

UNIUNCTIONS, TRIGGERS AND SWITCHES

Since the introduction of the commercial silicon unijunction transistor in 1956, General Electric has continued developing an extensive line of negative resistance threshold and four-layer switch devices. Each of these devices can be used as a power thyristor trigger, and each offers a special advantage for a particular trigger function. In addition, each can be used for various non-trigger applications.

The features—both in design and characteristics—which you receive with these products are concisely defined for each series:

TYPES

CONVENTIONAL UNIUNCTIONS 2N489-494—proved reliability, MIL spec version.

2N2646-47—low cost, proved hermetic sealed device.

PROGRAMMABLE UNIUNJUNCTION TRANSISTOR (PUT)—variable threshold, low cost, fast switching speed, and circuit adjustable electrical characteristics.

COMPLEMENTARY UNIUNJUNCTION TRANSISTOR—ultimate in temperature stability for timing and oscillator applications.

SILICON UNILATERAL SWITCH (SUS)—a stable fixed low voltage threshold, low cost, high performance “4-layer diode.”

SILICON BILATERAL SWITCH (SBS)—low voltage triac trigger, two silicon unilateral switches connected back to back.

SILICON CONTROLLED SWITCH (SCS)—high triggering sensitivity, 4-lead capability for multiple loads or dv/dt suppression.

APPLICATIONS

Use	Device	Unijunctions				Triggers	
		Conventional	Complementary	Programmable			
		2N489-94, 2N1671, 2N2160	2N2646 2N2647	D5K1 D5K2	2N6027 2N6028	SUS 2N4983-90	SBS 2N4991-93
Trigger for SCR's	DC, Lo Cost	P	F	P	E	E	E
	DC, Hi Perf.	F	F	F	E	F	F
	DC, Volt Regulator	P	P	F	F	E	E
	DC, Inverter	F	F	E	E	F	F
	DC, Hi $\Delta I/\Delta T$	P	P	P	E ¹	P	P
	AC, ϕ , Hi Perf.	F	F	E	E ¹	F	F
	AC, ϕ , Hi f	F	F	F	E	P	P
	AC, Lo RFI	P	P	F	F	E	E
	AC, ϕ , Lo Cost	P	F	P	E	E	E
Timers	>1 hr.	F ¹	P	F ¹	E ¹	N	N
	>1 min, Lo Cost	P	F	P	E	N	N
	>1 min, Stable	F	P	E	P	N	N
	<1 min, Lo Cost	P	F	P	E	F	F
	<1 min, Stable	F	P	E	P	F	N
	<10V	P	P	F	E	N	N
	10V-25V	E	E	E	E	F	F
	>25V	P	P	P	E	F	F
Oscillators	Stability	F	F	E	F	N	N
	Cost	P	F	P	E	N	N
	Adjust, Range	E	E	F	F ¹	N	N
Markets	Military	E	P	F	F ²	P	P
	Hi-Rel	E	P	E	F ²	F	F
	Economy	P	F	P	E	E	E

E = Excellent, F = Fair, P = Poor, N = Not Applicable

¹ With additional circuitry

² Hermetic version 2N6116-18

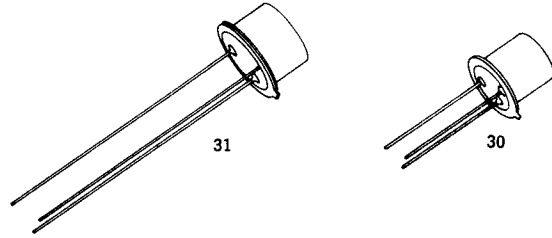
CONVENTIONAL UNIJUNCTIONS

General Electric produces a very broad line of standard UJT's. The TO-5 ceramic disc bar structure device has been the workhorse of the unijunction industry for over 10 years. MIL versions are available on the 2N489-494 series. The cube structure TO-18 series offers excellent value for those requiring proved, low cost units.

Applications

Oscillators
Timers
Sawtooth Generators

SCR Triggers
Frequency Divider
Stable Voltage Sensing



GE Type	R _{base} Interbase Resistance @ V _{BB} = 3V I _E = 0 (K Ω)	η Intrinsic Standoff Ratio @ V _{BB} = 10V	I _V Valley Current Min. (mA)	I _P Peak Point Emitter Current Max. (μ A)	I _{EO} Emitter Reverse Current		V _{BB1} Base One Peak Pulse Voltage Min. (V)	Comments	Package		
					Max. (μ A)	T _J = 25°C @ V _{BB2} F					
2N489 2N489A * 2N489B	4.7- 8.8	.51-.62	8	12 12 6	2 2 0.2	60 60 30	3 3 3	"A" versions are guaranteed in recommended circuit to trigger GE SCR's over range T _A = -55°C to 125°C.	31		
2N490 2N490A * 2N490B 2N490C	6.2- 9.1	.51-.62	8	12 12 6 2	2 2 0.2 .02	60 60 30 30	3 3 3 3				
2N491 2N491A * 2N491B	4.7- 6.8	.56-.68	8	12 12 6	2 2 0.2	60 60 30	3 3 3				
2N492 2N492A * 2N492B 2N492C	6.2- 9.1	.56-.68	8	12 12 6 2	2 2 0.2 .02	60 60 30 30	3 3 3 3			"B" versions in addition to SCR triggering guarantees lower I _{EO} and I _P for long timing periods with a smaller capacitor.	31
2N493 2N493A * 2N493B	4.7- 6.8	.62-.75	8	12 12 6	2 2 0.2	60 60 30	3 3 3				
2N494 2N494A * 2N494B 2N494C	6.2- 9.1	.62-.75	8	12 12 6 2	2 2 0.2 .02	60 60 30 30	3 3 3 3				
2N1671 2N1671A 2N1671B 2N1671C	4.7- 9.1	.47-.62	8	25 25 6 2	12 12 0.2 .02	30 30 30 30	3 3 3 3				
2N2160	4.0-12.0	.47-.80	8	25	12	30	3			General purpose—low cost.	31
2N2646	4.7- 9.1	.56-.75	4	5	12	30	3			General purpose.	30
2N2647	4.7- 9.1	.68-.82	8	2	0.2	30	6			For long timing periods and triggering high current SCR's.	30
D5J-43	4.7- 9.1	.68-.82	6	2	1	30	5	General purpose.	30		
D5J-44	4.7- 9.1	.68-.82	4	5	12	30	4	General purpose—low cost.	30		
2N2840	4.7- 9.1 ²	.62 Typical	2	10	1	30	—	For 1.5 volt applications.	30		

* JAN & JANTX types available

² V_{BB} = 1.5V

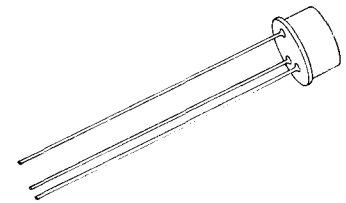
Silicon Unijunction Transistors



The General Electric Silicon Unijunction Transistor is a three terminal device having a stable "N" type negative resistance characteristic over a wide temperature range. A stable peak point voltage, a low peak point current, and a high pulse current rating make this device useful in oscillators, timing circuits, trigger circuits and pulse generators where it can serve the purpose of two conventional silicon or germanium transistors.

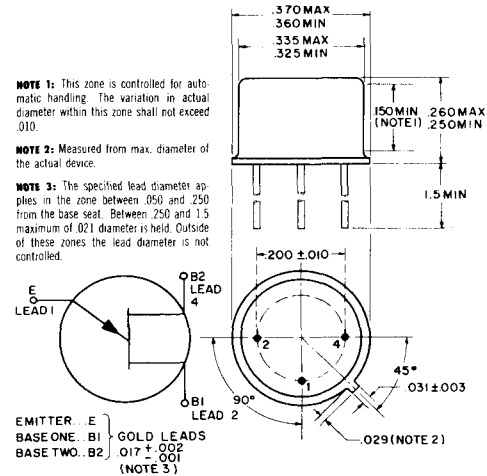
The 2N1671 is intended for general purpose industrial applications where circuit economy is of primary importance. The 2N1671A is intended for industrial use in firing circuits for Silicon Controlled Rectifiers and other applications where a guaranteed minimum pulse amplitude is required. The 2N1671C is intended for applications where a low emitter leakage current and a low peak emitter current (trigger current) are required.

These transistors feature Fixed-Bed Construction and are hermetically sealed in a welded case. All leads are electrically isolated from the case.



absolute maximum ratings (25°C)

RMS Power Dissipation	450 mw ¹
RMS Emitter Current	50 ma
Peak Emitter Current ²	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	-65°C to +140°C
Storage Temperature Range	-65°C to +150°C



electrical characteristics (25°C)

PARAMETER	SYMBOL	2N1671		2N1671A		2N1671B		2N1671C		UNITS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 3)	η	0.47	0.62	0.47	0.62	0.47	0.62	0.47	0.62	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$) (Note 4)	R_{BBO}	4.7	9.1	4.7	9.1	4.7	9.1	4.7	9.1	K Ω
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	V_E (SAT)		5		5		5		5	volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	I_{B2} (MOD)	6.8	22	6.8	22	6.8	22	6.8	22	ma
Emitter Reverse Current ($V_{R2E} = 30V, I_{B1} = 0$) (Fig. 6)	I_{EO}		12		12		0.2		.02	μ a
Peak Point Emitter Current ($V_{BB} = 25V$) (Fig. 8)	I_P		25		25		6		2	μ a
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\Omega$) (Fig. 9)	I_V	8		8		8		8		ma
Base-One Peak Pulse Voltage (Note 5)	V_{OB1}		3.0		3.0		3.0		3.0	volts
Emitter Reverse Current ($V_{BB} = 25V, V_{EB1} = V_P - .3V$) (Fig. 3)	I_{EX}								0.05	μ a

NOTES:

(1) Derate 3.9 MW/°C increase in ambient temperature (Thermal resistance to case = 0.16°C/MW.)

(2) Capacitor discharge—10 μ fd or less, 30 volts or less—Total interbase power dissipation must be limited by external circuitry.

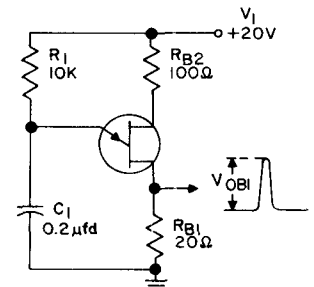
(3) The intrinsic standoff ratio, η , is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + \frac{200}{T_J}$$

Where V_P = Peak point emitter voltage
 V_{BB} = interbase voltage
 T_J = Junction Temperature (Degrees Kelvin)

(4) The interbase resistance is nearly ohmic and increases with temperature in a well defined manner as shown in figures 10 and 11. The temperature coefficient at 25°C is approximately 0.8%/°C.

(5) The base-one peak pulse voltage is measured in the circuit below. This specification on the 2N1671A is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits. The variation of pulse amplitude with temperature and circuit parameters is shown in figures 12 to 15.



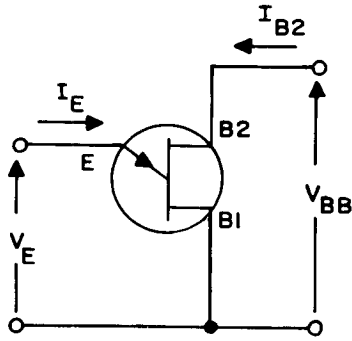


FIG. 1
Unijunction Transistor Symbol with Nomenclature used for voltage and currents.

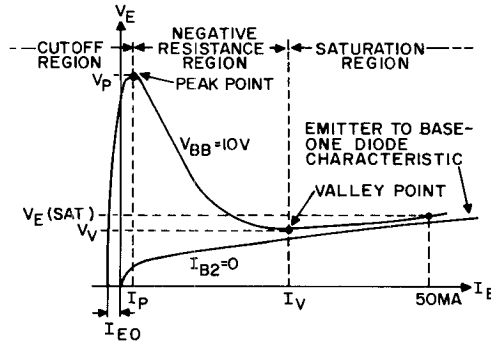


FIG. 2
Static Emitter Characteristic curves showing important parameters and measurement points (exaggerated to show details).

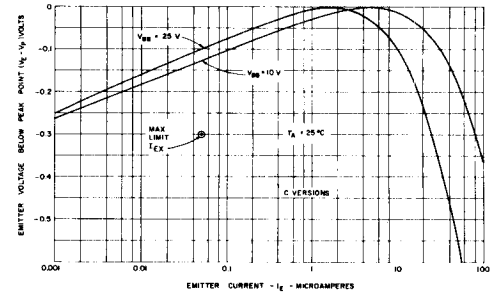


FIG. 3
Static Emitter Characteristics at Peak Point.

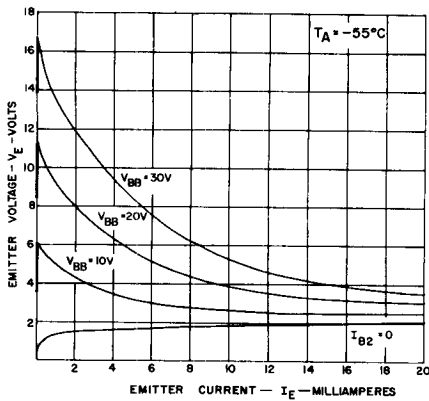
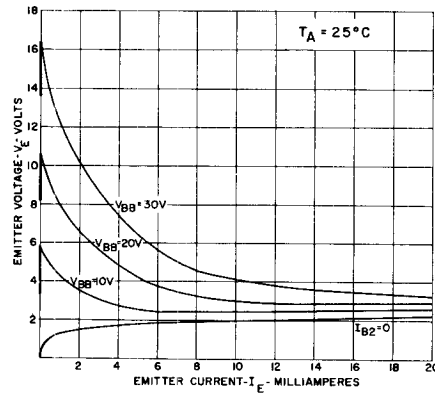


FIG. 4



Static emitter characteristics for a typical 2N1671 unijunction transistor at three different ambient temperatures.

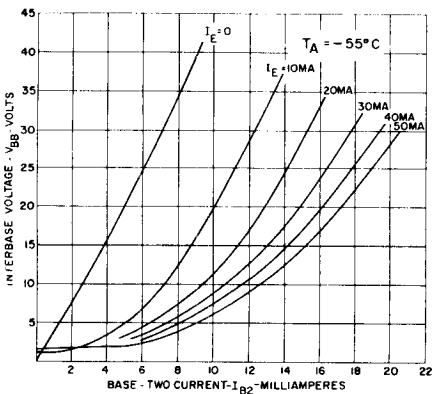
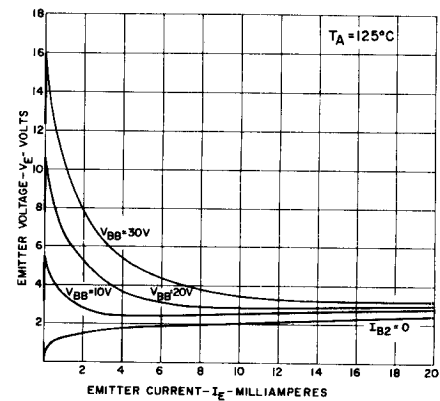
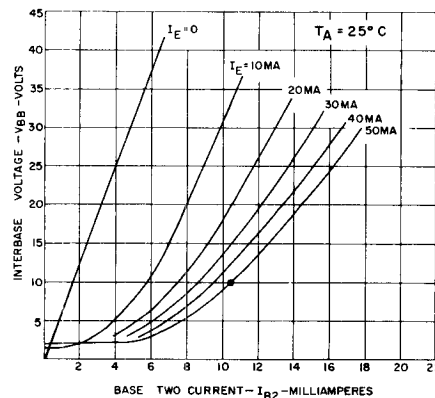
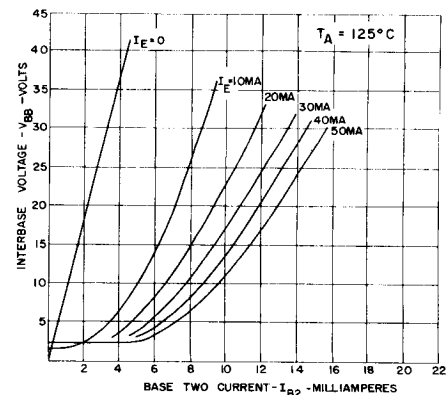


FIG. 5



Static interbase characteristics for a typical 2N1671 unijunction transistor at three different ambient temperatures.



2N1671, 1A, B, C

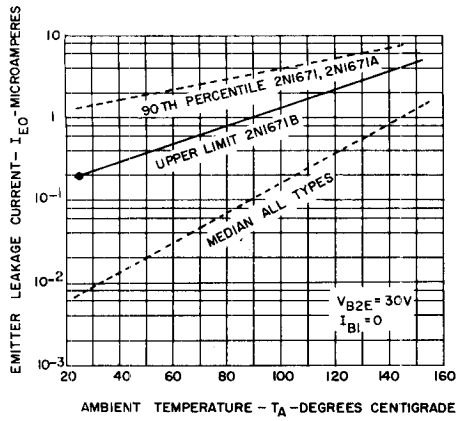


FIG. 6
Emitter reverse current vs. temperature.

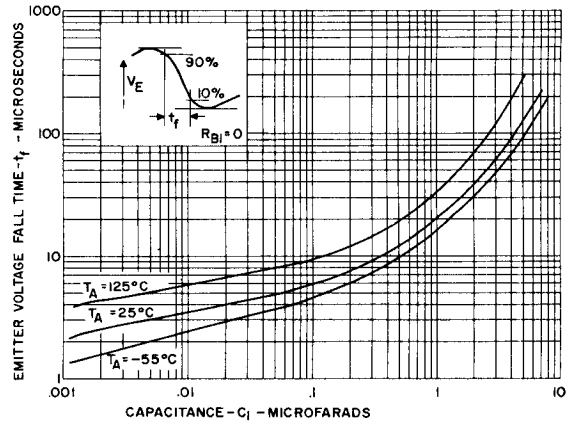


FIG. 7
Emitter voltage fall time vs. capacitance and ambient temperature for a typical unit in relaxation oscillator circuit.

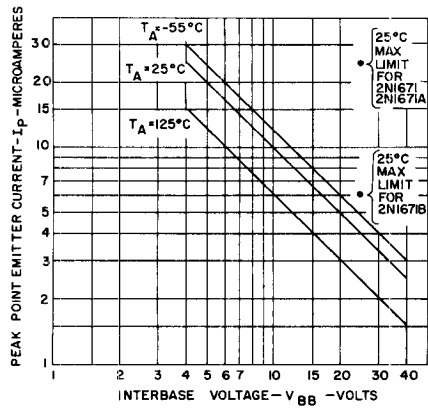


FIG. 8
Peak Point Emitter Current vs. interbase voltage and ambient temperature for a typical unit.

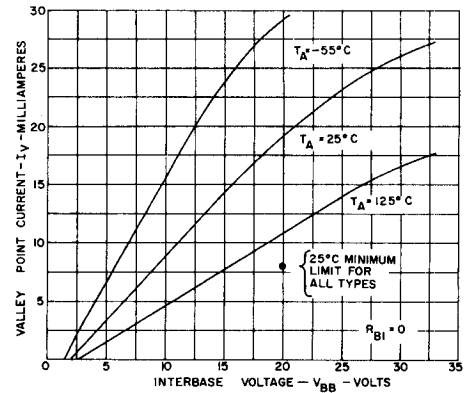


FIG. 9
Valley Point Current vs. interbase voltage and ambient temperature for a typical unit.

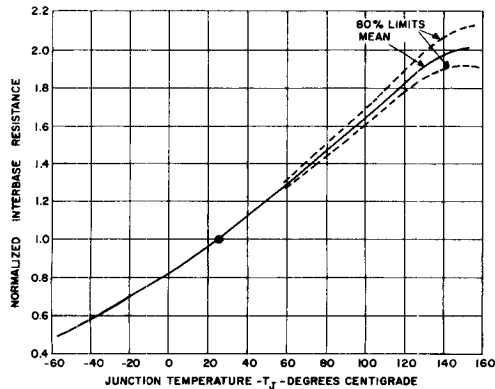


FIG. 10
Normalized interbase resistance vs. junction temperature.

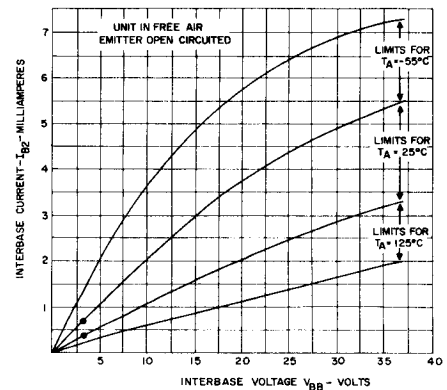


FIG. 11
Limit values of static interbase characteristics with zero emitter current.

2N1671A - 2N1671B

2N1671, 1A, B, C

GENERAL PURPOSE PULSE CIRCUITS AND FIRING CIRCUITS FOR SILICON CONTROLLED RECTIFIERS

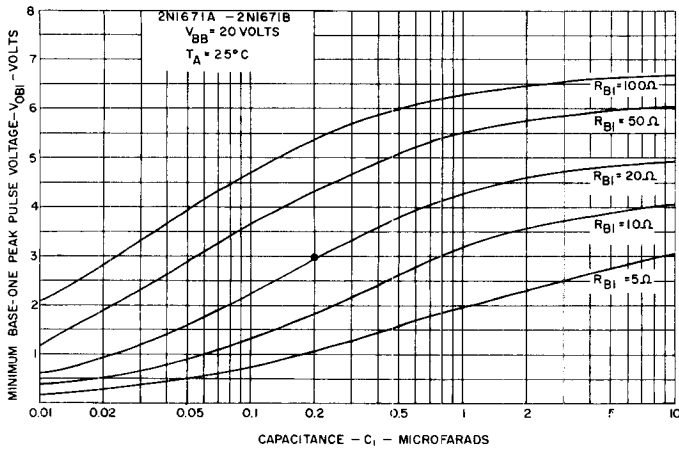


FIG. 12

Minimum base-one peak pulse voltage vs. capacitance and base-one resistance in relaxation oscillator circuit.

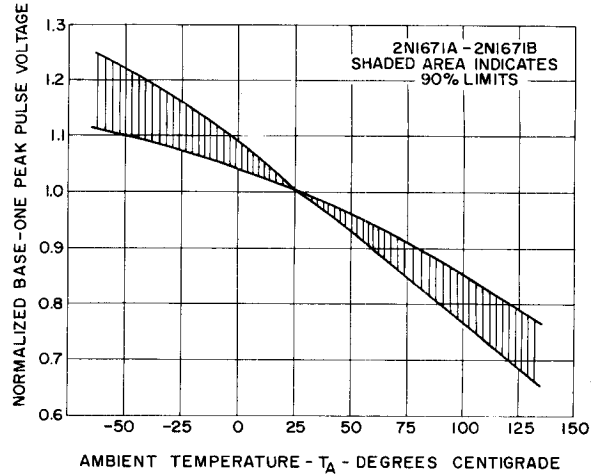


FIG. 13

Normalized base-one peak pulse voltage vs. temperature in relaxation oscillator circuit.

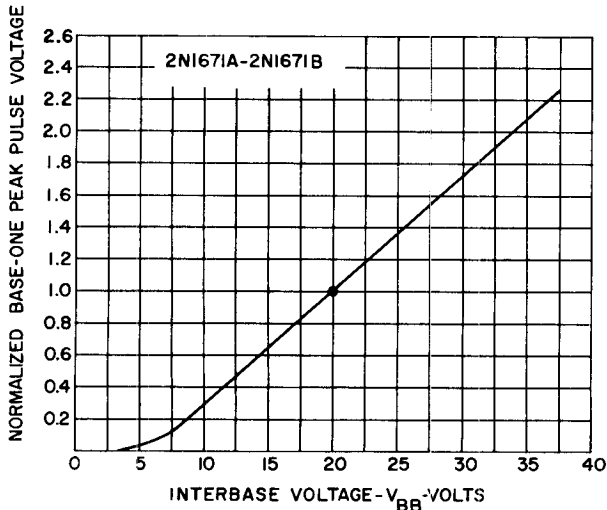


FIG. 14

Normalized base-one peak pulse voltage vs. interbase voltage in relaxation oscillator circuit.

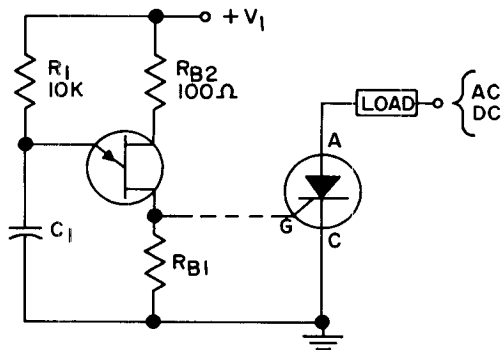


FIG. 16

Basic unijunction transistor firing circuit for silicon controlled rectifiers.

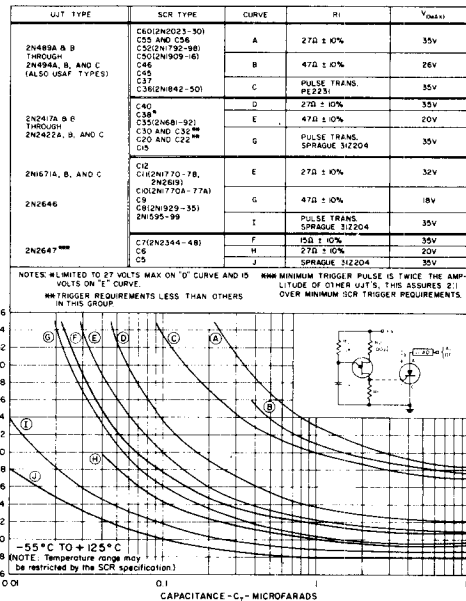


FIG. 15

Minimum supply voltage required to fire standard types of silicon controlled rectifiers vs. capacitance in circuit below.

Period of Relaxation Oscillator

$$\tau = 0.80 R_1 C_1 (\pm 0.21 R_1 C_1)$$

Maximum Value of R_1 for oscillation (-55°C to $+140^\circ\text{C}$)

$$R_1 (\text{max}) = 430 V_1^2 \text{ (2N1671-2N1671A)}$$

$$R_1 (\text{max}) = 1800 V_1^2 \text{ (2N1671B)}$$

$$\tau = \text{Period in Seconds}$$

$$C_1 = \text{Capacitance in Farads}$$

$$R_1 = \text{Resistance in ohms}$$

$$V_1 = \text{Supply voltage in volts}$$

REFERENCES:

1. "Notes on the Application of the Silicon Unijunction Transistor," 90.10.
2. "General Electric Controlled Rectifier Manual," Fifth Edition.