

CoolGaN™ Gen2

PG-DSO-20

650 V CoolGaN™ enhancement-mode Power Transistor

Infineon's CoolGaN™ is a highly efficient GaN (gallium nitride) transistor technology for power conversion in the voltage range up to 650 V. With extensive experience on the semiconductor market, Infineon's GaN technology brought the e-mode concept to maturity with end-to-end production in high volumes. The pioneering quality ensures the highest standards and offers the most reliable and performing solution among all GaN HEMTs on the market.

Features

- Enhancement mode transistor - Normally OFF switch
- Ultra fast switching
- No reverse-recovery charge
- Capable of reverse conduction
- Low gate charge, low output charge
- Superior commutation ruggedness
- ESD (HBM/CDM) JEDEC standards

Benefits

- Improves system efficiency
- Improves power density
- Enables highest operating frequency
- System cost reduction savings
- Reduces EMI

Potential applications

Industrial, telecom, datacenter SMPS, charger and adapter based on half-bridge topologies (half-bridge topologies for hard and soft switching such as Totem pole PFC, high frequency LLC).

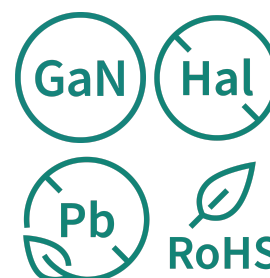
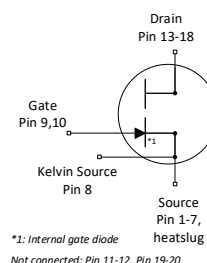
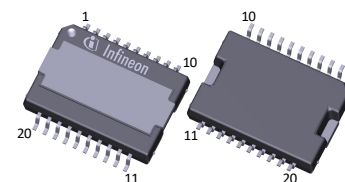
Product validation

Fully qualified according to JEDEC for Industrial Applications

Please note: Target Datasheet to change without further notice

Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS,max}$	650	V
$R_{DS(on),max}$	42	mΩ
$Q_{g,typ}$	11.0	nC
$I_{D,pulse}$	90	A
$Q_{oss} @ 400 V$	58	nC
Q_{rr}	0	nC



Type/Ordering Code	Package	Marking	Related Links
IGOT65R035D2	PG-DSO-20	65R035D2	see Appendix A



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Datasheet

1 Maximum ratings

at $T_j = 25\text{ °C}$, unless otherwise specified. Stresses beyond max ratings may cause permanent damage to the device. For optimum lifetime and reliability, Infineon recommends operating conditions that do not continuously exceed 80 % of the maximum ratings stated (unless otherwise explicitly stated). For further information, contact your local Infineon sales office.

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Drain source voltage, continuous	$V_{DS,max}$	-	-	650	V	$V_{GS} = 0\text{ V}$, derating recommendation acc. JEDEC JEP198
Leakage current at drain source transient voltage	$I_{DS,trans}$	-	-	20	mA	$V_{GS} = 0\text{ V}$, $V_{DS,trans} = 900\text{ V}$
Drain source voltage transient	$V_{DS,trans}$	-	-	900	V	<1 % duty cycle, <1 μs , 1 M pulses
Drain source voltage, pulsed	$V_{DS,pulse}$	-	-	750	V	$T_j = 25\text{ °C}$; $V_{GS} \leq 0\text{ V}$; cumulated stress time $\leq 1\text{ h}$ $T_j = 125\text{ °C}$; $V_{GS} \leq 0\text{ V}$; cumulated stress time $\leq 1\text{ h}$
	$V_{DS,pulsed}$	-	-	650		
Switching surge voltage, pulsed	$V_{DS,surge}$	-	-	750	V	DC bus voltage = 700 V; turn off $V_{DS,pulse} = 750\text{ V}$; turn on $I_{D,pulse} = 44\text{ A}$; $T_j = 105\text{ °C}$; $f \leq 100\text{ kHz}$, $t \leq 100\text{ sec.}$ (10 million pulses)
Continuous current, drain source ¹⁾	I_D	-	-	44	A	$T_c = 25\text{ °C}$; $T_j = T_{j,max}$
Pulsed current, drain source	$I_{D,pulse}$	-90 -45	-	90 45	A	$T_j = 25\text{ °C}$; $I_G = 42\text{ mA}$; See Diagram 3, 5 $T_j = 125\text{ °C}$; $I_G = 42\text{ mA}$; See Diagram 4, 6
Gate current, continuous ²⁾	$I_{G,avg}$	-	-	32	mA	$T_j = -55\text{ °C}$ to $T_j = 150\text{ °C}$; See Table 9
Gate current, pulsed ²⁾	$I_{G,pulsed}$	-3.2	-	3.2	A	$T_j = -55\text{ °C}$ to $T_j = 150\text{ °C}$; $t_{PULSE} = 50\text{ ns}$, $f = 100\text{ kHz}$; See Table 9
Gate source voltage, continuous ²⁾	V_{GS}	-10	-	-	V	$T_j = -55\text{ °C}$ to $T_j = 150\text{ °C}$; See Diagram 12
Gate source voltage, pulsed ²⁾	$V_{GS,pulse}$	-25	-	-	V	$T_j = -55\text{ °C}$ to $T_j = 150\text{ °C}$; $t_{PULSE} = 50\text{ ns}$, $f = 100\text{ kHz}$; open drain
Power dissipation	P_{tot}	-	-	132	W	$T_c = 25\text{ °C}$
Operating junction temperature	T_j	-55	-	150	°C	-
Storage temperature	T_{stg}	-55	-	150	°C	Max shelf life depends on storage conditions
Drain-source voltage slew-rate	dv/dt	-	-	200	V/ns	-

¹⁾ Limited by $T_{j,max}$. Maximum Duty Cycle $D = 0.75$

²⁾ We recommend using an advanced driving technique to optimize the device performance. Please see gate drive application note for more details.

2 Thermal characteristics

Table 3 Thermal characteristics

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.95	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	70	°C/W	Device on PCB, minimum footprint
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	-	61	°C/W	Device on 40 mm*40 mm*1.5 mm epoxy PCB FR4 with 6 cm ² (one layer, 70 µm thickness) copper area. PCB is vertical without air stream cooling.
Reflow soldering temperature	T_{sold}	-	-	260	°C	reflow MSL3

3 Electrical characteristics

at $T_j=25\text{ °C}$, unless specified otherwise

Table 4 Static characteristics

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate threshold voltage	$V_{GS(th)}$	0.9 -	1.2 1	1.6 -	V	$I_{DS}=4.2\text{ mA}$; $V_{DS}=10\text{ V}$; $T_j=25\text{ °C}$ $I_{DS}=4.2\text{ mA}$; $V_{DS}=10\text{ V}$; $T_j=150\text{ °C}$
Gate-Source reverse clamping voltage	$V_{GS, clamp}$	-	-	-8	V	$I_{GS}=-1\text{ mA}$
Drain-Source leakage current	I_{DSS}	-	1.6 32	160 -	μA	$V_{DS}=650\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$ $V_{DS}=650\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$
Drain-Source on-state resistance	$R_{DS(on)}$	-	0.035 0.075	0.042 -	Ω	$I_G=42\text{ mA}$; $I_D=13\text{ A}$; $T_j=25\text{ °C}$ $I_G=42\text{ mA}$; $I_D=13\text{ A}$; $T_j=150\text{ °C}$
Gate resistance	$R_{G,int}$	-	tbd	-	Ω	LCR impedance measurement; $f=f_{res}$, open drain;

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	530	-	pF	$V_{GS}=0\text{ V}$; $V_{DS}=400\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	85	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=400\text{ V}$, $f=1\text{ MHz}$
Reverse Transfer capacitance	C_{rss}	-	1.02	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=400\text{ V}$, $f=1\text{ MHz}$
Effective output capacitance, energy related ³⁾	$C_{o(er)}$	-	tbd	-	pF	$V_{DS}=0\text{ to }400\text{ V}$
Effective output capacitance, time related ⁴⁾	$C_{o(tr)}$	-	tbd	-	pF	$V_{GS}=0\text{ V}$; $V_{DS}=0\text{ to }400\text{ V}$; $I_D=\text{const}$
Output charge	Q_{oss}	-	58	-	nC	$V_{DS}=0\text{ to }400\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	tbd	-	ns	$I_D=13\text{ A}$; $R_{ON}=3.3\text{ Ohm}$; $R_{OFF}=3.3\text{ Ohm}$; $R_{SS}=220\text{ Ohm}$; $C_C=5.3\text{ nF}$; $V_{DRV}=12\text{ V}$; see Table 8
Turn-off delay time	$t_{d(off)}$	-	tbd	-	ns	$I_D=13\text{ A}$; $R_{ON}=3.3\text{ Ohm}$; $R_{OFF}=3.3\text{ Ohm}$; $R_{SS}=220\text{ Ohm}$; $C_C=5.3\text{ nF}$; $V_{DRV}=12\text{ V}$; see Table 8
Rise time	t_r	-	tbd	-	ns	$I_D=13\text{ A}$; $R_{ON}=3.3\text{ Ohm}$; $R_{OFF}=3.3\text{ Ohm}$; $R_{SS}=220\text{ Ohm}$; $C_C=5.3\text{ nF}$; $V_{DRV}=12\text{ V}$; see Table 8
Fall time	t_f	-	tbd	-	ns	$I_D=13\text{ A}$; $R_{ON}=3.3\text{ Ohm}$; $R_{OFF}=3.3\text{ Ohm}$; $R_{SS}=220\text{ Ohm}$; $C_C=5.3\text{ nF}$; $V_{DRV}=12\text{ V}$; see Table 8

³⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400 V

⁴⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 400 V

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate charge	Q_G	-	11	-	nC	$V_{GS}=0$ to 3 V; $V_{DS}=400$ V, $I_D=13$ A

Table 7 Reverse conduction characteristics

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Source-Drain reverse voltage	V_{SD}	-	2.2	2.5	V	$V_{GS}=0$ V; $I_{SD}=13$ A
Pulsed current, reverse	$I_{SD,pulse}$	-	-	90	A	$I_G=42$ mA
Reverse recovery charge ⁵⁾	Q_{rr}	-	0	-	nC	$I_{SD}=13$ A; $V_{DS}=400$ V

⁵⁾ Excluding Q_{oss}

4 Electrical characteristics diagrams

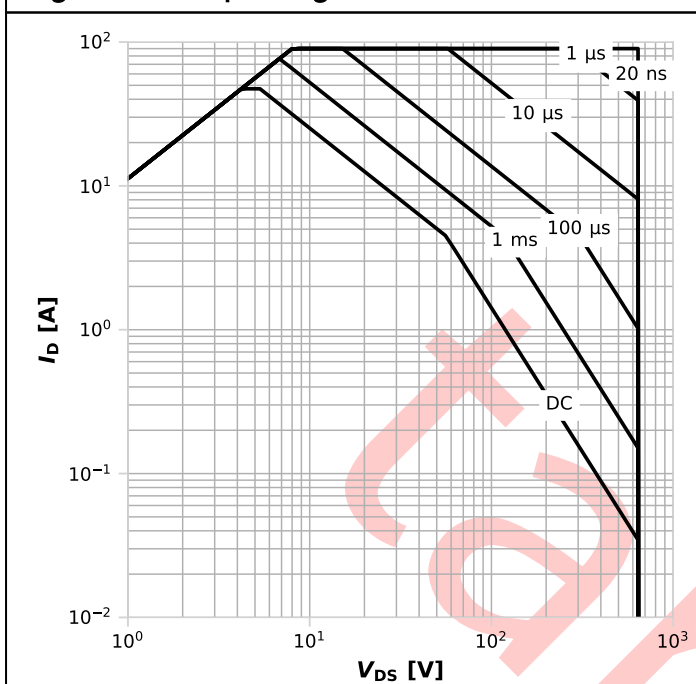
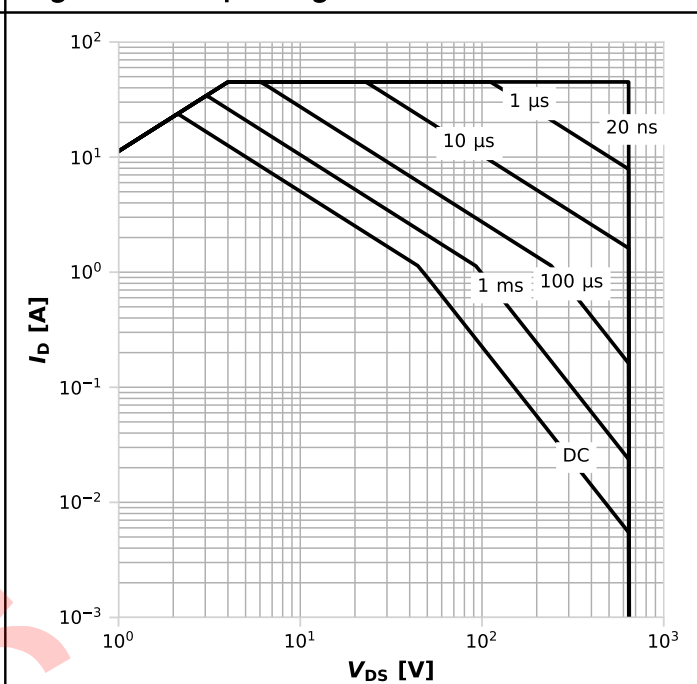
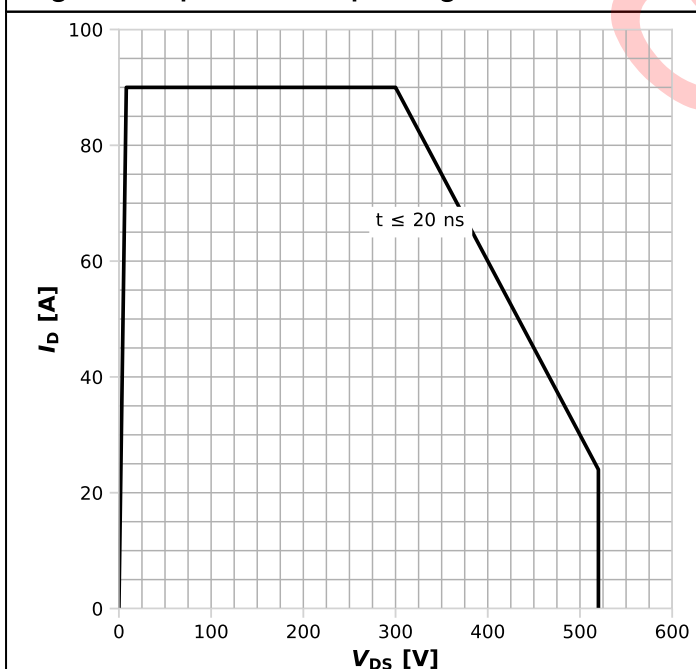
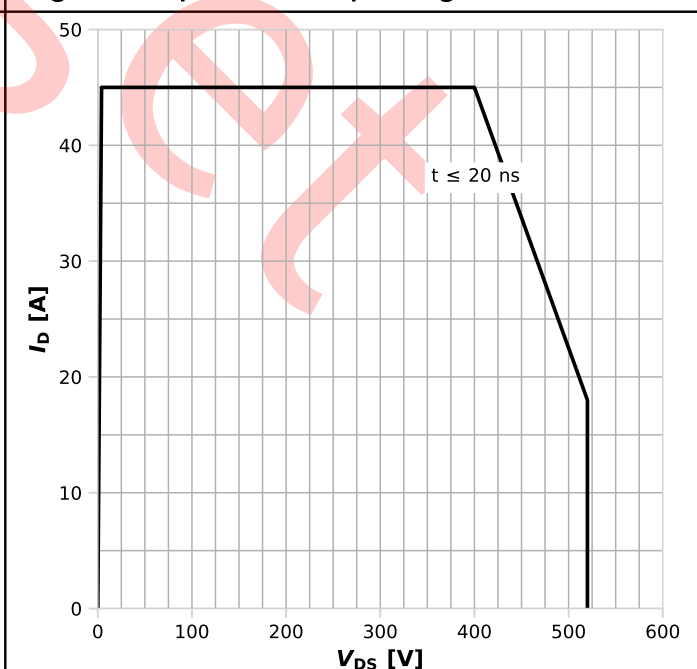
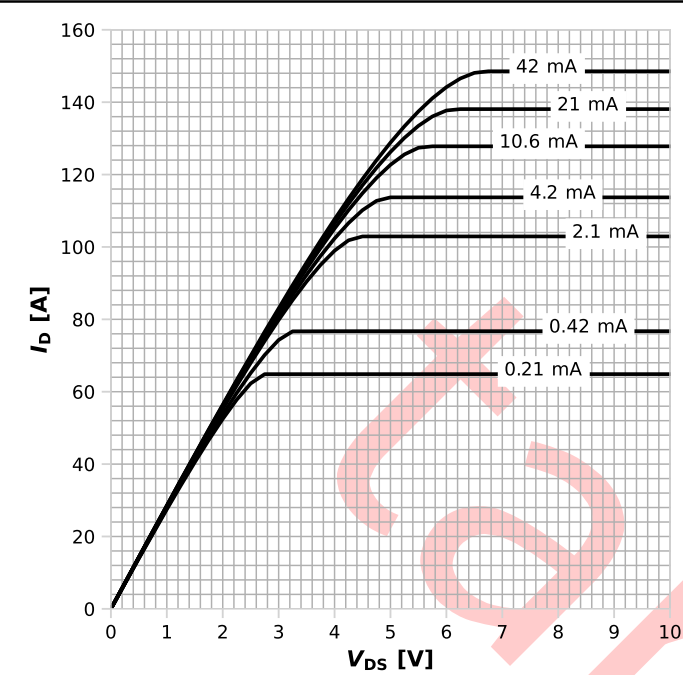
Diagram 3: Safe operating area

 $I_D = f(V_{DS}); T_C = 25\text{ °C}; D = 0; \text{parameter: } t_p$
Diagram 4: Safe operating area

 $I_D = f(V_{DS}); T_C = 125\text{ °C}; D = 0; \text{parameter: } t_p$
Diagram 5: Repetitive safe operating area

 $I_D = f(V_{DS}); T_C = 25\text{ °C}; T_J \leq 150\text{ °C}; \text{parameter: } t_p$
Diagram 6: Repetitive safe operating area

 $I_D = f(V_{DS}); T_C = 125\text{ °C}; T_J \leq 150\text{ °C}; \text{parameter: } t_p$

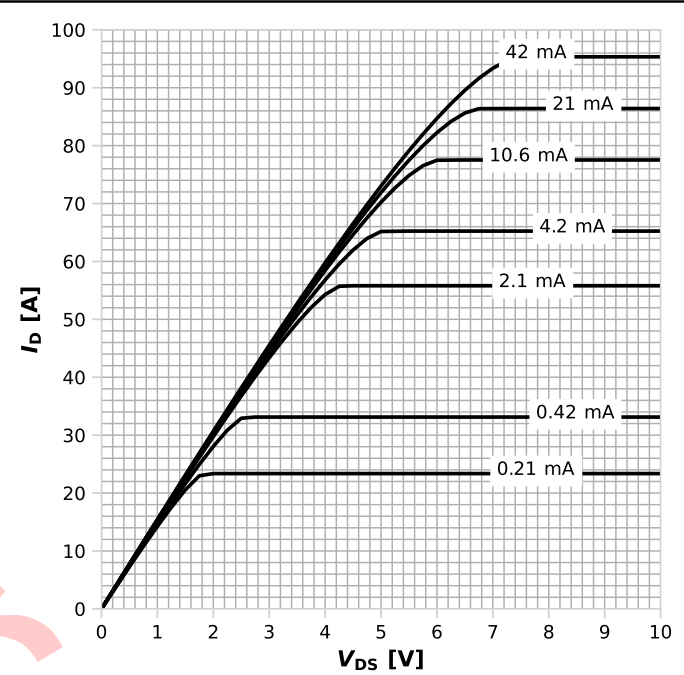


Diagram 7: Typ. output characteristics



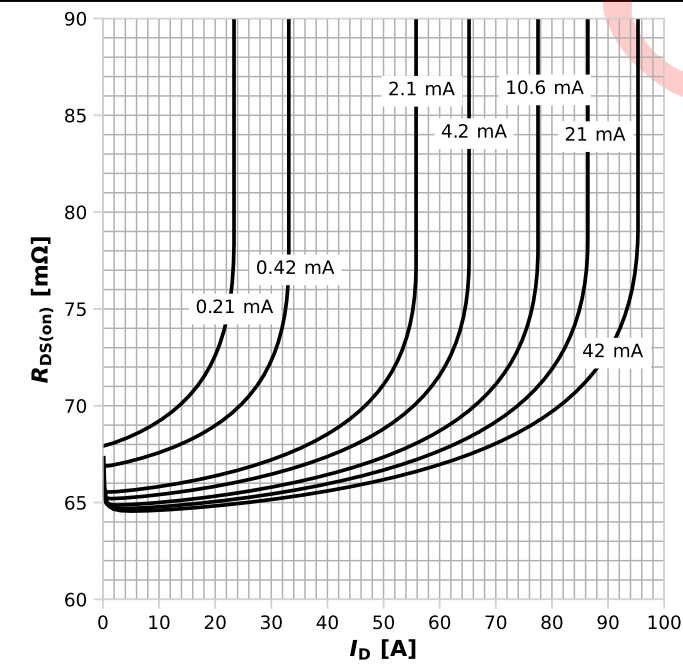
$I_D = f(V_{DS})$; $T_j = 25\text{ °C}$; parameter: I_{GS}

Diagram 8: Typ. output characteristics



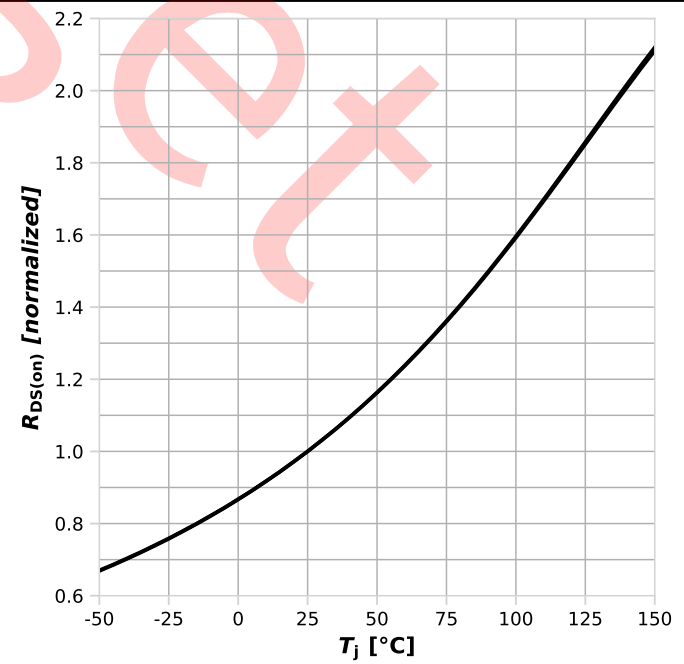
$I_D = f(V_{DS})$; $T_j = 125\text{ °C}$; parameter: I_{GS}

Diagram 9: Typ. Drain-source on-state resistance



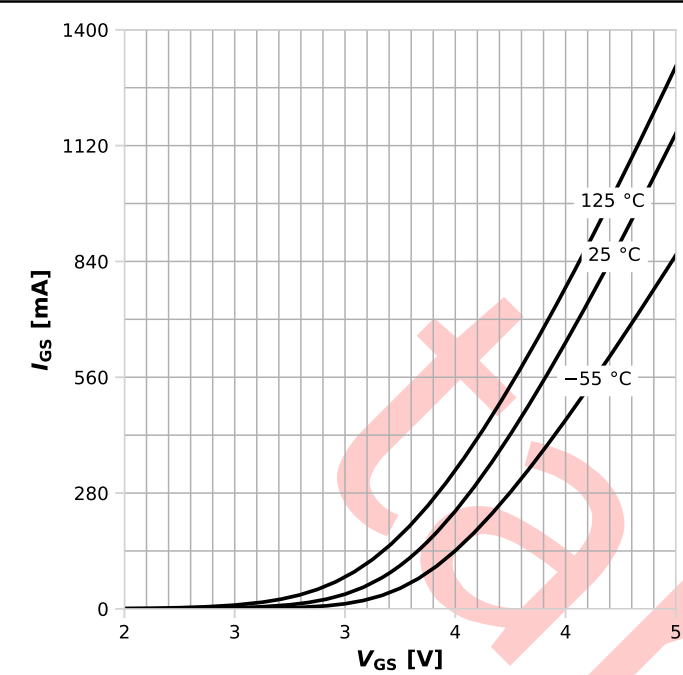
$R_{DS(on)} = f(I_D)$; $T_j = 125\text{ °C}$; parameter: I_{GS}

Diagram 10: Drain-source on-state resistance



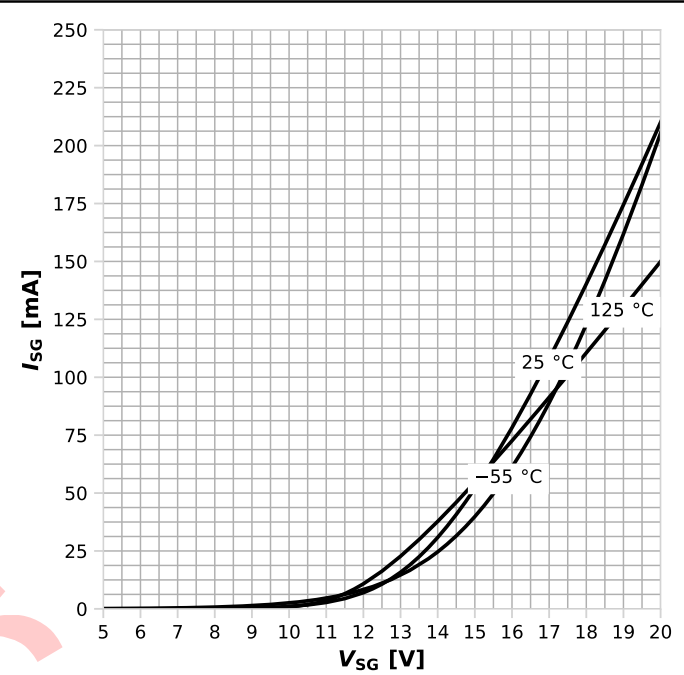
$R_{DS(on)} = f(T_j)$; $I_D = 13\text{ A}$

Diagram 11: Typ. gate characteristics forward



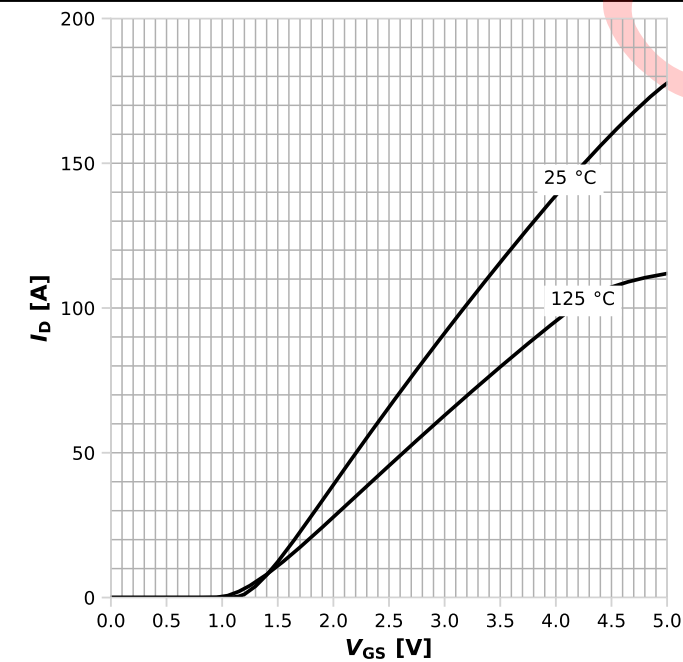
$I_{GS}=f(V_{GS})$; open drain; parameter: T_j

Diagram 12: Typ. gate characteristics reverse



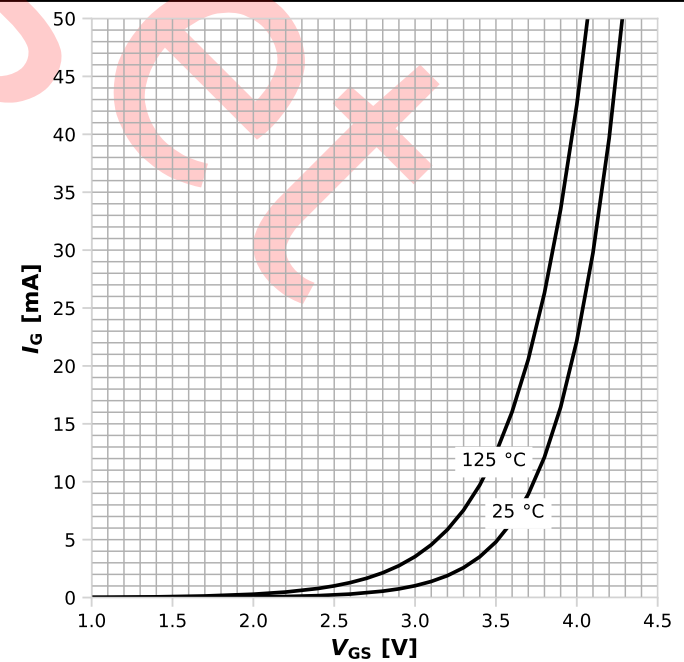
$I_{SG}=f(V_{SG})$; parameter: T_j

Diagram 13: Typ. transfer characteristics



$I_D=f(I_{GS})$; $V_{DS}=8V$; parameter: T_j

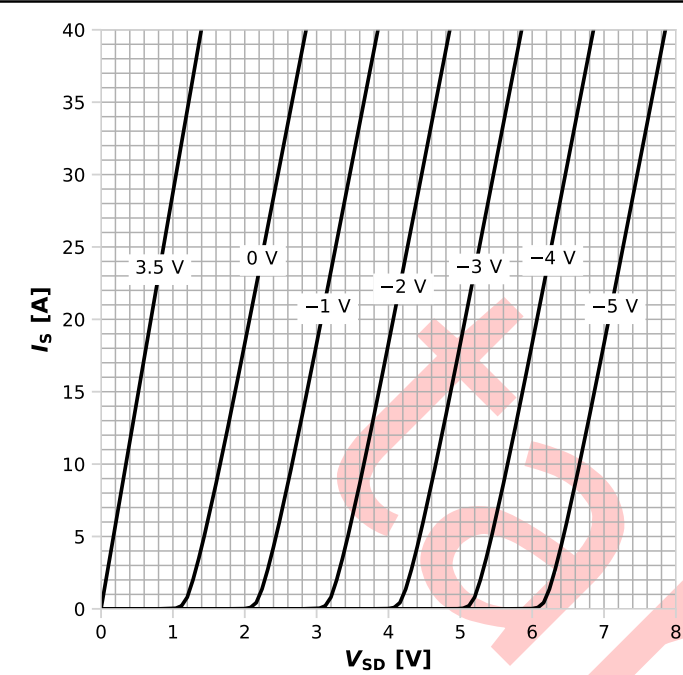
Diagram 14: Typ. transfer gate current characteristic



$I_G=f(V_{GS})$; $V_{DS}=8V$; parameter: T_j

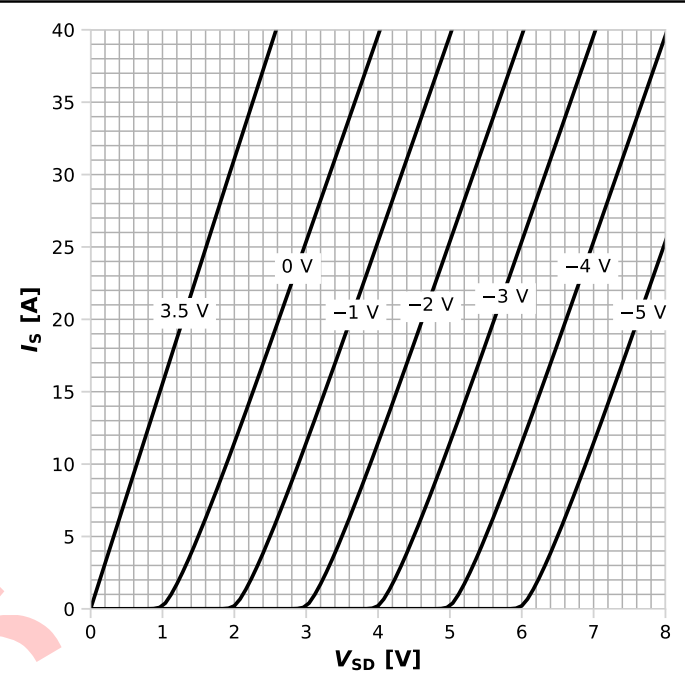


Diagram 15: Typ. channel reverse characteristics



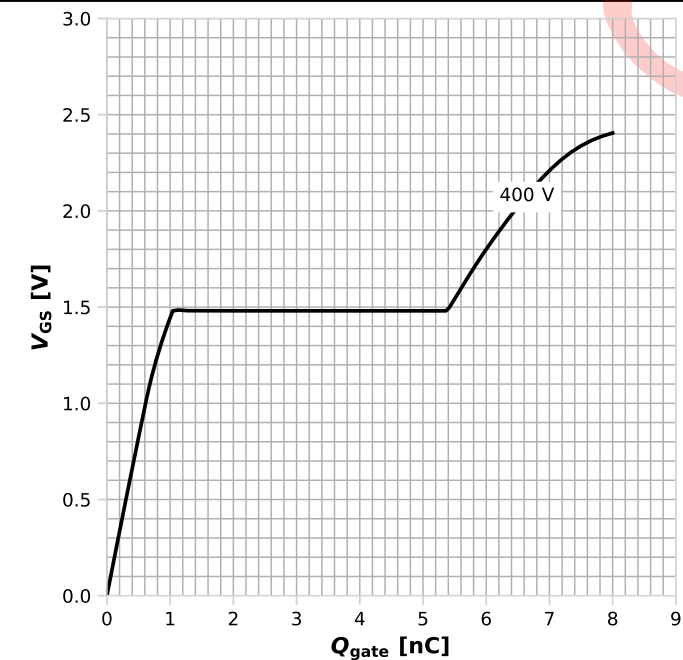
$I_S = f(V_{SD})$; $T_J = 25\text{ °C}$; parameter: V_{GS}

Diagram 16: Typ. channel reverse characteristics



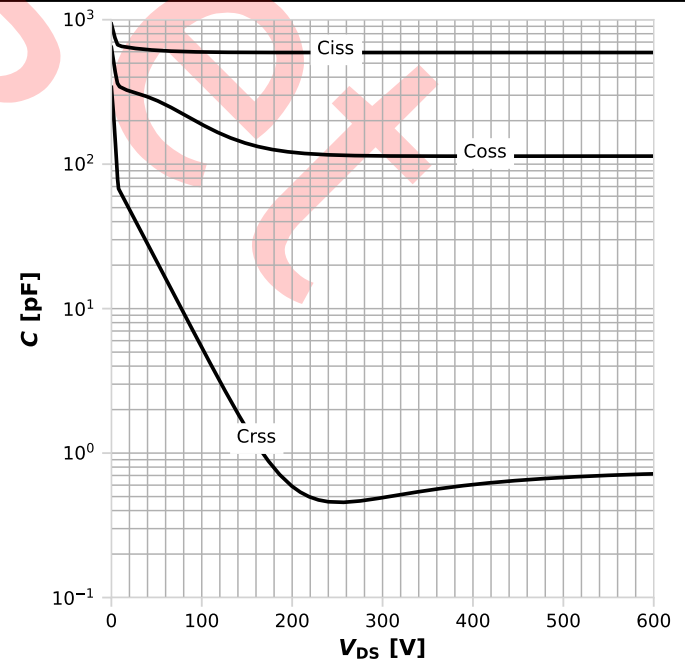
$I_S = f(V_{SD})$; $T_J = 125\text{ °C}$; parameter: V_{GS}

Diagram 17 Typ. gate charge



$V_{GS} = f(Q_{gate})$; $I_D = 13\text{ A}$ pulsed; parameter: V_{DD}

Diagram 18: Typ. capacitances



$C = f(V_{DS})$; $V_{GS} = 0\text{ V}$

5 Test Circuits

Table 8 Reverse Channel Characteristics Test

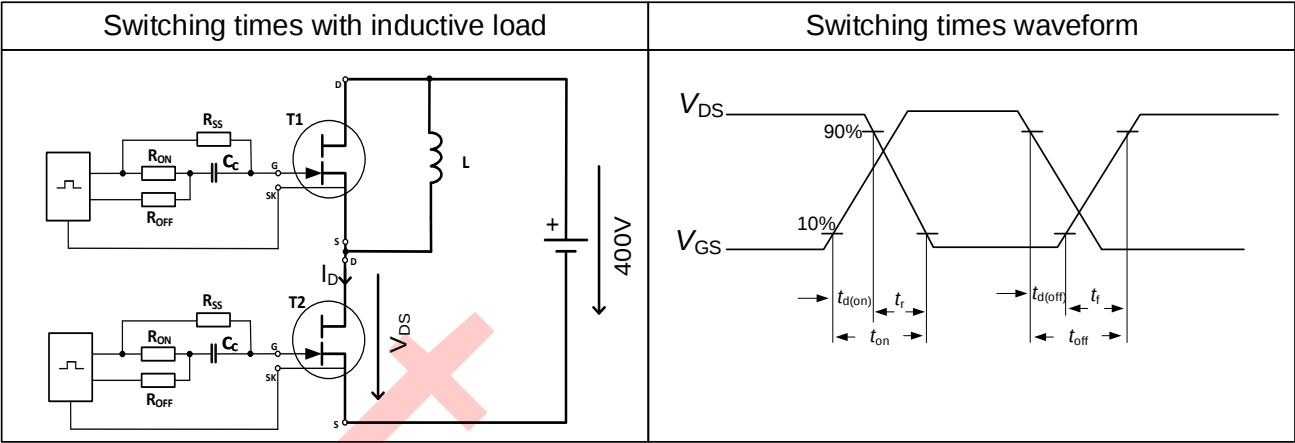
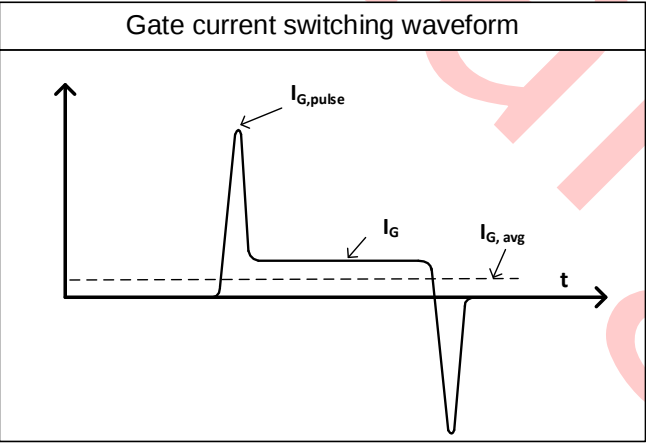
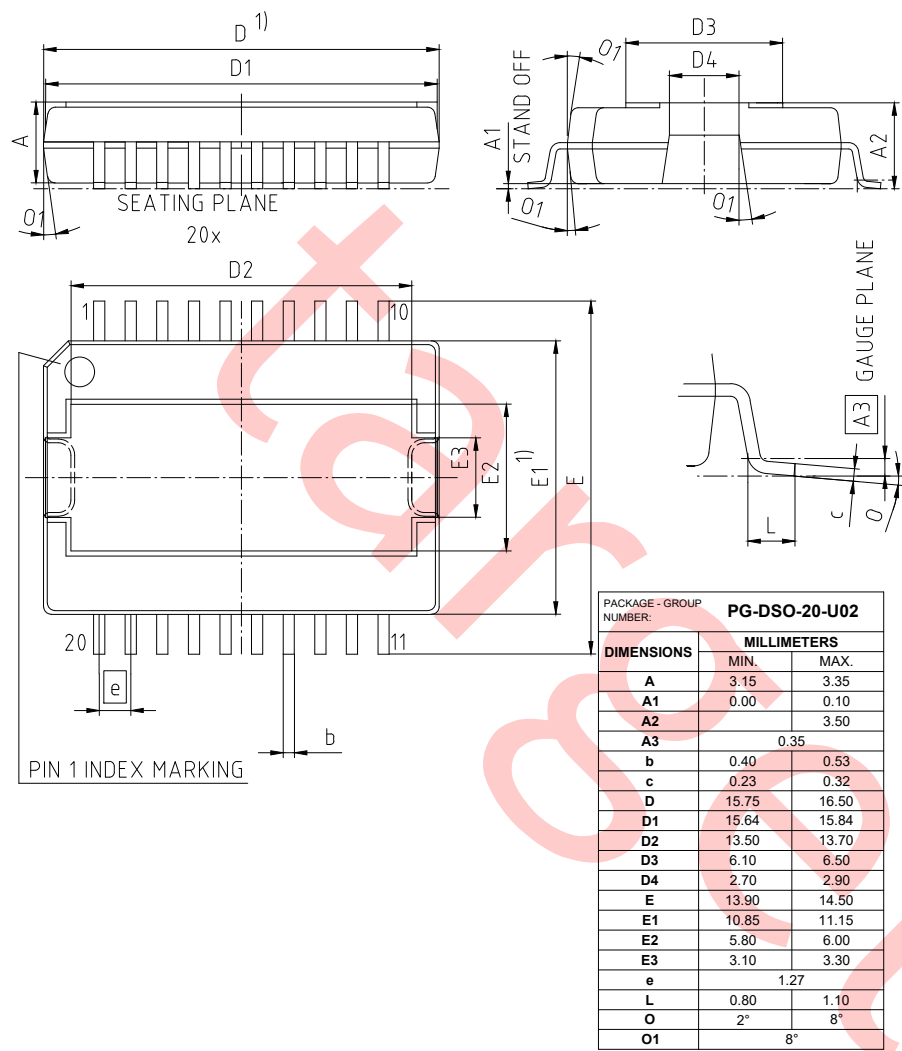


Table 9 Gate current switching waveform



6 Package Outlines



1) DOES NOT INCLUDE PLASTIC OR METAL PRUTRUSION OF 0.15 MAX. PER SIDE

Figure 1 Outline PG-DSO-20, dimensions in mm

7 Appendix A

Table 10 **Related Links**

- [IFX CoolGaN™ GaN 650 V webpage](#)
- [IFX CoolGaN™ GaN 650 V reliability white paper](#)
- [IFX CoolGaN™ GaN 650 V gate driver application note](#)
- [IFX CoolGaN™ GaN 650 V applications information](#)

datasheet

Revision History

IGOT65R035D2

Revision 2024-04-03, Rev. 0.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
0.1	2024-04-03	Release of target

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Information

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