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International
IOR Rectifier

# IRAM109-015SD

## iMOTION™ Series

## H-Bridge 1A, 500V

Integrated Power Hybrid IC for
Appliance Motor Drive Applications

## Description

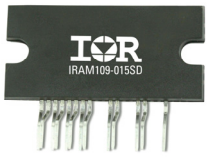
International Rectifier's IRAM109-015SD is a multi-chip Hybrid IC developed for low power appliance motor control applications such as Fans, Pumps, refrigerator compressors, etc. The compact Single in line (SIP-S) package minimizes PCB space.

Several built-in protection features such as temperature feedback, shoot through prevention, under voltage lockout, and shutdown input makes this a very robust solution. The internal shunt resistor saves board space and provides clean current feedback. The combination of highly efficient high voltage MOSFETs, the industry benchmark Half-Bridge HVIC driver (3.3V/5V input compatible) and thermally enhanced package makes this a highly competitive solution.

The bootstrapped power supplies for the high side drivers can be generated using internal bootstrap diodes eliminating the need for isolated power supplies. This feature reduces the component count, board space, and cost of the system.

## Features

- Motor Power range 60~250W / 85~253 Vac.
- Integrated Gate Drivers and Bootstrap Diodes.
- Shut-Down input turns off both channels.
- Under-voltage lockout for all switches.
- Matched propagation delay.
- Schmitt-triggered input logic.
- Cross-conduction prevention logic.
- Low di/dt switching for better noise immunity.
- Internal Current Shunt.
- Internal thermistor for temperature feedback.



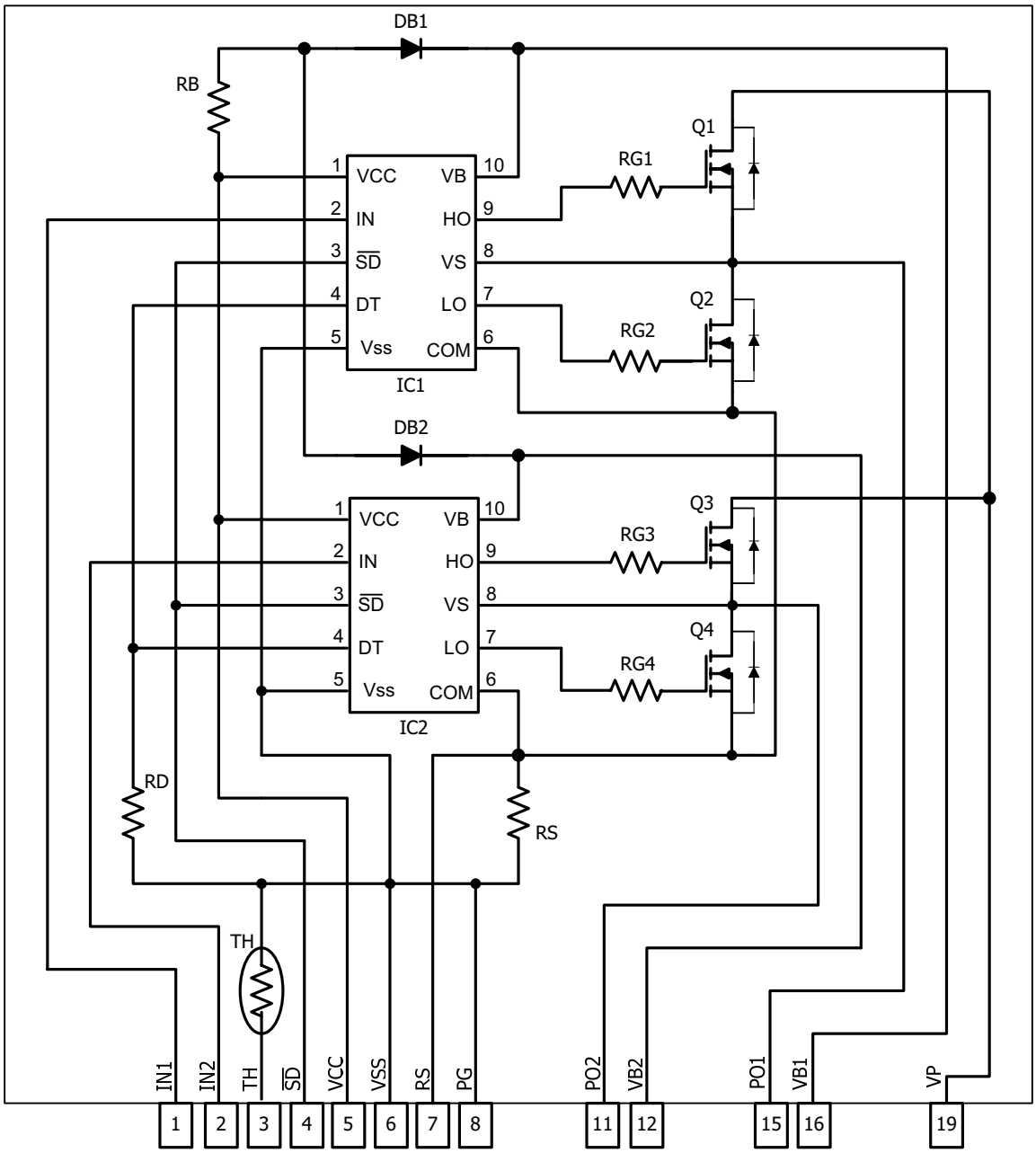

## Absolute Maximum Ratings

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

| | | | |
|---|---|---|---|
| $V_{DSS}$ | MOSFET Blocking Voltage | 500 | V |
| Vbus | Positive DC Bus Input Voltage | 400 | V |
| $I_o$ @ $T_C$=25°C | RMS Phase Current | 2.0 | A |
| $I_o$ @ $T_C$=100°C | RMS Phase Current (Note 1) | 1.0 | |
| $I_{pk}$ @ $T_C$=25°C | Maximum Peak Phase Current (tp<100µs) | 5.0 | |
| $P_d$ | Maximum Power dissipation per FET @ $T_C$ =25°C | 18 | W |
| $T_J$ (MOSFET & IC) | Maximum Operating Junction Temperature | +150 | °C |
| $T_C$ | Operating Case Temperature Range | -20 to +100 | |
| $T_{STG}$ | Storage Temperature Range | -40 to +125 | |
| T | Mounting torque Range (M3 screw) | 0.6 | Nm |

Note 1: Sinusoidal Modulation at $V^+$=360V, $T_J$=150°C, $F_{PWM}$=20kHz, $F_{MOD}$=50Hz, MI=0.8, PF=0.6, See Figure 5.

## Internal Electrical Schematic – IRAM109-015SD



## Absolute Maximum Ratings (Continued)

| Symbol | Parameter | Min | Max | Units | Conditions |
|---|---|---|---|---|---|
| $BV_R$ | Bootstrap Diode Reverse Breakdown Voltage | 600 | --- | V | $T_J$ = 25°C, $I_R$=1mA |
| $P_{BR\ Peak}$ | Bootstrap Resistor Peak Power (Single Pulse) | --- | 25.0 | W | $t_P$=100µs, $T_C$ =100°C |
| $V_{S1,2,3}$ | High side floating supply offset voltage | $V_{B1,2,3}$ - 20 | $V_{B1,2,3}$ +0.3 | V | |
| $V_{B1,2,3}$ | High side floating supply voltage | -0.3 | 500 | V | |
| $V_{DD}$ | Low Side and logic fixed supply voltage | -0.3 | 20 | V | |
| $V_{IN}$ | Input voltage IN1, IN2 | -0.3 | Lower of ($V_{SS}$+15V) or $V_{DD}$+0.3V | V | |

## Electrical Characteristics ($T_J$= 25°C Unless Otherwise Specified)

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 500 | --- | --- | V | $V_{IN}$=5V, $I_D$=250µA |
| $R_{DS(ON)}$ | Drain-to-Source On Resistance | --- | 2.2 | 2.7 | Ω | $I_D$=1A, $V_{DD}$=15V |
| | | --- | 5.5 | --- | | $I_D$=1A, $V_{DD}$=15V, $T_J$=150°C |
| $I_{DSS}$ | Drain-to-Source Leakage Current | --- | 10 | 100 | µA | $V_{IN}$=5V, $V^+$=500V |
| $V_{FM}$ | Diode Forward Voltage Drop | --- | 0.87 | 1.1 | V | $I_F$=1A |
| | | --- | 0.70 | --- | | $I_F$=1A, $T_J$=150°C |
| $V_{BDFM}$ | Bootstrap Diode Forward Voltage Drop | --- | --- | 1.25 | V | $I_F$=1A |
| $R_{BR}$ | Bootstrap Resistor Value | --- | 22 | --- | Ω | $T_J$=25°C |
| $\Delta R_{BR}/R_{BR}$ | Bootstrap Resistor Tolerance | --- | --- | ±5 | % | $T_J$=25°C |

## Recommended Operating Conditions

The Input/Output logic timing diagram is shown in Figure 1. For proper operation the device should be used within the recommended conditions. All voltages are absolute referenced to COM. The $V_S$ offset is tested with all supplies biased at 15V differential.

| Symbol | Definition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| $V^+$ | Positive Bus Input Voltage | --- | --- | 360 | V |
| $V_{B1,2,3}$ | High side floating supply voltage | $V_S$+10 | $V_S$+15 | $V_S$+20 | |
| $V_{DD}$ | Low side and logic fixed supply voltage | 10 | 15 | 20 | V |
| $V_{IN}$ | Logic input voltage (IN & SD) - Note 2 | $V_{SS}$ | --- | $V_{DD}$ | V |
| $F_p$ | PWM Carrier Frequency | --- | 20 | --- | KHz |

Note 2: Logic operational for $V_s$ from COM-5V to COM+500V. Logic state held for $V_s$ from COM-5V to COM-$V_{BS}$. (please refer to DT97-3 for more details).

## Static Electrical Characteristics ($T_J$= 25°C Unless Otherwise Specified)

$V_{BIAS}$ ($V_{DD}$, $V_{BS1,2,3}$)=15V, unless otherwise specified. The $V_{IN}$ and $I_{IN}$ parameters are referenced to COM and are applicable to all channels (Static Electrical Characteristics are Based on Driver IC Data Sheet).

| Symbol | Definition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| $V_{DDUV+}$, $V_{BSUV+}$ | $V_{DD}$ and $V_{BS}$ supply undervoltage, Positive going threshold | 8 | 8.9 | 9.8 | V |
| $V_{DDUV-}$, $V_{BSUV-}$ | $V_{DD}$ and $V_{BS}$ supply undervoltage, Negative going threshold | 7.4 | 8.2 | 9 | V |
| $I_{QBS}$ | Quiescent $V_{BS}$ supply current | 20 | 75 | 130 | µA |
| $I_{QDD}$ | Quiescent $V_{DD}$ supply current | 0.4 | 1 | 1.6 | mA |
| $I_{LK}$ | Offset Supply Leakage Current | --- | --- | 50 | µA |

## Dynamic Electrical Characteristics ($T_J$= 25°C Unless Otherwise Specified)

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $T_{ON}$ | Input to Output propagation turn-on delay time (see fig. 13a) | --- | 2.4 | --- | µs | $I_D$=1.5A, $V^+$=360V |
| $T_{OFF}$ | Input to Output propagation turn-off delay time (see fig. 13b) | --- | 570 | --- | ns | |

## Internal Current Sensing Resistor - Shunt Characteristics

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $R_{Shunt}$ | Resistance | 218 | 220 | 222 | mΩ | $T_C$ = 25°C |
| $T_{Coeff}$ | Temperature Coefficient | 0 | --- | 200 | ppm/°C | |
| $T_{Range}$ | Temperature Range | 0 | --- | 125 | °C | |

## Thermal and Mechanical Characteristics

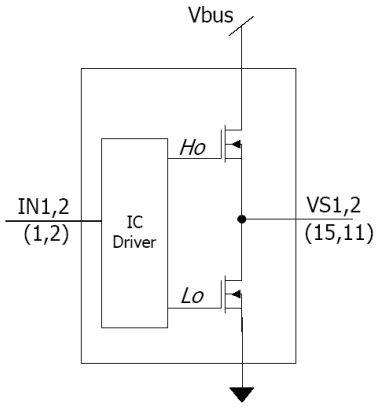
| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $R_{th(J-C)}$ | Thermal resistance, per FET | --- | 5.1 | 6.9 | °C/W | Flat, Insulation Material |

## Internal NTC - Thermistor Characteristics

| Parameter | Definition | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $R_{25}$ | Resistance | 97 | 100 | 103 | kΩ | $T_C$ = 25°C |
| $R_{125}$ | Resistance | 2.25 | 2.52 | 2.80 | kΩ | $T_C$ = 125°C |
| B | B-constant (25-50°C) | 4165 | 4250 | 4335 | k | $R_2 = R_1 e^{[B(1/T2 - 1/T1)]}$ |
| Temperature Range | | -40 | --- | 125 | °C | |
| Typ. Dissipation constant | | --- | 1.0 | --- | mW/°C | $T_C$ = 25°C |

## Input-Output Logic Level Table

| $\overline{SD}$ | IN1,2 | $V_{S1,2}$ |
|---|---|---|
| 1 | 1 | $V^+$ |
| 1 | 0 | 0 |
| 0 | x | Off |



Timing Parameter Definitions

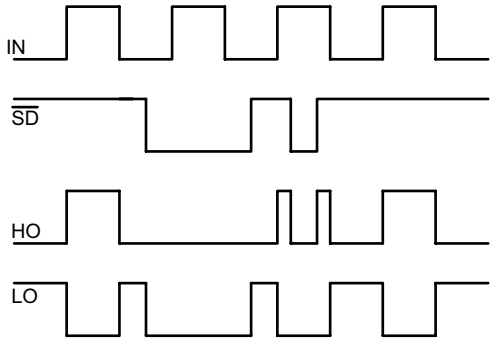



Figure 1. Input/Output Timing Diagram

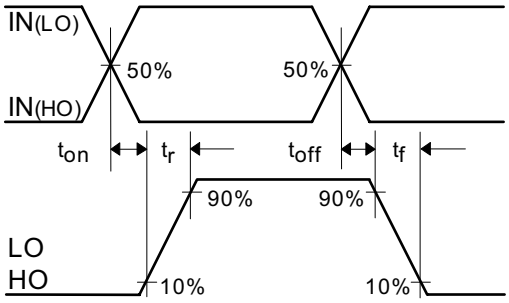



Figure 2. Switching Time Waveform Diagram

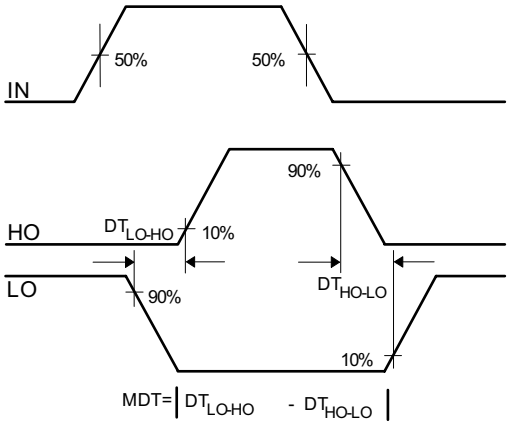



Figure 3. Deadtime Waveform Diagram

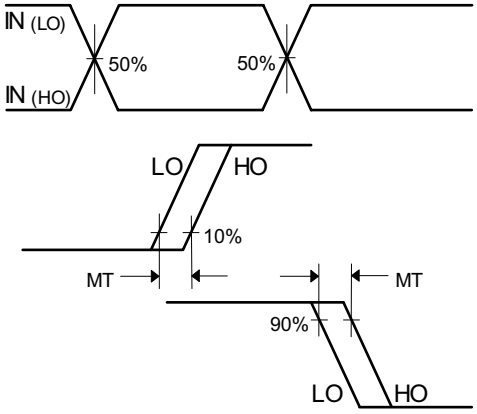
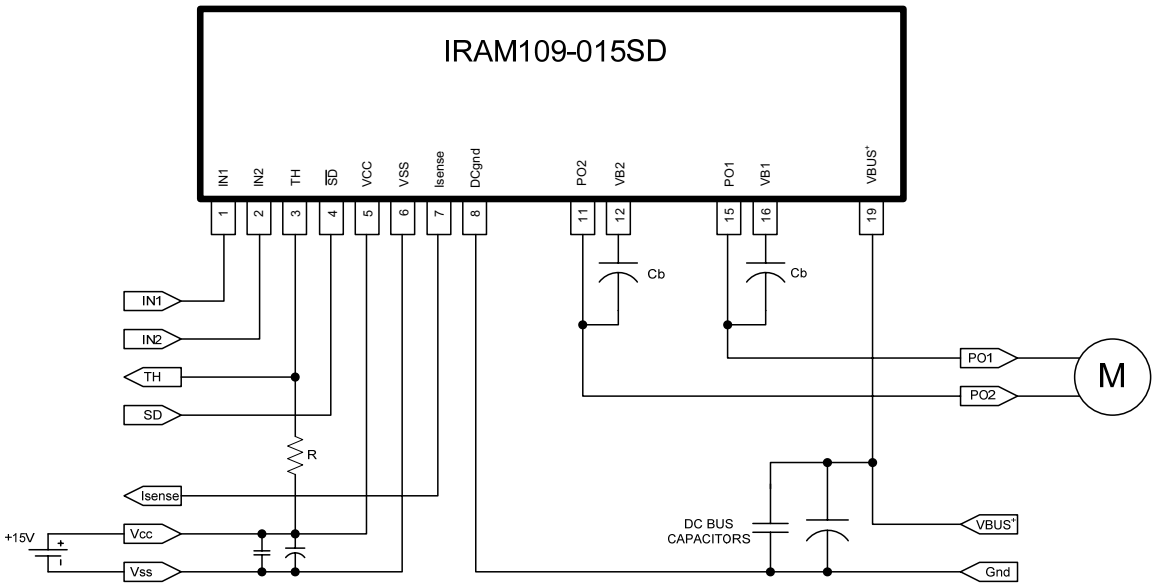



Figure 4. Delay Matching Waveform Diagram

## Typical Application Connection – IRAM109-015SD




## Application Circuit Recommendation

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.

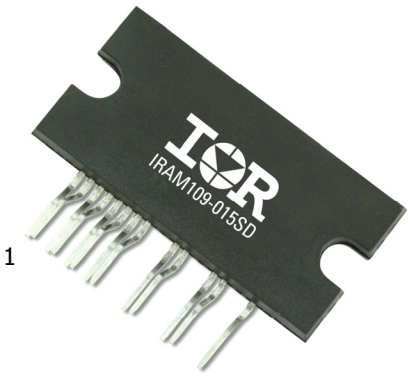
2. In order to provide good decoupling between VCC-VSS and PO1,2-VB1,2 terminals, and the capacitors shown connected between these terminals should be located very close to the module pins. Additional high frequency capacitors, typically 0.1µF, are strongly recommended.

3. Value of the boot-strap capacitors depends upon the switching frequency. Their selection should be made based on IR design tip DN 98-2a, application note AN-1044, or Figure 12. Bootstrap capacitor value must be selected to limit the power dissipation of the internal resistor in series with $V_{CC}$ (See maximum ratings Table on page 3).

**4. The case of the module is connected to the negative DC Bus and is NOT Isolated. It is recommended to provide isolation material between case and heat sink to avoid electrical shock.**

## Module Pin-Out Description

| Pin | Name | Description |
|---|---|---|
| 1 | IN1 | Logic Input Gate Driver - Phase 1 |
| 2 | IN2 | Logic Input Gate Driver - Phase 2 |
| 3 | $V_{TH}$ | Temperature Feedback |
| 4 | $\overline{SD}$ | Shun-down Function |
| 5 | $V_{DD}$ | +15V Main Supply |
| 6 | $V_{SS}$ | Negative Main Supply |
| 7 | $I_{SENSE}$ | Current Feedback |
| 8 | $V^-$ | Negative Bus Input Voltage |
| 9 | NA | none |
| 10 | NA | none |
| 11 | $V_{S2}$ | Output 2 - High Side Floating Supply Offset Voltage |
| 12 | $V_{B2}$ | High Side Floating Supply voltage 2 |
| 13 | NA | none |
| 14 | NA | none |
| 15 | $V_{S1}$ | Output 1 - High Side Floating Supply Offset Voltage |
| 16 | $V_{B1}$ | High Side Floating Supply voltage 1 |
| 17 | NA | none |
| 18 | NA | none |
| 19 | $V^+$ | Positive Bus Input Voltage |



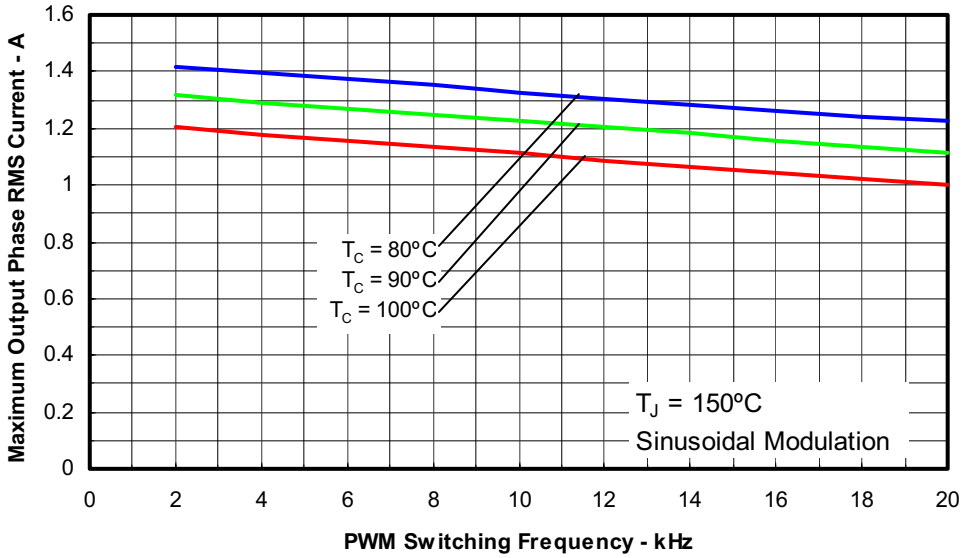



Figure 5. Maximum Sinusoidal Phase Current vs. PWM Switching Frequency
Sinusoidal Modulation, $V^+$=360V, $T_J$=150°C, $F_{MOD}$=50Hz, MI=0.8, PF=0.6

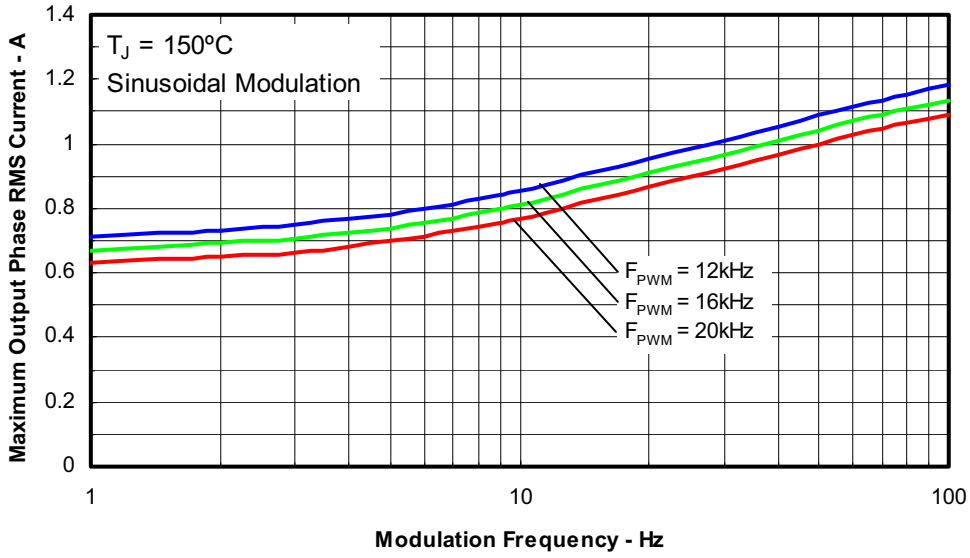



Figure 6. Maximum Sinusoidal Phase Current vs. Modulation Frequency
Sinusoidal Modulation, $V^+$=360V, $T_J$=150°C, MI=0.8, PF=0.6

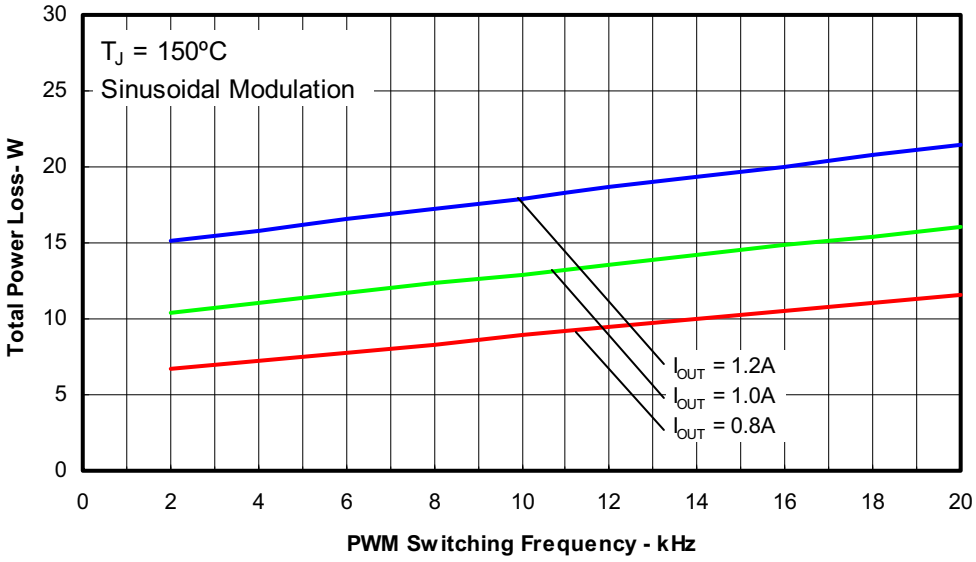



Figure 7. Total Power Losses vs. PWM Switching Frequency
Sinusoidal Modulation, $V^+$=360V, $T_J$=150°C, MI=0.8, PF=0.6

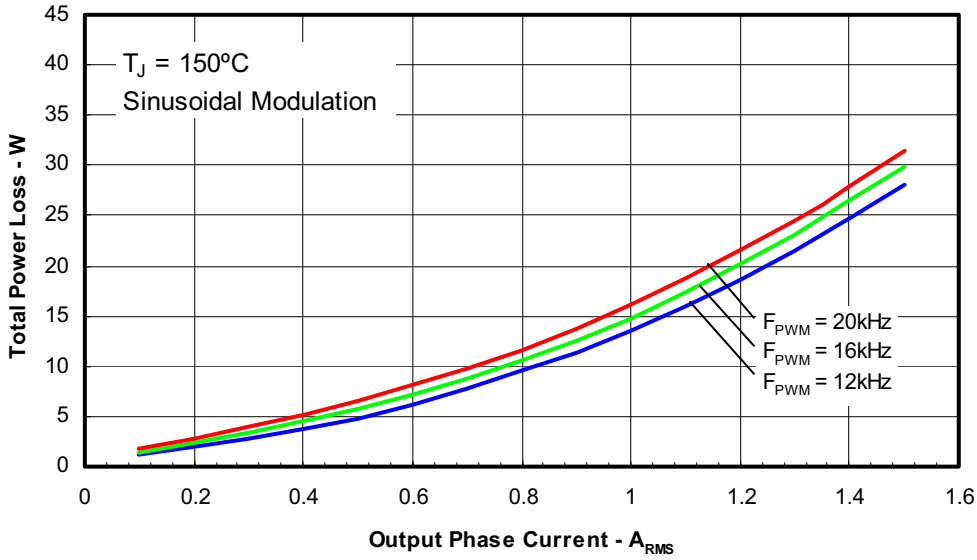



Figure 8. Total Power Losses vs. Output Phase Current
Sinusoidal Modulation, $V^+$=360V, $T_J$=150°C, MI=0.8, PF=0.6

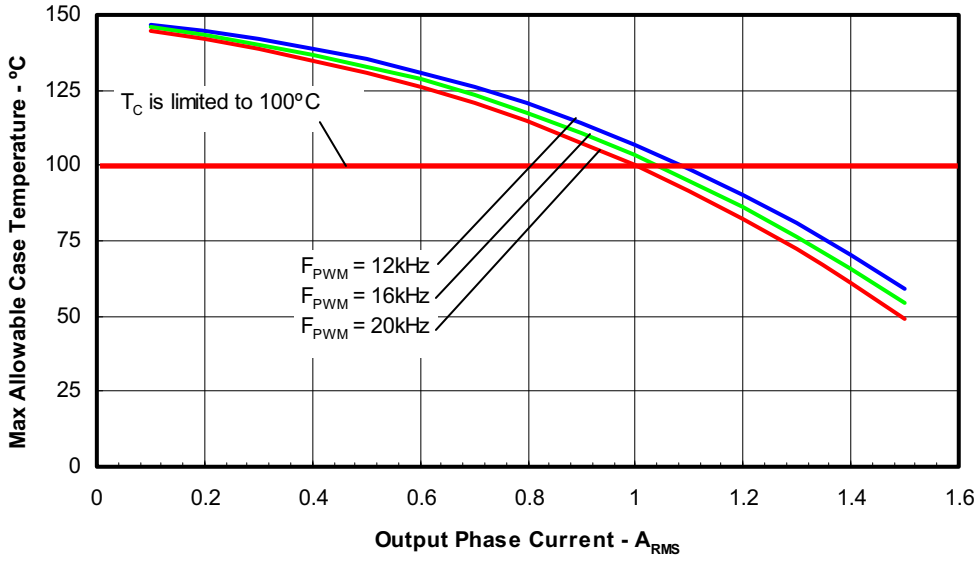



Figure 9. Maximum Allowable Case Temperature vs. Output RMS Current per Phase Sinusoidal Modulation, $V^+$=360V, $T_J$=150°C, Modulation Depth=0.8, PF=0.6

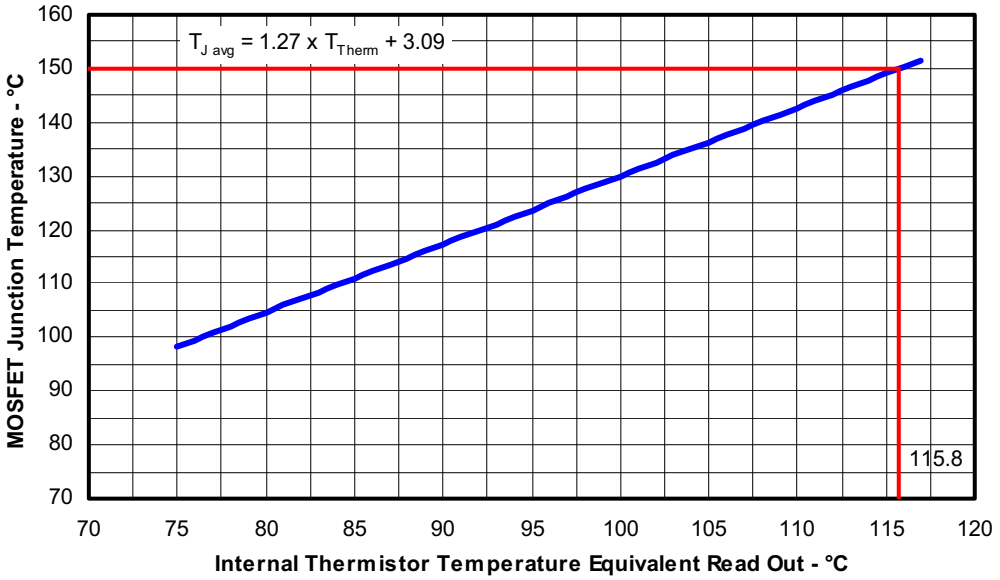
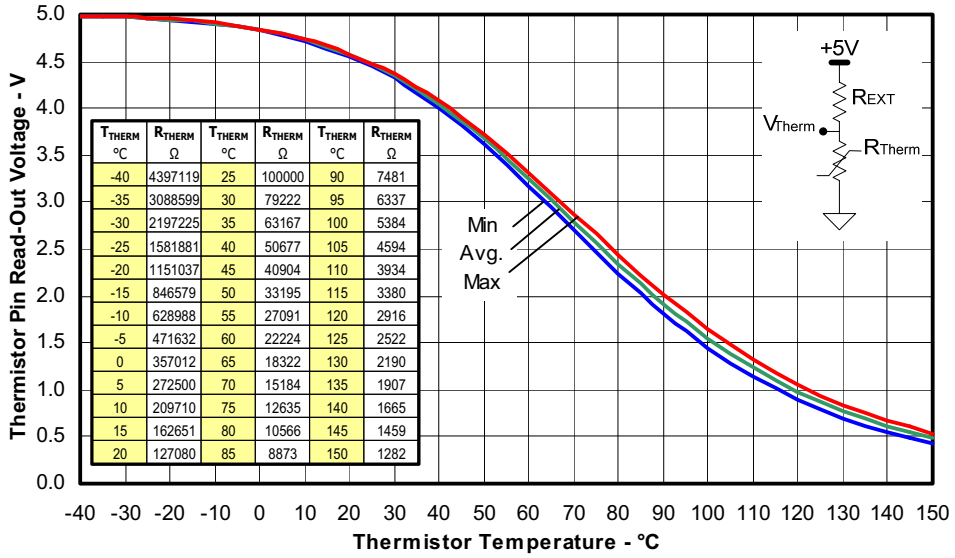



Figure 10. Estimated Maximum MOSFET Junction Temperature vs. Thermistor Temperature




| $T_{THERM}$ °C | $R_{THERM}$ Ω | $T_{THERM}$ °C | $R_{THERM}$ Ω | $T_{THERM}$ °C | $R_{THERM}$ Ω |
|---|---|---|---|---|---|
| -40 | 4397119 | 25 | 100000 | 90 | 7481 |
| -35 | 3088599 | 30 | 79222 | 95 | 6337 |
| -30 | 2197225 | 35 | 63167 | 100 | 5384 |
| -25 | 1581881 | 40 | 50677 | 105 | 4594 |
| -20 | 1151037 | 45 | 40904 | 110 | 3934 |
| -15 | 846579 | 50 | 33195 | 115 | 3380 |
| -10 | 628988 | 55 | 27091 | 120 | 2916 |
| -5 | 471632 | 60 | 22224 | 125 | 2522 |
| 0 | 357012 | 65 | 18322 | 130 | 2190 |
| 5 | 272500 | 70 | 15184 | 135 | 1907 |
| 10 | 209710 | 75 | 12635 | 140 | 1665 |
| 15 | 162651 | 80 | 10566 | 145 | 1459 |
| 20 | 127080 | 85 | 8873 | 150 | 1282 |

Figure 11. Thermistor Readout vs. Temperature (12Kohm pull-up resistor, 5V) and Normal Thermistor Resistance values vs. Temperature Table.

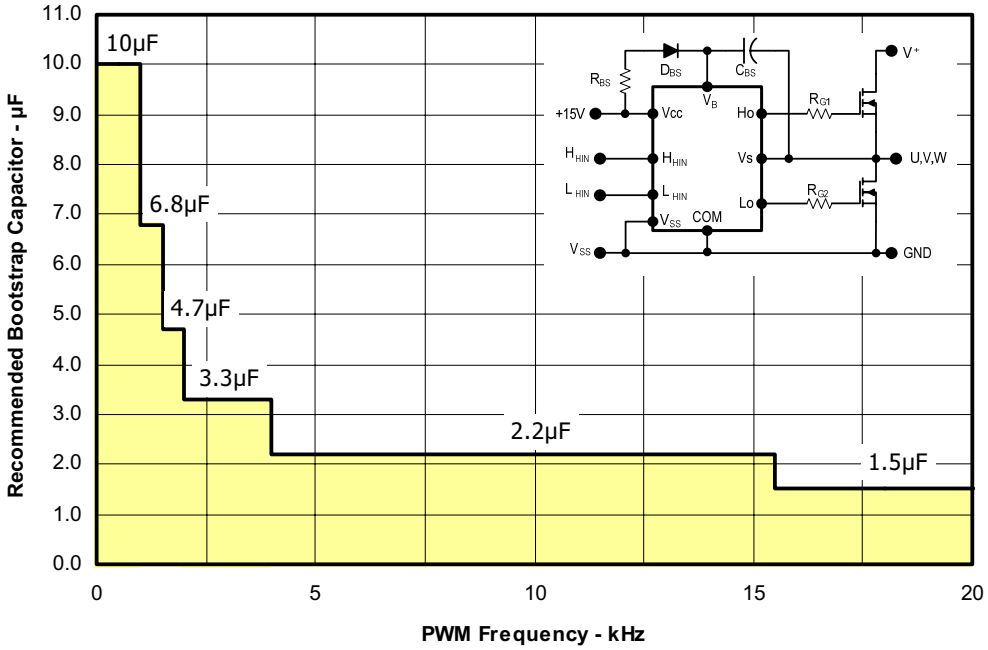



Figure 12. Recommended Bootstrap Capacitor Value vs. Switching Frequency

Figure 13. Switching Parameter Definitions

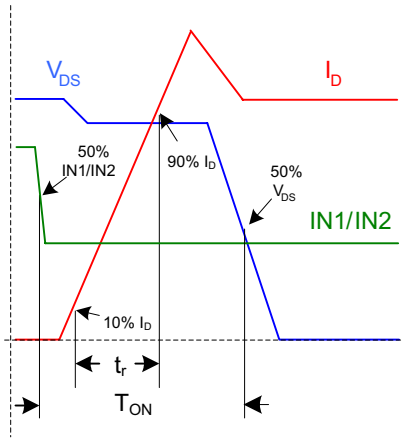



Figure 13a. Input to Output propagation turn-on delay time.

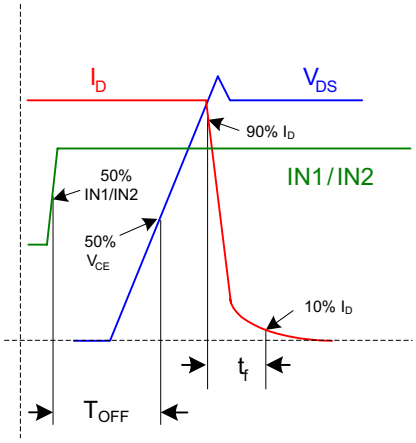



Figure 13b. Input to Output propagation turn-off delay time.

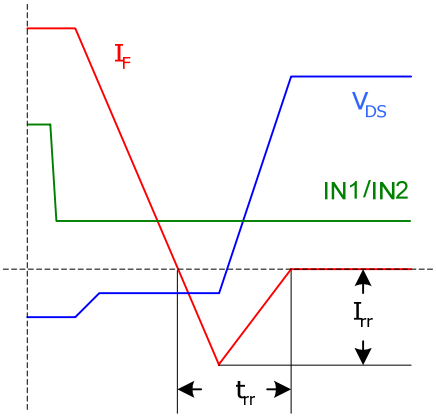



Figure 13c. Diode Reverse Recovery.

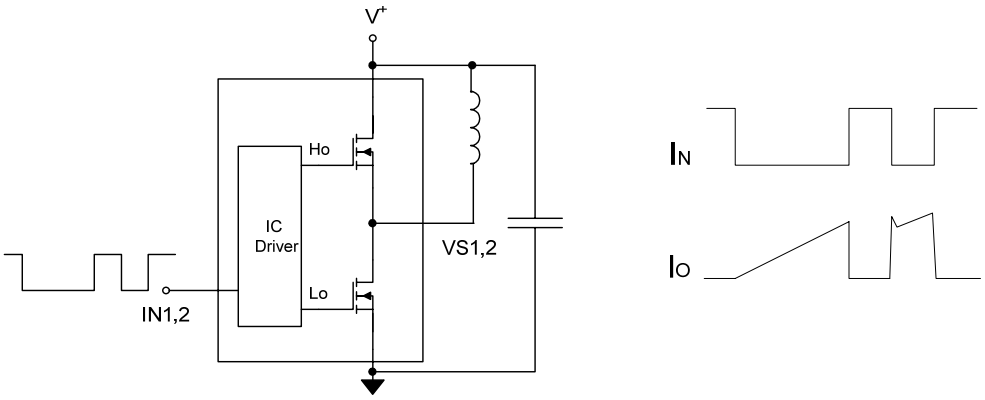
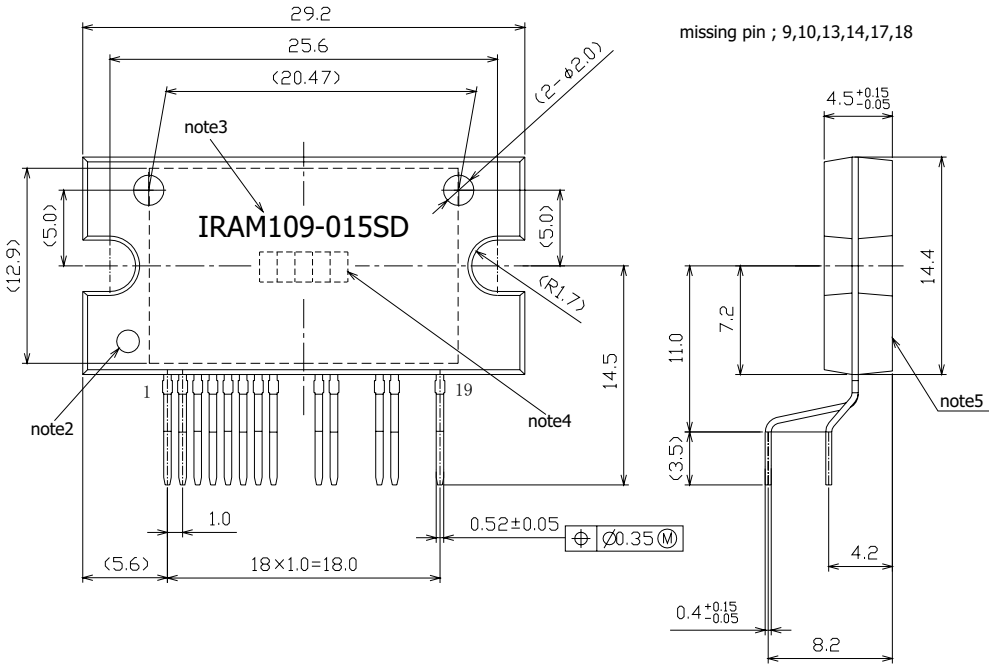



Figure CT1. Switching Loss Circuit

## Package Outline IRAM109-015SD




note1: Unit Tolerance is ±0.4mm,
Unless Otherwise Specified.
note2: Mirror Surface Mark indicates Pin1 Identification.
note3: Characters Font in this drawing differs from
Font shown on Module.
note4: Lot Code Marking.
Characters Font in this drawing differs from
Font shown on Module.
note5: Non-Isolated Back Side.

For mounting instruction see AN-1049

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