HIGH SPEED

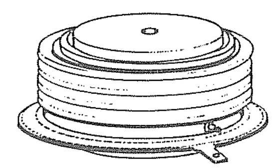
Silicon Controlled Rectifier

600 Volts (500-700) Amps RMS

C392/C393
C394/C395

AMPLIFYING GATE

The General Electric C392, C393, C394 and C395 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven amplifying gate.

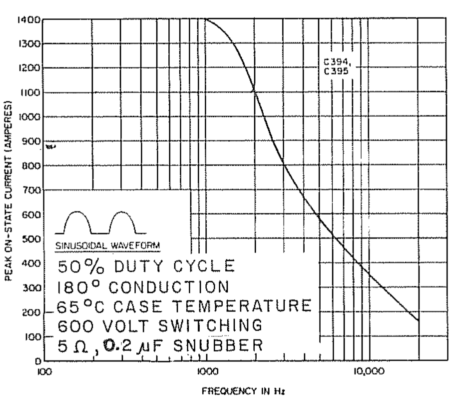


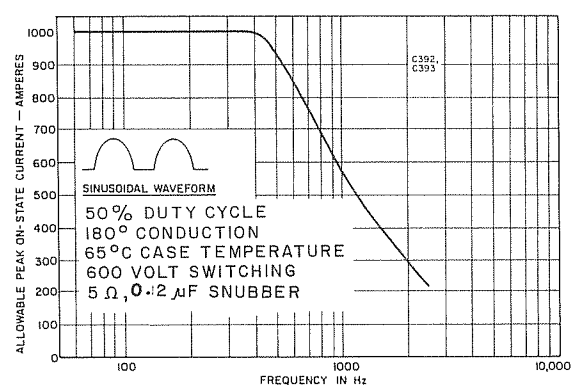
FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Rugged hermetic glazed ceramic package having 1″ creepage path.

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

HIGH FREQUENCY CURRENT RATINGS





Equipment designers can use the C392, C393, C394, C3 5 SCR's in demanding applications, such as:

- Choppers
- Inverters
- Regulated Power Supplies
- Cycloconverters
- DC to DC Converters
- High Frequency Lighting

FOR SINEWAVE OPERATION

Like the Type C140/141, C158/159 and C358 SCR's, the C392, C393, C394, C395 SCR's are rated for:

- Peak Current

  vs.
- Pulse Width
- Frequency
- Case Temperature

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C392, C393, C394, C395 SCR's, which are:

- Peak Current

  vs.
- di/dt of Leading Edge
- Frequency
- Duty Cycle
- Case Temperature

MAXIMUM ALLOWABLE RATINGS

TYPES	Repetitive Peak Off-State Voltage, V_{DRM} ①	Repetitive Peak Reverse Voltage, V_{RRM} ①	Non-repetitive Peak Reverse Voltage, V_{RSM} ①
	T_J = -40°C to +125°C	T_J = -40°C to +125°C	T_J = 125°C
C392, C393, C394, C395A	100 Volts	100 Volts	150 Volts
C392, C393, C394, C395B	200	200	300
C392, C393, C394, C395C	300	300	400
C392, C393, C394, C395D	400	400	500
C392, C393, C394, C395E	500	500	600
C392, C393, C394, C395M	600	600	720

① Half sinewave waveform, 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) – C392, C393 .... 5500 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) – C394, C395 .... 8000 Amperes
I^2t (for fusing) for times ≥ 1.5 milliseconds – C392, C393 .... 50,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ≥ 1.5 milliseconds – C394, C395 .... 100,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ≥ 8.3 milliseconds – C392, C393 .... 120,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ≥ 8.3 milliseconds – C394, C395 .... 250,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive .... 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive.. 500 A/μs †
Average Gate Oower Dissipation, $P_{G(AV)}$ .... 2 Watts
Storage Temperature, T_{stg} .... -40°C to +150°C
Operating Temperature, T_J .... -40°C to +125°C
Mounting Force Required .... 2000 Lb. ± 10%
8.9 KN ± 10%

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short trigger current rise time.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	15	mA	T_J = +25°C $V = V_{DRM} = V_{RRM}$
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_J = 125°C $V = V_{DRM} = V_{RRM}$
Thermal Resistance	$R_{\theta JC}$	–	.05	.06	°C/Watt	Junction-to-Case (Double-Side Cooled
Critical Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	40	1000	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Initial On-State Current = 10 Amps.
DC Gate Trigger Current	I_{GT}	–	70	200	mAdc	T_C = +25°C, V_D = 10 Vdc, R_L = 1 Ohm
		–	100	400		T_C = -40°C, V_D = 10 Vdc, R_L = 1 Ohm
		–	25	150		T_C = +125°C, V_D = 10 Vdc, R_L = 1 Ohm

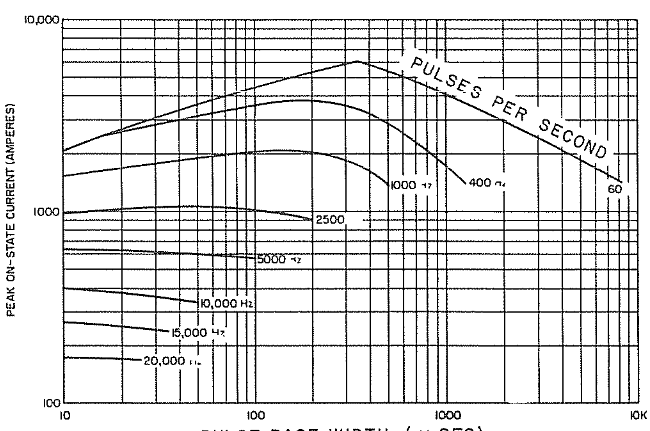
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 25°C, V_D = 10 Vdc, R_L = 1 Ohm
		–	1.50	3.0		T_C = 25°C to +125°C, V_D = 10 Vdc, R_L = 1 Ohm
		0.15	–	–		T_C = +125°C, V_{DRM}, R_L = 500 Ohms
Peak On-State Voltage C392, C393 C394, C395	V_{TM}	 – –	 3.3 2.3	 4.2 2.5	Volts	T_C = +25°C, I_{TM} = 3000 Amps Peak Duty Cycle ⩽ .01%. Pulse Width = 3.0 ms
Turn-On Delay Time	t_d	–	0.5	–	μsec	T_C = +25°C, I_{TM} = 50 Adc, V_{DRM}. Gate Supply: 20 Volt Open Circuit, 20 Ohms, 0.1 μsec max. rise time. ††, †††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage) C392, C394 C393, C395	t_q	 – –	 8 12	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 20 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C392, C394 C393, C395		– –	12 17	14 20		(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode) C392, C394 C393, C395	$t_{q(diode)}$	 – –	 18 25	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms

†Consult factory for specified maximum turn-off time.
††Delay time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test.
†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.

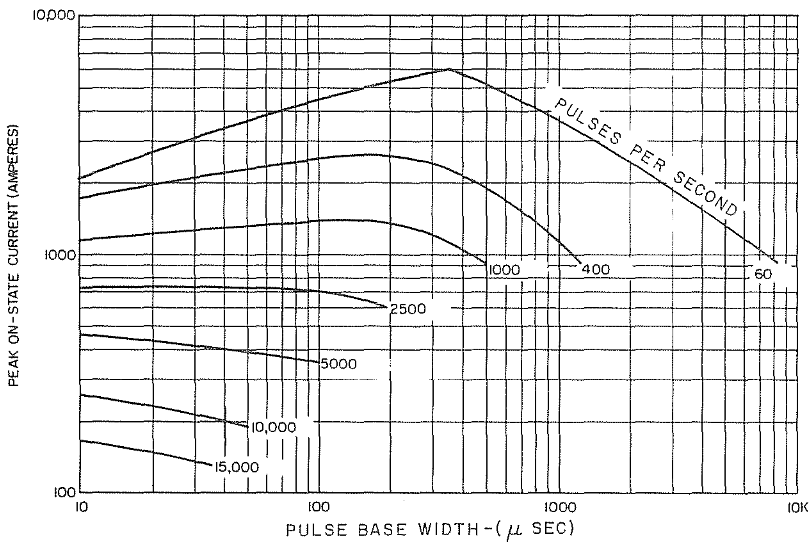
C394,C395

SINE WAVE CURRENT RATING DATA

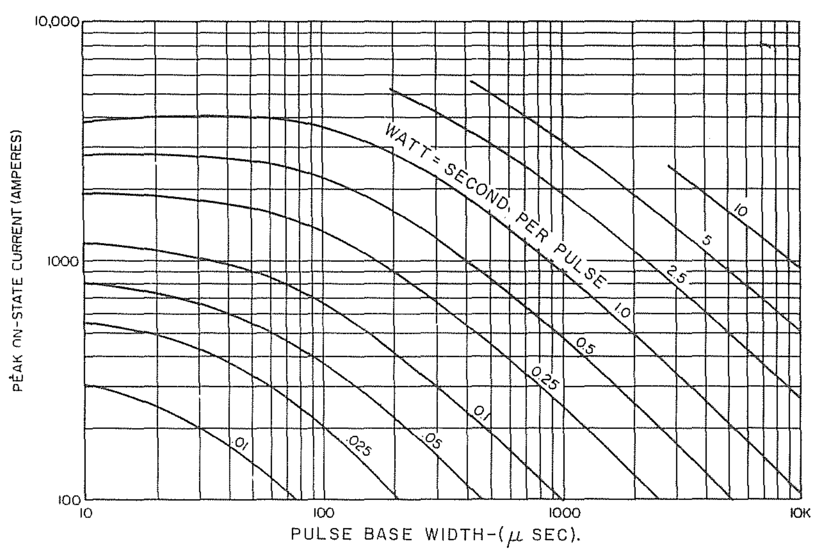


3. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)

C394,C395



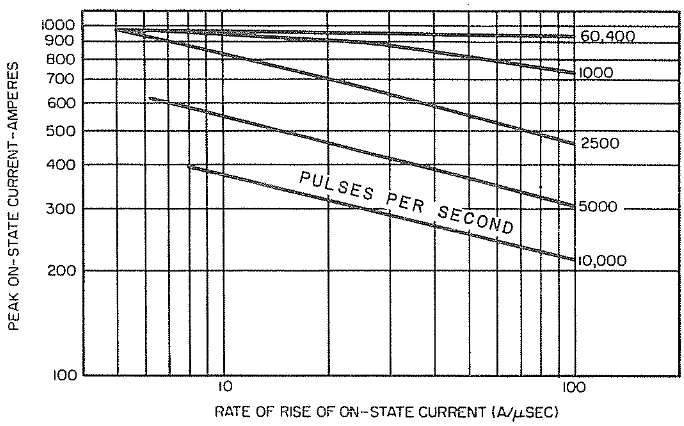
4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



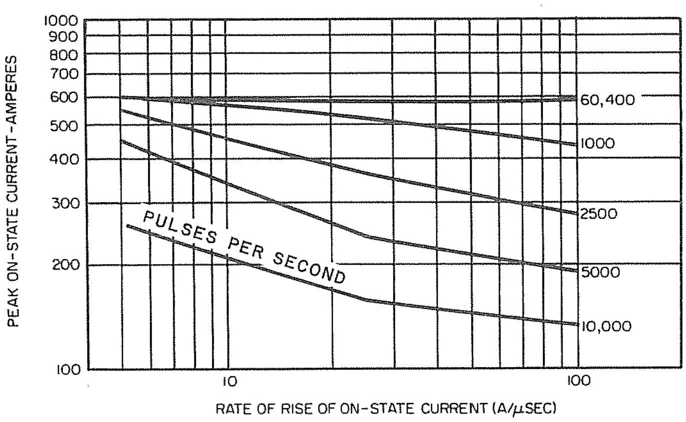
5. ENERGY PER PULSE FOR SINUSOIDAL PULSES

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

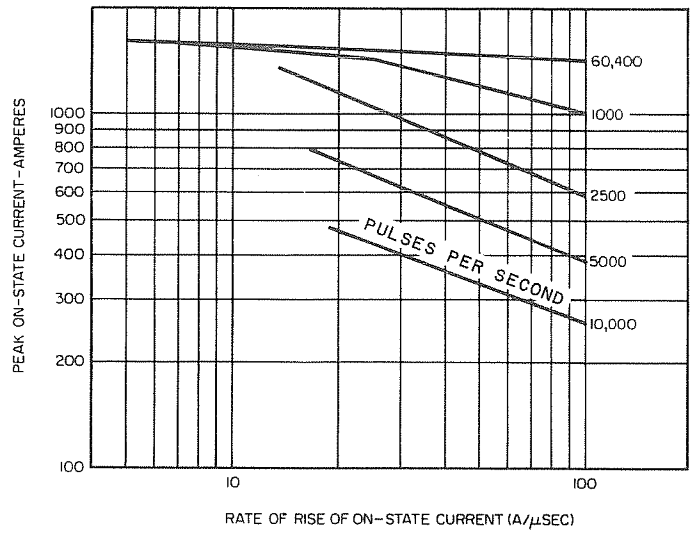


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

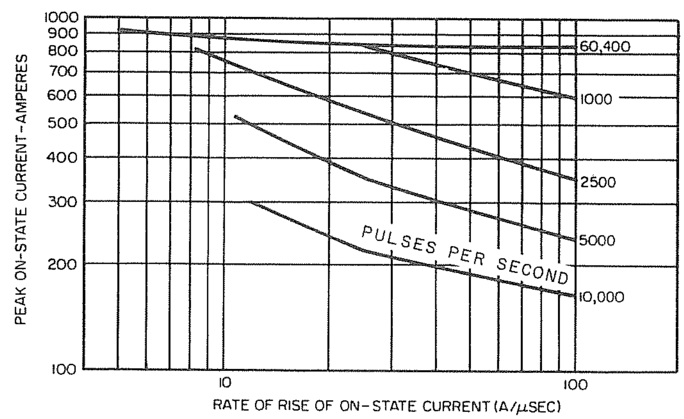


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE – 25%

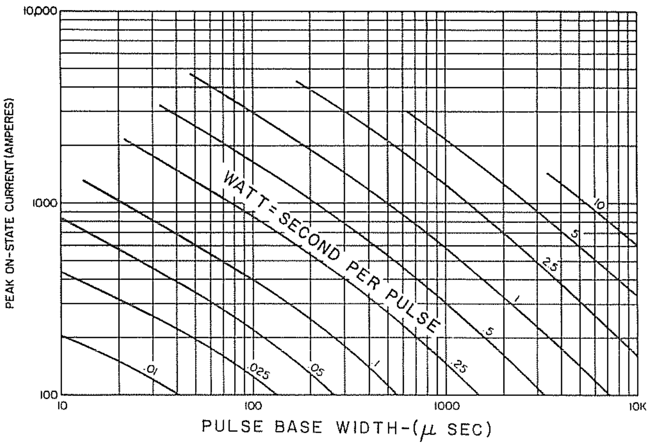


8. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

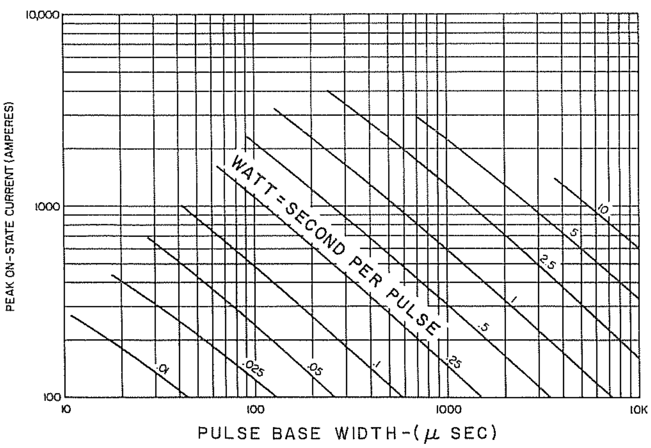


9. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

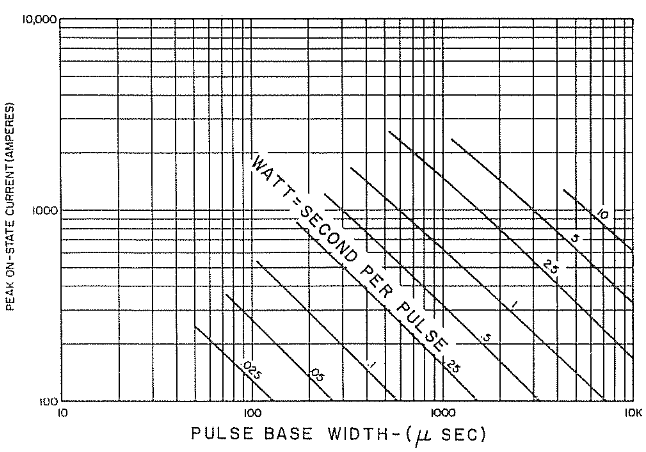
C394,C395
WATT-SECOND PER PULSE



10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)

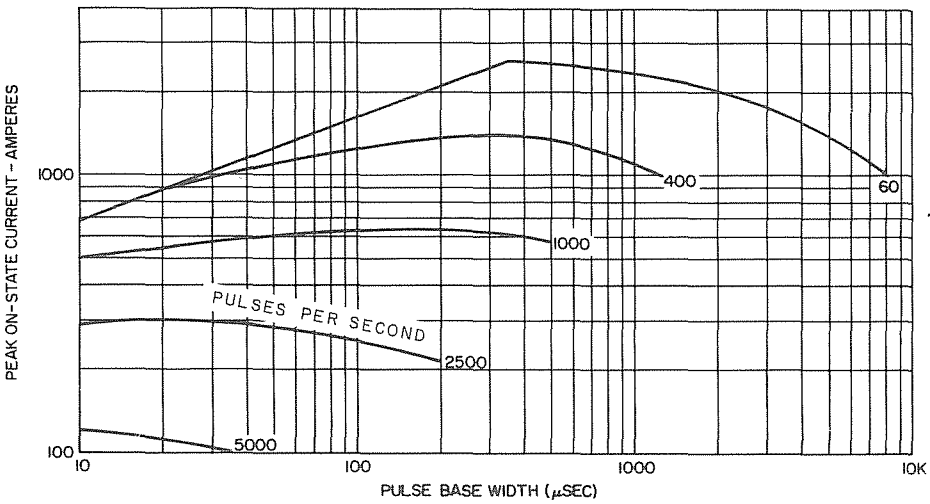


11. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)

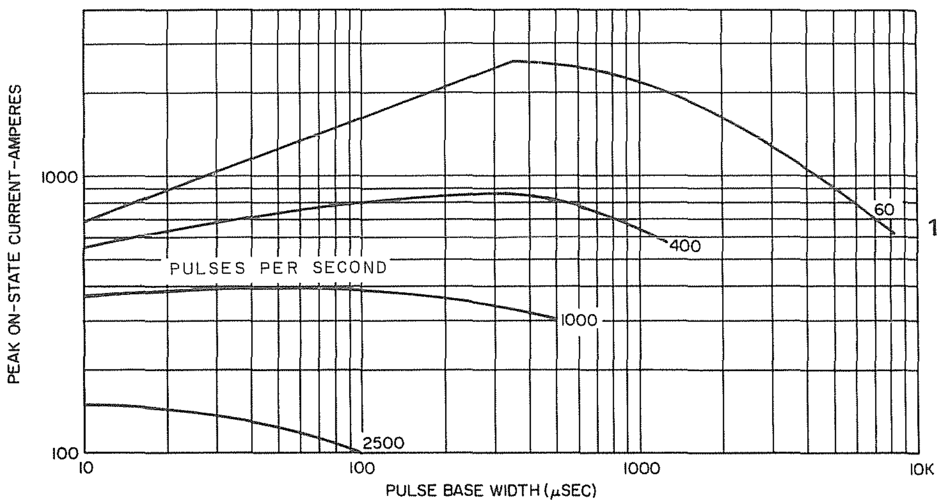


12. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)

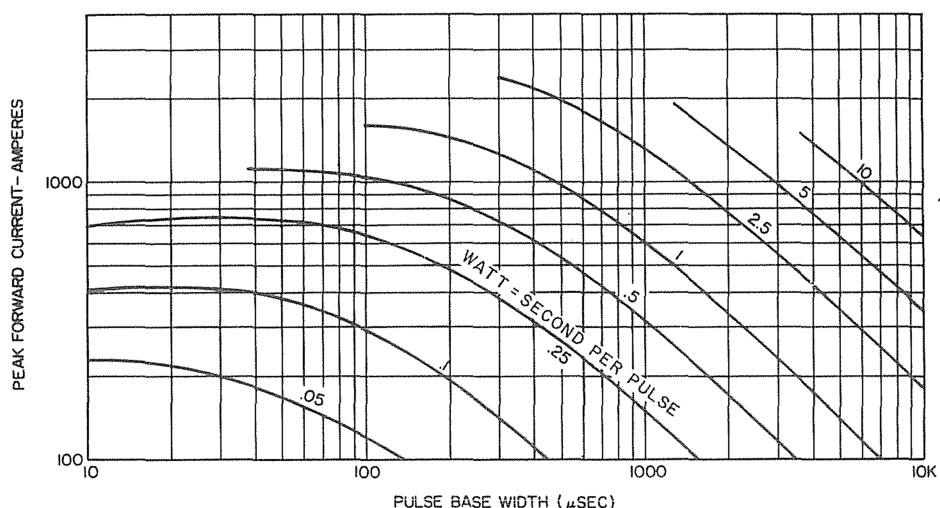
C394,C395 SINE WAVE CURRENT RATING DATA



13. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



14. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



15. ENERGY PER PULSE FOR SINUSOIDAL PULSES

NOTES:

(Pertaining to Sine and Rectangular Wave Current Ratings)

1. Switching voltage ⩽ 400 volts.
2. Reverse voltage applied = V_R ⩽ 400 volts.
3. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown or 0.03 W-S/P whichever is least. You can subtract this energy per pulse when operating with an inverse diode.
4. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec.
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μsec
5. RC Snubber ckt. = .2 μf, 5Ω.
6. Double-Side Cooled
7. Values of W-S/P are for T_J = 125°C'

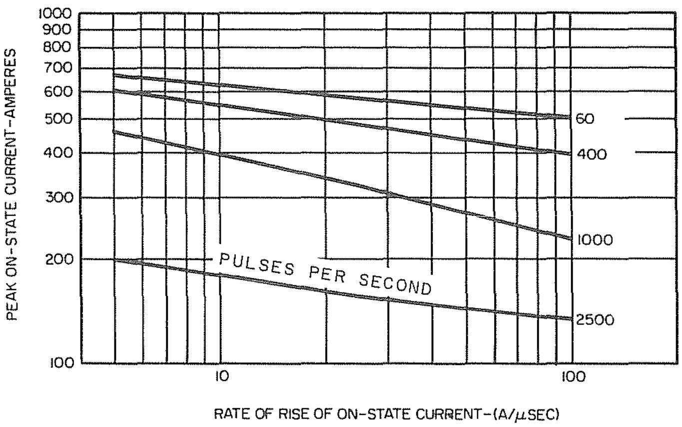
If the circuit di/dt remains below 100 amps/μs, and normally constructed snubbers using the components specified are employed, then the "soft" gate drive shown under "conditions" for each current rating curve is sufficient.

If the circuit di/dt exceeds 100 amps/μs then the stiff gate source (20V — 20Ω), t_r = .5μs, specified in Chart 27 must be used. In addition the total device di/dt must be checked to insure that it is not above the 500 amps/μs which is the long term repetitive limit noted in Chart 27 for stiff gate source.

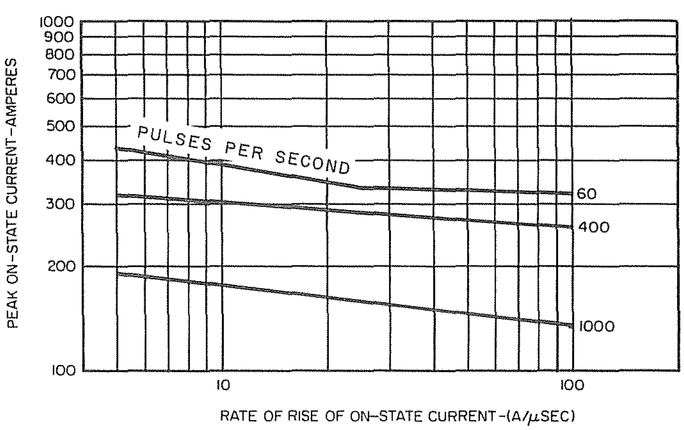
C392,C393

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

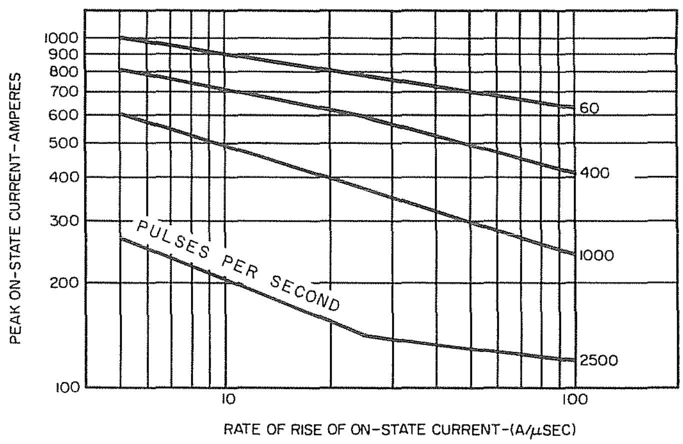


16. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS di/dt (T_C = 65°C)

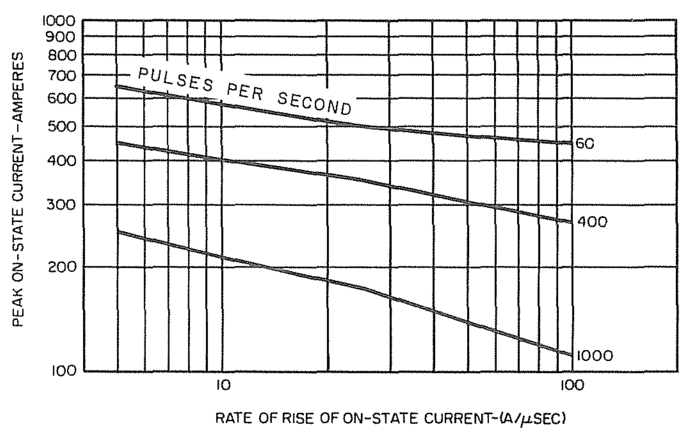


17. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE – 25%



18. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

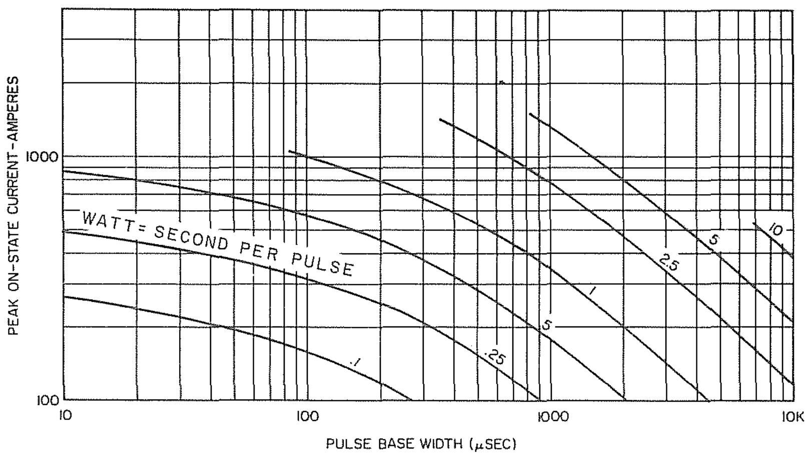


19. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

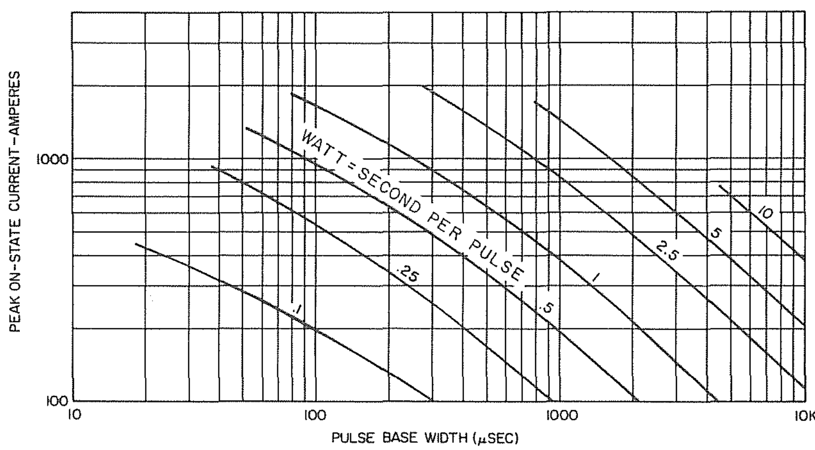
NOTES:
(Pertaining to Sine and Rectangular Wave Current Ratings)

1. RC Snubber ckt. = .25µf, 5Ω-
2. Off-State Voltage = 400 volts.
3. Reverse voltage = 50V $\leqslant V_R \leqslant$ 400 V.
4. Maximum T_J = +125°C.
5. Max. energy dissipated during reverse recovery to be 15% of total W-SYP shown or 0.03 W-S/P whichever is least. You can subtract this energy per pulse when operating with an inverse diode.
6. dv/dt (maximum) = 200 volts/µsec.
7. Required gate drive:
   20 volts, 65 ohms, 1 µsec risetime. See chart 27.
8. Double-Side Cooled.
9. Values of W-S/P are for T_J = 125°C.

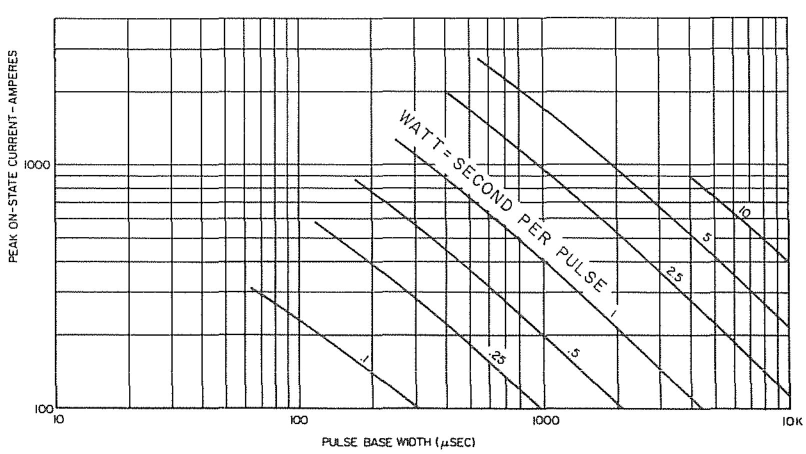
C392,C393
WATT-SECOND PER PULSE



20. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)

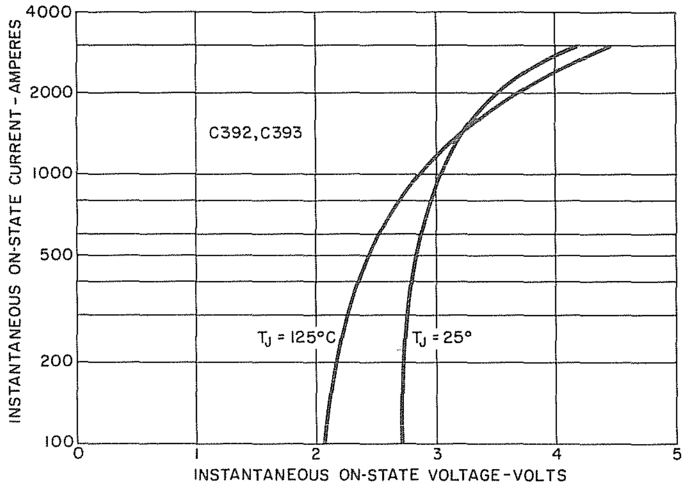


21. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)



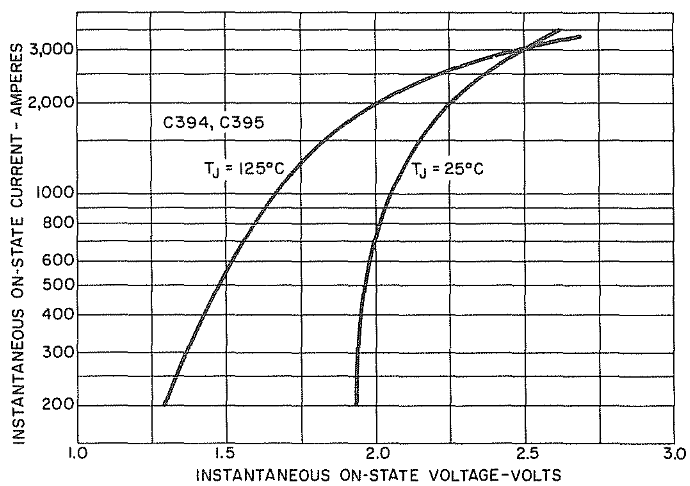
22. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)

C392,C393

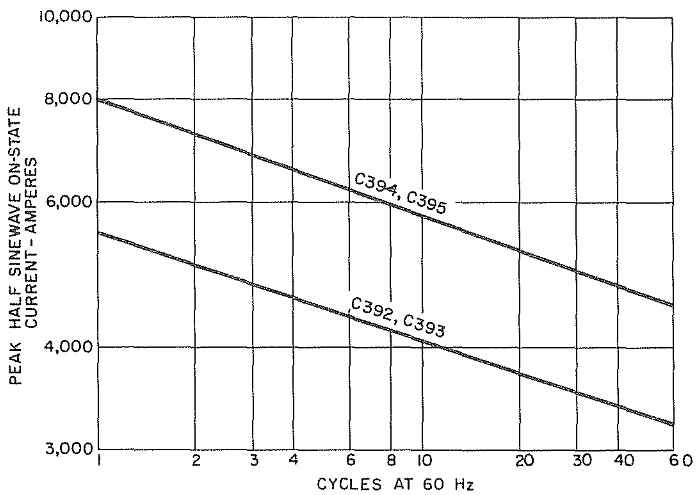


23. MAXIMUM ON-STATE CHARACTERISTICS

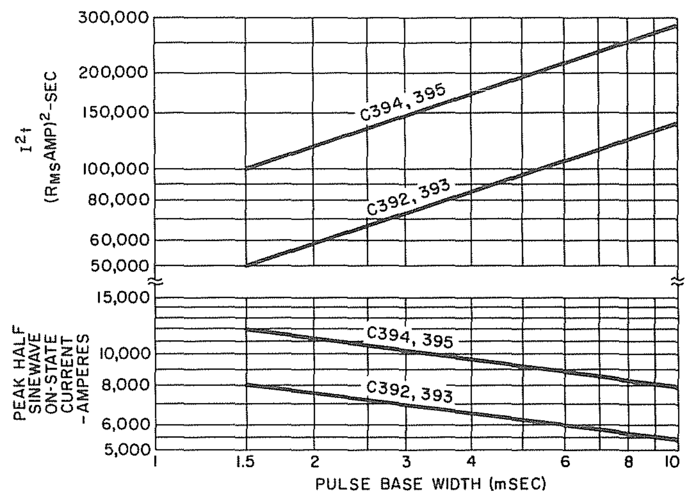
C394,C395



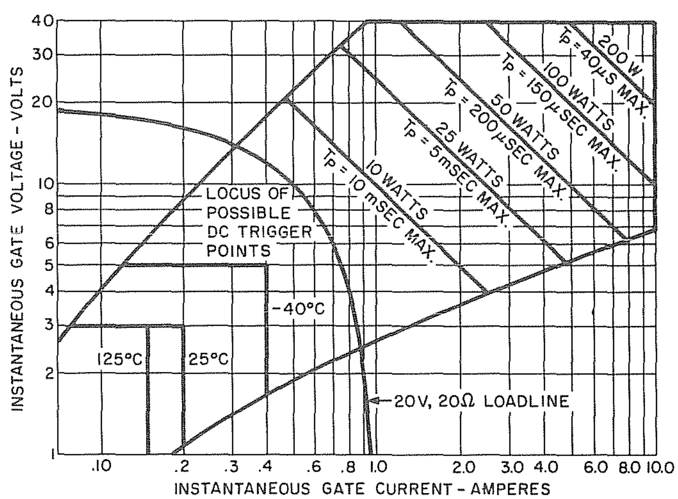
24. MAXIMUM ON-STATE CHARACTERISTICS



25. SURGE (NON-REPETITIVE) ON-STATE CURRENT



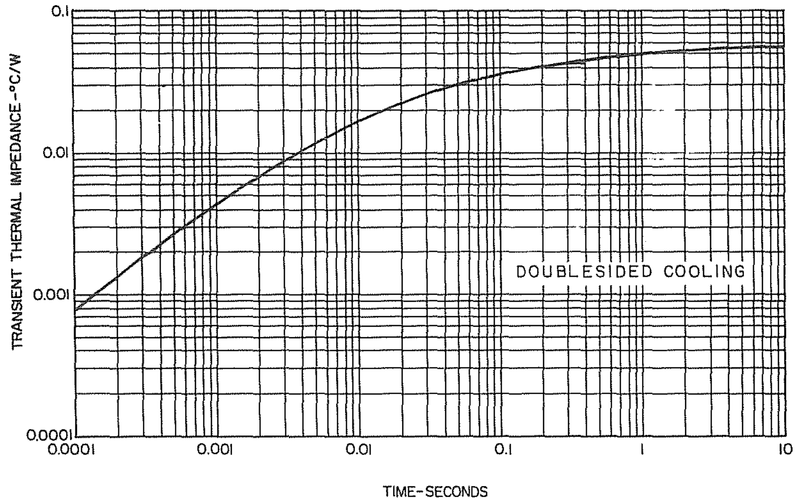
26. SUB-CYCLE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



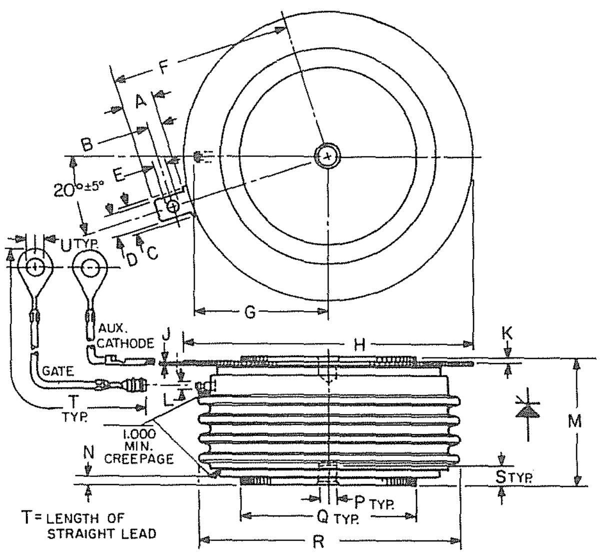
27. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

NOTES:

1. The locus of possible dc trigger points lie outside the boundaries shown at various case temperatures.
2. 20V — 20Ω is the minimum gate source load line when rate of circuit current rise > 100 amps/μs or anode rate of current rise > 200 amps/μs (Tp = 5 μs min., 0.5 μs max. risetime) Maximum long term repetitive anode di/dt = 500 amps/μs with 20V — 20Ω gate source.



28. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC M.M. MIN.	METRIC M.M. MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.70	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

OUTLINE DRAWING

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal resistance interface with result.

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surfaces should be flat within .0005 inches and have a surface finish of 63 micro-inches.

2. It is recommended that the heat dissipator be plated with nickel, tin or gold iridite. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.

3. Sand each surface *lightly* with 600 grit paper just prior to assembly. Clean off and apply silicone oil (GE SF1154 200. centistake viscosity) or silicone grease (GE G623 or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a *thin* film. (A thick film will adversely affect the electrical and thermal resistances.)

4. Assemble with the specified mounting force applied through a self beveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.