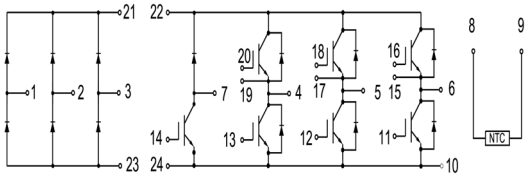
V_{CES} = 1200V
I_C = 40A at T_C = 80°C
t_{SC} ≥ 10µsec
$V_{CE(ON)}$ = 2.30V at I_C = 40A

Converter, Inverter, Brake (CIB) Module
POWIR ECO 2™ Package



Applications:

- Industrial Motor Drive
- Servo Drive
- Traction Inverter

Features	Benefits
Low $V_{CE(ON)}$ and Switching Losses	High Efficiency in a Wide Range of Applications
100% RBSOA Tested	Rugged Transient Performance
10µsec Short Circuit Safe Operating Area	
POWIR ECO 2™ Package	Industry Standard
Lead Free	RoHS Compliant, Environmental Friendly

Base Part Number	Package Type	Standard Pack	Quantity	Orderable Part Number
IRG5K40PM12E	***POWIR ECO 2™***	Box	80	IRG5K40PM12E

Module Absolute Maximum Ratings

V_{CES}	Collector to Emitter Voltage (Inverter IGBT)		1200	V
I_C	Continuous Collector Current (Inverter IGBT)	T_C = 80°C	40	A
		T_C = 25°C	70	A
T_{JOP}	Maximum Operating Junction Temperature Range		-40 to +150	°C
T_{stg}	Storage Temperature		-40 to +125	°C
V_{iso}	Isolation Voltage (All Terminals Shorted), f = 50Hz, 1minute		2500	V
M	Mounting Screw: M6		6.0	N·m
G	Typical Weight		200	g

Absolute Maximum Ratings of Inverter IGBT

V_{CES}	Collector to Emitter Voltage		1200	V
V_{GES}	Continuous Gate to Emitter Voltage		±20	V
I_C	Continuous Collector Current	T_C = 80°C	40	A
		T_C = 25°C	70	A
I_{CM}	Pulse Collector Current	T_J = 150°C	80	A
P_D	Maximum Power Dissipation	T_C = 25°C, T_J = 150°C	340	W

Electrical Characteristics of Inverter IGBT at T_J = 25°C (Unless Otherwise Specified)

Parameter		Min.	Typ.	Max.	Unit	Test Conditions	
$V_{(BR)CES}$	Collector to Emitter Breakdown Voltage	1200			V	V_{GE} = 0V, I_C = 1mA	
$V_{GE(th)}$	Gate Threshold Voltage	4.5	5.3	6.0	V	I_C = 1 mA, V_{CE} = V_{GE}	
$V_{CE(ON)}$	Collector to Emitter Saturation Voltage		2.30	2.60	V	T_J = 25°C	I_C = 40A, V_{GE} = 15V
			2.80		V	T_J = 125°C	
I_{CES}	Collector to Emitter Leakage Current			1	mA	V_{GE} = 0V, V_{CE} = V_{CES}	
I_{GES}	Gate to Emitter Leakage Current			200	nA	V_{GE} = ±20V, V_{CE} = 0V	

Switching Characteristics of Inverter IGBT

Parameter		Min.	Typ.	Max.	Unit	Test Conditions	
$t_{d(on)}$	Turn-on Delay Time		105		ns	T_J = 25°C	V_{CC}=600V, I_C = 40A, R_G = 20Ω, V_{GE}=±15V, Inductive Load
			100			T_J = 125°C	
t_r	Rise Time		75		ns	T_J = 25°C	
			75			T_J = 125°C	
$t_{d(off)}$	Turn-off Delay Time		255		ns	T_J = 25°C	
			270			T_J = 125°C	
t_f	Fall Time		170		ns	T_J = 25°C	
			235			T_J = 125°C	
E_{on}	Turn-on Switching Loss		3.71		mJ	T_J = 25°C	
			4.82			T_J = 125°C	
E_{off}	Turn-off Switching Loss		1.71		mJ	T_J = 25°C	
			2.86			T_J = 125°C	
Q_g	Total Gate Charge		400		nC	T_J = 25°C	

Switching Characteristics of Inverter IGBT (cont'd)

Parameter		Min.	Typ.	Max.	Unit	Test Conditions
C_{ies}	Input Capacitance		5.7		nF	V_{CE} = 25V, V_{GE} = 0V, f =1MHz, T_J = 25°C
C_{oes}	Output Capacitance		0.38			
C_{res}	Reverse Transfer Capacitance		0.15			
RBSOA	Reverse Bias Safe Operating Area	Trapezoid				I_C = 80A,V_{CC} = 960V, V_P =1200V, R_G = 15Ω, V_{GE} = +15V to 0V, T_J = 150°C
SCSOA	Short Circuit Safe Operating Area	10			µs	V_{CC} = 600V, V_{GE} = 15V, T_J = 150°C

Absolute Maximum Ratings of Inverter Freewheeling Diode

V_{RRM}	Repetitive Peak Reverse Voltage	1200	V
I_F	Diode Continuous Forward Current, T_C = 25°C	80	A
	Diode Continuous Forward Current, T_C = 80°C	40	
I_{FM}	Pulse Diode Current	80	A

Electrical and Switching Characteristics of Freewheeling Diode

Parameter		Typ.	Max.	Unit	Test Conditions	
V_F	Forward Voltage	2.10	2.70	V	T_J = 25°C	I_F = 40A , V_{GE} = 0V
		2.20			T_J = 125°C	
I_{rr}	Peak Reverse Recovery Current	30		A	T_J = 25°C	I_F=40A, di/dt=760A/µs, V_{rr} = 600V, V_{GE} = -15V
		40			T_J = 125°C	
Q_{rr}	Reverse Recovery Charge	2.50		µC	T_J = 25°C	
		4.13			T_J = 125°C	
E_{rec}	Reverse Recovery Energy	0.84		mJ	T_J = 25°C	
		1.64			T_J = 125°C	

Absolute Maximum Ratings of Rectifier Bridge Diode

V_{RRM}	Repetitive Peak Reverse Voltage, T_C = 25°C	1600	V
I_{FRMSM}	Maximum RMS Forward Current Per Chip, T_J = 80°C	50	A
I_{RMSM}	Maximum RMS Current at Rectifier Output, T_J = 80°C	60	A
I_{FSM}	Surge Current at tp = 10ms, T_J = 25°C	420	A
	Surge Current at tp = 10ms, T_J = 150°C	350	
I^2t	I^2t value for fusing, T_J = 25°C	900	A^2s
	I^2t value for fusing, T_J = 150°C	650	

Electrical Characteristics of Rectifier Bridge Diode

Parameter		Typ.	Max.	Unit	Test Conditions	
V_F	Forward Voltage	1.10	1.20	V	T_J = 25°C	I_F = 40A
		1.00			T_J = 150°C	
I_R	Reverse Current		1	mA	T_J = 25°C	$V_R = V_{RRM}$

Absolute Maximum Ratings of Brake-Chopper IGBT

V_{CES}	Collector to Emitter Voltage		1200	V
V_{GES}	Continuous Gate to Emitter Voltage		±20	V
I_C	Continuous Collector Current	T_C = 80°C	15	A
		T_C = 25°C	30	A
I_{CM}	Pulse Collector Current	T_J = 175°C	30	A
P_D	Maximum Power Dissipation	T_C = 25°C, T_J = 175°C	190	W
T_J	Maximum IGBT Junction Temperature		175	°C
T_{JOP}	Maximum Operating Junction Temperature Range		-40 to +150	°C

Electrical Characteristics of Brake-Chopper IGBT at T_J = 25°C (Unless Otherwise Specified)

Parameter		Min.	Typ.	Max.	Unit	Test Conditions	
$V_{(BR)CES}$	Collector to Emitter Breakdown Voltage	1200			V	V_{GE} = 0V, I_C = 1mA	
$V_{GE(th)}$	Gate Threshold Voltage	5.0	5.8	6.5	V	I_C = 1 mA, $V_{CE} = V_{GE}$	
$V_{CE(ON)}$	Collector to Emitter Saturation Voltage		1.90	2.20	V	T_J = 25°C	I_C = 15A, V_{GE} = 15V
			2.20		V	T_J = 125°C	
I_{CES}	Collector to Emitter Leakage Current			1	mA	V_{GE} = 0V, $V_{CE} = V_{CES}$	
I_{GES}	Gate to Emitter Leakage Current			200	nA	V_{GE} = ±20V, V_{CE} = 0V	

Switching Characteristics of Brake-Chopper IGBT

Parameter		Min.	Typ.	Max.	Unit	Test Conditions	
$t_{d(on)}$	Turn-on Delay Time		175		ns	T_J = 25°C	V_{CC}=600V, I_C = 15A, R_G = 40Ω, V_{GE}=±15V, Inductive Load
			160			T_J = 125°C	
t_r	Rise Time		50		ns	T_J = 25°C	
			55			T_J = 125°C	
$t_{d(off)}$	Turn-off Delay Time		140		ns	T_J = 25°C	
			145			T_J = 125°C	
t_f	Fall Time		245		ns	T_J = 25°C	
			380			T_J = 125°C	
E_{on}	Turn-on Switching Loss		1.74		mJ	T_J = 25°C	
			2.08			T_J = 125°C	
E_{off}	Turn-off Switching Loss		0.63		mJ	T_J = 25°C	
			1.09			T_J = 125°C	
Q_g	Total Gate Charge		140		nC	T_J = 25°C	
C_{ies}	Input Capacitance		2.0		nF	V_{CE} = 25V, V_{GE} = 0V, f =1MHz, T_J = 25°C	
C_{oes}	Output Capacitance		0.77				
C_{res}	Reverse Transfer Capacitance		0.46				
RBSOA	Reverse Bias Safe Operating Area	Trapezoid				I_C = 30A,V_{CC} = 960V, V_P =1200V, R_G = 15Ω, V_{GE} = +15V to 0V, T_J = 150°C	
SCSOA	Short Circuit Safe Operating Area	10			µs	V_{CC} = 600V, V_{GE} = 15V, T_J = 150°C	

Absolute Maximum Ratings of Brake-Chopper Diode

V_{RRM}	Repetitive Peak Reverse Voltage	1200	V
I_F	Diode Continuous Forward Current, T_C = 25°C	30	A
	Diode Continuous Forward Current, T_C = 80°C	15	
I_{FM}	Pulse Diode Current	30	A

Electrical and Switching Characteristics of Brake-Chopper Diode

Parameter		Typ.	Max.	Unit	Test Conditions	
V_F	Forward Voltage	2.00	2.70	V	T_J = 25°C	I_F = 15A , V_{GE} = 0V
		2.20			T_J = 125°C	
I_{rr}	Peak Reverse Recovery Current	12		A	T_J = 25°C	I_F = 15A , di/dt=380A/µs, V_{rr} = 600V, V_{GE} = -15V
		18			T_J = 125°C	
Q_{rr}	Reverse Recovery Charge	0.7		µC	T_J = 25°C	
		1.4			T_J = 125°C	
E_{rec}	Reverse Recovery Energy	0.30		mJ	T_J = 25°C	
		0.60			T_J = 125°C	

Module Thermal Resistance Characteristics

Parameter		Typ.	Unit
$R_{\theta JC}$	Junction-to-Case (Inverter IGBT)	0.442	°C/W
	Junction-to-Case (Freewheeling Diode)	0.77	°C/W
	Junction-to-Case (Rectifier Bridge Diode)	0.90	°C/W
	Junction-to-Case (Brake-Chopper IGBT)	0.801	°C/W
	Junction-to-Case (Brake-Chopper Diode)	1.42	°C/W
$R_{\theta CS}$	Case-To-Sink (Conductive Grease Applied)	0.1	°C/W

NTC-Thermistor Characteristics

Parameter		Typ.	Max.	Unit
R_{25}	T_C =25°C	5		kΩ
ΔR/R	T_C =100°C， R_{100} =481Ω		±5	%
P_{25}	T_C =25°C	50		mW
$B_{25/50}$	$R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15K))]$	3380		K
$B_{25/80}$	$R_2=R_{25}\exp[B_{25/80}(1/T_2-1/(298.15K))]$	3440		K

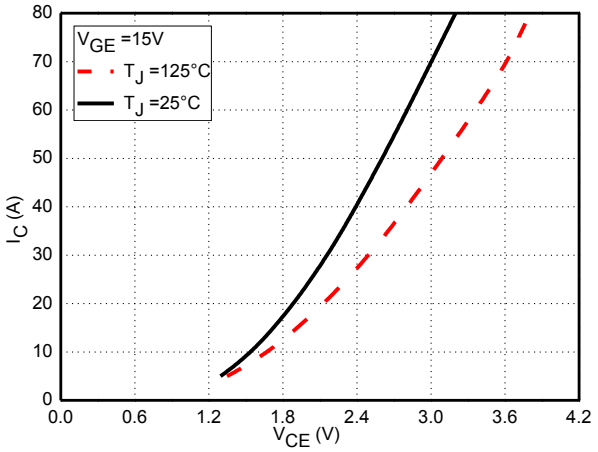


Fig.1 Typical Saturation Characteristics, Inverter IGBT

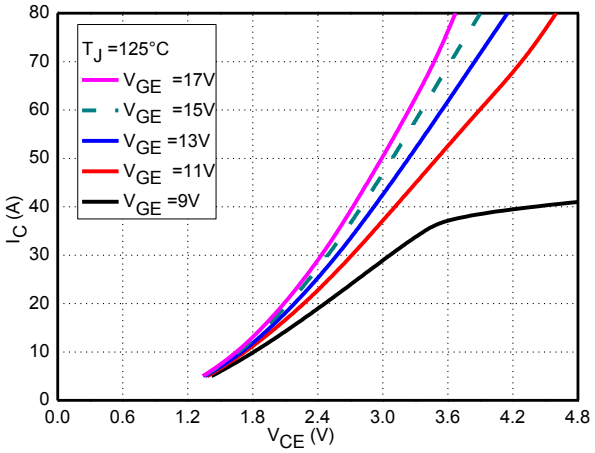


Fig.2 Typical Output Characteristics, Inverter IGBT

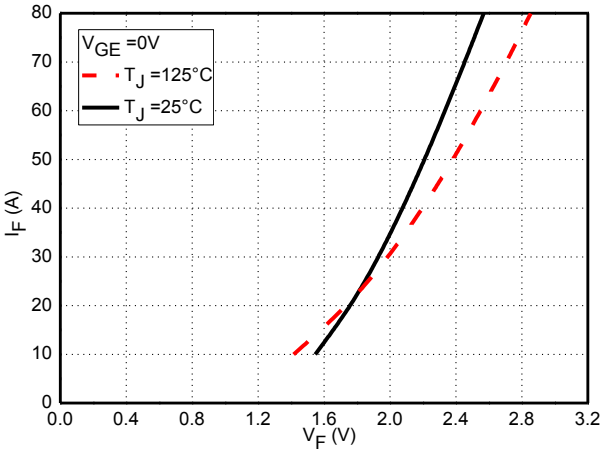


Fig.3 Typical Forward Characteristics, Freewheeling Diode

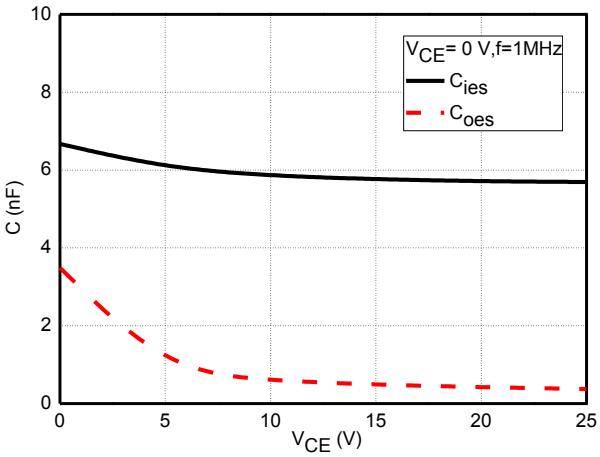


Fig.4 Typical Capacitance Characteristics, Inverter IGBT

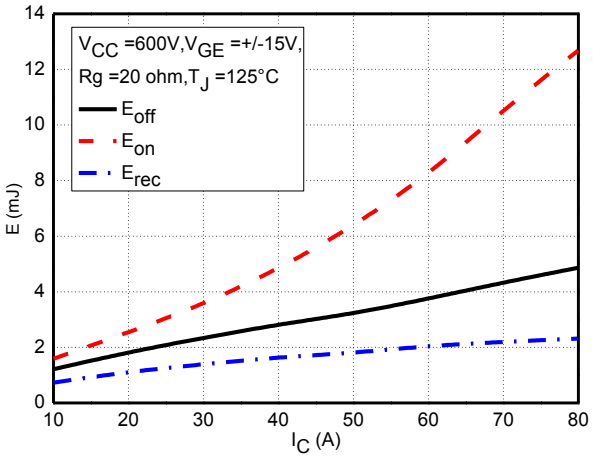


Fig.5 Typical Switching Loss vs. Collector Current, Inverter IGBT

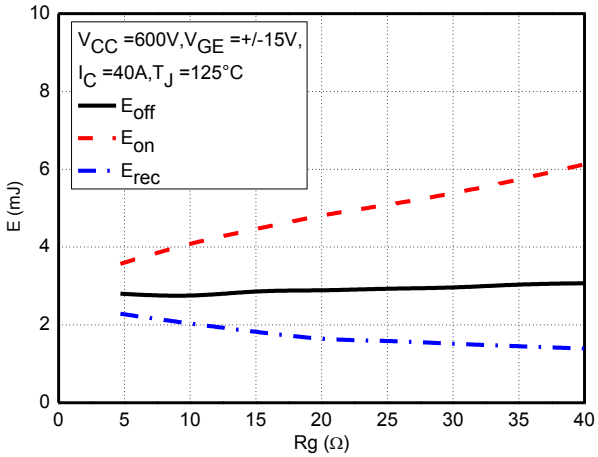


Fig.6 Typical Switching Loss vs. Gate Resistance, Inverter IGBT

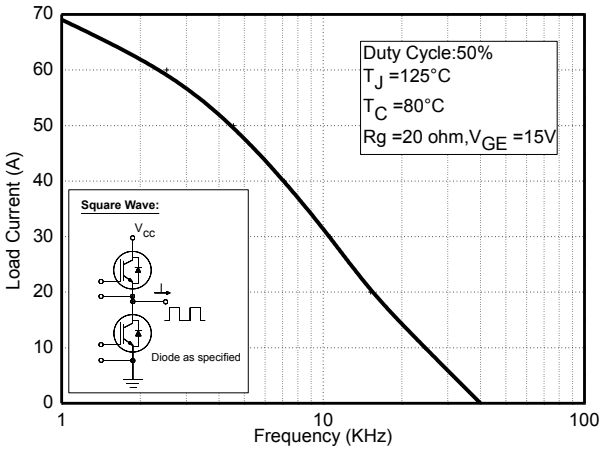


Fig.7 Typical Load Current vs. Frequency, Inverter IGBT

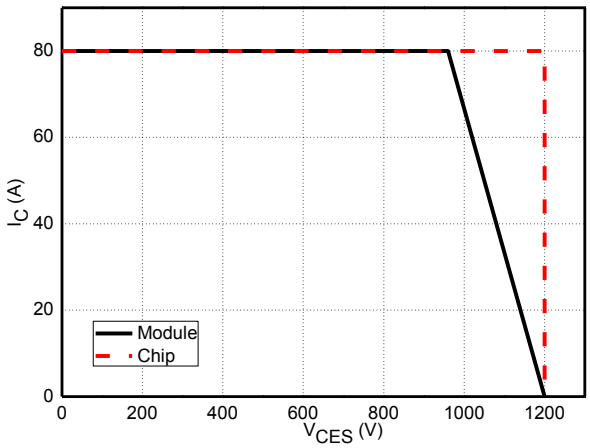


Fig.8 Reverse Bias Safe Operation Area (RBSOA), Inverter IGBT

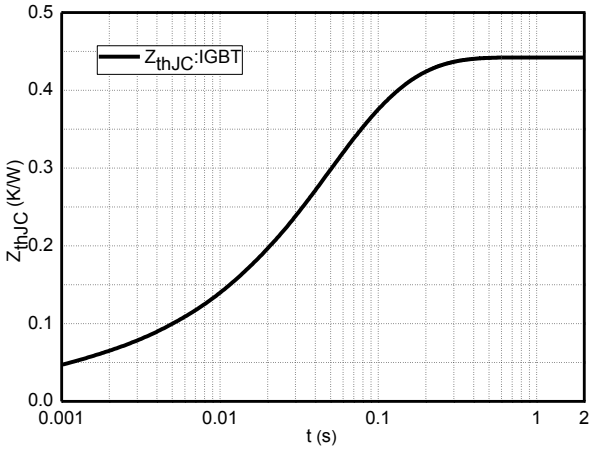


Fig.9 Typical Transient Thermal Impedance, Inverter IGBT

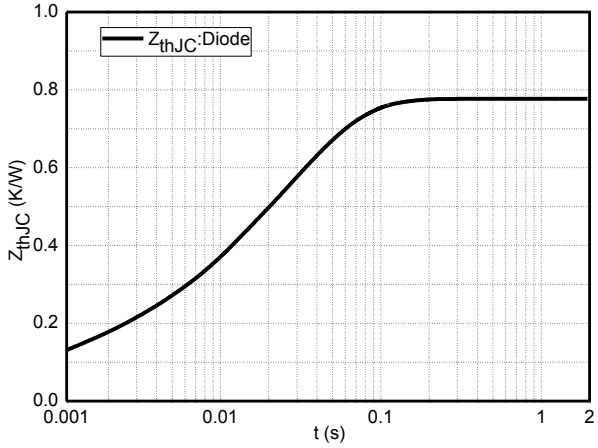


Fig.10 Typical Transient Thermal Impedance, Freewheeling Diode

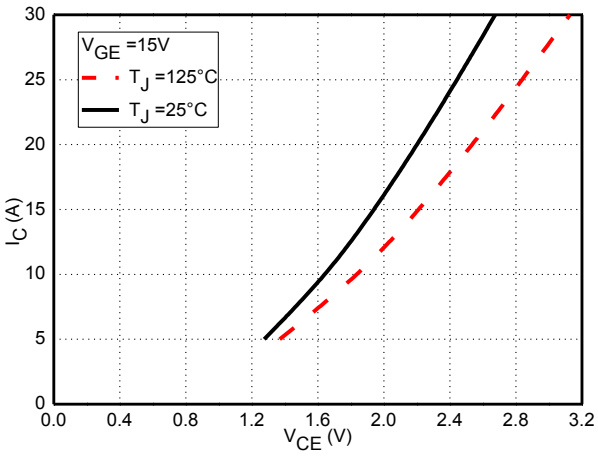


Fig.11 Typical Saturation Characteristics, Brake-Chopper IGBT

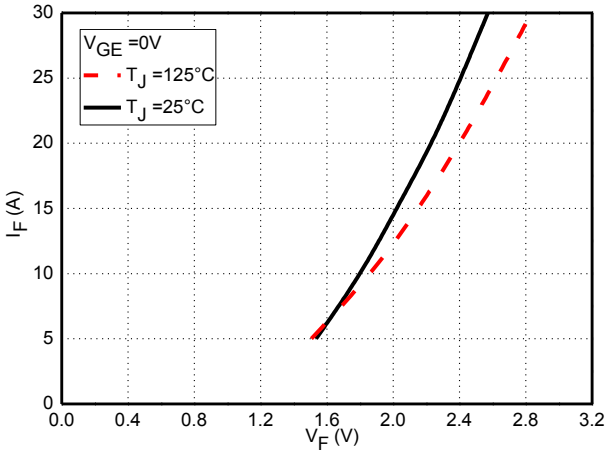


Fig.12 Typical Forward Characteristics, Brake-Chopper Diode

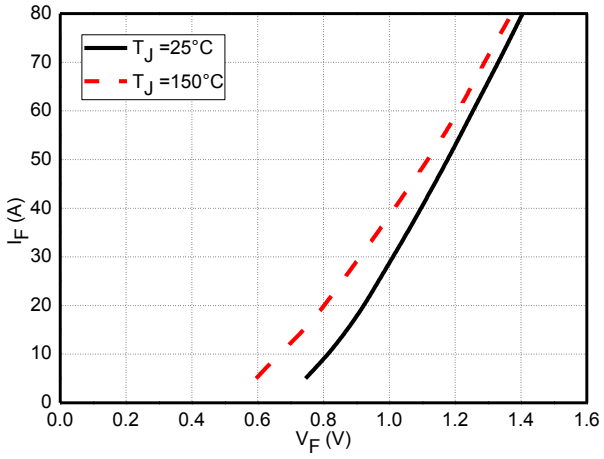


Fig.13 Typical Forward Characteristics, Rectifier Bridge Diode

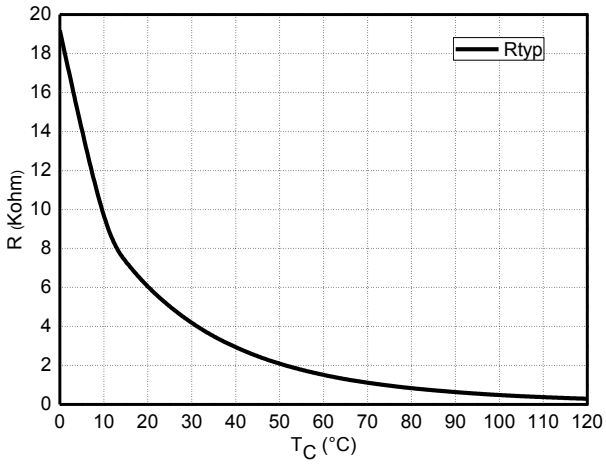
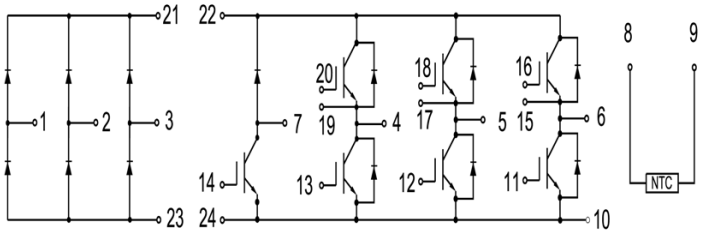
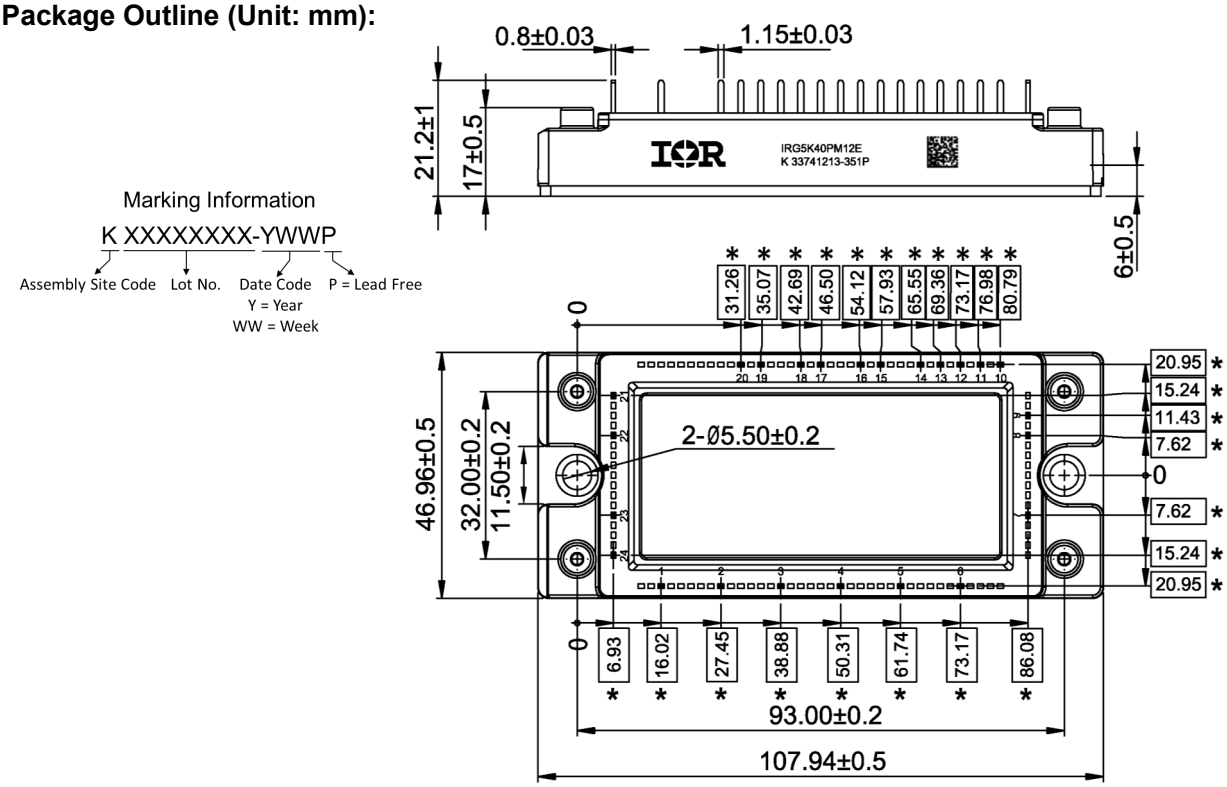


Fig. 14 NTC Temperature Characteristics

Internal Circuit:



Package Outline (Unit: mm):



Qualification Information†

Qualification Level	Industrial
Moisture Sensitivity Level	Not Applicable
RoHS Compliant	Yes

† Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability/

International
IOR Rectifier

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