LabVIEW Cycloid Waveform Generator Technical Documentation

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1 Introduction

1.1 Purpose

The LabVIEW Cycloid Waveform Generator implements specialized motion profiles with smooth transitions between linear segments. This document details the implementation of triangle and sawtooth cycloid waveforms in LabVIEW, providing both the mathematical foundation and practical implementation guidance. Furthermore, the program generates an output text file containing the generated waveform, which can be used as input for other applications, such as the “Custom Waveform Generator” example.

1.2 Key Features

- Triangle cycloid waveform with sine transitions
- Sawtooth cycloid waveform with cycloid retrace
- Adjustable transition timing and tracking delay
- Waveform array can be imported into a text file

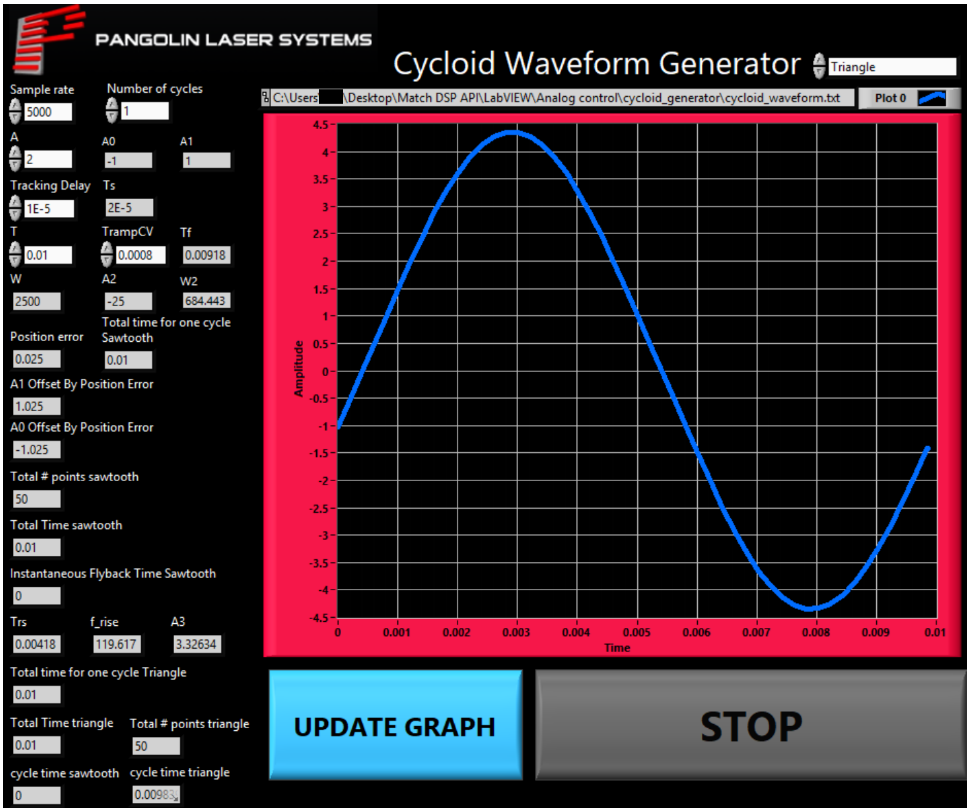

Figure 1: Cycloid Waveform Generator Front Panel

2 Mathematical Foundation

2.1 Triangle Cycloid Waveform

The triangle cycloid combines linear ramps with sinusoidal transitions:

$$y(t) = \begin{cases} A_0 + Wt & \text{for rising ramp} \\ A_1 + A_2 \sin(2\pi f_{\text{rise}} t) & \text{for rising transition} \\ A_1 - Wt & \text{for falling ramp} \\ A_0 - A_2 \sin(2\pi f_{\text{rise}} t) & \text{for falling transition} \end{cases} \tag{1}$$

Where:

- $A_0 = -\frac{A}{2}$ (starting position)

- $A_1 = \frac{A}{2}$ (ending position)
- $W = \frac{A}{T_{\text{rampCV}}}$ (ramp slope)
- $A_2 = \frac{W}{2\pi f_{\text{rise}}}$ (transition amplitude)
- $f_{\text{rise}} = \frac{1}{2T_{\text{rs}}}$ (transition frequency)
- Transition time: $T_{\text{rs}} = \frac{T}{2} - T_{\text{rampCV}} - T_s$
- Position error: $\Delta P = W \times T_{\text{TrackingDelay}}$

2.2 Sawtooth Cycloid Waveform

The sawtooth cycloid features a linear ramp with cycloid retrace:

$$y(t) = \begin{cases} A_0 + Wt & \text{for linear ramp} \\ \frac{A_2}{2\pi}\left(\omega t - \sin(\omega t)\right) + Wt + A_1 & \text{for flyback} \end{cases} \tag{2}$$

Where:

- $\omega = \frac{2\pi}{T_f}$ (flyback frequency)
- $A_2 = -(A + W(T_f + T_s))$ (flyback amplitude)

3 LabVIEW Implementation

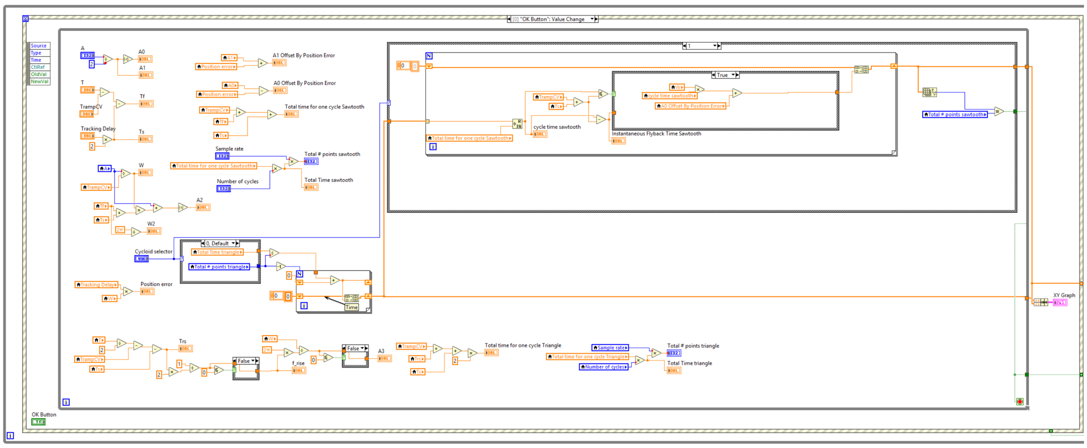

Figure 2: Cycloid Generator Block Diagram

4 Controls and Indicators

4.1 Input Parameters

Control	Description
A	Amplitude (peak-to-peak)
T	Total cycle period (s)
TrampCV	Constant velocity time (s)
TrackingDelay	Command delay (s)
sample_rate	Output sample rate (Hz)
num_points	Points per cycle
num_cycles	Number of cycles

Table 1: Input parameters

5 Implementation Details

5.1 Triangle Cycloid Algorithm

1. Calculate segment timing:
   - Rise time: $T_{\text{rampCV}} + T_s$
   - Rise transition: T_{rs}
   - Fall time: $T_{\text{rampCV}} + T_s$
   - Fall transition: T_{rs}
2. Generate time array for complete cycle
3. For each time point:
   - Determine current segment
   - Apply corresponding equation
   - Adjust for tracking delay

5.2 Sawtooth Cycloid Algorithm

1. Calculate flyback time: $T_f = T - T_{\text{rampCV}} - T_s$
2. Generate time array for complete cycle
3. For each time point:
   - If in ramp segment: linear increase
   - If in flyback: cycloid retrace function
   - Adjust for tracking delay

6 Appendices

6.1 Version History

- 1.0: Initial release (Triangle and Sawtooth Cycloids)