MOSFET - Power, Single N-Channel

60 V, 9 mΩ, 38 A

NTTFD9D0N06HL

$V_{(BR)DSS}$	$R_{DS(ON)}$ MAX	I_D MAX
60 V	9 mΩ @ 10 V	38 A
	13 mΩ @ 4.5 V	

General Description

This device includes two specialized N−Channel MOSFETs in a dual package. The switch node has been internally connected to enable easy placement and routing of synchronous buck converters. The control MOSFET (Q2) and synchronous (Q1) have been designed to provide optimal power efficiency.

Features

Q1: N−Channel

- Max $r_{DS(on)}$ = 9.0 mΩ at V_{GS} = 10 V, I_D = 10 A
- Max $r_{DS(on)}$ = 13 mΩ at V_{GS} = 4.5, I_D = 8.0 A

Q2: N−Channel

- Max $r_{DS(on)}$ = 9.0 mΩ at V_{GS} = 10 V, I_D = 10 A
- Max $r_{DS(on)}$ = 13 mΩ at V_{GS} = 4.5, I_D = 8.0 A
- Low Inductance Packaging Shortens Rise/Fall Times, Resulting in Lower Switching Losses
- RoHS Compliant

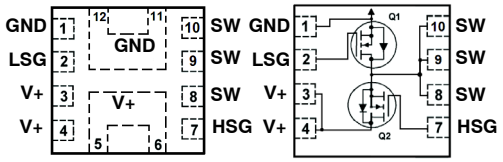
Typical Applications

- Computing
- Communications
- General Purpose Point of Load

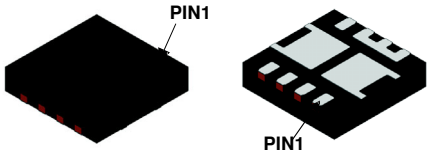
PIN DESCRIPTION

Pin	Name	Description
1, 11, 12	GND (LSS)	Low Side Source
2	LSG	Low Side Gate
3, 4, 5, 6	V + (HSD)	High Side Drain
7	HSG	High Side Gate
8, 9, 10	SW	Switching Node, Low Side Drain

ELECTRICAL CONNECTION



Dual N-Channel MOSFET



Top Bottom

WQFN12, 3x3
CASE 510CJ

MARKING DIAGRAM

D9D0 = Specific Device Code
A = Assembly Plant Code
Y = Numeric Year Code
WW = Work Week Code
ZZ = Assembly Lot Code

ORDERING INFORMATION

Device	Package	Shipping†
NTTFD9D0N06HLTWG	WQFN12 (Pb−Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

MOSFET MAXIMUM RATINGS (T_A = 25°C, Unless otherwise specified)

Symbol	Parameter				Q1	Q2	Units
V_{DS}	Drain−to−Source Voltage				60	60	V
V_{GS}	Gate−to−Source Voltage				±20	±20	V
I_D	Drain Current	−Continuous	T_C = 25°C	(Note 4)	38	38	A
		−Continuous	T_C = 100°C	(Note 4)	23	23	
		−Continuous	T_A = 25°C		9 (Note 1a)	9 (Note 1b)	
		−Pulsed	T_A = 25°C		349	349	
E_{AS}	Single Pulse Avalanche Energy			(Note 3)	46	46	mJ
P_D	Power Dissipation for Single Operation		T_C = 25°C		26	26	W
	Power Dissipation for Single Operation		T_A = 25°C		1.7 (Note 1a)	1.7 (Note 1b)	
T_J, T_{STG}	Operating and Storage Junction Temperature Range				−55 to +150		°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.

THERMAL CHARACTERISTICS

Symbol	Parameter	Q1	Q2	Units
$R_{\theta JC}$	Thermal Resistance, Junction−to−Case	4.8	4.8	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction−to−Ambient (Note 1a), max copper	70 (Note 1a)	70 (Note 1b)	
$R_{\theta JA}$	Thermal Resistance, Junction−to−Ambient (Note 1c), min copper	135 (Note 1a)	135 (Note 1b)	

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

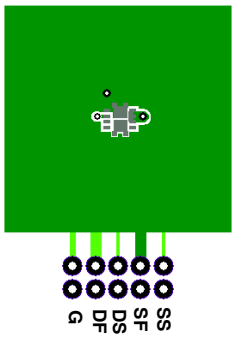
Symbol	Parameter	Test Conditions	Type	Min	Typ	Max	Units
OFF CHARACTERISTICS							
BV_{DSS}	Drain−to−Source Breakdown Voltage	I_D = 250 μA, V_{GS} = 0 V	Q1	60			V
		I_D = 250 μA, V_{GS} = 0 V	Q2	60			
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	I_D = 250 μA, referenced to 25°C	Q1		37.38		mV/°C
		I_D = 250 μA, referenced to 25°C	Q2		37.38		
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 60 V, V_{GS} = 0 V	Q1			10	μA
		V_{DS} = 60 V, V_{GS} = 0 V	Q2			10	
I_{GSS}	Gate−to−Source Leakage Current, Forward	V_{GS} = +20/−16 V, V_{DS} = 0 V	Q1			±100	nA
		V_{GS} = +20/−16 V, V_{DS} = 0 V	Q2			±100	
ON CHARACTERISTICS							
$V_{GS(th)}$	Gate−to−Source Threshold Voltage	V_{GS} = V_{DS}, I_D = 50 μA	Q1	1.2	1.6	2.0	V
		V_{GS} = V_{DS}, I_D = 50 μA	Q2	1.2	1.6	2.0	
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate−to−Source Threshold Voltage Temperature Coefficient	I_D = 50 μA, referenced to 25°C	Q1		−6.19		mV/°C
		I_D = 50 μA, referenced to 25°C	Q2		−6.19		
$r_{DS(on)}$	Drain−to−Source On Resistance	V_{GS} = 10 V, I_D = 10 A	Q1		7.3	9.0	mΩ
		V_{GS} = 4.5 V, I_D = 8 A			9.8	13	
		V_{GS} = 10 V, I_D = 10 A, T_J = 125°C			12.7		
$r_{DS(on)}$	Drain−to−Source On Resistance	V_{GS} = 10 V, I_D = 10 A	Q2		7.3	9.0	mΩ
		V_{GS} = 4.5 V, I_D = 8 A			9.8	13	
		V_{GS} = 10 V, I_D = 10 A, T_J = 125°C			12.7		
g_{FS}	Forward Transconductance	V_{DS} = 15 V, I_D = 10 A	Q1		53		S
		V_{DS} = 15 V, I_D = 10 A	Q2		53		

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

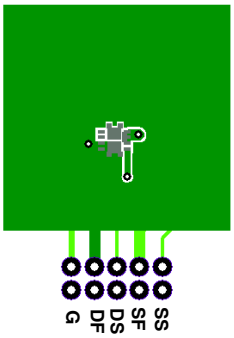
Symbol	Parameter	Test Conditions	Type	Min	Typ	Max	Units
DYNAMIC CHARACTERISTICS							
C_{ISS}	Input Capacitance	Q1: V_{DS} = 30 V, V_{GS} = 0 V, f = 1 Mhz	Q1		948		pF
			Q2		948		
C_{OSS}	Output Capacitance	Q2: V_{DS} = 30 V, V_{GS} = 0 V, f = 1 MHz	Q1		188		pF
			Q2		188		
C_{RSS}	Reverse Transfer Capacitance		Q1		12.3		pF
			Q2		12.3		
R_G	Gate Resistance	T_A = 25°C	Q1		2.0		Ω
			Q2		2.0		
SWITCHING CHARACTERISTICS							
$td_{(ON)}$	Turn−On Delay Time	Q1: V_{DD} = 48 V, I_D = 19 A, V_{GS} = 4.5 V, R_{GEN} = 2.5 Ω	Q1		9.4		ns
			Q2		9.4		
t_r	Rise Time	Q2: V_{DD} = 48 V, I_D = 19 A, V_{GS} = 4.5 V, R_{GEN} = 2.5 Ω	Q1		5.8		ns
			Q2		5.8		
$t_{D(OFF)}$	Turn−Off Delay Time		Q1		12.8		ns
			Q2		12.8		
t_f	Fall Time		Q1		4.4		ns
			Q2		4.4		
Q_g	Total Gate Charge	V_{GS} = 0 V to 10 V	Q1		13.5		nC
			Q2		13.5		
Q_g	Total Gate Charge	V_{GS} = 0 V to 4.5 V	Q1		6.4		nC
			Q2		6.4		
Q_{gs}	Gate−to−Source Gate Charge	Q1: V_{DD} = 48 V, I_D = 19 A	Q1		2.6		nC
			Q2		2.6		
Q_{gd}	Gate−to−Drain “Miller” Charge	Q2: V_{DD} = 48 V, I_D = 19 A	Q1		2.8		nC
			Q2		2.8		
DRAIN−SOURCE DIODE CHARACTERISTICS							
V_{SD}	Source to Drain Diode Forward Voltage	V_{GS} = 0 V, I_S = 10 A (Note 2)	Q1		0.79	1.2	V
		V_{GS} = 0 V, I_S = 10 A (Note 2)	Q2		0.79	1.2	
t_{rr}	Reverse Recovery Time	Q1: I_F = 19 A, di/dt = 100 A/μs	Q1		29		ns
			Q2		29		
Q_{rr}	Reverse Recovery Charge	Q2: I_F = 19 A, di/dt = 100 A/μs	Q1		14		nC
			Q2		14		

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.

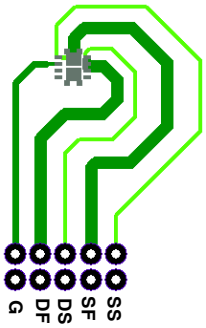
1. $R_{\theta JA}$ is determined with the device mounted on a 1 in^2 pad 2 oz copper pad on a 1.5 × 1.5 in. board of FR−4 material. $R_{\theta CA}$ is determined by the user’s board design.



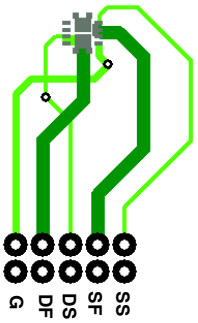
a) 70°C/W when mounted on a 1 in^2 pad of 2 oz copper.



b) 70°C/W when mounted on a 1 in^2 pad of 2 oz copper.



c) 135°C/W when mounted on a minimum pad of 2 oz copper.



d) 135°C/W when mounted on a minimum pad of 2 oz copper.

2. Pulse Test: Pulse Width < 300 μs, Duty cycle < 2.0%.
3. Q1: E_{AS} of 46 mJ is based on starting T_J = 25°C; N−ch: L = 1 mH, I_{AS} = 9.6 A, V_{DD} = 60 V, V_{GS} = 10 V. 100% test at L = 1 mH, I_{AS} = 9.6 A.
   Q2: E_{AS} of 46 mJ is based on starting T_J = 25°C; N−ch: L = 1 mH, I_{AS} = 9.6 A, V_{DD} = 60 V, V_{GS} = 10 V. 100% test at L = 1 mH, I_{AS} = 9.6 A.
4. Computed continuous current limited to Max Junction Temperature only, actual continuous current will be limited by thermal & electro−mechanical application board design.

TYPICAL CHARACTERISTICS

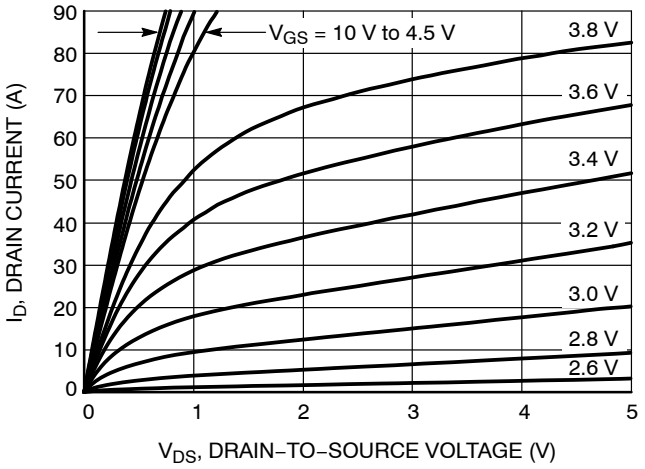


Figure 1. On−Region Characteristics

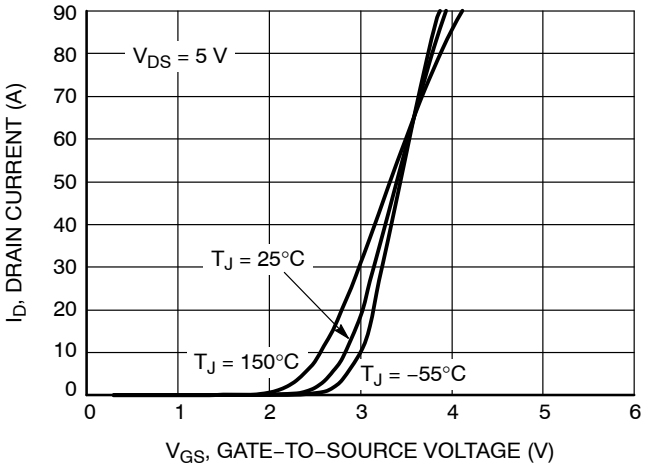


Figure 2. Transfer Characteristics

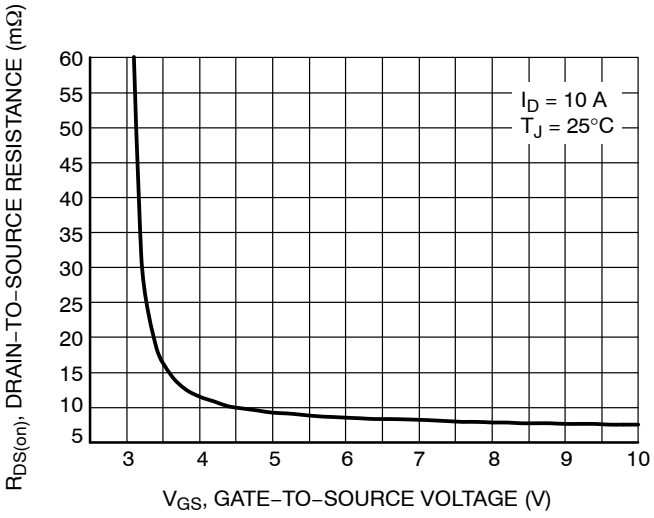


Figure 3. On−Resistance vs. Gate−to−Source Voltage

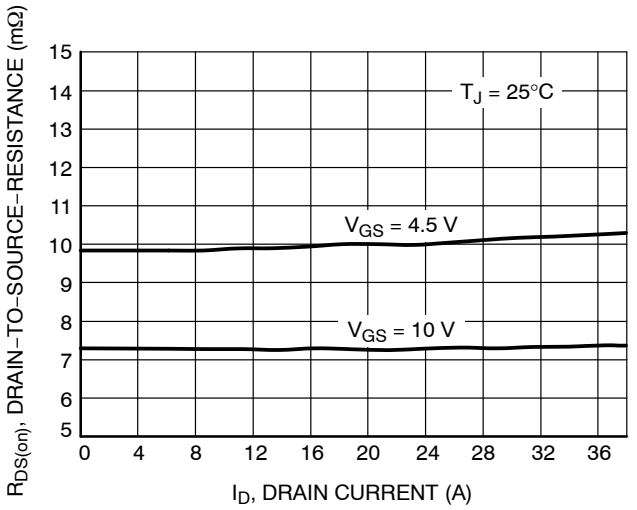


Figure 4. On−Resistance vs. Drain Current and Gate Voltage

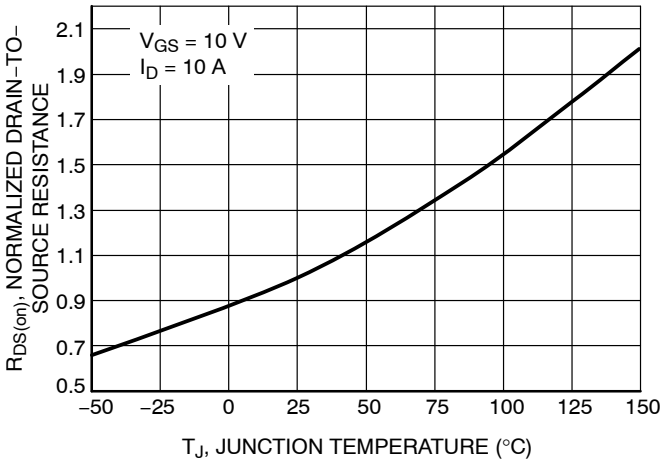


Figure 5. On−Resistance Variation with Temperature

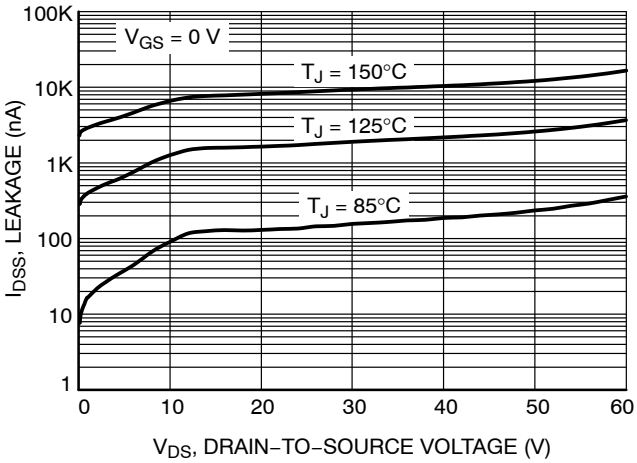


Figure 6. Drain−to−Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS

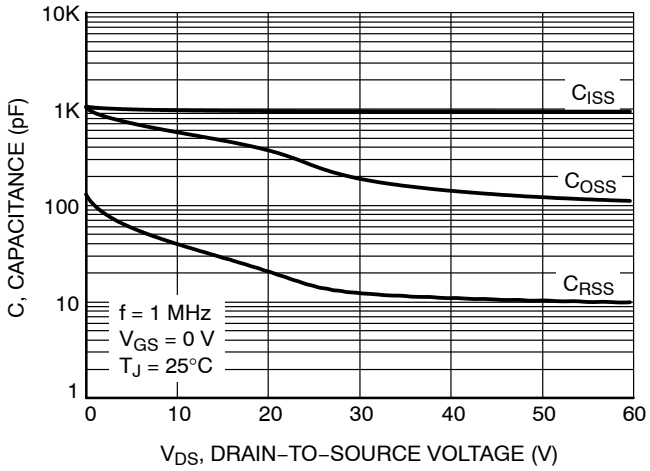


Figure 7. Capacitance Variation

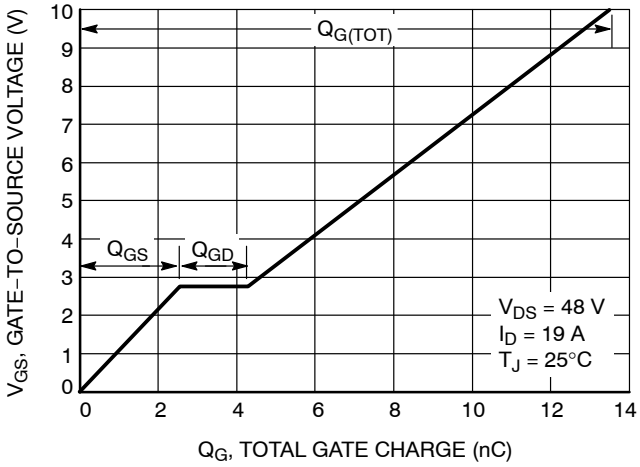


Figure 8. Gate−to−Source vs. Total Charge

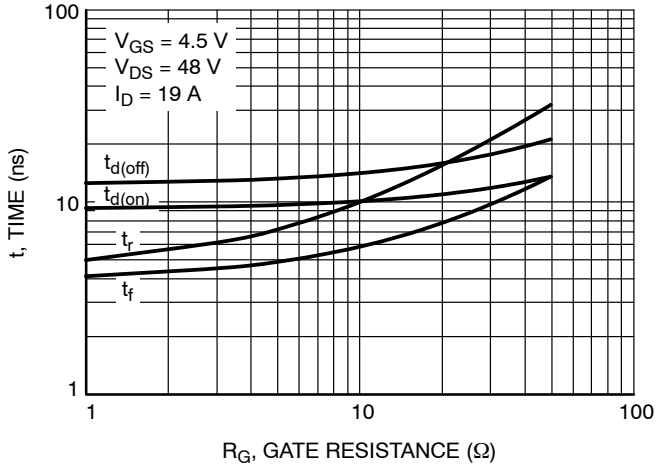


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

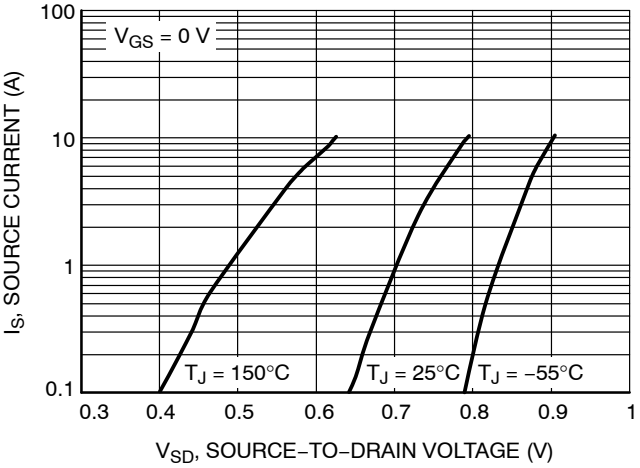


Figure 10. Diode Forward Voltage vs. Current

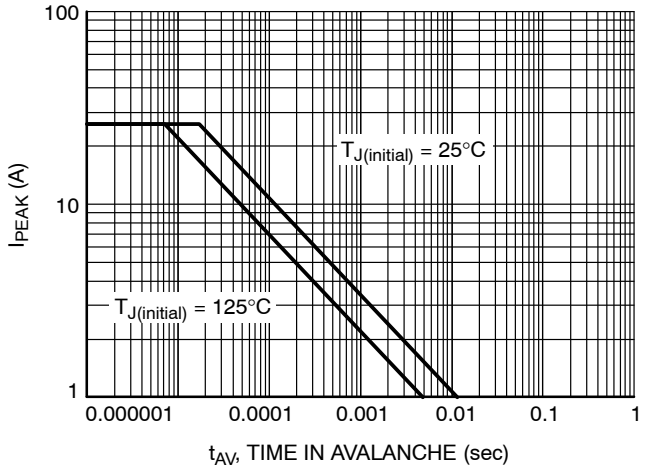


Figure 11. Unclamped Inductive Switching Capability

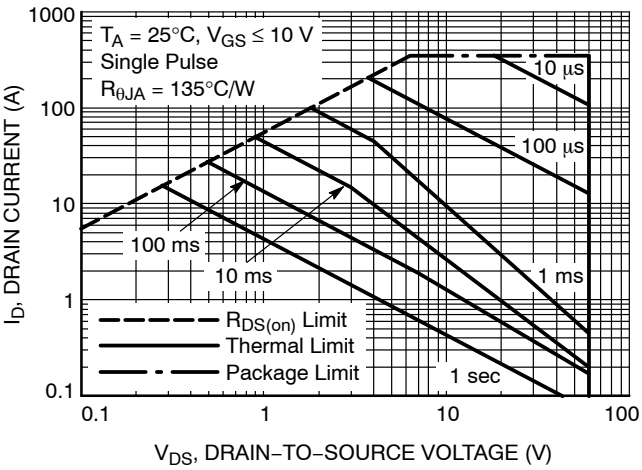


Figure 12. Forward Bias Safe Operating Area

TYPICAL CHARACTERISTICS

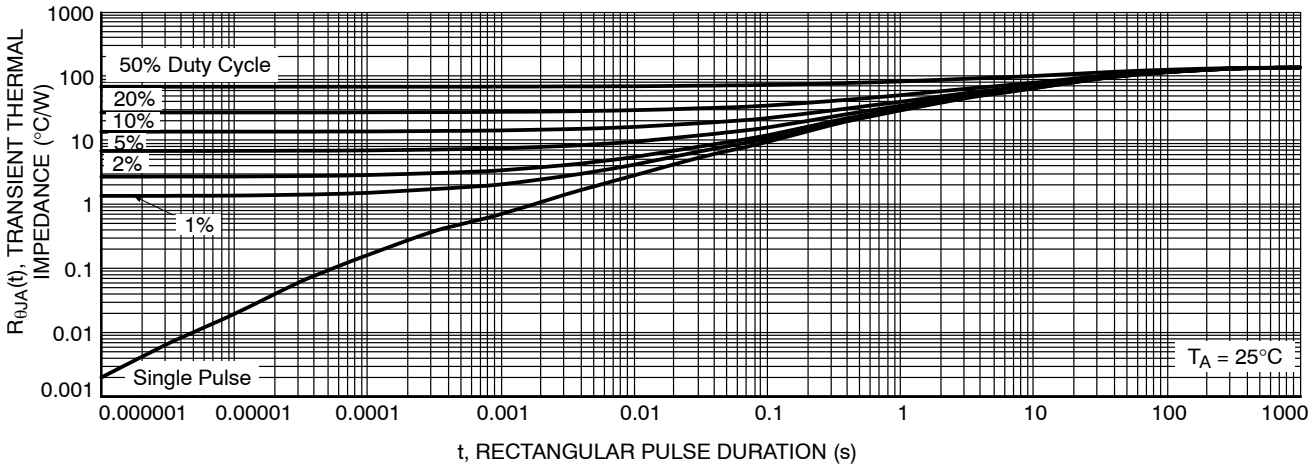


Figure 13. Thermal Response

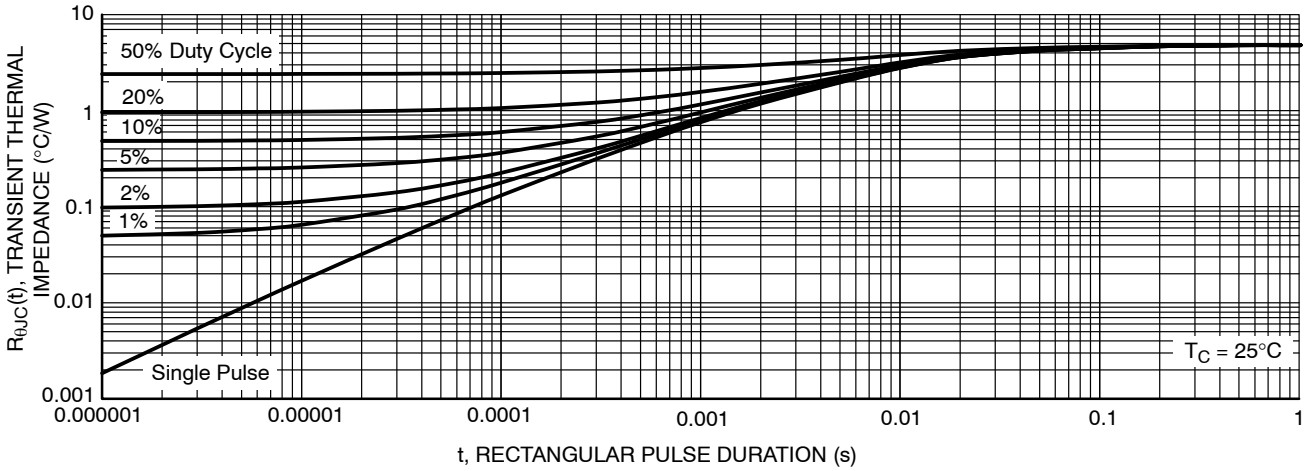
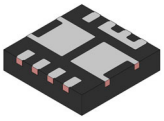
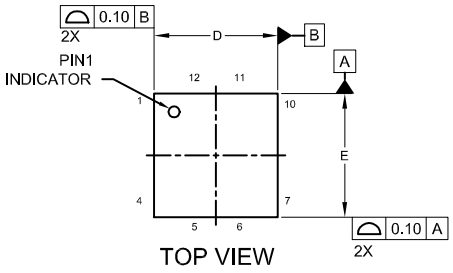


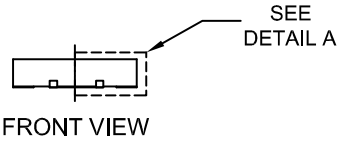
Figure 14. Thermal Response

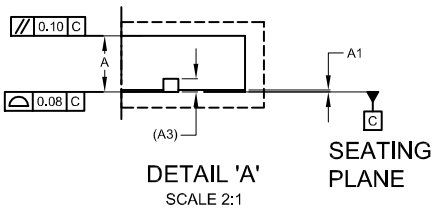


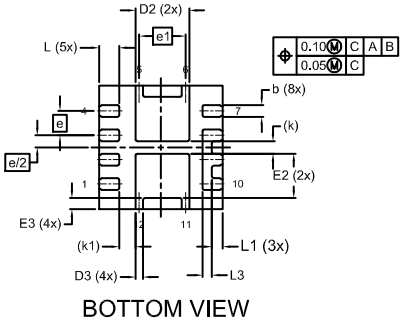
WQFN12 3.3X3.3, 0.65P
CASE 510CJ
ISSUE A

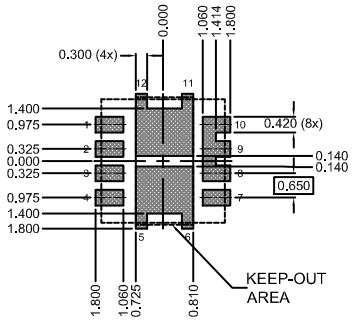
DATE 08 AUG 2022









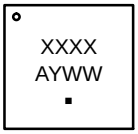


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE EXPOSED
4. SEATING PLANE IS DEFINED BY THE TERMINALS. "A1" IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.
5. IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	--	0.05
A3	0.20 REF		
b	0.27	0.32	0.37
D	3.20	3.30	3.40
D2	1.34	1.44	1.54
D3	0.10	0.20	0.30
E	3.20	3.30	3.40
E2	1.09	1.19	1.29
E3	0.20	0.30	0.40
e	0.65 BSC		
e/2	0.325 BSC		
e1	1.24 BSC		
k	0.33 REF		
k1	0.43 REF		
L	0.44	0.54	0.64
L1	0.19	0.29	0.39
L3	0.15	0.25	0.35

GENERIC MARKING DIAGRAM*



XXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = 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.

*FOR ADDITIONAL INFORMATION ON OUR PB-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

DOCUMENT NUMBER:	**98AON13806G**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red.	
DESCRIPTION:	**WQFN12 3.3X3.3, 0.65P**		**PAGE 1 OF 1**

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
Technical Library: www.onsemi.com/design/resources/technical−documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support
For additional information, please contact your local Sales Representative at
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