

# CHAPTER THIRTY FOUR

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*Digital ↔ Analog Converters (DAC  
and ADC)*

# Introduction

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In many applications, it is needed to process data digitally. Therefore, ADC and DAC circuits are of importance

# Digital-to-Analog Converter

## Example

$$\underbrace{(100110)_2}_{\text{Digital form}} \rightarrow \underbrace{(1 \times 2^5 + 0 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0)}_{\text{Analog form}} = 32 + 4 + 2 = 38$$

$$(10 \dots 01 \dots 10 \dots)_2 \rightarrow (D_{M-1} \times 2^{M-1} + D_{M-2} \times 2^{M-2} + \dots + D_1 \times 2^1 + D_0)$$

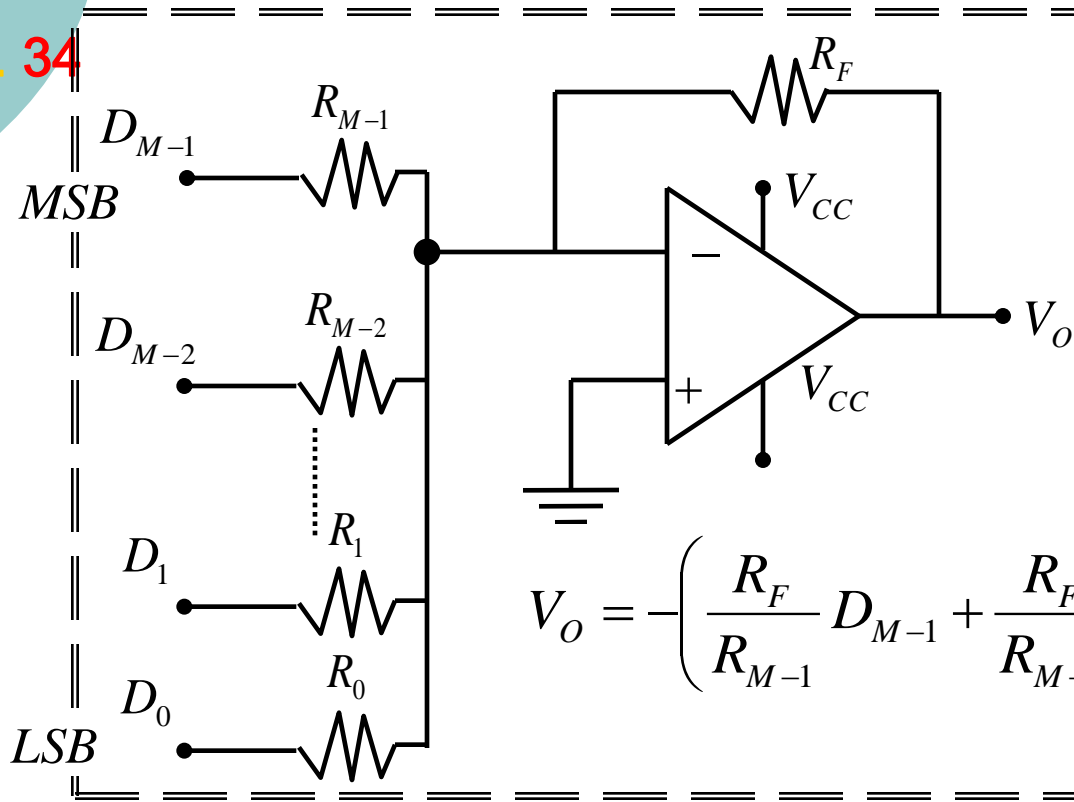
$(D_{M-1} D_{M-2} \dots D_1 D_0)$  : is the binary word

$M$  : number of bits

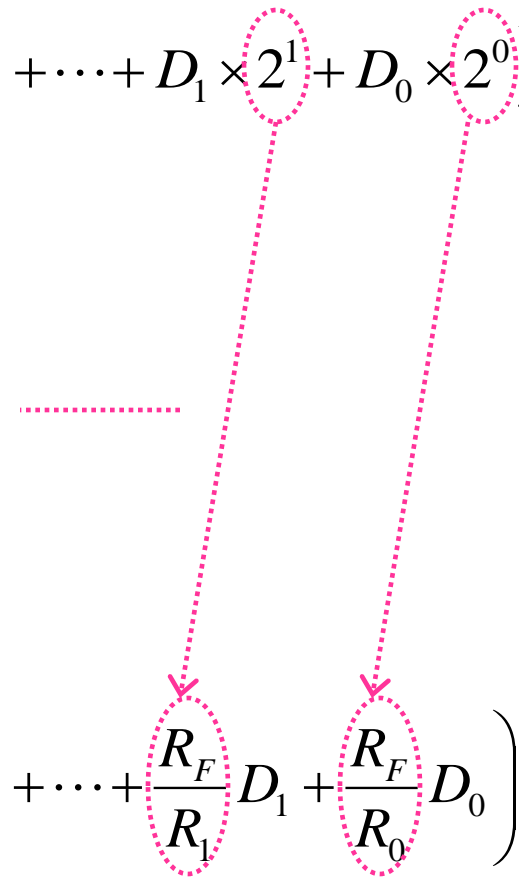
# Digital-to-Analog Converter

## Example

$$(10\dots 01\dots 10\dots)_2 \rightarrow (D_{M-1} \times 2^{M-1} + D_{M-2} \times 2^{M-2} + \dots + D_1 \times 2^1 + D_0 \times 2^0)$$



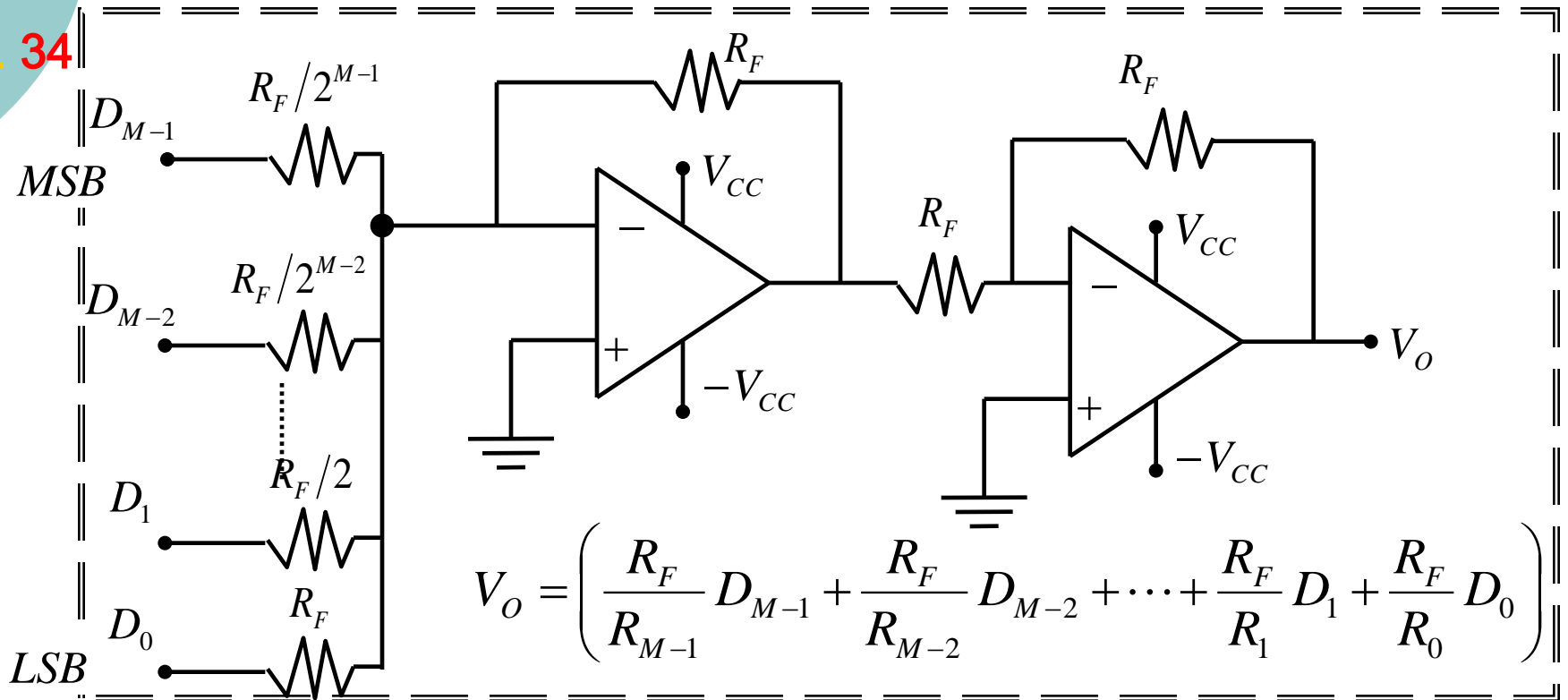
$$V_O = - \left( \frac{R_F}{R_{M-1}} D_{M-1} + \frac{R_F}{R_{M-2}} D_{M-2} + \dots + \frac{R_F}{R_1} D_1 + \frac{R_F}{R_0} D_0 \right)$$



# Digital-to-Analog Converter

## Example

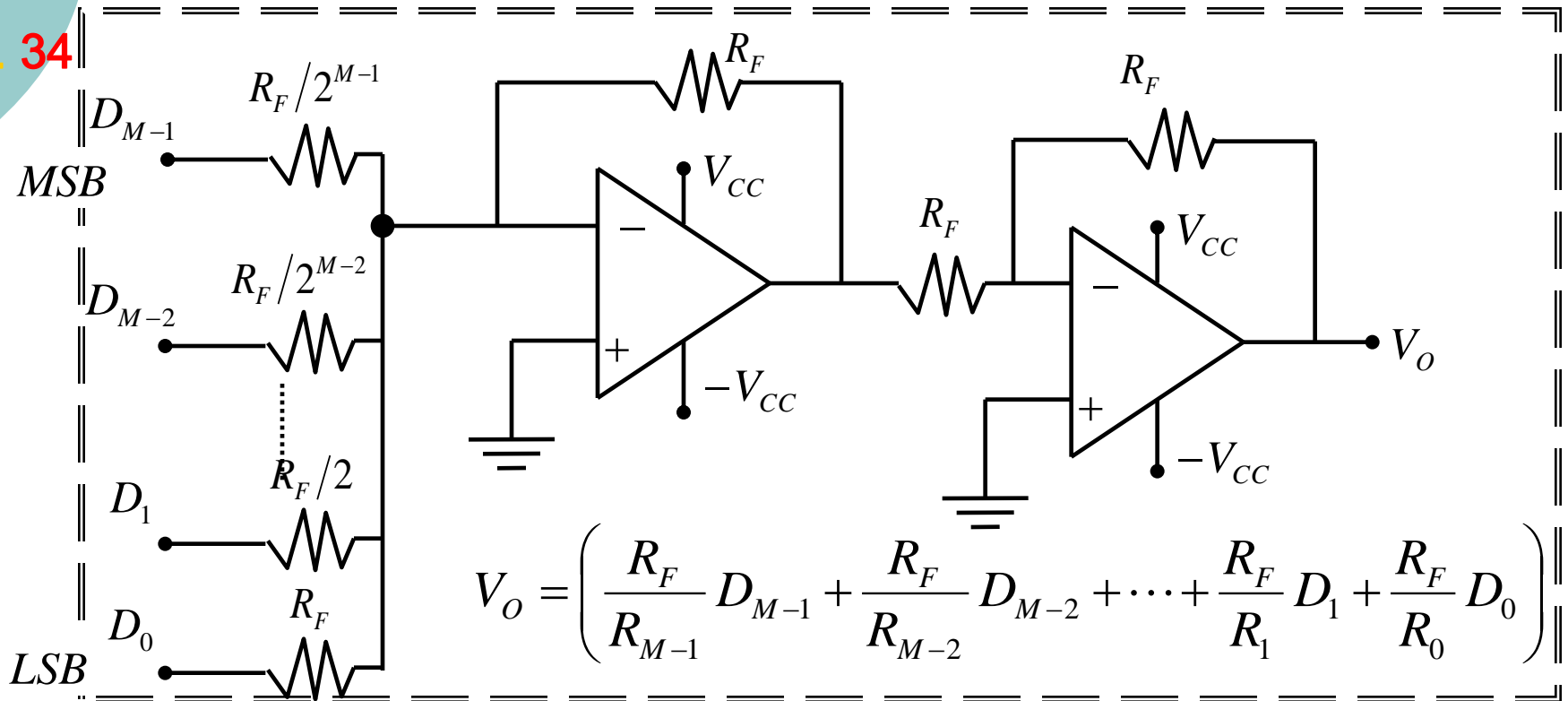
$$(10\dots 01\dots 10\dots)_2 \rightarrow (D_{M-1} \times 2^{M-1} + D_{M-2} \times 2^{M-2} + \dots + D_1 \times 2^1 + D_0 \times 2^0)$$



# Digital-to-Analog Converter

## Disadvantage

To design such a circuit, we need a wide range of resistor values which may not be easily found in the laboratory



# Ladder Digital-to-Analog Converter

Advantage To design such a circuit, we need only two values of resistors

