Advance Data
High Power Sonic FRD
Type E1780TG65E

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{RRM}	Repetitive peak reverse voltage, (note 1)	6500	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	6600	V
$V_{R(d.c.)}$	Maximum reverse d.c. voltage (note 1)	3600	V

	OTHER RATINGS (note 6)	MAXIMUM LIMITS	UNITS
$I_{F(AV)M}$	Mean forward current, T_{sink}=55°C, (note 2)	1780	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 2)	1109	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 3)	598	A
$I_{F(AV)M}$	Mean forward current. T_{sink}=100°C, (note 4)	780	A
$I_{F(RMS)}$	Nominal RMS forward current, T_{sink}=25°C, (note 2)	3354	A
$I_{F(d.c.)}$	D.C. forward current, T_{sink}=25°C, (note 5)	3023	A
I_{FSM}	Peak non-repetitive surge t_p=10ms, V_{RM}=60%V_{RRM}, (note 6)	25.6	kA
I_{FSM2}	Peak non-repetitive surge t_p=10ms, V_{RM}≤10V, (note 6)	28.2	kA
I^2t	I^2t capacity for fusing t_p=10ms, V_{RM}=60%V_{RRM}, (note 6)	$3.29{\times}10^6$	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, V_{RM}≤10V, (note 6)	$3.98{\times}10^6$	A^2s
P_{rr}	Maximum non-repetitive peak reverse recovery power, (note 8)	7	MW
$T_{j\ op}$	Operating temperature range	-40 to +140	°C
T_{stg}	Storage temperature range	-40 to +150	°C

Notes:-
1) De-rating factor of 0.13% per °C is applicable for T_j below 25°C.
2) Double side cooled, single phase; 50Hz, 180° half-sinewave.
3) Anode side cooled, single phase; 50Hz, 180° half-sinewave.
4) Cathode side cooled, single phase; 50Hz, 180° half-sinewave.
5) Double side cooled.
6) Half-sinewave, 140°C T_j initial.
7) Current (I_F) ratings have been calculated using V_{T0} and r_T (see page 2)
8) T_j=T_{jop}, I_F=1375A, di/dt=3500A/µs V_r=3600V and L_s=200nH. Test circuit and sample waveform are shown in diagram 1. IGBT type T1375DF65E used as switch.

Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V_{FM}	Maximum peak forward voltage	-	3.2	3.37	I_{FM}=1375A	V
		-	3.6	3.83	I_{FM}=1780A	
V_{T0}	Threshold voltage	-	-	2.021	Current range 1375A – 4125A (Note 2)	V
r_T	Slope resistance	-	-	0.983		mΩ
V_{T0}	Threshold voltage	-	-	2.2	Current range 1780A – 5340A (Note 2)	V
r_T	Slope resistance	-	-	0.917		mΩ
V_{FRM}	Maximum forward recovery voltage	-	-	340	di/dt = 3000A/µs, T_j=25°C	V
		-	-	600	di/dt = 3000A/µs	
I_{RRM}	Peak reverse current	-	-	1	Rated V_{RRM}, T_j=25°C	mA
		-	-	100	Rated V_{RRM}	
Q_{rr}		-	3500	4200	I_{FM}=1375A, t_p=1ms, di/dt=3500A/µs, V_r=3600V, 50% Chord. IGBT type T1375DF65E used as switch	µC
Q_{ra}	Maximum peak forward voltage	-	970	-		µC
I_{rm}		-	1590	1750		A
t_{rr}	Threshold voltage	-	1.22	-		µs
E_{rr}	Slope resistance	-	10	11.5		J
R_{thJK}	Thermal resistance, junction to heatsink	-	-	0.0077	Double side cooled	K/kW
		-	-	0.0129	Cathode side cooled	K/kW
		-	-	0.0188	Anode side cooled	K/kW
F	Mounting force	50	-	60	Note 3)	kN
W_t	Weight	-	1.15	-		kg

Notes:-
1) Unless otherwise indicated T_j=140°C.
2) V_{T0} and r_T were used to calculate the current ratings on page 1.
3) For clamp forces outside these limits, please consult factory.

Additional information on Ratings and Characteristics

1.0 De-rating Factor

A blocking voltage de-rating factor of 0.13% per °C is applicable to this device for T_j below 25°C.
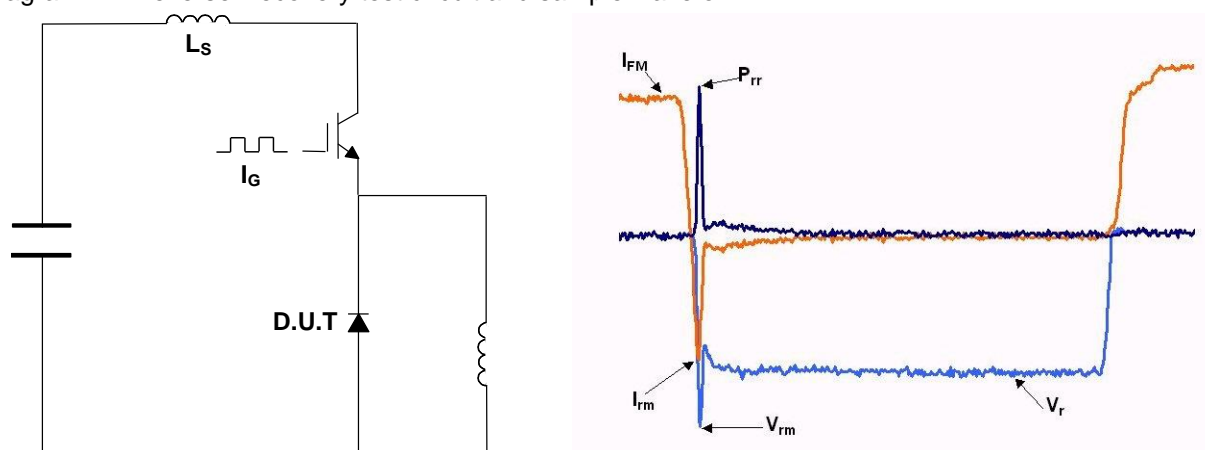
2.0 ABCD Constants

These constants (applicable only over current range of V_F characteristic in Figure 1) are the coefficients of the expression for the forward characteristic given below:

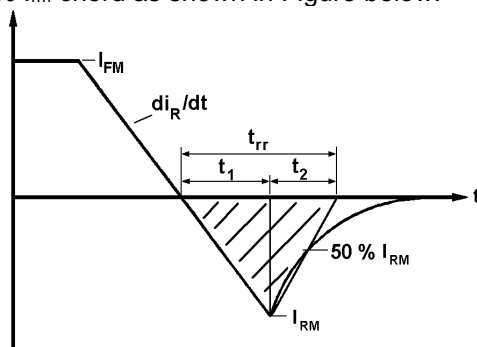$$V_F = A + B \cdot \ln(I_F) + C \cdot I_F + D \cdot \sqrt{I_F}$$

where I_F = instantaneous forward current.

3.0 Reverse recovery ratings

Diagram 1 – Reverse Recovery test circuit and sample waveform

(i) Q_{ra} is based on 50% I_{rm} chord as shown in Figure below.

(ii) Q_{rr} is based on a 40µs integration time.

I.e.
$$Q_{rr} = \int_0^{40\,\mu s} i_{rr}.dt$$

(iii)

$$K\ Factor = \frac{t_1}{t_2}$$

4.0 Reverse Recovery Loss

The following procedure is recommended for use where it is necessary to include reverse recovery loss.

From waveforms of recovery current obtained from a high frequency shunt (see Note 1) and reverse voltage present during recovery, an instantaneous reverse recovery loss waveform must be constructed. Let the area under this waveform be E joules per pulse. A new sink temperature can then be evaluated from:

$$T_{SINK} = T_{J(MAX)} - E \cdot \left[k + f \cdot R_{th(J-Hs)} \right]$$

Where k = 0.2314 (°C/W)/s

E = Area under reverse loss waveform per pulse in joules (W.s.)
f = Rated frequency in Hz at the original sink temperature.
$R_{th(J-Hs)}$ = d.c. thermal resistance (°C/W)

The total dissipation is now given by:

$$W_{(tot)} = W_{(original)} + E \cdot f$$

NOTE 1 - Reverse Recovery Loss by Measurement

This device has a low reverse recovered charge and peak reverse recovery current. When measuring the charge, care must be taken to ensure that:

(a) AC coupled devices such as current transformers are not affected by prior passage of high amplitude forward current.

(b) A suitable, polarised, clipping circuit must be connected to the input of the measuring oscilloscope to avoid overloading the internal amplifiers by the relatively high amplitude forward current signal.

(c) Measurement of reverse recovery waveform should be carried out with an appropriate critically damped snubber, connected across diode anode to cathode. The formula used for the calculation of this snubber is shown below:

$$R^2 = 4 \cdot \frac{V_r}{C_s \cdot \frac{di}{dt}}$$

Where: V_r = Commutating source voltage
C_s = Snubber capacitance
R = Snubber resistance

5.0 Computer Modelling Parameters

5.1 Device Dissipation Calculations

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

Where V_{T0} =2.2V, r_T =0.917mΩ

ff = form factor (normally unity for fast diode applications)

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

$$\Delta T = T_{j(MAX)} - T_K$$

5.2 Calculation of V_F using ABCD Coefficients

The forward characteristic I_F Vs V_F, on page 6 is represented in two ways;
(i)   the well established V_{T0} and r_T tangent used for rating purposes and
(ii)   a set of constants A, B, C, and D forming the coefficients of the representative equation for V_F in terms of I_F given below:

$$V_F = A + B \cdot \ln(I_F) + C \cdot I_F + D \cdot \sqrt{I_F}$$

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

	25°C Coefficients	140°C Coefficients
A	0.5555358	0.4100598
B	0.1386516	0.06491253
C	3.450368×10^{-4}	4.624684×10^{-4}
D	0.02959373	0.05008258

Curves

Figure 1 – Forward characteristics of limit device
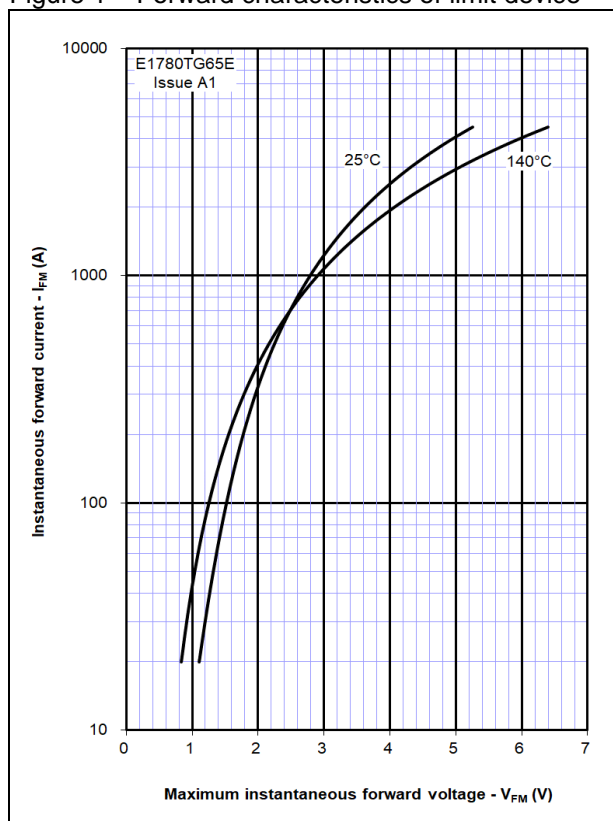
Figure 2 – Maximum forward recovery voltage
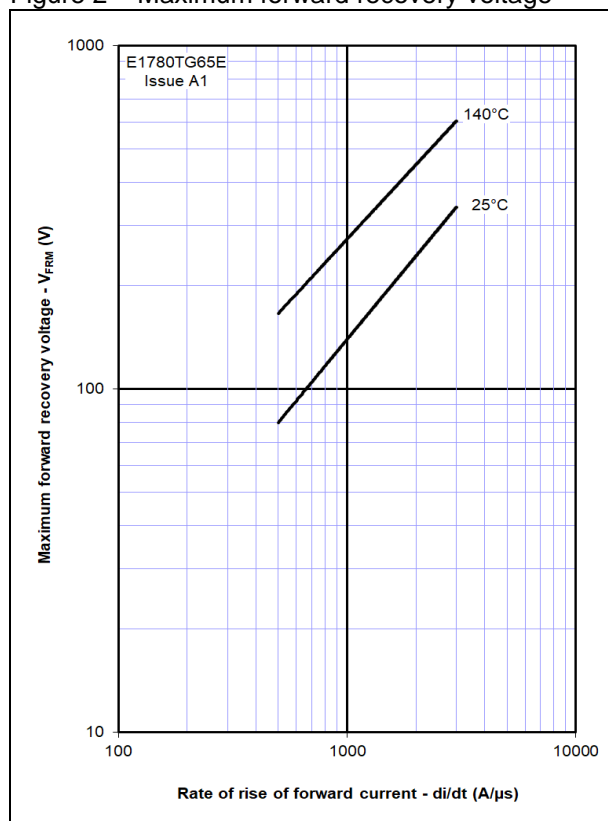
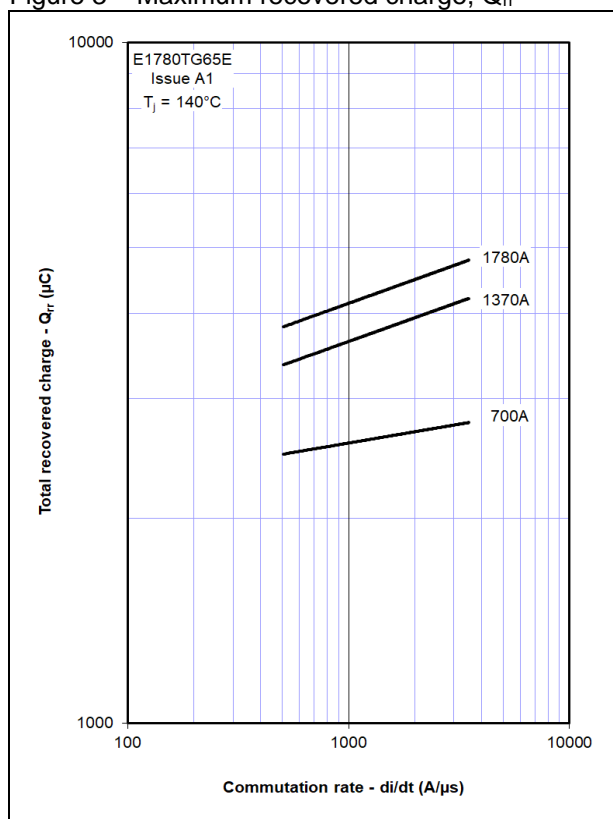### Figure 3 – Maximum recovered charge, Q_{rr}

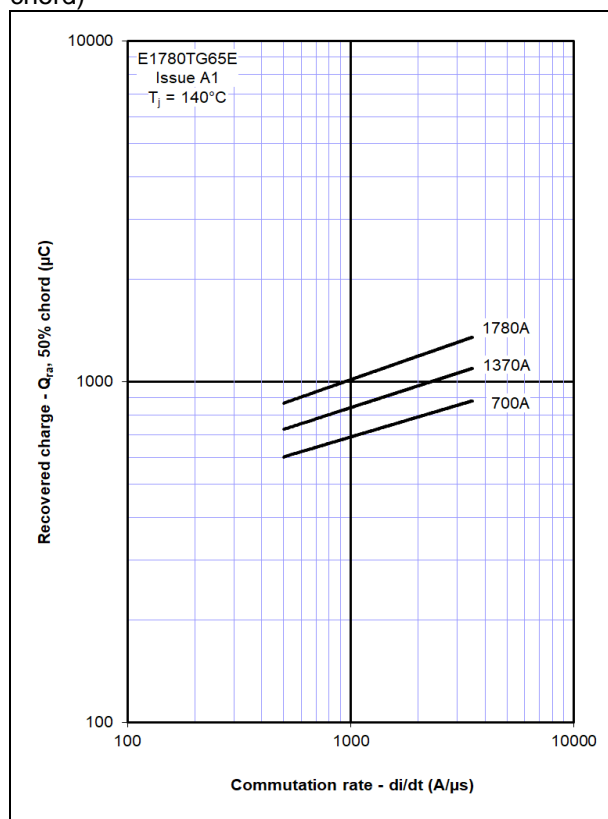### Figure 4 – Maximum recovery charge, Q_{ra} (50% chord)
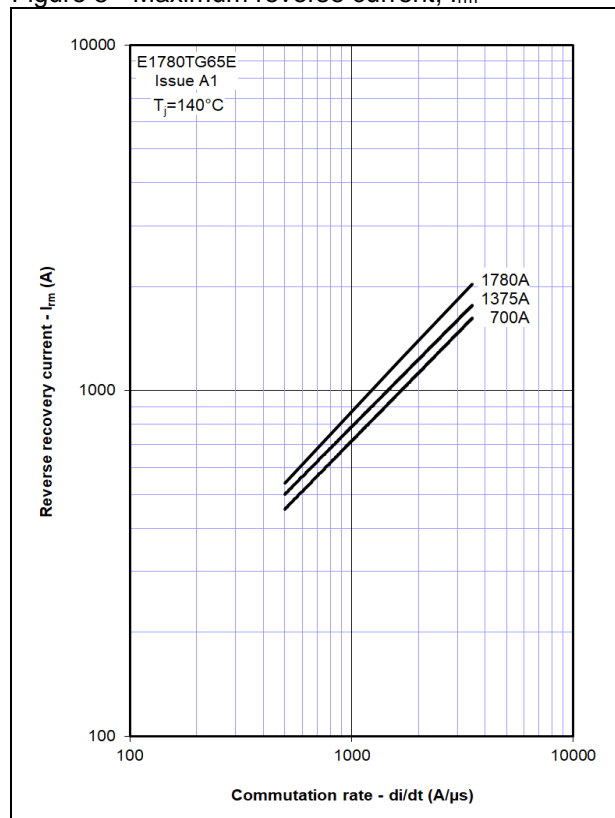
Figure 5 - Maximum reverse current, I$_{rm}$

E1780TG65E
Issue A1
T$_j$=140°C

1780A
1375A
700A

Reverse recovery current - I$_{rm}$ (A)

Commutation rate - di/dt (A/µs)

Figure 6 – Maximum recovery time, t$_{rr}$ (50% chord)

E1780TG65E
Issue A1
T$_j$ = 140°C

1780A
1375A
700A

Recovery time - t$_{rr}$ 50% chord (µs)

Commutation rate - di/dt (A/µs)
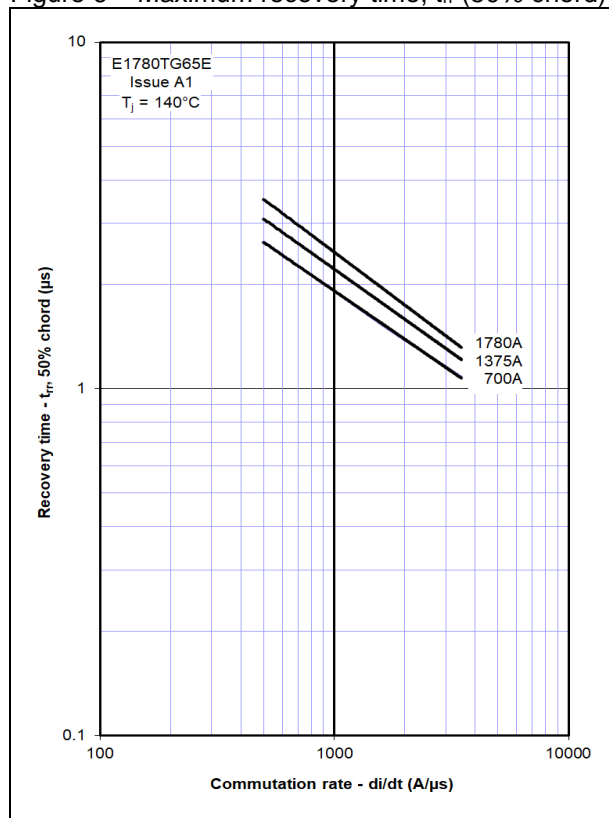
Figure 7 – Reverse recovery energy per pulse

E1780TG65E
Issue A1
T$_j$ = 140°C
V$_r$ = 3600V

Measured
without
snubber

1780A
1375A
700A

Reverse recovery energy per pulse - E$_r$ (J)

Commutation rate - di/dt (A/µs)
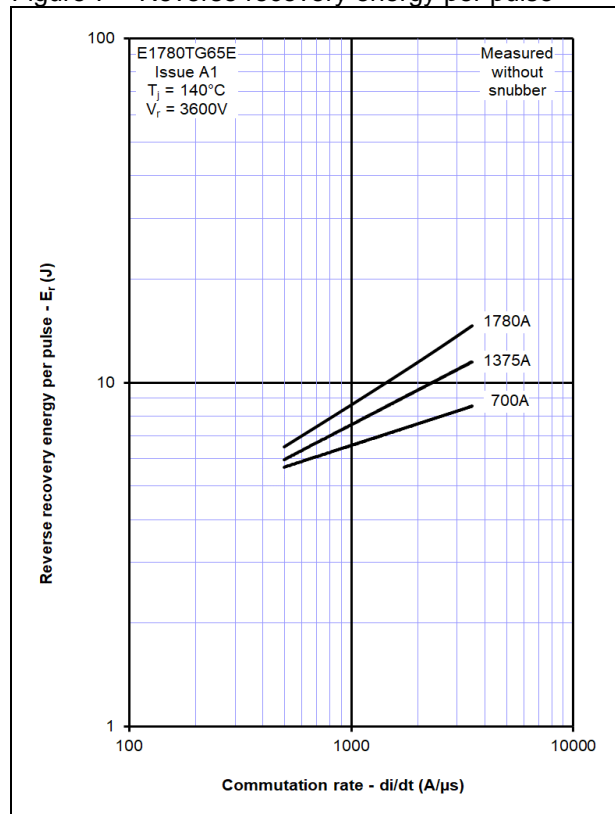
Figure 8 – Safe operating area

T$_j$ = 140°C
di/dt = 3500A/µs
L$_S$ < 120nH

E1780TG65E
Issue A1

Reverse recovery current - I$_r$ (A)

Reverse recovery voltage - V$_r$ (V)
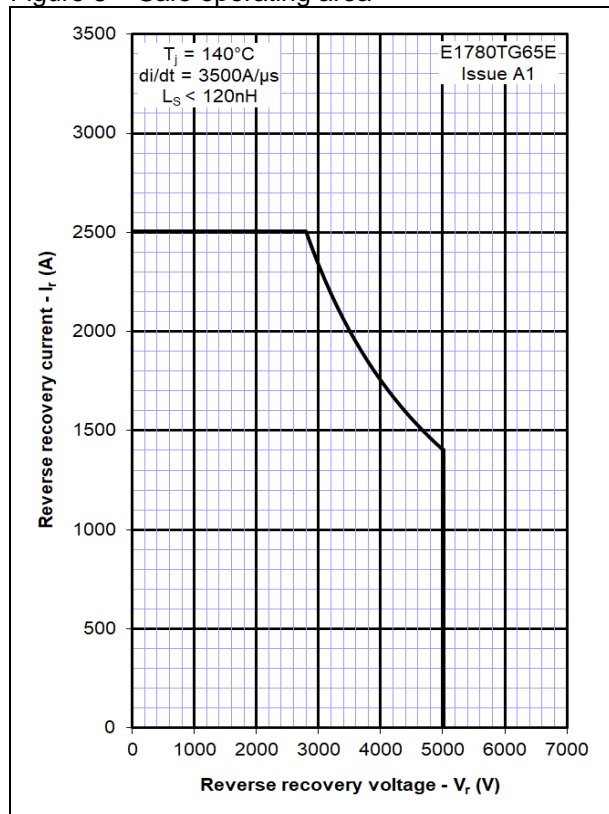
Figure 9 – Transient thermal impedance
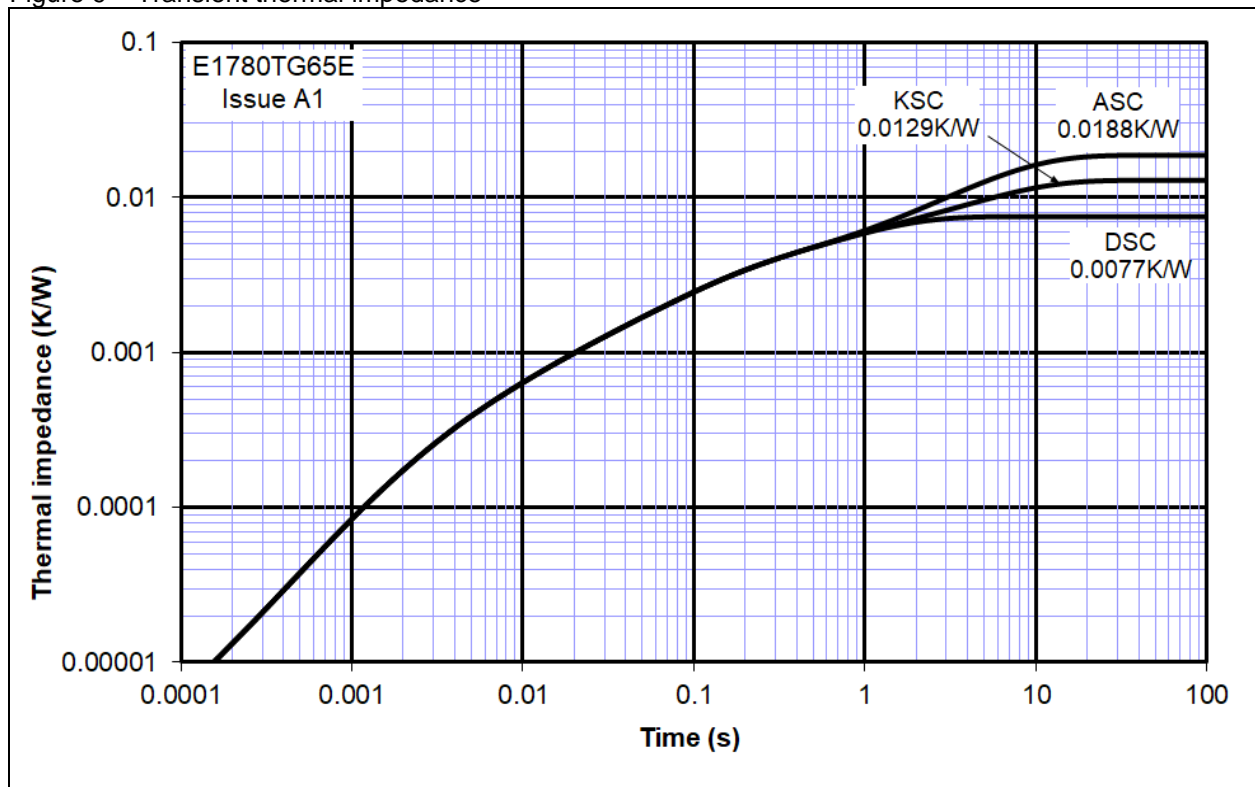
Figure 10 – Maximum surge and I²t ratings
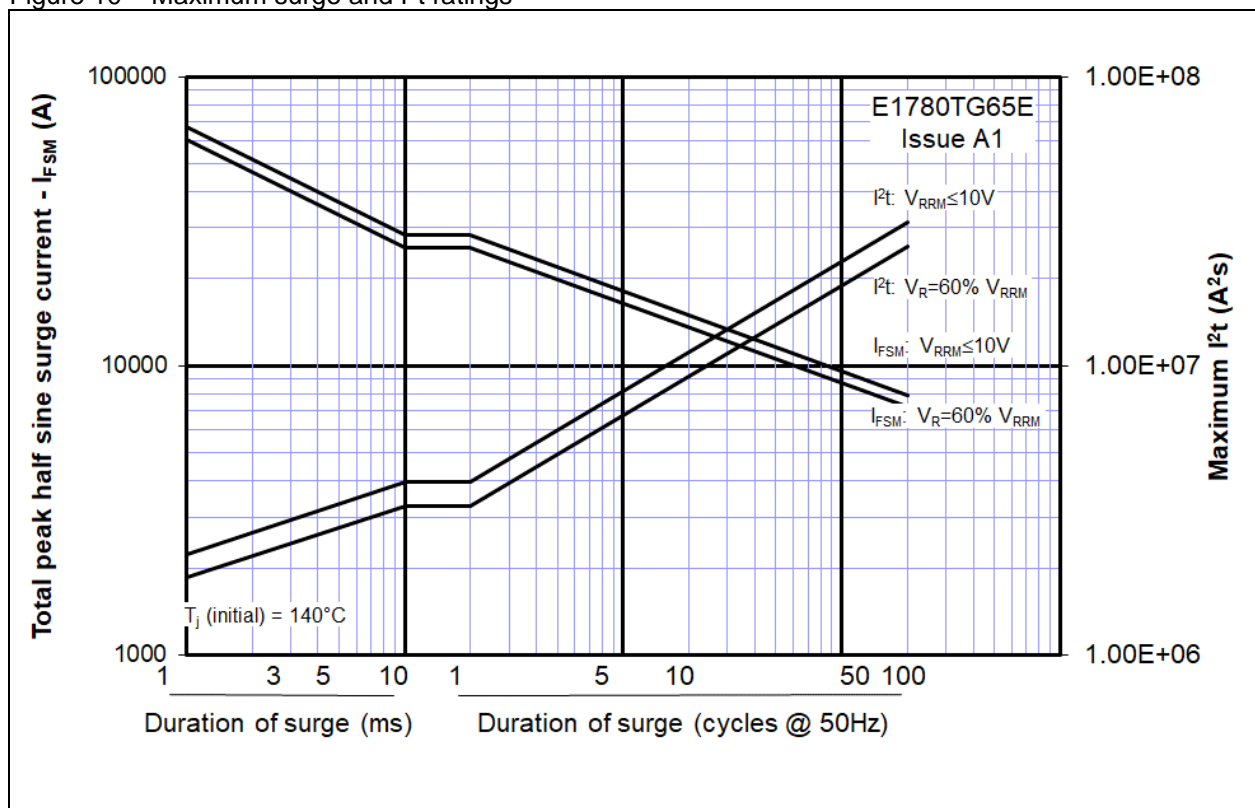
Outline Drawing & Ordering Information

Ø3.6/3.5 x 2 MIN DEPTH 2-HOLES, ONE IN CATHODE AND ONE IN ANODE

Ø 112 MAX
Ø75
Ø75
1 MIN
1 MIN
COMPRESSED HEIGHT Ø30 ±1
105.6 MAX OVER CONVOLUTIONS

100A400
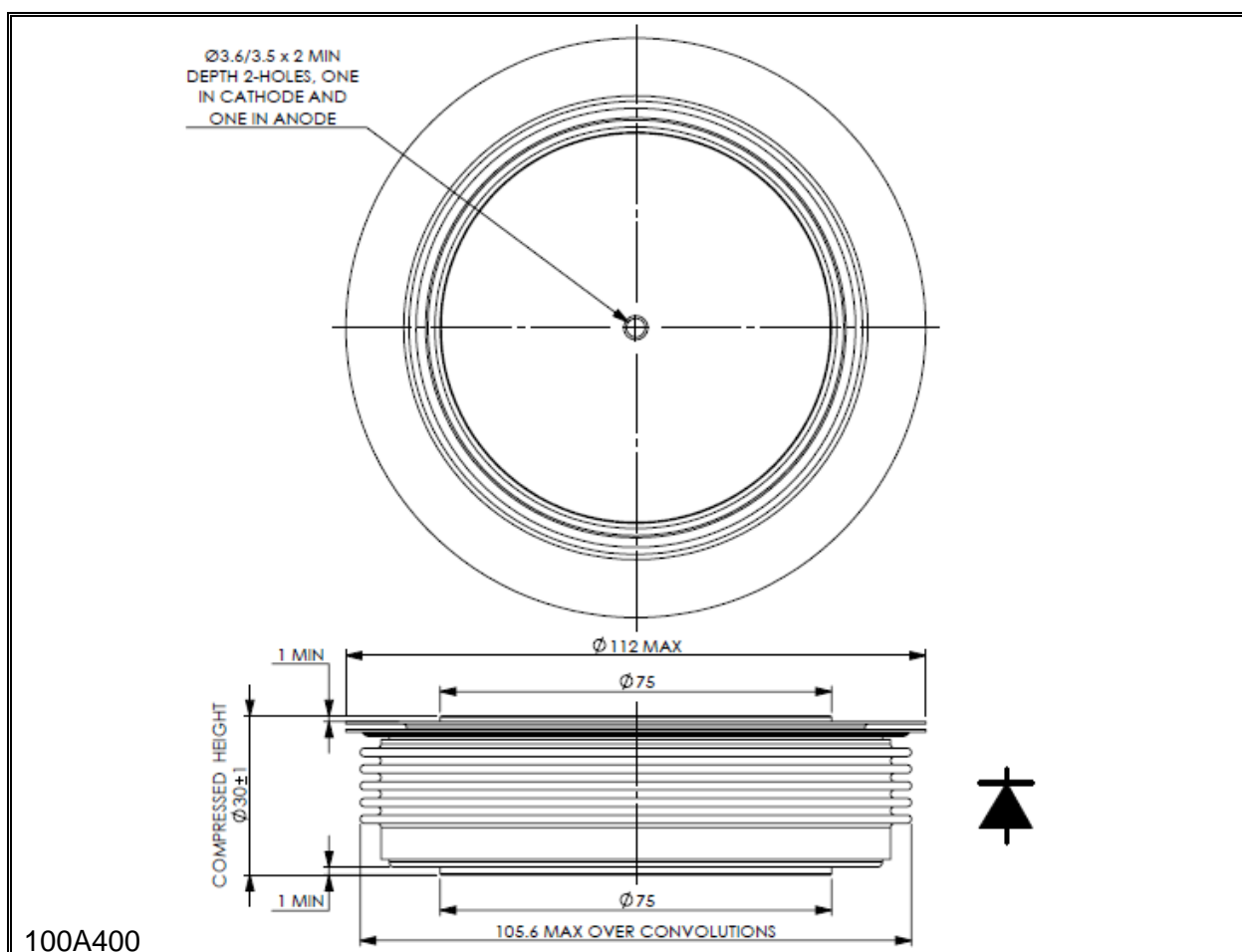
ORDERING INFORMATION
(Please quote 10 digit code as below)

E1780	TG	65	E
Fixed Type Code	Fixed Outline code	Fixed voltage code V_{RRM}/100 65	Fixed code, product series

Order code: E1780TG65E – 6500V V_{RRM}, 30mm clamp height capsule.

IXYS Long Beach Inc
2500 Mira Mar Avenue
Long Beach CA 90815 USA
Tel: +1 (562) 296 6584
Fax: +1 (562) 296 6585
Email: service@ixyslongbeach.com

![IXYS A Littelfuse Technology]

IXYS UK Westcode Ltd
Langley Park Way, Langley Park,
Chippenham, Wiltshire, SN15 1GE.
Tel: +44 (0)1249 455500
Fax: +44 (0)1249 659448
E-mail: sales@ixysuk.com

www.littelfuse.com

https://www.littelfuse.com/products/power-semiconductors/high-power.aspx

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