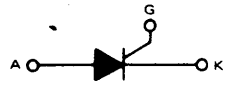
2N6394 thru 2N6399
MCR220-5 • MCR220-7 • MCR220-9



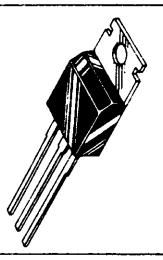
THYRISTORS

12 AMPERES RMS
50-800 VOLTS

SILICON CONTROLLED RECTIFIERS

. . . designed primarily for half-wave ac control applications, such as motor controls, heating controls and power supplies; or wherever half-wave silicon gate controlled, solid-state devices are needed.

- Glass Passivated Junctions and Center Gate Fire for Greater Parameter Uniformity and Stability
- Small, Rugged, Thermowatt▲ Construction for Low Thermal Resistance, High Heat Dissipation and Durability
- Blocking Voltage to 800 Volts



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Voltage (1)	V_{RRM}		Volts
2N6394		50	
2N6395		100	
2N6396		200	
MCR220-5		300	
2N6397		400	
MCR220-7		500	
2N6398		600	
MCR220-9		700	
2N6399		800	
Forward Current RMS T_J = 125°C (All Conduction Angles)	$I_{T(RMS)}$	12	Amps
Peak Forward Surge Current (1/2 cycle, Sine Wave, 60 Hz, T_J = 125°C)	I_{TSM}	100	Amps
Circuit Fusing Considerations (T_J = -40 to +125°C, t = 1.0 to 8.3 ms)	I^2t	40	A^2s
Forward Peak Gate Power	P_{GM}	20	Watts
Forward Average Gate Power	$P_{G(AV)}$	0.5	Watt
Forward Peak Gate Current	I_{GM}	2.0	Amps
Operating Junction Temperature Range	T_J	-40 to +125	°C
Storage Temperature Range	T_{stg}	-40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	°C/W

(1) V_{RRM} for all types can be applied on a continuous dc basis without incurring damage. Ratings apply for zero or negative gate voltage. Devices should not be tested for blocking capability in a manner such that the voltage supplied exceeds the rated blocking voltage.

*Indicates JEDEC Registered Data.
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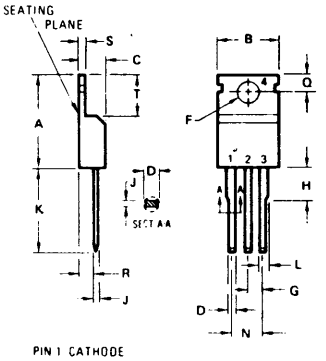

PIN 1 CATHODE
2 ANODE
3 GATE
4 ANODE

All JEDEC dimensions and notes apply

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H		6.35		0.250
J	0.31	1.14	0.012	0.045
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	0.51	1.39	0.020	0.055
T	5.85	6.85	0.230	0.270

CASE 221-02
TO 220 AB

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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
*Peak Forward Blocking Voltage (T_J = 125°C)	2N6394	V_{DRM}	50	–	–	Volts
	2N6395		100	–	–	
	2N6396		200	–	–	
	MCR220-5		300	–	–	
	2N6397		400	–	–	
	MCR220-7		500	–	–	
	2N6398		600	–	–	
	MCR220-9		700	–	–	
	2N6399		800	–	–	
* Peak Forward Blocking Current (Rated V_{DRM} @ T_J = 125°C)		I_{DRM}	–	–	2.0	mA
* Peak Reverse Blocking Current (Rated V_{RRM} @ T_J = 125°C)		I_{RRM}	–	–	2.0	mA
* Forward "On" Voltage (I_{TM} = 24 A Peak)		V_{TM}	–	1.7	2.2	Volts
* Gate Trigger Current (Continuous dc) (Anode Voltage = 12 Vdc, R_L = 100 Ohms)		I_{GT}	–	5.0	30	mA
* Gate Trigger Voltage (Continuous dc) (Anode Voltage = 12 Vdc, R_L = 100 Ohms)		V_{GT}	–	0.7	1.5	Volts
* Gate Non-Trigger Voltage (Anode Voltage = Rated V_{DRM}, R_L = 100 Ohms, T_J = 125°C)		V_{GD}	0.2	–	–	Volts
* Holding Current (Anode Voltage = 12 Vdc)		I_H	–	6.0	40	mA
Turn-On Time (I_{TM} = 12 A, I_{GT} = 40 mAdc)		t_{gt}	–	1.0	2.0	μs
Turn-Off Time (V_{DRM} = rated voltage)		tq				μs
(I_{TM} = 12 A, I_R = 12 A)			–	15	–	
(I_{TM} = 12 A, I_R = 12 A, T_J = 125°C)			–	35	–	
Forward Voltage Application Rate (T_J = 125°C)		dv/dt	–	50	–	V/μs

*Indicates JEDEC Registered Data.

FIGURE 1 – AVERAGE CURRENT DERATING

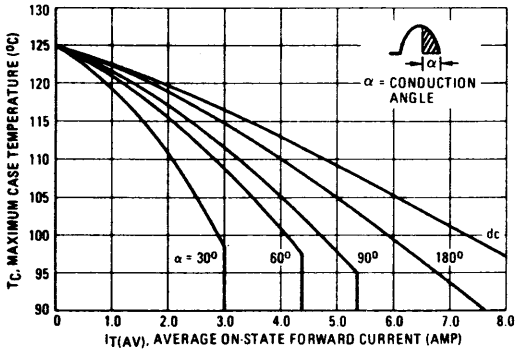


FIGURE 2 – MAXIMUM ON-STATE POWER DISSIPATION

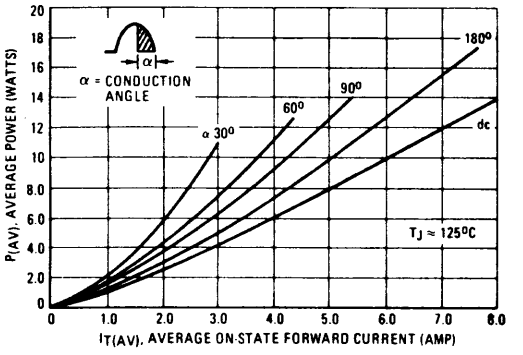


FIGURE 3 – ON-STATE CHARACTERISTICS

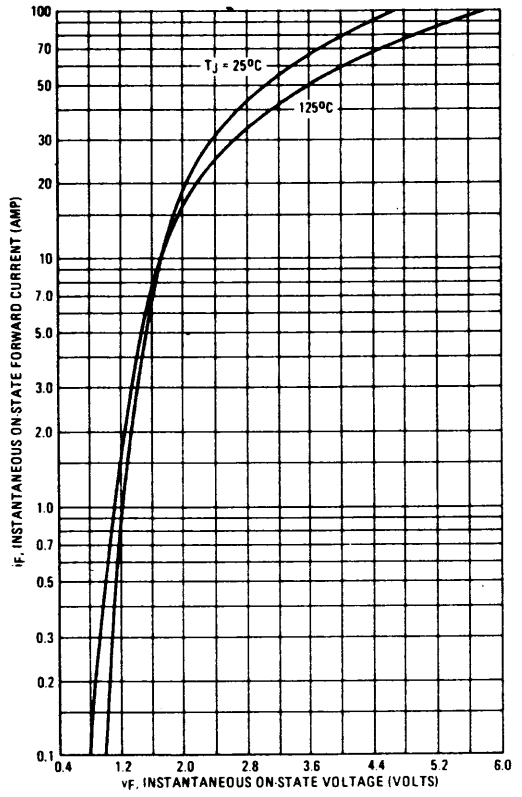


FIGURE 4 – MAXIMUM NON-REPETITIVE SURGE CURRENT

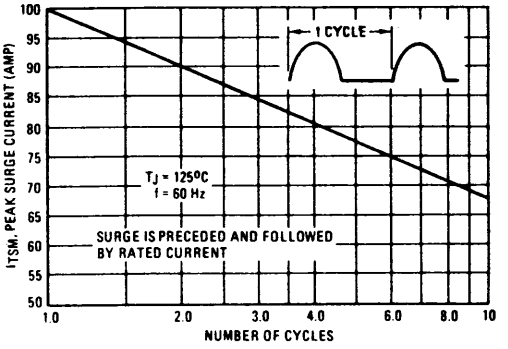


FIGURE 5 – CHARACTERISTICS AND SYMBOLS

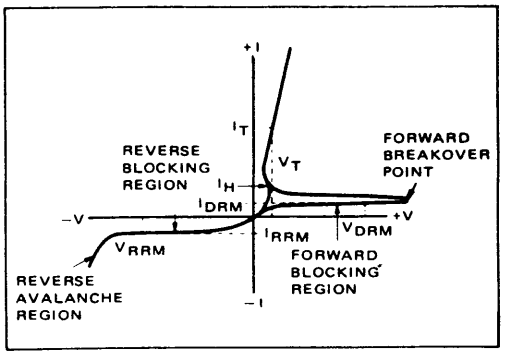
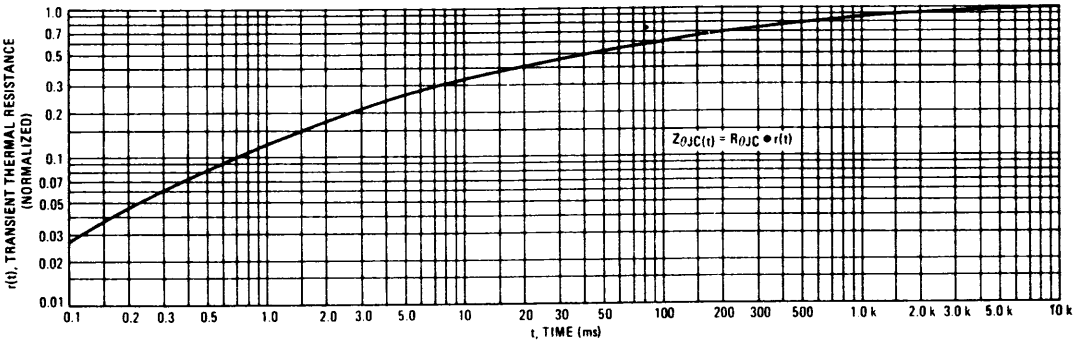


FIGURE 6 – THERMAL RESPONSE



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TYPICAL CHARACTERISTICS

FIGURE 7 – PULSE TRIGGER CURRENT

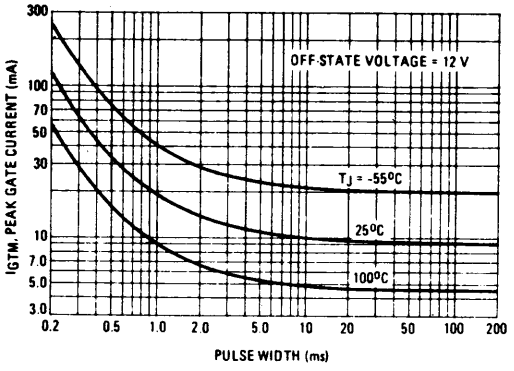


FIGURE 8 – GATE TRIGGER CURRENT

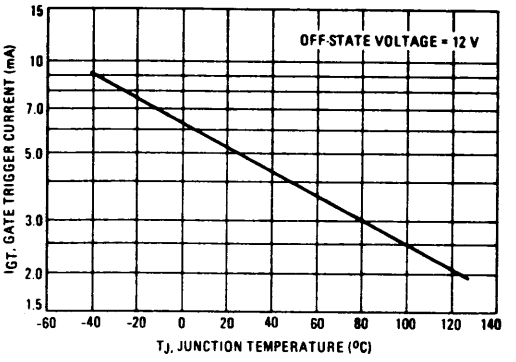


FIGURE 9 – GATE TRIGGER VOLTAGE

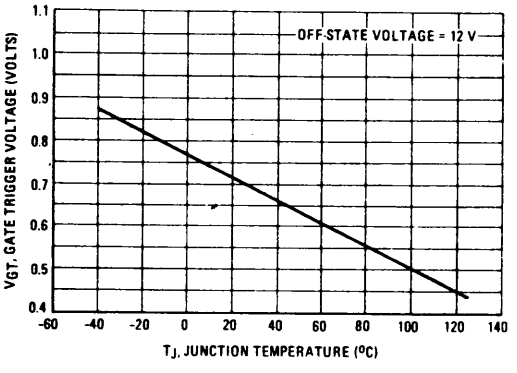
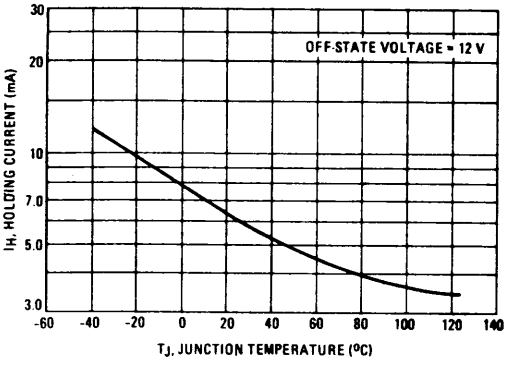


FIGURE 10 – HOLDING CURRENT



THYRISTOR APPLICATION NOTES

AN-189 Solid-State Pulse Width Modulation DC Motor Control

AN-240 SCR Power Control Fundamentals

AN-295 Suppressing RFI in Thyristor Circuits

AN-413 Unijunction Trigger Circuits for Gated Thyristors

AN-443 Directional and Speed Control for Series, Universal and Shunt Motors

AN-453 Zero Point Switching Techniques

AN-482 Electronic Speed Control of Appliance Motors

AN-526 Theory, Characteristics and Applications of Silicon Unilateral and Bilateral Switches

AN-527 Theory, Characteristics and Applications of the Programmable Unijunction Transistor

AN-568 A Fuse-Thyristor Coordinator Primer

AN-725 A Low-Cost 80-V-1.5 A Color TV Power Supply

AN-734 SCR Controller for a Series Field dc Motor

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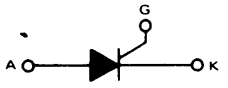
2N6400 thru 2N6405
MCR221-5 • MCR221-7 • MCR221-9



SILICON CONTROLLED RECTIFIERS

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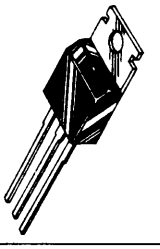
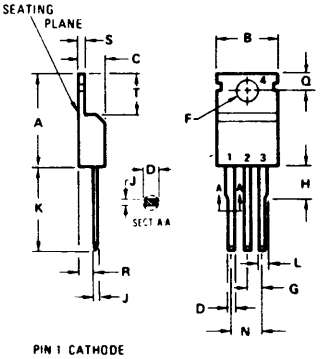
- Blocking Voltage to 800 Volts

THYRISTORS

16 AMPERES RMS
50-800 VOLTS





PIN 1. CATHODE
2. ANODE
3. GATE
4. ANODE

All JEDEC dimensions and notes apply

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	15.87	0.560	0.625
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.531	3.733	0.139	0.147
G	2.29	2.79	0.090	0.110
H	–	6.35	–	0.250
J	0.31	1.14	0.012	0.045
K	12.70	14.27	0.500	0.562
L	1.14	1.77	0.045	0.070
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.92	0.080	0.115
S	0.51	1.39	0.020	0.055
T	5.85	6.85	0.230	0.270

CASE 221-02
TO 220 AB

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Blocking Voltage (1) 2N6400 2N6401 2N6402 MCR221-5 2N6403 MCR221-7 2N6404 MCR221-9 2N6405	V_{RRM}	 50 100 200 300 400 500 600 700 800	Volts
Forward Current RMS (T_C = 90°C) (All Conduction Angles)	$I_{T(RMS)}$	16	Amps
Peak Forward Surge Current (1/2 cycle, Sine Wave, 60 Hz, T_J = 125°C)	I_{TSM}	160	Amps
Circuit Fusing Considerations (T_J = -40 to +125°C, t = 1.0 to 8.3 ms)	I^2t	100	A^2s
Forward Peak Gate Power	P_{GM}	20	Watts
Forward Average Gate Power	$P_{G(AV)}$	0.5	Watt
Forward Peak Gate Current	I_{GM}	2.0	Amps
Operating Junction Temperature Range	T_J	-40 to +125	°C
Storage Temperature Range	T_{stg}	-40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W

(1) V_{RRM} for all types can be applied on a continuous dc basis without incurring damage. Ratings apply for zero or negative gate voltage. Devices should not be tested for blocking capability in a manner such that the voltage supplied exceeds the rated blocking voltage.

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*Indicates JEDEC Registered Data.

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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
*Peak Forward Blocking Voltage (T_J = 125°C)	2N6400	V_{DRM}	50	–	–	Volts
	2N6401		100	–	–	
	2N6402		200	–	–	
	MCR221-5		300	–	–	
	2N6403		400	–	–	
	MCR221-7		500	–	–	
	2N6404		600	–	–	
	MCR221-9		700	–	–	
	2N6405		800	–	–	
*Peak Forward Blocking Current (Rated V_{DRM} @ T_J = 125°C)		I_{DRM}	–	–	2.0	mA
*Peak Reverse Blocking Current (Rated V_{RRM} @ T_J = 125°C)		I_{RRM}	–	–	2.0	mA
*Forward "On" Voltage (I_{TM} = 32 A peak)		V_{TM}	–	–	1.7	Volts
*Gate Trigger Current (Continuous dc) (Anode Voltage = 12 Vdc, R_L = 100 Ohms)		I_{GT}	–	5.0	30	mA
*Gate Trigger Voltage (Continuous dc) (Anode Voltage = 12 Vdc, R_L = 100 Ohms)		V_{GT}	–	0.7	1.5	Volts
*Gate Non-Trigger Voltage (Anode Voltage = Rated V_{DRM}, R_L = 100 Ohms, T_J = 125°C)		V_{GD}	0.2	–	–	Volts
*Holding Current (Anode Voltage = 12 Vdc)		I_H	–	6.0	40	mA
Turn-On Time (I_{TM} = 16 A, I_{GT} = 40 mAdc)		t_{gt}	–	1.0	–	μs
Turn-Off Time (V_{DRM} = rated voltage)		t_q				μs
(I_{TM} = 16 A, I_R = 16 A)			–	15	–	
(I_{TM} = 16 A, I_R = 16 A, T_J = 125°C)			–	35	–	
Forward Voltage Application Rate (T_J = 125°C)		dv/dt	–	50	–	V/μs

*Indicates JEDEC Registered Data.

FIGURE 1 – AVERAGE CURRENT DERATING

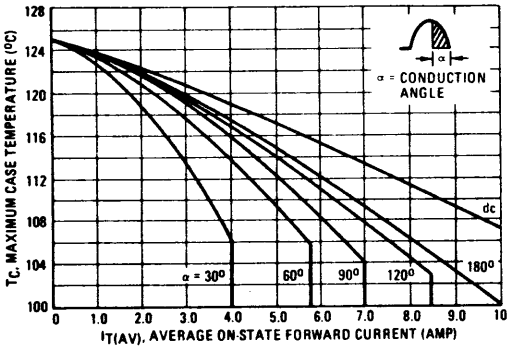


FIGURE 2 – MAXIMUM ON-STATE POWER DISSIPATION

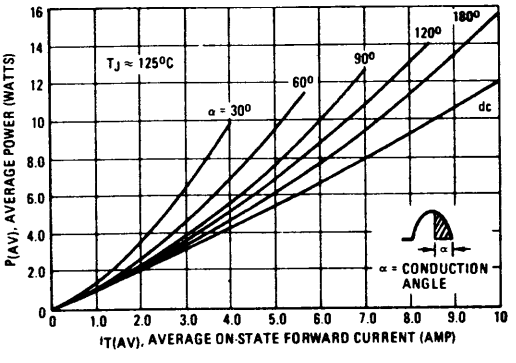


FIGURE 3 – ON-STATE CHARACTERISTICS

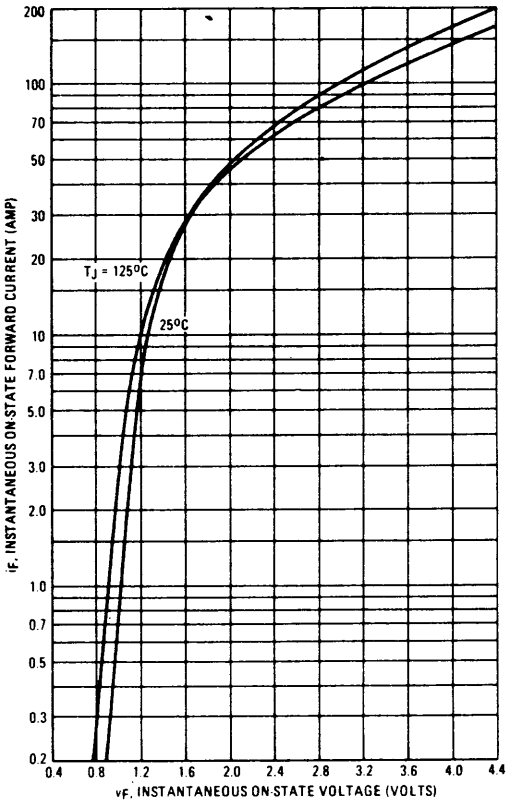


FIGURE 4 – MAXIMUM NON-REPETITIVE SURGE CURRENT

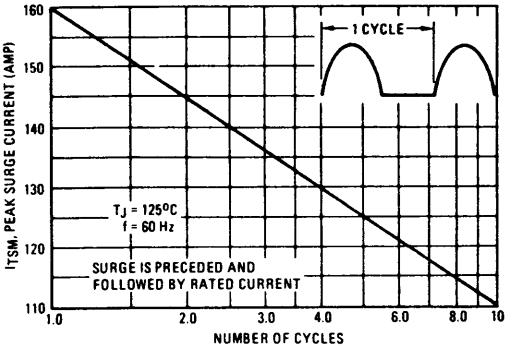


FIGURE 5 – CHARACTERISTICS AND SYMBOLS

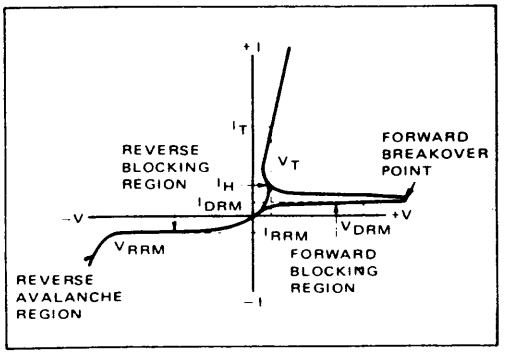
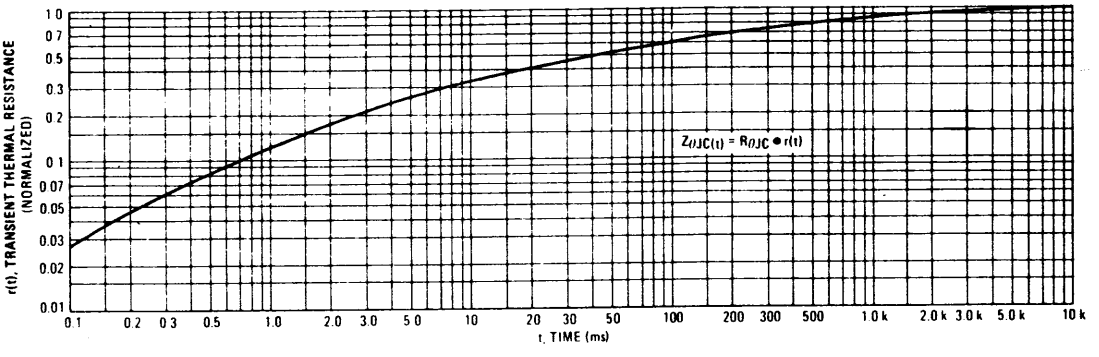


FIGURE 6 – THERMAL RESPONSE



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TYPICAL TRIGGER CHARACTERISTICS

FIGURE 7 – GATE TRIGGER CURRENT

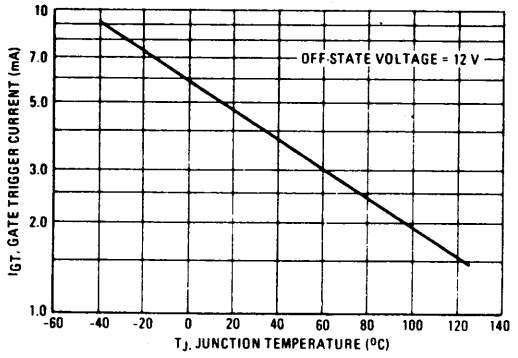


FIGURE 8 – GATE TRIGGER VOLTAGE

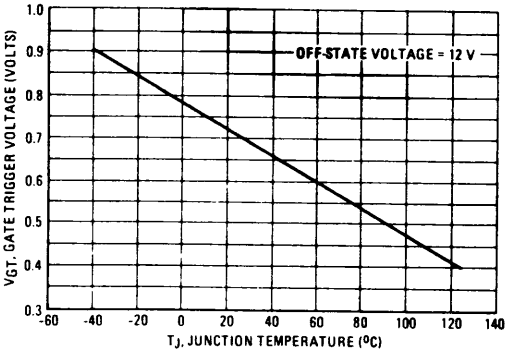
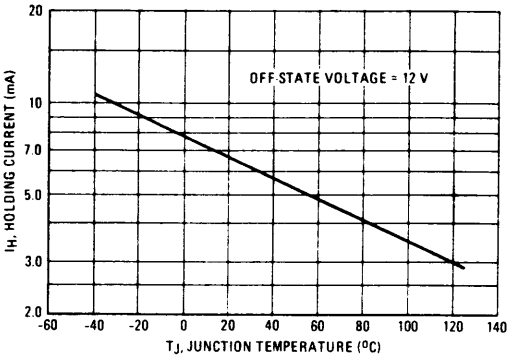


FIGURE 9 – HOLDING CURRENT



THYRISTOR APPLICATION NOTES

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AN-734 SCR Controller for a Series Field dc Motor

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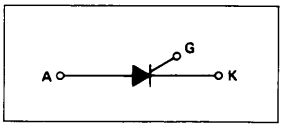
Silicon Controlled Rectifiers
Reverse Blocking Triode Thyristors

MCR229 Series
(See C228)

MCR230, 231
MCR230( )3,
231( )3
C232, 233
Series

. . . designed for industrial and consumer applications such as power supplies, battery chargers, temperature, motor, light and welder controls.

- Economical for a Wide Range of Uses
- High Surge Current — I_{TSM} = 300 Amps
- Low Forward "On" Voltage −1.2 V (Typ) @ I_{TM} = 25 Amps
- Practical Level Triggering and Holding Characteristics — 10 mA (Typ) @ T_C = 25°C
- Rugged Construction in Either Pressfit, Stud, or Isolated Stud
- Glass Passivated Junctions for Maximum Reliability

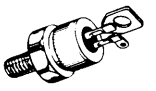


SCRs
25 AMPERES RMS
50 thru 600 VOLTS

MAXIMUM RATINGS

Rating	Suffix	Symbol	Value	Unit
Peak Repetitive Off-State Voltage, Note 1 (T_C = −40 to +100°C) All Types	F A B D M	V_{DRM} and V_{RRM}	50 100 200 400 600	Volts
Non-Repetitive Reverse Voltage (T_C = −40 to 100°C) All Types	F A B D M	V_{RSM}	75 150 300 500 720	Volts
Forward Current RMS		$I_{T(RMS)}$	25	Amps
Peak Surge Current (One Cycle, 60 Hz, T_C = −40 to 100°C)		I_{TSM}	250	Amps
Circuit Fusing (t = 8.3 ms)		I^2t	260	A^2s
Peak Gate Power		P_{GM}	5	Watts
Average Gate Power		$P_{G(AV)}$	0.5	Watt
Peak Forward Gate Current		I_{GM}	2	Amps
Operating Junction Temperature Range		T_J	−40 to +100	°C
Storage Temperature Range		T_{stg}	−40 to +125	°C
Stud Torque		—	30	in. lb.

CASE 174-04
(TO-203AA)
STYLE 1
C232 and C233 Series



CASE 263-04
STYLE 1
MCR230 and 231 Series

CASE 311-02
STYLE 1
MCR230( )3 and
MCR231( )3 Series

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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Peak Forward or Reverse Blocking Current (Rated V_{DRM} or V_{RRM}, gate open) T_C = 25°C T_C = 100°C	I_{DRM}, I_{RRM}	— —	— —	10 1	μA mA
Forward "On" Voltage (I_{TM} = 100 A Peak, Pulse Width ≤ 1 ms, Duty Cycle ≤ 2%)	V_{TM}	—	—	1.9	Volts
Gate Trigger Current, MCR230, MCR230( )3, C232 series (V_D = 12 Vdc, R_L = 120 Ohms) (V_D = 12 Vdc, R_L = 60 Ohms) T_C = −40°C	I_{GT}	— —	— —	25 40	mA
Gate Trigger Current, MCR231, MCR231( )3, C233 (Continuous dc) (V_D = 12 Vdc, R_L = 120 Ohms) (V_D = 12 Vdc, R_L = 60 Ohms) T_C = −40°C	I_{GT}	— —	— —	9 20	mA
Gate Trigger Voltage (Continuous dc) (V_D = 12 Vdc, R_L = 120 Ohms) (V_D = 12 Vdc, R_L = 60 Ohms) T_C = −40°C (V_D = Rated V_{DRM}, R_L = 1000 Ohms) T_C = +100°C	V_{GT}	— — 0.2	— — —	1.5 2 —	Volts
Holding Current (V_D = 24 V, gate open, I_T = 0.5 A) T_C = −40°C	I_H	— —	— —	50 100	mA
Turn-On Time (t_d + t_r) (I_{TM} = 25 Adc, I_{GT} = 40 mAdc, V_D = Rated V_{DRM})	t_{gt}	—	1	—	μs
Turn-Off Time (I_{TM} = 10 A, I_R = 10 A, Pulse Width = 50 μs, dv/dt = 20 V/μs, V_D = Rated V_{DRM}) T_C = 100°C	t_q	— —	25 35	— —	μs
Forward Voltage Application Rate (V_D = Rated V_{DRM}) T_C = 100°C	dv/dt	—	100	—	V/μs

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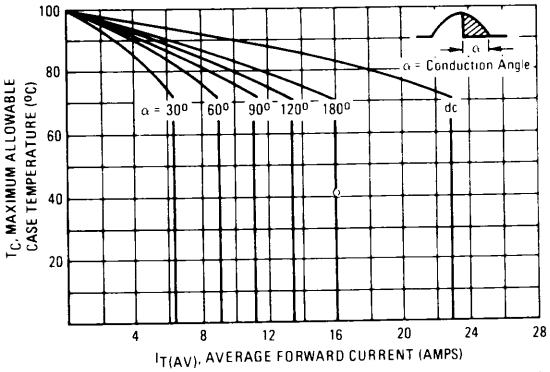
FIGURE 1 – CURRENT DERATING FOR PRESSFIT AND NON-ISOLATED STUD



NOTE: Derating is for Pressfit and Stud Devices. Isolated stud devices must be derated an additional 15%. For example, the max T_C @ 16 A (180° conduction angle) is 70°C, a derating of 30°C. Isolated stud devices must be derated 34.5°C; therefore, the maximum T_C is 65.5°C.

FIGURE 2 – ON-STATE POWER DISSIPATION versus ON-STATE CURRENT

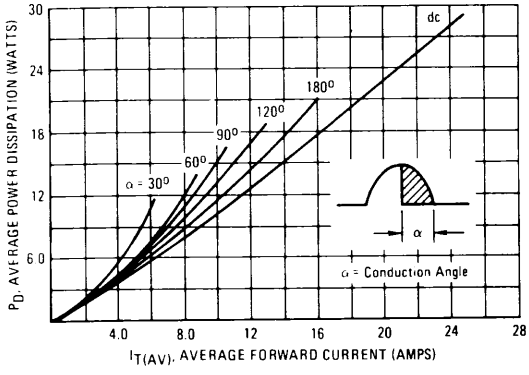


FIGURE 3 – GATE CURRENT VARIATION WITH TEMPERATURE

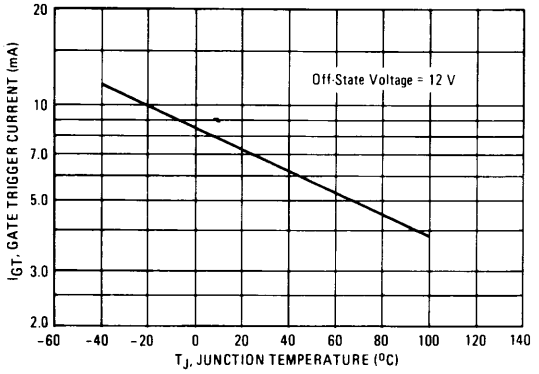
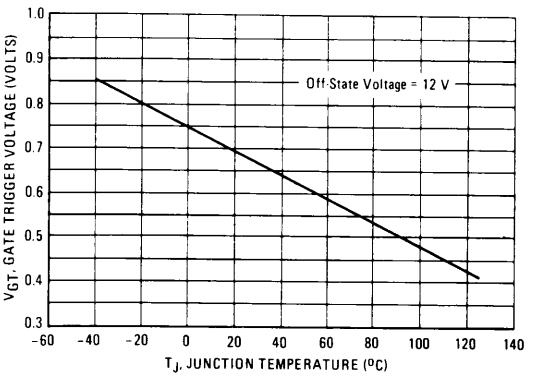


FIGURE 4 – GATE VOLTAGE VARIATION WITH TEMPERATURE



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