

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 VPE52RD-15A、输出整流二极管以及必要的阻容元件，实现 40V-160V 输入，12V 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 15W 的输出能力，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。

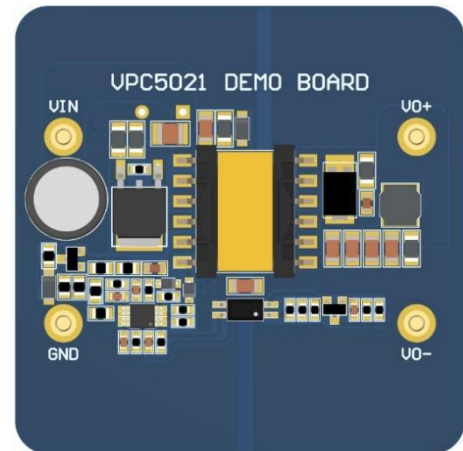
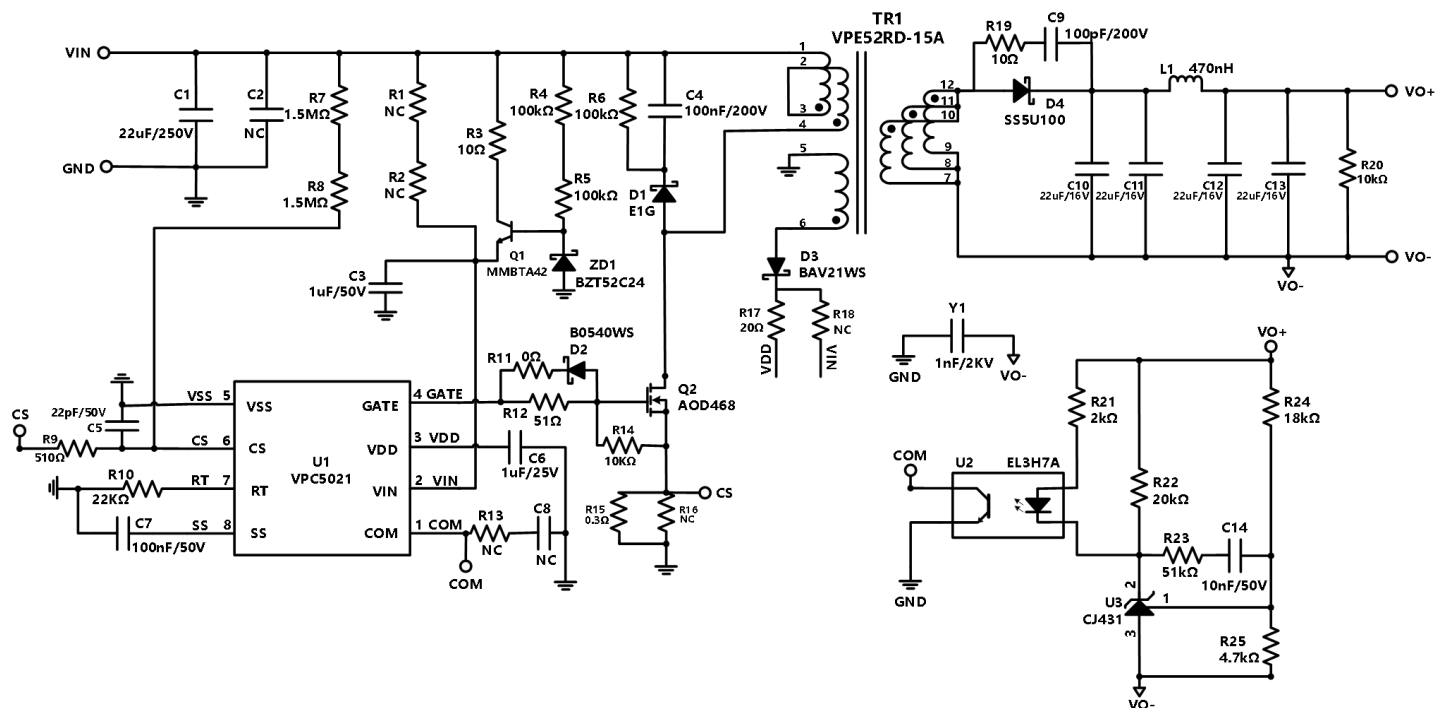


图 1: VPC5021 Demo 板(尺寸:55mm*55mm)

关键词：输入：40V-160V，输出 12V/15W，隔离电压：1500VDC，反馈方式：副边反馈-SSR

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

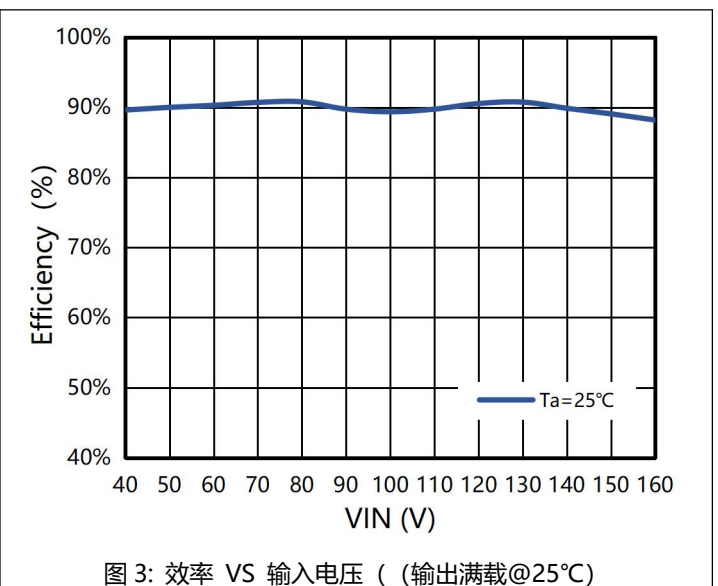
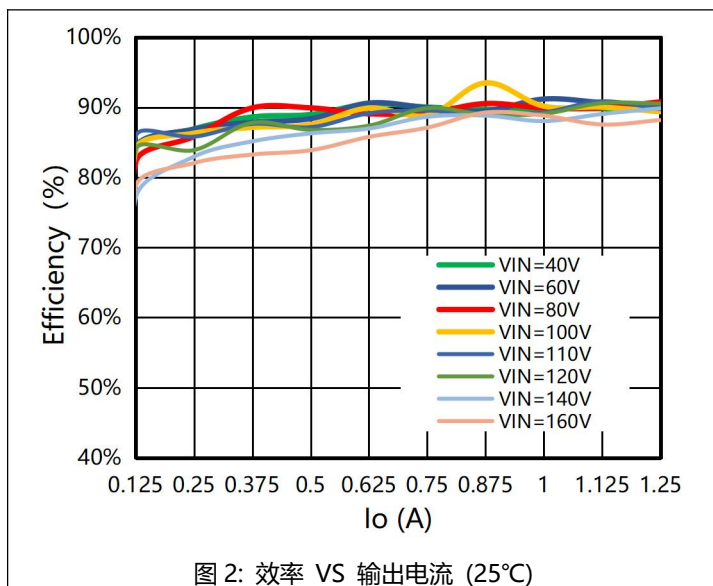
位号	参数	封装	型号	品牌
C1	22uF/250V	Φ10*16mm	250BXC22MEFC10X16	RUBYCON
C2	NC	-	-	-
C3	1uF/50V-X7R	0805	CC0805KKX7R9BB105	YAGEO
C4	100nF/200V-X7R	1206	CC1206KKX7RABB104	YAGEO
C5	22pF/50V-NP0	0603	CC0603JRNPO9BN220	YAGEO
C6	1uF/25V-X7R	0603	CC0603KRX7R8BB105	YAGEO
C7	100nF/50V-X7R	0603	CC0603KRX7R9BB104	YAGEO
C8	NC	-	-	-
C9	100pF/200V-NP0	0805	CC0805JRNPOABN101	YAGEO
C10	22uF/16V-X5R	1206	CC1206KKX5R7BB226	YAGEO
C11	22uF/16V-X5R	1206	CC1206KKX5R7BB226	YAGEO
C12	22uF/16V-X5R	1206	CC1206KKX5R7BB226	YAGEO
C13	22uF/16V-X5R	1206	CC1206KKX5R7BB226	YAGEO
C14	10nF/50V-X7R	0603	CC0603KRX7R9BB103	YAGEO
Y1	1nF/2KV-X7R	1206	CC1206KKX7RDBB102	YAGEO
R1	NC	-	-	-
R2	NC	-	-	-
R3	10Ω±1%	0805	RC0805FR-0710RL	YAGEO
R4	100KΩ±1%	0805	RC0805FR-07100KL	YAGEO
R5	100KΩ±1%	0805	RC0805FR-07100KL	YAGEO
R6	100KΩ±1%	1206	RC1206FR-07100KL	YAGEO
R7	1.5MΩ±1%	0805	RC0805FR-071M5L	YAGEO
R8	1.5MΩ±1%	0805	RC0805FR-071M5L	YAGEO
R9	510Ω±1%	0603	RC0603FR-07510RL	YAGEO
R10	22KΩ±1%	0603	RC0603FR-0722KL	YAGEO
R11	0Ω±1%	0603	RC0603FR-070RL	YAGEO
R12	51Ω±1%	0603	RC0603FR-0751RL	YAGEO
R13	NC	-	-	-
R14	10KΩ±1%	0603	RC0603FR-0710KL	YAGEO
R15	0.3Ω±1%	1206	PE1206FRF070R3L	YAGEO
R16	NC	-	-	-
R17	20Ω±1%	0603	RC0603FR-0720RL	YAGEO
R18	NC	-	-	-
R19	10Ω±1%	1206	RC1206FR-0710RL	YAGEO
R20	10KΩ±1%	1206	RC1206FR-0710KL	YAGEO
R21	2KΩ±1%	0603	RC0603FR-072KL	YAGEO
R22	20KΩ±1%	0603	RC0603FR-0720KL	YAGEO
R23	51KΩ±1%	0603	RC0603FR-0751KL	YAGEO
R24	18KΩ±1%	0603	RC0603FR-0718KL	YAGEO
R25	4.7KΩ±1%	0603	RC0603FR-074K7L	YAGEO

TR1	NP:NS:NA=24:6:6 Lp=80.64uH	ER14.5	VPE52RD-15A	VPSC
L1	470nH/4.6A ±30%	SWPA5020	SWPA5020SR47NT	SUNLORD
D1	400V/1A	SOD-123FL	E1G	YANGJIE
D2	40V/0.5A	SOD-323	B0540WS	YANGJIE
D3	200V/0.2A	SOD-323	BAV21WS	YANGJIE
D4	100V/5A	TO-277	SS5U100	YANGJIE
ZD1	24V/350mW	SOD-123	BZT52C24	CJ
Q1	NPN 300V/0.3A 1D 100~200	SOT23-3	MMBTA42	CJ
Q2	N 沟道 300V/11.5A	TO-252	AOD468	AOS
U1	峰值电流模式 PWM 控制器	ESOP-8	VPC5021	VPSC
U2	CTR=80~160, Viso=3750VAC	SSOP-4	EL3H7A	EVERLIGHT
U3	Vref=2.495V	SOT23-3	CJ431	CJ

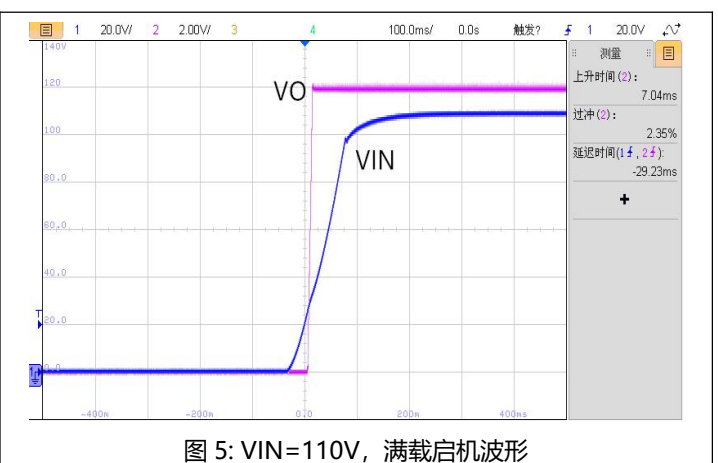
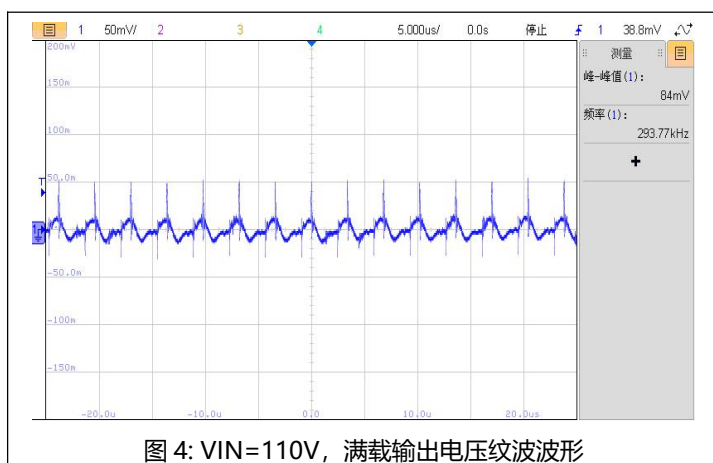
总体性能一览表

性能指标	测试条件	Min	Typ	Max	Unit
输入电流 (满载/空载)	VIN=110V	3	---	153	mA
转换效率	VIN=110V, IO=1.25A	---	89.7	---	%
纹波&噪声	VIN=110V, IO=1.25A	---	80	130	mV
输出电压精度	VIN=110V, IO=1.25A	---	0.6	---	%
线性调节率	VIN=40V-160V, IO=1.25A	---	0	---	%
负载调整率	VIN=110V, IO=1.25A	---	0	---	%
短路保护	VIN=40V-160V	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

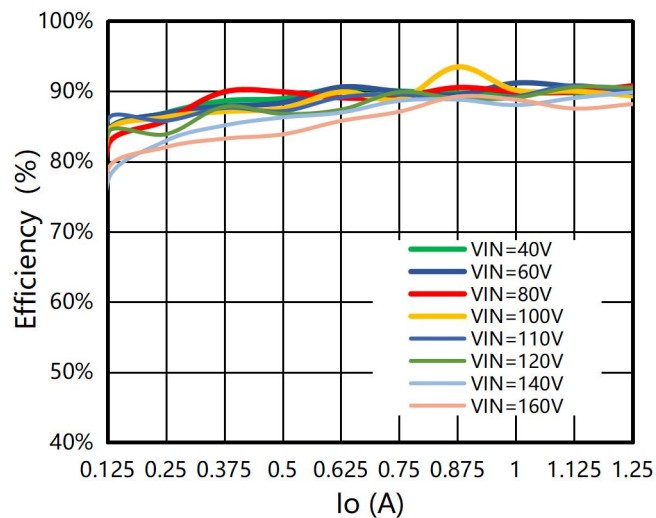


相关波形

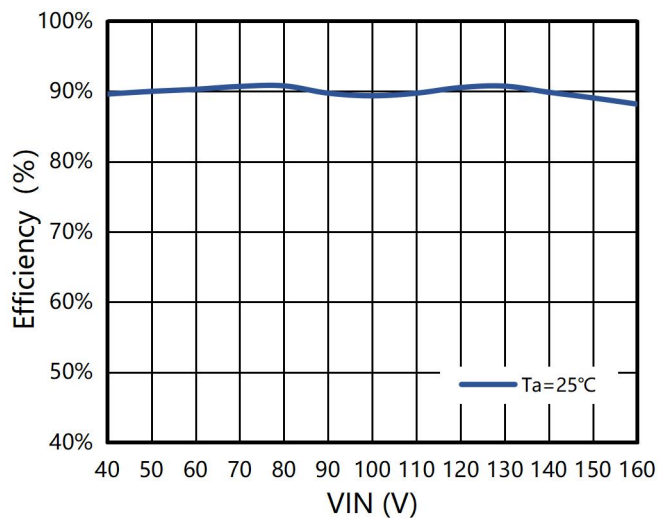


详细测试数据

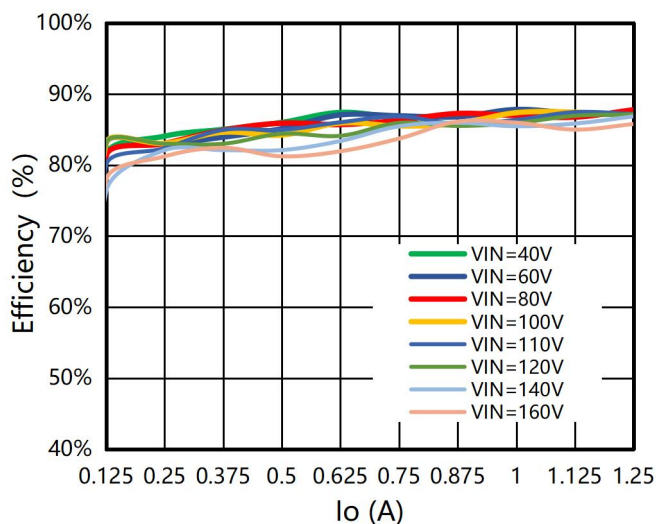
高低温测试曲线



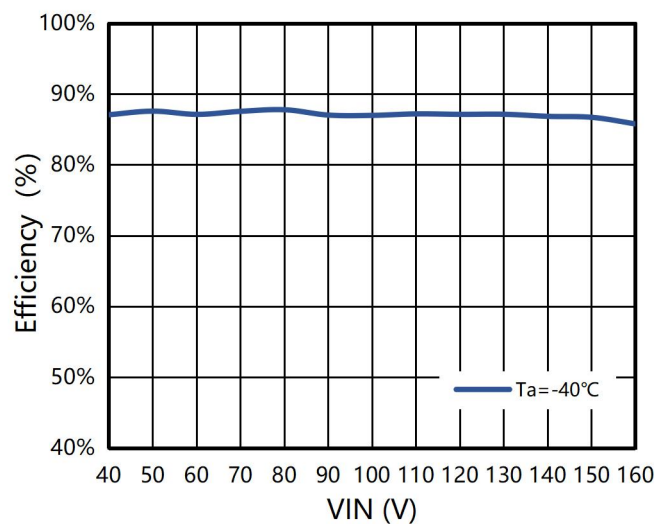
效率 VS 输出电流 (25°C)



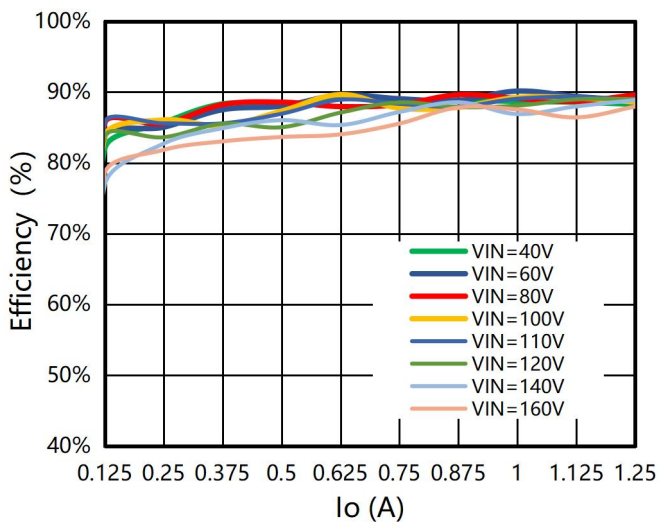
效率 VS 输入电压 (输出满载@25°C)



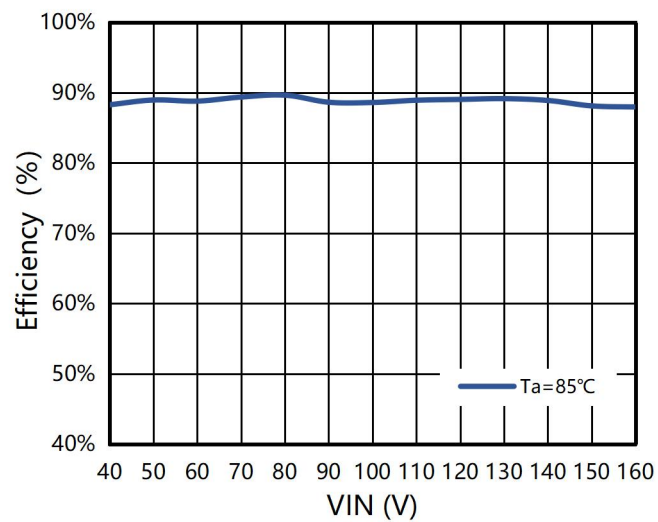
效率 VS 输出电流 (-40°C)



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=110V, Ta=25°C, 输入、输出及效率数据:

VIN(V)	IIN(A)	VO(V)	IO(A)	IO-max%	η(%)
109.9	0.003	12.07	0	0%	0.00%
109.9	0.016	12.07	0.125	10%	85.80%
109.9	0.032	12.07	0.250	20%	85.80%
109.9	0.047	12.07	0.375	30%	87.63%
109.9	0.063	12.07	0.500	40%	87.16%
109.9	0.077	12.07	0.625	50%	89.15%
109.9	0.092	12.07	0.750	60%	89.53%
109.9	0.108	12.07	0.875	70%	88.98%
109.9	0.123	12.07	1.000	80%	89.29%
109.9	0.136	12.07	1.125	90%	90.85%
109.9	0.153	12.07	1.250	100%	89.73%

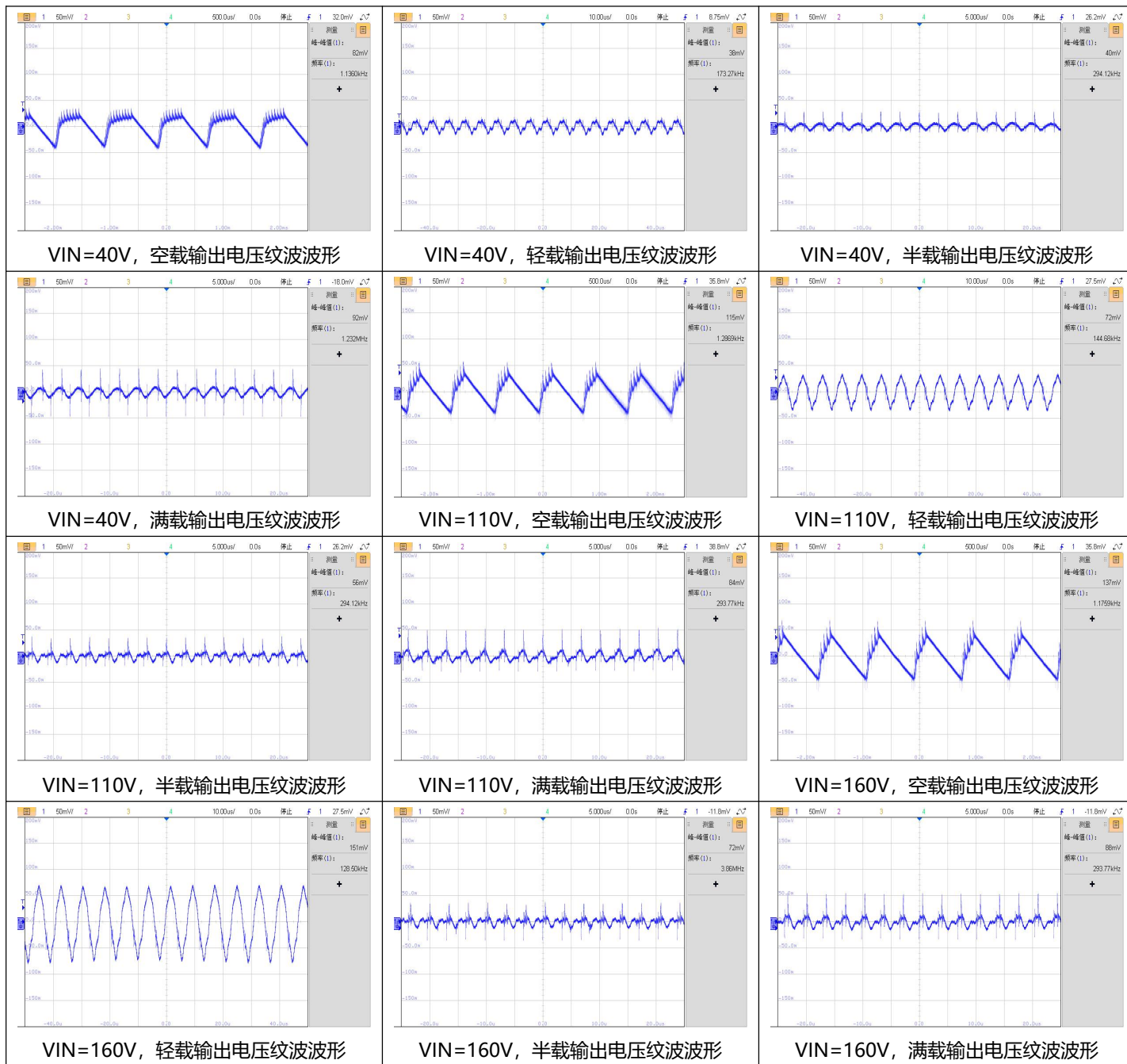
VIN=110V, Ta=-40°C, 输入、输出及效率数据:

VIN(V)	IIN(A)	VO(V)	IO(A)	IO-max%	η(%)
110.1	0.003	11.97	0	0%	0.00%
110.1	0.017	11.97	0.125	10%	79.94%
110.1	0.033	11.97	0.250	20%	82.36%
110.1	0.048	11.97	0.375	30%	84.94%
110.1	0.064	11.97	0.500	40%	84.94%
110.1	0.079	11.97	0.625	50%	86.01%
110.1	0.094	11.98	0.750	60%	86.82%
110.1	0.111	11.98	0.875	70%	85.77%
110.1	0.126	11.98	1.000	80%	86.36%
110.1	0.140	11.98	1.125	90%	87.44%
110.1	0.156	11.98	1.250	100%	87.19%

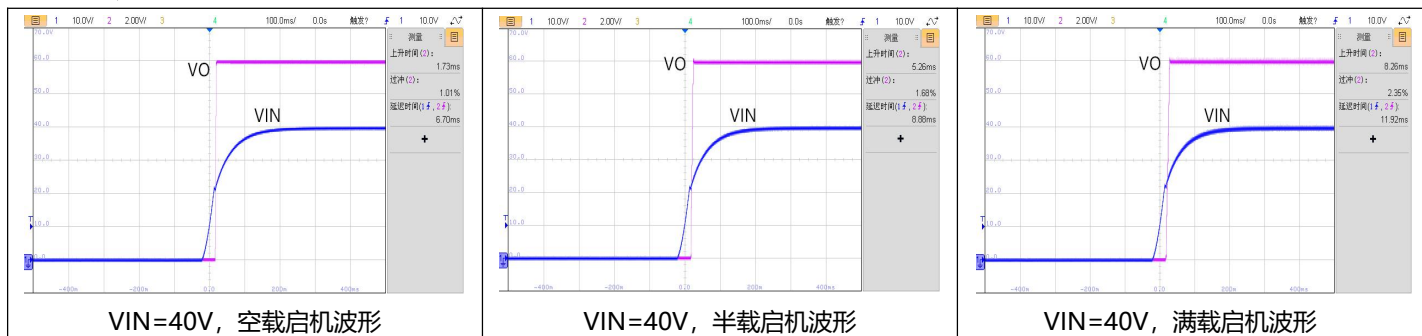
VIN=110V, Ta=85°C, 输入、输出及效率数据:

VIN(V)	IIN(A)	VO(V)	IO(A)	IO-max%	η(%)
110.1	0.003	12.06	0	0%	0.00%
110.1	0.016	12.06	0.125	10%	85.58%
110.1	0.032	12.06	0.250	20%	85.58%
110.1	0.048	12.06	0.375	30%	85.58%
110.1	0.063	12.06	0.500	40%	86.93%
110.1	0.077	12.06	0.625	50%	88.91%
110.1	0.093	12.06	0.750	60%	88.34%
110.1	0.109	12.06	0.875	70%	87.93%
110.1	0.123	12.06	1.000	80%	89.05%
110.1	0.138	12.06	1.125	90%	89.30%
110.1	0.154	12.06	1.250	100%	88.91%

输出电压纹波波形



开关机波形





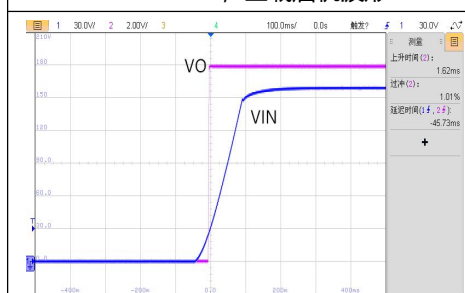
VIN=110V, 空载启机波形



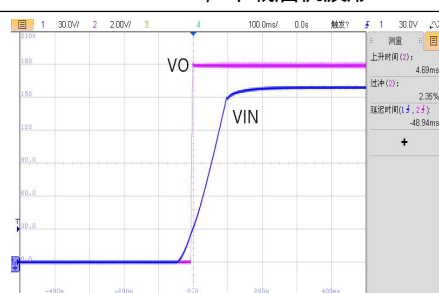
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VIN=110V, 满载启机波形



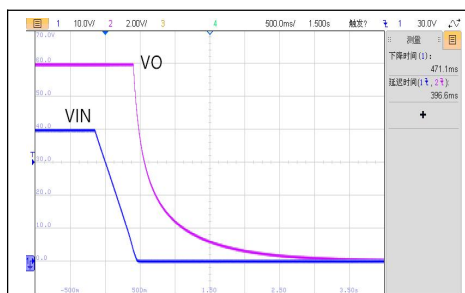
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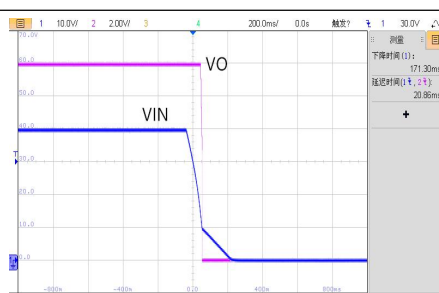
VIN=160V, 半载启机波形



VIN=160V, 满载启机波形



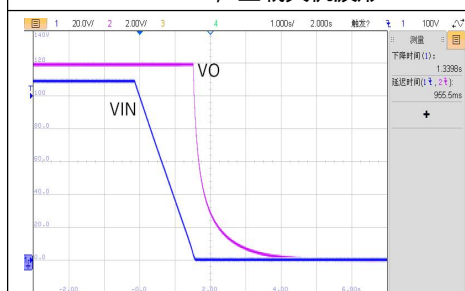
VIN=40V, 空载关机波形



VIN=40V, 半载关机波形



VIN=40V, 满载关机波形



VIN=110V, 空载关机波形



VIN=110V, 半载关机波形



VIN=110V, 满载关机波形



VIN=160V, 空载关机波形

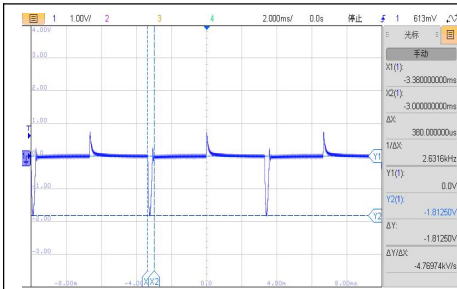


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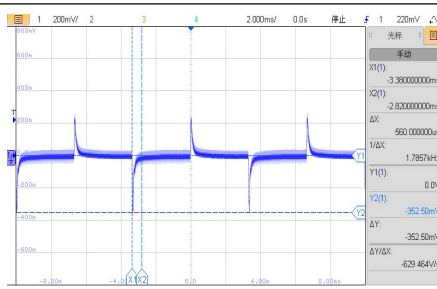


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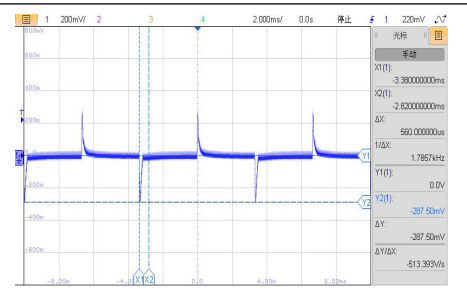
动态波形



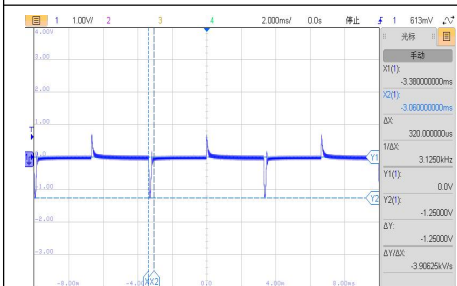
VIN=40V, 100%-10%-100%Io 动态波形



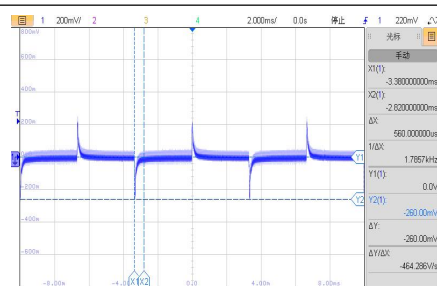
VIN=40V, 75%-50%-75%Io 动态波形



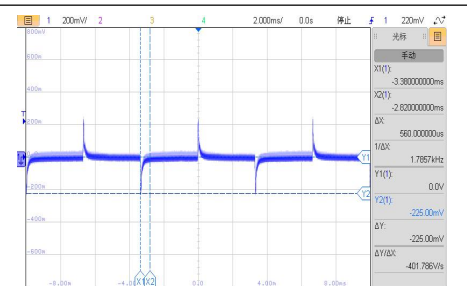
VIN=40V, 50%-25%-50%Io 动态波形



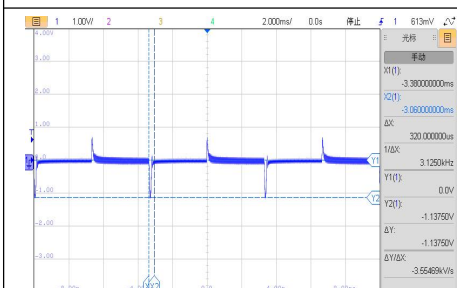
VIN=110V, 100%-10%-100%Io 动态波形



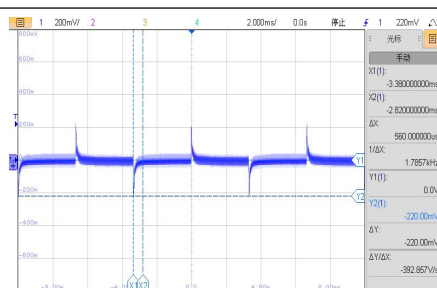
VIN=110V, 75%-50%-75%Io 动态波形



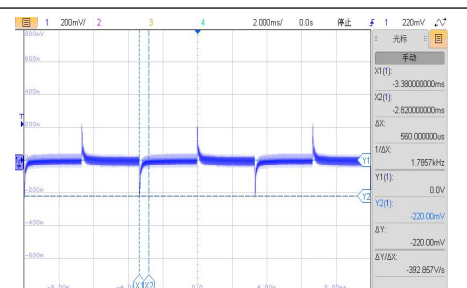
VIN=110V, 50%-25%-50%Io 动态波形



VIN=160V, 100%-10%-100%Io 动态波形

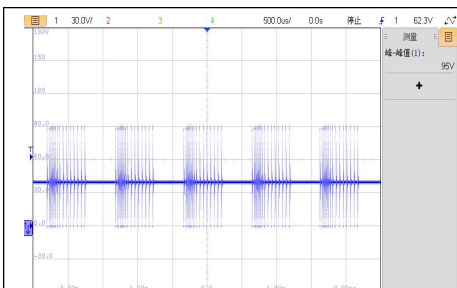


VIN=160V, 75%-50%-75%Io 动态波形

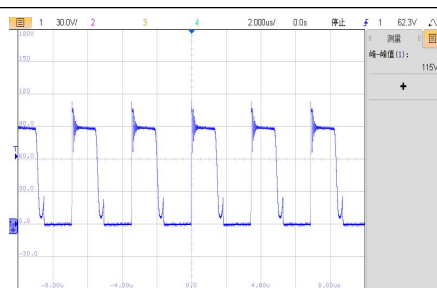


VIN=160V, 50%-25%-50%Io 动态波形

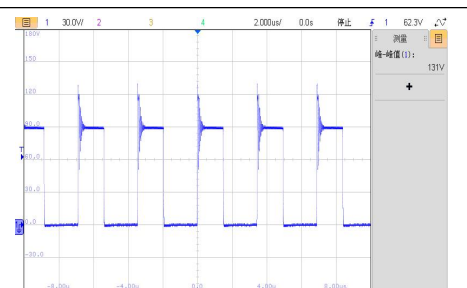
MOS 管电压应力波形



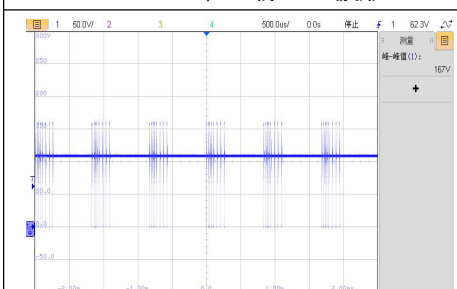
VIN=40V, 空载 VDS 波形



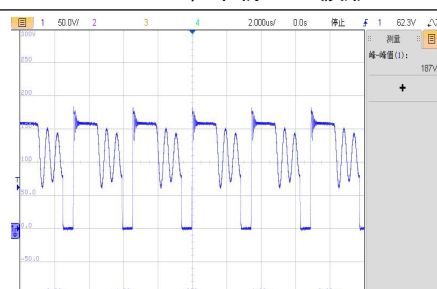
VIN=40V, 半载 VDS 波形



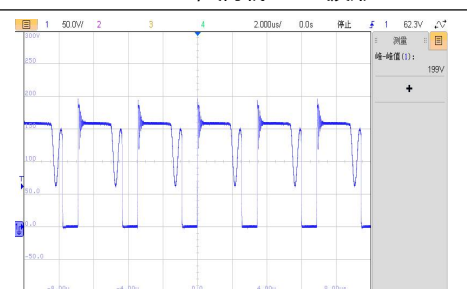
VIN=40V, 满载 VDS 波形



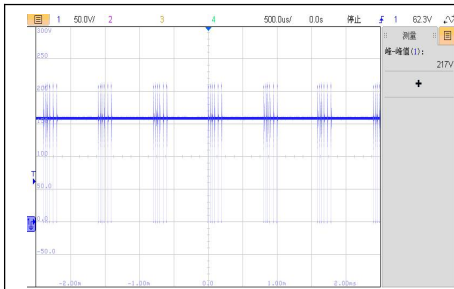
VIN=110V, 空载 VDS 波形



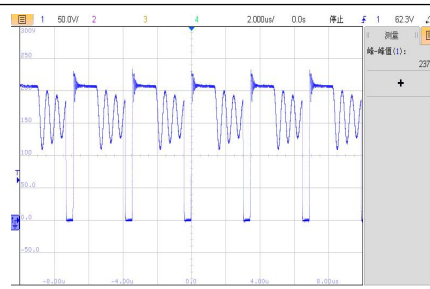
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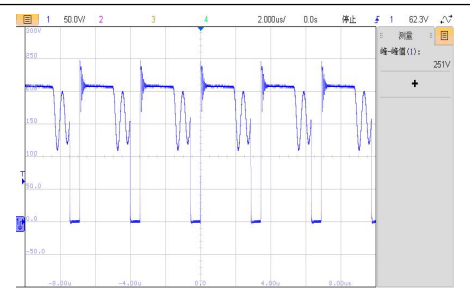
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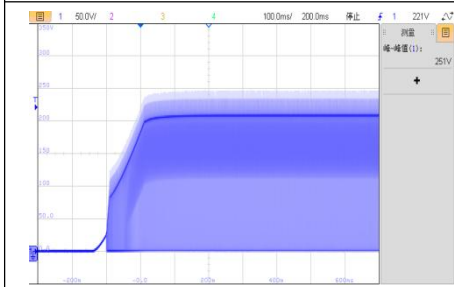
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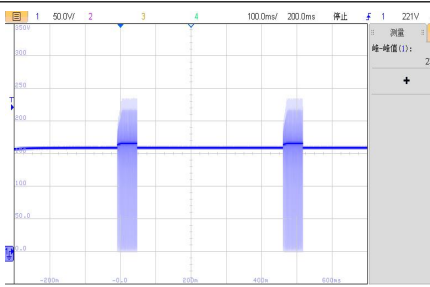
VIN=160V, 半载 VDS 波形



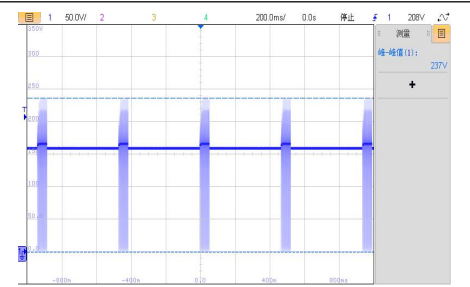
VIN=160V, 满载 VDS 波形



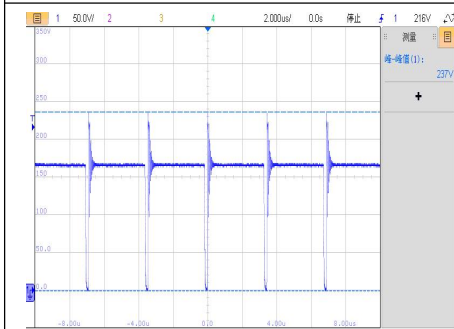
VIN=160V, 满载启机 VDS 波形



VIN=160V, 满载短路启机 VDS 波形

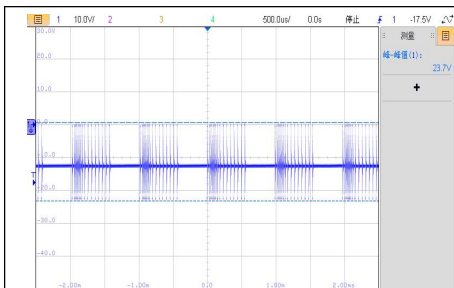


VIN=160V, 满载短路保护 VDS 波形

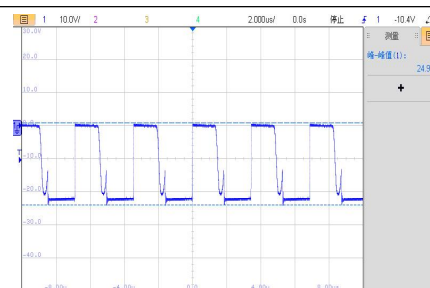


VIN=160V, 满载短路保护 VDS 展开波形

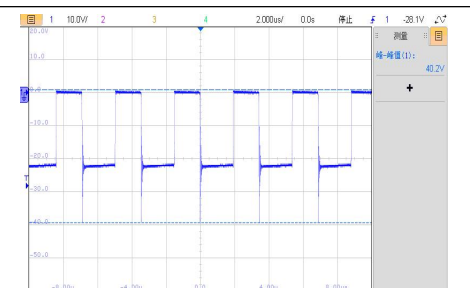
副边输出整流二极管 D4 应力波形



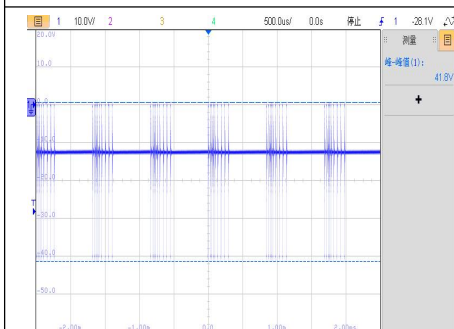
VIN=40V, D4 空载工作电压波形



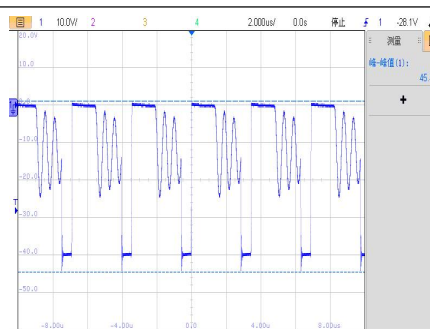
VIN=40V, D4 半载工作电压波形



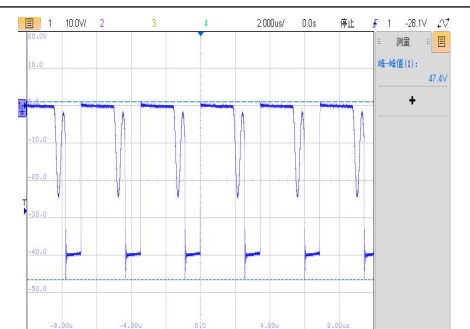
VIN=40V, D4 满载工作电压波形



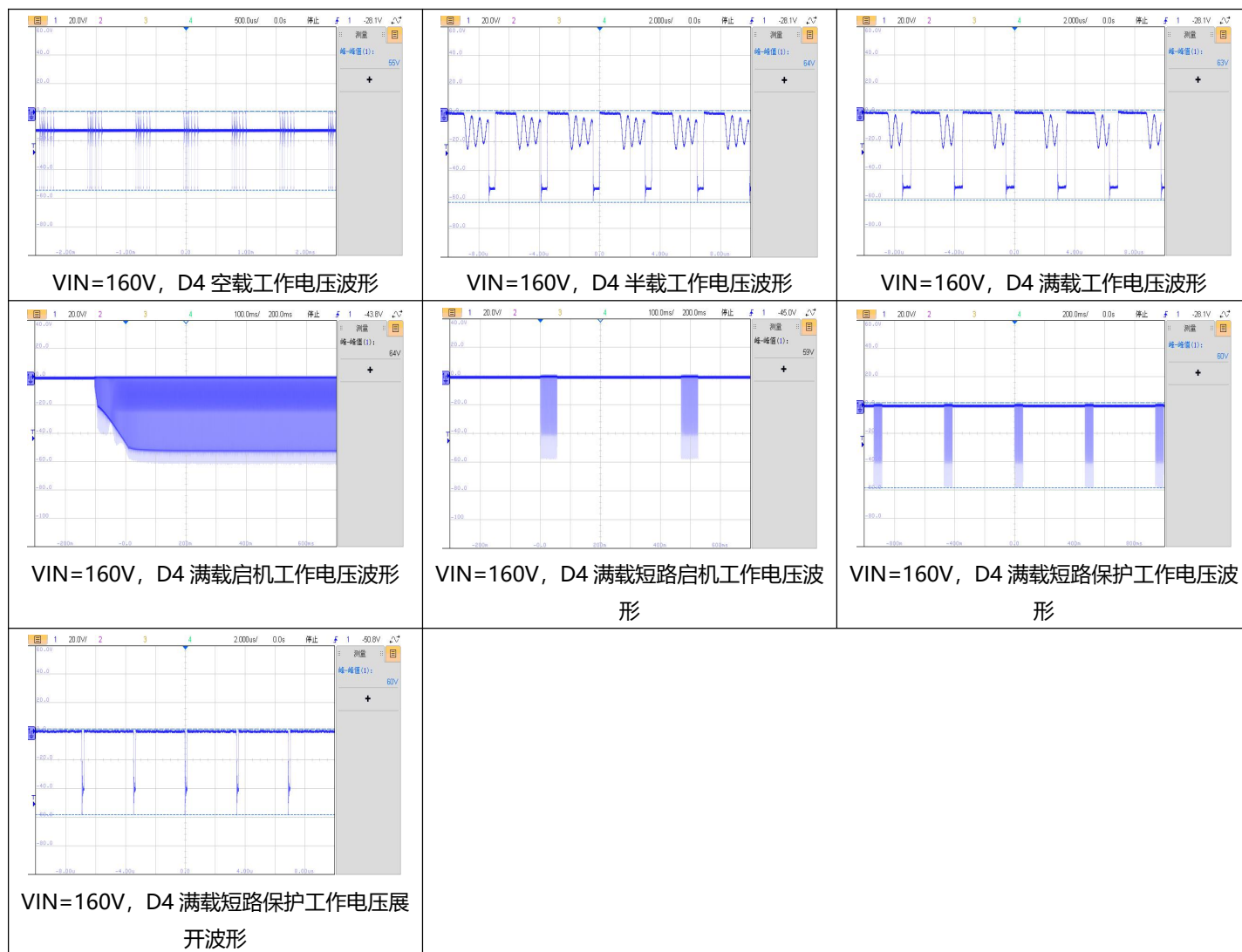
VIN=110V, D4 空载工作电压波形



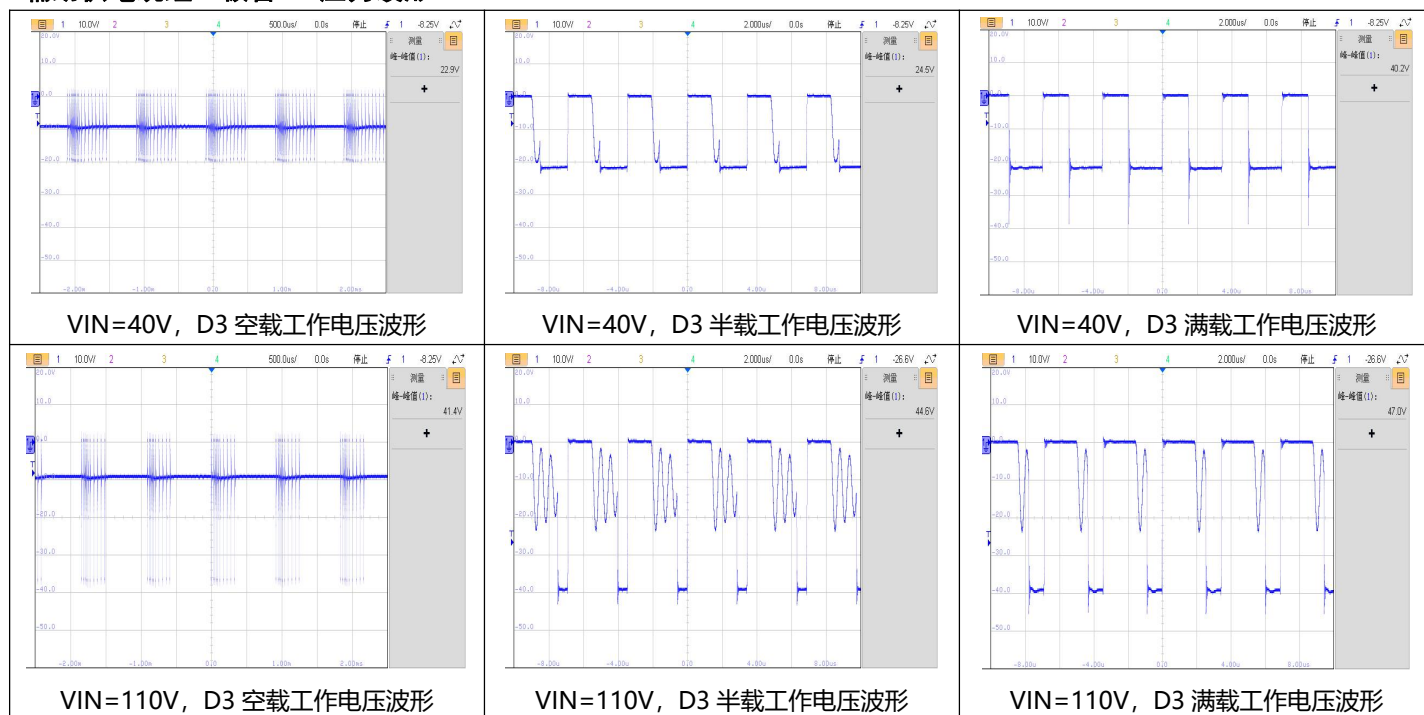
VIN=110V, D4 半载工作电压波形

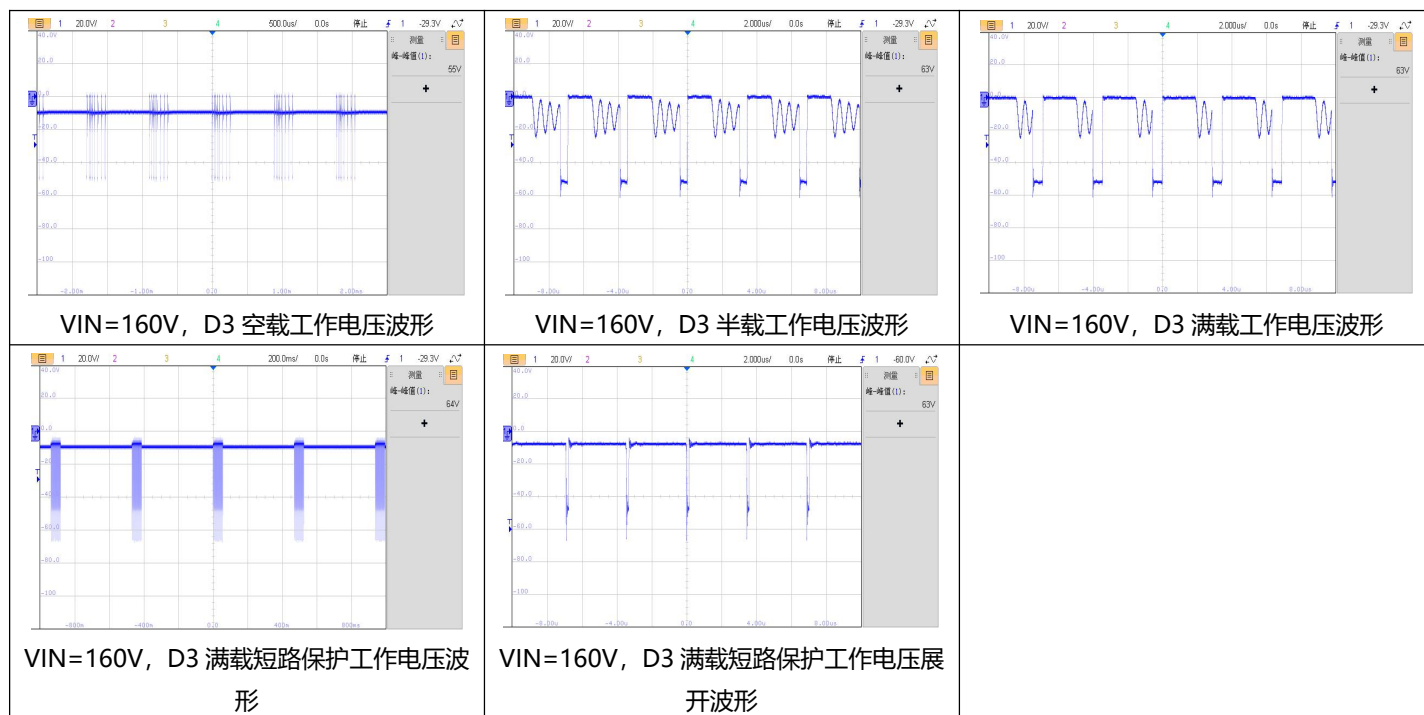


VIN=110V, D4 满载工作电压波形

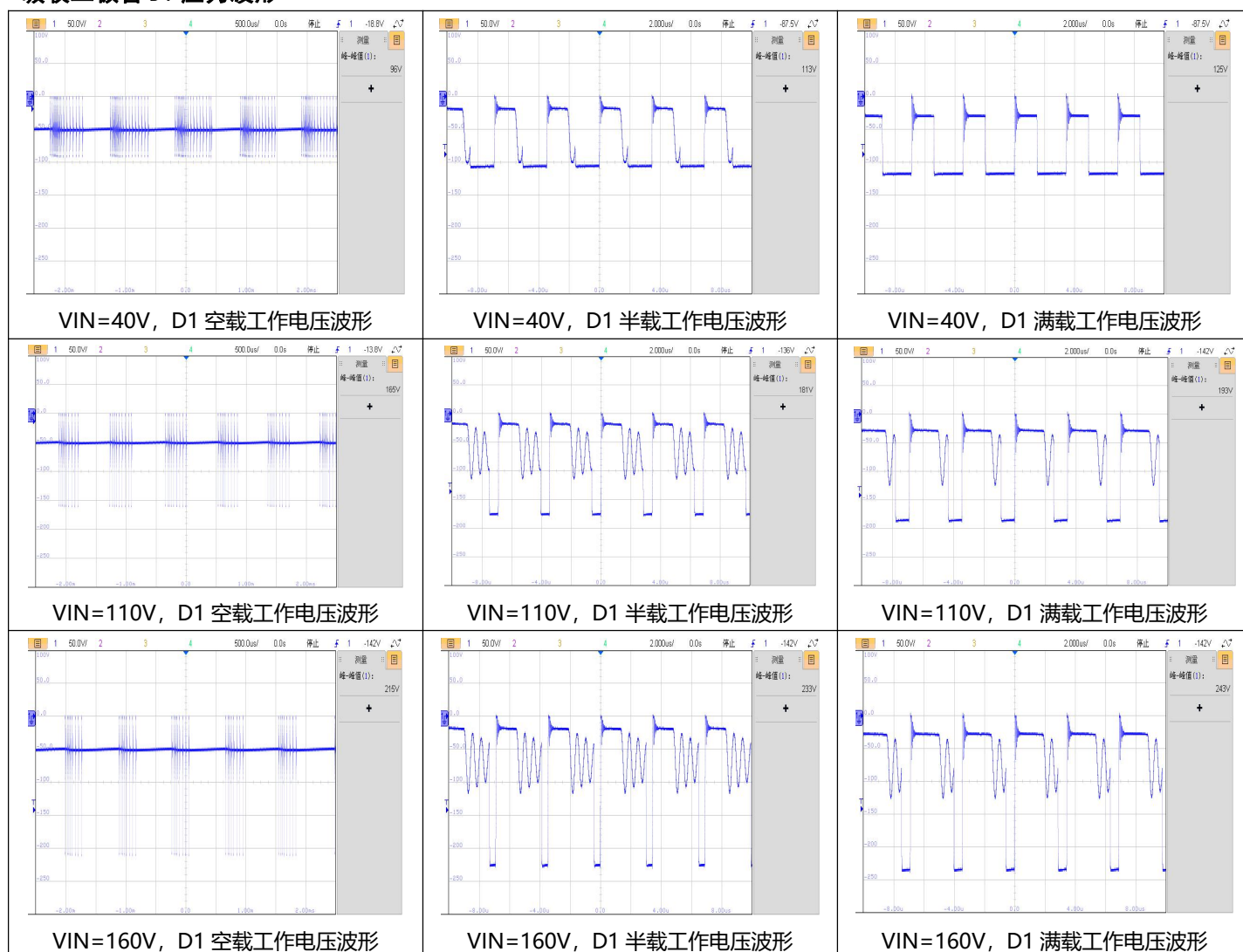


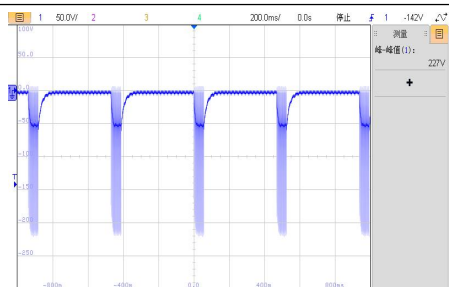
辅助供电绕组二极管 D3 应力波形



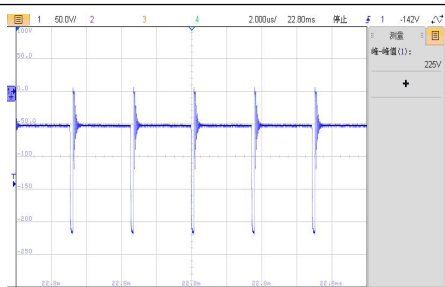


吸收二极管 D1 应力波形





VIN=160V, D1 满载短路保护工作电压波形



VIN=160V, D1 满载短路保护工作电压展开波形

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