

650V GaN Power Transistor (FET)

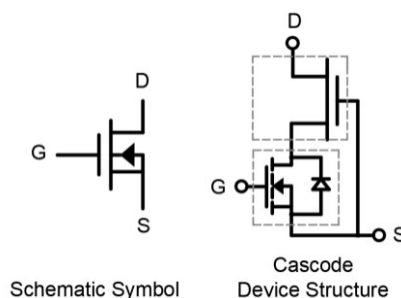
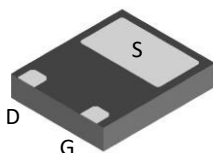
Features

- Easy to use, compatible with standard gate drivers
- Excellent $Q_G \times R_{DS(on)}$ 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 |
| $R_{DS(on), typ}$ | 480 | mΩ |
| Q_G, typ | 5.5 | nC |
| $Q_{RR, typ}$ | 21 | nC |

Applications

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



Packaging

| Part Number | Package | Packaging | Base QTY |
|--------------|-----------|---------------|----------|
| RX65T480MS2A | DFN 5 x 6 | Tape and Reel | 5000 |

Maximum ratings, at $T_C=25\text{ }^{\circ}\text{C}$, unless otherwise specified

| Symbol | Parameter | | Limit Value | Unit |
|-------------|--|----------|-------------|------|
| I_D | Continuous drain current @ $T_C=25^{\circ}\text{C}$ | | 4.1 | A |
| | Continuous drain current @ $T_C=100^{\circ}\text{C}$ | | 2.6 | A |
| I_{DM} | Pulsed drain current @ $T_C=25^{\circ}\text{C}$ (pulse width: 100us) | | 12.5 | A |
| | Pulsed drain current @ $T_C=150^{\circ}\text{C}$ (pulse width: 100us) | | 9.3 | A |
| V_{DSS} | Drain to source voltage ($T_J = -55^{\circ}\text{C}$ to 150°C) | | 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 @ $T_C=25^{\circ}\text{C}$ | | 16 | W |
| T_C | Operating temperature | Case | -55 to 150 | °C |
| T_J | | Junction | -55 to 150 | °C |
| T_S | Storage temperature | | -55 to 150 | °C |
| T_{CSOLD} | Soldering peak temperature | | 260 | °C |

Thermal Resistance

| Symbol | Parameter | Typical | Unit |
|-----------------|----------------------------------|---------|------|
| $R_{\theta JC}$ | Junction-to-case | 8.0 | °C/W |
| $R_{\theta JA}$ | Junction-to-ambient ^b | 50 | °C/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 6cm² copper area and 70μm thickness)

Electrical Parameters, at $T_J=25^\circ\text{C}$, unless otherwise specified

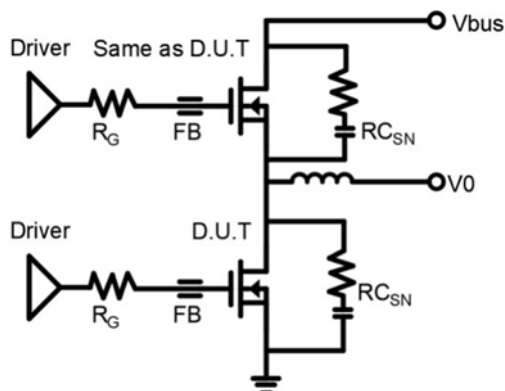
| Symbol | Min | Typ | Max | Unit | Test Conditions |
|----------------------------------|-----|------|------|------|--|
| Forward Characteristics | | | | | |
| V _{DSS-MAX} | 650 | - | - | V | V _{GS} =0V |
| BV _{DSS} | - | 1000 | - | | V _{GS} =0V, I _{DSS} =250μA |
| V _{GS(th)} | 1.1 | 1.8 | 2.5 | V | V _{DS} =V _{GS} , I _D =500μA |
| R _{DS(on)} ^c | - | 480 | 600 | mΩ | V _{GS} =8V, I _D =4A, T _J =25℃ |
| | - | 960 | - | | V _{GS} =8V, I _D =4A, T _J =150℃ |
| I _{DSS} | - | 8 | 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} | - | 308 | - | pF | V _{GS} =0V, V _{DS} =400V, f=1MHz |
| C _{OSS} | - | 12.9 | - | pF | |
| C _{RSS} | - | 0.6 | - | pF | |
| C _{O(er)} | - | 18.6 | - | pF | V _{GS} =0V, V _{DS} =0 - 400V |
| C _{O(tr)} | - | 51.8 | - | pF | |
| Q _{oss} | - | 21 | - | nC | |
| Q _G | - | 5.5 | - | nC | V _{DS} =400V, V _{GS} =0 - 8V, I _D =3A |
| Q _{GS} | - | 1.1 | - | | |
| Q _{GD} | - | 2.5 | - | | |
| t _{D(on)} | - | 10 | - | ns | V _{DS} =400V, V _{GS} =0 - 12V, I _D =3.6A, R _G =47Ω |
| t _R | - | 6 | - | | |
| t _{D(off)} | - | 40 | - | | |
| t _F | - | 10 | - | | |
| Reverse Characteristics | | | | | |
| V _{SD} | - | 1.4 | - | V | V _{GS} =0V, I _S =1.6A, T _J =25℃ |
| | - | 2 | - | | V _{GS} =0V, I _S =3A, T _J =25℃ |
| | - | 3.1 | - | | V _{GS} =0V, I _S =3A, T _J =150℃ |
| t _{RR} | - | 15 | - | ns | I _S =3A, V _{GS} =0V, d _i /d _t =1000A/us, V _{DD} =400V |
| Q _{RR} | - | 21 | - | 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

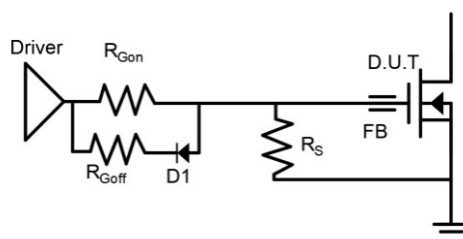
Recommended gate drive: (0 V, 8 V) with $R_{G(tot)} = 40 \Omega$, where $R_{G(tot)} = R_G + R_{driver}$

| Gate Ferrite Bead (FB) | Gate Resistance (R_G) | RC Snubber (R_{CSN}) |
|------------------------|---------------------------|--------------------------|
| MPZ1608S471ATA00 | 33 Ω | 69 pF + 15 Ω |

Notes:

- d. R_{CSN} 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 $R_{Gon} = 300 - 500 \Omega$, $R_{Goff} = 10 \Omega$

| Gate Ferrite Bead (FB) | Gate Source Resistance (R_S) | Gate Diode (D1) |
|----------------------------|----------------------------------|-----------------|
| 300 - 600 Ω @100MHz | 10 k Ω | 1N4148 |

Typical Characteristics, at $T_c=25^\circ\text{C}$, unless otherwise specified

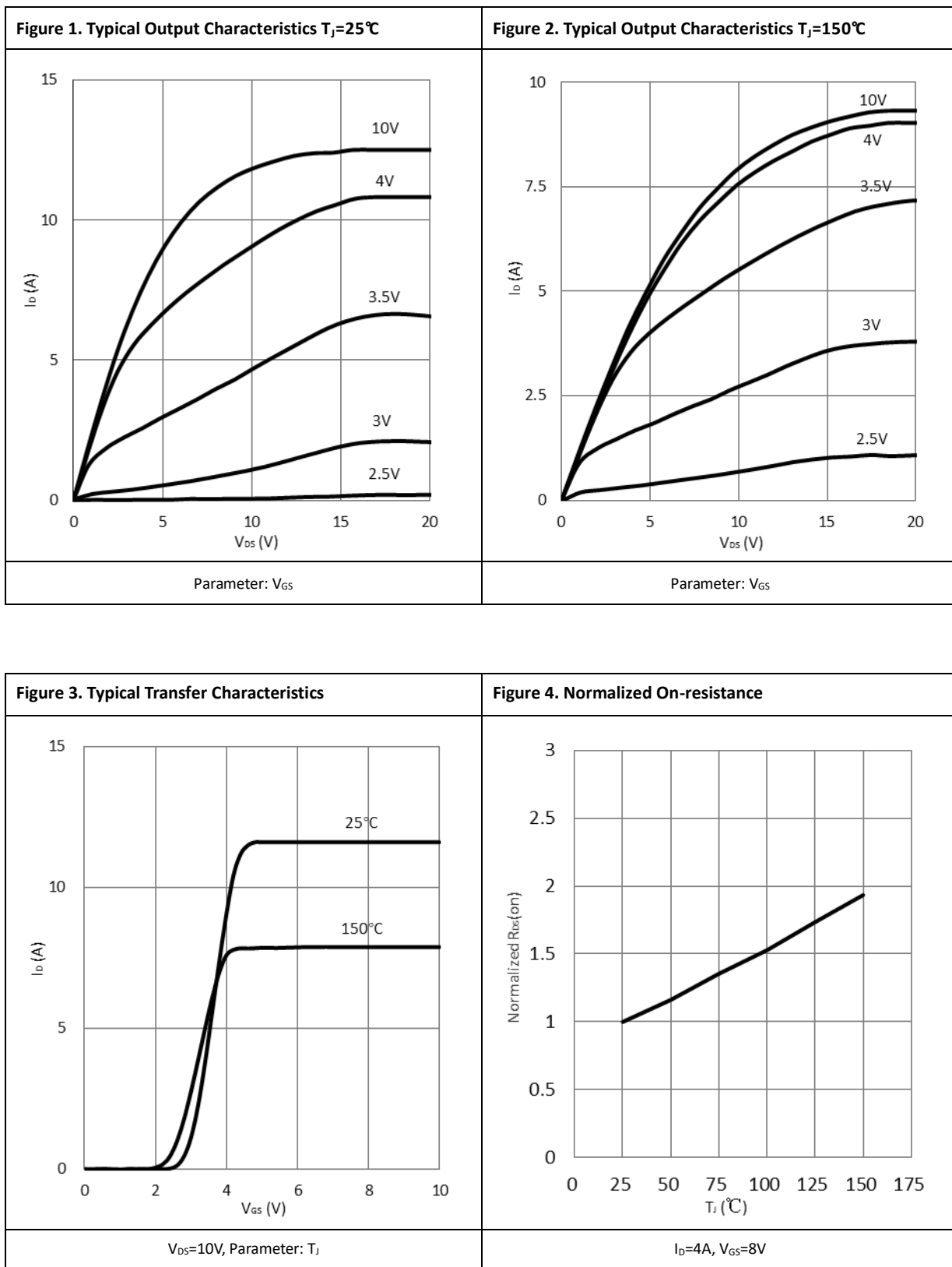
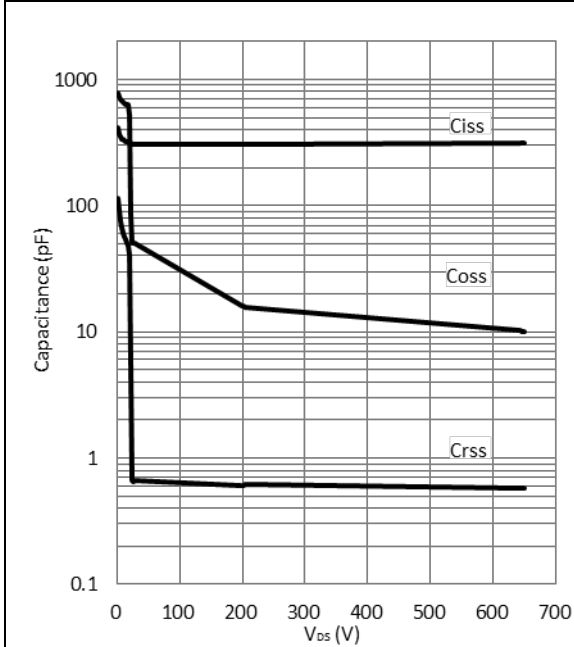
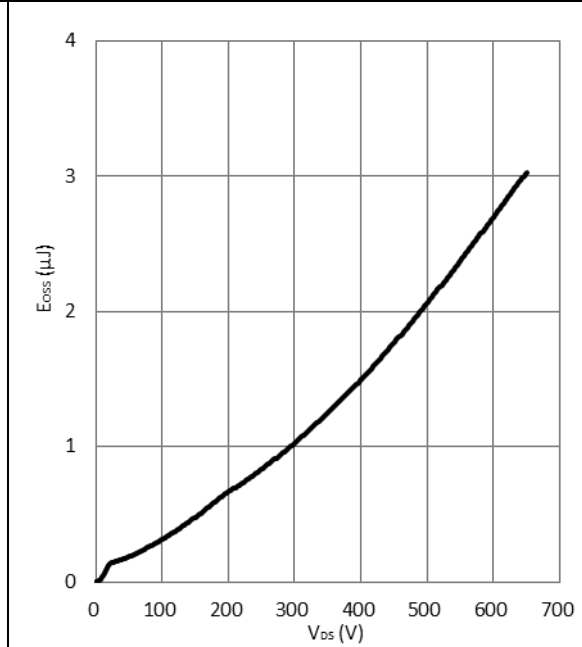


Figure 5. Typical Capacitance



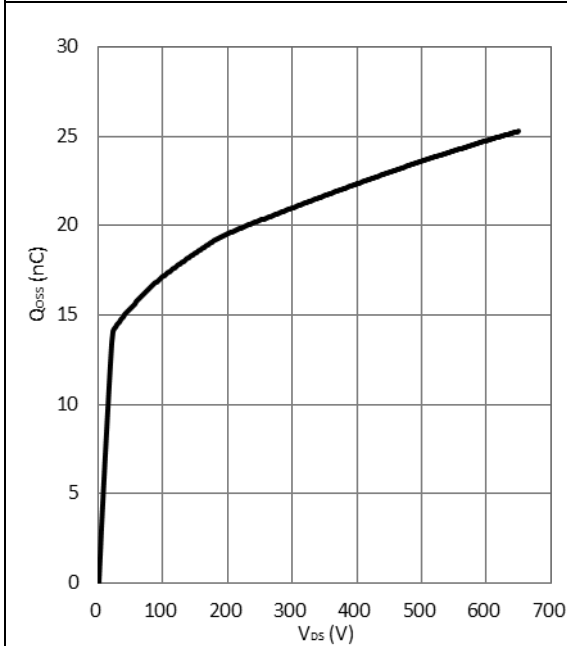
$V_{GS}=0V$, $f=1MHz$

Figure 6. Typical Coss Stored Energy



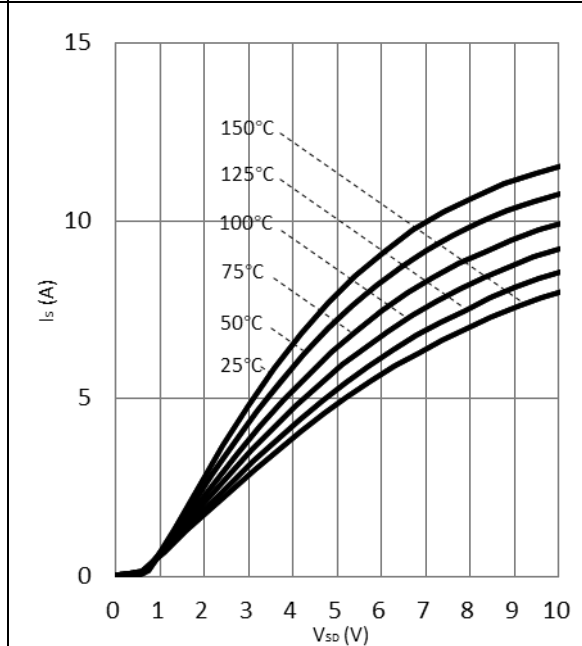
$V_{GS}=0V$, $f=1MHz$

Figure 7. Typical Qoss



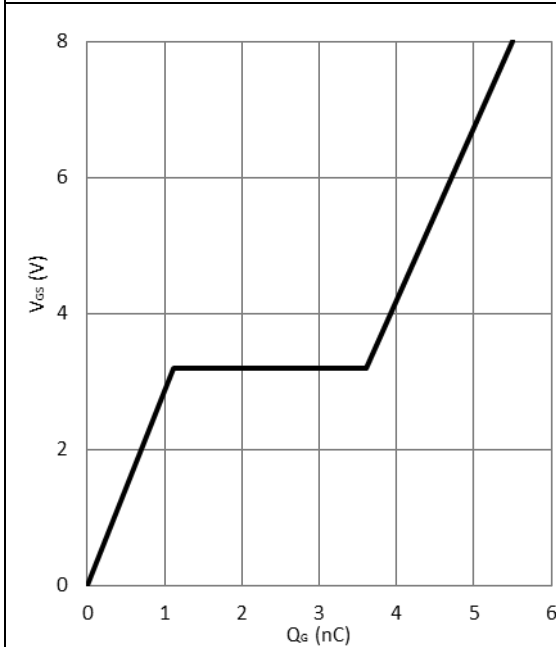
$V_{GS}=0V$, $f=1MHz$

Figure 8. Forward Characteristic of Rev. Diode



$I_S=f(V_{SD})$, Parameter T_J

Figure 9. Typical Gate Charge



I_{DS}=3A, V_{DS}=400V

Figure 10. Power Dissipation

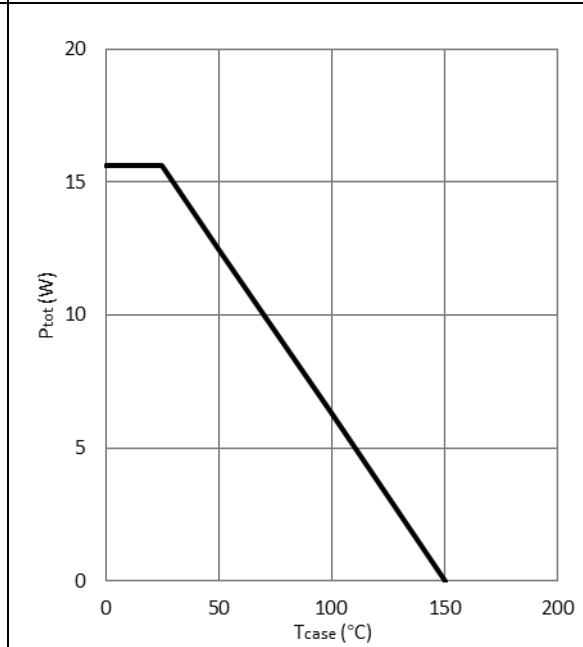


Figure 11. Current Derating

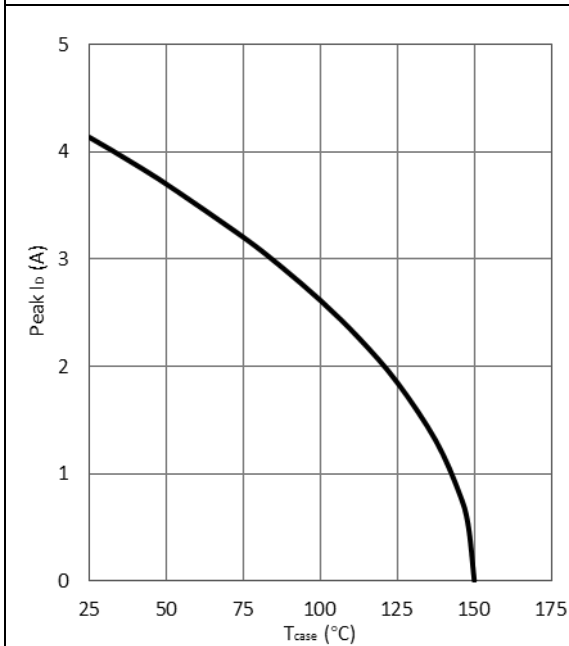
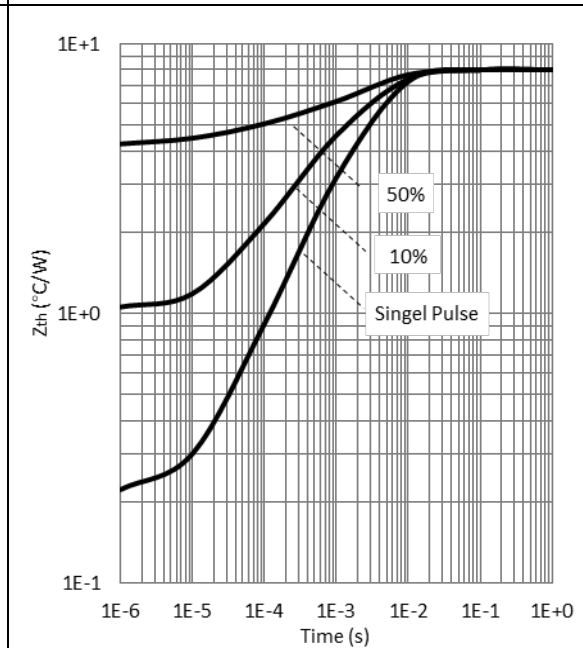
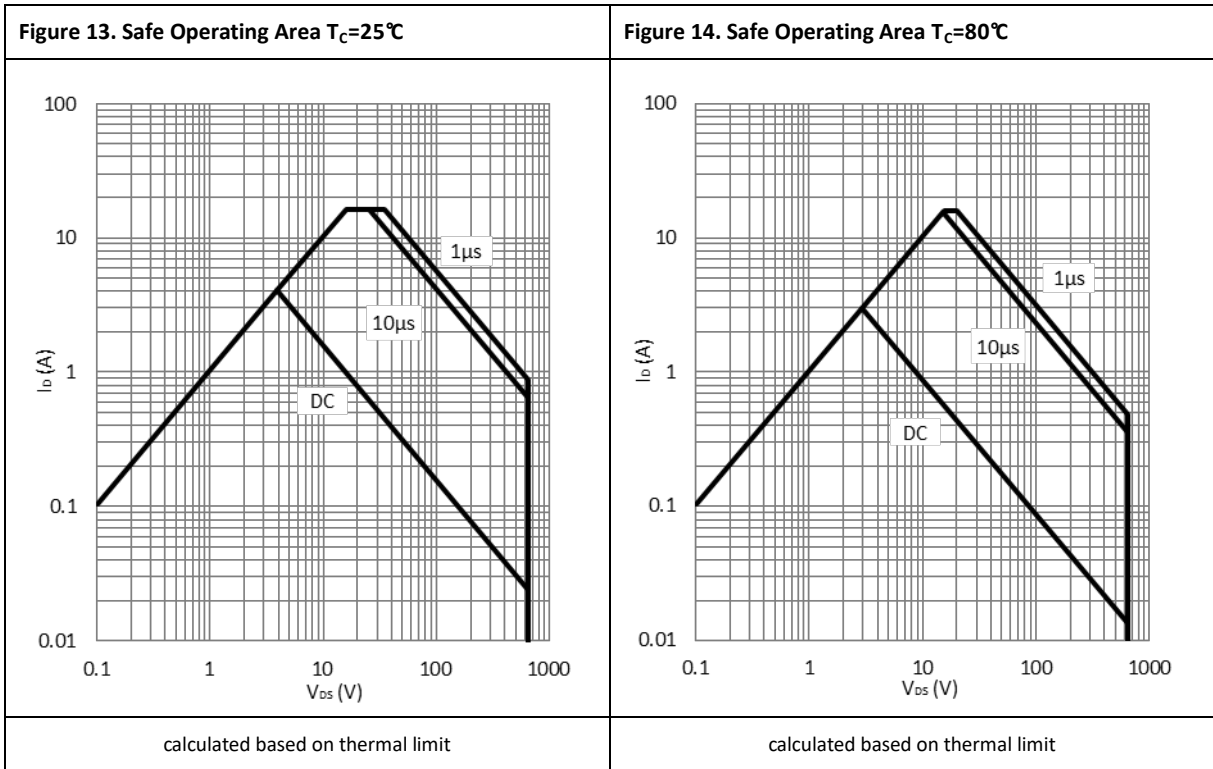


Figure 12. Transient Thermal Resistance





Test Circuits and Waveforms

Figure 15. Switching Time Test Circuit

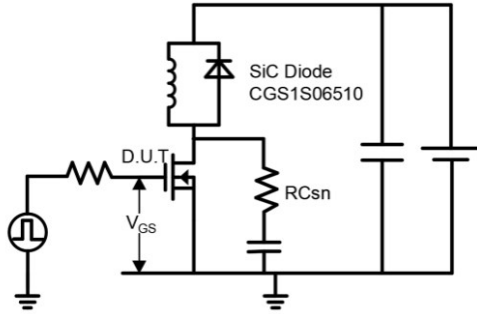


Figure 16. Switching Time Waveform

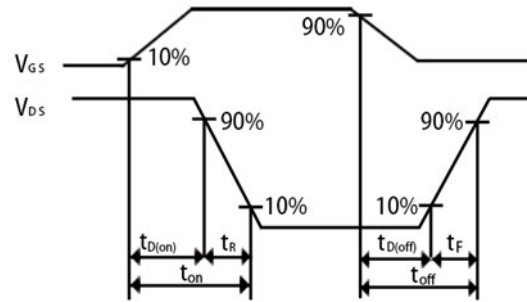


Figure 17. Dynamic R_{DS(on)} Test Circuit

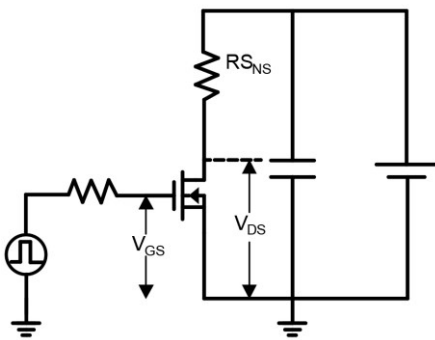


Figure 18. Dynamic R_{DS(on)} Waveform

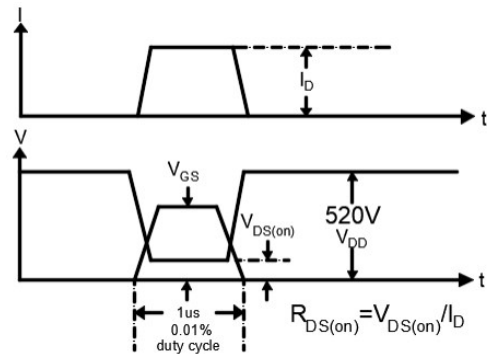


Figure 19. Diode Characteristic Test Circuits

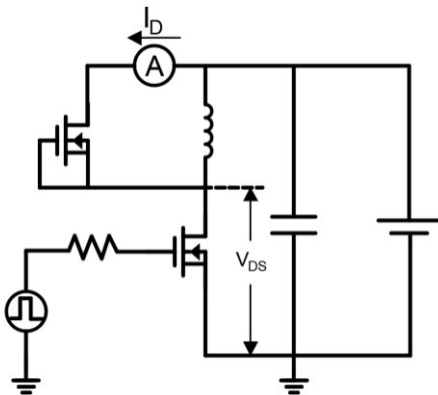
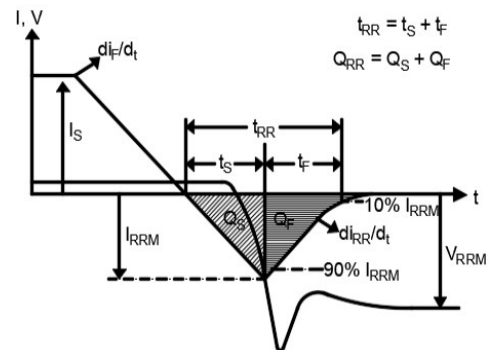


Figure 20. Diode Recovery Waveform



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

TOP VIEW

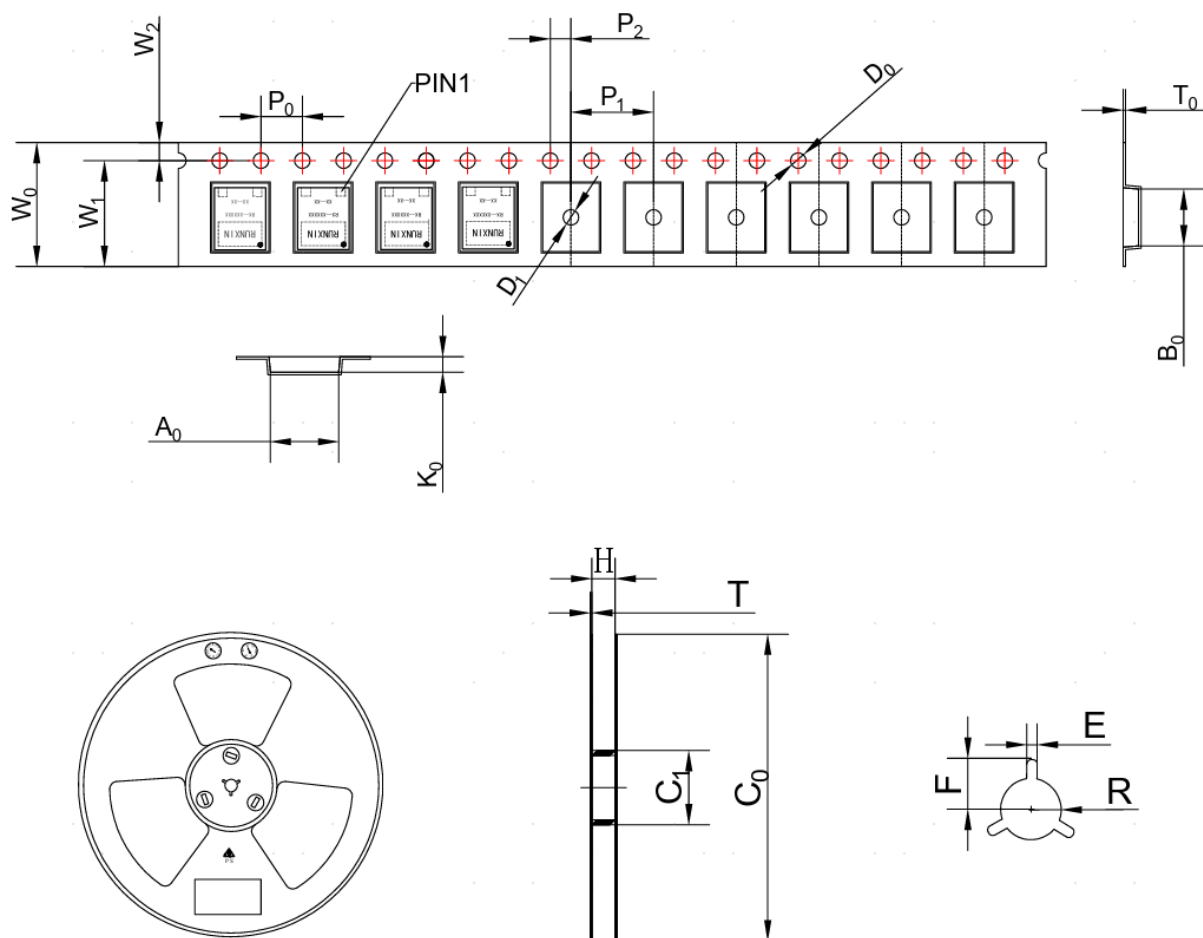
SIDE VIEW

BOTTOM VIEW

| Symbol | Millimeter | | |
|--------|------------|-------|------|
| | Min | Nom | Max |
| A1 | 0.80 | 0.90 | 1.15 |
| A2 | 0.19 | 0.203 | 0.22 |
| B | 0.82 | 0.87 | 0.92 |
| D | 4.90 | 5.00 | 5.10 |
| E | 5.90 | 6.00 | 6.10 |
| D1 | 4.09 | 4.23 | 4.39 |
| E1 | 2.15 | 2.30 | 2.45 |
| L | 0.71 | 0.81 | 0.91 |
| K1 | 0.28 | 0.38 | 0.48 |
| K2 | 2.40 | 2.50 | 2.60 |
| K3 | 2.40 | 2.50 | 2.60 |
| K4 | 0.29 | 0.39 | 0.49 |

Tape and Reel Information

Dimensions are shown in millimeters

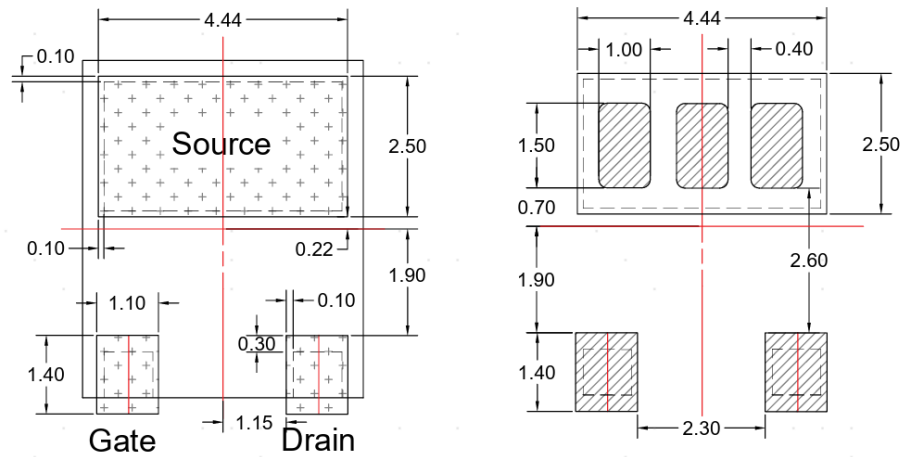


| Tape Dimension | | | | | |
|----------------|--------------------|-------|---------------|-------|-----------------|
| W_0 | $12 \pm 0.3 - 0.1$ | P_0 | 4 ± 0.1 | A_0 | 5.4 ± 0.1 |
| W_1 | 10.25 ± 0.1 | P_1 | 8 ± 0.1 | B_0 | 6.4 ± 0.1 |
| W_2 | 1.75 ± 0.1 | P_2 | 2 ± 0.1 | D_1 | 1.5 ± 0.25 |
| K_0 | 1.4 ± 0.1 | D_0 | 1.5 ± 0.1 | T_0 | 0.30 ± 0.05 |

| Reel Dimension | | | |
|----------------|--------------|---|----------------|
| H | 14 ± 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 & Stencil apertures

Dimensions are shown in millimeters



Chip electrodes



PCB layout



Stencil aperture

Revision History

| Version | Date | Change(s) |
|---------|------------|---|
| 1.0 | 2023/05/22 | Release formal datasheet |
| 1.1 | 2024/03/13 | Revise P_D , output, transfer, Capacitance, I_s , Q_g , Q_{rr} , Q_{oss} , Figure 1, 2, 3, 8, 9, 10 |

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.