UNIJUNCTIONS, 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 UNIJUNCTIONS 2N489-494—proved reliability, MIL spec version.
2N2646-47—low cost, proved hermetic sealed device.

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

COMPLEMENTARY UNIJUNCTION 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

	Device	Unijunctions				Triggers	
		Conventional		Complementary	Programmable		
Use		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

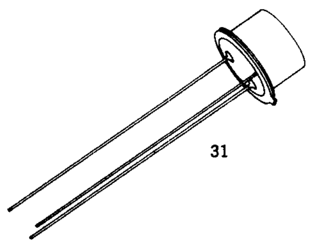
CONVENTIONAL UNIJUNCTIONS

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	SCR Triggers
Timers	Frequency Divider
Sawtooth Generators	Stable Voltage Sensing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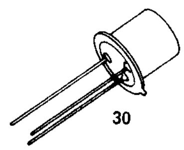
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	GE Type	R_{BBO} Interbase Resistance @ V_{BB} = 3V I_E = 0 (KΩ)	η Intrinsic Standoff Ratio @ V_{BB} = 10V	I_V Valley Current Min. (mA)	I_P Peak Point Emitter Current Max. (μA)	I_{EO} Emitter Reverse Current Max. (μA)	I_{EO} Emitter Reverse Current T_J=25°C @ V_{B_2E}	V_{OB_1} Base One Peak Pulse Voltage Min. (V)	Comments	Package
TO-5 Bar Structure	2N489	4.7- 6.8	.51-.62	8	12	2	60	—		31
	2N489A *				12	2	60	3		
	2N489B				6	0.2	30	3		
	2N490	6.2- 9.1	.51-.62	8	12	2	60	—		
	2N490A *				12	2	60	3		
	2N490B				6	0.2	30	3		
	2N490C				2	.02	30	3	"A" versions are guaranteed in recommended circuit to trigger GE SCR's over range T_A = −55°C to 125°C.	
	2N491	4.7- 6.8	.56-.68	8	12	2	60	—		31
	2N491A *				12	2	60	3		
	2N491B				6	0.2	30	3		
	2N492	6.2- 9.1	.56-.68	8	12	2	60	—		31
	2N492A *				12	2	60	3		
	2N492B				6	0.2	30	3		
	2N492C				2	.02	30	3	"B" versions in addition to SCR triggering guarantees lower I_{EO} and I_P for long timing periods with a smaller capacitor.	
	2N493	4.7- 6.8	.62-.75	8	12	2	60	—		31
	2N493A *				12	2	60	3		
	2N493B				6	0.2	30	3		
	2N494	6.2- 9.1	.62-.75	8	12	2	60	—		31
	2N494A *				12	2	60	3		
	2N494B				6	0.2	30	3		
	2N494C				2	.02	30	3		
	2N1671	4.7- 9.1	.47-.62	8	25	12	30	—	Industrial types.	31
	2N1671A				25	12	30	3		
	2N1671B				6	0.2	30	3		
	2N1671C				2	.02	30	3		
	2N2160	4.0-12.0	.47-.80	8	25	12	30	3	General purpose—low cost.	31
TO-18 Cube Structure	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

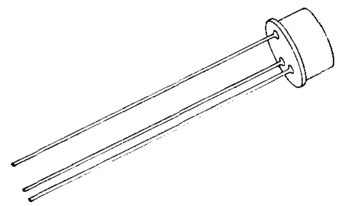
Silicon Unijunction Transistors

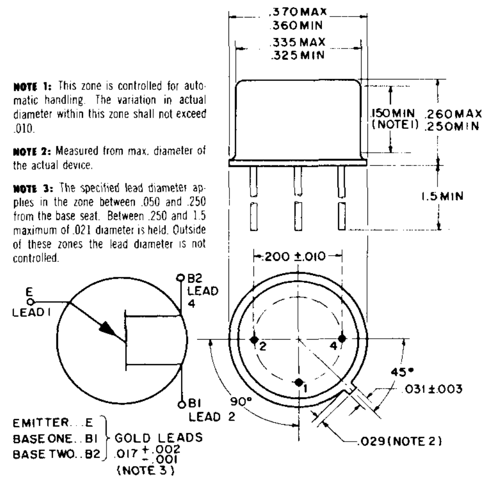
2N1671,1A,B,C

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 MIN.	2N1671 MAX.	2N1671A MIN.	2N1671A MAX.	2N1671B MIN.	2N1671B MAX.	2N1671C MIN.	2N1671C MAX.	UNITS
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	KΩ
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 ($V_{B2E} = 30V$, $I_{B1} = 0$) (Fig. 6)	I_{EO}		12		12		0.2		.02	μa
Peak Point Emitter Current ($V_{BB} = 25V$) (Fig. 8)	I_P		25		25		6		2	μa
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		volts
Emitter Reverse Current ($V_{BB}=25V$, $V_{EB1}=V_P-.3V$) (Fig. 3)	I_{EX}								0.05	μa

NOTES:

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

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

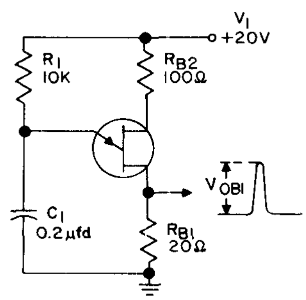
(3) The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

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

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.



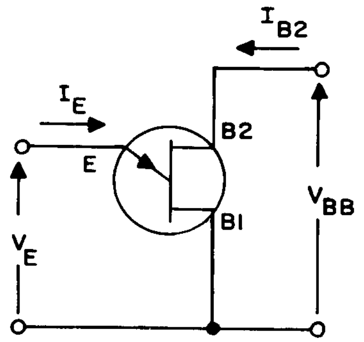


FIG. 1

Unijunction Transistor Symbol with Nomenclature used for voltage and currents.

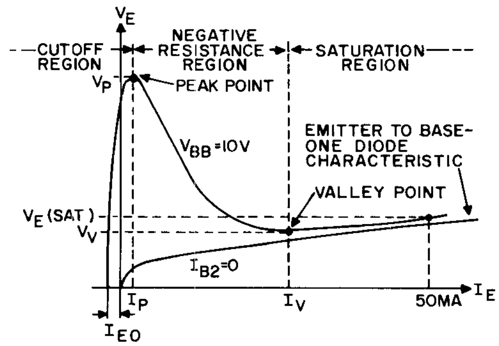


FIG. 2

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

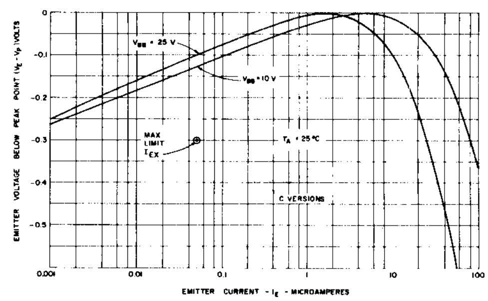


FIG. 3

Static Emitter Characteristics at Peak Point.

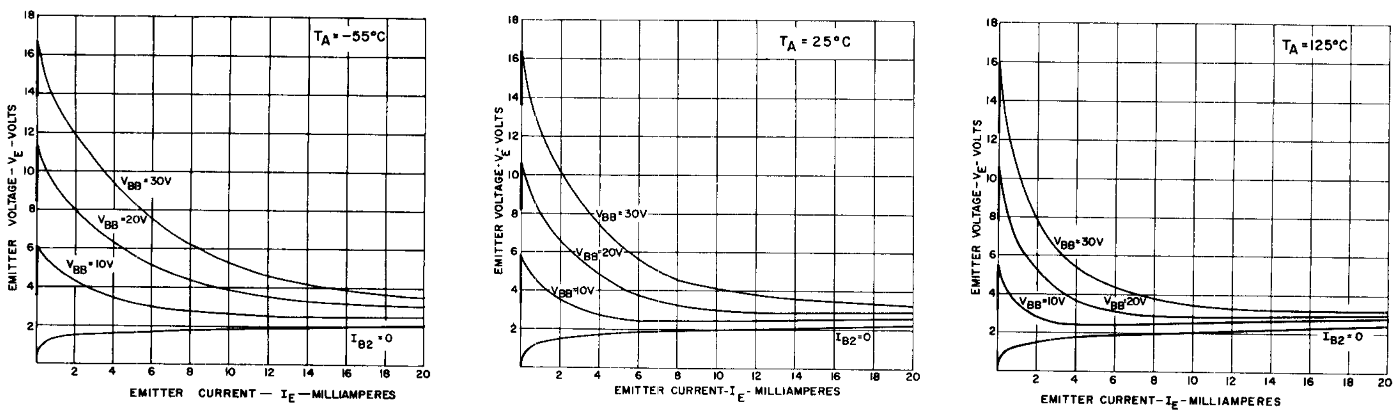


FIG. 4

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

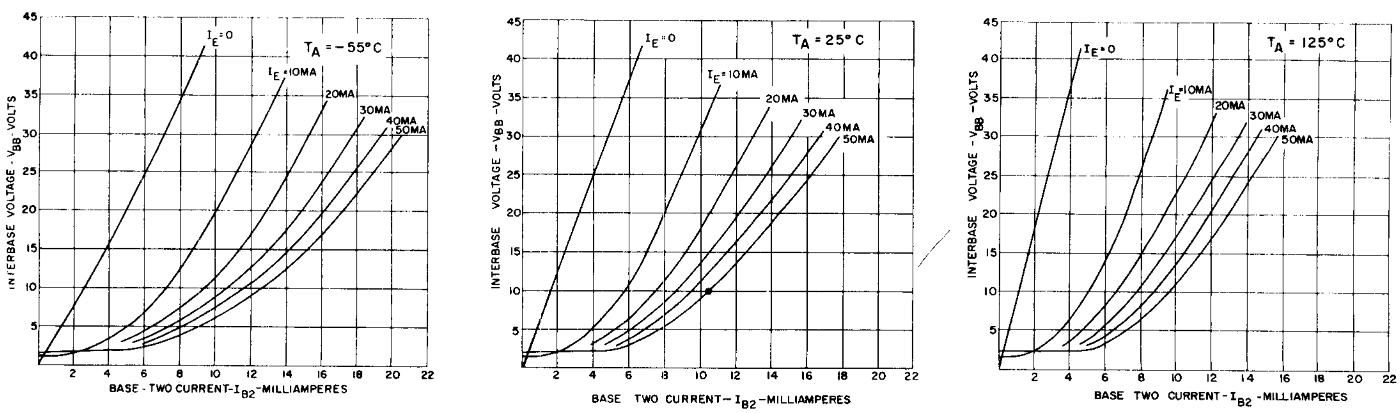


FIG. 5

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

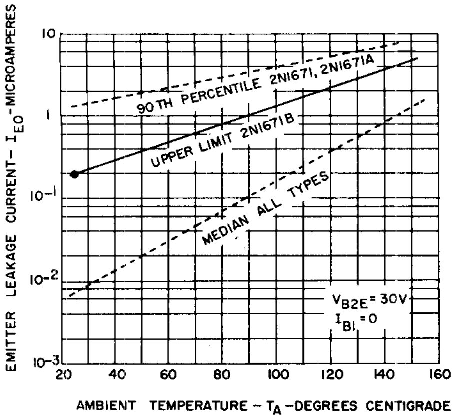


FIG. 6

Emitter reverse current vs. temperature.

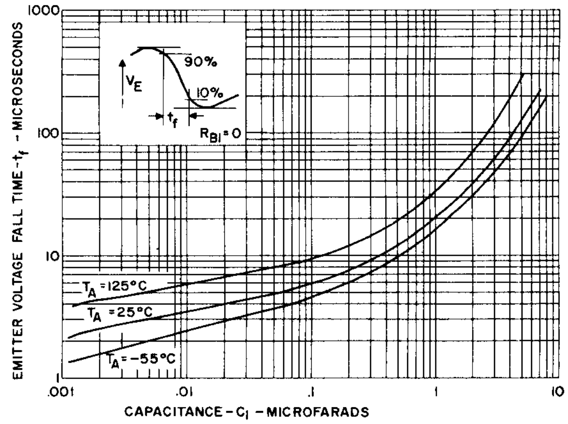


FIG. 7

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

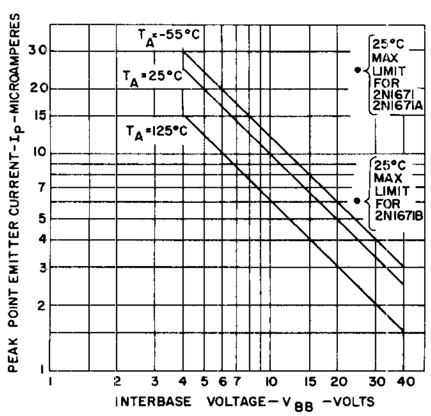


FIG. 8

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

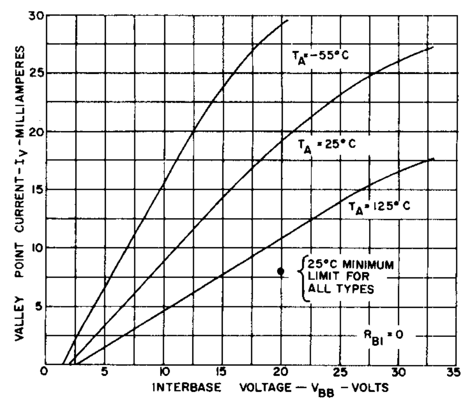


FIG. 9

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

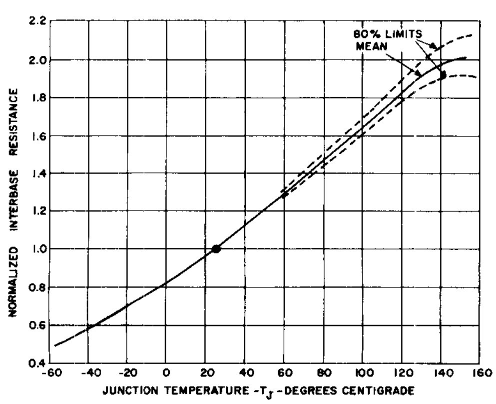


FIG. 10

Normalized interbase resistance vs. junction temperature.

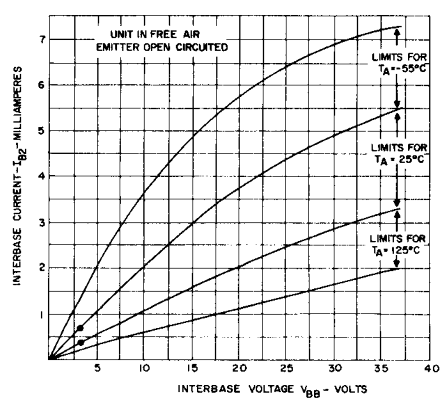


FIG. 11

Limit values of static interbase characteristics with zero emitter current.

2N1671A - 2N1671B

GENERAL PURPOSE PULSE CIRCUITS AND FIRING CIRCUITS FOR SILICON CONTROLLED RECTIFIERS

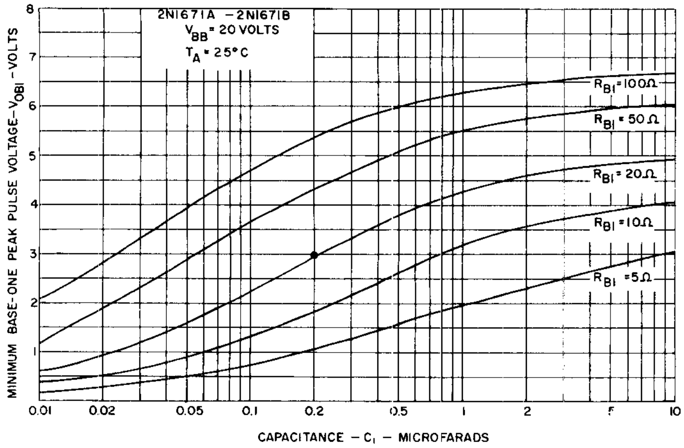


FIG. 12

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

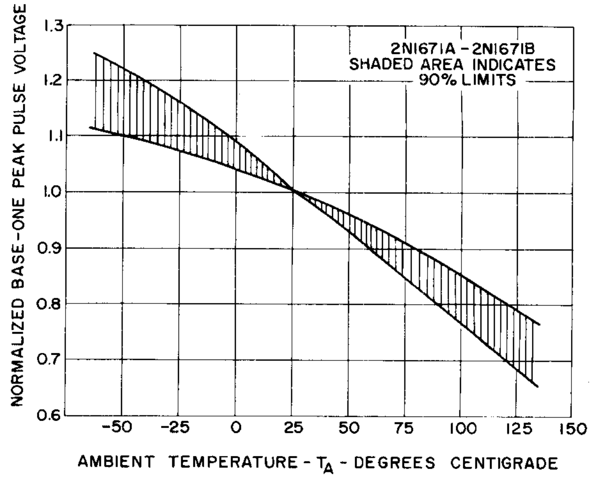


FIG. 13

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

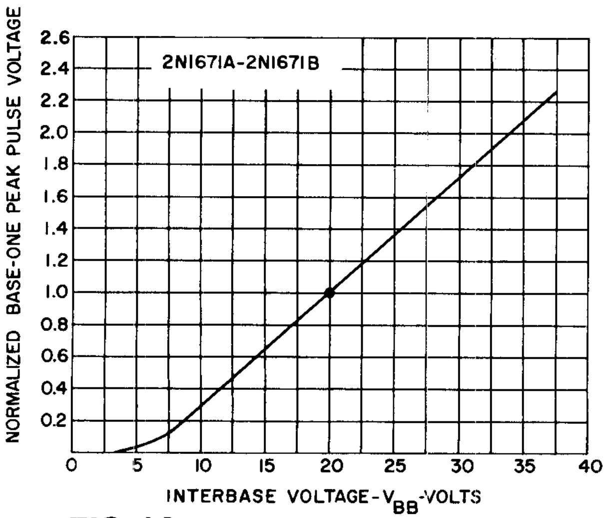


FIG. 14

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

UJT TYPE	SCR TYPE	CURVE	R1	$V_{1(MAX)}$
2N489A & B THROUGH 2N494A, B, AND C (ALSO USAF TYPES)	C60(2N2023-30) C55 AND C56 C52(2N1792-98) C50(2N1909-16) C46 C45 C37 C36(2N1842-50)	A	27Ω ± 10%	35V
		B	47Ω ± 10%	26V
		C	PULSE TRANS. PE2231	35V
2N2417A & B THROUGH 2N2422A, B, AND C	C40 C38* C35(2N681-92) C30 AND C32** C20 AND C22** C15	D	27Ω ± 10%	35V
		E	47Ω ± 10%	20V
		G	PULSE TRANS. SPRAGUE 31Z204	35V
2N1671A, B, AND C	C12 C11(2N1770-78, 2N2619) C10(2N1770A-77A) C9 C8(2N1929-35) 2N1595-99	E	27Ω ± 10%	32V
2N2646		G	47Ω ± 10%	18V
		I	PULSE TRANS. SPRAGUE 31Z204	35V
2N2647***	C7(2N2344-48) C6 C5	F	15Ω ± 10%	35V
		H	27Ω ± 10%	20V
		J	SPRAGUE 31Z204	35V

NOTES: * LIMITED TO 27 VOLTS MAX ON "D" CURVE AND 15 VOLTS ON "E" CURVE.
** TRIGGER REQUIREMENTS LESS THAN OTHERS IN THIS GROUP.
*** MINIMUM TRIGGER PULSE IS TWICE THE AMPLITUDE OF OTHER UJT'S, THIS ASSURES 2:1 OVER MINIMUM SCR TRIGGER REQUIREMENTS.

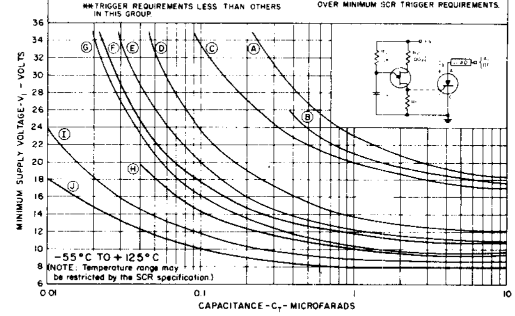


FIG. 15

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

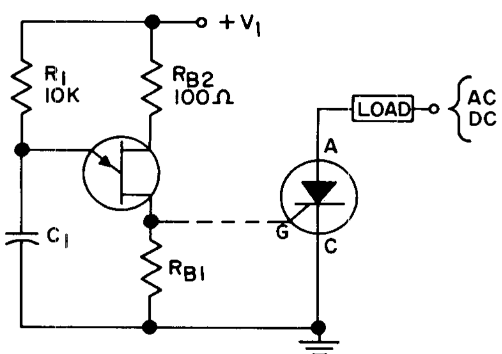


FIG. 16

Basic unijunction transistor firing circuit for silicon controlled rectifiers.

Period of Relaxation Oscillator

$\tau = 0.80\ R_1C_1\ (\pm\ 0.21\ R_1C_1)$

Maximum Value of R_1 for oscillation (−55°C to +140°C)

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

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

τ = Period in Seconds

C_1 = Capacitance in Farads

R_1 = Resistance in ohms

V_1 = 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.