MORNSUN®

Application Guide for

LS-R3 Series

6+ Applications

- IoT
- Electric power
- White household appliances
- Instrument
- Intelligent building
- Industrial control

And more...

4 Temperature levels

Class I -5 to 45°C
Class II -25 to 55°C
Class III -40 to 70°C
Class IV -40 to 85°C

Optional EMC levels

EMS(EFT&SURGE)	EMI
EFT: ±2KV Surge: line to line ±1KV	Class A Class B
EFT: ±4KV Surge: line to line ±2KV	

Instrument

Smart miniature circuit breaker

Smart home

Smart gateway

New energy

Portable charging box

Content

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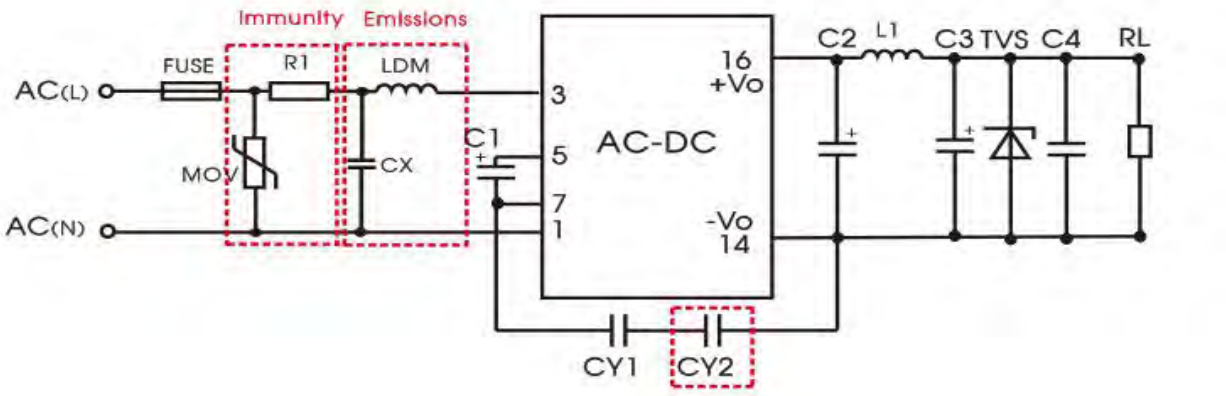
1. Preface

In order to solve the LS core board may encounter in the use of the wrong peripheral device selection and unreasonable PCB design, resulting in abnormal application. MORNSUN has released this design guide. This guide recommends the selection of peripheral components on the LS-R3 core board and PCB design. At the same time, in order to make customer design more convenient, MORNSUN recommends different types of solutions in Chapter 4 of this manual, and provides test reports and recommended peripheral device type.

2. Peripheral device selection

The combination of Mornsun LS core board and different recommended peripheral components can meet the power supply module requirement of various applications and equipment. The complete recommended peripheral circuit can achieve EMI (CISPR32/EN55032) CLASS B level, EMS (IEC/EN61000) EFT ±4KV and Surge ±2KV.

The peripheral recommended circuit is as follows:



Note: In order to meet the IEC/EN60335 certification for home appliances, CY2 is mandatory. If there is no IEC/EN60335 certification requirement, just need add CY1.

Peripheral device code	Component
FUSE	Fuse
R1	Wire-wound Resistor
CX	Class-X Capacitor
LDM	DM inductor
C1	Input filter capacitor
CY1、CY2*	Class-Y Capacitor
C2	Output filter capacitor
L1	Output inductor
C3	Output filter capacitor

The selection of each peripheral device are based on various factors when designing the power supply module.

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For specific considerations, please refer to the following device selection guide.

2.1. Fuse

Fuse is also called as current fuse, and the IEC127 standard defines it as a "fuse-link". It is mainly used for overload protection in the circuit. The fuse will thermal fusing due to high temperature after the current rises abnormally, and cut off the electrical connection after thermal fusing, which protects the circuitry connected behind. The fuse selection mainly considers the following aspects:

1）Rated voltage

Rated voltage means the highest voltage that the fuse can withstand during and after the overload current is cut off. The rated voltage of the selected fuse must be higher than or equal to the highest voltage in the circuit.

Take LS05-13BXXR3 as an example, the input voltage range is 85-305VAC. it can be compatible with 115VAC, 230VAC, 277VAC grid, then the fuse selection can refer to the following table:

Power gird voltage	Fuse selection(Rated voltage)
110VAC	125VAC
230VAC	250VAC
277VAC	300VAC

2）Rated current

Rated current (In) refers to the working current that the fuse can withstand, it means that the fuse should be able to work stably for a long time under this current load. This value is determined by the manufacturer. The rated current is usually the standard recommended current, such as 1, 1.25, 2, 3.15, etc. (unit: A)

Taking LS05-13BXXR3 as an example, According to the technical manual, the maximum value of the input current of the product is several hundred mA. However, the actual rated current selection should also consider the input impulse current and surge current. According to the data given in the datasheet, the impulse current is around 23A, and the time is at the level of microsecond. At the same time, the surge current is related to the surge level to be achieved and the selection of the MOV. The current value is basically a few hundred amperes or higher, and the time is also at the level of microsecond. Therefore, selecting a fuse based on the rated current is only a basic condition, that is, the rated current of the fuse must be higher than the actual steady-state operating current.

3）Melting Integral (I^2t)

It refers to the energy value when the fuse is melted, which indicates the surge capacity that the fuse can withstand, I is the overload current, and t is the time required for fusing. The fuse selection needs to consider the surge and input inrush current of the power supply module, that is refer to the fuse technical manual based on the calculated value of I^2t. The actual value selected higher than the calculated value is enough, and the value of I^2t can be preliminarily estimated during model selection.

Taking LS05-13BXXR3 as an example, the current flowing through the fuse during ±2KV surge test according to

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IEC/EN61000-4-5 is estimated to be about several hundred ampere, and the time is about tens of microseconds. Then the final value must be higher than the estimated melting heat energy value.

2.2. Wire-wound resistor

The use of wire-wound resistor in LS recommended peripheral circuits is mainly to reduce input inrush current and improve surge immunity The main consideration in the selection of wire-wound resistor is:

1）Rated power

The rated power of a resistor refers to the power that the resistor can withstand for a long time in the circuit. The rated power value will decrease as the operation temperature rises. Please refer to the curve given by the resistor manufacturer for the specific derating curve.

Taking LS05-13BXXR3 as an example, the operating current is 0.1A when the input voltage is 230Vac. In other words, the current through the resistor is 0.1A, and the recommended resistance value in the datasheet is 12Ω, so the power consumed by the resistor is 0.12W during steady state operation. Considering that there would be a derating when the operating temperature and large current when there is surge or turn on, a 12Ω/3W resistor is recommended.

Note: Considering the large transient power when there is surge or inrush current when start up, please do not select chip resistor or carbon film resistor.

2.3. Class-X capacitor

Class-X capacitor is also called capacitor for suppressing electromagnetic interference of power supply, it is generally used between L and N of the AC input. To suppress differential mode interference and improve the EMI performance of power supply module. The selection of Class-X capacitor mainly needs to take the following aspects into consideration:

1）Rated voltage

It refers to the maximum DC voltage of the capacitor or the peak value of the AC voltage of the maximum effective value. This voltage value is given within the promised operating temperature range. The rated voltage of the Class-X capacitor must be higher than the voltage of the application circuit (including voltage fluctuations), otherwise the Class-X capacitor will be damaged (Capacity drops or open circuit).

2）Rated temperature

The rated temperature refers to the maximum operating temperature at which the rated voltage can be continuously applied. This value needs to be selected according to the operating environment temperature, and the selected value must be wider than the actual operating temperature range.

Take LS05-13BXXR3 as an example, the working voltage range is 85-305VAC. Considering the upper limit of the working voltage is 305VAC, it is recommended to choose a capacitor of 0.1uf/305VAC. The 0.1uf refers to the capacitance, which is the value recommended based on the actual EMI debugging. As with the fuse selection, if the working voltage is not 305VAC, the customer may choose according to the actual grid voltage.

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Note: According to the certification requirements, the Class-X capacitor needs to be connected in parallel with the bleeder resistance, the recommended resistance value is less than 3.8MΩ, and And actually it need to be selected according to the certification standard.

2.4. Differential mode inductance

Differential mode inductor is an inductor that has a large inductance working on high-frequency differential mode interference, and it's also called a differential mode choke coil. It is mainly used to suppress the high frequency interference noise of the differential mode. For LS products, it is used to suppress the high frequency noise between the Live and the Neutral. The selection of differential mode inductance mainly needs to take the following aspects into consideration:

1）Rated current

Rated current refers to the current that can be withstood within the operating temperature range. Therefore, the selected differential mode inductor rated current value must be greater than the actual current passed.

2）Inductance value

The change of inductance will affect the EMI performance of LS products, so please select according to recommended inductance value.

3）Operating temperature

It should be noted that the upper limit of this temperature refers to the temperature of the differential mode inductor. In other words, it is necessary to consider the heating of the inductor during operation.

2.5. Input filter capacitance

LS is only the core control board, and the input filter capacitor needs to be added to realize the normal power supply function. It is recommended to use aluminum electrolytic capacitors in LS applications. The selection of input filter capacitors mainly needs to take the following aspects into consideration:

1）Rated voltage

The selection of the rated voltage is mainly related to the upper limit of the input AC voltage. When choosing the input filter capacitor, the rated voltage must be higher than 1.414 times of the upper limit of the input AC voltage. The following is the selection of capacitor rated voltage in different grid:

Upper limit of grid voltage	Input filter capacitor (Rated voltage)
144VAC	≥250VDC
264VAC	≥400VDC
305VAC	≥450VDC

Note: Generally speaking, the higher rated voltage of the capacitor, the higher price and larger volume;

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2）Operating temperature

The operating temperature also refers to the temperature of the electrolytic capacitor itself, Because the capacitor will generate heat during operation, the actual temperature of the capacitor must be lower than the promised operating temperature. Usually, for the operating temperature range of most electrolytic capacitors, the wider range, the higher price. At the same time, the capacity of the electrolytic capacitor will decrease at low temperature, which will affect the performance of the power supply. Therefore, special attention should be paid to the low temperature working temperature and capacity decline of the electrolytic capacitor.

3）Rated Ripple Current

The ripple current of the electrolytic capacitor will cause internal heating and increase with the rise of temperature. Therefore, electrolytic capacitor manufacturers will give the maximum ripple current value that the electrolytic capacitor can withstand when designing. In practical applications, the ripple current of the electrolytic capacitor needs to be lower than the value given by the manufacturer. Otherwise, it will cause serious heating of the capacitor and shorten the lifetime.

4）Lifetime

The lifetime of an electrolytic capacitor refers to the continuous working time that the electrolytic capacitor can meet within the promised operating temperature range and ripple current. This value is tested at the maximum temperature of the capacitor and the rated ripple current. If in other temperature and ripple current conditions, the life of electrolytic capacitors needs to refer to the calculation formula given by each manufacturer.

Take LS05-13BXXR3 as an example, the working voltage range promised by is 85-305VAC. Considering the upper limit of the working voltage is 305VAC, it is recommended to choose a capacitor of 10uf/450VDC or 22uf/450VDC. Among them, 10uf and 22uf refer to the capacitance, which is the value recommended in datasheet. At a low temperature of -40°C, the capacitance of the capacitor decreases significantly, so 22uf is recommended. Same as the fuse selection, if the working voltage is not 305VAC, the customer can also select the input filter capacitor according to the actual grid voltage.

2.6. Class-Y Capacitor

Class-Y capacitors refer to the safety capacitors connected between the two power lines and the ground (L-E, N-E), mainly to suppress common mode interference. According to the different withstand voltages of Class-Y capacitors, they are divided into Y1, Y2, Y3, Y4 capacitors. The common ones are Y1 and Y2 capacitors. The selection of Class-Y capacitors mainly focuses on the following points:

1）Insulation grade

The Class-Y capacitor is a jumper capacitor. If the capacitor is incorrectly selected, the insulation level of the product will decrease, which cannot meet the safety requirements.

Capacitor types	Insulation grade	Rated voltage

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Y1	Double insulation or reinforced insulation	Y1≥250V
Y2	Basic insulation or supplementary insulation	150V≤Y3≤250V
Y3	Basic insulation or supplementary insulation	150V≤Y3≤250V
Y4	Basic insulation or supplementary insulation	Y4＜150V

Notes: Some standards require the use of Class-Y capacitors in series to achieve higher creepage and clearance Distance.

2）Operating temperature

Class-Y capacitors will generate heat during use, so the temperature range of Y capacitors must be controlled within the product specifications.

Take LS05-13BXXR3 as an example, we recommends Y1 capacitors in normal use. In the peripherals that meet the IEC/EN60335 certification for home appliances, the two Class-Y capacitors is recommended in series. Can be selected as Y1.

2.7. Output Filter Capacitor (Solid Capacitor)

The output filter capacitor is must to be connected. By adding this capacitor at the output can achieve smooth filtering of the output voltage. In LS recommended circuit is to use two output filter capacitors and a differential mode inductor to achieve output π-type filtering. The filter capacitor before π-type filtering is recommended to use solid capacitors. The main reason is that solid capacitors have lower ESR than electrolytic capacitors. The selection requirements of this capacitor can refer to following points:

1）Rated Voltage

The selection of the rated voltage of the output filter capacitor is mainly related to the upper limit of the output voltage. The rated voltage of the capacitor must be higher than the output rated voltage during designing. For products with output overvoltage, the rated voltage of the output filter capacitor is generally selected to be greater than the overvoltage protection point.

2）Operating Temperature

The operating temperature means the temperature of the solid capacitor body. The capacitor itself will also generate heat during operation. The actual temperature of the capacitor must be lower than the promised operating temperature. Generally speaking, the wider the operating temperature range of solid capacitors, the higher price it will be. At the same time, the capacity will decrease at low temperature, which will affect the performance of the power supply. Therefore, special attention should be paid to the low temperature working temperature and capacity decline of the capacitor.

3）Ripple Current

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The ripple current of the solid capacitor will cause internal heating, and it will increase as the temperature rises. Therefore, the solid capacitor manufacturer will give the maximum ripple current value that the solid capacitor can withstand when designing. In practical applications, the ripple current of the solid capacitor needs to be lower than the value given by the manufacturer. Otherwise it will cause serious heating of the capacitor and shorten the lifetime.

4）Lifetime

The lifetime of solid capacitor refers to the continuous working time that the solid capacitor can meet within the promised operating temperature range and rated ripple current. This value is tested at the highest temperature of the capacitor and the rated ripple current. The lifetime of solid capacitors under other conditions of temperature and ripple current needs to refer to the calculation formula given by each capacitor manufacturer.

Taking LS05-13B12R3 as an example, the output voltage is 12V. Considering the commonly used voltage class of solid capacitor and certain voltage margin, we recommends the solid capacitor of 270uF /16V.

2.8. Output differential mode inductor

The output differential mode inductor and output filter capacitor recommended by our company form a π-type filter, which can reduce the output ripple very well. The selection of output differential mode inductance mainly considers the following points:

1）Rated Current

The rated current refers to the current that can withstand the flow of current within the operating temperature range promised by the differential mode inductor, so the selected differential mode inductor's rated current value must be greater than the actual current flowing..

2）Inductance value

The value change of inductance will affect the output ripple of LS products, so please select according to our recommended inductance value.

3）Operating Temperature

Operating Temperature refers to the operating temperature range of the differential mode inductor. It should be noted that the upper limit of this temperature refers to the temperature of the differential mode inductor. The heating of the inductor during normal operation must be considered.

4）DCR(Direct Current Resistance)

The value change of inductance will affect the output ripple of LS products, so please select according to our recommended inductance value.

2.9. Output Filter Capacitor (Electrolytic Capacitor)

The electrolytic capacitor of the output filter, the output differential mode and the output solid capacitor together form

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a π-type filter. The selection requirements of the output filter electrolytic capacitor can refer to following points.

1）Rated Voltage

The selection of the rated voltage of the output filter capacitor is mainly related to the upper limit of the output voltage. The rated voltage of the capacitor must be higher than the output rated voltage during designing. For products with output overvoltage, the rated voltage of the output filter capacitor is generally selected to be greater than the overvoltage protection point.

2）Operating Temperature

The operating temperature means the temperature of the electrolytic capacitor body. The capacitor will also generate heat during operation. The actual temperature of the capacitor must be lower than the promised operating temperature. Generally speaking, the wider the operating temperature range of electrolytic capacitors, the higher price it will be. At the same time, the capacity of the electrolytic capacitor will decrease at low temperature, which will affect the performance of the power supply. Therefore, special attention should be paid to the low temperature working temperature and capacity decline of the electrolytic capacitor.

3）Ripple Current

The ripple current of the electrolytic capacitor will cause internal heating, and it will increase as the temperature rises. Therefore, the electrolytic capacitor manufacturer will give the maximum ripple current value that the electrolytic capacitor can withstand when designing. In practical applications, the ripple current of the electrolytic capacitor needs to be lower than the value given by the manufacturer. Otherwise it will cause serious heating of the capacitor and shorten the lifetime.

4）Lifetime

The lifetime of electrolytic capacitor refers to the continuous working time that the electrolytic capacitor can meet within the promised operating temperature range. This value is tested at the maximum temperature of the capacitor and the rated ripple current. The lifetime of electrolytic capacitor under other conditions of temperature and ripple current needs to refer to the calculation formula given by each capacitor manufacturer.

Taking LS05-13B12R3 as an example, the output voltage is 12V. Considering the commonly used voltage class of electrolytic capacitor and certain voltage margin, Mornsun recommends 47uf/35V electrolytic capacitor. The rated voltage of the electrolytic capacitor here could be selected as 16V, but in order to meet the requirements of 15V and 24V, 35V electrolytic capacitor is recommended.

3. PCB design

After adopting the LS core power board solution, only a few simple external device need be added to realize the power supply function. Hence the difficulty of self-design is greatly simplified. Only the following two aspects are mainly considered in the design of the peripheral PCB of LS:

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3.1. PCB Wire Width Design

The minimum width and thickness of the wire need to be determined according to the current carrying capacity and the maximum allowable temperature rise of the wire. According to the IPC-2221A general standard for printed plate design, the following calculation formula can be referred:

$$I = K * \Delta T^{0.44} * A^{0.725}$$

I is the current flowing through the PCB wire, in amperes (A)

A is the cross-sectional area of the wire, in square mils (mil2)

Δ T is the temperature rise in degrees Celsius (°C)

K is a constant, K=0.024 for the inner PCB and K=0.048 for the outer PCB

For convenient design, please refer to following table:

Copper thickness 1OZ(35um)		Copper thickness 1.5OZ(50um)		Copper thickness 2OZ(75um)	
0.15	0.2	0.15	0.5	0.15	0.7
0.2	0.55	0.2	0.7	0.2	0.9
0.3	0.8	0.3	1.1	0.3	1.3
0.4	1.1	0.4	1.35	0.4	1.7
0.5	1.35	0.5	1.7	0.5	2
0.6	1.6	0.6	1.9	0.6	2.3
0.8	2	0.8	2.4	0.8	2.8
1	2.3	1	2.6	1	3.2
1.2	2.7	1.2	3	1.2	3.6
1.5	3.2	1.5	3.5	1.5	4.2
2	4	2	4.3	2	5.1
2.5	4.5	2.5	5.1	2.5	6
Note: This data is given according to the temperature rise of the copper skin ΔT=10℃					

3.2. PCB layout and safety distance design

The LS core board has been considered the requirements of different safety standards. LS core board meets the standard of IEC/EN61558, IEC/EN60335 and IEC/EN/UL62368 requirement. The safety design of the peripheral PCB trace design mainly consider the safety distance requirements between the input L and N lines of the LS core board, and between the input and the output. There are two points for safety distance:

1）Electrical clearance

Electrical clearance refers to the shortest distance measured between two conductive parts or between a

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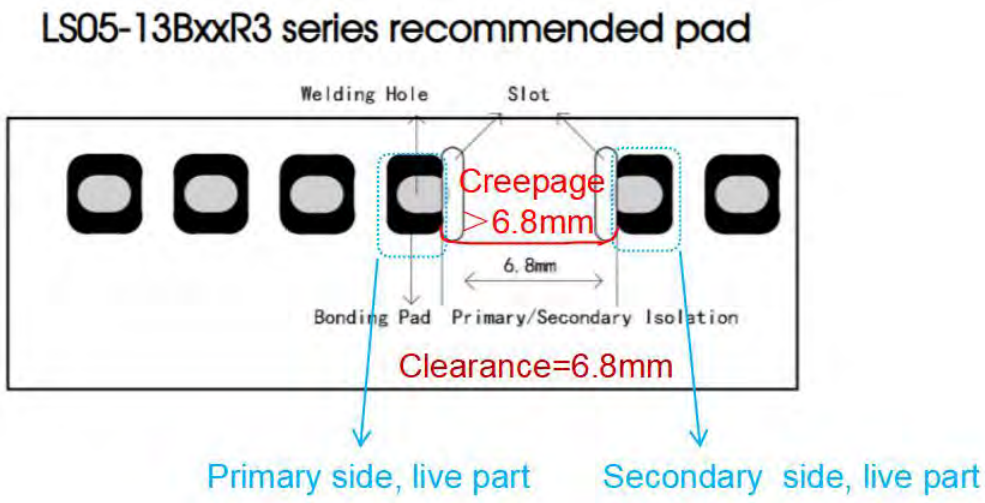
conductive part and the equipment protection interface. That is, the shortest distance of insulation can be achieved through air while ensuring the stability and safety of electrical performance.

Take LS series as an example, the distance between the live part of the input side L line and the live part of the N line must be greater than or equal to the clearance distance required by the corresponding safety regulations. The distance between the input live part and the output live part should be greater than or equal to the clearance distance required by the corresponding safety regulations.

2）Creepage distance

Creepage distance refers to the distance between two conductive parts measured along the insulating surface. Under different usage conditions, the insulating material around the conductor is polarized, causing the insulating material to be charged. Because the creepage distance refers to the distance through the surface of an object, the creepage distance can generally be increased by means of slotting.

The understanding of creepage distance and electrical clearance can be seen in the recommended pad design in LS-R3 datasheet. Take LS05-13BxxR3 as an example. The following is the analysis of creepage distance and electrical clearance:



It can be seen from the figure that the electrical clearance refers to the shortest distance between the input terminal and the output terminal, and the creepage distance refers to the shortest distance from the primary terminal to the output terminal after bypassing the slotted hole.

The three standards referenced in LS peripheral design have requirements for creepage distance and electrical clearance as shown in the following table. The recommended distances in this table are for reference only. For details, please refer to the latest version of the standard for design.

Location	Standard	Creepage distance	Electrical clearance
Between L line and N line	IEC/EN61558	3mm	3mm
	IEC/EN60335	3mm	3mm
	IEC/EN/UL62368	3mm	3mm

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Between input and output	IEC/EN61558	6mm	5.5mm
	IEC/EN60335	6mm	6mm
	IEC/EN/UL62368	6mm	5mm

Note: The selection of this safety distance is based on the upper limit of the input voltage of 277VAC. If the input voltage is low, the PCB trace creepage distance and electrical clearance can be designed according to the requirements of various standards.

4. Recommended solutions and relevant data (BOM, PCB, Layout and test report)

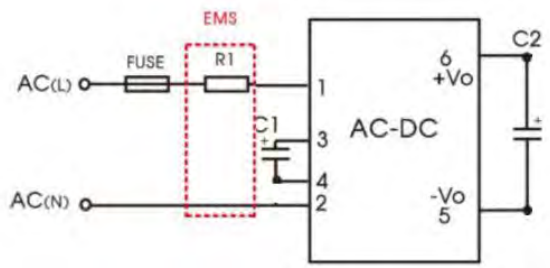
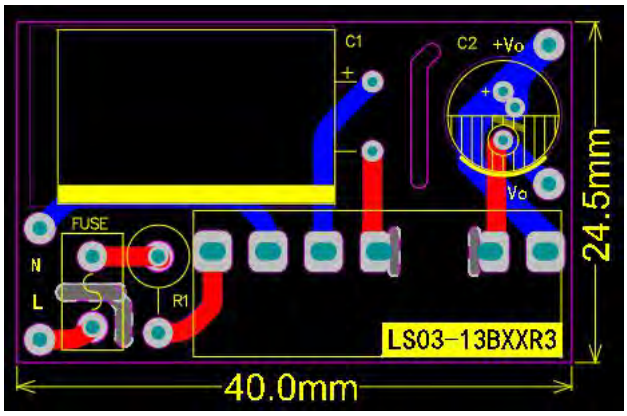
To facilitate the design of customers, MORNSUN integrated the design solutions according to the common EMC requirements. And take LS05-13B12R3 as an example for the component selection and testing. Customers can refer to it based on their requirement for the power supply.

4.1. LS03-13BxxR3 series uses 12VDC output as an example to recommend solutions and data packages

4.1.1. Minimization solution (Achieve normal output function)

This solution can achieve normal output of power supply module, but we do not promise other performance. This solution suitable for strict cost requirements, but no performance requirements application.

1）Design circuit and PCB layout are as follows:

Recommended circuit	PCB layout (L*W*H: 40mm*24.5mm*17mm)
	
Recommended circuit	**PCB layout (L*W*H32.8mm*24.5mm*23.mm)**

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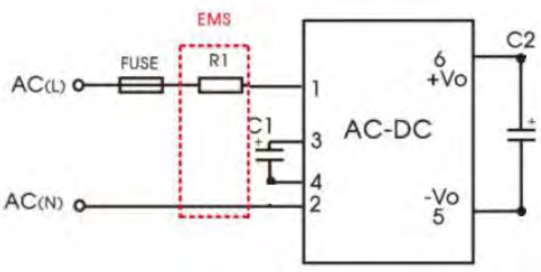

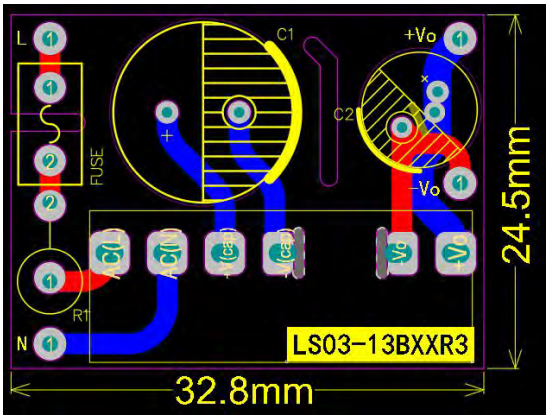

Notes: There are two kinds of PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited.

2) BOM

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	36911000000
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
C1	Input filter capacitor	22uF/450V/Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
C2	Output filter capacitor	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1

Notes: there are three component combinations above for reference.

3) Test report

General performance test (Test part number: LS03-13B12R3)				
NO.	Test item	Test conditions	Specification	Test result
1	No load power consumption	I/P: 230 VAC O/P: Min LOAD Ta: 25℃	≤0.15W	0.098W
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±5%	1.5%
3	Output voltage tolerance	I/P: 85 to 305VAC	±1.5%	0.24%

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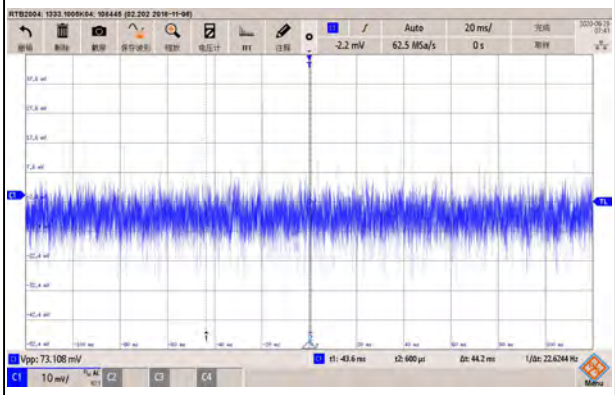
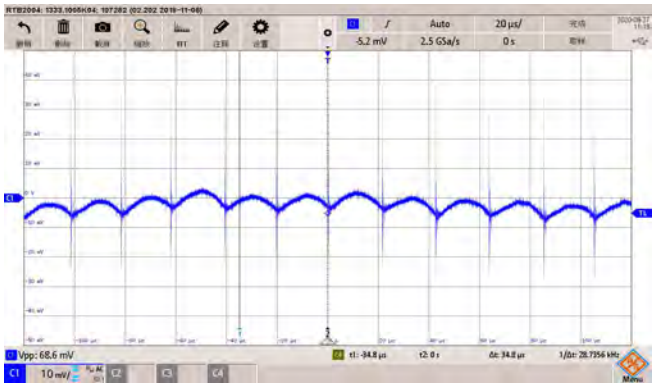
		O/P: 100%Io Ta: 25℃		
4	Load regulation	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±3%	0.91%
5	Efficiency (Typ.)	I/P: 230VAC O/P: 100%Io Ta: 25℃	79%	79.03%
6	Ripple & Noise (Max)	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	150mV	73.10mV
	Low frequency:		High frequency:	
				

Protection function test (Test part number: LS03-13B12R3)				
NO.	**Test item**	**Test conditions**	**Specification**	**Test result**
1	Over-current Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	≥110%Io	160.4%Io/ 85VAC 170.8% Io / 230VAC 180.4% Io /305VAC Hiccup mode: recovers automatically after fault condition is removed
2	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	Short circuit lasts for a period is available	No damage after one-hour short circuit Protection mode: output hiccup, self-recoverable

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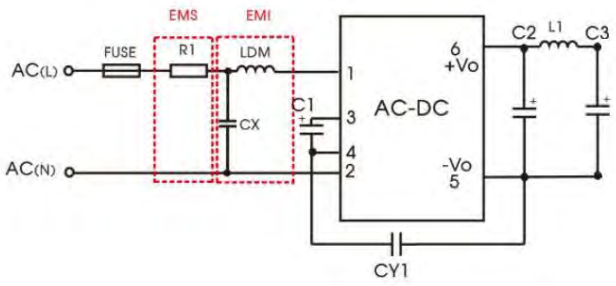
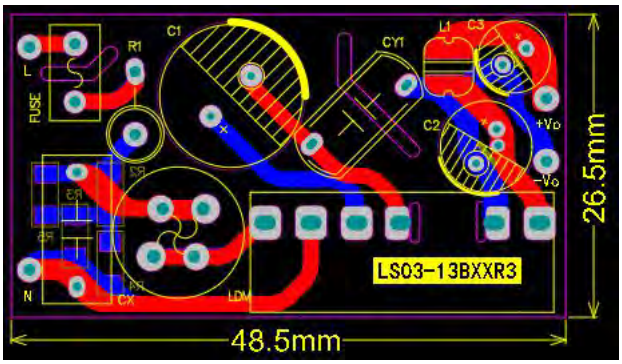
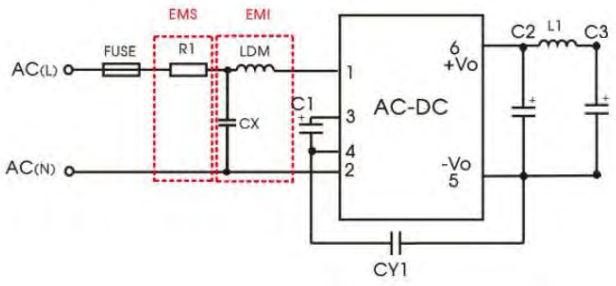
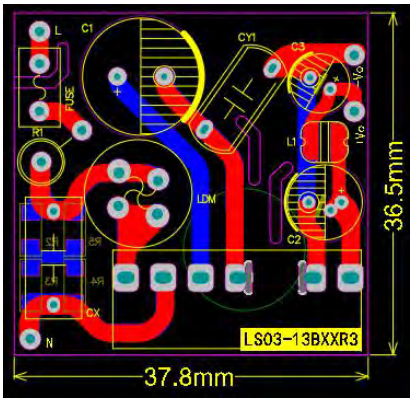
Safety test (Test part number: LS03-13B12R3)				
NO.	**Test item**	**Test conditions**	**Specification**	**Test result**
1	Withstand voltage	I/P-O/P: last for 1 min leakage current＜5mA	≥3KVAC	3.3KV ok, leakage current = 0.78mA
2	Isolation resistance	I/P-O/P: 500VDC	＞100MΩ	OK

4.1.2. EMS (EFT: ±2KV, Surge: line to line ±1KV) and EMI (Class B)

This solution can meet all the performance in the datasheet, as well as EMS (EFT: ±2KV, Surge: line to line ±1KV) and EMI (Class B).

1）Design circuit and PCB layout are as follows:

Recommended circuit	PCB layout (L*W*H: 48.5mm*26.5mm*23mm)
	
Recommended circuit	**PCB layout (L*W*H: 37.8mm*36.5mm*23mm)**
	
Recommended circuit	**PCB layout (L*W*H: 44.0mm*32.4mm*23mm)**

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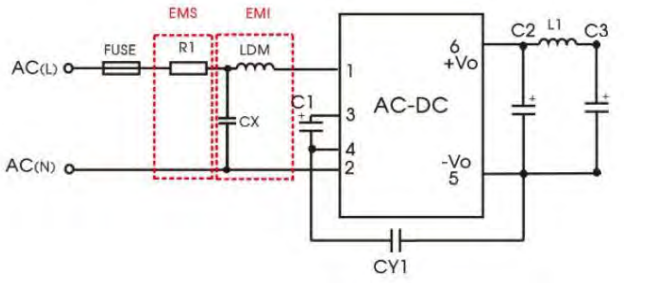

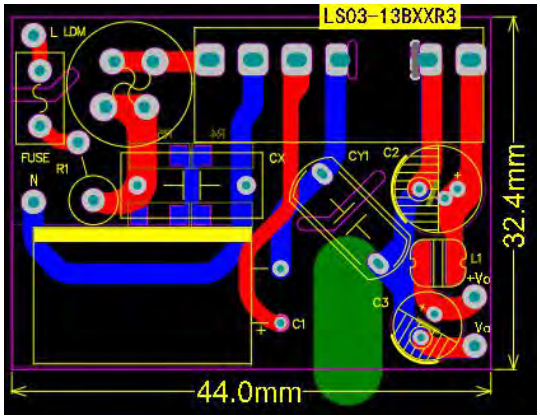

Note: There are three kinds of PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2) BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	80711000000
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
CX	Class-X Capacitor	0.1uF/310VAC	Faratronic	C42Q2104K4SA405	HJC	MKP-104K0305AT1108-PV	TDK	B32671Z6104
LDM	Input inductor	1.2mH/0.2A	Codaca Electronic	PK0608-122K	Wurth	768772122	Bourns	RLB9012-122KL
C1	Input filter capacitor	22uF/450V/Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102M	Walsin	YU1AH102M070BASDAH	TDK	CD85-E2GA102MYASA
C2	Output filter capacitor	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1
L1	Output inductor	4.7uH/2.2A	Hua Chen	HCCD0403T-4R7M	Chilisin	BPSD000504324R7	Bourns	SDE0403A-4R7M
C3	Output filter capacitor	47uF/35V	SAMXON	ESK476M1VD11TUSRP	Nichicon	UHV1V470MDD	Rubycon	35ZLH47MHFCT15X11

3) Test report

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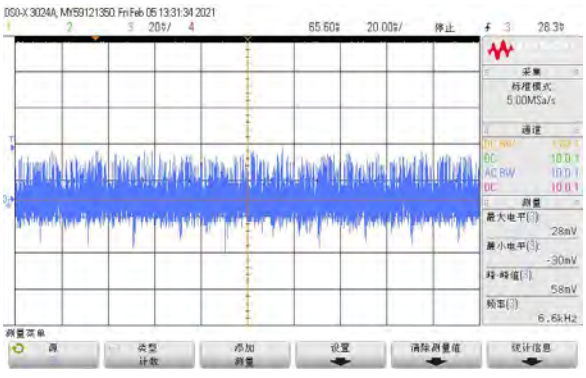
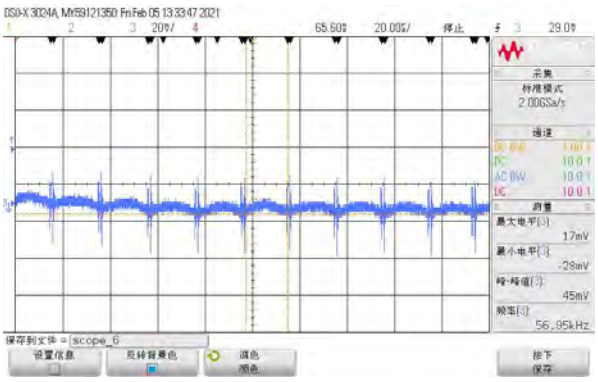
General performance test (Test part number: LS03-13B12R3)				
NO.	**Test item**	**Test conditions**	**Specification**	**Test result**
1	No load power consumption	I/P: 230 VAC O/P: No Load Ta: 25℃	≤0.15W	0.104W
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±5%	1.08%
3	Output voltage tolerance	I/P: 85 to 305VAC O/P: 100%Io Ta: 25℃	±1.5%	0.50%
4	Load regulation	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±3%	1.08%
5	Efficiency (Typ.)	I/P: 230VAC O/P: 100%Io Ta: 25℃	77%	78.292%
6	Ripple & Noise (Max)	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	150mV	58mV
	Low frequency:		High frequency:	
				

Protection function test (Test part number: LS03-13B12R3)				
NO.	**Test item**	**Test conditions**	**Specification**	**Test result**
1	Over-current Protection	I/P: 85VAC I/P: 230VAC	≥110%Io	160.4%Io/ 85VAC 170.8% Io / 230VAC

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		I/P: 305VAC Ta:25℃		180.4% Io /305VAC Hiccup mode: recovers automatically after fault condition is removed
2	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	Short circuit lasts for a period is available	No damage after one-hour short circuit Protection mode: output hiccup, self-recoverable

Safety test (Test part number: LS03-13B12R3)				
NO.	**Test item**	**Test conditions**	**Specification**	**Test result**
1	Withstand voltage	I/P-O/P: last for 1 min leakage current＜5mA	≥3KVAC	3.3KVAC ok, Leakage current 0.78mA
2	Isolation resistance	I/P-O/P: 500VDC	＞100MΩ	OK

EMC test (Test part number: LS03-13B12R3)				
NO.	**Test item**	**Test conditions**	**Specification**	**Test result**
1	Surge	I/P: 230 VAC O/P: 100%Io Ta: 25℃	IEC/EN61000-4-5 line to line ±1KV	PASS
2	EFT	I/P: 230 VAC O/P: 100%Io Ta: 25℃	IEC/EN61000-4-4 ±2KV	PASS
3	ESD	I/P: 230 VAC O/P: 100%Io Ta: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CONDUCTION	I/P: 115/230 VAC O/P: 100%Io Ta: 25℃	CISPR32/EN55032 CLASS B	PASS

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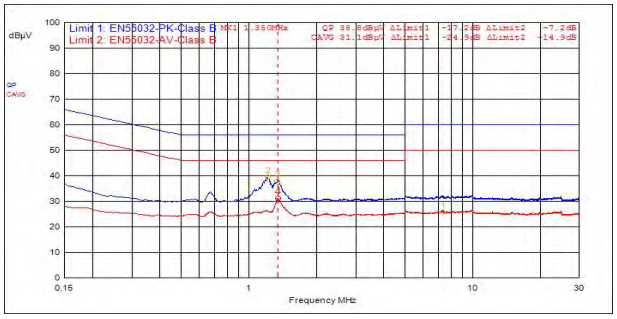
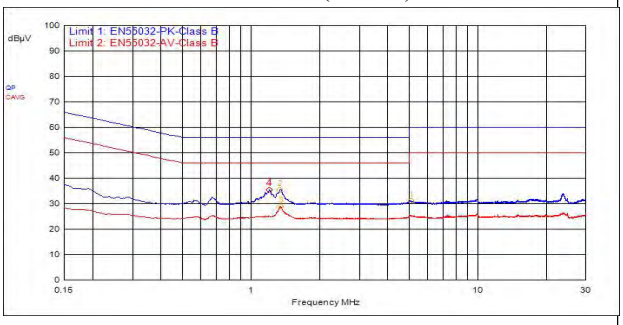
115VAC (L Line)



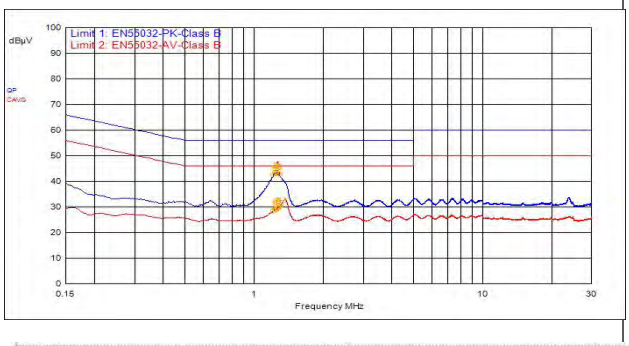
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
4	1.347MHz	0.3	0.2	10.0	C_AVG	20.6	31.1	46.0	-14.9
2	1.212MHz	0.3	0.2	10.0	QPeak	28.8	39.3	56.0	-16.7
3	1.341MHz	0.3	0.2	10.0	QPeak	27.5	38.1	56.0	-17.9
1	7.368MHz	0.6	0.2	10.0	C_AVG	14.9	25.8	50.0	-24.2

115VAC (N Line)



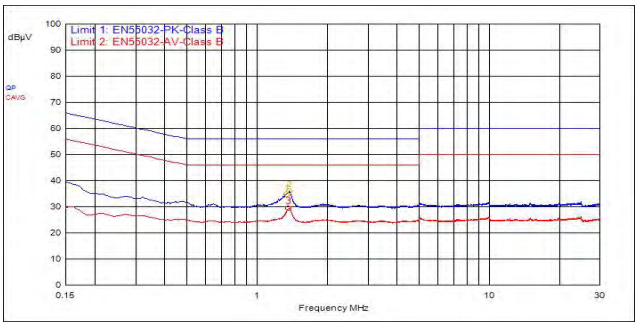
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.350MHz	0.3	0.2	10.0	C_AVG	18.3	28.8	46.0	-17.2
2	1.341MHz	0.3	0.2	10.0	QPeak	24.8	35.3	56.0	-20.7
4	1.206MHz	0.3	0.2	10.0	QPeak	24.8	35.3	56.0	-20.7
1	5.064MHz	0.5	0.2	10.0	QPeak	20.4	31.1	60.0	-28.9

230VAC (L Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	1.263MHz	0.3	0.2	10.0	QPeak	32.9	43.5	56.0	-12.5
2	1.239MHz	0.3	0.2	10.0	QPeak	32.8	43.3	56.0	-12.7
3	1.275MHz	0.3	0.2	10.0	QPeak	32.6	43.1	56.0	-12.9
4	1.251MHz	0.3	0.2	10.0	QPeak	32.5	43.0	56.0	-13.0

230VAC (N Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.368MHz	0.3	0.2	10.0	C_AVG	18.7	29.3	46.0	-16.7
2	1.374MHz	0.3	0.2	10.0	QPeak	25.4	35.9	56.0	-20.1
1	1.335MHz	0.3	0.2	10.0	QPeak	24.3	34.8	56.0	-21.2

5	RADIATION	I/P: 115/230 VAC O/P: 100%Io Ta: 25℃	CISPR32/EN55032 CLASS B	PASS

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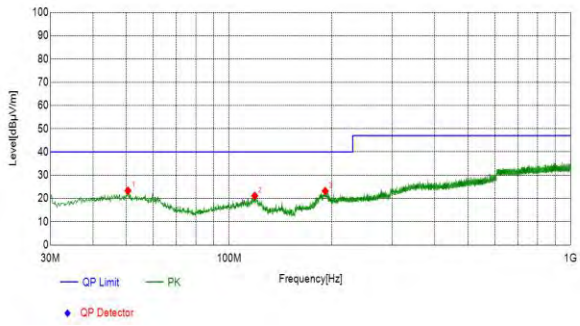
115VAC

(Horizontal)

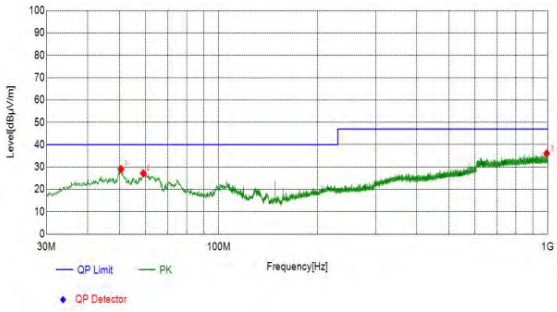


Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.5661	Horizontal	15.52	7.79	23.31	40.00	16.69	PK	100	189	PASS
118.8609	Horizontal	11.74	9.41	21.15	40.00	18.85	PK	100	5	PASS
191.1331	Horizontal	12.17	11.03	23.20	40.00	16.80	PK	100	1	PASS

115VAC

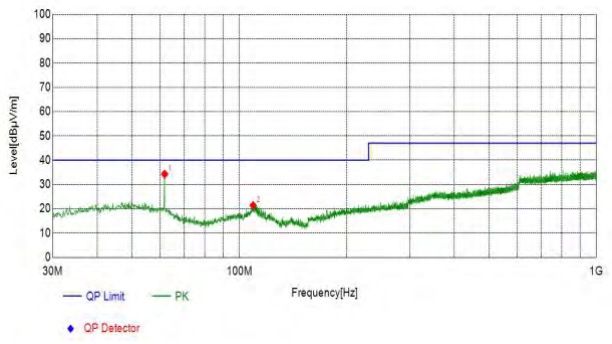
(Vertical)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	13.54	29.08	40.00	10.92	PK	100	348	PASS
59.0059	Vertical	13.90	13.31	27.21	40.00	12.79	PK	100	21	PASS
991.4631	Vertical	26.87	9.20	36.07	47.00	10.93	PK	100	339	PASS

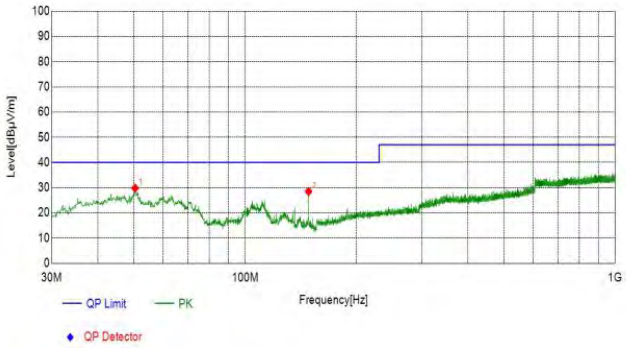
230VAC (Horizontal)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
61.7222	Horizontal	13.02	21.24	34.26	40.00	5.74	PK	100	25	PASS
109.2569	Horizontal	13.22	8.16	21.38	40.00	18.62	PK	100	0	PASS

230VAC (Vertical)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.3720	Vertical	15.56	14.26	29.82	40.00	10.18	PK	100	60	PASS
148.3518	Vertical	9.52	18.98	28.50	40.00	11.50	PK	100	40	PASS

4.1.3. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A)

This solution can meet all the performance in the datasheet, as well as EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A).

1）Design circuit and PCB layout are as follows:

Recommended circuit	PCB layout (L*W*H: 48.5mm*26.5mm*17mm)

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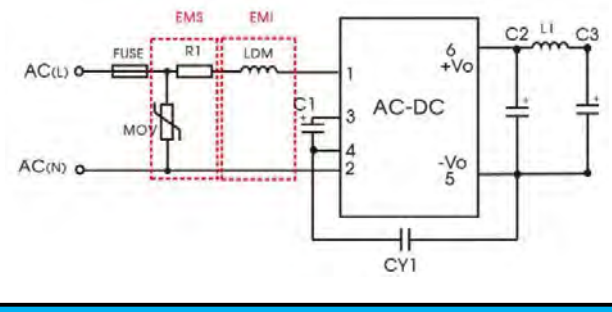
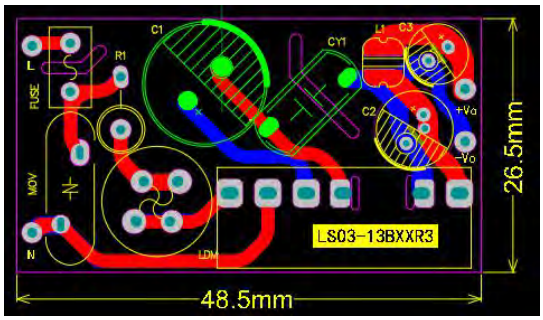
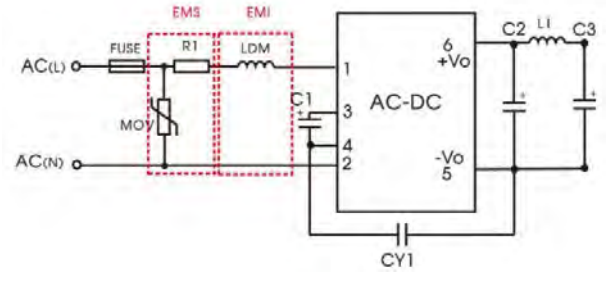
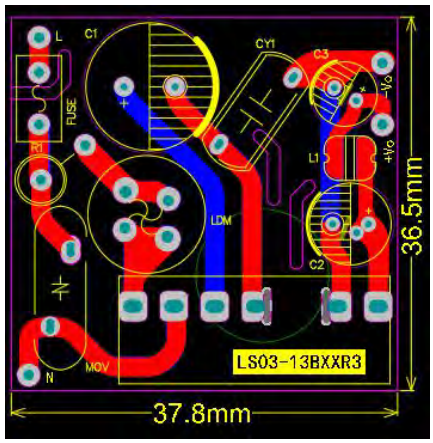
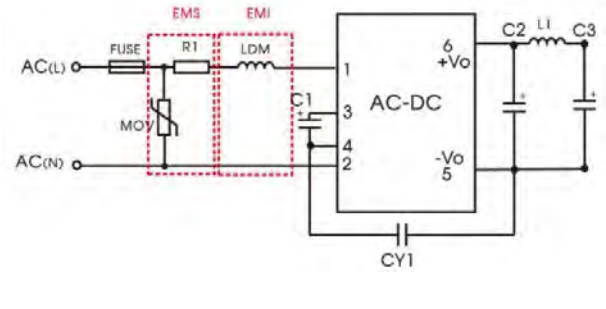
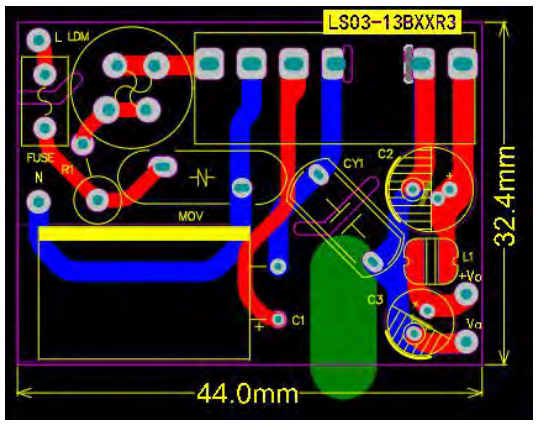
	
Recommended circuit	**PCB layout (L*W*H: 37.8mm*36.5mm*23mm)**
	
Recommended circuit	**PCB layout (L*W*H: 44.0mm*32.4mm*23mm)**
	

Note: There are three kinds of PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2）BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	2A/300VAC	Better	9321200301	Conquer	MST-2A-300V	Littelfuse	36912000000

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MOV	VARISTOR	S14K350	XINFUTE	DNR S14K350	Thinking	TVR14561	TDK	B72214S0351K101
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
LDM	input inductor	1.2mH/0.2A	Codaca Electronic	PK0608-122K	Wurth	768772122	Bourns	RLB9012-122KL
C1	Input filter capacitor	22uF/450V/Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102M	Walsin	YU1AH102M070BASD	TDK	CD85-E2GA102MYASA
C2	Output filter capacitor	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1
L1	Output inductor	4.7uH/2.2A	Hua Chen	HCCD0403T-4R7M	Chilisin	BPSD000504324R7	Bourns	SDE0403A-4R7M
C3	Output filter capacitor	47uF/35V	SAMXON	ESK476M1VD11TUSRP	Nichicon	UHV1V470MDD	Rubycon	35ZLH47MHFCT15X11

3）Test Report:

General performance test (Test part number: LS03-13B12R3)				
NO.	**Test item**	**Test conditions**	**Specification**	**Test result**
1	No load power consumption	I/P: 230VAC O/P: No load Ta: 25℃	≤0.15W	0.107W
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±5%	1.21%
3	Output voltage tolerance	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±1.5%	0.62%
4	Load regulation	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±3%	1.09%
5	Efficiency (Typ.)	I/P: 230VAC O/P: 100%Io	77%	78.45%

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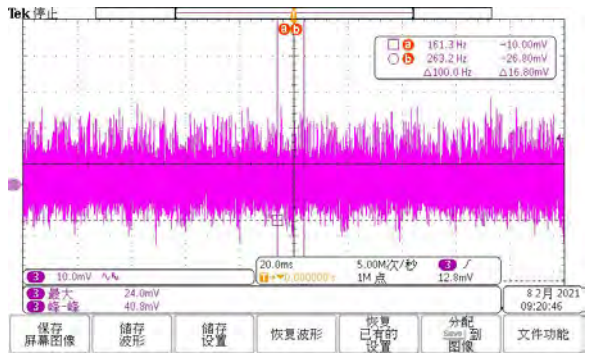
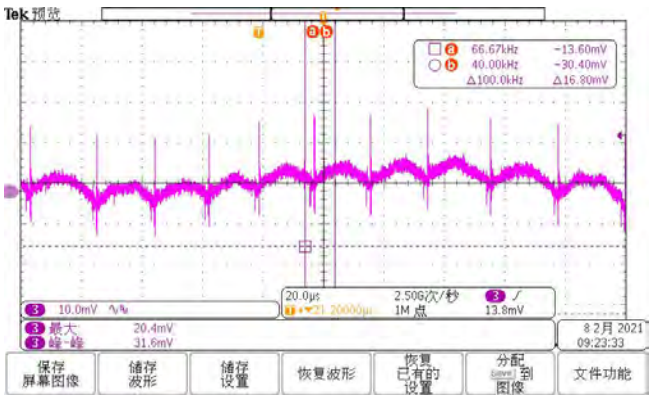
		Ta: 25℃		
6	Ripple & Noise (Max)	I/P: 85 to 305VAC O/P: 100%Io Ta: 25℃	150mV	40.8mV
	Low frequency:		High frequency:	
				

Protection function test (Test part number: LS03-13B12R3)

NO.	Test item	Test conditions	Specification	Test result
1	Over-current Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	≥110%Io	162%Io/85VAC 172.4% Io/230VAC 181.6% Io/305VAC Hiccup mode: recovers automatically after fault condition is removed
2	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	Short circuit lasts for a period is available	No damage after one-hour short circuit Protection mode: output hiccup, self-recoverable

Safety test (Test part number: LS03-13B12R3)

NO.	Test item	Test conditions	Specification	Test result
1	Withstand voltage	I/P-O/P: last for 1 min leakage current＜5mA	≥3KVAC	3.3KVAC ok, Leakage current 0.812mA
2	Isolation resistance	I/P-O/P: 500VDC	＞100MΩ	OK

EMC test (Test part number: LS03-13B12R3)

NO.	Test item	Test conditions	Specification	Test result

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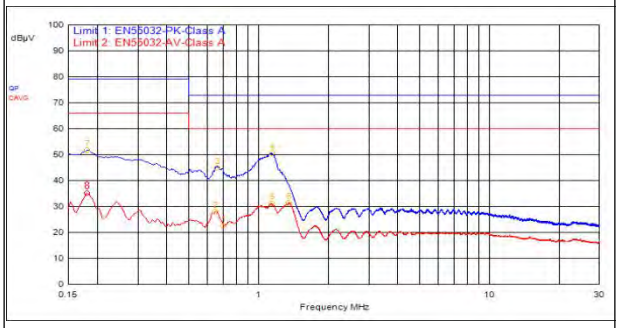
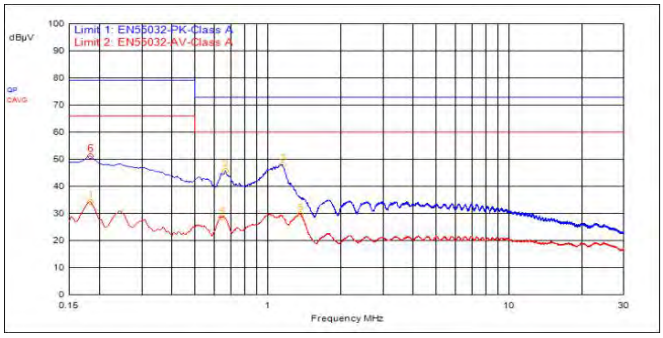
1	Surge	I/P: 230 VAC/50HZ O/P: FULL LOAD Ta: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS
2	EFT	I/P: 230 VAC/50HZ O/P: FULL LOAD Ta: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	I/P: 230 VAC/50HZ O/P: FULL LOAD Ta: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CONDUCTION	I/P: 115/230 VAC@50HZ O/P: FULL LOAD Ta: 25℃	CISPR32/EN55032 CLASS A	PASS

115VAC (L Line)



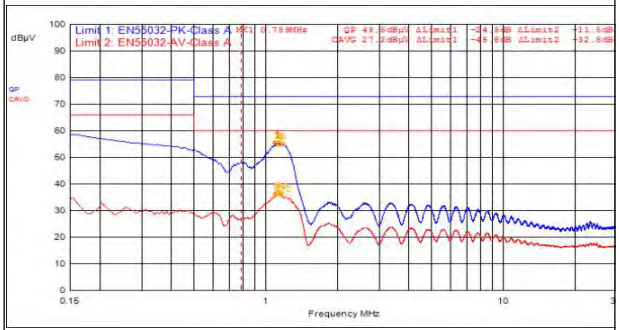
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dis
4	1.143MHz	0.3	0.2	10.0	QPeak	40.1	50.6	73.0	-22.4
7	180.000kHz	0.2	0.2	10.0	QPeak	41.3	51.6	79.0	-27.4
3	660.000kHz	0.2	0.2	10.0	QPeak	34.6	45.0	73.0	-28.0
6	1.347MHz	0.3	0.2	10.0	C_AVG	20.8	31.3	60.0	-28.7
5	1.143MHz	0.3	0.2	10.0	C_AVG	20.5	31.0	60.0	-29.0
8	180.000kHz	0.2	0.2	10.0	C_AVG	24.7	35.1	66.0	-30.9
2	651.000kHz	0.2	0.2	10.0	C_AVG	17.7	28.1	60.0	-31.9
1	705.000kHz	0.2	0.2	10.0	C_AVG	12.1	22.5	60.0	-37.5

115VAC (N Line)



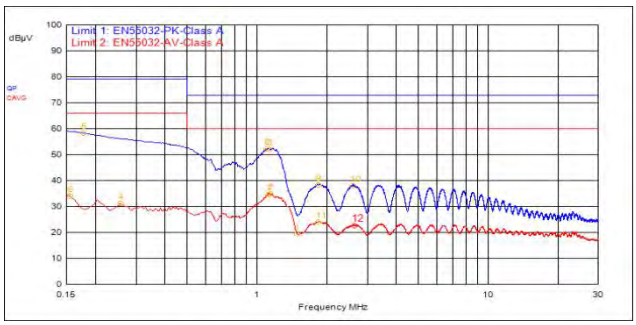
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.149MHz	0.3	0.2	10.0	QPeak	37.5	48.1	73.0	-24.9
2	666.000kHz	0.2	0.2	10.0	QPeak	35.1	45.6	73.0	-27.4
6	183.000kHz	0.2	0.2	10.0	QPeak	40.8	51.1	79.0	-27.9
5	1.362MHz	0.3	0.2	10.0	C_AVG	19.2	29.8	60.0	-30.2
4	642.000kHz	0.2	0.2	10.0	C_AVG	18.2	28.6	60.0	-31.4
1	183.000kHz	0.2	0.2	10.0	C_AVG	23.9	34.2	66.0	-31.8

230VAC (L Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	1.116MHz	0.3	0.2	10.0	QPeak	45.0	55.5	73.0	-17.5
2	1.137MHz	0.3	0.2	10.0	QPeak	44.8	55.3	73.0	-17.7
3	1.107MHz	0.3	0.2	10.0	QPeak	44.8	55.3	73.0	-17.7
4	1.128MHz	0.3	0.2	10.0	QPeak	44.6	55.1	73.0	-17.9
5	1.158MHz	0.3	0.2	10.0	QPeak	44.5	55.0	73.0	-18.0
6	1.185MHz	0.3	0.2	10.0	QPeak	44.4	54.9	73.0	-18.1
8	1.137MHz	0.3	0.2	10.0	C_AVG	26.4	36.9	60.0	-23.1

230VAC (N Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
8	1.101MHz	0.3	0.2	10.0	QPeak	41.8	52.3	73.0	-20.7
5	177.000kHz	0.2	0.2	10.0	QPeak	47.9	58.2	79.0	-20.8
3	1.137MHz	0.3	0.2	10.0	QPeak	41.6	52.1	73.0	-20.9
2	1.143MHz	0.3	0.2	10.0	C_AVG	24.3	34.8	60.0	-25.2
7	1.119MHz	0.3	0.2	10.0	C_AVG	24.2	34.7	60.0	-25.3
6	156.000kHz	0.1	0.2	10.0	C_AVG	23.7	34.0	66.0	-32.0
9	1.848MHz	0.3	0.2	10.0	QPeak	27.7	38.2	73.0	-34.8

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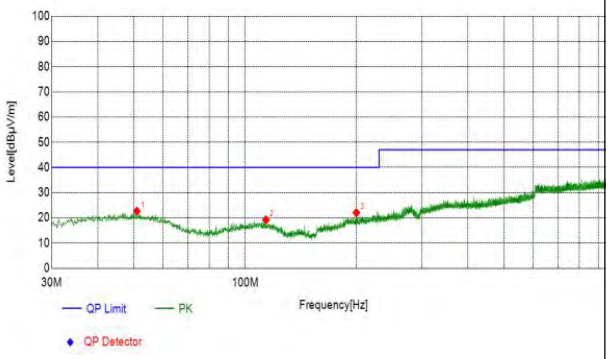
5	RADIATION	I/P: 115/230 VAC@50HZ O/P: FULL LOAD Ta: 25℃	CISPR32/EN55032 CLASS A	PASS

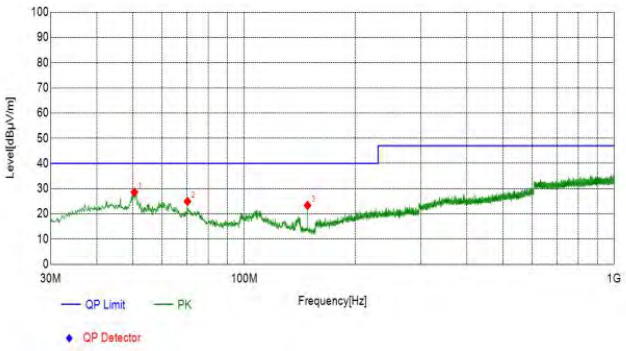
115VAC(horizontal)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.9541	Horizontal	15.45	7.19	22.64	40.00	17.36	PK	100	151	PASS
113.8164	Horizontal	12.62	6.58	19.20	40.00	20.80	PK	100	141	PASS
199.6700	Horizontal	12.48	9.58	22.06	40.00	17.94	PK	100	1	PASS

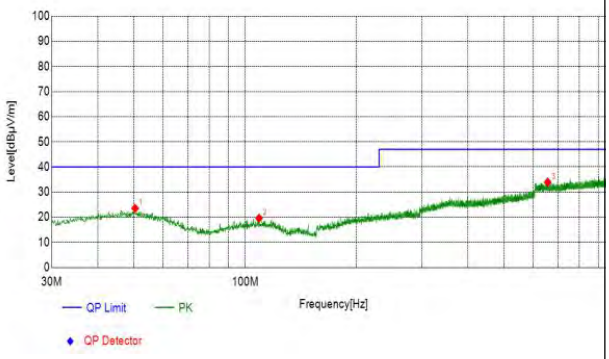
115VAC (vertical)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	13.04	28.58	40.00	11.42	PK	100	359	PASS
70.2590	Vertical	9.68	15.27	24.95	40.00	15.05	PK	100	357	PASS
148.3518	Vertical	9.52	13.83	23.35	40.00	16.65	PK	100	81	PASS

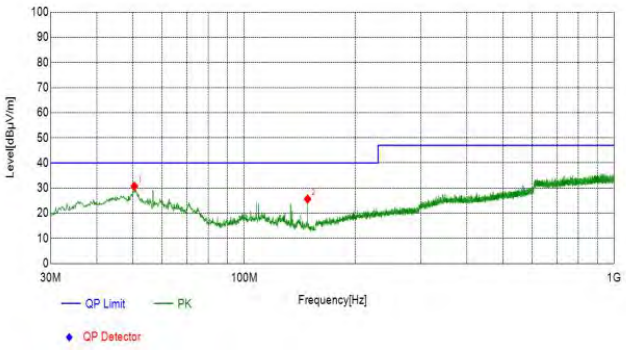
230VAC(horizontal)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.3720	Horizontal	15.56	7.98	23.54	40.00	16.46	PK	100	279	PASS
108.9659	Horizontal	13.20	6.39	19.59	40.00	20.41	PK	100	21	PASS
656.7797	Horizontal	23.03	10.94	33.97	47.00	13.03	PK	100	210	PASS

230VAC (vertical)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	15.23	30.77	40.00	9.23	PK	100	82	PASS
148.3518	Vertical	9.52	16.14	25.66	40.00	14.34	PK	100	228	PASS

4.1.4. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B)

This solution can meet all the performance in our datasheet, as well as EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B).

1）Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H: 55.0mm*25.3mm*17mm)

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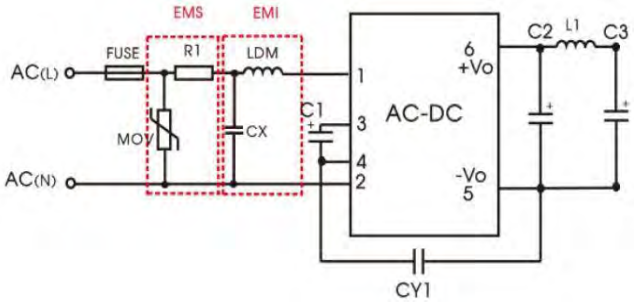
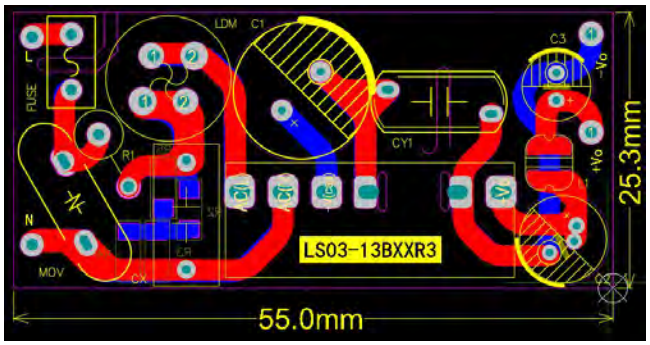
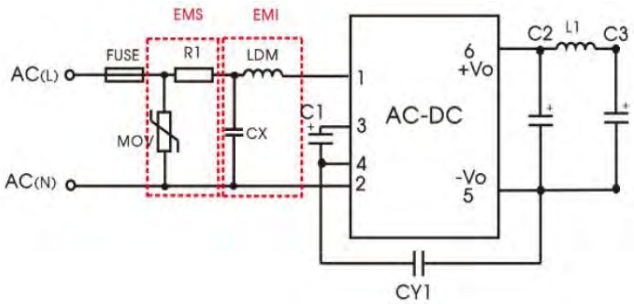
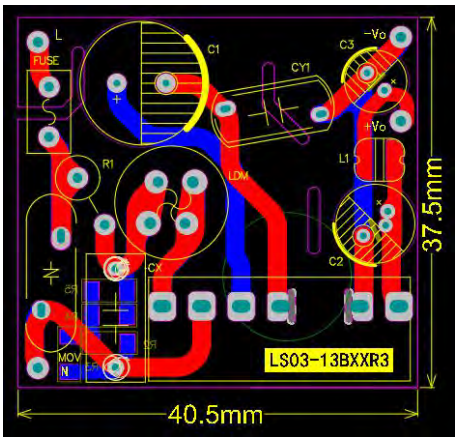


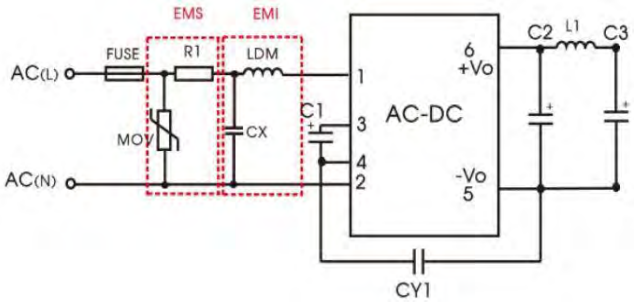


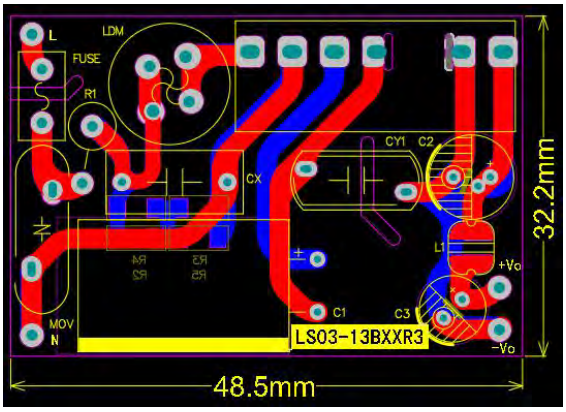
Recommend circuit	PCB layout(L*W*H: 40.5mm*37.5mm*23mm)





Recommend circuit	PCB layout(L*W*H: 48.5mm*32.2mm*23mm)





Note: There are three kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2）BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N

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FUSE	FUSE	2A/300VAC	Better	9321200301	Conquer	MST-2A-300V	Littelfuse	36912000000
MOV	VARISTOR	S14K350	XINFUTE	DNR S14K350	Thinking	TVR14561	TDK	B72214S0351K101
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
CX	Class-X Capacitor	0.1uF/310VAC	Faratronic	C42Q2104K4SA405	HJC	MKP-104K0305AT1108-PV	TDK	B32671Z6104
LDM	Input inductor	1.2mH/0.2A	Hua Chen	PK0608-122K	Wurth	768772122	Bourns	RLB9012-122KL
C1	Input filter capacitor	22uF/450V/Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Capxon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102M	walsin	YU1AH102M070BASDAH	TDK	CD85-E2GA102MYASA
C2	Output filter capacitor	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	Capxon	UPE1C271MNN6308	NCC	RS81C271MDN1
L1	Output inductor	4.7uH/2.2A	Hua Chen	HCCD0403T-4R7M	Chilisin	BPSD000504324R7	Bourns	SDE0403A-4R7M
C3	Output filter capacitor	47uF/35V	SAMXON	ESK476M1VD11TUSRP	Capxon	UHV1V470MDD	Rubycon	35ZLH47MHFCT15X11

3）Test report

General performance test(test module: LS03-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	NO LOAD POWER CONSUMPTION	I/P: 230 VAC O/P: Min LOAD Ta: 25℃	≤0.15W	0.101W
2	Output Voltage Accuracy	I/P: 85VAC to 305VAC O/P: Full to Min LOAD Ta:25℃	±5%	1.48%
3	OUTPUT VOLTAGE TOLERANCE	I/P: 85VAC to 305VAC O/P: Full to Min LOAD Ta:25℃	±1.5%	0.34%
4	LOAD REGULATION	I/P: 85VAC to 305VAC O/P: Full to Min LOAD	±3%	0.87%

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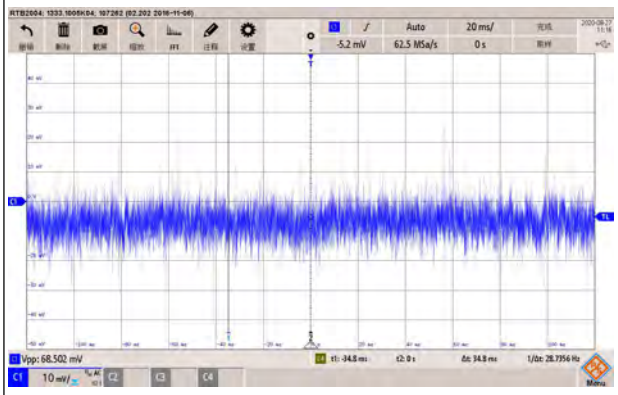
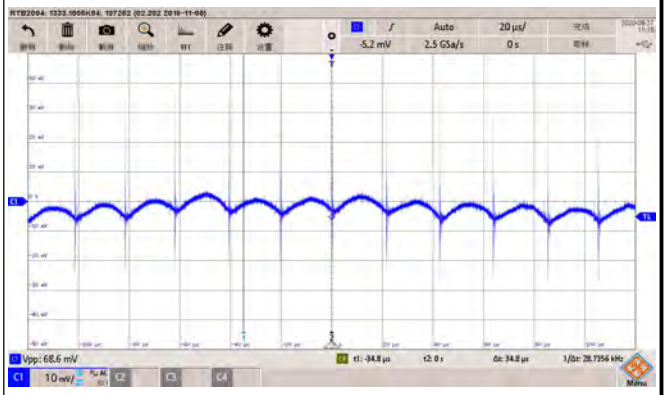
		Ta:25℃		
5	EFFICIENCY(Typ.)	I/P: 230 VAC O/P: Full LOAD Ta: 25℃	77%	78.03%
6	RIPPLE & NOISE(Max)	I/P: 85VAC to 305VAC O/P: Full LOAD Ta:25℃	150mV	68.50mV
	low frequency:		high frequency:	
				

Protection function test(test module: LS03-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATIO N	RESULT
1	Over-current Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta: 25℃	≥110%Io	158%Io/85VAC 171.2% Io/230VAC 182.4% Io/305VAC Hiccup mode, recovers automatically after fault condition is remove
2	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta: 25℃	Short output 1 hour no damage	No damage Hiccup mode, recovers automatically after fault condition is removed

Safety test (test module: LS03-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	WITHSTAND VOLTAGE	I/P-O/P: 3KVAC/min leakage current＜5mA	≥3KVAC	3.3KV ok, leakage current:0.86mA

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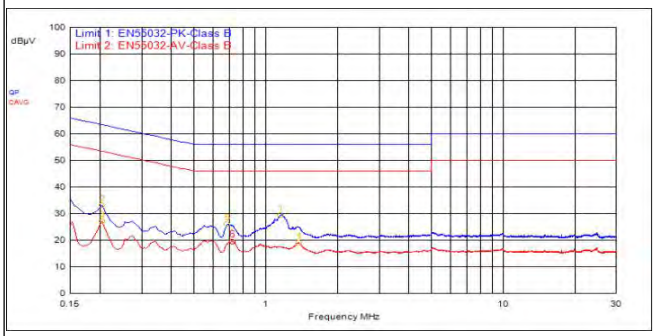
2	ISOLATION RESISTANCE	I/P-O/P: 500VDC	＞100MΩ	Ok

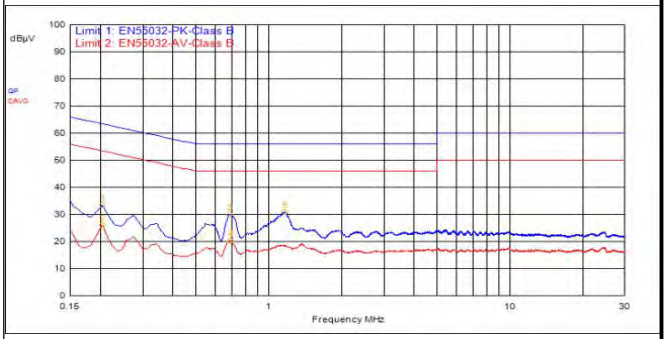
EMC test (test module: LS03-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	Surge	I/P: 230 VAC/50HZ O/P: FULL LOAD Ta: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS
2	EFT	I/P: 230 VAC/50HZ O/P: FULL LOAD Ta: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	I/P: 230 VAC/50HZ O/P: FULL LOAD Ta: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CONDUCTION	I/P: 115/230 VAC/50HZ O/P: FULL LOAD Ta: 25℃	CISPR32/EN55032 CLASS B	PASS

115VAC (L Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	204.000kHz	0.2	0.2	10.0	C_AVG	16.8	27.2	53.4	-26.3
1	1.158MHz	0.3	0.2	10.0	QPeak	19.0	29.5	56.0	-26.5
6	720.000kHz	0.2	0.2	10.0	C_AVG	9.0	19.5	46.0	-26.5
4	1.377MHz	0.3	0.2	10.0	C_AVG	8.6	19.1	46.0	-26.9
5	687.000kHz	0.2	0.2	10.0	QPeak	15.4	25.9	56.0	-30.1
2	204.000kHz	0.2	0.2	10.0	QPeak	22.7	33.1	63.4	-30.4

115VAC (N Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
5	1.164MHz	0.3	0.2	10.0	QPeak	20.4	30.9	56.0	-25.1
4	690.000kHz	0.2	0.2	10.0	C_AVG	9.8	20.2	46.0	-25.8
3	684.000kHz	0.2	0.2	10.0	QPeak	19.5	29.9	56.0	-26.1
2	204.000kHz	0.2	0.2	10.0	C_AVG	15.7	26.1	53.4	-27.4
1	204.000kHz	0.2	0.2	10.0	QPeak	22.9	33.3	63.4	-30.1

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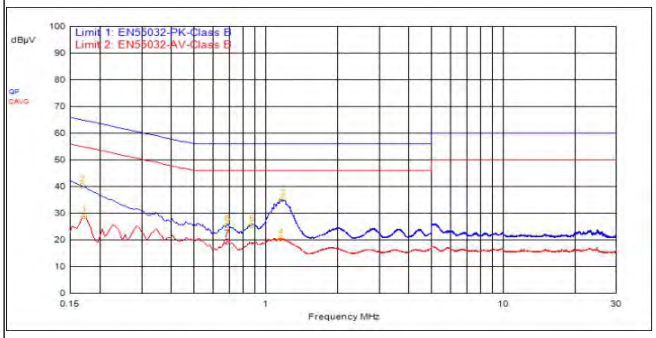
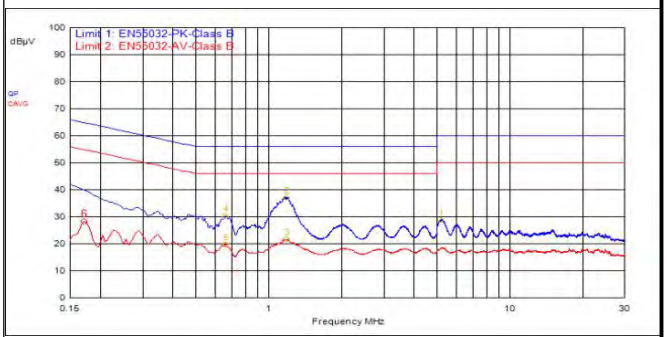
230VAC(L Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.179MHz	0.3	0.2	10.0	QPeak	24.7	35.2	56.0	-20.8
2	168.000kHz	0.1	0.2	10.0	QPeak	29.9	40.2	65.1	-24.8
4	1.155MHz	0.3	0.2	10.0	C_AVG	10.1	20.6	46.0	-25.4
1	171.000kHz	0.1	0.2	10.0	C_AVG	18.4	28.8	54.9	-26.2
7	687.000kHz	0.2	0.2	10.0	C_AVG	8.9	19.3	46.0	-26.7
5	870.000kHz	0.3	0.2	10.0	QPeak	15.0	25.5	56.0	-30.5
6	684.000kHz	0.2	0.2	10.0	QPeak	15.1	25.5	56.0	-30.5

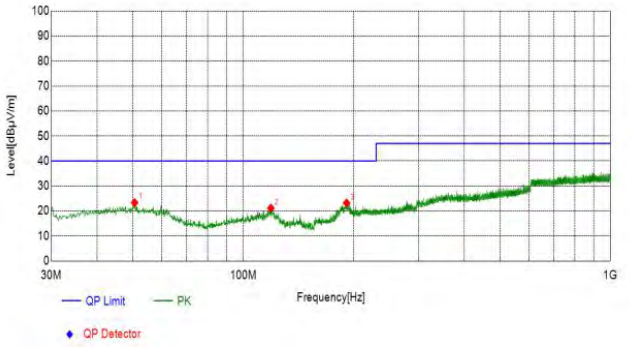
230VAC (N Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	1.182MHz	0.3	0.2	10.0	QPeak	26.7	37.2	56.0	-18.8
3	1.182MHz	0.3	0.2	10.0	C_AVG	11.1	21.6	46.0	-24.4
4	663.000kHz	0.2	0.2	10.0	QPeak	19.9	30.3	56.0	-25.7
5	660.000kHz	0.2	0.2	10.0	C_AVG	9.4	19.8	46.0	-26.2
6	171.000kHz	0.1	0.2	10.0	C_AVG	17.9	28.2	54.9	-26.7
1	5.181MHz	0.5	0.2	10.0	QPeak	18.1	28.8	60.0	-31.2

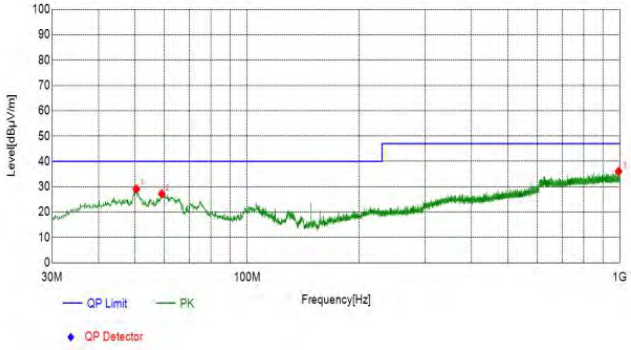
RADIATION	I/P: 115/230 VAC /50HZ O/P: FULL LOAD Ta: 25℃	CISPR32/EN55032 CLASS B	PASS

115VAC(horizontal)



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.5661	Horizontal	15.52	7.79	23.31	40.00	16.69	PK	100	189	PASS
118.8609	Horizontal	11.74	9.41	21.15	40.00	18.85	PK	100	5	PASS
191.1331	Horizontal	12.17	11.03	23.20	40.00	16.80	PK	100	1	PASS

115VAC(vertical)



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	13.54	29.08	40.00	10.92	PK	100	348	PASS
59.0059	Vertical	13.90	13.31	27.21	40.00	12.79	PK	100	21	PASS
991.4631	Vertical	26.87	9.20	36.07	47.00	10.93	PK	100	339	PASS

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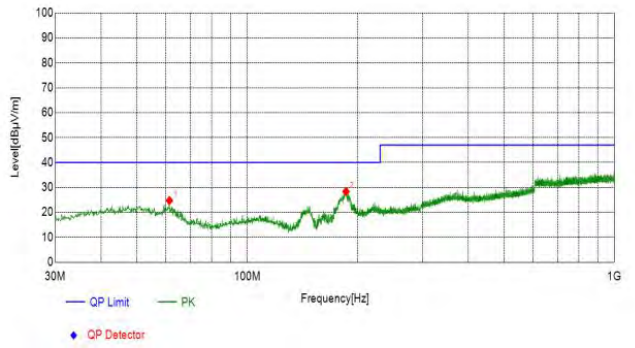
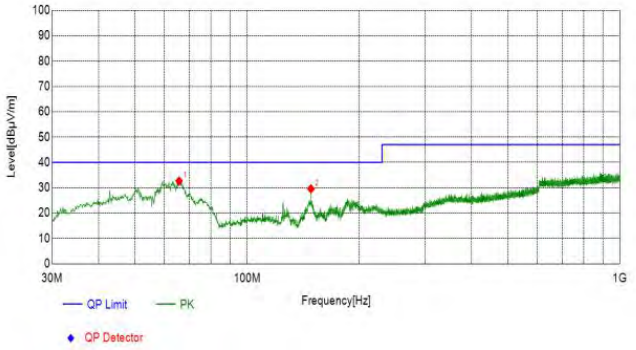
230VAC(horizontal)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
61.3341	Horizontal	13.18	11.60	24.78	40.00	15.22	PK	100	0	PASS
185.7006	Horizontal	11.63	16.75	28.38	40.00	11.62	PK	100	40	PASS

230VAC (vertical)



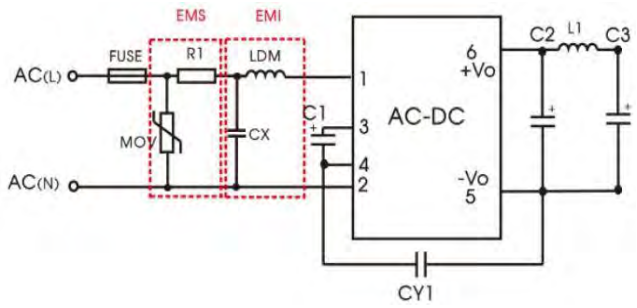
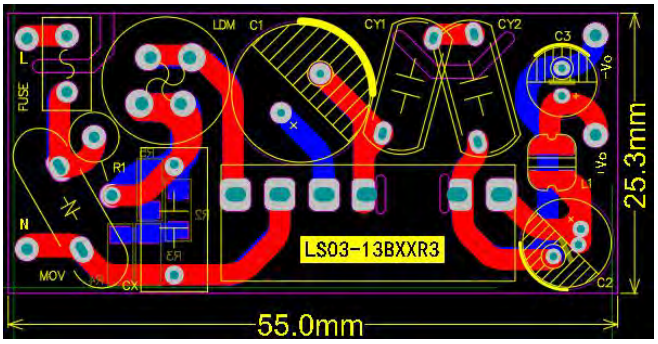
Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
65.6996	Vertical	11.43	21.22	32.65	40.00	7.35	PK	100	238	PASS
148.3518	Vertical	9.52	20.04	29.56	40.00	10.44	PK	100	40	PASS

4.1.5. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B) that meets EN60335

This solution can meet all the performance in our datasheet, as well as EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B).

1) Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H: 55.0mm*25.3mm*17mm)
	
Recommend circuit	**PCB layout(L*W*H: 40.5mm*37.5mm*23mm)**

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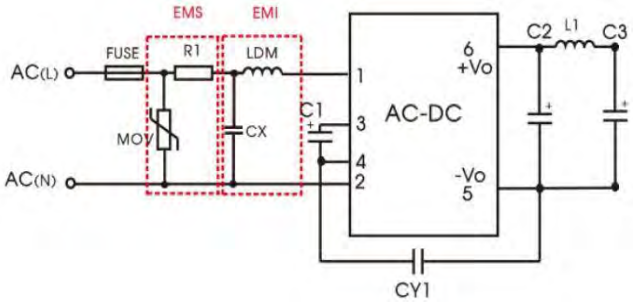
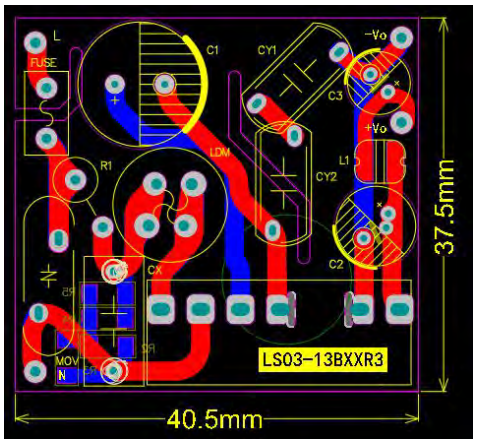
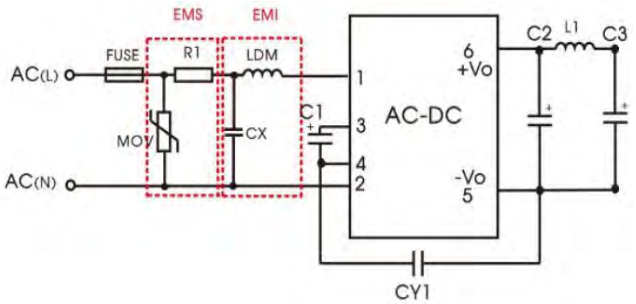
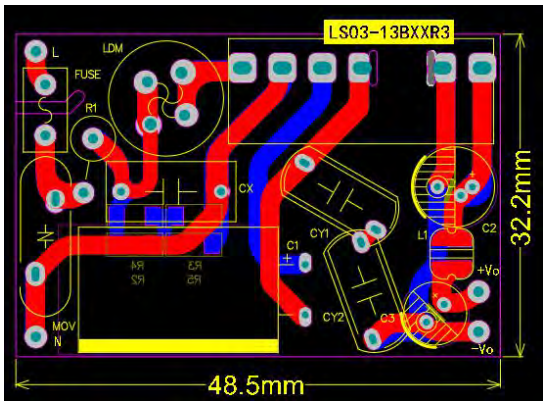




Recommend circuit	PCB layout(L*W*H: 48.5mm*32.2mm*23mm)





Note: There are three kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2) BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
CY1/CY2	Class-Y Capacitor	1nF/ 250VAC	Wmec	HME102 M	Walsin	YU1AC10 2M060	TDK	CS80-E2G A102MY

Note: The only difference between two Class-Y Capacitor and one Class-Y Capacitor in section 4.1.4 are material and PCB pin distance, test result is similar to one Class-Y Capacitor. **Hence refer to section 4.1.4 for other parameters and test content besides Class-Y Capacitor.**

4) Test report

Test report refer to section 4.1.4. The only difference between two Class-Y Capacitor and one Class-Y Capacitor in section 4.1.4 are material and PCB pin distance.

Note: It's fine to meet EMS (EFT: ±2KV, Surge: line to line ±1KV) for white goods standard base on EN60335, while our design is to meet EMS (EFT: ±4KV, Surge: line to line ±2KV) as customers are asking for higher level

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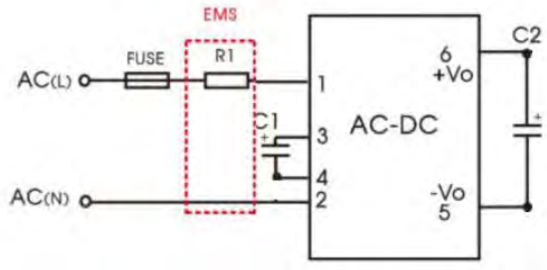
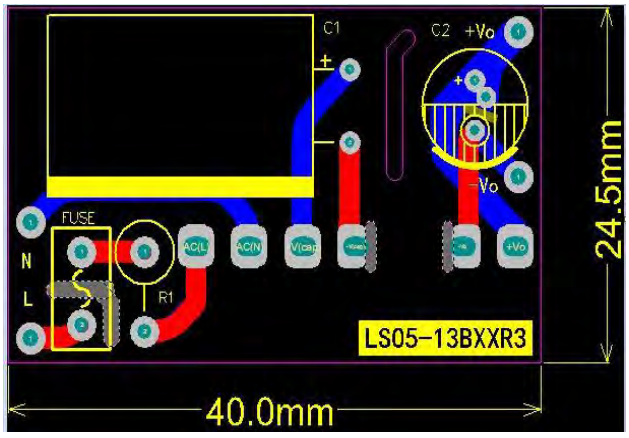
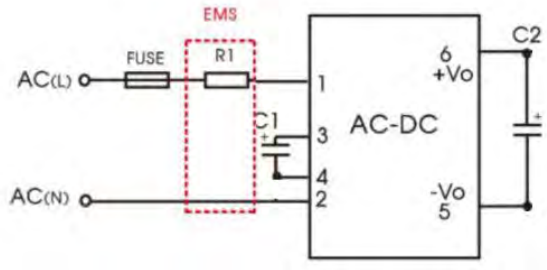
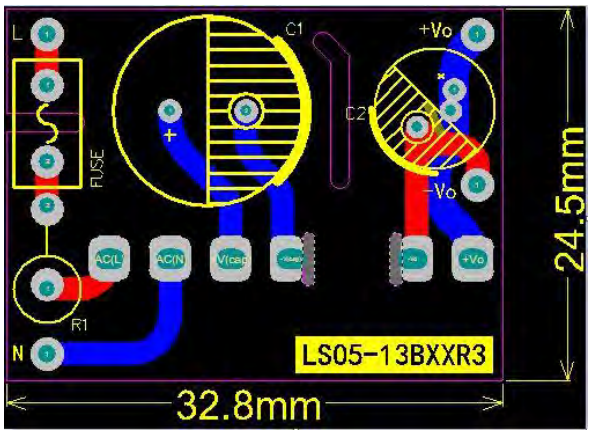
EMS performance. If only white goods standard needed, just remove the voltage dependent resistor (MOV).

4.2. LS05-13BxxR3 series uses 12VDC output as an example to recommend solutions and data packages

4.2.1. Minimization solution (Achieve normal output function)

This solution can achieve normal output of power supply module, but we do not promise other performance. This solution suitable for strict cost requirements, but no performance requirements application.

1) Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H: 40mm*24.5mm*17mm)
	
Recommend circuit	**PCB layout(L*W*H: 32.8mm*24.5mm*23.mm)**
	

Note: There are two kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited.

2) BOM:

Note: We recommend three device combinations, you can choose any one.

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PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	36911000000
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
C1	Input filter capacitor	22uF/450V/Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
C2	Output filter capacitor	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1

3) Test report

General performance test(test module: LS05-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	NO LOAD POWER CONSUMPTION	I/P: 230VAC O/P: No load Ta:25℃	≤0.15W	0.094w
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P:10%Io to 100%Io Ta:25℃	±5%	1.25%
3	VOLTAGE REGULATION	I/P: 85 to 305VAC O/P:10%Io to 100%Io Ta:25℃	±1.5%	0.08%
4	LOAD REGULATION	I/P: 85 to 305VAC O/P: 100%Io Ta:25℃	±3%	1.25%
5	EFFICIENCY(Typ.)	I/P: 230VAC O/P:100%Io Ta:25℃	79%	81.14%
6	RIPPLE & NOISE	I/P: 85 to 305VAC O/P:10%Io to 100%Io Ta:25℃	150mV	68.6mV

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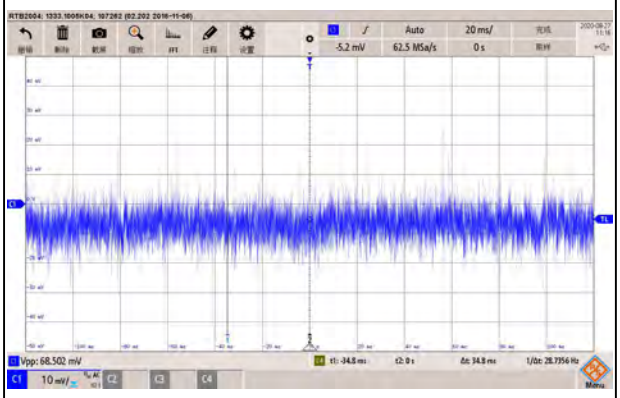
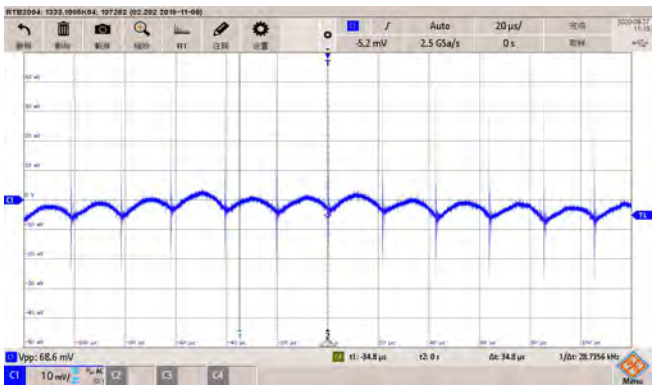
	low frequency:		high frequency:	
				
Protection function test (test module: LS05-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	Over-current Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	≥110%Io	132%Io/ 85VAC 131%Io/ 230VAC 138%Io/300VAC Hiccup mode, recovers automatically after fault condition is removed
2	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	Short output 1 hour no damage	No damage Hiccup mode, recovers automatically after fault condition is removed
Safety test(test module: LS05-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	WITHSTAND VOLTAGE	I/P-O/P: 3KVAC/min leakage current＜5mA	≥3.6KVAC	3.6KVAC ok, leakage current: 0.812mA
2	ISOLATION RESISTANCE	I/P-O/P: 500VDC	＞100MΩ	OK

4.2.2. EMS (EFT: ±2KV, Surge: line to line ±1KV) and EMI (Class B)

This solution can meet all the performance in our datasheet, as well a EMS (EFT: ±2KV, Surge: line to line ±1KV) and EMI (Class B).

1) Design circuit and PCB layout are as follows:

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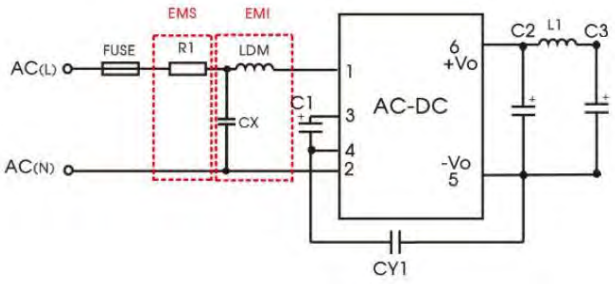
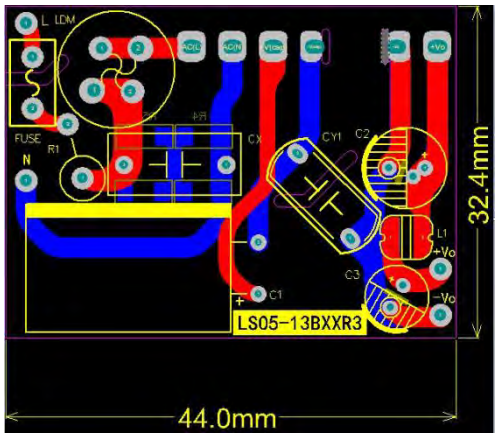
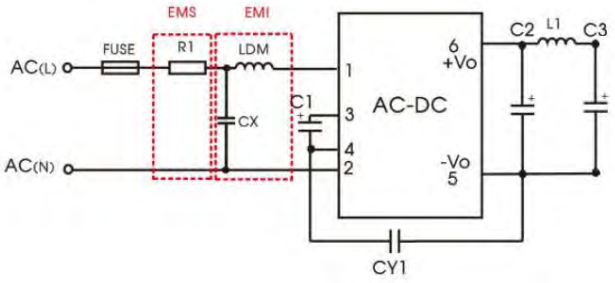
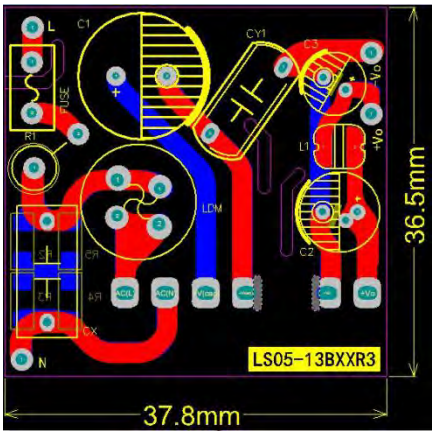
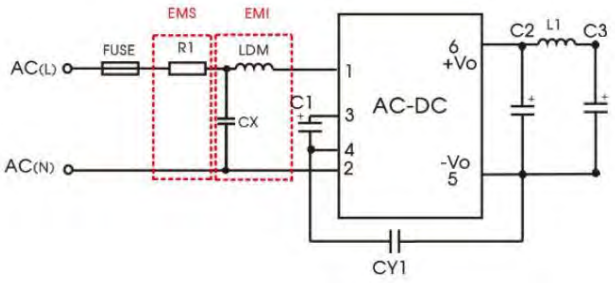
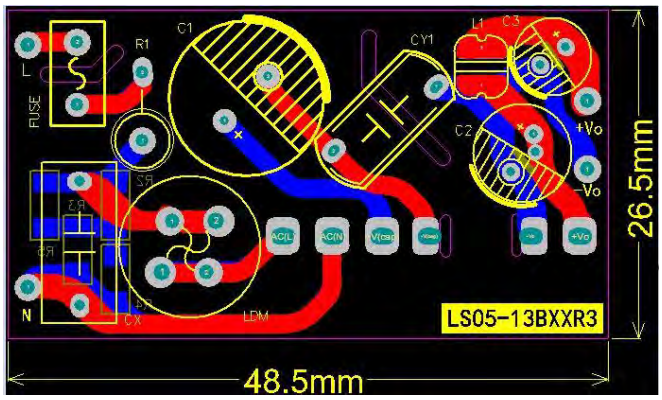
Recommend circuit	PCB layout(L*W*H: 44.0mm*32.4mm*17mm)
	
Recommend circuit	**PCB layout(L*W*H: 37.8mm*36.5mm*23mm)**
	
Recommend circuit	**PCB layout(L*W*H: 48.5mm*26.5mm*23mm)**
	

Note: There are three kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2) BOM:

PCB	Type	Spec	Recommended material	Recommended	Recommended material

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			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	80711000000
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
CX	Class-X Capacitor	0.1uF/310VAC	Faratronic	C42Q2104K4SA405	HJC	MKP-104K0305AT1108-PV	TDK	B32671Z6104
LDM	Input inductor	4.7mH/0.2A	Codaca	PK0810-472K	Wurth	768772122	Bourns	RLB1014-472KL
C1	Input filter capacitor	22uF/450V/Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102M	Walsin	YU1AH102M070BASDAH	TDK	CD85-E2GA102MYASA
C2	Output filter	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1
L1	Output inductor	4.7uH/2.2A	Hua Chen	HCCD0403T-4R7M	Chilisin	BPSD000504324R7	Bourns	SDE0403A-4R7M
C3	Output filter	47uF/35V	SAMXON	ESK476M1VD11TUSRP	Nichicon	UHV1V470MDD	Rubycon	35ZLH47MHFCT15X11

3) Test report

General performance test (test module: LS05-13B12R3)				
NO.	Test Item	Test Condition	Specification	Result
1	NO LOAD POWER CONSUMPTION	I/P: 230VAC O/P: No load Ta:25℃	≤0.15W	0.103W
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta:25℃	±5%	1.08%
3	OUTPUT VOLTAGE TOLERANCE	I/P: 85 to 305VAC O/P: 100%Io Ta:25℃	±1.5%	-0.08%
4	LOAD REGULATION	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta:25℃	±3%	1.17%

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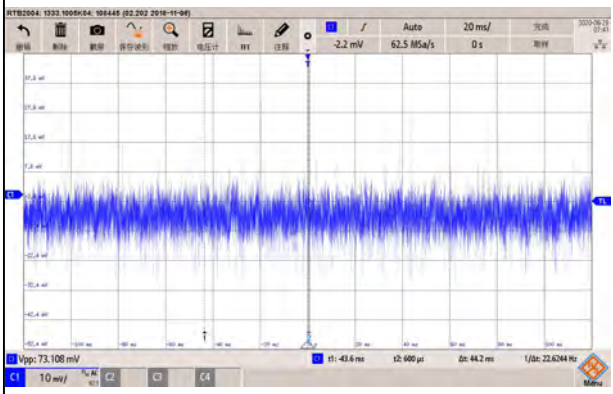
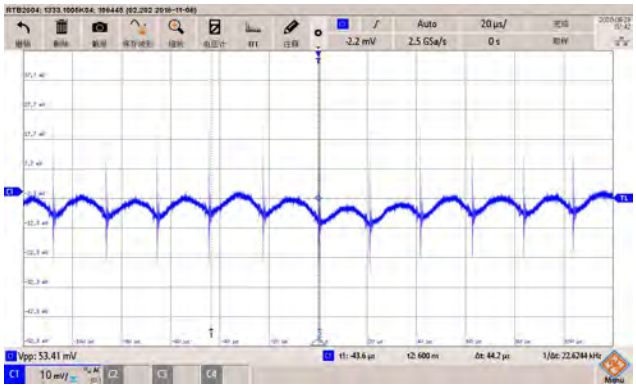
5	EFFICIENCY(Typ.)	I/P: 230VAC O/P: 100%Io Ta:25℃	79%	80.62%
6	RIPPLE & NOISE(Max)	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta:25℃	150mV	74mV
	low frequency: :		high frequency:	
				

Protection function test(test module: LS05-13B12R3)

NO.	Test Item	Test Condition	Specification	Result
1	Over-current Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	≥110%Io	132%Io/ 85VAC 131%Io/ 230VAC 138%Io/300VAC Protection mode: output hiccup, self-recovery
2	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta:25℃	Long short circuit	No damage after one hour short circuit Protection mode: output hiccup, self-recoverable

Safety test(test module: LS05-13B12R3)

NO.	Test Item	Test Condition	Specification	Result
1	WITHSTAND VOLTAGE	I/P-O/P: test time 1 minute, leakage current＜5mA	≥3.6KVAC	3.6KV ok, leakage current=0.812mA
2	ISOLATION RESISTANCE	I/P-O/P: 500VDC	＞100MΩ	OK

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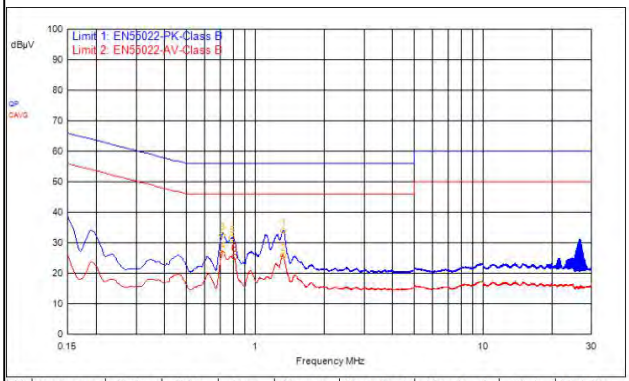
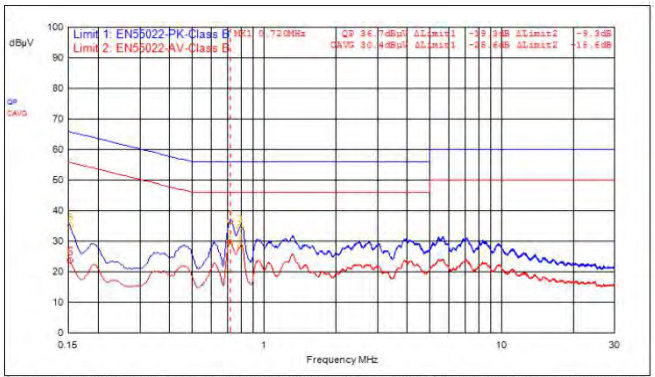
EMC Test(Test module: LS05-13B12R3)				
NO.	Test Item	Test Condition	Specification	Result
1	surge	I/P: 230VAC O/P: 100%Io Ta:25℃	IEC/EN61000-4-5 line to line ±1KV	PASS
2	EFT	I/P: 230VAC O/P: 100%Io Ta:25℃	IEC/EN61000-4-4 ±2KV	PASS
3	ESD	I/P: 230VAC O/P: 100%Io Ta:25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	I/P: 115V/230VAC O/P: 100%Io Ta:25℃	CISPR32/EN55032 CLASS B	PASS

115VAC input L line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
4	714.000kHz	0.2	0.2	10.0	C_AVG	16.2	26.7	46.0	-19.3
2	1.332MHz	0.3	0.2	10.0	C_AVG	15.2	25.7	46.0	-20.3
6	807.000kHz	0.3	0.2	10.0	C_AVG	14.8	25.3	46.0	-20.7
1	1.323MHz	0.3	0.2	10.0	QPeak	23.4	33.9	56.0	-22.1
3	717.000kHz	0.2	0.2	10.0	QPeak	22.3	32.7	56.0	-23.3

115VAC input N line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	714.000kHz	0.2	0.2	10.0	C_AVG	19.3	29.8	46.0	-16.2
4	798.000kHz	0.3	0.2	10.0	C_AVG	18.2	28.6	46.0	-17.4
1	720.000kHz	0.2	0.2	10.0	QPeak	26.3	36.7	56.0	-19.3
3	792.000kHz	0.3	0.2	10.0	QPeak	24.2	34.7	56.0	-21.3
5	153.000kHz	0.1	0.2	10.0	QPeak	24.7	35.0	65.8	-30.8

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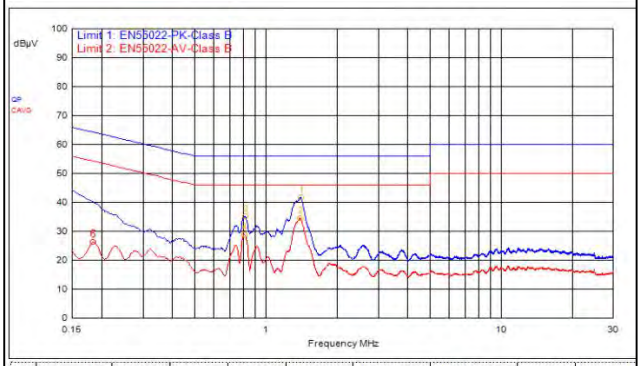
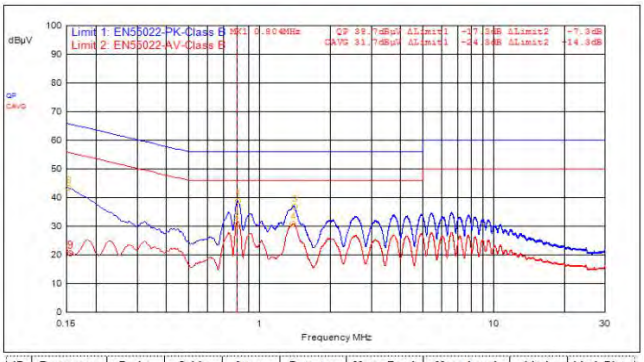
230VAC input L line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	1.395MHz	0.3	0.2	10.0	C_AVG	24.0	34.5	46.0	-11.5
1	1.407MHz	0.3	0.2	10.0	QPeak	31.1	41.6	56.0	-14.4
4	807.000kHz	0.3	0.2	10.0	C_AVG	18.4	28.8	46.0	-17.2
3	816.000kHz	0.3	0.2	10.0	QPeak	24.7	35.1	56.0	-20.9
5	150.000kHz	0.1	0.2	10.0	QPeak	34.1	44.4	66.0	-21.6
6	183.000kHz	0.2	0.2	10.0	C_AVG	16.0	26.3	54.3	-28.0

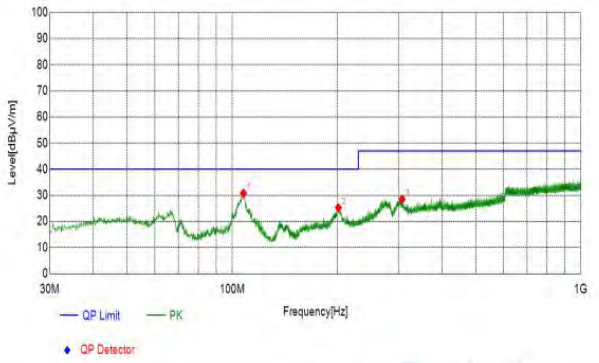
230VAC input N line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	798.000kHz	0.3	0.2	10.0	C_AVG	20.7	31.2	46.0	-14.8
4	1.389MHz	0.3	0.2	10.0	C_AVG	20.3	30.8	46.0	-15.2
1	807.000kHz	0.3	0.2	10.0	QPeak	28.3	38.8	56.0	-17.2
3	1.413MHz	0.3	0.2	10.0	QPeak	26.4	36.9	56.0	-19.1
5	150.000kHz	0.1	0.2	10.0	QPeak	33.7	44.0	66.0	-22.0
6	150.000kHz	0.1	0.2	10.0	QPeak	33.7	44.0	66.0	-22.0

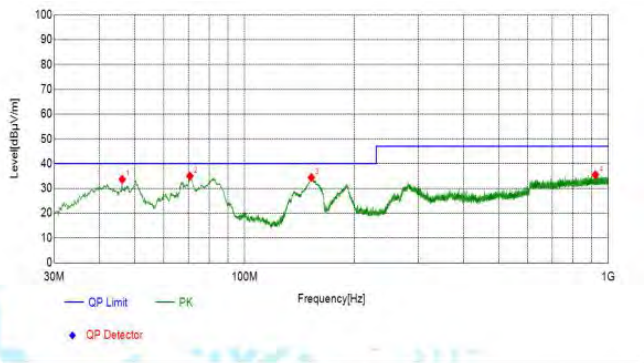
RE	I/P: 115V/230VAC O/P: 100%Io Ta:25℃	CISPR32/EN55032 CLASS B	PASS

115VAC (horizontal)



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
107.7048	Horizontal	13.11	17.61	30.72	40.00	9.28	PK	100	143	PASS
201.6102	Horizontal	12.56	12.60	25.16	40.00	14.84	PK	100	4	PASS
307.0597	Horizontal	16.00	12.45	28.45	47.00	18.55	PK	100	132	PASS

115VAC (vertical)



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
46.1036	Vertical	15.05	18.59	33.64	40.00	6.36	PK	100	84	PASS
70.7441	Vertical	9.67	25.31	34.98	40.00	5.02	PK	100	187	PASS
152.5233	Vertical	9.40	25.00	34.40	40.00	5.60	PK	100	208	PASS
921.1311	Vertical	26.32	9.18	35.50	47.00	11.50	PK	100	99	PASS

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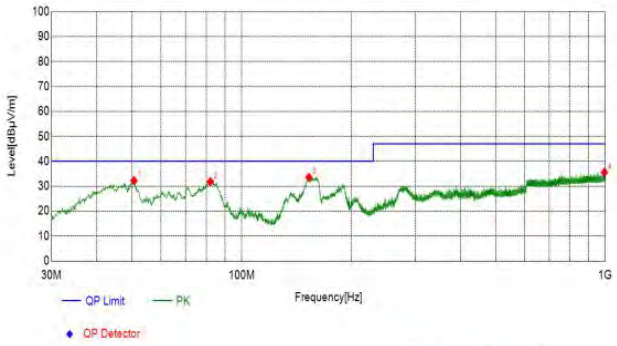
230VAC (horizontal)

Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
100.1380	Horizontal	12.53	17.02	29.55	40.00	10.45	PK	100	171	PASS

230VAC (vertical)



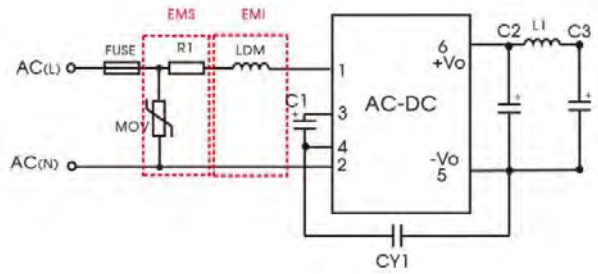
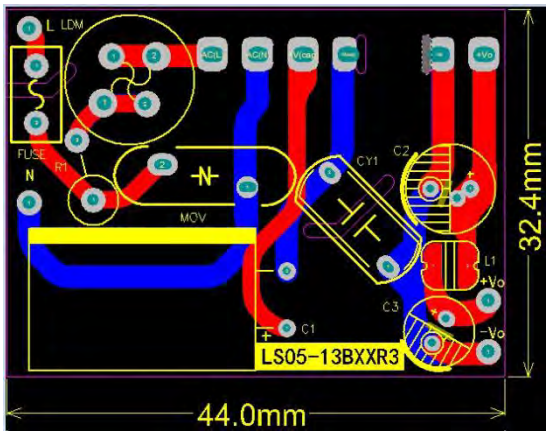
Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.5661	Vertical	15.52	16.73	32.25	40.00	7.75	PK	100	275	PASS
81.9972	Vertical	9.79	21.99	31.78	40.00	8.22	PK	100	270	PASS
153.0083	Vertical	9.42	24.18	33.60	40.00	6.40	PK	100	203	PASS
994.2764	Vertical	26.90	8.62	35.52	47.00	11.48	PK	100	239	PASS

4.2.3. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A)

This solution can meet all the performance in our datasheet, as well as EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A).

1) Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H: 44mm*32.4mm*17mm)
	
Recommend circuit	**PCB layout(L*W*H: 37.8mm*36.5mm*23mm)**

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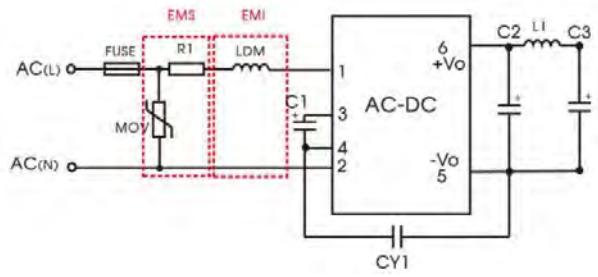
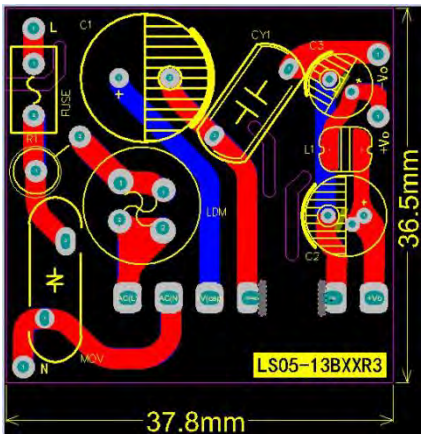
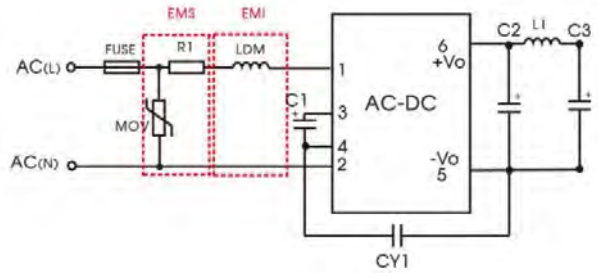
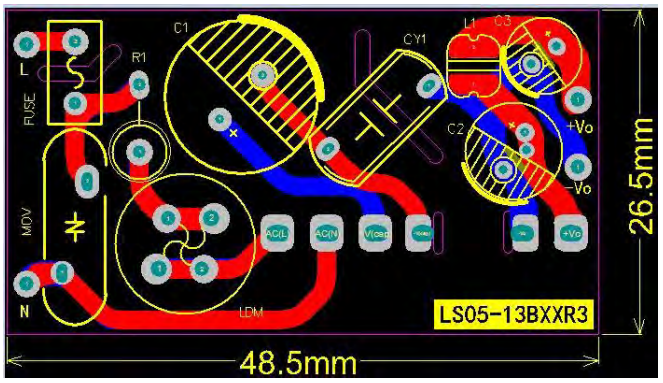




Recommend circuit	PCB layout(L*W*H: 48.5mm*26.5mm*23mm)





Note: There are three kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is strict for width requirement situations.

1）BOM:

PCB position	Type	Spec	Recommended material		Recommended material		Recommended material	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	2A/300VAC	Better	9321200301	Conquer	MST-2A-300V	Littelfuse	36912000000
MOV	VARISTOR	S14K350	DNR	DNR S14K350	Thinking	TVR14561	TDK	B72214S0351K101
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
LDM	input inductor	4.7mH/0.2A	Codaca	PK0810-472K	Wurth	768772122	Bourns	RLB1014-472KL

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C1	Input filter capacitor	22uF/450V/ Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/ 400VAC	Wmec	HJE102M	walsin	YU1AH102M070BASDAH	TDK	CD85-E2GA102MYASA
C2	Output filter capacitor	270uF/16V/ Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1
L1	Output inductor	4.7uH/2.2A	Hua Chen	HCCD0403T-4R7M	chilisin	BPSD000504324R7	Bourns	SDE0403A-4R7M
C3	Output filter capacitor	47uF/35V	SAMXON	ESK476M1VD11TUSRP	Nichicon	UHV1V470MDD	Rubycon	35ZLH47MHFCT15X11

2）Test Report:

General performance test(test module: LS05-13B12R3)				
NO.	Test Item	Test Condition	Specification	Result
1	NO LOAD POWER CONSUMPTION	I/P: 230VAC O/P: No load Ta: 25℃	≤0.15W	0.134W
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±5%	-2.00%
3	OUTPUT VOLTAGE TOLERANCE	I/P: 85 to 305VAC O/P: 100%Io Ta: 25℃	±1.5%	-0.08%
4	LOAD REGULATION	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±3%	1.60%
5	EFFICIENCY(Typ.)	I/P: 230VAC O/P: 100%Io Ta: 25℃	79%	80.45%
6	RIPPLE & NOISE(Max)	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	150mV	71.7mV
	low frequency:		high frequency:	

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	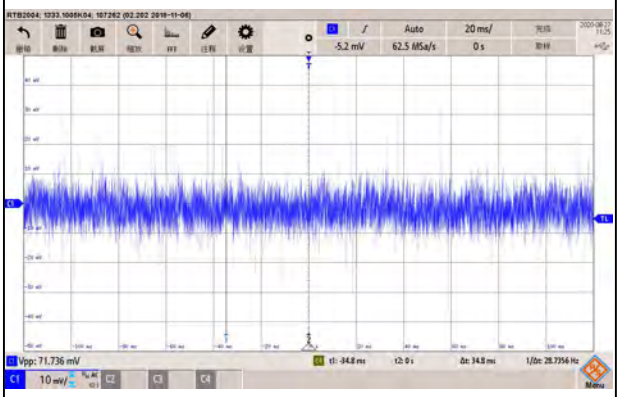	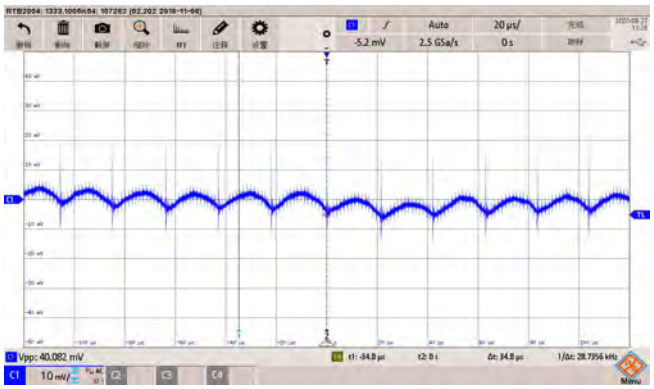

Protection function test(test module: LS05-13B12R3)				
NO.	Test Item	Test Condition	Specification	Result
1	Over-current Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta: 25℃	≥110%Io	142%Io/ 264VAC 150%Io/ 230VAC 142%Io/88VAC Protection mode: output hiccup, self-recovery
2	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta: 25℃	Long short circuit	No damage after one hour short circuit Protection mode: output hiccup, self-recoverable

Safety test(test module: LS05-13B12R3)				
NO.	Test Item	Test Condition	Specification	Result
1	WITHSTAND VOLTAGE	I/P-O/P: Test time 1 minute, leakage current<5mA	≥3.6KVAC	3.6KV ok, leakage current 0.812mA
2	ISOLATION RESISTANCE	I/P-O/P: 500VDC		＞100MΩ

EMC test(test module: LS05-13B12R3)				
NO.	Test Item	Test Condition	Specification	Result
1	surge	I/P: 230VAC O/P: 100%Io Ta: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS

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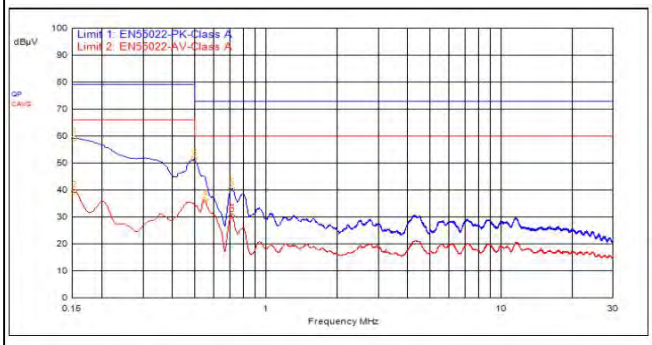
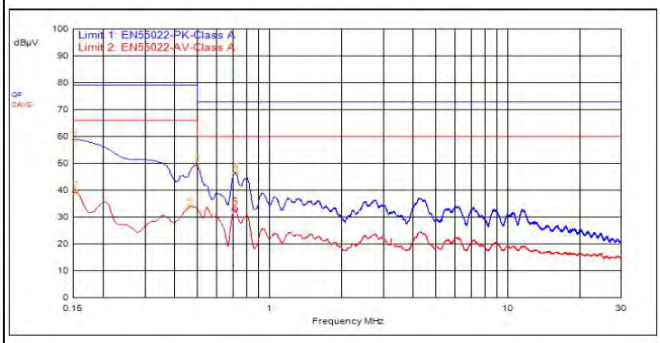
2	EFT	I/P: 230VAC O/P: 100%Io Ta: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	I/P: 230VAC O/P: 100%Io Ta: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	I/P: 115V/230VAC O/P: 100%Io Ta: 25℃	CISPR32/EN55032 CLASS A	PASS

115VAC (L Line)



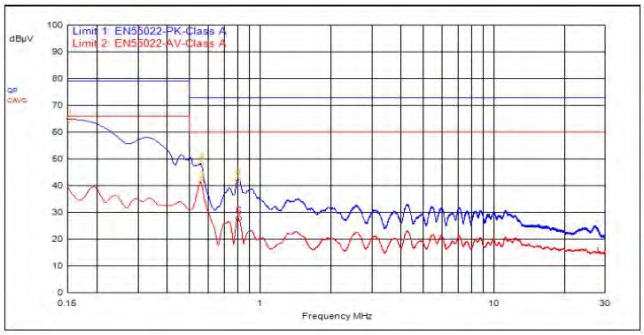
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	153.000kHz		0.2	10.0	QPeak	49.0	59.2	79.0	-19.8
4	549.000kHz		0.2	10.0	C_AVG	26.2	36.4	60.0	-23.6
2	153.000kHz		0.2	10.0	C_AVG	29.1	39.3	66.0	-26.7
3	492.000kHz		0.2	10.0	QPeak	41.2	51.4	79.0	-27.6
6	717.000kHz		0.2	10.0	C_AVG	20.2	30.4	60.0	-29.6
5	717.000kHz		0.2	10.0	QPeak	30.4	40.6	73.0	-32.4

115VAC (N Line)



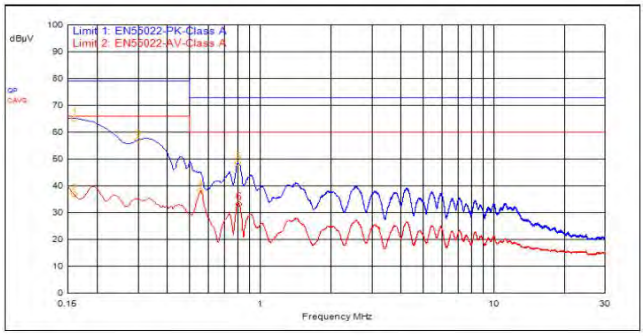
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	153.000kHz		0.2	10.0	QPeak	48.7	58.9	79.0	-20.1
5	720.000kHz		0.2	10.0	QPeak	36.2	46.4	73.0	-26.6
2	153.000kHz		0.2	10.0	C_AVG	29.1	39.3	66.0	-26.7
6	714.000kHz		0.2	10.0	C_AVG	22.8	33.0	60.0	-27.0
3	492.000kHz		0.2	10.0	QPeak	39.2	49.4	79.0	-29.6
4	462.000kHz		0.2	10.0	C_AVG	23.8	34.0	66.0	-32.0

230VAC (L Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	153.000kHz		0.2	10.0	QPeak	54.7	64.9	79.0	-14.1
3	558.000kHz		0.2	10.0	C_AVG	31.2	41.4	60.0	-18.6
4	558.000kHz		0.2	10.0	QPeak	38.0	48.2	73.0	-24.8
2	150.000kHz		0.2	10.0	C_AVG	29.3	39.5	66.0	-26.5
5	804.000kHz		0.2	10.0	QPeak	32.0	42.2	73.0	-30.8
6	807.000kHz		0.2	10.0	C_AVG	17.5	27.7	60.0	-32.3

230VAC (N Line)



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	159.000kHz		0.2	10.0	QPeak	55.0	65.2	79.0	-13.8
4	555.000kHz		0.2	10.0	C_AVG	28.2	38.4	60.0	-21.6
3	300.000kHz		0.2	10.0	QPeak	46.9	57.1	79.0	-21.9
5	804.000kHz		0.2	10.0	QPeak	38.3	48.5	73.0	-24.5
6	810.000kHz		0.2	10.0	C_AVG	23.0	33.2	60.0	-26.8
2	159.000kHz		0.2	10.0	C_AVG	26.7	36.9	66.0	-29.1

	RADIATION	I/P: 115V/230VAC O/P: 100%Io Ta: 25℃	CISPR32/EN55032 CLASS A	PASS

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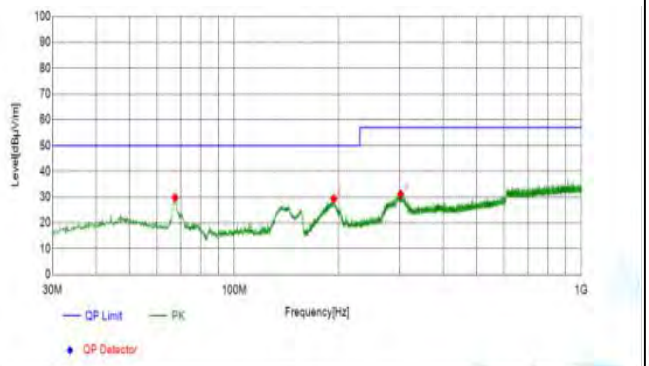
115VAC

(horizontal)

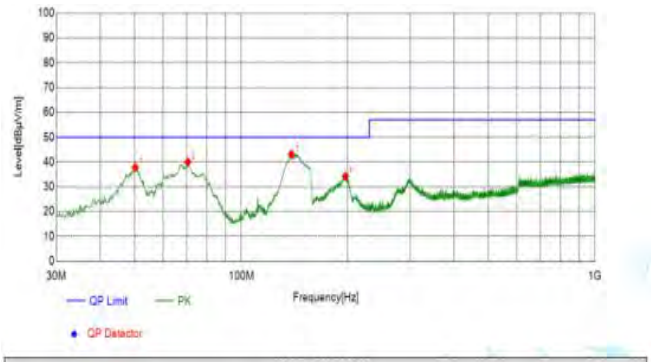


Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
67.5428	Horizontal	10.68	19.14	29.82	50.00	20.18	PK	100	295	PASS
193.5584	Horizontal	12.26	17.13	29.39	50.00	20.61	PK	100	350	PASS

115VAC

(vertical)

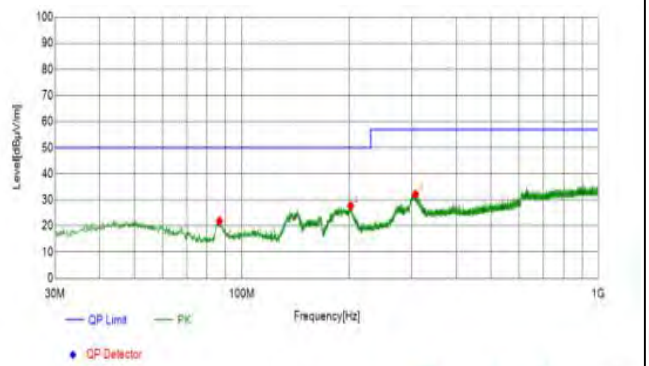


Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.0810	Vertical	15.61	22.22	37.83	50.00	12.17	PK	100	0	PASS
70.5501	Vertical	9.67	30.31	39.98	50.00	10.02	PK	100	211	PASS
138.5539	Vertical	10.33	32.72	43.05	50.00	6.95	PK	100	200	PASS

230VAC

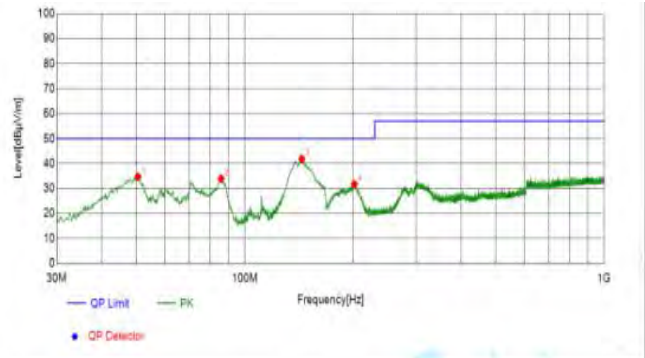
(horizontal)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
86.6537	Horizontal	10.75	11.15	21.90	50.00	28.10	PK	100	133	PASS

230VAC (vertical)



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	19.17	34.71	50.00	15.29	PK	100	80	PASS
85.8776	Vertical	10.59	23.38	33.97	50.00	16.03	PK	100	250	PASS
144.0834	Vertical	10.05	31.80	41.85	50.00	8.15	PK	100	238	PASS
201.8042	Vertical	12.56	19.18	31.74	50.00	18.26	PK	100	181	PASS

4.2.4. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B)

This solution can meet all the performance in our datasheet, as well as EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B).

1) Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H: 48.5mm*32.2mm*17mm)

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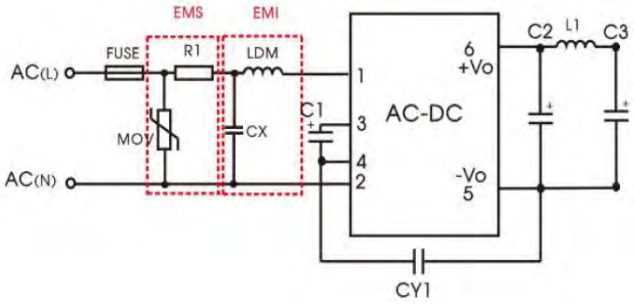
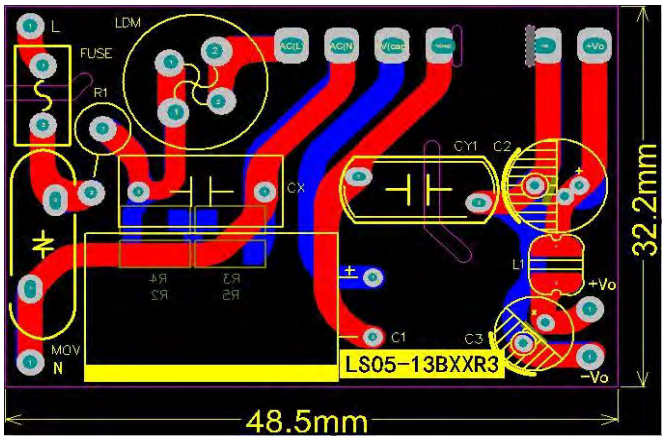
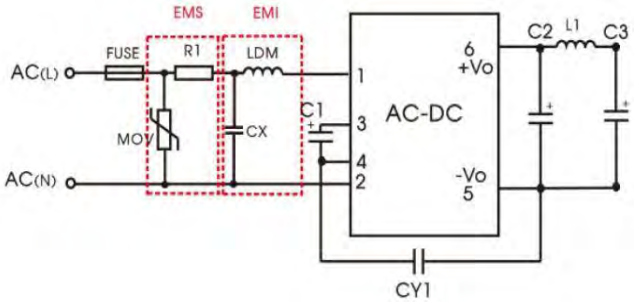
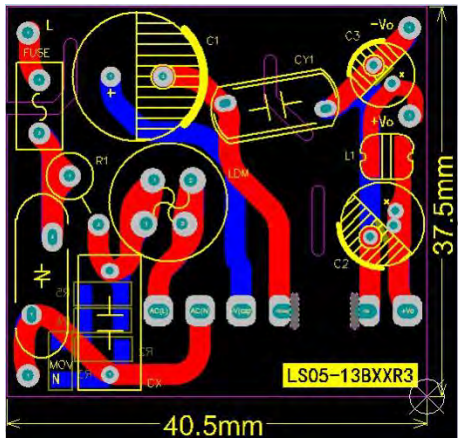


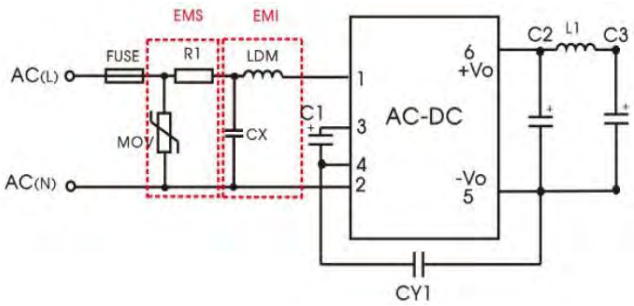


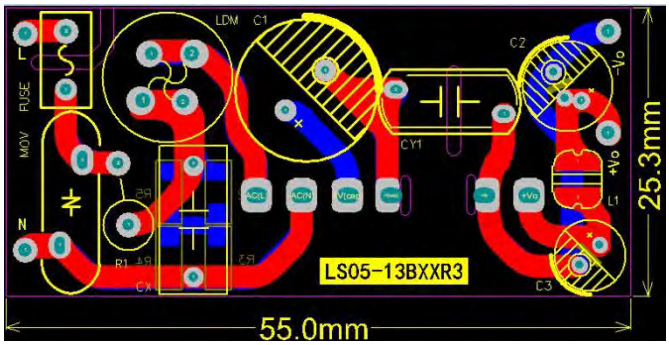
Recommend circuit	PCB layout(L*W*H: 40.5mm*37.5mm*23mm)





Recommend circuit	PCB layout(L*W*H: 55mm*25.3mm*23mm)





Note: There are three kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2) BOM:

PCB position	Type	Spec	Recommended		Recommended material		Recommended material	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	2A/300VAC	Better	9321200301	Conquer	MST-2A-300V	Littelfuse	36912000000

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MOV	VARISTOR	S14K350	DNR	DNR S14K350	Thinking	TVR14561	TDK	B72214S0351K101
R1	Wire-wound Resistor	12Ω/3W/Φ5*15	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSJT-73-12R	Vishay	RWM041012R0JR15E1
CX	Class-X Capacitor	0.1uF/310VAC	Faratronic	C42Q2104K4SA405	HuaJung	MKP-104K0305AT1108-PV	TDK	B32671Z6104
LDM	Input inductor	4.7mH/0.2A	Codaca	PK0810-472K	Wurth	768772122	Bourns	RLB1014-472KL
C1	Input filter capacitor	22uF/450V/Φ12.5*20	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/ 400VAC	SAMXON	HJE102M	Walsin	YU1AH102M070BASDAH	TDK	CD85-E2GA102MYASA
C2	Output filter capacitor	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1
L1	Output inductor	4.7uH/2.2A	Hua Chen	HCCD0403T-4R7M	Chilisin	BPSD000504324R7	Bourns	SDE0403A-4R7M
C3	Output filter capacitor	47uF/35V	SAMXON	ESK476M1VD11TUSRP	Nichicon	UHV1V470MDD	Rubycon	35ZLH47MHFCT15X11

3) Test report

General Performance Test(Part# LS05-13B12R3)				
No.	Test Item	Test Condition	Specification	Test Result
1	No-load power consumption	Input: 230VAC Output: No load Temp.: 25℃	≤0.15W	0.135W
2	Output Voltage Accuracy	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	±5%	-1.67%
3	Line Regulation	Input: 85 to 305VAC	±1.5%	0.08%

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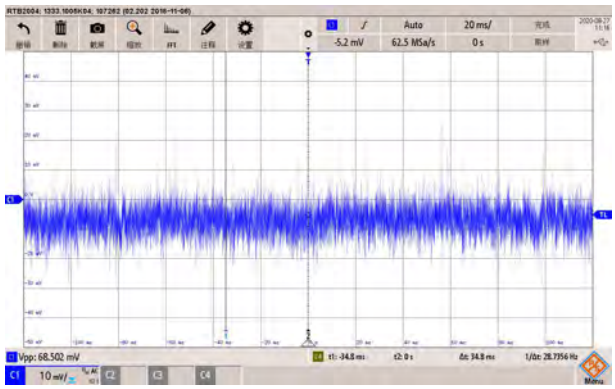
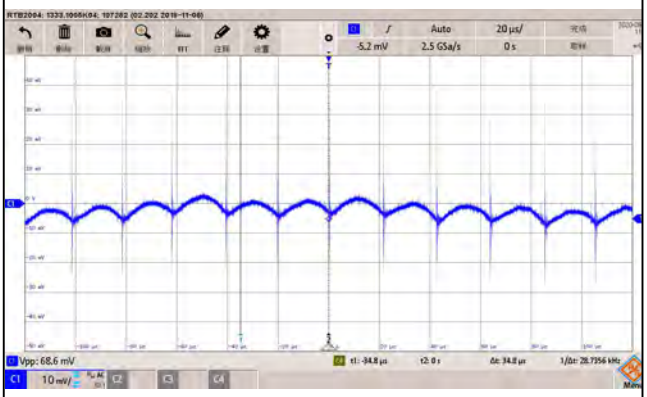
		Output: 100%Io Temp.: 25℃		
4	Load Regulation	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	±3%	1.52%
5	Efficiency	Input: 230VAC Output: 100%Io Temp.: 25℃	79%	80.34%
6	Ripple & Noise	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	150mV	68.6mV
	Low frequency ripple:		High frequency ripple:	
				

Protection Test(Part# LS05-13B12R3)				
No.	Test Item	Test Condition	Specification	Test Result
1	Over-current Protection	Input: 85VAC Input: 230VAC Input: 305VAC Temp.: 25℃	≥110%Io	132%Io/ 85VAC 131%Io/ 230VAC 138%Io/300VAC Mode: Hiccup, self-recovery
2	Short Circuit Protection	Input: 85VAC Input: 230VAC Input: 305VAC Temp.: 25℃	continuous, self-recovery	Short circuit for one hour without damage Mode: Hiccup, self-recovery

Safety Test(Part# LS05-13B12R3)				
No.	Test Item	Test Condition	Specification	Test Result

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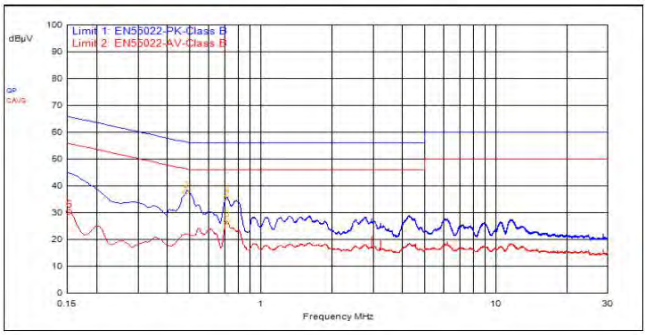
1	Isolation Voltage	Input-Output, Test for 1min., leakage current＜5mA	≥3.6KVAC	3.6KVAC ok, leakage current: 0.812mA
2	Insulation resistance	Input-Output, 500VDC	＞100MΩ	OK

EMC Test(Part# LS05-13B12R3)

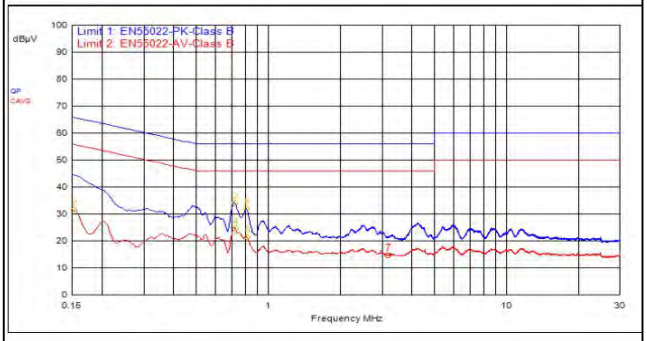
No.	Test Item	Test Condition	Specification	Test Result
1	Surge	Input: 230VAC Output: 100%Io Temp.: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS
2	EFT	Input: 230VAC Output: 100%Io Temp.: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	Input: 230VAC Output: 100%Io Temp.: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	Input: 115V/230VAC Output: 100%Io Temp.: 25℃	CISPR32/EN55032 CLASS B	PASS

115VAC Input L line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	483.000kHz		0.2	10.0	QPeak	27.6	37.8	56.3	-18.5
3	714.000kHz		0.2	10.0	C_AVG	16.6	26.8	46.0	-19.2
4	717.000kHz		0.2	10.0	QPeak	25.6	35.8	56.0	-20.2
1	150.000kHz		0.2	10.0	QPeak	34.8	45.0	66.0	-21.0
5	150.000kHz		0.2	10.0	QPeak	34.8	45.0	66.0	-21.0
6	153.000kHz		0.2	10.0	C_AVG	20.2	30.4	55.8	-25.5

115VAC Input N line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dis
1	150.000kHz		0.2	10.0	QPeak	34.6	44.8	66.0	-21.2
4	726.000kHz		0.2	10.0	C_AVG	14.3	24.5	46.0	-21.5
3	720.000kHz		0.2	10.0	QPeak	23.9	34.1	56.0	-21.9
5	810.000kHz		0.2	10.0	QPeak	21.8	32.0	56.0	-24.0
2	153.000kHz		0.2	10.0	C_AVG	21.1	31.3	55.8	-24.5
6	816.000kHz		0.2	10.0	C_AVG	11.1	21.3	46.0	-24.7

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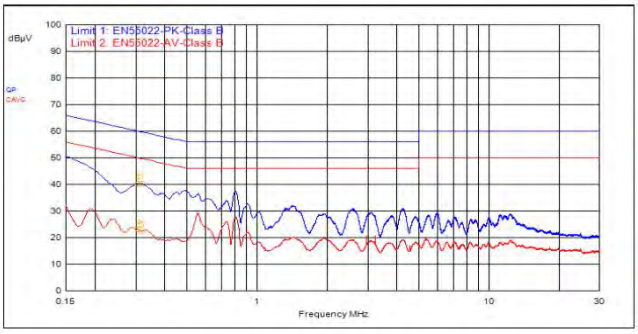
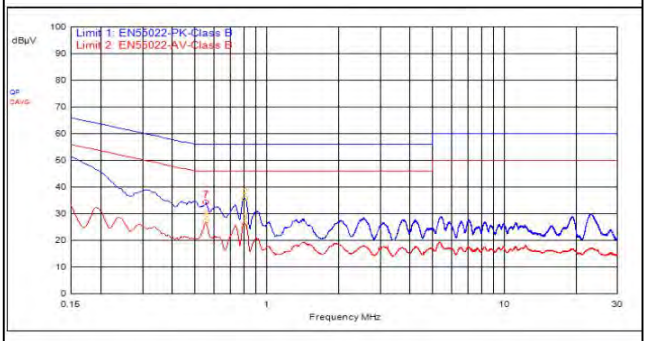
230VAC Input L line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
5	150.000kHz		0.2	10.0	QPeak	40.4	50.6	66.0	-15.4
1	318.000kHz		0.2	10.0	QPeak	30.1	40.3	59.8	-19.4
2	306.000kHz		0.2	10.0	QPeak	30.1	40.3	60.1	-19.8
6	150.000kHz		0.2	10.0	C_AVG	21.7	31.9	56.0	-24.1
4	306.000kHz		0.2	10.0	C_AVG	12.8	23.0	50.1	-27.1
3	318.000kHz		0.2	10.0	C_AVG	12.2	22.4	49.8	-27.3

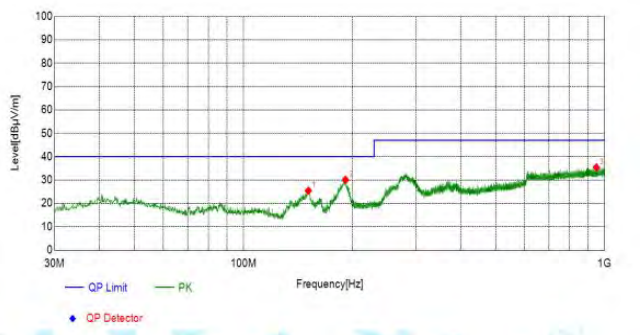
230VAC Input N line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist
4	150.000kHz		0.2	10.0	QPeak	41.2	51.4	66.0	-14.6
6	555.000kHz		0.2	10.0	C_AVG	16.8	27.0	46.0	-19.0
3	807.000kHz		0.2	10.0	C_AVG	16.2	26.4	46.0	-19.6
2	807.000kHz		0.2	10.0	QPeak	25.6	35.8	56.0	-20.2
7	555.000kHz		0.2	10.0	QPeak	24.0	34.2	56.0	-21.8
1	150.000kHz		0.2	10.0	C_AVG	22.8	33.0	56.0	-23.0

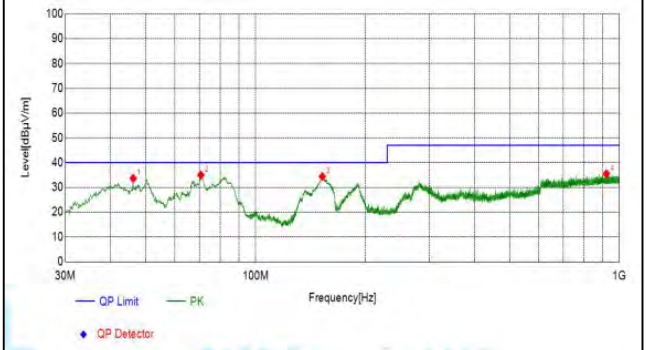
RE	Input: 115V/230VAC Output: 100%Io Temp.: 25℃	CISPR32/EN55032 CLASS B	PASS

115VAC Input Horizontal



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
151.1651	Horizontal	9.35	16.08	25.43	40.00	14.57	PK	100	127	PASS
191.6182	Horizontal	12.19	17.90	30.09	40.00	9.91	PK	100	297	PASS
948.2938	Horizontal	26.40	8.99	35.39	47.00	11.61	PK	100	276	PASS

115VAC Input Vertical



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
46.1036	Vertical	15.05	18.59	33.64	40.00	6.36	PK	100	84	PASS
70.7441	Vertical	9.67	25.31	34.98	40.00	5.02	PK	100	187	PASS
152.5233	Vertical	9.40	25.00	34.40	40.00	5.60	PK	100	208	PASS
921.1311	Vertical	26.32	9.18	35.50	47.00	11.50	PK	100	99	PASS

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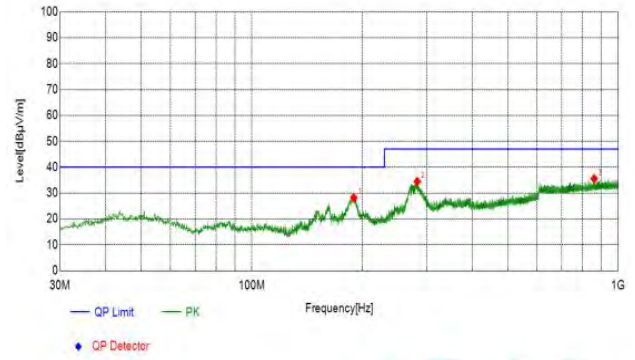
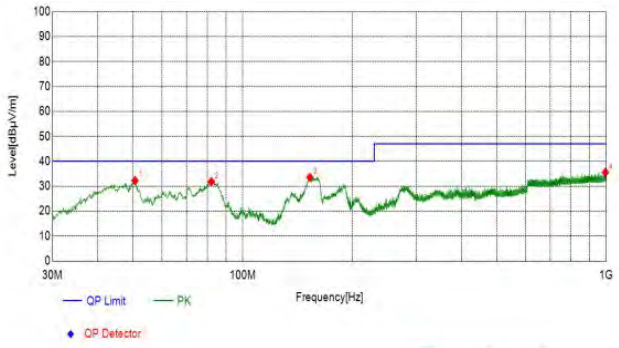
230VAC Input Horizontal



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
189.7750	Horizontal	12.10	16.08	28.18	40.00	11.82	PK	100	121	PASS
282.8073	Horizontal	15.24	19.21	34.45	47.00	12.55	PK	100	147	PASS
859.5300	Horizontal	25.60	9.89	35.49	47.00	11.51	PK	100	341	PASS

230VAC Input Vertical



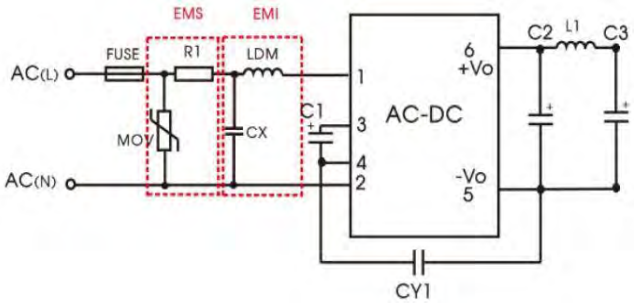
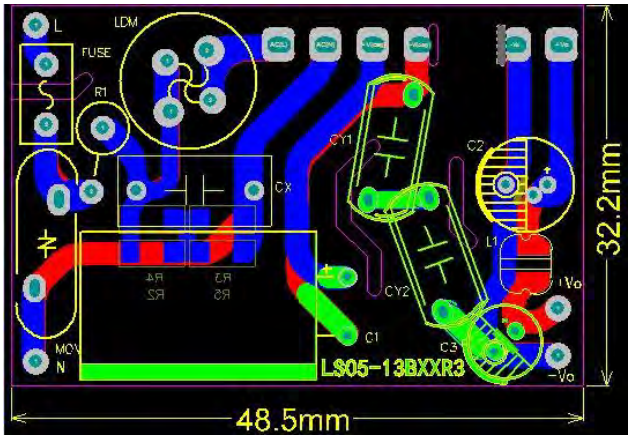
Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.5661	Vertical	15.52	16.73	32.25	40.00	7.75	PK	100	275	PASS
81.9972	Vertical	9.79	21.99	31.78	40.00	8.22	PK	100	270	PASS
153.0083	Vertical	9.42	24.18	33.60	40.00	6.40	PK	100	203	PASS
994.2764	Vertical	26.90	8.62	35.52	47.00	11.48	PK	100	239	PASS

4.2.5. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B), meets EN60335 standard

The solution can meet the conventional performance in the datasheet, and meet EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B).

1) Peripheral circuits, PCB layout and recommended materials are as follows:

Recommended circuit	PCB Design(L*W*H: 48.5mm*32.2mm*17mm)
	
Recommended circuit	**PCB Design(L*W*H: 40.5mm*37.5mm*23mm)**

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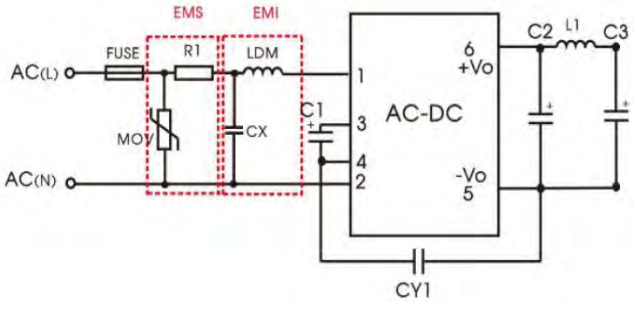
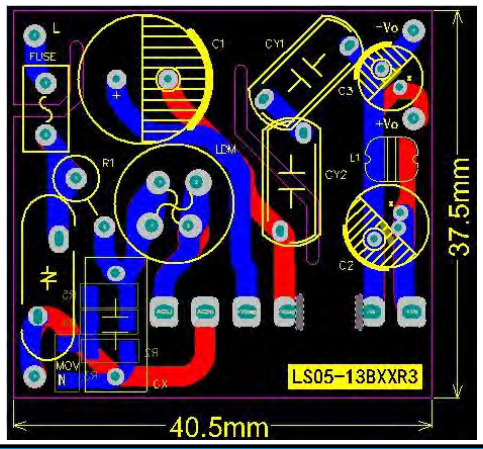
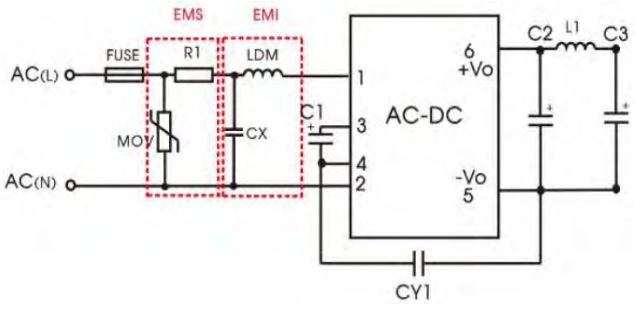
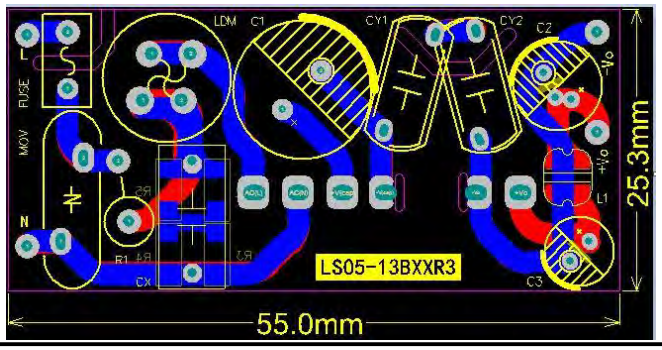




Recommended circuit	PCB Design(L*W*H: 55.0mm*25.3mm*23mm)





Note: There are three PCB layouts are recommended. The first one is to meet the strict height requirements, the second one is to meet the strict length and width requirements, and the third one is to meet the strict width requirements.

2) **BOM:**

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
CY1/CY2	Y2-cap	1nF/ 250VAC	Wmec	HME102M	Walsin	YU1AC102M060	TDK	CS80-E2GA102MY

Note: The two Y-capacitor solution is different from the single Y-capacitor solution in section 4.2.4 only in terms of Y-capacitor material and PCB foot spacing, and the test results are not much different, so please **refer to section 4.2.4 for other device parameters and related test contents in addition to Y-capacitor in the recommended BOM.**

3) Test Report:

The two Y-capacitor solution is different from the single Y-capacitor solution in section 4.2.4 only in terms of Y-capacitor material and PCB foot spacing, and the test results are not much different, so please refer to the test report in section 4.2.4 for test result.

Note: According to EN60335 standard requirements for white goods to meet EMS (EFT: ±2KV, Surge: line to line ±1KV) will be OK, but because many customers currently require a higher level of EMS, so this solution is

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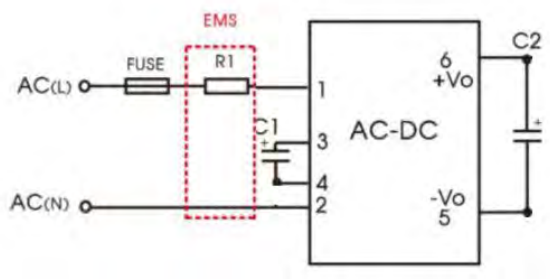
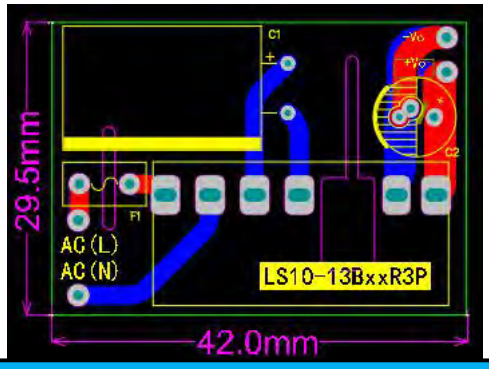
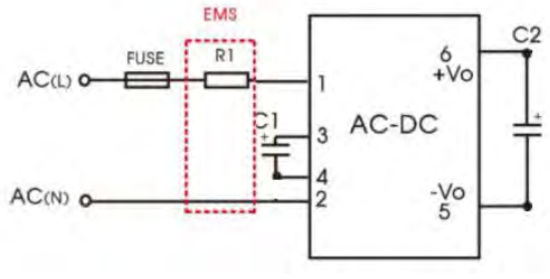
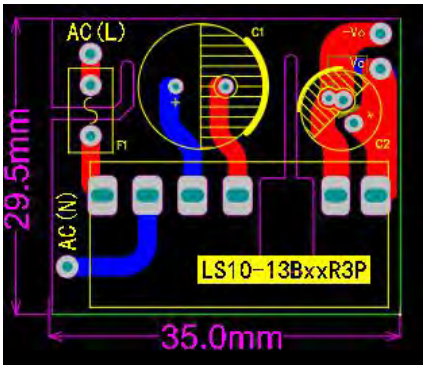
designed for EMS (EFT: ±4KV, Surge: line to line ±2KV). If you only need to meet the white goods requirements then remove the varistor (MOV).

4.3. LS10-13BxxR3P series uses 12VDC output as an example to recommend solutions and data packages

4.3.1. Minimization solution (Achieve normal output function)

This solution can achieve normal power output, but we do not promise other performance indicators. Suitable for occasions with extremely high cost requirements but low performance requirements;

1) Peripheral circuits, PCB layout and recommended materials are as follows:

Recommended circuit	PCB Design(L*W*H: 32.8mm*29.5mm*20.05mm)
	
Recommended circuit	**PCB Design(L*W*H: 35.0mm*29.5mm*23mm)**
	

Note: There are two PCB layouts are recommended. The first one is to meet the strict height requirements, the second one is to meet the strict length and width requirements.

2) BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N

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FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	36911000000
R1	Wire-wound Resistor	6.8Ω/3W	PAK HENG	NKN03BJ6R8	Yageo	NKN3WSFR-73-6R8	Vishay	AC03000006808JAC00
C1	Input filter capacitor	22uF/450V	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
C2	Output filter capacitor	470uF/16V/Φ8*11	SAMXON	UER477M1CF1ATVX0CR	ELITE	UPE1C471MNN0811	NCC	APSF160ETD471MJB5S

Note: Three different brands of materials were recommended, and it is possible to choose any one brand.

3) Test report

General Performance Test(Part# LS10-13B12R3P)				
No.	Test Item	Test Condition	Specification	Test Result
1	No-load power consumption	Input: 230VAC Output: No load Temp.: 25℃	≤0.15W	0.12W
2	Output Voltage Accuracy	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	±5%	1.16%
3	Line Regulation	Input: 85 to 305VAC Output: 100%Io Temp.: 25℃	±1.5%	0.16%
4	Load Regulation	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	±1.5%	0.17%
5	Efficiency	Input: 230VAC Output: 100%Io Temp.: 25℃	81%	84.02%
6	Ripple & Noise	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	150mV	108mV
	Low frequency ripple:		High frequency ripple:	

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	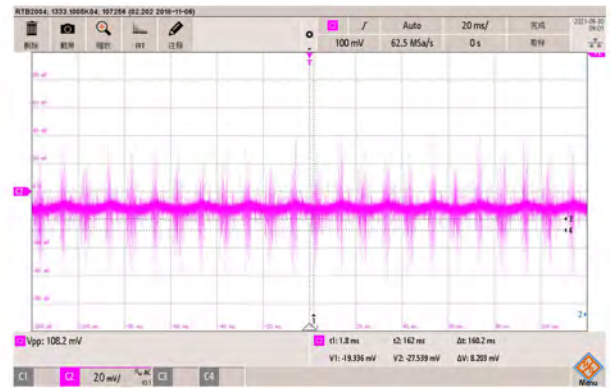	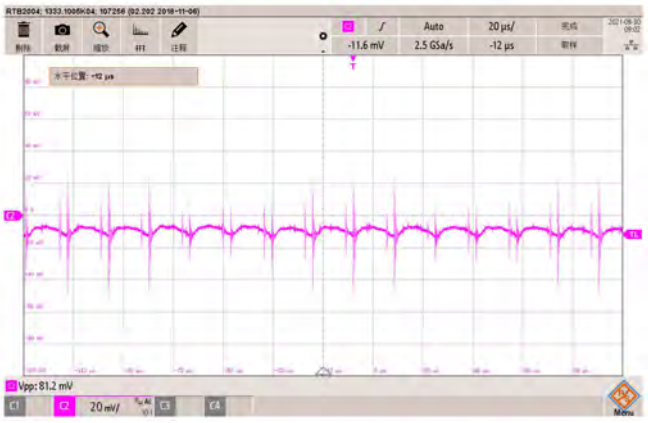

Protection Test(Part# LS10-13B12R3P)				
No.	Test Item	Test Condition	Specification	Test Result
1	Over-current Protection	Input: 85VAC Input: 230VAC Input: 305VAC Temp.: 25℃	≥110%Io	122%Io/85VAC 123%Io /230VAC 124%Io A/305VAC
2	Short Circuit Protection	Input: 85VAC Input: 230VAC Input: 305VAC Temp.: 25℃	continuous, self-recovery	Short circuit for one hour without damage Mode: Hiccup, self-recovery

Safety Test(Part# LS10-13B12R3P)				
No.	Test Item	Test Condition	Specification	Test Result
1	Isolation Voltage	Input-Output, Test for 1min., leakage current＜5mA	≥3.6KVAC	PASS
2	Insulation resistance	Input-Output, 500VDC	≥100MΩ	PASS

4.3.2. EMS (EFT: ±2KV, Surge: line to line ±1KV) and EMI (Class B)

This solution can meet the conventional performance in the datasheet, and meet EMS (EFT: ±2KV, Surge: line to line ±1KV) and EMI (Class B).

1) Peripheral circuits, PCB layout and recommended materials are as follows:

Recommended circuit	PCB Design(L*W*H: 59.0mm*29.0mm*20.05mm)

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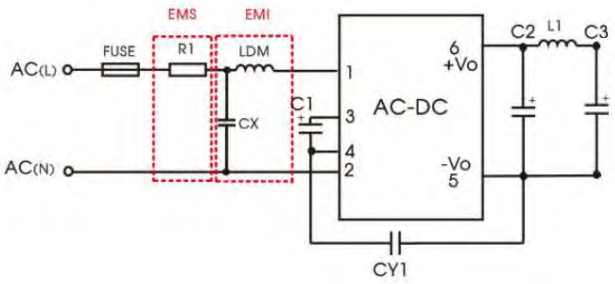
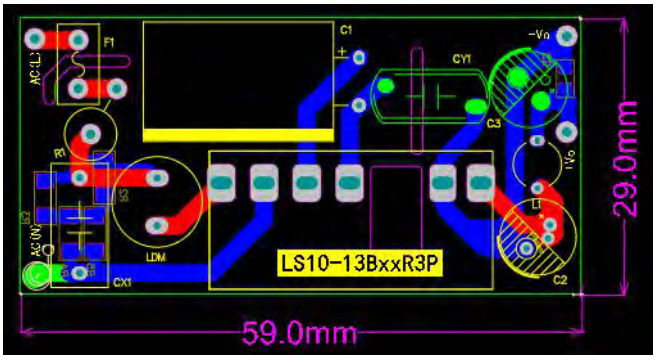
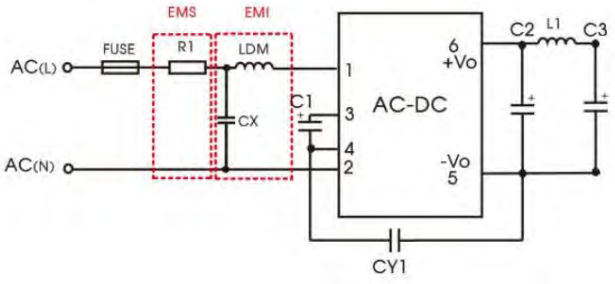
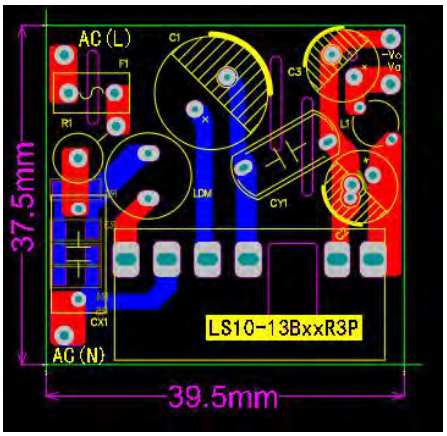


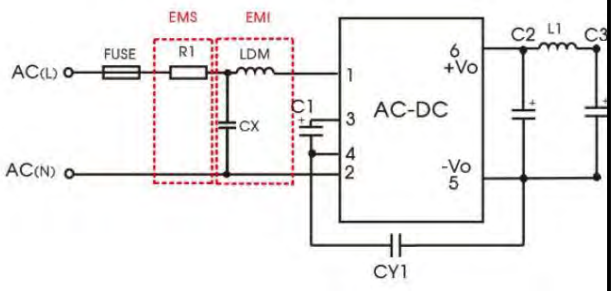


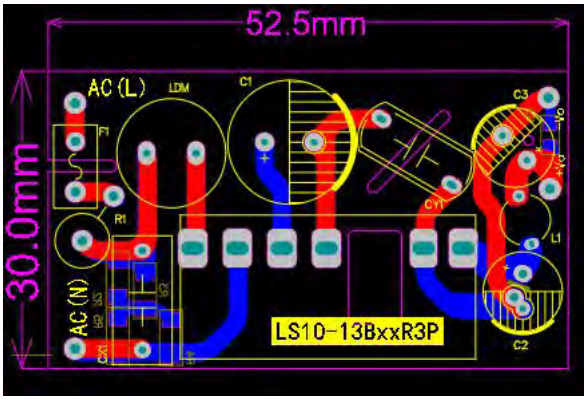
Recommended circuit	PCB Design(L*W*H: 39.5mm*37.5mm*23mm)





Recommended circuit	PCB Design(L*W*H: 52.5mm*30.0mm*23mm)





Note: There are three PCB layouts are recommended. The first one is to meet the strict height requirements, the second one is to meet the strict length and width requirements, and the third one is to meet the strict width requirements.

2) BOM:

PCB position	Type	Spec	Recommended		Recommended material		Recommended material	
			Brand	P/N	Brand	P/N	Brand	P/N

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FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	36911000000
R1	Wire-wound Resistor	6.8Ω/3W	PAK HENG	NKN03BJ6R8	Yageo	RSF3WSJT-73-6R8	Vishay	AC03000006808JAC00
CX	Class-X Capacitor	104K/310VAC	Faratronic	C42Q2104K4SA405	HuaJung	MKP-104K0305AT1108-PV	TDK	B32671Z6104
LDM	Input inductor	1.2mH/0.35A	EMei	DR8X10P2M1.2-00	Wurth	7447720122	Bourns	RLB1014-122KL
C1	Input filter capacitor	22uF/450V	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102MA4DW-400V-F6	Walsin	YU1AH102M070BASDAH	TDK	CD45-E2GA102M-NKA
C2	Output filter capacitor	470uF/16V	SAMXON	UER477M1CF1ATVXOCR	ELITE	UPE1C471MNN0811	Nichicon	RNE1C471MDNASQKX
L1	Output inductor	2.2uH/6.5A	Sunlord	SWPA4030S2R2NT	Chilisin	AMQU000606302R2MA1	Bourns	SRP5030C-2R2M
C3	Output filter capacitor	150uF/35V	SAMXON	ESK157M1JF20TCSHP	Rubycon	35YXG150MEFC8X11.5	Rubycon	35YXG150MEFC8X11.5

3) Test report

General Performance Test(Part# LS10-13B12R3P)				
No.	Test Item	Test Condition	Specification	Test Result
1	No-load power consumption	Input: 230VAC Output: No load Temp.: 25℃	≤0.15W	0.12
2	Output Voltage Accuracy	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	±5%	1.15%
3	Line Regulation	Input: 85 to 305VAC Output: 100%Io Temp.: 25℃	±1.5%	1.16%
4	Load Regulation	Input: 85 to 305VAC Output: 10%Io to 100%Io	±3%	0.93%

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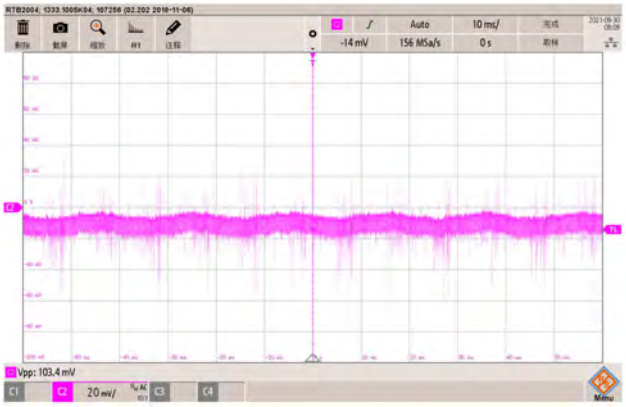
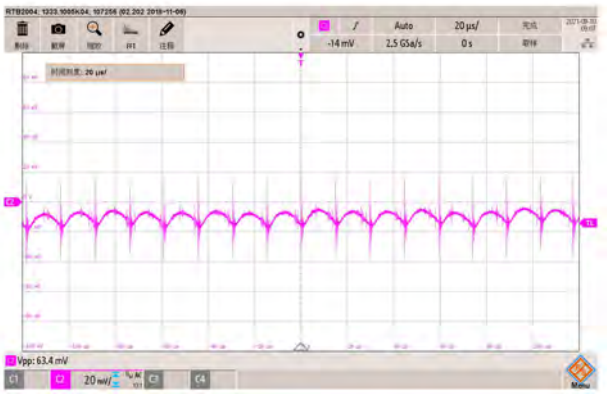
		Temp.: 25℃		
5	Efficiency	Input: 230VAC Output: 100%Io Temp.: 25℃	81%	84.08%
6	Ripple & Noise	Input: 85 to 305VAC Output: 10%Io to 100%Io Temp.: 25℃	150mV	103mV
	Low frequency ripple::		High frequency ripple:	
				

Protection Test(Part# LS10-13B12R3P)

No.	Test Item	Test Condition	Specification	Test Result
1	Over-current Protection	Input: 85VAC Input: 230VAC Input: 305VAC Temp.: 25℃	≥110%Io	122%Io/85VAC 123%Io /230VAC 124%Io A/305VAC
3	Short Circuit Protection	Input: 85VAC Input: 230VAC Input: 305VAC Temp.: 25℃	continuous, self-recovery	Short circuit for one hour without damage Mode: Hiccup, self-recovery

Safety Test(Part# LS10-13B12R3P)

No.	Test Item	Test Condition	Specification	Test Result
1	Isolation Voltage	Input-Output, Test for 1min., leakage current＜5mA	≥3.6KVAC	PASS
2	Insulation resistance	Input to Output: 500VDC	≥100MΩ	PASS

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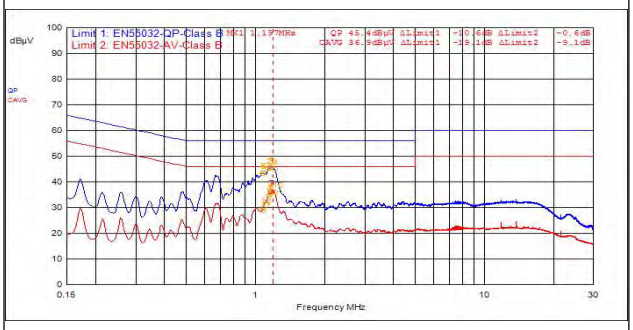
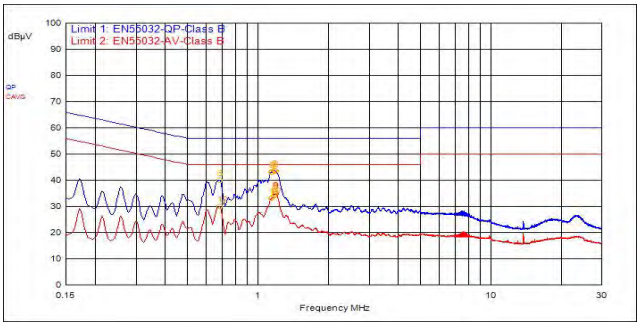
EMC test(Test model: LS10-13B12R3P)				
NO.	Item	Condition	Specification	Result
1	surge	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-5 line to line ±1KV	PASS
2	EFT	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-4 ±2KV	PASS
3	ESD	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	Input: 115V/230VAC Output: 100%Io Ambient temperature: 25℃	CISPR32/EN55032 CLASS B	PASS

115VAC Input L LINE



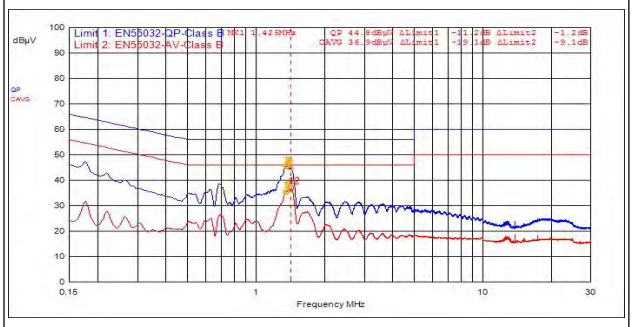
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
7	1.179MHz	0.3	0.2	10.0	C_AVG	25.9	36.4	46.0	-9.6
10	1.212MHz	0.3	0.2	10.0	C_AVG	25.6	36.1	46.0	-9.9
1	1.179MHz	0.3	0.2	10.0	QPeak	35.4	45.9	56.0	-10.1
2	1.140MHz	0.3	0.2	10.0	QPeak	34.9	45.4	56.0	-10.6

115VAC Input N LINE



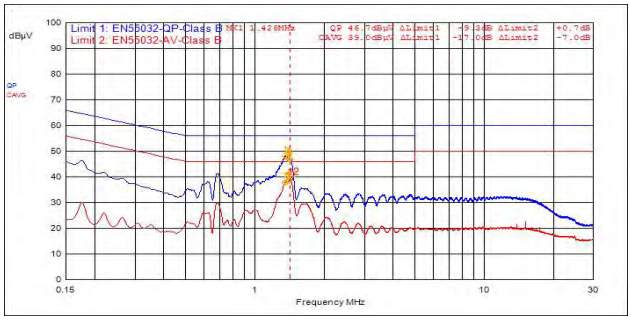
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
9	1.197MHz	0.3	0.2	10.0	C_AVG	24.4	34.9	46.0	-11.1
7	1.185MHz	0.3	0.2	10.0	C_AVG	24.3	34.8	46.0	-11.2
8	1.173MHz	0.3	0.2	10.0	C_AVG	23.6	34.1	46.0	-11.9
1	1.185MHz	0.3	0.2	10.0	QPeak	33.3	43.8	56.0	-12.2

230VAC Input L LINE



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dis
12	1.422MHz	0.3	0.2	10.0	C_AVG	26.3	36.8	46.0	-9.2
10	1.401MHz	0.3	0.2	10.0	C_AVG	25.6	36.1	46.0	-9.9
11	1.395MHz	0.3	0.2	10.0	C_AVG	25.5	36.0	46.0	-10.0
9	1.374MHz	0.3	0.2	10.0	C_AVG	25.2	35.8	46.0	-10.2
1	1.356MHz	0.3	0.2	10.0	QPeak	35.0	45.6	56.0	-10.4

230VAC Input N LINE



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
12	1.422MHz	0.3	0.2	10.0	C_AVG	28.4	39.0	46.0	-7.0
11	1.416MHz	0.3	0.2	10.0	C_AVG	28.3	38.8	46.0	-7.2
10	1.404MHz	0.3	0.2	10.0	C_AVG	27.9	38.4	46.0	-7.6
1	1.350MHz	0.3	0.2	10.0	QPeak	37.8	48.4	56.0	-7.6

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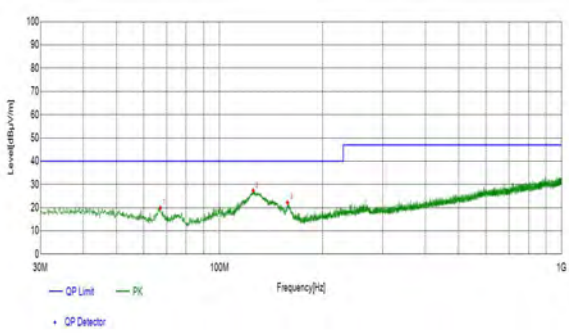
5	Radiation harassment	Input: 115V/230VAC Output: 100%Io Ambient temperature: 25℃	CISPR32/EN55032 CLASS B	PASS

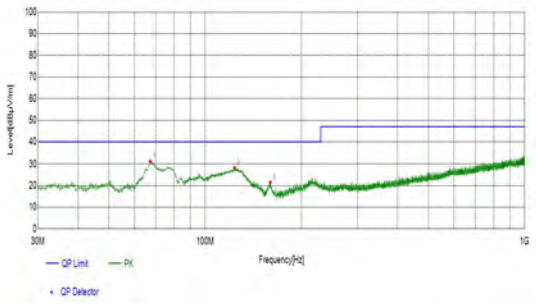
115VAC Input level



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
67.1547	Horizontal	16.81	3.09	19.90	40.00	20.10	PK	100	276	PASS
125.4575	Horizontal	16.84	10.49	27.33	40.00	12.67	PK	100	113	PASS
158.0528	Horizontal	15.93	6.31	22.24	40.00	17.76	PK	100	100	PASS

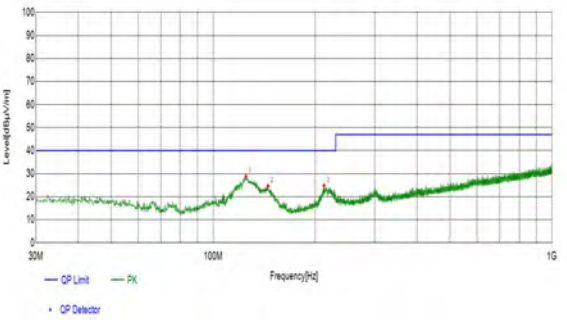
115VAC Input vertical



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
67.3487	Vertical	16.77	14.51	31.28	40.00	8.72	PK	100	95	PASS
123.6144	Vertical	16.98	11.32	28.30	40.00	11.70	PK	100	178	PASS
159.8960	Vertical	15.95	5.56	21.51	40.00	18.49	PK	100	183	PASS

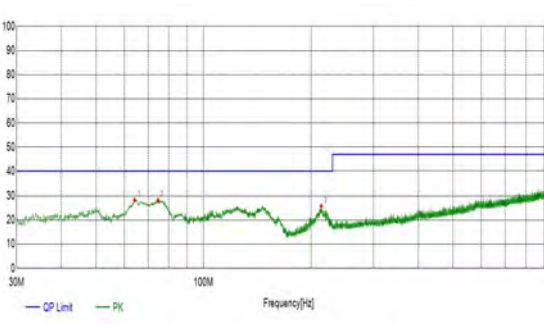
230VAC Input level



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
124.8755	Horizontal	16.88	11.92	28.80	40.00	11.20	PK	100	100	PASS
145.1505	Horizontal	15.80	8.83	24.63	40.00	15.37	PK	100	87	PASS
212.4752	Horizontal	18.79	6.00	24.79	40.00	15.21	PK	100	256	PASS

230VAC Input vertical



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
64.1474	Vertical	17.48	10.82	28.30	40.00	11.70	PK	100	169	PASS
74.6245	Vertical	15.81	12.44	28.25	40.00	11.75	PK	100	200	PASS
213.9304	Vertical	18.80	6.91	25.71	40.00	14.29	PK	100	230	PASS

4.3.3. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A)

The plan can meet the conventional performance in our datasheet, and meet EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A).

1) Design peripheral circuits, PCB layout, and recommended materials list:

Recommended circuit	PCB design(L*W*H:59.0mm*29.0mm*20.05mm)

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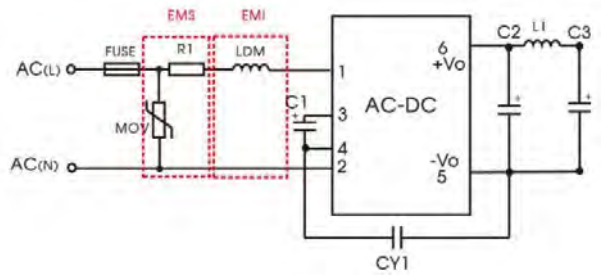
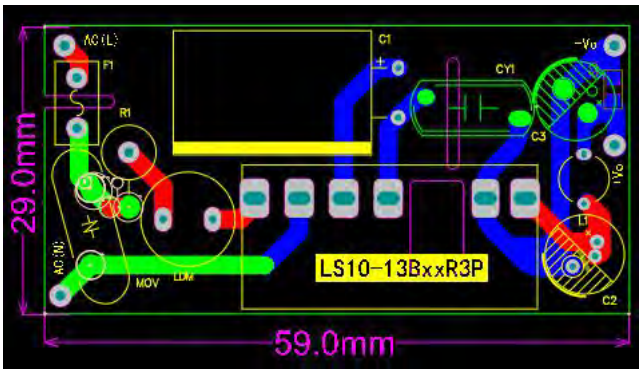
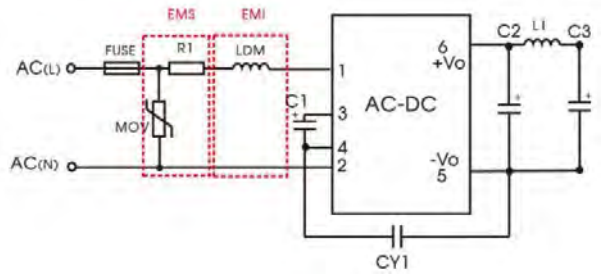
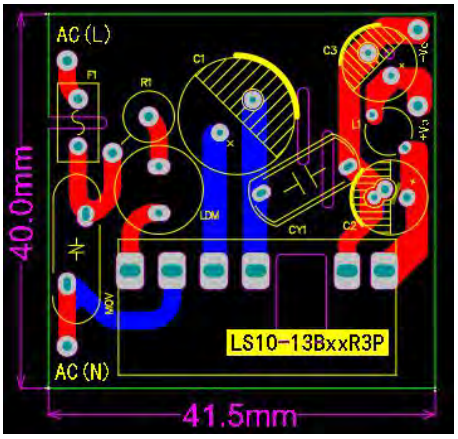
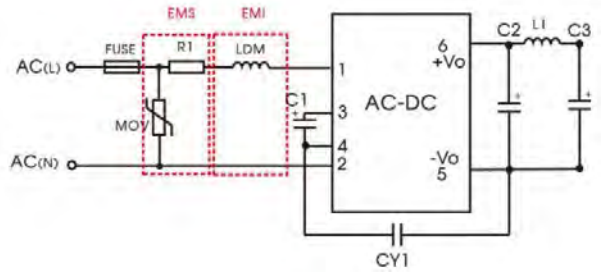
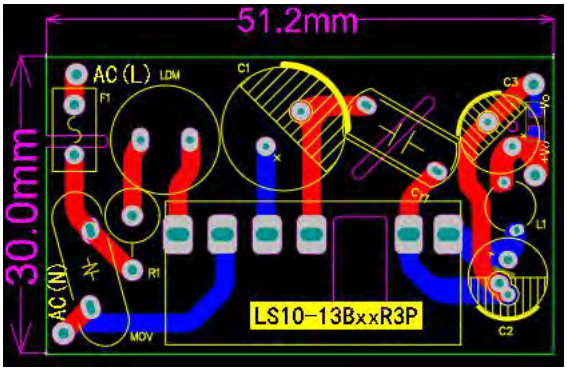
	
Recommended circuit	**PCB design(L*W*H: 41.5mm*40.0mm*23mm)**
	
Recommended circuit	**PCB design(L*W*H: 51.2mm*30.0mm*23mm)**
	

Note: Three PCB layouts are recommended for this solution. The first is to meet the occasions with strict requirements for Height, the second is for occasions with requirements for length, and the third is for occasions with strict requirements for wide.

2）BOM:

PCB position	Type	Spec	Recommended material		Recommended		Recommended material	
			Brand	P/N	Brand	P/N	Brand	P/N

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FUSE	FUSE	2A/300VAC	Better	9321200301	Gongde	MST-2A-300V	Littelfuse	36912000000
MOV	VARISTOR	S14K350	New ford	DNR S14K350	TKS	TVR14561	YAGEO	681KD14
R1	Wire-wound Resistor	6.8Ω/3W	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSFR-73-6R8	Vishay	AC03000006808JAC00
LDM	input inductor	1.2mH/0.35A	Yi mei	DR8X10P2M1.2-00	Wurth	7447720122	Bourns	RLB1014-122KL
C1	Input filter capacitor	22uF/450V	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102MA4DW-400V-F60	Hua xin ke	YU1AH102M070BASD	TDK	CD45-E2GA102M-NKA
C2	Output filter capacitor	470uF/16V	SAMXON	UER477M1CF1ATVXOCR	ELITE	UPE1C471MNN0811	NCC	RNE1C471MDNASQKX
L1	Output inductor	2.2uH/6.5A	Sunlord	SWPA4030S2R2NT	Qi li xin	AMQU000606302R2MA	Bourns	SRP5030C-2R2M
C3	Output filter capacitor	150uF/35V/Φ8*9	SAMXON	ESK157M1JF20TCSHP	Rubycon	35YXG150MEFC8X11.	Rubycon	35YXG150MEFC8X11.5

3）Test report

Routine performance test(Test model: LS10-13B12R3P)				
NO.	Item	Condition	Specification	Result
1	No-load power consumption	Input: 230VAC Output: No load Ambient temperature: 25℃	≤0.15W	0.12
2	Output voltage accuracy	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±5%	1.75%
3	Voltage regulation rate	Input: 85 to 305VAC Output: 100%Io Ambient temperature: 25℃	±1.5%	0.16%
4	Load Regulation	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±3%	1.25%
5	Efficiency	Input: 230VAC	81%	84.08%

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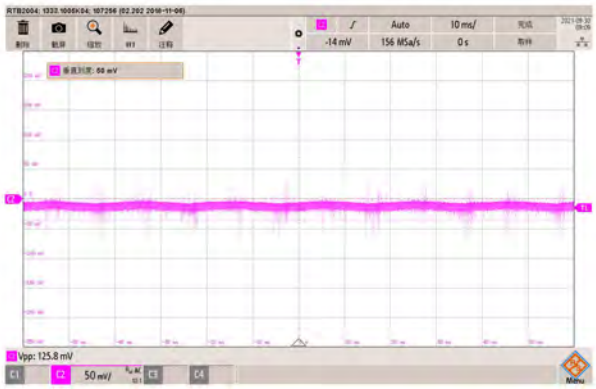
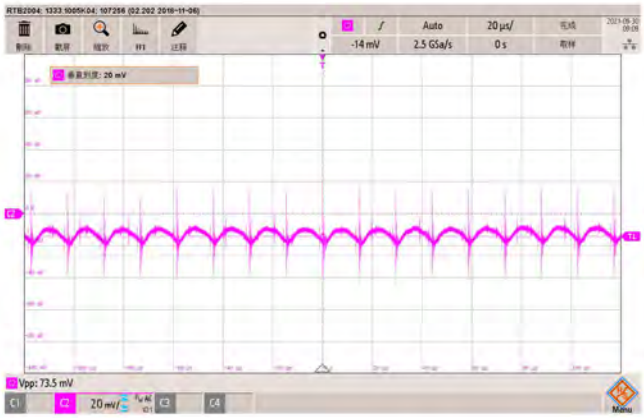
		Output: 100%Io Ambient temperature: 25℃		
6	Ripple noise	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	150mV	125mV
	Low frequency ripple:		High frequency ripple:	
				

Protection test(Test model: LS10-13B12R3P)

NO.	Item	Condition	Specification	Result
1	Overcurrent Protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	≥110%Io	122%Io/85VAC 123%Io /230VAC 124%Io A/305VAC
3	Short circuit Protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	Can be short-circuited for a long time	No damage after one hour short circuit Protection mode: output hiccup, self-recoverable

Safety test (test # LS10-13B12R3P)

No.	Test Item	Test Condition	Specification	Test Result
1	Isolation Voltage	Input-Output, Test for 1min., leakage current＜5mA	≥3.6KVAC	PASS
2	Insulation resistance	Input to Output: 500VDC	≥50MΩ	PASS

EMC test(Test model: LS10-13B12R3P)

NO	Item	Condition	Specification	Result

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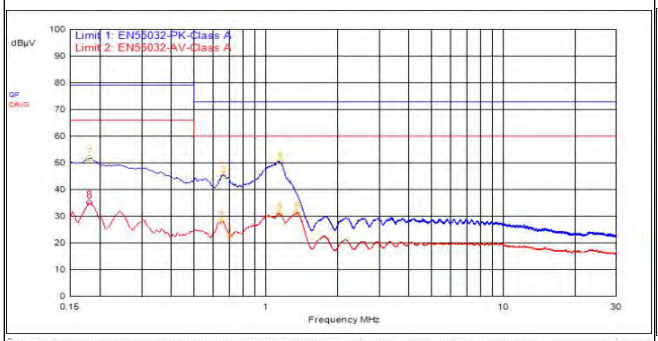
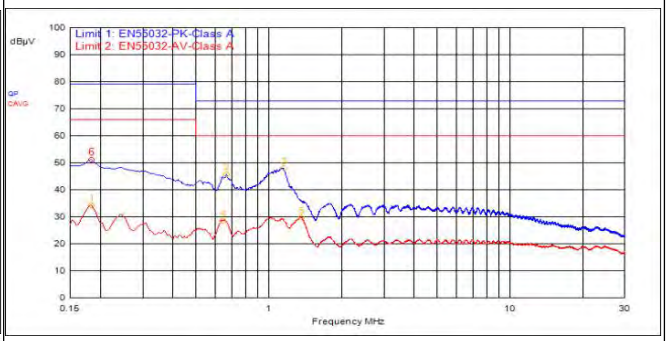
.				
1	surge	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS
2	EFT	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	Input: 115V/230VAC Output: 100%Io Ambient temperature: 25℃	CISPR32/EN55032 CLASS A	PASS

115VAC Input L LINE



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
4	1.143MHz	0.3	0.2	10.0	QPeak	40.1	50.6	73.0	-22.4
7	180.000kHz	0.2	0.2	10.0	QPeak	41.3	51.6	79.0	-27.4
3	660.000kHz	0.2	0.2	10.0	QPeak	34.6	45.0	73.0	-28.0
6	1.347MHz	0.3	0.2	10.0	C_AVG	20.8	31.3	60.0	-28.7
5	1.143MHz	0.3	0.2	10.0	C_AVG	20.5	31.0	60.0	-29.0
8	180.000kHz	0.2	0.2	10.0	C_AVG	24.7	35.1	66.0	-30.9
2	651.000kHz	0.2	0.2	10.0	C_AVG	17.7	28.1	60.0	-31.9
1	705.000kHz	0.2	0.2	10.0	C_AVG	12.1	22.5	60.0	-37.5

115VAC Input N LINE



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.149MHz	0.3	0.2	10.0	QPeak	37.5	48.1	73.0	-24.9
2	666.000kHz	0.2	0.2	10.0	QPeak	35.1	45.6	73.0	-27.4
6	183.000kHz	0.2	0.2	10.0	QPeak	40.8	51.1	79.0	-27.9
5	1.362MHz	0.3	0.2	10.0	C_AVG	19.2	29.8	60.0	-30.2
4	642.000kHz	0.2	0.2	10.0	C_AVG	18.2	28.6	60.0	-31.4
1	183.000kHz	0.2	0.2	10.0	C_AVG	23.9	34.2	66.0	-31.8

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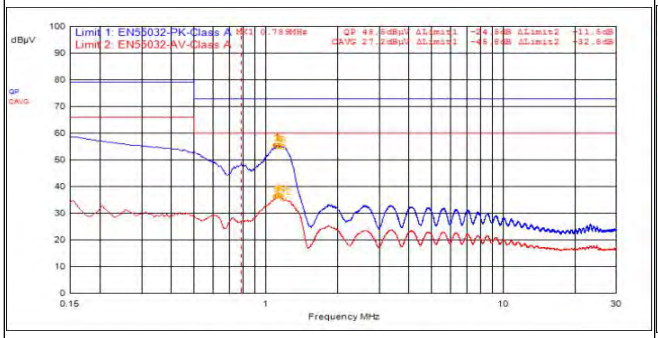
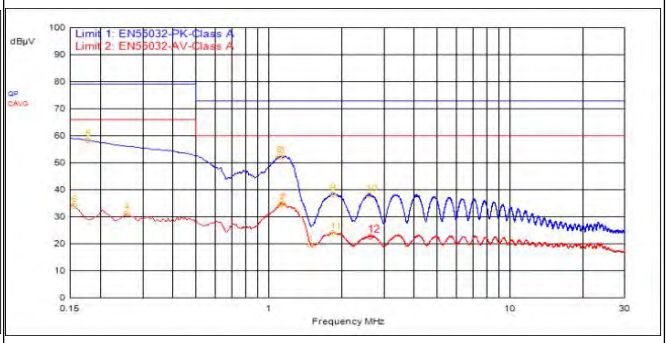
230VAC Input L LINE



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	1.116MHz	0.3	0.2	10.0	QPeak	45.0	55.5	73.0	-17.5
2	1.137MHz	0.3	0.2	10.0	QPeak	44.8	55.3	73.0	-17.7
3	1.107MHz	0.3	0.2	10.0	QPeak	44.8	55.3	73.0	-17.7
4	1.128MHz	0.3	0.2	10.0	QPeak	44.6	55.1	73.0	-17.9
5	1.158MHz	0.3	0.2	10.0	QPeak	44.5	55.0	73.0	-18.0
6	1.185MHz	0.3	0.2	10.0	QPeak	44.4	54.9	73.0	-18.1
8	1.137MHz	0.3	0.2	10.0	C_AVG	26.4	36.9	60.0	-23.1

230VAC Input N LINE

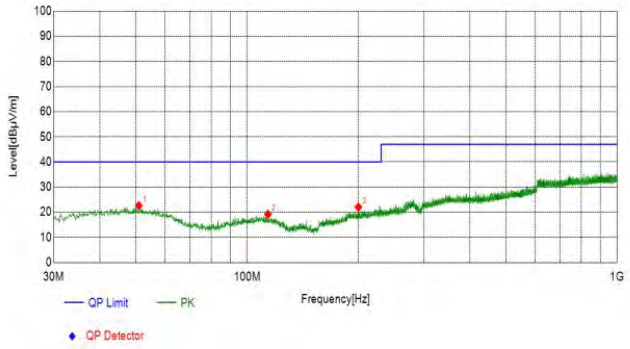


ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
8	1.101MHz	0.3	0.2	10.0	QPeak	41.8	52.3	73.0	-20.7
5	177.000kHz	0.2	0.2	10.0	QPeak	47.9	58.2	79.0	-20.8
3	1.137MHz	0.3	0.2	10.0	QPeak	41.6	52.1	73.0	-20.9
2	1.143MHz	0.3	0.2	10.0	C_AVG	24.3	34.8	60.0	-25.2
7	1.119MHz	0.3	0.2	10.0	C_AVG	24.2	34.7	60.0	-25.3
6	156.000kHz	0.1	0.2	10.0	C_AVG	23.7	34.0	66.0	-32.0
9	1.848MHz	0.3	0.2	10.0	QPeak	27.7	38.2	73.0	-34.8

Radiation harassment	Input: 115V/230VAC Output: 100%Io Ambient temperature: 25℃	CISPR32/EN55032 CLASS A	PASS

115VAC Input

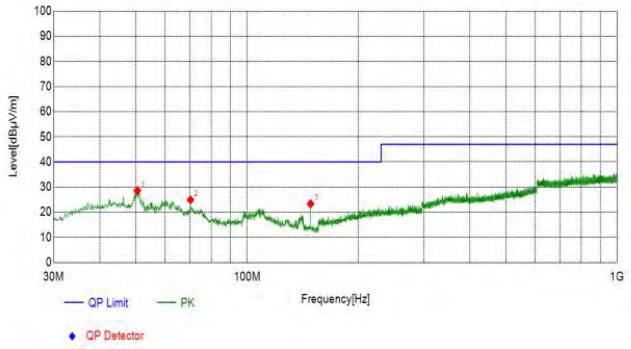
level



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.9541	Horizontal	15.45	7.19	22.64	40.00	17.36	PK	100	151	PASS
113.8164	Horizontal	12.62	6.58	19.20	40.00	20.80	PK	100	141	PASS

115VAC Input

vertical



Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	13.04	28.58	40.00	11.42	PK	100	359	PASS
70.2590	Vertical	9.68	15.27	24.95	40.00	15.05	PK	100	357	PASS

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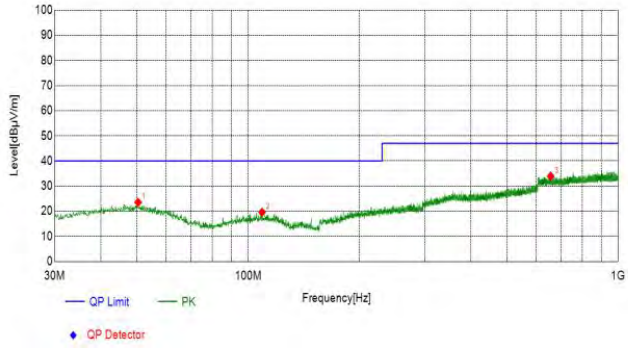
230VAC Input

level

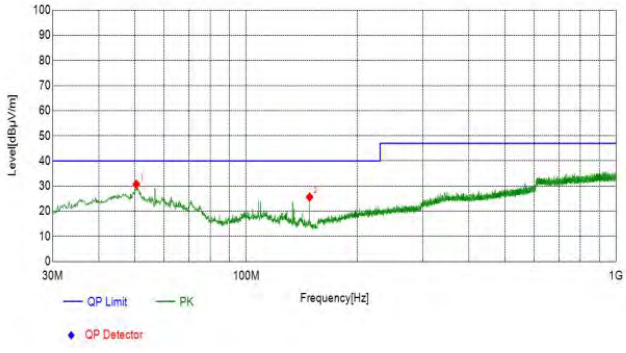


Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.3720	Horizontal	15.56	7.98	23.54	40.00	16.46	PK	100	279	PASS
108.9659	Horizontal	13.20	6.39	19.59	40.00	20.41	PK	100	21	PASS

230VAC Input

vertical



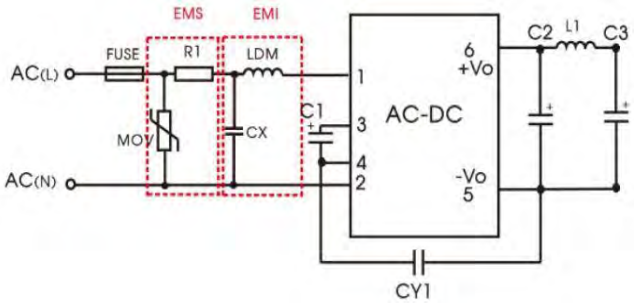
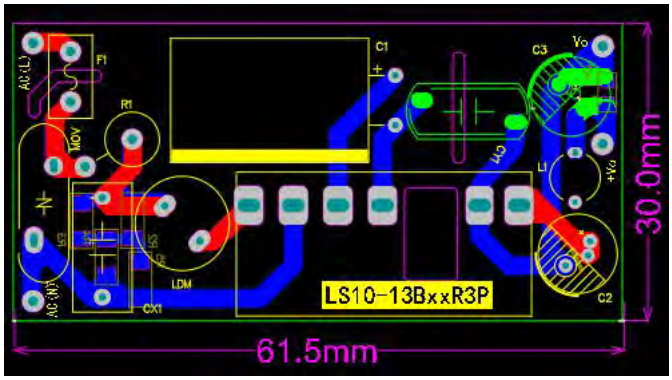
Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	15.23	30.77	40.00	9.23	PK	100	82	PASS

4.3.4. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B)

The plan can meet the conventional performance in our datasheet, and meet EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B)

1) Design peripheral circuits, PCB layout, and recommended materials list:

Recommended circuit	PCB design(L*W*H:61.5mm*30.0mm*20.05mm)
	
Recommended circuit	**PCB design(L*W*H: 39.5mm*37.5mm*23mm)**

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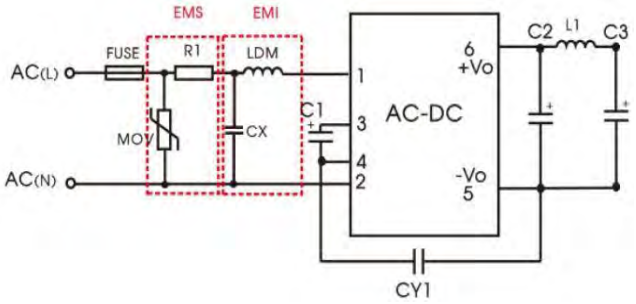
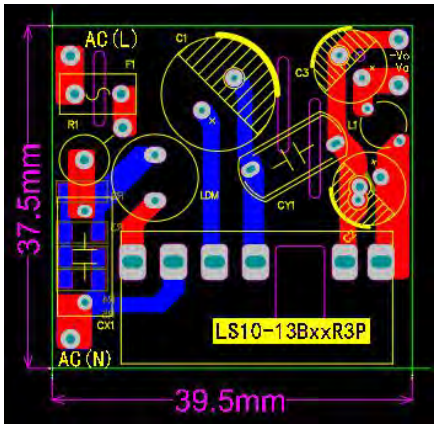
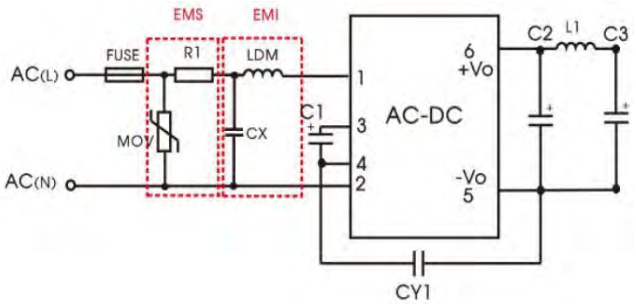
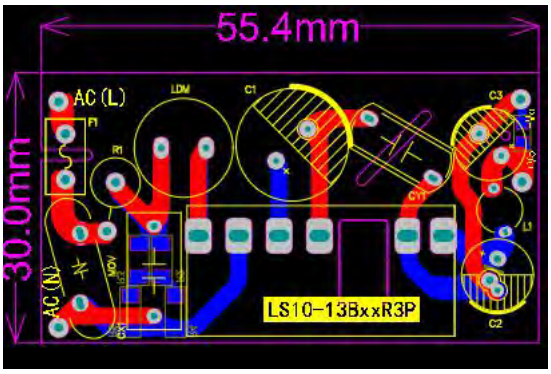




Recommended circuit	PCB design(L*W*H: 55.4mm*30.0mm*23mm)





Note: Three PCB layouts are recommended for this solution. The first is to meet the occasions with strict requirements for Height, the second is for occasions with requirements for length, and the third is for occasions with strict requirements for wide.

2) BOM:

PCB position	Type	Spec	Recommended material		Recommended		Recommended material	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	2A/300VAC	Better	9321200301	Gongde	MST-2A-300V	Littelfuse	36912000000
MOV	VARISTOR	S14K350	New ford	DNR S14K350	TKS	TVR14561	YAGEO	681KD14
R1	Wire-wound Resistor	6.8Ω/3W	PAK HENG	NKN03BJ6R8	Yageo	NKN3WSFR-73-6R8	Vishay	AC03000006808JAC00
CX	Class-X Capacitor	104K/310VAC	Faratronic	C42Q2104K4SA405	Huahung	MKP-104K03050AT1108-PV	TDK	B32912A3104K
LDM	Input inductor	1.2mH/0.35A	Dong guan Yi mei	DR8X10P2M1.2-00	Wurth	7447720122	Bourns	RLB1014-122KL

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C1	Input filter capacitor	22uF/450V	SAMXON	ERD226M2WI 20RR4RF	Rubycon	450BXW22ME FR18X16	Rubycon	450BXW22MEFR1 2.5X20
CY1	Class-Y Capacitor	1nF/ 400VAC	Wmec	HJE102MA4D W-400V-F6001	Hua xin ke	YU1AH102M0 70BASDAH	TDK	CD45-E2GA102M- NKA
C2	Output filter capacitor	470uF/16V	SAMXON	UER477M1CF 1ATVXOCR	ELITE	UPE1C471MN N0811	Nichicon	RNE1C471MDNA SQKX
L1	Output inductor	2.2uH/6.5A	Sunlord	SWPA4030S2 R2NT	Qi li xin	AMQU000606 302R2MA1	Bourns	SRP5030C-2R2M
C3	Output filter capacitor	150uF/35V	SAMXON	ESK157M1JF2 0TCSHP	Rubycon	35YXG150ME FC8X11.5	Rubycon	35YXG150MEFC8 X11.5

3) Test report

Routine performance test(Test model: LS10-13B12R3P)				
NO.	Item	Condition	Specification	Result
1	No-load power consumption	Input: 230VAC Output: No load Ambient temperature: 25℃	≤0.15W	0.12
2	Output voltage accuracy	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±5%	1.75%
3	Voltage regulation rate	Input: 85 to 305VAC Output: 100%Io Ambient temperature: 25℃	±1.5%	0.16%
4	Load Regulation	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±3%	1.25%
5	Efficiency	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	81%	84.08%
6	Ripple noise	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	150mV	108mV
	Low frequency ripple:		High frequency ripple:	

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	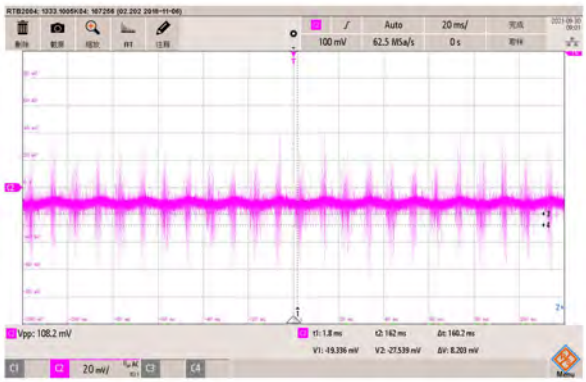	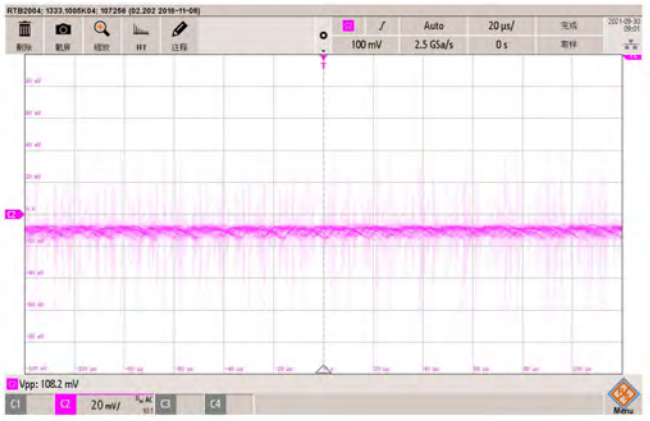

Protection test(Test model: LS10-13B12R3P)				
NO.	Item	Condition	Specification	Result
1	Overcurrent Protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	≥110%Io	122%Io/85VAC 123%Io /230VAC 124%Io A/305VAC
3	Short circuit Protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	Can be short-circuited for a long time	No damage after one hour short circuit Protection mode: output hiccup, self-recoverable

Safety test(testLS10-13B12R3P)				
No.	Test Item	Test Condition	Specification	Test Result
1	Isolation Voltage	Input-Output, Test for 1min., leakage current＜5mA	≥3.6KVAC	PASS
2	Insulation resistance	Input to Output: 500VDC	≥50MΩ	PASS

EMC test(Test model: LS10-13B12R3P)				
NO.	Item	Condition	Specification	Result
1	surge	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS

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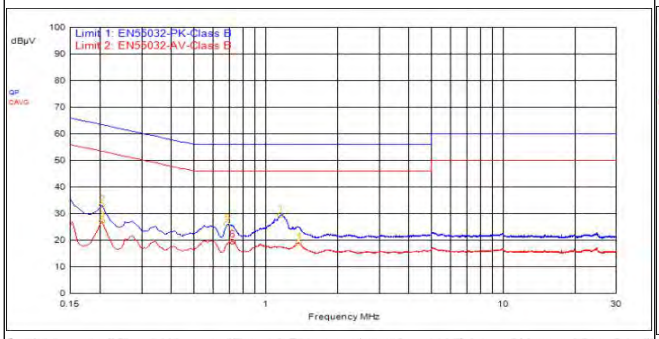
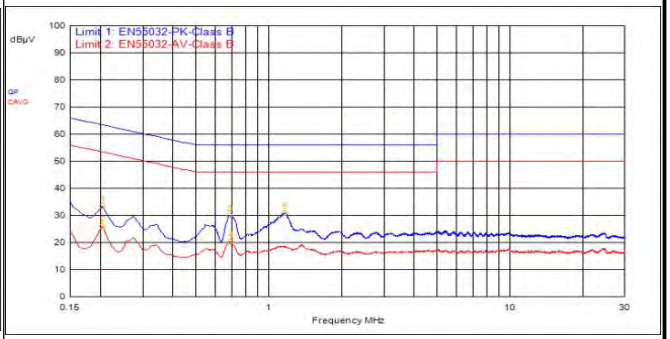
2	EFT	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	Input: 115V/230VAC Output: 100%Io Ambient temperature: 25℃	CISPR32/EN55032 CLASS B	PASS

115VAC Input L LINE



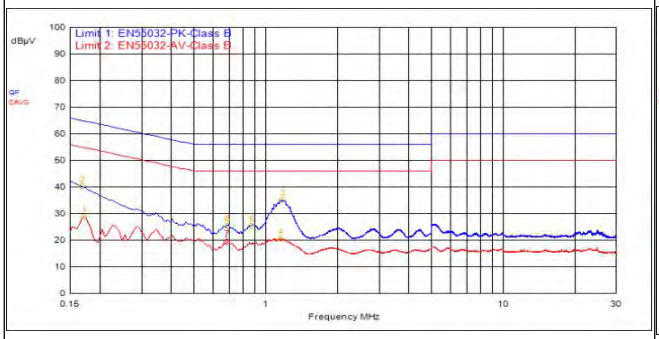
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	204.000kHz	0.2	0.2	10.0	C_AVG	16.8	27.2	53.4	-26.3
1	1.158MHz	0.3	0.2	10.0	QPeak	19.0	29.5	56.0	-26.5
6	720.000kHz	0.2	0.2	10.0	C_AVG	9.0	19.5	46.0	-26.5
4	1.377MHz	0.3	0.2	10.0	C_AVG	8.6	19.1	46.0	-26.9
5	687.000kHz	0.2	0.2	10.0	QPeak	15.4	25.9	56.0	-30.1
2	204.000kHz	0.2	0.2	10.0	QPeak	22.7	33.1	63.4	-30.4

115VAC Input N LINE



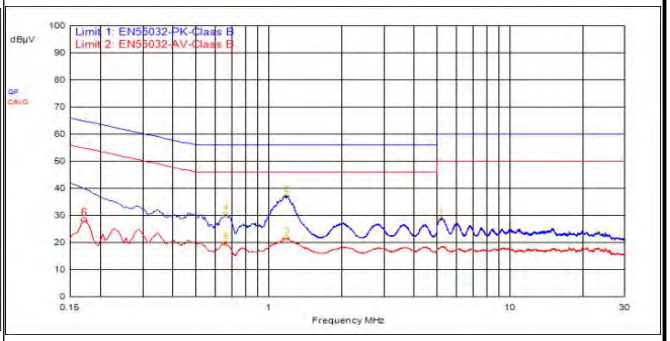
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
5	1.164MHz	0.3	0.2	10.0	QPeak	20.4	30.9	56.0	-25.1
4	690.000kHz	0.2	0.2	10.0	C_AVG	9.8	20.2	46.0	-25.8
3	684.000kHz	0.2	0.2	10.0	QPeak	19.5	29.9	56.0	-26.1
2	204.000kHz	0.2	0.2	10.0	C_AVG	15.7	26.1	53.4	-27.4
1	204.000kHz	0.2	0.2	10.0	QPeak	22.9	33.3	63.4	-30.1

230VAC Input L LINE



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.179MHz	0.3	0.2	10.0	QPeak	24.7	35.2	56.0	-20.8
2	168.000kHz	0.1	0.2	10.0	QPeak	29.9	40.2	65.1	-24.8
4	1.155MHz	0.3	0.2	10.0	C_AVG	10.1	20.6	46.0	-25.4
1	171.000kHz	0.1	0.2	10.0	C_AVG	18.4	28.8	54.9	-26.2
7	687.000kHz	0.2	0.2	10.0	C_AVG	8.9	19.3	46.0	-26.7
5	870.000kHz	0.3	0.2	10.0	QPeak	15.0	25.5	56.0	-30.5
6	684.000kHz	0.2	0.2	10.0	QPeak	15.1	25.5	56.0	-30.5

230VAC Input N LINE



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	1.182MHz	0.3	0.2	10.0	QPeak	26.7	37.2	56.0	-18.8
3	1.182MHz	0.3	0.2	10.0	C_AVG	11.1	21.6	46.0	-24.4
4	663.000kHz	0.2	0.2	10.0	QPeak	19.9	30.3	56.0	-25.7
5	660.000kHz	0.2	0.2	10.0	C_AVG	9.4	19.8	46.0	-26.2
6	171.000kHz	0.1	0.2	10.0	C_AVG	17.9	28.2	54.9	-26.7
1	5.181MHz	0.5	0.2	10.0	QPeak	18.1	28.8	60.0	-31.2

	Radiation harassment	Input: 115V/230VAC Output: 100%Io Ambient temperature: 25℃	CISPR32/EN55032 CLASS B	PASS

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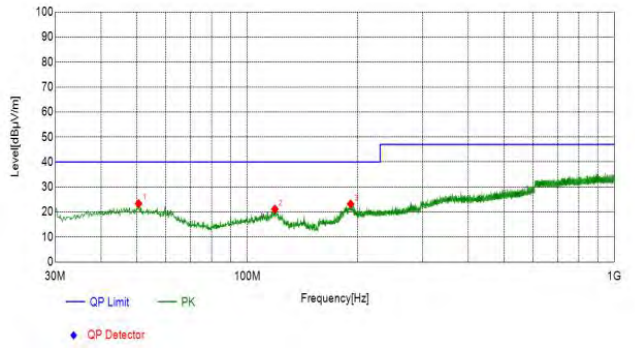
115VAC Input

level

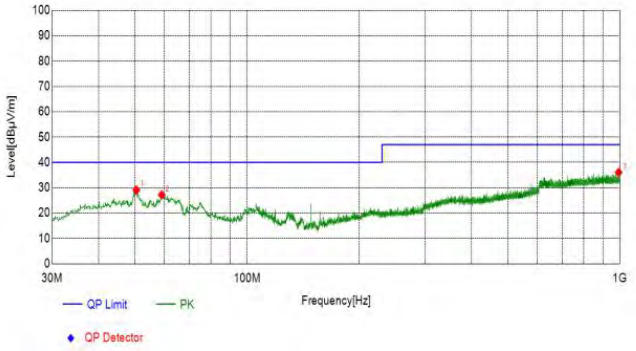


Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.5661	Horizontal	15.52	7.79	23.31	40.00	16.69	PK	100	189	PASS

115VAC Input

vertical

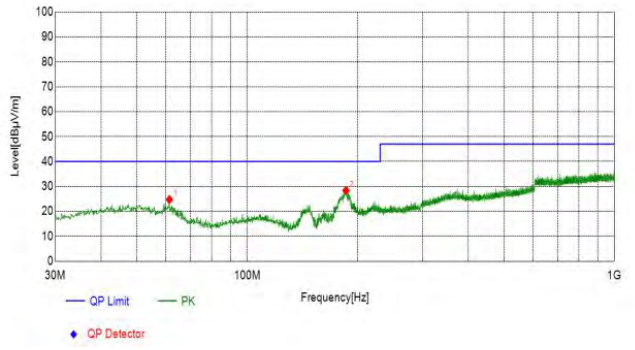


Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	13.54	29.08	40.00	10.92	PK	100	348	PASS

230VAC Input

level

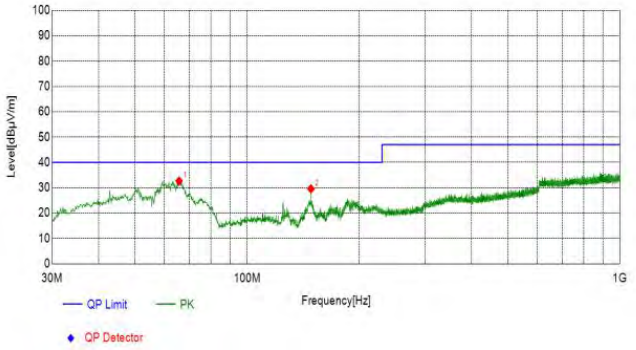


Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
61.3341	Horizontal	13.18	11.60	24.78	40.00	15.22	PK	100	0	PASS

230VAC Input

vertical



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
65.6996	Vertical	11.43	21.22	32.65	40.00	7.35	PK	100	238	PASS

4.3.5. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B) meets EN60335 standard

The plan can meet the conventional performance in our datasheet, and meet EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B)

1) Design peripheral circuits, PCB layout, and recommended materials list:

Recommended circuit	PCB design(L*W*H: 62.0mm*29.8mm*20.05mm)

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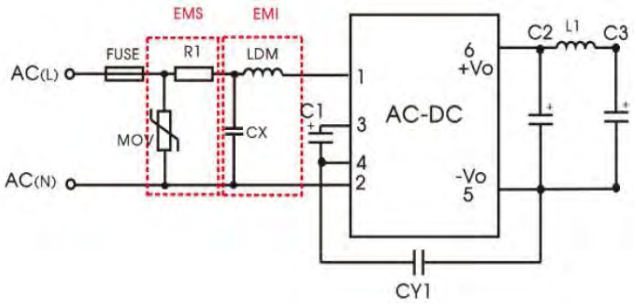
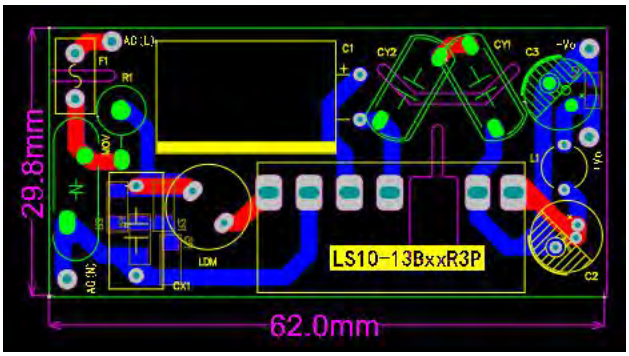
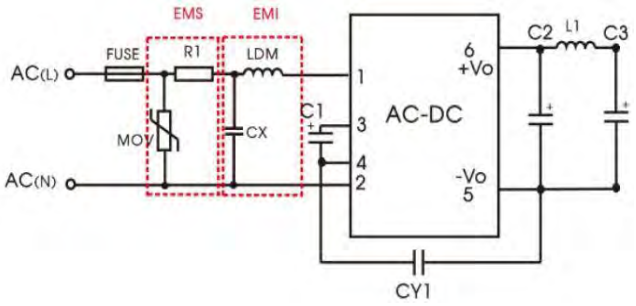
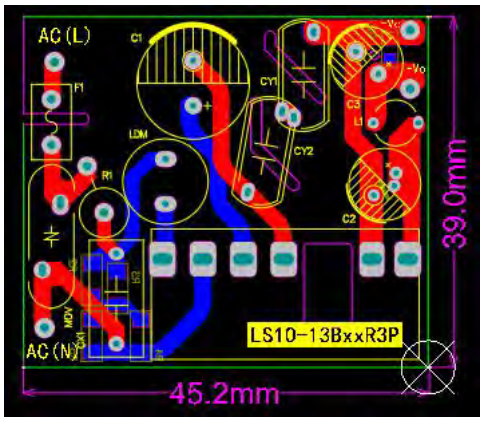


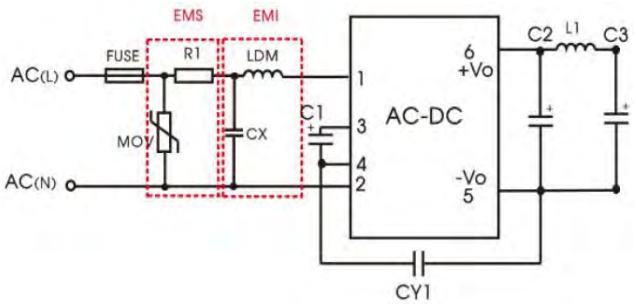


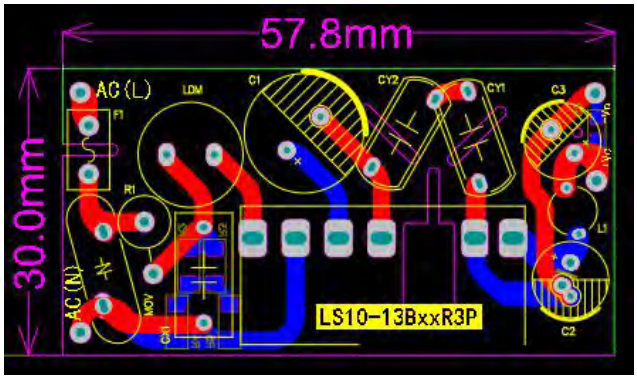
Circuit plan	PCB design(L*W*H: 45.2mm*39.0mm*23mm)





Circuit plan	PCB design(57.8mm*30.0mm*23mm)





Note: Three PCB layouts were recommended to this solution. The first type is to meet the occasion that has requirement for height, the second one is for those has requirement for length and the last one is for those has requirement for Width.

2) **BOM:**

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
CY1/CY2	Y2 Cap	1nF/ 250VAC	WMEC	HME102M	Walsin	YU1AC102 M060	TDK	CS80-E2G A102MY

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Note: The only difference between two Y cap solution and part 4.3.4 single Y cap solution are on the distance of PCB and raw materials of Y cap. Test result of the two solutions do not have much difference. Therefore, the recommend materials list can refer to the test data and specification of other components of 4.3.4 except Y cap.

3) Test report

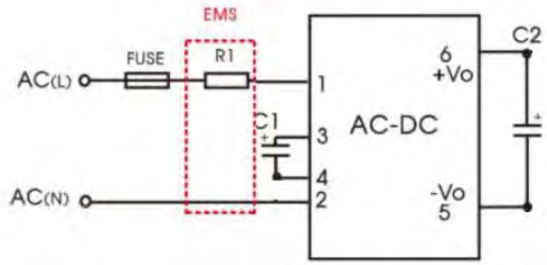
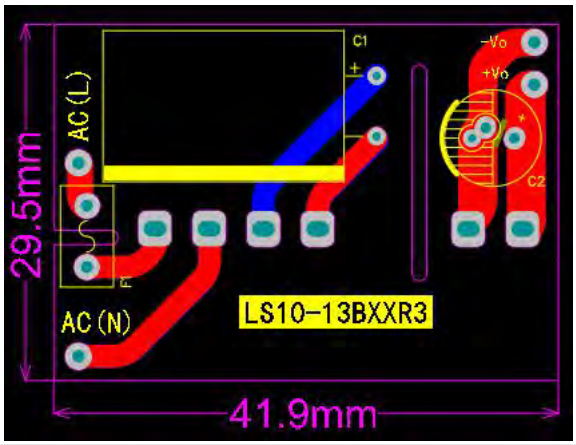
Test result between two Y cap solution and part 4.3.4 single Y cap solution do not have much difference. The only difference is on the distance of PCB and raw materials of Y cap. Therefore, test result can refer to the test report on 4.3.4.

4.4. LS10-13BxxR3 series uses 12VDC output as an example to recommend solutions and data packages

4.4.1. Minimization solution (Achieve normal output function)

This solution can achieve normal output of power supply module, but we do not promise other performance. This solution suitable for strict cost requirements, but no performance requirements application.

1) Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H: 41.9mm*29.5mm*21.05mm)
	
Recommend circuit	**PCB layout(L*W*H: 37.5mm*29.5mm*23mm)**

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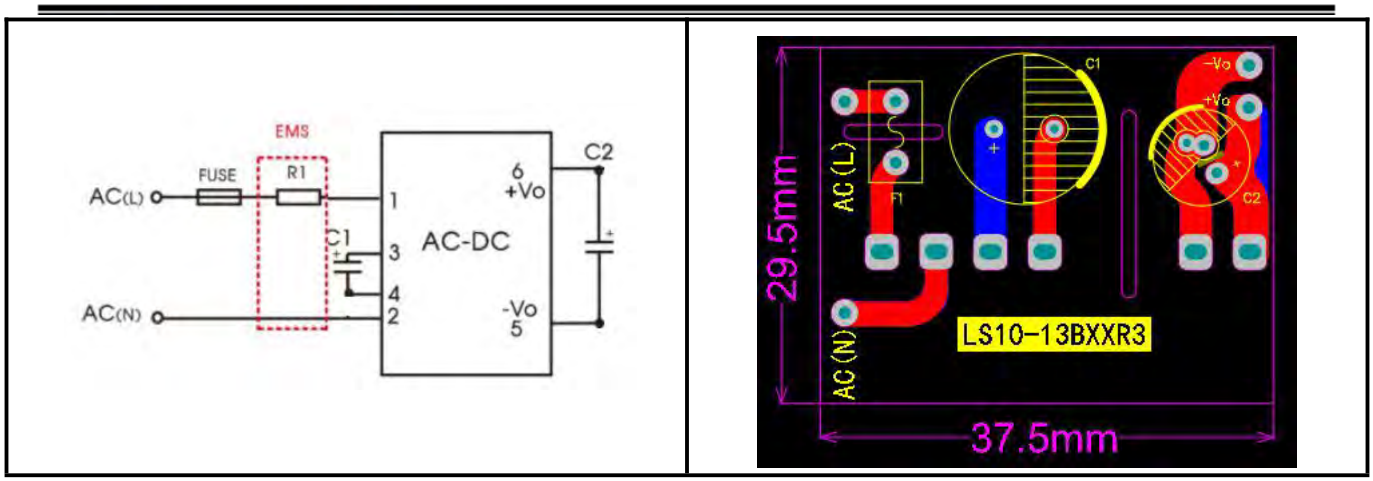

Note: There are two kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited.

2) Recommended Materials List:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	36911000000
R1	Wire-wound Resistor	6.8Ω/3W	PAK HENG	NKN03BJ6R8	Yageo	NKN3WSFR-73-6R8	Vishay	AC03000006808JAC00
C1	Input filter capacitor	22uF/450V	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
C2	Output filter capacitor	270uF/16V/Φ6.3*8	SAMXON	UER277M1CE08TUX0CR	ELITE	UPE1C271MNN6308	NCC	RS81C271MDN1

Note: We recommend three device combinations, you can choose any one.

3) Test report

General performance test(test module: : LS10-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	NO LOAD POWER CONSUMPTION	I/P: : 230VAC O/P: No load Ta: 25℃	≤0.15W	0.12W

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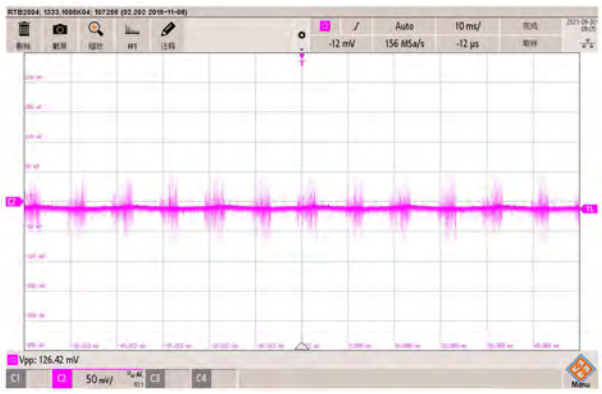
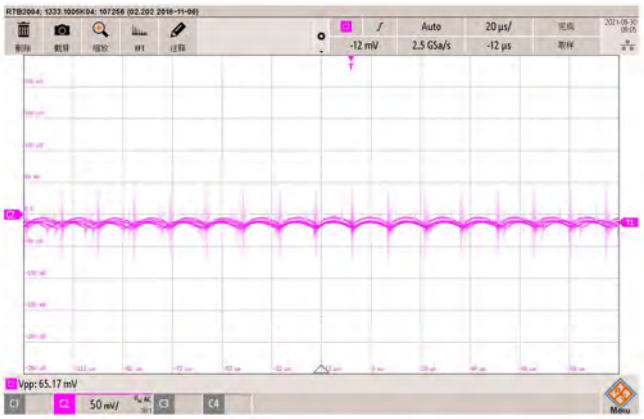
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±2%	0.75%
3	OUTPUT VOLTAGE TOLERANCE	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±1%	0.16%
4	LOAD REGULATION	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	±1.5%	0.25%
5	EFFICIENCY(Typ.)	I/P: 230VAC O/P: 100%Io Ta: 25℃	80%	82.88%
6	RIPPLE & NOISE(Max)	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: 25℃	150mV	126mV
	low frequency:		high frequency:	
				

Protection function test(test module: LS10-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	Over-current Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta: : 25℃	≥110%Io	136%Io/85VAC 145%Io/230VAC 146%Io/305VAC
3	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta: : 25℃	Can short circuit for long time	Short output 1 hour no damage, Hiccup mode, recovers automatically after

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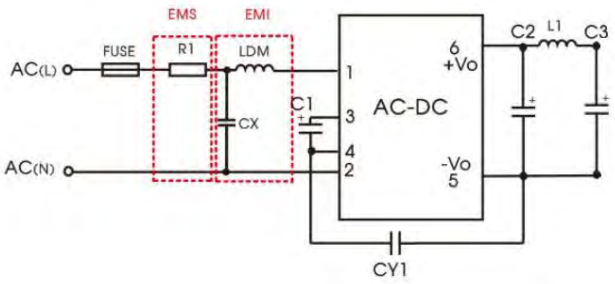
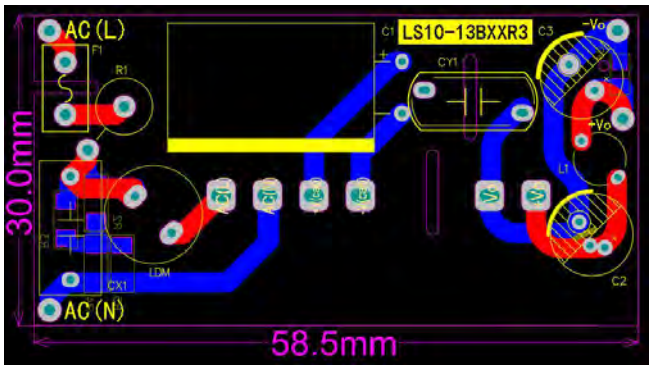
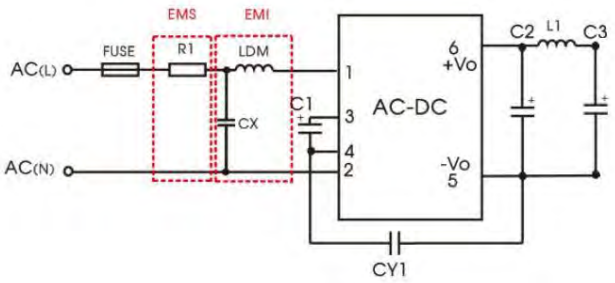
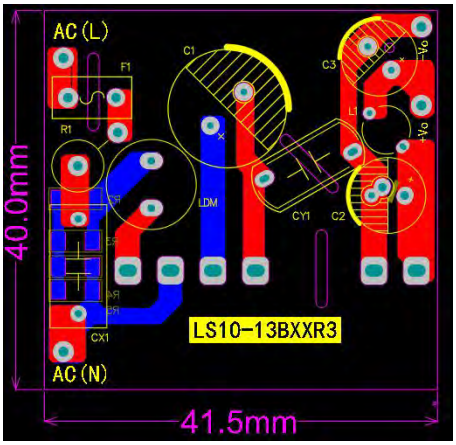
				fault condition is removed
Safety test(test module: LS10-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	WITHSTAND VOLTAGE	I/P to O/P: testing time 1 mins, leakage current＜5mA	≥3.6KVAC	PASS
2	ISOLATION RESISTANCE	I/P to O/P: 500VDC	≥100MΩ	PASS

4.4.2. EMS (EFT: ±2KV, Surge: line to line ±1KV) and EMI (Class B)

This solution can meet all the performance in our datasheet, as well as EMS (EFT: ±2KV, Surge: line to line: ±1KV) and EMI (Class B).

1) Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H: 58.5mm*30.0mm*21.05mm)
	
Recommend circuit	**PCB layout(L*W*H: 41.5mm*40.0mm*23mm)**
	
Recommend circuit	**PCB layout(L*W*H: 54.7mm*30.0mm*23mm)**

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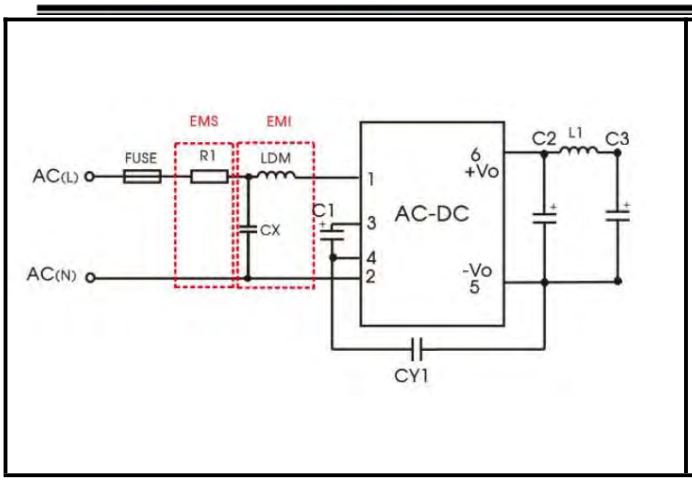

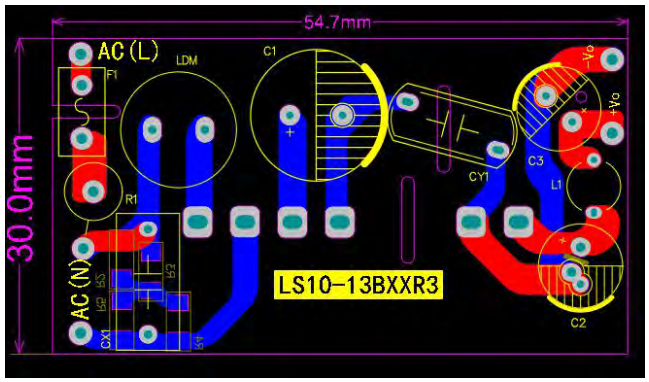

Note: There are three kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2) BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	1A/300VAC	Better	9321100	Conquer	MST-1A-300V	Littelfuse	36911000000
R1	Wire-wound Resistor	6.8Ω/3W	PAK HENG	NKN03BJ6R8	Yageo	RSF3WSJT-73-6R8	Vishay	AC03000006808JAC00
CX	Class-X Capacitor	104K/310VAC	faratronic	C42Q2104K4SA405	HJC	MKP-104K03 05AT1108-PV	TDK	B32671Z6104
LDM	Input inductor	2.2mH/0.24A	Hua Chen	HCRC0312T-2ROM	Wurth	7447720222	Bourns	RLB1014-222KL-ND
C1	Input filter capacitor	22uF/450V	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	wmec	HJE102MA4DW-400V-F6001	walsin	YU1AH102M070BASDAH	TDK	CD45-E2GA102M-NKA
C2	Output filter	270uF/16V	SAMXON	UER277M1CE08TUXOCR	ELITE	UPE1C271MNN6308	Nichicon	PLS1C271MDO1
L1	Output inductor	2.2uH/6.5A	Hua Chen	SWPA4030S2R2NT	chilisin	AMQU000606302R2MA1	Bourns	SRP5030C-2R2M
C3	Output filter	150uF/35V	SAMXON	ESK157M1JF20TCSHP	Rubycon	35YXG150MEFC8X11.5	Rubycon	35YXG150MEFC8X11.5

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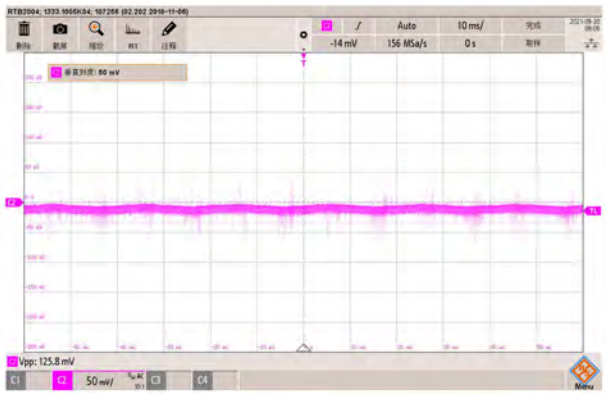
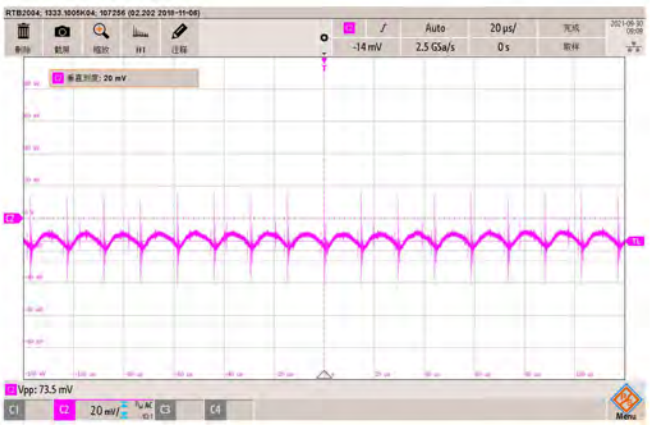
3) Test Report

General performance test(test module: LS10-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	NO LOAD POWER CONSUMPTION	I/P: 230VAC O/P: No load Ta: : 25℃	≤0.15W	0.12W
2	Output Voltage Accuracy	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: : 25℃	±2%	0.75%
3	OUTPUT VOLTAGE TOLERANCE	I/P: 85 to 305VAC O/P: 100%Io Ta: : 25℃	±1%	0.16%
4	LOAD REGULATION	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: : 25℃	±1.5%	0.25%
5	EFFICIENCY(Typ.)	I/P: 230VAC O/P: 100%Io Ta: : 25℃	80%	82.88%
6	RIPPLE & NOISE(Max)	I/P: 85 to 305VAC O/P: 10%Io to 100%Io Ta: : 25℃	150mV	125mV
	low frequency:		high frequency:	
				

Protection function test(test moduleLS10-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	Over-current Protection	I/P: 85VAC	≥110%Io	1.13A/85VAC

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		I/P: 230VAC I/P: 305VAC Ta: : 25℃		1.20A/230VAC 1.21A/305VAC
3	Short Circuit Protection	I/P: 85VAC I/P: 230VAC I/P: 305VAC Ta: : 25℃	Can Short output for long term	Short output 1 hour no damage Hiccup mode, recovers automatically after fault condition is removed

Safety test(test module: LS10-13B12R3)				
No.	Test Item	Test Condition	Specification	Test Result
1	Isolation Voltage	Input-Output, Test for 1min., leakage current＜5mA	≥3.6KVAC	PASS
2	Insulation resistance	Input to Output: 500VDC	≥100MΩ	PASS

EMC test(test module: LS05-13B12R3)				
NO	TEST ITEM	SPECIFICATION	SPECIFICATION	RESULT
1	surge	I/P: 230VAC O/P: 100%Io Ta: : 25℃	IEC/EN61000-4-5 line to line ±1KV	PASS
2	EFT	I/P: 230VAC O/P: 100%Io Ta: : 25℃	IEC/EN61000-4-4 ±2KV	PASS
3	ESD	I/P: 230VAC O/P: 100%Io Ta: : 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	I/P: 115V/230VAC O/P: 100%Io Ta: : 25℃	CISPR32/EN55032 CLASS B	PASS

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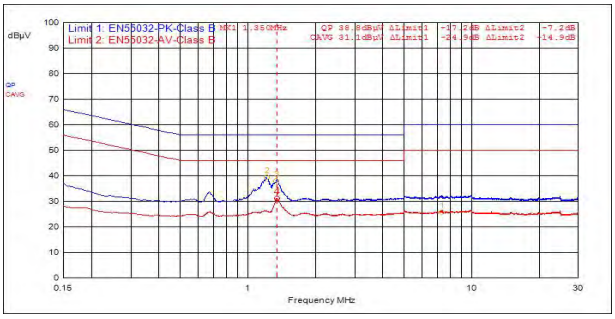
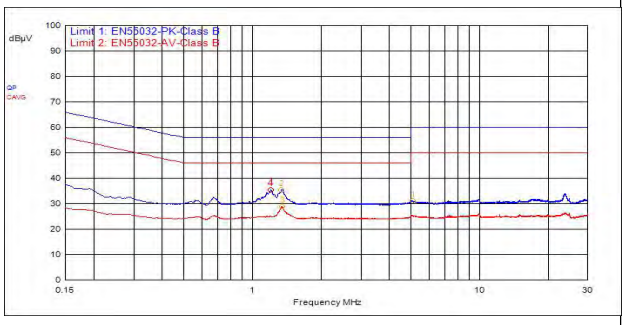
115VAC I/P L Line



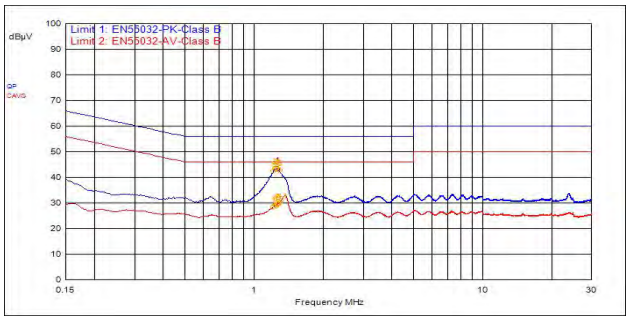
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
4	1.347MHz	0.3	0.2	10.0	C_AVG	20.6	31.1	46.0	-14.9
2	1.212MHz	0.3	0.2	10.0	QPeak	28.8	39.3	56.0	-16.7
3	1.341MHz	0.3	0.2	10.0	QPeak	27.5	38.1	56.0	-17.9
1	7.368MHz	0.6	0.2	10.0	C_AVG	14.9	25.8	50.0	-24.2

115VAC I/PN Line



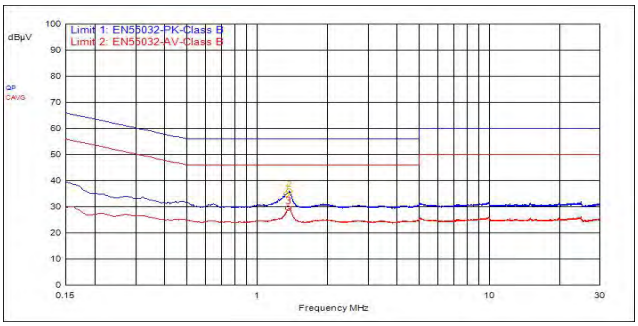
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.350MHz	0.3	0.2	10.0	C_AVG	18.3	28.8	46.0	-17.2
2	1.341MHz	0.3	0.2	10.0	QPeak	24.8	35.3	56.0	-20.7
4	1.206MHz	0.3	0.2	10.0	QPeak	24.8	35.3	56.0	-20.7
1	5.064MHz	0.5	0.2	10.0	QPeak	20.4	31.1	60.0	-28.9

230VAC I/P L Line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	1.263MHz	0.3	0.2	10.0	QPeak	32.9	43.5	56.0	-12.5
2	1.239MHz	0.3	0.2	10.0	QPeak	32.8	43.3	56.0	-12.7
3	1.275MHz	0.3	0.2	10.0	QPeak	32.6	43.1	56.0	-12.9
4	1.251MHz	0.3	0.2	10.0	QPeak	32.5	43.0	56.0	-13.0

230VAC I/P N Line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.368MHz	0.3	0.2	10.0	C_AVG	18.7	29.3	46.0	-16.7
2	1.374MHz	0.3	0.2	10.0	QPeak	25.4	35.9	56.0	-20.1
1	1.335MHz	0.3	0.2	10.0	QPeak	24.3	34.8	56.0	-21.2

RADIATION	I/P: 115V/230VAC O/P: 100%Io Ta: : 25℃	CISPR32/EN55032 CLASS B	PASS

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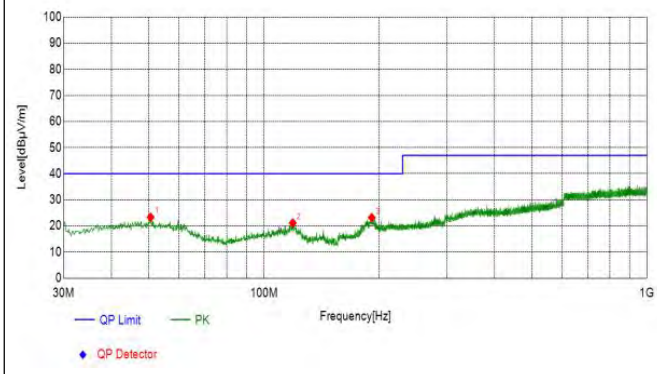
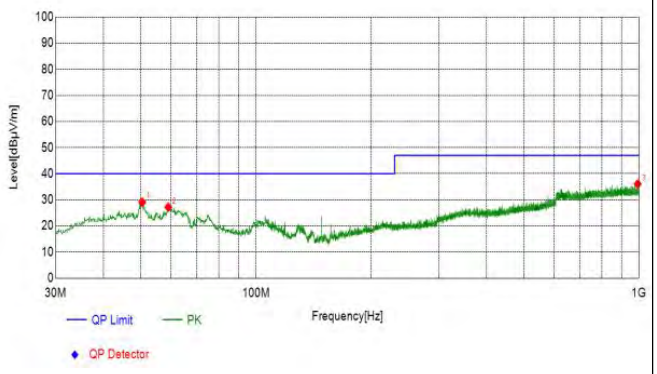
115VAC I/P Horizontal



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.5661	Horizontal	15.52	7.79	23.31	40.00	16.69	PK	100	189	PASS
118.8609	Horizontal	11.74	9.41	21.15	40.00	18.85	PK	100	5	PASS
191.1331	Horizontal	12.17	11.03	23.20	40.00	16.80	PK	100	1	PASS

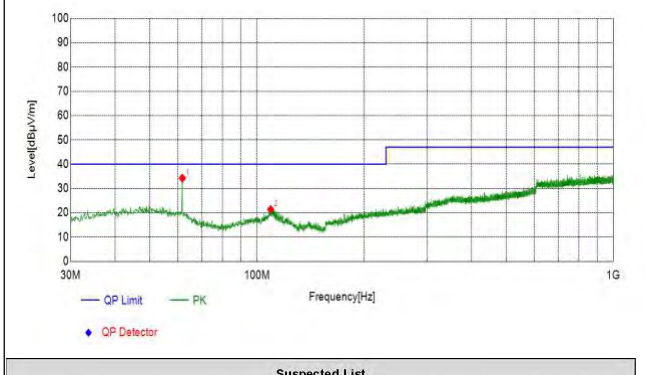
115VAC I/P Vertical



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	13.54	29.08	40.00	10.92	PK	100	348	PASS
59.0059	Vertical	13.90	13.31	27.21	40.00	12.79	PK	100	21	PASS

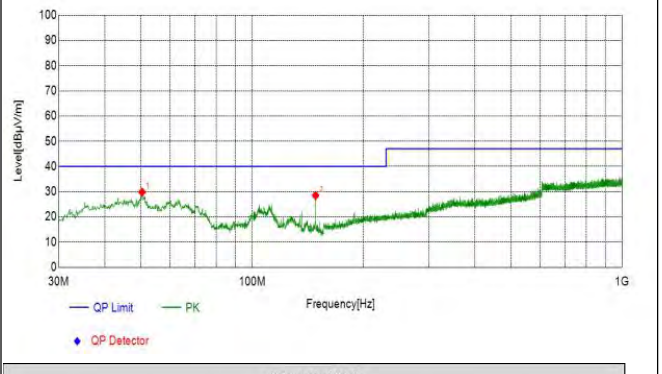
230VAC I/P Horizontal



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
61.7222	Horizontal	13.02	21.24	34.26	40.00	5.74	PK	100	25	PASS
109.2569	Horizontal	13.22	8.16	21.38	40.00	18.62	PK	100	0	PASS

230VAC I/P Vertical



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.3720	Vertical	15.56	14.26	29.82	40.00	10.18	PK	100	60	PASS
148.3518	Vertical	9.52	18.98	28.50	40.00	11.50	PK	100	40	PASS

4.4.3. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A)

This solution can meet all the performance in our datasheet, as well as EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class A)

1) Design circuit and PCB layout are as follows:

Recommend circuit	PCB layout(L*W*H 58.0mm*30.0mm*21.05mm)

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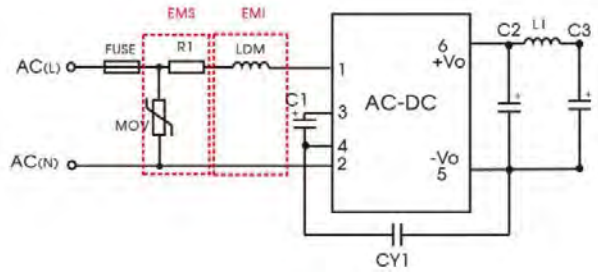
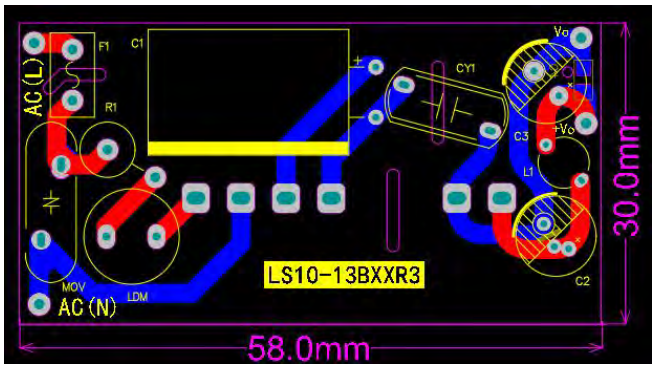
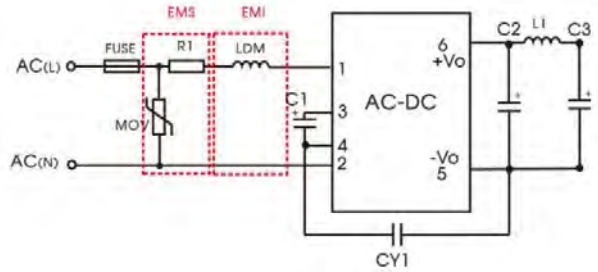
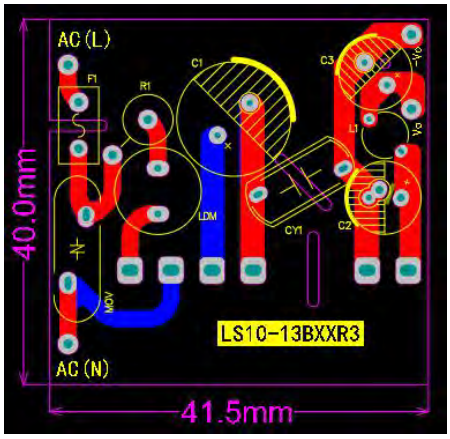


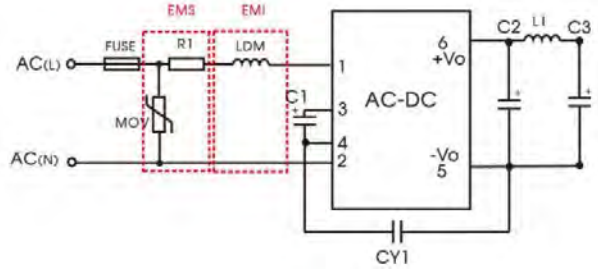


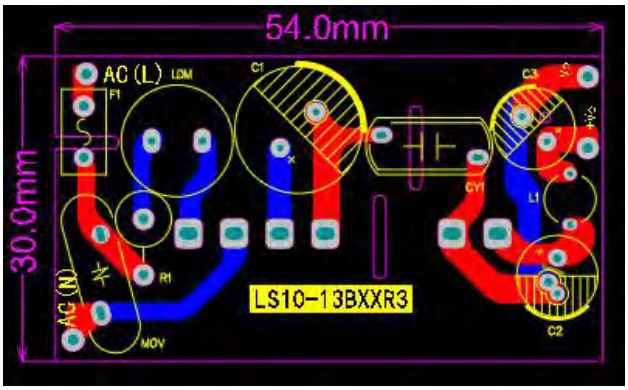
Recommend circuit	PCB layout(L*W*H 41.5mm*40.0mm*23mm)





Recommend circuit	PCB layout(L*W*H: 54.0mm*30.0mm*23mm)





Note: There are three kinds PCB layouts are recommended for this solution. The first is for strict height requirement situations, and the second is for situations where length and width are required but the height is less limited. The third is for strict width requirement situations.

2) BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N

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FUSE	FUSE	2A/300VAC	Better	9321200301	Gongde	MST-2A-300V	Littelfuse	36912000000
MOV	VARISTOR	S14K350	New ford	DNR S14K350	Thinking	TVR14561	YAGEO	681KD14
R1	Wire-wound	6.8Ω/3W	PAK HENG	NKN3WJ12RT	Yageo	NKN3WSFR-73-6R8	Vishay	AC03000006808JAC00
LDM	input inductor	2.2mH/0.24A	Yi mei	HCRC0312T-2ROM	Wurth	7447720222	Bourns	RLB1014-222KL-ND
C1	Input filter	22uF/450V	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102MA4DW-400V-F60	Hua xin ke	YU1AH102M070BASD	TDK	CD45-E2GA102M-NKA
C2	Output filter	270uF/16V	SAMXON	UER277M1CE08TUXOCR	ELITE	UPE1C271MNN6308	NCC	PLS1C271MDO1
L1	Output inductor	2.2uH/6.5A	Sunlord	SWPA4030S2R2NT	Qi li xin	AMQU000606302R2MA	Bourns	SRP5030C-2R2M
C3	Output filter	150uF/35V/Φ8*9	SAMXON	ESK157M1JF20TCSHP	Rubycon	35YXG150MEFC8X11.	Rubycon	35YXG150MEFC8X11.5

3) Test Report

Routine performance test (test model: LS10-13B12R3)				
NO.	Test items	Test condition	Spec.	Result
1	No-load power consumption	Input: 230VAC Output: No load Ambient temperature: 25℃	≤0.15W	0.12
2	Output voltage accuracy	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±2%	0.75%
3	Voltage regulation rate	Input: 85 to 305VAC Output: 100%Io Ambient temperature: 25℃	±1%	0.16%
4	Load Regulation	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±1.5%	0.25%
5	Efficient	Input: 230VAC	80%	82.88%

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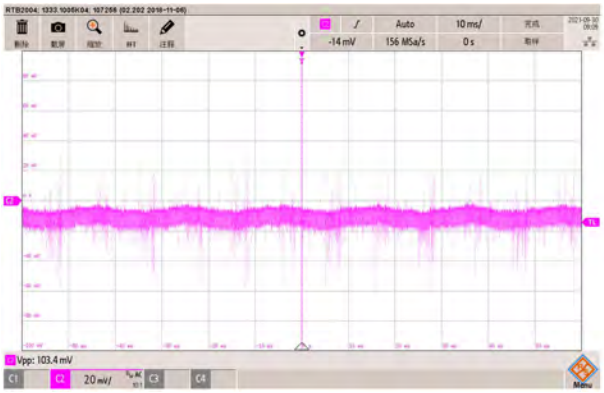
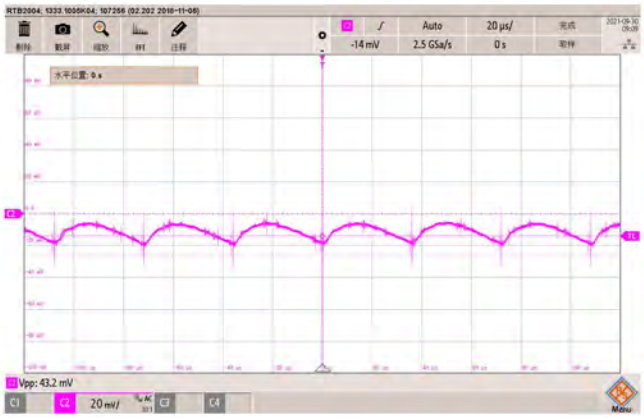
		Output: 100%Io Ambient temperature: 25℃		
6	Ripple noise	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	150mV	103mV
	Low frequency ripple:		High frequency ripple:	
				

Protection test (test model: LS10-13B12R3)

NO.	Test items	Test condition	Spec.	Result
1	Over-current protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	≥110%Io	136%Io/85VAC 145%Io/230VAC 146%Io/305VAC
3	Short circuit protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	Can be short-circuited for a long time	No damage after one hour short circuit Protection mode: output hiccup, self-recovery

Safety test (test LS10-13B12R3)

NO.	Test items	Test condition	Spec.	Result
1	Isolation withstand voltage	Input to output: test time 1 minute, leakage current <5mA	≥3.6KVAC	PASS
2	Insulation resistance	Input to output: 500VDC	≥100MΩ	PASS

EMC 测试(测试型号: LS10-13B12R3)

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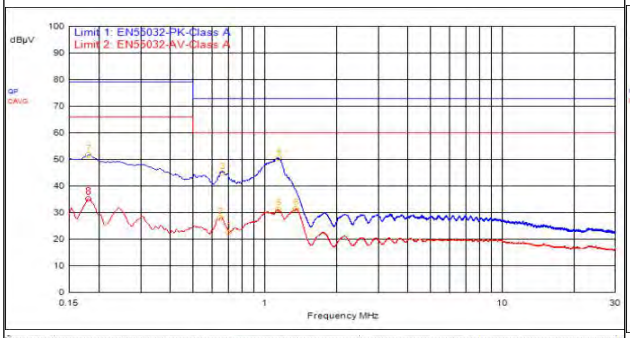
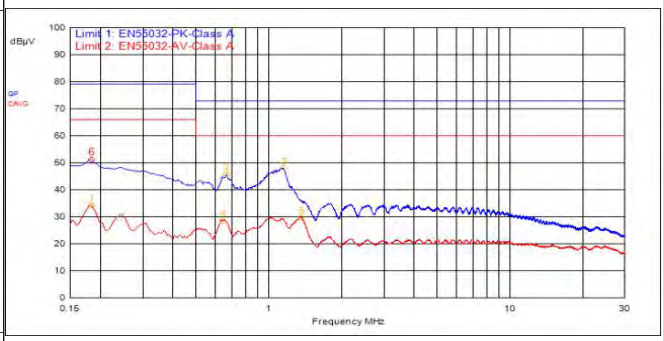
NO.	Test items	Test condition	Spec.	Result
1	surge	Input: 230VAC Output: 100%Io Environment temperature: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS
2	EFT	Input: 230VAC Output: 100%Io Environment temperature: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	Input: 230VAC Output: 100%Io Environment temperature: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	Input: 115V/230VAC Output: 100%Io Environment temperature: 25℃	CISPR32/EN55032 CLASS A	PASS

115VAC input L line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit D
4	1.143MHz	0.3	0.2	10.0	QPeak	40.1	50.6	73.0	-22.4
7	180.000kHz	0.2	0.2	10.0	QPeak	41.3	51.6	79.0	-27.4
3	660.000kHz	0.2	0.2	10.0	QPeak	34.6	45.0	73.0	-28.0
6	1.347MHz	0.3	0.2	10.0	C_AVG	20.8	31.3	60.0	-28.7
5	1.143MHz	0.3	0.2	10.0	C_AVG	20.5	31.0	60.0	-29.0
8	180.000kHz	0.2	0.2	10.0	C_AVG	24.7	35.1	66.0	-30.9
2	651.000kHz	0.2	0.2	10.0	C_AVG	17.7	28.1	60.0	-31.9
1	705.000kHz	0.2	0.2	10.0	C_AVG	12.1	22.5	60.0	-37.5

115VAC input N line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
3	1.149MHz	0.3	0.2	10.0	QPeak	37.5	48.1	73.0	-24.9
2	666.000kHz	0.2	0.2	10.0	QPeak	35.1	45.6	73.0	-27.4
6	183.000kHz	0.2	0.2	10.0	QPeak	40.8	51.1	79.0	-27.9
5	1.362MHz	0.3	0.2	10.0	C_AVG	19.2	29.8	60.0	-30.2
4	642.000kHz	0.2	0.2	10.0	C_AVG	18.2	28.6	60.0	-31.4
1	183.000kHz	0.2	0.2	10.0	C_AVG	23.9	34.2	66.0	-31.8

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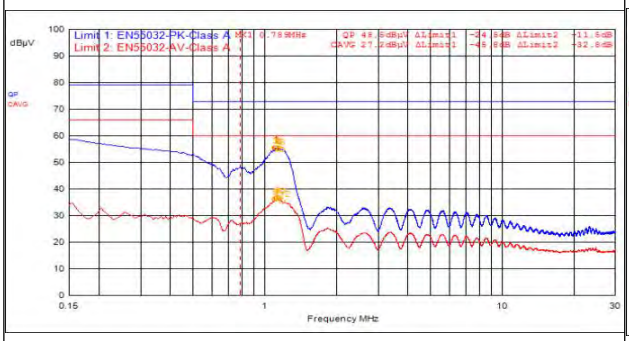
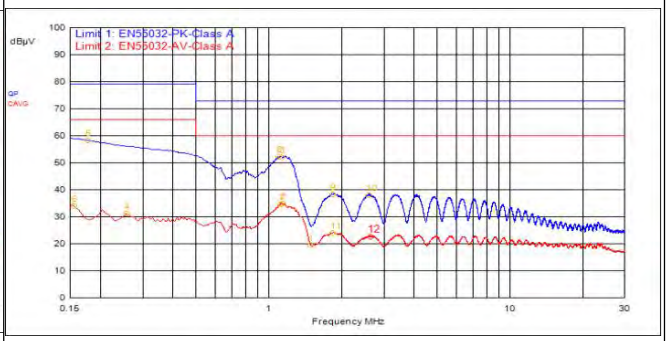
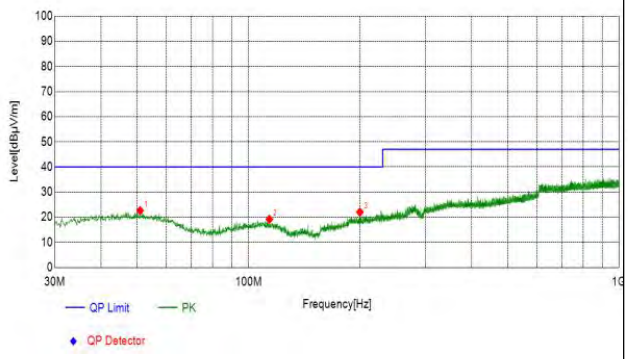
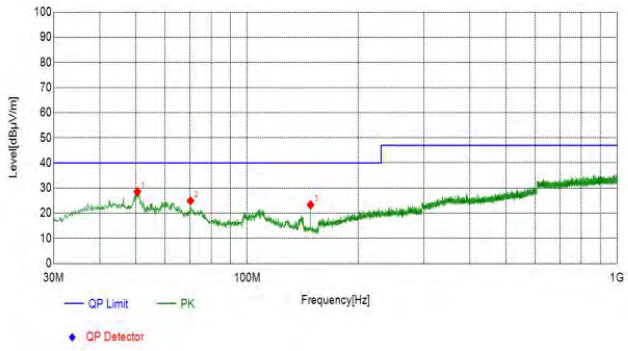
	230VAC input L line  230VAC input N line  			
5	Radiation harassment	Input: 115V/230VAC Output: 100%Io Environment temperature: 25℃	CISPR32/EN55032 CLASS A	PASS
	115VAC input level  115VAC input vertical  			

230VAC input L line

ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Di
1	1.116MHz	0.3	0.2	10.0	QPeak	45.0	55.5	73.0	-17.5
2	1.137MHz	0.3	0.2	10.0	QPeak	44.8	55.3	73.0	-17.7
3	1.107MHz	0.3	0.2	10.0	QPeak	44.8	55.3	73.0	-17.7
4	1.128MHz	0.3	0.2	10.0	QPeak	44.6	55.1	73.0	-17.9
5	1.158MHz	0.3	0.2	10.0	QPeak	44.5	55.0	73.0	-18.0
6	1.185MHz	0.3	0.2	10.0	QPeak	44.4	54.9	73.0	-18.1
8	1.137MHz	0.3	0.2	10.0	C_AVG	26.4	36.9	60.0	-23.1

230VAC input N line

ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
8	1.101MHz	0.3	0.2	10.0	QPeak	41.8	52.3	73.0	-20.7
5	177.000kHz	0.2	0.2	10.0	QPeak	47.9	58.2	79.0	-20.8
3	1.137MHz	0.3	0.2	10.0	QPeak	41.6	52.1	73.0	-20.9
2	1.143MHz	0.3	0.2	10.0	C_AVG	24.3	34.8	60.0	-25.2
7	1.119MHz	0.3	0.2	10.0	C_AVG	24.2	34.7	60.0	-25.3
6	156.000kHz	0.1	0.2	10.0	C_AVG	23.7	34.0	66.0	-32.0
9	1.848MHz	0.3	0.2	10.0	QPeak	27.7	38.2	73.0	-34.8

115VAC input level

Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.9541	Horizontal	15.45	7.19	22.64	40.00	17.36	PK	100	151	PASS
113.8164	Horizontal	12.62	6.58	19.20	40.00	20.80	PK	100	141	PASS
199.6700	Horizontal	12.48	9.58	22.06	40.00	17.94	PK	100	1	PASS

115VAC input vertical

Suspected List										
Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	13.04	28.58	40.00	11.42	PK	100	359	PASS
70.2590	Vertical	9.68	15.27	24.95	40.00	15.05	PK	100	357	PASS
148.3518	Vertical	9.52	13.83	23.35	40.00	16.65	PK	100	81	PASS

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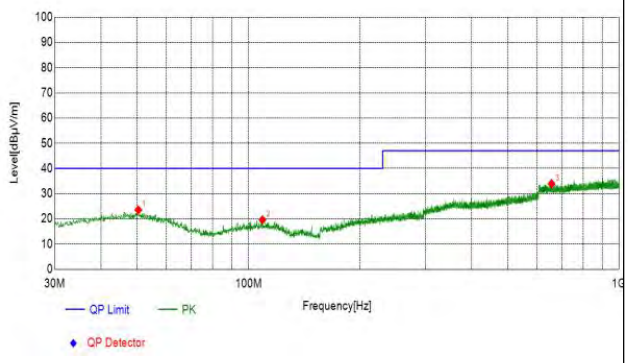
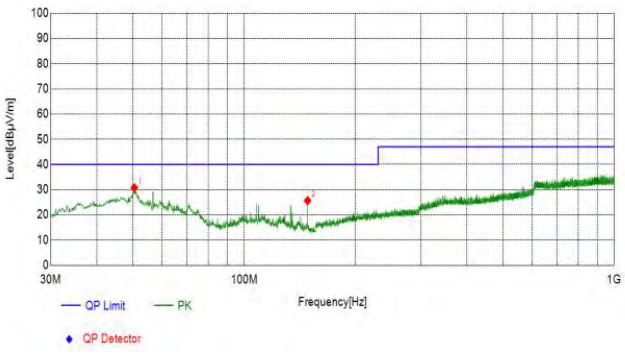
230VAC input level



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.3720	Horizontal	15.56	7.98	23.54	40.00	16.46	PK	100	279	PASS
108.9659	Horizontal	13.20	6.39	19.59	40.00	20.41	PK	100	21	PASS
656.7797	Horizontal	23.03	10.94	33.97	47.00	13.03	PK	100	210	PASS

230VAC input vertical



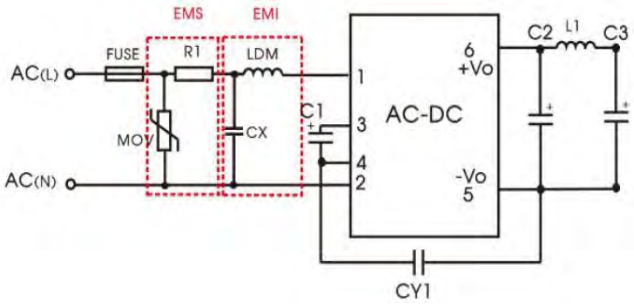
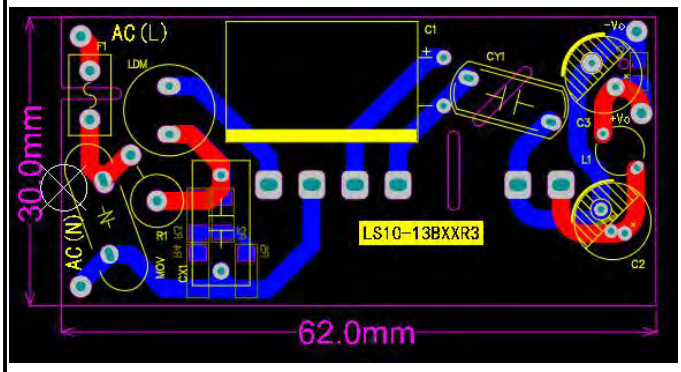
Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.4690	Vertical	15.54	15.23	30.77	40.00	9.23	PK	100	82	PASS
148.3518	Vertical	9.52	16.14	25.66	40.00	14.34	PK	100	228	PASS

4.4.4. EMS(EFT: ±4KV, Surge: line to line ±2KV)及 EMI(Class B)

The solution can meet the conventional performance in our technical manual, and meet EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B)

1) Designed peripheral circuits, PCB layout and recommended materials are as follows:

Recommended circuit	PCB design(L*W*H: 62.0mm*30.0mm*21.05mm)
	
Recommended circuit	**PCB design(L*W*H: 46.0mm*39.0mm*23mm)**

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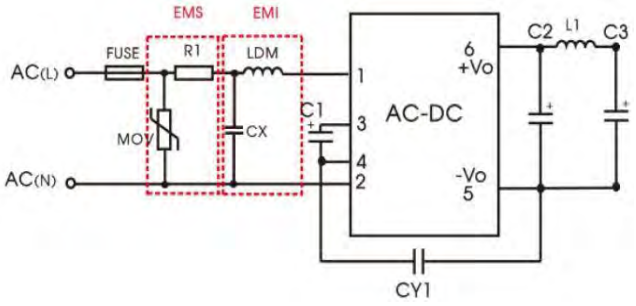
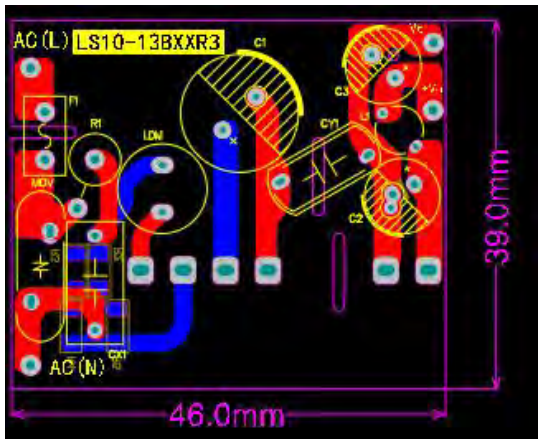
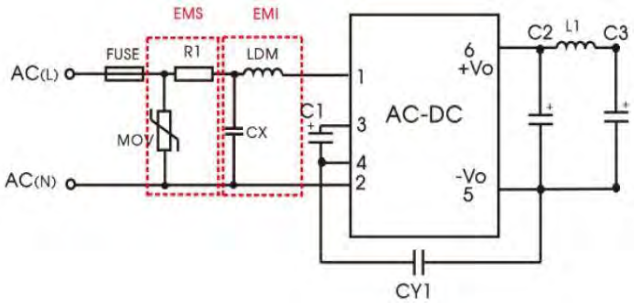
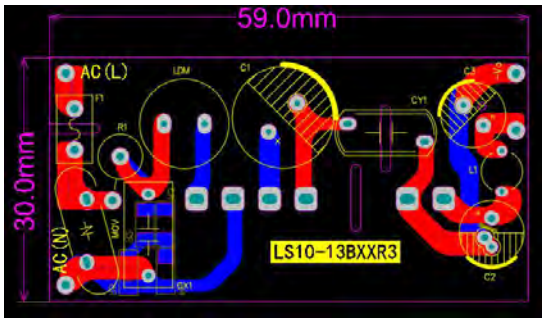




Recommended circuit	PCB design(L*W*H: 59.0mm*30.0mm*23mm)





Note: Three PCB layouts are recommended for this solution. The first is to meet the occasions with strict requirements for height, the second is for occasions with requirements for product length and width, and the third is for occasions with strict requirements for width.

2) BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
FUSE	FUSE	2A/300VAC	Better	9321200301	Conquer	MST-2A-300V	Littelfuse	36912000000
MOV	VARISTOR	S14K350	DNR	DNR S14K350	Thinking	TVR14561	YAGEO	681KD14
R1	Wire-wound Resistor	6.8Ω/3W	PAK HENG	NKN03BJ6R8	Yageo	NKN3WSFR-73-6R8	Vishay	AC03000006808JAC00
CX	Class-X Capacitor	104K/310VAC	Faratronic	C42Q2104K4SA405	HJC	MKP-104K0305AT1108-PV	TDK	B32912A3104K
LDM	Input inductor	2.2mH/0.24A	Hua Chen	HCRC0312T-2ROM	Wurth	7447720222	Bourns	RLB1014-222KL-ND

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C1	Input filter capacitor	22uF/450V	SAMXON	ERD226M2WI20RR4RF	Rubycon	450BXW22MEFR18X16	Rubycon	450BXW22MEFR12.5X20
CY1	Class-Y Capacitor	1nF/400VAC	Wmec	HJE102MA4DW-400V-F6	Walsin	YU1AH102M070BASDAH	TDK	CD45-E2GA102M-NKA
C2	Output filter capacitor	270uF/16V	SAMXON	UER277M1CE08TUXO	ELITE	UPE1C271MNN6308	Nichicon	PLS1C271MDO1
L1	Output inductor	2.2uH/6.5A	Sunlord	SWPA4030S2R2NT	CHILISIN	AMQU000606302R2MA1	Bourns	SRP5030C-2R2M
C3	Output filter capacitor	150uF/35V	SAMXON	ESK157M1JF20TCSHP	Rubycon	35YXG150MEFC8X11.5	Rubycon	35YXG150MEFC8X11.5

3) Test report:

Routine performance test (test model: LS10-13B12R3)				
NO.	Test items	Test condition	Spec.	Result
1	No-load power consumption	Input: 230VAC Output: No load Ambient temperature: 25℃	≤0.15W	0.135W
2	Output voltage accuracy	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±5%	-1.67%
3	Voltage regulation rate	Input: 85 to 305VAC Output: 100%Io Ambient temperature: 25℃	±1.5%	0.08%
4	Load Regulation	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	±3%	1.52%
5	Efficient	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	79%	80.34%
6	Ripple noise	Input: 85 to 305VAC Output: 10%Io to 100%Io Ambient temperature: 25℃	150mV	68.6mV
	Low frequency ripple:		High frequency ripple:	

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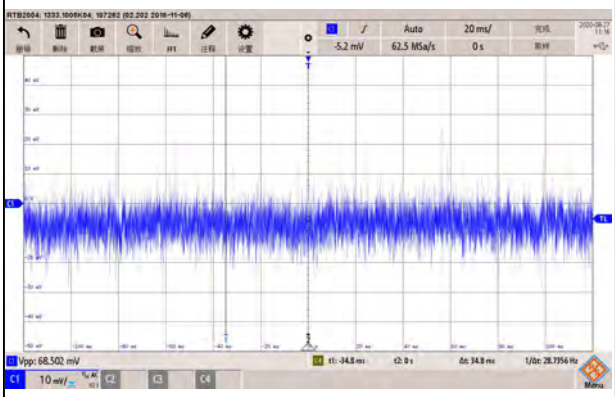

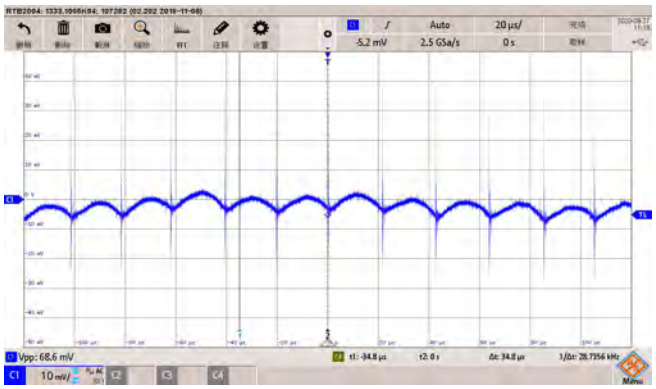

Protection test (test model: LS10-13B12R3)				
NO.	Test items	Test condition	Spec.	Result
1	Over-current protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	≥110%Io	132%/ 85VAC 131%/ 230VAC 138%/300VAC Protection mode: output hiccup, self-recovery
2	Short circuit protection	Input: 85VAC Input: 230VAC Input: 305VAC Ambient temperature: 25℃	Can be short-circuited for a long time	No damage after one hour short circuit. Protection mode: output hiccup, self-recovery

Safety test (test model: LS10-13B12R3)				
NO.	Test items	Test condition	Spec.	Result
1	Isolation withstand voltage	Input to output: test time 1 minute, leakage current <5mA	≥3.6KVAC	3.6KVAC ok. Leakage current: 0.812mA
2	Insulation resistance	Input to output: 500VDC	＞100MΩ	OK

EMC test (test model: LS10-13B12R3)				
NO.	Test items	Test condition	Spec.	Result
1	surge	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-5 line to line ±2KV	PASS

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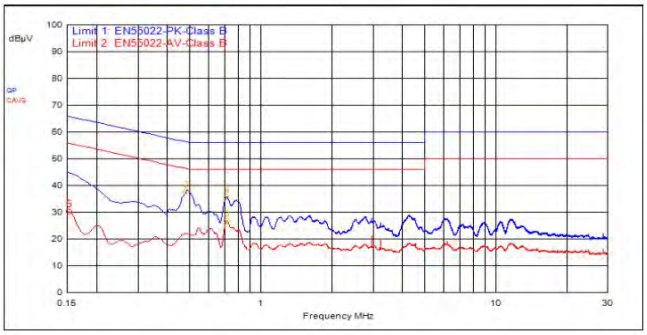
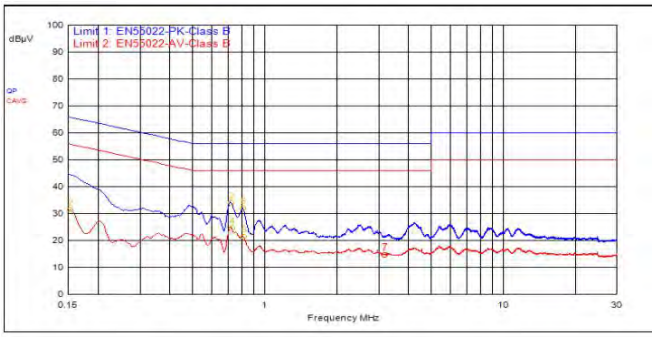
2	EFT	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-4 ±4KV	PASS
3	ESD	Input: 230VAC Output: 100%Io Ambient temperature: 25℃	IEC/EN61000-4-2 Contact ±6KV	PASS
4	CE	Input: 115V/230VAC Output: 100%Io Ambient temperature: 25℃	CISPR32/EN55032 CLASS B	PASS

115VAC input L line



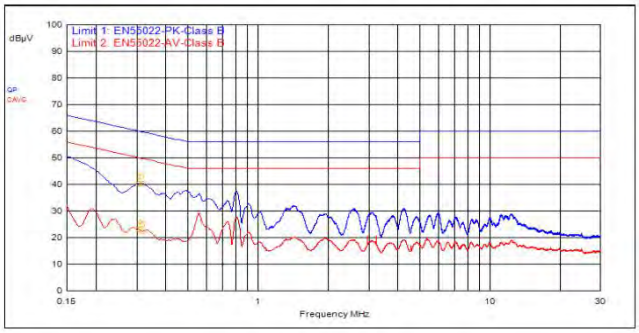
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	483.000kHz		0.2	10.0	QPeak	27.6	37.8	56.3	-18.5
3	714.000kHz		0.2	10.0	C_AVG	16.6	26.8	46.0	-19.2
4	717.000kHz		0.2	10.0	QPeak	25.6	35.8	56.0	-20.2
1	150.000kHz		0.2	10.0	QPeak	34.8	45.0	66.0	-21.0
5	150.000kHz		0.2	10.0	QPeak	34.8	45.0	66.0	-21.0
6	153.000kHz		0.2	10.0	C_AVG	20.2	30.4	55.8	-25.5

115VAC input N line



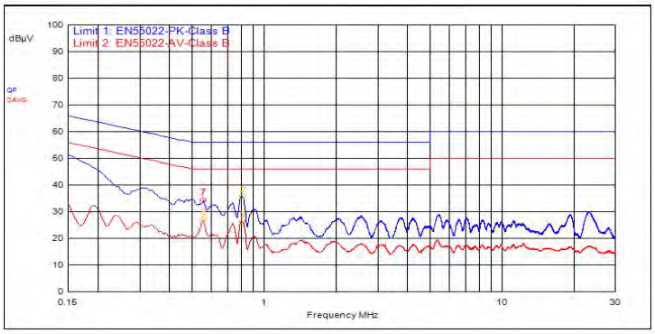
ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
1	150.000kHz		0.2	10.0	QPeak	34.6	44.8	66.0	-21.2
4	726.000kHz		0.2	10.0	C_AVG	14.3	24.5	46.0	-21.5
3	720.000kHz		0.2	10.0	QPeak	23.9	34.1	56.0	-21.9
5	810.000kHz		0.2	10.0	QPeak	21.8	32.0	56.0	-24.0
2	153.000kHz		0.2	10.0	C_AVG	21.1	31.3	55.8	-24.5
6	816.000kHz		0.2	10.0	C_AVG	11.1	21.3	46.0	-24.7

230VAC input L line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
5	150.000kHz		0.2	10.0	QPeak	40.4	50.6	66.0	-15.4
1	318.000kHz		0.2	10.0	QPeak	30.1	40.3	59.8	-19.4
2	306.000kHz		0.2	10.0	QPeak	30.1	40.3	60.1	-19.8
6	150.000kHz		0.2	10.0	C_AVG	21.7	31.9	56.0	-24.1
4	306.000kHz		0.2	10.0	C_AVG	12.8	23.0	50.1	-27.1
3	318.000kHz		0.2	10.0	C_AVG	12.2	22.4	49.8	-27.3

230VAC input N line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
4	150.000kHz		0.2	10.0	QPeak	41.2	51.4	66.0	-14.6
6	555.000kHz		0.2	10.0	C_AVG	16.8	27.0	46.0	-19.0
3	807.000kHz		0.2	10.0	C_AVG	16.2	26.4	46.0	-19.6
2	807.000kHz		0.2	10.0	QPeak	25.6	35.8	56.0	-20.2
7	555.000kHz		0.2	10.0	QPeak	24.0	34.2	56.0	-21.8
1	150.000kHz		0.2	10.0	C_AVG	22.8	33.0	56.0	-23.0

	Radiation harassment	Input: 115V/230VAC Output: 100% Io Environment temperature: 25℃	CISPR32/EN55032 CLASS B	PASS

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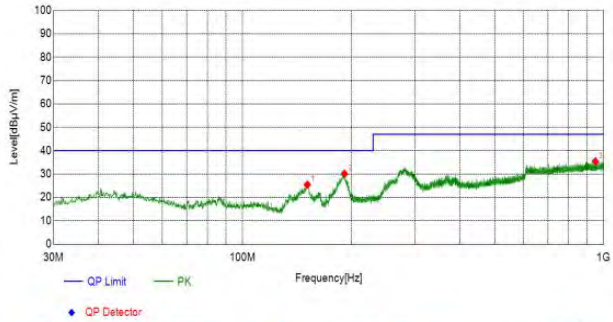
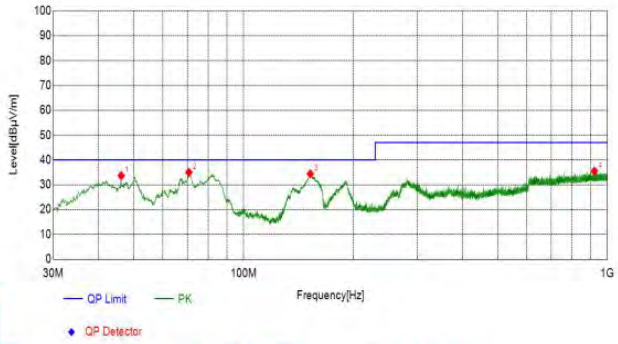
115VAC input level



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
151.1651	Horizontal	9.35	16.08	25.43	40.00	14.57	PK	100	127	PASS
191.6182	Horizontal	12.19	17.90	30.09	40.00	9.91	PK	100	297	PASS
948.2938	Horizontal	26.40	8.99	35.39	47.00	11.61	PK	100	276	PASS

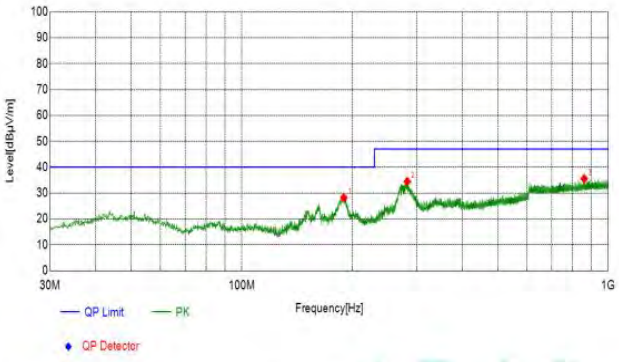
115VAC input vertical



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
46.1036	Vertical	15.05	18.59	33.64	40.00	6.36	PK	100	84	PASS
70.7441	Vertical	9.67	25.31	34.98	40.00	5.02	PK	100	187	PASS
152.5233	Vertical	9.40	25.00	34.40	40.00	5.60	PK	100	208	PASS
921.1311	Vertical	26.32	9.18	35.50	47.00	11.50	PK	100	99	PASS

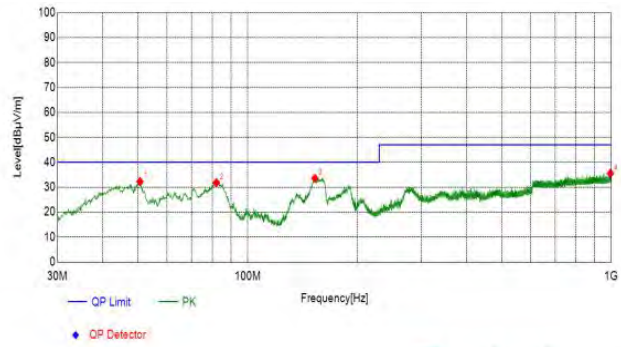
230VAC input level



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
189.7750	Horizontal	12.10	16.08	28.18	40.00	11.82	PK	100	121	PASS
282.8073	Horizontal	15.24	19.21	34.45	47.00	12.55	PK	100	147	PASS
859.5300	Horizontal	25.60	9.89	35.49	47.00	11.51	PK	100	341	PASS

230VAC input vertical



Suspected List

Frequency [MHz]	Polarity	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Detector	Height [cm]	Angle deg	Pass/Fail
50.5661	Vertical	15.52	16.73	32.25	40.00	7.75	PK	100	275	PASS
81.9972	Vertical	9.79	21.99	31.78	40.00	8.22	PK	100	270	PASS
153.0083	Vertical	9.42	24.18	33.60	40.00	6.40	PK	100	203	PASS
994.2764	Vertical	26.90	8.62	35.52	47.00	11.48	PK	100	239	PASS

4.4.5. EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B) meets EN60335 standard

The solution can meet the conventional performance in our technical manual, and meet EMS (EFT: ±4KV, Surge: line to line ±2KV) and EMI (Class B).

1) Designed peripheral circuits, PCB layout and recommended materials are as follows:

Circuit scheme	PCB design diagram(L*W*H:64.0*31.0*21.05mm)

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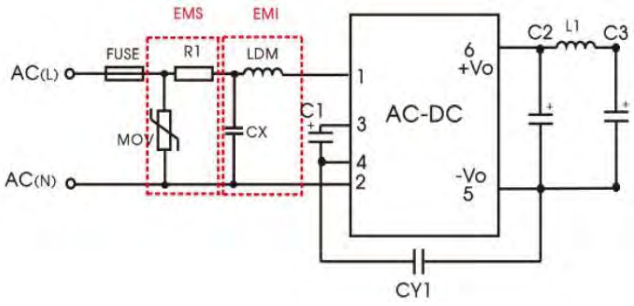
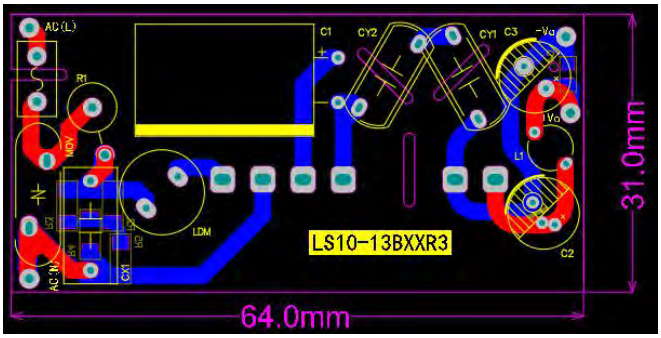
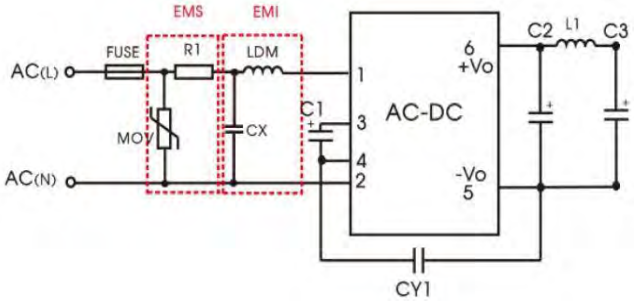
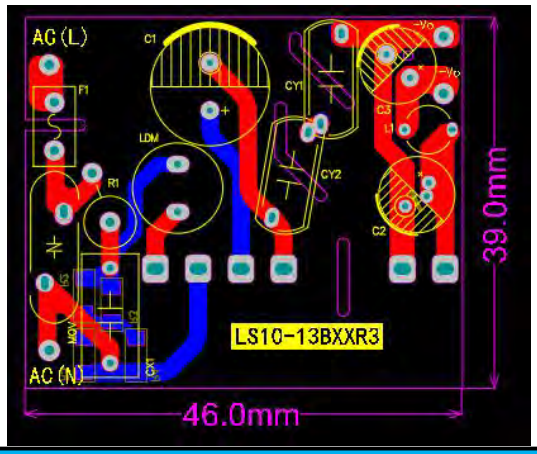


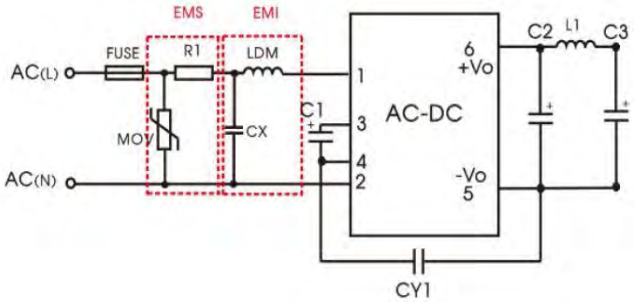


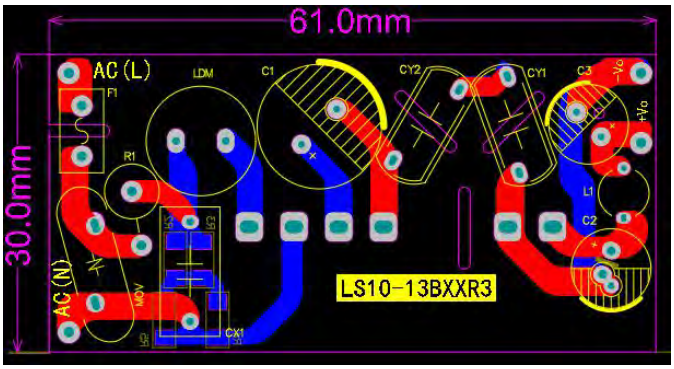
Circuit scheme	PCB design diagram (L*W*H:46.0*39.0*23mm)





Circuit scheme	PCB design diagram(61.0mm*30.0mm*23mm)





Note: Three PCB layouts are recommended for this solution. The first is to meet the occasions with strict requirements for height, the second is for occasions with requirements for product length and width, and the third is for occasions with strict requirements for width.

2) BOM:

PCB position	Type	Spec	Recommended material combination 1		Recommended material combination 2		Recommended material combination 3	
			Brand	P/N	Brand	P/N	Brand	P/N
CY1/CY2	Y2Capacitor	1nF/250VAC	wmec	HME102M	Walsin	YU1AC102M060	TDK	CS80-E2GA102MY

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Note: The two Y-capacitor solutions are different from the single Y-capacitor solution in Section 4.4.4, except that the Y capacitor material and PCB pitch are different, and the test results are not different from the single Y capacitor solution. **Therefore, in addition to Y capacitors, please refer to section 4.4.4 for other device parameters and related test content in the recommended material list.**

2) Test report

The two Y-capacitor solutions are different from the single Y-capacitor solution in Section 4.4.4. Only the Y-capacitor material and PCB pitch are different, and the test results are not much different from the single Y-capacitor solution. Therefore, please refer to the test report in Section 4.4.4 for the actual measured data.

5. Version and update record

Version	change content	Date
V0	First issue	2021.10

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