

700V 350mΩ SolidGaN with Si MOSFET Compatibility

1. Features

- 350mΩ E-Mode GaN with Built-In Gate Clamp
- 700V Continuous, 750V Pulsed Voltage Rating
- Wide 8V to 20V Gate Input Voltage Range
- Adjustable Turn-On and Turn-Off Slew Rate
- Drop-In Replacement for Si MOSFET
- Work with Si MOSFET Controllers and Drivers
- Zero Reverse Recovery Charge
- Short Circuit Protection with Built-In DESAT
- Available in TO220 FullPAK Package

2. Applications

- Boost PFC, QR Flyback Topology
- AHB, LLC Topology
- AC-DC Power Adaptor, LED Lighting
- TV Power, Home Appliance Power

3. Description

The ISG6136 SolidGaN IC seamlessly integrates a 700V enhanced mode Gallium Nitride (GaN) FET with a built-in gate clamp and DESAT protection in a conventional TO220 FullPAK package, establishing a new standard for performance, ease of use, and reliability in power electronics. It provides self-powered features without requiring a sustainable supply voltage for internal supply, ensuring consistent driving of integrated GaN FET. With built-in DESAT protection, the ISG6136 further ensures device robustness and system safety.

The ISG6136 offers the ability to adjust the turn-on slew rate of the GaN FET using an external gate resistor, allowing users to optimize efficiency and EMI performance. The ISG6136's high integration level with a GaN FET and robust protection makes it suitable for wide range of Si MOSFET applications with simple drop-in replacement.

4. Typical Application

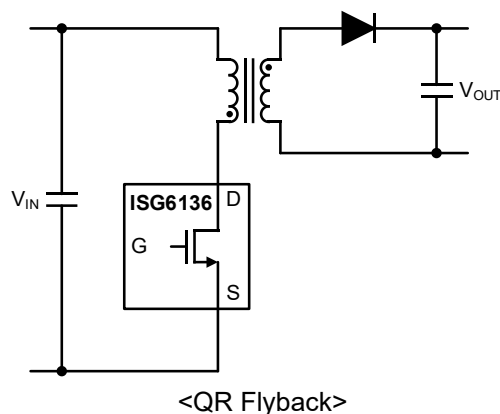
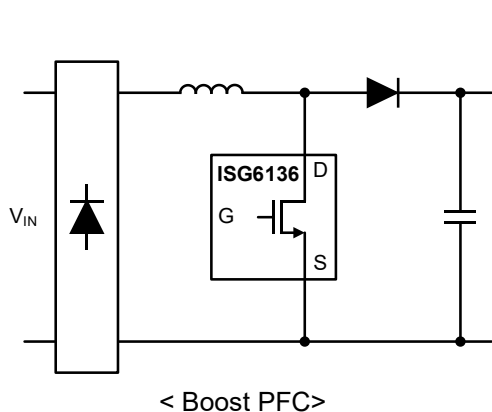


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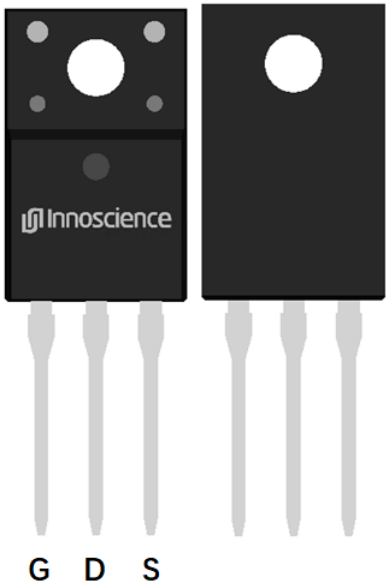
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5. Revision History

Major changes since the last revision

Revision	Date	Description of Changes
1.0	2025-03-28	Final datasheet release
1.1	2025-11-15	Update ESD ratings (Section 8) and V_{GS_TH} specification (Section 11)

6. Pin Configuration and Functions



3-Lead TO220 FullPAK Package – Top and Bottom View

Pin Number	Pin Name	Description
1	G	Gate Input. Connect to the driver output of controller or gate driver.
2	D	Drain of Power GaN FET.
3	S	Source of Power GaN FET.

7. Absolute Maximum Ratings

All pins are referred to S pin, unless otherwise specified. Stress beyond the absolute maximum ratings can cause permanent damage or deteriorate device lifetime.

Parameter	Value	Unit
Drain Voltage, Continuous	700	V
Drain Voltage, Pulsed ⁽¹⁾	750	V
Drain Current, Continuous ($T_C = 25^{\circ}\text{C}$)	6	A
Drain Current, Pulsed (10us @ $T_C = 25^{\circ}\text{C}$)	10	A
Drain Current, Pulsed (10us @ $T_C = 125^{\circ}\text{C}$)	6	A
Gate Voltage, Continuous	-0.6 to 20	V
Gate Voltage, Pulsed ⁽¹⁾	-5 to 24	V
Power Dissipation	20.5	W
Operating Junction Temperature T_J	-40 to 150	$^{\circ}\text{C}$
Storage Temperature	-55 to 150	$^{\circ}\text{C}$

(1) Intended for repetitive events, $t_{\text{PULSE}} < 100\text{ns}$.

8. ESD Ratings

$T_J = 25^{\circ}\text{C}$ unless otherwise specified.

Parameter	Value	Unit
Human Body Model (HBM), per ANSI/ESDA/JEDEC JS-001	± 1500	V
Charged Device Model (CDM), per ANSI/ESDA/JEDEC JS-002	± 1000	V

9. Recommended Operating Conditions

Parameter	Min	Max	Unit
Gate Input High Voltage	8	20	V
Gate Input Low Voltage	-0.3	0.3	V
Operating Junction Temperature	-40	125	$^{\circ}\text{C}$

10. Thermal Information

Symbol	Parameter	ISG6136TJ	Unit
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50.0	$^{\circ}\text{C/W}$
$R_{\theta JC}$	Thermal Resistance, Junction to Case	6.1	$^{\circ}\text{C/W}$

According to standards defined in JESD51 and JESD51-1, thermal characteristics of the package are simulated. $R_{\theta JA}$ is determined with the device mounted on one square inch of copper pad, single layer 2 oz copper on FR4 board.

11. Electrical Characteristics

$T_J = 25^\circ\text{C}$, $V_{GS} = 12\text{V}$, unless otherwise noted.

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Gate Characteristic						
Gate input threshold voltage	V_{GS_TH}	2.8	3.3	4	V	
Gate quiescent current	I_{GON_Q}		200		μA	$V_{GS} = 12\text{V}$
Protection						
DESAT protection threshold ⁽²⁾	V_{DS_DESAT}		5.9		V	
DESAT blanking time ⁽²⁾	t_{BLK_DESAT}		600		ns	
Power GaN FET						
Drain-source leakage current	I_{DSS}		0.6	12	μA	$V_{GS}=0\text{V}$, $V_{DS}=700\text{V}$, $T_J=25^\circ\text{C}$
			5		μA	$V_{GS}=0\text{V}$, $V_{DS}=700\text{V}$, $T_J=150^\circ\text{C}$
Drain-source resistance	$R_{DS(ON)}$		270	350	$\text{m}\Omega$	$V_{GS}=12\text{V}$, $I_{DS}=2.2\text{A}$; $T_J=25^\circ\text{C}$
			580			$V_{GS}=12\text{V}$, $I_{DS}=2.2\text{A}$; $T_J=150^\circ\text{C}$
Source-drain reverse voltage	V_{SD}		2.6		V	$V_{GS}=0\text{V}$, $I_{SD}=2.2\text{A}$
Total gate charge ⁽²⁾	Q_G		1.5		nC	$V_{GS}=0\text{V}$, $V_{DS}=0$ to 400V
Output charge ⁽²⁾	Q_{OSS}		13		nC	$V_{GS}=0\text{V}$, $V_{DS}=0$ to 400V
Reverse recovery charge ⁽²⁾	Q_{RR}		0		nC	$V_{DS}=400\text{V}$, $I_{SD}=2.2\text{A}$
Input capacitance ⁽²⁾	C_{ISS}		50		pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=100\text{kHz}$
Output capacitance ⁽²⁾	C_{OSS}		15		pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=100\text{kHz}$
Effective output capacitance, energy related ⁽²⁾	$C_{O(er)}$		20		pF	$V_{GS}=0\text{V}$, $V_{DS}=0$ to 400V
Effective output capacitance, time related ⁽²⁾	$C_{O(tr)}$		28		pF	$V_{GS}=0\text{V}$, $V_{DS}=0$ to 400V

12. Switching Characteristics

$T_J = 25^\circ\text{C}$, $V_{GS} = 12\text{V}$, unless otherwise noted.

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Turn-on propagation delay	t_{ON_PD}		50		ns	
Turn-off propagation delay	t_{OFF_PD}		30		ns	

(2) Not 100% tested and guaranteed by design.

13. Typical Characteristics

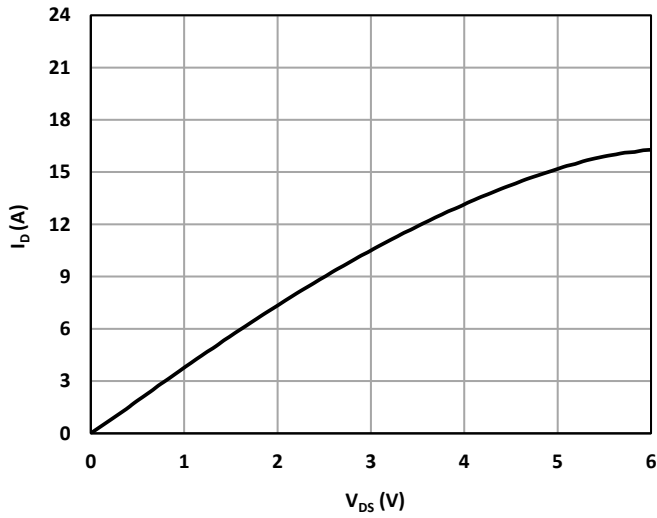


Figure 1. Drain Current vs Drain-to-Source Voltage, $T_J = 25^\circ\text{C}$

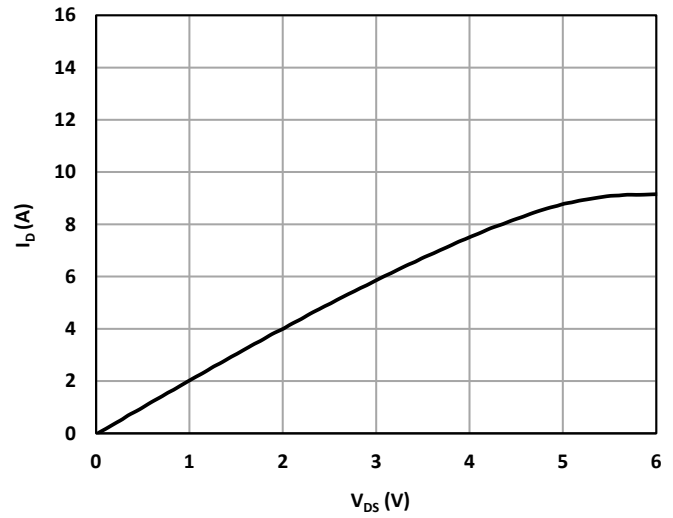


Figure 2. Drain Current vs Drain-to-Source Voltage, $T_J = 125^\circ\text{C}$

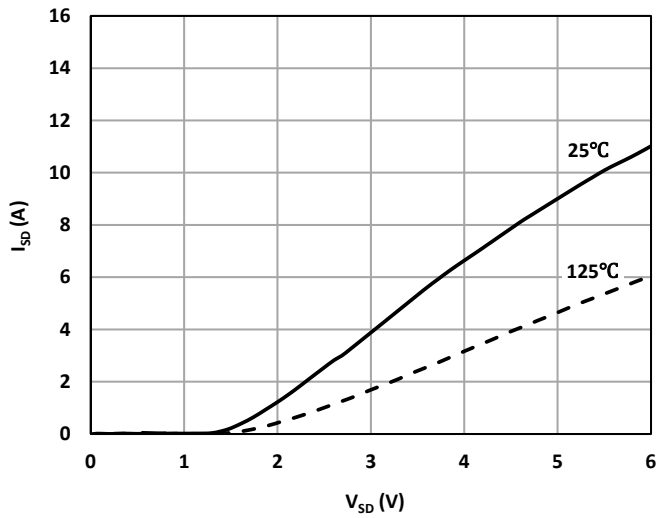


Figure 3. Source-Drain Reverse Conduction Current vs Voltage

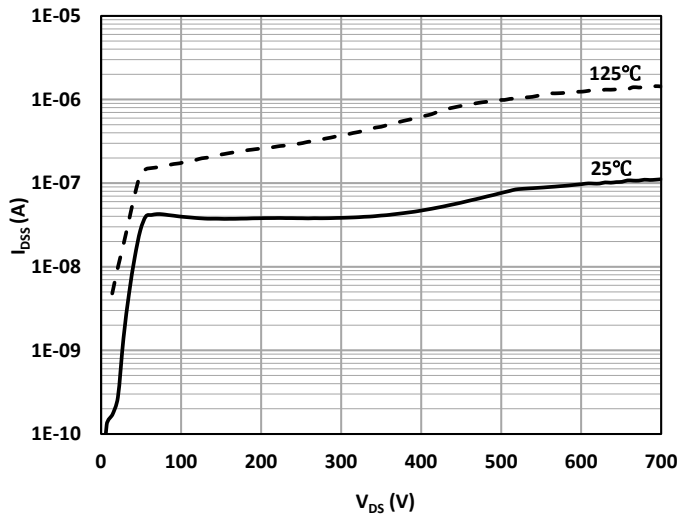


Figure 4. Drain Leakage Current vs Drain Voltage

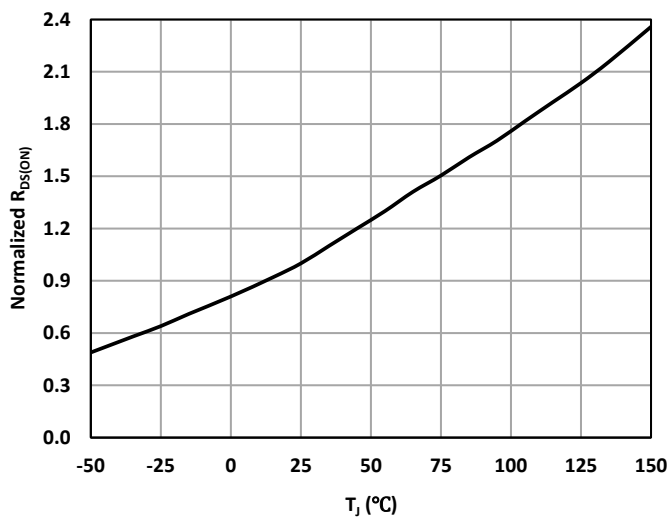


Figure 5. Normalized $R_{DS(ON)}$ vs Temperature

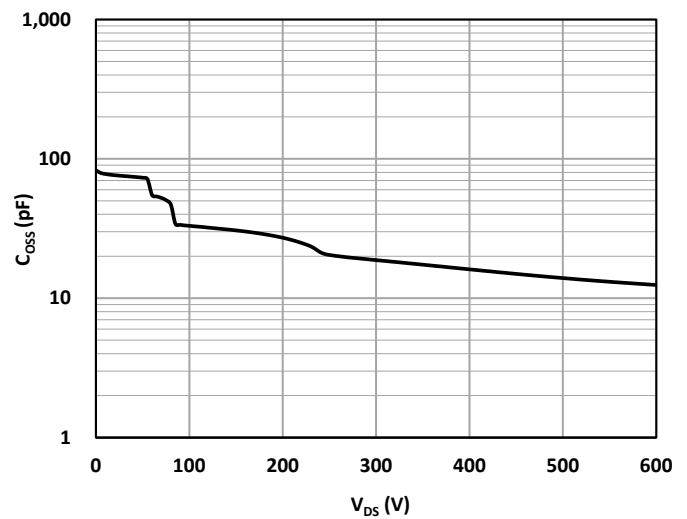


Figure 6. Output Capacitance vs Drain Voltage

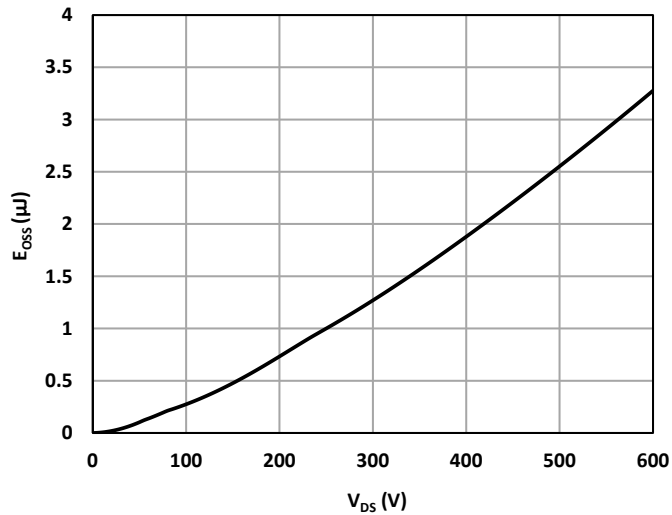


Figure 7. Output Capacitance Stored Energy vs Drain Voltage

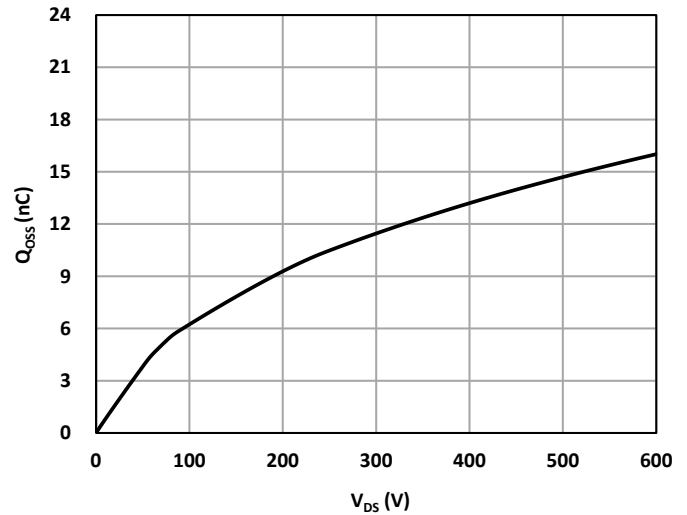


Figure 8. Output Charges vs Drain Voltage

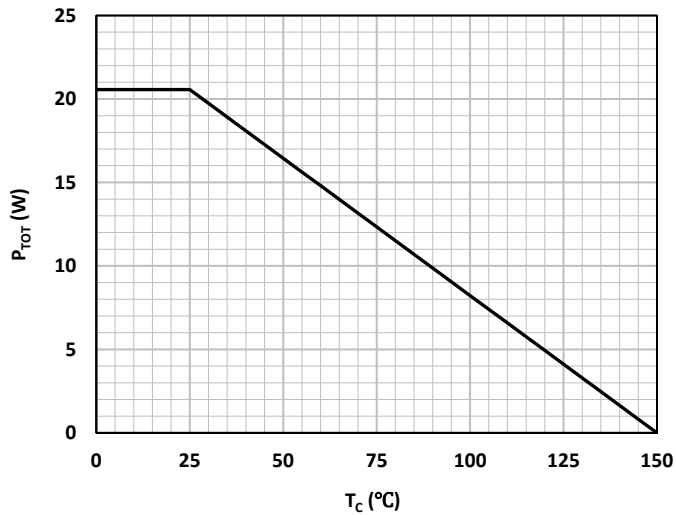


Figure 9. Power Dissipation

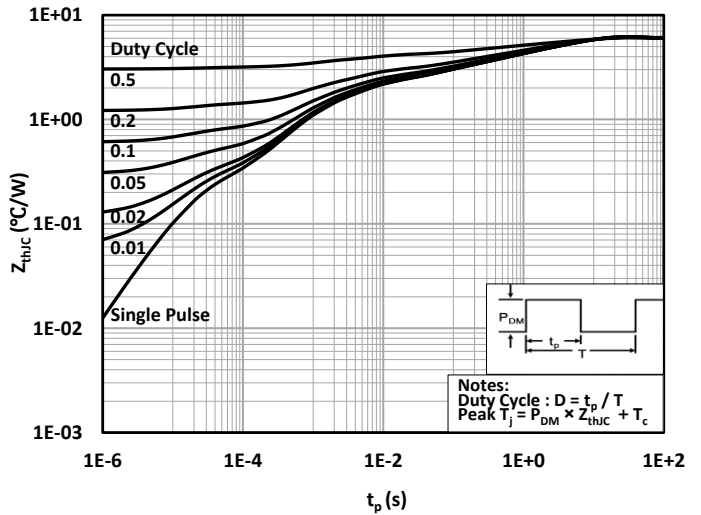


Figure 10. Max. Transient Thermal Impedance

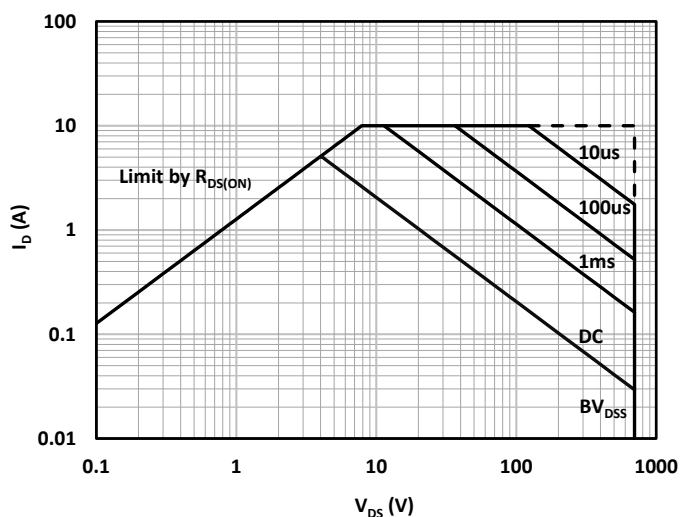


Figure 11. Safe Operating Area, $T_J=25^{\circ}\text{C}$

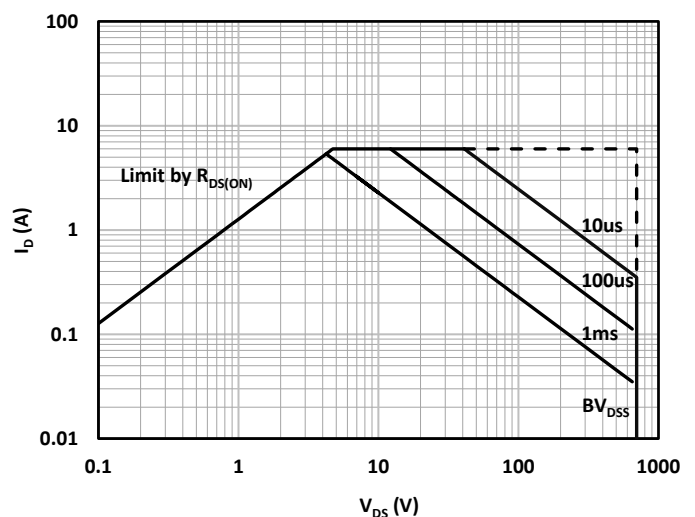


Figure 12. Safe Operating Area, $T_J=125^{\circ}\text{C}$

14. Block Diagram

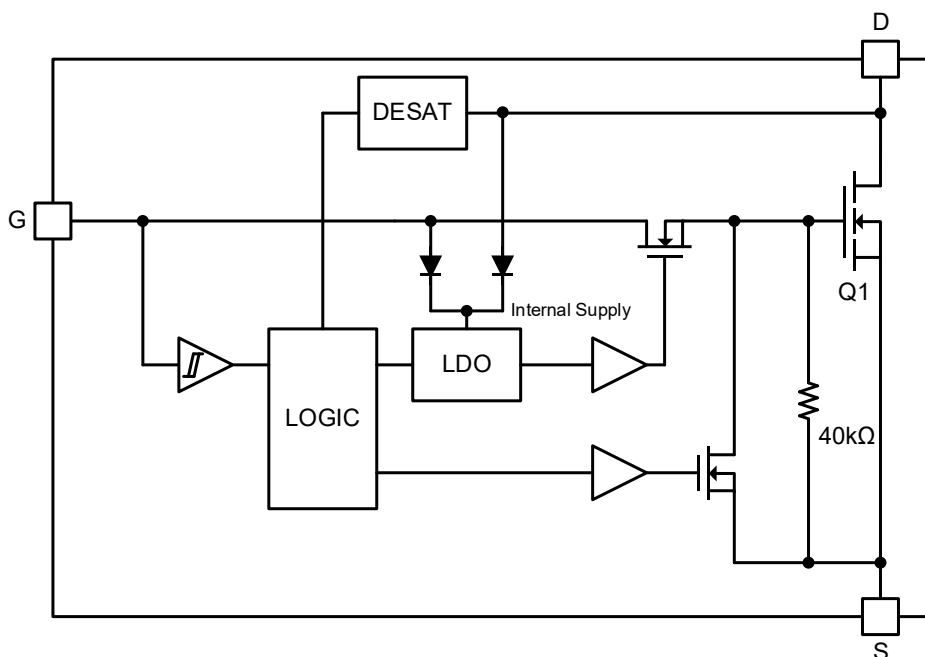


Figure 13. Functional Block Diagram

15. Function Description

The ISG6136 SolidGaN IC in a TO220 FullPAK package contains high performance E-mode GaN FET with a built-in gate clamp and DESAT protection. It incorporates a self-powered feature without specified supply voltage for internal circuitry, converting supply either G or D pin corresponding its operation. This ensures consistent driving of GaN FET with easy-of-use and reliable operation.

The ISG6136 enables the independent adjustment of turn-on slew rate for driver by an external gate resistor, optimizing both EMI performance and efficiency. With the high integration level of GaN FET and robust protection, the ISG6136 offers a simple setup with a low component count, ensuring it is suitable for high-frequency and high-power applications.

Power-On-Sequence and Self-Powered Operation

The ISG6136 offers the self-powered feature without sustainable supply voltage for internal supply (VDD). It converts supply either G or D pin according to operation states to guarantee consistent driving of GaN FET.

Figure 14 shows the switching characteristics of the G and D. When the system is powered on, D pin is pulled high, the internal supply is powered from the D pin. The D voltage exceeding 30V is required for proper power supply typically. When G pin voltage goes above 3.3V, the internal GaN FET turns on with a time delay, t_{ON_PD} , and the D is pulled down to ground, powering the internal supply from G pin. When the G pin voltage goes below 3.3V, the internal GaN FET turns off with a time delay, t_{OFF_PD} .

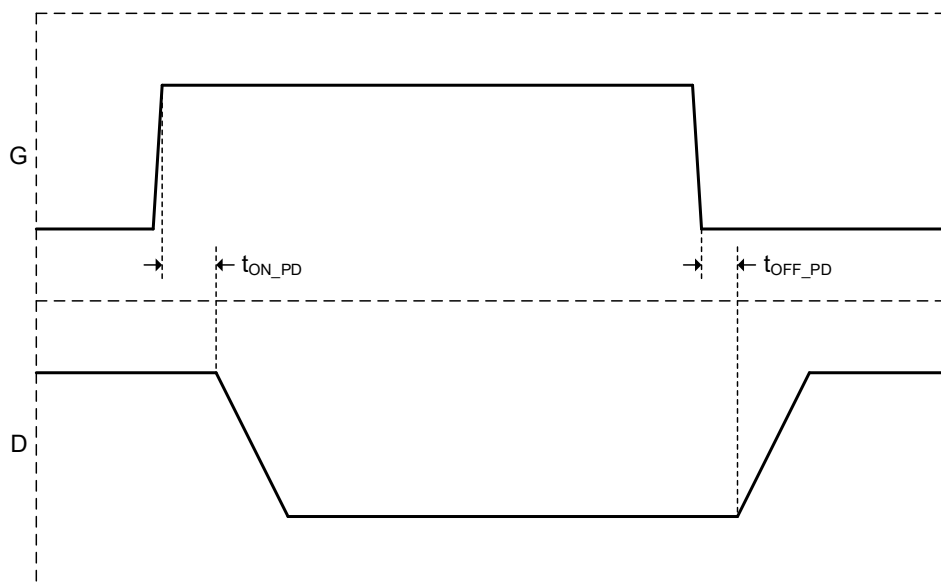


Figure 14. Timing Diagram of Input and Output

Adjustable Turn-On and Turn-Off Slew Rate

The ISG6136 supports users the ability to adjust both turn-on and turn-off slew rate of the GaN FET independently. This is achieved by adding external gate resistors and diode between the driver output and G pin of ISG6136 as shown in Figure 15, targeting optimization of efficiency, reliability, and EMI performance.

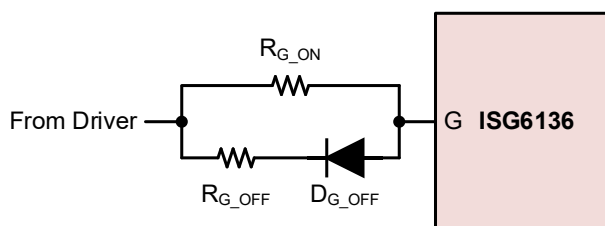


Figure 15. Configuration of Adjustable Turn-On Slew Rate

DESAT Protection

The ISG6136 provides cycle-by-cycle DESAT protection by monitoring the drain-source voltage, V_{DS} , to protect the GaN FET from potential damage in the desaturation region. As illustrated in the timing diagram of Figure 16, when the V_{DS} exceeds the DESAT protection threshold (5.9V typical), the GaN FET is turned off. The GaN FET will be turned on again at the next rising edge of G signal. The blanking time of 600ns (typical) is added to prevent false triggering during the GaN FET turn-on.

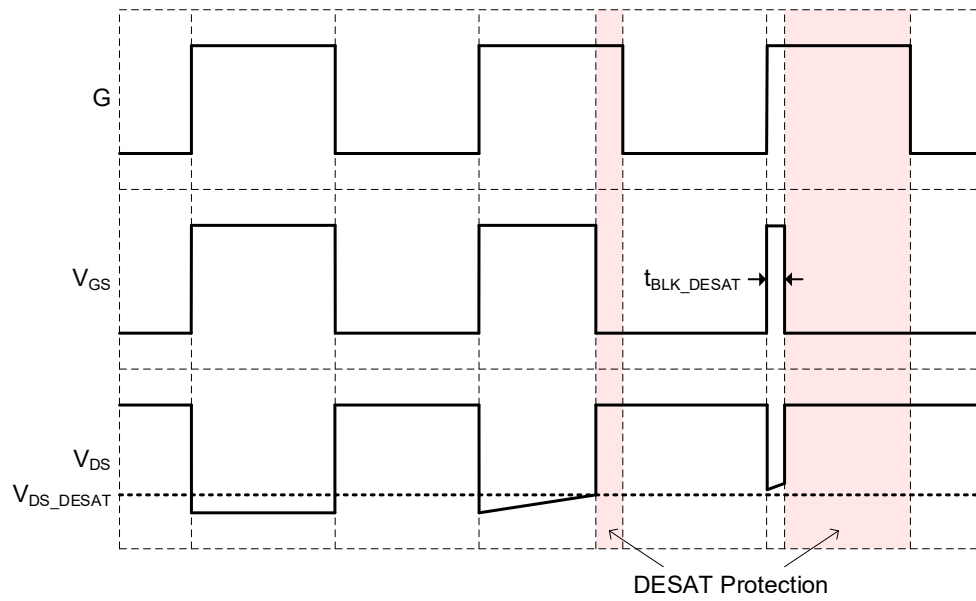
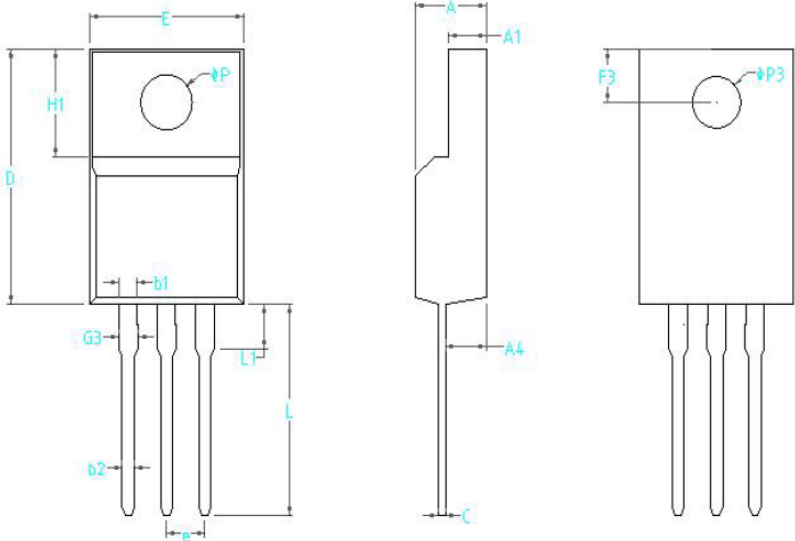
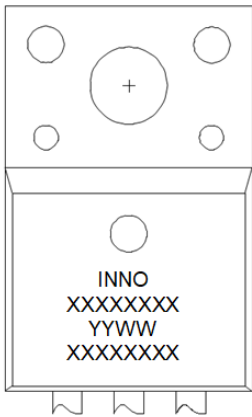


Figure 16. Timing Diagram of DESAT Protection

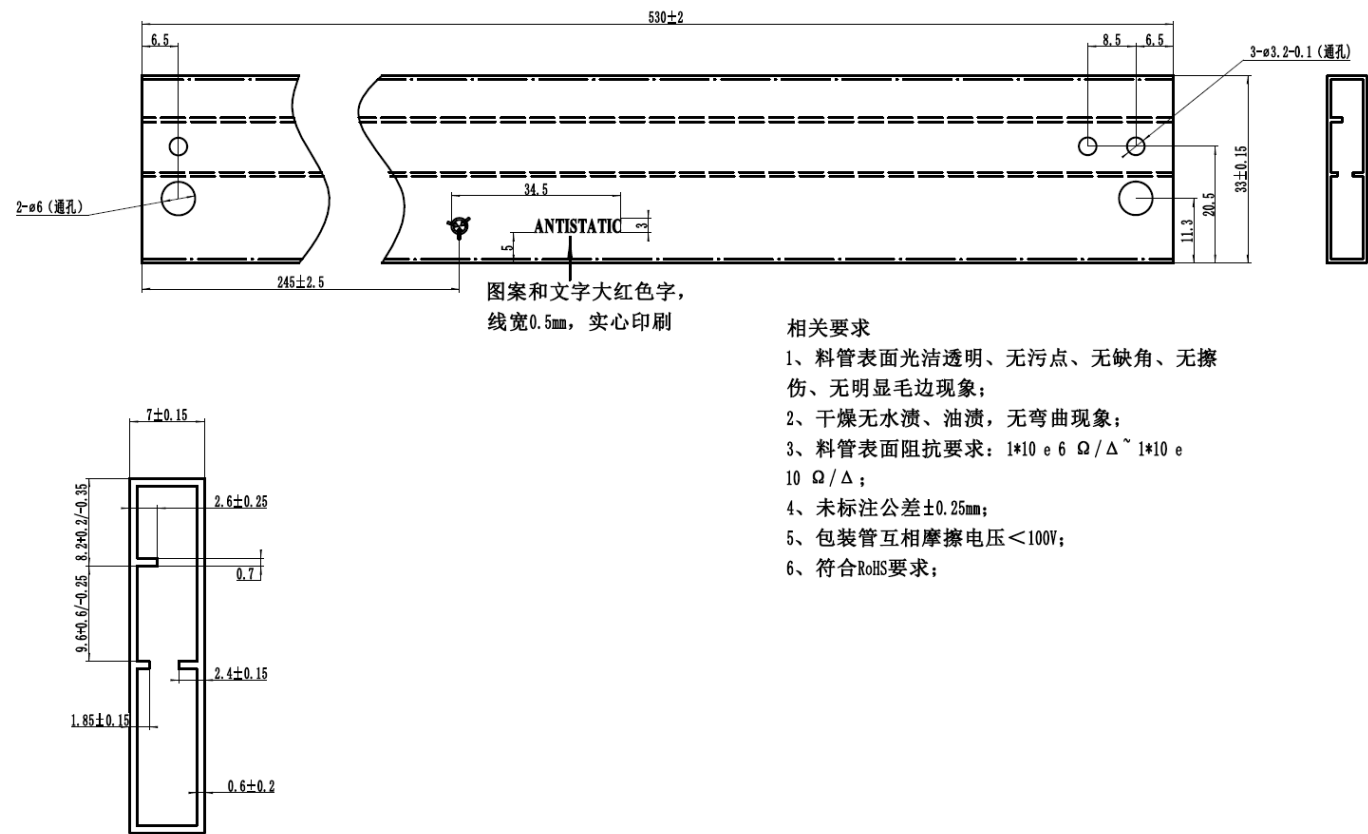
16. Package Information

			
symbol	mm		
	min	nom	max
E	9.96	10.16	10.36
A	4.5	4.7	4.9
A1	2.34	2.54	2.74
A4	2.56	2.76	2.96
C	0.4	0.5	0.6
D	15.57	15.87	16.17
H1	6.5	6.8	7.1
e	2.34	2.54	2.74
L	12.73	13.03	13.33
L1	2.75	2.85	3.05
ϕP	3.2	3.4	3.6
$\phi P3$	2.98	3.18	3.38
F3	3.15	3.3	3.45
G3	1.12	1.27	1.42
b1	1.1	1.2	1.3
b2	0.7	0.8	0.9



Row	Description	Example
Row1	Company Name	INNO
Row2	Product Code (In short)	XXXXXXXX
Row3	Date Code	YYWW
Row4	ASSY Lot No.	XXXXXXXX

17. Tube Information



18. Order Information

Ordering Code	Package	Product Code	Packing (Tube)
ISG6136TJ	TO220F	6136TJ	50PCS/Tube

Important Notice

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