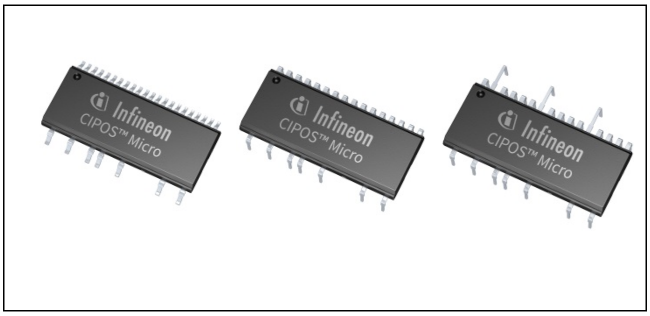
CIPOS™ Micro IPM: 600 V, 3 & 4 A

IM240 Series

Description

CIPOS™ Micro IM240 Series are three-phase Intelligent Power Modules (IPM) designed for advanced appliance motor drive applications such as energy efficient fans and pumps. These advanced IPMs offers a combination of low $V_{CE(sat)}$ RC-DF IGBT technology and the industry benchmark half-bridge high voltage, rugged driver in a familiar package.

Features



- 600V three-phase inverter including gate drivers & bootstrap function
- Based on low 2.1V $V_{CE(sat)}$ RC-DF IGBT
- Advanced input filter with shoot-through protection
- Optimized dV/dt for loss and EMI trade offs
- Open-emitter for single and leg-shunt current sensing
- 3.3V logic compatible
- Driver tolerant to negative voltage ($-V_S$)
- Undervoltage lockout for all channels
- Isolation 1900VRMS, 1min
- UL-certified

Potential Applications

- Air-conditioner fans
- Refrigerator compressors
- Ventilation fans & blower fans
- Low power motor drives

Product validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22.

Table 1 Product Information

Series	Package Type	Standard Pack		Product Name
		Form	Quantity	
IM240-S6	DIP 29x12F	Tube	240	IM240-S6Y1B
	DIP 29x12F	Tube	240	IM240-S6Y2B
	SOP 29x12F	Tube	240	IM240-S6Z1B
IM240-M6	DIP 29x12F	Tube	240	IM240-M6Y1B
	DIP 29x12F	Tube	240	IM240-M6Y2B
	SOP 29x12F	Tube	240	IM240-M6Z1B

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1 Internal Electrical Schematic

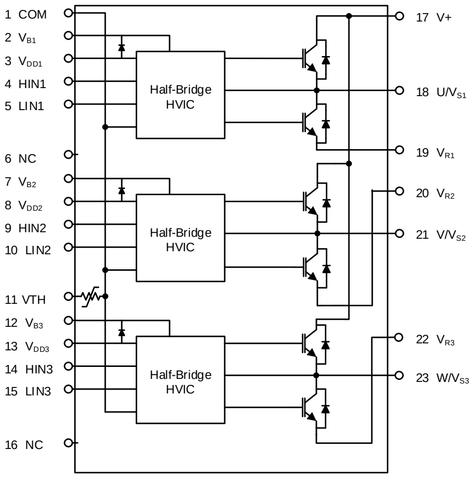


Figure 1 **Internal electrical schematic.**

2 Pin Configuration

2.1 Pin Assignment

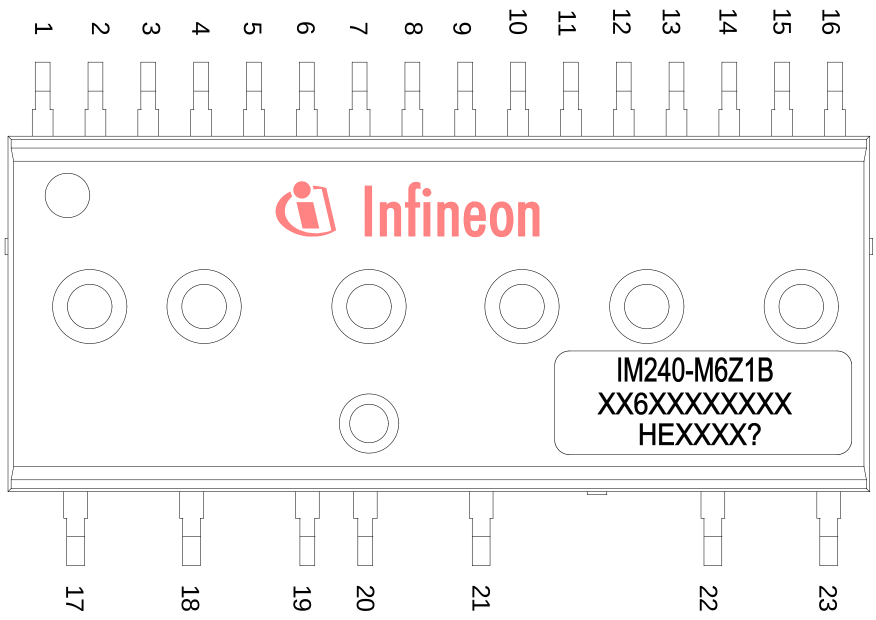


Figure 2 Module pinout

Table 2 Pin Assignment

Pin	Name	Description
1	COM	Logic ground
2	V_{B1}	High side floating supply voltage 1
3	V_{DD1}	Low side control supply 1
4	HIN1	Logic Input for High Side Gate Driver - Phase 1
5	LIN1	Logic Input for Low Side Gate Driver - Phase 1
6	NC	Not connected
7	V_{B2}	High side floating supply voltage 2
8	V_{DD2}	Low side control supply 2
9	HIN2	Logic Input for High Side Gate Driver - Phase 2
10	LIN2	Logic Input for Low Side Gate Driver - Phase 2
11	VTH	Thermistor output
12	V_{B3}	High side floating supply voltage 3
13	V_{DD3}	Low side control supply 3
14	HIN3	Logic Input for High Side Gate Driver - Phase 3
15	LIN3	Logic Input for Low Side Gate Driver - Phase 3
16	NC	Not connected
17	V+	Dc bus voltage positive

Pin Configuration

Pin	Name	Description
18	U/V_{S1}	Output - phase 1, high side floating supply offset 1
19	V_{R1}	Phase 1 low side emitter
20	V_{R2}	Phase 2 low side emitter
21	V/V_{S2}	Output - phase 2, high side floating supply offset 2
22	V_{R3}	Phase 3 low side emitter
23	W/V_{S3}	Output – phase 3, high side floating suppyl offset 3

2.2 Pin Descriptions

HIN(1,2,3) and LIN(1,2,3) (Low side and high side control pins)

These pins are positive logic and they are responsible for the control of the integrated IGBT. The Schmitt-trigger input thresholds of them are such to guarantee LSTTL and CMOS compatibility down to 3.3V controller outputs. Pull-down resistor of about 800kΩ is internally provided to pre-bias inputs during supply start-up and an ESD diode is provided for pin protection purposes. Input Schmitt-trigger and noise filter provide beneficial noise rejection to short input pulses.

The noise filter suppresses control pulses which are below the filter time T_{FILIN}. The filter acts according to Figure 4.

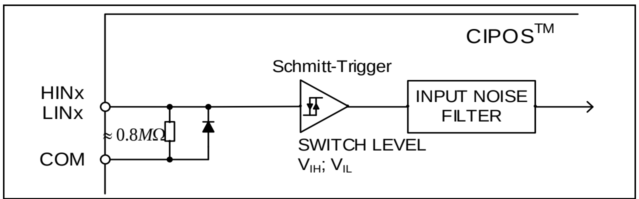


Figure 3 Input pin structure

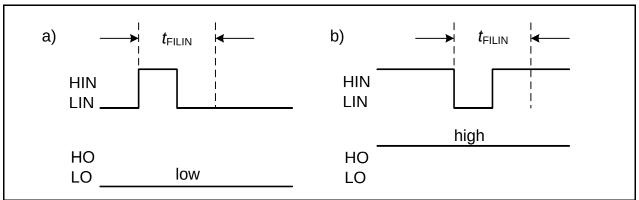


Figure 4 Input filter timing diagram

The integrated gate drive provides additionally a shoot through prevention capability which avoids the simultaneous on-state of the high-side and low-side switch of the same inverter phase. A minimum deadtime insertion of typically 300ns is also provided by driver IC, in order to reduce cross-conduction of the external power switches.

V_{DD}, COM (Low side control supply and reference)

V_{DD} is the control supply and it provides power both to input logic and to output power stage. Input logic is referenced to COM ground.

The under-voltage circuit enables the device to operate at power on when a supply voltage of at least a typical voltage of V_{DDUV+} = 11.1V is present.

The IC shuts down all the gate drivers power outputs, when the V_{DD} supply voltage is below V_{DDUV-} = 10.9V. This prevents the external power switches from critically low gate voltage levels during on-state and therefore from excessive power dissipation.

$V_{B(1,2,3)}$ and $V_{S(1,2,3)}$ (High side supplies)

V_B to V_S is the high side supply voltage. The high side circuit can float with respect to COM following the external high side power device emitter voltage.

Due to the low power consumption, the floating driver stage is supplied by integrated bootstrap circuit.

The under-voltage detection operates with a rising supply threshold of typical V_{BSUV+} = 11.1V and a falling threshold of V_{BSUV-} = 10.9V.

$V_{S(1,2,3)}$ provide a high robustness against negative voltage in respect of COM. This ensures very stable designs even under rough conditions.

$V_{R(1,2,3)}$ (Low side emitters)

The low side emitters are available for current measurements of each phase leg. It is recommended to keep the connection to pin COM as short as possible in order to avoid unnecessary inductive voltage drops.

Pin Configuration

VTH (Thermistor output)

A UL certified NTC is integrated in the module with one terminal of the chip connected to COM and the other to VTH. When pulled up to a rail voltage such as V_{DD} or 3.3V by a resistor, the VTH pin provides an analog voltage signal corresponding to the temperature of the thermistor.

U/V_{S1}, V/V_{S2}, W/V_{S3} (High side emitter and low side collector)

These pins are motor U, V, W input pins.

V+ (Positive bus input voltage, Pin 23)

The high side IGBTs are connected to the bus voltage. It is noted that the bus voltage does not exceed 450V.

3 Absolute Maximum Rating

3.1 Module

Table 3

Parameter	Symbol	Condition		Units
Storage temperature	T_{STG}		-40 ~ 150	°C
Operating case temperature	T_C		-40 ~ 125	°C
Operating junction temperature	T_J		-40 ~ 150	°C
Isolation test voltage	V_{ISO}	1min, RMS, f = 60Hz	1900	V

3.2 Inverter

Table 4: IM240-S6

Parameter	Symbol	Condition		Units
Max. blocking voltage	V_{CES}/V_{RRM}		600	V
Output current	I_O	$T_C = 25°C$	3	A
Peak output current	I_{OP}	$T_C = 25°C$, $t_p < 1ms$	6	A
Peak power dissipation per IGBT	P_{tot}	$T_C = 25°C$	8.4	W
Short circuit withstand time	T_{SC}	$V_{DC} = 400V$, $T_J = 150°C$, $V_{DD} = 15V$	5	μs

Table 5: IM240-M6

Parameter	Symbol	Condition		Units
Max. blocking voltage	V_{CES}/V_{RRM}		600	V
Output current	I_O	$T_C = 25°C$	4	A
Peak output current	I_{OP}	$T_C = 25°C$, $t_p < 1ms$	8	A
Peak power dissipation per IGBT	P_{tot}	$T_C = 25°C$	8.9	W
Short circuit withstand time	T_{SC}	$V_{DC} = 400V$, $T_J = 150°C$, $V_{DD} = 15V$	5	μs

3.3 Control

Table 6

Parameter	Symbol	Condition		Units
Low side control supply voltage	V_{DD}		-3 ~ 20	V
Input voltage LIN, HIN	V_{IN}		-0.3 ~ V_{DD}	V
High side floating supply voltage (V_B reference to V_S)	V_{BS}		-0.3 ~ 20	V

4 Thermal Characteristics

Table 7: IM240-S6

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Single IGBT thermal resistance, junction-case	$R_{TH(J-C)}$	Low side V-phase IGBT (See Figure 6 for T_C measurement point)	-	10.1	13.1	°C/W
Single diode thermal resistance, junction-case	$R_{TH(J-C)D}$	Low side V-phase diode (See Figure 6 for T_C measurement point)	-	11.5	14.9	°C/W

Table 8: IM240-M6

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Single IGBT thermal resistance, junction-case	$R_{TH(J-C)}$	Low side V-phase IGBT (See Figure 6 for T_C measurement point)	-	8.3	10.8	°C/W
Single diode thermal resistance, junction-case	$R_{TH(J-C)D}$	Low side V-phase diode (See Figure 6 for T_C measurement point)	-	10.9	14.1	°C/W

5 Recommended Operating Conditions

Table 9

Parameter	Symbol	Min.	Typ.	Max.	Units
Positive DC bus input voltage	V+	-	-	450	V
Low side control supply voltage	V_{DD}	13.5	-	16.5	V
High side floating supply voltage	V_{BS}	12.5	-	17.5	V
Input voltage	V_{IN}	0	-	5	V
PWM carrier frequency	F_{PWM}	-	20	-	kHz
External dead time between HIN & LIN	DT	1	-	-	µs
Voltage between COM and $V_{R(1,2,3)}$	V_{COMR}	-5	-	5	V
Minimum input pulse width	$PW_{IN(ON)}$, $PW_{IN(OFF)}$	0.5	-	-	µs

6 Static Parameters

6.1 Inverter

(V_{DD}-COM) = (V_B - V_S) = 15 V. T_C = 25°C unless otherwise specified.

Table 10: IM240-S6

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Collector-to-emitter saturation voltage	$V_{CE(sat)}$	I_C = 1A	-	1.54	-	V
		I_C = 2.5A	-	2.2	2.7	V
		I_C = 2.5A, T_J = 150°C	-	2.3	-	V
Collector emitter leakage current	I_{CES}	V_{IN} = 0V, V+ = 600V	-	-	40	µA
Diode forward voltage	V_F	I_C = 1A	-	1.53	-	V
		I_C = 2.5A	-	2.10	2.6	V
		I_C = 2.5A, T_J = 150°C	-	2.05	-	V

Table 11: IM240-M6

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Collector-to-emitter saturation voltage	$V_{CE(sat)}$	I_C = 1A	-	1.35	-	V
		I_C = 2.5A	-	2.25	2.6	V
		I_C = 2.5A, T_J = 150°C	-	2.3	-	V
Collector emitter leakage current	I_{CES}	V_{IN} = 0V, V+ = 600V	-	-	40	µA
Diode forward voltage	V_F	I_C = 1A	-	1.53	-	V
		I_C = 2.5A	-	2.10	2.6	V
		I_C = 4A, T_J = 150°C	-	2.05	-	V

6.2 Control

(V_{DD}-COM) = (V_B - V_S) = 15 V. T_C = 25°C unless otherwise specified. The V_{IN} and I_{IN} parameters are referenced to COM and are applicable to all six channels. The V_{DDUV} parameters are referenced to COM. The V_{BSUV} parameters are referenced to VS.

Table 12

Parameter	Symbol	Min.	Typ.	Max.	Units
Logic "1" input voltage (LIN, HIN)	$V_{IN,TH+}$	2.2	-	-	V
Logic "0" input voltage (LIN, HIN)	$V_{IN,TH-}$	-	-	0.8	V
V_{DD}/V_{BS} supply undervoltage, positive going threshold	$V_{DD,UV+}$, $V_{BS,UV+}$	10.0	11.1	12.2	V
V_{DD}/V_{BS} supply undervoltage, negative going threshold	$V_{DD,UV-}$, $V_{BS,UV-}$	9.8	10.9	12.0	V

Static Parameters

Parameter	Symbol	Min.	Typ.	Max.	Units
V_{DD}/V_{BS} supply undervoltage lock-out hysteresis	V_{DDUVH}, V_{BSUVH}	-	0.2	-	V
Quiescent V_{BS} supply current	I_{QBS}	-	-	70	µA
Quiescent V_{DD} supply current	I_{QCC}	-	-	3.0	mA
Input bias current V_{IN}=5V for LIN, HIN	I_{IN+}	-	5	20	µA
Bootstrap resistance	R_{BS}	-	240	-	Ω

7 Dynamic Parameters

7.1 Inverter

(V_{DD}-COM) = (V_B - V_S) = 15 V. T_C = 25°C unless otherwise specified.

Table 13: IM240-S6

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input to output turn-on propagation delay	T_{ON}	I_C = 1A, V+ = 300V	-	690	-	ns
Turn-on rise time	T_R		-	23	-	ns
Turn-on switching time	$T_{C(on)}$		-	132	-	ns
Input to output turn-off propagation delay	T_{OFF}	I_C = 1A, V+ = 300V	-	770	-	ns
Turn-off fall time	T_F		-	101	-	ns
Turn-off switching time	$T_{C(off)}$		-	83	-	ns
Turn-on switching energy	E_{ON}	I_C = 1A, V+ = 300V, V_{DD} = 15V, L = 7mH	-	37	-	µJ
Turn-off switching energy	E_{OFF}		-	8.3	-	
Diode reverse recovery energy	E_{REC}		-	7.6	-	
Diode reverse recovery time	T_{RR}		-	41	-	ns
Turn-on switching energy	E_{ON}	I_C = 1A, V+ = 300V, V_{DD} = 15V, L = 7mH, T_J = 150°C	-	62	-	µJ
Turn-off switching energy	E_{OFF}		-	17.6	-	
Diode reverse recovery energy	E_{REC}		-	19.0	-	
Diode reverse recovery time	T_{RR}		-	146	-	ns

Table 14: IM240-M6

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input to output turn-on propagation delay	T_{ON}	I_C = 1A, V+ = 300V	-	760	-	ns
Turn-on rise time	T_R		-	26	-	ns
Turn-on switching time	$T_{C(on)}$		-	160	-	ns
Input to output turn-off propagation delay	T_{OFF}	I_C = 1A, V+ = 300V	-	880	-	ns
Turn-off fall time	T_F		-	120	-	ns
Turn-off switching time	$T_{C(off)}$		-	100	-	ns
Turn-on switching energy	E_{ON}	I_C = 1A, V+ = 300V, V_{DD} = 15V, L = 7mH	-	40	-	µJ
Turn-off switching energy	E_{OFF}		-	15	-	
Diode reverse recovery energy	E_{REC}		-	7.8	-	
Diode reverse recovery time	T_{RR}		-	38	-	ns
Turn-on switching energy	E_{ON}	I_C = 1A, V+ = 300V, V_{DD} = 15V, L = 7mH, T_J = 150°C	-	73	-	µJ
Turn-off switching energy	E_{OFF}		-	29	-	
Diode reverse recovery energy	E_{REC}		-	26	-	

Dynamic Parameters

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Diode reverse recovery time	T_{RR}		-	69	-	ns

7.2 Control

$(V_{DD}\text{-COM}) = (V_B - V_S) = 15V$. $T_C = 25°C$ unless otherwise specified.

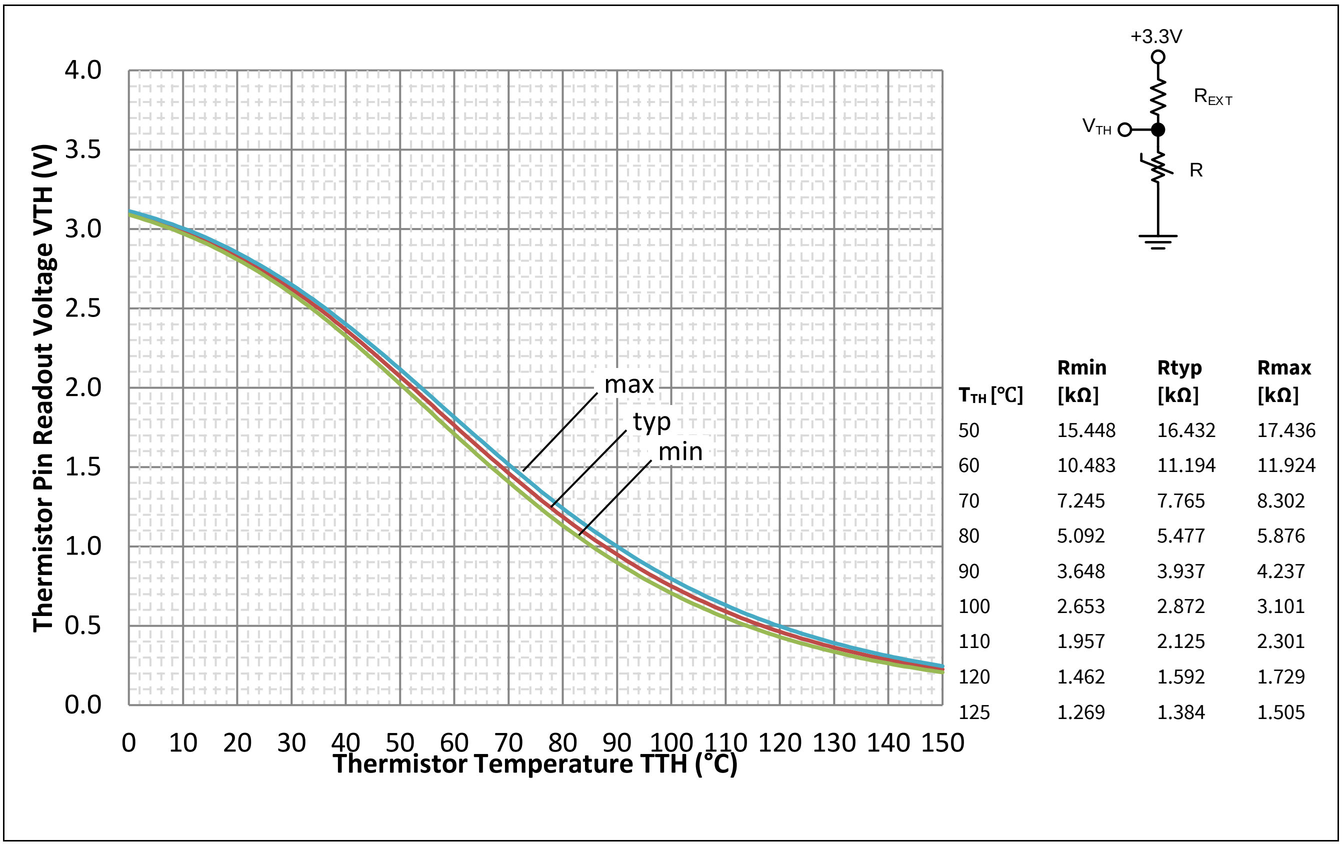
Table 15

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input filter time (HIN, LIN)	$T_{FIL,IN}$	$V_{IN} = 0$ or $V_{IN} = 5V$	-	300	-	ns
Internal dead time	DT_{IC}	$V_{IN} = 0$ or $V_{IN} = 5V$	-	300	-	ns
Matching propagation delay time (on and off) for same phase high-side and low-side	M_T	External dead time > 500ns	-	-	50	ns

8 Thermistor Characteristics

Table 16

Parameter			Symbol	Conditions	Min.	Typ.	Max.	Units
Resistance	R_{25}	T_C = 25°C, ±5% tolerance	44.65	47	49.35	kΩ		
Resistance	R_{125}	T_C = 125°C	1.27	1.39	1.51	kΩ		
B-constant (25/100)	B	±1% tolerance	-	4006	-	K		
Temperature Range			-40	-	125	°C		



T_{TH} [°C]	Rmin [kΩ]	Rtyp [kΩ]	Rmax [kΩ]
50	15.448	16.432	17.436
60	10.483	11.194	11.924
70	7.245	7.765	8.302
80	5.092	5.477	5.876
90	3.648	3.937	4.237
100	2.653	2.872	3.101
110	1.957	2.125	2.301
120	1.462	1.592	1.729
125	1.269	1.384	1.505

Figure 5 Thermistor resistance – temperature curve, for R_{EXT}=9.76kΩ, and thermistor resistance variation with temperature.

9 Mechanical Characteristics and Ratings

Table 17

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Comparative Tracking Index	CTI		550	-	-	V
Curvature of module backside	BC	See Figure 6	-50	-	100	µm
Weight	W		-	3.1	-	g

10 Qualification Information

Table 18

UL Certification	File number E252584 (pending)	
Moisture sensitivity level (SOP23 only)	MSL3	
RoHS Compliant	Yes	
ESD	Human body model	Class 2
	Charge discharge model	Class C3

11 Diagrams & Tables

11.1 T_C Measurement Point

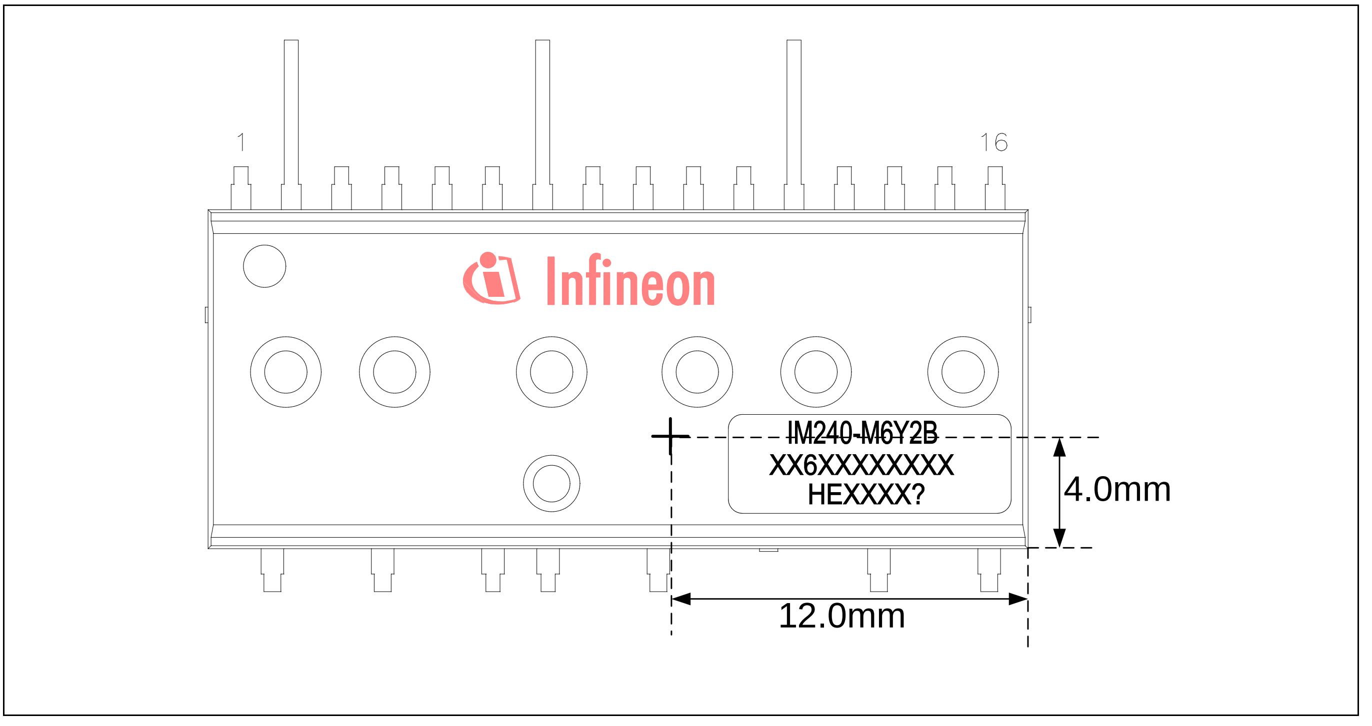


Figure 6 T_C measurement point

11.2 Backside Curvature Measurement Points

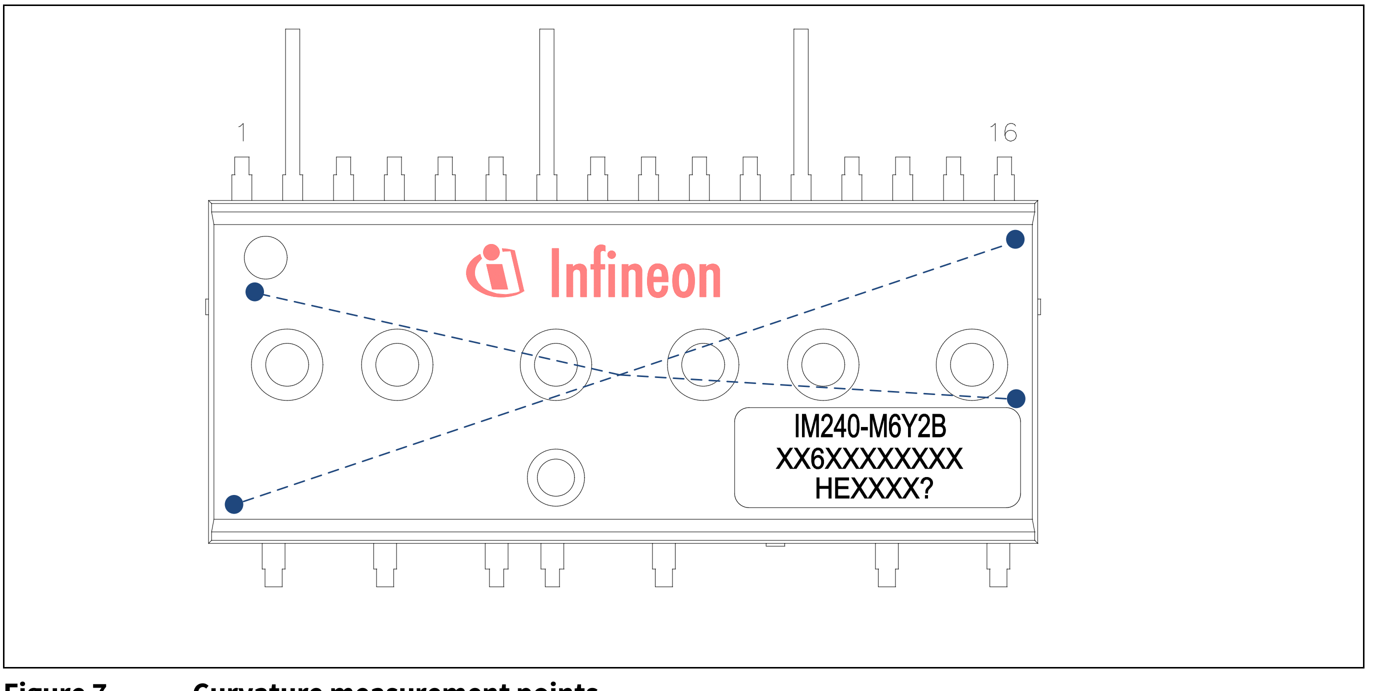


Figure 7 Curvature measurement points

11.3 Input-Output Logic Table

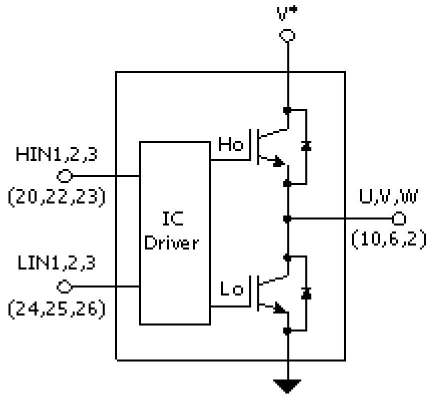


Figure 8 Module block diagram

Table 19

HIN1,2,3	LIN1,2,3	U,V,W
1	0	V+
0	1	0
0	0	‡
1	1	‡

‡ Voltage depends on direction of phase current

11.4 Switching Time Definitions

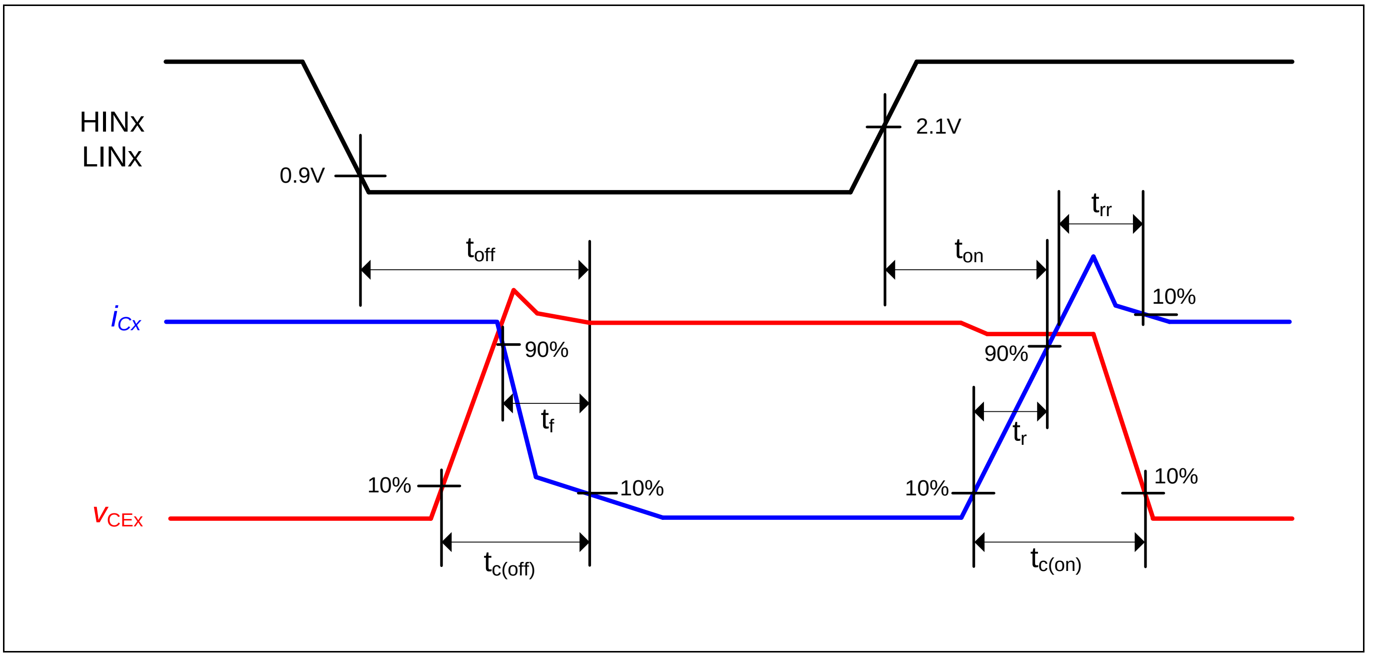


Figure 9 **Switching times definition**

12 Application Guide

12.1 Typical Application Schematic

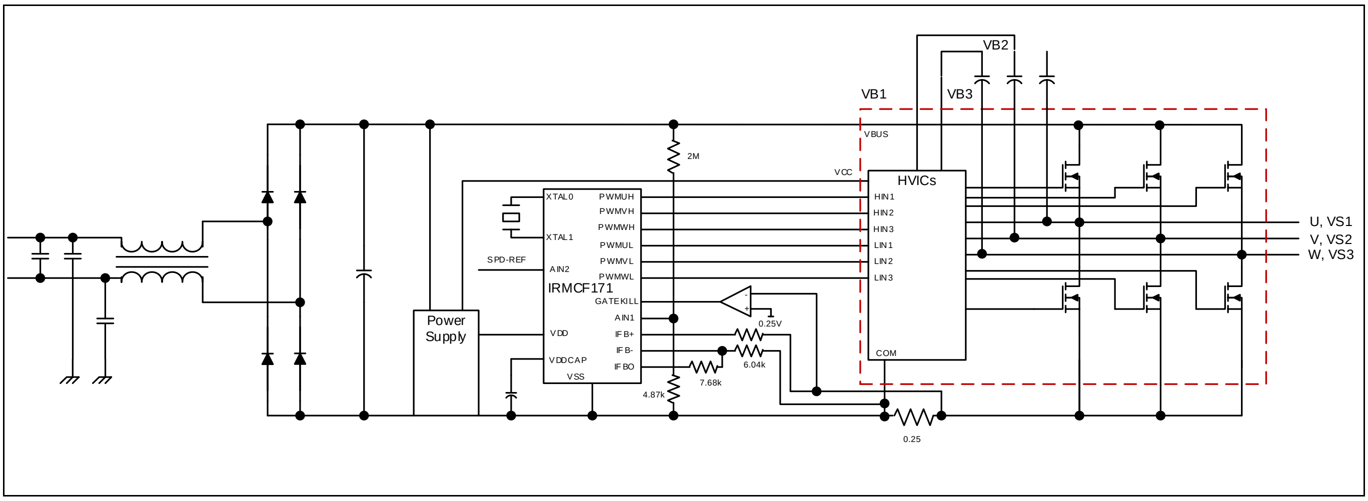


Figure 10 **Application schematic**

12.2 Performance Charts

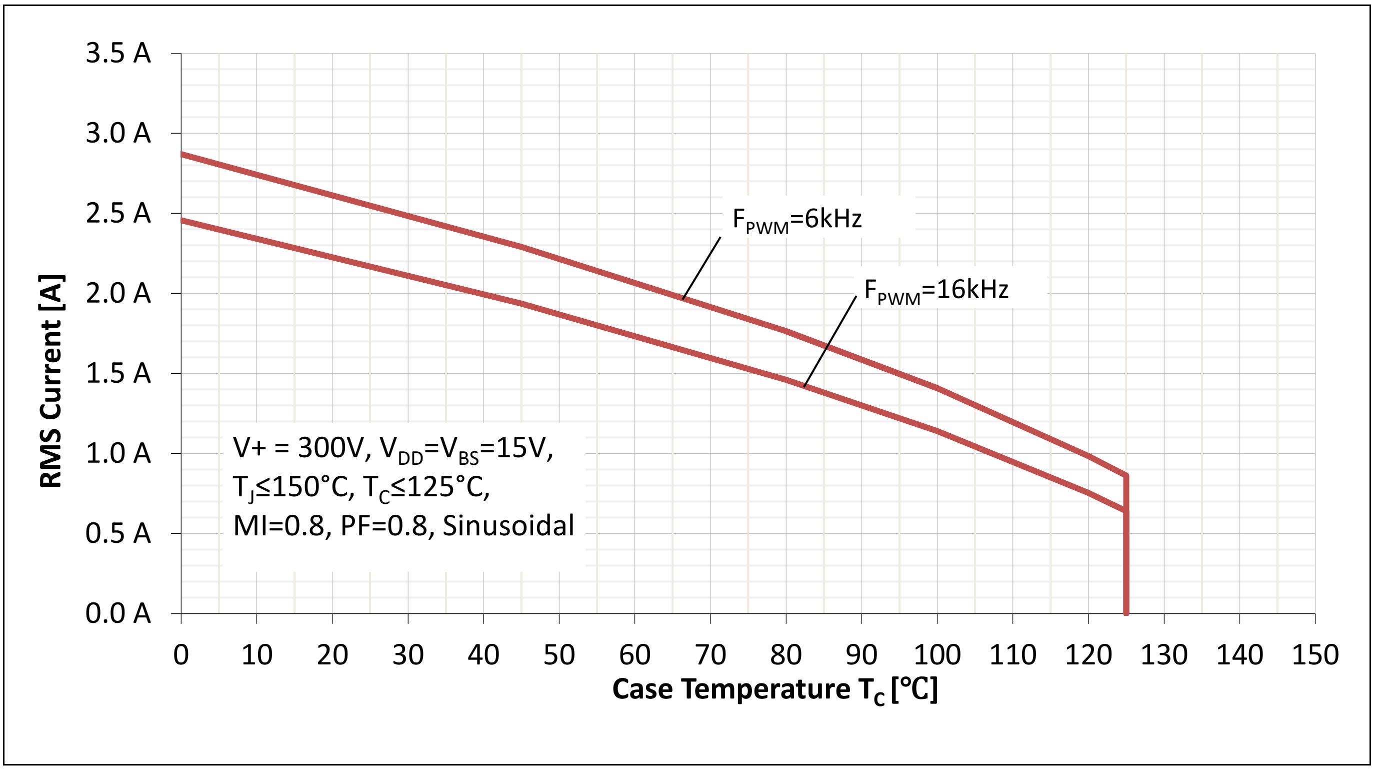


Figure 11: IM240-S6 **Continuous current using a typical loss and worse case Zthjc model**

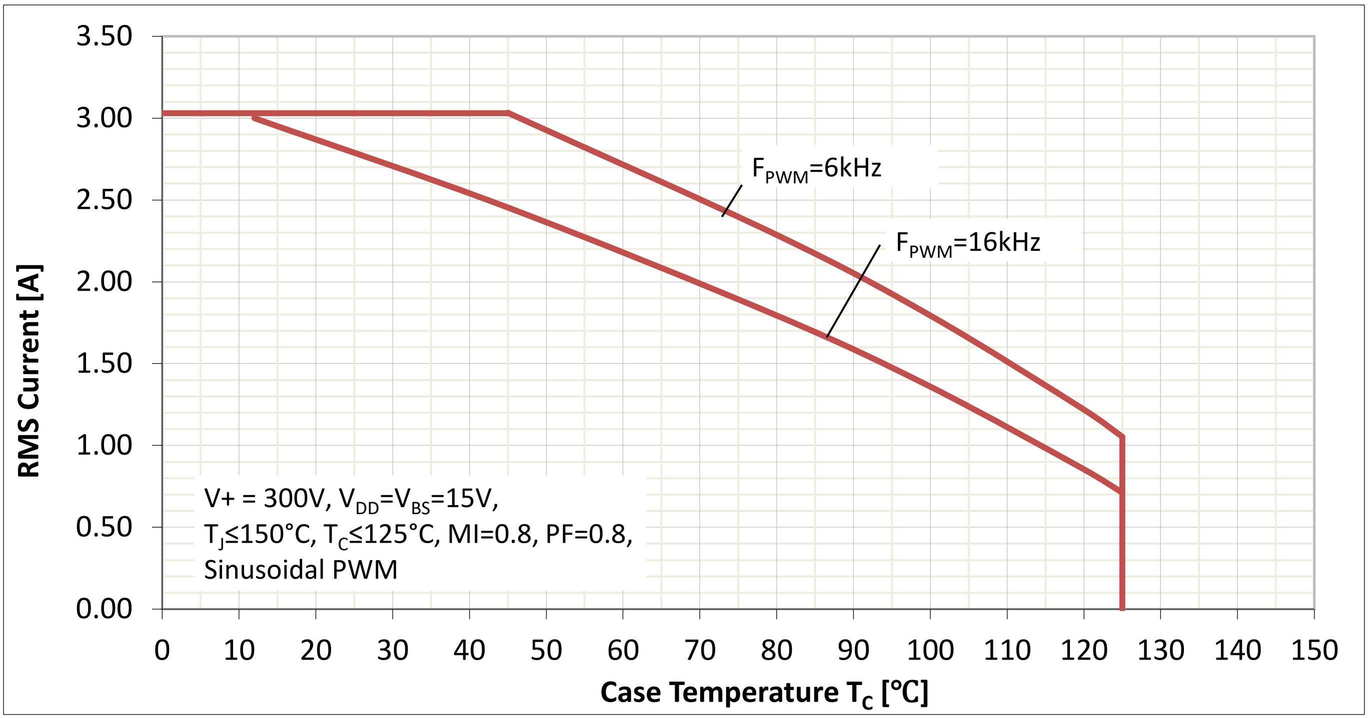


Figure 12: IM240-M6 Continuous current using a typical loss and worse case Zthjc model

12.3 T_J vs T_{TH}

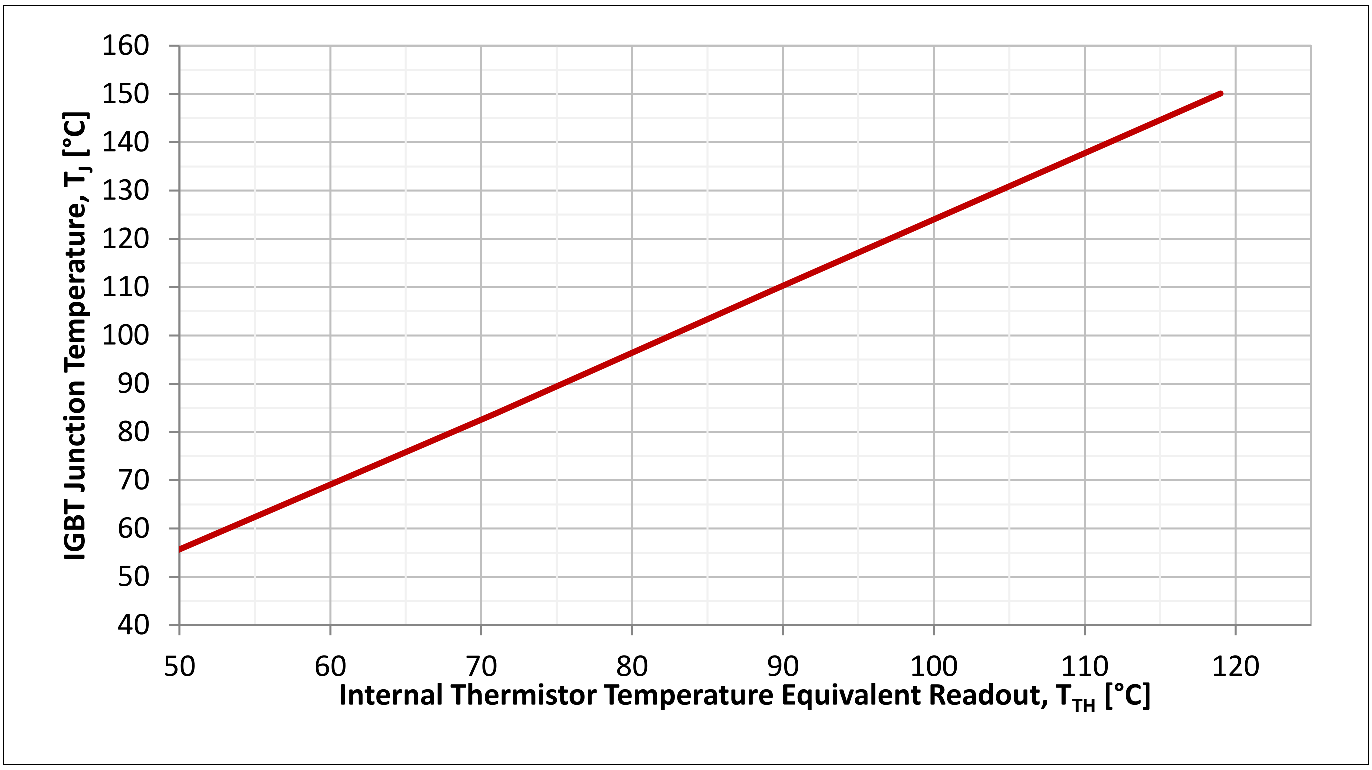


Figure 13: IM240-S6 Typical T_J vs T_{TH} correlation

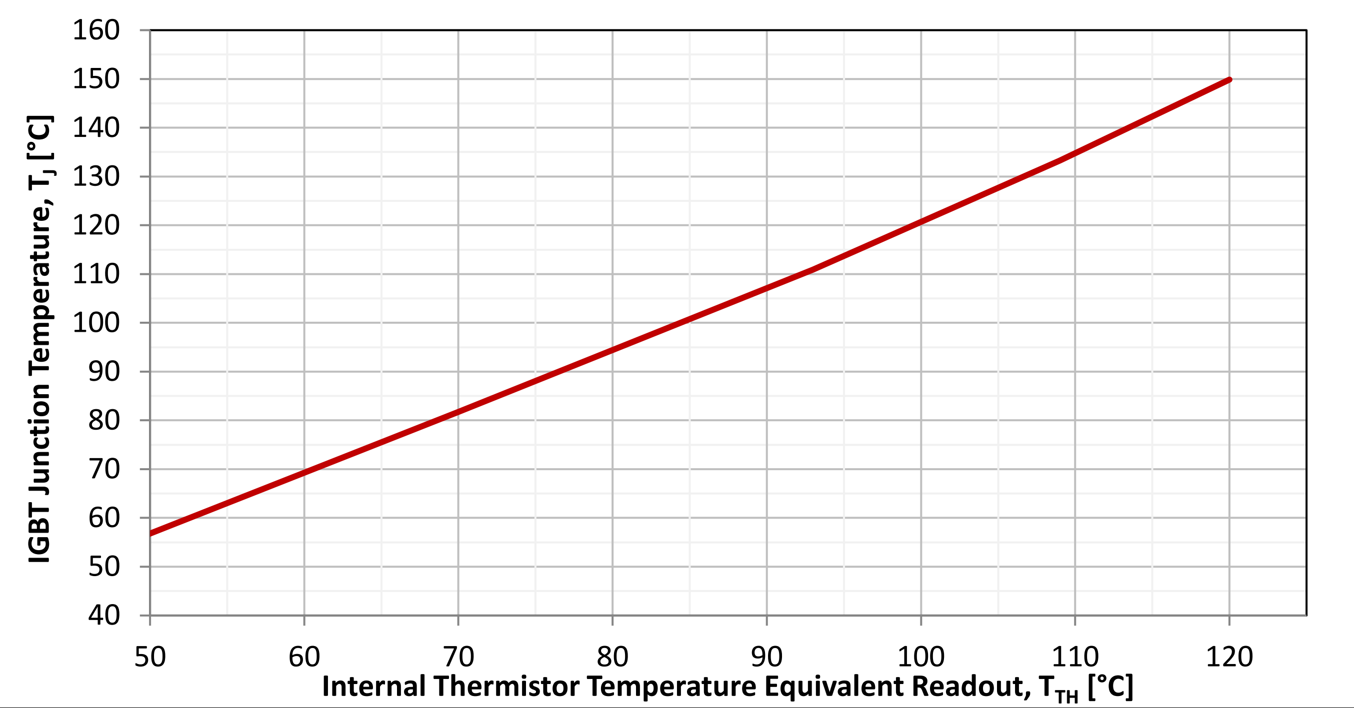


Figure 14: IM240-M6 Typical T_J vs T_{TH} correlation

12.4 $-V_S$ Immunity

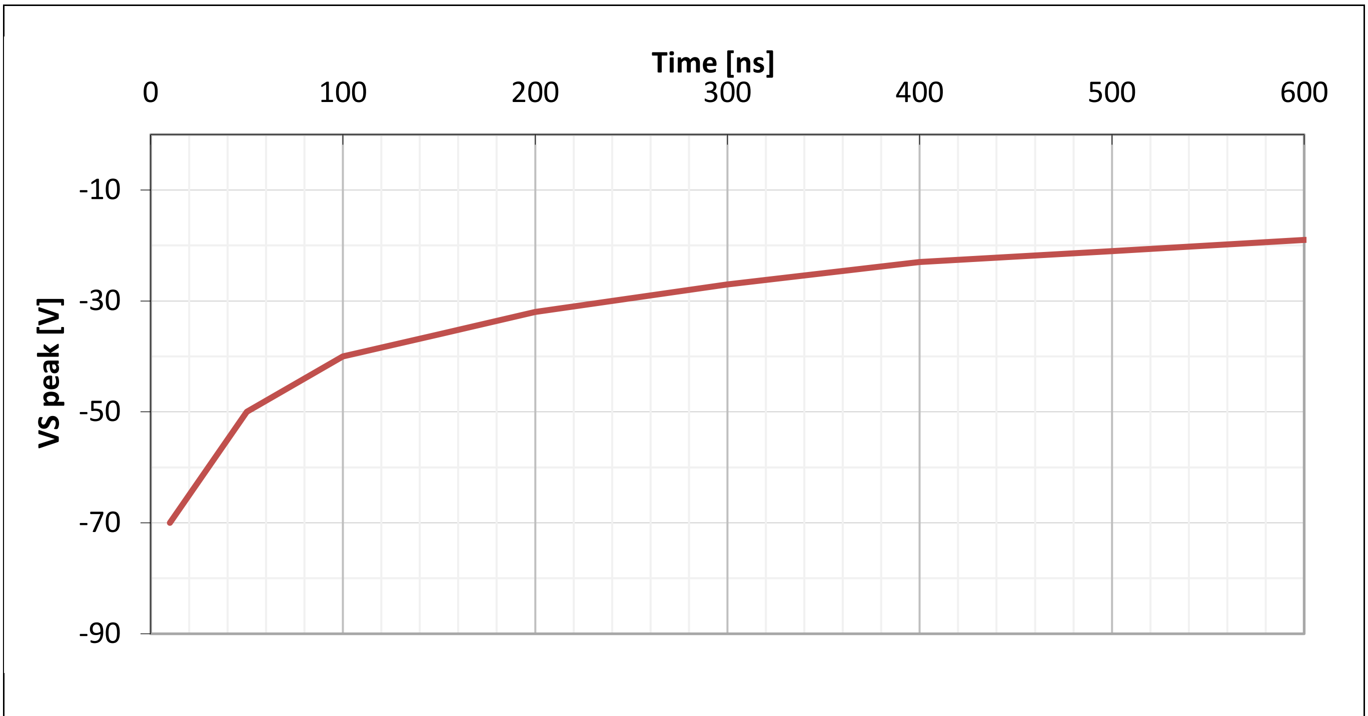
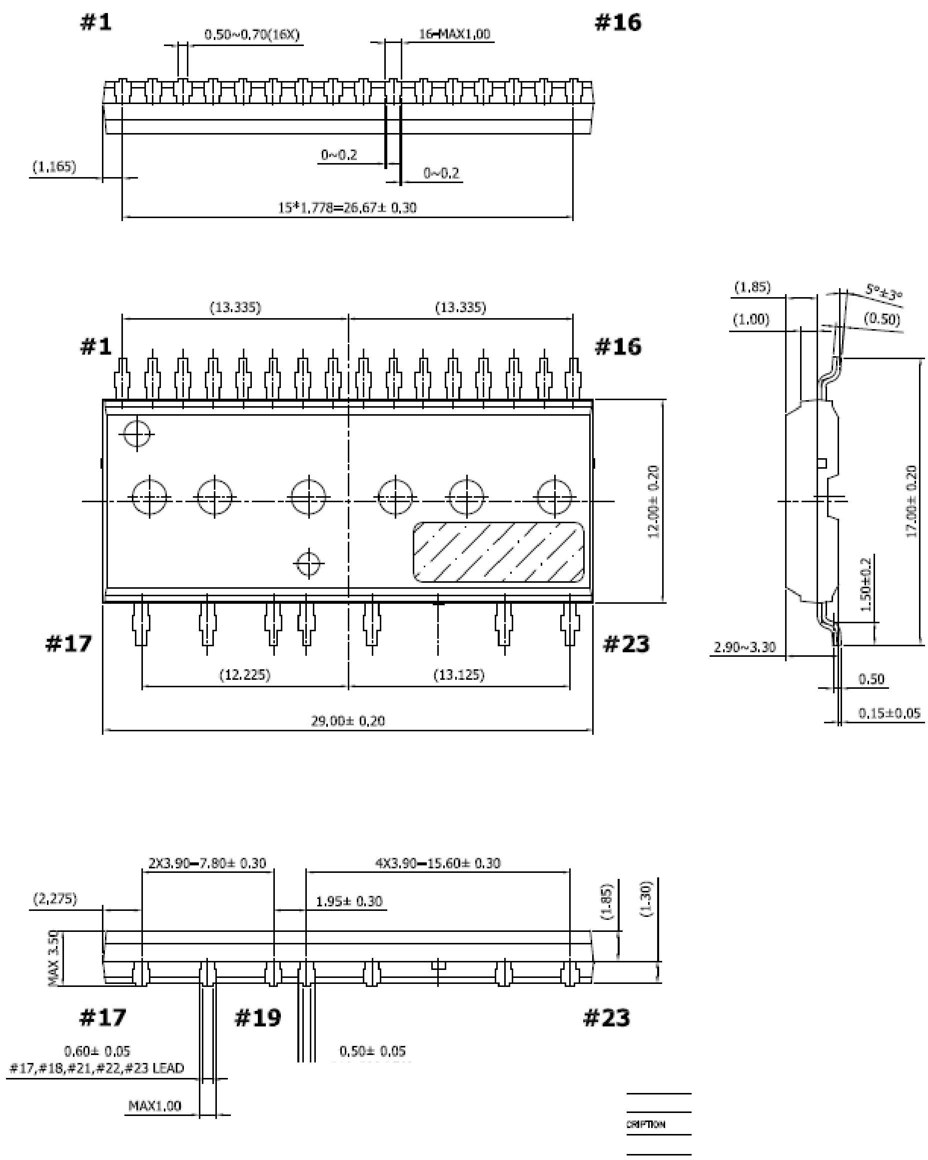


Figure 15 Negative transient V_s SOA for integrated gate driver

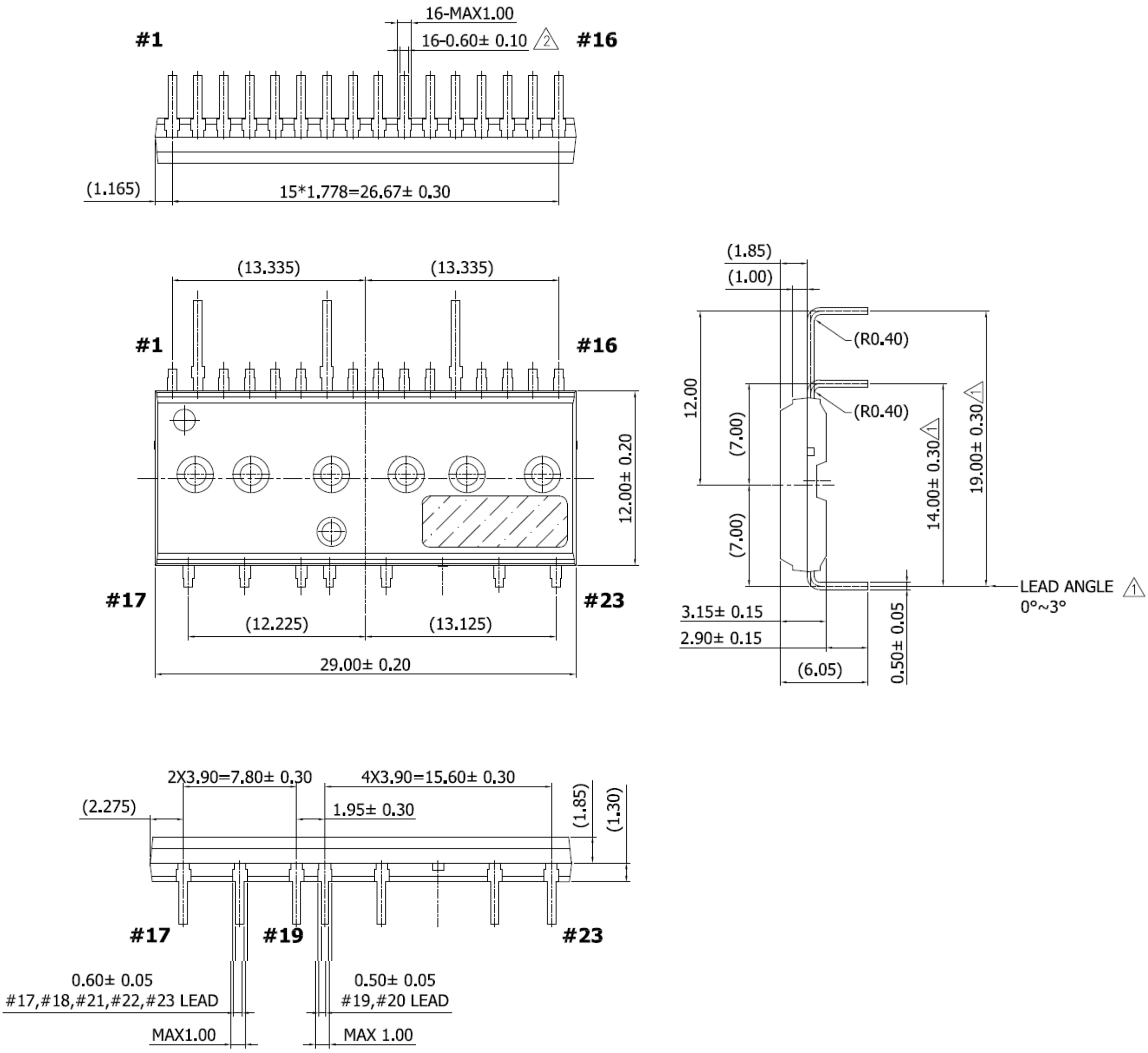
13 Package Outline

13.1 SOP23 (for IM240-S6Z1B & IM240-M6Z1B)



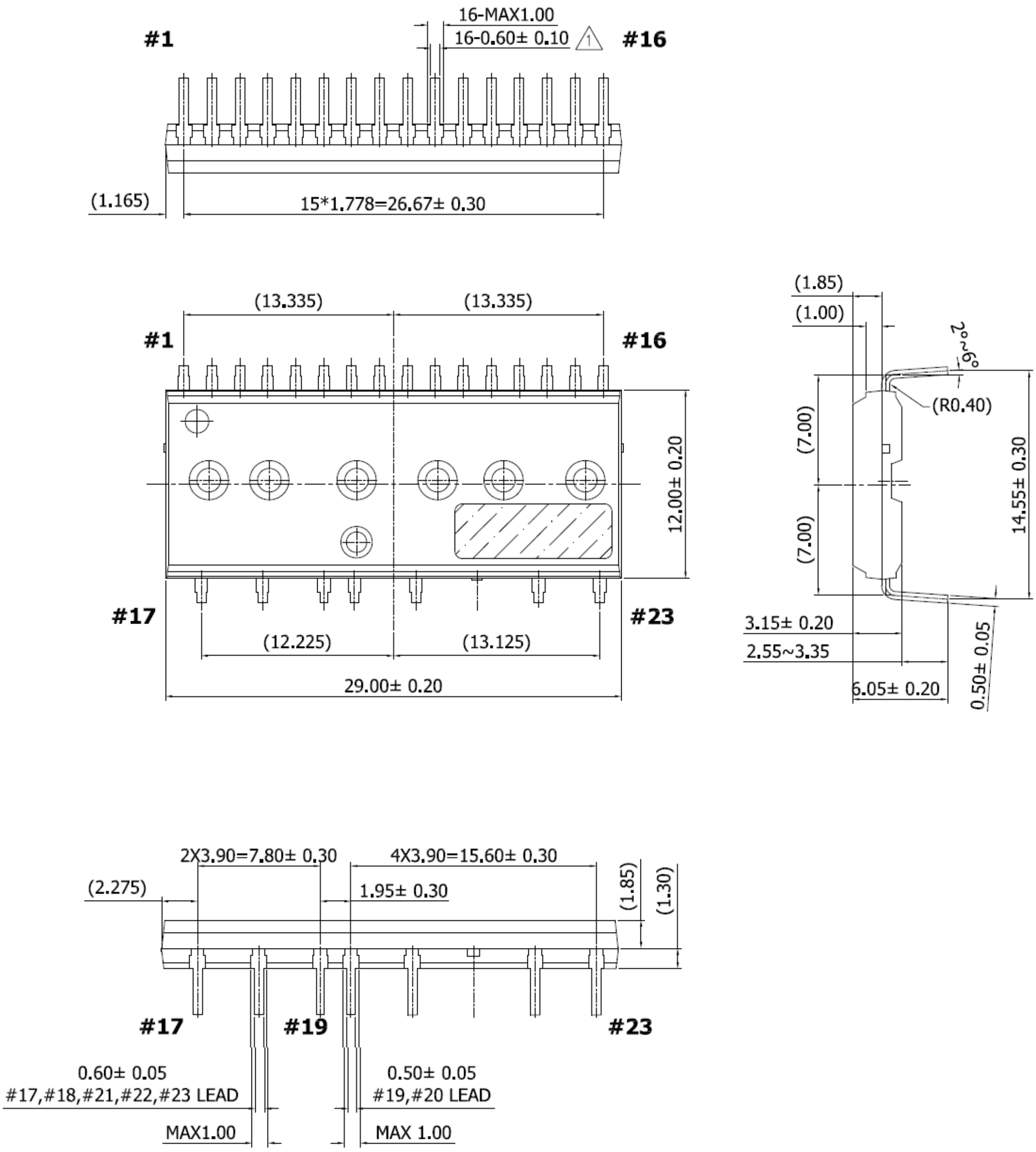
Dimensions in mm

13.2 DIP23A (for IM240-S6Y2B & IM240-M6Y2B)



Dimensions in mm

13.3 DIP23 (for IM240-S6Y1B & IM240-M6Y1B)



Dimensions in mm

14 Revision History

Major changes since the last revision

Page or Reference	Description of change
All pages	Merge “IM240-S6” and “IM240-M6” into one “IM240 Series”
Pages 1, 3	Fixed typo, figure 1 labels visibility