IXYS UK WESTCODE

Date: 29th Sept, 2014

Data Sheet Issue: 3

Thyristor/Diode Modules M## 552

Absolute Maximum Ratings

V_{RRM} V_{DRM} [V]			
	MCC	MCD	MDC
1200	552-12io2	552-12io2	552-12io2
1400	552-14io2	552-14io2	552-14io2
1600	552-16io2	552-16io2	552-16io2

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{DRM}	Repetitive peak off-state voltage [1]	1200-1600	V
V_{DSM}	Non-repetitive peak off-state voltage [1]	1300-1700	V
V_{RRM}	Repetitive peak reverse voltage [1]	1200-1600	V
V_{RSM}	Non-repetitive peak reverse voltage [1]	1300-1700	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{T(AV)M}$	Maximum average on-state current, $T_C = 85°C$ [2]	550	A
$I_{T(AV)M}$	Maximum average on-state current. $T_C = 100°C$ [2]	380	A
$I_{T(RMS)M}$	Nominal RMS on-state current, $T_C = 55°C$ [2]	1300	A
$I_{T(d.c.)}$	D.C. on-state current, $T_C = 55°C$	1035	A
I_{TSM}	Peak non-repetitive surge $t_p = 10$ ms, $V_{RM} = 60\%V_{RRM}$ [3]	15.8	kA
I_{TSM2}	Peak non-repetitive surge $t_p = 10$ ms, $V_{RM} \leq 10V$ [3]	17.5	kA
I^2t	I^2t capacity for fusing $t_p = 10$ ms, $V_{RM} = 60\%V_{RRM}$ [3]	1.25×10^6	A^2s
I^2t	I^2t capacity for fusing $t_p = 10$ ms, $V_{RM} \leq 10$ V [3]	1.53×10^6	A^2s
$(di/dt)_{cr}$	Critical rate of rise of on-state current (repetitive) [4]	200	A/µs
	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	30	W
V_{ISOL}	Isolation Voltage [5]	3000	V
$T_{vj\ op}$	Operating temperature range	-40 to +125	°C
T_{stg}	Storage temperature range	-40 to +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, $t_r \leq 0.5$µs, $T_C = 125°C$.
5) AC RMS voltage, 50 Hz, 1min test

Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS [1]	UNITS
V_{TM}	Maximum peak on-state voltage	-	-	1.40	I_{TM} = 1700 A	V
V_{TM}	Maximum peak on-state voltage	-	-	1.33	I_{TM} = 1500 A	V
V_{T0}	Threshold voltage	-	-	0.770		V
r_T	Slope resistance	-	-	0.259		mΩ
$(dv/dt)_{cr}$	Critical rate of rise of off-state voltage	1000	-	-	V_D = 80% V_{DRM}, linear ramp, Gate o/c	V/μs
I_{DRM}	Peak off-state current	-	-	100	Rated V_{DRM}	mA
I_{RRM}	Peak reverse current	-	-	100	Rated V_{RRM}	mA
V_{GT}	Gate trigger voltage	-	-	2.50	T_{vj} = 25°C, V_D = 12 V, I_T = 3 A	V
I_{GT}	Gate trigger current	-	-	250		mA
V_{GD}	Gate non-trigger voltage	0.25	-	-	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	-	0.5	1.0	I_{FG} = 2 A, t_r = 0.5 μs, V_D = 67%V_{DRM}, I_{TM} = 2000 A, di/dt = 10 A/μs, T_{vj} = 25°C	μs
t_{gt}	Turn-on time	-	1.0	2.0		
Q_{rr}	Recovered Charge	-	2000	2250	I_{TM} = 550 A, di/dt = 10A/μs, V_R = 100 V	μC
Q_{ra}	Recovered Charge, 50% chord	-	1600	-		μC
I_{rm}	Reverse recovery current	-	140	-		A
t_{rr}	Reverse recovery time, 50% chord	-	23	-		μs
t_q	Turn-off time	-	180	-	I_{TM} = 550 A, di/dt = 10 A/μs, V_R = 100 V, V_{DR} = 67%V_{DRM}, dv$_{DR}$/dt = 20 V/μs	μs
		-	240	-	I_{TM} = 550 A, di/dt = 10 A/μs, V_R = 100 V, V_{DR} = 67%V_{DRM}, dv$_{DR}$/dt = 200 V/μs	
R_{thJC}	Thermal resistance, junction to case	-	-	0.062	Single Thyristor	K/W
		-	-	0.031	Whole Module	K/W
R_{thCH}	Thermal resistance, case to heatsink	-	-	0.02	Single Thyristor	K/W
		-	-	0.01	Whole Module	K/W
F_1	Mounting force (to heatsink)	4.25	-	5.75		Nm
F_2	Mounting force (to terminals)	10.2	-	13.8	[2]	Nm
W_t	Weight	-	1.5	-		kg

Notes:

1) Unless otherwise indicated T_{vj}=125°C.
2) 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
12	1200	1300	900
14	1400	1500	1050
16	1600	1700	1200

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_{vj} 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.
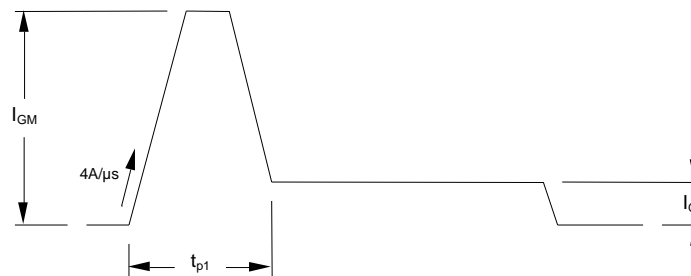
The magnitude of I_{GM} should be between five and ten times I_{GT}, which is shown on page 2. Its duration (t_{p1}) should be 20µs or sufficient to allow the anode current to reach ten times I_L, whichever is greater. Otherwise, an increase in pulse current could be needed to supply the necessary charge 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

$$I_{AV} = \frac{-V_{T0} + \sqrt{V_{T0}{}^2 + 4 \cdot ff^2 \cdot r_T \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_T}$$

and:

$$W_{AV} = \frac{\Delta T}{R_{th}}$$

$$\Delta T = T_{j\,max} - T_K$$

Where V_{T0} = 0.770 V, r_T = 0.259 mΩ.

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.
Square wave	0.0702	0.0685	0.0679	0.0668	0.0658	0.0637	0.0620
Sine wave	0.0677	0.0673	0.0664	0.0655	0.0650		

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	
A	1.238754	A	0.5570029
B	-0.1633889	B	-0.03013580
C	-3.109066×10^{-6}	C	1.144276×10^{-4}
D	0.03236259	D	0.02116443

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
r_t = 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
r_p	1.37×10^{-3}	4.86×10^{-3}	0.0114	0.0223	0.0221
τ_p	7.6×10^{-4}	8.6×10^{-3}	0.101	0.56	3.12

9.0 Reverse recovery ratings

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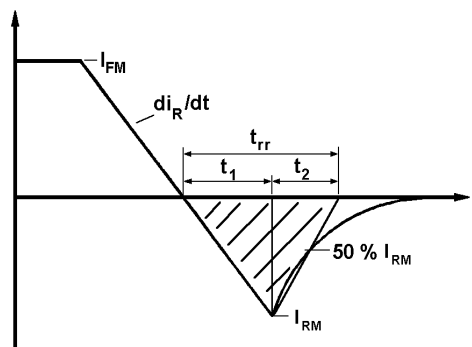
Fig. 1

(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
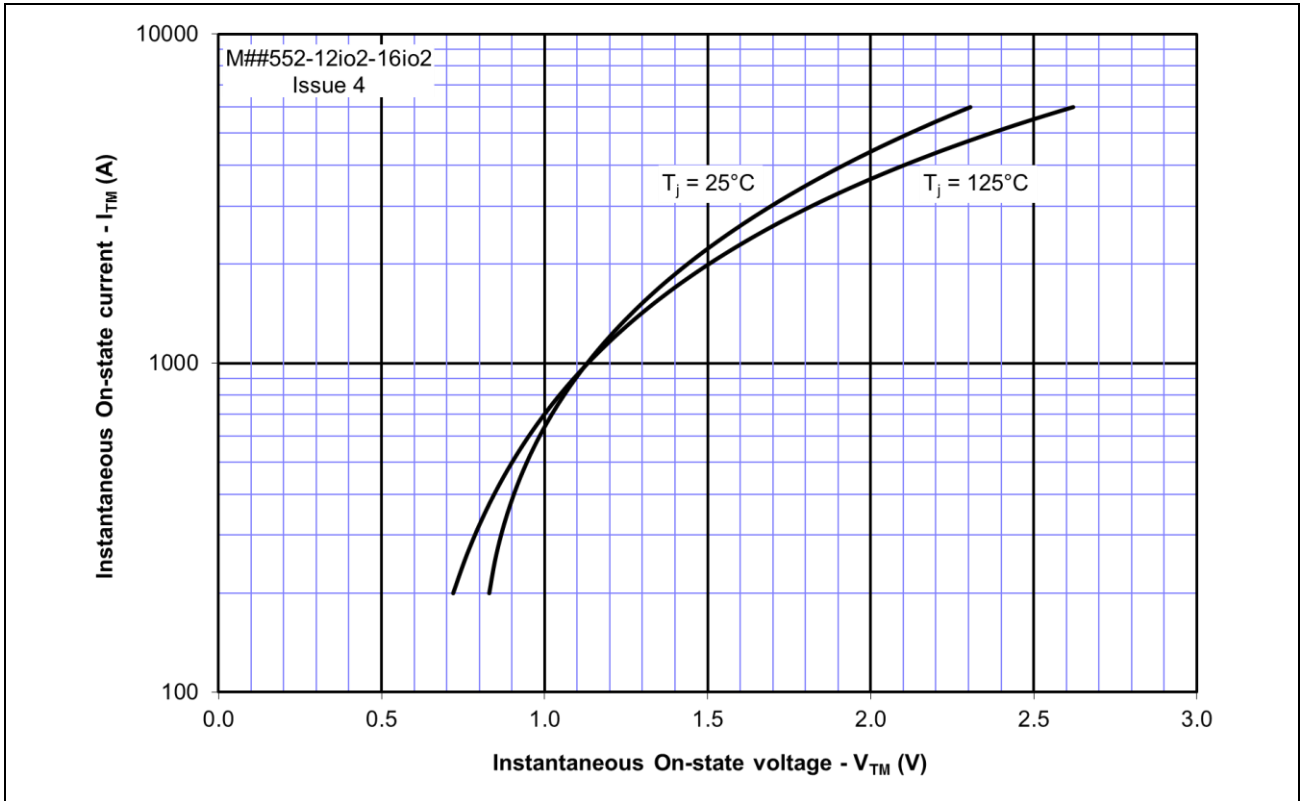
Figure 2 – Gate characteristics – Trigger limits
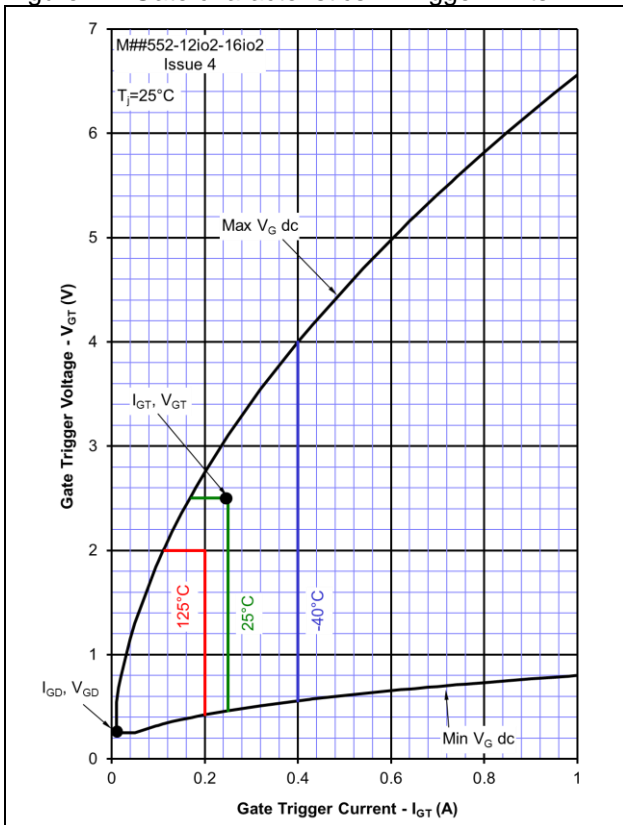
Figure 3 – Gate characteristics – Power curves
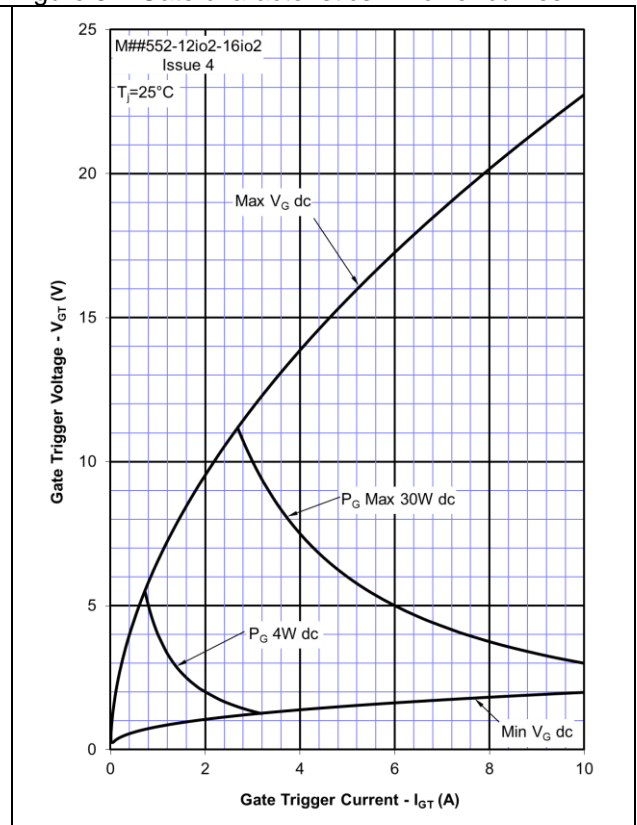
Figure 4 – Recovered Charge, Q_{rr}
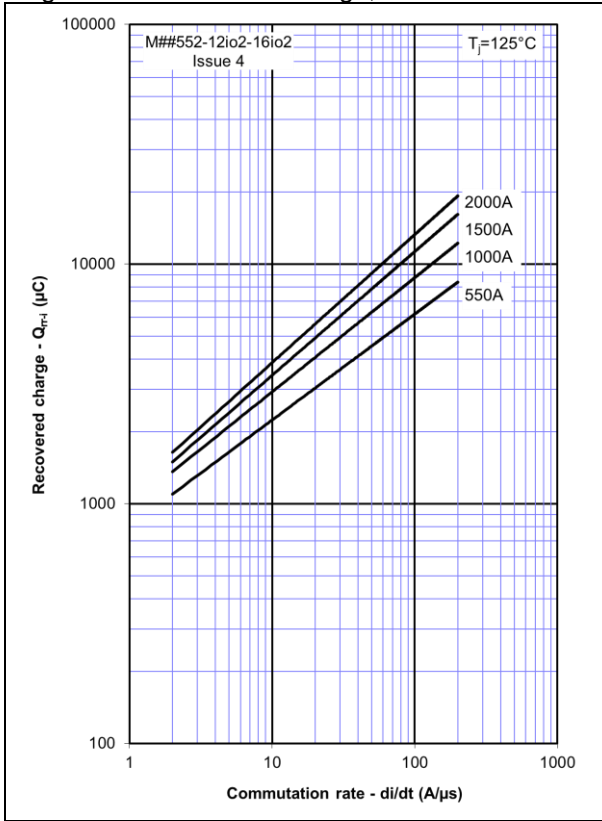
Figure 5 – Recovered Charge, Q_{ra} (50% chord)
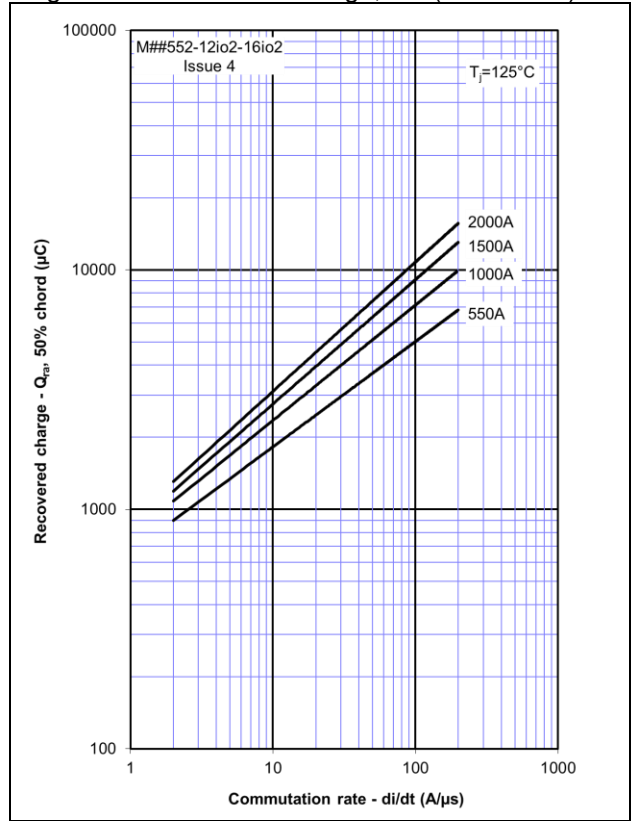
Figure 6 – Reverse recovery current, I_{rm}
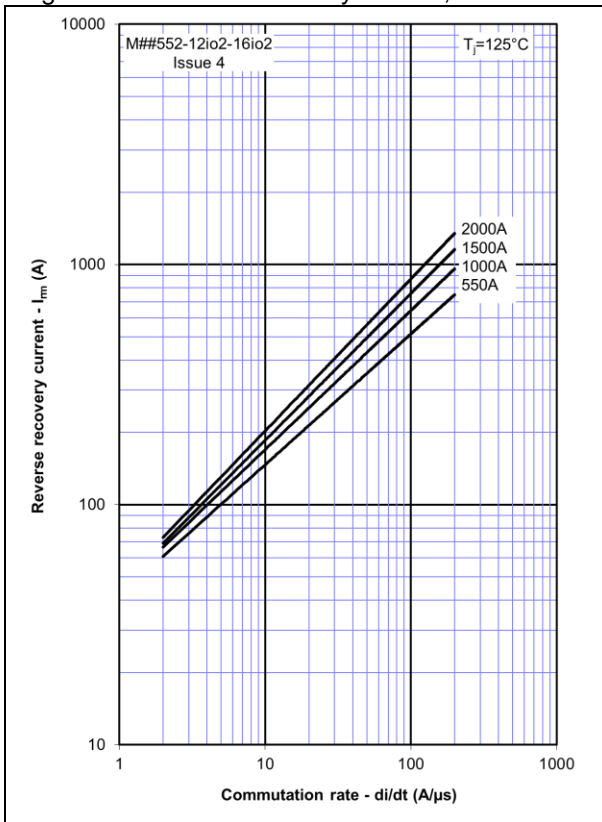
Figure 7 – Reverse recovery time, t_{rr} (50% chord)
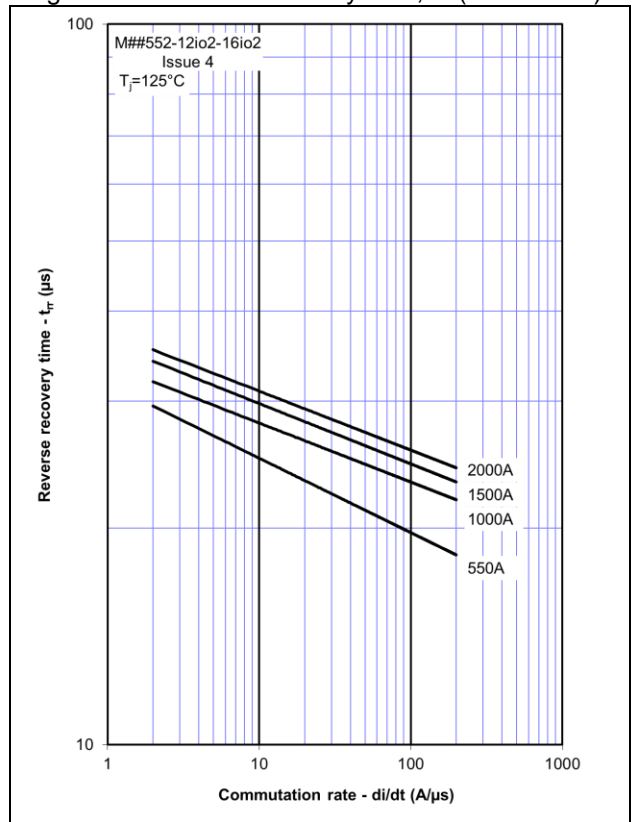
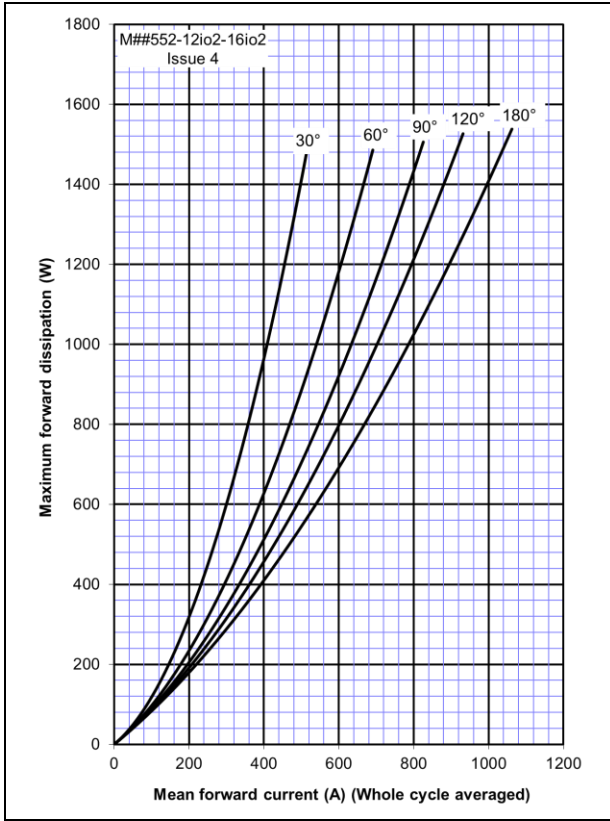Figure 8 – On-state current vs. Power dissipation – Sine wave
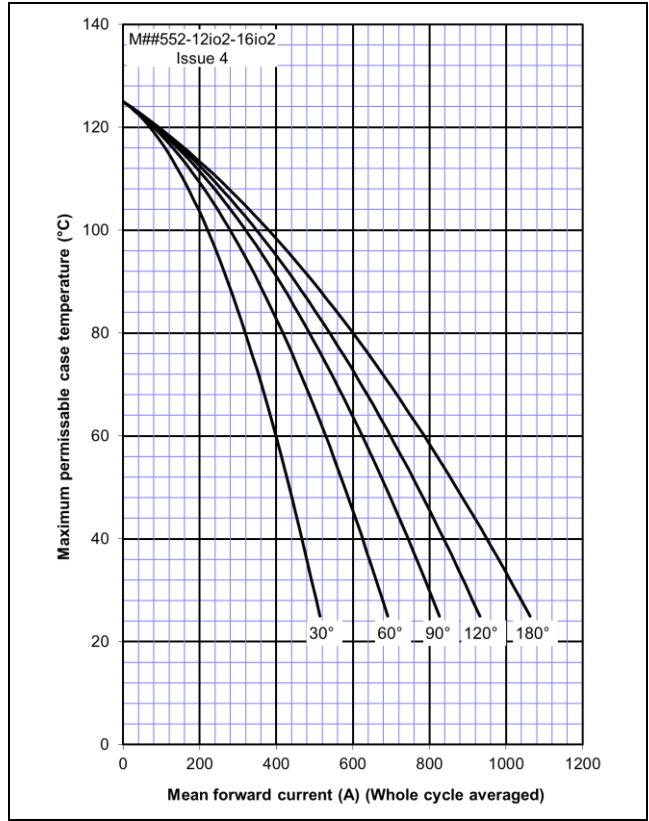

Figure 9 – On-state current vs. case temperature – Sine wave

Figure 10 – On-state current vs. Power dissipation – Square wave
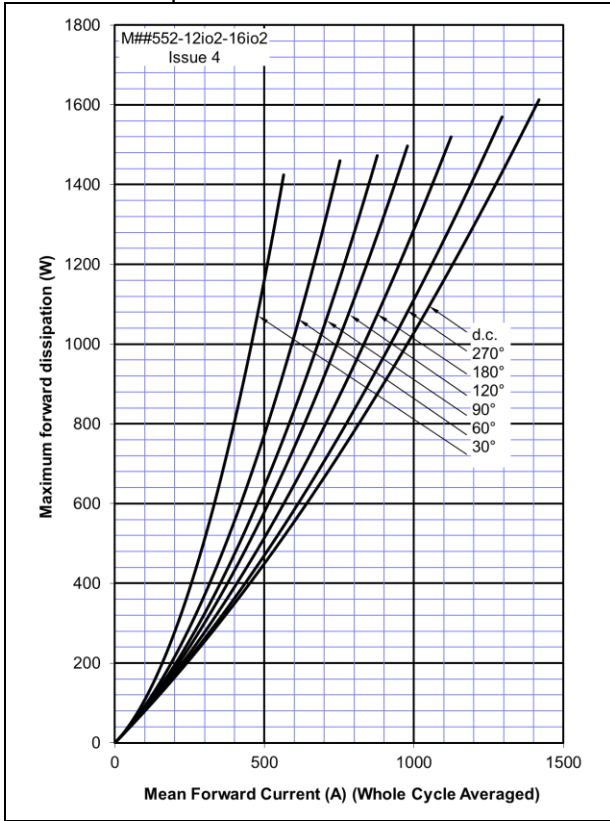
Figure 11 – On-state current vs. case temperature – Square wave
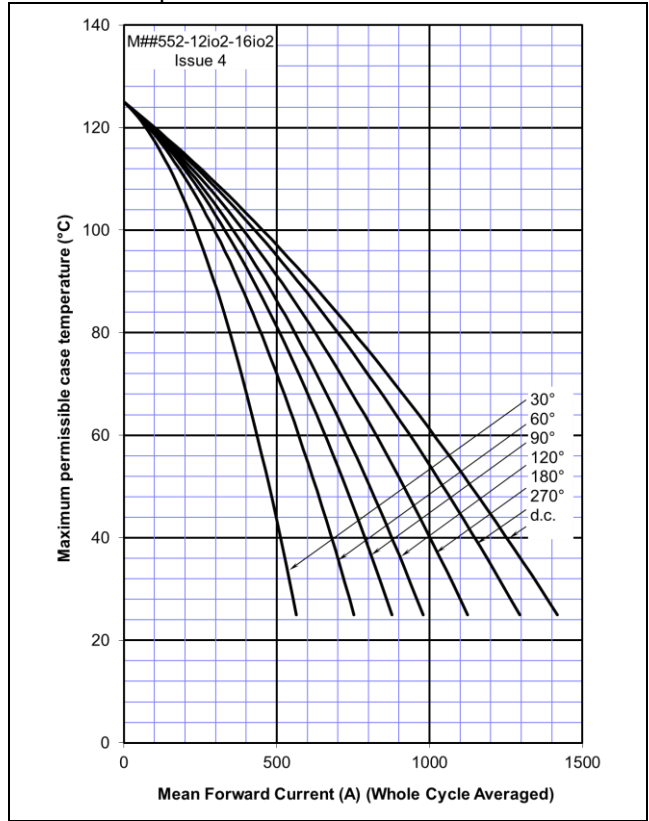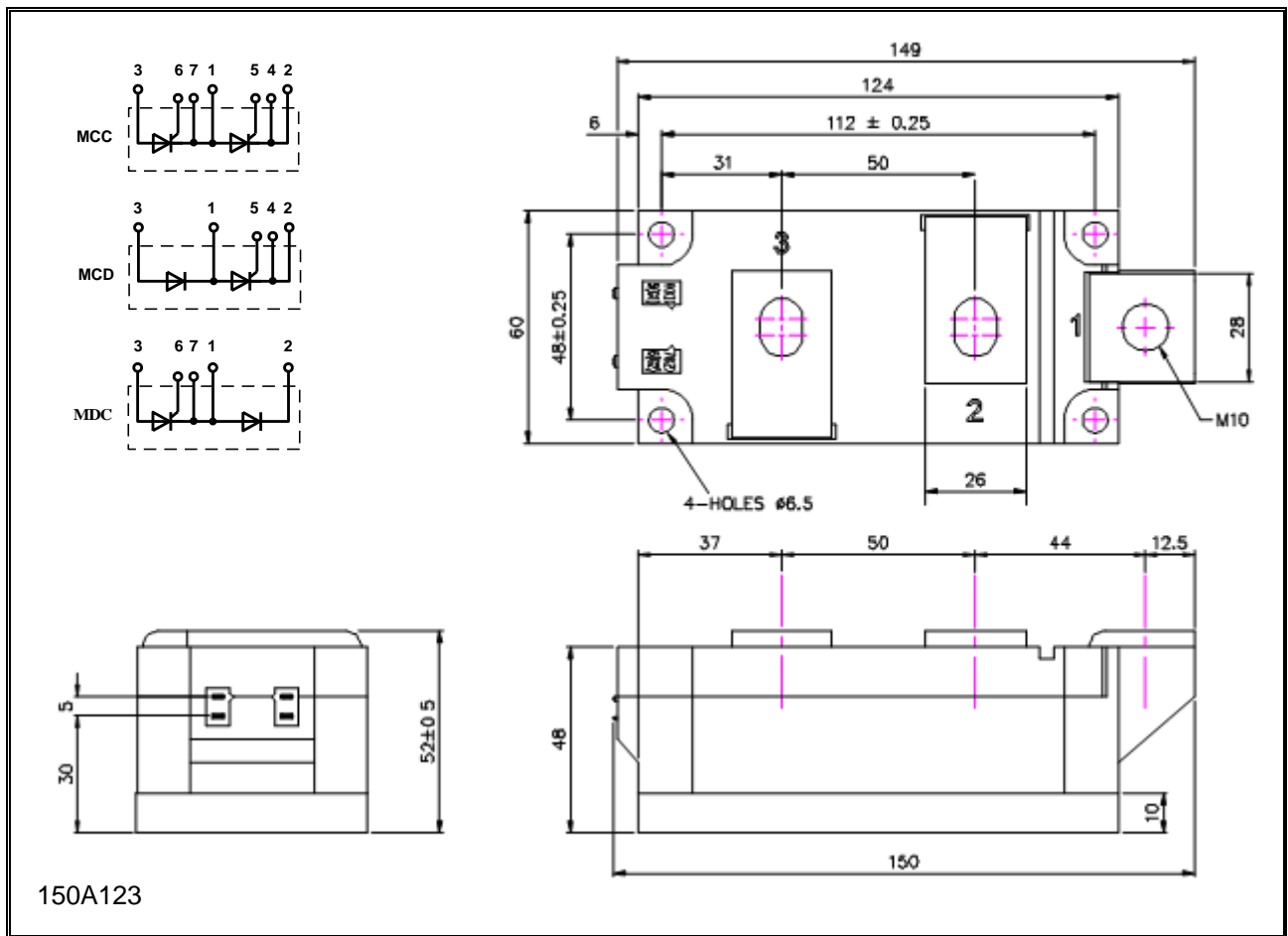
Figure 12 – Maximum surge and I²t Ratings

Gate may temporarily lose control of conduction angle

I²t: $V_{RRM} \leq 10V$

I²t: 60% V_{RRM}

I_{TSM}: $V_{RRM} \leq 10V$

I_{TSM}: 60% V_{RRM}

T_j (initial) = 125°C
M##552-12io2-16io2
Issue 4

Total peak half sine surge current (A)

Maximum I²t (A²s)

Duration of surge (ms)

Duration of surge (cycles @ 50Hz)
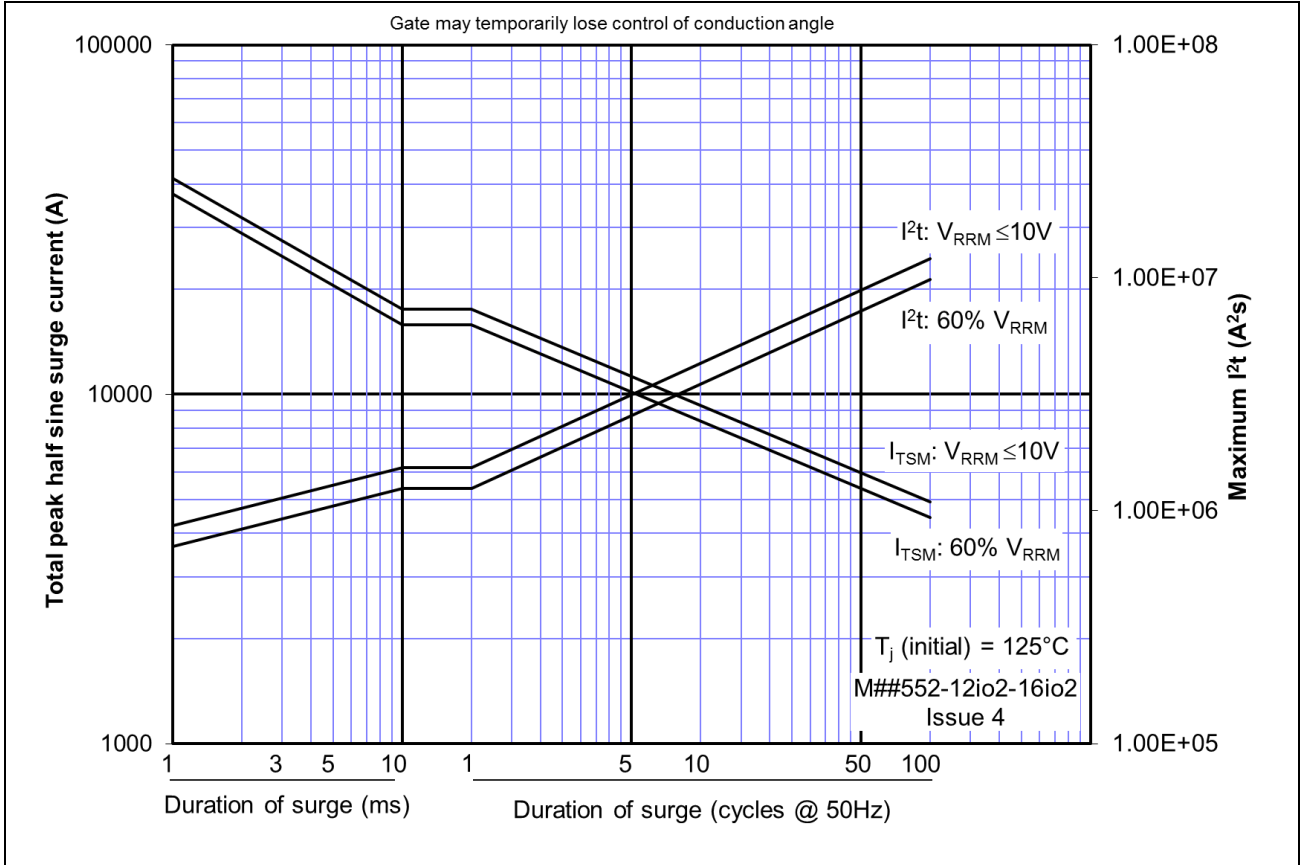
Figure 13 – Transient thermal impedance

M##552-12io2-16io2
Issue 4

Single Thyristor

Thermal impedance (K/W)

Time (s)
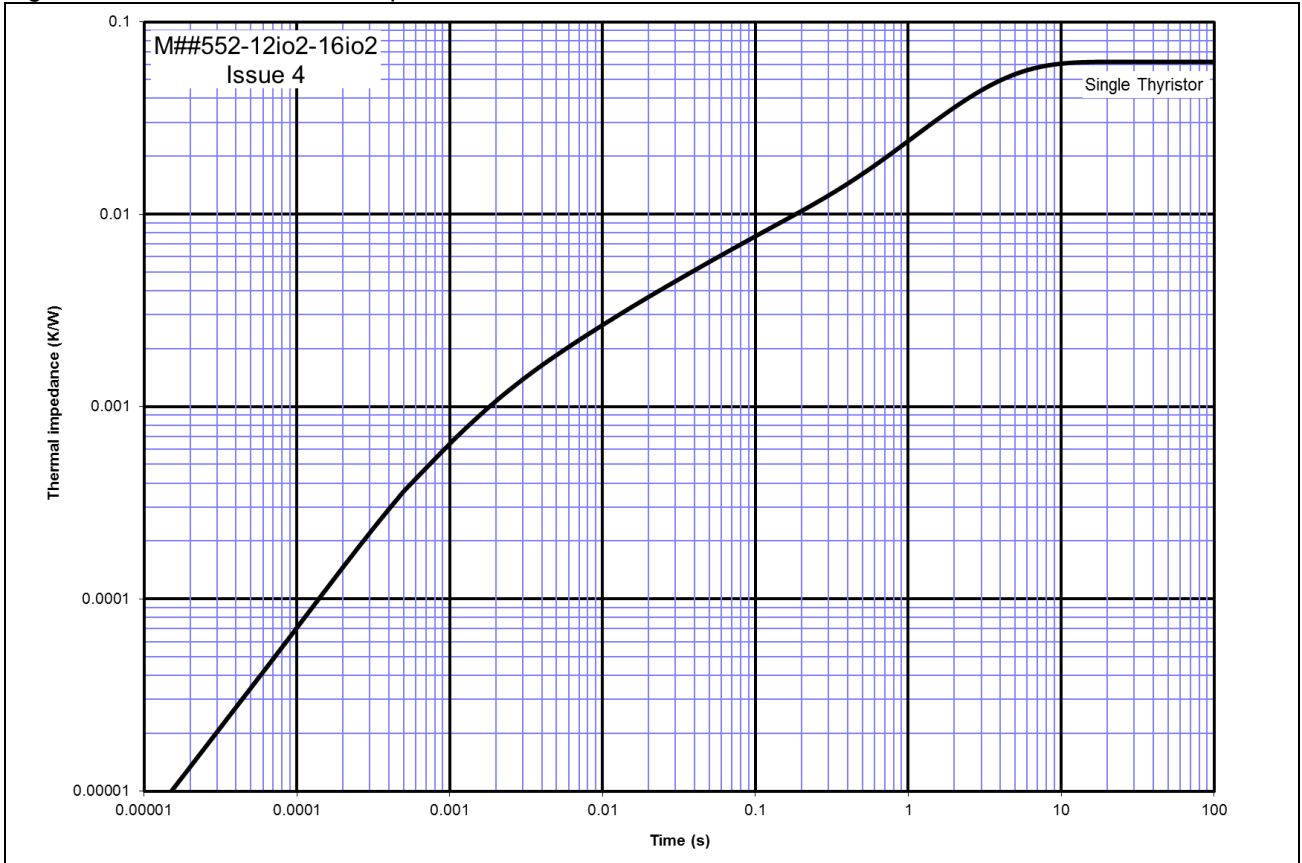
Outline Drawing & Ordering Information

150A123

ORDERING INFORMATION				(Please quote 11 digit code as below)	
M	**##**	**552**	**♦♦**	**io**	**2**
Fixed Type Code	Configuration code CC, CD or DC	Fixed Type Code	Voltage code V_{RRM}/100 12-16	i = Critical dv/dt 1000 V/µs o = Typical turn-off time	Fixed Version Code
Typical order code: MCC552-14io2– MCC configuration, 1400V V_{RRM}					