ECE3411 – Fall 2015

Lab 7a.

Digital to Analogue Conversion (DAC)

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With the help of:

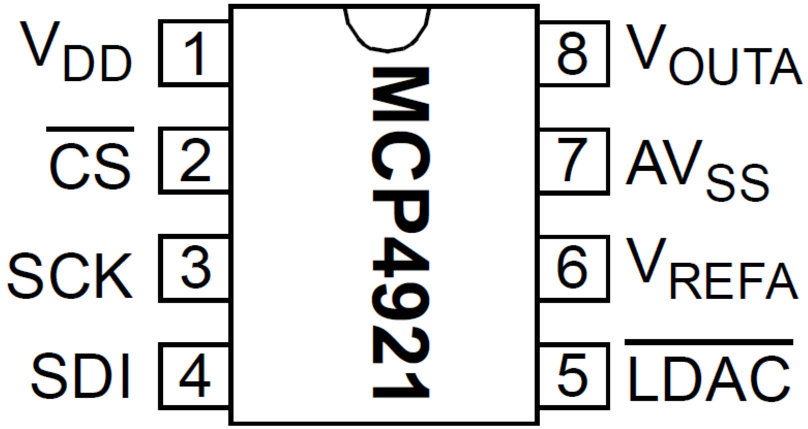
ATmega328P Datasheet
MCP4921 Datasheet

DAC: Digital to Analog Converter

We use an external DAC for this lab: MCP4921

- 12 bit resolution.
- SPI interface.

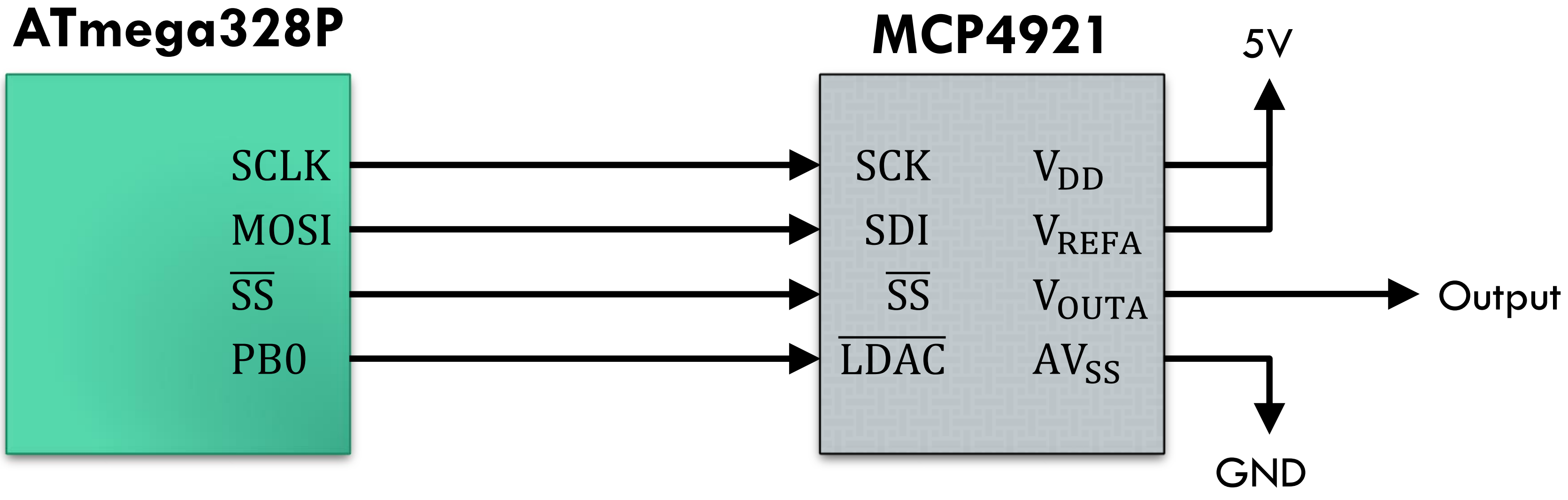
1	V_{DD}	Positive Power Supply Input (2.7V to 5.5V)
2	CS	Chip Select Input. (SPI Slave Select)
3	SCK	SPI Serial Clock Input
4	SDI	SPI Serial Data Input (MOSI)
5	LDAC	Synchronization input used to transfer DAC settings from serial latches to the output latches.
6	V_{REFA}	DAC_A Voltage Input (AV_{SS} to V_{DD})
7	AV_{SS}	Analog ground
8	V_{OUTA}	DAC_A Output



DAC SPI Interface

MCP4921 acts as SPI Slave and only receives data → MISO is not connected.

- Connect the ATmega328P with MCP4921 as shown in the figure below.
- Notice that LDAC pin also needs to be connected to a GPIO pin on ATmega328P.



DAC SPI Frame Format

- MCP4921 receives a 16-bit word from the MCU in two 8-bit SPI transactions.
- The format of the 16-bit frame containing 4 command and 12 data bits is shown below.

REGISTER 5-1: WRITE COMMAND REGISTER

Upper Half:

W-x	W-x	W-x	W-0	W-x	W-x	W-x	W-x
$\overline{A}$/B	BUF	$\overline{GA}$	$\overline{SHDN}$	D11	D10	D9	D8
bit 15							bit 8

Lower Half:

W-x	W-x	W-x	W-x	W-x	W-x	W-x	W-x
D7	D6	D5	D4	D3	D2	D1	D0
bit 7							bit 0

DAC Command Bits

- The upper 4 bits of the 16 bit word are DAC command bits.
- The description of the 16 bit frame bits is as follows:

bit 15 **A/B:** DAC_A or DAC_B Select bit
1 = Write to DAC_B
0 = Write to DAC_A

bit 14 **BUF:** V_{REF} Input Buffer Control bit
1 = Buffered
0 = Unbuffered

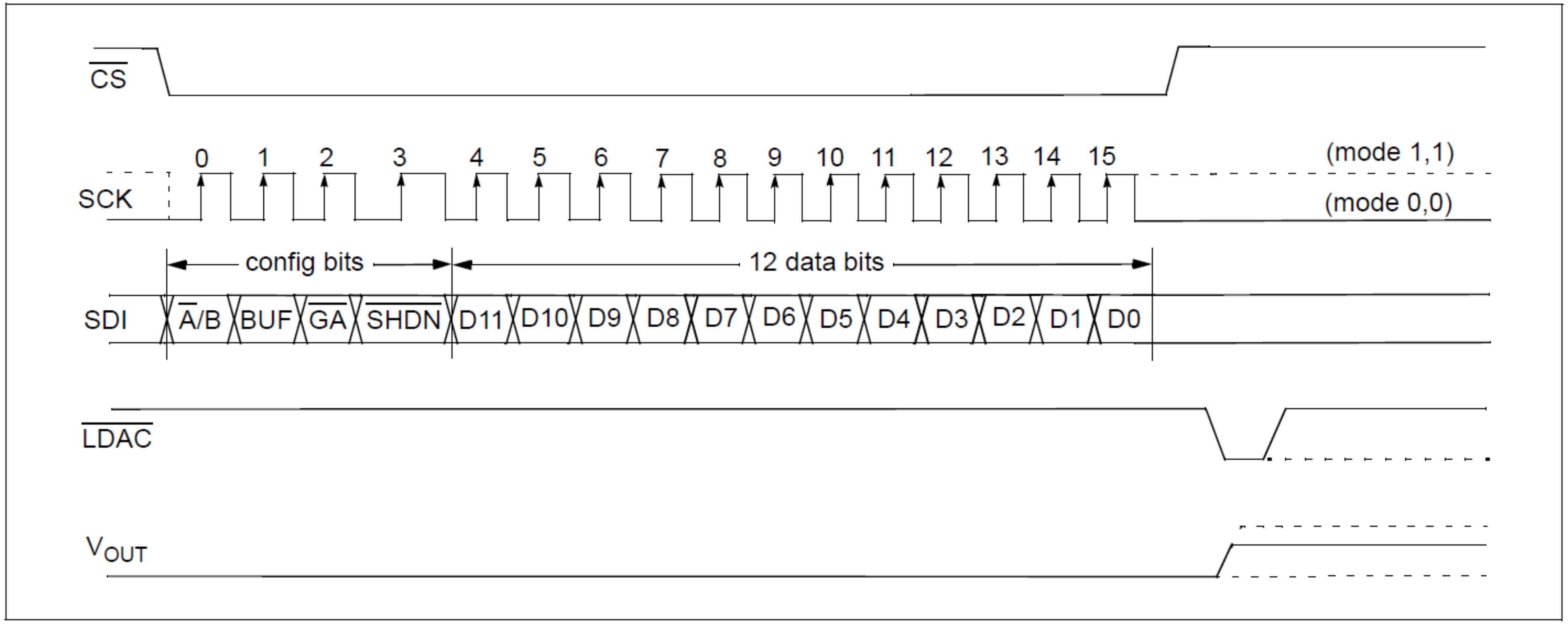
bit 13 **$\overline{\text{GA}}$:** Output Gain Select bit
1 = 1x ($V_{OUT} = V_{REF} * D/4096$)
0 = 2x ($V_{OUT} = 2 * V_{REF} * D/4096$)

bit 12 **$\overline{\text{SHDN}}$:** Output Power Down Control bit
1 = Output Power Down Control bit
0 = Output buffer disabled, Output is high impedance

bit 11-0 **D11:D0:** DAC Data bits
12 bit number “D” which sets the output value. Contains a value between 0 and 4095.

DAC SPI Interface Timing

- The figure below shows the timing of one SPI transaction (command + data) between the MCU and DAC.
- You need to implement the same timing through SPI interface on ATmega328P.



Task1: Controlling LED Glow

Write a simple program to control the glow of a LED using DAC.

In particular:

- Configure the SPI in Master mode.
- Read a potentiometer's voltage through ADC every 100ms (full 10 bit resolution).
- Normalize the 10-bit ADC reading to a 12-bit digital value for DAC.
- Transmit the 4-bit command and 12-bit data value to DAC over SPI.
- Don't forget to generate a LOW pulse at LDAC pin after transmission.
- Print the ADC's and DAC's readings on LCD.

Homework: Use DAC to generate a 100Hz sine wave with a peak-to-peak amplitude of 5V.