Advanced Digital Power Solution On Home Appliance Application

iWatt

Power Management Simplified Digitally™

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What's New!

- 1 Billion ICs shipped

iWatt Solution Inside

What We do

Customer-Focused Power IC Solutions Leveraging Innovative Technology and Best-in-Class Service

Power Source

AC/DC Conversion

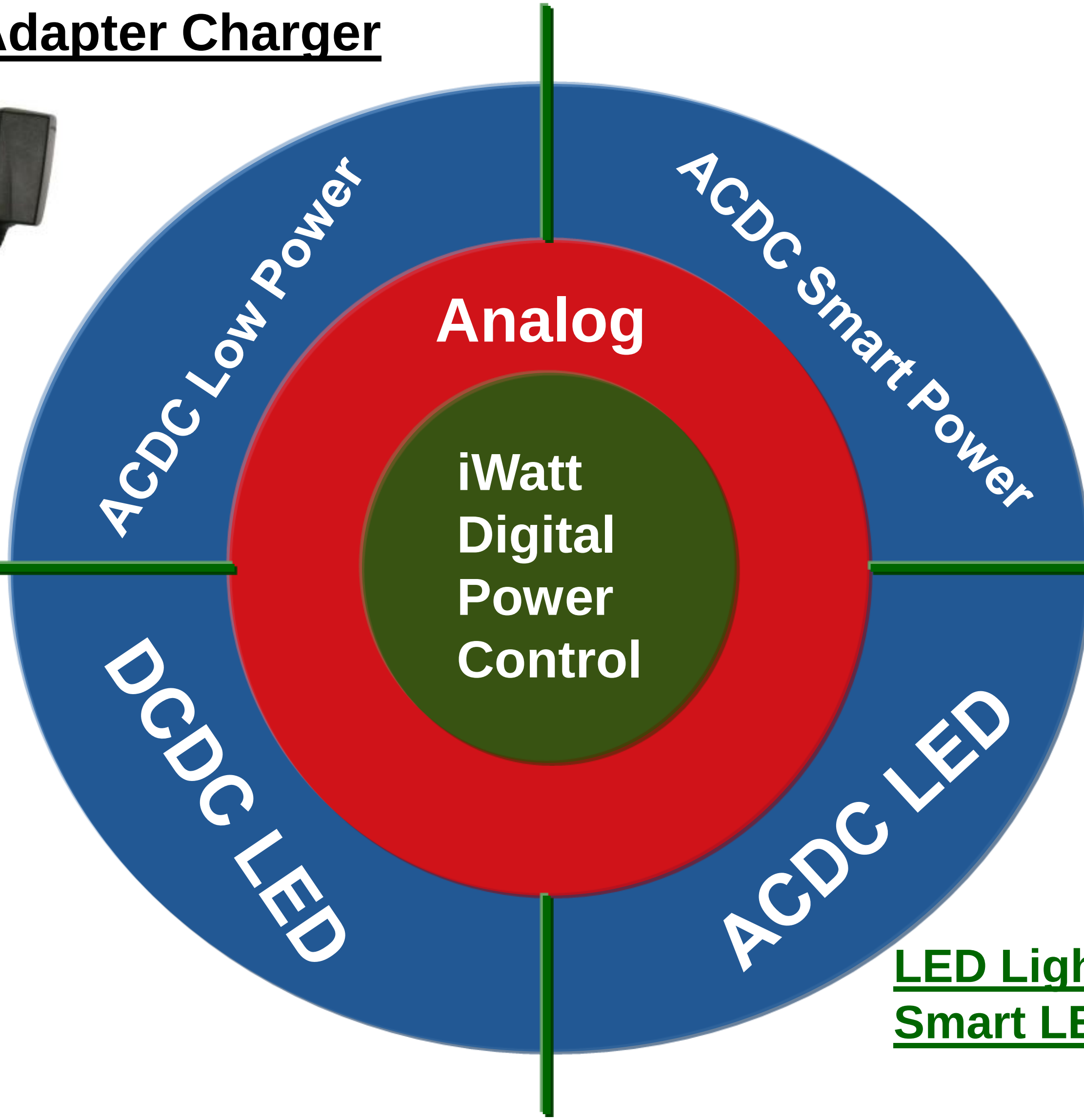
DC/DC Conversion

Communications and Optimization

Points Of Load

Green Power Solutions Providers

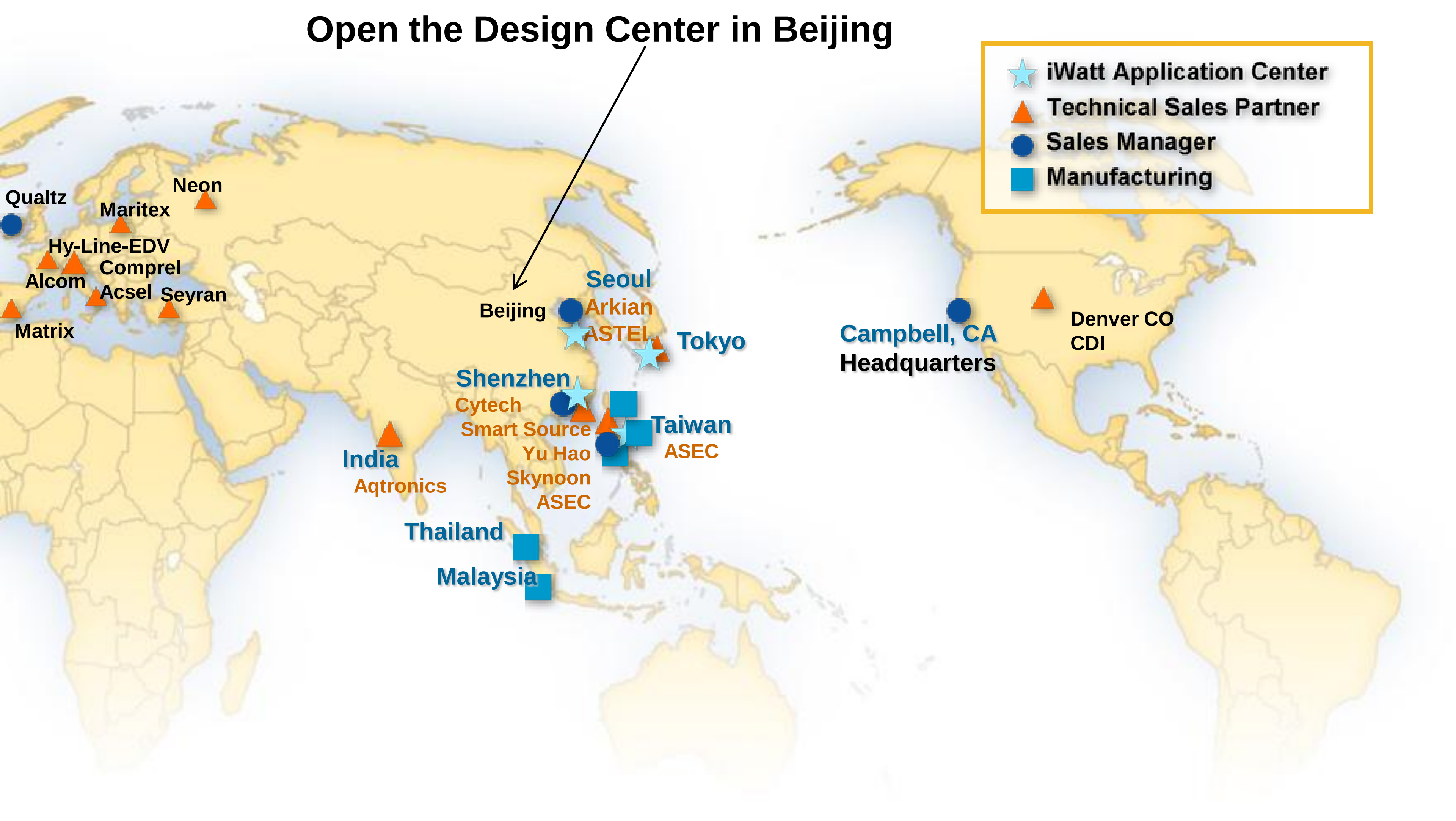
Universal Smart Adapter Charger



Adaptive LED Backlight Engine

LED Lighting
Smart LED controller

World-Wide Infrastructure



Experienced Management Team

iWatt
Power Management Simplified Digitally™

	Years of Experience	Prior Companies
 **Ron Edgerton** *CEO*	20+ years	Cyrix, Ford, Kodak, Northern Telecom, SigmaTel
 **James McCanna** *CFO*	20+ years	3Dconnexion (A Logitech Company), innergy power, SiliconMotion
 **Paul Chu** *VP Worldwide Sales*	30+ years	AMD, C-Cube Microsystems, Cypress, Fairchild Semiconductor, freescale semiconductor, LSI Logic
 **Xuecheng Jin** *VP Engineering*	20+ years	intersil, Siemens, Texas Instruments
 **Jerry Zheng** *VP Technology Marketing*	15+ years	Delta, N2Power (A Qualstar Company), National Semiconductor
 **Zahid Rahim** *VP/GM ACDC*	20+ years	Fairchild Semiconductor, Maxim, National Semiconductor, NXP
 **Gyan Tiwary** *VP/GM TV IC's*	20+ years	intel, Synopsys
 **Alex Sinar** *SVP Operations*	25+ years	OAK, TeraLogic, Zoran
 **Sal Sestito** *VP Business Dev.& OEM Sales*	25+ years	Cyrix, phoenix technologies, inacom, Hughes, SigmaTel
 **Scott Brown** *VP Strategic Marketing*	20+ years	National Semiconductor, Micrel, Catalyst Semiconductor, Inc., ON Semiconductor

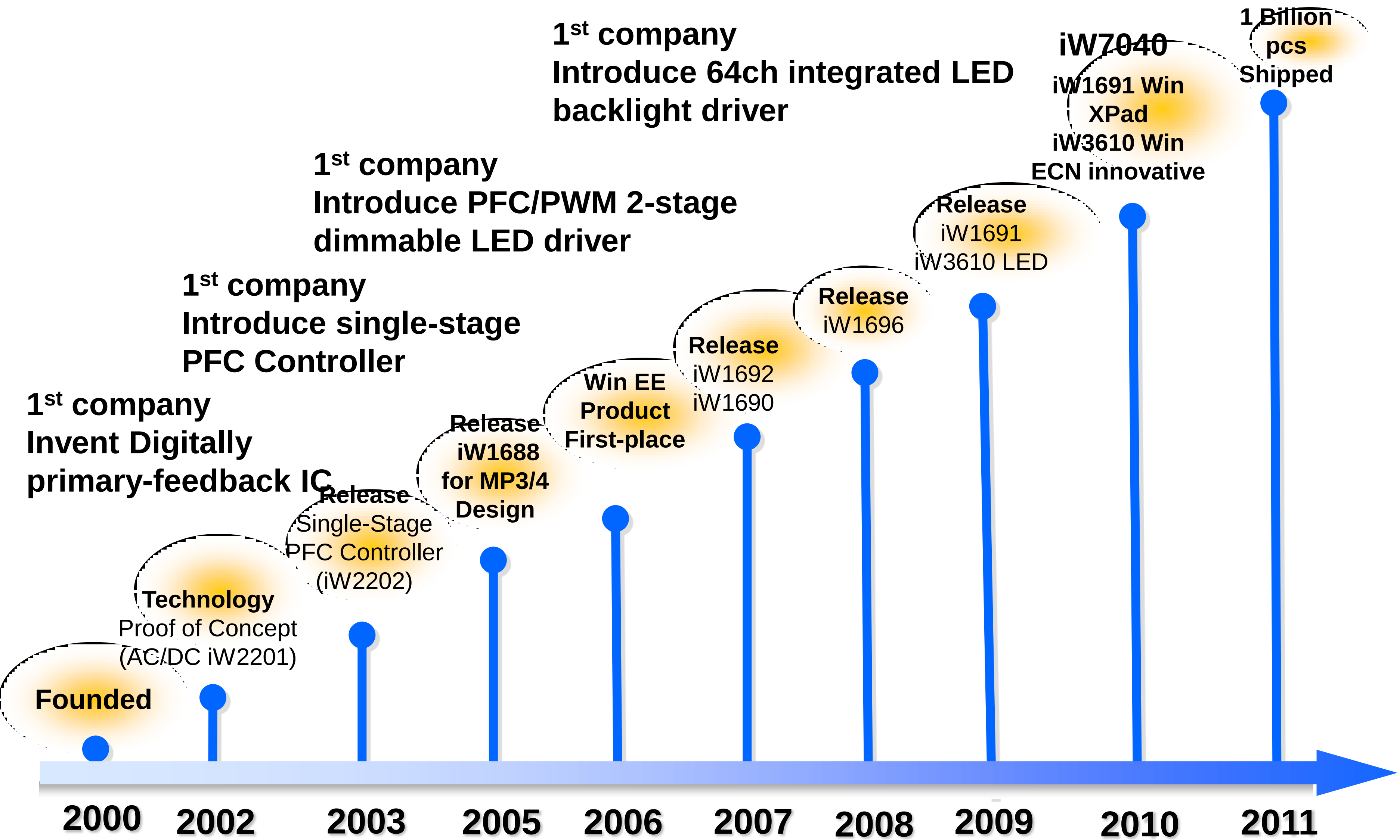
iWatt IP Review & Primary Feedback Technology

Summary of iWatt Patents

- iWatt is the company who invented the primary-feedback control with digital solutions.
- The claim for digital primary feedback means to use the 1-bit comparator to detect the V_{SENSE}.

- iWatt Patent Portfolio
  - Issued Patents 44
  - Pending Applications 29
  - PCT 25

iWatt History



iWatt ACDC Offline Digital Power Solutions

- **The first company to release Digital Power Control IC's for AC/DC offline**

  AC/DC Charger/ Adaptor

  - ***iW1689, iW1692, iW1690, iW1696, iW1698, iW1810, iW1691 & iW1710, iW1676, iW1677, iW1700, iW1706, iW1707, iW1699, iW1760, iW1761, iW1762***

  LED offline drivers:

  - ***iW3620, iW3610, iW3602, iW3612, iW3614***

- **Provides Total System Solutions for low-power adapters and chargers with low cost and high performance**
  - **Patented digital primary-feedback control technology with Tight CV regulation**
  - **Patented Constant Current (CC) regulation with primary-feedback**
  - **Advanced multi-layer fault protection technology**

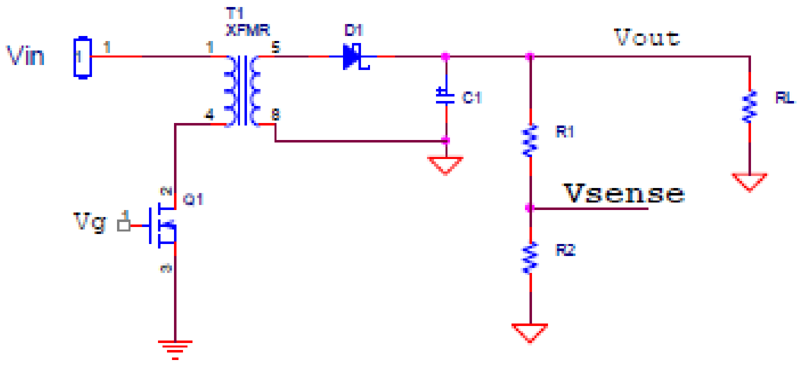
Patent Categories for AC/DC Offline Controller

iWatt
Power Management Simplified Digitally™

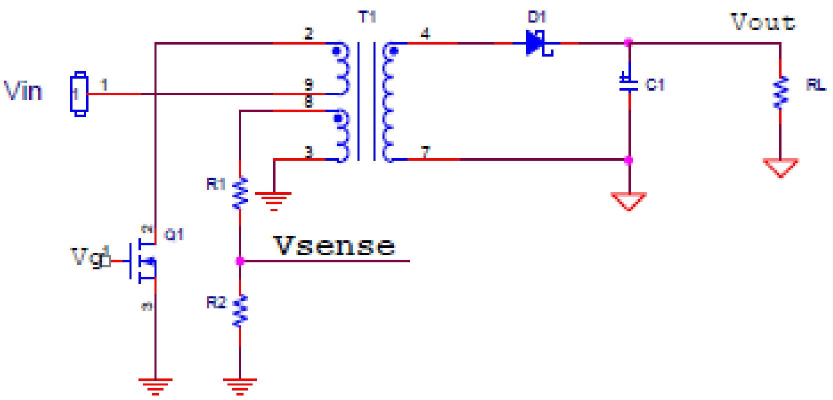
- 5 Issued patents related to fly-back converter Primary-feedback constant voltage control
  1) "Isolated power converter having primary feedback control"
     6,370,039 April 9, 2002
  2) "Transformer-coupled switching power converter having primary feedback control"
     6,385,059 May 7, 2002
  3) "PWM power converter with digital sampling control circuitry"
     6,862,198 March 1, 2005
  4) "PWM power converter controlled by transition detection of a comparator error signal"
     6,900,995 May 31, 2005
  5) "Reconstruction of the output voltage of an AC-DC power converter"
     6,990,000 January 24, 2006
- 3 Issued patents related to primary-feedback control constant current
  1) "System and method for controlling current limit with primary side sensing"
     6,972,969 December 6, 2005
  2) "System and method for input current shaping in a power converter"
     6,944,034 September 13, 2005
  3) **"on-time control for constant current mode in a flyback power supply"**
     7,443,700 Oct 2008
- 1 Issued patent related to the integrated power converter
  1) "Switching power supply packages"
     6,434,021 August 13, 2002

Knowing Primary Feedback Technology

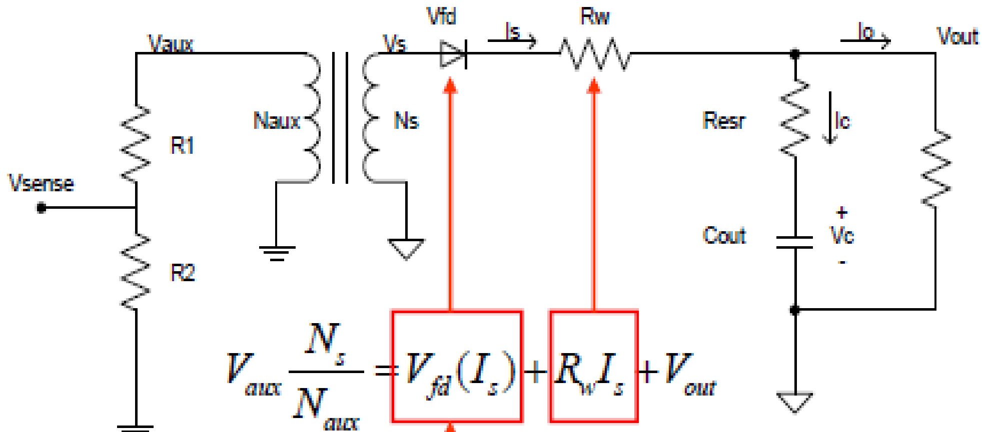
- Secondary Output Voltage Sensing
  - Traditional
  - Straightforward
  - Need additional isolation media to transfer feedback signal to controller
  - High cost , large size



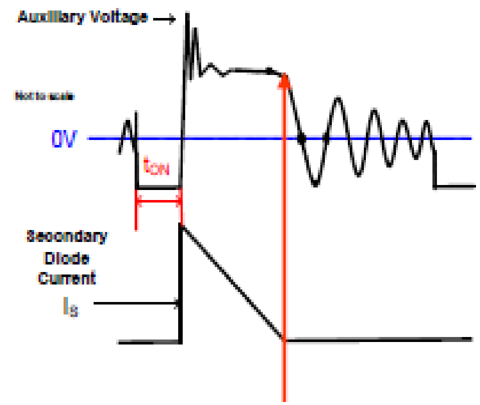
- Primary Output Voltage Sensing
  - Indirect
  - Do not need additional isolation media
  - Output voltage is reflected on third winding when Q1 is turns off
  - Need intelligently read real time waveform



Correlation: Aux Voltage vs. Output Voltage



$$V_{aux}\frac{N_s}{N_{aux}} = \boxed{V_{fd}(I_s)} + \boxed{R_w I_s} + V_{out}$$



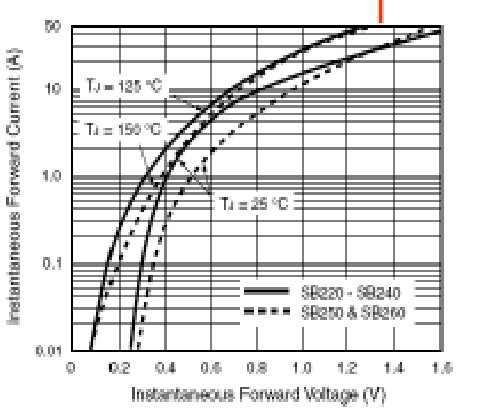
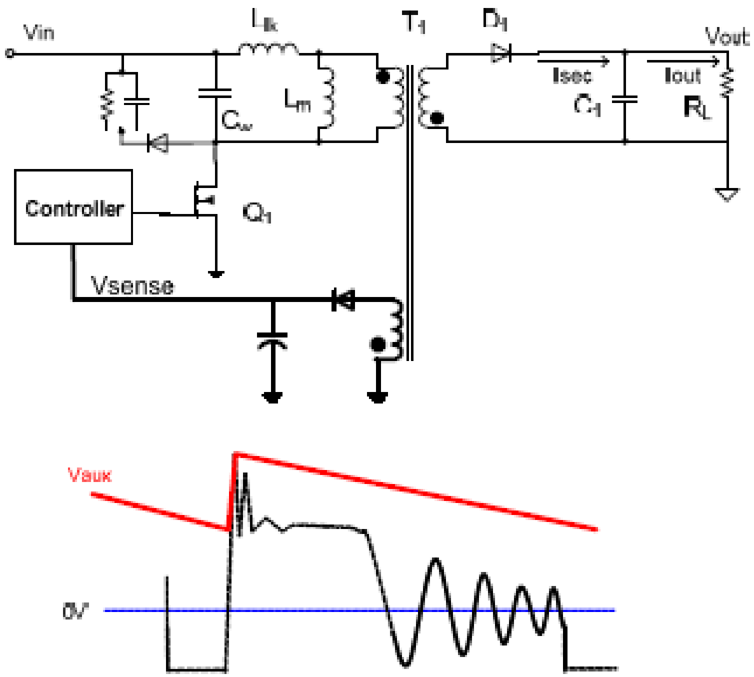


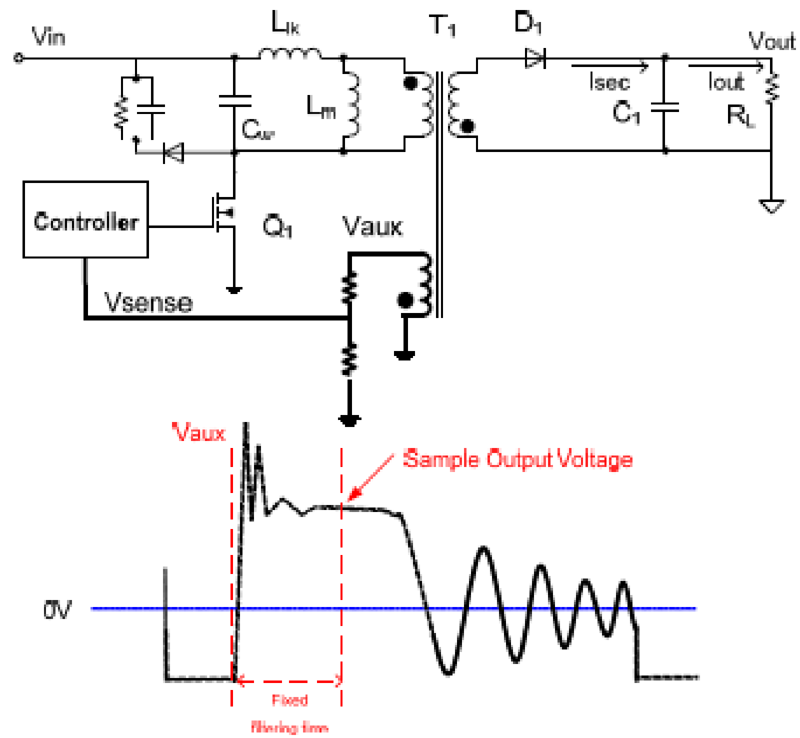
Figure 3. Typical Instantaneous Forward Characteristics

- The best time to sample output voltage is when the secondary current is close to ZERO, where there is no voltage drop in the PCB trace resistance R_W, and the diode forward voltage drop is minimum and can be ignored, thus

$$V_{aux}\frac{N_s}{N_{aux}} = V_{out}$$

Conventional Primary Side Feedback



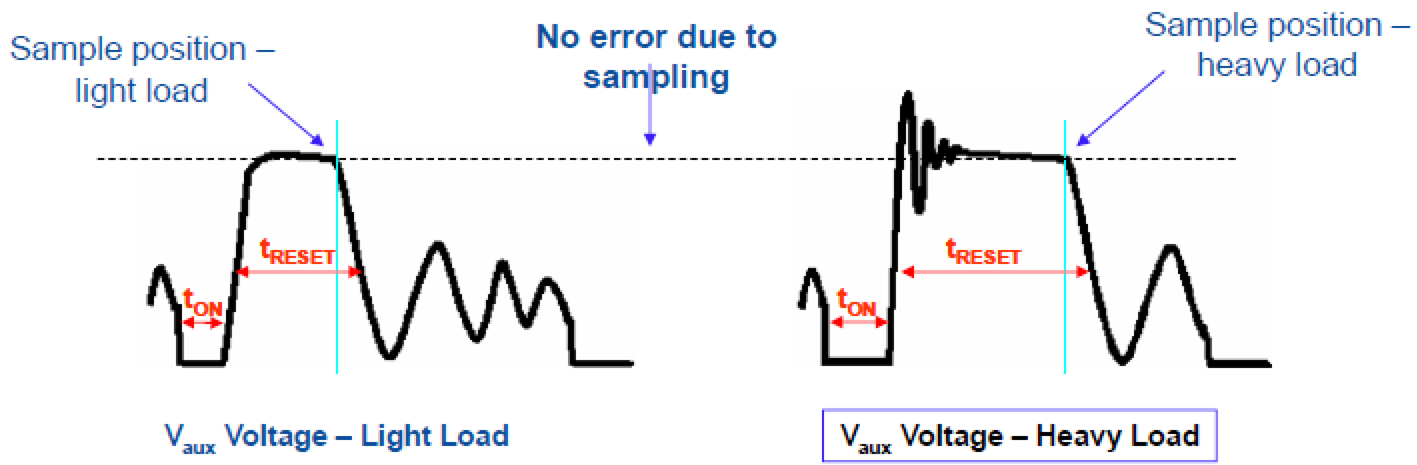


- Method 1 –peak value detection
- Problem – Ringing affects output voltage sampling

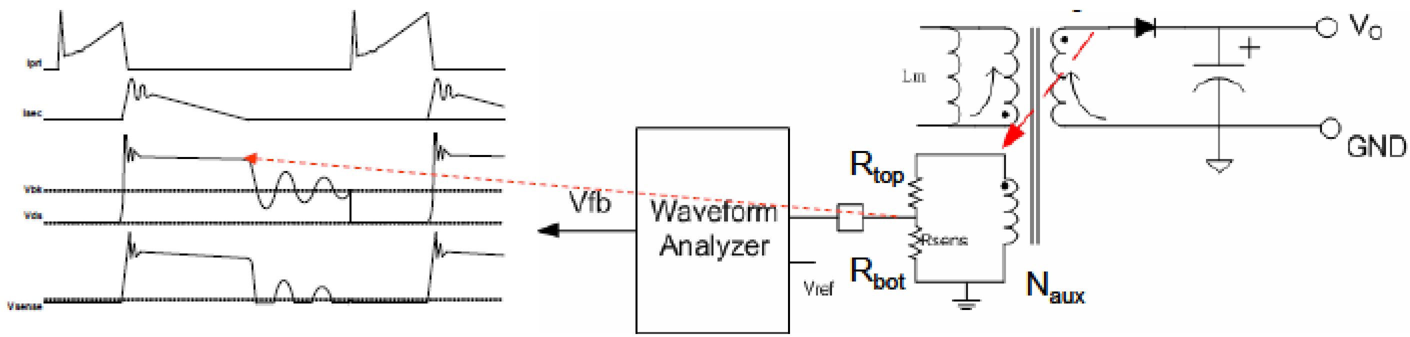
- Method 2 – sample after fixed filtering time to remove ringing impacts
- Problem – Sensed voltage varies with output current

iWatt Patented Digital Primary Feedback

- Actively searches the best location (before transformer voltage collapse) to sense output the voltage.
- Cycle by cycle response is possible because valuable data is not filtered out
- Excellent load regulation performance due to controlled sample position
- Digitally implemented in all iWatt AC/DC products



Output Voltage Regulation



- Output voltage is sampled at zero secondary current. It removes the output voltage dependence on PCB trace resistance and output rectifier forward voltage drop.

- By regulating the sensing voltage toward internal reference voltage at this particular sampling point, the output voltage is tightly regulated

→ Achieves <+-3% CV regulation at PCB end in typical designs

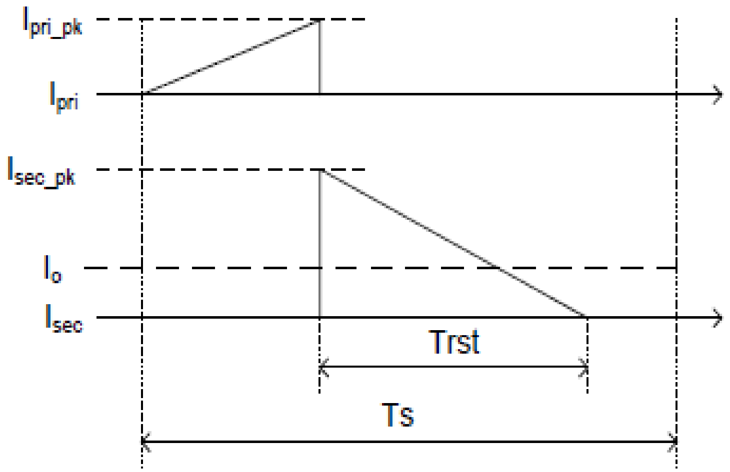
$$V_o = \frac{N_s}{N_{aux}} V_{ref} \left(1 + \frac{R_{top}}{R_{bot}} \right)$$

Cycle by Cycle O/P Current Estimation

$$I_o = \frac{I_{\sec\_pk}}{2} \frac{T_{rst}}{T_p}$$

$$I_{\sec\_pk} = I_{pri\_pk} N_{ps}$$

$$I_o = \frac{1}{2} N_{ps} \frac{V_{ipk}}{R_{sense}} \frac{T_{rst}}{T_p}$$



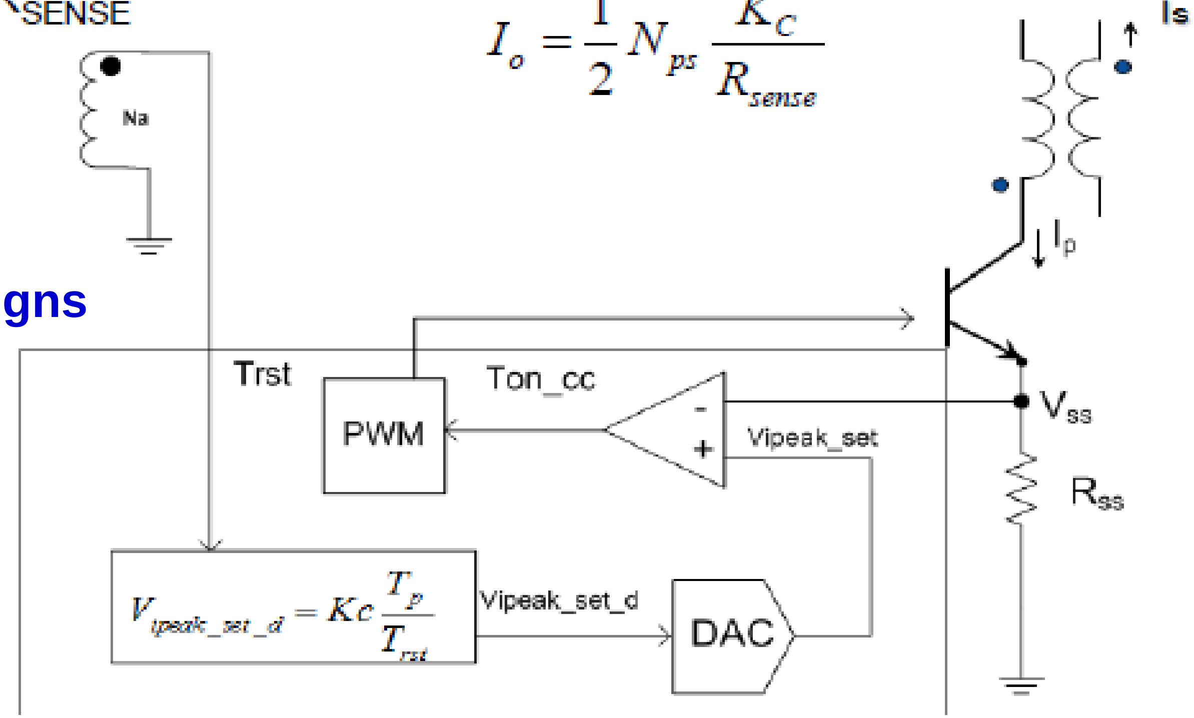
Discontinuous Current Mode (DCM)

iWatt Patented Primary-Feedback CC Regulation

iWatt Power Management Simplified Digitally™

- Output Current, by operation $$I_o = \frac{1}{2} N_{ps} \frac{V_{ipk}}{R_{sense}} \frac{T_{rst}}{T_p}$$
- Control Equation $$V_{ipk} = K_C \frac{T_p}{T_{rst}}$$
- Output Current, setup by transformer turns ratio Nps and sensing resistor R_{SENSE} $$I_o = \frac{1}{2} N_{ps} \frac{K_C}{R_{sense}}$$

→ Achieves <+-5% CC regulation in typical designs



What We can Do for You?

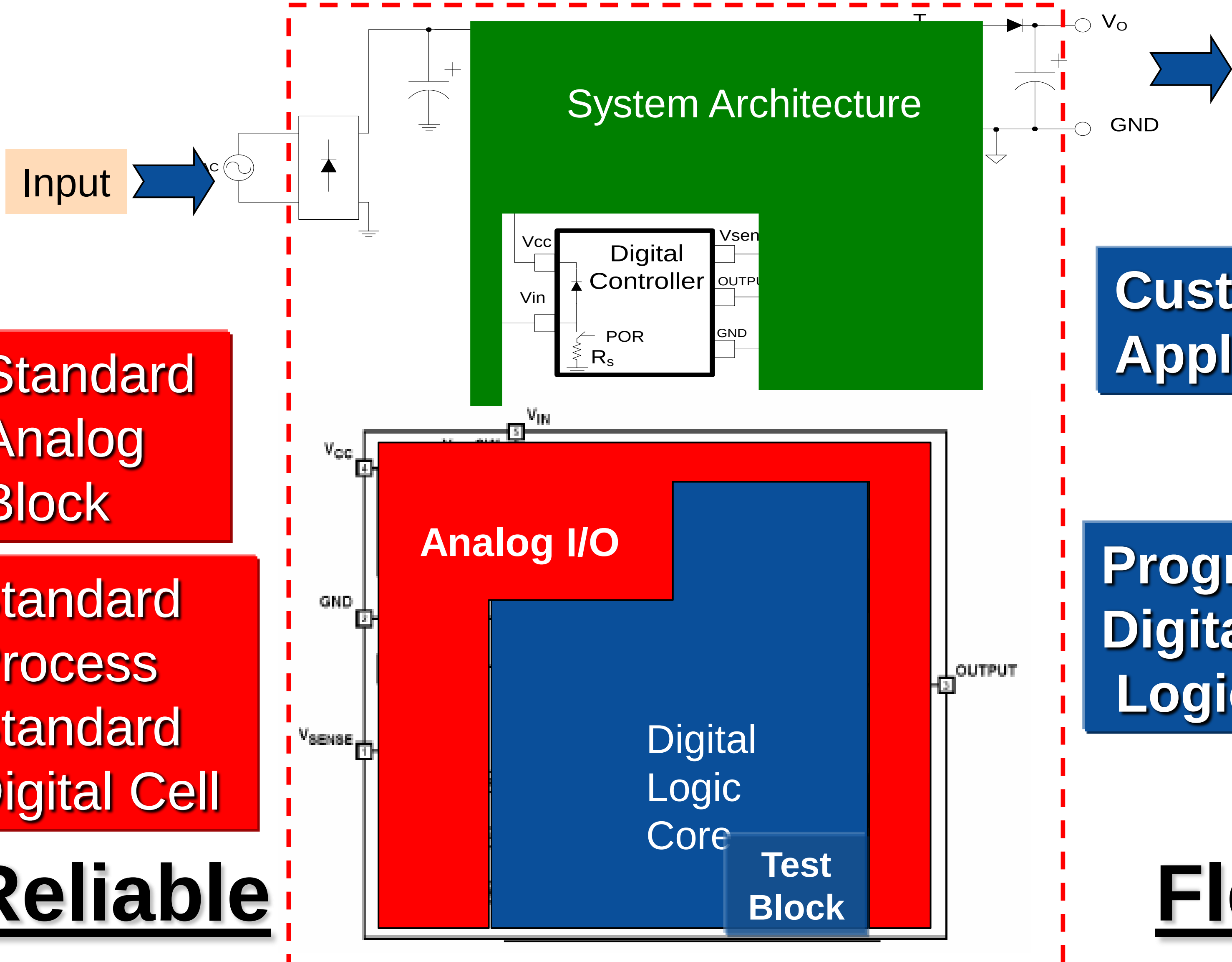
A Simple Flexible and Reliable Platform

What the Next Is? 3S Adapter

- **S**lim, Slim and Slim
- **S**mart, Smart and Smart
- **S**ingle Adapter to Support All Product

Smart Power Supply for Home Appliance

Intelligent Digital Power Control Platform



Standard Analog Block

Standard Process Standard Digital Cell

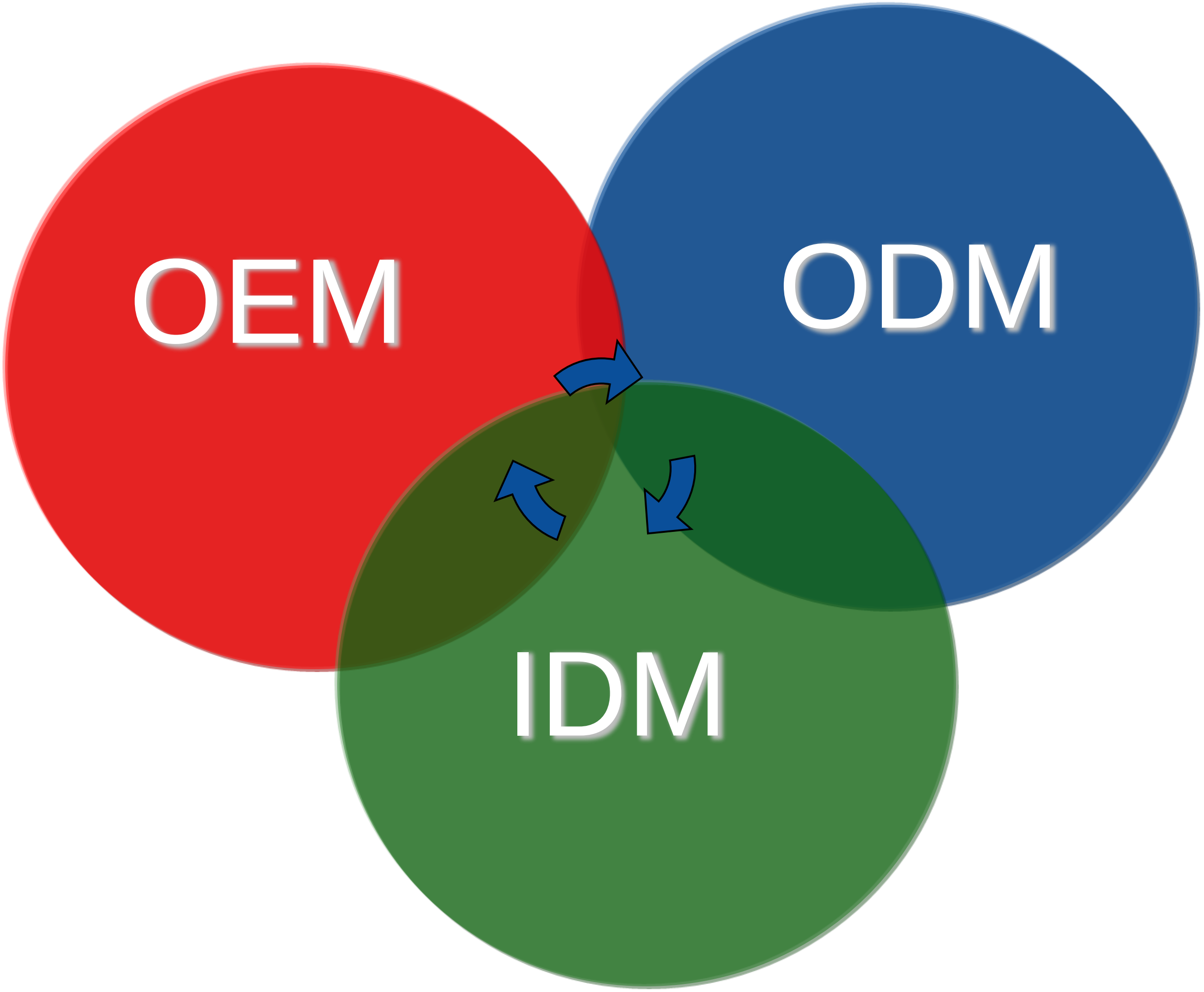
Reliable

Custom Application

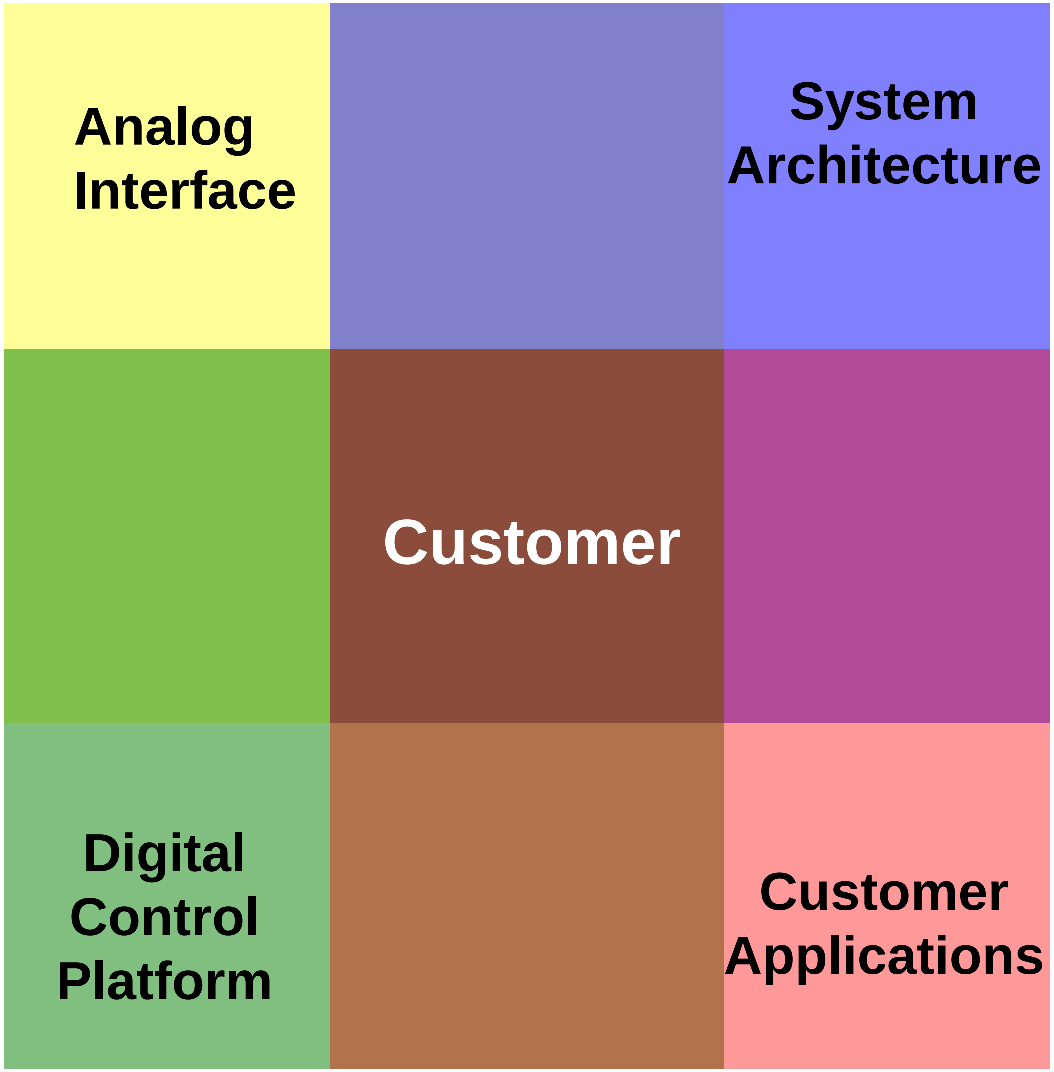
Programmable Digital Logic

Flexible

Green Power Solutions Providers



iWatt Digital Power Control Technology:
Bringing It All Together



Update ACDC Product Roadmap

AC/DC Roadmap

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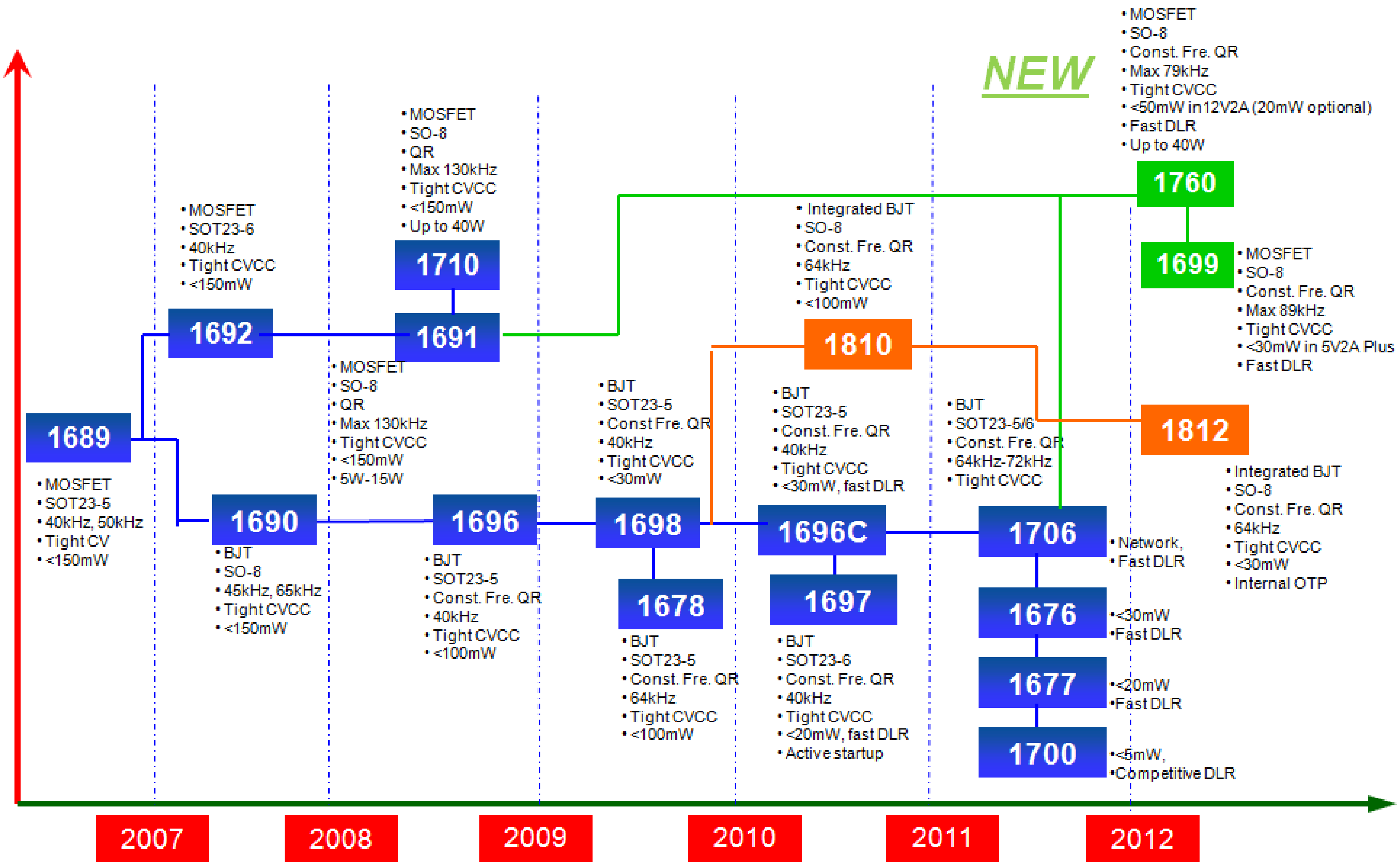


Focus: Low ownership cost by design

- Reduce the BOM cost
  - New system architecture to improve efficiency
  - Reduce the component account
  - More integration
- Manufacturability
  - Easy EMI design to simplify the transformer design
  - Auto-wind transformer
- Enhance the quality by design

Design for Environment

- Digital control technology optimizes green technology
- Design for Efficiency
  - iWatt technology achieves industry leading efficiency from “control” not from “component”
  - Achieve 80+ efficiency while reducing components
  - Advanced multi-mode operation
- EzEMI design
  - iWatt technology improves EMI performance from “control” not from “component”
  - Patented “ dynamic gate control”
  - Advanced digital “ EMI white noise generation”

NPD Focus

ACDC, Low-Power, Low-voltage 5V (<15W)	
iW1676	BJT Drive, No ASU, 30mW, SOT23-5
iW1677	BJT, ASU, < 20mW, SOT-23-6
iW1700	BJT, ASU, < 10mW, Zero-Power, SOT23-6
iW1812	Integrate 800V Switch, 30mW, SOIC7

ACDC, Low-Power, Hi-Voltage 12V (<15W)	
iW1706	BJT Drive, No ASU, 50mW, SOT-23-5
iW1707	BJT Drive, <30mW, SOT-23-6
iW1677	BJT, ASU, < 20mW, SOT-23-6
iW1816	Integrate 800V Switch, 30mW, SOIC7

ACDC, Hi-Power, Low-voltage 5V (<20W)	
iW1699	FET, ASU, 30mW, CDC programmable, SOIC8
iW1762	FET, ASU,10mW, CDC programmable, SOIC8

ACDC, Hi-Power, Hi-voltage 12V (<60W)	
iW1760	FET, ASU, 30mW, CDC programmable, SOIC8
iW1761	FET, ASU, 20mW, CDC programmable, SOIC8

iWatt Solutions are Ready

Table I-1. Proposed Energy Conservation Standards for Direct Operation External Power Supplies

AC-DC, Basic-Voltage External Power Supply		
Nameplate Output Power (P_{out})	**Minimum Average Efficiency in Active Mode** *(expressed as a decimal)*	**Maximum Power in No-Load Mode [W]**
0 to ≤ 1 watt	$\geq 0.5 * P_{out} + 0.16$	≤ 0.100
> 1 to ≤ 49 watts	$\geq 0.071 * \ln(P_{out}) - 0.0014 * P_{out} + 0.67$	≤ 0.100
> 49 watts to ≤ 250 watts	≥ 0.880	≤ 0.210
> 250 watts	0.875	≤ 0.500
AC-DC, Low-Voltage External Power Supply		
Nameplate Output Power (P_{out})	**Minimum Average Efficiency in Active Mode** *(expressed as a decimal)*	**Maximum Power in No-Load Mode [W]**
0 to ≤ 1 watt	$\geq 0.517 * P_{out} + 0.087$	≤ 0.100
> 1 to ≤ 49 watts	$\geq 0.0834 * \ln(P_{out}) - 0.0014 * P_{out} + 0.609$	≤ 0.100
> 49 watts to ≤ 250 watts	≥ 0.870	≤ 0.210
> 250 watts	0.875	≤ 0.500

DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EERE–2008–BT–STD–0005]

RIN: 1904–AB57

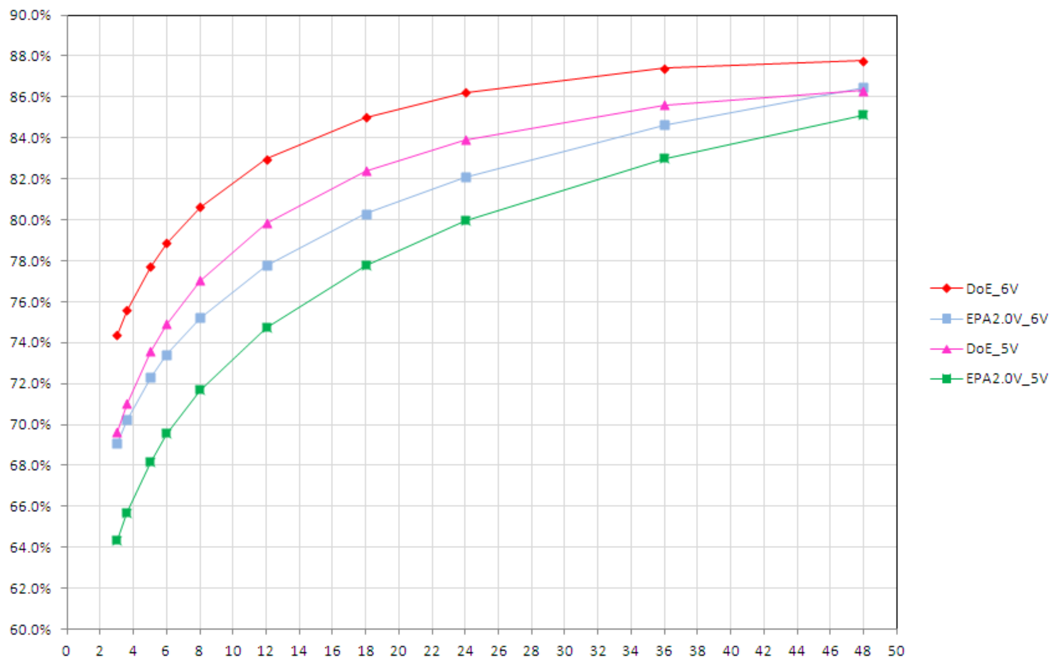
Energy Conservation Program: Energy Conservation Standards for Battery Chargers and External Power Supplies

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of proposed rulemaking (NOPR) and public meeting.

SUMMARY: The Energy Policy and Conservation Act (EPCA) prescribes energy conservation standards for various consumer products and commercial and industrial equipment, including

Efficiency Requirement (EPA2.0 vs. DoE)



Vout (V)	Pout (W)	IC Recommendation
≤5	3~5W	iW1676/1677
	5W~10W	iW1706/iW1677/iW1699
	10W~20W	iW1699
>5	3~5W	iW1676/1677/iW1707/iW1706
	5W~10W	iW1677/iW1707
	10W~20W	iW1760

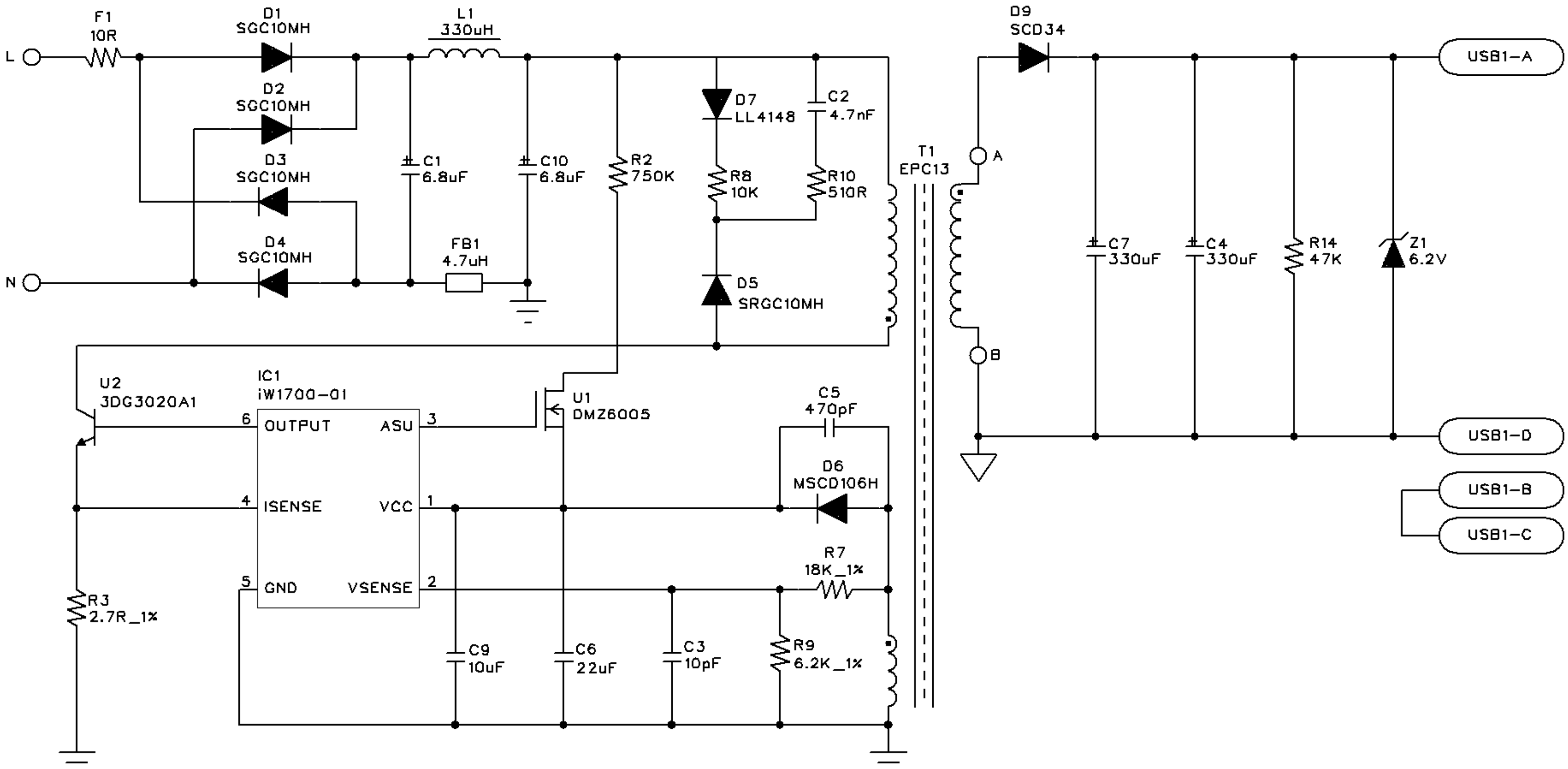
iWatt 12V1A High Efficiency Design Sample

V_{IN} (VAC)	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (A)	V_{RIPPLE} (mV_{P-P})	P_{OUT} (W)	η (%)	OCP (A)	Average η (%)	EPA2.0 η(%)
90	0.018	12.02	0.000	16.0			1.19	87.6	74.74
	3.41	11.98	0.250	38.0	3.00	87.83			
	6.81	11.99	0.500	48.0	6.00	88.03			
	10.28	11.99	0.750	80.0	8.99	87.48			
	13.77	12.00	1.000	94.0	12.00	87.15			
115	0.021	12.02	0.000	14.0			1.18	88.4	
	3.39	11.99	0.250	54.0	3.00	88.42			
	6.76	12.00	0.500	52.0	6.00	88.76			
	10.17	12.00	0.750	78.0	9.00	88.50			
	13.64	12.00	1.000	80.0	12.00	87.98			
230	0.027	12.02	0.000	22.0			1.15	88.5	
	3.42	12.00	0.250	44.0	3.00	87.72			
	6.78	12.00	0.500	58.0	6.00	88.50			
	10.13	12.00	0.750	78.0	9.00	88.85			
	13.50	12.00	1.000	88.0	12.00	88.89			
264	0.036	12.03	0.000	16.0			1.13	88.0	
	3.45	11.99	0.250	56.0	3.00	86.88			
	6.83	11.99	0.500	76.0	6.00	87.77			
	10.14	11.97	0.750	78.0	8.98	88.54			
	13.55	12.01	1.000	94.0	12.01	88.63			

* Note: Output voltage is measured at end of PCB

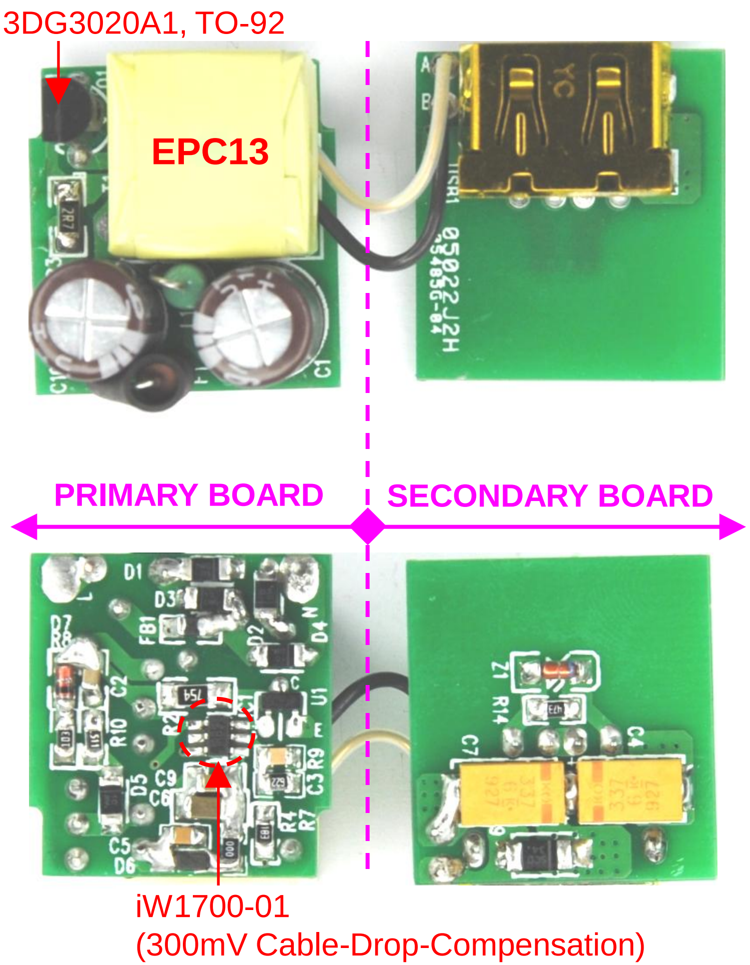
Zero-Power SOLUTION: iW1700-01 For 5V1A Mini-TA Charge Design

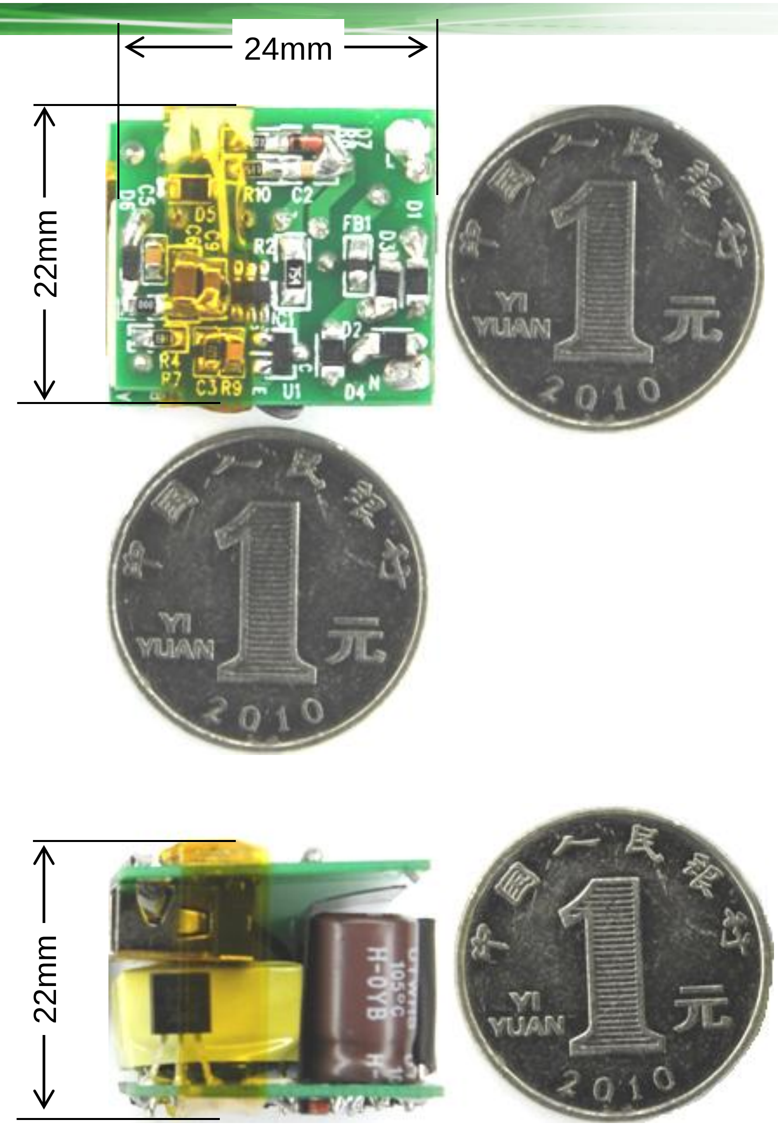
Schematic



L
N
F1
10R
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%

Circuit Board Photograph



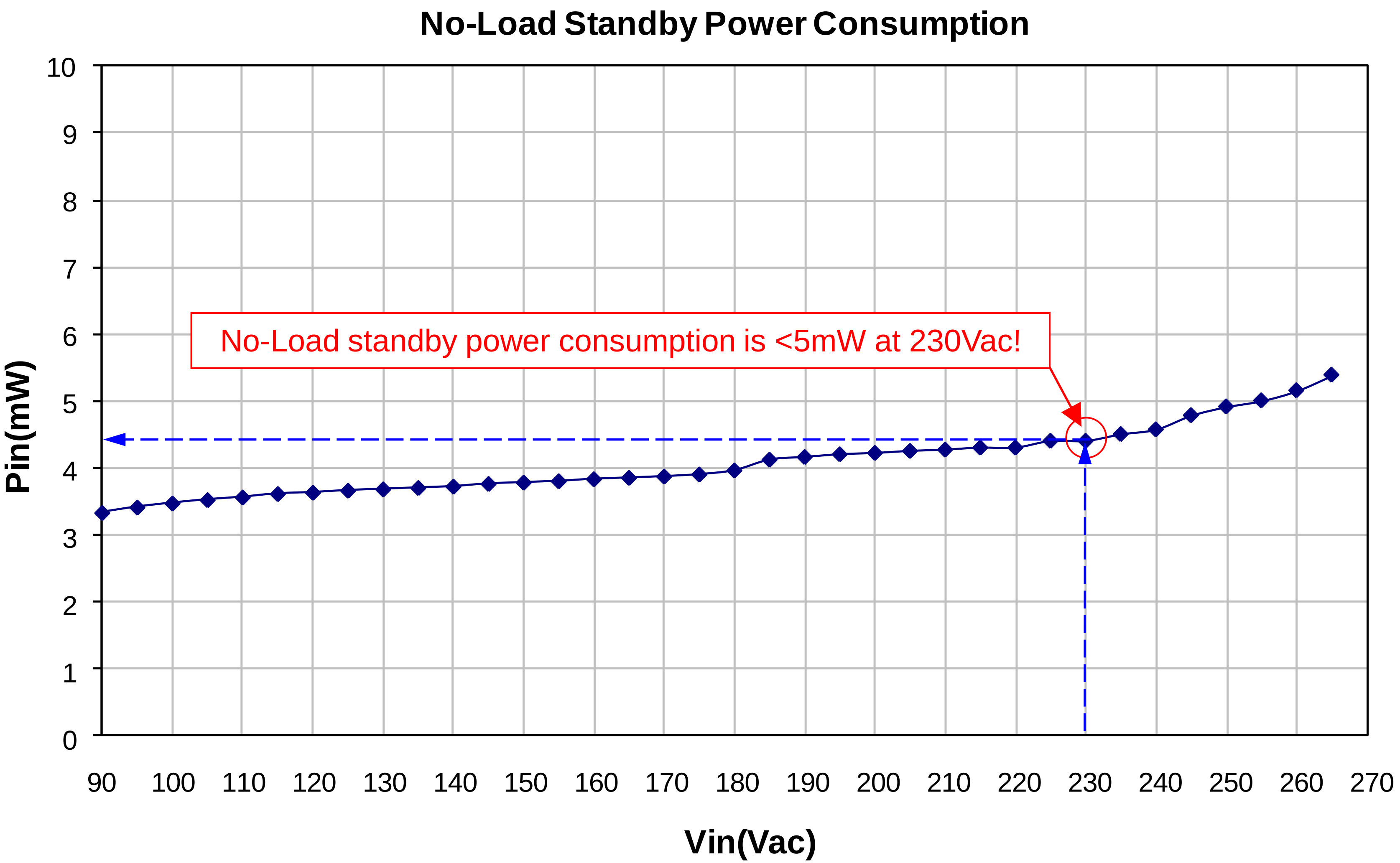


Regulation, Ripple and Efficiency Measurement

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		

* Note: Output voltage is measured at end of PCB

No-Load Standby Power Consumption



Output VI Characteristics

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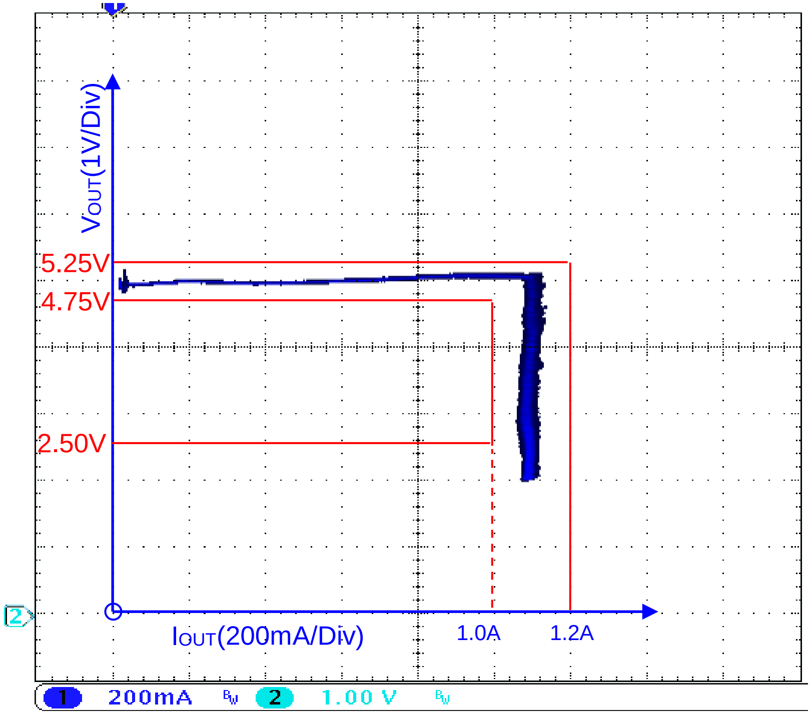
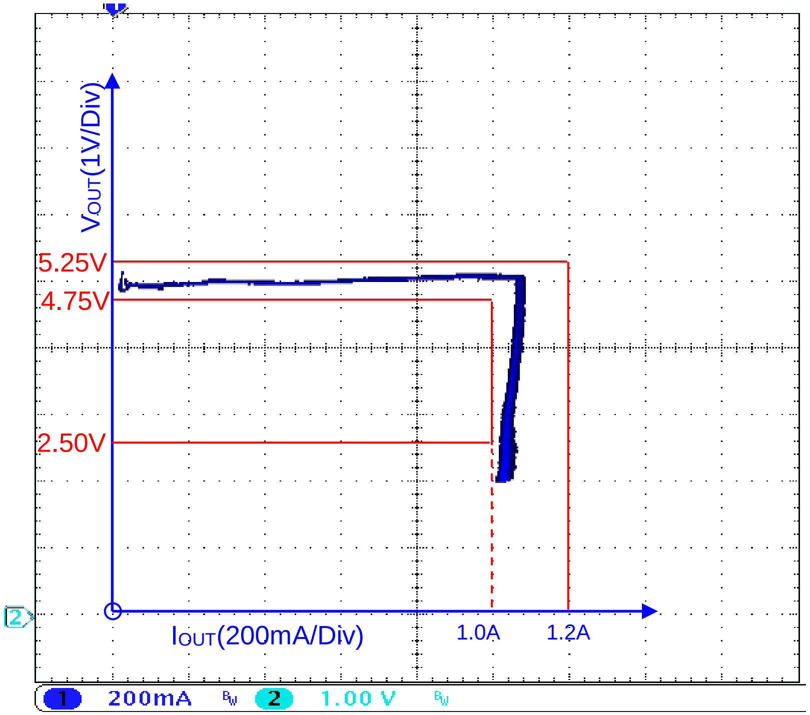
V_{IN}=90Vac/50Hz



V_{IN}=264Vac/50Hz



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

Dynamic Load Response

Test Conditions:

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

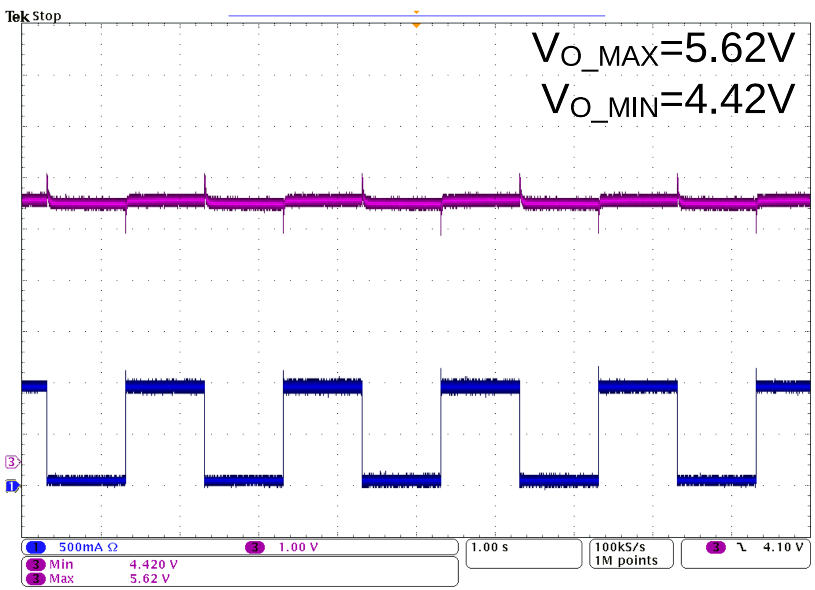
2). Frequency: *1Hz*

3). Duty-Cycle: *50%*

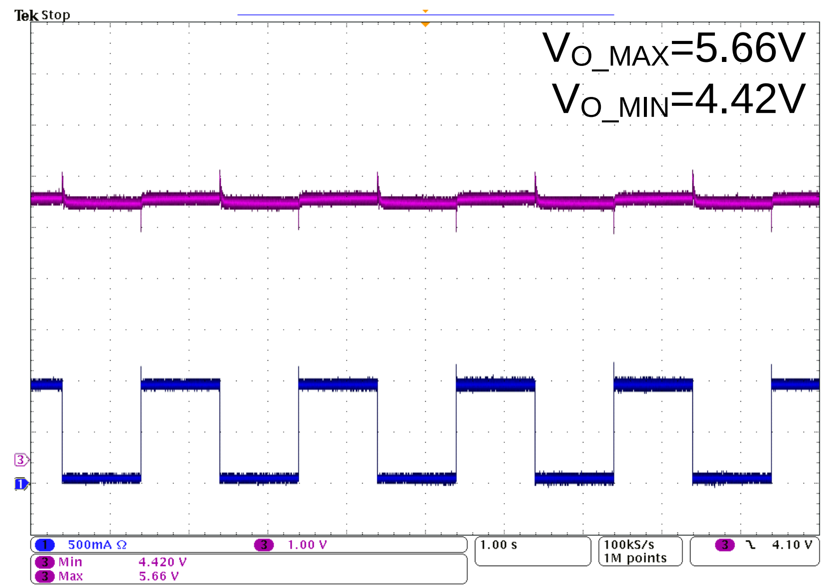
4). Slew-Rate*: 0.1A/us*

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

iW1812-20 for 3W Soymilk machine Design

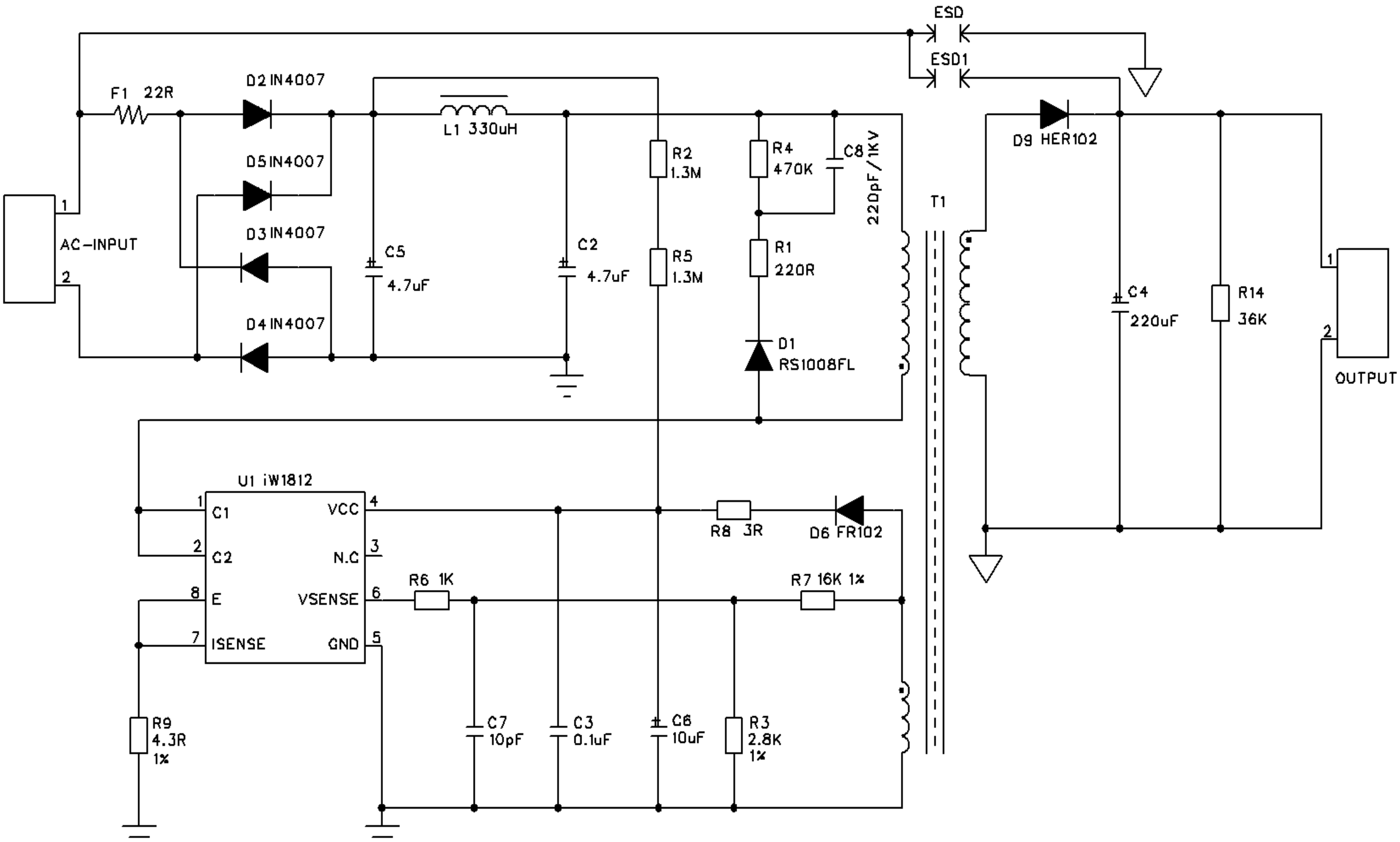
General Design Specification :

1. **AC Input Range 90-264Vac**
2. **DC Output 12V0.2A**
3. **Meet *"100mW"* No-Load Standby Power Consumption Requirement**
4. **No Y-CAP Design**

1. Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	90		264	V_{AC}	2 Wire
Frequency	f_{LINE}	63	50/60	47	Hz	
No-load Input Power (230V_{AC})				100	mW	
Output						
Output Voltage	V_{OUT}	11.4		12.6	V	Measured at the end of PCB
Output Current	I_{OUT}	0		0.2	A	
Output Ripple Voltage	V_{RIPPLE}			150	mV_{P_P}	Measured at the end of PCB I_{OUT}=0.2A @T_A = 25 ℃ 20 MHz Bandwidth
Total Output Power						
Continuous Output Power	P_{OUT}		2.4		W	
Over Current Protection	*OCP*			0.35	A	Auto-restart
Active Mode Efficiency (Meet EPA2.0 Requirement)	η	67.7			%	Measured at end of PCB, 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



ESD
ESD1
F1 22R
D2 IN4007
D5 IN4007
D3 IN4007
D4 IN4007
L1 330uH
C5 4.7uF
C2 4.7uF
R2 1.3M
R5 1.3M
R4 470K
C8 220pF/1KV
R1 220R
D1 RS1008FL
T1
D9 HER102
C4 220uF
R14 36K
AC-INPUT
OUTPUT
U1 iW1812
C1
C2
E
ISENSE
VCC
N.C
VSENSE
GND
R8 3R
D6 FR102
R6 1K
R7 16K 1%
R9 4.3R 1%
C7 10pF
C3 0.1uF
C6 10uF
R3 2.8K 1%

3. Circuit Board Photograph

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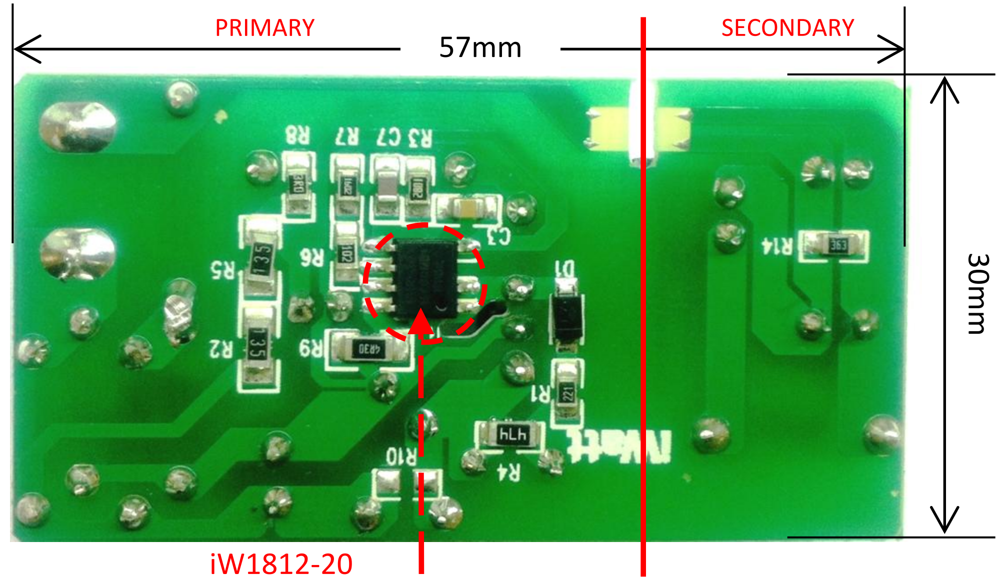
Top side

Bottom side



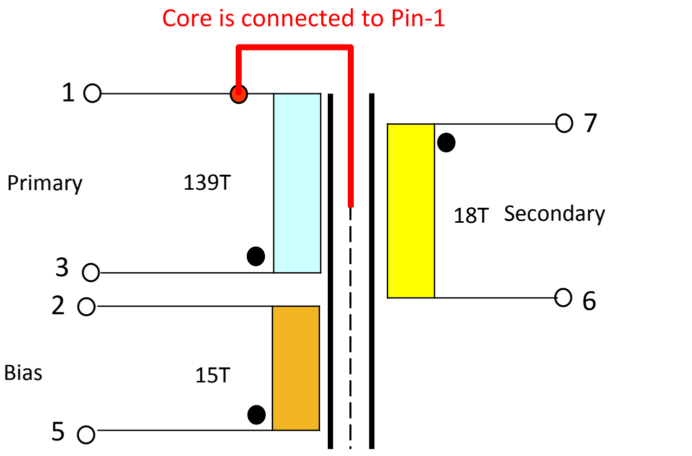
iW1812-20
(No Cable-Drop-Compensation)

4. Bill of Material

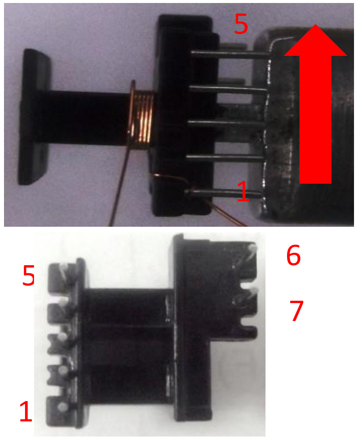
Item	Qty.	Ref.	Description
1	1	U1	iW1812-20, Off-line Digital PSR & VMS PWM Controller, SOIC-7
2	2	C2,C5	4.7uF, 400V, E-Cap, Φ8mmX12mm
3	1	C3	0.1uF, 50V, X7R, SMD-0805
4	1	C4	220uF, 25V, Low ESR E-Cap, Φ8mmX12mm
5	1	C6	10uF, 50V, Low ESR E-Cap, Φ5mmX11.5mm
6	1	C7	10pF, 25V, X7R, SMD-0805
7	1	C8	220pF, 1kV, Ceramic Capacitor
8	1	D1	RS1008FL, 1A 800V,Fast Rectifier Diode,SOD-123FL
9	4	D2,D3,D4,D5	1N4007, 1A1000V, Rectifier Diode, DO-41
10	1	D6	FR102, 1A100V, Fast Recovery Rectifier (Trr=150ns), DO-41
11	1	D9	HER102, 1A100V, Ultra Fast Diode, DO-41
12	1	L1	330uH, Color Ring Inductor, 0410
13	1	R1	220Ω±5%, SMD-0805
14	2	R2,R5	1.3MΩ ±5%, SMD-1206
15	1	R3	2.8KΩ±1%, SMD-0805
16	1	R4	470KΩ±5%, SMD-1206
17	1	R6	1KΩ±5%, SMD-0805
18	1	R7	16KΩ±1%, SMD-0805
20	1	R8	3Ω±5%, SMD-0805
19	1	R9	4.3Ω ±1%, SMD-1206
21	1	R14	36KΩ±5%, SMD-0805
22	1	F1	22Ω, Fusible Resistor, 1Ws
23	1	T1	EE13, vertical Taye
24	1	AC-INPUT	Connector,3PIN2,L=3.96mm
25	1	OUTPUT	Connector,2PIN, L=2.54mm
26	1	PCB	Single Side Board, 94V0

5. Transformer Design

SCHEMATIC



Winding Start pin1 & End pin-3 in "Clockwise" direction – looking from Pin 1/5 side of the Bobbin.



Rotating direction of winding machine

ELECTRICAL SPECIFICATIONS:

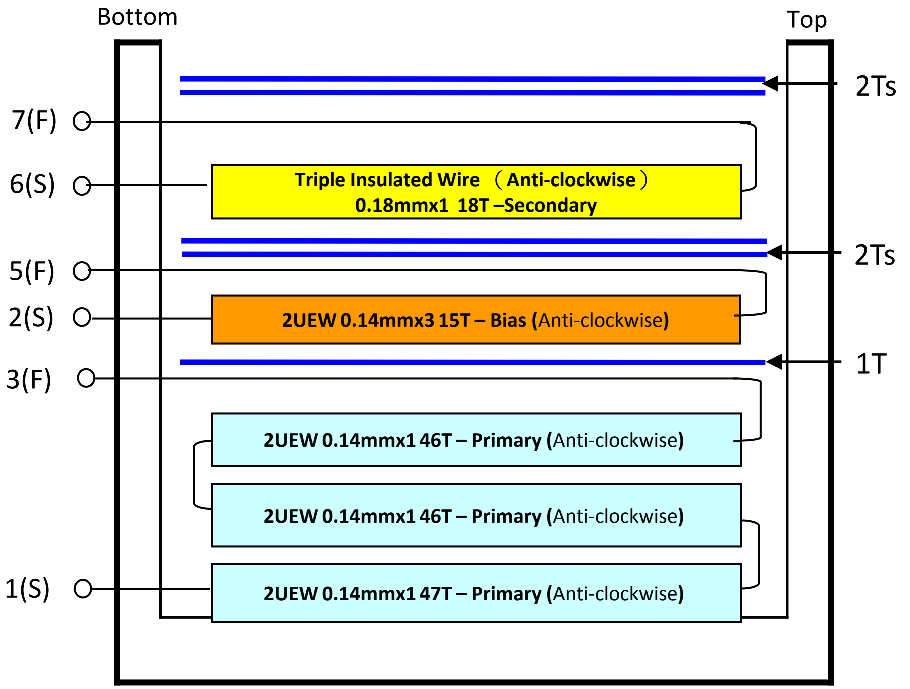
1. Primary Inductance (Lp) = 3.15mH±7% @10KHz
2. Primary Leakage Inductance
3. Electrical Strength = 3KV, 50/60Hz,1Min

MATERIALS:

1. Core : EE13 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin :EE13 Vertical.
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



6. Regulation, Ripple and Efficiency Measurement

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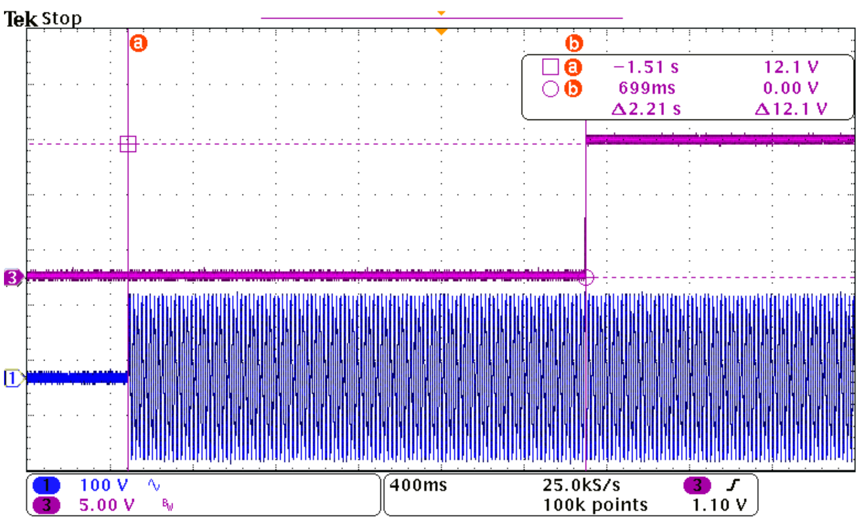
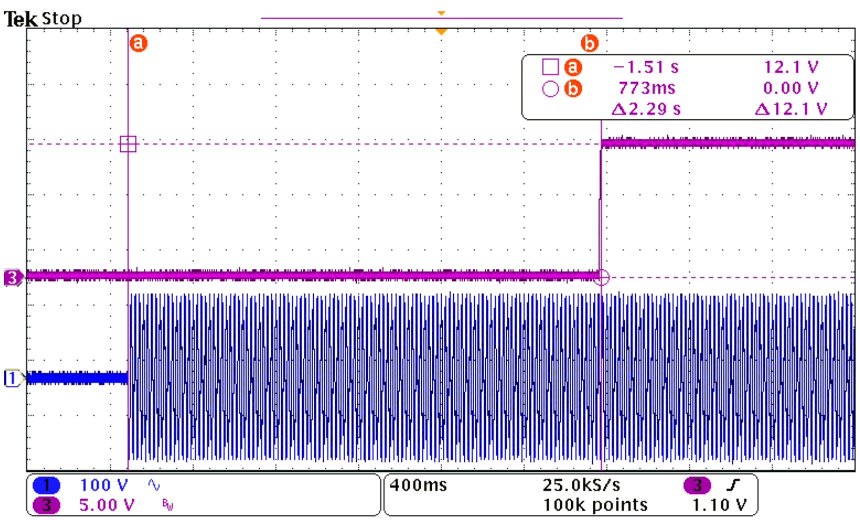
* Note: Output voltage measured at end of PCB

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	V_{RIPPLE} (mV_{P-P})	P_{OUT} (W)	η (%)	OCP (mA)	Average η(%)
85	0.028	11.96	0	44.0			300	75.83
	0.787	11.89	50	39.2	0.59	75.54		
	1.546	11.91	100	53.6	1.19	77.01		
	2.349	11.91	150	67.6	1.79	76.05		
	3.189	11.92	200	80.8	2.38	74.74		
115	0.031	11.94	0	48.0			310	77.58
	0.781	11.89	50	45.6	0.59	76.12		
	1.521	11.91	100	57.6	1.19	78.27		
	2.287	11.91	150	56.8	1.79	78.12		
	3.063	11.92	200	67.2	2.38	77.81		
230	0.061	11.94	0	52.0			310	75.35
	0.838	11.89	50	54.4	0.59	70.94		
	1.576	11.91	100	50.8	1.19	75.54		
	2.322	11.91	150	64.8	1.79	76.95		
	3.056	11.91	200	67.2	2.38	77.96		
264	0.075	11.94	0	58.0			310	73.66
	0.867	11.89	50	48.4	0.59	68.57		
	1.613	11.91	100	57.2	1.19	73.81		
	2.366	11.91	150	69.2	1.79	75.52		
	3.105	11.91	200	64.8	2.38	76.73		

7. Turn On Delay Time





100V_{AC},No Load

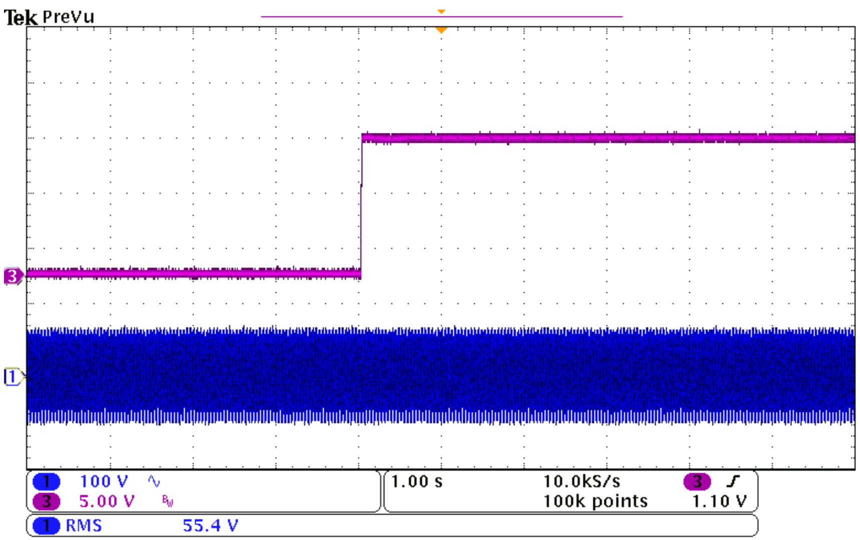
T_{ST_DELAY}=2.21S

100V_{AC},Full Load

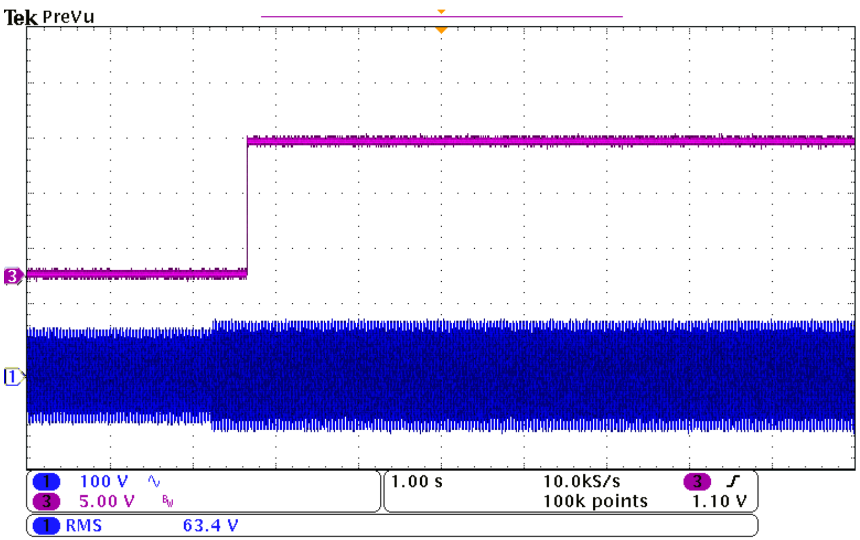
T_{ST_DELAY}=2.29S

8. AC Startup Voltage Characteristic

No Load, $V_{IN\_STARTUP}$ =55.4V_{AC}

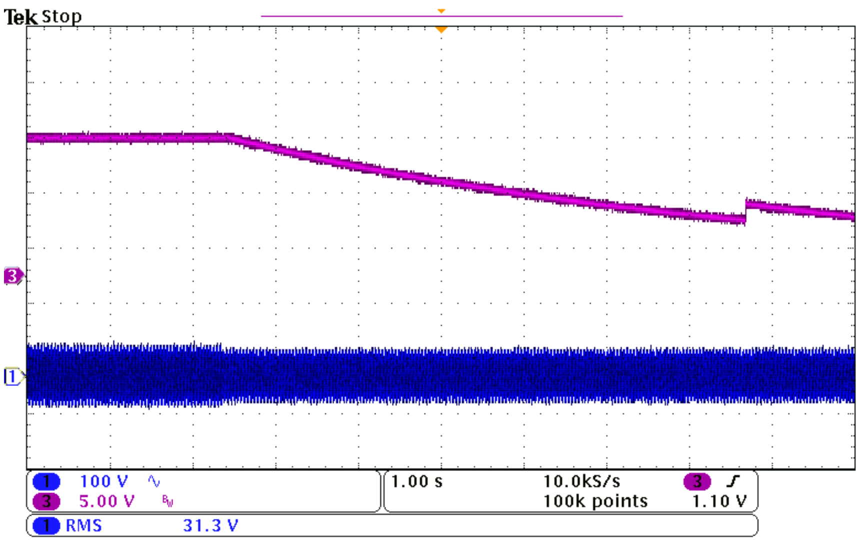


Full Load, $V_{IN\_STARTUP}$=63.4V_{AC}

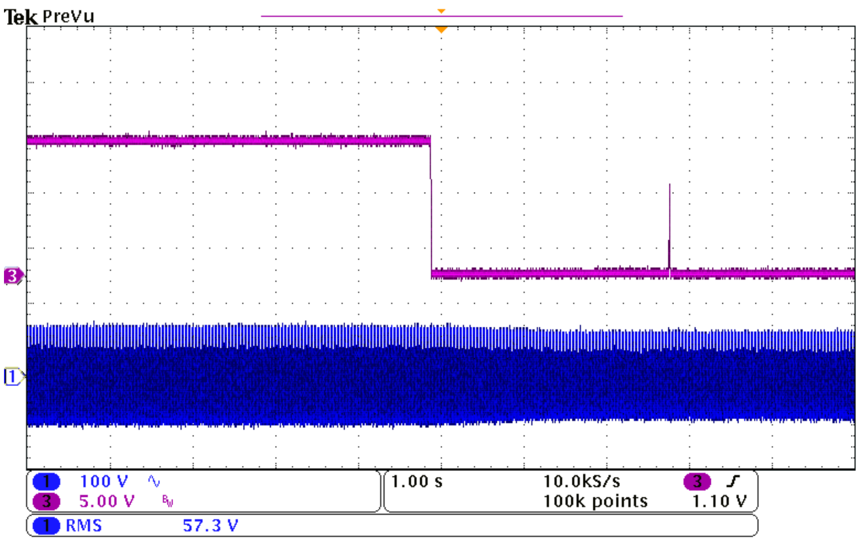


9. AC Brownout Voltage Characteristic

No Load, $V_{IN\_BROWNOUT}$ =31.3V_{AC}

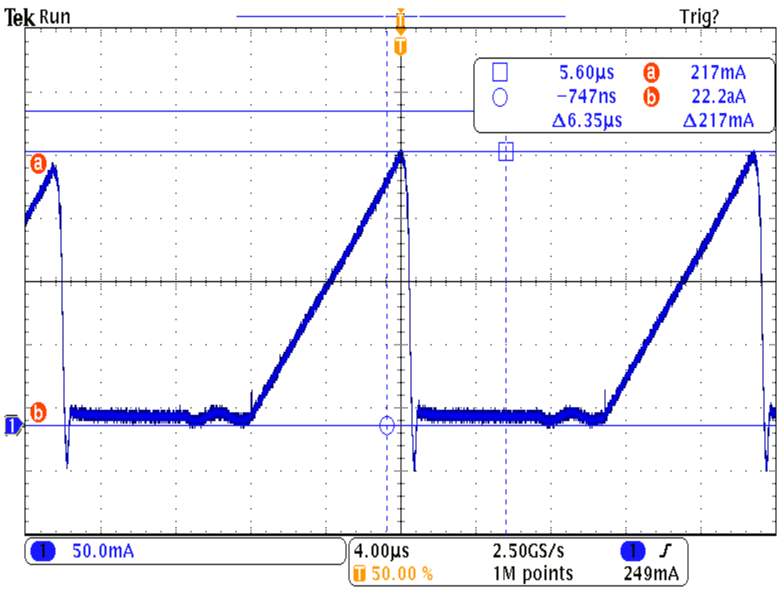


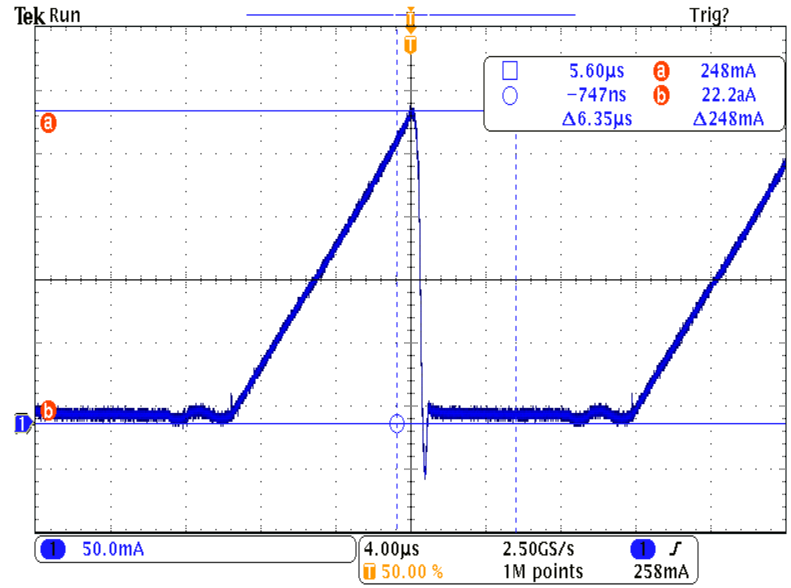
Full Load, $V_{IN\_BROWNOUT}$=57.3V_{AC}



10. Transformer Flux Density

(N_P= 139Ts, L_P=3.3mH,Ae=17.1mm^2-EE13)





I_{PRI} is monitored at 85Vac and *200mA* load

I_{PRI} =217mA

B_{MAX} =(I_{PRI} *L_P) / (N_P*A_E)

=(217*3.3) / (139*17.1)

=0.301Tesla

Ip is monitored at 85Vac and 3*00mA* load (Max Output Power).

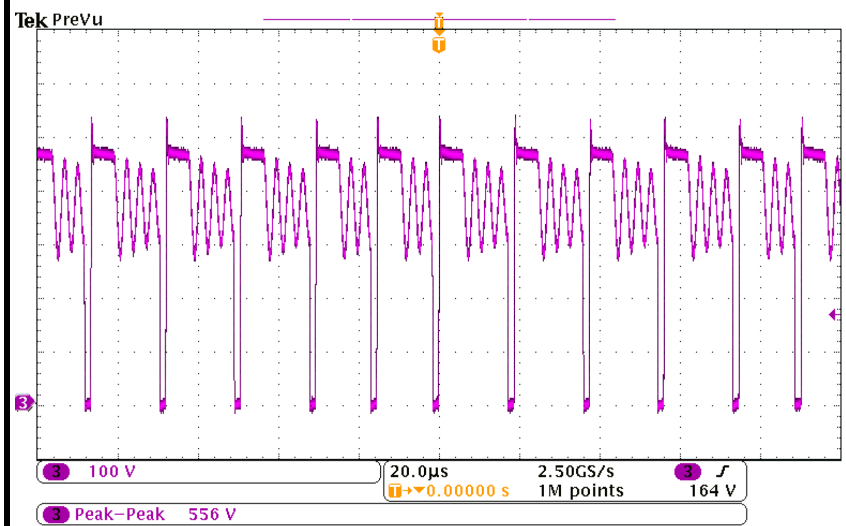
I_{PRI} =248mA

B_{MAX} =(I_{PRI} *L_P) / (N_P*A_E)

=(248*3.3) / (139*17.1)

=0.344 Tesla

11. V_{CE} Waveform



Test Condition:

V_{IN}=264V_{AC}, I_{OUT_CV}=200mA

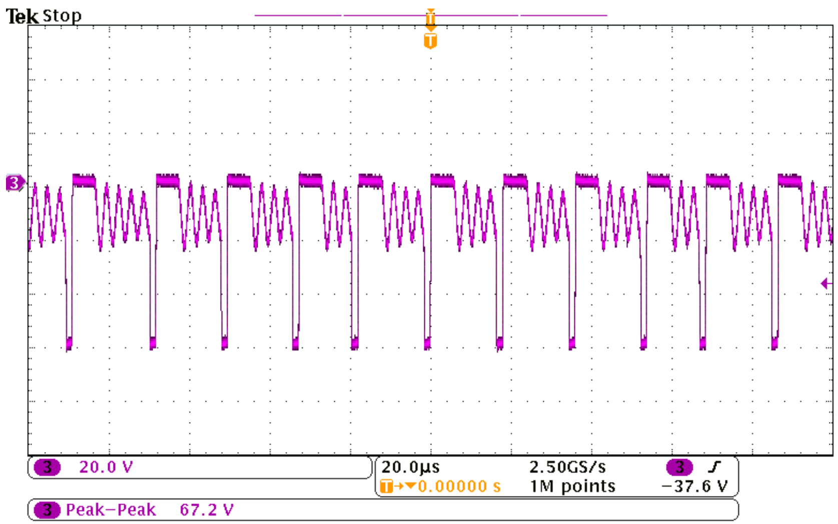
Result:

V_{CE_MAX}=556V

iW1812-20

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	℃

12. Output Diode



Test Condition:

V_{IN}=264V_{AC}, I_{OUT_CV}=200mA

Result:

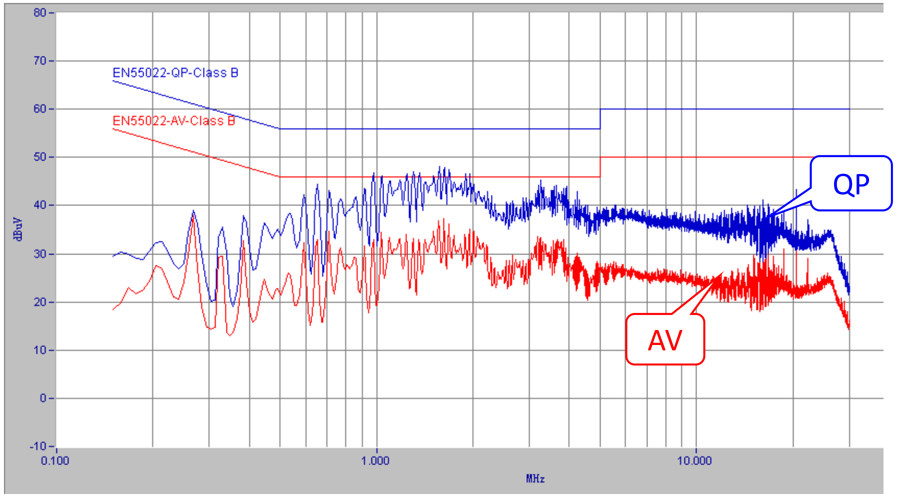
V_{D9_PP}=67.2V

Appendix – Simple Specification for used Transistor(HER102)

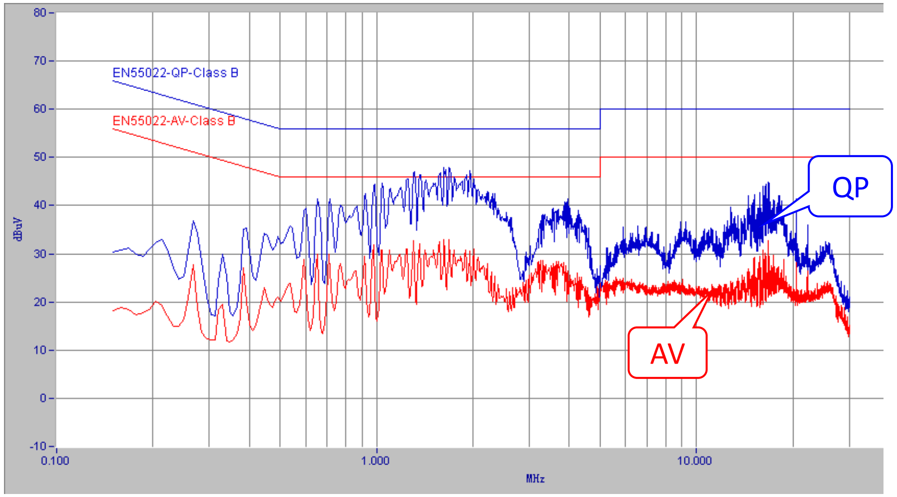
Type Number	HER 101	HER 102	HER 103	HER 104	HER 105	HER 106	HER 107	HER 108	Units
Maximum Recurrent Peak Reverse Voltage	50	100	200	300	400	600	800	1000	V
Maximum RMS Voltage	35	70	140	210	280	420	560	700	V
Maximum DC Blocking Voltage	50	100	200	300	400	600	800	1000	V
Maximum Average Forward Rectified Current .375 (9.5mm) Lead Length @T_A = 55°C	1.0								A
Peak Forward Surge Current, 8.3 ms Single Half Sine-wave Superimposed on Rated Load (JEDEC method)	30								A
Maximum Instantaneous Forward Voltage @ 1.0A	1.0				1.3	1.7			V
Maximum DC Reverse Current @ T_A=25°C at Rated DC Blocking Voltage @ T_A=100°C	5.0 100								uA uA
Maximum Reverse Recovery Time (Note 1)	50					75			nS
Typical Junction Capacitance (Note 2)	20					15			pF

13. Conducted EMI

V_{IN}=230Vac/50Hz, Live



V_{IN}=230Vac/50Hz, Neutral



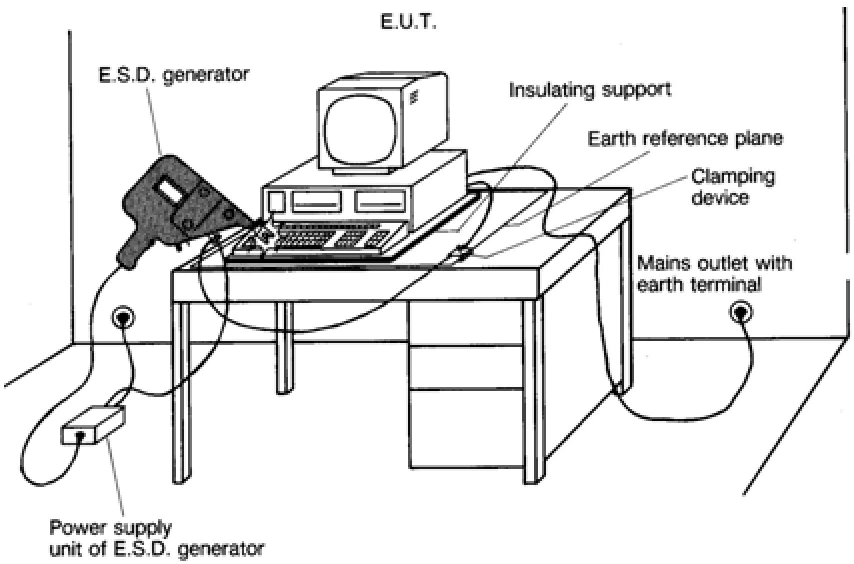
Note: Resistive & Full load; output (-) is Grounding.

14. ESD (IEC 61000-4-2)

Test condition:

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

Air-Discharged		Result (no-load)	Result (full-load)
15KV	+	PASS	PASS
	-	PASS	PASS
18KV	+	PASS	PASS
	-	PASS	PASS
20KV	+	PASS	PASS
	-	PASS	PASS
22KV	+	PASS	PASS
	-	PASS	PASS
23KV	+	PASS	PASS
	-	PASS	PASS
25KV	+	PASS	PASS
	-	PASS	PASS



iW1812 for 5W Microwave oven Design

General Design Specification:

1.AC Input Range: 90-264Vac

2.DC Output: 5.0V/250mA,12V/250mA

3.Meet *"100mW"* No-Load standby Power Consumption Requirement

4.Max Ripple <150mV$_{P_P}$

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})				100	mW	
Output						
Output Voltage	V_{OUT1}	11	12	14	V	Measured at the end of PCB
	V_{OUT2}	4.8	5.0	5.3		
Output Current	I_{OUT1}/I_{OUT2}	0		0.25	A	
Output Ripple Voltage	V_{RIPPLE}			150	mV_{P_P}	Measured at the end of PCB I_{OUT1}=0.25A, I_{OUT2}=0.25A@T_A = 25 ℃ 20 MHz Bandwidth
Total Output Power						
Continuous Output Power	P_{OUT}		4.25		W	
Over Current Protection	*OCP*			0.35	A	Auto-restart
Active Mode Efficiency (Meet EPA2.0 Requirement)	η	72			%	Measured at end of PCB, V_{IN} = 115VAC and 230VAC (T_{Amb} = 25 ℃).
Environmental						
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC60065, IEC60950,UL1950 Class II				
Ambient Temperature	T_{AMB}	0		40	°C	Free convection, sea level

2. Schematic Circuit

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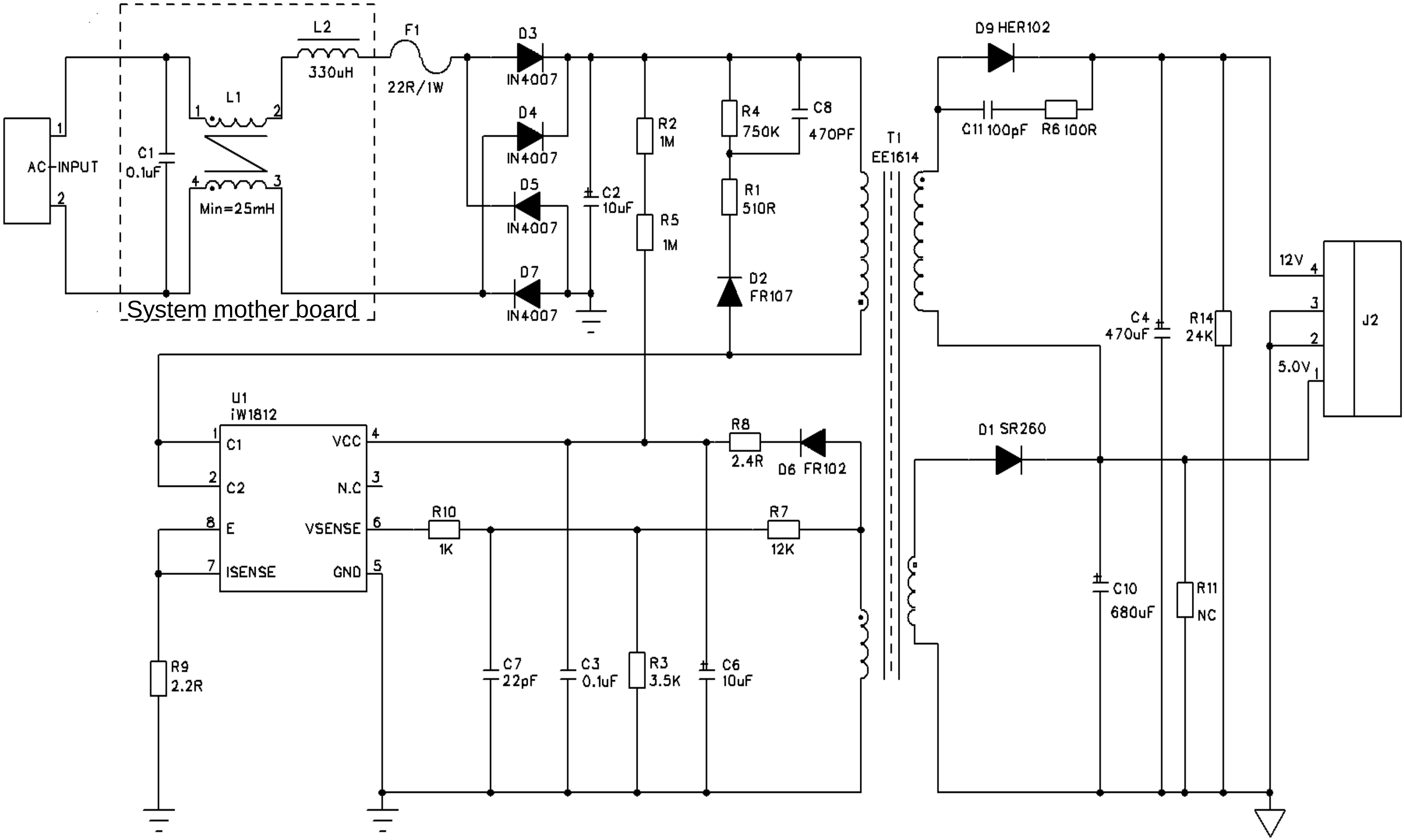
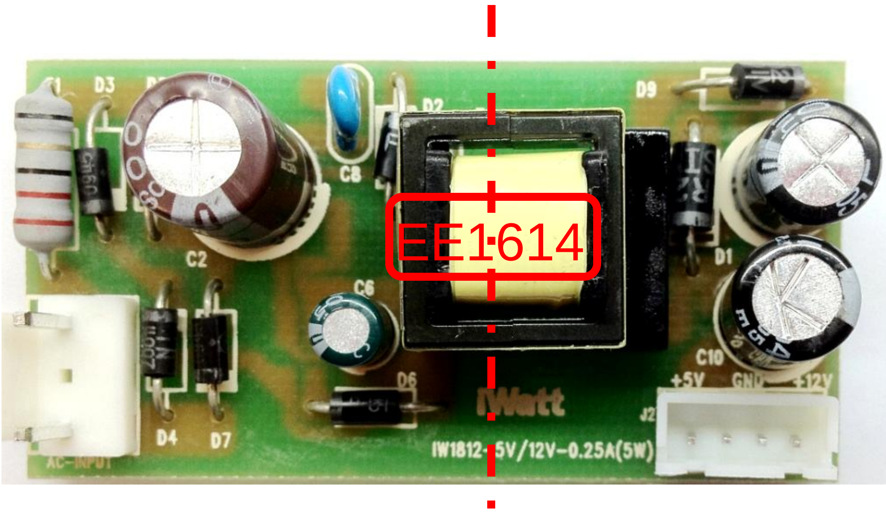
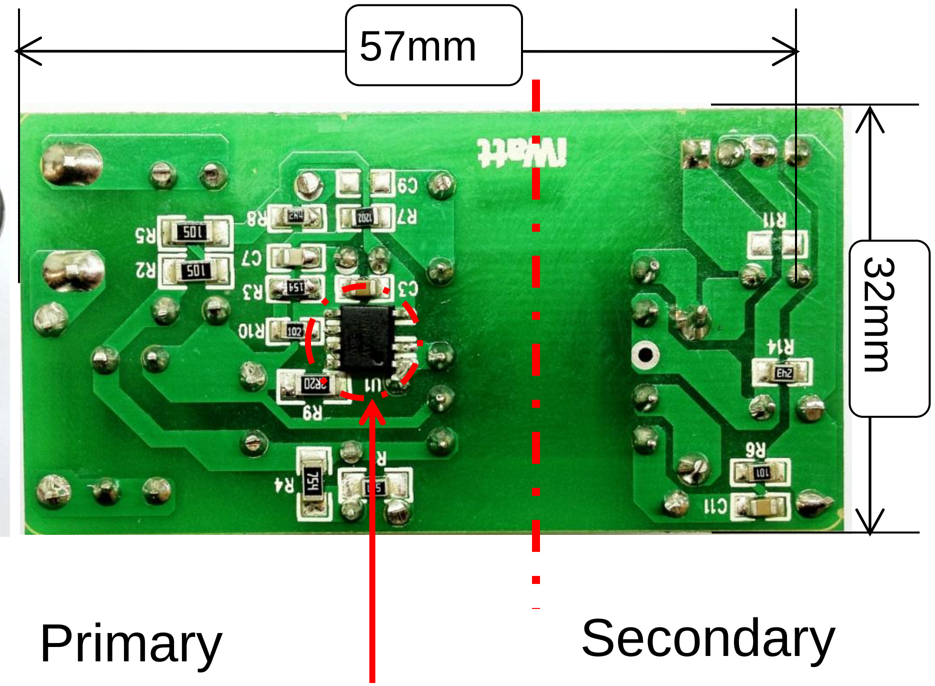


3. Circuit Board Photograph

Top side



Bottom side



Primary

Secondary

Primary

Secondary

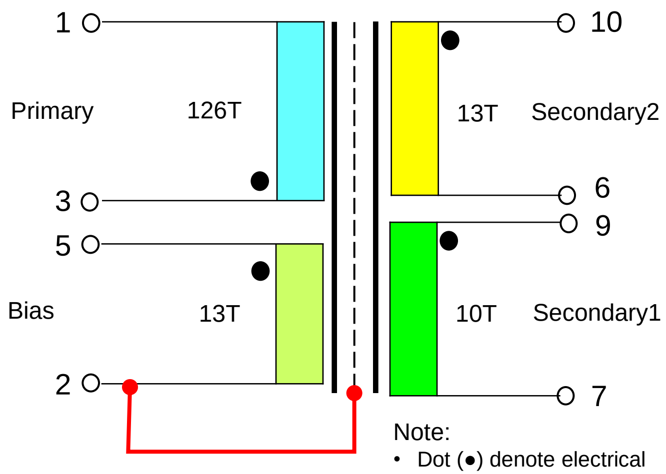
iW1812-20 PSR VMS Controler
(No Cable-Drop-Compensation)

4. Bill of Material

Item	Qty	Reference	Description
1	1	U1	iW1812,Off-line Digital&Primary VMS Controller, SOIC-7
2	1	C2	10uF/400V, E-Cap,10*16
3	1	C3	0.1uF,X7R, SMD-0805
4	1	C4	470uF/16V, E-Cap, 8*12 Low ESR
5	1	C6	10uF/50V, E-Cap, 5*11 Low ESR
6	1	C7	22pF, NPO, SMD-0805
7	1	C8	470pF,1KV,Ceramic Capacitor
8	1	C10	680uF/10V, E-Cap, 8*12 Low ESR
9	1	C11	100pF, 250V SMD-0805
10	1	D1	SR260,2A 60V,Schottky Barrier Diode DO-15
11	1	D2	FR107,1A 1000V,Fast Rectifier Diode DO-41
12	4	D3,D4,D5,D7	1N4007, 1A1000V, Rectifier diode DO-41
13	1	D6	FR102, 1A100V, Fast Recovery Rectifier (Trr=150ns), DO-41
14	1	D9	HER102,1A 100V,Ultra Fast Recovery Rectifier DO-41
15	1	R1	510Ω ±5%, SMD-0805
16	2	R2,R5	1MΩ ±5%, SMD-1206
17	1	R3	3.5KΩ ±1%, SMD-0805
18	1	R4	750KΩ ±5%, SMD-1206
19	1	R6	100Ω ±5%, SMD-0805
20	1	R7	12KΩ ±1%, SMD-0805
21	1	R8	2.4Ω ±5%, SMD-0805
22	1	R9	2.2Ω ±1%, SMD-1206
23	1	R10	1KΩ ±5%, SMD-0805
24	1	R14	24KΩ ±5%, SMD-0805
25	1	F1	22Ω, Fusible Resistor, 1W
26	1	AC-INPUT	Connector,3PIN2,L=3.96mm
27	1	OUTPUT	Connector,4PIN, L=2.54mm
28	1	T1	EE1614, Horizontal
29	1	PCB	Single Side Board,T=1.0mm FR-1 94V0
30	NC	L1	CM Inductor >25mH 0.16*80Ts
31	NC	L2	330uH, Color Ring Inductor, 0410
32	NC	C1	X-Cap 0.1uF/275V

5. Transformer Design

SCHEMATIC



Core is connected to Pin-2

Note:
- Dot (●) denote electrical start.
- Electrical start could be different to Mechanical Winding start.

ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (Lp) = 1.50mH±7%@10KHz
2. Primary Leakage Inductance<5% * L_P, Short pin6-pin10
3. Electrical Strength = 3KV, 50/60Hz,1Min

MATERIALS:

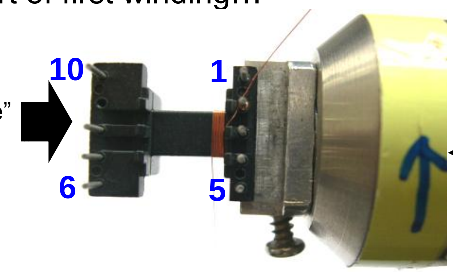
1. Core : EE16 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin : EE16 Vertical.
3. Magnet Wires (Pri) : Type 2-UEW
4. Magnet Wire (Sec) : Triple Insulated Wires
5. Layer Insulation Tape :3M1298 or equivalent.

FINISHED :

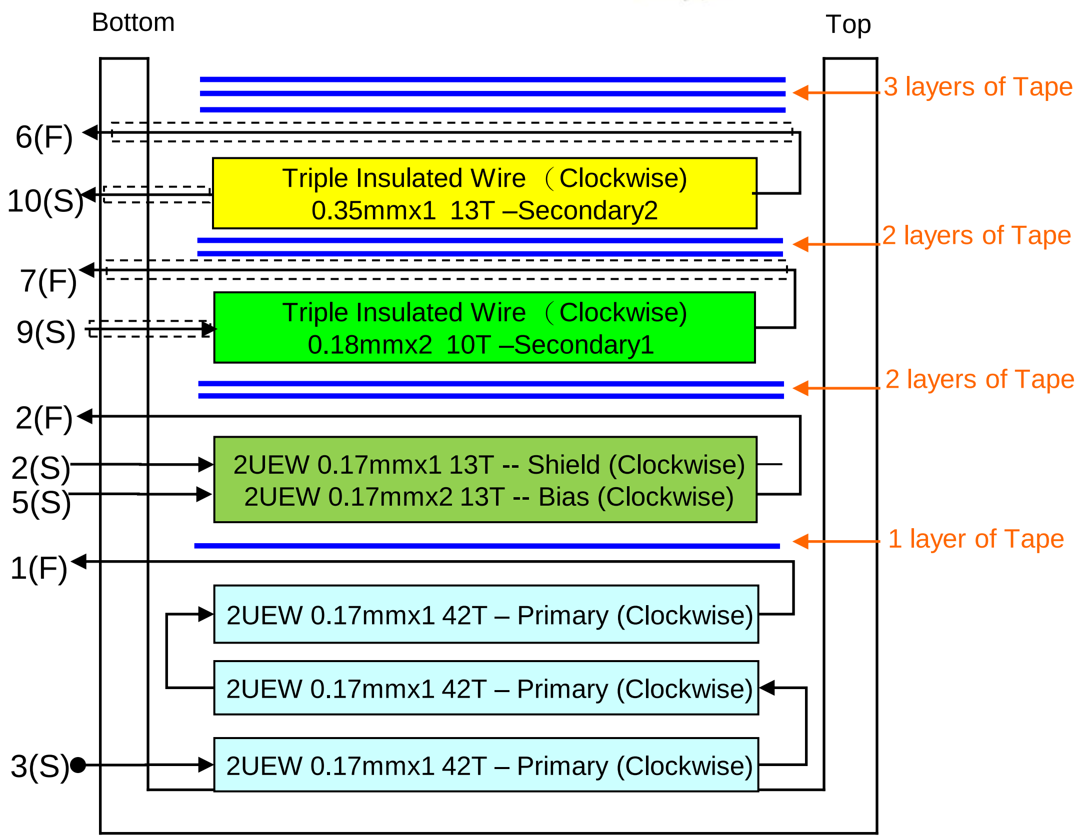
1. Varnish the complete assembly

Instruction for start of first winding…

Winding Start pin-3 & End pin-1 in "Clockwise" direction – looking from Pin side of the Bobbin.



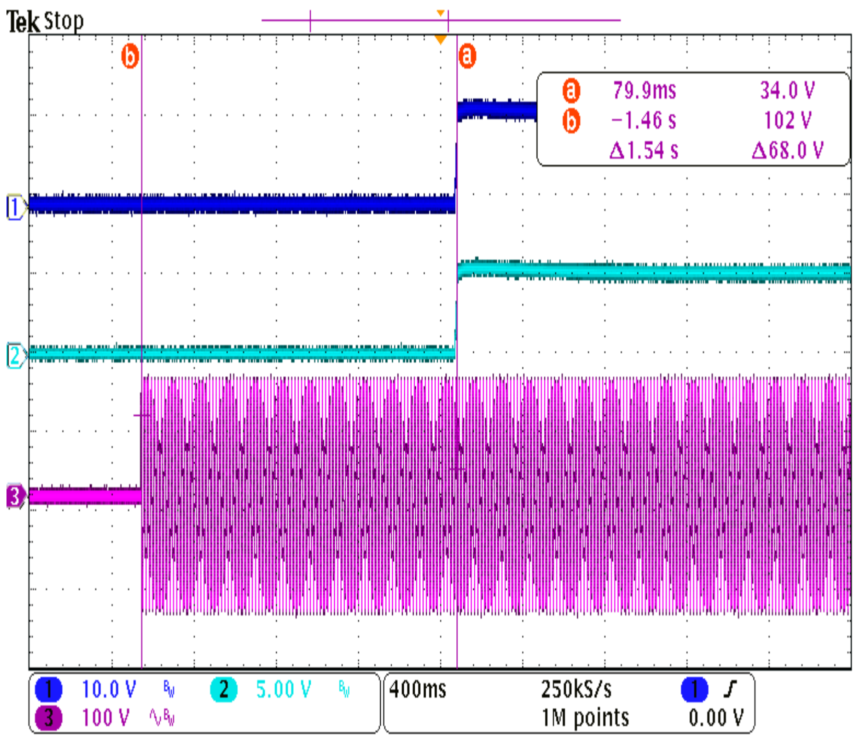
Rotating direction of winding machine



6. Regulation, Ripple and Efficiency Measurement

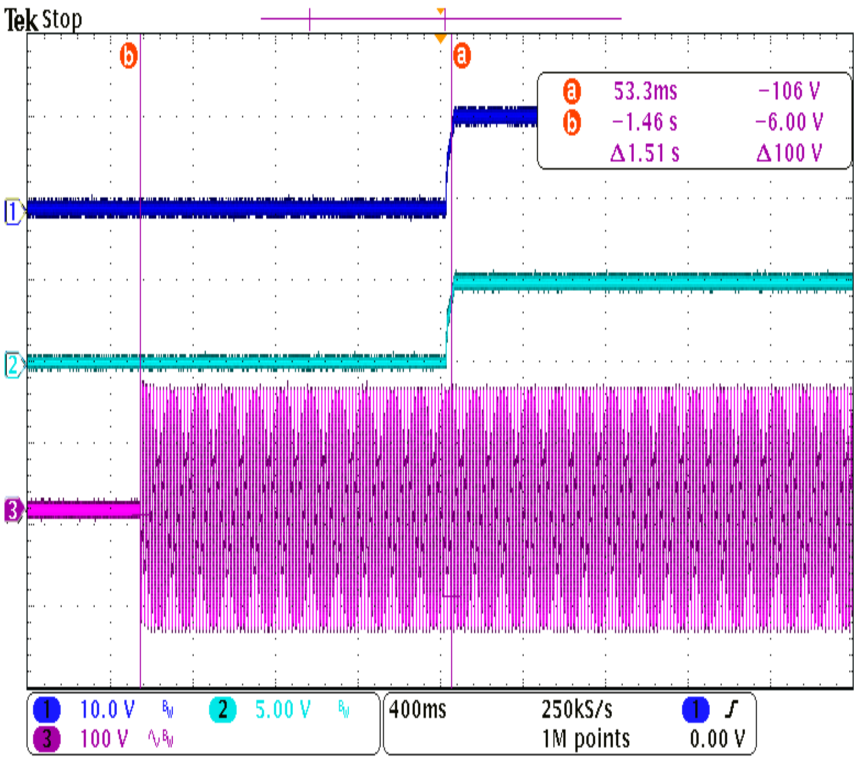
V_{IN} (V_{AC})	P_{IN} (W)	$V_{OUT(5V)}$ (V)	$V_{OUT(12V)}$ (V)	$I_{OUT(5V)}$ (mA)	$I_{OUT(12V)}$ (mA)	$V_{RIPPLE(5V)}$ (mV_{P-P})	$V_{RIPPLE(12V)}$ (mV_{P-P})	P_{OUT} (W)	η (%)
	0.021	5.09	11.35	0	0				
	0.283	4.95	11.57	40	0			0.198	69.96
90	1.620	4.95	12.27	250	0			1.238	76.44
	3.701	5.12	11.41	0	250			2.852	77.05
	5.335	4.98	11.31	250	250	57	92	4.073	76.34
	0.026	5.08	11.34	0	0				
	0.292	4.95	11.56	40	0			0.198	67.81
115	1.616	4.95	12.28	250	0			1.239	76.64
	3.655	5.11	11.41	0	250			2.851	78.01
	5.220	4.98	11.31	250	250	54	82	4.072	78.01
	0.068	5.07	11.32	0	0				
	0.370	4.95	11.56	40	0			0.198	53.51
230	1.688	4.95	12.36	250	0			1.239	73.37
	3.720	5.11	11.40	0	250			2.849	76.58
	5.232	4.98	11.30	250	250	48	80	4.070	77.79
	0.088	5.07	11.31	0	0				
	0.401	4.95	11.58	40	0			0.198	49.42
264	1.723	4.95	12.36	250	0			1.239	71.88
	3.766	5.10	11.39	0	250			2.848	75.62
	5.290	4.98	11.30	250	250	51	84	4.070	76.94

7. Turn On Delay Time



100VAC,CH1,CH2:No Load

T_{ST_DELAY}=1.54S



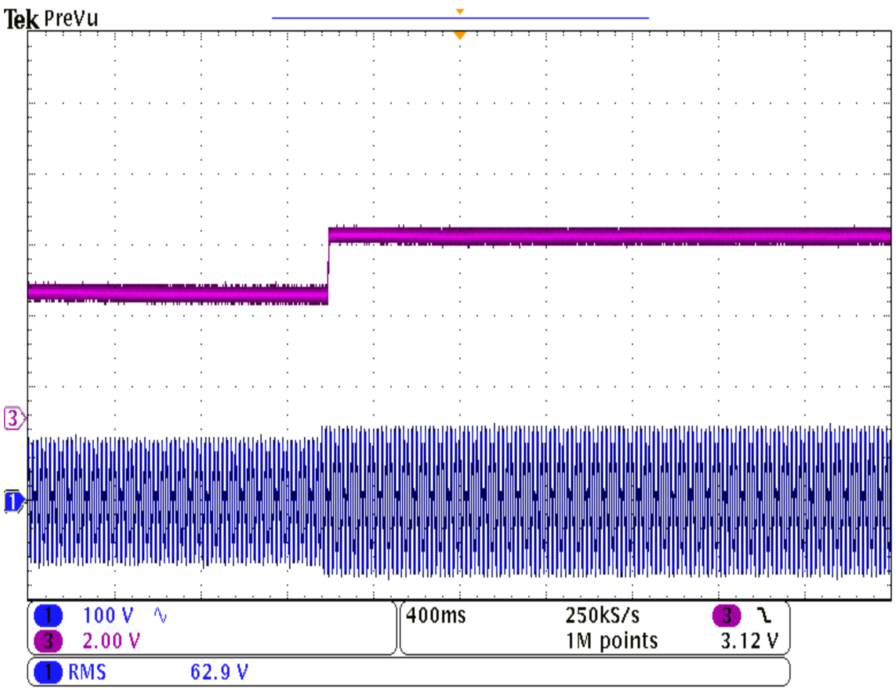
100VAC,CH1,CH2:Full Load

T_{ST_DELAY}=1.51S

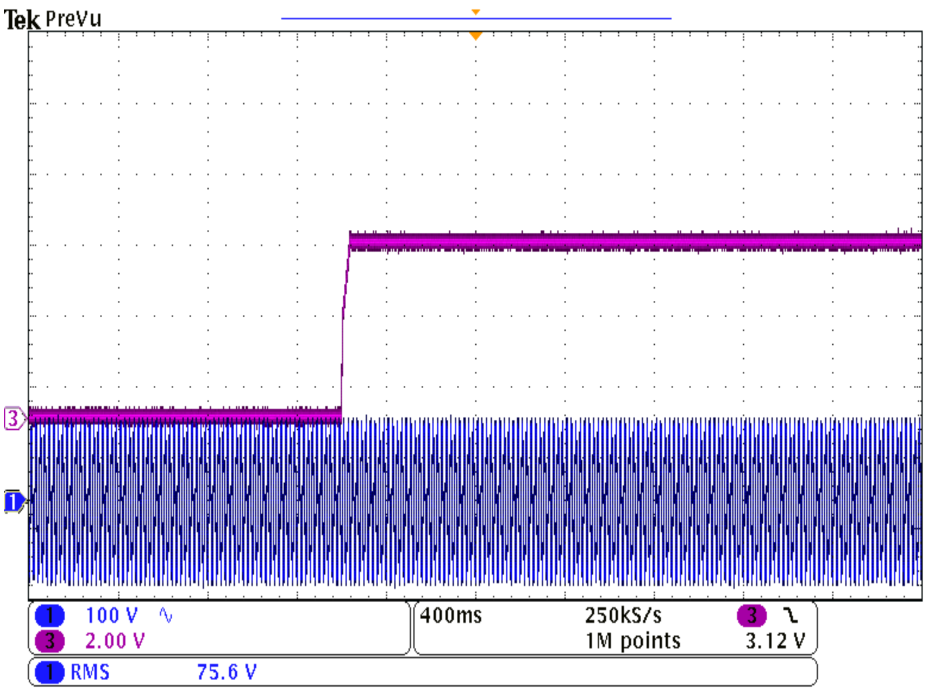
CH1:12V CH2:5.0V CH3:AC INPUT

8. AC Startup Voltage Characteristic

No Load, $V_{IN\_STARTUP}$ =62.9V_{AC}



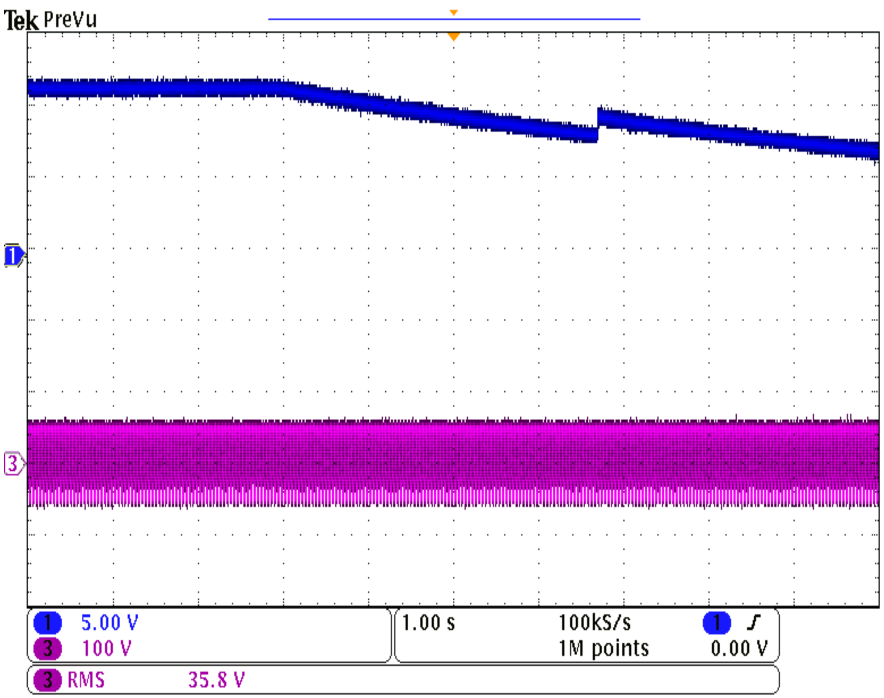
Full Load, $V_{IN\_STARTUP}$=75.6V_{AC}



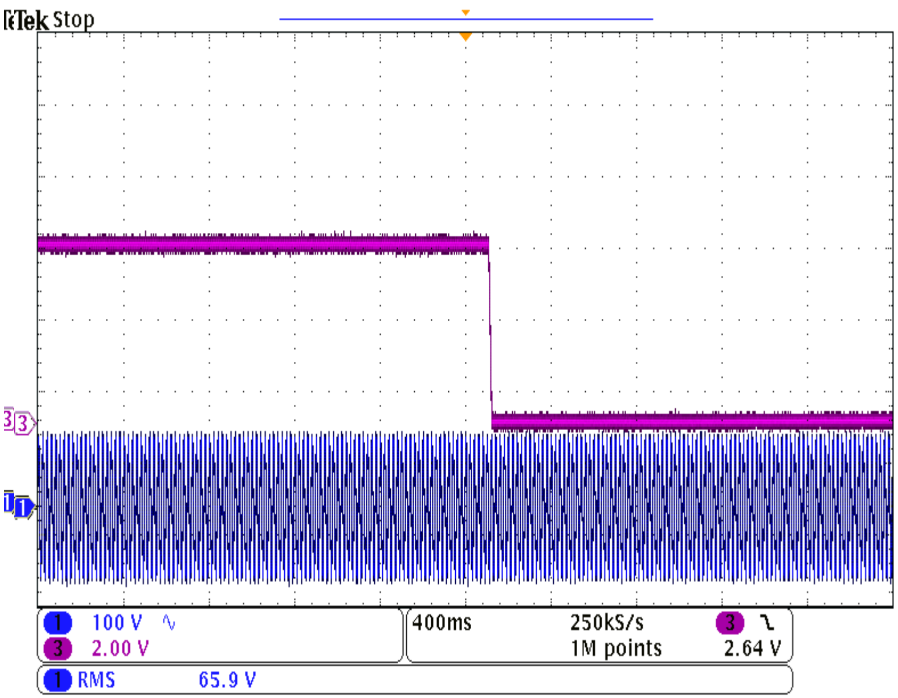
CH1:AC Input CH3:5V

9. AC Brownout Voltage Characteristic

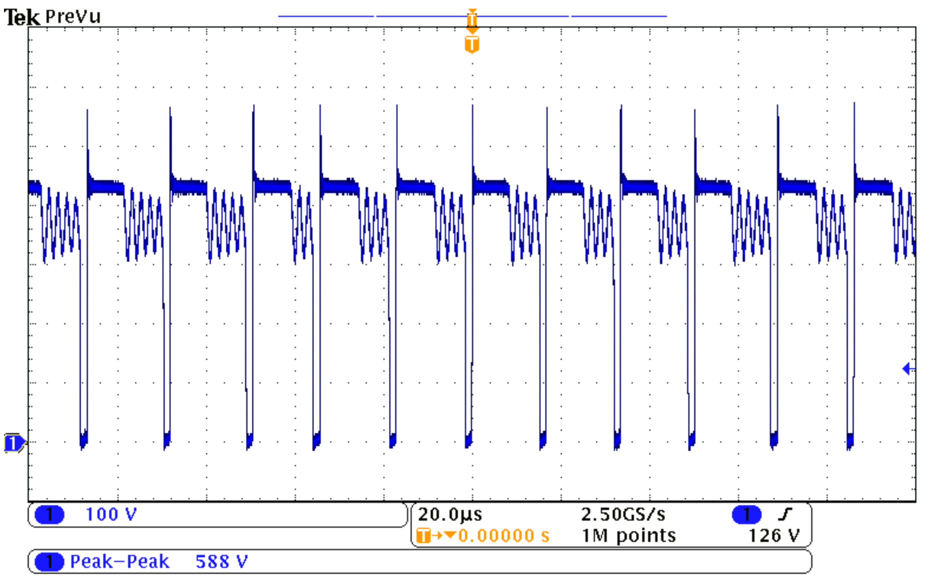
No Load, $V_{IN\_BROWNOUT}$ =35.8VAC



Full Load, $V_{IN\_BROWNOUT}$=65.9VAC



10. V_{CE} Waveform



Test Condition:

Vin=264Vac, I_{OUT1}=0.25A,I_{OUT2}=0.25A

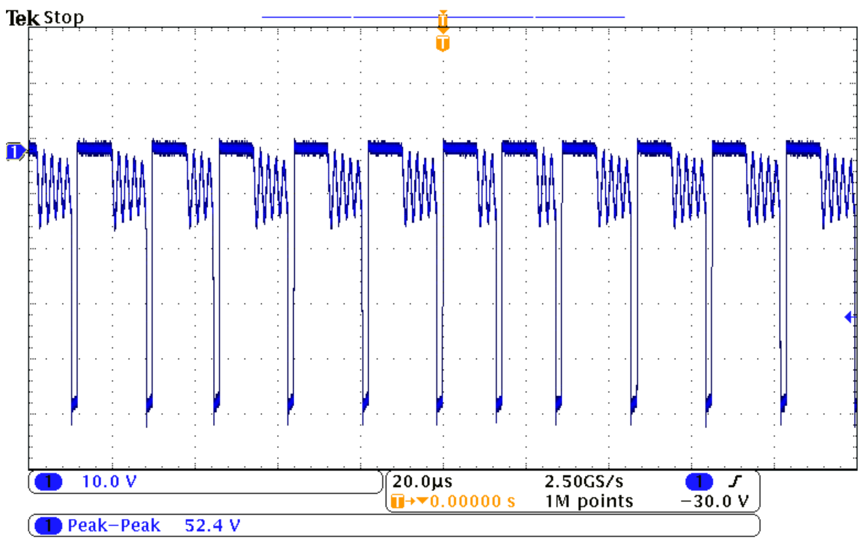
Result:

V_{CE_MAX}=**588V**

iW1812

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	℃

11. Output Diode(12V)



Test Condition:

V_{IN}=264V_{AC}, $I_{OUT(12V)}$=250mA

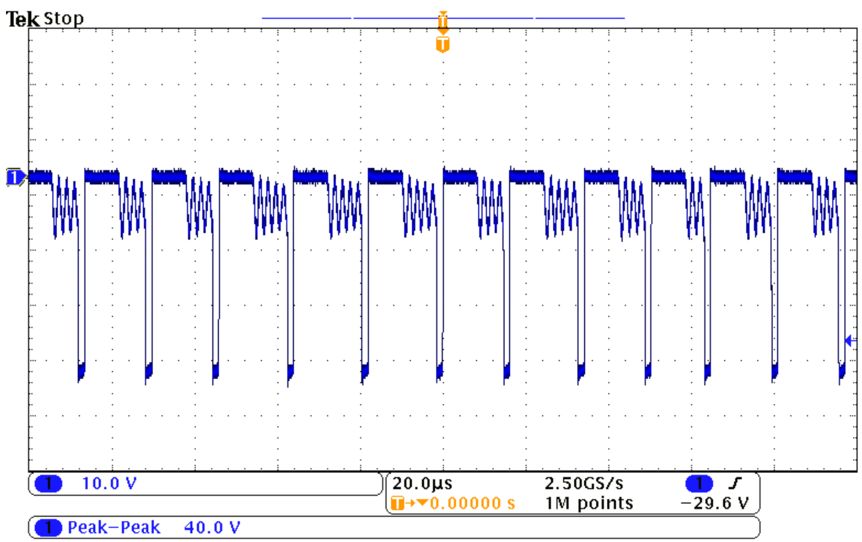
Result:

V_{D9_PP}=52.4V

Appendix – Simple Specification for used Diode (HER102)

Type Number	HER 101	HER 102	HER 103	HER 104	HER 105	HER 106	HER 107	HER 108	Units
Maximum Recurrent Peak Reverse Voltage	50	100	200	300	400	600	800	1000	V
Maximum RMS Voltage	35	70	140	210	280	420	560	700	V
Maximum DC Blocking Voltage	50	100	200	300	400	600	800	1000	V
Maximum Average Forward Rectified Current .375 (9.5mm) Lead Length @T_A = 55°C	1.0								A
Peak Forward Surge Current, 8.3 ms Single Half Sine-wave Superimposed on Rated Load (JEDEC method)	30								A
Maximum Instantaneous Forward Voltage @ 1.0A	1.0				1.3	1.7			V
Maximum DC Reverse Current @ T_A=25°C at Rated DC Blocking Voltage @ T_A=100°C	5.0 100								uA uA
Maximum Reverse Recovery Time (Note 1)	50					75			nS
Typical Junction Capacitance (Note 2)	20					15			pF

12. Output Diode(5V)



Test Condition:

V_{IN}=264V_{AC}, $I_{OUT(5V)}$=250mA

Result:

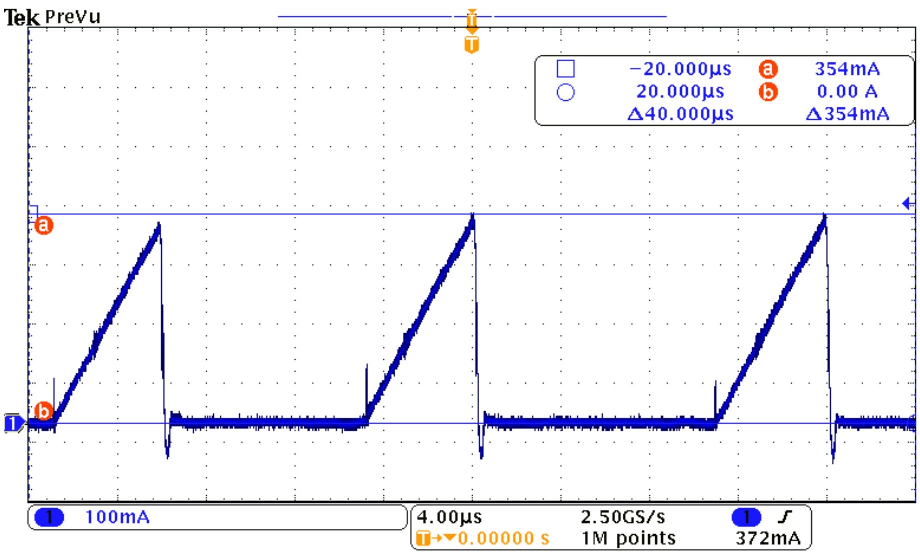
V_{D1_PP}=40V

Appendix – Simple Specification for used Schottky Diode (SR260)

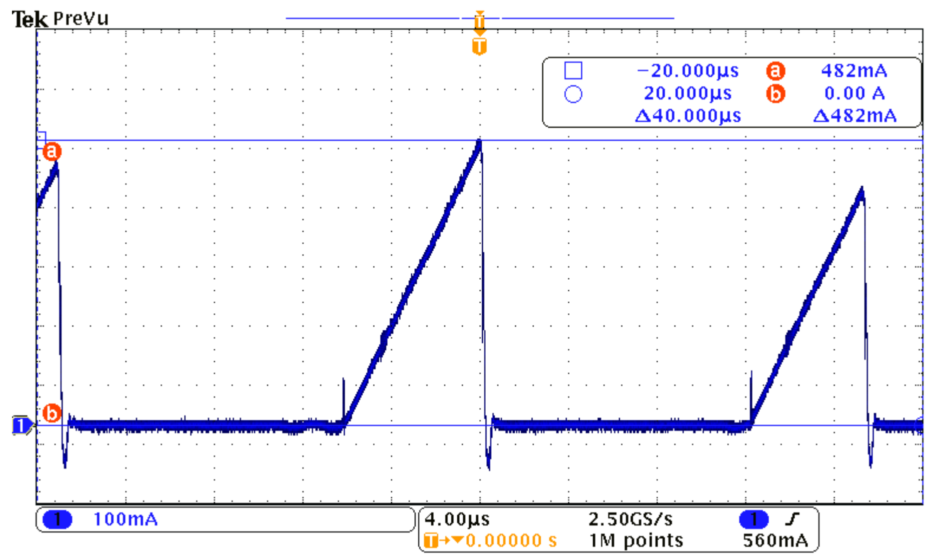
Characteristic	Symbol	SR220	SR230	SR240	SR250	SR260	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	50	60	V
RMS Reverse Voltage	$V_{R(RMS)}$	14	21	28	35	42	V
Average Rectified Output Current (Note 1) @T_L = 100°C	I_O			2.0			A
Non-Repetitive Peak Forward Surge Current 8.3ms Single half sine-wave superimposed on rated load (JEDEC Method)	I_{FSM}			50			A
Forward Voltage @I_F = 2.0A	V_{FM}		0.50		0.70		V
Peak Reverse Current @T_A = 25°C At Rated DC Blocking Voltage @T_A = 100°C	I_{RM}			0.5 10			mA

13. Transformer Flux Density

(Np=126Ts, Lm=1.6mH, Ae=18.5mm²-EE1614)



CH1: I_{PRI} ,100mA/div



CH1: I_{PRI} ,100mA/div

I_{PRI} is monitored at 85Vac and *(250+250)mA* load

I_{PRI}=354mA

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

=(354*1.6)/(126*18.5)

=0.243Tesla

I_{PRI} is monitored at 90Vac and *(320+320)mA* load (Max Output Power).

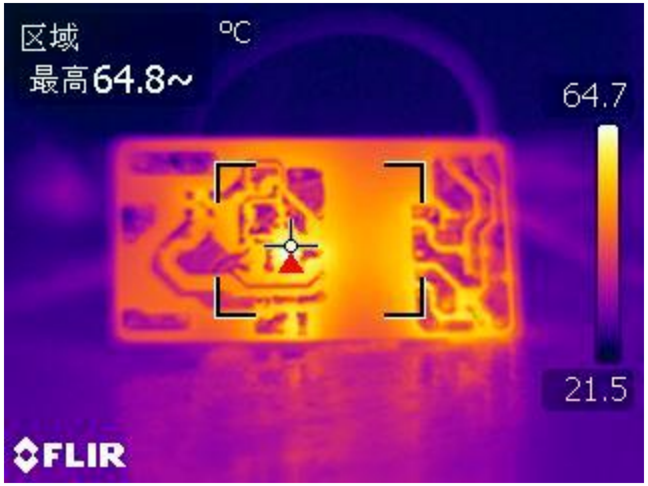
I_{PRI}=482mA

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

=(482*1.6)/(126*18.5)

=0.331Tesla

14. Thermal Test for Critical Components



Top side

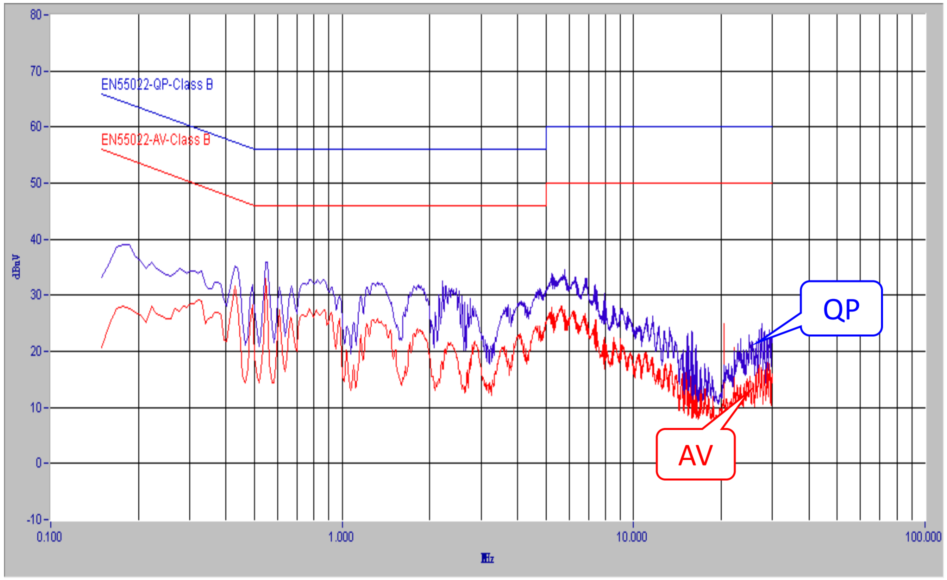
Bottom side

Item	V_{IN}=90Vac,I_{OUT1}/I_{OUT2}=0.25A		V_{IN}=264Vac, I_{OUT1}/I_{OUT2}=0.25A	
	Temp.(℃)	Rising Temp. (℃)	Temp.(℃)	Rising Temp. (℃)
Transformer(T1)	51	27	55	31
U1(iW1812)	57.6	33.6	64.8	40.8
D1 SR260	58.5	34.5	60.7	36.7
D9 HER102	52	28	53.4	29.4
Ambient (Chamber) Temp.	24		24	

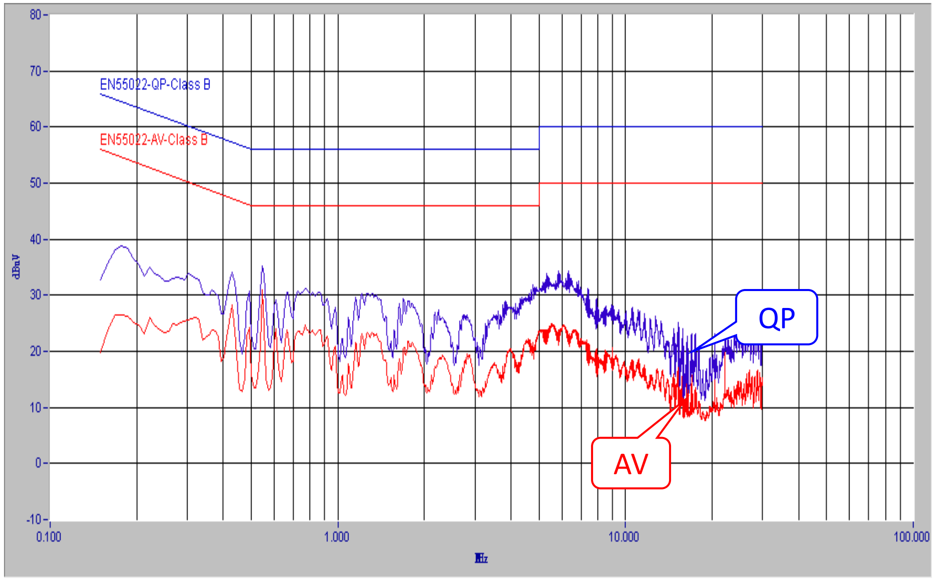
15. Conducted EMI

Power Management Simplified Digitally™

230VAC, Live



230VAC, Neutral



Note: 1. Vin=230Vac, output is loading resistance-load(Full load)

2. Input add filter circuit, Output is floating.