

INTERNATIONAL RECTIFIER



## 2N681 & 2N5204 SERIES

### 25 and 35 Amp RMS SCRs

#### Major Ratings and Characteristics

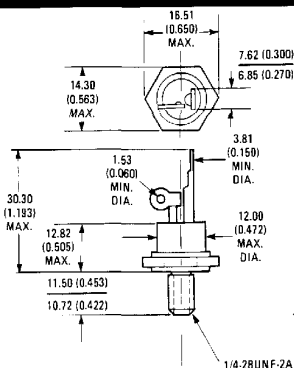
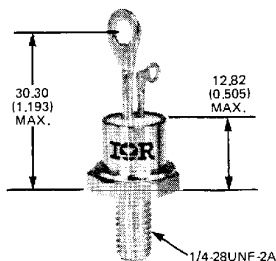
|                          | 2N681-92    | 2N5204-07   | Units            |
|--------------------------|-------------|-------------|------------------|
| $I_T(\text{RMS})$        | 25          | 35          | A                |
| $I_T(\text{AV})$         | 16*         | 22*         | A                |
| @ $T_C$                  | -65 to 65*  | -40 to 40   | °C               |
| $I_{TSM}$                |             |             |                  |
| @ 50 Hz                  | 145         | 285         | A                |
| @ 60 Hz                  | 150*        | 300*        |                  |
| $i_{2t}$                 |             |             | A <sup>2</sup> s |
| @ 50 Hz                  | 103         | 410         |                  |
| @ 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 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 Same conditions as above except with $V_{RRM}$ applied following surge = 0.           |
|                                                                               | 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                                                                                       |
| $I^2 t$ Max. $I^2 t$ 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                                                                                                                               |
| $I^2 t$ Max. $I^2 t$ 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 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 @ $25^{\circ}\text{C}$ † | 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†                        | 100*                         | V/ $\mu\text{s}$             | $T_J = 125^{\circ}\text{C}$ . Exponential to 100% rated $V_{DRM}$ Gate open circuited.                                                     |
|                                                                               | 250†                        | 250                          |                              | $T_J = 125^{\circ}\text{C}$ . Exponential to 67% rated $V_{DRM}$                                                                           |

\* JEDEC Registered value.

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

† Typical

**ELECTRICAL SPECIFICATIONS (Continued)**

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

## THERMAL-MECHANICAL SPECIFICATIONS

|                                                       |                                                    | 2N681-82         | 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<br>$\pm 10\%$<br><br>to device |                                                    | 20.(27.5)        |              | lbf · in. | Lubricated threads (non-lubricated threads). |
|                                                       |                                                    | 0.23(.32)        |              | kgf · m   |                                              |
|                                                       |                                                    | 2.3(3.1)         |              | N·m       |                                              |
|                                                       |                                                    | 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

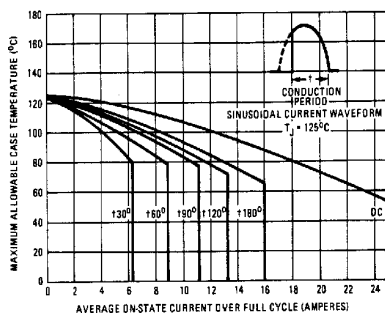


Fig. 1 — Maximum Allowable Case Temperature Vs. Average On-State Current, 2N681 Series

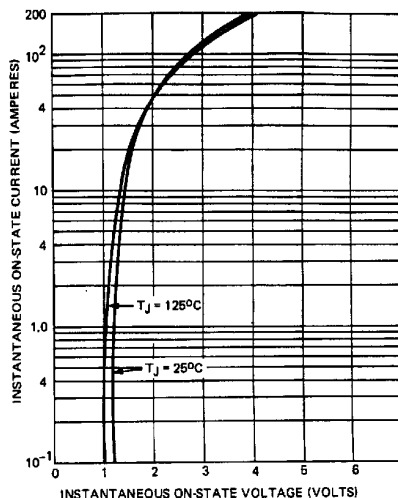


Fig. 2 — Maximum On-State Voltage Vs. Current, 2N681 Series

2N681 Series

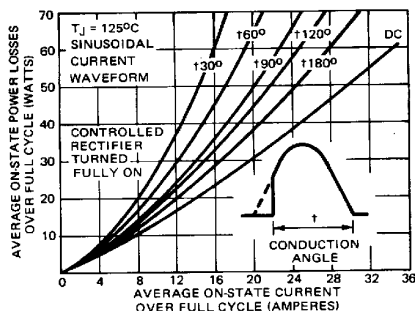


Fig. 3 - Maximum Low Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

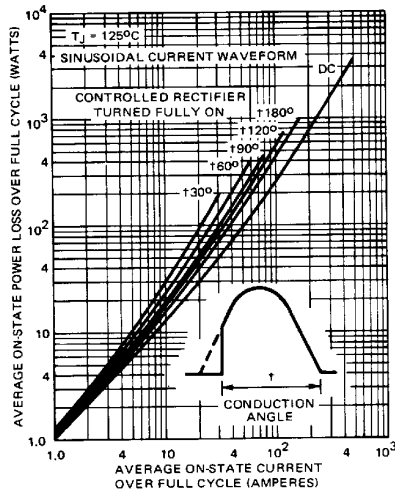


Fig. 4 - Maximum High Level On-State Power Loss Vs. Current (Sinusoidal Current Waveform), 2N681 Series

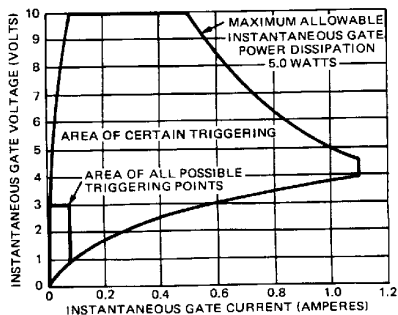


Fig. 5 - Gate Characteristics, 2N681 Series

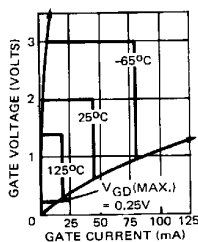


Fig. 5A - Area of All Possible Triggering Points Vs. Temperature 2N681 Series

## 2N681 Series

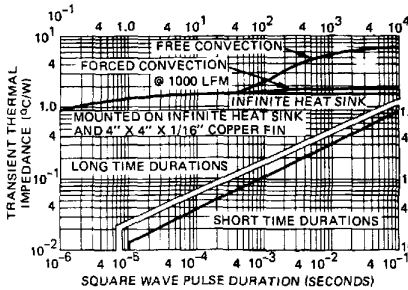


Fig. 6 - Maximum Transient Thermal Impedance, Junction to Case, Vs. Pulse Duration, 2N681 Series

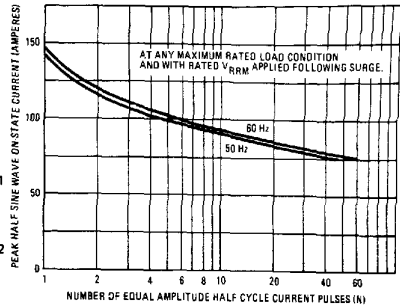


Fig. 7 - Maximum Non-Repetitive Surge Current, Vs. Number of Current Pulses, 2N681 Series

## 2N5204 Series

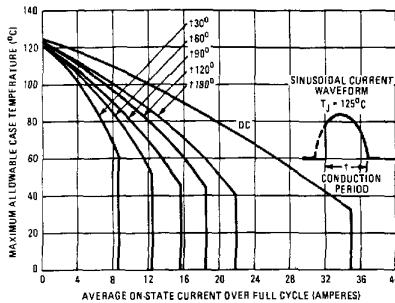


Fig. 8 - Maximum Allowable Case Temperature Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series

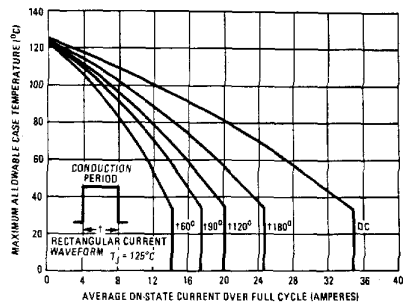
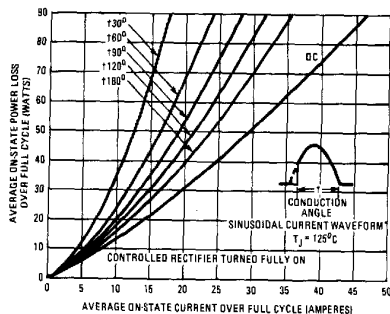
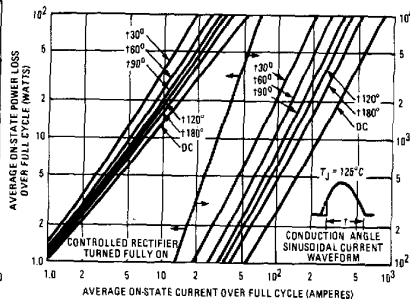


Fig. 9 - Maximum Allowable Case Temperature Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series

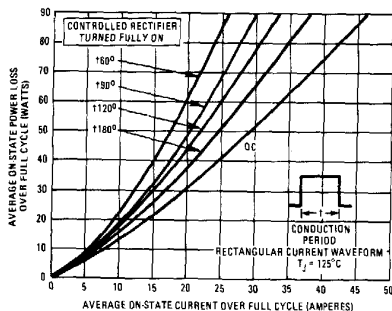
2N5204 Series



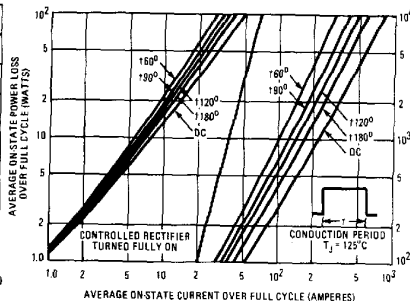
**Fig. 10 - Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series**



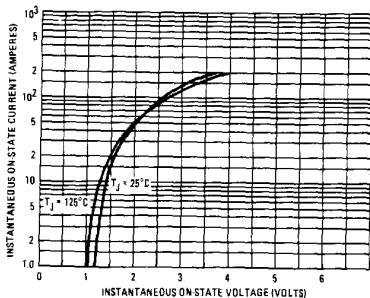
**Fig. 11 - Maximum High-Level On-State Power Loss Vs. Average On-State Current (Sinusoidal Current Waveform), 2N5204 Series**



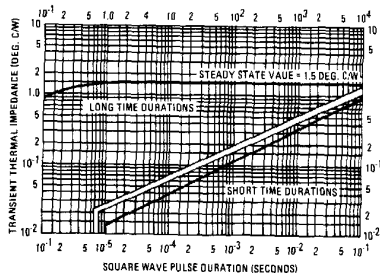
**Fig. 12 - Maximum Low-Level On-State Power Loss Vs. Average On-State Current (Rectangular Current Waveform), 2N5204 Series**



**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**