International
IOR Rectifier

Preliminary

Rev 3.0

IRAMS10UP60A

PlugNDrive™ Series

Advanced Intelligent Power Module
for Appliance Electronic Motor Drive

Description

International Rectifier IRAMS10UP60A is an Application Specific Intelligent Power Module (AIPM) developed and optimized for electronic motor control in appliance applications such as washing machines and refrigerators. The IRAMS10UP60A offers an extremely compact, high performance AC motor-driver in a single isolated package for a very simple design.

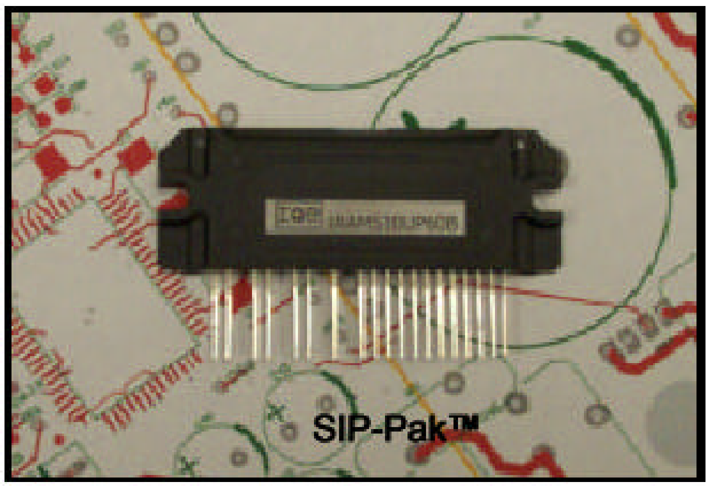
This advanced module is a combination of IR's low $V_{CE\ (on)}$ Non-Punch-Through IGBT technology and the industry benchmark 3 phase high voltage, high speed driver.

A built-in temperature monitor and over-temperature/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, as well as the single polarity power supply, required to drive the internal circuitry simplify the utilization of the module and deliver further cost reduction advantages.

Features

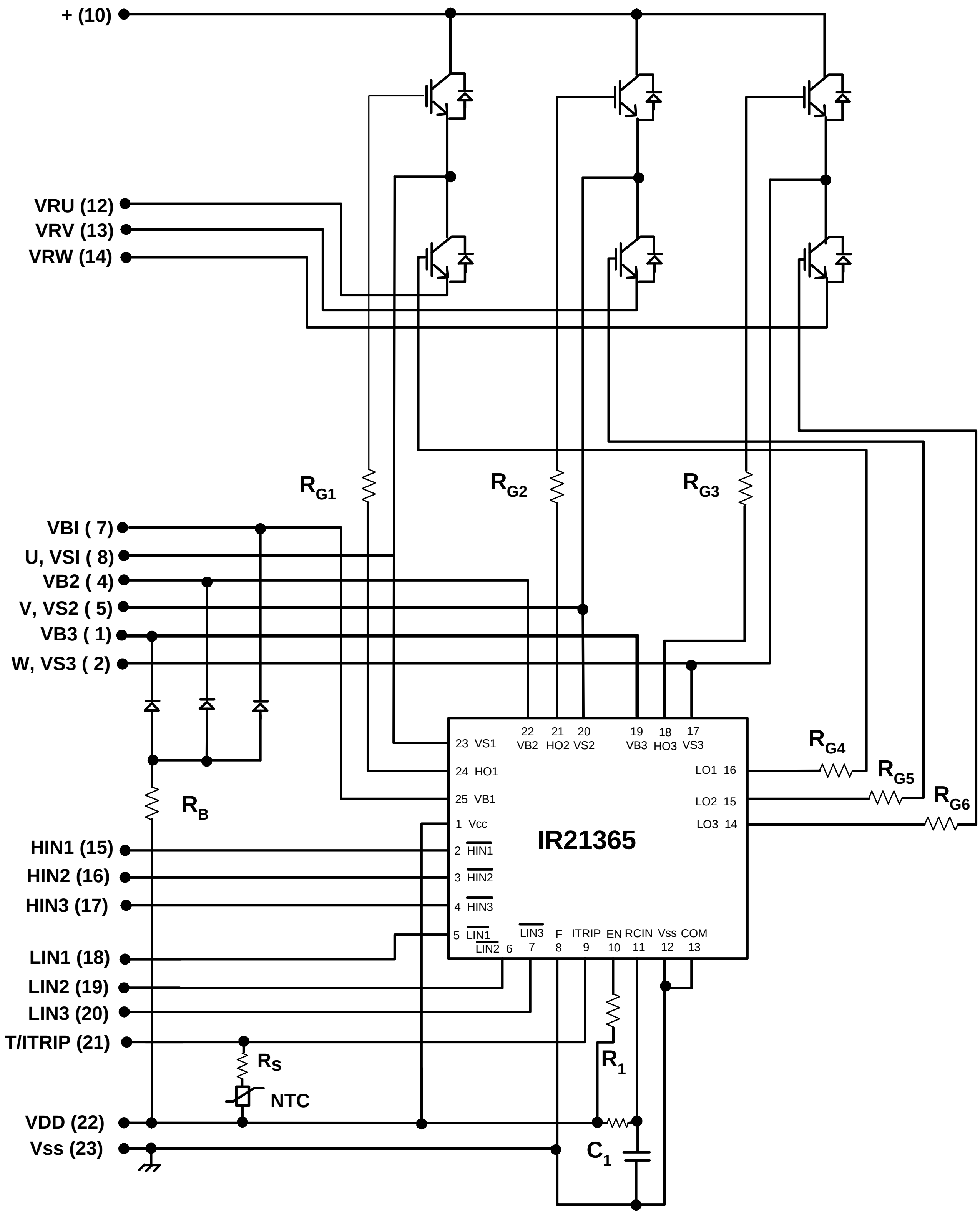
- Integrated Gate Drivers and Bootstrap Diodes.
- Temperature Monitor
- Temperature and Overcurrent shutdown
- Fully Isolated Package.
- Low VCE (on) Non Punch Through IGBT Technology.
- Undervoltage lockout for all channels
- Matched propagation delay for all channels
- Lowside outputs pins for current conrol
- 5V 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}.



Absolute Maximum Ratings

Parameter	Description	Max. Value	Units
V_{Bus}	Maximum DC Bus Voltage	450	V
V_{CES}	Maximum IGBT Blocking Voltage	600	
I_o @ T_C = 25°C	RMS Phase Current	10	A
I_o @ T_C = 100°C	RMS Phase Current	4.5	
I_{pk}	Maximum Peak Phase Current (tp<100µs)	15	
Fp	Maximum PWM Carrier Frequency	20	kHz
Pd	Maximum Power dissipation per Phase	10	W
R_{thJ-C}	Thermal Resistance per IGBT	4.5	°C/W
V_{iso}	Isolation Voltage (1min)	2000	V_{RMS}
T_C	Operating Case temperature	-20 to +100	°C
T_J	Operating Junction temperature	-20 to +150	
T	Mounting torque Range (M3 screw)	0.8 to 1.0	Nm

Internal Electrical Schematic



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_{GE} = 0V, I_C = 500µA
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	---	0.57	---	V/°C	V_{GE} = 0V, I_C = 1.0mA, (25°C-150°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	---	1.52	1.56	V	I_C = 5A T_J = 25°C, V_{GE} = 15V
		---	1.76	1.83		I_C = 5A T_J = 150°C
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5		V_{CE} = V_{GE}, I_C = 250µA
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	---	-9.5	---	mV/°C	V_{CE} = V_{GE}, I_C = 1.0mA, (25°C-150°C)
g_{fe}	Forward Transconductance	---	3.7	---	S	V_{CE} = 50V, I_C = 5A, PW=80µs
I_{CES}	Zero Gate Voltage Collector Current	---	1	150	µA	V_{GE} = 0V, V_{CE} = 600V
		---	200	500		V_{GE} = 0V, V_{CE} =600V, T_J = 150°C
V_{FM}	Diode Forward Voltage Drop	---	1.45	1.75		I_C = 5A
		---	1.25	1.65		I_C = 5A, T_J = 150°C
I_{GES}	Gate-to-Emitter Leakage Current	---	---	±100	nA	V_{GE} = ±20V

Inverter Section Switching Characteristics @ T_J = 25°C

Symbol	Parameter	Min	Typ	Max	Units	Conditions
E_{on}	Turn-On Switching Loss	---	96	---	µJ	I_C = 5A, V_{CC} = 400V
E_{off}	Turn-Off Switching Loss	---	140	---		V_{GE} = 15V,R_G = 51Ω, L =1.4µH
E_{tot}	Total Switching Loss	---	225	---		Ls = 150nH T_J = 25°C
E_{on}	Turn-On Switching Loss	---	130	---	µJ	T_J = 150°C
E_{off}	Turn-Off Switching Loss	---	180	---		Energy losses include "tail" and
E_{tot}	Total Switching Loss	---	310	---		diode reverse recovery.
$t_{d(on)}$	Turn-On Delay Time	---	470	---	ns	I_C = 5A, V_{CC} = 360V
t_r	Rise Time	---	18	---		V_{GE} = 15V, R_G =51Ω L =1.4µH
$t_{d(off)}$	Turn-Off Delay Time	---	615	---		Ls = 150nH, T_J = 150°C
t_f	Fall Time	---	47	---		
Erec	Diode Reverse Recovery energy	---	64	---	µJ	T_J = 150°C
t_{rr}	Diode Reverse Recovery time	---	90	---	ns	V_{CC} = 400V, I_F = 5A, L =1.4µH
I_{rr}	Diode Peak Reverse Recovery Current	---	11	---	A	V_{GE} = 15V,R_G = 51Ω, Ls = 150nH
RBSOA	Reverse Bias Safe Operting Area	FULL SQUARE				
SCSOA	Short Circuit Safe Operting Area	10	---	---	µs	

Note 1: Delay times above include delays in driver IC and switching IGBT, see figure 10 for timing definitions

Thermal Resistance

Symbol	Parameter	Min	Typ	Max	Units	Conditions
$R_{th(J-C)}$	Junction to case thermal resistance each IGBT under inverter operation.	---	---	4.5	°C/W	
$R_{th(J-C)}$	Junction to case thermal resistance each Diode under inverter operation.	---	---	6.5	°C/W	
$R_{th(C-S)}$	Thermal Resistance case to sink	---	0.1	---	°C/W	

Absolute Maximum Ratings Driver function

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

Symbol	Definition	Min	Max	Units
V_S	High Side offset voltage	- 0.3	600	V
V_{BS}	High Side floating supply voltage	- 0.3	20	V
V_{CC}	Low Side and logic fixed supply voltage	- 0.3	20	V
V_{IN}	Input voltage LIN, HIN, ITRIP	- 0.3	7	V
T_J	Junction 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 voltage parameters are absolute referenced to V_{SS}. The V_S offset rating is tested with all supplies biased at 15V differential.

Symbol	Definition	Min	Max	Units
$V_{B1,2,3}$	High side floating supply voltage	12.5	17.5	V
$V_{S1,2,3}$	High side floating supply offset voltage	Note 1	450	
V_{CC}	Low side and logic fixed supply voltage	13.5	16.5	V
V_{ITRIP}	ITRIP input voltage	V_{SS}	V_{SS} +5	
V_{IN}	Logic input voltage LIN, HIN	V_{SS}	V_{SS} +5	V

Note 2 : Logic operational for V S of COM -5V to COM +600V. Logic state held for V S of COM -5V to COM -V BS . (Please refer to the Design Tip DT97-3 for details).
Note 3: All input pins and the ITRIP pin are internally clamped with a 5.2V zener diode.

Static Electrical Characteristics Driver Function

V_{BIAS} (V_{CC}, V_{BS}1,2,3) = 15V unless otherwise specified. The V_{IN} and I_{IN} parameters are referenced to V_{SS} and are applicable to all six channels.

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+} V_{BSUV+}	V_{CC} and V_{BS} supply undervoltage positive going threshold	10.7	11.2	11.7	V
V_{CCUV-} V_{BSUV-}	V_{CC} and V_{BS} supply undervoltage negative going threshold	10.5	11.0	11.5	V
V_{CCUVH} V_{BSUVH}	V_{CC} and V_{BS} supply undervoltage lockout hysteresis	–	0.2	–	V
I_{QBS}	Quiescent V_{BS} supply current	20	60	150	µA
I_{QCC}	Quiescent V_{CC} supply current	–	2	10	mA
I_{LK}	Offset Supply Leakage Curent	–	–	50	µA
I_{IN+}	Input bias current (OUT = HI or OUT = LO)	–	120	–	µA
V_{ITrip+}	V_{ITrip} threshold Voltage (OUT = HI or OUT = LO)	3.6	4	4.4	V

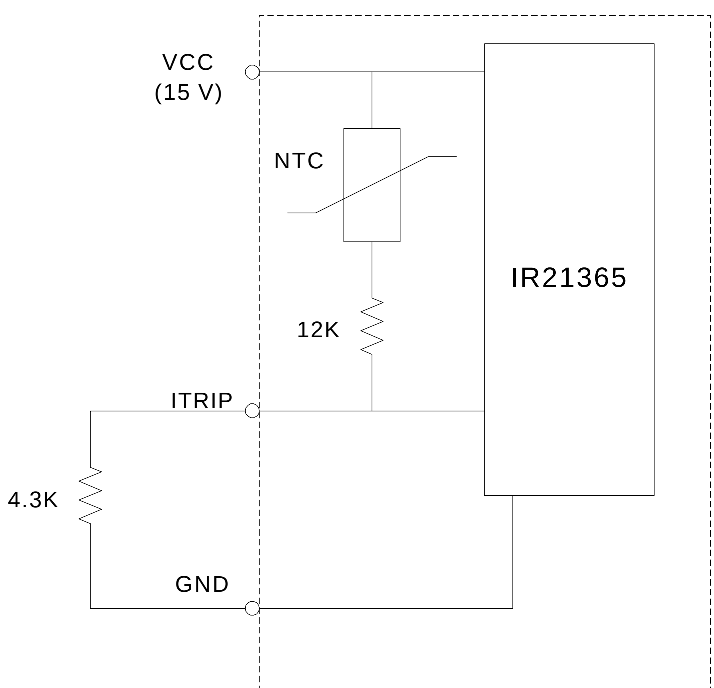
Dynamic Electrical Characteristics

$V_{CC} = V_{BS} = V_{BIAS}$ = 15V, I_o= 1A, V_D=9V , 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.2)	–	450	–	ns
T_{OFF}	Input to output propagation turn-off delay time (see fig.2)	–	400	–	ns
T_{TRIP}	I_{Trip} to six switch to turn-off propagation delay (see fig.3)	–	750	–	ns
T_{FCLTRL}	Post I_{Trip} to six switch to turn-off clear time (see fig.3)	–	9	–	ms

Internal NTC - Thermistor Charaxteristics

Parameter		Typ.	Units	Conditions
R_{25}	Resistance	100 +/- 5%	kW	T_C= 25°C
R_{125}	Resistance	2.522 +/- 5%	kW	T_C= 125°C
$R_{25/50}$	B-value	3375 +/- 3%	K	$R_2=R_1\exp[B(1/T_2-1/T_1)]$
-	Temperature Range	-40/+125	°C	
-	Typ. Dissipation constant	1	mW/°C	T_C=25°C



Note 3: The Maximum recommended sense voltage at the ITRIP terminal under normal operating conditions is 3.3V.

Figure1. Input/Output Timing Diagram

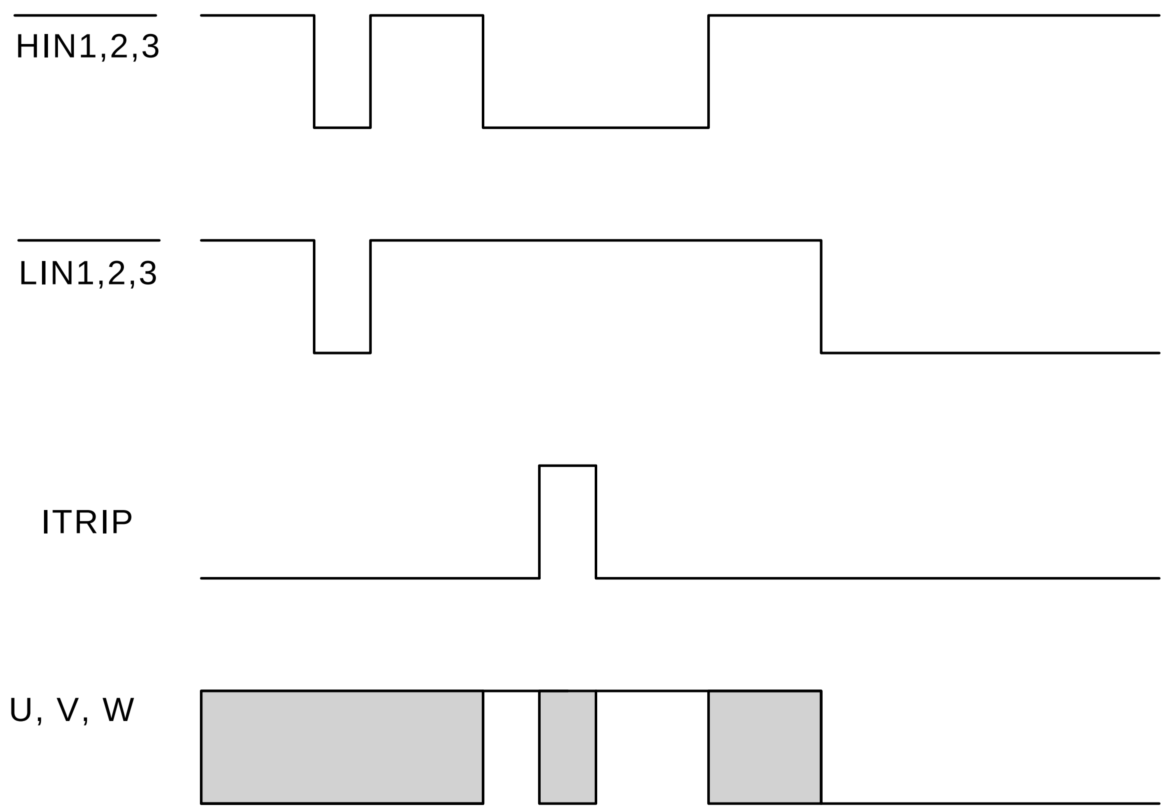


Figure2. Switching Time Waveforms

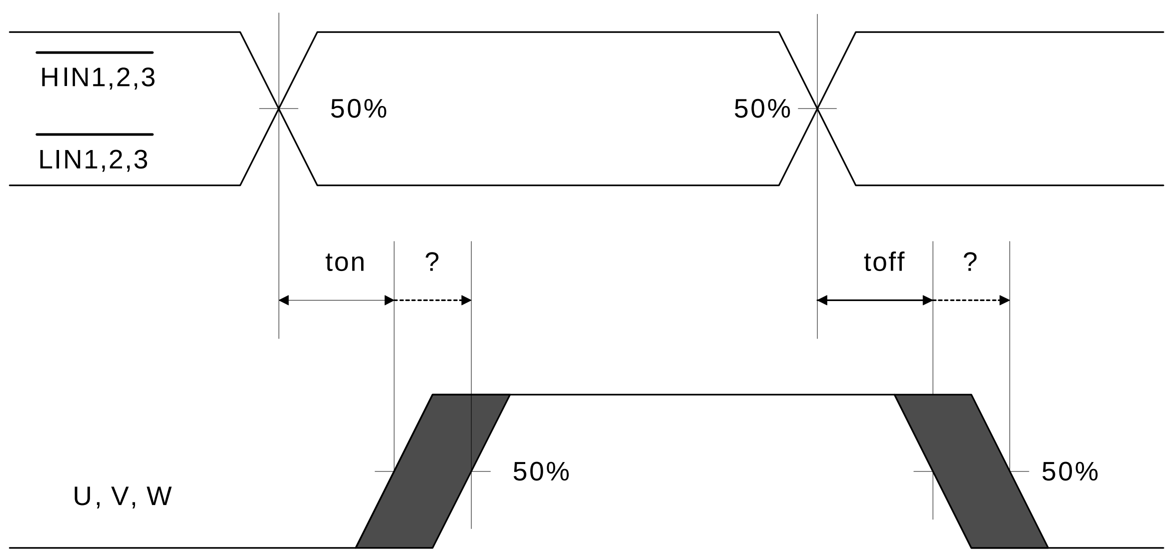
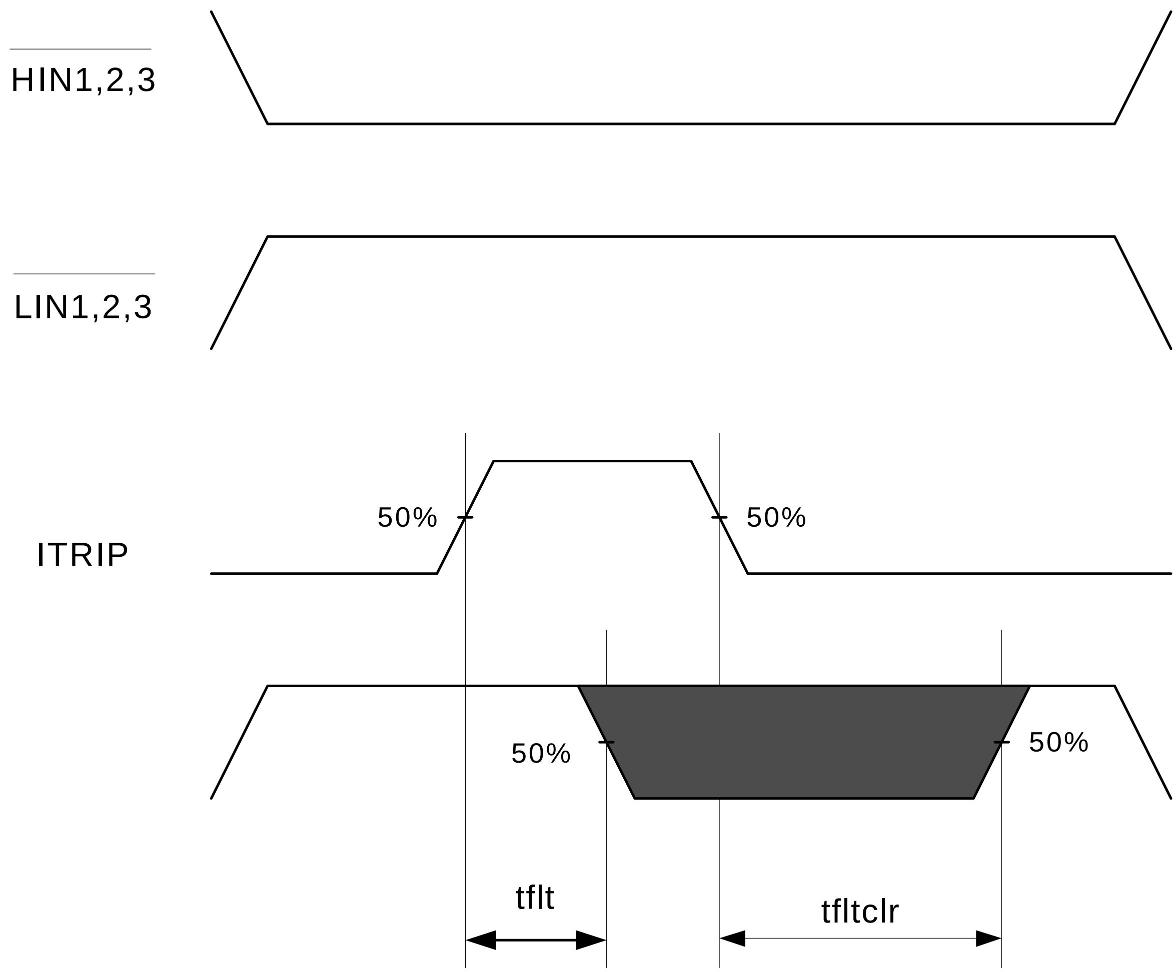


Figure 3. I_{TRIP} Timing Waveform

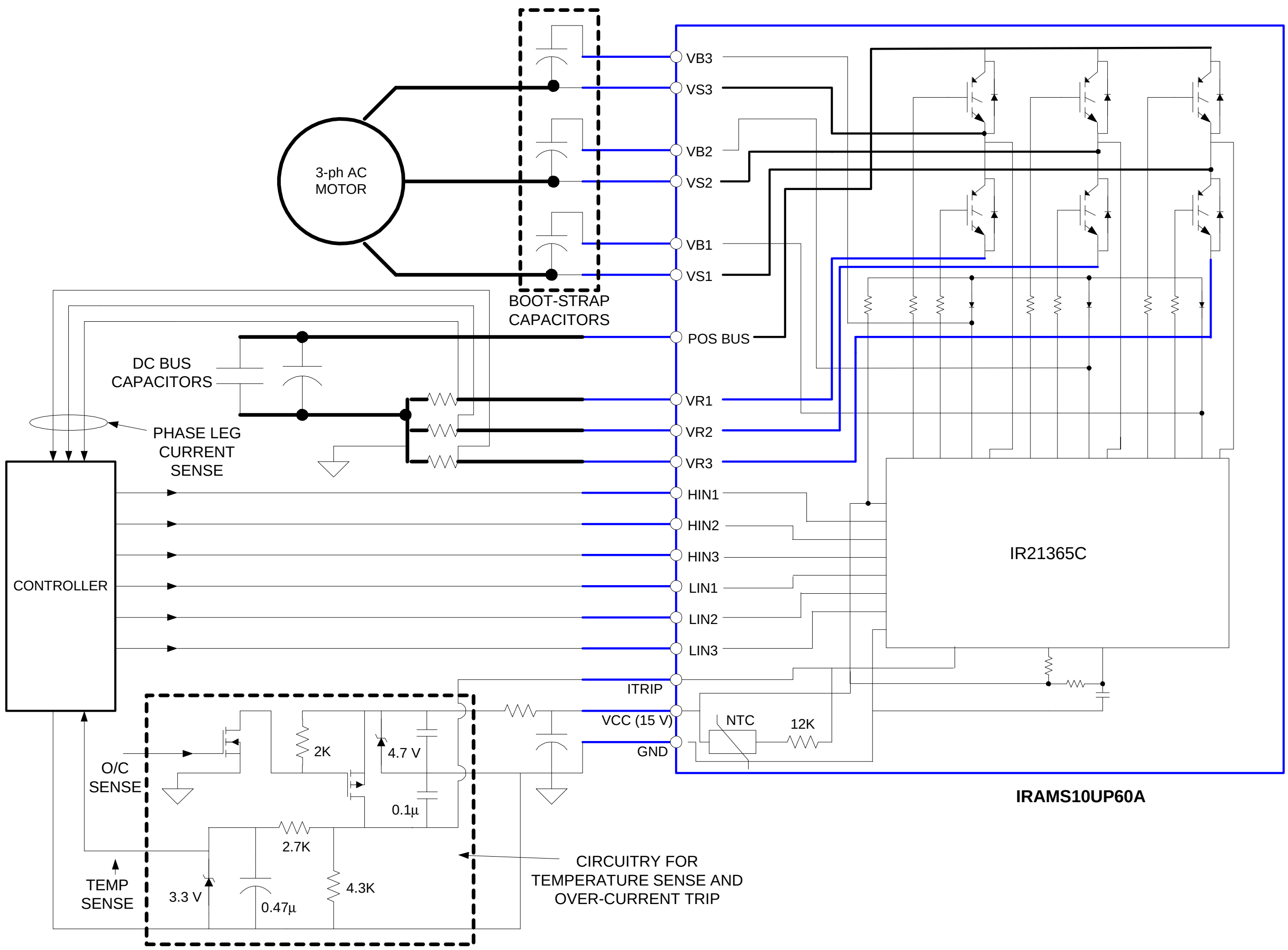


Note 4: The shaded area indicates that both high-side and low-side switches are off and therefore the half-bridge output voltage would be determined by the direction of current flow in the load.

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_{DD}	Positive Bus Input Voltage
11	na	none
12	VRU	Low Side Emitter Connection - Phase 1
13	VRV	Low Side Emitter Connection - Phase 2
14	VRW	Low Side Emitter Connection - Phase 3
15	HI-In1	Logic Input High Gate Driver - Phase 1
16	HI-In2	Logic Input High Gate Driver - Phase 2
17	HI-In3	Logic Input High Gate Driver - Phase 3
18	Lo-In1	Logic Input Low Gate Driver - Phase 1
19	Lo-In2	Logic Input Low Gate Driver - Phase 2
20	Lo-In3	Logic Input Low Gate Driver - Phase 3
21	T_{Trip}	Temperature Monitor and Shut-down Pin
22	V_{CC}	+15V Main Supply
23	V_{SS}	Negative Main Supply

Typical Application Connection



1. Bus capacitors should be mounted as close to the module bus terminals as possible to reduce ringing and EMI problems

2. In order to provide good decoupling between Vcc-Gnd and Vb-Vs terminals, the capacitors shown connected between these terminals should be located very close to the module pins

3. Low inductance shunt resistors should be used for phase leg current sensing. Similarly, the length of the traces between pins 12, 13 and 14 to the corresponding shunt resistors should be kept as small as possible

4. Value of the boot-strap capacitors depends upon the switching frequency. Their selection should be made based on IR application note DN 98-2a

5. Over-current sense signal can be obtained from hardware detecting excessive instantaneous current in inverter

Figure 4a. IGBT Turn-on

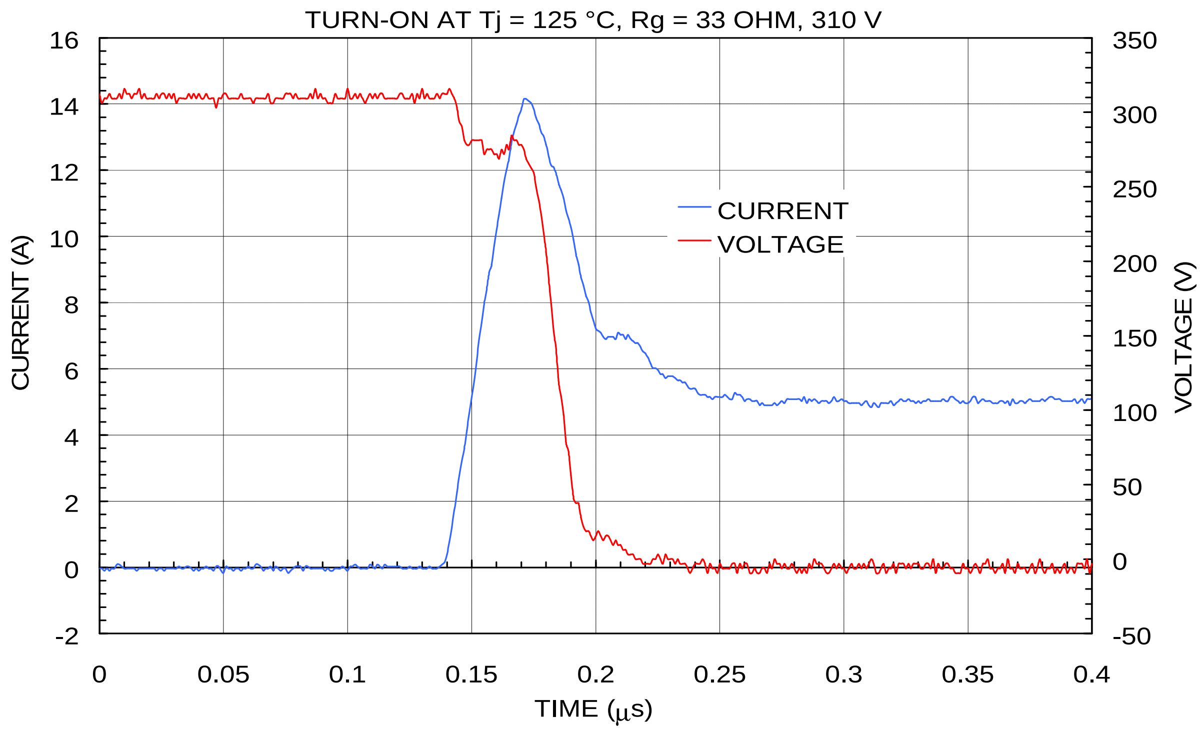


Figure 4b. IGBT Turn-off

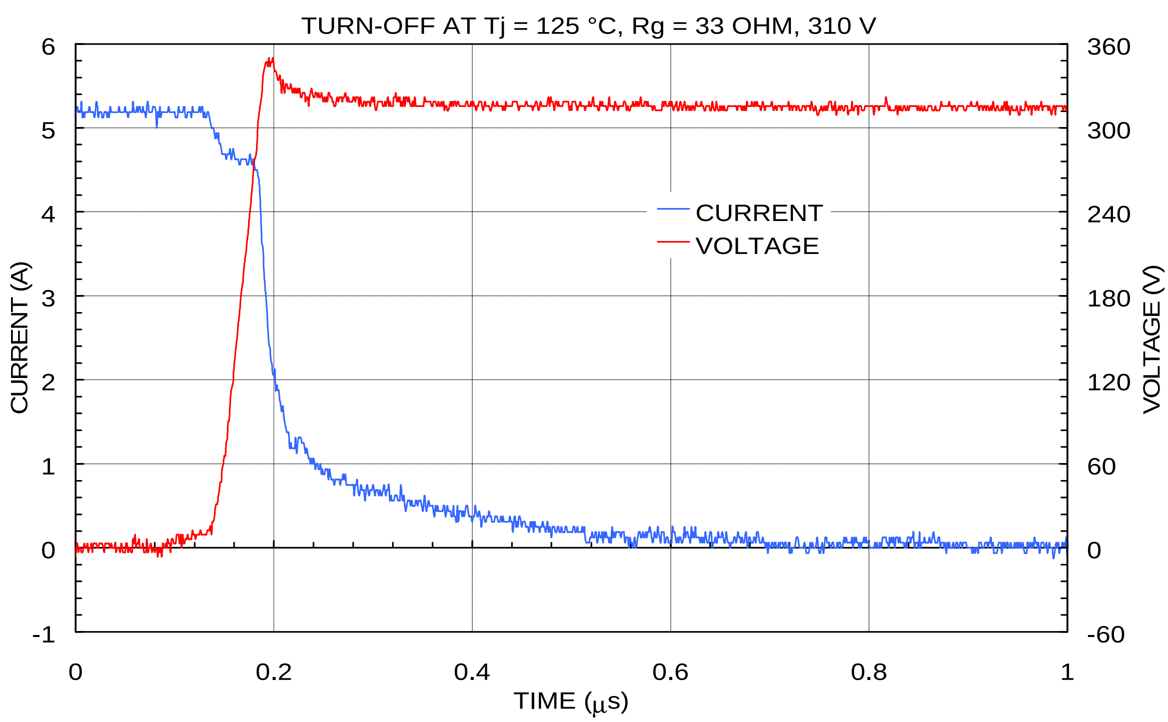


Figure 5. Variation of Thermistor Resistance with Temperature

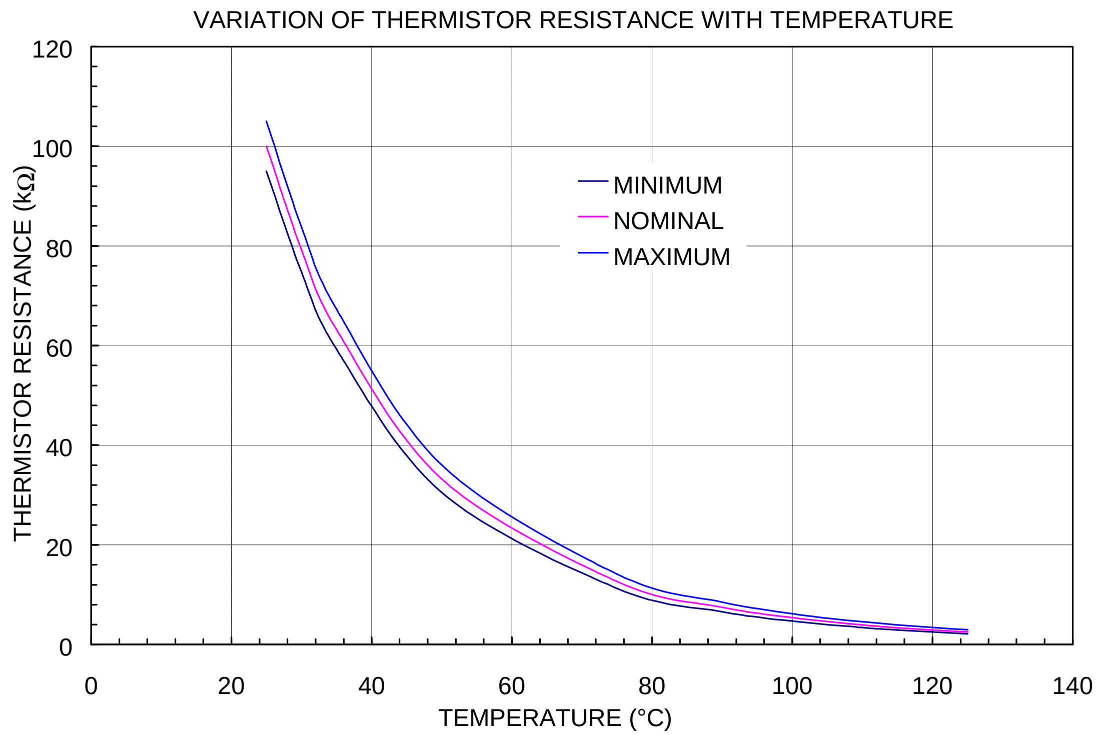


Figure 6. Variation of Temperature Sense Voltage with Thermistor Temperature Using External Bias Resistance of 4.3K

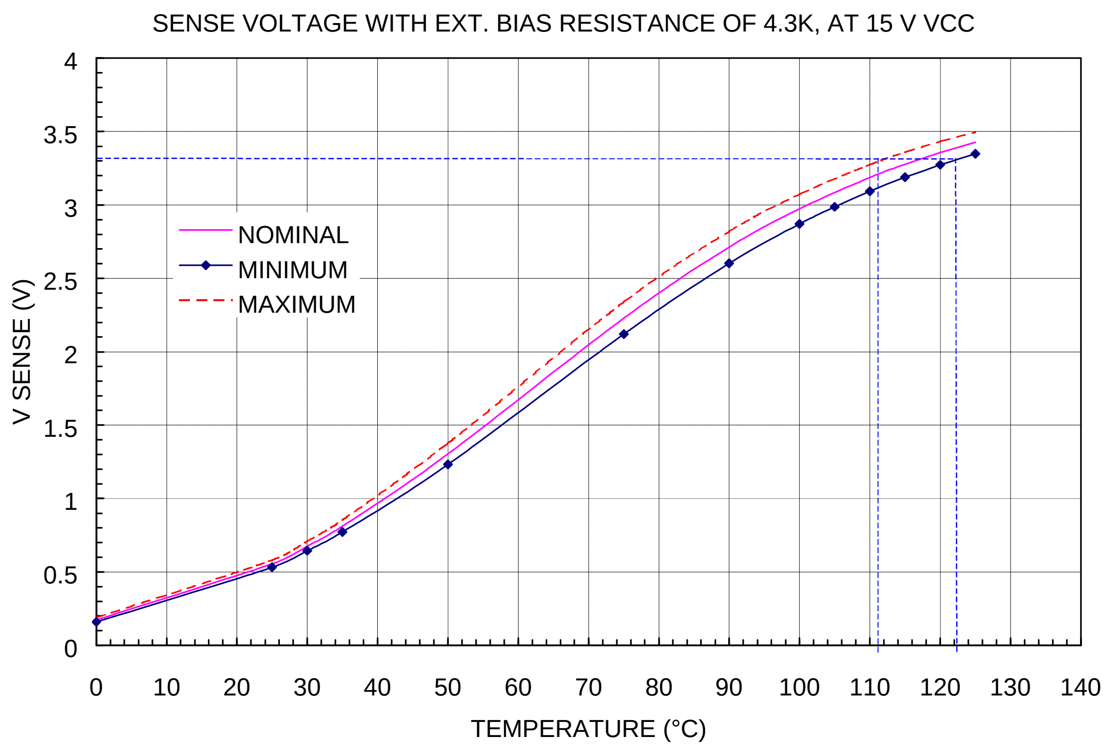


Figure 7. Estimated Maximum IGBT Junction temperature with Thermistor Temperature

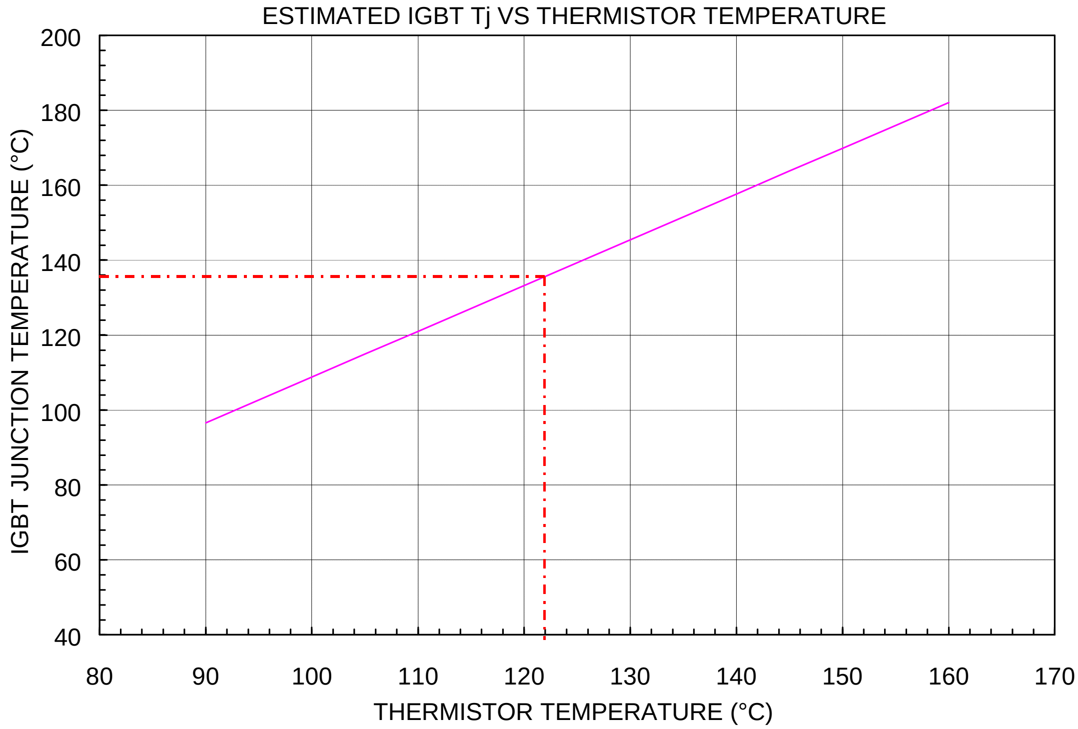


Figure 8. Recommended Minimum Bootstrap Capacitor Value Vs Switching Frequency

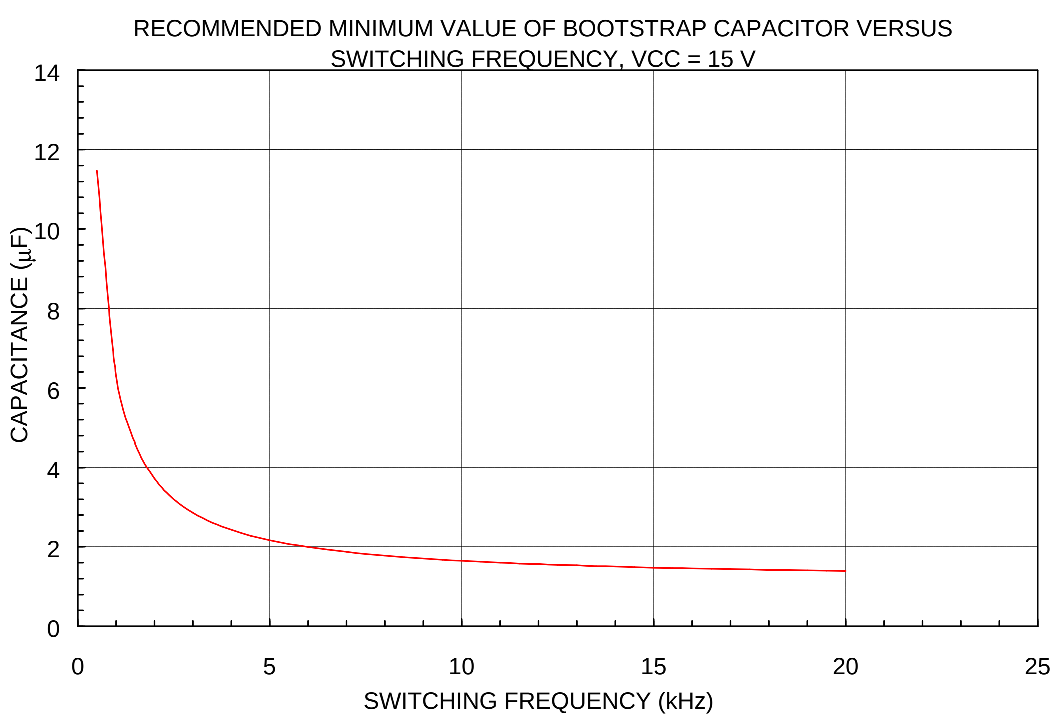


Figure 9. Estimated Maximum Sinusoidal IGBT Current as Function of Switching Frequency

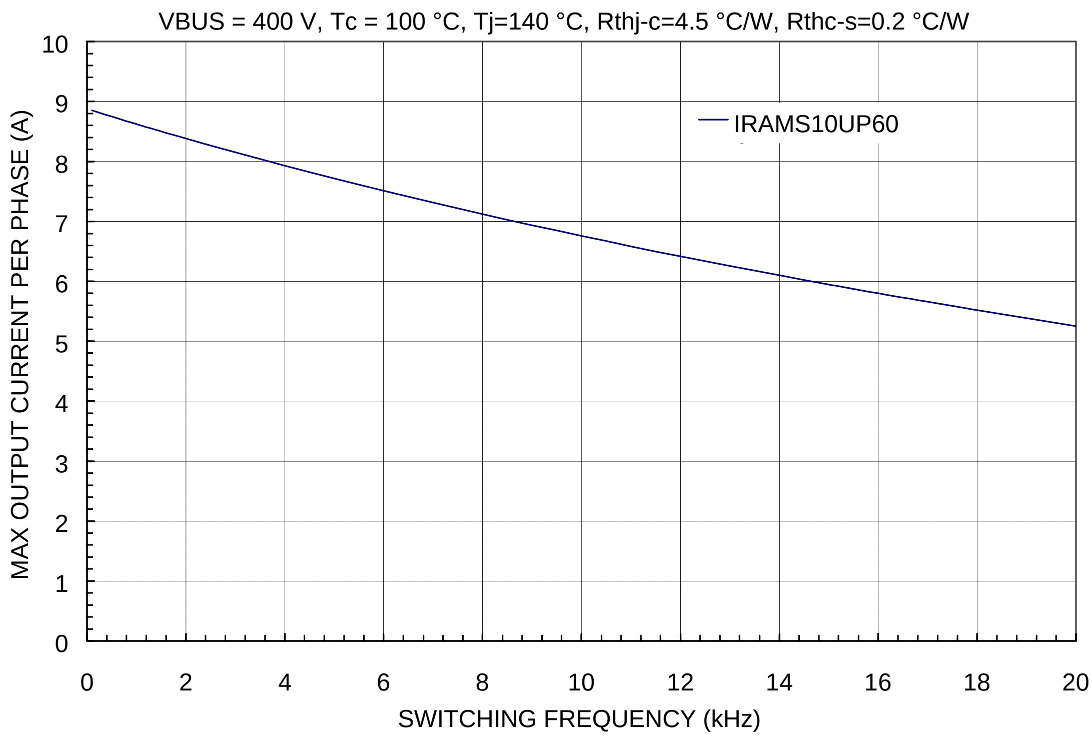


Figure 10. Switching Parameter Definitions

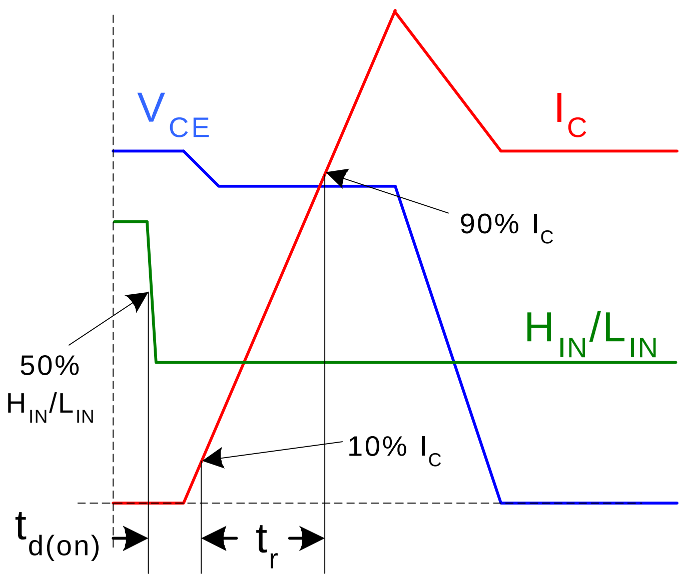


Figure 10a. IGBT Turn-on

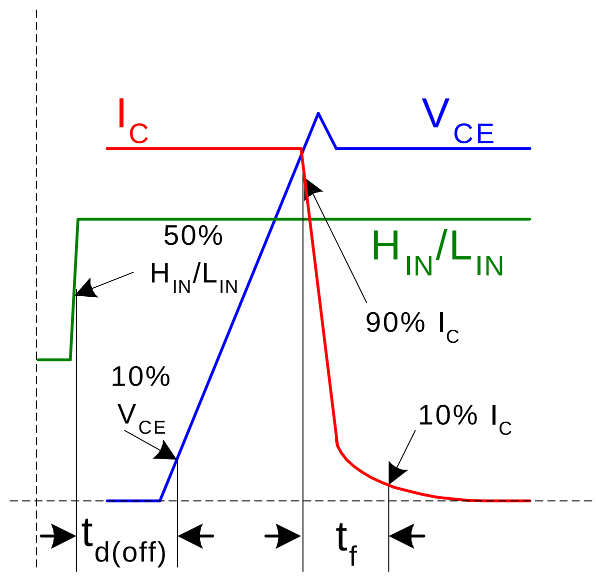


Figure 10b. IGBT Turn-off

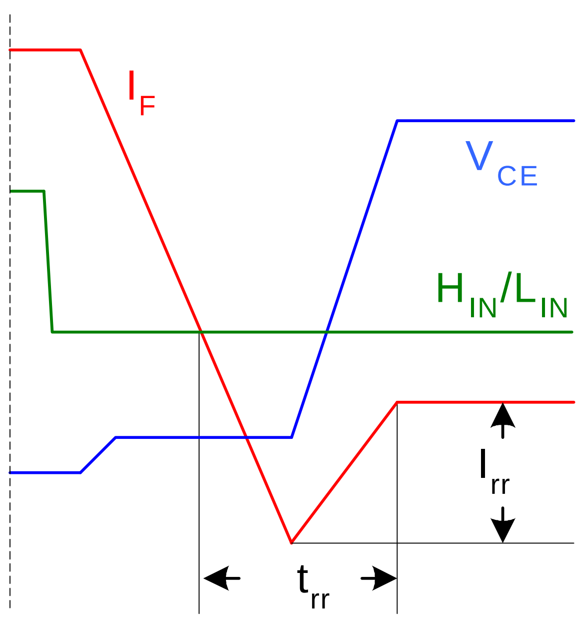
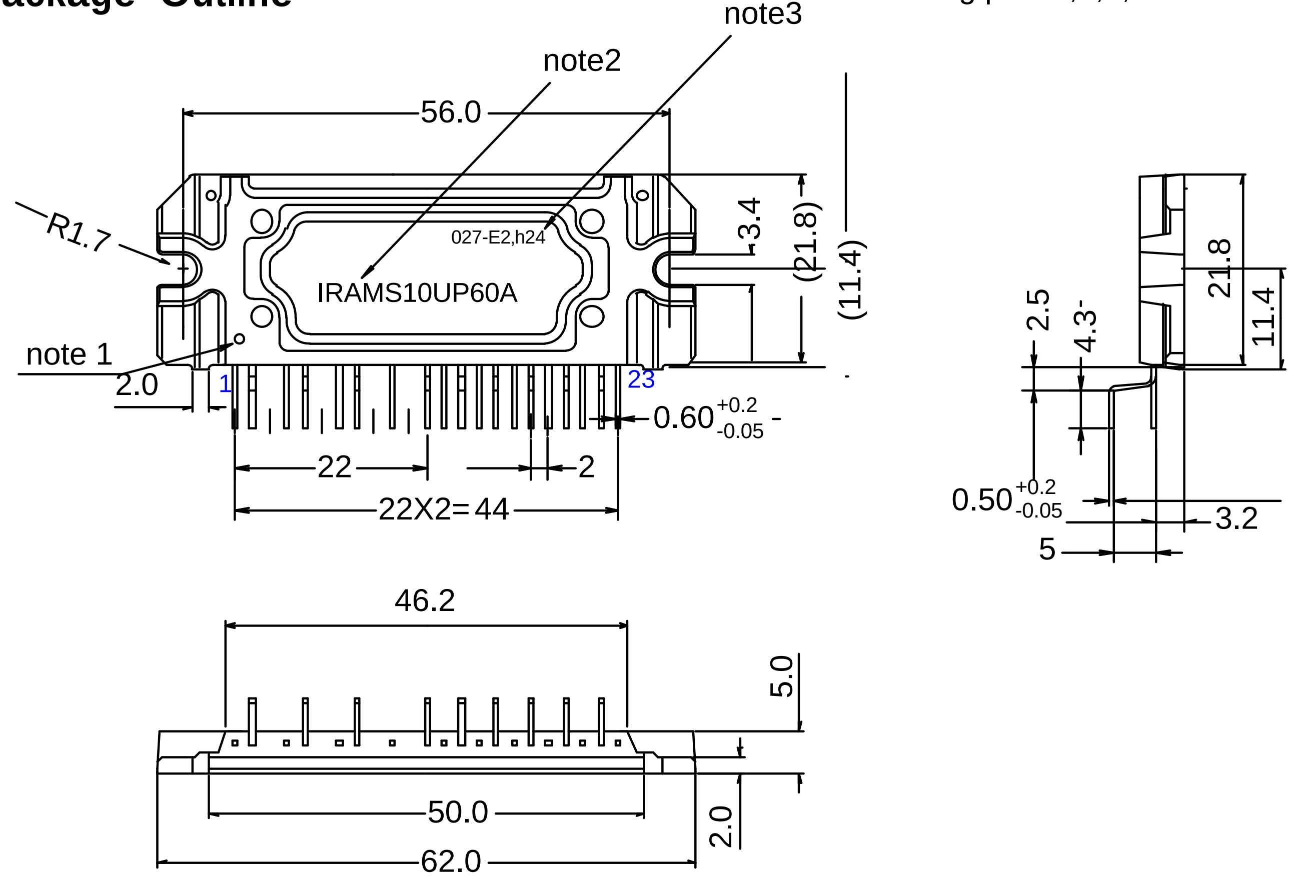


Figure 10c. Diode Reverse Recovery

Package Outline

missing pins 3,6,9,11



Standard pin leadforming option

Notes:

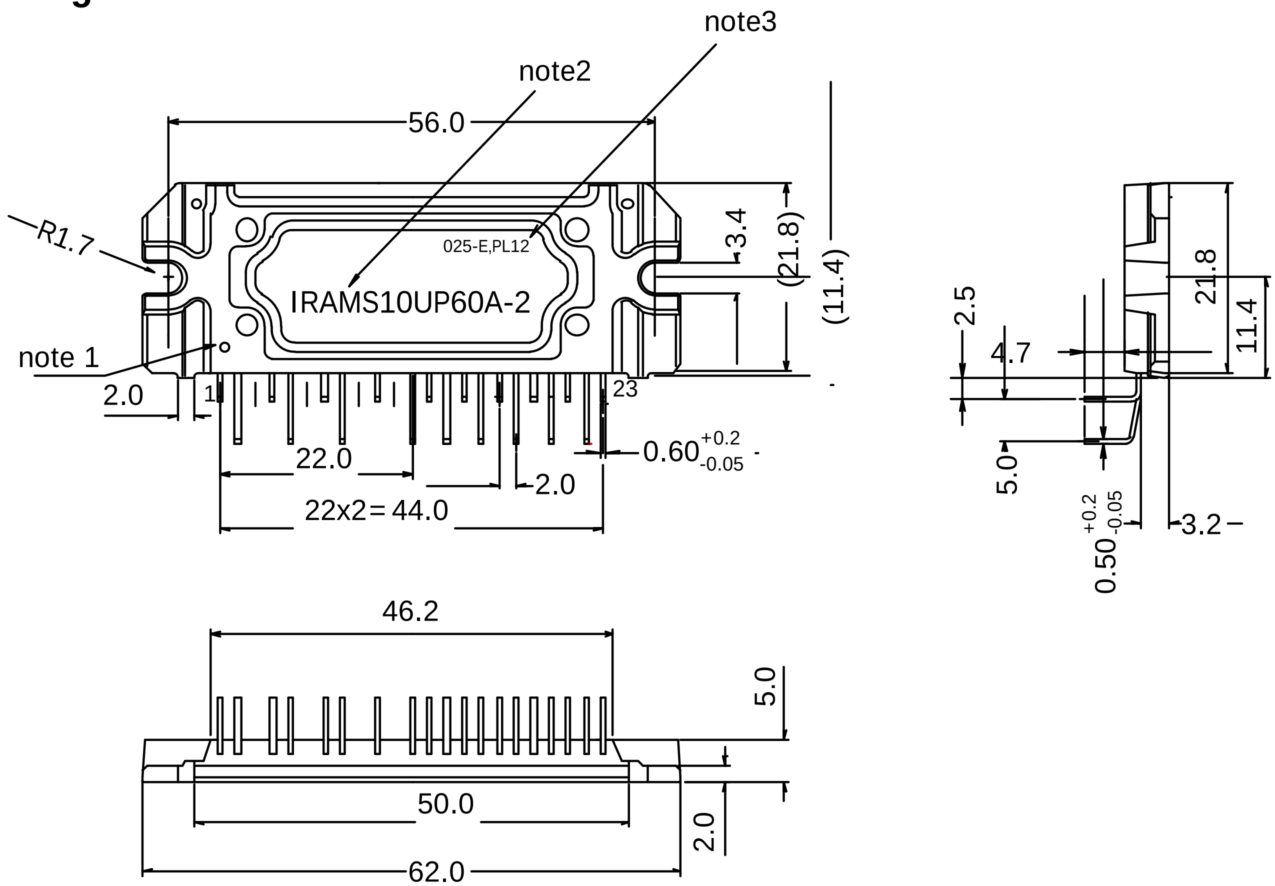
Dimensions in mm

1 - Marking for pin 1 identification

2- Product Part Number

3- Lot and Date code marking

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

International Rectifier

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