HybridPACK™ DC6 Module

FS400R07A3E3_H6

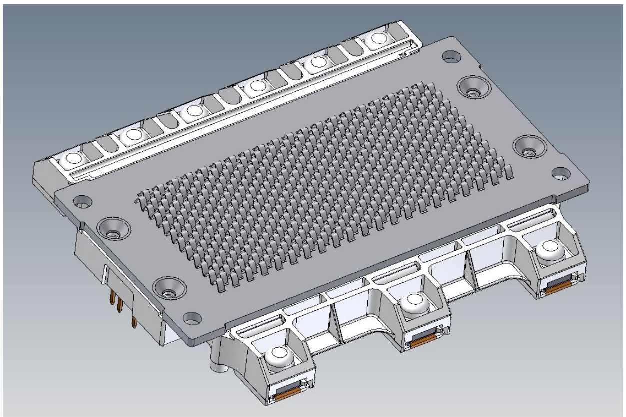
Final Data Sheet

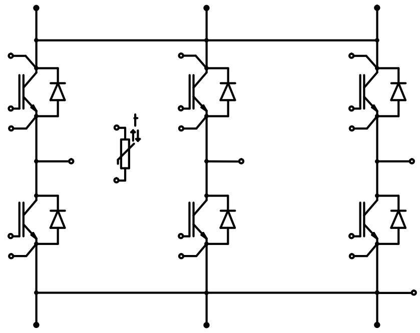
V3.1, 2019-12-19

Automotive High Power

1 Features / Description

HybridPACK™ DC6 module with Trench/Fieldstop IGBT3 and Emitter Controlled 3 diode and NTC





V_{CES} = 700 V
I_C = 400 A

Typical Applications

- Automotive Applications
- Hybrid Electrical Vehicles (H)EV
- Commercial Agriculture Vehicles
- Motor Drives

Electrical Features

- Low Switching Losses
- Low V_{CEsat}
- $T_{vj\ op}$ = 150°C
- V_{CEsat} with positive Temperature Coefficient
- Increased blocking voltage capability to 705V

Mechanical Features

- 2.5kV AC 1min Insulation
- Al_2O_3 Substrate with Low Thermal Resistance
- Direct Cooled Base Plate with Ribbon Bonds
- High mechanical robustness
- Integrated NTC temperature sensor
- Copper Base Plate
- RoHS compliant

Description

Infineon's HybridPACK™ DC6 with ribbon bonded cooling structures is a variant of the HybridPACK™ 1 power module family with increased continuous current capability and a reduced stray inductance. Like all HybridPACK™ 1 products the HybridPACK™ DC6 with ribbon bonds is an automotive qualified power module designed for electric vehicle applications. Designed for a 150°C junction operation temperature, with a 30 hour limited 175°C capacity the module accommodates a 3-phase Six-Pack configuration of Trench-Field-Stop IGBT3 and matching emitter controlled diodes. The HybridPACK™ DC6 power module family is built on Infineon's long time experience in the development of IGBT power modules, intense research efforts of new material combinations and assembly technologies. HybridPACK™ DC6 with ribbon bonds is suitable for direct liquid cooling. The copper base plate combined with high-performance ceramic substrate and Infineon's enhanced wire-bonding process provides unparalleled thermal and power cycling capabilityand highest reliability for mild hybrid inverter or generator applications. For a compact design the driver stage PCB can easily be soldered on top of the module. All power connections are realized with screw terminals.

Product Name	Ordering Code
FS400R07A3E3_H6	SP001632430

2 IGBT,Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	705	V
Continuous DC collector current	T_F = 75°C, $T_{vj\,max}$ = 175°C T_F = 25°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$ I_C	400[1)] 500[1)]	A A
Repetitive peak collector current	t_P = 1 ms	I_{CRM}	800	A
Total power dissipation	T_F = 25°C, $T_{vj\,max}$ = 175°C	P_{tot}	811	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 Characteristic Values

				min.	typ.	max.	
Collector-emitter saturation voltage	I_C = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$V_{CE\,sat}$		1.45 1.60 1.70	1.70	V
Gate threshold voltage	I_C = 6.40 mA, V_{CE} = V_{GE}	T_{vj} = 25°C	V_{GEth}	4.90	5.80	6.50	V
Gate charge	V_{GE} = -15 V ... 15 V		Q_G		4.30		µC
Internal gate resistor		T_{vj} = 25°C	R_{Gint}		1.0		Ω
Input capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{ies}		26.0		nF
Reverse transfer capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{res}		0.76		nF
Collector-emitter cut-off current	V_{CE} = 705 V, V_{GE} = 0 V	T_{vj} = 25°C	I_{CES}			0.1	mA
Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = 20 V	T_{vj} = 25°C	I_{GES}			400	nA
Turn-on delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,on}$		0.12 0.12 0.12		µs
Rise time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_r		0.08 0.08 0.08		µs
Turn-off delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,off}$		0.36 0.40 0.40		µs
Fall time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_f		0.02 0.03 0.03		µs
Turn-on energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = ±15 V, di/dt = 5500 A/µs (T_{vj} = 150°C) R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{on}		5.10 6.80 7.30		mJ
Turn-off energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = ±15 V, du/dt = 3000 V/µs (T_{vj} = 150°C) R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{off}		9.10 12.0 12.5		mJ
SC data	V_{GE} ≤ 15 V, V_{CC} = 360 V V_{CEmax} = V_{CES} -L_{sCE} ·di/dt	t_P ≤ 8 µs, T_{vj} = 25°C t_P ≤ 6 µs, T_{vj} = 150°C	I_{SC}		2800 2000		A
Thermal resistance, junction to cooling fluid	per IGBT; ΔV/Δt = 10 dm³/min		R_{thJF}		0.170	0.185	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\,op}$	-40		150	°C

[1)] DC-collector current limited by power terminals.

3 Diode, Inverter

3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj} = 25°C	V_{RRM}	705	V
Continuous DC forward current		I_F	400[1]	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	800	A
I²t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C V_R = 0 V, t_P = 10 ms, T_{vj} = 150°C	I²t	8800 8500	A²s A²s

3.2 Characteristic Values

	Conditions		Symbol	min.	typ.	max.	Unit
Forward voltage	I_F = 400 A, V_{GE} = 0 V I_F = 400 A, V_{GE} = 0 V I_F = 400 A, V_{GE} = 0 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	V_F		1.55 1.50 1.45	1.95	V
Peak reverse recovery current	I_F = 400 A, - di_F/dt = 5500 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	I_{RM}		205 295 305		A
Recovered charge	I_F = 400 A, - di_F/dt = 5500 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	Q_r		15.0 32.0 34.0		µC
Reverse recovery energy	I_F = 400 A, - di_F/dt = 5500 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{rec}		3.35 6.90 8.10		mJ
Thermal resistance, junction to cooling fluid	per diode; ΔV/Δt = 10 dm³/min		R_{thJF}		0.270	0.300	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\ op}$	-40		150	°C

4 NTC-Thermistor

Parameter	Conditions	Symbol	min.	Value (typ.)	max.	Unit
Rated resistance	T_C = 25°C	R_{25}		5.00		kΩ
Deviation of R100	T_C = 100°C, R_{100} = 493 Ω	ΔR/R	-5		5	%
Power dissipation	T_C = 25°C	P_{25}			20.0	mW
B-value	$R_2 = R_{25}$ exp [$B_{25/50}(1/T_2$ - 1/(298,15 K))]	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25}$ exp [$B_{25/80}(1/T_2$ - 1/(298,15 K))]	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25}$ exp [$B_{25/100}(1/T_2$ - 1/(298,15 K))]	$B_{25/100}$		3433		K

Specification according to the valid application note.

[1] DC-collector current limited by power terminals.

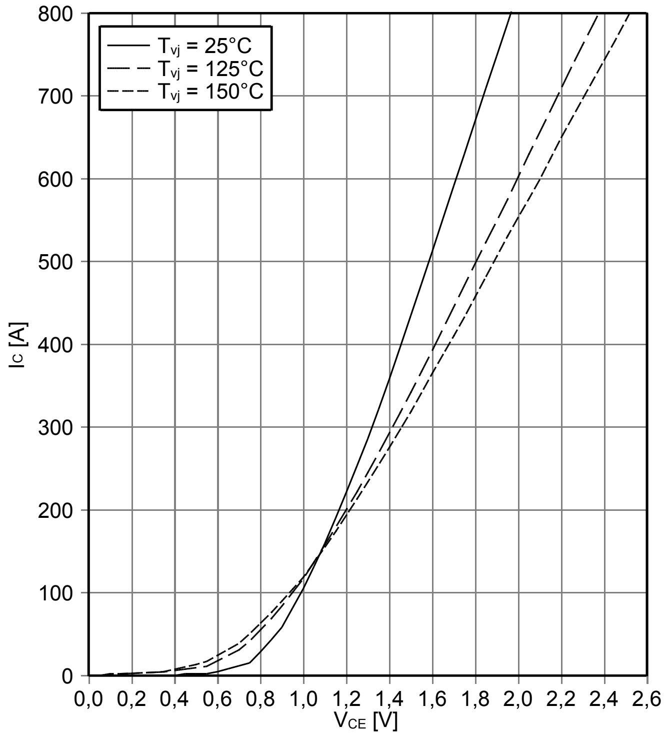
5 Module

Parameter	Conditions	Symbol	Value			Unit
Isolation test voltage	RMS, f = 50 Hz, t = 1 min.	V_{ISOL}	2.5			kV
Maximum RMS module terminal current	T_F = 25°C, T_{Ct} = 150°C	I_{tRMS}	320[1]			A
Material of module baseplate			Cu			
Internal isolation	basic insulation (class 1, IEC 61140)		Al_2O_3			
Creepage distance	terminal to heatsink terminal to terminal	d_{Creep}	12.0 6.1			mm
Clearance	terminal to heatsink terminal to terminal	d_{Clear}	12.0 6.1			mm
Comperative tracking index		CTI	> 200			
			min.	typ.	max.	
Pressure drop in cooling circuit	$\Delta V/\Delta t$ = 10.0 dm³/min; T_F = 25°C	Δp		100		mbar
Maximum pressure in cooling circuit		p			2.0	bar
Stray inductance module		L_{sCE}		15		nH
Module lead resistance, terminals - chip	T_F = 25 °C, per switch	$R_{CC'+EE'}$		1.00		mΩ
Storage temperature		T_{stg}	-40		125	°C
Mounting torque for modul mounting	Screw M5 baseplate to heatsink	M	3.00		6.00	Nm
Terminal connection torque	Screw M6	M	3.0	-	6.0	Nm
Weight		G		515		g

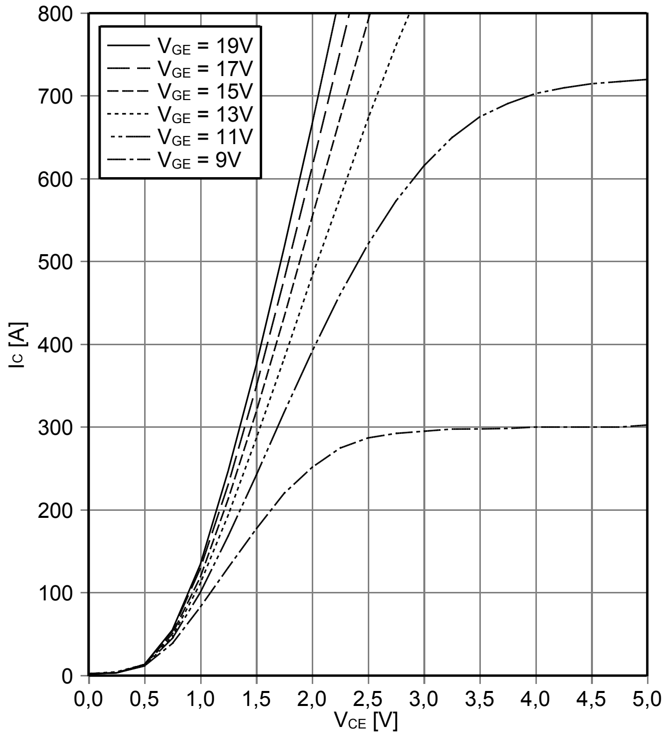
[1] DC-collector current limited by internal busbar

6 Characteristics Diagrams

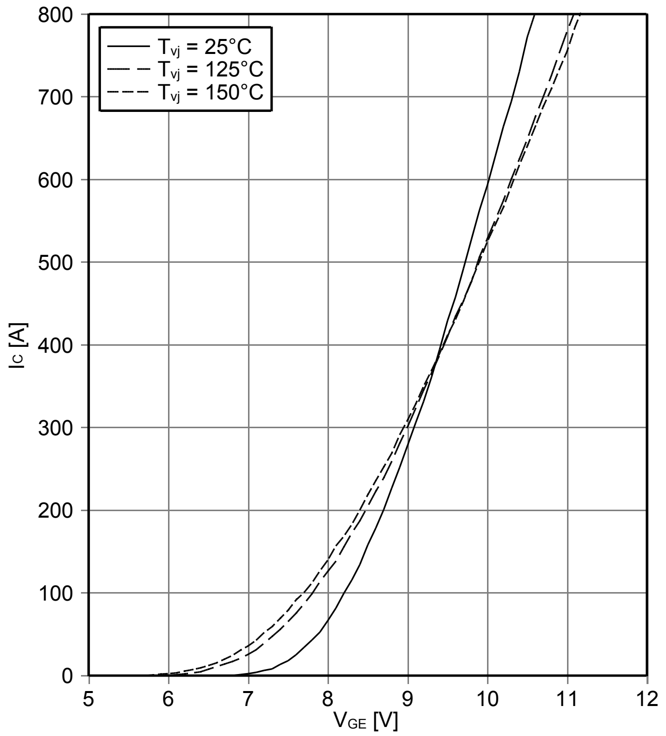
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



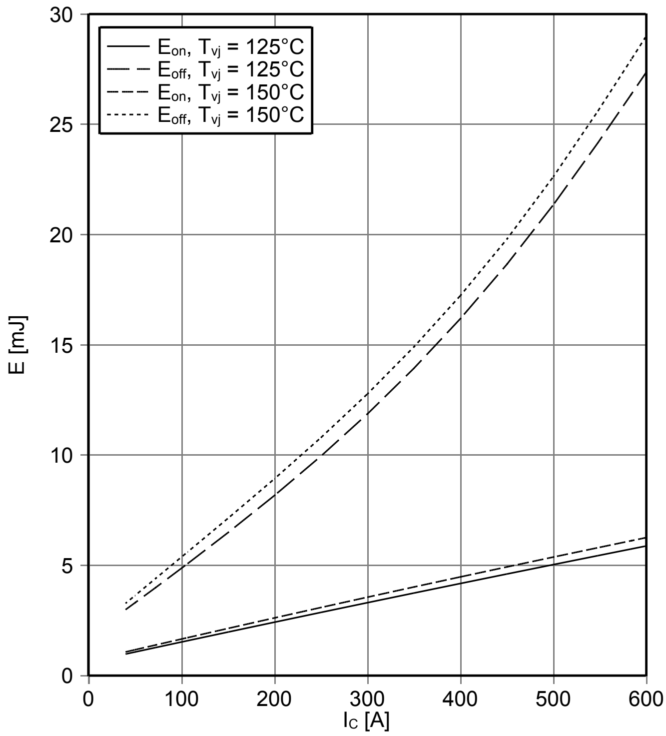
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 150°C$



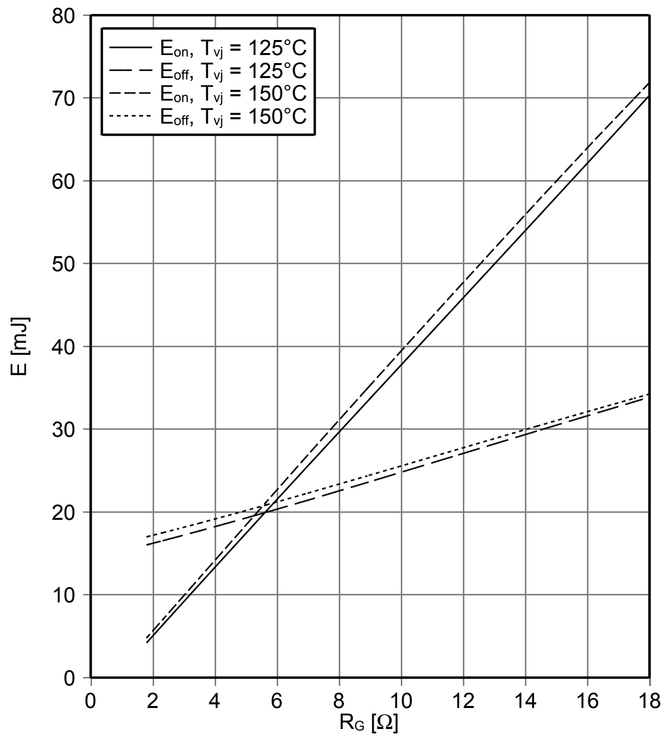
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



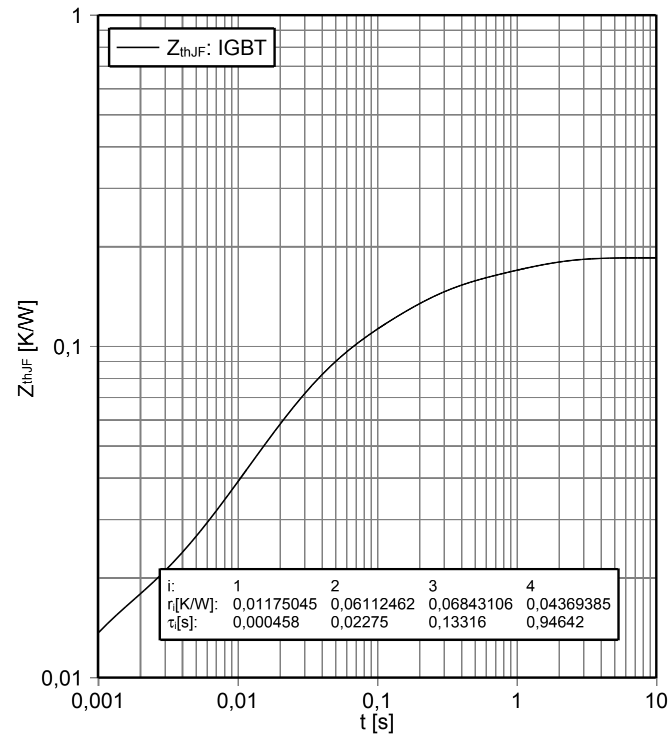
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
$V_{GE} = \pm 15$ V, $R_{Gon} = 1.8\ \Omega$, $R_{Goff} = 1.8\ \Omega$, $V_{CE} = 300$ V



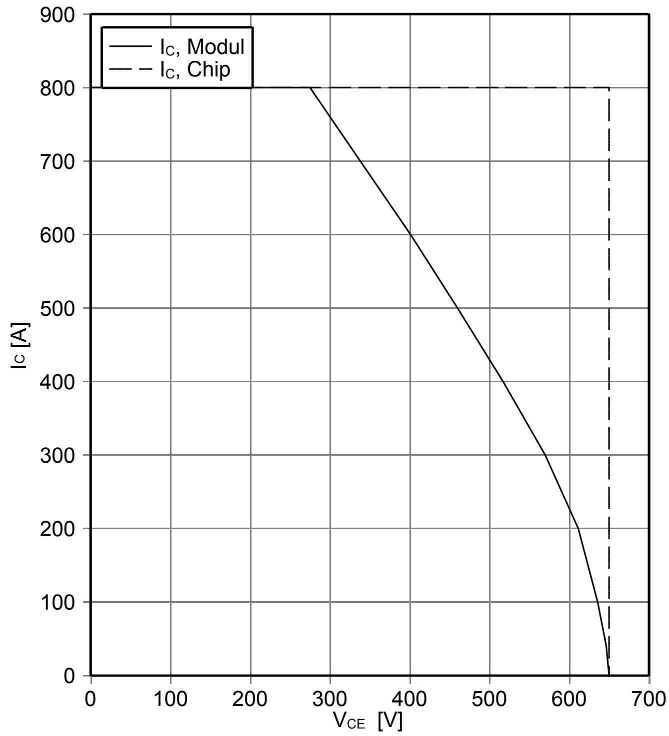
switching losses IGBT,Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$
$V_{GE} = \pm 15$ V, $I_C = 400$ A, $V_{CE} = 300$ V



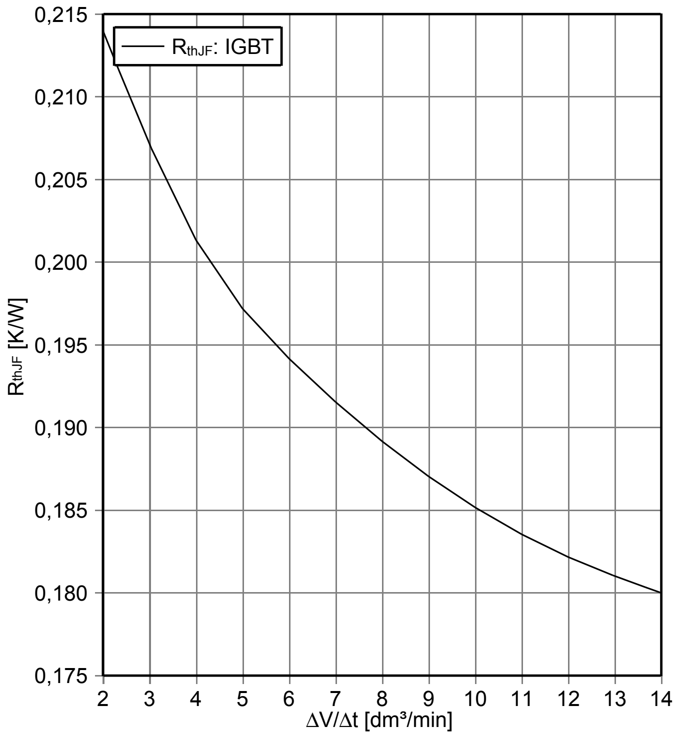
transient thermal impedance IGBT,Inverter
$Z_{thJF} = f(t)$ (ΔV/Δt=10 dm³/min)



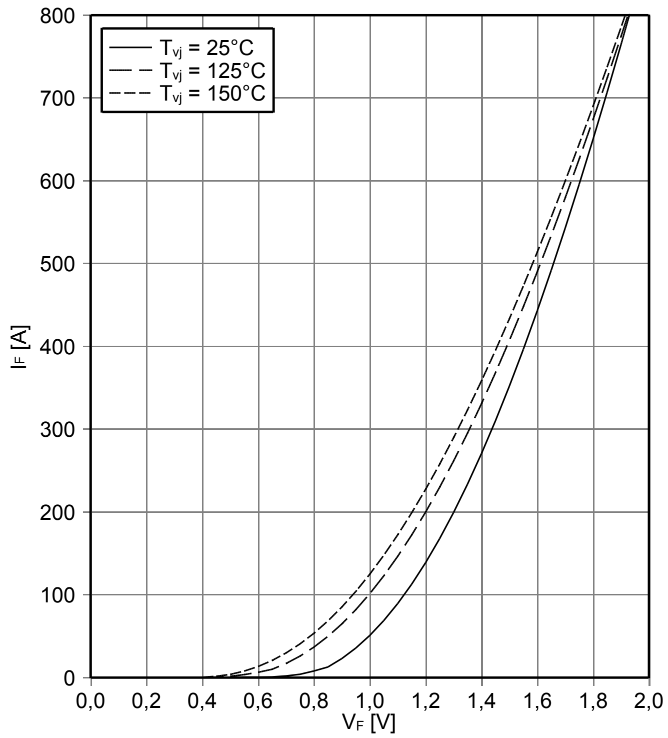
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f(V_{CE})$
$V_{GE} = \pm 15$ V, $R_{Goff} = 1.8$ Ω, $T_{vj} = 150$°C



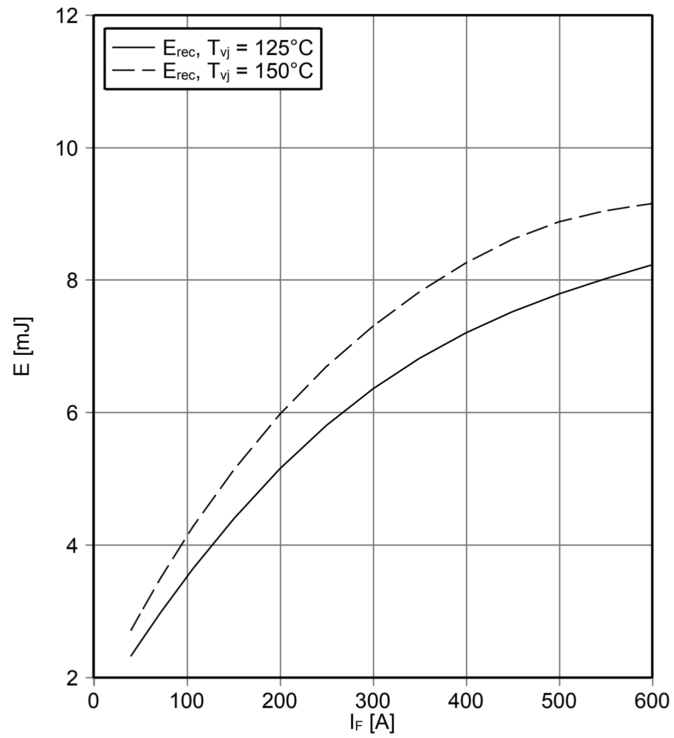
thermal impedance IGBT,Inverter
$R_{thJF} = f(\Delta V/\Delta t)$
cooling fluid = 50% water/50% ethylenglycol



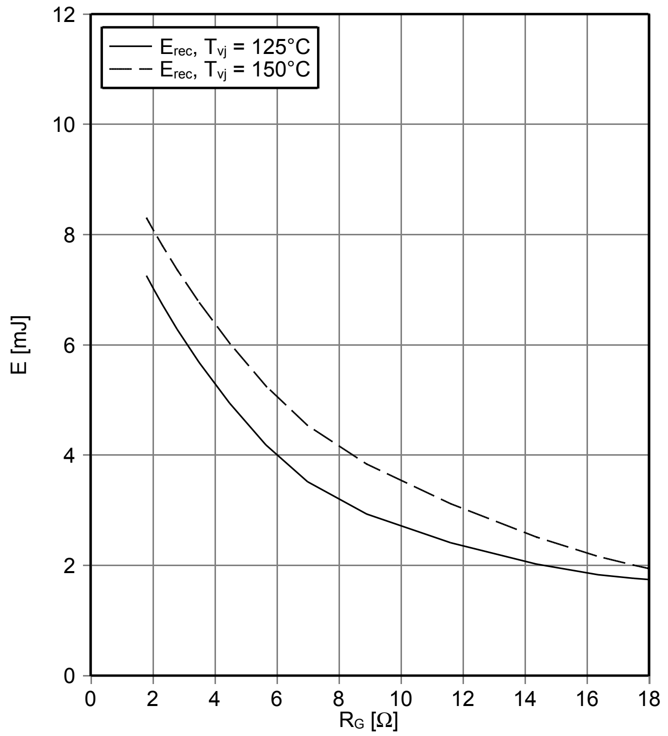
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



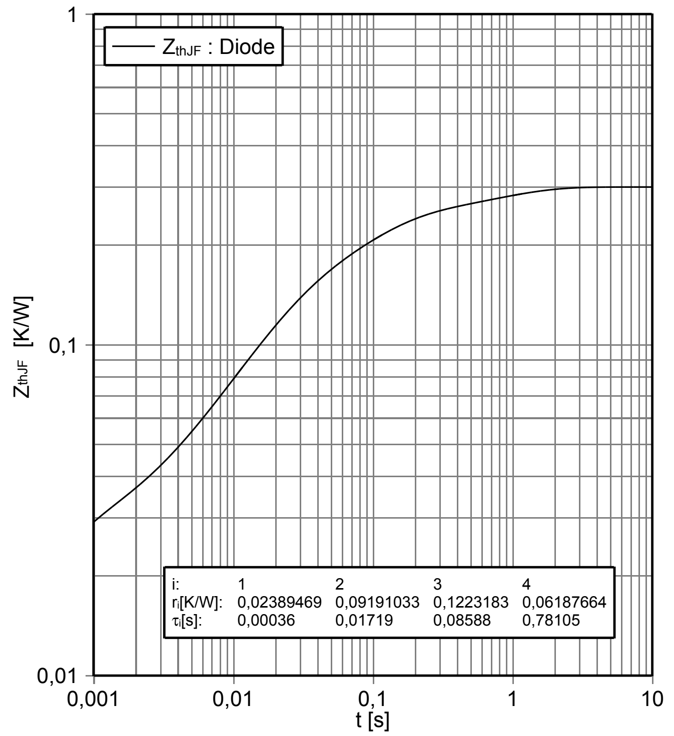
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$
$R_{Gon} = 1.8\ \Omega$, $V_{CE} = 300$ V



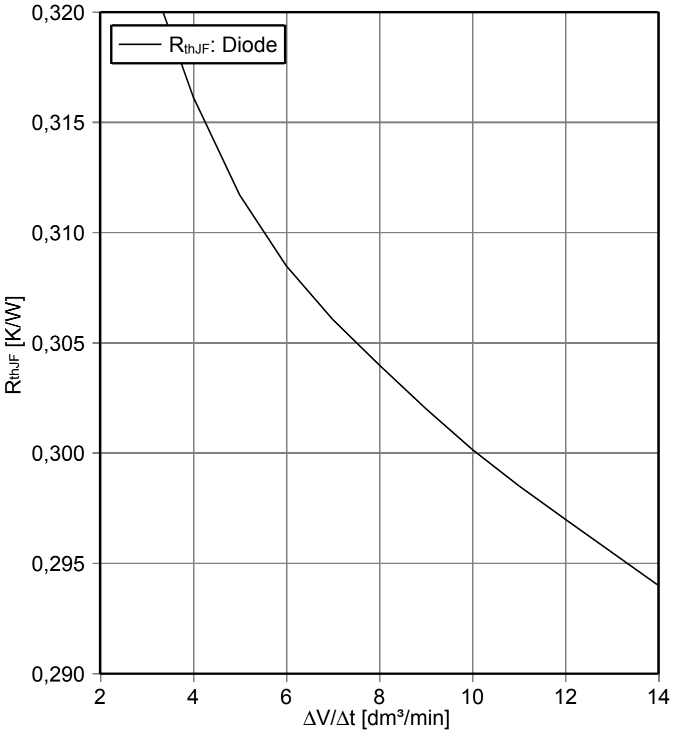
switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$
$I_F = 400$ A, $V_{CE} = 300$ V



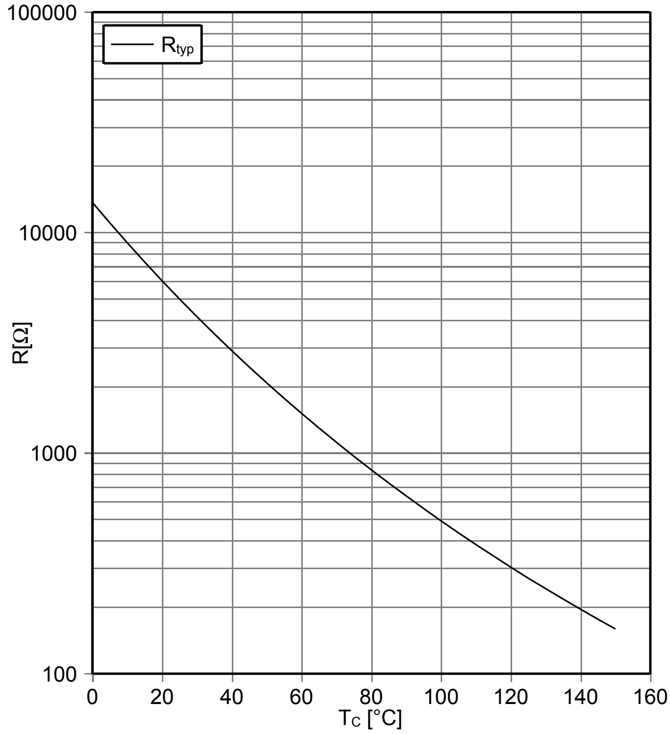
transient thermal impedance Diode, Inverter
$Z_{thJF} = f(t)$ ($\Delta V/\Delta t$=10 dm³/min)



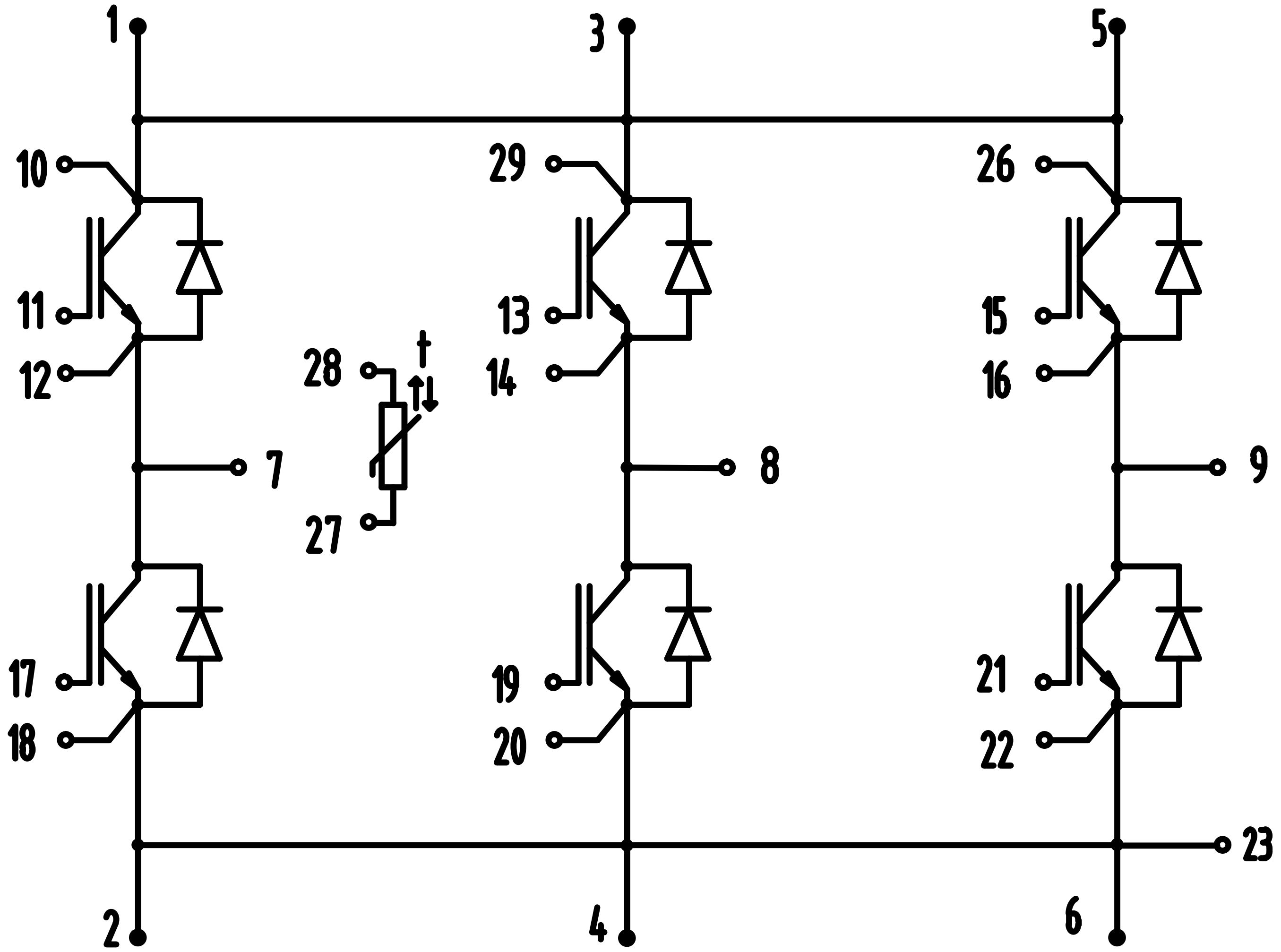
thermal impedance Diode, Inverter
$R_{thJF} = f\ (\Delta V/\Delta t)$
cooling fluid = 50% water/50% ethylenglycol



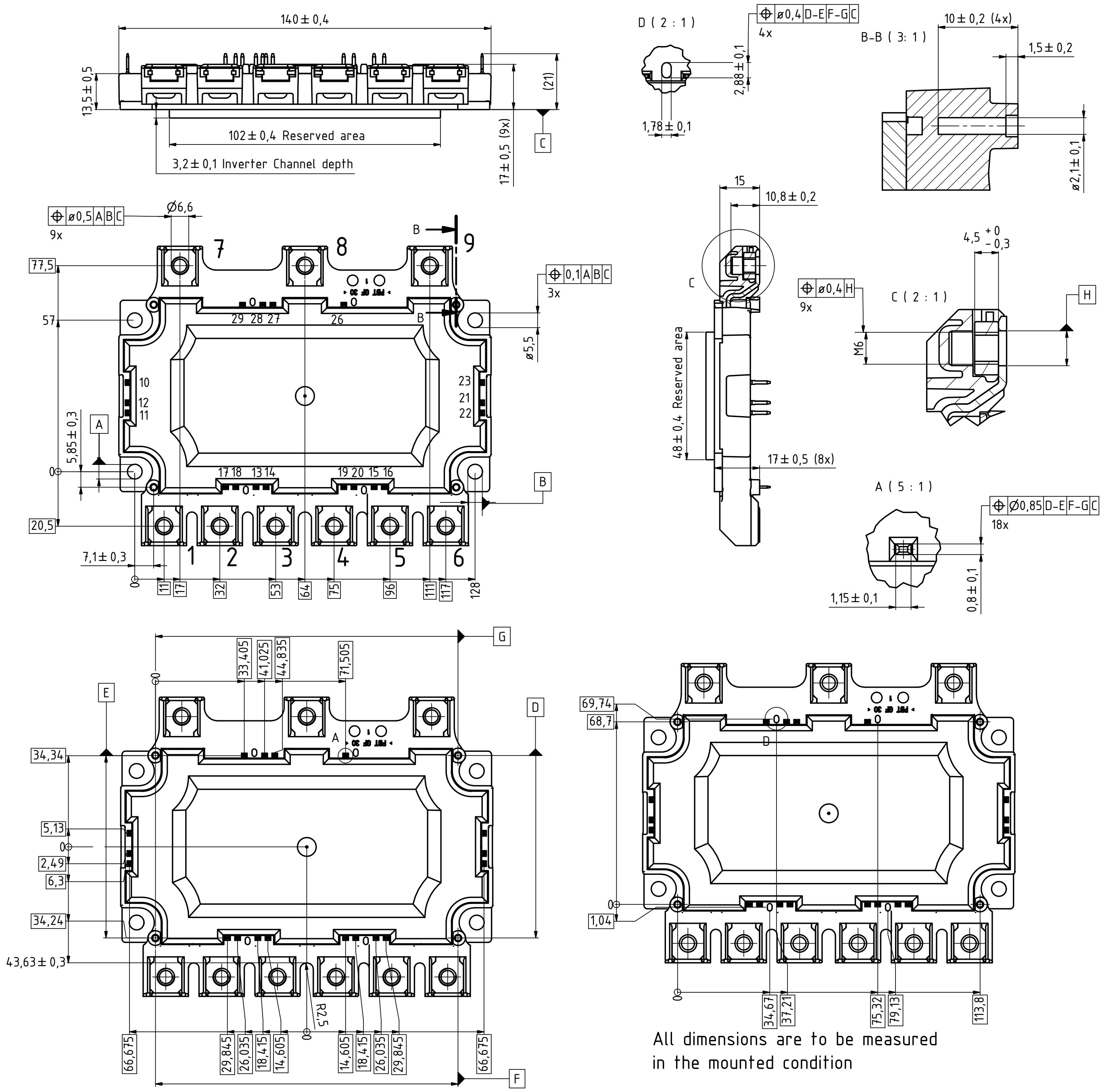
NTC-Thermistor-temperature characteristic (typical)
R = f (T)



7 Circuit diagram



8 Package outlines



9 Label Codes

9.1 Module Code

Code Format	Data Matrix		
Encoding	ASCII Text		
Symbol Size	16x16		
Standard	IEC24720 and IEC16022		
Code Content	**Content** Module Serial Number Module Material Number Production Order Number Datecode (Production Year) Datecode (Production Week)	**Digit** 1 - 5 6 - 11 12 - 19 20 - 21 22 - 23	**Example (below)** 71549 142846 55054991 15 30
Example	71549142846550549911530		

9.2 Packing Code

Code Format	Code128			
Encoding	Code Set A			
Symbol Size	34 digits			
Standard	IEC8859-1			
Code Content	**Content** Backend Construction Number Production Lot Number Serial Number Date Code Box Quantity	**Identifier** X 1T S 9D Q	**Digit** 2 - 9 12 - 19 21 - 25 28 - 31 33 - 34	**Example (below)** 95056609 2X0003E0 754389 1139 15
Example	X950566091T2X0003E0S754389D1139Q15			

Revision History

Major changes since previous revision

Revision History		
Reference	**Date**	**Description**
V1.0	2017-04-06	-
V2.0	2018-01-15	-
V3.0	2018-03-26	Final datasheet
V3.1	2019-12-19	Correction of mechanical feature

Terms & Conditions of usage

Edition 2018-08-01

Published by
Infineon Technologies AG
81726 Munich, Germany

Legal Disclaimer
The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics. With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation, warranties of non-infringement of intellectual property rights of any third party.

Information
For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office (http://www.infineon.com)

Warnings
Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.
These components are not designed for "special applications" that demand extremely high reliability or safety such as aerospace, defense or life support devices or systems (Class III medical devices). If you intend to use the components in any of these special applications, please contact your local representative at International Rectifier HiRel Products, Inc. or the Infineon support (https://www.infineon.com/support) to review product requirements and reliability testing.
Infineon Technologies components may be used in special applications only with the express written approval of Infineon Technologies. Class III medical devices are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

Trademarks

Trademarks of Infineon Technologies AG

AURIX™, C166™, CanPAK™, CIPOS™, CIPURSE™, EconoPACK™, CoolMOS™, CoolSET™, CORECONTROL™, CROSSAVE™, DAVE™, DI-POL™, EasyPIM™, EconoBRIDGE™, EconoDUAL™, EconoPIM™, EconoPACK™, EiceDRIVER™, eupec™, FCOS™, HITFET™, HybridPACK™, I²RF™, ISOFACE™, IsoPACK™, MIPAQ™, ModSTACK™, my-d™, NovalithIC™, OptiMOS™, ORIGA™, POWERCODE™, PRIMARION™, PrimePACK™, PrimeSTACK™, PRO-SIL™, PROFET™, RASIC™, ReverSave™, SatRIC™, SIEGET™, SINDRION™, SIPMOS™, SmartLEWIS™, SOLID FLASH™, TEMPFET™, thinQ!™, TRENCHSTOP™, TriCore™.

Other Trademarks

Advance Design System™ (ADS) of Agilent Technologies, AMBA™, ARM™, MULTI-ICE™, KEIL™, PRIMECELL™, REALVIEW™, THUMB™, µVision™ of ARM Limited, UK. AUTOSAR™ is licensed by AUTOSAR development partnership. Bluetooth™ of Bluetooth SIG Inc. CAT-iq™ of DECT Forum. COLOSSUS™, FirstGPS™ of Trimble Navigation Ltd. EMV™ of EMVCo, LLC (Visa Holdings Inc.). EPCOS™ of Epcos AG. FLEXGO™ of Microsoft Corporation. FlexRay™ is licensed by FlexRay Consortium. HYPERTERMINAL™ of Hilgraeve Incorporated. IEC™ of Commission Electrotechnique Internationale. IrDA™ of Infrared Data Association Corporation. ISO™ of INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. MATLAB™ of MathWorks, Inc. MAXIM™ of Maxim Integrated Products, Inc. MICROTEC™, NUCLEUS™ of Mentor Graphics Corporation. MIPI™ of MIPI Alliance, Inc. MIPS™ of MIPS Technologies, Inc., USA. muRata™ of MURATA MANUFACTURING CO., MICROWAVE OFFICE™ (MWO) of Applied Wave Research Inc., OmniVision™ of OmniVision Technologies, Inc. Openwave™ Openwave Systems Inc. RED HAT™ Red Hat, Inc. RFMD™ RF Micro Devices, Inc. SIRIUS™ of Sirius Satellite Radio Inc. SOLARIS™ of Sun Microsystems, Inc. SPANSION™ of Spansion LLC Ltd. Symbian™ of Symbian Software Limited. TAIYO YUDEN™ of Taiyo Yuden Co. TEAKLITE™ of CEVA, Inc. TEKTRONIX™ of Tektronix Inc. TOKO™ of TOKO KABUSHIKI KAISHA TA. UNIX™ of X/Open Company Limited. VERILOG™, PALLADIUM™ of Cadence Design Systems, Inc. VLYNQ™ of Texas Instruments Incorporated. VXWORKS™, WIND RIVER™ of WIND RIVER SYSTEMS, INC. ZETEX™ of Diodes Zetex Limited.

Last update	2011-11-11

www.infineon.com

Published by Infineon Technologies AG