

## 方案简介

本应用方案基于一款高集成度的电流型反激式电源控制器 VPC2187B，结合隔离功率变压器、输出整流二极管以及必要的阻容元件，实现 9V-36V 输入，12V 输出 24W 的隔离稳压电源方案，原副边隔离耐压不小于 1500VDC，同时具备远程控制关断，可长期短路保护并自恢复等功能。本方案可应用在系统板需要实施电气隔离以达到安全和（或）抗干扰目的的相关场合。

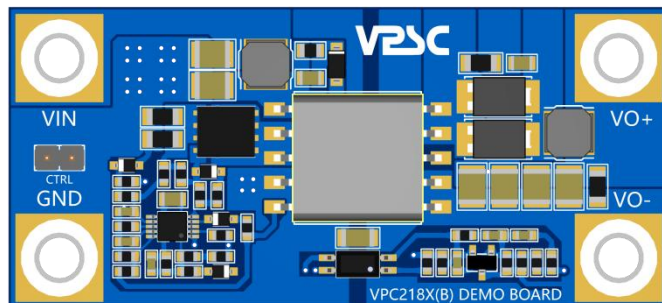


图 1: VPC2187B Demo 板(尺寸:67.5mm\*30.7mm)

关键词：输入：9V-36V，输出 12V/24W，隔离电压：1500VDC，反馈方式：副边反馈-SSR，开关频率：330kHz

## 原理图

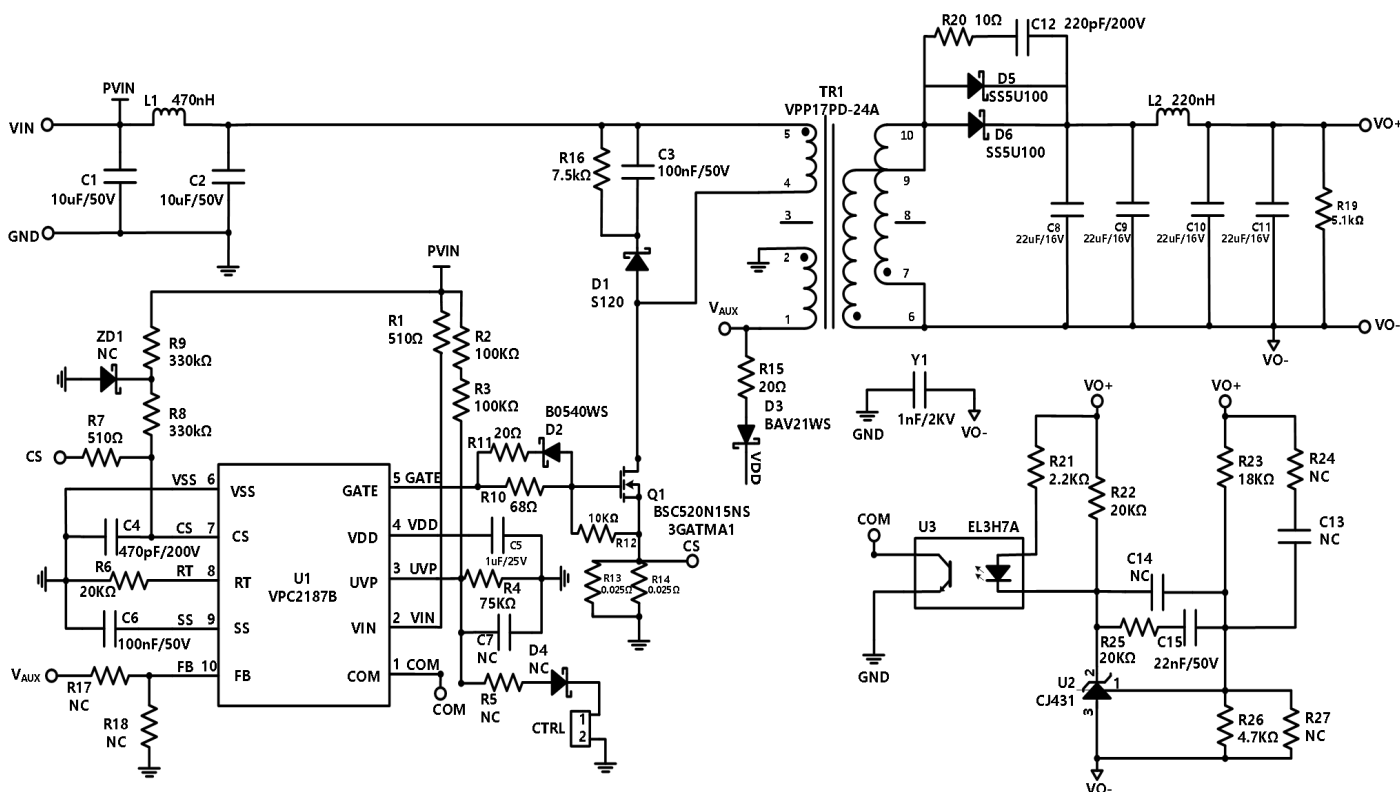


图 2: VPC2187B 12V/24W 原理图

## 引脚功能说明

| 编号 | 功能  | 功能描述  |
|----|-----|-------|
| 1  | VIN | 电源输入端 |
| 2  | GND | 电源接地端 |
| 3  | VO+ | 电源输出正 |
| 4  | VO- | 电源输出负 |

物料清单

| 位号  | 参数              | 封装   | 型号                | 品牌    |
|-----|-----------------|------|-------------------|-------|
| C1  | 10uF/50V-X7R    | 1210 | CC1210KKX7R9BB106 | YAGEO |
| C2  | 10uF/50V-X7R    | 1210 | CC1210KKX7R9BB106 | YAGEO |
| C3  | 100nF/50V-X7R   | 0805 | CC0805KRX7R9BB104 | YAGEO |
| C4  | 470pF/50V-X7R   | 0603 | CC0603KKX7R0BB471 | YAGEO |
| C5  | 1uF/25V-X7R     | 0805 | CC0805KKX7R8BB105 | YAGEO |
| C6  | 100nF/25V-X7R   | 0603 | CC0603KKX7R0BB104 | YAGEO |
| C7  | NC              | -    | -                 | -     |
| C8  | 22uF/16V-X5R    | 1206 | CC1206KKX5R9BB226 | YAGEO |
| C9  | 22uF/16V-X5R    | 1206 | CC1206KKX5R9BB226 | YAGEO |
| C10 | 22uF/16V-X5R    | 1206 | CC1206KKX5R9BB226 | YAGEO |
| C11 | 22uF/16V-X5R    | 1206 | CC1206KKX5R9BB226 | YAGEO |
| C12 | 220pF/200V- X7R | 0805 | CC0805KRX7RABB221 | YAGEO |
| C13 | NC              | -    | -                 | -     |
| C14 | NC              | -    | -                 | -     |
| C15 | 22nF/50V-X7R    | 0603 | CC0603KRX7R9BB223 | YAGEO |
| Y1  | 1nF/2KV-X7R     | 1206 | CC1206KKX7RDBB102 | YAGEO |
| R1  | 510Ω±1%         | 0603 | RC0603FR-07510RL  | YAGEO |
| R2  | 100KΩ±1%        | 0603 | RC0603FR-07100KL  | YAGEO |
| R3  | 100KΩ±1%        | 0603 | RC0603FR-07100KL  | YAGEO |
| R4  | 75KΩ±1%         | 0603 | RC0603FR-0775KL   | YAGEO |
| R5  | NC              | -    | -                 | -     |
| R6  | 20KΩ±1%         | 0603 | RC0603FR-0720KL   | YAGEO |
| R7  | 510Ω±1%         | 0603 | RC0603FR-07510RL  | YAGEO |
| R8  | 330KΩ±1%        | 0603 | RC0603FR-07330KL  | YAGEO |
| R9  | 330KΩ±1%        | 0603 | RC0603FR-07330KL  | YAGEO |
| R10 | 68Ω±1%          | 0603 | RC0603FR-0768RL   | YAGEO |
| R11 | 20Ω±1%          | 0603 | RC0603FR-0720RL   | YAGEO |
| R12 | 10KΩ±1%         | 0603 | RC0603FR-0710KL   | YAGEO |
| R13 | 0.025Ω ±1%      | 1206 | RL1206FR-070R025L | YAGEO |
| R14 | 0.025Ω ±1%      | 1206 | RL1206FR-070R025L | YAGEO |
| R15 | 20Ω±1%          | 0603 | RC0603FR-0720RL   | YAGEO |
| R16 | 7.5KΩ±1%        | 0805 | RC0805FR-077K5L   | YAGEO |
| R17 | NC              | -    | -                 | -     |
| R18 | NC              | -    | -                 | -     |
| R19 | 5.1KΩ±1%        | 1206 | RC1206FR-075K1L   | YAGEO |
| R20 | 10Ω±1%          | 1206 | RC1206FR-0710RL   | YAGEO |
| R21 | 2.2KΩ±1%        | 0603 | RC0603FR-072K2L   | YAGEO |
| R22 | 20KΩ±1%         | 0603 | RC0603FR-0720KL   | YAGEO |
| R23 | 18KΩ±1%         | 0603 | RC0603FR-0718KL   | YAGEO |
| R24 | NC              | -    | -                 | -     |

|     |                            |         |                    |           |
|-----|----------------------------|---------|--------------------|-----------|
| R25 | 20K $\Omega$ ±1%           | 0603    | RC0603FR-0720KL    | YAGEO     |
| R26 | 4.7K $\Omega$ ±1%          | 0603    | RC0603FR-074K7L    | YAGEO     |
| R27 | NC                         | -       | -                  | -         |
| TR1 | NP:NS:NA=6:6:6<br>Lp=3.6uH | EPD13   | VPP17PD-24A        | VPSC      |
| Q1  | N 沟道 150V 21A              | TDSON-8 | BSC520N15NS3GATMA1 | INFINEON  |
| L1  | 470nH ±30%                 | SMD     | SWPA5020SR47NT     | SUNLORD   |
| L2  | 220nH ±20%                 | SMD     | WPN4020HR22MT      | SUNLORD   |
| D1  | 200V/1A                    | SOD-123 | S120               | YANGJIE   |
| D2  | 40V/0.5A                   | SOD-323 | B0540WS            | YANGJIE   |
| D3  | 200V/0.2A                  | SOD-323 | BAV21WS            | CJ        |
| D4  | NC                         | -       | -                  | -         |
| D5  | 100V/5A                    | SMA     | SS5U100            | YANGJIE   |
| D6  | 100V/5A                    | SMA     | SS5U100            | YANGJIE   |
| ZD1 | NC                         | -       | -                  | -         |
| U1  | 4-100VIN 电源管理芯片            | MSOP-10 | VPC2187B           | VPSC      |
| U2  | Vref=2.495V                | SOT23-3 | CJ431              | CJ        |
| U3  | CTR=80~160, Viso=3750VAC   | SSOP-4  | EL3H7A             | EVERLIGHT |

## 总体性能一览表

| 性能指标         | 测试条件              | Min        | Typ  | Max  | Unit |
|--------------|-------------------|------------|------|------|------|
| 输入电流 (满载/空载) | VIN=24V           | 4          | ---  | 1118 | mA   |
| 转换效率         | VIN=24V, IO=2A    | ---        | 89.8 | ---  | %    |
| 纹波&噪声        | VIN=24V, IO=2A    | ---        | 72   | 220  | mV   |
| 输出电压精度       | VIN=24V, IO=2A    | ---        | 0.4  | ---  | %    |
| 线性调节率        | VIN=9V-36V, IO=2A | ---        | 0.1  | ---  | %    |
| 负载调整率        | VIN=24V, IO=2A    | ---        | 0.2  | ---  | %    |
| 输出过流点系数      | VIN=9V, IO=2A     | ---        | 1.5  | ---  | 倍    |
| 输入欠压保护       | 锁定电压              | ---        | 7.3  | ---  | V    |
|              | 恢复电压              | ---        | 8.3  | ---  | V    |
| 短路保护         | VIN=9V-36V        | 可长期保护, 自恢复 |      |      |      |
| 工作温度         | 大于 70°C需降额使用      | -40        | ---  | 85   | °C   |
| 绝缘电压         | 原边短接 VS 副边短接      | 1500       | ---  | ---  | VDC  |

## 关键性能指标测试结果

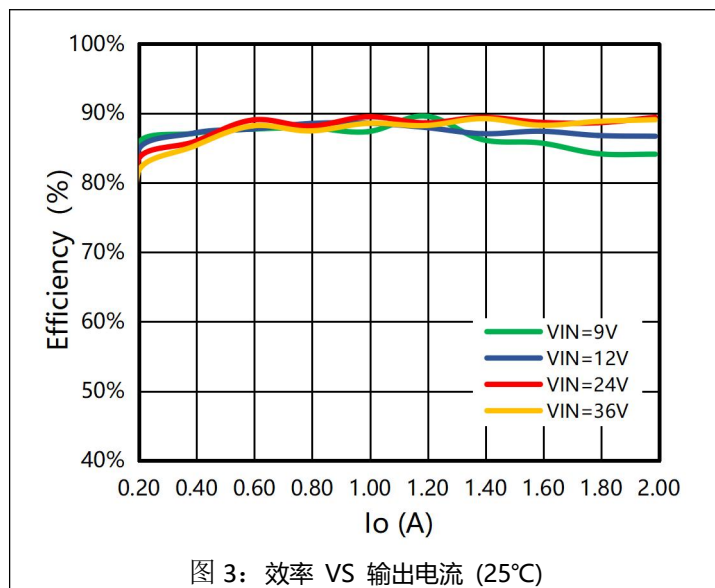


图 3: 效率 VS 输出电流 (25°C)

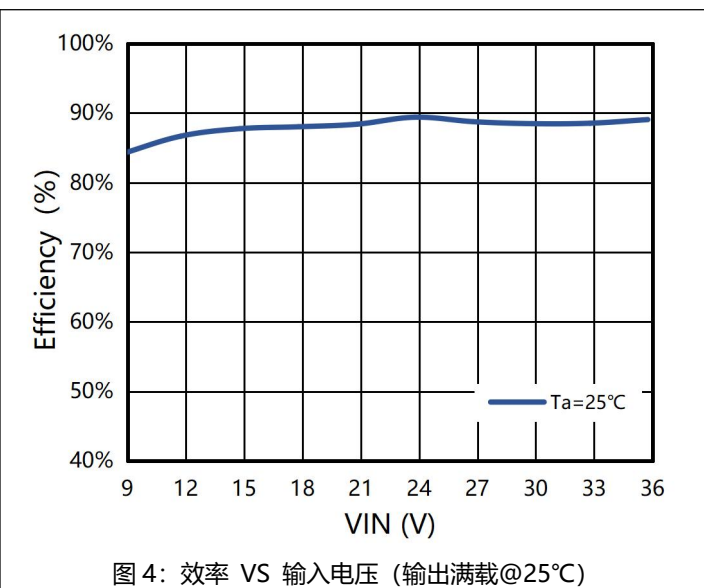


图 4: 效率 VS 输入电压 (输出满载@25°C)

## 相关波形

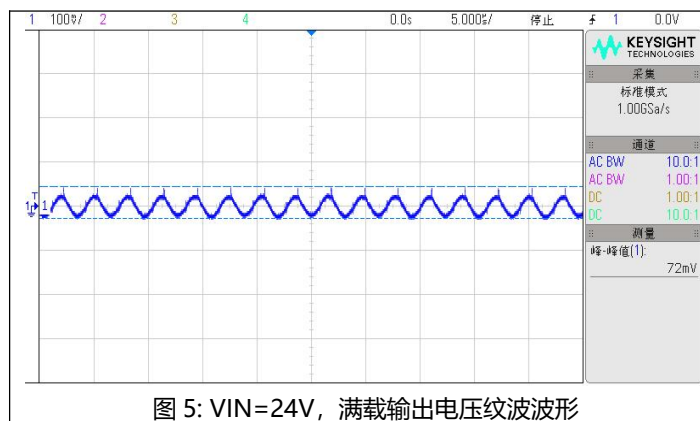


图 5: VIN=24V, 满载输出电压纹波波形

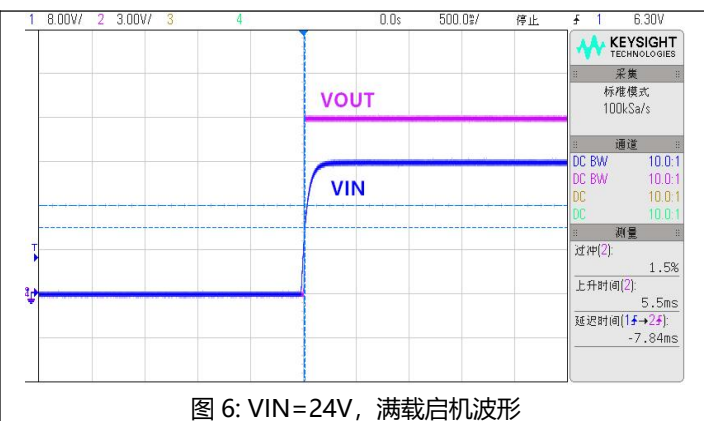
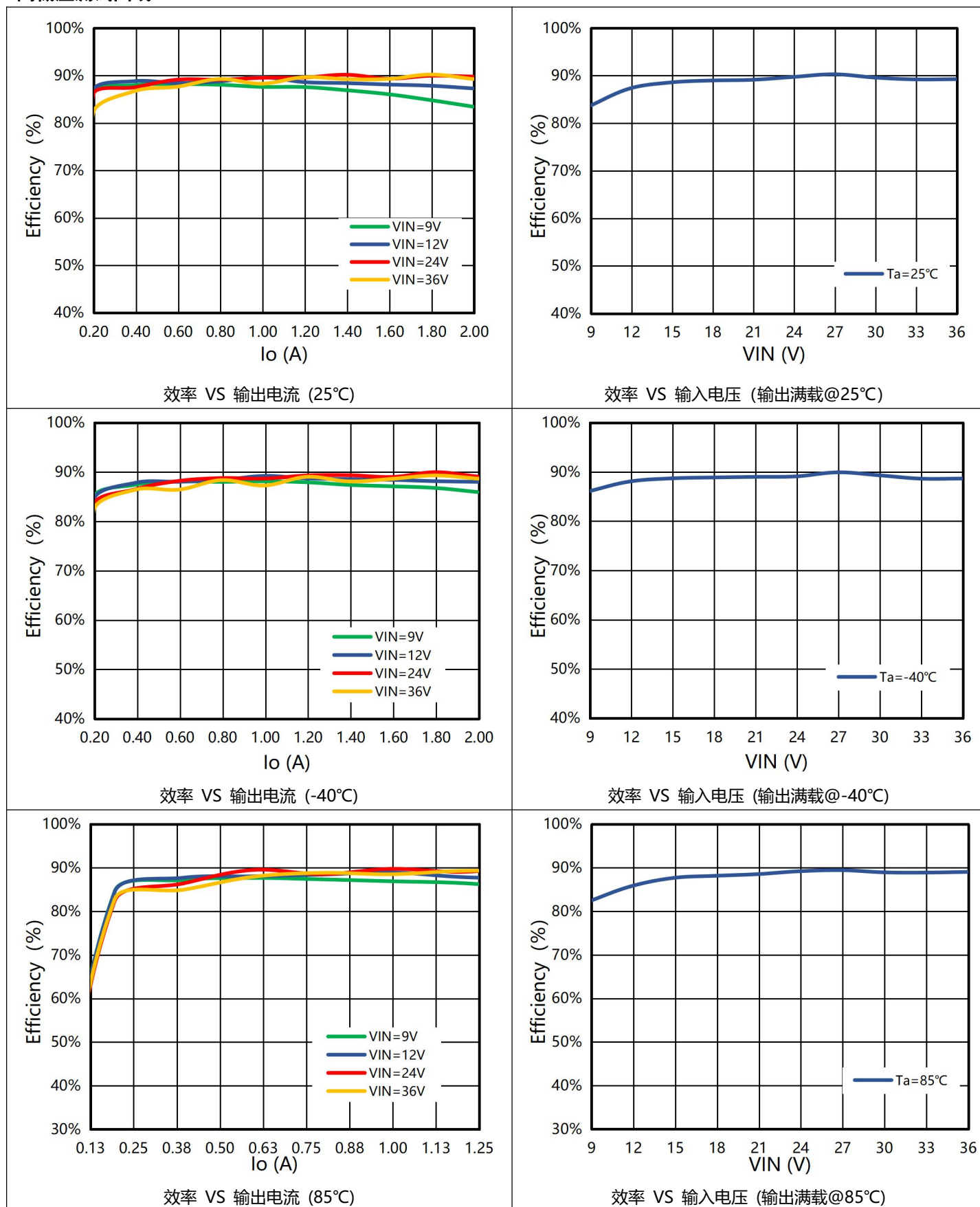


图 6: VIN=24V, 满载启机波形

## 详细测试数据

### 高低温测试曲线



VIN=24V, Ta=25°C, 输入、输出及效率数据:

| VIN(V) | IIN(A) | VO(V) | IO(A) | IO-max% | η(%)   |
|--------|--------|-------|-------|---------|--------|
| 24.01  | 0.004  | 12.05 | 0     | 0%      | 0.00%  |
| 24.01  | 0.115  | 12.05 | 0.197 | 10%     | 85.97% |
| 23.99  | 0.227  | 12.04 | 0.396 | 20%     | 87.55% |
| 23.99  | 0.335  | 12.04 | 0.595 | 30%     | 89.14% |
| 23.97  | 0.448  | 12.04 | 0.795 | 40%     | 89.13% |
| 23.98  | 0.558  | 12.04 | 0.995 | 50%     | 89.53% |
| 23.97  | 0.670  | 12.04 | 1.195 | 60%     | 89.59% |
| 23.97  | 0.777  | 12.04 | 1.395 | 70%     | 90.18% |
| 23.96  | 0.897  | 12.04 | 1.595 | 80%     | 89.35% |
| 23.95  | 1.003  | 12.04 | 1.795 | 90%     | 89.97% |
| 23.94  | 1.118  | 12.04 | 1.996 | 100%    | 89.79% |

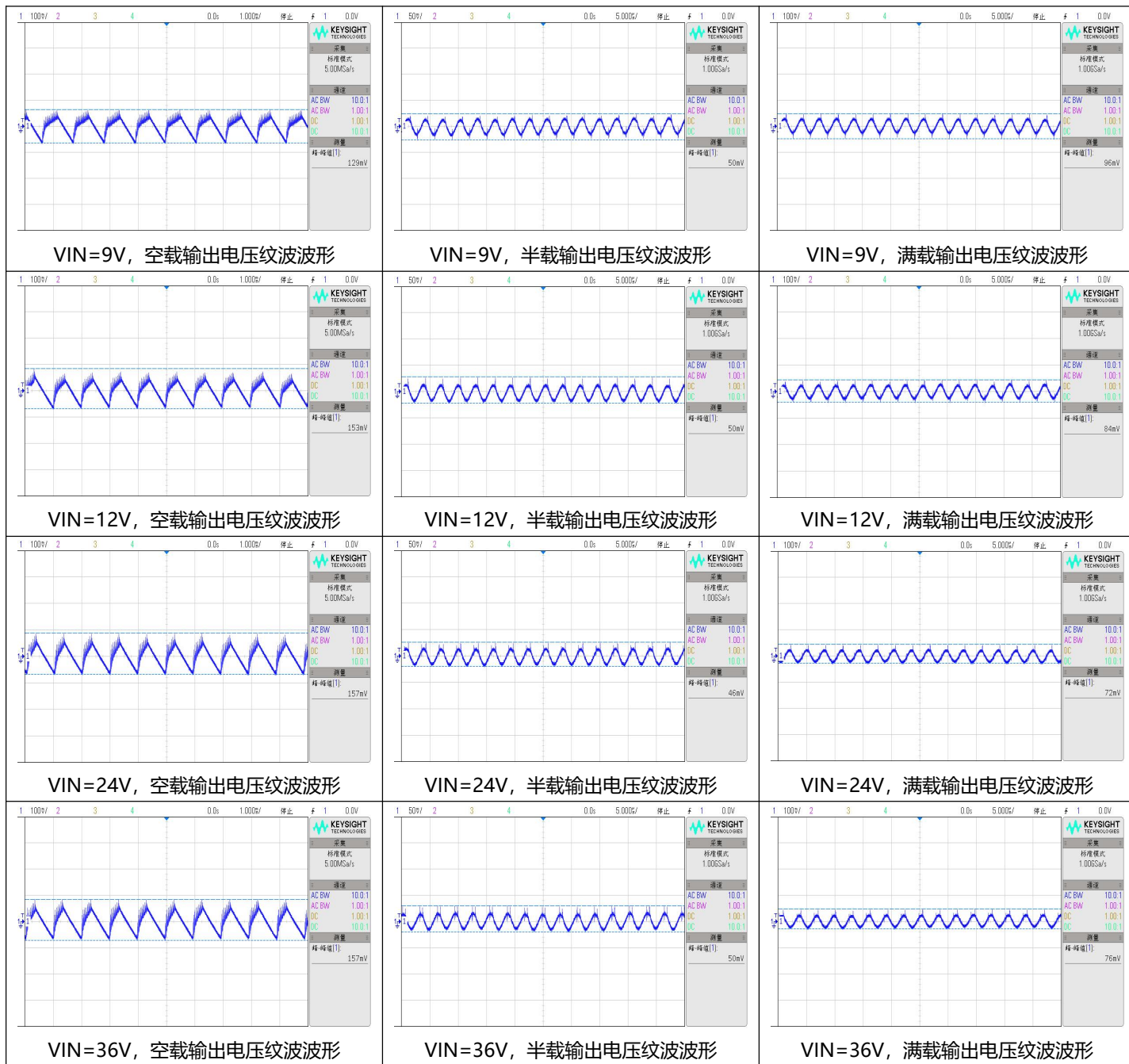
VIN=24V, Ta=-40°C, 输入、输出及效率数据:

| VIN(V) | IIN(A) | VO(V) | IO(A) | IO-max% | η(%)   |
|--------|--------|-------|-------|---------|--------|
| 24.01  | 0.004  | 11.99 | 0     | 0%      | 0.00%  |
| 24.01  | 0.117  | 11.99 | 0.195 | 10%     | 83.23% |
| 23.98  | 0.228  | 11.98 | 0.395 | 20%     | 86.55% |
| 23.98  | 0.337  | 11.98 | 0.595 | 30%     | 88.21% |
| 23.97  | 0.447  | 11.98 | 0.794 | 40%     | 88.78% |
| 23.98  | 0.560  | 11.98 | 0.994 | 50%     | 88.68% |
| 23.96  | 0.669  | 11.98 | 1.195 | 60%     | 89.31% |
| 23.97  | 0.779  | 11.97 | 1.394 | 70%     | 89.36% |
| 23.94  | 0.896  | 11.97 | 1.595 | 80%     | 89.01% |
| 23.93  | 0.998  | 11.97 | 1.795 | 90%     | 89.97% |
| 23.93  | 1.118  | 11.96 | 1.993 | 100%    | 89.10% |

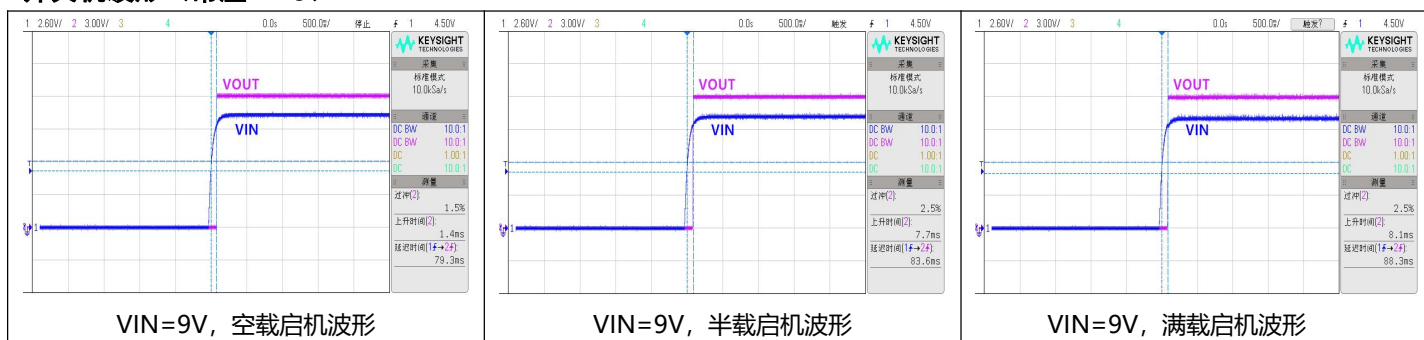
VIN=24V, Ta=85°C, 输入、输出及效率数据:

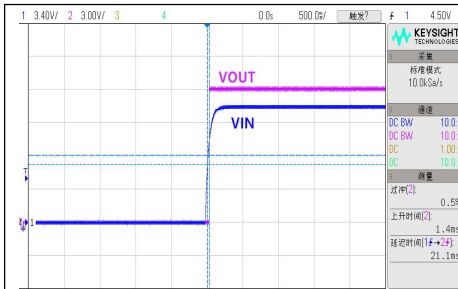
| VIN(V) | IIN(A) | VO(V) | IO(A) | IO-max% | η(%)   |
|--------|--------|-------|-------|---------|--------|
| 24.02  | 0.004  | 12.08 | 0     | 0%      | 0.00%  |
| 24.02  | 0.119  | 12.08 | 0.195 | 10%     | 82.41% |
| 24     | 0.230  | 12.08 | 0.395 | 20%     | 86.44% |
| 24.01  | 0.335  | 12.08 | 0.596 | 30%     | 89.51% |
| 23.98  | 0.452  | 12.07 | 0.795 | 40%     | 88.53% |
| 23.98  | 0.558  | 12.07 | 0.995 | 50%     | 89.75% |
| 23.96  | 0.676  | 12.07 | 1.195 | 60%     | 89.05% |
| 23.96  | 0.780  | 12.07 | 1.394 | 70%     | 90.03% |
| 23.95  | 0.905  | 12.06 | 1.595 | 80%     | 88.75% |
| 23.94  | 1.013  | 12.06 | 1.794 | 90%     | 89.21% |
| 23.92  | 1.127  | 12.06 | 1.994 | 100%    | 89.20% |

### 输出电压纹波波形

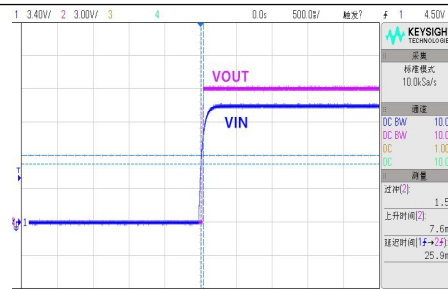


### 开关机波形 (常温 25°C)

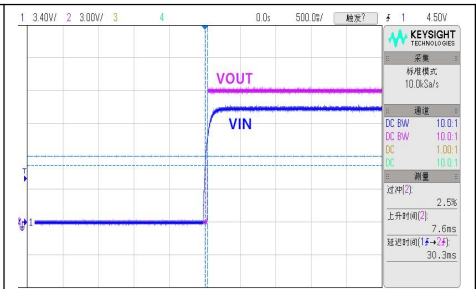




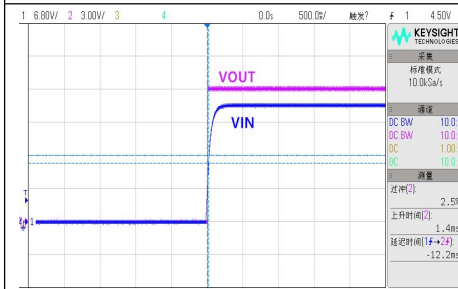
VIN=12V, 空载启机波形



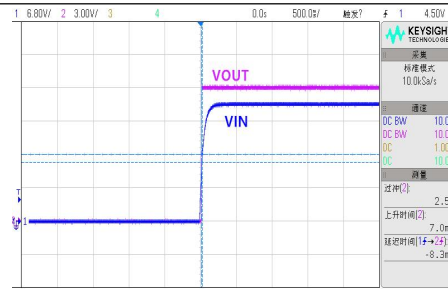
VIN=12V, 半载启机波形



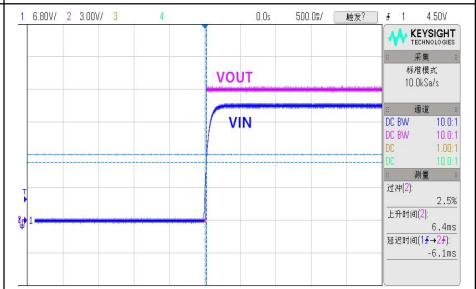
VIN=12V, 满载启机波形



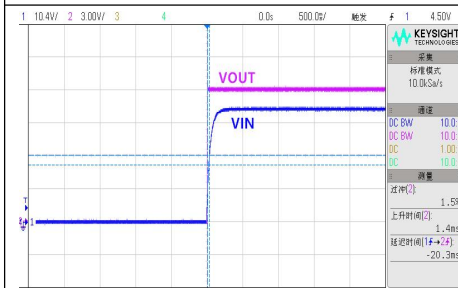
VIN=24V, 空载启机波形



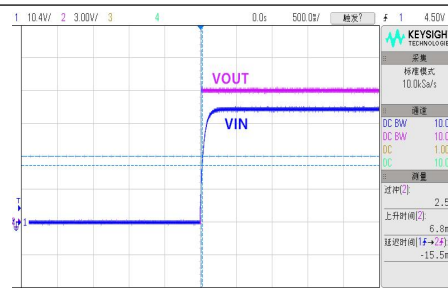
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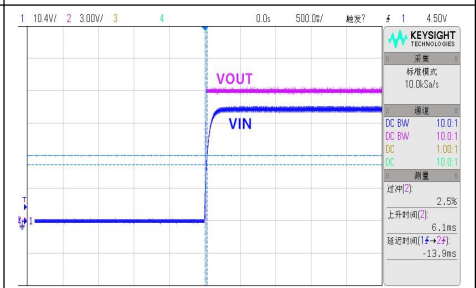
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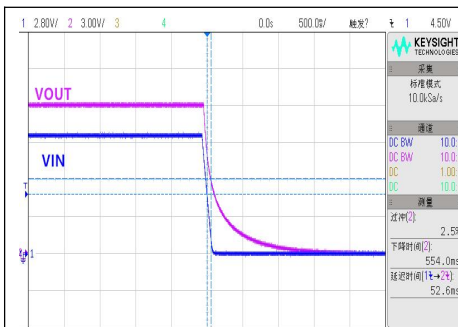
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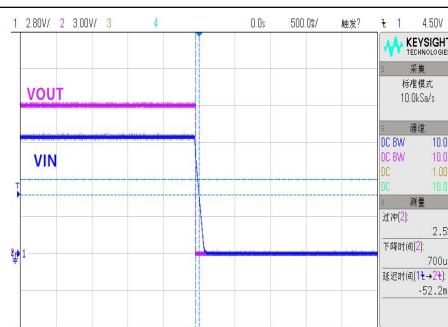
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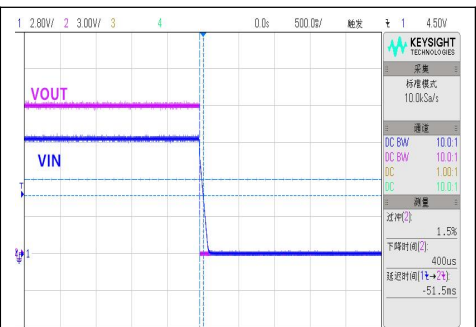
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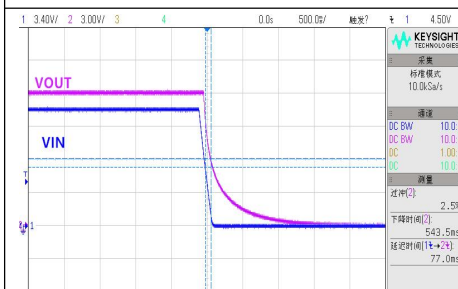
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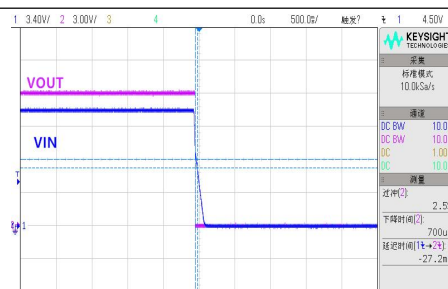
VIN=9V, 半载关机波形



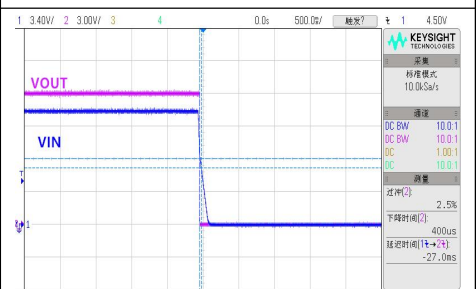
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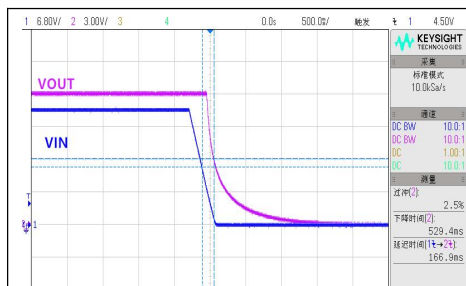
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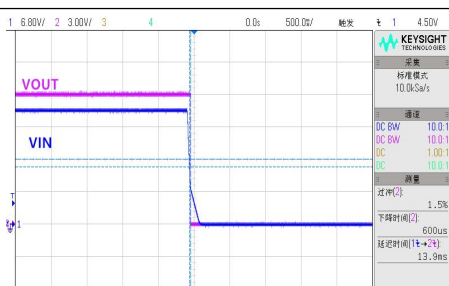
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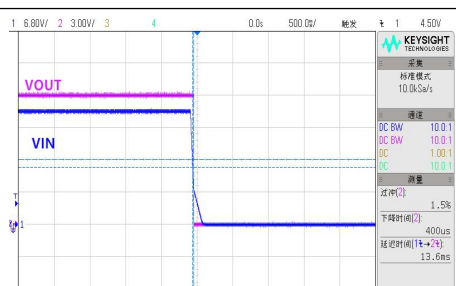
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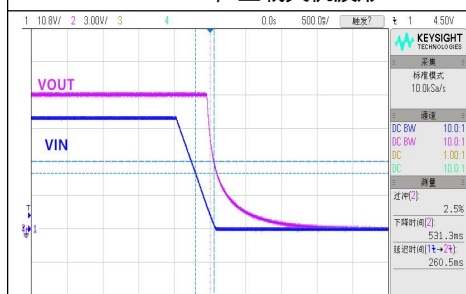
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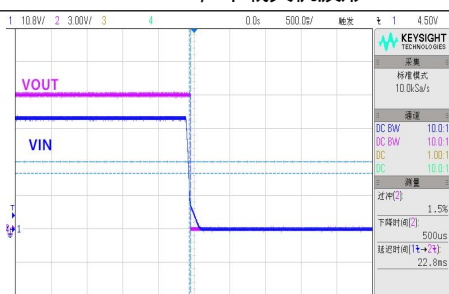
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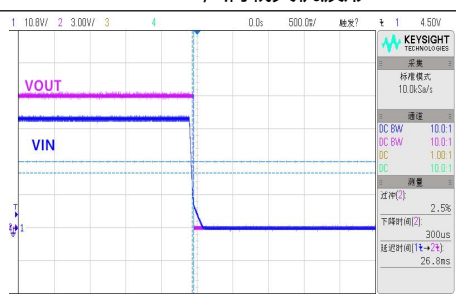
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VIN=36V, 空载关机波形

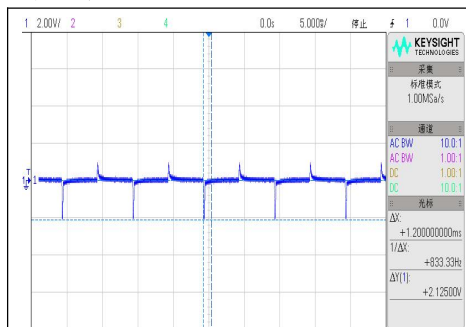


VIN=36V, 半载关机波形

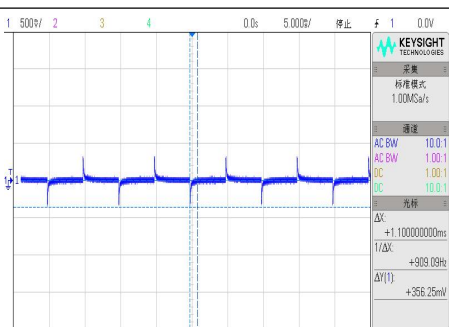


VIN=36V, 满载关机波形

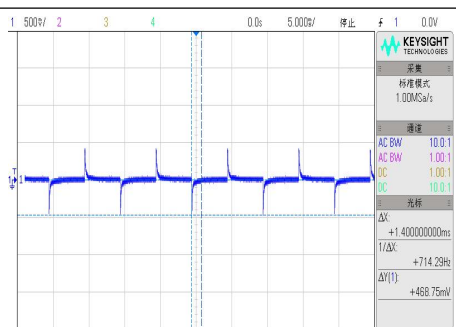
## 动态波形



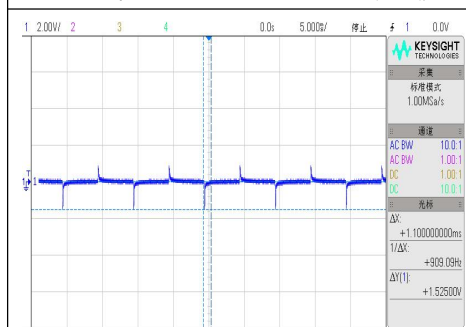
VIN=9V, 100%-10%-100%Io 动态波形



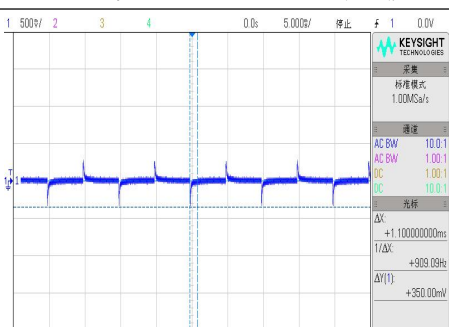
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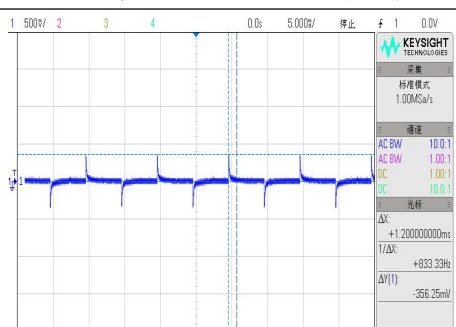
VIN=9V, 50%-25%-50%Io 动态波形



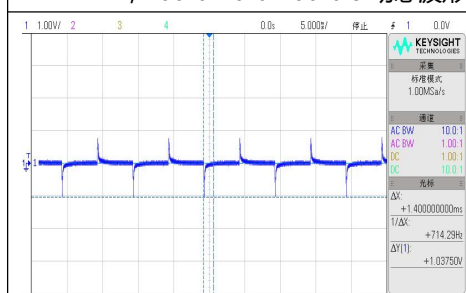
VIN=12V, 100%-10%-100%Io 动态波形



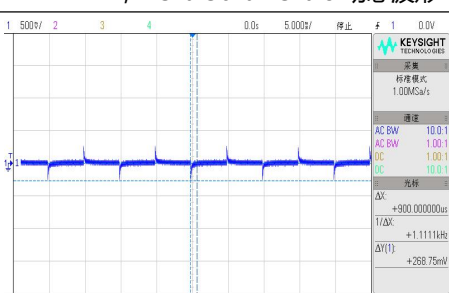
VIN=12V, 75%-50%-75%Io 动态波形



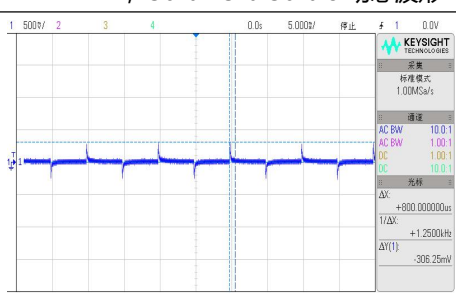
VIN=12V, 50%-25%-50%Io 动态波形



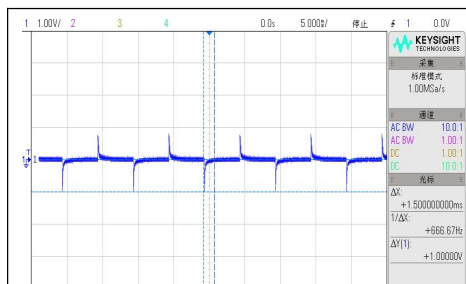
VIN=24V, 100%-10%-100%Io 动态波形



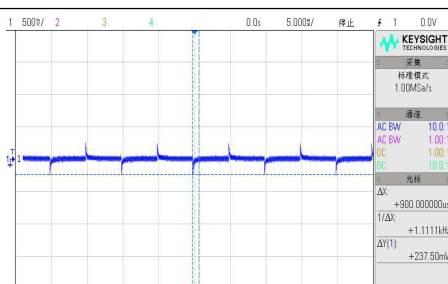
VIN=24V, 75%-50%-75%Io 动态波形



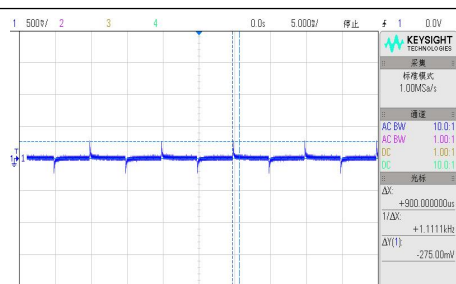
VIN=24V, 50%-25%-50%Io 动态波形



VIN=36V, 100%-10%-100%Io 动态波形

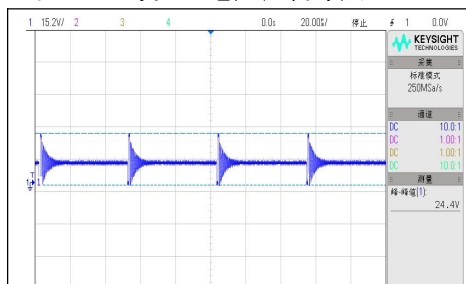


VIN=36V, 75%-50%-75%Io 动态波形

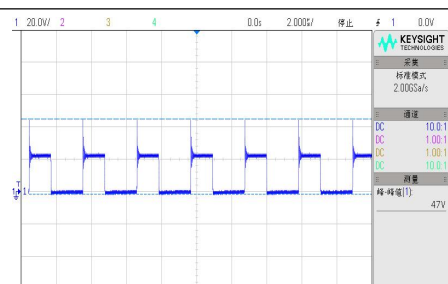


VIN=36V, 50%-25%-50%Io 动态波形

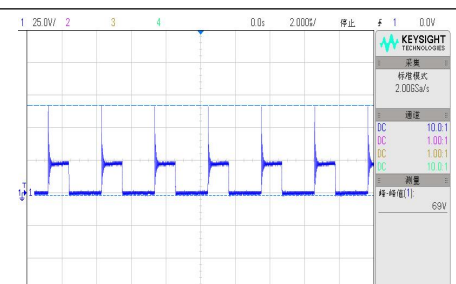
### 外置 MOS 管 Q1 电压应力波形



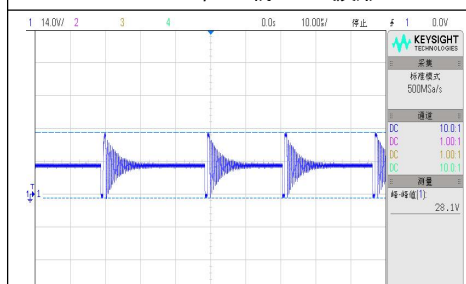
VIN=9V, 空载 VDS 波形



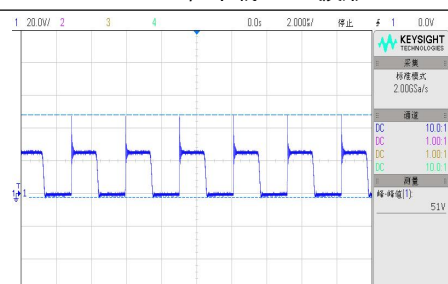
VIN=9V, 半载 VDS 波形



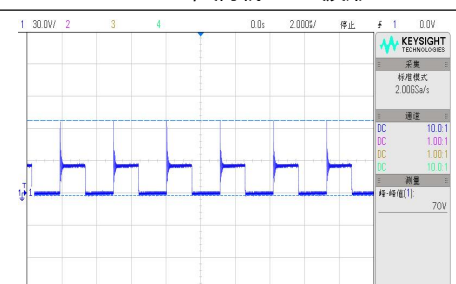
VIN=9V, 满载 VDS 波形



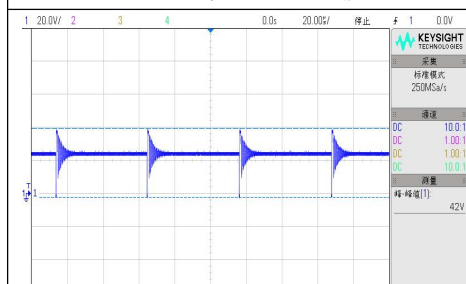
VIN=12V, 空载 VDS 波形



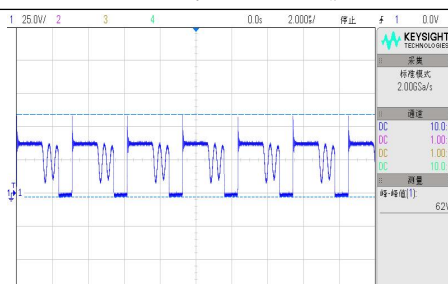
VIN=12V, 半载 VDS 波形



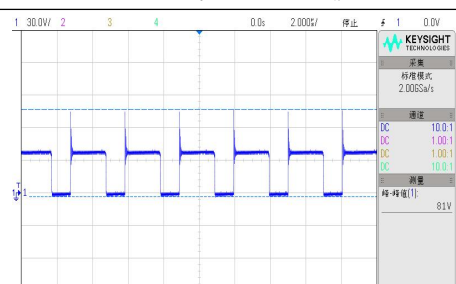
VIN=12V, 满载 VDS 波形



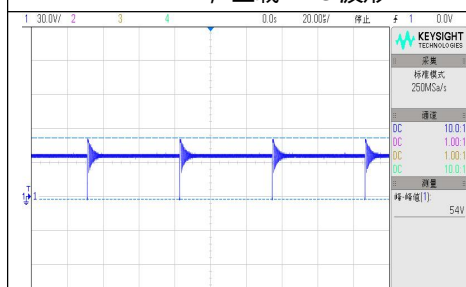
VIN=24V, 空载 VDS 波形



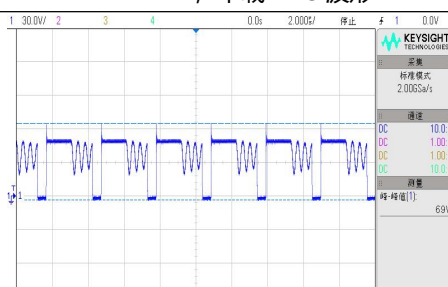
VIN=24V, 半载 VDS 波形



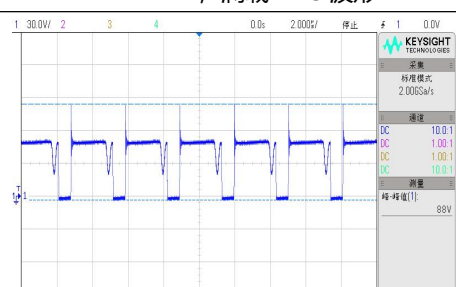
VIN=24V, 满载 VDS 波形



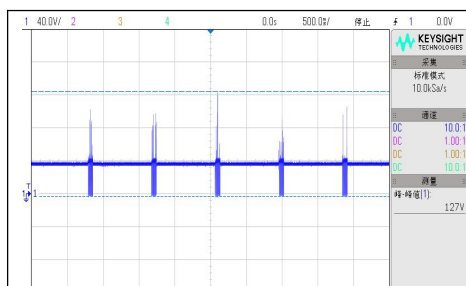
VIN=36V, 空载 VDS 波形



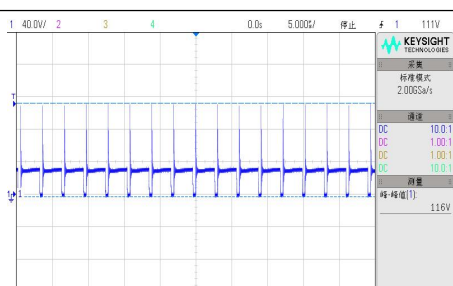
VIN=36V, 半载 VDS 波形



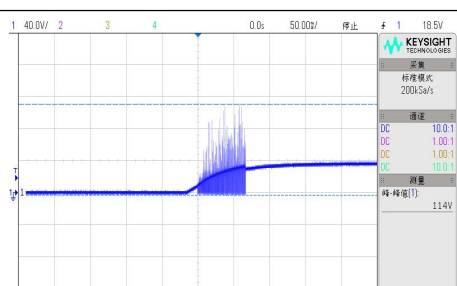
VIN=36V, 满载 VDS 波形



VIN=36V, 短路保护 VDS 波形

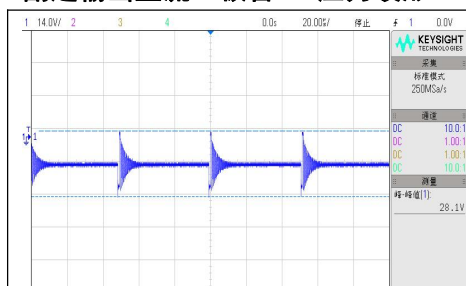


VIN=36V, 短路保护 VDS 展开波形

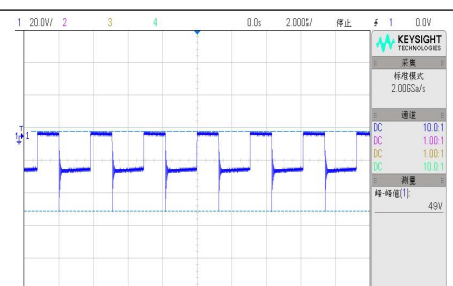


VIN=36V, 短路保护 VDS 启机波形

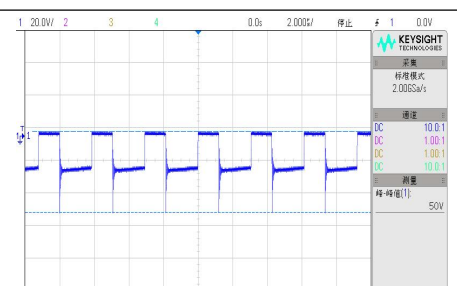
### 副边输出整流二极管 D4 应力波形



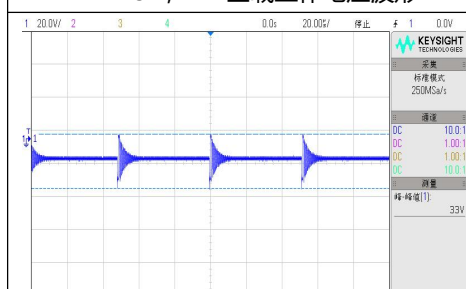
VIN=9V, D4 空载工作电压波形



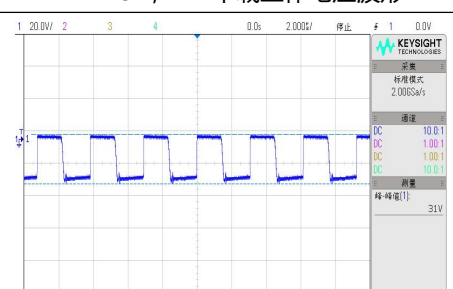
VIN=9V, D4 半载工作电压波形



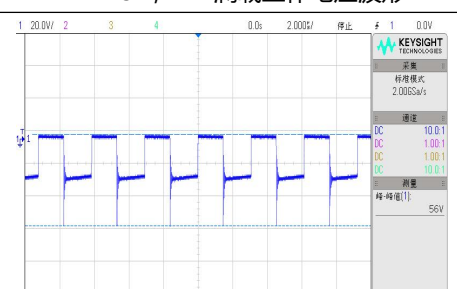
VIN=9V, D4 满载工作电压波形



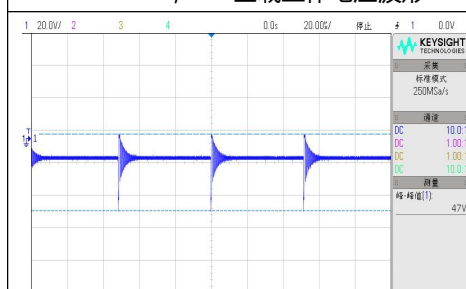
VIN=12V, D4 空载工作电压波形



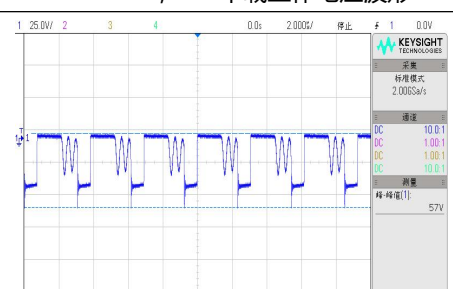
VIN=12V, D4 半载工作电压波形



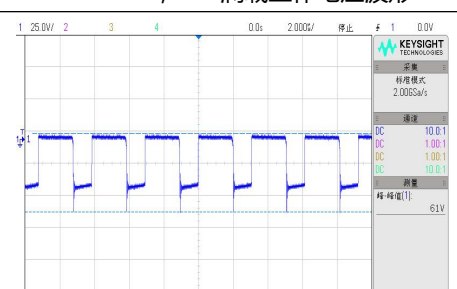
VIN=12V, D4 满载工作电压波形



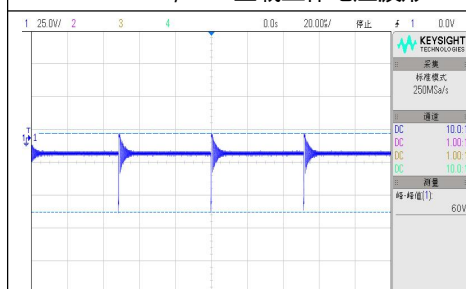
VIN=24V, D4 空载工作电压波形



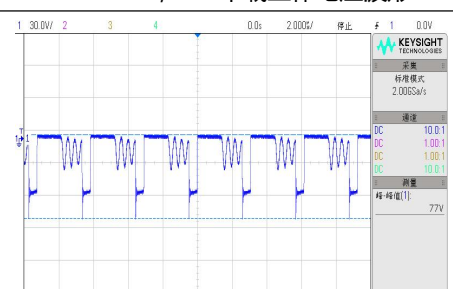
VIN=24V, D4 半载工作电压波形



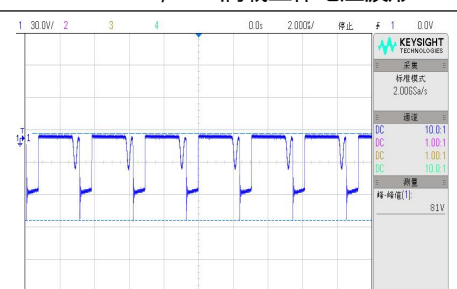
VIN=24V, D4 满载工作电压波形



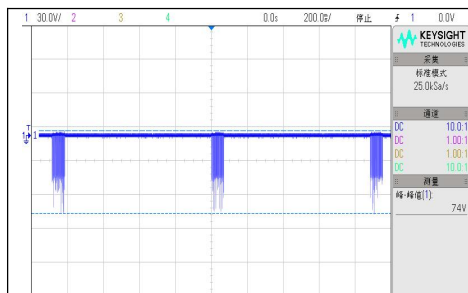
VIN=36V, D4 空载工作电压波形



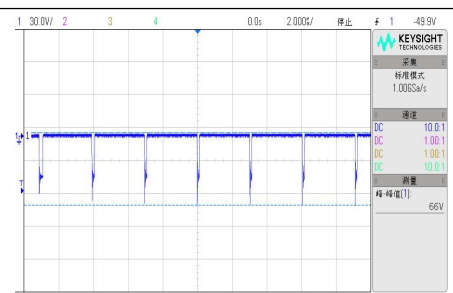
VIN=36V, D4 半载工作电压波形



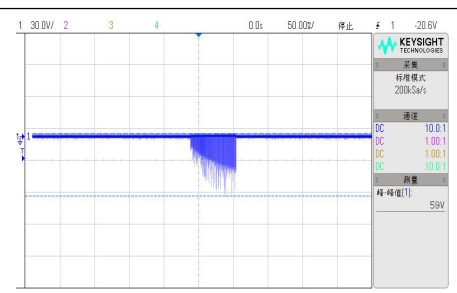
VIN=36V, D4 满载工作电压波形



VIN=36V, D4 短路保护工作电压波形

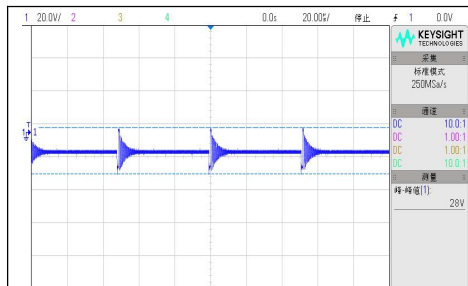


VIN=36V, D4 短路保护工作电压展开波形

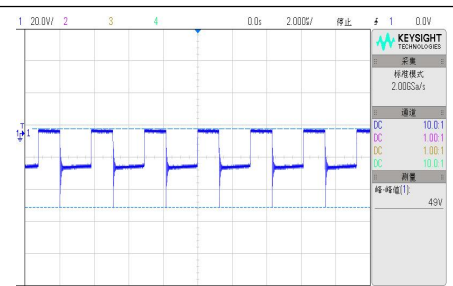


VIN=36V, D4 短路保护 VDS 启机波形

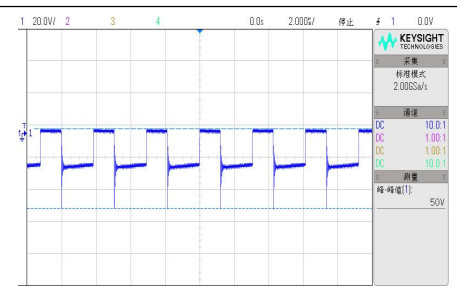
### 副边输出整流二极管 D5 应力波形



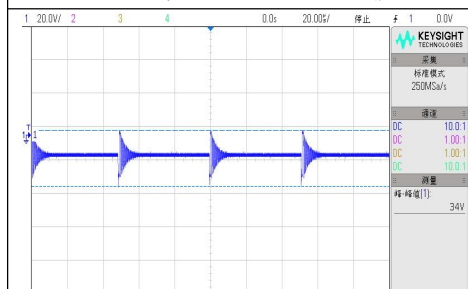
VIN=9V, D5 空载工作电压波形



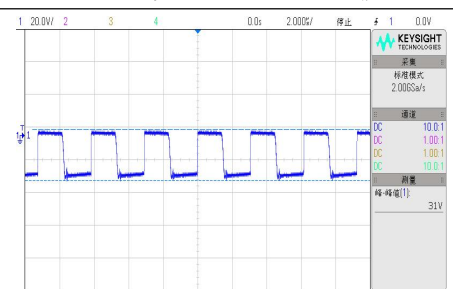
VIN=9V, D5 半载工作电压波形



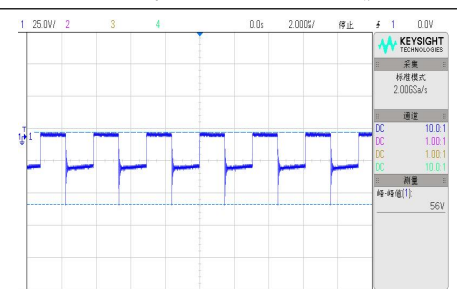
VIN=9V, D5 满载工作电压波形



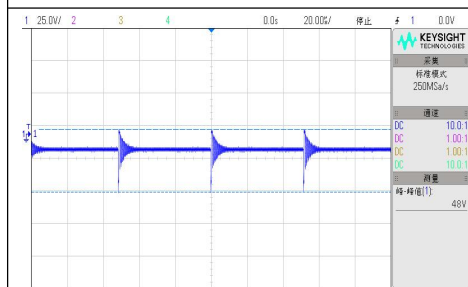
VIN=12V, D5 空载工作电压波形



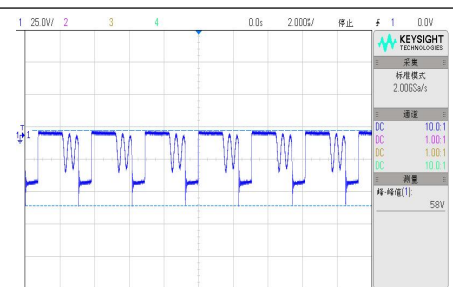
VIN=12V, D5 半载工作电压波形



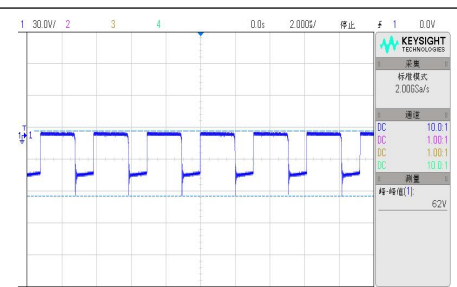
VIN=12V, D5 满载工作电压波形



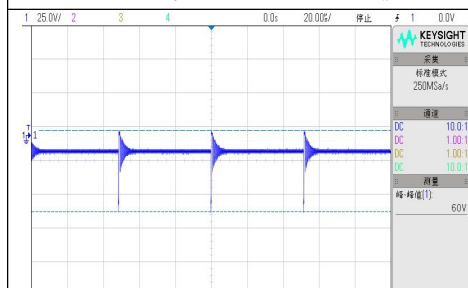
VIN=24V, D5 空载工作电压波形



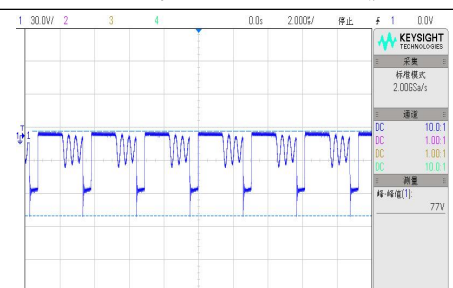
VIN=24V, D5 半载工作电压波形



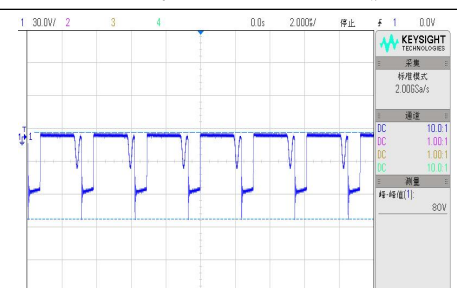
VIN=24V, D5 满载工作电压波形



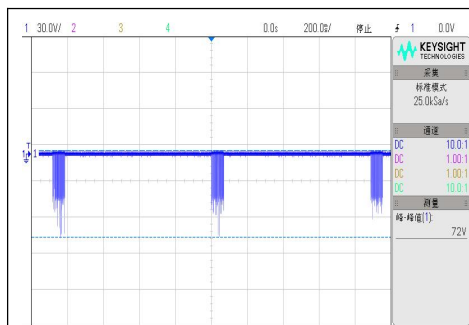
VIN=36V, D5 空载工作电压波形



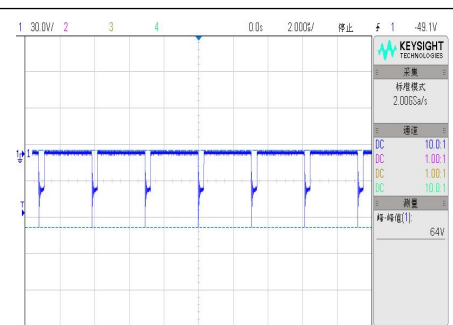
VIN=36V, D5 半载工作电压波形



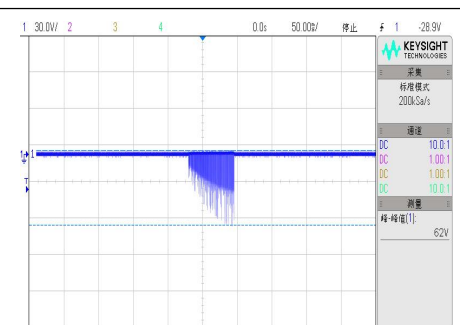
VIN=36V, D5 满载工作电压波形



VIN=36V, D5 短路保护工作电压波形



VIN=36V, D5 短路保护工作电压展开波形



VIN=36V, D5 短路保护 VDS 启机波形

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