INTERNATIONAL RECTIFIER IOR

# 2N681 & 2N5204 SERIES

## 25 and 35 Amp RMS SCRs

### Major Ratings and Characteristics

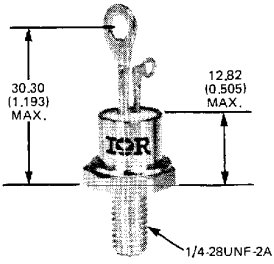
| | 2N681-92 | 2N5204-07 | Units |
|---|---|---|---|
| $I_{T(RMS)}$ | 25 | 35 | A |
| $I_{T(AV)}$ | 16* | 22* | A |
| @ $T_C$ | -65 to 65* | -40 to 40 | °C |
| $I_{TSM}$ | | | |
| @ 50 Hz | 145 | 285 | A |
| @ 60 Hz | 150* | 300* | |
| $I^2t$ | | | |
| @ 50 Hz | 103 | 410 | $A^2s$ |
| @ 60 Hz | 94 | 375 | |
| $I_{GT}$ | 40 | 40 | mA |
| dv/dt | – | 100* | V/μs |
| di/dt | 75–100 | 100 | A/μs |
| $T_J$ | -65 to 125* | -40 to 125* | °C |
| $V_{RRM}$, $V_{DRM}$ range | 25–800 | 600–1200 | V |

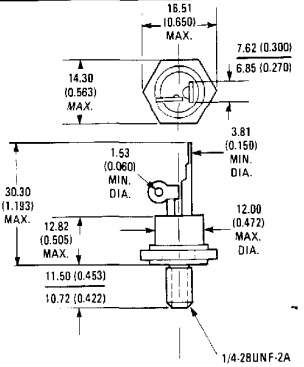
*JEDEC registered value.

### 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°C to 125°C | $T_J$ = -65°C to 125°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°C to 125°C | $T_J$ = -40°C to 125°C |
| 2N5204 | 600 | 720 |
| 2N5205 | 800 | 960 |
| 2N5206 | 1000 | 1200 |
| 2N5207 | 1200 | 1440 |

## ELECTRICAL SPECIFICATIONS

| | | 2N681-92 | 2N5204-07 | Units | Conditions |
|---|---|---|---|---|---|
| | ON-STATE | | | | |
| $I_{T(RMS)}$ | Max. RMS on-state current | 25 | 35 | A | |
| $I_{T(AV)}$ | Max. average on-state current | 16* | 22* | A | 180° half sine wave conduction |
| | @ $T_C$ = | -65 to 65* | -40 to 40* | °C | |
| $I_{TSM}$ | Max. peak one cycle, non-repetitive surge current | 145 | 285 | A | 50 Hz half cycle sine wave or 6 ms rectangular pulse — Following any rated load condition, and with rated $V_{RRM}$ applied following surge. |
| | | 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 — Same conditions as above except with $V_{RRM}$ applied following surge = 0. |
| | | 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°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°C. |
| | | 135 | 530 | | t = 8.3 ms |
| $I^2\sqrt{t}$ | Max. $I^2\sqrt{t}$ capability, for individual device fusing ① | 1450 | 5800 | $A^2\sqrt{s}$ | t = 0.1 to 10ms initial $T_J \leq 125°C$ $V_{RRM}$ following surge = 0. |
| $V_{TM}$ | Max. peak on-state voltage | 2* | 2.3* | V | $T_J$ = 25°C, $I_{T(AV)}$ = 16A (50A peak) 2N681, $I_{T(AV)}$ = 22A (70A peak) 2N5204 |
| $I_H$ | Max. holding current | 20 @ 25°C† | 200* @ -40°C | mA | Anode supply = 24V, initial $I_T$ = 1.0A. |
| | BLOCKING | | | | |
| dv/dt | Min. critical rate-of-rise of off-state voltage | 100† | 100* | V/μs | $T_J$ = 125°C. Exponential to 100% rated $V_{DRM}$ — Gate open circuited. |
| | | 250† | 250 | | $T_J$ = 125°C. Exponential to 67% rated $V_{DRM}$ |

*JEDEC Registered value.

① $I^2t$ for time $t_x = I^2\sqrt{t} \cdot \sqrt{t_x}$.

† *Typical*

## ELECTRICAL SPECIFICATIONS (Continued)

| | | 2N681-92 | 2N5204-07 | Units | Conditions |
|---|---|---|---|---|---|
| | BLOCKING (Continued) | | | | |
| $I_{R(-)}$ & $I_{D(-)}$ | Max. reverse and off-state current | $I_{R(AV)}$ & $I_{D(AV)}$ (Average Values) | $I_{RM}$ & $I_{DM}$ (Peak Values) | | |
| | $V_{RRM}$ & $V_{DRM}$ = 5V | | | | |
| | 25 to 150V | 6.5* | – | | |
| | 200 & 250V | 6.0* | – | | |
| | 300V | 5.0* | – | | |
| | 400V | 4.0* | – | mA | $T_J$ = 125°C, gate open circuited. |
| | 500V | 3.0* | – | | |
| | 600V | 2.5* | 3.3* | | |
| | 700V | 2.25* | – | | |
| | 800V | 2.0* | 2.5* | | |
| | 1000V | – | 2.0* | | |
| | 1200V | – | 1.7* | | |
| | SWITCHING | | | | |
| $t_d$ | Typical delay time | 1 | 1 | μs | $T_C$ = 25°C, $V_{DM}$ = rated $V_{DRM}$, $I_{TM}$ = 10A dc *resistive circuit. Gate pulse: 10V, 40Ω source,* $t_p$ = 6 μs, $t_r$ = 0.1 μs. |
| di/dt | Max. non-repetitive rate of rise of turned-on current | | | | $T_C$ = 125°C, $V_{DM}$ = rated $V_{DRM}$, $I_{TM}$ = 2 x di/dt, Gate pulse: 20V, 15Ω, $t_p$ = 6 μs, $t_r$ = 0.1 μs max. Per JEDEC standard RS-397, 5.2.2.6. |
| | $V_{DM}$ = 25 to 600V | 100 | – | A/μs | |
| | = 700 to 800V | 75 | – | | |
| | | – | 100 | | $T_C$ = 125°C, $V_{DM}$ = 600V, $I_{TM}$ = 200A @ 400 Hz, max., Gate pulse: 20V, 15Ω, $t_p$ = 6 μs, $t_r$ = 0.1 μs max. Per JEDEC standard RS-397, 5.2.2.6. |
| | TRIGGERING | | | | |
| $P_{GM}$ | Max. peak gate power | 5* | 60* | W | $t_p$ ≤ 5 ms for 2N681 series; $t_p$ ≤ 500 μs 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* | | $T_C$ = min. rated value. Max. required gate trigger current is the lowest value which will trigger all units with +6V anode-to-cathode. |
| | | 40 | 40 | | $T_C$ = 25°C |
| | | 18.5 | 20 | mA | $T_C$ = 125°C |
| | Typical DC gate current to trigger | 30 | 30 | | $T_C$ = 25°C +6V anode-to-cathode |
| $V_{GT}$ | Max. required DC gate voltage to trigger | 3* | 3* | | $T_C$ = -65°C. Max. required gate trigger voltage is *the lowest value which will trigger all units with* +6V anode-to-cathode. |
| | | 2 | 2 | V | $T_C$ = 25°C |
| | Typical DC gate voltage to trigger | 1.5 | 1.5 | | $T_C$ = 25°C +6V anode-to-cathode |
| $V_{GD}$ | Max. DC gate voltage not to trigger | 0.25* | 0.25* | V | $T_C$ = 125°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 ±10% | 20.(27.5) | | lbf · in. | Lubricated threads (non-lubricated threads). |
| | | 0.23(.32) | | kgf · m | |
| | | 2.3(3.1) | | N·m | |
| | to device | 25 | | lbf · in. | Lubricated threads. |
| | | 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

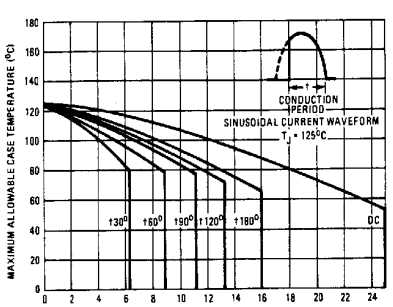



Fig. 1 – Maximum Allowable Case Temperature Vs. Average On-State Current, 2N681 Series

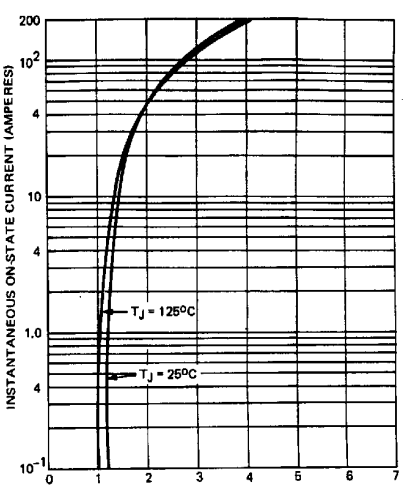



Fig. 2 – Maximum On-State Voltage Vs. Current, 2N681 Series

## 2N681 Series

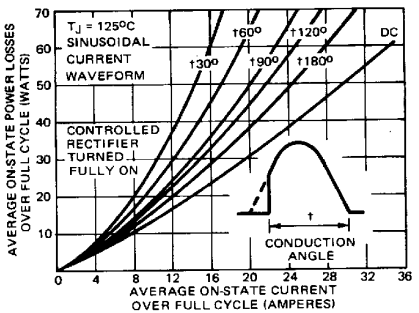



Fig. 3 – Maximum Low Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

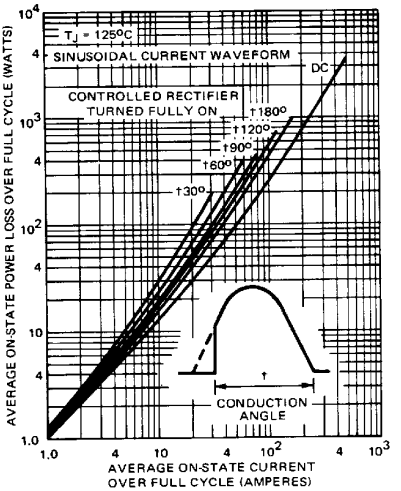



Fig. 4 – Maximum High Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

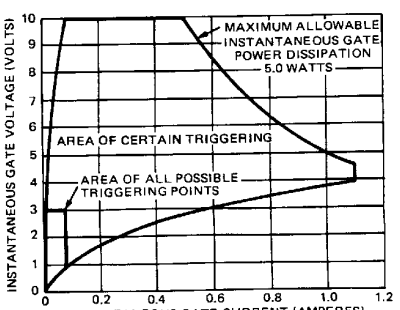



Fig. 5 – Gate Characteristics, 2N681 Series

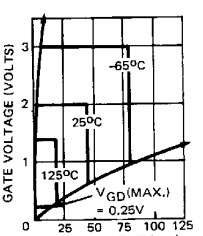



Fig. 5A – Area of All Possible Triggering Points Vs. Temperature 2N681 Series

## 2N681 Series

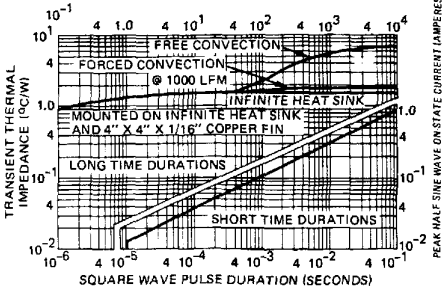



Fig. 6 – Maximum Transient Thermal Impedance, Junction to Case, Vs. Pulse Duration, 2N681 Series

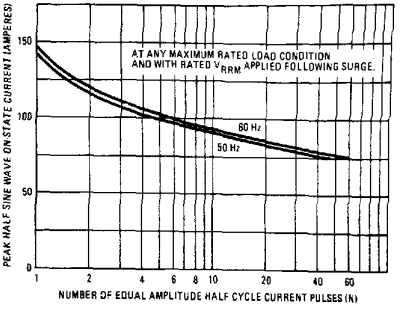



Fig. 7 – Maximum Non-Repetitive Surge Current, Vs. Number of Current Pulses, 2N681 Series

## 2N5204 Series

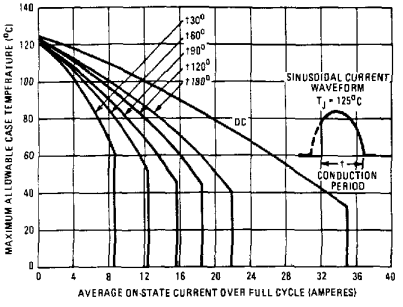



Fig. 8 – Maximum Allowable Case Temperature Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series

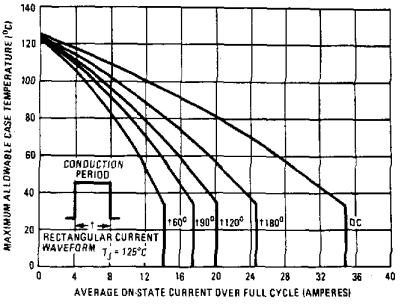



Fig. 9 – Maximum Allowable Case Temperature Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series

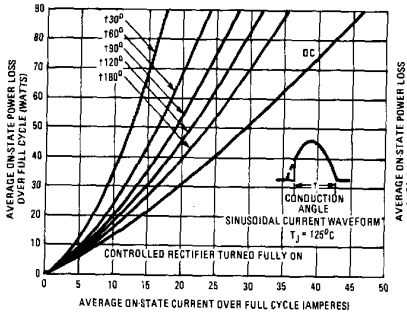



Fig. 10 – Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series

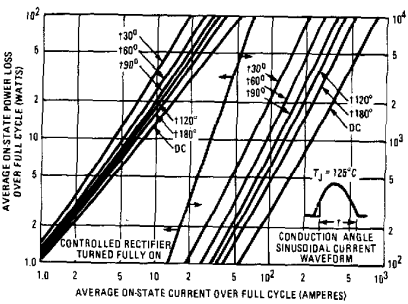



Fig. 11 – Maximum High-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series

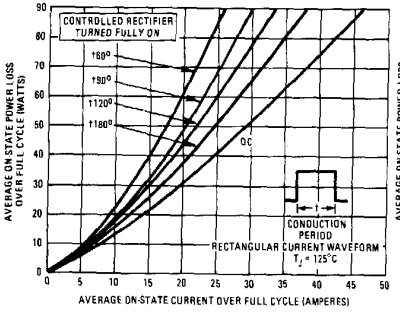



Fig. 12 – Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series

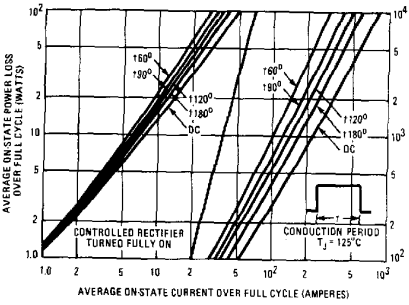



Fig. 13 – Maximum High-Level On-State Power Loss Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series

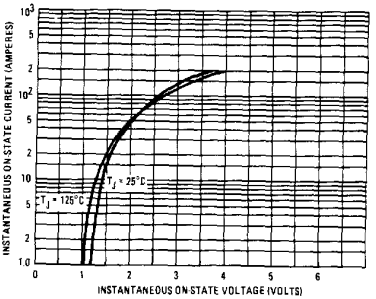



Fig. 14 – Maximum Instantaneous On-State Voltage Vs. Instantaneous On-State Current, 2N5204 Series

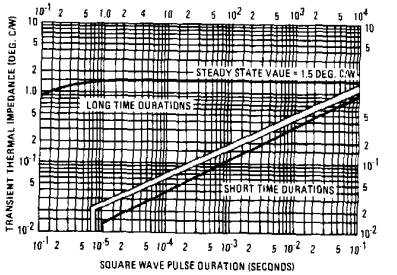



Fig. 15 – Maximum Transient Thermal Resistance, Junction to Case, Vs. Pulse Duration, 2N5204 Series