650V Silicon Carbide Power MOSFET

Features

- Revolutionary semiconductor material Silicon Carbide
- High blocking voltage with low on-resistance
- High-speed switching with very low switching losses
- High-speed and high robust intrinsic body diode
- Optimized package with separate driver source pin

Product Summary

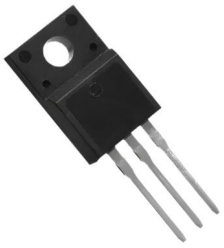
Green

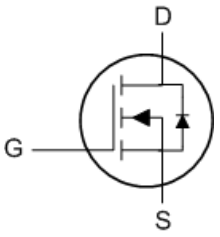
BVDSS	RDSON	ID
650V	260mΩ	15.5A

Applications

- LED Driver
- PD charger
- PC adapter
- Air-condictioning
- E-bike charger

TO220F Pin Configuration





Maximum Ratings For MOSFET (T_{VJ}= 25˚C unless otherwise specified)

Symbol	Parameter	Value	Unit	Testing Conditions
V_{DSS}	Drain-Source Voltage	650	V	
I_D	Continuous DC Drain Current for $R_{th(j-c,typ.)}$, Limited by $T_{VJ(max)}$	15.5	A	T_C = 25 ℃
		11		Tc = 100℃
I_{DM}	Peak Drain Current, tp Limited by $T_{VJ(max)}$	25	A	T_C = 25 ℃
$V_{GS, max}$	Gate-Source Max Voltage	-10/22	V	
$V_{GS, op}$	Gate-Source Operate Voltage	0/15	V	
E_{AS}	Single Pulse Avalanche Energy	25	mJ	L=0.5 mH, I_{AS}=10 A, V_{DD}=50 V, V_{GS}=15 V
P_{tot}	Power Dissipation for $R_{th(j-c,typ.)}$	67	W	T_C = 25℃

Package Values

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions
$R_{th(j-c)}$	MOSFET/Body Diode Junction-Case Thermal Resistance		2.23	2.67	K/W	
T_{VJ}, T_{STG}	Operating Junction and Storage Temperature	-55		175	℃	
T_{SOLD}	Soldering Temperature, Wave Soldering only Allowed at Leads 1.6mm from Case for 10s		260		℃	

MOSFET Characteristics (T_{VJ}= 25˚C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions	
$V_{(BR)DSS}$	Drain-Source breakdown voltage	650			V	I_D = 100 μA	
$V_{GS(th)}$	Gate Threshold Voltage	3.2	4.1	5	V	V_{DS} = V_{GS}, I_D = 10 mA	T_{VJ} = 25 ℃
			2.9				T_{VJ} = 175 ℃
I_{DSS}	Drain-Source Leakage Current		0.1	20	μA	V_{GS} = 0 V, V_{DS} = 650 V	T_{VJ} = 25 ℃
			0.5				T_{VJ} = 175 ℃
I_{GSS}	Gate-Source Leakage Current			250	nA	V_{GS} = 22 V, V_{DS} = 0 V	T_{VJ} = 25 ℃
I_{SGS}	Source-Gate Leakage Current			250	nA	V_{GS} = -10 V, V_{DS} = 0 V	T_{VJ} = 25 ℃
$R_{DS(on)}$	Drain-Source On-State Resistance		260	300	mΩ	V_{GS} = 15 V, I_D = 5 A	T_{VJ} = 25 ℃
			231				T_{VJ} = 175 ℃
g_{fs}	Transconductance		3.6		S	V_{DS} = 20 V, I_D = 5 A	
$R_{G(int)}$	Internal Gate Resistance		25.5		Ω	f = 1MHz, V_{AC} = 25 mV	
C_{iss}	Input Capacitance		294		pF	V_{GS} = 0 V, V_{DS} = 650 V, f = 1MHz	
C_{oss}	Output Capacitance		25		pF		
C_{rss}	Reverse Transfer Capacitance		4		pF		
Q_{GS}	Gate to Source Charge		4.3		nC	V_{GS} = 0/15 V , V_{DS} = 400V, I_D =5 A	
Q_{GD}	Gate to Drain Charge		1.6		nC		
Q_G	Total Gate Charge		12.5		nC		

Dynamic MOSFET Characteristics (T_{VJ}= 25˚C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions	
$t_{d(on)}$	Turn−On Delay Time		6.6		ns	V_{GS}= 0/15V L=600uH V_{DS} = 400 V, I_D = 5 A, $R_{G(on)}$ = 2.2 Ω, $R_{G(off)}$ = 2.2 Ω	T_{VJ} = 25 ℃
			6.0				T_{VJ} = 175 ℃
t_r	Rise Time		18.3		ns		T_{VJ} = 25 ℃
			14.2				T_{VJ} = 175 ℃
$t_{d(off)}$	Turn−Off Delay Time		17.7		ns		T_{VJ} = 25 ℃
			21.3				T_{VJ} = 175 ℃
t_f	Fall Time		32.1		ns		T_{VJ} = 25 ℃
			35.6				T_{VJ} = 175 ℃
E_{on}	Turn−On Switching Loss		43.2		μJ		T_{VJ} = 25 ℃
			40.7				T_{VJ} = 175 ℃
E_{off}	Turn−Off Switching Loss		5.5		μJ		T_{VJ} = 25 ℃
			5.2				T_{VJ} = 175 ℃
E_{tot}	Total Switching Energy		48.7		μJ		T_{VJ} = 25 ℃
			45.9				T_{VJ} = 175 ℃

Note: E_{on}/E_{off} result is with body diode.

Maximum Ratings For Body Diode (T_{VJ}= 25˚C unless otherwise specified)

Symbol	Parameter	Value	Unit	Testing Conditions
V_{DSS}	Drain-Source Voltage	650	V	
I_S	Continuous DC Source Current, Limited by $T_{VJ(max)}$	12	A	T_C = 25 ℃
		7	A	T_C = 100 ℃
I_{SM}	Peak Reverse Drain Current, tp Limited by $T_{VJ(max)}$	23	A	T_C = 25 ℃

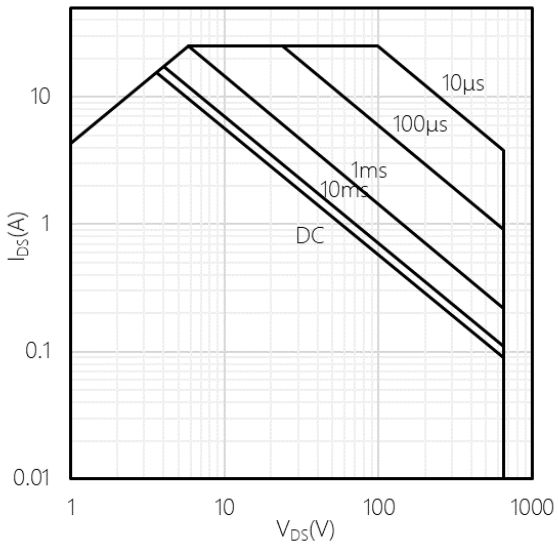
Body Diode Characteristics (T_{VJ}= 25˚C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Testing Conditions	
V_{SD}	Body Diode Forward Voltage		3.3		V	V_{GS} = 0 V, I_{SD} = 2.5 A	T_{VJ} = 25 ℃
			2.8				T_{VJ} = 175 ℃
I_{rrm}	Peak Reverse Recovery Current		5.8		A	V_{DS} = 400 V, V_{GS} = -0 V, I_{SD} =5 A, di/dt = 1.6kA/μs	T_{VJ} = 25 ℃
			6.2				T_{VJ} = 175 ℃
Q_{rr}	Reverse Recovery Charge		32.6		nC		T_{VJ} = 25 ℃
			36.1				T_{VJ} = 175 ℃
t_{rr}	Reverse Recovery Time		9.9		ns		T_{VJ} = 25 ℃
			9.4				T_{VJ} = 175 ℃
E_{rr}	Reverse Recovery Energy		0.31		μJ		T_{VJ} = 25 ℃
			0.39				T_{VJ} = 175 ℃

Typical Performances

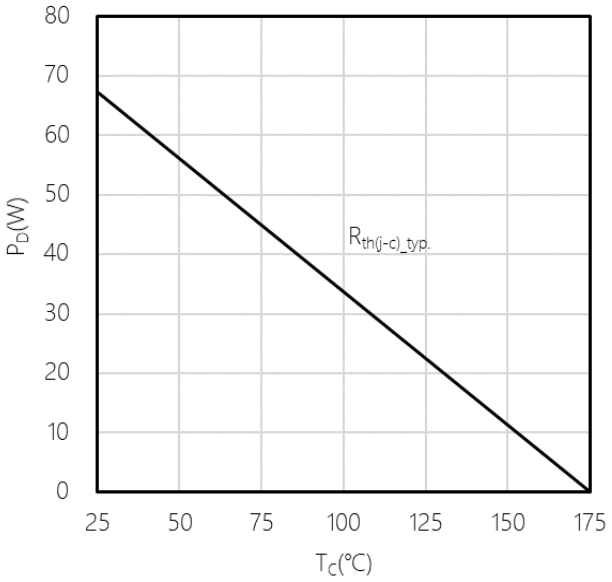
Safe operating area (SOA)

$R_{th(j-c)}$ =2.67 °C/W, Single Pulse, T_{VJ} = 25°C



Power dissipation as a function of case temperature limited by bond wire

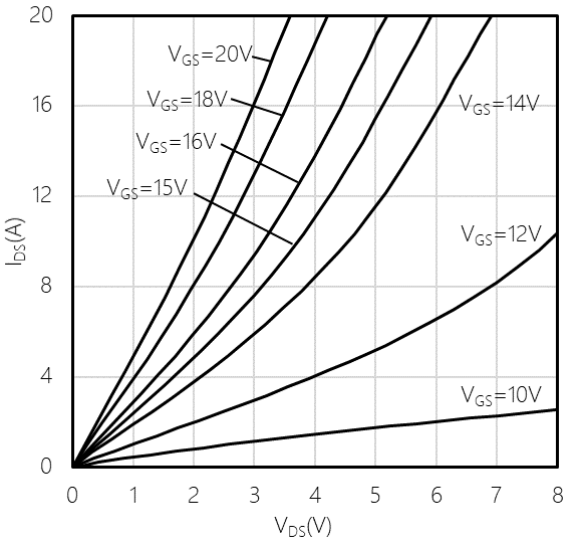
$P_D = f(T_C)$



Typical output characteristic, V_{GS} as parameter

I_{DS}= f(V_{DS})

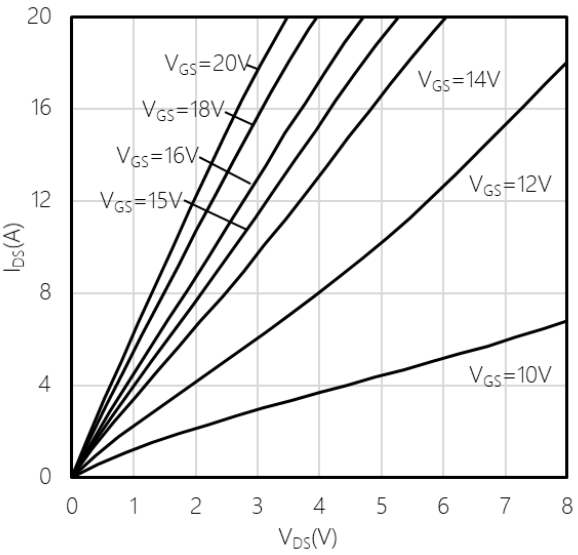
T_{VJ} = -55 ℃



Typical output characteristic, V_{GS} as parameter

I_{DS} = f(V_{DS})

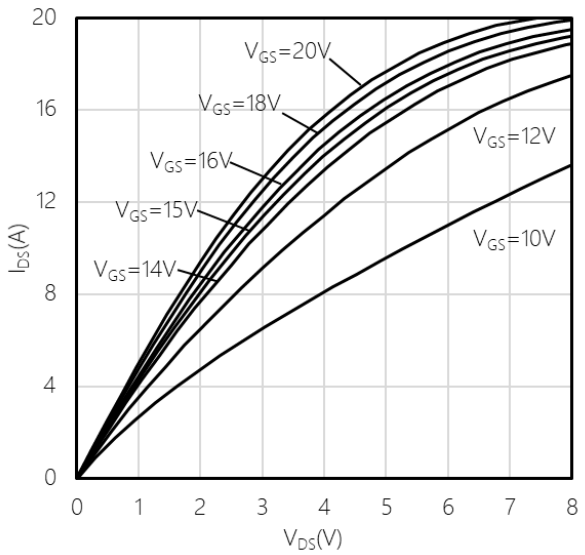
T_{VJ} = 25 ℃



Typical output characteristic, V_{GS} as parameter

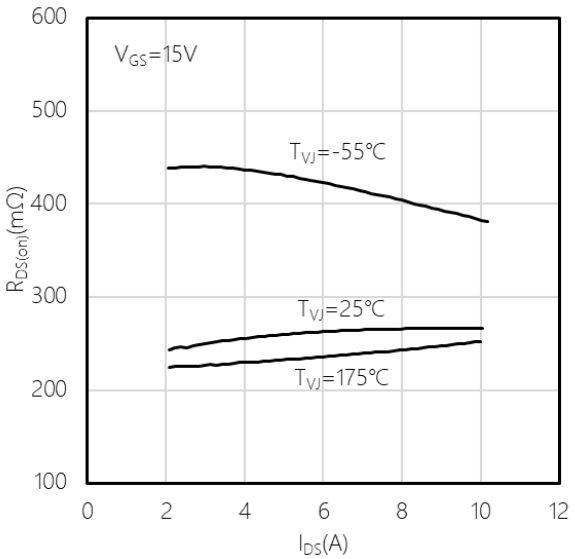
$I_{DS} = f(V_{DS})$

T_{VJ} = 175℃



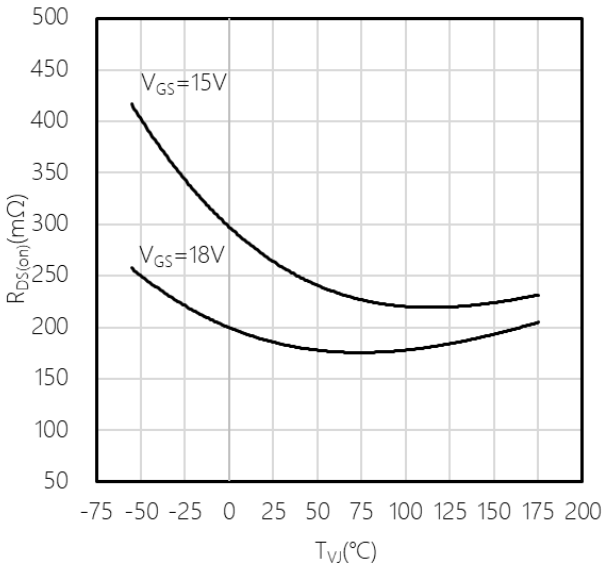
Typical on-state resistance as a function of drain current

$R_{DS(on)} = f(I_{DS})$, V_{GS} = 18V



Typical on-state resistance as a function of temperature

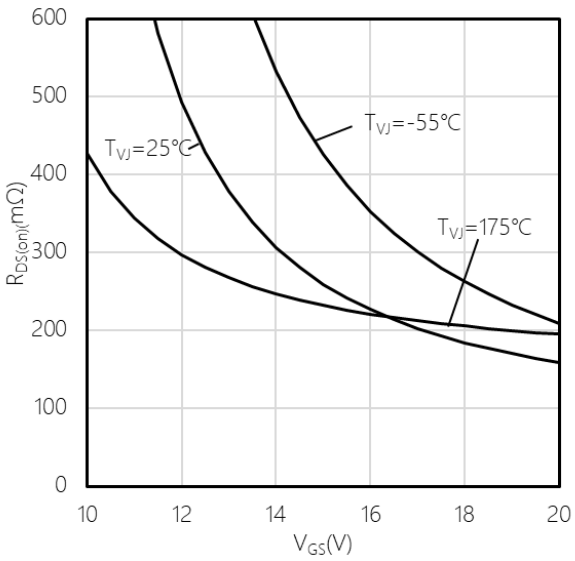
$R_{DS(on)} = f(T_{VJ})$, I_{DS} = 5 A



Typical on-state resistance as a function of V_{GS}

$R_{DS(on)} = f(V_{GS})$

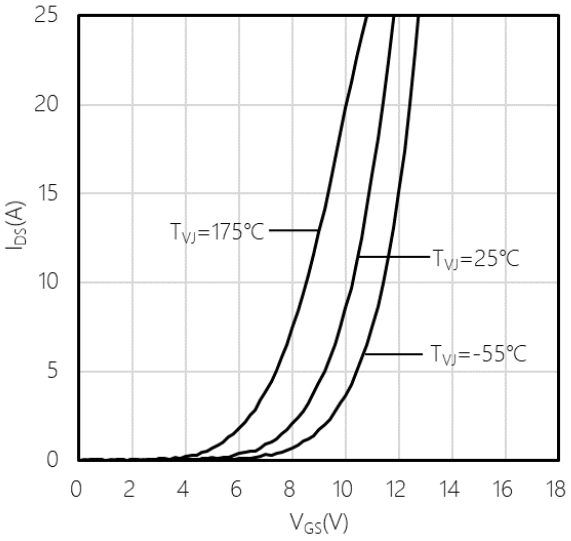
I_{DS} = 5 A



Typical transfer characteristic

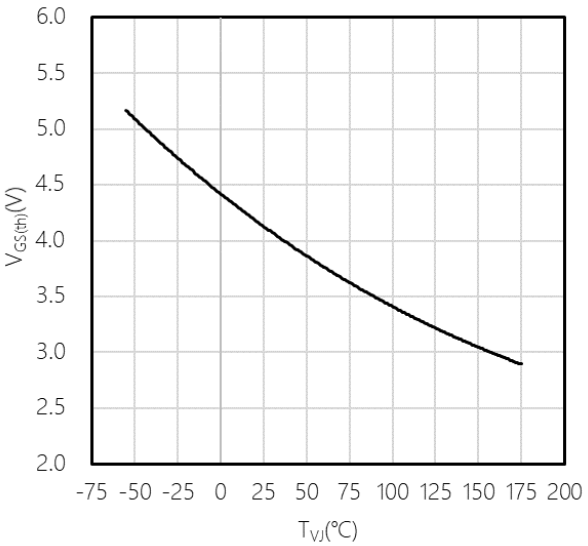
$I_{DS} = f(V_{GS})$

V_{DS}= 20 V



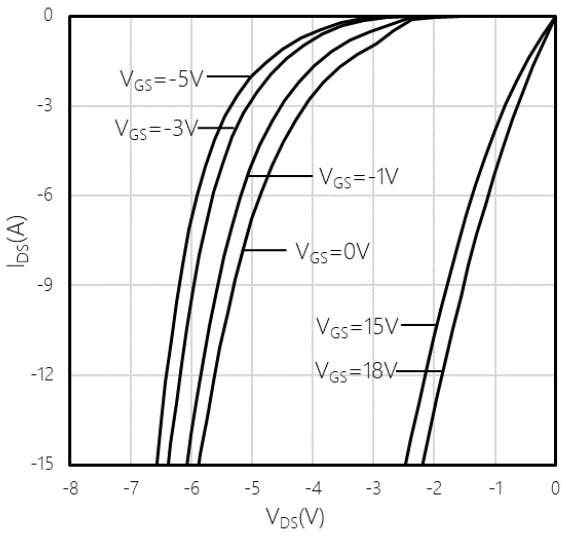
Typical gate-source threshold voltage as a function of junction temperature

$V_{GS(th)} = f(T_{VJ})$, I_{DS} = 10 mA



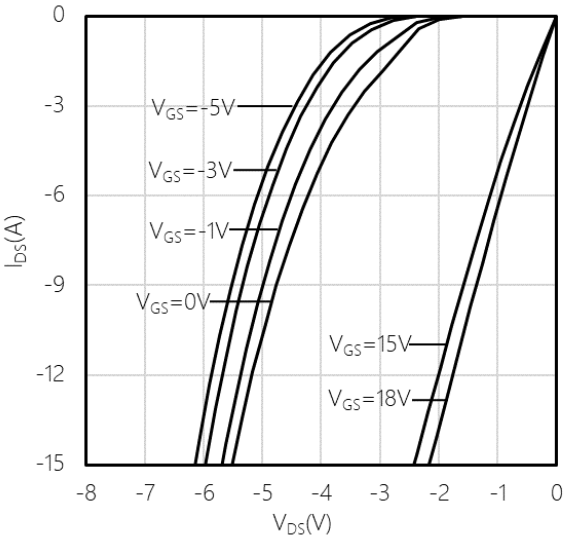
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

$I_{DS} = f(V_{DS})$, T_{VJ} = -55 °C



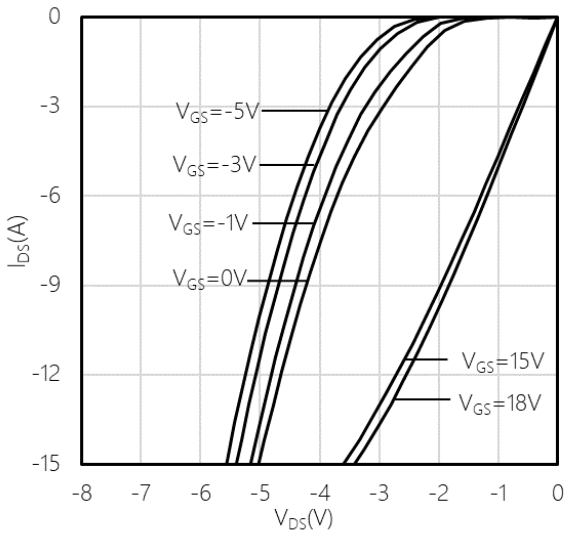
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

$I_{DS} = f(V_{DS})$, T_{VJ} = 25 °C



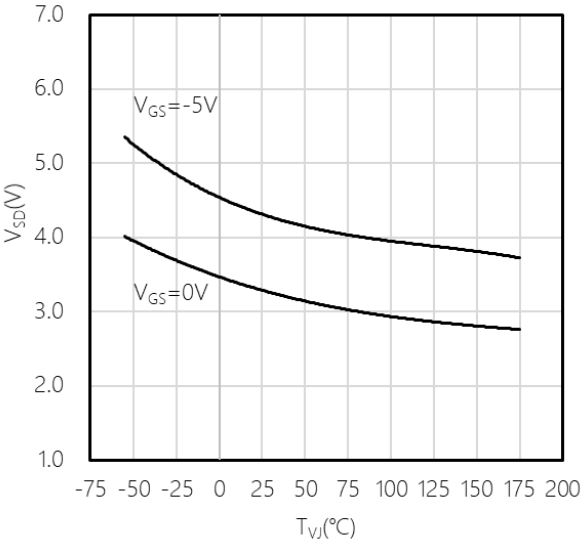
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

$I_{DS} = f(V_{DS})$, T_{VJ} = 175 °C



Typical reverse drain voltage as function of junction temperature

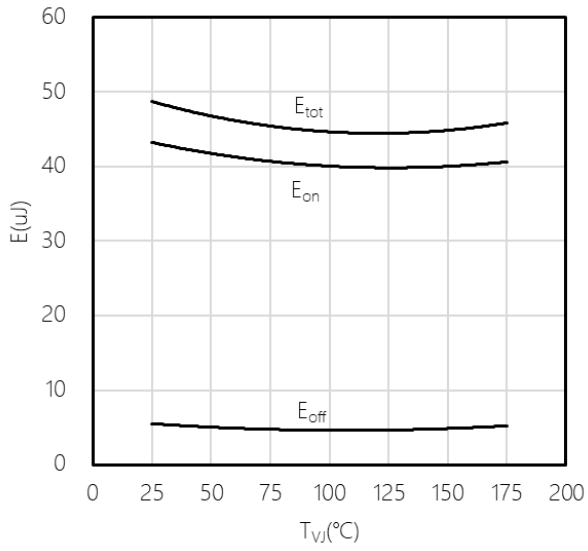
$V_{SD} = f(T_{VJ})$, I_{SD} = 2.5 A



Typical switching energy as a function of junction temperature, 2nd device own body diode: V_{GS} = -5 V

$E = f(T_{VJ})$

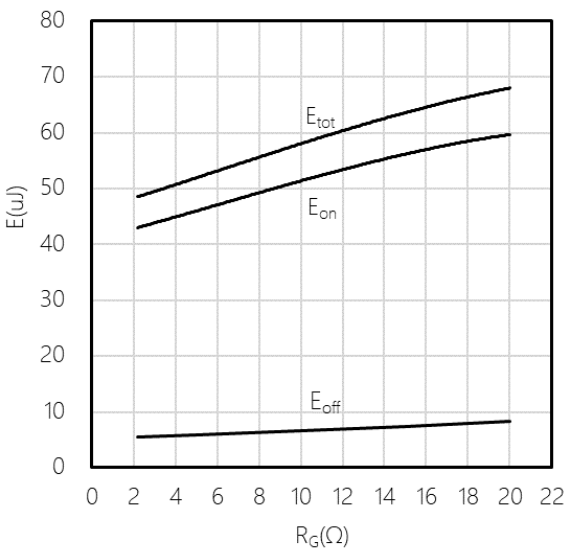
V_{DS} = 400 V, $R_{G(ext)}$ = 2.2 Ω, V_{GS} = 0/15 V, I_{DS} = 5 A



Typical switching energy losses as a function of gate resistance, 2nd device own body diode: V_{GS} = -5 V

$E = f(R_{G(ext)})$

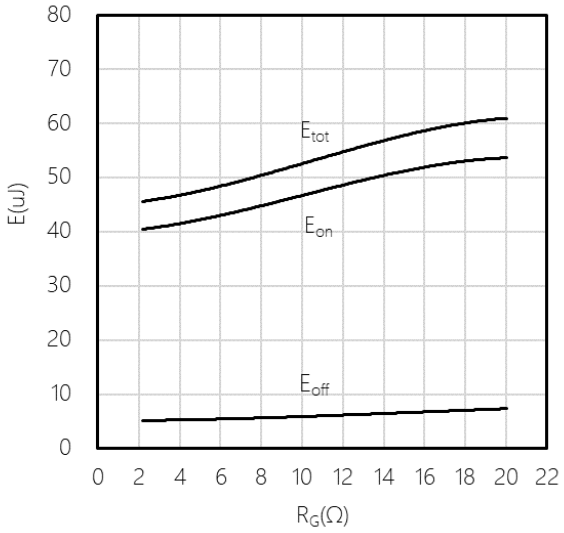
V_{GS} = 0/15 V, I_{DS} = 5 A, T_{VJ} = 25 °C, V_{DS} = 400 V



Typical switching energy losses as a function of gate resistance, 2nd device own body diode: V_{GS} = 0 V

E = f($R_{G(ext)}$)

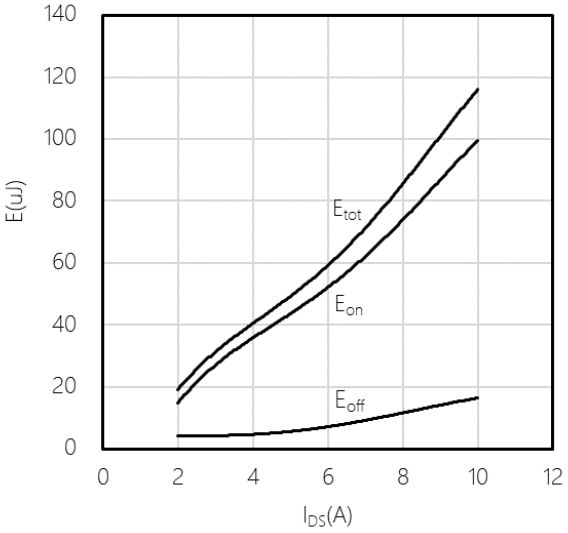
V_{GS} = 0/15 V, I_{DS} = 5 A, T_{VJ} = 175 °C, V_{DS} = 400 V



Typical switching energy losses as a function of I_{DS}, 2nd device own body diode: V_{GS} =0 V

E = f(I_{DS})

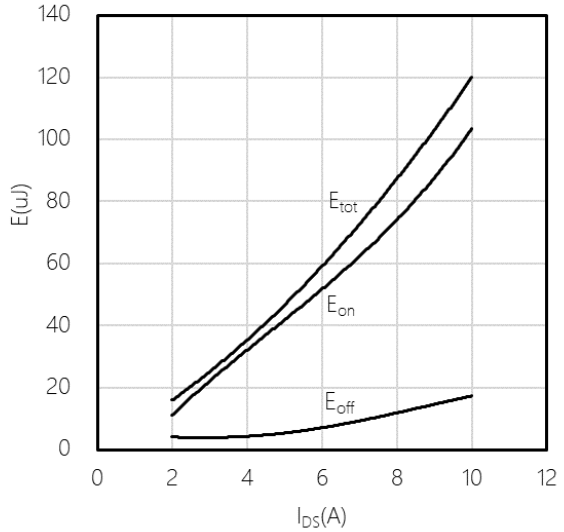
V_{GS} = 0/15 V, $R_{G(ext)}$ = 2.2 Ω, T_{VJ} = 25 °C, V_{DS} = 400 V



Typical switching energy losses as a function of I_{DS}, 2nd device own body diode: V_{GS} = 0 V

E = f(I_{DS})

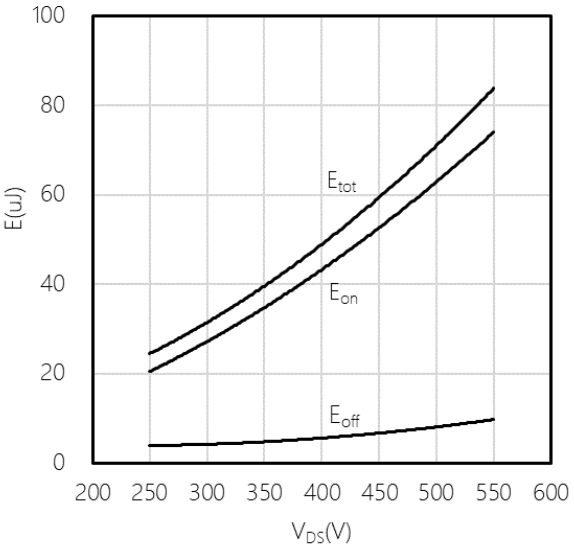
V_{GS} = 0/15 V, $R_{G(ext)}$ = 2.2 Ω, T_{VJ} = 175 °C, V_{DS} = 400 V



Typical switching energy losses as a function of V_{DS}, 2nd device own body diode: V_{GS} = 0V

E = f(V_{DS})

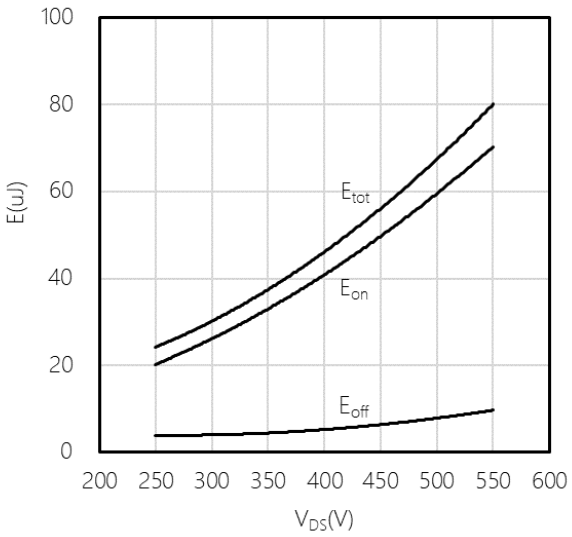
V_{GS} = 0/15 V, $R_{G(ext)}$ = 2.2 Ω, T_{VJ} = 25 °C, I_{DS} = 5 A



Typical switching energy losses as a function of V_{DS}, 2nd device own body diode: V_{GS} = 0 V

E = f(V_{DS})

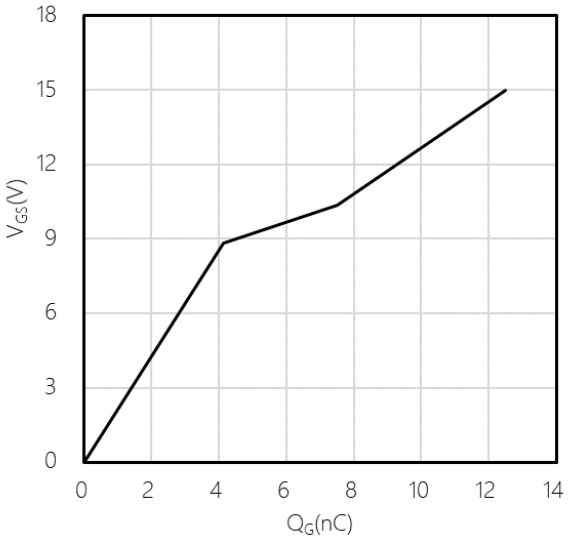
V_{GS} = 0/15 V, $R_{G(ext)}$ = 2.2 Ω, T_{VJ} = 175 °C, I_{DS} = 5 A



Typical gate charge

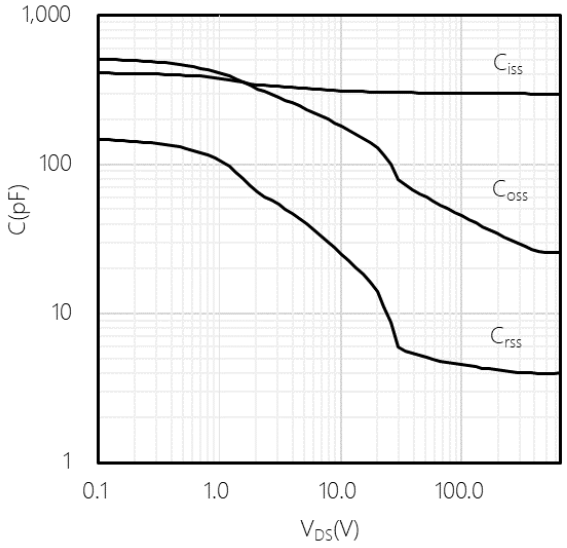
V_{GS} =f(Q_G), I_{DS} = 5 A, V_{DS} = 400V

turn-on pulse



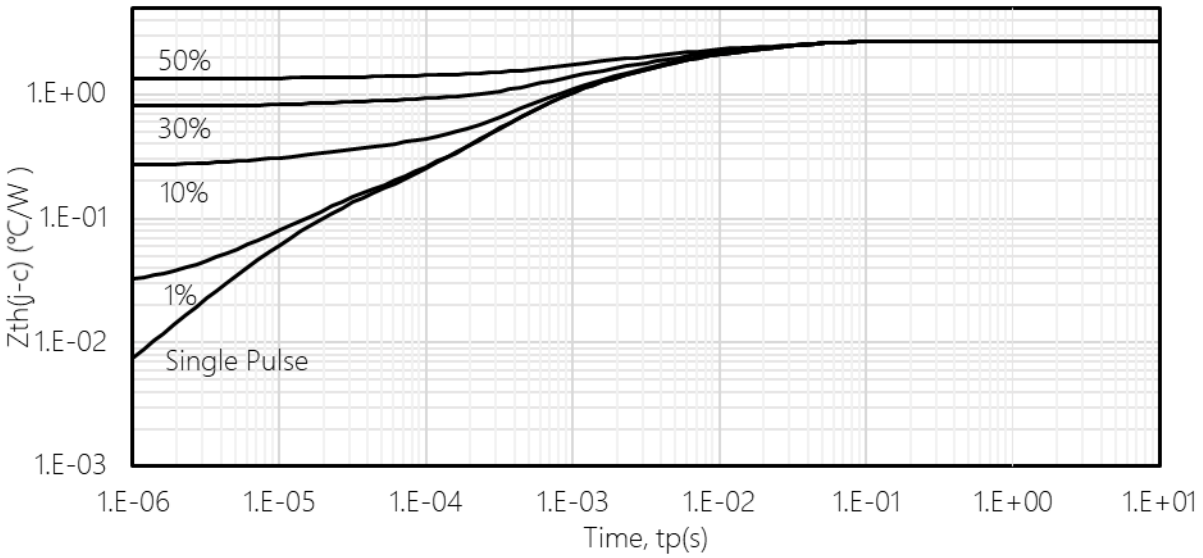
Typical capacitance as a function of drain-source voltage

C = f(V_{DS}), V_{GS} = 0V, f = 1MHz



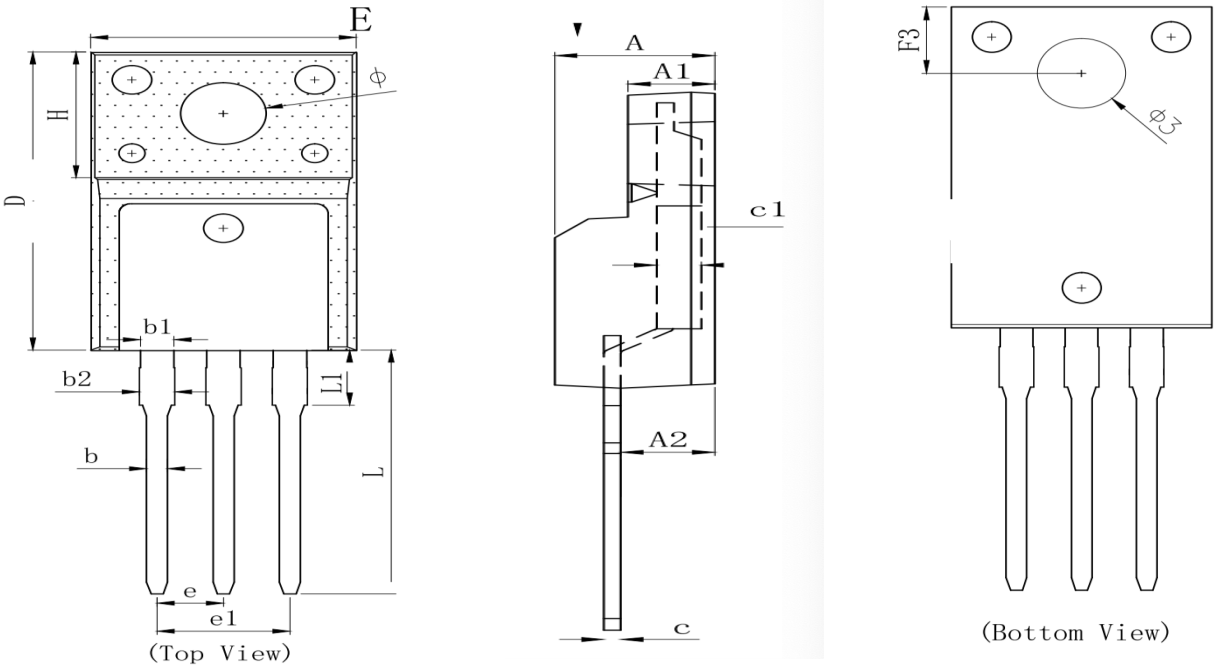
Transient thermal resistance (MOSFET)

($Z_{th(j-c,max)}$ = f(t_p), Parameter D = t_p/T



Package Dimensions

Mechanical Dimensions for TO-220F



SYMBOL	MILLIMETER		
	MIN	Typ.	MAX
A	4.500	4.700	4.900
A1	2.340	2.540	2.740
A2	2.560	2.760	2.960
b	0.700	0.800	0.950
b1	1.180	1.280	1.430
b2	1.250	1.350	1.550
c	0.400	0.500	0.650
c1	1.200	1.300	1.350
D	15.570	15.870	16.170
H	6.700 REF		
E	9.960	10.160	10.360
e	2.540 BSC		
e1	5.080 BSC		
L	12.680	12.980	13.280
L1	2.780	2.930	3.080
F3	3.150	3.300	3.450
ϕ	3.030	3.180	3.450
ϕ3	3.150	3.450	3.650