# The Automatic Primary Charge Roller Detecting System

*Hungjing Tiong and Hsu Jonathan*
*OES, ITRI*
*Hsinchu, Taiwan, R.O.C*

## Abstract

In the electro-photography system, the photoconductive materials are charged by either the corona devices or the primary charge rollers. Unlike the corona device, the primary charge roller does not pollute the air, so it is commonly used to charge the photoconductive material in the low speed printing nowadays.

Traditionally, the measurement of the PCR resistance is used to detect the charging ability of the PCR and determine the quality of the PCR.

A new automatic primary charge roller detecting system is introduced in this paper. A high voltage needle tip is used to ionize the air around the PCR. The PCR is charged and discharged under high frequency, the response voltage in the PCR then undergoes the conditioning process where the signal is amplified and the noise are filtered. The signal is then accessed by the high-speed data acquisition interface. A graphic user interface is to display the charging and discharging curve of the PCR test specimen. These curves can be compared with the standard charge and discharge curve of the standard PCR, to determine whether the test specimen is “go” or “not go”. The detection process is easy and time saving.

## Introduction

In the electro-photography system, the photoconductive materials are charged by either the corona devices or the primary charge rollers. Corona device has some drawbacks. A high voltage of 5000volts is applied to the tungsten wire to ionize the air surrounding the OPC. This high voltage produces a large amount of ozone, which is a pollutant. Moreover, if a small amount of airborne toner lands on corona wire, it will blocks the charging path and lowers the charge voltage of the OPC. Unlike the corona devices, the primary charge roller does not pollute the air; it can sufficiently charge the OPC surface with much lower applied voltage (-650volts in canon/HP printer). PCR is usually used in most of the printer nowadays.

As the print speed of the machine becomes faster, a number of problems appear in the old PCR design. The hard rubber PCR causes high wear and noises during the charging process. The canon cartridge introduces soft foam PCR in the Hewlett-Packard LaserJet 4000. The soft foam PCR overcomes the wear and vibration problems, it also introduces uniform charging due to nip shape and bump-free surface, so the foam PCR becomes feasible in the high-speed printer.

In the PCR charging, the ionization takes place in both nips. Cannon printer uses AC with DC voltage to create uniform charges on the OPC drum surface. (See Fig. 1) The pulsing AC voltage facilitates uniform charging on its peaks. Higher AC voltage frequency also enhances the PCR charge phenomenon.

The structure of the PCR consists of metal shaft, rubber layer and the outer coating layer. The outer layer serves two purposes, it blocks the plasticizers and prevents localized electric shorting. The electric shorting will cause the power supply to exceed its output and lower its output voltage, this will lead to the black-line shorting. The outer layer reduces current flow directly laterally across the PCR surface.

If the outer layer of the PCR wears thin, it is more susceptible to form pinhole defect in the next cycle of reuse. The pinhole defect usually expresses itself in the repeating black dots on the printed page.

From the above we can see that the surface properties of the PCR, which determine its performance, are the PCR outer layer weariness and the surface resistance. A low surface resistance may lead to destructive arcing to the both PCR and OPC, A high surface resistance may result in the undercharging or non-uniform charging on the OPC.

In this paper, we are going to introduce a new automatic primary charge roller detecting system. Comparisons between the convectional and the new detecting system are done.

## Conventional PCR Detecting Equipment

Two kinds of PCR detecting equipment are available in the market. The instantaneous PCR resistance measurement apparatus by the anakeneasis company and the electrostatic charge decay measurement equipment by QEA Company.

In the anakeneasis PCR resistance measurement apparatus, high power voltage is applied to the PCR test specimen and the aluminum substrate roller. As the PCR test specimen is going to get rotational contact with the aluminum substrate roller, the resistance of the PCR specimen is measured.

In the QEA electrostatic charge decay measurement equipment (See figure 3). A scorotron type corona deposits a negative charge on the surface of the PCR. A non-contact electrostatic voltage probe is used to measure the residual potential on the roller surface after a fixed time interval after the charge deposition.

In the ECD measurement technique, the PCR material is modeled as a resistor and a capacitor in parallel, the surface voltage measured is given by:

$$V(t)=V_o e^{-t/RC} \quad (1)$$

Where $V_o$ is the initial voltage, t is time, R is the resistance and C is the capacitance of the material being tested.

## The Automatic Primary Charge Roller Detecting System

Here, we introduce a new PCR detecting system, the automatic Primary Charge Roller Detecting System. Figure 4 is the structure of the system; The PCR is fixed on a highness adjustable frame. Below the PCR is a rotating disk with the diameter of 6cm. A 0.2-micrometer diameter needle is fitting on the rotating disk with the protruding end of 1.1 cm. A high voltage is connected to one end of the needle, such that, the tip of the other end of the needle is able to ionize the air around the PCR. The height of PCR is adjusted such that a constant gap between the needle tip and the PCR surface is to be within 1~3mm. The rotating speed of the disk is also adjustable within 0~3200 rpm. When the high power voltage is switched on, the PCR will be charged and discharged under high frequency, the response voltage in the PCR is measured automatically by the measurement of the voltage variation between the two ends of the resistor. The signal is accessed by the high-speed data acquisition card where the signal is amplified. The noise is filtered via software. A graphic user interface program is used to access the signal and to display the charging and discharging curve of the test specimen. These curves can be calibrated to relate the curve peak value to the resistance of the PCR.

As compare with the QEA ECD system, the automatic PCR detecting system is simple and less expensive. In the QEA system, in order to detect the very small charge relaxation time, an expensive voltmeter with the high resolution and fast response time is used. In addition, the PCR should be rotated at very high speed, however there is speed limitation due to the PCR inertia. The automatic detecting system overcomes this by rotating the needle for instead.

## Experiment

A number of measurements were carried out to show the functions of the automatic PCR detecting system.

Ten pieces of primary charge roller of different types, under different conditions from different manufacturers were used to carry out the measurement. Both the anaeknesis PCR resistance test system and the automatic PCR detecting system were used to measure the resistance and the peak voltage value of the charge and the discharge curve of each PCR.

The test temperature is 25 degree Celsius, the relative humidity is 51%RH, the voltage applied to the automatic PCR detecting system is –2.95KV, the revolution speed of the disk is 3200rpm, the needle tip is 2mm away from each PCR surface.

## Results and Discussion

The correlation between the resistance and the peak voltage value measured is shown in figure 5.

Figure 6 shows a charging and discharge curve of a piece of PCR by HP 92274A, the resistance of the PCR measured by the anakeneasis PCR resistance test system is 0.3 MΩ. From the figure, we can see that the peak voltage of the curve is 115µV.

Figure 7 is the charging and discharge curve of the PCR used in HP 4092 cartridge, the resistance value of the PCR is 1.4 MΩ, and the peak voltage of the curve is 85µV.

Figure 6 and 7 are the PCR with the foam rubber; Figure 8 is the charge and discharge curve of the hard rubber. The resistance of the PCR is 5.5MΩ; we can see from the charge and discharge curve that the peak voltage is 30µV. Hence, the hard rubber PCR has higher PCR resistance than the foam rubber PCR.

Figure 9 is the charge and discharge curve of the old used HP 4092 PCR. As compare with the new HP 4092 PCR curve in figure 7, we can see that the peak voltage of the PCR increases to 110µV, which is equivalent to the resistance of 0.8 MΩ. The resistance of the PCR decreases as the PCR surface wears, and eventually arcing will occurs.

Figure 10 is the charge and discharge curve of the PCR HP 92274A having a defect hole of diameter 0.43µm detected under SEM, as compare to Fig. 6, we can see that the peak voltage increases 45% to 148mV. The peak voltage increases at the pinhole on the PCR, the resistance drops sharply.

## Conclusions

From the above tests, we conclude that charge and discharge curve of the automatic primary charge roller detecting system serve varies purposes:

1. The peak voltage values can be used to compare the different surface resistance value of the PCR for different printer.
2. Tests may be carried out to build up the database of the standard charging and discharging curves of the standard PCR with good print quality, to determine whether the test specimen is “go” or “not go”. This system can be used in the PCR quality control process for the new product.
3. Worn PCR with low outer layer thickness has higher voltage peak value. The automatic PCR system can help the recycle manufacturer to determine the reuse of

the PCR. If the database is built, the life of the PCR can also be predicted.

4. The micro-hole defect can be detected with high resolution.

The automatic PCR detecting system has the merits over the convectional one by its GUI interface, simple and less expensive and high detecting resolution.

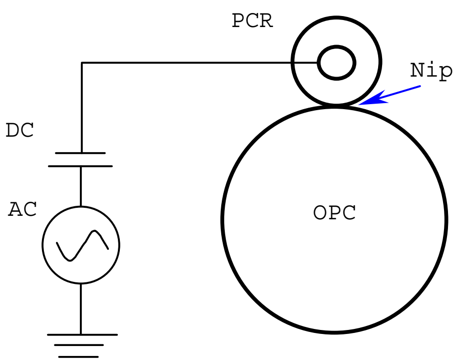


*Figure 1. PCR charging in cannon printer*

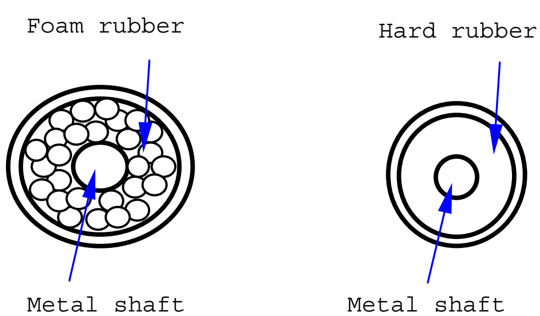


*Figure 2. Types of PCR*

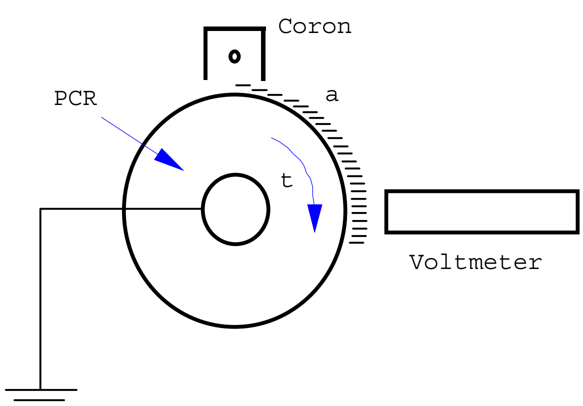


*Figure 3. Electrostatic charge decay measurement system by QEA*

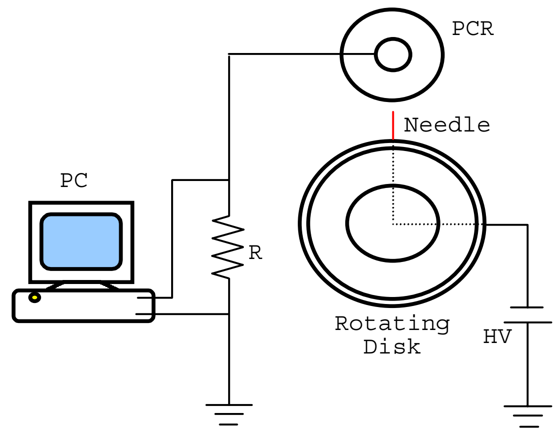


*Figure 4. The automatic PCR detecting system*

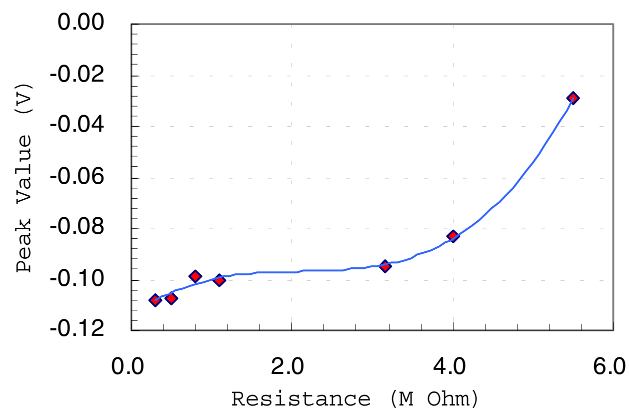


*Figure 5. Correlation between the measured resistance and peak voltage of charge and discharge curve*

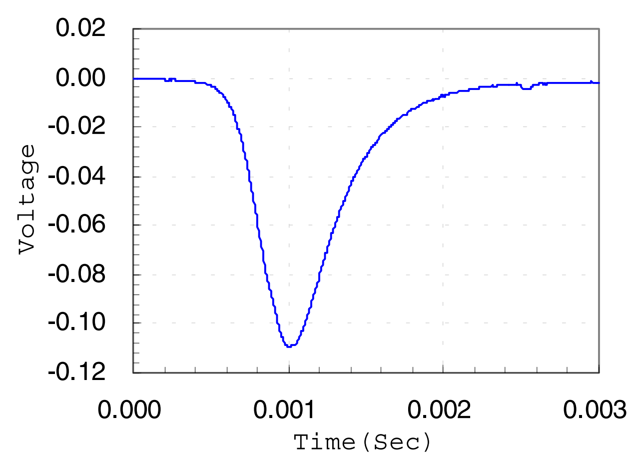


*Figure 6. Charge and discharge curve of HP 92274A PCR*

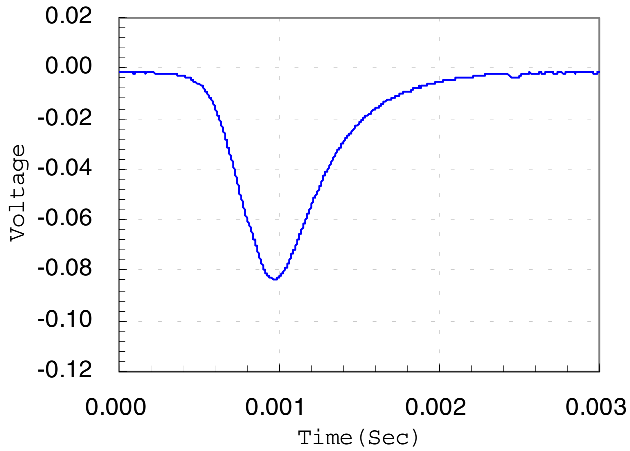


*Figure 7. Charge and discharge curve of HP 4092 PCR*

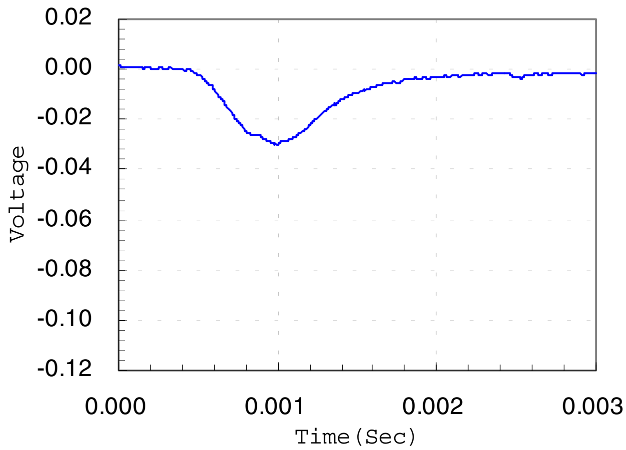


*Figure 8. Charge and discharge curve of hard rubber PCR.*

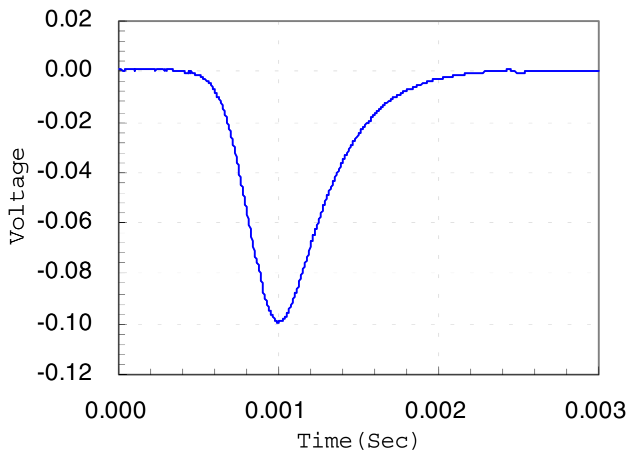


*Figure 9. Charge and discharge curve of old HP 4092 PCR.*

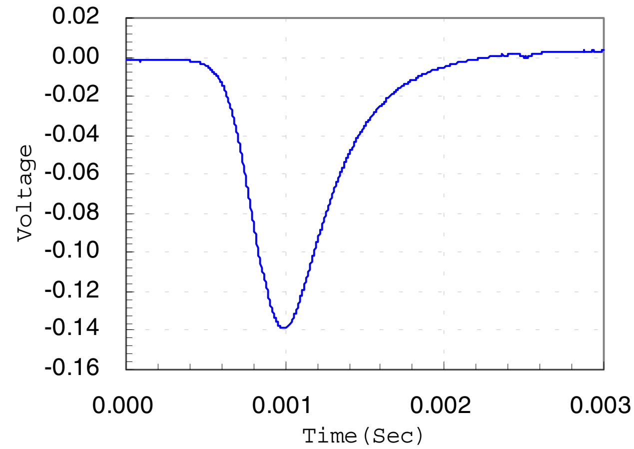


*Figure10. Charge and discharge curve of 92274A PCR with pinhole*

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## Biography

Hung Jing Tiong received her MS in Mechanical Engineering from National Central University, Taiwan in 1993, She is a mechanical engineer in the printing Technology department, Opto-Electronics and system Laboratories, ITRI, Hsinchu, Taiwan. She had experienced on the mechanical design of the ink-jet cartridge, electrophotographic cartridge, and the Thermal printer. she also involved in the measuring instrument design and signal processing.