

PrimePACK™3+ B-series module with TRENCHSTOP™ IGBT7 and emitter controlled 7 diode and NTC**Features**

- Electrical features
 - $V_{CES} = 1200\text{ V}$
 - $I_{C\text{ nom}} = 2400\text{ A} / I_{CRM} = 4800\text{ A}$
 - High current density
 - Low inductive design
 - Low $V_{CE,sat}$
 - $T_{vj,op} = 150^{\circ}\text{C}$
 - Overload operation up to 175°C
 - TRENCHSTOP™ IGBT7
- Mechanical features
 - High creepage and clearance distances
 - High power density
 - Package with CTI > 400

**Potential applications**

- Three-level applications
- Solar applications
- Energy storage systems

Product validation

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

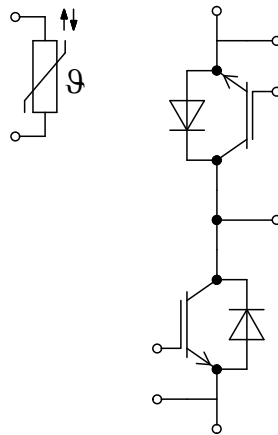
Description

Table of contents

	Description	1
	Features	1
	Potential applications	1
	Product validation	1
	Table of contents	2
1	Package	3
2	IGBT, 3-Level	3
3	Diode, 3-Level	5
4	NTC-Thermistor	6
5	Characteristics diagrams	7
6	Circuit diagram	11
7	Package outlines	11
8	Module label code	12
	Revision history	13
	Disclaimer	14

1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50$ Hz	4.0	kV
Material of module baseplate			Cu	
Creepage distance	d_{Creep}	terminal to heatsink	36.0	mm
Creepage distance	d_{Creep}	terminal to terminal	28.0	mm
Clearance	d_{Clear}	terminal to heatsink	21.0	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}			5		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C = 25^\circ\text{C}$, per switch		0.045		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25^\circ\text{C}$, per switch		0.045		mΩ
Storage temperature	T_{stg}		-40		150	°C
Maximum baseplate operation temperature	T_{BPmax}				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			1400		g

2 IGBT, 3-Level

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CES}		$T_{vj} = 25^\circ\text{C}$	1200	V
Implemented collector current	I_{CN}			2400	A
Continuous DC collector current	I_{CDC}	$T_{vj\ max} = 150^\circ\text{C}$	$T_C = 70^\circ\text{C}$	2400	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 $T_{vj\ op}$	4800	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	$V_{CE\ sat}$	$I_C = 2400\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.27	1.79	V
			$T_{vj} = 125\ ^\circ C$	1.37	1.82	
			$T_{vj} = 150\ ^\circ C$	1.40	1.84	
Gate threshold voltage	V_{GEth}	$I_C = 48\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.15	5.80	6.45	V
Gate charge	Q_G	$V_{GE} = \pm 15\ V, V_{CE} = 600\ V$		38.1		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\ ^\circ C$		0.23		Ω
Input capacitance	C_{ies}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		325		nF
Reverse transfer capacitance	C_{res}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		1.92		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 1200\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$		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}	$I_C = 2400\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.4\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.645		μs
			$T_{vj} = 125\ ^\circ C$	0.785		
			$T_{vj} = 150\ ^\circ C$	0.820		
Rise time (inductive load)	t_r	$I_C = 2400\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.4\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.185		μs
			$T_{vj} = 125\ ^\circ C$	0.210		
			$T_{vj} = 150\ ^\circ C$	0.215		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 2400\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$	2.800		μs
			$T_{vj} = 125\ ^\circ C$	2.900		
			$T_{vj} = 150\ ^\circ C$	3.000		
Fall time (inductive load)	t_f	$I_C = 2400\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.205		μs
			$T_{vj} = 125\ ^\circ C$	0.245		
			$T_{vj} = 150\ ^\circ C$	0.275		
Turn-on energy loss per pulse	E_{on}	$I_C = 2400\ A, V_{CE} = 600\ V, L_\sigma = 50\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 0.4\ \Omega, di/dt = 9000\ A/\mu s (T_{vj} = 150\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	110		mJ
			$T_{vj} = 125\ ^\circ C$	205		
			$T_{vj} = 150\ ^\circ C$	240		

(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}	$I_C = 2400\text{ A}$, $V_{CE} = 600\text{ V}$, $L_\sigma = 50\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Goff} = 3.3\ \Omega$, $dv/dt = 1030\text{ V}/\mu\text{s}$ ($T_{vj} = 150\text{ }^\circ\text{C}$)	$T_{vj} = 25\text{ }^\circ\text{C}$	715		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	845		
			$T_{vj} = 150\text{ }^\circ\text{C}$	890		
Thermal resistance, junction to case	R_{thJC}	per IGBT			17.9	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$		12.9		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$		-40		150	$^\circ\text{C}$

3 Diode, 3-Level

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		2400	A
Repetitive peak forward current	I_{FRM}	$t_p = 1\text{ ms}$	4800	A

Table 6 **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 2400\text{ A}$, $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1.70	2.03	V
			$T_{vj} = 125\text{ }^\circ\text{C}$	1.65	1.96	
			$T_{vj} = 150\text{ }^\circ\text{C}$	1.60	1.94	
Peak reverse recovery current	I_{RM}	$V_R = 600\text{ V}$, $I_F = 2400\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 6850\text{ A}/\mu\text{s}$ ($T_{vj} = 150\text{ }^\circ\text{C}$)	$T_{vj} = 25\text{ }^\circ\text{C}$	735		A
			$T_{vj} = 125\text{ }^\circ\text{C}$	885		
			$T_{vj} = 150\text{ }^\circ\text{C}$	895		
Recovered charge	Q_r	$V_R = 600\text{ V}$, $I_F = 2400\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 6850\text{ A}/\mu\text{s}$ ($T_{vj} = 150\text{ }^\circ\text{C}$)	$T_{vj} = 25\text{ }^\circ\text{C}$	210		μC
			$T_{vj} = 125\text{ }^\circ\text{C}$	410		
			$T_{vj} = 150\text{ }^\circ\text{C}$	475		
Reverse recovery energy	E_{rec}	$V_R = 600\text{ V}$, $I_F = 2400\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 6850\text{ A}/\mu\text{s}$ ($T_{vj} = 150\text{ }^\circ\text{C}$)	$T_{vj} = 25\text{ }^\circ\text{C}$	80		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	150		
			$T_{vj} = 150\text{ }^\circ\text{C}$	170		

(table continues...)
 Datasheet

Table 6 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, junction to case	R_{thJC}	per diode			34.1	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, $\lambda_{grease} = 1 \text{ W/(m}^2\text{K)}$		14.7		K/kW
Temperature under switching conditions	$T_{vj op}$		-40		150	°C

Note: Dynamic data for 3-level valid in conjunction with datasheet FF1800R23IE7, version 1.0.
 $T_{vj op}$ up to 175 °C is allowed for operations in overload conditions. For detailed specifications please refer to AN2021-11.

4 NTC-Thermistor

Table 7 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	$T_{NTC} = 25 \text{ °C}$		5		kΩ
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 100 \text{ °C}$, $R_{100} = 493 \text{ Ω}$	-5		5	%
Power dissipation	P_{25}	$T_{NTC} = 25 \text{ °C}$			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

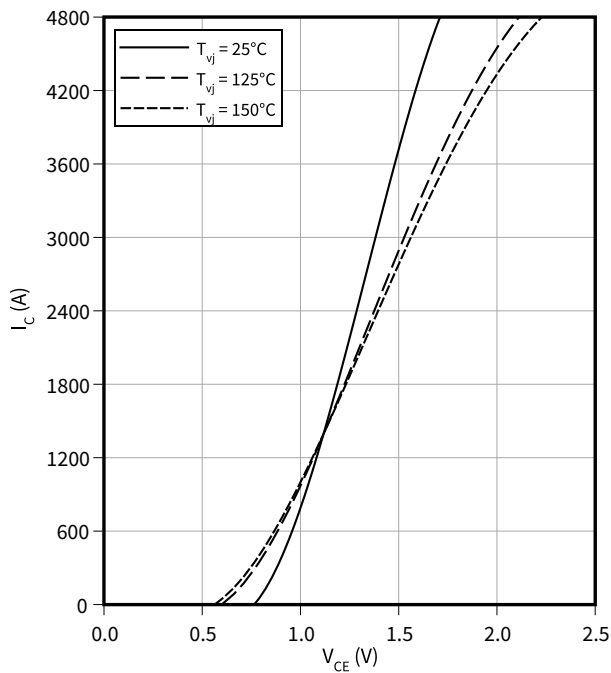
Note: For detailed specifications please refer to AN2009-10.

5 Characteristics diagrams

Output characteristic (typical), IGBT, 3-Level

$I_C = f(V_{CE})$

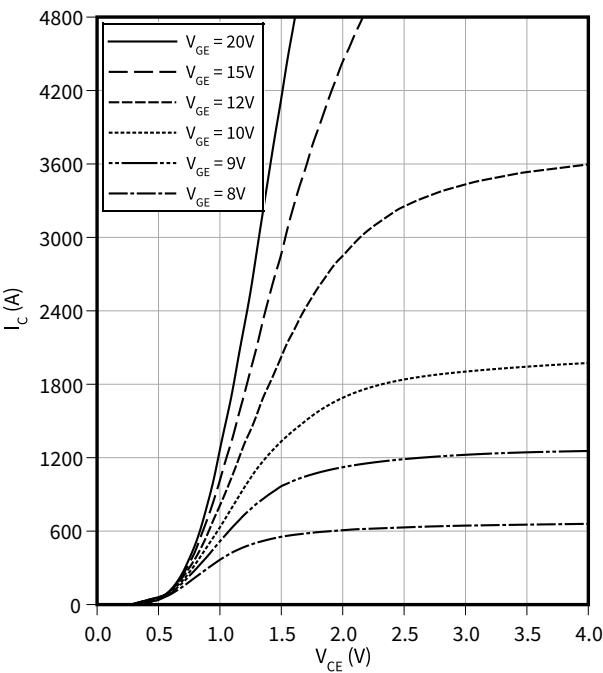
$V_{GE} = 15\text{ V}$



Output characteristic field (typical), IGBT, 3-Level

$I_C = f(V_{CE})$

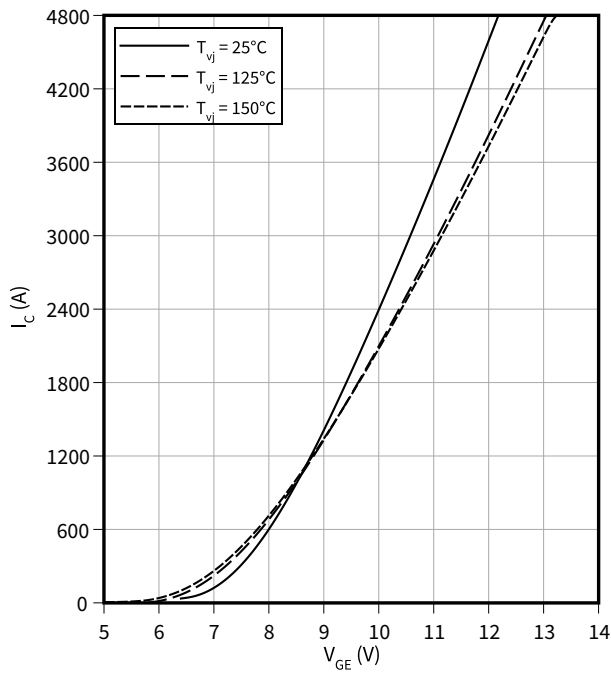
$T_{vj} = 150^\circ\text{C}$



Transfer characteristic (typical), IGBT, 3-Level

$I_C = f(V_{GE})$

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

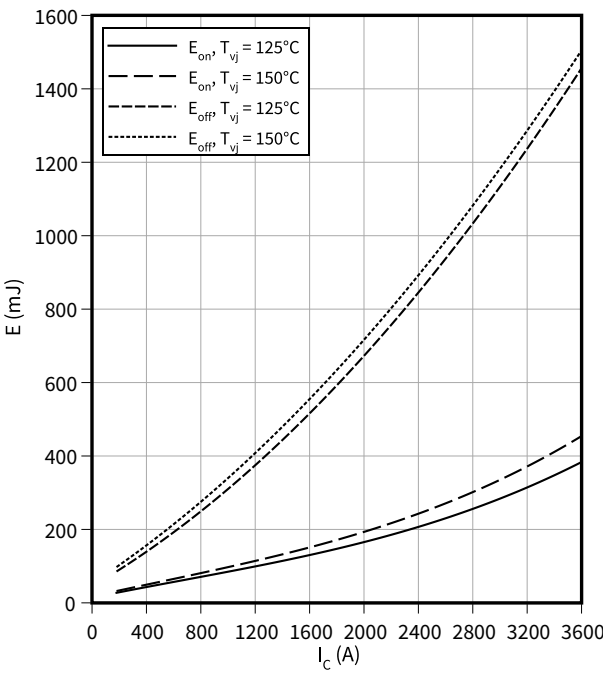


Switching losses (typical), IGBT, 3-Level

$E = f(I_C)$

$R_{Goff} = 3.3\ \Omega$, $R_{Gon} = 0.4\ \Omega$, $V_{CE} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$

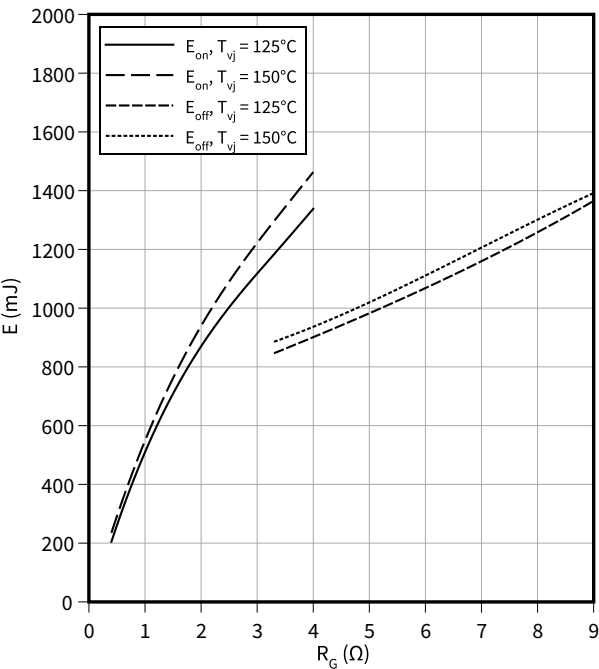
I_C is limited to 3600A by FF1800R23IE7 module.



5 Characteristics diagrams

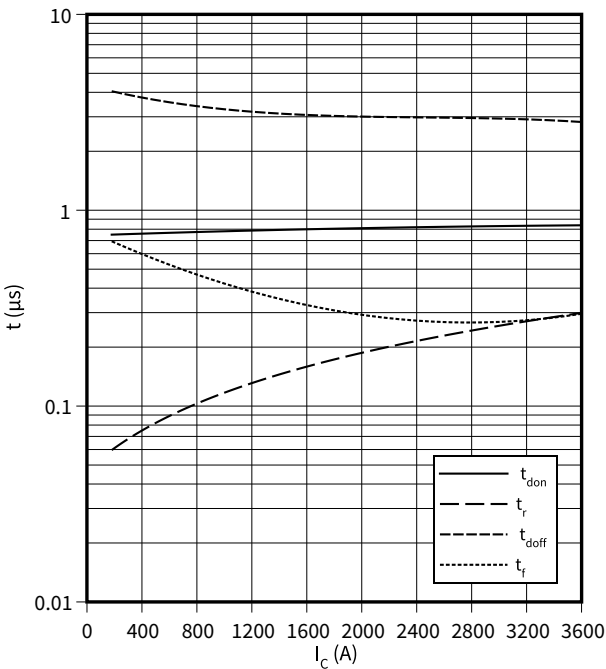
Switching losses (typical), IGBT, 3-Level

$E = f(R_G)$
 $I_C = 2400\text{ A}$, $V_{CE} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$



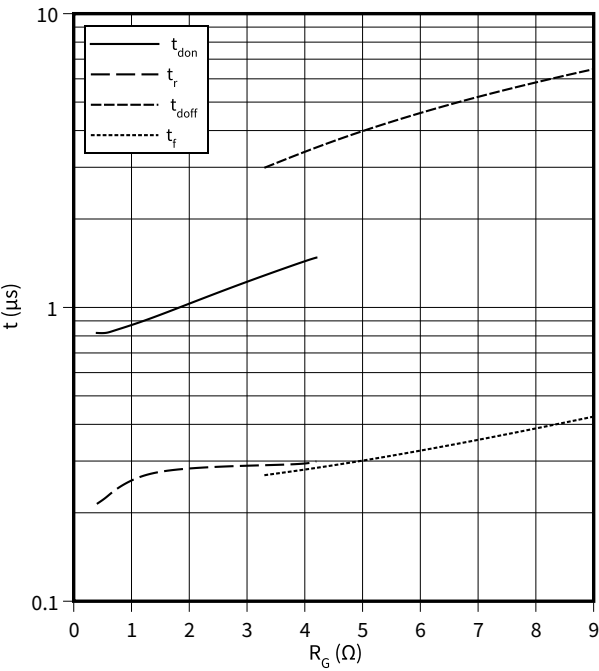
Switching times (typical), IGBT, 3-Level

$t = f(I_C)$
 $R_{Goff} = 3.3\text{ }\Omega$, $R_{Gon} = 0.4\text{ }\Omega$, $V_{CE} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 150\text{ }^\circ\text{C}$



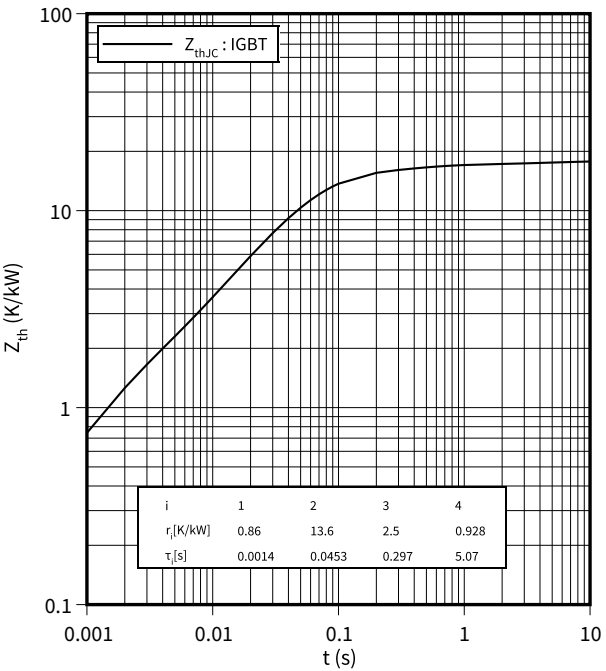
Switching times (typical), IGBT, 3-Level

$t = f(R_G)$
 $I_C = 2400\text{ A}$, $V_{CE} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 150\text{ }^\circ\text{C}$



Transient thermal impedance , IGBT, 3-Level

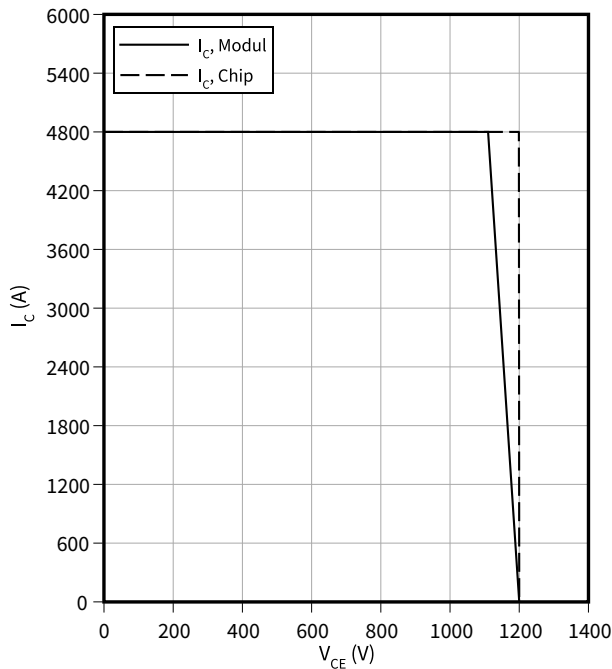
$Z_{th} = f(t)$



5 Characteristics diagrams

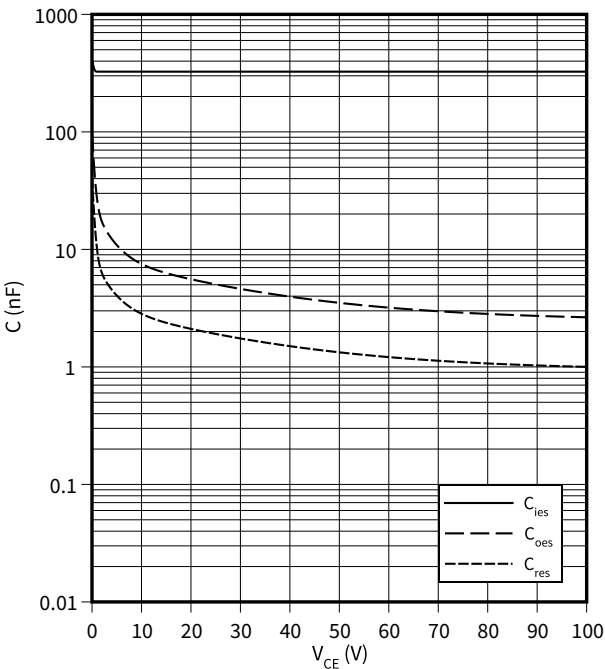
Reverse bias safe operating area (RBSOA), IGBT, 3-Level

$I_C = f(V_{CE})$
 $R_{Goff} = 3.3 \Omega$, $V_{GE} = 15 \text{ V}$, $T_{vj} = 150 \text{ }^\circ\text{C}$



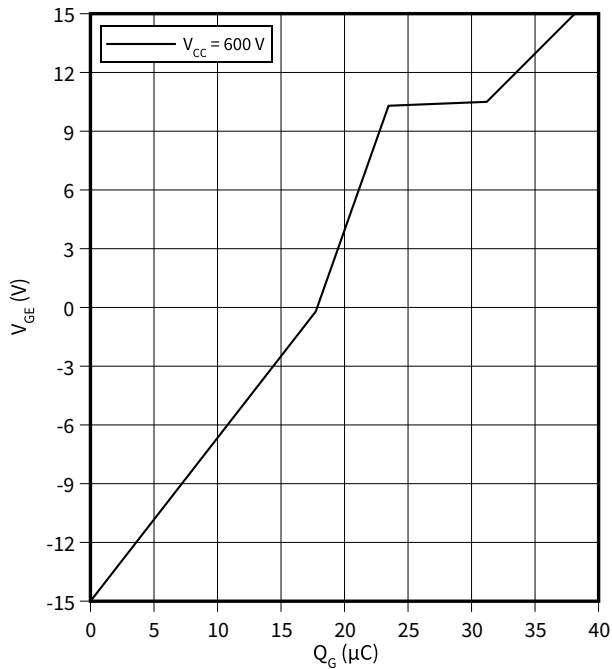
Capacity characteristic (typical), IGBT, 3-Level

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



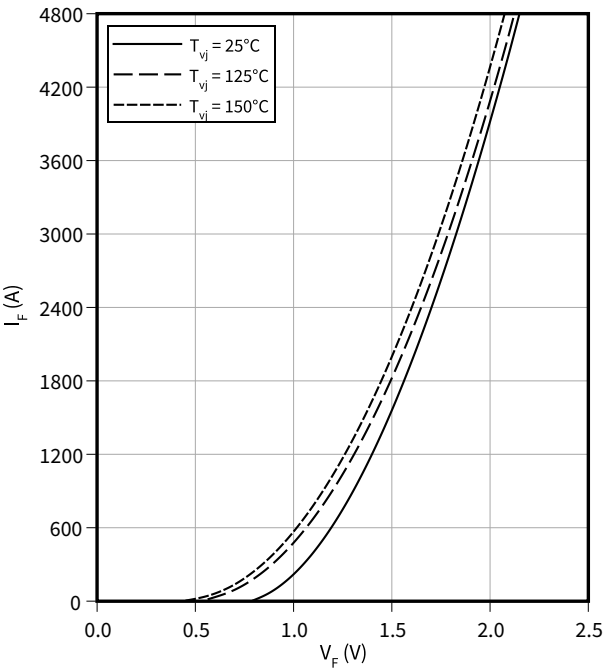
Gate charge characteristic (typical), IGBT, 3-Level

$V_{GE} = f(Q_G)$
 $I_C = 2400 \text{ A}$, $T_{vj} = 25 \text{ }^\circ\text{C}$



Forward characteristic (typical), Diode, 3-Level

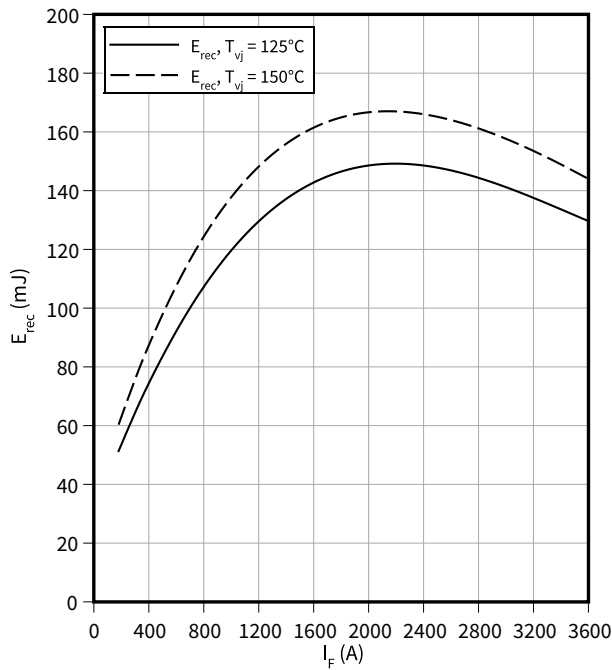
$I_F = f(V_F)$



5 Characteristics diagrams

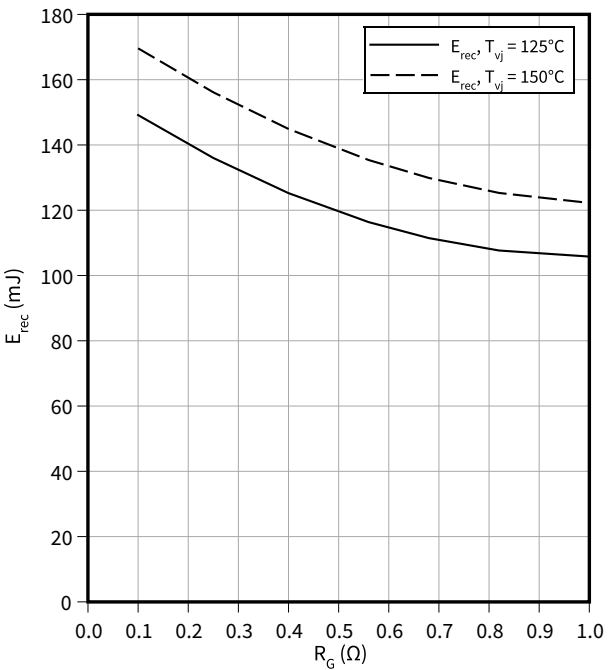
Switching losses (typical), Diode, 3-Level

$E_{rec} = f(I_F)$
 $V_{CE} = 600\text{ V}, R_{Gon} = R_{Gon}(IGBT)$



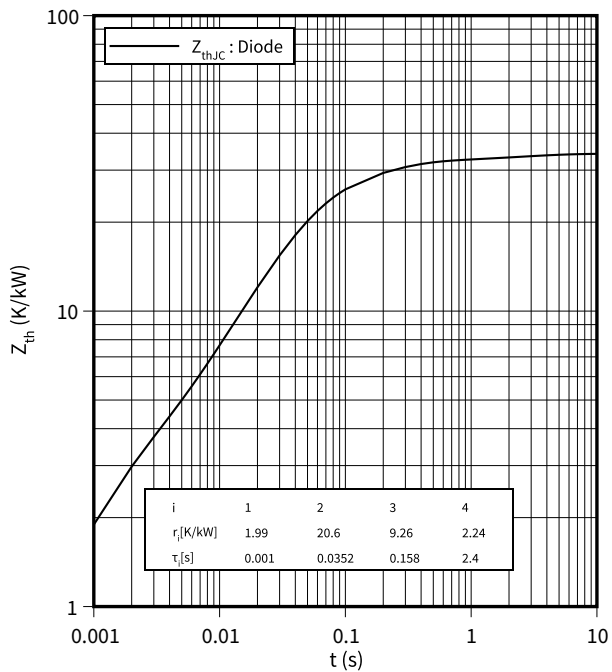
Switching losses (typical), Diode, 3-Level

$E_{rec} = f(R_G)$
 $V_{CE} = 600\text{ V}, I_F = 2400\text{ A}$



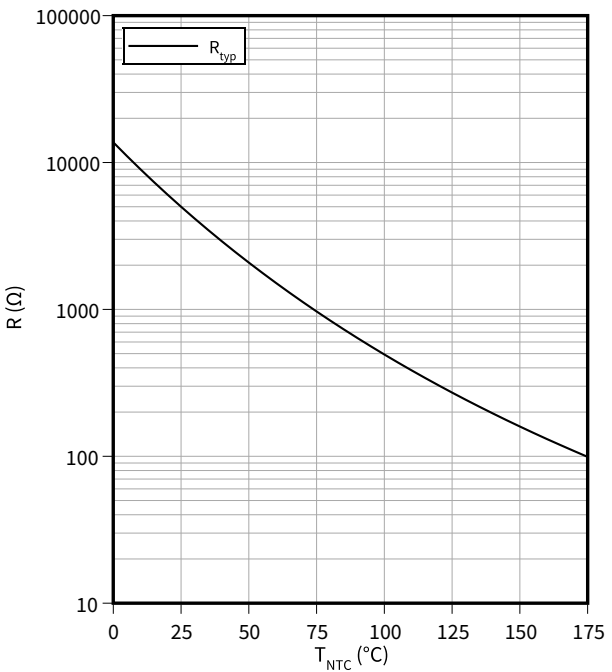
Transient thermal impedance, Diode, 3-Level

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



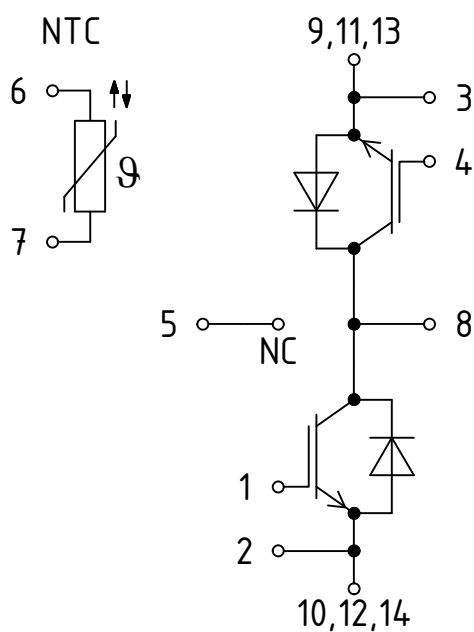


Figure 1

7 Package outlines

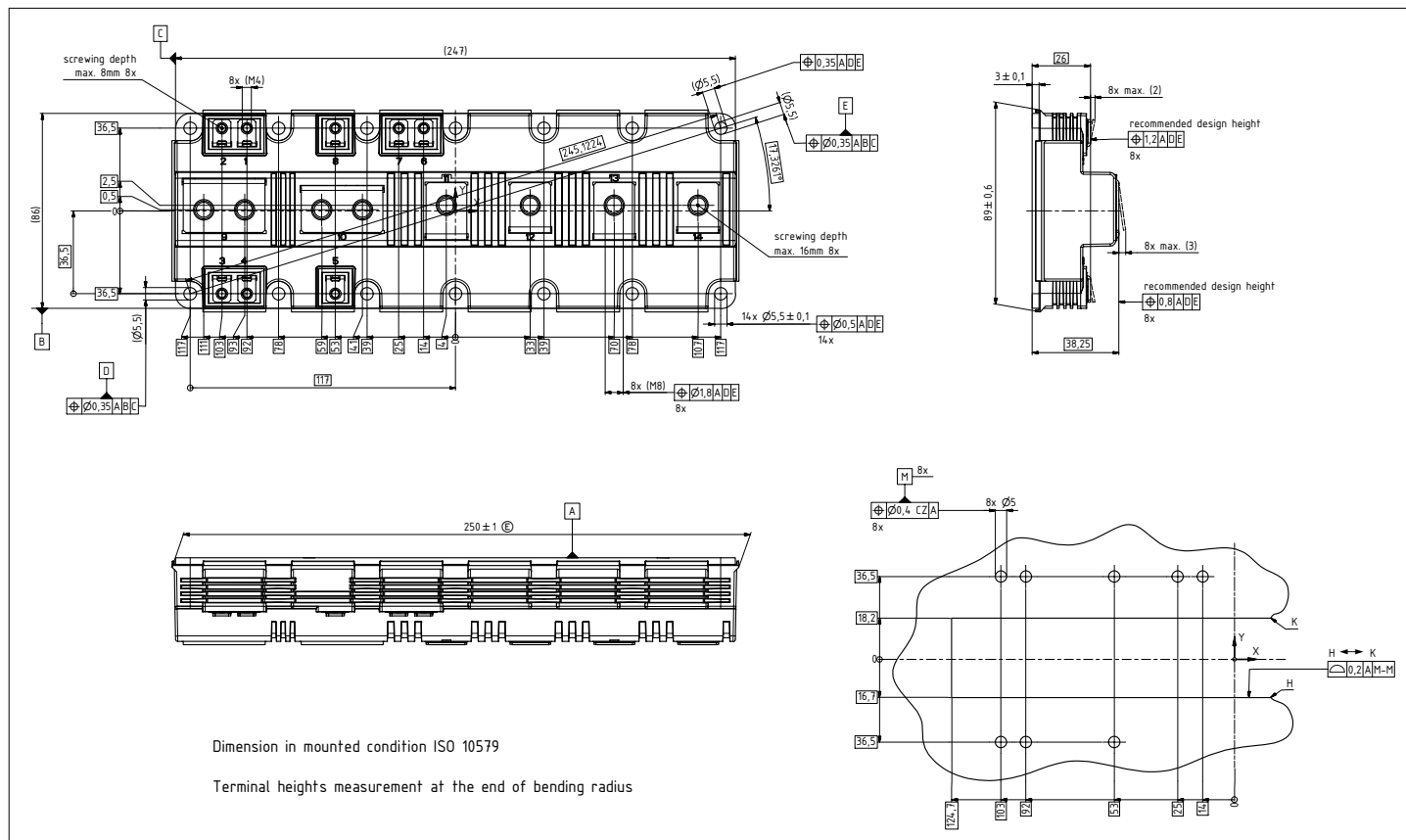


Figure 2

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	<i>Content</i>	<i>Digit</i>	<i>Example</i>
	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	2019-07-19	Target datasheet
V1.1	2020-02-14	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	2020-12-15	Final datasheet
1.20	2022-03-17	Final datasheet - update to FF1800R23IE7 Rev. 1.0; Extension of diagrams to 4800A (except of dynamic data, which is limited by FF1800R23IE7)

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