

IRAMS10UP60B •MOTION[™] Series 10A, 600V

Integrated Power Hybrid IC for Appliance Motor Drive Applications.

with Internal Shunt Resistor

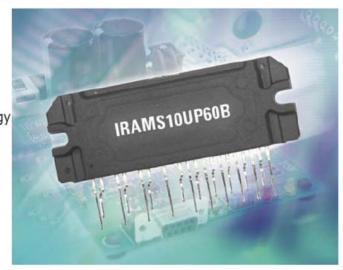
International Rectifier's IRAMS10UP60B is an Integrated Power Module developed and optimized for electronic motor control in appliance applications such as washing machines and refrigerators. Plug N Drive technology offers an extremely compact, high performance AC motor-driver in a single isolated package for a very simple design. An internal shunt is also included and offers easy current feedback and overcurrent monitor for precise 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

RoHS Compliant

Description

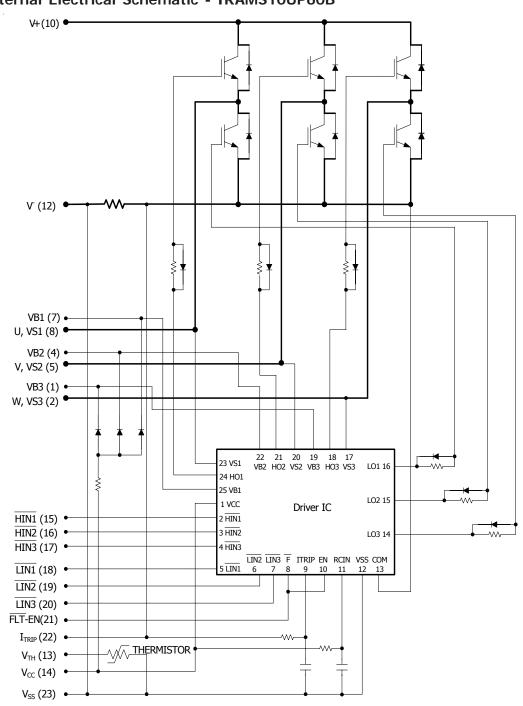
- · Internal Shunt Resistor
- Integrated Gate Drivers and Bootstrap Diodes
- Temperature Monitor
- · Fully Isolated Package
- Low V_{CE(on)} Non Punch Through IGBT Technology
- · Undervoltage lockout for all channels
- Matched propagation delay for all channels
- · Schmitt-triggered input logic
- · Cross-conduction prevention logic
- Lower di/dt gate driver for better noise immunity
- Motor Power range 0.4~0.75kW / 85~253 Vac
- Isolation $2000V_{RMS}/1$ min and CTI > 600V
- · UL certification pending (UL number: E78996)



Absolute Maximum Ratings

Parameter	Description	Values	Units
V _{CES} / V _{RRM}	IGBT/Diode Blocking Voltage	600	V
V ⁺	Positive Bus Input Voltage	450	
I _O @ T _C =25°C	RMS Phase Current (Note 1)	10	
I _O @ T _C =100°C	RMS Phase Current (Note 1)	5	Α
Io	Pulsed RMS Phase Current (Note 2)	15	
F _{PWM}	PWM Carrier Frequency	20	kHz
P_D	Power dissipation per IGBT @ TC =25°C	27	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	
Т	Mounting torque Range (M3 screw)	0.5 to 1.0	Nm

Internal Electrical Schematic - IRAMS10UP60B





Absolute Maximum Ratings (Continued)

Symbol	Parameter	Min	Max	Units	Conditions
I_{BDF}	Bootstrap Diode Peak Forward Current		4.5	Α	t _P = 10ms, T _J = 150°C, T _C =100°C
P _{BR Peak}	Bootstrap Resistor Peak Power (Single Pulse)		80	W	t_P =100 μ s, T_C =100 $^{\circ}$ C ESR / ERJ series
V _{S1,2,3}	High side floating supply offset voltage	V _{B1,2,3} - 25	V _{B1,2,3} +0.3	٧	
V _{B1,2,3}	High side floating supply voltage	-0.3	600	٧	
V _{CC}	Low Side and logic fixed supply voltage	-0.3	20	٧	
V_{IN} , V_{EN} , V_{ITRIP}	Input voltage LIN, HIN, EN, I_{Trip}	-0.3	Lower of (V _{SS} +15V) or V _{CC} +0.3V	٧	

Inverter Section Electrical Characteristics @T_J= 25°C

Symbol	Parameter	Min	Тур	Max	Units	Conditions
V _{(BR)CES}	Collector-to-Emitter Breakdown Voltage	600			V	V _{IN} =5V, I _C =250μA
$\Delta V_{(BR)CES}$ / ΔT	Temperature Coefficient of Breakdown Voltage		0.57		V/°C	V _{IN} =5V, I _C =1.0mA (25°C - 150°C)
V _{CE(ON)}	Collector-to-Emitter Saturation		1.70	2.00	V	$I_C=5A$, $V_{CC}=15V$
VCE(ON)	Voltage		2.00	2.40	\ \ \	$I_{C}=5A$, $V_{CC}=15V$, $T_{J}=150$ °C
T	Zero Gate Voltage Collector		5	80	μA	V _{IN} =5V, V ⁺ =600V
I _{CES}	Current		10		μΑ	V _{IN} =5V, V ⁺ =600V, T _J =150°C
V _{FM}	Diada Farward Voltago Drop		1.80	2.35	V	I _C =5A
V FM	Diode Forward Voltage Drop		1.30	1.70	\ \ \	I _C =5A, T _J =150°C
V	Bootstrap Diode Forward Voltage			1.25	V	I _F =1A
V_{BDFM}	Drop			1.10	\ \ \	I _F =1A, T _J =150°C
R _{BR}	Bootstrap Resistor Value		2		Ω	T _J =25°C
$\Delta R_{BR}/R_{BR}$	Bootstrap Resistor Tolerance			±5	%	T _J =25°C
I _{BUS_TRIP}	Current Protection Threshold (positive going)	13.1		16.4	Α	T_J =-40°C to 125°C See fig. 2



Inverter Section Switching Characteristics @ T_J= 25°C

Symbol	Parameter	Min	Тур	Max	Units	Conditions	
E _{ON}	Turn-On Switching Loss		200	235		I _C =5A, V ⁺ =400V	
E _{OFF}	Turn-Off Switching Loss		75	100	1	V _{CC} =15V, L=2mH	
E _{TOT}	Total Switching Loss		275	335	μJ	Energy losses include "tail" and diode reverse recovery	
E _{REC}	Diode Reverse Recovery energy		15	25		diode reverse recovery	
t _{RR}	Diode Reverse Recovery time		70	100	ns	See CT1	
E _{ON}	Turn-On Switching Loss		300	360		I _C =5A, V ⁺ =400V	
E _{OFF}	Turn-off Switching Loss		135	165		V _{CC} =15V, L=2mH, T _J =150°C	
Етот	Total Switching Loss		435	525	μЈ	Energy losses include "tail" and diode reverse recovery	
E _{REC}	Diode Reverse Recovery energy		30	40		diode reverse recovery	
t _{RR}	Diode Reverse Recovery time		100	145	ns	See CT1	
Q_G	Turn-On IGBT Gate Charge		29	44	nC	I _C =15A, V ⁺ =400V, V _{GE} =15V	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE			T_J =150°C, I_C =5A, V_P =600V V^+ = 450V V_{CC} =+15V to 0V See CT3		
SCSOA	Short Circuit Safe Operating Area	10			μs	$T_J=150$ °C, $V_P=600$ V, $V^+=360$ V, $V_{CC}=+15$ V to 0V See CT2	
I _{CSC}	Short Circuit Collector Current		47		А	T_J =150°C, V_P =600V, t_{SC} <10 μ s V^+ = 360V, V_{GE} =15V V_{CC} =+15V to 0V See CT2	

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 recommende conditions. All voltages are absolute referenced to COM/ I_{TRIP} . The V_S offset is tested with all supplies biased at 15V differential (Note 3)

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 4	450	v
V _{CC}	Low side and logic fixed supply voltage	12	20	V
V _{ITRIP}	I _{TRIP} input voltage	V _{SS}	V _{SS} +5	v
V _{IN}	Logic input voltage LIN, HIN	V _{SS}	V _{SS} +5	V
V _{EN}	Logic input voltage EN	V _{SS}	V _{SS} +5	V

Note 3: For more details, see IR21363 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, unless otherwise specified. The V_{IN} and I_{IN} parameters are referenced to COM/ I_{TRIP} and are applicable to all six channels. (Note 3)

Symbol	Definition	Min	Тур	Max	Units
V _{INH} , V _{ENH}	Logic "0" input voltage	3.0			V
V _{INL} , V _{ENL}	Logic "1" input voltage			0.8	V
V _{CCUV+} , V _{BSUV+}	V _{CC} and V _{BS} supply undervoltage Positive going threshold	10.6	11.1	11.6	V
V _{CCUV-} , V _{BSUV-}	V _{CC} and V _{BS} supply undervoltage Negative going threshold	10.4	10.9	11.4	V
V _{CCUVH} , V _{BSUVH}	V _{CC} and V _{BS} supply undervoltage lock-out hysteresis		0.2		V
$V_{IN,Clamp}$	Input Clamp Voltage (HIN, LIN, I_{TRIP}) I_{IN} =10 μ A	4.9	5.2	5.5	V
I_{QBS}	Quiescent V _{BS} supply current V _{IN} =0V			165	μΑ
I_{QCC}	Quiescent V _{CC} supply current V _{IN} =0V			3.35	mA
I _{LK}	Offset Supply Leakage Current			60	μΑ
I _{IN+} , I _{EN+}	Input bias current V _{IN} =5V		200	300	μΑ
I _{IN-} , I _{EN-}	Input bias current V _{IN} =0V		100	220	μΑ
I _{TRIP+}	I _{TRIP} bias current V _{ITRIP} =5V		30	100	μΑ
I _{TRIP-}	I _{TRIP} bias current V _{ITRIP} =0V		0	1	μΑ
V(I _{TRIP})	I _{TRIP} threshold Voltage	440	490	540	mV
V(I _{TRIP} , HYS)	I _{TRIP} Input Hysteresis		70		mV
R _{ON} ,FLT	Fault Output ON Resistance		50	100	ohm

Dynamic Electrical Characteristics

Driver only timing unless otherwise specified.)

Symbol	Parameter	Min	Тур	Max	Units	Conditions	
T _{ON}	Input to Output propagation turn- on delay time (see fig.11)		590		ns	V _{CC} =V _{BS} = 15V, I _C =10A, V ⁺ =400V	
T _{OFF}	Input to Output propagation turn- off delay time (see fig. 11)		700		ns	VCC-VBS- 13V, 1C-10A, V -400V	
T _{FLIN}	Input Filter time (HIN, LIN)	100	200		ns	V _{IN} =0 & V _{IN} =5V	
T _{BLT-Trip}	I _{TRIP} Blancking Time	100	150		ns	V _{IN} =0 & V _{IN} =5V	
D_T	Dead Time (V _{BS} =V _{DD} =15V)	220	290	360	ns	$V_{BS}=V_{CC}=15V$	
M _T	Matching Propagation Delay Time (On & Off)		40	75	ns	$V_{CC} = V_{BS} = 15V$, external dead time > 400ns	
T _{ITrip}	I _{Trip} to six switch to turn-off propagation delay (see fig. 2)			1.75	μs	V _{CC} =V _{BS} = 15V, I _C =10A, V ⁺ =400V	
T	Post I _{Trip} to six switch to turn-off		7.7		mc	T _C = 25°C	
T _{FLT-CLR}	clear time (see fig. 2)		6.7		ms	T _C = 100°C	



Thermal and Mechanical Characteristics

Symbol	Parameter	Min	Тур	Max	Units	Conditions
R _{th(J-C)}	Thermal resistance, per IGBT		4.2	4.7		Flat, greased surface. Heatsink
R _{th(J-C)}	Thermal resistance, per Diode		5.5	6.5		compound thermal conductivity
R _{th(C-S)}	Thermal resistance, C-S		0.1			1W/mK
C _D	Creepage Distance	3.2			mm	See outline Drawings

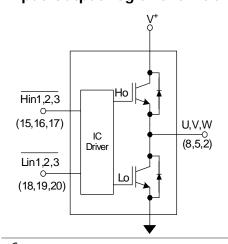
Internal Current Sensing Resistor - Shunt Characteristics

Symbol	Parameter	Min	Тур	Max	Units	Conditions
R _{Shunt}	Resistance	33.0	33.3	33.7	mΩ	T _C = 25°C
T _{Coeff}	Temperature Coefficient	0		200	ppm/°C	
P _{Shunt}	Power Dissipation			2.2	W	-40°C< T _C <100°C
T _{Range}	Temperature Range	-40		125	°C	

Internal NTC - Thermistor Characteristics

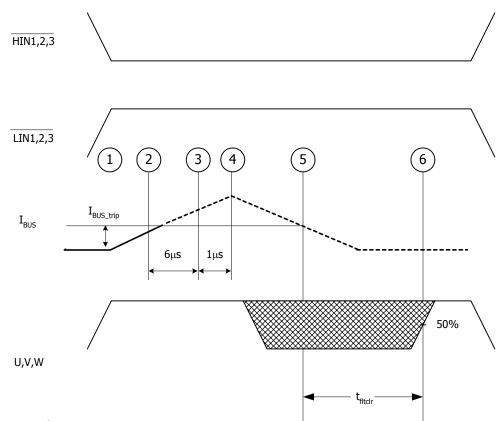
Parameter	Definition	Min	Тур	Max	Units	Conditions	
R ₂₅	Resistance	97	100	103	kΩ	T _C = 25°C	
R ₁₂₅	Resistance	2.25	2.52	2.80	kΩ	T _C = 125°C	
В	B-constant (25-50°C)	4165	4250	4335	k	$R_2 = R_1 e^{[B(1/T2 - 1/T1)]}$	
Temperature Range		-40		125	°C		
Typ. Dissipation constant			1		mW/°C	T _C = 25°C	

Input-Output Logic Level Table



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





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 $I_{\text{BUS trip'}}$ 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 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.



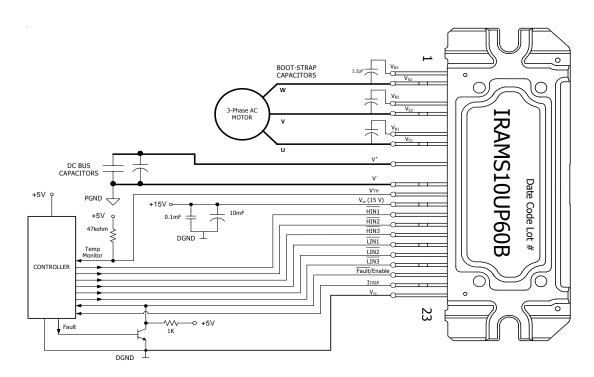
Module Pin-Out Description

Pin	Name	Description
1	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	H _{IN1}	Logic Input High Side Gate Driver - Phase 1
16	H _{IN2}	Logic Input High Side Gate Driver - Phase 2
17	H _{IN3}	Logic Input High Side Gate Driver - Phase 3
18	L _{IN1}	Logic Input Low Side Gate Driver - Phase 1
19	L _{IN2}	Logic Input Low Side Gate Driver - Phase 2
20	L _{IN3}	Logic Input Low Side Gate Driver - Phase 3
21	FLT/Enable	Fault Output and Enable Pin
22	I _{TRIP}	Current Sense and Itrip Pin
23	V _{SS}	Negative Main Supply





Typical Application Connection IRAMS10UP60B



- 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 $V_{B1,2,3}$ - $V_{S1,2,3}$ 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 V_{CC} . (see maximum ratings Table on page 3).
- 4. Current sense signal can be obtained from pin 22 and pin 23. Care should be taken to avoid having inverter current flowing through pin 22 to mantain required current measurement accuracy.
- 5. After approx. 8ms the FAULT is reset. (see Dynamic Characteristics Table on page 5).
- 6. PWM generator must be disabled within Fault duration to garantee shutdown of the system, overcurrent condition must be cleared before resuming operation.
- 7. Fault/Enable pin must be pulled-up to +5V.

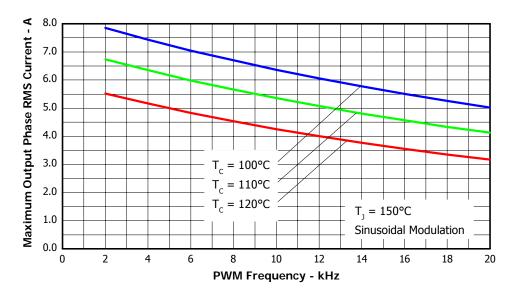


Figure 3. Maximum Sinusoidal Phase Current vs. PWM Switching Frequency V^+ =400V , T_3 =150°C, Modulation Depth=0.8, PF=0.6

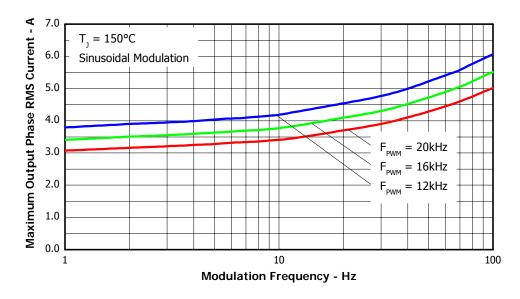


Figure 4. Maximum Sinusoidal Phase Current vs. Modulation Frequency $V^+=400V$, $T_1=150$ °C, $T_C=100$ °C, Modulation Depth=0.8, PF=0.6

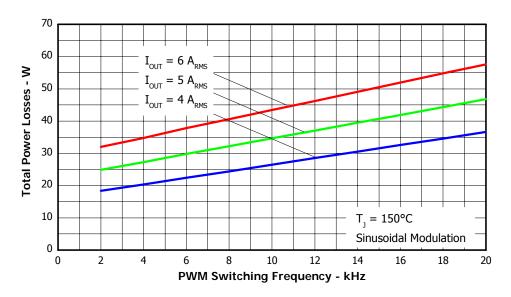


Figure 5. Total Power Losses vs. PWM Switching Frequency, Sinusoidal modulation $V^{+}{=}400V\ ,\ T_{J}{=}150^{\circ}C,\ Modulation\ Depth{=}0.8,\ PF{=}0.6$

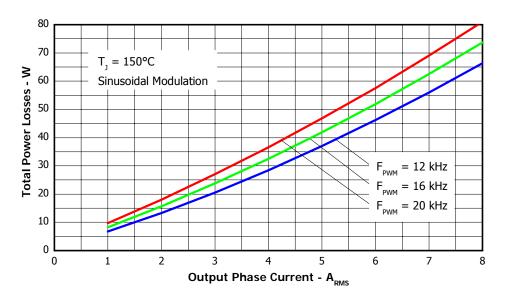


Figure 6. Total Power Losses vs. Output Phase Current, Sinusoidal modulation V_{BUS} =400V , T_{J} =150°C, Modulation Depth=0.8, PF=0.6

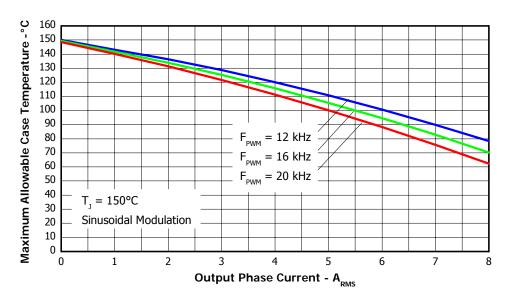


Figure 7. Maximum Allowable Case temperature vs. Output RMS Current per Phase

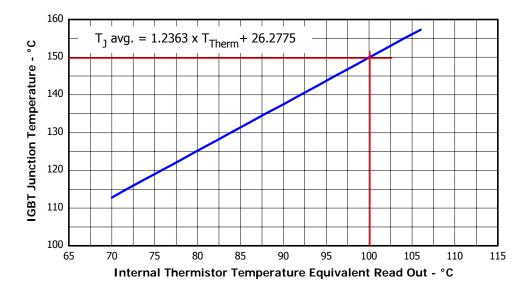


Figure 8. Estimated Maximum IGBT Junction Temperature vs. Thermistor Temperature

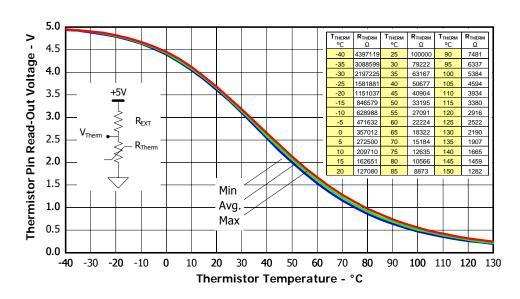


Figure 9. Thermistor Readout vs. Temperature (47kohm pull-up resistor, 5V) and Nominal Thermistor Resistance values vs. Temperature Table.

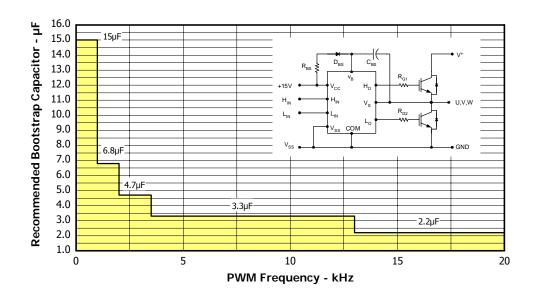


Figure 10. Recommended Bootstrap Capacitor Value vs. Switching Frequency

Figure 11. Switching Parameter Definitions

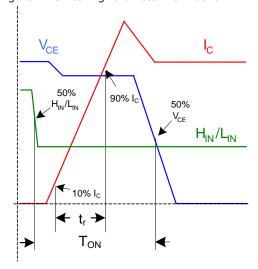


Figure 11a. Input to Output Propagation turn-on Delay Time

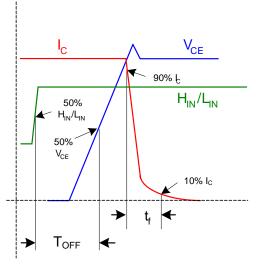


Figure 11b. Input to Output Propagation turn-off Delay Time

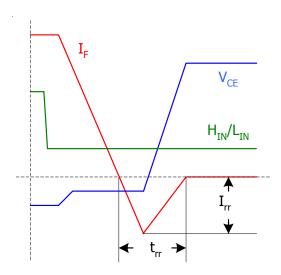
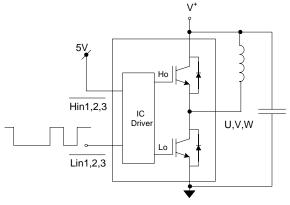


Figure 11c. Diode Reverse Recovery





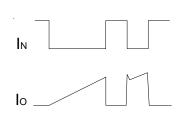
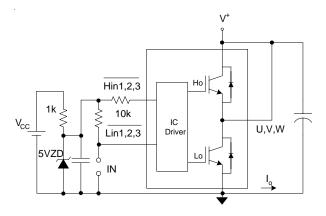


Figure CT1. Switching Loss Circuit



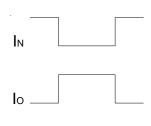
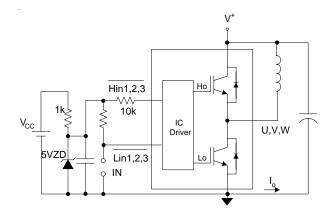


Figure CT2. S.C.SOA Circuit



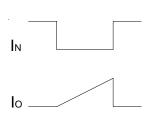
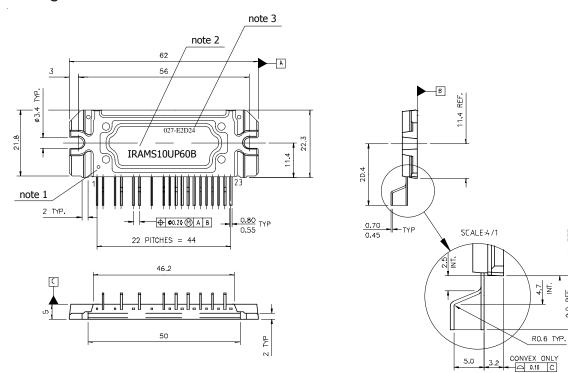


Figure CT3. R.B.SOA Circuit



Package Outline



Standard pin leadforming option

Notes:

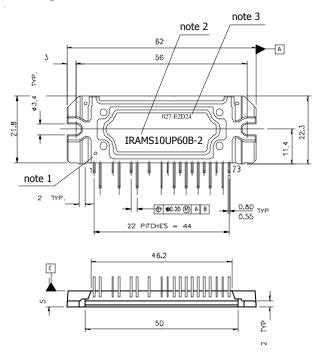
Dimensions in mm

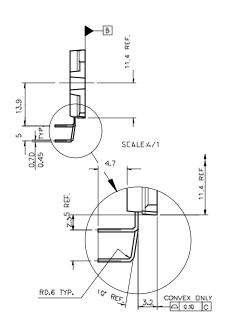
- 1- Marking for pin 1 identification
- 2- Product Part Number
- 3- Lot and Date code marking
- 4- Tollerances ±0.5mm, unless otherwise stated

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
- 4- Tollerances ±0.5mm, unless otherwise stated

For mounting instruction see AN-1049



Data and Specifications are subject to change without notice

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