

How to improve ADC accuracy in case of overlarge internal resistance

Questions:

How to improve ADC accuracy in case of over-large internal impedance of ADC input source?

Answer:

In user applications, if the input impedance of input source is too large or does not match the recommended one, ADC conversion accuracy would be reduced.

Taking AT32F403 as an example here, the internal impedance of input source for ADC is recommended below:

ADC CLK = 14MHz		
Sampling clocks	Sampling time (us)	The desired input source internal resistance <= recommended one (kΩ)
1.5	0.11	0.2
7.5	0.54	1.0
13.5	0.96	2.0
28.5	2.04	4.2
41.5	2.96	6.0
55.5	3.96	8.5
71.5	5.11	11
239.5	17.11	32

ADC CLK = 28MHz		
Sampling clocks	Sampling time (us)	The desired input source internal resistance <= recommended one (kΩ)
1.5	0.05	0.1
7.5	0.27	0.4
13.5	0.48	0.9
28.5	1.02	2.1
41.5	1.48	3.0
55.5	1.98	4.0
71.5	2.55	5.0
239.5	8.55	19

To improve ADC conversion precision, the following steps are recommended:

1. Increasing the sampling time will help solve the problem of low ADC conversion accuracy caused by insufficient sampling time. For example, assuming that the 1.5 CLK sampling time used produces poor ADC conversion accuracy, this issue can be solved by a gradual increase in CLK cycles (7.5-13.5-28.5-41.5-55.5 CLK), in case this condition permitted.
2. Connect a capacitance of 330pF-0.1uF to the input I/O of ADC in parallel, so as to pre-sample signals
3. If the sampling signal is lower than $V_{DDA}/2$ ($V_{REF}/2$), then insert a sampling operation on the internal $V_{REF}/2$ before sampling a target signal. This helps discharge the sampling capacitance inside ADC to the desired voltage before starting the sampling operation on the target signal.
4. Software sampling: ignore or discard the first ADC sample value, and use the second value instead, or conduct median filtering. This operation can help avoid a certain ADC channel value to be too large or too small because it has not enough time to discharge voltage during multiple-channel switching in the case of over-large input source internal impedance.

Special attention paid to ADC I/O: the input voltage on all I/O ports shared with ADC must not exceed V_{DDA} (*MCU operating voltage*)+0.3V; if this happens, it is recommended to reduce the voltage to the specified range with a resistive divider.

5. Add time interval between two consecutive samplings.

Type: MCU application

Applicable products: AT32 series

Main function: ADC

Minor function: None

Document revision history

Date	Revision	Changes
2022.2.16	2.0.0	Initial release

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