



Date: 13th Mar 2013

Data Sheet Issue: 1

Thyristor/Diode Modules MC#500

Absolute Maximum Ratings

-	Abbotate Maximum ratings								
VRRM VDRM [V]	1 6 7 7 3 4 2 MCC	3 4 MCR	-1 -3 -5 -4 -2 MCD	1 1 7 3 3 4 MDC					
3000	500-30io7	500-30io7	500-30io7	500-30io7					
3600	500-36io7	500-36io7	500-36io7	500-36io7					

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{DRM}	Repetitive peak off-state voltage 1)	3000-3600	V
V_{DSM}	Non-repetitive peak off-state voltage 1)	3100-3700	V
V_{RRM}	Repetitive peak reverse voltage 1)	3000-3600	V
V_{RSM}	Non-repetitive peak reverse voltage 1)	3100-3700	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{T(AV)M}$	Maximum average on-state current, T _C = 85°C ²⁾	500	Α
$I_{T(AV)M}$	Maximum average on-state current. T _C = 100°C ²⁾	347	Α
I _{T(RMS)M}	Nominal RMS on-state current, T _C = 55°C ²⁾	1181	Α
I _{T(d.c.)}	D.C. on-state current, T _C = 55°C	948	Α
I _{TSM}	Peak non-repetitive surge t_p = 10 ms, V_{RM} = 60% V_{RRM} ³⁾	16.2	kA
I _{TSM2}	Peak non-repetitive surge t_p = 10 ms, $V_{RM} \le 10V^{3}$	18.0	kA
I ² t	$I^{2}t$ capacity for fusing $t_{p} = 10$ ms, $V_{RM} = 60\%V_{RRM}^{3}$	1310	kA ² s
I ² t	I^2t capacity for fusing t_p = 10 ms, $V_{RM} \le 10 \text{ V}^{-3}$	1620	kA ² s
(d:/dt)	Critical rate of rise of on-state current (repetitive) 4)	200	A/µs
(di/dt) _{cr}	Critical rate of rise of on-state current (non-repetitive) 4)	400	A/µs
V_{RGM}	Peak reverse gate voltage	5	V
$P_{G(AV)}$	Mean forward gate power	4	W
P_GM	Peak forward gate power	40	W
V _{ISOL}	Isolation Voltage ⁵⁾	3000	V
T _{vj op}	Operating temperature range	-40 - +125	°C
T _{stg}	Storage temperature range	-40 - +125	°C

Notes:

- 1) De-rating factor of 0.13% per °C is applicable for T_{vj} below 25°C.
- 2) Single phase; 50 Hz, 180° half-sinewave.
- 3) Half-sinewave, 125°C T_{vj} initial.
- 4) V_D = 67% V_{DRM} , I_{FG} = 2 A, $t_r \le 0.5 \mu s$, T_C = 125°C.
- 5) AC RMS voltage, 50 Hz, 1min test



Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS 1)	UNITS
V_{TM}	Maximum peak on-state voltage	-	-	1.29	$I_{TM} = 500A$, $T_{vj} = T_{vjMAX}$	V
V_{TM}	Maximum peak on-state voltage	-	-	1.71	$I_{TM} = 1500A$, $T_{vj} = T_{vjMAX}$	V
V_{T0}	Threshold voltage	-	-	1.079		V
r _T	Slope resistance	-	-	0.422		mΩ
(dv/dt) _c	Critical rate of rise of off-state voltage	1000	-	-	V _D = 0.67% V _{DRM} , Gate o/c	V/μs
I _{DRM}	Peak off-state current	-	-	250	Rated V _{DRM}	mA
I _{RRM}	Peak reverse current	-	-	250	Rated V _{RRM}	mA
V _{GT}	Gate trigger voltage	-	-	2.5	T - 25°C V - 42 V L - 2 A	V
I _{GT}	Gate trigger current	-	-	250	$T_{vj} = 25^{\circ}C, V_{D} = 12 \text{ V}, I_{T} = 3 \text{ A}$	mA
V_{GD}	Gate non-trigger voltage	0.35	-	-	67% V _{DRM}	V
I _H	Holding current	-	-	300	V _D = 12 V, T _{vj} = 25°C	mA
t _{gd}	Gate controlled turn-on delay time	ı	3.00	-	$I_{FG} = 2 \text{ A}, t_r = 0.5 \text{ µs}, V_D = 40\% V_{DRM},$	μs
t _{gt}	Turn-on time	ı	4.5	-	$I_{TM} = 800A$, di/dt = 10 A/µs, $T_{vj} = 25$ °C	μs
Qrr	Recovered Charge	ı	-	3300		μC
Q _{ra}	Recovered Charge, 50% chord	-	-	3000	 I _{TM} = 500A, di/dt = 5A/μs,	μC
I _{rm}	Reverse recovery current	-	-	120	V _R = 100 V	Α
t _{rr}	Reverse recovery time, 50% chord	-	-	50		μs
t _q	Turn-off time	-	-	400	I_{TM} = 500A, di/dt = 10 A/µs, V _R = 100 V, V _{DR} = 67%V _{DRM} , dv _{DR} /dt = 50 V/µs	μs
	Th	-	-	0.050	Single Thyristor	K/W
R_{thJC}	Thermal resistance, junction to case	-	-	0.025	Whole Module	K/W
Б		ı	-	0.016	Single Thyristor	K/W
R _{thCH}	Thermal resistance, case to heatsink	-	-	0.008	Whole Module	K/W
F ₁	Mounting force (to heatsink)		-	9.00		Nm
F ₂	Mounting force (to terminals)		-	18.00	2)	Nm
Wt	Weight	-	3.5	-		kg

Notes:

- Unless otherwise indicated T_{vj}=125°C.
 Screws must be lubricated.



Notes on Ratings and Characteristics

1.0 Voltage Grade Table

Voltage Grade	V _{DRM} V _{RRM} V	V _{DSM} V _{RSM} V	V _D V _R DC V	
30	3000	3100	1750	
36	3600	3700	1900	

2.0 Extension of Voltage Grades

This report is applicable to other voltage grades when supply has been agreed by Sales/Production.

3.0 De-rating Factor

A blocking voltage de-rating factor of 0.13%/°C is applicable to this device for T_{vi} below 25°C.

4.0 Repetitive dv/dt

Standard dv/dt is 1000V/µs.

5.0 Snubber Components

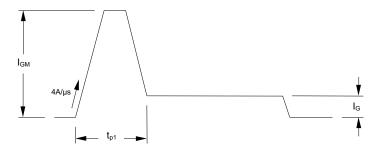
When selecting snubber components, care must be taken not to use excessively large values of snubber capacitor or excessively small values of snubber resistor. Such excessive component values may lead to device damage due to the large resultant values of snubber discharge current. If required, please consult the factory for assistance.

6.0 Rate of rise of on-state current

The maximum un-primed rate of rise of on-state current must not exceed 400A/µs at any time during turn-on on a non-repetitive basis. For repetitive performance, the on-state rate of rise of current must not exceed 200A/µs at any time during turn-on. Note that these values of rate of rise of current apply to the total device current including that from any local snubber network.

7.0 Gate Drive

The nominal requirement for a typical gate drive is illustrated below. An open circuit voltage of at least 30V is assumed. This gate drive must be applied when using the full di/dt capability of the device.



The magnitude of I_{GM} should be between five and ten times I_{GT} , which is shown on page 2. Its duration (t_{p1}) should be 20µs or sufficient to allow the anode current to reach ten times I_L , whichever is greater. Otherwise, an increase in pulse current could be needed to supply the necessary charge to trigger. The 'back-porch' current I_G should remain flowing for the same duration as the anode current and have a magnitude in the order of 1.5 times I_{GT} .



8.0 Computer Modelling Parameters

8.1 Thyristor Dissipation Calculations

$$I_{AV} = \frac{-V_{T0} + \sqrt{{V_{T0}}^2 + 4 \cdot ff^2 \cdot r_T \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_T} \qquad \text{and:} \qquad W_{AV} = \frac{\Delta T}{R_{th}} \\ \Delta T = T_{j \max} - T_K$$

Where $V_{T0} = 1.079 \text{ V}$, $r_T = 0.422 \text{ m}\Omega$.

 R_{th} = Supplementary thermal impedance, see table below and

ff = Form factor, see table below.

Supplementary Thermal Impedance								
Conduction Angle 30° 60° 90° 120° 180° 270° d.c.							d.c.	
Square wave	0.0595	0.0561	0.0547	0.0537	0.0525	0.0511	0.0500	
Sine wave 0.0536 0.0527 0.0522 0.0518 0.0500								

Form Factors							
Conduction Angle	30°	60°	90°	120°	180°	270°	d.c.
Square wave	3.464	2.449	2	1.732	1.414	1.149	1
Sine wave	3.98	2.778	2.22	1.879	1.57		

8.2 Calculating thyristor V_T using ABCD Coefficients

The on-state characteristic I_T vs. V_T , on page 6 is represented by a set of constants A, B, C, D, forming the coefficients of the representative equation for V_T in terms of I_T given below:

$$V_T = A + B \cdot \ln(I_T) + C \cdot I_T + D \cdot \sqrt{I_T}$$

The constants, derived by curve fitting software, are given below for both hot and cold characteristics. The resulting values for V_T agree with the true device characteristic over a current range, which is limited to that plotted.

	25°C Coefficients	125°C Coefficients		
Α	1.113312E+00	A 9.469148E-01		
В	4.149038E-02	В	1.031913E-02	
С	3.240304E-04	С	3.254697E-04	
D	-1.954991E-03	D	5.185360E-03	



8.3 D.C. Thermal Impedance Calculation

$$r_t = \sum_{p=1}^{p=n} r_p \cdot \left(1 - e^{\frac{-t}{\tau_p}}\right)$$

Where p = 1 to n and:

n = number of terms in the series

t = Duration of heating pulse in seconds

rt = Thermal resistance at time t

r_p = Amplitude of p_{th} term

 τ_p = Time Constant of r_{th} term

The coefficients for this device are shown in the table below:

D.C.									
Term 1 2 3 4 5 6									
r_p	0.02506	0.009643	0.00348	0.009712	0.001719	0.0004399			
$ au_{ ho}$	8.474	1.110	0.2289	0.04529	0.009524	0.0002414			

9.0 Reverse recovery ratings

(i) Q_{ra} is based on 50% I_{RM} chord as shown in Fig. 1

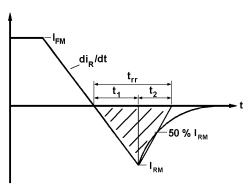


Fig. 1

(ii) Q_{rr} is based on a 150 μs integration time i.e.

$$Q_{rr} = \int_{0}^{150 \, \mu s} i_{rr}.dt$$

(iii)
$$K Factor = \frac{t_1}{t_2}$$



Curves

Figure 1 – On-state characteristics of Limit device

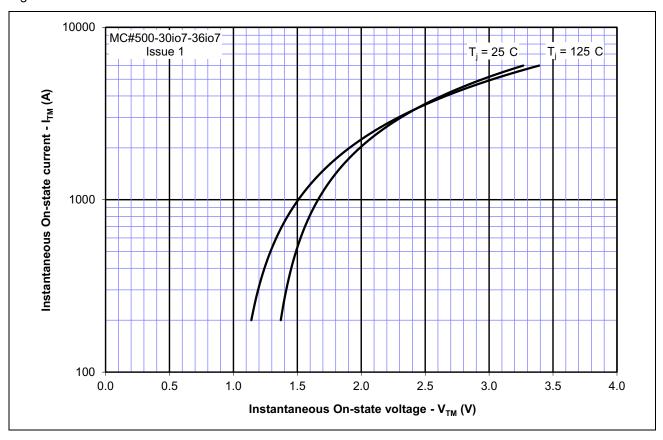


Figure 2 – Gate characteristics – Trigger limits

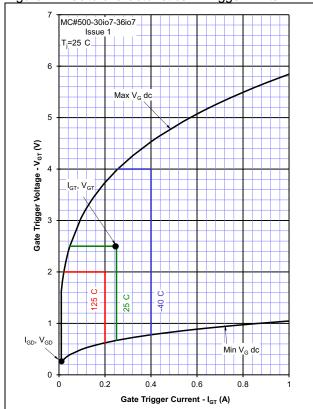


Figure 3 – Gate characteristics – Power curves

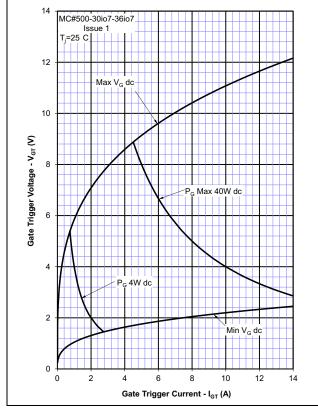




Figure 4 - Recovered Charge, Qrr

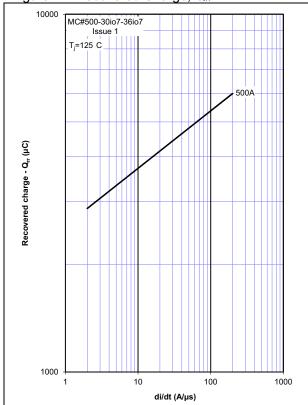
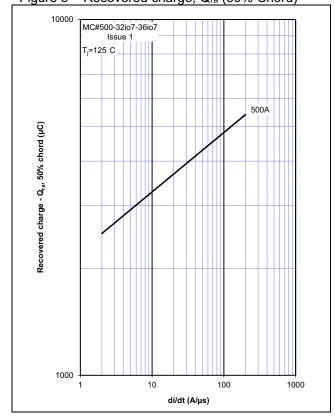


Figure 5 – Recovered charge, Q_{ra} (50% Chord)



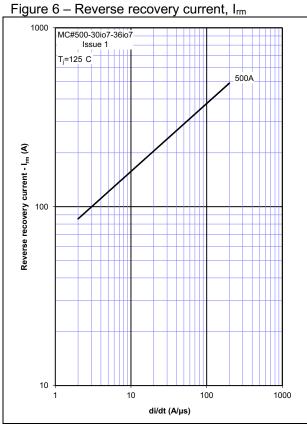


Figure 7 - Reverse recovery time, t_{rr}

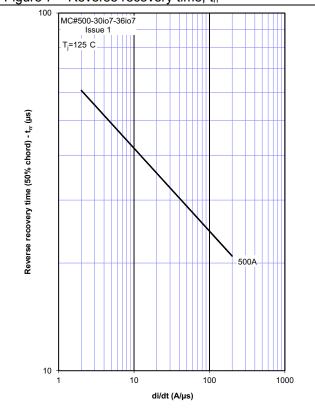




Figure 8 – On-state current vs. Power dissipation – Sine wave

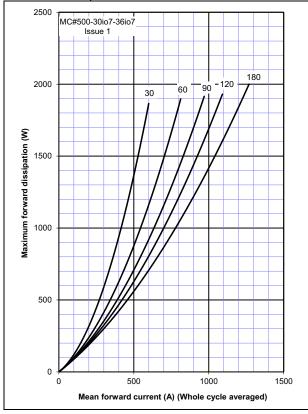


Figure 10 – On-state current vs. Power dissipation – Square wave

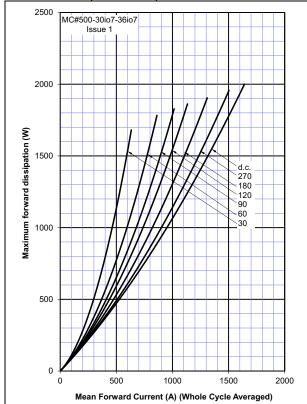


Figure 9 – On-state current vs. case temperature – Sine wave

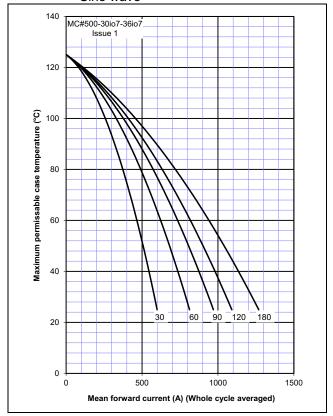


Figure 11 – On-state current vs. case temperature – Square wave

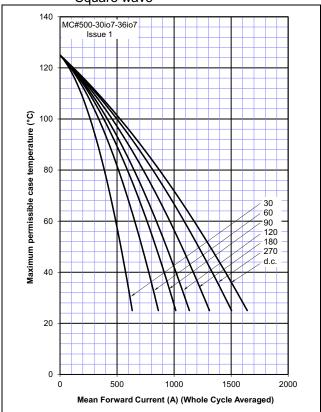
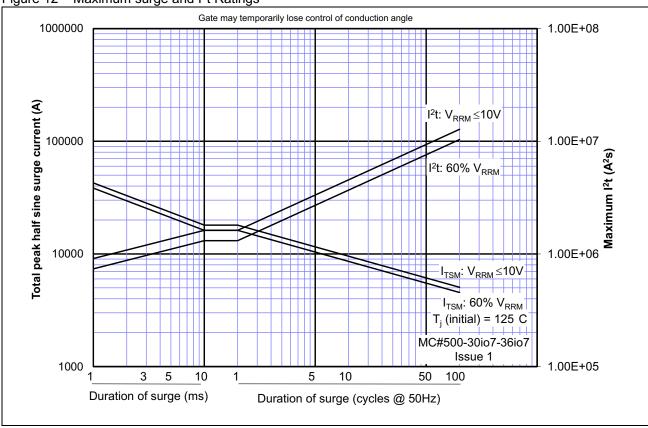
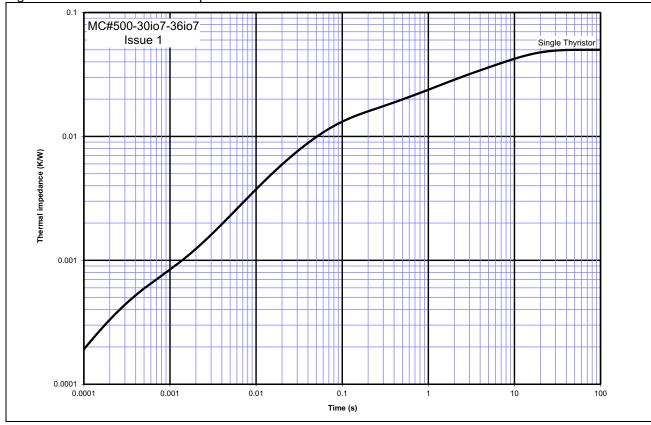




Figure 12 – Maximum surge and I²t Ratings

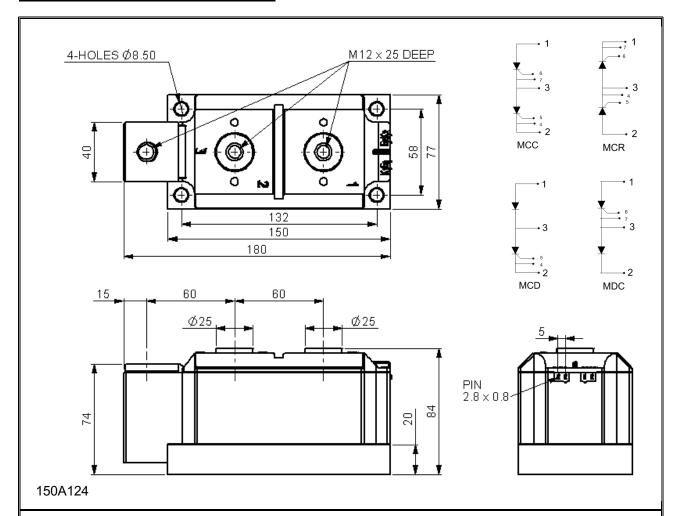








Outline Drawing & Ordering Information



	ORDERING INFO	DRMATION	(Please qu	uote 11 digit code as below)	
M	C#	500	**	io	7
Fixed Type Code	Configuration code CC, CD or DC	Fixed Type Code	Voltage code V _{RRM} /100 30-36	i = Critical dv/dt 1000 V/μs o = Typical turn-off time	Fixed Version Code

Typical order code: MCC500-30io7- MCC configuration, 3000V VRRM

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