Programmable unijunction transistor/ Silicon controlled switch

BRY39

FEATURES

- Silicon controlled switch
- Programmable unijunction transistor.

APPLICATIONS

- Switching applications such as:
  - Motor control
  - Oscillators
  - Relay replacement
  - Timers
  - Pulse shapers, etc.

DESCRIPTION

Silicon planar PNPN switch or trigger device in a TO-72 metal package.
It is an integrated PNP/NPN transistor pair with all electrodes accessible.

PINNING

PIN	DESCRIPTION
1	cathode
2	cathode gate
3	anode gate (connected to case)
4	anode

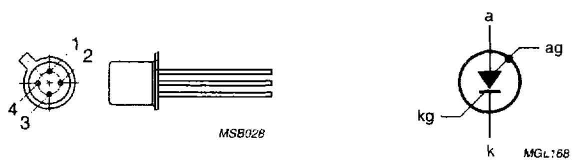

Fig.1 Simplified outline (TO-72) and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MAX.	UNIT
Silicon controlled switch				
PNP TRANSISTOR				
V_{EBO}	emitter-base voltage	open collector	−70	V
NPN TRANSISTOR				
V_{CBO}	collector-base voltage	open emitter	70	V
I_{ERM}	repetitive peak emitter current		−2.5	A
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	275	mW
T_j	junction temperature		150	°C
V_{AK}	forward on-state voltage	I_A = 50 mA; I_{AG} = 0; R_{KG-K} = 10 kΩ	1.4	V
I_H	holding current	I_{AG} = 10 mA; V_{BB} = −2 V; R_{KG-K} = 10 kΩ	1	mA
t_{on}	turn-on time		0.25	µs
t_{off}	turn-off time		15	µs
Programmable unijunction transistor				
V_{GA}	gate-anode voltage		70	V
I_A	anode current (DC)	$T_{amb} \leq 25$ °C	175	mA
T_j	junction temperature		150	°C
I_p	peak point current	V_S = 10 V; R_G = 10 kΩ	0.2	µA

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	275	mW
T_{stg}	storage temperature		−65	+200	°C
T_j	junction temperature		–	150	°C
T_{amb}	operating ambient temperature		−65	+150	°C
Silicon controlled switch					
V_{CBO}	collector-base voltage	open emitter			
	PNP		–	−70	V
	NPN		–	70	V
V_{CER}	collector-emitter voltage	R_{BE} = 10 kΩ			
	PNP		–	–	V
	NPN		–	70	V
V_{CEO}	collector-emitter voltage	open base			
	PNP		–	−70	V
	NPN		–	–	V
V_{EBO}	emitter-base voltage	open collector			
	PNP		–	−70	V
	NPN		–	5	V
I_C	collector current (DC)	note 1			
	PNP		–	–	
	NPN		–	175	mA
I_{CM}	peak collector current	note 2			
	PNP		–	–	
	NPN		–	175	mA
I_E	emitter current (DC)				
	PNP		–	175	mA
	NPN		–	−175	mA
I_{ERM}	repetitive peak emitter current	t_p = 10 μs; δ = 0.01			
	PNP		–	2.5	A
	NPN		–	−2.5	A
Programmable unijunction transistor					
V_{GA}	gate-anode voltage		–	70	V
I_A	anode current (AV)	$T_{amb} \leq 25$ °C	–	175	mA

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SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
I_{ARM}	repetitive peak anode current	$t_p = 10\ \mu s$; $\delta = 0.01$	–	2.5	A
I_{ASM}	non-repetitive peak anode current	$t_p = 10\ \mu s$; $T_j = 150\ °C$	–	3	A
dI_A/dt	rate of rise of anode current	$I_A \leq 2.5$ A	–	20	A/µs

Notes

1. Provided the I_E rating is not exceeded.
2. During switching on, the device can withstand the discharge of a capacitor of a maximum value of 500 pF. This capacitor is charged when the transistor is in cut-off condition, with a collector supply voltage of 160 V and a series resistance of 100 kΩ.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	in free air	450	K/W

CHARACTERISTICS

$T_{amb} = 25\ °C$ unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
Silicon controlled switch					
INDIVIDUAL PNP TRANSISTOR					
I_{CEO}	collector cut-off current	$I_B = 0$; $V_{CE} = -70$ V; $T_j = 150\ °C$	–	−10	µA
I_{EBO}	emitter cut-off current	$I_C = 0$; $V_{EB} = -70$ V; $T_j = 150\ °C$	–	−10	µA
h_{FE}	DC current gain	$I_E = 1$ mA; $V_{CE} = -5$ V	3	15	
INDIVIDUAL NPN TRANSISTOR					
I_{CER}	collector cut-off current	$V_{CE} = 70$ V; $R_{BE} = 10$ kΩ	–	100	nA
		$V_{CE} = 70$ V; $R_{BE} = 10$ kΩ; $T_j = 150\ °C$	–	10	µA
I_{EBO}	emitter cut-off current	$I_C = 0$; $V_{EB} = 5$ V; $T_j = 150\ °C$	–	10	µA
V_{CEsat}	collector-emitter saturation voltage	$I_C = 10$ mA; $I_B = 1$ mA	–	0.5	V
V_{BEsat}	base-emitter saturation voltage	$I_C = 10$ mA; $I_B = 1$ mA	–	0.9	V
h_{FE}	DC current gain	$I_C = 10$ mA; $V_{CE} = 2$ V	50	–	
C_c	collector capacitance	$I_E = i_e = 0$; $V_{CB} = 20$ V	–	5	pF
C_e	emitter capacitance	$I_C = i_c = 0$; $V_{EB} = 1$ V; f = 1 MHz	–	25	pF
f_T	transition frequency	$I_C = 10$ mA; $V_{CE} = 2$ V; f = 100 MHz	100	–	MHz
COMBINED DEVICE					
V_{AK}	forward on-state voltage	$R_{KG\text{-}K} = 10$ kΩ			
		$I_A = 50$ mA; $I_{AG} = 0$	–	1.4	V
		$I_A = 50$ mA; $I_{AG} = 0$; $T_j = -55\ °C$	–	1.9	V
		$I_A = 1$ mA; $I_{AG} = 10$ mA	–	1.2	V
I_H	holding current	$V_{BB} = -2$ V; $I_{AG} = 10$ mA; $R_{KG\text{-}K} = 10$ kΩ; see Fig.14	–	1	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
SWITCHING TIMES					
t_{on}	turn-on time	V_{KG-K} = −0.5 to 4.5 V; R_{KG-K} = 1 kΩ; see Figs 15 and 16	–	0.25	µs
		V_{KG-K} = −0.5 to 0.5 V; R_{KG-K} = 10 kΩ	–	1.5	µs
t_{off}	turn-off time	R_{KG-K} = 10 kΩ; see Figs 17 and 18	–	15	µs
Programmable unijunction transistor					
I_p	peak point current	V_S = 10 V; R_G = 10 kΩ; see Figs 3 and 8	–	0.2	µA
		V_S = 10 V; R_G = 100 kΩ; see Figs 3 and 8	–	0.06	µA
I_v	valley point current	V_S = 10 V; R_G = 10 kΩ; see Figs 3 and 8	–	2	µA
		V_S = 10 V; R_G = 100 kΩ; see Figs 3 and 8	–	1	µA
V_{offset}	offset voltage	typical curve; I_A = 0; for V_P and V_S see Fig.8	–	–	V
I_{GAO}	gate-anode leakage current	I_K = 0; V_{GA} = 70 V	–	10	nA
I_{GKS}	gate-cathode leakage current	V_{AK} = 0; V_{KG} = 70 V	–	100	nA
V_{AK}	anode-cathode voltage	I_A = 100 mA	–	1.4	V
V_{OM}	peak output voltage	V_{AA} = 20 V; C = 10 nF; see Figs 9 and 11	6	–	V
t_r	rise time	V_{AA} = 20 V; C = 10 nF; see Fig.11	–	80	ns

Explanation of symbols

For application of the BRY39 as a programmable *unijunction transistor*, only the anode gate is used. To simplify the symbols, the term gate instead of anode gate will be used (see Fig.2).

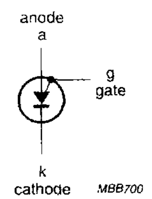


Fig.2 Programmable unijunction transistor explanation of symbols.

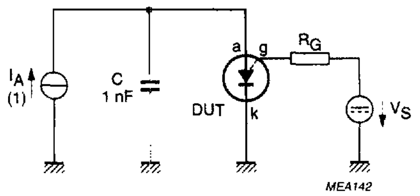


Fig.3 Programmable unijunction transistor test circuit for peak and valley points.

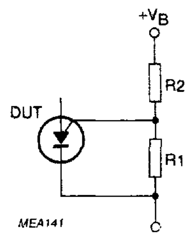


Fig.4 Programmable unijunction transistor with 'program' resistors R1 and R2.

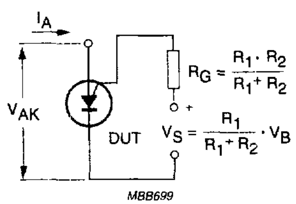


Fig.5 Programmable unijunction transistor equivalent test circuit for characteristics testing.

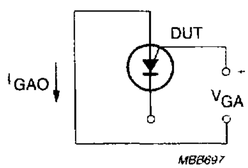


Fig.6 Programmable unijunction transistor equivalent test circuit for gate-anode leakage current.

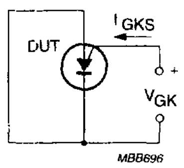


Fig.7 Programmable unijunction transistor equivalent test circuit for gate-cathode leakage current.

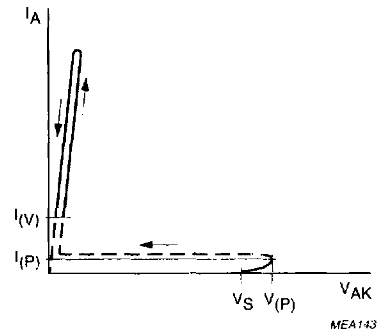


Fig.8 Programmable unijunction transistor offset voltage.

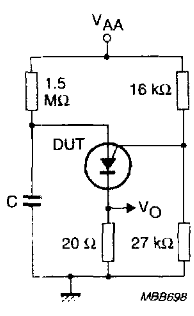


Fig.9 Programmable unijunction transistor test circuit for peak output voltage.

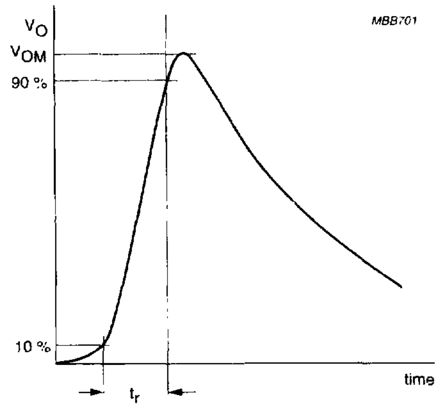


Fig.10 Programmable unijunction transistor peak output voltage.

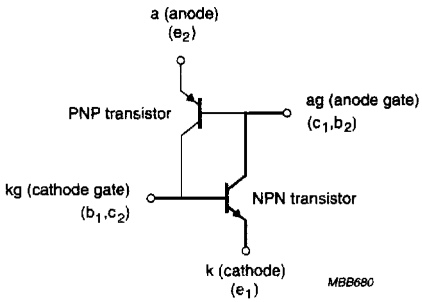


Fig.11 Silicon controlled switch two transistor equivalent circuit.

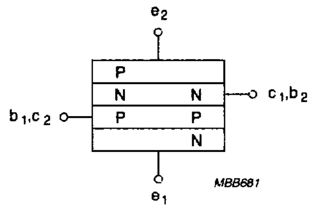


Fig.12 PNPN silicon controlled switch structure.

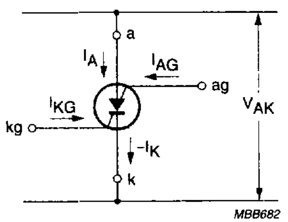


Fig.13 Silicon controlled switch symbol.

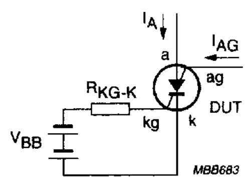


Fig.14 Silicon controlled switch equivalent test circuit for holding current.

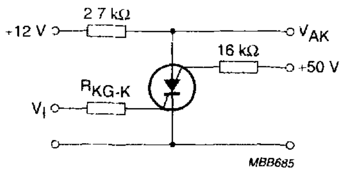


Fig.15 Silicon controlled switch test circuit for turn-on time.

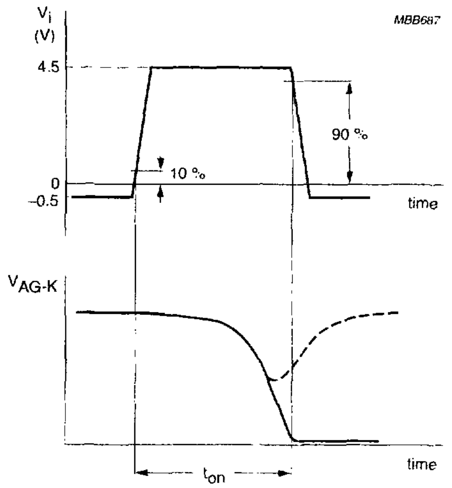


Fig.16 Silicon controlled switch pulse duration increased until dashed curve disappears.

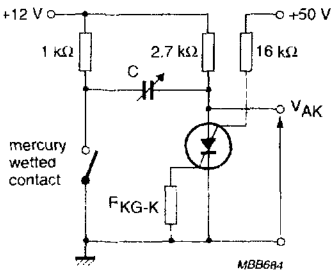


Fig.17 Silicon controlled switch test circuit for turn-on time.

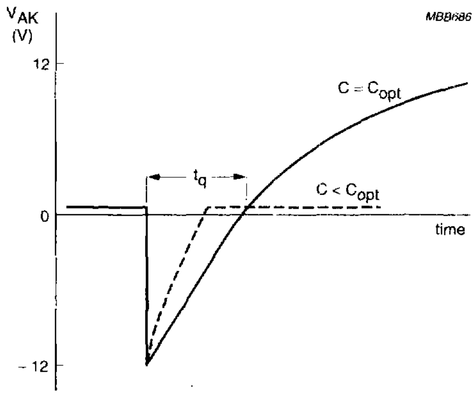
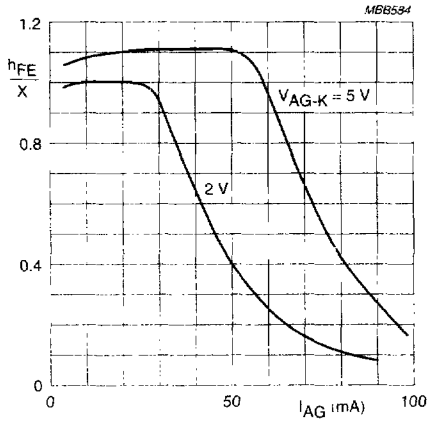
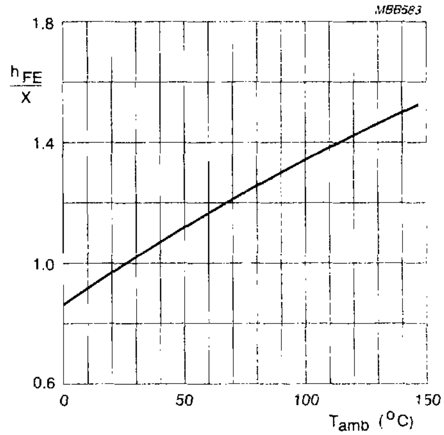


Fig.18 Silicon controlled switch capacitance increased until $C = C_{opt}$ dashed curve disappears.



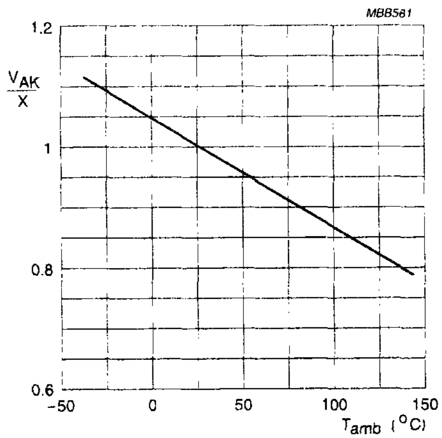
X = value of h_{FE} at I_C = 10 mA; V_{AG-K} = 2 V; T_{amb} = 25 °C.

Fig.19 Silicon controlled switch normalized DC current gain as a function of anode gate current.



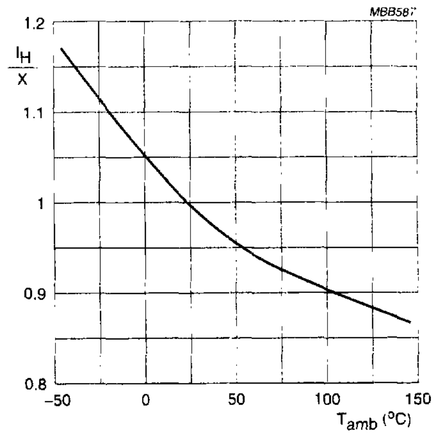
X = value of h_{FE} at I_{AG} = 10 mA; V_{AG-K} = 2 V; T_{amb} = 25 °C.

Fig.20 Silicon controlled switch normalized DC current gain as a function of ambient temperature.



X = value of V_{AK} at I_A = 1 mA; I_{AG} = 10 mA; V_{BB} = −2 V; R_{KG-K} = 10 kΩ; T_{amb} = 25 °C.

Fig.21 Silicon controlled switch normalized anode-cathode voltage as a function of ambient temperature.



X = value of I_H at I_{AG} = 10 mA; V_{BB} = −2 V; R_{KG-K} = 10 kΩ; T_{amb} = 25 °C.

Fig.22 Silicon controlled switch normalized holding current as a function of ambient temperature.

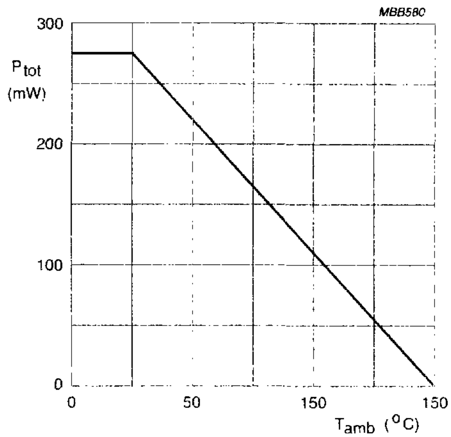


Fig.23 Silicon controlled switch power derating curve.

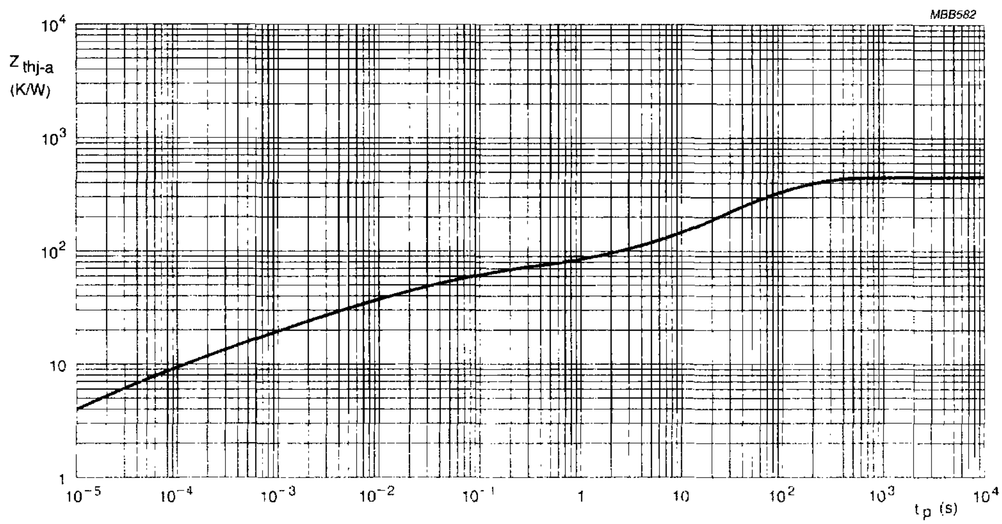


Fig.24 Silicon controlled switch thermal impedance as a function of pulse duration.

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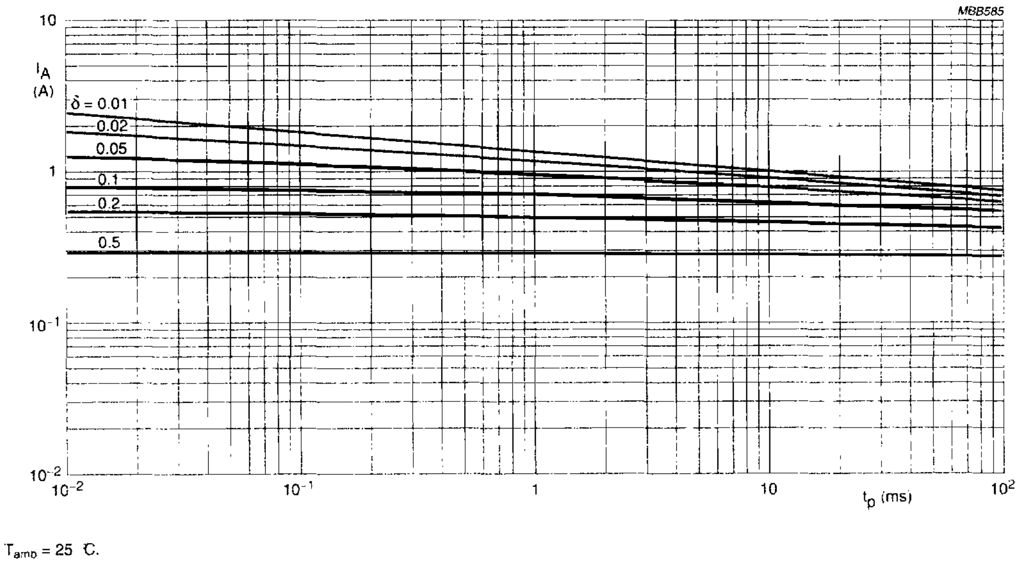

Fig.25 Silicon controlled switch anode current as a function of pulse duration.

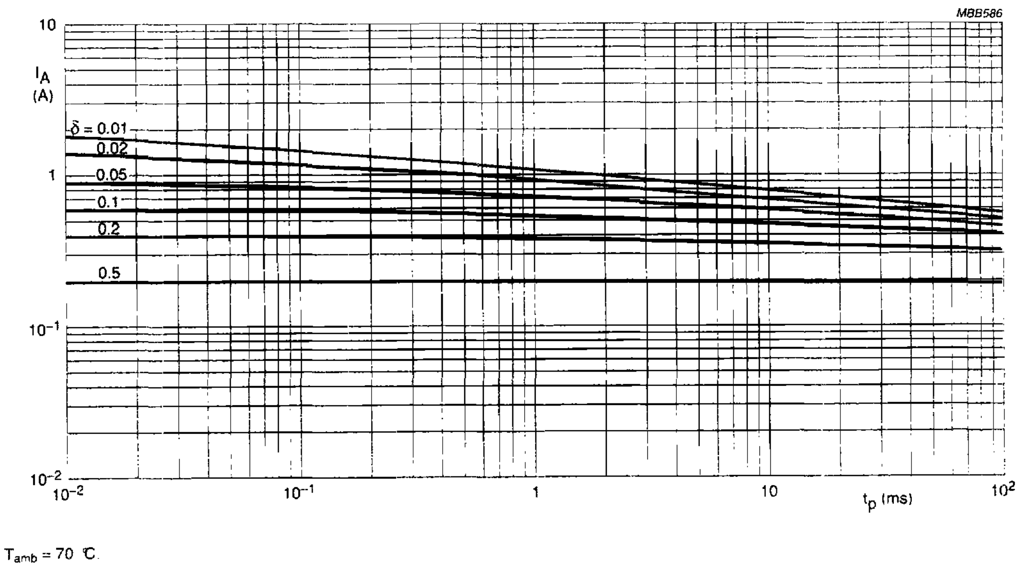

Fig.26 Silicon controlled switch anode current as a function of pulse duration.