

Synctonic CSS Framework Treatise & Manual

A rigorous academic study of liquid glass optical physics, zero-specificity cascade mathematics, 8-theme runtime mechanics, and enterprise component architecture.

FRAMEWORK VERSION

Synctonic CSS v0.2.0

ARCHITECTURE PHILOSOPHY

Zero-Specificity (0,0,0) via :where()

BUNDLE FOOTPRINT

<12KB Gzipped (cssnano)

RUNTIME ENGINE

Zero-Dependency Light Engine (<1.5KB)

CHAPTER 1 The Optical Physics of Liquid Glass

"Physical realism in human-computer interfaces cannot be achieved through naive opacity reduction. Convincing optical glass requires multi-planar light reflection, dynamic refraction, and caustic accumulation."

1.1 The Failure of Flat Translucency

Standard industry CSS frameworks implement "glassmorphism" through two declarations: `background: rgba(255,255,255,0.1); backdrop-filter: blur(10px);`. This fails because physical light striking curved mineral crystal or optical lenses does not disperse uniformly. The result in traditional frameworks is a milky, low-contrast plastic haze.

AXIOM 1.1 — THE UNIFIED OPTICAL GLASS FORMULATION

$$F_{\text{glass}}(\lambda) = R_{\text{specular}}(\theta_{\text{inc}}) \oplus B_{\text{refract}}(\text{Blur}, \text{Sat}_{180\%}, \text{Bright}) \oplus C_{\text{caustic}}(\text{Inset}_1, \text{Inset}_2) \oplus S_{\text{ambient}}$$

1.2 The Four Physical Layers in Synctonic CSS

PHYSICAL PLANE	OPTICAL BEHAVIOR	SYNCTONIC CSS IMPLEMENTATION MECHANISM
1. Specular Rim Seam	Fresnel incident light reflection concentrated along the upper curved apex.	<code>::before</code> pseudo-element with XOR gradient perimeter clipping via <code>mask-composite: exclude</code> .
2. Convex Refraction Body	Gaussian dispersion with chromatic saturation intensification.	<code>backdrop-filter: blur(24px) saturate(1.8) brightness(1.04)</code> .
3. Internal Lens Caustics	Subsurface light bouncing inside the internal solid volume.	Dual-inset box-shadows: <code>inset 0 1px 1px 0 rgba(255,255,255,0.95), inset 0 0 16px rgba(255,255,255,0.45)</code> .
4. Ambient Occlusion Drop	Multi-stop ground shadow cast by elevated physical lens.	3-stop diffuse shadow: <code>0 16px 36px rgba(20,22,26,0.08), 0 4px 12px rgba(20,22,26,0.04)</code> .

1.3 Specular Perimeter XOR Masking Code Reference

```
/* Exact rule from src/components/button.css & src/effects/glass.css */
.sync-btn-liquid::before {
  content: "";
  position: absolute;
  inset: 0;
  border-radius: inherit;
  padding: 1px;
  background: linear-gradient(
    to bottom,
    var(--sync-liquid-highlight-top) 0%,
    rgba(255, 255, 255, 0.25) 25%,
    transparent 50%
  );
  -webkit-mask: linear-gradient(#000 0 0) content-box, linear-gradient(#000 0 0);
  -webkit-mask-composite: xor;
  mask-composite: exclude;
  pointer-events: none;
}
```

CHAPTER 2 Zero-Specificity Architecture (:where())

"A foundational flaw in twentieth-century CSS frameworks is specificity inflation. Synctonic enforces strict (0,0,0) cascade scoring across all auto-styled semantic elements."

2.1 The Specificity Vector Theorem

Standard CSS specificity is computed as a 3-component vector: (IDs, Classes/Attributes/Pseudo-classes, Elements) . When a traditional framework writes `button.btn-primary` , its score is (0, 1, 1) . Overriding it requires equal or greater specificity, often spiraling into `!important` declarations.

THEOREM 2.1 — THE :WHERE() ZERO-WEIGHT GUARANTEE
Specificity(:where(Selector_A, Selector_B, Selector_C)) ≡ (0, 0, 0)

In `src/base/auto-styling.css` , Synctonic wraps all bare HTML elements in `:where()` :

```
/* src/base/auto-styling.css */
:where(button:not(.sync-no-auto button, .sync-raw button)) {
  display: inline-flex;
  align-items: center;
  justify-content: center;
  padding: 0.65rem 1.4rem;
  border-radius: var(--sync-radius-full);
  background: var(--sync-liquid-bg);
  border: 1px solid var(--sync-liquid-border);
  font-family: var(--sync-font-sans);
  font-weight: 500;
  cursor: pointer;
  transition: all var(--sync-duration-normal) var(--sync-ease-spring);
}
```

2.2 Architectural Consequences

Instant Baseline Aesthetics
Any plain HTML element (e.g. `<button>Submit</button>` or `<input type="text">`) is instantly styled with full liquid glass physics without adding a single class name.

Total Developer Freedom
Adding any custom class (e.g. `.custom-btn { background: #f00; }`) carries a weight of (0, 1, 0) , silently overriding the framework without resistance.

2.3 Framework Subtree Escape Hatches

UTILITY SELECTOR	SCOPE TARGET	FUNCTIONAL OPERATION
<code>.sync-no-auto</code>	Container / Tree	Deactivates all automatic element styling for child elements within that DOM subtree.
<code>.sync-raw</code>	Element / Container	Strips framework resets, restoring browser-native User-Agent styling behavior.

CHAPTER 3 Design Token Taxonomy (--sync-*)

All visual properties in `src/tokens/tokens.css` are parameterized as CSS Custom Properties on `:root` :

TOKEN GROUP	VARIABLE KEY	CANONICAL VALUE	MATHEMATICAL ROLE
Accent Primary	<code>--sync-accent</code>	<code>#4f6bff</code> (rgb: 79, 107, 255)	Primary brand spectral locus
Accent Secondary	<code>--sync-accent-2</code>	<code>#8a5cf6</code> (rgb: 138, 92, 246)	Secondary chromatic complement
Substrate Alpha	<code>--sync-liquid-bg</code>	<code>rgba(255, 255, 255, 0.55)</code>	Base refraction substrate opacity
Crest Luma	<code>--sync-liquid-highlight-top</code>	<code>rgba(255, 255, 255, 0.95)</code>	Upper apex specular line intensity
Gaussian Kernel	<code>--sync-liquid-blur</code>	<code>24px</code>	Gaussian diffusion spread
Color Saturation	<code>--sync-liquid-saturation</code>	<code>1.8</code> (180%)	Optical chroma enhancement factor
Spring Kinematics	<code>--sync-ease-spring</code>	<code>cubic-bezier(0.34, 1.4, 0.64, 1)</code>	Overshooting viscoelastic spring curve

CHAPTER 4 Glass Material Tiers & Optical Shaders

"Optical materials in user interfaces serve as semantic depth indicators. Synctonic classifies glass into five calibrated material tiers and three specialized chromatic shaders."

4.1 The 5-Tier Material System (src/effects/glass.css)

Tier Class	Blur Kernel	Base Opacity	Layer Role & Context
<code>.sync-glass-clear</code>	6px	~25%	Subtle ambient divider panes and low-contrast background backdrops.
<code>.sync-glass-soft</code>	10px	~45%	Secondary tab strips, inactive list items, and subtle pill containers.
<code>.sync-glass</code>	16px	~60%	Standard workhorse UI surface: default cards, popovers, and menus.
<code>.sync-glass-strong</code>	24px	~78%	Elevated interface elements: floating navigation capsules and dialog sheets.
<code>.sync-glass-solid</code>	32px	~92%	Dense Acrylic / Mica material: high-contrast modals, mobile drawers, and command palettes.
<code>.sync-glass-liquid</code>	24px	Dynamic	Curved 3D lens featuring dual-specular caustics and perimeter XOR masks.

4.2 Specialized Optical Shaders (src/effects/chromatic.css)

<code>.sync-glass-chromatic</code> Simulates Snell's law dispersion where differing wavelengths bend at different angles, creating a shimmering rainbow crest along the top specular rim.	<code>.sync-glass-holographic</code> Simulates thin-film optical interference, casting a futuristic angular color shift across the surface plane.	<code>.sync-glass-grain</code> Applies an ultra-fine SVG turbulence noise filter to simulate physical frosted sandblasted glass.
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CHAPTER 5 Complete Enterprise Component Suite

5.1 Capsule Button System (src/components/button.css)

Buttons support 5 size scales (`xs` , `sm` , `md` , `lg` , `xl`) and 6 physical variants:

```
<!-- 3D Specular Pill Button with Spring Tilt -->
<button class="sync-btn-liquid sync-btn-xl sync-btn-shine sync-tilt" data-sync-tilt>
  Synctonic Labs
</button>

<!-- Variant Classes -->
.sync-btn-primary /* Luminous accent gradient fill */
.sync-btn-secondary /* Frosted neutral substrate */
.sync-btn-ghost /* Translucent rim with transparent body */
.sync-btn-chromatic /* Spectral dispersion gradient */
.sync-btn-glow /* Radial ambient halo projection */
```

5.2 Floating Dynamic Island Navigation (src/components/navbar.css)

The navigation bar operates as a floating capsule with responsive adaptation:

```
<header class="sync-navbar sync-navbar-floating">
  <a href="#" class="sync-navbar-brand">
    
    <span>Synctonic CSS</span>
  </a>
  <nav class="sync-navbar-menu" id="mobileNavMenu">
    <div class="sync-navbar-menu-header"><span>Navigation</span><span>v0.2.0</span></div>
    <a href="#innovations" class="sync-nav-link sync-active">
      <span class="sync-nav-link-main">
        <span class="sync-nav-icon">🌟</span>
        <span class="sync-nav-text-desktop">Innovations</span>
        <span class="sync-nav-text-mobile">Core Innovations</span>
      </span>
      <kbd class="sync-kbd"><code></code></kbd>
    </a>
  </nav>
  <div class="sync-navbar-actions">
    <button class="sync-navbar-icon-btn" id="themeModeToggle">🌙</button>
    <button class="sync-navbar-toggle sync-navbar-icon-btn">☰</button>
  </div>
</header>
```

CHAPTER 5 (CONT.) Advanced Component Architectures

5.3 visionOS Floating App Dock (src/components/dock.css)

```
<div class="sync-dock-container">
  <div class="sync-dock">
    <a href="#" class="sync-dock-item sync-active" data-sync-title="Finder">📁</a>
    <a href="#" class="sync-dock-item" data-sync-title="Terminal">🔥</a>
    <a href="#" class="sync-dock-item" data-sync-title="Studio">🎨</a>
    <div class="sync-dock-divider"></div>
    <a href="#" class="sync-dock-item" data-sync-title="Settings">⚙️</a>
  </div>
</div>
```

5.4 Form Physics & Advanced Inputs (src/components/form.css, input.css)

Floating Labels & Validation

```
<div class="sync-form-floating">
  <input type="email"
    class="sync-input sync-is-valid"
    placeholder=" ">
  <label class="sync-label">Email</label>
</div>
```

Glass Switch Controls

```
<label class="sync-switch">
  <input type="checkbox" checked>
  <span class="sync-switch-track">
    <span class="sync-switch-thumb"></span>
  </span>
  <span>Specular Caustics</span>
</label>
```

CHAPTER 6 The 8-Theme Material Runtime Engine

In `src/themes/themes.css`, Synctonic defines 8 distinct theme palettes that dynamically remap RGB channels without requiring CSS rebuilds:

THEME ATTRIBUTE	ACCENT HEX / RGB	ACCENT 2 HEX / RGB	AESTHETIC PROFILE
<code>data-sync-theme="default"</code>	<code>#4f6bff</code> (79, 107, 255)	<code>#8a5cf6</code> (138, 92, 246)	Signature Cobalt & Electric Purple (SaaS)
<code>data-sync-theme="midnight"</code>	<code>#6366f1</code> (99, 102, 241)	<code>#a855f7</code> (168, 85, 247)	Obsidian OLED Pure Dark Glass
<code>data-sync-theme="aurora"</code>	<code>#06b6d4</code> (6, 182, 212)	<code>#10b981</code> (16, 185, 129)	Ethereal Cyan & Emerald Aurora
<code>data-sync-theme="nebula"</code>	<code>#d946ef</code> (217, 70, 239)	<code>#8b5cf6</code> (139, 92, 246)	Cyberpunk Magenta & Violet Neon
<code>data-sync-theme="ocean"</code>	<code>#0284c7</code> (2, 132, 199)	<code>#2563eb</code> (37, 99, 235)	Deep Subsurface Oceanic Refraction
<code>data-sync-theme="sunset"</code>	<code>#f59e0b</code> (245, 158, 11)	<code>#f43f5e</code> (244, 63, 94)	Warm Amber & Radiant Coral
<code>data-sync-theme="rose"</code>	<code>#ec4899</code> (236, 72, 153)	<code>#f43f5e</code> (244, 63, 94)	Blush Pink & Ruby Crystal
<code>data-sync-theme="emerald"</code>	<code>#10b981</code> (16, 185, 129)	<code>#84cc16</code> (132, 204, 22)	Electric Lime & Mint High-Tech
<code>data-sync-theme="mono"</code>	<code>#475569</code> (71, 85, 105)	<code>#334155</code> (51, 65, 85)	Minimalist Platinum & Obsidian Monochrome

CHAPTER 7 Interactive 3D Cursor Light-Tracking (`synctonic.js`)

"In physical reality, as an observer moves relative to glass, the specular crest angle shifts. Synctonic computes pointer trigonometry at 60 frames per second using `requestAnimationFrame`."

7.1 Mathematical Vector Formulation

When a pointer moves across a `.sync-tilt` or `.sync-btn-liquid` element, `synctonic.js` executes the following real-time calculation:

ALGORITHM 7.1 — SPECULAR ANGLE AND SUBSURFACE NORMALIZATION

```
const posX = clientX - rect.left;
const posY = clientY - rect.top;
const angleRad = Math.atan2(posY - rect.height / 2, posX - rect.width / 2);
let angleDeg = (angleRad * (180 / Math.PI)) + 90;
if (angleDeg < 0) angleDeg += 360;

el.style.setProperty("--sync-glass-tilt", `${angleDeg.toFixed(1)}deg`);
el.style.setProperty("--sync-mouse-x", `${((posX / rect.width) * 100).toFixed(1)}%`);
el.style.setProperty("--sync-mouse-y", `${((posY / rect.height) * 100).toFixed(1)}%`);
```

7.2 JavaScript API Interface

METHOD / HOOK	PARAMETER SIGNATURES	DESCRIPTION
<code>Synctonic.init()</code>	<code>(options = {})</code>	Auto-discovers and binds tilt, dock, form, codeblock, and command palette listeners.
<code>Synctonic.attachElement()</code>	<code>(el, options = {})</code>	Attaches physical 3D light-tracking to a dynamically generated DOM node.
<code>Synctonic.toggleCommand()</code>	<code>(open?: boolean)</code>	Toggles the modal state of the <code>Cmd + K</code> Command Palette dialog.

CHAPTER 8 Production Framework Integration

React / Next.js Component Pattern

```
import React from "react";

export function LiquidButton({
  children,
  variant = "liquid",
  size = "md",
  ...props
}) {
  return (
    <button
      className={`sync-btn sync-btn-${variant} sync-btn-${size} sync-tilt`}
      data-sync-tilt
      {...props}>
      {children}
    </button>
  );
}
```

Vue 3 Component Pattern

```
<template>
  <button
    :class="['sync-btn', `sync-btn-${variant}`, 'sync-tilt']"
    data-sync-tilt>
    <slot />
  </button>
</template>

<script setup>
  defineProps({
    variant: { type: String, default: 'liquid' }
  });
</script>
```

CHAPTER 9 Performance & WCAG 2.1 AA Compliance

GPU Compositing: Lenses use <code>isolation: isolate</code> and <code>will-change: transform</code> to maintain locked 60fps scrolling without full-page repaints.	Motion Safety: Respects <code>prefers-reduced-motion: reduce</code> by disabling 3D tilts and animated light gleams.	Optical Focus: High-visibility <code>:focus-visible</code> luminous focus rings guarantee full accessibility for keyboard navigators.
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