

# 650V GaN Power Transistor (FET)

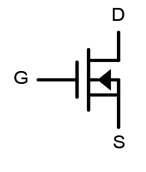
## Features

- 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

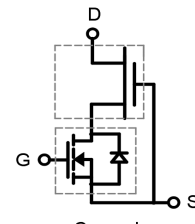
Product Summary		
$V_{DSS}$	650	V
$R_{DS(on), typ}$	80	m $\Omega$
$Q_G, typ$	21	nC
$Q_{RR, typ}$	26	nC

## Applications

- High efficiency power supplies
- Telecom and datacom
- Automotive
- Servo motors



Schematic Symbol



Cascode Device Structure

## Packaging

Part Number	Package	Packaging	Base QTY
RX65T080PS3A	3 Lead TO-220	Tube	50

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

Symbol	Parameter	Limit Value	Unit
$I_D$	Continuous drain current @ $T_c=25^\circ\text{C}$	30	A
	Continuous drain current @ $T_c=100^\circ\text{C}$	19	A
$I_{DM}$	Pulsed drain current @ $T_c=25^\circ\text{C}$ (pulse width: 10us)	125	A
	Pulsed drain current @ $T_c=150^\circ\text{C}$ (pulse width: 10us)	90	A
$V_{DSS}$	Drain to source voltage ( $T_J = -55^\circ\text{C}$ to $150^\circ\text{C}$ )	650	V
$V_{TDSS}$	Transient drain to source voltage <sup>a</sup>	800	V
$V_{GSS}$	Gate to source voltage	$\pm 20$	V
$P_D$	Maximum power dissipation @ $T_c=25^\circ\text{C}$	125	W
$T_C$	Operating temperature	Case	-55 to 150 $^\circ\text{C}$
$T_J$		Junction	-55 to 150 $^\circ\text{C}$
$T_S$	Storage temperature	-55 to 150	$^\circ\text{C}$
$T_{CSOLD}$	Soldering peak temperature	260	$^\circ\text{C}$

**Thermal Resistance**

Symbol	Parameter	Typical	Unit
$R_{\theta JC}$	Junction-to-case	1	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Junction-to-ambient <sup>b</sup>	50	$^{\circ}\text{C}/\text{W}$

## Notes:

- a. Off-state spike duty cycle < 0.01, spike duration < 2 $\mu\text{s}$
- b. Device on one layer epoxy PCB for drain connection (vertical and without air stream cooling, with 6cm<sup>2</sup> copper area and 70 $\mu\text{m}$  thickness)

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

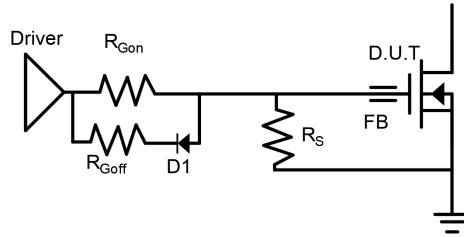
Symbol	Min	Typ	Max	Unit	Test Conditions
<b>Forward Characteristics</b>					
$V_{DSS-MAX}$	650	-	-	V	$V_{GS}=0V$
$BV_{DSS}$		1000			$V_{GS}=0V, I_{DSS}=250\mu A$
$V_{GS(th)}$	3	4	5	V	$V_{DS}=V_{GS}, I_D=500\mu A$
$R_{DS(on)}^c$	-	80	100	m $\Omega$	$V_{GS}=8V, I_D=4A, T_J=25^\circ\text{C}$
	-	160	-		$V_{GS}=8V, I_D=4A, T_J=150^\circ\text{C}$
$I_{DSS}$	-	10	30	$\mu A$	$V_{DS}=700V, V_{GS}=0V, T_J=25^\circ\text{C}$
	-	50	-	$\mu A$	$V_{DS}=700V, V_{GS}=0V, T_J=150^\circ\text{C}$
$I_{GSS}$	-	-	150	nA	$V_{GS}=20V$
	-	-	-150	nA	$V_{GS}=-20V$
$C_{ISS}$	-	650	-	pF	$V_{GS}=0V, V_{DS}=400V, f=1\text{MHz}$
$C_{OSS}$	-	60	-	pF	
$C_{RSS}$	-	1.5	-	pF	
$C_{O(er)}$	-	90	-	pF	$V_{GS}=0V, V_{DS}=0 - 400V$
$C_{O(tr)}$	-	180	-	pF	
$Q_G$	-	21	-	nC	$V_{DS}=400V, V_{GS}=0 - 12V, I_D=5.5A$
$Q_{GS}$	-	6.7	-		
$Q_{GD}$	-	9	-		
$t_{D(on)}$	-	44	-	ns	$V_{DS}=400V, V_{GS}=0 - 12V, I_D=3A, R_G=30\Omega$
$t_R$	-	16	-		
$t_{D(off)}$	-	40	-		
$t_F$	-	12	-		
<b>Reverse Characteristics</b>					
$V_{SD}$	-	1.3	-	V	$V_{GS}=0V, I_S=2A, T_J=25^\circ\text{C}$
	-	1.9	-		$V_{GS}=0V, I_S=5A, T_J=25^\circ\text{C}$
	-	3	-		$V_{GS}=0V, I_S=5A, T_J=150^\circ\text{C}$
$t_{RR}$	-	16	-	ns	$I_S=3A, V_{GS}=0V, d_i/d_t=1000A/\mu s, V_{DD}=400V$
$Q_{RR}$	-	26	-	nC	

Notes:

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

**Circuit Implementation**

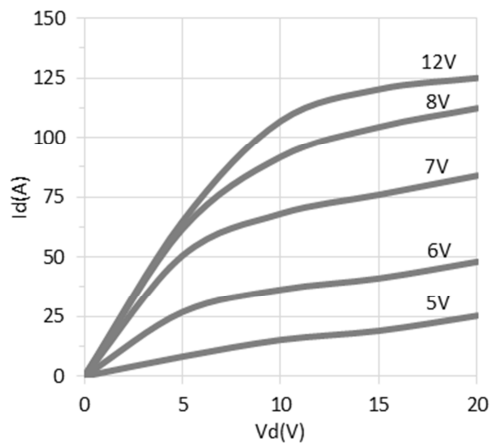
Mostly used in flyback, forward and push-pull converters

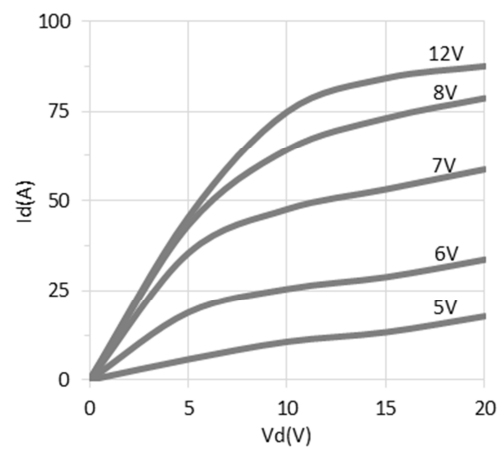


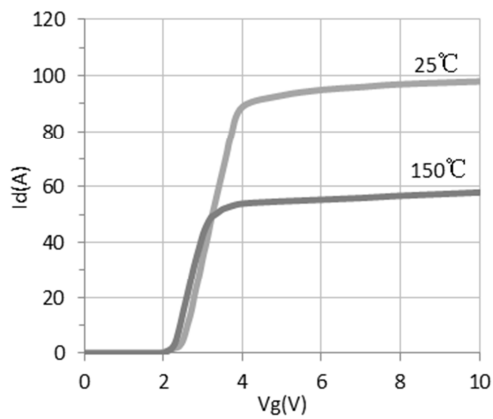
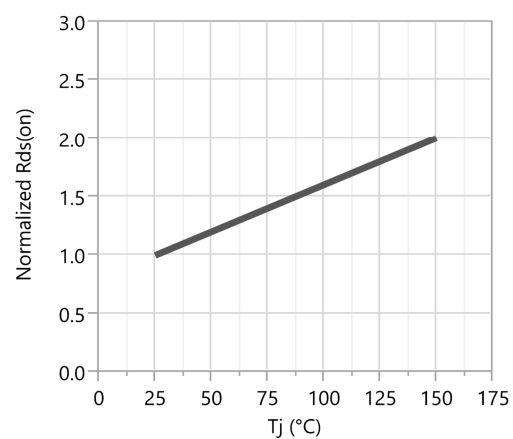
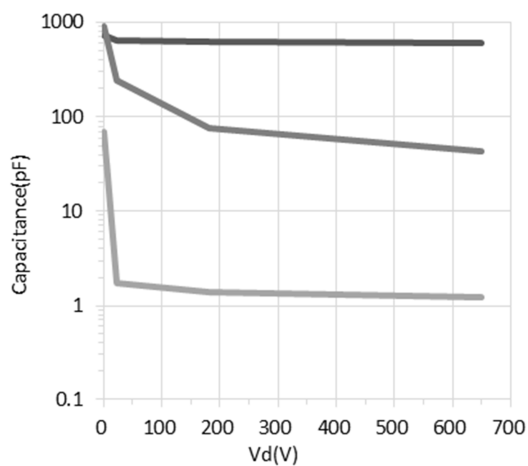
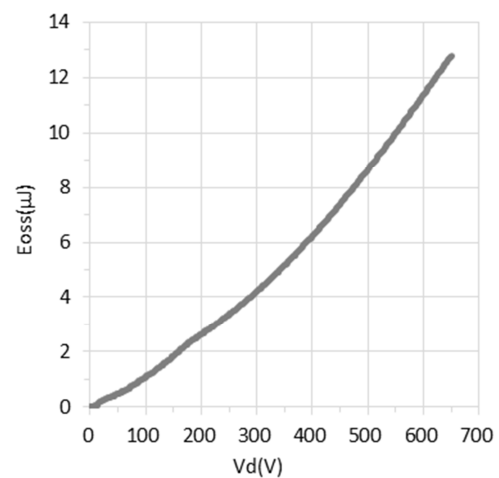
**Recommended Single Ended Drive Circuit**

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

Gate Ferrite Bead (FB)	Gate Resistance ( $R_{Gon}$ )	Gate Resistance ( $R_{Goff}$ )	Gate Source Resistance ( $R_s$ )	Gate Diode (D1)
300 - 600 $\Omega$ @100 MHz	300 - 500 $\Omega$	10 $\Omega$	10 k $\Omega$	1N4148

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

**Figure 1. Typical Output Characteristics  $T_j=25^\circ\text{C}$** 

 Parameter:  $V_{GS}$ 

**Figure 2. Typical Output Characteristics  $T_j=150^\circ\text{C}$** 

 Parameter:  $V_{GS}$ 

**Figure 3. Typical Transfer Characteristics**
 $V_{DS}=10\text{V}$ , Parameter:  $T_j$ 

**Figure 4. Normalized On-resistance**
 $I_D=4\text{A}$ ,  $V_{GS}=8\text{V}$ 

**Figure 5. Typical Capacitance**
 $V_{GS}=0\text{V}$ ,  $f=1\text{MHz}$ 

**Figure 6. Typical  $C_{OSS}$  Stored Energy**

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

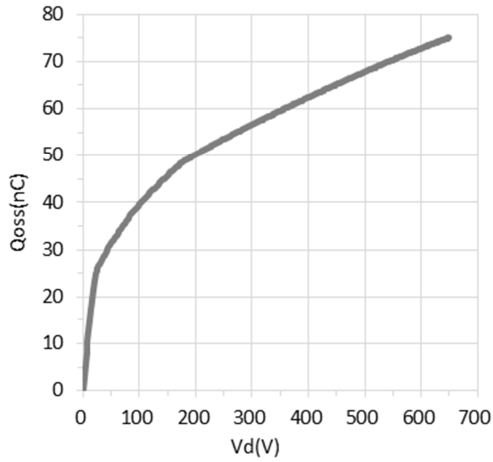


Figure 7. Typical Qoss

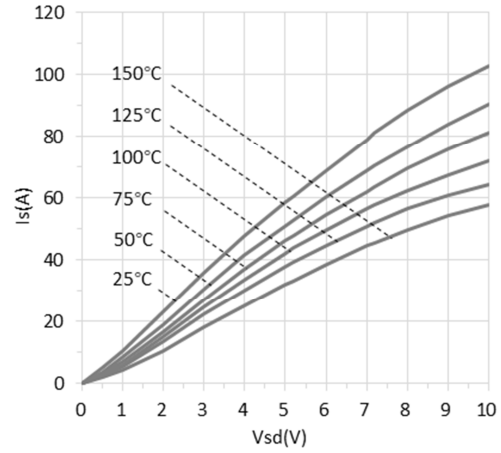


Figure 8. Forward Characteristic of Rev. Diode

$I_s=f(V_s)$ , Parameter  $T_j$

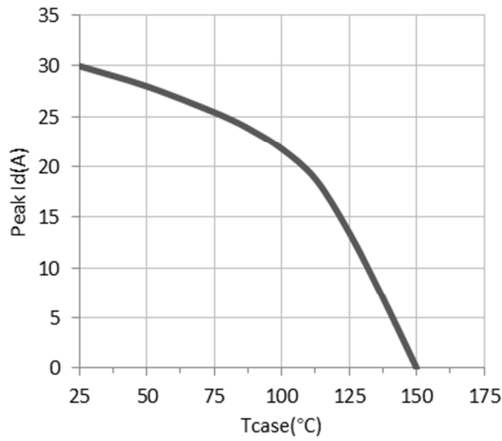


Figure 9. Current Derating

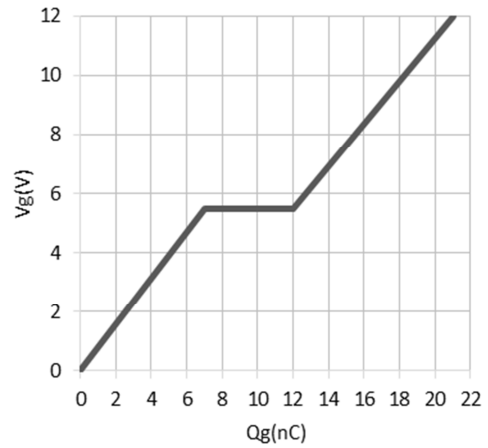


Figure 10. Typical Gate Charge

$I_{DS}=5.5\text{A}$ ,  $V_{DS}=400\text{V}$

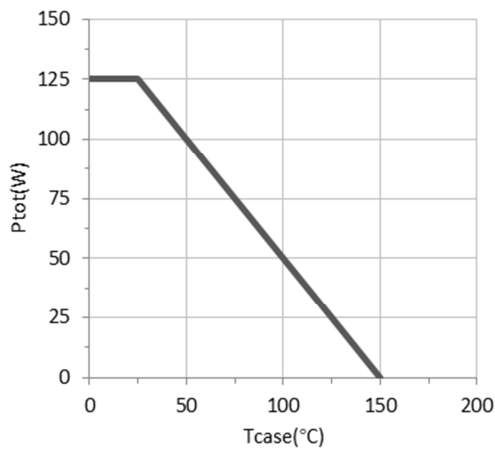


Figure 11. Power Dissipation

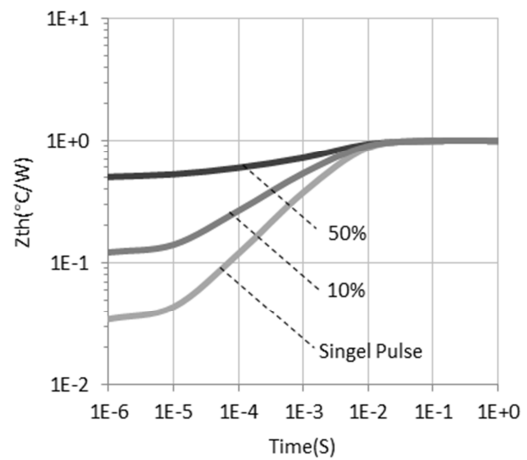
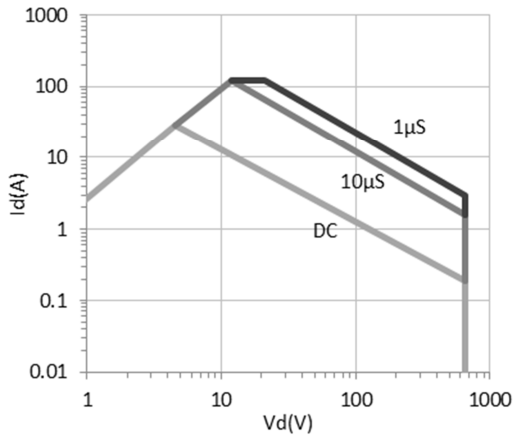
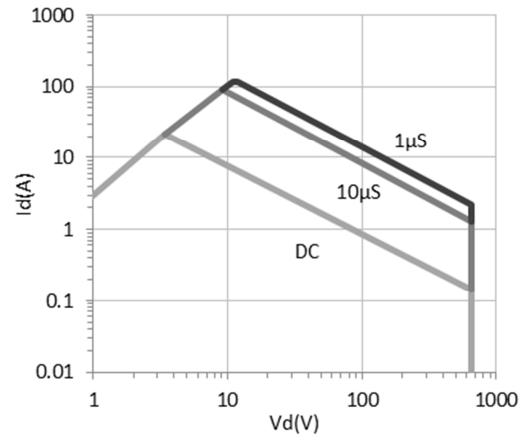


Figure 12. Transient Thermal Resistance

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

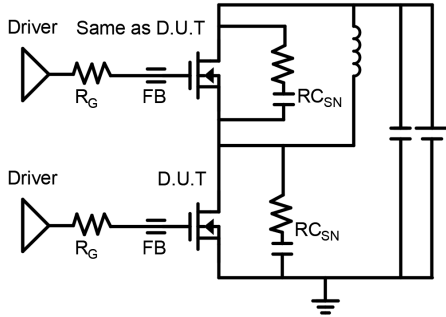


**Figure 13. Safe operating Area  $T_c=25\text{ }^\circ\text{C}$**   
(calculated based on thermal limits)

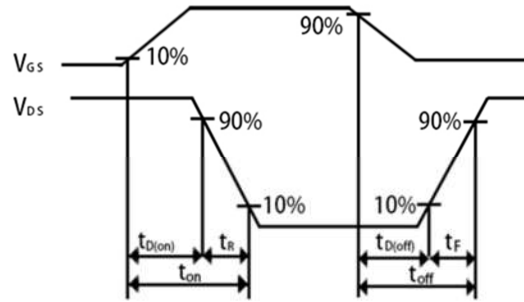


**Figure 14. Safe operating Area  $T_c=80\text{ }^\circ\text{C}$**   
(calculated based on thermal limits)

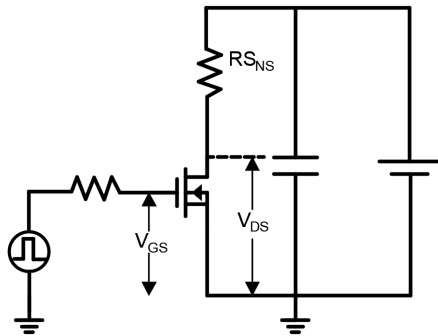
**Test Circuits and Waveforms**



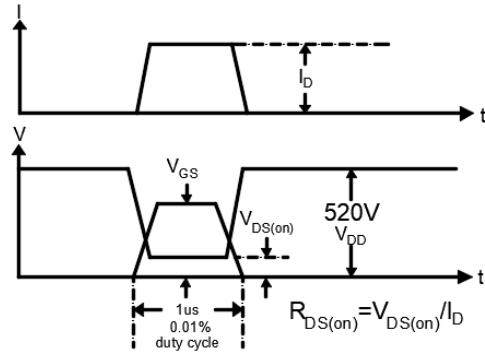
**Figure 15. Switching Time Test Circuit**



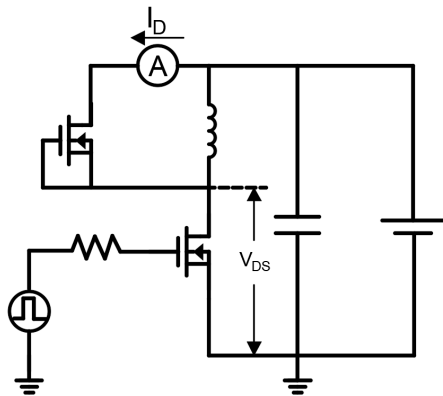
**Figure 16. Switching Time Waveform**



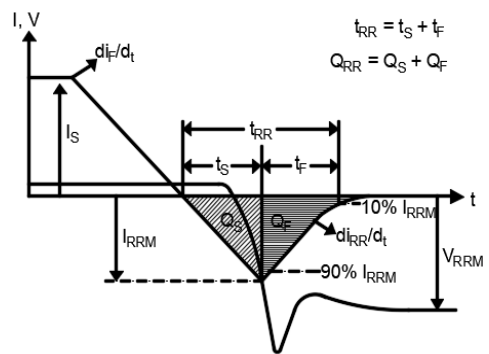
**Figure 17. Dynamic  $R_{DS(on)eff}$  Test Circuit**



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



**Figure 19. Diode Characteristic Test Circuits**



**Figure 20. Diode Recovery Waveform**



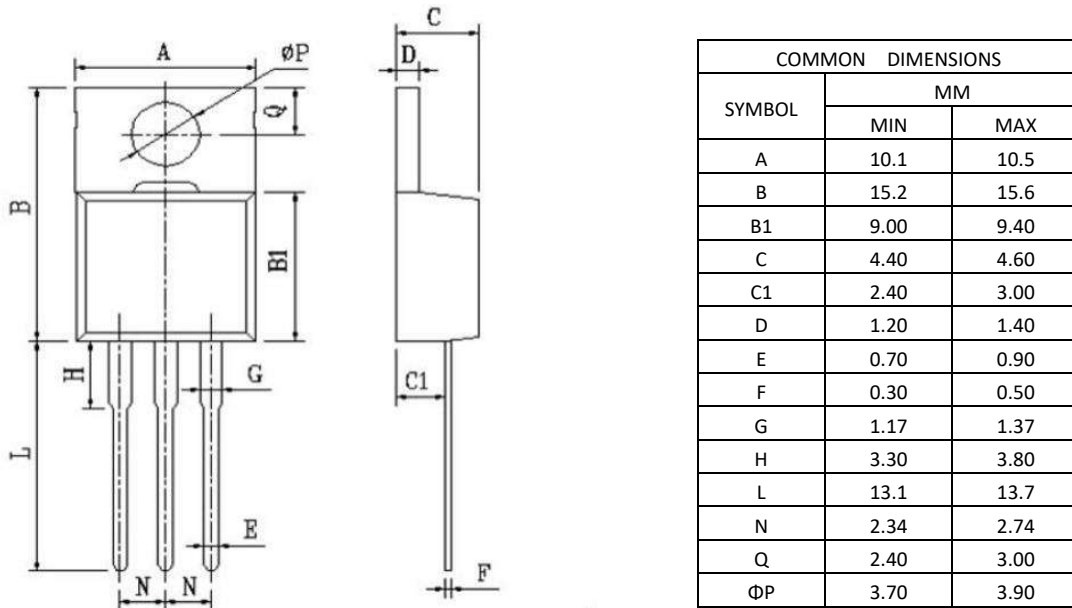
### Design Considerations

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.

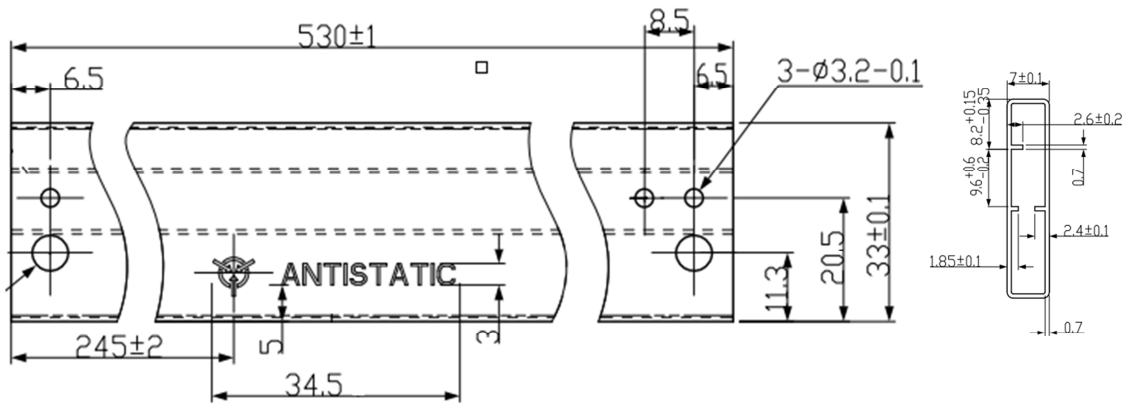
Before evaluating Runxin Micro's GaN devices, please refer to the table below which provides some practical rules that should be followed during the evaluation.

**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 TO packages when installing them to PCB	Use long traces in drive circuit, or long lead length of the devices

**Package Outline**

**Tube Information**

Dimensions are shown in millimeters


**Revision History**

Version	Date	Change(s)
0.1	05/30/2023	Release formal datasheet