10-F407PNA020I7-P445C69
datasheet

*flow*PIM 0	650 V / 20 A

Topology features

- Converter+Inverter
- Open Emitter configuration
- Temperature sensor

Component features

- Easy paralleling
- Low collector emitter saturation voltage
- Low turn-off losses
- Positive temperature coefficient

Housing features

- Base isolation: Al_2O_3
- Clip-in, reliable mechanical connection, qualified for wave soldering
- Convex shaped substrate for superior thermal contact
- Thermo-mechanical push-and-pull force relief
- Solder pin

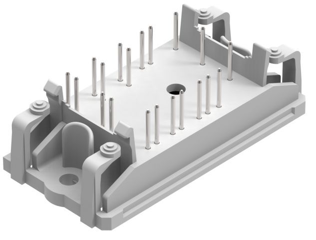
Target applications

- Embedded Drives
- HVAC
- Industrial Drives

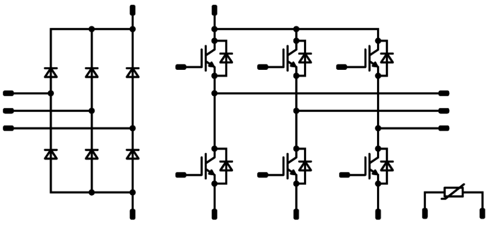
Types

- 10-F407PNA020I7-P445C69

flow 0 17 mm housing



Schematic



Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions		Value	Unit
Inverter Switch					
Collector-emitter voltage	V_{CES}			650	V
Collector current (DC current)	I_C	$T_j = T_{jmax}$	T_s = 80 °C	32	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		60	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	58	W
Gate-emitter voltage	V_{GES}			±20	V
Short circuit ratings	t_{SC}	V_{GE} = 15 V, V_{CC} = 400 V	T_j = 150 °C	3	µs
Maximum junction temperature	T_{jmax}			175	°C
Inverter Diode					
Peak repetitive reverse voltage	V_{RRM}			650	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$	T_s = 80 °C	23	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		60	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	37	W
Maximum junction temperature	T_{jmax}			175	°C
Rectifier Diode					
Peak repetitive reverse voltage	V_{RRM}			1600	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$	T_s = 80 °C	39	A
Surge (non-repetitive) forward current	I_{FSM}	Single Half Sine Wave, t_p = 10 ms	T_j = 150 °C	270	A
Surge current capability	I^2t			370	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	44	W
Maximum junction temperature	T_{jmax}			150	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions		Value	Unit
Module Properties					
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{jop}			-40…+(T_{jmax} - 25)	°C
Isolation Properties					
Isolation voltage	V_{isol}	DC Test Voltage*	t_p = 2 s	4000	V
Creepage distance				>12,7	mm
Clearance				>12,7	mm
Comparative Tracking Index	CTI			≥ 200	

*100 % tested in production

Characteristic Values

Parameter	Symbol	Conditions	V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_{F} [V]	I_{C} [A] I_{D} [A] I_{F} [A]	T_j [°C]	Min	Typ	Max	Unit
Inverter Switch										
Static										
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0002	25	4,35	5	5,65	V
Collector-emitter saturation voltage	V_{CEsat}		15		20	25 125 150		1,32 1,4 1,43	1,65(1)	V
Collector-emitter cut-off current	I_{CES}		0	650		25			20	µA
Gate-emitter leakage current	I_{GES}		20	0		25			100	nA
Internal gate resistance	r_g							None		Ω
Input capacitance	C_{ies}							1310		pF
Output capacitance	C_{oes}	f = 1 Mhz	0	25		25		42		pF
Reverse transfer capacitance	C_{res}							13		pF
Gate charge	Q_g	V_{CC} = 520 V	15		20	25		128		nC
Thermal										
Thermal resistance junction to sink(2)	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						1,63		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$					25 125 150		90,8 93,01 93,57		ns
Rise time	t_r	R_{gon} = 16 Ω R_{goff} = 16 Ω				25 125 150		38,54 38,79 38,74		ns
Turn-off delay time	$t_{d(off)}$					25 125 150		118,1 139,16 143,85		ns
Fall time	t_f		±15	350	30	25 125 150		31,44 55,29 61,87		ns
Turn-on energy (per pulse)	E_{on}	Q_{rFWD}=0,504 µC Q_{rFWD}=1,11 µC Q_{rFWD}=1,31 µC				25 125 150		0,733 0,972 1,03		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		0,45 0,66 0,715		mWs

Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
			V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_F [V]	I_C [A] I_D [A] I_F [A]	T_j [°C]	Min	Typ	Max	
Inverter Diode										
Static										
Forward voltage	V_F				20	25 125 150		1,71 1,6 1,55	2(1)	V
Reverse leakage current	I_R	V_r = 650 V				25			20	µA
Thermal										
Thermal resistance junction to sink(2)	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						2,59		K/W
Dynamic										
Peak recovery current	I_{RM}	d*i*/d*t*=572 A/µs d*i*/d*t*=548 A/µs d*i*/d*t*=607 A/µs	±15	350	30	25 125 150		8,24 12,58 13,56		A
Reverse recovery time	t_{rr}					25 125 150		97,26 143,97 160,25		ns
Recovered charge	Q_r					25 125 150		0,504 1,11 1,31		µC
Reverse recovered energy	E_{rec}					25 125 150		0,097 0,225 0,269		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		354,08 220,3 183,54		A/µs

Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
			V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_F [V]	I_C [A] I_D [A] I_F [A]	T_j [°C]	Min	Typ	Max	
Rectifier Diode										
Static										
Forward voltage	V_F				13	25 125 150		0,983 0,89 0,869	1,21(1) 1,1(1)	V
Reverse leakage current	I_R	V_r = 1600 V				25			50	µA
Thermal										
Thermal resistance junction to sink(2)	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						1,59		K/W
Thermistor										
Static										
Rated resistance	R					25		22		kΩ
Deviation of R100	$\Delta_{R/R}$	R_{100} = 1484 Ω				100	-5		5	%
Power dissipation	P					25		130		mW
Power dissipation constant	d					25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. ±1 %						3962		K
B-value	$B_{(25/100)}$	Tol. ±1 %						4000		K
Vincotech Thermistor Reference									I	

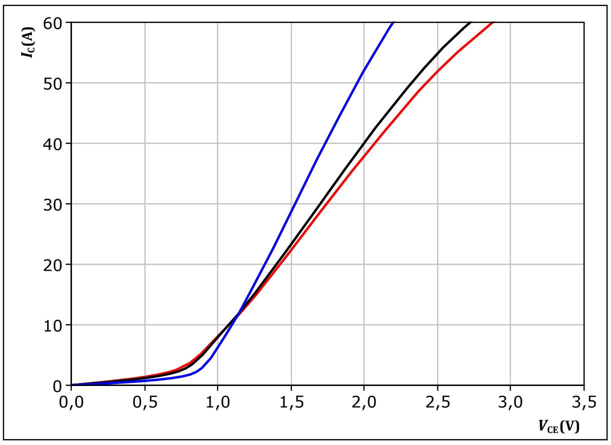
(1) Value at chip level
(2) Only valid with pre-applied Vincotech thermal interface material.

Inverter Switch Characteristics

figure 1. **IGBT**

Typical output characteristics

I_C = f(V_{CE})

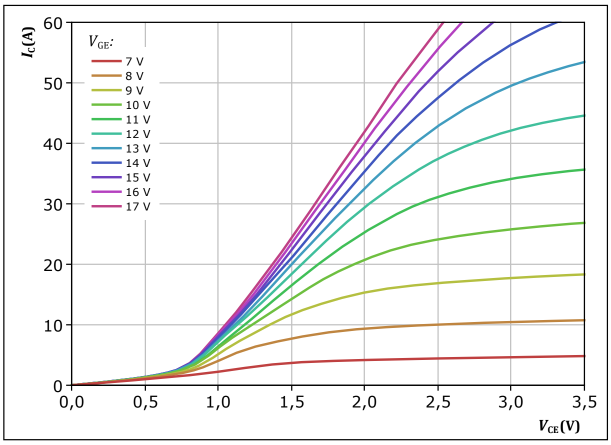


t_p =	250	μs		25 °C
V_{GE} =	15	V	T_j:	125 °C
				150 °C

figure 2. **IGBT**

Typical output characteristics

I_C = f(V_{CE})



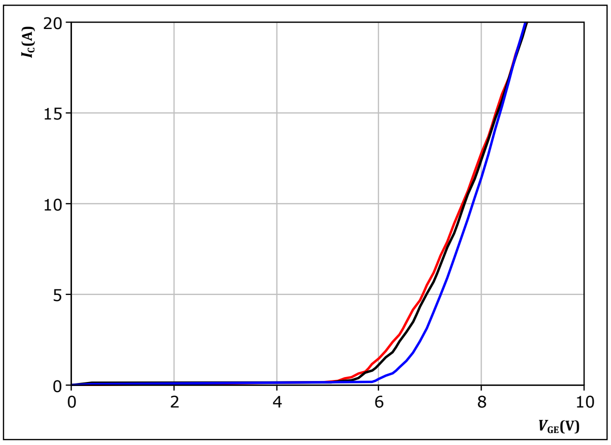
t_p =	250	μs
T_j =	150	°C

V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. **IGBT**

Typical transfer characteristics

I_C = f(V_{GE})

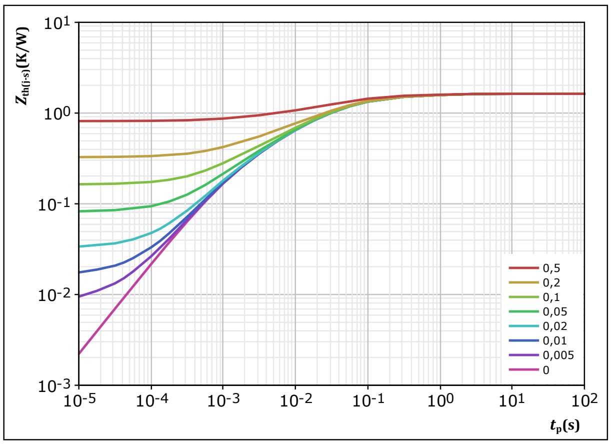


t_p =	250	μs		25 °C
V_{CE} =	9	V	T_j:	125 °C
				150 °C

figure 4. **IGBT**

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)}$ = f(t_p)



D =	t_p / T	
$R_{th(j-s)}$ =	1,631	K/W

IGBT thermal model values

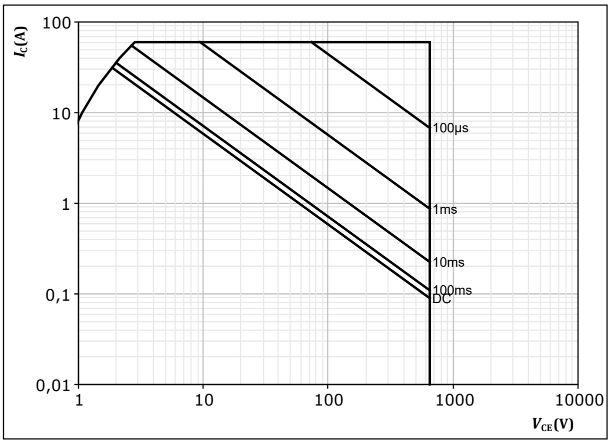
R (K/W)	τ (s)
1,22E-01	1,15E+00
3,54E-01	1,26E-01
6,61E-01	2,93E-02
3,54E-01	5,82E-03
1,40E-01	1,02E-03

Inverter Switch Characteristics

figure 5. **IGBT**

Safe operating area

I_C = f(V_{CE})

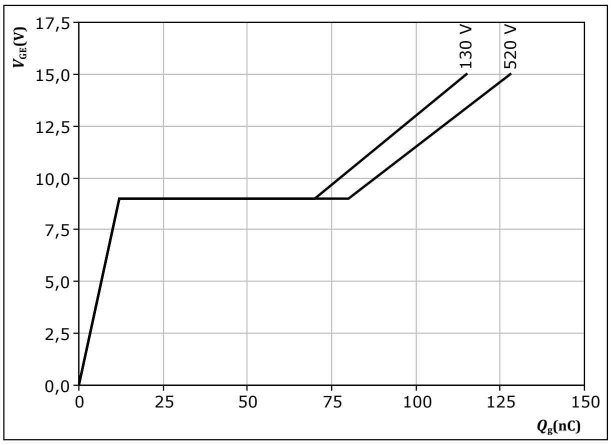


D = single pulse
T_s = 80 °C
V_{GE} = 15 V
T_j = T_{jmax}

figure 6. **IGBT**

Gate voltage vs gate charge

V_{GE} = f(Q_g)



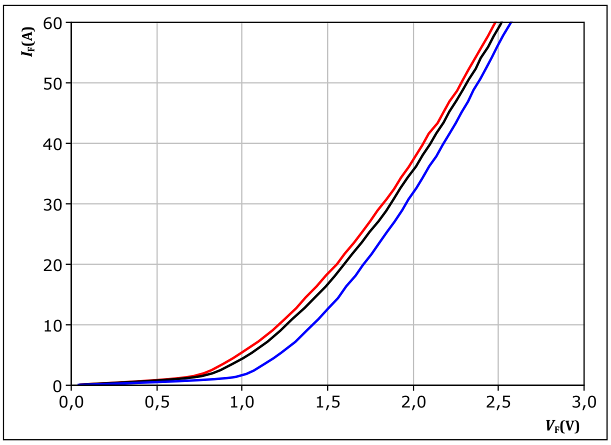
I_C = 20 A
T_j = 25 °C

Inverter Diode Characteristics

figure 7. **FWD**

Typical forward characteristics

I_F = f(V_F)



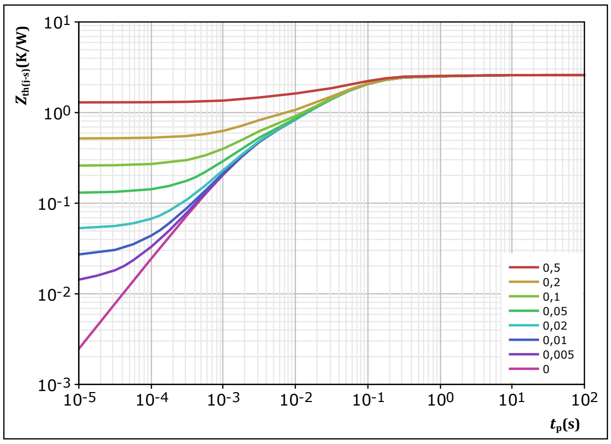
t_p = 250 µs

T_j: 25 °C, 125 °C, 150 °C

figure 8. **FWD**

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)}$ = f(t_p)



D = t_p / T

$R_{th(j-s)}$ = 2,592 K/W

FWD thermal model values

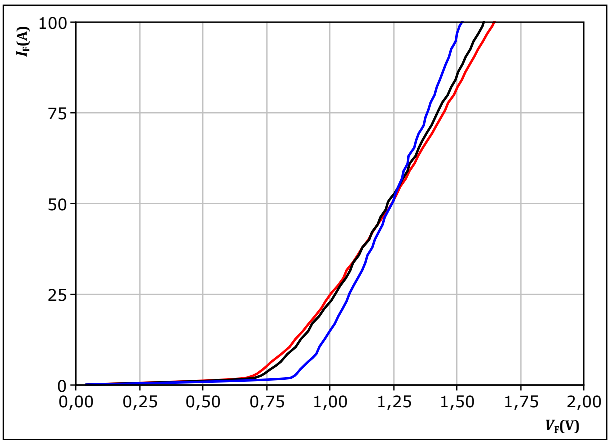
R (K/W)	τ (s)
7,36E-02	3,57E+00
5,92E-02	1,43E+00
1,09E+00	9,46E-02
9,44E-01	2,55E-02
4,28E-01	2,15E-03

Rectifier Diode Characteristics

figure 9. **Rectifier**

Typical forward characteristics

$I_F = f(V_F)$



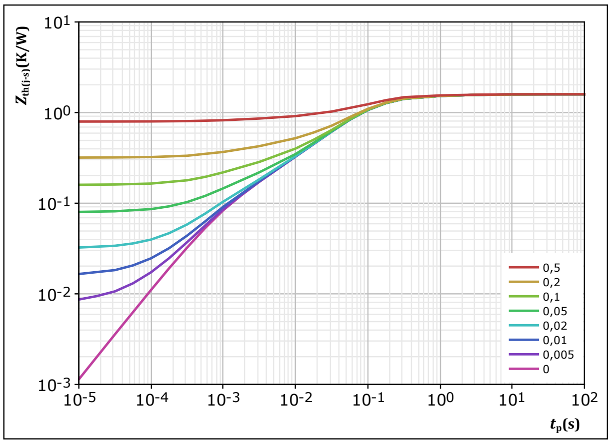
t_p = 250 µs

T_j: 25 °C, 125 °C, 150 °C

figure 10. **Rectifier**

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)} = f(t_p)$



$D = t_p / T$

$R_{th(j-s)}$ = 1,592 K/W

Rectifier thermal model values

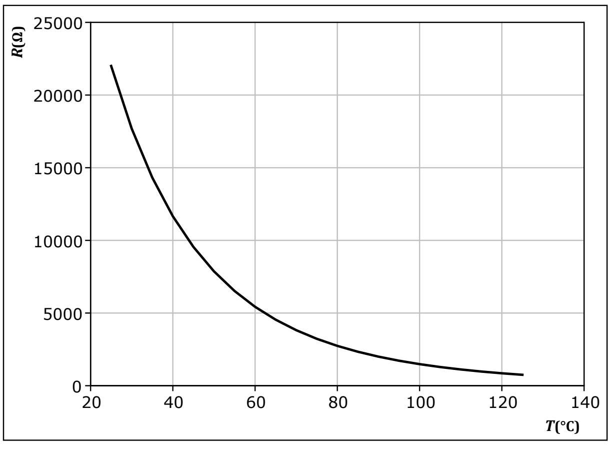
R (K/W)	τ (s)
5,25E-02	3,88E+00
2,04E-01	4,78E-01
1,08E+00	7,99E-02
1,71E-01	9,86E-03
8,68E-02	1,04E-03

Thermistor Characteristics

figure 11.	Thermistor

Typical NTC characteristic as function of temperature

R_T = f(T)

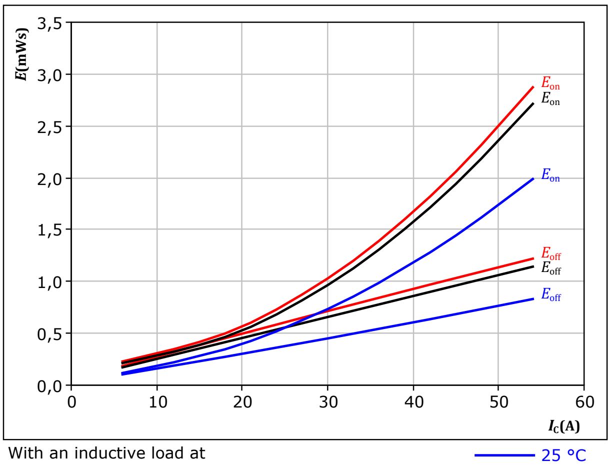


Inverter Switching Characteristics

figure 12. **IGBT**

Typical switching energy losses as a function of collector current

E = f(I_C)



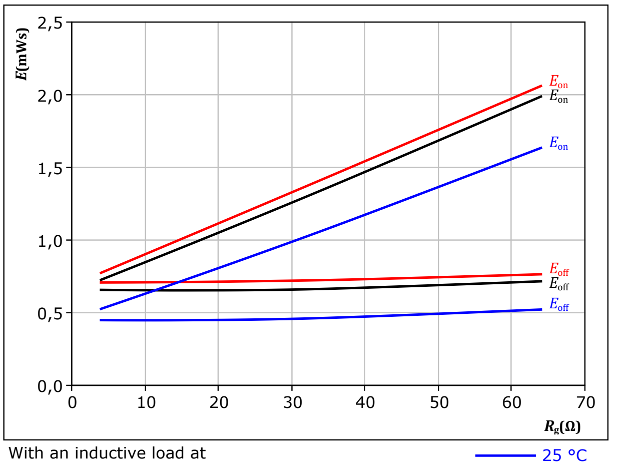
With an inductive load at

V_{CE} =	350	V	T_j: 25 °C / 125 °C / 150 °C
V_{GE} =	±15	V	
R_{gon} =	16	Ω	
R_{goff} =	16	Ω	

figure 13. **IGBT**

Typical switching energy losses as a function of IGBT turn on gate resistor

E = f(R_g)



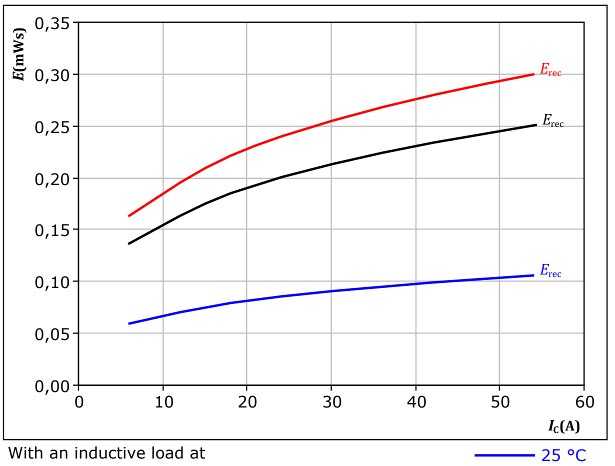
With an inductive load at

V_{CE} =	350	V	T_j: 25 °C / 125 °C / 150 °C
V_{GE} =	±15	V	
I_C =	30	A	

figure 14. **FWD**

Typical reverse recovered energy loss as a function of collector current

E_{rec} = f(I_C)



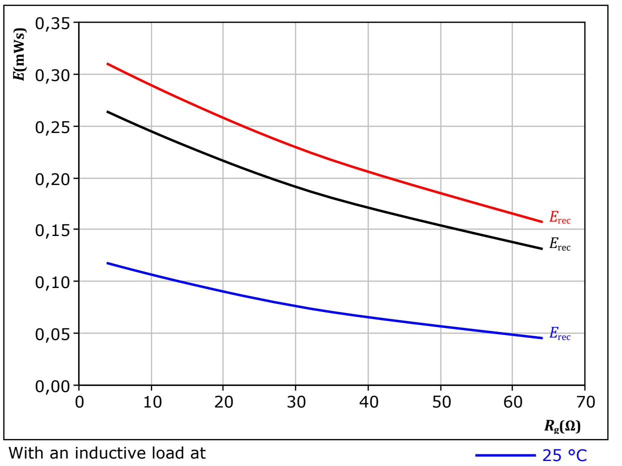
With an inductive load at

V_{CE} =	350	V	T_j: 25 °C / 125 °C / 150 °C
V_{GE} =	±15	V	
R_{gon} =	16	Ω	

figure 15. **FWD**

Typical reverse recovered energy loss as a function of IGBT turn on gate resistor

E_{rec} = f(R_g)



With an inductive load at

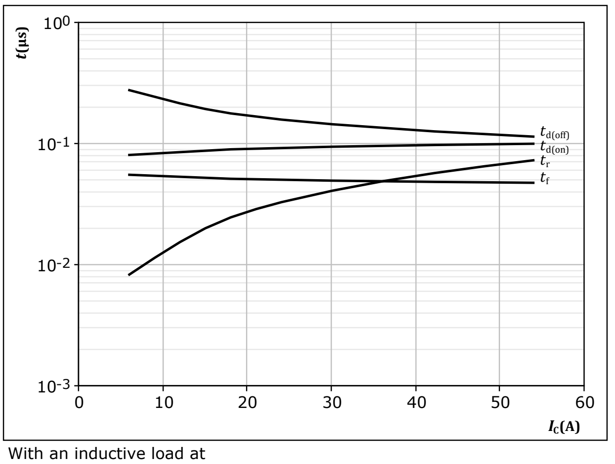
V_{CE} =	350	V	T_j: 25 °C / 125 °C / 150 °C
V_{GE} =	±15	V	
I_C =	30	A	

Inverter Switching Characteristics

figure 16. **IGBT**

Typical switching times as a function of collector current

t = f(I_C)



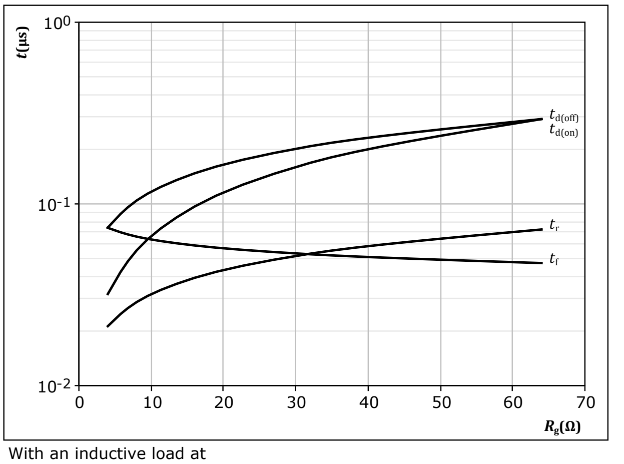
With an inductive load at

T_j =	150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 17. **IGBT**

Typical switching times as a function of IGBT turn on gate resistor

t = f(R_g)



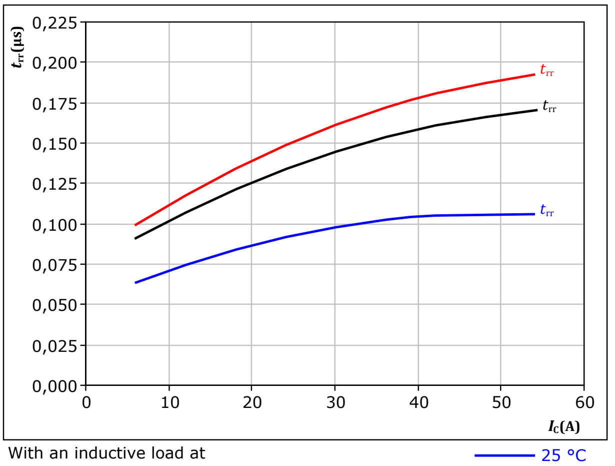
With an inductive load at

T_j =	150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	30	A

figure 18. **FWD**

Typical reverse recovery time as a function of collector current

t_{rr} = f(I_C)



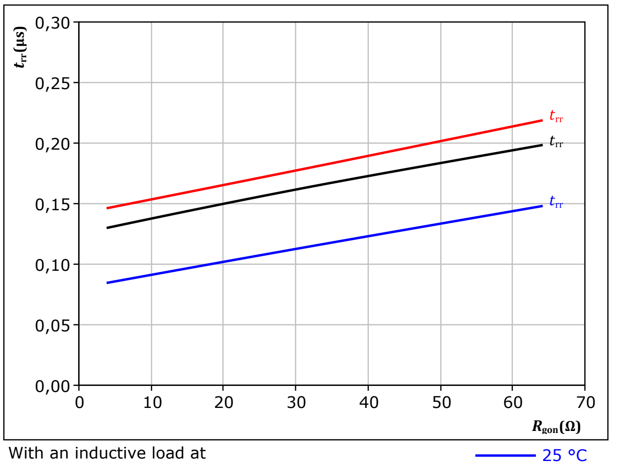
With an inductive load at

V_{CE} =	350	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
R_{gon} =	16	Ω		150 °C

figure 19. **FWD**

Typical reverse recovery time as a function of IGBT turn on gate resistor

t_{rr} = f(R_{gon})



With an inductive load at

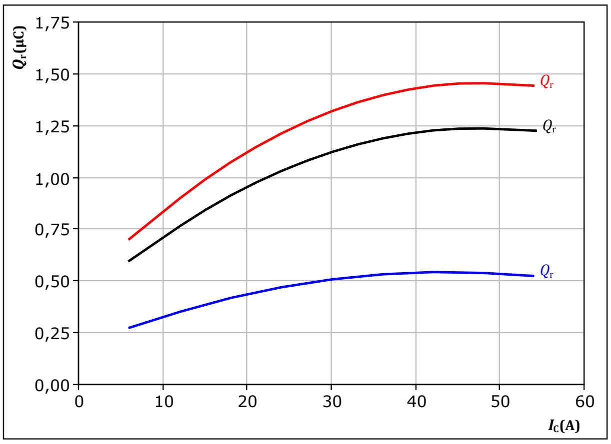
V_{CE} =	350	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
I_C =	30	A		150 °C

Inverter Switching Characteristics

figure 20. **FWD**

Typical recovered charge as a function of collector current

Q_r = f(I_C)



With an inductive load at

V_{CE} = 350 V

V_{GE} = ±15 V

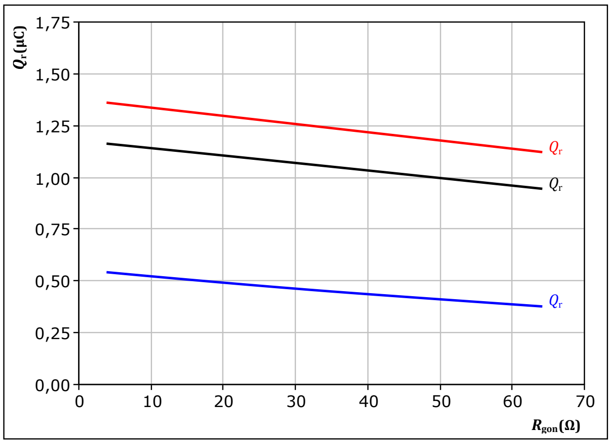
R_{gon} = 16 Ω

T_j: 25 °C, 125 °C, 150 °C

figure 21. **FWD**

Typical recovered charge as a function of IGBT turn on gate resistor

Q_r = f(R_{gon})



With an inductive load at

V_{CE} = 350 V

V_{GE} = ±15 V

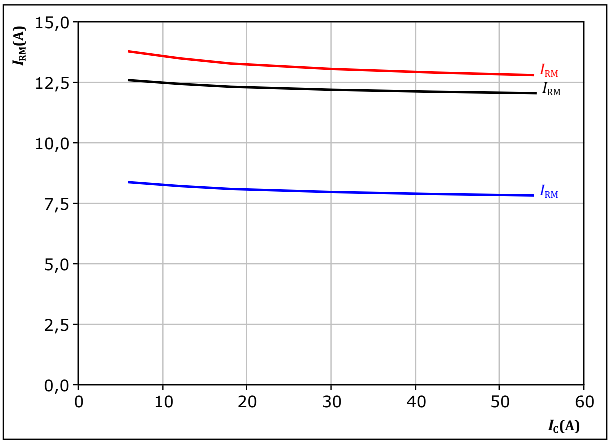
I_C = 30 A

T_j: 25 °C, 125 °C, 150 °C

figure 22. **FWD**

Typical peak reverse recovery current as a function of collector current

I_{RM} = f(I_C)



With an inductive load at

V_{CE} = 350 V

V_{GE} = ±15 V

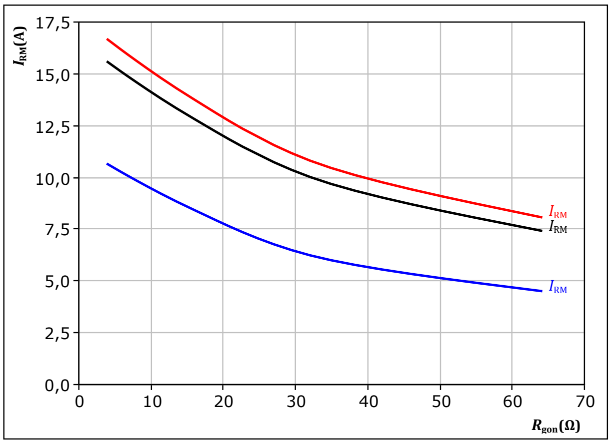
R_{gon} = 16 Ω

T_j: 25 °C, 125 °C, 150 °C

figure 23. **FWD**

Typical peak reverse recovery current as a function of IGBT turn on gate resistor

I_{RM} = f(R_{gon})



With an inductive load at

V_{CE} = 350 V

V_{GE} = ±15 V

I_C = 30 A

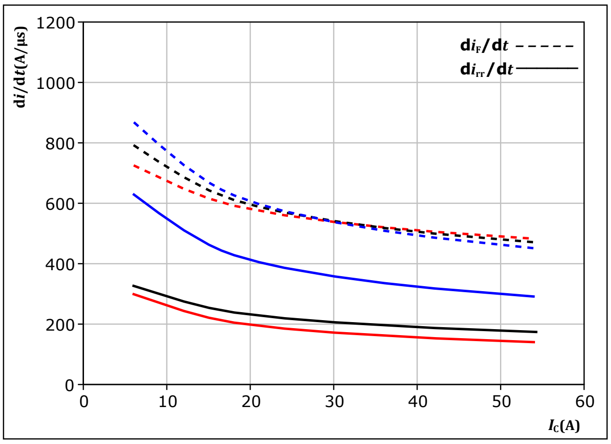
T_j: 25 °C, 125 °C, 150 °C

Inverter Switching Characteristics

figure 24. **FWD**

Typical rate of fall of forward and reverse recovery current as a function of collector current

di_F/dt, di_{rr}/dt = f(I_C)



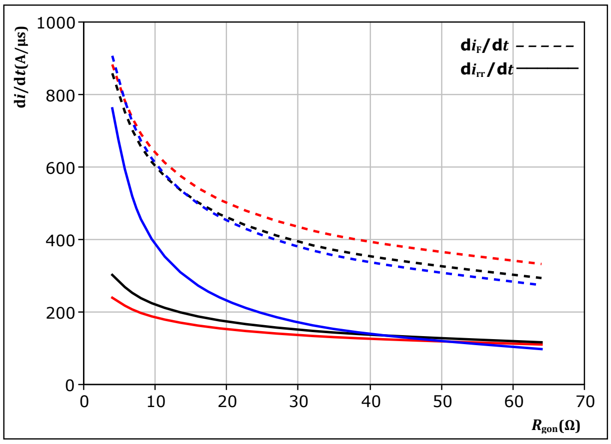
With an inductive load at

V_{CE} =	350	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
R_{gon} =	16	Ω		150 °C

figure 25. **FWD**

Typical rate of fall of forward and reverse recovery current as a function of turn on gate resistor

di_F/dt, di_{rr}/dt = f(R_{gon})



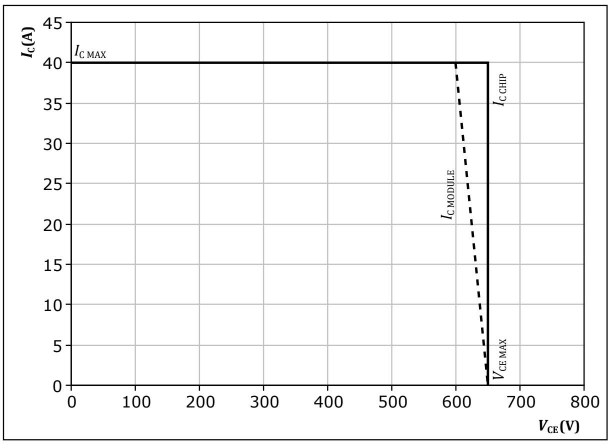
With an inductive load at

V_{CE} =	350	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
I_C =	30	A		150 °C

figure 26. **IGBT**

Reverse bias safe operating area

I_C = f(V_{CE})



At	T_j =	150	°C
	R_{gon} =	16	Ω
	R_{goff} =	16	Ω

Inverter Switching Definitions

figure 27. IGBT

Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{tEoff} = integrating time for E_{off})

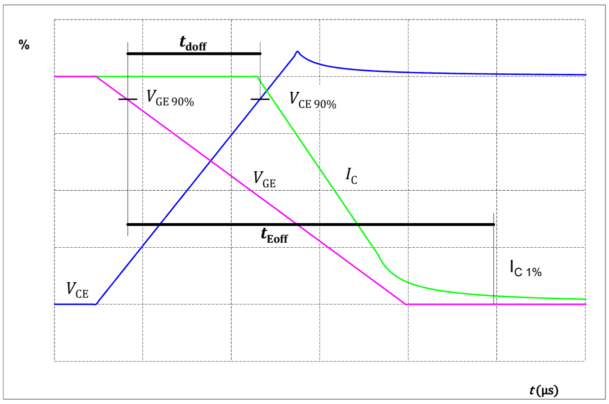


figure 28. IGBT

Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})

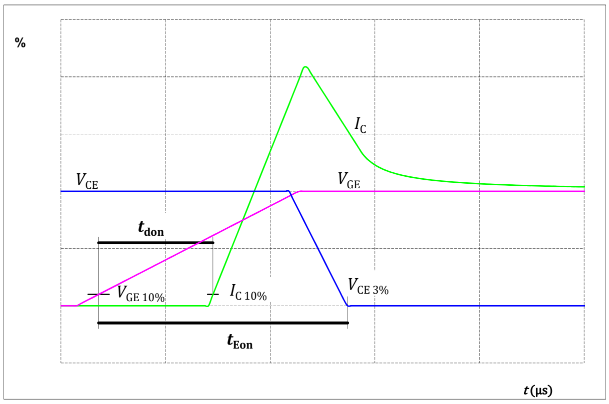


figure 29. IGBT

Turn-off Switching Waveforms & definition of t_f

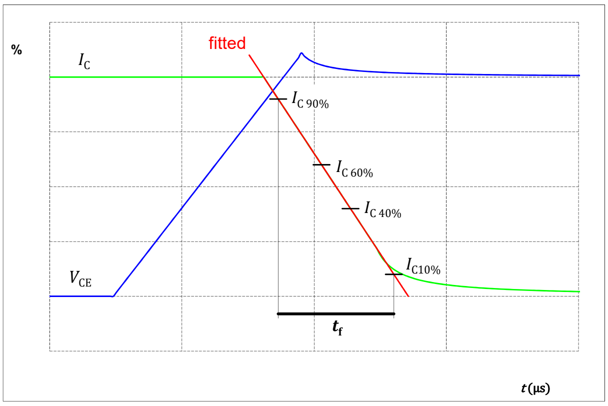
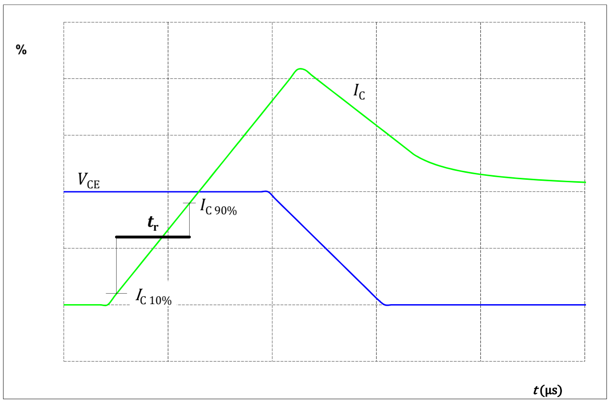


figure 30. IGBT

Turn-on Switching Waveforms & definition of t_r



Inverter Switching Definitions

figure 31. **FWD**

Turn-off Switching Waveforms & definition of t_{rr}

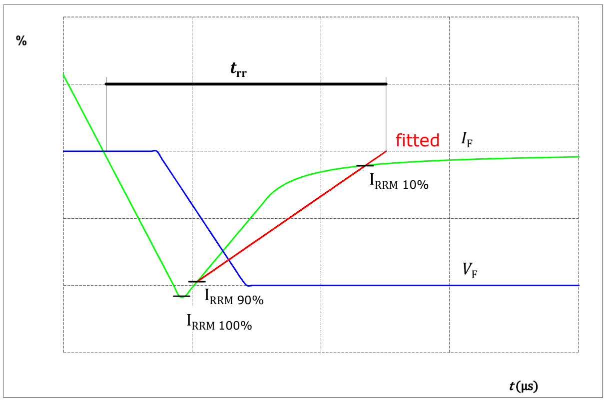
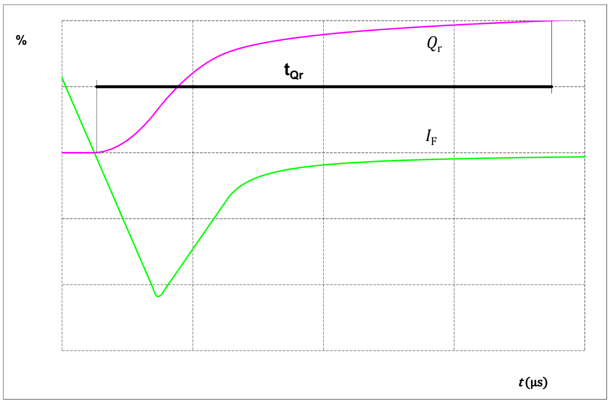


figure 32. **FWD**

Turn-on Switching Waveforms & definition of t_{Qr} (t_{Qr} = integrating time for Q_r)



Ordering Code

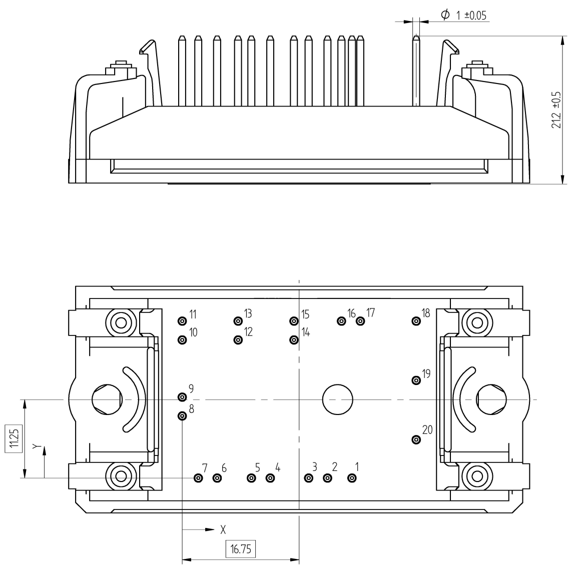
Version	Ordering Code
Without thermal paste	10-F407PNA020I7-P445C69
With thermal paste (5,2 W/mK, PTM6000HV)	10-F407PNA020I7-P445C69-/7/

Marking

	**Text**	**VIN**	**Date code**	**Type&Ver**	**UL**	**Lot**	**Serial**
		VIN	WWYY	TTTTTTTTVV	UL	LLLLL	SSSS
	Datamatrix	**Type&Ver**	**Lot number**	**Serial**	**Date code**		
		TTTTTTTTVV	LLLLL	SSSS	WWYY		

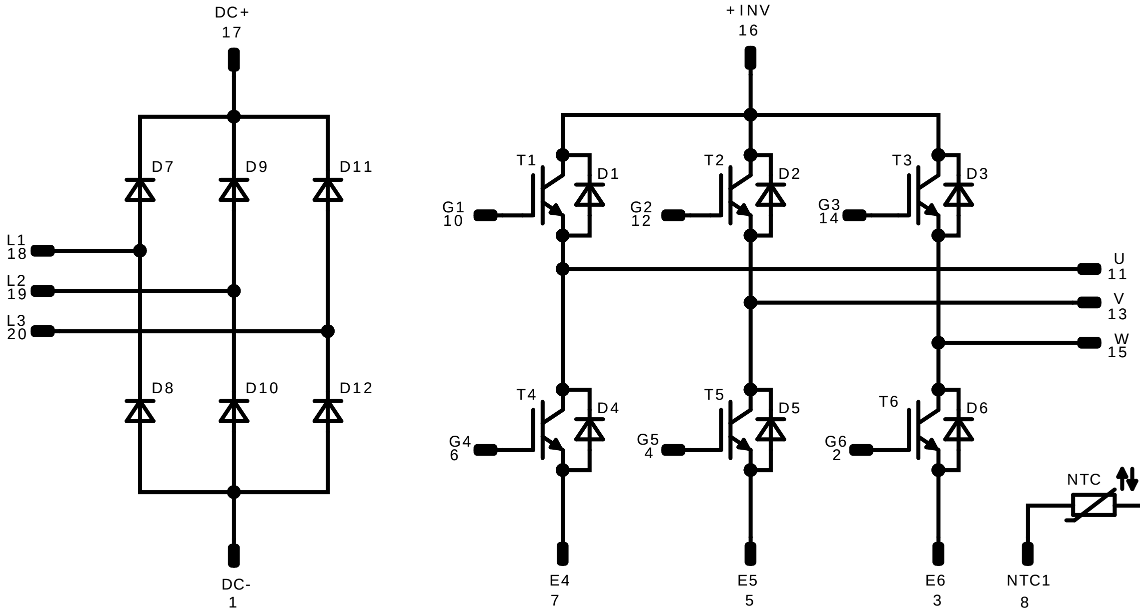
Outline

Pin table [mm]			
Pin	X	Y	Function
1	24,3	0	DC-
2	20,8	0	G6
3	18,1	0	E6
4	12,6	0	G5
5	9,9	0	E5
6	5	0	G4
7	2,3	0	E4
8	0	8,9	NTC1
9	0	11,6	NTC2
10	0	19,8	G1
11	0	22,5	U
12	8	19,8	G2
13	8	22,5	V
14	16	19,8	G3
15	16	22,5	W
16	22,8	22,5	+INV
17	25,5	22,5	DC+
18	33,5	22,5	L1
19	33,5	14	L2
20	33,5	5,5	L3



Tolerance of pinpositions: ±0,5mm at the end of pins
Dimension of coordinate axis is only offset without tolerance

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T4, T1, T5, T2, T6, T3	IGBT	650 V	20 A	Inverter Switch	
D1, D4, D2, D5, D3, D6	FWD	650 V	20 A	Inverter Diode	
D8, D7, D10, D9, D12, D11	Rectifier	1600 V	35 A	Rectifier Diode	
NTC	Thermistor			Thermistor	

Packaging instruction				
Standard packaging quantity (SPQ) 135	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for *flow* 0 packages see vincotech.com website.

Package data
Package data for *flow* 0 packages see vincotech.com website.

Vincotech thermistor reference
See Vincotech thermistor reference table at vincotech.com website.

UL recognition and file number
This device is UL 1557 recognized under E192116 up to a junction temperature under switching condition $T_{j,op}$=175°C and up to 3500VAC/1min isolation voltage. For more information see vincotech.com website.

Document No.:	Date:	Modification:	Pages
10-F407PNA020I7-P445C69-D1-14	13 Sep. 2024	Initial Release	