μIPM™-DIP

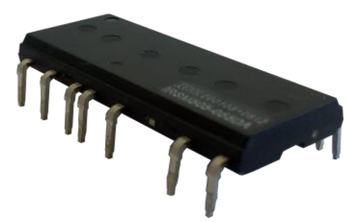
600V, 4A
Integrated Power Module for Small Appliance Motor Drive Applications

Description

IRSM506-076 and IRSM516-076 are 3-phase Integrated 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 $V_{CE(sat)}$ Trench IGBT technology and the industry benchmark half-bridge high voltage, rugged driver in a familiar package. The modules are optimized for low EMI characteristics.
IRSM506-076 includes temperature feedback while IRSM516-076 does not.

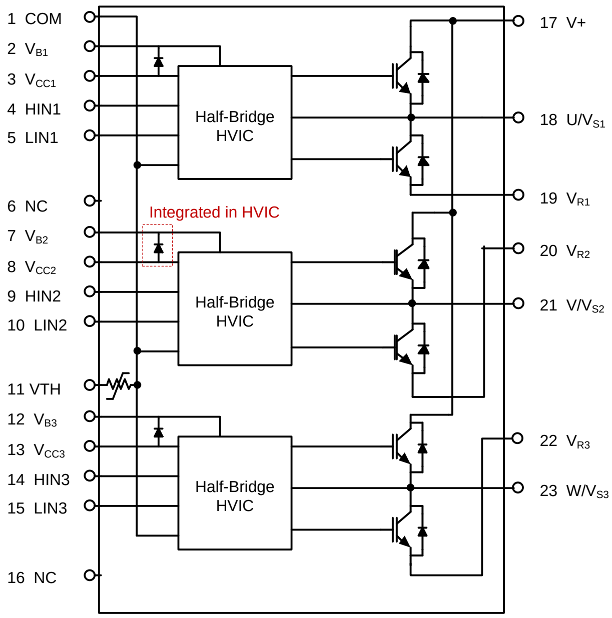
Features

- 600V 3-phase inverter including high voltage gate drivers
- Integrated bootstrap functionality
- Low 1.7V $V_{CE(sat)}$ (max, 25°C, 1A) Trench IGBT
- Under-voltage lockout for all channels
- Matched propagation delay for all channels
- Temperature feedback via NTC (IRSM506-076 only)
- 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 transient voltage (-Vs)
- Advanced input filter with shoot-through protection
- Rugged design for PM fan and pump motors
- Isolation 1900V_{RMS}, 1min

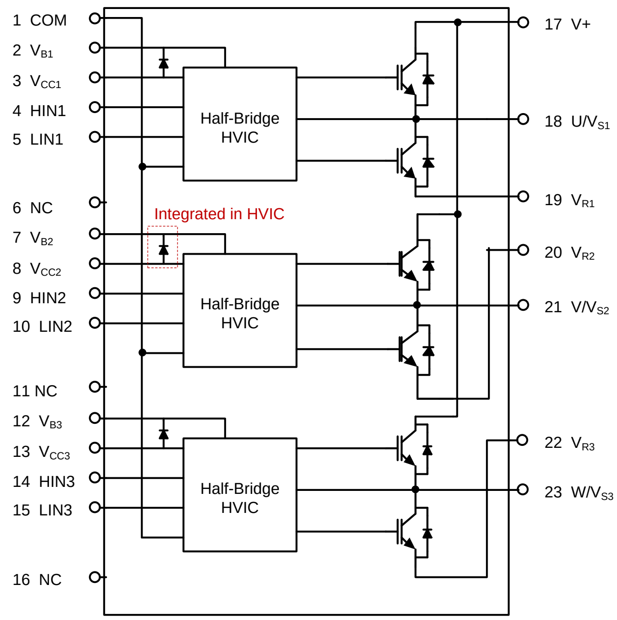


Base Part Number	NTC	Package Type	Standard Pack		Orderable Part Number
			Form	Quantity	
IRSM506-076	Yes	SOP23	Tube	240	IRSM506-076PA
		DIP23	Tube	240	IRSM506-076DA
		DIP23A	Tube	240	IRSM506-076DA2
IRSM516-076	No	SOP23	Tube	240	IRSM516-076PA
		DIP23	Tube	240	IRSM516-076DA
		DIP23A	Tube	240	IRSM516-076DA2

Internal Electrical Schematic



IRSM506-076



IRSM516-076

Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the module may occur. These are not tested at manufacturing. All voltage parameters are absolute voltages referenced to COM unless otherwise stated in the table.

Symbol	Description	Min	Max	Unit
V_{CES} / V_{RRM}	IGBT/ FW Diode Blocking Voltage	---	600	V
I_O @ T_C=25°C	DC Output Current per IGBT	---	4.0	A
I_{OP} @ T_C =25°C	Pulsed Output Current per IGBT (Note 1)	---	15	
P_d @ T_C=25°C	Maximum Power Dissipation per IGBT	---	16	W
V_{ISO}	Isolation Voltage (1min)	---	1900	V_{RMS}
T_J	Operating Junction Temperature	-40	150	°C
T_C	Operating Case Temperature	-40	150	°C
T_S	Storage Temperature	-40	150	°C
$V_{S1,2,3}$	High Side Floating Supply Offset Voltage	$V_{B1,2,3}$ - 20	$V_{B1,2,3}$ +0.3	V
$V_{B1,2,3}$	High Side Floating Supply Voltage	-0.3	625	V
V_{CC}	Low Side and Logic Supply voltage	-0.3	25	V
V_{IN}	Input Voltage of LIN, HIN	COM -0.3	V_{CC}+0.3	V

Note 1: Pulse Width = 100µs, Single Pulse

Recommended Operating Conditions

Symbol	Description	Min	Max	Unit
V+	Positive DC Bus Input Voltage	---	480	V
$V_{S1,2,3}$	High Side Floating Supply Offset Voltage	(Note 2)	480	V
$V_{B1,2,3}$	High Side Floating Supply Voltage	V_S+12	V_S+20	V
V_{CC}	Low Side and Logic Supply Voltage	13.5	16.5	V
V_{IN}	Input Voltage of LIN, HIN, I_{TRIP}, EN, FLT	0	5	V
F_p	PWM Carrier Frequency	---	20	kHz

Note 2: Logic operational for Vs from COM-8V to COM+600V. Logic state held for Vs from COM-8V to COM-V_{BS}.

Static Electrical Characteristics

(V_{CC}-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_{CCUV} parameters are referenced to COM. The V_{BSUV} parameters are referenced to V_S.

Symbol	Description	Min	Typ	Max	Units	Conditions
$V_{(BR)CES}$	Collector to Emitter Breakdown Voltage	600	---	---	V	T_J=25°C, I_{LK}=250µA
I_{LKH}	Leakage Current of Each High Side IGBT		5		µA	T_J=25°C, V_{CE}=600V
I_{LKL}	Leakage Current of Low Side IGBT Plus Gate Drive IC		10		µA	T_J=25°C, V_{CE}=600V
$V_{CE(ON)}$	Collector to Emitter Saturation Voltage	---	1.2	1.7	V	T_J=25°C, V_{CC}=15V, Ic = 1A
		---	1.3	---		T_J=150°C, V_{CC}=15V, Ic = 1A (Note 3)
V_{FM}	Diode Forward Voltage Drop	---	1.05	---	V	T_J=25°C, V_{CC}=15V, I_F=1A
$V_{IN,th+}$	Positive Going Input Threshold	2.2	---	---	V	
$V_{IN,th-}$	Negative Going Input Threshold	---	---	0.8	V	
V_{CCUV+}, V_{BSUV+}	V_{CC} and V_{BS} Supply Under-Voltage, Positive Going Threshold	10.4	11.1	11.8	V	
V_{CCUV-}, V_{BSUV-}	V_{CC} and V_{BS} supply Under-Voltage, Negative Going Threshold	10.2	10.9	11.6	V	
V_{CCUVH}, V_{BSUVH}	V_{CC} and V_{BS} Supply Under-Voltage Lock-Out Hysteresis	---	0.2	---	V	
I_{QBS}	Quiescent V_{BS} Supply Current V_{IN}=0V	---	42	60	µA	
$I_{QBS, ON}$	Quiescent V_{BS} Supply Current V_{IN}=4V	---	42	60	µA	
I_{QCC}	Quiescent V_{CC} Supply Current V_{IN}=0V	---	1.7	4	mA	
$I_{QCC, ON}$	Quiescent V_{CC} Supply Current V_{IN}=4V	---	1.8	4	mA	
I_{IN+}	Input Bias Current V_{IN}=4V	---	4.6	18	µA	V_{IN}=3.3V
I_{IN-}	Input Bias Current V_{IN}=0V	---	---	2	µA	V_{IN}=0V
R_{BR}	Internal Bootstrap Equivalent Resistor Value	---	200	---	Ω	T_J=25°C

Note 3: Characterized, not tested at manufacturing

Dynamic Electrical Characteristics

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

Symbol	Description	Min	Typ	Max	Units	Conditions
T_{ON}	Input to Output Propagation Turn-On Delay Time	---	0.7	1.5	µs	I_D=120mA, V+=30V See Fig.1
T_{OFF}	Input to Output Propagation Turn-Off Delay Time	---	0.8	1.5	µs	
$T_{FIL,IN}$	Input Filter Time (HIN, LIN)	200	300	---	ns	V_{IN}=0 & V_{IN}=3.3V
DT	Deadtime Inserted	---	400	---	ns	V_{IN}=0 & V_{IN}=3.3V without external deadtime
E_{ON}	Turn-on switching energy loss	---	16	---	µJ	V_+=320V, I_D=0.5A, L=40mH, T_C=25°C (Note 4)
E_{OFF}	Turn-off switching energy loss	---	10	---	µJ	
E_{REC}	Recovery energy loss	---	5	---	µJ	
$E_{ON,150}$	Turn-on switching energy loss	---	35	---	µJ	V_+=320V, I_D=0.5A, L=40mH, T_C=150°C (Note 4)
$E_{OFF,150}$	Turn-off switching energy loss	---	21	---	µJ	
$E_{REC,150}$	Recovery energy loss	---	13	---	µJ	

Note 4: Characterized, not tested at manufacturing

Thermal and Mechanical Characteristics

Symbol	Description	Min	Typ	Max	Units	Conditions
$R_{th(J-C)}$	Junction to Case Thermal Resistance, one IGBT	---	7.2	---	°C/W	High Side V-Phase IGBT (Note 5)
$R_{th(J-C)}$	Junction to Case Thermal Resistance, one diode	---	9.1	---	°C/W	High Side V-Phase Diode (Note 5)

Note 5: Characterized, not tested at manufacturing. Case temperature (T_C) point shown in Figure 2.

Internal NTC – Thermistor Characteristics (IRSM506-076 Only)

Symbol	Description	Min	Typ	Max	Units	Conditions
R_{25}	Resistance	---	47	---	kΩ	T_C=25°C, ±5% tolerance
R_{125}	Resistance	---	1.41	---	kΩ	T_C=125°C
B	B-constant (25-50°C)	---	4050	---	K	±2% tolerance (Note 6)
Temperature Range		-40	---	125	°C	

Note 6: See application notes for usage

Qualification Information†

Qualification Level		Industrial††
Moisture Sensitivity Level		MSL3†††
RoHS Compliant		Yes
UL Certified		Yes – File Number E252584
ESD	**Machine Model**	Class B
	Human Body Model	Class 2

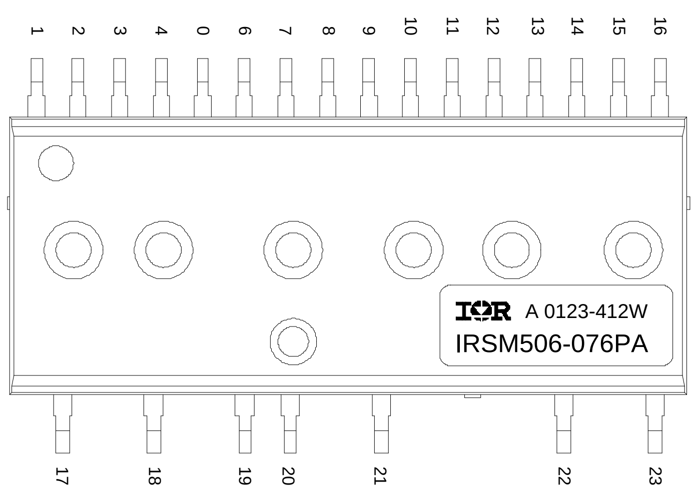
† Qualification standards can be found at International Rectifier's web site http://www.irf.com/

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information.

††† SOP23 package only. Higher MSL ratings may be available for the specific package types listed here. Please contact your International Rectifier sales representative for further information.

Module Pin-Out Description

Pin	Name	Description
1	COM	Logic Ground
2	V_{B1}	High Side Floating Supply Voltage 1
3	V_{CC1}	15V 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_{CC2}	15V 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	V_{TH}	Thermistor Output (IRSM506-076DA)
	NC	Not Connected (IRSM516-076DA)
12	V_{B3}	High Side Floating Supply Voltage 3
13	V_{CC3}	15V 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
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 Supply Offset 2



Referenced Figures

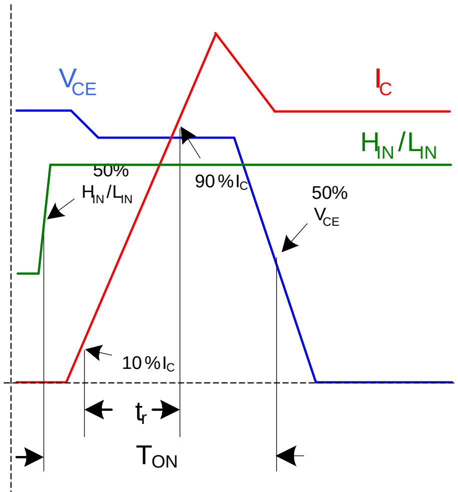


Figure 1a: Input to Output propagation turn-on delay time.

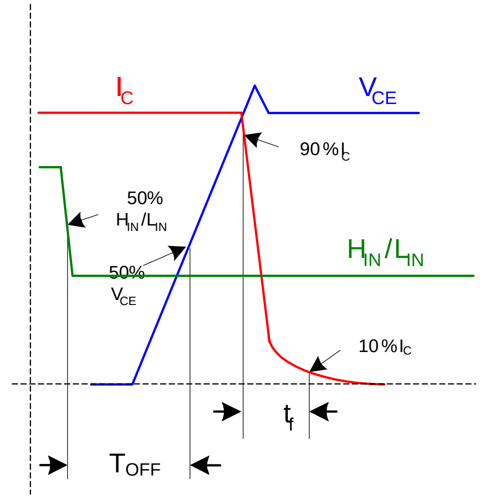


Figure 1b: Input to Output propagation turn-off delay time.

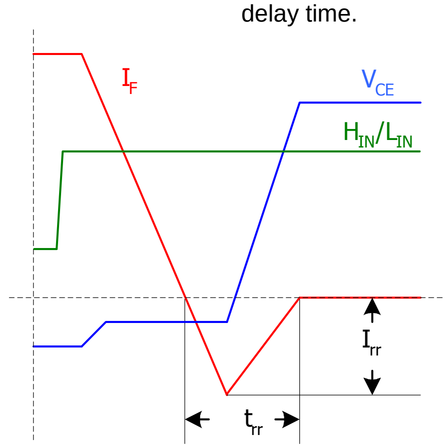


Figure 1c: Diode Reverse Recovery.

Figure 1: Switching Parameter Definitions

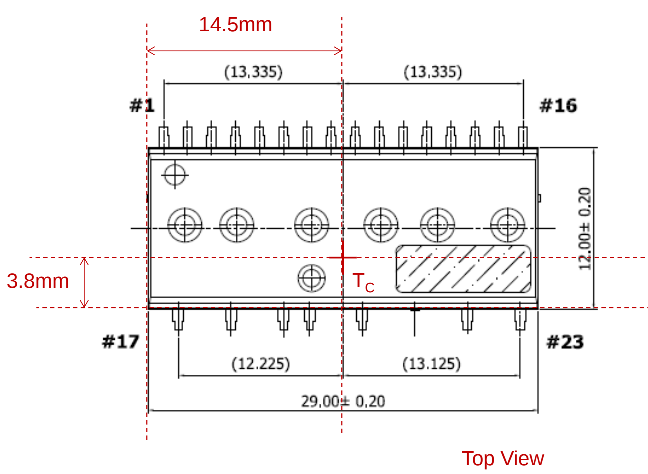


Figure 2: T_C measurement point for $R_{th(j\text{-}C)}$

Application Notes

A basic application schematic is shown below.

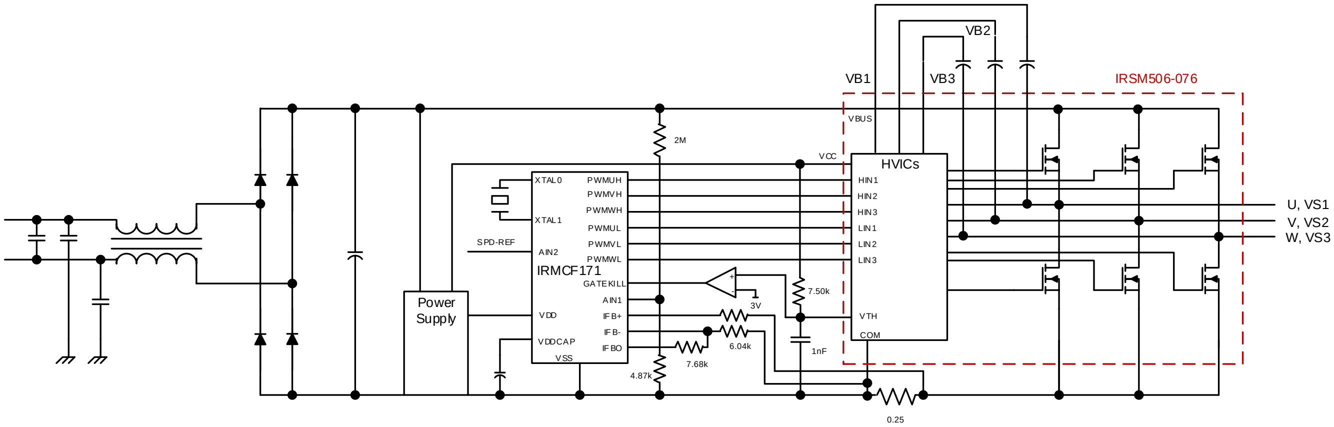


Figure 3: Basic sensor-less motor drive circuit connection. Motor is connected to U, V, W

A complete reference design board for running any permanent magnet motor via sensorless sinusoidal control is available. The board – photo below – features the µIPM™-DIP module and the iMotion™ digital control IC. Reference design kits are available on the Infineon website (irf.com > Design Resources > Reference Designs > Intelligent Power Modules)

Figure 4: Reference design board featuring the µIPM™-DIP module and the iMotion™ IRMCF171 digital control IC

Figures 5-7 show the typical current capability for this module at specified conditions. In all tests, the application board – the IRMCS1071-1-D reference board – was placed in a box to prevent cooling from ambient airflow. Figure 5 is derived from using a heat sink that maintains T_C at 125°C. Figures 6-7 represent current capability for the module as used without any heat sink. ΔT_{JA} represents the difference in temperature between the junction of the high-side V-phase IGBT and the ambient, measured 10cm above and 6cm away from the board. Ambient temperature kept within 28-29°C.

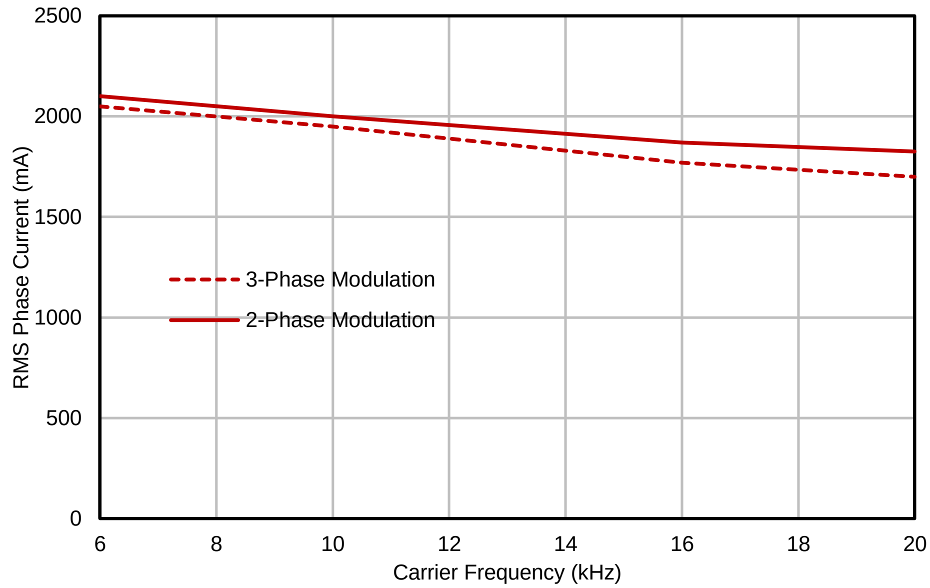


Figure 5: Maximum sinusoidal phase current vs PWM switching frequency with a heat sink. Space Vector Modulation, V+=320V, T_A=28°C, T_J=150°C, T_C=125°C

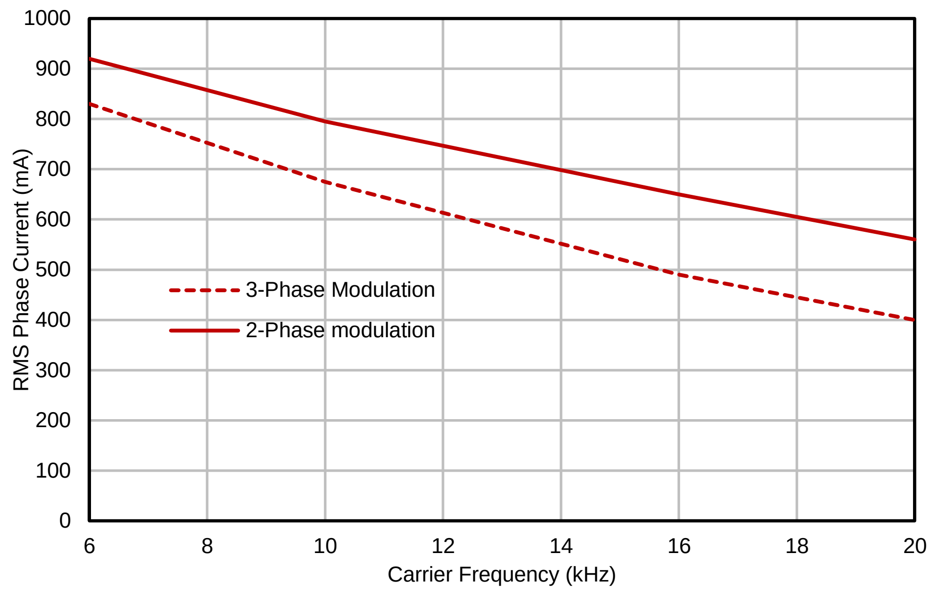


Figure 6: Maximum sinusoidal phase current vs PWM switching frequency, no heat sink. Space Vector Modulation, V+=320V, T_A=28°C, T_J=128°C

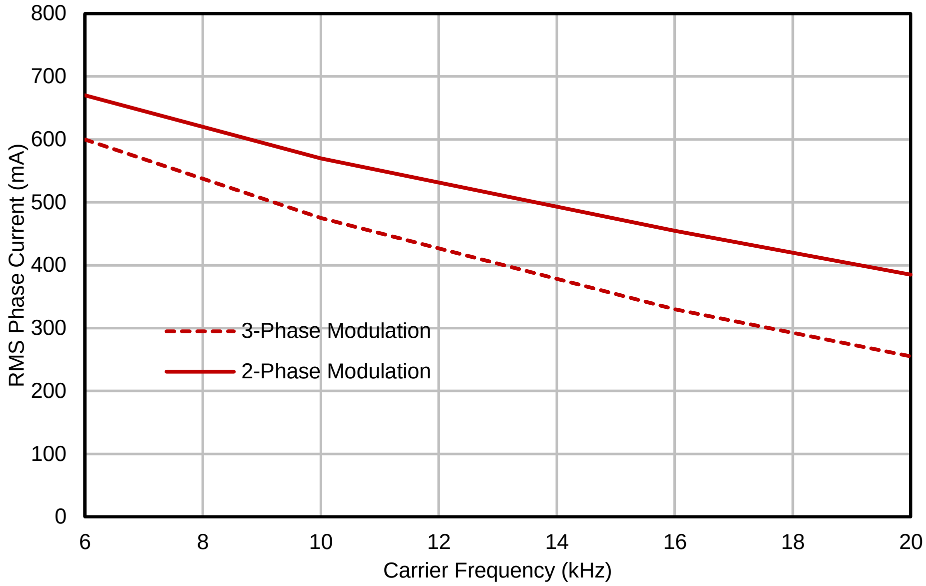


Figure 7: Maximum sinusoidal phase current vs PWM switching frequency, no heat sink. Space Vector Modulation, V+=320V, T_A=28°C, T_J=98°C

The module contains an NTC – connected between COM and the V_{TH} pin – which can be used to monitor the temperature of the module. The NTC is effectively a resistor whose value decreases as the temperature rises. The NTC resistance can be calculated at any temperature as follows:

$R_{TH} = R_{25}e^{\left[B\left(\frac{1}{T_{TH}}-\frac{1}{T_{25}}\right)\right]}$, where R_{25} is 47kΩ and B is 4050K

An external resistor network is connected to the NTC, the simplest of which is one resistor pulled up to V_{CC} as shown in Figure 3. The V_{TH} vs NTC temperature, T_{TH} curve for this configuration is shown in Figure 8 below. The min, typical and max curves result from the NTC having a ±5% tolerance on its resistance and ±2% tolerance on the B-parameter.

Figure 9 shows the thermistor temperature, T_{TH} plotted against the high-side V-phase junction temperature, T_J for a module without a heat sink. It is thus advisable to shut down the module when T_{TH} reaches 125°C.

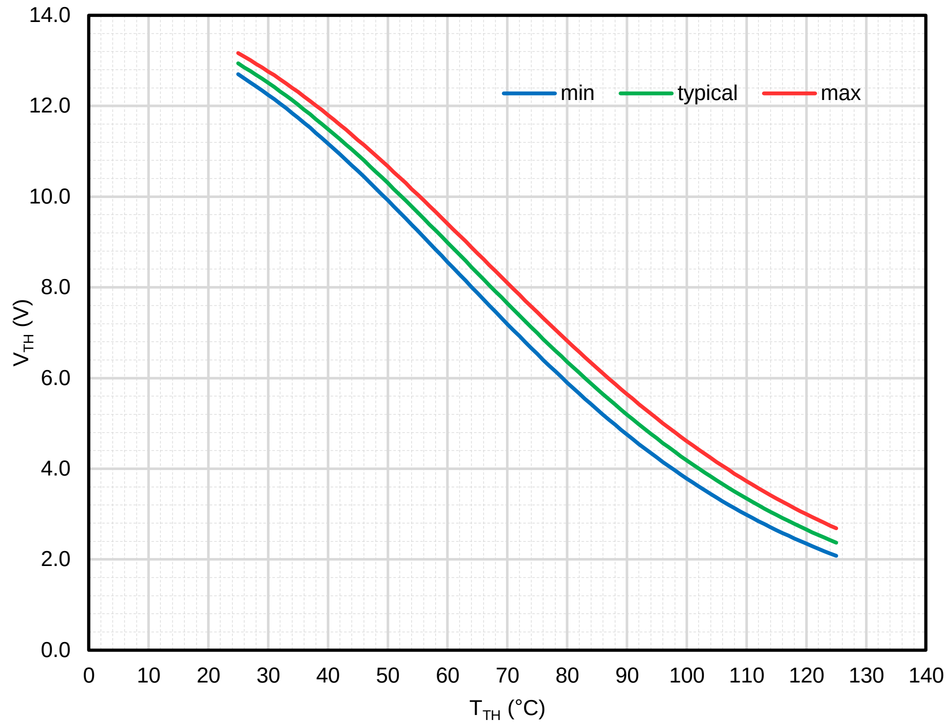


Figure 8: V_{TH} vs T_{TH} with V_{TH} pin pulled up to V_{CC} with a 7.50kΩ (1%, 100ppm) resistor. A 15V, 1% variation in V_{CC} is assumed.

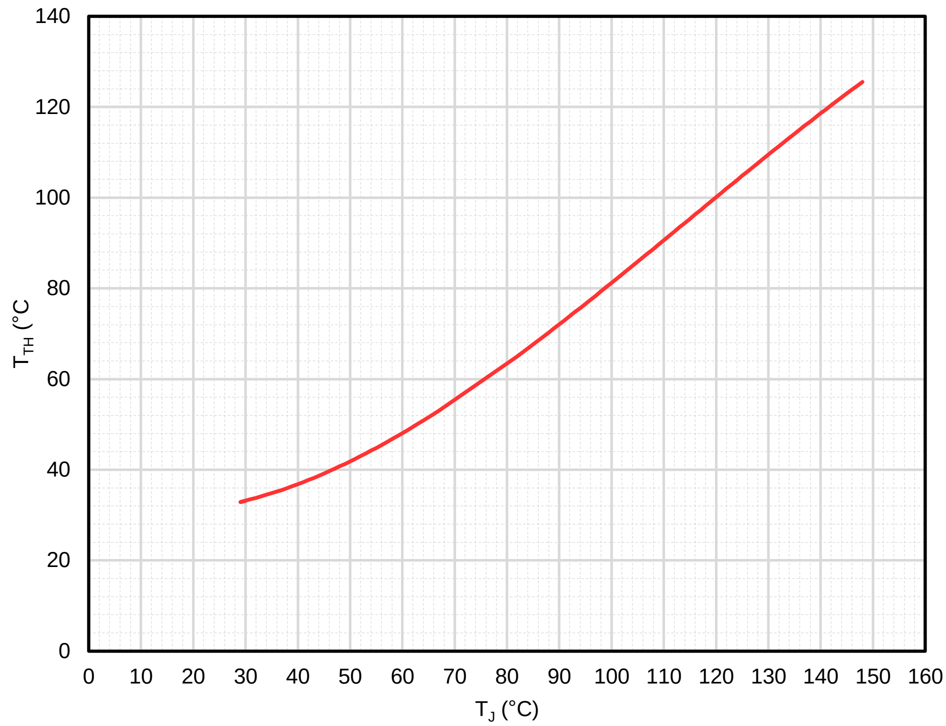


Figure 9: T_{TH} vs T_J for a module without a heat sink. V_{CC}=15.4V, R=7.50kΩ

The µIPM™-DIP module series features an advanced filter for input pins, LIN and HIN. The filter rejects noise spikes and short pulses with widths shorter than $T_{FIL,IN}$ as illustrated in Figure 10 below.

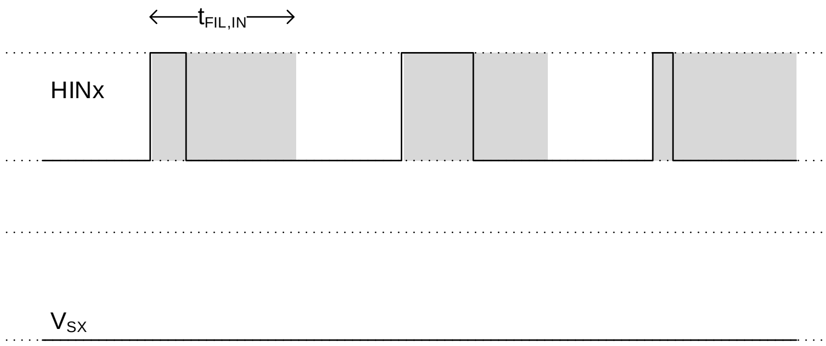


Figure 10: Advanced input filter rejects noise spikes on a logic 0-level HIN signal. The behavior is similar for noise spikes on logic 1-level signals

The advanced input filter maintains the pulse duration for pulses slightly longer than $t_{FIL,IN}$. Figure 11 illustrates this feature.

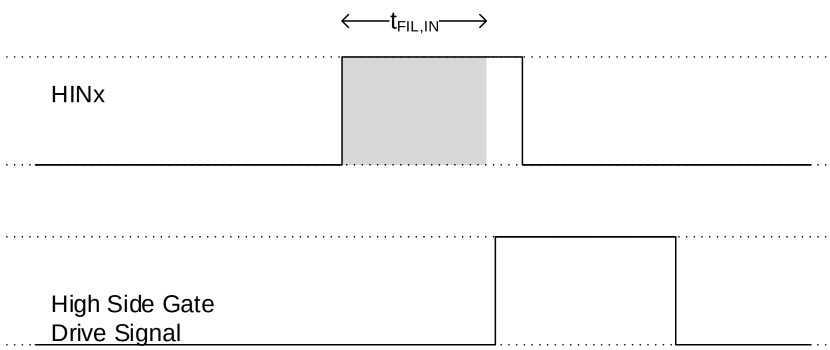


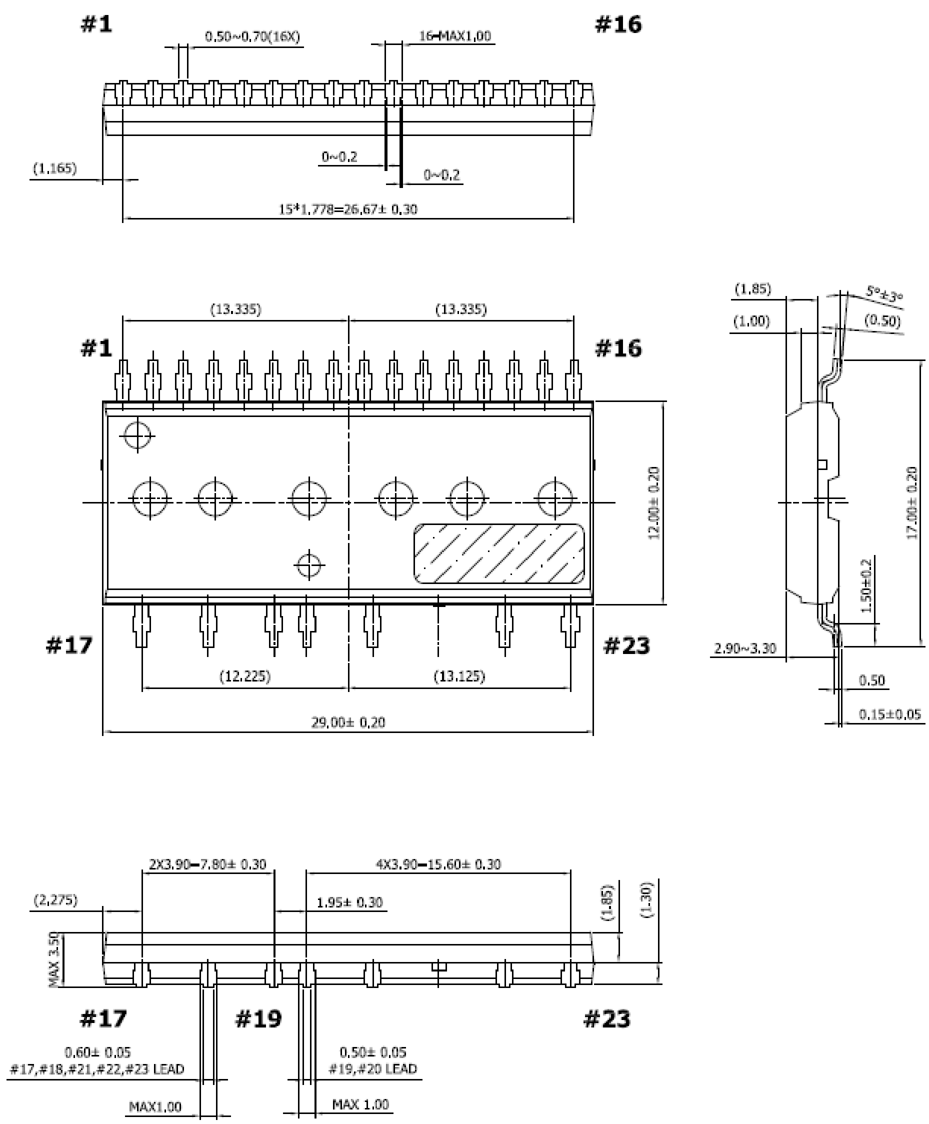
Figure 11: Advanced input filter maintains the pulse duration for pulses longer than $t_{FIL,IN}$

The module series also features shoot-through protection. If a logic 1-level signal is applied to LIN and HIN simultaneously, the IGBTs of the corresponding inverter leg are kept off. For overlapping logic 1-level LIN & HIN signals, a deadtime of duration DT is applied. The input-output logic table is shown below.

HINx	**LINx**	V_{Sx}
1	0	V+
0	1	0
0	0	*
1	1	*[$]

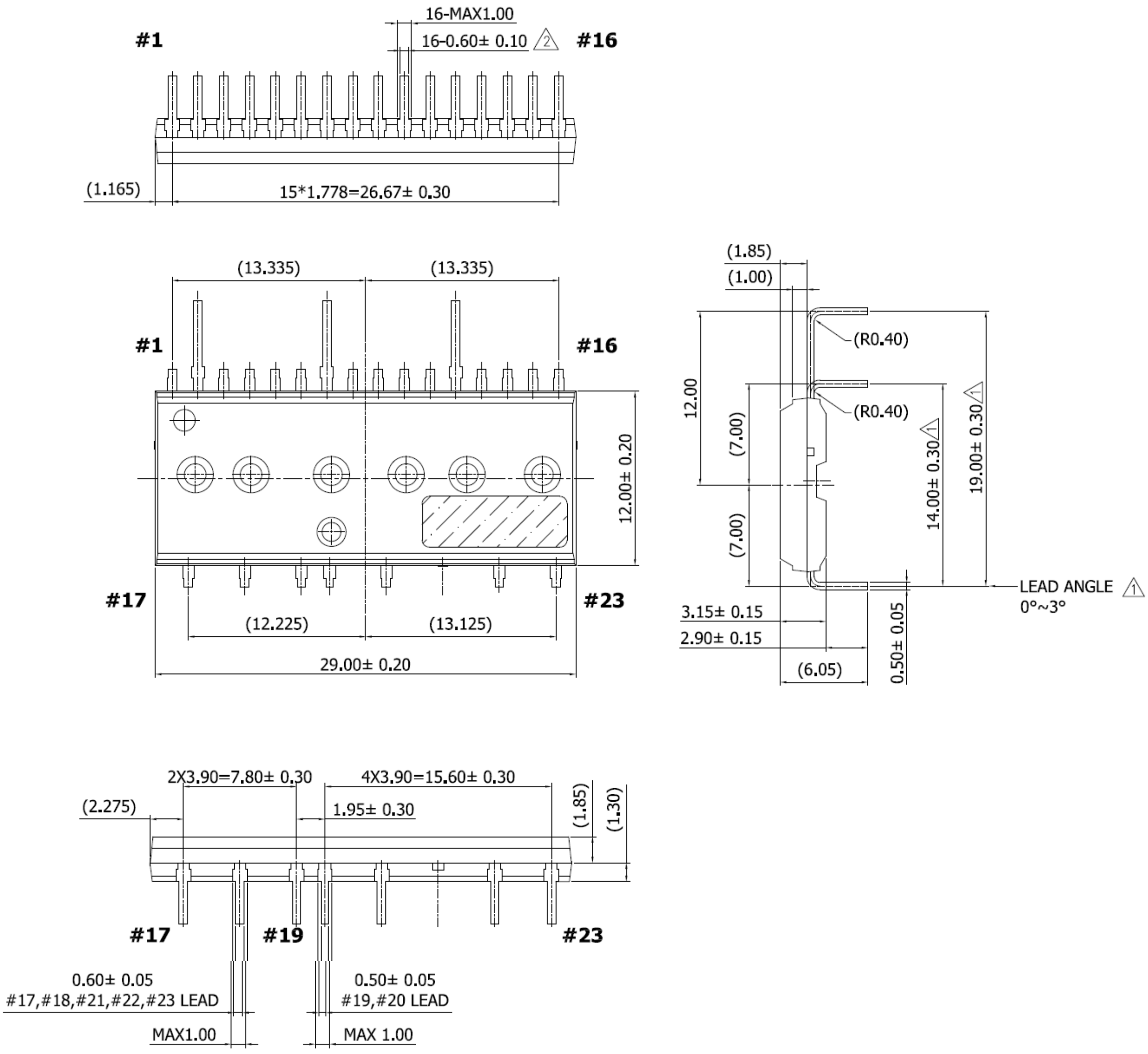
* Voltage depends on direction of phase current
[$] Integrated shoot-through protection prevents simultaneous turn on of high side and low side IGBTs of the same inverter leg

SOP23 Package Outline



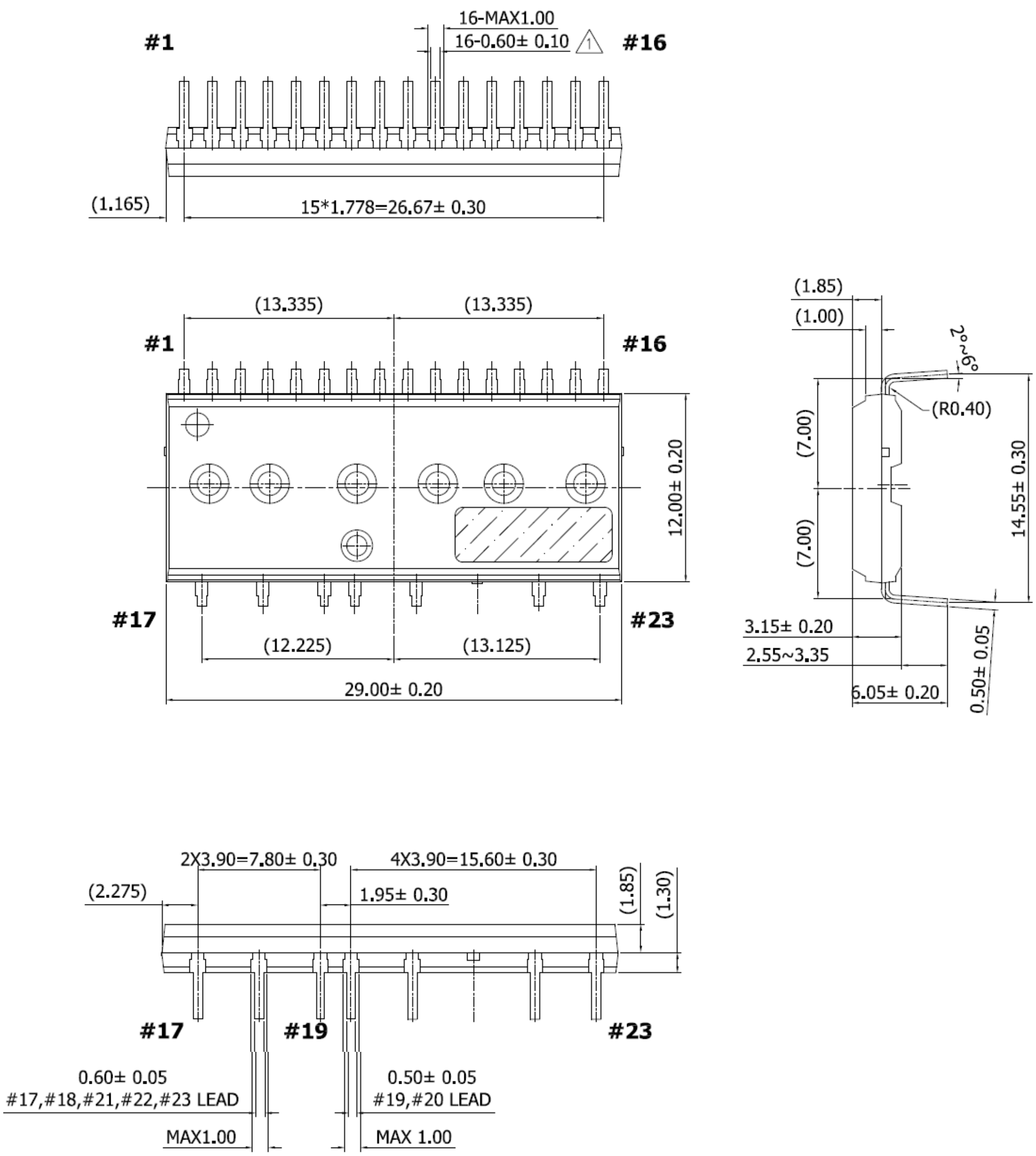
Dimensions in mm

DIP23A Package Outline



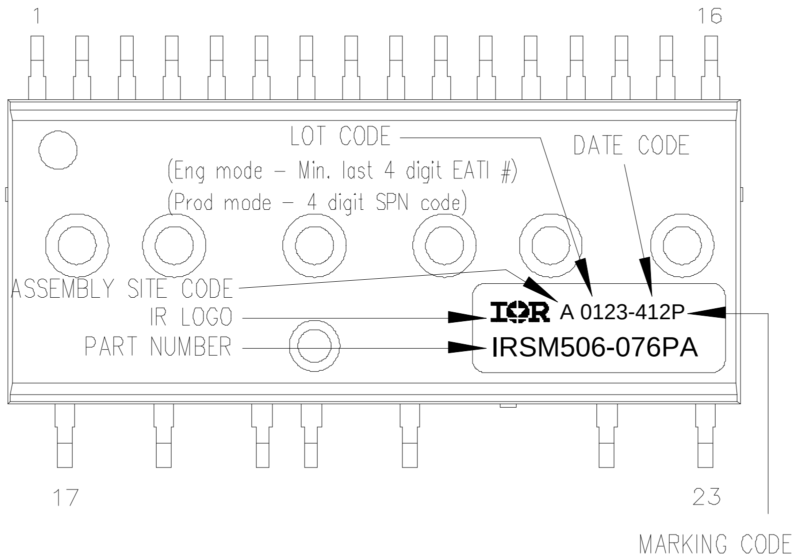
Dimensions in mm

DIP23 Package Outline



Dimensions in mm

Top Marking



Marking Code P = Pb Free; Y = Engineering Samples

Date Code YWW format, where Y = least significant digit of the production year , WW = two digits representing the week of the production year

Revision History

Feb 9 Updated header & footer designs; added application notes related to advanced input filter

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