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STM32 ADC

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CONTENTS

***Abstract*—This manual shows how to interface the 16×2 HD44780-controlled LCD using STM32F103C8T6.**

1 Components

Component	Value	Quantity
Resistor	220 Ohm	1
	1K	1
Breadboard		1
STM32F103C8T6		1
LCD	16 x 2 HD44780	1
Jumper Wires	M-F	20
	F-F	5
	M-M	5

TABLE 1.0: Components

2 Internal Temperature Sensor

Problem 2.1. Make connections as shown in Table 2.1.

Problem 2.2. Execute the following program

https://github.com/gadepall/STM32F103C8T6/blob/master/examples/adc/internal_temp.c

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Rpi 3	STM32	LCD Pins	LCD Pin Label	LCD Pin Description
GND		1	GND	
5V		2	Vcc	
GND		3	Vee	Contrast
	A0	4	RS	Register Select
GND		5	R/W	Read/Write
	A1	6	EN	Enable
	A2	11	DB4	Serial Connection
	A3	12	DB5	Serial Connection
	A4	13	DB6	Serial Connection
	A5	14	DB7	Serial Connection
5V		15	LED+	Backlight
GND		16	LED-	Backlight

TABLE 2.1: Pin Connections

What do you observe?

Solution: You should observe a number between 1750-1760. This is the output of the internal temperature sensor, captured in $ADC1->DR$.

Problem 2.3. Find an expression for V_{SENSE}

Solution:

$$V_{SENSE} = 3.3 \times \frac{ADC1->DR}{4095} \tag{2.3.1}$$

Problem 2.4. Obtain the formula for finding the temperature of the STM32 and list the values of the various parameters.

Solution: The desired formula is

$$T = (V_{25} - V_{SENSE})/AvgSlope + 25 \tag{2.4.1}$$

where the typical values of the above parameters are

V_{25}	AvgSlope
1.43	4.3

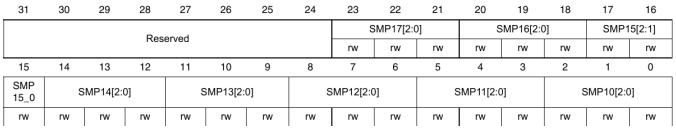

Fig. 2.6: SMPR1

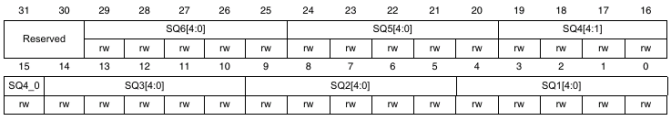

Fig. 2.8: SQR3

Problem 2.5. What is the default ADC frequency?

Solution: The ADC operates at 14 MHz by default and is indpendent of the processor frequency (8 MHz in this case). It can, however be synchronized with the processor clock for some real time applications.

Problem 2.6. Explain the significance of the following instruction

```
ADC1->SMPR1 |= ADC_SMPR1_SMP16;
```

Solution: Through this command, $ADC1- > SMPR1 = 0x001C0000$ where the SMPR1 register is shown in Fig. 2.6. Note that this makes SMP16 = 111 which means that channel 16 sample time = 239.5 cycles. Channel 16 is reserved for the internal temperature sensor and is connected to ADC1.

Problem 2.7. What is the sampling time?

Solution: Since the sample time is 239.5 cycles and the ADC frequency is 14 MHz,

$$T_s = 239.5 \times \frac{1}{14}\mu s = 17.1\mu s \tag{2.7.1}$$

Problem 2.8. Explain the following instruction.

```
ADC1->SQR3 |= ADC_SQR3_SQ1_4;
```

Solution: ADC_SQR3_SQ1_4 = 0x00000010. This implies that SQ1=0b10000 in the ADC regular sequence register 3 ($ADC1- > SQR3$)shown in Fig. 2.8. Since SQ1=16, this means that the ADC input in channel 16 will be the first in the queue for conversion. The ADC is capable of converting analog 16 inputs one after the other. The inputs are called *channels* and the sequence number corresponding to the channel is decided according to the 5 bit entry in SQ.

3 Measuring an Unkown Resistance

Problem 3.1. Configure SQR3 so that the 9th channel for ADC1 is 2nd in sequence.

Solution: This implies that SQ2=1001. Thus,

$$ADC1- > SQR3 = 0x000000120 \tag{3.1.1}$$

Problem 3.2. List the various pin numbers corresponding to the different channels of the ADC.

Solution: See Fig. 3.2

Channel	0	1	2	3	4	5	6	7	8	9
Pin	PA0	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PB0	PB1

TABLE 3.2: ADC Analog Input Pins

Problem 3.3. Use the 9th channel of ADC1 in SQ2 to measure 3.3V.

Solution: Connect PB1 (Fig. 3.2) to 3.3 V of the STM 32 and execute the following code.

```
https://github.com/gadepall/
    STM32F103C8T6/blob/master/
    examples/adc/3_3V.c
```

Problem 3.4. Measure an unkown resistance using the STM32 and display the result on the LCD.

Problem 3.5. Display the output of the internal temperature sensor as well the unknown resistance on the LCD.