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.

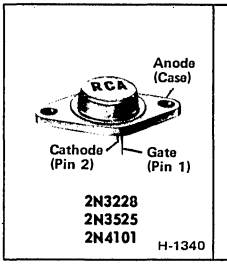
Types 2N3228, 2N3525, and 2N4101 use the JEDEC TO-66 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 5 amperes (rms value) at a case temperature of 75°C.

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.

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

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



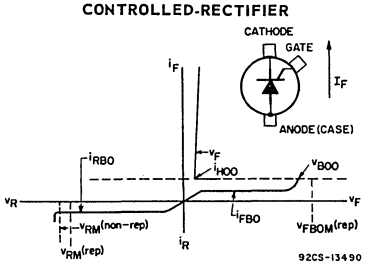
JEDEC TO-66 JEDEC TO-8

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

FEATURES

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

TYPICAL E-I CHARACTERISTIC OF SILICON CONTROLLED-RECTIFIER



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 cylce of applied principal voltage.							
60 Hz (sinusoidal), T_C = 75°C		60			60		amperes
50 Hz (sinusoidal), T_C = 75°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°C, t = 1 to 8.3 ns, I^2t		15			15		ampere^2 second
Rate of Change of Forward Current, di/dt		200			200		amperes/ microsecond
V_{FB} = v_{BO0}(min. value) I_{GT} = 200mA, 0.5 μs rise time (See waveshapes of Fig. 1)							
Gate Power*:							
Peak, Forward or Reverse, for 10 μs duration, P_{GM} (See Figs. 5 and 6)		13			13		watts
Average, P_{GAV}		0.5			0.5		watt
Temperature:							
Storage, T_{stg}		–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_{BOO}: At T_C = +100°C	200	—	—	400	—	—	600	—	—	volts
Peak Blocking Current, at T_C = +100°C: Forward, I_{FBOM}	—	0.10	1.5	—	0.20	3.0	—	0.40	4.0	mA
V_{FBO}^{p} = v_{BOO} (min. value) Reverse, I_{RBOM}	—	0.05	0.75	—	0.10	1.5	—	0.20	2.0	mA
V_{RBO}^{p} = v_{RM} (rep) value Forward Voltage Drop, v_F At a Forward Current of 30 amperes and a T_C = +25°C	—	2.15	2.8	—	2.15	2.8	—	2.15	2.8	volts
DC Gate-Trigger Current, I_{GT} At T_C = +25°C (See Fig. 5)	—	8	15	—	8	15	—	8	15	mA(dc)
Gate-Trigger Voltage, V_{GT} At T_C = +25°C (See Fig. 5)	—	1.2	2.0	—	1.2	2.0	—	1.2	2.0	volts(dc)
Holding Current, i_{HOO} At T_C = +25°C	—	10	20	—	10	20	—	10	20	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt V_{FB} = v_{BOO} (min. value), exponential rise, T_C = +100°C (See waveshape of Fig. 2)	10	200	—	10	200	—	10	200	—	volts/ microsecond
Turn-On Time, t_{on}, (Delay Time + Rise Time) V_{FB} = v_{BOO} (min. value), i_F = 4.5 amperes, I_{GT} = 200mA, 0.1 μs rise time, T_C = +25°C (See waveshapes of Fig. 3)	0.75	1.5	—	0.75	1.5	—	0.75	1.5	—	microseconds
Turn-Off Time, t_{off}. i_F = 2 amperes, 50 μs pulse width, dv_{FB}/dt = 20v/μs, di_r/dt = 30A/μs, I_{GT} = 200mA, T_C = +75°C (See waveshapes of Fig. 4)	—	15	50	—	15	50	—	15	50	microseconds

	2N3228, 2N3525, 2N4101			2N3528, 2N3529, 2N4102			
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Thermal Resistance:							
Junction-to-case	—	—	4	—	—	5	°C/W
Junction-to-ambient	—	—	40	—	—	40	°C/W

WAVESHAPE OF di/dt RATING TEST

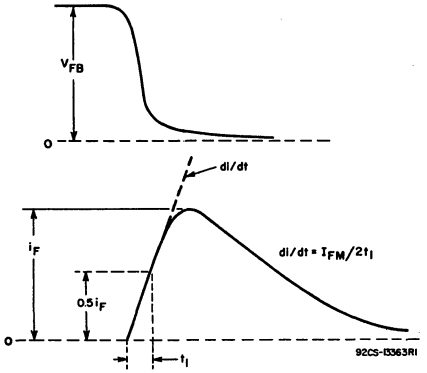


Fig. 1

WAVESHAPE OF CRITICAL dv/dt RATING TEST

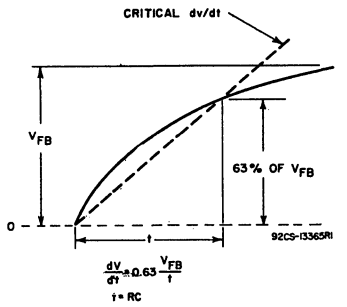


Fig. 2

WAVESHAPE OF t_{on} RATING TEST

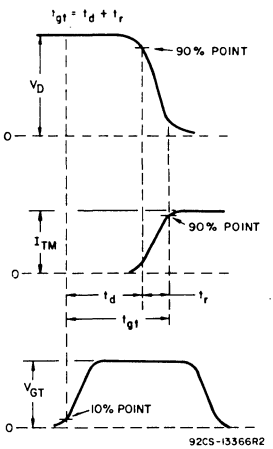


Fig. 3

WAVESHAPE OF t_{off} RATING TEST

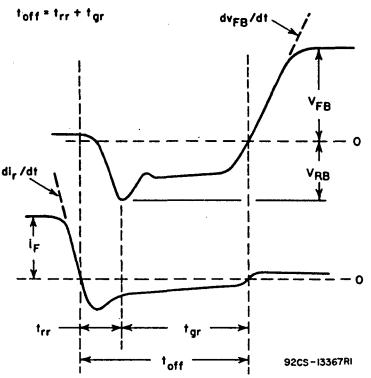


Fig. 4

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

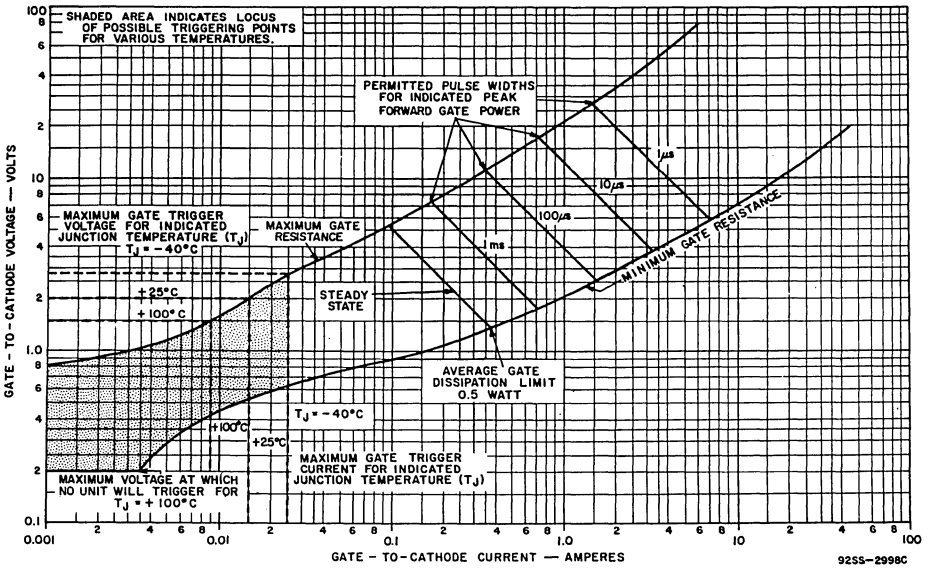


Fig. 5

REVERSE GATE CHARACTERISTICS

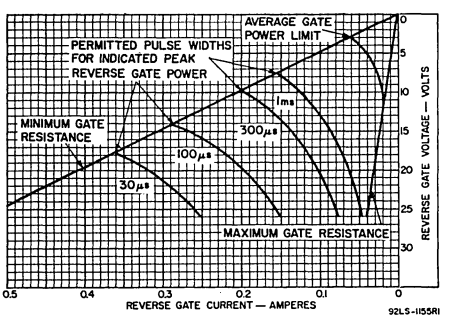


Fig. 6

TURN-ON TIME CHARACTERISTICS

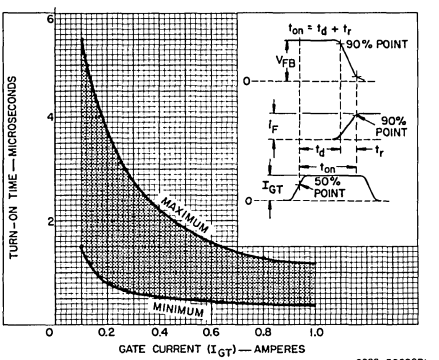


Fig. 7

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

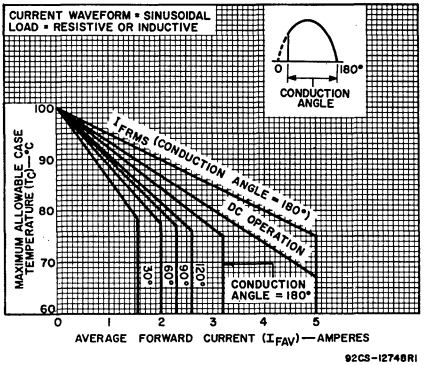


Fig. 8

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

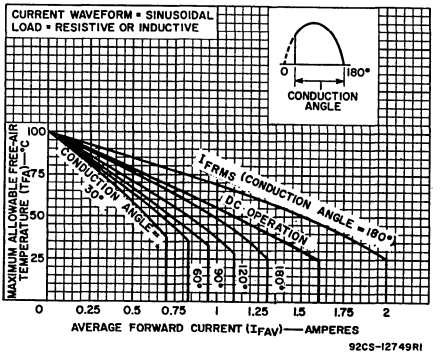


Fig. 9

POWER DISSIPATION CHART FOR ALL TYPES

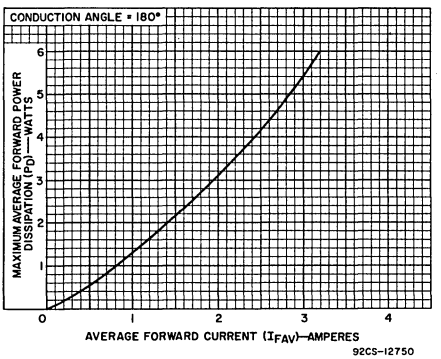


Fig. 10

FORWARD CHARACTERISTICS FOR ALL TYPES

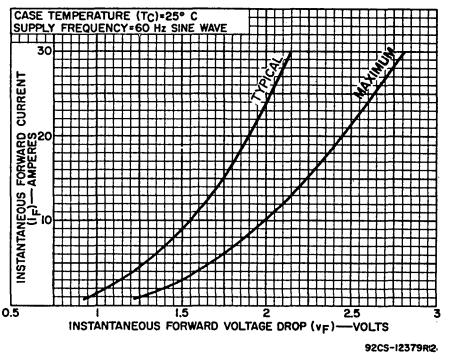


Fig. 11

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

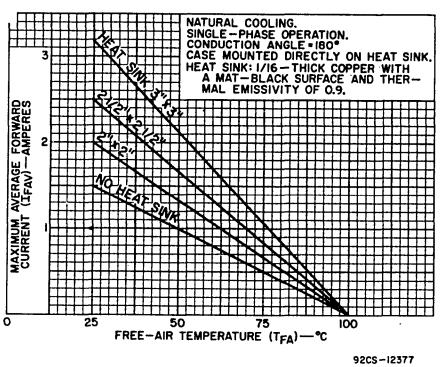


Fig. 12

SURGE CURRENT RATING CHART

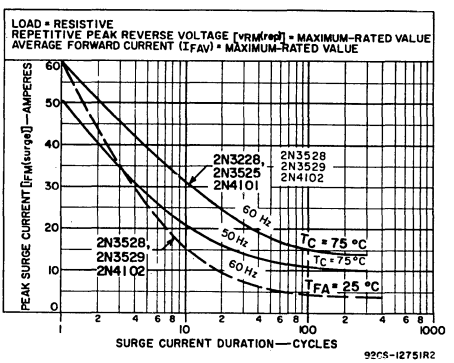


Fig. 13