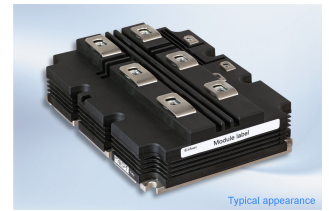


## Highly insulated module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode

### Features

- Electrical features
  - $V_{CES} = 4500\text{ V}$
  - $I_{C\text{nom}} = 800\text{ A} / I_{CRM} = 1600\text{ A}$
  - High DC stability
  - High dynamic robustness
  - High short-circuit capability
  - Low  $V_{CE,sat}$
  - Trench IGBT 3
  - $V_{CE,sat}$  with positive temperature coefficient
- Mechanical features
  - ALSiC base plate for increased thermal cycling capability
  - High creepage and clearance distances
  - Isolated base plate
  - Package with CTI > 600
  - Package with enhanced insulation of 10.4 kV AC 60 s



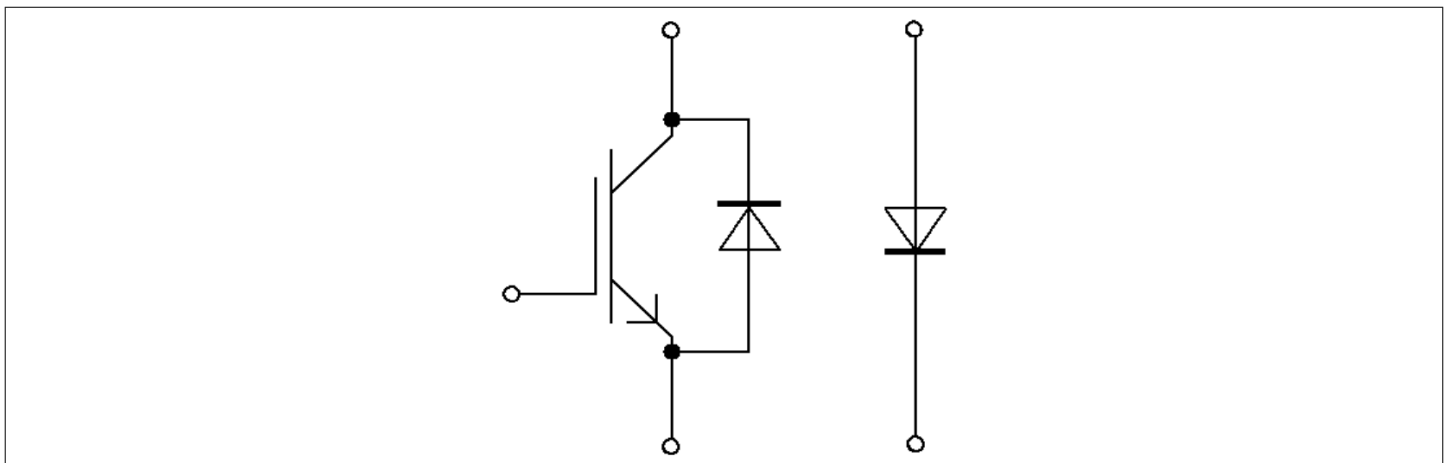
### Potential applications

- Traction drives
- Motor drives
- Medium-voltage converters
- Chopper applications
- High-power converters

### 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, $f = 50 \text{ Hz}$ , $t = 60 \text{ s}$	10.4	kV
Partial discharge extinction voltage	$V_{isol}$	RMS, $f = 50 \text{ Hz}$ , $Q_{PD} \leq 10 \text{ pC}$	3.5	kV
DC stability	$V_{CE(D)}$	$T_{vj}=25^{\circ}\text{C}$ , 100 Fit	3000	V
Material of module baseplate			AlSiC	
Internal isolation		basic insulation (class 1, IEC 61140)	AlN	
Creepage distance	$d_{Creep}$	terminal to heatsink	64.0	mm
Creepage distance	$d_{Creep}$	terminal to terminal	56.0	mm
Clearance	$d_{Clear}$	terminal to heatsink	40.0	mm
Clearance	$d_{Clear}$	terminal to terminal	26.0	mm
Comparative tracking index	$CTI$		>600	

**Table 2** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Stray inductance module	$L_{sCE}$			20		nH	
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C=25^{\circ}\text{C}$ , per switch		0.18		mΩ	
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C=25^{\circ}\text{C}$ , per switch		0.18		mΩ	
Storage temperature	$T_{stg}$		-55		125	°C	
Mounting torque for module mounting	$M$	- Mounting according to valid application note	M6, Screw	4.25		5.75	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	

Note: The maximum allowed  $dv/dt$  measured between 0,6 and  $1 \times V_{ce}$  is  $2400\text{V}/\mu\text{s}$ .

## 2 IGBT, Brake-Chopper

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Collector-emitter voltage	$V_{CES}$		$T_{vj} = -40\text{ °C}$	4500	V
			$T_{vj} = 25\text{ °C}$	4500	
			$T_{vj} = 125\text{ °C}$	4500	
Continuous DC collector current	$I_{CDC}$	$T_{vj\text{ max}} = 125\text{ °C}$	$T_C = 95\text{ °C}$	800	A
Repetitive peak collector current	$I_{CRM}$	$t_p = 1\text{ ms}$		1600	A
Gate-emitter peak voltage	$V_{GES}$			$\pm 20$	V

**Table 4** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\text{ sat}}$	$I_C = 800\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	2.50	2.85	V
			$T_{vj} = 125\text{ °C}$	3.10	3.70	
Gate threshold voltage	$V_{GEth}$	$I_C = 70.5\text{ mA}, V_{CE} = V_{GE}, T_{vj} = 25\text{ °C}$	5.40	6	6.60	V
Gate charge	$Q_G$	$V_{CE} = 2800\text{ V}$		26.5		$\mu\text{C}$
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\text{ °C}$		1.1		$\Omega$
Input capacitance	$C_{ies}$	$f = 1000\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$		185		nF
Reverse transfer capacitance	$C_{res}$	$f = 1000\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$		3.1		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 4500\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		5	mA
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}, T_{vj} = 25\text{ °C}$			400	nA
Turn-on delay time (inductive load)	$t_{don}$	$I_C = 800\text{ A}, V_{CE} = 2800\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 1\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.580		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	0.600		
Rise time (inductive load)	$t_r$	$I_C = 800\text{ A}, V_{CE} = 2800\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 1\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.190		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	0.220		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 800\text{ A}, V_{CE} = 2800\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 7.5\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	6.600		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	6.900		
Fall time (inductive load)	$t_f$	$I_C = 800\text{ A}, V_{CE} = 2800\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 7.5\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.350		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	0.450		
Turn-on time (resistive load)	$t_{on\_R}$	$I_C = 500\text{ A}, V_{CE} = 2000\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 1\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	1.80		$\mu\text{s}$

(table continues...)

**Table 4** (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on energy loss per pulse	$E_{on}$	$I_C = 800\text{ A}$ , $V_{CE} = 2800\text{ V}$ , $L_\sigma = 95\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Gon} = 1\ \Omega$ , $di/dt = 3300\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	3100		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	4100		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 800\text{ A}$ , $V_{CE} = 2800\text{ V}$ , $L_\sigma = 95\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Goff} = 7.5\ \Omega$ , $dv/dt = 2000\text{ V}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	2800		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	3400		
SC data	$I_{SC}$	$V_{GE} \leq 15\text{ V}$ , $V_{CC} = 2800\text{ V}$ , $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_p \leq 10\ \mu\text{s}$ , $T_{vj} \leq 125\text{ }^\circ\text{C}$	4600		A
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			11.1	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m} \cdot \text{K})$		13.5		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-50		125	$^\circ\text{C}$

### 3 Diode, Brake-Chopper

**Table 5** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$		$T_{vj} = -40\text{ }^\circ\text{C}$	4500	V
			$T_{vj} = 25\text{ }^\circ\text{C}$	4500	
			$T_{vj} = 125\text{ }^\circ\text{C}$	4500	
Continuous DC forward current	$I_F$		800	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	1600	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}$ , $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	255	$\text{kA}^2\text{s}$
Maximum power dissipation	$P_{RQM}$	$T_{vj} = 125\text{ }^\circ\text{C}$	1600	kW	
Minimum turn-on time	$t_{onmin}$		10	$\mu\text{s}$	

**Table 6** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$I_F = 800\text{ A}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	2.50	3.10	V
			$T_{vj} = 125\text{ }^\circ\text{C}$	2.50	3.00	

(table continues...)

**Table 6** (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Peak reverse recovery current	$I_{RM}$	$V_R = 2800\text{ V}$ , $I_F = 800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 3300\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	1000		A
			$T_{vj} = 125\text{ }^\circ\text{C}$	1150		
Recovered charge	$Q_r$	$V_R = 2800\text{ V}$ , $I_F = 800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 3300\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	770		$\mu\text{C}$
			$T_{vj} = 125\text{ }^\circ\text{C}$	1400		
Reverse recovery energy	$E_{rec}$	$V_R = 2800\text{ V}$ , $I_F = 800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 3300\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	1200		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	2400		
Thermal resistance, junction to case	$R_{thJC}$	per diode			25.5	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$		21.0		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$		-50		125	$^\circ\text{C}$

## 4 Diode, Reverse

**Table 7** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$		$T_{vj} = -40\text{ }^\circ\text{C}$	4500	V
			$T_{vj} = 25\text{ }^\circ\text{C}$	4500	
			$T_{vj} = 125\text{ }^\circ\text{C}$	4500	
Continuous DC forward current	$I_F$		800	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	1600	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}$ , $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	255	$\text{kA}^2\text{s}$
Maximum power dissipation	$P_{RQM}$	$T_{vj} = 125\text{ }^\circ\text{C}$	1600	kW	
Minimum turn-on time	$t_{onmin}$		10	$\mu\text{s}$	

**Table 8** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$I_F = 800\text{ A}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	2.50	3.10	V
			$T_{vj} = 125\text{ }^\circ\text{C}$	2.50	3.00	

(table continues...)

**Table 8 (continued) Characteristic values**

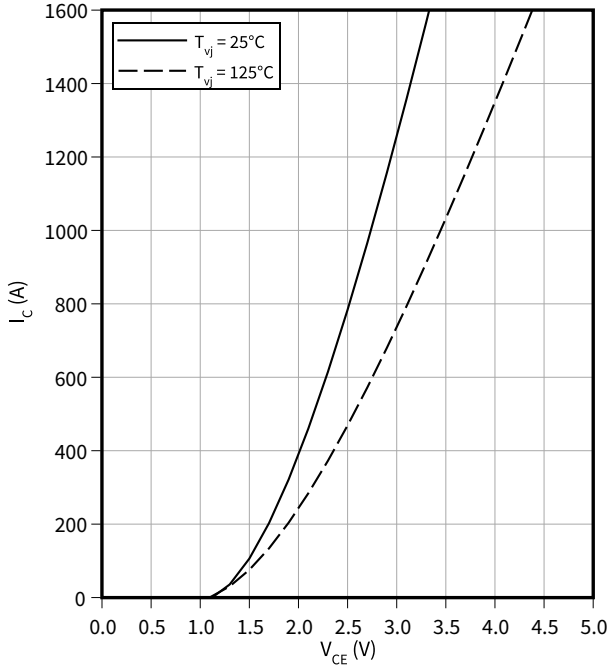
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Peak reverse recovery current	$I_{RM}$	$V_R = 2800\text{ V}$ , $I_F = 800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 3300\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	1000		A
			$T_{vj} = 125\text{ }^\circ\text{C}$	1150		
Recovered charge	$Q_r$	$V_R = 2800\text{ V}$ , $I_F = 800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 3300\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	770		$\mu\text{C}$
			$T_{vj} = 125\text{ }^\circ\text{C}$	1400		
Reverse recovery energy	$E_{rec}$	$V_R = 2800\text{ V}$ , $I_F = 800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 3300\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	1200		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	2400		
Thermal resistance, junction to case	$R_{thJC}$	per diode			25.5	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$		21.0		K/kW
Temperature under switching conditions	$T_{vj\text{op}}$		-50		125	$^\circ\text{C}$

## 5 Characteristics diagrams

**Output characteristic (typical), IGBT, Brake-Chopper**

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

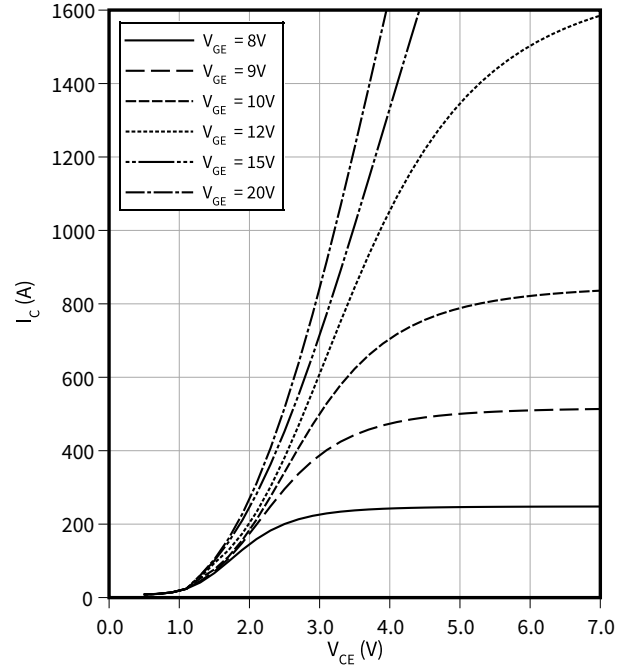
$$V_{GE} = 15 \text{ V}$$



**Output characteristic field (typical), IGBT, Brake-Chopper**

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

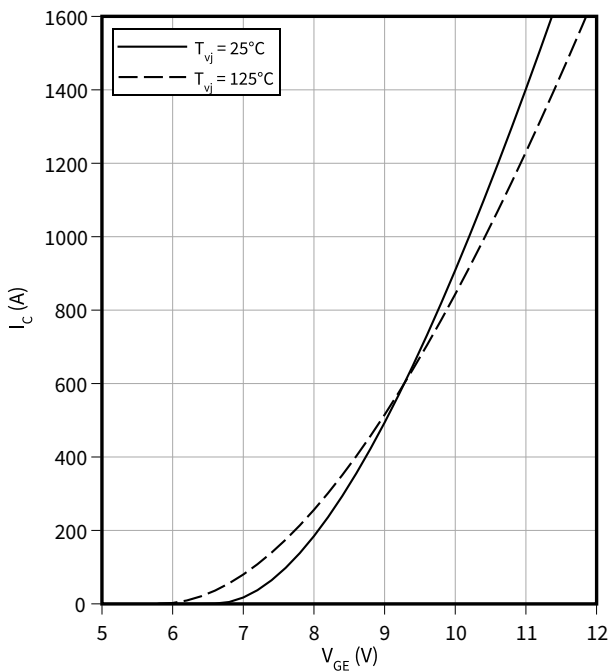
$$T_{vj} = 125 \text{ °C}$$



**Transfer characteristic (typical), IGBT, Brake-Chopper**

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

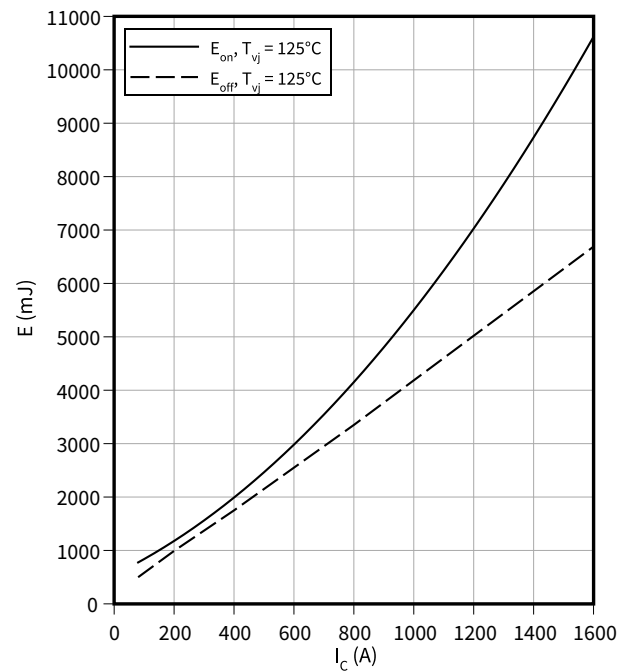
$$V_{CE} = 20 \text{ V}$$



**Switching losses (typical), IGBT, Brake-Chopper**

$$E = f(I_C)$$

$$R_{Goff} = 7.5 \text{ } \Omega, R_{Gon} = 1 \text{ } \Omega, V_{CE} = 2800 \text{ V}, V_{GE} = \pm 15 \text{ V}$$



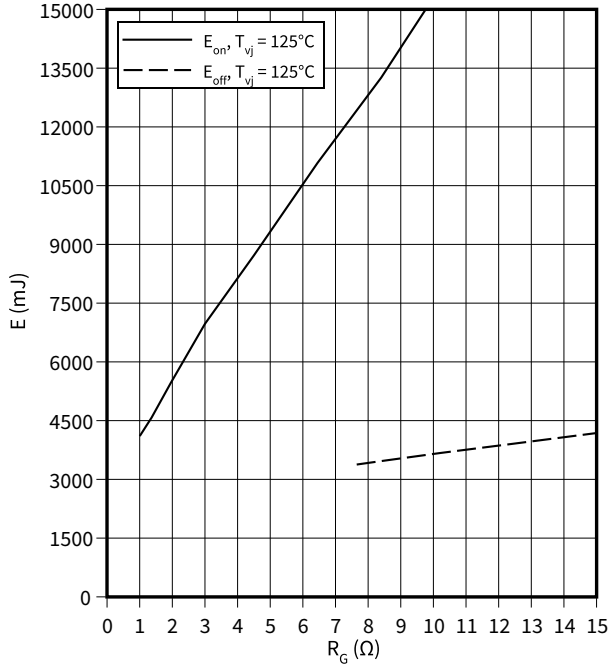


5 Characteristics diagrams

**Switching losses (typical), IGBT, Brake-Chopper**

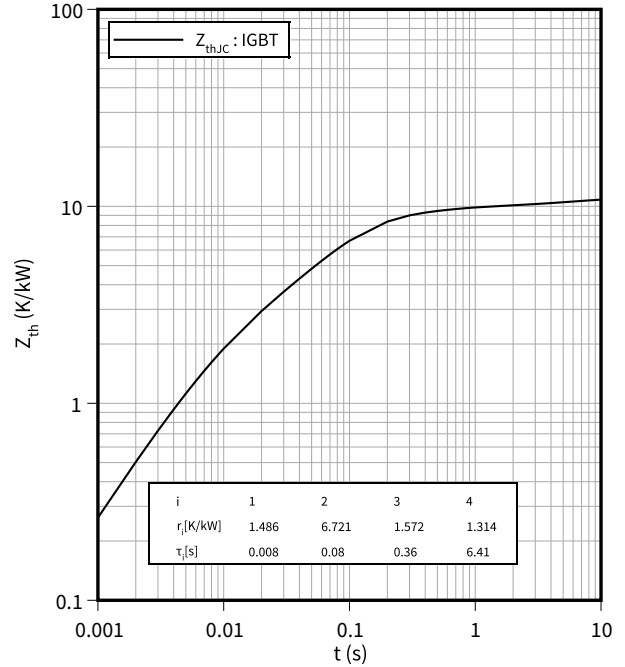
$E = f(R_G)$

$I_C = 800 \text{ A}$ ,  $V_{CE} = 2800 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$



**Transient thermal impedance, IGBT, Brake-Chopper**

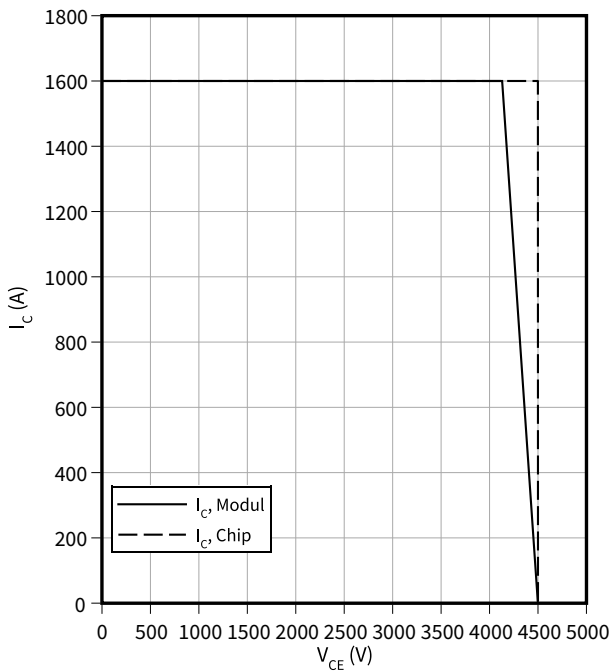
$Z_{th} = f(t)$



**Reverse bias safe operating area (RBSOA), IGBT, Brake-Chopper**

$I_C = f(V_{CE})$

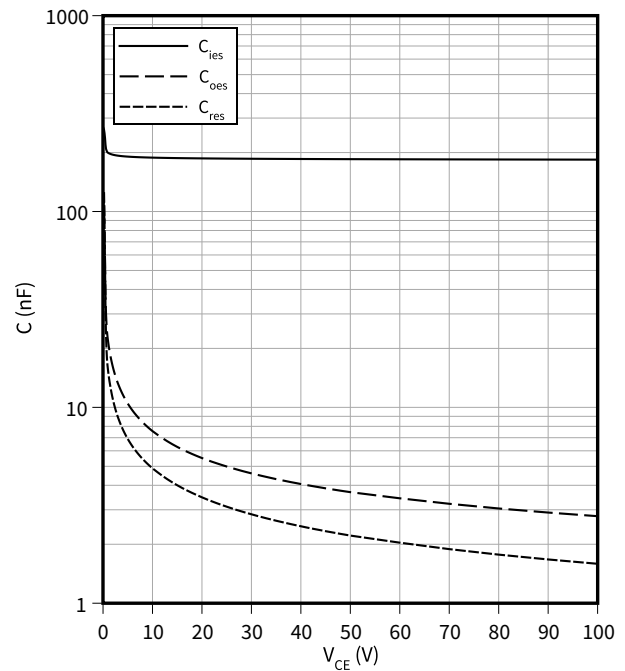
$R_{Goff} = 7.5 \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $T_{vj} = 125 \text{ °C}$



**Capacity characteristic (typical), IGBT, Brake-Chopper**

$C = f(V_{CE})$

$f = 1000 \text{ kHz}$ ,  $V_{GE} = 0 \text{ V}$ ,  $T_{vj} = 25 \text{ °C}$

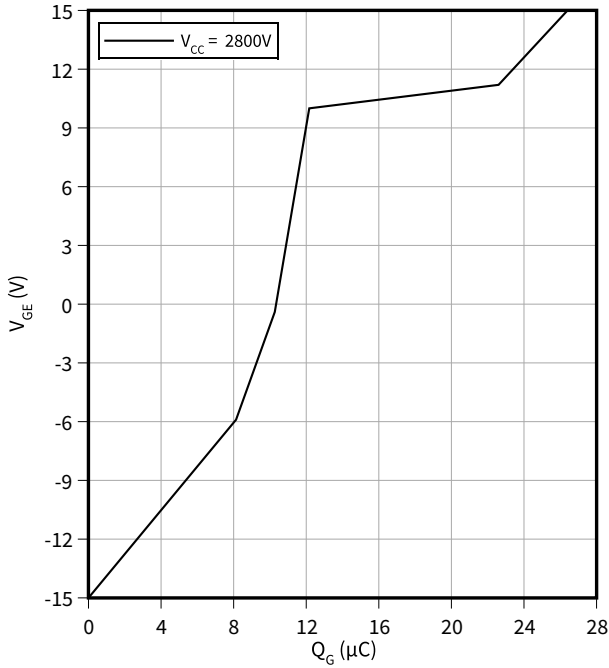


5 Characteristics diagrams

**Gate charge characteristic (typical), IGBT, Brake-Chopper**

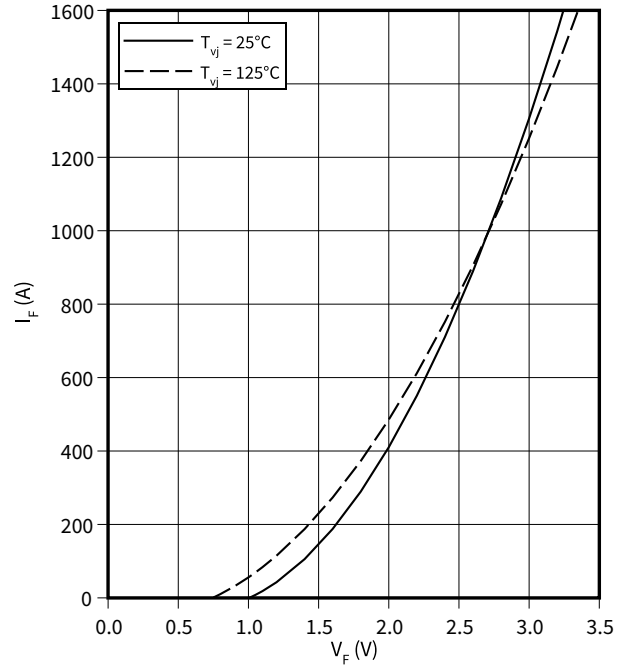
$V_{GE} = f(Q_G)$

$I_C = 800 \text{ A}$ ,  $T_{vj} = 25 \text{ }^\circ\text{C}$



**Forward characteristic (typical), Diode, Brake-Chopper**

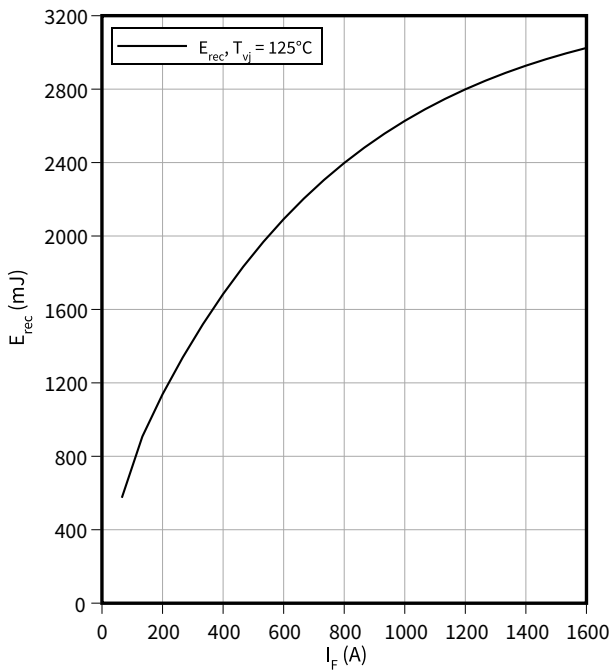
$I_F = f(V_F)$



**Switching losses (typical), Diode, Brake-Chopper**

$E_{rec} = f(I_F)$

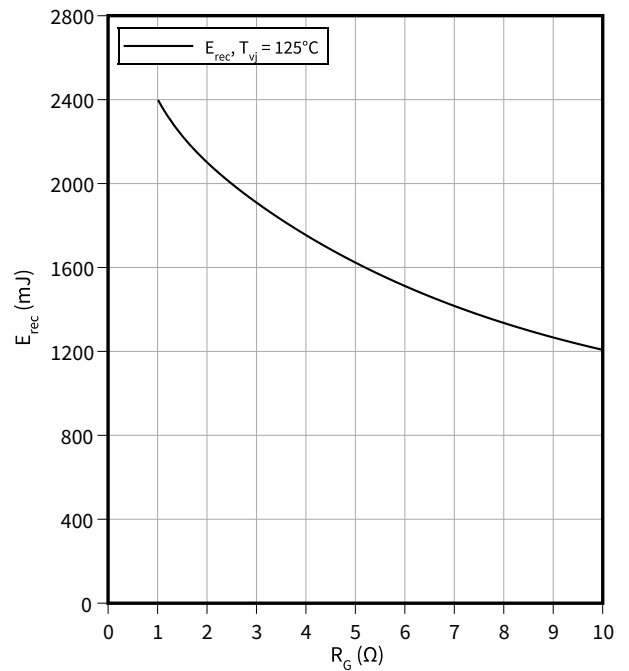
$V_{CE} = 2800 \text{ V}$ ,  $R_{Gon} = R_{Gon}(\text{IGBT})$



**Switching losses (typical), Diode, Brake-Chopper**

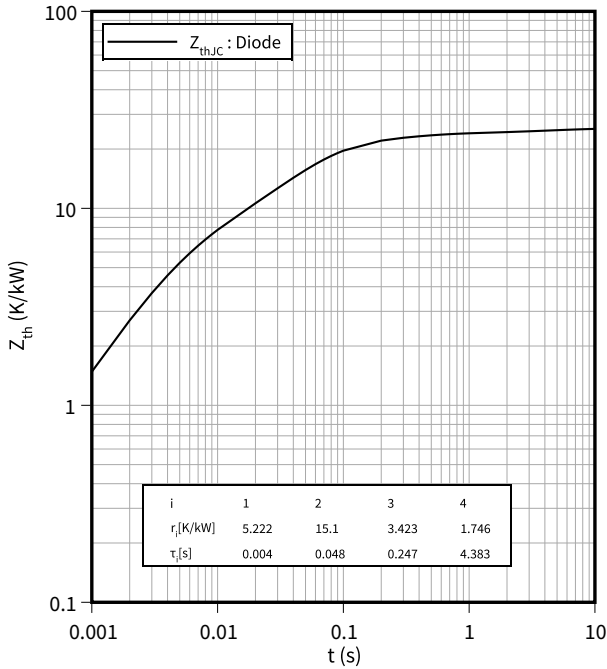
$E_{rec} = f(R_G)$

$V_{CE} = 2800 \text{ V}$ ,  $I_F = 800 \text{ A}$



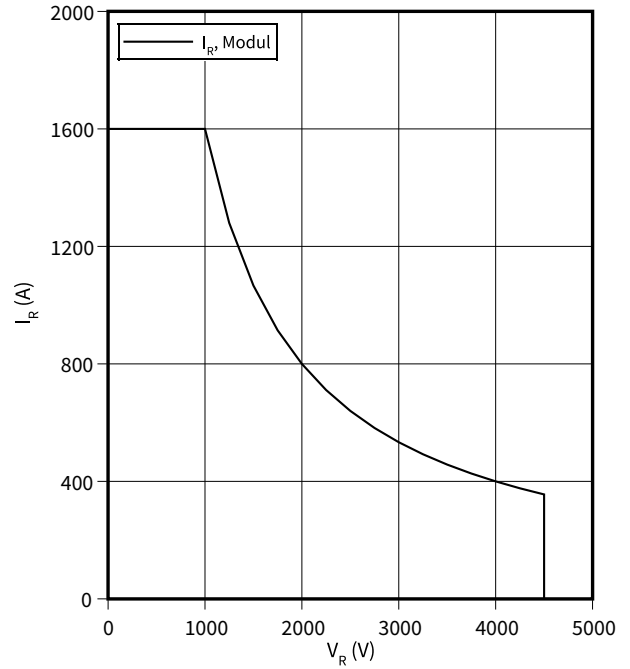
**Transient thermal impedance, Diode, Brake-Chopper**

$Z_{th} = f(t)$



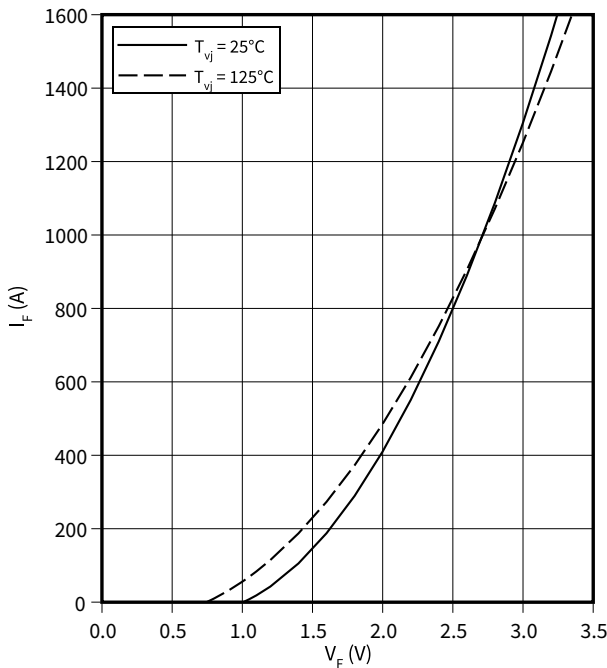
**Safe operating area (SOA), Diode, Brake-Chopper**

$I_R = f(V_R)$   
 $T_{vj} = 125^\circ\text{C}$



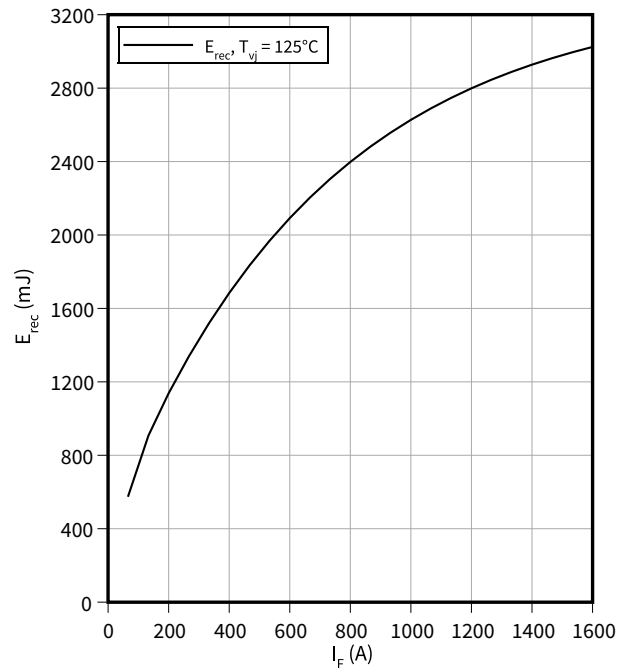
**Forward characteristic (typical), Diode, Reverse**

$I_F = f(V_F)$



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

$E_{rec} = f(I_F)$   
 $V_{CE} = 2800\text{ V}, R_{Gon} = R_{Gon}(\text{IGBT})$

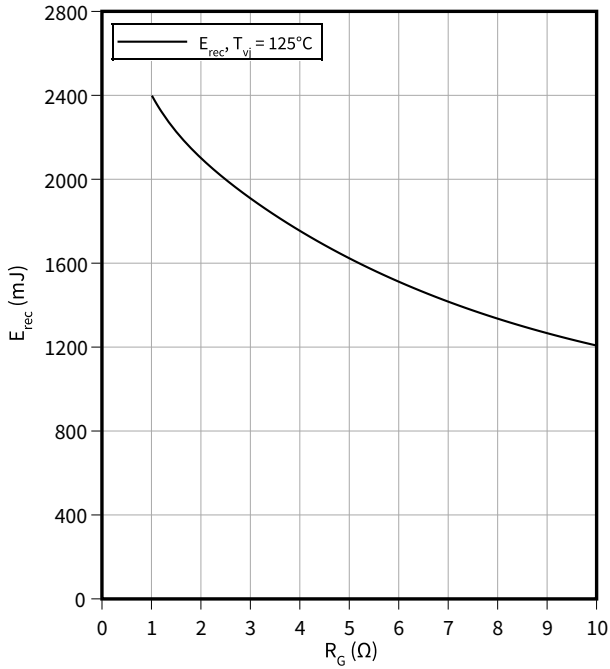


5 Characteristics diagrams

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

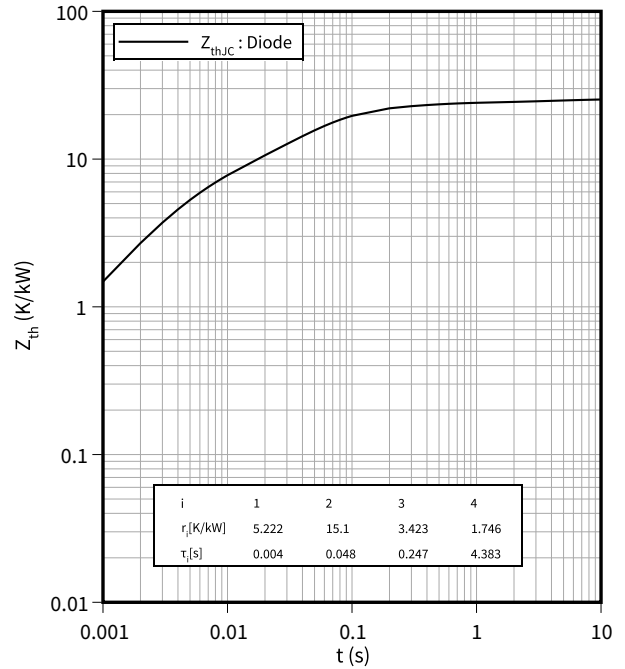
$E_{rec} = f(R_G)$

$V_{CE} = 2800\text{ V}, I_F = 800\text{ A}$



**Transient thermal impedance, Diode, Reverse**

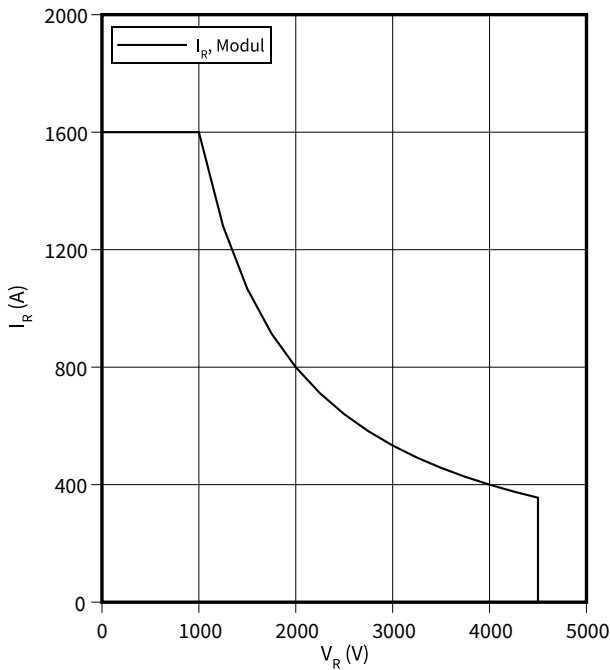
$Z_{th} = f(t)$



**Safe operating area (SOA), Diode, Reverse**

$I_R = f(V_R)$

$T_{vj} = 125\text{ °C}$



## 6 Circuit diagram

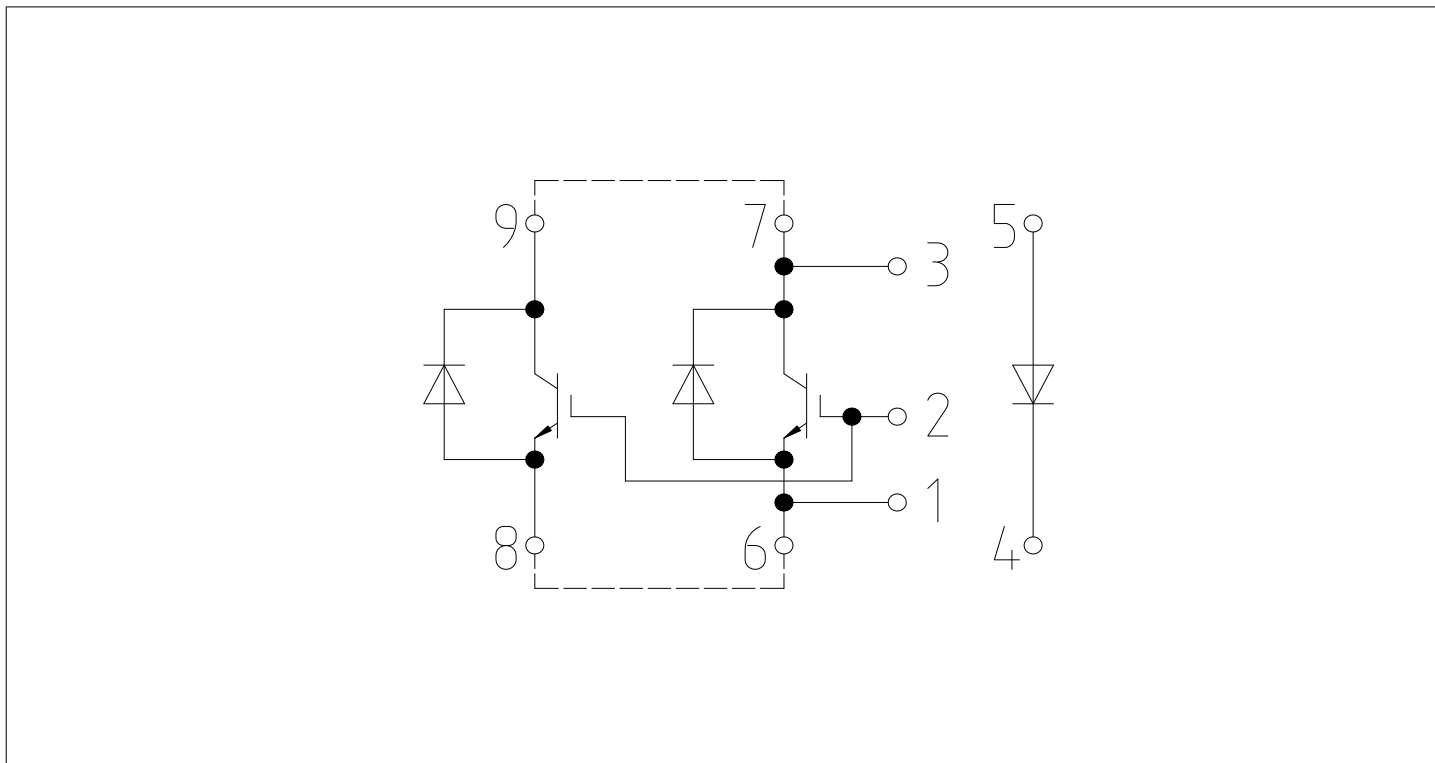

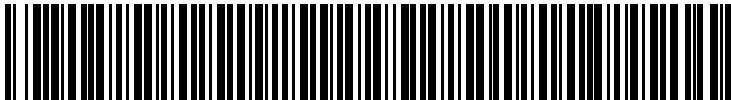


Figure 1



## 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
V2.0	2015-07-08	Preliminary datasheet
V3.0	2015-09-14	Final datasheet
V3.1	2016-08-30	Final datasheet
V3.2	2018-01-15	Final datasheet
V3.3	2019-08-23	Final 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	2021-12-23	Final datasheet



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