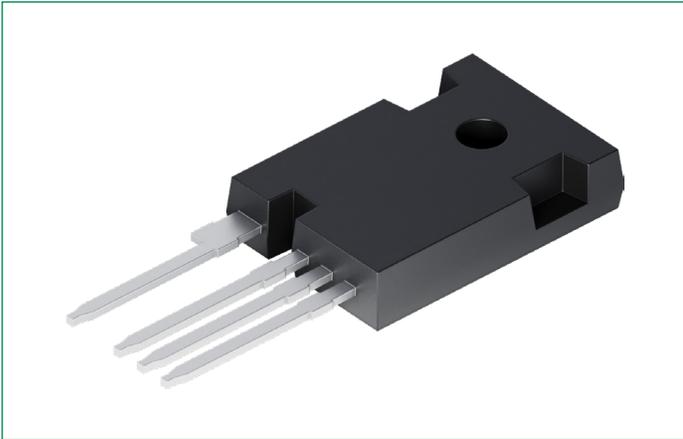# IXSH65N120L2KHV
1200 V, 40 mΩ, 65 A SiC MOSFET

RoHS **HF**

Features

- SiC MOSFET Technology with –3/+15. . .18 V gate drive
- High blocking voltage with low on-state resistance
- High-speed switching with low capacitance
- Maximum virtual junction temperature of T_{vj} = 175 °C
- Ultra-fast intrinsic body diode
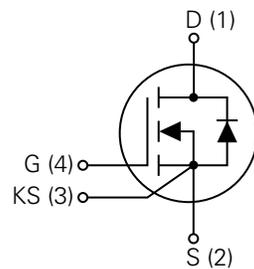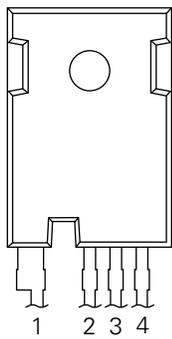- Kelvin source contact
- MSL1 rated

Applications

- Switch mode power supplies
- UPS
- EV charging infrastructure
- Energy storage system

Pinout Diagram (TO-247-4L)

D: Drain; **G:** Gate; **KS:** Kelvin Source; **S:** Power Source

Product Summary

Characteristic	Value	Unit
V_{DSS}	1200	V
$R_{DS(on)}$	40	mΩ
I_D @ 25 °C	65	A

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Maximum Ratings (T_c = 25 °C unless otherwise specified)

Symbol	Characteristic	Conditions	Value	Unit
V_{DSS}	Drain-source voltage	V_{GS} = 0 V, I_D = 100 μA	1200	V
V_{GSM}	Maximum gate-source voltage	–	−5 to +20	V
	Transient gate-source voltage	$t_{transient}$ = 200 ns, D < 1%	−10 to +23	
I_D	Drain current (continuous) [Fig.23]	V_{GS} = 18 V, T_c = 25 °C	65	A
		V_{GS} = 18 V, T_c = 100 °C	48	A
I_{DM}	Peak drain current [Fig. 25, 26]	Pulse width limited by SOA and dynamic $R_{th(j-c)}$	162	A
I_{SM}	Diode pulsed forward current [Fig. 25, 26]	Pulse width limited by SOA and dynamic $R_{th(j-c)}$	162	A
P_{tot}	Total power dissipation [Fig. 24]	T_c = 25 °C	375	W
T_{vj}	Virtual junction temperature range	–	−55 to +175	°C
T_{stg}	Storage temperature range	–	−55 to +175	°C
T_{sold}	Soldering temperature	Wave soldering only allowed at leads, 1.6 mm from case for 10 s	260	°C

Recommended Values

Symbol	Characteristic	Value			Unit
		Min.	Typ.	Max.	
V_{GSon}	Recommended turn-on voltage	15	–	18	V
V_{GSoff}	Recommended turn-off voltage	−5	−3.5	−2	

Thermal Characteristics

Symbol	Characteristic	Value			Unit
		Min.	Typ.	Max.	
$R_{th(j-c)}$	Thermal resistance from junction to case [Fig. 25]	–	0.4	–	K/W

Electrical Characteristics – Static (T_c = 25 °C unless otherwise specified)

Symbol	Characteristic	Conditions	Value			Unit
			Min.	Typ.	Max.	
I_{DSS}	Drain-source leakage current	V_{DS} = 1200 V, V_{GS} = 0 V	–	5	100	μA
I_{GSS}	Gate leakage current	V_{DS} = 0 V, V_{GS} = −5 ~ 20 V	–	–	±100	nA
$V_{GS(th)}$	Gate threshold voltage [Fig. 8, 9]	V_{GS} = V_{DS}, I_D = 9 mA	1.8	2.8	4.5	V
		V_{GS} = V_{DS}, I_D = 9 mA, T_{vj} = 175 °C	–	2.1	–	
$R_{DS(on)}$	Drain-source on-state resistance [Fig. 4, 5, 6, 7]	V_{GS} = 18 V, I_D = 20 A @ T_{vj} = 25 °C	–	40	52	mΩ
		V_{GS} = 18 V, I_D = 20 A @ T_{vj} = 175 °C	–	75	–	
		V_{GS} = 15 V, I_D = 20 A @ T_{vj} = 25 °C	–	50	65	
		V_{GS} = 15 V, I_D = 20 A @ T_{vj} = 175 °C	–	80	–	

Electrical Characteristics – Dynamic (T$_{vj}$ = 25 °C unless otherwise specified)

Symbol	Characteristic	Conditions		Value			Unit
				Min.	Typ.	Max.	
C$_{iss}$	Input capacitance [Fig. 16]	V$_{DS}$ = 800 V, V$_{GS}$ = 0 V, f = 1 MHz, V$_{AC}$ = 25 mV		–	2160	–	pF
C$_{oss}$	Output capacitance [Fig. 16]			–	100	–	pF
C$_{rss}$	Reverse transfer capacitance [Fig. 16]			–	5.8	–	pF
E$_{oss}$	C$_{oss}$ stored energy [Fig. 17]			–	40	–	µJ
Q$_G$	Total gate charge [Fig. 18]	V$_{DS}$ = 800 V, I$_D$ = 30 A, V$_{GS}$ = −3 to +18 V		–	110	–	nC
Q$_{GS}$	Gate-source charge [Fig. 18]			–	25	–	nC
Q$_{GD}$	Gate-drain charge [Fig. 18]			–	59	–	nC
R$_{g(int)}$	Gate input resistance	f = 1 MHz		–	2.1	–	Ω
E$_{on}$	Turn-on switching energy [Fig. 19, 20]	V$_{DS}$ = 800 V, I$_D$ = 30 A, V$_{GS}$ = −3.5 to +18 V, R$_{G(ext)}$ = 3.3 Ω, L = 200 µH	T$_{vj}$ = 25 °C	–	446.3	–	µJ
			T$_{vj}$ = 175 °C	–	644.4	–	
E$_{off}$	Turn-off switching energy [Fig. 19, 20]		T$_{vj}$ = 25 °C	–	70	–	
			T$_{vj}$ = 175 °C	–	73.8	–	
t$_{d(on)}$	Turn-on delay time [Fig. 19, 20]		T$_{vj}$ = 25 °C	–	9.6	–	ns
t$_r$	Rise time [Fig. 19, 20]		T$_{vj}$ = 25 °C	–	22.1	–	
t$_{d(off)}$	Turn-off delay time [Fig. 19, 20]		T$_{vj}$ = 25 °C	–	19.3	–	
t$_f$	Fall time [Fig. 19, 20]		T$_{vj}$ = 25 °C	–	10.5	–	

Reverse Diode Characteristics (T$_{vj}$ = 25 °C unless otherwise specified)

Symbol	Characteristic	Conditions	Value			Unit
			Min.	Typ.	Max.	
V$_{SD}$	Diode forward voltage [Fig. 10, 11, 12]	I$_{SD}$ = 20 A, V$_{GS}$ = 0 V	–	4.2	–	V
		I$_{SD}$ = 20 A, V$_{GS}$ = 0 V, T$_{vj}$ = 175 °C	–	4	–	V
I$_s$	Diode forward current (continuous)	V$_{GS}$ = −2 V, T$_c$ = 25 °C	–	–	63	A
		V$_{GS}$ = −2 V, T$_c$ = 100 °C	–	–	36	
t$_{rr}$	Reverse recovery time	V$_{GS}$ = −3.5 V/+18 V, I$_{SD}$ = 30 A, V$_R$ = 800 V, R$_{G(ext)}$ = 10 Ω, L = 200 µH, di/dt = 3000 A/µs	–	42	–	ns
Q$_{rr}$	Reverse recovery charge		–	198.1	–	nC
I$_{rrm}$	Peak reverse recovery current		–	17.4	–	A

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Characteristic Curves

Fig. 1. Typical Output Characteristics @ T$_{vj}$ = −55 °C

T$_{vj}$ = −55 °C
Pulsed

V$_{GS}$ = 20 V
18 V
16 V
14 V
12 V
10 V

Drain-Source Current, I$_{DS}$ (A)

Drain-Source Voltage, V$_{DS}$ (V)

Fig. 2. Typical Output Characteristics @ T$_{vj}$ = 25 °C

T$_{vj}$ = 25 °C
Pulsed

V$_{GS}$ = 20 V
18 V
16 V
14 V
12 V
10 V

Drain-Source Current, I$_{DS}$ (A)

Drain-Source Voltage, V$_{DS}$ (V)

Fig. 3. Typical Output Characteristics @ T$_{vj}$ = 175 °C

V$_{GS}$ = 20 V
18 V
16 V
14 V
12 V
10 V

T$_{vj}$ = 175 °C
Pulsed

Drain-Source Current, I$_{DS}$ (A)

Drain-Source Voltage, V$_{DS}$ (V)

Fig. 4. Typical Drain-source On-state Resistance vs. Junction Temperature

V$_{GS}$ = 18 V
I$_{DS}$ = 20 A

R$_{DS(on)}$ (mΩ)

Junction Temperature, T$_{vj}$ (°C)

Fig. 5. Typical Drain-source On-State Resistance (Normalized) vs. Junction Temperature

V$_{GS}$ = 18 V
Pulsed

T$_{vj}$ = 175 °C

T$_{vj}$ = 25 °C

T$_{vj}$ = −55 °C

Normalized R$_{DS(on)}$, (mΩ)

Junction Temperature, T$_{vj}$ (°C)

Fig. 6. Typical Drain-source On-state Resistance vs. Drain Current

V$_{GS}$ = 15 V
16 V
18 V
20 V

I$_{DS}$ = 20 A
Pulsed
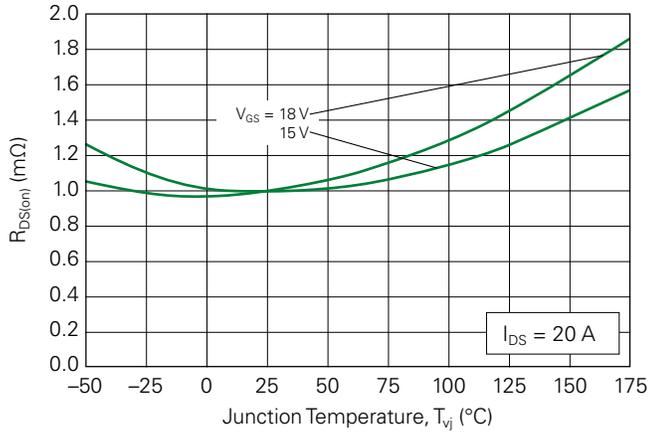
R$_{DS(on)}$ (mΩ)

Junction Temperature, T$_{vj}$ (°C)

Fig. 7. R$_{DS(on)}$ vs. Temperature

R$_{DS(on)}$ (mΩ)

V$_{GS}$ = 18 V
15 V

I$_{DS}$ = 20 A

Junction Temperature, T$_{vj}$ (°C)

Fig. 8. Transfer Curves

Drain Current, I$_D$ (A)

T$_{vj}$ = 175 °C
25°C
−55 °C

V$_{DS}$ = 20 V
Pulsed

Gate-source Voltage, V$_{GS}$ (V)
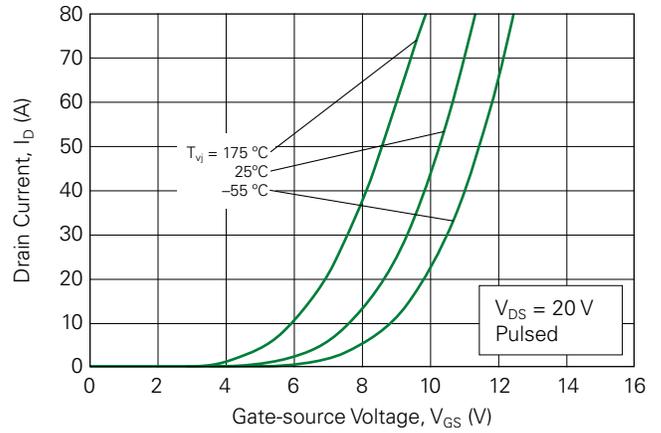
Fig. 9. Threshold Voltage vs. Temperature

Threshold Voltage, V$_{GS(th)}$ (V)

V$_{GS}$ = V$_{DS}$
I$_{DS}$ = 9 mA

Junction Temperature, T$_{vj}$ (°C)
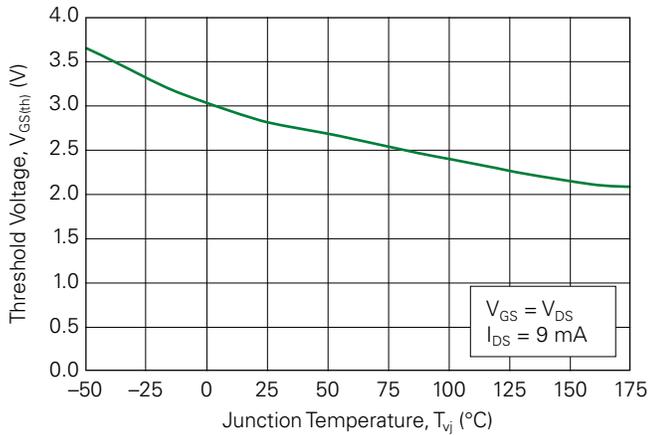
Fig. 10. Body Diode Curves @ T$_{vj}$ = −55 °C

Drain-source Current, I$_{DS}$ (A)

V$_{GS}$ = 0 V
−2 V
−5 V

T$_{vj}$ = −55 °C
Pulsed

Drain-source Voltage, V$_{DS}$ (V)
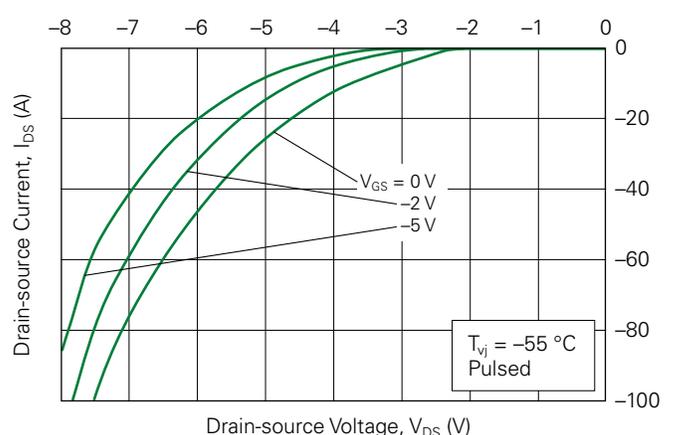
Fig. 11. Body Diode Curves @ T$_{vj}$ = 25 °C

Drain-source Current, I$_{DS}$ (A)

V$_{GS}$ = 0 V
−2 V
−5 V

T$_{vj}$ = 25 °C
Pulsed

Drain-source Voltage, V$_{DS}$ (V)
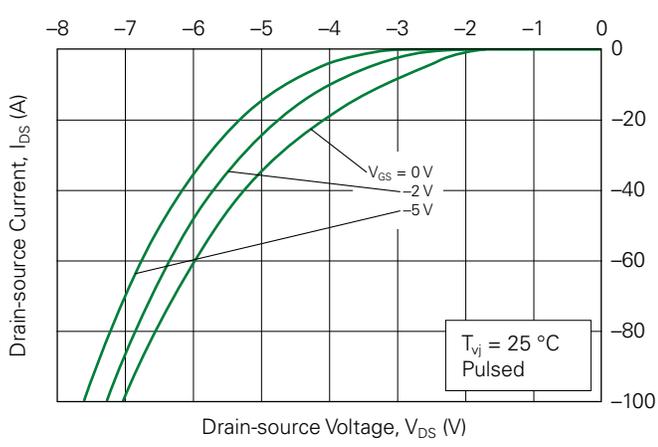
Fig. 12. Body Diode Curves @ T$_{vj}$ = 175 °C

Drain-source Current, I$_{DS}$ (A)

V$_{GS}$ = 0 V
−2 V
−5 V

T$_{vj}$ = 175 °C
Pulsed

Drain-source Voltage, V$_{DS}$ (V)
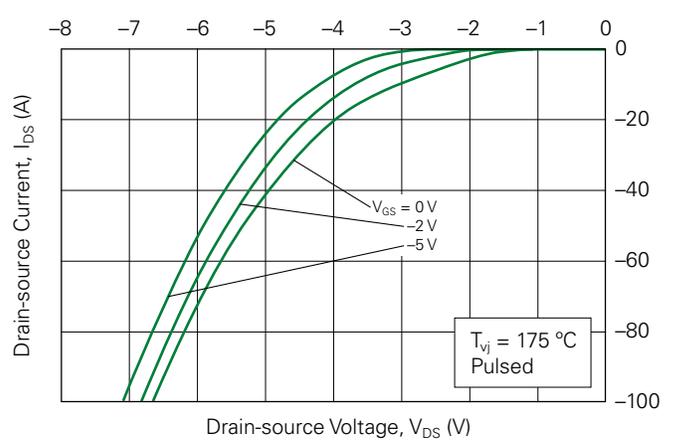
Fig. 13. 3rd Quadrant Curves @ T$_{vj}$ = −55 °C

V_{GS} = 0 V
5 V
10 V
15 V
18 V

T$_{vj}$ = −55 °C
Pulsed

Drain-source Current, I$_{DS}$ (A)

Drain-source Voltage, V$_{DS}$ (V)
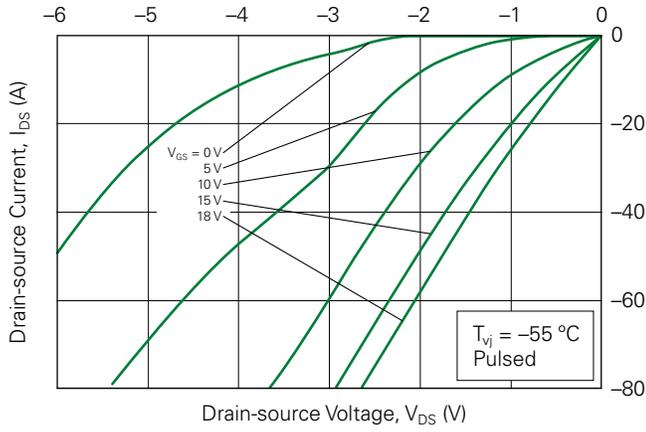
Fig. 14. 3rd Quadrant Curves @ T$_{vj}$ = 25 °C

V_{GS} = 0 V
5 V
10 V
15 V
18 V

T$_{vj}$ = 25 °C
Pulsed

Drain-source Current, I$_{DS}$ (A)

Drain-source Voltage, V$_{DS}$ (V)
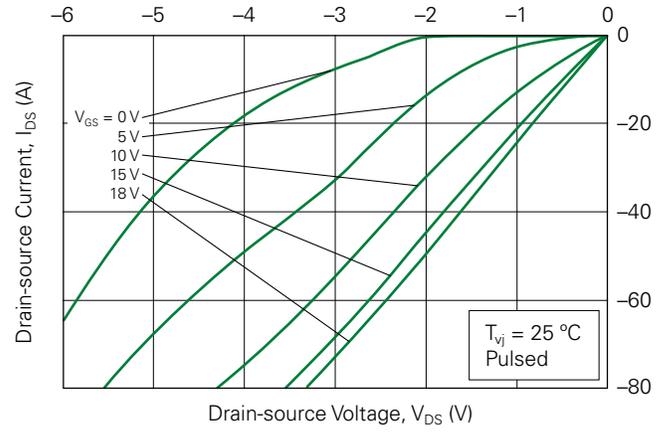
Fig. 15. 3rd Quadrant Curves @ T$_{vj}$ = 175 °C

V_{GS} = 0 V
5 V
10 V
15 V
18 V

T$_{vj}$ = 175 °C
Pulsed

Drain-source Current, I$_{DS}$ (A)

Drain-source Voltage, V$_{DS}$ (V)
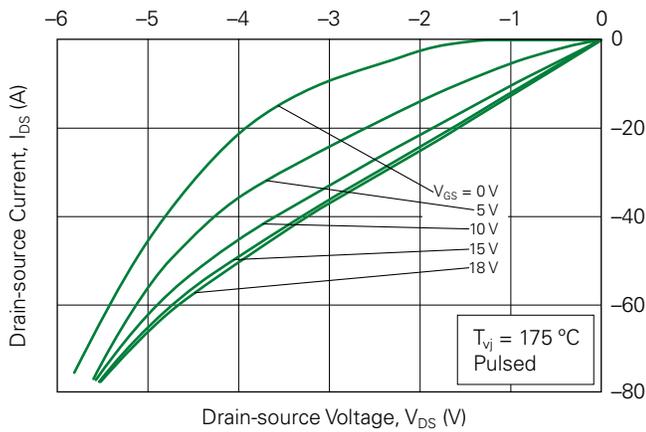
Fig. 16. Capacitance vs. V$_{DS}$

C$_{iss}$

C$_{oss}$

C$_{rss}$

T$_{vj}$ = 25 °C
f = 1 MHz

Capacitance (pF)

Drain-source Voltage, V$_{DS}$ (V)
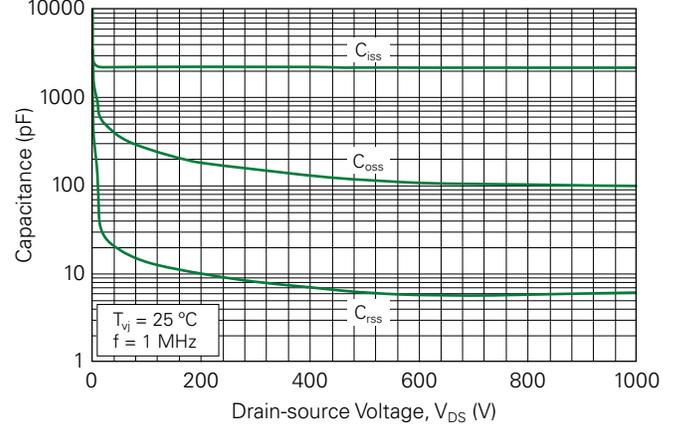
Fig. 17. Output Capacitor Stored Energy

Stored Energy E$_{oss}$ (µJ)

Drain-Source Voltage, V$_{DS}$ (V)
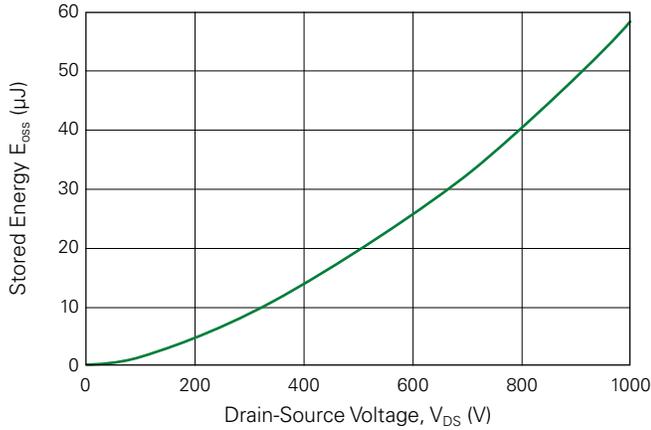
Fig. 18. Gate Charge Characteristics

V$_{DS}$ = 800 V
I$_{DS}$ = 30 A
T$_{vj}$ = 25 °C

Gate-source Voltage, V$_{GS}$ (V)

Gate Charge, Q$_G$ (nC)

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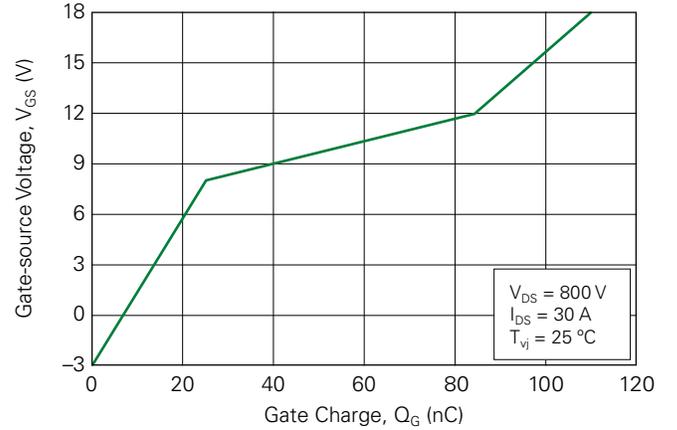
Fig. 19. Switching Energy vs. R_G(ext)

V_{DD} = 800 V I_D = 30 A
V_{GS} = −3.5 V⁻18 V
L = 200 µH
T_{vj} = 25 °C
FWD = IXSH65N120L2KHV

E_total
E_on
E_off

Switching Loss (µJ)
External Gate Resistor, R_G(ext)
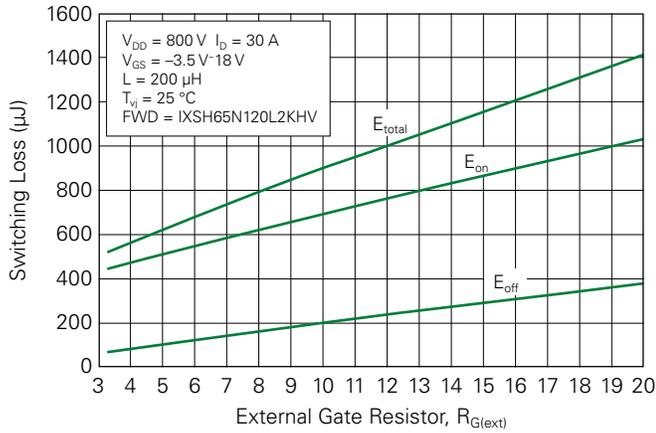
Fig. 20. Switching Times vs. R_G(ext)

V_{DD} = 800 V I_D = 30 A
V_{GS} = −3.5 V⁻18 V
L = 200 µH
T_{vj} = 25 °C
FWD = IXSH65N120L2KHV

t_d(off)
t_r
t_d(on)
t_f

Switching Time (ns)
External Gate Resistor, R_G(ext)
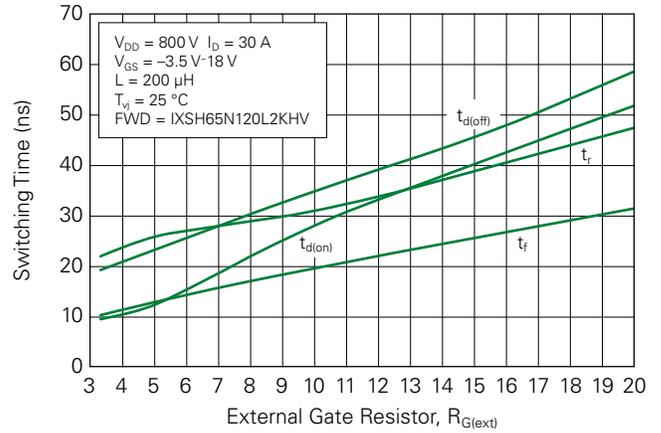
Fig. 21. Switching Energy vs. I_DS

V_{DD} = 800 V
$R_{G(ext)}$ = 3.3 Ω
V_{GS} = −3.5 V⁻18 V
L = 200 µH T_{vj} = 25 °C
FWD = IXSH65N120L2KHV

E_total
E_on
E_off

Switching Loss (µJ)
Drain Current, I_D (A)
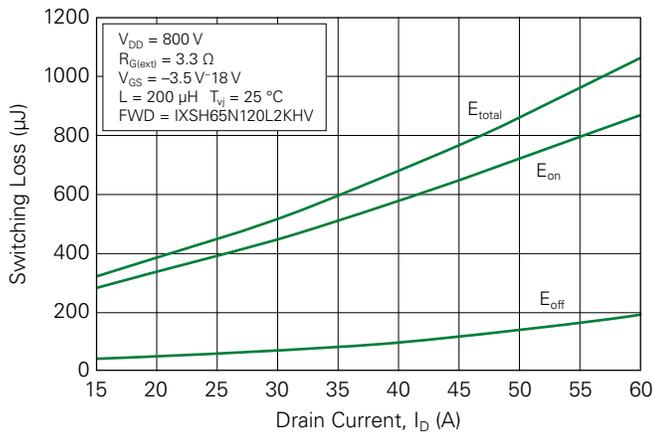
Fig. 22. Switching Energy vs. Temperature

E_total
E_on
E_off

V_{DD} = 800 V I_D = 30 A
V_{GS} = −3.5 V⁻18 V
L = 200 µH $R_{G(ext)}$ = 3.3 Ω
FWD = IXSH65N120L2KHV

Switching Loss (µJ)
Junction Temperature, T_vj (°C)
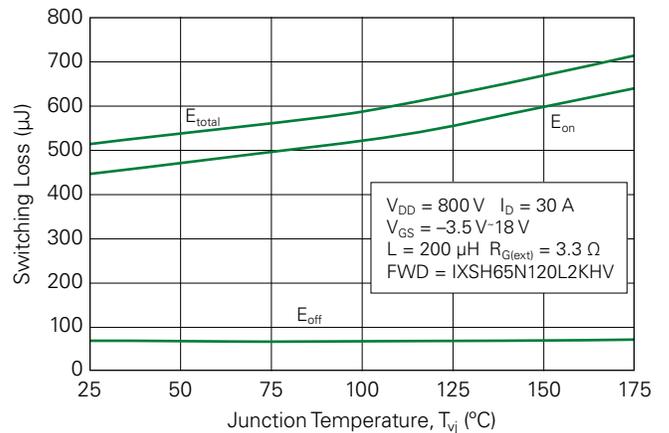
Fig. 23. Continuous Drain Current vs. Case Temperature

Drain Current, I_D (A)
Case Temperature, T_C (°C)
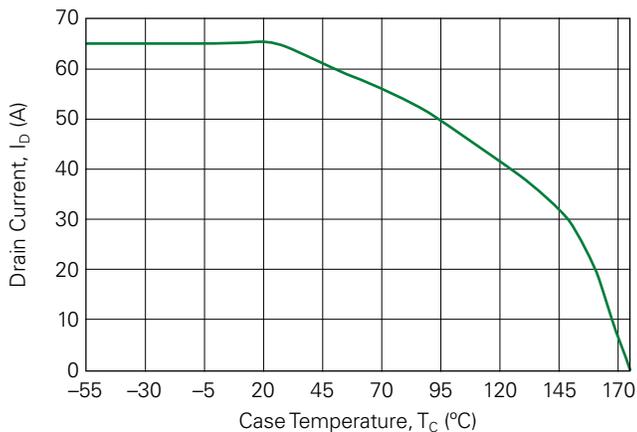
Fig. 24. Max. Power Dissipation Derating vs. Case Temperature
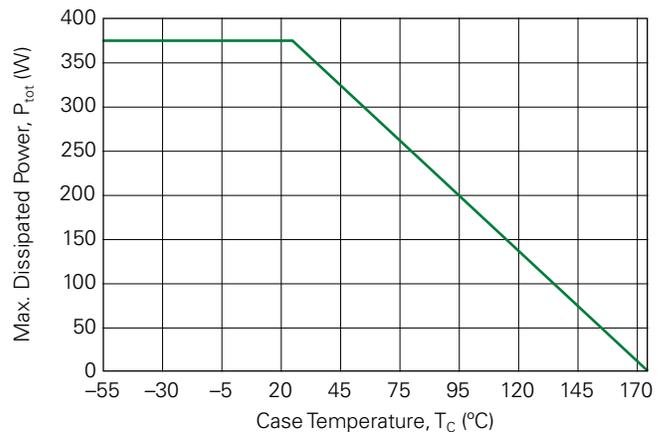
Max. Dissipated Power, P_tot (W)
Case Temperature, T_C (°C)

Fig. 25. Thermal Impedance
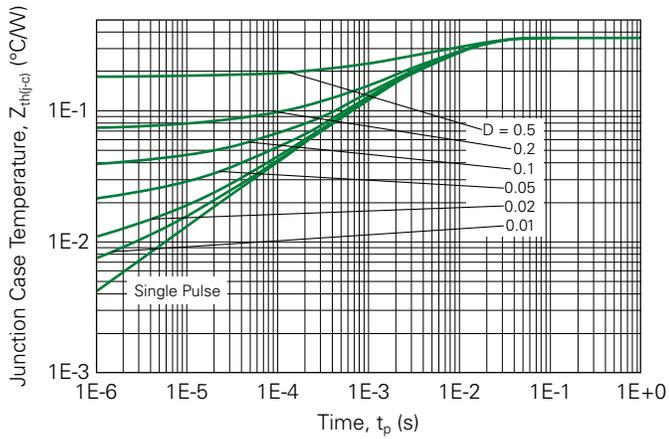
Fig. 26. Safe Operating Area
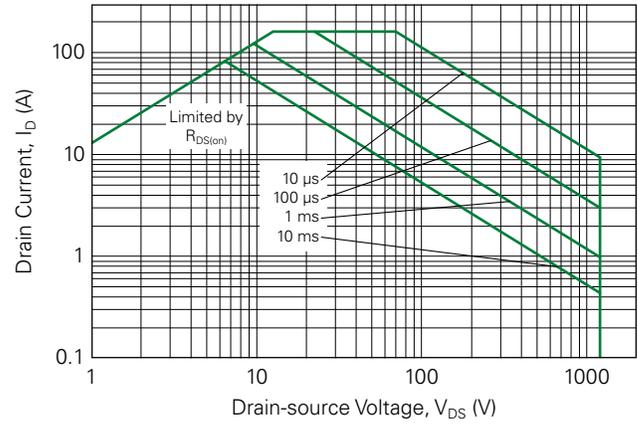
Part Number and Marking

IXSH65N120L2KHV
YYWWZ
XXXX

IXSH65N120L2KHV = Specific Device Code

YY = Year

WW = Work Week

Z = Assembly Location

XXXX = Lot Traceability

Part Outline Drawing (TO-247-4L)

Symbol	Inches			Millimeters		
	Min.	Typical	Max.	Min.	Typical	Max
A	0.190	–	0.205	4.83	–	5.21
A1	0.090	–	0.100	2.29	–	2.54
A2	0.075	–	0.085	1.91	–	2.16
b	0.042	–	0.052	1.07	–	1.33
b*	0.042	–	0.050	1.07	–	1.28
b1	0.094	–	0.116	2.39	–	2.94
b2	0.094	–	0.112	2.39	–	2.84
b3	0.042	–	0.063	1.07	–	1.60
b4	0.042	–	0.059	1.07	–	1.50
b5	0.094	–	0.106	2.39	–	2.69
b6	0.094	–	0.104	2.39	–	2.64
c	0.022	–	0.027	0.55	–	0.68
c1	0.022	–	0.026	0.55	–	0.65
D	0.917	–	0.929	23.30	–	23.60
D1	0.640	–	0.695	16.25	–	17.65
D2	0.037	–	0.049	0.95	–	1.25
E	0.620	–	0.635	15.75	–	16.13
E1	0.516	–	0.557	13.10	–	14.15
E2	0.145	–	0.201	3.68	–	5.10
E3	0.039	–	0.075	1.00	–	1.90
E4	0.487	–	0.529	12.38	–	13.43
e	0.100 BSC			2.54 BSC		
e1	0.200 BSC			5.08 BSC		
e2	–	0.500	–	–	12.70	–
e3	–	0.330	–	–	8.38	–
H1	–	0.200	–	–	5.08	–
H2	–	0.100	–	–	2.54	–
H3	–	0.100	–	–	2.54	–
L	0.681	–	0.702	17.31	–	17.82
L1	0.156	–	0.172	3.97	–	4.37
L2	0.093	–	0.104	2.35	–	2.65
ØP	0.138	–	0.144	3.51	–	3.65
ØP1	0.283 REF.			7.18 REF.		
ØP2	–	0.088	–	–	2.24	–
ØP3	–	0.067	–	–	1.70	–
Q	0.216	–	0.236	5.49	–	6.00
S	0.238	–	0.248	6.04	–	6.30

Recommended Solder Pad Layout

Section F–F, G–G, H–H

Note:

1. Package reference: JEDEC TO247, Variation AD

2. Slot required, notch may be rounded

3. Dimension D&E do not include mold flash

4. Subject to change without notice

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