IRISHWAVY
USER MANUAL

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ENEE440 – Final Project

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1. Program Operation

1.1 Introduction

The program utilizes various IO devices and interfaces to allow for versatile signal generation. All 13 switches of the primary switches and the rotary encoder on the board are leveraged. All six of the primary LEDs and the seven segment display are used to indicate program status and modes, as well as reading and writing variable values. The program also uses serial communication to enable custom waveforms that can be created and removed on the fly. The following sections will discuss each input and output medium available for this program.

1.2 Input Overview

The rotary encoder and each switch have a dedicated usage that is consistent regardless of the program state. The usage of the rotary encoder and these switches is illustrated in Figure 1.

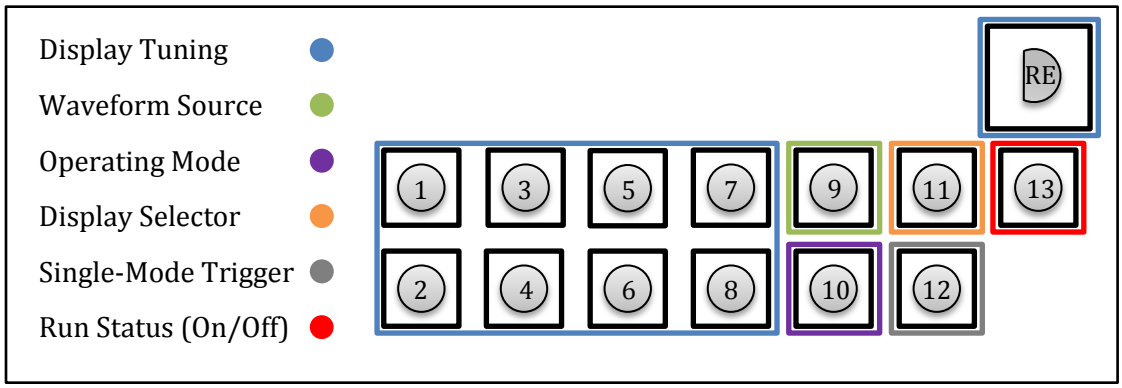

Figure 1: Input devices

The rotary encoder and switches 1-8 are used to modify the value being displayed on the seven segment display (if it is not a read-only value). Switch 9 is used to step through the waveform sources (Sinusoid, Sawtooth, Square, & USART2). Switch 10 is used to step through the operating modes (Repetitive, Single, Trigger). Switch 11 steps through various values for the seven segment display (Frequency, Amplitude, Read-Only Values 1-4). Switch 12 is used as a trigger when the program is in Single-Mode, each press triggers a single period to be output (the switch cannot be held down). Switch 13 is used to toggle the run status of the program between On and Off.

The behavior of the display selector switches and rotary encoder is described in Table 1, below. The rotary encoder has several "notches" in which it requires a bit of force to move it. Between each "notch" are three intermediate steps. Each "notch" change corresponds to ± 4 to the display value and each step change corresponds to ± 1 to the display value. Turning clockwise will increase the display value while turning counterclockwise will decrease it.

Switch	Effect
1	+1000
2	-1000
3	+100
4	-100
5	+10
6	-10
7	+1
8	-1
RE Step (CW)	+1
RE Step (CCW)	-1
RE Notch (CW)	+4
RE Notch (CCW)	-4

Table 1: Switch/Rotary Encoder Behavior
RE=Rotary Encoder CW = Clockwise Turn
CCW = Counterclockwise Turn

1.3 Serial Communication Overview

The program can be interfaced using a serial communication terminal on a PC. The proper configuration for the serial communication terminal is shown below in Table 2.

Parameter	Value
Baud rate	9600
Data Size	8 bit
Parity	None
Stop Bits	1 bit
Flow Control	None

Table 2: Serial Communication Configuration

Once connected, the USART will accept any character sent to it, and will transmit the character back as confirmation. This connection can be used to build a waveform period that can be sent to the DAC. Since the DAC accepts 12-bit values, the USART will buffer and combine three valid hex characters into a single 12-bit number to be added to the waveform's period. The hex characters sent to the USART do not need to be consecutive, as all non-hex characters will only be transmitted back (but not buffered). As confirmation of a buffered 12-bit number, the USART will transmit back a newline character followed by a carriage return character. For example, if you send the USART the string "1h2j3", that exact string will be sent back to you and the terminal cursor will now appear on the next line. The result of the previous string is that the number 0x123 will be added to the USART waveform buffer, and the effect will be immediately visible in the waveform. This functionality is further discussed in the section for **Waveform Source**, below.

1.4 Output Overview

The seven segment display is used to display various values, some of which are read-only. The LEDs are used to indicate the program state, such as the current operating mode and waveform source. Figure 2 illustrates the uses of the six LEDs. Each LED has three states: Off, Green and Red. The possible LED states will be discussed in the following sections.

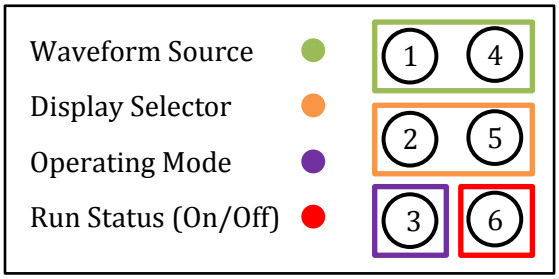

Figure 2: LED usage

The primary output for the program is the waveform output, which can be probed from pin PA5. All changes made via the input devices should have an immediate effect on the waveform produced.

1.5 Waveform Source

The waveform can come from two sources (USART and RAM) and produce four different signals (User-Defined, Sinusoid, Triangle, and Square). For the sake of simplicity, the four possible signals are treated as four different sources, to be stepped through by a single switch (Switch 9). Table 3, below, illustrates how the LEDs indicate which waveform is selected. The order of the states in the figure is also the order they appear by stepping through them using the switch.

Waveform	LEDs	
Sinusoid	1	4
Triangle	1	4
Square	1	4
USART	1	4

Table 3: Waveform LED Indicator

The USART waveform is created by user input via a serial communication terminal. The USART handler will accept all characters, and transmit them back as confirmation, but only stores valid hex characters. After storing three valid hex characters, the characters are combined to form a single 12 bit number, which is added to the USART's waveform buffer. This buffer is what is used by the DMA to output a waveform. The period size is determined by the amount of values given to the USART, for example if you give the USART two valid 12-bit hex values, those two values will be the entire period that is output. In order for the frequency used for the other waveforms to be valid for the USART data, the max sample amount of 256 must be given to the USART to create a complete waveform. The waveform amplitude is applied to the USART waveform as usual.

When the USART waveform buffer is full (at 256 12-bit numbers), the USART will send back a "!" character after all future attempts to add more numbers. To clear the USART data buffer, simply send the "x" or "X" character. The amount of 12-bit numbers in the USART waveform buffer can be viewed from the first read-only value that can be displayed on the seven segment display, see the **Display Selector** section, below, for more information.

1.6 Display Selector - Variable Selection

The display selector switch (Switch 11) is used to step through various 32-bit BCD values to be shown on the seven segment display. Internally, this display selection is referred to as variable selection. Both writeable and read-only values are stepped through by this switch. The writeable values that are displayed are Frequency and Amplitude. The frequency can be any value (inclusive) between 1 and 1000, and the amplitude can be any value (inclusive) between 1 and 100. The frequency value shown is in Hz, and the amplitude is in percentage of the maximum output voltage. There are four read-only values that can be displayed, of which only two are currently configured. The first read-only value is the amount of samples currently stored in the USART waveform buffer, the second read-only value is a counter that is being incremented by a service call (as a demonstration value) and the remaining two read-only will always be zero, as they have not been connected to any values. Table 4, below, illustrates how the LEDs indicate which display value is selected.

Display Value	LEDs
Frequency	2 (green) 5
Amplitude	2 5 (green)
Read-Only 1:RO1	2 5
Read-Only 2:RO2	2 5 (red)
Read-Only 3:RO3	2 (red) 5
Read-Only 4:RO4	2 (red) 5 (red)

Table 4: Display Value LED Indicator
RO1=USART waveform buffer size
RO2=SVC demonstration
RO3=RO4=No connected value

1.7 Operation Mode

The operation mode can be one of three values: Repetitive, Single and Triggered. For repetitive mode, the signal is output continuously, each time a period ends to begins another one. For single mode, only one period is output, then the program waits for the user to press Switch 12 before outputting the period again. Each time a period finishes, a flag is set, and pressing Switch 12 simply clears this flag so that another period can be output. Holding the switch or pre-emptively pressing it will have no effect. For triggered mode, the signal will only output if an input pin is being triggered. By default, the input pin is PB15 and is set to Pull-Down, so a high signal on PB15 will trigger the signal. Configuring this input pin will be discussed in a later section. Table 5, below, illustrates how the LED indicates which operation mode is selected.

Mode	LED
Repetitive	3 (green)
Single	3
Triggered	3 (red)

Table 5: Operation Mode LED Indicator

1.8 Run Status

The run status of the program (either On or Off) is toggled by Switch 13 and indicated by LED 6. By setting the run status to Off, the program simply disables the Timer (TIM6) used to send values from the DMA to the DAC. When toggling the run status to On, the program simply enables the Timer (TIM6). Table 6, below, illustrates how the LED indicates the run status.

Status	LED
On	6
Off	6

Table 6: Run Status LED Indicator