

## N-Channel Enhancement Mode Power MOSFET

### Description

SMIRF12N65 is an N-channel enhancement mode power MOS field effect transistor. The improved planar stripe cell and the improved guard ring terminal have been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode.

These devices are widely used in AC-DC power suppliers, DCDC converters and H-bridge PWM motor drivers.

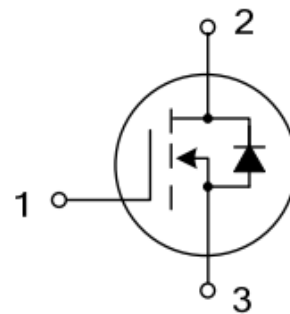
### General Features

- 12A,650V, $R_{DS(on)(typ.)} = 0.6\Omega @ V_{GS}=10V$
- Low Gate charge
- Low Crss
- Fast Switching
- Improved dv/dt Capability

### Application

- Power switching application
- Hard switched and high frequency circuits
- Uninterruptible power supply

$I_D$	12A
$V_{DSS}$	650V
$R_{dson (max)}$	$0.75\Omega (V_{GS}=10V, I_D=6A)$
$Q_g$	45nC



1.Gate 2.Drain 3.Source



TO-220



TO-220F

**Order Information**

Order Information	Marking ID	Package	Packing Type Supplied As
SMIRF12N65T2TL	IRF12N65	TO220F-3L	1000 units on Box, 5000 units on Carton
SMIRF12N65T1TL	IRF12N65	TO220-3L	1000 units on Box, 5000 units on Carton

**Absolute Maximum Ratings Ta=25 °C unless otherwise noted**

Parameter	Symbol	Value	Unit
Drain-source Voltage	$V_{DS}$	650	V
Gate-source Voltage	$V_{GS}$	$\pm 30$	V
Continuous Drain Current(Ta=25°C)	$I_D$	12	A
Drain Current-Pulsed	$I_{DM}$	48	A
Total Dissipation(Ta=25°C)	TO220	225	W
	TO220F	56	
Junction Temperature	$T_J$	150	°C
Storage Temperature	$T_{STG}$	-55 to 150	°C
Single Pulse Avalanche Energy	$E_{AS}$	820	mJ
ESD HBM(Human Body Mode)		$\geq 2000$	V
ESD MM(Machine Mode)		$\geq 200$	V

**Electrical Characteristics Ta = 25°C**

PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Drain-source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	650			V
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS}=V_{DS}, I_D=250\mu A$	2.0		4.0	V
Drain-source Leakage Current	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			10	$\mu A$
Drain-Source Diode Forward Voltage	$V_{SD}$	$V_{GS}=0V, I_S=12A$			1.5	V
Gate-body Leakage Current ( $V_{DS} = 0$ )	$I_{GSS}$	$V_{GS}=\pm 30V$			$\pm 100$	nA
Static Drain-source On Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=6A$		0.6	0.75	$\Omega$

**Note:** Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant in temperature etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings

## Thermal Characteristics Ta=25°C

PARAMETER		Symbol	TYP	MAX	UNIT
Maximum Junction-to-case	TO220F, TO220	R <sub>QJC</sub>		2.4	°C/W
Maximum Junction-to-Ambient	TO220F, TO220	R <sub>QJA</sub>		62.5	°C/W

**Note1:** Ensure that the channel temperature does not exceed 150°C

**Note2:** V<sub>DD</sub>=50V, T<sub>ch</sub>=25 °C(initial), I<sub>AS</sub>=12A, R<sub>g</sub>=25Ω

**Note3:** This transistor is sensitive to electrostatic and should be handled with care

## Dynamic Characteristics Ta = 25 °C

PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1.0MHZ		1810	2300	pF
output Capacitance	C <sub>oss</sub>			150	250	pF
Reverse Transfer Capacitance	C <sub>rss</sub>			16	32	pF

## Switching Characteristics Ta=25 °C

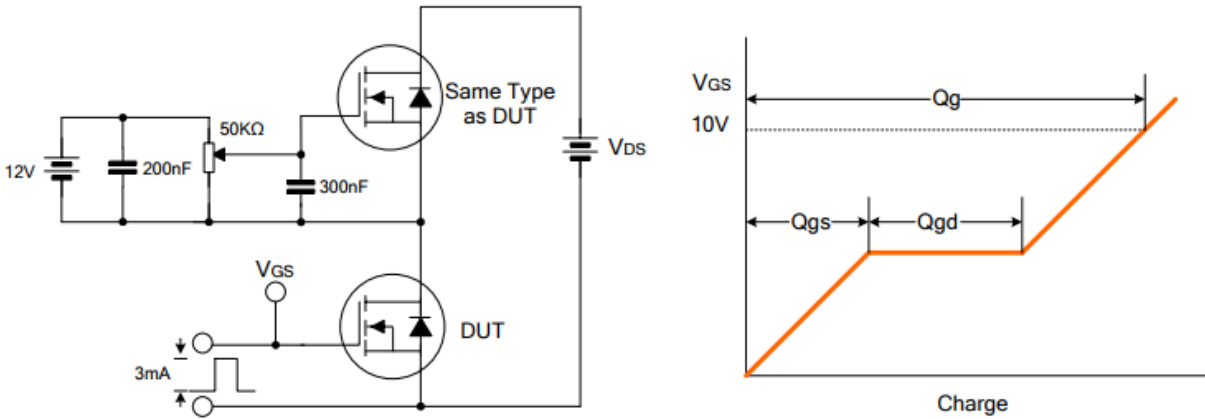
PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Turn-On Delay Time	T <sub>d(on)</sub>	V <sub>DS</sub> =325V, I <sub>D</sub> =12A, V <sub>GS</sub> =10V, R <sub>G</sub> =25Ω		32	65	nS
Turn-On Rise Time	T <sub>r</sub>			105	245	nS
Turn-Off Delay Time	T <sub>d(off)</sub>			90	170	nS
Turn-Off Rise Time	T <sub>f</sub>			85	160	nS
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> =520V, I <sub>D</sub> =12A, V <sub>GS</sub> =10V		45	55	nC
Gate-Source Charge	Q <sub>gs</sub>			8.2		nC
Gate-Drain Charge	Q <sub>gd</sub>			25		nC

## Drain-Source Diode Maximum Ratings and Characteristics Ta=25 °C

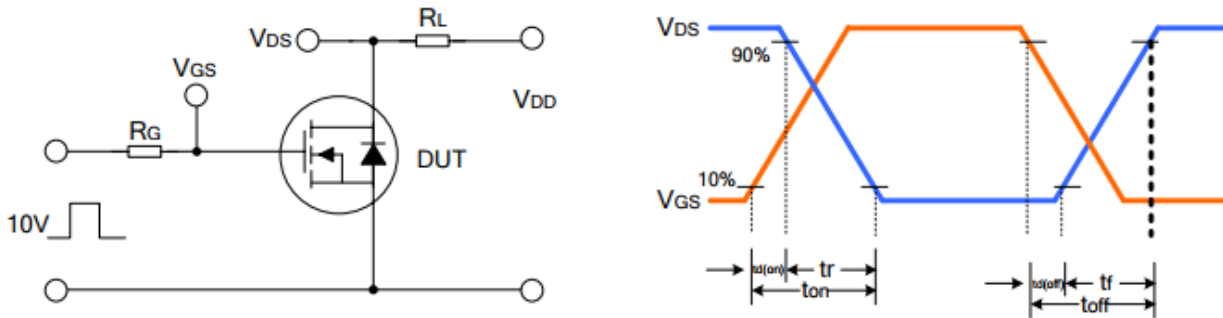
PARAMETER	Symbol	Test Condition	MIN	TYP	MAX	UNIT
Max. Diode Forward Current	I <sub>s</sub>	Integral Reverse P-N Junction Diode in the MOSFET			12	A
Pulsed Source Current	I <sub>sm</sub>				48	A
Diode Forward Voltage	V <sub>SD</sub>	V <sub>GS</sub> =0V, I <sub>s</sub> =12A			1.5	V
Reverse Recovery Time	t <sub>rr</sub>	V <sub>GS</sub> =0V, I <sub>s</sub> =12A, dIF/dt=100A/μs		385		nS
Reverse Recovery Charge	Q <sub>rr</sub>				3	

## Test Circuit

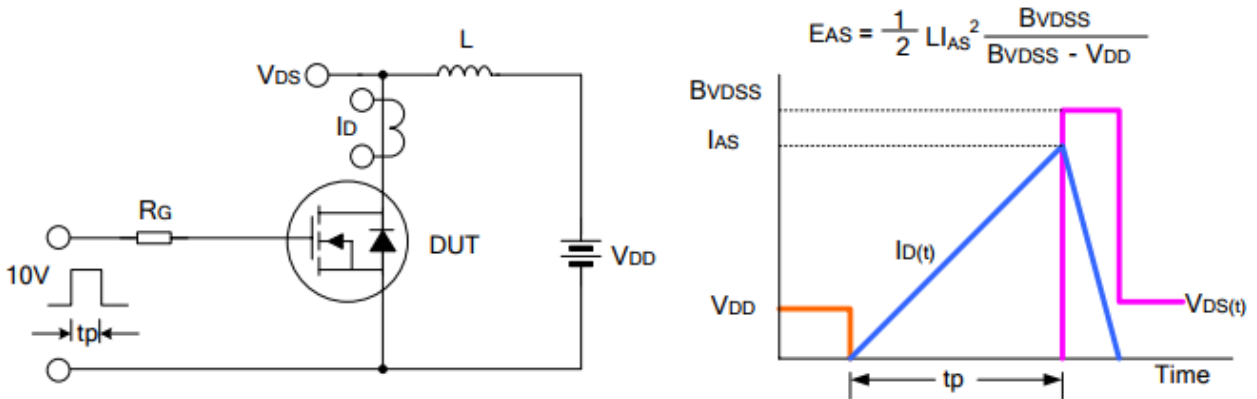
### Gate Charge Test Circuit & Waveform



### Resistive Switching Test Circuit & Waveform



### Unclamped Inductive Switching Test Circuit & Waveform



## Typical Characteristics Curve

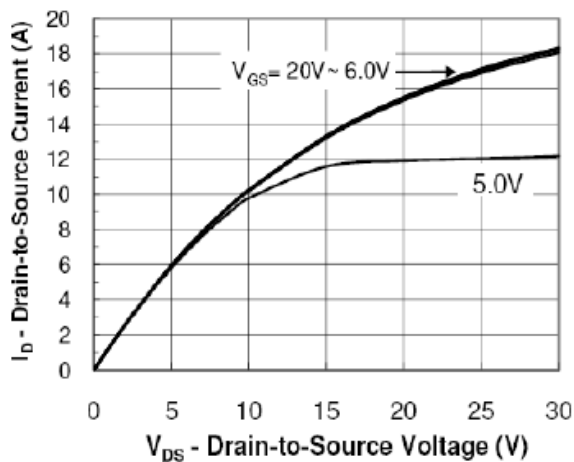


Figure 1: Output Characteristics

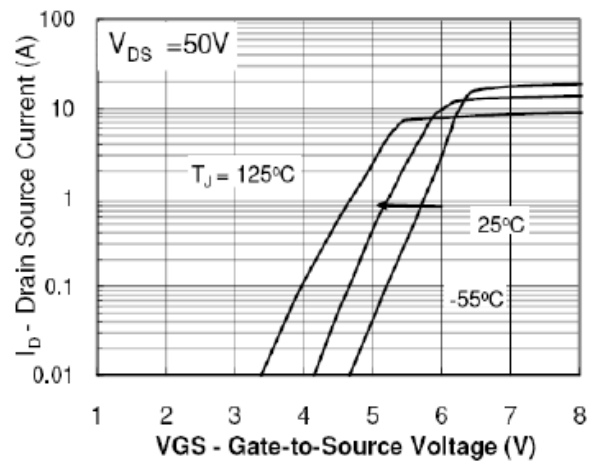


Figure 2: Transfer Characteristics

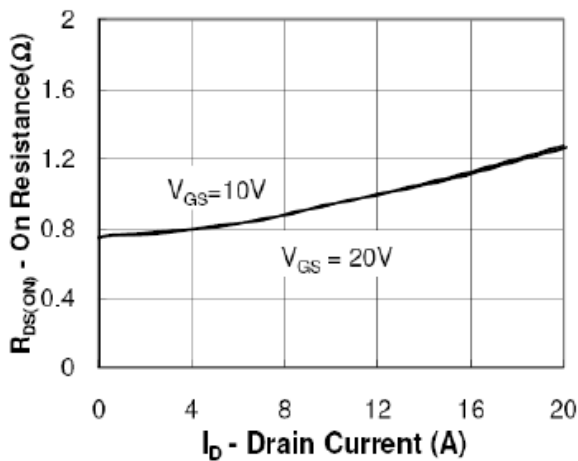


Figure 3: On Resistance Vs Drain Current Source Voltage

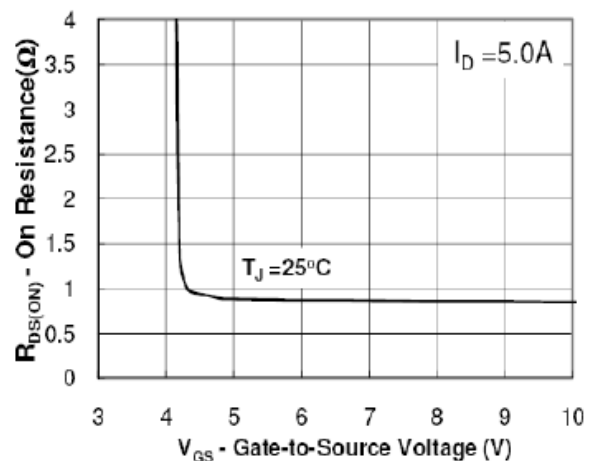


Figure 4: On Resistance Vs Gate Source Voltage

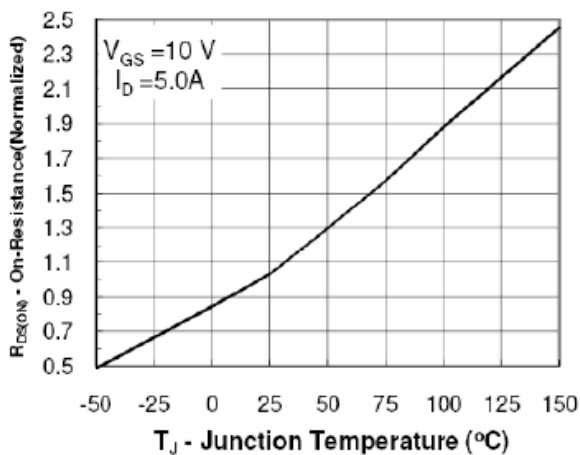


Figure 5: On Resistance Vs Junction Temperature Characteristics

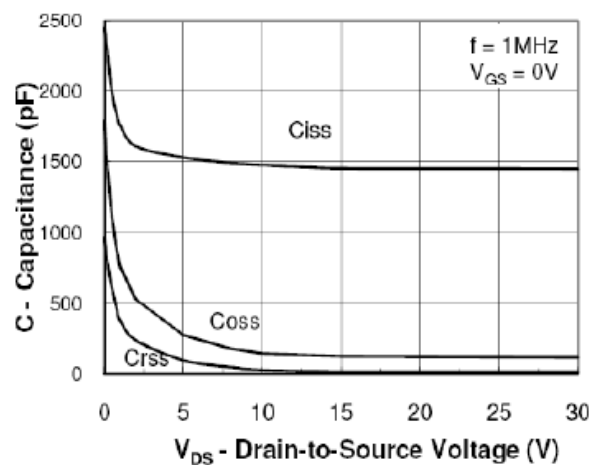


Figure 6: Capacitance

## Typical Characteristics Curve

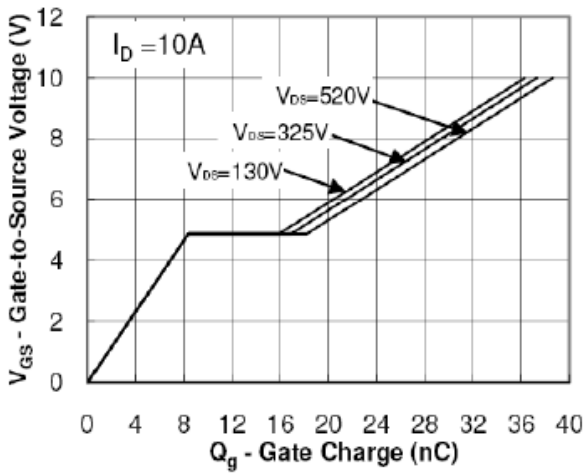


Figure7: Gate Charge Waveform Forward Voltage

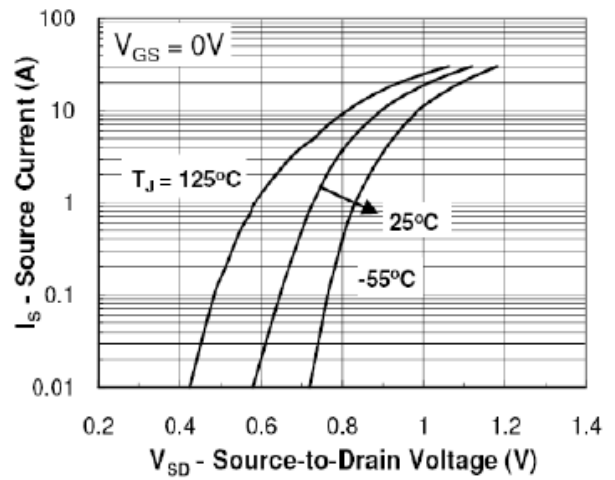


Figure8: Source-Drain Diode

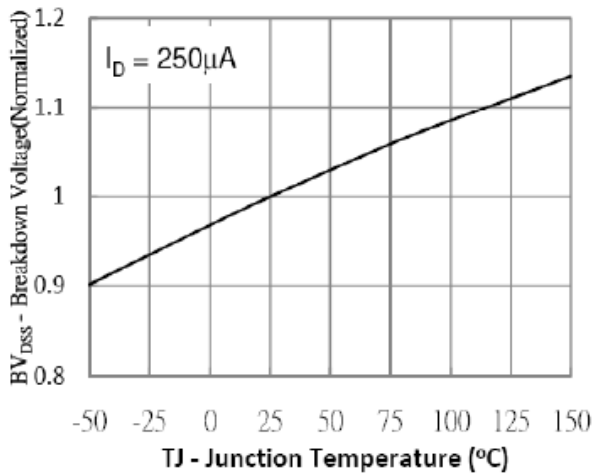
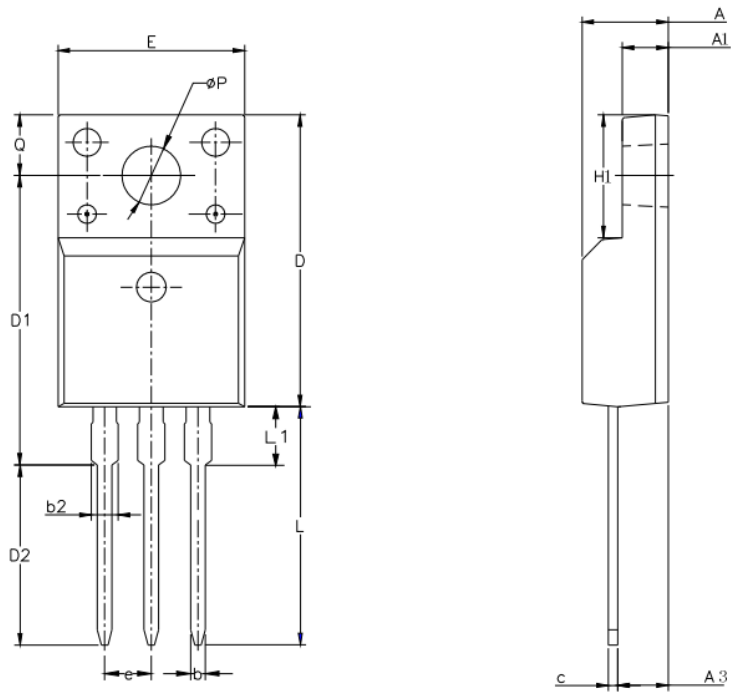


Figure9: Breakdown Voltage Vs Junction Temperature

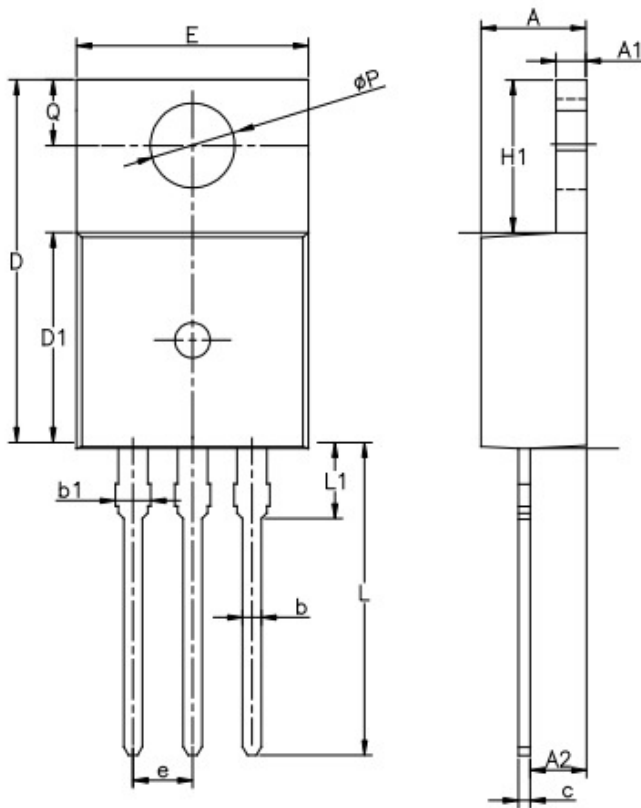
**Note:** The above characteristics curves are presented for reference only and not guaranteed by production test unless otherwise noted

## Outline Information (TO220F-3L)



SYMBOL	MIN	NOM	MAX
A	4.42	4.70	5.02
A1	2.30	2.54	2.80
A3	2.50	2.76	3.10
b	0.70	0.80	0.90
b2	—	—	1.47
c	0.35	0.50	0.65
D	15.25	15.87	16.25
D1	15.30	15.75	16.30
D2	9.30	9.80	10.30
E	9.73	10.16	10.36
e	2.54BCS		
H1	6.40	6.68	7.00
L	12.48	12.98	13.48
L1	/	/	3.50
$\phi P$	3.00	3.18	3.40
Q	3.05	3.30	3.55

## Outline Information (TO220-3L)



SYMBOL	MIN	NOM	MAX
A	4.30	4.50	4.70
A1	1.00	1.30	1.50
A2	1.80	2.40	2.80
b	0.60	0.80	1.00
b1	1.00	—	1.60
c	0.30	—	0.70
D	15.10	15.70	16.10
D1	8.10	9.20	10.00
E	9.60	9.90	10.40
e	2.54BSC		
H1	6.10	6.50	7.00
L	12.60	13.08	13.60
L1	—	—	3.95
$\phi P$	3.40	3.70	3.90
Q	2.60	—	3.20



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