Charger Design with iW1690 (EBC101)

General Design Specification :

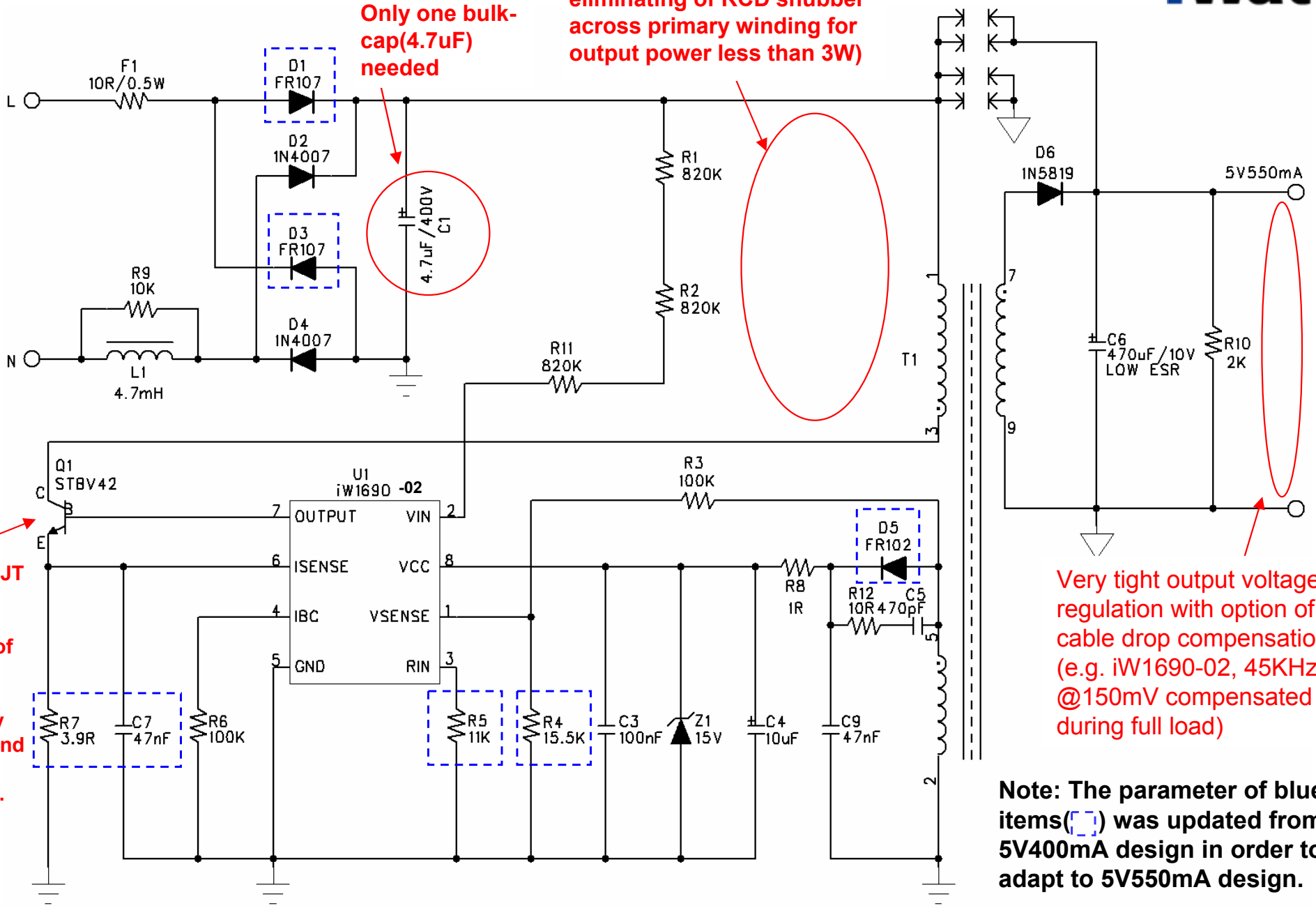
1. **AC Input Range 90-264Vac**
2. **DC Output 5V, 550mA~650mA (CC)**
3. **No-load Standby Power Consumption <0.15W@230Vac**
4. **Max Ripple 150mV$_{P_P}$**
5. **No Y-CAP design.**

26 May '08

1. Specification

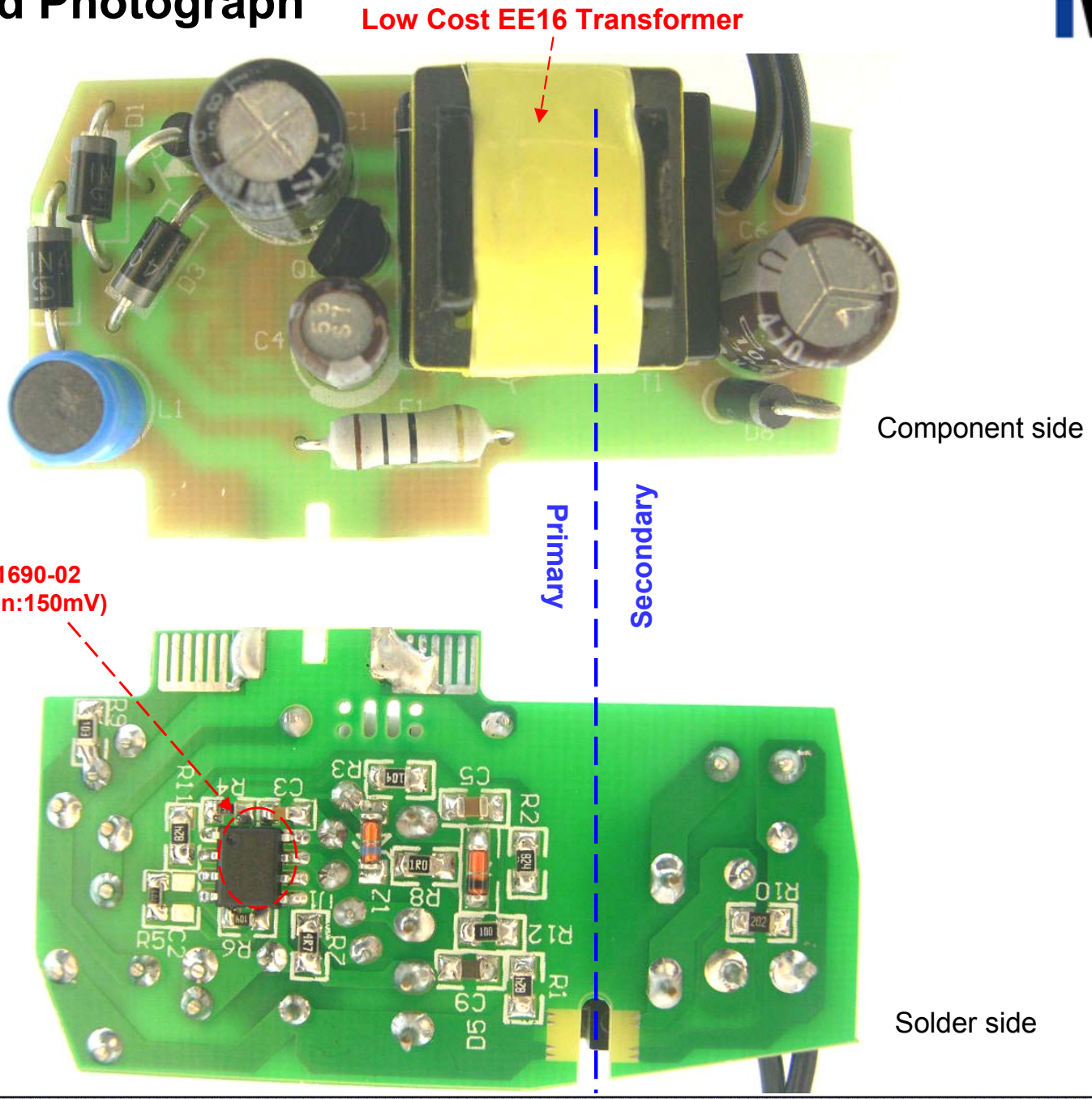
Description		Symbol	Min	Typ	Max	Units	Comment
Input							
Voltage		V_{IN}	90		264	V_{AC}	2 Wire
Frequency		f_{LINE}	47	50/60	63	Hz	
No-load Input Power ($264V_{AC}$)					0.15	W	
Output							
Const Voltage	Output Voltage	V_{OUT_CV}	4.75	5	5.25	V	Measured at the end of Cable
	Output Current	I_{OUT_CV}	0		0.8	A	
Const 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}	0.55		0.65	A	
Output Ripple Voltage		V_{RIPPLE}			150	mV_{P_P}	Measured at the End of DC Output cable I_{OUT}=0.55A @T_A = 25 ℃ 20 MHz Bandwidth
Total Output Power							
Continuous Output Power		P_{OUT}			2.75	W	
Over Current Protection		I_{OUT_MAX}			0.65	A	Auto-restart
Efficiency		η	64			%	Measured at end of PCB, V_{IN} = $90V_{AC}$ I_{OUT}= 550mA. (T_A = 25 ℃)
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



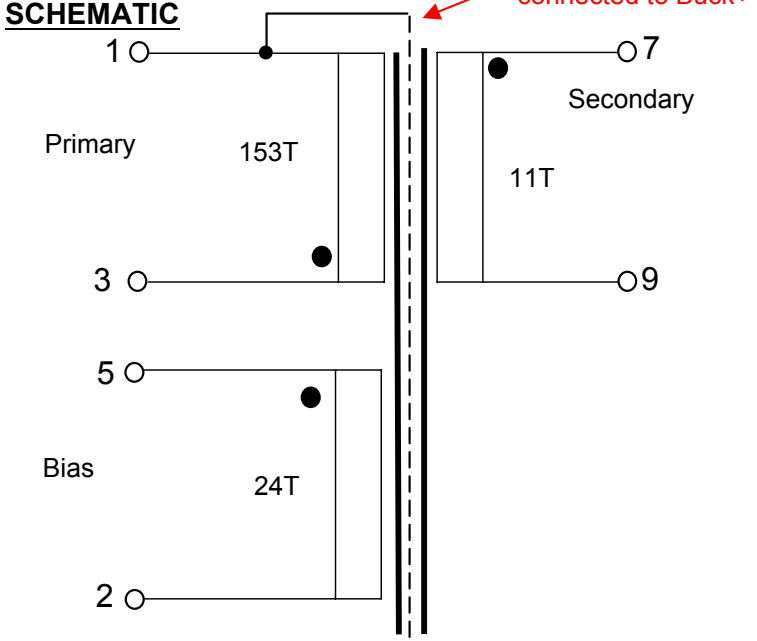
Note: The parameter of blue items( ) was updated from 5V400mA design in order to adapt to 5V550mA design.

3. Circuit Board Photograph

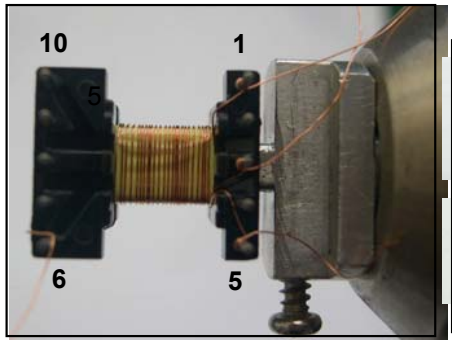


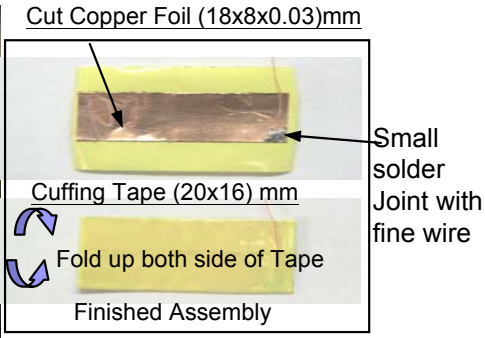
4.Transformer

SCHEMATIC



Winding Start Pin-3 & End at Pin-1 in Clockwise direction looking from pin 6-10 side of the bobbin





ELECTRICAL SPECIFICATIONS:

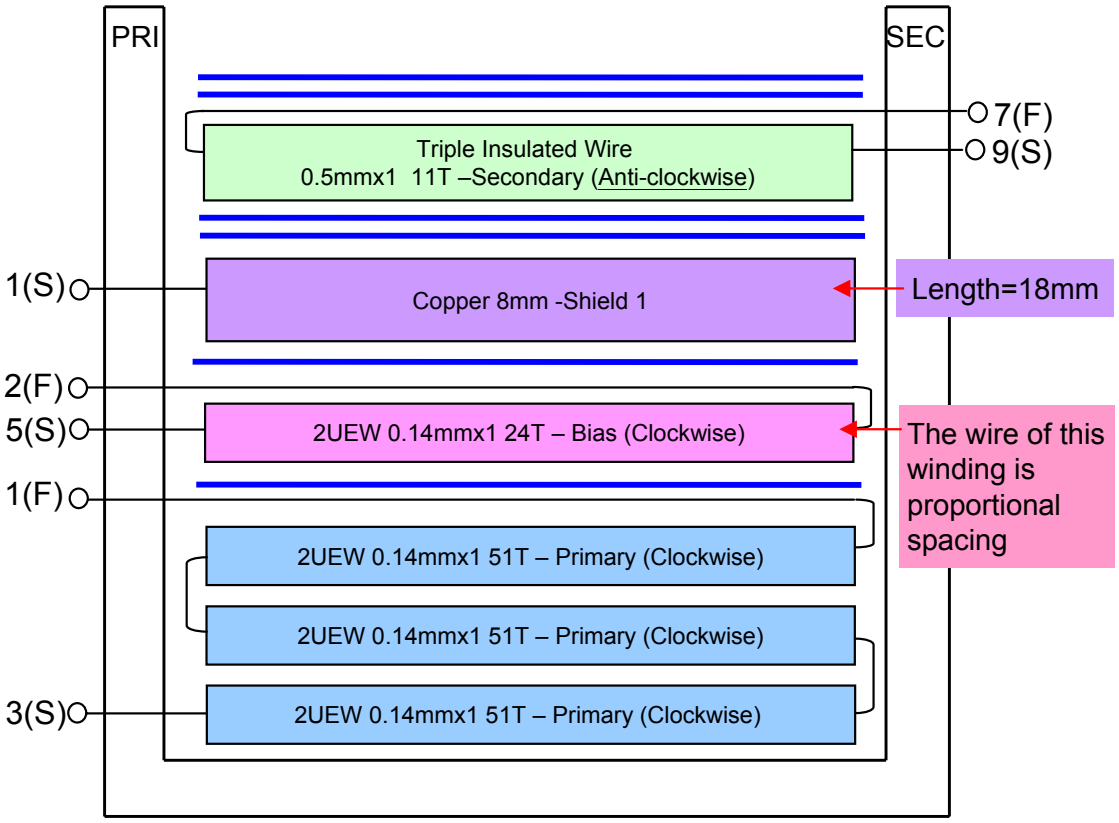
1. Primary Inductance (Lp) = 3.3mH (±10%)@10KHz
2. Electrical Strength = 3KV, 50/60Hz,1Min (pins1~5 to pins 6~10)

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 Pin4,6.8.pin10 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	iW1690-02, Off-line digital PWM Controller, SO-8		
3	1	C1	4.7uF, 400V, E-CAP, (ESR<7Ω@10KHz and 25℃)		
2	1	C2	OPEN		
4	1	C3	100nF, 25V, X5R, SMD-0603		
5	1	C4	4.7uF, 50V, Low ESR E-CAP, 5x11.5		
6	1	C5	470pF,100V,SMD-0805		
7	1	C6	470uF,10V, Low ESR E-CAP		
6	1	C7	47nF,SMD-0603		
6	1	C9	47nF,SMD-0805		
8	2	D1,D3	FR107, Rectifier Diode, DO-41		
8	2	D2,D4	1N4007, Rectifier Diode, DO-41		
9	1	D5	FR102, Fast Rectifier Diode		
10	1	D6	SR160, Schottky Diode,DO-41		
11	1	F1	10Ω, Fuse Resistor, 0.5W		
12	1	L1	4.7mH, Filter Inductor		
13	1	Q1	STBV42, 700V/1A, HV Transistor, TO-92		
14	1	R9	10KΩ ±5％, SMD-0805		
15	1	R7	3.9Ω ±1％, SMD-0805		
16	1	R3	100KΩ ±1％, SMD-0805		
17	1	R4	15.5KΩ ±1％, SMD-0603		
18	1	R5	11KΩ ±1％, SMD-0603		
19	1	R6	100KΩ ±1％, SMD-0603		
20	3	R1,R2,R11	820KΩ ±1％, SMD-0805		
21	1	R12	10Ω ±5％, SMD-0805		
22	1	R8	1Ω ±5％, SMD-0805		
23	1	R10	2KΩ ±5％, SMD-0805		
24	1	T1	EE16, Transformer		
25	1	Z1	15V±2%, Zener diode, 0.5W		
26	1	PCB	Single Board, 94V0		

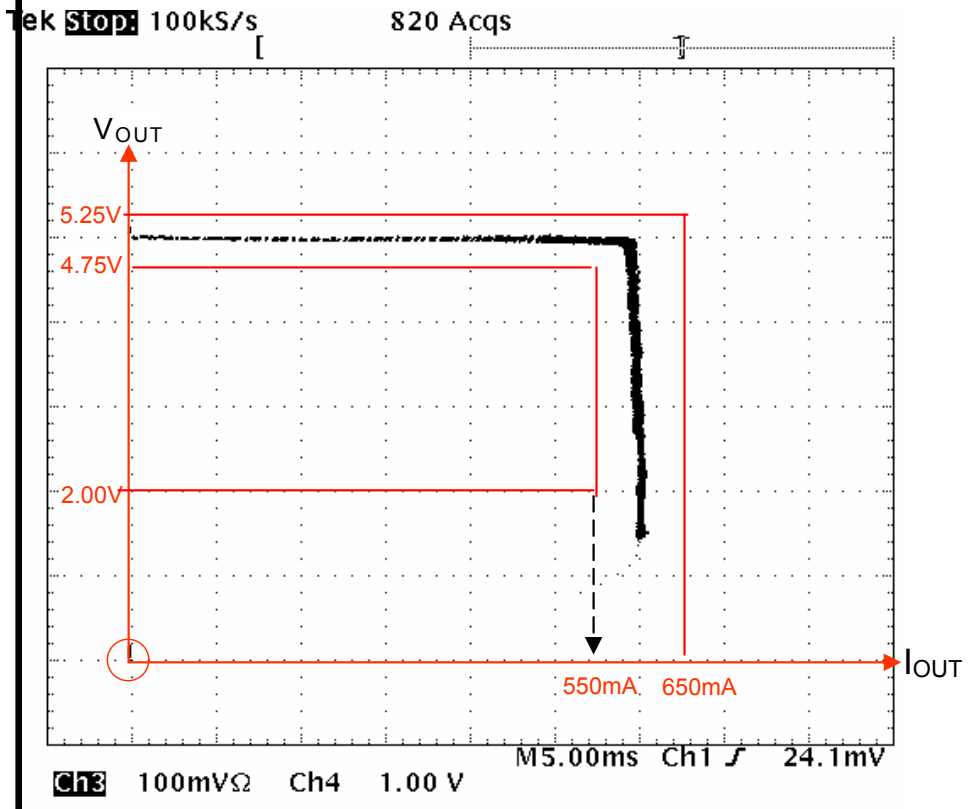
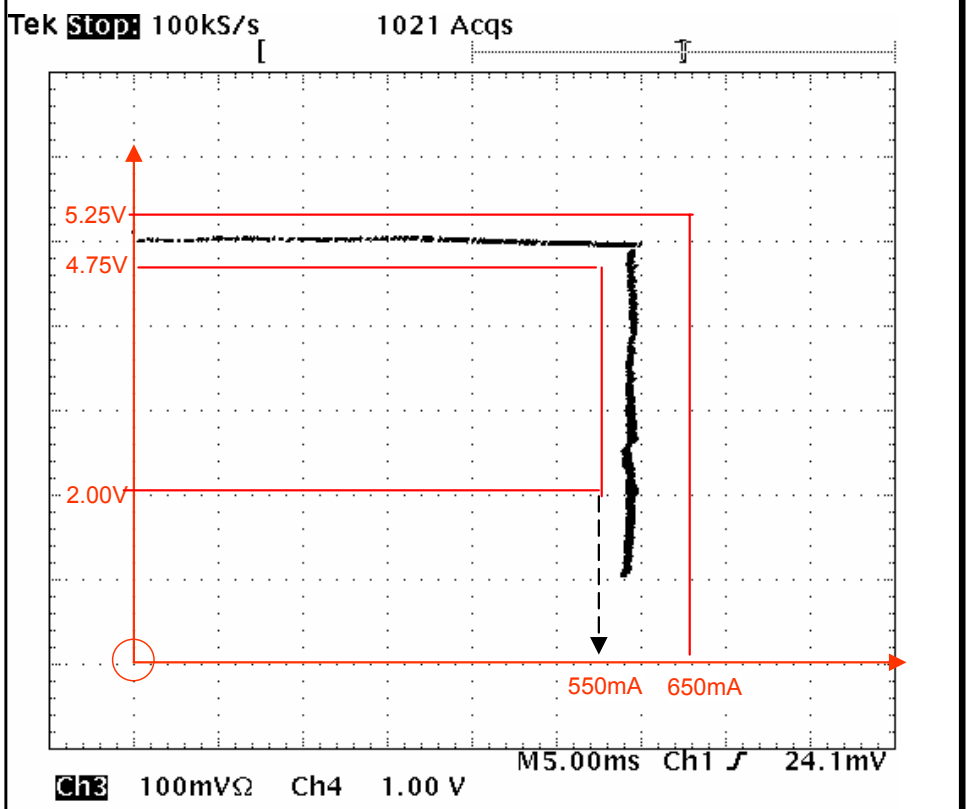
6. Regulation, Ripple and Efficiency Measurement

*** Note: Output voltage measured at end of PCB.**

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	V_{RIPPLE} (mV_{P-P})	P_{OUT} (W)	η (%)	OCP (mA)	$P_{IN-S/C}$ (mW)	Average η(%)	EPA 2.0 η (%)
90	0.06	5.10	0	7			607	52	73.0	Meet EPA2.0 With lot of margins !
	0.94	5.08	137	35	0.70	74.04				
	1.90	5.13	275	45	1.41	74.25				
	2.95	5.19	412	70	2.14	72.48				
	4.02	5.22	550	88	2.87	71.42				
115	0.07	5.09	0	7			609	58	73.9	63.7
	0.97	5.08	137	37	0.70	71.75				
	1.88	5.13	275	45	1.41	75.04				
	2.88	5.19	412	65	2.14	74.25				
	3.86	5.22	550	75	2.87	74.38				
230	0.12	5.10	0	7			592	104	70.3	
	1.13	5.11	137	36	0.70	61.95				
	1.99	5.17	275	43	1.42	71.44				
	2.94	5.21	412	62	2.15	73.01				
	3.84	5.23	550	64	2.88	74.91				
264	0.14	5.12	0	7			590	122	68.2	
	1.20	5.11	137	39	0.70	58.34				
	2.05	5.17	275	42	1.42	69.35				
	3.02	5.21	412	60	2.15	71.08				
	3.89	5.23	550	62	2.88	73.95				

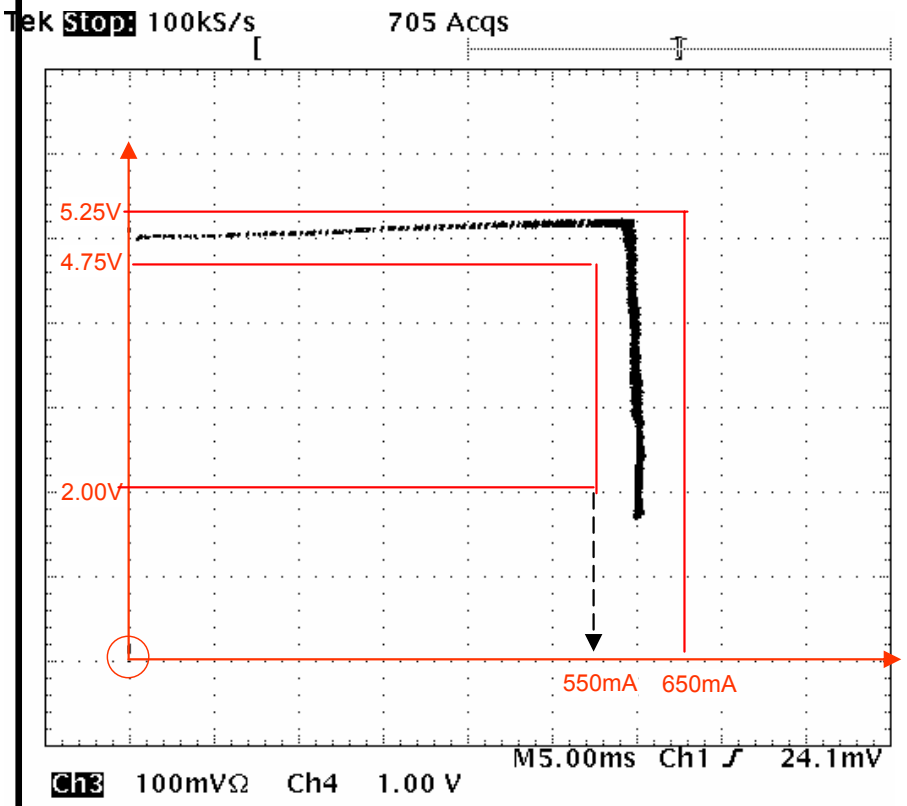
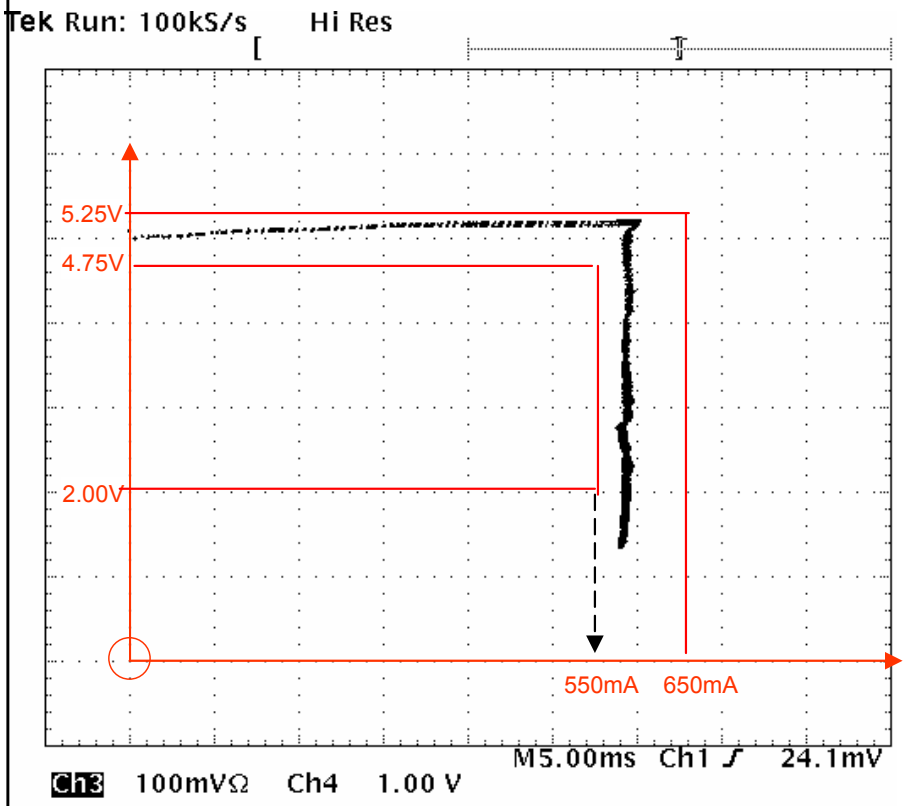
7. Output VI Characteristics

*** Note: Output voltage measured at DC-Cable(24AWG, 1.8m, 0.4Ω) terminal, T_{AMB}=25℃**

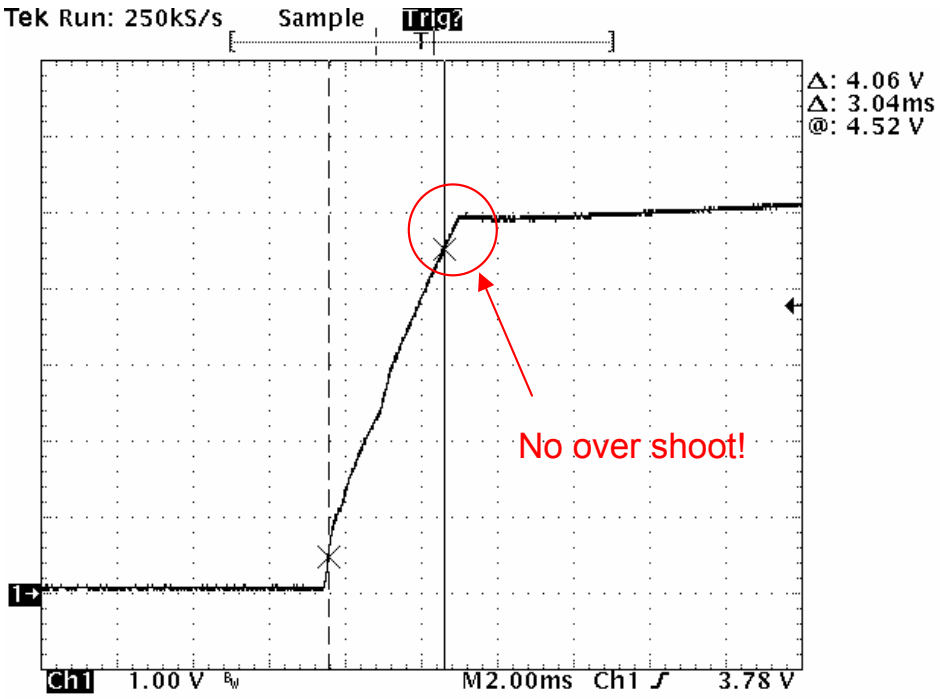
V_{IN}=90V_{AC}, T_{AMB}=25℃	V_{IN}=264V_{AC}, T_{AMB}=25℃
	

8. Output VI Characteristics

*** Note: Output voltage measured at the end of PCB, T_{AMB}=25 ℃**

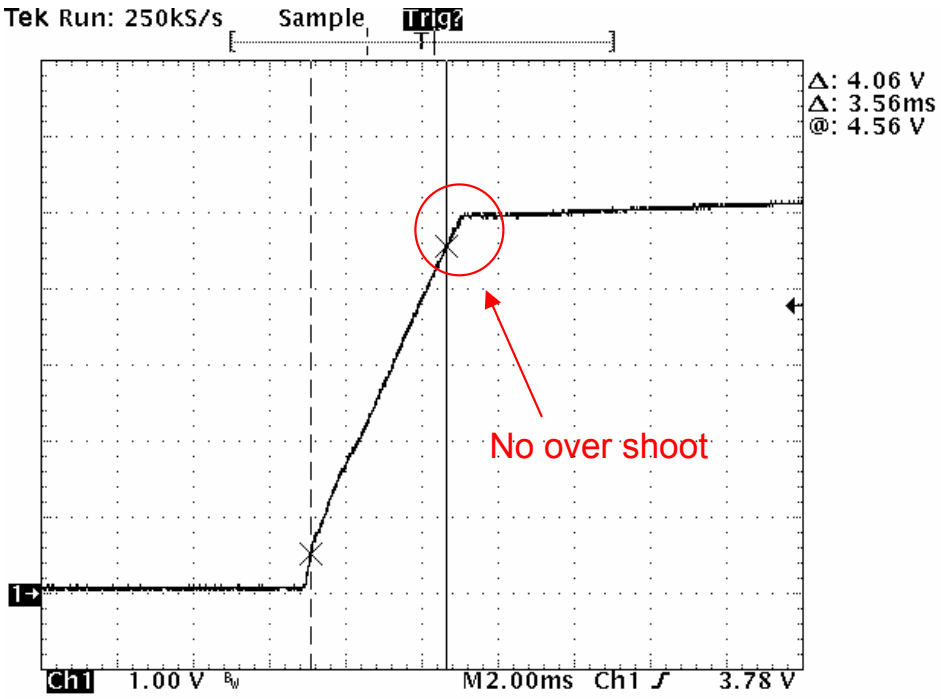
V_{IN}=90V_{AC}, T_{AMB}=25℃	V_{IN}=264V_{AC}, T_{AMB}=25℃
	

9. Output Voltage Rise Time



90VAC,No Load

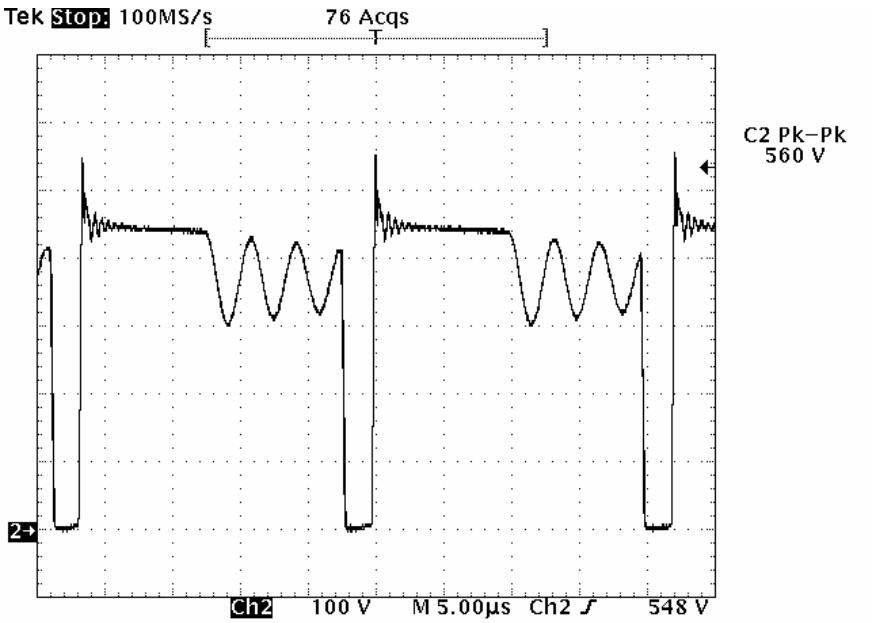
1V/Div,2ms/Div



264VAC,No Load

1V/Div,2ms/Div

10. V_{CE} waveform



Test Condition:

V_{IN}=264V_{AC}, I_{OUT_CV}=550mA

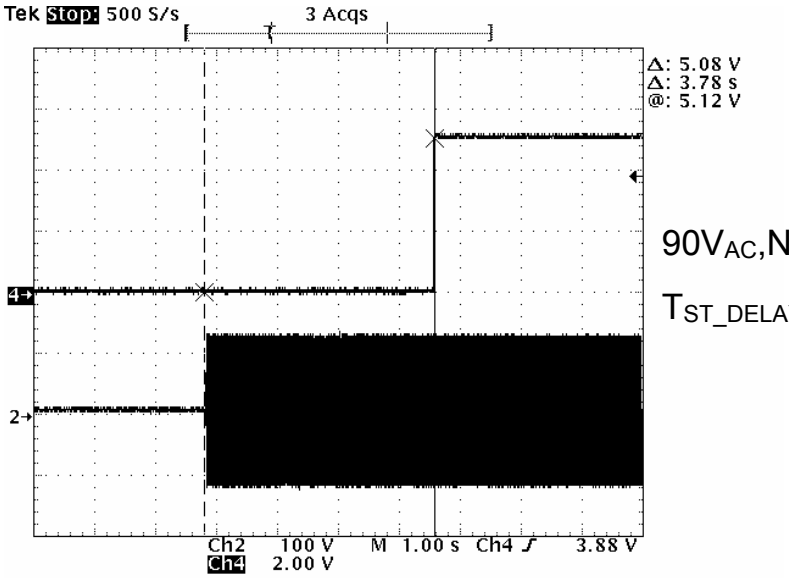
Result:

V_{CE_MAX}=**560V**

Appendix – Simple Specification for used Transistor(STBV42)

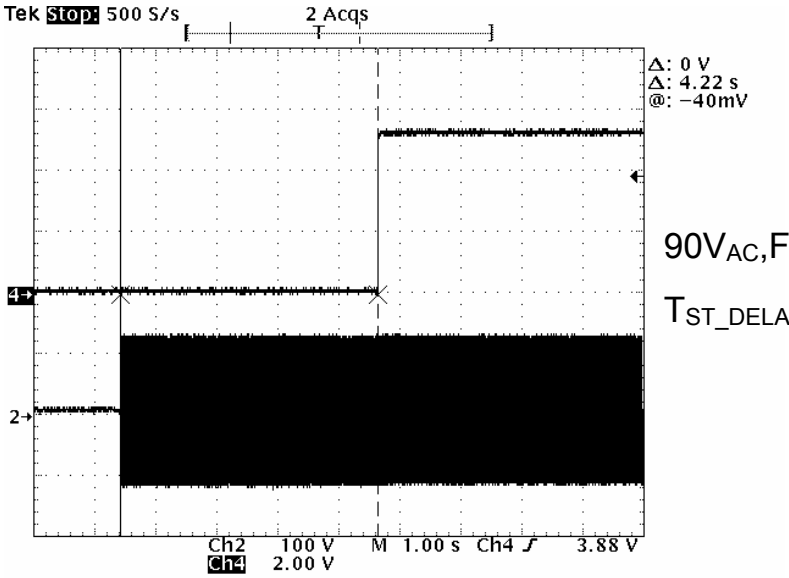
Symbol	Parameter	Value	Unit
V_{CES}	Collector-Emitter Voltage (V_{BE} = 0)	700	V
V_{CEO}	Collector-Emitter Voltage (I_B = 0)	400	V
V_{EBO}	Emitter-Base Voltage (I_C = 0)	9	V
I_C	Collector Current	1	A
I_{CM}	Collector Peak Current (t_p < 5 ms)	2	A
I_B	Base Current	0.5	A
I_{BM}	Base Peak Current (t_p < 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

11. Start Up & Turn On Delay Time



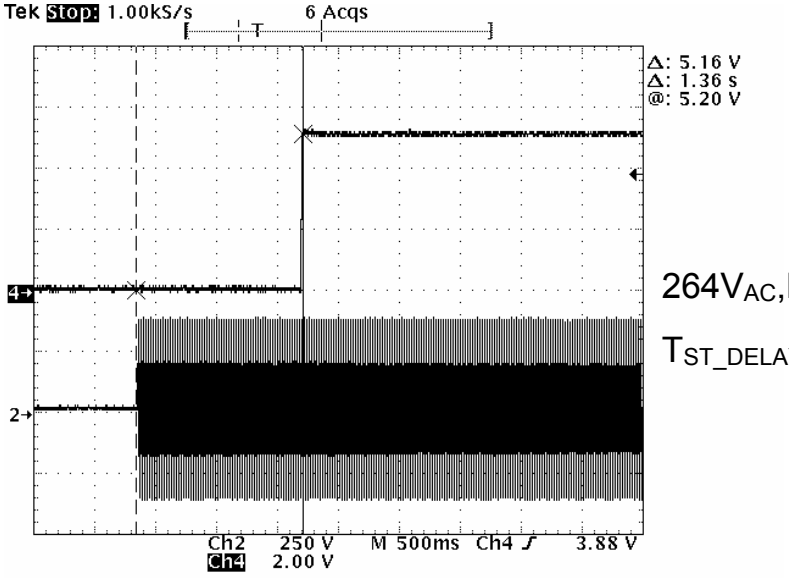
90V_{AC},No Load

T_{ST_DELAY}=3.78S



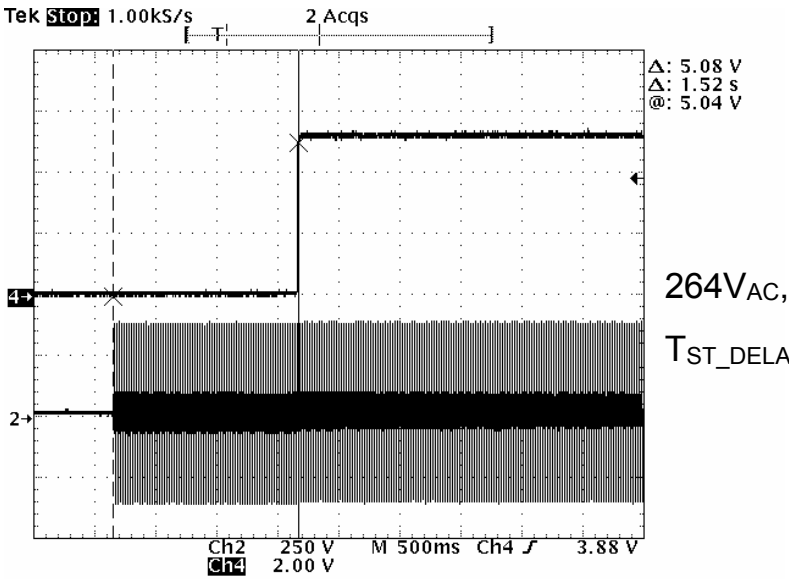
90V_{AC},Full Load

T_{ST_DELAY}=4.22S



264V_{AC},No Load

T_{ST_DELAY}=1.36S

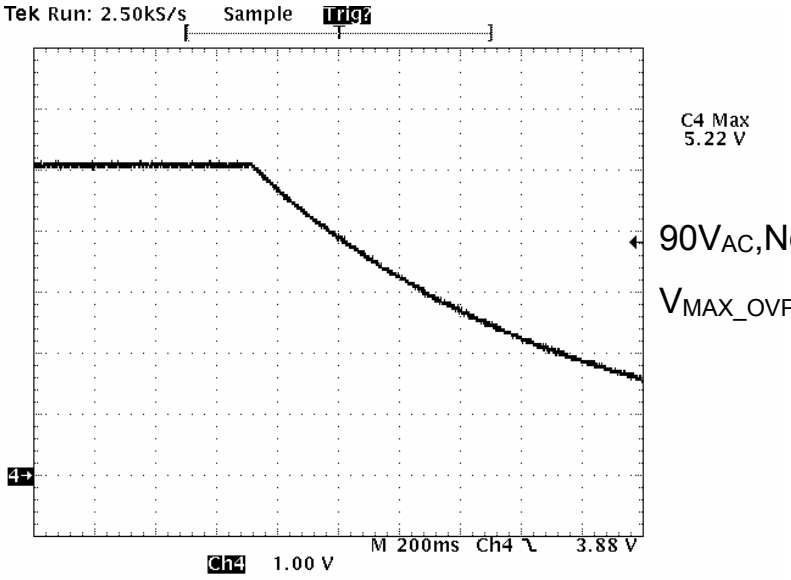


264V_{AC},Full Load

T_{ST_DELAY}=1.52S

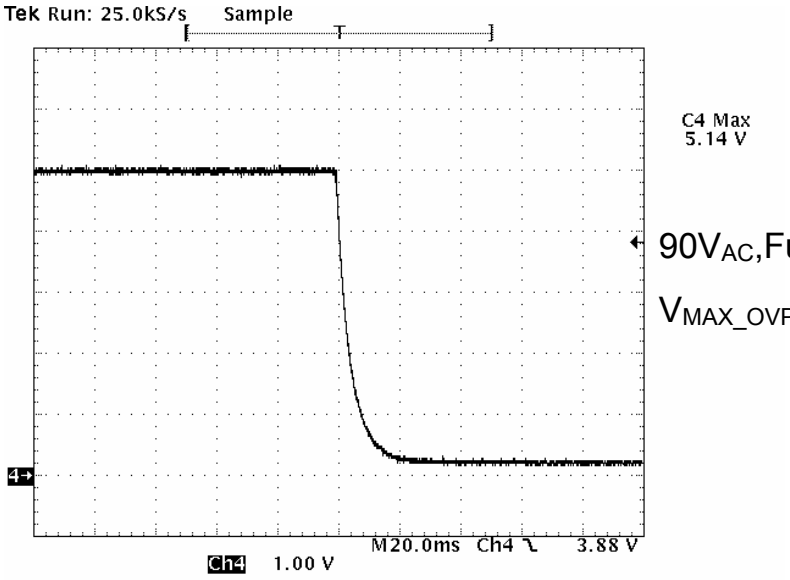
12. OVP Performance

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



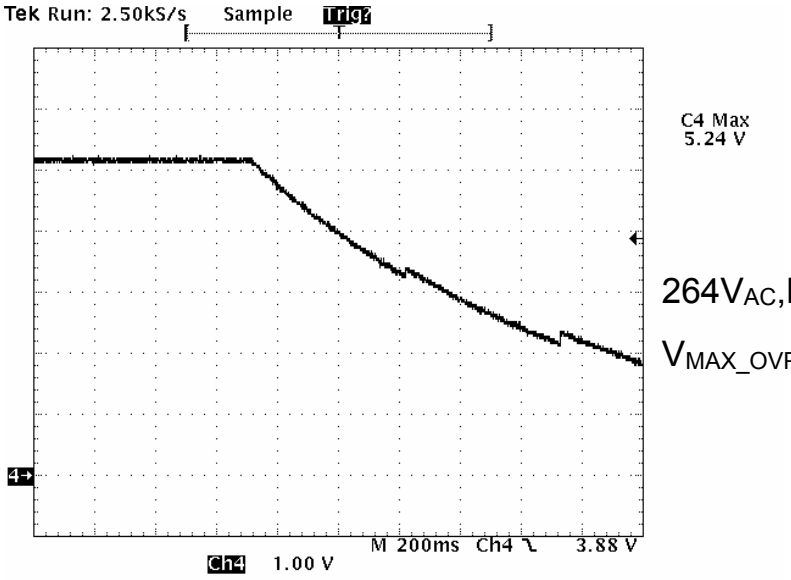
90V_{AC},No Load

V_{MAX_OVP}=5.22V



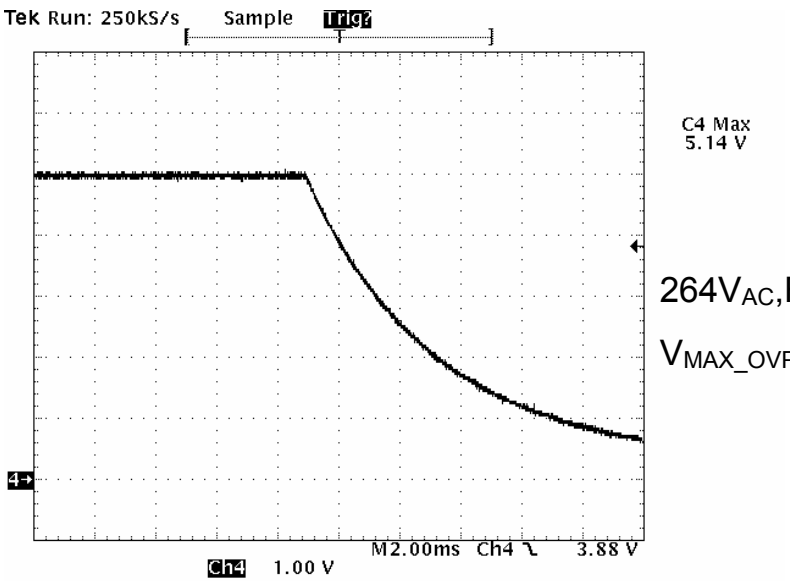
90V_{AC},Full Load

V_{MAX_OVP}=5.14V



264V_{AC},No Load

V_{MAX_OVP}=5.24V

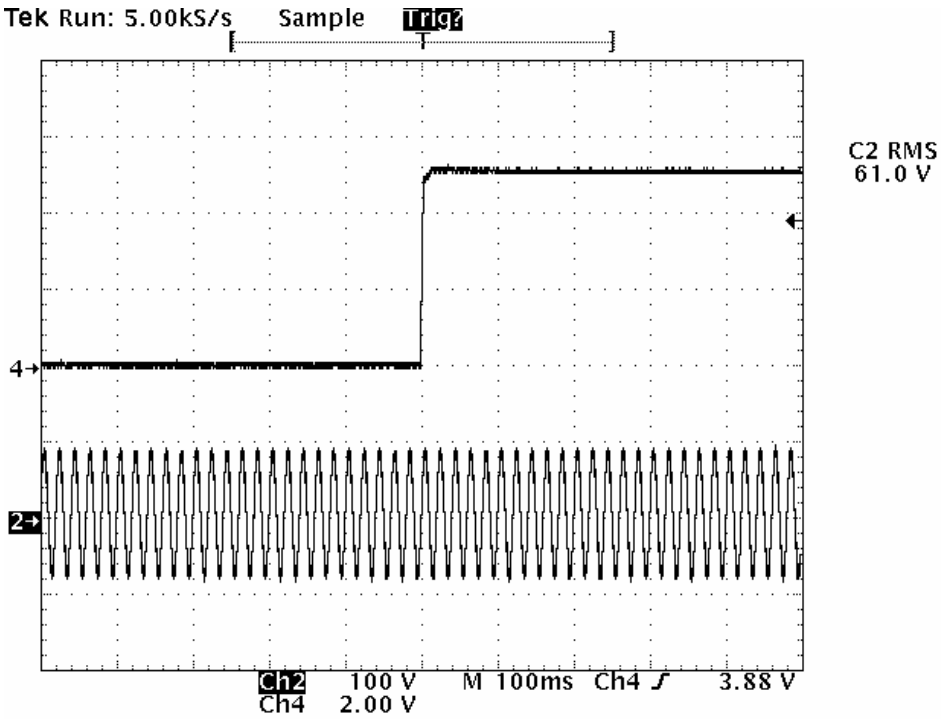


264V_{AC},Full Load

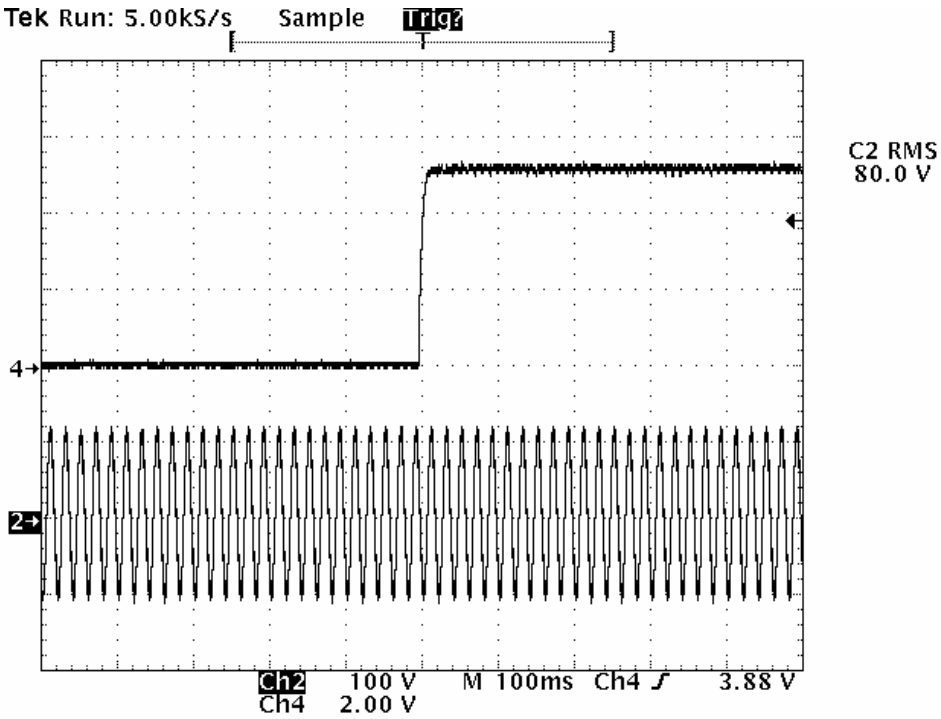
V_{MAX_OVP}=5.14V

13. AC Startup Voltage Characteristic

No Load, $V_{IN\_STARTUP}$ =61.0V_{AC}

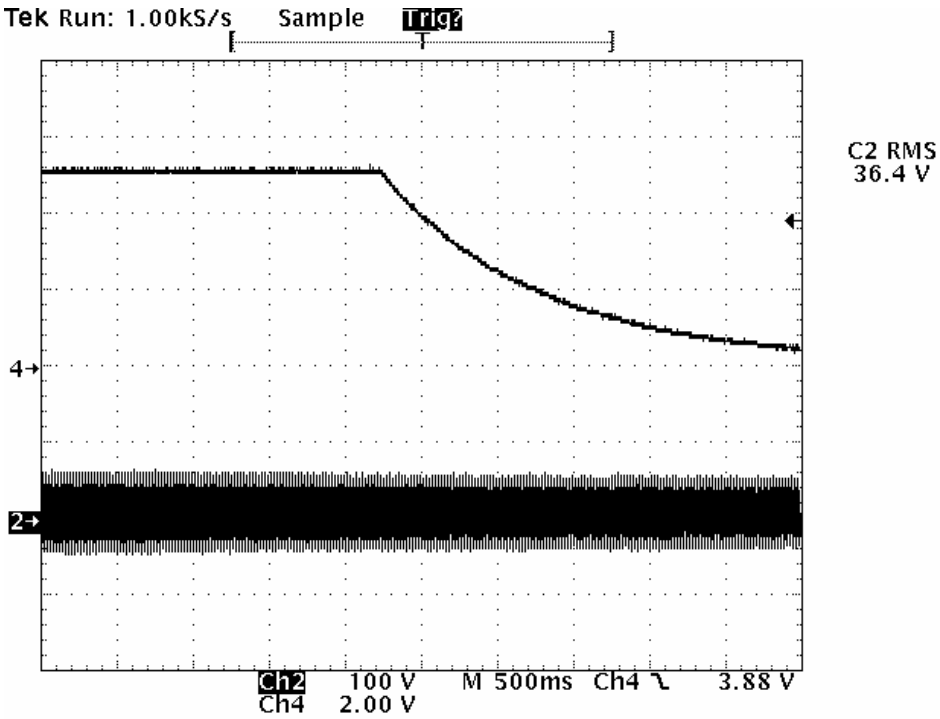


Full Load, $V_{IN\_STARTUP}$=80.0V_{AC}

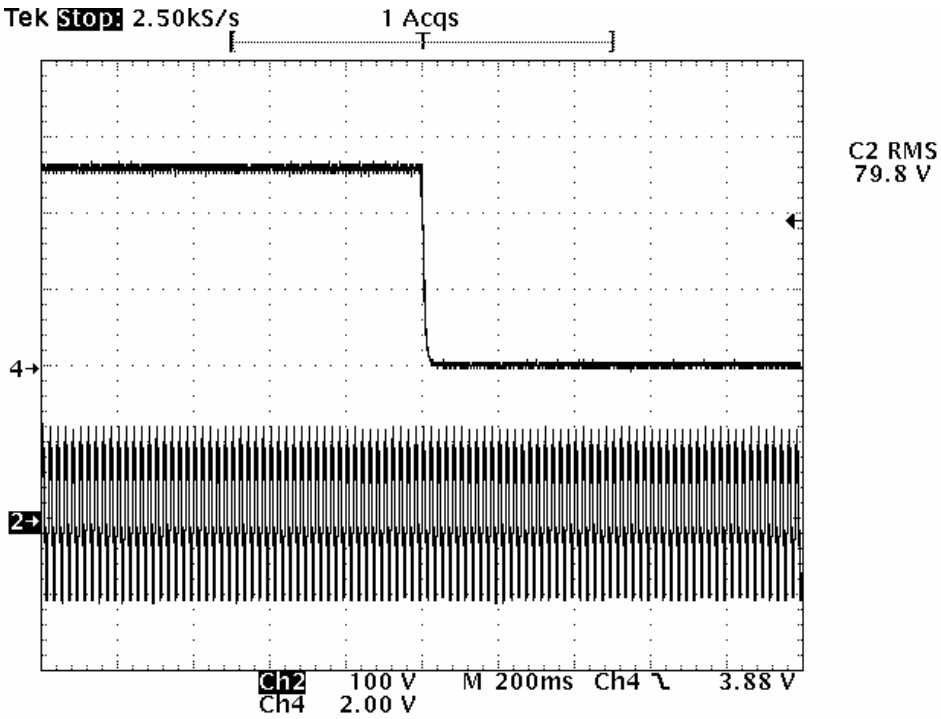


14. AC Brownout Voltage Characteristic

No Load, $V_{IN\_BROWNOUT}$ =36.4V_{AC}

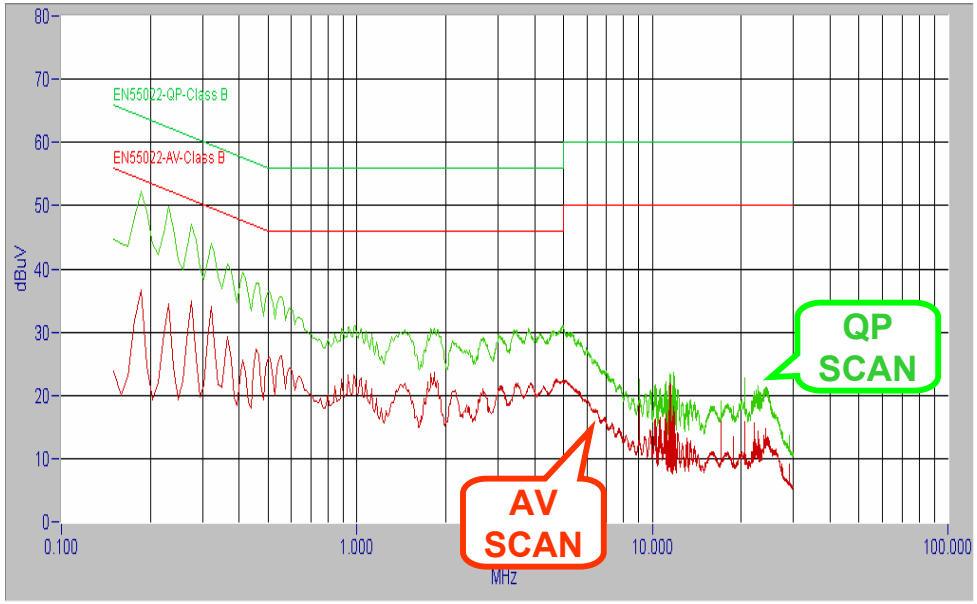


Full Load, $V_{IN\_BROWNOUT}$=79.8V_{AC}

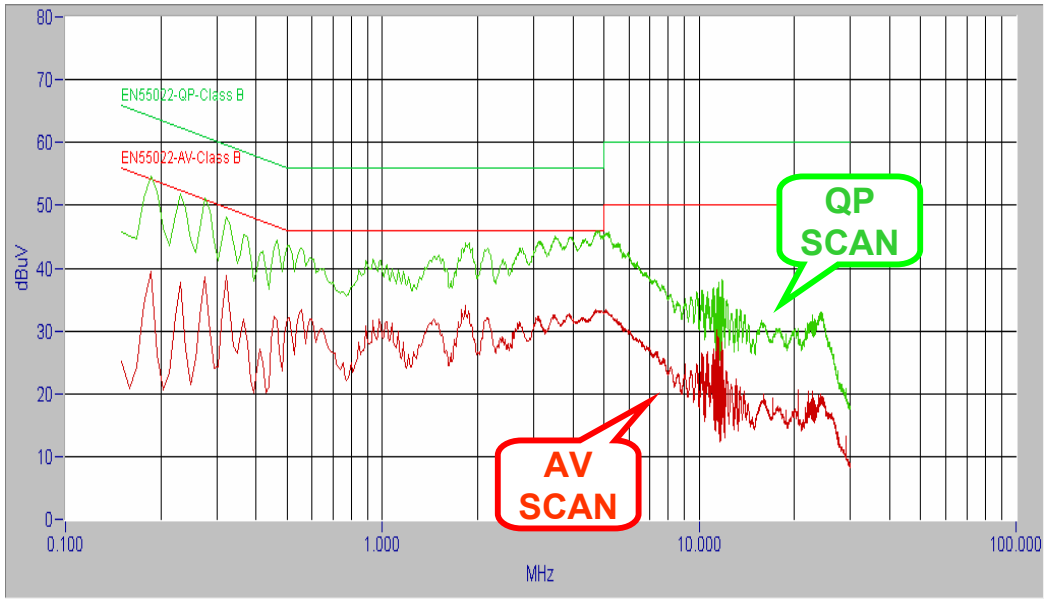


15.Conducted EMI

230V_{AC}/50Hz,Live



230V_{AC}/50Hz,Neutral



Test Conditions : Resistive Full load. Output Ungrounded.