Features:

- Operating Voltage 3.3Volts.
- Two 12 bit SAR ADCs with 0V to 3.3V range.
- Two PWM Outputs for driving hobby RC Servo Motors, with 3000 steps of resolution. 0.8 millisecond pulse to 2.4 millisecond pulse. 
  \[ \frac{1.6ms}{3000} = .000533ms \text{ resolution} \]
- SPI Interface, Standard 4-wire connection MOSI, MISO, SS, SCLK. Slave Mode Only.
- SPI maximum SCLK rate of 1 MHz.
- Also has I2C interface. (SE423 Project #3)

General Description

The DAN28027 IC is an expansion board that adds two 12 bit ADC inputs and two PWM outputs for driving RC servo motors to your embedded system. It uses standard 4-wire SPI serial communication and the DAN28027 is a SPI slave only device.

The two ADC channels are SAR (Successive Approximation Register) type ADCs with an input range of 0 to 3.3Volts. With 12 bits, that gives an input resolution of 3.3Volts/4095 steps. The DAN28027 continuously samples the two ADC channels every 1 millisecond and the most current samples are transmitted to the SPI Master when the SPI Master issues a read/write command.

The two PWM outputs are specifically setup for driving RC servo motors. RC servo motors have an internal potentiometer for angle feedback. This allows the RC servo to move to a desired angle and hold there. To command an RC servo to a desired angle a repeating 3.3V pulse width drives the signal pin. This pulse needs to be repeated at least every 15ms. The DAN28027 repeats the pulse every 20ms. Each brand of RC servo motor is slightly different when it comes to which pulse width commands a certain motor angle so a bit of experimenting is needed when driving a new RC servo motor. For example a pulse width around 1.6 ms should command the RC servo motor to its zero angle. A pulse width around 0.8 ms should command a -90 degree angle and a pulse width around 2.4 ms should command a 90 degree angle. Instead of thinking in terms of pulse width as the command, %duty cycle of a PWM signal can also be used to describe the input. The PWM signal has a carrier frequency of 50 Hz or 0.02s period and a range of duty cycles from 4% to 12%.

Device Pins

Vcc: 3.3V power for the IC

Gnd: Ground of the 3.3V power

ADC1: ADC channel one’s input pin. Accepts a voltage in the range of 0 to 3.3 volts. Value communicated over SPI is an integer with the range of 0 to 4095 where 0 equals 0 volts and 4095 equals 3.3volts.

ADC2: ADC channel two’s input pin. Accepts a voltage in the range of 0 to 3.3 volts. Value communicated over SPI is an integer with the range of 0 to 4095 where 0 equals 0 volts and 4095 equals 3.3volts.
RCSERVO1: RC servo motor command output one. RC servos are driven by pulse widths in the range of 0.8 ms to 2.4 ms. These pulses are repeated every 20 ms. So you can also think of this as a PWM signal with carrier frequency 50Hz and duty cycles ranging from 4% to 12%. The value communicated over SPI is an integer with the range of 1500 to 4500 where 1500 equals 4% and 4500 equals 12% duty cycle.

RCSERVO2: RC servo motor command output two. RC servos are driven by pulse widths in the range of 0.8 ms to 2.4 ms. These pulses are repeated every 20 ms. So you can also think of this as a PWM signal with carrier frequency 50Hz and duty cycles ranging from 4% to 12%. The value communicated over SPI is an integer with the range of 1500 to 4500 where 1500 equals 4% and 4500 equals 12% duty cycle.

SPI_SS: Slave Select, Active Low. Slave select must be held for the entire SPI communication to the DAN28027. If high the DAN28027 is not selected and no communication can occur.

SPI_SCLK: SPI CLK Clock is normally low when no communication is in progress. During communication, both the SPI master and SPI slave read in a new bit on the rising edge of the SCLK. The SPI master reads the new bit (1 or 0) of the MISO pin. The SPI slave reads the new bit (1 or 0) of the MOSI pin.

SPI_MOSI: SPI Slave Input pin. RCservo commands are received on this pin from the master.

SPI_MISO: SPI Slave Output pin. ADC result values are transmitted on this pin to the master.

LED: Is the DAN28027 running status. This is a useful pin that indicates if the DAN28027 is operating. This pin is also wired to the LED on the DAN28027 board. When powered the DAN28027 will blink on and off this LED.

Reset: This is the pushbutton on the DAN28027 board. Used to reset the program running on the DAN28027 back to the beginning of its code. This is a nice feature when debugging the SPI Master’s code. Whenever the SPI Master code is restarted the DAN28027 should be reset by pressing this button, in order that the SPI communication is in sync.

RESERVED: Reserved for future use in new releases of the DAN28027.

**Registers in the DAN28027**

ADC1: Value between 0 and 4095

- ADC1: (16 bit value)
  - ADC1 voltage reading received over SPI. This 16 bit value, has a range from 0 to 4095 where 0 is 0V and 4095 is 3.3V

ADC2: Value between 0 and 4095

- ADC2: (16 bit value)
  - ADC2 voltage reading received over SPI. This 16 bit value, has a range from 0 to 4095 where 0 is 0V and 4095 is 3.3V

RCSERVO1: Value between 1500 and 4500

- RCSERVO1: (16 bit value)
  - In terms of a 50Hz carrier frequency PWM signal, 1500 = 4% duty cycle and 4500 = 12% duty cycle. 4% duty cycle approximately commands an angle of -90 degrees. 8% approximately commands an angle of 0 degrees. 12% approximately commands an angle of 90 degrees.
  - If the DAN28027 receives a value less than 1500, the value of 1500 or 4% duty cycle is commanded. If the DAN28027 receives a value greater than 4500, the value of 4500 or 12% duty cycle is commanded.
RCSERVO2: Value between 1500 and 4500

RCSERVO2: (16 bit value)

In terms of a 50Hz carrier frequency PWM signal, 1500 = 4% duty cycle and 4500 = 12% duty cycle. 4% duty cycle approximately commands an angle of -90 degrees. 8% approximately commands an angle of 0 degrees. 12% approximately commands an angle of 90 degrees.

If the DAN28027 receives a value less than 1500, the value of 1500 or 4% duty cycle is commanded. If the DAN28027 receives a value greater than 4500, the value of 4500 or 12% duty cycle is commanded.

**SPI Interface**

Each time the SPI master needs to communicate with the DAN28027 the above timing diagram must be followed:

1. SS\ must be pulled low by the SPI Master.
2. 0x00DA must be sent as the first 16 bit value. During this transmission of 0x00DA, the DAN28027 sends nothing important back to the Master so this 16 bit value can be discarded once read on the Master’s end.
3. SPI master sends the 16 bit RCservo1 command value between 1500 and 4500. During this transmission, ADC1’s 16 bit value is sent to the SPI Master.
4. SPI master sends the 16 bit RCservo2 command value between 1500 and 4500. During this transmission, ADC2’s 16 bit value is sent to the SPI Master.
5. SS\ must be pulled high by the SPI Master.