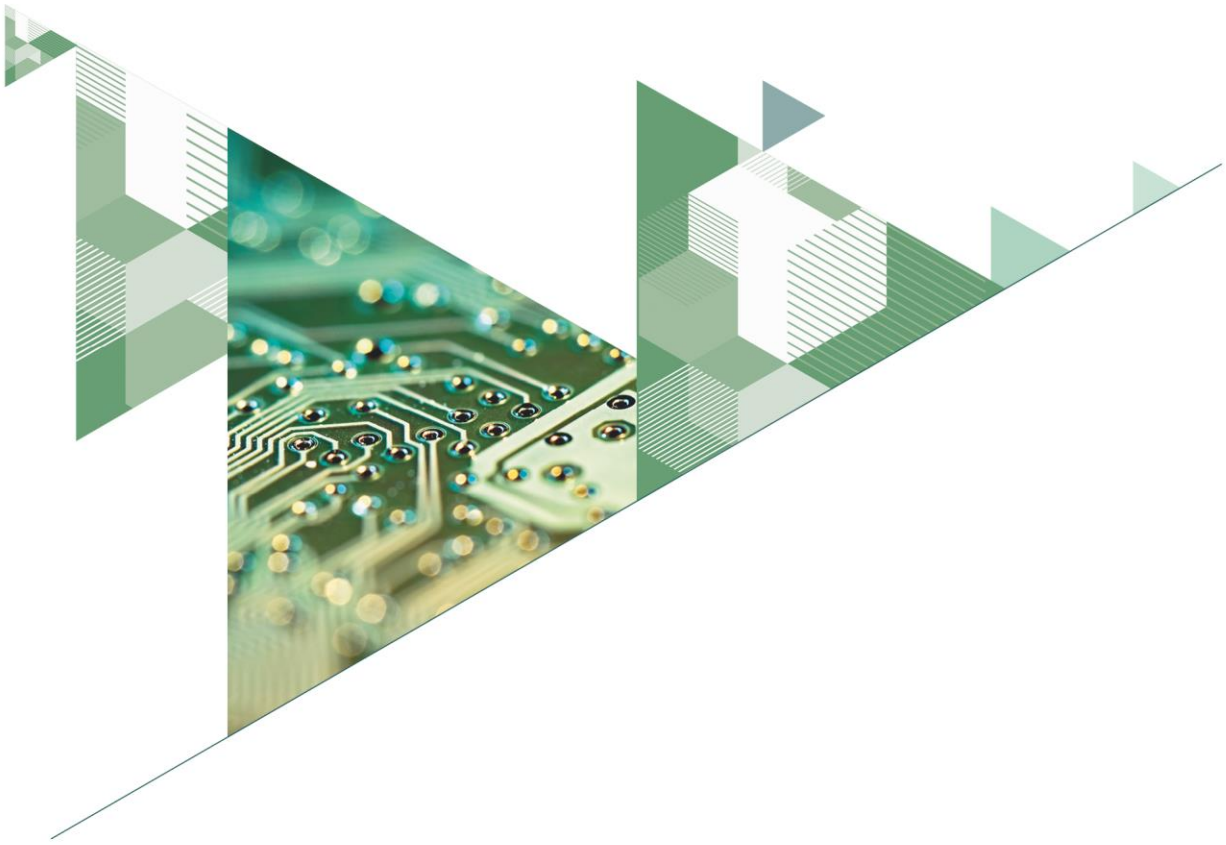


CGD65A130S2
DATASHEET

650 V / 130 mΩ GaN HEMT with ICeGaN™ Gate and Current Sense

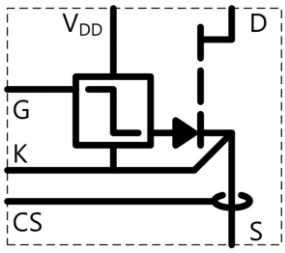
DECEMBER 2022

CAMBRIDGE GaN DEVICES

650 V / 130 mΩ GaN HEMT with ICeGaN™ Gate and Current Sense

Key features

- 650 V - 12 A e-mode GaN power switch
- ICeGaN™ gate technology for high gate threshold and broad gate voltage window compatible with gate-drivers for Si MOSFETs
- Gate drive voltage 9 V to 20 V
- Current sense function
- $R_{DS(on)}$ = 130 mΩ
- Suitable for very high switching frequency
- Kelvin Contact
- Small 8x8 mm^2 PCB footprint
- Bottom side cooled DFN package



Description

The CGD65A130S2 is an enhancement mode GaN-on-silicon power transistor, exploiting the unique material properties of GaN to deliver high current, high breakdown voltage and high switching frequency for a wide range of electronics applications. The CGD65A130S2 features CGD's ICeGaN™ gate technology enabling compatibility with virtually all gate drivers and controller chips available. The integrated current sense function eliminates a separate current sense resistor and the associated efficiency losses. Because no external sense resistor is needed, the device can be directly soldered to the large copper area of the ground plane, improving the thermal performance and simplifying the thermal design. It comes in a DFN 8x8 SMD package to support high frequency operation while ensuring the highest thermal performance.

Application & Topologies

PSUs, Industrial SMPS and inverters

- Server power and data centres
- Telecom rectifiers
- Gaming PSUs
- PC power
- LED drivers
- High power Class-D Audio
- General purpose SMPS
- PV inverters
- SMPS and converters in single-switch and half-bridge topologies with hard- or soft-switching
- AC/DC inverters
- Totem pole and single-switch PFC
- Forward, flyback and LLC converters at high frequency

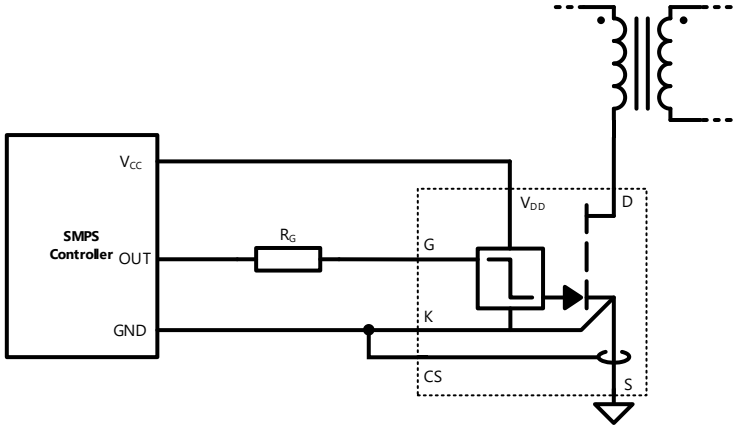
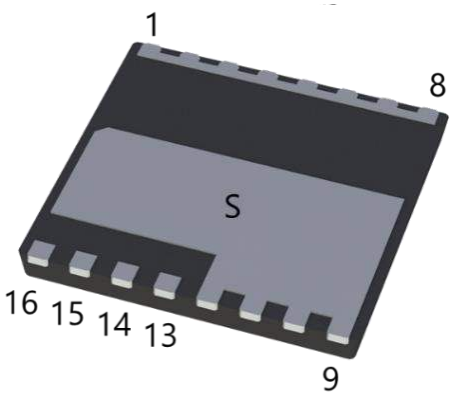


Figure 1. Exemplary Application Circuit



PIN	NAME	DESCRIPTION
1-8	Drain	Power HEMT drain
9-12	Source	Power HEMT source, thermal pad
13	Kelvin Source	Kelvin source connection (internally tied to power HEMT source), reference potential for gate voltage.
14	Gate	Gate signal input. Recommended gate-drive voltage: V_{drive} (V_{GS} in on-state) = 9 V to V_{DD}.
15	Current Sense	Current sense output, relative to source, non-isolated.
16	V_{DD}	ICeGaN™ gate supply voltage (recommended at 12 V), relative to source.

Figure 2. Pin Configuration and Functions

Absolute Maximum Ratings

T_{case} = 25 °C if not listed.

PARAMETER		VALUE	UNIT
Operating Junction Temperature	T_J	-55 to +150	°C
Storage Temperature Range	T_S	-55 to +150	°C
Drain-to-Source Voltage	V_{DS}	650	V
Drain-to-Source Voltage - transient [1]	$V_{DS(transient)}$	750	V
Gate-to-Source Voltage	V_{GS}	-1 to +20 and $V_{GS} \leq V_{DD}$	V
Gate-to-Source Voltage - transient [2]	$V_{GS(transient)}$	-1.5 to +21.5 and $V_{GS} \leq V_{DD}$ + 1.5	V
Current Sense Voltage	V_{CS}	-1.5 to 1.5	V
ICeGaN™ Gate Supply Voltage	V_{DD}	0 to +20	V
Continuous Drain Current (T_{case}= 25 °C)	I_D	12	A

The recommended range of operation for V_{drive} (V_{GS} in on-state) and V_{DD} is 9 V to 20 V, enabling simple integration with a large variety of control chips and gate drivers.
Recommended maximum operating case temperature: T_{case} = 125 °C.

[1] Non-repetitive pulsed conditions, < 1 ms.

[2] Non-repetitive pulsed conditions.

Electrical Characteristics

Values at T_J = 25 °C, V_{DD} = 12 V if not listed. To turn the device on the recommended gate voltage range is V_{GS} = 9 V to V_{DD}. To turn the device off set V_{GS} = 0 V. An integrated Miller Clamp eliminates the need for negative gate voltages.

STATIC CHARACTERISTICS

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNIT
Drain-to-Source Blocking Voltage	BV_{DS}	V_{GS} = 0 V, I_{DSS} = 8.5 µA	650			V
Drain-to-Source On Resistance	$R_{DS(on)}$	V_{GS} = 12 V, I_D = 0.9 A		130	182	mΩ
Drain-to-Source On Resistance	$R_{DS(on)}$	T_J = 150 °C V_{GS} = 12 V, I_D = 0.9 A		350		mΩ
Source-to-Drain Voltage	$V_{SD(on)}$	V_{GS} = 0 V, I_D = 0.9 A		2.0	3.7	V
Gate-to-Source Threshold	$V_{GS(th)}$	V_{DS} = 0.1 V, I_D = 4.2 mA	2.2	2.9	4.2	V
Gate-to-Source Threshold	$V_{GS(th)}$	T_J = 150 °C V_{DS} = 0.1 V, I_D = 4.2 mA		2.6		V
Gate-to-Source Current	I_{GS}	V_{GS} = 12 V, V_{DS}= 0 V		2.8	3.7	mA
Gate-to-Source Current	I_{GS}	T_J = 150 °C V_{GS} = 12 V, V_{DS}= 0 V		2.5		mA
V_{DD} current	I_{VDD}	V_{GS} = 12 V, V_{DS}= 0 V		1.8	2.8	mA
V_{DD} current	I_{VDD}	T_J = 150 °C V_{GS} = 12 V, V_{DS}= 0 V		1.1		mA
Drain-to-Source Leakage Current	I_{DSS}	V_{GS} = 0 V, V_{DS} = 650 V		0.2	8.5	µA
Drain-to-Source Leakage Current	I_{DSS}	TJ = 150 °C V_{GS} = 0 V, V_{DS} = 650 V		12		µA

DYNAMIC CHARACTERISTICS

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNIT
Output Capacitance	C_{OSS}	V_{DS} = 400 V, V_{GS} = 0 V f = 100 kHz		25		pF
Output Charge	Q_{OSS}	V_{DS} = 400 V, V_{GS} = 0 V		25		nC
Total Gate Charge[3]	Q_G	V_{DS} = 400 V, V_{GS} = 0...12 V I_D = 4.2 A, I_G= 20 mA		2.3		nC
Reverse Recovery Charge	Q_{RR}	I_S = 8 A, V_{DS} = 400 V		0		nC
Turn-on delay time	$t_{d(on)}$	See Figure 17 and Figure 18		6		ns
Turn-off delay time	$t_{d(off)}$	See Figure 17 and Figure 18		20		ns
Rise time	t_r	See Figure 17 and Figure 18		6		ns
Fall time	t_f	See Figure 17 and Figure 18		6		ns

[3] Turn-on gate charge value is listed. Turn-off gate charge value is lower, because ICeGaN™ gate discharges the gate internally.

CURRENT SENSING

Please refer to the application note CG-AN2206: Current Sensing with ICeGaN™. Please contact CGD for advice on the use of the current sense function.

ESD RATING

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNIT
ESD withstand rating	HBM	Human Body Model (per JEDEC JS-001-2017)	2000			V

Thermal Characteristics

Typical values unless otherwise specified.

PARAMETER		CONDITIONS	VALUE	UNIT
Thermal resistance, junction to case	$R_{th(JC)}$		2.3	°C/W
Maximum reflow soldering temperature	T_{reflow}	MSL 3	260	°C

Figures

Figures at T_J = 25 °C, V_{DD} = 12 V if not specified.

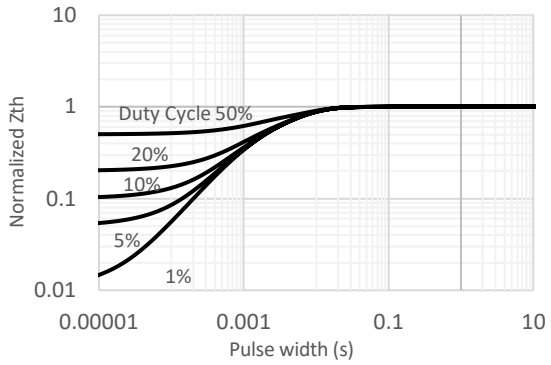


Figure 3. Normalized thermal transient impedance ($Z_{th,JC}$) as a function of pulse width.

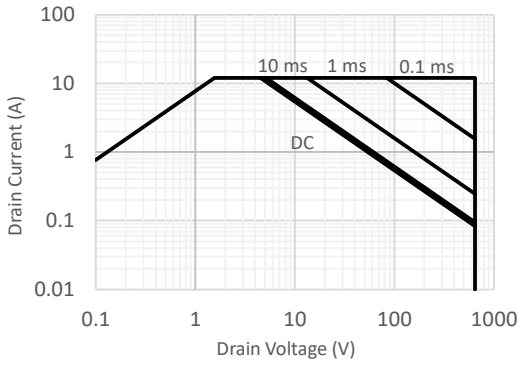


Figure 4. Safe Operating Area (SOA) based on thermal impedance $Z_{th,JC}$ at T_{CASE} = 25 °C.

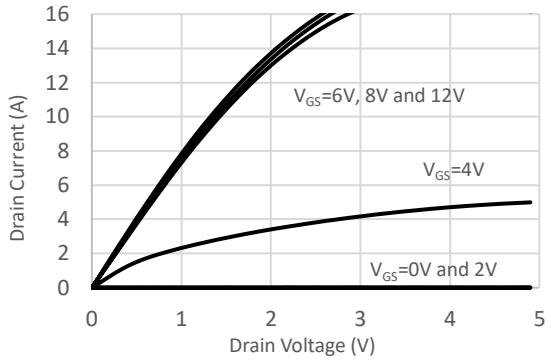


Figure 5. Forward output characteristics at T_J = 25 °C.

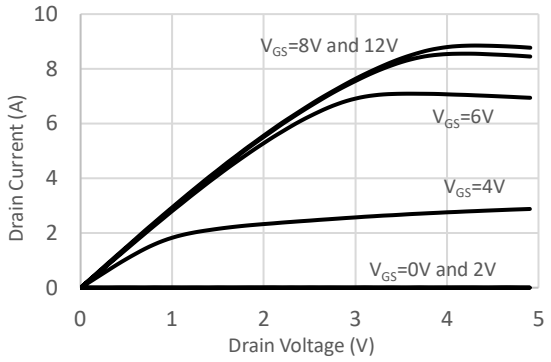


Figure 6. Forward output characteristic at T_J = 150 °C.

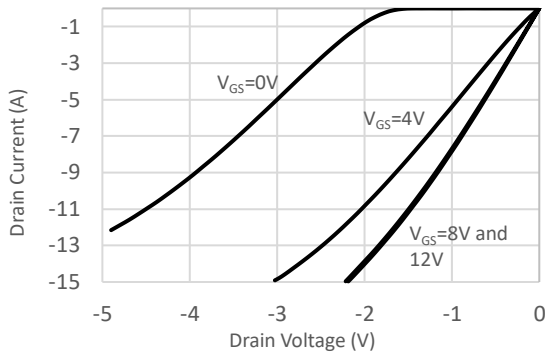


Figure 7. Reverse output characteristics at T_J = 25 °C.

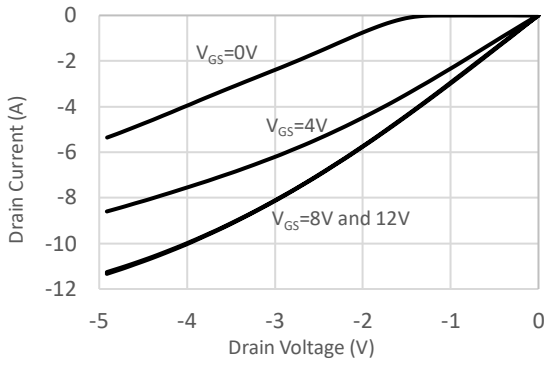


Figure 8. Reverse output characteristics at T_J = 150 °C.

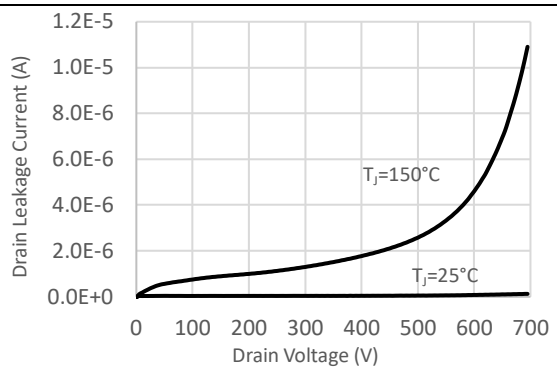


Figure 9. Drain leakage current characteristics at T_J = 25 °C and T_J = 150 °C.

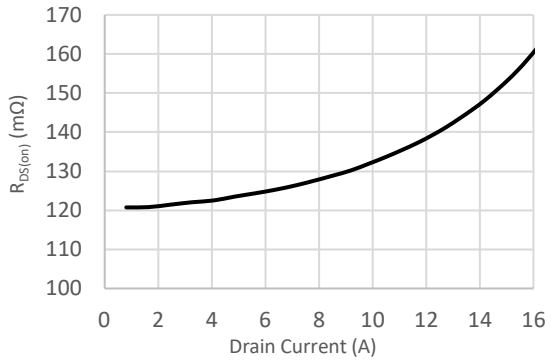


Figure 10. On-state resistance as a function of drain current at T_J = 25 °C.

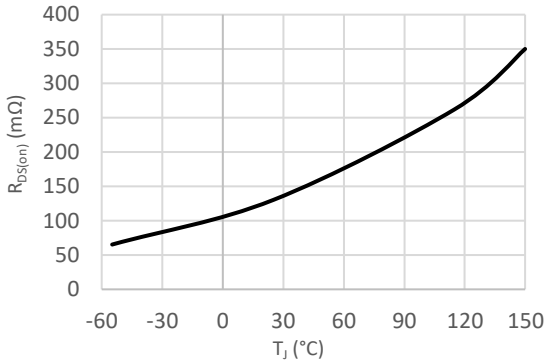


Figure 11. On-state resistance as a function of junction temperature at V_{GS} = 12 V.

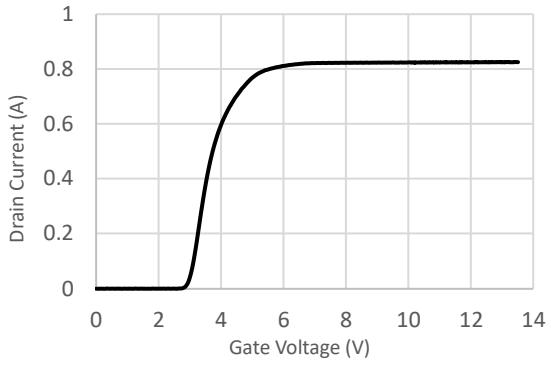


Figure 12. Transfer characteristics at V_{DS} = 0.1 V, T_J = 25 °C.

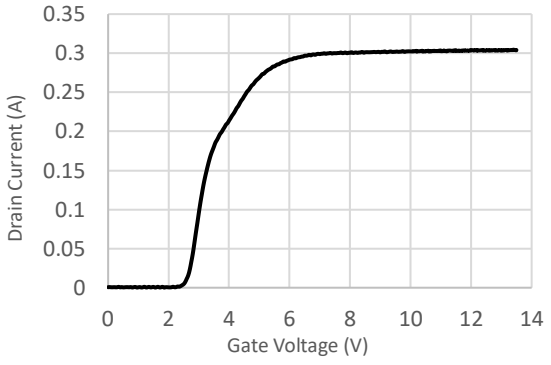


Figure 13. Transfer characteristics at V_{DS} = 0.1 V, T_J = 150 °C.

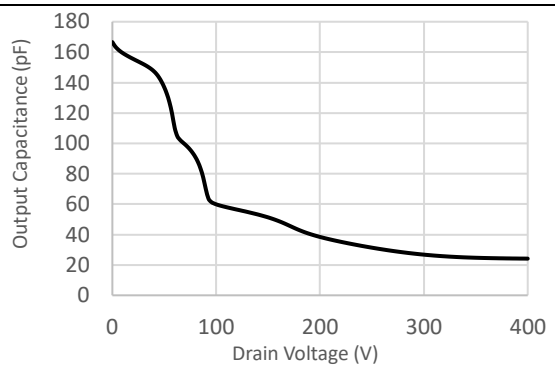


Figure 14. Typical output capacitance C_{OSS} vs. V_{DS} at 100 kHz, T_J = 25 °C.

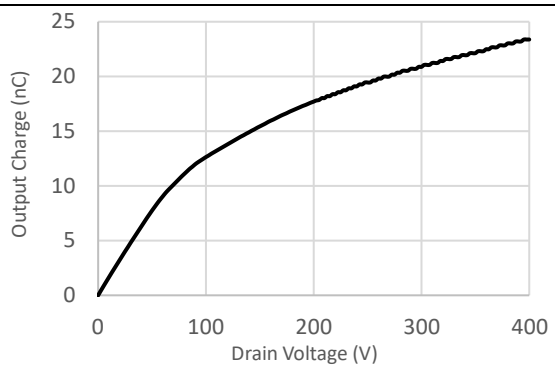


Figure 15. Typical output charge Q_{OSS} vs. V_{DS} at 100 kHz, T_J = 25 °C.

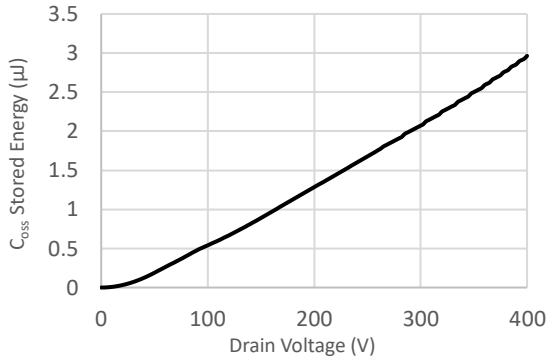


Figure 16. Typical C_{OSS} stored energy E_{OSS} vs. V_{DS} at T_J = 25 °C.

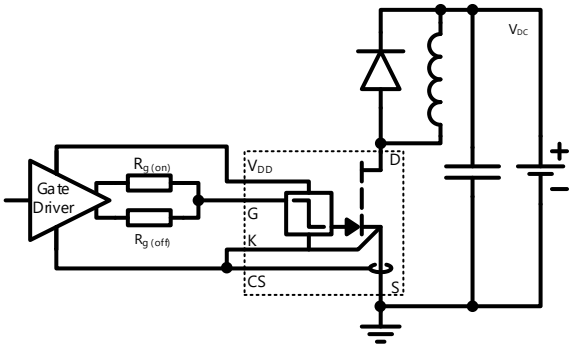


Figure 17. Inductive switching circuit. I_D = 6 A, $R_{g(on)}$ = 15 Ω, $R_{g(off)}$ = 2 Ω, V_{DD} = 12 V, V_{DC} = 400 V, L = 125 µH, diode = IDH04G65C5.

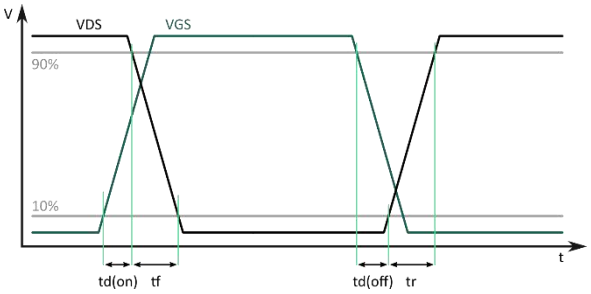


Figure 18. Switching waveform timing definitions.

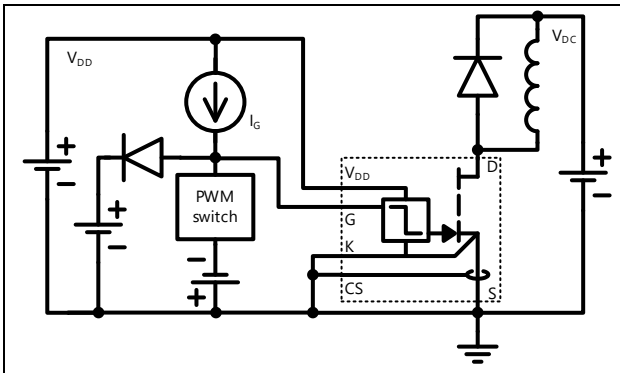


Figure 19. Q_G gate charge characterization circuit. I_G=20 mA, V_{DC} = 400 V, V_{DD}=12V, L = 125 µH, freewheeling diode = IDH04G65C5.

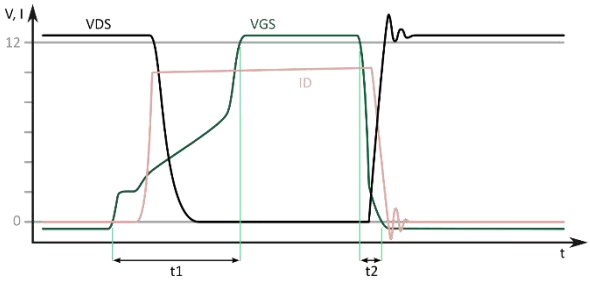
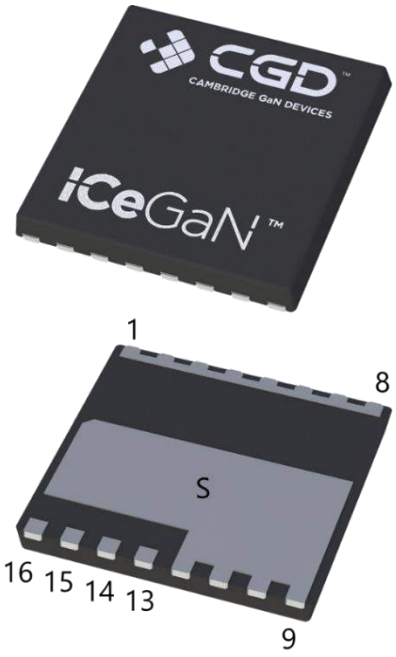


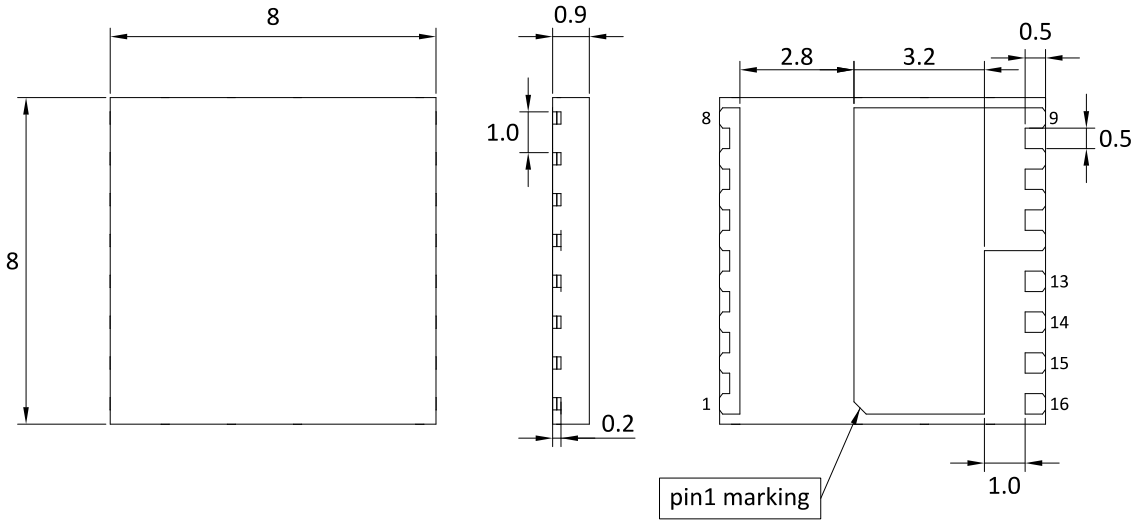
Figure 20. Q_G gate charge characterisation waveform at I_G = 20 mA and V_{DD} = 12 V. Time intervals t1 and t2 indicate the integration boundaries to calculate Q_G from I_G at turn-on and turn-off. Turn-off gate charge is lower than turn-on gate charge.

Packaging

DFN8x8 mm.

PIN NUMBER	NAME
1-8	Drain
9-12	Source
13	Kelvin Source
14	Gate
15	Current Sense
16	V_{DD}

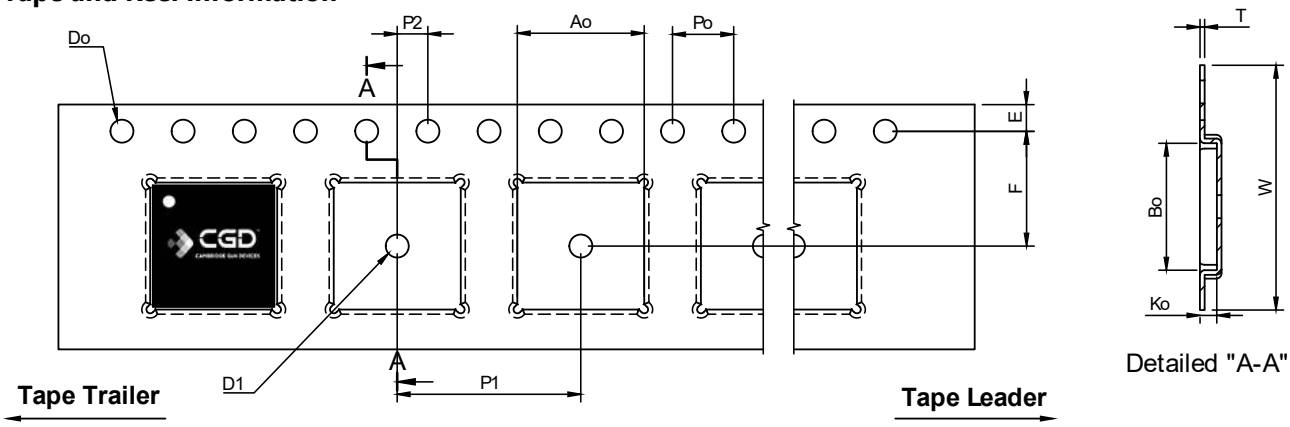




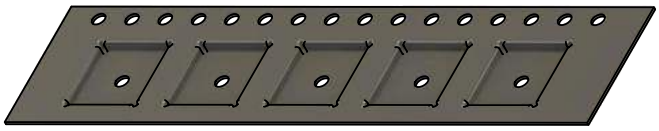
top view bottom view

Like any unwanted electronic device, CGD components should be recycled or otherwise disposed of in accordance with local laws and regulations.

Tape and Reel Information

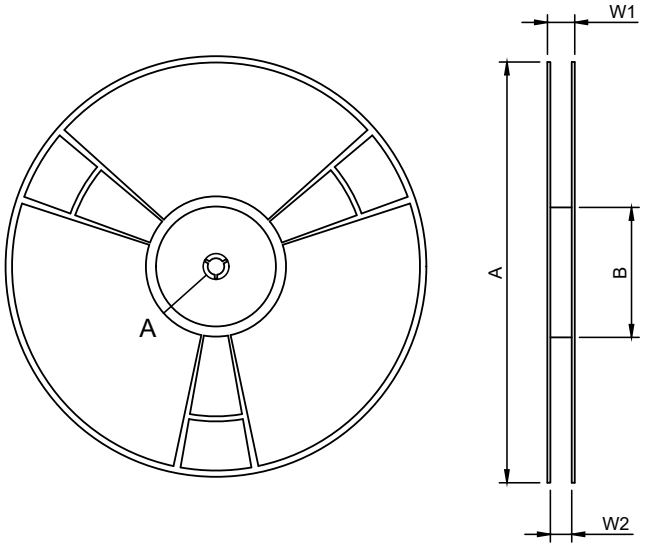


Tape Trailer - a minimum length of 160mm empty cavities sealed with cover tape.
Tape Leader - a minimum length of 400mm empty cavities sealed with cover tape.



Isometric View

Dimensions (mm)		
	Nominal	Tolerance
Ao	8.30	± 0.10
Bo	8.30	± 0.10
Ko	1.25	± 0.05
E	1.75	± 0.10
F	7.50	± 0.10
Po	4.00	± 0.10
P1	12.00	± 0.10
P2	2.00	± 0.10
W	16.00	± 0.3
T	0.30	± 0.05
Do	Ø1.50	+ 0.1 / - 0.0
D1	Ø1.50	+ 0.2 / - 0.0



13" Reel Dimensions (mm)		
	Min	Max
W1		22.2
W2	16.6	17.1
A	328.0	332.0
B	100.0	104.0
C	20.2	
D	1.5	2.5
E	12.8	13.5

Version History

This version is 1.0

VERSION	DESCRIPTION	DATE	BY
1.0	Initial Release	December 2022	MA, AB, JZ

Dare to innovate differently

CGD™
CAMBRIDGE GaN DEVICES

Cambridge GaN Devices Limited
Jeffreys Building, Suite 8
St John's Innovation Park
Cambridge
CB4 0DS