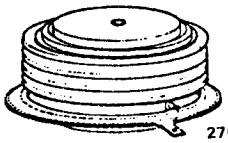
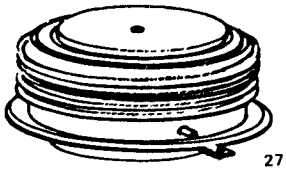


276

# INVERTER SCR's
## 700 TO 1500 AMPERES



276.1

| GE TYPE | | C648 | C612 | C613 | C712 |
|---|---|---|---|---|---|
| CONSTRUCTION | | AMPLIFYING GATE | AMPLIFYING GATE | AMPLIFYING GATE | AMPLIFYING GATE |
| **ELECTRICAL SPECIFICATIONS** | | | | | |
| VOLTAGE RANGE | | 500-1200 | 1500-1800 | 1500-2000 | 1500-2000 |
| **FORWARD CONDUCTION** | | | | | |
| $I_{T(RMS)}$ | Max. forward conduction sinusoidal @ $T_C$ = 65°C, 50% duty (A) | | | | |
| | @ 60 Hz | 1150 | 700 | 800 | 1500 |
| | @ 600 Hz | 1150 | 700 | 800 | 1500 |
| | @ 1200 Hz | 1150 | – | 800 | 1500 |
| | @ 2500 Hz | 1100 | – | 750 | 1500 |
| | @ 5000 Hz | 1100 | – | 675 | 1100 |
| $I_{TSM}$ | Max. peak one cycle, non-repetitive surge current (A) | 10,000 | 6500 | 6500 | 20,000 |
| $I^2t$ | Max. $I^2t$ for fusing for 5 to 8.3 msec ($A^2$ sec) | 415,000 | 150,000 | 80,000 | 1,660,000 |
| $R_{\theta JC}$ | Max. thermal impedance (°C/W) | .04 | .04 | .04 | .023 |
| $t_d + t_r$ | Typical turn-on time (μsec) | 2.5 | 2.0 | – | – |
| $t_q$ | Turn-off time @ rated voltage and $T_J$ $V_R$ = 50V min. (μsec) @ 20V/μsec | – | – | – | – |
| | @ 200V/μsec reapplied | – | – | 40 | 50 |
| | @ 400V/μsec reapplied | 40 | 60 | 40 | – |
| di/dt | Critical rate-of-rise of on-state current (A/μsec) | 800 | 500 | 500 | 800 |
| $T_J$ | Junction operating temperature range (°C) | −40 to 125°C | −40 to 125°C | −40 to 125°C | −40 to 125°C |
| **BLOCKING** | | | | | |
| dv/dt | Min. critical rate-of-rise of off-state voltage exponential to rated $V_{DRM}$ @ Max. $T_J$ (V/μsec) | 400 | 200 | 400 | 500 |
| **FIRING** | | | | | |
| $I_{GT}$ | Max. required gate current to trigger (mA) @ −40°C | 350 | 200 Typ | 200 | 200 |
| | @ 125°C | 100 | 125 Typ | 30 | 30 |
| $V_{GT}$ | Max. required voltage to trigger (V) @ −40°C | 5 | 5 | 5 | 5 |
| | @ 125°C | 3 | 3 | 3 | 3 |
| **VOLTAGE TYPES** | | | | | |
| Repetitive Peak Forward and Reverse Voltages | | | | | |
| | 100 | – | – | – | – |
| | 200 | – | – | – | – |
| | 300 | – | – | – | – |
| | 400 | – | – | – | – |
| | 500 | C648E | – | – | – |
| | 600 | C648M | – | – | – |
| | 700 | C648S | – | – | – |
| | 800 | C648N | – | – | – |
| | 900 | C648T | – | – | – |
| | 1000 | C648P | – | – | – |
| | 1100 | C648PA | – | – | – |
| | 1200 | C648PB | – | – | – |
| | 1300 | – | – | – | – |
| | 1400 | – | – | – | – |
| | 1500 | – | C612PE | C613PE | C712PE |
| | 1600 | – | C612PM | C613PM | C712PM |
| | 1700 | – | C612PS | C613PS | C712PS |
| | 1800 | – | C612PN | C613PN | C712PN |
| | 1900 | – | – | C613PT | C712PT |
| | 2000 | – | – | C613L | C712L |
| PACKAGE TYPE | | 1" PRESS PAK | 1" PRESS PAK | 1" PRESS PAK | 1" PRESS PAK |
| PACKAGE OUTLINE NO. | | 276 | 276 | 276 | 276.1 |

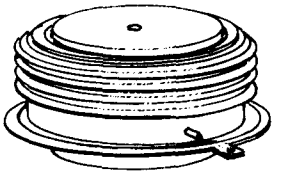
# High Speed Silicon Controlled Rectifier

**1000 A Avg. Up to 2000 Volts**

**C712**

AMPLIFYING GATE

The General Electric device type C712 is a new pressure-mounted, high current SCR designed for power switching at high voltage and high frequencies (up to 5 KHz). The C712 gate structure has an involute, interdigitated pattern to optimize the turn-on area for high di/dt capability and it is processed using a newly developed multi-diffusion technology.



**FEATURES:**

- Off-State and Reverse Blocking Capabilities to 2000 Volts.
- Very Low Switching Losses at High Frequencies.
- 60 μsec Maximum Turn-Off Time at Severe Operating Conditions with **Feedback** diode.
- Involute, Interdigitated Gate for High di/dt Capability.
- Narrow Pulse Capability for PWM Inverter Commutating SCR Socket.
- 1″ Creepage-Path, Glazed-Ceramic Package.

**IMPORTANT:** Mounting instructions on the last page of C702 specification **must** be followed.

## MAXIMUM ALLOWABLE RATINGS

| TYPE | $V_{DRM}/V_{RRM}$[1] REPETITIVE $T_J$ = -40°C to +125°C | $V_{DRM}/V_{RRM}$[1] REPETITIVE $T_J$ = 0°C to +125°C | TRANSIENT PEAK REVERSE VOLTAGE, $V_{RSM}$[1] $T_J$ = -40°C to +125°C |
|---|---|---|---|
| C712L | 2000 Volts | 2100 Volts | 2100 Volts |
| C712PT | 1900 | 2000 | 2000 |
| C712PN | 1800 | 1900 | 1900 |
| C712PS | 1700 | 1800 | 1800 |
| C712PM | 1600 | 1700 | 1700 |
| C712PE | 1500 | 1600 | 1600 |

*Consult factory for lower rated voltage devices.*

Peak One-Cycle Surge On-State Current, $I_{TSM}$ (8.3 msec) ..... 20,000 Amperes
Maximum Rate-of-Rise of Anode Current Turn-On Interval (Switching From 1200 Volts) ..... 800 A/μsec
Repetitive di/dt Rating[2] ..... 200 A/μsec
$I^2t$ (for fusing) (at 8.3 milliseconds) ..... 1,660,000 Ampere$^2$ Seconds
Peak Gate Power Dissipation, $P_{GM}$ ..... 100 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ ..... 5 Watts
Peak Reverse Gate Voltage, $V_{GRM}$ ..... 20 Volts
Storage and Operating Temperature, $T_{STG}$ and $T_J$ ..... -40°C to +125°C
Mounting Force Required ..... 5000 Lb. + 1000 – 0 Lb.
22.2 KN + 4.4 – 0 KN

**NOTES:**

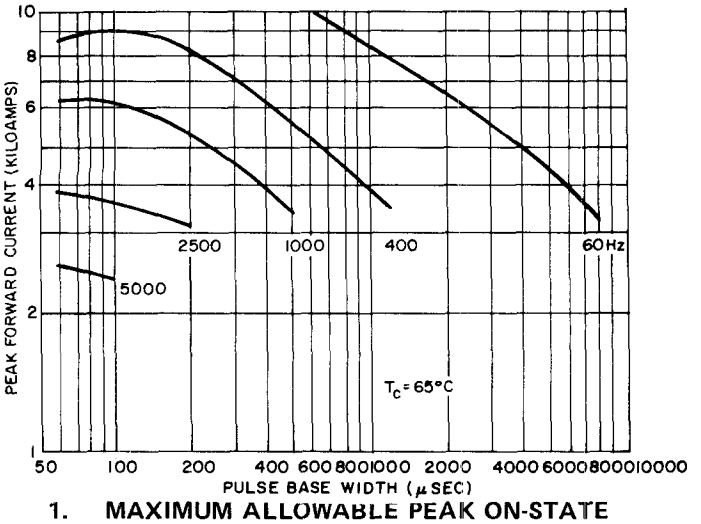
[1] 10 msec voltage sinewave.

[2] di/dt rating established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2. This di/dt is in addition to the discharge of a 0.25 μf, 20 ohm snubber circuit in parallel with the DUT.

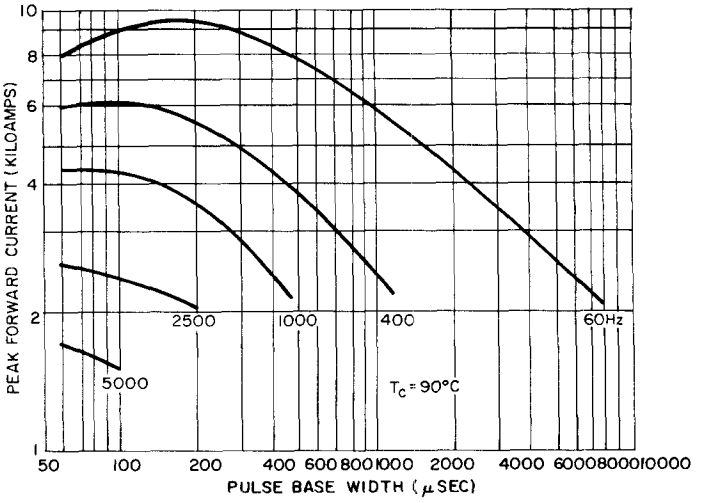
## CHARACTERISTICS

**C712**

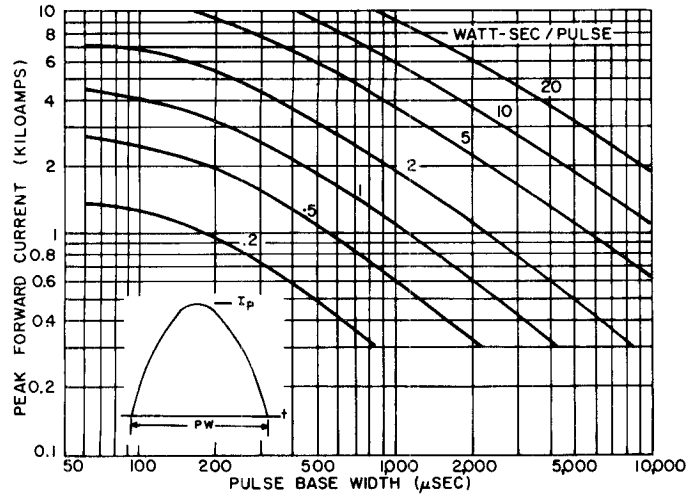
| TEST | SYMBOL | MIN. | TYP. | MAX. | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|
| Peak Reverse and On-State Blocking Current | $I_{DRM}$ and $I_{RRM}$ | – | 20 | 60 | mA | $T_J$ = +125°C, V = $V_{DRM}$ = $V_{RRM}$ |
| Effective Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | – | – | .023 | °C/Watt | Double-Side Cooled (DC) |
| Critical Linear Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching) | dv/dt | 500 | – | – | V/μsec | $T_J$ = +125°C, $V_{DRM}$ = .80 Rated $V_{RRM}$ Gate Open. |
| Delay Time | $t_d$ | – | 1.5 | – | μsec | Switching from 140 Volts, 20 Volt, 10 Ohm Gate 0.5 μsec Rise Time, $T_J$ = 25°C |
| Gate Pulse Width Necessary To Trigger | | – | – | 10 | μsec | $T_J$ = 25°C |
| Gate Trigger Current | $I_{GT}$ | – | 120 | – | mAdc | $T_C$ = 25°C, $V_D$ = 10 Vdc, $R_L$ = 3 Ohms |
| | | 5.0 | 30 | – | | $T_C$ = +125°C, $V_D$ = .5 x Rated, $R_L$ = 1000 Ohms |
| Gate Trigger Voltage | $V_{GT}$ | – | 3.0 | – | Vdc | $T_C$ = 0°C to +125°C, $V_D$ = 10 Vdc, $R_L$ = 3 Ohms |
| Peak On-State Voltage | $V_{TM}$ | – | – | 1.45 | Volts | $T_C$ = +125°C, $I_T$ = 1000 Amps. Peak Duty Cycle ≤ 0.01% |
| Conventional Circuit Commutated Turn-Off Time (With Reverse Voltage) | $t_q$ | – | – | 50 | μsec | (1) $T_C$ = +125°C<br>(2) $I_T$ = 500 Amps.<br>(3) $V_R$ ≥ 50 Volts<br>(4) 80% $V_{DRM}$ Reapplied<br>(5) Rate-of-Rise of Forward Blocking Voltage = 200 V/μsec<br>(6) Gate Bias = Open During Turn-Off Interval = 0 Volts, 100 Ohms<br>(7) Duty Cycle ≤ 0.01% |
| Conventional Circuit Commutated Turn-Off Time (With Feedback Diode) | $t_q$ | – | 55 | 60 | μsec | (1) $T_C$ = +125°C<br>(2) $I_T$ = 500 Amps.<br>(3) $V_R$ = 2 Volts Min.<br>(4) 80% $V_{DRM}$ Reapplied<br>(5) Rate-of-Rise of Forward Blocking Voltage = 200V/μsec.<br>(6) Gate Bias = Open During Turn-Off Interval<br>(7) Duty Cycle ≤ 0.01% |




1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH AT $T_C$ = 65°C




2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH AT $T_C$ = 90°C




**NOTES:**

1. —— Switching capability and losses with bypass diode.
2. Switching voltage from 15 Volts to 0.8 $V_{DRM}$.
3. Snubber discharge < 50 Amps. RC time constant < 10 μsec.
4. High gate drive, 20V/10 Ohms, 0.5 μsec rise time.

**3. ENERGY PER PULSE FOR SINUSOIDAL PULSES**

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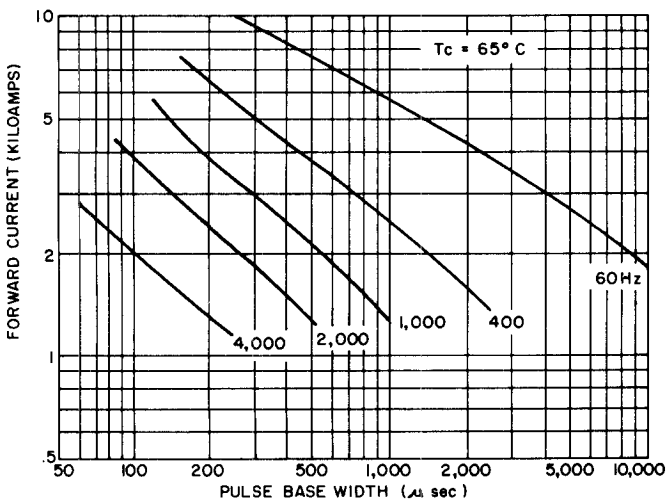
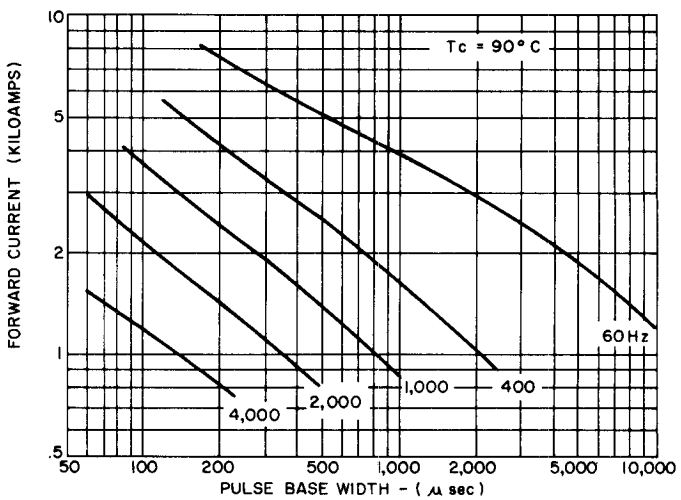
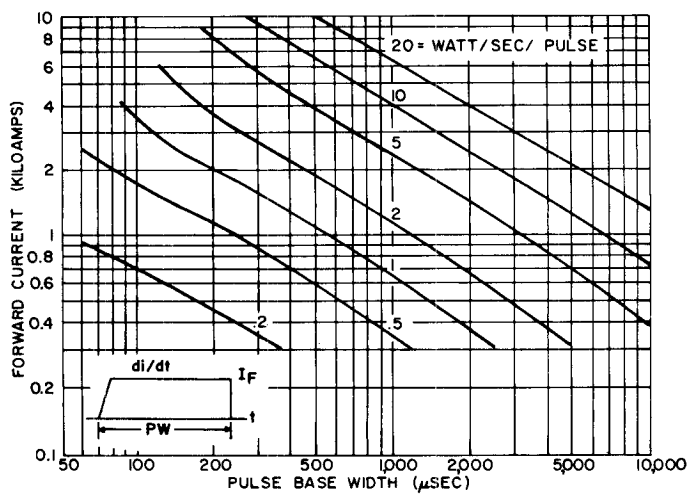



**4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR TRAPEZOIDAL CURRENT WAVEFORMS FOR $T_C$ = 65°C**



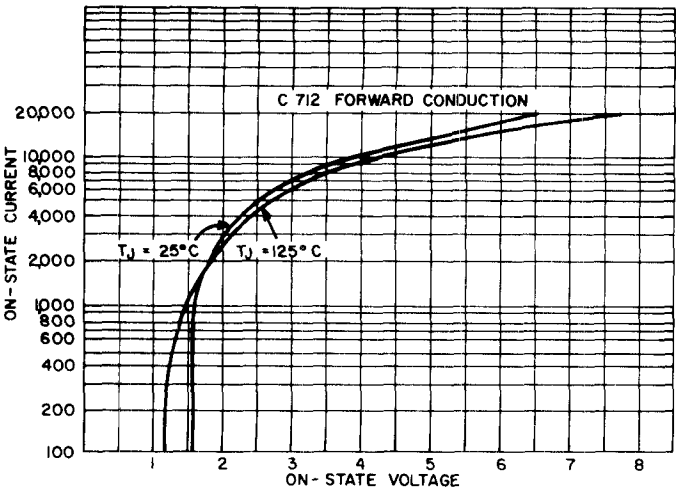

**5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR TRAPEZOIDAL CURRENT WAVEFORMS FOR $T_C$ = 90°C**



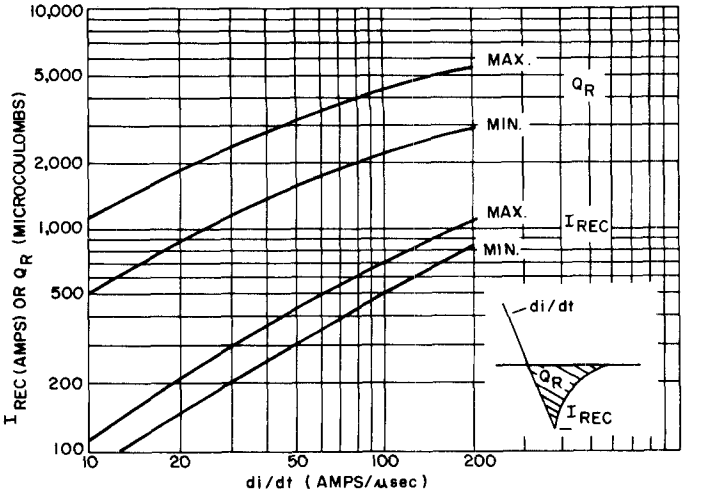

**NOTES:**

1. Switching voltage from 15 Volts to 0.8 $V_{DRM}$.
2. DI/DT during turn-on: 100A/μsec.
3. Reverse voltage < 50 Volts. If no bypass diode is used, recovery switching losses must be added.
4. RC snubber time constant < 10 μsec.
5. High gate drive: 20V/10 Ohms, 0.5 μsec rise time.

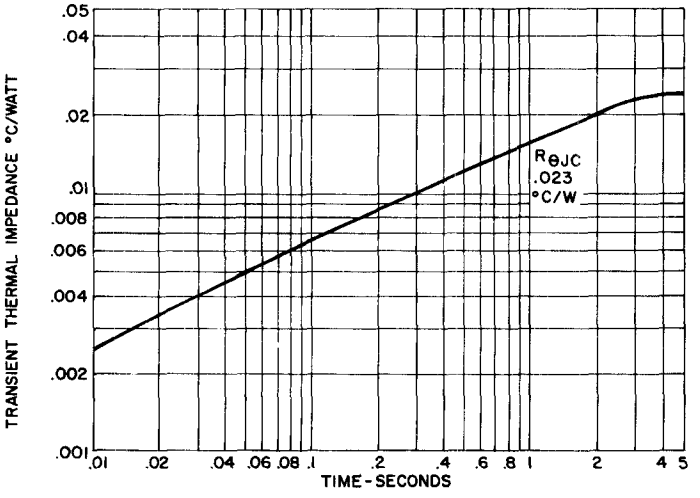
**6. ENERGY PER PULSE FOR TRAPEZOIDAL CURRENT WAVEFORMS**




7. FORWARD CONDUCTION CHARACTERISTIC ON-STATE



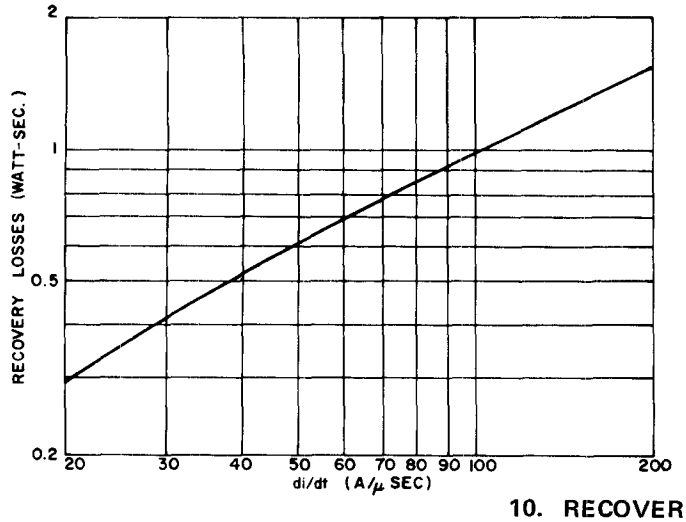

8. RECOVERED CHARGE (125°C)




**NOTES:**

1. Add .006°C/W to account for both case to dissipator interfaces when properly mounted; e.g., $R\theta_{JS}$ = .029° C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications:
   - end of conducting portion of cycle
     - 120° sq. wave add .0025°C/W along entire curve
     - 180° sq. wave add .0018°C/W along entire curve
     - 180° sine wave add .0010°C/W along entire curve
   - end of full cycle
     - any wave, subtract .001°C/W along entire curve

9. TRANSIENT THERMAL RESISTANCE – JUNCTION-TO-CASE




**NOTES:**

If no bypass diode is used with this thyristor, the switching losses during recovery can be significant. The actual magnitude of these losses will vary widely depending on circuit conditions and snubber design.

This curve represents typical recovery losses versus circuit di/dt. Since this curve is typical, it serves primarily to alert the equipment designer to the possible need for special design attention. The switching losses in a given circuit may be calculated with the following equation:

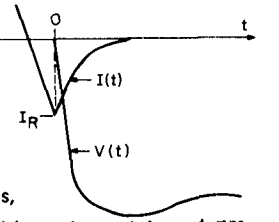
$$SLR = \int_o \bar{I}(t) .V/t) \ dt$$

Where SLR is the recovery switching losses; I (t) is the recovery current decay; V(t) is the recovery voltage; and t = o occurs at the peak of the recovery current. I (t) may be expressed as an exponential decay:

$$I(t) = I_{Re} - (t/T)$$

Where $I_R$ is the peak recovery current and T = 2.5μsec. The junction temperature rise due to the recovery losses may be computed as follows:

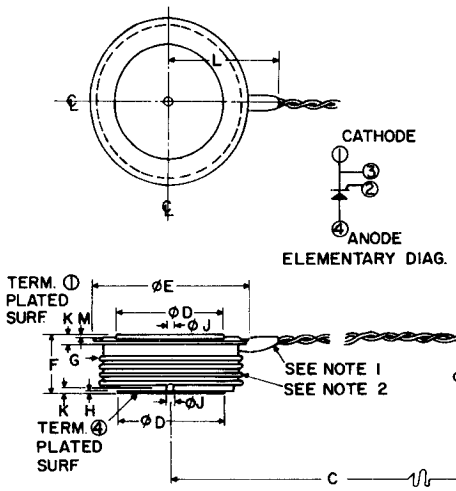
$$\Delta T_j = F * \sigma_{\mathcal{N}} * R\theta_{JA} + \alpha_{\mathcal{N}} * 3.5$$




Where $\sigma_{\mathcal{N}}$ is the recovery losses, $R\theta_{JA}$ is the DC junction to ambient thermal impedance, and F is the operating frequency.

10. RECOVERY CURRENT SWITCHING LOSSES

# OUTLINE DRAWING




| SYMBOL | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | NOTES |
|---|---|---|---|---|---|
| A | 0.200 | 0.240 | 5.08 | 6.10 | 1 |
| ΦB | 0.140 | | 3.56 | | |
| C | 16.000 | 20.000 | 406.40 | 508.00 | |
| ΦD | 1.700 | 1.900 | 43.18 | 48.26 | |
| ΦE | | 2.960 | | 75.18 | |
| F | 1.000 | 1.070 | 25.40 | 27.18 | |
| G | | | | | 2. |
| H | .005 | .067 | 0.13 | 1.70 | |
| ΦJ | 0.136 | 0.146 | 3.45 | 3.71 | |
| K | .070 | | 1.78 | | |
| L | | 2.500 | | 63.50 | |
| M | .030 | | 0.76 | | |