

**RCA**  
Solid State  
Division

## Thyristors

2N3228 2N3529  
2N3525 2N4101  
2N3528 2N4102

### All-Diffused SCR's for Low-Cost Power-Control and Power-Switching Applications

RCA 2N3228\*, 2N3525\*, 2N4101\*, and 2N3528\*, 2N3529\*, and 2N4102\* are all-diffused, three-junction, silicon controlled-rectifiers (SCR's\*) intended for use in power-control and power-switching applications.

Types 2N3228, 2N3525, and 2N4101 use the JEDEC TO-66 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 5 amperes (rms value) at a case temperature of 75°C.

Types 2N3528, 2N3529, and 2N4102 use the JEDEC TO-8 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 2 amperes (rms value) at an ambient temperature of 25°C.

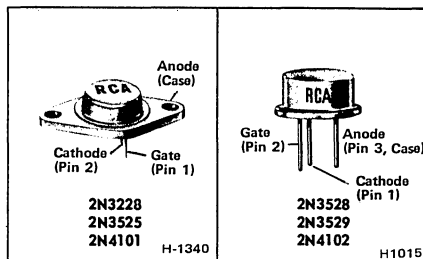
\* Formerly Dev. Types TA1222, TA1225, and TA2773, respectively.

o Formerly Dev. Types TA2597, TA2617, and TA2774, respectively.

▲ The silicon controlled-rectifier is also known as a reverse-blocking triode thyristor.

#### FEATURES

- o Designed especially for high-volume systems
- o Readily adaptable for printed-circuit boards and metal heat sinks
- o Low switching losses
- o High di/dt and dv/dt capabilities
- o Shorted emitter gate-cathode construction
- o Forward and reverse gate dissipation ratings
- o All-diffused construction—assures exceptional uniformity and stability of characteristics
- o Direct-soldered internal construction—assures exceptional resistance to fatigue
- o Symmetrical gate-cathode construction—provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- o All-welded construction and hermetic sealing
- o Low leakage currents, both forward and reverse
- o Low forward voltage drop at high current levels
- o Low thermal resistance

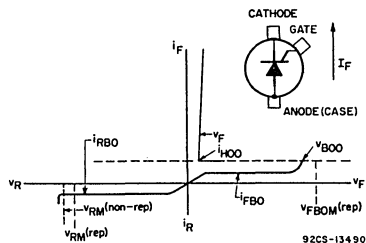


JEDEC TO-66

JEDEC TO-8

Current → Voltage ↓	Average Forward Amperes 3.2	Average Forward Amperes 1.3
For 120-Volt Line Operation	2N3228	2N3528
For 240-Volt Line Operation	2N3525	2N3529
For High-Voltage Power Supplies	2N4101	2N4102

TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER



92CS-13490

*Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load*

RATINGS	CONTROLLED-RECTIFIER TYPES						UNITS
	2N3228	2N3525	2N4101	2N3528	2N3529	2N4102	
Transient Peak Reverse Voltage (Non-Repetitive), $v_{RM}(non-rep)$ .....	330	660	700	330	660	700	volts
Peak Reverse Voltage (Repetitive), $v_{RM}(rep)$ .....	200	400	600	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), $v_{FBOM}(rep)$ .....	200	400	600	200	400	600	volts
Forward Current:							
For case temperature ( $T_C$ ) of + 75°C, and unit mounted on heat sink—							
Average DC value at a conduction angle of 180°, $I_{FAV}$ .....	3.2	3.2	3.2	—	—	—	amperes
RMS value, $I_{FRMS}$ .....	5.0	5.0	5.0	—	—	—	amperes
For other conditions, See Fig. 8							
For free-air temperature ( $T_{FA}$ ) of 25°C, and with no heat sink employed—							
Average DC value at a conduction angle of 180°, $I_{FAV}$ .....	—	—	—	1.3	1.3	1.3	amperes
RMS value, $I_{FRMS}$ .....	—	—	—	2.0	2.0	2.0	amperes
For other conditions, See Fig. 9.							
Peak Surge Current, $i_{FM}(surge)$ :							
For one cycle of applied principal voltage.							
60 Hz (sinusoidal), $T_C = 75^\circ C$ .....		60			60		amperes
50 Hz (sinusoidal), $T_C = 75^\circ C$ .....		50			50		amperes
For more than one cycle of applied voltage. ....		See Fig. 13			See Fig. 13		
Fusing Current (for SCR protection):							
$T_J = -40$ to $100^\circ C$ , $t = 1$ to $8.3 ns$ , $12t$		15			15		ampere <sup>2</sup> second
Rate of Change of Forward Current, $di/dt$ .....		200			200		amperes/microsecond
$V_{FB} = v_{B00}$ (min. value)							
$I_{GT} = 200mA$ , $0.5 \mu s$ rise time (See waveshapes of Fig. 1)							
Gate Power*:							
Peak, Forward or Reverse, for $10 \mu s$ duration, $P_{GM}$ (See Figs. 5 and 6)		13			13		watts
Average, $P_{GAV}$ .....		0.5			0.5		watt
Temperature:							
Storage, $T_{slg}$ .....		-40 to +125			-40 to +125		°C
Operating (Case), $T_C$		-40 to +100			-40 to +100		°C

\*Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature ( $T_C$ )

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES									UNITS
	2N3228, 2N3528			2N3525, 2N3529			2N4101, 2N4102			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Breakover Voltage, $v_{B00}$ : At $T_C = +100^\circ\text{C}$ .....	200	—	—	400	—	—	600	—	—	volts
Peak Blocking Current, at $T_C = +100^\circ\text{C}$ : Forward, $I_{FB0M}$ .....	—	0.10	1.5	—	0.20	3.0	—	0.40	4.0	mA
$V_{FB0}^P = v_{B00}$ (min. value)										
Reverse, $I_{RB0M}$ .....	—	0.05	0.75	—	0.10	1.5	—	0.20	2.0	mA
$V_{RB0}^P = v_{RM}$ (rep) value										
Forward Voltage Drop, $v_F$ At a Forward Current of 30 amperes and a $T_C = +25^\circ\text{C}$	—	2.15	2.8	—	2.15	2.8	—	2.15	2.8	volts
DC Gate-Trigger Current, $I_{GT}$ At $T_C = +25^\circ\text{C}$ (See Fig. 5) .....	—	8	15	—	8	15	—	8	15	mA (dc)
Gate-Trigger Voltage, $V_{GT}$ At $T_C = +25^\circ\text{C}$ (See Fig. 5) .....	—	1.2	2.0	—	1.2	2.0	—	1.2	2.0	volts (dc)
Holding Current, $I_{H00}$ At $T_C = +25^\circ\text{C}$ .....	—	10	20	—	10	20	—	10	20	mA
Critical Rate of Applied Forward Voltage, Critical $dv/dt$ .....	10	200	—	10	200	—	10	200	—	volts/ microsecond
$V_{FB} = v_{B00}$ (min. value), exponential rise, $T_C = +100^\circ\text{C}$ (See waveshape of Fig. 2)										
Turn-On Time, $t_{0n}$ , (Delay Time + Rise Time) .....	0.75	1.5	—	0.75	1.5	—	0.75	1.5	—	microseconds
$V_{FB} = v_{B00}$ (min. value), $i_F = 4.5$ amperes, $I_{GT} = 200$ mA, $0.1 \mu\text{s}$ rise time, $T_C = +25^\circ\text{C}$ (See waveshapes of Fig. 3)										
Turn-Off Time, $t_{0ff}$ .....	—	15	50	—	15	50	—	15	50	microseconds
$i_F = 2$ amperes, $50 \mu\text{s}$ pulse width, $dv_{FB}/dt = 20 \text{V}/\mu\text{s}$ , $di_F/dt = 30 \text{A}/\mu\text{s}$ , $I_{GT} = 200$ mA, $T_C = +75^\circ\text{C}$ (See waveshapes of Fig. 4)										
	2N3228, 2N3525, 2N4101			2N3528, 2N3529, 2N4102						
	Min.	Typ.	Max.	Min.	Typ.	Max.				
Thermal Resistance: Junction-to-case .....	—	—	4	—	—	—	5			$^\circ\text{C}/\text{W}$
Junction-to-ambient .....	—	—	40	—	—	—	40			$^\circ\text{C}/\text{W}$

WAVESHAPE OF  $di/dt$  RATING TEST

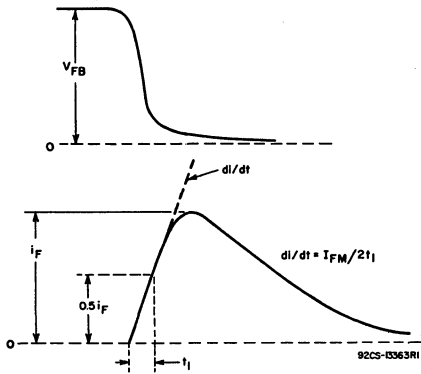


Fig. 1

WAVESHAPE OF CRITICAL  $dv/dt$  RATING TEST

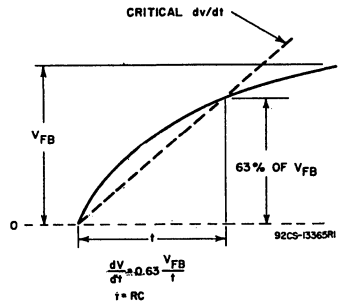


Fig. 2

WAVESHAPE OF  $t_{on}$  RATING TEST

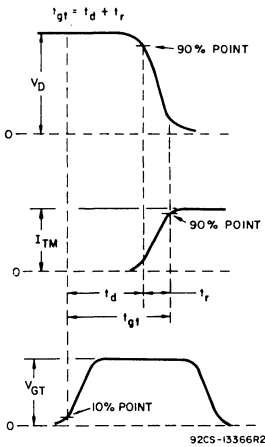


Fig. 3

WAVESHAPE OF  $t_{off}$  RATING TEST

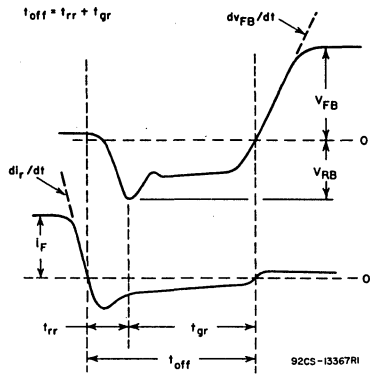


Fig. 4

TERMINAL CONNECTIONS  
FOR TYPES  
2N3228, 2N3525, AND 2N4101

- Pin 1 — Gate
- Pin 2 — Cathode
- Case, Mounting Flange — Anode

TERMINAL CONNECTIONS  
FOR TYPES  
2N3528, 2N3529, AND 2N4102

- Pin 1 — Cathode
- Pin 2 — Gate
- Case, Pin 3 — Anode

FORWARD GATE CHARACTERISTICS

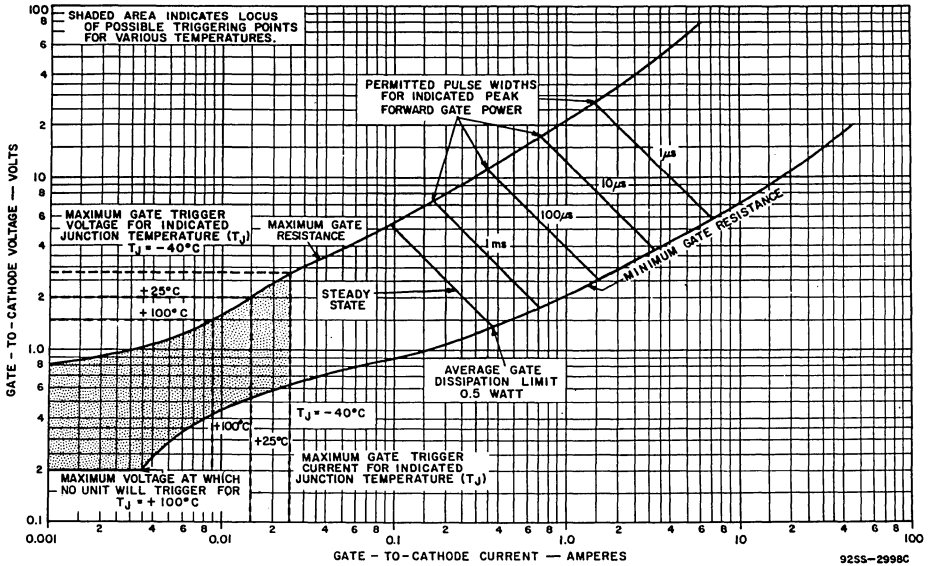


Fig. 5

REVERSE GATE CHARACTERISTICS

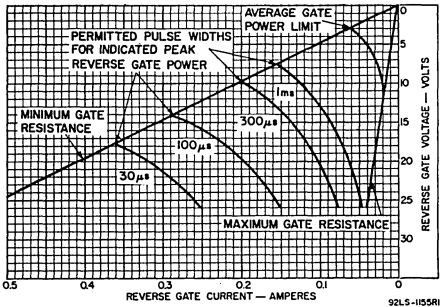


Fig. 6

TURN-ON TIME CHARACTERISTICS

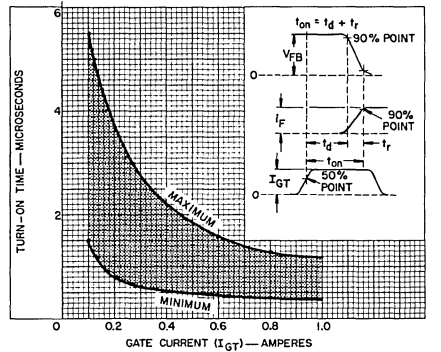


Fig. 7

**RATING CHART (CASE TEMPERATURE) FOR TYPES 2N3228, 2N3525, AND 2N4101**

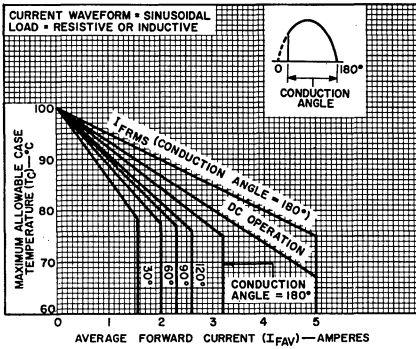


Fig. 8

**RATING CHART (FREE-AIR TEMPERATURE) FOR TYPES 2N3528, 2N3529, AND 2N4102**

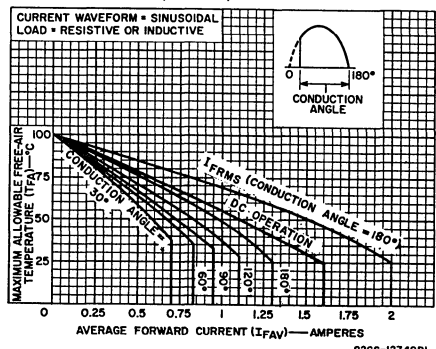


Fig. 9

**POWER DISSIPATION CHART FOR ALL TYPES**

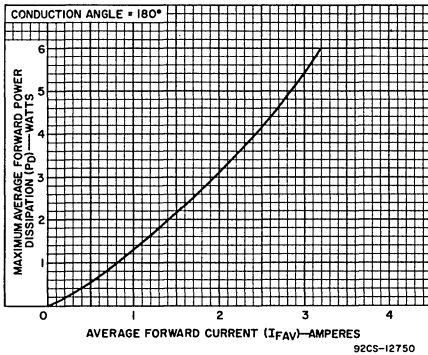


Fig. 10

**FORWARD CHARACTERISTICS FOR ALL TYPES**

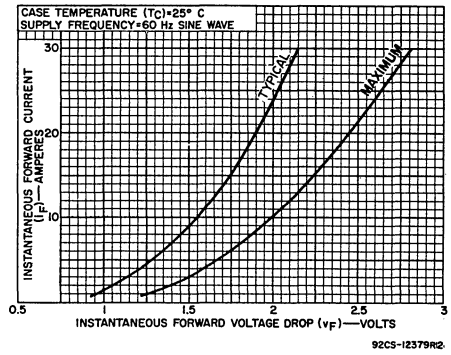


Fig. 11

**OPERATION GUIDANCE CHART FOR TYPES 2N3228, 2N3525, AND 2N4101**

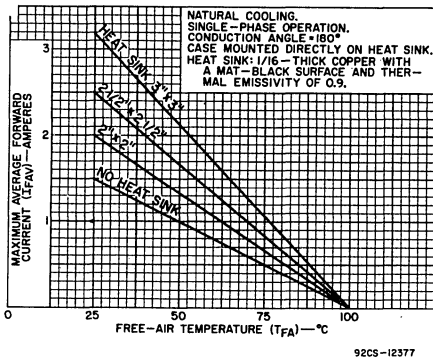


Fig. 12

**SURGE CURRENT RATING CHART**

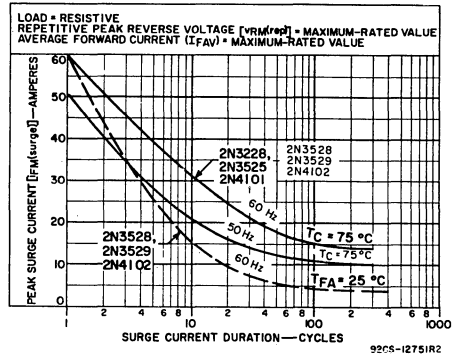


Fig. 13