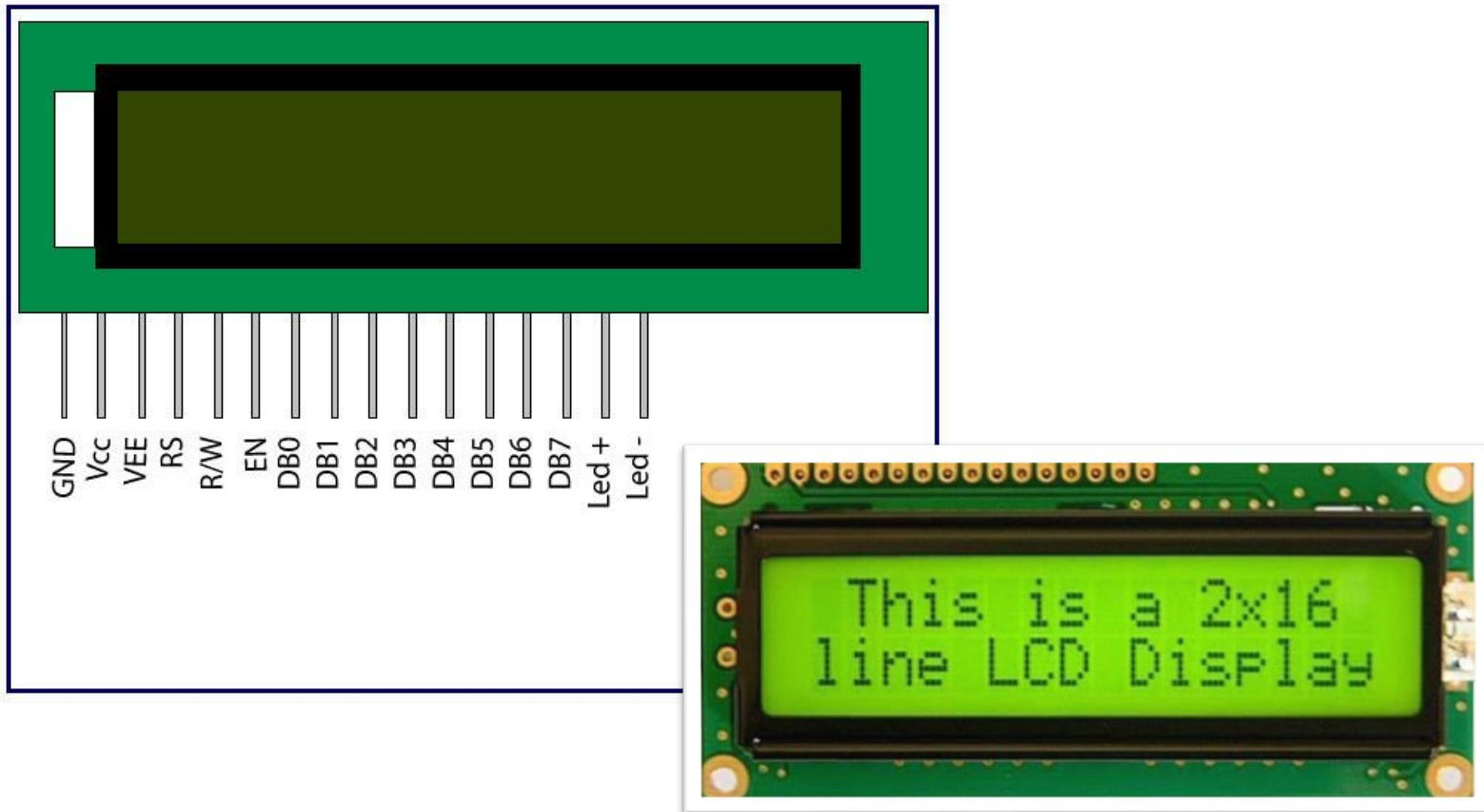


STM32 Microcontrollers Course

ADC and LCD

Winter&Summer 2016

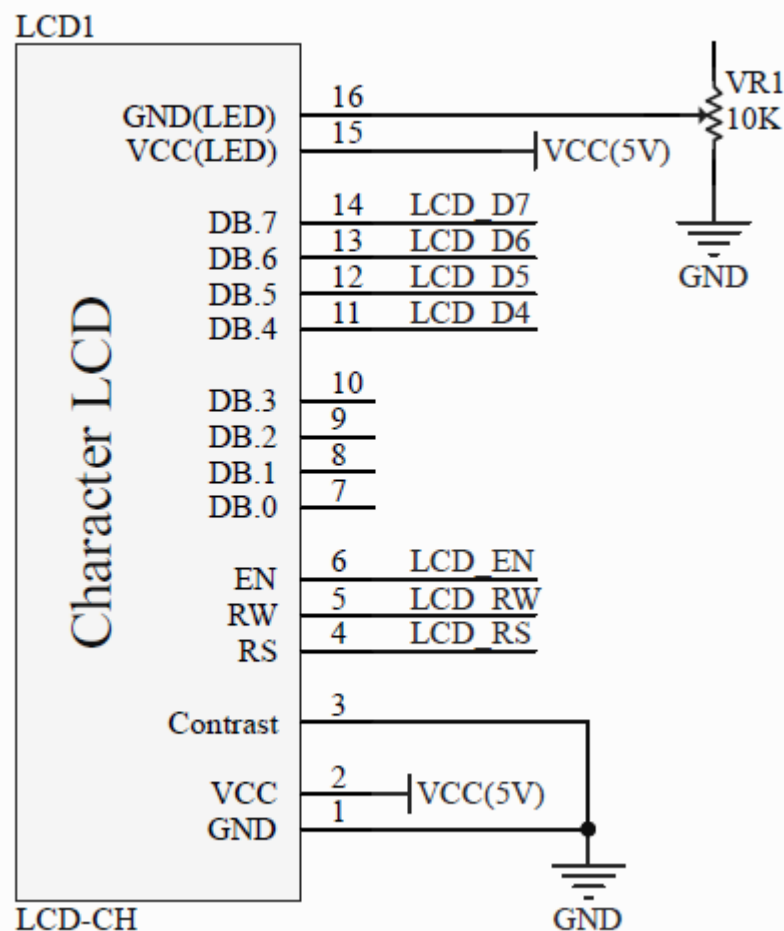
Liquid Crystal Display



Liquid Crystal Display

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	V _{CC}
3	Contrast adjustment; through a variable resistor	V _{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V _{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Liquid Crystal Display



Liquid Crystal Display Library

- `void LCD_Init(void);`
 - Initialize LCD
- `void LCD_PutChar(unsigned char c);`
 - Printing a character on LCD
- `void LCD_GotoXY(unsigned char x, unsigned char y);`
 - Changing Cursor position to a specific location
- `void LCD_PutStr(char *str);`
 - Printing a sequence of characters on LCD
- `void LCD_ClrScr(void);`
 - Clearing the LCD data

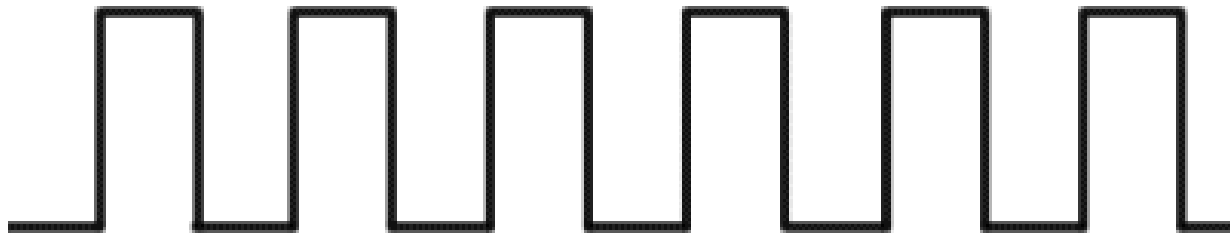
Project

- Write your name on your LCDs

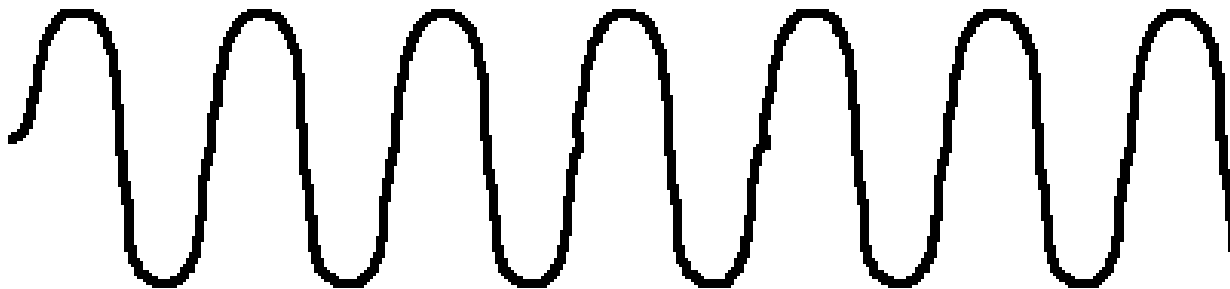


Analog vs Digital

Digital signal

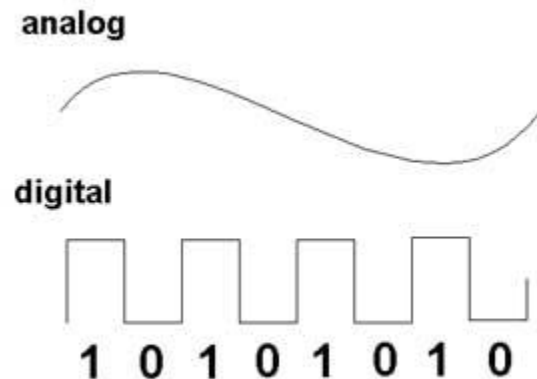


Analog signal

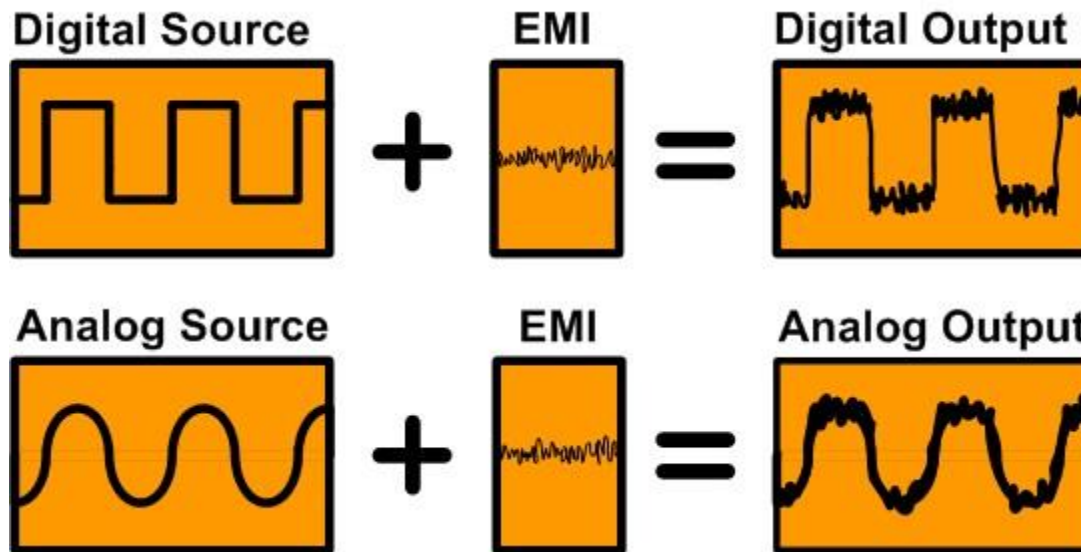


Analog and Digital Transmissions

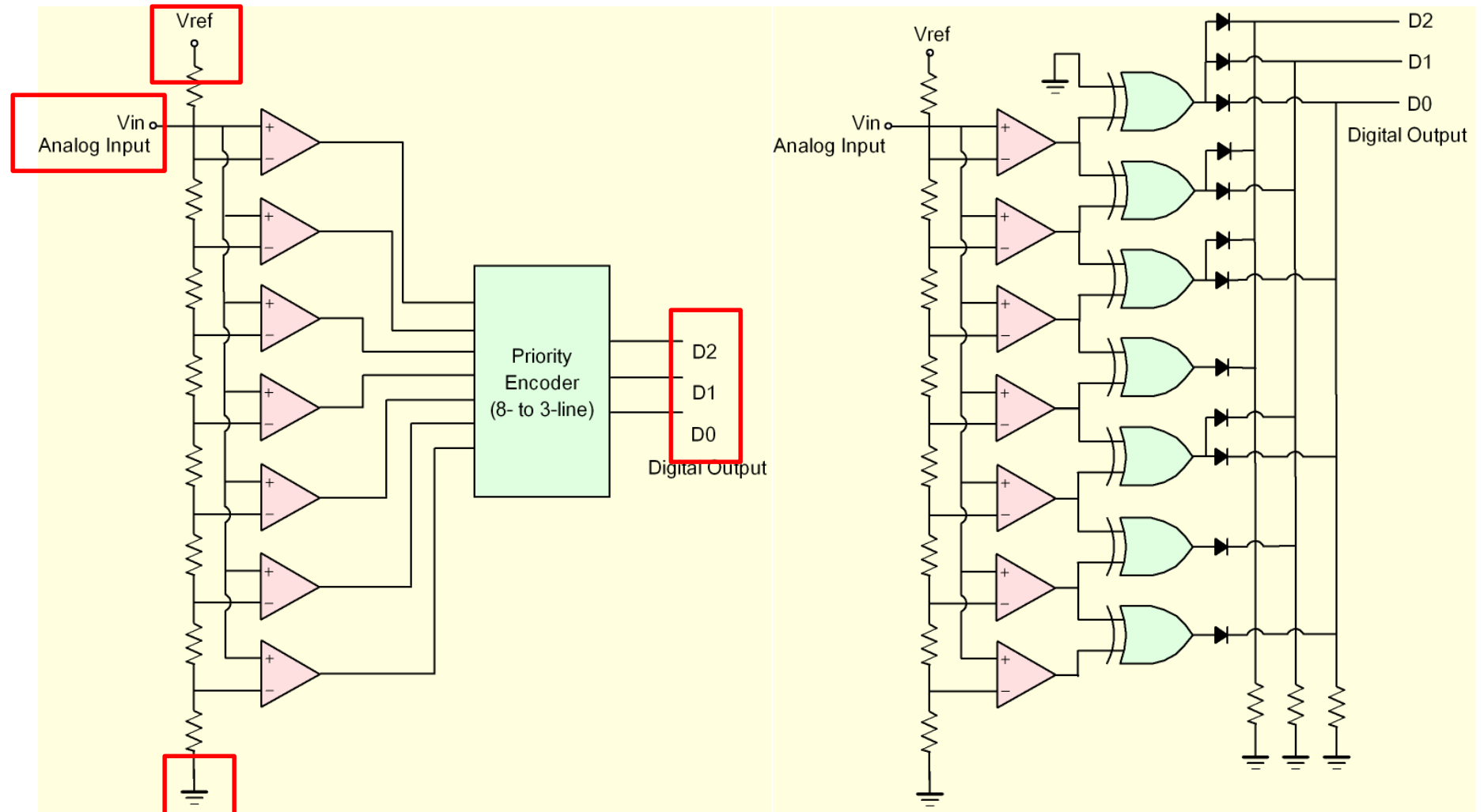
- In digital data transmitted using a sequence of 0/1
- In analog data transmitted using change of amplitudes



Analog VS Digital



Analog to Digital Converter



STM32F10xx Devices

- Up to 16 Conversation Channels
- 0 to 3.3v measurements (0-4096)
- 12-bit ADC conversion
- Analog Watchdog
 - Check the programmed boundary of voltage and makes interrupt if voltage get outside of boundary
- Up to 14Mhz ADC Clock
- 1us to 1.55us conversion time
- External trigger option for both regular and injected conversion

STM32F10xx Devices

Table 65. ADC pins

Name	Signal type	Remarks
V_{REF+}	Input, analog reference positive	The higher/positive reference voltage for the ADC, $2.4\text{ V} \leq V_{REF+} \leq V_{DDA}$
$V_{DDA}^{(1)}$	Input, analog supply	Analog power supply equal to V_{DD} and $2.4\text{ V} \leq V_{DDA} \leq 3.6\text{ V}$
V_{REF-}	Input, analog reference negative	The lower/negative reference voltage for the ADC, $V_{REF-} = V_{SSA}$
$V_{SSA}^{(1)}$	Input, analog supply ground	Ground for analog power supply equal to V_{SS}
ADCx_IN[15:0]	Analog signals	Up to 21 analog channels ⁽²⁾

1. V_{DDA} and V_{SSA} have to be connected to V_{DD} and V_{SS} , respectively.
2. For full details about the ADC I/O pins, please refer to the “Pinouts and pin descriptions” section of the corresponding device datasheet.

STM32F10xx Devices

$$\frac{\text{Resolution of the ADC}}{\text{System Voltage}} = \frac{\text{ADC Reading}}{\text{Analog Voltage Measured}}$$

$$\frac{4096}{3.3v} = \frac{x}{3.3v}$$

$$\text{ADC Reading} = \frac{4096 * \text{Analog Voltage}}{\text{System Voltage}}$$

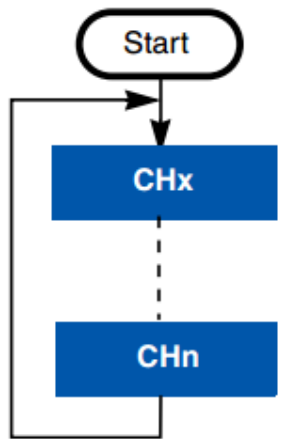
Reading Voltage	ADC Value
4096	3.3v
0	0
1.8	2234
2.9	3599

Conversion Modes

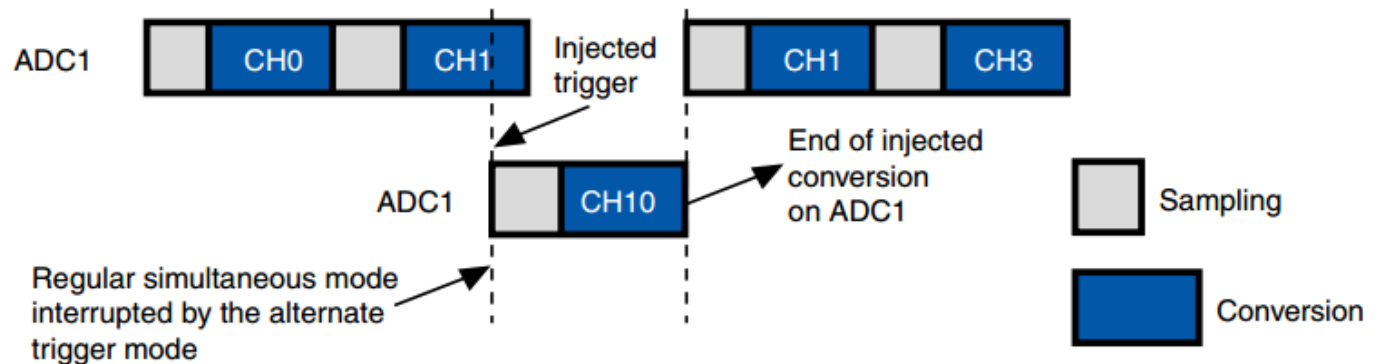
- Single Conversion Mode
 - ADC conversion may start by external trigger or ADON register
 - The converted data stored in ADC 16 Bit registers
 - EOC(End of Conversion) Flag set and Interrupt generated if EOCIE bit is set
 - After One Conversion ADC will stop
- Continues Conversion mode
 - ADC Conversion may start by external trigger or ADON Register
 - The converted data stored in ADC 16 bit registers
 - EOC(End of Conversion) Flag set and interrupt generated if EOCIE bit is set
 - Next conversion will start right after the previous one finished

Conversion Modes

- Regular Mode (Scanning)
 - Conversion of a sequence of ADC channels in a sequential loop order
- Injected Mode
 - Injecting a high priority conversion in middle of sequential loop



Regular Mode

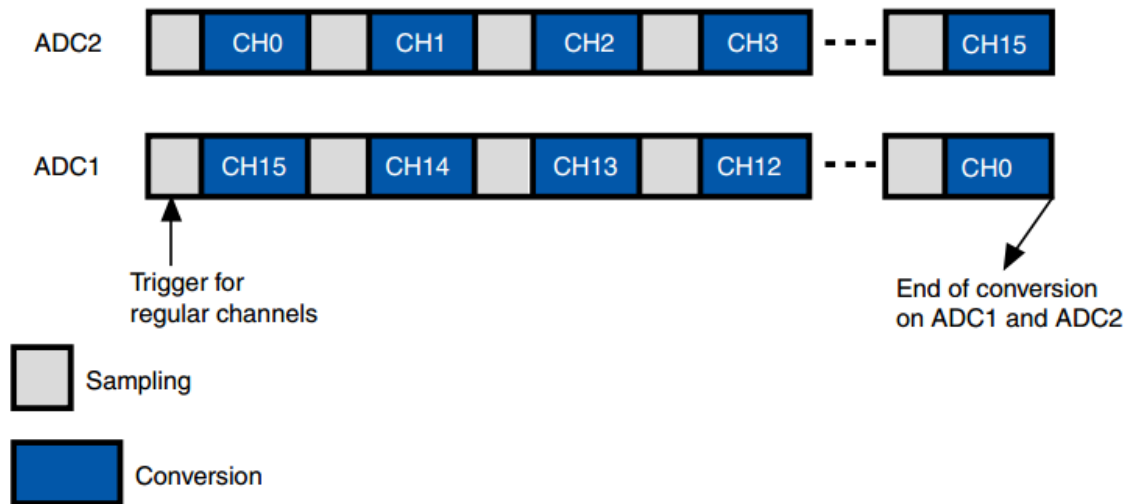


Injected Mode

ai17605

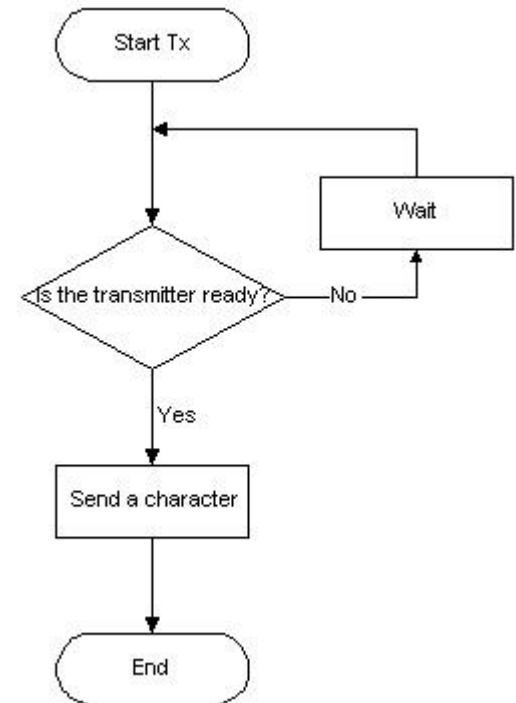
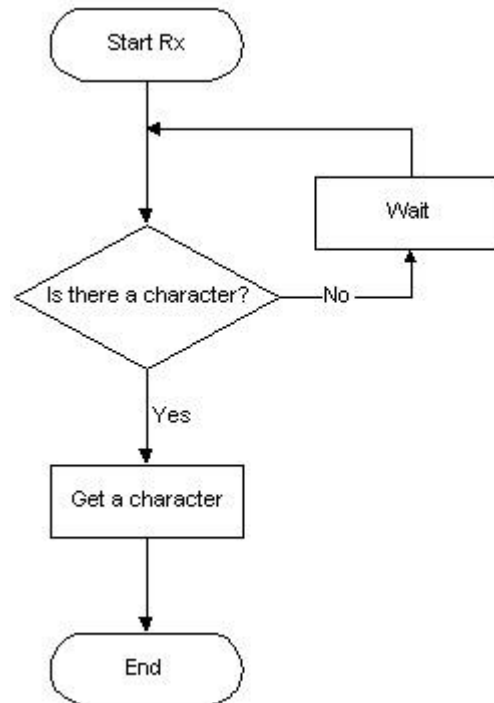
Conversion Modes

- Dual Mode
 - Simultaneous conversion of two channels, one in ADC 1 and the other one in ADC2



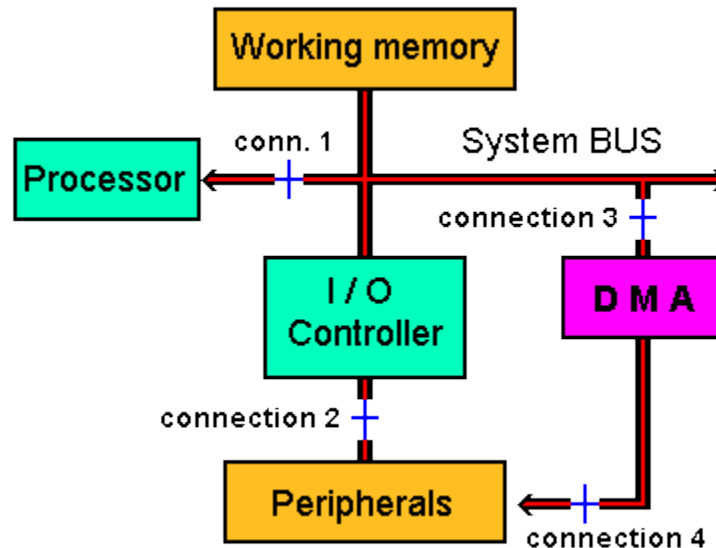
Poll ADC Conversions

- Polling



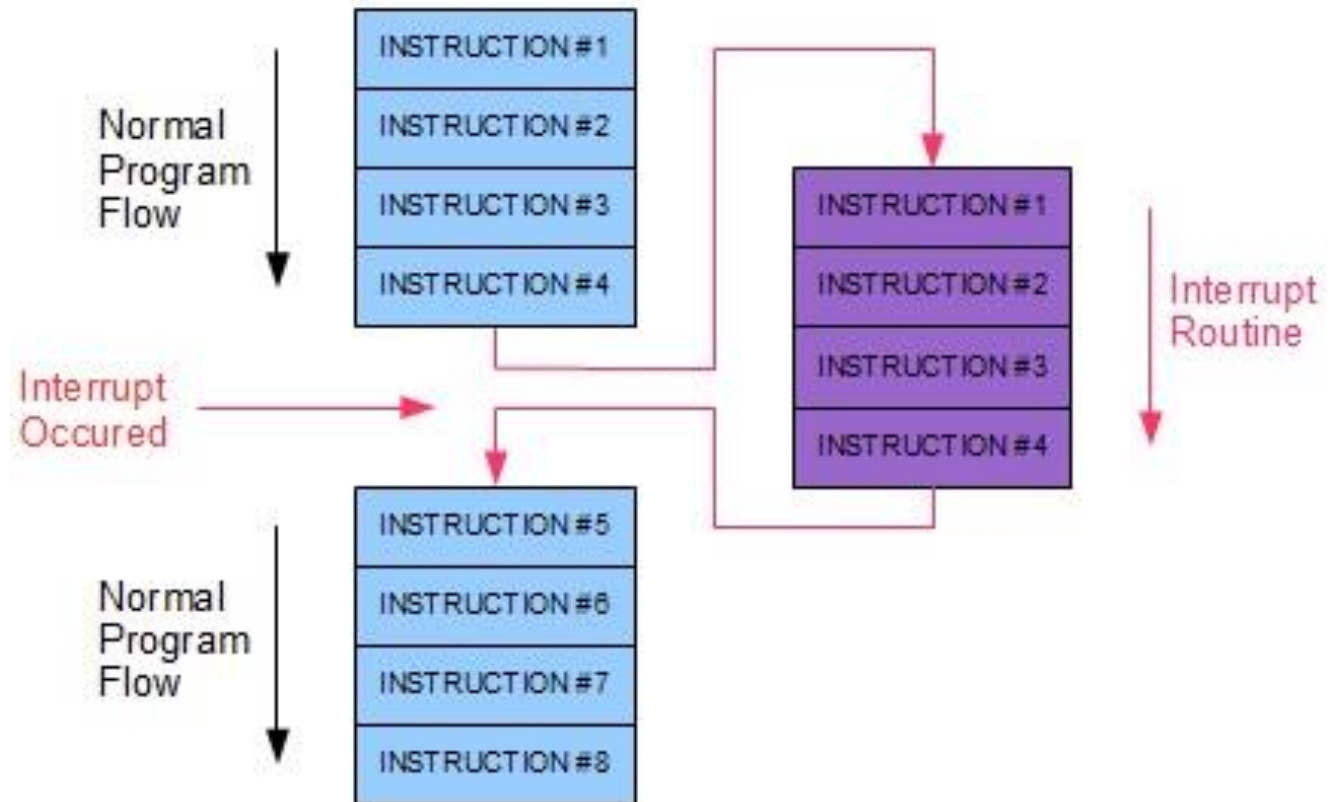
Poll ADC Conversions

- DMA

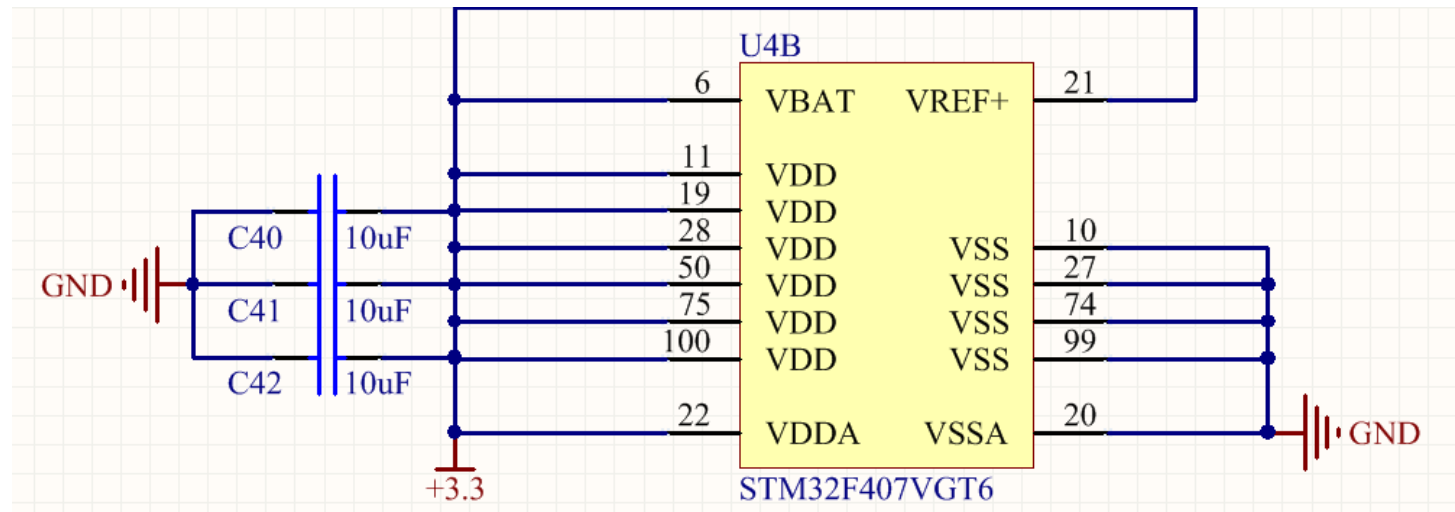
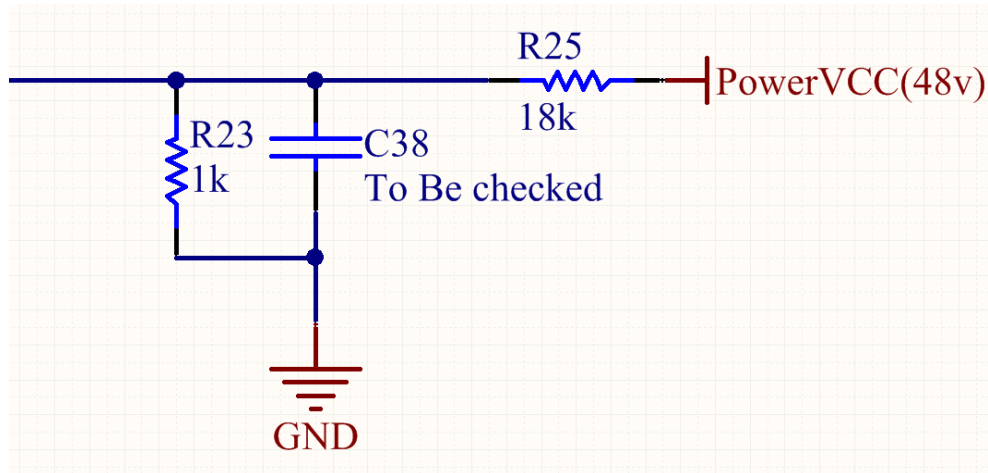


Poll ADC Conversions

- Interrupt



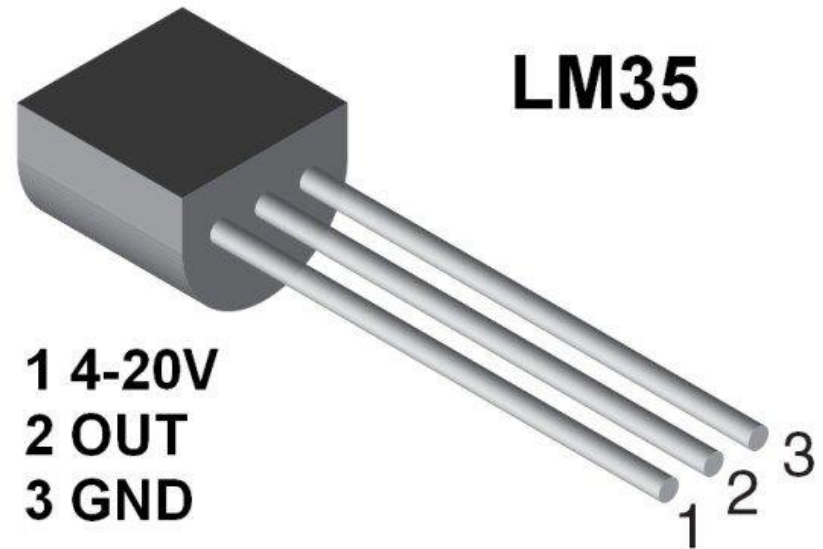
ADC Schematics



LM35 Temperature Sensor

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteeable (at +25°C)
- Rated for full -55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 μ A current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only $\pm 1/4^\circ\text{C}$ typical
- Low impedance output, 0.1 Ω for 1 mA load



Project

- Get the room temperature in Celsius and Fahrenheit

