三相无刷电机
驱动芯片

KA44143A
产品规格

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For additional information or question, please contact Nuvoton Technology Corporation Japan
www.nuvoton.co.jp

■ 重要通知

Regarding the specifications of this product, it is considered that you have agreed to the quality level and disclaimer described below.

Support for industry standards and quality standards

Functional safety standards for automobiles ISO26262	**No**
AEC-Q100	**Yes**
Market failure rate	**50Fit**

Disclaimer

1. When the application system is designed using this IC, please design the system at your own risk. Please read, consider, and apply appropriate usage notes and description in this standard.

2. When designing your application system, please take into the consideration of break down and failure mode occurrence and possibility in semiconductor products. Measures on the systems such as, but not limited to, redundant design, mitigating the spread of fire, or preventing glitch, are recommended in order to prevent physical injury, fire, social damages, etc. in using the Nuvoton Technology Japan Corporation (hereinafter referred to as NTCJ) products.

3. When using this IC, for each actual application systems, verify the systems and the all functionality of this IC as intended in application systems and the safety including the long-term reliability at your own risk

4. Please use this IC in compliance with all applicable laws, regulations and safety-related requirements that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. NTCJ shall not be held responsible for any damage incurred as a result of this IC being used not in compliance with the applicable laws, regulations and safety-related requirements.

5. This IC does not have any security functions using cryptographic algorithms, such as authentication, encryption, tampering detection.

6. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular industry standard (e.g., ISO 9001, IATF 16949, ISO 26262, etc.), this IC is neither designed nor intended for use in such environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular industry standard.

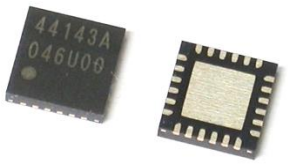
7. Using IC that have been indicated as compliant with industry functional safety standards does not warrant that the application meets the requirements of industry functional safety standards. NTCJ shall not be held responsible for the application compliance with requirements of the particular industry functional safety standard.

8. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular quality standard (e.g., AEC-Q100, etc.), this IC is neither designed nor intended for use in such the environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular quality standard.

9. In case of damages, costs, losses, and/or liabilities incurred by NTCJ arising from customer's non-compliance with above from 1 to 8, customer will indemnify NTCJ against every damages, costs, losses and responsibility.

特点

- 电源电压范围: 4.5 V ~ 26.4 V
- 内置 5-V 调节器
- 1个霍尔传感器实现三相全波正弦波PWM驱动
- 可选输入模式：线性电压输入或通过VSP引脚的PWM输入
- 通过SWSF引脚选择起始频率
- 导电角自动驱动相移校正
- 可选旋转方向 (正向/反向)
- 可选FG脉冲分频
- 睡眠模式
- 多款保护机制:
  欠压锁定(UVLO), 过压锁定(OVLO), 过热保护,
  过载保护, 和 过流保护
- 封装
  QFN 24L (4x4x0.8mm3, 脚距 0.5mm)



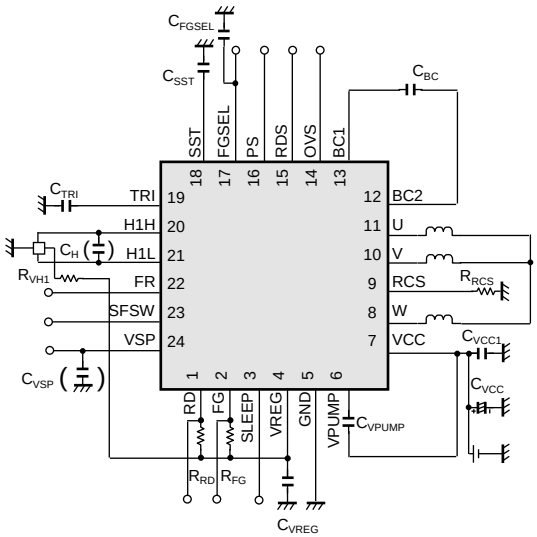
说明

- KA44143A是用于风扇电动机的三相无刷电动机的驱动芯片。
  通过采用转子位置检测器和1-霍尔传感器的正弦波PWM驱动，该芯片实现了电机组的部件减少和小型化，以及低噪声，低振动和低功耗的电机驱动。

应用

- 冰箱，投影仪，打印机，工厂自动化，汽车HVAC 风扇

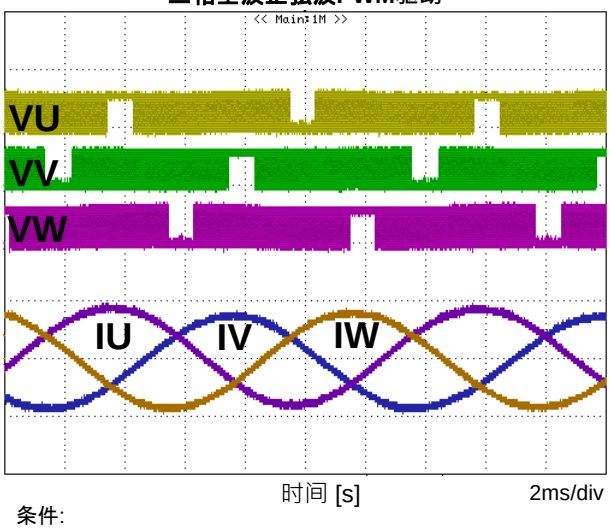
典型应用



注意事项: 此应用电路仅为示例，不保证批量生产的操作。
在批量生产的设计中，需要对其进行充分的评估和验证。
客户应付产品设计中并入以上应用电路的责任。

电机驱动波形

三相全波正弦波PWM驱动



条件:
V_{CC} = 12 V, V_{FR} = 0 V, V_{VSP} = PWM 模式 (60kHz, 占空比60%)

目录

绝对最大额定值

参数	符号	额定值	单位	注意事项
电源	V_{CC}	28	V	*1
工作环境温度	T_{opr}	– 40 ～ + 105	°C	*2
储存温度	T_{stg}	– 55 ～ +150	°C	*2
输入电压范围	V_{VREG}	– 0.3 ～ 6.0	V	*3
	V_{SLEEP},V_{H1H},V_{H1L},V_{FGSEL}, V_{VSP},V_{SFSW},V_{FR},V_{RDS},V_{PS},V_{OVS}	– 0.3 ～ 6.0	V	—
	V_{TRI} ,V_{SST}	– 0.3 ～ 6.0	V	—
输出电压范围	V_{FG},V_{RD}	– 0.3 ～ 6.0	V	—
	V_{VREG}	– 0.3 ～ 6.0	V	—
	V_{RCS}	– 0.3 ～ 6.0	V	*4
	V_{BC1}	28	V	*4
	V_{BC2},V_{pump}	37	V	*4
输出电流范围	I_{Upeak}, I_{Vpeak}, I_{Wpeak}	± 2200	mA	*5, *6
	I_{FG},I_{RD}	5	mA	—
	I_{VREG}	−10	mA	—
静电放电防护(ESD)	HBM	2	kV	—

注意事项：如果在高于上述绝对最大额定值的条件下使用，此产品可能会遭受永久性损坏。
此额定值是最大额定值，超出此范围的设备将无法保证工作，因为它高于我们规定的建议工作范围。
长时间在绝对最大额定值下工作，可能会影响产品的可靠性。
*1：在不超过上述绝对最大额定值和功耗的条件下的值。
*2：除功耗，工作环境温度和存储温度外，所有额定值都在Ta = 25℃的情况下得到。
*3: 仅当该引脚和VCC引脚连接时，才可以向该引脚施加外部电压。
当向此引脚施加外部电压时，即使在瞬态下也不要超过规定的额定值
*4:禁止在这些引脚上施加外部电流。在瞬态下也不要超过规定的额定值。
*5:禁止在这些引脚上施加外部电流。在瞬态下也不要超过规定的额定值。
*6: 对于VCC≧5.6 V，输出电流为±2200 mA。对于VCC ＜5.6 V，输出电流为±1500 mA。
请确保有足够的余量，并且设计不要超过功耗（P_D）和安全运行区域（ASO）的允许值。

额定功耗

封装	θ_{j-a}	θ_{j-c}	P_D (T_a=25 °C)	P_D (T_a=105 °C)
QFN 24L (4x4x0.8mm3, Lead Pitch 0.5mm)	56.1 °C/W	4.4 °C/W	2.22 W	0.80 W

注意事项： 在实际应用下，须遵循电源电压，负载和环境温度条件，以确保有足够的余量，并且确保散热设计不会超过允许值。
玻璃环氧基材(2 层板) : 50 x 50 x 0.8t (mm)，散热片：垫板，焊接。
(通过2层板散热)

警告
尽管此芯片具有内置的ESD保护电路，但如果处理不当，仍可能遭受永久性损坏。
因此，建议采取适当的ESD预防措施，以避免静电损坏 MOS 栅极。

推荐操作条件

参数	符号	最小值	典型值	最大值	单位	注意事项
电源范围	V_{CC}	4.5	—	26.4	V	—
输入电压范围	V_{SLEEP}	0	—	V_{VREG}	V	*1
	V_{H1H}	0	—	V_{VREG}	V	*1
	V_{H1L}	0	—	V_{VREG}	V	*1
	V_{PS}	0	—	V_{VREG}	V	*1
	V_{RDS}	0	—	V_{VREG}	V	*1
	V_{OVS}	0	—	V_{VREG}	V	*1
	V_{FGSEL}	0	—	V_{VREG}	V	*1
	V_{VSP}	0	—	V_{VREG}	V	*1
	V_{SFSW}	0	—	V_{VREG}	V	*1
	V_{FR}	0	—	V_{VREG}	V	*1
外部元件常熟	C_{VCC}	4.7µ	—	—	F	*2,*3
	C_{VCC1}	—	0.1µ	—	F	*2,*3
	C_{VREG}	—	0.1µ	—	F	*2,*4
	C_{SST}	22p	1800p	—	F	*2,*5
	C_{BC}	—	0.1µ	—	F	*2,*4
	C_{VPUMP}	—	0.1µ	—	F	*2,*4
	C_{TRI}	220p	390p	1300p	F	*2,*5
	R_{RCS}	0.15	0.22	—	Ω	*2,*5,*6
	R_{VH}	—	1k	—	Ω	*2,*5
	C_{FGSEL}	—	0.01µ	—	F	*2,*7
	C_{VSP}	—	0.1µ	—	F	*2,*8

注意事项 : *1: 有关输入控制电压的设置范围, 请参阅电气特性(第6-9页)和操作(第12-34页)。
*2: 不保证批量生产的操作。须对批量生产的设计进行足够的评估和验证。
*3: 请进行充分的评估和验证, 以确保减小VCC引脚电压纹波。
*4: 建议使用推荐值。
*5: 请根据用途选择设置。请参考电气特性(第6-9页)和操作(第12-34页)。
*6: 请勿使用小于此值的电阻。当使用小于最小值的电阻值时, 由于外部因素(PCB散热, 金属阻抗等)或内部因素(阈值变化等), 用于防止热损坏的闩锁功能可能被启用。
*7: 在FGSEL引脚开路的情况下使用时, 请在FGSEL引脚上连接电容器以防止产生噪声, 并进行充分的评估和验证。
*8: 当VSP引脚用于DC输入时, 建议在VSP引脚上插入一个电容器。

电气特点

V_{CC} = 12.0 V, V_{VREG} = 5.0 V

注意事项: 除非另有说明， 否则均在T_a = 25°C±2°C 时测量。

参数	符号	条件	极限值			单位	注意事项
			最小	典型	最大		
电路电流							
V_{CC} 电流	I_{CC1}	—	3.0	5.6	9.0	mA	—
睡眠模式的V_{CC} 电流	I_{CC3}	V_{SLEEP} = H	—	—	50	μA	—
调节器区块							
VREG 电压	V_{VREG}	—	4.7	5	5.3	V	—
输出阻抗	Z_{VREG}	I_{VREG} = −10 mA	—	—	10	Ω	—
FG 区块							
FG 输出 (低电压)	V_{FGL}	I_{FG} = 1.0 mA	—	0.1	0.3	V	—
RD 区块							
RD 输出 (点电压)	V_{RDL}	I_{RD} = 1.0 mA	—	0.1	0.3	V	—
电源区块							
导通电阻	R_{ONHL}	I = 400 mA	0.5	1.0	1.5	Ω	—
导通电阻 (Vcc=4.5V)	R_{ONHL}	Vcc = 4.5V I = 400 mA	—	1.25	2.05	Ω	—
二极管正向电压	V_{DI}	I = 400 mA	0.6	0.8	1	V	—
电机锁定保护							
锁定检测时间_LL	t_{LOCK1_LL}	RDS, SFSW = L,L	0.35	0.5	0.65	s	—
锁定解除时间_LL	t_{LOCK2_LL}	RDS, SFSW = L,L	3.5	5	6.5	s	—
锁定保护比_LL	PR_{RATIO_LL}	RDS, SFSW = L,L	9	10	11	—	—
锁定检测时间_LH	t_{LOCK1_LH}	RDS, SFSW = L,H	0.7	1	1.3	s	—
锁定解除时间_LH	t_{LOCK2_LH}	RDS, SFSW = L,H	7	10	13	s	—
锁定保护比_LH	PR_{RATIO_LH}	RDS, SFSW = L,H	9	10	11	—	—
锁定检测时间_HL	t_{LOCK1_HL}	RDS, SFSW = H,L	1.4	2	2.6	s	*1
锁定检测时间_HH	t_{LOCK1_HH}	RDS, SFSW = H,H	0.35	0.5	0.65	s	*2
过流保护							
过电流检测等级	V_{CL1}	—	0.225	0.250	0.275	V	—
睡眠模式							
低电平输入电压	V_{SLL}	—	—	—	0.5	V	—
高电平输入电压	V_{SLH}	—	2.5	—	—	V	—
开路电压	V_{SLZ}	—	—	0	0.3	V	—
输入阻抗	Z_{SL}	—	70	100	130	kΩ	—
内部震荡频率							
内部震荡频率	f_{OSC}	—	17.5	25	32.5	MHz	—

注意事项:* 1:电机锁定保护通过UVLO信号输入和SLEEP信号输入立即释放。
* 2:电机锁定保护会立即自动复位(经过70us之后)。

电气特点（续)

V_{CC} = 12.0 V, V_{VREG} = 5.0 V

注意事项: 除非另有说明， 否则均在T_a = 25°C±2°C 时测量。

参数	符号	条件	极限值			单位	注意事项
			最小	典型	最大		
VSP							
引脚电流	I_{VSP}	V_{VSP}=5.0V	—	15	45	μA	—
VSP DC 输入控制							
停止控制的VSP输入	V_{VSPDCL}	—	0.9	1.0	1.1	V	—
最大速度的VSP输入	V_{VSPDCH}	—	3.6	4.0	4.4	V	—
VSP PWM 输入控制							
停止控制的VSP输入	$V_{VSPPWML}$	V_{VREG}=V_{OSC}=5.0V	2	3	4	%	*1,*2
最大速度的VSP输入	$V_{VSPPWMH}$	V_{VREG}=V_{OSC}=5.0V	—	100	—	%	*1,*4
在PWM输入期间的低电平输入电压	V_{VSPLL}	V_{VREG}=V_{OSC}=5.0V	—	—	1.0	V	*1
在PWM输入期间的高电平输入电压	V_{VSPHL}	V_{VREG}=V_{OSC}=5.0V	2.0	—	—	V	*1
PWM输入频率范围	F_{PWM}	—	15	—	100	kHz	*1
PWM波形的三角波振荡器 （TRI 引脚）							
振幅	V_{TRI}	—	1.36	1.53	1.70	Vpp	—
外部电容器充电电流	I_{TRI1}	V_{TRI} =0.5V	−83.5	−64.5	−45.5	μA	—
外部电容器放电电流	I_{TRI2}	V_{TRI} =2.0V	45.5	64.5	83.5	μA	—
在PWM控制期间的TRI引脚输入电压	V_{TRITH}	—	2.9	—	—	V	*1
软启动期间的三角波振荡器 (SST 引脚)							
振幅	V_{SST}	—	0.75	1.0	1.25	Vpp	—
外部电容器充电电流	I_{SST1}	V_{SST} =0.6V	−6.0	−4.0	−2.0	μA	—
外部电容器放电电流	I_{SST2}	V_{SST} =1.6V	2.0	4.0	6.0	μA	—
在软启动期间的SST引脚输入电压	V_{SSTTH}	—	2.9	—	—	V	*3
霍尔区块							
输入动态范围	V_{HALL}	—	0	—	VREG -2.0V	V	—
引脚电流	I_{HALL}	—	– 2	0	2	μA	—
对于H1H−H1L下降的输入失调电压	V_{HOFS}	—	-6	0	6	mV	—
最小输入幅度电压	V_{HA}	—	25	—	—	mV	—
迟滞宽度	V_{HHYS}	—	7.5	10	13	mV	—

注意事项:* 1: 在PWM控制设置期间, 必须将TRI引脚连接到VREG引脚。
* 2: 当输入STOP时, 建议设置0%占空比(低输入)。
* 3: 当不使用软启动时, 必须将SST引脚连接到VREG引脚。
* 4: 典型设计值。

电气特点 (续)

V_{CC} = 12.0 V, V_{VREG} = 5.0 V

注意事项: 除非另有说明， 否则均在T_a = 25°C±2°C 时测量。

参数	符号	条件	极限值			单位	注意事项
			最小	典型	最大		
FR (三态輸入电路)							
低电平输入电压	V_{FRL}	—	—	—	0.8	V	—
中电平输入电压	V_{FRM}	—	1.3	—	2.0	V	—
高电平输入电压	V_{FRH}	—	2.5	—	—	V	—
开路电压	V_{FRZ}	—	1.4	1.65	1.9	V	—
引脚电流	I_{INFR}	V_{FR} = 0 V	- 40	- 20	—	µA	—
FGSEL (三态輸入电路)							
低电平输入电压	V_{FGSELL}	—	—	—	1.0	V	—
高电平输入电压	V_{FGSELH}	—	4.0	—	—	V	*1
开路电压	V_{FGSELZ}	—	1.8	2.4	2.8	V	*2
引脚电流	I_{INFG}	V_{FGSEL} = 0 V	- 40	- 20	—	µA	—
PS (二态輸入电路)							
低电平输入电压	V_{PSL}	—	—	—	1.0	V	—
高电平输入电压	V_{PSH}	—	4.0	—	—	V	*1
开路电压	V_{PSZ}	—	—	0.0	0.5	V	—
引脚电流	I_{INPS}	V_{PS} = 5.0 V	—	5	15	µA	—
RDS (二态輸入电路)							
低电平输入电压	V_{RDSL}	—	—	—	1.0	V	—
高电平输入电压	V_{RDSH}	—	4.0	—	—	V	*1
开路电压	V_{RDSZ}	—	—	0.0	0.5	V	—
引脚电流	I_{INRDS}	V_{RDS} = 5.0 V	—	5	15	µA	—
OVS (二态輸入电路)							
低电平输入电压	V_{OVSL}	—	—	—	1.0	V	—
高电平输入电压	V_{OVSH}	—	4.0	—	—	V	*1
开路电压	V_{OVSZ}	—	—	0.0	0.5	V	—
引脚电流	I_{INOVS}	V_{OVS} = 5.0 V	—	5	15	µA	—
SFSW (2态輸入电路)							
低电平输入电压	V_{SFSWL}	—	—	—	1.0	V	—
高电平输入电压	V_{SFSWH}	—	4.0	—	—	V	*1
开路电压	V_{SFSWZ}	—	—	0.0	0.5	V	—
引脚电流	I_{INSFSW}	V_{SFSW} = 5.0 V	—	5	15	µA	—

注意事项: * 1: 在高电平设置期间, 请确保连接到VREG引脚。
* 2: 在使用过程中断开时, 请将电容器连接至FGSEL引脚, 以防止产生噪音。
为了防止噪音, 请进行充分的评估和验证。

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电气特点 (续)

V_{CC} = 12.0 V, V_{VREG} = 5.0 V

注意事项: 除非另有说明， 否则均在T_a = 25°C±2°C 时测量。

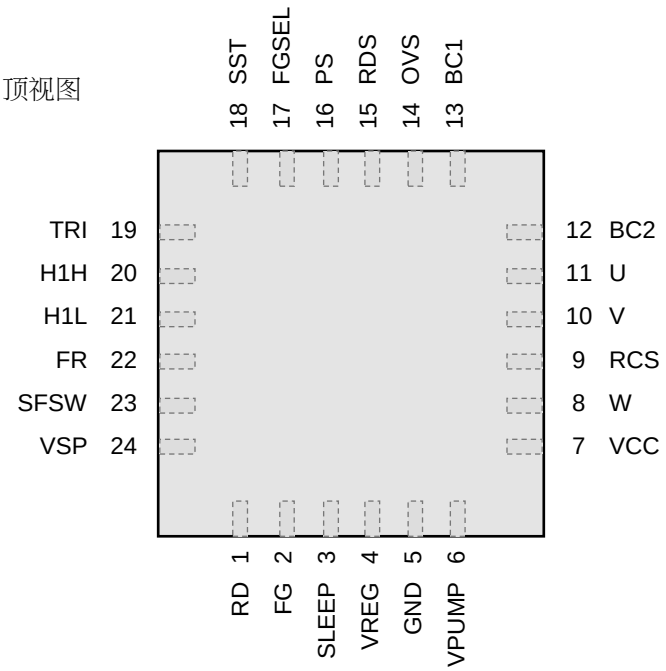
参数	符号	条件	极限值			单位	注意事项
			最小	典型	最大		
过热保护							
热保护工作温度	TSD_{ON}	—	—	160	—	°C	*1*2
迟滞宽度	TSD_{HYS}	—	—	25	—	°C	*1*2
输出区块							
拉电流时输出上升摆率	V_{TRSO}	—	—	300	—	V/µs	*1*2
拉电流时输出下降摆率	V_{TFSO}	—	—	300	—	V/µs	*1*2
灌电流时输出上升摆率	V_{TRSI}	—	—	300	—	V/µs	*1*2
灌电流时输出下降摆率	V_{TFSI}	—	—	300	—	V/µs	*1*2
PWM波形的三角波振荡器（TRI 引脚）							
振荡频率范围	f_{TRI}	—	15	—	100	kHz	*2
标准震荡频率	F_{TRI}	C_{TRI} = 390 pF	—	55.4	—	kHz	*1*2
软启动期间的三角波振荡器 (SST 引脚)							
标准震荡频率	F_{SST}	C_{SST} = 1800 pF	—	1.13	—	kHz	*1*2
最高转速							
最小霍尔周期	T_{HMIN}	—	—	173	—	µs	*1*2
欠压锁定							
保护工作电压	V_{LVON}	—	—	3.55	—	V	*1*2
保护解除电压	V_{LVOFF}	—	—	3.75	—	V	*1*2
过压锁定							
保护工作电压1	V_{OVON1}	V_{OVS} = VREG	15.0	16.0	17.0	V	*2
保护工作电压2	V_{OVON2}	V_{OVS} = 0V	26.4	27.2	28.0	V	*2

注意事项: *1: 典型设计值

*2: 设计检查值, 非量产测试值

引脚配置

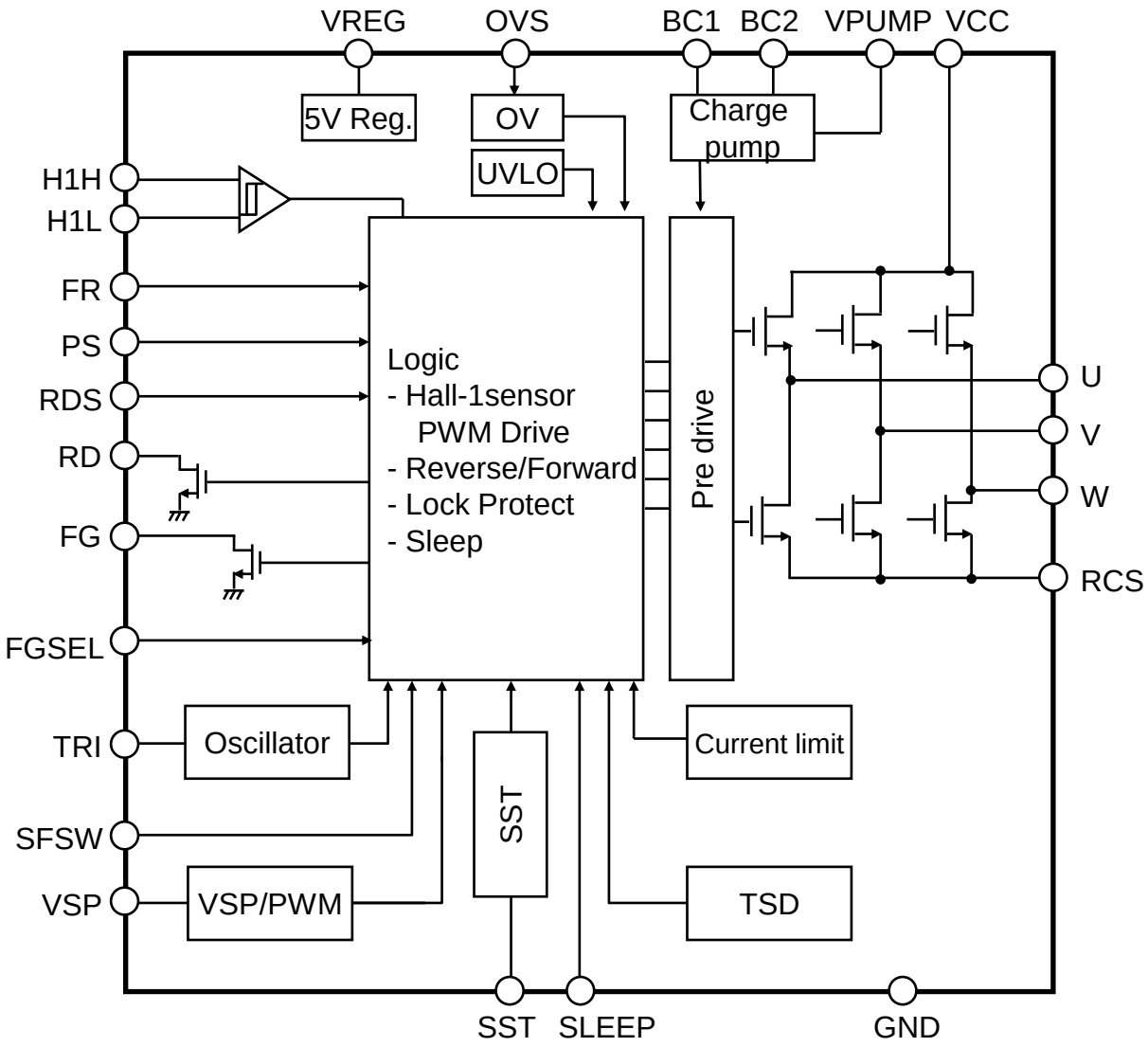
顶视图



引脚功能

引脚编号	引脚名	形式	说明
1	RD	输出	过载保护
2	FG	输出	FG 外部输出
3	SLEEP	输入	睡眠设置
4	VREG	输出	内部参考电压
5	GND	接地	接地
6	VPUMP	输出	电荷泵电路输出
7	VCC	电源	电机电源
8	W	输出	W相输出
9	RCS	输出	电机电流检测
10	V	输出	V相输出
11	U	输出	U相输出
12	BC2	输出	电荷泵的电容器连接引脚2
13	BC1	输出	电荷泵的电容器连接引脚1
14	OVS	输入	过压检测可选阈值。高用于16V检测，低用于27.2V检测
15	RDS	输入	可选择解除电机锁定保护。高电平用于启用锁定保护解除。低电平用于禁用锁定保护解除。
16	PS	输入	可选相移模式。高电平用于启用恒定相移模式。低电平用于启用自动相位FB移位模式。
17	FGSEL	输入	FG 脉冲计数选择
18	SST	输入/输出	用于软启动三角波振荡器频率设置的电容器连接引脚
19	TRI	输入/输出	用于PWM三角波振荡器频率设置的电容器连接引脚
20	H1H	输入	霍尔放大器输入(+)
21	H1L	输入	霍尔放大器输入 (-)
22	FR	输入	旋转方向选择 (正向/反向)
23	SFSW	输入	可选起始频率
24	VSP	输入	用于设置转速的电压输入

功能框图


VREG
OVS
BC1
BC2
VPUMP
VCC
5V Reg.
OV
UVLO
Charge pump
H1H
H1L
FR
PS
RDS
RD
FG
FGSEL
TRI
SFSW
VSP
Logic
- Hall-1sensor
PWM Drive
- Reverse/Forward
- Lock Protect
- Sleep
Pre drive
U
V
W
RCS
Oscillator
SST
Current limit
VSP/PWM
TSD
SST
SLEEP
GND

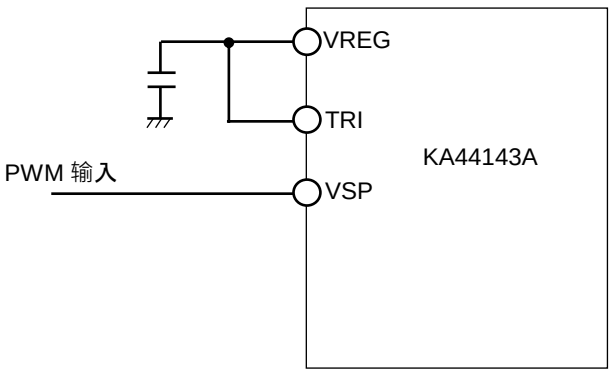
操作

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

1. VSP 输入配置

1-1. PWM 输入模式

PWM输入控制或DC输入控制用作VSP引脚的输入控制。
使用PWM输入控制时，请确保将TRI引脚连接到VREG引脚。
平均输出电压的峰值是根据PWM占空比信号决定。



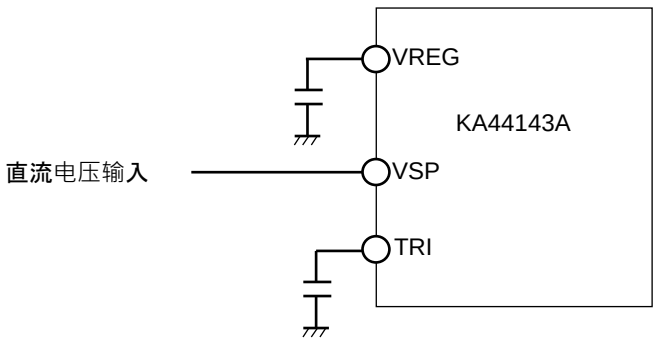
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

1. VSP 输入配置 (续)

1-2. VSP 输入模式

PWM输入控制或DC输入控制用作VSP引脚的输入控制
使用直流输入控制时，请确保在TRI引脚和GND引脚之间连接一个电容器。



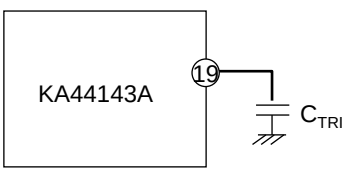
直流电压输入模式下的信号
在直流电压输入模式下，PMW信号时通过比较TRI引脚的三角波形与VSP引脚的输入直流电压来生成的。
平均输出电压的峰值取决于VSP引脚电压，而输出PWM频率取决于TRI引脚三角波形频率。
.

TRI引脚三角波振荡器频率

使用以下公式计算输入到TRI引脚的三角波振荡器的频率。

三角波振荡器频率 $f_{TRI} = \frac{I_{TRI}}{2 \times C_{TRI} \times V_{TRI}}$

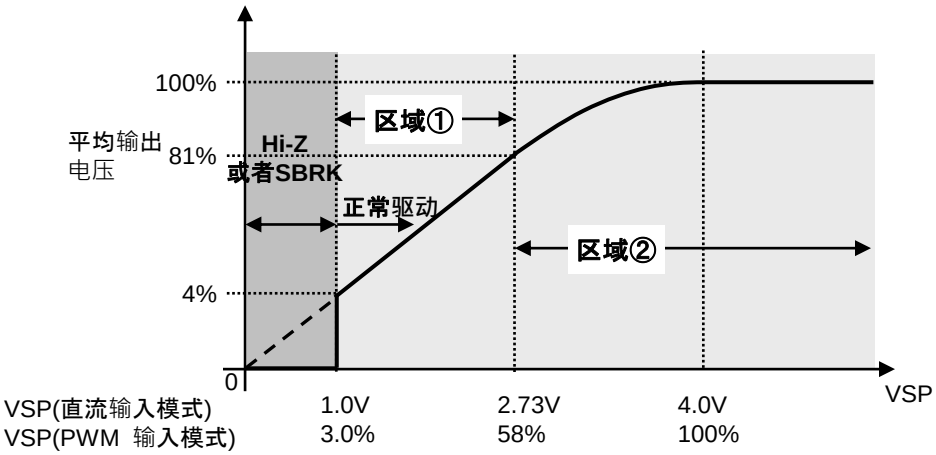
V_{TRI} ：三角波振幅 (低于典型值1.53 V)
A　　：64.5 μA (低于典型值)



操作 (续)

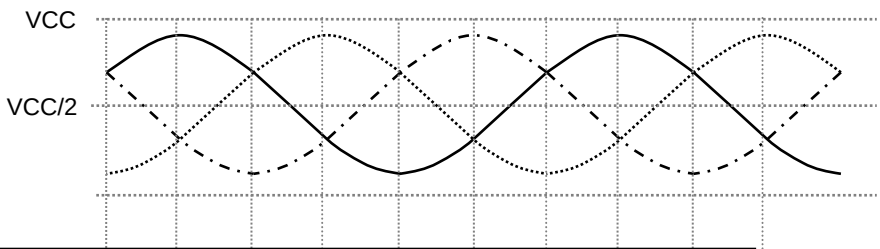
注) 下列的特性是从芯片设计得出的参考值，将不被保证。

2. VSP 输入电压和平均输出电压

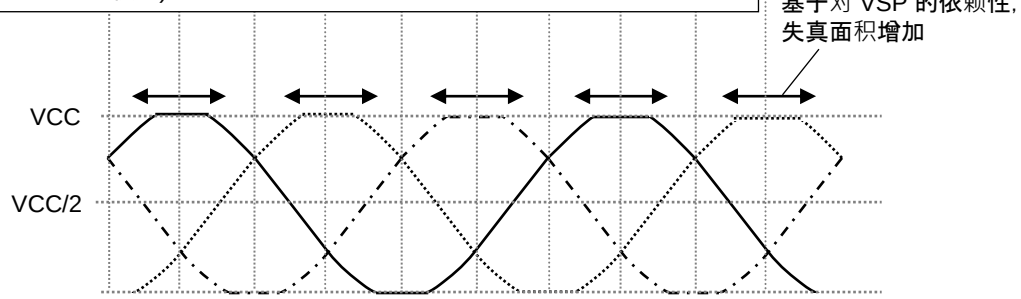


○平均输出电机电压

区域① 输出占空比是线性的取决于VSP输入
- VSP(直流输入模式) ≒ 1.0V ~ 2.73 V
- VSP(PWM 输入模式) = 3.0% ~ 58 %



区域② 输出占空比与 VSP 呈非线性关系，因为平均电压会因 VCC 而失真
- VSP(直流输入模式) ≒ 2.73V ~ 4.0 V
- VSP(PWM 输入模式) = 58% ~ 100 %



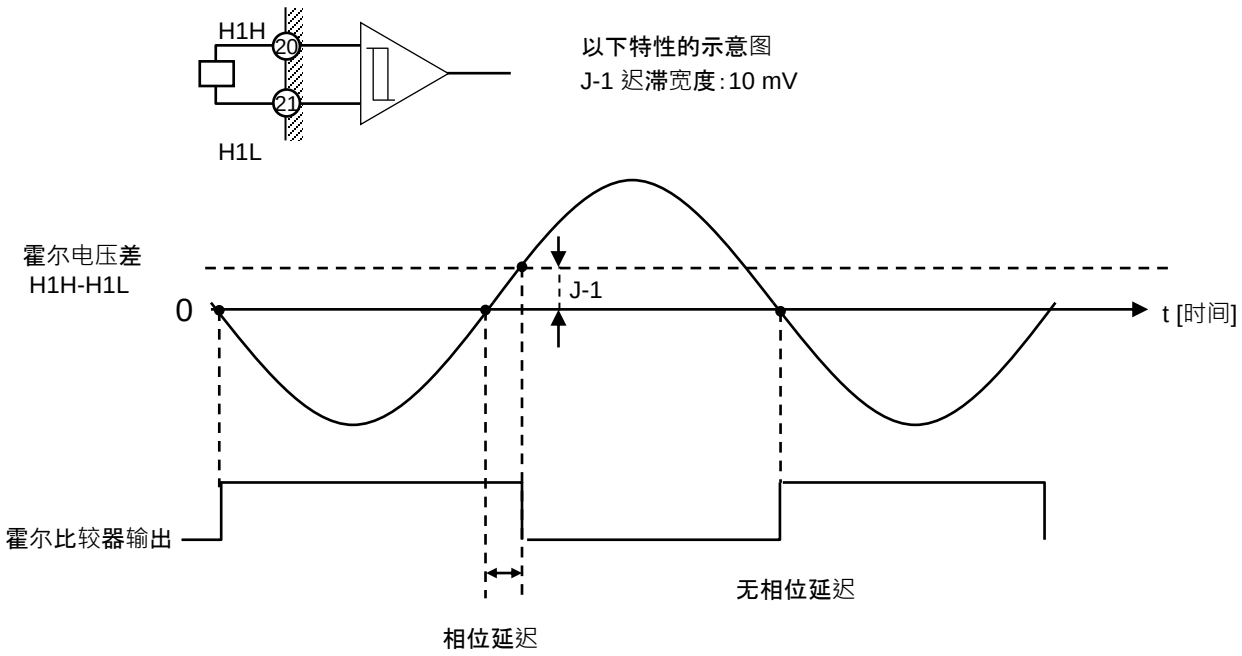
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

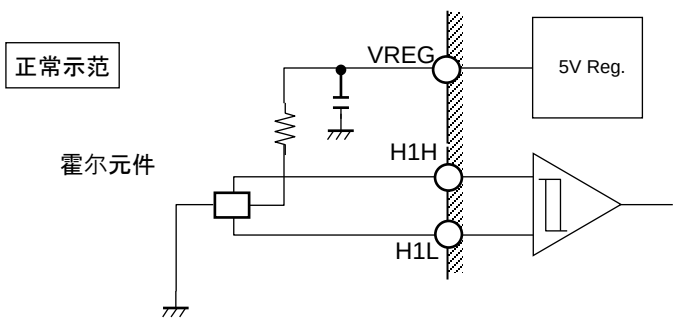
3. 霍尔输入规格

3-1. 霍尔信号检测系统

电机位置由霍尔迟滞比较器检测。如果正弦波的振幅较小，则相位比较器输出的延迟将非常明显。
因此，请增大正弦波的振幅。
建议振幅为 200 mV 或以上。当霍尔元件发生抖动时，请在H1H（引脚20）和H1L（引脚21）之间插入一个电容器。



对于霍尔元件的偏置源，请通过与VREG引脚的外部短路来构建。



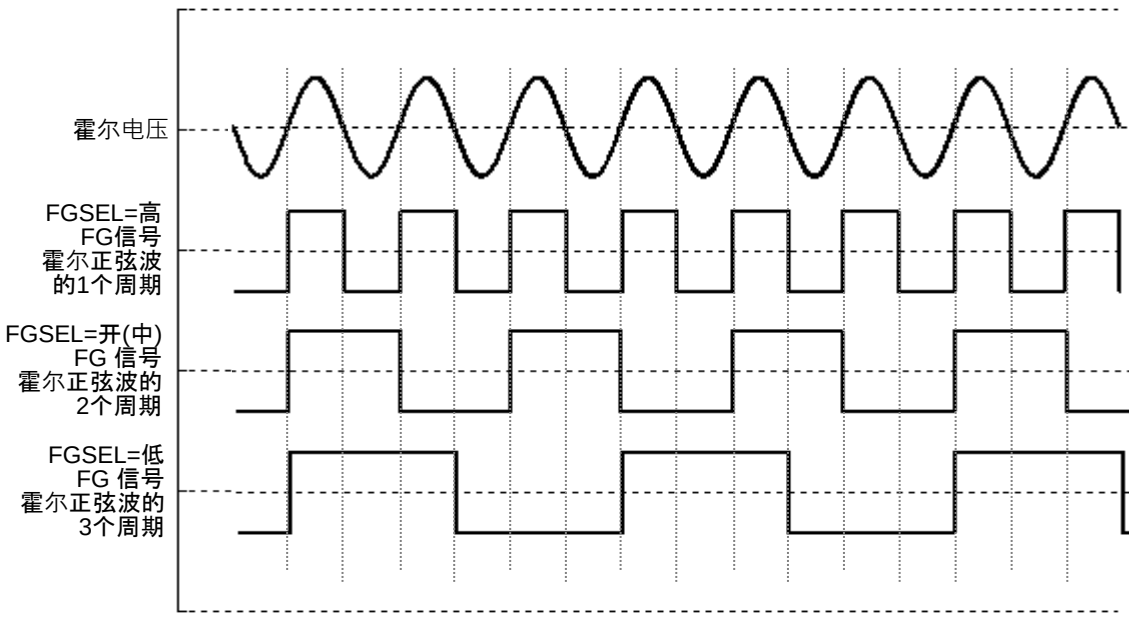
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

3. 霍尔输入规格 (续)

3-2. 霍尔电压与FGSEL的关系

输出相当于霍尔正弦波的1周期/ 2周期/ 3周期（由FGSEL选择）的1周期FG信号。



操作 (续)

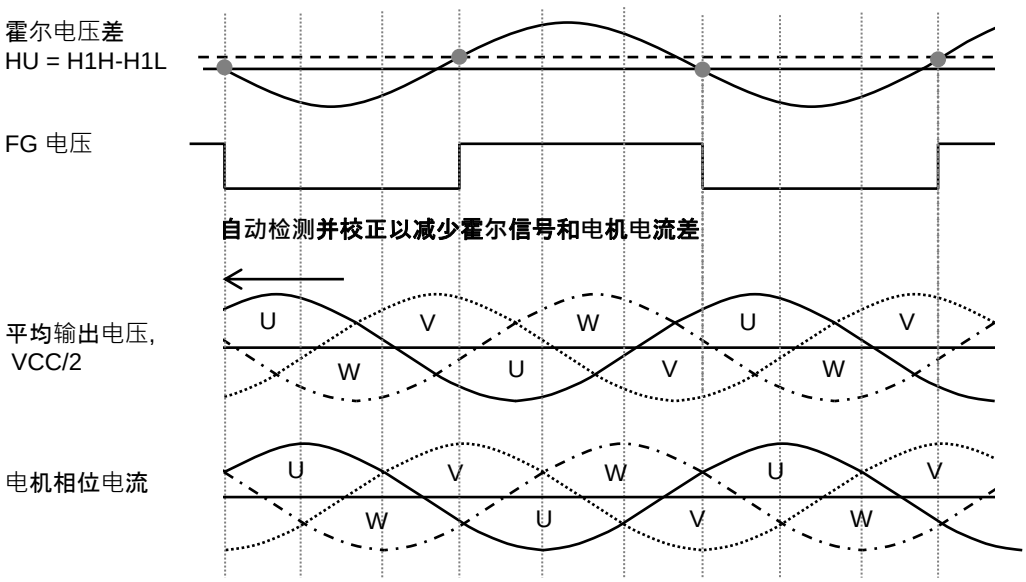
注) 下列的特性是从芯片设计得出的参考值，将不被保证。

3. 霍尔输入规格 (续)

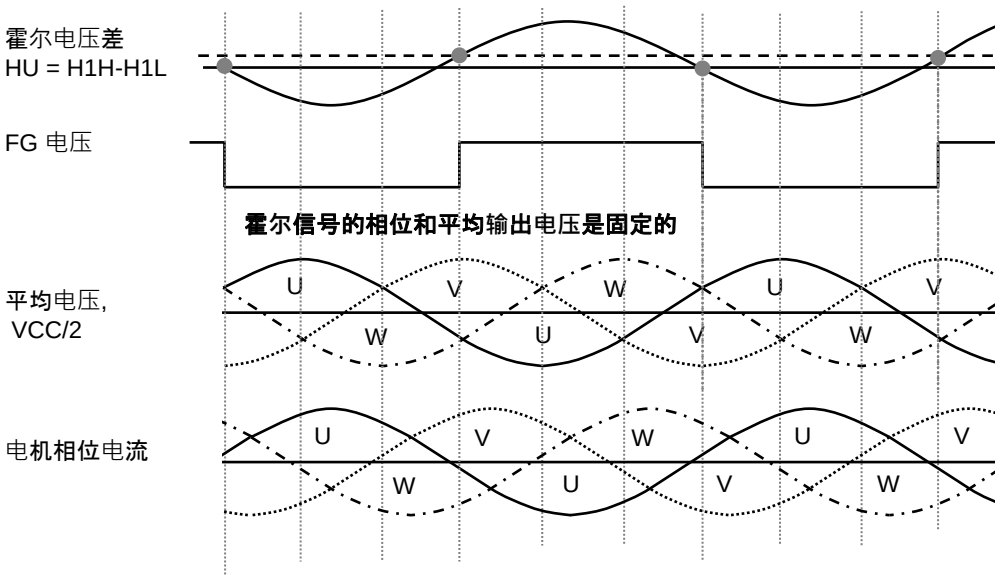
3-3. 驱动相移控制

PS = L时的自动驱动相移控制。相对于导通角的霍尔信号相位会检测出芯片自身的相位差，并自动将其校正为最佳相位。U相输出电压的示例如下所示。

当PS = L时，自动驱动相移控制



当PS = H时，固定在 0 度



操作 (续)

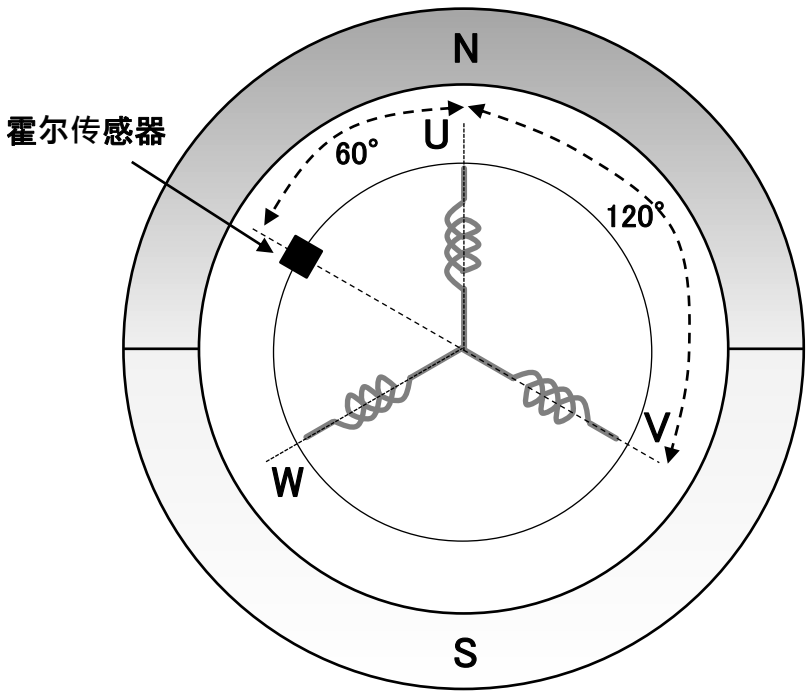
注) 下列的特性是从芯片设计得出的参考值，将不被保证。

3. 霍尔输入规格 (续)

3-4. 霍尔传感器放置

该芯片仅使用1个霍尔传感器。
请将霍尔传感器放在U和W定子线圈之间的中心。

下图显示了2极3槽电机的霍尔传感器位置。



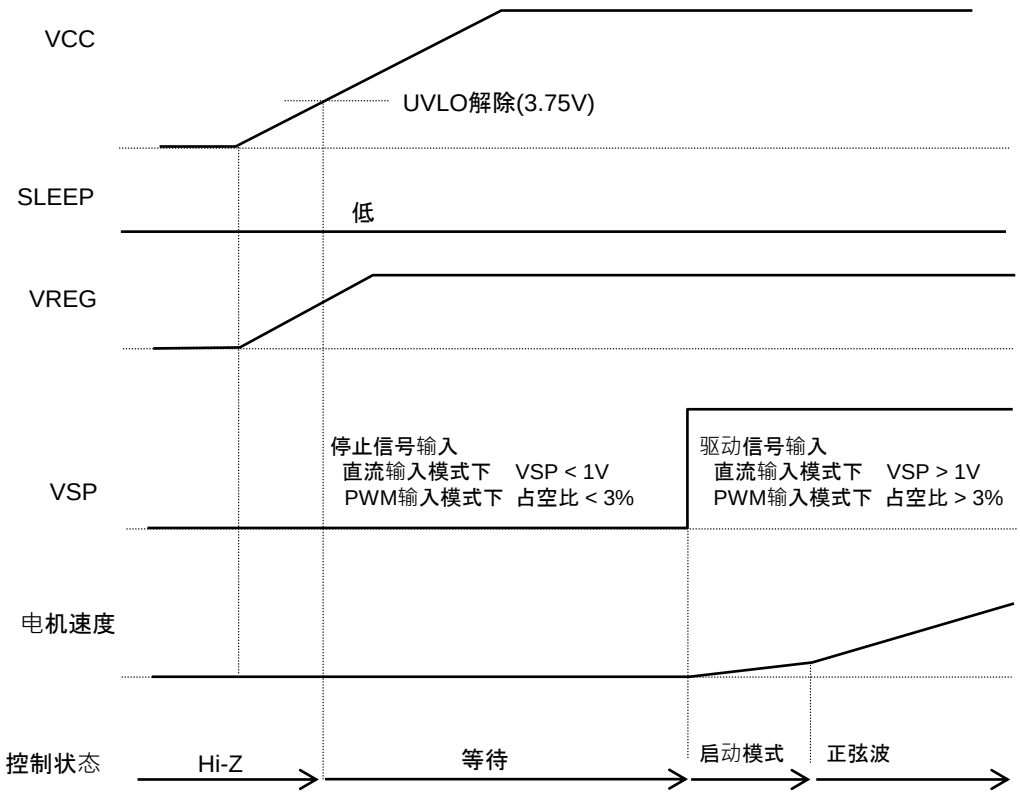
霍尔传感器的示例放置
（2极3槽电机）

操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

4. 启动 / 停止 控制

通过升高VCC引脚电压启动



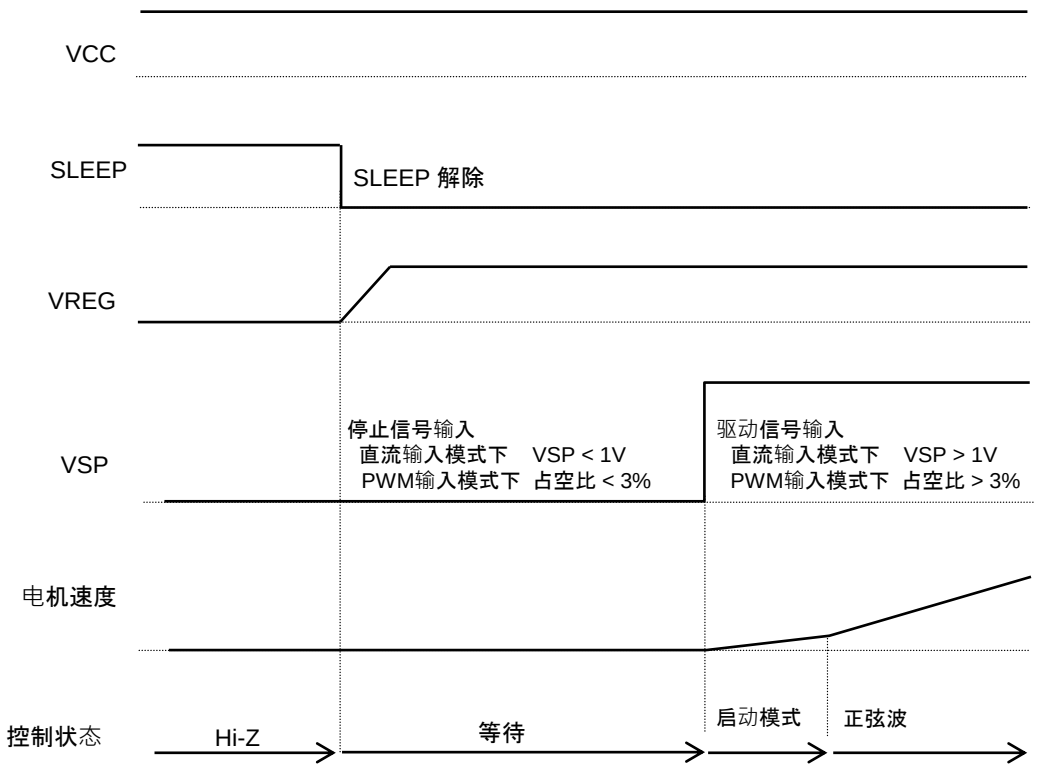
・在启动模式期间，没有FG信号输出。

操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

4. 启动 / 停止 控制 (续)

通过解除SLEEP信号来启动



- 在启动模式期间，没有FG信号输出。

操作 (续)

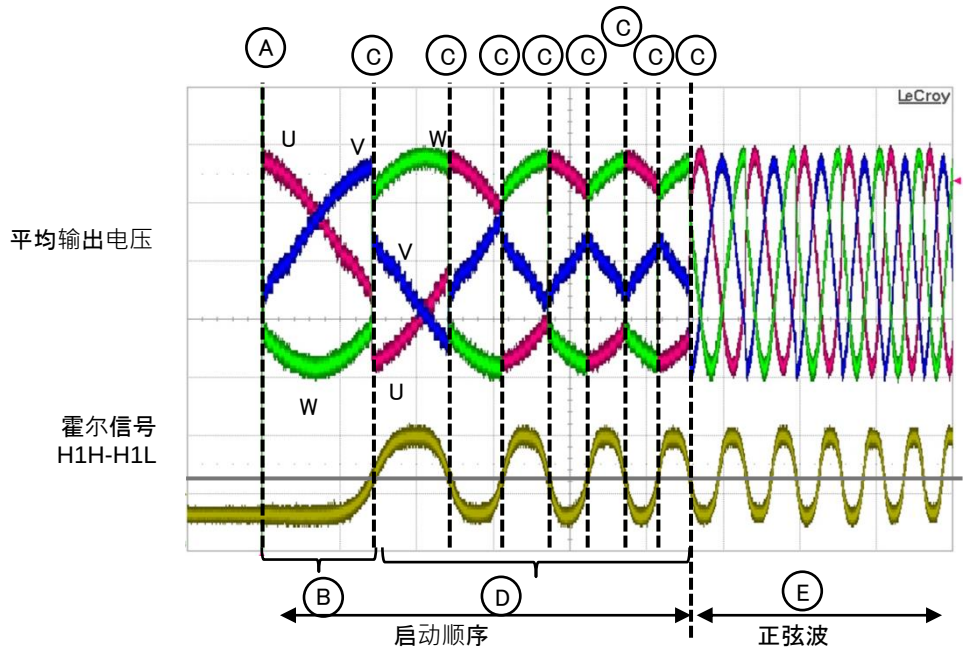
注) 下列的特性是从芯片设计得出的参考值，将不被保证。

4. 启动 / 停止 控制 (续)

启动顺序

启动时的波形如下图所示。

启动波形



(RDS, SFSW) ≠ (L, H) 1.8Hz
(RDS, SFSW) = (L, H) 0.9Hz

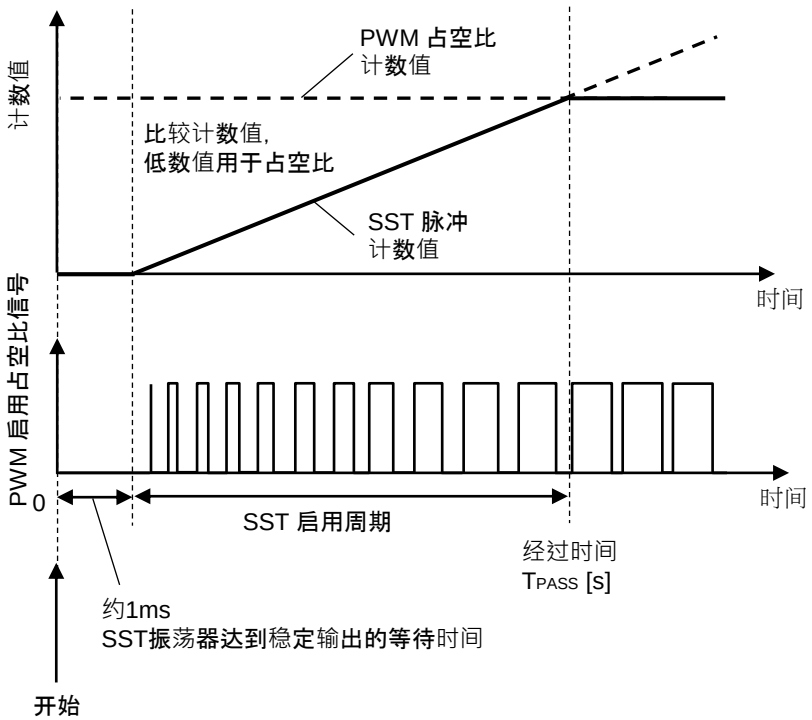
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

5. 软启动功能和PWM规格

通过将电容器连接到SST引脚，可以在模式转换期间根据启动模式条件执行软启动控制。软启动控制的时间由下一页所示的公式确定。当不需要软启动控制时，请确保将SST引脚连接到VREG引脚。

下面显示了VSP和SST的计数值和PMW启动占空比的相关时序图.



·关于软启动功能的使用注意事项。

随着软启动时间的增加，电动机电流也将缓慢增加。因此，如果软启动时间过长，则会导致电机启动转矩不足，如果软启动时间超过0.5s（典型值），则会触发锁定保护检测。这将导致电动机无法启动。使用此功能时，请充分评估并检查这种情况。

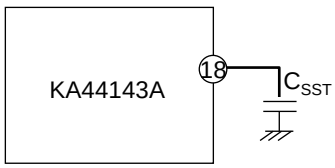
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

5. 软启动功能和PWM规格 (续)

SST引脚输出的三角波振荡器频率由以下公式确定。通过比较VSP引脚输入PWM频率和该三角波形频率来生成软启动时序。

三角波振荡器频率 $$f_{SST} = \frac{I_{SST}}{2 \times C_{SST} \times V_{SST}}$$



V_{SST} ：三角波振幅 (在典型值 1 V时)
A ：电流流入/流出 SST 引脚 (在典型值4 μA时)

在SST启用时序内经过时间T_{PASS} 时，输出中反映的PWM启用占空比由以下公式确定:

$$\text{PWM 占空比} = \frac{T_{PASS} \times T_{OSC}}{T_{SST} \times T_{PWM}}$$

T_{PWM} ：输入PWM周期 [s]
T_{OSC} ：内部振荡器的振荡周期 $40*10^{-9}$ [s]
T_{SST} ：SST三角波振荡周期 [s]
T_{PASS} ：经过时间 [s]

SST时序结束时的经过时间T_{PASS} 可以通过以下公式确定:

$$T_{PASS} = \frac{T_{PWM} \times D \times T_{SST}}{T_{OSC}}$$

D ：输入PWM占空比 [%]

直流输入期间的输入PWM占空比可以通过以下公式确定

$$D = \left(\frac{97}{3} \times V_{VSP} - \frac{88}{3}\right) \times 0.01$$

直流输入期间，V_{VSP}=1V～4V

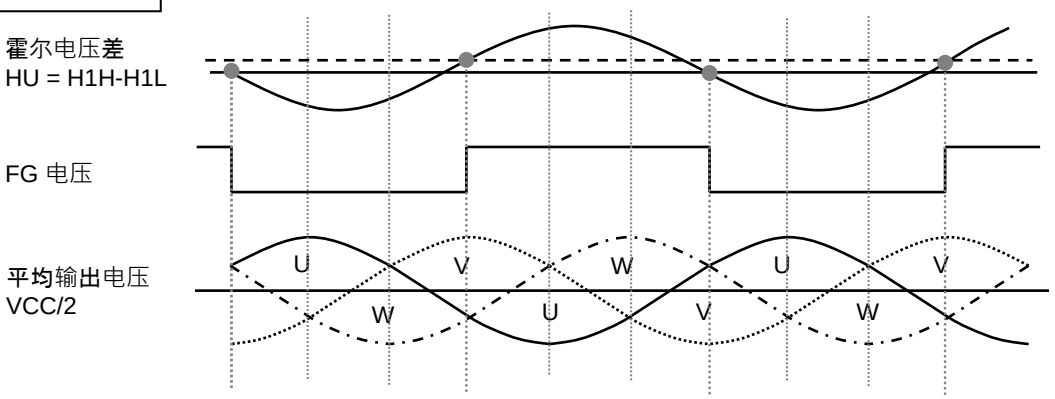
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

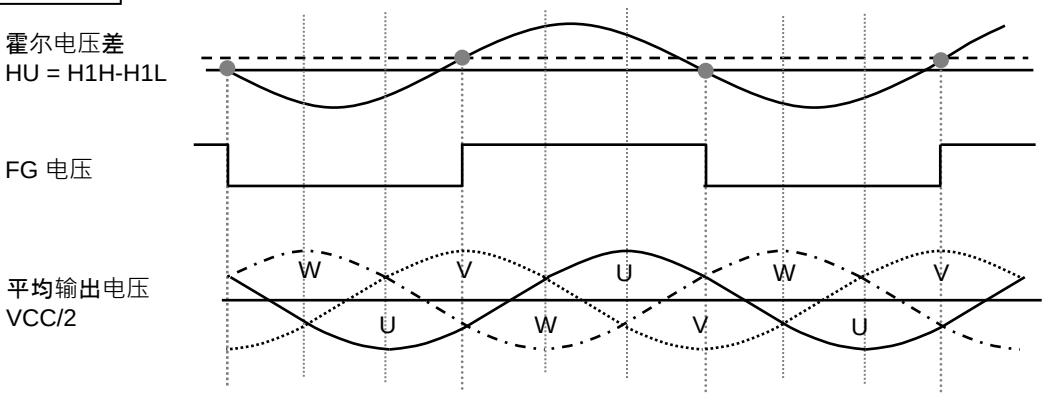
6. 正向, 反向和短路制动

霍尔，FR（正向/反向）与平均输出电压之间的关系

正向 (FR = L)



反向 (FR = H)



FR 开关操作

F / R不会立即切换。在电机停止旋转后，才执行反向运行。

操作 (续)

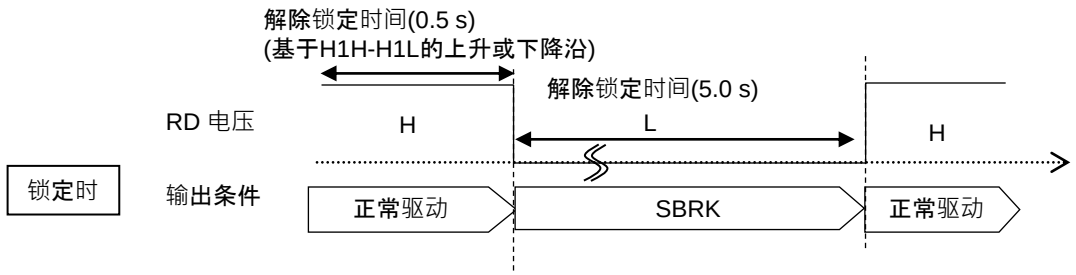
注) 下列的特性是从芯片设计得出的参考值，将不被保证。

7. 保护功能

7-1. 电机锁定保护

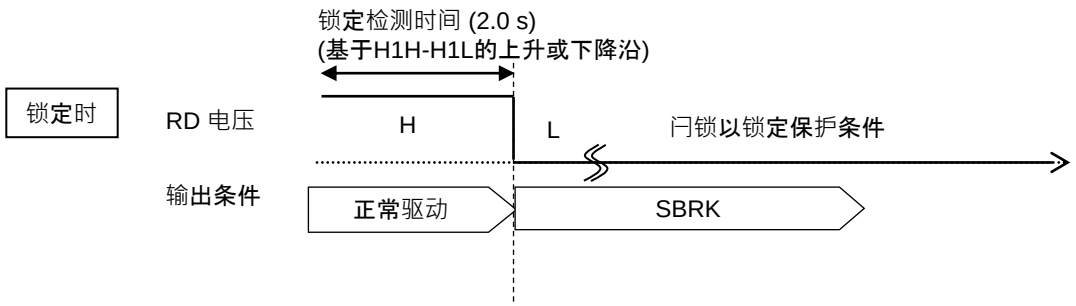
当 RDS=L, SFSW=L 或 H 时 (自动重置模式)

当没有霍尔信号输入的信号（基于H1H-H1L的上升或下降沿）持续0.5s（SFSW = L）或1.0s（SFSW = H）或更长时间时，电机输出将关闭 (短路制动)，电机锁定保护开始工作 (RD = L)，并在经过5s（SFSW = L）或10s（SFSW = H）之后自动重置。霍尔信号输入（H1H-H1L的上升沿或下降沿），VSP信号输入，FR信号切换，UVLO信号输入和SLEEP信号输入会立即解除电机锁定保护。



当 RDS=H, SFSW=L时 (闩锁模式)

当没有霍尔信号（基于H1H-H1L的上升或下降沿）超过2.0s时，电动机输出将关闭（短路制动），操作将切换并锁定到RD = L保护。UVLO信号输入和SLEEP信号输入将立即解除保护。



操作 (续)

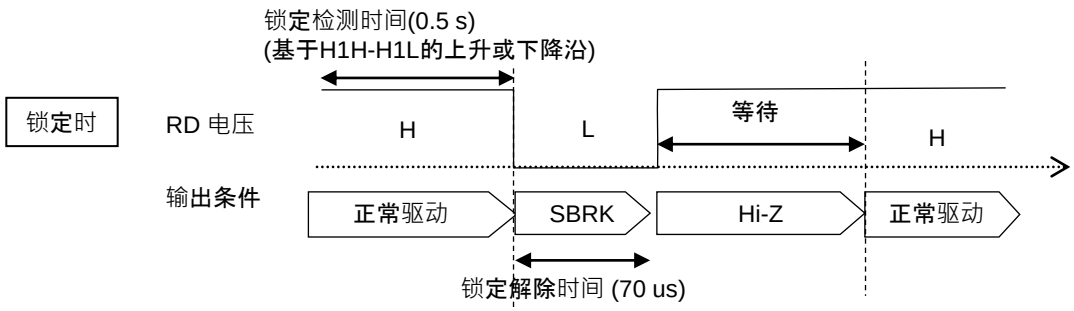
注) 下列的特性是从芯片设计得出的参考值，将不被保证。

7. 保护功能

7-1. 电机锁定保护 (续)

当 RDS=H, SFSW=H 时 (即刻充值模式)

如果没有霍尔信号输入（基于H1H-H1L的上升或下降沿）持续0.5s或更长时间，则电机锁定保护立即重置（经过70us之后）。



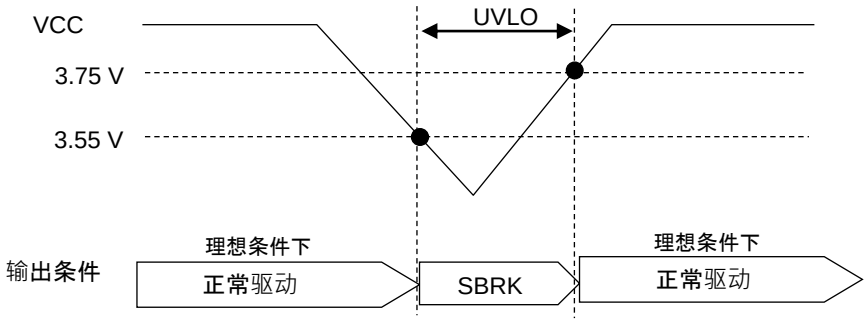
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

7. 保护功能

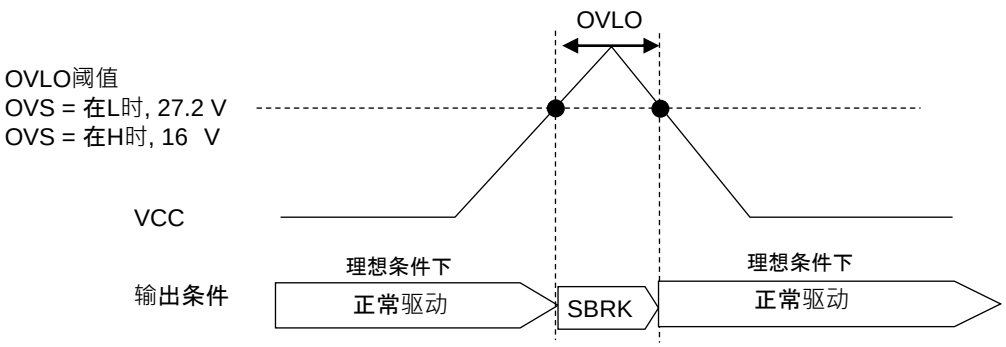
7-2. 欠压锁定 (UVLO)

当VCC电压降至3.55V及以下时，UVLO启动，电机输出进入短路制动模式。
当VCC电压升至3.75V及以上时，UVLO解除。



7-3. 过压锁定 (OVLO)

当VCC电压增加到阈值以上时，OVLO启动，电机输出进入短路制动模式。
当VCC电压降至阈值以下时，OVLO解除。



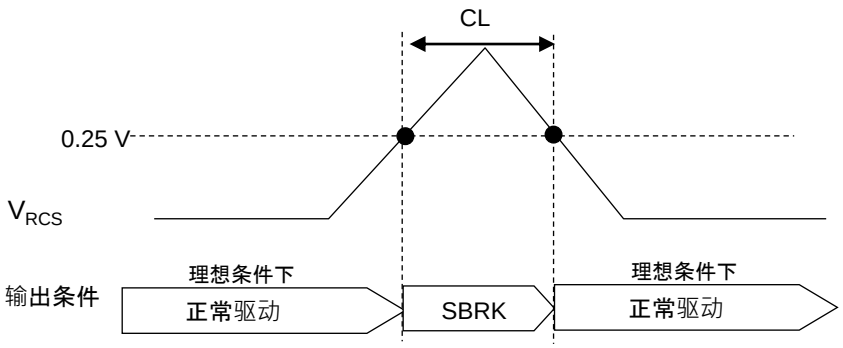
操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

7. 保护功能

7-4. 过流保护 (CL)

当RCS电压增加到0.25 V及以上时，OCP启动，电机输出进入短路制动模式。
当RCS电压降至0.25 V及以下时，OCP解除。



可以通过改变RCS引脚检测电阻（RCS）来设置用于过电流检测的电流值。

过流保护当前检测值

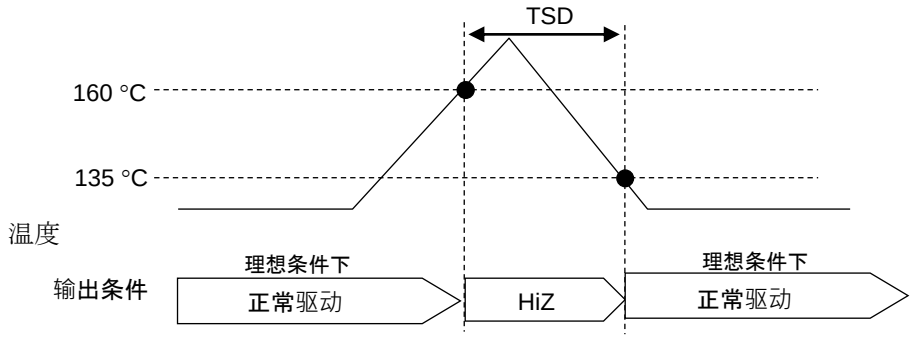
$$I_{PEAK} = 0.250V \times \frac{1}{RCS}$$

例如: I_{PEAK} = 要设置为 1.0 A, 根据以下公式将RCS设置为0.250 Ω 。

$$RCS = 0.250(V) \times \frac{1}{1.00(A)} = 0.250(\Omega)$$

7-5. 过热保护 (TSD)

当芯片结温升至160℃或更高时，TSD启用，电机输出关闭。
当芯片结温降至135℃及以下时，TSD解除。



操作 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

8. 控制模式表格

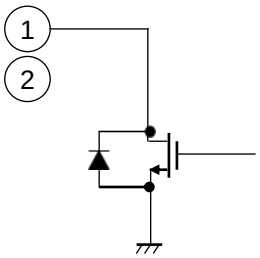
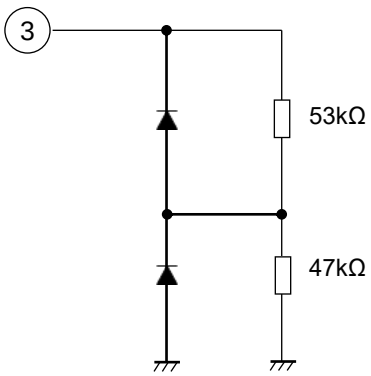
引脚号	引脚名称	说明	电压		备注
			开路(低)	高	
3	SLEEP	睡眠模式选择	正常	睡眠	SLEEP =“ H”:睡眠模式 (电机输出:OFF，VREG输出:OFF) SLEEP =“ L”:正常模式 注)关于睡眠控制电压的设定范围，请参阅第6页电气特性下的“睡眠”。
14	OVS	OVP 阈值选择	27.2V	16V	注意:设置为高电平时，请连接到VREG引脚高。
16	PS	相移模式选择	自动	不变	注意:设置为高电平时，请连接到VREG引脚高。 注意:请勿在电机驱动期间进行切换
18	SST	电容器连接引脚，用于软启动三角波振荡器频率设置	-	软启动控制未使用	当不使用软启动控制时，请将SST引脚连接到VREG引脚。 使用软启动控制时，请在SST端子上连接电容器。
19	TRI	用于PWM三角波振荡器频率设置的电容器连接引脚	-	PWM 输入控制	当PWM输入用于速度控制时，请将TRI引脚连接到VREG引脚。当直流输入用于速度控制时，请 将电容器连接到TRI引脚。

引脚号	引脚名称	说明	电压			备注
			低	开路(中)	高	
22	FR	旋转方向选择 (前进/后退) 短路制动控制输入	正向	短路制动	反向	任意方向表示为“正向”，而反向方向表示为“反向”。 注)关于FR控制电压的设定范围，请参阅第8页电气特性下的“ FR”。
17	FGSEL	FG脉冲计数选择 [霍尔信号周期比]	1/3	1/2	1	FG脉冲输出等效于任意 霍尔信号周期的放大 注)关于FGSEL控制电压的设定范围，请参阅第8页电气特性的“ FGSEL”

引脚号 15 引脚名称 RDS	引脚号 23 引脚名称 SFSW	起始频率 [Hz]	锁定检测时间 [s]	锁定解除时间 [s]	自动重置	备注
低	低	1.8	0.5	5	是	起始频率，锁定检测和解除时间可以通过RDS和SFSW引脚电压进行选择。 RDS =“ H”，SFSW =“ L”:在这种模式下，锁定保护不会自动解除。通过UVLO信号输入和SLEEP信号输入来解除保护。 注意:设置为高电平时，请连接到VREG引脚。
低	高	0.9	1.0	10	是	
高	低	1.8	2.0	-	否	
高	高	1.8	0.5	70µ	是	

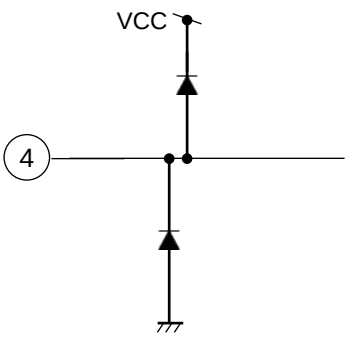
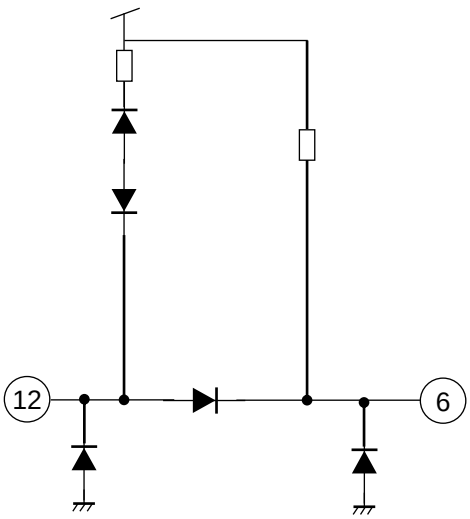
等效引脚电路

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

引脚号	内部电路	阻抗	描述
1, 2		100Ω	引脚1 (RD), 电机锁定保护输出信号引脚。 引脚2 (FG), FG 输出信号引脚。
3		100kΩ	引脚3(SLEEP), 睡眠选择输入引脚。

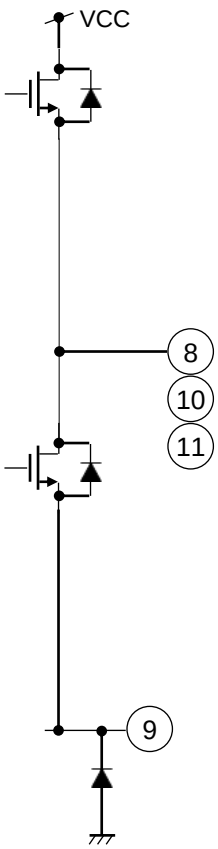
等效引脚电路 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

引脚号	内部电路	阻抗	描述
4		10Ω (VREG 工作中)	引脚4 (VREG) 内部电压调节器。
6, 12		—	引脚6(VPUMP), 电荷泵输出引脚。 Pin12(BC2) , 连接到升压电容器的引脚。

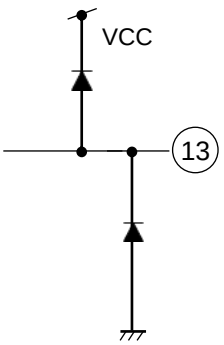
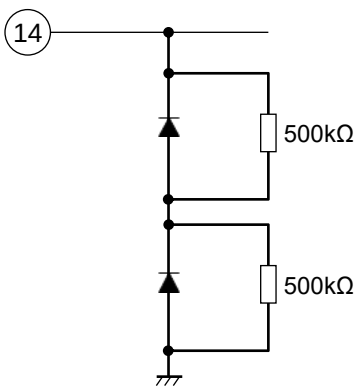
等效引脚电路 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

引脚号	内部电路	阻抗	描述
8, 9, 10, 11		—	引脚8 (W), 10 (V), 11 (U), 连接到电机的输出通道引脚。 引脚9（RCS), 电机电流感应电阻引脚。

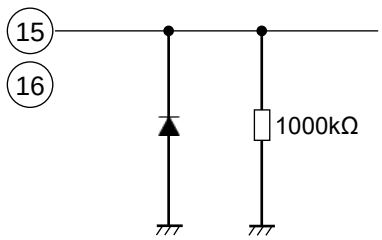
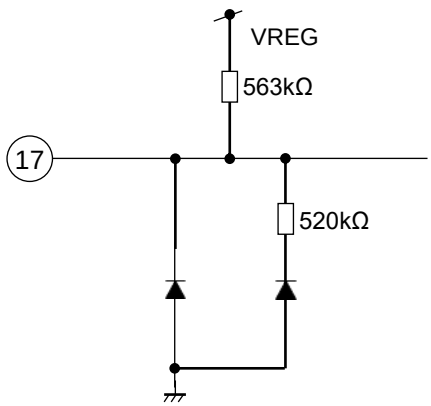
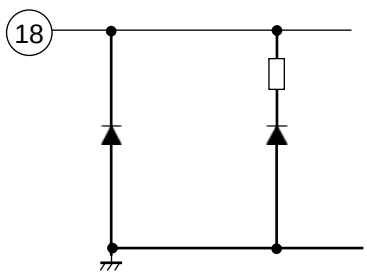
等效引脚电路 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

引脚号	内部电路	阻抗	描述
13		—	引脚13 (BC1), 连接到升压电容器的引脚。
14		1000kΩ	引脚14(OVS), 过压保护阈值选择引脚。

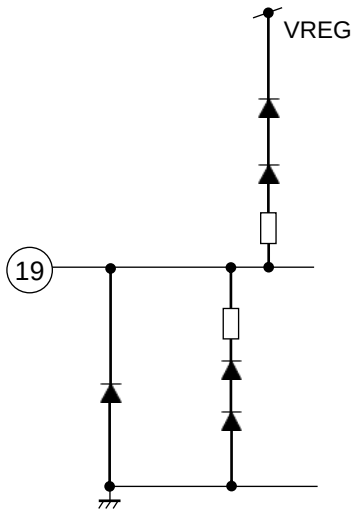
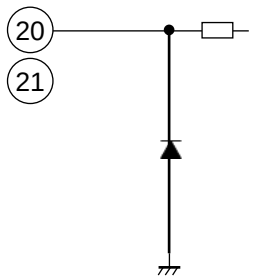
等效引脚电路 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

引脚号	内部电路	阻抗	描述
15, 16		1000kΩ	引脚15 (RDS), 电机锁定保护输入控制引脚。 Pin16(PS) , 自动相位控制设置输入控制引脚。 ·需要将其设置为高电平时，将引脚连接至VREG电压。
17		—	引脚17(FGSEL), FG信号输入控制引脚。 ·需要将其设置为高电平时，将引脚连接至VREG电压。 ·当引脚在开路状态下使用时，请在引脚上连接电容器，以防止噪声影响。请对此情况进行验证和评估。
18		—	引脚18 (SST), 使用外部电容器软启动三角波形来设置频率。 ·不使用SST时，将引脚连接到VREG电压。

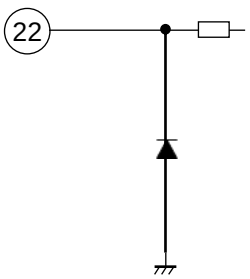
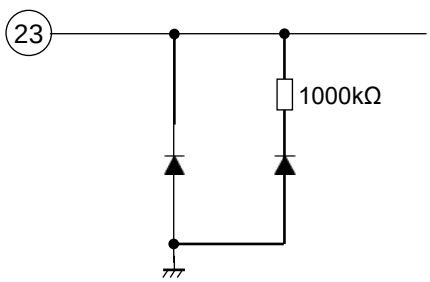
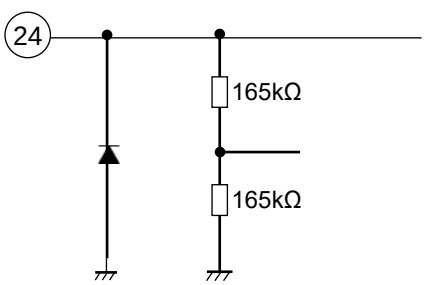
等效引脚电路 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

引脚号	内部电路	阻抗	描述
19		—	引脚19 (TRI), 在TRI引脚上连接一个电容器以设置DC输入模式下的频率 ·在PWM模式下，将引脚连接到VREG电压
20, 21		—	引脚20 (H1H) , 霍尔放大器+输入端子。 引脚21(H1L) , 霍尔放大器-输入端子。

等效引脚电路 (续)

注) 下列的特性是从芯片设计得出的参考值，将不被保证。

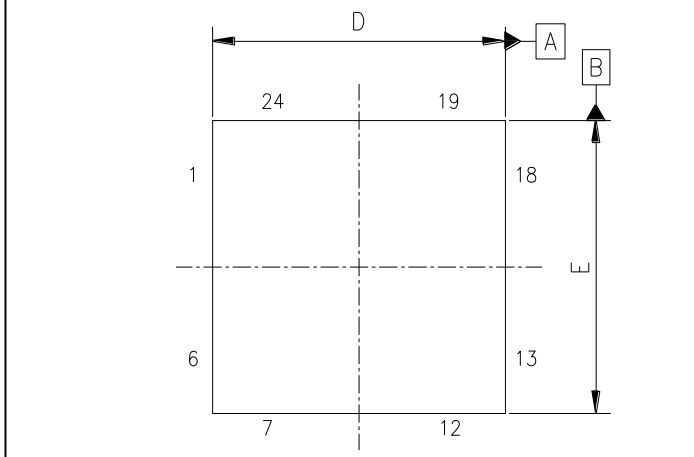
引脚号	内部电路	阻抗	描述
22		—	引脚22 (FR), 正转/反转和短制动控制输入引脚。
23		—	引脚23 (SFSW), 起始频率选择引脚。
24		330kΩ	引脚24 (VSP), 所需速度的输入引脚 ·在PWM输入模式下，请根据规格要求使用高电平和低电平。

封装信息

轮廓图

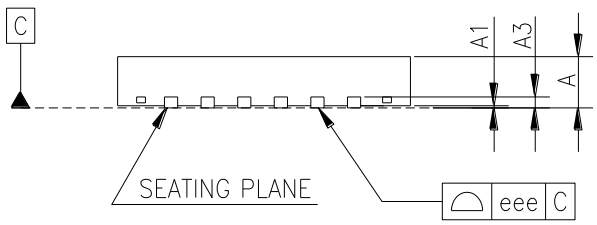
QFN 24L 4x4mm², 厚度 0.8mm, 脚距 0.5mm,

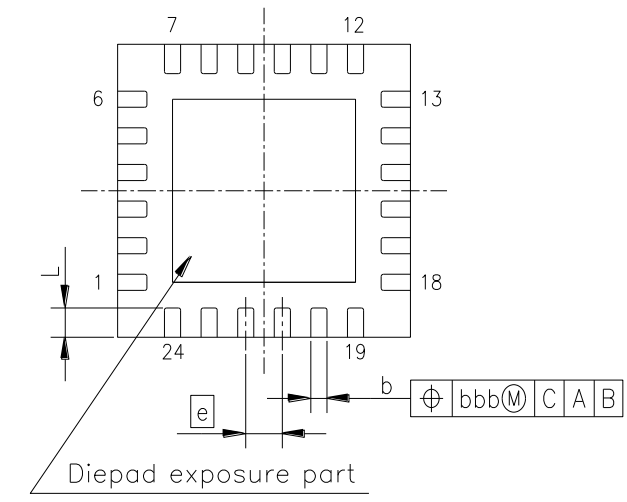
脚长 0.4mm, EP 尺寸 2.5x2.5mm

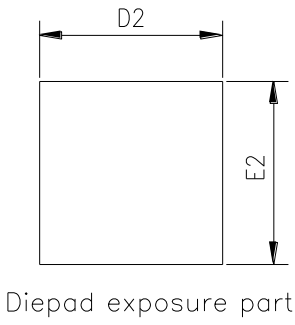


VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.00	–	0.05
A3		0.20REF	
D	3.92	4.00	4.08
E	3.92	4.00	4.08
b	0.17	0.22	0.25
bbb		0.10	
e		0.50BSC	
eee		0.08	
L	0.35	0.40	0.45
D2	2.40	2.50	2.60
E2	2.40	2.50	2.60







注意事项

- 以下是使用该芯片时应注意的事项

1. Pay attention to the direction of the IC. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might be damaged.
2. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
3. Perform visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as solder-bridge between the pins of the IC. Also, perform full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the IC during transportation.
4. Take notice in the use of this IC that it might be damaged when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short). Safety measures such as installation of fuses are recommended because the extent of the above-mentioned damage will depend on the current capability of the power supply.

   Although the following pins comes with short circuit protection function, the protection may be damaged depending on the VCC voltage. Pins with short circuit protection function: Pin11(U), Pin10(V) and Pin8(W).
5. The protection circuit is for maintaining safety against abnormal operation.

   When sudden voltage or current change is applied to the pin, it may exceed the designated voltage and current level and therefore, customer shall perform sufficient evaluation and verification to ensure these are not exceeded in the usage.

   Especially for the thermal protection circuit, if the area of safe operation or the absolute maximum rating is momentarily exceeded due to output pin to VCC short (Power supply fault), or output pin to GND short (Ground fault), the IC might be damaged before the thermal protection circuit could operate.
6. Unless specified in the product specifications, make sure that negative voltage or excessive voltage are not applied to the pins because the IC might be damaged, which could happen due to negative voltage or excessive voltage generated during the ON and OFF timing when the inductive load of a motor coil or actuator coils of optical pick-up is being driven.
7. Product which has specified ASO (Area of Safe Operation) should be operated in ASO
8. Verify the risks which might be caused by the malfunctions of external components.
9. Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process
10. Dip soldering is not recommended.
11. Connect the metallic plate (fin) on the back side of the IC to the GND potential. The thermal resistance and electrical characteristics are guaranteed only when the metallic plate (fin) is connected with the GND potential.
12. Follow the power supply voltage, load and ambient temperature conditions to ensure that there is enough margin and the thermal design does not exceed the allowable value.
13. When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment, etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.

    Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damage, for example, by using the products.

注意事项 (续)

- 以下是使用该芯片时应注意的事项 (续)

14. Apply power supply with low impedance to VCC and connect bypass capacitor near to the IC.
15. When designing PCB pattern for RCS pin (Pin 9), place a resistor for current detection (R_{RCS}) close to the IC. The setting value for over current protection may fluctuate due to the impedance of wiring pattern between RCS pin and the RCS resistor.
16. When VCC is input, VCC voltage will start to rise to the designated voltage. However, at the same time, motor driver starts driving and when this results in decreases the VCC voltage, it may disrupt the normal start-up. Therefore, please conduct sufficient evaluation and verification to ensure the power supply current.
17. The minimum input amplitude of hall signal comparator should be designed in consideration of tolerances and temperature characteristics of the hall element, so that it will not result in failure to the motor operation.
18. In the 1-HALL-sensor system motor driver adopted in this IC, energization pattern of a cycle is generated based on previous 1-cycle of a HALL input signal. Therefore, when the acceleration of a motor is very high, the motor may be unable to accelerate normally because of the big difference in cycle between the generated energization pattern and the motor rotation. When using a motor with very high speed acceleration, ensure to conduct sufficient technical evaluation and examination on the sudden acceleration from low rotation.

    When the above acceleration problems arises, the problem may be improved by putting the speed to zero first and then input the required speed. Please conduct sufficient evaluation before use.

    (When HALL input signal of below 10Hz is inputted to this IC, putting the speed to zero and then input the required speed again will restart the rotation.)
19. Do not change the control signal of SLEEP pin (pin 3) from Low to High while motor is running at high speed. The IC can be damaged due to the effect of induced voltage and conduction angle. Conduct sufficient technical evaluation to verify.
20. Brake current during short brake is determined by the motor running speed and motor characteristics.
    Before the short brake, please review and evaluate by reducing the motor current and lower the motor speed.
    Please refer to the ASO data and perform sufficient evaluation to ensure that the IC is not damaged.
21. In case the motor running speed changes from high to low rapidly, supply voltage can be increased due to the flow back of motor current. Conduct sufficient evaluation and examination to ensure there is no issue.
22. When designing PCB pattern, place a resistor for current detection (RCS) close to the IC. The setting value for over current protection may fluctuate due to the impedance of wiring pattern between RCS pin and the RCS resistor.
23. FG pin (Pin 1) and RD pin (Pin 2) are open-drain outputs. Connect a pull-up resistor to the designated power supplies and use this IC within the allowable voltage and current ranges.
24. For the below pins, please ensure to connect to VREG pin under High level condition.
    TRI pin (Under PWM control), SST pin (When Soft Start not used), FGSEL pin, PS pin, RDS pin, OVS pin and SFSW pin.
    In addition, these terminals, changing the applied voltage during the operation of this product, we do not assume.
    When changing the voltage applied to the terminal settings, please temporarily turn off the power.
25. When connecting TRI pin to VREG pin using PWM input mode, please make sure to input High level or Low level to the VSP pin. Other voltage levels between High and Low level may result in unexpected operation.
26. Due to the initial position of the rotor, the starting torque differs slightly during start-up. For motor type that requires large inertia force to turn, please ensure that sufficient starting current is available for the motor. Please perform sufficient testing and evaluations to ensure this.
27. If the soft-start timing is too long, it will result in the motor not having enough starting torque and lock protection detection will be triggered if soft start timing is more than 0.5s (typ). This will cause the motor to be unable to start. Please evaluate and check this condition thoroughly when using this function.
28. Sufficiently check the characteristics before use. When there is changes in the external circuits, please check both static and transient characteristics and ensure that there is enough margin.

注意事项 (续)

- 以下是使用该芯片时应注意的事项（续)

29. When input power to VCC(Pin7), it is recommended that VCC voltage rises slower than 1.5V/μs and when turn off, VCC voltage drops slower than -1.5V/μs.
    When performing power up and shutdown at high-speed, please ensure sufficient evaluation is performed to verify that there is no problem.

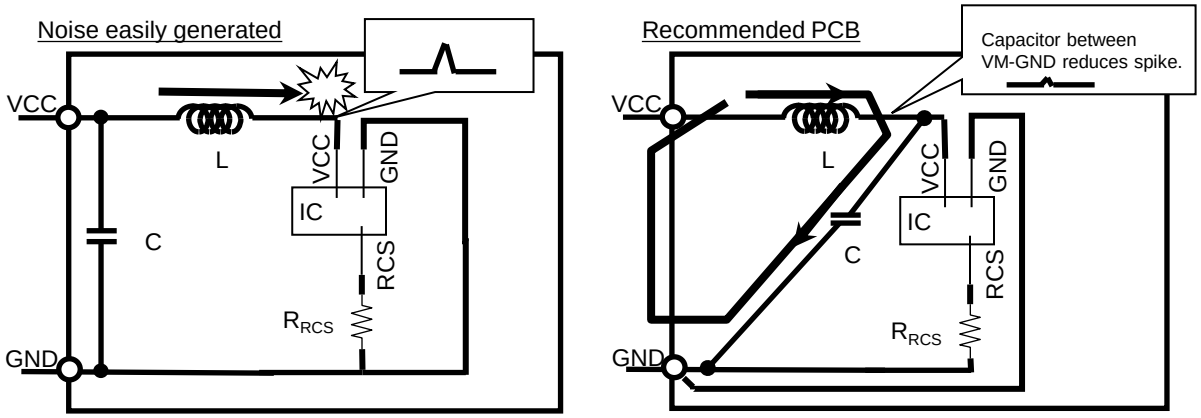
30. Capacitor between VCC and GND
    This IC employs the PWM driving method and hence, output transistor switches under high current condition and this easily generates noise. Therefore the IC may be damaged or malfunction due to noise.
    Hence, it is necessary to ensure that the power supply is stable so as to avoid circuit damaged or malfunction due to noise.
    Where possible, place a capacitor between VCC and GND near to the IC so that IC will not malfunction due to PWM noise and gets damaged.

31. Points to note for Motor PCB pattern
    As this IC is used under high current, it is necessary to take note of common impedance in the pattern.
    Please take care of the following in the pattern design of the motor PCB.

- As high current flows from VCC connector to the IC VCC pin (Pin7) and through the metal lines, if the metal line is a 'L' shape pattern, noise may be easily generated resulting in malfunction and damage during switching (Bottom left figure).
  From the figure on the right, if a capacitor is placed with respect to the connector near VCC, a noise discharge route is created and this reduces the VCC voltage directly to the IC pin. Where possible, please follow the figure on the right.
  In addition, metal line impedance depends on the pattern length and therefore, please keep the metal line between VCC connector and IC VCC pin as short and as thick as possible in the design.

- The line between current detection resistor (R_{RCS}) to RCS pin (Pin9) is very important. Therefore, where possible, it is recommended to use an isolated line to connect from the start of the detection resistor to the RCS pin.
  Accurate current value may not be detected due to metal impedance if R_{RCS} is placed far from the IC. Therefore, if it is not possible to place near to the IC, please ensure that the motor current waveform and R_{RCS} current waveform is accurate.

- Please ensure that the line between the GND connector and RCS resistor is isolated from the IC GND pin (Pin5).
  If a common line is used, it may result in malfunction or IC ground connection voltage unstable due to line impedance.
  In addition, to reduce line impedance effect, please ensure that GND line is as short and as thick as possible in the design.



注意事项 (续)

•以下是使用该芯片时应注意的事项（续)

19. This IC has five protecting functions. Pay attention to the descriptions below.

Function	Operate/Release	Conditions	Remarks
Under voltage lock out (UVLO)	• Operate VCC ≤ 3.55 V • Release VCC ≥ 3.75 V	(Short brake) Upper-phase: OFF Lower-phase: ON	Large current may be generated due to a short brake during motor rotation. Conduct sufficient verification to prevent damages.
Over voltage lock out (OVLO)	• Operate/Release VCC input voltage1: 16.0V (typ.) VCC input voltage2: 27.2V (typ.)	(Short brake) Upper-phase: OFF Lower-phase: ON	Large current may be generated due to a short brake during motor rotation. Conduct sufficient verification to prevent damages.
Over Current Protection (CL)	• Operate: RCSS voltage ≥ 0.25V (typ.) • Release: RCSS voltage ≤ 0.25V (typ.)	(Short brake) Upper-phase: OFF Lower-phase: ON	R_{RCS} is a current detection resistor. Concerning level of detection, false detection may occur due to the effect of PCB layout or noise. In addition, when specifying the resistance value of R_{RCS}, take the followings into consideration: Level of detection, tolerance in resistance value of R_{RCS}, temperature, ratings, etc.
Motor Lock Protection	• Operate: Hall signal input cycle ≥ 0.5 s (RDS=L, SFSW=L) (RDS=H, SFSW=H) ≥ 1.0 s (RDS=L, SFSW=H) ≥ 2.0 s (RDS=H, SFSW=L) (Based on the rising or falling edge of H1H-H1L) • Release: • With RDS and SFSW is set to following voltage,any of the below 7 conditions will result in the protection to release. ・RDS = L or open and SFSW = L or H ・RDS = H and SFSW = H ①SLEEP is input with 'H' ②UVLO operates (VCC<3.55V) ③Automatic reset after the following time; 5 s (RDS=L, SFSW=L) 10 s (RDS=L, SFSW=H) 70 us (RDS=H,SFSW=H) ④Hall signal being input (Rising or falling edge of H1H-H1L) ⑤VSP(PWM)<3.0%(typ), or VSP(DC)<1.0V(typ) is inputted ⑥FR signal switch is inputted ⑦SBRK signal is inputted • Control restrictions to protection functions When RDS is set to 'H' and SFSW is set to 'L', the above ③～⑦ will be disabled.	(Short brake) Upper-phase: OFF Lower-phase: ON	Brake current may be generated due to protection circuit operating during the motor rotation. Conduct sufficient verification to prevent damages.
Thermal Protection	• Operate: IC junction temperature > 160℃ • Release: IC junction temperature < 135℃	All phases: OFF	Since all phases are OFF when protecting function operates, reverse current may be generated due to the repetition ON-OFF switching of the protection function during motor rotation. Pay attention to the voltage rise.

Revision History

Date	Revision		Description	
2020.10.31	1.00	1	Initially issued.	
2022.6.9	1.05	1	Changed important notice	Page2
		2	Operating ambient temperature max “ 95□C”-> “ 105□C”	Page5
		3	POWER DISSIPATION RATING PD(Ta=70□C) 1.42W -> PD(Ta=105□C) 0.8W	
		4	Remove important notice page from previous version page46,47	Page47, 48,49
		5	Changed the description of usage notes Add “(Continued)”	Page48
		6	Change page number to refer because of adding page 2	Page6,23,35 Page42
		7	Change pin names. “N1H”,”N1L” -> “H1H”,”H1L”	
2023.8.31	1.06	1	Changed power dissipation rating notice	Page5
		2	Changed block diagram composition	Page12
		3	Changed pin equivalent circuit composition	Page37-43
		4	Deleted some Package information	Page44-45
2024.2.13	1.07	1	Changed AEC-Q100 in Important Notice	Page2

Important Notice

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All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.