

Features

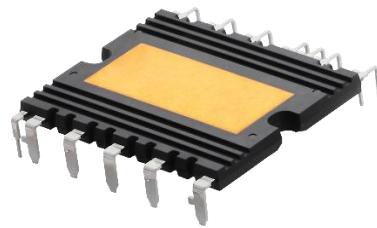
- HSDIP20 package with the 4th Generation SiC-MOSFET
- $V_{DSS} = 1200V$
- Low $R_{DS(on)}$
- High-speed switching possible
- Low switching losses
- $T_{vjmax} = 175^{\circ}C$
- Compact design
- With high thermal conductivity isolation
- Integrated NTC temperature sensor
- 4.2kV AC 1s insulation

Construction

The power module is a 6in1 module. which implements SiC-MOSFETs.

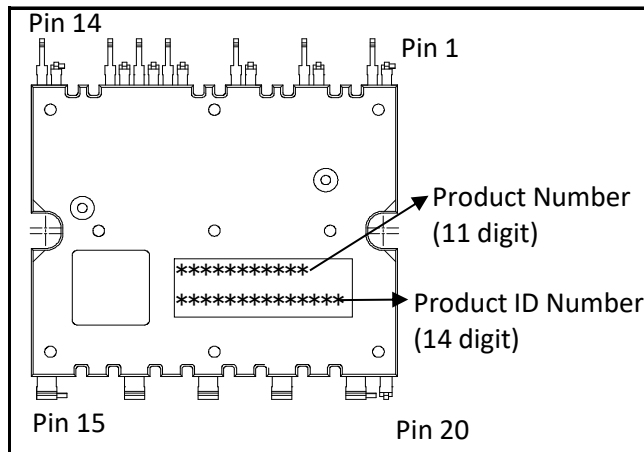
Application

- Automotive application
- Converter
- (Hybrid) electrical vehicles EV/HEV

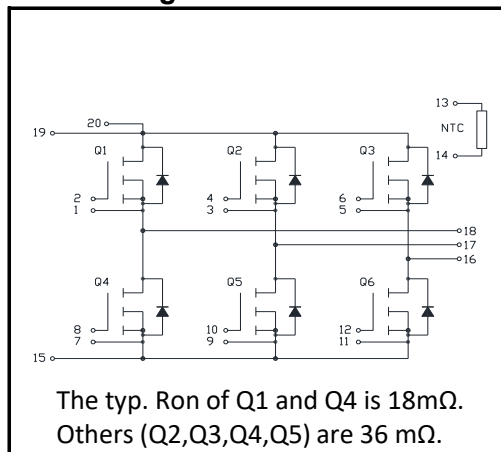


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Outline



Circuit diagram



Pin No.	Pin Name	Function
1	S1	MOSFET Source
2	G1	MOSFET Gate
3	S2	MOSFET Source
4	G2	MOSFET Gate
5	S3	MOSFET Source
6	G3	MOSFET Gate
7	S4	MOSFET Source
8	G4	MOSFET Gate
9	S5	MOSFET Source
10	G5	MOSFET Gate

Pin No.	Pin Name	Function
11	S6	MOSFET Source
12	G6	MOSFET Gate
13	T1	Thermistor
14	T2	Thermistor
15	N	Negative power
16	W	Output
17	V	Output
18	U	Output
19	P	Positive Power
20	Ps	Positive Power sense

Absolute maximum ratings (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Rating		Unit
			Q1,Q4	Others	
Drain - source voltage	V _{DSS}	V _{GS} = 0V	1200		V
Gate - source voltage (DC)	V _{GSS}		-4 to +21		
Gate - source voltage (t _{surge} < 300ns)	V _{GSSsurge}		-4 to +23		
Continuous drain current (DC)	I _D	Tc = 25°C, V _{GS} = 18V	70	38	A
		Tc = 100°C, V _{GS} = 18V	49	27	
Pulsed drain current	I _{D,pulse}	Pulse 1ms, Tc = 25°C, V _{GS} = 18V ^{Note 2), 5)}	151	83	
		Pulse 1ms, Tc = 100°C, V _{GS} = 18V ^{Note 2), 5)}	107	58	
Continuous source current (DC)	I _S	Tc = 25°C, V _{GS} = 18V	70	38	
Pulsed source current	I _{S,pulse}	Pulse 1.5μs, Tc = 25°C, V _{GS} = 18V ^{Note 2)}	151	83	
Body diode surge forward current	I _{S,pulse}	Pulse 1.5μs, Tc = 100°C, V _{GS} = 0V ^{Note 2), 4), 5)}	81	43	
Total power dissipation ^{Note 3), 5)}	P _{tot}	Tc = 25°C	385	227	W
Virtual junction temperature	T _{vj}		-40 to +175		°C
Storage temperature	T _{stg}		-40 to +125		

Note 1) If the product is used beyond absolute maximum ratings defined in the specifications, as its internal structure may be damaged, please replace the product with a new one.

Note 2) Repetition rate should be kept within the range where temperature rise of die should not exceed T_{vjmax} .

Note 3) Case temperature (T_c) is defined on the copper surface just under the chips.

Note 4) Repetitive pulse, $PW \leq 1.5\mu s$, Duty cycle $\leq 5\%$

Note 5) T_{vj} is less than 175°C.

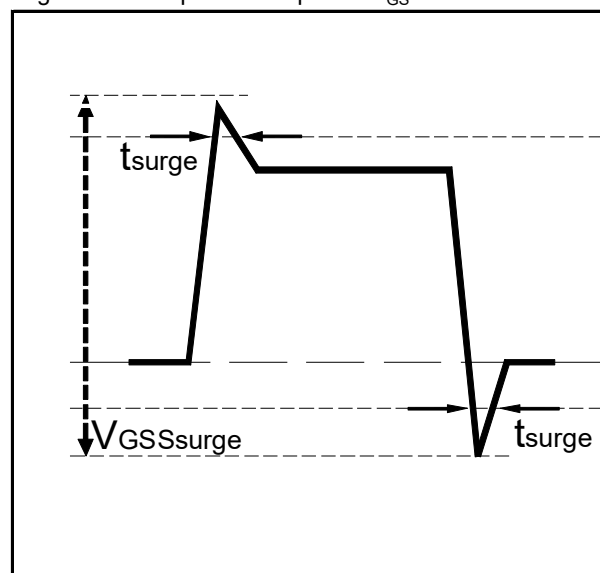
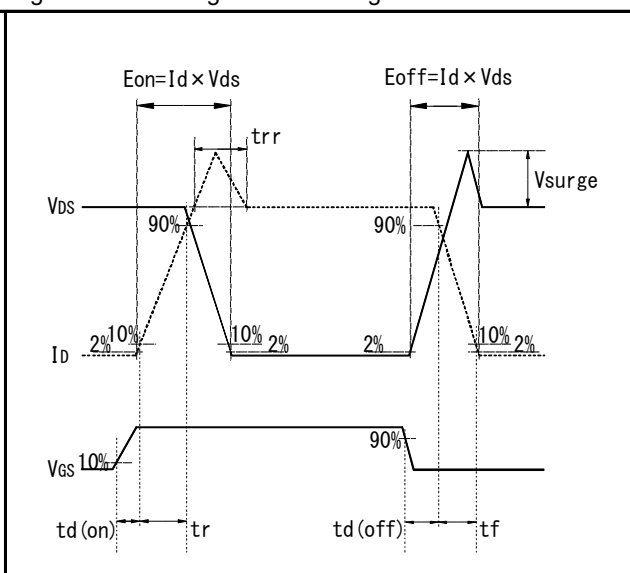
Figure 1. Example of acceptable V_{GS} waveform

Figure 2. Wavelength for switching test



Module (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Isolation test voltage	V _{isol}	All terminals to baseplate AC 60Hz 1sec.	4200	—	—	V _{rms}
Stray inductance	L _s	Terminal P to Terminal N	—	46	—	nH
Creepage distance	—	Terminal to heat sink	13.9	—	—	mm
		Terminal to terminal	8.2	—	—	
Clearance distance	—	Terminal to heat sink	10.2	—	—	mm
		Terminal to terminal	4.3	—	—	
Module flatness (Heatsink side)	—	Measurement point is shown in Figure 3.	0	—	100	μm
Mounting torque	—	Mounting to heatsink with M3 screw ^{Note 6)}	0.59	0.69	0.78	N·m
Terminal pulling strength	—	Load:4.9N(Control terminal), 9.8N(Power terminal) ^{Note 7)}	10	—	—	s
Terminal bending strength	—	Load:2.45N (Control terminal), 4.9N(Power terminal) ^{Note7)}	2	—	—	time
Thermal resistance, junction - case	R _{th(j-c)}	UMOSFET 1/6 module ^{Note 8)}	Q1,Q4	—	0.28	°C/W
			Others	—	0.48	

- Note 6) 8 mm (outside diameter) plain washers are recommended.
- Note 7) EIAJ-ED-4701/400
- Note 8) R_{th(j-c)} was measured after 1chip heating. Heatsink temperature was kept at 25°C.
The R_{th(j-c)} result was calculated from measured structure function, based on JESD51-14 guideline.
- Note 9) When installing a module to a heat sink, excessive uneven fastening force might apply stress to inside chips or ceramic of heat sink plate, which will break or crack or degrade a module.
An example of recommended fastening sequence is shown in Figure 5. The temporary fastening torque is set to 20 to 30% of the maximum torque rating.

Figure 3. Measurement point of module flatness

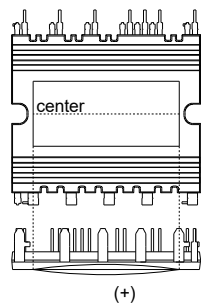


Figure 4. Flatness after installing to a heatsink (when using a heat radiation sheet)

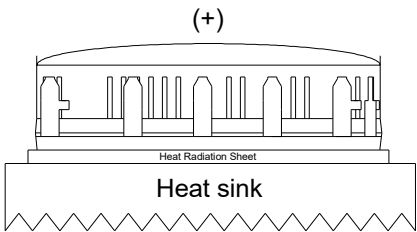
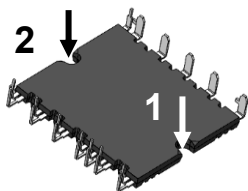


Figure 5. Example of recommended fastening sequence



Temporary fastening: 1→2
Permanent fastening: 1→2

MOSFET electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions		Values			Unit
				Min.	Typ.	Max.	
Drain - source on resistance	R _{DS(on)}	Q1,Q4 I _D = 42A, V _{GS} = 18V	Tvj = 25°C	—	18	—	mΩ
		Q1,Q4 I _D = 70A, V _{GS} = 18V	Tvj = 25°C	—	18	25	
			Tvj = 175°C	—	44	—	
		Others I _D = 21A, V _{GS} = 18V	Tvj = 25°C	—	36	—	
		Others I _D = 38A, V _{GS} = 18V	Tvj = 25°C	—	37	53	
			Tvj = 175°C	—	94	—	
Zero gate voltage drain current	I _{DSS}	All MOSFETs V _{DS} = 1200V, V _{GS} = 0V		—	—	80	μA
Drain-Source breakdown voltage	V _{(BR)DSS}	Q1,Q4 V _{GS} = 0V, I _D =18.6mA, T _{vj} =25°C		1200	—	—	V
		Others VGS = 0V, ID=9.3mA, Tvj=25°C					
Gate - source threshold voltage	V _{GS(th)}	Q1,Q4 V _{DS} = 10V, I _D = 22.2mA ^{Note 12)}		2.8	—	4.8	V
		Others VDS = 10V, ID = 11.1mA Note 12)					
Gate - source leakage current	I _{GSS}	All MOSFETs V _{GS} = +21V, V _{DS} = 0V		—	—	0.1	μA
		All MOSFETs V _{GS} = -4V, V _{DS} = 0V		-0.1	—	—	
Turn - on delay time	t _{d(on)}	VGS(on) = 18V, VGS(off) = 0V VDS = 800V ID = 70A RG(on) = 15Ω, RG(off) = 15Ω Inductive load	Q1,Q4	—	36	—	ns
Rise time	t _r			—	36	—	
Turn - off delay time	t _{d(off)}			—	153	—	
Fall time	t _f			—	15	—	
Turn - on switching loss	E _{on}			—	2.46	—	mJ
Turn - off switching loss	E _{off}			—	1.37	—	
Turn - on delay time	t _{d(on)}	VGS(on) = 18V, VGS(off) = 0V VDS = 800V ID = 38A RG(on) = 15Ω, RG(off) = 15Ω Inductive load	Others	—	25	—	ns
Rise time	t _r			—	23	—	
Turn - off delay time	t _{d(off)}			—	83	—	
Fall time	t _f			—	10	—	
Turn - on switching loss	E _{on}			—	1.07	—	mJ
Turn - off switching loss	E _{off}			—	0.52	—	
Input capacitance	C _{iss}	VDS = 800V, VGS = 0V, 1MHz	Q1,Q4	—	4.5	—	nF
			Others	—	2.3	—	
Total gate charge	Q _g	V _{GS(on)} = 18V, V _{GS(off)} = 0V V _{DS} = 800V I _D = 42A	Q1,Q4	—	170	—	nC
Gate - source charge	Q _{gs}			—	32	—	
Gate - drain charge	Q _{gd}			—	52	—	
Total gate charge	Q _g	V _{GS(on)} = 18V, V _{GS(off)} = 0V V _{DS} = 800V I _D = 21A	Others	—	91	—	
Gate - source charge	Q _{gs}			—	20	—	
Gate - drain charge	Q _{gd}			—	24	—	
Internal gate resistance	R _{Gint}	Tvj = 25°C	Q1,Q4	—	1	—	Ω
			Others	—	1	—	

Note 10) Evenly apply thermally-conductive grease with 100μm to 200μm thickness over the contact surface between the module and the heat sink. Pay attention not to have any dirt left on the contact surface between the module and the heat sink.

It is recommended to install a module directly to a heat sink after applying grease.

- Note 11) When installing a module to a heat sink, inserting a heat radiation sheet between a module and a heat sink might apply stress depending on thickness and elastic modulus of the sheet to inside chips or ceramic of heat sink plate, which will break or crack or degrade a module.
When using a heat radiation sheet, it is needed to prevent power module from bending into + side of Figure 4.
- Note 12) Tested after applying $V_{GS} = 21V$ for 100ms.
- Note 13) SiC devices have lower short circuit withstand capability due to high current density.
Please be advised to pay careful attention to short circuit accident
and try to adjust protection time to shutdown them as short as possible.

Body diode electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions			Values			Unit
					Min.	Typ.	Max.	
Souce - drain voltage	V_{SD}	$V_{GS} = 0V, I_S = 70A$	Q1,Q4	Tvj = 25°C	—	4.0	—	V
				Tvj = 175°C	—	4.3	—	
		$V_{GS} = 0V, I_S = 38A$	Others	Tvj = 25°C	—	4.1	—	
				Tvj = 175°C	—	4.4	—	
		$V_{GS} = 18V, I_S = 70A$	Q1,Q4	Tvj = 25°C	—	1.1	—	
				Tvj = 175°C	—	2.7	—	
		$V_{GS} = 18V, I_S = 38A$	Others	Tvj = 25°C	—	1.3	—	
				Tvj = 175°C	—	2.8	—	

NTC Thermistor electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
NTC rated resistance	R_{25}	$T_c = 25^\circ C$	—	10	—	kΩ
NTC B Value	$B_{50/25}$		—	3380	—	K
Maximum operating current	—		—	—	0.1	mA

Electrical characteristic curves (Typical)

Figure 6. Output characteristic at 25°C
Q1,Q4(Typ.)

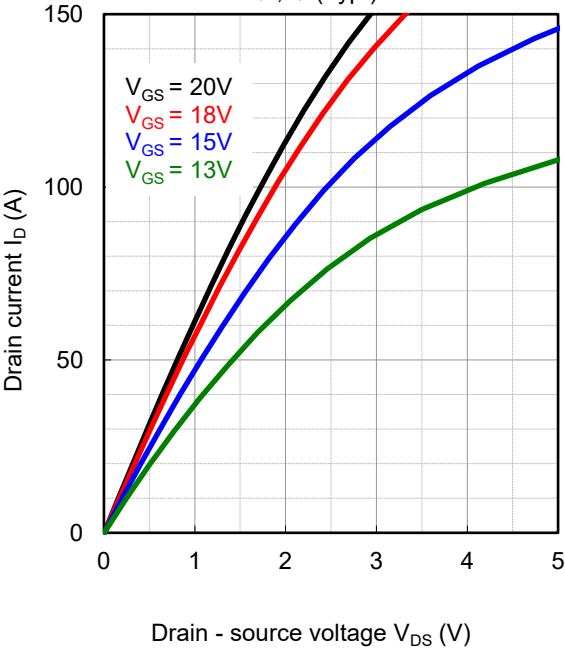


Figure 7. Drain - source voltage characteristic
Q1,Q4(Typ.)

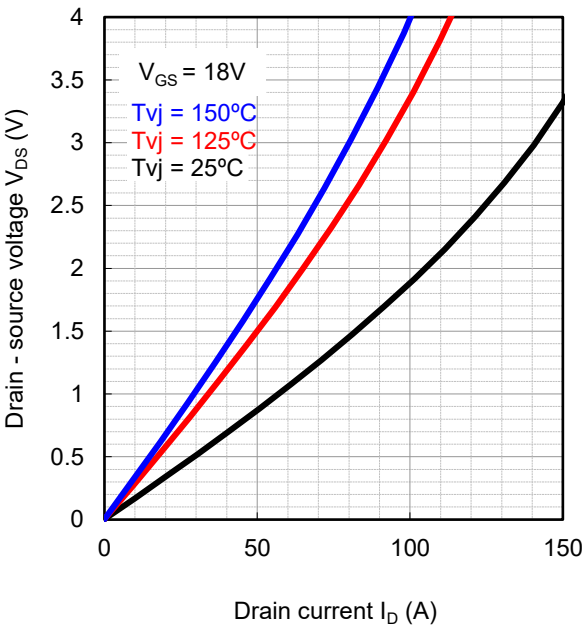
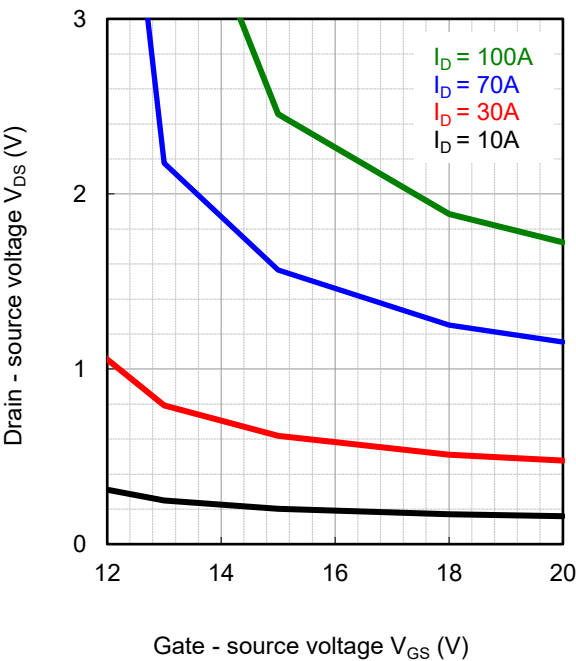


Figure 8. Drain - source voltage characteristic
at 25°C Q1,Q4(Typ.)



Electrical characteristic curves (Typical)

Figure 9. $R_{DS(on)}$ vs. T_{vj} characteristic
Q1,Q4(Typ.)

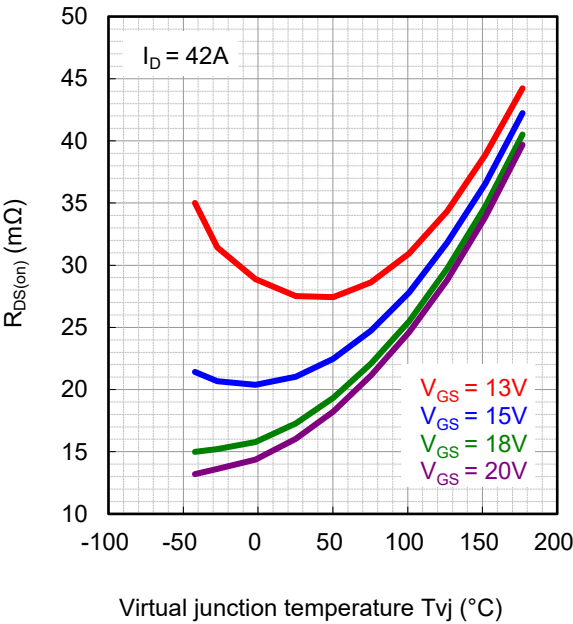


Figure 10. Forward characteristic of diode
Q1,Q4(Typ.)

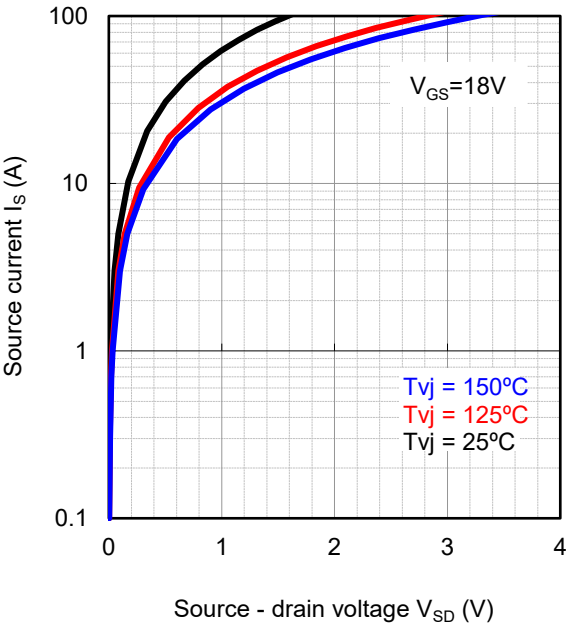
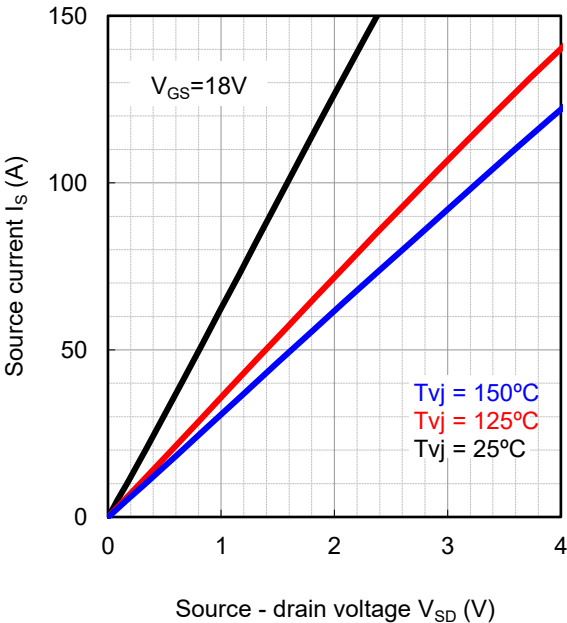


Figure 11. Forward characteristic of diode
Q1,Q4(Typ.)



Electrical characteristic curves (Typical)

Figure 12. Forward characteristic of diode Q1,Q4(Typ.)

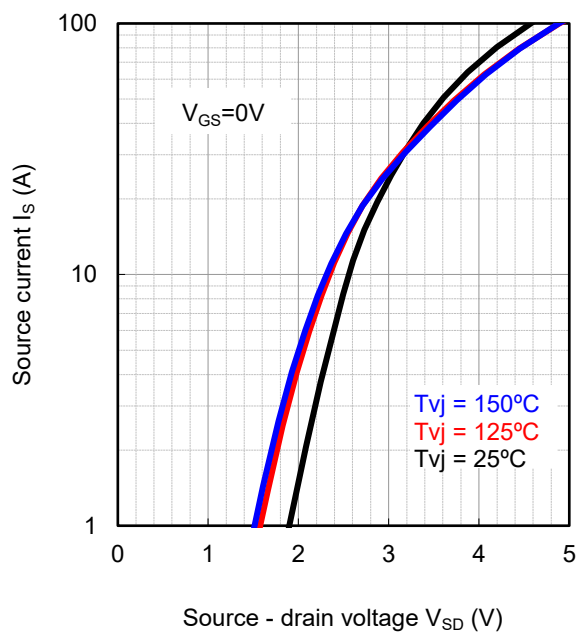


Figure 13. Forward characteristic of diode Q1,Q4(Typ.)

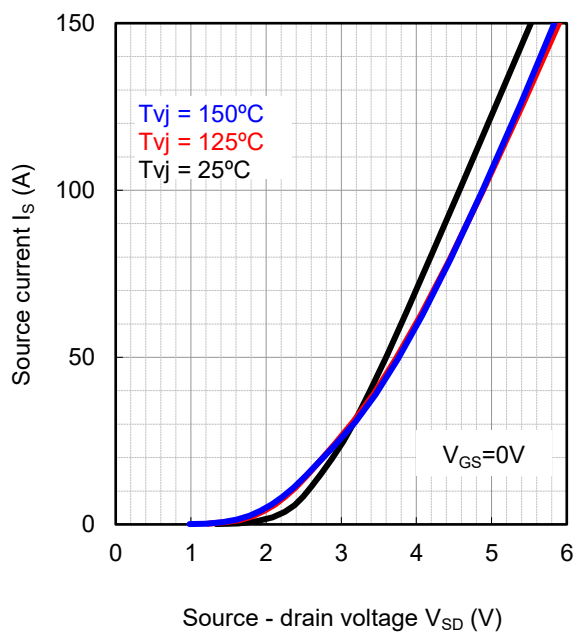


Figure 14. Drain current vs. Gate - source voltage Q1,Q4(Typ.)

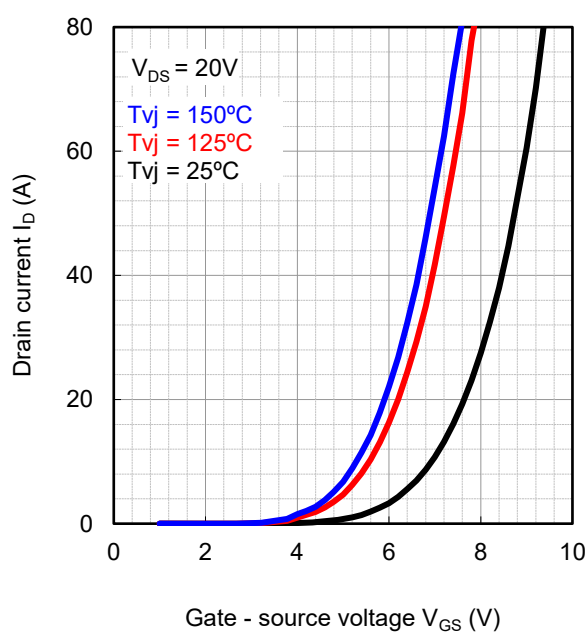
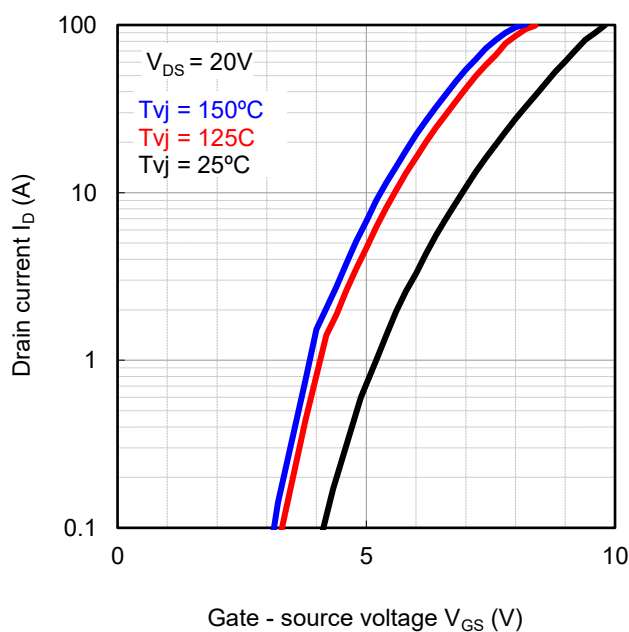


Figure 15. Drain current vs. Gate - source voltage Q1,Q4(Typ.)



Electrical characteristic curves (Typical)

Figure 16. Switching time vs. Drain current at 25°C Q1,Q4(Typ.)

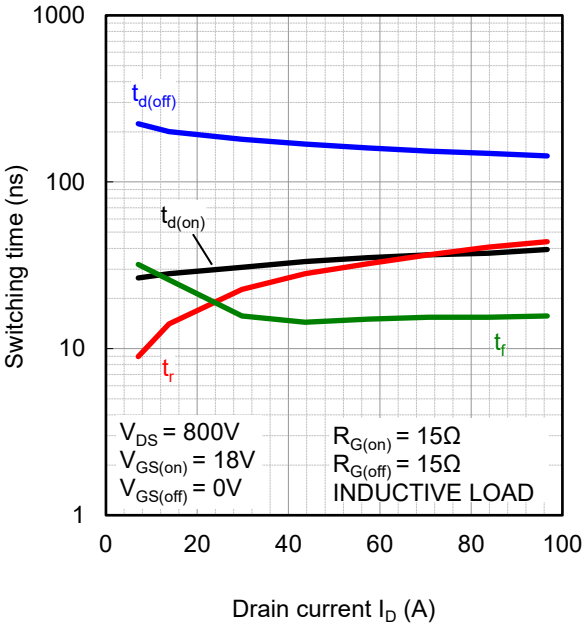


Figure 17. Switching time vs. Drain current at 150°C Q1,Q4(Typ.)

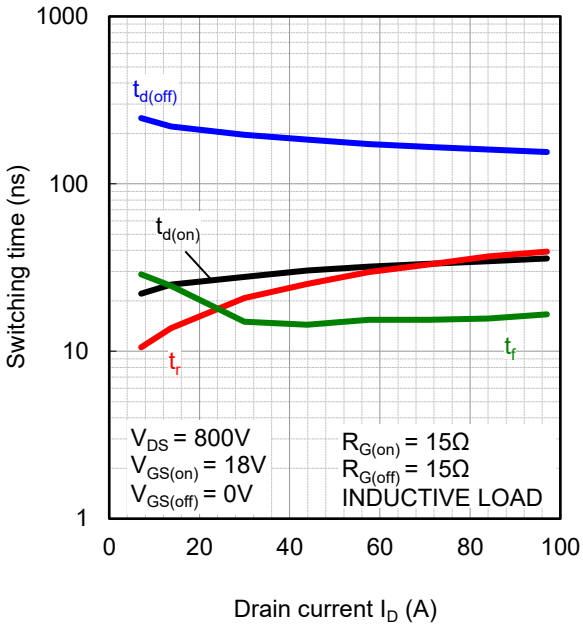


Figure 18. Switching loss vs. Drain current at 25°C Q1,Q4(Typ.)

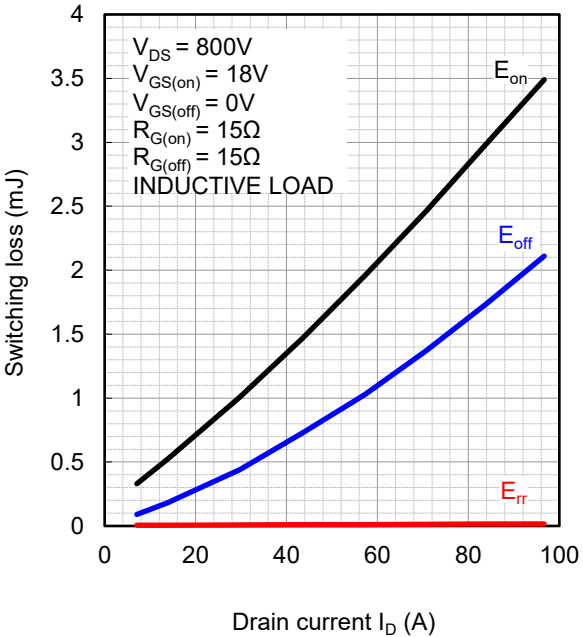
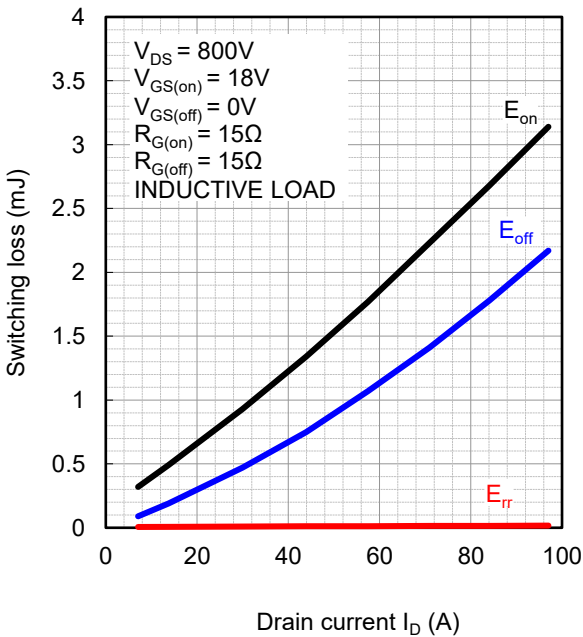


Figure 19. Switching loss vs. Drain current at 150°C Q1,Q4(Typ.)



Electrical characteristic curves (Typical)

Figure 20. Recovery characteristic vs. Drain current at 25°C Q1,Q4(Typ.)

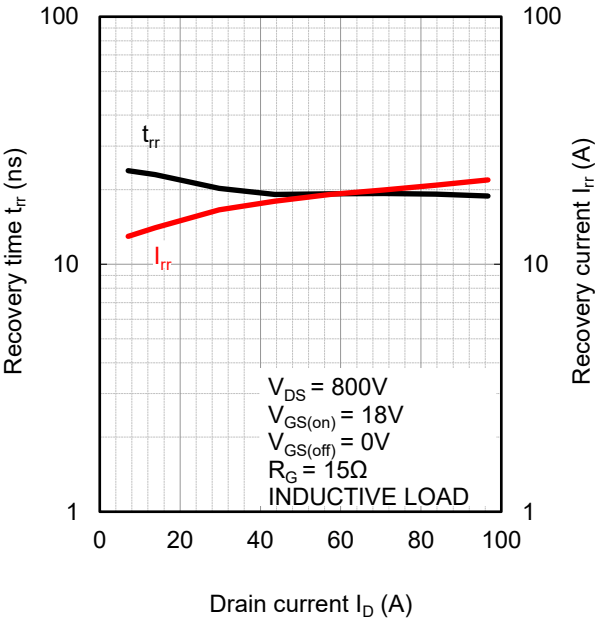


Figure 21. Recovery characteristic vs. Drain current at 150°C Q1,Q4(Typ.)

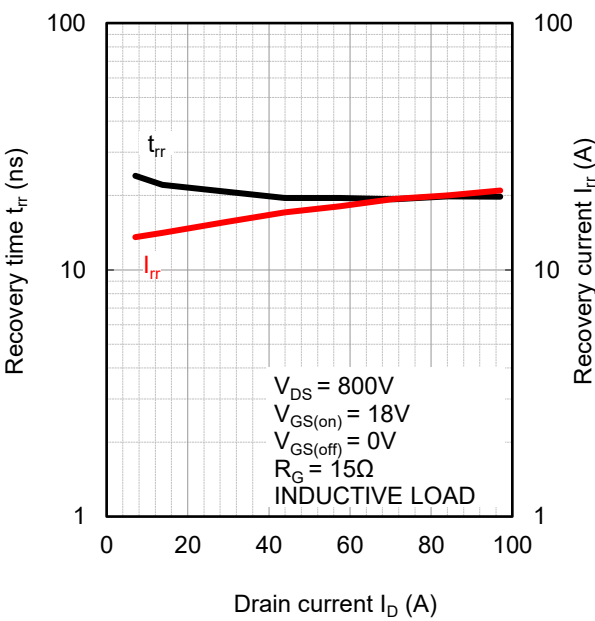


Figure 22. Switching time vs. Gate resistance at 25°C Q1,Q4(Typ.)

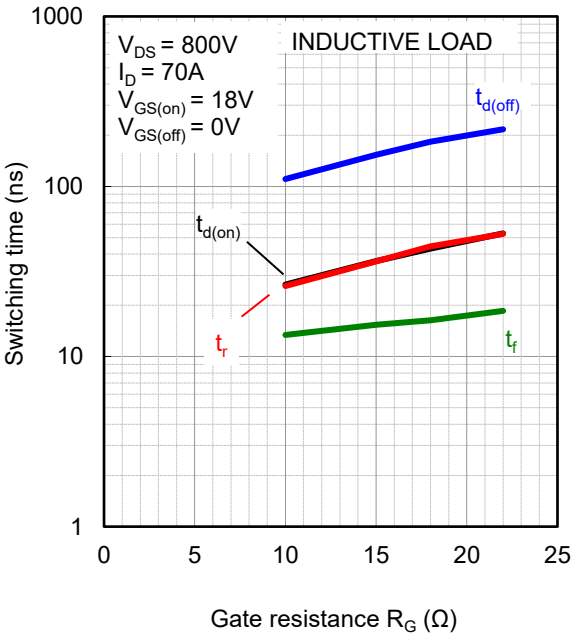
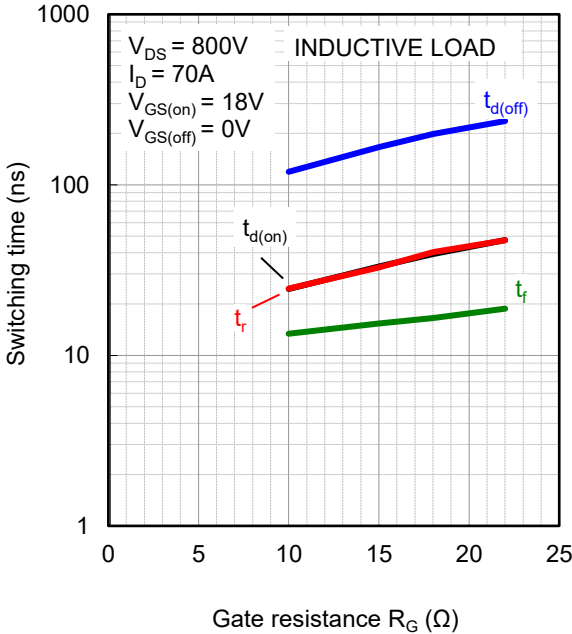


Figure 23. Switching time vs. Gate resistance at 150°C Q1,Q4(Typ.)



Electrical characteristic curves (Typical)

Figure 24. Switching loss vs. Gate resistance at 25°C Q1,Q4(Typ.)

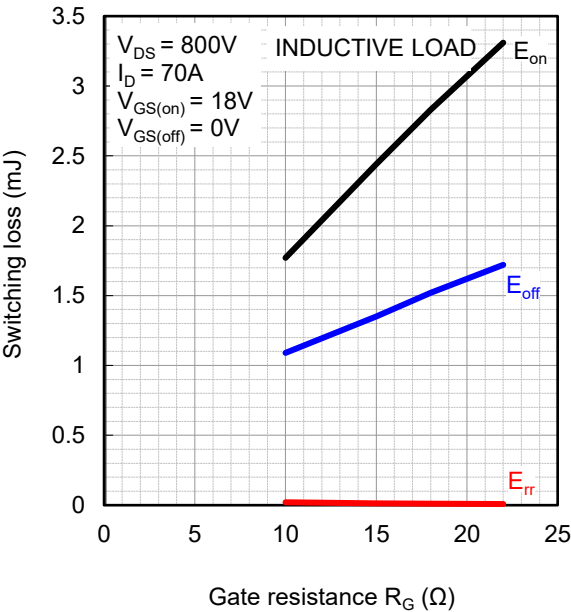


Figure 25. Switching loss vs. Gate resistance at 150°C Q1,Q4(Typ.)

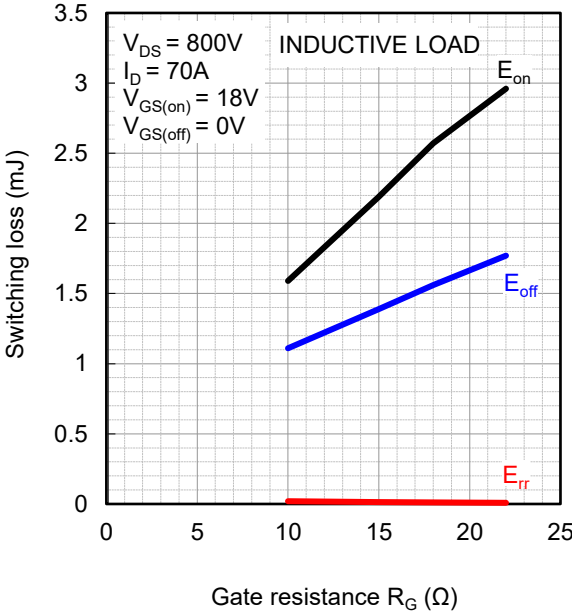


Figure 26. Capacitance vs. Drain - source voltage at 25°C Q1,Q4(Typ.)

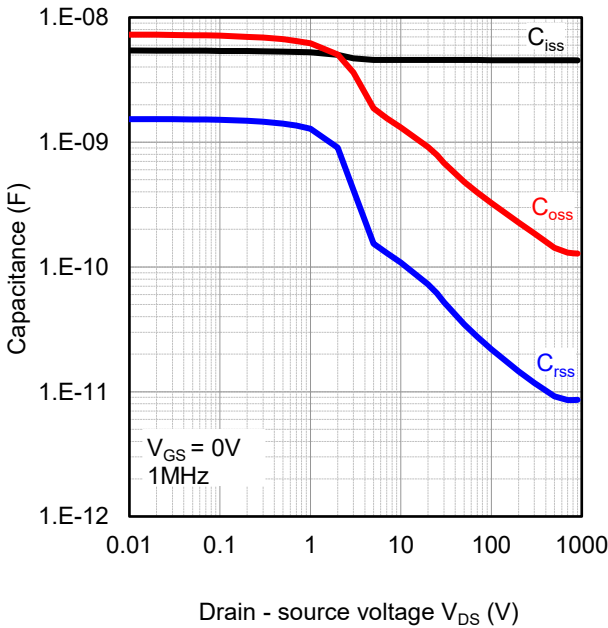
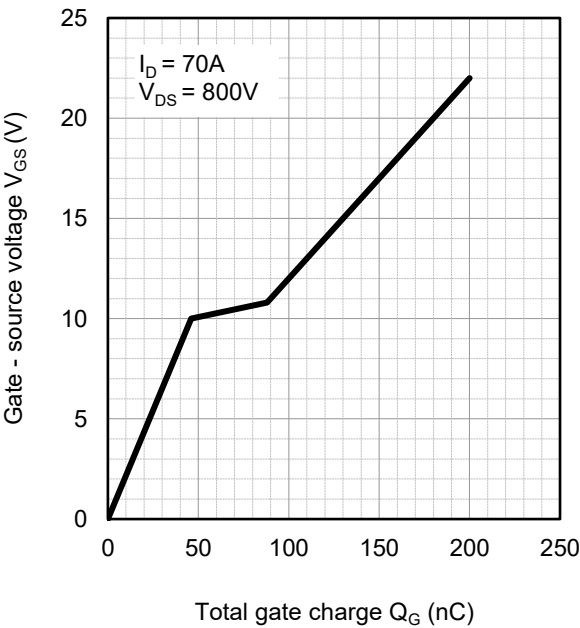
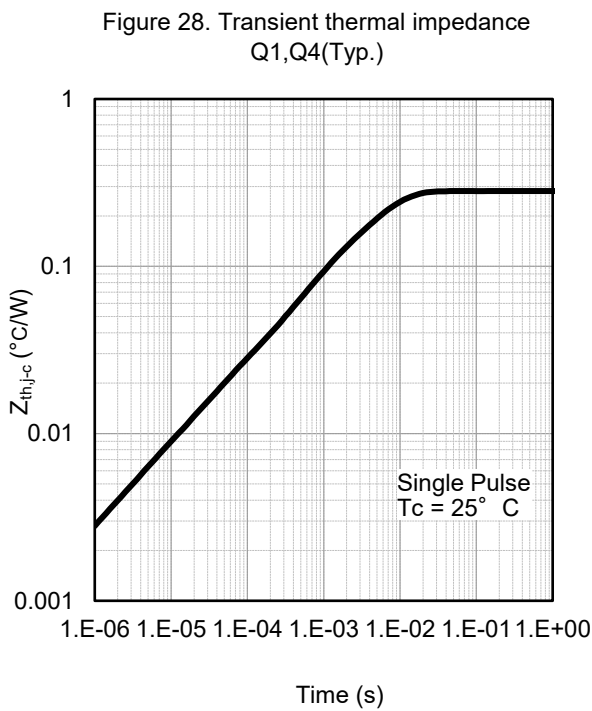


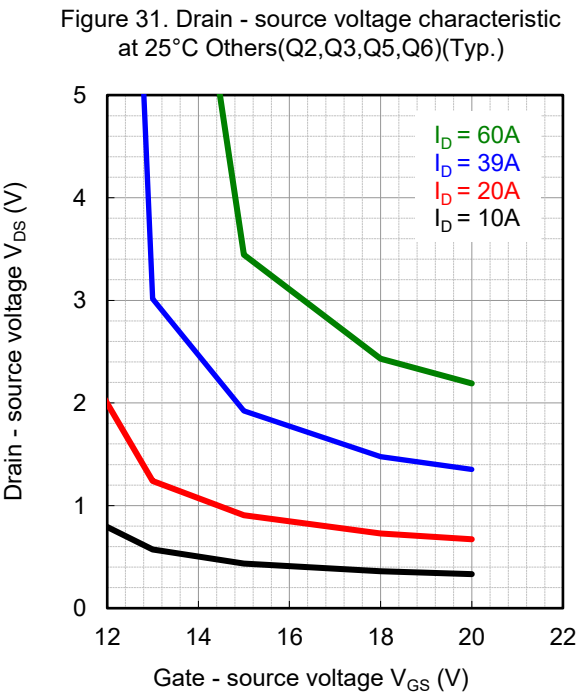
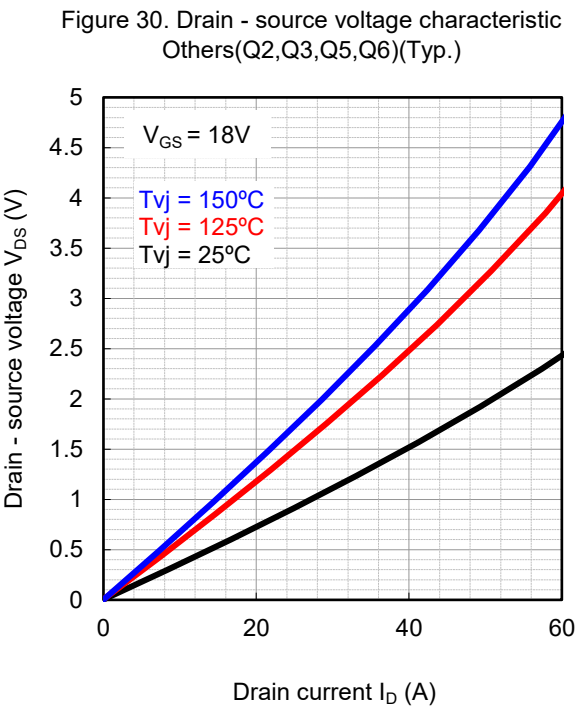
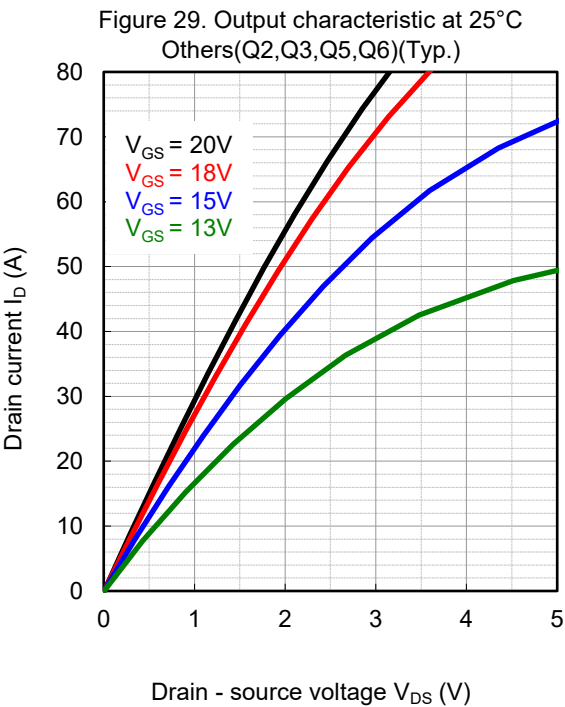
Figure 27. Gate charge characteristic at 25°C Q1,Q4(Typ.)



Electrical characteristic curves (Typical)



Electrical characteristic curves (Typical)



Electrical characteristic curves (Typical)

Figure 32. RDS(on) vs. Tvj characteristic
Others(Q2,Q3,Q5,Q6)(Typ.)

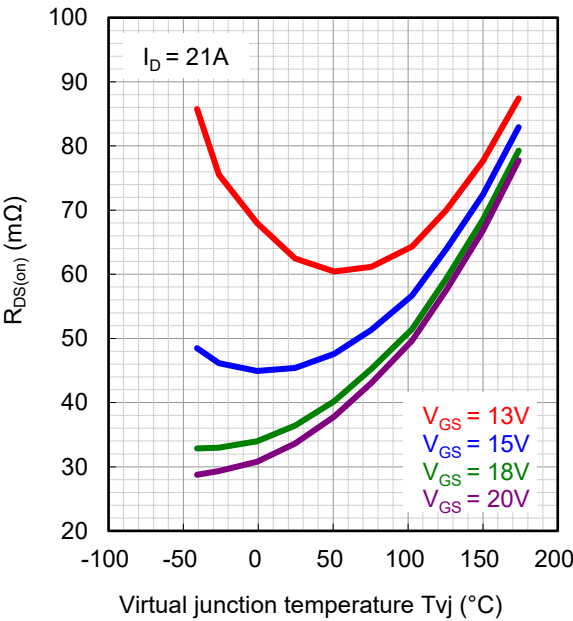


Figure 33. Forward characteristic of diode
Others(Q2,Q3,Q5,Q6)(Typ.)

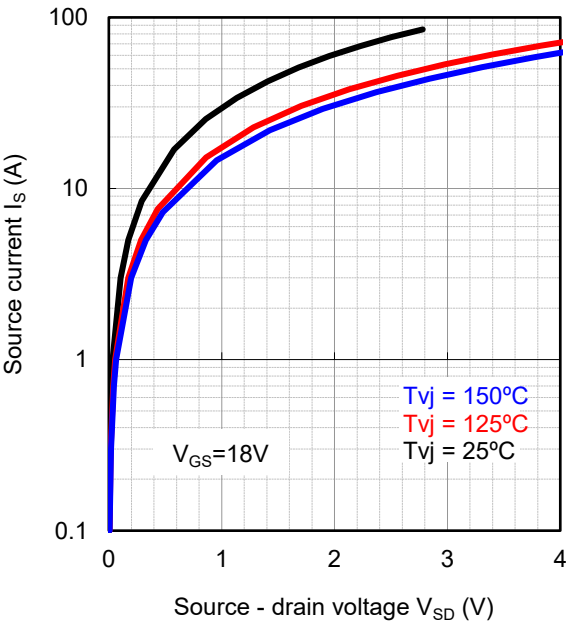
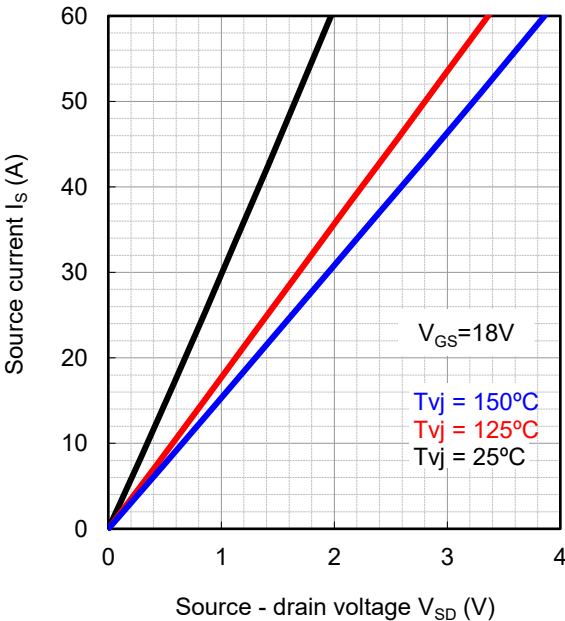


Figure 34. Forward characteristic of diode
Others(Q2,Q3,Q5,Q6)(Typ.)



Electrical characteristic curves (Typical)

Figure 35. Forward characteristic of diode
Others(Q2,Q3,Q5,Q6)(Typ.)

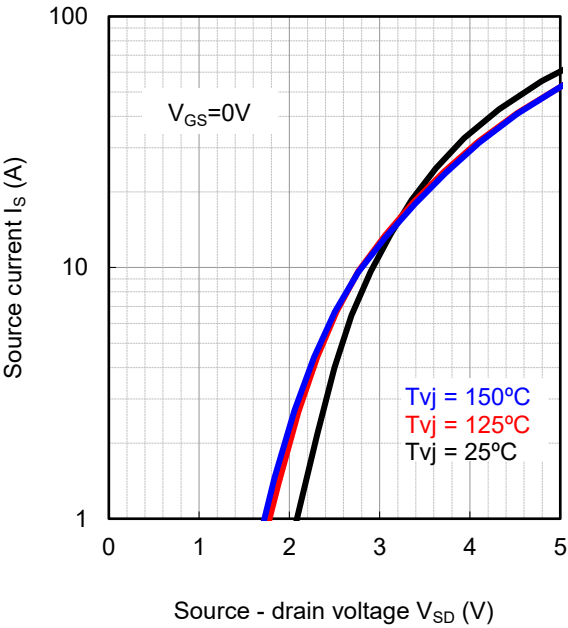


Figure 36. Forward characteristic of diode
Others(Q2,Q3,Q5,Q6)(Typ.)

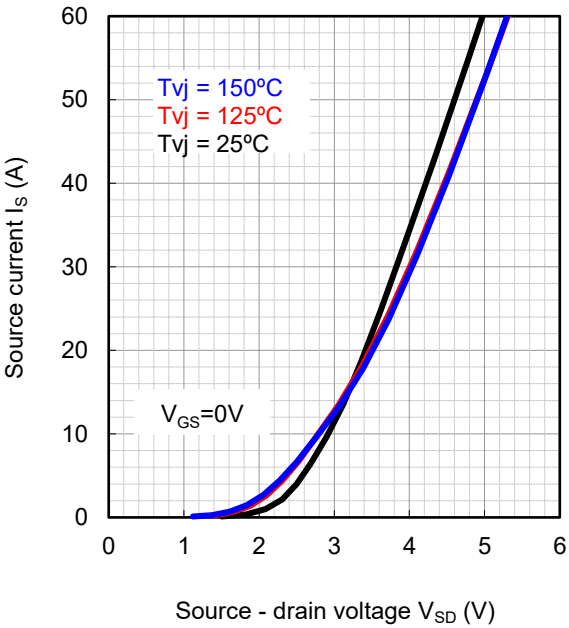


Figure 37. Drain current vs. Gate-source voltage
Others(Q2,Q3,Q5,Q6)(Typ.)

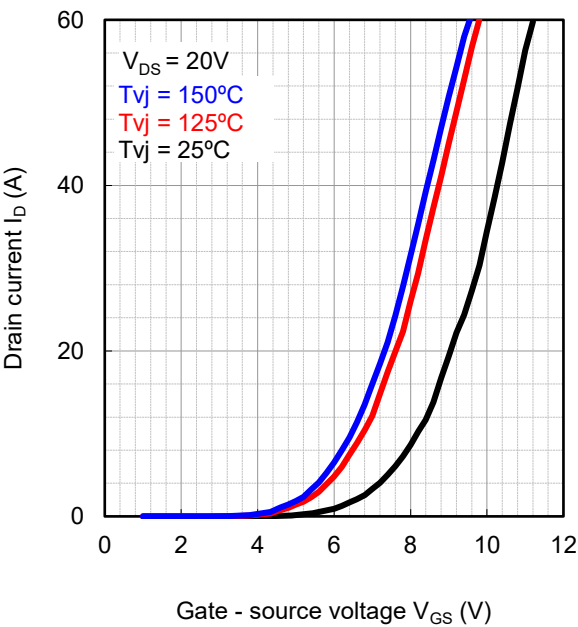
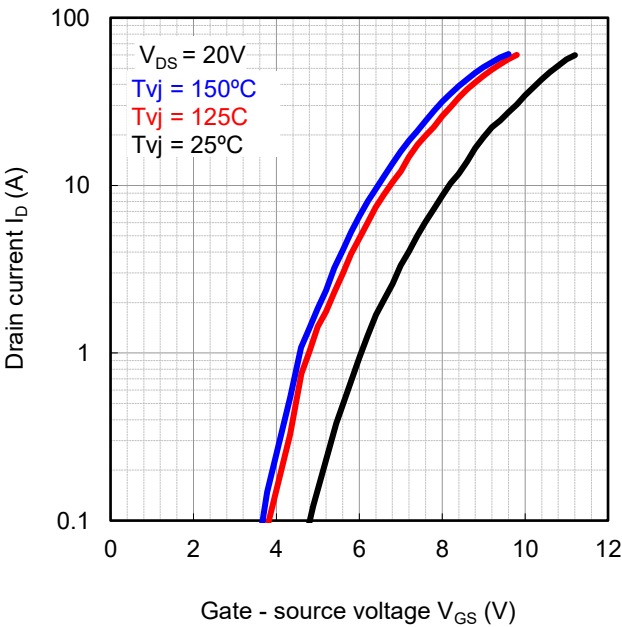


Figure 38. Drain current vs. Gate-source voltage
Others(Q2,Q3,Q5,Q6)(Typ.)



Electrical characteristic curves (Typical)

Figure 39. Switching time vs. Drain current at 25°C Others(Q2,Q3,Q5,Q6) (Typ.)

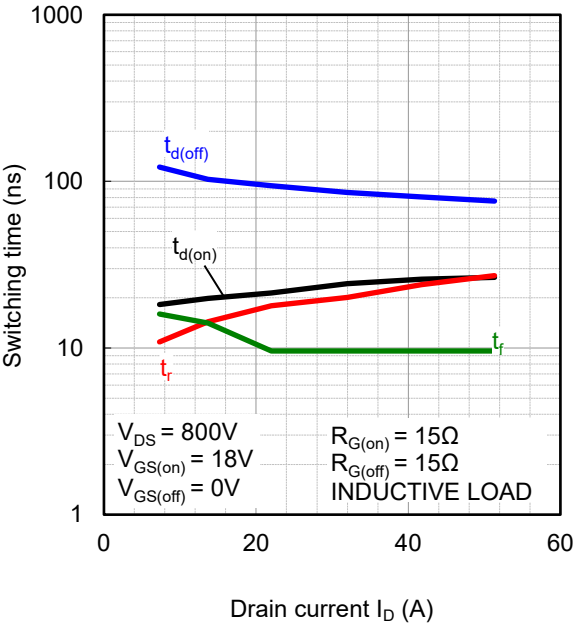


Figure 40. Switching time vs. Drain current at 150°C Others(Q2,Q3,Q5,Q6) (Typ.)

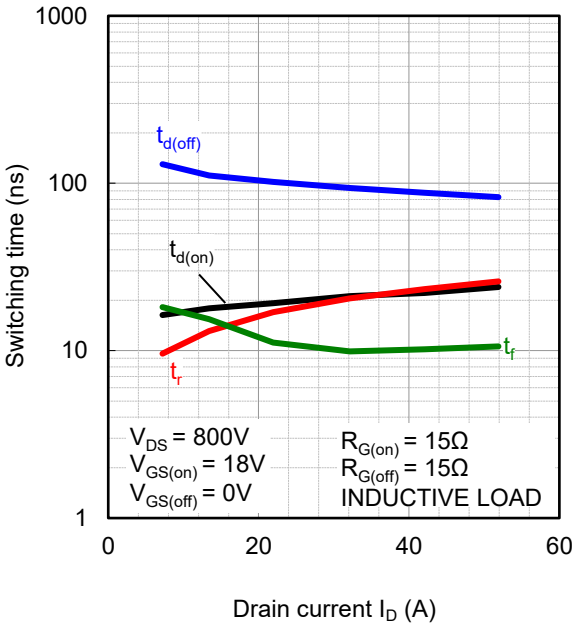


Figure 41. Switching loss vs. Drain current at 25°C Others(Q2,Q3,Q5,Q6) (Typ.)

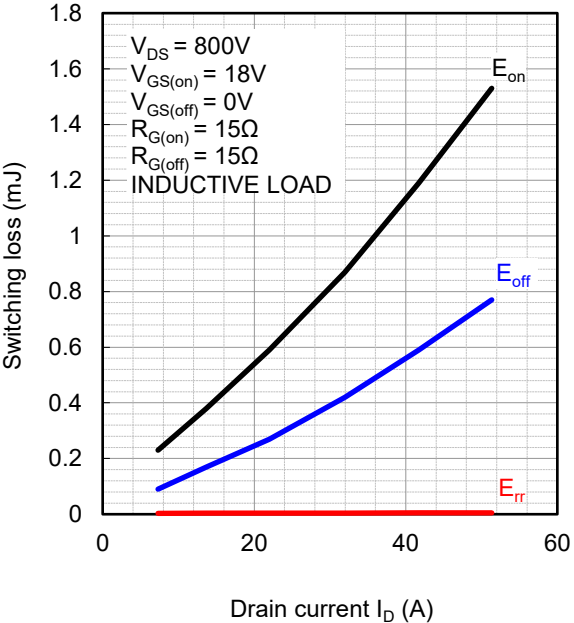
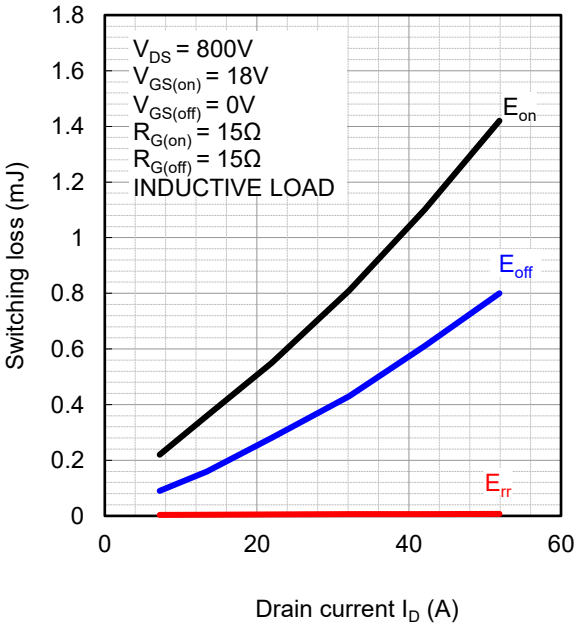


Figure 42. Switching loss vs. Drain current at 150°C Others(Q2,Q3,Q5,Q6) (Typ.)



Electrical characteristic curves (Typical)

Figure 43. Recovery characteristic vs. Drain current at 25°C Others(Q2,Q3,Q5,Q6) (Typ.)

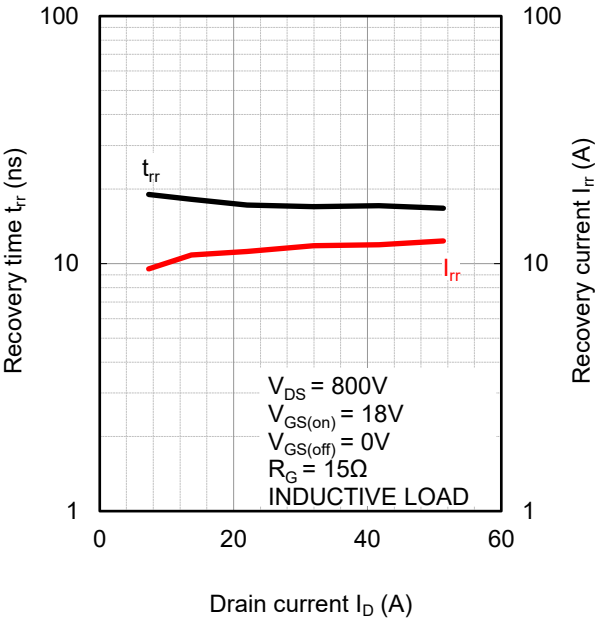


Figure 44. Recovery characteristic vs. Drain current at 150°C Others(Q2,Q3,Q5,Q6) (Typ.)

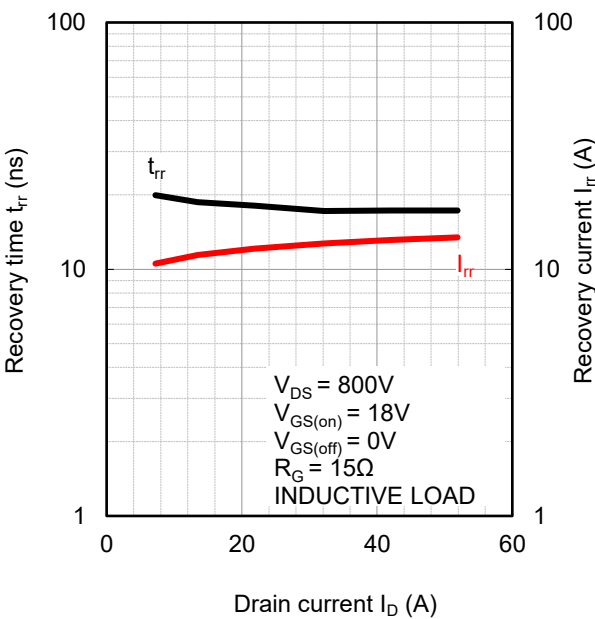


Figure 45. Switching time vs. Gate resistance at 25°C Others(Q2,Q3,Q5,Q6) (Typ.)

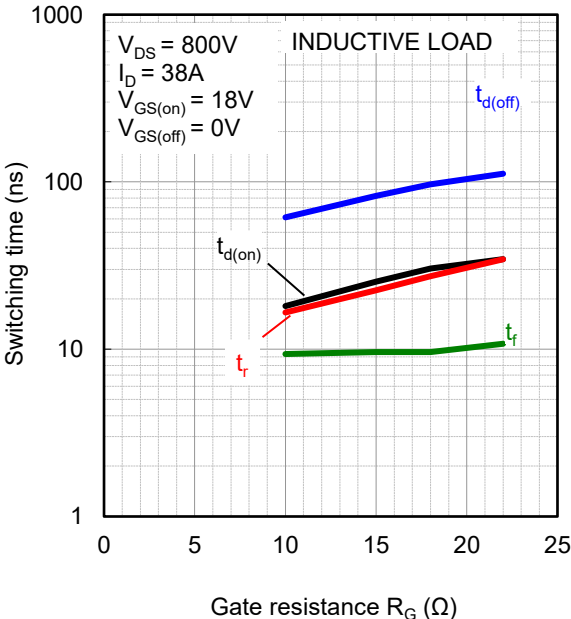
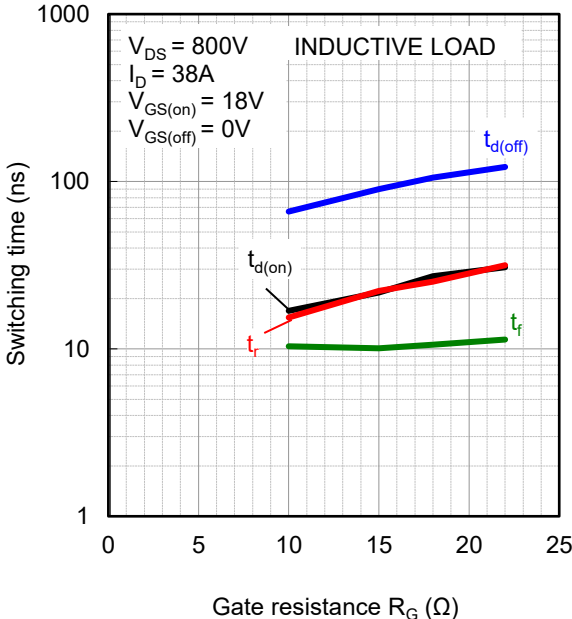


Figure 46. Switching time vs. Gate resistance at 150°C Others(Q2,Q3,Q5,Q6) (Typ.)



Electrical characteristic curves (Typical)

Figure 47. Switching loss vs. Gate resistance at 25°C Others(Q2,Q3,Q5,Q6) (Typ.)

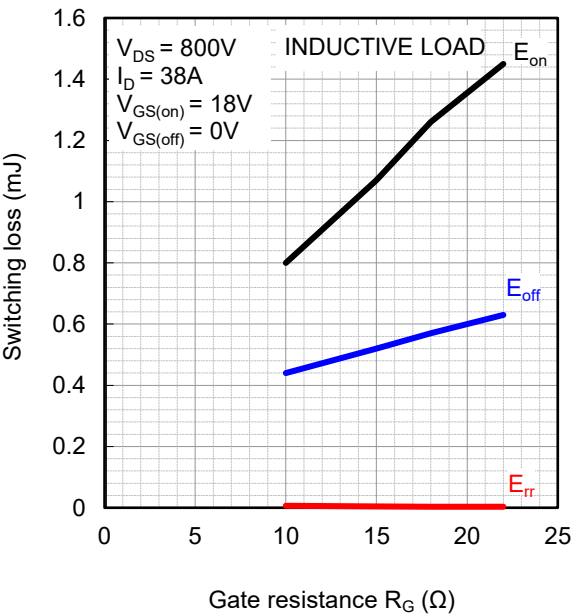


Figure 48. Switching loss vs. Gate resistance at 150°C Others(Q2,Q3,Q5,Q6) (Typ.)

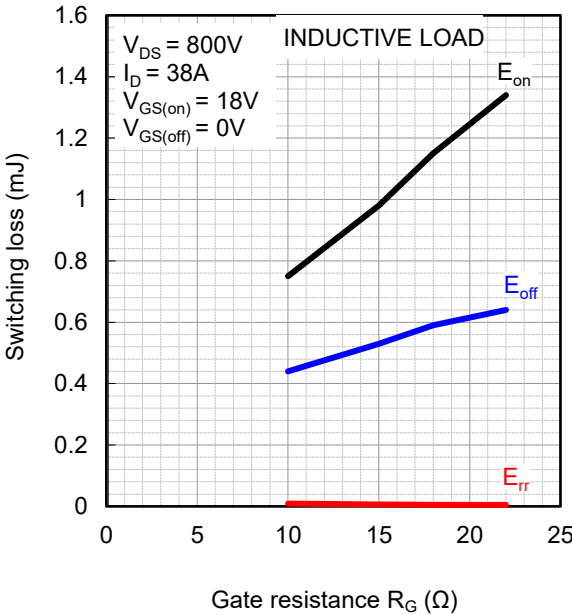


Figure 49. Capacitance vs. Drain - source voltage at 25°C Others(Q2,Q3,Q5,Q6) (Typ.)

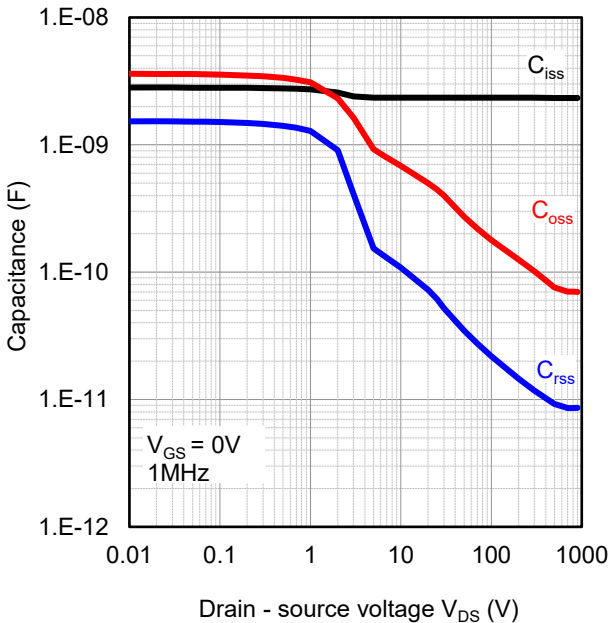
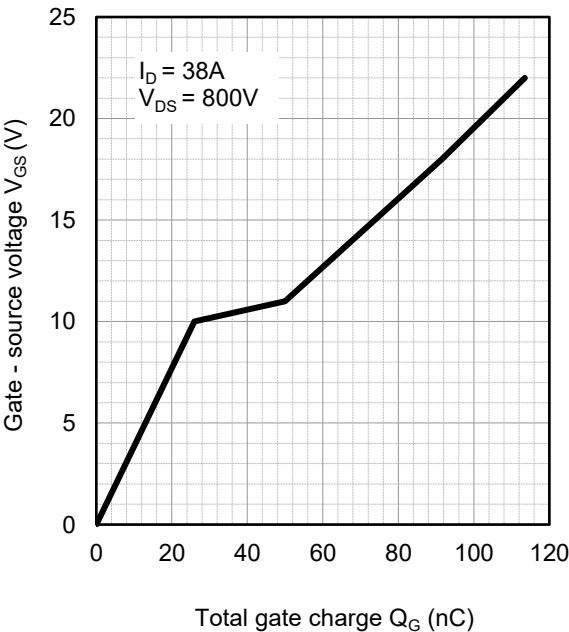
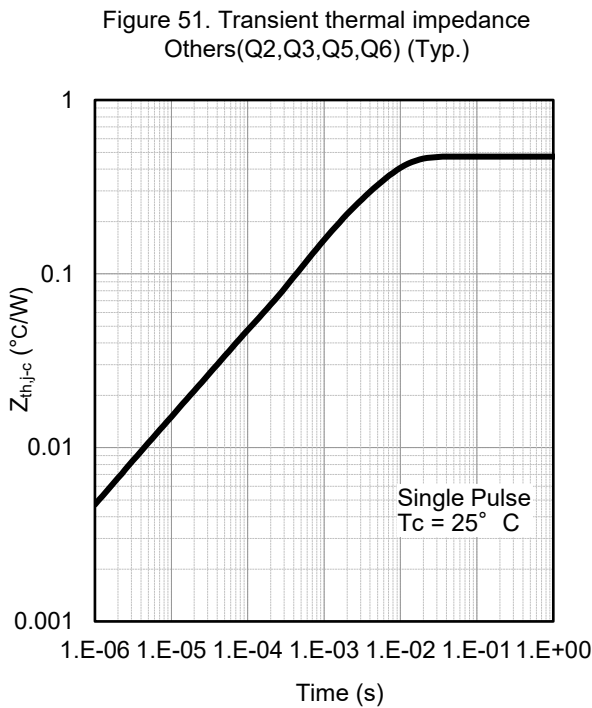


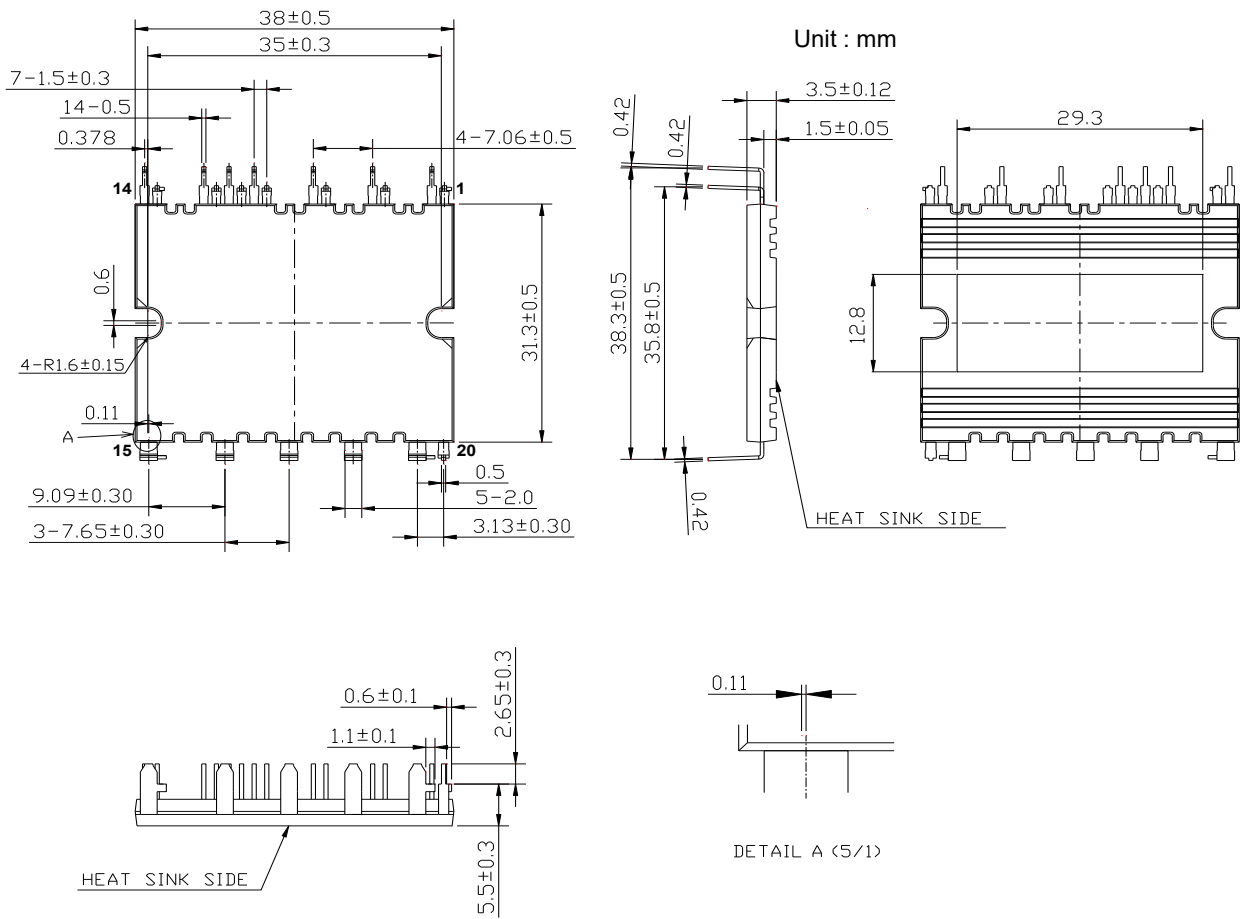
Figure 50. Gate charge characteristic at 25°C Others(Q2,Q3,Q5,Q6) (Typ.)



Electrical characteristic curves (Typical)



Package outlines



Notes

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