (V = 500 V)			—	10^{11}	—	Ohms
*Collector-Emitter Saturation Voltage (1) (I_C = 2.0 mA, I_F = 8.0 mA)	4N31	$V_{CE(sat)}$	—	—	1.2	Volts
	4N29, 4N30, 4N32, 4N33		—	—	1.0	
Isolation Capacitance (2) (V = 0, f = 1.0 MHz)		—	—	0.8	—	pF
Bandwidth (3) (I_C = 2.0 mA, R_L = 100 ohms, Figures 6 and 8)		—	—	30	—	kHz

SWITCHING CHARACTERISTICS (Figures 7 and 8, (4))

Turn-On Time (I_C = 50 mA, I_F = 200 mA, V_{CC} = 10 V)		t_{on}	—	0.6	5.0	μs
Turn-Off Time (I_C = 50 mA, I_F = 200 mA, V_{CC} = 10 V)	4N29,30,31	t_{off}	—	17	40	μs
	4N32,33		—	45	100	

*Indicates JEDEC Registered Data.

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%

(2) For this test LED pins 1 and 2 are common and Photo Transistor pins 4,5 and 6 are common.

(3) I_F adjusted to yield I_C = 2.0 mA and i_c = 2.0 mA P-P at 10 kHz.

(4) t_d and t_r are inversely proportional to the amplitude of I_F; t_s and t_f are not significantly affected by I_F.

DC CURRENT TRANSFER CHARACTERISTICS

FIGURE 5 — 4N29, 4N30, 4N31

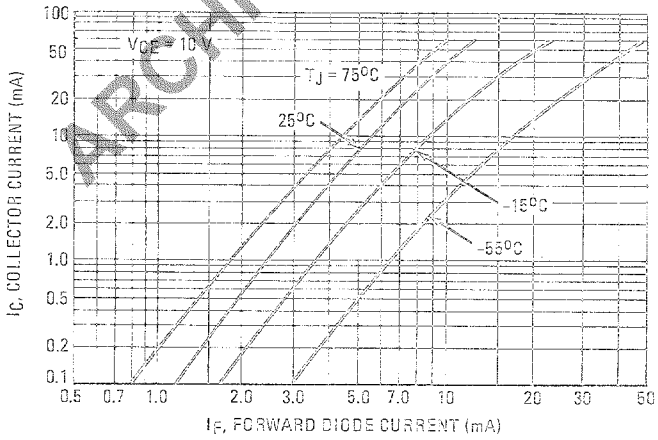
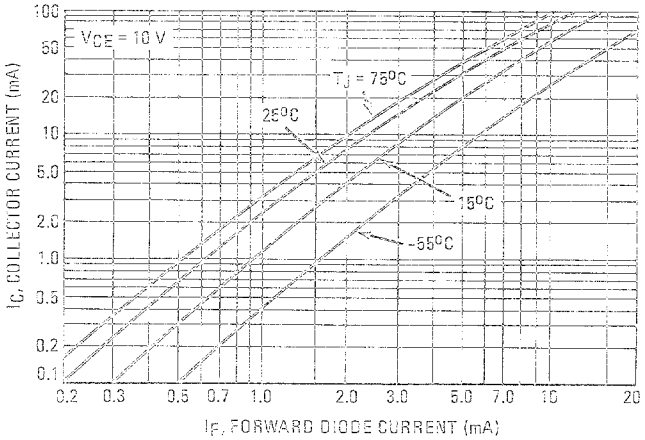


FIGURE 6 — 4N32, 4N33



TYPICAL ELECTRICAL CHARACTERISTICS
(Printed Circuit Board Mounting)

FIGURE 4 – DIODE FORWARD CHARACTERISTIC

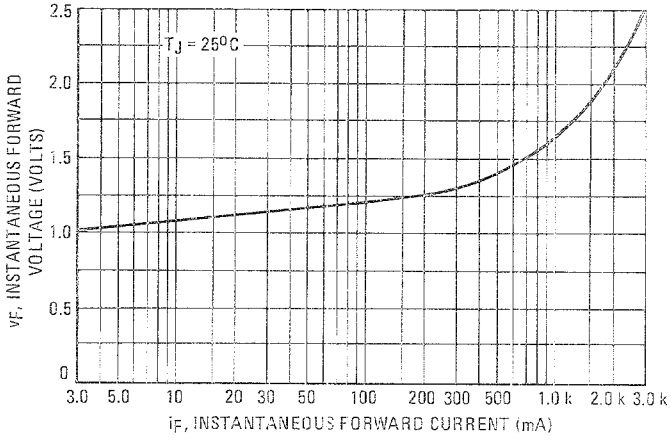


FIGURE 5 – COLLECTOR-EMITTER CUTOFF CURRENT

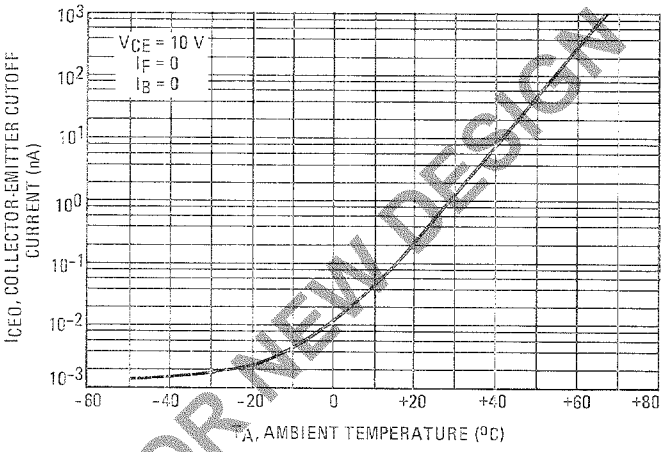


FIGURE 6 – FREQUENCY RESPONSE

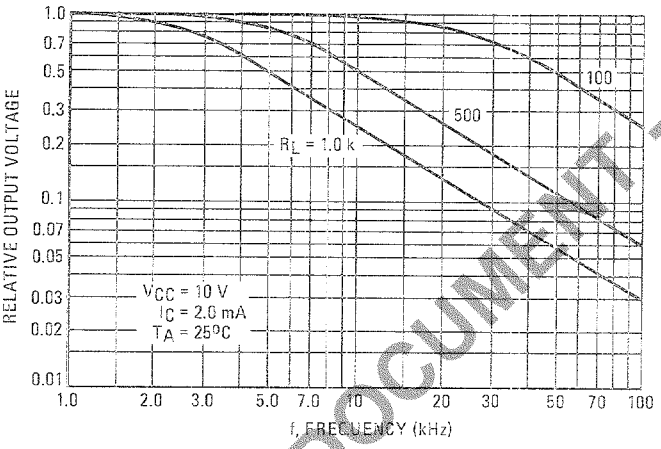


FIGURE 7 – SWITCHING TIMES

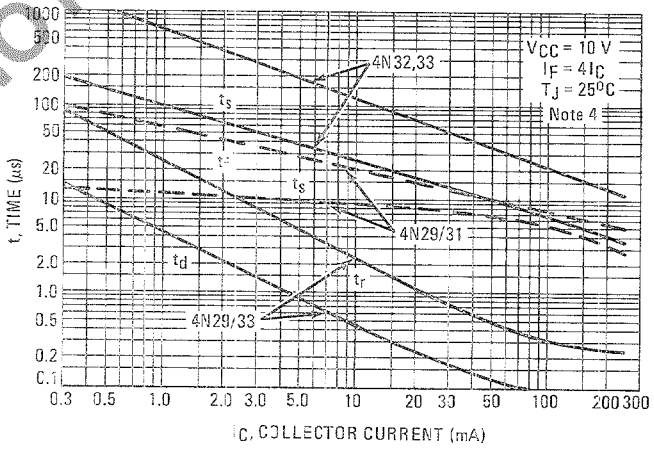


FIGURE 8 – FREQUENCY RESPONSE TEST CIRCUIT

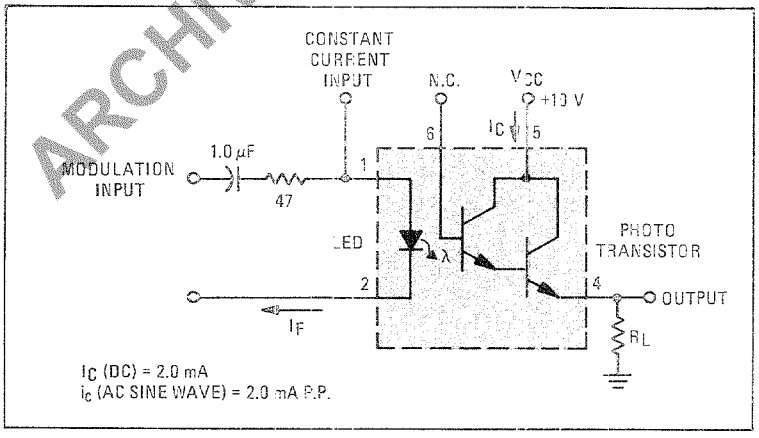
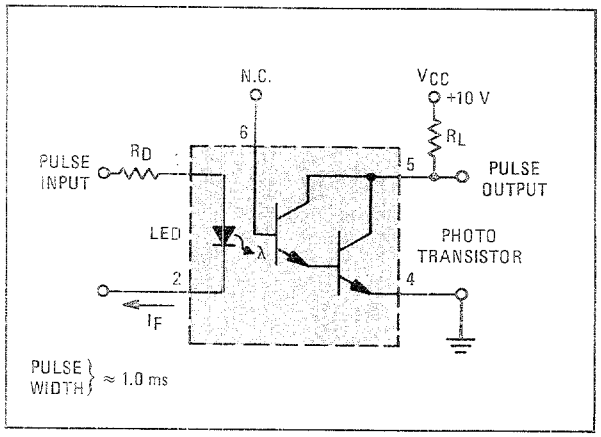


FIGURE 9 – SWITCHING TIME TEST CIRCUIT



TYPICAL APPLICATIONS

FIGURE 10 – VOLTAGE CONTROLLED TRIAC

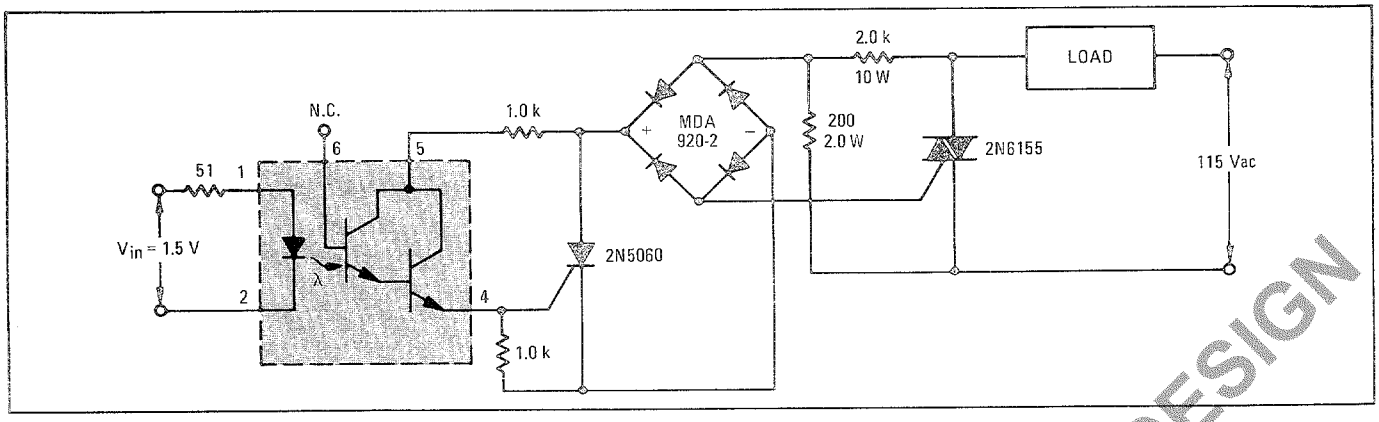


FIGURE 11 – AC SOLID STATE RELAY

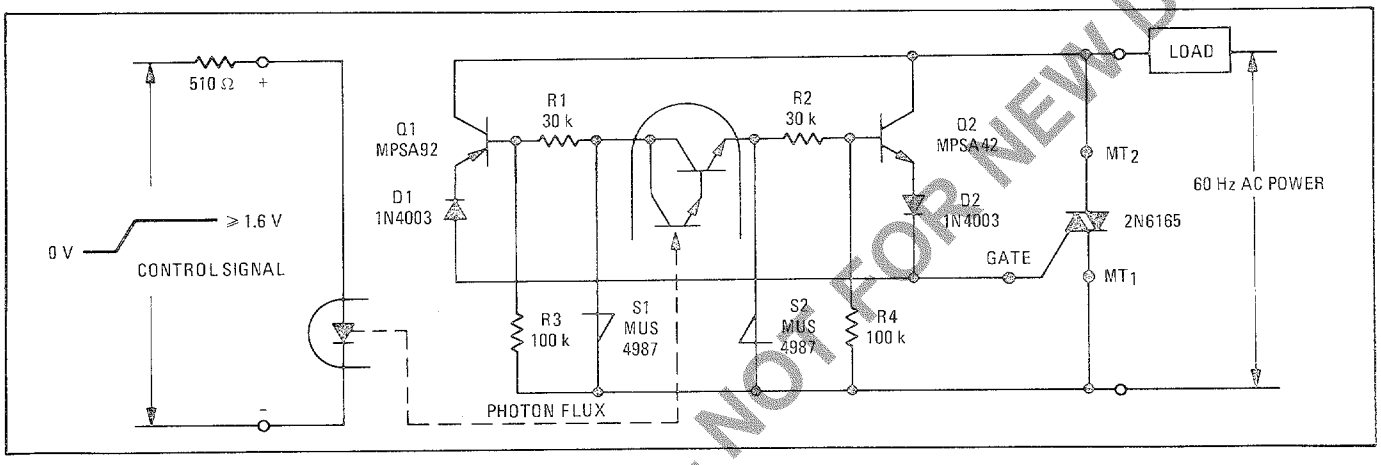


FIGURE 12 – OPTICALLY COUPLED ONE SHOT

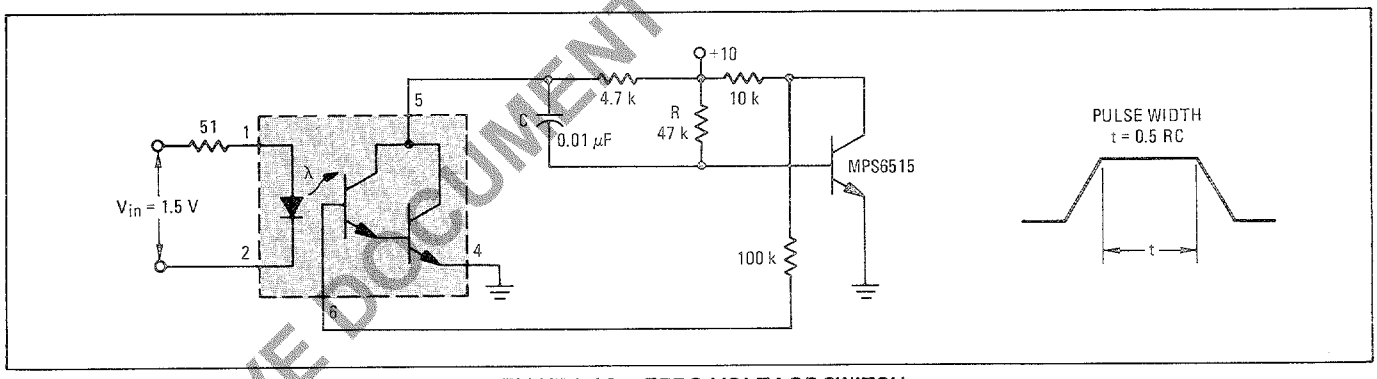
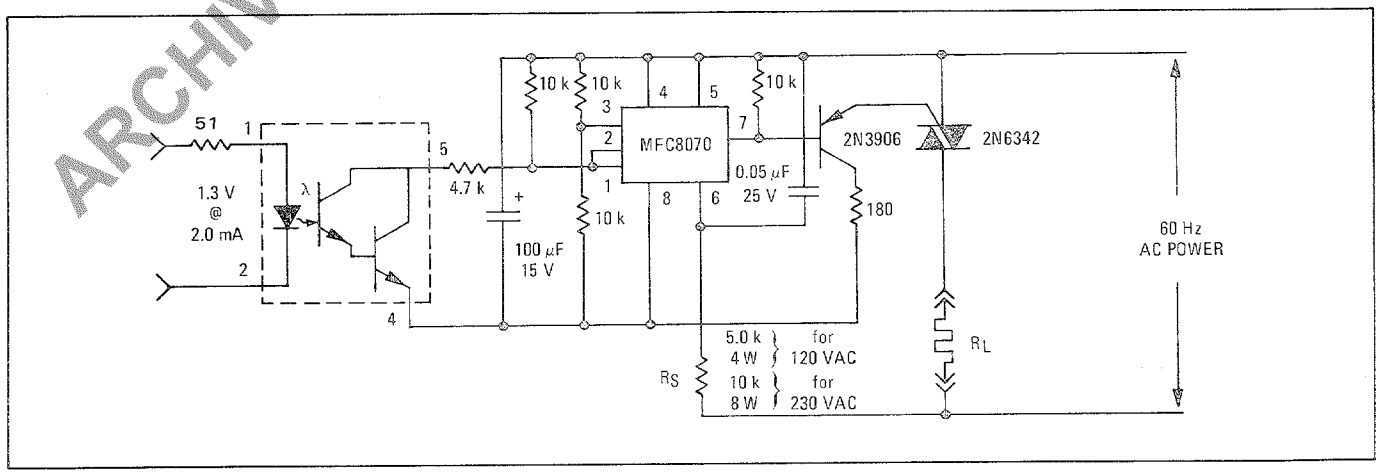


FIGURE 13 – ZERO VOLTAGE SWITCH



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