

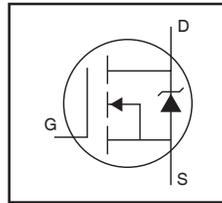
**AUTOMOTIVE GRADE**

**AUIRFZ48Z**  
**AUIRFZ48ZS**

HEXFET® Power MOSFET

**Features**

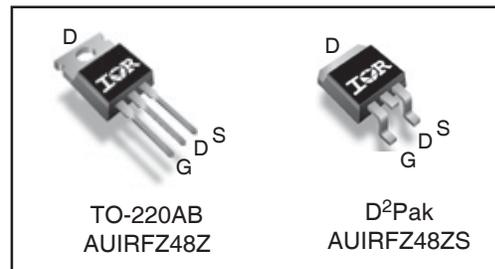
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified \*



$V_{(BR)DSS}$	<b>55V</b>
$R_{DS(on)}$ max.	<b>11mΩ</b>
$I_D$	<b>61A</b>

**Description**

Specifically designed for Automotive applications, this HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this design are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating. These features combine to make this design an extremely efficient and reliable device for use in Automotive applications and a wide variety of other applications.



<b>G</b>	<b>D</b>	<b>S</b>
Gate	Drain	Source

**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 ( $T_A$ ) is 25°C, unless otherwise specified.

	Parameter	Max.	Units
$I_D @ T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	61	A
$I_D @ T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	43	
$I_{DM}$	Pulsed Drain Current ①	240	
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation	91	W
	Linear Derating Factor	0.61	W/°C
$V_{GS}$	Gate-to-Source Voltage	± 20	V
$E_{AS}$	Single Pulse Avalanche Energy (Thermally Limited) ②	73	mJ
$E_{AS}(\text{tested})$	Single Pulse Avalanche Energy Tested Value ③	120	
$I_{AR}$	Avalanche Current ④	See Fig. 12a, 12b, 15, 16	A
$E_{AR}$	Repetitive Avalanche Energy ⑤		mJ
dv/dt	Peak Diode Recovery dv/dt ⑥	7.2	V/ns
$T_J$	Operating Junction and	-55 to + 175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds (1.6mm from case )		
	Mounting torque, 6-32 or M3 screw		
		10 lbf•in (1.1N•m)	

**Thermal Resistance**

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ⑦	—	1.64	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient	—	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state)⑧	—	40	

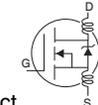
HEXFET® is a registered trademark of International Rectifier.

\*Qualification standards can be found at <http://www.irf.com/>

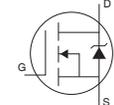
### Static Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	55	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.054	—	V/°C	Reference to $25^\circ\text{C}, I_D = 1mA$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	8.6	11	m $\Omega$	$V_{GS} = 10V, I_D = 37A$ ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$g_{fs}$	Forward Transconductance	24	—	—	S	$V_{DS} = 25V, I_D = 37A$
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	20	$\mu A$	$V_{DS} = 55V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 55V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	200	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage	—	—	-200		$V_{GS} = -20V$

### Dynamic Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge	—	43	64	nC	$I_D = 37A$
$Q_{gs}$	Gate-to-Source Charge	—	11	16		$V_{DS} = 44V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	16	24		$V_{GS} = 10V$ ⑥
$t_{d(on)}$	Turn-On Delay Time	—	15	—	ns	$V_{DD} = 28V$
$t_r$	Rise Time	—	69	—		$I_D = 37A$
$t_{d(off)}$	Turn-Off Delay Time	—	35	—		$R_G = 12\Omega$
$t_f$	Fall Time	—	39	—		$V_{GS} = 10V$ ⑥
$L_D$	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	—	1720	—	pF	$V_{GS} = 0V$
$C_{oss}$	Output Capacitance	—	300	—		$V_{DS} = 25V$
$C_{rss}$	Reverse Transfer Capacitance	—	160	—		$f = 1.0MHz$ , See Fig. 5
$C_{oss}$	Output Capacitance	—	1020	—		$V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$
$C_{oss}$	Output Capacitance	—	230	—		$V_{GS} = 0V, V_{DS} = 44V, f = 1.0MHz$
$C_{oss\ eff.}$	Effective Output Capacitance	—	380	—		$V_{GS} = 0V, V_{DS} = 0V$ to 44V

### Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	61	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{SM}$	Pulsed Source Current (Body Diode) ①	—	—	240		
$V_{SD}$	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}, I_S = 37A, V_{GS} = 0V$ ④
$t_{rr}$	Reverse Recovery Time	—	20	31	ns	$T_J = 25^\circ\text{C}, I_F = 37A, V_{DD} = 30V$
$Q_{rr}$	Reverse Recovery Charge	—	13	20	nC	$di/dt = 100A/\mu s$ 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 Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.11mH$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 37A$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value.
- ③  $I_{SD} \leq 37A$ ,  $di/dt \leq 920A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$ .
- ④ Pulse width  $\leq 1.0ms$ ; duty cycle  $\leq 2\%$ .
- 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 Limited by  $T_{Jmax}$ , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- ⑦ This value determined from sample failure population, starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.11mH$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 37A$ ,  $V_{GS} = 10V$ .
- ⑧ This is applied to D<sup>2</sup>Pak, when mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.
- ⑨  $R_\theta$  is rated at  $T_J$  of approximately  $90^\circ\text{C}$ .

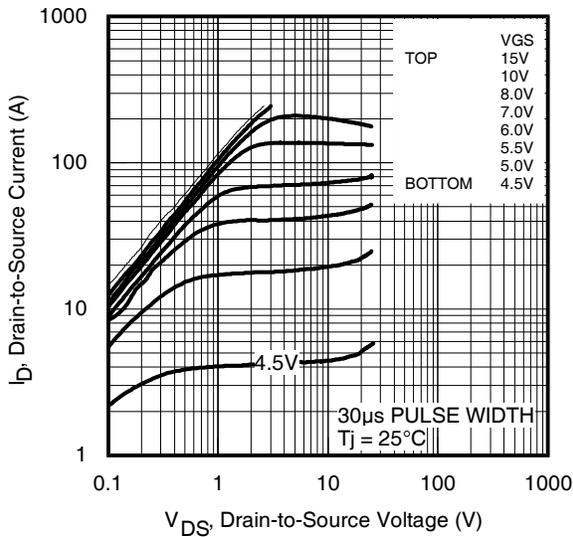
## Qualification Information†

<b>Qualification Level</b>		Automotive (per AEC-Q101) ††	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		TO-220AB	N/A
		D <sup>2</sup> Pak	MSL1
<b>ESD</b>	Machine Model	Class M4 (+/- 425V) ††† AEC-Q101-002	
	Human Body Model	Class H1B (+/- 1000V) ††† AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1125V) ††† AEC-Q101-005	
<b>RoHS Compliant</b>		Yes	

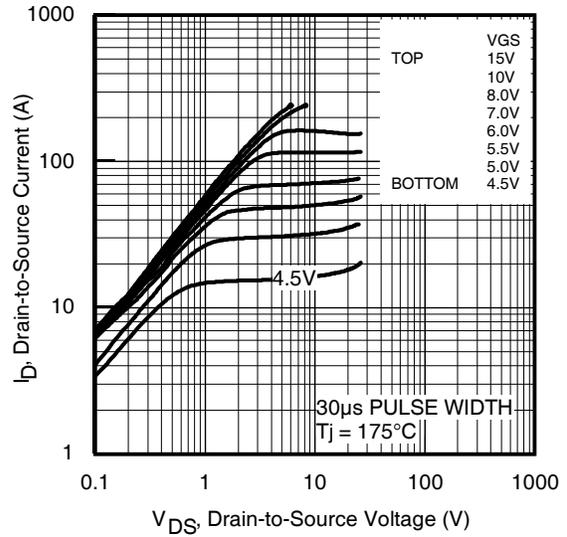
† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/>

†† Exceptions to AEC-Q101 requirements are noted in the qualification report.

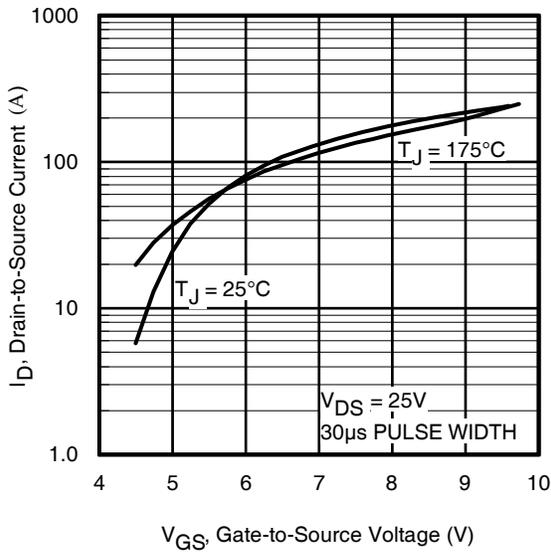
††† Highest passing voltage.



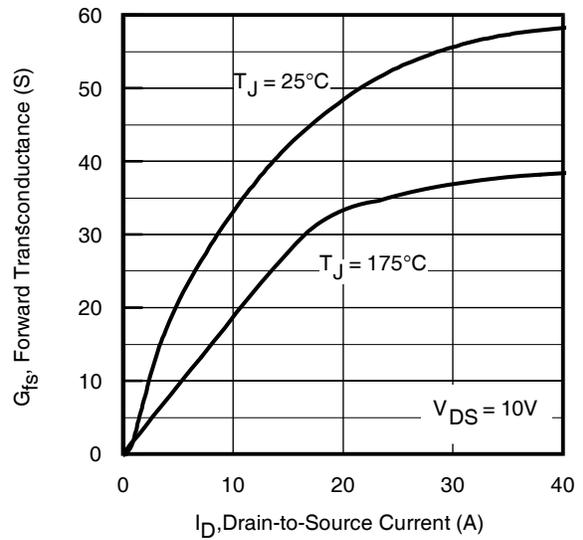
**Fig 1.** Typical Output Characteristics



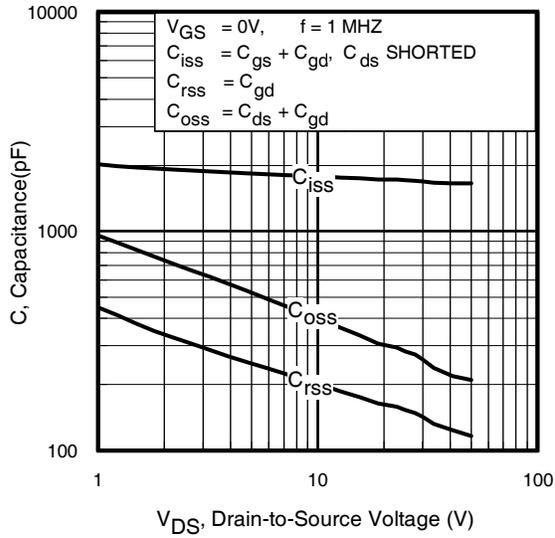
**Fig 2.** Typical Output Characteristics



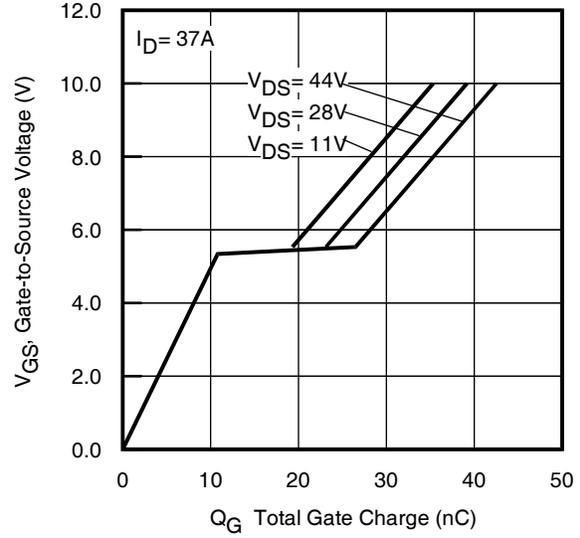
**Fig 3.** Typical Transfer Characteristics



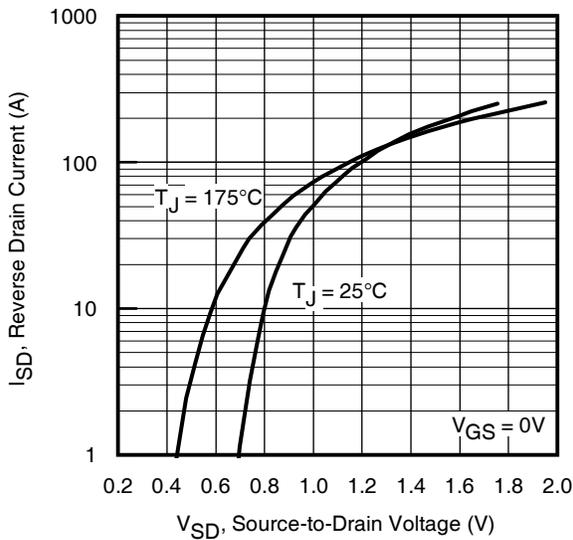
**Fig 4.** Typical Forward Transconductance vs. Drain Current



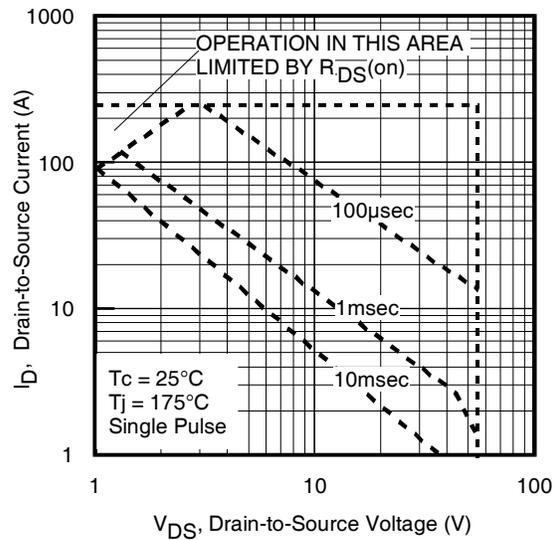
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



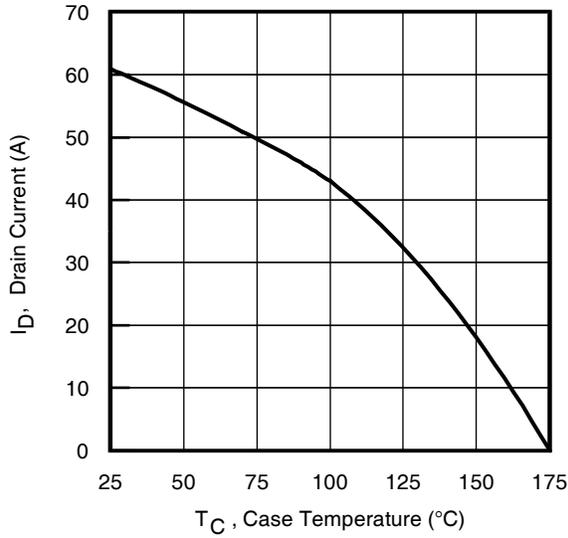
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



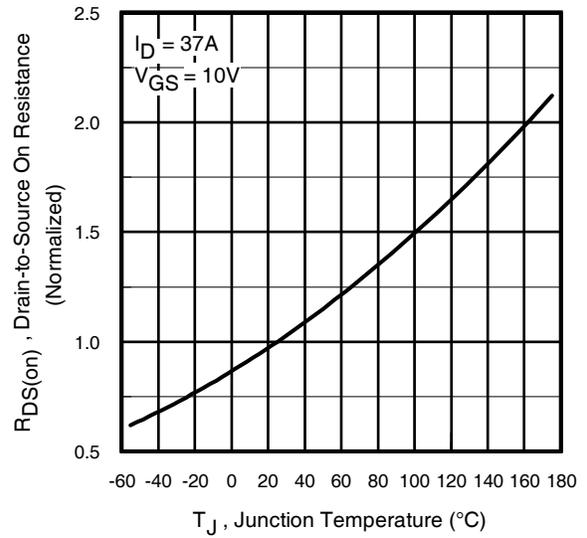
**Fig 7.** Typical Source-Drain Diode Forward Voltage



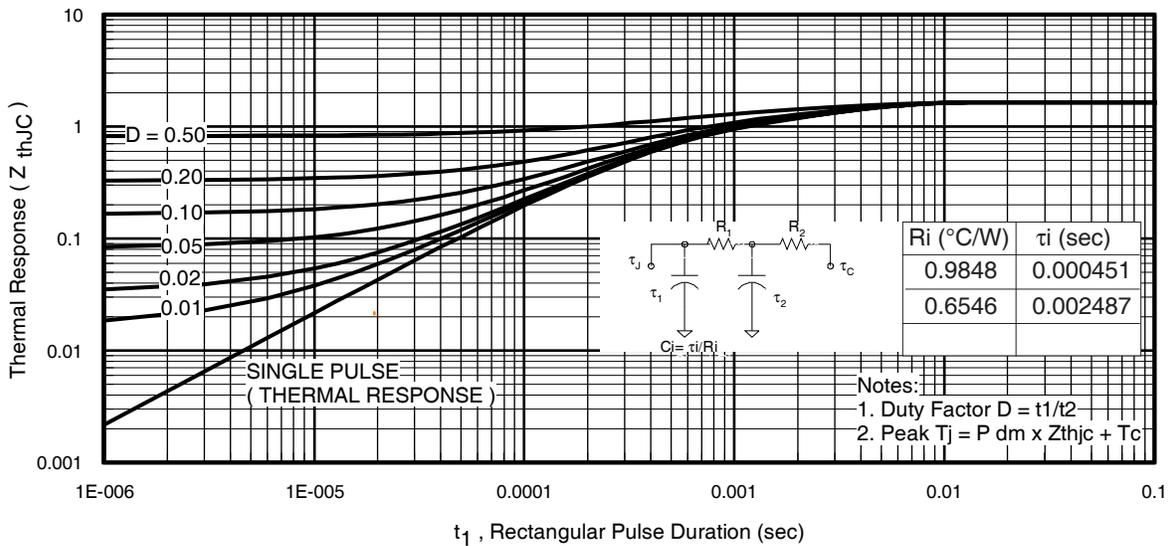
**Fig 8.** Maximum Safe Operating Area



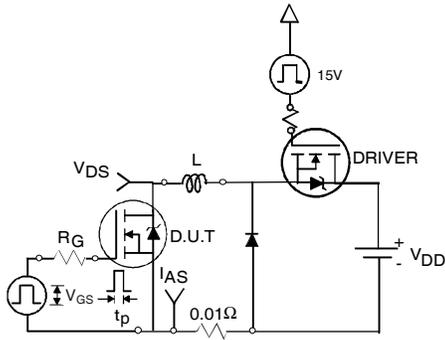
**Fig 9.** Maximum Drain Current vs. Case Temperature



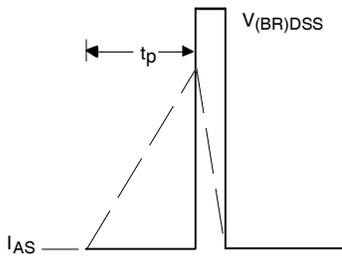
**Fig 10.** Normalized On-Resistance vs. Temperature



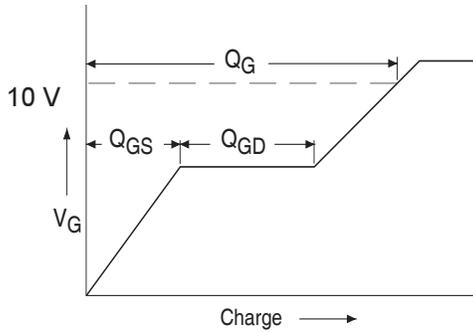
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



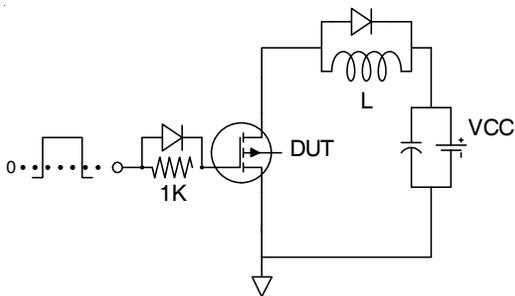
**Fig 12a.** Unclamped Inductive Test Circuit



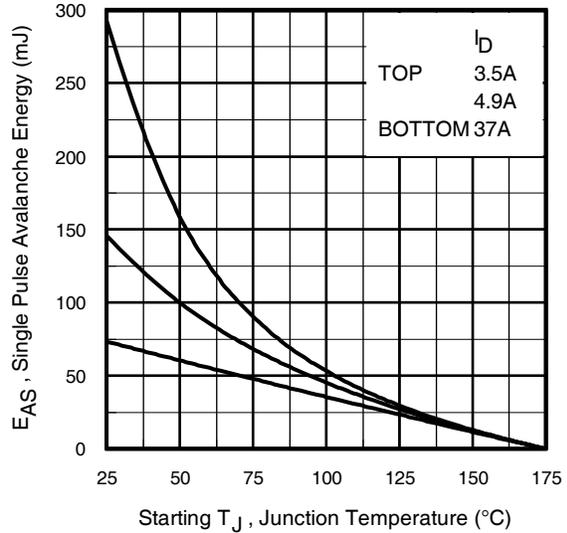
**Fig 12b.** Unclamped Inductive Waveforms



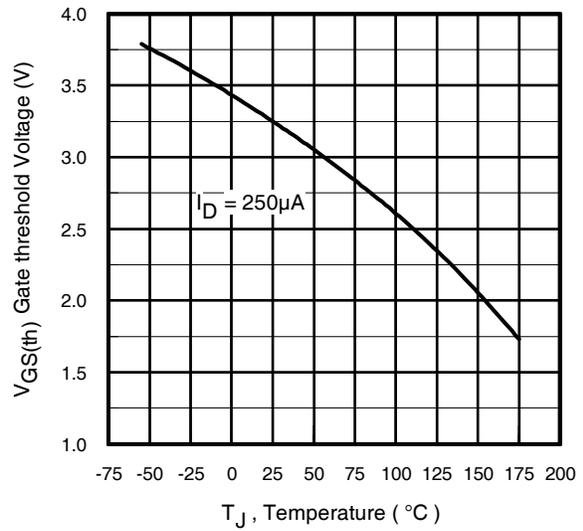
**Fig 13a.** Basic Gate Charge Waveform



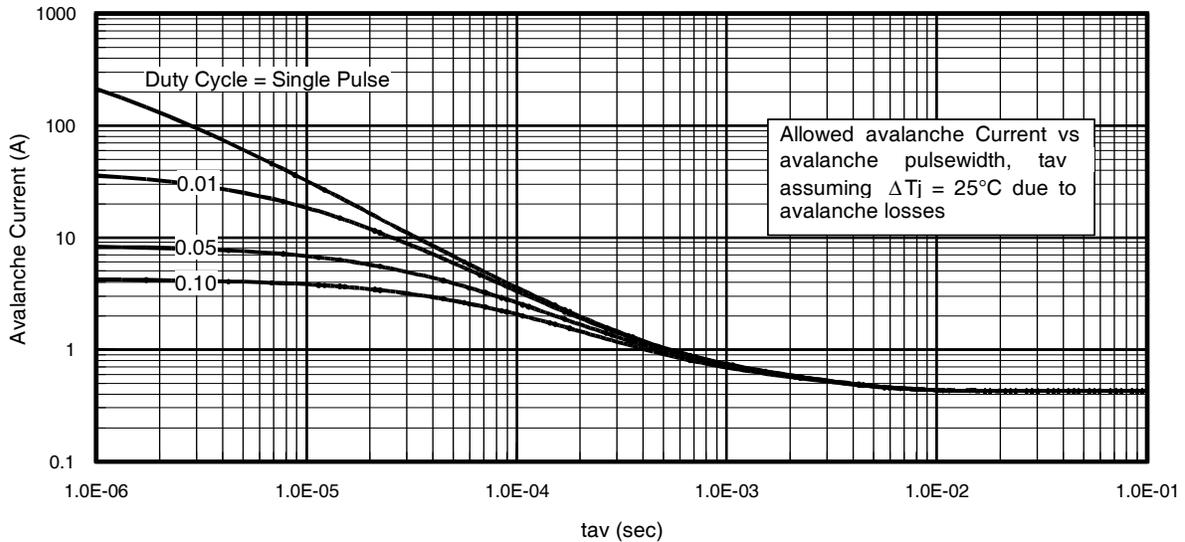
**Fig 13b.** Gate Charge Test Circuit  
www.irf.com



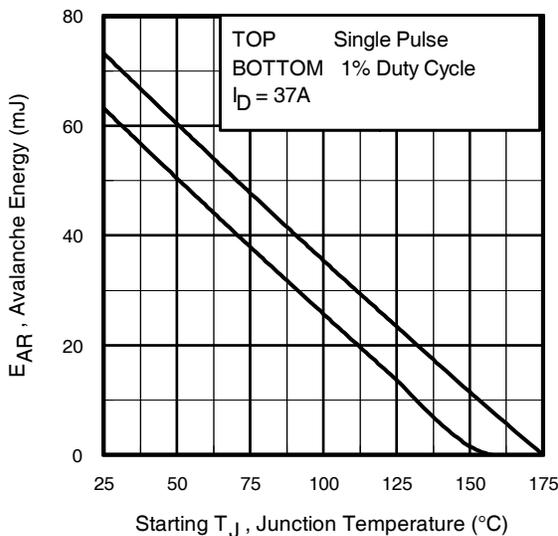
**Fig 12c.** Maximum Avalanche Energy vs. Drain Current



**Fig 14.** Threshold Voltage vs. Temperature



**Fig 15.** Typical Avalanche Current vs.Pulsewidth



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

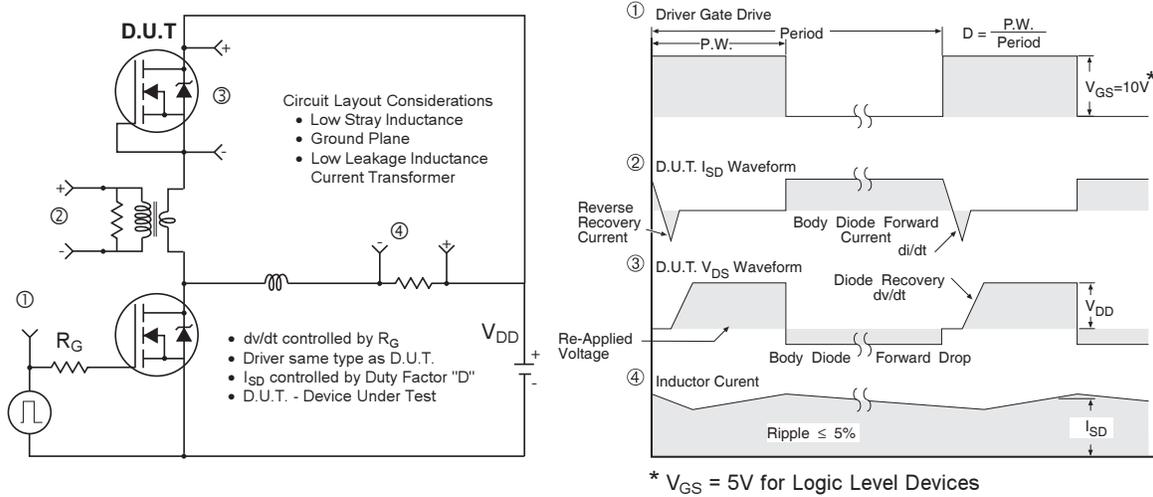
1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms 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.  $\Delta T$  = 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 figure 11)

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

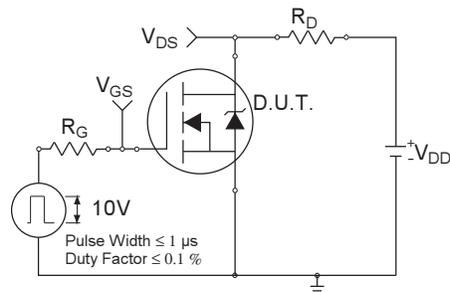
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

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

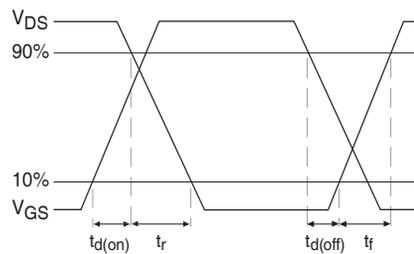
**Fig 16.** Maximum Avalanche Energy vs. Temperature



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



**Fig 18a. Switching Time Test Circuit**

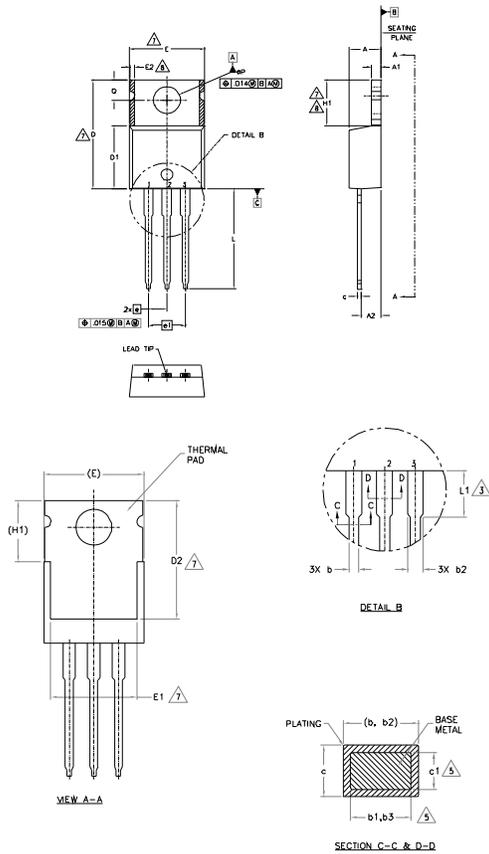


**Fig 18b. Switching Time Waveforms**

# AUIRFZ48Z/ZS

## 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	0.51	1.40	.020	.055	
A2	2.03	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.97	.015	.038	5
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**

- HEXCEL  
1- GATE  
2- DRAIN  
3- SOURCE

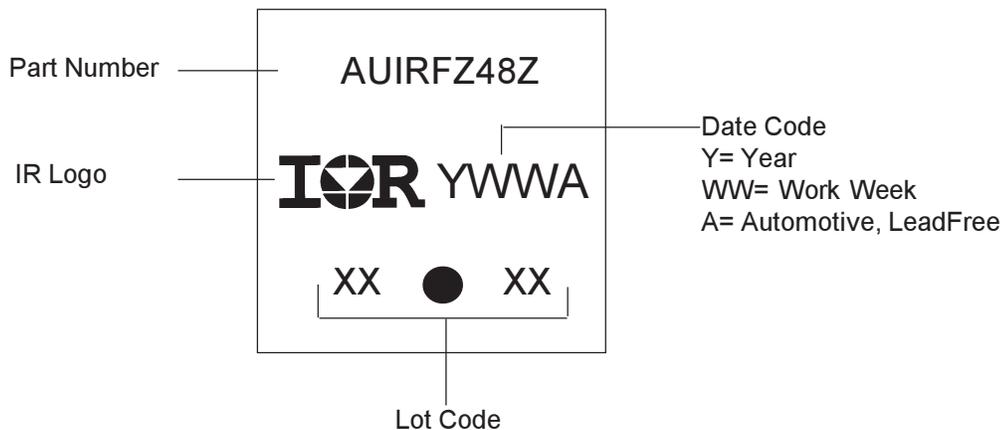
**IRIS. GUPACK**

- 1- GATE  
2- COLLECTOR  
3- EMITTER

**ROSES**

- 1- ANODE  
2- CATHODE  
3- ANODE

## TO-220AB Part Marking Information

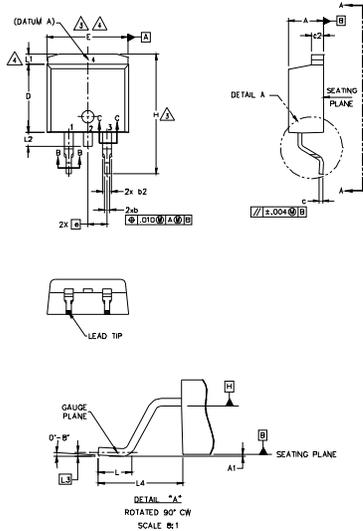


TO-220AB packages are not recommended for Surface Mount Application.

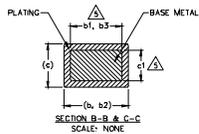
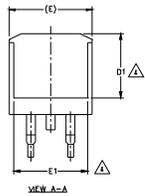
**Note:** For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## D<sup>2</sup>Pak (TO-263AB) Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	0.00	0.254	.000	.010	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	5
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	3
D1	6.86	-	.270	-	4
E	9.65	10.67	.380	.420	3,4
E1	6.22	-	.245	-	4
e	2.54 BSC		.100 BSC		
H	14.61	15.88	.575	.625	
L	1.78	2.79	.070	.110	
L1	-	1.65	-	.066	4
L2	-	1.78	-	.070	
L3	0.25 BSC		.010 BSC		
L4	4.78	5.28	.188	.208	



### LEAD ASSIGNMENTS

#### DIODES

- 1 - ANODE (TWO DIE) / OPEN (ONE DIE)
- 2, 4 - CATHODE
- 3 - ANODE

#### HEXFET

- 1 - GATE
- 2, 4 - DRAIN
- 3 - SOURCE

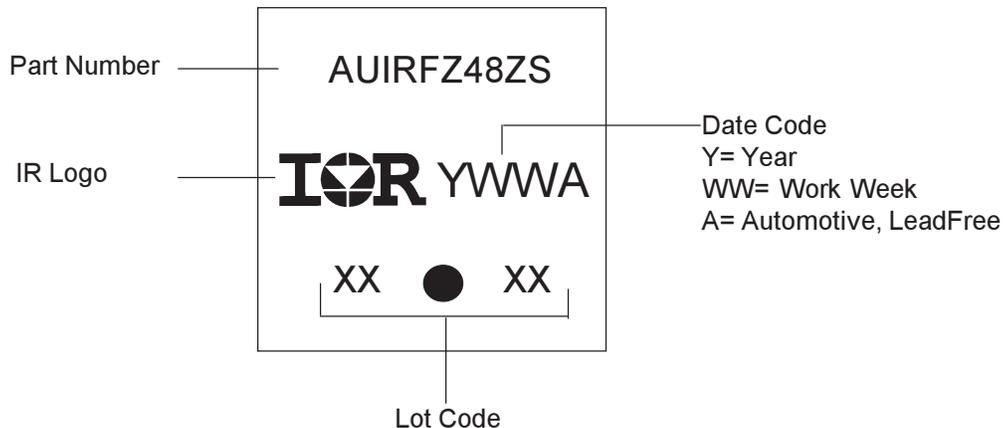
#### IGBTs, CoPACK

- 1 - GATE
- 2, 4 - COLLECTOR
- 3 - EMITTER

### NOTES

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

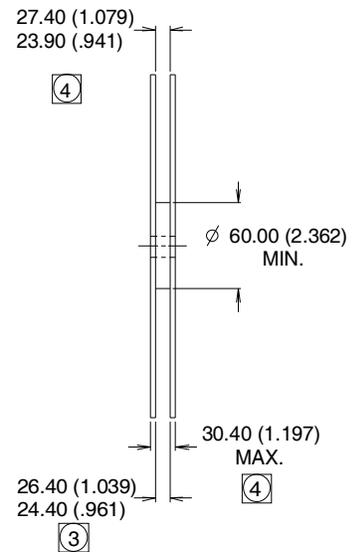
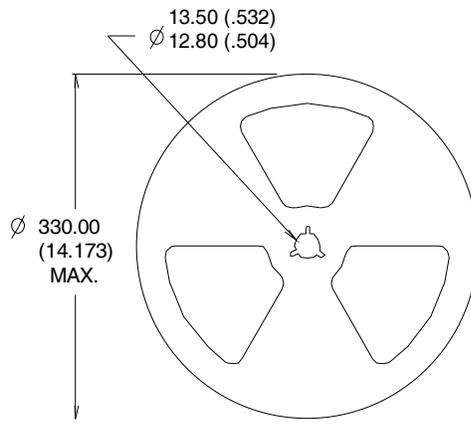
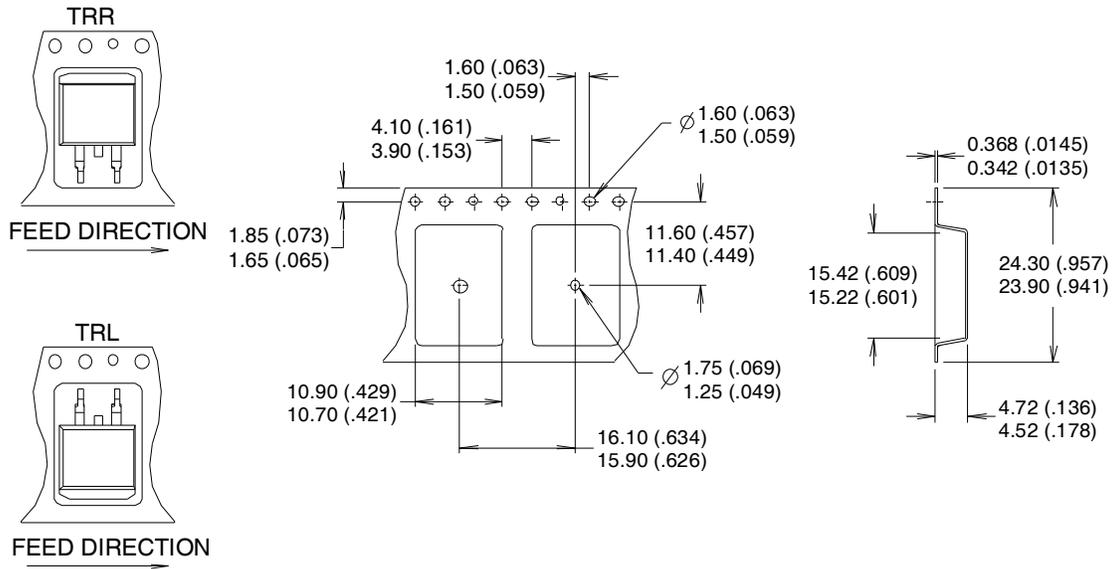
## D<sup>2</sup>Pak (TO-263AB) Part Marking Information



Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



**NOTES :**

1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
- ③ DIMENSION MEASURED @ HUB.
- ④ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

## Ordering Information

Base part	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRFZ48Z	TO-220	Tube	50	AUIRFZ48Z
AUIRFZ48ZS	D2Pak	Tube	50	AUIRFZ48ZS
		Tape and Reel Left	800	AUIRFZ48ZSTRL
		Tape and Reel Right	800	AUIRFZ48ZSTRR

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