

650V, 120mΩ typ., GaN FET in TO-220 Package

1. General Description

The HG65C1R120F is a 650V, 120 mΩ Gallium Nitride (GaN) FET in a TO-220 package. It is a normally-off device that combines asiasemitech latest high-voltage GaN HEMT with a low voltage silicon MOSFET to offer superior reliability and performance.

2. Features and Benefits

- JEDEC-qualified GaN technology
- Dynamic $R_{DS(on)eff}$ production tested
- Wide gate safety margin
- Capable of reverse conduction
- Low gate charge
- RoHS compliant and Halogen-free packaging
- Achieves increased efficiency in both hard- and soft- switched circuits
 - Increased power density
 - Reduced system size and weight
 - Overall lower system cost
- Easy to drive with commonly-used gate drivers

3. Applications

- Industrial power supplies
- Telecom power supplies
- Data center
- Consumer

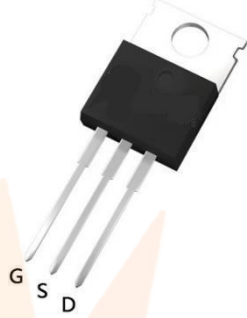
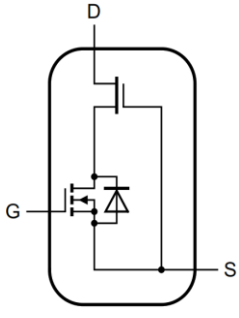
4. Key Specifications

Table 1. Key Specifications

Symbol	Parameter	Value	Unit
$V_{DS, max}$	Drain-source voltage	650	V
I_D, max	Continuous drain current @Tc = 25°C	22	A
$R_{DS(on), typ}$	Drain-source on-state resistance	87	mΩ
Q_G, typ	Total gate charge	14.3	nC
$Q_{RR, typ}$	Reverse recovered charge	103	nC

5. Pin Description

Table 2. Pin Description

Pin	Description	Top View	Graphic Symbol
G	Gate		
S	Source		
D	Drain		

6. Ordering Information

Table 3. Ordering Information

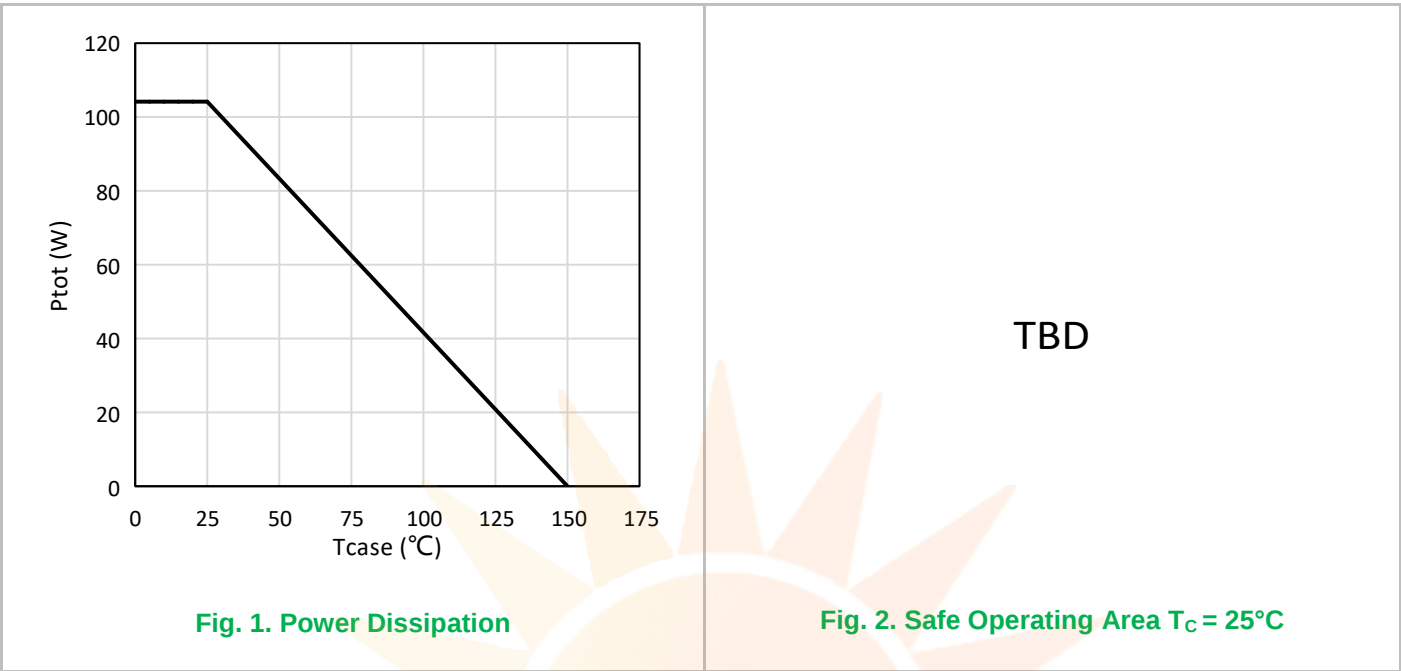
Part number	Package	Package Configuration	Marking Code
HG65C1R120F	TO-220	Source	65C1R120

7. Absolute Maximum Ratings

Table 4. Absolute Maximum Ratings (Tc=25°C unless otherwise stated)

Parameter	Symbol	Min.	Max.	Unit.	Conditions
Drain to source voltage	V_{DSS}	650	-	V	$V_{GS} = 0V$
Transient drain to source voltage	$V_{DSS(TR)}$	-	800		Non-repetitive Pulse for $\leq 10ms$ at 25°C
Gate to source voltage	V_{GSS}	-20	20		
Maximum power dissipation	P_D	-	104	W	$T_C = 25^\circ C$, Fig.1
Continuous drain current	I_D	-	22	A	$T_C = 25^\circ C$
		-	14	A	$T_C = 100^\circ C$
Pulsed drain current	I_{DM}	-	TBD	A	Pulsed, $t_p \leq 200\mu s$, $T_C = 25^\circ C$
Operating temperature	T_J	-55	150	°C	
Storage temperature	T_S	-55	150	°C	

650V, 120mΩ typ., Gallium Nitride (GaN) FET in TO-220



8. Thermal Characteristics

Table 5. Thermal Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Thermal resistance (Junction-to-case)	R _{th(j-c)}	-	-	1.2	°C/W	
Thermal resistance (Junction-to-ambient)	R _{th(j-a)}	-	-	50	°C/W	
Reflow soldering temperature	T _{SOLD}	-	-	260	°C	Reflow MSL3

TBD

Fig. 3. Transient Thermal Impedance

9. Electrical Characteristics ($T_J=25^\circ\text{C}$ unless otherwise stated)

Table 6. Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Forward Device Characteristics						
Gate threshold voltage	$V_{GS(th)}$	-	3.8	-	V	$V_{DS} = V_{GS}$, $I_D = 0.5\text{mA}$, $T_J = 25^\circ\text{C}$
		-	2.1	-		$V_{DS} = V_{GS}$, $I_D = 0.5\text{mA}$, $T_J = 150^\circ\text{C}$
Drain-source on-state resistance	$R_{DS(on)}$	-	87	-	mΩ	$V_{GS} = 12\text{V}$, $I_D = 6\text{A}$, $T_J = 25^\circ\text{C}$
		-	201	-		$V_{GS} = 12\text{V}$, $I_D = 6\text{A}$, $T_J = 150^\circ\text{C}$
Drain-to-source leakage current	I_{DSS}	-	8	-	μA	$V_{DS} = 650\text{V}$, $V_{GS} = 0\text{V}$, $T_J = 25^\circ\text{C}$
		-	90	-		$V_{DS} = 650\text{V}$, $V_{GS} = 0\text{V}$, $T_J = 150^\circ\text{C}$
Gate-to-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS} = 20\text{V}$, $V_{DS} = 0\text{V}$, $T_J = 25^\circ\text{C}$
		-	-	-100		$V_{GS} = -20\text{V}$, $V_{DS} = 0\text{V}$, $T_J = 25^\circ\text{C}$

650V, 120mΩ typ., Gallium Nitride (GaN) FET in TO-220

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input capacitance	C _{ISS}	-	765	-	pF	V _{GS} = 0V, V _{DS} = 400V, f = 1MHz, Fig.8
Output capacitance	C _{OSS}	-	49	-		
Reverse transfer capacitance	C _{RSS}	-	1	-		
Output capacitance, energy related ^a	C _{O(er)}	-	95	-	pF	V _{GS} = 0V, V _{DS} = 0V to 400V, Fig. 9 , Fig. 10
Output capacitance, time related ^b	C _{O(tr)}	-	184	-		
Total gate charge	Q _G	-	14.3	-	nC	V _{DS} = 400V, V _{GS} = 0V to 12V, I _D = 10A, Fig. 11
Gate-source charge	Q _{GS}	-	3.4	-		
Gate-drain charge	Q _{GD}	-	4.8	-		
Output charge	Q _{OSS}	-	74	-	nC	V _{GS} = 0V, V _{DS} = 0V to 400V
Turn-on delay	t _{D(on)}	-	43	-	ns	V _{DS} = 400V, V _{GS} = 0V to 12V, I _D = 10A, R _{G_on} = 68Ω, R _{G_off} = 2Ω, Fig.14 , Fig.15
Rise time	t _R	-	13	-		
Turn-off delay	t _{D(off)}	-	28	-		
Fall time	t _F	-	13	-		
Reverse Device Characteristics						
Reverse voltage	V _{SD}	-	1.7	-	V	V _{GS} = 0V, I _S = 10A, T _J = 25°C, Fig. 12
		-	2.5	-		V _{GS} = 0V, I _S = 10A, T _J = 150°C, Fig. 12
Reverse recovery time	t _{RR}	-	25	-	ns	V _{DD} = 400V, di/dt = 1000A/us, V _{GS} = 0V, I _S = 10A, T _J = 25°C, Fig.16 , Fig. 17
Reverse recovery charge	Q _{RR}	-	103	-	nC	

Notes:

- Equivalent capacitance to give same stored energy from 0V to 400V
- Equivalent capacitance to give same charging time from 0V to 400V

650V, 120mΩ typ., Gallium Nitride (GaN) FET in TO-220

9.1 Electrical characteristics(curves) ($T_C=25^{\circ}\text{C}$ unless otherwise stated)

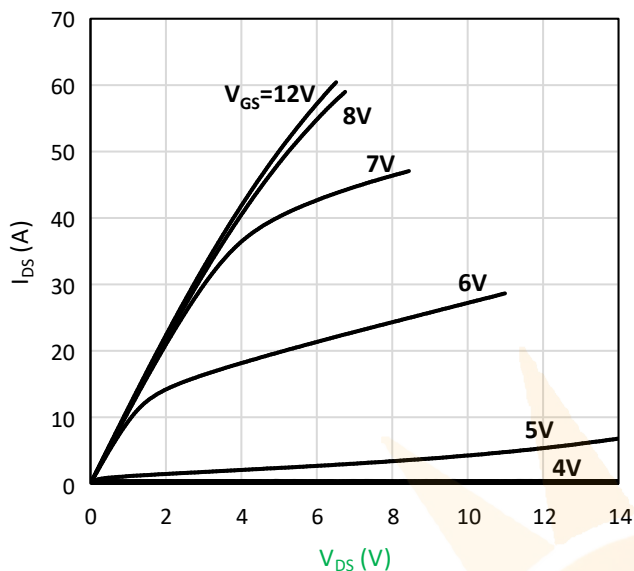


Fig. 4. Typical Output Characteristics

$T_j = 25^{\circ}\text{C}$

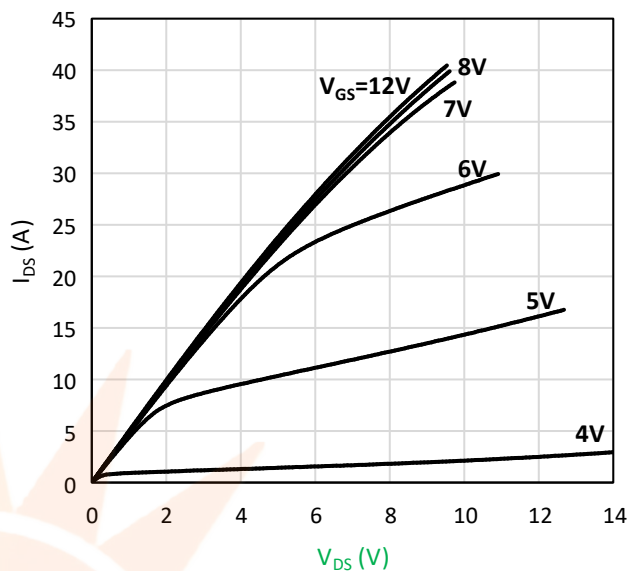


Fig. 5. Typical Output Characteristics

$T_j = 150^{\circ}\text{C}$

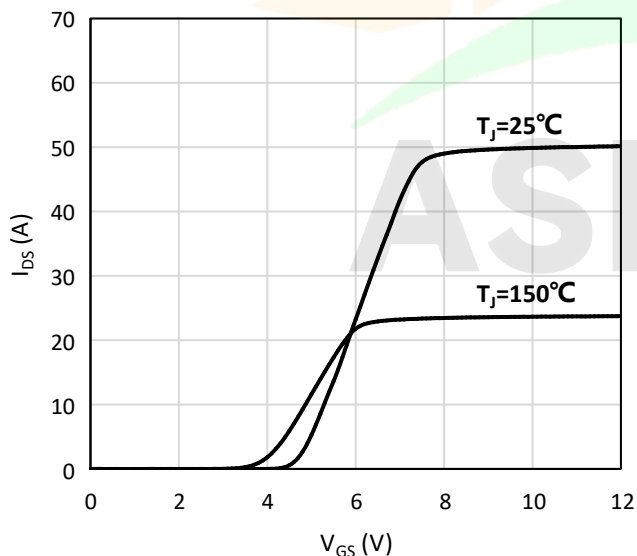


Fig. 6. Typical Transfer Characteristics

$V_{DS} = 5\text{V}$

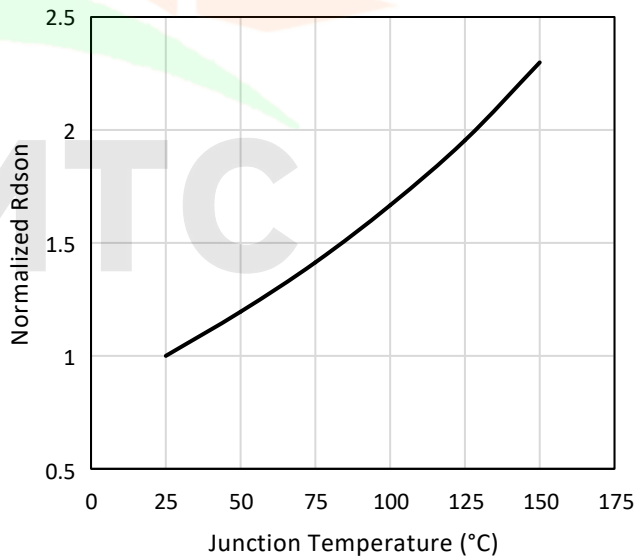


Fig. 7. Normalized On-resistance

$I_D = 6\text{A}$, $V_{GS} = 12\text{V}$

650V, 120mΩ typ., Gallium Nitride (GaN) FET in TO-220

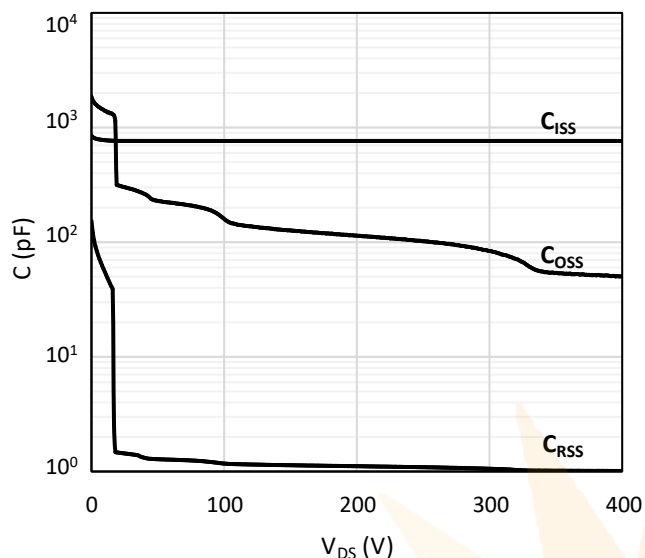


Fig. 8. Typical Capacitance

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

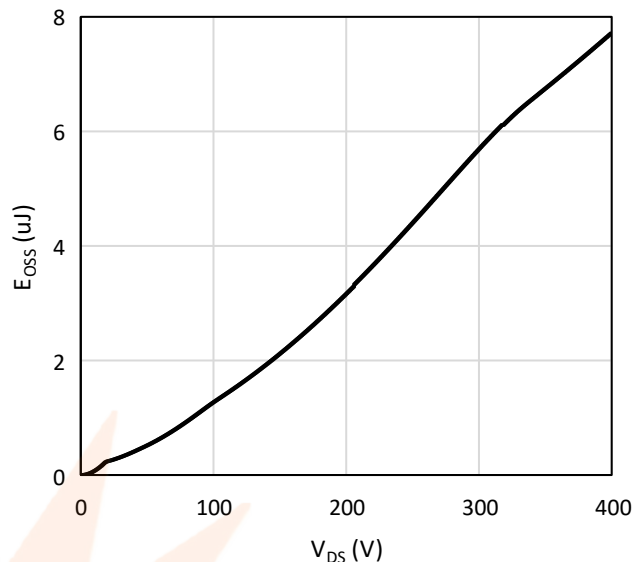


Fig. 9. Typical Coss Stored Energy

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

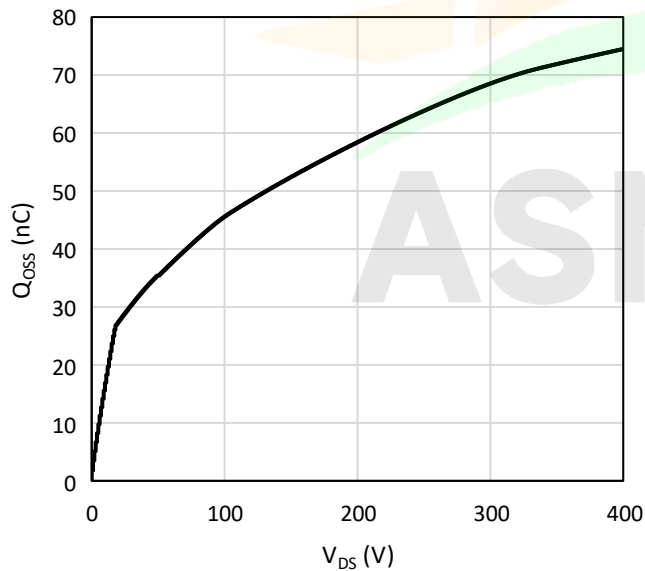


Fig. 10. Typical Q_{oss}

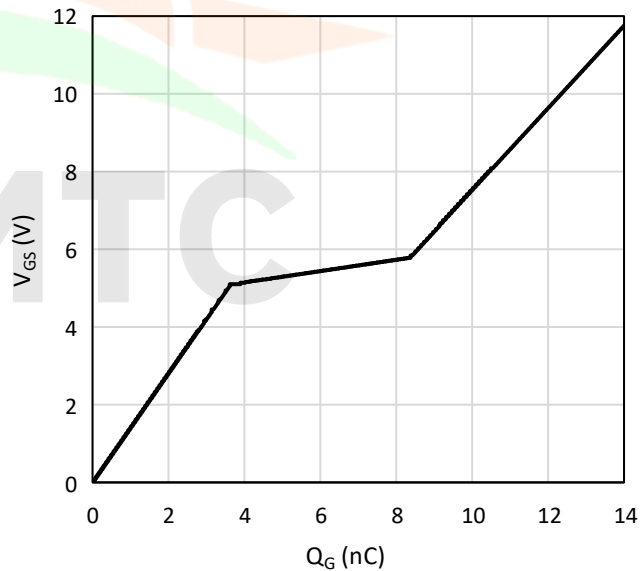


Fig. 11. Typical Gate Charge

$I_{DS} = 10A, V_{DS} = 400V$

650V, 120mΩ typ., Gallium Nitride (GaN) FET in TO-220

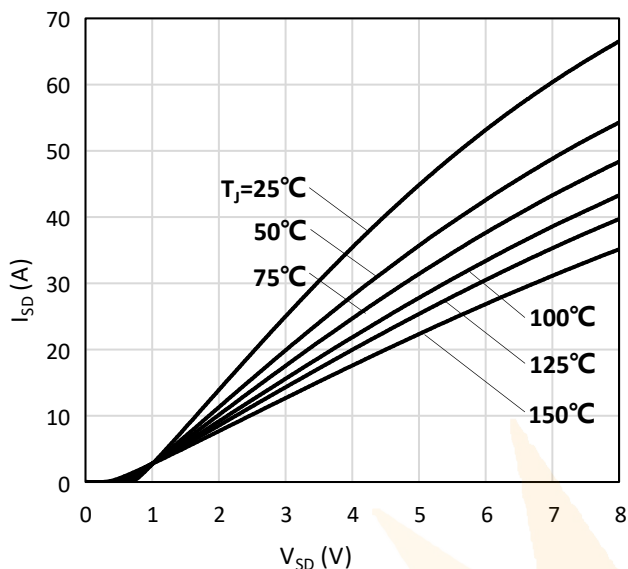


Fig. 12. Forward Characteristics of Rev. Diode

$$I_{SD} = f(V_{SD})$$

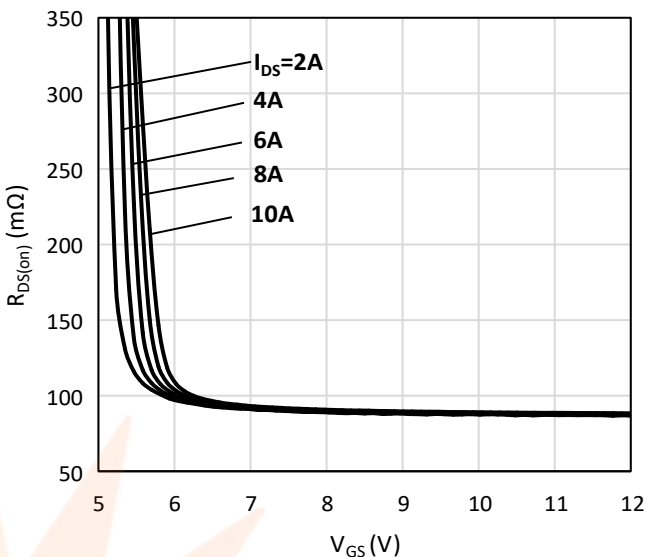


Fig. 13. Typical $R_{DS(on)}$

10. Test Circuits

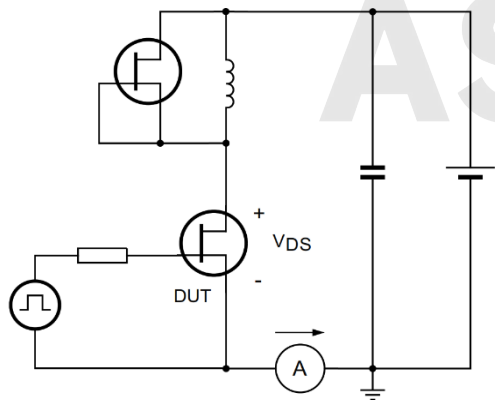


Fig. 14. Switching Time Test Circuit

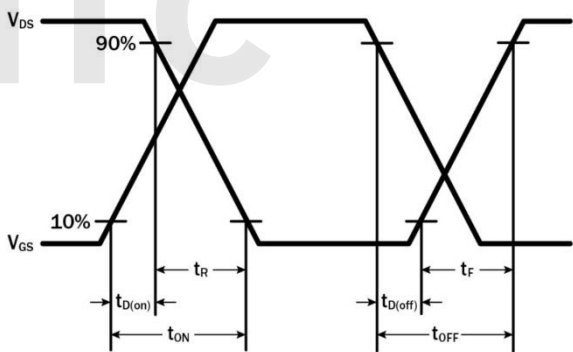


Fig. 15. Switching Time Waveform

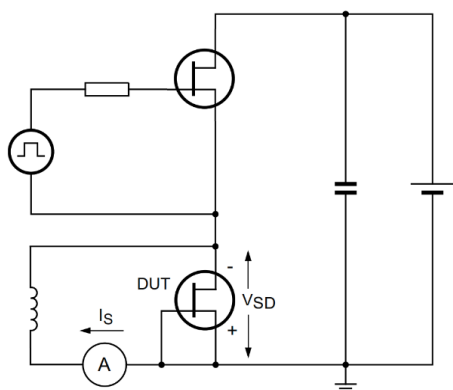


Fig. 16. Diode Characteristics Test Circuit

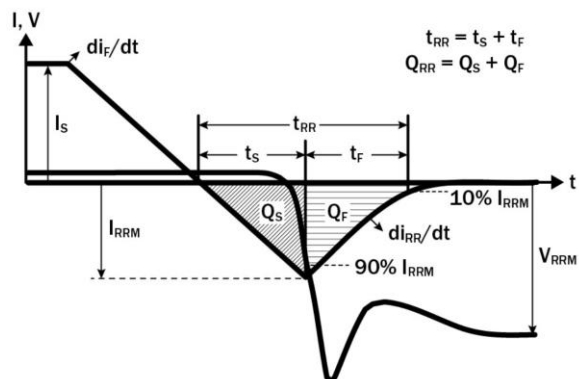


Fig. 17. Diode Recovery Waveform

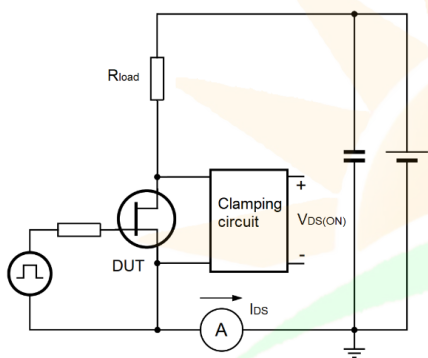


Fig. 18. Dynamic $R_{DS(on)eff}$ Test Circuit

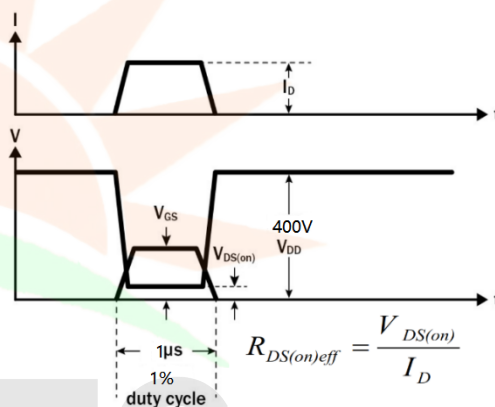


Fig. 19. Dynamic $R_{DS(on)eff}$ Waveform

650V, 120mΩ typ., Gallium Nitride (GaN) FET in TO-220

11. Package Information

11.1 TO-220 Package Information

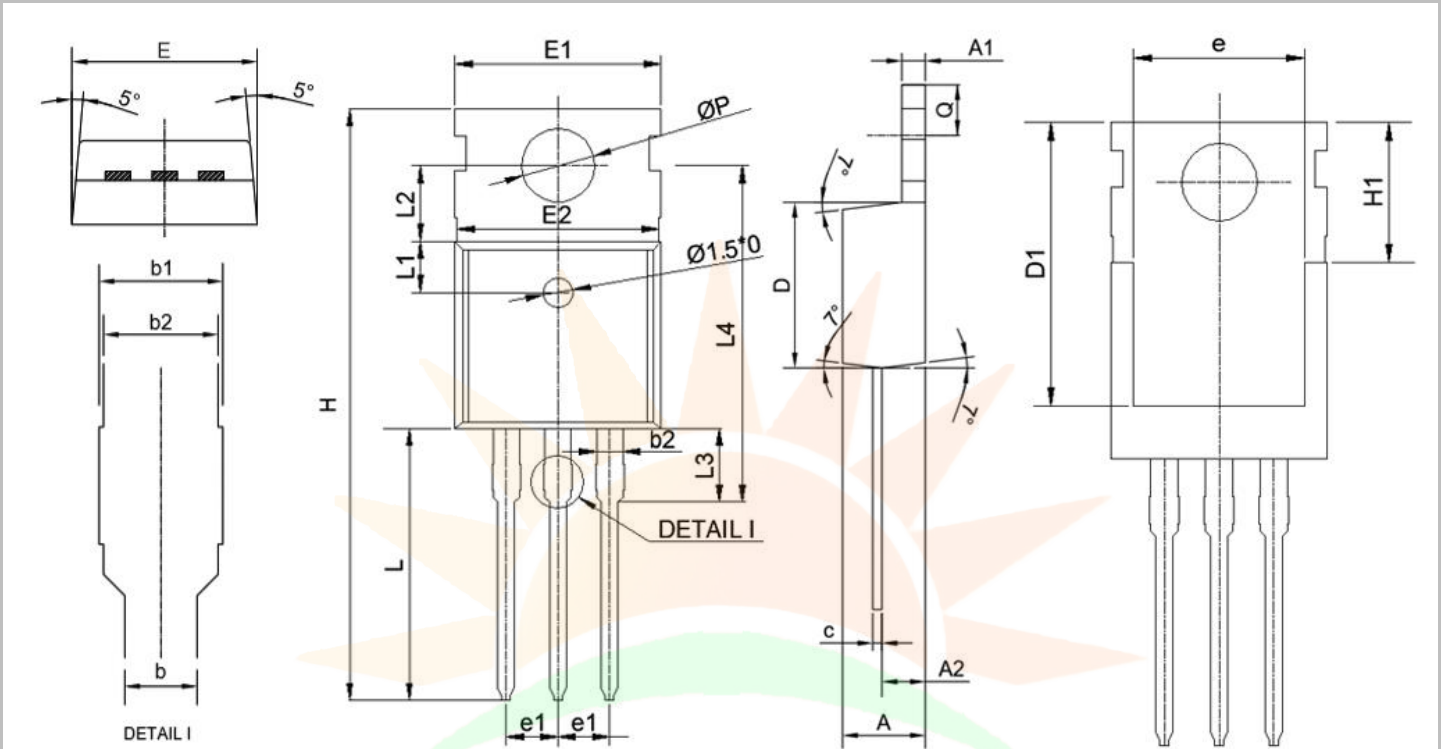


Fig. 17. TO-220 Package Outline

SYMBOL	MIN	NOM	MAX	SYMBOL	MIN	NOM	MAX
A	4.56	4.57	4.58	e	7.50	8.00	8.40
A1	1.28	1.3	1.32	e1	2.53	2.54	2.55
A2	2.3	2.4	2.5	H	28.8	29	29.2
b	0.7	0.8	0.9	H1	6.4	6.5	6.6
b1	1.27	1.37	1.47	L	13.05	13.35	13.65
b2	1.26	1.27	1.28	L1	2.4	2.5	2.6
c	0.45	0.5	0.6	L2	3.6	3.7	3.8
D	9.14	9.15	9.16	L3	2.92	3	3.08
D1	13.2	13.21	13.22	L4	15.82	15.9	15.98
E	9.95	10.05	10.15	Q	2.73	2.8	2.87
E1	10.0	10.05	10.1	P	3.6	-	3.65
E2	9.87	9.88	9.89				

12. Important Notice

asiasemitech reserves the right to modify or enhance the products and/or specifications described herein at any time and at asiasemitech sole discretion. All information in this document, including descriptions of product features and performance, is subject to change without notice. Purchasers should obtain the latest relevant information on asiasemitech products before placing orders. Performance specifications and the operating parameters given in this document shall in no event be regarded as a guarantee of conditions or characteristics. The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

Revision History

Revision	Date	Changes
1.0	2023/11/2	Release Preliminary Datasheet

