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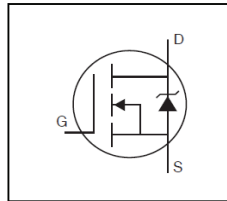
[International Rectifier \(Infineon Technologies Americas Corp.\)
AU1RF1404](#)

For any questions, you can email us directly:

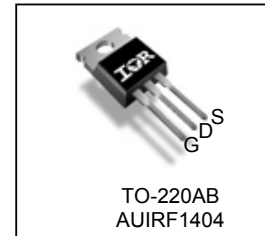
sales@integrated-circuit.com

AUTOMOTIVE GRADE
AU1RF1404
Features

- Advanced Planar Technology
- Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified *



V_{DSS}		40V
$R_{DS(on)}$	typ.	3.5mΩ
	max.	4.0mΩ
I_D (Silicon Limited)		202A[Ⓞ]
I_D (Package Limited)		160A



G	D	S
Gate	Drain	Source

Description

Specifically designed for Automotive applications, this Stripe Planar design of HEXFET[®] Power MOSFETs utilizes the latest processing techniques to achieve low on-resistance per silicon area. This benefit combined with the fast switching speed and ruggedized device design that HEXFET[®] power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in Automotive and a wide variety of other applications.

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AU1RF1404	TO-220	Tube	50	AU1RF1404

Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature (TA) is 25°C, unless otherwise specified.

Symbol	Parameter	Max.	Units
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited)	202 [Ⓞ]	A
$I_D @ T_C = 100^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited)	143	
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ (Package Limited)	160	
I_{DM}	Pulsed Drain Current ^①	808	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	333	W
	Linear Derating Factor	2.2	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ^②	620	mJ
I_{AR}	Avalanche Current ^①	See Fig.15,16, 12a, 12b	A
E_{AR}	Repetitive Avalanche Energy ^①		mJ
dv/dt	Peak Diode Recovery dv/dt ^③	1.5	V/ns
T_J	Operating Junction and Storage Temperature Range	-55 to + 175	°C
T_{STG}			
	Mounting torque, 6-32 or M3 screw	10 lbf•in (1.1N•m)	

Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ^⑦	—	0.45	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient	—	62	

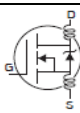
HEXFET[®] is a registered trademark of Infineon.

*Qualification standards can be found at www.infineon.com

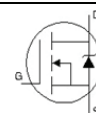
Static @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
V _{(BR)DSS}	Drain-to-Source Breakdown Voltage	40	—	—	V	V _{GS} = 0V, I _D = 250μA
ΔV _{(BR)DSS} /ΔT _J	Breakdown Voltage Temp. Coefficient	—	0.039	—	V/°C	Reference to 25°C, I _D = 1mA
R _{DS(on)}	Static Drain-to-Source On-Resistance	—	3.5	4.0	mΩ	V _{GS} = 10V, I _D = 121A ④
V _{GS(th)}	Gate Threshold Voltage	2.0	—	4.0	V	V _{DS} = V _{GS} , I _D = 250μA
g _{fs}	Forward Trans conductance	76	—	—	S	V _{DS} = 25V, I _D = 121A
I _{DSS}	Drain-to-Source Leakage Current	—	—	20	μA	V _{DS} = 40V, V _{GS} = 0V
		—	—	250		V _{DS} = 32V, V _{GS} = 0V, T _J = 150°C
I _{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	V _{GS} = 20V
	Gate-to-Source Reverse Leakage	—	—	-100		V _{GS} = -20V

Dynamic Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

Q _g	Total Gate Charge	—	131	196	nC	I _D = 121A V _{DS} = 32V V _{GS} = 10V ④
Q _{gs}	Gate-to-Source Charge	—	36	—		
Q _{gd}	Gate-to-Drain Charge	—	37	56		
t _{d(on)}	Turn-On Delay Time	—	17	—	ns	V _{DD} = 20V I _D = 121A R _G = 2.5Ω R _D = 0.2Ω
t _r	Rise Time	—	190	—		
t _{d(off)}	Turn-Off Delay Time	—	46	—		
t _f	Fall Time	—	33	—		
L _D	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6mm (0.25in.) from package and center of die contact 
L _S	Internal Source Inductance	—	7.5	—		
C _{iss}	Input Capacitance	—	5669	—	pF	V _{GS} = 0V V _{DS} = 25V f = 1.0MHz, See Fig. 5
C _{oss}	Output Capacitance	—	1659	—		
C _{rss}	Reverse Transfer Capacitance	—	223	—		
C _{oss}	Output Capacitance	—	6205	—		
C _{oss}	Output Capacitance	—	1467	—		
C _{oss eff.}	Effective Output Capacitance	—	2249	—		

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I _S	Continuous Source Current (Body Diode)	—	—	202⑥	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I _{SM}	Pulsed Source Current (Body Diode) ①	—	—	808		
V _{SD}	Diode Forward Voltage	—	—	1.5	V	T _J = 25°C, I _S = 121A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	78	117	ns	T _J = 25°C, I _F = 121A
Q _{rr}	Reverse Recovery Charge	—	163	245	nC	di/dt = 100A/μs ④
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L _S +L _D)				

Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)
- ② starting T_J = 25°C, L = 85μH, R_G = 25Ω, I_{AS} = 121A, V_{GS} = 10V. (See fig. 12)
- ③ I_{SD} ≤ 121A, di/dt ≤ 130A/μs, V_{DD} ≤ V_{(BR)DSS}, T_J ≤ 175°C.
- ④ Pulse width ≤ 400μs; duty cycle ≤ 2%.
- ⑤ C_{oss eff.} is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.
- ⑥ Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 160A.
- ⑦ R_θ is measured at T_J of approximately 90°C.

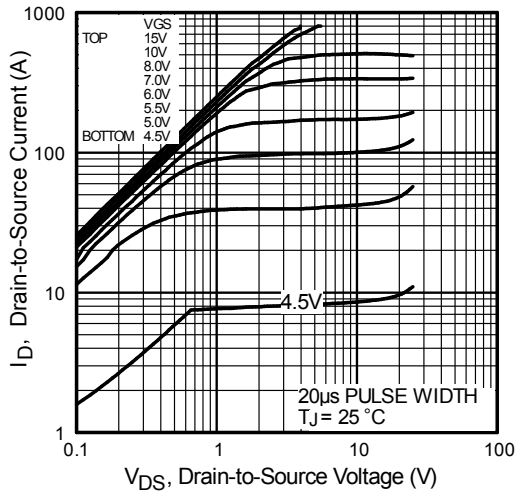


Fig. 1 Typical Output Characteristics

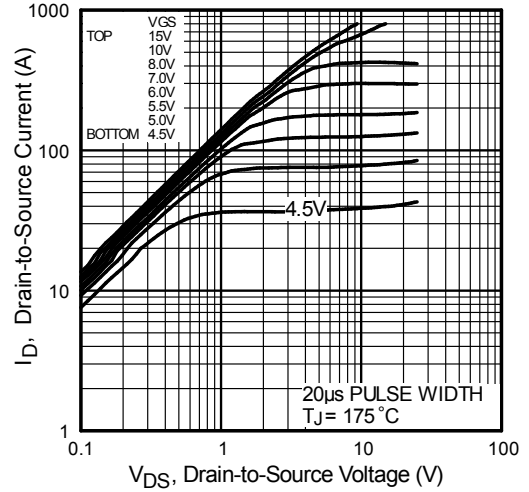


Fig. 2 Typical Output Characteristics

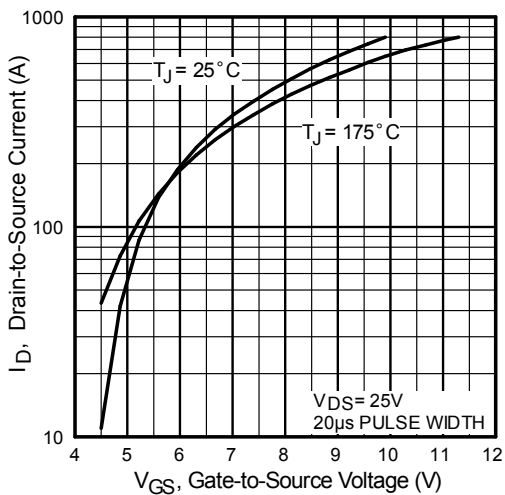


Fig. 3 Typical Transfer Characteristics

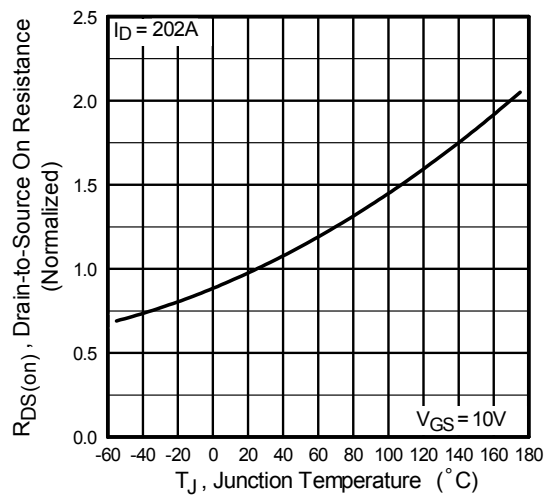


Fig. 4 Normalized On-Resistance vs. Temperature

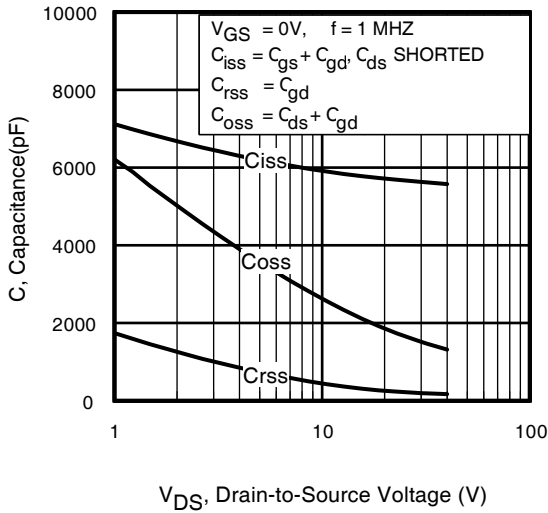


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

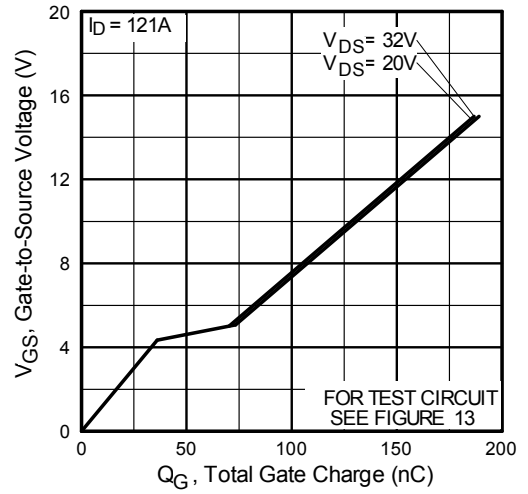


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

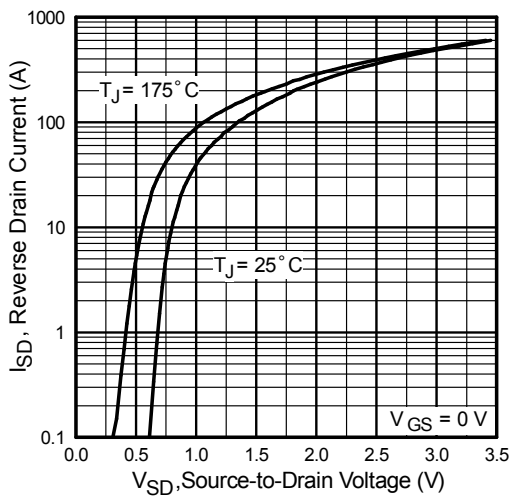


Fig 7 Typical Source-to-Drain Diode Forward Voltage

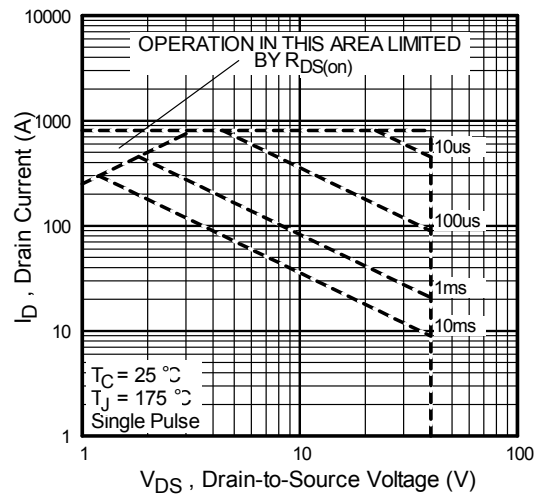


Fig 8. Maximum Safe Operating Area

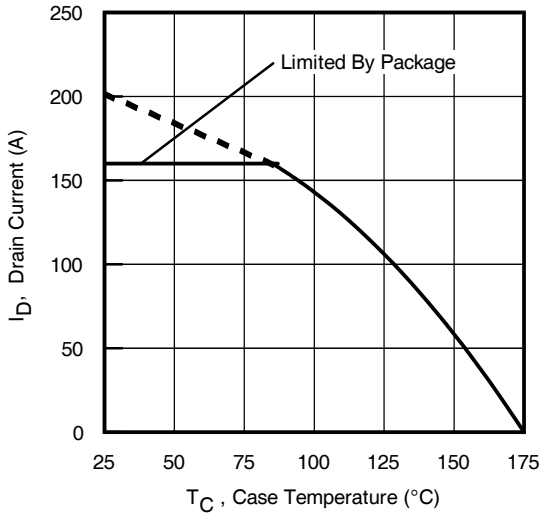


Fig 9. Maximum Drain Current vs. Case Temperature

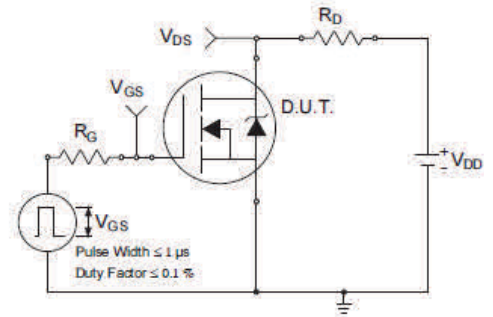


Fig 10a. Switching Time Test Circuit

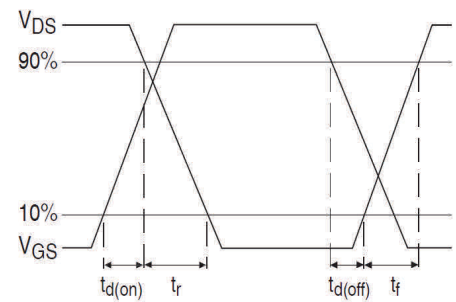


Fig 10b. Switching Time Waveforms

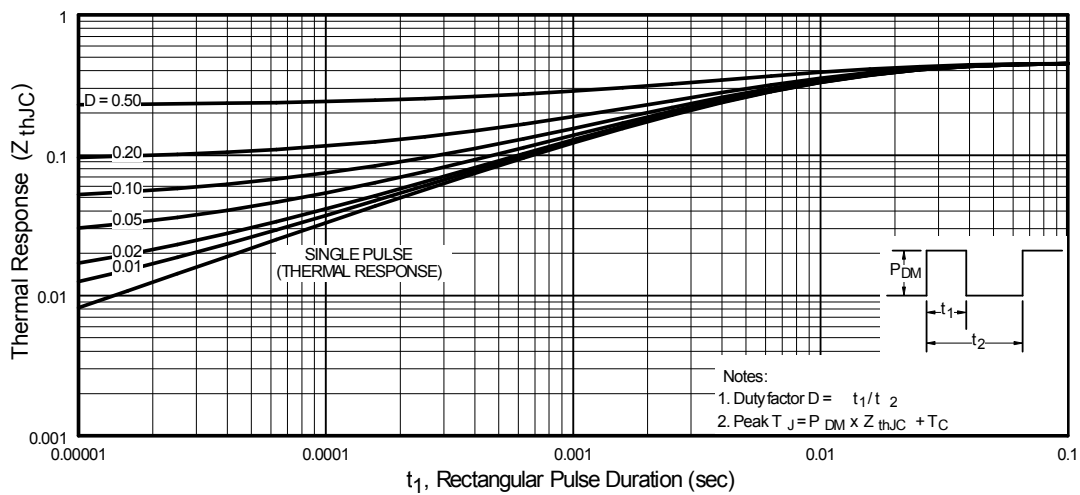


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

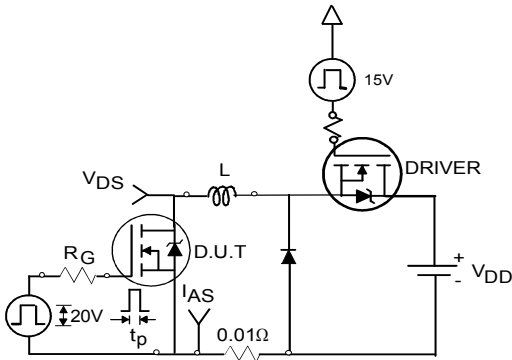


Fig 12a. Unclamped Inductive Test Circuit

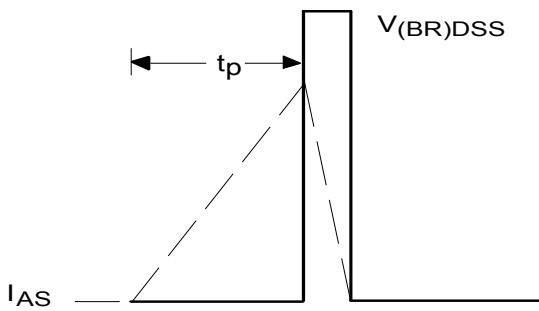


Fig 12b. Unclamped Inductive Waveforms

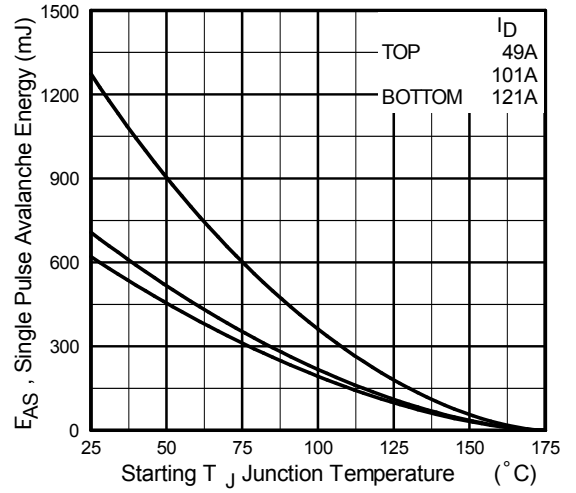


Fig 12c. Maximum Avalanche Energy vs. Drain Current

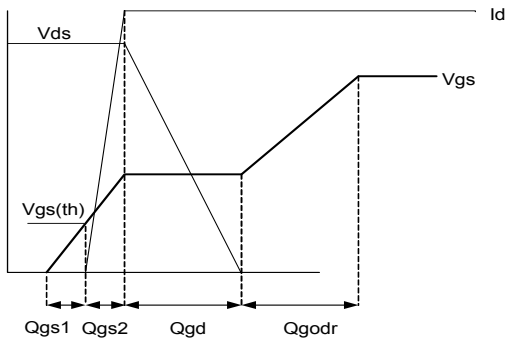


Fig 13a. Gate Charge Waveform

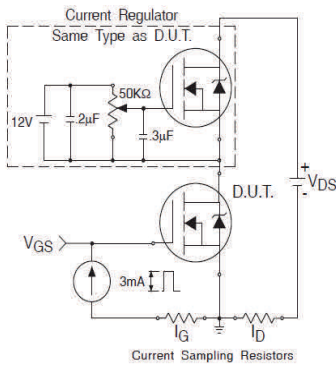


Fig 13b. Gate Charge Test Circuit

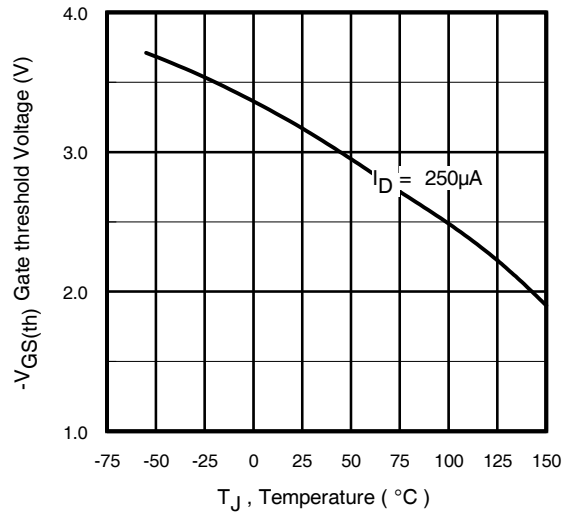


Fig 14. Threshold Voltage vs. Temperature

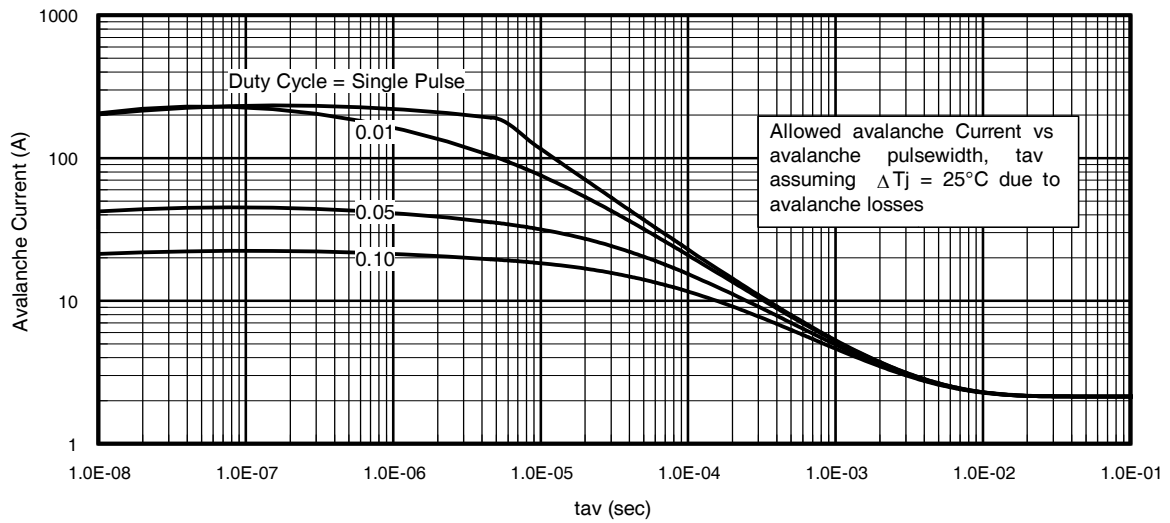


Fig 15. Typical Avalanche Current vs. Pulse width

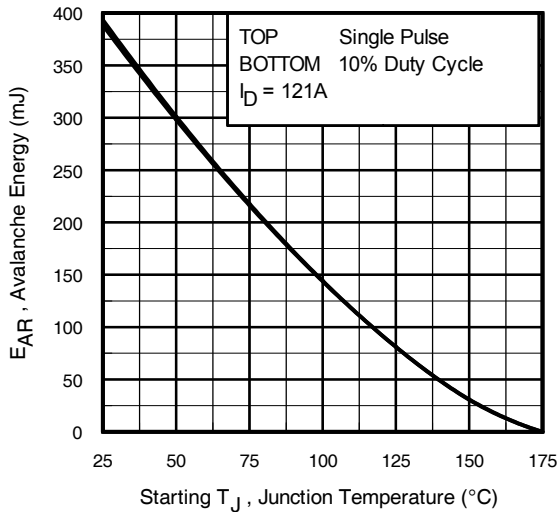


Fig 16. Maximum Avalanche Energy vs. Temperature

**Notes on Repetitive Avalanche Curves , Figures 15, 16:
 (For further info, see AN-1005 at www.infineon.com)**

1. Avalanche failures assumption:
 Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax} . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
4. $P_{D(ave)}$ = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6. I_{av} = Allowable avalanche current.
7. ΔT = Allowable rise in junction temperature, not to exceed T_{jmax} (assumed as 25°C in Figure 15, 16).
 t_{av} = Average time in avalanche.
 D = Duty cycle in avalanche = $t_{av} \cdot f$
 $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see Figures 13)

$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$

Peak Diode Recovery dv/dt Test Circuit

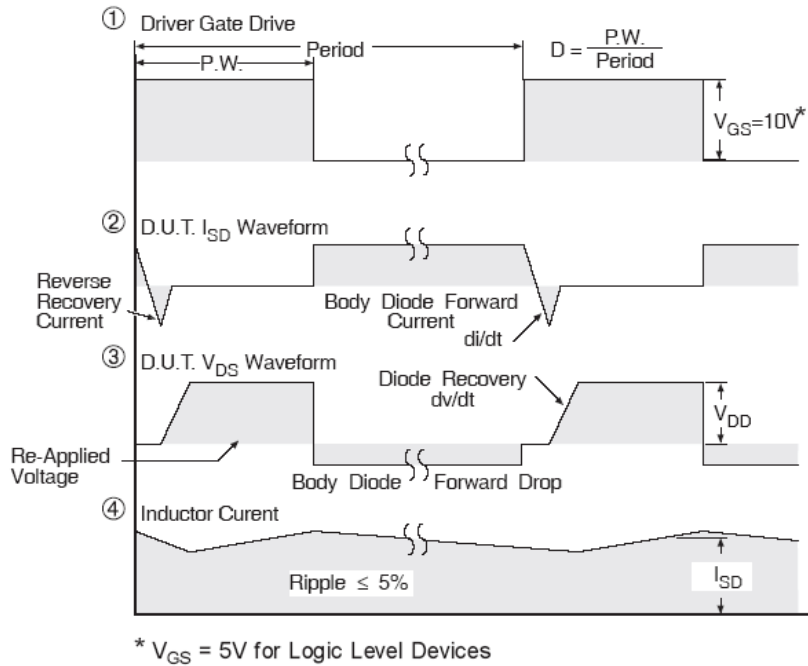
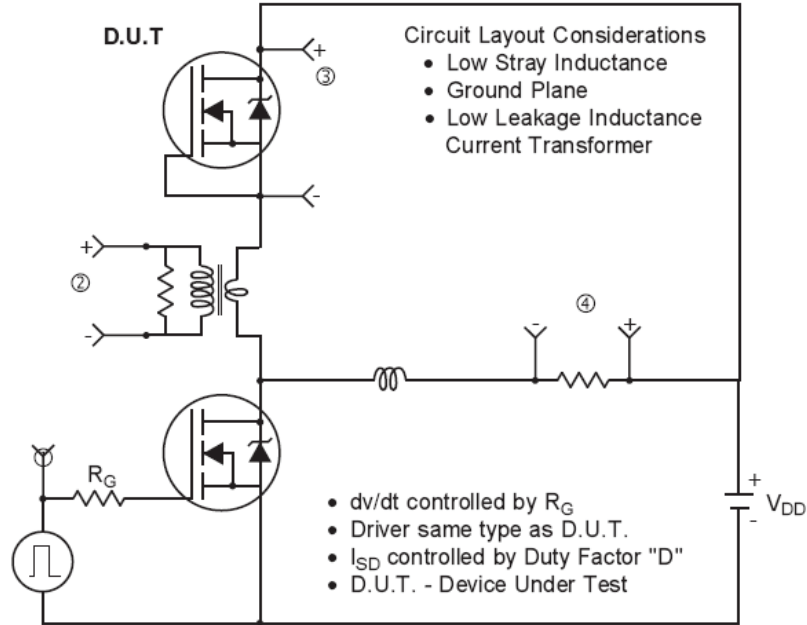
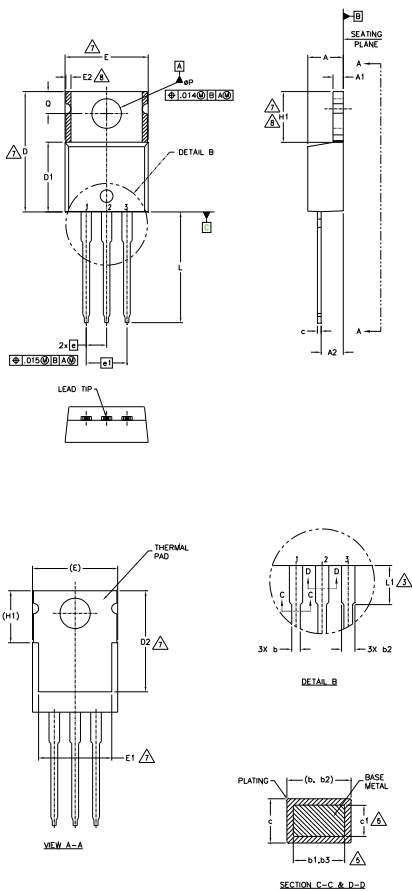


Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

TO-220AB Package Outline (Dimensions are shown in millimeters (inches))



NOTES:

- 1.- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
- 2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3.- LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 4.- DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
- 6.- CONTROLLING DIMENSION : INCHES.
- 7.- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
- 8.- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
- 9.- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.83	.140	.190	
A1	1.14	1.40	.045	.055	
A2	2.03	2.92	.080	.115	
b	0.38	1.01	.015	.040	5
b1	0.38	0.97	.015	.038	
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	11.68	12.88	.460	.507	7
E	9.65	10.67	.380	.420	4,7
E1	6.86	8.89	.270	.350	7
E2	-	0.76	-	.030	8
e	2.54 BSC		.100 BSC		
e1	5.08 BSC		.200 BSC		
H1	5.84	6.86	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	3.56	4.06	.140	.160	3
øP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	

LEAD ASSIGNMENTS

- HEXFET**
 1.- GATE
 2.- DRAIN
 3.- SOURCE

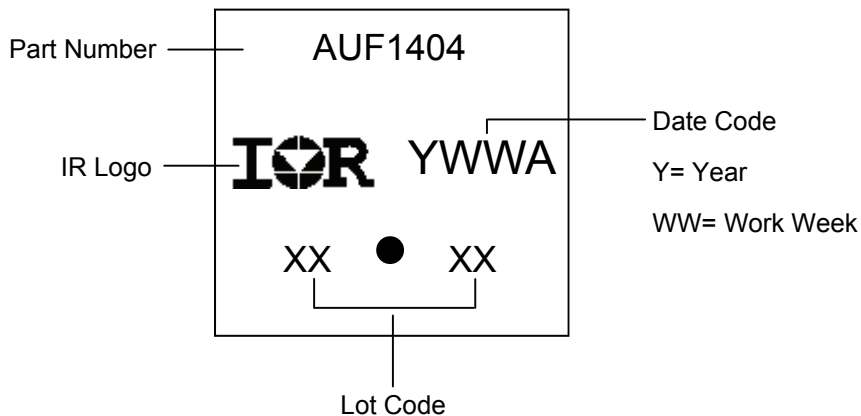
IGBTs, CoPACK

- 1.- GATE
 2.- COLLECTOR
 3.- EMITTER

DIODES

- 1.- ANODE
 2.- CATHODE
 3.- ANODE

TO-220AB Part Marking Information



TO-220AB package is not recommended for Surface Mount Application.

Qualification Information

Qualification Level		Automotive (per AEC-Q101)	
		Comments: This part number(s) passed Automotive qualification. Infineon's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level		TO-220AB	N/A
ESD	Machine Model	Class M4 (+/- 425V) [†] AEC-Q101-002	
	Human Body Model	Class H2 (+/- 4000V) [†] AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1125V) [†] AEC-Q101-005	
RoHS Compliant		Yes	

† Highest passing voltage.

Revision History

Date	Comments
9/30/2015	<ul style="list-style-type: none"> Updated datasheet with corporate template. Corrected typo on IDSS test condition on page 2. Updated Package outline on page 9.

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