

## PrimePACK™2 module with TRENCHSTOP™ IGBT7 and emitter controlled 7 diode and NTC

### Features

- Electrical features
  - $V_{CES} = 1200\text{ V}$
  - $I_{C\text{nom}} = 1600\text{ A} / I_{CRM} = 3200\text{ A}$
  - Extended operating temperature  $T_{vj\text{op}}$
  - Low  $V_{CE,\text{sat}}$
- Mechanical features
  - 4 kV AC 1 min insulation
  - High creepage and clearance distances
  - High power and thermal cycling capability
  - High power density



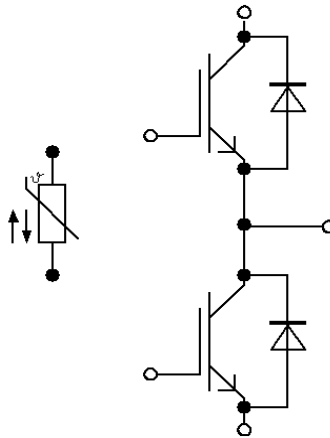
### Potential applications

- Motor drives
- Construction, commercial, and agriculture vehicles
- UPS systems
- Energy storage systems

### Product validation

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

### Description



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## 1 Package

**Table 1** Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	$V_{ISOL}$	RMS, $f = 50$ Hz, $t = 60$ s	4.0	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	$Al_2O_3$	
Creepage distance	$d_{Creep}$	terminal to heatsink	33.0	mm
Creepage distance	$d_{Creep}$	terminal to terminal	33.0	mm
Clearance	$d_{Clear}$	terminal to heatsink	19.0	mm
Clearance	$d_{Clear}$	terminal to terminal	19.0	mm
Comparative tracking index	$CTI$		> 400	

**Table 2** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray inductance module	$L_{SCE}$			18		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C = 25^\circ C$ , per switch		0.22		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25^\circ C$ , per switch		0.3		mΩ
Storage temperature	$T_{stg}$		-40		150	°C
Mounting torque for module mounting	$M$	- Mounting according to valid application note	M5, Screw	3	6	Nm
Terminal connection torque	$M$	- Mounting according to valid application note	M4, Screw	1.8	2.1	Nm
			M8, Screw	8	10	
Weight	$G$			825		g

## 2 IGBT, Inverter

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	$V_{CES}$	$T_{vj} = 25^\circ C$	1200	V
Implemented collector current	$I_{CN}$		1600	A
Continuous DC collector current	$I_{CDC}$	$T_{vj\ max} = 175^\circ C$ $T_C = 90^\circ C$	1600	A

(table continues...)

**Table 3 (continued) Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{vj\ op}$	3200	A
Gate-emitter peak voltage	$V_{GES}$		±20	V

**Table 4 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\ sat}$	$I_C = 1600\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.27	1.79	V
			$T_{vj} = 125\ ^\circ C$	1.37	1.82	
			$T_{vj} = 175\ ^\circ C$	1.43	1.85	
Gate threshold voltage	$V_{GEth}$	$I_C = 32\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.15	5.80	6.45	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\ V, V_{CC} = 600\ V$		25.4		µC
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\ ^\circ C$		0.5		Ω
Input capacitance	$C_{ies}$	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		217		nF
Reverse transfer capacitance	$C_{res}$	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		1.28		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 1200\ V, V_{GE} = 0\ V$			5	mA
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\ V, V_{GE} = 20\ V, T_{vj} = 25\ ^\circ C$			400	nA
Turn-on delay time (inductive load)	$t_{don}$	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.35\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.700		µs
			$T_{vj} = 125\ ^\circ C$	0.800		
			$T_{vj} = 175\ ^\circ C$	0.870		
Rise time (inductive load)	$t_r$	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.35\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.130		µs
			$T_{vj} = 125\ ^\circ C$	0.150		
			$T_{vj} = 175\ ^\circ C$	0.160		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 1\ \Omega$	$T_{vj} = 25\ ^\circ C$	1.050		µs
			$T_{vj} = 125\ ^\circ C$	1.150		
			$T_{vj} = 175\ ^\circ C$	1.250		
Fall time (inductive load)	$t_f$	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 1\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.200		µs
			$T_{vj} = 125\ ^\circ C$	0.400		
			$T_{vj} = 175\ ^\circ C$	0.500		
Turn-on energy loss per pulse	$E_{on}$	$I_C = 1600\ A, V_{CC} = 600\ V, L_\sigma = 30\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 0.35\ \Omega, di/dt = 9350\ A/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	125		mJ
			$T_{vj} = 125\ ^\circ C$	225		
			$T_{vj} = 175\ ^\circ C$	290		

(table continues...)

**Table 4 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off energy loss per pulse	$E_{off}$	$I_C = 1600\text{ A}, V_{CC} = 600\text{ V}, L_\sigma = 30\text{ nH}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 1\ \Omega, dv/dt = 2100\text{ V}/\mu\text{s} (T_{vj} = 175\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	260		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	360		
			$T_{vj} = 175\text{ }^\circ\text{C}$	410		
SC data	$I_{SC}$	$V_{GE} \leq 15\text{ V}, V_{CC} = 800\text{ V}, V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_p \leq 6\ \mu\text{s}, T_{vj} \leq 150\text{ }^\circ\text{C}$	5300		A
			$t_p \leq 6\ \mu\text{s}, T_{vj} \leq 175\text{ }^\circ\text{C}$	5100		
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			27.4	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT		20.6		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-40		175	$^\circ\text{C}$

Note: Maximum RMS module DC-terminal current according to application note AN2009-08.

$T_{vj\ op} > 150\text{ }^\circ\text{C}$  is only allowed for operation at overload conditions. For detailed specifications please refer to AN2018-14.

### 3 Diode, Inverter

**Table 5 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1200	V	
Continuous DC forward current	$I_F$		1600	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	3200	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}, V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	150	kA <sup>2</sup> s
			$T_{vj} = 175\text{ }^\circ\text{C}$	145	

**Table 6 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$I_F = 1600\text{ A}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1.70	2.03	V
			$T_{vj} = 125\text{ }^\circ\text{C}$	1.65	1.96	
			$T_{vj} = 175\text{ }^\circ\text{C}$	1.55	1.91	

(table continues...)

**Table 6 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Peak reverse recovery current	$I_{RM}$	$V_{CC} = 600\text{ V}, I_F = 1600\text{ A}, V_{GE} = -15\text{ V}, -di_F/dt = 9350\text{ A}/\mu\text{s} (T_{vj} = 175\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	865		A
			$T_{vj} = 125\text{ }^\circ\text{C}$	1080		
			$T_{vj} = 175\text{ }^\circ\text{C}$	1180		
Recovered charge	$Q_r$	$V_{CC} = 600\text{ V}, I_F = 1600\text{ A}, V_{GE} = -15\text{ V}, -di_F/dt = 9350\text{ A}/\mu\text{s} (T_{vj} = 175\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	160		$\mu\text{C}$
			$T_{vj} = 125\text{ }^\circ\text{C}$	305		
			$T_{vj} = 175\text{ }^\circ\text{C}$	400		
Reverse recovery energy	$E_{rec}$	$V_{CC} = 600\text{ V}, I_F = 1600\text{ A}, V_{GE} = -15\text{ V}, -di_F/dt = 9350\text{ A}/\mu\text{s} (T_{vj} = 175\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	75		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	130		
			$T_{vj} = 175\text{ }^\circ\text{C}$	170		
Thermal resistance, junction to case	$R_{thJC}$	per diode			50.7	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode		25.2		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$		-40		175	$^\circ\text{C}$

Note:  $T_{vj\text{ op}} > 150\text{ }^\circ\text{C}$  is only allowed for operation at overload conditions. For detailed specifications please refer to AN2018-14.

## 4 NTC-Thermistor

**Table 7 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	$R_{25}$	$T_{NTC} = 25\text{ }^\circ\text{C}$		5		k $\Omega$
Deviation of $R_{100}$	$\Delta R/R$	$T_{NTC} = 100\text{ }^\circ\text{C}, R_{100} = 493\text{ }\Omega$	-5		5	%
Power dissipation	$P_{25}$	$T_{NTC} = 25\text{ }^\circ\text{C}$			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\text{ K}))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15\text{ K}))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\text{ K}))]$		3433		K

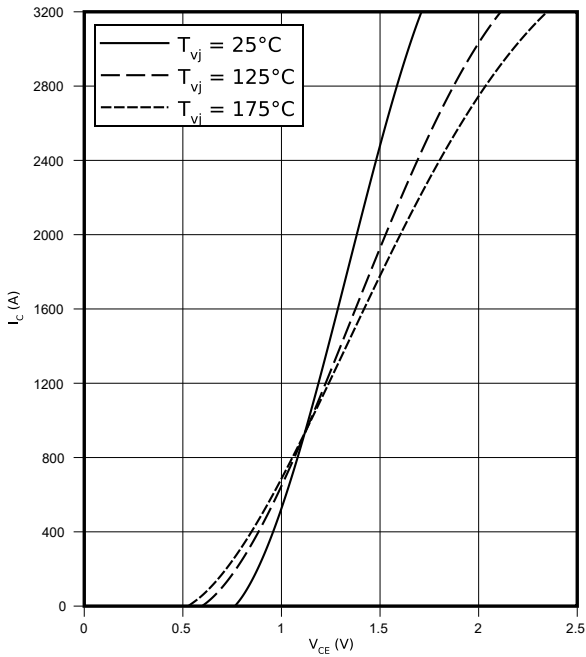
Note: For detailed specifications please refer to AN2009-10.

## 5 Characteristics diagrams

### Output characteristic (typical), IGBT, Inverter

$$I_C = f(V_{CE})$$

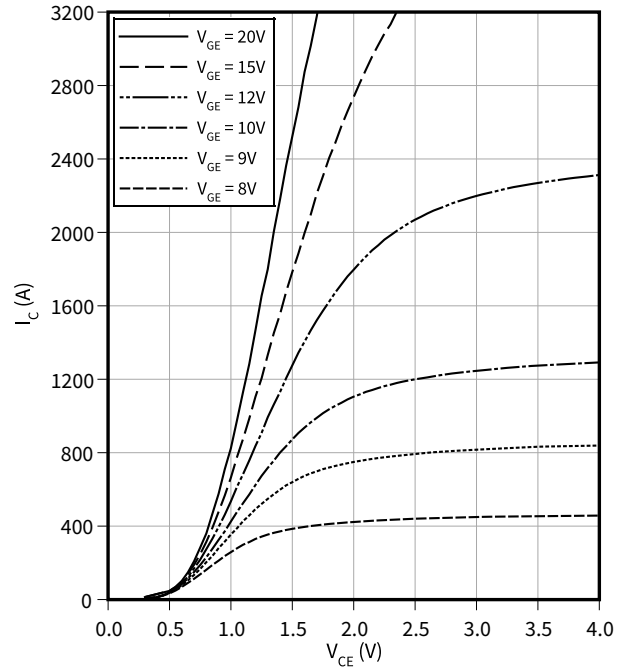
$$V_{GE} = 15 \text{ V}$$



### Output characteristic field (typical), IGBT, Inverter

$$I_C = f(V_{CE})$$

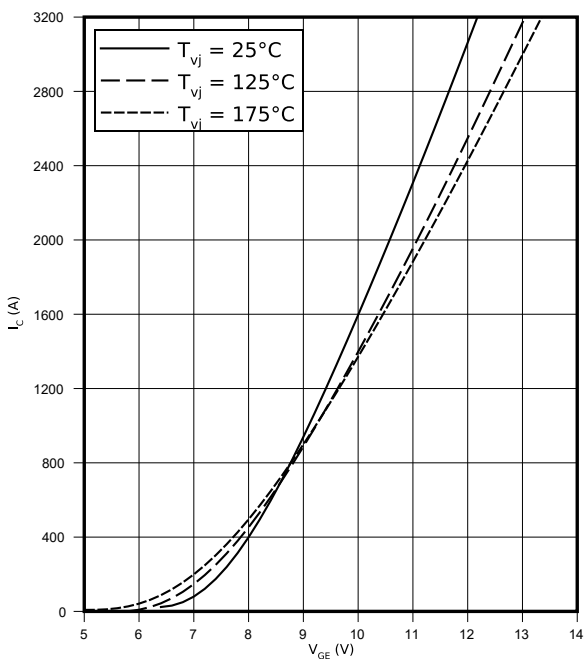
$$T_{vj} = 175 \text{ °C}$$



### Transfer characteristic (typical), IGBT, Inverter

$$I_C = f(V_{GE})$$

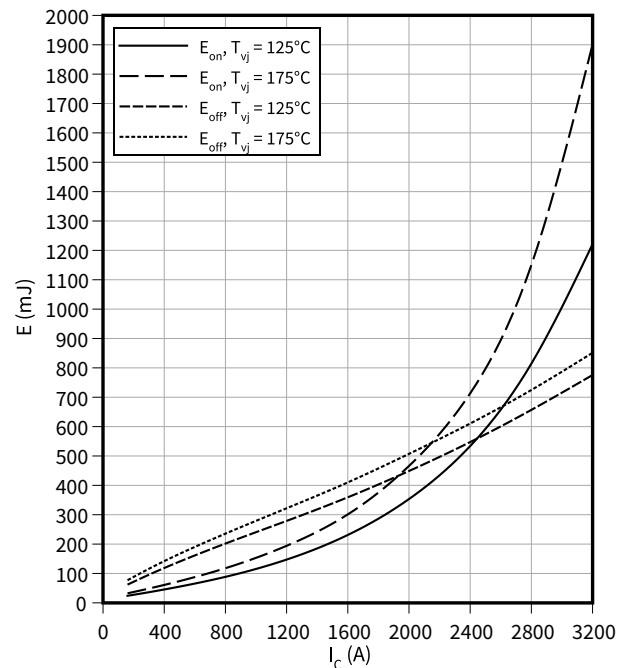
$$V_{CE} = 20 \text{ V}$$



### Switching losses (typical), IGBT, Inverter

$$E = f(I_C)$$

$$R_{Goff} = 1 \text{ } \Omega, R_{Gon} = 0.35 \text{ } \Omega, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}$$

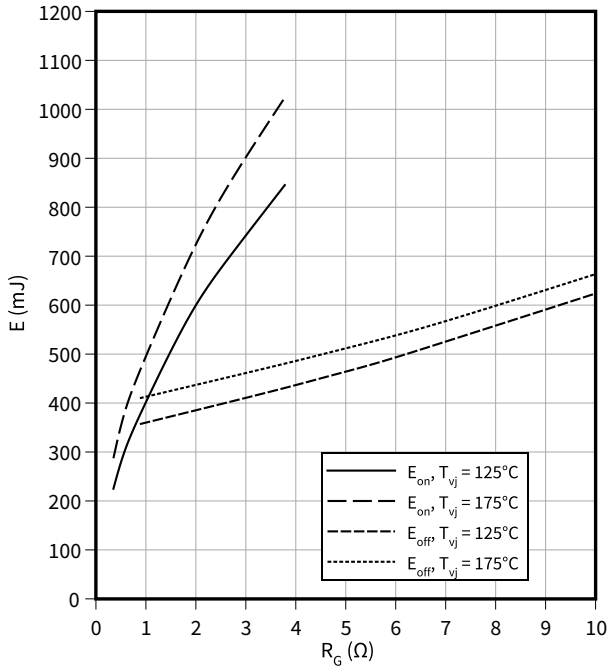


5 Characteristics diagrams

**Switching losses (typical), IGBT, Inverter**

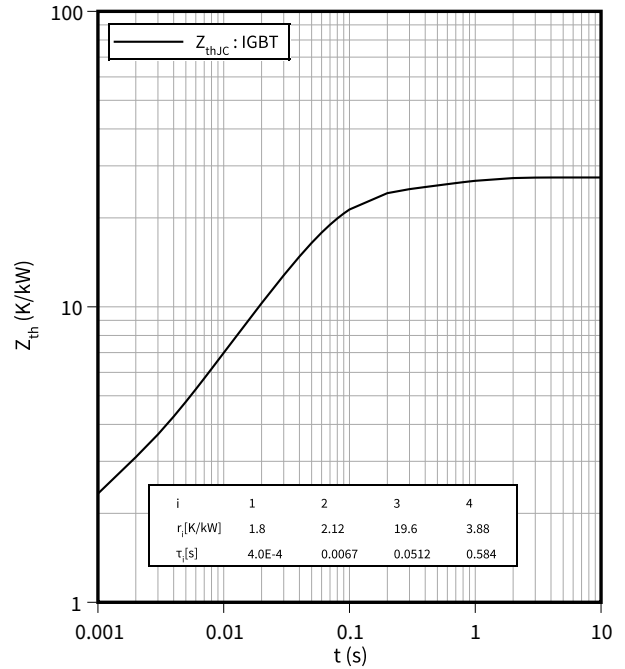
$E = f(R_G)$

$I_C = 1600 \text{ A}, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}$



**Transient thermal impedance, IGBT, Inverter**

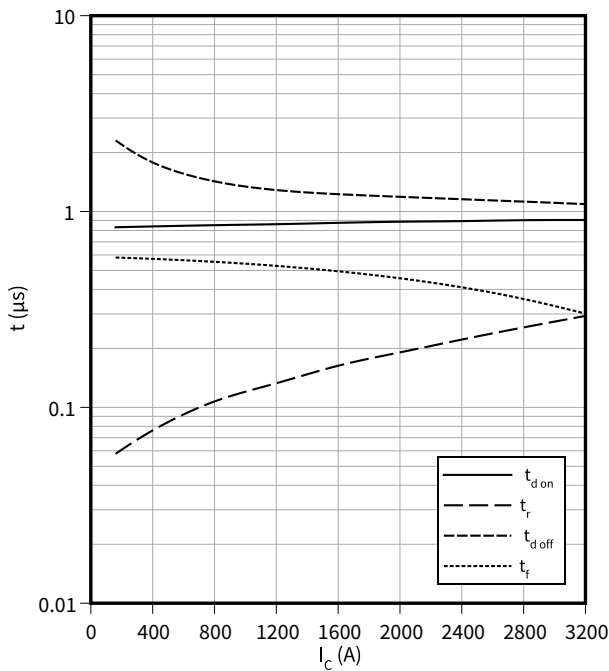
$Z_{th} = f(t)$



**Switching times (typical), IGBT, Inverter**

$t = f(I_C)$

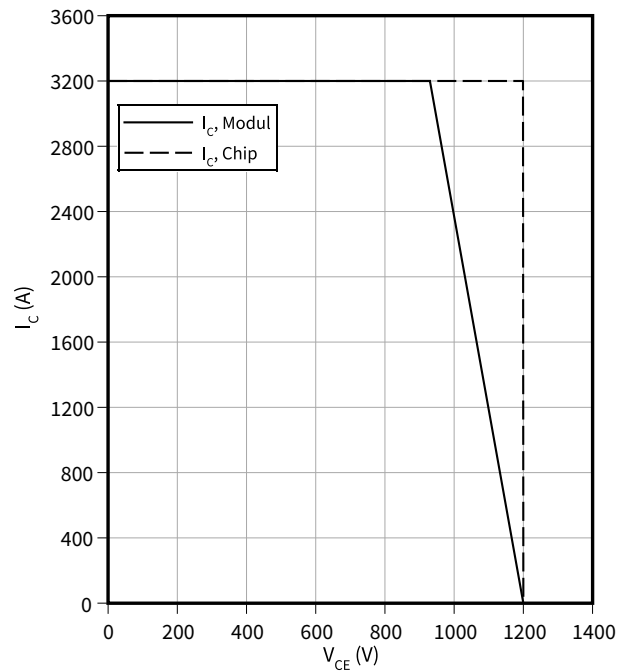
$R_{Goff} = 1 \Omega, R_{Gon} = 0.35 \Omega, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 175 \text{ °C}$



**Reverse bias safe operating area (RBSOA), IGBT, Inverter**

$I_C = f(V_{CE})$

$R_{Goff} = 1 \Omega, V_{GE} = \pm 15 \text{ V}, T_{vj} = 175 \text{ °C}$

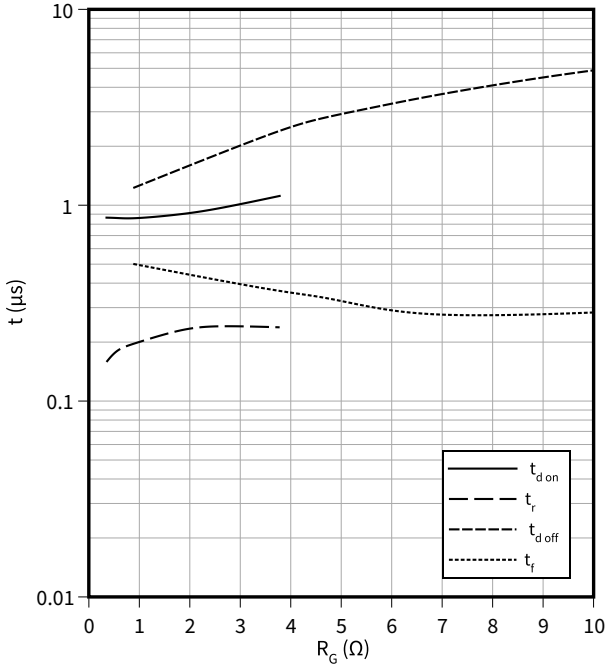




**Switching times (typical), IGBT, Inverter**

$t = f(R_G)$

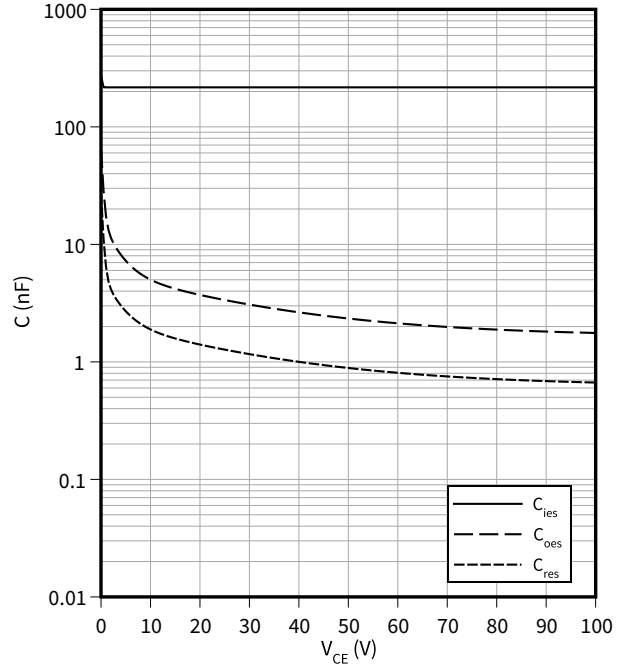
$I_C = 1600 \text{ A}$ ,  $V_{CC} = 600 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $T_{vj} = 175 \text{ }^\circ\text{C}$



**Capacity characteristic (typical), IGBT, Inverter**

$C = f(V_{CE})$

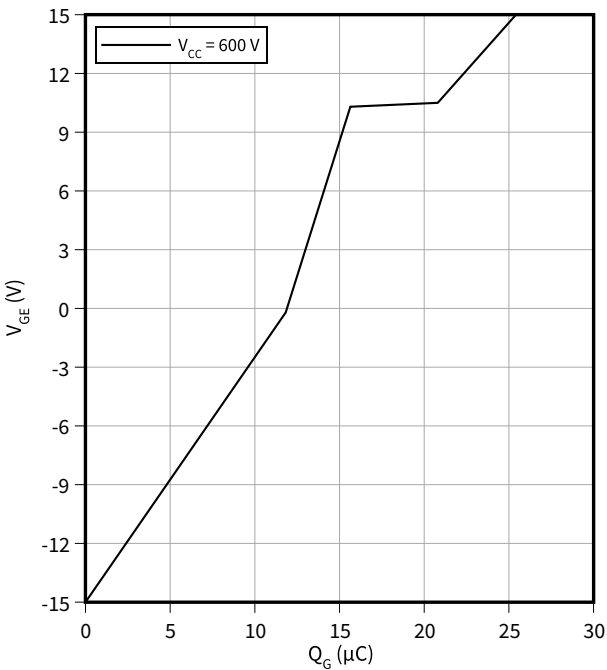
$f = 100 \text{ kHz}$ ,  $V_{GE} = 0 \text{ V}$ ,  $T_{vj} = 25 \text{ }^\circ\text{C}$



**Gate charge characteristic (typical), IGBT, Inverter**

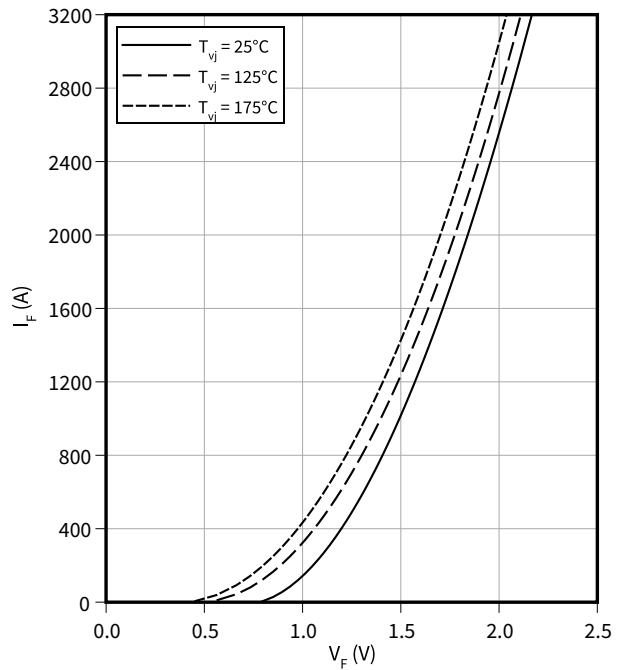
$V_{GE} = f(Q_G)$

$I_C = 1600 \text{ A}$ ,  $T_{vj} = 25 \text{ }^\circ\text{C}$



**Forward characteristic (typical), Diode, Inverter**

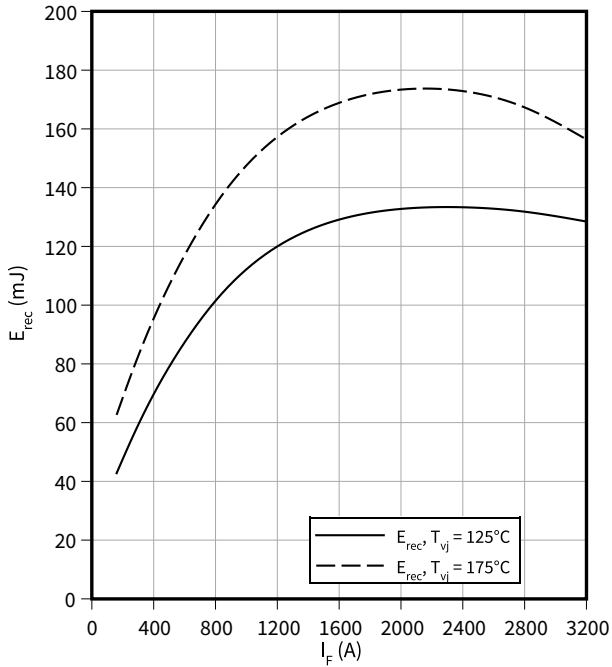
$I_F = f(V_F)$



**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(I_F)$

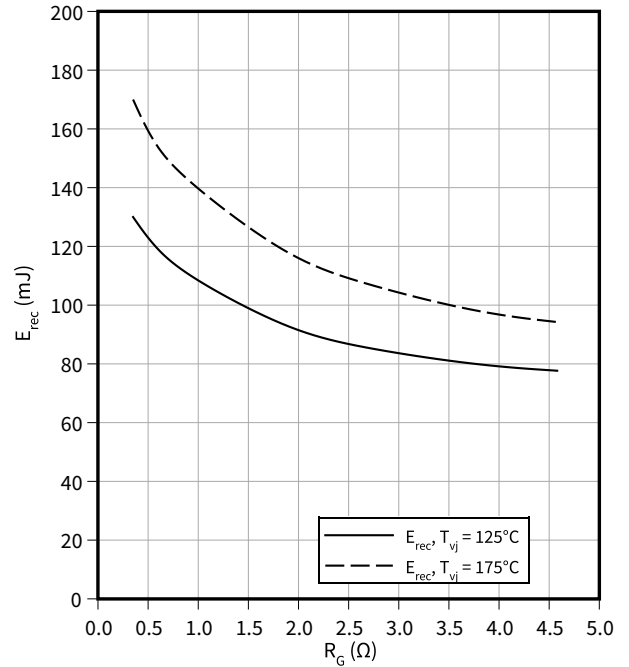
$R_{Gon} = R_{Gon}(IGBT), V_{CC} = 600 V$



**Switching losses (typical), Diode, Inverter**

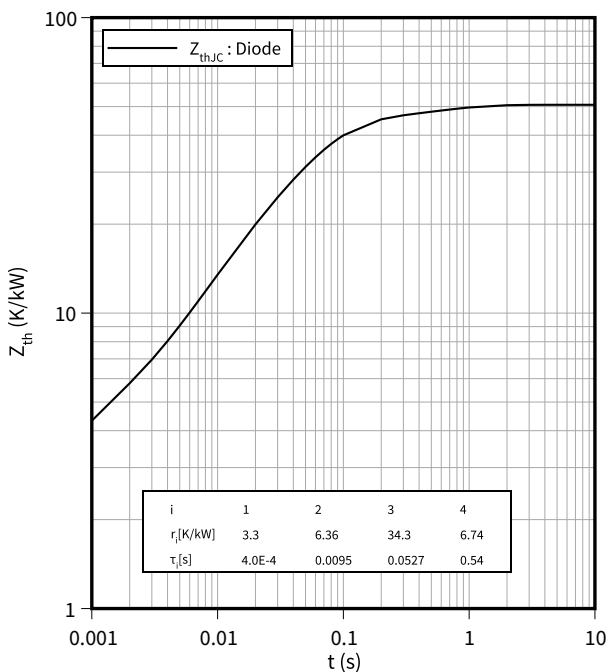
$E_{rec} = f(R_G)$

$I_F = 1600 A, V_{CC} = 600 V$



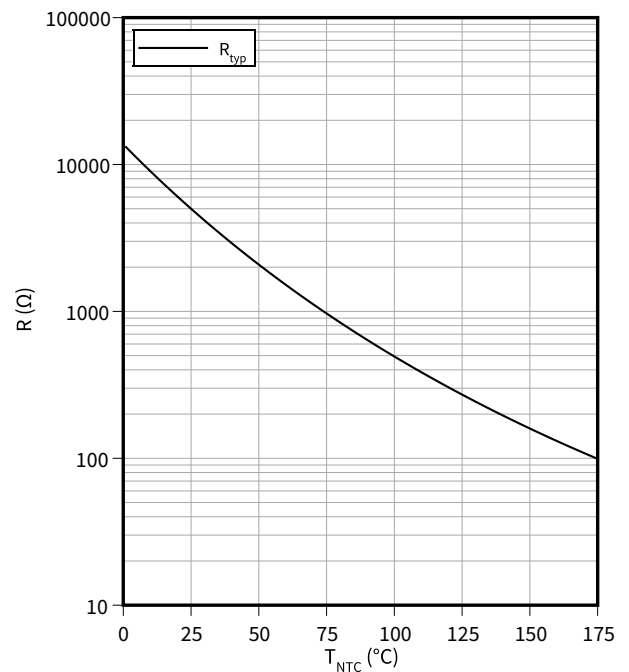
**Transient thermal impedance, Diode, Inverter**

$Z_{th} = f(t)$



**Temperature characteristic (typical), NTC-Thermistor**


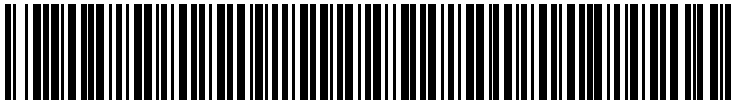
$R = f(T_{NTC})$







## 8 Module label code

Module label code			
Code format	Data Matrix	Barcode Code128	
Encoding	ASCII text	Code Set A	
Symbol size	16x16	23 digits	
Standard	IEC24720 and IEC16022	IEC8859-1	
Code content	Content	Digit	Example
	Module serial number	1 - 5	71549
	Module material number	6 - 11	142846
	Production order number	12 - 19	55054991
	Date code (production year)	20 - 21	15
	Date code (production week)	22 - 23	30
Example	 		
	71549142846550549911530		71549142846550549911530

**Figure 3**

## Revision history

Document revision	Date of release	Description of changes
V1.0	2020-02-18	Target datasheet
V1.1	2020-08-21	Target datasheet
n/a	2020-09-01	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.10	2020-11-18	
1.11	2022-05-17	Final datasheet

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**Document reference**

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