TP65H050G4BS

650V Cascode GaN FET in TO-263 (source tab) Preliminary Datasheet

Description

The TP65H050G4BS 650V, 50 mΩ gallium nitride (GaN) FET is a normally-off device using Transphorm's Gen IV platform. It combines a state-of-the-art high voltage GaN HEMT with a low voltage silicon MOSFET to offer superior reliability and performance.

The Gen IV SuperGaN™ platform uses advanced epi and patented design technologies to simplify manufacturability while improving efficiency over silicon via lower gate charge, output capacitance, crossover loss, and reverse recovery charge.

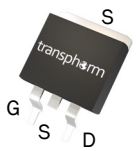
Related Literature

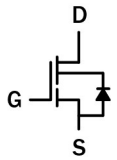
- AN0009: Recommended External Circuitry for GaN FETs
- AN0003: Printed Circuit Board Layout and Probing

Ordering Information

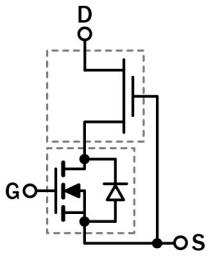
Part Number	Package	Package Configuration
TP65H050G4BS	TO-263	Source Tab

TP65H050G4BS
TO-263
(top view)





Cascode Schematic Symbol



Cascode Device Structure

Features

- GaN technology for automotive applications
- Dynamic $R_{DS(on)eff}$ production tested
- Robust design, defined by
  - Intrinsic lifetime tests
  - Wide gate safety margin
  - Transient over-voltage capability
- Very low Q_{RR}
- Reduced crossover loss
- RoHS compliant and Halogen-free packaging

Benefits

- Enables AC-DC bridgeless totem-pole PFC designs
  - Increased power density
  - Reduced system size and weight
  - Overall lower system cost
- Achieves increased efficiency in both hard- and soft-switched circuits
- Easy to drive with commonly-used gate drivers
- GSD pin layout improves high speed design

Applications

- Datacom
- Broad industrial
- PV inverter
- Servo motor

Key Specifications	
V_{DS} (V) min	650
$V_{(TR)DSS}$ (V) max	800
$R_{DS(on)eff}$ (mΩ) max*	60
Q_{RR} (nC) typ	112
Q_G (nC) typ	16

* Dynamic on-resistance; see Figures 17 and 18

Absolute Maximum Ratings (T_C=25°C unless otherwise stated.)

Symbol	Parameter		Limit Value	Unit
V_{DSS}	Drain to source voltage (T_J = -55°C to 150°C)		650	V
$V_{(TR)DSS}$	Transient drain to source voltage [a]		800	
V_{GSS}	Gate to source voltage		±20	
P_D	Maximum power dissipation @T_C=25°C		119	W
I_D	Continuous drain current @T_C=25°C [b]		34	A
	Continuous drain current @T_C=100°C [b]		22	A
I_{DM}	Pulsed drain current (pulse width: 10µs)		150	A
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_{SOLD}	Soldering peak temperature [c]		260	°C

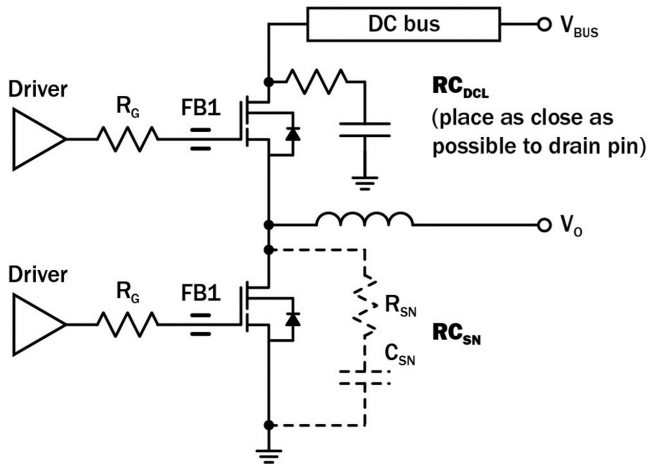
Notes:
a. In off-state, spike duty cycle D<0.01, spike duration <30µs, non repetitive
b. For increased stability at high current operation, see Circuit Implementation on page 3
c. For 10 sec., 1.6mm from the case

Thermal Resistance

Symbol	Parameter	Max	Unit
$R_{\Theta JC}$	Junction-to-case	1.05	°C/W
$R_{\Theta JA}$	Junction-to-ambient [d]	40	°C/W

Notes:
a. Device on PCB, minimal footprint

Circuit Implementation



Simplified Half-bridge Schematic (See also on Figure 13)

Layout Recommendations: (See also AN0009)

Gate Loop:

- Gate Driver: SiLab Si823x/Si827x
- Keep gate loop compact
- Minimize coupling with power loop

Power loop:

- Minimize power loop path inductance
- Minimize switching node coupling with high and low power plane
- Add DC bus snubber to reduce to voltage ringing
- Add Switching node snubber for high current operation

Recommended gate drive: (0V, 12V) with R_G= 45Ω

Gate Ferrite Bead (FB1)	Required DC Link RC Snubber (RC_{DCL}) [a]	Recommended Switching Node RC Snubber (RC_{SN}) [b, c]
240 – 300Ω at 100MHz	[4.7nF + 5Ω] x 2	Not necessary [b]

Notes:
a. RC_{DCL} should be placed as close as possible to the drain pin
b. RC_{SN} is needed only if R_G is smaller than recommendations

Electrical Parameters (T_J=25°C unless otherwise stated)

Symbol	Parameter	Min	Typ	Max	Unit	Test Conditions
Forward Device Characteristics						
$V_{(BL)DSS}$	Drain-source voltage	650	—	—	V	V_{GS}=0V
$V_{GS(th)}$	Gate threshold voltage	3.3	4	4.8	V	V_{DS}=V_{GS}, I_D=0.7mA
$R_{DS(on)eff}$	Drain-source on-resistance [a]	—	50	60	mΩ	V_{GS}=10V, I_D=22A
		—	105	—		V_{GS}=10V, I_D=22A, T_J=150°C
I_{DSS}	Drain-to-source leakage current	—	4	40	μA	V_{DS}=650V, V_{GS}=0V
		—	15	—		V_{DS}=650V, V_{GS}=0V, T_J=150°C
I_{GSS}	Gate-to-source forward leakage current	—	—	100	nA	V_{GS}=20V
		—	—	-100		V_{GS}=-20V
C_{ISS}	Input capacitance	—	1000	—	pF	V_{GS}=0V, V_{DS}=400V, *f*=1MHz
C_{OSS}	Output capacitance	—	110	—		
C_{RSS}	Reverse transfer capacitance	—	6	—		
$C_{O(er)}$	Output capacitance, energy related [b]	—	164	—	pF	V_{GS}=0V, V_{DS}=0V to 400V
$C_{O(tr)}$	Output capacitance, time related [c]	—	280	—		
Q_G	Total gate charge	—	16	24	nC	V_{DS}=400V, V_{GS}=0V to 10V, I_D=22A
Q_{GS}	Gate-source charge	—	6	—		
Q_{GD}	Gate-drain charge	—	5	—		
Q_{OSS}	Output charge	—	112	—	nC	V_{GS}=0V, V_{DS}=0V to 400V
$t_{D(on)}$	Turn-on delay	—	TBD	—	ns	V_{DS}=480V, V_{GS}=0V to 10V, I_D=22A
t_R	Rise time	—	TBD	—		
$t_{D(off)}$	Turn-off delay	—	TBD	—		
t_F	Fall time	—	TBD	—		

Notes:
a. Dynamic on-resistance; see Figures 17 and 18 for test circuit and conditions
b. Equivalent capacitance to give same stored energy as V_{DS} rises from 0V to 400V
c. Equivalent capacitance to give same charging time as V_{DS} rises from 0V to 400V

Electrical Parameters (T_J=25°C unless otherwise stated)

Symbol	Parameter	Min	Typ	Max	Unit	Test Conditions
Reverse Device Characteristics						
I_S	Reverse current	–	–	22	A	V_{GS}=0V, T_C=100°C, ≤25% duty cycle
V_{SD}	Reverse voltage [a]	–	2.2	2.6	V	V_{GS}=0V, I_S=22A
		–	1.6	1.9		V_{GS}=0V, I_S=11A
t_{RR}	Reverse recovery time	–	50	–	ns	I_S=22A, V_{DD}=400V
Q_{RR}	Reverse recovery charge	–	112	–	nC	
$(di/dt)_{RM}$	Reverse diode di/dt, transient [b]	–	–	2500	A/µs	

Notes:
a. Includes dynamic $R_{DS(on)}$ effect
b. Reverse conduction di/dt will not exceed this max value with recommended R_G

Test Circuits and Waveforms

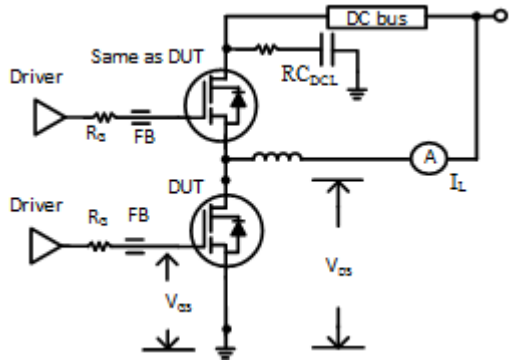


Figure 13. Switching Time Test Circuit
(see Circuit Implementation on page 3
for methods to ensure clean switching)

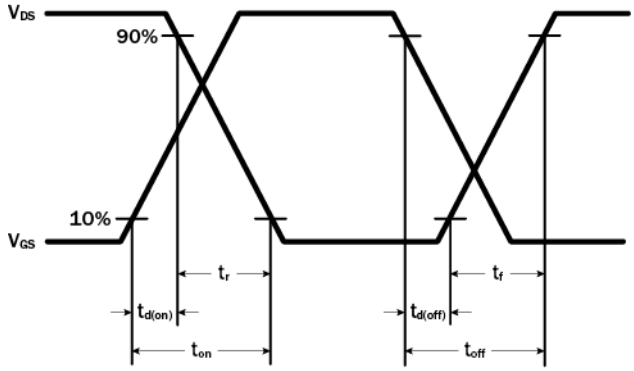


Figure 14. Switching Time Waveform

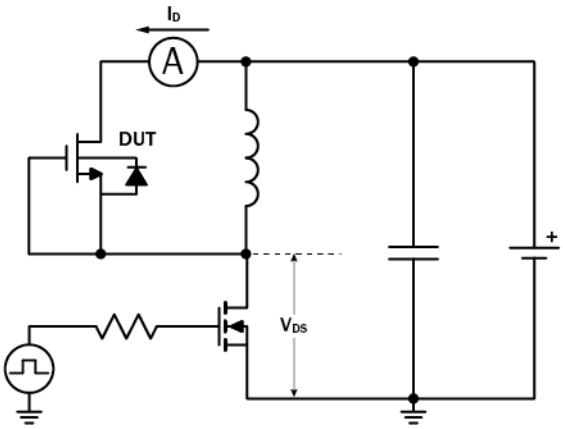


Figure 15. Diode Characteristics Test Circuit

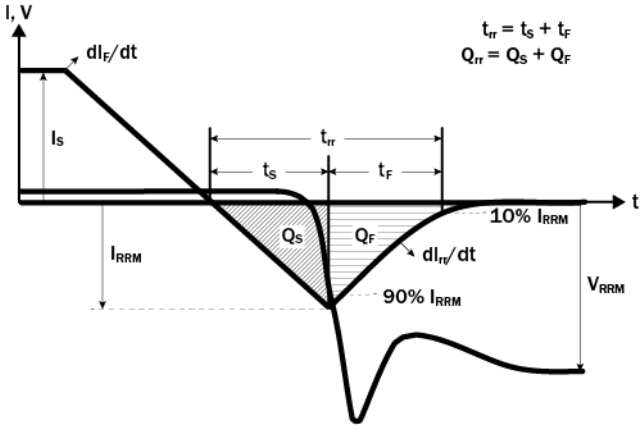


Figure 16. Diode Recovery Waveform

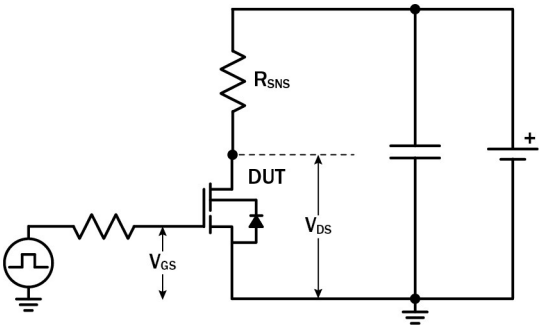


Figure 17. Dynamic $R_{DS(on)eff}$ Test Circuit

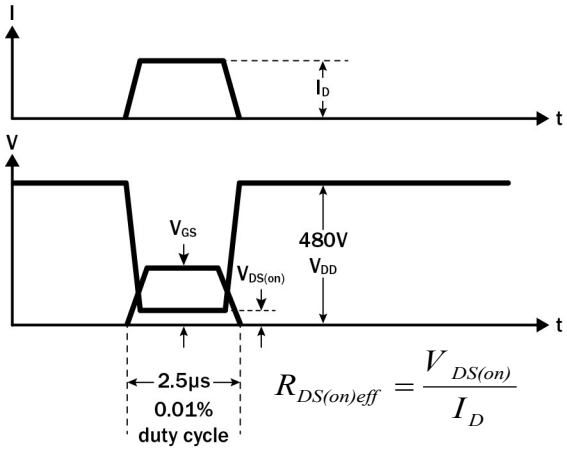


Figure 18. Dynamic $R_{DS(on)eff}$ Waveform

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.

Before evaluating Transphorm GaN devices, see application note Printed Circuit Board Layout and Probing for GaN Power Switches. The table below provides some practical rules that should be followed during the evaluation.

When Evaluating Transphorm GaN Devices:

DO	DO NOT
Minimize circuit inductance by keeping traces short, both in the drive and power loop	Use long traces in drive circuit, long lead length of the devices
Use shortest sense loop for probing; attach the probe and its ground connection directly to the test points	Use differential mode probe or probe ground clip with long wire
See AN0003: Printed Circuit Board Layout and Probing	

GaN Design Resources

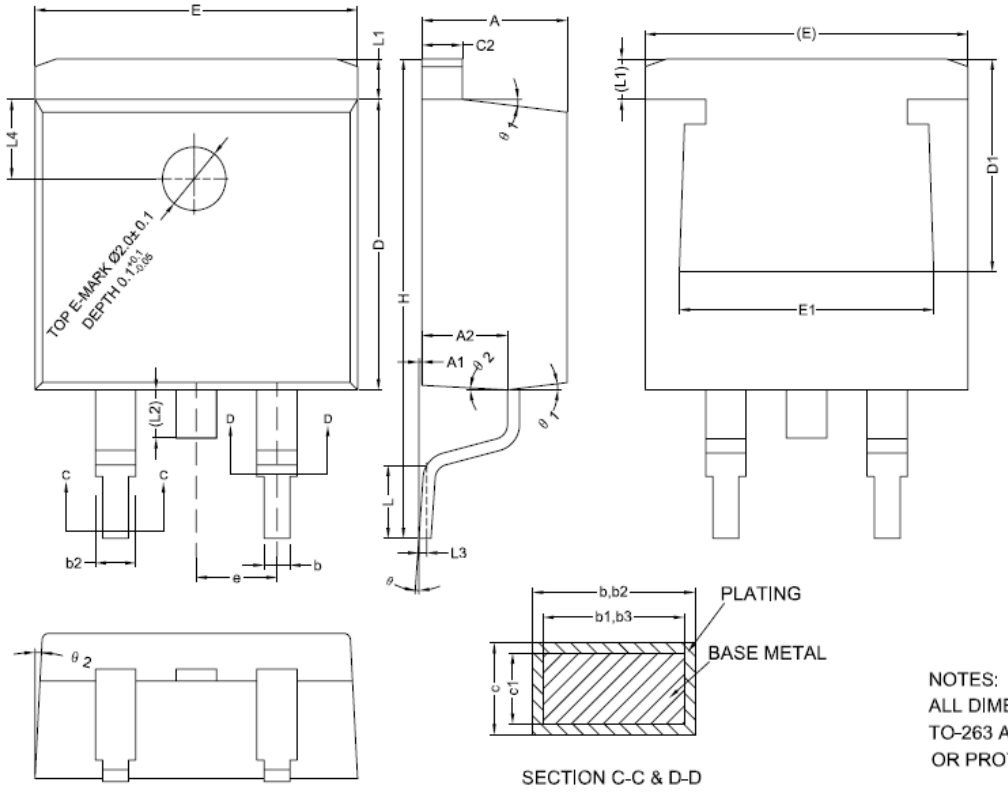
The complete technical library of GaN design tools can be found at transphormusa.com/design:

- Evaluation kits
- Application notes
- Design guides
- Simulation models
- Technical papers and presentations

Mechanical

3 Lead SMD TO-263 Package

Pin 1: Gate; Pin 2: Source; Pin 3: Drain, Tab: Source



SECTION C-C & D-D

COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	4.40	4.57	4.70
A1	0	0.10	0.25
A2	2.59	2.69	2.79
b	0.77	-	0.90
b1	0.76	0.81	0.86
b2	1.23	-	1.36
b3	1.22	1.27	1.32
c	0.34	-	0.47
c1	0.33	0.38	0.43
c2	1.22	-	1.32
D	9.05	9.15	9.25
D1	6.60	-	-
E	10.06	10.16	10.26
E1	7.80	-	8.20
e		2.54BSC	
H	14.70	15.10	15.50
L	2.00	2.30	2.60
L1	1.17	1.27	1.40
L2	-	-	1.75
L3		0.25BSC	
L4		2.00REF	
θ	0°	-	8°
θ 1	5°	7°	9°
θ 2	1°	3°	5°

NOTES:
ALL DIMENSIONS REFER TO JEDEC STANDARD TO-263 AB DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

Revision History

Version	Date	Change(s)
0	10/16/2020	Create preliminary datasheet