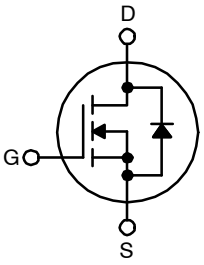
MOSFET – Power, N-Channel, SUPERFET III, FRFET
650 V, 46 A, 65 mΩ

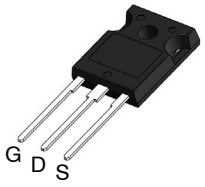
NTHL065N65S3HF

ON Semiconductor®

www.onsemi.com

V_{DSS}	$R_{DS(on)}$ MAX	I_D MAX
650 V	65 mΩ @ 10 V	46 A





TO−247−3LD
CASE 340CX

Description

SUPERFET III MOSFET is ON Semiconductor's brand−new high voltage super−junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on−resistance and lower gate charge performance. This advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate.

Consequently, SUPERFET III MOSFET is very suitable for the various power system for miniaturization and higher efficiency.

SUPERFET III FRFET MOSFET's optimized reverse recovery performance of body diode can remove additional component and improve system reliability.

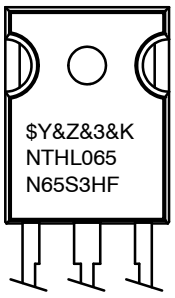
Features

- 700 V @ T_J = 150°C
- Typ. $R_{DS(on)}$ = 54 mΩ
- Ultra Low Gate Charge (Typ. Q_g = 98 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 876 pF)
- 100% Avalanche Tested
- This Device is Pb−Free and is RoHS Compliant

Applications

- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- USP / Solar

MARKING DIAGRAM



$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Numeric Date Code
&K	= Lot Code
NTHL065N65S3HF	= Specific Device Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

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ABSOLUTE MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Symbol	Parameter		Value	Unit
V_{DSS}	Drain to Source Voltage		650	V
V_{GSS}	Gate to Source Voltage	DC	±30	V
		AC (f > 1 Hz)	±30	
I_D	Drain Current	Continuous (T_C = 25°C)	46	A
		Continuous (T_C = 100°C)	30	
I_{DM}	Drain Current	Pulsed (Note 1)	115	A
E_{AS}	Single Pulsed Avalanche Energy (Note 2)		635	mJ
I_{AS}	Avalanche Current (Note 2)		5.3	A
E_{AR}	Repetitive Avalanche Energy (Note 1)		3.37	mJ
dv/dt	MOSFET dv/dt		100	V/ns
	Peak Diode Recovery dv/dt (Note 3)		50	
P_D	Power Dissipation	T_C = 25°C	337	W
		Derate Above 25°C	2.7	W/°C
T_J, T_{STG}	Operating and Storage Temperature Range		−55 to +150	°C
T_L	Maximum Lead Temperature for Soldering, 1/8” from Case for 5 Seconds		300	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Repetitive rating: pulse−width limited by maximum junction temperature.
2. I_{AS} = 5.3 A, R_G = 25 Ω, starting T_J = 25°C.
3. $I_{SD} \le$ 23 A, di/dt ≤ 200 A/μs, $V_{DD} \le$ 400 V, starting T_J = 25°C.

THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.37	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	°C/W

PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
NTHL065N65S3HF	NTHL065N65S3HF	TO−247	Tube	N/A	N/A	30 Units

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
BV_{DSS}	Drain to Source Breakdown Voltage	V_{GS} = 0 V, I_D = 1 mA, T_J = 25°C	650	–	–	V
		V_{GS} = 0 V, I_D = 1 mA, T_J = 150°C	700	–	–	V
ΔBV_{DSS} / ΔT_J	Breakdown Voltage Temperature Coefficient	I_D = 15 mA, Referenced to 25°C	–	0.63	–	V/°C
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 650 V, V_{GS} = 0 V	–	–	10	μA
		V_{DS} = 520 V, T_C = 125°C	–	153	–	
I_{GSS}	Gate to Body Leakage Current	V_{GS} = ±30 V, V_{DS} = 0 V	–	–	±100	nA
ON CHARACTERISTICS						
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 1.3 mA	3.0	–	5.0	V
$R_{DS(on)}$	Static Drain to Source On Resistance	V_{GS} = 10 V, I_D = 23 A	–	54	65	mΩ
g_{FS}	Forward Transconductance	V_{DS} = 20 V, I_D = 23 A	–	31	–	S
DYNAMIC CHARACTERISTICS						
C_{iss}	Input Capacitance	V_{DS} = 400 V, V_{GS} = 0 V, f = 1 MHz	–	4075	–	pF
C_{oss}	Output Capacitance		–	95	–	pF
$C_{oss(eff.)}$	Effective Output Capacitance	V_{DS} = 0 V to 400 V, V_{GS} = 0 V	–	876	–	pF
$C_{oss(er.)}$	Energy Related Output Capacitance	V_{DS} = 0 V to 400 V, V_{GS} = 0 V	–	160	–	pF
$Q_{g(tot)}$	Total Gate Charge at 10V	V_{DS} = 400 V, I_D = 23 A, V_{GS} = 10 V (Note 4)	–	98	–	nC
Q_{gs}	Gate to Source Gate Charge		–	30	–	nC
Q_{gd}	Gate to Drain “Miller” Charge		–	38	–	nC
ESR	Equivalent Series Resistance	f = 1 MHz	–	1.5	–	Ω
SWITCHING CHARACTERISTICS						
$t_{d(on)}$	Turn−On Delay Time	V_{DD} = 400 V, I_D = 23 A, V_{GS} = 10 V, R_g = 2.7 Ω (Note 4)	–	33	–	ns
t_r	Turn−On Rise Time		–	24	–	ns
$t_{d(off)}$	Turn−Off Delay Time		–	79	–	ns
t_f	Turn−Off Fall Time		–	14	–	ns
SOURCE−DRAIN DIODE CHARACTERISTICS						
I_S	Maximum Continuous Source to Drain Diode Forward Current		–	–	46	A
I_{SM}	Maximum Pulsed Source to Drain Diode Forward Current		–	–	115	A
V_{SD}	Source to Drain Diode Forward Voltage	V_{GS} = 0 V, I_{SD} = 23 A	–	–	1.3	V
t_{rr}	Reverse Recovery Time	V_{DD} = 400 V, I_{SD} = 23 A, dI_F/dt = 100 A/μs	–	116	–	ns
Q_{rr}	Reverse Recovery Charge		–	488	–	nC

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Essentially independent of operating temperature typical characteristics.

TYPICAL PERFORMANCE CHARACTERISTICS

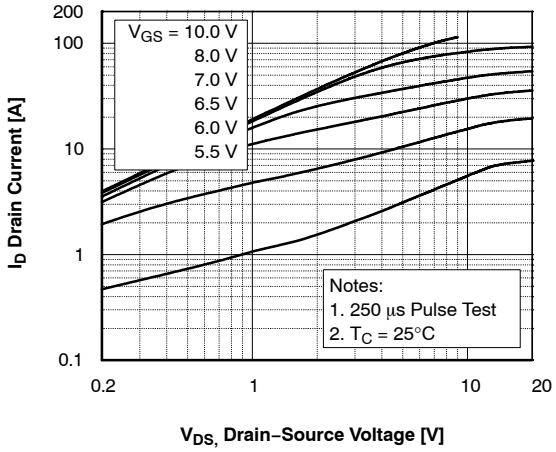

Figure 1. On−Region Characteristics

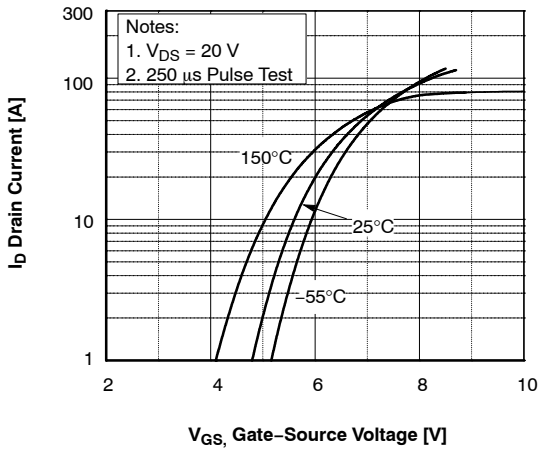

Figure 2. Transfer Characteristics

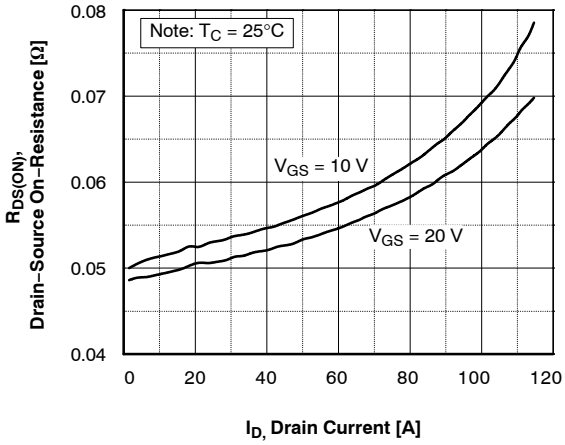

Figure 3. On−Resistance Variation vs. Drain Current and Gate Voltage

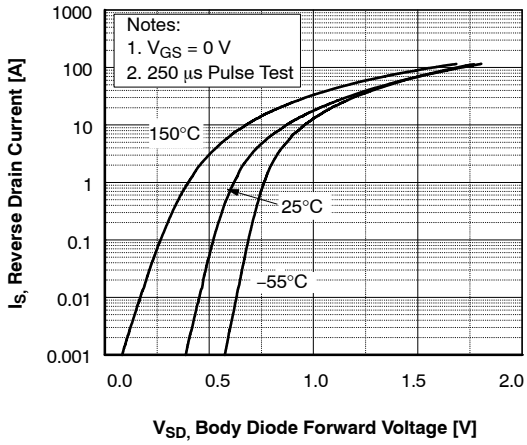

Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

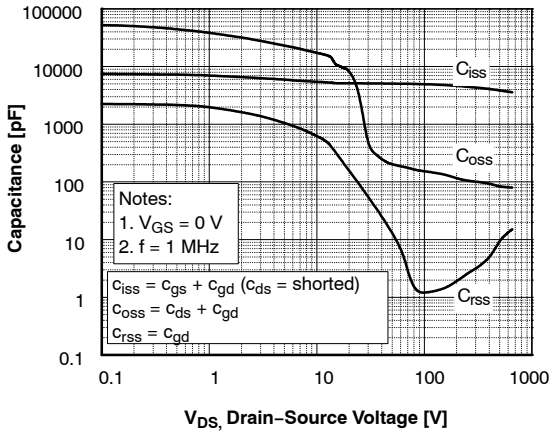

Figure 5. Capacitance Characteristics

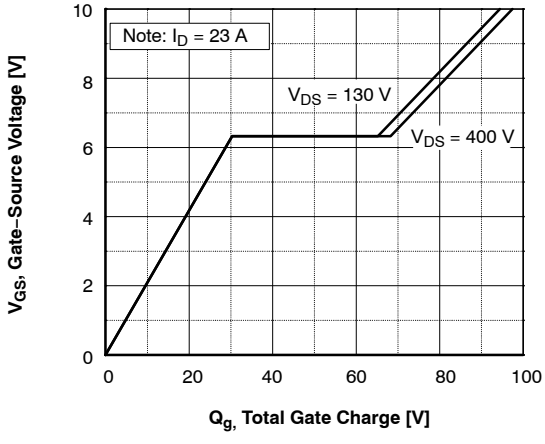

Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

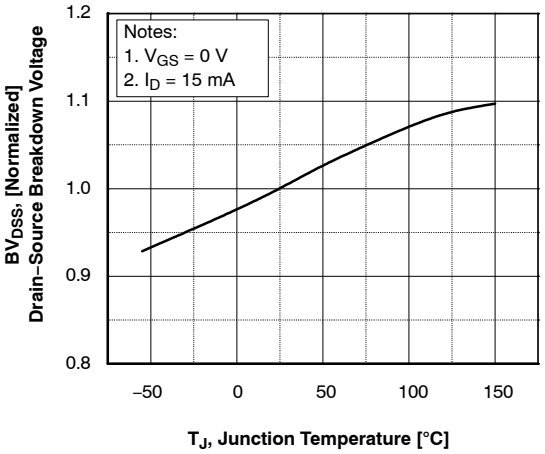

Figure 7. Breakdown Voltage Variation vs. Temperature

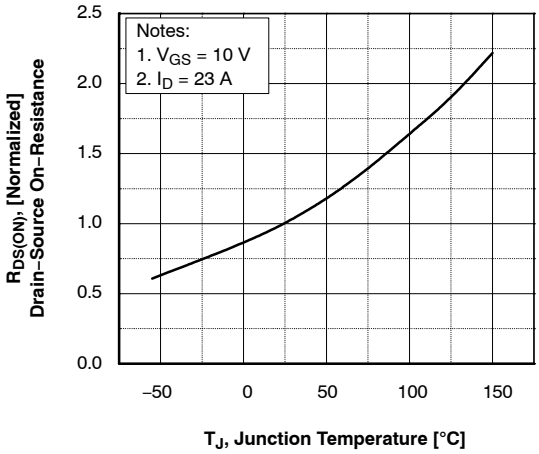

Figure 8. On−Resistance Variation vs. Temperature

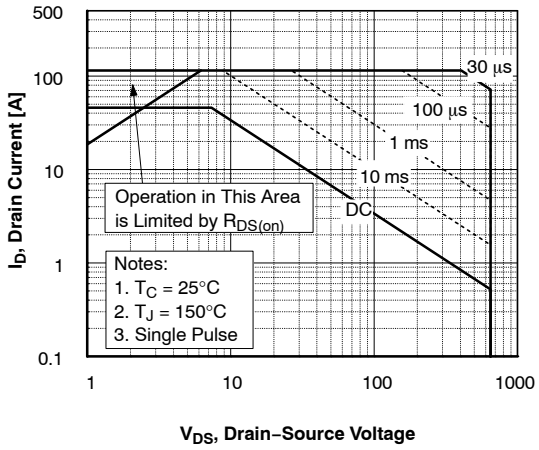

Figure 9. Maximum Safe Operating Area

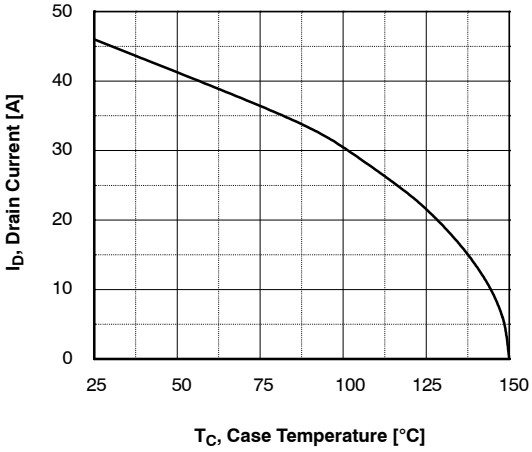

Figure 10. Maximum Drain Current vs. Case Temperature

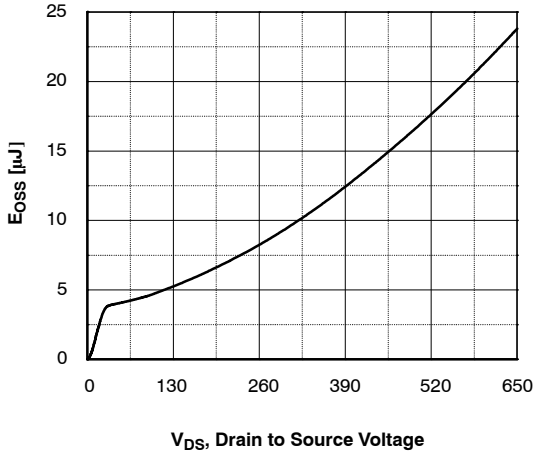

Figure 11. E_{oss} vs. Drain to Source Voltage

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

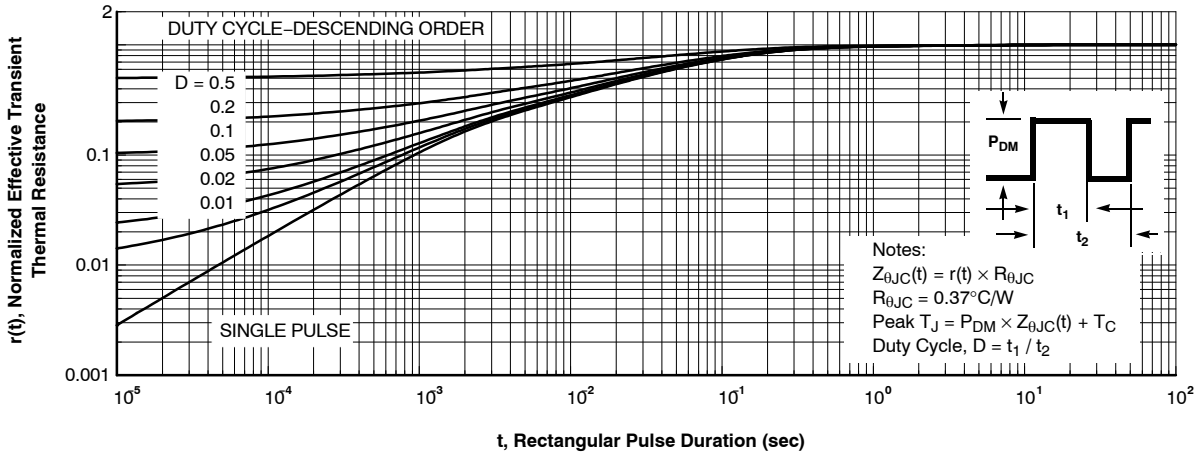

Figure 12. Transient Thermal Response Curve

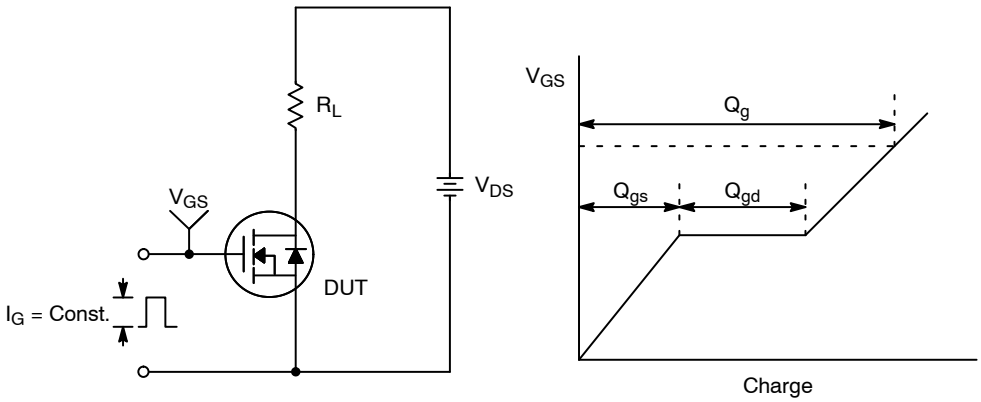

Figure 13. Gate Charge Test Circuit & Waveform

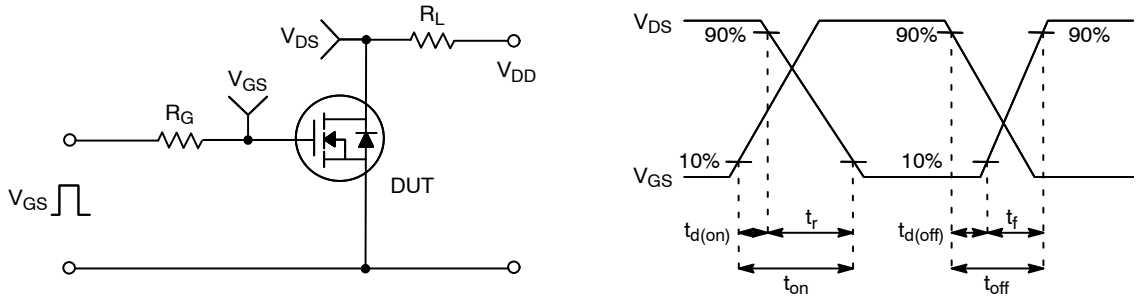

Figure 14. Resistive Switching Test Circuit & Waveforms

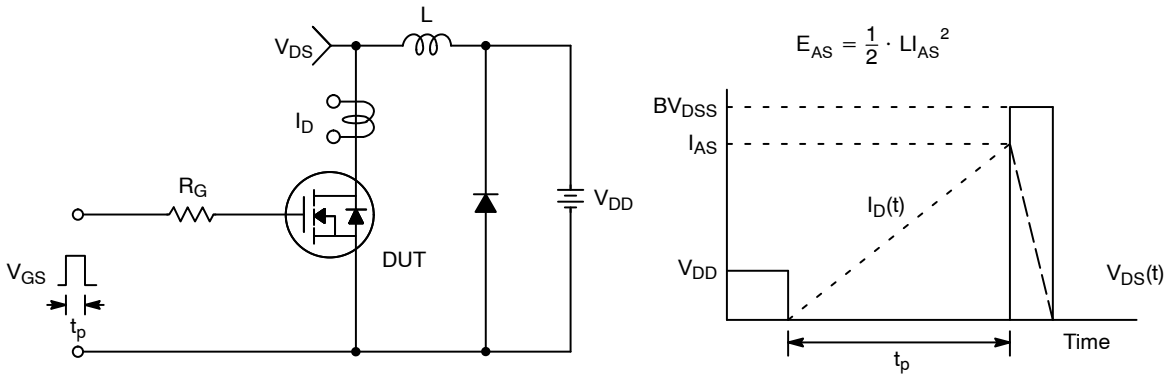

Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

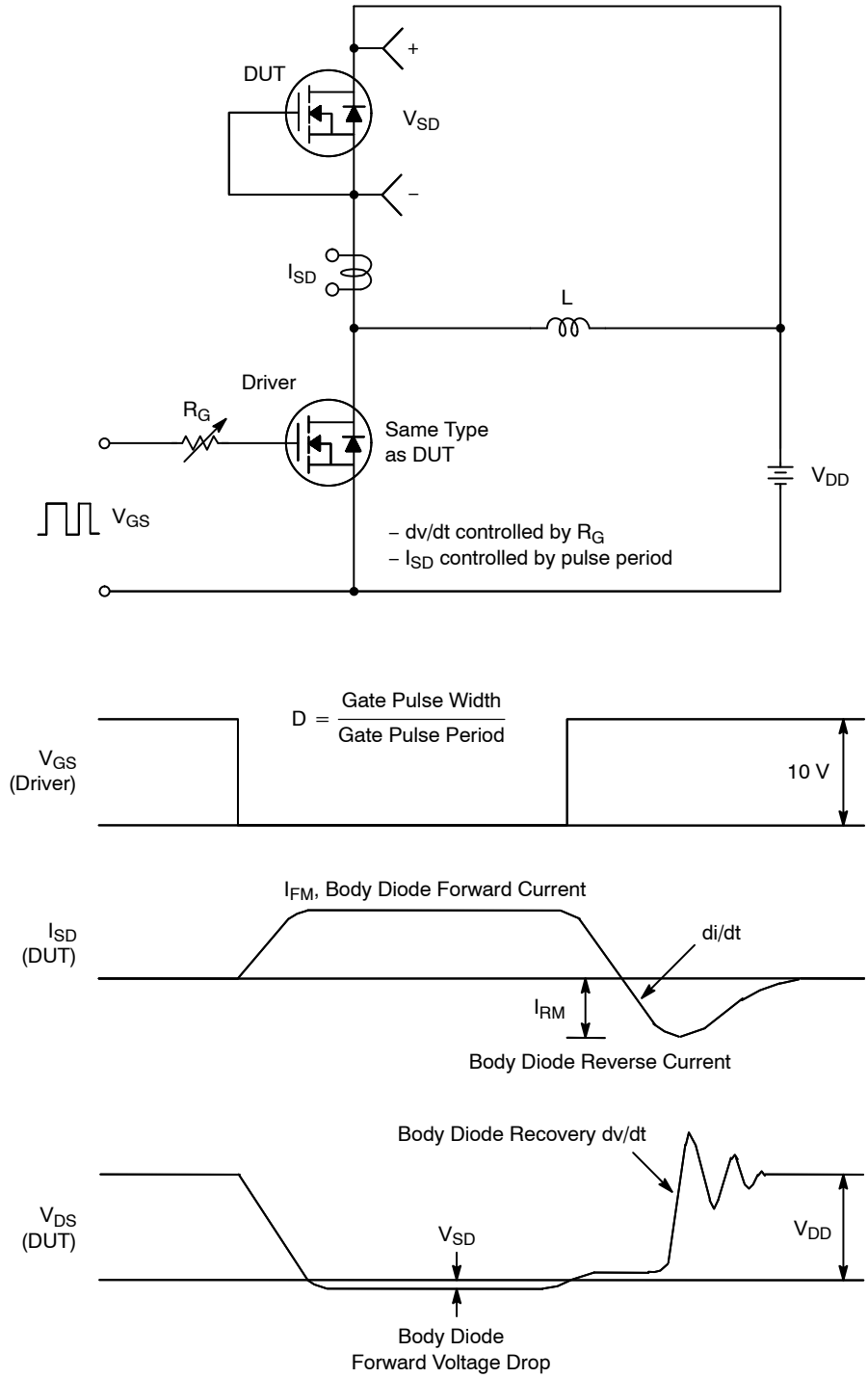

Figure 16. Peak Diode Recovery dv/dt Test Circuit & Waveforms

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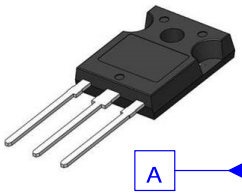
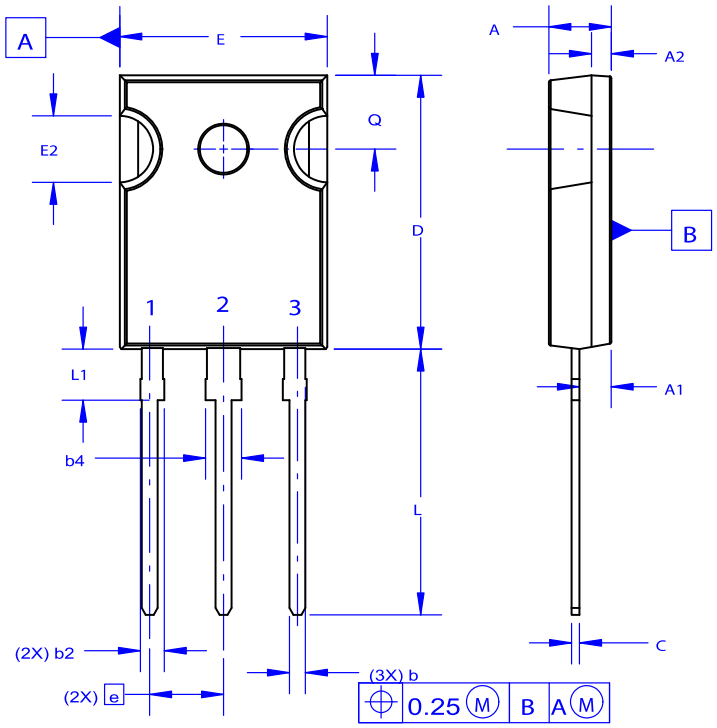
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

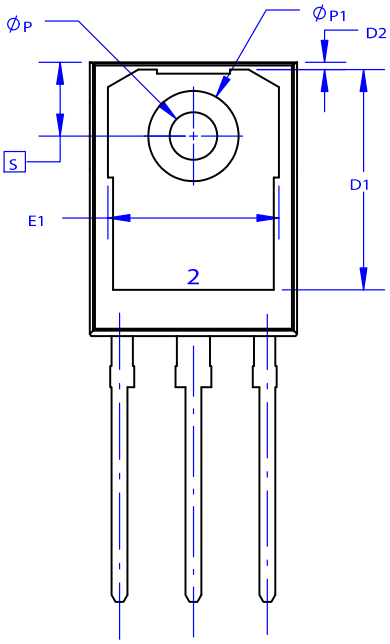
ON Semiconductor®

TO−247−3LD
CASE 340CX
ISSUE A

DATE 06 JUL 2020







NOTES: UNLESS OTHERWISE SPECIFIED.

A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.20	2.40	2.60
A2	1.40	1.50	1.60
D	20.32	20.57	20.82
E	15.37	15.62	15.87
E2	4.96	5.08	5.20
e	~	5.56	~
L	19.75	20.00	20.25
L1	3.69	3.81	3.93
ØP	3.51	3.58	3.65
Q	5.34	5.46	5.58
S	5.34	5.46	5.58
b	1.17	1.26	1.35
b2	1.53	1.65	1.77
b4	2.42	2.54	2.66
c	0.51	0.61	0.71
D1	13.08	~	~
D2	0.51	0.93	1.35
E1	12.81	~	~
ØP1	6.60	6.80	7.00

GENERIC MARKING DIAGRAM*

XXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present. Some products may not follow the Generic Marking.

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