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FAIRCHILD SEMICONDUCTOR®

2014 年 9 月

FPDB40PH60B
用于两相无桥功率因数校正的 PFC SPM® 3 系列

特性

- 通过 UL 第 E209204 号认证 (UL1557)
- 600 V - 40 A 两相无桥功率因数校正，包含栅极驱动和保护的控制 IC
- 采用 Al_2O_3 DBC 基板，实现非常低的热阻
- 内置负温度系数热敏电阻可实现温度监测
- 内置分流电阻可实现电流感应
- 针对 20 kHz 开关频率进行优化
- 绝缘等级：2500 Vrms / 分钟

应用

- 两相无桥功率因数校正转换器

相关资料

- *AN-9041 - Bridgeless PFC SPM 3 Series Design Guide*

概述

The FPDB40PH60B 是一种先进的 PFC SPM® 3 模块，为消费、医药和工业应用提供非常全面的高性能无桥功率因数校正输入功率平台。这些模块综合优化了内置 IGBT 的栅极驱动以最小化电磁干扰和能量损耗。同时也提供多重模组保护特性，集成欠压闭锁，过流保护，热量监测和故障报告。这些模块内的高性能输出二极管和分流电阻，为额外节省空间和方便安装起到了重要作用。

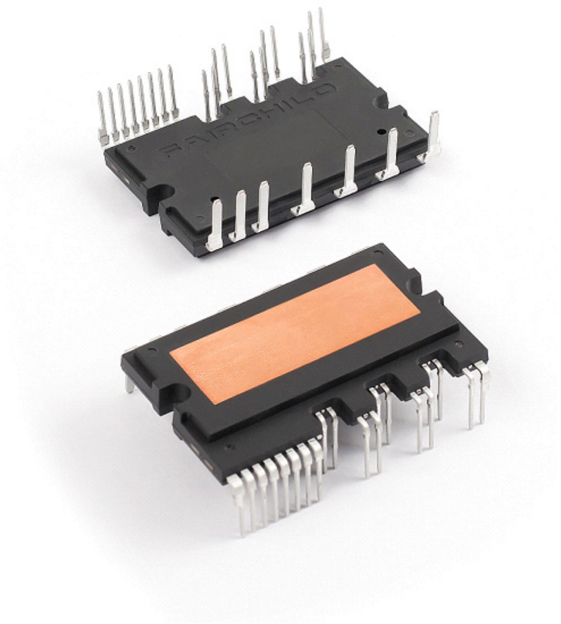


图 1. 封装概览

封装标识与定购信息

器件	器件标识	封装	包装类型	数量
FPDB40PH60B	FPDB40PH60B	SPMGC-027	Rail	10

集成的驱动、保护和系统控制功能

- 对于 IGBT：栅极驱动电路、过流保护 (OCP)、控制电源欠压锁定 (UVLO) 保护
- 故障信号：对应 OC 和 UV 故障
- 内置热敏电阻：温度监控
- 输入接口：高电平有效接口，可用于 3.3 / 5 V 逻辑电平，施密特触发脉冲输入

引脚布局

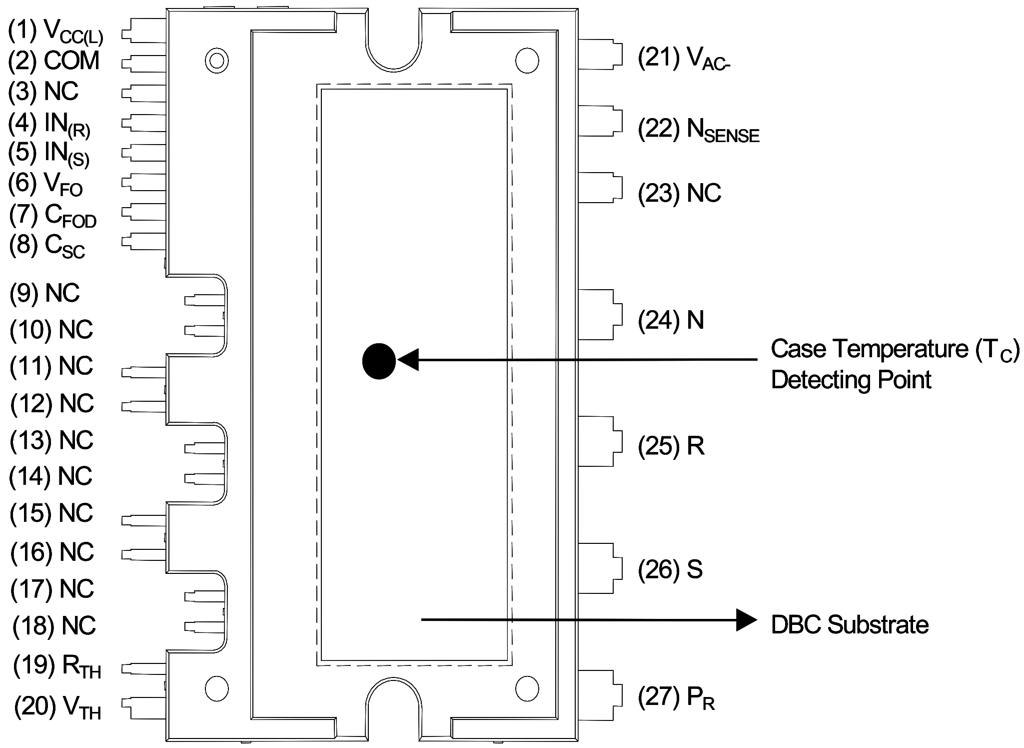


图 2. 俯视图

引脚描述

引脚号	引脚名	引脚描述
1	V_{CC}	IC 和 IGBT 驱动的公共偏压
2	COM	公共电源接地
4	$IN_{(R)}$	低端 R 相 IGBT 的信号输入
5	$IN_{(S)}$	低端 S 相 IGBT 的信号输入
6	V_{FO}	故障输出
7	C_{FOD}	设置故障输出持续时间的电容
8	C_{SC}	过电流感测电容 （低通滤波器）
19	$R_{(TH)}$	供热敏电阻使用的串联电阻器
20	$V_{(TH)}$	热敏电阻偏压
21	V_{AC-}	电流感测端
22	N_{SENSE}	电流感测参考端
24	N	直流负端
25	R	R 相输出
26	S	S 相输出
27	P_R	直流正端
3, 9~18, 23	NC	无连接

内部等效电路

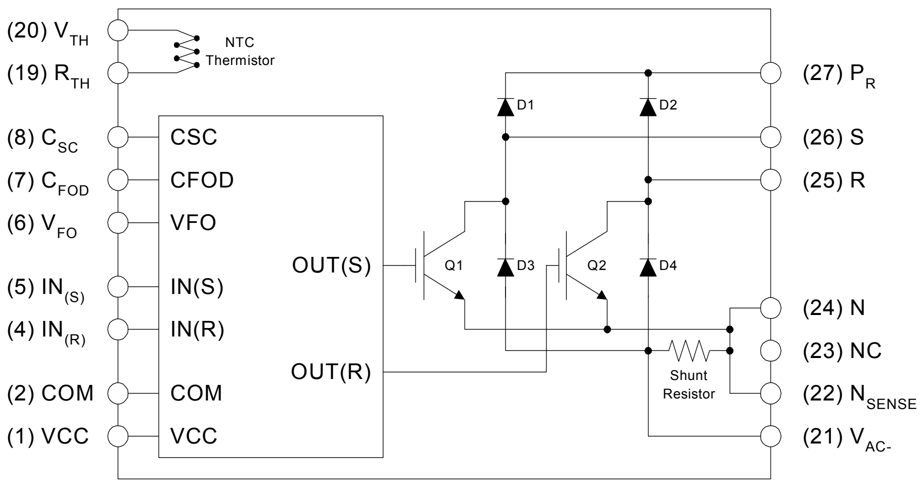


图 3. 内部框图

注：

1. 转换器由两个 IGBT 组成，内置有四个二极管，以及一个具有栅极驱动和保护功能的 IC。

绝对最大额定值 （T_J = 25°C，除非另有说明。）

转换器部分

符号	项目	条件	额定值	单位
V_i	电源电压	施加在 R - S 之间	264	V_{rms}
V_i（浪涌）	电源电压 （浪涌）	施加在 R - S 之间	500	V
V_{PN}	输出电压	施加在 P - N 之间	450	V
V_{PN}（浪涌）	输出电压 （浪涌）	施加在 P - N 之间	500	V
V_{CES}	集电极 - 发射极之间电压		600	V
$\pm I_C$	单个 IGBT 的集电极电流	T_C = 25°C	40	A
$\pm I_{CP}$	单个 IGBT 的集电极电流 （峰值）	T_C = 25°C，脉冲宽度小于 1 ms	70	A
P_C	集电极功耗	T_C = 25°C 单个 IGBT	113	W
V_{RRM}	重复峰值反向电压		600	V
I_{FSM}	正向浪涌峰值电流	单一正弦半波	350	A
P_{RSH}	分流电阻的额定功率	T_C < 125°C	2	W
T_J	工作结温	（注 2）	-40 ~ 150	°C

注：
2. PFC SPM® 产品中集成的功率芯片的最大结温额定值为 150 °C(@$T_C \leq$ 100°C).

控制部分

符号	项目	条件	额定值	单位
V_{CC}	控制电源电压	施加在 V_{CC} - COM 之间	20	V
V_{IN}	输入信号电压	施加在 IN - COM 之间	-0.3 ~ 17.0	V
V_{FO}	故障输出电源电压	施加在 V_{FO} - COM 之间	-0.3 ~ V_{CC}+0.3	V
I_{FO}	故障输出电流	V_{FO} 引脚处的灌电流	5	mA
V_{SC}	电流感测输入电压	施加在 C_{SC} - COM 之间	-0.3~V_{CC}+0.3	V

整个系统

符号	项目	条件	额定值	单位
T_C	模块壳体工作温度		-20 ~ 100	°C
T_{STG}	存储温度		-40 ~ 150	°C
V_{ISO}	绝缘电压	60 Hz，正弦波形，交流 1 分钟，连接陶瓷基板到引脚	2500	V_{rms}

热阻

符号	项目	条件	最小值	典型值	最大值	单位
$R_{\theta(j-c)Q}$	结点 - 壳体的热阻 （参考 PKG 中心）	IGBT	-	-	1.1	°C/W
$R_{\theta(j-c)HD}$		高端二极管	-	-	1.9	°C/W
$R_{\theta(j-c)LD}$		低端二极管	-	-	1.4	°C/W

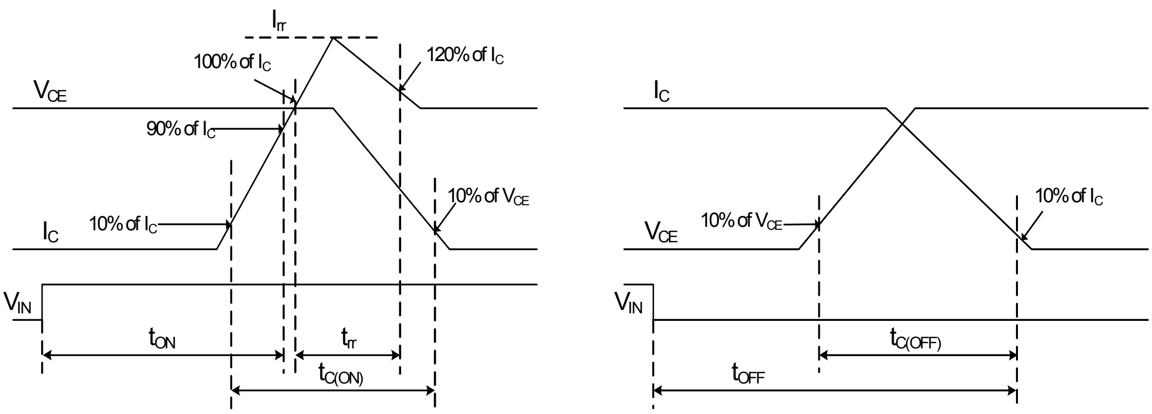
注：
3. 关于壳体温度 (T_C) 的测量点，请参见图 2。

电气特性 （T_J = 25°C，除非另有说明。）

转换器部分

符号	项目	条件	最小值	典型值	最大值	单位
$V_{CE(SAT)}$	IGBT 饱和电压	V_{CC} = 15 V，V_{IN} = 5 V，I_C = 40 A	-	1.8	2.3	V
V_{FH}	高端二极管电压	I_F = 40 A	-	2.2	2.7	V
V_{FL}	低端二极管电压	I_F = 40 A	-	1.15	1.55	V
t_{ON}	开关时间	V_{PN} = 400 V, V_{CC} = 15 V, I_C = 40 A V_{IN} = 0 V ↔ 5 V，电感负载 （注 4）	-	500	-	ns
$t_{C(ON)}$			-	180	-	ns
t_{OFF}			-	500	-	ns
$t_{C(OFF)}$			-	90	-	ns
t_{rr}			-	43	-	ns
I_{rr}			-	6	-	A
R_{SENSE}	电流感测电阻		1.8	2.0	2.2	mΩ
I_{CES}	集电极 - 发射极间漏电流	V_{CE} = V_{CES}	-	-	250	μA

注：
4. t_{ON} 和 t_{OFF} 包括模块内部驱动 IC 的传输延迟时间。$t_{C(ON)}$ 和 $t_{C(OFF)}$ 指在内部给定的栅极驱动条件下， IGBT 本身的开关时间。详细信息，请参见图 4。



(a) Turn-on **(b) Turn-off**

图 4. 开关时间的定义

控制部分

符号	项目	条件	最小值	典型值	最大值	单位
I_{QCCL}	V_{CC} 静态电源电流	V_{CC} = 15 V, IN = 0 V; V_{CC} - COM	-	-	26	mA
V_{FOH}	故障输出电压	V_{SC} = 0 V, V_{FO} 电路：4.7 kΩ 至 5 V 上拉	4.5	-	-	V
V_{FOL}		V_{SC} = 1 V, V_{FO} 电路：4.7 kΩ 至 5 V 上拉	-	-	0.8	V
$V_{SC(ref)}$	过电流保护触发电平	V_{CC} = 15 V	0.45	0.50	0.55	V
UV_{CCD}	电源电路欠压保护	检测电平	10.7	11.9	13.0	V
UV_{CCR}		复位电平	11.2	12.4	13.2	V
t_{FOD}	故障输出脉宽	C_{FOD} = 33 nF （注 5）	1.4	1.8	2.0	ms
$V_{IN(ON)}$	导通阈值电压	施加在 IN - COM 之间	3.0	-	-	V
$V_{IN(OFF)}$	关断阈值电压		-	-	0.8	V
R_{TH}	热敏电阻的阻值	at T_C = 25°C （见图 5）	-	50	-	kΩ
		at T_C = 80°C （见图 5）	-	5.76	-	kΩ

注：
5. 故障输出脉宽 t_{FOD} 取决于电容 C_{FOD} 的值，可采用下面的近似公式进行计算：$C_{FOD} = 18.3 \times 10^{-6} \times t_{FOD}$[F]

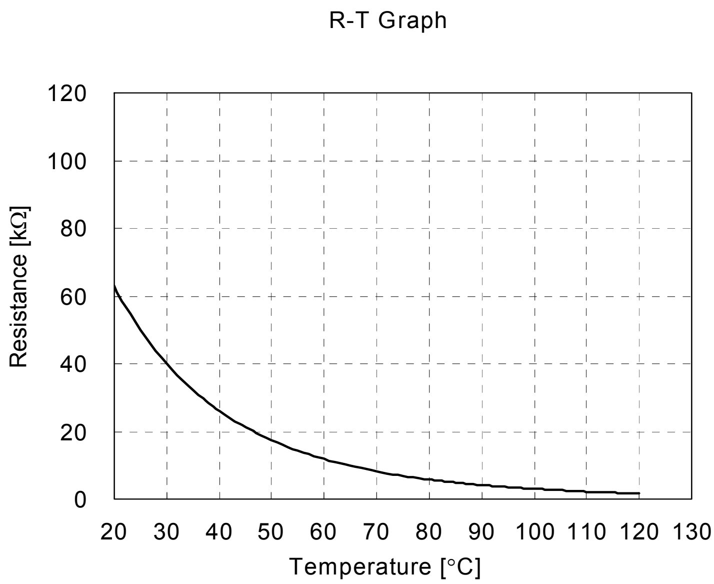


图 5. 内置热敏电阻的 R-T 曲线

推荐工作条件

符号	项目	条件	最小值	典型值	最大值	单位
V_I	输入电源电压	施加在 R - S 之间	180	-	264	V_{rms}
V_{PN}	输出电压	施加在 P - N 之间	-	280	400	V
V_{CC}	控制电源电压	施加在 V_{CC} - COM 之间	13.5	15	16.5	V
dV_{CC}/dt	控制电源波动	施加在 IN - COM 之间	-1	-	1	V/μs
f_{PWM}	PWM 输入信号	$T_C \leq 100°C$, $T_J \leq 125°C$, 单个 IGBT	-	20	-	kHz

机械特性和额定值

项目	条件		最小值	典型值	最大值	单位
安装扭矩	安装螺钉：M3	建议 0.62 N•m	0.51	0.62	0.72	N•m
器件平面度	见图 6		0	-	+120	μm
重量			-	15.00	-	g

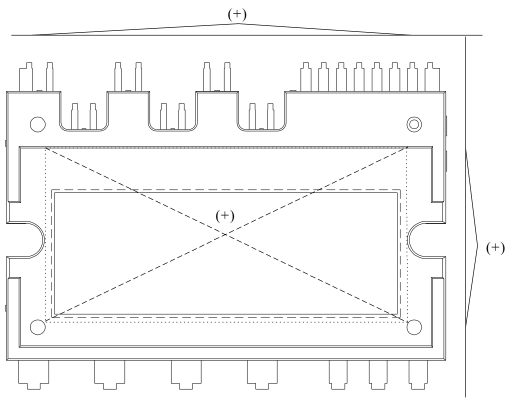
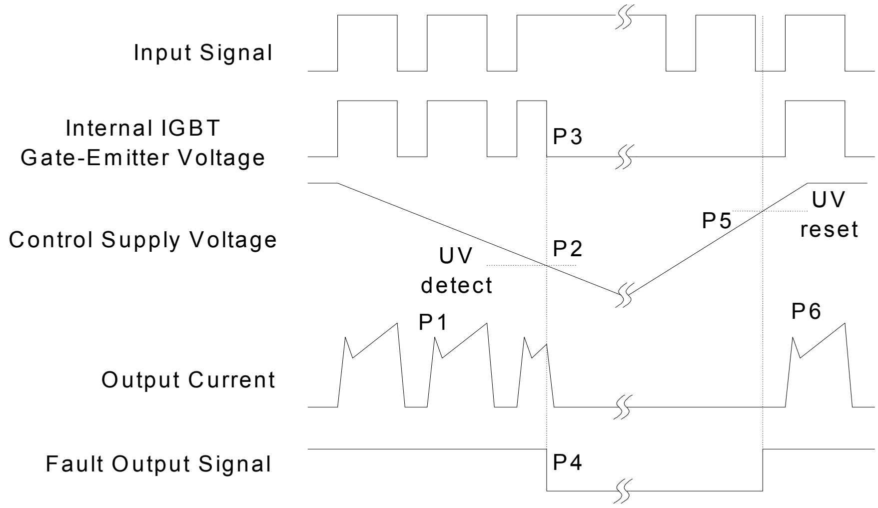


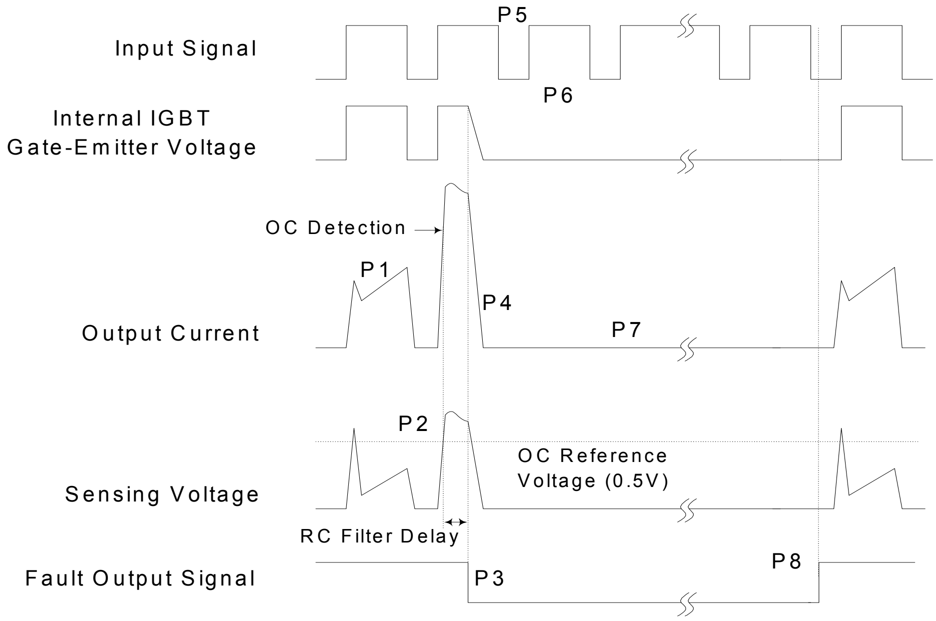
图 6. 平面度测量位置

保护功能时序图



P1 : 正常工作：IGBT 导通并传导电流。
P2 : 欠压检测。
P3 : IGBT 栅极中断。
P4 : 故障信号产生。
P5 : 欠压复位。
P6 : 正常工作：IGBT 导通并传导电流。

图 7. 欠压保护



P1 : 正常工作：IGBT 导通并传导电流。
P2 : 过流检测。
P3 : IGBT 栅极中断 / 故障信号产生。
P4 : IGBT 缓慢关断。
P5 : IGBT 关断信号。
P6 : IGBT 导通信号：但是在故障输出有效的时间内， IGBT 不导通。
P7 : IGBT 关断状态。
P8 : 故障输出复位并启动正常工作。

图 8. 过流保护

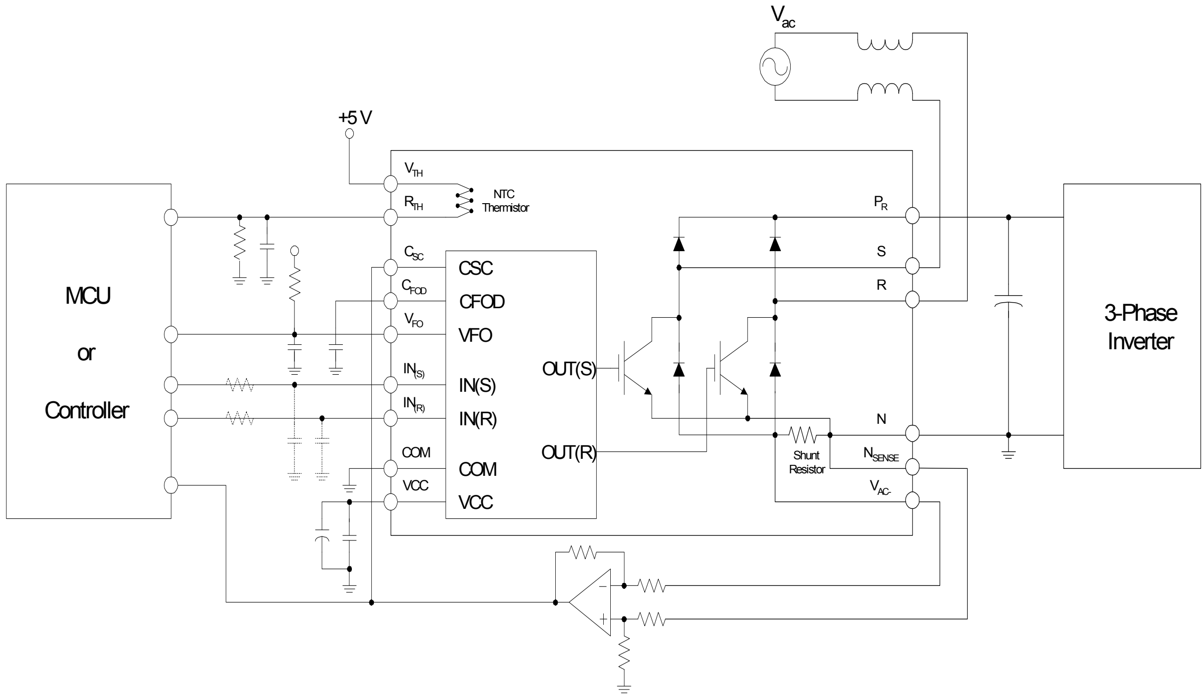
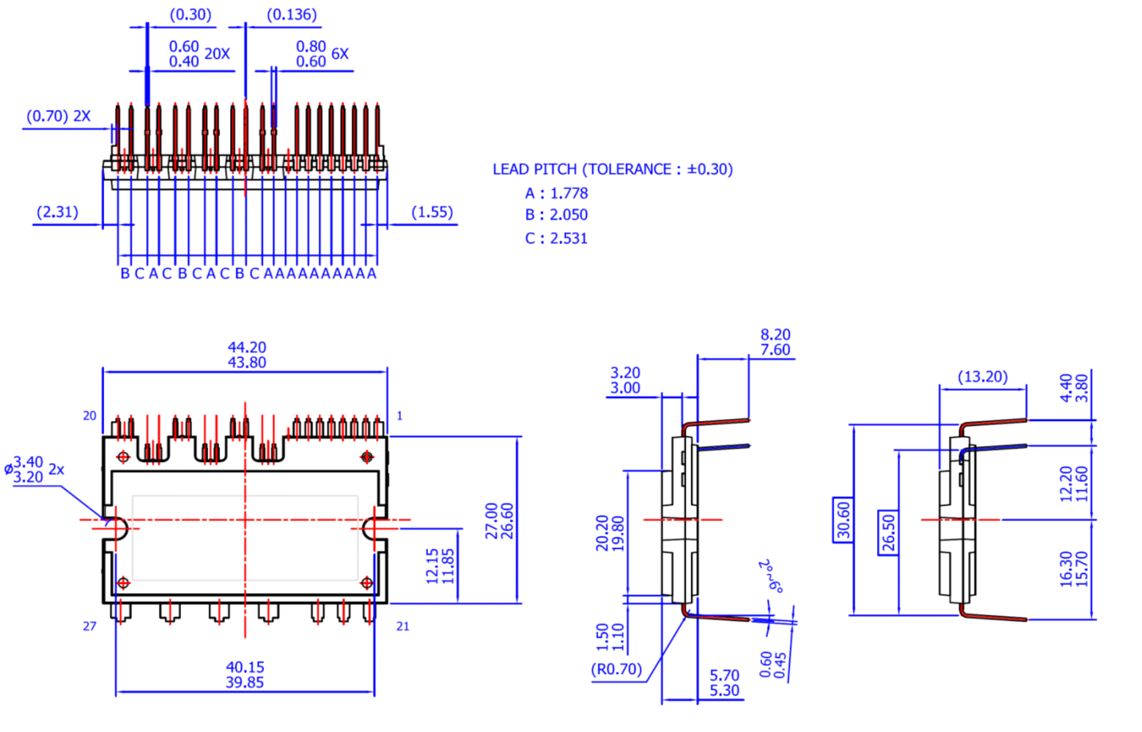
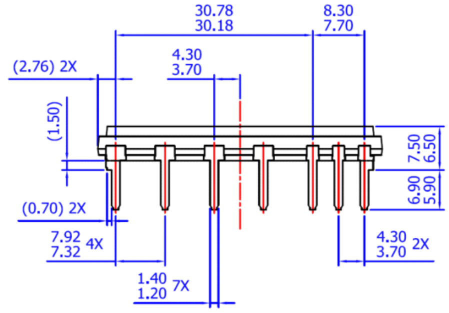


图 9. 应用实例

注：
6. 关于过流保护，时间常数应在 3 ~ 4 μs 的范围内进行选择。

封装轮廓详图





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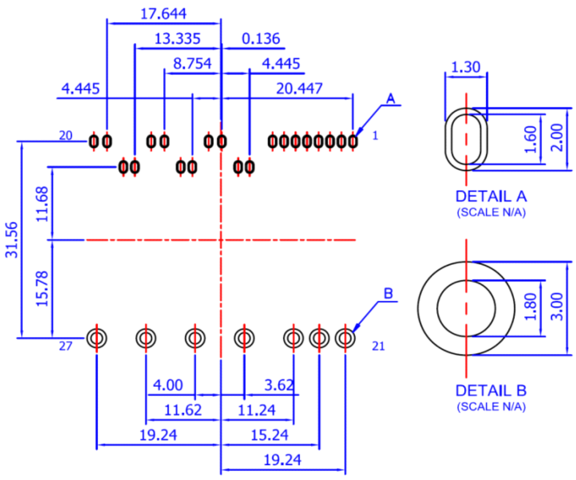

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Rev. I66

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