RT7306 Evaluate Report for RFID Dim Bulb EVB (Buck-Boost)

ACDC BU / SLM Division
Apr . 2015

http://www.richtek.com/LED

RICHTEK
your power partner.

RT7306 Brief introduction

RT7306 is an active power factor correction controller specifically designed for using as a constant current LED driver.
Supporting:
Isolation: PSR mode
Non-isolation: Buck-Boost mode

Applications ➡ AC/DC LED lighting driver for Smart dimming function


PAR Lamp


E27 Bulb


T5/T8 Tube

. . . . . .

RT7306 Features

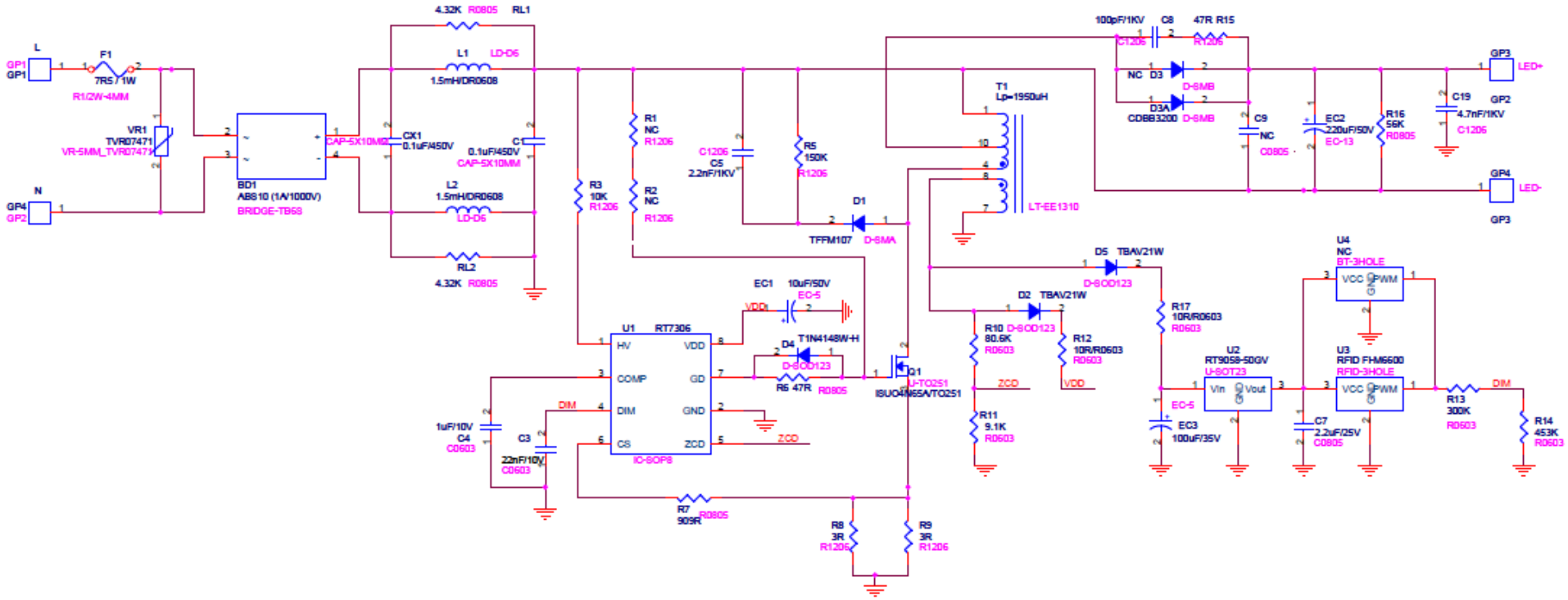
Primary-Side Regulation PWM Controller and High PF LED Driver

- Primary Side Regulation(PSR)
- Power Factor Correction(PFC)
- Compatible with Analog Dimming
- Built-in HV start-up Device
- Critical conduction mode(CRM)
- Max/Min switch frequency clamping
- Max/Min on time limitation
- THD Optimization
- Input Voltage Feed-Forward Compensation

RT7306 Advantage

- Universal input voltage. (90Vac~264Vac)
- Tight LED current regulation.
- No shunt regulator and photo to achieve the 2nd regulation.
- Protection:
  - a. LED Open-circuit protection
  - b. LED Short-circuit protection
  - c. Output diode short-circuit protection
  - d. Vdd under/over voltage protection
  - e. Over temperature protection
  - f . Cycle-by-cycle current limitation
  - g. Excellent PF and THD.

Circuit



Electrical Performance

Load:LED Series With RF Dim function Line filter off

Frequency	Vac [V]	Iac [mA]	Pin [watt]	V-LED [V]	I-LED[mA]	Pout [watt]	Total Eff. [%]	PF Value	THD [%]
60Hz	90	120.5	10.81	35.95	253	9.09535	84.14%	0.9972	4.666
60Hz	110	97.3	10.68	35.97	253	9.10041	85.21%	0.9958	4.438
60Hz	132	80.8	10.59	35.98	253	9.10294	85.96%	0.9925	4.822
50Hz	180	59.6	10.54	35.97	253	9.10041	86.34%	0.9824	7.071
50Hz	200	54	10.54	35.98	253	9.10294	86.37%	0.9746	8.644
50Hz	220	49.8	10.56	36.00	253	9.108	86.25%	0.9646	10.609
50Hz	240	46.4	10.60	36.02	253	9.11306	85.97%	0.9528	12.714
50Hz	264	43.1	10.66	36.06	253	9.12318	85.58%	0.9353	15.432

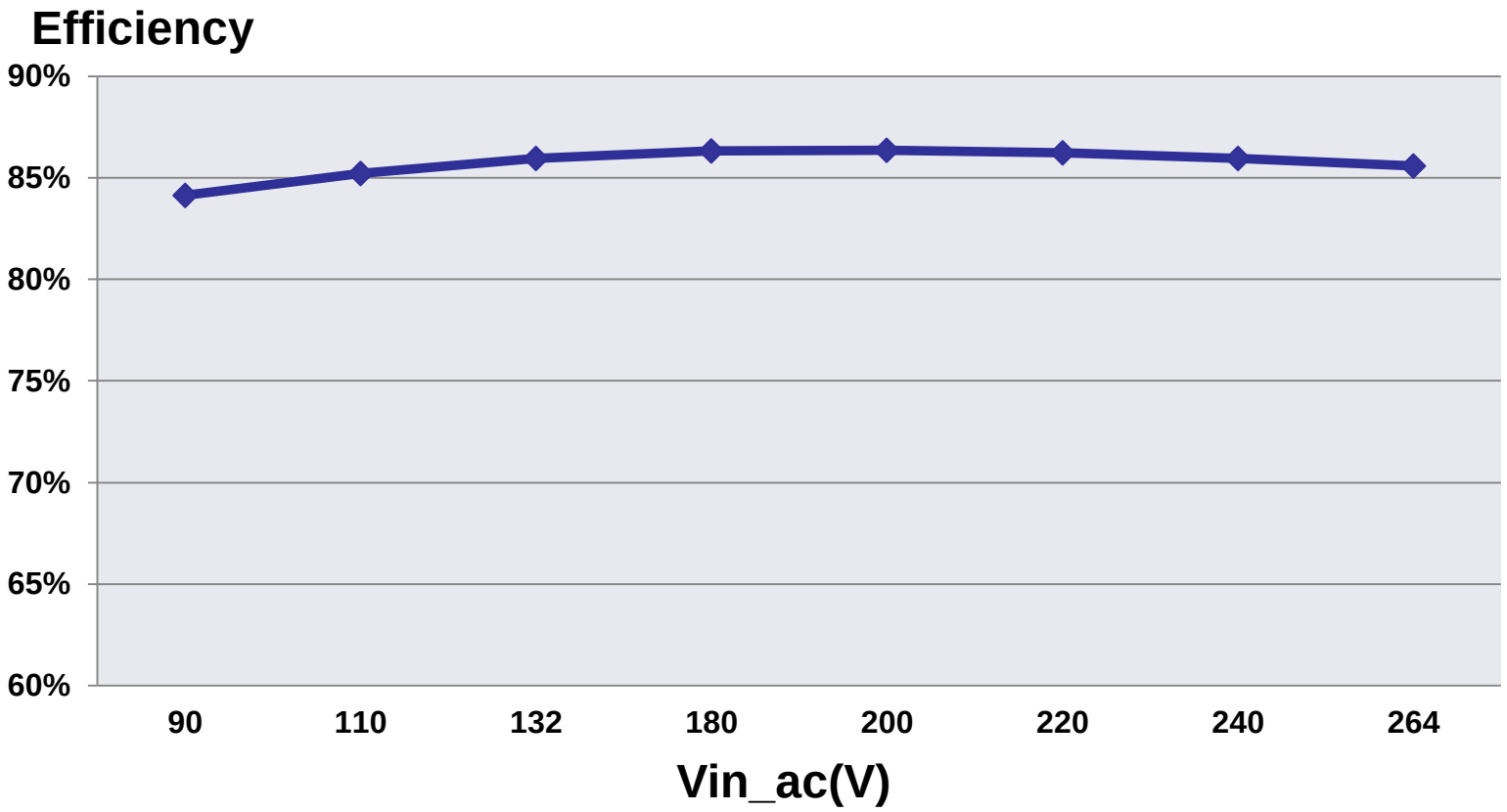
current regulation = 0.00%

△ Effiency = 2.23%

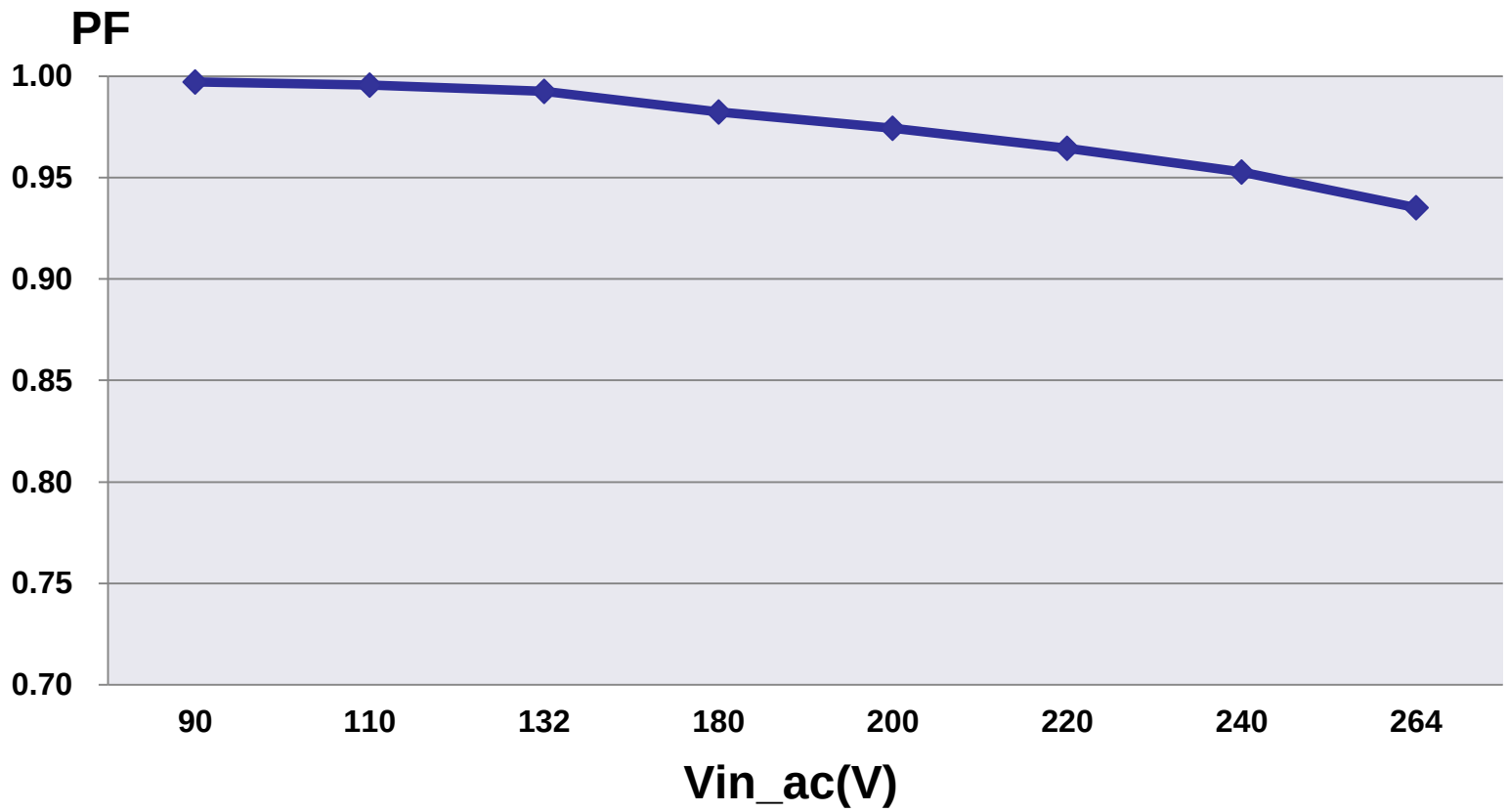
Maximum PFC = 0.997

Minimum PFC = 0.935

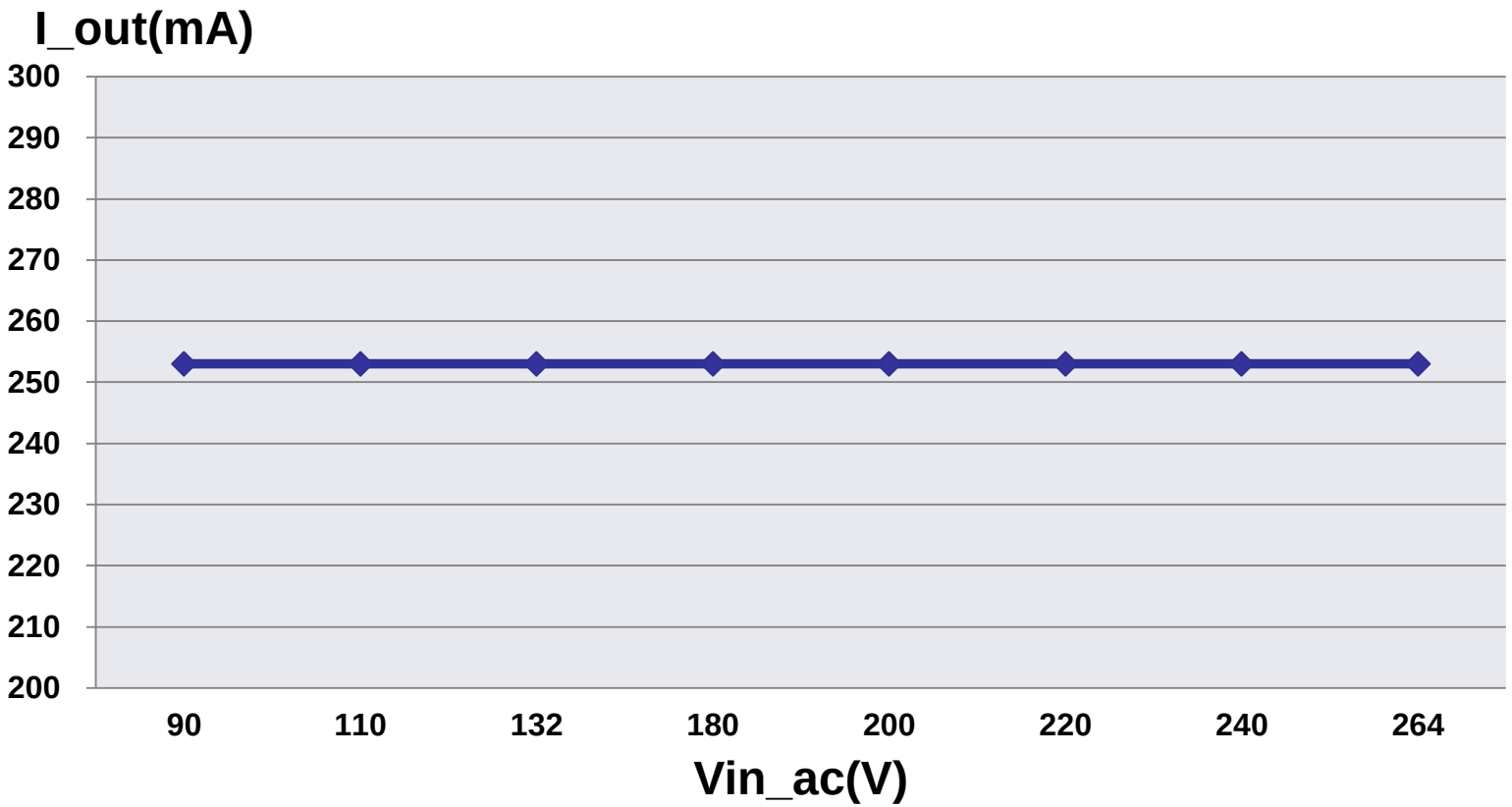
Efficiency



Power Factor



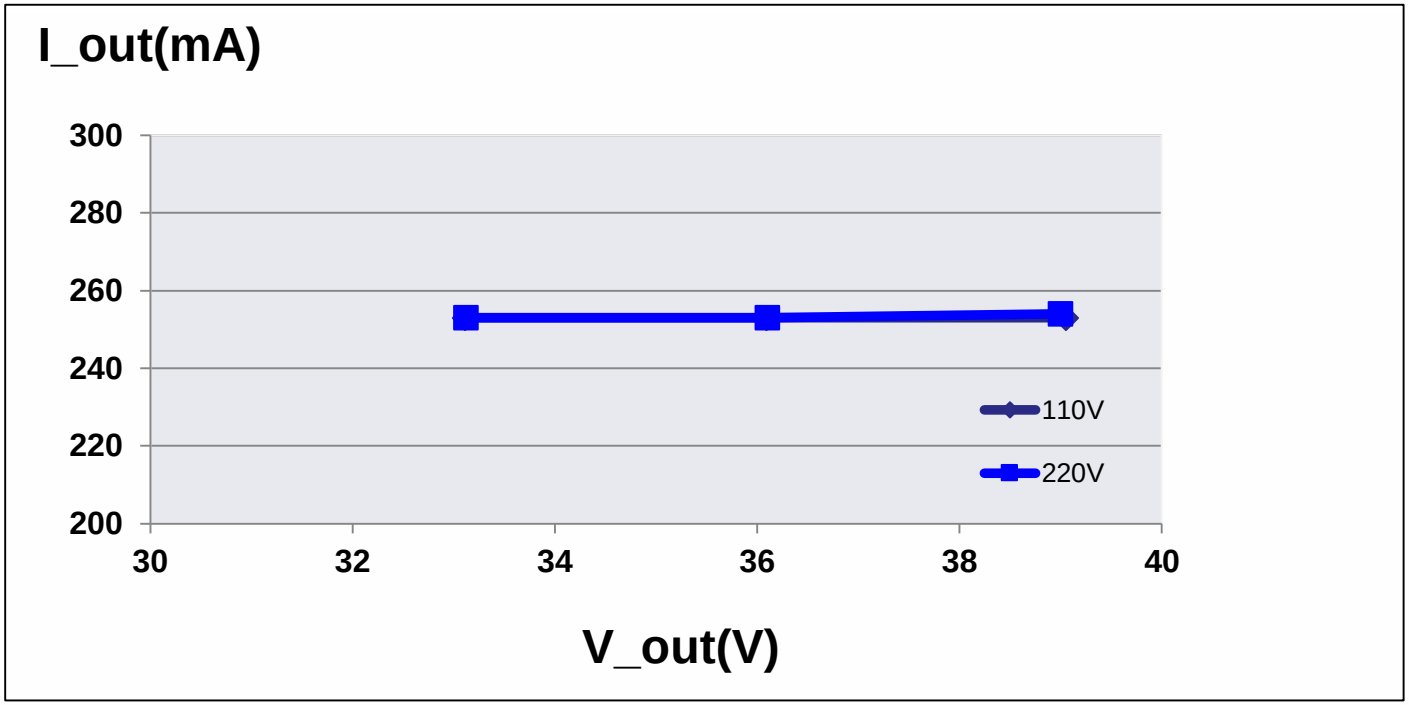
Current regulation



Load regulation

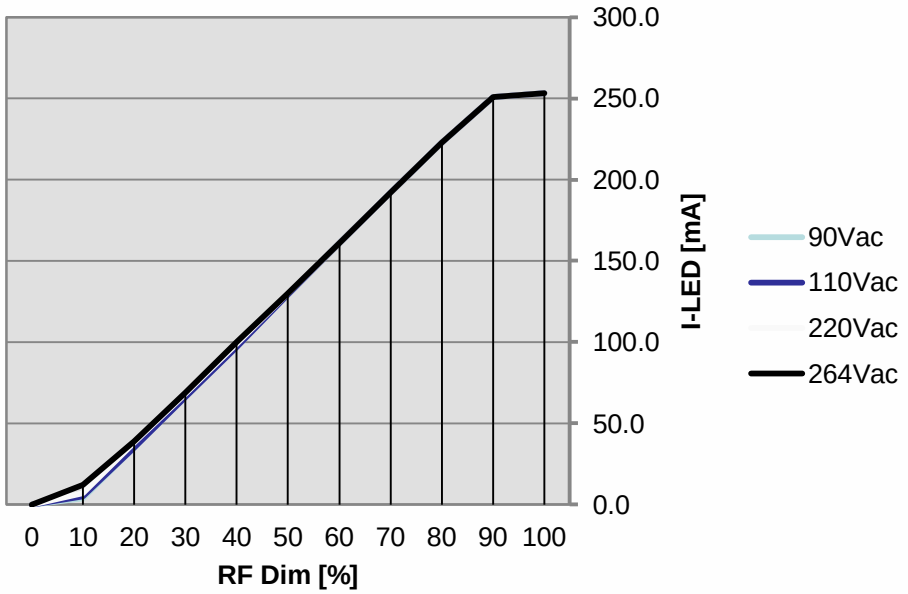
Load: LED Series

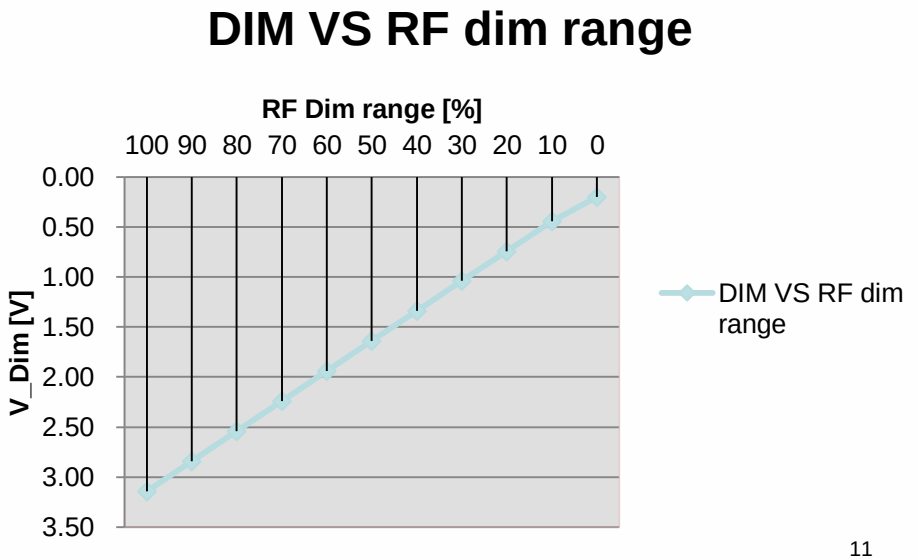
Frequency	Vac [V]	Vout(76V)	Vout [V]	Iout [mA]	Load regulation
60Hz	110	VLED+5%	39.05	253	0.00%
		VLED	36.09	253	
		VLED-5%	33.11	253	
50Hz	220	VLED+5%	39	254	0.39%
		VLED	36.1	253	
		VLED-5%	33.12	253	



RFID Dimming Performance

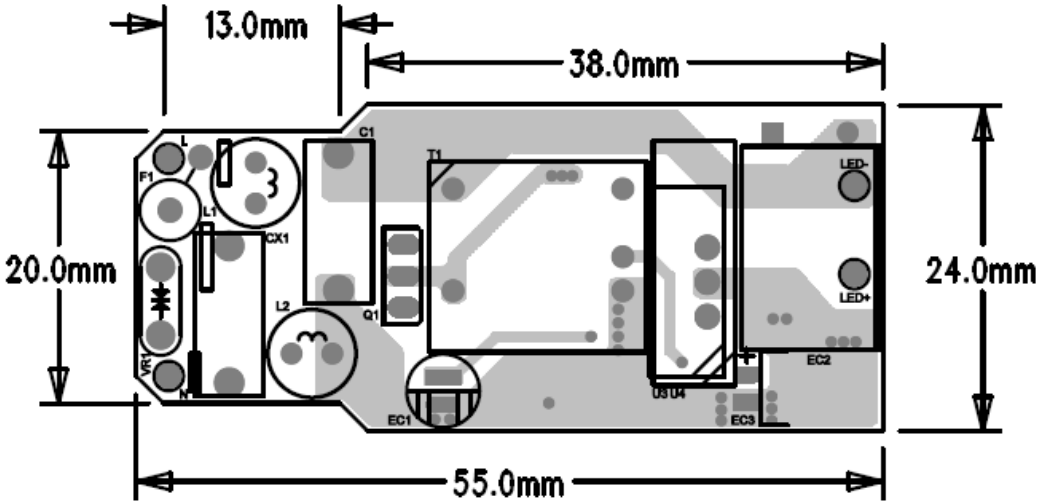
RF Dim [%]	100	90	80	70	60	50	40	30	20	10	0
I-90Vac [mA]	253.0	251.0	223.0	192.0	161.0	129.0	97.0	66.0	35.0	4.0	0.0
I-110Vac [mA]	253.0	251.0	223.0	192.0	161.0	129.0	97.0	66.0	35.0	5.0	0.0
I-220Vac [mA]	253.0	251.0	223.0	192.0	161.0	130.0	99.0	68.0	38.0	7.0	0.0
I-264Vac [mA]	253.0	251.0	223.0	192.0	161.0	130.0	100.0	69.0	39.0	12.0	0.0
V-DIM [V]	3.14	2.84	2.54	2.24	1.94	1.64	1.34	1.04	0.74	0.44	0.20



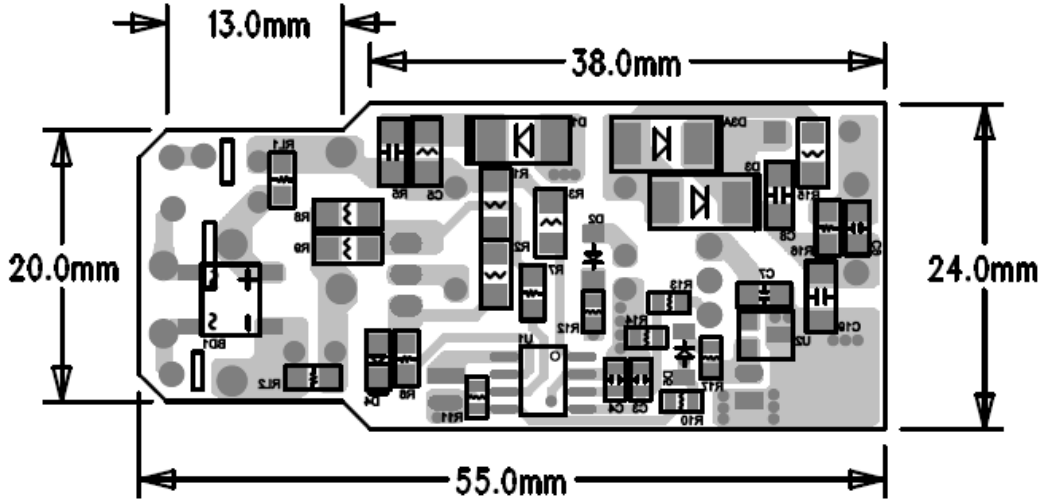


PCB layout

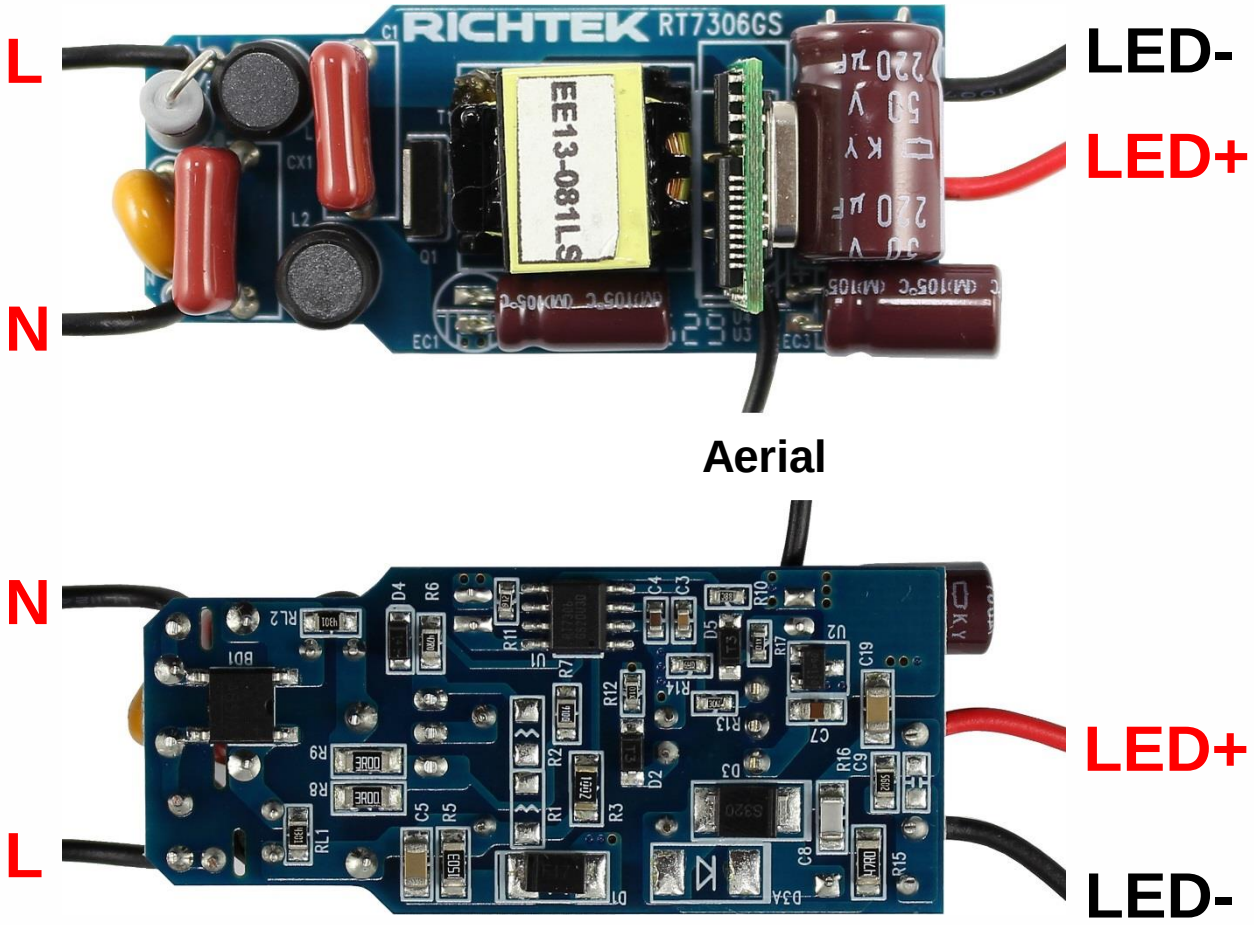
Top Trace



Bottom Trace



Demo board photo



PCB No : PCB018_V1

BOM

Item	Location	Value	Type
1	F1	7R5 / 1W	(DIP)
2	VR1	TVR07471	D=7mm (DIP)
3	L1, L2	1.5mH	DR0608
4	T1	Lp=1950uH	EE1310
5	BD1	ABS10	Mini-Dip
6	D1	RS1M	D-SMA
7	D2, D5	TBAV21W	SOD-123
8	D3	CDBB3200	D-SMB
9	D4	T1N4148W-H	SOD-123
10	Q1	ISU04N65A	TO-251
11	U1	RT7306	SOP-8
12	U2	RT9058-50GV	SOT-23

BOM

Item	Location	Value	Type
13	U3	FI-MM6600	---
14	RL1, RL2	4.32K	0805
15	R3	10K	1206
16	R5	150K	1206
17	R6	47R	0805
18	R7	909R	0805
19	R8	3R	1206
20	R9	3R	1206
21	R10	80.6K	0603
22	R11	9.1K	0603
23	R12, R17	10R	0603
24	R13	300K	0603

BOM

Item	Location	Value	Type
25	R14	453K	0603
26	R15	47R	1206
27	R16	56K	0805
28	CX1, C1	0.1uF/450V	(DIP)
29	C3	22nF/10V	0603
30	C4	1uF/10V	0603
31	C5	2.2nF/1KV	1206
32	C7	2.2uF/25V	0805
33	C8	100pF/1KV	1206
34	C19	4.7nF/1KV	1206
35	EC1	10uF/50V	D=5mm (DIP)
36	EC2	220uF/50V	D=10mm (DIP)

BOM

Item	Location	Value	Type
37	EC3	100uF/35V	D=6.3mm (DIP)

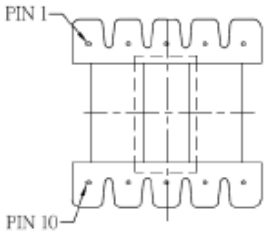
Total :42pcs

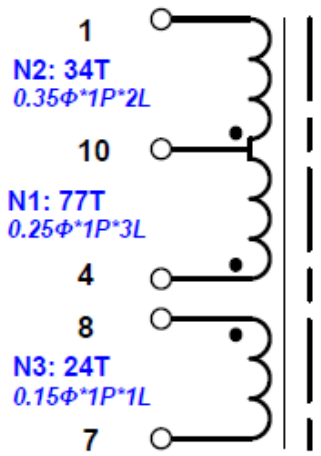
Transformer

Vender : 豐達
CORE SIZE: EE-1310 Material: PC40
Bobbin/PINs: Vertical/ 10 pins
Primary inductor: (+-10%) 1950uH
Leakage inductor: N/A
Test condition: 1kHz/1V
Varnish : Yes

Electrical :

Bottom View





WINDING TABLE: (繞線結構)

Winding No. (組別)	PIN (腳位)	Wire & Wire & Copper (線徑 x 股數 x 層數)	Turns (圈數)	Winding Type (繞線方式)	Tape Layer (膠帶層次)
	Bobbin				
N1	4 → 10	0.25x 1P x 3L	77Ts	密繞	1L
N2	10 → 1	0.35 x 1P x 2L	34Ts	密繞	1L
N3	8 → 7	0.15 x 1P x 1L	24Ts	密繞	1L
	Core – EE1310			1950uH	

Note1: Cut pin2, pin3, pin5, pin6, pin9

Power Component Stress Voltage

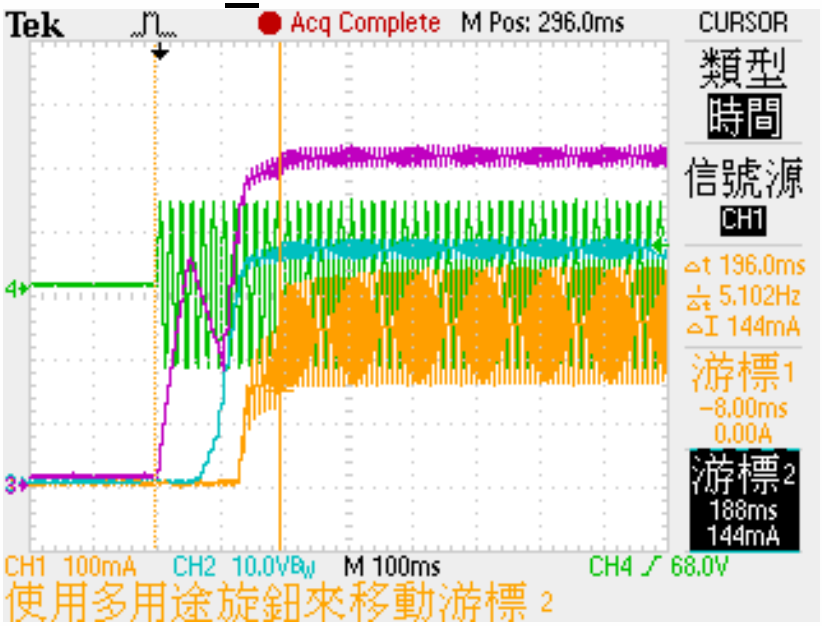
Test condition: 264Vac input / 36V,260mA output

Stead state			
Location	Max rating (V)	Measure	De-rating
Q1	650	564	86.7%
D1	200	174	87%

Transient State			
Location	Max rating (V)	Measure	De-rating
Q1	650	548	84.3%
D1	200	166	83%

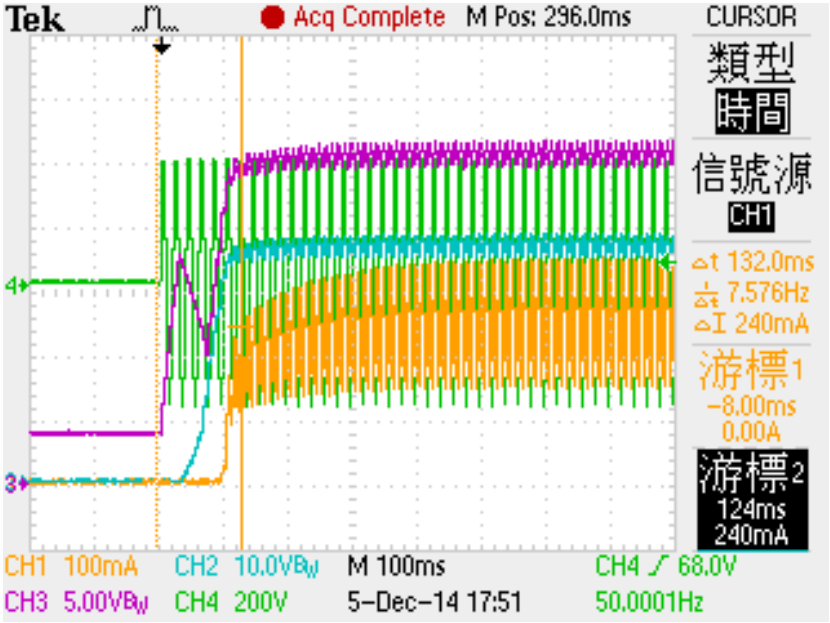
Start up waveform

Vac_in = 90V



T_start up =196ms

Vac_in = 264V

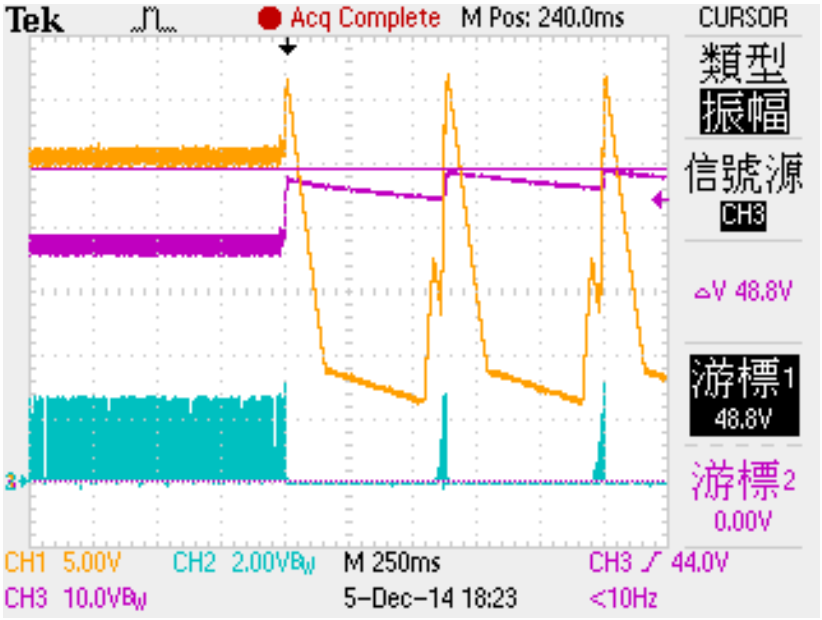


T_start up =132ms

CH1: I-LED , CH2: VCC , CH3: V-LED , CH4: V-AC LINE

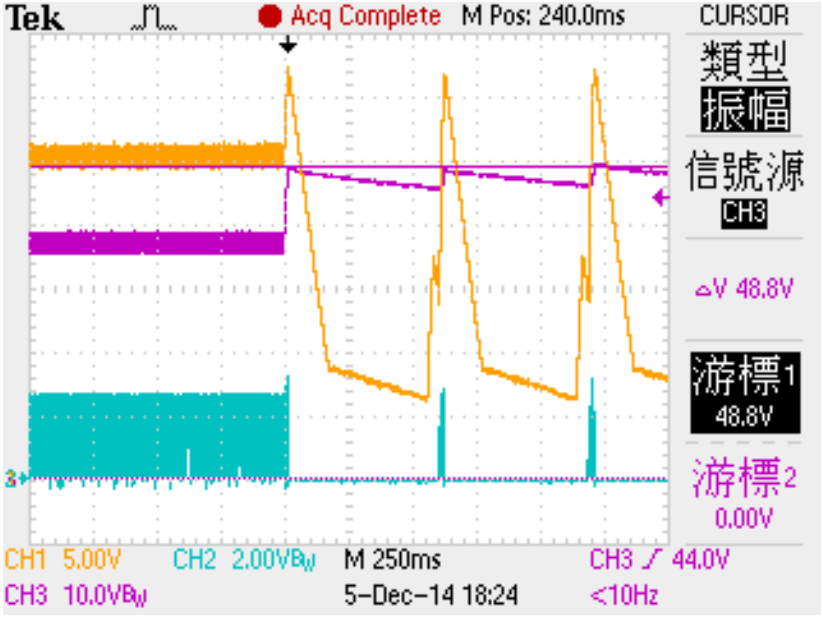
LED open protection

Vac_in = 90V



CH1: VCC , CH2: V-ZCD , CH3: V-OUT

Vac_in = 264V

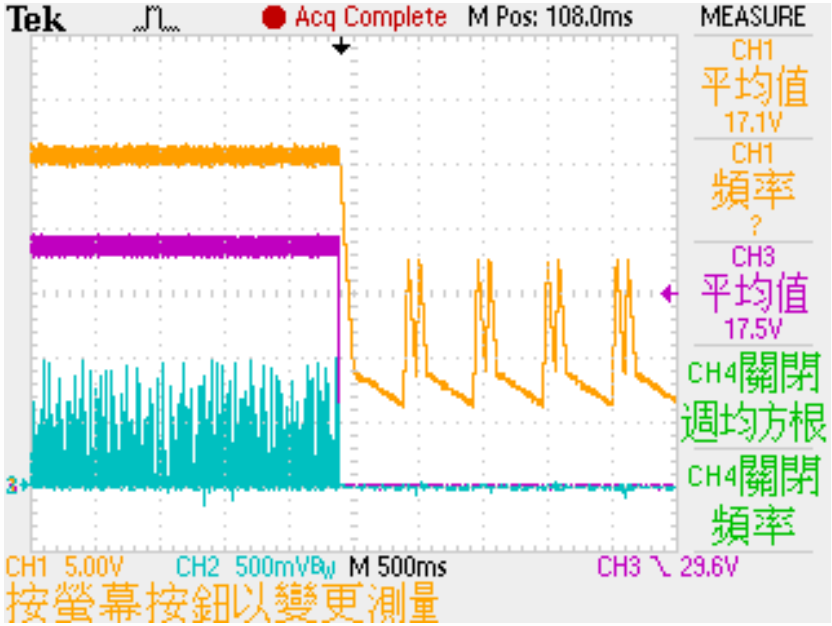


CH1: VCC , CH2: V-ZCD , CH3: V-OUT

When LED open , the output keeps rising and causing the V_{ZCD} rising accordingly. If Vzcd trigger the protected level(2.9V~3.3V), the IC latch down. IC will be auto-restarted when the output is recovered.

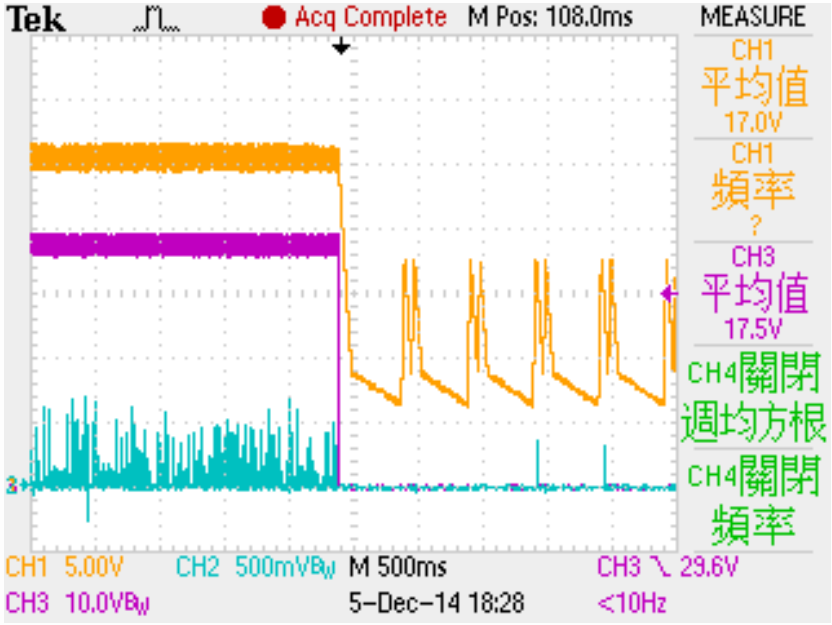
LED Short protection

Vac_in = 90V



CH1: VCC , CH2: V-CS , CH3: V-OUT

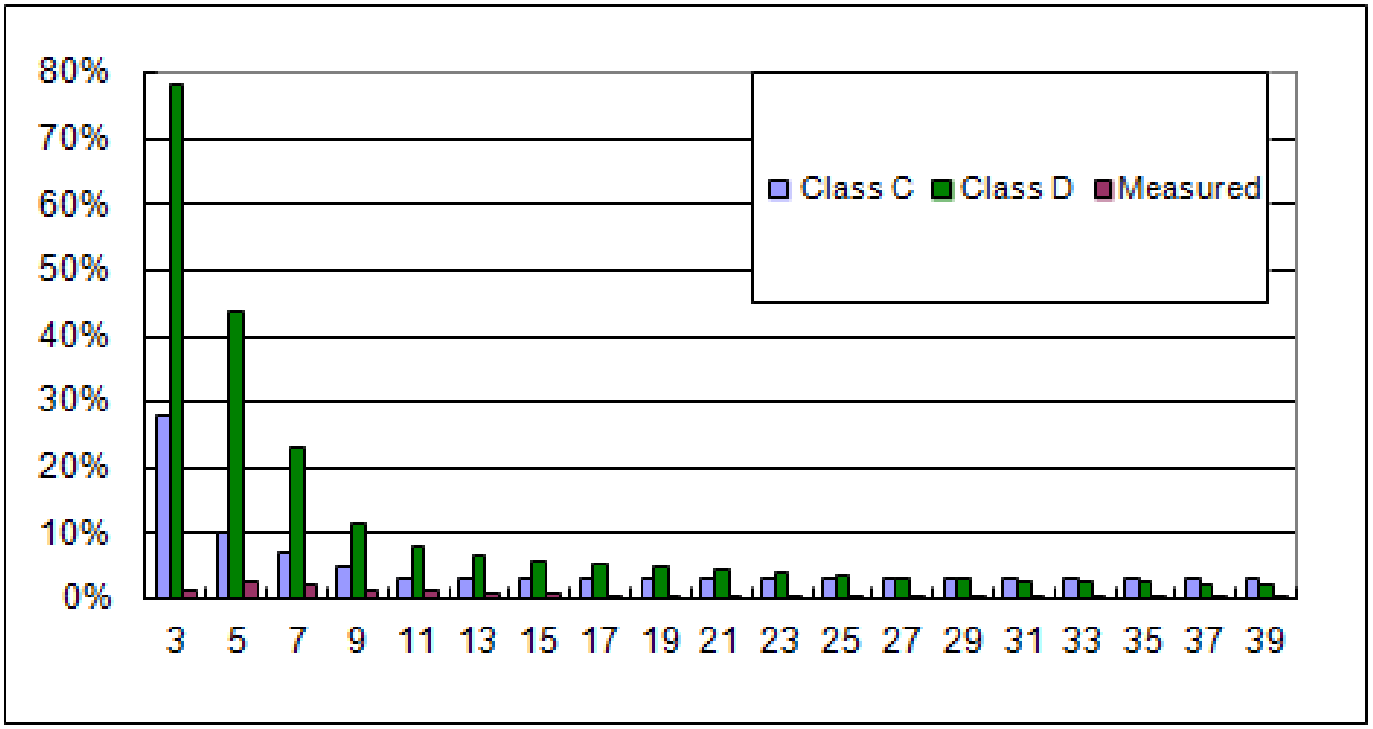
Vac_in = 264V



CH1: VCC , CH2: V-CS , CH3: V-OUT

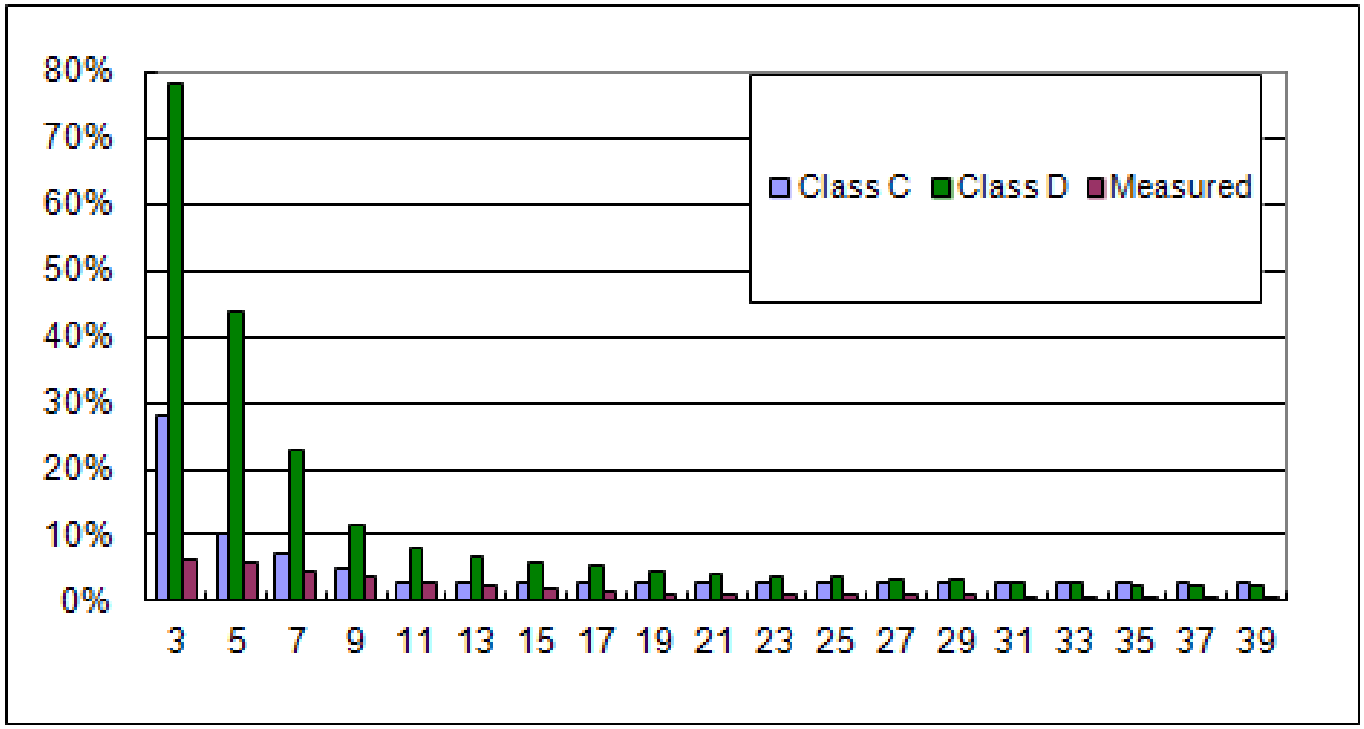
When LED short , the output level is 0V and the Vcs will rise to trigger the protected function. IC will be auto-restarted when the output is recovered.

Harmonic(IEC61000-3-2)



110V input
Class C : Pass
Class D : Pass

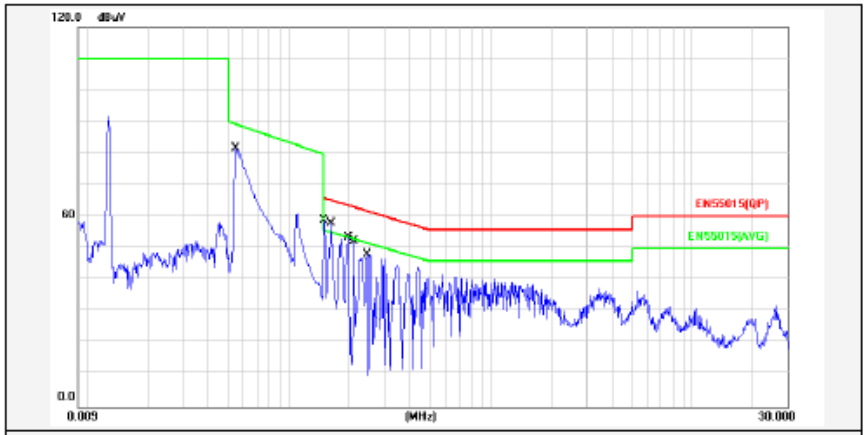
Harmonic(IEC61000-3-2)



230V input
Class C : Pass
Class D : Pass

Conduction-EMI

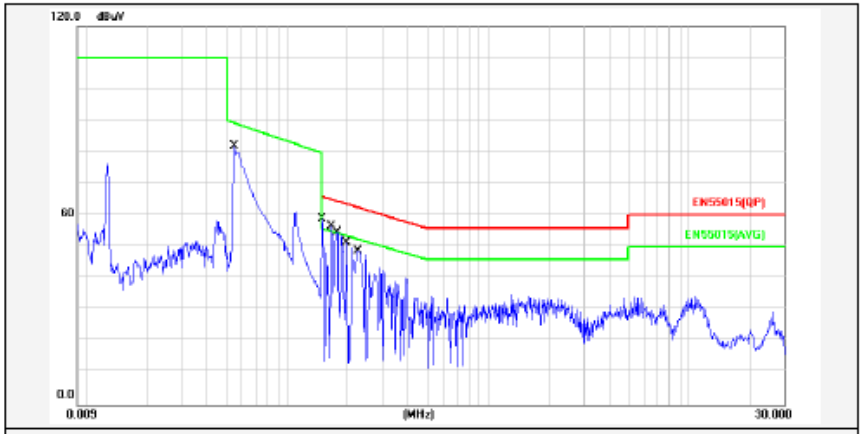
110V-L → Pass



Report No.: SL38-T2
Test Standard: EN55015(QP)
Test item: Conducted Emission
Applicant:
Product:
Model No.: RT7306-RFID
Phase: L1
Temp.(℃)/Hum.(%)/Air p.(hpa):26(C) / 48 %/1008
Power Rating: AC 120V/60Hz
Test Engineer:
Test Mode: light on
Remark:

No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.0548	9.95	67.37	77.32	89.17	-11.85	QP	P	
2	0.0548	9.95	65.08	75.03	89.17	-14.14	AVG	P	
3	0.1500	9.91	48.52	58.43	65.99	-7.56	QP	P	
4	0.1500	9.91	26.45	36.36	55.99	-19.63	AVG	P	
5	0.1620	9.92	47.71	57.63	65.36	-7.73	QP	P	
6	0.1620	9.92	33.53	43.45	55.36	-11.91	AVG	P	
7	0.1980	9.92	40.98	50.90	63.69	-12.79	QP	P	
8	0.1980	9.92	20.53	30.45	53.69	-23.24	AVG	P	
9	0.2100	9.92	38.54	48.46	63.20	-14.74	QP	P	
10	0.2100	9.92	18.14	28.06	53.20	-25.14	AVG	P	
11	0.2460	9.92	35.93	45.85	61.89	-16.04	QP	P	
12	0.2460	9.92	16.24	26.16	51.89	-25.73	AVG	P	

110V-N → Pass

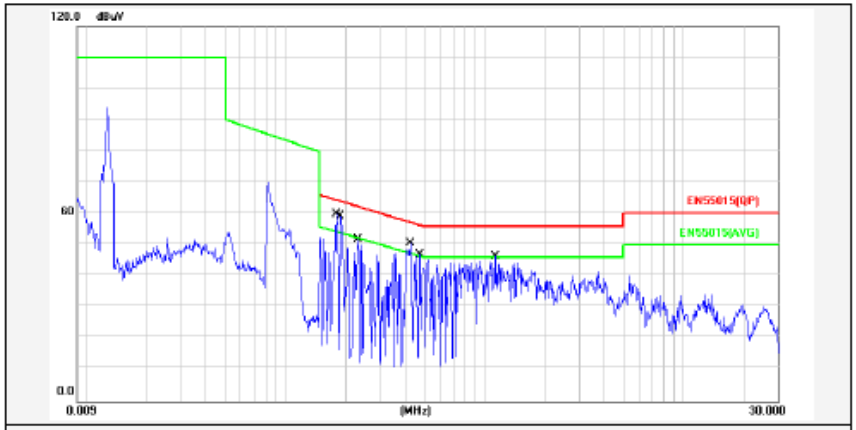


Report No.: SL38-T2
Test Standard: EN55015(QP)
Test item: Conducted Emission
Applicant:
Product:
Model No.: RT7306-RFID
Phase: N
Temp.(℃)/Hum.(%)/Air p.(hpa):26(C) / 48 %/1008
Power Rating: AC 120V/60Hz
Test Engineer:
Test Mode: light on
Remark:

No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.0548	9.95	67.45	77.40	89.17	-11.77	QP	P	
2	0.0548	9.95	65.06	75.01	89.17	-14.16	AVG	P	
3	0.1500	9.91	48.45	58.36	65.99	-7.63	QP	P	
4	0.1500	9.91	26.32	36.23	55.99	-19.76	AVG	P	
5	0.1660	9.92	47.61	57.53	65.15	-7.62	QP	P	
6	0.1660	9.92	35.77	45.69	55.15	-9.46	AVG	P	
7	0.1780	9.91	44.44	54.35	64.57	-10.22	QP	P	
8	0.1780	9.91	28.38	38.29	54.57	-16.28	AVG	P	
9	0.1980	9.91	39.78	49.69	63.69	-14.00	QP	P	
10	0.1980	9.91	20.43	30.34	53.69	-23.35	AVG	P	
11	0.2260	9.91	38.93	48.84	62.59	-13.75	QP	P	
12	0.2260	9.91	25.22	35.13	52.59	-17.46	AVG	P	

Conduction-EMI

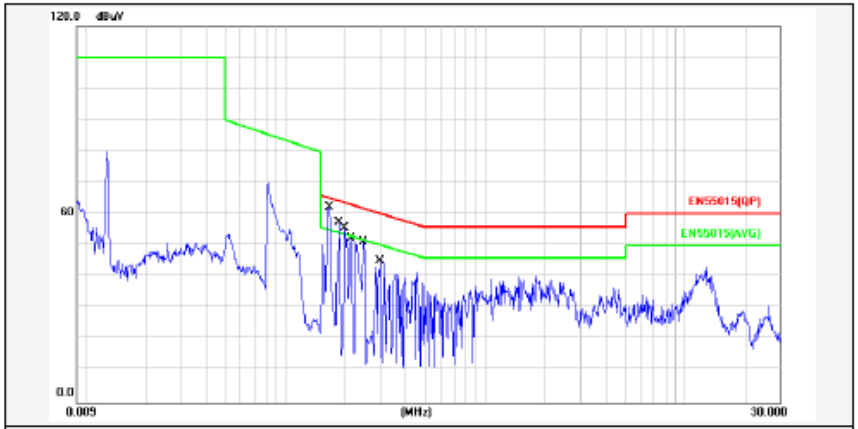
230V-L ➔ Pass



Report No.: SL38-T2
Test Standard: EN55015(QP)
Test item: Conducted Emission
Applicant: 兼其
Product:
Model No.: RT7306-RFID
Phase: L1
Temp.(℃)/Hum.(%)/Air p.(hpa):26(C) / 48 %/1008
Power Rating: AC 230V/50Hz
Test Engineer:
Test Mode: light on
Remark:

No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1819	9.92	47.66	57.58	64.39	-6.81	QP	P	
2	0.1819	9.92	28.06	37.98	54.39	-16.41	AVG	P	
3	0.1900	9.92	45.89	55.81	64.03	-8.22	QP	P	
4	0.1900	9.92	25.69	35.61	54.03	-18.42	AVG	P	
5	0.2340	9.92	38.82	48.74	62.30	-13.56	QP	P	
6	0.2340	9.92	17.43	27.35	52.30	-24.95	AVG	P	
7	0.4260	9.92	38.80	48.72	57.33	-8.61	QP	P	
8	0.4260	9.92	21.44	31.36	47.33	-15.97	AVG	P	
9	0.4740	9.92	33.07	42.99	56.44	-13.45	QP	P	
10	0.4740	9.92	17.14	27.06	46.44	-19.38	AVG	P	
11	1.1460	9.97	34.01	43.98	56.00	-12.02	QP	P	
12	1.1460	9.97	19.48	29.45	46.00	-16.55	AVG	P	

230V-N ➔ Pass

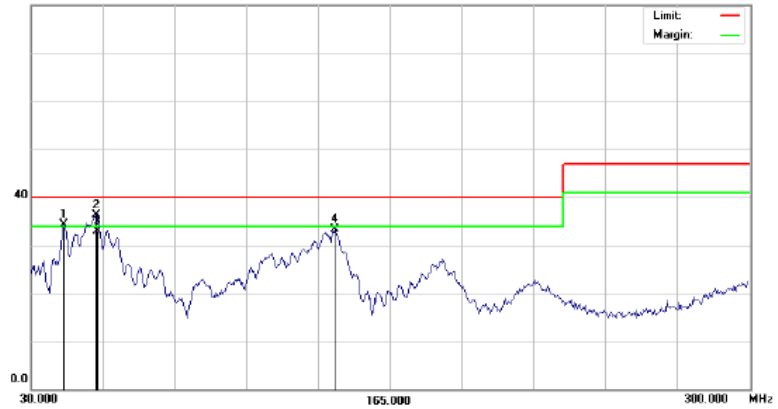


Report No.: SL38-T2
Test Standard: EN55015(QP)
Test item: Conducted Emission
Applicant: 兼其
Product:
Model No.: RT7306-RFID
Phase: N
Temp.(℃)/Hum.(%)/Air p.(hpa):26(C) / 48 %/1008
Power Rating: AC 230V/50Hz
Test Engineer:
Test Mode: light on
Remark:

No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1660	9.92	51.03	60.95	65.15	-4.20	QP	P	
2	0.1660	9.92	37.51	47.43	55.15	-7.72	AVG	P	
3	0.1860	9.91	46.26	56.17	64.21	-8.04	QP	P	
4	0.1860	9.91	26.23	36.14	54.21	-18.07	AVG	P	
5	0.1980	9.91	43.56	53.47	63.69	-10.22	QP	P	
6	0.1980	9.91	24.99	34.90	53.69	-18.79	AVG	P	
7	0.2140	9.91	40.18	50.09	63.04	-12.95	QP	P	
8	0.2140	9.91	24.23	34.14	53.04	-18.90	AVG	P	
9	0.2460	9.91	39.80	49.71	61.89	-12.18	QP	P	
10	0.2460	9.91	24.28	34.19	51.89	-17.70	AVG	P	
11	0.2980	9.91	31.25	41.16	60.30	-19.14	QP	P	
12	0.2980	9.91	10.82	20.73	50.30	-29.57	AVG	P	

Radiation-EMI

110V-V ➔Pass



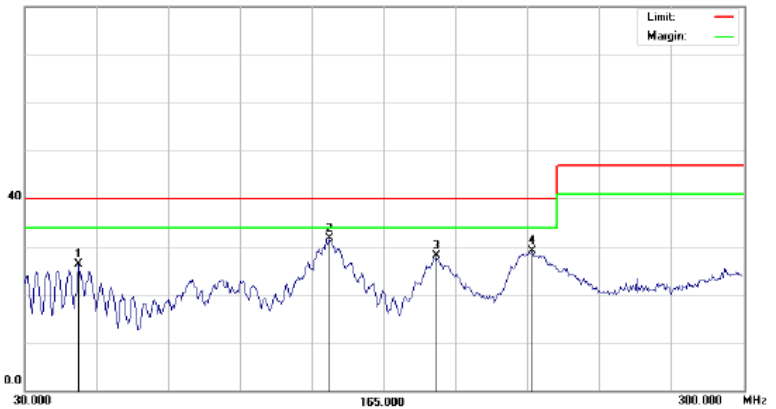
Site site A6
Limit: (RE)CISPR22 class B 3m
EUT: LED
M/N: RT7306-RFID
Mode:
Note:

Polarization: *Vertical*
Power: AC 230V/50Hz
Distance: 3m RBW: 100 KHz
VBW: 1000 KHz

Temperature: 28 ℃
Humidity: 60 %
Sweep Time: 300 ms

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	!	42.5481	48.71	-14.44	34.27	40.00	-5.73	peak			
2	*	54.6635	50.75	-14.43	36.32	40.00	-3.68	peak			
3		54.6956	47.30	-14.43	32.87	40.00	-7.13	QP	100	32	
4		144.2308	47.69	-14.45	33.24	40.00	-6.76	peak			

110V-H ➔Pass



Site site A6
Limit: (RE)CISPR22 class B 3m
EUT: LED
M/N: RT7306-RFID
Mode:
Note:

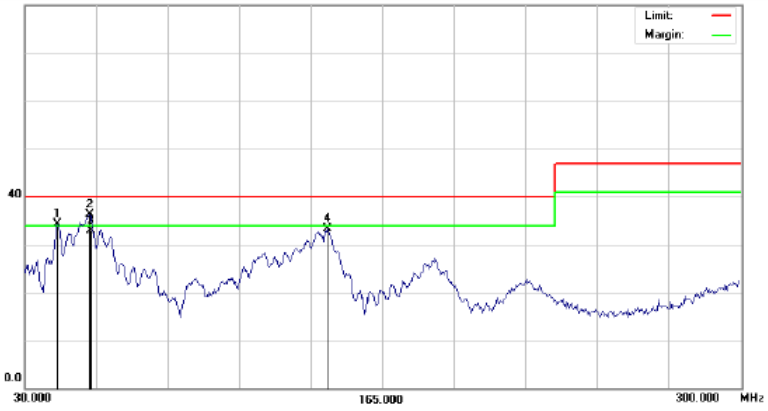
Polarization: *Horizontal*
Power: AC 230V/50Hz
Distance: 3m RBW: 100 KHz
VBW: 1000 KHz

Temperature: 28 ℃
Humidity: 60 %
Sweep Time: 300 ms

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		50.3365	40.30	-14.05	26.25	40.00	-13.75	peak			
2	*	144.6635	46.19	-14.44	31.75	40.00	-8.25	peak			
3		184.9038	43.96	-15.93	28.03	40.00	-11.97	peak			
4		220.8173	44.98	-15.80	29.18	40.00	-10.82	peak			

Radiation-EMI

230V-V ➔Pass



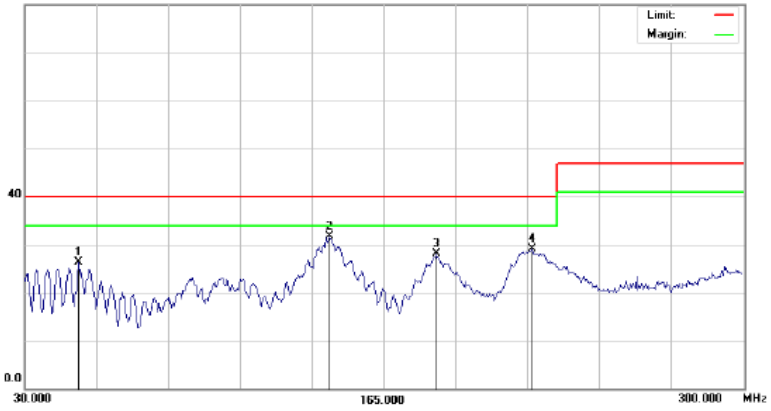
Site site A6
Limit: (RE)CISPR22 class B 3m
EUT: LED
M/N: RT7306-RFID
Mode:
Note:

Polarization: *Vertical*
Power: AC 230V/50Hz
Distance: 3m
RBW: 100 KHz
VBW: 1000 KHz

Temperature: 28 ℃
Humidity: 60 %
Sweep Time: 300 ms

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	!	42.5481	48.71	-14.44	34.27	40.00	-5.73	peak			
2	*	54.6635	50.75	-14.43	36.32	40.00	-3.68	peak			
3		54.6956	47.30	-14.43	32.87	40.00	-7.13	QP	100	32	
4		144.2308	47.69	-14.45	33.24	40.00	-6.76	peak			

230V-H ➔Pass



Site site A6
Limit: (RE)CISPR22 class B 3m
EUT: LED
M/N: RT7306-RFID
Mode:
Note:

Polarization: *Horizontal*
Power: AC 230V/50Hz
Distance: 3m
RBW: 100 KHz
VBW: 1000 KHz

Temperature: 28 ℃
Humidity: 60 %
Sweep Time: 300 ms

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		50.3365	40.30	-14.05	26.25	40.00	-13.75	peak			
2	*	144.6635	46.19	-14.44	31.75	40.00	-8.25	peak			
3		184.9038	43.96	-15.93	28.03	40.00	-11.97	peak			
4		220.8173	44.98	-15.80	29.18	40.00	-10.82	peak			

RICHTEK

your power partner.

thank you.