

International  
**IR** Rectifier

Half-Bridge FredFet  
and Integrated Driver

**IR3101**  
**iMOTION™ Series**  
**1.6A, 500V**

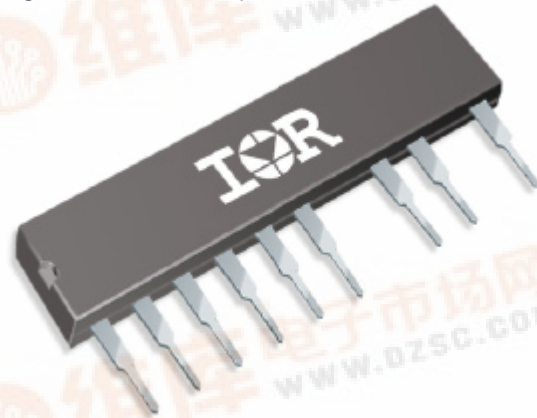
## Description

IR3101 is a gate driver IC integrated half bridge FredFET designed for sub 250W (heat-sink-less) motor drive applications. The sleek and compact single-in-line package is optimized for electronic motor control in appliance applications such as fans and compressors for refrigerators. The IR3101 offers an extremely compact, high performance half-bridge inverter, in a single isolated package for a very simple design for two-phase and three-phase motor drivers.

Proprietary HVIC and latch immune CMOS technologies, along with the HEXFET® power FredFET® technology (HEXFET® with ultra-fast recovery body diode characteristics), enable efficient and rugged single package construction. Propagation delays for the high and low side power FredFETs are matched thanks to the advance IC technology.

## Features

- Output power FredFets in half-bridge configuration
- High side gate drive designed for bootstrap operation
- Bootstrap diode integrated into package.
- Lower power level-shifting circuit
- Lower di/dt gate drive for better noise immunity
- Excellent latch immunity on all inputs and outputs
- ESD protection on all leads
- Isolation 1500 V<sub>RMS</sub> min



## Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM. The thermal resistance and power dissipation are measured under board mounted and still air conditions.

Parameters	Description	Max. Values	Units	
V <sub>DD</sub>	High voltage supply	500	V	
V <sub>B</sub>	High side floating supply	V <sub>o</sub> + 25	V	
P <sub>D</sub>	Package power dissipation @ T <sub>C</sub> ≤ 80°C (per die)	5.8	W	
R <sub>thJC</sub>	Thermal resistance, junction to case	12	°C/W	
R <sub>thJA</sub>	Thermal resistance, junction to ambient (note 1)	85	°C/W	
V <sub>ISO</sub>	Isolation Voltage (1 min)	1500	V <sub>RMS</sub>	
T <sub>J</sub>	Junction temperature (Power Mosfet)	-40 to +150	°C	
T <sub>S</sub>	Storage temperature	-40 to +150	°C	
T <sub>L</sub>	Lead temperature (soldering, 10 seconds)	300	°C	
I <sub>O</sub>	Maximum current rating (note 2)	1.6	A	
I <sub>O</sub>	Continuous output current (V <sub>IN</sub> =5V, V <sub>CC</sub> =15V)	(T <sub>C</sub> = 100°C)	1.3	A
		(T <sub>C</sub> = 25°C)	2	A

Note 1: under normal operational conditions: both power devices working, no heatsink

Note 2: see figure 4, f<sub>PWM</sub>=20kHz

## Internal Electrical Schematic - IR3101

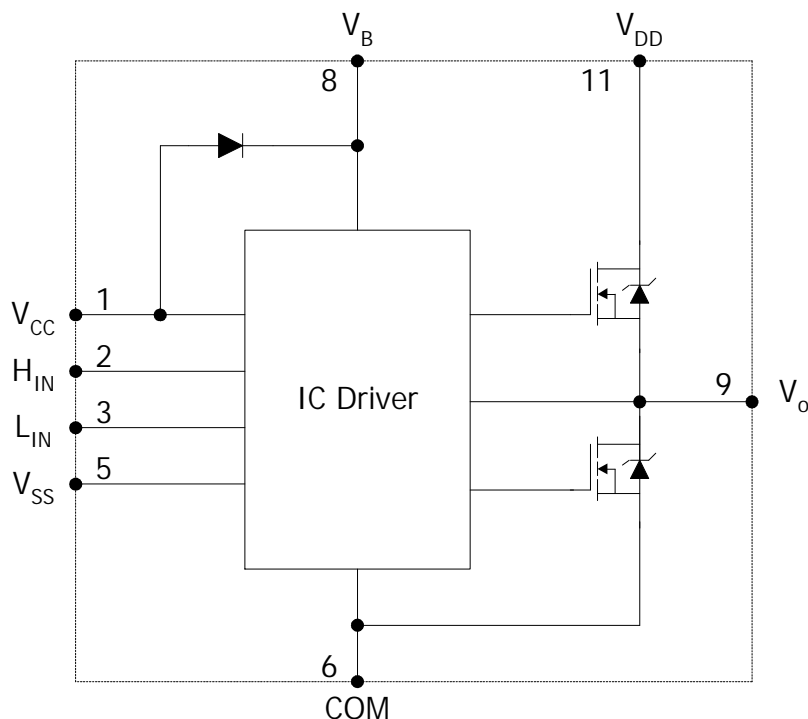


Figure 1: Internal connections

### Recommended Operating Conditions

For proper operation, the device should be used within the recommended conditions.

Symbol	Definition	Min.	Max.	Units
$V_B$	High side floating supply absolute voltage	$V_O + 10$	$V_O + 20V$	V
$V_{DD}$	High voltage supply	-	450	V
$V_{CC}$	Low side and logic fixed supply voltage	10	20	V
$V_{IN}$	Logic input voltage	$V_{SS}$	$V_{CC}$	V
$V_{SS}$	Logic ground	-5	5	V

Note 3: Care should be taken to avoid switching condition where the  $V_O$  node flies inductively below COM by more than 5V

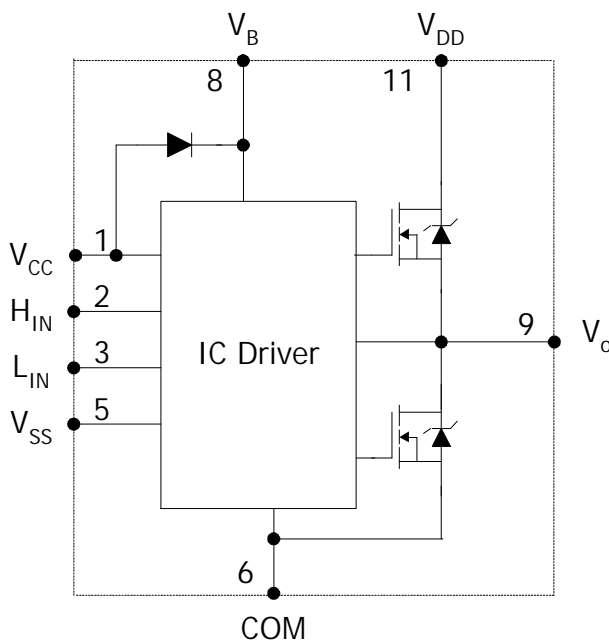
## MOSFET Characteristics

$V_{BIAS}$  ( $V_{CC}$ ,  $V_B$ ) = 15V and  $T_A$  = 25°C unless otherwise specified. The  $V_{DD}$  parameter is referenced to COM.

Symbol	Definition	Min.	Typ	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source breakdown voltage	500	-	-	V	$V_{IN}=0V$ , $I_D=250\mu A$
$I_{DSS}$	Drain-to-Source leakage current	-	-	50	$\mu A$	$V_{DS}=500V$ , $V_{IN}=0V$
$R_{DS(on)}$	Static drain-to-source on resistance	-	0.8	1.0	$\Omega$	$I_D = 1.5A$
$V_{SD}$	Diode forward voltage	-	0.82	0.9	V	$I_D = 1.5A$ , $V_{IN}=0V$
$R_{DS(on)}$	Static drain-to-source on resistance	-	1.7	2.0	$\Omega$	$I_D = 1.5A$ , $T_J=125^\circ C$
$V_{SD}$	Diode forward voltage	-	0.70	0.79	V	$I_D = 1.5A$ , $V_{IN}=0V$ , $T_J=125^\circ C$
$E_{ON}$	Turn-On energy losses	-	100	135	$\mu J$	$I_F = 1.5A$ $V_{CC} = 300V$ $di/dt = 200A/\mu s$
$E_{OFF}$	Turn-Off energy losses	-	5	10	$\mu J$	
$E_{REC}$	Body-Diode reverse recovery Losses	-	10	20	$\mu J$	
$t_{RR}$	Reverse recovery time	-	105	180	ns	$T_J=125^\circ C$ $I_F = 1.5A$ $V_{CC} = 300V$ $di/dt = 200A/\mu s$
$E_{ON}$	Turn-On energy losses	-	150	205	$\mu J$	
$E_{OFF}$	Turn-Off energy losses	-	10	17	$\mu J$	
$E_{REC}$	Body-Diode reverse recovery Losses	-	15	35	$\mu J$	
$t_{RR}$	Reverse recovery time	-	130	230	ns	
$C_{OSS}$	Output capacitance	-	-	100	pF	$V_{IN}=0V$ , $V_{DD}=30V$ , $f=1MHz$

## Driver IC Characteristic

Symbol	Definition	Min.	Typ.	Max.	Units	Conditions
$V_{CCUV+}$	$V_{CC}$ supply undervoltage positive going threshold	8.0	8.9	9.8	V	
$V_{CCUV-}$	$V_{CC}$ supply undervoltage negative going threshold	7.4	8.2	9.0	V	
$V_{CCUVH}$	$V_{CC}$ supply undervoltage lockout hysteresis	0.3	0.7	-	V	
$V_{BSUV+}$	$V_{BS}$ supply undervoltage positive going threshold	8.0	8.9	9.8	V	
$V_{BSUV-}$	$V_{BS}$ supply undervoltage negative going threshold	7.4	8.2	9.0	V	
$V_{BSUVH}$	$V_{BS}$ supply undervoltage lockout hysteresis	0.3	0.7	-	V	
$V_{IH}$	Logic "1" input voltage for H <sub>IN</sub> & L <sub>IN</sub>	2.9	-	-	V	$V_{CC}=10V$ to $20V$
$V_{IL}$	Logic "0" input voltage for H <sub>IN</sub> & L <sub>IN</sub>	-	-	0.8	V	$V_{CC}=10V$ to $20V$
$I_{IN+}$	Logic "1" input bias current	-	5	20	$\mu A$	$H_{IN}, L_{IN} = 5V$
$I_{IN-}$	Logic "0" input bias current	-	1	2	$\mu A$	$H_{IN}, L_{IN} = 0V$
MT	Delay Matching HS & LS turn on/ turn off	-	0	30	ns	



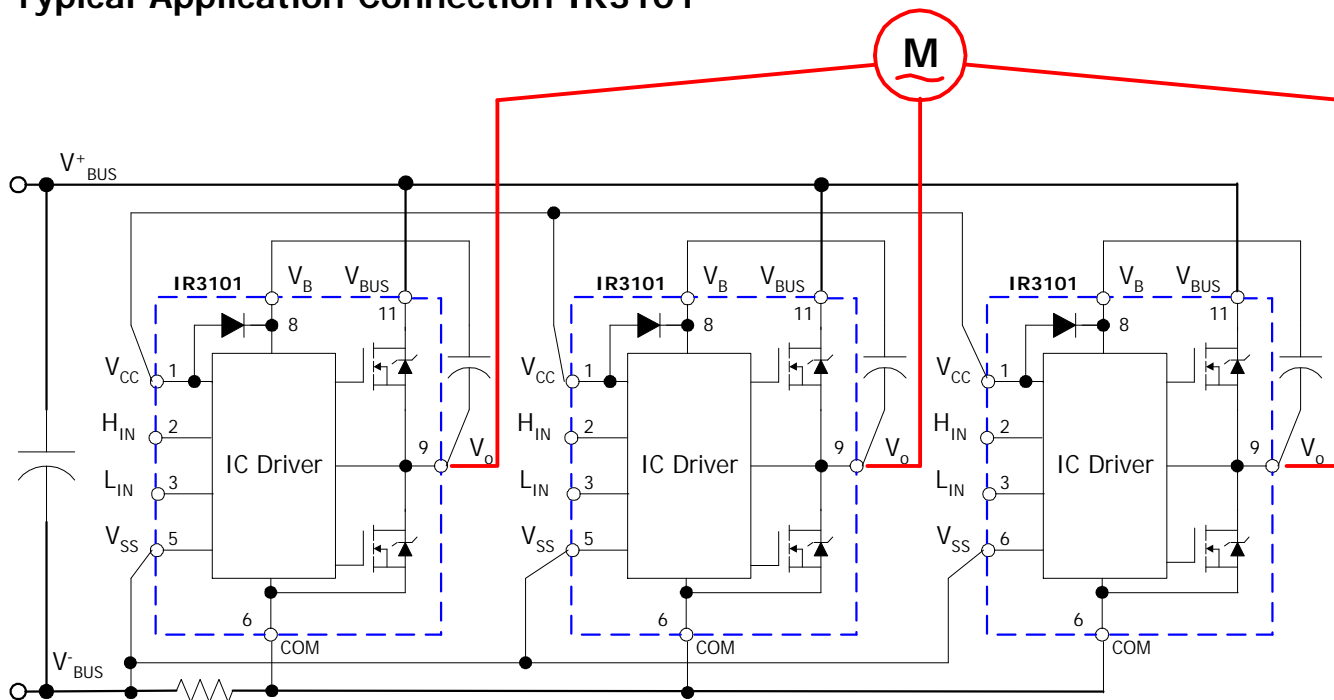
H <sub>IN</sub>	L <sub>IN</sub>	V <sub>O</sub>
0	1	0
1	0	$V_{DD}$
1	1	Shoot-Through condition
X	X	X

Figure 2: Driver input/output relation

## Module Pin-Out Description

Pin	Symbol	Lead Definitions
1	$V_{CC}$	Logic and internal gate drive supply
2	$H_{IN}$	Logic input for high side gate output
3	$L_{IN}$	Logic input for low side gate output
4		Not Connected
5	$V_{SS}$	Logic Ground
6	COM	Low side MOSFET gate return
7		Not Connected
8	$V_B$	High side gate drive floating supply
9	$V_O$	Half bridge output
10		Not Connected
11	$V_{DD}$	High voltage supply

## Typical Application Connection IR3101



1. Electrolytic bus capacitors should be mounted as close to the module bus terminals as possible to reduce ringing and EMI problems. Additional high frequency ceramic capacitor mounted close to the module pins will further improve performance.
2. In order to provide good decoupling between  $V_{CC}$ - $V_{SS}$  and  $V_B$ - $V_O$  terminals, a capacitor connected between these terminals is recommended and should be located very close to the module pins. Additional high frequency capacitors, typically  $0.1\mu F$ , are strongly recommended.
3. Low inductance shunt resistor should be used for phase leg current sensing. Similarly, the length of the traces from the pin to the corresponding shunt resistor should be kept as small as possible.
4. Value of the bootstrap capacitors depends upon the switching frequency. Their selection should be made based on IR design tip DN 98-2a or Figure 8.
5. Application conditions should guarantee minimum dead-time of 200ns

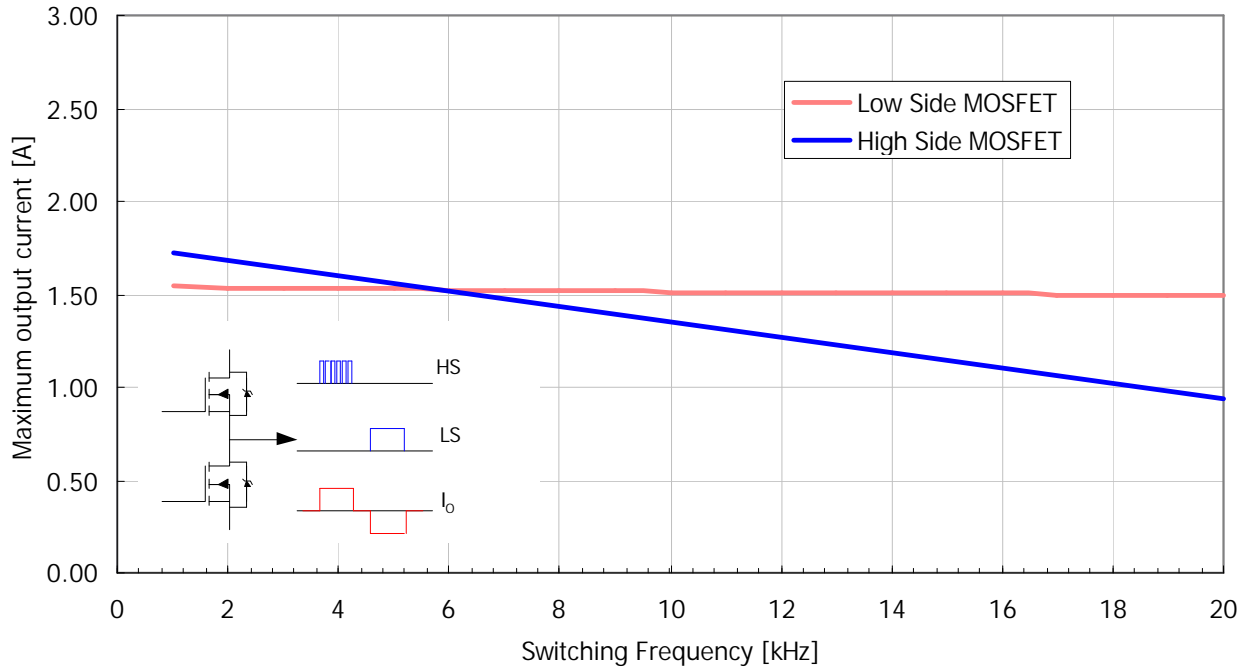


Figure 3: Maximum phase current as function of switching frequency  
Trapezoidal modulation, 120° switching,  $V_{BUS}=300V$ , Duty Cycle=0.8, without heatsink:  
 $T_a=55^{\circ}C$ ,  $T_J=150^{\circ}C$

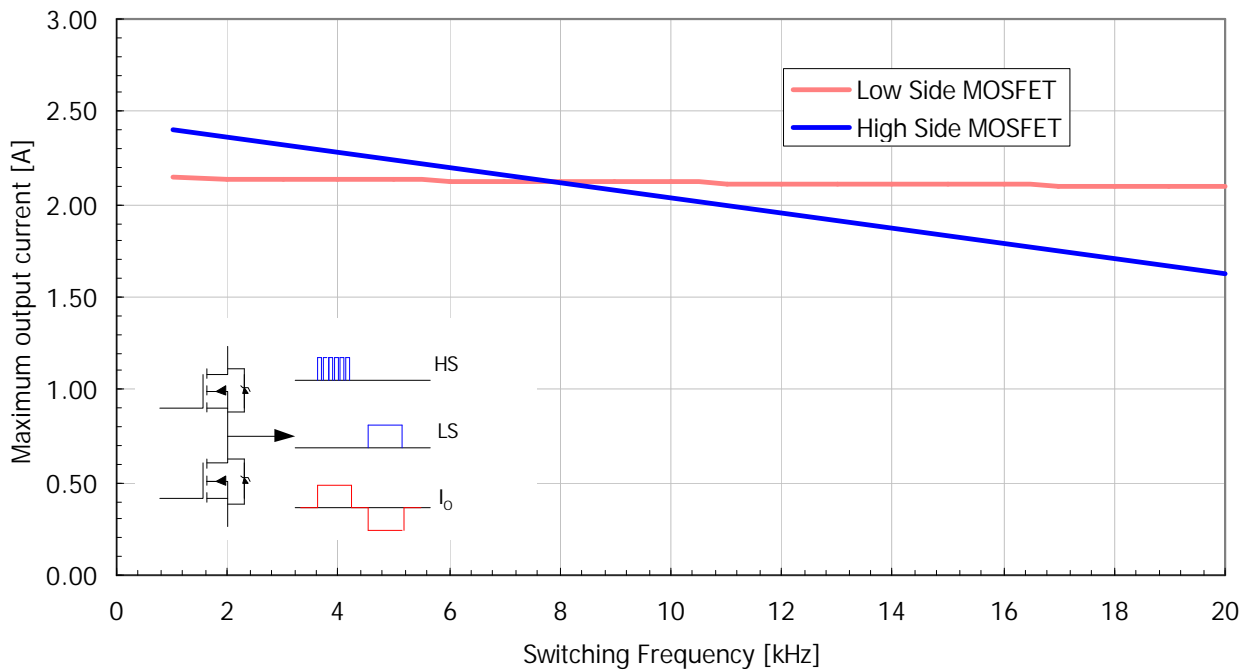


Figure 4: Maximum phase current as function of switching frequency  
Trapezoidal modulation, 120° switching,  $V_{BUS}=300V$ , Duty Cycle=0.8, with heatsink:  
 $T_C=100^{\circ}C$ ,  $T_J=125^{\circ}C$

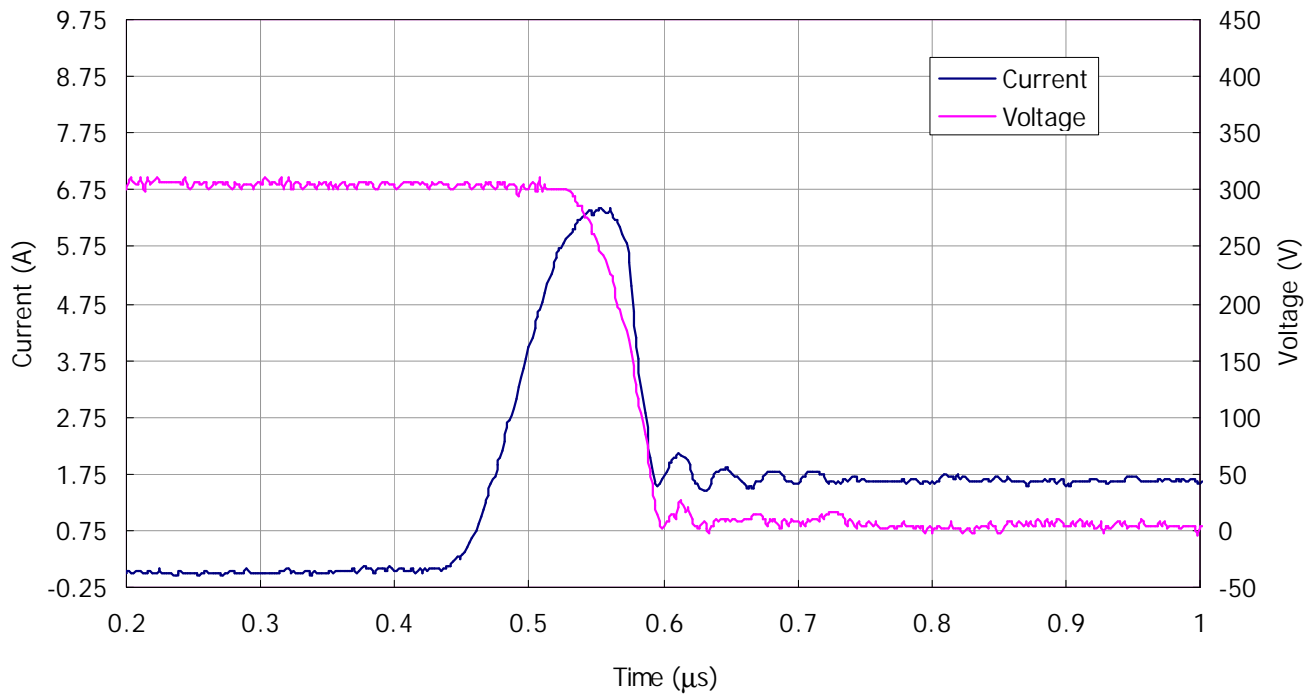


Figure 5. FredFET Turn-on. Typical turn-on waveform @ $T_j=125^{\circ}\text{C}$ ,  $V_{\text{BUS}}=300\text{V}$

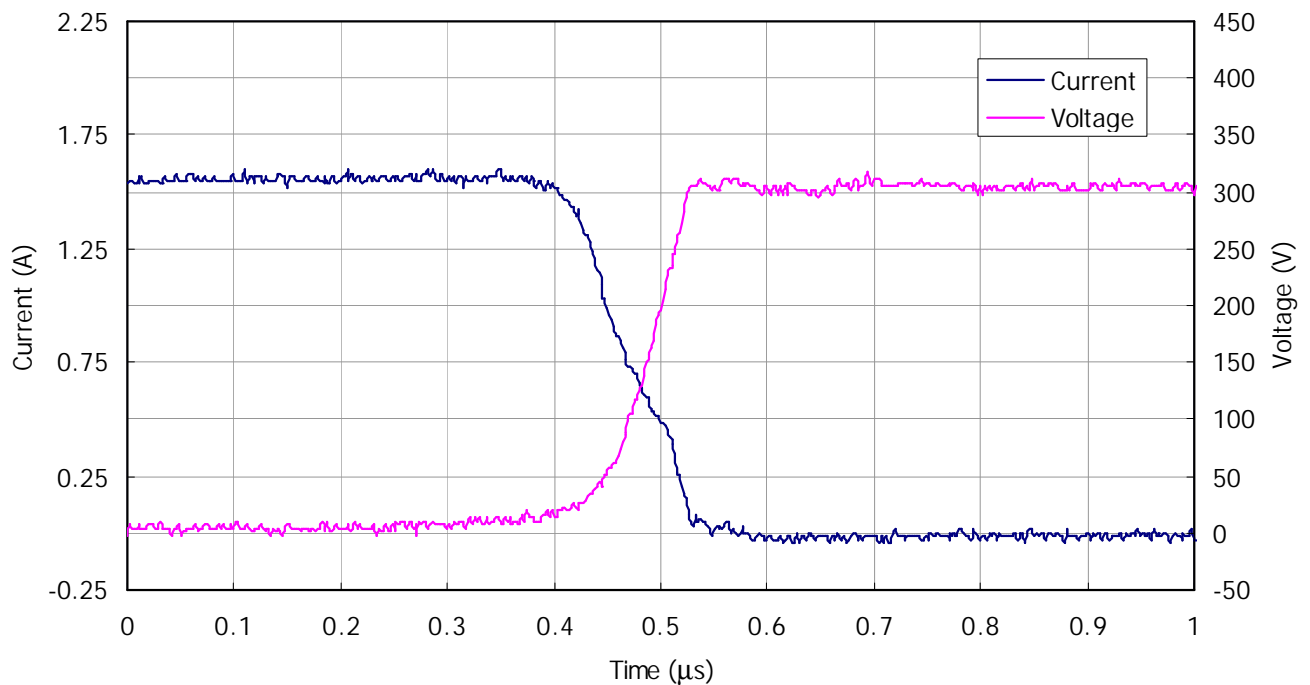


Figure 6. FredFET Turn-off. Typical turn-on waveform @ $T_j=125^{\circ}\text{C}$ ,  $V_{\text{BUS}}=300\text{V}$



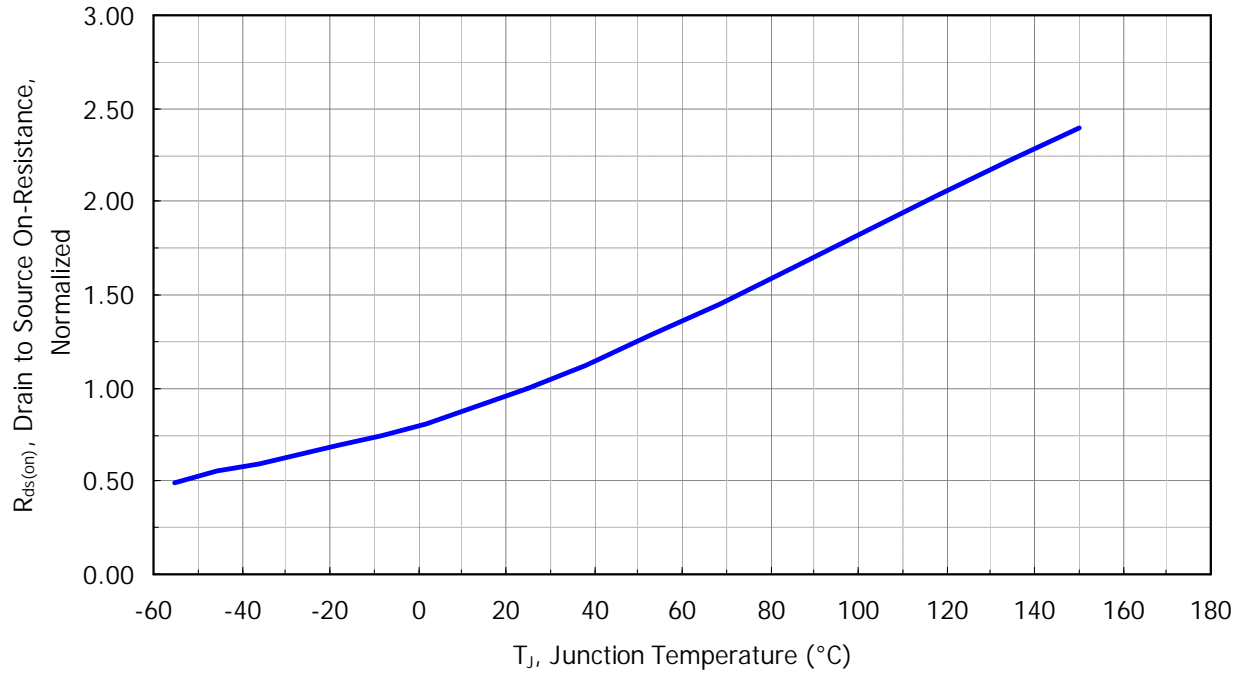


Figure 7: Normalized On-Resistance vs temperature  
V<sub>CC</sub>=10V, I<sub>D</sub>=1.5A

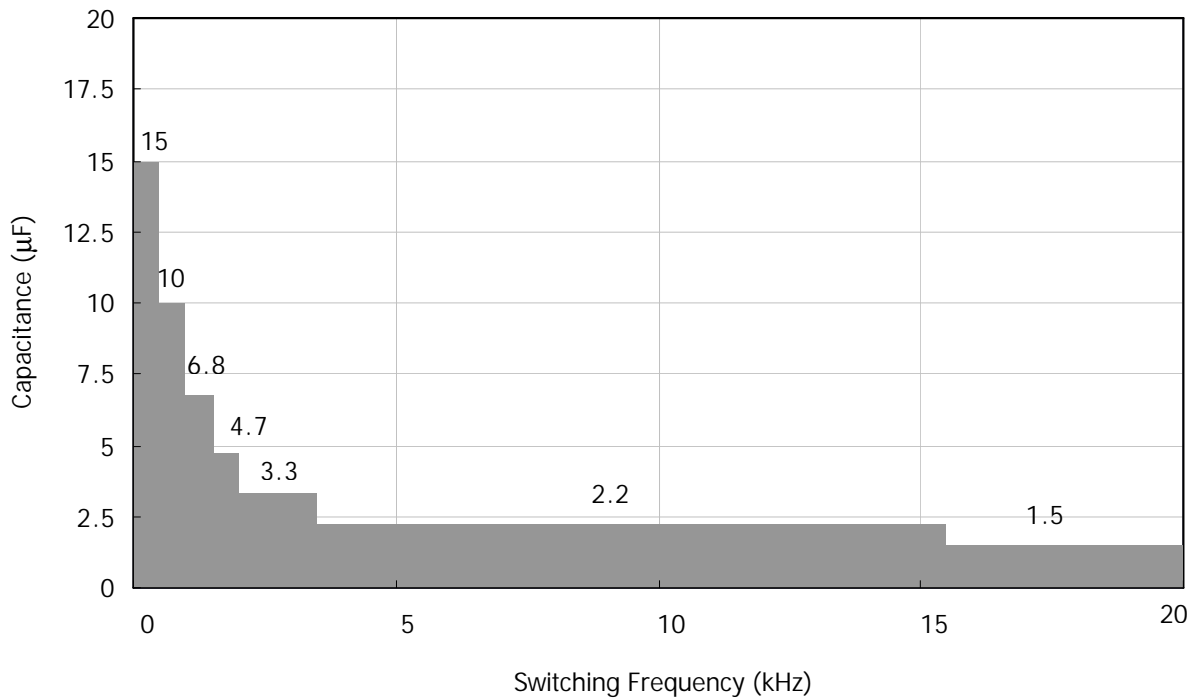
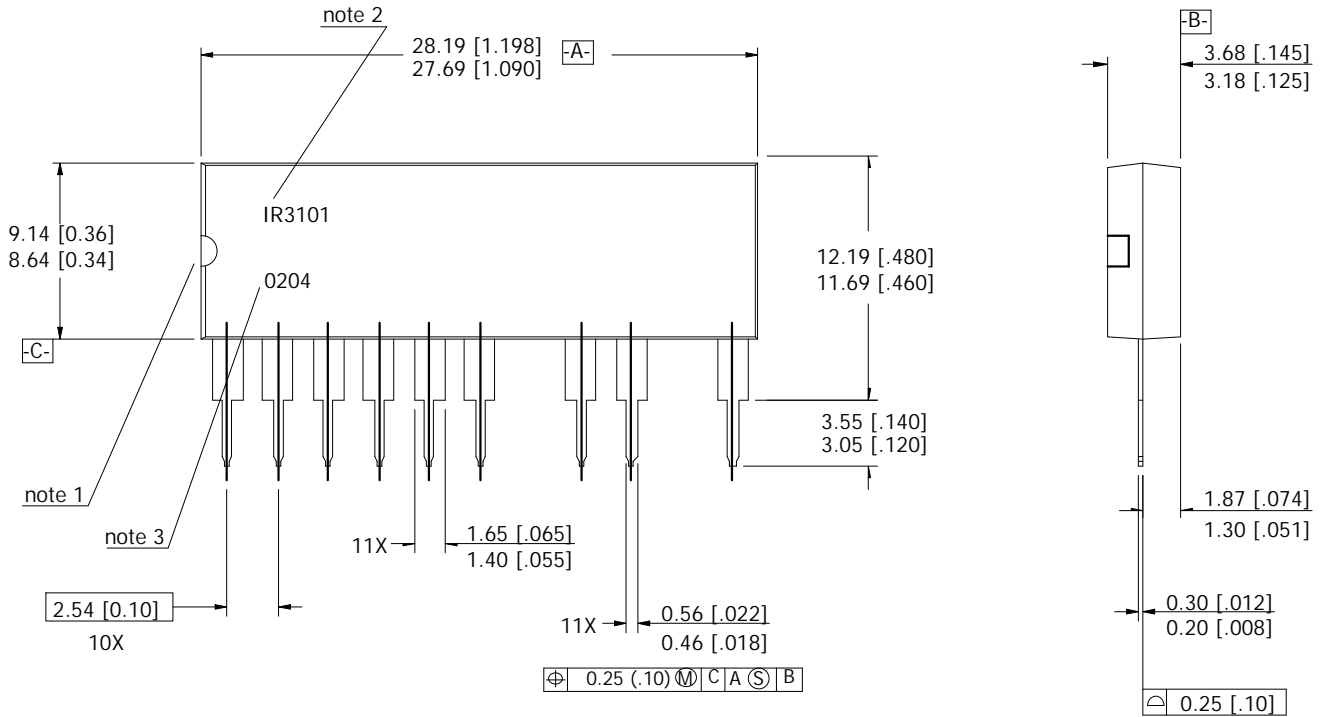


Figure 8: Recommended minimum bootstrap capacitor value vs switching frequency

# IR3101



## Package Outline



Note 1: Marking for pin 1 identification  
 Note 2: Product Part Number  
 Note 3: Lot and Date code marking  
 Dimensioning and Tolerancing per ANSY Y14.5M-1992  
 Controlling Dimensions: INCH  
 Dimensions are shown in millimeters [inches]

Data and Specifications are subject to change without notice



**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
 TAC Fax: (310) 252-7903  
 Visit us at [www.irf.com](http://www.irf.com) for sales contact information

01/04