DESCRIPTION

PT5N50IA is an advanced IPM based on Fast-Recovery MOSFET technology as a compact inverter solution for small power motor drive applications, such as fans and pumps. PT5N50IA contains six MOSFETs, three half-bridge gate drive HVICs and three bootstrap diodes in a compact package fully isolated and optimized for thermal performance. PT5N50IA features low electromagnetic interference (EMI) characteristics through optimizing switching speed and reducing parasitic inductance.

Since PT5N50IA employs MOSFETs as power switches, It provides much more ruggedness and larger Safe Operating Area (SOA) than IGBT-based power modules. PT5N50IA is the right solution for compact and reliable inverter designs where the assembly space is constrained. PT5N50IA is packaged in DIP23.

描述

PT5N50IA 基于快恢复 MOSFET 技术，为小功率电机驱动应用（如风扇和水泵）提供紧凑型逆变解决方案。PT5N50IA 由 6 个 MOSFET，3 个 HVIC 和 3 个自举二极管组成，紧凑高绝缘并具有优化的热性能。PT5N50IA 通过优化开关速度和减小寄生电感实现低电磁干扰（EMI）特性。

PT5N50IA 使用 MOSFET 比使用 IGBT 更坚固耐用，具有更大的安全操作区（SOA）。PT5N50IA 内置于电机的应用和要求紧凑安装的场合。PT5N501A 为 DIP23 包装。

FEATURES

- 500 V $R_{DS(on)}$=1.6Ω(Max) MOSFET 3-phase inverter including HVICs
- Three separate open-source pins from low side
- HVIC for gate driving and under voltage protection
- Optimized for low electromagnetic interference
- Isolation voltage rating of 1500 V_{rms} for 1 min
- Embedded bootstrap diode in the package
- Thermal feedback via NTC
- ROHS compliant

APPLICATIONS

- Small power AC motor

主要特点

- 内置 6 个 500V/1.6Ω(最大) MOSFET 和 3 个半桥栅极驱动（HVIC）
- 3 个独立的 MOSFET 源极副直流端用于变频器电流检测的应用
- HVIC 实现驱动和欠压保护功能
- 完全兼容 3.3V 和 5V 的 MCU 接口，高电平有效
- 优化并采用了低电磁干扰设计
- 绝缘级别 1500Vrms/1min
- 封装内置自举二极管
- 内置负温度系数的电阻用于温度检测
- 符合 ROHS

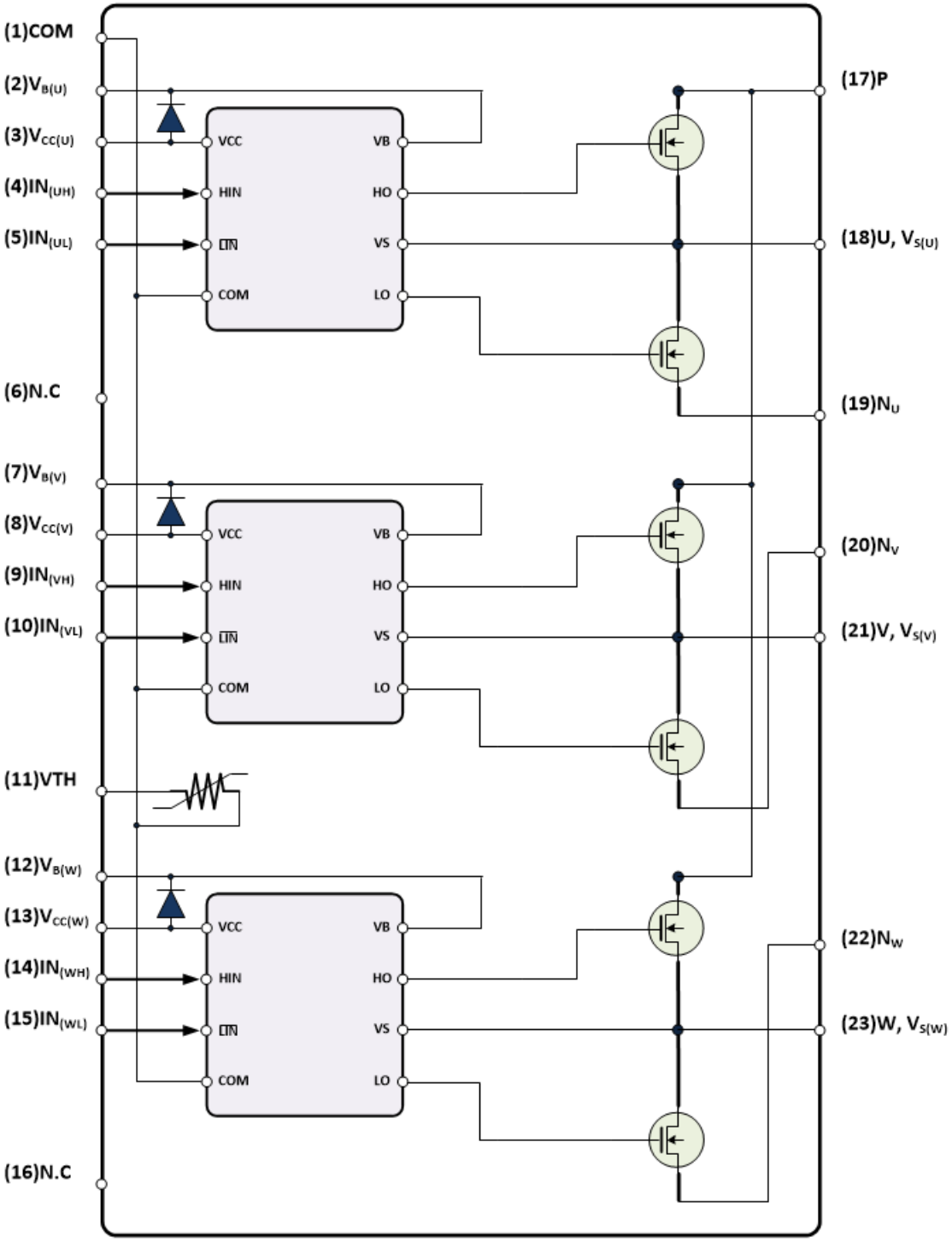
应用

- 小功率电机

引脚描述/PIN DESCRIPTIONS

引脚号 /Pin Number	引脚名 /Pin Name	引脚描述 /Pin Description
1	COM	IC 公共电源接地 IC Common Supply Ground
2	$V_{B(U)}$	U 相高端 MOSFET 驱动的偏压 Bias Voltage for U Phase High Side MOSFET Driving
3	$V_{CC(U)}$	U 相 IC 和低端 MOSFET 驱动的偏压 Bias Voltage for U Phase IC and Low Side MOSFET Driving
4	$IN_{(UH)}$	U 相高端的信号输入 Signal Input for U Phase High-Side
5	$IN_{(UL)}$	U 相低端的信号输入 Signal Input for U Phase Low-Side
6	N.C	无连接 N.C
7	$V_{B(V)}$	V 相高端 MOSFET 驱动的偏压 Bias Voltage for V Phase High Side MOSFET Driving
8	$V_{CC(V)}$	V 相 IC 和低端 MOSFET 驱动的偏压 Bias Voltage for V Phase IC and Low Side MOSFET Driving
9	$IN_{(VH)}$	V 相高端的信号输入 Signal Input for V Phase High-Side
10	$IN_{(VL)}$	V 相低端的信号输入 Signal Input for V Phase Low-Side
11	V_{TH}	热敏电阻电压 NTC Voltage
12	$V_{B(W)}$	W 相高端 MOSFET 驱动的偏压 Bias Voltage for W Phase High Side MOSFET Driving
13	$V_{CC(W)}$	W 相 IC 和低端 MOSFET 驱动的偏压 Bias Voltage for W Phase IC and Low Side MOSFET Driving
14	$IN_{(WH)}$	W 相高端的信号输入 Signal Input for W Phase High-Side
15	$IN_{(WL)}$	W 相低端的信号输入 Signal Input for W Phase Low-Side
16	N.C	无连接 N.C
17	P	直流输入正端 Positive DC–Link Input
18	U, $V_{S(U)}$	高端 MOSFET 驱动的 U 相偏压接地输出 Output for U Phase & Bias Voltage Ground for High Side MOSFET Driving
19	N_U	U 相的直流输入负端 Negative DC–Link Input for U Phase
20	N_V	V 相的直流输入负端 Negative DC–Link Input for V Phase
21	V, $V_{S(V)}$	高端 MOSFET 驱动的 V 相偏压接地输出 Output for V Phase & Bias Voltage Ground for High Side MOSFET Driving
22	N_W	W 相的直流输入负端 Negative DC–Link Input for W Phase
23	W, $V_{S(W)}$	高端 MOSFET 驱动的 W 相偏压接地输出 Output for W Phase & Bias Voltage Ground for High Side MOSFET Driving

图 1. 引脚布局和内部框图（仰视图）
Figure 1. Pin Configuration and Internal Block Diagram (Bottom View)



每个低端 MOSFET 的源极端子与 IPM 中的电源接地或偏压接地不连接。
Source Terminal of Each Low-Side MOSFET is Not Connected to Supply Ground or Bias Voltage Ground Inside IPM.
外部连接应当如图 10 所示。
External Connections Should be Made as Indicated in Figure 9.

绝对最大额定值 / ABSOLUTE MAXIMUM RATINGS

逆变器部分(单个 MOSFET，除非另有说明)

/Inverter Part(Each MOSFET®Unless Otherwise Specified)

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	额定值 /Rating	单位 /Unit
V_{PN}	加在 P-N 之间的电源电压 DC Link Input Voltage		500	V
*$I_{D\ 25}$	单个 MOSFET 漏极持续电流 Each MOSFET Drain Current, Continuous	T_C= 25°C	2.0	A
*$I_{D\ 80}$	单个 MOSFET 漏极持续电流 Each MOSFET Drain Current, Continuous	T_C= 80°C	1.5	A
*I_{DP}	单个 MOSFET 漏极峰值电流 Each MOSFET Drain Current, Peak	T_C= 25°C, PW < 100 μs	5.0	A
*I_{DRMS}	单个 MOSFET 漏极电流有效值 Each MOSFET Drain Current, RMS	T_C= 80°C, F_{PWM}< 20 KHz	1.1	A_{rms}
*P_D	最大功耗 Maximum Power Dissipation	T_C= 25°C, For Each MOSFET	14.5	W

控制部分(单个 HVIC，除非另有说明)

/ Control Part (Each HVIC Unless Otherwise Specified)

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	额定值 /Rating	单位 /Unit
V_{CC}	控制电源电压 Control Supply Voltage	施加在 V_{CC} 和 COM 之间 Applied Between V_{CC} and COM	20	V
V_{BS}	高端偏置电压 High-side Bias Voltage	施加在 V_B 和 V_S 之间 Applied Between V_B and V_S	20	V
V_{IN}	输入信号电压 Input Signal Voltage	施加在 IN 和 COM 之间 Applied Between IN and COM	- 0.3~ V_{CC}+ 0.3	V

自举二极管部分(单个二极管，除非另有说明)

/ Bootstrap Diode Part (Each Bootstrap Diode Unless Otherwise Specified)

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	额定值 /Rating	单位 /Unit
V_{RRMB}	最大重复反向电压 Maximum Repetitive Reverse Voltage		500	V
* I_{FB}	正向电流 Forward Current	T_C= 25°C	0.5	A
* I_{FPB}	正向电流（峰值） Forward Current (Peak)	T_C= 25°C, Under 1ms Pulse Width	1.5	A

热阻

/ Thermal Resistance

符号 /Symbol	参数/Parameter	工作条件 /Conditions	额定值 /Rating	单位 /Unit
$R_{\theta JC}$	节点-壳体热阻 Junction to Case Thermal Resistance	逆变器工作条件下的单个 MOSFET（注 1） Each MOSFET under Inverter Operating Condition (Note 1)	8.6	°C /W

整个系统

/ Total System

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	额定值 /Rating	单位 /Unit
T_J	工作结温 Operating Junction Temperature		-40 ~ 150	°C
T_{STG}	存储温度 Storage Temperature		-40 ~ 125	°C
V_{ISO}	绝缘电压 Isolation Voltage	60Hz，正弦波，1 分钟，连接基板到引脚 60 Hz, Sinusoidal, 1 minute, Connection Pins to Heatsink	1500	V_{rms}

注 / Note:
1.关于壳体温度（TC）的测量点，参见图 4。/ For the Measurement Point of Case Temperature TC, Please refer to Figure 4.
2. 标记“*”的为计算值或设计因素。 / Marking “ * “ Is Calculation Value or Design Factor

推荐工作条件 / RECOMMENDED OPERATING CONDITION

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	最小值 /Min	典型值 /Typ	最大值 /Max	单位 /Unit
V_{PN}	电源电压 Supply Voltage	施加在 P 和 N 之间 Applied Between P and N	-	300	400	V
V_{CC}	控制电源电压 Control Supply Voltage	施加在 V_{CC} 和 COM 之间 Applied Between V_{CC} and COM	13.5	15	16.5	V
V_{BS}	高端偏压 High-Side Bias Voltage	施加在 V_B 和 V_S 之间 Applied Between V_B and V_S	13.5	15	16.5	V
$V_{IN(ON)}$	输入导通阈值电压 Input ON Threshold Voltage	施加在 V_{IN} 和 COM 之间 Applied Between IN and COM	3.0	-	V_{CC}	V
$V_{IN(OFF)}$	输入关断阈值电压 Input OFF Threshold Voltage		0	-	0.6	V
t_{dead}	防止桥臂直通的死区时间 Blanking Time for Preventing Arm-Short	V_{CC}=V_{BS}= 13.5 ~ 16.5 V, T_J≤ 150°C	1	-	-	us
f_{PWM}	PWM 开关频率 PWM Switching Frequency	T_J≤ 150°C	-	15	-	kHz

电气特性/ELECTRICAL CHARACTERISTICS

逆变器部分(单个 MOSFET，除非另有说明)

/Inverter Part (Each MOSFET Unless Otherwise Specified)

(T_J= 25°C, V_{CC}=V_{BS}= 15 V，除非另有说明) / (T_J= 25°C, V_{CC}=V_{BS}= 15 V Unless Otherwise Specified)

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	最小值 /Min	典型值 /Typ	最大值 /Max	单位 /Unit
BV_{DSS}	漏极-源极击穿电压 Drain-Source Break down Voltage	V_{IN}= 0V, I_D = 1 mA (Note 1)	500	-	-	V
I_{DSS}	零栅极电压漏极电流 Zero Gate Voltage Drain Current	V_{IN}= 0V, V_{DS}= 500 V	-	-	1	mA
$R_{DS(on)}$	漏极-源极静态导通电阻 Static Drain-Source On-Resistance	V_{CC}= V_{BS}= 15 V, V_{IN}= 5 V, I_D= 1.2 A	-	1.2	1.6	Ω
V_{SD}	漏极-源极二极管正向导通电压 Drain-Source Diode Forward Voltage	V_{CC}= V_{BS}= 15 V, V_{IN}= 0 V, I_D= -1.2 A	-	0.8	1.2	V
t_{ON}	开关时间 Switching Times	V_{PN}= 300 V, V_{CC}= V_{BS}= 15 V, I_D= 1.2 A V_{IN}= 0 V ↔5 V,电感负载 / Inductive Load L= 3 mH, 高端和低端 MOSFET 开关(注 2) / High- and Low-Side MOSFET Switching(Note 2)	-	420	-	ns
t_{OFF}			-	600	-	ns
t_{rr}			-	60	-	ns
E_{ON}			-	30	-	uJ
E_{OFF}			-	4	-	uJ
RBSOA	反向偏压安全工作区 Reverse-Bias Safe Operating Area	V_{PN}= 400 V, V_{CC}= V_{BS}= 15 V, I_D= I_{DP}, V_{DS}=BV_{DSS}, T_J= 150°C, 高端和低端 MOSFET 开关(注 3) / High- and Low-Side MOSFET Switching (Note 3)	整个区域 Full Square			

控制部分(单个 HVIC，除非另有说明)

/Control Part(Each HVIC Unless Otherwise Specified)

符号 /Symbol	参数 /Parameter	工作条件 /Conditions		最小值 /Min	典型值 /Typ	最大值 /Max	单位 /Unit
I_{QCC}	V_{CC} 静态电流 Quiescent V_{CC} Current	V_{CC}=15 V, V_{IN}=0V	施加在 V_{CC} 和 COM 之间 Applied Between $V_{CC}$and COM	-	220	300	uA
I_{QBS}	V_{BS} 静态电流 Quiescent V_{BS} Current	V_{BS}=15 V, V_{IN}=0V	施加在 $V_{B(U)}$-U, $V_{B(V)}$-V, $V_{B(W)}$-W Applied Between $V_{B(U)}$-U, $V_{B(V)}$-V, $V_{B(W)}$-W	-	55	100	uA
UV_{CCD}	低端欠压保护 Low-Side Under voltage Protection	V_{CC} 欠压保护检测电平 V_{CC} Under voltage Protection Detection Level		7.4	8.0	9.4	V
UV_{CCR}		V_{CC} 欠压保护复位电平 V_{CC} Under voltage Protection Reset Level		8.0	8.9	9.8	V
UV_{BSD}	高端欠压保护 High-Side Under voltage Protection	V_{BS} 欠压保护检测电平 V_{BS} Under voltage Protection Detection Level		7.4	8.0	9.4	V
UV_{BSR}		V_{BS} 欠压保护复位电平 V_{BS} Under voltage Protection Reset Level		8.0	8.9	9.8	V
V_{IH}	导通阈值电压 ON Threshold Voltage	逻辑高电平 Logic High Level	施加在 V_{IN} 和 COM 之间 Applied between IN and COM	-	-	2.9	V
V_{IL}	关断阈值电压 OFF Threshold Voltage	逻辑低电平 Logic Low		0.8	-	-	V

		Level					

自举二极管部分(单个二极管，除非另有说明)
/Bootstrap Diode Part(Each Bootstrap Diode Unless Otherwise Specified)

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	最小值 /Min	典型值 /Typ	最大值 /Max	单位 /Unit
V_{FB}	正向电压 Forward Voltage	I_F= 0.1 A, T_C= 25°C (注 5) I_F= 0.1 A, T_C= 25°C (Note 5)	-	4.5	-	V
t_{rrB}	反向恢复时间 Reverse Recovery Time	I_F= 0.1 A, T_C= 25°C	-	80	-	ns

内部NTC(负温度系数)电阻参数
/Internal NTC Thermistor Characteristic

符号 /Symbol	参数 /Parameter	工作条件 /Conditions	最小值 /Min	典型值 /Typ	最大值 /Max	单位 /Unit
R_{25}	电阻 Resistor	T_C= 25°C，±5% tolerance	-	47	-	KΩ
R_{125}	电阻 Resistor	T_C= 125°C, T_C= 25°C (注 6) T_C= 125°C, T_C= 125°C (Note 6)	-	1.34	-	KΩ
B	B 常数 (25-50°C) B-constant (25-50°C)	±2% tolerance	-	4050	-	K

注/Note:

1.BV_{DSS} 是 IPM 产品中单个 MOSFET 的漏极和源极端子之间的绝对最大额定电压。考虑到寄生电感，V_{PN} 应远低于该值，因此 V_{PN} 在任何情况下不得超过 BV_{DSS}。
BV_{DSS} is the Absolute Maximum Voltage Rating Between Drain and Source Terminal of Each MOSFET Inside IPM. V_{PN} Should be Sufficiently Less Than This Value Considering the Effect of the Stray Inductance so that V_{DS} Should Not Exceed BV_{DSS} in Any Case.

2.t_{ON} 和 t_{OFF} 包括内部驱动 IC 的传输延迟。所列出的数值是在实验室条件下测得，在实际应用中因为印刷电路板和布线的差异，数值也会有所不同。请参阅图 6 介绍的开关时间定义，以及图 7 中的开关测试电路。
t_{ON} and t_{OFF} Include the Propagation Delay Time of the Internal Drive IC. Listed Values are Measured at the Laboratory Test Condition, and They Can be Different According to the Field Applications Due to the Effect of Different Printed Circuit Boards and Wirings. Please see Figure 6 for the Switching Time Definition with the Switching Test Circuit of Figure 7.

3. 每个 MOSFET 在开关工作时的峰值电流和电压也应在安全工作区（SOA）的范围内。请参阅图 7 的 RBSOA 测试电路，它与开关测试电路相同。
The peak current and voltage of each MOSFET during the switching operation should be included in the safe operating area (SOA). Please see Figure 7 for the RBSOA test circuit that is same as the switching test circuit.

4. V_{TH} 只能用于模块的温度检测，但不能自动关闭 MOSFETs。
V_{TH} is only for sensing temperature of module and cannot shutdown MOSFETs automatically.

5. 内置自举二极管其阻抗特性约为 30 Ω。
Built in bootstrap diode includes around 30 Ω resistance characteristic.

6. 内置 NTC 电阻阻值参数请参阅图 2、3。
Internal NTC – Thermistor Characteristics, Please refer to Figure 2、3.

特性描述與說明 / FUNCTION DESCRIPTION

內置 NTC 電阻 / Internal NTC Thermistor

R25=47kΩ±5% B25/50=4050K±2%							
Temp(℃)	Rmin(KΩ)	Rnor(KΩ)	Rmax(KΩ)	Temp(℃)	Rmin(KΩ)	Rnor(KΩ)	Rmax(KΩ)
-40	1399.615	1580.590	1780.504	3	123.714	132.962	142.544
-39	1311.659	1479.301	1664.198	4	117.799	126.478	135.458
-38	1229.811	1385.170	1556.254	5	112.197	120.344	128.760
-37	1153.607	1297.644	1456.016	6	106.890	114.538	122.427
-36	1082.623	1216.220	1362.886	7	101.862	109.043	116.439
-35	1016.468	1140.432	1276.316	8	97.095	103.839	110.773
-34	954.783	1069.857	1195.803	9	92.576	98.910	105.412
-33	897.239	1004.102	1120.885	10	88.290	94.239	100.338
-32	843.531	942.810	1051.138	11	84.224	89.813	95.533
-31	793.381	885.649	986.175	12	80.366	85.617	90.982
-30	746.531	832.315	925.637	13	76.704	81.637	86.671
-29	702.743	782.530	869.197	14	73.226	77.862	82.585
-28	661.798	736.034	816.551	15	69.924	74.281	78.712
-27	623.496	692.592	767.422	16	66.786	70.881	75.040
-26	587.648	651.984	721.554	17	63.805	67.654	71.556
-25	554.084	614.008	678.711	18	60.971	64.590	68.252
-24	522.644	578.477	638.674	19	58.277	61.679	65.116
-23	493.181	545.221	601.245	20	55.715	58.913	62.139
-22	465.559	514.079	566.237	21	53.278	56.284	59.312
-21	439.652	484.905	533.479	22	50.959	53.786	56.627
-20	415.344	457.563	502.814	23	48.752	51.410	54.077
-19	392.606	432.017	474.197	24	46.651	49.150	51.654
-18	371.245	408.047	447.374	25	44.650	47.000	49.350
-17	351.171	385.545	422.225	26	42.669	44.954	47.244
-16	332.299	364.414	398.634	27	40.784	43.007	45.238
-15	314.550	344.563	376.497	28	38.992	41.153	43.326
-14	297.850	325.907	355.716	29	37.286	39.388	41.504
-13	282.132	308.367	336.199	30	35.663	37.706	39.766
-12	267.333	291.871	317.864	31	34.119	36.104	38.110
-11	253.394	276.350	300.632	32	32.648	34.577	36.530
-10	240.260	261.741	284.431	33	31.247	33.122	35.023
-9	227.880	247.987	269.193	34	29.912	31.735	33.584
-8	216.207	235.031	254.857	35	28.641	30.412	32.211
-7	205.196	222.825	241.362	36	27.429	29.150	30.901
-6	194.807	211.319	228.657	37	26.274	27.945	29.649
-5	185.001	200.470	216.690	38	25.172	26.796	28.454
-4	175.742	190.238	205.414	39	24.122	25.700	27.312
-3	166.997	180.583	194.786	40	23.120	24.653	26.222
-2	158.735	171.471	184.765	41	22.164	23.653	25.179
-1	150.925	162.867	175.314	42	21.251	22.698	24.182
0	143.542	154.741	166.397	43	20.381	21.786	23.229
1	136.564	147.069	157.986	44	19.549	20.914	22.318
2	129.962	139.818	150.045	45	18.755	20.081	21.447

R25=47kΩ±5% B25/50=4050K±2%							
Temp(℃)	Rmin(KΩ)	Rnor(KΩ)	Rmax(KΩ)	Temp(℃)	Rmin(KΩ)	Rnor(KΩ)	Rmax(KΩ)
46	17.997	19.285	20.613	89	3.6434	4.0283	4.4428
47	17.272	18.523	19.815	90	3.5234	3.8982	4.3021
48	16.580	17.795	19.051	91	3.4079	3.7729	4.1665
49	15.919	17.099	18.320	92	3.2966	3.6520	4.0356
50	15.286	16.432	17.621	93	3.1894	3.5355	3.9095
51	14.685	15.799	16.954	94	3.0861	3.4232	3.7877
52	14.110	15.192	16.316	95	2.9865	3.3149	3.6703
53	13.560	14.612	15.705	96	2.8906	3.2105	3.5569
54	13.035	14.056	15.119	97	2.7981	3.1098	3.4475
55	12.532	13.524	14.558	98	2.7090	3.0126	3.3419
56	12.050	13.014	14.021	99	2.6230	2.9189	3.2400
57	11.589	12.526	13.505	100	2.5401	2.8284	3.1416
58	11.148	12.059	13.011	101	2.4602	2.7411	3.0465
59	10.726	11.611	12.537	102	2.3831	2.6568	2.9547
60	10.321	11.181	12.082	103	2.3087	2.5755	2.8660
61	9.9340	10.770	11.646	104	2.2369	2.4970	2.7803
62	9.5628	10.375	11.228	105	2.1676	2.4211	2.6975
63	9.2071	9.9964	10.826	106	2.1007	2.3478	2.6175
64	8.8661	9.6333	10.441	107	2.0361	2.2771	2.5402
65	8.5393	9.2850	10.071	108	1.9738	2.2087	2.4654
66	8.2259	8.9508	9.7153	109	1.9136	2.1427	2.3932
67	7.9253	8.6301	9.3740	110	1.8555	2.0789	2.3233
68	7.6370	8.3222	9.0462	111	1.7994	2.0172	2.2557
69	7.3605	8.0266	8.7312	112	1.7452	1.9576	2.1904
70	7.0951	7.7428	8.4285	113	1.6928	1.8999	2.1271
71	6.8404	7.4702	8.1376	114	1.6421	1.8442	2.0660
72	6.5959	7.2083	7.8579	115	1.5932	1.7903	2.0068
73	6.3611	6.9567	7.5891	116	1.5459	1.7382	1.9496
74	6.1357	6.7150	7.3305	117	1.5002	1.6878	1.8942
75	5.9193	6.4826	7.0819	118	1.4560	1.6391	1.8405
76	5.7113	6.2593	6.8427	119	1.4133	1.5919	1.7886
77	5.5115	6.0446	6.6125	120	1.3720	1.5463	1.7383
78	5.3196	5.8381	6.3911	121	1.3321	1.5021	1.6897
79	5.1351	5.6395	6.1780	122	1.2934	1.4594	1.6425
80	4.9577	5.4485	5.9728	123	1.2560	1.4180	1.5969
81	4.7880	5.2656	5.7763	124	1.2198	1.3780	1.5527
82	4.6248	5.0896	5.5870	125	1.1848	1.3392	1.5099
83	4.4679	4.9202	5.4047	126	1.1510	1.3016	1.4684
84	4.3170	4.7572	5.2292	127	1.1182	1.2653	1.4282
85	4.1717	4.6002	5.0600	128	1.0864	1.2301	1.3892
86	4.0320	4.4491	4.8971	129	1.0557	1.1960	1.3514
87	3.8975	4.3036	4.7400	130	1.0260	1.1629	1.3148
88	3.7681	4.1634	4.5887				

图 2. R-T 表
Figure 2. R-T Table

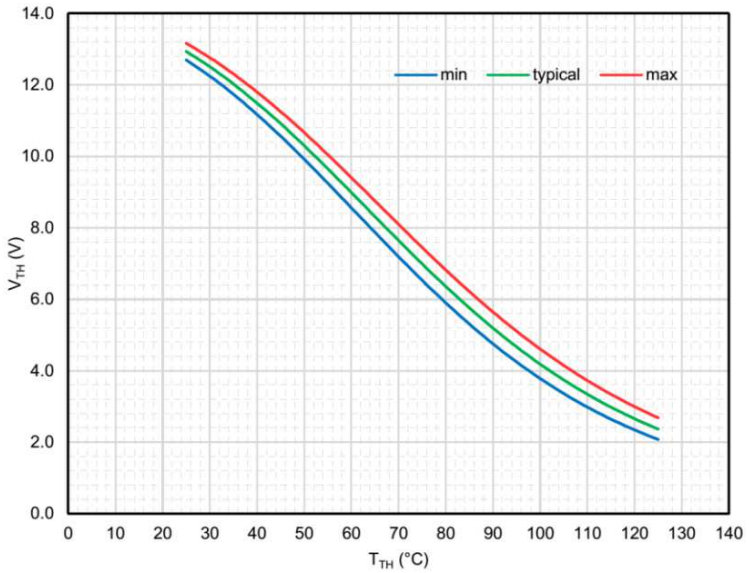
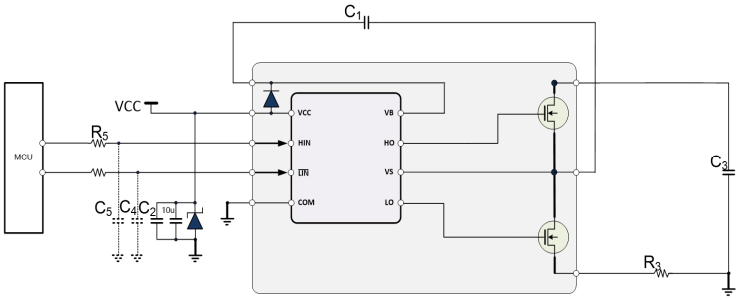


图 3. V TH vs T TH ，V TH 通过 7.5 KΩ (1%, 100ppm)的电阻上拉至 15V 的 V CC ，推荐电压波动为 1%
Figure 3. V TH vs T TH with V TH pin pulled up to V CC with a 7.5KΩ (1%, 100ppm) resistor. A 15V, 1% variation in V CC is assumed.

MCU 接口和自举电路 / MCU Interface and Bootstrap Circuit



HIN	LIN	Output	Note
0	0	Z	Both FRFET Off
0	1	0	Low side FRFET On
1	0	V_{DC}	High side FRFET On
1	1	Forbidden	Shoot through
Open	Open	Z	Same as (0,0)

图 4. 推荐的 MCU 接口和自举电路及其参数
Figure 4. Recommended MCU Interface and Bootstrap Circuit with Parameters

1. 自举电路的参数取决于 PWM 算法。上述为开关频率 15K 时的参数的典型例子。
   Parameters for Bootstrap Circuit Elements are Dependent on PWM Algorithm. For 15 kHz of Switching Frequency, Typical Example of Parameters is Shown Above.
2. IPM 产品和 MCU（虚线显示部分）的每个输入端的 RC 耦合（R_5 和 C_5）和 C_4，可用于防止由浪涌噪声产生的错误信号。
   RC coupling ($R_5$and C_5) and C_4at Each Input of IPM and Mcu (Indicated as Dotted Lines) May be Used to Prevent Improper Signal Due to Surge Noise.
3. 印刷电路板图形中的粗线应尽量短且粗，以减小电路中的寄生电感，从而导致浪涌电压的降低。旁路电容 C_1，C_2 和 C_3 应具有良好的高频特性，以吸收高频纹波电流。
   Bold lines should be short and thick in PCB pattern to have small stray inductance of circuit, which results in the reduction of surge voltage. Bypass capacitors such as C_1, $C_2$and C_3Should Have Good High-Frequency characteristics to Absorb High-Frequency Ripple Current.

PM 封装和散热 / Package and heatsink of IPM

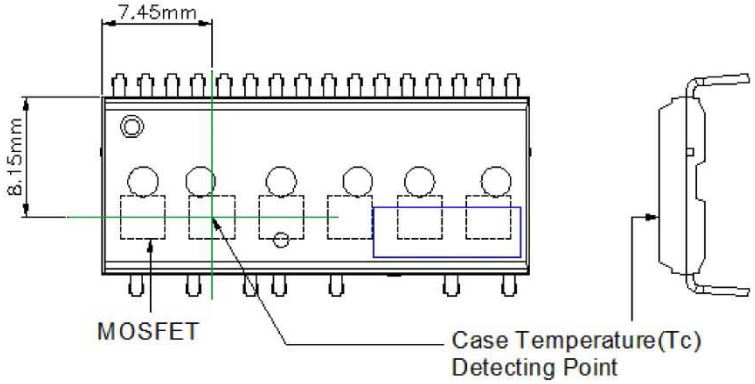


图 5. 壳体温度测量
Figure 5. Case Temperature Measurement

将热电偶贴在 IPM 封装（如果应用到，放在 IPM 封装和散热器中间）的散热片的顶部，以获得正确的温度测量数值。
Attach the thermocouple on top of the heatsink-side of IPM (between IPM and heatsink if applied) to get the correct temperature measurement.

开关时间 / Switching Time

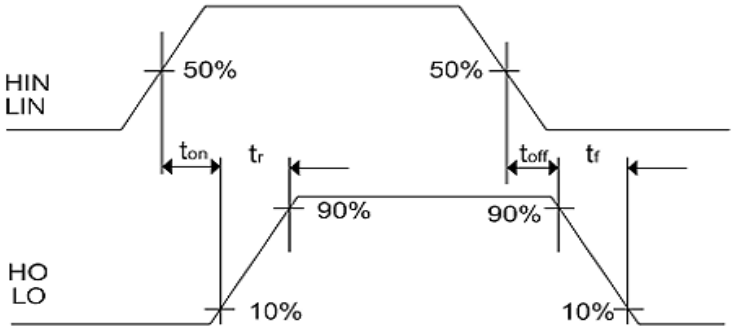


图 6. 开关时间定义
Figure 6. Switching Time Definitions

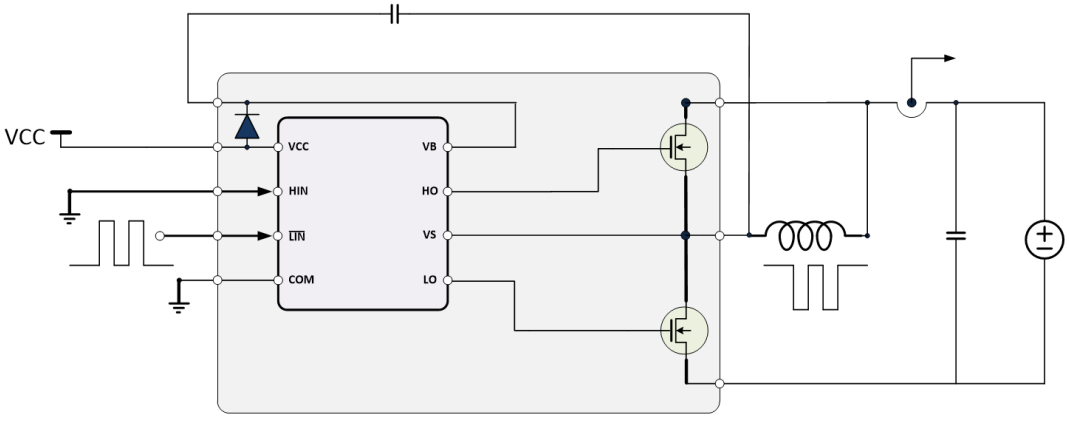


图 7. 开关和 RBSOA（单脉冲）测试电路（低端）
Figure 7. Switching and RBSOA (Single-pulse) Test Circuit (Low-side)

欠压保护 / Under Voltage Protection

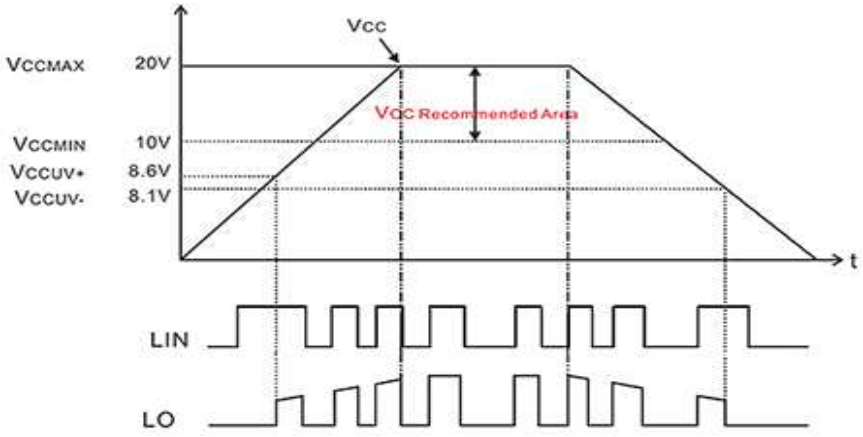


图 8. 欠压保护（低端）
Figure 8.Under Voltage Protection (Low-side)

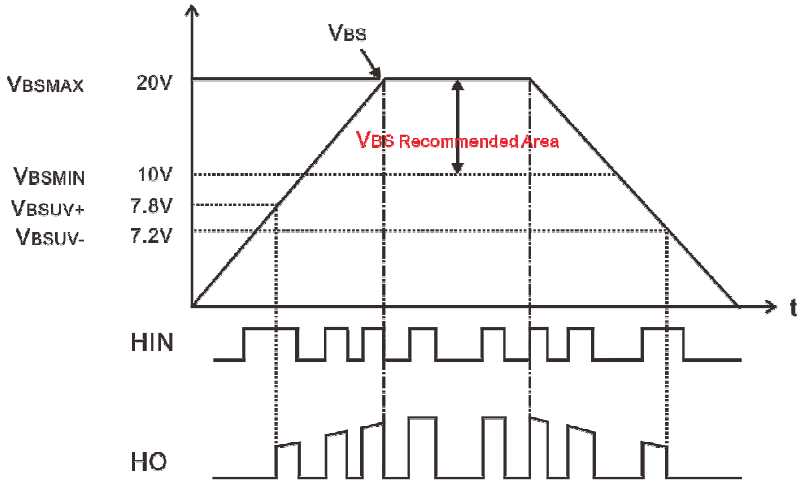


图 9. 欠压保护（高端）
Figure 9.Undervoltage Protection (High-side)

应用电路实例 / Example of Application Circuit

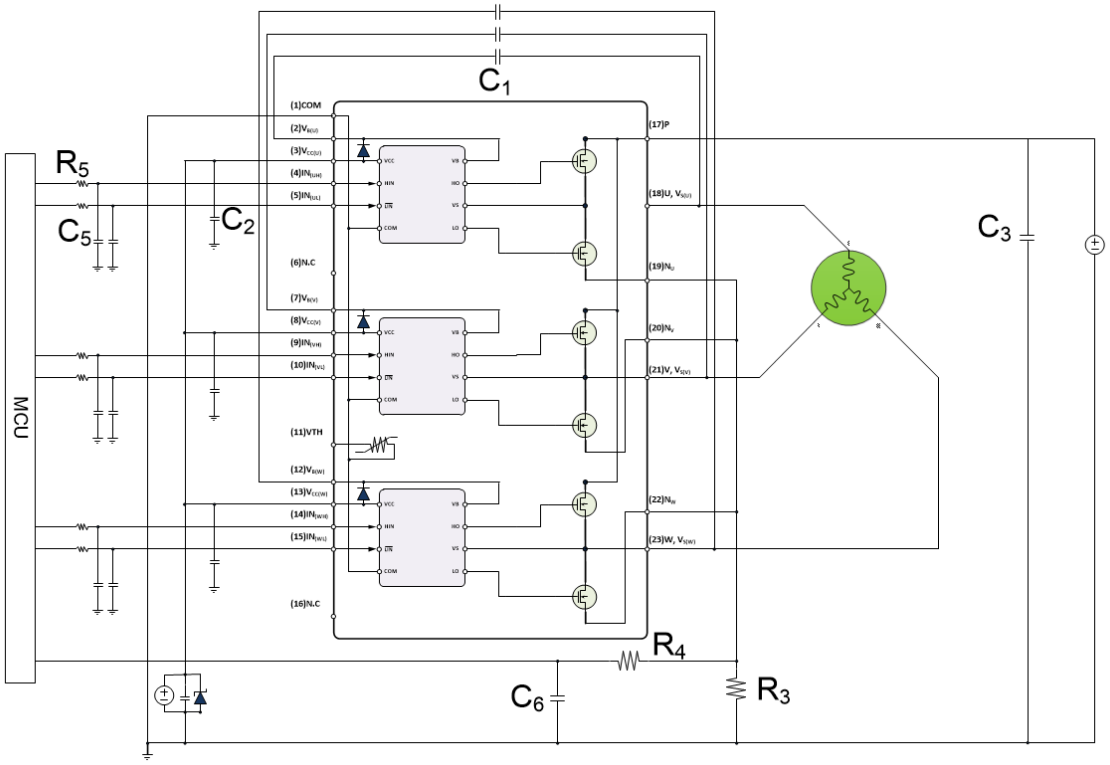
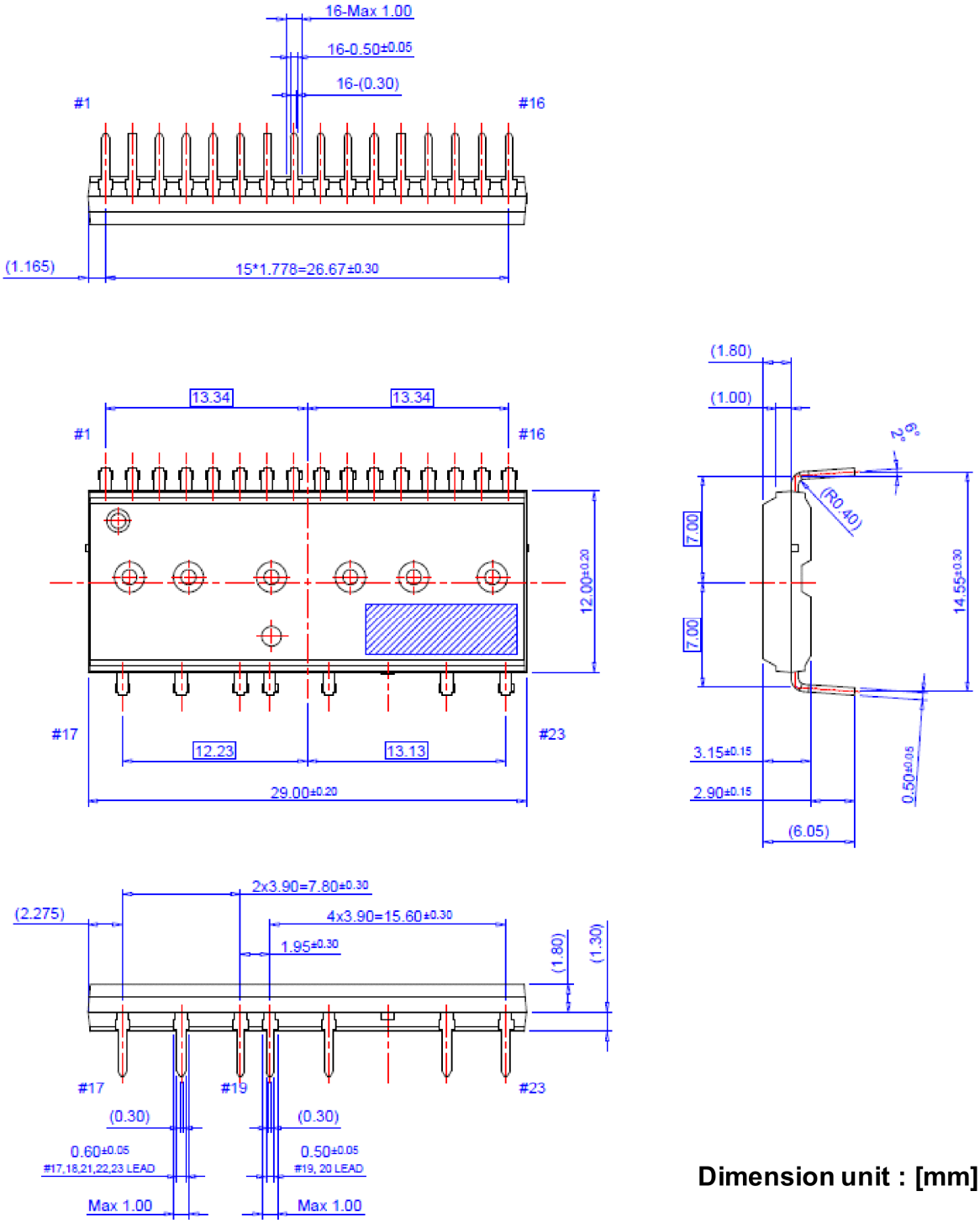


图 10. 应用电路实例
Figure 10. Example of Application Circuit

1. 关于引脚的位置请参阅图 1。
   About Pin Position, Refer to Figure 1.
2. IPM 产品和 MCU 的每个输入端的 RC 耦合（R_5 和 C_5，R_4 和 C_6）和 C_4，能有效地防止由浪涌噪声产生的错误的输入信号。
   RC Coupling ($R_5$and C_5, $R_4$and C_6) and C_4at Each Input of IPMMcu are Useful to Prevent Improper Input Signal Caused by Surge Noise.
3. 由于位于 COM 和低端 MOSFET 的源极端子之间，R3 的压降会影响低端的开关性能和自举特性。为此稳态情况下的 R3 的压降应小于 1V。
   The voltage Drop Across R_3Affects the Low Side Switching Performance and the Bootstrap Characteristics Since it is Placed Between COM and the Source Terminal of the Low Side MOSFET. For this Reason, the Voltage Drop Across R_3Should Be Less Than 1 V in the Steady-State.
4. 为避免浪涌电压和 HVIC 故障，接地线和输出端子之间的接线应短且粗。
   Ground Wires and Output Terminals, Should Be Thick and Short in Order to Avoid Surge Voltage and Malfunction of HVIC.
5. 所有的滤波电容器应紧密连接到 IPM 产品，他们应当具有能够很好的阻挡高频纹波电流的特性。
   All the Filter Capacitors Should Be Connected Close to Motion SPM, and They Should Have Good Characteristics for Rejecting High-Frequency Ripple Current.

轮廓封装详图/DETAILED PACKAGE OUTLINE DRAWINGS



Dimension unit : [mm]

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