Física Experimental VI – 4300314

1º Semestre de 2017

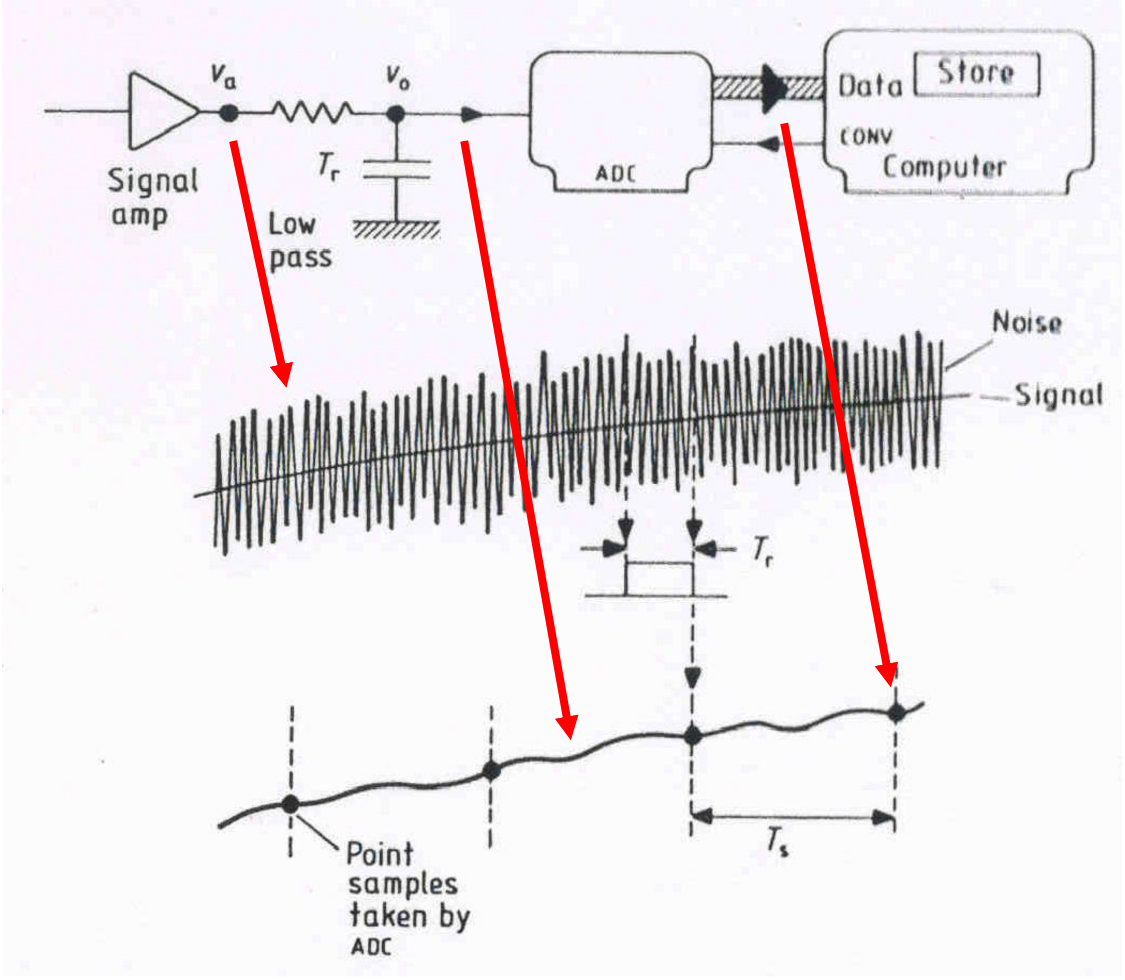
Instituto de Física
Universidade de São Paulo

Professor: Antonio Domingues dos Santos

E-mail: adsantos@if.usp.br
Fone: 3091.6886

Ruído e Digitalização

Sistema típico de digitalização de sinais



Para otimizar o desempenho e evitar desperdício de tempo,

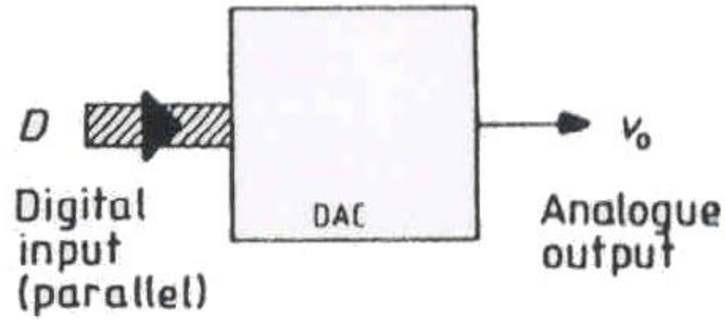
T_r deve ser igual a T_s

Acréscimo no ruído dado por

$(T_r/T_s)^{-1/2}$

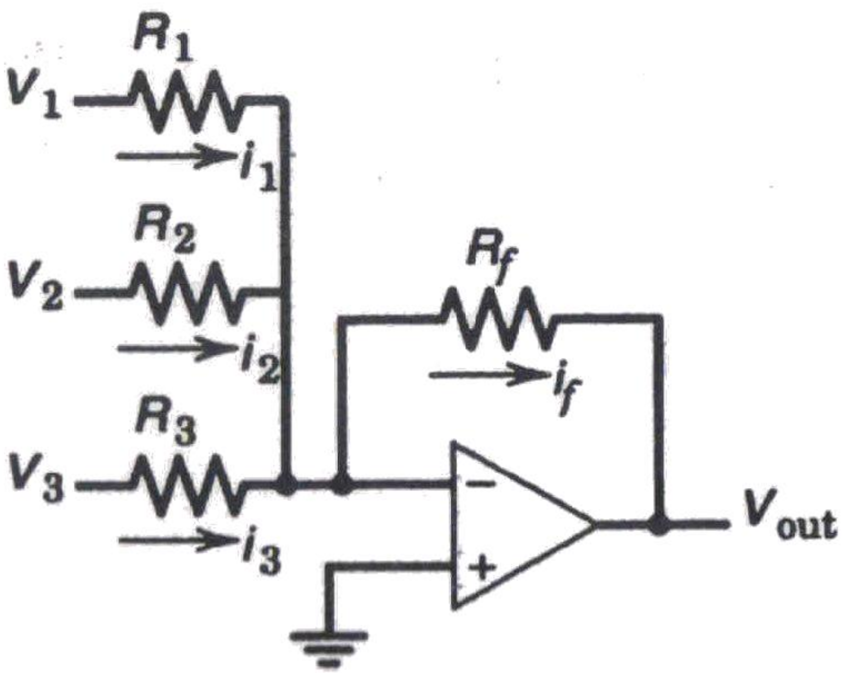
Ruído e Digitalização

Conversor Digital-Analógico (DAC)



Amplificador Somador

Onde o número de entradas corresponde ao número de bits



$$V_{out} = -\frac{R_f}{R_0}\cdot V_0 - \frac{R_f}{R_1}\cdot V_1 \cdots - \frac{R_f}{R_7}\cdot V_7$$

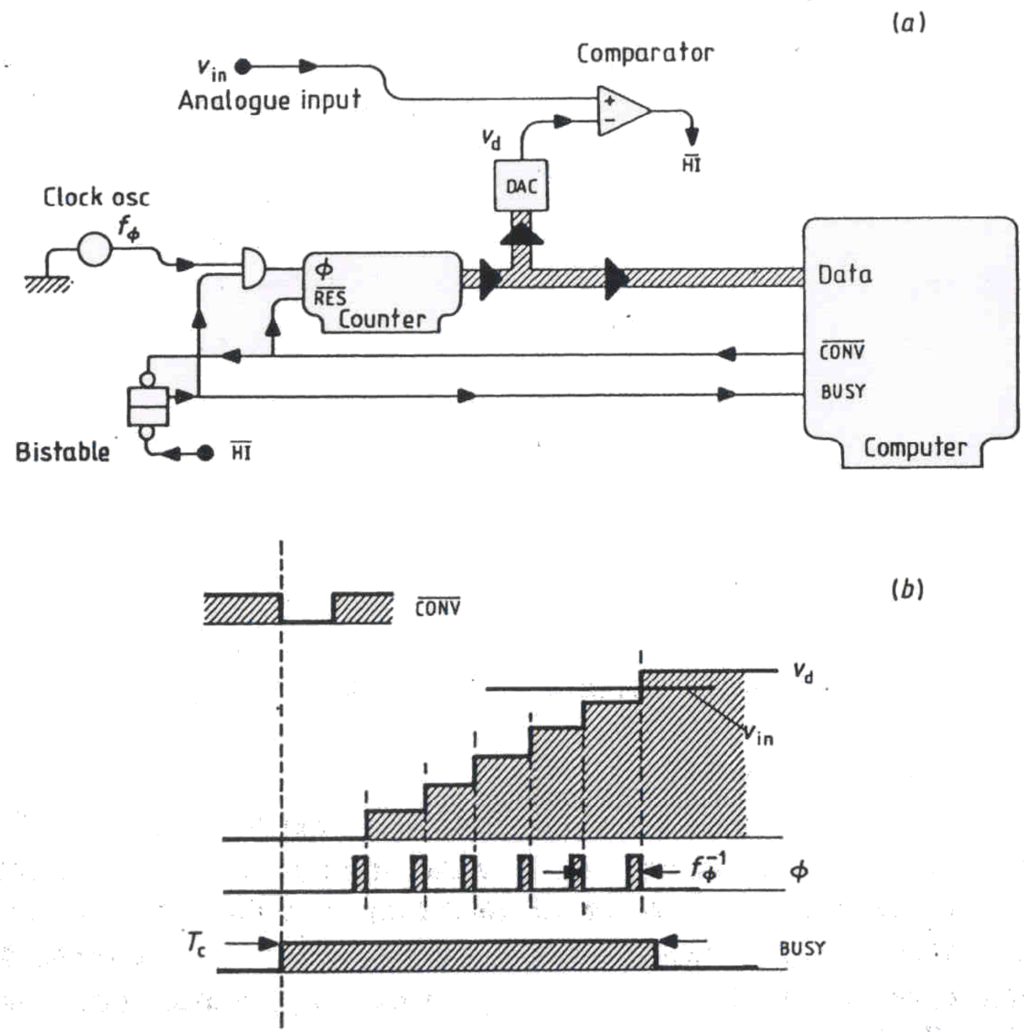
Considerando-se $V_0=V_1=...=V_7= 0$ ou 1

$$V_{out} = -R_f \sum_{i=0}^{7} \frac{V_i}{R_i}$$

Onde: $R_i=2^iR$

Ruído e Digitalização

Conversor Analógico-Digital (ADC)



1) Tipo "Contador"

O contador soma +1 a cada pulso do "clock".

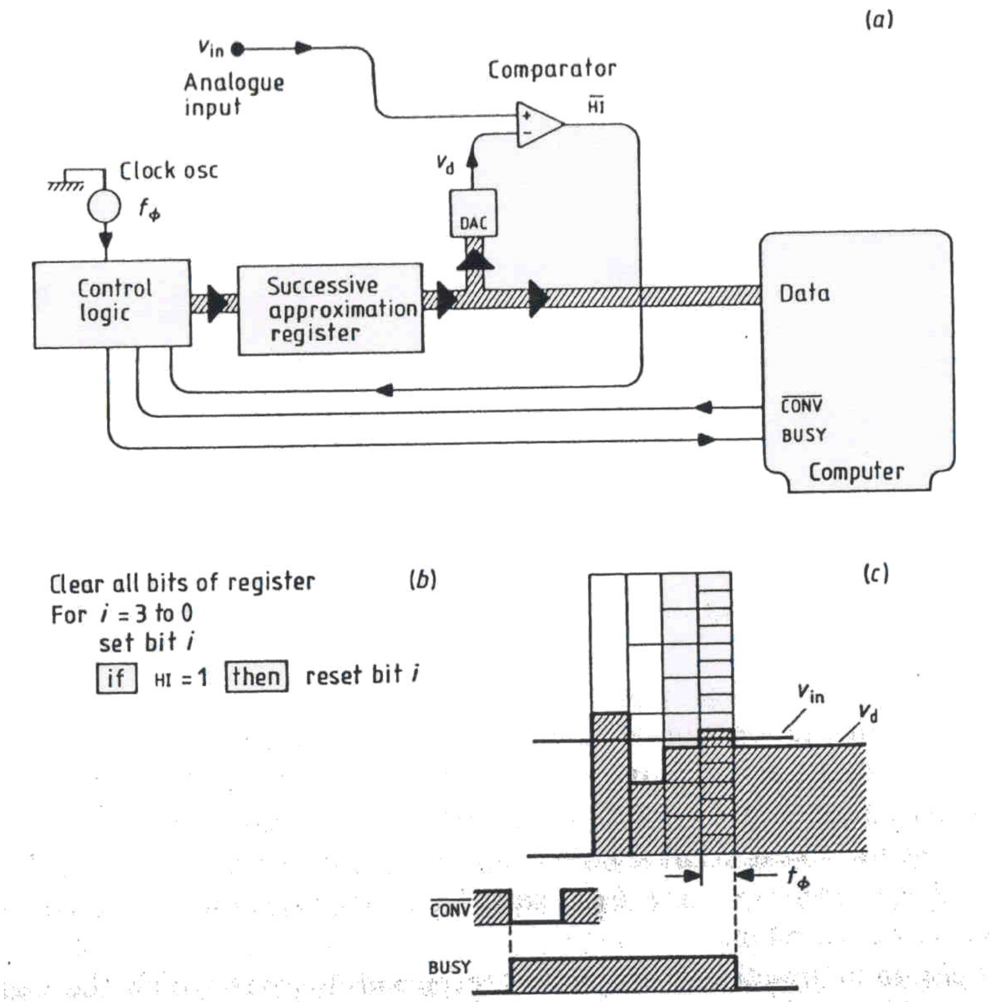
Quando $V_d > V_{in}$, para-se a contagem e armazena-se o dado.

Para 8 bits e f= 1 MHz, o tempo máximo de amostragem é

T_c= 1μs . 2^8= 256 μs

Ruído e Digitalização

Conversor Analógico-Digital (ADC)



2) de "Aproximação sucessiva"

Coloca-se sequencialmente cada bit em 1 e verifica-se

se $V_d > V_{in}$ ➔ bit= 0.

Após todos os bits serem testados, armazena-se o dado resultante.

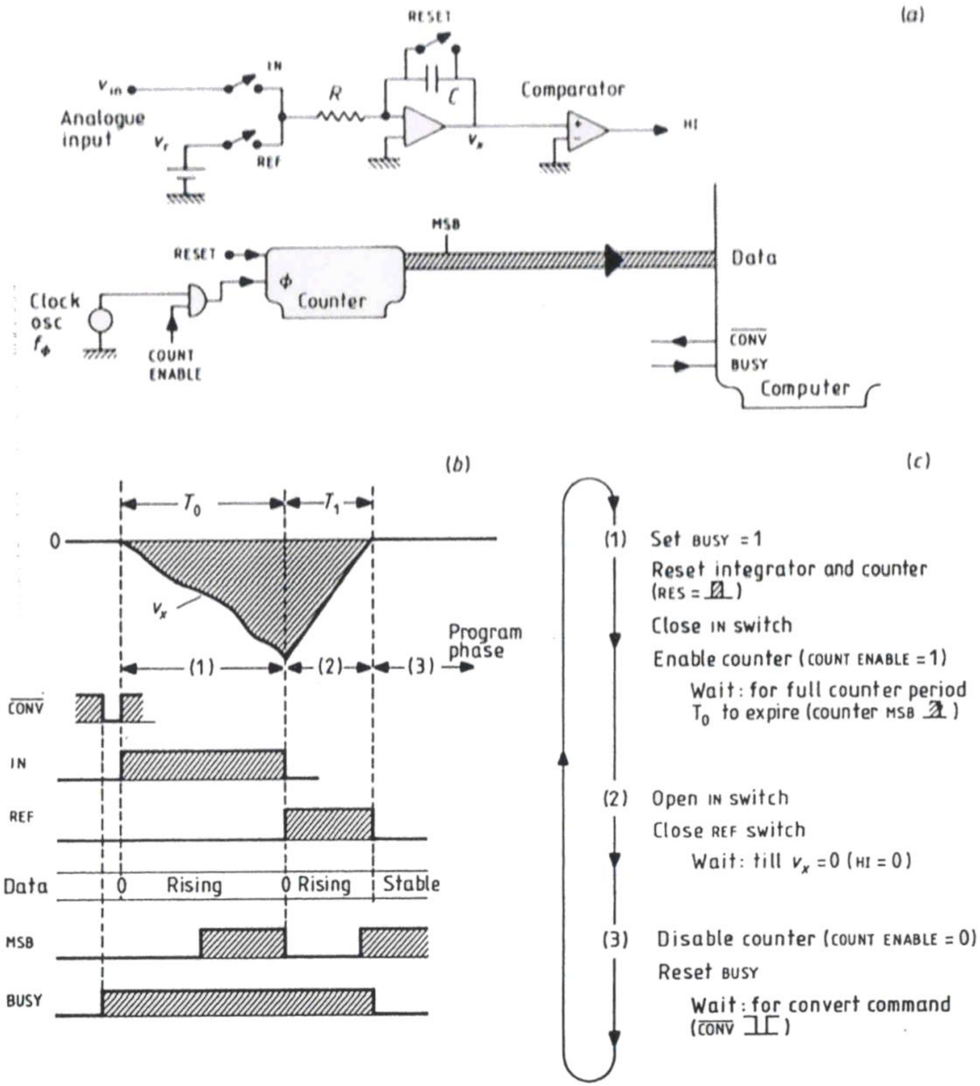
Para 8 bits e f= 1 MHz, o tempo máximo de amostragem é

T_c= 1μs . 8= 8 μs

Mais rápido !!!

Ruído e Digitalização

Conversor Analógico-Digital (ADC)



3) de "Rampa dupla"

Integra-se V_{in} durante o tempo T_o e integra-se V_r durante o tempo T_1, quando o integrador volta a zero.

$V_{in} = T_1 \, V_r / T_o$.

$$V_x = -\frac{1}{RC}\int_0^T V_{in}\,dt$$

Para 8 bits e f= 1 MHz, o tempo máximo de amostragem é

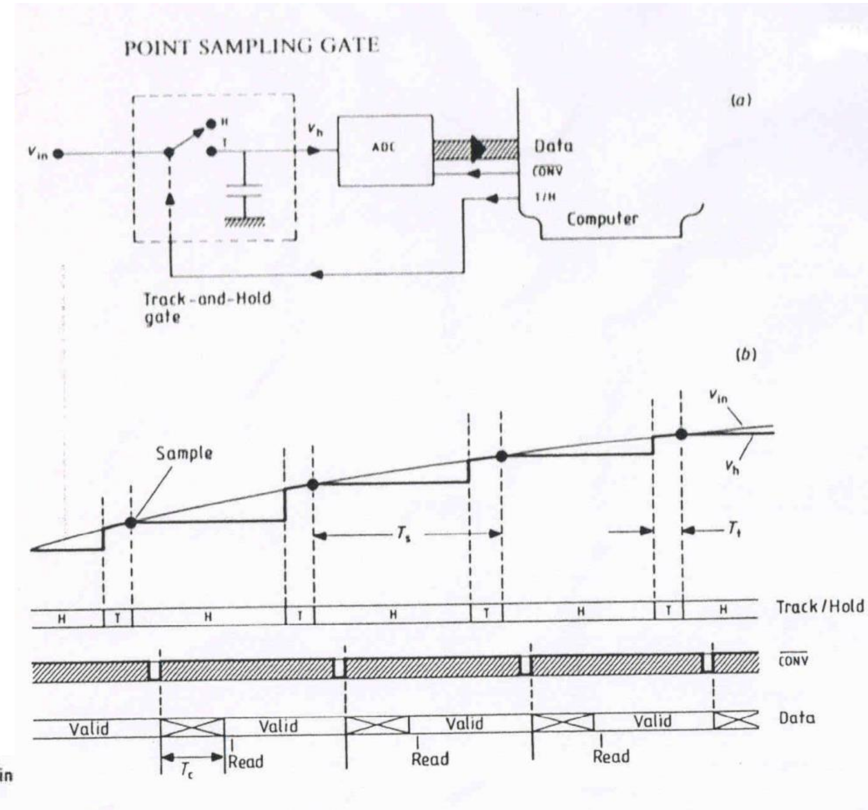
$T_c = 1\mu s \cdot 2^8 = 256\ \mu s$ (x2)

Mais lento !

Mais preciso !

Ruído e Digitalização

Conversor Analógico-Digital (ADC)

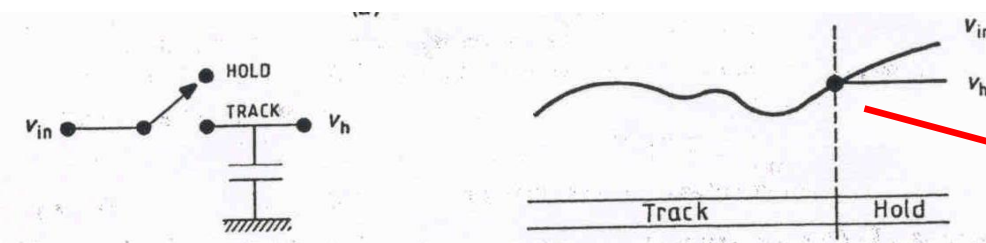


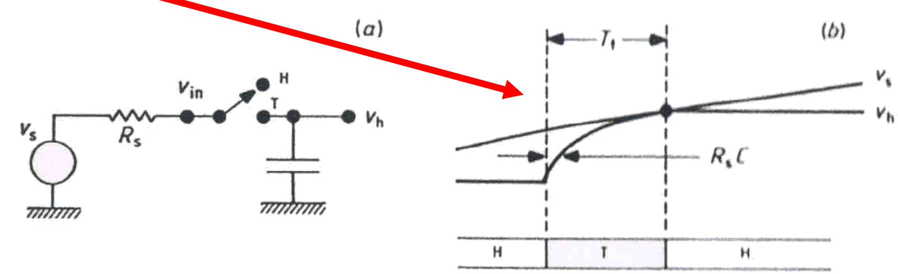
Para ADCs "Contadores" e de "Aproximação sucessiva",

se V_{in} não é constante, haverá flutuações de medida (ruído extra!).

Tornando-se conveniente o uso de "amostragem e sustentação"

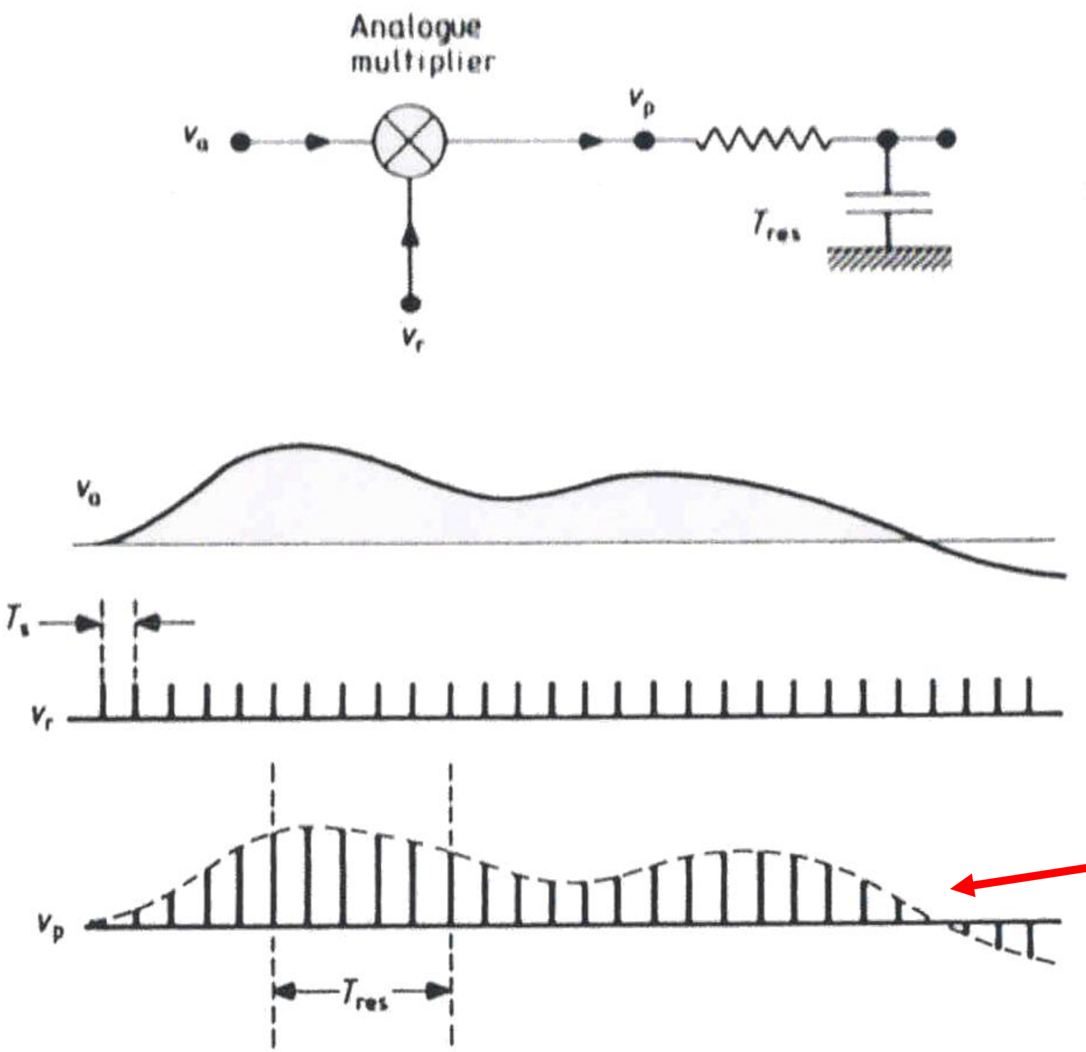
(track-and-hold)





Ruído e Digitalização

Conversor Analógico-Digital (ADC)

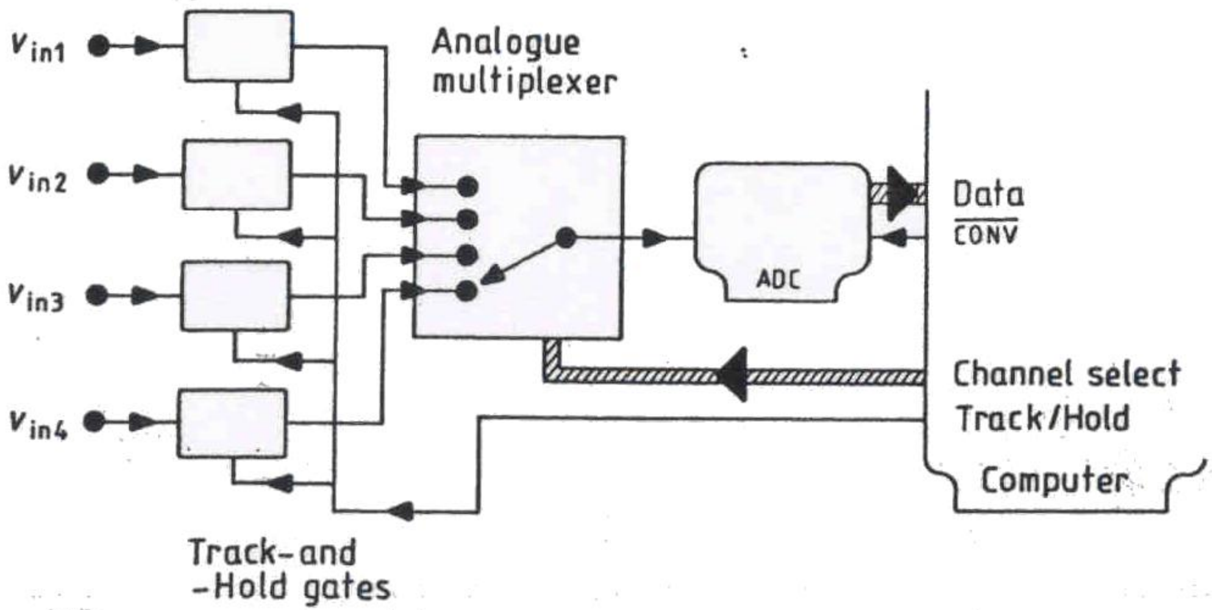


Representação digital do sinal

Ruído e Digitalização

Conversor Analógico-Digital (ADC)

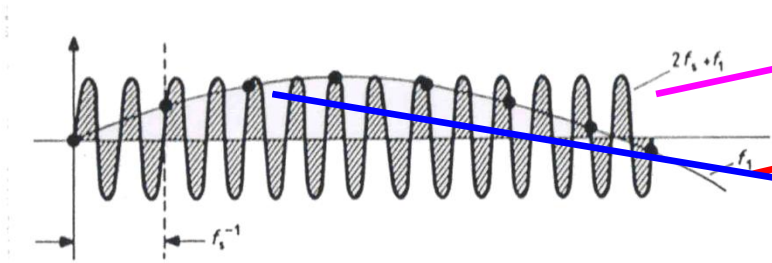
Com o uso de circuitos de "amostragem e sustentação" (track-and-hold) é possível se adquirir múltiplos sinais sincronizadamente, com um único ADC.



Ruído e Digitalização

Conversor Analógico-Digital (ADC)

Aliasing (Homônimo ?)



$\text{Cos}(2\pi(nf_s \pm f_1)t)$

$\text{Cos}(2\pi f_1 t)$

Para um ponto m,

$t = mT_s$, portanto:

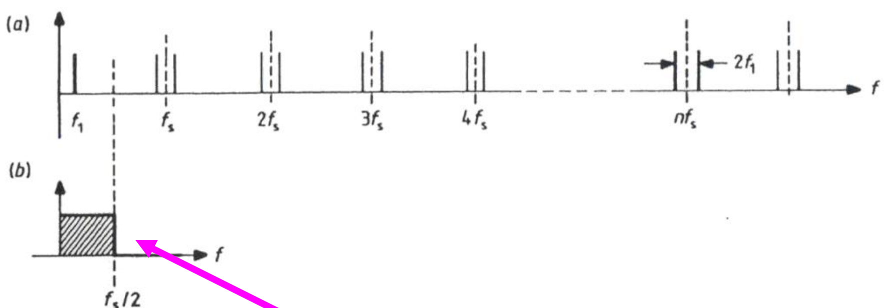
$\text{Cos}(2\pi(nf_s \pm f_1)mT_s)$

$\text{Cos}(2\pi f_1 mT_s)$

ou

$\text{Cos}(2\pi nm \pm 2\pi f_1 mT_s) =$

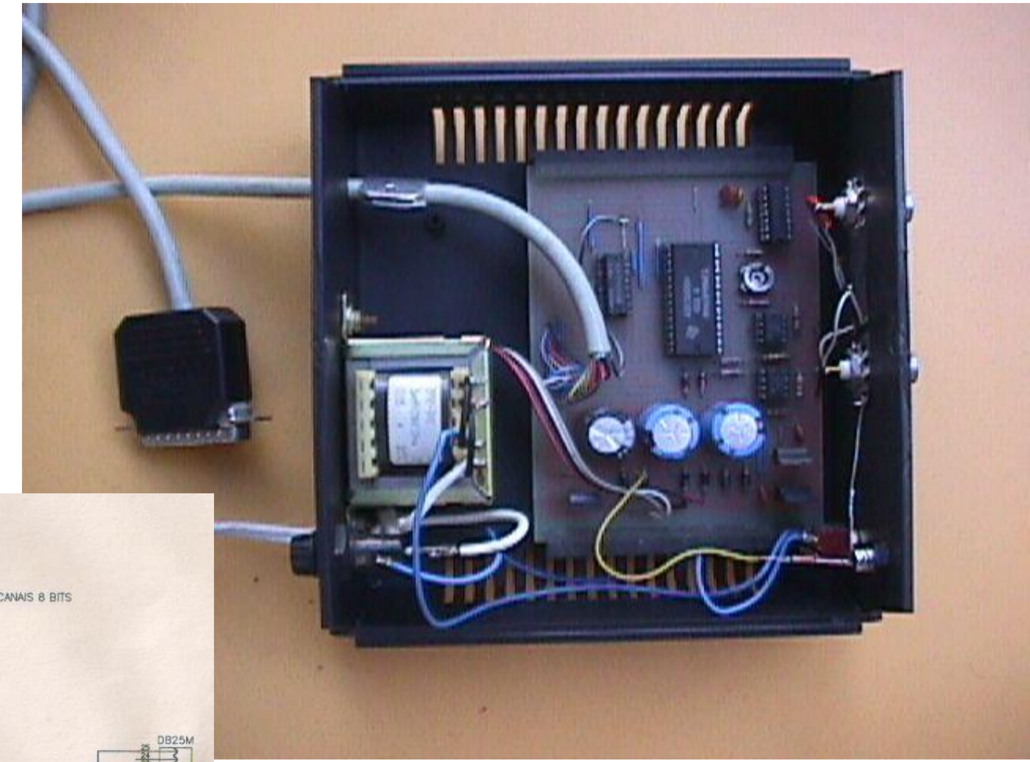
$= \text{Cos}(2\pi f_1 mT_s)$

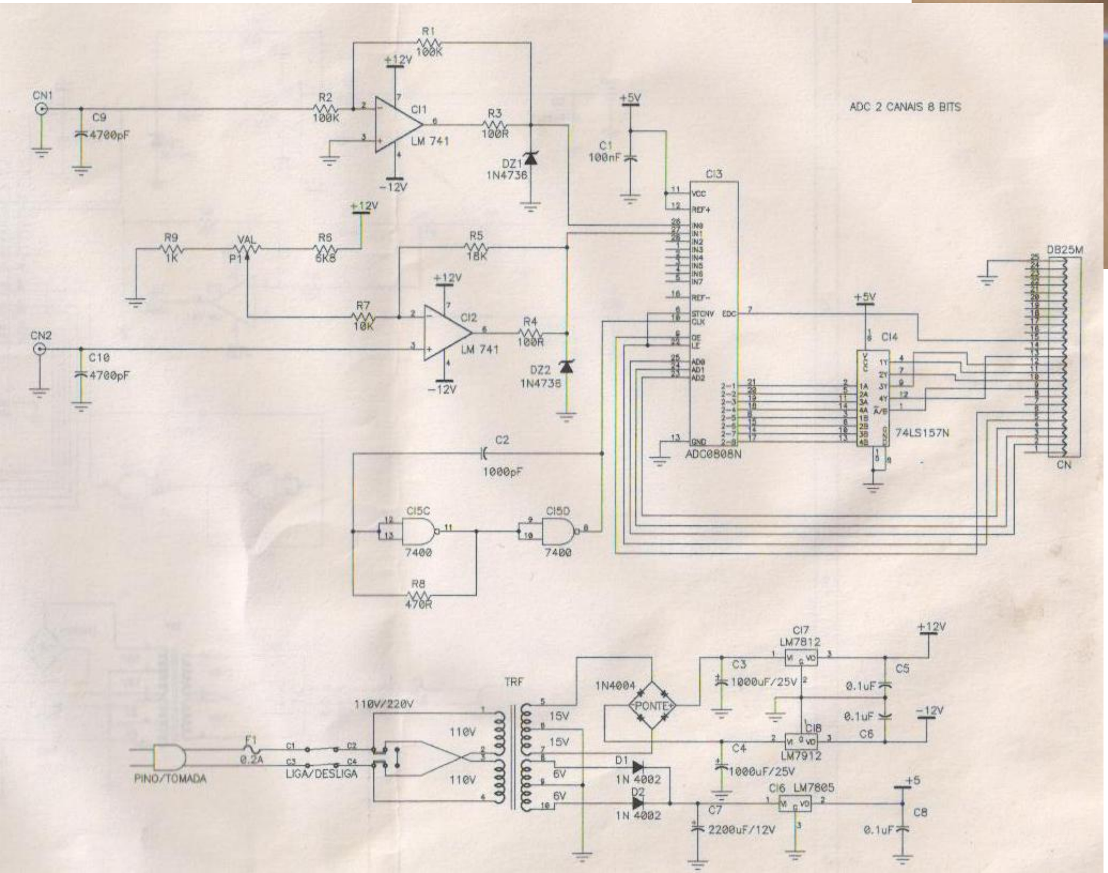


Filtro anti-aliasing

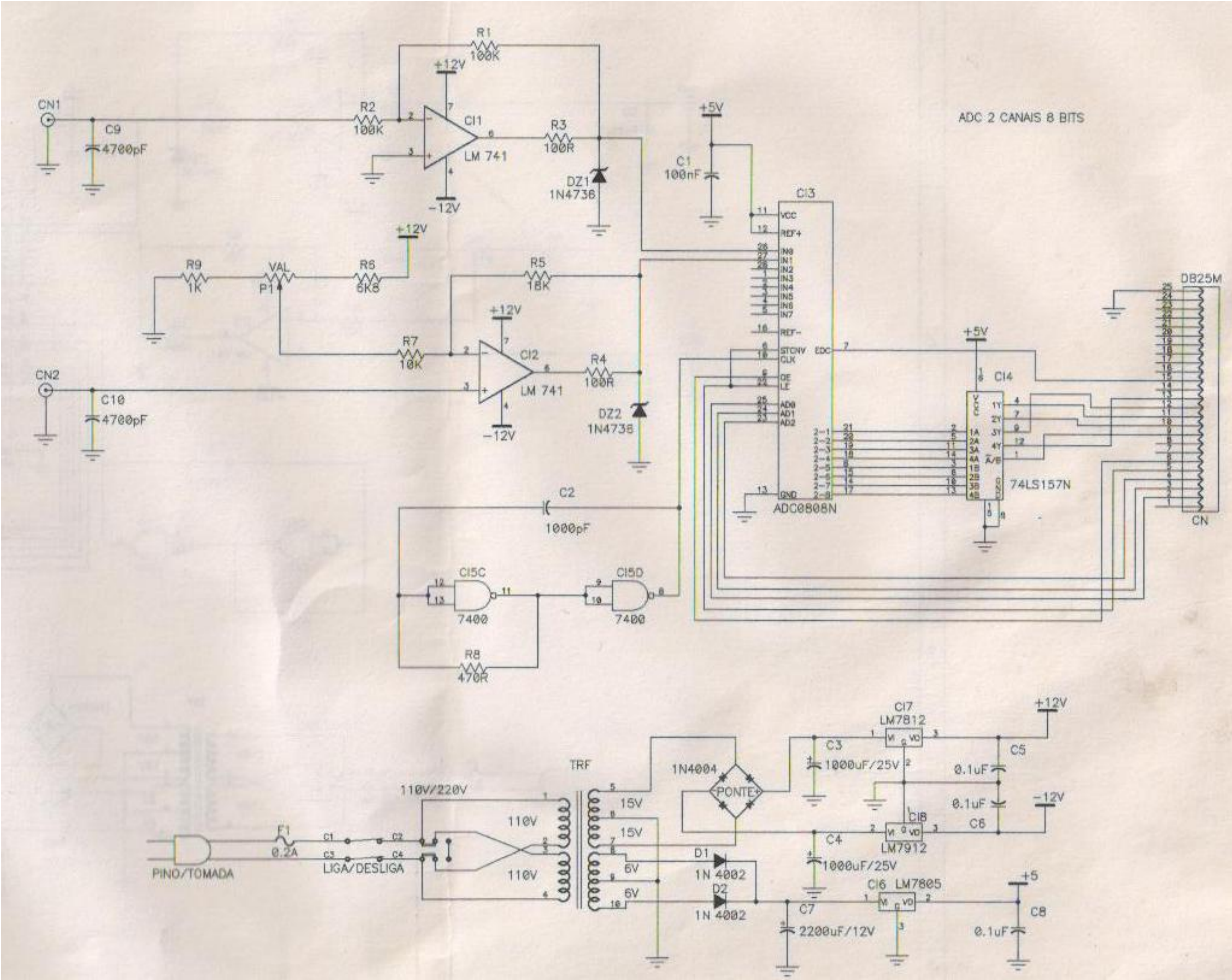
(passa-baixas com corte em $f_s/2$)

Conversor Analógico-Digital (ADC)





Efeito fotoelétrico e Franck-Hertz


ADC 2 CANAIS 8 BITS
CN1
C9 4700pF
R2 100K
R1 100K
+12V
-12V
CI1 LM 741
R3 100R
DZ1 1N4736
+5V
C1 100nF
CI3
VCC
REF+
IN0
IN1
IN2
IN3
IN4
IN5
IN6
IN7
REF-
STCNV
CLK
OE
LE
AD0
AD1
AD2
EOC
GND
ADC0808N
R9 1K
VAL P1
R6 6K8
R5 18K
R7 10K
CI2 LM 741
R4 100R
DZ2 1N4736
CN2
C10 4700pF
C2 1000pF
CI5C 7400
CI5D 7400
R8 470R
CI4
74LS157N
DB25M
CN
CI7 LM7812
C3 1000uF/25V
C5 0.1uF
C6 0.1uF
CI8 LM7912
C4 1000uF/25V
1N4004
PONTE
TRF
110V/220V
110V
15V
6V
F1 0.2A
PINO/TOMADA
LIGA/DESLIGA
D1 1N 4002
D2 1N 4002
C7 2200uF/12V
CI6 LM7805
+5
C8 0.1uF

Conversor Analógico-Digital (ADC)

- Total Unadjusted Error . . . ±0.75 LSB Max for ADC0808 and ±1.25 LSB Max for ADC0809
- Resolution of 8 Bits
- 100 μs Conversion Time
- Ratiometric Conversion
- Monotonicity Over the Entire A/D Conversion Range
- No Missing Codes
- Easy Interface with Microprocessors
- Latched 3-State Outputs
- Latched Address Inputs
- Single 5-V Supply
- Low Power Consumption

ADC0808, ADC0809 CMOS ANALOG-TO-DIGITAL CONVERTERS WITH 8-CHANNEL MULTIPLEXERS

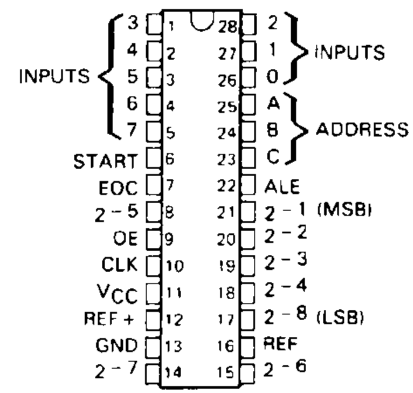
D2642, JUNE 1981 – REVISED MAY 1988

MULTIPLEXER FUNCTION TABLE

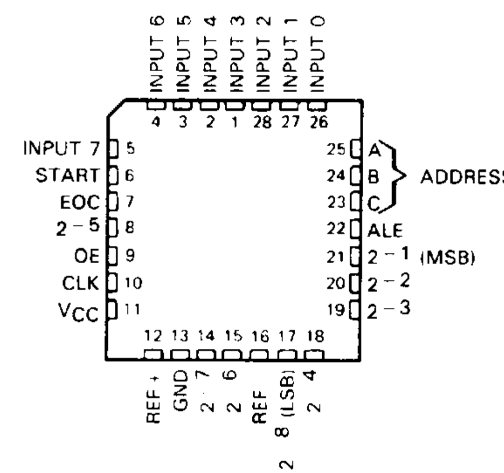
INPUTS				SELECTED
ADDRESS			ADDRESS	ANALOG
C	B	A	STROBE	CHANNEL
L	L	L	↑	0
L	L	H	↑	1
L	H	L	↑	2
L	H	H	↑	3
H	L	L	↑	4
H	L	H	↑	5
H	H	L	↑	6
H	H	H	↑	7

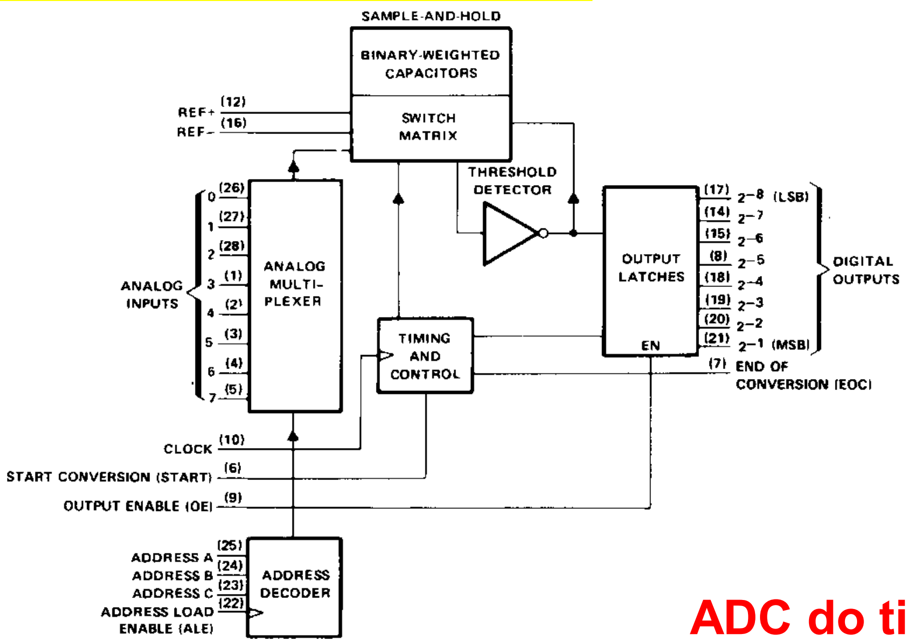
H = high level, L = low level
↑ = low-to-high transition

N
DUAL-IN-LINE PACKAGE
(TOP VIEW)



FN PACKAGE
(TOP VIEW)





ADC do tipo "contador"

Conversor Analógico-Digital (ADC)

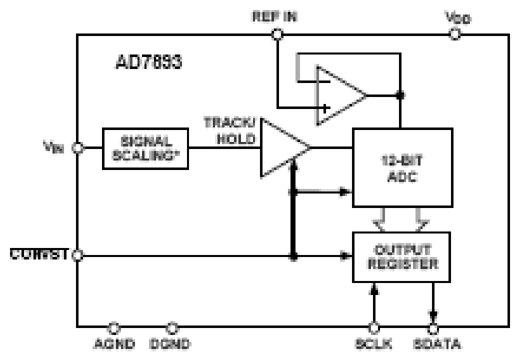
ANALOG DEVICES

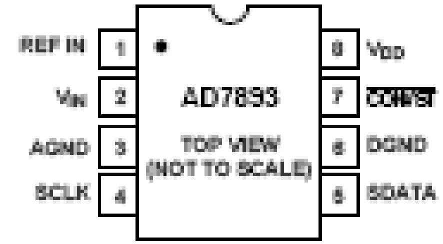
LC²MOS 12-Bit, Serial 6 μs ADC in 8-Pin Package

AD7893

FEATURES
- Fast 12-Bit ADC with 6 μs Conversion Time
- 8-Pin Mini-DIP and SOIC
- Single Supply Operation
- High Speed, Easy-to-Use, Serial Interface
- On-Chip Track/Hold Amplifier
- Selection of Input Ranges
  - ±10 V for AD7893-10
  - ±2.5 V for AD7893-3
  - 0 V to +2.5 V for AD7893-2
  - 0 V to +5 V for AD7893-5
- Low Power: 25 mW typ

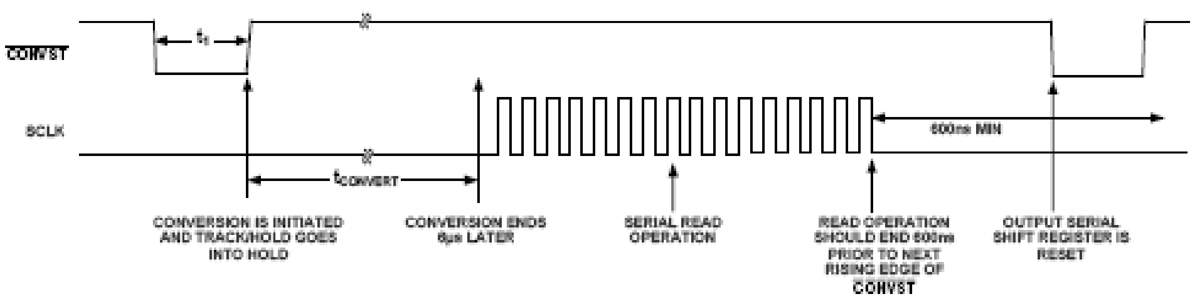
FUNCTIONAL BLOCK DIAGRAM





PIN FUNCT

Pin No.	Pin Mnemonic	Description
1	REF IN	Voltage Reference Input.
2	V_{IN}	Analog Input Channel.
3	AGND	Analog Ground.
4	SCLK	Serial Clock Input.
5	SDATA	Serial Data Output.
6	DGND	Digital Ground.
7	$\overline{CONVST}$	Convert Start.
8	V_{DD}	Positive supply voltage, +5 V ± 5%.



ADC de "dupla rampa"

Microcontroladores (PIC)

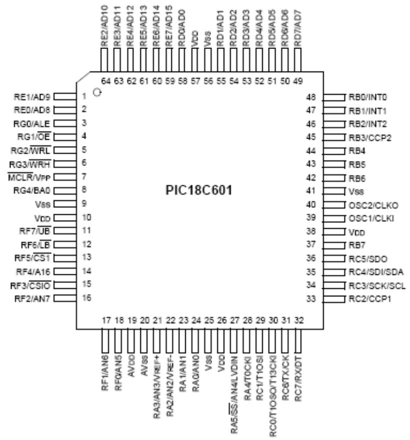


FIGURE 4-2: PROGRAM MEMORY MAP AND STACK FOR PIC18C801 (PGRM = 0)

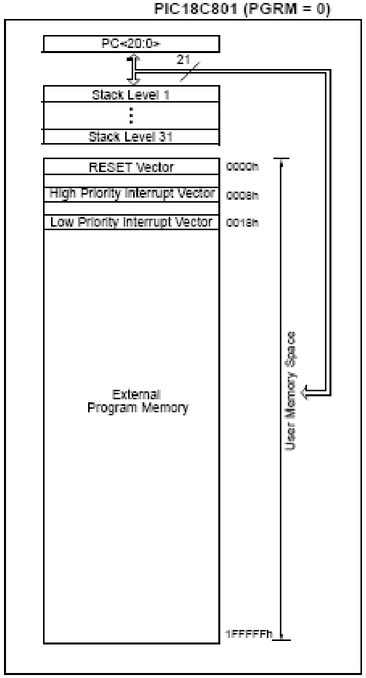
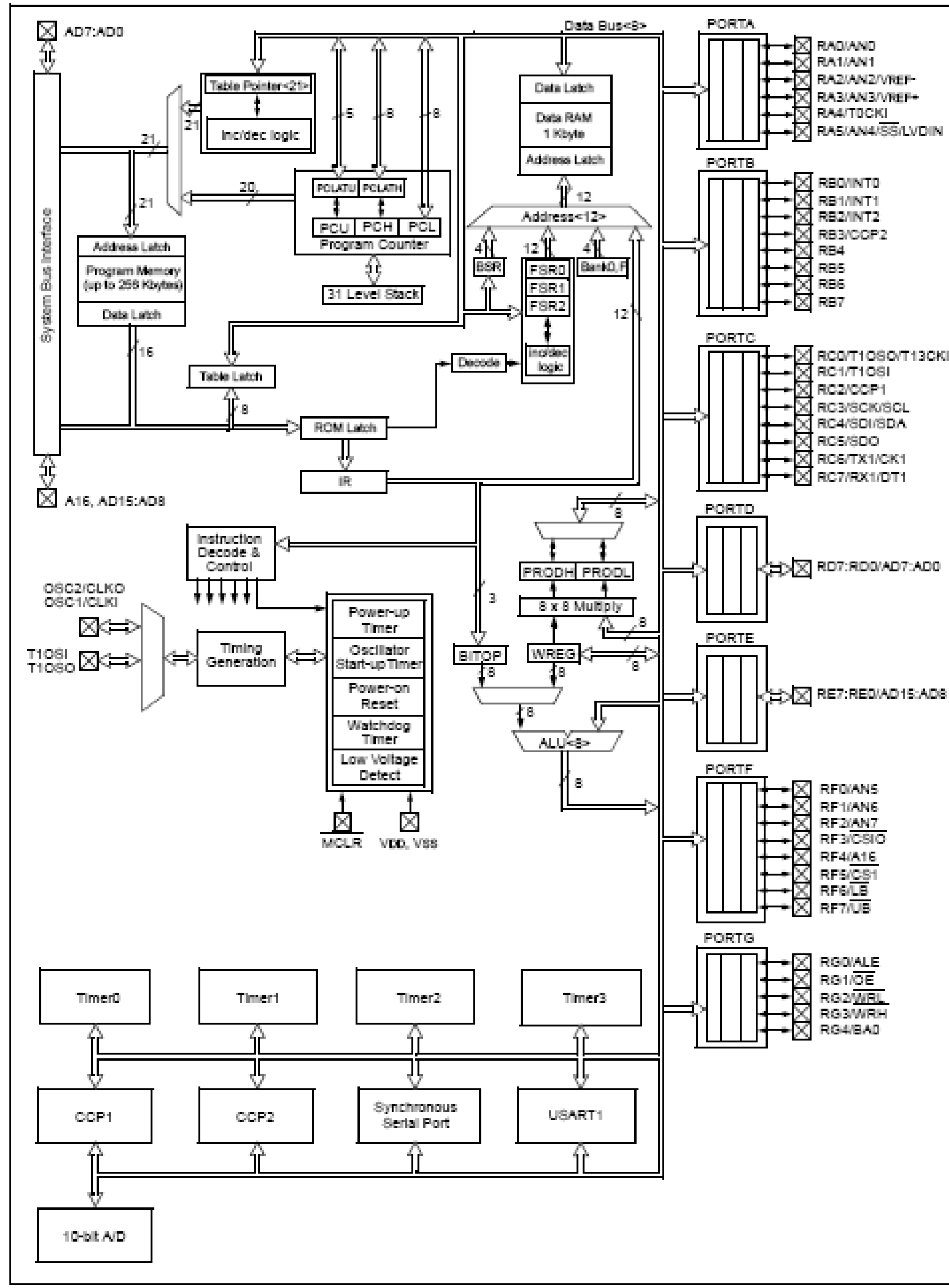


FIGURE 1-1: PIC18C601 BLOCK DIAGRAM



Microcontroladores (PIC)

TABLE 1-1: DEVICE FEATURES

Features		PIC18C601	PIC18C801
Operating Frequency		DC - 25 MHz	DC - 25 MHz
External Program Memory	Bytes	256K	2M
	Max. # of Single Word Instructions	128K	1M
Data Memory (Bytes)		1536	1536
Interrupt Sources		15	15
I/O Ports		Ports A - G	Ports A - H, J
Timers		4	4
Capture/Compare/PWM modules		2	2
Serial Communications		MSSP, Addressable USART	MSSP, Addressable USART
10-bit Analog-to-Digital Module		8 input channels	12 input channels
RESETS (and Delays)		POR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST)	POR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST)
Programmable Low Voltage Detect		Yes	Yes
8-bit External Memory Interface		Yes	Yes
8-bit De-multiplexed External Memory Interface		No	Yes
16-bit External Memory Interfaces		Yes	Yes
On-chip Chip Select Signals		$\overline{CS1}$	$\overline{CS1}$, $\overline{CS2}$
On-chip I/O Chip Select Signal		Yes	Yes
Instruction Set		75 Instructions	75 Instructions
Packages		64-pin TQFP 68-pin PLCC	80-pin TQFP 84-pin PLCC

Digital Signal Processor (DSP)

Specifications

- 16 bits fixed point TMS320VC5402 DSP @ 100 MHz
- USB data throughput: 0.5 Mb/s

Memory

- 16K words on-chip (DSP) dual-access RAM, mapped in data space and program space
- 64K words external 1-wait-state static RAM, mapped in data space

Analog I/Os

- Eight 16 bits sigma-delta analog inputs, sampling at up to 80Ks/s (22Ks/s with anti-aliasing filters); Dynamic range ± 10 V
- Eight 16 bits sigma-delta analog outputs, sampling at up to 80Ks/s (22Ks/s with anti-aliasing filters); Dynamic range ± 2.5 V

Digital Signal Processor (DSP)

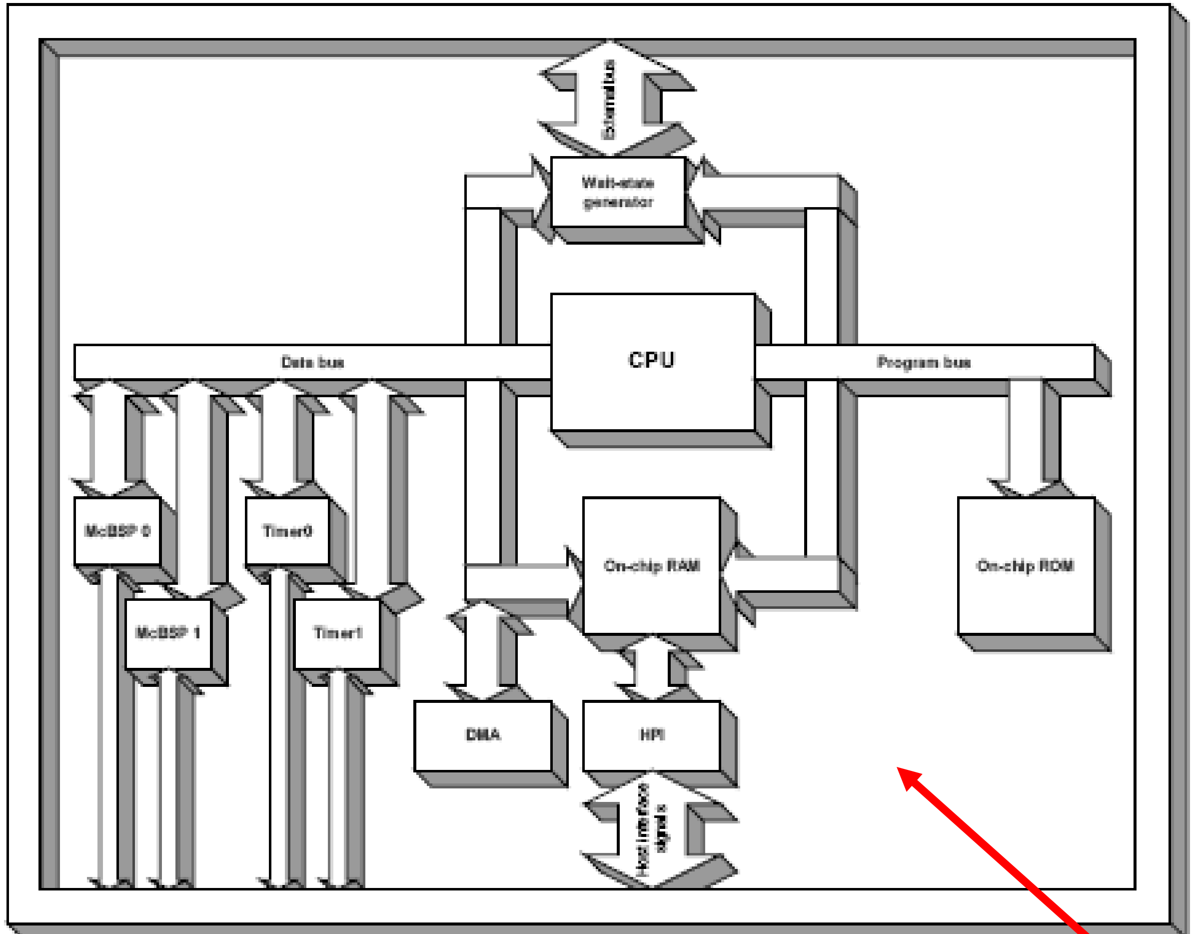


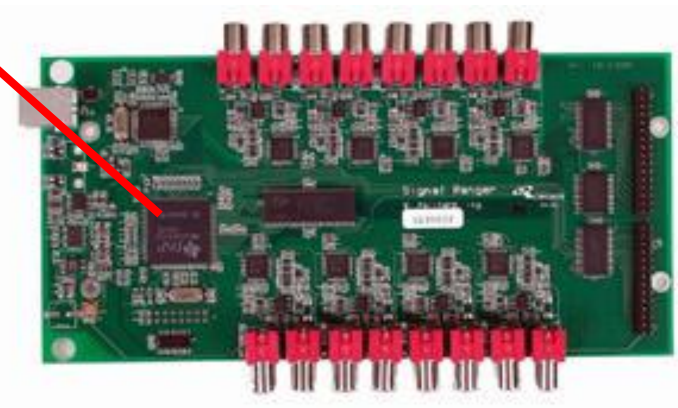
Figure 7-1

Figure 7-1 shows a simplified description of the architecture of the TMS320VC5402

Gnome X Scanning Microscopy

The GXSM is the Gnome X Scanning Microscopy project, it is a bit more than just a piece of software (the GXSM itself), there is full hardware support for DSP cards including open source DSP software and a growing set of Scanning Probe Microscopy (SPM) related elec-tronics. And it is not limited to SPM at all, it provides generic multidimensional image and data movie processing.

http://gxsm.sourceforge.net/



Digital Signal Processor (DSP)

Figure 2-2 *"Bikeman at DSPWorld 1997" Photo: Cory Roy*

The microprocessor used in this application is a TMS320C50 from Texas Instruments.

The system has 3 inputs that are brought to the CPU via 3 peripherals:

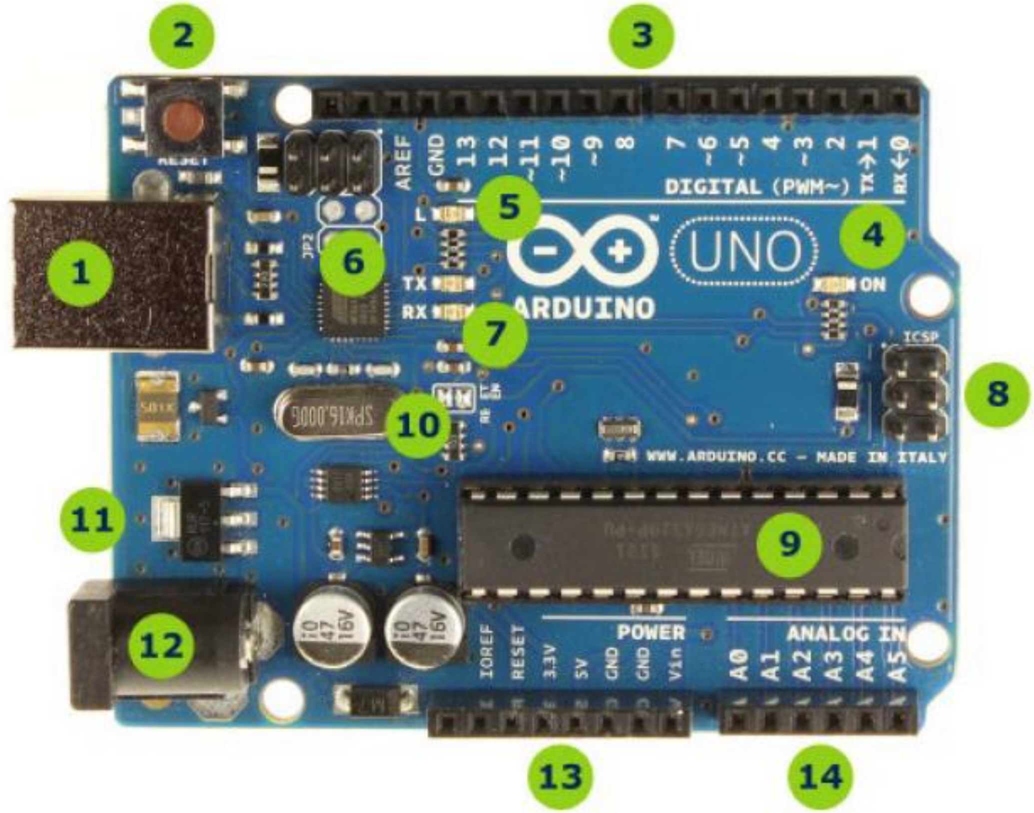
- A Pulse Width Modulation (PWM) signal follows the position of a radio-control joystick. The width of the pulses transmitted by the radio-control system represent the trajectory input of the pilot. The signal is transmitted to a peripheral called a *timer* that measures the width of its pulses, and provides this information to the CPU.
- A vibrating gyrometer is placed in the head of the cyclist. It provides an analog signal proportional to the rate of roll of the bicycle around the axis passing through the contact points of the wheels. This analog signal is measured by a peripheral called an Analog to Digital converter that provides this information to the CPU.
- An optical sensor placed in the gear train of the bicycle provides a square wave with a frequency proportional to the speed of the bicycle. This frequency is measured and provided to the CPU by another timer.

The system has one output that is generated by the CPU:

- A PWM signal is generated by a third timer, and sent to the servomotor that controls the position of the handlebars.

Arduino

Figure 2-2 “Bikeman at DSPWorld 1997” Photo: Cory Roy

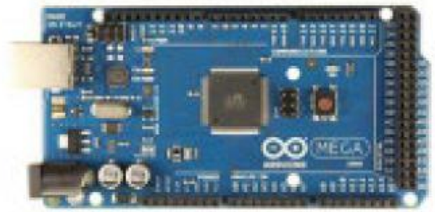


1 - Conector USB para o cabo tipo AB
2 - Botão de reset
3 - Pinos de entrada e saída digital e PWM
4 - LED verde de placa ligada
5 - LED laranja conectado ao pin13
6 - ATmega encarregado da comunicação com o computador
7 - LED TX (transmissor) e RX (receptor) da comunicação serial
8 - Porta ICSP para programação serial
9 - Microcontrolador ATmega 328, cérebro do Arduino
10 - Cristal de quartzo 16Mhz
11 - Regulador de voltagem
12 - Conector fêmea 2,1mm com centro positivo
13 - Pinos de voltagem e terra
14 - Entradas analógicas

Família Arduino

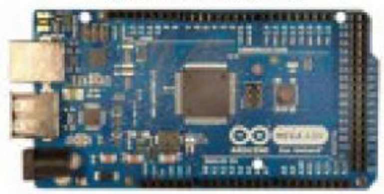
Arduino Leonardo

Arduino Mega2560 R3



Arduino Esplora

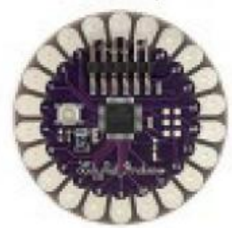
Arduino Mega ADK



Arduino Pro

Arduino FIO V3

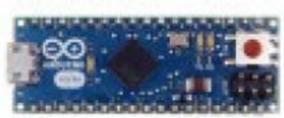
Arduino LilyPad



Arduino Mini 05

Arduino Pro Mini

Arduino Micro



Shields p/ Arduino

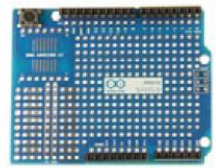
Arduino Ethernet Shield R3

Kit Motor Shield R3

Arduino WiFi Shield

Arduino XBee Shield

Arduino ProtoShield R3



Kit Joystick Shield

Shield celular com SM5100B

Shield GPS

Shield LCD Colorido

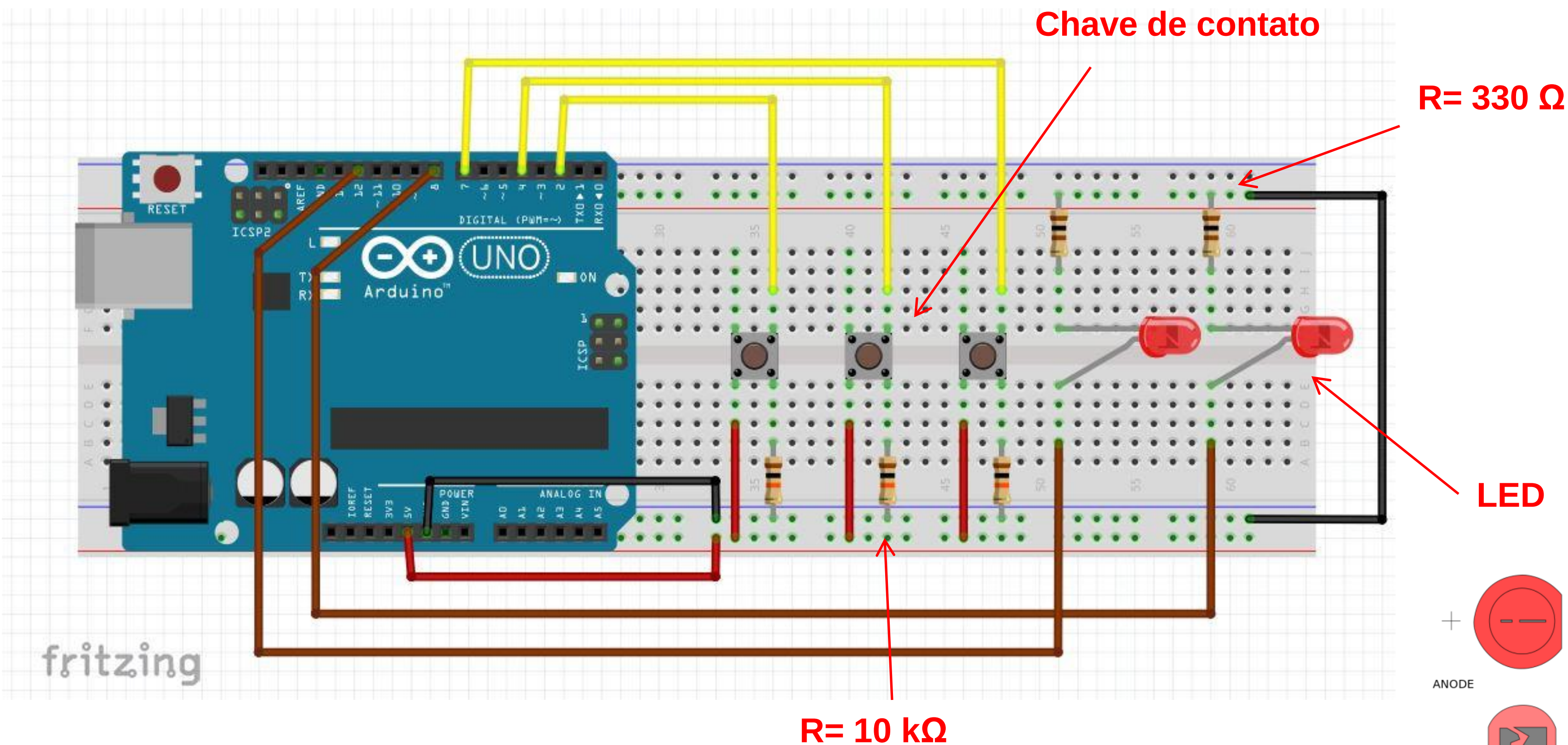
Shield MP3 Player

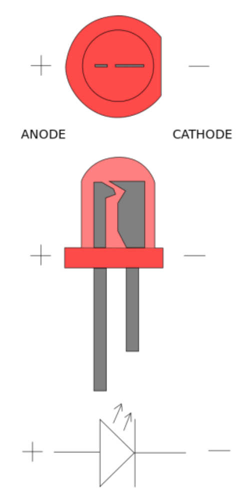
Shield WiFly

Wireless SD Shield

Arduino

Exercício – Teste de tempo de resposta visual





Arduino

Exercício – Acionamento de um motor de corrente contínua