# SecondDegreeAffineTransform: Specification & Math

## Purpose

A lightweight, optional 2D view transform used to map data-space coordinates (time, amplitude) into screen-space coordinates (viewed position) for visualization. It enables zooming, panning, and scaling of a strip chart–like waveform without modifying the underlying data.

## Conceptual Model

- Treat the data as a 2D field: time on the X axis, amplitude on the Y axis

- The transform defines a view window over this field

- The window slides (pans), resizes (zooms), or centers as needed

## Mathematical Formulation

Let a data point be:

- p = (x, y) where:

- x is time in seconds (or relative sample index)

- y ∈ [-1, 1] is normalized amplitude

Let the transform parameters be:

- sx: horizontal scale (zoom in time)

- sy: vertical scale (zoom in amplitude)

- ox: horizontal offset (pan in time)

- oy: vertical offset (pan in amplitude)

Then the forward transform is:

p' = T(p) = (sx \* x + ox, sy \* y + oy)

The inverse transform is:

p = T⁻¹(p') = ((x' - ox)/sx, (y' - oy)/sy)

## Properties

- The transform is linear in each axis (affine, no rotation/skew)

- Supports dynamic zooming and panning via UI controls

- If unset (null), no transform is applied — raw coordinates are used

## Usage Scenarios

- Mapping recorded waveform blocks to view

- Scrolling through long strip charts

- Adjusting focus around a trigger point

- Supporting a memory scope-like data recorder

## Integration Notes

- May be owned by data source or view

- UI components may manipulate scale and offset via exposed methods

- All drawing should go through this transform if present