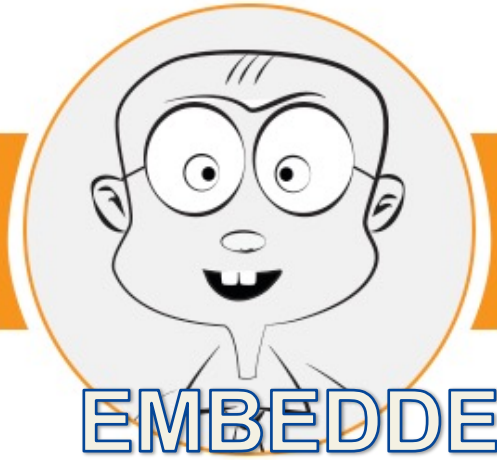

EMBEDDED SYSTEM COURSE

LECTURE 8: PERIPHERAL ADC

Learning Goals

- Understanding basis concepts about A/D converter.
- Understanding on how to configure the ADC module in KL46.
- Understanding on how to create a simple project for ADC module.

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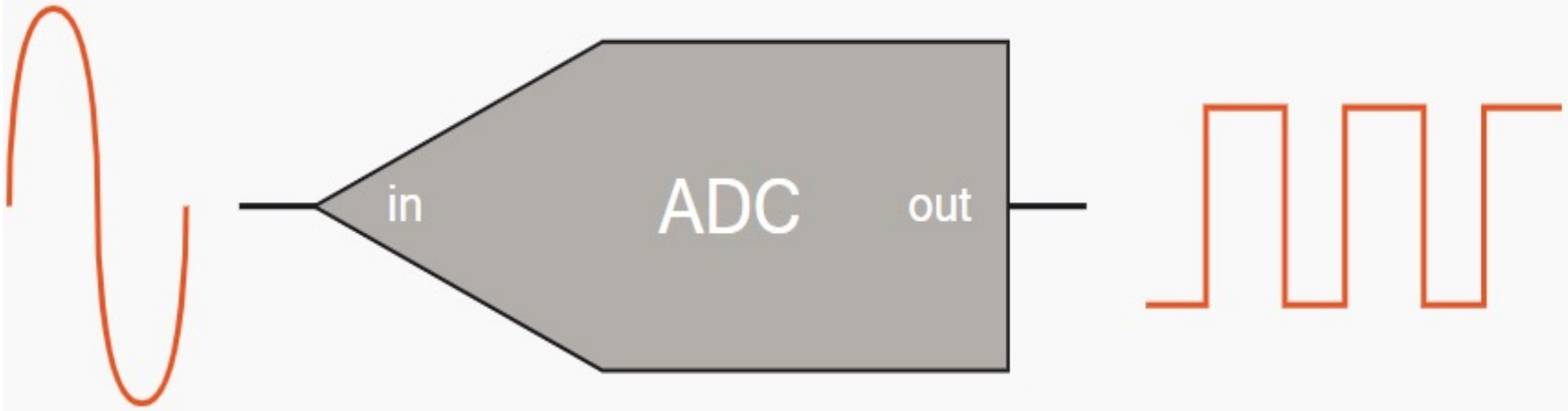
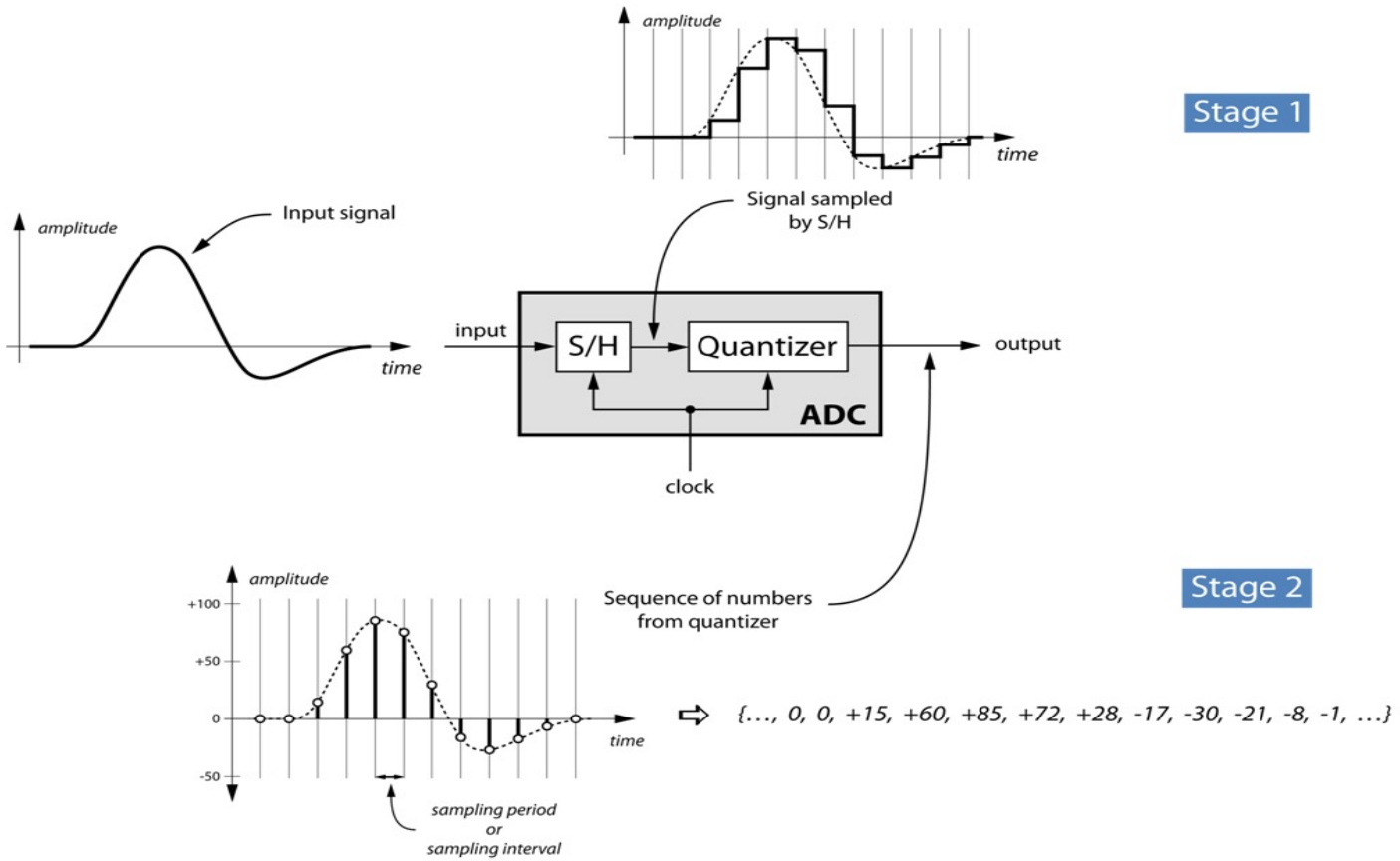
What is A/D converter?

The main purpose of the A/D converters within a data acquisition system is to convert conditioned analog signals into a stream of digital data so that the data acquisition system can process them for display, storage, and analysis.



ADC converter takes an analog signal and converts it into the digital domain

What Do A/D Converters Do?



What is resolution?

The resolution of the converter indicates the number of different, ie discrete, values it can produce over the allowed range of analog input values.

(wiki)

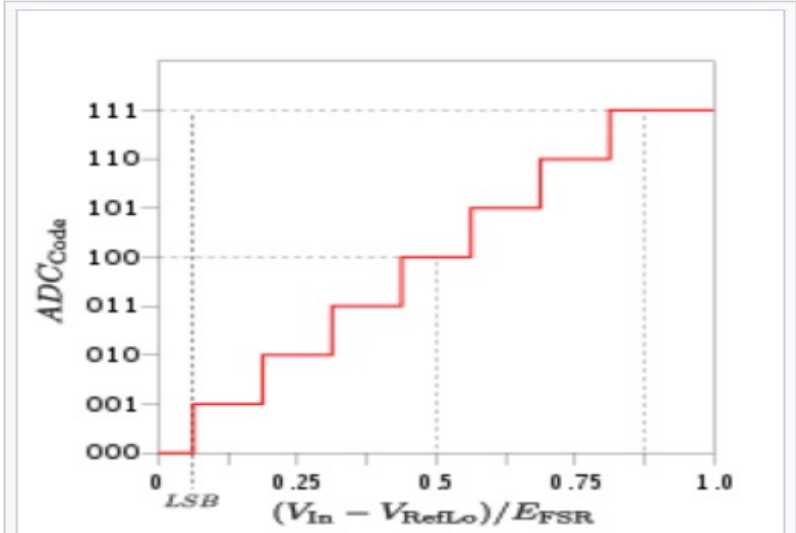


Fig. 1. An 8-level ADC coding scheme.

What is the Sampling Rate?

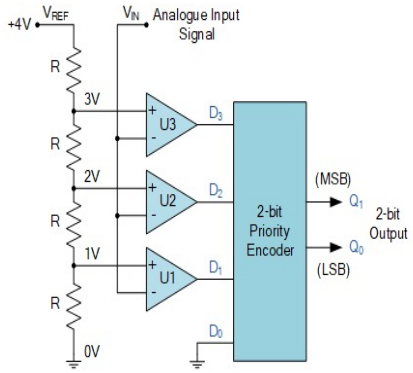
- An analog signal is continuous in time and it is necessary to convert this to a flow of digital values. It is therefore required to define the rate at which new digital values are sampled from the analog signal. The rate of new values is called the *sampling rate* or *sampling frequency* of the converter.
- The Nyquist–Shannon:

(wiki)

A/D converter architecture

- **Flash ADC**
- **Sucessive-approximation ADC**
- **Ramp-compare ADC**
- **Delta-encoded ADC or counter-ramp**
- **…**

2-bit Analogue to Digital Converter Circuit



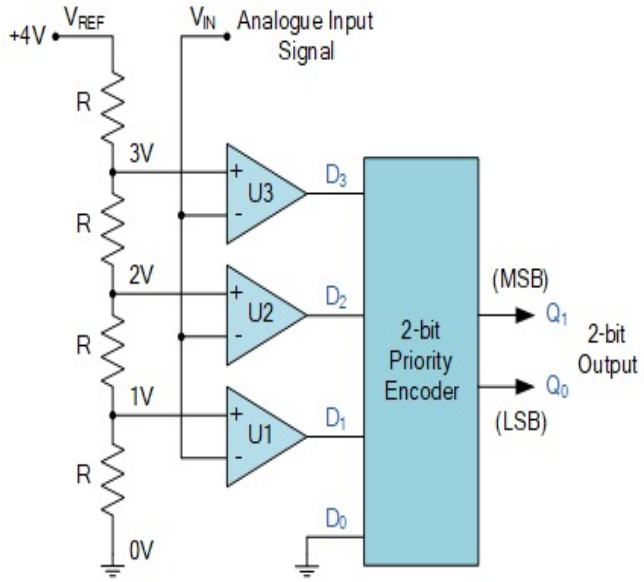
2-bit A/D converter Output

Analogue Input Voltage (V_{IN})	Comparator Outputs				Digital Outputs	
	D_3	D_2	D_1	D_0	Q_1	Q_0
0 to 1 V	0	0	0	**0**	0	0
1 to 2 V	0	0	**1**	X	0	1
2 to 3 V	0	**1**	X	X	1	0
3 to 4 V	**1**	X	X	X	1	1

A/D converter architecture

- **Flash ADC**

2-bit Analogue to Digital Converter Circuit

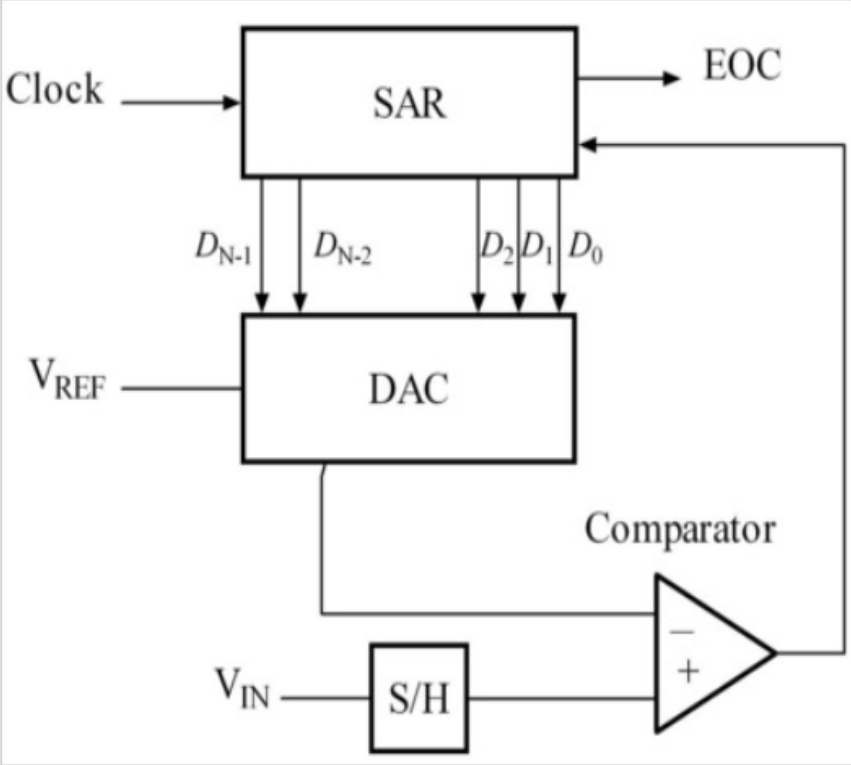


2-bit A/D converter Output

Analogue Input Voltage (V_{IN})	Comparator Outputs				Digital Outputs	
	D_3	D_2	D_1	D_0	Q_1	Q_0
0 to 1 V	0	0	0	0	0	0
1 to 2 V	0	0	1	X	0	1
2 to 3 V	0	1	X	X	1	0
3 to 4 V	1	X	X	X	1	1

A/D converter architecture

Sucessive-approximation ADC



Successive-approximation ADC block diagram

Key

DAC = digital-to-analog converter

EOC = end of conversion

SAR = successive approximation register

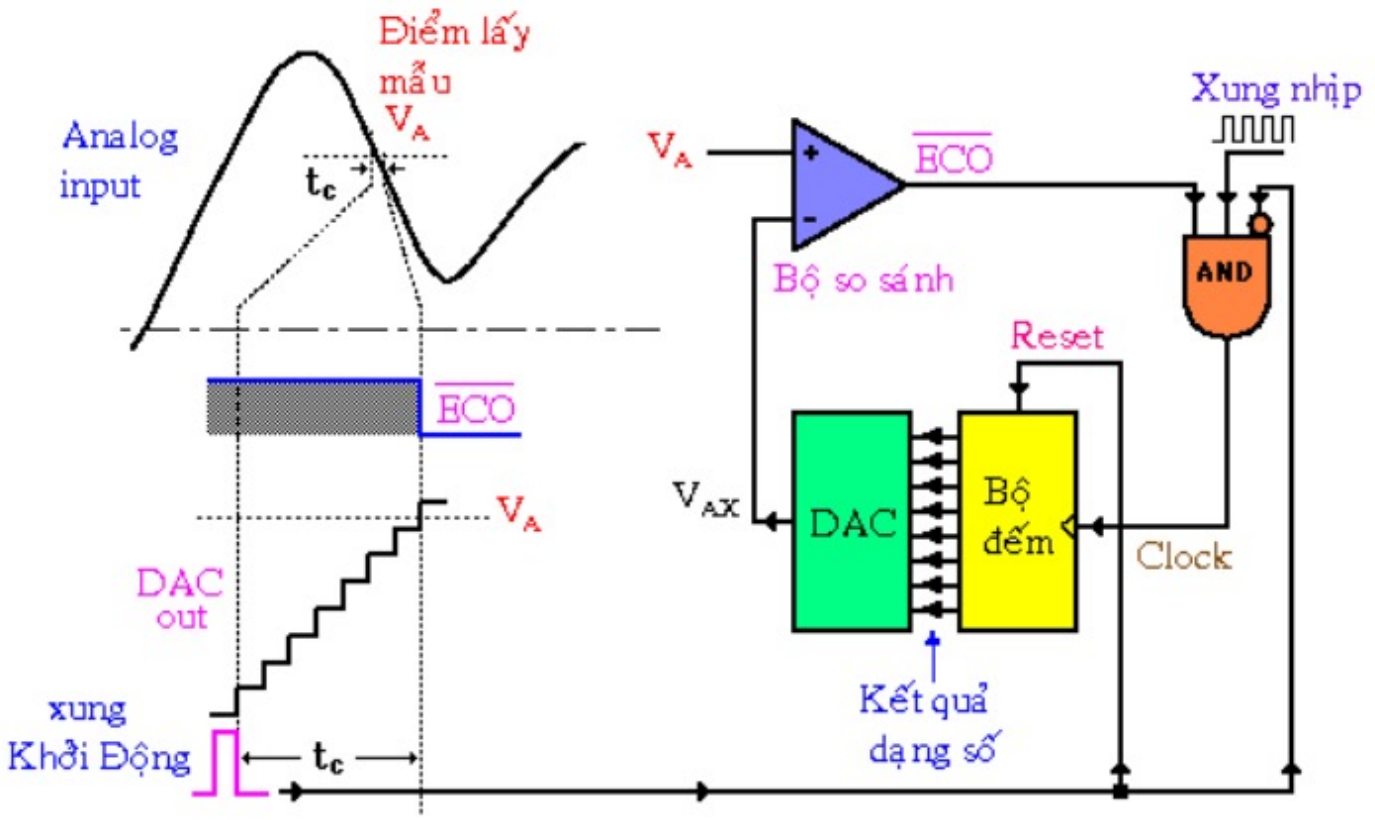
S/H = sample and hold circuit

V_{IN} = input voltage

V_{REF} = reference voltage

A/D converter architecture

Ramp-compare ADC



Hình 5.20 DAC dạng sóng bậc thang

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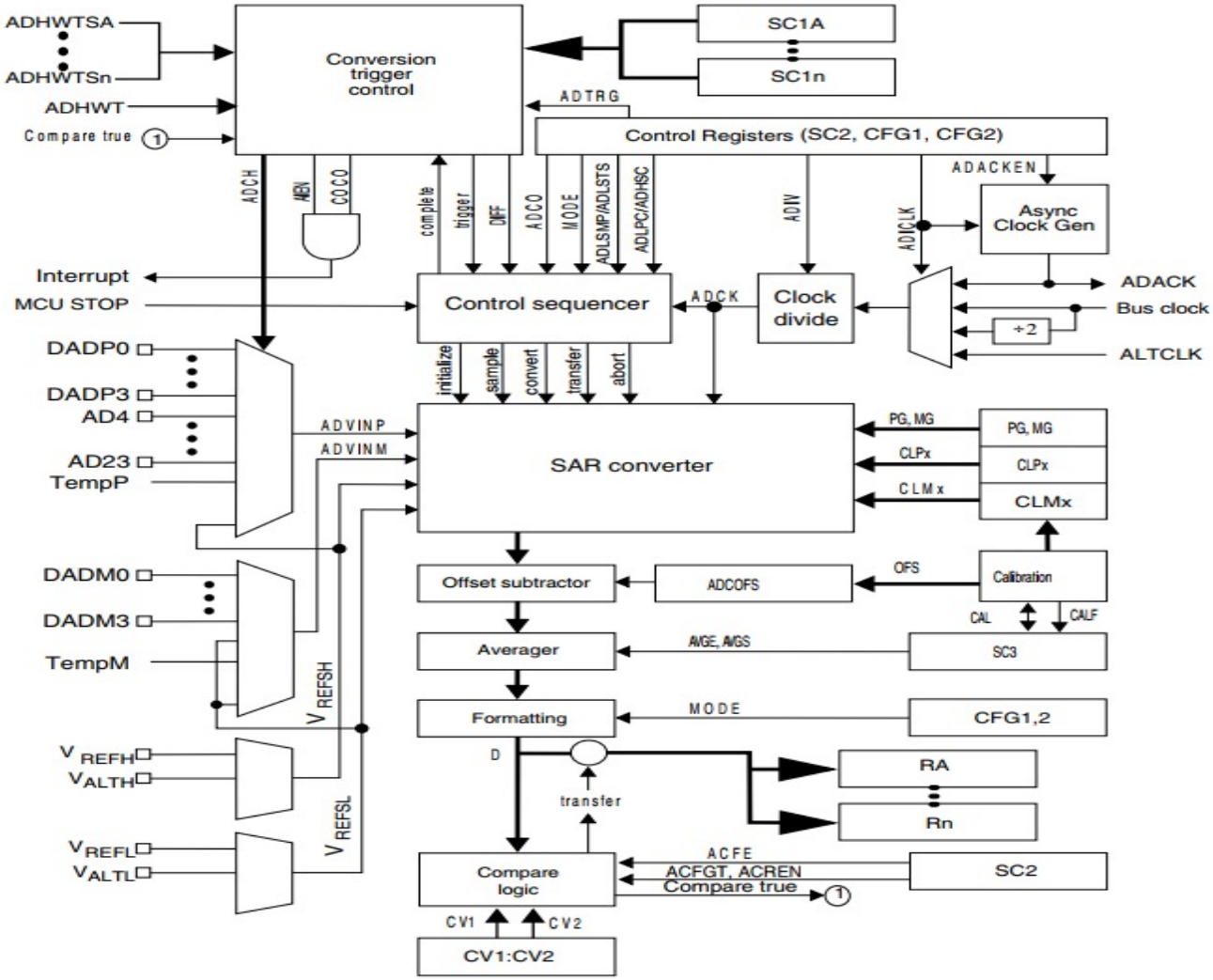
MKL46Z ADC features

- Linear successive approximation algorithm with up to 16-bit resolution
- Up to four pairs of differential and 24 single-ended external analog inputs
- Output modes:
  - differential 16-bit, 13-bit, 11-bit, and 9-bit modes
  - single-ended 16-bit, 12-bit, 10-bit, and 8-bit modes
- Output format in 2's complement 16-bit sign extended for differential modes
- Single or continuous conversion, that is, automatic return to idle after singlen conversion
- Conversion complete/hardware average complete flag and interrupt
- Input clock selectable from up to four sources
- Selectable hardware conversion trigger with hardware channel select
- Automatic compare with interrupt for less-than, greater-than or equal-to, within range, or out-of-range, programmable value

MKL46Z ADC Block Diagram



MKL46Z ADC Register

Fpt Software

FSOFT Workforce Assurance FWA.CTC Corporate Training Center

ADC memory map

Absolute address (hex)	Register name	Width (in bits)	Access	Reset value	Section/ page
4003_B000	ADC Status and Control Registers 1 (ADC0_SC1A)	32	R/W	0000_001Fh	28.3.1/476
4003_B004	ADC Status and Control Registers 1 (ADC0_SC1B)	32	R/W	0000_001Fh	28.3.1/476
4003_B008	ADC Configuration Register 1 (ADC0_CFG1)	32	R/W	0000_0000h	28.3.2/479
4003_B00C	ADC Configuration Register 2 (ADC0_CFG2)	32	R/W	0000_0000h	28.3.3/481
4003_B010	ADC Data Result Register (ADC0_RA)	32	R	0000_0000h	28.3.4/482
4003_B014	ADC Data Result Register (ADC0_RB)	32	R	0000_0000h	28.3.4/482
4003_B018	Compare Value Registers (ADC0_CV1)	32	R/W	0000_0000h	28.3.5/483
4003_B01C	Compare Value Registers (ADC0_CV2)	32	R/W	0000_0000h	28.3.5/483

Table continues on the next page...

How to program for adc?

Question & Answer

Thanks for your attention !

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