power integrations™

Engineering Test Report

Design of 5V*2A Charger into 1-Inch-Cu INN2024K (InnoSwitch)

WT/WR, FAE - China

31 AUG, 2015 (Rev-1)

Design Features :

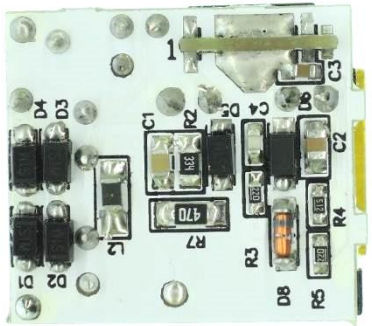
- Smallest Possible Size in 1-inch-cu
- Less than 30mW No-Load
- Simple 3-Windings Transformer construction
- Integrated-Secondary Side Regulation for Fast DLR
- High average efficiency (>85%), Easy meeting DOE_6 & CoC_v5
- Complete System and Output Protections (SCP, OPP, OCP, OTP)

1. Power Supply Specification

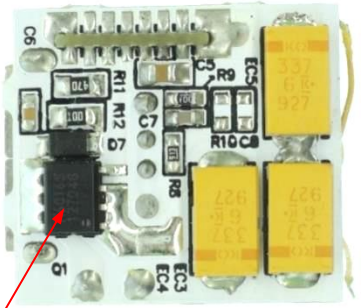
Description	Symbol	Min	Typ	Max	Units	Comment/Conditions
INPUT						
Voltage	V_{IN}	90		265	V_{AC}	2 Wire no P.E.
Frequency	f_{LINE}	47	50/60	63	Hz	
No-load Input Power	P_{IN}			30	mW	Input 230 V_{AC}
OUTPUT						
Output Voltage	V_{OUT}	4.75	5.0	5.25	V	Measured at the End of USB
Output Current	I_{OUT}	2			A	
Output Ripple Voltage	V_{RIPPLE}			150	mV_{P-P}	Measured at the End of PCB
Total Output Power						
Continuous Output Pov	P_{OUT}		10		W	
Peak Output Power	P_{OUT_PK}				W	
Conducted EMI Margin		6			dB	CISPR22B/EN55022 class B
Average Efficiency	η	85			%	DoE6 for 115Vac and CoCv5.0 for 230V_{AC}
Ambient Temprature	T_{AMB}	0		40	℃	Free convection, sea level
Surge Test			1		kV	Differential Mode:2Ω□
ESD(Air Discharge)				15	kV	On each output terminals; +/-□
Safety		Designed to meet IEC950, UL1950 Class II				

2. Demo Board

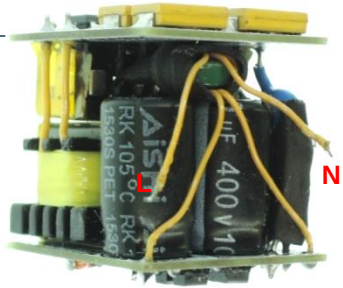
Primary PCB

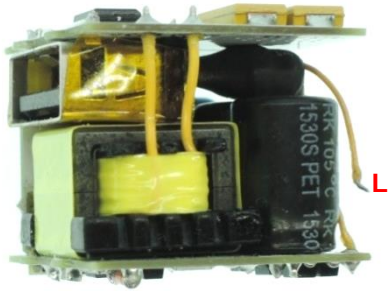


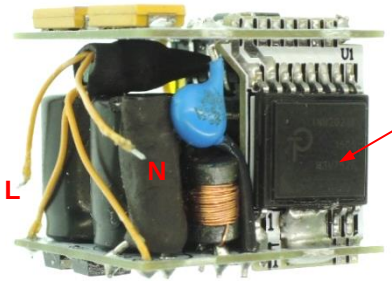
Secondary PCB



QM6016 (Q1)



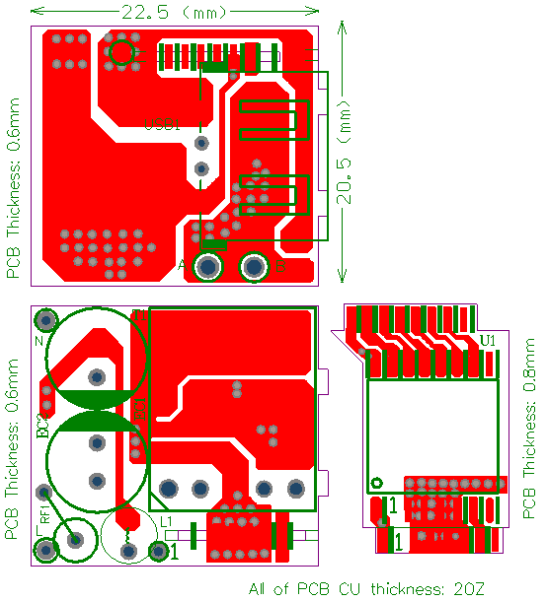




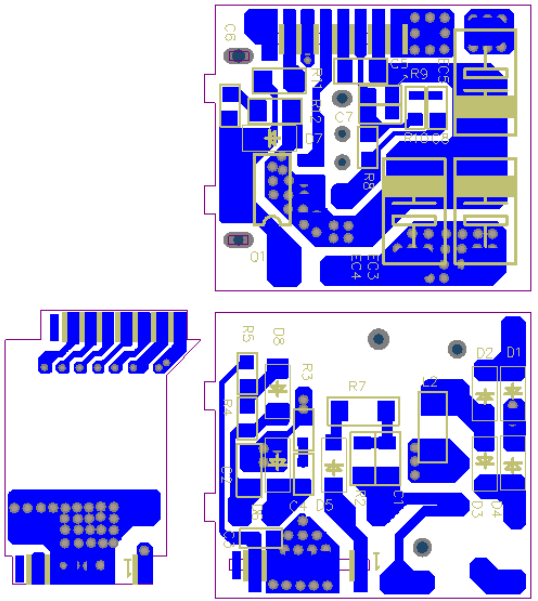
INN2024K (U1)

3. PCB Layout

TOP side (Component side)



Bottom side (Solder side)

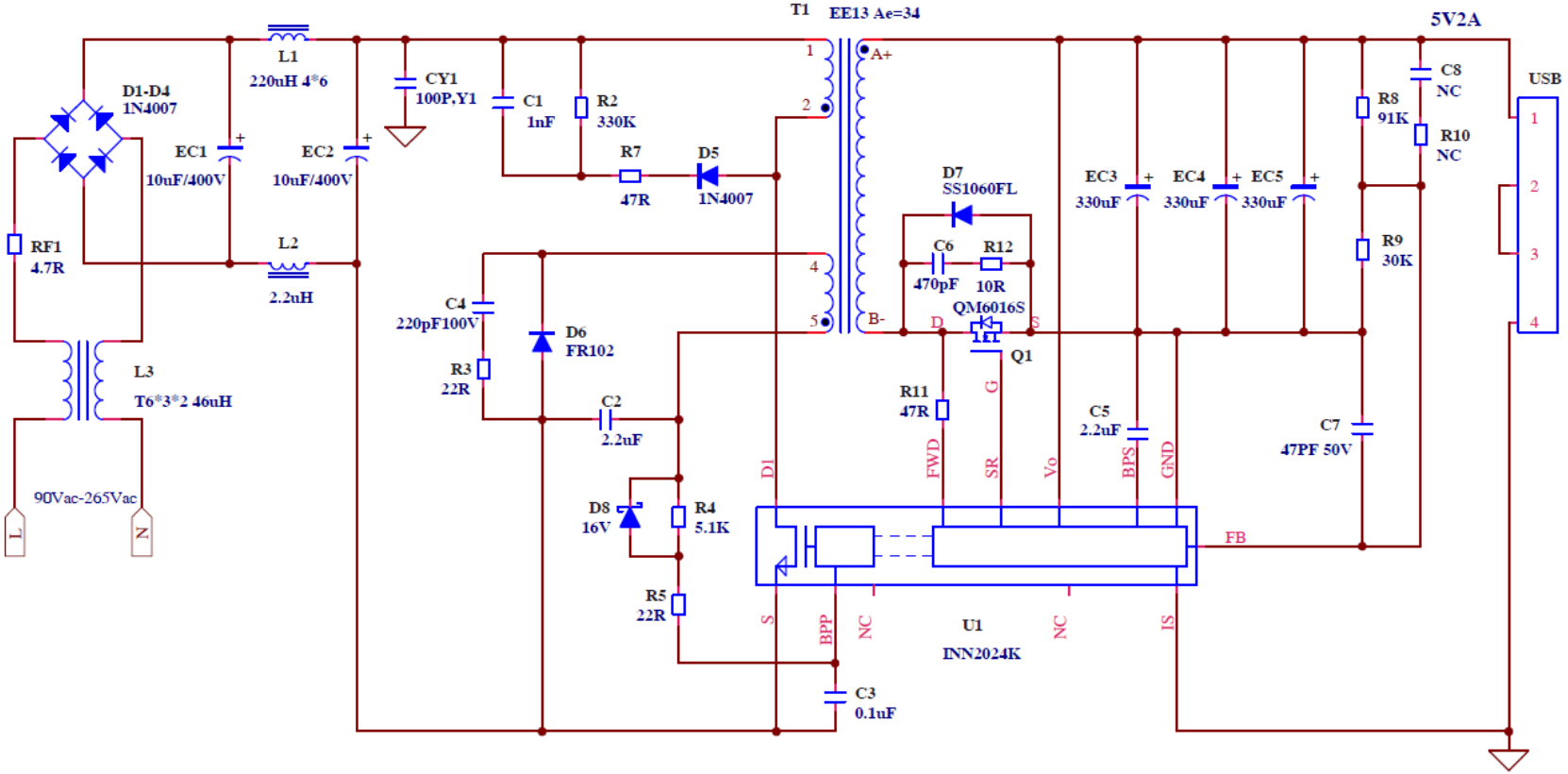


Note:

a) Double sided PCB;

b) Copper Thickness **2oz**

4. Schematic

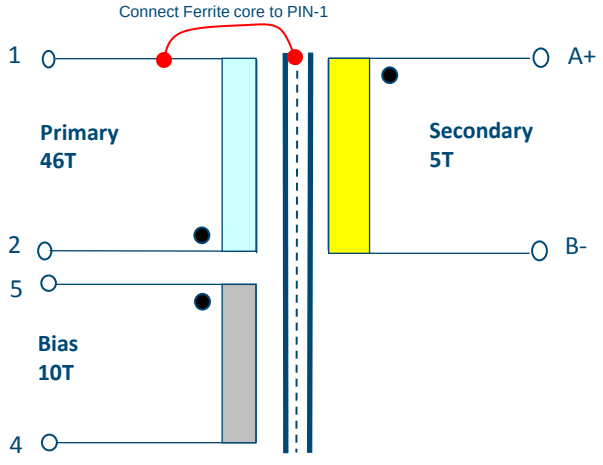

T1
EE13 Ae=34
5V2A
L1
220uH 4*6
D1-D4
1N4007
CY1
100P,Y1
C1
1nF
R2
330K
R7
47R
D5
1N4007
EC1
10uF/400V
EC2
10uF/400V
RF1
4.7R
L2
2.2uH
L3
T6*3*2 46uH
90Vac-265Vac
L
N
C4
220pF100V
R3
22R
D6
FR102
C2
2.2uF
D8
16V
R4
5.1K
R5
22R
C3
0.1uF
D7
SS1060FL
C6
470pF
R12
10R
QM6016S
Q1
R11
47R
EC3
330uF
EC4
330uF
EC5
330uF
C5
2.2uF
C7
47PF 50V
R8
91K
R9
30K
C8
NC
R10
NC
USB
FB
U1
INN2024K
D
G
S
D1
FWD
SR
Vo
BPS
GND
S
BPP
NC
NC
IS

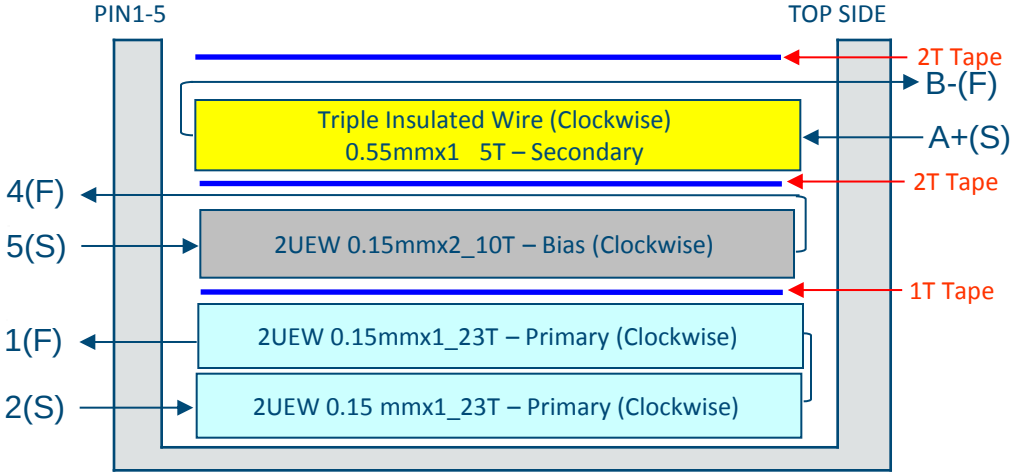
5. BOM

Item	Ref.	Description	Qty
1	D1-D5	Diode 1N4007 1A/1000V SOD-123	5
2	D6	SMD-Diode FR102 Fast Recovery SOD-123	1
3	D7	SMD-Diode SS1060 1A60V Schottky SOD-123	1
4	D8	SMD-Diode 16V 1/2W Stabilivolt SOD-123	1
5	RF1	Fuse 4.7R,1/2W,Fusible-Res	1
6	L1	Inductor 220uH 120Hz 4 X 6 0.15mm X 110T	1
7	L2	SMD Inductor 3.3uH MPH201210S3R3MT 0805	1
8	L3	Inductor 46uH 120Hz 0.3mm x 6.5T T6x3x2 K5A	1
9	EC1,EC2	E-cap 10uF 400V 8X11	2
10	EC3-EC5	SMD 330uF 6.3V Tantalum cap C# Size H:1.5mm	3
11	C1	SMD-CAP 1nF X7R 500V 0805	1
12	C2	SMD-CAP 2.2uF 25V X7R 0805	1
13	C3	SMD-CAP 0.1uF X7R 50V 0805	1
14	C4	SMD-CAP 220pF 100V X7R 0603	1
15	C5	SMD-CAP 2.2uF 25V X7R 0805	1
16	C6	SMD-CAP 470pF 100V X7R 0603	1

Item	Ref.	Description	Qty
17	C7	SMD-CAP 47pF X7R 50V 0603	1
18	R2	SMD-Res 330kΩ 0805 5%	1
19	R3,R5	SMD-Res 22Ω 0603 5%	2
20	R4	SMD-Res 5.1kΩ 0603 5%	1
21	R7	SMD-Res 47Ω 1206 5%	1
22	R8	SMD-Res 91kΩ 0603 1%	1
23	R9	SMD-Res 30kΩ 0603 1%	1
24	R11	SMD-Res 47Ω 0805 5%	1
25	R12	SMD-Res 10Ω 0805 5%	1
26	Q1	SMD-MOSFET QM6016S 8A60V <12mΩ SO-8	1
27	U1	PI IC INN2024K ESOP-R16B 100kHz 2A_CC	1
28	CY1	Y-CAP, 100pF Y1	1
29	T1	Transformer_EE13 V Lp=0.52mH ,BW=4.0MM	1
30	USB	USB	1
		Total	38

6. Transformer Design





ELECTRICAL SPECIFICATIONS:

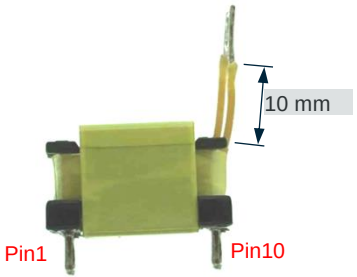
1. Primary Inductance (Lp) = 520uH ± 5% @100KHz
2. Primary Leakage Inductance < 20uH
3. Electrical Strength = 3KV, 50/60Hz,1Min

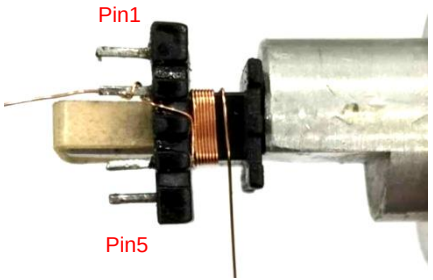
MATERIALS:

1. Core : EE13 (Ferrite Material TDK PC95 or equivalent, Ae=34mm^2)
2. Bobbin : EE13 (5pin+5pin V Bw=4mm) - **Custom**
3. Magnet Wire (Pri) : Type 2-UEW
4. Magnet Wire (Sec) : Triple Insulated Wires

REMARK :

1. Bias must be full winding
2. Made electrical connection between Ferrite core to PIN-1





Bobbin dressing direction –CCW
(Looking from Pin side)

7. Transformer Calculation(1)

1	ACDC_InnoSwitch-CH_102014; Rev.2.0; Copyright Power Integrations 2014	INPUT	INFO	OUTPUT	UNIT	ACDC_InnoSwitch-CH_101714_Rev2-0; InnoSwitch-CH Continuous/Discontinuous Flyback Transformer Design Spreadsheet
2	▼ ENTER APPLICATION VARIABLES					Customer
3	VACMIN	90		90	V	Minimum AC Input Voltage
4	VACMAX			265	V	Maximum AC Input Voltage
5	fL			50	Hz	AC Mains Frequency
6	VO	5.00		5.00	V	Output Voltage (continuous power at the end of the cable)
7	IO	2.05		2.05	A	Power Supply Output Current (corresponding to peak power)
8	Power			10.865	W	Continuous Output Power, including cable drop compensation
9	n	0.84		0.84		Efficiency Estimate at output terminals. Use 0.8 if no better data available
10	Z			0.50		Z Factor. Ratio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available
11	tC			3.00	mSeconds	Bridge Rectifier Conduction Time Estimate
12	CIN	20.00		20.00	uFarad	Input Capacitance
13						
14						
15						
16	▼ ENTER InnoSwitch-CH VARIABLES					
17	**InnoSwitch-CH**	**INN20x4**		**INN20x4**		User defined InnoSwitch
18	**Cable drop compensation**	**6%**		**6%**		Select Cable Drop Compensation option
19	**Complete Part Number**			**INN2024K**		Final part number including package
20	Chose Configuration	**STD**		**Standard Current Limit**		Enter "RED" for reduced current limit (sealed adapters), "STD" for standard current limit or "INC" for increased current limit (peak or higher power applications)
21	ILIMITMIN			0.705	A	Minimum Current Limit
22	ILIMITTYP			0.750	A	Typical Current Limit
23	ILIMITMAX			0.795	A	Maximum Current Limit
24	fSmin			93000	Hz	Minimum Device Switching Frequency
25	I^2fmin			48.94	A^2kHz	Worst case I2F parameter across the temperature range
26	VOR	49		49	V	Reflected Output Voltage (VOR <= 100 V Recommended)
27	VDS			5.00	V	InnoSwitch on-state Drain to Source Voltage
28	KP			0.89		Ripple to Peak Current Ratio at Vmin, assuming ILIMITMIN, and I2FMIN (KP < 6)
29	KP_TRANSIENT			0.42		Worst case transient Ripple to Peak Current Ratio. Ensure KP_TRANSIENT > 0.25
30						
31						
32	▼ ENTER BIAS WINDING VARIABLES					
33	VB	10.00		10.00	V	Bias Winding Voltage

7. Transformer Calculation (2)

1	ACDC_InnoSwitch-CH_102014; Rev.2.0; Copyright Power Integrations 2014	INPUT	INFO	OUTPUT	UNIT	ACDC_InnoSwitch-CH_101714_Rev2-0; InnoSwitch-CH Continuous/Discontinuous Flyback Transformer Design Spreadsheet
34	VDB			0.70	V	Bias Winding Diode Forward Voltage Drop
35	NB			9.32	V	Bias Winding Number of Turns
36	PIVB			118.34	V	Bias winding peak reverse voltage at VACmax and assuming VB*1.2
37						
38	▼ ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLE					
39	Core Type	EE13		EE13		Enter Transformer Core
40	Core			PC40EE13-Z		Enter core part number, if necessary
41	Bobbin			BE-13		Enter bobbin part number, if necessary
42	AE	0.340		0.340	cm^2	Core Effective Cross Sectional Area
43	LE			3.02	cm	Core Effective Path Length
44	AL			1130	nH/T^2	Ungapped Core Effective Inductance
45	BW			7.40	mm	Bobbin Physical Winding Width
46	M			0.00	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
47	L			3		Number of Primary Layers
48	NS	5		5		Number of Secondary Turns
49						
50						
51						
52	▼ DC INPUT VOLTAGE PARAMETERS					
53	VMIN			85	V	Minimum DC Input Voltage
54	VMAX			375	V	Maximum DC Input Voltage
55						
56	▼ CURRENT WAVEFORM SHAPE PARAMETERS					
57	DMAX			0.38		Duty Ratio at full load, minimum primary inductance and minimum input voltage
58	IAVG			0.15	A	Average Primary Current
59	IP			0.705	A	Peak Primary Current assuming ILIMITMIN
60	IR			0.625	A	Primary Ripple Current assuming ILIMITMIN, and LPMIN
61	IRMS			0.27	A	Primary RMS Current, assuming ILIMITMIN, and LPMIN
62						
63	▼ TRANSFORMER PRIMARY DESIGN PARAMETERS					
64	LP			519	uHenry	Typical Primary Inductance. +/- 5% to ensure a minimum primary inductance of 492 uH
65	LP_TOLERANCE	5.0		5.0	%	Primary inductance tolerance
66	NP			46		Primary Winding Number of Turns
67	ALG			245	nH/T^2	Gapped Core Effective Inductance

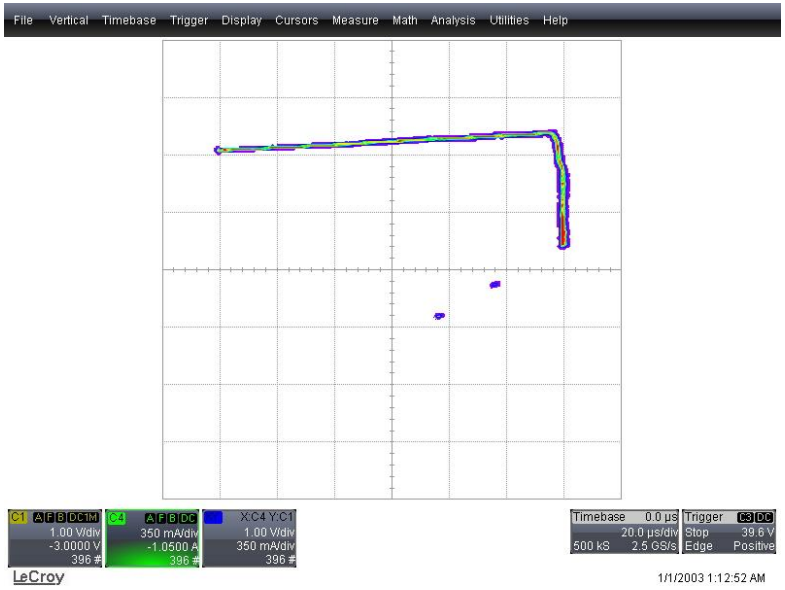
7. Transformer Calculation (3)

1	ACDC_InnoSwitch-CH_102014; Rev.2.0; Copyright Power Integrations 2014	INPUT	INFO	OUTPUT	UNIT	ACDC_InnoSwitch-CH_101714_Rev2-0; InnoSwitch-CH Continuous/Discontinuous Flyback Transformer Design Spreadsheet
68	BM			2988	Gauss	Maximum Operating Flux Density, BM<3000 is recommended
69	BAC			1325	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
70	ur			799		Relative Permeability of Ungapped Core
71	LG			0.14	mm	Gap Length (Lg > 0.1 mm)
72	BWE			22.2	mm	Effective Bobbin Width
73	OD			0.48	mm	Maximum Primary Wire Diameter including insulation
74	INS			0.06	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
75	DIA			0.42	mm	Bare conductor diameter
76	AWG			26	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
77	CM			256	Cmils	Bare conductor effective area in circular mils
78	CMA		Info	960	Cmils/Amp	CAN DECREASE CMA < 500 (decrease L(primary layers),increase NS,use smaller Core)
79						
80						
81	▼ TRANSFORMER SECONDARY DESIGN PARAMETERS					
82	Lumped parameters					
83	ISP			6.49	A	Peak Secondary Current, assuming ILIMITMIN
84	ISRMS			3.13	A	Secondary RMS Current
85	IRIPPLE			2.36	A	Output Capacitor RMS Ripple Current
86	CMS			625	Cmils	Secondary Bare Conductor minimum circular mils
87	AWGS			22	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
88						
89						
90						
91	▼ VOLTAGE STRESS PARAMETERS					
92	VDRAIN			498	V	Maximum Drain Voltage Estimate
93	PIVS			63	V	Output Rectifier Maximum Peak Inverse Voltage, assuming the primary has a Voltage spike 40% above VMAX and VO*1.05
94						
95	▼ TRANSFORMER SECONDARY DESIGN PARAMETERS					
96	1st output					
97	VO1			5.30	V	Main Output Voltage directly after output rectifier
98	IO1			2.05	A	Output DC Current
99	PO1			10.87	W	Output Power
100	VD1			0.06	V	Output Synchronous Rectification FET Forward Voltage Drop

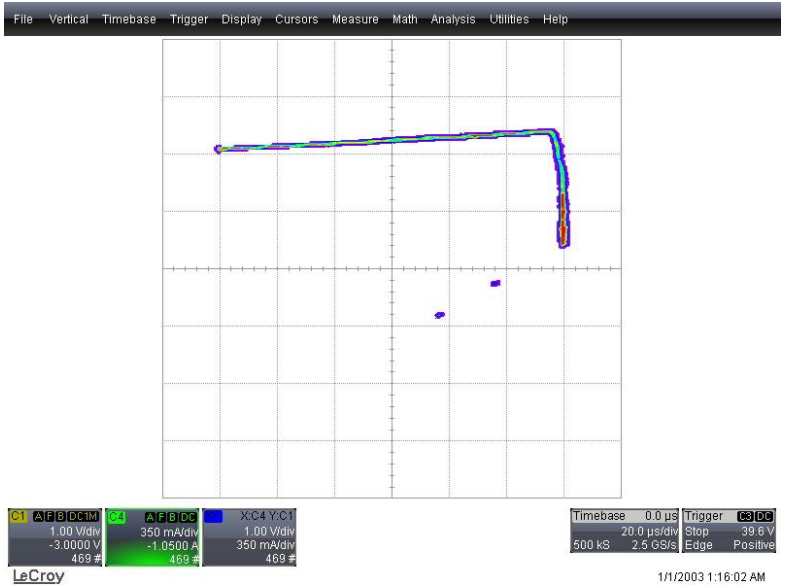
8. Regulation, Ripple, Efficiency (measured on PCB)

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	V_{RIPPLE} (mV_{P-P})	P_{OUT} (W)	η (%)	Average η(%)	DOE η (%)
90	0.009	5.11	0	33			84.78	78.70
	1.232	5.12	200	38	1.02	83.12		
	3.071	5.16	500	40	2.58	84.03		
	6.140	5.25	1000	73	5.25	85.52		
	9.394	5.32	1500	85	7.99	85.01		
	12.750	5.39	2000	89	10.78	84.56		
115	0.110	5.11	0	31			85.74	
	1.231	5.12	200	35	1.02	83.20		
	3.057	5.16	500	43	2.58	84.46		
	6.078	5.25	1000	75	5.25	86.39		
	9.269	5.33	1500	84	7.99	86.17		
	12.560	5.40	2000	90	10.79	85.94		
230	0.022	5.11	0	45			85.83	
	1.254	5.12	200	44	1.02	81.71		
	3.115	5.17	500	50	2.58	82.94		
	6.055	5.26	1000	83	5.26	86.85		
	9.212	5.33	1500	84	8.00	86.79		
	12.480	5.41	2000	95	10.83	86.75		
264	0.025	5.11	0	43			84.94	
	1.270	5.12	200	45	1.02	80.63		
	3.140	5.17	500	53	2.58	82.25		
	6.210	5.25	1000	64	5.25	84.49		
	9.244	5.33	1500	88	8.00	86.52		
	12.520	5.42	2000	99	10.83	86.50		

9.1 Output VI Characteristic (measured on end PCB)

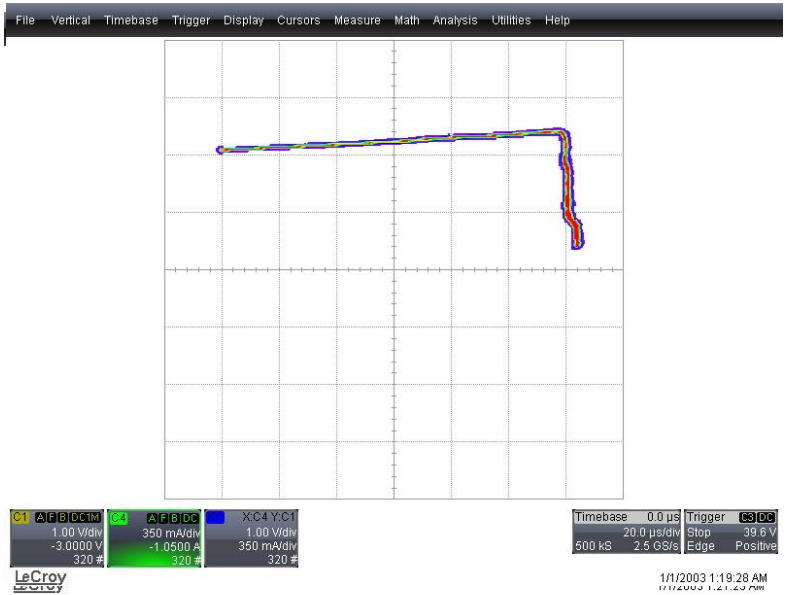


90Vac

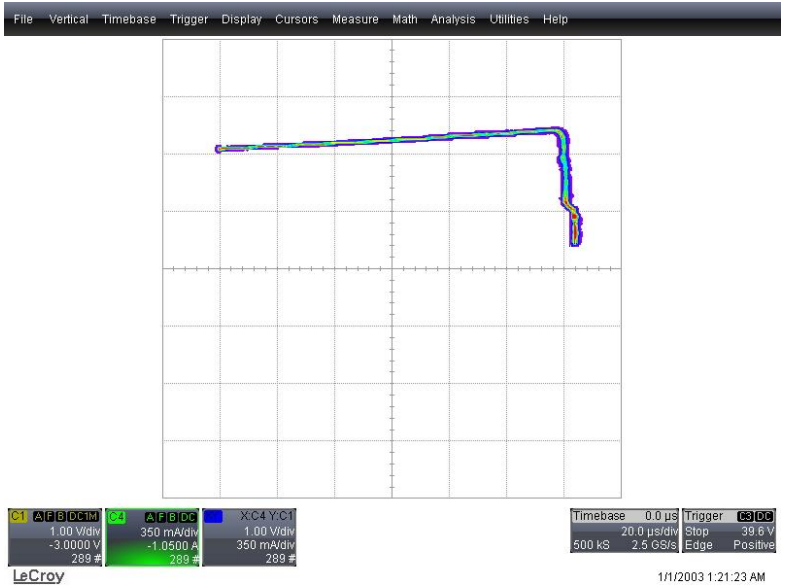


115Vac

9.2 Output VI Characteristic (measured on end PCB)

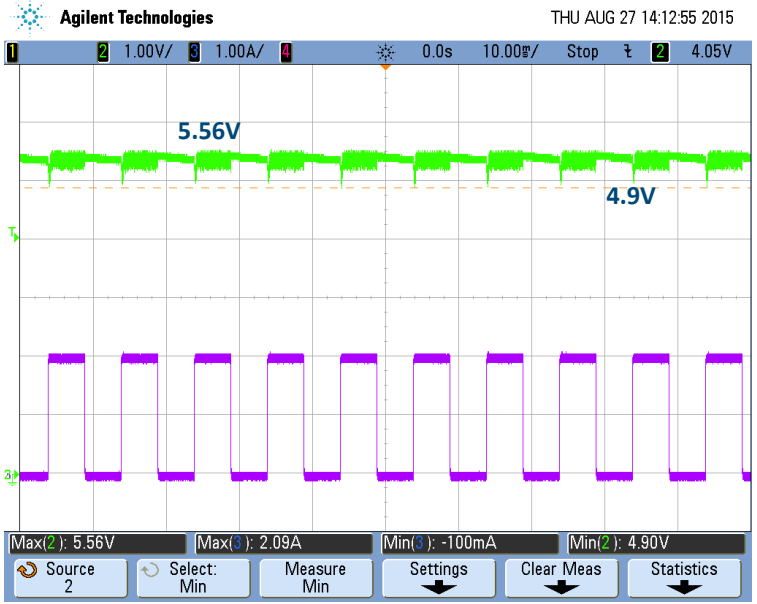


230Vac



264Vac

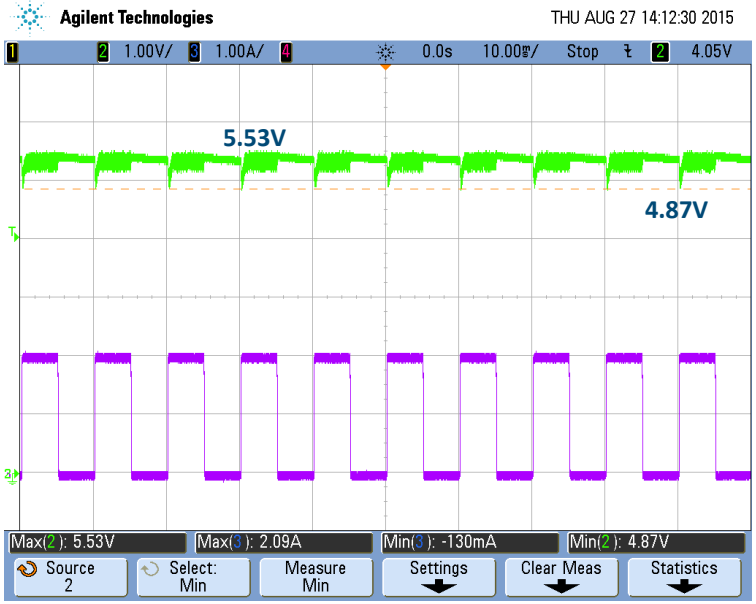
10. Dynamic Load Response (measured on end of PCB)



CH2: Output Voltage, 1V/Div (offset 5V)
CH3: Output Current, 1A/Div

Test Conditions:

1. AC input = 90VAC
2. Load range: 0A-2A-0A
3. Frequency: 100Hz(5ms/5ms)
4. Slew rate: 0.1A/uS

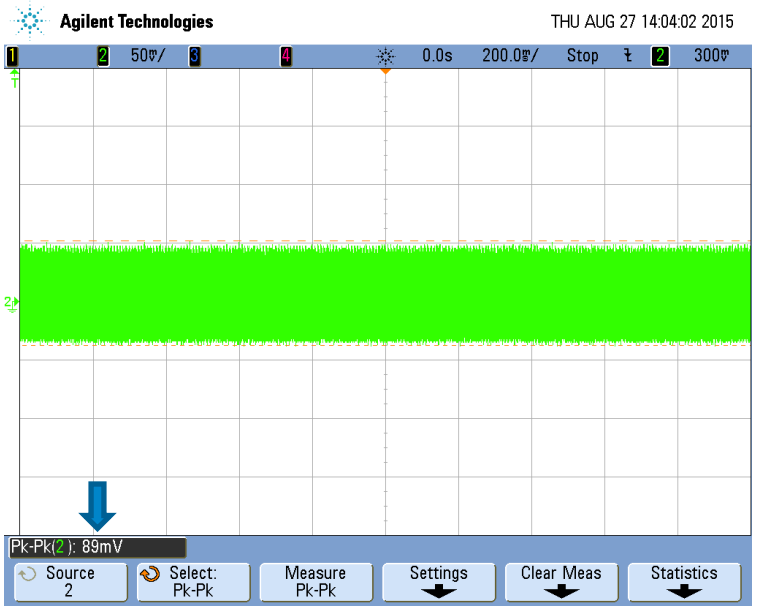


CH2: Output Voltage, 1V/Div (offset 5V)
CH3: Output Current, 1A/Div

Test Conditions:

1. AC input = 264VAC
2. Load range: 0A-2A-0A
3. Frequency: 100Hz(5ms/5ms)
4. Slew rate: 0.1A/uS

11. Ripple Test

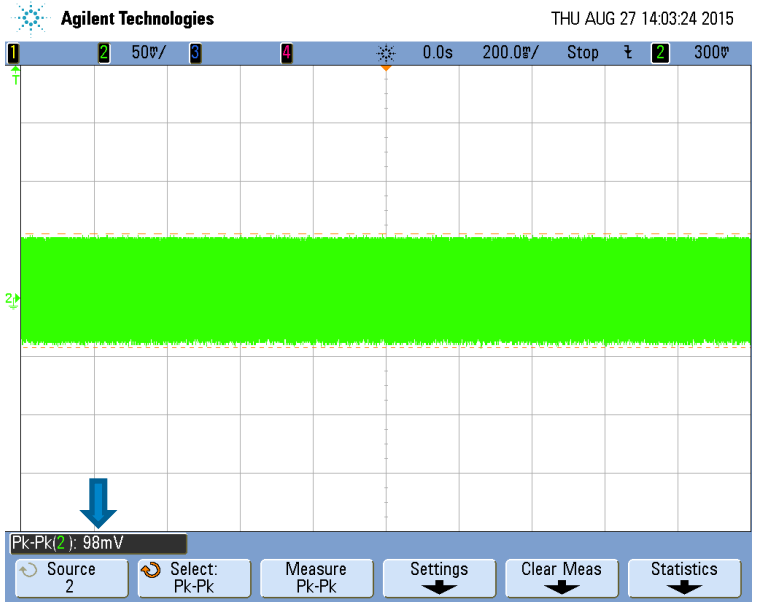


Test condition:

1.AC Input Test voltage : 90Vac

2.Output Load : 2A Load

3.Length of Output DC-Cable : 20AWG 0.4M



Test condition:

1.AC Input Test voltage : 264Vac

2.Output Load : 2A Load

3.Length of Output DC-Cable : 20 AWG 0.4M

12. Conducted Emission – PK and AV (Output Full Load)

EMI TEST REPORT

parameter

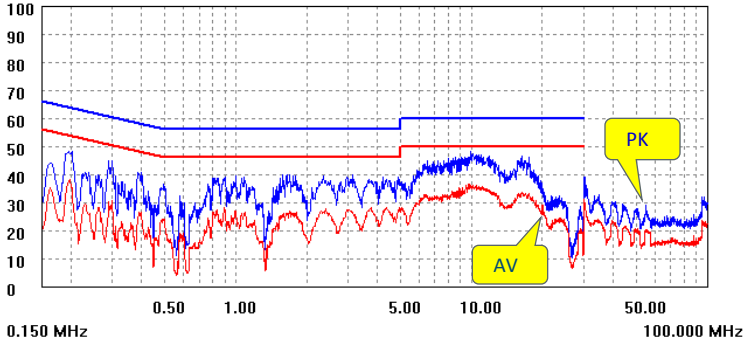
Organization:	Operator:	EUT:
Place:	Time: 2015/8/26/17:1	Test equipment:KH3939
Detector: PK+AV	Test-time(ms): 10	SN: 1039036
Limit: EN55022B	Transductor: PK1	
Remark: 230Vin L		

freq, step

Start(MHz)	End(MHz)	Step(MHz)
0.150	1.000	0.002
1.000	2.000	0.005
2.000	10.000	0.020
10.000	30.000	0.050
30.000	100.000	0.100

scan result

dBuV



230Vac (Full-Load) - L

EMI TEST REPORT

parameter

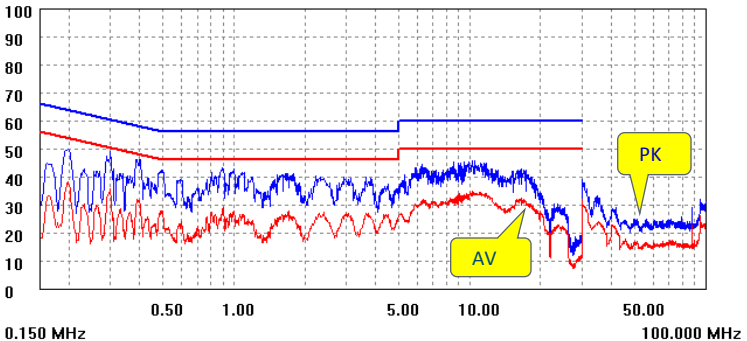
Organization:	Operator:	EUT:
Place:	Time: 2015/8/26/16:59	Test equipment:KH3939
Detector: PK+AV	Test-time(ms): 10	SN: 1039036
Limit: EN55022B	Transductor: PK1	
Remark: 230Vin N		

freq, step

Start(MHz)	End(MHz)	Step(MHz)
0.150	1.000	0.002
1.000	2.000	0.005
2.000	10.000	0.020
10.000	30.000	0.050
30.000	100.000	0.100

scan result

dBuV



230Vac (Full-Load) - N

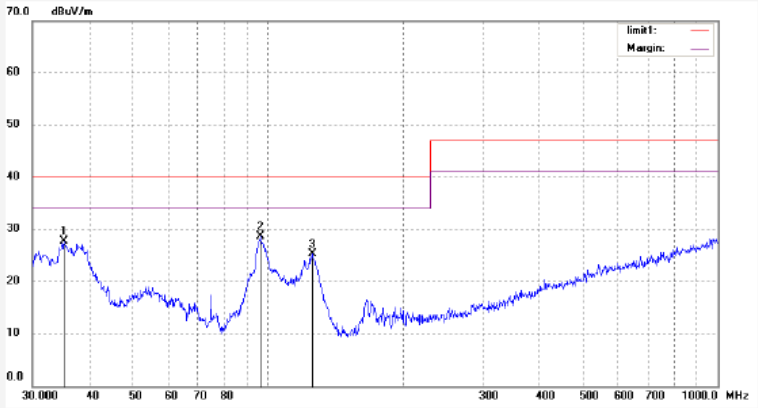
13.1 Radiated Emission (Vertical)

ACCURATE TECHNOLOGY CO., LTD.
F1,Bldg,A,Changyuan New Material Port Keyuan Rd, Science & Industry Park,Nanshan Shenzhen,P.R.China
Site: 2# Chamber
Tel:+86-0755-26503290
Fax:+86-0755-26503396

Job No.: PI #3141
Standard: EN55022 ClassB Radiated
Test item: Radiation Test
Temp.(C)/Hum.(%) 23 C / 48 %
EUT:
Mode: FULL LOAD
Model: 5V 2A
Manufacturer:

Polarization: Vertical
Power Source: AC 120V/60Hz
Date: 2015/08/28
Time: 16:06:48
Engineer Signature:
Distance: 3m

Note:



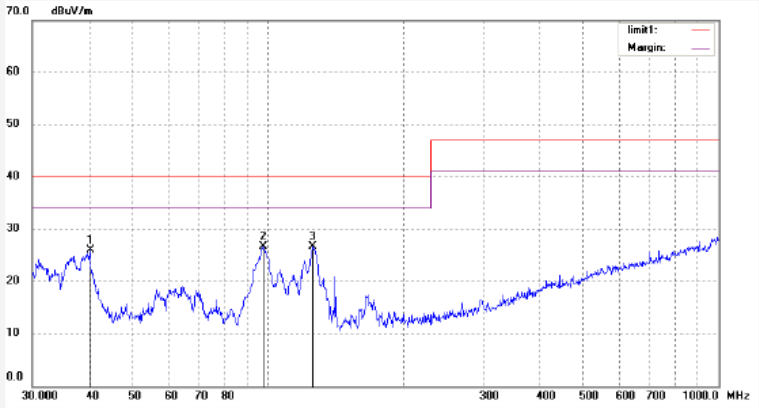
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	35.2512	38.27	-10.48	27.79	40.00	-12.21	peak			
2	96.4362	43.90	-15.32	28.58	40.00	-11.42	peak			
3	125.4457	39.96	-14.75	25.21	40.00	-14.79	peak			

ACCURATE TECHNOLOGY CO., LTD.
F1,Bldg,A,Changyuan New Material Port Keyuan Rd, Science & Industry Park,Nanshan Shenzhen,P.R.China
Site: 2# Chamber
Tel:+86-0755-26503290
Fax:+86-0755-26503396

Job No.: PI #3140
Standard: EN55022 ClassB Radiated
Test item: Radiation Test
Temp.(C)/Hum.(%) 23 C / 48 %
EUT:
Mode: FULL LOAD
Model: 5V 2A
Manufacturer:

Polarization: Vertical
Power Source: AC 230V/50Hz
Date: 2015/08/28
Time: 16:04:51
Engineer Signature:
Distance: 3m

Note:



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	40.2757	37.60	-11.61	25.99	40.00	-14.01	peak			
2	97.4560	41.71	-14.98	26.73	40.00	-13.27	peak			
3	125.8864	41.38	-14.76	26.62	40.00	-13.38	peak			

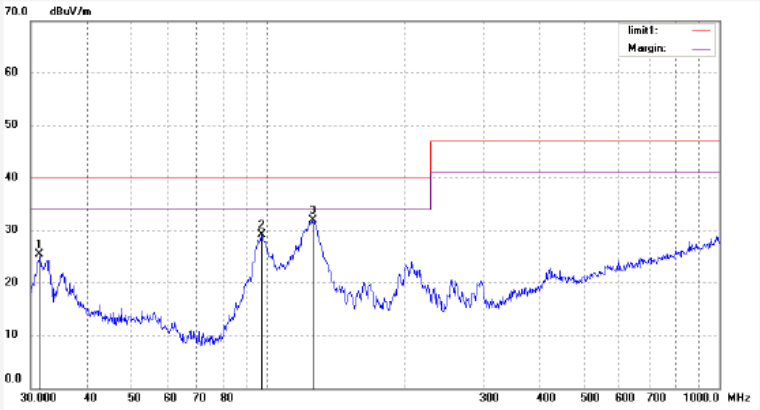
13.2 Radiated Emission (Horizontal)

ACCURATE TECHNOLOGY CO., LTD.
F1,Bldg,A,Changyuan New Material Port Keyuan Rd, Science & Industry Park,Nanshan Shenzhen,P.R.China
Site: 2# Chamber
Tel:+86-0755-26503290
Fax:+86-0755-26503396

Job No.: PI #3142
Standard: EN55022 ClassB Radiated
Test item: Radiation Test
Temp.(C)/Hum.(%) 23 C / 48 %
EUT:
Mode: FULL LOAD
Model: 5V 2A
Manufacturer:

Polarization: Horizontal
Power Source: AC 120V/60Hz
Date: 2015/08/28
Time: 16:09:02
Engineer Signature:
Distance: 3m

Note:



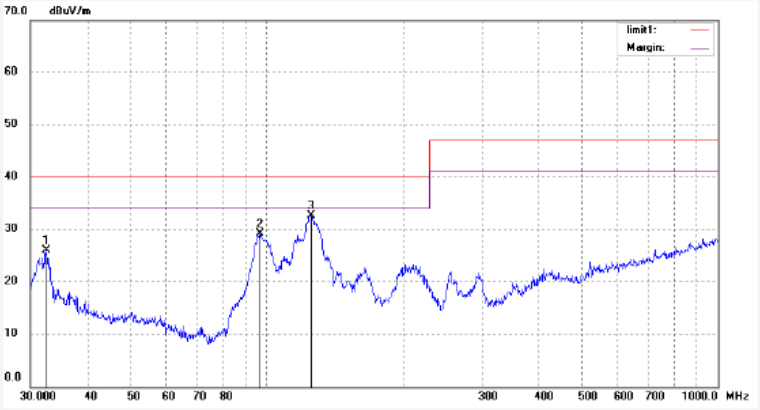
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	31.3992	35.52	-10.06	25.46	40.00	-14.54	peak			
2	97.1148	44.31	-15.09	29.22	40.00	-10.78	peak			
3	126.3286	46.65	-14.77	31.88	40.00	-8.12	peak			

ACCURATE TECHNOLOGY CO., LTD.
F1,Bldg,A,Changyuan New Material Port Keyuan Rd, Science & Industry Park,Nanshan Shenzhen,P.R.China
Site: 2# Chamber
Tel:+86-0755-26503290
Fax:+86-0755-26503396

Job No.: PI #3139
Standard: EN55022 ClassB Radiated
Test item: Radiation Test
Temp.(C)/Hum.(%) 23 C / 48 %
EUT:
Mode: FULL LOAD
Model: 5V 2A
Manufacturer:

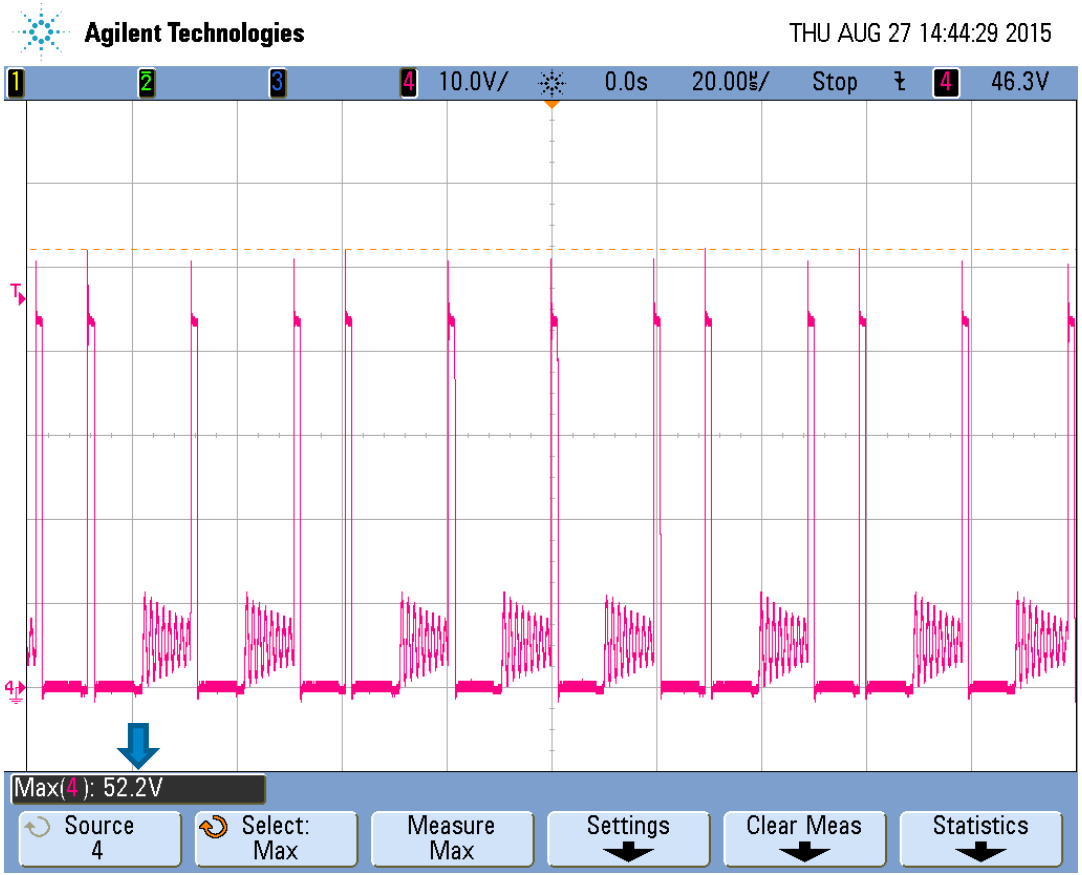
Polarization: Horizontal
Power Source: AC 230V/50Hz
Date: 2015/08/28
Time: 16:03:41
Engineer Signature:
Distance: 3m

Note:



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	32.5198	36.10	-10.17	25.93	40.00	-14.07	peak			
2	96.7749	44.35	-15.21	29.14	40.00	-10.86	peak			
3	125.4457	47.43	-14.75	32.68	40.00	-7.32	peak			

14. Output Rectifier Maximum Invers Voltage



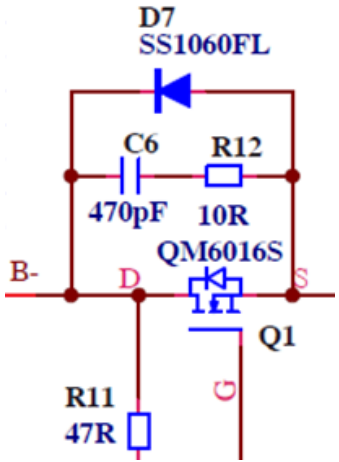
Test Condition:

V_{IN}=264$V_{AC,}$ V_{OUT}=5.0V, I_{OUT}=2.0A

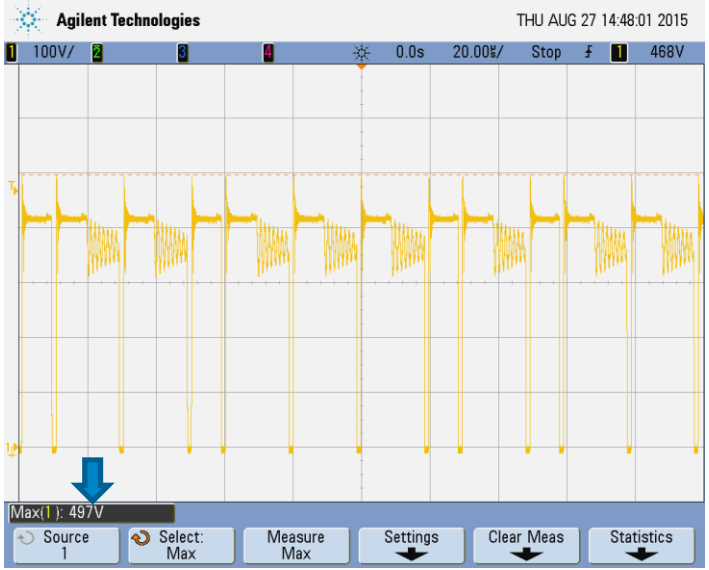
RESULT: V_{PIV}= 52.2V (87% of 60V)

Component Stress on Output Rectifications :

- QM6016S @8A/60V (Q1);
- SS1060FL @1A/60V (D7).



15. Maximum Drain Voltage



Test Condition:

V_{IN}=264V_{AC}, V_{OUT}=5.0V @ I_{OUT}=2.0A

Measured Results:

Max Drain = 497V
Voltage stress = 497V/650V or 76.4%

Absolute Maximum Ratings[1,2]

DRAIN Pin Voltage	-0.3 V to 650 V
DRAIN Pin Peak Current[3] INN20x3	1200 (2250) mA
INN20x4	1360 (2550) mA
INN20x5	1680 (3150) mA
PRIMARY BYPASS/SECONDARY BYPASS Pin Voltage	-0.3 V to 9 V
PRIMARY BYPASS/SECONDARY BYPASS Pin Current	100 mA
FORWARD Pin Voltage	-1.5 V to 150 V
FEEDBACK Pin Voltage	-0.3 to 9 V
SR/P Pin Voltage	-0.3 to 9 V[6]
OUTPUT VOLTAGE Pin Voltage	-0.3 to 15 V
Storage Temperature	-65 to 125 °C
Operating Junction Temperature[4,7]	-40 to 125 °C
Ambient Temperature	-40 to 85 °C
Lead Temperature[5]	260 °C

Notes:
1. All voltages referenced to Source and Secondary Ground, T_A = 25 °C.
2. Maximum ratings specified may be applied one at a time without causing permanent damage to the product. Exposure to Absolute Maximum Ratings conditions for extended periods of time may affect product reliability.
3. Higher peak Drain current is allowed while the Drain voltage is simultaneously less than 400 V.
4. Normally limited by internal circuitry.
5. 1/16" from case for 5 seconds.
6. -1.8 V for a duration of ≤500 nsec. See Figure 23.
7. Maximum silicon operating junction temperature is 150 °C, however safety agency maximum operating junction is 125 °C.

16.1 Temperature Rise on PCB Components

	Input:90Vac Load:2A		Input:100Vac Load:2A		Input:240Vac Load:2A		Input:264Vac Load:2A	
Description	Temperature(℃)	Trise(℃)	Temperature(℃)	Trise(℃)	Temperature(℃)	Trise(℃)	Temperature(℃)	Trise(℃)
T - Ambient	44.8		44.0		44.7		44.3	
Q1 QM6016S	97.8	53.0	96.4	52.4	95.9	51.2	97.2	52.9
T1 (winding)	105.1	60.3	102.9	58.9	100.6	56.0	102.0	57.7
T1 (core)	100.2	55.4	97.9	53.9	94.2	49.5	95.3	51.1
U1 INN2024K	104.8	60.0	102.0	58.0	101.0	56.3	103.1	58.8
HousingSurface Above T1 Core	78.8	34.0	77.7	33.7	76.5	31.8	77.5	33.2
HousingSurface Above U1	78.5	33.8	77.2	33.2	76.4	31.7	77.4	33.2
HousingSurface Above T1 Wire	69.7	24.9	68.9	24.9	67.7	23.0	68.3	24.1

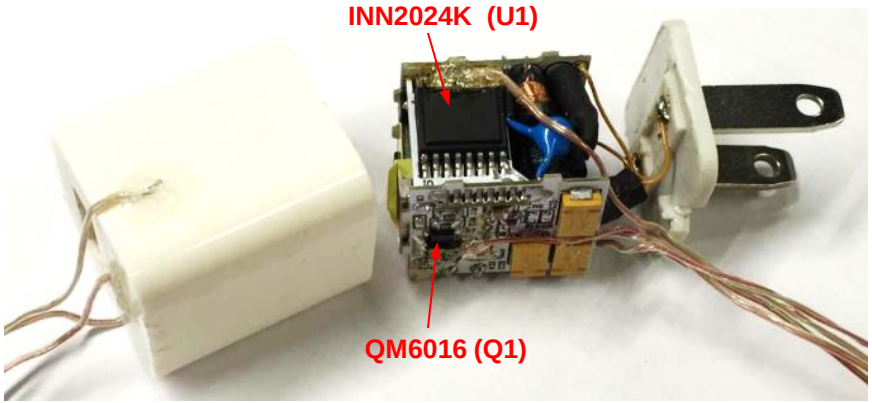
Testing Conditions and Setup :

a) Perform under a controlled temperature chamber;

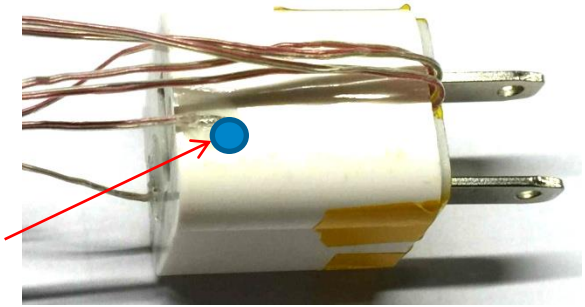
b) PCB is being mounted inside an enclosed simulated plastic housing

c) Thermal coupler (type-K) are attached to respective measuring points;

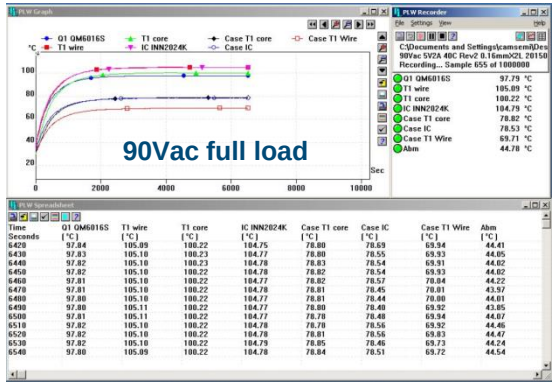
d) Temperature is recorded after 1 hours from initial turn on.

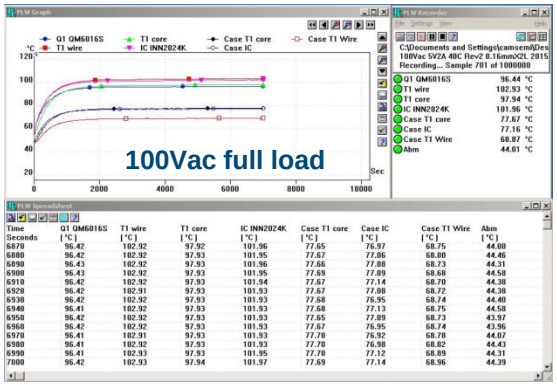


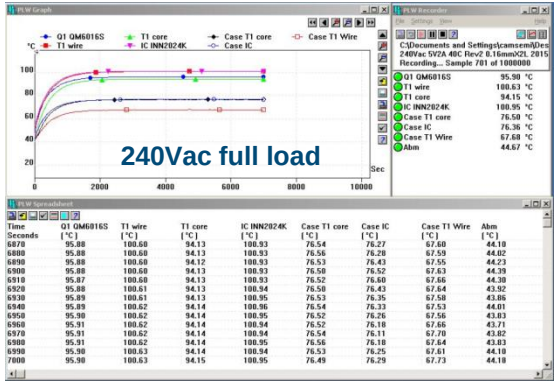
Housing Surface above T1 wire. (Total 3 such measuring spots)

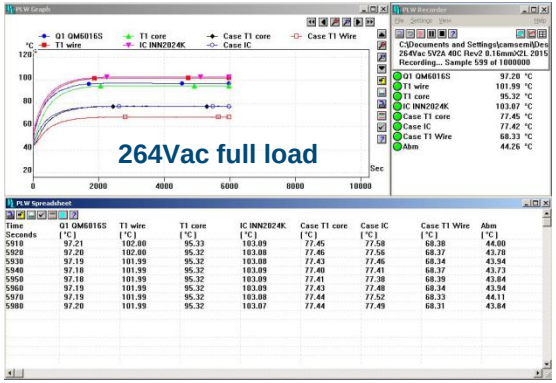


16.2 Temperature Rise curve（constant temperature 40℃）









INN20x3-20x5
InnoSwitch-CH Family

Off-Line CV/CC Flyback Switcher IC with Integrated MOSFET, Synchronous Rectification and Feedback

Product Highlights

Highly Integrated, Compact Footprint
- Incorporates flyback controller, 650 V MOSFET, secondary-side sensing and synchronous rectification driver
- Integrated FluxLink™, HIPOT-isolated, feedback link
- Exceptional CV/CC accuracy, independent of transformer design or external components
- Instantaneous transient response ±5% CV with 0%-100%-0% load step

EcoSmart™– Energy Efficient
- <10 mW no-load at 230 VAC when supplied by an optional transformer bias winding
- Easily meets all global energy efficiency regulations
- Low heat dissipation

Advanced Protection / Safety Features
- Primary sensed output OVP
- Secondary sensed output overshoot clamp
- Secondary sensed output OCP to zero output voltage
- Hysteretic thermal shutdown

Full Safety and Regulatory Compliance
- 100% production HIPOT compliance testing at 6 kV DC/1 sec
- Reinforced insulation
- Isolation voltage >3,500 VAC
- UL1577 and TUV (EN60950) safety approved
- EN61000-4-8 (100 A/m) and EN61000-4-9 (1000 A/m) compliant

Green Package
- Halogen free and RoHS compliant

Applications
- Chargers and adapters for smart mobile devices
- High efficiency, low voltage, high current power supplies

Description

The InnoSwitch™-CH family of ICs dramatically simplifies the development and manufacturing of low-voltage, high current power supplies, particularly those in compact enclosures or with high efficiency requirements. The InnoSwitch-CH architecture is revolutionary in that the devices incorporate both primary and secondary controllers, with sense elements and a safety-rated feedback mechanism into a single IC.

Close component proximity and innovative use of the integrated communication link permit accurate control of a secondary-side synchronous rectification MOSFET and optimization of primary-side switching to maintain high efficiency across the entire load range. Additionally, the minimal DC bias requirements of the link enables the system to achieve less than 10 mW no-load in challenging applications such as smart-mobile device chargers.

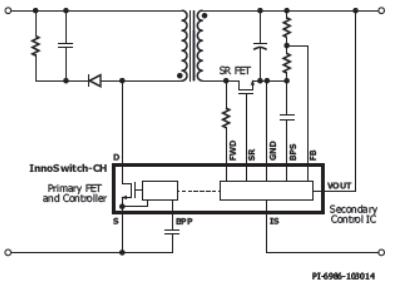


Figure 1. Typical Application/Performance.

Figure 2. High Creepage, Safety-Compliant eSOP Package.

Output Power Table

Product[3]	85-265 VAC	
	Adapter[1]	Peak or Open Frame[2]
INN20x3K	12 W	15 W
INN20x4K	15 W	20 W
INN20x5K	20 W	25 W

Table 1. Output Power Table.

Notes:
1. Minimum continuous power in a typical non-ventilated enclosed typical size adapter measured at 40 °C ambient. Max output power is dependent on the design. With condition that package temperature must be < = 125 °C.
2. Minimum peak power capability.
3. Package: eSOP-R16B.

QM6016S

N-Ch 60V Fast Switching MOSFETs

General Description

The QM6016S is the highest performance trench N-ch MOSFETs with extreme high cell density , which provide excellent RDSON and gate charge for most of the synchronous buck converter applications .

The QM6016S meet the RoHS and Green Product requirement , 100% EAS guaranteed with full function reliability approved.

Features

- Advanced high cell density Trench technology
- Super Low Gate Charge
- Excellent CdV/dt effect decline
- 100% EAS Guaranteed
- Green Device Available

Product Summery

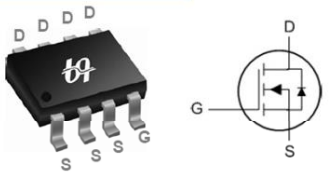
Green

BVDSS	RDSON	ID
60V	12mΩ	8A

Applications

- High Frequency Point-of-Load Synchronous Buck Converter for MB/NB/UMPC/VGA
- Networking DC-DC Power System
- LCD/LED back light

SOP8 Pin Configuration



Absolute Maximum Ratings

Symbol	Parameter	Rating	Units
V_{DS}	Drain-Source Voltage	60	V
V_{GS}	Gate-Source Voltage	±20	V
I_D@T_A=25℃	Continuous Drain Current, V_{GS} @ 10V[1]	8	A
I_D@T_A=70℃	Continuous Drain Current, V_{GS} @ 10V[1]	6.4	A
I_{DM}	Pulsed Drain Current[2]	32	A
EAS	Single Pulse Avalanche Energy[3]	123	mJ
I_{AS}	Avalanche Current	38	A
P_D@T_A=25℃	Total Power Dissipation[4]	1.5	W
T_{STG}	Storage Temperature Range	-55 to 150	℃
T_J	Operating Junction Temperature Range	-55 to 150	℃

Thermal Data

Symbol	Parameter	Typ.	Max.	Unit
$R_{\theta JA}$	Thermal Resistance Junction-Ambient [1]	---	85	℃/W
$R_{\theta JC}$	Thermal Resistance Junction-Case[1]	---	24	℃/W

Rev A.01 D121409

www.ubiq-semi.com

18. Document Change History

Revision History				
Date	Author	Revision	Description & changes	Reviewed
31-Aug-2015	WT/WR	Rev-1	Initial release	EH Quek

China Sales Contacts & Important Note

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CHINA (PI Guangzhou Lab) Room 311,3nd floor, No.9, Jianggong Road, Tianhe Software Park, Zhongshan thoroughfard, Tianhe District, Guangzhou, PRC 510660 TEL:+86 20-8566-4509 FAX:+86 20-8555-1081 chinasales@powerint.com	**中国深圳-广州实验室** 广州市天河区中山大道 天河软件园建工路9号3楼311室 邮编:510660 电话:+86-20-8566-4509 传真 +86 20-8555-1081 chinasales@powerint.com
CHINA (PI Chengdu Lab) Room 1426,Colorful Holiday Internation Mansion No.2 Baisi Street,Chengdu, China, 610016 TEL: +86-28-8676-3012 FAX: +86-28-8676-3011 chinasales@powerint.com	**中国深圳-成都实验室** 四川省成都市白丝街2号 缤纷假日国际公寓1426号 邮编:610016 电话:+86-28-8676-3012 传真:+86-28-8676-3011 chinasales@powerint.com

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