

方案简介

本应用方案基于一款高集成度的峰值电流型反激电源控制器 VPC5021，结合隔离功率变压器 VPQ52PV-02B、输出整流二极管以及必要的阻容元件，实现 100V-500V 输入，24V 输出的隔离稳压电源方案。本方案可实现全输入电压范围最大功率 30W 的输出能力，原副边隔离耐压不小于 3000VDC，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）抗干扰目的相关场合。

关键词：输入：100V-500V，输出 24V/30W，隔离电压：3000VDC

反馈方式：副边反馈-SSR

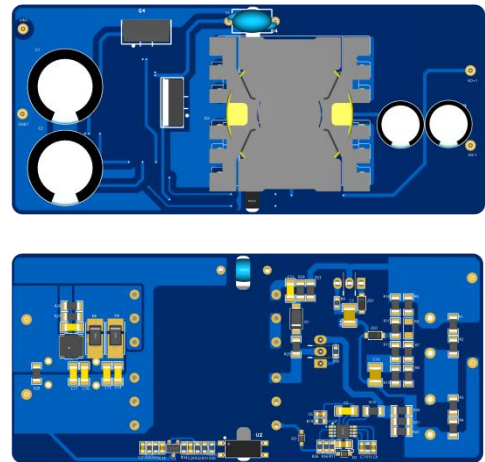
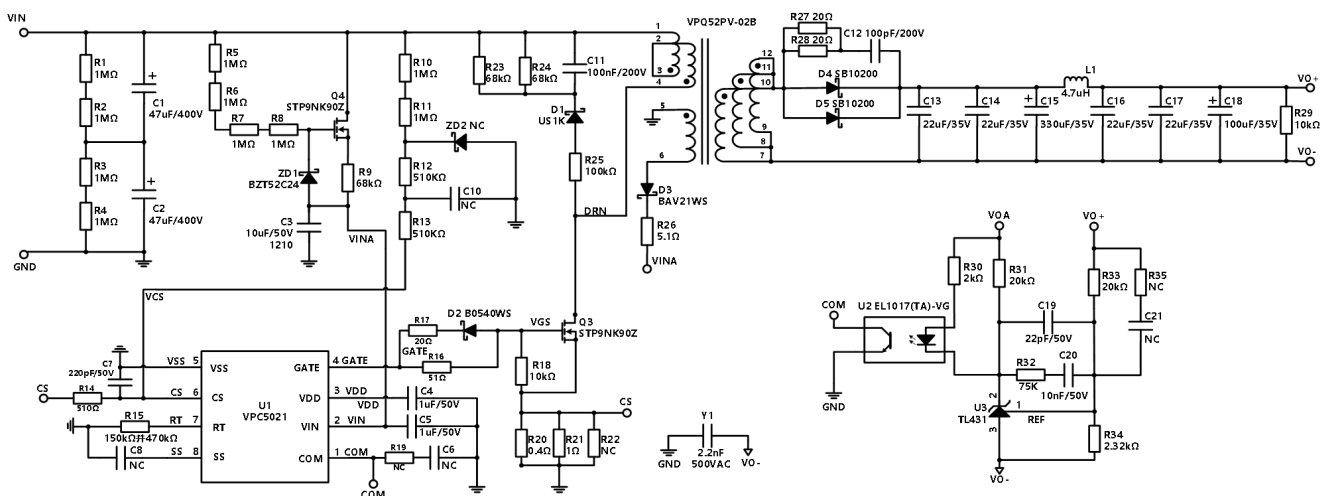


图 1: VPC5021 Demo 板(尺寸 102mm*45mm)

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

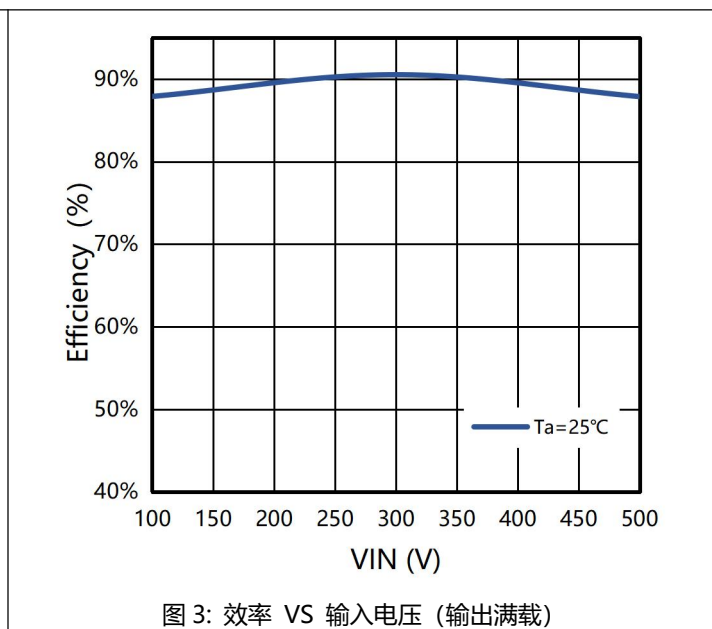
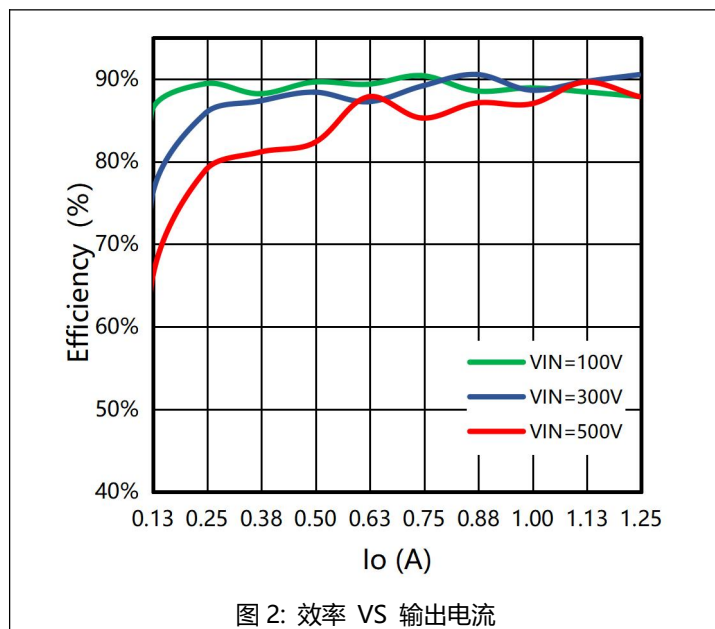
位号	参数	封装	型号	品牌
C1	47uF/400V	插件,D16xL20mm	400BXW47MEFR16X20	RUBYCON
C2	47uF/400V	插件,D16xL20mm	400BXW47MEFR16X20	RUBYCON
C3	10uF/50V	1210	CC1210ZKY5V9BB106	YAGEO
C4	1uF/50V	0805	CC0805KKX7R9BB105	YAGEO
C5	1uF/50V	1206	CC1206KKX7R9BB105	YAGEO
C6	NC	-	-	-
C7	220pF/50V-X7R	0603	CC0603KRX7R9BB221	YAGEO
C8	NC	-	-	-
C9	-	-	-	-
C10	NC	-	-	-
C11	100nF/200V	1206	CC1206KKX7RABB104	YAGEO
C12	100pF/200V	1206	CC1206JRNPOABN101	YAGEO
C13	22uF/35V	1206	C3216X5R1V226MTJ00E	TDK
C14	22uF/35V	1206	C3216X5R1V226MTJ00E	TDK
C15	330uF/35V	插件,D10xL12.5mm	35YXJ330M10X12.5	RUBYCON
C16	22uF/35V	1206	C3216X5R1V226MTJ00E	TDK
C17	22uF/35V	1206	C3216X5R1V226MTJ00E	TDK
C18	100uF/35V	插件,D6.3xL11mm	35ZLH100MEFC6.3X11	RUBYCON
C19	22pF/50V	0603	CC0603JRNPO9BN220	YAGEO
C20	10nF/50V	0603	CC0603KRX7R9BB103	YAGEO
C21	NC	-	-	-
Y1	2.2nF/500VAC	插件	DE1E3RA222MJ4BQ01F	muRata(村田)
R1	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R2	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R3	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R4	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R5	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R6	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R7	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R8	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R9	68kΩ±1%	0603	RC0603FR-0768KL	YAGEO
R10	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R11	1MΩ±1%	1206	RC1206FR-071ML	YAGEO
R12	510K±1%	1206	RC1206FR-07510KL	YAGEO
R13	510K±1%	1206	RC1206FR-07510KL	YAGEO
R14	510Ω±1%	1206	RC1206FR-07510RL	YAGEO
R15	150kΩ±1%并联 470kΩ±1%	0603	RC0603FR-07150KL RC0603FR-07470KL	YAGEO
R16	51Ω±1%	0603	RC0603FR-0751RL	YAGEO
R17	20Ω±1%	0603	RC0603FR-0720RL	YAGEO

R18	10k Ω ±1%	0603	RC0603FR-0710KL	YAGEO
R19	NC	-	-	-
R20	0.4 Ω ±1%	1206	RL1206FR-070R4L	YAGEO
R21	1 Ω ±1%	1206	RC1206FR-071RL	YAGEO
R22	NC	-	-	-
R23	68K Ω ±1%	1206	RC1206FR-0768KL	YAGEO
R24	68K Ω ±1%	1206	RC1206FR-0768KL	YAGEO
R25	100K Ω ±1%	1206	RC1206FR-07100KL	YAGEO
R26	5.1 Ω ±1%	0603	AC0603FR-075R1L	YAGEO
R27	20 Ω ±1%	1206	RC1206FR-0720RL	YAGEO
R28	20 Ω ±1%	1206	RC1206FR-0720RL	YAGEO
R29	10K Ω ±1%	1206	RC1206FR-0710KL	YAGEO
R30	2K Ω ±1%	0603	RC0603FR-072KL	YAGEO
R31	20K Ω ±1%	0603	RC0603FR-0720KL	YAGEO
R32	75K Ω ±1%	0603	RC0603FR-0775KL	YAGEO
R33	20K Ω ±1%	0603	RC0603FR-0720KL	YAGEO
R34	2.32K Ω ±1%	0603	RC0603FR-072K32L	YAGEO
R35	NC	-	-	-
TR1	NP:NS:NA=100:20:10 Lp=1000uH	PQ3230	VPQ52PV-02B	VPSC
L1	4.7uH/5.5A ±20%	SMD	SWPA5040S4R7NT	SUNLORD
D1	800V/1A	SMA	US1K	晶导微电子
D2	40V/0.5A	SOD-323	B0540WS	YANGJIE
D3	200V/0.2A	SOD-323	BAV21WS	YANGJIE
D4	200V/10A	TO-277	SB10200	GOODWORK
D5	200V/10A	TO-277	SB10200	GOODWORK
ZD1	24V/350mW	SOD-123	BZT52C24	CJ
ZD2	NC	-	-	-
Q3	N 沟道 900V/8A	TO-220-3	STP9NK90Z	ST
Q4	N 沟道 900V/8A	TO-220-3	STP9NK90Z	ST
U1	峰值电流模式 PWM 控制器	ESOP-8	VPC5021	VPSC
U2	CTR=80~160, Viso=5000VAC	SOP-4-2.54mm	EL1017(TA)-VG	EVERLIGHT
U3	Vref=2.495V	SOT23-3	CJ431	CJ

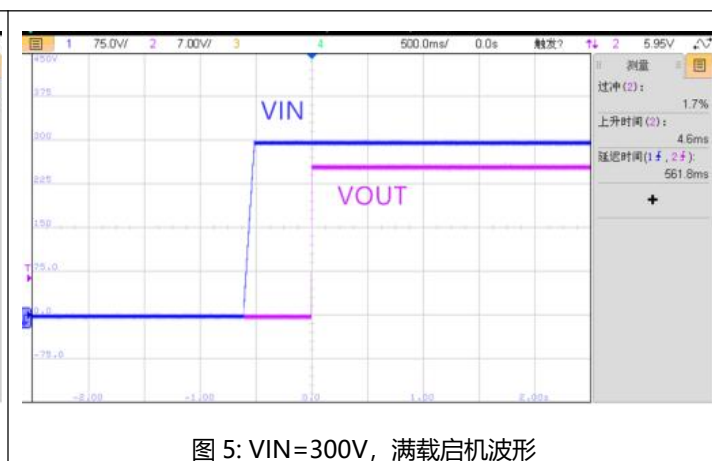
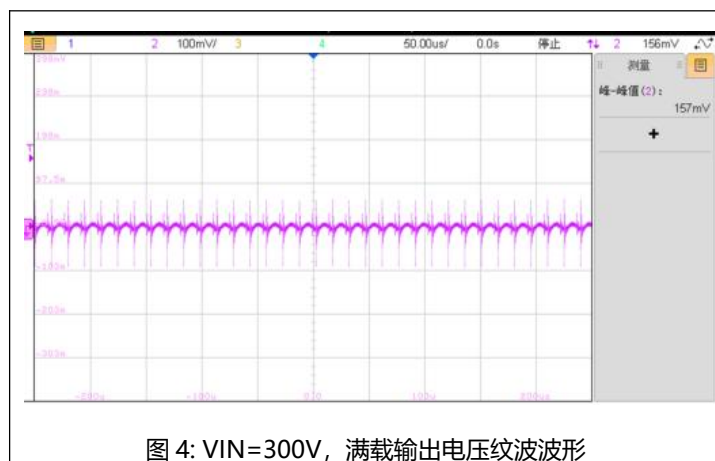
总体性能一览表

性能指标	测试条件	Min	Typ	Max	Unit
输入电流（满载/空载）	VIN=300V	1	---	110	mA
转换效率	VIN=300V, IO=1.25A	---	90.5	---	%
纹波&噪声	VIN=300V, IO=1.25A	---	157	180	mV
输出电压精度	VIN=300V, IO=1.25A	---	0.33	---	%
线性调节率	VIN=100V-500V, IO=1.25A	---	0	---	%
负载调整率	VIN=300V, IO=1.25A	---	0.21	---	%
短路保护	VIN=100V-500V	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	3000	---	---	VDC

关键性能指标测试结果

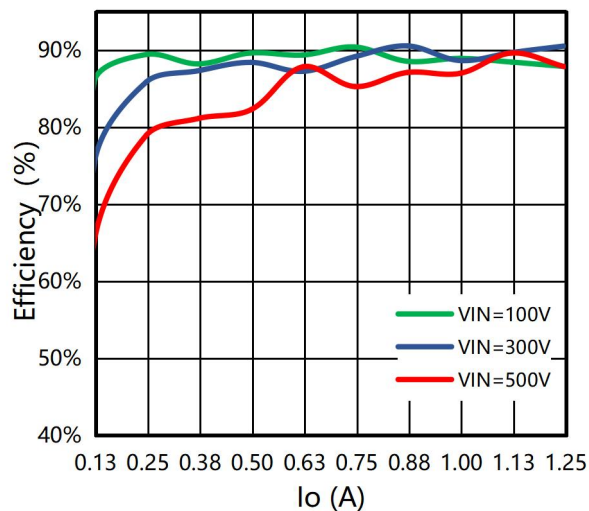


相关波形

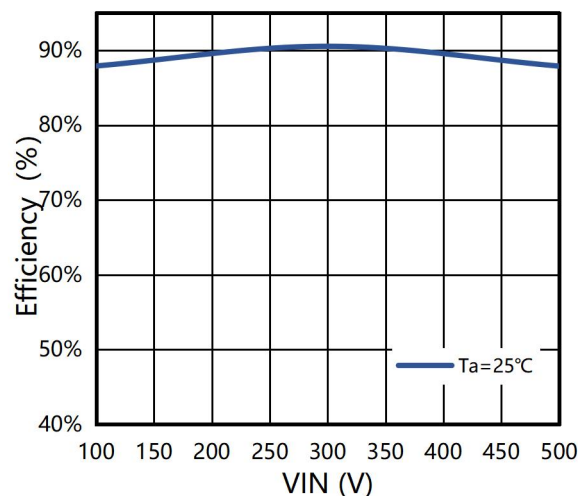


详细测试数据

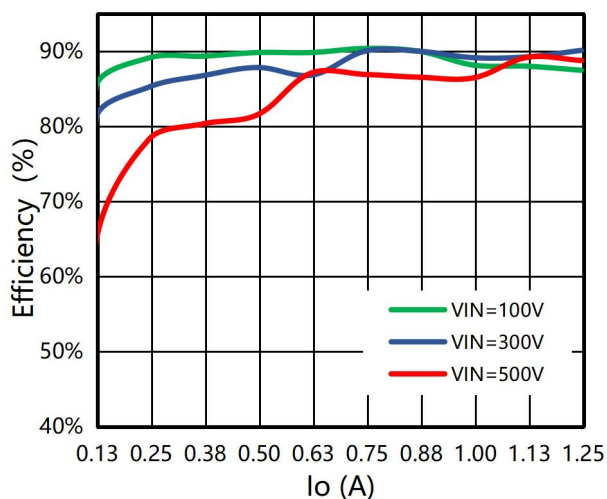
高低温测试曲线



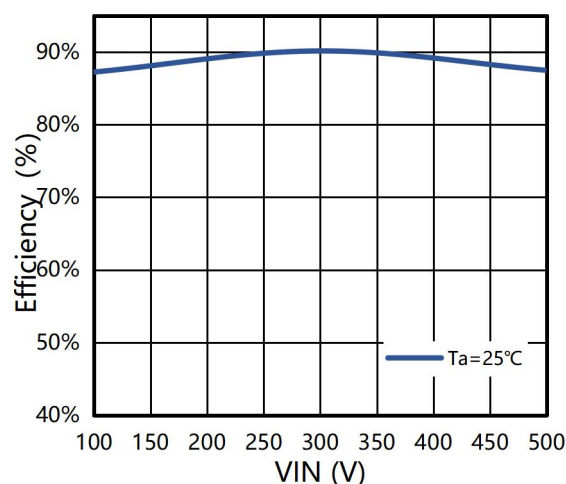
效率 VS 输出电流 (25°C)



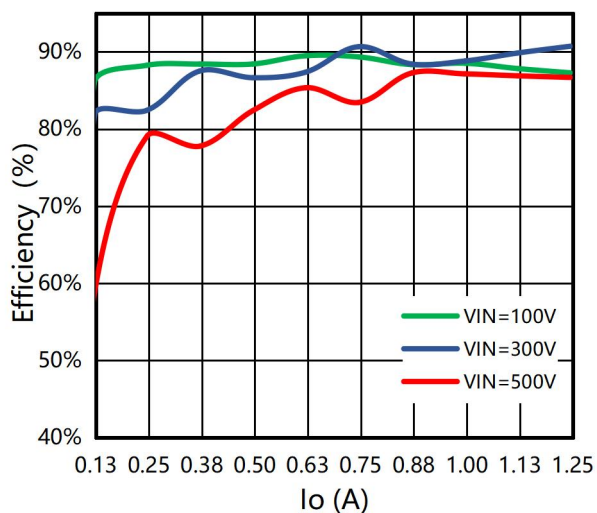
效率 VS 输入电压 (输出满载@25°C)



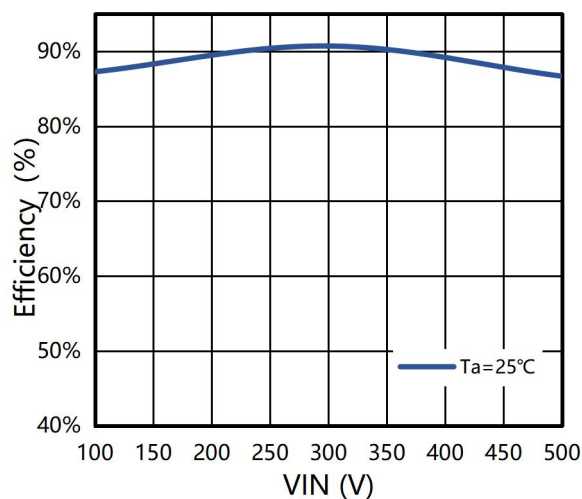
效率 VS 输出电流 (-40°C)



效率 VS 输入电压 (输出满载@-40°C)



效率 VS 输出电流 (85°C)



效率 VS 输入电压 (输出满载@85°C)

VIN=300V, Ta=25℃, 输入、输出及效率数据:

VIN(V)	IIN(A)	VO(V)	IO(A)	IO-max%	η(%)
299.8	0.001	24.09	0	0%	0%
299.8	0.013	24.08	0.122	10%	75.4%
299.8	0.023	24.07	0.246	20%	85.9%
299.8	0.034	24.06	0.370	30%	87.3%
299.8	0.045	24.05	0.496	40%	88.4%
299.8	0.057	24.05	0.620	50%	87.3%
299.8	0.067	24.04	0.745	60%	89.2%
299.8	0.077	24.03	0.870	70%	90.6%
299.8	0.09	24.02	0.996	80%	88.7%
299.8	0.1	24.01	1.120	90%	89.7%
299.8	0.11	24.00	1.244	100%	90.5%

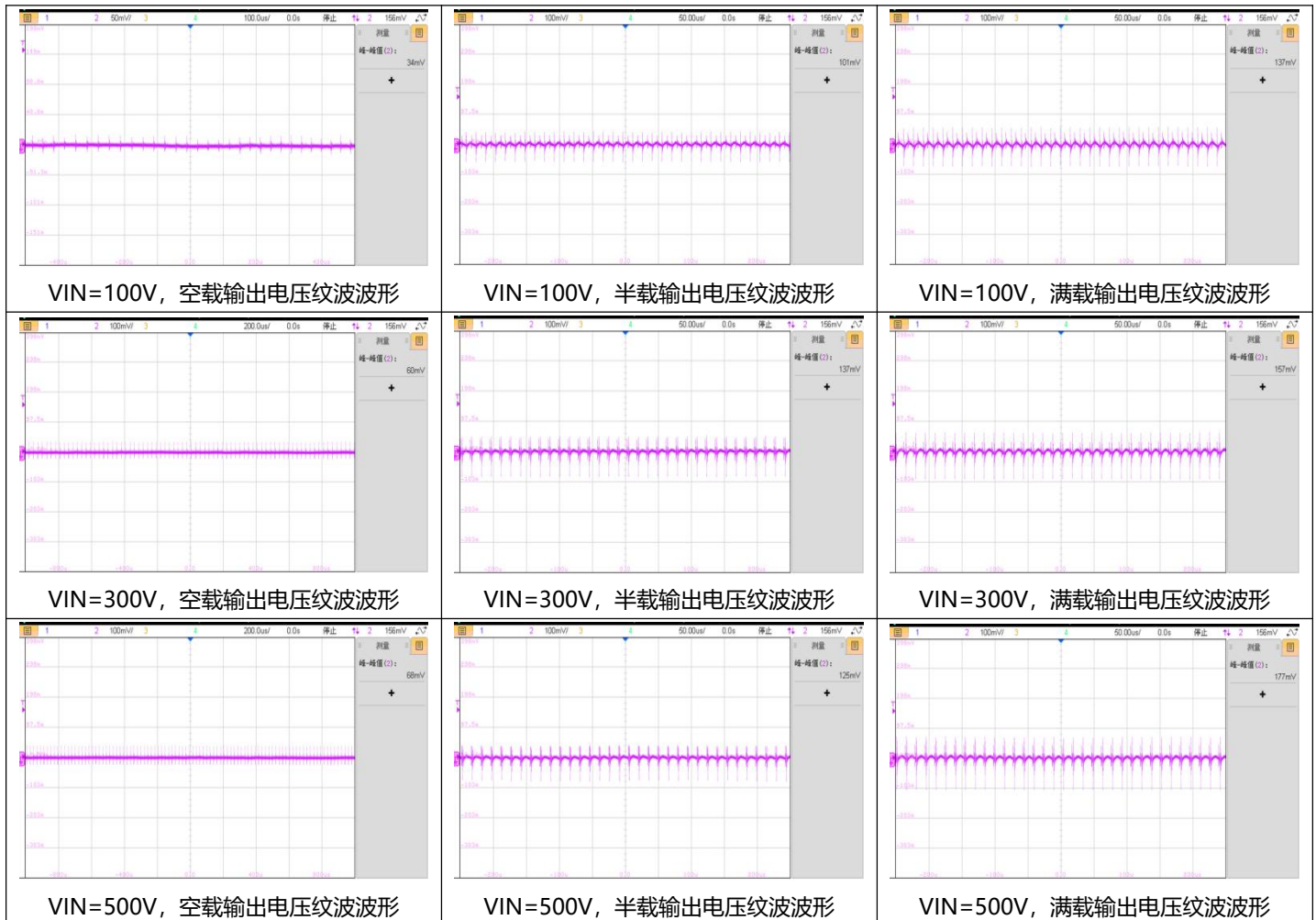
VIN=300V, Ta=-40℃, 输入、输出及效率数据:

VIN(V)	IIN(A)	VO(V)	IO(A)	IO-max%	η(%)
299.8	0.001	23.91	0	0%	0%
299.7	0.012	23.90	0.122	10%	81.1%
299.7	0.023	23.90	0.246	20%	85.3%
299.7	0.034	23.90	0.370	30%	86.8%
299.7	0.045	23.89	0.496	40%	87.9%
299.7	0.057	23.89	0.621	50%	86.9%
299.7	0.066	23.88	0.746	60%	90.1%
299.7	0.077	23.88	0.870	70%	90.0%
299.7	0.089	23.88	0.996	80%	89.2%
299.7	0.100	23.87	1.121	90%	89.3%
299.7	0.110	23.87	1.245	100%	90.2%

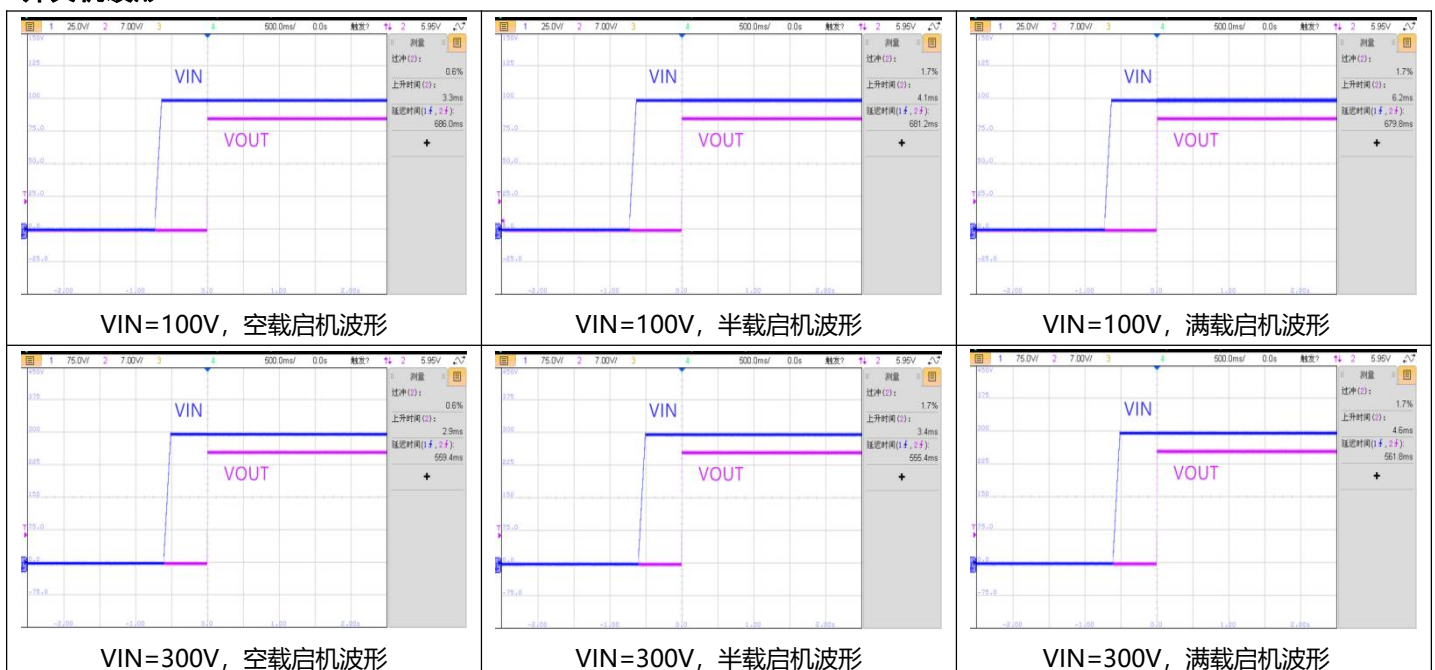
VIN=300V, Ta=85℃, 输入、输出及效率数据:

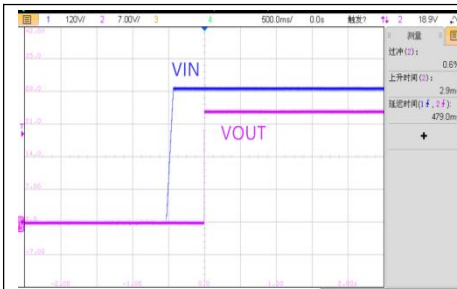
VIN(V)	IIN(A)	VO(V)	IO(A)	IO-max%	η(%)
299.8	0.001	24.13	0	0%	0%
299.8	0.012	24.12	0.122	10%	81.8%
299.8	0.024	24.11	0.246	20%	82.4%
299.8	0.034	24.11	0.370	30%	87.5%
299.8	0.046	24.09	0.496	40%	86.6%
299.8	0.057	24.08	0.620	50%	87.4%
299.8	0.066	24.08	0.745	60%	90.7%
299.8	0.079	24.07	0.870	70%	88.4%
299.8	0.090	24.06	0.996	80%	88.8%
299.8	0.100	24.05	1.120	90%	89.9%
299.8	0.110	24.05	1.244	100%	90.7%

输出电压纹波波形

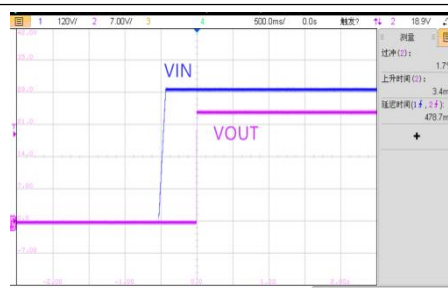


开关机波形

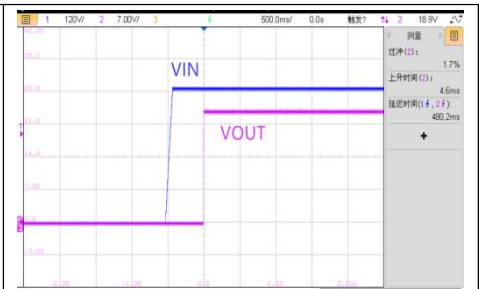




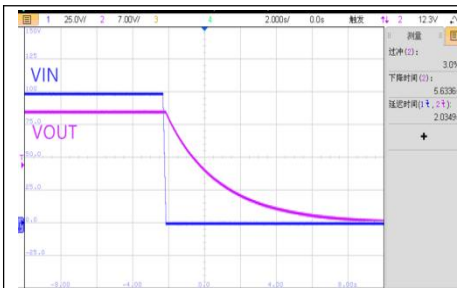
VIN=500V, 空载启机波形



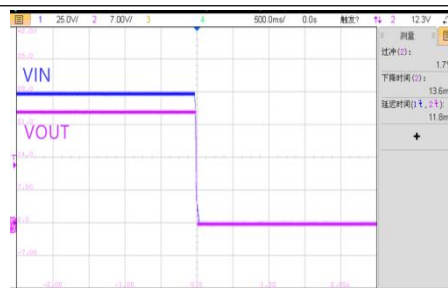
VIN=500V, 半载启机波形



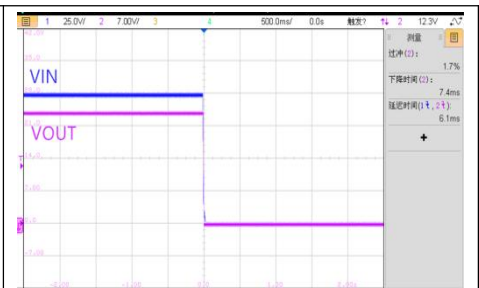
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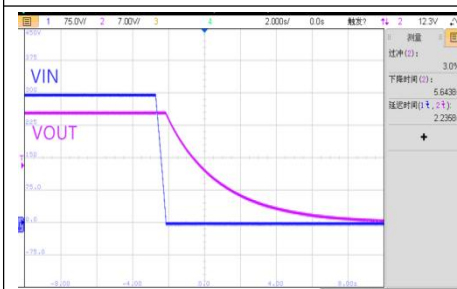
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VIN=100V, 半载关机波形



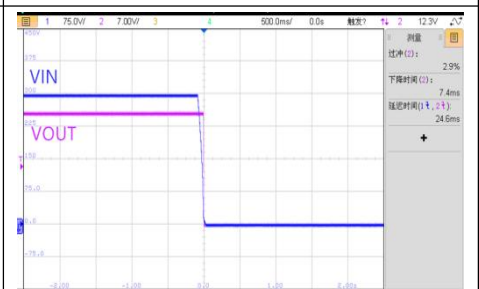
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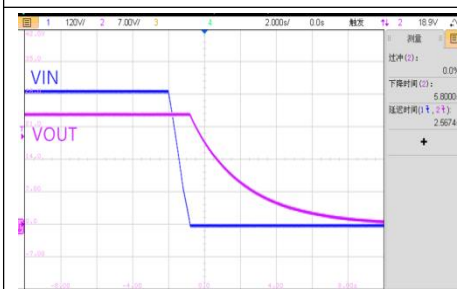
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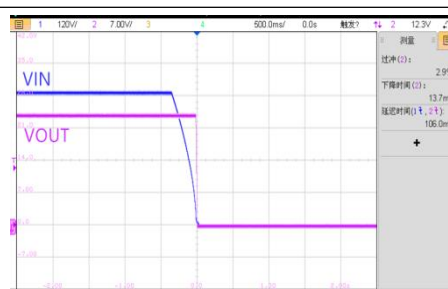
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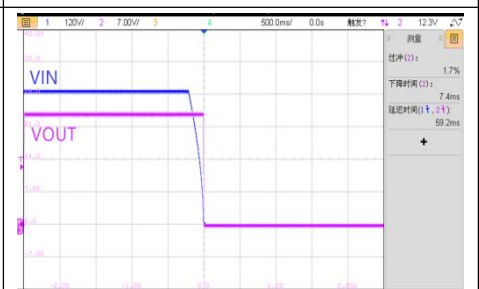
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VIN=500V, 空载关机波形

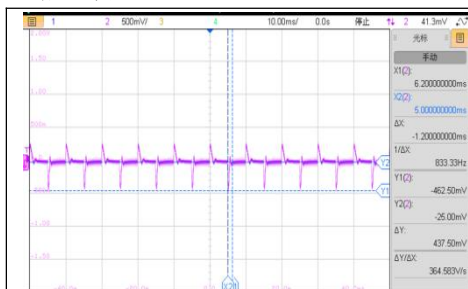


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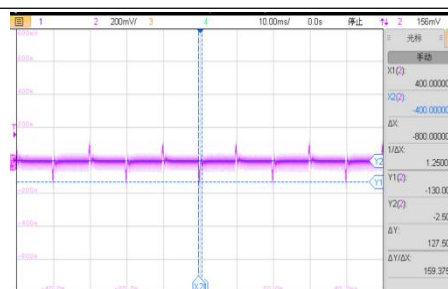


VIN=500V, 满载关机波形

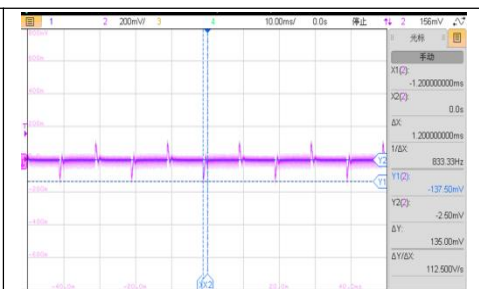
动态波形



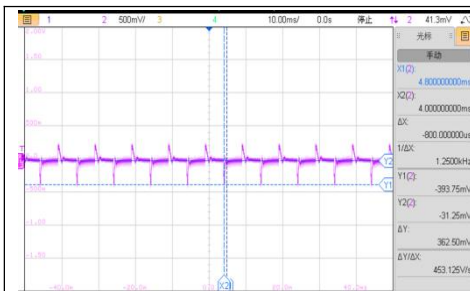
VIN=100V, 100%-10%-100%Io 动态波形



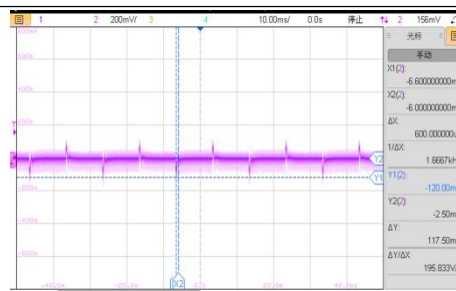
VIN=100V, 75%-50%-75%Io 动态波形



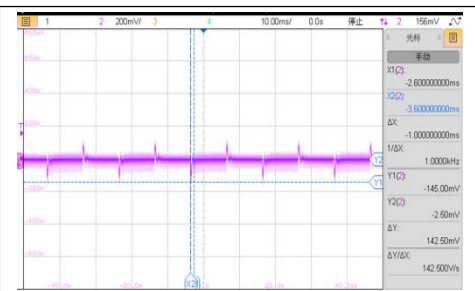
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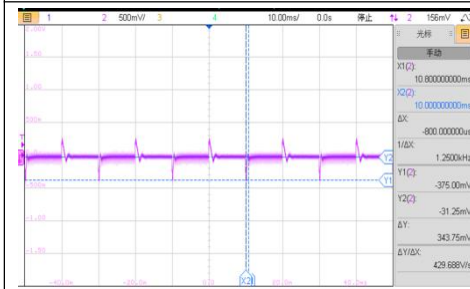
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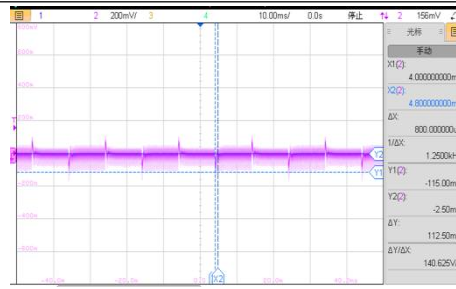
VIN=300V, 75%-50%-75%Io 动态波形



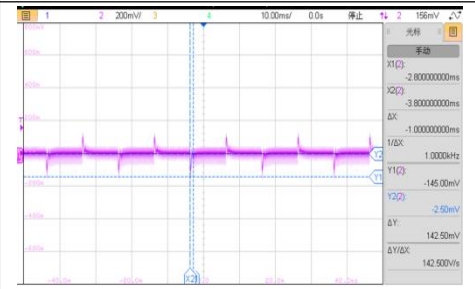
VIN=300V, 50%-25%-50%Io 动态波形



VIN=500V, 100%-10%-100%Io 动态波形

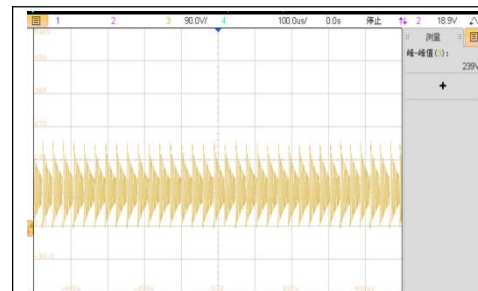


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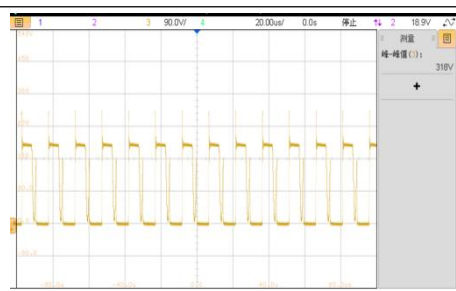


VIN=500V, 50%-25%-50%Io 动态波形

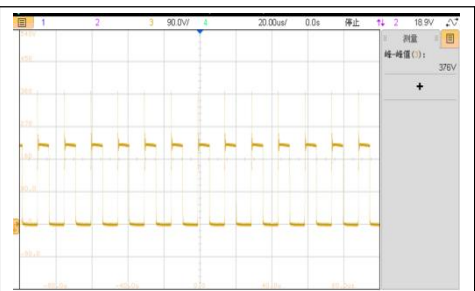
MOS 管 Q3 应力波形



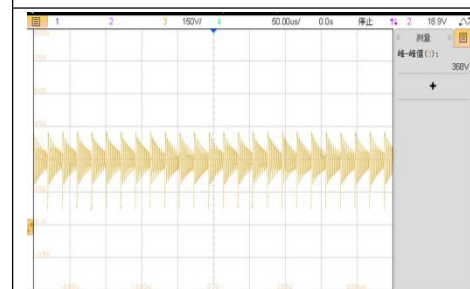
VIN=100V, 空载 VDS 波形



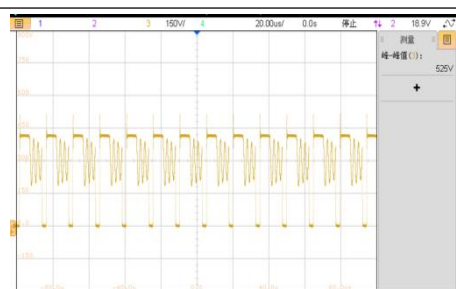
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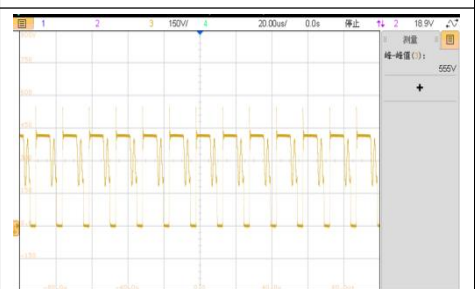
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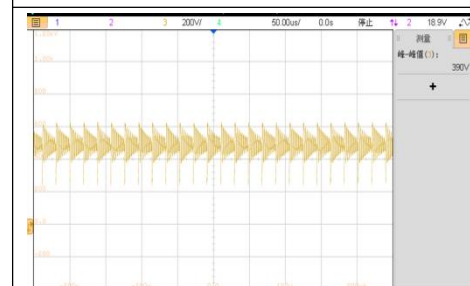
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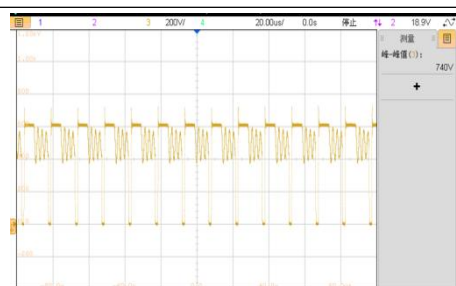
VIN=300V, 半载 VDS 波形



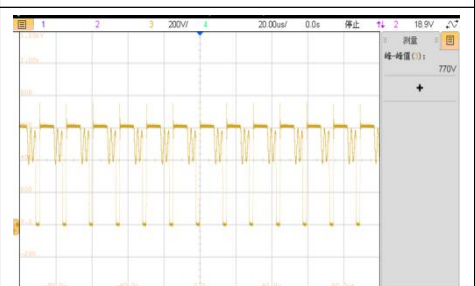
VIN=300V, 满载 VDS 波形



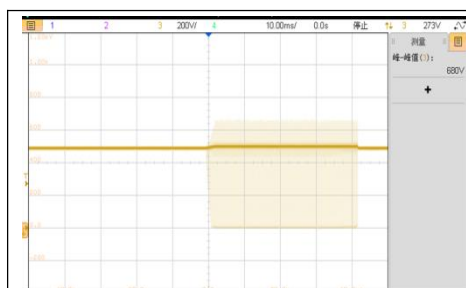
VIN=500V, 空载 VDS 波形



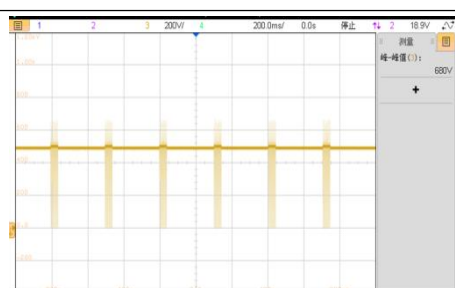
VIN=500V, 半载 VDS 波形



VIN=500V, 满载 VDS 波形

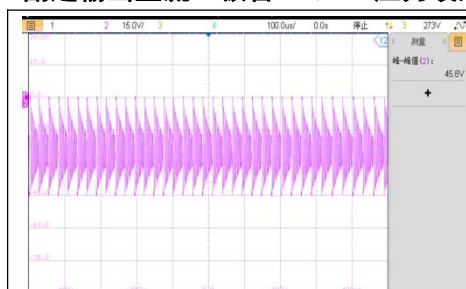


VIN=500V, 满载短路启机 VDS 波形

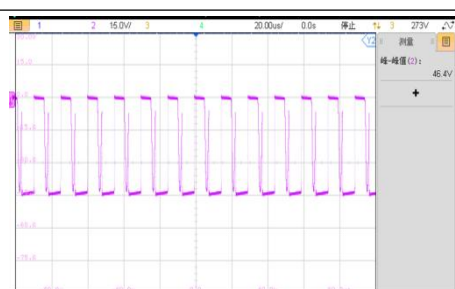


VIN=500V, 短路保护 VDS 波形

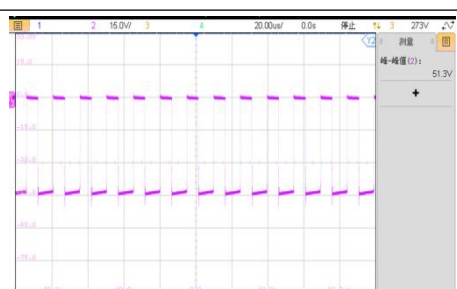
副边输出整流二极管 D4、D5 应力波形



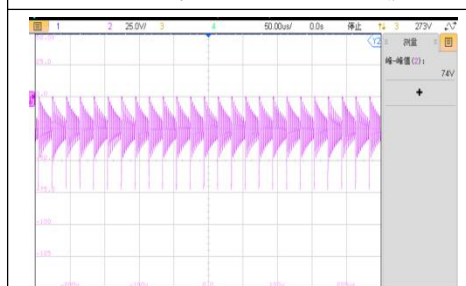
VIN=100V, D4 空载工作电压波形



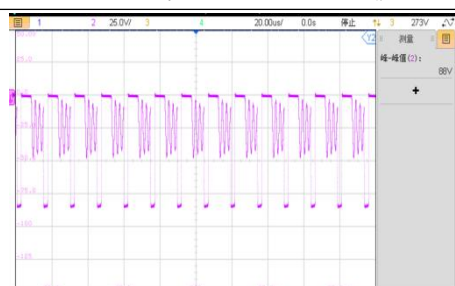
VIN=100V, D4 半载工作电压波形



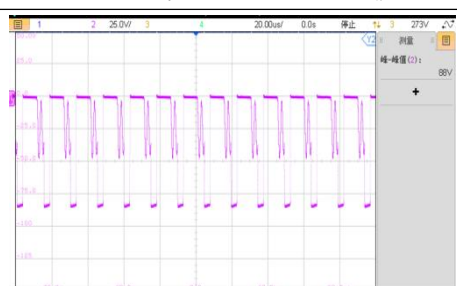
VIN=100V, D4 满载工作电压波形



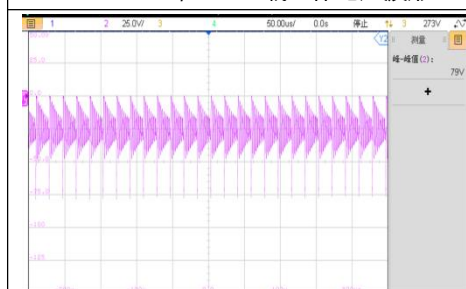
VIN=300V, D4 空载工作电压波形



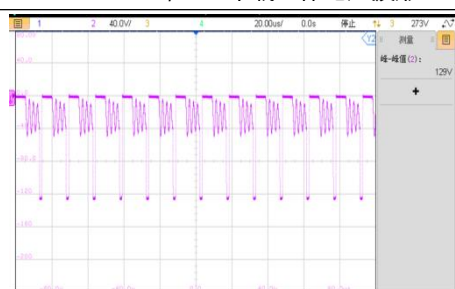
VIN=300V, D4 半载工作电压波形



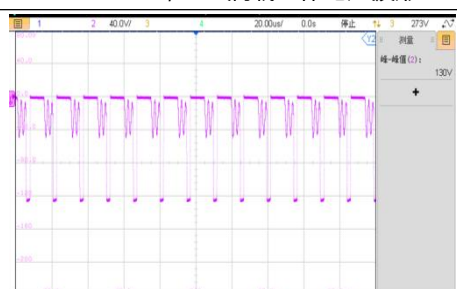
VIN=300V, D4 满载工作电压波形



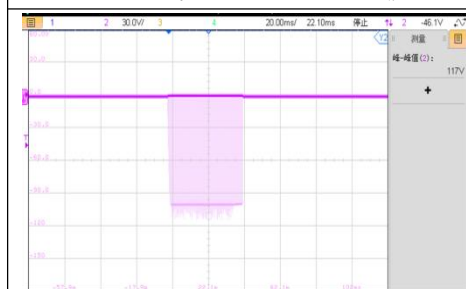
VIN=500V, D4 空载工作电压波形



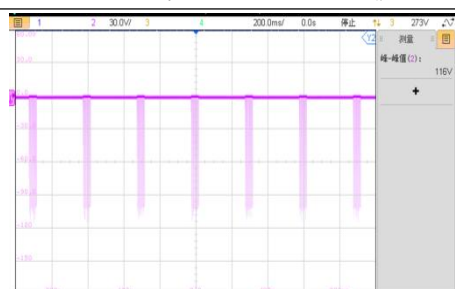
VIN=500V, D4 半载工作电压波形



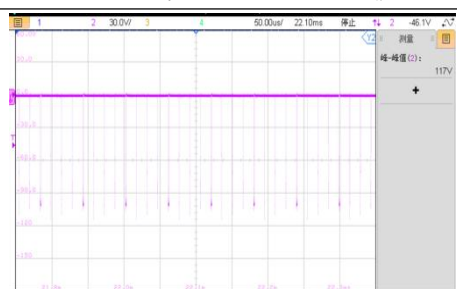
VIN=500V, D4 满载工作电压波形



VIN=500V, 满载短路启机 VDS 波形



VIN=500V, D4 短路保护工作电压波形



VIN=500V, D4 短路保护工作电压展开波形

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