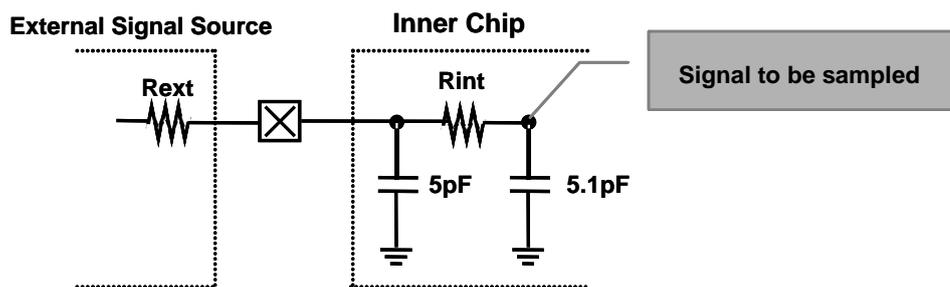


Output impedance of ADC analog signal source Application Note

Applied for: All MCU that includes ADC

Attention must be paid on impedance matching when the external analog signal sent by the external electric circuit to ADC for measuring. The impedance of external circuit must be matching to that of IO input of ADC in order to avoid measuring tolerance. The signal to be sampled must reach an appropriated accuracy before being sampled. Concerning the condition that varies on or within 0V~5V, the equivalent electric circuit that is charged/discharged by external signal source is shown as below,



The input accuracy is formulated as below,

$$1 - e^{-\frac{T}{RC}} = 1 - \Delta$$

“ Δ ” means tolerance on signal error

“ Δ ” must be under 0.001 ($1/2^{10}$) while in 10-bit resolution; that means the accuracy should reach 0.999 or above before signal is sampled.

$$e^{-\frac{T}{RC}} < 0.001$$

When sample period = 2us, the allowed highest signal cycle will also be 2us. When the input is charged / discharged by signal source, its appropriated accuracy must be reached before being sampled.

$$-\frac{T}{RC} < -6.9$$

$$R < \frac{T}{6.9C}$$

The internal chip capacitor is around 10pF and only half cycle is required for ADC charge/discharge to sampled signal. Therefore, T is given as 1us.

$$\frac{1\mu}{6.9 \times 10^{-11}} \sim 14.5K > R$$

Here

$$R = R_{\text{ext}} + R_{\text{int}} \quad R_{\text{ext}} \text{ means external circuit impedance, } R_{\text{int}} \text{ means internal chip impedance.}$$

∴ When ADC input signal cycle is 2us and the resolution is required as 10-bit, the input impedance of external circuit is recommended below 10kΩ.

The output impedance should be recalculated in case that input signal cycle or required resolution is changed.

$$R < \frac{T}{6.9C} \quad , \quad C \approx 10\text{PF}$$

- When input signal cycle is 1kHz and the required resolution is 10-bit, the signal output impedance should be :

$$R < \frac{0.5 \times 10^{-3}}{6.9 \times 10^{-11}}$$

$$R < 7.25\text{M}\Omega$$

- When input signal cycle is 100kHz and the required resolution is 10-bit, the signal output impedance should be :

$$R < 72.5\text{K}\Omega$$

Please put signal cycle and resolution into formula in accordance with your requirements. It will help you to get the reference value of highest external circuit output impedance.

If you have further questions to the application, please consult to our agent at your nearest location or contact us at fae@padauk.com.tw