

# INTERNATIONAL RECTIFIER

## 2N681 & 2N5204 SERIES

### 25 and 35 Amp RMS SCRs

#### Major Ratings and Characteristics

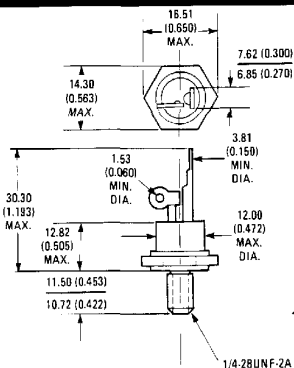
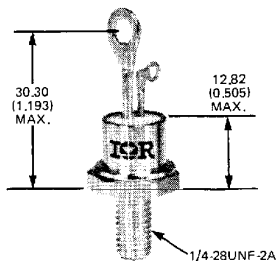
	2N681-92	2N5204-07	Units
$I_T$ (RMS)	25	35	A
$I_T$ (AV)	16*	22*	A
@ $T_C$	-65 to 65*	-40 to 40	°C
$I_{TSM}$	@ 50 Hz	145	A
	@ 60 Hz	150*	
		300*	
$i^2t$	@ 50 Hz	103	A <sup>2</sup> s
	@ 60 Hz	94	
		375	
$I_{GT}$	40	40	mA
$dv/dt$	—	100*	V/ $\mu$ s
$di/dt$	75–100	100	A/ $\mu$ s
$T_J$	-65 to 125*	-40 to 125*	°C
$V_{RRM}, V_{DRM}$ range	25–800	600–1200	V

\*JEDEC registered value.

#### Description/Features

- General purpose stud mounted
- Broad forward and reverse voltage range – through 1200 volts
- Can be supplied to meet stringent military, aerospace and other high-reliability requirements

#### CASE STYLE AND DIMENSIONS



Conforms to JEDEC Outline TO-208AA (TO-48)  
Dimensions in Millimeters and (Inches)

## VOLTAGE RATINGS (Applied gate voltage zero or negative)

Part Numbers	$V_{RRM}$ , $V_{DRM}$ - Max. Repetitive Peak Reverse and Off-State Voltage (V)	$V_{RSM}$ Max. Non Repetitive Peak Reverse Voltage $t_p < 5$ ms (V)
	$T_J = -65^{\circ}\text{C}$ to $125^{\circ}\text{C}$	$T_J = -65^{\circ}\text{C}$ to $125^{\circ}\text{C}$
2N681	25*	35*
2N682	50*	75*
2N683	100*	150*
2N685	200*	300*
2N687	300*	400*
2N688	400*	500*
2N689	500*	600*
2N690	600*	720*
2N691	700*	840*
2N692	800*	960*
	$T_J = -40^{\circ}\text{C}$ to $125^{\circ}\text{C}$	$T_J = -40^{\circ}\text{C}$ to $125^{\circ}\text{C}$
2N5204	600	720
2N5205	800	960
2N5206	1000	1200
2N5207	1200	1440

## ELECTRICAL SPECIFICATIONS

		2N681-92	2N5204-07	Units	Conditions
ON-STATE					
$I_T(\text{RMS})$	Max. RMS on-state current	25	35	A	
$I_T(\text{AV})$	Max. average on-state current	16*	22*	A	
	@ $T_C =$	-65 to 65*	-40 to 40*	$^{\circ}\text{C}$	180° half sine wave conduction
$I_{TSM}$	Max. peak one cycle, non-repetitive surge current	145	285	A	50 Hz half cycle sine wave or 6 ms rectangular pulse
		150*	300*		60 Hz half cycle sine wave or 5 ms rectangular pulse
		170	340		50 Hz half cycle sine wave or 6 ms rectangular pulse
		180	355		60 Hz half cycle sine wave or 5 ms rectangular pulse
$I_{2t}$	Max. $I_{2t}$ capability, for fusing	103	410	$A^2s$	$t = 10$ ms Rated $V_{RRM}$ applied following surge, initial $T_J = 125^{\circ}\text{C}$
		94	375		$t = 8.3$ ms
$I_{2t}$	Max. $I_{2t}$ capability, for individual device fusing	145	580	$A^2s$	$t = 10$ ms $V_{RRM} = 0$ following surge, initial $T_J = 125^{\circ}\text{C}$
		135	530		$t = 8.3$ ms
$I_{2\sqrt{t}}$	Max. $I_{2\sqrt{t}}$ capability, for individual device fusing $\text{\textcircled{1}}$	1450	5800	$A^2\sqrt{s}$	$t = 0.1$ to $10$ ms initial $T_J \leq 125^{\circ}\text{C}$ $V_{RRM}$ following surge = 0.
$V_{TM}$	Max. peak on-state voltage	2*	2.3*	V	$T_J = 25^{\circ}\text{C}$ , $I_T(\text{AV}) = 16\text{A}$ (50A peak) 2N681, $I_T(\text{AV}) = 22\text{A}$ (70A peak) 2N5204
$I_H$	Max. holding current	20 @ $25^{\circ}\text{C}$ $\dagger$	200* @ $-40^{\circ}\text{C}$	mA	Anode supply = 24V, initial $I_T = 1.0\text{A}$ .
BLOCKING					
$dv/dt$	Min. critical rate-of-rise of off-state voltage	100 $\dagger$	100*	V/ $\mu\text{s}$	$T_J = 125^{\circ}\text{C}$ . Exponential to 100% rated $V_{DRM}$
		250 $\dagger$	250		$T_J = 125^{\circ}\text{C}$ . Exponential to 67% rated $V_{DRM}$
Gate open circuited.					

\*JEDEC Registered value.

 $\text{\textcircled{1}}$   $I_{2t}$  for time  $t_x = I_{2\sqrt{t}} \cdot \sqrt{t_x}$ . $\dagger$  Typical

**ELECTRICAL SPECIFICATIONS (Continued)**

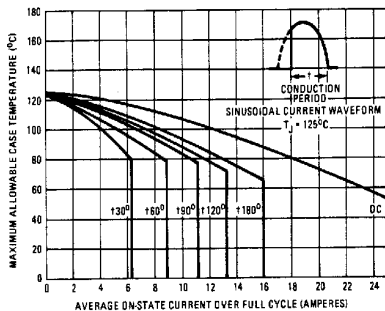
		2N681-92	2N5204-07	Units	Conditions
<b>BLOCKING (Continued)</b>					
$I_{R(-)}$ & $I_{D(-)}$ Max. reverse and off-state current $V_{RRM}$ & $V_{DRM} =$	5V	$I_{R(AV)}$ & $I_{D(AV)}$ (Average Values)	$I_{RM}$ & $I_{DM}$ (Peak Values)	mA	$T_J = 125^\circ\text{C}$ , gate open circuited.
	25 to 150V	6.5*	—		
	200 & 250V	6.0*	—		
	300V	5.0*	—		
	400V	4.0*	—		
	500V	3.0*	—		
	600V	2.5*	3.3*		
	700V	2.25*	—		
	800V	2.0*	2.5*		
	1000V	—	2.0*		
1200V	—	1.7*			
<b>SWITCHING</b>					
$t_d$	Typical delay time	1	1	$\mu\text{s}$	$T_C = 25^\circ\text{C}$ , $V_{DM} =$ rated $V_{DRM}$ , $I_{TM} = 10\text{A}$ dc resistive circuit. Gate pulse: 10V, $40\Omega$ source, $t_p = 6 \mu\text{s}$ , $t_r = 0.1 \mu\text{s}$ .
$di/dt$	Max. non-repetitive rate of rise of turned-on current $V_{DM} = 25$ to 600V	100	—	A/ $\mu\text{s}$	$T_C = 125^\circ\text{C}$ , $V_{DM} =$ rated $V_{DRM}$ , $I_{TM} = 2 \times di/dt$ . Gate pulse: 20V, $15\Omega$ , $t_p = 6 \mu\text{s}$ , $t_r = 0.1 \mu\text{s}$ max. Per JEDEC standard RS-397, 5.2.2.6.
		= 700 to 800V	75		
		—	100		$T_C = 125^\circ\text{C}$ , $V_{DM} = 600\text{V}$ , $I_{TM} = 200\text{A}$ @ 400 Hz, max., Gate pulse: 20V, $15\Omega$ , $t_p = 6 \mu\text{s}$ , $t_r = 0.1 \mu\text{s}$ max. Per JEDEC standard RS-397, 5.2.2.6.
<b>TRIGGERING</b>					
$P_{GM}$	Max. peak gate power	5*	60*	W	$t_p \leq 5$ ms for 2N681 series; $t_p \leq 500 \mu\text{s}$ for 2N5204 series.
$P_{G(AV)}$	Max. average gate power	0.5*	0.5*	W	
$+I_{GM}$	Max. peak positive gate current	2*	2	A	
$+V_{GM}$	Max. peak positive gate voltage	10*	—	V	
$-V_{GM}$	Max. peak negative gate voltage	5*	5*	V	
$I_{GT}$	Max. required DC gate current to trigger	80*	80*	mA	$T_C =$ min. rated value. Max. required gate trigger current is the lowest value which will trigger all units with +6V anode-to-cathode. $T_C = 25^\circ\text{C}$ $T_C = 125^\circ\text{C}$
		40	40		
		18.5	20		
	Typical DC gate current to trigger	30	30	$T_C = 25^\circ\text{C}$ +6V anode-to-cathode	
$V_{GT}$	Max. required DC gate voltage to trigger	3*	3*	V	$T_C = -65^\circ\text{C}$ . Max. required gate trigger voltage is the lowest value which will trigger all units with +6V anode-to-cathode. $T_C = 25^\circ\text{C}$
		2	2		
	Typical DC gate voltage to trigger	1.5	1.5	$T_C = 25^\circ\text{C}$ +6V anode-to-cathode	
$V_{GD}$	Max. DC gate voltage not to trigger	0.25*	0.25*	V	$T_C = 125^\circ\text{C}$ . Max. gate voltage not to trigger is the maximum value which will not trigger any unit with rated $V_{DRM}$ anode-to-cathode.

**THERMAL-MECHANICAL SPECIFICATIONS**

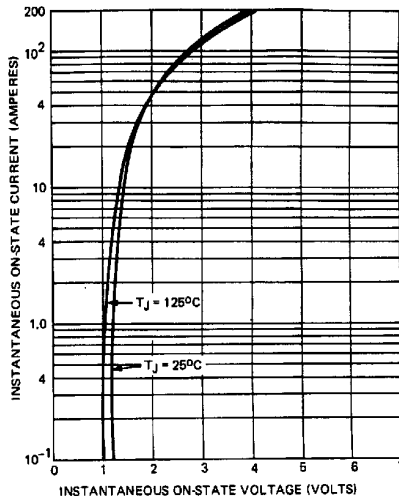
		2N681-92	2N5204-07	Units	Conditions
$T_J$	Operating junction temperature range	-65° to 125°	-40° to 125°	°C	
$T_{stg}$	Storage temperature range	-65° to 125°	-40° to 125°	°C	
$R_{thJC}$	Max. internal thermal resistance, junction to case	1.5	1.5*	deg. C/W	DC operation
$R_{thCS}$	Thermal resistance, case to sink	0.35	0.35	deg. C/W	Mounting surface smooth, flat and greased.
	Mounting torque to nut $\pm 10\%$	20,(27.5)		lbf · in.	Lubricated threads (non-lubricated threads).
		0.23(.32)		kgf · m	
	to device	2.3(3.1)		N·m	Lubricated threads.
		25		lbf · in.	
		0.29		kgf · m	
		2.8		N·m	
wt	Approximate weight	14(0.49)	14 (0.5)	g (oz.)	
	Case Style	TO-208AA (TO-48)			

\*JEDEC Registered value.

**2N681 Series**



**Fig. 1 – Maximum Allowable Case Temperature Vs. Average On-State Current, 2N681 Series**



**Fig. 2 – Maximum On-State Voltage Vs. Current, 2N681 Series**

2N681 Series

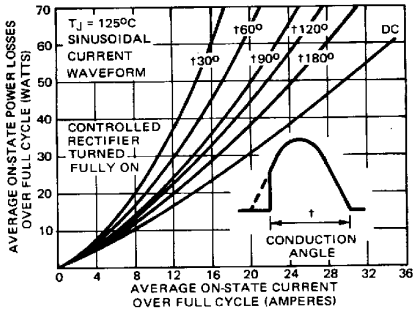


Fig. 3 — Maximum Low Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

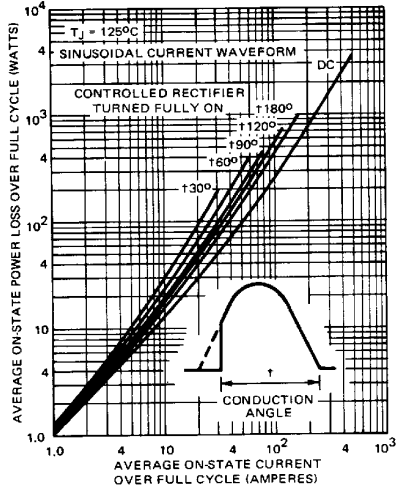


Fig. 4 — Maximum High Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

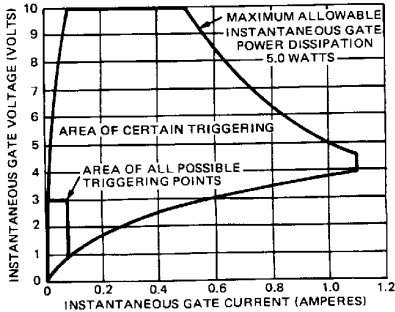


Fig. 5 — Gate Characteristics, 2N681 Series

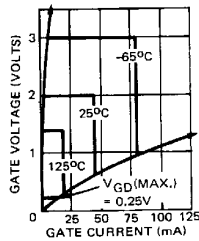


Fig. 5A — Area of All Possible Triggering Points Vs. Temperature 2N681 Series

2N681 Series

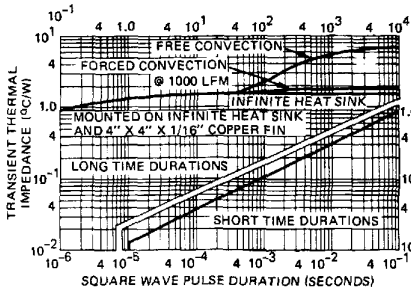


Fig. 6 – Maximum Transient Thermal Impedance, Junction to Case, Vs. Pulse Duration, 2N681 Series

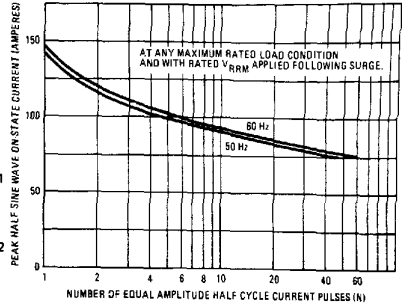


Fig. 7 – Maximum Non-Repetitive Surge Current, Vs. Number of Current Pulses, 2N681 Series

2N5204 Series

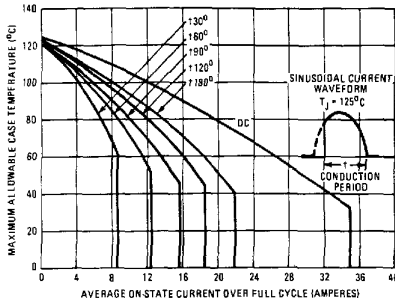


Fig. 8 – Maximum Allowable Case Temperature Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series

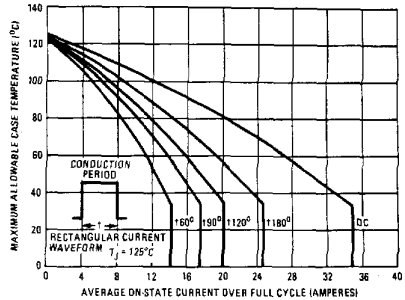
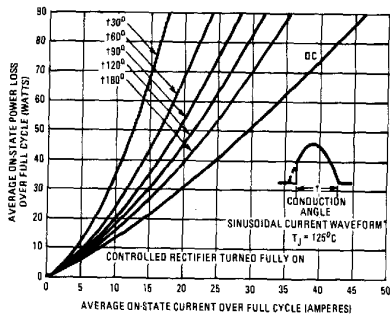
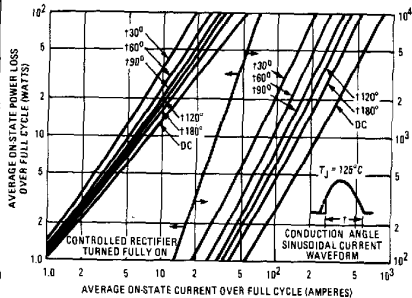


Fig. 9 – Maximum Allowable Case Temperature Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series

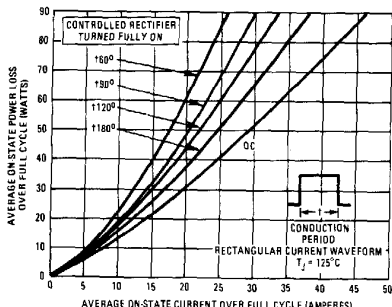
2N5204 Series



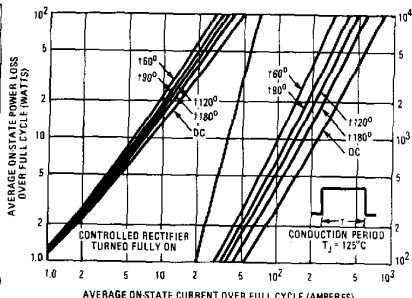
**Fig. 10** — Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series



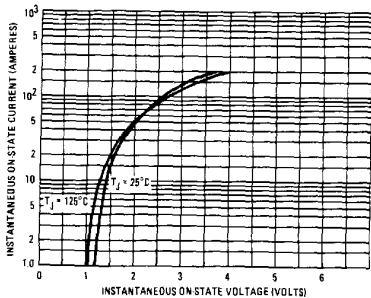
**Fig. 11** — Maximum High-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series



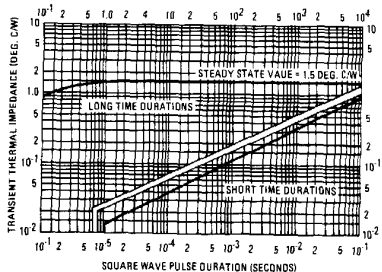
**Fig. 12** — Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series



**Fig. 13** — Maximum High-Level On-State Power Loss Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series



**Fig. 14** — Maximum Instantaneous On-State Voltage Vs. Instantaneous On-State Current, 2N5204 Series



**Fig. 15** — Maximum Transient Thermal Resistance, Junction to Case, Vs. Pulse Duration, 2N5204 Series