RH850/U2A-EVA Group

Usage notes of SAR-ADC

Introduction

This application note explains notes regarding SAR-ADC(ADCJ) usage of RH850/U2A-EVA Group.

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Target Device

- RH850/U2A-EVA Group
  - RH850/U2A-EVA
  - RH850/U2A16
  - RH850/U2A8
  - RH850/U2A6

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1. Usage Notes of SAR-ADC

1.1 Notes on Board Design

Isolate digital and analog circuits as much as possible when you design a board layout. Also, make a best effort to avoid such a layout where signal lines of digital and analog circuits are intersected, or they are put in proximity to each other. Otherwise, induction may occur, leading to malfunction of analog circuits or a negative effect on A/D conversion values. Never fail to separate an analog input pin (ANnpq), analog reference voltage (AnVREFH), analog power supply (AnVCC), and analog GND (AnVSS) from digital circuits. Since AnVSS shares the pin with the lower reference voltage in the A/D Converter, a low value resistance should be used to prevent offset errors. Also, connect the analog GND (AnVSS) to the stable on-board digital GND (VSS) at one point.

1.2 Recommended Examples for Capacitor Insertion

Figure.1 shows two examples for capacitor insertion.

The following examples differ in how voltage is supplied to AnVCC and AnVREFH. Refer to the figure appropriate for each product.

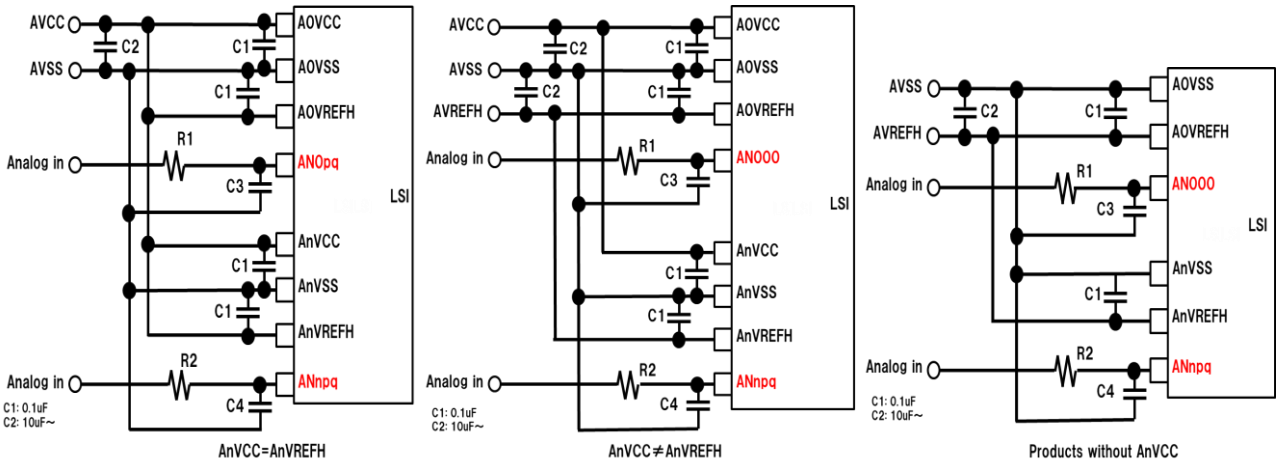

Figure.1 Example of Capacitor Insertion

C1: Preventive measures against surge and noise (0.1uF)

Connect a protective capacitor (C1) between AnVCC-AnVSS, and AnVREFH-AnVSS to prevent analog input pins from being destroyed by abnormal voltage, such as excessive surge. Put C1 as close as possible to the LSI for better denoising.

C2: Countermeasures against power supply stabilizing capacitor and mutual interference (10uF to 100uF)

Place the stabilizing capacitor (C2).

If the accuracy deteriorates when multiple SAR-ADC are operated at the same time, increase the capacitance value of C2 to reduce mutual interference.

C3, C4: Denoising

Put the capacitors (C3, C4) to be connected to the analog input pin (ANnpq) as close as possible to the LSI for better denoising.

Pay close attention when you determine circuit parameters, as shown in Figure.1, averaged input current resulting from the placement of filters may cause errors.

1.3 Sampling Error due to External Circuit

For details of sampling error due to the external circuit of A/D pins, see the RH850/U2A User's Manual: Hardware : Section 55.4.1 Sampling Errors in the External Circuit of the A/D Converter.

1.4 Notes on Analog Input Pin

An analog input pin can also be used as a general-purpose digital input or output pin.

The precision of a conversion may be reduced due to the changes in the digital inputs or outputs during A/D conversion by such as

- Power supply noise due to changes in the digital input of the general-purpose input pin of the same analog power supply as the analog input pin
- Coupling noise due to changes in digital input/output of neighboring pins

Notes on how to reduce the effects of digital input and output noise on the results of A/D conversion are given below.

(1) Notes on Analog Input Pins

(a) Place the capacitor to stabilize the analog input voltage as close to the LSI pin as close as possible. This will reduce the conversion precision drawdown of the analog pins caused by change of digital inputs and outputs. Since the improvement in precision also depends on other conditions of the board, evaluate the situation on the actual board.

(2) Notes on Digital Input and Output Pins near Analog Pins

(a) If digital input through the pin is not essential, disable the digital input.

(b) If a digital signal is input to such a pin, the signal should not include overshoot or undershoot.

(c) Design the board so that the load capacitance connected to the output pins should be small in order to suppress power supply voltage fluctuations inside the MCU and crosstalk effects from the digital pins due to the output current when the pin output changes.

(d) Lower the output driving ability of pins that may be affected.

(3) Software Measures against Effects on the Results of Conversion

(a) Use the average of multiple A/D conversion results.

(b) When using multiple consecutive results of A/D conversion, exclude outlying results.

1.5 Configuration Example of Battery Input

When you directly input the battery voltage to an analog pin, make sure that the value is within the injection current limits Imax and the pin voltage limits Vmax. Otherwise, the value in the injection current that exceeds Imax may increase the pin voltage, resulting in destruction of the MCU. When a high voltage is directly input to a pin, convert the voltage with a voltage divider not to exceed the limits of the injection current and the pin voltage, as shown in Figure.2.

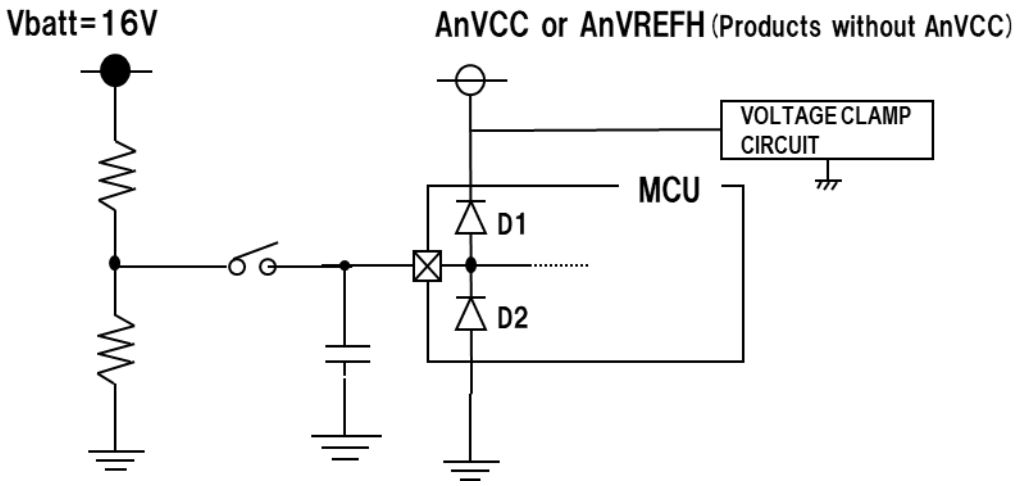

Figure.2 Configuration Example of Battery Input

Table.1 Injection current and input voltage Characteristics

Item	Symbol	Reference
DC injection current (per analogue pin)	Imax	See the RH850/U2A User's Manual: Hardware 55.2.7 Injection Current Characteristics (IINJ_AIN)
Analog input voltage	Vmax	See the RH850/U2A User's Manual: Hardware 55.4 A/D Convertor Characteristics (VIAN)

Revision History

Rev.	Date	Description	
		Page	Summary
0.1	2019.08.31	-	1st edition
0.7	2020.03.20	3	Modified section 1.3 Sampling Error due to External Circuit.
1.00	2020.10.05	-	Revision update
1.10	2022.04.01	All	Added support for RH850/U2A6.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)
   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on
   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins
   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses
   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products
   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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