

Function Generator

Inputs

- 2 Potentiometers (Pots), FREQ_POT, V_POT
- External Function Generator connected to ADC
- At least 2 Buttons for mode/waveform selection (debounced by HW or SW)
- One (debounced) button to turn ON/OFF the Function Generator output

Outputs

- DAC for Function Generator
- At least 2 LEDs to display saturation
 - UP_SATURATION_LED
 - LOW_SATURATION_LED
- The board LED to display the status of the Function Generator Output (ON/OFF)
- UART

Functional Requirements

The system will be a Function Generator (FG) that will output different types of waveforms, controllable by pots. The types of waveforms will be selectable from a waveform bank.

Additionally, the FG will have a bypass mode (ADC->DAC bypass) where it will output to the DAC whatever voltage it is sensing in an ADC input

The FG will report its status to the UART at all times

There are no requirements for maximum/minimum waveform frequency

Modes of operation

Normal function generator

- Output a waveform through the DAC/PWM pin
- Waveform bank includes the following waveforms:
 - a. Sine wave
 - b. Triangular wave
 - c. Sawtooth
 - d. Square Wave
 - e. PWM
- For the first 4 waveforms:
 - a. FREQ_POT will control the frequency
 - b. V_POT will control the max voltage of the waveform
- For the PWM:
 - a. FREQ_POT will control the frequency
 - b. V_POT will control the duty cycle
- A button will enable/disable the Frequency Generator output

ADC->DAC bypass

- Output to the DAC whatever voltage is coming from the ADC, which will be connected to a Function Generator
- The output voltage of the DAC should have a gain controlled by the V_POT, so that $V_{in} = A \cdot V_{out}$:
 - If the V_POT is at 50% the gain is unitary i.e. $A=1$, therefore $V_{in} = V_{out}$
 - If the $V_{POT} < 50\%$ the gain is between $0 < A < 1$, therefore $V_{in} > V_{out}$
 - If the $V_{POT} > 50\%$ the gain is between $1 < A < MAX_A$, therefore $V_{in} < V_{out}$

- MAX_A by default it should be 10. It shall be configurable by FREQ_POT between 2 and 20
- If the calculated DAC output voltage is outside the range $0 > V > V_{ref}$ the LEDs will turn on to indicate saturation, whether it is upper or lower bound saturation

Other requirements

- The microcontroller shall output through the UART the status of the FG, for example:
 - Mode: Normal
 - Waveform: Sawtooth
 - Frequency: 100Hz
 - Max Voltage: 2V
 - Output: OFF
- Example for the ADC->DAC bypass mode:
 - Mode: ADC->DAC bypass
 - Instant Voltage: 3V
 - Upper Saturated: No
 - Lower Saturated: No
 - Gain: 1
 - Max Gain: 10I
 - Output: ON
- If the pots/buttons change the mode/waveform/voltage/frequency, the UART shall display the change.
- A button will enable/disable the Frequency Generator output