

IRAM Gen2

iMOTION™ Series **10A, 600V**

Integrated Power Module for Appliance Motor Drive Applications

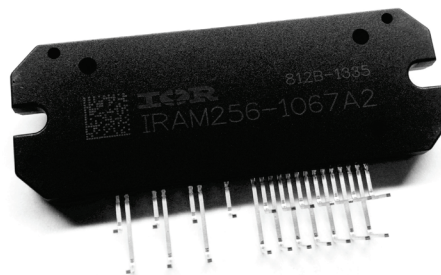
Description

International Rectifier's IRAM256-1067A is a 10A, 600V Integrated Power Hybrid IC with Open Emitter pins for advanced Appliance Motor Drives applications such as energy efficient Air Conditioner and Washing Machine. IR's technology offers an extremely compact, high performance AC motor-driver in a single isolated package to simplify design.

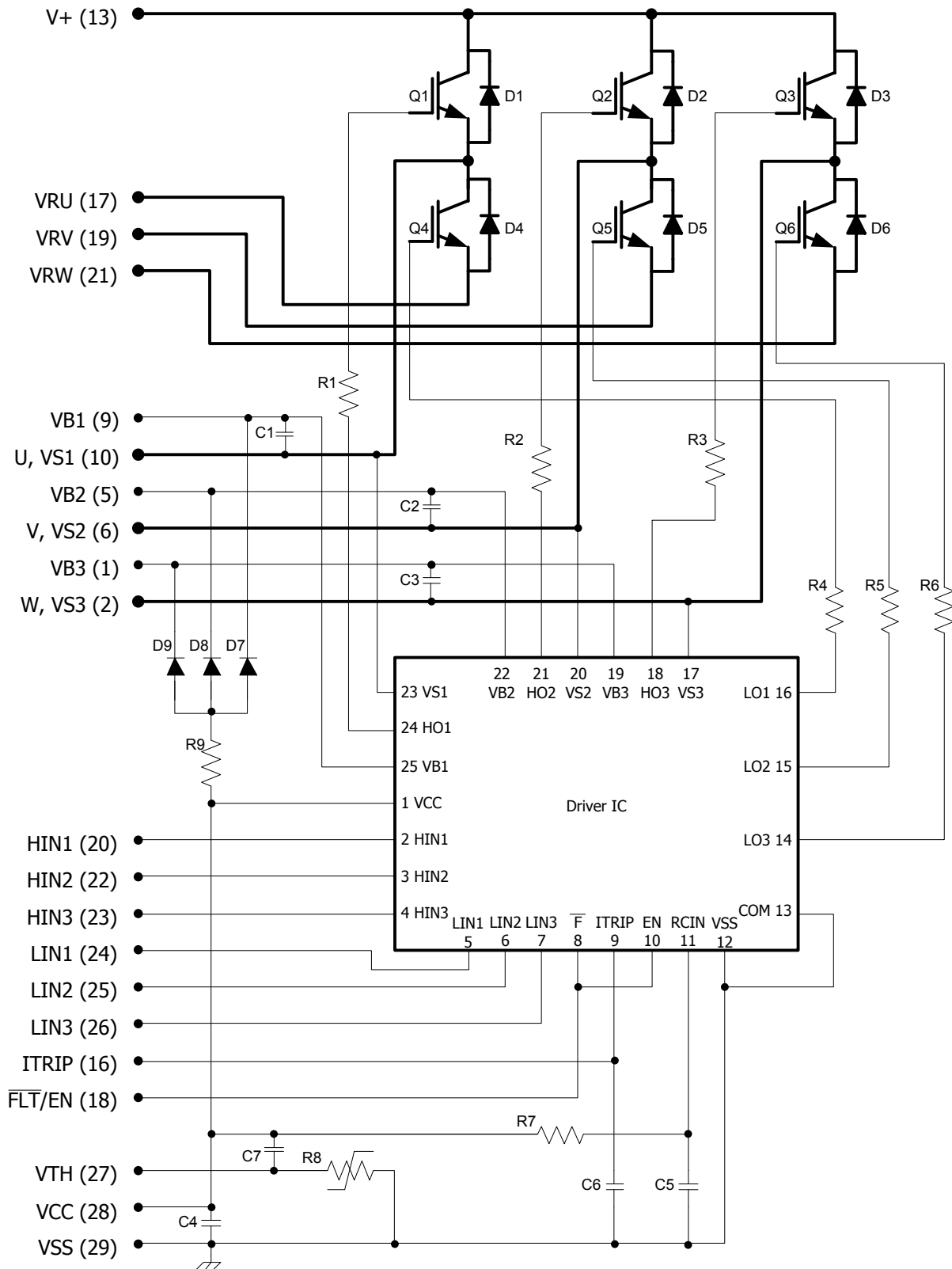
This advanced HIC is a combination of IR's low VCE (on) Trench IGBT technology and the industry benchmark 3 phase high voltage, high speed driver (3.3V compatible) in a fully isolated thermally enhanced package. A built-in high precision temperature monitor and over-current protection feature, along with the short-circuit rated IGBTs and integrated under-voltage lockout function, deliver high level of protection and fail-safe operation. Using a Single in line package with full transfer mold structure and CTI>600 minimizes PCB space and resolves isolation problems to heatsink.

Features

- Integrated gate drivers and bootstrap diodes
- Temperature monitor
- Protection shutdown pin
- Low VCE (on) Trench IGBT technology
- Undervoltage lockout for all channels
- Matched propagation delay for all channels
- 3.3V Schmitt-triggered input logic
- Cross-conduction prevention logic
- Motor Power range 0.25~0.75kW / 85~253 Vac
- Isolation 2000V_{RMS} min and CTI> 600
- High operating case temperature, T_CMAX=125°C



| Base Part Number | Package Type | Standard Pack | | Orderable Part Number |
|------------------|--------------------|---------------|----------|-----------------------|
| | | Form | Quantity | |
| IRAM256-1067A | SIP1A, option 1 LF | 10 tubes | 80 | IRAM256-1067A |
| IRAM256-1067A2 | SIP1A, option 2 LF | 10 tubes | 80 | IRAM256-1067A2 |

Internal Electrical Schematic – IRAM256-1067A


Absolute Maximum Ratings

| Symbol | Description | Min | Max | Unit |
|---------------------------------|---|-------------------|--------------------|--------------------|
| V_{CES} / V_{RRM} | IGBT/ FW Diode Blocking Voltage | --- | 600 | V |
| V_+ | Positive Bus Input Voltage | --- | 450 | |
| $I_o @ T_C=25^{\circ}\text{C}$ | RMS Phase Current (Note 1) | --- | 10 | A |
| $I_o @ T_C=100^{\circ}\text{C}$ | RMS Phase Current (Note 1) | --- | 5 | |
| I_{PK} | Maximum Peak Phase Current (Note 2) | --- | 15 | |
| F_P | Maximum PWM Carrier Frequency | --- | 20 | kHz |
| P_D | Maximum Power dissipation per IGBT @ $T_C = 25^{\circ}\text{C}$ | --- | 28 | W |
| V_{ISO} | Isolation Voltage (1min) | --- | 2000 | V_{RMS} |
| T_J (IGBT/Diode/IC) | Operating Junction Temperature | -40 | 150 | $^{\circ}\text{C}$ |
| T_C | Operating Case Temperature Range | -40 | 125 | |
| T_{STG} | Storage Temperature Range | -40 | 125 | |
| T | Mounting torque Range (M3 screw) | 0.8 | 1.0 | Nm |
| I_{BDF} | Bootstrap Diode Peak Forward Current | --- | 1.0 | A |
| P_{BR_Peak} | Bootstrap Resistor Peak Power (Single Pulse) | --- | 15 | W |
| $V_{S1,2,3}$ | 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 | 600 | V |
| V_{CC} | Low Side and logic fixed supply voltage | -0.3 | 20 | V |
| V_{IN} | Input voltage LIN, HIN, I _{TRIP} , FLT/EN | -0.3 | 7 | V |

Note 1: See Figure 4 and [IR IPM Design Tool](#).

Note 2: $t_P < 100\text{ms}$.

Inverter Section Electrical Characteristics

$V_{BIAS}(V_{CC}, V_{BS1,2,3}) = 15\text{V}$, $T_J = 25^{\circ}\text{C}$ unless otherwise specified.

| Symbol | Description | Min | Typ | Max | Unit | Conditions |
|---------------------------------|---|-----|------|---------|----------------------|---|
| $V_{(BE)CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | --- | --- | V | $V_{IN}=0\text{V}$, $I_C=100\mu\text{A}$ |
| $\Delta V_{(BR)CES} / \Delta T$ | Temperature Coeff. Of Breakdown Voltage | --- | 0.3 | --- | $V/^{\circ}\text{C}$ | $V_{IN}=0\text{V}$, $I_C=250\text{A}$ ($25^{\circ}\text{C} - 150^{\circ}\text{C}$) |
| $V_{CE(ON)}$ | Collector-to-Emitter Saturation Voltage | --- | 1.5 | 1.75 | V | $I_C=4\text{A}$ |
| | | --- | 1.7 | --- | | $I_C=4\text{A}$, $T_J=150^{\circ}\text{C}$ |
| I_{CES} | Zero Gate Voltage Collector Current | --- | 5 | 80 | μA | $V_{IN}=0\text{V}$, $V^+=600\text{V}$ |
| | | --- | 80 | --- | | $V_{IN}=0\text{V}$, $V^+=600\text{V}$, $T_J=150^{\circ}\text{C}$ |
| V_{FM} | Diode Forward Voltage Drop | --- | 1.6 | 2.35 | V | $I_F=4\text{A}$ |
| | | --- | 1.3 | --- | | $I_F=4\text{A}$, $T_J=150^{\circ}\text{C}$ |
| V_{BDFM} | Bootstrap Diode Forward Voltage Drop | --- | 1.65 | 1.8 | V | $I_F=1\text{A}$ |
| | | --- | 1.3 | --- | | $I_F=1\text{A}$, $T_J=150^{\circ}\text{C}$ |
| R_{BR} | Bootstrap Resistor Value | --- | 22 | --- | Ω | |
| $\Delta R_{BR}/R_{BR}$ | Bootstrap Resistor Tolerance | --- | --- | ± 5 | % | |
| $C_{1,2,3,4}$ | VCC / VBS Capacitor Value | --- | 47 | --- | nF | |
| C_6 | I _{TRIP} Capacitor Value | --- | 1 | --- | nF | |
| C_7 | NTC Capacitor Value | --- | 2.2 | --- | nF | |

Inverter Section Switching Characteristics

$V_{BIAS}(V_{CC}, V_{BS1,2,3})=15V$, $T_J=25^{\circ}C$ unless otherwise specified.

| Symbol | Description | Min | Typ | Max | Unit | Conditions |
|------------------|-----------------------------------|-------------|-----|-----|------|--|
| E _{ON} | Turn-On Switching Loss | --- | 170 | --- | μJ | I _C =4A, V ⁺ =400V V _{CC} =15V, L=1.2mH Energy losses include "tail" and diode reverse recovery See CT1 |
| E _{OFF} | Turn-Off Switching Loss | --- | 60 | --- | | |
| E _{TOT} | Total Switching Loss | --- | 230 | --- | | |
| E _{REC} | Diode Reverse Recovery energy | --- | 15 | --- | | |
| T _{RR} | Diode Reverse Recovery time | --- | 115 | --- | ns | I _C =4A, V ⁺ =400V V _{CC} =15V, L=1.2mH, T _J =150°C Energy losses include "tail" and diode reverse recovery See CT1 |
| E _{ON} | Turn-On Switching Loss | --- | 260 | --- | μJ | |
| E _{OFF} | Turn-Off Switching Loss | --- | 100 | --- | | |
| E _{TOT} | Total Switching Loss | --- | 360 | --- | | |
| E _{REC} | Diode Reverse Recovery energy | --- | 40 | --- | | |
| T _{RR} | Diode Reverse Recovery time | --- | 150 | --- | ns | |
| Q _G | Turn-On IGBT Gate Charge | --- | 13 | --- | nC | I _C =6A, V ⁺ =400V, V _{GE} =15V |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | T _J =150°C, I _C =20A, V _P =600V V ⁺ = 450V, V _{CC} =+15V to 0V See CT3 |
| SCSOA | Short Circuit Safe Operating Area | 5 | --- | --- | μs | T _J =25°C, V ⁺ = 400V, V _{GE} =+15V to 0V |
| SCSOA | Short Circuit Safe Operating Area | 3 | --- | --- | μs | T _J =100°C, V ⁺ = 400V, V _{GE} =+15V to 0V |

Recommended Operating Conditions Driver Function

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 VS offset is tested with all supplies biased at 15V differential (Note 3)

| Symbol | Description | Min | TYP | Max | Unit |
|--------------|---|------------|----------|------------|---------|
| $V_{B1,2,3}$ | High side floating supply voltage | $V_S+12.5$ | V_S+15 | $V_S+17.5$ | V |
| $V_{S1,2,3}$ | High side floating supply offset voltage | Note 4 | --- | 450 | V |
| V_{CC} | Low side and logic fixed supply voltage | 13.5 | 15 | 16.5 | V |
| V_{IN} | Input voltage LIN, HIN, I_{TRIP} , FLT/EN | V_{SS} | --- | $V_{SS}+5$ | V |
| HIN | High side PWM pulse width | 1 | --- | --- | μs |
| Deadtime | External dead time between HIN and LIN | 1 | --- | --- | μs |

Note 3: For more details, see IR21364 data sheet

Note 4: Logic operational for V_S from COM-5V to COM+600V. Logic state held for V_S from COM-5V to COM- V_{BS} . (please refer to DT97-3 for more details)

Static Electrical Characteristics Driver Function

V_{BIAS} (V_{CC} , $V_{BS1,2,3}$)=15V, T_J =25°C, unless otherwise specified. The V_{IN} and I_{IN} parameters are referenced to COM and are applicable to all six channels. (Note 3)

| Symbol | Description | Min | TYP | Max | Unit |
|---------------------------|--|------|------|------|------|
| $V_{IN,TH+}$ | Positive going input threshold for LIN, HIN, FLT/EN | 2.5 | --- | --- | V |
| $V_{IN,TH-}$ | Negative going input threshold for LIN, HIN, FLT/EN | --- | --- | 0.8 | V |
| V_{CCUV+} , V_{BSUV+} | VCC/VBS supply undervoltage, Positive going threshold | 10.6 | 11.1 | 11.6 | V |
| V_{CCUV-} , V_{BSUV-} | VCC/VBS supply undervoltage, Negative going threshold | 10.4 | 10.9 | 11.4 | V |
| V_{CCUVH} , V_{BSUVH} | VCC and VBS supply undervoltage lock-out hysteresis | --- | 0.2 | --- | V |
| I_{QBS} | Quiescent VBS supply current | --- | --- | 150 | μA |
| I_{QCC} | Quiescent VCC supply current | --- | --- | 3.2 | mA |
| I_{LK} | Offset Supply Leakage Current | --- | --- | 50 | μA |
| I_{IN+} | Input bias current V_{IN} =3.3V for LIN, HIN, FLT/EN | --- | 100 | 195 | μA |
| I_{IN-} | Input bias current V_{IN} =0V for LIN, HIN, FLT/EN | -1 | --- | --- | μA |
| I_{TRIP+} | I_{TRIP} bias current V_{ITRIP} =3.3V | --- | 3.3 | 6 | μA |
| I_{TRIP-} | I_{TRIP} bias current V_{ITRIP} =0V | -1 | --- | --- | μA |
| V_{ITRIP} | I_{TRIP} threshold Voltage | 0.44 | 0.49 | 0.54 | V |
| V_{ITRIP_HYS} | I_{TRIP} Input Hysteresis | --- | 0.07 | --- | V |
| R_{FLT} | Fault low on resistance | --- | 50 | 100 | Ω |

Dynamic Electrical Characteristics

V_{BIAS} (V_{CC} , $V_{BS1,2,3}$)=15V, T_J =25°C, unless otherwise specified. Dynamic parameters are guaranteed by design. (Note 3)

| Symbol | Description | Min | Typ | Max | Unit | Conditions |
|----------------|--|-----|-----|------|------|--|
| T_{ON} | Input to Output propagation turn-on delay time (see Fig.12) | --- | --- | 1.15 | μs | $I_C=4A$, $V^+=300V$ |
| T_{OFF} | Input to Output propagation turn-off delay time (see Fig.12) | --- | --- | 1.15 | μs | |
| T_{FILIN} | Input filter time (HIN,LIN) | --- | 310 | --- | ns | $V_{IN}=0$ or $V_{IN}=5V$ |
| T_{FILEN} | Input filter time (FLT/EN) | 100 | 200 | --- | ns | $V_{EN}=0$ or $V_{EN}=5V$ |
| T_{EN} | EN low to six switch turn-off propagation delay (see fig. 3) | --- | --- | 1.35 | μs | $V_{IN}=0$ or $V_{IN}=5V$, $V_{EN}=0$ |
| T_{FLT} | I_{TRIP} to Fault propagation delay | 400 | 600 | 800 | ns | $V_{IN}=0$ or $V_{IN}=5V$, $V_{ITRIP}=5V$ |
| $T_{BLT-TRIP}$ | I_{TRIP} Blanking Time | 100 | 150 | --- | ns | $V_{IN}=0$ or $V_{IN}=5V$, $V_{ITRIP}=5V$ |
| T_{ITRIP} | I_{TRIP} to six switch turn-off propagation delay (see fig. 2) | --- | --- | 1.5 | μs | $I_C=4A$, $V^+=300V$ |
| D_T | Internal Dead Time injected by driver | 220 | 290 | 360 | ns | $V_{IN}=0$ or $V_{IN}=5V$ |
| M_T | Matching Propagation Delay Time (On & Off) all channels | --- | 40 | 75 | ns | External dead time > 400ns |
| $T_{FLT-CLR}$ | Post I_{TRIP} to six switch turn-off clear time (see fig. 2) | 1.1 | 1.7 | 2.3 | ms | $T_C = 25^\circ C$ |
| | | 1 | 1.5 | 1.9 | | $T_C = 100^\circ C$ |

Thermal and Mechanical Characteristics

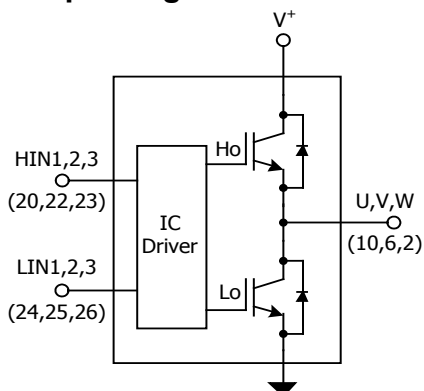
| Symbol | Description | Min | Typ | Max | Unit | Conditions |
|---------------|-------------------------------|-----|-----|-----|------|---|
| $R_{TH(J-C)}$ | Thermal resistance, per IGBT | --- | 3.5 | 4.4 | °C/W | Inverter Operating Condition Flat, greased surface. Heatsink compound thermal conductivity 1W/mK |
| $R_{TH(J-C)}$ | Thermal resistance, per Diode | --- | 5.0 | 6.3 | | |
| $R_{TH(C-S)}$ | Thermal resistance, C-S | --- | 0.1 | --- | | |
| CTI | Comparative Tracking Index | 600 | --- | --- | V | |
| BKCurve | Curvature of module backside | 0 | --- | --- | μm | Convex only |

Note 5: Flatness of the heatsink should be between -50μm to 100μm.

Internal NTC - Thermistor Characteristics

| Symbol | Description | Min | Typ | Max | Unit | Conditions |
|---------------------------|----------------------|-------|------|-------|-------|------------------------------------|
| R_{25} | Resistance | 44.65 | 47 | 49.35 | kΩ | $T_C = 25^{\circ}\text{C}$ |
| R_{125} | Resistance | 1.27 | 1.41 | 1.56 | kΩ | $T_C = 125^{\circ}\text{C}$ |
| B | B-constant (25-50°C) | 3989 | 4050 | 4111 | k | $R_2 = R_1 e^{[B(1/T_2 - 1/T_1)]}$ |
| Temperature Range | | -40 | --- | 125 | °C | |
| Typ. Dissipation constant | | --- | 1 | --- | mW/°C | $T_C = 25^{\circ}\text{C}$ |

Input-Output Logic Level Table



| FLT/EN | I_{TRIP} | HIN1,2,3 | LIN1,2,3 | U,V,W |
|--------|------------|----------|----------|-------|
| 1 | 0 | 1 | 0 | V+ |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | Off |
| 1 | 0 | 1 | 1 | Off |
| 1 | 1 | X | X | Off |
| 0 | X | X | X | Off |

Qualification Information[†]

| Qualification Level | | Industrial ^{††} (per JEDEC JESD 47E) |
|---------------------|------------------|--|
| ESD | Machine Model | Class C (per JEDEC standard JESD22-A115-A) |
| | Human Body Model | Class 1C (per JEDEC standard JESD22-A114-D) |
| RoHS Compliant | | Yes |

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

^{††} Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information.

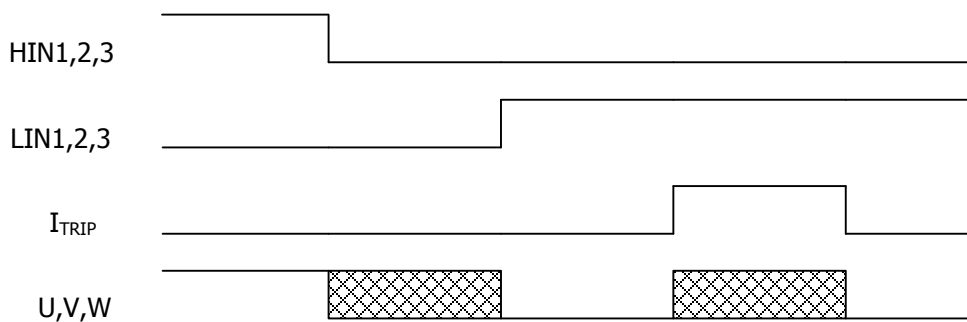


Figure 1. Input/Output Timing Diagram

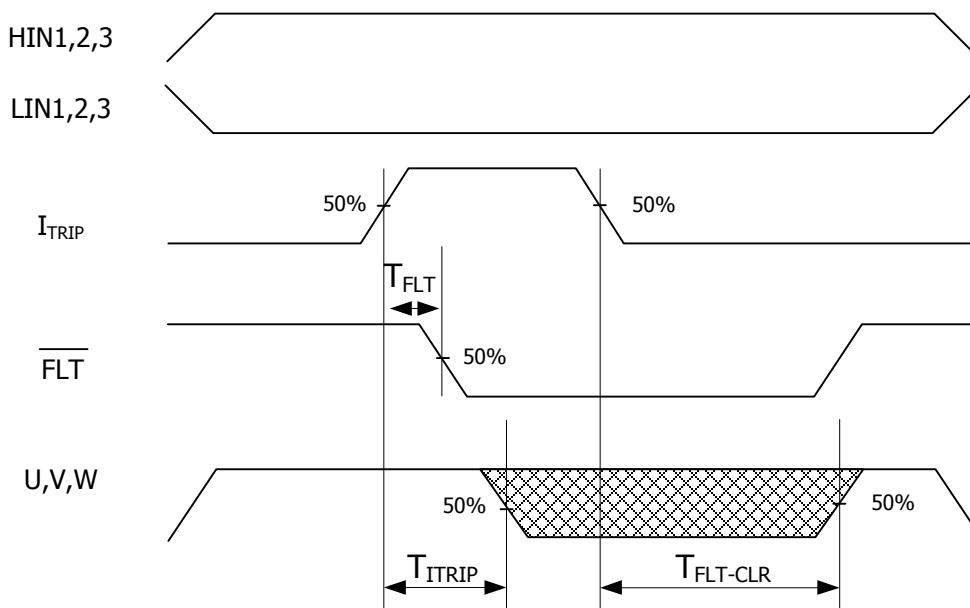


Figure 2. I_{TRIP} Timing Waveform

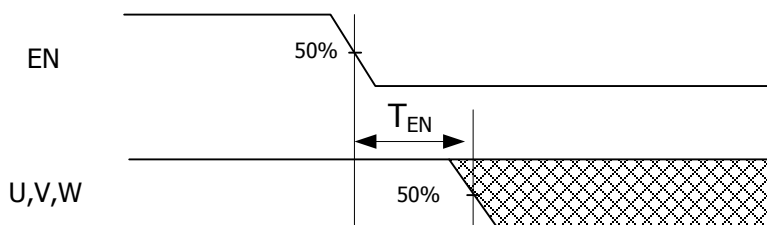


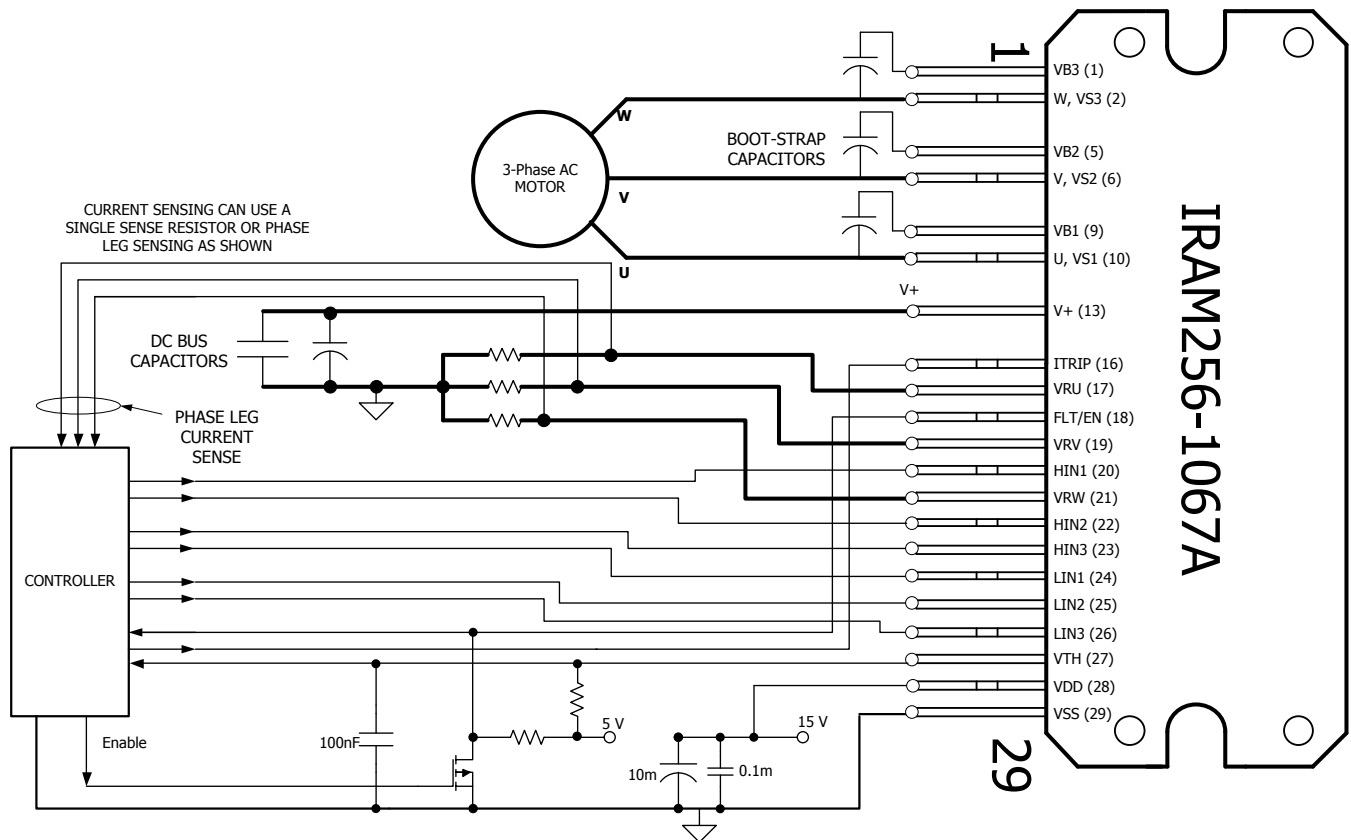
Figure 3. Output Enable Timing Diagram

Note 5: The shaded area indicates that both high-side and low-side switches are off and therefore the half-bridge output voltage would be determined by the direction of current flow in the load.

Module Pin-Out Description

| Pin | Name | Description |
|-----|-------------------|---|
| 1 | VB3 | High Side Floating Supply Voltage 3 |
| 2 | W,VS3 | Output 3 - High Side Floating Supply Offset Voltage |
| 3 | N/A | None |
| 4 | | |
| 5 | VB2 | High Side Floating Supply Voltage 2 |
| 6 | V,VS2 | Output 2 - High Side Floating Supply Offset Voltage |
| 7 | N/A | None |
| 8 | | |
| 9 | VB1 | High Side Floating Supply Voltage 1 |
| 10 | U,VS1 | Output 1 - High Side Floating Supply Offset Voltage |
| 11 | N/A | None |
| 12 | | |
| 13 | V+ | Positive Bus Input Voltage |
| 14 | N/A | None |
| 15 | | |
| 16 | I _{TRIP} | Current Protection Pin |
| 17 | VRU | Low Side Emitter Connection - Phase 1 |
| 18 | FLT/EN | Fault Output and Enable Pin |
| 19 | VRV | Low Side Emitter Connection - Phase 2 |
| 20 | HIN1 | Logic Input High Side Gate Driver - Phase 1 |
| 21 | VRW | Low Side Emitter Connection - Phase 3 |
| 22 | HIN2 | Logic Input High Side Gate Driver - Phase 2 |
| 23 | HIN3 | Logic Input High Side Gate Driver - Phase 3 |
| 24 | LIN1 | Logic Input Low Side Gate Driver - Phase 1 |
| 25 | LIN2 | Logic Input Low Side Gate Driver - Phase 2 |
| 26 | LIN3 | Logic Input Low Side Gate Driver - Phase 3 |
| 27 | VTH | Temperature Feedback |
| 28 | VCC | +15V Main Supply |
| 29 | VSS | Negative Main Supply |

Typical Application Connection IRAM256-1067A



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 VB1,2,3-VS1,2,3 terminals, the capacitors shown connected between these terminals should be located very close to the module pins. Additional high frequency capacitors, typically 0.1 μ F, 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 9. Bootstrap capacitor value must be selected to limit the power dissipation of the internal resistor in series with the VCC. (see maximum ratings Table on page 3).
4. After approx. 2ms the FAULT is reset. (see Dynamic Characteristics Table on page 5).
5. PWM generator must be disabled within Fault duration to guarantee shutdown of the system, overcurrent condition must be cleared before resuming operation.

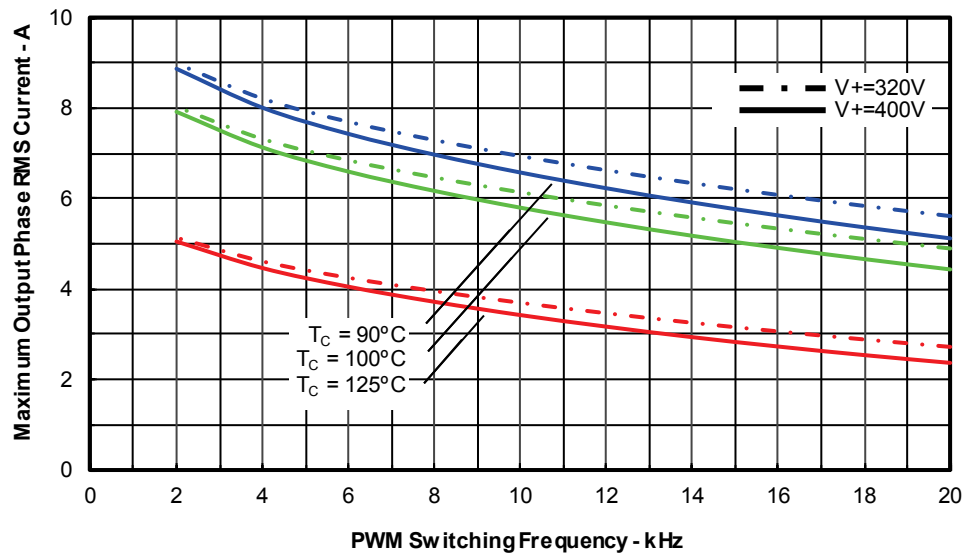


Figure 4. Maximum Sinusoidal Phase Current vs. PWM Switching Frequency
Sinusoidal Modulation, $T_J=150^\circ\text{C}$, $MI=0.8$, $PF=0.6$, $f_{mod}=50\text{Hz}$

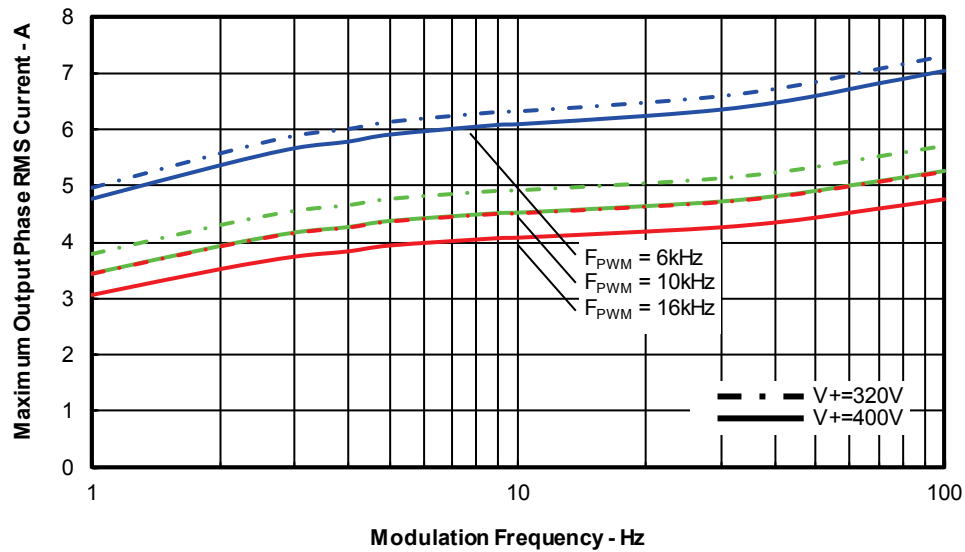


Figure 5. Maximum Sinusoidal Phase Current vs. Modulation Frequency
Sinusoidal Modulation, $T_J=150^\circ\text{C}$, $T_c=100^\circ\text{C}$, $MI=0.8$, $PF=0.6$

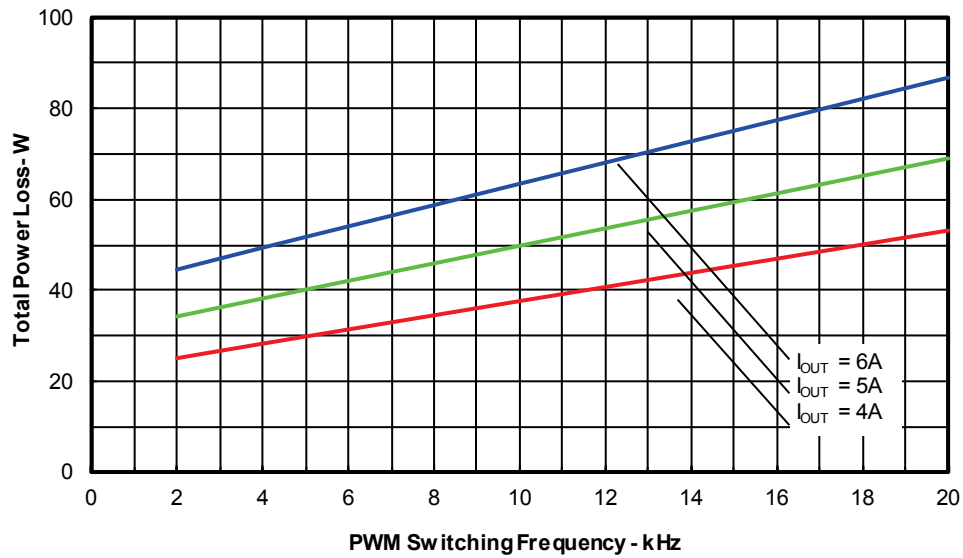


Figure 6. Total Power Losses vs. PWM Switching Frequency
Sinusoidal Modulation, $V^+ = 400V$, $T_J = 150^\circ C$, $MI = 0.8$, $PF = 0.6$, $f_{mod} = 50Hz$

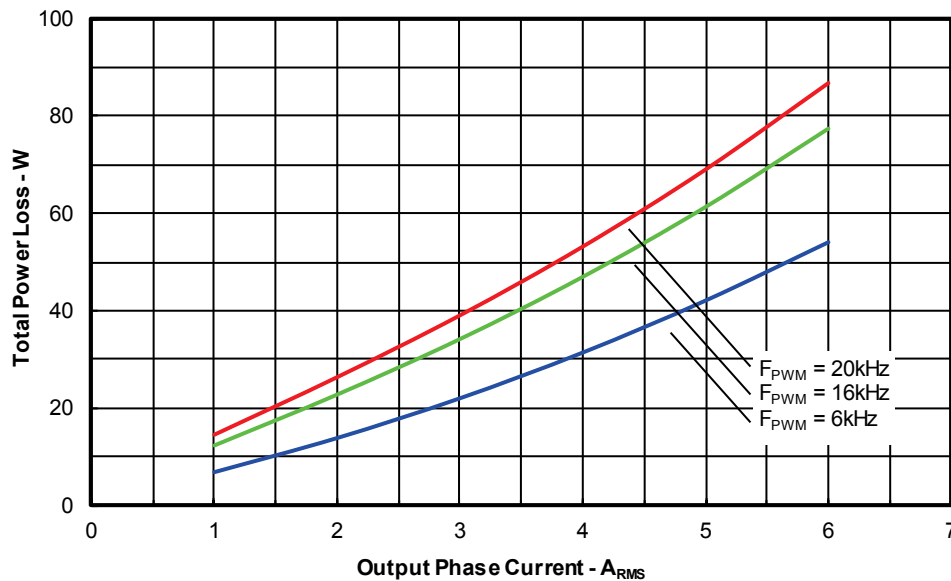


Figure 7. Total Power Losses vs. Output Phase Current
Sinusoidal Modulation, $V^+ = 400V$, $T_J = 150^\circ C$, $MI = 0.8$, $PF = 0.6$, $f_{mod} = 50Hz$

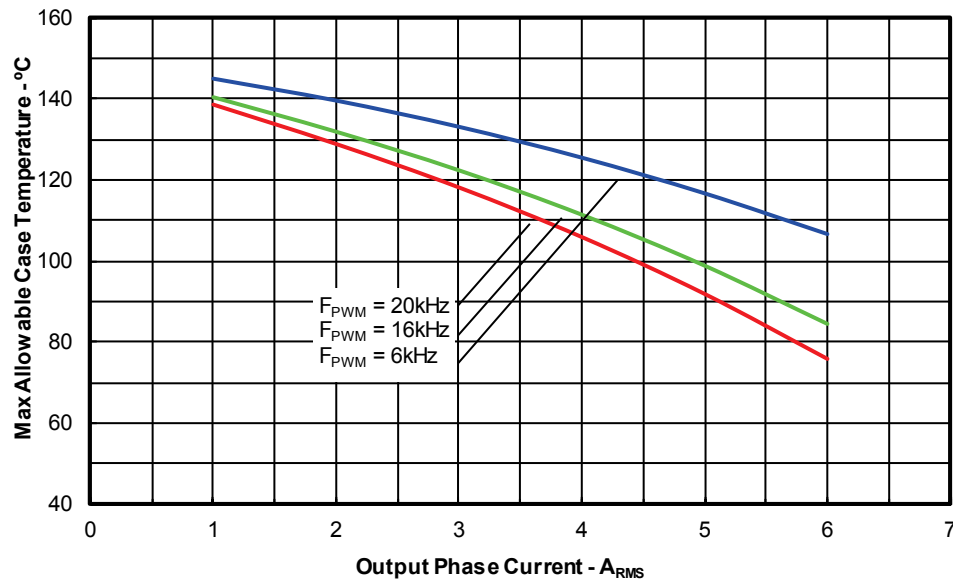


Figure 8. Maximum Allowable Case Temperature vs. Output RMS Current per Phase
Sinusoidal Modulation, $V^+=400V$, $T_J=150^\circ C$, $MI=0.8$, $PF=0.6$, $f_{mod}=50Hz$

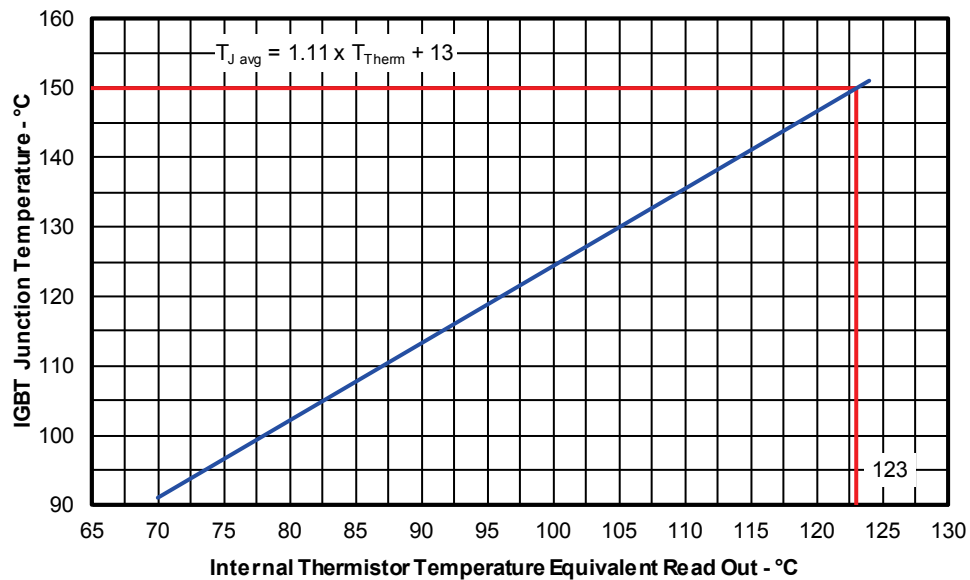


Figure 9. Estimated Maximum IGBT Junction Temperature vs. Thermistor Temperature
Sinusoidal Modulation, $V^+=400V$, $I_{phase}=5A_{rms}$, $f_{sw}=6kHz$, $f_{mod}=50Hz$, $MI=0.8$, $PF=0.6$

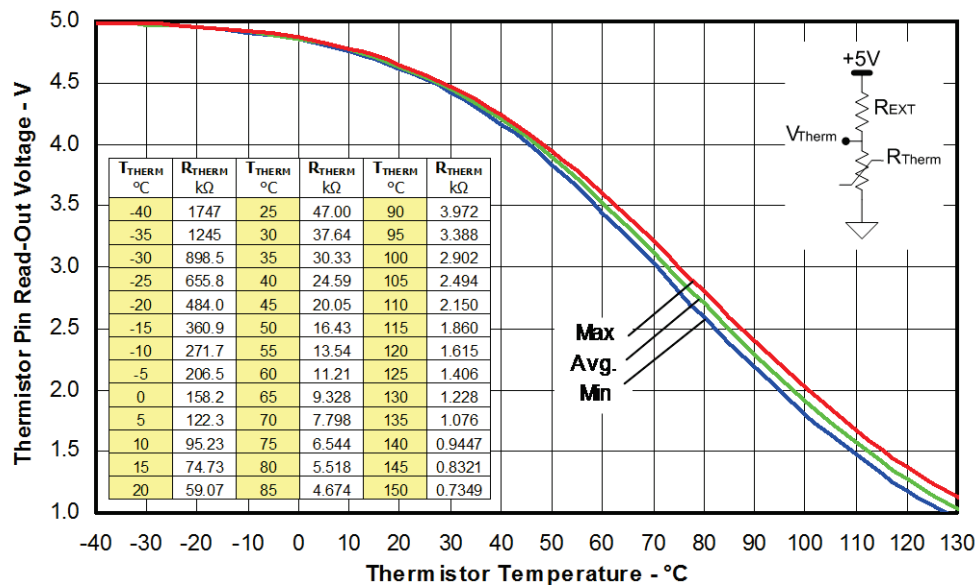


Figure 10. Thermistor Readout vs. Temperature (7.5kohm R_{EXT} pull-down resistor) and Normal Thermistor Resistance values vs. Temperature Table.

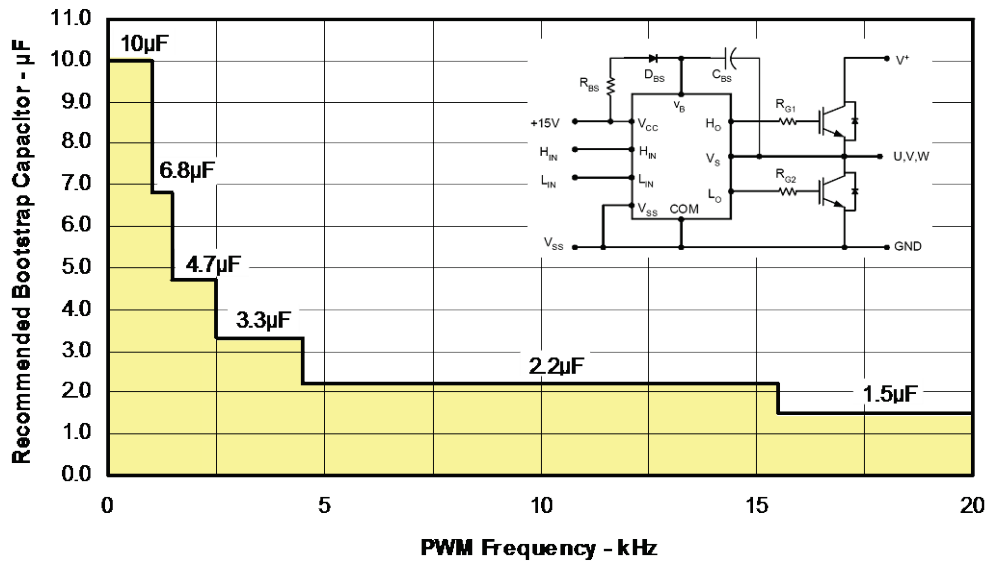


Figure 11. Recommended Bootstrap Capacitor Value vs. Switching Frequency

Figure 12. Switching Parameter Definitions

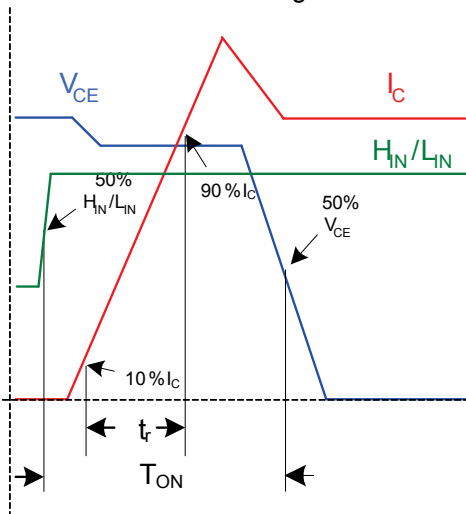


Figure 12a. Input to Output propagation turn-on delay time.

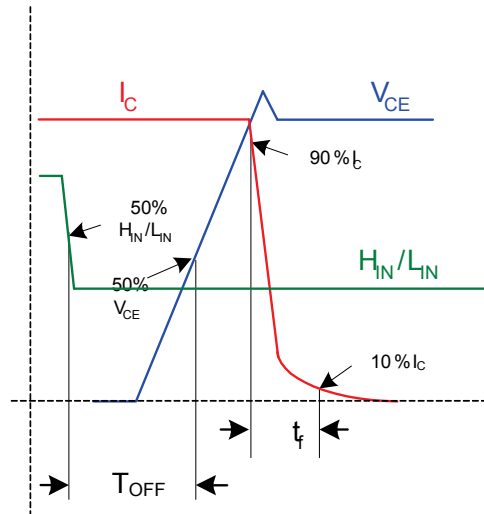


Figure 12b. Input to Output propagation turn-off delay time.

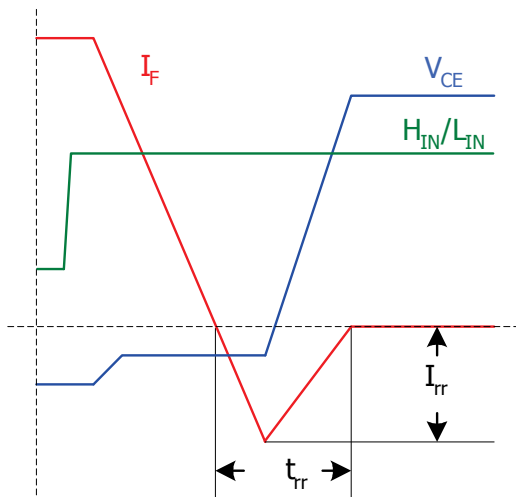


Figure 12c. Diode Reverse Recovery.

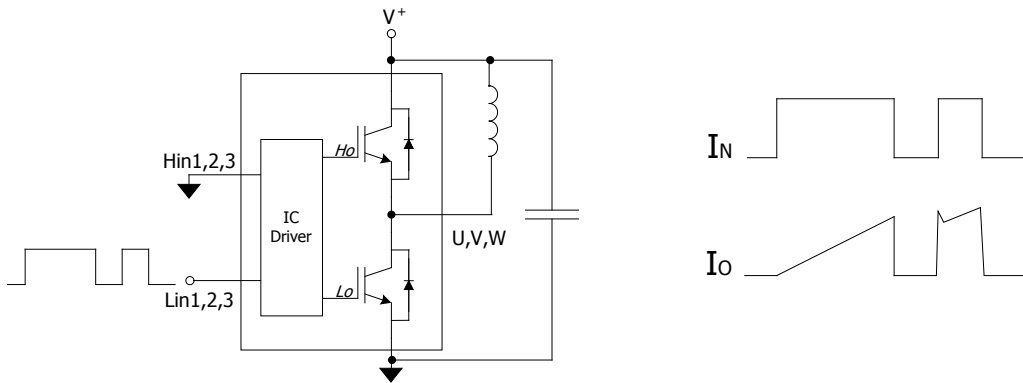


Figure CT1. Switching Loss Circuit

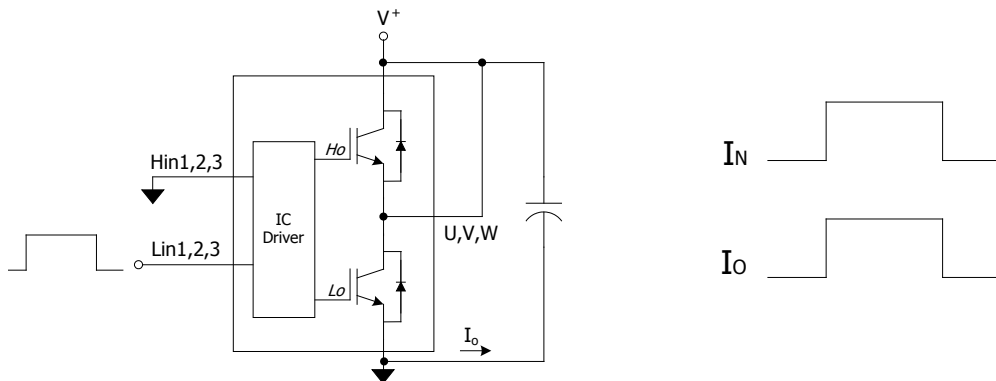


Figure CT2. S.C.SOA Circuit

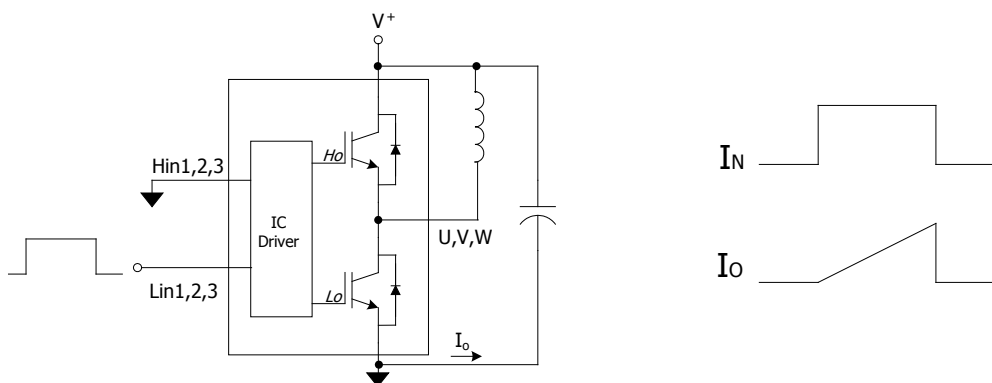
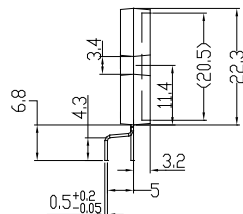
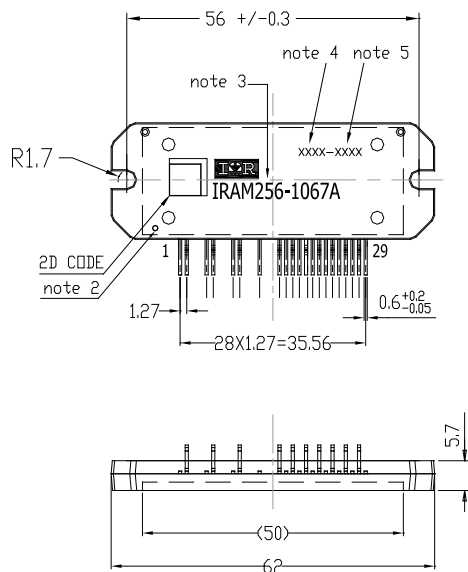


Figure CT3. R.B.SOA Circuit

Package Outline IRAM256-1067A

Missing pins: 3,4,7,8,11,12,14,15



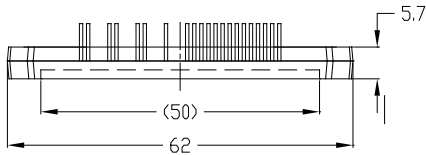
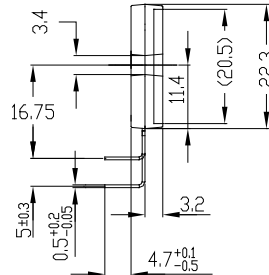
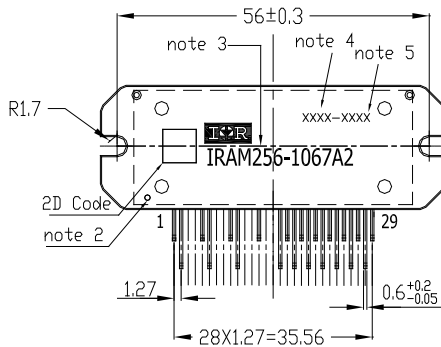
- note1: Unit tolerance is ± 0.5 mm,
Unless Otherwise Specified.
- note2: Mirror Surface Mark indicates Pin 1 Identification.
- note3: Part Number Marking.
Characters Font in this drawing differs from
Font shown on Module.
- note4: Lot Code Marking.
Characters Font in this drawing differs from
Font shown on Module.
- note5: Date Code Marking.
Characters Font in this drawing differs from
Font shown on Module.

Dimensions in mm

For mounting instruction see AN-1049

Package Outline IRAM256-1067A2

Missing pins: 3,4,7,8,11,12,14,15



- note1: Unit tolerance is ± 0.5 mm, Unless Otherwise Specified.
- note2: Mirror Surface Mark indicates Pin 1 Identification.
- note3: Part Number Marking. 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: Date Code Marking. Characters Font in this drawing differs from Font shown on Module.

Dimensions in mm

For mounting instruction see AN-1049

International
IR Rectifier

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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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