

# CIPOS™ Micro IPN: 600 V, 3 & 4 A

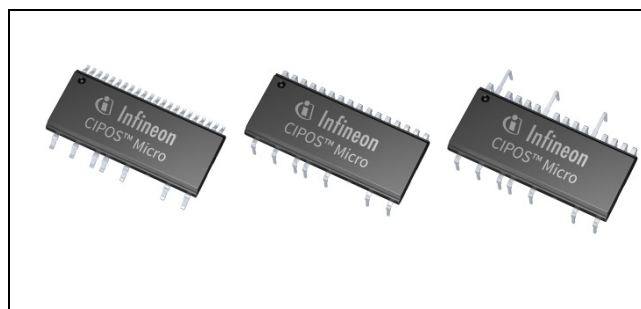
## IM240 Series

### 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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### Description1

#### Features 1

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Internal Electrical Schematic

# 1 Internal Electrical Schematic

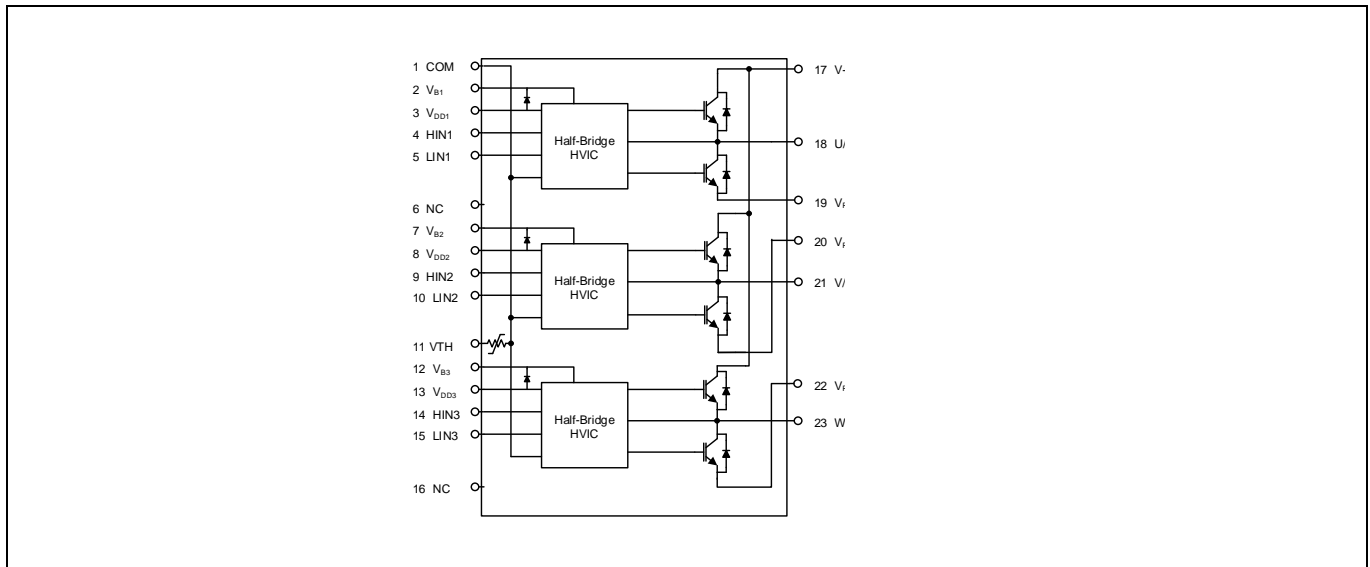


Figure 1 Internal electrical schematic.

Pin Configuration

## 2 Pin Configuration

### 2.1 Pin Assignment

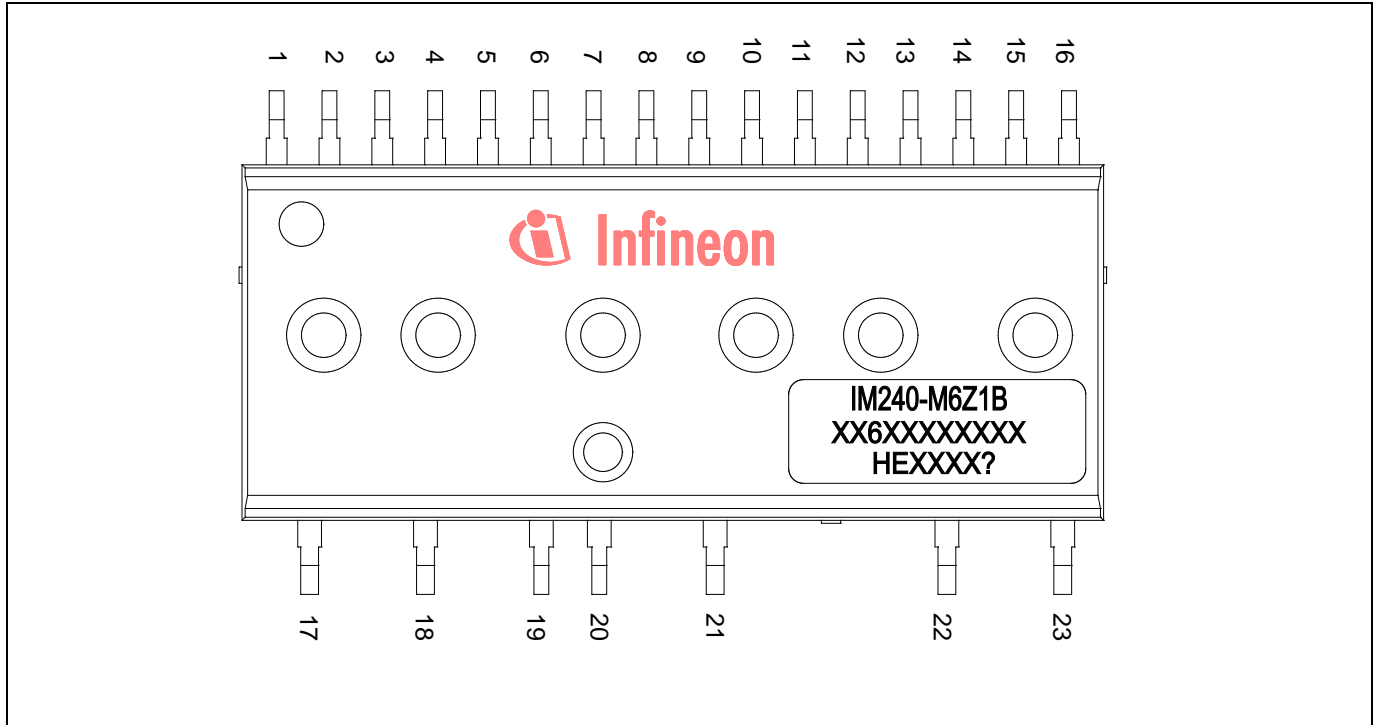


Figure 2 Module pinout

Table 2 Pin Assignment

Pin	Name	Description
1	COM	Logic ground
2	V <sub>B1</sub>	High side floating supply voltage 1
3	V <sub>DD1</sub>	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 <sub>B2</sub>	High side floating supply voltage 2
8	V <sub>DD2</sub>	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 <sub>B3</sub>	High side floating supply voltage 3
13	V <sub>DD3</sub>	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 <sub>S1</sub>	Output - phase 1, high side floating supply offset 1
19	V <sub>R1</sub>	Phase 1 low side emitter
20	V <sub>R2</sub>	Phase 2 low side emitter
21	V/V <sub>S2</sub>	Output - phase 2, high side floating supply offset 2
22	V <sub>R3</sub>	Phase 3 low side emitter
23	W/V <sub>S3</sub>	Output - phase 3, high side floating supply 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.

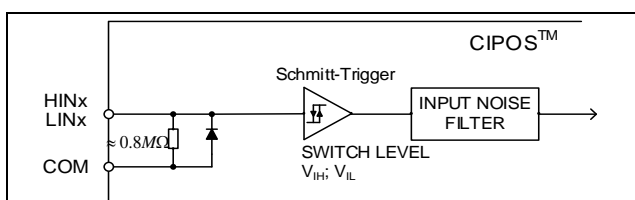


Figure 3 Input pin structure

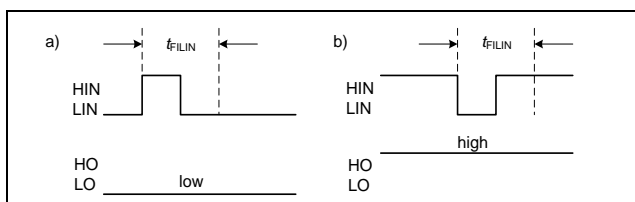


Figure 4 Input filter timing diagram

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<sub>DD</sub>, COM (Low side control supply and reference)**

V<sub>DD</sub> 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<sub>DDUV+</sub> = 11.1V is present.

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

**V<sub>B(1,2,3)</sub> and V<sub>S(1,2,3)</sub> (High side supplies)**

V<sub>B</sub> to V<sub>S</sub> 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<sub>BSUV+</sub> = 11.1V and a falling threshold of V<sub>BSUV-</sub> = 10.9V.

V<sub>S(1,2,3)</sub> provide a high robustness against negative voltage in respect of COM. This ensures very stable designs even under rough conditions.

**V<sub>R(1,2,3)</sub> (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<sub>S1</sub>, V/V<sub>S2</sub>, W/V<sub>S3</sub> (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.

Absolute Maximum Rating

### 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	$I_O$	$T_C = 25^\circ\text{C}$	3	A
Peak output current	$I_{OP}$	$T_C = 25^\circ\text{C}, t_p < 1\text{ms}$	6	A
Peak power dissipation per IGBT	$P_{tot}$	$T_C = 25^\circ\text{C}$	8.4	W
Short circuit withstand time	$T_{SC}$	$V_{DC} = 400\text{V}, T_J = 150^\circ\text{C}, V_{DD} = 15\text{V}$	5	µs

Table 5: IM240-M6

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

Thermal Characteristics

## 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



Recommended Operating Conditions

## 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 <sub>DD</sub>	13.5	-	16.5	V
High side floating supply voltage	V <sub>BS</sub>	12.5	-	17.5	V
Input voltage	V <sub>IN</sub>	0	-	5	V
PWM carrier frequency	F <sub>PWM</sub>	-	20	-	kHz
External dead time between HIN & LIN	DT	1	-	-	μs
Voltage between COM and V <sub>R(1,2,3)</sub>	V <sub>COMR</sub>	-5	-	5	V
Minimum input pulse width	PW <sub>IN(ON)</sub> , PW <sub>IN(OFF)</sub>	0.5	-	-	μs

Static Parameters

## 6 Static Parameters

### 6.1 Inverter

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

**Table 10: IM240-S6**

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

**Table 11: IM240-M6**

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

### 6.2 Control

( $V_{DD-COM}$ ) = ( $V_B - V_S$ ) = 15 V.  $T_C = 25^\circ\text{C}$  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**

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

Dynamic Parameters

## 7 Dynamic Parameters

### 7.1 Inverter

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

**Table 13: IM240-S6**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input to output turn-on propagation delay	$T_{ON}$	$I_C = 1\text{A}, V_+ = 300\text{V}$	-	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	$T_{OFF}$	$I_C = 1\text{A}, V_+ = 300\text{V}$	-	770	-	ns
Turn-off fall time	$T_F$		-	101	-	ns
Turn-off switching time	$T_{C(off)}$		-	83	-	ns
Turn-on switching energy	$E_{ON}$	$I_C = 1\text{A}, V_+ = 300\text{V}, V_{DD} = 15\text{V}, L = 7\text{mH}$	-	37	-	$\mu\text{J}$
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	$E_{ON}$	$I_C = 1\text{A}, V_+ = 300\text{V}, V_{DD} = 15\text{V}, L = 7\text{mH}, T_J = 150^\circ\text{C}$	-	62	-	$\mu\text{J}$
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	$T_{ON}$	$I_C = 1\text{A}, V_+ = 300\text{V}$	-	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	$T_{OFF}$	$I_C = 1\text{A}, V_+ = 300\text{V}$	-	880	-	ns
Turn-off fall time	$T_F$		-	120	-	ns
Turn-off switching time	$T_{C(off)}$		-	100	-	ns
Turn-on switching energy	$E_{ON}$	$I_C = 1\text{A}, V_+ = 300\text{V}, V_{DD} = 15\text{V}, L = 7\text{mH}$	-	40	-	$\mu\text{J}$
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	$E_{ON}$	$I_C = 1\text{A}, V_+ = 300\text{V}, V_{DD} = 15\text{V}, L = 7\text{mH}, T_J = 150^\circ\text{C}$	-	73	-	$\mu\text{J}$
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**

$(V_{DD-COM}) = (V_B - V_S) = 15V$ .  $T_C = 25^\circ C$  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

Thermistor Characteristics

## 8 Thermistor Characteristics

Table 16

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Resistance	$R_{25}$	$T_C = 25^\circ\text{C}$ , $\pm 5\%$ tolerance	44.65	47	49.35	k $\Omega$
Resistance	$R_{125}$	$T_C = 125^\circ\text{C}$	1.27	1.39	1.51	k $\Omega$
B-constant (25/100)	B	$\pm 1\%$ tolerance	-	4006	-	K
Temperature Range			-40	-	125	$^\circ\text{C}$

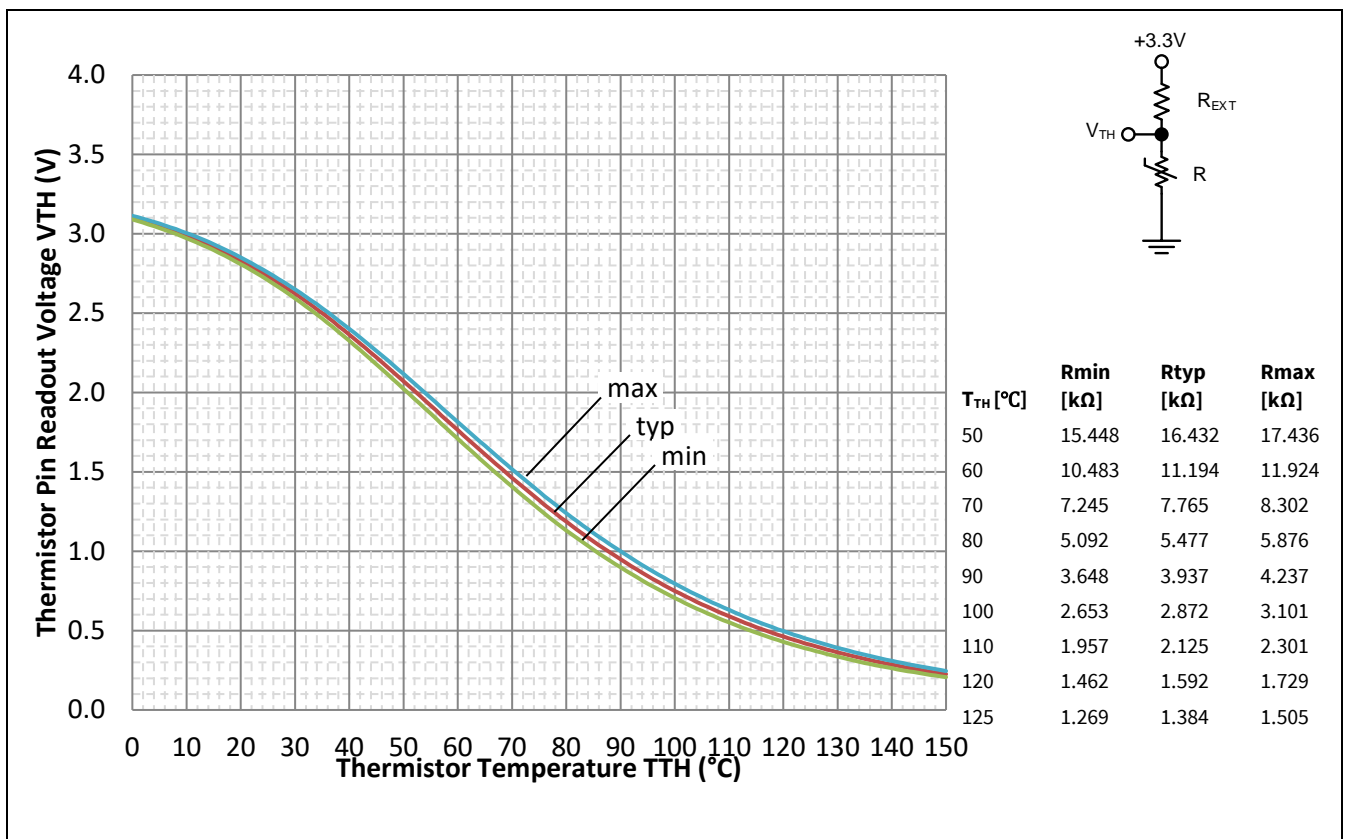


Figure 5 Thermistor resistance - temperature curve, for  $R_{EXT}=9.76\text{k}\Omega$ , and thermistor resistance variation with temperature.

## 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

Qualification Information

## 10 Qualification Information

Table 18

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



## 11 Diagrams & Tables

### 11.1 T<sub>c</sub> Measurement Point

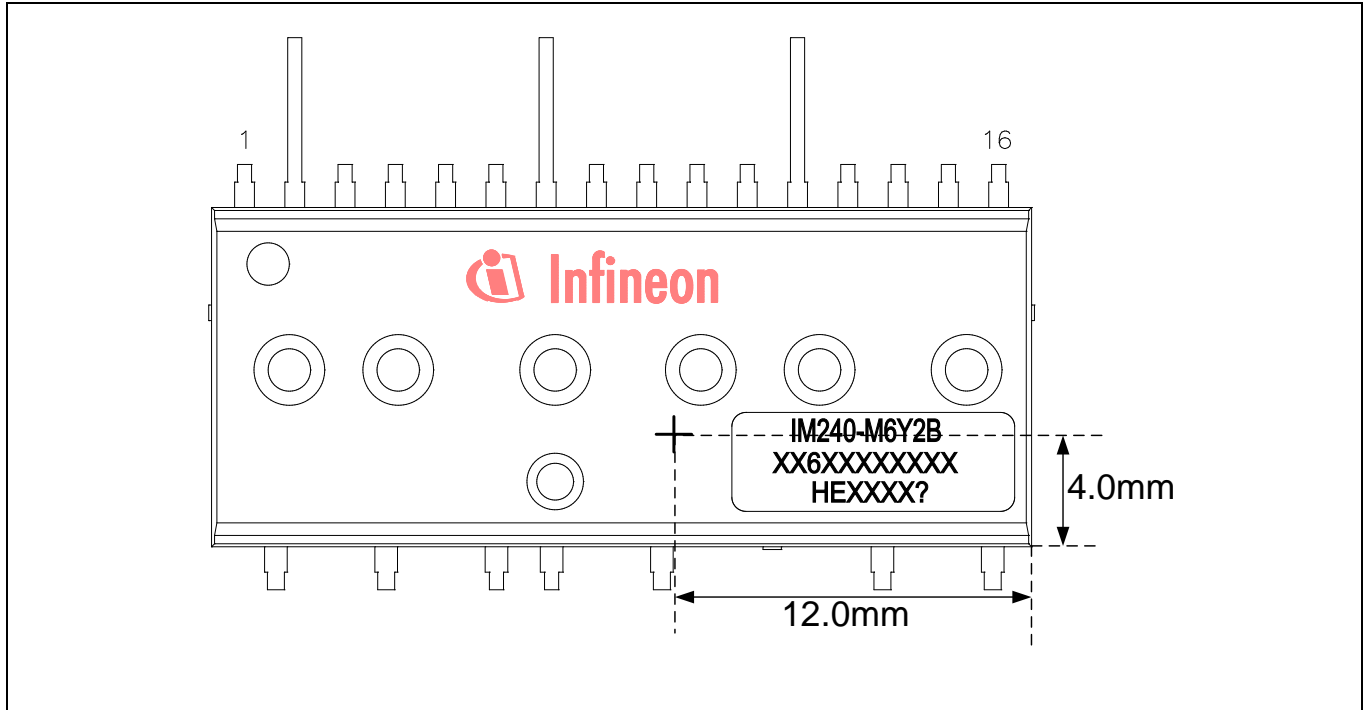


Figure 6 T<sub>c</sub> measurement point

### 11.2 Backside Curvature Measurement Points

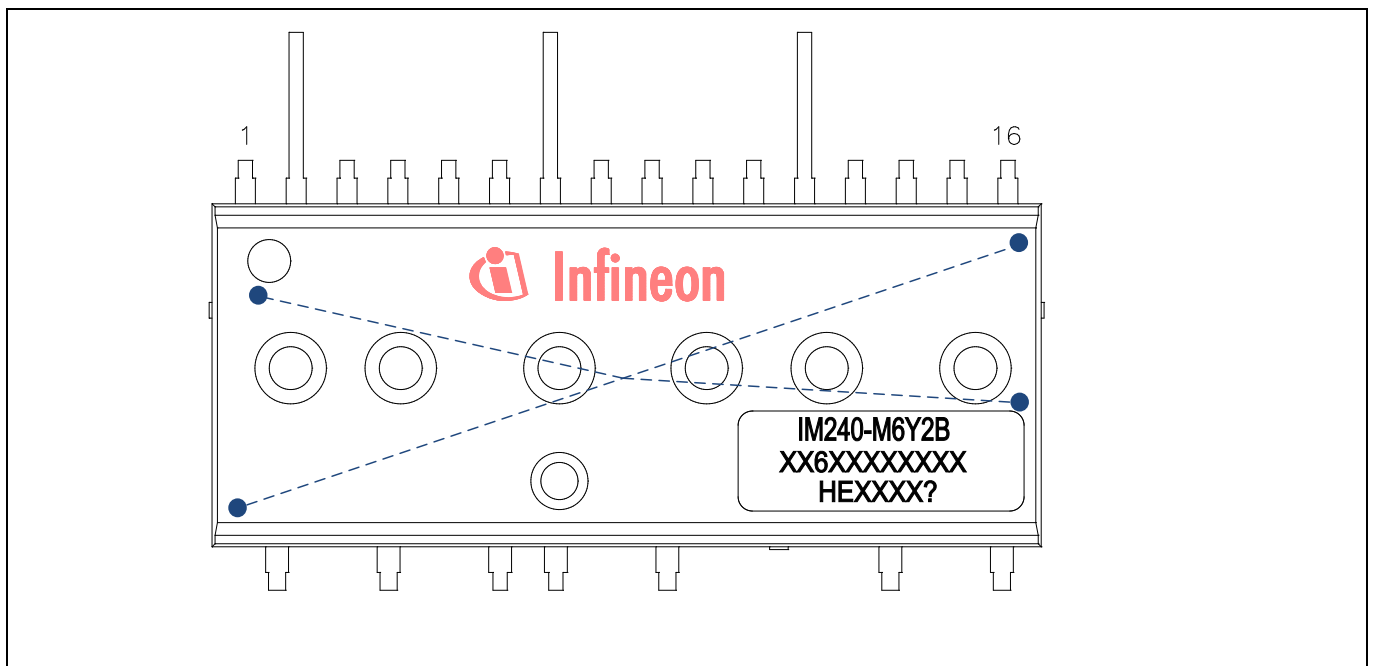


Figure 7 Curvature measurement points

### 11.3 Input-Output Logic Table

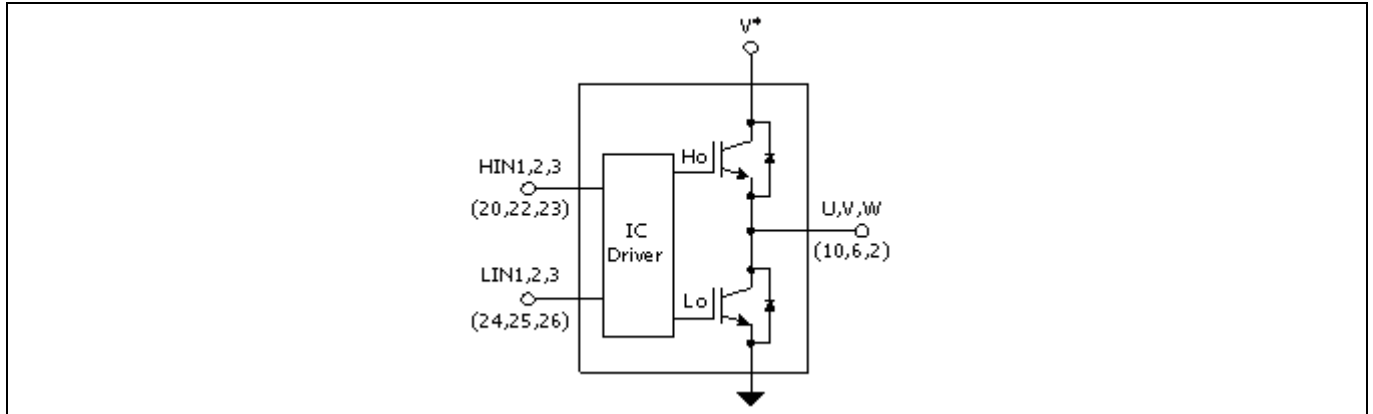


Figure 8 Module block diagram

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

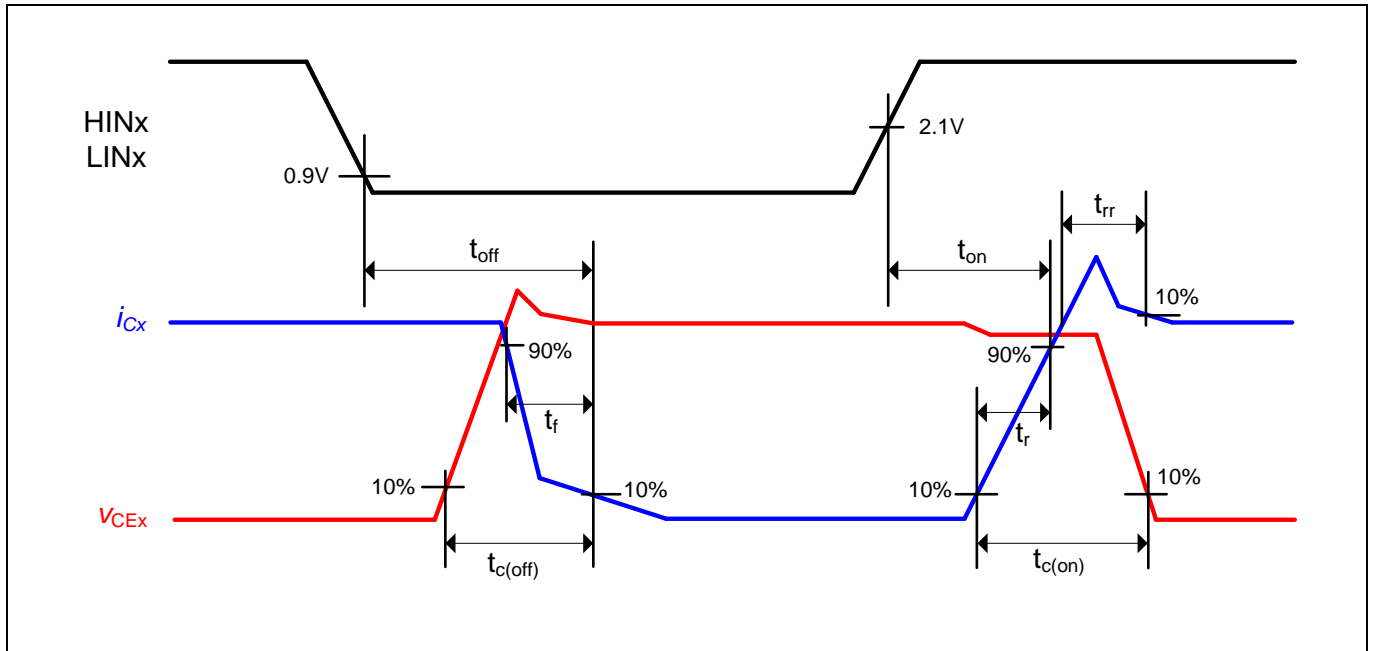


Figure 9 Switching times definition

## 12 Application Guide

### 12.1 Typical Application Schematic

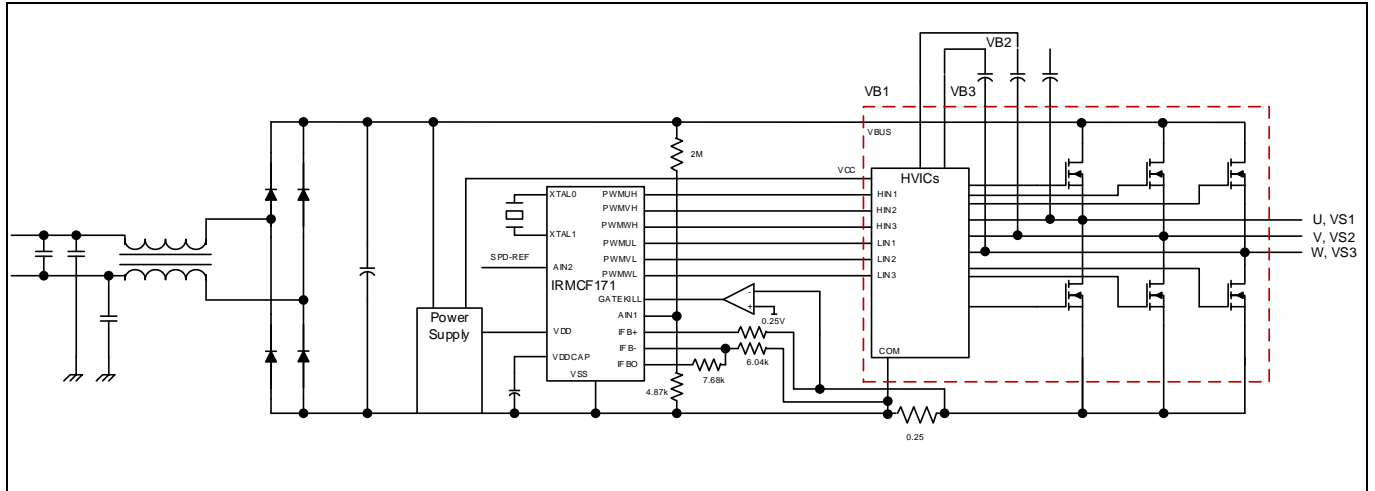


Figure 10 Application schematic

### 12.2 Performance Charts

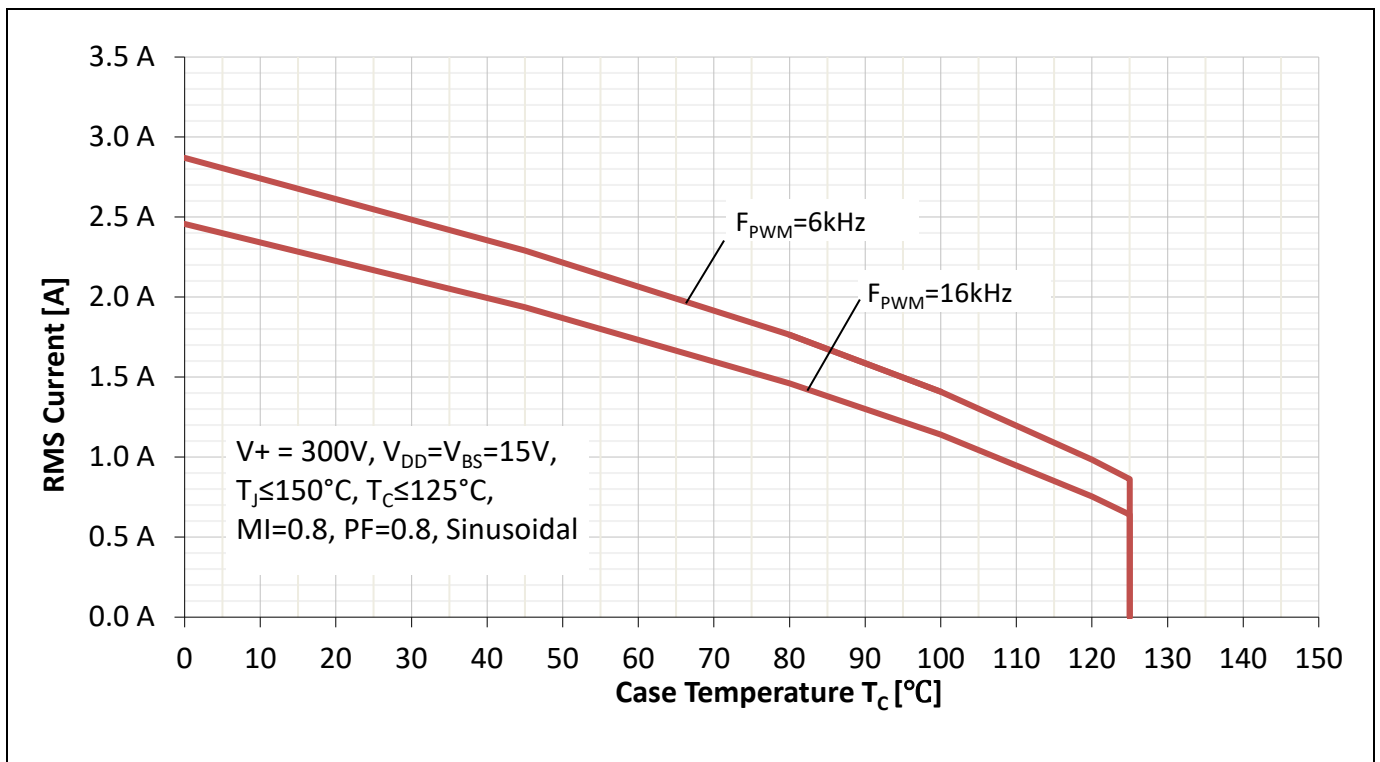


Figure 11: IM240-S6 Continuous current using a typical loss and worse case  $Z_{thjc}$  model

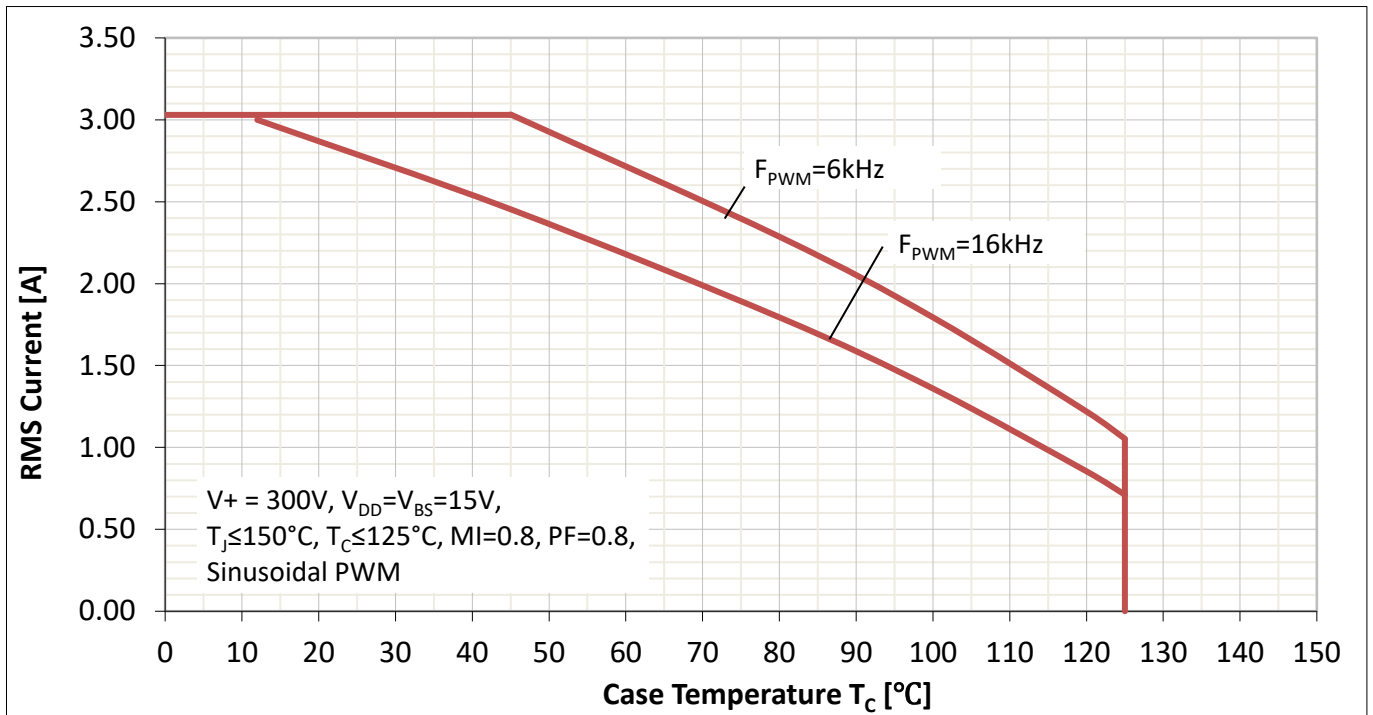


Figure 12: IM240-M6 Continuous current using a typical loss and worse case Zthjc model

### 12.3 $T_J$ vs $T_{TH}$

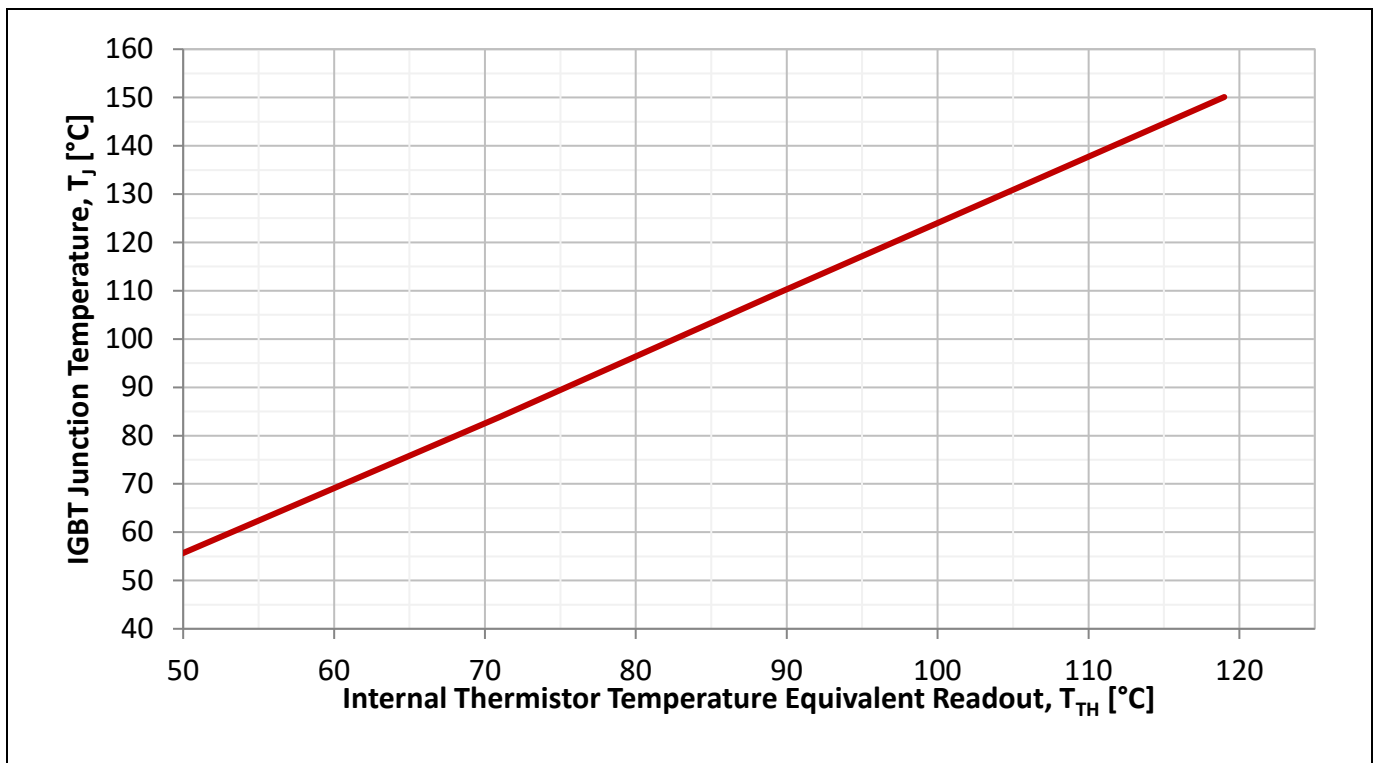


Figure 13: IM240-S6 Typical  $T_J$  vs  $T_{TH}$  correlation

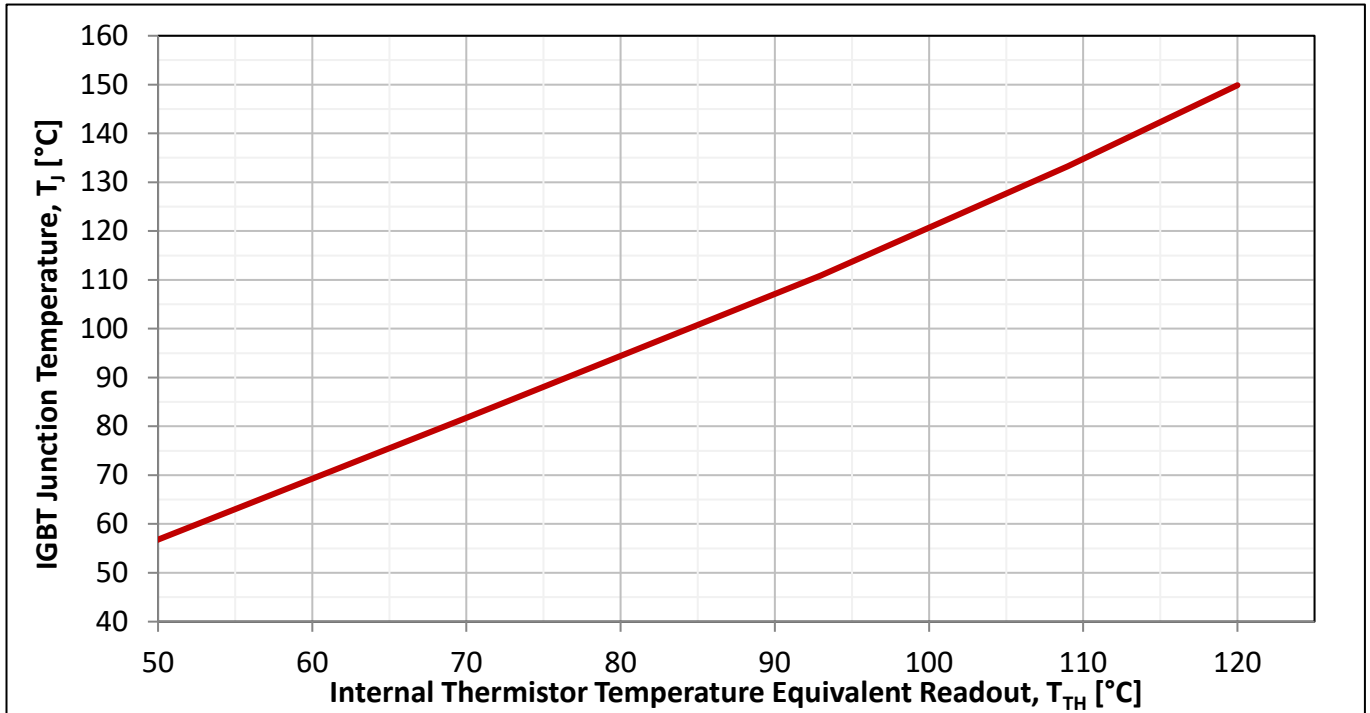


Figure 14: IM240-M6 Typical  $T_J$  vs  $T_{TH}$  correlation

## 12.4 - $V_S$ Immunity

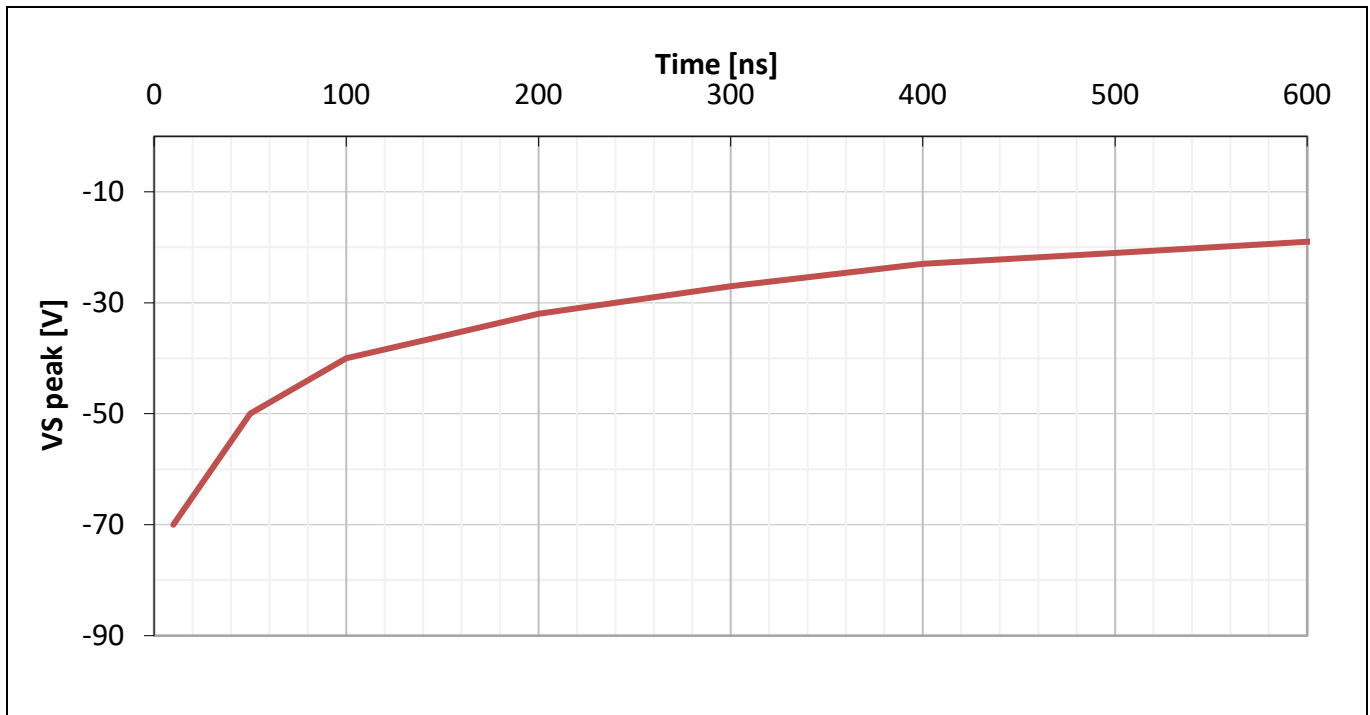
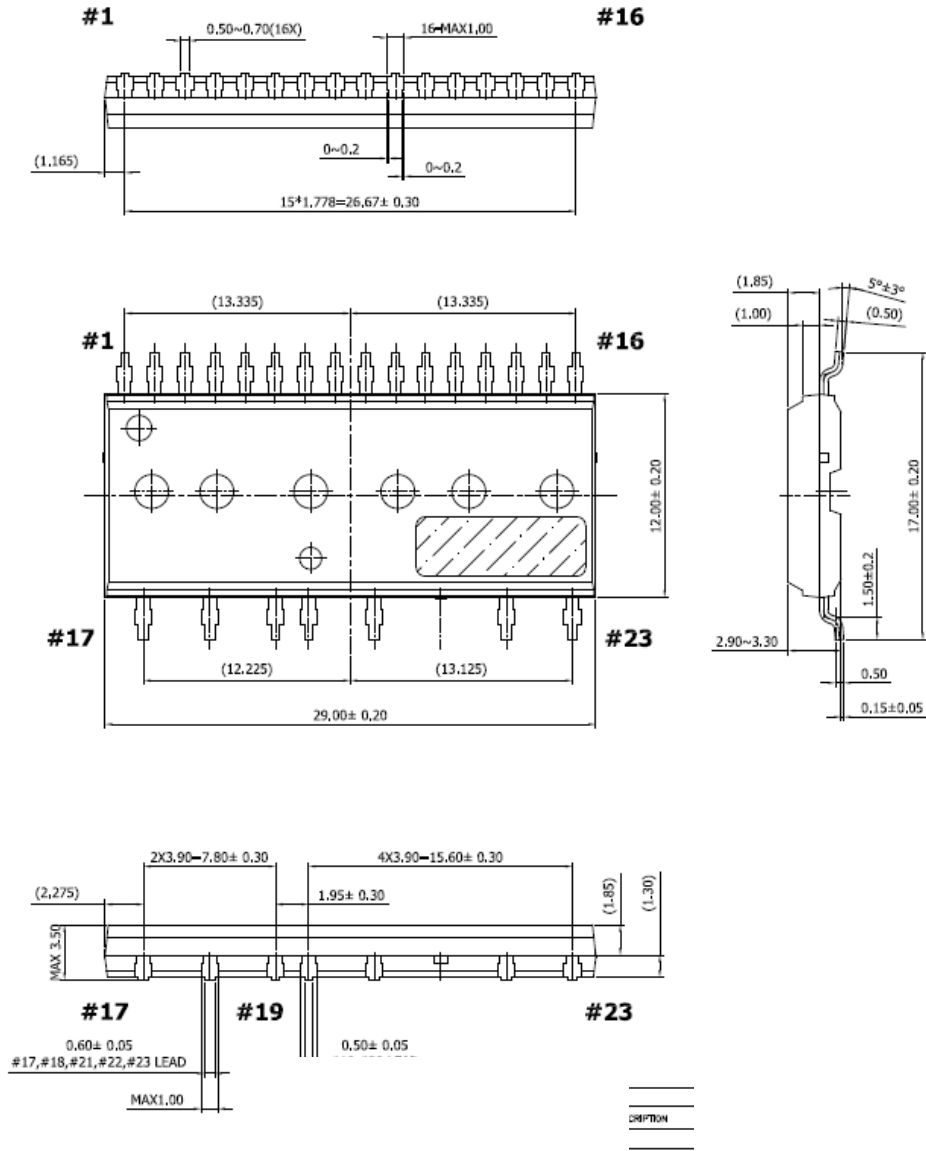


Figure 15 Negative transient  $V_S$  SOA for integrated gate driver

Package Outline

13 Package Outline

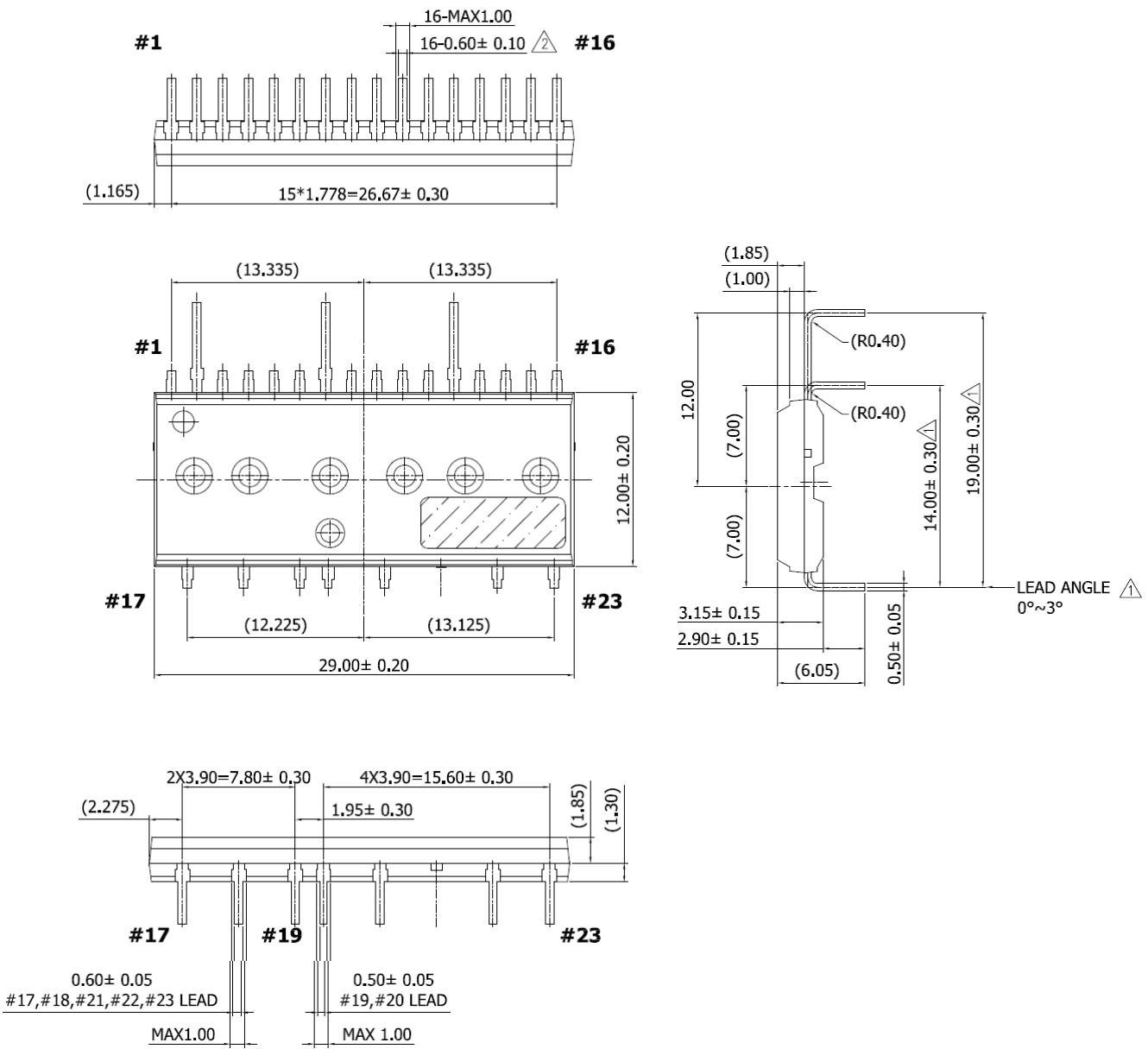
13.1 SOP23 (for IM240-S6Z1B & IM240-M6Z1B)



Dimensions in mm

Package Outline

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

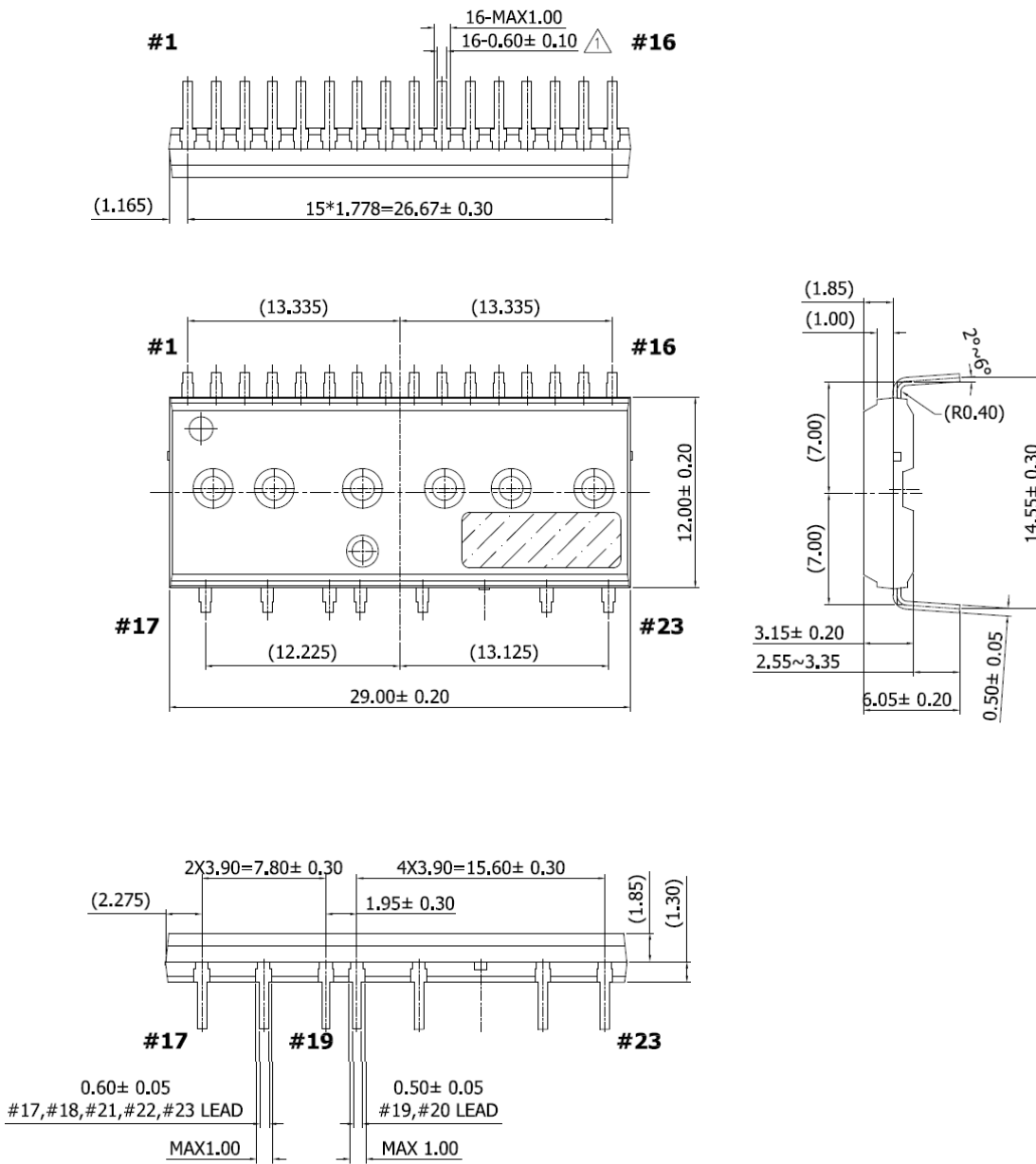


Dimensions in mm



Package Outline

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



Dimensions in mm

Revision History

## 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”

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