International
IOR Rectifier

# IR3103

## iMOTION™ Series

## 0.75A, 500V

Half-Bridge FredFET
and Integrated Driver

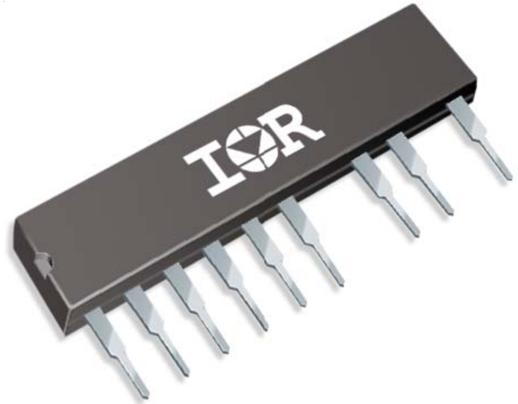
## Description

The IR3103 is a gate driver IC integrated with a half bridge FredFET designed for motor drive applications up to 180W (heatsink-less). 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 IR3103 offers an extremely compact, high performance half-bridge inverter in a single isolated package for two-phase and three-phase motor drivers.

Proprietary HVIC and latch immune CMOS technologies, along with the HEXFET® power FredFET technology (HEXFET® MOSFET 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 advanced IC technology.

## Features

- Output Power FredFET 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 $V_{RMS}$ 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. Power dissipation is measured under board mounted and still air conditions.

| Parameter | Description | Max. Value | Units |
|---|---|---|---|
| $V_{DS}$ | Drain to Source Blocking Voltage | 500 | V |
| $V_{DD}$ | DC Bus Supply Voltage (No Switching Operation) | 500 | V |
| $I_O$ ($T_A$=25°C) | Continuous Output Current (1) | 0.7 | A |
| $I_O$ ($T_A$=55°C) | Continuous Output Current (1) | 0.6 | A |
| $I_O$ ($T_A$=25°C) | Pulsed Output Current (2) | 2.7 | A |
| $P_d$ | Package Power Dissipation @$T_A \leq$ 55°C (3) | 1.4 | W |
| $V_{ISO}$ | Isolation Voltage (1min) | 1500 | $V_{RMS}$ |
| $T_J$ | Junction Temperature (Power MOSFET) | -40 to +150 | °C |
| $T_S$ | Storage Temperature | -40 to +150 | °C |
| $T_L$ | Lead Temperature (soldering, 10 seconds) | 300 | °C |
| $T_S$ | Storage Temperature | -40 to +150 | °C |

Note 1: See figure 3, $f_{PWM}$=16kHz

Note 2: $T_P$=100ms, other conditions as per Figure 3, $f_{PWM}$=16kHz

Note 3: Single Device Operating

## Absolute Maximum Ratings (Continued)

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM.

| Symbol | Parameter | Min | Max | Units | Conditions |
|---|---|---|---|---|---|
| $I_{BDF}$ | Bootstrap Continuous Diode Forward Current | --- | 0.3 | A | $T_J$ = 150°C, $T_A$=55°C |
| $V_B$ | High Side Floating Supply Absolute Voltage | -0.3 | 525 | V | |
| $V_O$ | High Side Floating Supply Offset Voltage | $V_B$ - 25 | $V_B$ +0.3 | V | |
| $V_{CC}$ | Low Side and Logic Fixed Supply Voltage | -0.3 | 25 | V | |
| $V_{IN}$ | Input Voltage $L_{IN}$, $H_{IN}$ | $V_{SS}$-0.3 | $V_{CC}$+0.3V | V | |
| $V_{SS}$ | Logic Ground | $V_{CC}$-25 | $V_{CC}$+0.3V | V | |

## Recommended Operating Conditions Driver Function

For proper operation the device should be used within the recommended conditions. All voltages are absolute referenced to COM. The $V_S$ and $V_O$ offset are tested with all supplies biased at 15V differential.

| Symbol | Definition | Min | Max | Units |
|---|---|---|---|---|
| $V_B$ | High Side Floating Supply Absolute Voltage | $V_O$+10 | $V_O$+20 | V |
| $V_{DD}$ | High Voltage Supply | Note 4 | 400 | 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 4: Logic operation for $V_O$ of -5 to +500V. Logic state held for $V_O$ of -5V to -$V_{BO}$. (Please refer to the Design Tip DT97-3 for more details).

## Half Bridge Electrical Characteristics @$T_J$= 25°C

$V_{CC}$=$V_{BO}$=15V and $T_J$=25°C unless otherwise specified. $V_{DD}$ and $V_{IN}$ parameters referenced to COM

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 500 | --- | --- | V | $V_{IN}$=0V, $I_{DD}/I_O$=250µA |
| $I_{HS\text{-}LK}$ | Low Side Leakage Current | --- | 5 | 50 | µA | $V_{DS}$=500V, $V_{IN}$=0V |
| | | --- | 80 | | | $V_{DS}$=500V, $V_{IN}$=0V, $T_J$=150°C |
| $I_{LS\text{-}LK}$ | Low Side Leakage Current | --- | 5 | 105 | µA | $V_{DS}$=500V, $V_{IN}$=0V |
| | | --- | 100 | | | $V_{DS}$=500V, $V_{IN}$=0V, $T_J$=150°C |
| $R_{DS(ON)}$ | Drain-to-Source ON Resistance | --- | 1.9 | 2.5 | Ω | $I_O$ = 0.75A, $V_{IN}$=5V |
| $V_{SD}$ | Diode Forward Voltage | --- | 0.8 | 0.9 | V | $I_O$ = 0.75A, $V_{IN}$=0V |
| $R_{DS(ON)}$ | Drain-to-Source ON Resistance | --- | 4.6 | 6.5 | Ω | $I_O$ = 0.75A, $V_{IN}$=5V, $T_J$=150°C |
| $V_{SD}$ | Diode Forward Voltage | --- | 0.6 | 0.75 | V | $I_O$ = 0.75A, $V_{IN}$=0V, $T_J$=150°C |
| $V_{BDFM}$ | Bootstrap Diode Forward Voltage Drop | --- | --- | 1.25 | V | $I_F$=1A |
| | | --- | --- | 1.10 | | $I_F$=1A, $T_J$=125°C |
| $E_{ON}$ | Turn-On Energy Losses | --- | 55 | 75 | µJ | $I_{DD}/I_O$ = 0.75A, $V_{DD}$=300V, $V_{BO}/V_{CC}$=15V, L= 6.3mH<br>Energy Losses include Body-Diode Reverse Recovery |
| $E_{OFF}$ | Turn-Off Energy Losses | --- | 4 | 10 | µJ | |
| $E_{TOT}$ | Total Energy Losses | --- | 59 | 85 | µJ | |
| $E_{REC}$ | Body-Diode Reverse Recovery Losses | --- | 2 | 5 | µJ | |
| $t_{RR}$ | Reverse Recovery Time | --- | 70 | --- | ns | |
| $E_{ON}$ | Turn-On Energy Losses | --- | 85 | 115 | µJ | $I_{DD}/I_O$ = 0.75A, $V_{DD}$=300V, $V_{BO}/V_{CC}$=15V, L=6.3mH $T_J$=150°C<br>Energy Losses include Body-Diode Reverse Recovery |
| $E_{OFF}$ | Turn-Off Energy Losses | --- | 5 | 11 | µJ | |
| $E_{TOT}$ | Total Energy Losses | --- | 90 | 126 | µJ | |
| $E_{REC}$ | Body-Diode Reverse Recovery Losses | --- | 6 | 11 | µJ | |
| $t_{RR}$ | Reverse Recovery Time | --- | 90 | --- | ns | |
| $Q_G$ | Turn-ON MOSFET Gate Charge | --- | 15 | 21 | nC | $V_{DD}$=250V, $I_O$=3.2A. Note 5 |
| $C_{OSS}$ | Output Capacitance | --- | 12 | --- | pF | $V_{DD}$=400V, f=1MHz. Note 5 |
| $C_{OSS}$ eff. | Effective Output Capacitance | --- | 30 | --- | pF | $V_{DD}$=0V to 400V. Note 5,6 |
| SCSOA | Short Circuit Safe Operating Area | 10 | --- | --- | µs | $T_J$=150°C, $V_P$=450V,<br>$V^+$= 320V,$V_{CC}$=+15V |
| $I_{SC}$ | Short Circuit Drain Current | --- | 18.5 | --- | A | $T_J$=150°C, $V_P$=450V, $t_{SC}$<10µs<br>$V^+$= 320V, $V_{GE}$=15V, $V_{CC}$=+15V |

Note 5: Characterized on FREDFET die level, not measured at EOL
Note 6: $C_{OSS}$ eff. is a fixed capacitance that gives same charging time as $C_{OSS}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

## Thermal Resistance

Thermal Resistance is measured under board mounted and still air conditions.

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $Rth_{JA\ self}$ | Self Thermal resistance, junction to ambient (note 7,8) | --- | --- | 70 | °C/W | No airflow |
| $Rth_{JA\ mutual}$ | Mutual Thermal resistance, junction to ambient (note 7,8) | --- | --- | 45 | °C/W | |

Note 7: under normal operational conditions: both power devices working, no heatsink

Note 8: TJ=RthJA_self*PA+RthJA_mutual*PB

## Static Electrical Characteristics Driver Function

$V_{BIAS}$ ($V_{CC}$, $V_O$)=15V, $V_{SS}$=COM and $T_A$=25°C, unless otherwise specified. $V_{DD}$, $V_{IN}$ and $I_{IN}$ parameters are referenced to COM.

| Symbol | Definition | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{IN,th}$ | Logic "1" Input Voltage | 2.9 | --- | --- | V | |
| $V_{IN,th}$ | Logic "0" Input Voltage | --- | --- | 0.8 | V | |
| $V_{CCUV+}$<br>$V_{BO}$ | $V_{CC}$ and $V_{BO}$ Supply Undervoltage Positive Going Threshold | 8.0 | 8.9 | 9.8 | V | |
| $V_{CCUV-}$<br>$V_{BO}$ | $V_{CC}$ and $V_{BO}$ Supply Undervoltage Negative Going Threshold | 7.4 | 8.2 | 9.0 | V | |
| $V_{CCUVH}$<br>$V_{BO}$ | $V_{CC}$ and $V_{BO}$ Supply Undervoltage Lock-Out Hysteresis | 0.3 | 0.7 | --- | V | |
| $I_{LK}$ | Offset Supply Leakage Current | --- | --- | 50 | µA | $V_B$=$V_O$=600V |
| $I_{QBS}$ | Quiescent $V_{BO}$ Supply Current | --- | 75 | 130 | µA | $V_{IN}$=0V to 5V |
| $I_{QCC}$ | Quiescent $V_{CC}$ Supply current | --- | 120 | 180 | µA | $V_{IN}$=0V to 5V |
| $I_{IN+}$ | Input Bias Current | --- | 5 | 20 | µA | $V_{IN}$=5V |
| $I_{IN-}$ | Input Bias Current | --- | --- | 2 | µA | $V_{IN}$=0V |

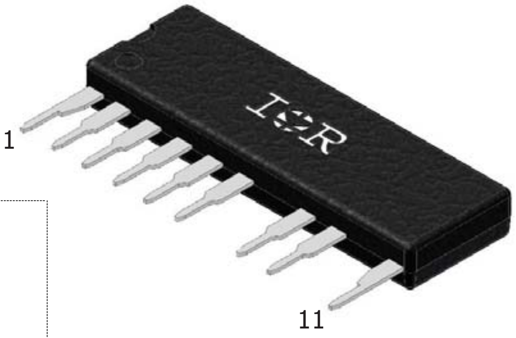
## Dynamic Electrical Characteristics Driver Function

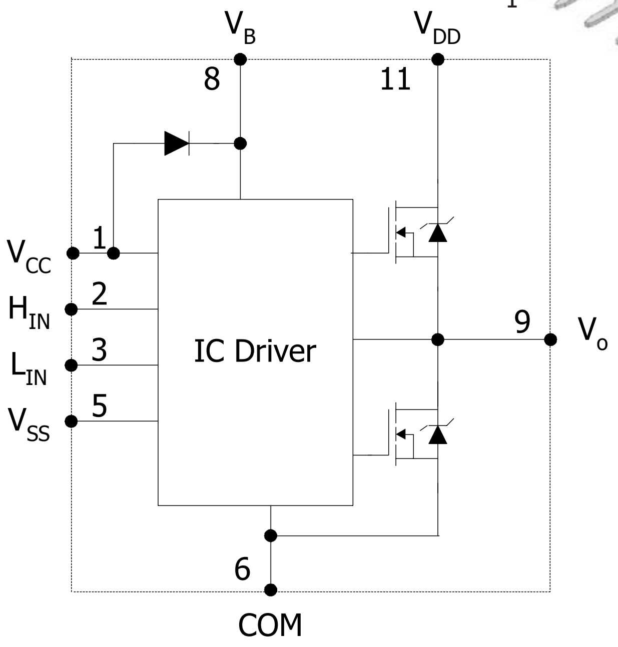
Driver only timing unless otherwise specified.

| Symbol | Definition | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $T_{ON}$ | Input to Output Propagation Turn-on Delay Time (see fig. 2) | --- | 300 | --- | ns | $V_{CC}$=$V_{BO}$= 15V, $I_O$=0.75A, $V_{DD}$=300V |
| $T_{OFF}$ | Input to Output Propagation Turn-off Delay Time (see fig. 2) | --- | 400 | --- | ns | |
| $M_T$ | Matching Propagation Delay Time (On & Off) | --- | 0 | 30 | ns | $V_{CC}$= $V_{BO}$= 15V |

## Pin-Out Description

| Pin | Name | Description |
|---|---|---|
| 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 | NC | Not Connected |
| 5 | $V_{SS}$ | Logic Ground |
| 6 | COM | Low Side MOSFET Gate Return |
| 7 | NC | Not Connected |
| 8 | $V_B$ | High Side Gate Drive Floating Supply |
| 9 | $V_O$ | Half Bridge Output |
| 10 | NC | Not Connected |
| 11 | $V_{DD}$ | High Voltage Supply |

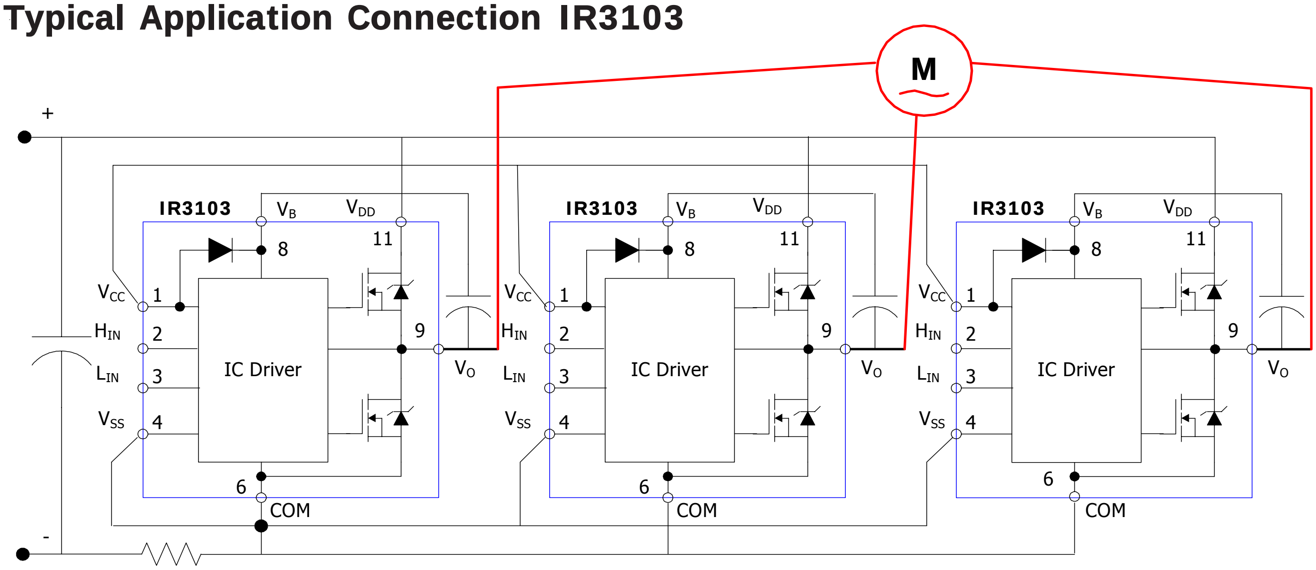




| $H_{IN}$ | $L_{IN}$ | $V_O$ |
|---|---|---|
| 0 | 1 | 0 |
| 1 | 0 | $V_{DD}$ |
| 1 | 1 | Shoot-Through condition |
| X | X | X |

Figure 1: Driver Input/Output relation

## Typical Application Connection IR3103



1. Electrolytic bus capacitors should be mounted as close as possible to the module bus terminals to reduce ringing and EMI problems. High frequency ceramic capacitors 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 0.1mF, 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 400ns

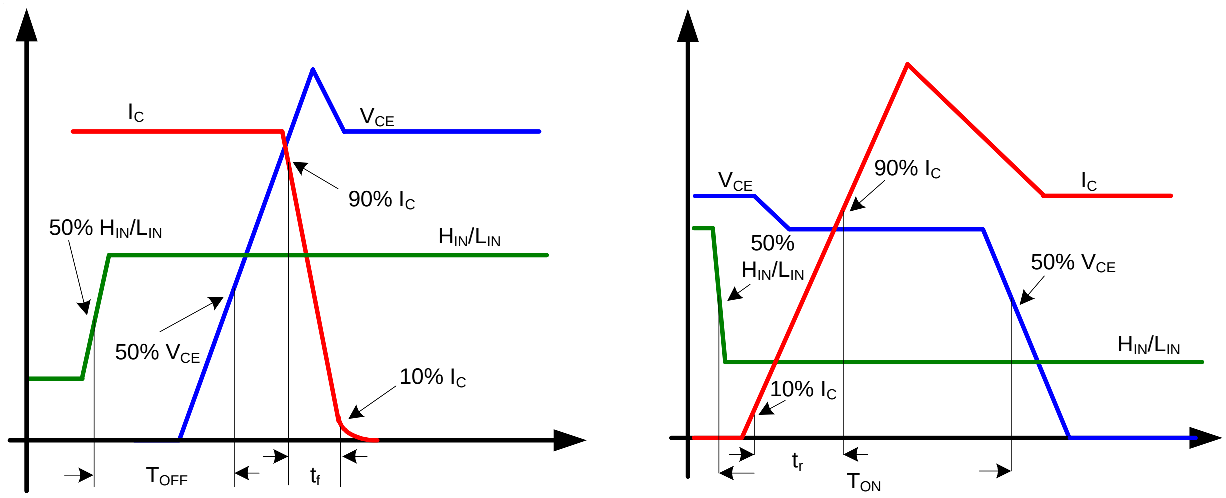


Figure 2. $T_{ON}$ and $T_{OFF}$ Definitions.

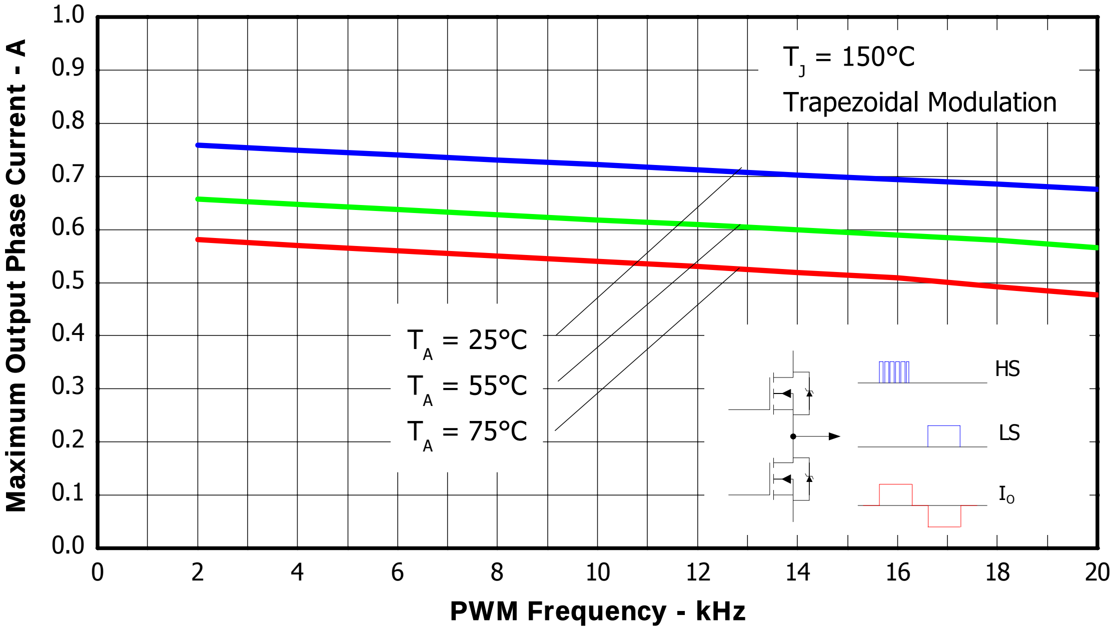


Figure 3. Maximum RMS Phase Current vs. PWM Switching Frequency
$V_{DD}$=300V , $T_J$=150°C, Modulation Depth=0.5, PF=0.99

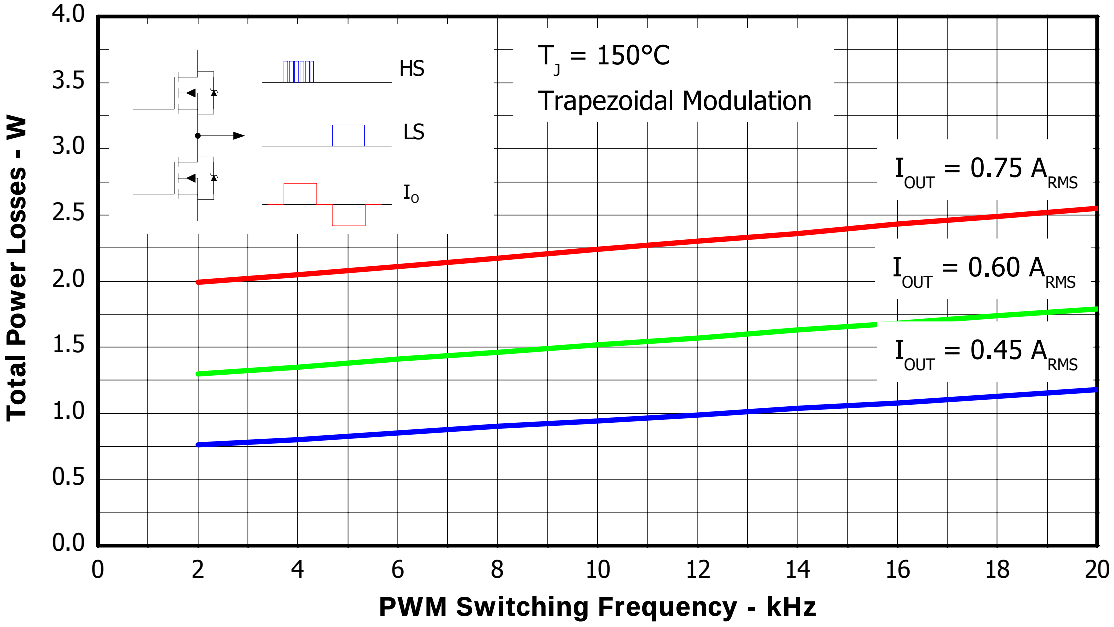


Figure 4. Total Power Losses as Function of Switching Frequency
$V_{DD}$=300V, $T_J$=150°C, Modulation Depth=0.5, PF=0.99

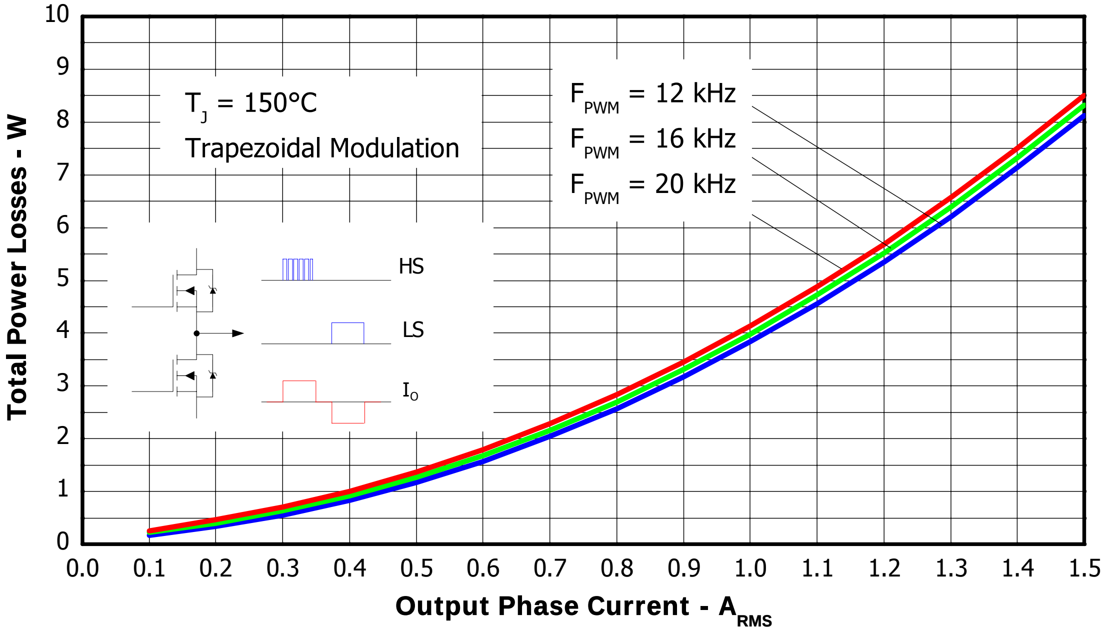


Figure 5. Total Power Losses as Function of Output Phase Current
$V_{DD}$=300V, $T_J$=150°C, Modulation Depth=0.5, PF=0.99

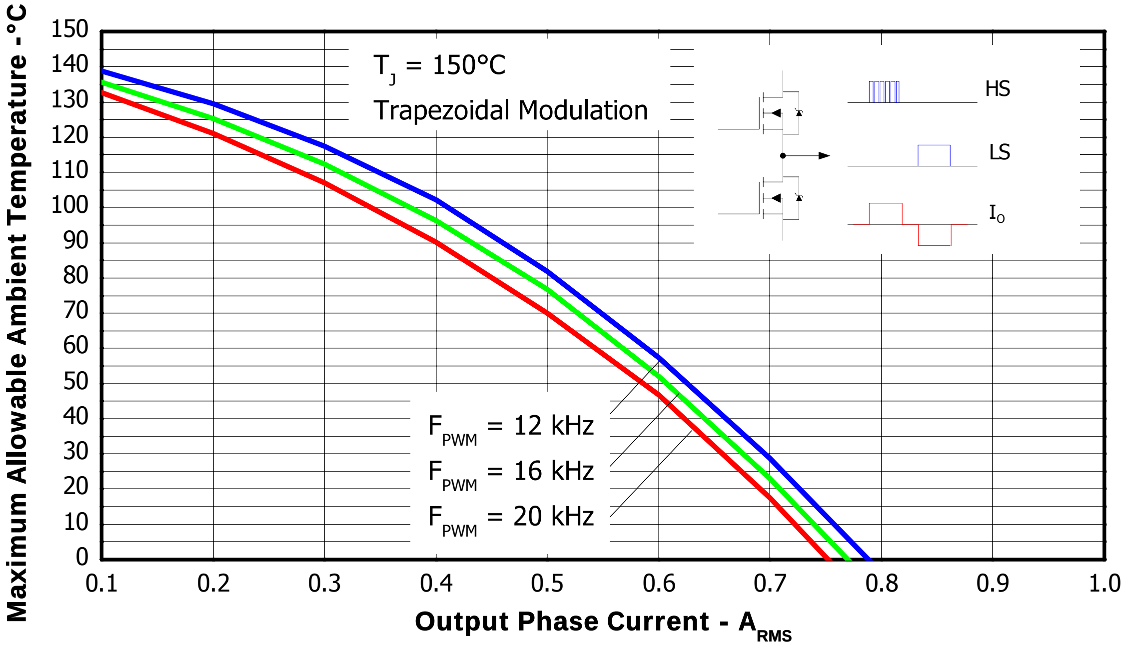


Figure 6. Maximum Allowable Ambient Temperature vs. Output Phase Current
$V_{DD}$=300V, $T_J$=150°C, Modulation Depth=0.5, PF=0.99

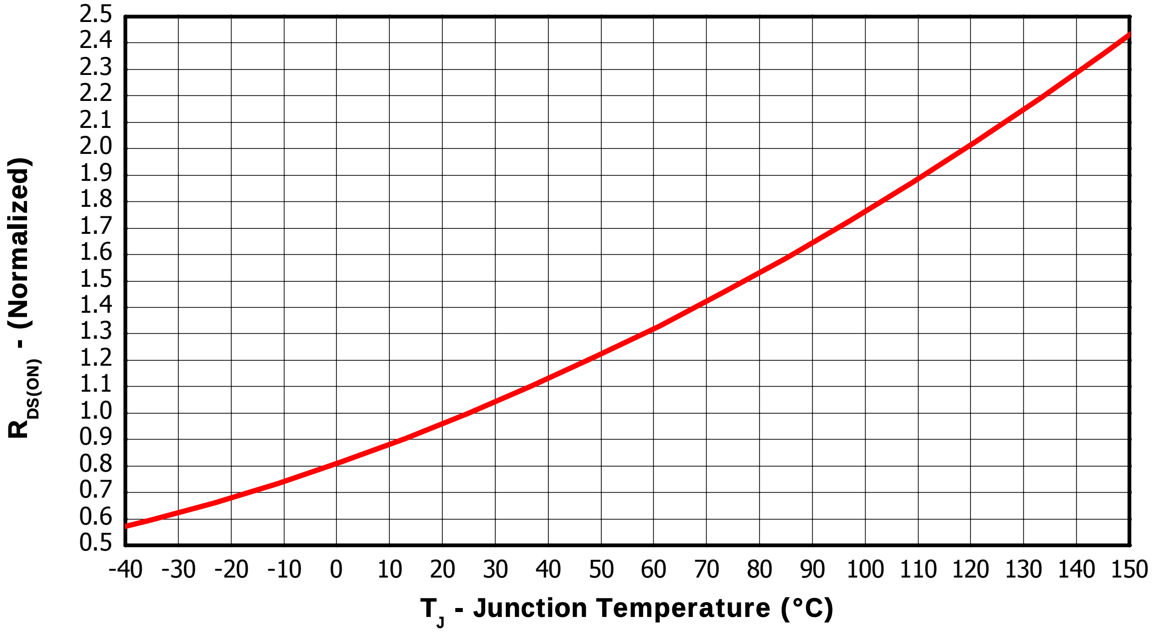


Figure 7. Normalized Drain to Source Resistance vs Junction Temperature

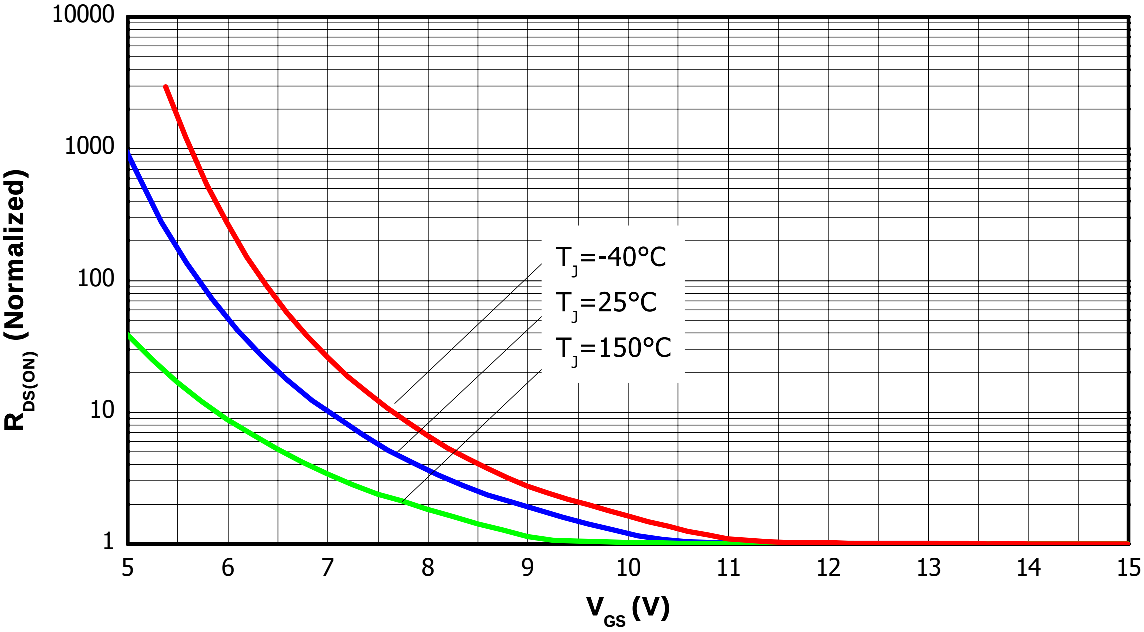


Figure 8. Normalized Drain to Source Resistance vs Gate Source Voltage

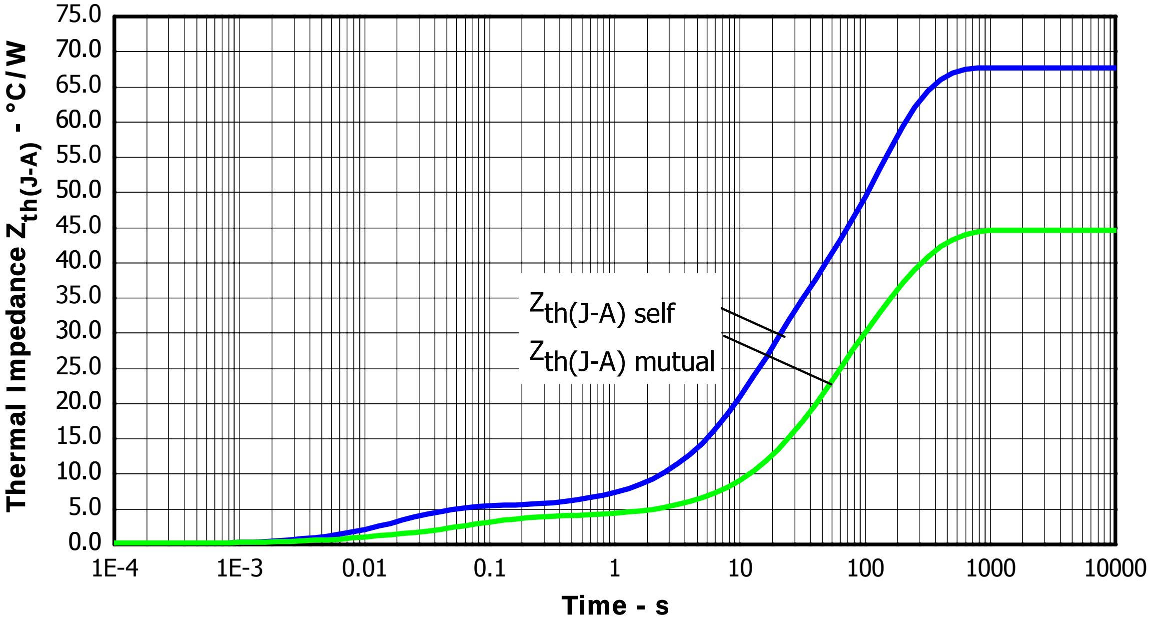


Figure 9. Thermal Impedance vs. Time

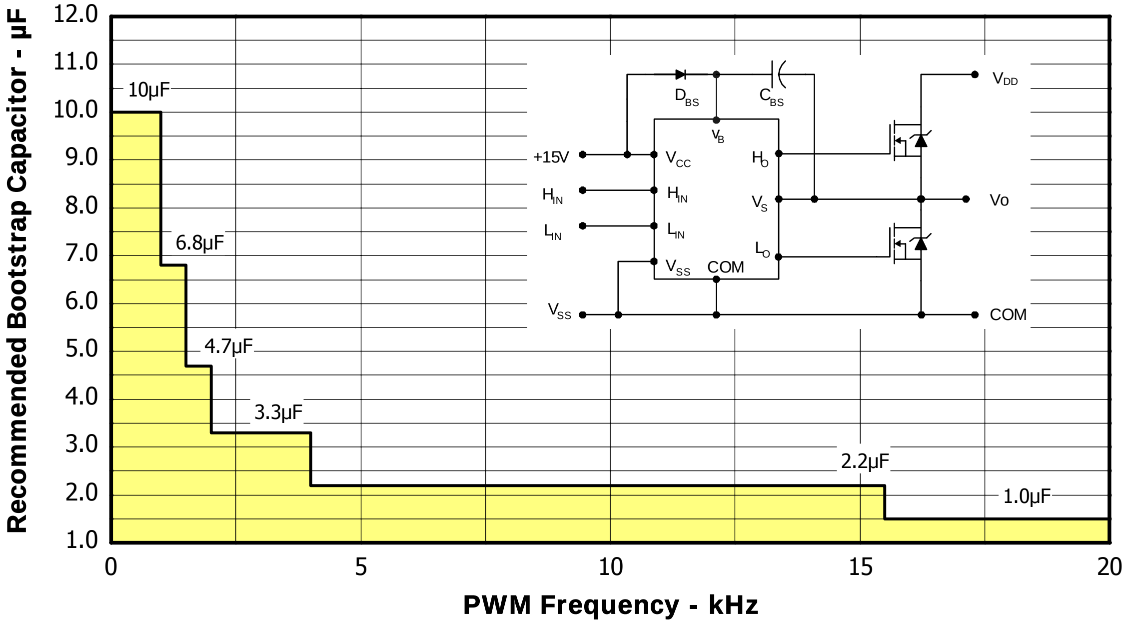
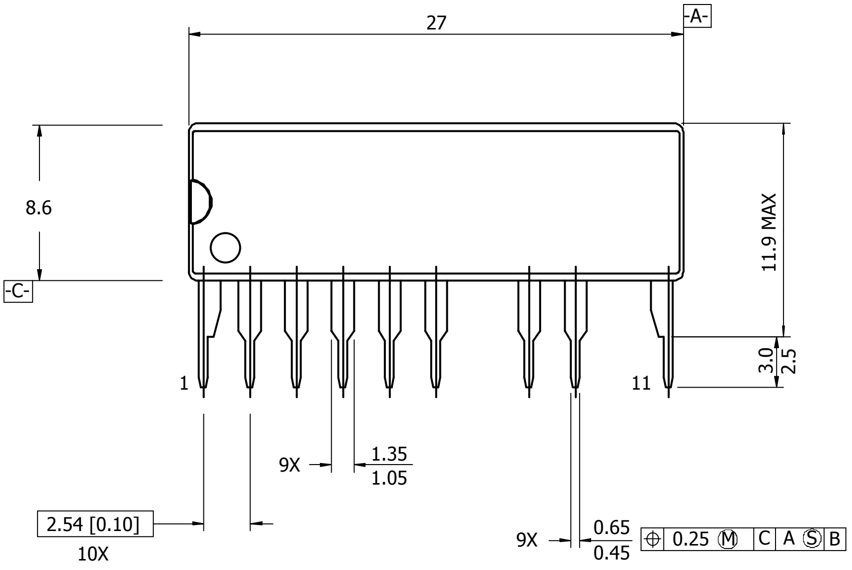
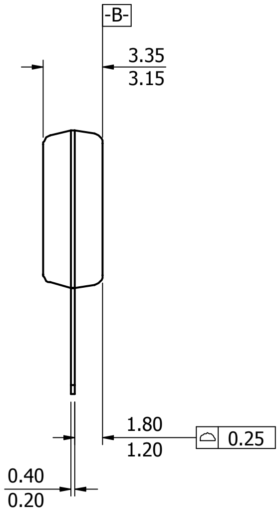


Figure 10. Recommended Bootstrap Capacitor Value vs. Switching Frequency

## 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]

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**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903
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