

Charger Design with iW1690

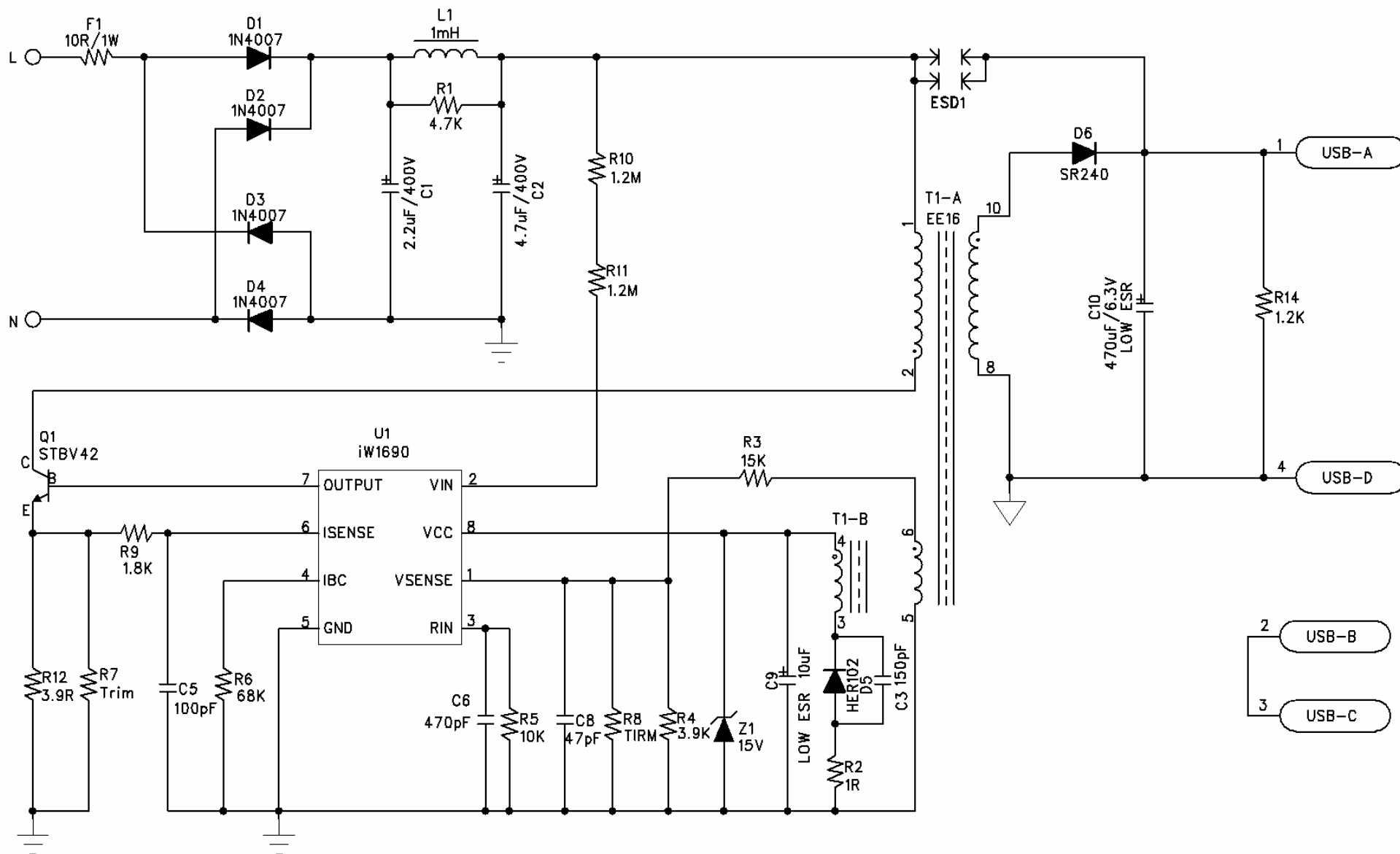
General Design Specification :

1. AC Input Range 90-264Vac
2. DC Output 5V, 0.65A(CC)
3. Max Ripple 200mV_{P_P}
4. No Y-CAP design.
5. BJT design

1. Specification

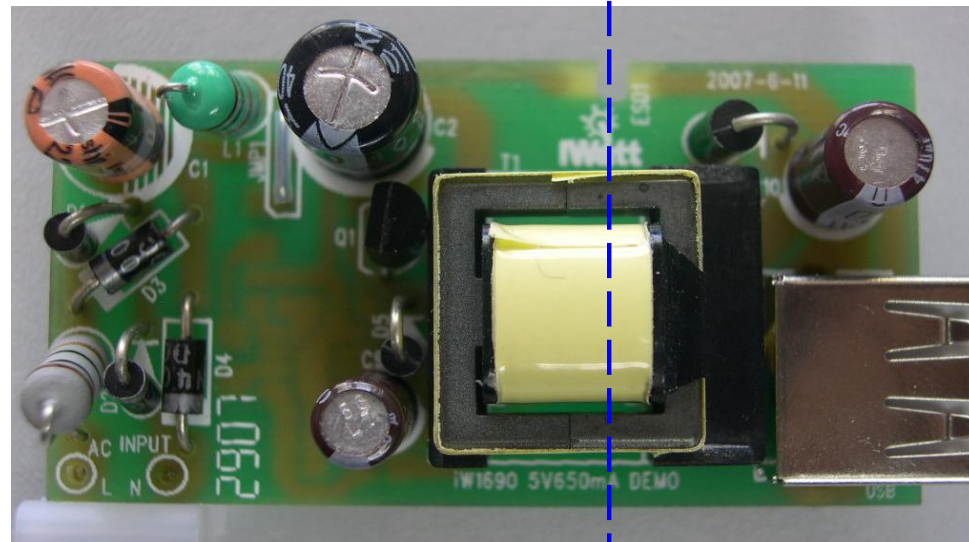
Description		Symbol	Min	Typ	Max	Units	Comment	
Input								
Voltage		V_{IN}	90		264	V _{AC}	2 Wire	
Frequency		f_{LINE}	47	50/60	63	Hz		
No-load Input Power (264V _{AC})					0.3	W		
Output								
Constant Voltage	Output Voltage	V_{OUT_CV}	4.75	5.00	5.25	V	Measured at the end of Cable	
	Output Current	I_{OUT_CV}	0		0.8	A		
Constant Current	Output Voltage	V_{OUT_CC}	< 2.0	Depending on battery voltage		V	Min V _{OUT} is dependence of V _{CC} supply voltage	
	Output Current	I_{OUT_CC}	0.60	0.65	0.70	A		
Output Ripple Voltage		V_{RIPPLE}			200	mV _{P-P}	Measured at the End of DC Output cable I _{OUT} =0.9A @T _A = 25 °C 20 MHz Bandwidth	
Output Ripple Current		I_{RIPPLE}			100	mA _{P-P}	Measured at CC model,	
Total Output Power								
Continuous Output Power		P_{OUT}		3.25		W		
Over Current Protection		I_{OUT_MAX}			0.80	A	Auto-restart	
Efficiency		η	60			%	Measured at end of PCB, V _{IN} = 90V _{AC} I _{OUT_CV} = 600mA. (T _A = 25 °C)	
Environmental								
Conducted EMI			Meets CISPR22B / EN55022B					
Safety			Designed to meet IEC950, UL1950 Class II					
Ambient Temperature		T_{AMB}	0		40	° C	Free convection, sea level	

2. Schematic

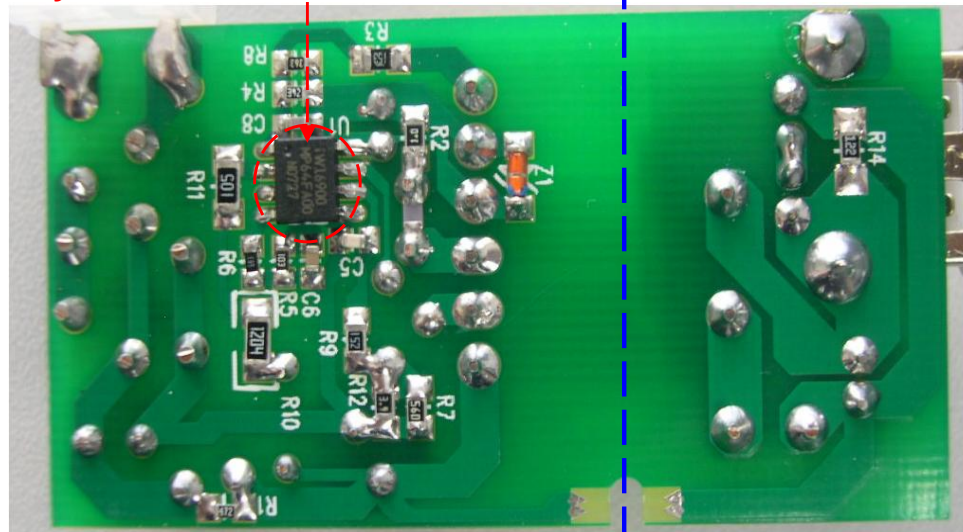


No Snubber, No Y-cap

3. Circuit Board Photograph

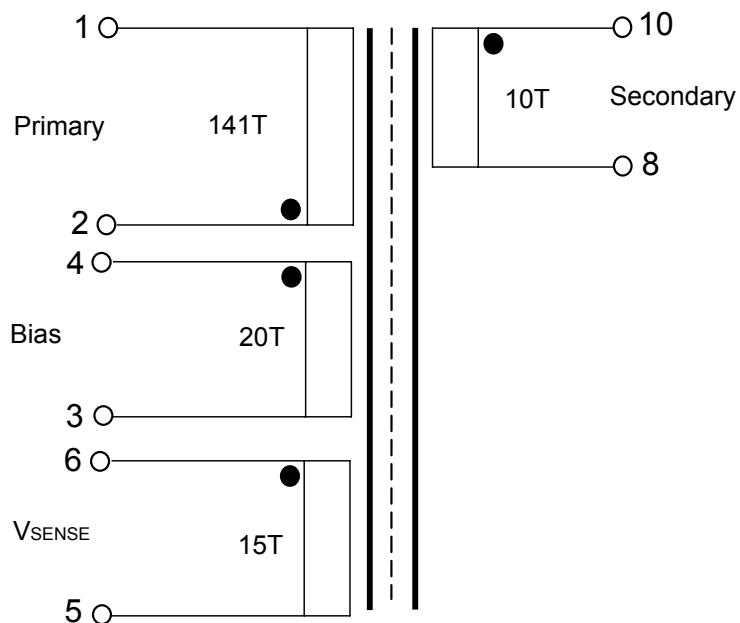


← Primary Secondary →
Primary PWM Controller- iw1690

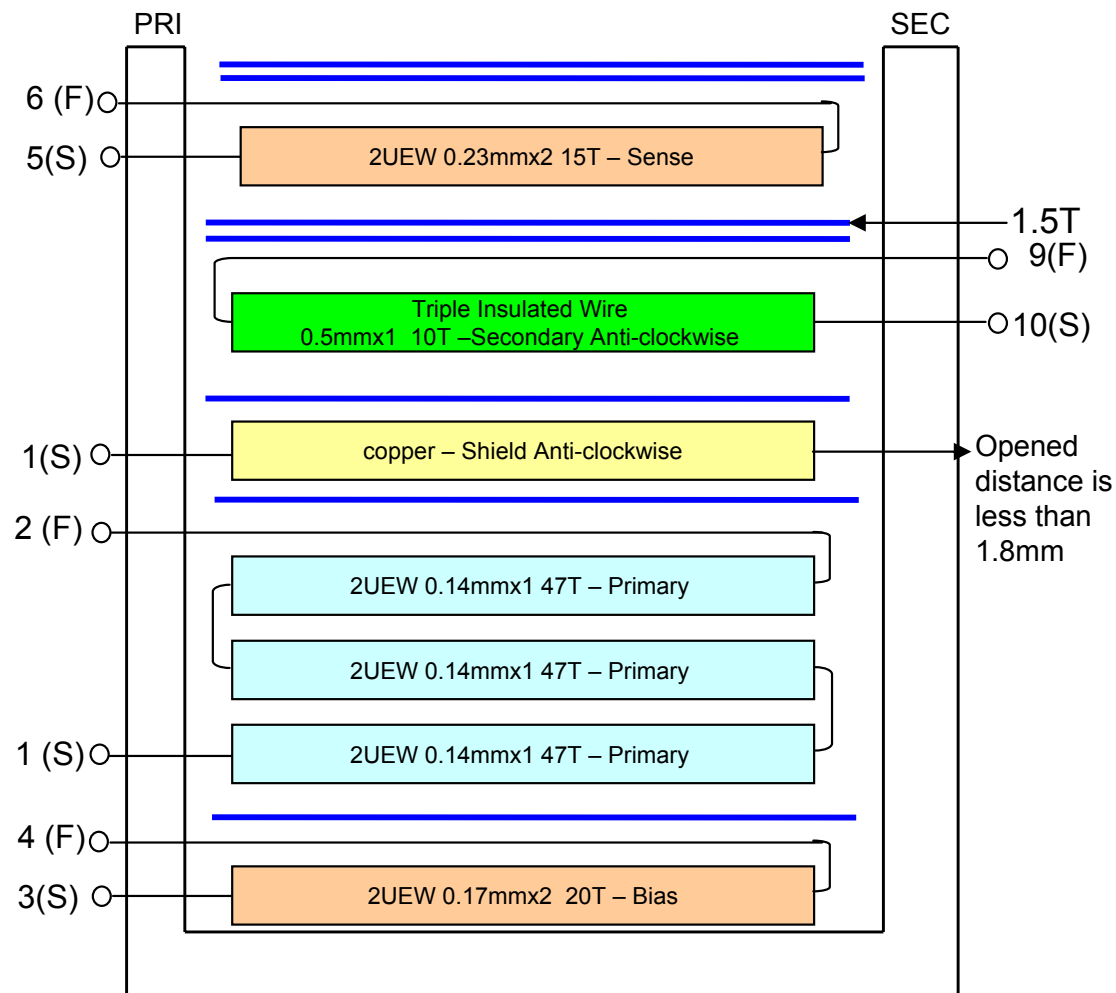
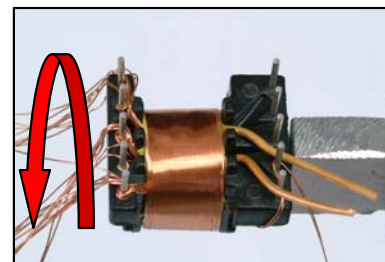


4. Transformer Design

SCHEMATIC



Clockwise
looking at pin
1-5 side



ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (L_p) = 2.7mH @10KHz
2. Primary Leakage Inductance (L_k) <= 100uH @10KHz
3. Electrical Strength = 3KV, 50/60Hz, 1Min(pins2~3 to pins 9,10)

MATERIALS:

1. Core : EE16 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin : EE16 Horizontal.
3. Magnet Wires (Pri) : Type 2-UEW
4. Magnet Wire (Sec) : Triple Insulated Wires
5. Layer Insulation Tape :3M1298 or equivalent.

FINISHED :

1. Cut remained of Pin7,9 after wires termination
2. Varnish the complete assembly

5. Bill of Material



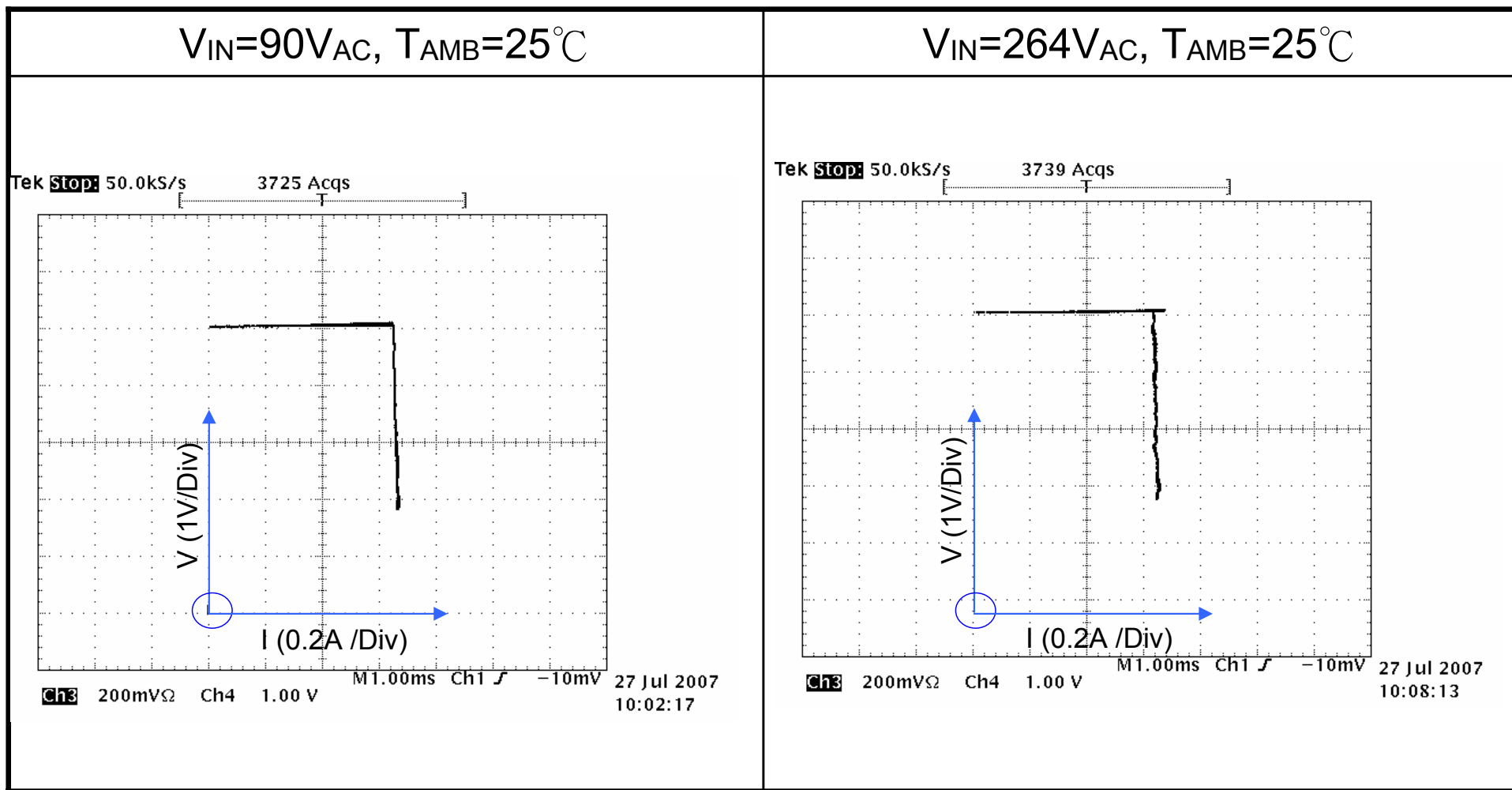
Item	Qty.	Ref.	Description	Cost (US Cent) / unit	Sub-Total (Cent)
1	1	U1	iW1690-1, Off-line digital PWM Controller, SOP-8		
2	1	C1	2.2uF, 400V, E-CAP		
3	1	C2	4.7uF, 400V, E-CAP		
4	1	C10	470uF, 6.3V, Low ESR E-CAP		
5	1	C3	150pF, 100V, X7R, SMD-0805		
5	1	C5	100pF, 50V, NPO, SMD-0603		
6	1	C6	470pF, 50V, NPO, SMD-0603		
7	1	C8	47pF, 50V, NPO, SMD-0603		
8	1	C9	10uF, 50V, Low ESR E-CAP, 5x11.5		
9	4	D1,D2,D3,D4	1N4007, Rectifier Diode, DO-41		
10	1	D5	HER102, Fast Rectifier Diode		
11	1	D6	SR240, Schotkky Diode		
12	1	F1	10Ω, Fuse Resistor, 1W		
13	1	L1	1mH, Filter Inductor		
14	1	Q1	STBV42, Transistor,		
15	1	R1	4.7KΩ ±5 %, SMD-0603		
16	1	R10	1.2MΩ ±1 %, SMD-1206		
17	1	R11	1.0MΩ ±1 %, SMD-1206		
18	1	R2	1Ω ±5 %, SMD-0805		
19	1	R14	1.2KΩ ±5 %, SMD-0805		
20	1	R12	3.9Ω ±1 %, SMD-0805		
21	1	R3	15KΩ ±5 %, 1/8W		
22	1	R4	3.9KΩ ±1 %, SMD-0603		
23	1	R5	10KΩ ±5 %, SMD-0603		
24	1	R6	68KΩ ±5 %, SMD-0603		
25	1	R9	1.5KΩ ±5 %, SMD-0603		
26	1	R7	Trim, SMD-0805		
27	1	R8	Trim, SMD-0603		
28	1	T1	EE1614, Transformer		
29	1	Z1	15V.DO-35		
30	1	J1	USB (A series)		

6. Regulation, Ripple and Efficiency Measurement

V _{IN} (V _{AC})	P _{IN}	V _{OUT}	I _{OUT}	V _{RIPPLE}	P _{OUT}	η	OCP (A)	I _{RIPPLE} (max) mA _{P-P}	P _{IN_S/C} (mW)	Average η (%)	CEC Standard η (%)
	(W)	(V)	(mA)	(mV _{P-P})	(W)	(%)		η (%)			
90	0.07	5.10	0	12			0.65	29.20	40	0.73	Meet CEC With lot of margins !
	1.05	5.09	150	38	0.76	0.73					
	2.08	5.09	300	70	1.53	0.73					
	3.17	5.11	450	84	2.30	0.72					
	4.29	5.12	600	116	3.07	0.72					
115	0.08	5.09	0	14			0.66	31.60	53	0.73	0.60
	1.09	5.09	150	47	0.76	0.70					
	2.09	5.10	300	72	1.53	0.73					
	3.11	5.11	450	84	2.30	0.74					
	4.15	5.12	600	100	3.07	0.74					
230	0.14	5.10	0	18			0.68	27.70	113	0.69	0.60
	1.27	5.09	150	50	0.76	0.60					
	2.17	5.10	300	66	1.53	0.71					
	3.21	5.11	450	86	2.30	0.72					
	4.11	5.12	600	102	3.07	0.75					
264	0.16	5.10	0	18			0.68	30.00	123	0.67	0.60
	1.35	5.09	150	50	0.76	0.57					
	2.26	5.10	300	70	1.53	0.68					
	3.28	5.11	450	86	2.30	0.70					
	4.20	5.12	600	100	3.07	0.73					

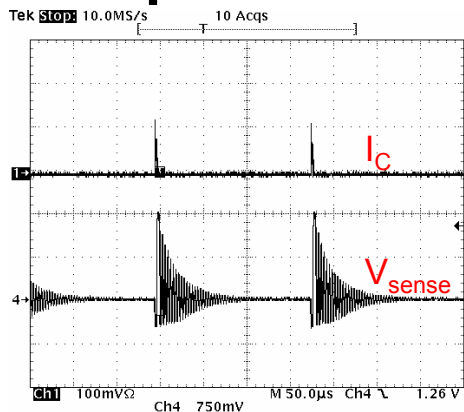
Note: 1, Output voltage measured at end of PCB

7. Output VI Characteristics

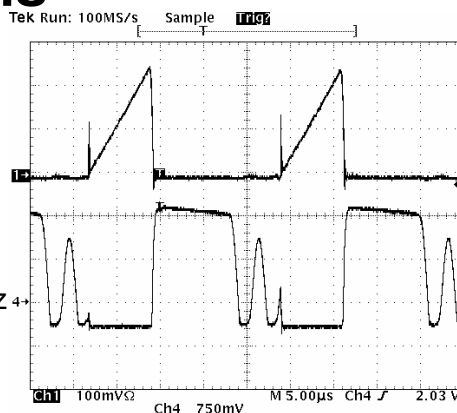


Note: 1, Output voltage measured at end of PCB

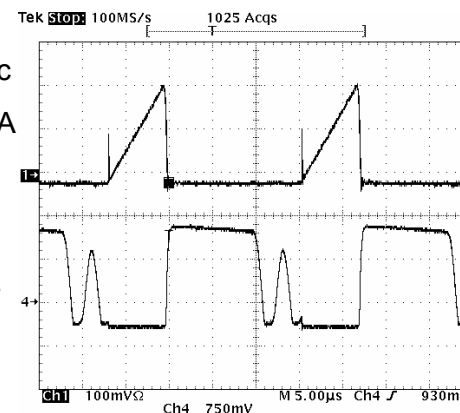
8. Operation waveforms



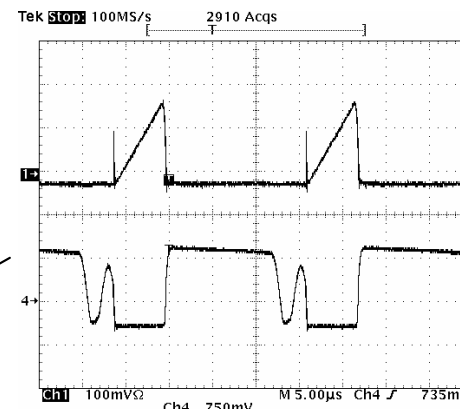
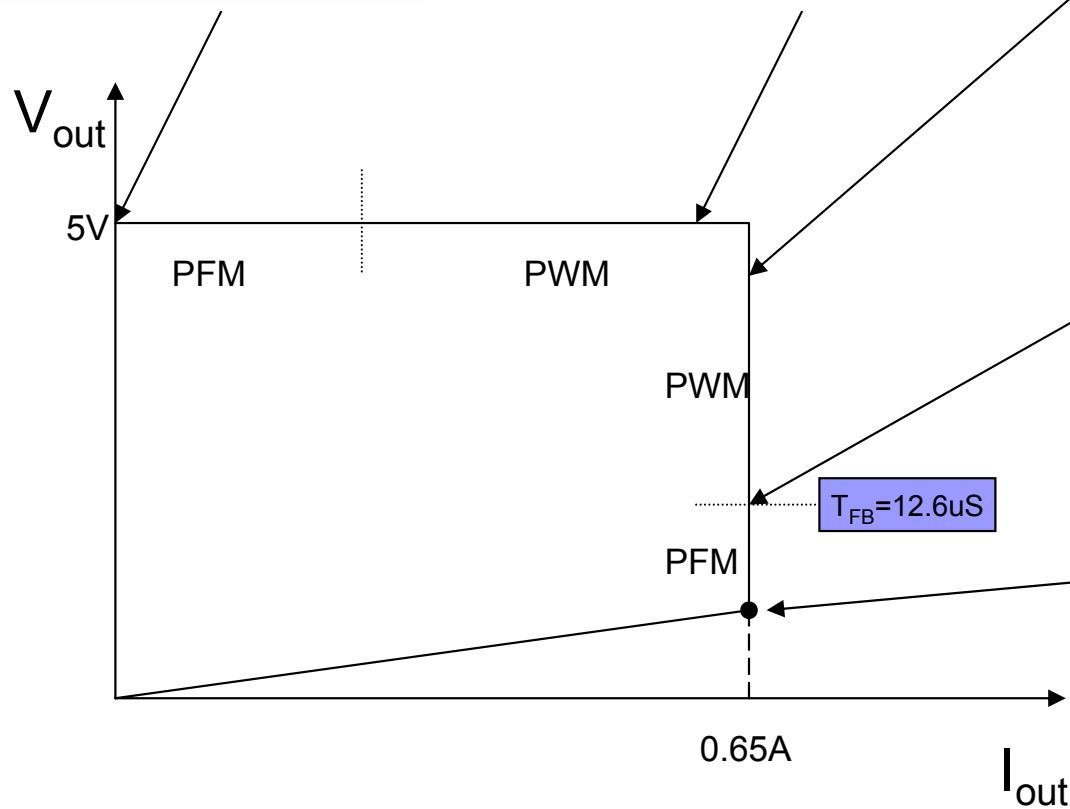
$V_{IN}=100Vdc$
 $I_{OUT}=0mA$
 $T_{ON}=2.2\mu s$
 $I_{pk}=86mA$
 $f_{SW}=5.56KHz$



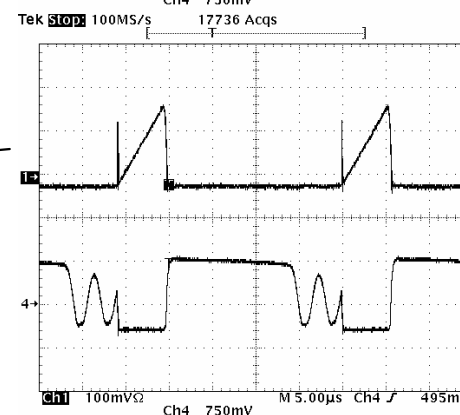
$V_{IN}=100Vdc$
 $I_{OUT}=600mA$
 $T_{ON}=6.9\mu s$
 $I_{pk}=254mA$
 $f_{SW}=45KHz$



$V_{IN}=100Vdc$
 $V_{OUT}=4V$
 $T_{ON}=6.5\mu s$
 $T_{FB}=10.4\mu s$
 $I_{pk}=230mA$
 $f_{SW}=45KHz$

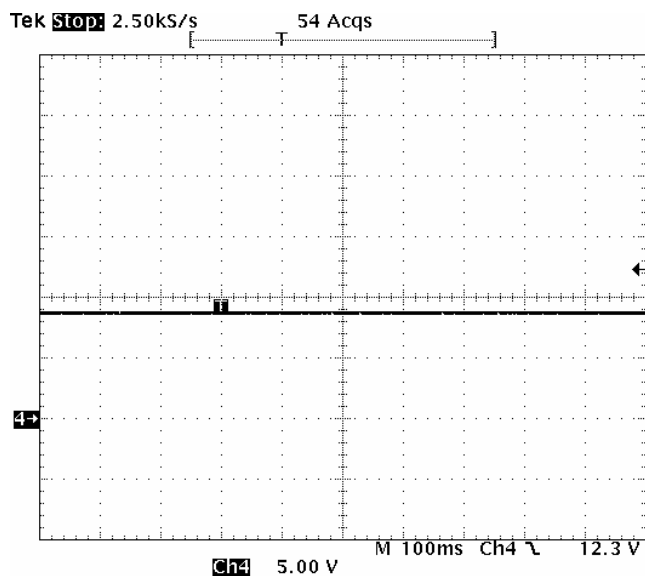


$V_{IN}=100Vdc$
 $V_{OUT}=2.68V$
 $T_{ON}=5.7\mu s$
 $T_{FB}=12.6\mu s$
 $I_{pk}=192mA$
 $f_{SW}=45KHz$



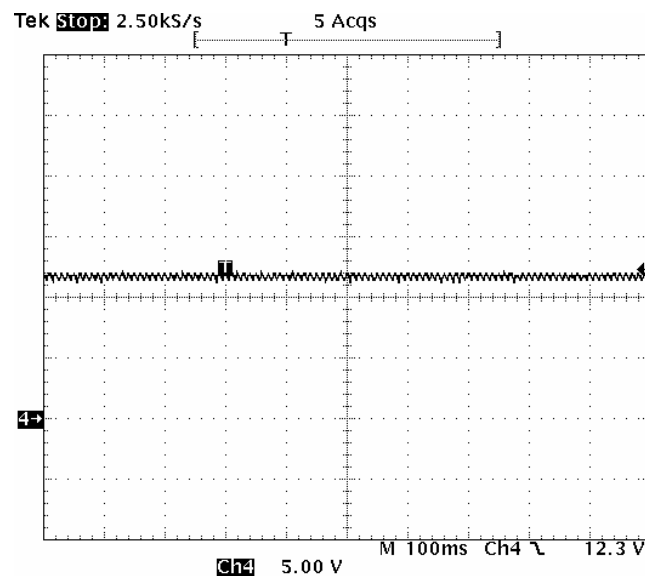
$V_{IN}=100Vdc$
 $V_{OUT}=2.2V$
 $T_{ON}=5.6\mu s$
 $T_{FB}=14.6\mu s$
 $I_{pk}=192mA$
 $f_{SW}=38.61KHz$

9. V_{CC} Waveform



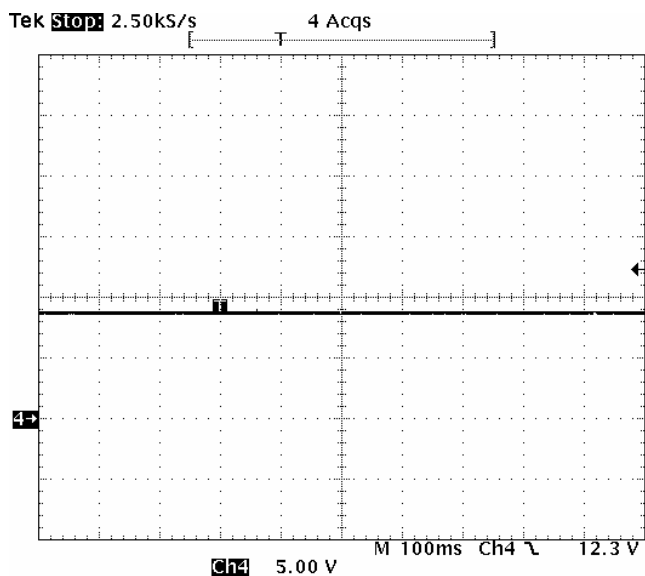
C4 Max
8.8 V

90V_{AC}, NO Load
Max: 8.8V



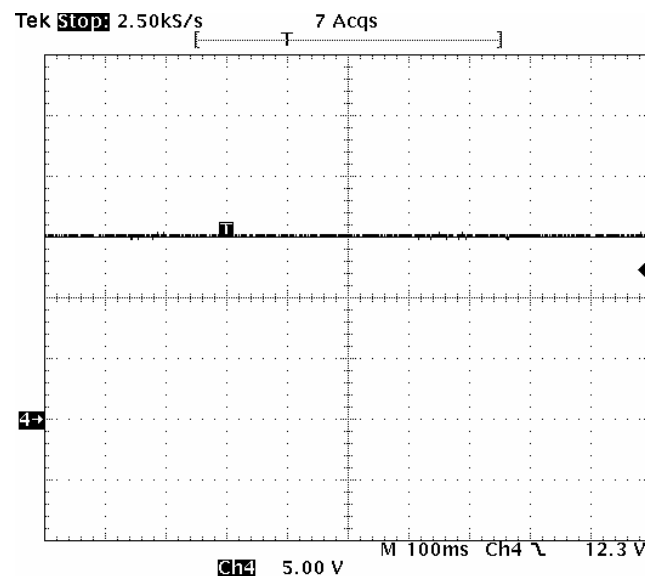
C4 Max
12.2 V

90V_{AC}, Full Load
Max: 12.2V



C4 Max
9.0 V

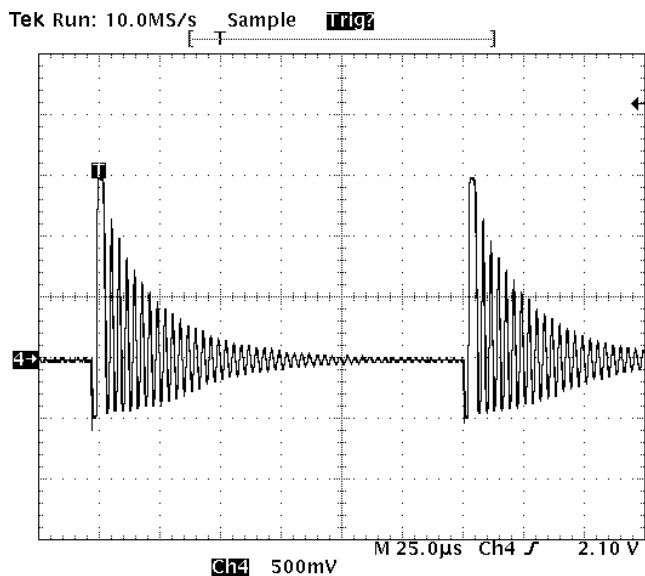
265V_{AC}, NO Load
Max: 9.0V



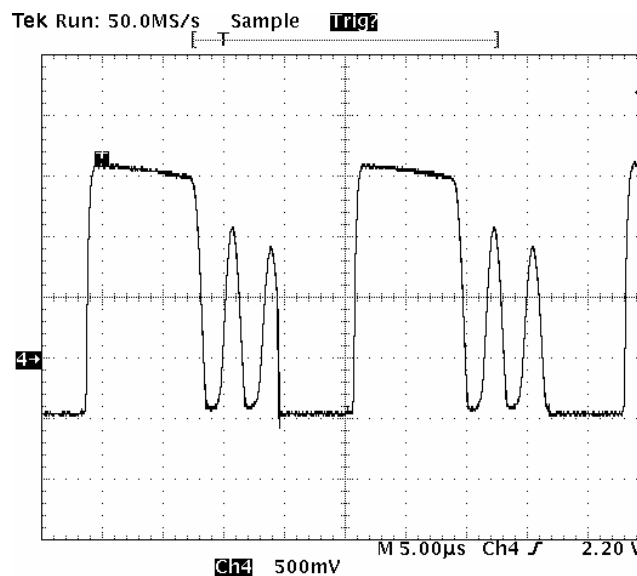
C4 Max
15.4 V

265V_{AC}, Full Load
Max: 15.4V

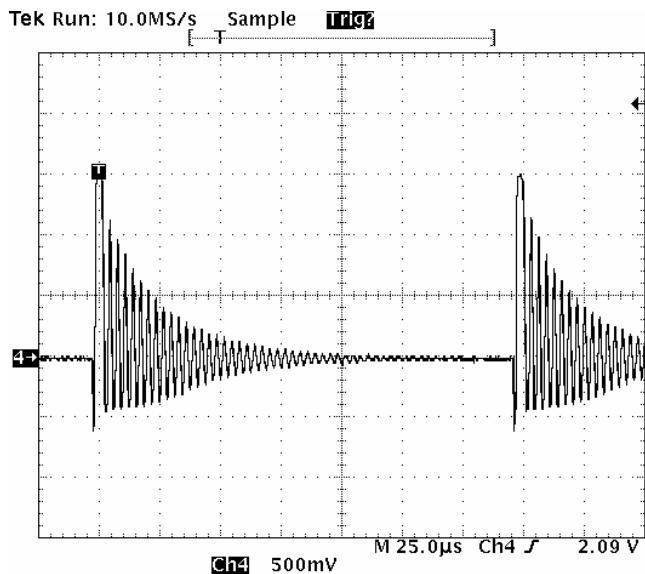
10. V_{SENSE} Waveform



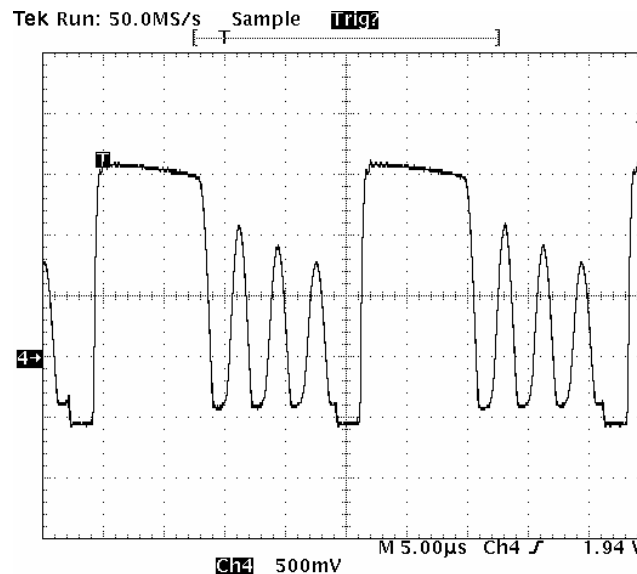
90V_{AC}, NO Load



90V_{AC}, Full Load

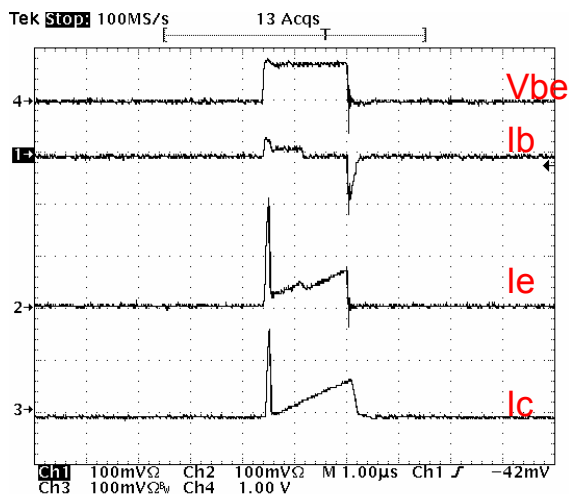


265V_{AC}, NO Load

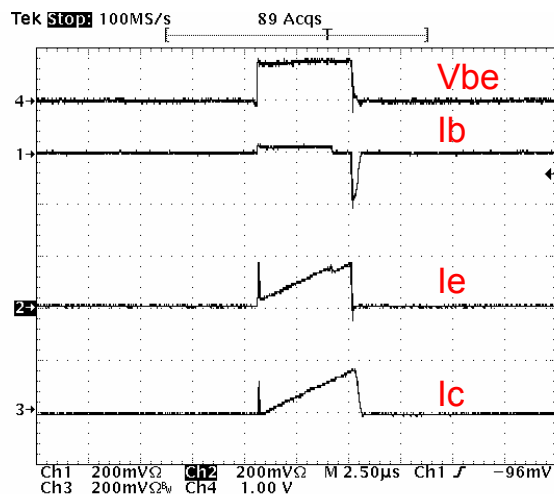


265V_{AC}, Full Load

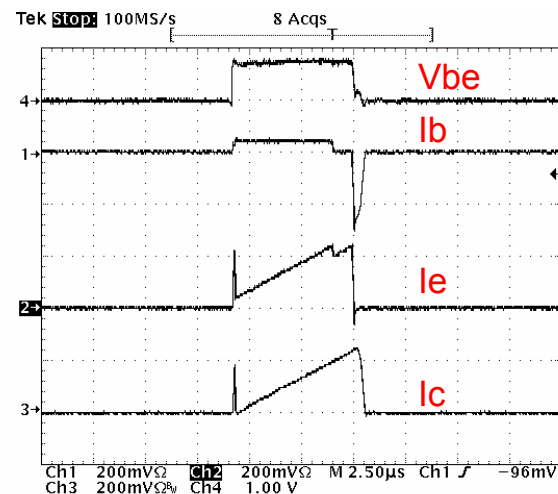
11. BJT waveforms



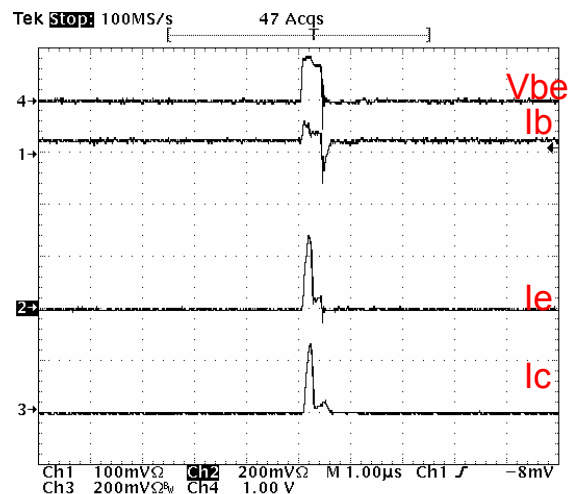
90V_{AC}, NO Load



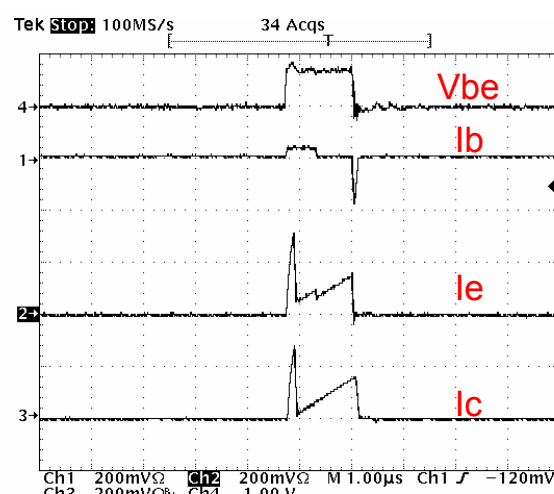
90V_{AC}, I_{out}=300mA



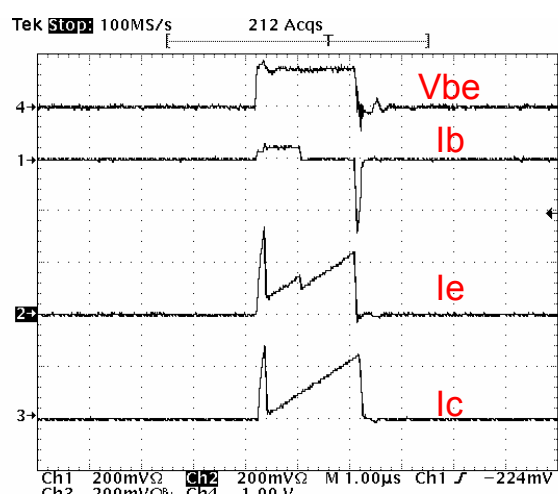
90V_{AC}, Full Load



265V_{AC}, NO Load

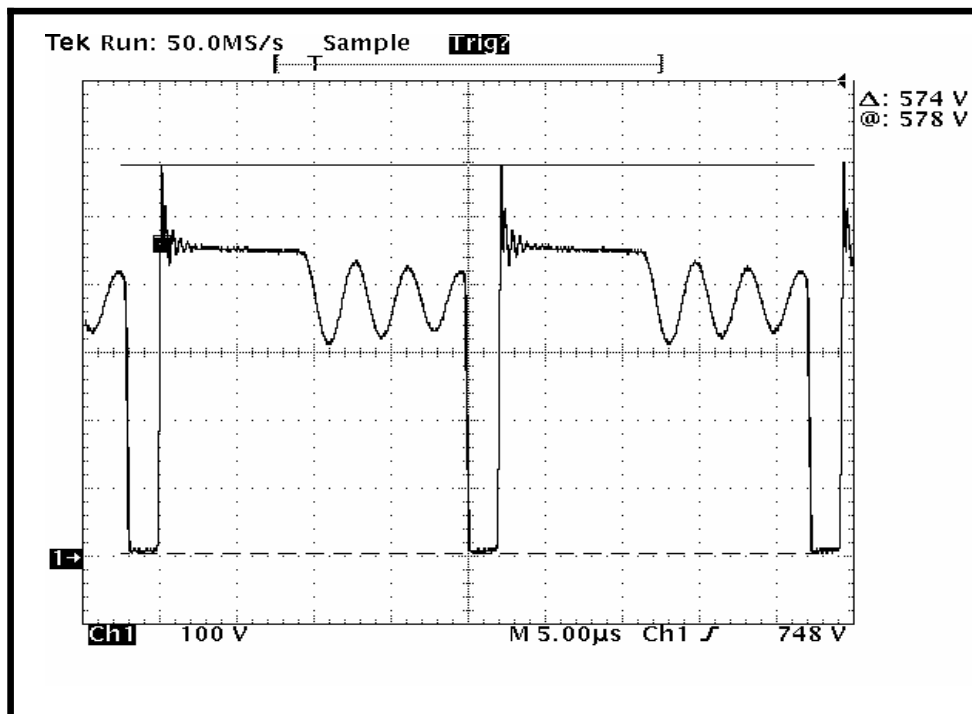


265V_{AC}, I_{out}=300mA



265V_{AC}, Full Load

12. V_{EC} waveform



Test Condition:

$V_{IN}=264VAC$, $I_{OUT_CV}=624mA$

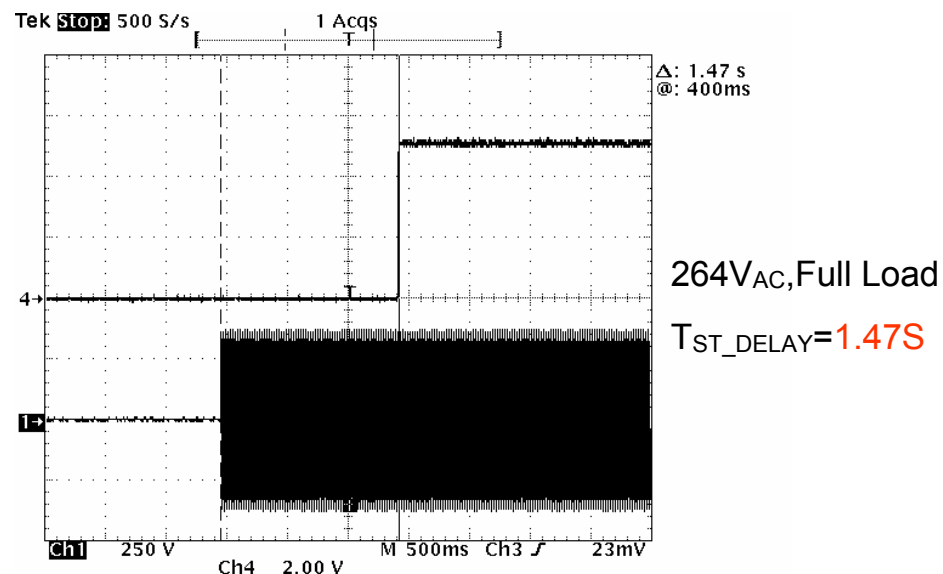
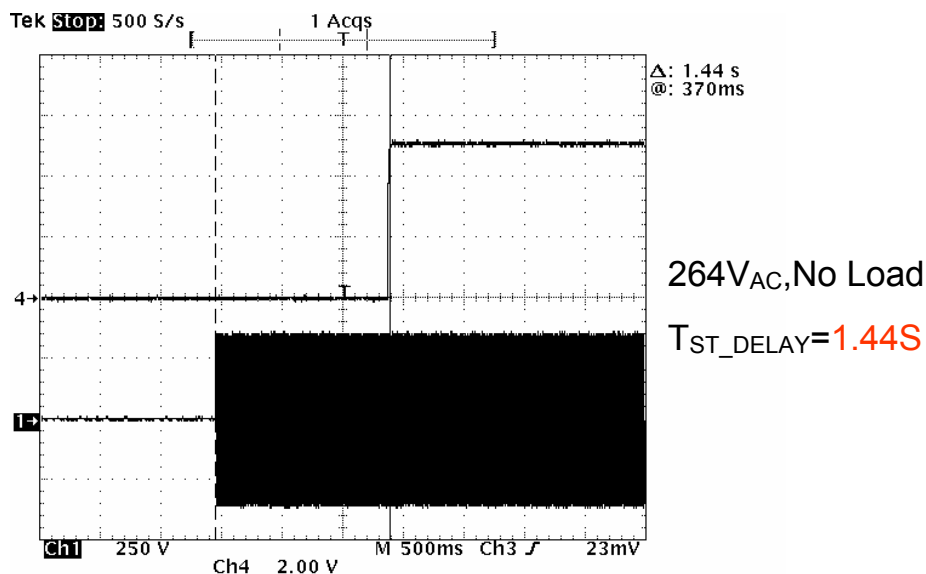
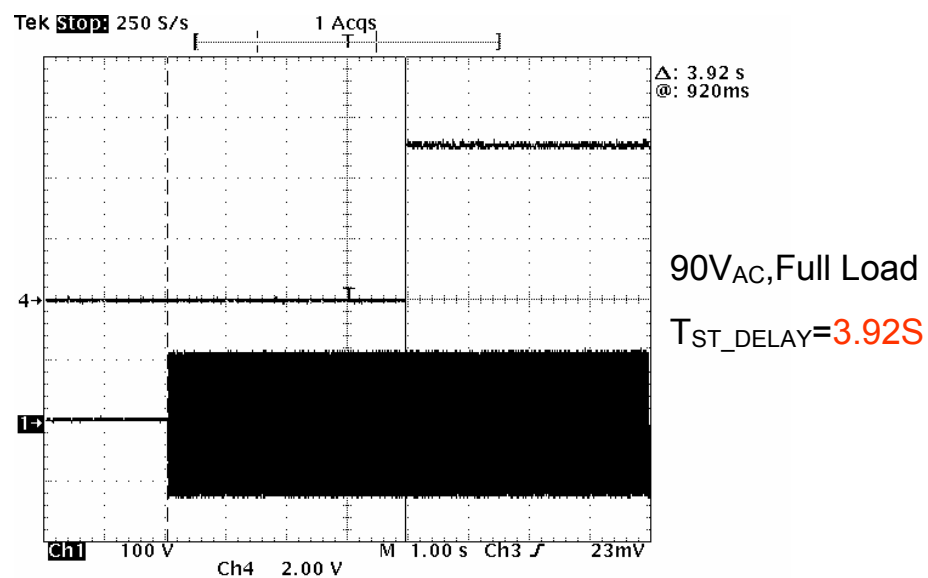
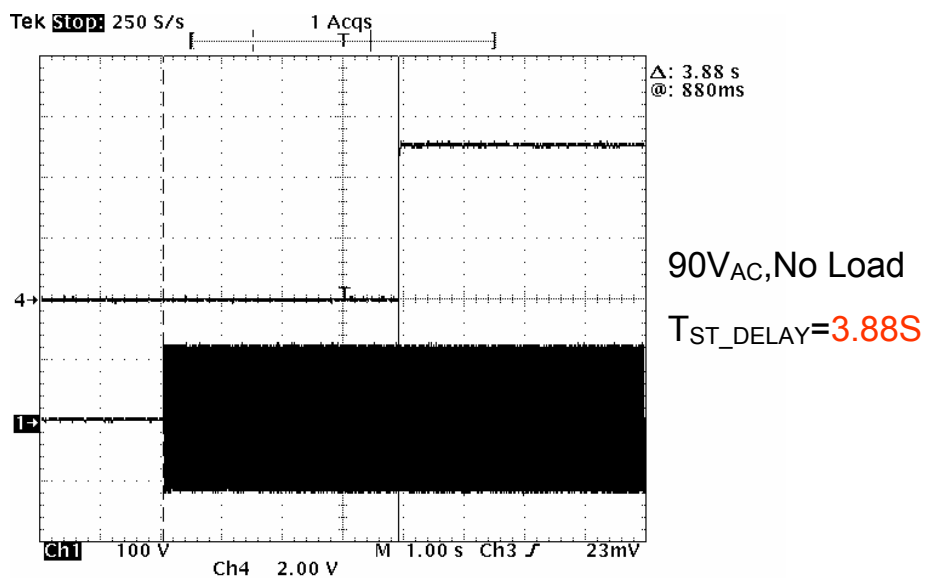
Result:

$V_{DS_MAX}=\mathbf{574V}$

Appendix – Simple Specification for used STBV42

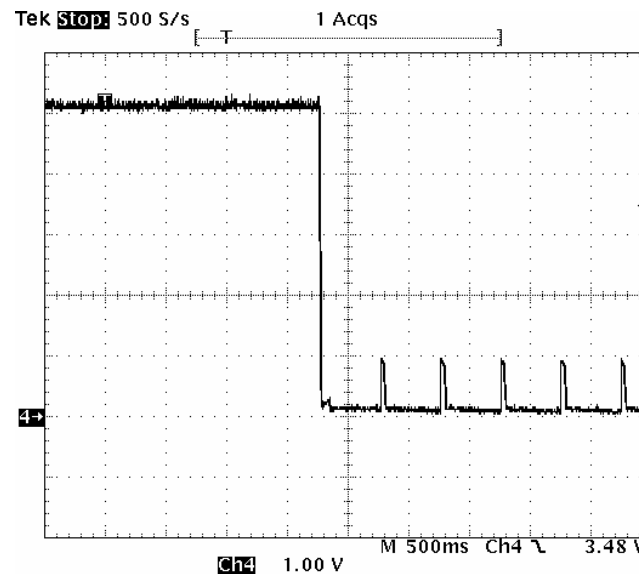
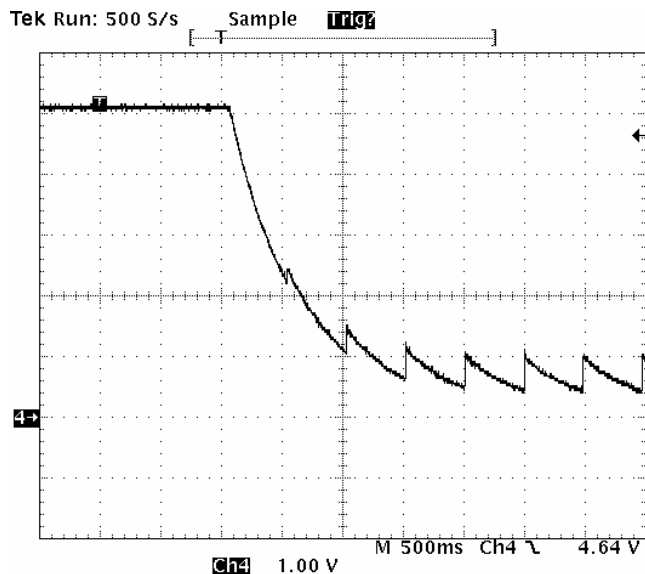
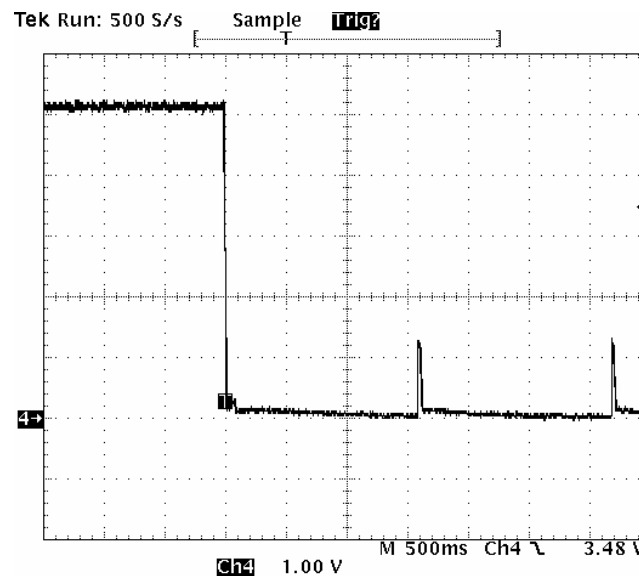
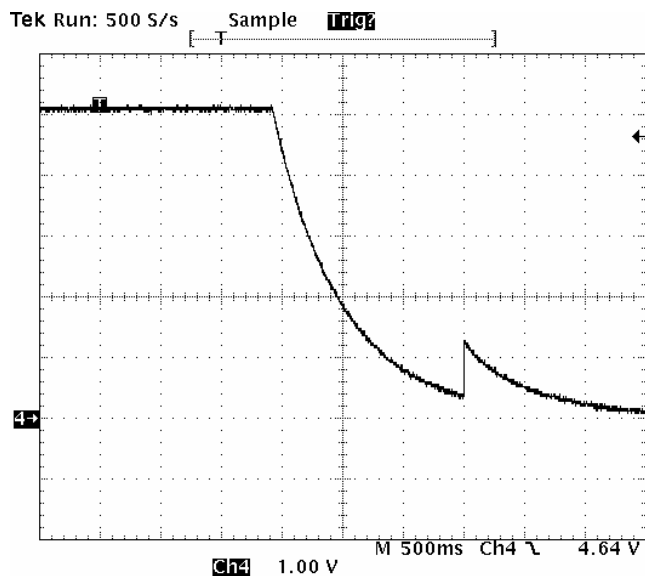
Symbol	Parameter	Value	Unit
V_{CES}	Collector-Emitter Voltage ($V_{BE} = 0$)	700	V
V_{CEO}	Collector-Emitter Voltage ($I_B = 0$)	400	V
V_{EBO}	Emitter-Base Voltage ($I_C = 0$)	9	V
I_C	Collector Current	1	A
I_{CM}	Collector Peak Current ($t_p < 5$ ms)	2	A
I_B	Base Current	0.5	A
I_{BM}	Base Peak Current ($t_p < 5$ ms)	1	A
P_{tot}	Total Dissipation at $T_{amb} = 25$ °C	1	W
T_{stg}	Storage Temperature	-65 to 150	°C
T_j	Max. Operating Junction Temperature	150	°C

13. Start Up & Turn On Delay Time



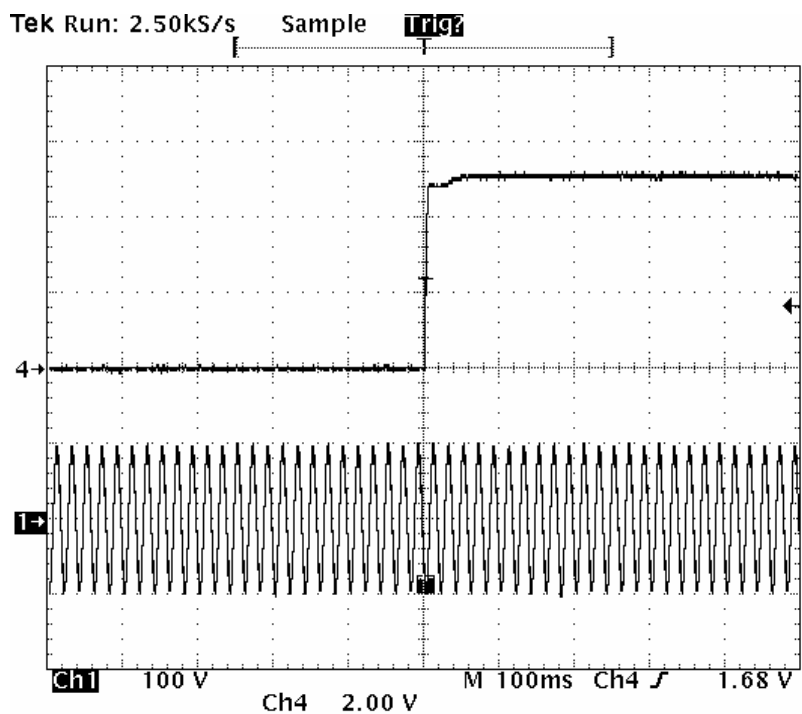
14. OVP Performance

-(R4 is shorted, or R3 is opened.)



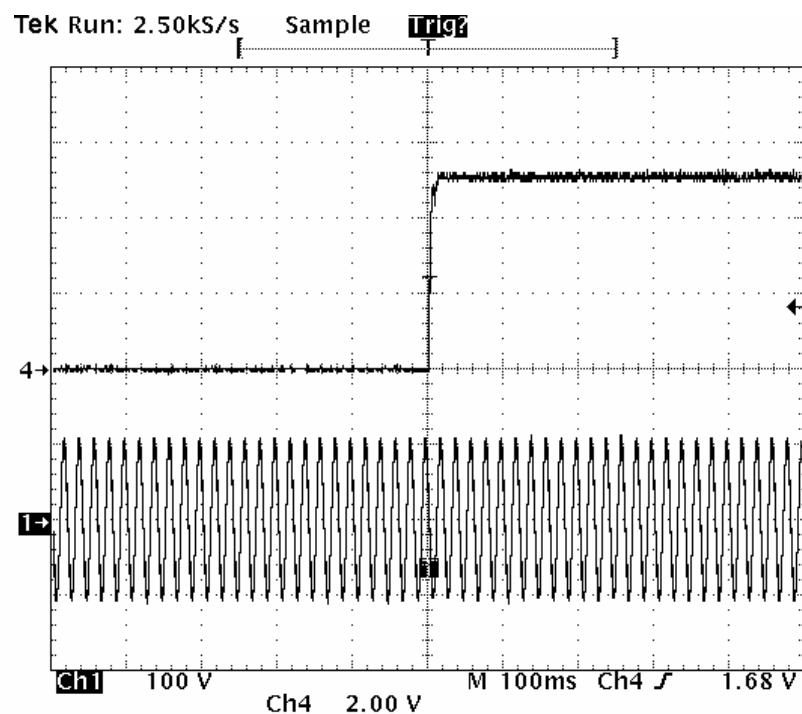
15. AC Startup Voltage Characteristic

No Load, $V_{IN_STARTUP} = 69V_{AC}$



C1 RMS
69.0 V

Full Load, $V_{IN_STARTUP} = 76.0V_{AC}$

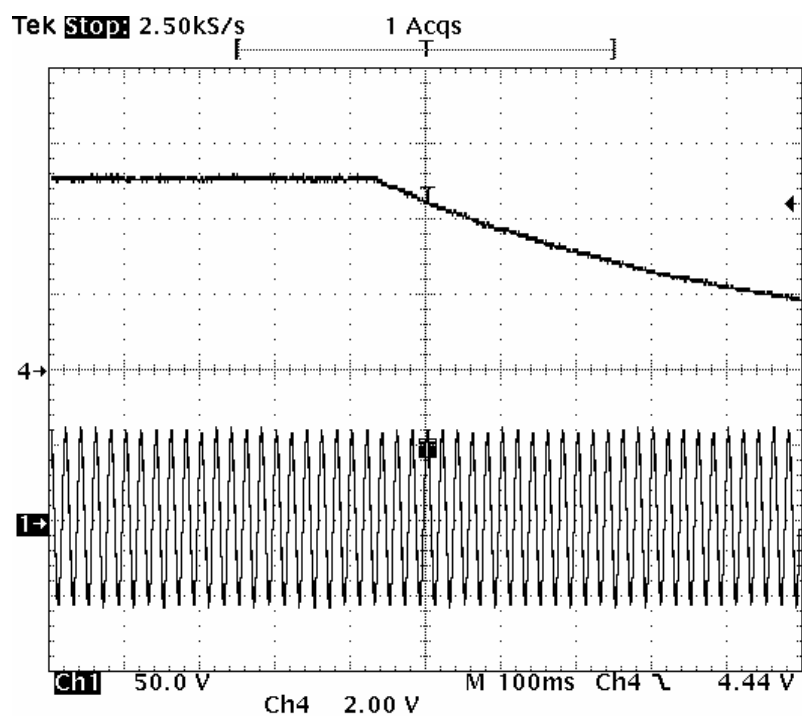


C1 RMS
76.0 V

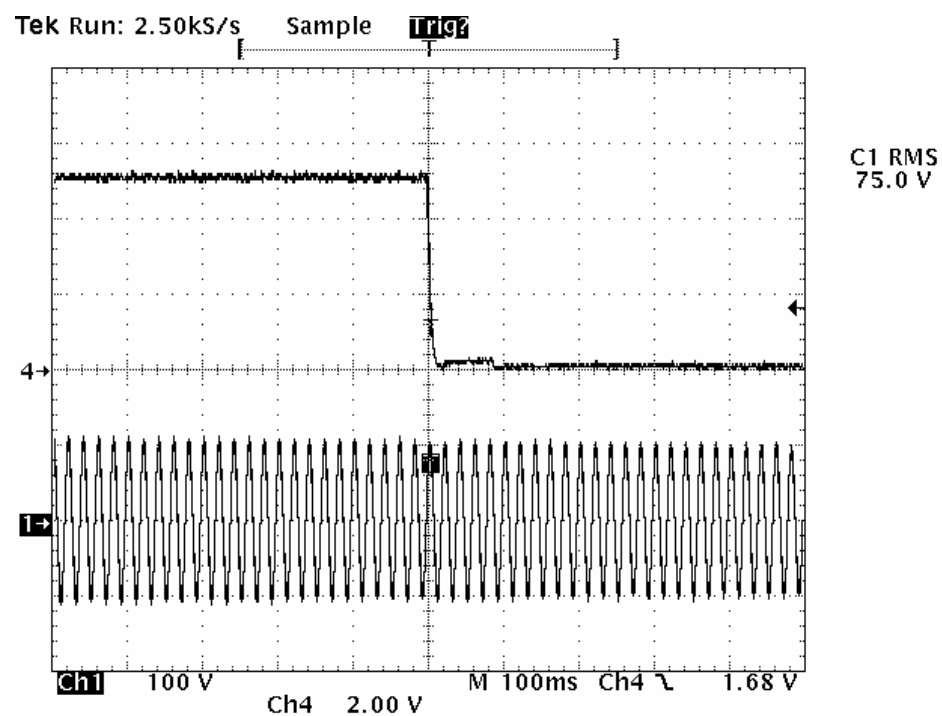
16. AC Shutdown Voltage Characteristic

No Load, $V_{IN_SHUTDOWN} = 40.9V_{AC}$

Full Load, $V_{IN_SHUTDOWN} = 75.0V_{AC}$



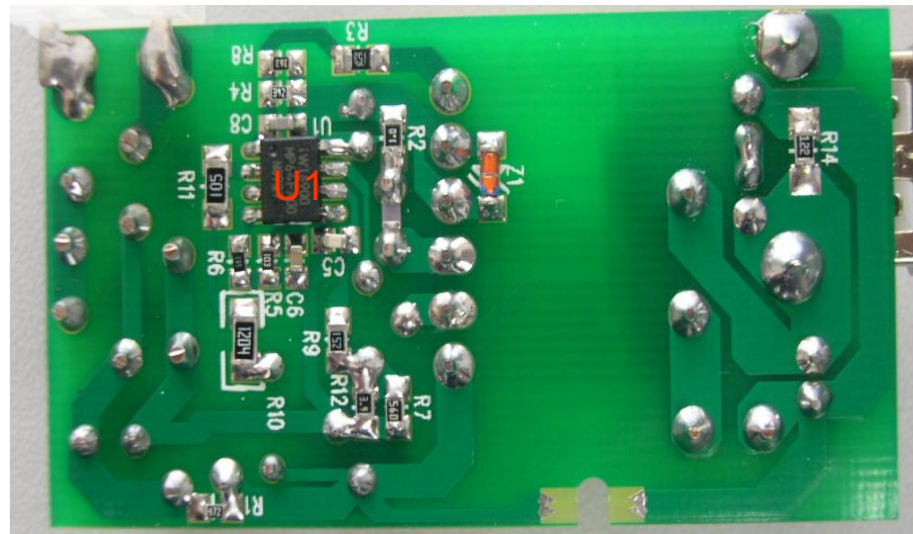
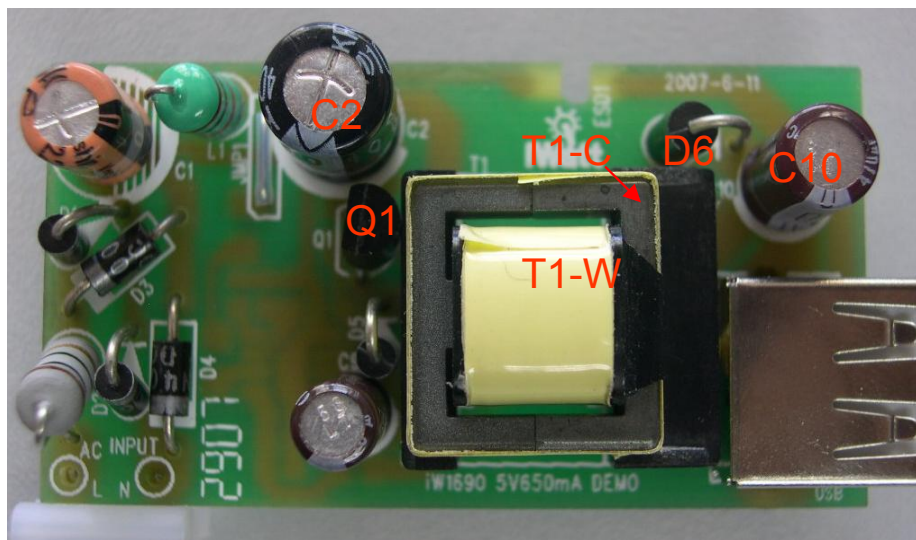
C1 RMS
40.9 V



C1 RMS
75.0 V

17. Thermal Test

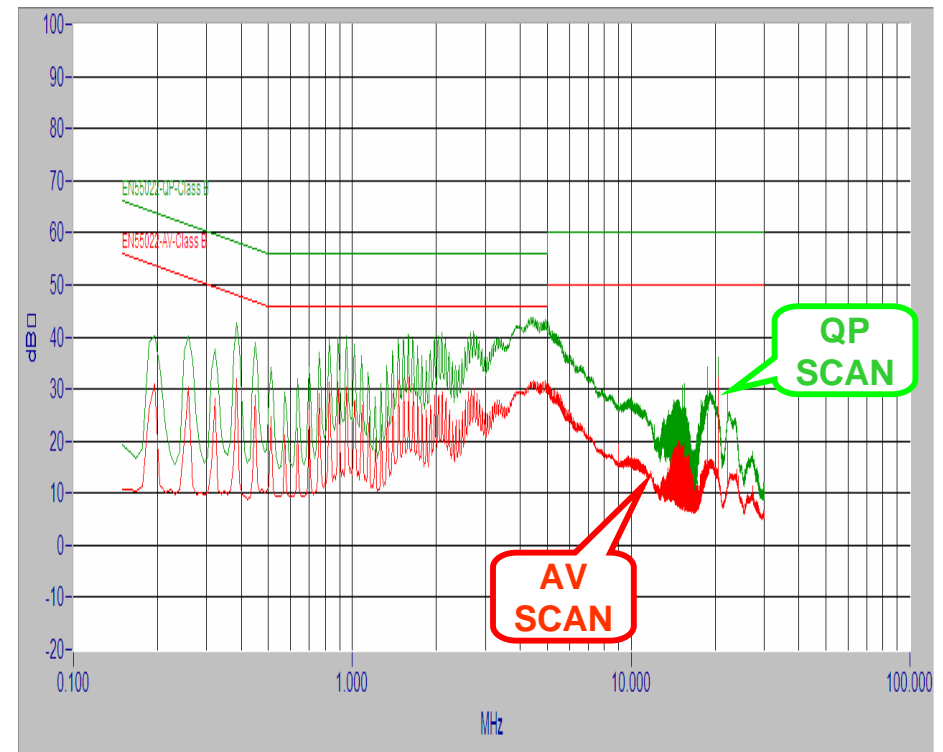
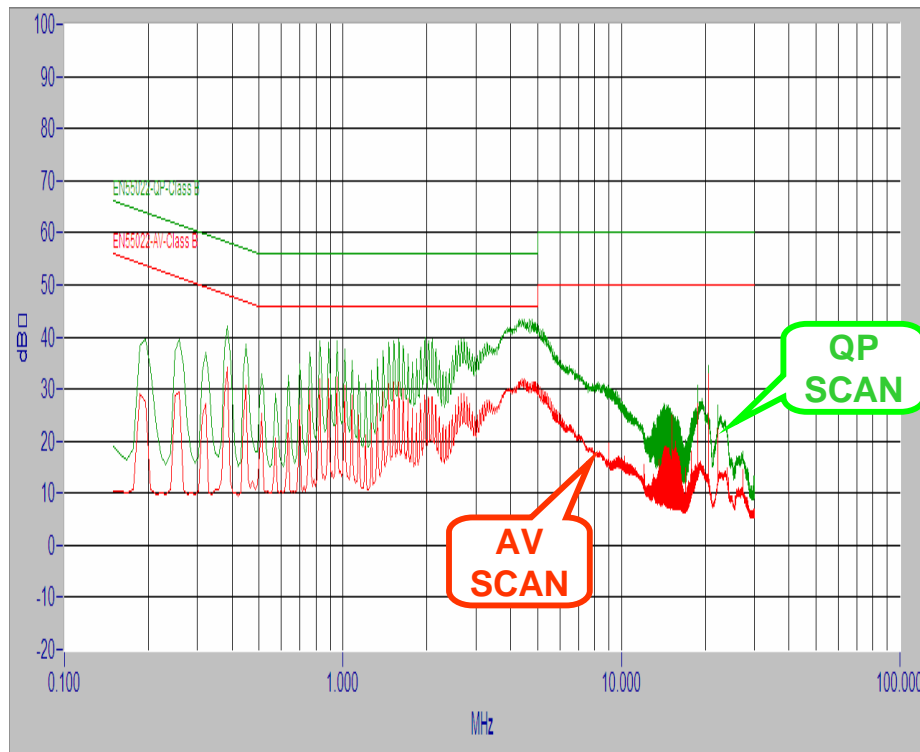
Item	90Vac		264Vac	
	T(°C)	Tr(°C)	T(°C)	Tr(°C)
T1-W	68.0	17.9	65.8	24.5
T1-C	60.8	18.7	60.6	19.3
Q1	80.0	37.9	85.9	44.6
D6	71.6	29.5	71.1	29.8
C10	60.4	18.3	59.9	18.6
C2	58.1	16.0	55.6	14.3
U1	68	25.9	60.3	19.0
Ambient Temperature	42.1		41.3	



18. Conducted EMI

230V_{AC}/50Hz, Live

230V_{AC}/50Hz, Neutral

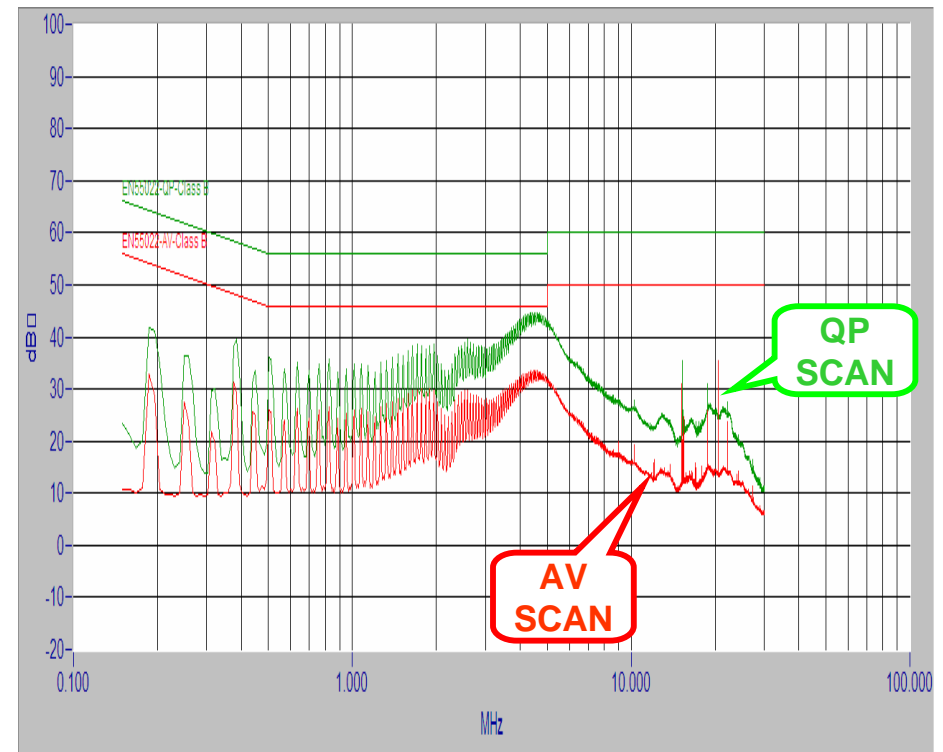
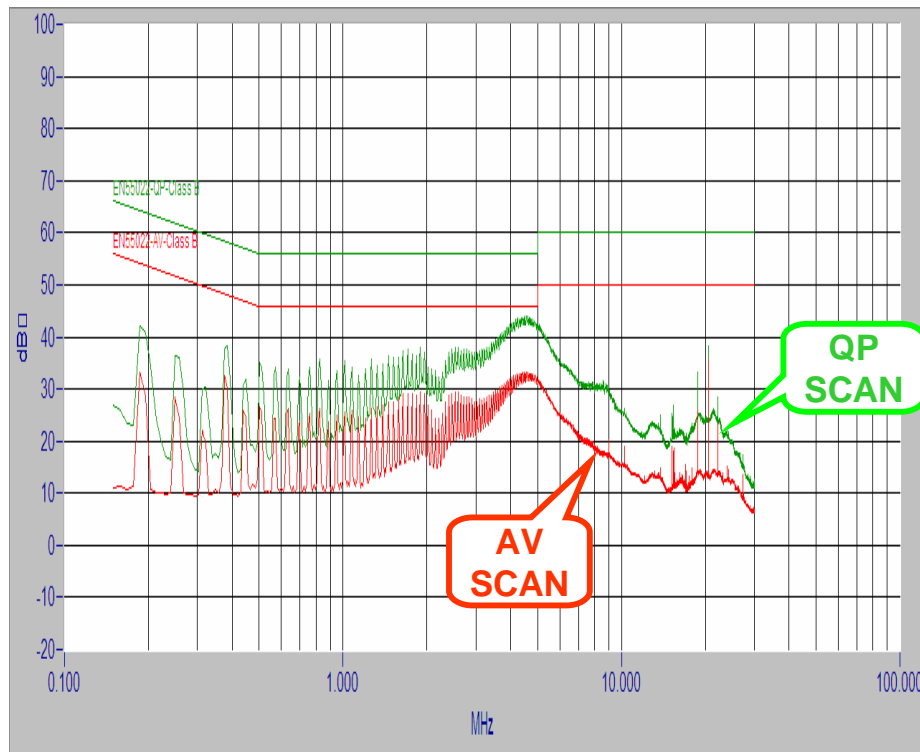


Test Conditions : Resistive Full load. Output Ungrounded.

19. Conducted EMI

115V_{AC}/50Hz, Live

115V_{AC}/50Hz, Neutral



Test Conditions : Resistive Full load. Output Ungrounded.