iWatt
Intelligent AC-DC and LED Power™

iW1700-01 For 5V1A Mini-TA Charge Design

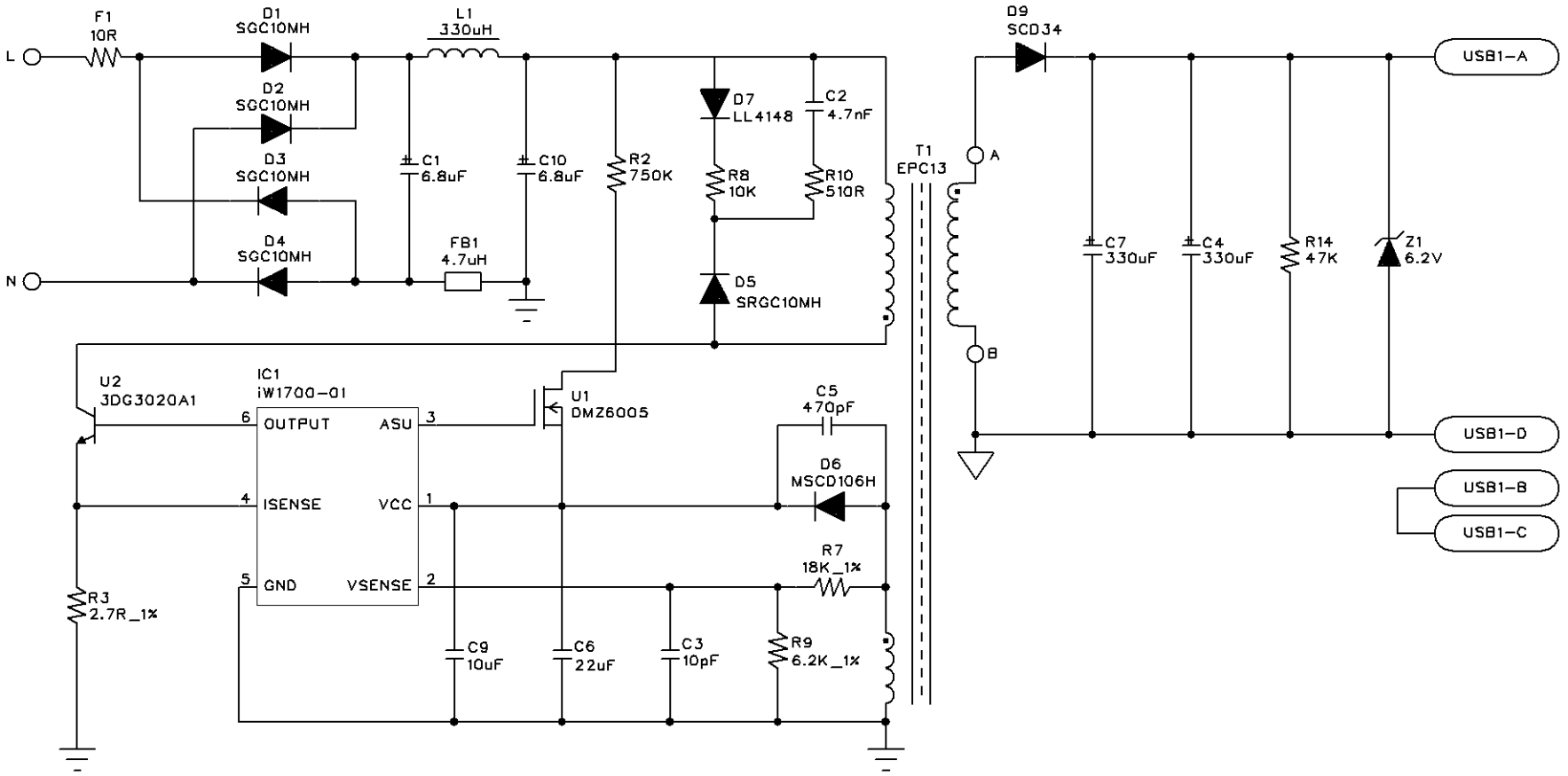
General Design Specification:

1. AC Input Range 90-264Vac
2. DC Output 5V, 1.00~1.20A(CC)
3. Meet *"ZeroPower"* No-Load Standby Power Consumption Requirement
4. Meet *"EPA_2.0"* Requirement with 26AWG/1.2m DC-Cable
5. Meet "*USB3.0" Dynamic Load Response* Requirement
6. Meet *"MoU"* Requirement

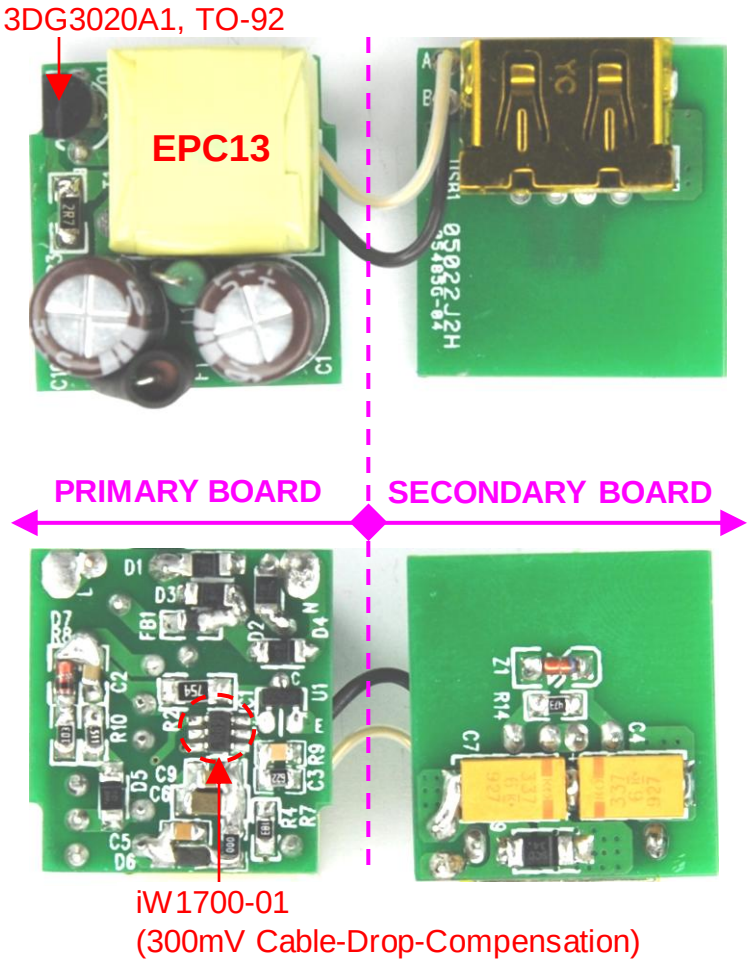
1. Specification

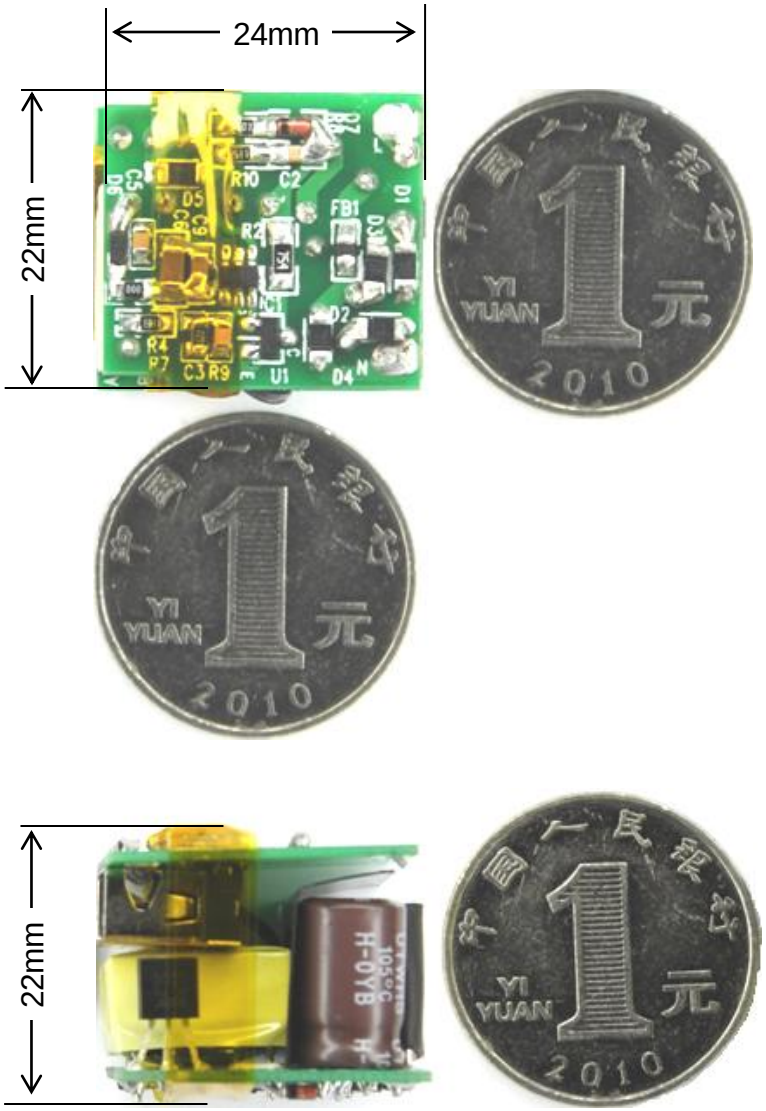
Description		Symbol	Min	Typ	Max	Units	Comment
Input							
Voltage		V_{IN}	90		264	V_{AC}	2 Wire
Frequency		f_{LINE}	47	50/60	63	Hz	
No-load Input Power (230V_{AC})					5	mW	
Output							
Constant Voltage	Output Voltage	V_{OUT_CV}	4.75	5.00	5.25	V	Measured at end of output DC-Cable
	Output Current	I_{OUT_CV}	0		1.00	A	
Constant Current	Output Voltage	V_{OUT_CC}	>2.5	Depending on battery voltage		V	Min V_{OUT} is dependence of V_{CC} supply voltage
	Output Current	I_{OUT_CC}	1.00		1.20	A	
Output Ripple Voltage		V_{RIPPLE}			80	mV_{P_P}	Measured at end of Output DC-Cable I_{OUT}=1A @T_A = 25 ℃ 20 MHz Bandwidth
Total Output Power							
Continuous Output Power		P_{OUT}		5		W	
Over Current Protection		I_{OUT_MAX}			1.20	A	Auto-restart
Active Mode Efficiency		η	68.2			%	Measured at end of output DC-Cable, V_{IN} = 115VAC and 230VAC (T_{AMB} = 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


F1
10R
L
N
D1
SGC10MH
D2
SGC10MH
D3
SGC10MH
D4
SGC10MH
L1
330uH
C1
6.8uF
C10
6.8uF
FB1
4.7uH
R2
750K
D7
LL4148
C2
4.7nF
R8
10K
R10
510R
D5
SRGC10MH
T1
EPC13
A
B
D9
SCD34
C7
330uF
C4
330uF
R14
47K
Z1
6.2V
USB1-A
USB1-D
USB1-B
USB1-C
U2
3DG3020A1
IC1
iW1700-01
OUTPUT
ASU
ISENSE
VCC
GND
VSENSE
U1
DMZ6005
C5
470pF
D6
MSCD106H
R7
18K_1%
R3
2.7R_1%
C9
10uF
C6
22uF
C3
10pF
R9
6.2K_1%

3. Circuit Board Photograph



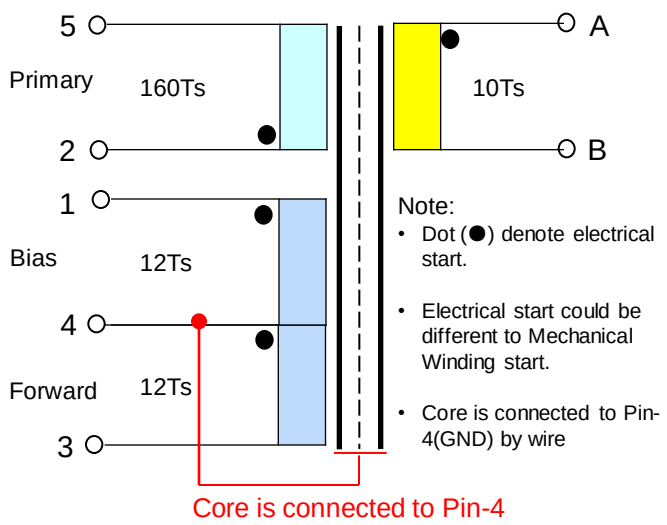


4. Bill of Material

Item	Qty	Reference	Description
1	1	IC1	iW1700-01(300mV CDC), Off-line Digital PSR & PWM & VMS Controller, SOT23-6
2	2	C1,C10	6.8uF, 400V, E-Cap, Φ8mm X 12mm
3	1	C2	4.7nF, 250V, X7R, SMD-0805
4	1	C3	10pF, 25V, NPO, SMD-0805
5	1	C5	470pF, 100V, X7R, SMD-0805
6	1	C6	22uF, 16V, X7R, SMD-1206
7	2	C4,C7	330uF, 6.3V, Tantalum Capacitors
8	1	C9	10uF, 16V, X7R, SMD-0805
9	5	D1,D2,D3,D4,D5	SGC10MH, 1A1000V, Fast Recovery Rectifier (Trr=500ns), SMD-1206S
10	1	D6	MSCD106H, 1A60V, Schottky Diode, SMD-0805
11	1	D7	LL4148, Fast Recovery Diode, LL34
12	1	D9	SCD34, 3A40V, Schottky Diode, SMD-2010
13	1	Z1	6.2V, Zener Diode, LL34
14	1	F1	10Ω, Fusible Resistor, 1W
15	1	L1	330uH, Color Ring Inductor, 0410
16	1	FB1	4.7uH, Chip Inductor(P/N: LQM21FN4R7M80), SMD-0805
17	1	Q1	3DG3020A1, 1.5A800V, NPN Transistor(hFE:25-30), TO-92
18	1	U1	DMZ6005, 12mA600V, Depletion Mode MOSFET, SOT23
19	1	R2	750KΩ ±5%, SMD-1206
20	1	R3	2.7Ω ±1%, SMD-0805
21	1	R7	18KΩ ±1%, SMD-0805
22	1	R8	10KΩ ±5%, SMD-0805
23	1	R9	6.2KΩ ±1%, SMD-0805
24	1	R10	510Ω, ±5%,SMD-0805
25	1	R14	47KΩ ±5%, SMD-0805
26	1	T1	EPC13, Horizontal Type
27	1	PCB	Double Sides Board, 94V0

5.Transformer Design

SCHEMATIC



ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (Lp) = 1.55mH(±7%)@10KHz
2. Electrical Strength = 3KV, 50/60Hz,1Min

MATERIALS:

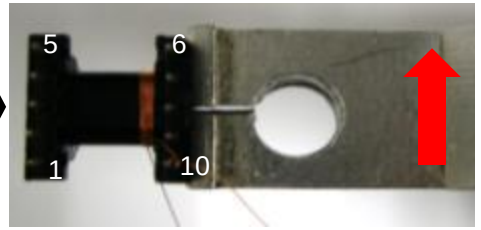
1. Core : EPC13(Ferrite Material TDK PC40 or equivalent)
2. Bobbin : EPC13 Horizontal.
3. Magnet Wires (Pri) : Type 2-UEW
4. Magnet Wire (Sec) : Triple Insulated Wires
5. Layer Insulation Tape :3M1298 or equivalent.

FINISHED :

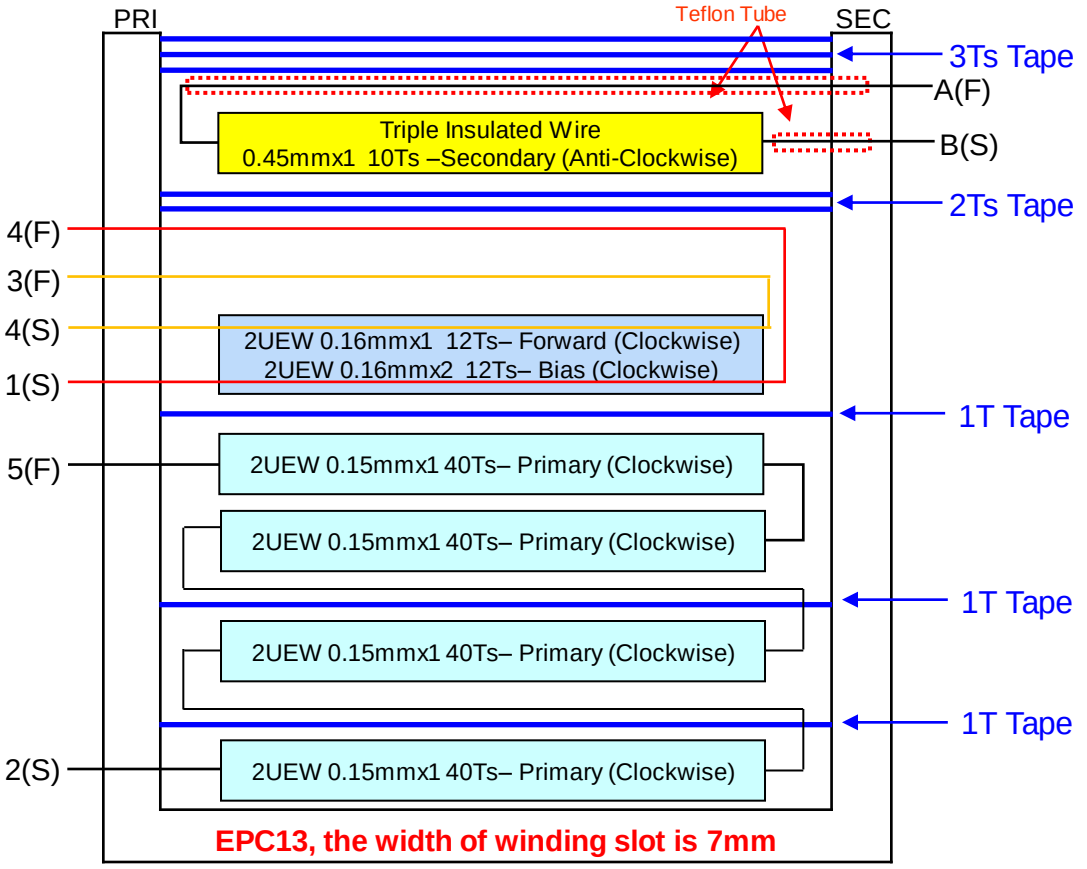
1. Varnish the complete assembly

Instruction for start of first winding…

Winding Start pin-2 & End pin-5 in "Clockwise" direction – looking from Pin 1/5 side of the Bobbin.



Rotating direction of winding machine



6. Regulation, Ripple and Efficiency Measurement

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* Note: Output voltage is 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 (A)	Average η(%)
90	0.0032	4.92	0	5.6			1.08	77.68
	1.59	5.03	250	29.2	1.26	79.17		
	3.24	5.09	500	37.6	2.55	78.65		
	5.08	5.23	750	53.6	3.92	77.14		
	7.02	5.32	1000	73.2	5.32	75.78		
115	0.0035	4.93	0	4.4			1.07	79.12
	1.58	5.03	250	32.8	1.26	79.55		
	3.20	5.10	500	39.6	2.55	79.69		
	4.95	5.21	750	44.4	3.91	79.05		
	6.81	5.32	1000	61.6	5.32	78.18		
230	0.0045	4.92	0	6.4			1.07	79.12
	1.62	5.05	250	38.0	1.26	78.24		
	3.23	5.09	500	44.8	2.55	78.91		
	4.93	5.23	750	52.4	3.92	79.57		
	6.67	5.32	1000	59.2	5.32	79.75		
264	0.0054	4.92	0	4.4			1.05	78.43
	1.64	5.05	250	42.4	1.26	77.22		
	3.26	5.10	500	47.6	2.55	78.17		
	4.95	5.22	750	54.2	3.91	78.98		
	6.71	5.32	1000	64.4	5.32	79.35		

7. EPA_2.0 Requirement

*Table 1: Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode: **Standard Models***

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal) [2]
0 to ≤ 1 watt	≥ 0.480 * P_{no} + 0.140
> 1 to ≤ 49 watts	≥ [0.0626 * Ln (P_{no})] + 0.622
> 49 watts	≥ 0.870

*Table 2: Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode: **Low Voltage Models***

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal) [2]
0 to ≤ 1 watt	≥ 0.497 * P_{no} + 0.067
> 1 to ≤ 49 watts	≥ [0.0750 * Ln (P_{no})] + 0.561
> 49 watts	≥ 0.860

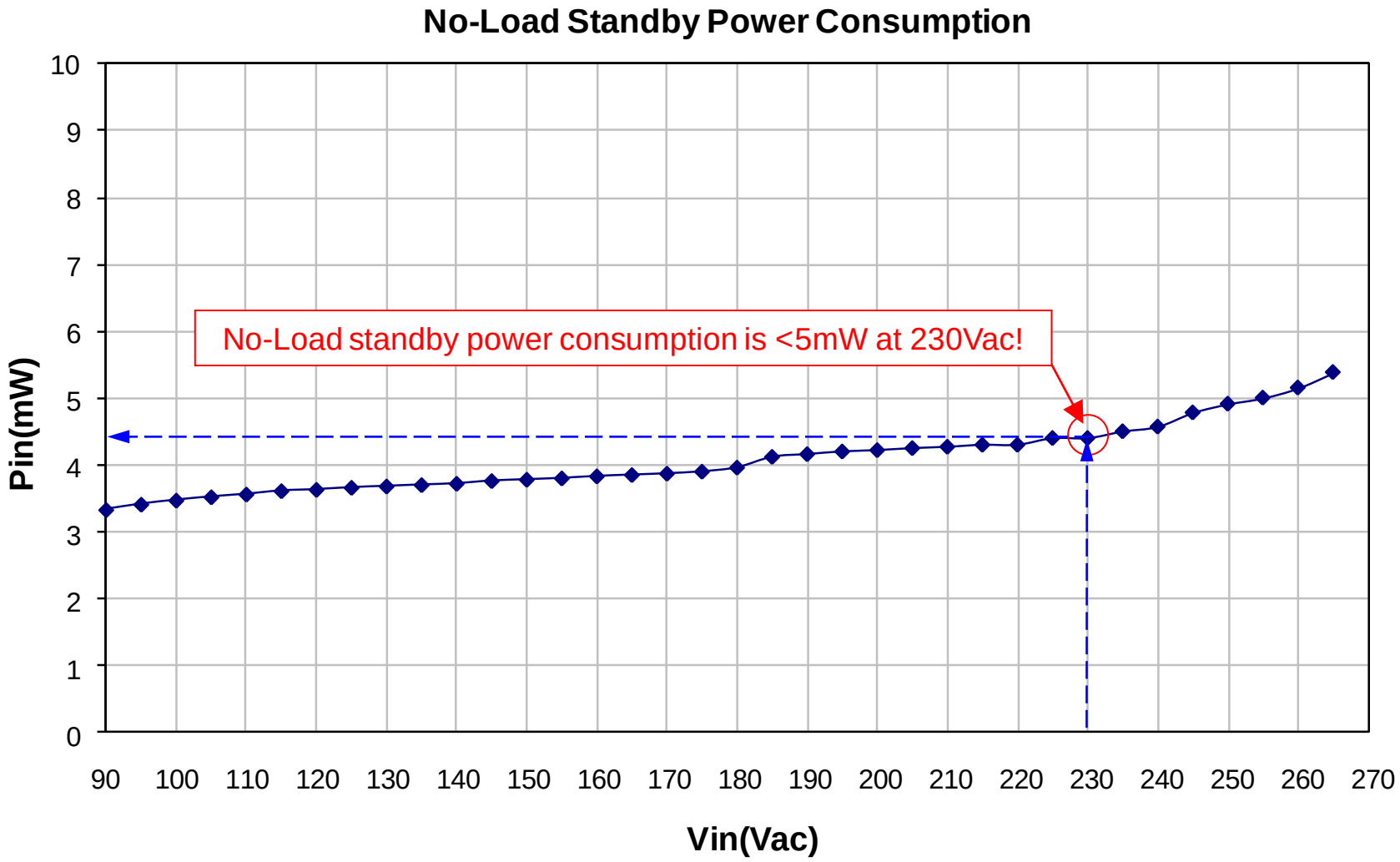
EPA2.0 (Final) for Low Voltage Model (P_{no}=5W)

$$0.075 \times \mathrm{Ln}(5\mathrm{W}) + 0.561 = 68.2\%$$

Meet EPA2.0 with lots of Margin!

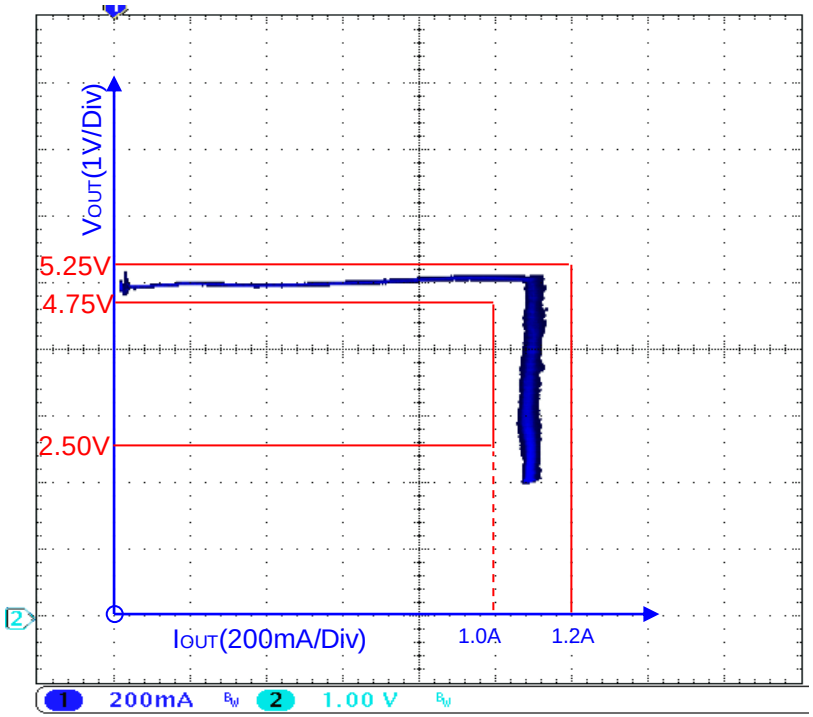
V_{IN} (VAC)	I_{OUT} (mA)	P_{IN} (W)	Measure at end of PCB				Measure at end of Output DC-Cable 26AWG/1.2m, R_{Cable}=0.34Ω			
			$V_{OUT\ PCB}$ (V)	$P_{OUT\ PCB}$ (W)	EFF_{PCB} (%)	AV-EFF_{PCB} (%)	$V_{OUT\ Cable}$ (V)	$P_{OUT\ Cable}$ (W)	EFF_{Cable} (%)	AV-EFF_{Cable} (%)
115	250	1.580	5.03	1.26	79.59	79.08	4.95	1.24	78.24	75.87
	500	3.200	5.10	2.55	79.69		4.93	2.47	77.03	
	750	4.950	5.21	3.91	78.94		4.96	3.72	75.08	
	1000	6.810	5.32	5.32	78.12		4.98	4.98	73.13	
230	250	1.620	5.05	1.26	77.93	79.01	4.97	1.24	76.62	75.78
	500	3.230	5.09	2.55	78.79		4.92	2.46	76.16	
	750	4.930	5.23	3.92	79.56		4.98	3.73	75.68	
	1000	6.670	5.32	5.32	79.76		4.98	4.98	74.66	

8. No-Load Standby Power Consumption

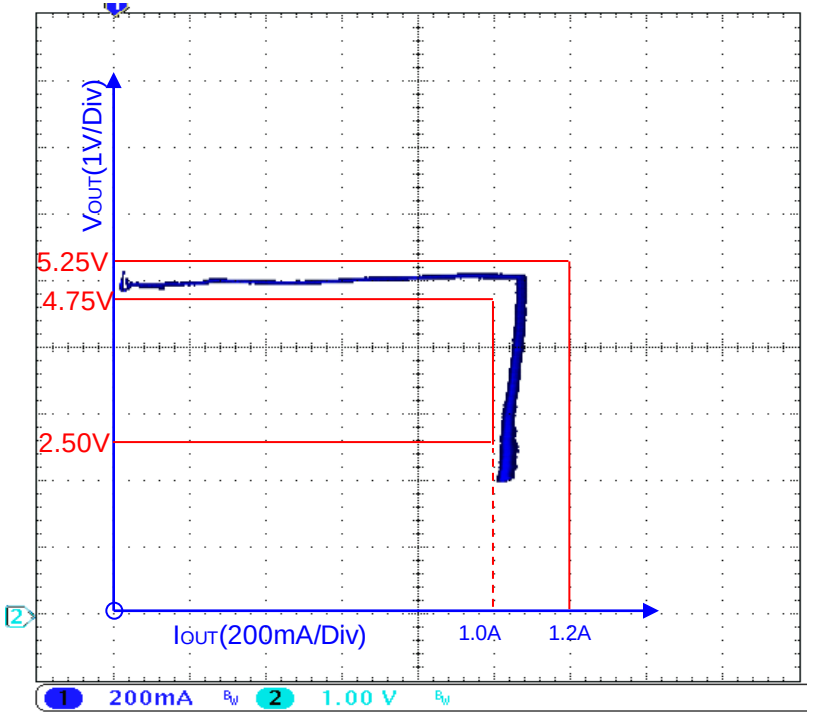


9. Output VI Characteristics

V_{IN}=90Vac/50Hz

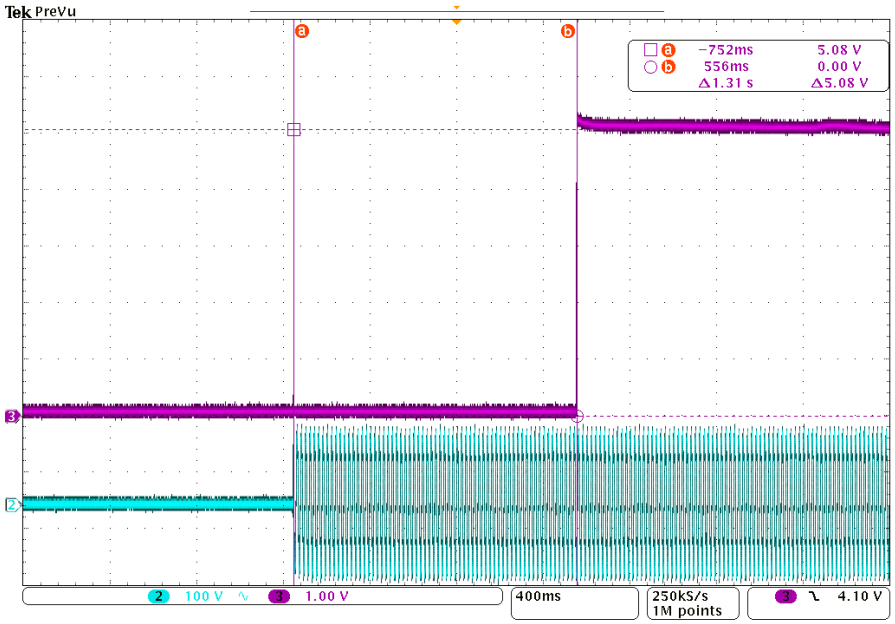


V_{IN}=264Vac/50Hz



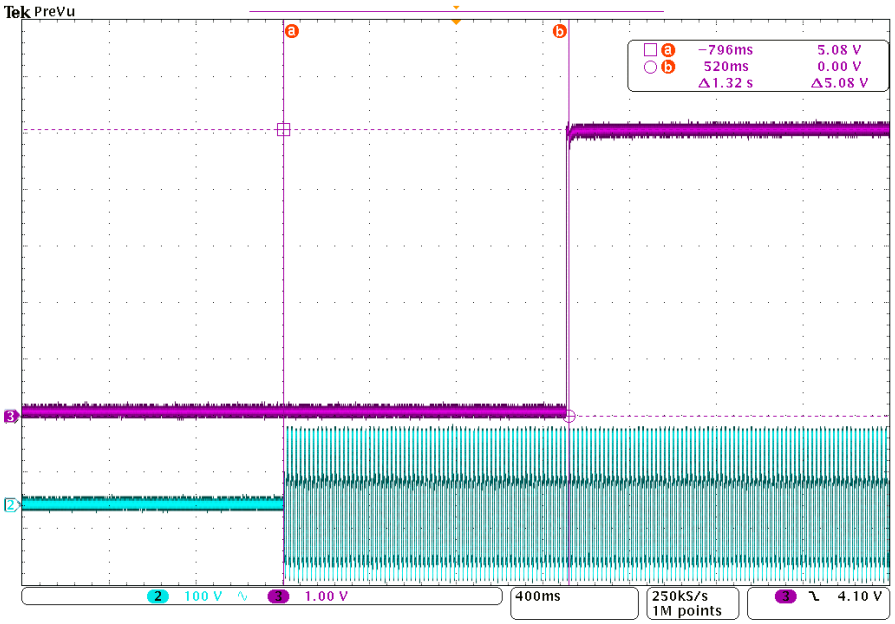
* Note: Output voltage is monitored at end of Output DC-Cable (26AWG1.2m, R_{CABLE}=0.34Ω).

10. Turn-On Delay Time



90Vac, No Load

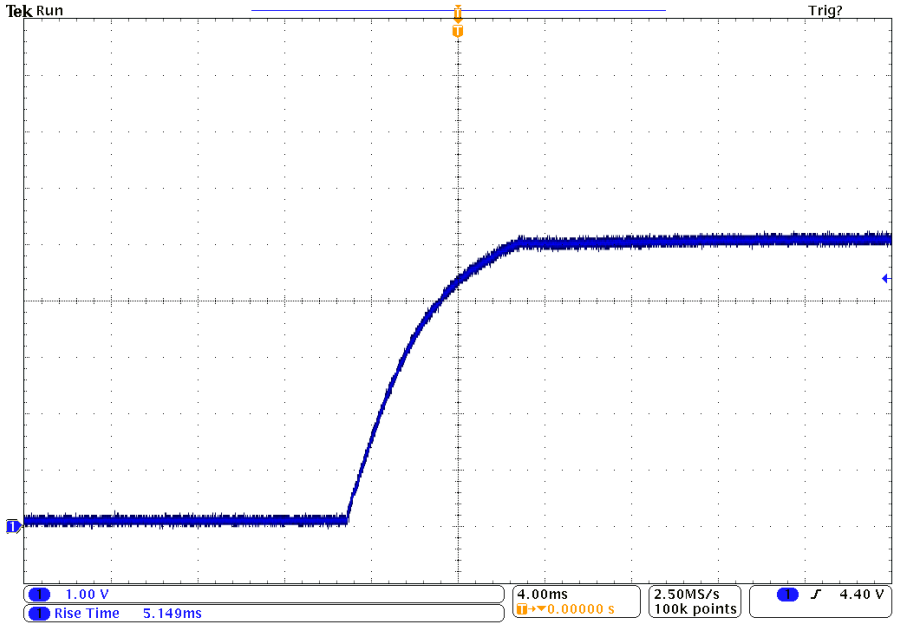
T_{ST_DELAY}=1.31S



90Vac, Full Load

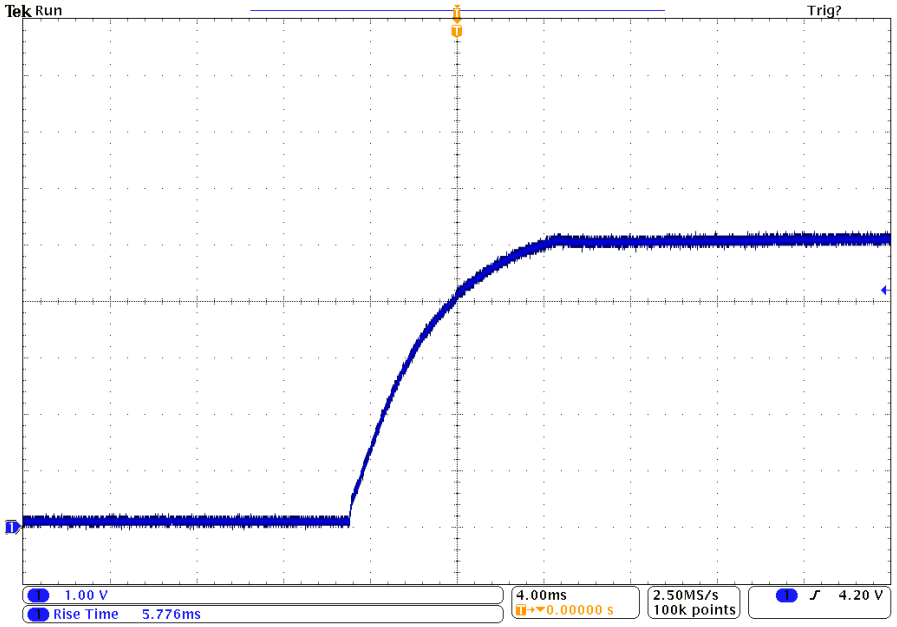
T_{ST_DELAY}=1.32S

11. Output Rise Time



90Vac, Full Load

T_{RISE}=5.149mS

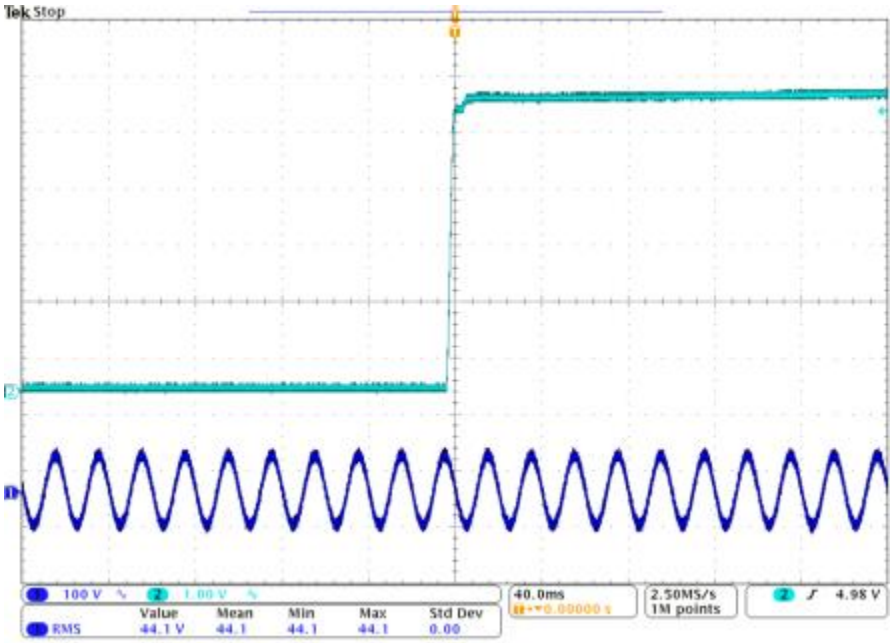


264Vac, Full Load

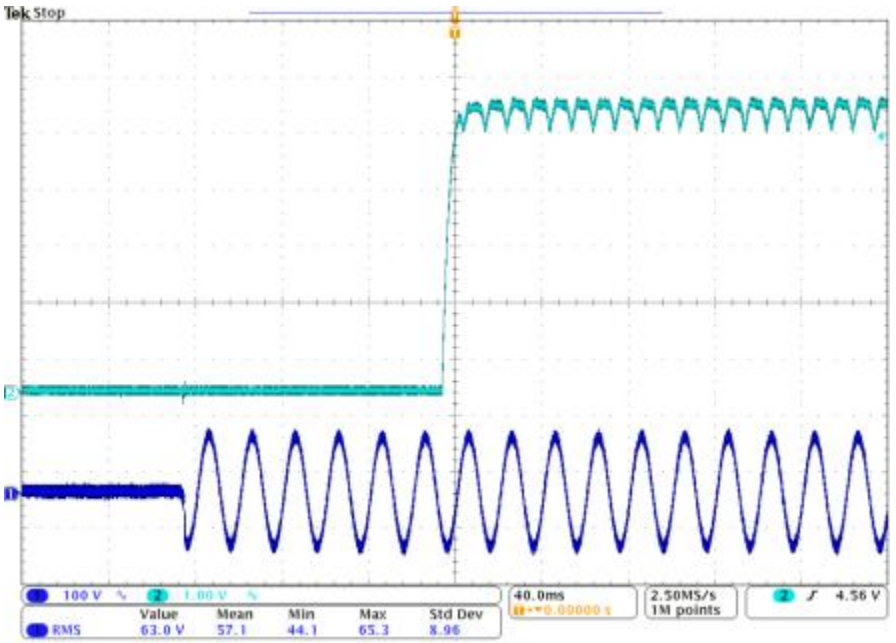
T_{RISE}=5.776mS

12. AC Startup Voltage Characteristic

No Load, $V_{IN\_STARTUP}$ =44.1Vac

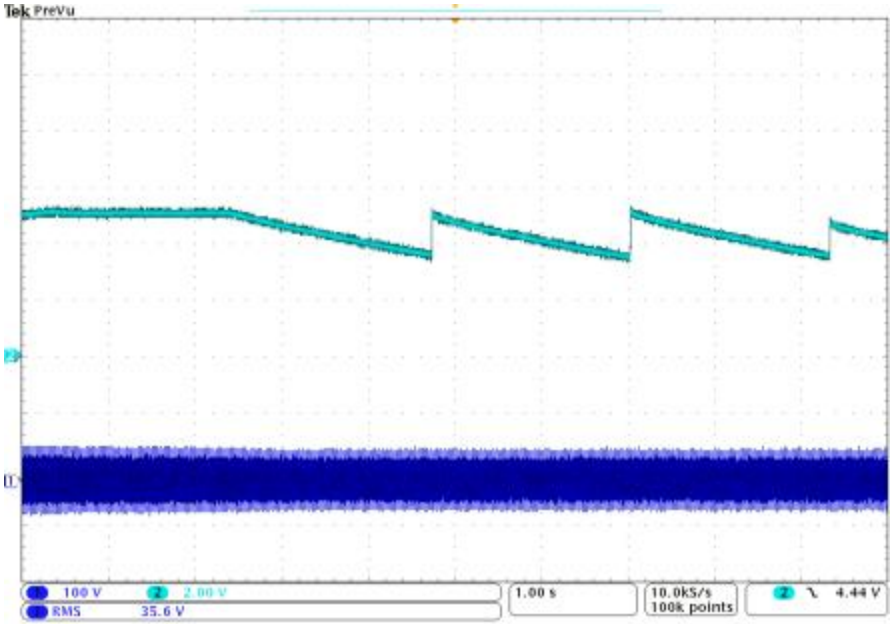


Full Load, $V_{IN\_STARTUP}$=63Vac

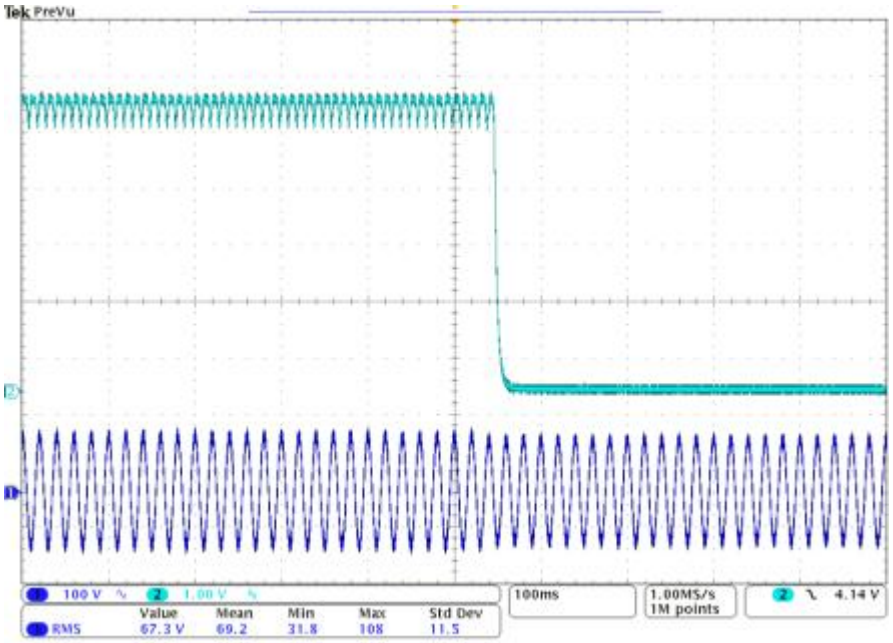


13. AC Brownout Voltage Characteristic

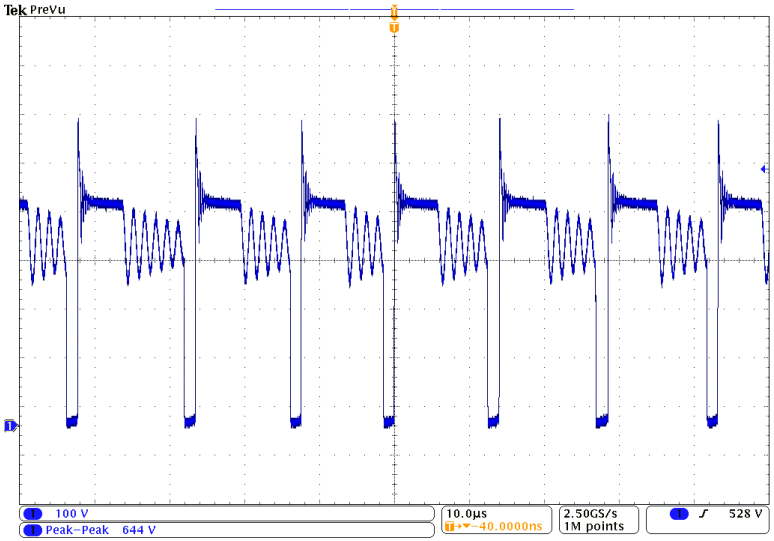
No Load, $V_{IN\_BROWNOUT}$ =35.6Vac



Full Load, $V_{IN\_BROWNOUT}$=67.3Vac



14. V_{CE} Waveform



Test Condition:

V_{IN}=264Vac, I_{OUT} is max load

Result:

V_{CE_MAX}=**644V**

Appendix – Simple Specification for used transistor (3DG3020A1 TO-92)

Parameter Note		Symbol	Rating	Unit
Collector-Base Breakdown Voltage		V_{CBO}	800	V
Collector-Emitter Breakdown Voltage		V_{CEO}	450	V
Emitter-Base Breakdown Voltage		V_{EBO}	9	V
Collector Current		I_C	1.5	A
Power Dissipation	T_a=25℃	P_{tot}	0.8	W
Junction Temperature		T_j	150	℃
Storage Temperature		T_{stg}	−55～150	℃

15. Dynamic Load Response

Test Conditions:

1). Load: *0mA-1000mA-0A*

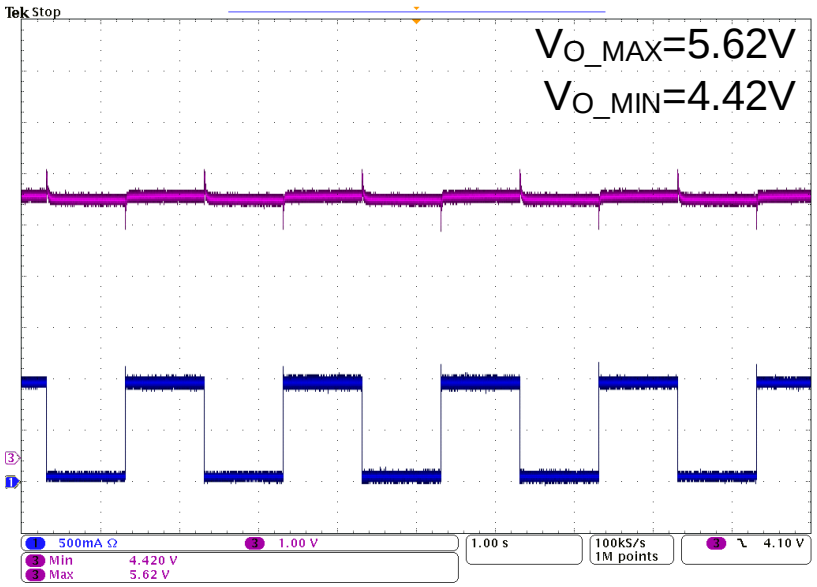
2). Frequency: *1Hz*

3). Duty-Cycle: *50%*

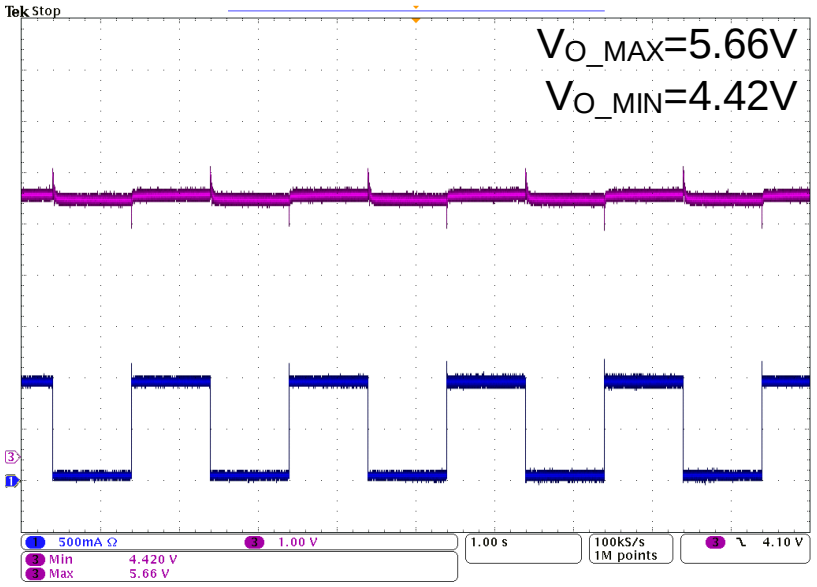
4). Slew-Rate*: 0.1A/us*

5). V_{OUT} is monitored at end of Cable(26AWG/1.2M, R_{CABLE}=0.34Ω)

Vin=90Vac



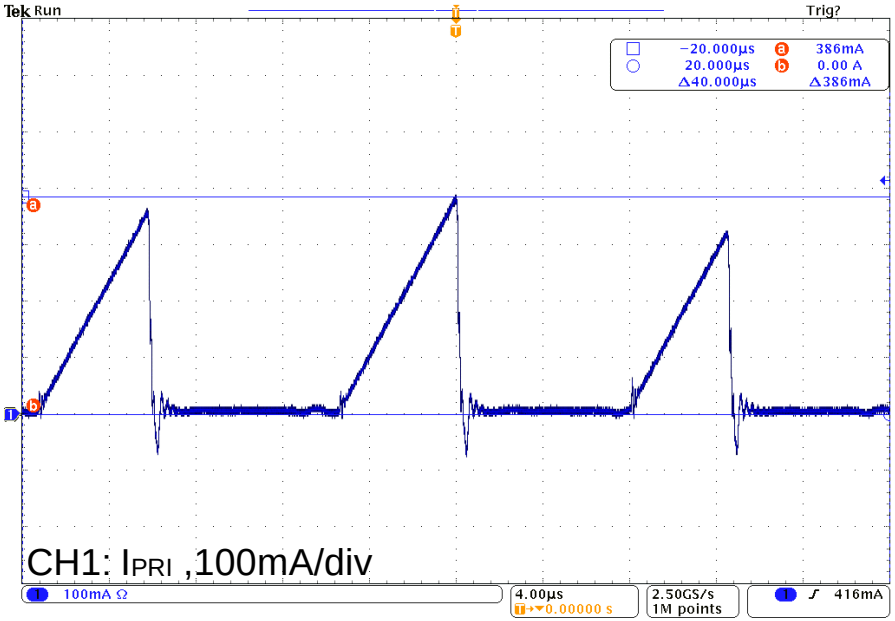
Vin=264Vac

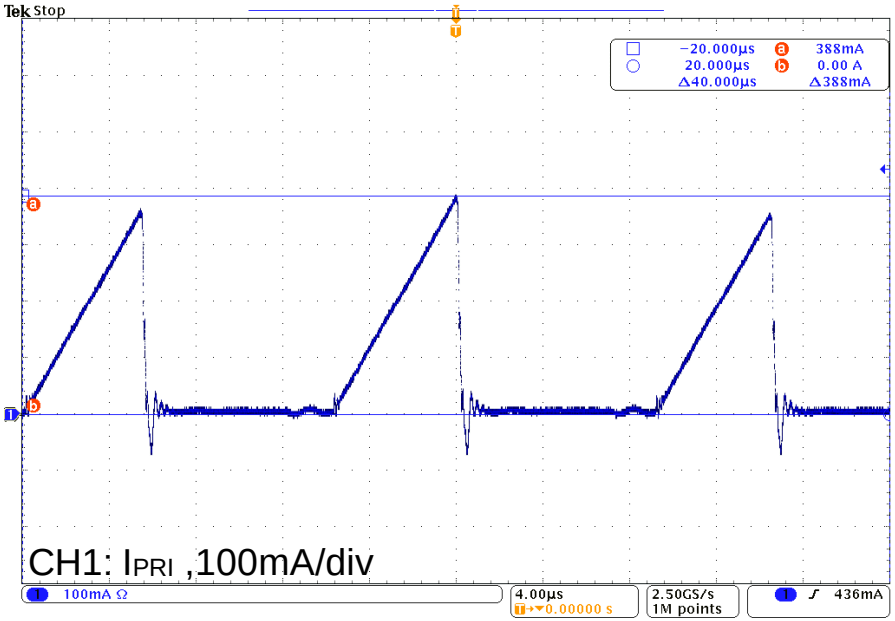


CH2: Output Voltage, 1V/Div; CH1: Output Current, 0.5A/Div

16. Transformer Flux Density

(Np=160Ts, Lm_max=1.66mH, Ae=12.7mm^2-EPC13)





I_{PRI} is monitored at 90Vac and *1A* load

I_{PRI}=386mA

B_{MAX} =(I_{PRI} * L_{P_MAX}) / (N_P*A_e)

=(386*1.66) / (160*12.7)

=0.315Tesla

I_{PRI} is monitored at 90Vac and *1.07A* load (Max Output Power).

I_{PRI}=388mA

B_{MAX} =(I_{PRI} * L_{P_MAX}) / (N_P * A_e)

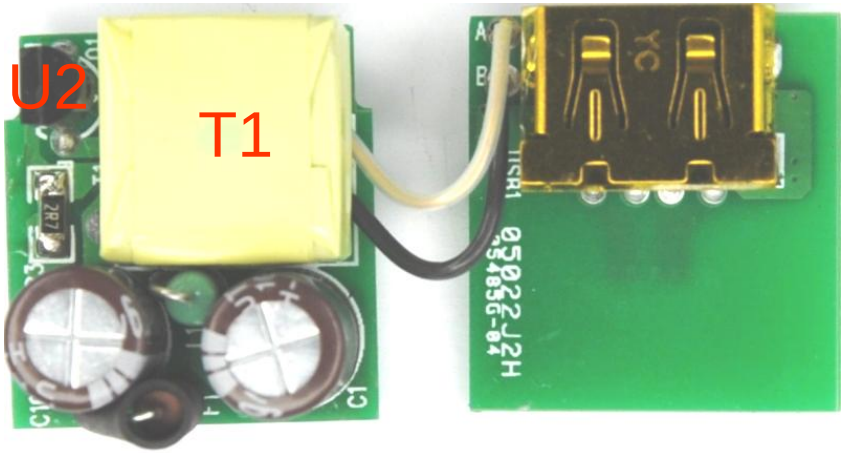
=(388*1.66) / (160*12.7)

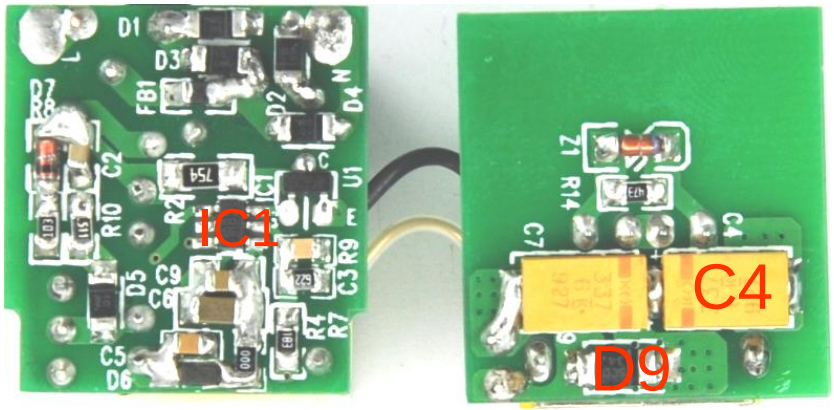
=0.316Tesla

17. Thermal Test for Critical Component

Note: The UUT is assembled with case and placed in a temperature Chamber.

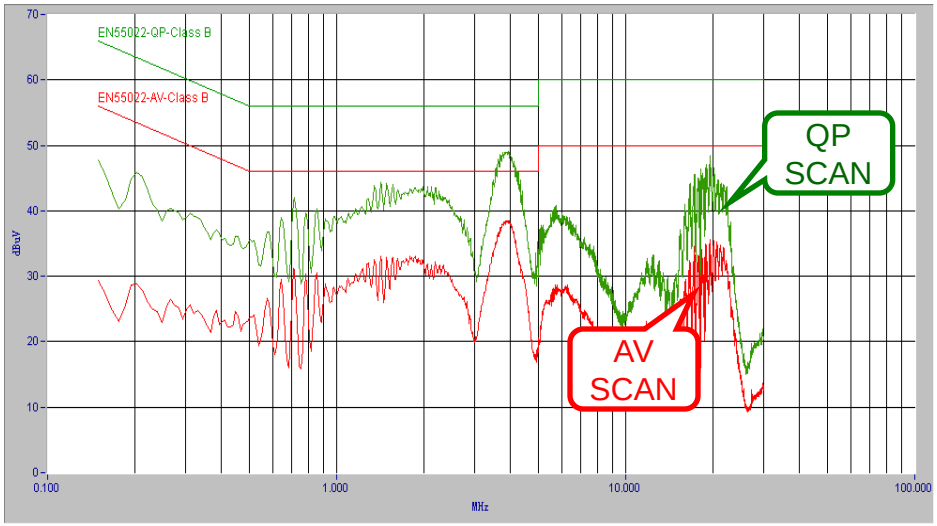
Item	I_{OUT}=1000mA			
	V_{IN}=90V_{AC}		V_{IN}=264V_{AC}	
	T(℃)	Tr(℃)	T(℃)	Tr(℃)
Output Tantalum Capacitors (C4,330uF/6.3V)	76.4	36.4	75.7	35.7
Transistor (U2,3DG3020A1)	98.3	58.3	96.5	56.5
Transformer(T1, EPC13)	91.8	51.8	89.9	49.9
Output SK-Diode(D9, SCD34)	98.8	58.8	96.6	56.6
IC1(iW1700-01)	86.4	46.4	85.1	45.1
Ambient Temperature	40℃		40℃	



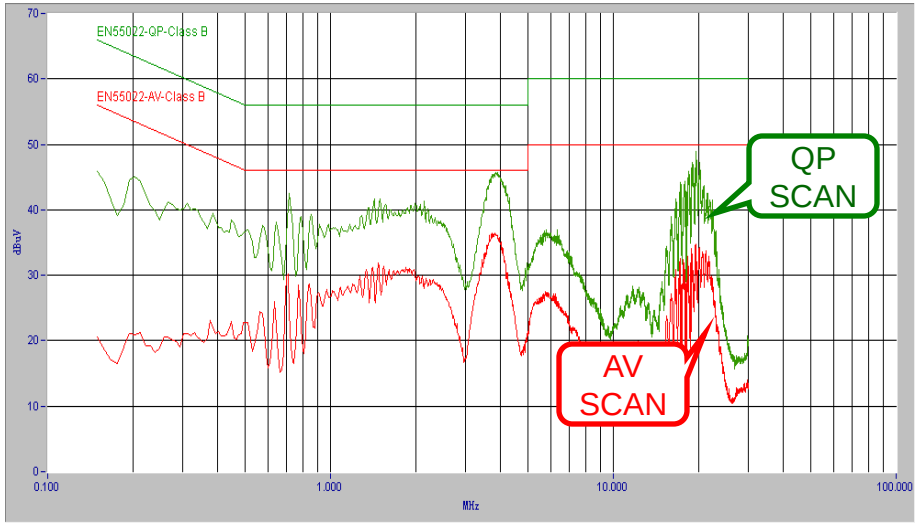


18. Conducted EMI

Vin=230Vac/50, Live



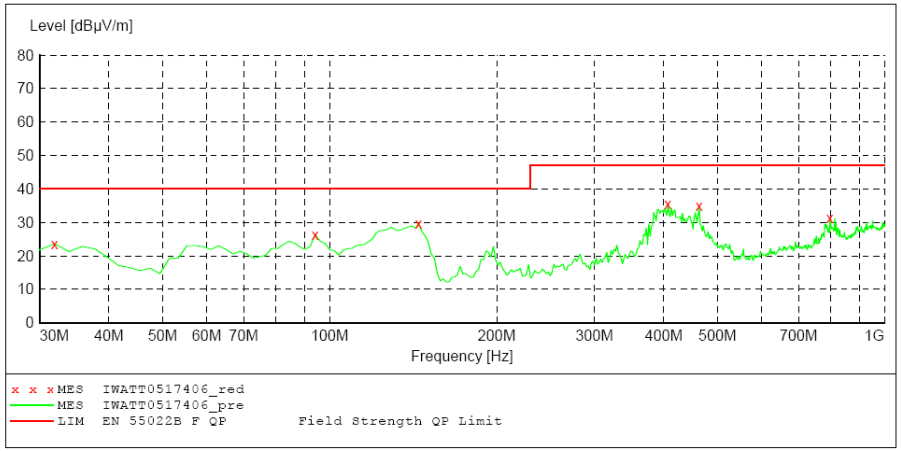
Vin=230Vac/50Hz, Neutral



Note: Full & Resistive Load (5Ω), output (-) is floating.

19. Radiated EMI

Vin=230Vac/50Hz, HORIZONTAL

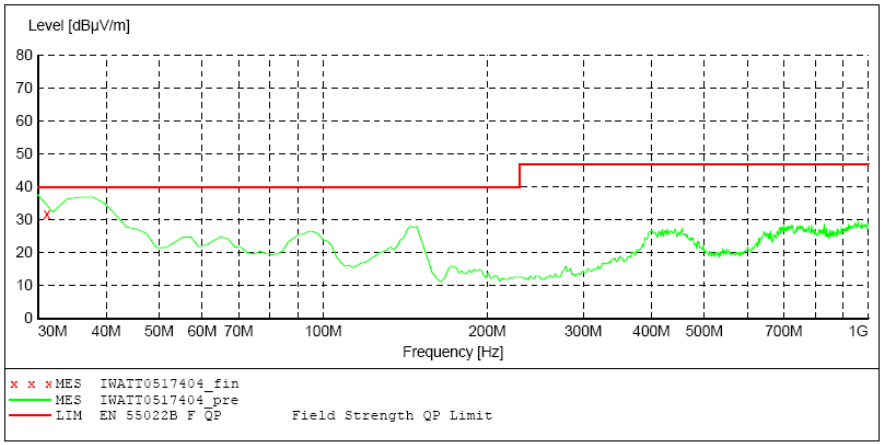


MEASUREMENT RESULT: "IWATT0517406_red"

3/17/2011 10:11PM

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
31.943888	23.60	-11.2	40.0	16.4	---	300.0	147.00	HORIZONTAL
94.148297	26.40	-20.4	40.0	13.6	---	300.0	359.00	HORIZONTAL
144.689379	29.70	-21.8	40.0	10.3	---	300.0	79.00	HORIZONTAL
407.114228	35.40	-15.4	47.0	11.6	---	100.0	274.00	HORIZONTAL
463.486974	35.00	-15.0	47.0	12.0	---	100.0	277.00	HORIZONTAL
797.835671	31.20	-8.8	47.0	15.8	---	100.0	0.00	HORIZONTAL

Vin=230Vac/50Hz, VERTICAL



MEASUREMENT RESULT: "IWATT0517404_fin"

3/17/2011 10:05PM

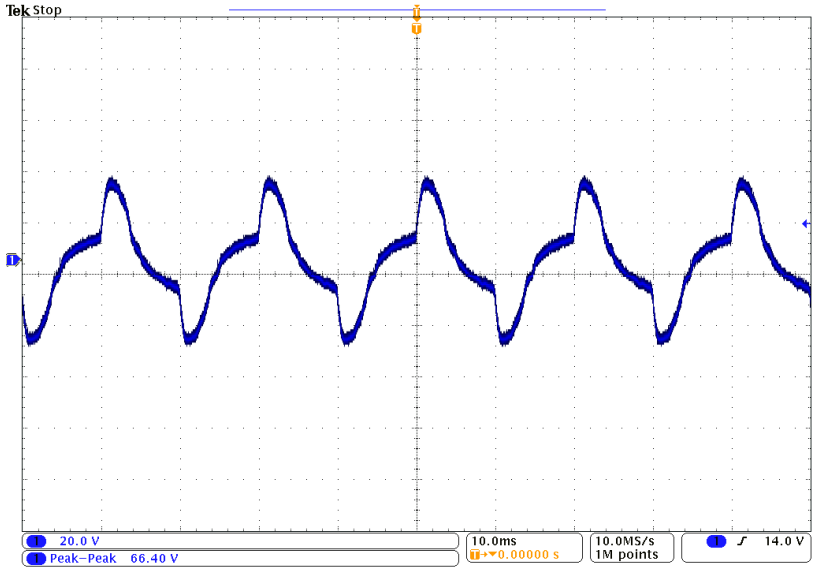
Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
31.140000	31.90	-10.8	40.0	8.1	QP	100.0	91.00	VERTICAL

Note: Full & Resistive Load (5Ω), output (-) is floating.

20. MoU

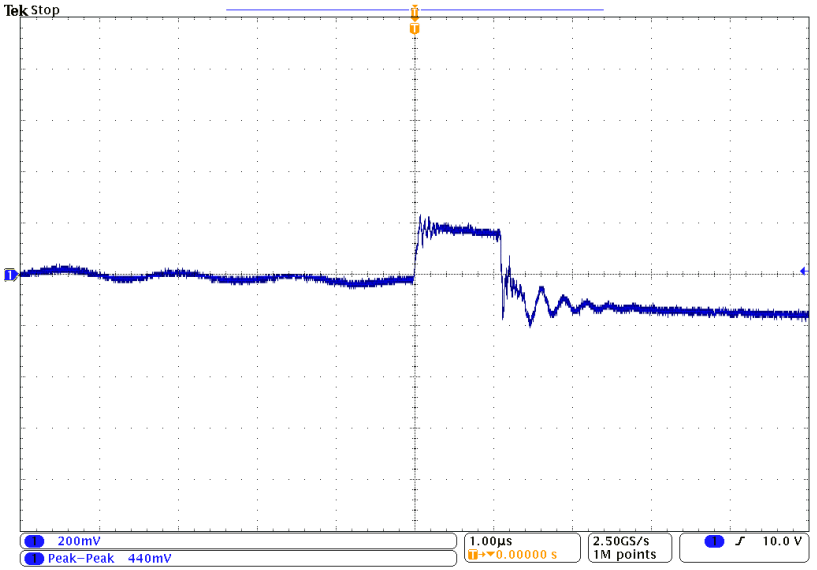
Test condition:

1). Vin=264Vac/50Hz
2). Load: 10Ω resistive Load
3). The Length of Output DC-Cable: 1 Meter
4). Connect 170pF cap from load to line under EPS Switching Frequency Component



AC frequency component

V_pp=66.4V



EPS switching frequency component

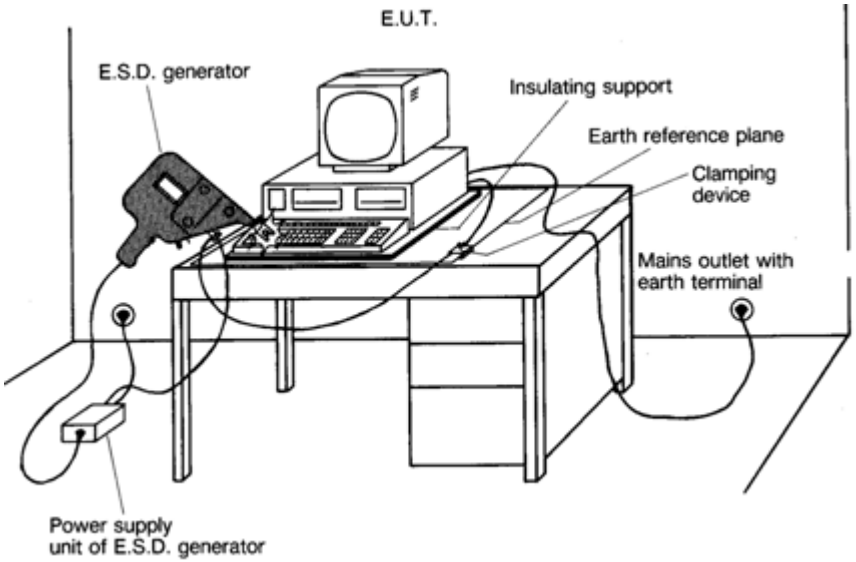
V_pp=440mV

21. ESD (IEC 61000-4-2)

Test condition:

V_{IN}=230VAC/50Hz, No_Load and Full_Load (Resistive Load)

Air-Discharge		Result (no-load)	Result (full-load)
12KV	+	PASS	PASS
	-	PASS	PASS
14KV	+	PASS	PASS
	-	PASS	PASS
15KV	+	PASS	PASS
	-	PASS	PASS
16KV	+	PASS	PASS
	-	PASS	PASS
18KV	+	PASS	PASS
	-	PASS	PASS
19KV	+	PASS	PASS
	-	PASS	PASS
20KV	+	PASS	PASS
	-	PASS	PASS

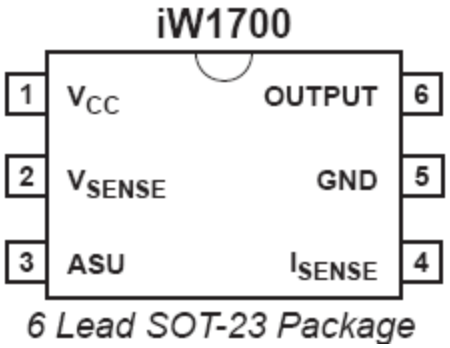


Appendix-1. V_{CC} Supply Voltage

The purpose of this test is to verify range of Vcc voltage under different loading conditions.

Item	Vcc range [Max: 16V, Min:4.2V]			
Input Vac	Vin=90Vac	Vin=115Vac	Vin=230Vac	Vin=264Vac
Output No-load	5.22	5.22	5.20	5.19
Output Full-load (1000mA)	10.67	11.24	11.79	11.76
Max load (CC/CV corner)	10.76	11.34	12.01	11.95

Above test result show all voltage measuring points is within normal operating range.



V_{CC} SECTION (Pin 1)						
Maximum operating voltage (Note 1)	$V_{CC(MAX)}$				16	V
Start-up threshold	$V_{CC(ST)}$	V_{CC} rising	10.0	11.0	12.0	V
Undervoltage lockout threshold	$V_{CC(UVL)}$	V_{CC} falling	3.8	4.0	4.2	V
Start-up current	$I_{IN(ST)}$	V_{CC} = 10 V	1.0	1.7	3.0	µA
Quiescent current	I_{CCQ}	No I_B current		2.7	4.0	mA
Zener breakdown voltage	V_{ZB}	Zener current = 5 mA T_A=25°C	18.5	19.5	20.5	V

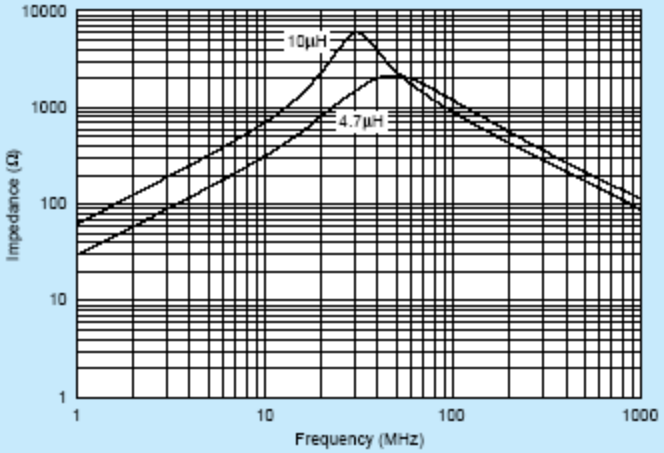
Appendix-2. Chip Inductor (FB1)

■ Rated Value (☐: packaging code)

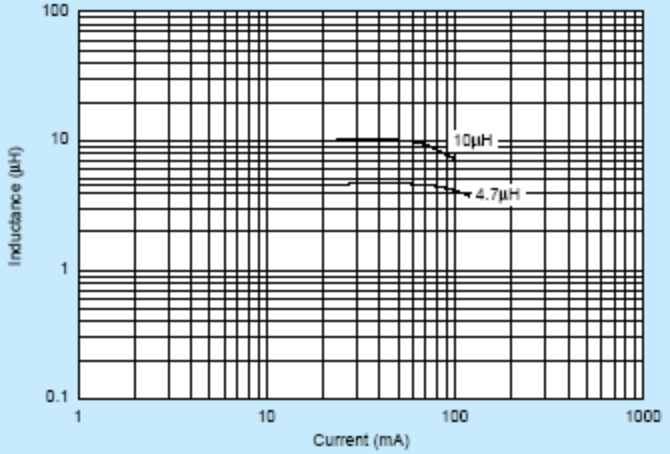
Part Number	Inductance	Test Frequency	Rated Current	DC Resistance	Self Resonance Frequency (min.)	
LQM21FN4R7M80☐	4.7µH±20%	1MHz	120mA	0.18ohm±30%	25MHz	Kit
LQM21FN100M80☐	10µH±20%	1MHz	100mA	0.30ohm±30%	15MHz	Kit

Class of Magnetic Shield: Magnetic shield of ferrite Operating Temperature Range: -55°C to +125°C

■ Impedance-Frequency Characteristics (Typ.)



■ Inductance-Current Characteristics (Typ.)



Appendix-3. Vcc Schottky Diode (D6)

iWatt
Intelligent AC-DC and LED Power™

WMSCD106RH

● **FEATURES**

* Halogen-free type
* Compliance to RoHS product
* Lead less chip form, no lead damage
* Lead-free solder joint, no wire bond & lead frame
* Low power loss, High efficiency
* High current capability, low VF
* Plastic package has Underwriters Laboratory Flammability Classification 94V-0

● **APPLICATION**

* Switching mode power supply applications
* Portable equipment battery applications
* High frequency rectification
* DC / DC Converter
* Telecommunication

● **MECHANICAL DATA**

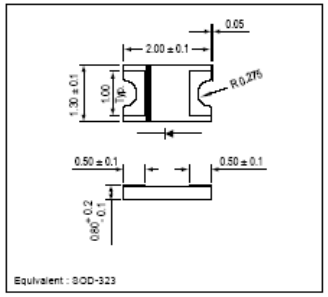
Case : Packed with FRP substrate and epoxy underfilled
Terminals : Pure Tin plated (Lead-Free),
solderable per MIL-STD-750, Method 2026.
Polarity : Laser Cathode band marking
Weight : 0.005 gram

● **PACKING**

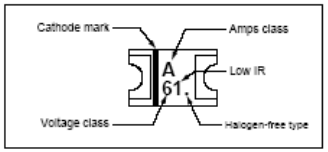
* **3,000 pieces per 7" (178mm ± 2mm) reel**
* **5 reels per box**
* **6 boxes per carton**

● **OUTLINE DIMENSIONS**

Case : 0805 Unit : mm



● **MARKING**



Absolute Maximum Ratings (Ta = 25 °C)

ITEM	Symbol	Conditions	Rating WMSCD106RH	Unit
Repetitive peak reverse voltage	V_{RRM}		60	V
Average forward current	$I_{F(AV)}$		1.0	A
Peak forward surge current	I_{FSM}	8.3ms single half sine-wave	10	A
Operating junction temperature Range	T_J		-55 to +150	°C
Storage temperature Range	T_{STG}		- 55 to +150	°C

Electrical characteristics (Ta = 25 °C)

ITEM	Symbol	Conditions	Min.	Typ.	Max.	Unit
Forward voltage (NOTE 1)	V_F	I_F = 1.0 A	-	0.63	0.70	V
Repetitive peak reverse current (NOTE 1)	I_{RRM}	V_R = Max. V_{RRM}, T_J = 25 °C T_J = 125 °C	- -	0.002 1.00	0.03 -	mA
Junction capacitance	C_J	V_R = 4V, f = 1.0 MHz	-	110	-	pF
Thermal resistance	$R_{th(JA)}$	Junction to ambient	-	88	-	°C/W
	$R_{th(JL)}$	Junction to lead	-	28	-	°C/W

NOTES : (1) Pulse test width PW=300usec , 1% duty cycle.
(2) Mounted on P.C. board with 0.2 x 0.2"(5.0 x5.0mm) copper pad areas.