

700V GaN FET

Datasheet
Preliminary

1. Description

The G2N70 series FETs are hybrid normally-off Gallium Nitride (GaN) field effect transistors with the strongest gate and the lowest reverse voltage drop of all wide-band-gap devices in the market. They allow simple gate drive, offer best-in-class performance and outstanding reliability.

Features

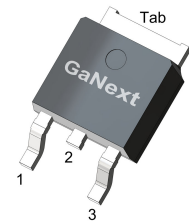
- Strong gate with a high threshold, no need for negative gate drive, and a high repetitive input voltage tolerance of $\pm 20V$.
- Fast turn-on/off speed for reduced cross-over losses.
- Low Q_g and simple gate drive for lowest driver consumption at high frequencies.
- Lowest V_F in off-state reverse conduction among all SiC and GaN FETs for low loss during dead-times.
- Negligible Q_{rr} for outstanding hard-switched bridge applications.
- High spike tolerance of 800V for enhanced reliability.

Benefits

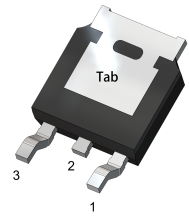
- Enable very high conversion efficiencies.
- Enable higher frequency for compact power supplies.
- End-product cost & size savings due to reduced cooling requirements.
- Improved safety & reliability due to cooler operation temperature.
- Higher output power due to the best efficiency and thermal capability.

Applications

- High-frequency compact chargers with QR or ACF flyback topologies.
- Half-bridge buck/boost.
- High-efficiency/ High-frequency LLC or other soft-switching topologies.

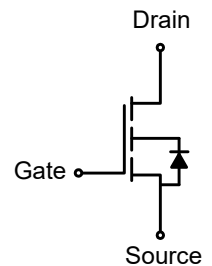


Top View



Bottom View

Gate	1
Source	2, Tab
Drain	3



Schematic Symbol

Key Performance Parameters

V_{DSS} (V)	700
$V_{DSS(PK)}$ (V) ^{a)}	800
$R_{DS(on), typ}$ (m Ω) ^{b)}	480
Q_{oss} (nC)	12.3
Q_g (nC)	16

^{a)} Duty cycle < 1%, spike duration < 30 μ s, repetitive for $\leq 85^\circ C$, non-repetitive up to $150^\circ C$

^{b)} Dynamic on-resistance



Part Number & Package Information

Part #	Package	Package Base
G2N70R480TC-H	TO-252-3L	Source

2. Maximum Ratings

Symbol	Parameter	Value
V_{DSS} (V)	Drain-source maximum voltage ($T_J = -55^{\circ}\text{C}$ to 150°C)	700
$V_{DSS(PK)}$ (V)	Drain-source maximum peak voltage ^{a)}	800
$V_{GSS, DC}$ (V)	Gate-source maximum voltage	± 20
$V_{GSS, AC}$ (V)	Gate-source maximum voltage ($f \geq 50\text{Hz}$)	± 30
P_D (W)	Maximum power dissipation ($T_C = 25^{\circ}\text{C}$)	22
I_{DS} (A)	Maximum continuous drain current ($T_C = 25^{\circ}\text{C}$)	5
	Maximum continuous drain current ($T_C = 100^{\circ}\text{C}$)	3.2
$I_{DS (pulse)}$ (A)	Maximum pulsed drain current ($T_C = 25^{\circ}\text{C}$) ^{b)}	16
T_J ($^{\circ}\text{C}$)	Operating junction temperature	-55 to 150
T_S ($^{\circ}\text{C}$)	Storage temperature	-55 to 150
T_{solder} ($^{\circ}\text{C}$)	Reflow soldering temperature ^{c)}	260

^{a)} Duty cycle < 1%, spike duration < 30 μs , repetitive for $\leq 85^{\circ}\text{C}$, non-repetitive up to 150°C

^{b)} Pulse width = 10 μs

^{c)} Reflow MSL3

3. Thermal Characteristics

Symbol	Parameter	Typ.
$R_{\theta JC}$ ($^{\circ}\text{C/W}$)	Junction-to-case thermal resistance	5.6
$R_{\theta JA}$ ($^{\circ}\text{C/W}$)	Junction-to-ambient thermal resistance ^{a)}	48

^{a)} Soldered on a PCB of 6cm² metal area

4. Device Characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$V_{GS(th)}$	Gate threshold voltage	3.02	3.52	4.02	V	$V_{DS} = V_{GS}$, $I_D = 2.1\text{mA}$
$R_{DS(on)}$	Drain-source on resistance ^{a)}	-	480	560	m Ω	$V_{GS} = 10\text{V}$, $I_D = 3.4\text{A}$
		-	1000	-	m Ω	$V_{GS} = 10\text{V}$, $I_D = 3.4\text{A}$, $T_J = 150^\circ\text{C}$
I_{DSS}	Drain-source leakage current	-	1	10	μA	$V_{DS} = 700\text{V}$, $V_{GS} = 0\text{V}$
		-	5	-	μA	$V_{DS} = 700\text{V}$, $V_{GS} = 0\text{V}$, $T_J = 150^\circ\text{C}$
I_{GSS}	Gate-source leakage current	-100	-	100	nA	$V_{GS} = \pm 20\text{V}$
C_{iss}	Input capacitance	-	938	-	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 400\text{V}$, $f = 500\text{kHz}$
C_{oss}	Output capacitance	-	8.5	-	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 400\text{V}$, $f = 500\text{kHz}$
C_{rss}	Reverse transfer capacitance	-	0.6	-	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 400\text{V}$, $f = 500\text{kHz}$
$C_{o(er)}$	Equivalent output capacitance (energy related)	-	12.5	-	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 400\text{V}$
$C_{o(tr)}$	Equivalent output capacitance (time related)	-	30.6	-	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 400\text{V}$
Q_g	Gate charge total	-	16	-	nC	$V_{DS} = 400\text{V}$, $V_{GS} = 0\text{V to } 10\text{V}$, $I_D = 3.4\text{A}$
Q_{gs}	Gate to source charge	-	4.78	-	nC	$V_{DS} = 400\text{V}$, $V_{GS} = 0\text{V to } 10\text{V}$, $I_D = 3.4\text{A}$
Q_{gd}	Gate to drain charge	-	4.75	-	nC	$V_{DS} = 400\text{V}$, $V_{GS} = 0\text{V to } 10\text{V}$, $I_D = 3.4\text{A}$
Q_{oss}	Output charge	-	12.3	-	nC	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 400\text{V}$
$t_{d(on)}$	Turn-on delay time	-	34	-	ns	$V_{DS} = 400\text{V}$, $V_{GS} = 0\text{V to } 12\text{V}$, $I_D = 3.4\text{A}$, $R_{ON} = 47\Omega$, $R_{OFF} = 33\Omega$, $Z_{FB} = 120\Omega$ at 100MHz , see Figure 14
t_r	Rise time	-	2.7	-	ns	
$t_{d(off)}$	Turn-off delay time	-	85	-	ns	
t_f	Fall time	-	11	-	ns	

^{a)} Dynamic on-resistance

Reverse Device Characteristics, $T_J = 25^\circ\text{C}$ unless specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
I_S	Reverse current	-	-	3.2	A	$V_{GS} = 0V$, $T_C = 100^\circ\text{C}$, $\leq 50\%$ duty cycle
$I_{S(pulse)}$	Pulsed reverse current	-	-	6.3	A	$V_{GS} = 0V$, $V_{SD} = 6V$, pulse width $\leq 10\mu\text{s}$, $T_J = 150^\circ\text{C}$
V_{SD}	Reverse voltage ^{a)}	-	1.2	-	V	$V_{GS} = 0V$, $I_S = 1.15A$
		-	1.7	-	V	$V_{GS} = 0V$, $I_S = 2.3A$
t_{rr}	Reverse recovery time	-	24	-	ns	$I_S = 3.4A$, $V_{DD} = 400V$, $di/dt = 1000A/\mu\text{s}$
Q_{rr}	Reverse recovery charge ^{b)}	-	1.7	-	nC	

^{a)} Including the effect of dynamic on-resistance

^{b)} Excluding Q_{oss}

5. Typical Characteristics ($T_C = 25^\circ\text{C}$ unless specified)

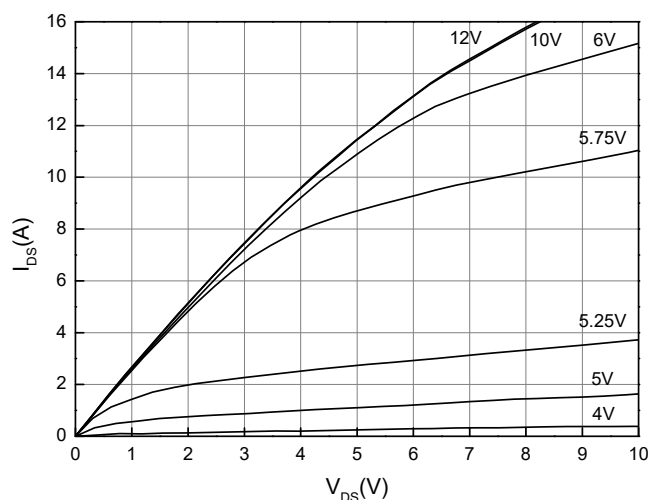


Figure 1. Typical Output Characteristics at $T_J = 25^\circ\text{C}$
(Parameter: V_{GS})

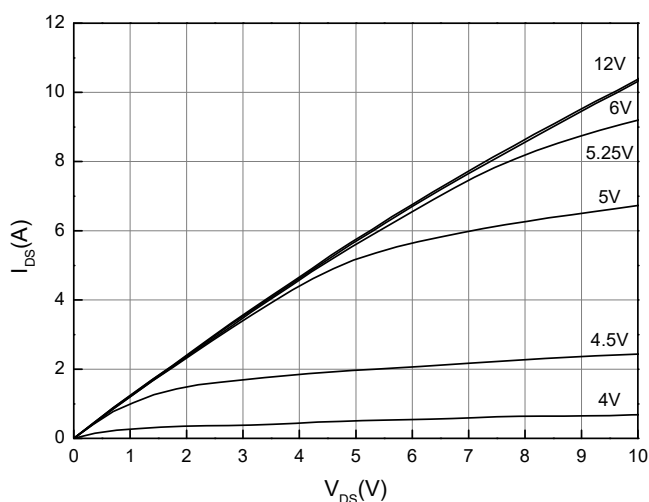


Figure 2. Typical Output Characteristics at $T_J = 150^\circ\text{C}$
(Parameter: V_{GS})

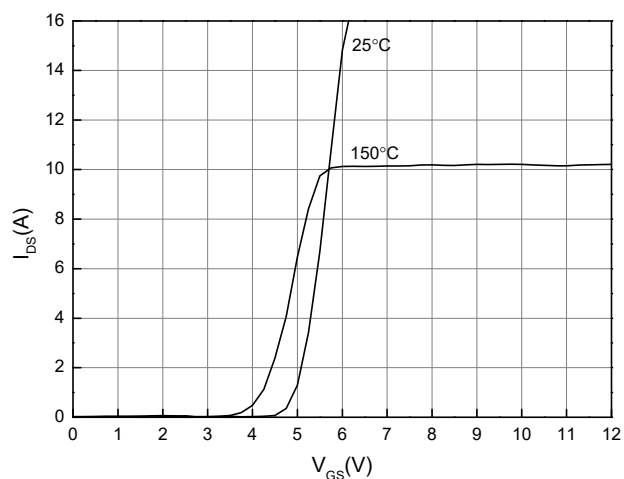


Figure 3. Typical Transfer Characteristics
($V_{DS} = 10\text{V}$, Parameter: T_J)

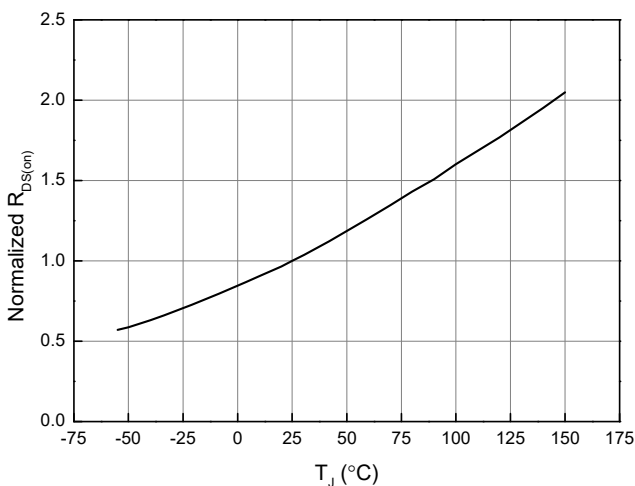


Figure 4. Normalized On-Resistance
($I_D = 3.4\text{A}$, $V_{GS} = 10\text{V}$)

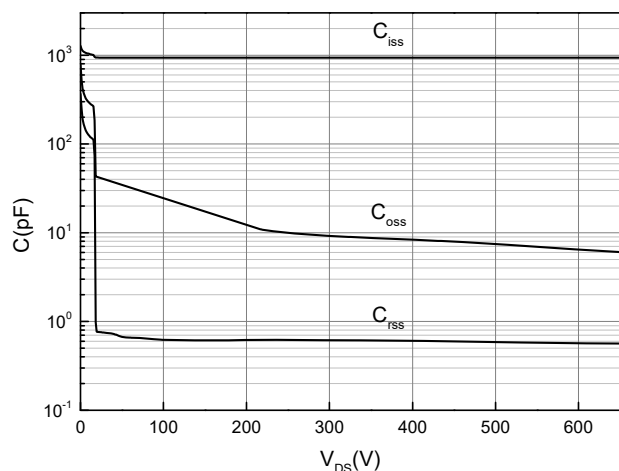


Figure 5. Typical Capacitance
($V_{GS} = 0V$, $f = 500kHz$)

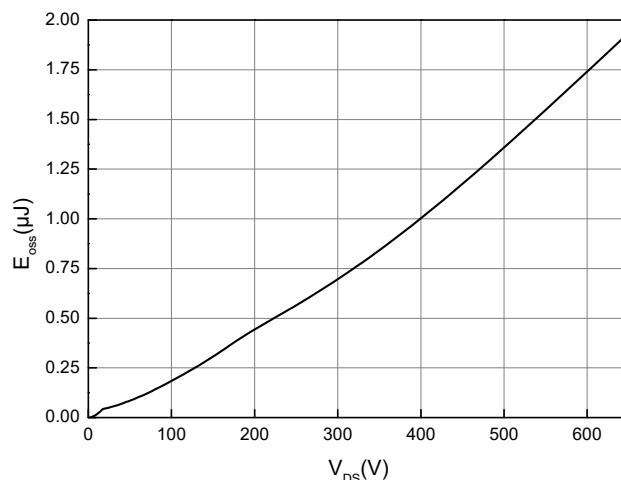


Figure 6. Typical C_{oss} Stored Energy

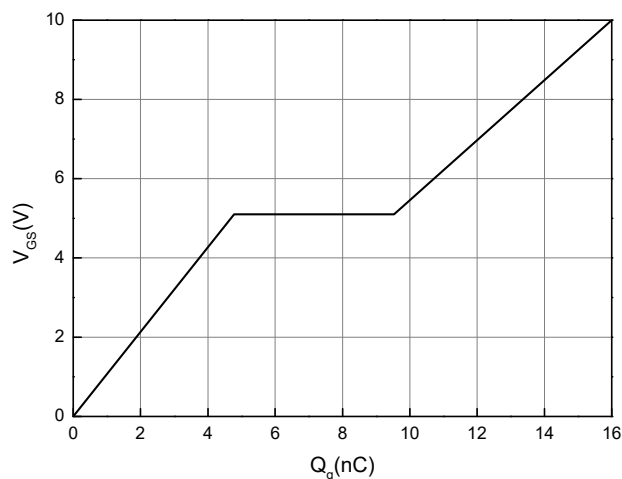


Figure 7. Typical Gate Charge
($I_{DS} = 3.4A$, $V_{DS} = 400V$)

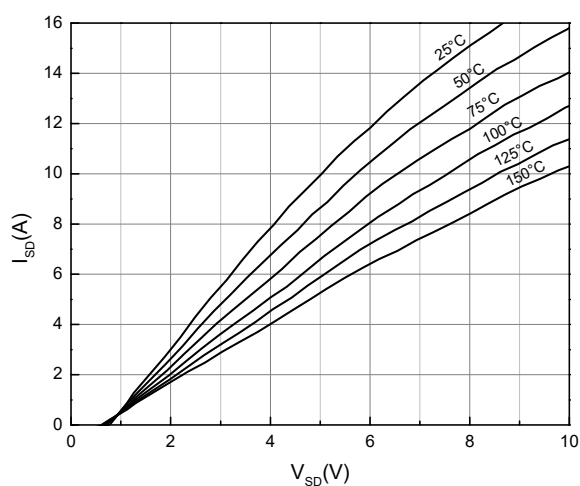


Figure 8. Reverse Conduction Characteristics
($-20V \leq V_{GS} \leq 0V$, Parameter: T_J)

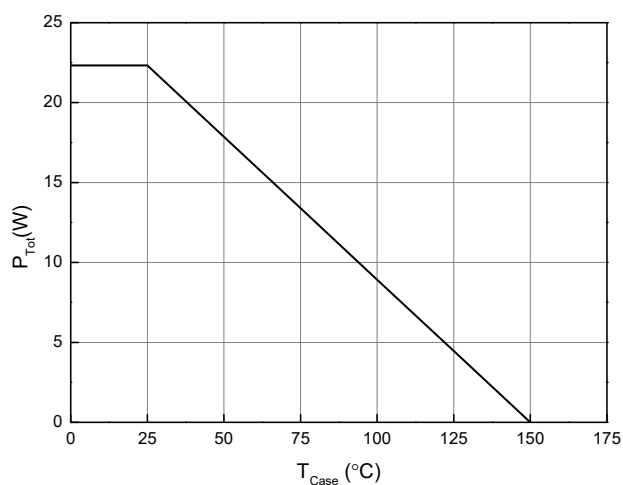


Figure 9. Power Dissipation

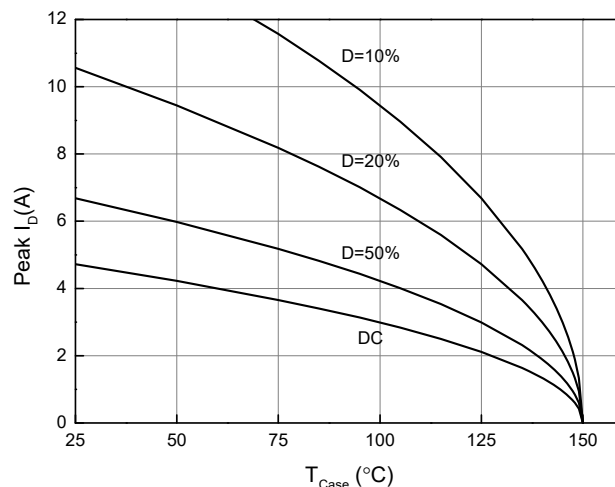


Figure 10. Current Derating
(Pulse Width $\leq 10\mu s$, $V_{GS} \geq 10V$)

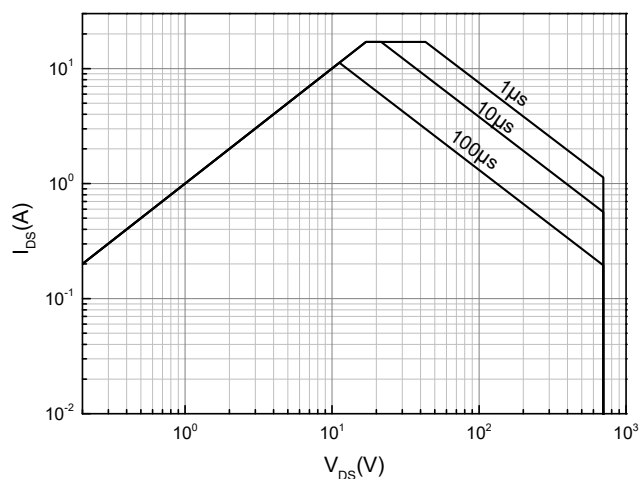


Figure 11. Safe Operating Area at $T_C = 25°C$

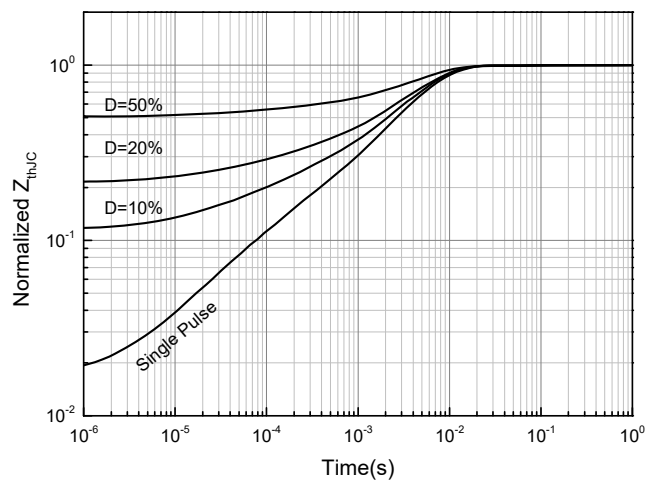


Figure 12. Normalized Transient Thermal Resistance

6. Design Considerations

The fast switching of GaN devices reduces current-voltage crossover losses and enables high frequency operation while simultaneously achieving high efficiency. However, taking full advantage of the fast switching characteristics of GaN switches requires adherence to specific PCB layout guidelines and probing techniques.

DO	DO NOT
Place gate driver close to the GaN device and separate input traces from output traces	Use long gate drive traces, long lead length and route the output traces next to the input
Use gate ferrite bead and dc-link RC snubber	Use close-by decoupling capacitor without series resistor
Minimize trace length of the PCB layout for both drive loop and power loop	Use a traditional differential voltage probe for V_{gs} of high side device

7. Circuit Implementation

(1) Flyback Schematic

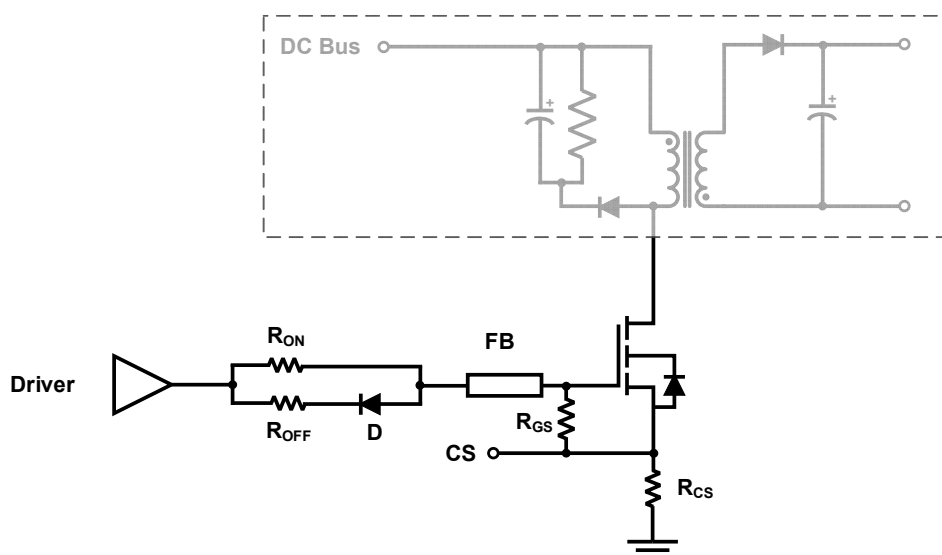


Figure 13. Simplified flyback schematic

Recommended gate drive: (0V, 12V)

Ferrite Bead (FB)	R_{ON}	R_{OFF}
120Ω at 100MHz	30-330Ω	10-50Ω

(2) Half-bridge Schematic

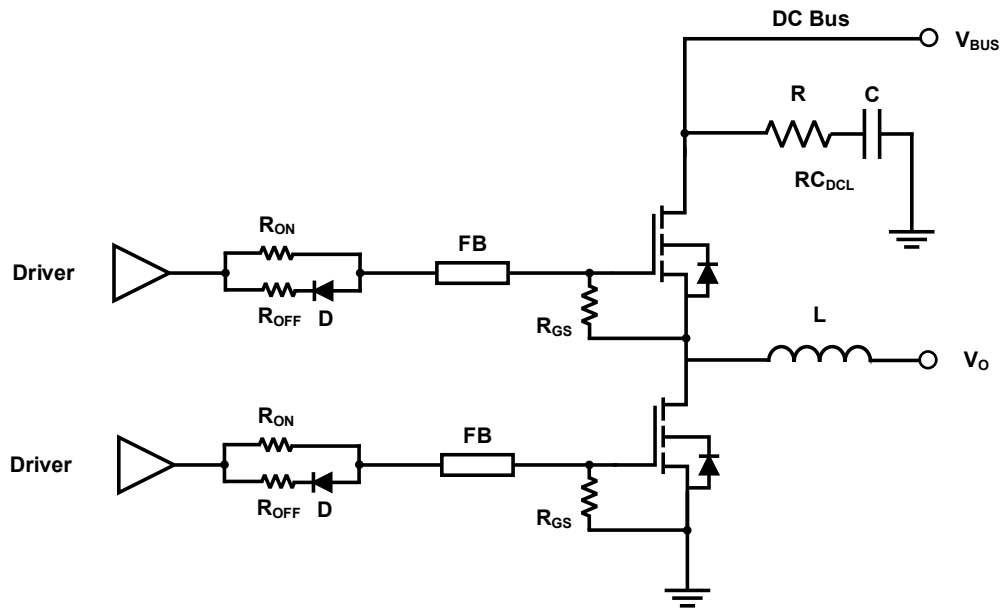


Figure 14. Simplified half-bridge schematic

Recommended gate drive: (0V, 12V) with $R_{ON} = 47\Omega$, $R_{OFF} = 33\Omega$ ^{a)}

Gate Ferrite Bead (FB) ^{b)}	Required DC Link RC Snubber (RC_{DCL}) ^{c)}
60-120 Ω @100MHz	(4.7-10)nF + 5 Ω

Notes:

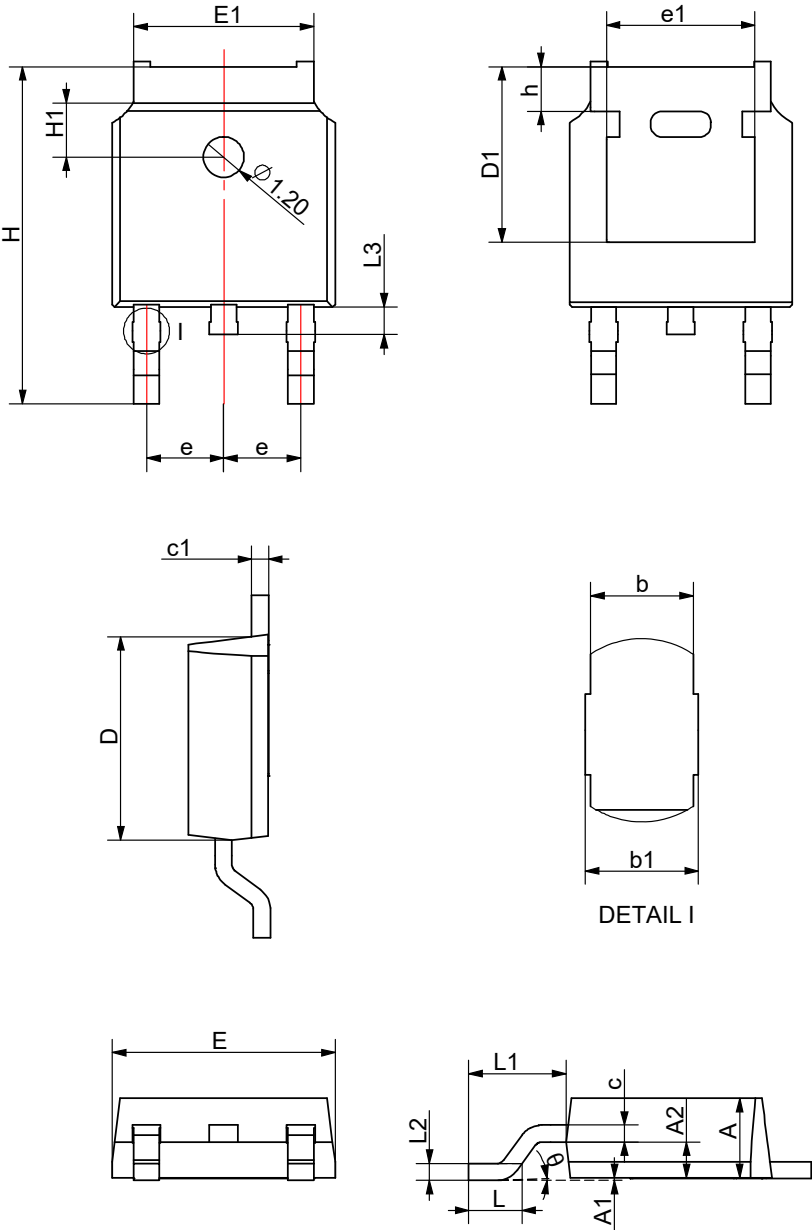
^{a)} For bridge topologies only. 1N4148 can be used for Diode D.

^{b)} Examples of material selection: MPZ2012S***AT000(TDK), BLM21PG***SZ1D(Murata).

^{c)} RC_{DCL} should be placed as close as possible to the drain pin. Other decoupling capacitors should be located away from the RC_{DCL} .

^{d)} The typical value of R_{GS} is 10k Ω .

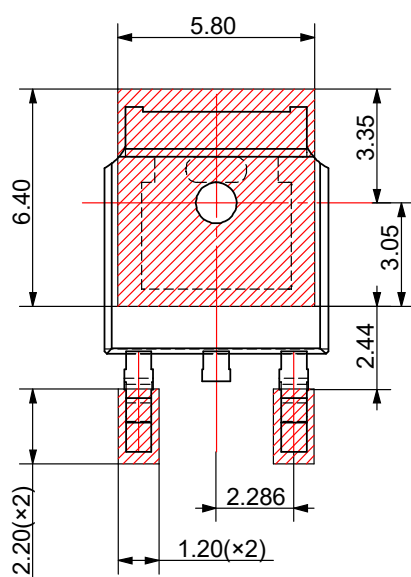
8. Package Dimensions



DIM.	Millimeters		
	MIN.	NOM.	MAX.
A	2.20	2.30	2.40
A1	0.00	0.075	0.15
A2	0.97	1.02	1.07
b	0.60	0.67	0.74
b1	0.65	—	1.15
c	0.508	0.528	0.548
c1	0.478	0.508	0.538
D	6.00	6.10	6.20
D1	5.15	5.25	5.35
E	6.50	6.60	6.70
E1	5.184	5.334	5.484
e	2.286BSC		
e1	4.806	4.826	4.846
H	9.80	10.00	10.20
H1	1.50	1.60	1.70
h	1.15	1.25	1.35
L	1.40	1.50	1.60
L1	2.888REF		
L2	0.51BSC		
L3	0.80	0.90	1.00
θ	0°	—	10°
TO-252-3L			
GaNNext			
DATE: 2022.12			Rev. 01

Lead Finish: Sn Plating

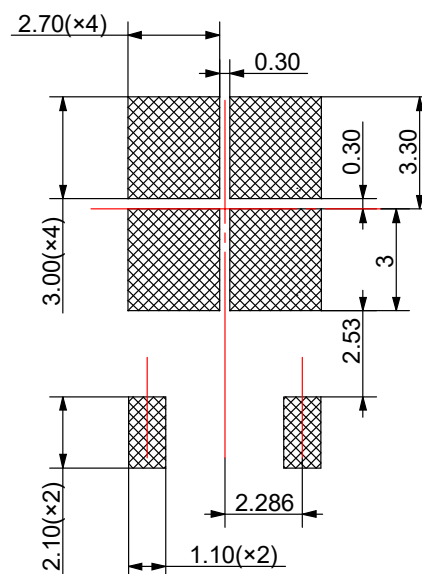
9. Recommended PCB Land Pattern



 Footprint

TOP VIEW

Recommended PCB footprint



TOP VIEW

Recommended stencil apertures
(Based on stencil thickness of 0.130mm)

10. Part Marking

