650V GaN Power Transistor (FET)

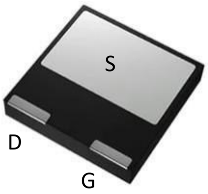
Features

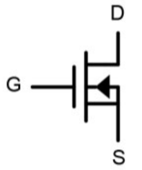
- Easy to use, compatible with standard gate drivers
- Excellent Q_G x $R_{DS(on)}$ figure of merit (FOM)
- Low Q_{RR}, no free-wheeling diode required
- Low switching loss
- RoHS compliant and Halogen-free

Product Summary		
V_{DSS}	650	V
$R_{DS(on),\ typ}$	180	mΩ
$Q_{G,\ typ}$	16	nC
$Q_{RR,\ typ}$	41	nC

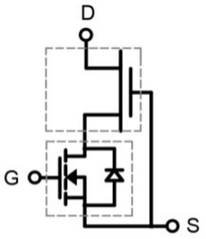
Applications

- High efficiency power supplies
- High efficiency USB PD adapters
- Other consumer electronics





Schematic Symbol



Cascode Device Structure

Packaging

Part Number	Package	Packaging	Base QTY
RX65T180HS3H	DFN 8 x 8	Tape and Reel	2500

Maximum ratings, at T_C=25 ℃, unless otherwise specified

Symbol	Parameter		Limit Value	Unit
I_D	Continuous drain current @T_C=25℃		9.7	A
	Continuous drain current @T_C=100℃		6.1	A
I_{DM}	Pulsed drain current @T_C=25℃ (pulse width: 100us)		41	A
	Pulsed drain current @T_C=150℃ (pulse width: 100us)		31	A
V_{DSS}	Drain to source voltage (T_J = -55℃ to 150℃)		650	V
V_{TDSS}	Transient drain to source voltage [a]		800	V
V_{GSS}	Gate to source voltage		±20	V
P_D	Maximum power dissipation @T_C=25℃		36	W
T_C	Operating temperature	Case	-55 to 150	℃
T_J		Junction	-55 to 150	℃
T_S	Storage temperature		-55 to 150	℃
T_{CSOLD}	Soldering peak temperature		260	℃

Thermal Resistance

Symbol	Parameter	Typical	Unit
$R_{\Theta JC}$	Junction-to-case	3.5	℃/W
$R_{\Theta JA}$	Junction-to-ambient [b]	50	℃/W

Notes:

a. Off-state spike duty cycle < 0.01, spike duration < 2us

b. Device on one layer epoxy PCB for drain connection (vertical and without air stream cooling, with 6cm^{2}copper area and 70µm thickness)

Electrical Parameters, at T_J=25 ℃, unless otherwise specified

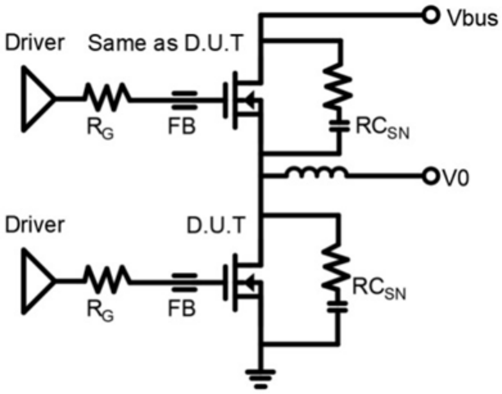
Symbol	Min	Typ	Max	Unit	Test Conditions
Forward Characteristics					
$V_{DSS-MAX}$	650	-	-	V	V_{GS}=0V
BV_{DSS}	-	1000	-		V_{GS}=0V, I_{DSS}=250µA
$V_{GS(th)}$	3	4	5	V	V_{DS}=V_{GS}, I_D=500µA
$\triangle V_{GS(th)}/T_J$	-	-10.7	-	mV/℃	
$R_{DS(on)}$ [c]	-	180	225	mΩ	V_{GS}=12V, I_D=4A, T_J=25℃
	-	360	-		V_{GS}=12V, I_D=4A, T_J=150℃
I_{DSS}	-	9	20	µA	V_{DS}=700V, V_{GS}=0V, T_J=25℃
	-	50	-	µA	V_{DS}=700V, V_{GS}=0V, T_J=150℃
I_{GSS}	-	-	150	nA	V_{GS}=20V
	-	-	-150	nA	V_{GS}=-20V
C_{ISS}	-	643	-	pF	V_{GS}=0V, V_{DS}=400V, f=1MHz
C_{OSS}	-	29	-	pF	
C_{RSS}	-	1.5	-	pF	
$C_{O(er)}$	-	44	-	pF	V_{GS}=0V, V_{DS}=0 - 400V
$C_{O(tr)}$	-	101	-	pF	
Q_{oss}	-	41	-	nC	
Q_G	-	16	-	nC	V_{DS}=400V, V_{GS}=0 - 12V, I_D=6A
Q_{GS}	-	4.6	-		
Q_{GD}	-	5.6	-		
$t_{D(on)}$	-	60	-	ns	V_{DS}=400V, V_{GS}=0 - 12V, I_D=6A, R_G=47Ω
t_R	-	12	-		
$t_{D(off)}$	-	80	-		
t_F	-	10	-		
Reverse Characteristics					
V_{SD}	-	1.1	-	V	V_{GS}=0V, I_S=3A, T_J=25℃
	-	1.5	-		V_{GS}=0V, I_S=6A, T_J=25℃
	-	2	-		V_{GS}=0V, I_S=6A, T_J=150℃
t_{RR}	-	20	-	ns	I_S=9A, V_{GS}=0V, d_i/d_t=1000A/us, V_{DD}=400V
Q_{RR}	-	41	-	nC	

Notes:

c. Dynamic on-resistance; see Figure 17 and 18 for test circuit and configurations

Circuit Implementation

(1) Mostly used in half bridge and full bridge topology



Recommended Half-bridge Circuit

Recommended gate drive: (0 V, 12V) with $R_{G(tot)}$ = 40 Ω, where $R_{G(tot)} = R_G + R_{driver}$

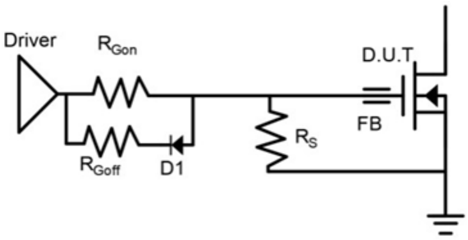
Gate Ferrite Bead (FB)	Gate Resistance (R_G)	RC Snubber (RC_{SN})
MPZ1608S471ATA00	33 Ω	69 pF + 15 Ω

Notes:

d. RC_{SN} should be placed as close as possible to the drain pin

e. The layout and wiring of the drive circuit should be as short as possible

(2) Mostly used in flyback, forward and push-pull converters

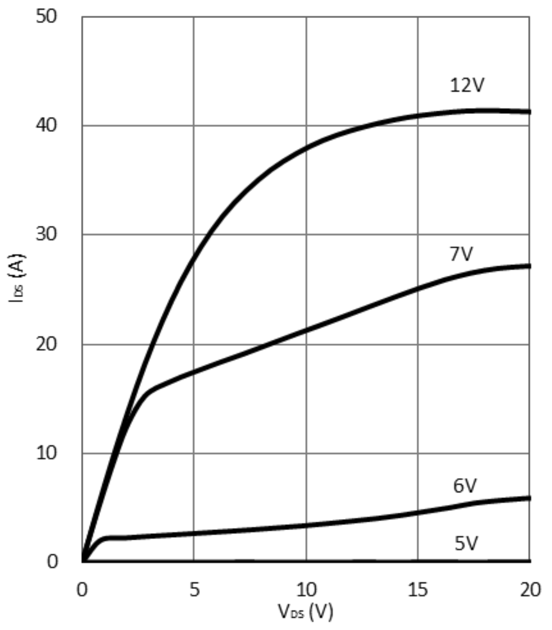


Recommended Single Ended Drive Circuit

Recommended gate drive: (0 V, 12 V) with R_{Gon} = 300 - 500 Ω, R_{Goff} =10 Ω

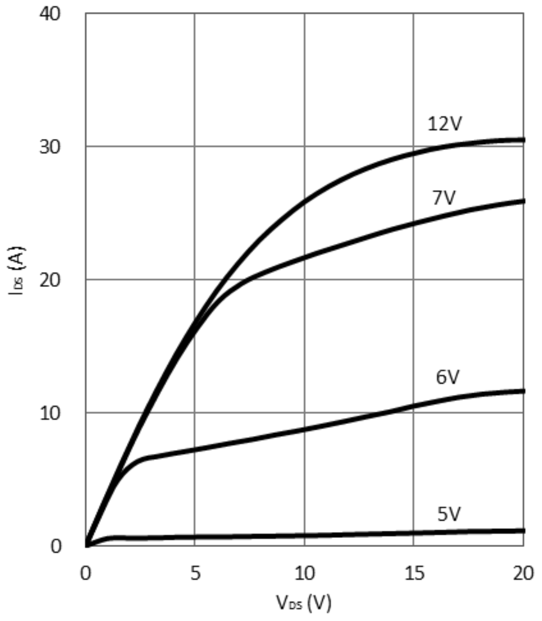
Typical Characteristics, at T_C=25 ℃, unless otherwise specified

Figure 1. Typical Output Characteristics T_J=25℃



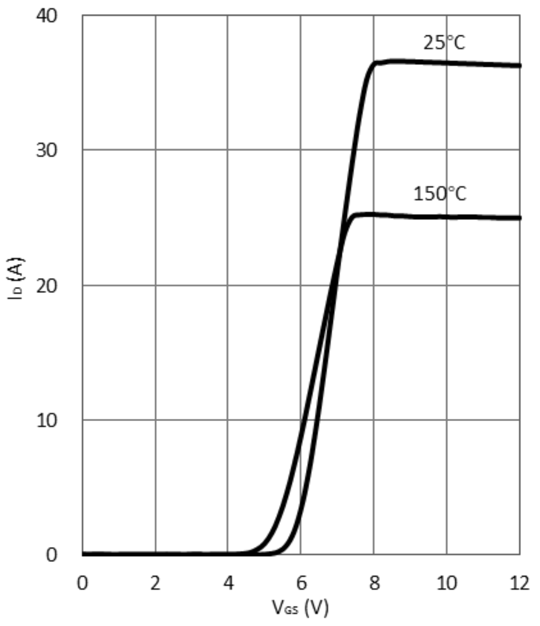
Parameter: V_{GS}

Figure 2. Typical Output Characteristics T_J=150℃



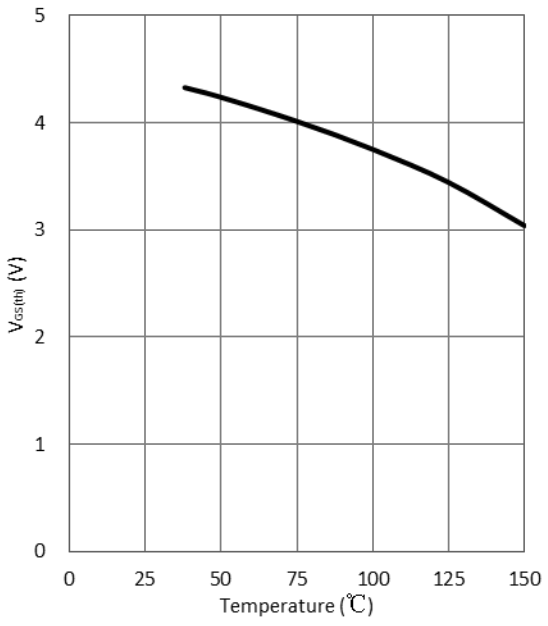
Parameter: V_{GS}

Figure 3. Typical Transfer Characteristics



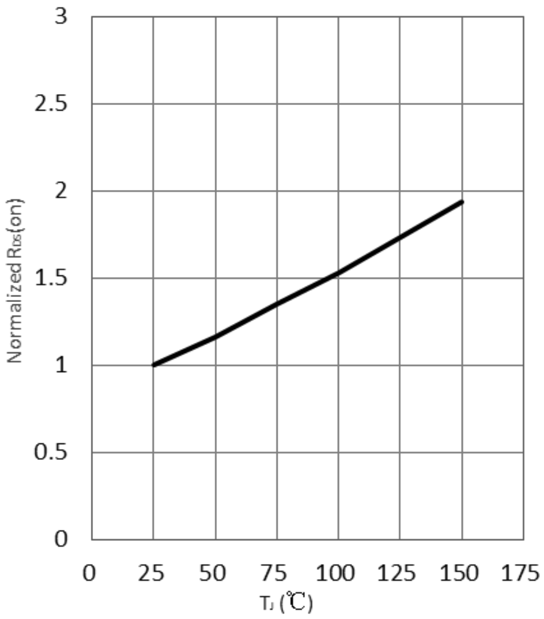
V_{DS}=10V, Parameter: T_J

Figure 4. $V_{GS(th)}$ Vs Temperature Characteristics



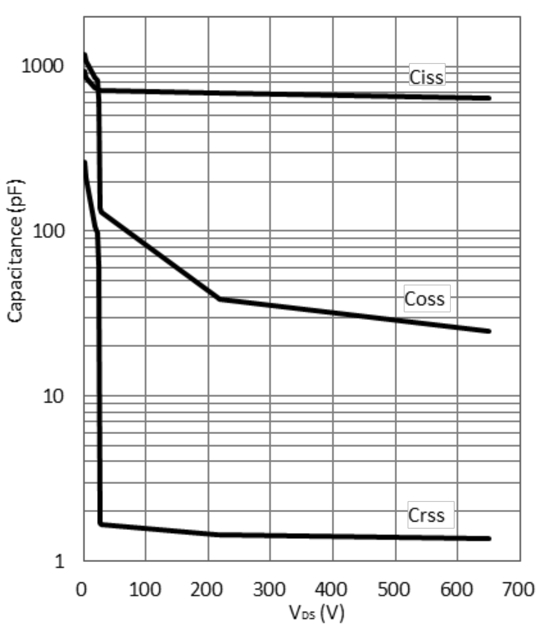
I_D=500uA

Figure 5. Normalized On-resistance



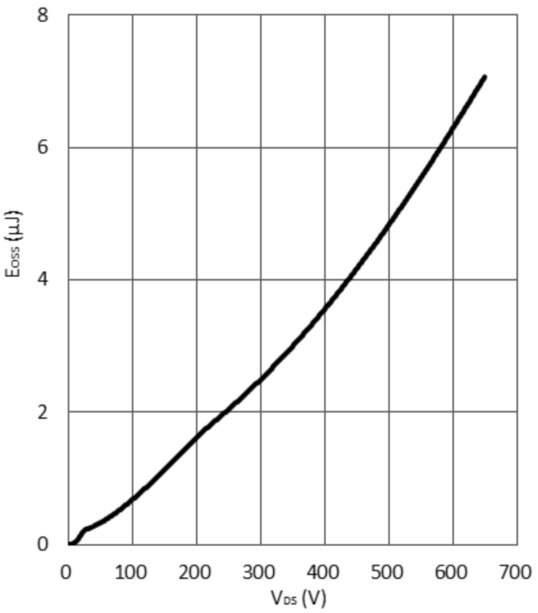
I_D=4A, V_{GS}=12V

Figure 6. Typical Capacitance



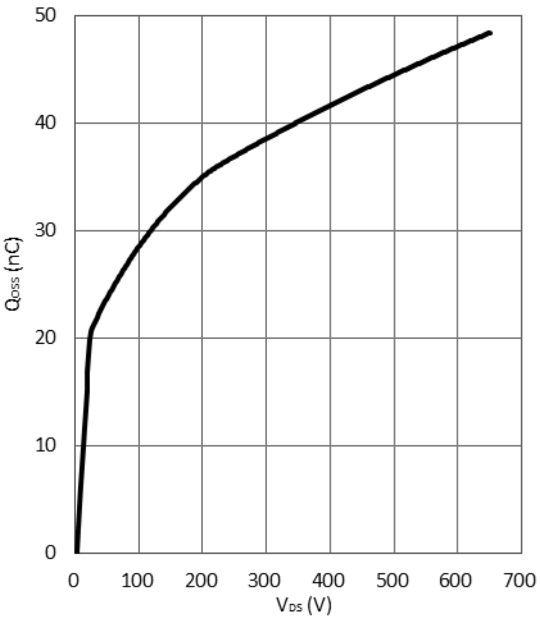
V_{GS}=0V, f=1MHz

Figure 7. Typical Coss Stored Energy



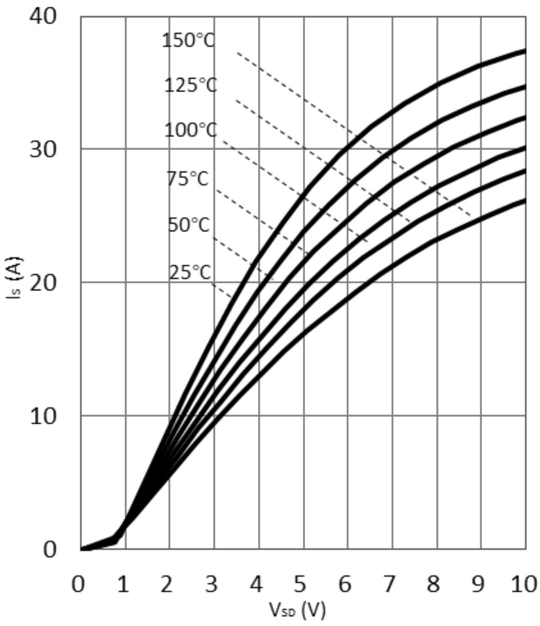
V_{GS}=0V, f=1MHz

Figure 8. Typical Qoss



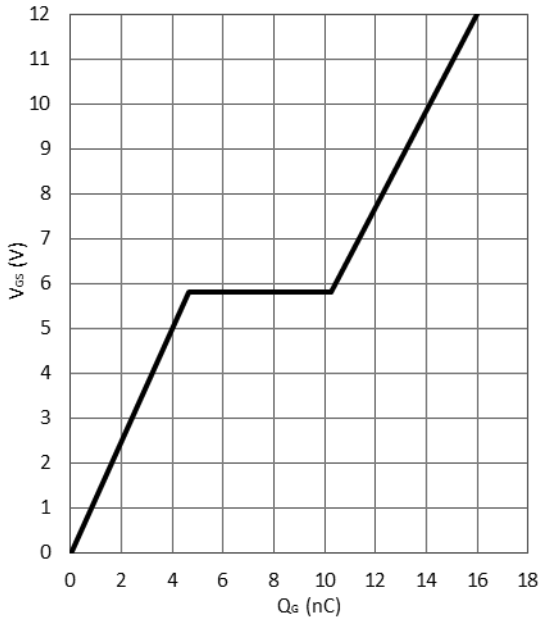
V_{GS}=0V, f=1MHz

Figure 9. Forward Characteristic of Rev. Diode



Is=f(V_{SD}), Parameter T_J

Figure 10. Typical Gate Charge



I_{DS}=6A, V_{DS}=400V

Figure 11. Power Dissipation

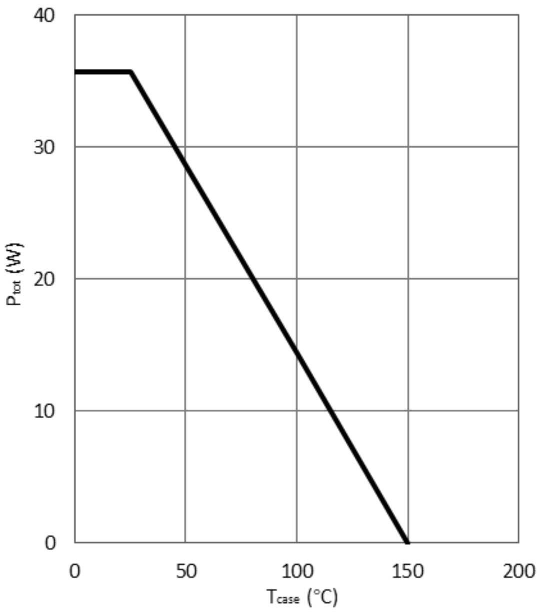


Figure 12. Current Derating

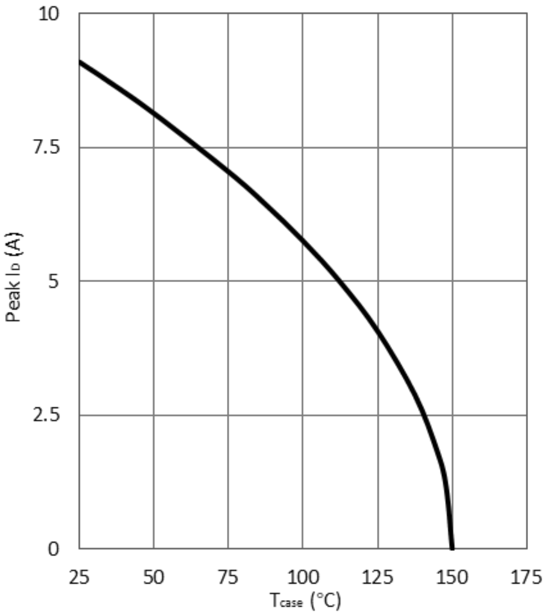


Figure 13. Transient Thermal Resistance

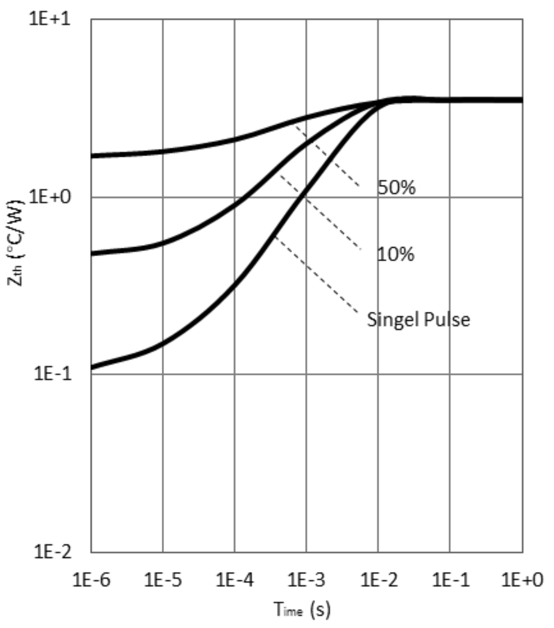
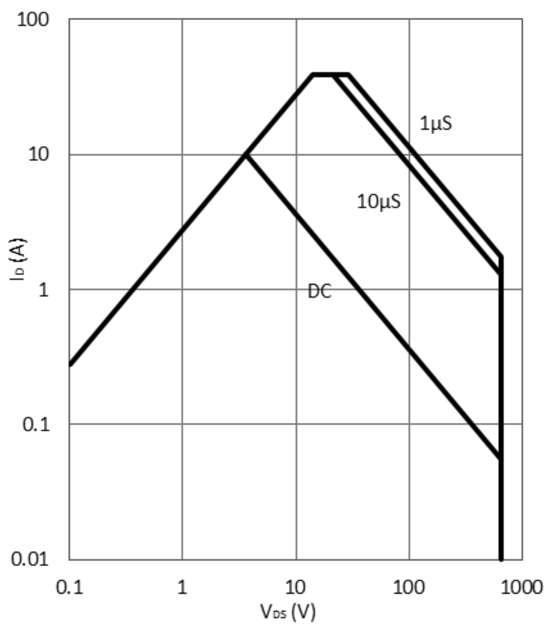
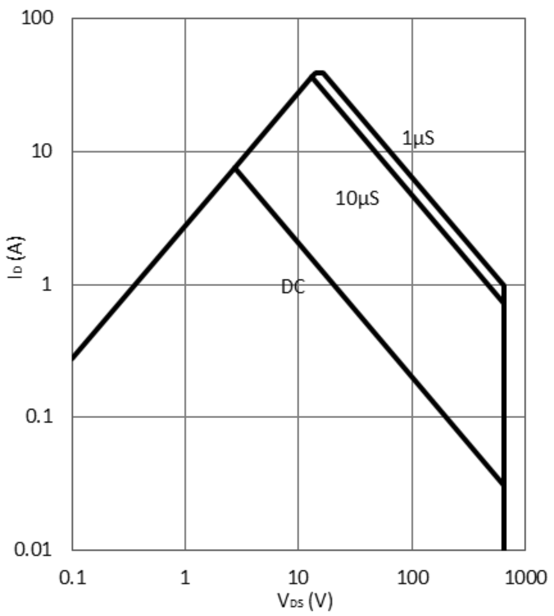


Figure 14. Safe Operating Area T_C=25℃



calculated based on thermal limit

Figure 15. Safe Operating Area T_C=80℃



calculated based on thermal limit

Test Circuits and Waveforms

Figure 15. Switching Time Test Circuit

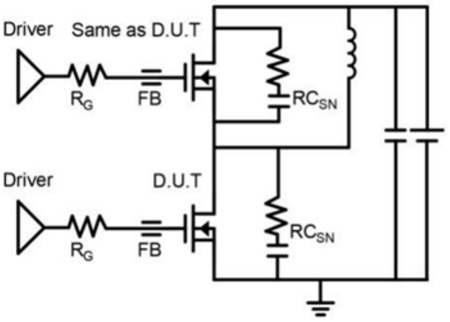


Figure 16. Switching Time Waveform

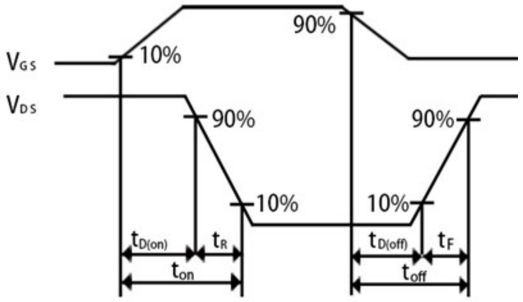


Figure 17. Dynamic $R_{DS(on)}$ Test Circuit

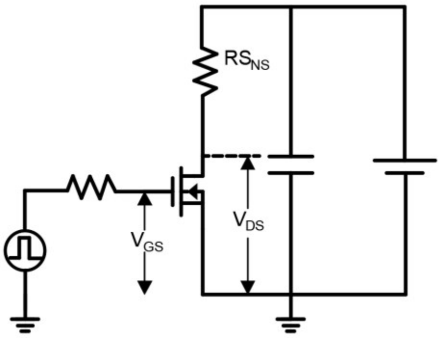


Figure 18. Dynamic $R_{DS(on)}$ Waveform

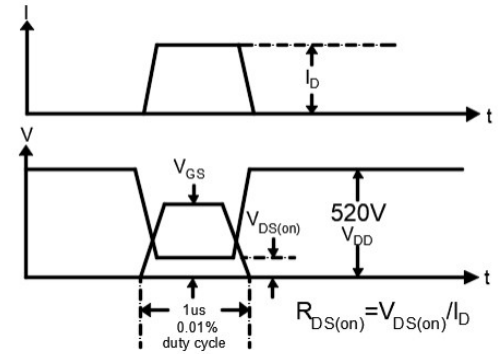


Figure 19. Diode Characteristic Test Circuits

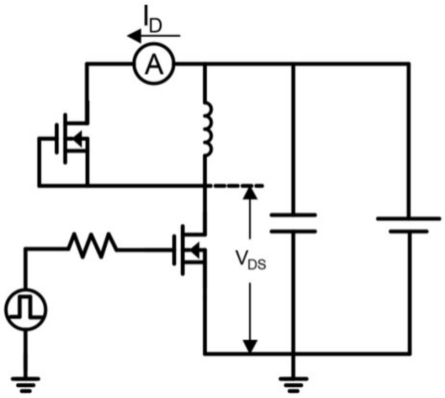
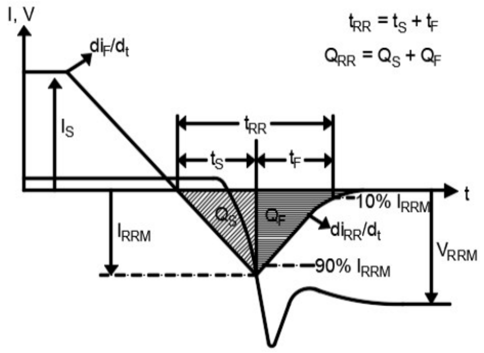


Figure 20. Diode Recovery Waveform



Design Considerations

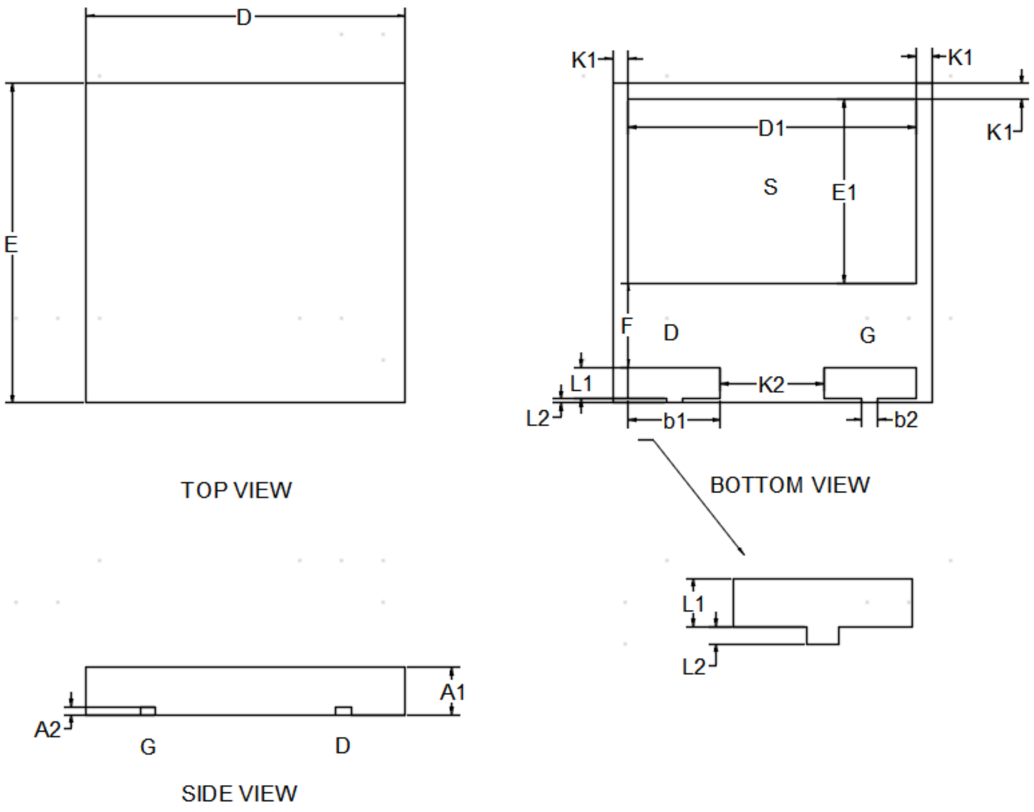
Fast switching GaN device can reduce power conversion losses, and thus enable high frequency operations. Certain PCB design rules and instructions, however, need to be followed to take full advantages of fast switching GaN devices.

Before evaluating Runxin Micro's GaN devices, please refer to the table below which provides some practical rules that should be followed during the evaluation.

When Evaluating Runxin Micro's GaN Devices:

DO	DO NOT
Make sure the traces are as short as possible for both drive and power loops to minimize parasitic inductance	Using Runxin Micro's devices in GDS board layouts
Use the test tool with the shortest inductive loop, and make sure test points should be placed close enough	Use differential mode probe or probe ground clip with long wires
Minimize the lead length of DFN 8*8mm packages when installing them to PCB	Use long traces in drive circuit, or long lead length of the devices

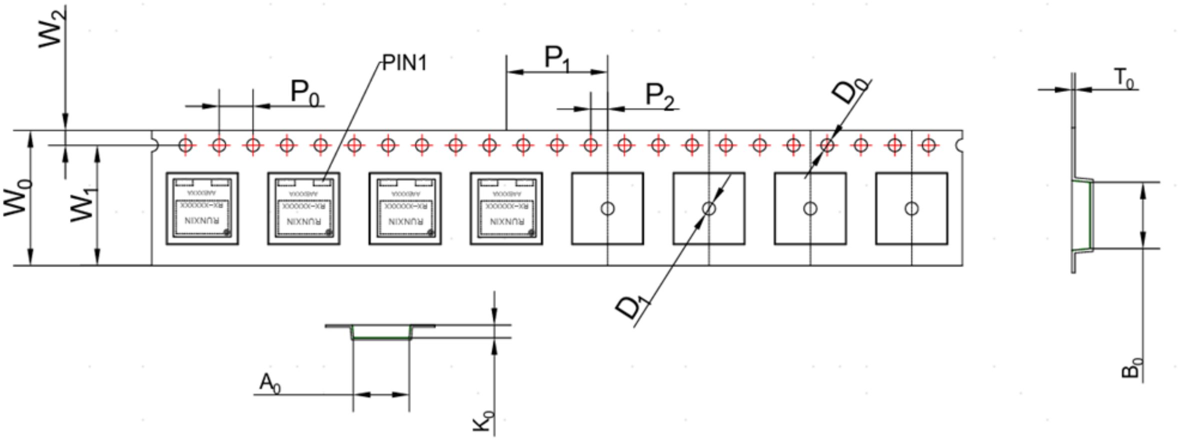
Package Outline

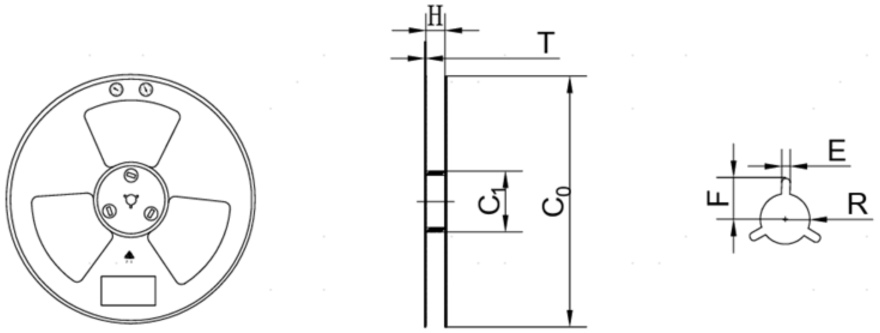


SYMBOL	Millimeter		
	Min	**Nom**	**Max**
A1	0.80	0.90	1.15
A2	0.19	0.203	0.22
b1	2.20	2.30	2.40
b2		0.80REF	
D	7.90	8.00	8.10
E	7.90	8.00	8.10
D1	6.90	7.20	7.50
E1	4.40	4.60	4.80
L1	0.70	0.80	0.90
L2		0.12REF	
K1	0.30	0.40	0.50
K2	2.50	2.60	2.70
F	2.05	2.15	2.35

Tape and Reel Information

Dimensions are shown in millimeters





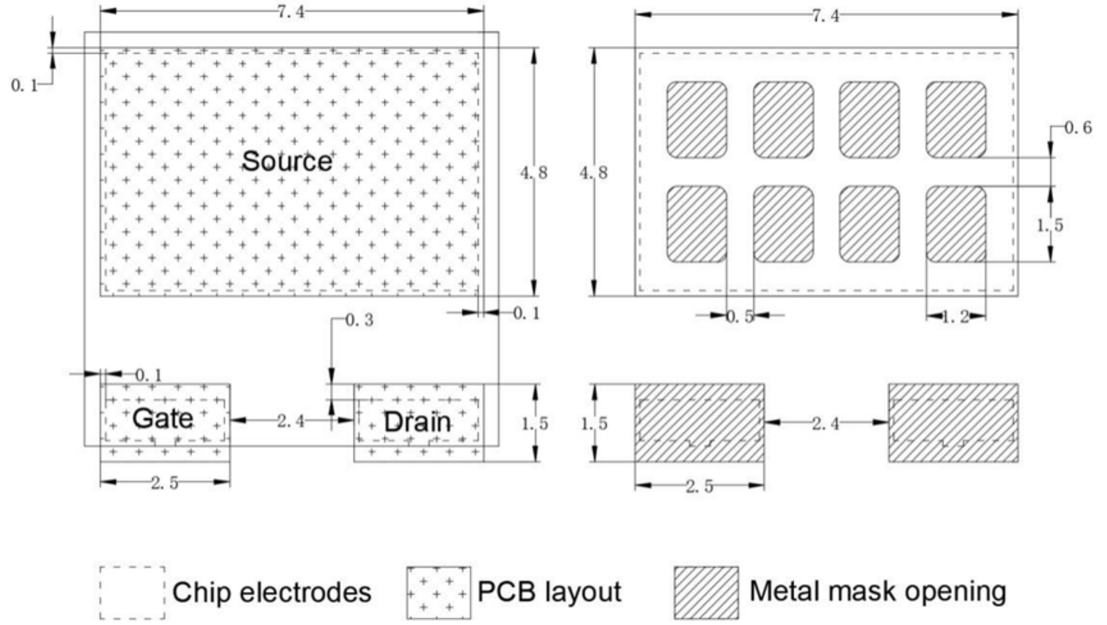
Tape Dimension

W_0	16+0.3-0.1	P_0	4±0.1	A_0	8.3±0.1
W_1	14.25±0.1	P_1	12±0.1	B_0	8.3±0.1
W_2	1.75±0.1	P_2	2±0.1	D_1	1.5±0.25
K_0	1.3±0.1	D_0	1.5±0.1	T_0	0.3±0.05

Reel Dimension

H	17±0.1	F	10.5±0.1
T	2±0.2	E	2.8±0.1
C_0	330±3	R	6.5±0.1
C_1	100±1		

Recommended PCB Layout & Metal mask opening **Dimensions are shown in millimeters**



Revision History

Vesion	Date	Change(s)
1.0	2021/06/24	Release formal datasheet
1.1	2024/05/14	Revise Q_G, Q_{RR},I_D,P_D,$R_{\Theta JC}$, $\triangle V_{GS(th)}/T_J$, Q_{oss}, V_{SD}, Figure 4/11/13/14/15

Disclaimer

Unless otherwise specified in the datasheet, the product is designed and qualified as a standard commercial product and is not intended for use in applications that require extraordinary levels of quality and reliability, such as automotive, aviation/aerospace and life-support devices or systems.

Any and all semiconductor products have certain probability to fail or malfunction, which may result in personal injury, death or property damage. Customer are solely responsible for providing adequate safe measures when design their systems.