Supercap enables “battery-less” smart card/ID card

1. Introduction

In recently, various cards, such as credit cards, membership cards and ID cards, have been progressively made smarter or computerized to ensure the safety and enhance the users’ convenience. Although there are various type of smart cards, they can be classified into two types in terms of power supply: Built-in battery type which can work stand-alone, and Battery-less type powered by harvested energy from RF signals when it is held over a NFC(Near Field Communication) card reader /writer mounted on a POS terminal or access controller. This application note proposes a supercapacitor solution to smart cards using RF energy harvesting system.

Fig 1: Types of smartcard (in terms of power supply)

2. Benefits and challenges to battery-less cards powered by RF energy harvesting system

By using RF energy harvesting, there is no need to worry about battery run-out, charge, battery-lifetime, and so on. In addition, RF energy harvesting is convenient because proximity wireless communication function installed in existing POS terminals or access controls can be used as a power supply.

On the other hand, there are some challenges to smartcards powered by RF energy harvesting system. Since energy generated by RF harvesting is small, operation becomes unstable or processing time becomes longer when system load is larger than harvested energy. For example, in the case of a smartcard which rewrite its built-in e-paper display when it is held over a reader/writer, it takes several tens of seconds to rewrite the display. Therefore, it is needed to keep holding the card until rewriting is finished.

Challenges to smartcards with RF energy harvesting

✓ Operation becomes unstable when harvested energy from reader/writer is small
✓ When system load such as fingerprint authentication and rewriting e-paper display is larger than harvested energy, operation may not be performed or processing time may become long.

3. Supercapacitor Solution

Murata’s supercapacitors can be charged/discharged quickly. By using Murata’s supercapacitor as an energy buffer for smartcards powered by RF energy harvesting, operation becomes stable and processing time can be reduced. It is optimally used for speeding up rewriting e-paper display or fingerprint authentication.

Murata’s DMH series ultra-thin (0.4mm max) supercapacitor can be embedded in ISO7816 (International standard of smartcard) – compliant card (85.60 x 53.98 x 0.76mm). Also, DMH series have enough mechanical strength compliant to ISO/IEC7816.

Fig.2: Ultra-thin package of DMH series

Benefits of using DMH series as energy buffer:
✓ By charging small power generated by RF harvesting to DMH series, and quickly discharging needed current to the system, the process can be executed stably and quickly.
✓ As a result, rewriting e-paper display or fingerprint authentication can be speeded up.

4. Applications

This solution is applicable to any card type devices with proximity wireless communication function such as NFC, and powered by RF energy harvesting using proximity wireless communication.

(Application examples)
① Credit card / access cards with fingerprint authentication function
② Cards with e-paper display
③ Tags with e-paper display

Fig.3: Typical circuit and example of application
5. Example of DMH series effect

As an example of DMH series effect, charge and discharge characteristics of a supercapacitor (35mF/4.5V/300mΩ/20×20×0.4mm) are shown below. Fig.4 shows the charge characteristics when DMH series is charged from 0V. Charge current is 10mA/100mA/1A. Fig. 5 shows the discharge characteristics when DMH series is discharged at constant current after being charged up to 4.5V. Discharge current is 10mA/100mA/1A.

As shown in Fig.4 and Fig.5, DMH series can be charged-discharged flexibly. Therefore, when using DMH series with RF energy harvesting system as shown in Fig.3, it can be charged even at small current and can activate system by quick discharge.

![Charge characteristics of 35mF Supercapacitor](image1)

**Fig.4: Charge characteristics of 35mF Supercapacitor**

![Discharge characteristics of 35mF Supercapacitor](image2)

**Fig. 5: Discharge characteristics of 35mF Supercapacitor**

Charge-discharge time depends on capacitance of supercapacitor. When capacitance is small, quick charge / short time discharge is available. On the other hand, when capacitance is large, charging time becomes longer. However, long time discharge is available. When setting charge-discharge conditions, please consider start charging voltage, cut-off voltage, minimum operating voltage and current of the system.

6. Specifications

<table>
<thead>
<tr>
<th>Series</th>
<th>DMH (Ultra-thin type)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>DMHA14R5V353M4ATA0</td>
</tr>
<tr>
<td>Capacitance</td>
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<tr>
<td>Rated voltage</td>
<td>4.5V</td>
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<tr>
<td>ESR</td>
<td>300mΩ</td>
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<tr>
<td>Operating temperature</td>
<td>-40°C to 85°C</td>
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<td>Weight</td>
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※Please contact us if you need lower or higher capacitance.

7. Technical support

Please contact Murata sales or Distributor.
Please access more information to support for your design. [http://www.murata.com/en-global/products/capacitor/edlc](http://www.murata.com/en-global/products/capacitor/edlc)

If you have any questions, please contact your local Murata sales or engineering representative.