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New X-ray Source System Design

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Abstract

The X-ray source is a key part for public security detection applied in airport, custom and many public security detection places. In this paper, it introduces how to design X-ray source system and its X-ray source controller.

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1. Introduction

With the development of public security detection, many new technique of X-ray detection are being applied in airport, custom and train station. How to improve the detection resolution and correctness rate becomes the key performance of these equipments. The public security detection systems with X-ray source have the ability to detect the suspicious baggage in different view, the penetration performance and resolution ability have great advantage than other x-ray detection systems. As a subsystem of the systems, X-ray source and its controller’s design are considered as most important and complicated for their application. In this paper, it introduces how to design the X-ray source and X-ray controller.

2. X-ray source design

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The key of X-ray source design is how to satisfy the requirements of the detection system. For the best detection, the detection system has designed many directions. The photos of X-ray source controllers applied in public security detection are showed in Fig.1.

3. X-ray source controller design

There are four parts for an X-ray source controller, showed as Fig.2.

In the paper, it describes how X-ray source controller works. X-ray source control has adopted the technique of intermediate frequency with bridge inverter. It has realized high voltage drive of transformers. With flyback power technique design of assistance power and PFC skill, the harmonic contamination is limited. With the microcontroller
stm32F10xm, the communication ability with main computer of public security detection and part of digital control could be realized.

3.1. PFC design

Reduction of line current harmonic distortion and improvement of power factor are of great concern to many designers of switched mode power supplies. This concern has been motivated by present and impending regulatory requirements regarding line current harmonics. Active power factor correction using the boost topology and operating in the continuous inductor current control mode is an excellent method to comply with these requirements and is well accepted in the industry. The integrated circuit with L4981 is a continuous mode average current controller with several specific functions for active power factor correction. It can operate in high quality, medium/high power conversion range and provide all the necessary features to achieve a very high power factor, up to 0.99. This design is showed in Fig.3.

Fig.3 Application of L4981

Fig.4 Flyback power design
3.2 FLYBACK CONVERTER

The flyback circuit has the specification of easy to design. It consists of only one power driver transistor, a transformer and several resistors and capacitors. In the design, UC 3845 is one element of flyback power. The output gives power supply to X-ray source controllers. The function of flyback power is showed as Fig.4. The parameters are listed as followed.

Switching frequency: 100kHz. Output1: ±15V, Output2: ±75V Output3: +12V Output4: ±12V Output5: ±12V.

3.3 Half bridge inverter

To overcome the influence of distribution of the transformer, lots of optimizing and reformation job on the traditional half bridge reverse converter circuits have been done, the sketch circuit showed as Fig.5.

![Half bridge inverter](image1)

By adjusting the inverter frequency, the inverter works at the best working status. In the system, the detector has high sensitive to line frequency. High frequency could bring ripple at the background of the detecting image. For solving this problem, we use the skill of insulated transformer and let the original side of the transformer contact to the ground. In this way, we handle the problem of ripple disturbing to our system.

3.4 Micro-processor application design

With the development of Micro-processor, lots of micro-processors have been applied to the power control system. The application of micro-processors have made the power control system more efficiency and easy to complicate digital control. During the past, the system computer is open loop control to the X-ray source. With the application of microcontroller, now it’s much convenient to control the x-ray source power on or off by system computer through the USART interface of main computer and micro-controller. The main computer exchanges commands and data with microcontroller by the RS232. At the same time, the main computer order the x-ray on or off the x-ray source and sampling feedback data such as the anode voltage and current and filament current. With these data, the main computer makes decision of what to do next of the X-ray source. By RS232, the microcontroller even can send the X-ray source failure signal to the main computer directly and the main computer can fully handle all failures from X-ray source controller and also the microcontroller deal with all the problem of the x-ray source system such as over voltage, over current and X-ray on or off problem. It’s so called real-time control. With the microcontroller, the system computer can communicate with 4 x-ray source controllers at the same time easily. So, the multi-view EDS becomes much easy to realize the multi-view detection. In the system, the baud rate is 9600bit.
3.5 Experiment Result:

Fig. 7 shows the AC curves of input voltage and current. With the module of power analysis, (a) shows that the true power is 394w, true power factor is 0.999, (b) shows harmonic current curve, its aberrance parameter is 4.09%. The experiment result indicated that the design have improved X-ray source controller’s performance greatly. The X-ray source controller design is green.

4. Conclusion

Now, the public security detection system has been successfully applied in many airports for public security detection. During the past years, there are no any problem reports about our X-ray source. In the next, we have lots of works to do with our x-ray source controller and our green power design, Such as fully digital control design and totally green power in the future public security detection system.

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