International
IOR Rectifier

# IRAMS06UP60B

## iMOTION™ Series

Plug N Drive™ Integrated Power Module for Appliance Motor Drive

6A, 600V
with Internal Shunt Resistor

## Description

International Rectifier's IRAMS06UP60B is an Integrated Power Module developed and optimized for electronic motor control in appliance applications specifically for VF compressor drives for refrigerators and freezer or in heating and ventilation as electronic fan controls. The IRAMS06UP60B offers an extremely compact, high performance AC motor-driver in a single isolated package for a very simple design.
An internal shunt is included and offers easy current feedback and overcurrent monitor for precise control and safe operation. A built-in temperature monitor and over-current protection, along with the short-circuit rated IGBTs and integrated under-voltage lockout function, deliver high level of protection and fail-safe operation. The integration of the bootstrap diodes for the high-side driver section, and the single polarity power supply required to drive the internal circuitry, simplify the utilization of the module and deliver further cost reduction advantages.

## Features

- Internal Shunt Resistor
- Integrated Gate Drivers and Bootstrap Diodes
- Temperature Monitor
- Overcurrent shutdown
- Fully Isolated Package.
- Low $V_{CE(on)}$ Non Punch Through IGBT Technology
- Undervoltage lockout for all channels
- Matched propagation delay for all channels
- Schmitt-triggered input logic
- Cross-conduction prevention logic
- Lower di/dt gate driver for better noise immunity
- Motor Power range 0.1~0.5kW / 85~253 Vac
- Isolation 2000$V_{RMS}$ /1min

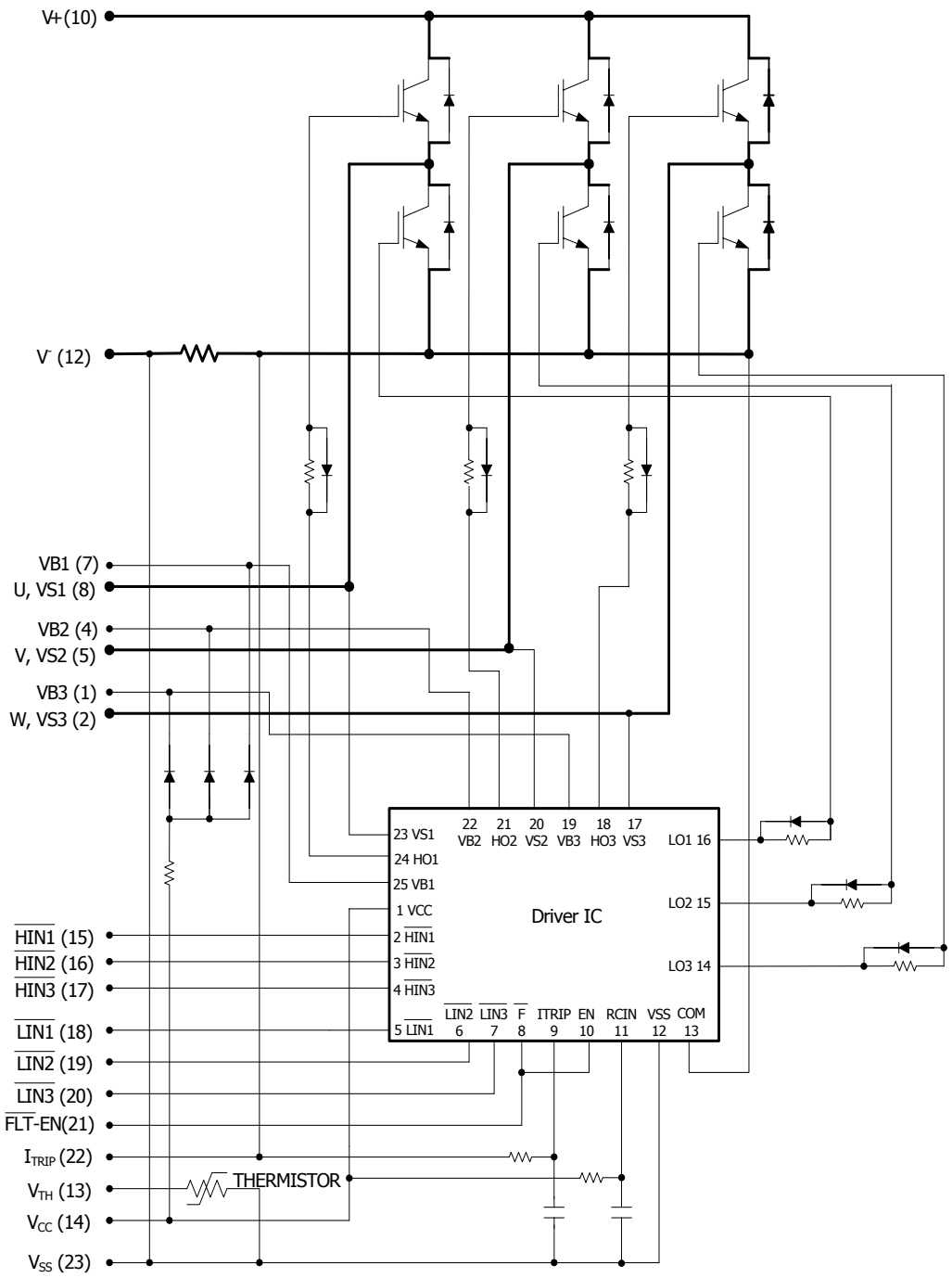



## Absolute Maximum Ratings

| Parameter | Description | Max. Value | Units |
|---|---|---|---|
| $V_{CES}$ | Maximum IGBT Blocking Voltage | 600 | V |
| $V^+$ | Positive Bus Input Voltage | 450 | |
| $I_o$ @ $T_C$=25°C | RMS Phase Current | 6 | A |
| $I_o$ @ $T_C$=100°C | RMS Phase Current | 3 | |
| $I_{pk}$ | Max Peak Phase Current (tp<100ms) (see Note 1) | 9 | |
| $F_p$ | Maximum PWM Carrier Frequency | 20 | kHz |
| $P_d$ | Maximum Power dissipation per Phase | 7.5 | W |
| $V_{iso}$ | Isolation Voltage (1min) | 2000 | $V_{RMS}$ |
| $T_{J\ (IGBT\ \&\ Diodes)}$ | Operating Junction temperature Range | -40 to +150 | °C |
| $T_{J\ (Driver\ IC)}$ | Operating Junction temperature Range | -40 to +150 | |
| T | Mounting torque Range (M3 screw) | 0.8 to 1.0 | Nm |

Note 1: Limited by current protection, see table "Inverter Section Electrical Characteristics" on page 3

## Internal Electrical Schematic - IRAMS06UP60B



## Inverter Section Electrical Characteristics @ $T_J$ = 25°C

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | --- | --- | V | $V_{IN}$=5V, $I_C$=250µA |
| $\Delta V_{(BR)CES}$ / $\Delta T$ | Temperature Coeff. Of Breakdown Voltage | --- | 0.3 | --- | V/°C | $V_{IN}$=5V, $I_C$=1.0mA (25°C - 150°C) |
| $V_{CE(ON)}$ | Collector-to-Emitter Saturation Voltage | --- | 1.9 | 2.4 | V | $I_C$=3A, $V_{DD}$=15V |
| | | --- | 2.2 | 2.6 | | $I_C$=3A, $V_{DD}$=15V, $T_J$=150°C |
| $I_{CES}$ | Zero Gate Voltage Collector-to-Emitter Current | --- | 15 | 45 | µA | $V_{IN}$=5V, $V^+$=600V |
| | | --- | 60 | 170 | | $V_{IN}$=5V, $V^+$=600V, $T_J$=150°C |
| $I_{lk_module}$ | Zero Gate Phase-to-Phase Current | -- | -- | 50 | µA | $V_{IN}$=5V, $V^+$=600V |
| $V_{FM}$ | Diode Forward Voltage Drop | --- | 1.45 | 1.85 | V | $I_C$=3A |
| | | --- | 1.25 | 1.65 | | $I_C$=3A, $T_J$=150°C |
| $I_{BUS_Trip}$ | Current Protection Threashold (positive going) | 8.5 | --- | 10.5 | A | $T_j$=-40°C to 150°C (Overcurrent duration ≥ 6µs) |

## Inverter Section Switching Characteristics @ $T_J$ = 25°C

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $E_{on}$ | Turn-On Switching Loss | --- | 130 | 235 | µJ | $I_C$=3A, $V^+$=400V |
| $E_{off}$ | Turn-Off Switching Loss | --- | 65 | 120 | | $V_{DD}$=15V, L=1mH |
| $E_{tot}$ | Total Switching Loss | --- | 195 | 355 | | See CT1 $T_J$=25°C |
| $E_{on}$ | Turn-on Swtiching Loss | --- | 200 | 345 | µJ | See CT1 $T_J$=150°C |
| $E_{off}$ | Turn-off Switching Loss | --- | 90 | 150 | | Energy losses include "tail" and |
| $E_{tot}$ | Total Switching Loss | --- | 290 | 495 | | diode reverse recovery |
| $E_{rec}$ | Diode Rev. Recovery energy | --- | 50 | 110 | µJ | $T_J$=150°C, $V^+$ =400V $V_{DD}$=15V, |
| $t_{rr}$ | Diode Reverse Recovery time | --- | 150 | 200 | ns | $I_F$=3A, L=1mH |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | $T_J$=150°C, $I_C$=3A, $V_P$=600V $V^+$=480V, $V_{DD}$=+15V to 0V See CT3 |
| SCSOA | Short Circuit Safe Operating Area | 10 | --- | --- | µs | $T_J$=150°C, $V_P$=600V, $V^+$=360V, $V_{DD}$=+15V to 0V See CT2 |

## Thermal Resistance

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $R_{th(J-C)}$ | Junction to case thermal resistance, each IGBT under inverter operation. | --- | --- | 6.5 | °C/W | Flat, greased surface. Heatsink compound thermal conductivity - 1W/mK |
| $R_{th(J-C)}$ | Junction to case thermal resistance, each Diode under inverter operation. | --- | --- | 9 | °C/W | |
| $R_{th(C-S)}$ | Case to sink thermal resistance | --- | 0.1 | --- | °C/W | |

## Absolute Maximum Ratings Driver Function

Absolute Maximum Ratings indicate substained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to $V_{SS}$ . (Note 2)

| Symbol | Definition | Min | Max | Units |
|---|---|---|---|---|
| $V_{S1,2,3}$ | High Side offset voltage | -0.3 | 600 | V |
| $V_{B1,2,3}$ | High Side floating supply voltage | -0.3 | 20 | V |
| $V_{DD}$ | Low Side and logic fixed supply voltage | -0.3 | 20 | V |
| $V_{IN}$ | Input voltage LIN, HIN, T/$I_{TRIP}$ | -0.3 | $V_{SS}$+15 | V |
| $T_J$ | Juction Temperature | -40 | 150 | °C |

## 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 $V_{SS}$. The $V_S$ offset is tested with all supplies biased at 15V differential (Note 2). All input pin ($V_{IN}$ ) and $I_{TRIP}$ are clamped with a 5.2V zener diode and pull-up resistor to $V_{DD}$.

| Symbol | Definition | Min | Max | Units |
|---|---|---|---|---|
| $V_{B1,2,3}$ | High side floating supply voltage | $V_S$+12 | $V_S$+20 | V |
| $V_{S1,2,3}$ | High side floating supply offset voltage | Note 3 | 450 | |
| $V_{DD}$ | Low side and logic fixed supply voltage | 12 | 20 | V |
| $V_{IN}$ | Logic input voltage LIN, HIN | $V_{SS}$ | $V_{SS}$+5 | V |

## Static Electrical Characteristics Driver Function

$V_{BIAS}$ ($V_{DD}$, $V_{BS1,2,3}$)=15V, unless otherwise specified. The $V_{IN}$ and $I_{IN}$ parameters are referenced to $V_{SS}$ and are applicable to all six channels. (Note 2)

| Symbol | Definition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| $V_{IN,th+}$ | Positive going input threshold | 3.0 | --- | --- | V |
| $V_{IN,th-}$ | Negative going input threshold | --- | --- | 0.8 | V |
| $V_{CCUV+}$<br>$V_{BSUV+}$ | $V_{CC}$ and $V_{BS}$ supply undervoltage<br>Positive going threshold | 10.6 | 11.1 | 11.6 | V |
| $V_{CCUV-}$<br>$V_{BSUV-}$ | $V_{CC}$ and $V_{BS}$ supply undervoltage<br>Negative going threshold | 10.4 | 10.9 | 11.4 | V |
| $V_{CCUVH}$<br>$V_{BSUVH}$ | $V_{CC}$ and $V_{BS}$ supply undervoltage<br>$I_{lockout}$ hysteresis | --- | 0.2 | --- | V |
| $I_{QBS}$ | Quiescent $V_{BS}$ supply current | --- | 70 | 120 | µA |
| $I_{QCC}$ | Quiscent $V_{CC}$ supply current | --- | 1.6 | 2.3 | mA |
| $I_{LK}$ | Offset Supply Leakage Current | --- | --- | 50 | µA |
| $I_{IN+}$ | Input bias current (OUT=LO) | --- | 100 | 220 | µA |
| $I_{IN+}$ | Input bias current (OUT=HI) | --- | 200 | 300 | µA |
| $V(I_{TRIP})$ | $I_{TRIP}$ threshold Voltage (OUT=HI or OUT=LO) | 0.44 | 0.49 | 0.54 | V |

## Dynamic Electrical Characteristics

$V_{DD}$=$V_{BS}$=$V_{BIAS}$=15V, $PWM_{IN}$=2kHz, $V_{IN_ON}$=$V_{IN_th+}$, $V_{IN_OFF}$=$V_{IN_th-}$
$T_A$=25°C, unless otherwise specified

| Symbol | Definition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| $T_{ON}$ | Input to output propagation turn-on delay time (see fig.11) | - | 470 | - | ns |
| $T_{OFF}$ | Input to output propagation turn-off delay time (see fig. 11) | - | 615 | - | ns |
| $D_T$ | Dead Time | - | 290 | - | ns |
| $I/T_{Trip}$ | $T/I_{Trip}$ to six switch to turn-off propagation delay (see fig. 2) | - | 750 | - | ns |
| $T_{FCLTRL}$ | Post $I_{Trip}$ to six switch to turn-off clear time (see fig. 2) | - | 9 | - | ms |

## Internal NTC - Thermistor Characteristics

| Parameter | | Typ | Units | Conditions |
|---|---|---|---|---|
| $R_{25}$ | Resistance | 100 +/- 3% | kΩ | $T_C$ = 25°C |
| $R_{125}$ | Resistance | 2.522 ±10.9% | kΩ | $T_C$ = 125°C |
| B | B-constant (25-50°C) | 4250 +/- 2% | k | $R_2 = R_1 e^{[B(1/T2 - 1/T1)]}$ |
| Temperature Range | | -40 / 125 | °C | |
| Typ. Dissipation constant | | 1 | mW/°C | $T_C$ = 25°C |

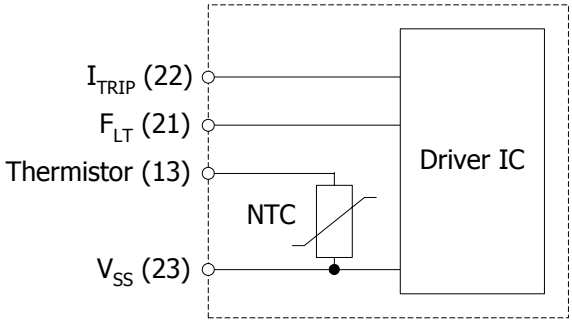
## Internal Current Sensing Resistor - Shunt Characteristics

| Parameter | | Units |
|---|---|---|
| Resistance | 50 ±1% | mΩ |
| Tollerance | ±1% | |
| Max Power Dissipation | 1.5 | W |
| Temperature Range | -40 / 125 | °C |

Note 2: For more details, see IR21363 data sheet

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

### Thermistor Built-in IRAMS06UP60B




Note 4: The Maximum recommended sense voltage at the $I_{TRIP}$ terminal under normal operating conditions is 3.3V.

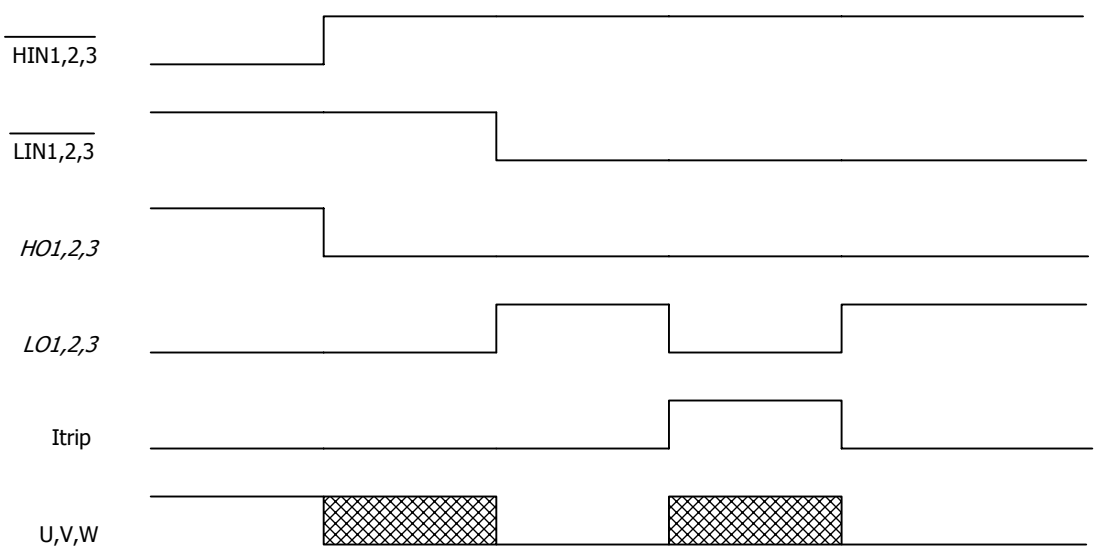
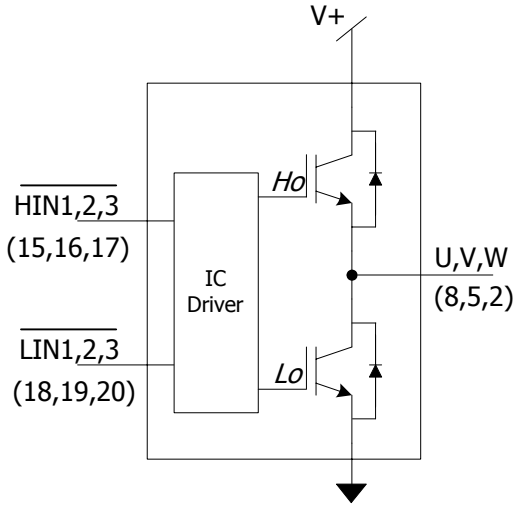
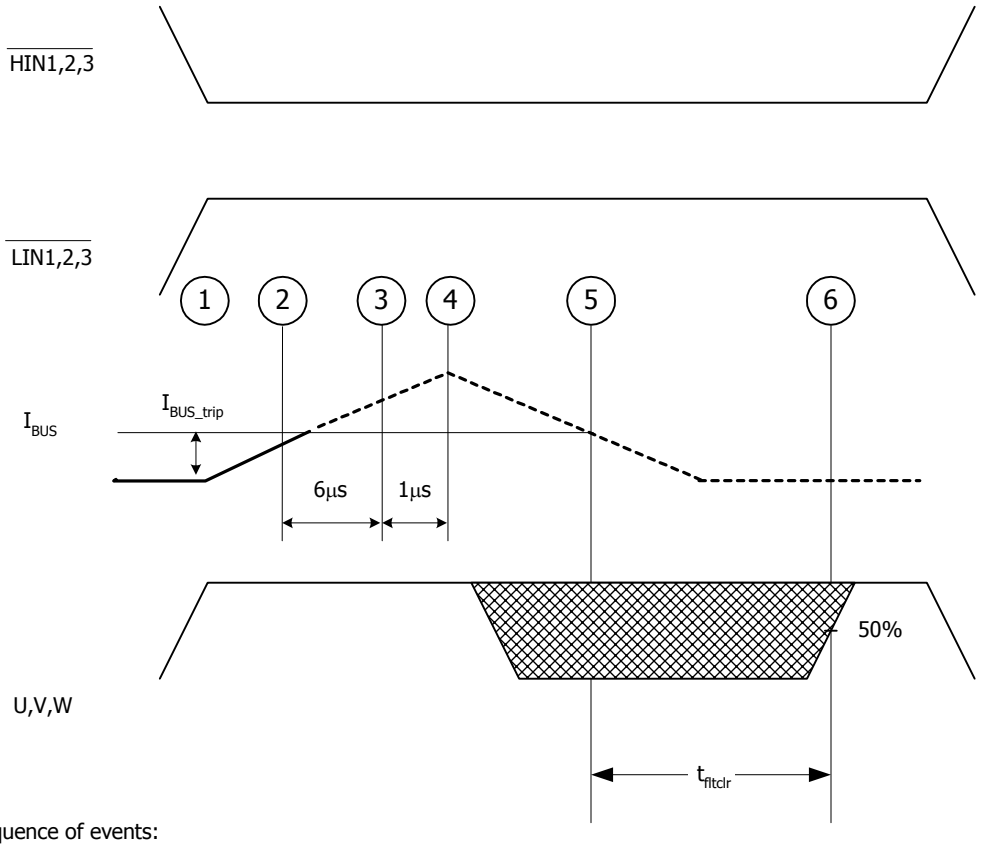



Figure1. Input/Output Timing Diagram

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.




| Itrip | $\overline{\text{HIN1,2,3}}$ | $\overline{\text{LIN1,2,3}}$ | U,V,W |
|---|---|---|---|
| 0 | 0 | 1 | V+ |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | X |
| 1 | X | X | X |




Sequence of events:
1-2) Current begins to rise
2) Current reaches $I_{BUS_Trip}$ level
2-3) Current is higher than $I_{BUS_Trip}$ for at least 6µs. This value is the worst-case condition with very low over-current. In case of high current (short circuit), the actual delay will be smaller.
3-4) Delay between driver identification of over-current condition and disabling of all outputs
4) Current starts decreasing, eventually reaching 0
5) Current goes below $I_{BUS_trip}$, the driver starts its auto-reset sequence
6) Driver is automatically reset and normal operation can resume (over-current condition must be removed by the time the drivers automatically resets itself)

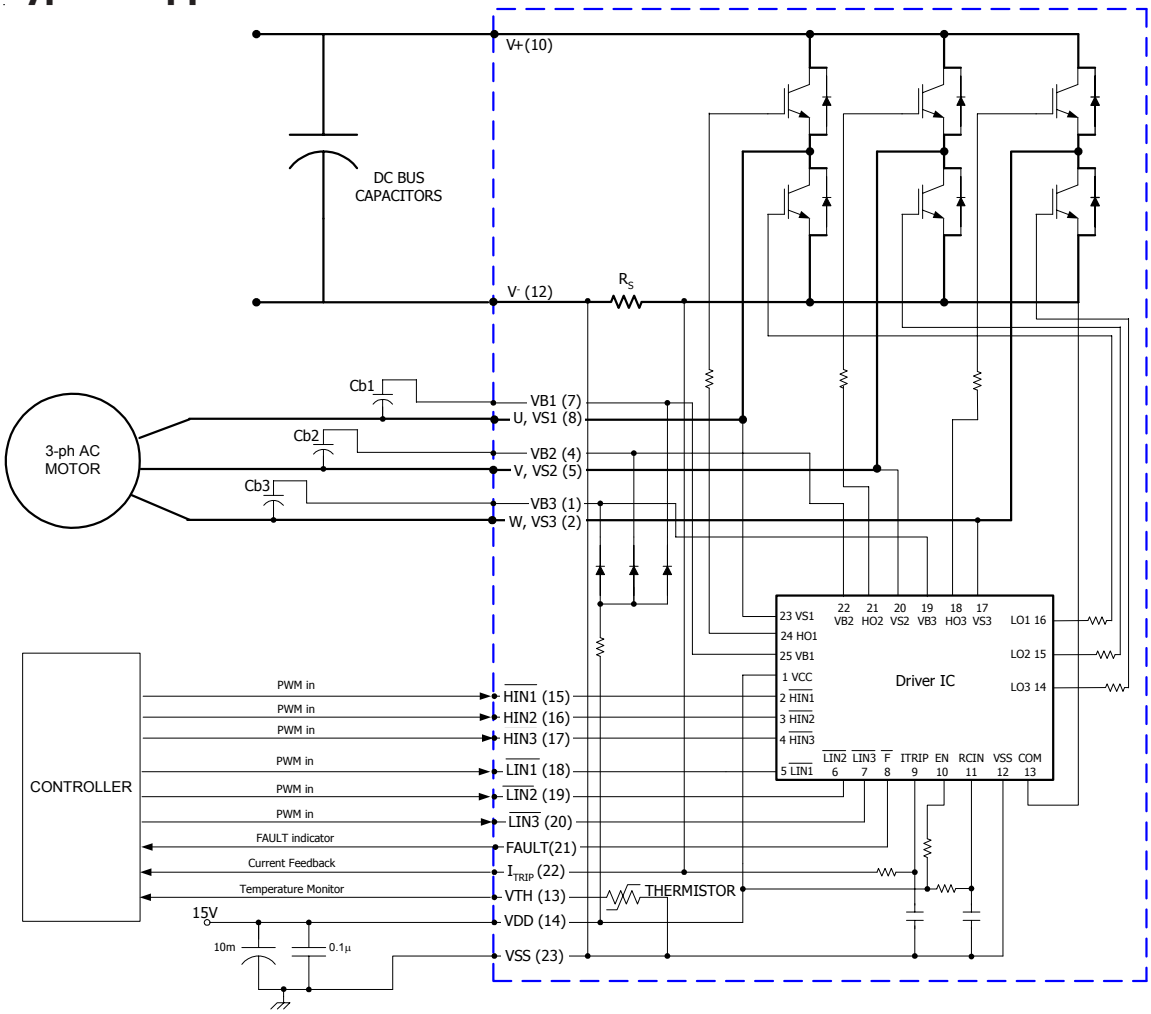
Figure 2. $I_{Trip}$ Timing Waveform

Note 6: 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 | $V_{B3}$ | High Side Floating Supply Voltage 3 |
| 2 | W,$V_{S3}$ | Output 3 - High Side Floating Supply Offset Voltage |
| 3 | NA | none |
| 4 | $V_{B2}$ | High Side Floating Supply voltage 2 |
| 5 | V,$V_{S2}$ | Output 2 - High Side Floating Supply Offset Voltage |
| 6 | NA | none |
| 7 | $V_{B1}$ | High Side Floating Supply voltage 1 |
| 8 | U, $V_{S1}$ | Output 1 - High Side Floating Supply Offset Voltage |
| 9 | NA | none |
| 10 | $V^+$ | Positive Bus Input Voltage |
| 11 | NA | none |
| 12 | $V^-$ | Negative Bus Input Voltage |
| 13 | $V_{TH}$ | Temperature Feedback |
| 14 | $V_{CC}$ | +15V Main Supply |
| 15 | $\overline{H_{IN1}}$ | Logic Input High Side Gate Driver - Phase 1 |
| 16 | $\overline{H_{IN2}}$ | Logic Input High Side Gate Driver - Phase 2 |
| 17 | $\overline{H_{IN3}}$ | Logic Input High Side Gate Driver - Phase 3 |
| 18 | $\overline{L_{IN1}}$ | Logic Input Low Side Gate Driver - Phase 1 |
| 19 | $\overline{L_{IN2}}$ | Logic Input Low Side Gate Driver - Phase 2 |
| 20 | $\overline{L_{IN3}}$ | Logic Input Low Side Gate Driver - Phase 3 |
| 21 | $\overline{FLT}$/Enable | Fault Output and Enable Pin |
| 22 | $I_{TRIP}$ | Current Sense and Itrip Pin |
| 23 | $V_{SS}$ | Negative Main Supply |

## Typical Application Connection IRAMS06UP60B




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 $V_{CC}$-Gnd and $V_B$-$V_{SS}$ terminals, 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 9.

4. Current sense signal can be obtained from pin 22 and pin 23

5. After approx. 9 ms the FAULT is reset

6.PWM generator must be disabled within Fault duration to garantee shutdown of the system, overcurrent condition must be cleared before resuming operation

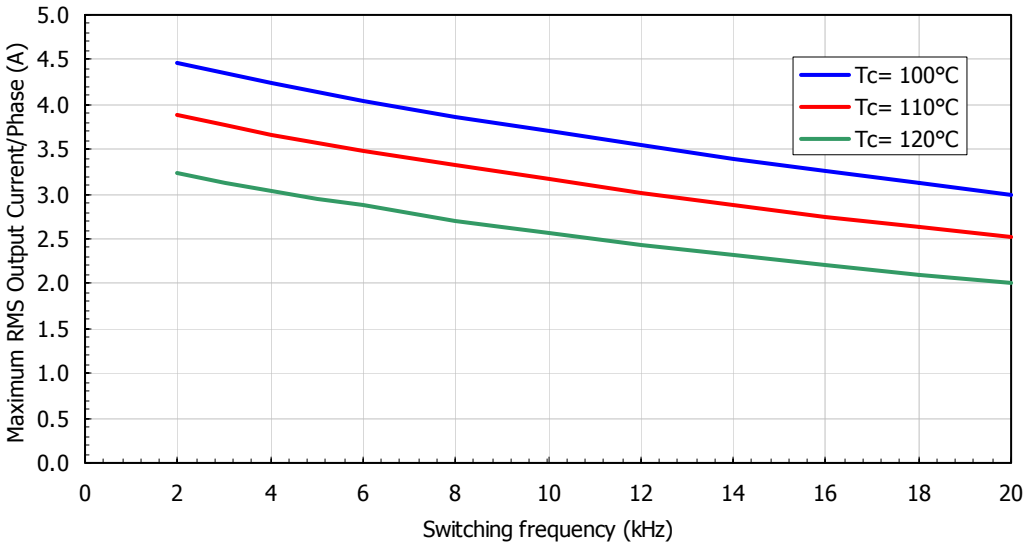



Figure 3. Maximum sinusoidal phase current as function of switching frequency
V+ = 400V, $T_j$=150°C, Modulation Depth=0.8, PF=0.6

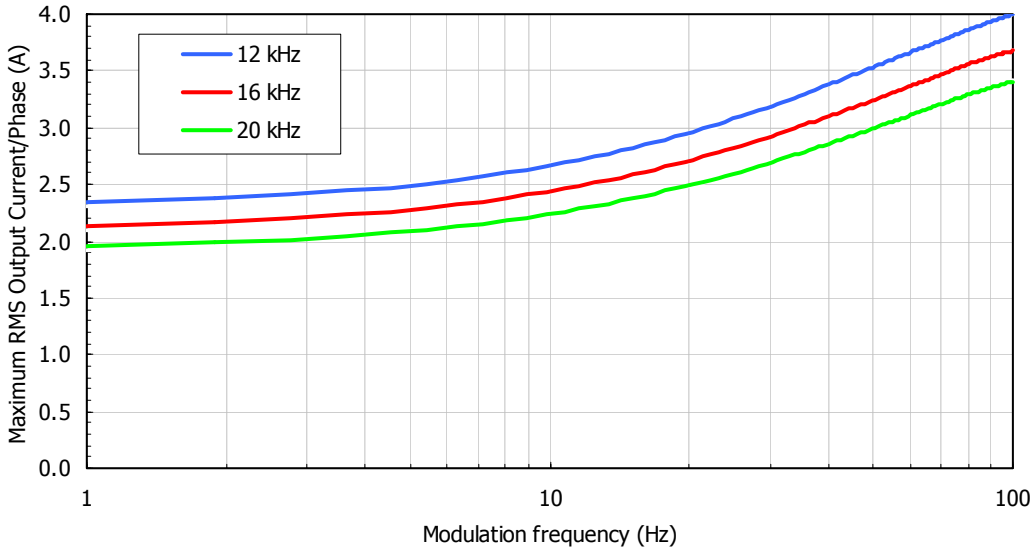



Figure 4. Maximum sinusoidal phase current as function of modulation frequency
V+=400V, $T_j$=150°C, $T_c$=100°C, Modulation Depth=0.8, PF=0.6

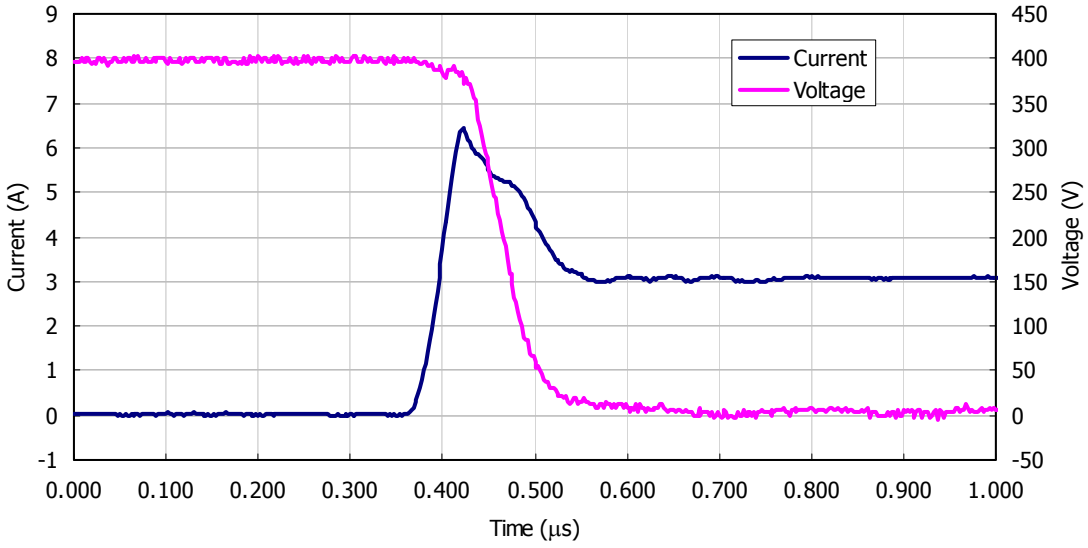



Figure 5. IGBT Turn-on. Typical turn-on waveform @$T_j$=125°C, V+=400V

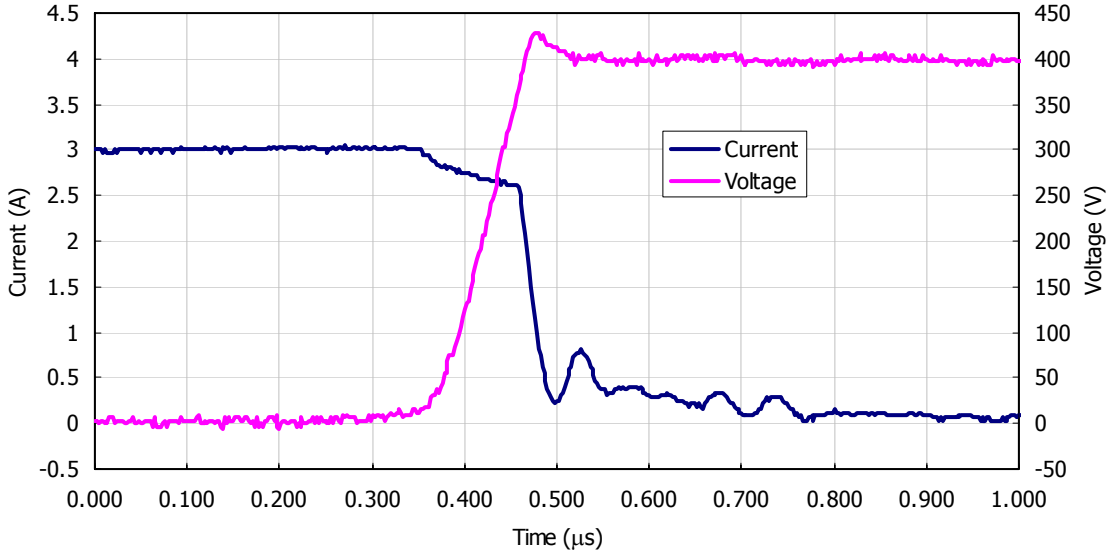



Figure 6. IGBT Turn-off. Typical turn-off waveform @$T_j$=125°C, V+=400V

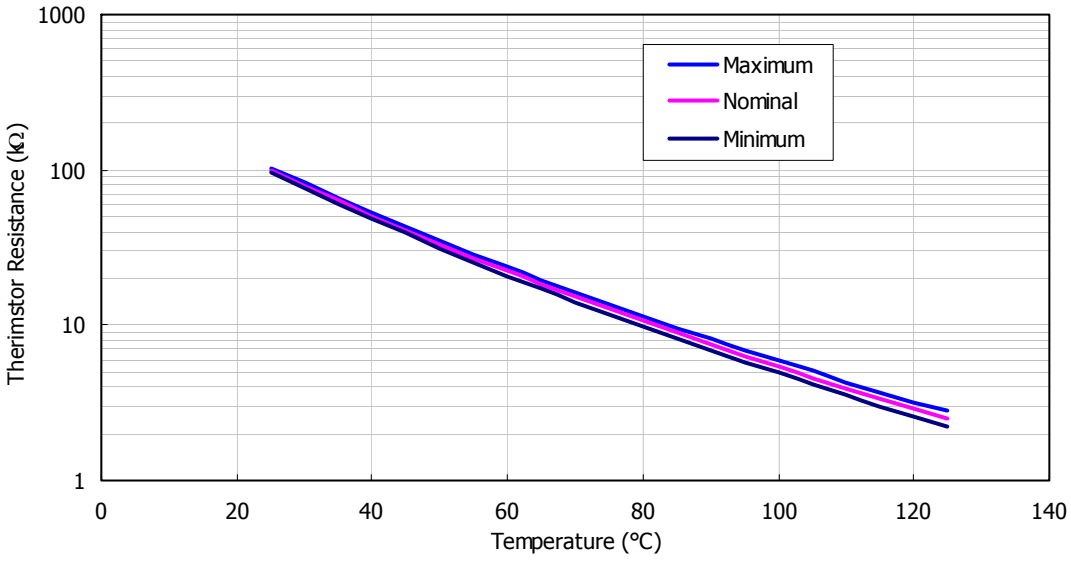



Figure 7. Variation of thermistor resistance with temperature

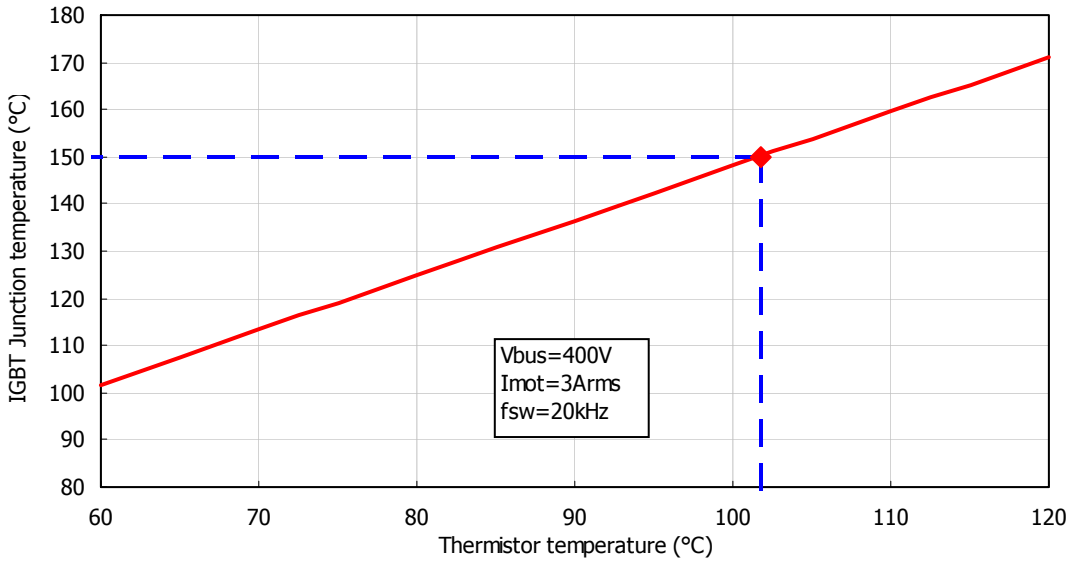



Figure 8. Estimated maximum IGBT junction temperature with thermistor temperature

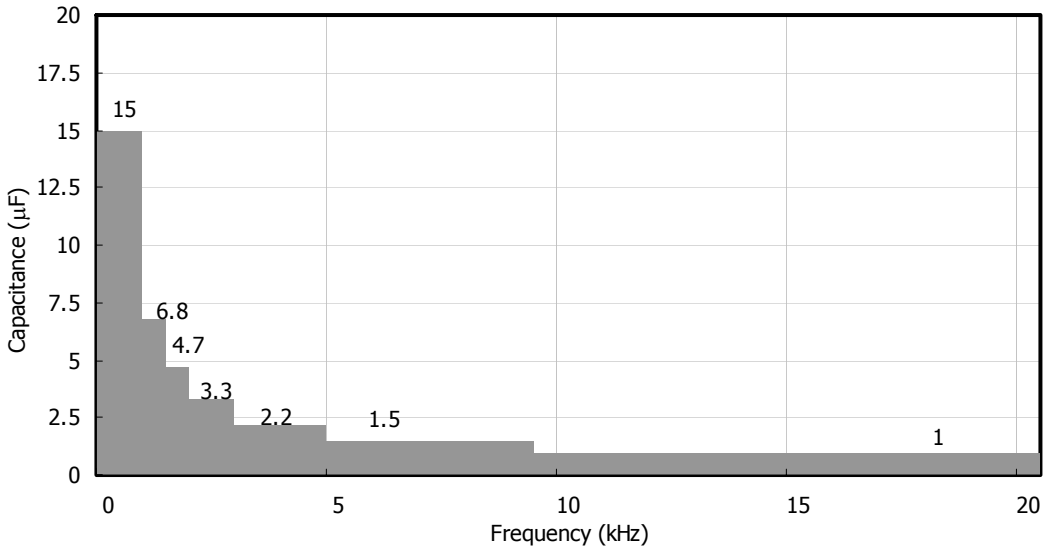



Figure 9. Recommended minimum Bootstrap Capacitor value Vs Switching Frequency

Figure 11. Switching Parameter Definitions

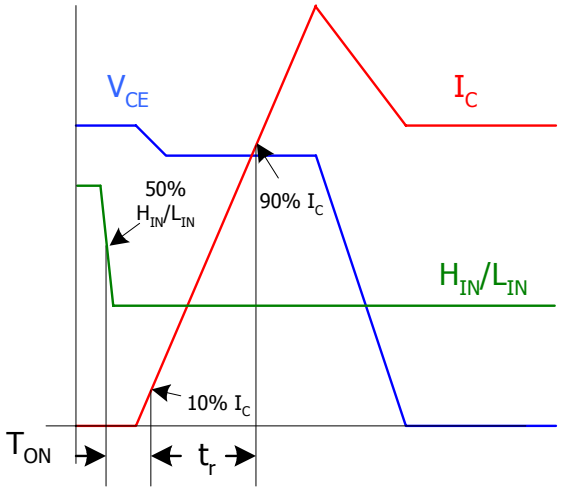



Figure 11a. Input to Output propagation turn-on delay time

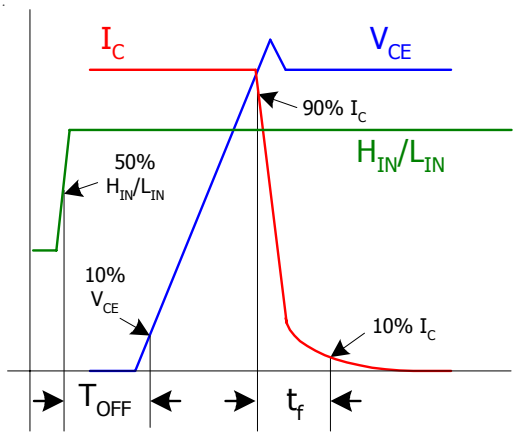



Figure 11b. Input to Output propagation turn-off delay time

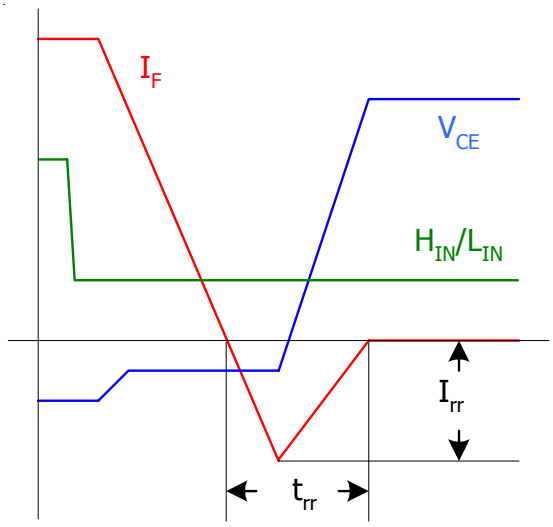



Figure 11c. Diode Reverse Recovery

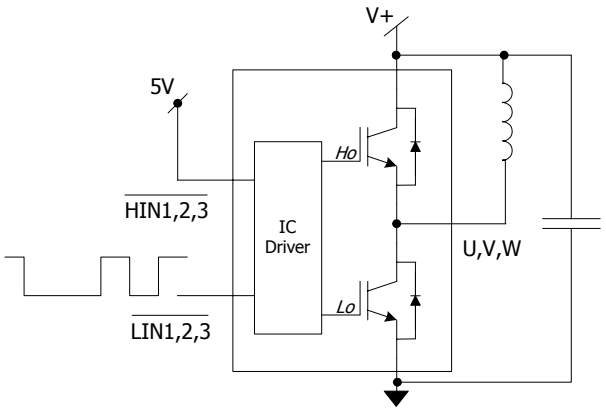
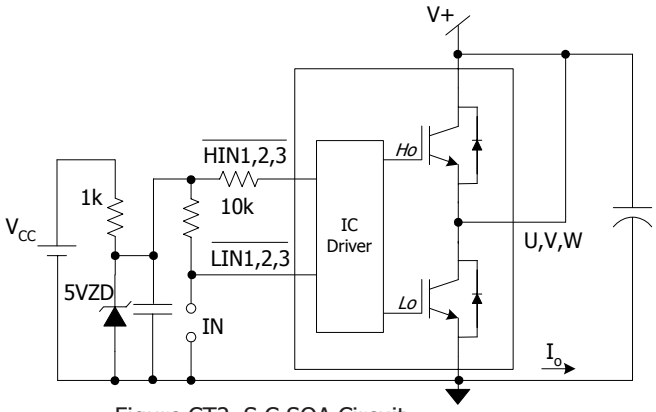
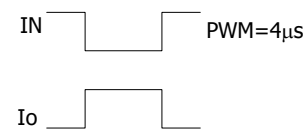


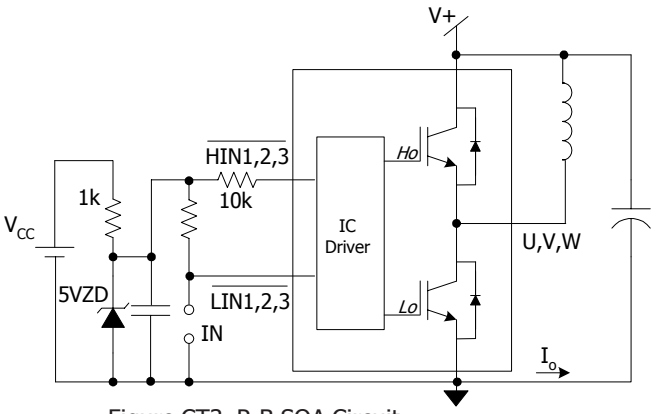

Figure CT1. Switching Loss Circuit

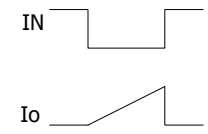



$V_P$=Peak Voltage on the IGBT die

Figure CT2. S.C.SOA Circuit

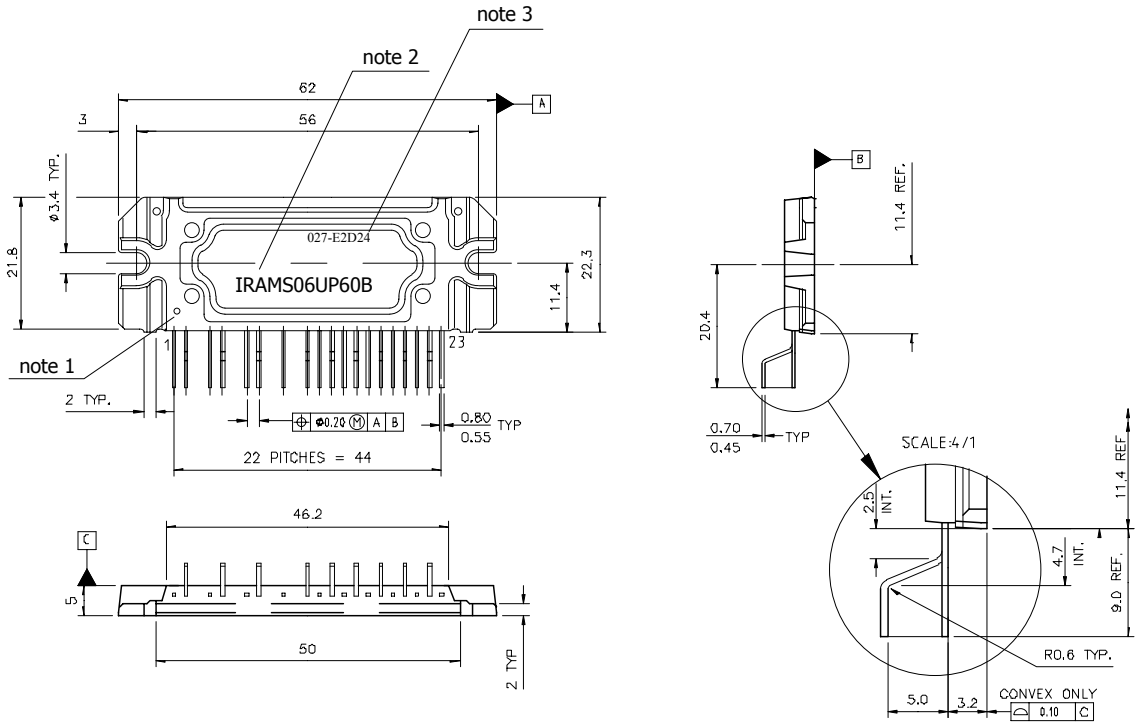



$V_P$=Peak Voltage on the IGBT die

Figure CT3. R.B.SOA Circuit

## Package Outline

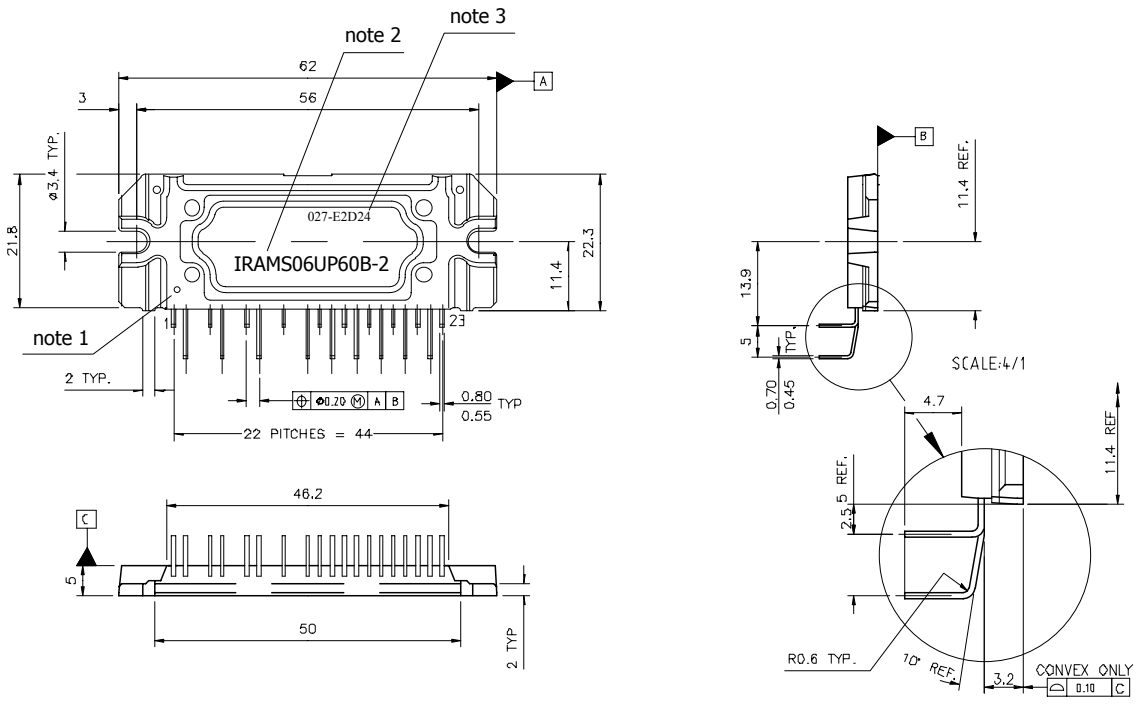



Standard pin leadforming option

Notes:
Dimensions in mm
1- Marking for pin 1 identification
2- Product Part Number
3- Lot and Date code marking

For mounting instruction, see AN1049

## Package Outline




Pin leadforming option -2

Notes:
Dimensions in mm
1- Marking for pin 1 identification
2- Product Part Number
3- Lot and Date code marking

Data and Specifications are subject to change without notice

International
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гарантия бесперебойности производства и качества выпускаемой продукции

## О компании

ООО "ТрейдЭлектроникс" - это оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов. Реализуемая нашей компанией продукция насчитывает более полумиллиона наименований.

Благодаря этому наша компания предлагает к поставке практически не ограниченный ассортимент компонентов как оптовыми, мелкооптовыми партиями, так и в розницу.

Наличие собственной эффективной системы логистики обеспечивает надежную поставку продукции по конкурентным ценам в точно указанные сроки.

Срок поставки со стоков в **Европе и Америке – от 3 до 14 дней.**

Срок поставки из **Азии – от 10 дней.**

Благодаря развитой сети поставщиков, помогаем в поиске и приобретении экзотичных или снятых с производства компонентов.

Предоставляем спец цены на элементы для создания инженерных сэмплов.

**Упорный труд, качественный результат дают нам право быть уверенными в себе и надежными для наших клиентов.**

## Наша компания это:

- Гарантия качества поставляемой продукции
- Широкий ассортимент
- Минимальные сроки поставок
- Техническая поддержка
- Подбор комплектации
- Индивидуальный подход
- Гибкое ценообразование

Наша организация особенно сильна в поставках модулей, микросхем, пассивных компонентов, ксайленсах (XC), EPF, EPM и силовой электроники.

Большой выбор предлагаемой продукции, различные виды оплаты и доставки, позволят Вам сэкономить время и получить максимум выгоды от сотрудничества с нами!

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## Перечень производителей, продукцию которых мы поставляем на российский рынок



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С удовольствием будем прорабатывать для Вас поставки всех необходимых компонентов по текущим запросам для скорейшего выявления групп элементов, по которым сотрудничество именно с нашей компанией будет для Вас максимально выгодным!

С уважением,

Менеджер отдела продаж ООО

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