*1200V Single channel driver for IGBT/SiC MOS*

## General Description 概述

BF1181 is a galvanic isolated single channel gate driver for SIC MOSFETs and IGBTs. The complementary inputs compatible with 5V signals and could be directly connected to a microcontroller. For output, drive peak current up to ±8A.

BF1181 provides several functions, such as desaturation protection, input and output side power supply UVLO, fault reporting, active Miller clamping and analog voltage sampling, which make the system operating safety and simplifying the system design.

BF1181是一款电隔离单通道SIC/IGBT驱动芯片。其互补的输入信号满足5V的信号输入，可直接与微控制器相连。其输出驱动峰值电流高达±8A。

BF1181 内置许多功能，包括去饱和保护，输入与输出的电源欠压保护，故障输出功能，有源密勒钳位以及模拟电平采样功能。使系统设计简化并确保系统更安全。

## Applications 应用

- Drive inverters for HEV and EV
  HEV 和 EV 电机驱动
- High Power DC/DC inverters
  大功率 DC-DC 转换器
- On-board charger / 车载充电器

## Features 特点

- AEC-Q100 qualified for automotive applications
  满足 AEC-Q100 汽车级应用标准
- SiC MOSFETs and IGBTs up to 1200V
  满足 1200V SiC/IGBT 驱动应用
- 100KV/μs Minimum CMTI
  CMTI 大于 100KV/μs
- 8A drive output / 驱动峰值电流高达 8A
- Built-in Active Miller Clamp / 内置密勒钳位
- Built-in Desaturation Protection / 内置去饱和保护
- Built-in Input and Output Side Power Supply UVLO
  内置输入及输出电源欠压保护
- Built-in Soft Turn-off / 内置软关断功能
- SOW16 Package / SOW16 封装形式

## Typical Application
## 典型应用

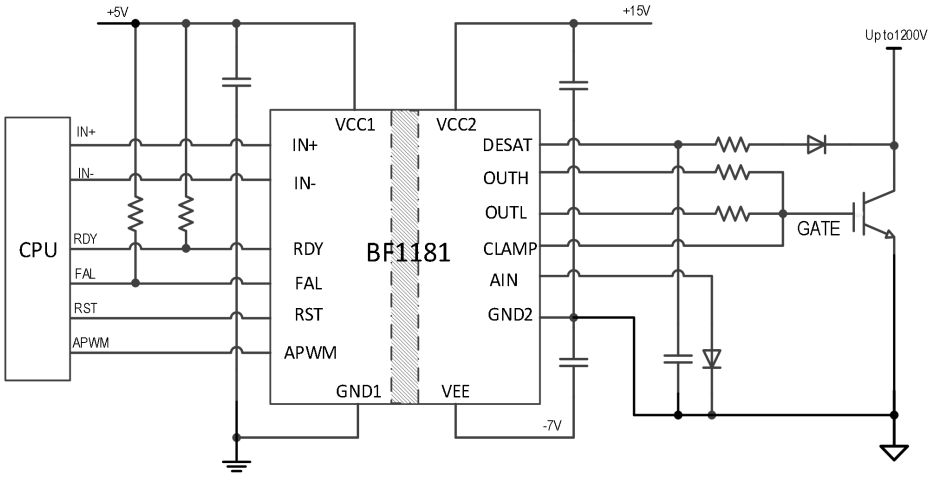



Figure1: BF1181 Typical Application Circuit
图 1：BF1181 典型应用电路

## Block Diagram
## 内部原理图

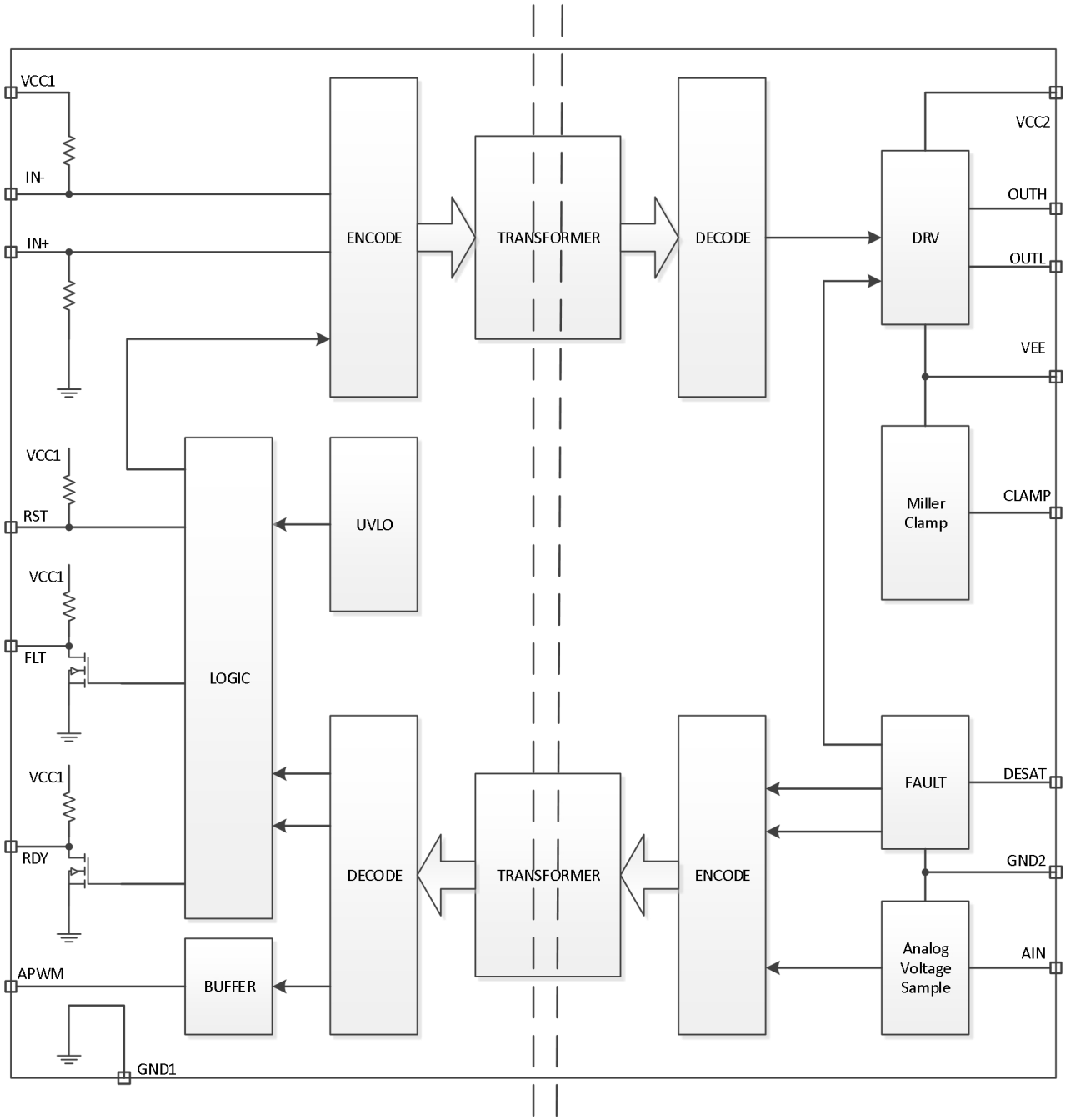



Figure2: BF1181 Functional Block Diagram
图 2：BF1181 功能模块原理图

## Package Type
## 封装类型

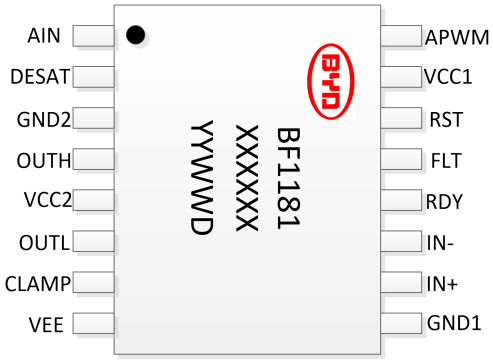



Figure3: BF1181 Pin Configuration & Product model
YYWWD: Year Code, Week Code, Date Code; XXXXXX: Product lot number

图 3：BF1181 打标图 & 产品型号
YYWWD：年周天号； XXXXXX：产品批号

## Pin Description
## 引脚说明

| Pin No.<br>引脚编号 | Pin Name<br>引脚名称 | Description<br>说明 |
|---|---|---|
| 1 | AIN | Analog voltage sample/模拟电平采样端 |
| 2 | DESAT | Desaturation protection sense/去饱和保护检测 |
| 3 | GND2 | Secondary Ground, connecting to IGBT emitter or SIC source<br>次级地，与 IGBT 发射极或 SIC 源极相连 |
| 4 | OUTH | Pull up drive/输出上拉驱动 |
| 5 | VCC2 | Power Supply for secondary/次级工作电源 |
| 6 | OUTL | Pull down drive/输出下拉驱动 |
| 7 | CLAMP | Active miller clamp pin/有源密勒钳位端口 |
| 8 | VEE | Negative power/负电源 |
| 9 | GND1 | Primary Ground/主边地 |
| 10 | IN+ | In-phase input/同相输入 |
| 11 | IN- | Opposite phase input/反相输入 |
| 12 | RDY | Power Ready output/电源就绪状态输出 |
| 13 | FLT | Desaturation protection output/去饱和故障输出 |
| 14 | RST | Reset input/复位输入端口 |
| 15 | VCC1 | Primary power supply/主边电源输入 |
| 16 | APWM | Analog voltage sample output/模拟电平采样输出 |

## Absolute Maximum Ratings
## 最大额定值

| Parameter<br>参数 | Symbol<br>符号 | Value<br>额定值 | Unit<br>单位 |
|---|---|---|---|
| VCC1 pin input voltage, reference to GND1<br>VCC1 电压，参考 GND1 | VCC1 | -0.3 to 6.2 | V |
| VCC2 pin input voltage, reference to GND2<br>VCC2 电压，参考 GND2 | VCC2 | -0.3 to 29 | V |
| VEE pin input voltage, reference to GND2<br>VEE 电压，参考 GND2 | VEE | -15 to 0.3 | V |
| VCC2 pin input voltage, reference to VEE<br>VCC2 电压，参考 VEE | $V_{MAX}$ | -0.3 to 29 | V |
| IN+, IN-, RST input voltages, reference to GND1<br>IN+, IN-,RST 输入电压，参考 GND1 | $V_{LIN}$ | -0.3 to VCC1 | V |
| RDY, FLT, APWM output voltages, reference to GND1<br>RDY, FLT, APWM 输出电压，参考 GND1 | $V_{LOUT}$ | -0.3 to VCC1 | V |
| AIN input voltage, reference to GND2<br>AIN 输入电压，参考 GND2 | $V_{AIN}$ | -0.3 to 5 | V |
| DESAT input voltage, reference to GND2<br>DESAT 输入电压，参考 GND2 | $V_{DESAT}$ | -0.3 to VCC2+0.3 | V |
| CLAMP voltage, reference to VEE<br>CLAMP 电压，参考 VEE | $V_{CLAMP}$ | -0.3 to VCC2+0.3 | V |
| OUTH, OUTL voltage, reference to VEE<br>OUTH, OUTL 电压，参考 VEE | $V_{OUT}$ | -0.3 to VCC2+0.3 | V |
| Lead temperature<br>焊接温度 | $T_L$ | 260 | ℃ |
| Operating junction temperature<br>工作结温 | $T_J$ | -40 to +150 | ℃ |
| Storage temperature range<br>储存温度范围 | $T_{STJ}$ | -55 to +150 | ℃ |

**Attention:** Stresses beyond those listed under "absolute maximum ratings" may cause perm anent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

**注意：**超过绝对最大额定值，可能对器件造成永久损坏。长时间工作在绝对最大额定状态会影响器件可靠性。

## Electrical Characteristic
## 电气特性

($T_A$ = 25°C, unless otherwise noted) （如果没有其它说明，$T_A$ = 25°C）

| Parameter<br>参数 | Symbol<br>符号 | Test Conditions<br>测试条件 | Min.<br>最小 | Typ.<br>典型 | Max.<br>最大 | Unit<br>单位 |
|---|---|---|---|---|---|---|
| **Input Power / 输入电源** | | | | | | |
| VCC1 Operation voltage / VCC1工作电压 | $V_{VCC1}$ | -- | 4.5 | | 5.5 | V |
| VCC1 Quiescent current<br>VCC1静态功耗 | $I_{VCC1}$ | VCC1=5V<br>IN+='1' IN-='0' | | | 5 | mA |
| VCC1 Turn-on threshold voltage<br>VCC1开启电压 | UVLO(ON)1 | -- | 3.2 | 3.5 | 3.8 | V |
| VCC1 Turn-off threshold voltage<br>VCC1关闭电压 | UVLO(OFF)1 | -- | 2.9 | 3.2 | 3.5 | V |
| VCC2 Quiescent current<br>VCC2静态功耗 | $I_{VCC2}$ | VCC1=5V<br>VCC2=15V, VEE=-7V<br>IN+='1' IN-='0' | | | 5 | mA |
| VCC2 Turn-on threshold voltage<br>VCC2开启电压 | UVLO(ON)2 | To GND2 /参考 GND2 | | 12 | 13 | V |
| VCC2 Turn-off threshold voltage<br>VCC2关闭电压 | UVLO(OFF)2 | To GND2 /参考 GND2 | 10 | 11 | | V |
| **Logic Input and Output / 逻辑输入和输出** | | | | | | |
| IN+, IN-, RST low input voltage<br>IN+、IN-、RST为低输入电压范围 | $V_{IN+L}$<br>$V_{IN-L}$<br>$V_{RSTL}$ | VCC1=5V | | | 1.5 | V |
| IN+, IN-, RST high input voltage<br>IN+、IN-、RST为高输入电压范围 | $V_{IN+H}$<br>$V_{IN-H}$<br>$V_{RSTH}$ | VCC1=5V | 3.5 | | | V |
| IN-, RST input current / IN-、RST输入电流 | $I_{IN-}$, $I_{RST}$ | $V_{IN-}$=GND1<br>$V_{RST}$=GND1 | | -100 | | μA |
| IN+ input current / IN+输入电流 | $I_{IN+}$ | $V_{IN+}$=VCC1 | | 100 | | μA |
| RDY, FLT pull up current<br>RDY、FLT上拉电流 | $I_{RDYU}$, $I_{FLTU}$ | $V_{RDY}$=GND1<br>$V_{FLT}$=GND1 | | -100 | | μA |
| RST input pulse width to reset FLT<br>RST实现FLT复位脉冲宽度 | $T_{RST}$ | | | 550 | | ns |
| RDY, FLT pull down current<br>RDY、FLT下拉电流 | $I_{RDYD}$, $I_{FLTD}$ | $V_{RDY}$=300mV<br>$V_{FLT}$=300mV | | 7.5 | | mA |
| RDY='0', FLT='0' minimum holding time<br>RDY='0'、FLT='0'最小保持时间 | $T_{RDYHLD}$<br>$T_{FLTHLD}$ | | 0.55 | | 1 | ms |
| **Miller Clamp / 密勒钳位** | | | | | | |
| Miller clamp threshold / 密勒钳位阈值 | $V_{CLAMP}$ | To VEE / 参考 VEE | 1.6 | 2.1 | 2.5 | V |
| Miller clamp pull down resistance<br>密勒钳位下拉电阻 | $R_{CLAMP}$ | $I_{CLAMP}$=0.2A | | 0.7 | | Ω |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Desaturation Protection / 去饱和保护** | | | | | | |
| Desaturation protection threshold<br>去饱和保护阈值电压 | $V_{DESAT}$ | To GND2<br>参考 GND2 | 8.5 | 9 | 9.5 | V |
| DESAT pull up current source<br>DESAT 上拉电流源 | $I_{CHG}$ | $V_{DESAT}$=2V | | 500 | | μA |
| DESAT pull down current<br>DESAT 下拉电流 | $I_{DCHG}$ | $V_{DESAT}$=6V | 10 | | | mA |
| Leading edge blanking time / 消隐时间 | $T_{LEB}$ | | | 200 | | ns |
| Desaturation protection filter time<br>去饱和保护输出滤波时间 | $T_{FILTER}$ | | | 150 | | ns |
| Desaturation sense to FLT low delay<br>去饱和保护响应到 FLT 低延时 | $T_{DESATFLT}$ | | | 600 | | ns |
| Soft turn-off resistance / 软关断电阻 | $R_{STO}$ | $I_{OUT}$=50mA | | 40 | | Ω |
| **Output Driver / 输出驱动** | | | | | | |
| Output pull-up resistance<br>输出驱动上管内阻 | $R_{OUTH}$ | $I_{OUT}$=-0.1A | | 0.9 | | Ω |
| Output pull-down resistance<br>输出驱动下管内阻 | $R_{OUTL}$ | $I_{OUT}$=0.1A | | 0.6 | | Ω |
| **Analog Voltage Sampling / 模拟电平采样** | | | | | | |
| Analog sensing voltage range<br>模拟电平采样范围 | $V_{AIN}$ | To GND2<br>参考 GND2 | 0.5 | | 4.5 | V |
| AIN pull-up current source<br>AIN 端口上拉电流源 | $I_{AIN}$ | $V_{AIN}$=2.5V | | n/a | | μA |
| APWM output frequency / APWM 输出频率 | $f_{APWM}$ | $V_{AIN}$=2.5V | 1 | | 5 | KHz |
| APWM duty cycle / APWM 输出占空比 | $D_{APWM}$ | $V_{AIN}$=0.5V | | n/a | | % |
| | | $V_{AIN}$=2.5V | | n/a | | |
| | | $V_{AIN}$=4.5V | | n/a | | |
| **Switching Characteristics / 开关特性** | | | | | | |
| On propagation delay time<br>开通传输延时 | $T_{PDON}$ | $C_{LOAD}$=100pF<br>$V_{IN+}$=50%, $V_{OUT}$=10% | | 130 | | ns |
| Off propagation delay time<br>关断传输延时 | $T_{PDOFF}$ | $C_{LOAD}$=100pF<br>$V_{IN+}$=50%, $V_{OUT}$=90% | | 130 | | ns |
| **Others / 其他** | | | | | | |
| Common mode transient immunity<br>瞬态共模抑制 | CMTI | | 100 | | | V/ns |
| 1min insulation withstand voltage<br>1分钟绝缘隔离耐压 | $V_{ISO}$ | | 4500 | | | $V_{RMS}$ |

## Operation Description
## 工作描述

The BF1181 is a signal channel gate driver for SIC/IGBT, and can support up to 1400V DC operating voltage. There are two galvanic separated parts, for the input part, BF1181 can be directly connected to a 5V DSP/MCU. For the output part, it is connected to the high voltage side.

The device includes complementary inputs, and output drive capability is enough to drive the power devices directly without an extra buffer. The driver can also be used to drive higher power modules or parallel modules with external buffer stage.

The device includes extensive control and protection functions to increase the reliability and robustness of the systems. The desaturation protection with FLT status output, is used to detect if over-current or short of power device happened, the soft turn off is triggered when the desaturation fault is detected, reducing the overshoot voltage on the switches. UVLO protection is used to detect if the power supplied correctly, and RDY output is relate to the UVLO protection. Active miller clamp prevents the false turn on causing by miller capacitance during fast switching. Analog voltage sampling function can be used to detect the power device temperature and feedback to DSP/MCU.

BF1181 是一款单通道 SiC/IGBT 驱动芯片，可以支持高达 1400V 的直流工作电压。芯片输入输出为电隔离，输入部分可以直接与标准 5V DSP/MCU 相连，输出部分与高压部分相连。

芯片集成互补输入。其输出驱动能力足够大，不接外部的缓冲器就可以驱动功率器件，同时在更大功率应用的场合，也可以外接缓冲器以进一步提高驱动能力。

为了提高系统工作的可靠性，芯片还集成了保护及控制功能。去饱和保护用于检测功率器件是否发生过流或短路，通过 FLT 输出给主边。一旦检测到去饱和保护故障，则触发软关断来减小开关上的过冲电压。欠压保护用来确认芯片电源电压是否正常供电，其输出反馈给 RDY。有源密勒钳位用于防止快速开关下由于密勒电容导致的输出误开启。模拟电平采样功能可以用于采样功率器件的温度并反馈给 DSP/MCU。

● **Propagation Delay**

**传输延时**

There are two different phase input signals. At in-phase mode IN+ controls the driver output while IN- is set to low. At opposite phase mode IN- controls the driver output while IN+ is set to high. Fig shows the propagation delay measurement.

芯片有两种不同相位的输入信号端。当 IN-保持低时，输出受输入 IN+控制，且输入输出同相。当 IN+信号保持高，输出受输入 IN-控制，且输入输出反相。上升与下降的传输延时说明见下图。

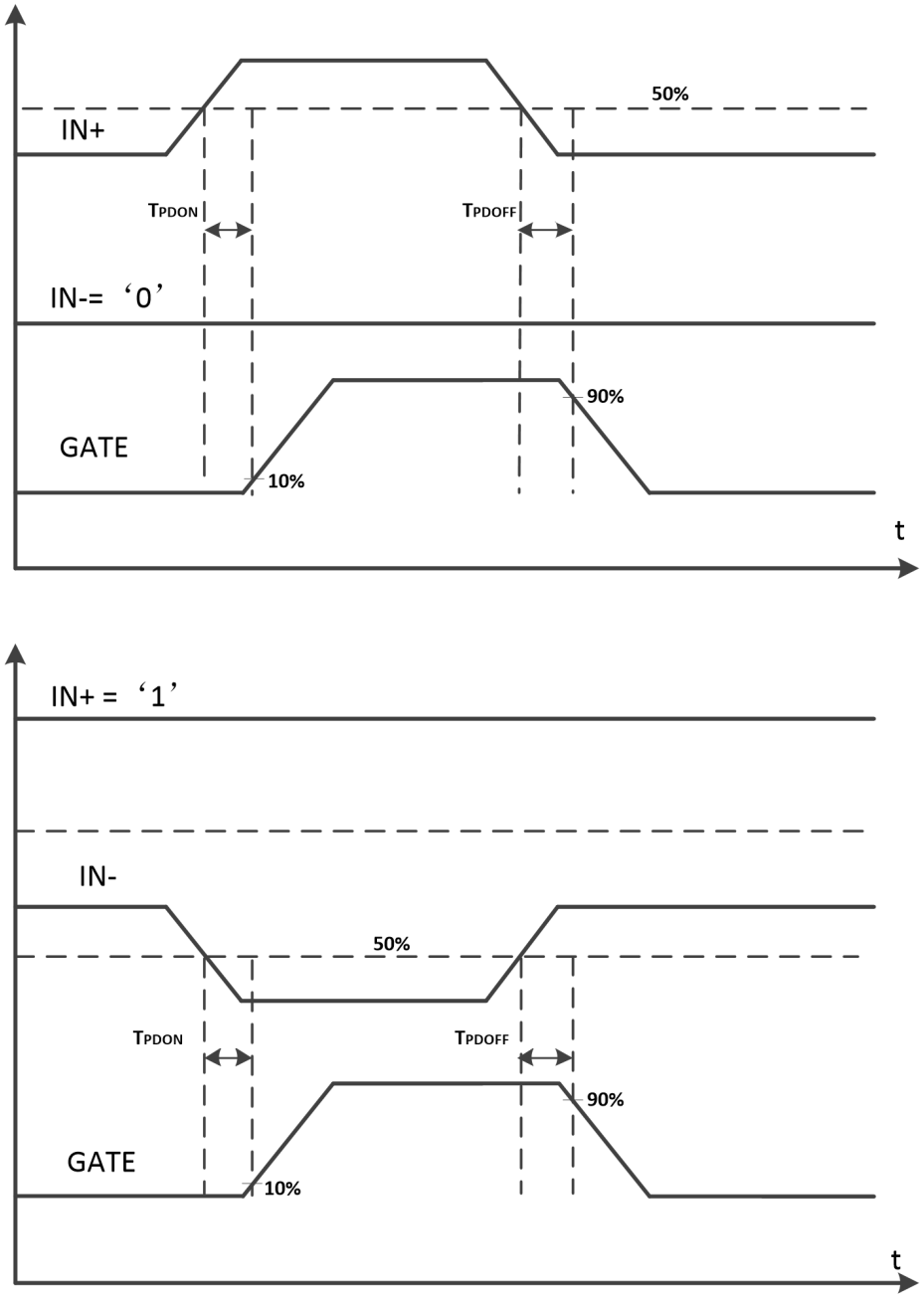



Figure 4: Propagation delay time

图 4：传输延时

● **Under-voltage Lockout (UVLO)**

**欠压锁定**

The device has a function that protect against power (VCC1&VCC2) under-voltage. Once the VCC1 or VCC2 drops below the UVLO (OFF) threshold, the RDY pin output will goes low and turn off power device. When the power supply voltage goes up to above UVLO (ON) threshold, RDY will goes high and drive output will be released at the same time.

芯片具有电源欠压保护功能。无论是主边电源 VCC1 还是次级电源 VCC2，一旦低于给定的 UVLO 保护阈值，RDY 脚都将变为低电平，同时关断输出。当电源电压恢复到 UVLO 回复阈值以上，RDY 脚将变为高电平，同时放开输出。

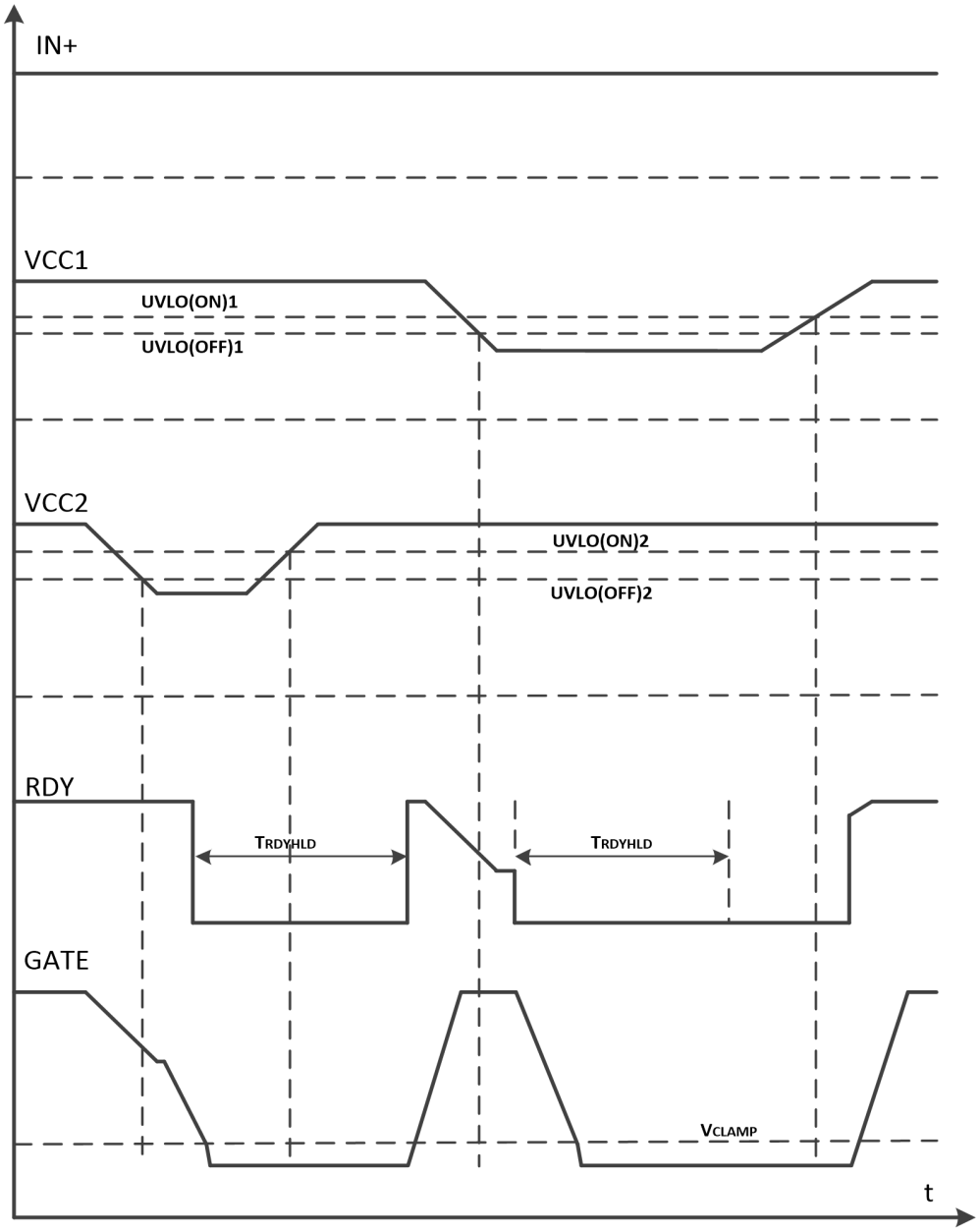



Figure 5: Under Voltage Protection (IN-='0')

图 5：欠压保护（IN-='0'）

● **Desaturation Protection**

**去饱和保护**

A desaturation protection is used to detect the power devices under over current condition. Once desaturation protection happened, BF1181 will soft turn off the power devices and the FLT output will pull down to '0'.

Figure 6 shows the desaturation protection diagram.

去饱和保护功能主要用于实现对功率器件的过流检测。一旦发生去饱和保护，则芯片将对功率器件进行软关断，同时FLT端将被下拉到低。

图6给出了去饱和保护所对应的波形示意图。

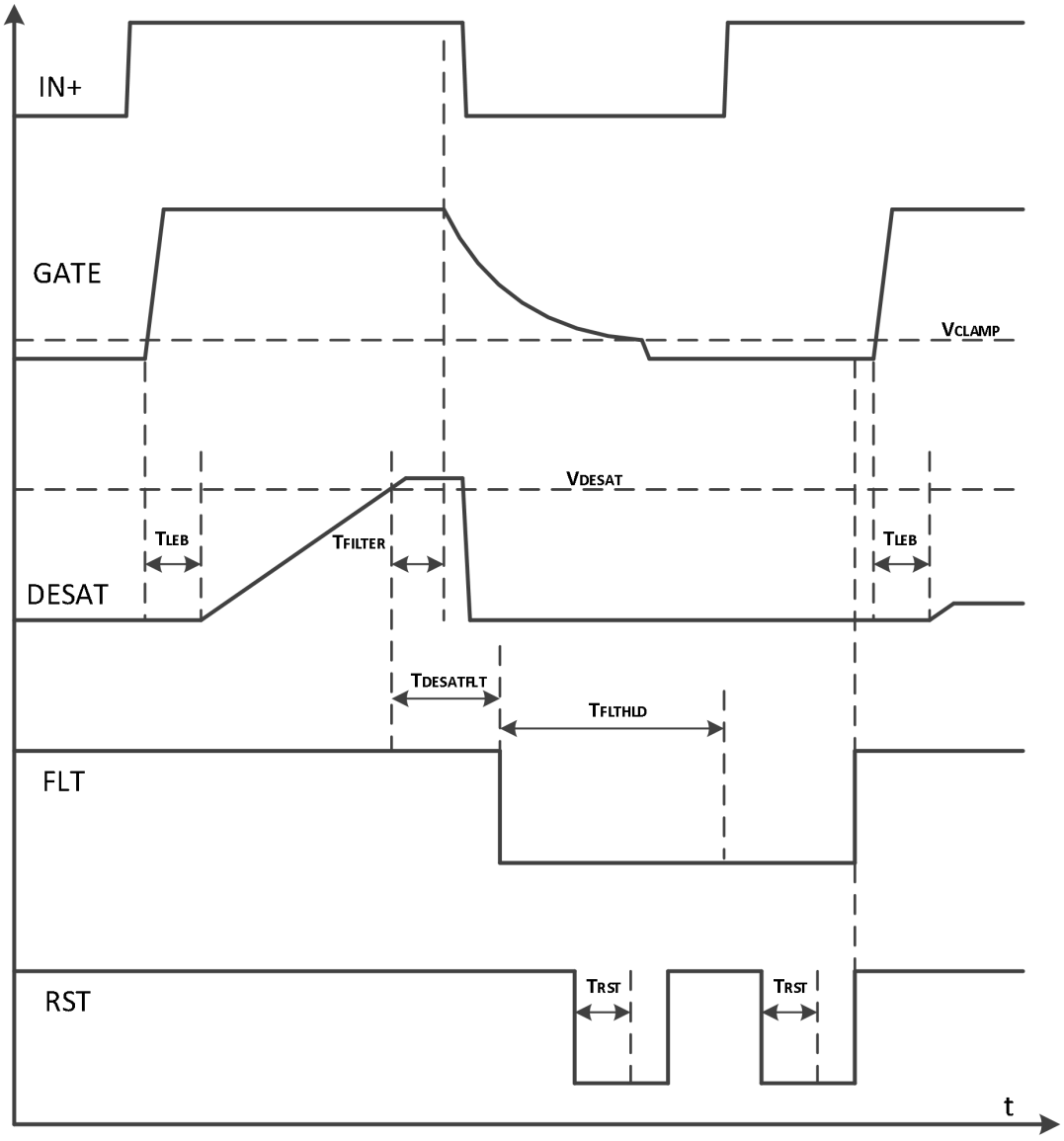



Figure 6: Desaturation Protection (IN-='0')

图 6：去饱和保护（IN-='0'）

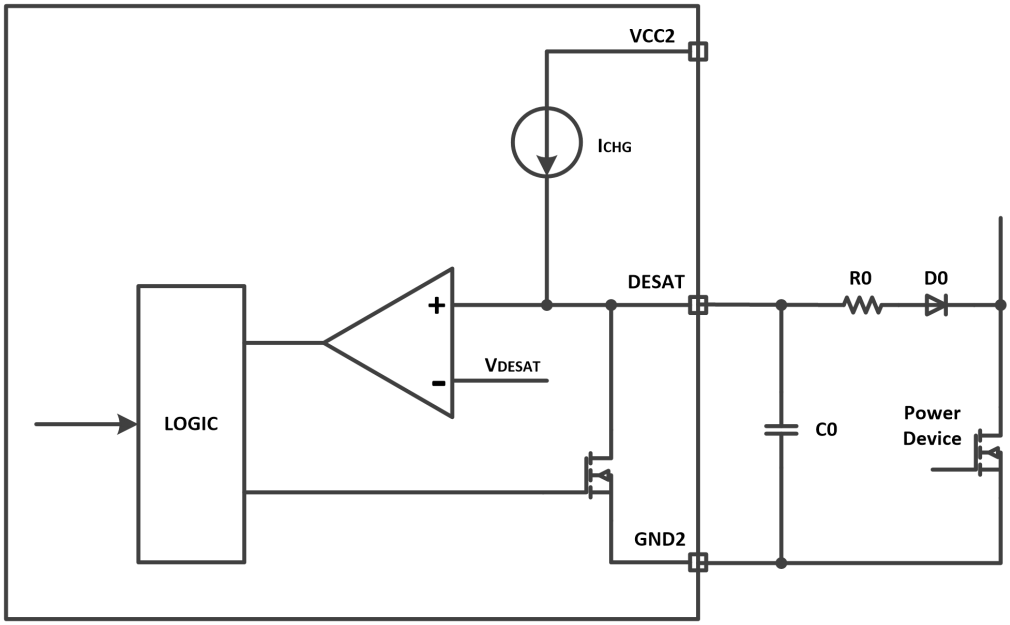



Figure 7: Desaturation Protection
图 7：去饱和保护

**● RESET 复位**

RST works as reset function to shutdown output. RST can also be used to reset the FLT signal. Once desaturation protection happened, FLT signal will pull down to '0', if RST is low longer than a given time $T_{RST}$, FLT will be cleared at the rising edge of RST. The detail is as Fig 6.

RST 可以作为芯片的复位端，对芯片进行复位并关断输出。还可以用于实现对 FLT 故障信号的复位。一旦发生去饱和保护，FLT 信号将跳变为'0'并锁定，此时通过 RST 给入低电平时间超过给定时间宽度 $T_{RST}$，则在 RST 由低翻转为高的瞬间，FLT 的故障状态将被撤销，FLT 输出回复'1'。具体见图 6。

**● Soft Turn-off 软关断**

Desaturation protection is triggered when the overcurrent or short circuit happened, and soft turn-off used to limit the overshoot of power devices and prevents the overvoltage breakdown. The turn-off speed needs to be slow to limit the overshoot voltage, but the shutdown time should not be too long that the large energy dissipation can make the power device destroy. The diagram of soft turn-off shows in Fig 6.

在发生过流或短路的情况下，芯片将快速进入去饱和保护。此时输出将进行软关断以抑制功率器件出现电压过冲，避免出现过压击穿。关断速度必须足够慢以抑制过冲电压，同时关断时间不能太长，否则功率器件能量损耗过大甚至可能损坏。软关断过程示意图见图 6。

**● Active Miller Clamp 有源密勒钳位**

During turn-on, miller clamp switch keep closing. During turn-off, when the gate voltage related to VEE goes below $V_{CLAMP}$（typical 2.1V）, the miller clamp switch will turn-on and help add an additional low impedance path to bypass the miller current, prevent the high dV/dt introduced through the miller capacitance, then miller clamp will keep activating till output turn-on again. Therefore in many applications, the use of a negative supply voltage can be avoided.

在输出开启期间，密勒钳位器件保持关断。在输出关断期间，当 CLAMP 管脚电压相对 VEE 低于 $V_{CLAMP}$（约 2.1V）时，内部的密勒钳位器件将开启，从而为栅极电流创建第二条低阻抗电流路径，抑制由功率器件密勒电容引起的门极电压尖峰。之后密勒钳位器件将持续保持开启直到输出再次开启。在许多的应用场合中，通过采用密勒钳位，可以做到不需要提供负电源进行输出关断。

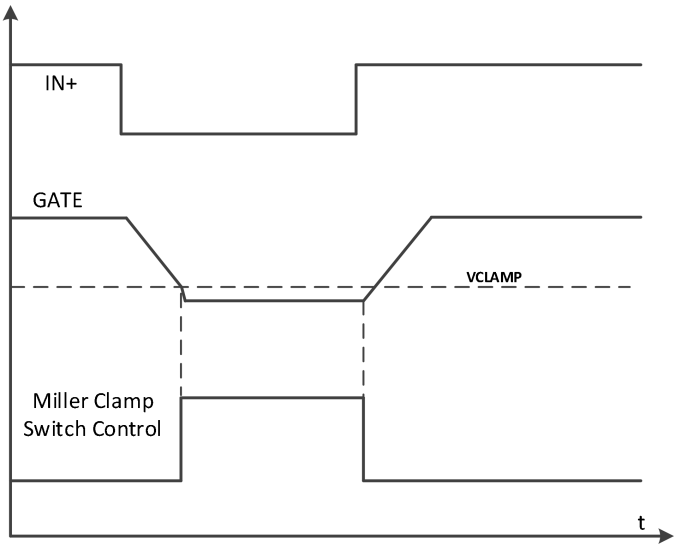



Figure 8: Miller Clamp Function (IN-='0')

图 8：密勒钳位功能（IN-='0'）

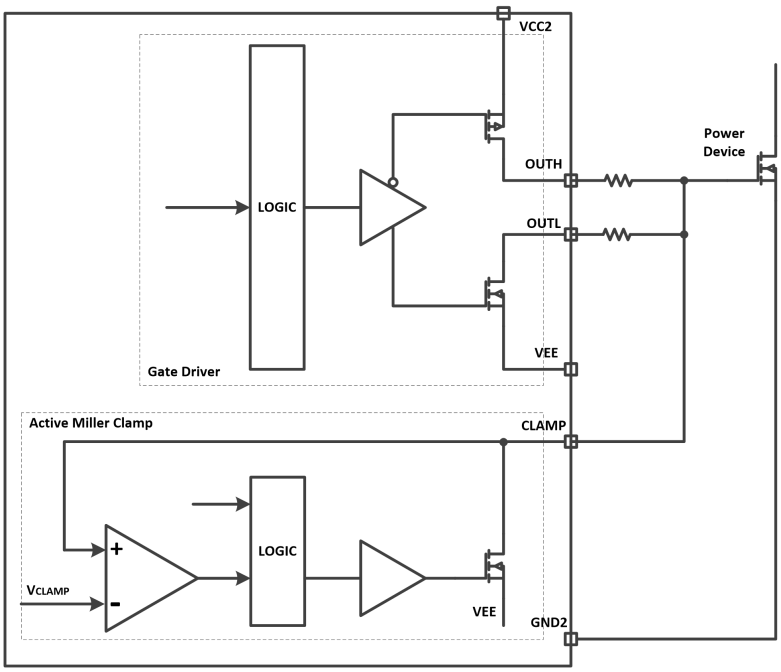



Figure 9: Active Miller Clamp

图 9：有源密勒钳位

● **Gate Driver**
**门极驱动**

The split output of the driver stage are OUTH and OUTL. When turn on the power device, the OUTH will be shorted to VCC2 by the pull-up driver MOS and the OUTL pin is high-impedance state. When turn off the power device, the OUTL will be shorted to VEE by the pull-down driver MOS, and the OUTH pin is high-impedance state. The RDSON of driver stage are small enough that can operate without extra buffer stage.

Since the split driver output structure, The OUTH and OUTL pins should be provided with individual gate resistors, and the slew rates of the rise and fall of the gate voltage can be separately adjusted using the external resistors.

芯片驱动的上下管输出分别接出，上管输出 OUTH，下管输出 OUTL。当芯片输出开启时，相应的 OUTH 将通过驱动上管短路到电源 VCC2，而 OUTL 则为高阻状态。当芯片输出关断，OUTL 将通过驱动下管短路到地 VEE，而 OUTH 则为高阻状态。驱动级的器件内阻足够小，因此可以无需外接推挽。

在具体的应用中，由于 OUTH 和 OUTL 分开接出，因此驱动开通电阻和关闭电阻可分开设置，可以实现对开通速度和关闭速度的独立调节。

● **Analog Voltage Sample**
**模拟电平采样**

Analog voltage sample function is used to convert input analog voltage of AIN to PWM signal output. For temperature sensing, an internal current source of AIN pin will be provided to the external thermal diode or temperature sensing resistor, and the voltage of thermal device will be detected via the AIN pin, and converted to PWM signal. The PWM signal duty cycle proportional to the AIN voltage, The AIN voltage input range is from 4.5V to 0.5V.

模拟电平采样功能可以实现将 AIN 引脚的模拟电平转换成占空比信号输出。当通过模拟电平采样功能进行温度采样时，AIN 引脚的内部电流源提供给外部的温度二极管或热敏电阻，芯片将采样到的热敏器件上的模拟电平转换成 PWM 信号并通过 APWM 引脚输出。APWM 信号占空比由 AIN 模拟电平决定，AIN 输入电平的采样有效范围为 4.5V 到 0.5V。

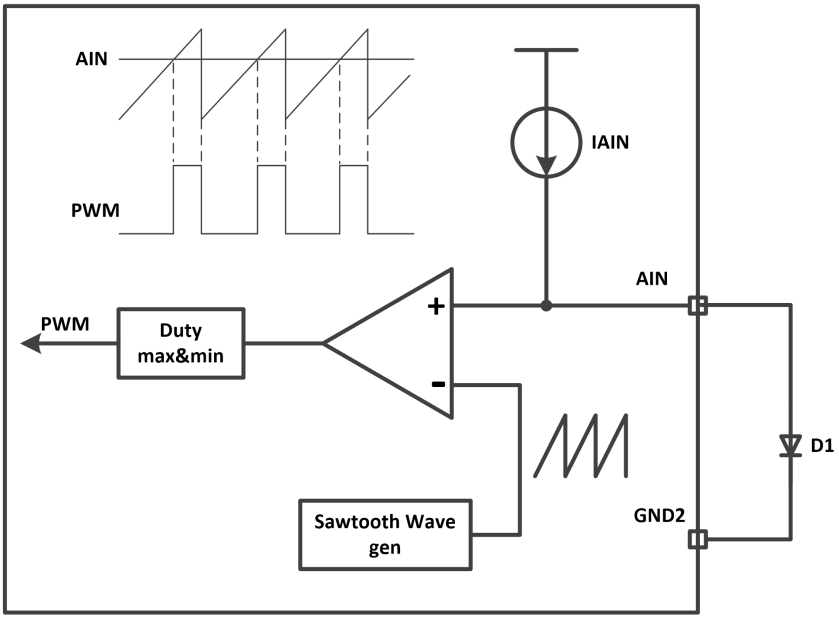
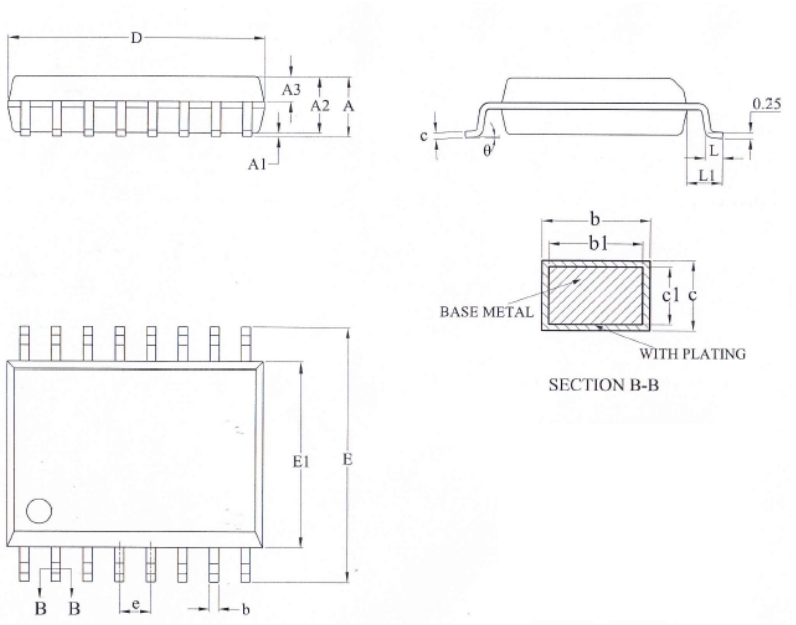



Figure 10: Analog Signal Sampling
图 10：模拟电平采样

## Package Outline
## 封装外形图

**SOW16**




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | — | — | 2.65 |
| A1 | 0.1 | — | 0.3 |
| A2 | 2.25 | 2.3 | 2.35 |
| A3 | 0.97 | 1.02 | 1.07 |
| b | 0.35 | — | 0.43 |
| b1 | 0.34 | 0.37 | 0.40 |
| c | 0.25 | — | 0.29 |
| c1 | 0.24 | 0.25 | 0.26 |
| D | 10.20 | 10.30 | 10.40 |
| E | 10.10 | 10.30 | 10.50 |
| E1 | 7.40 | 7.50 | 7.60 |
| e | 1.27BSC | | |
| L | 0.55 | — | 0.85 |
| L1 | 1.40REF | | |
| θ | 0 | — | 8° |

## Packing
## 包装

MBB packing / MBB 包装

13”reel: Pizza box 360mm*360mm*40mm.carton 380mm*380*mm*330mm.1000PCS per reel.

13 寸卷盘：小箱 360mm*360mm*40mm；大箱 380mm*380mm*330mm，每盘 1000PCS

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