

INTERNATIONAL RECTIFIER



# 2N681 & 2N5204 SERIES

## 25 and 35 Amp RMS SCRs

### Major Ratings and Characteristics

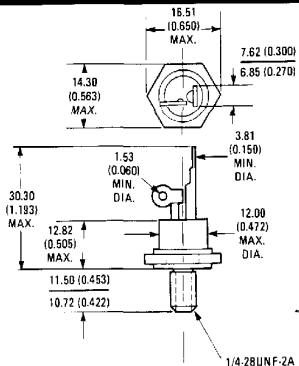
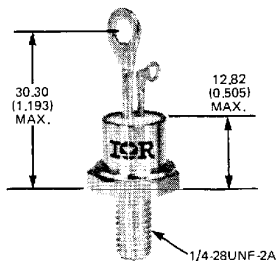
|                          | 2N681-92    | 2N5204-07   | Units            |
|--------------------------|-------------|-------------|------------------|
| $I_T$ (RMS)              | 25          | 35          | A                |
| $I_T$ (AV)               | 16*         | 22*         | A                |
| @ $T_C$                  | -65 to 65*  | -40 to 40   | °C               |
| $I_{TSM}$                | @ 50 Hz     | 145         | A                |
|                          | @ 60 Hz     | 150*        |                  |
|                          |             | 285         |                  |
| $i^2t$                   | @ 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 | $V_{RRM}$ , $V_{DRM}$ -<br>Max. Repetitive Peak<br>Reverse and Off-State Voltage<br>(V) | $V_{RSM}$<br>Max. Non Repetitive Peak<br>Reverse Voltage<br>$t_p < 5$ ms<br>(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                          | $\text{A}^2\text{s}$        | $t = 10$ 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                          | $\text{A}^2\text{s}$        | $t = 10$ 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                         | $\text{A}^2\sqrt{\text{s}}$ | $t = 0.1$ to $10$ ms initial $T_J \leq 125^{\circ}\text{C}$<br>$V_{RRM}$ 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,<br>$I_T(\text{AV}) = 22\text{A}$ (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)**

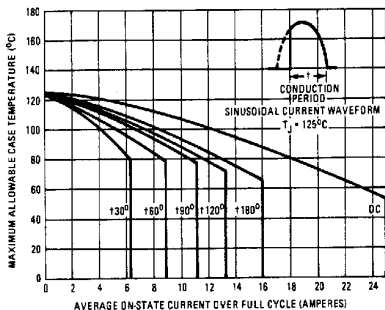
|  |  | 2N681-92  | 2N5204-07                            | Units            | Conditions  |
|--|--|---|--------------------------------------|------------------|---|
| <b>BLOCKING (Continued)</b>  |  |   |                                      |                  |   |
| $I_{R(-)}$ &<br>$I_{D(-)}$<br>Max. reverse and<br>off-state current<br>$V_{RRM}$ & $V_{DRM} =$ | 5V   | $I_{R(AV)}$ &<br>$I_{D(AV)}$<br>(Average<br>Values) | $I_{RM}$ & $I_{DM}$<br>(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                                    | $\mu\text{s}$    | $T_C = 25^\circ\text{C}$ , $V_{DM} = \text{rated } V_{DRM}$ , $I_{TM} = 10\text{A}$ 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<br>$V_{DM} = 25$ to 600V | 100   | —                                    | A/ $\mu\text{s}$ | $T_C = 125^\circ\text{C}$ , $V_{DM} = \text{rated } V_{DRM}$ , $I_{TM} = 2 \times di/dt$ . 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;<br>$t_p \leq 500 \mu\text{s}$ 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               | $T_C = \text{min. rated value}$ . Max. required gate trigger current is the lowest value which will trigger all units with +6V anode-to-cathode.<br>$T_C = 25^\circ\text{C}$<br>$T_C = 125^\circ\text{C}$           |
|  |  | 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.<br>$T_C = 25^\circ\text{C}$  |
|  |  | 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**

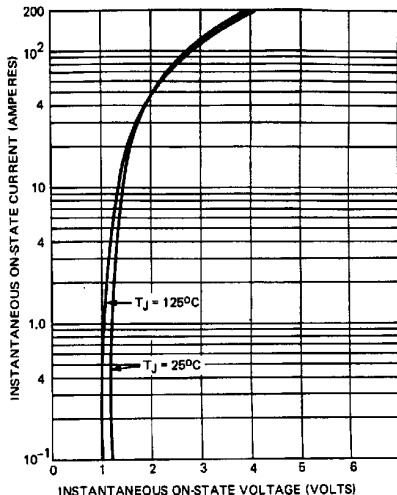
|            |  | 2N681-92         | 2N5204-07    | Units     | Conditions                                   |
|------------|--|------------------|--------------|-----------|--|
| $T_J$      | Operating junction temperature range               | -65° to 125°     | -40° to 125° | °C        |  |
| $T_{stg}$  | 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 gressed.   |
|            | Mounting torque to nut ±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

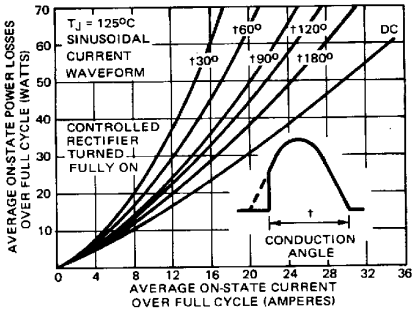


Fig. 3 — Maximum Low Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

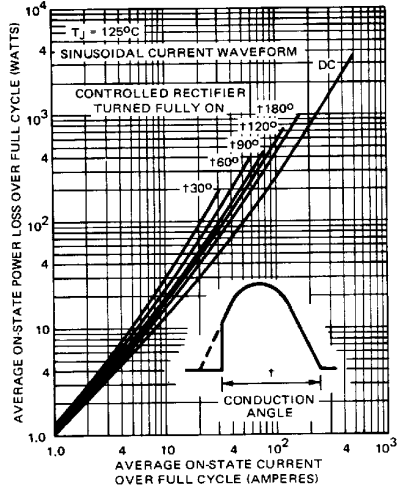


Fig. 4 — Maximum High Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

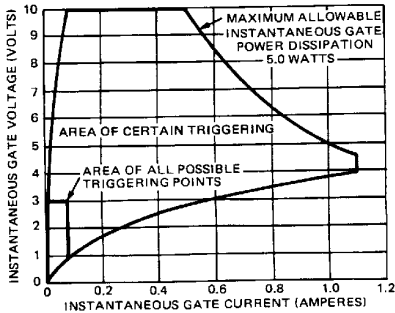


Fig. 5 — Gate Characteristics, 2N681 Series

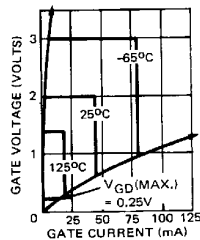


Fig. 5A — Area of All Possible Triggering Points Vs. Temperature 2N681 Series

2N681 Series

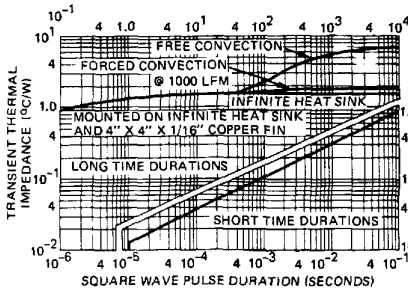


Fig. 6 – Maximum Transient Thermal Impedance, Junction to Case, Vs. Pulse Duration, 2N681 Series

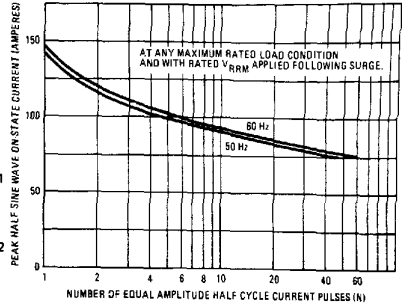


Fig. 7 – Maximum Non-Repetitive Surge Current, Vs. Number of Current Pulses, 2N681 Series

2N5204 Series

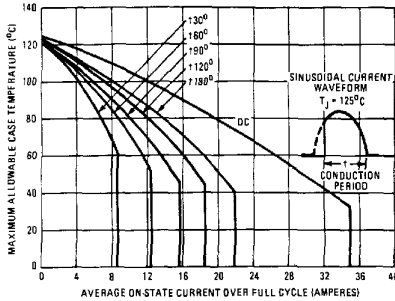


Fig. 8 – Maximum Allowable Case Temperature Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series

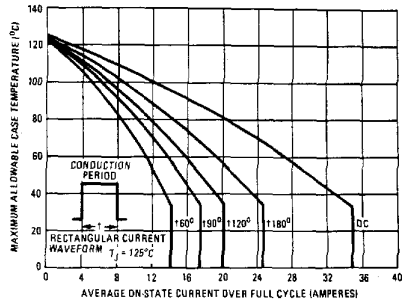
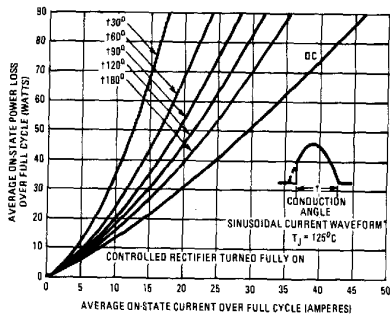
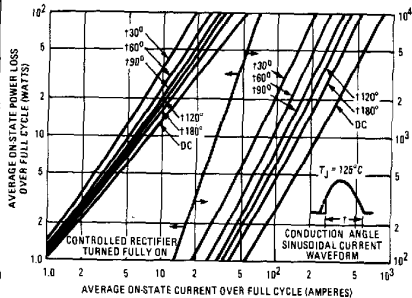


Fig. 9 – Maximum Allowable Case Temperature Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series

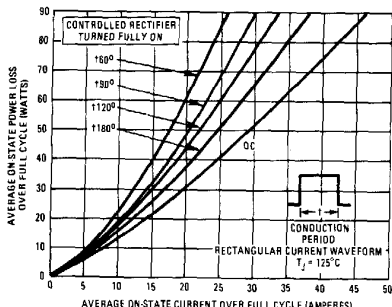
2N5204 Series



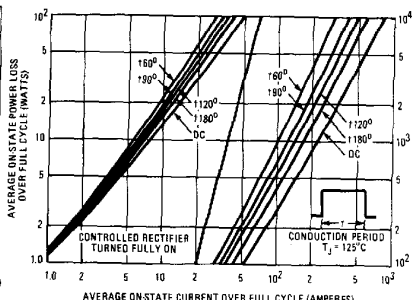
**Fig. 10** — Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series



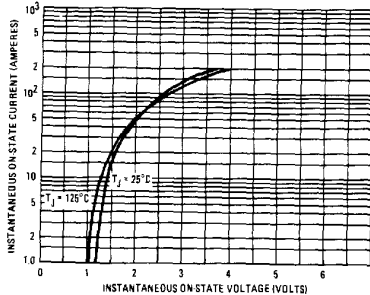
**Fig. 11** — Maximum High-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series



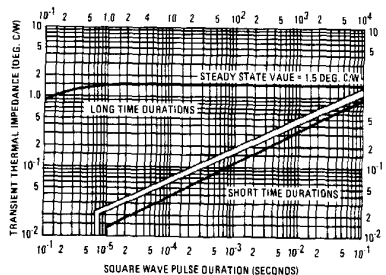
**Fig. 12** — Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series



**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