



# Thyristors

2N3650 2N3651  
2N3652 2N3653  
S7430M

RCA-2N3650 to 2N3653, inclusive, and the S7430M\* are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) intended for high-speed switching applications such as power inverters, switching regulators, and high-current pulse applications. They feature fast turn-off, high dv/dt, and high di/dt characteristics and may be used at frequencies up to 25 kHz.

The 2N3650 to 2N3653 have forward and reverse off-state voltage ratings of 100, 200, 300, and 400 volts, respectively. Type S7430M has a forward and reverse off-state voltage rating of 600 volts.

Formerly RCA Type No. 40735

### FEATURES

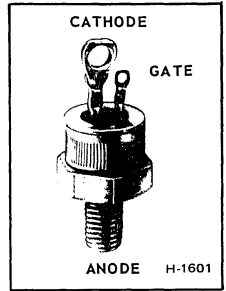
- o Fast turn-off time - 15  $\mu$ s max.
- o High di/dt and dv/dt capabilities
- o High peak-current capability
- o Shorted-emitter gate-cathode construction
- o Forward and reverse gate dissipation ratings
- o All-diffused construction - assures exceptional uniformity and stability of characteristics

### MAXIMUM RATINGS, Absolute-Maximum Values:

- \*NON-REPETITIVE PEAK REVERSE VOLTAGE  
Gate Open . . . . .
- NON-REPETITIVE PEAK FORWARD VOLTAGE  
Gate Open . . . . .
- \*REPETITIVE PEAK REVERSE VOLTAGE  
Gate Open . . . . .
- \*REPETITIVE PEAK OFF-STATE VOLTAGE  
Gate Open . . . . .
- \*PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:  
For one cycle of applied principal voltage (60 Hz, sinusoidal)  
ON-STATE CURRENT:  
For case temperature ( $T_C$ ) = 25  $^{\circ}$ C
- \* Average DC value, conduction angle of 180 $^{\circ}$  . . . . .
- RMS value . . . . .
- \*RATE-OF-CHANGE OF ON-STATE CURRENT:  
 $V_{DM} = v(BO)O$ ,  $I_{GT} = 200$  mA,  $t_r = 0.1$   $\mu$ s (See Fig. 2)
- FUSING CURRENT (for SCR protection):  
 $T_J = -65$  to 120 $^{\circ}$ C,  $t = 1$  to 8.3 ms . . . . .
- \*GATE POWER DISSIPATION  
PEAK FORWARD (for 10  $\mu$ s max.) . . . . .
- AVERAGE (averaging time = 10 ms, max.) . . . . .
- \*TEMPERATURE RANGE  
Storage . . . . .
- Operating (Case). . . . .
- Soldering (10 s max, for case) . . . . .
- STUD TORQUE:  
Recommended . . . . .
- Maximum (DO NOT EXCEED) . . . . .

## 35-A SILICON CONTROLLED RECTIFIERS

### Fast Turn-Off Types for Inverter and Pulse Applications



JEDEC TO-48

- o Symmetrical gate-cathode construction - provides uniform current density, rapid electrical conduction, and efficient heat dissipation
- o Hermetic construction
- o Low thermal resistance

|              | 2N3650         | 2N3651 | 2N3652 | 2N3653 | S7430M |              |
|--------------|----------------|--------|--------|--------|--------|--------------|
| $V_{RSOM}$   | 150            | 300    | 400    | 500    | 700    | V            |
| $V_{DSOM}$   | 150            | 300    | 400    | 500    | 700    | V            |
| $V_{RR0M}$   | 100            | 200    | 300    | 400    | 600    | V            |
| $V_{DR0M}$   | 100            | 200    | 300    | 400    | 600    | V            |
| $I_{TSM}$    | ← 180 →        |        |        |        |        | A            |
| $I_{T(AV)}$  | ← 25 →         |        |        |        |        | A            |
| $I_{T(RMS)}$ | ← 35 →         |        |        |        |        | A            |
| di/dt        | ← 400 →        |        |        |        |        | A/ $\mu$ s   |
| $I_2 t$      | ← 165 →        |        |        |        |        | A $^2$ s     |
| $P_{GM}$     | ← 40 →         |        |        |        |        | W            |
| $P_{G(AV)}$  | ← 1 →          |        |        |        |        | W            |
|              | ← -65 to 150 → |        |        |        |        | $^{\circ}$ C |
|              | ← -65 to 120 → |        |        |        |        | $^{\circ}$ C |
|              | ← 225 →        |        |        |        |        | $^{\circ}$ C |
| $\tau_s$     | ← 35 →         |        |        |        |        | in-lb        |
|              | ← 50 →         |        |        |        |        | in-lb        |

\*In accordance with JEDEC registration data format (JS-14, RDF1)-- applies to the JEDEC (2N-Series) types only.

**ELECTRICAL CHARACTERISTICS, At Maximum Ratings and at Indicated Case Temperature ( $T_C$ )  
Unless Otherwise Specified**

| CHARACTERISTIC  | SYMBOL         | LIMITS      |      |      |             |      |      |             |      |      |             |      |      |             |      |      | UNITS                     |
|---|----------------|-------------|------|------|-------------|------|------|-------------|------|------|-------------|------|------|-------------|------|------|---------------------------|
|   |                | Type 2N3650 |      |      | Type 2N3651 |      |      | Type 2N3652 |      |      | Type 2N3653 |      |      | Type S7430M |      |      |                           |
|   |                | MIN.        | TYP. | MAX. | MIN.        | TYP. | MAX. | MIN.        | TYP. | MAX. | MIN.        | TYP. | MAX. | MIN.        | TYP. | MAX. |                           |
| INSTANTANEOUS FORWARD BREAKOVER VOLTAGE:<br>Gate Open, $T_C = 120^\circ\text{C}$  | $V_{(BO)}$     | 100         | -    | -    | 200         | -    | -    | 300         | -    | -    | 400         | -    | -    | 600         | -    | -    | V                         |
| PEAK OFF-STATE CURRENT:<br>(Gate Open, $T_C = 120^\circ\text{C}$ )<br>FORWARD, $V_{DO} = V_{DROM}$  | $I_{DOM}$      | -           | -    | 6    | -           | -    | 6    | -           | -    | 5.5  | -           | -    | 4    | -           | -    | 3    | mA                        |
| REVERSE, $V_{RO} = V_{RROM}$  | $I_{RROM}$     | -           | -    | 6    | -           | -    | 6    | -           | -    | 5.5  | -           | -    | 4    | -           | -    | 3    |                           |
| INSTANTANEOUS ON-STATE VOLTAGE:<br>For $i_T = 25\text{ A}$ , $T_C = 25^\circ\text{C}$   | $V_T$          | -           | -    | 2.05 | -           | -    | 2.05 | -           | -    | 2.05 | -           | -    | 2.05 | -           | -    | 2.05 | V                         |
| DC GATE TRIGGER CURRENT:<br>$V_D = 6\text{ V (DC)}$ , $R_L = 4\ \Omega$ , $T_C = 25^\circ\text{C}$  | $I_{GT}$       | -           | 80   | 180  | -           | 80   | 180  | -           | 80   | 180  | -           | 80   | 180  | -           | 80   | 180  | mA                        |
| $V_D = 6\text{ V (DC)}$ , $R_L = 2\ \Omega$ , $T_C = -65^\circ\text{C}$   |                | -           | 150  | 500* | -           | 150  | 500* | -           | 150  | 500* | -           | 150  | 500* | -           | 150  | 500  |                           |
| DC GATE TRIGGER VOLTAGE:<br>$V_D = 6\text{ V (DC)}$ , $R_L = 4\ \Omega$ , $T_C = 25^\circ\text{C}$  | $V_{GT}$       | -           | 1.5  | 3    | -           | 1.5  | 3    | -           | 1.5  | 3    | -           | 1.5  | 3    | -           | 1.5  | 3    | V                         |
| $V_D = V_{DROM}$ , $R_L = 200\ \Omega$ , $T_C = 120^\circ\text{C}$  |                | 0.25*       | -    | -    | 0.25*       | -    | -    | 0.25*       | -    | -    | 0.25*       | -    | -    | 0.25        | -    | -    |                           |
| $V_D = 6\text{ V (DC)}$ , $R_L = 2\ \Omega$ , $T_C = -65^\circ\text{C}$   |                | -           | 2    | 4.5* | -           | 2    | 4.5* | -           | 2    | 4.5* | -           | 2    | 4.5* | -           | 2    | 4.5  |                           |
| INSTANTANEOUS HOLDING CURRENT:<br>Gate Open<br>At $T_C = 25^\circ\text{C}$<br>At $T_C = -65^\circ\text{C}$  | $I_{HO}$       | -           | 75   | 150  | -           | 75   | 150  | -           | 75   | 150  | -           | 75   | 150  | -           | 75   | 150  | mA                        |
|   |                | -           | 150  | 350  | -           | 150  | 350  | -           | 150  | 350  | -           | 150  | 350  | -           | 150  | 350  |                           |
| CRITICAL RATE-OF-RISE OF OFF-STATE VOLTAGE:<br>$V_{DO} = V_{DROM}$<br>Exponential rise, $T_C = 120^\circ\text{C}$ ,<br>(See Fig. 4.)  | $dv/dt$        | 200         | -    | -    | 200         | -    | -    | 200         | -    | -    | 200         | -    | -    | 200         | -    | -    | V/ $\mu\text{s}$          |
| CIRCUIT COMMUTATED TURN-OFF TIME (Rectangular Pulse):<br>$V_{DX} = V_{DROM}$ , $i_T = 10\text{ A}$ (pulse duration = $50\ \mu\text{s}$ ), $I_{GT} = 200\text{ mA}$<br>at turn-on, $-di/dt = 5\text{ A}/\mu\text{s}$ ,<br>$dv/dt = 200\text{ V}/\mu\text{s}$ , $V_{RX} = 15\text{ min.}$ ,<br>$V_{GK} = 0\text{ V}$ (at turn-off),<br>$T_C = 120^\circ\text{C}$ (See Fig. 4 & 5) | $t_q$          | -           | 11   | 15   | -           | 11   | 15   | -           | 11   | 15   | -           | 11   | 15   | -           | 11   | 15   | $\mu\text{s}$             |
| CIRCUIT COMMUTATED TURN-OFF TIME (Half-Sinusoidal Waveform):<br>$V_{DX} = V_{DROM}$ , $i_T = 100\text{ A}$ (pulse duration = $2\ \mu\text{s}$ ), $I_{GT} = 200\text{ mA}$<br>$dv/dt = 200\text{ V}/\mu\text{s}$ , $V_{RX} = 30\text{ V min.}$ ,<br>$V_{GK} = 0\text{ V}$ (at turn-off),<br>$T_C = 115^\circ\text{C}$ (See Fig. 6 & 7)   | $t_q$          | -           | 12   | 15*  | -           | 12   | 15*  | -           | 12   | 15*  | -           | 12   | 15*  | -           | 12   | 15   | $\mu\text{s}$             |
| THERMAL RESISTANCE:<br>Junction-to-Case   | $\theta_{J-C}$ | -           | -    | 1.7  | -           | -    | 1.7  | -           | -    | 1.7  | -           | -    | 1.7  | -           | -    | 1.7  | $^\circ\text{C}/\text{W}$ |

\*In accordance with JEDEC registration data format (JS-14, RD 1) -- applies to the JEDEC (2N-Series) types only.

**TERMINAL CONNECTIONS**

Terminal 1 (Small Lug) – Gate  
Terminal 2 (Large Lug) – Cathode  
Terminal 3 (Stud) – Anode

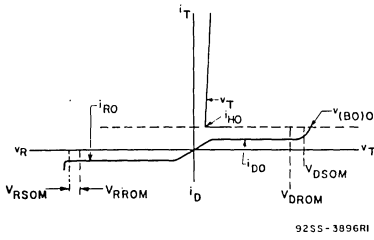


Fig. 1—Principal voltage-current characteristic.

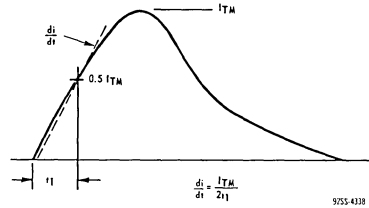


Fig. 2—Rate of change of on-state current with time (defining  $di/dt$ ).

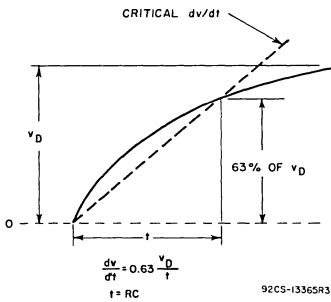


Fig. 3—Rate of rise of off-state voltage with time (defining  $dv/dt$ ).

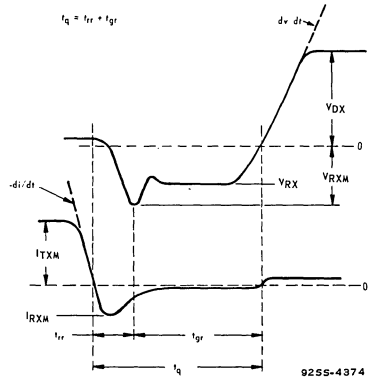


Fig. 4—Relationship between off-state voltage, reverse voltage, on-state current, and reverse current, showing reference points defining turn-off time ( $t_g$ ), rectangular pulse.

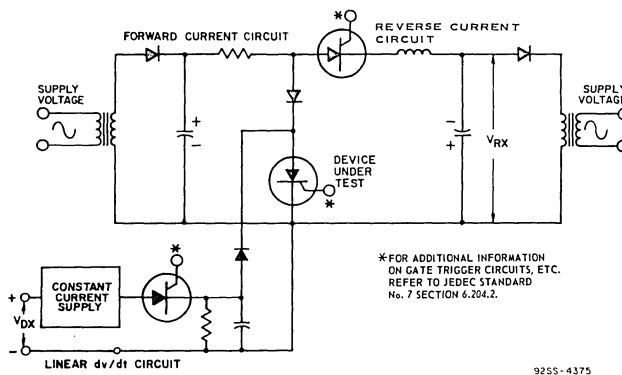
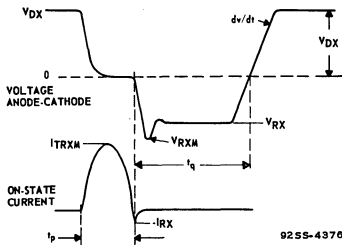
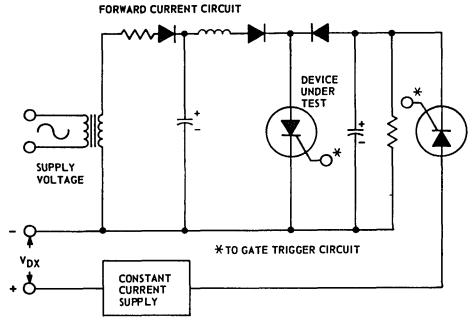


Fig. 5—Circuit used to measure turn-off time ( $t_g$ ), rectangular pulse.



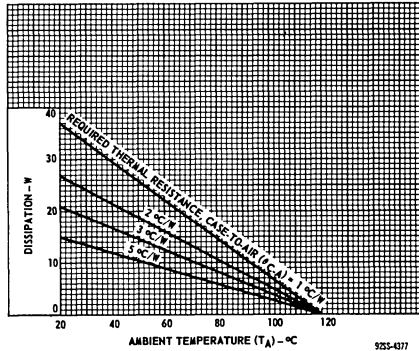
9255-4376

Fig. 6—Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points for specification of turn-off time ( $t_q$ ), half sine wave pulse.



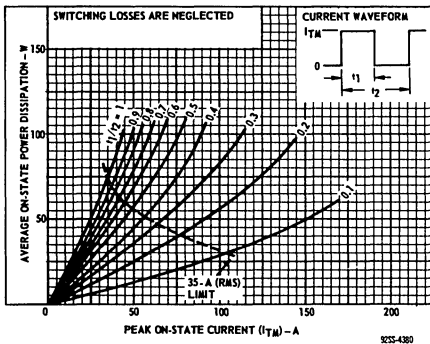
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Fig. 7—Circuit used to measure turn-off time ( $t_q$ ), half sine wave pulse.



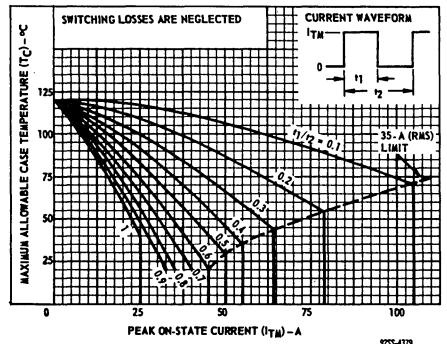
9255-4317

Fig. 8—Heat sink guidance.



9255-4360

Fig. 9—Power dissipation vs. on-state current.



9255-4379

Fig. 10—Maximum allowable case-temperature vs. on-state current.

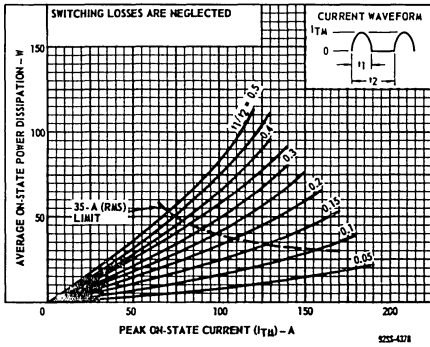


Fig. 11—Power dissipation vs. on-state current.

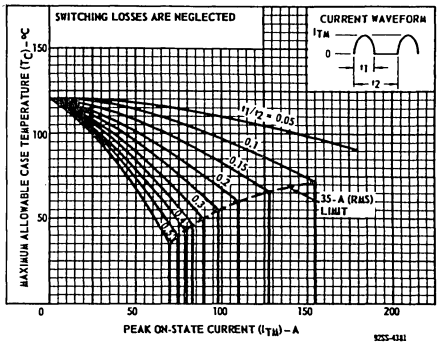


Fig. 12—Maximum allowable case-temperature vs. on-state current.

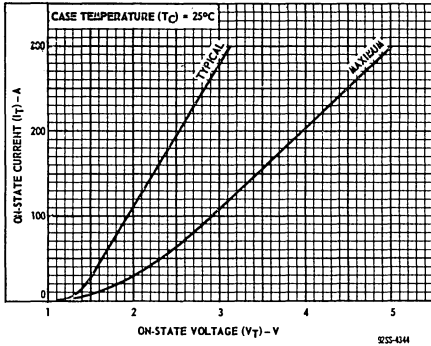


Fig. 13—Variation of on-state current with on-state voltage.

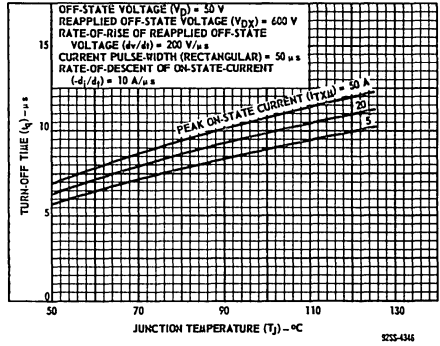


Fig. 14—Typical variation of turn-off time with junction temperature (rectangular pulse).

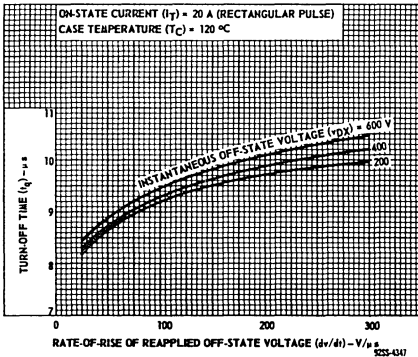


Fig. 15—Typical variation of turn-off time with rate of rise of reapplied off-state voltage (rectangular pulse).

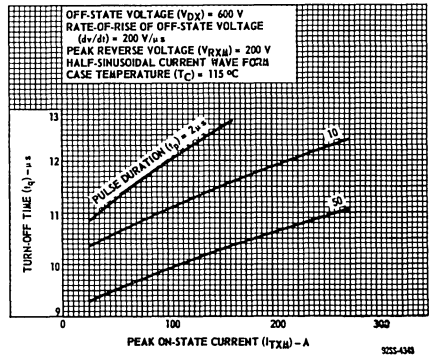


Fig. 16—Typical variation of turn-off time with peak on-state current (half-sinusoidal pulse).

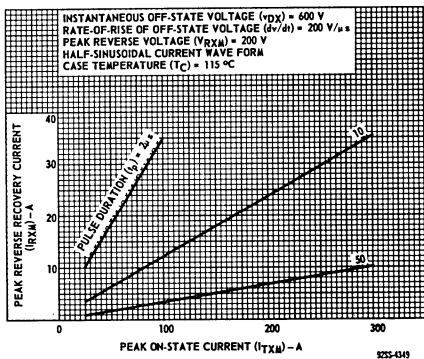


Fig. 17—Typical variation of peak reverse recovery current with peak on-state current (half) sinusoidal pulse.

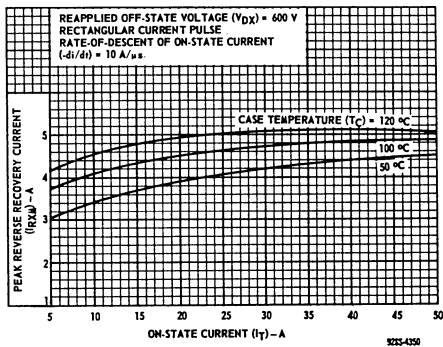


Fig. 18—Typical variation of peak reverse-recovery current with on-state current.

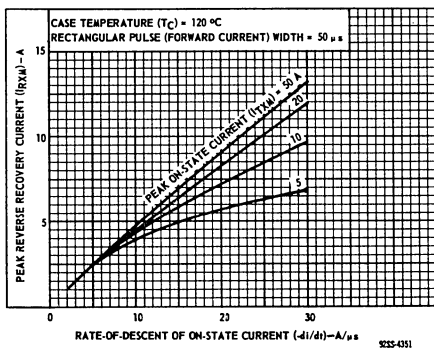


Fig. 19—Typical variation of peak reverse recovery current with rate of descent of on-state current.

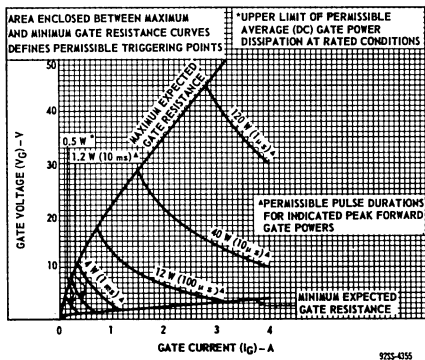


Fig. 20—Typical forward-biased gate characteristics.

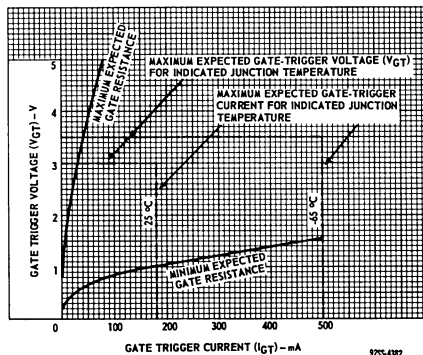


Fig. 21—Typical gate trigger characteristics.