

## Vovina Nano Armor & Performance Package

*1997 Chevrolet Suburban K2500 4×4*

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### Introducing the Vovina Nano-Armored Suburban

Experience the ultimate fusion of stealth, security, luxury, and cutting-edge nanotechnology. The Vovina-enhanced 1997 K2500 Suburban transcends its '90s heritage, emerging as a futuristic super-utility vehicle: silent, bullet-resistant, energy-regenerative, and irresistibly stylish. Each element—inside and out—was engineered to work in perfect harmony, delivering unparalleled performance, protection, and presence.

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## 1. Exterior: Nano-Engineered Armor & Aesthetic Excellence

### A. Deep Black Nano-Armor Paint with Subtle Green Glow

- **Seven Total Coats:**
  - **Conductive EMP-Shielding Primer:** Faraday-cage foundation that blocks electromagnetic pulses and radio-frequency surveillance.
  - **Casimir-Enhanced Dielectric Layer:** Barium-titanate & aerogel sub-coating that leverages Casimir-effect physics to repel stray fields, doubling EM shielding.
  - **Graphene-Reinforced Thermal/Abrasion Overcoat:** Withstands engine heat, road debris, and friction.
  - **Ceramic/Graphene Ballistic Layer:** Stops pistol rounds and deflects stone chips—integrated with carbon-fiber patches at vulnerable zones.
  - **Reactive Plasma Electrode Mesh:** Micro-tungsten spike arrays around body edges, capable of 10 kV pulsed discharges at a moment's notice.
  - **Nano-Ceramic Self-Healing Diamond-Dust Clearcoat:** Glossy finish embedded with 0.5  $\mu\text{m}$  diamond dust for a gentle sparkle by day; strontium aluminate pigment for a *ghostly* green glow by night.
  - **Hydrophobic "Hydracoat" Elastomeric Final Finish:** Repels water, mud, and grime; self-cleaning in motion.
- **Underbody Fortification:**
  - **Aerogel Thermal Blanket & Carbon-Fiber Abrasion Shield** protect the engine bay.

- UHMW Polyethylene Skid Plates on critical undercarriage areas resist rocks, earth, and fire embers.
  - Electrostatic Slipstream Strips (–10 kV “nano-brushes”) create an ion barrier, forcing dust and water away—improving aerodynamics.
  - **KW DDC Smart Suspension with Electronic Ride-Height Control:**  
Instantly raise or lower at speeds (Low at < 35 mph, Normal at 35–80 mph, High at > 80 mph) for optimum clearance, handling, and stealth profile.
  - **Aesthetic Highlights:**
    - Deep Gloss Black Pearlescent Base underlies the nano-layers.
    - Subtle Green Night Glow (“Phantom Glow”): By ambient light, the Suburban’s body kisses with a faint emerald aura—dramatic yet discreet, never “police-flare” bright.
    - Diamond-Dust Sparkle: Under daylight, microscopic diamond facets catch the sun at certain angles—an understated shimmer that hints at unbreakable strength.
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## 2. Interior: Ultimate Luxury Meets Nanotech Functionality

### A. Premium Exotic Materials

- **Flooring:** Genuine Hawaiian Curly Koa Wood planks, sealed with nano-scale “ProSeal” for UV resistance, scratch immunity, and a warm, amber glow underfoot.
- **Seat & Accent Surfaces:**
  - Metallic Green Eel Skin for center panels (front Captain’s chairs, three-passenger middle row).
  - Green Crocodile Skin door inlays & headliner trim—harmony with exterior glow.
  - Rich Black Eel Skin bolsters with gold piping edges. Each hide treated with Nanoprotect™ coating for antimicrobial protection and abrasion resistance.
  - 4” Memory Foam + Gel-Memory Top for unmatched comfort, with heated PTC & ventilated seat blowers integrated beneath each cushion.
- **Dashboard & Door Panels:**
  - Carbon-Fiber Inserts vacuum-sealed behind nanoceramic clearcoat.
  - Custom 3D-printed PEEK trim rods coated in anti-scrub nanocoating.

### B. Ambient & Functional Lighting

- **Retro Analog Dials** with diffuse milky-acrylic rings behind each gauge, backlit by individually addressable RGBW LEDs controlled by a TCS3472 ambient light sensor + Teensy microcontroller.
- **Gesture & Touch Controls:**

- Leap Motion sensor overhead for swipe, pinch, and hover commands that control track changes, volume, and ambient light color.
- 7" OLED Touchscreen in center dash for quick mode changes—"Armor Standby," "Energy-Regeneration," "Ambient Lounge," etc.

#### C. McIntosh Audiophile Sound Suite

- McIntosh C12000 Preamp + DA2 DAC feeding four McIntosh MA252 Hybrid Tube Amplifiers (Front L/R, Rear L/R) and two bridged MA252s for dual 12" sealed subwoofers.
- MVP901 Emergency PA Amplifier wired to a front-bumper horn (120 dB) for immediate "Attention!" broadcasts.
- Interior Vibration Speakers & Exciters hidden under koa wood floors and headliner for a "7.3 Surround" tactile audio field.
- Rodin Coil Array Integration: Six N52 magnet-core coils positioned in floor & headliner modules. Three tuned for harmonic resonance, three for "Fractal Antenna" broadcast—projecting any chosen audio or healing frequencies into a 50 m radius (UL-certifiable, FCC-compliant modes).

#### D. Climate & Comfort Systems

- Digital Climate Control Module replaces factory vacuum HVAC—precise temperature, fan, and mode management.
- Heated & Cooled Seats: PTC heaters + 2" micro-fans move air through perforated leather. Programmable via touchscreen or handheld app.
- Ultrasonic Aromatherapy Diffuser: Hidden reservoir under center console delivers essential-oil mist into footwells.
- Humidity Sensor & Auto-Ventilation: Detects cabin RH > 75 % → automatically cycles seat vents and A/C to defog and sanitize.

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### 3. Performance & Powertrain: High-Octane, High-Efficiency

#### A. Engine & Drivetrain Enhancements

- 454 ci Vortec V8 upgraded with:
  - Edelbrock CNC Cylinder Heads, 64 cc chambers, flow-bench tested for sealed-combustion performance.
  - Comp Cams "Thumpr" Hydraulic Roller Cam + matching valvetrain springs—rock-solid idle, healthy midrange torque.
  - Hooker BlackHeart Headers + dual MagnaFlow Catalytic Converters + Borla Cat-Back exhaust for CARB E.O. compliance (DG-5, D-161-118, D-550-45).

- Holley Terminator X EFI: Handles flex-fuel (E85) mapping, multi-port injection, wideband O<sub>2</sub> closed-loop tuning.
- MSD 6-Plus Ignition with HEI distributor ensures crisp spark.
- **Cooling & Thermal Management**
  - Be Cool Billet Radiator + SPAL Electric Fan: Keeps engine < 200 °F even under towing load.
  - Setrab Oil Cooler + Frostbite Transmission Cooler: Protect fluids from heat soak.
  - Sanden e-A/C Compressor for cold-climate comfort.

#### **B. 48 V e-Assist Hybrid System**

- BorgWarner B-1000 Motor/Generator replaces stock alternator—delivers up to 3 kW of immediate torque at low revs and regenerates braking energy back into a Battle Born 48 V LiFePO<sub>4</sub> Battery Pack (50 Ah).
- Victron Orion-Tr 48 → 12 V DC/DC Converter provides stable house power for audio, computing, and accessories.
- Holley-Tuned M/G Control: Seamlessly blends electric assist with throttle input—instant off-the-line torque, reduced lag, and improved fuel economy (up to 15 % better in city driving).

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## **4. Security & Safety: Secret-Agent-Grade Protection**

### **A. Multi-Tiered Electronic Defense**

1. **EMP/EMI Hardening:**
  - Copper Foil Taping & EMI Gasket Seals under headliner, dash, and door skins form a continuous shield.
  - Ferrite Beads & Shielded Wiring on every critical harness ensure no stray pulses disturb electronics.
2. **Reactive Plasma Armor:**
  - Tungsten Spike Array around leading edges forms a localized plasma barrier on command—capable of disintegrating or deflecting small arms projectiles.
  - Underbody IR Strobe Modules (940 nm) silently blind night-vision devices; perfect for “ghost mode” operations after sundown.
3. **Active EMP Discharge:**
  - High-Voltage Capacitor Banks (10 nF at 10 kV) with IGBT switches can generate a rapid-pulse “EMP wave” to preemptively disable proximate electronics (e.g., remote IED triggers).

- **Seamless Jetson AI Integration:** Push a dashboard “Armored Mode” button—Vehicle HUD cue glows emerald, and all EMP-reactive systems stand by.

#### **B. Biometric & RF Countermeasures**

- **Viper SmartStart Biometric Immobilizer:** Fingerprint/hand-vein reader under dash ensures only authorized operators can start the engine.
- **Compustar CM25-U Ultrasonic Sensor:** Detects any cabin intrusion—sends immediate alerts via smartphone and sets off alarms if armed.
- **Passive RF Scabbard Pouches** inside hidden vault to temporarily block GPS/remote trackers.

#### **C. Surveillance & Broadcasting**

- **4K Dual-Channel Dashcam (BlackVue DR750S):** Records front/rear continuously, with loop recording and event tagging.
- **4K 360° Interior Camera (Rove R2):** Monitors cabin activity—ideal for security logs or remote conference monitoring.
- **Escort MAX Ci 360° Radar Detector** triggers roof-integrated IR Plate Scrambler to defeat police-issued radar.
- **2.4 GHz RF Noise Generator (optional)** deploys a low-power jamming field (compliant under Part 15) to mask onboard/emitted signals.

#### **D. Covert Storage & Lifesaving Gear**

- **Hidden Underbody Vault (18” × 10” × 6”):** TIG-welded, EMI-lined, RFID-locked compartment for valuables, impervious to RF interrogation.
- **FE-36 Clean Agent Fire Suppression:** Engine bay & cabin system discharges in seconds—no residue, zero collateral damage.
- **Hidden Fire Blanket Deployment:** Step-activated release for footwell or engine bay.
- **Integrated First-Aid & Defibrillator:** Carbon-fiber-encased Trauma Pro Kit and ZOLL AED Plus: readily accessible, discreetly stowed.
- **Inogen One G4 Oxygen Concentrator:** Onboard 12 V-powered O<sub>2</sub> support for medical emergencies.

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## **5. Connectivity & Onboard Intelligence**

#### **A. NVIDIA Jetson AGX Orin AI Core**

- **Neural-Engine-Powered (275 T FLOPS):** Runs adaptive algorithms for system health, intrusion detection, gesture control, and HUD mapping—all in real time.

- **LiFi Integration:** Gentex ClearVu windows double as LiFi receivers—centralized cabin lighting and HUD driven by secure optical data links.
- **802.11ax Wi-Fi & Starlink Roam Roamers:** Provides 4G/5G/satellite connectivity for telematics, remote diagnostics, and live-stream telemetry.

#### **B. AR HUD & User Interface**

- **Continental AR-HUD** projects critical data (speed, navigation, sensor warnings) onto the windshield. Calibration delivers crisp, 12-in virtual imagery.
  - **Custom 7" OLED Dashboard Display:** Touch-responsive interface for mode toggles (Armor, Stealth, Comfort, Energy Recover).
  - **Full CAN-Bus Orchestration:** Over 20 microcontrollers (Teensy, Arduino) manage backlighting, modes, and safety interlocks—every action is instantaneously reflected in visual feedback.
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## **6. Interior Luxury & Convenience**

#### **A. Styling & Comfort**

- **Crocodile & Eel Leather Accents:** Rich emerald green croc and black/gold eel combine for an opulent “Dragon’s Breath” motif—complemented by koa-wood trim throughout.
- **Captain’s Swivel Bucket Seats:** Modern single-pole swivels with 360° rotation on locking base, simplifying entry/exit.
- **Hardwood Flooring:** Seamlessly flush koa underfoot, with micro-dialed contour to preserve cabin height.
- **Ambient LED Color-Change:** Around footwells, dash edges, and door panels—100+ colors selectable via hue sliders.

#### **B. Advanced Comfort Systems**

- **Heated & Ventilated Seats:** PTC film heaters plus integrated 2" fans circulate air through leather perforations.
  - **Aromatherapy / Humidity Control:** Ultrasonic diffuser, on-demand, with cabin RH sensor auto-adjusting seat ventilation & AC.
  - **Onboard Office:** In-dashboard Wi-Fi hotspot (Starlink/Poe-enclosed modem), 4K UHD monitor (LG 32" retractable), wireless keyboard/mouse, built-in compact printer in rear console.
  - **High-Voltage USB-C & AC Outlets:** Four 100 W USB-C ports and two 120 VAC outlets behind front console for laptops or charging tools.
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## 7. Mechanical Upgrades & Secret-Agent Gizmos

### A. Under-Hood Performance

- **Cylinder Heads & Camshaft:** Edelbrock & Comp Cams combination yields ~ 450 HP @ 5 200 RPM, ~ 500 lb-ft @ 3 000 RPM.
- **Cold-Air Intake & MAF:** K&N flow-bench tuned for max torque.
- **LSA-Grade EFI:** Holley Terminator X with in-tank pump, Aeromotive regulator, wideband O<sub>2</sub> for rock-solid tuning.
- **4L80E Transmission:** Strengthened valve body, 2 800 rpm torque converter, Frostbite cooler, Setrab oil cooler—delivering crisp 4-speed shifts and highway overdrive.

### B. Underbody & Tire

- **Kevlar®-Strengthened Tires:** Custom 35" Kevlar sidewall all-terrain tires reduce flat-risk.
- **Foam-Filled Deafening Dampers:** 2 cm high-density foam in wheel wells for near-silence at highway speeds.
- **Pneumatic Tire Sealant:** Underfloor reservoir auto-injects sealant to self-heal punctures up to 6 mm.

### C. Suspension & Ride Control

- **KW DDC Adaptive Coilovers:** Electronically adjustable ride height, 3 modes—"Stealth" (low), "Cruise," "Off-Road" (high).
  - **Active Smart Dampers:** KW's Dynamic Damping Control fine-tunes stiffness based on G-sensor and vehicle speed data.
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## 8. Connectivity, Communication & Convenience

### A. Communications Suite

- **CB & Ham Radio:** Integrated under dash with hidden microphone boom; dual-band (27 MHz & 144/430 MHz).
- **GPS with Military-Grade Encryption:** On a separate, faraday-insulated CAN circuit—prevents GPS spoofing.
- **Augmented Reality Navigation:** HUD overlays turn-by-turn with live satellite imagery when connected to Starlink.

### B. Surveillance & Remote Control

- **Jetson-Backed Monitoring App:** Access vehicle vitals (battery, pressure, camera feeds) remotely via encrypted 5G/Wi-Fi link.
  - **Biometric Entry & Start:** No keys; just place finger on scanner.
  - **Geo-Fence & Curfew Alerts:** Receive push notifications if the Suburban leaves “safe zones.”
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## **9. Aesthetic Harmony: “Dragon’s Breath” Design Language**

- **Color Palette:** Matte & gloss Onyx Black base with Spectral Emerald Highlights. Every trim accent, from seat stitching to door inlays, ties into that emerald vivacity.
  - **Material Contrast:** Dark koa wood marries the exotic reptile skins—creating an interior that feels both organic and otherworldly.
  - **Subtle Sparkle:** Only under direct sun will microscopic diamond dust reveal a delicate shimmer—like stars on a midnight sky. At night, a refined ambient glow emanates from edges, contours, and underbody lines, leaving an ethereal “dragon trail.”
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### **Why Choose Vovina Nano Armor?**

1. **Bulletproof & EMP-Resistant** – Deflect small arms, disrupt hostile electronics.
  2. **Ghost-Mode Stealth** – Subtle glow, silent e-assist, and adaptive suspension let you blend in—then vanish.
  3. **Ultra-Luxury Interior** – Genuine eel & croc leather, koa wood, and McIntosh tube-amplified sound create a sensorial sanctuary.
  4. **Cutting-Edge Performance** – 450 HP V8, 48 V hybrid assist, and fine-tuned EFI deliver V-class power and efficiency.
  5. **Comprehensive Safety Systems** – Biometric immobilizer, ultrasonic cabin sensors, hidden vault, and onboard medical gear.
  6. **Seamless Connectivity** – AI-driven HUD, LiFi windows, 4K-capable dashcams, and Starlink internet on the go.
  7. **Modular Future-Proofing** – EV-axle pre-brackets ready; potential to convert to full electric in the next decade.
  8. **Luxury that Protects** – Every surface is nano-coated for antimicrobial, scratch-resistant durability—perfect for years of impeccable service.
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## 10. Specifications & Package Pricing

Feature Category	Detail
Exterior Armor	7-Layer Nano Armor Build (EMP, Plasma, Ballistic, Diamond Glow)
Underbody Protection	Aerogel Insulation + UHMW Skid Plates + Acoustic Dampers
Suspension	KW DDC Coilovers with Auto Height (Smart Modes)
Engine/Drivetrain	454 ci V8, Edelbrock Heads, Comp Cams, Holley EFI, 48 V e-Assist
Audio System	McIntosh C12000 + 4 × MA252 + 2 × Br MA252 (Subwoofer) + MVP901
Interior Luxury	Koa Wood Flooring, Green Croc/Eel Leather Seats, Aromatherapy, Heated/Vented Seats
Security	Biometric Immobilizer, EMP/EMI Hardening, Vault, IR Strobes, Plasma Armor
Connectivity	NVIDIA Jetson AI hub, Continental AR HUD, LiFi Glass, 4K Cameras, Starlink
Safety & Medical	FE-36 Fire Suppression, Res-Q-Me Tools, AED, O <sub>2</sub> Concentrator

<b>Secret-Agent Gizmos</b>	<b>RF Jamming, IR License Plate Scrambler, Covert Antenna, CB/Ham, Ultrasonic Sensors</b>
<b>Warranty &amp; Support</b>	<b>3-Year/36 000 mi Vovina Comprehensive Warranty (Armor &amp; Nano Systems)</b>

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**Pricing (Base Vehicle Not Included)**

<b>Vehicle Size</b>	<b>Vovina Nano Armor Package</b>
<b>1997 K2500 Suburban 4×4</b>	<b>\$295,000 USD</b>
<b>Full-Size SUV (e.g., Tahoe)</b>	<b>\$305,000 USD</b>
<b>Mid-Size SUV (e.g., Explorer)</b>	<b>\$275,000 USD</b>
<b>Full-Size Sedan (e.g., Charger)</b>	<b>\$260,000 USD</b>
<b>Compact SUV (e.g., CR-V)</b>	<b>\$245,000 USD</b>
<b>Truck (e.g., F-150)</b>	<b>\$280,000 USD</b>

**Note: Prices include all parts, labor, end-to-end engineering, and tuning. Vovina offers a white-glove concierge process: we arrange shipping, supervise installation, and provide complete training on your new features.**

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# 11. Seamless Integration: How It All Works Together

## 1. Start-Up & Biometric Authentication

- Place finger on biometric pad. Viper unlocks ignition, sends “Green Light” to Jetson. Interior OLED illuminates emerald-accent accents.

## 2. Adaptive Lighting & Ambience

- Cabin TCS3472 reads ambient light—automatically adjusts dial backlights, floor lighting, and accent LED strip colors for best visibility and mood.
- Swipe gesture over Leap Motion to switch between “Day Mode” (bright white) and “Night Mode” (subtle green hues).

## 3. Drive & Energy Management

- As you pull away, the BorgWarner 48 V M/G assists torque onset. Suspension auto-raises to “Cruise Mode” at 35 mph.
- On downhill or deceleration, M/G harvests regen energy into the 48 V pack. All low-draw electronics (Jetson, audio, lighting) run off the 48 V DC/DC converter—minimizing load on alternator.

## 4. Stealth & Armor at Hand

- Press “Armor” on touchscreen: Jetson sends CAN 0x200 to charge HV capacitors. HUD displays “Plasma Ready.”
- When threat detected (radar or proximity), a simple flick of switch triggers a plasma pulse around body edges and IR strobes underneath—silently neutralizing pursuit sensors.

## 5. Command Center & Surveillance

- 4K dashcams record all angles; anytime an event (harsh braking, impact) is detected, the Jetson tags timeline and locks footage.
- AR HUD displays navigation, speed, and a small “Threat Alert” icon when the Biometric or Ultrasonic sensor trips.

## 6. Comfort & Luxury in Motion

- In parallel: enjoy McIntosh-driven tube-warmer sound—seat and floor vibrators deliver haptic bass without turning heads.
- Aromatherapy diffusion triggers on startup (your signature “eucalyptus mint” scent).
- If cabin humidity rises (rain or condensation), the system auto-vents seats and engages A/C.

## 7. Emergency & Medical Readiness

- If fire is detected (thermal link), FE-36 suppression automatically discharges—fire contained in seconds.
- If occupant requires urgent care, O<sub>2</sub> concentrator is at hand; AED is ready with a single push.

## 8. Return & Park

- Replacing your finger on the biometric pad locks the vehicle:
  - All plasma systems discharge capacitors.
  - Jetson logs data to a secure encrypted drive.
  - Rear vault automatically locks behind electromagnetic sealing.

- LiFi windows revert to opaque mode (privacy).
  - Underbody IR strobes and plasma electrodes stand down.
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## 12. Aesthetic & Emotional Appeal

- **First Glance:** A silhouette of pure onyx, unbroken by chrome or trim. Soft emerald lines glow faintly at edges—suggesting power and mystery.
  - **Daytime Presence:** Subtle diamond dust flickers across curves in sunlight—like stardust dancing on black velvet. Passersby catch only a hint of brilliance.
  - **Nighttime Aura:** Under minimal light, the ultra-dark paint seems to swallow surroundings—then, at a touch, the gentle green luminescence pulses to life. A spectral apparition on wheels.
  - **Interior Ambience:** The moment you open the door, the scent of koa wood and essential oils greets you. Touch metallic green eel skin—cool to the hand yet vibrant, reassuring. Crimson-stitched black-eel bolsters invite you to sink in.
  - **Sound & Feel:** Each note from the McIntosh tubes arrives like velvet—both crisp and warm. A sub-sonic rumble resonates through memory foam-moored seats (no rattles, just articulation).
  - **Emotive Impact:** You don't just drive the Vovina Suburban; you command respect. Whether cruising urban streets or forging off-road, you're encased in a fortress of luxury.
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## 13. Ordering & Contact

### Vovina Performance Division

- **Website:** [www.vovina-performance.com](http://www.vovina-performance.com)
- **Showroom & Fabrication Center:** 123 NanoDrift Way, San Diego, CA 92121
- **Sales & Concierge:** 800-VOVINA-8 (Voice) / [sales@vovina-performance.com](mailto:sales@vovina-performance.com)
- **Support & Service:** [support@vovina-performance.com](mailto:support@vovina-performance.com)

### Next Steps:

1. **Schedule Your Consultation:** Visit us or set up a video showroom tour.
  2. **Customize Your Palette:** Black/Emerald is standard; custom colorways available.
  3. **Confirm Package Options:** Choose from Base Armor, Luxury Suite, or Elite “DJ7” Armoring Bundle.
  4. **Book Your Build Window:** Typical turnaround is 10–12 weeks from deposit.
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## **Join the Vanguard of Automotive Innovation**

**The Vovina Nano-Armored Suburban isn't just a vehicle—it's a statement. It's where bulletproof security, ultra-luxury, and state-of-the-art nanotechnology converge. It's the car you never fall victim to; it's the car you become.**

**Are you ready to command the future?**

**Vovina Performance Division**

**—Defining the Next Generation of Protection & Prestige—**

## Comprehensive Retrofit & Installation Manual

“Ultimate Vovina Suburban”

*1997 Chevrolet Suburban K2500 4×4 (2-door, no third-row seat)*

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## I. Introduction & Overview

This manual provides a complete, step-by-step retrofit guide to transform a 1997 Chevrolet Suburban K2500 4×4 into the “Ultimate Vovina Supercar.” It covers every aspect—from nano-engineered exterior coatings and reactive armor layers to an audiophile-grade vacuum-tube sound system, a 48 V hybrid drive, secret-agent security, and a luxury, futuristically-active interior.

Each Part (A, B & C) is self-contained yet interlinked. Every material, tool, and sub-assembly is listed with U.S.-based suppliers (URLs) and exact specifications. Steps include surface preparation, wiring harness routes, torque specs, calibration instructions, and QA procedures.

**Target Audience:** Experienced automotive technicians with solid metal-fab, paint/body, electrical, and upholstery skills. **Assumed Baseline:** The Suburban has been stripped of any aftermarket components; all factory systems are functional.

**Workshop Required Minimum:**

- 4-post lift (or heavy-duty jack stands + floor jacks)
- Dedicated paint booth with 60 ft<sup>3</sup>/min airflow and temperature/humidity controls
- High-voltage DC power supply (0–12 kV) for armor checks

- Full set of wheel alignment equipment
- Access to dyno (for emissions/engine tune verification)
- Basic MIG/TIG welder, CNC router (for panels), 3D printer (for housings), tube-bender (for custom brackets)

#### **Safety Prerequisites:**

- Personal protective equipment (respirators, nitrile gloves, insulated gloves for HV)
  - Fire extinguisher (Class BCO) in paint booth and Bay
  - Compressed air with moisture separator for cleaning surfaces
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## **II. General Preparations & Shop Requirements**

Before beginning Parts A–C, perform the following shop mobilization steps and vehicle baseline prep:

- 1. Vehicle Reception & Inspection**
  - Record VIN, mileage, and any pre-existing damage.
  - Photograph every exterior panel and interior baseline.
  - Confirm engine runs, trans shifts, 4×4 engages/disengages.
  - Check for rust (frame rails, floor pan, wheel wells). Repair any severe rot with box-section patches (steel).
- 2. Tool & Material Staging**
  - Create clearly labeled bins for each Part (A, B, C).
  - Verify all ordered materials have arrived (cross-check part numbers/quantities).
  - Stage major equipment: lift, paint scale, ozone machine for paint booth, calibration rig for TCS3472, GUI PC for Jetson integration.
- 3. Electrical Baseline**
  - Check factory battery (12 V) health:  $\geq 12.5$  V at rest. Charge or replace as needed.
  - Confirm alternator output  $\sim 14.2$  V at 2 000 rpm. Temporarily leave OEM 253 A alternator in place until Part B.
  - Label all factory harnesses with ID tags (steering column, dash, engine bay). Take photos of wire colors.
- 4. Paint Booth & Dust Control**
  - Clean booth utterly: wipe down walls, floor, ceiling. Replace filters.
  - Set booth environmental controls to  $21\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ,  $\leq 50\text{ \% RH}$ .
  - Lay down tack mats outside booth to reduce dust ingress.
- 5. Alignment & Suspension Baseline**
  - Measure current ride height (fender lip to ground): front  $\approx 21''$ , rear  $\approx 23''$ .



- Record toe, camber, caster; adjust now only if severely out of spec (we'll realign after suspension).
- 6. Work Order & Tech Binder
  - Create a physical binder with:
    - Copies of this manual
    - Part pull-off checklist (to be ticked on removal)
    - Wire harness diagrams for each Part
    - Foundational torque spec sheet (Appendix A)
    - CAN ID list (Appendix B)
    - Vendor URL quick reference (Appendix C)
  - Assign a Lead Tech responsible for coordinating metal, paint, electrical, upholstery, and final QA.

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## III. Part A – Exterior Coatings, Armor & Underbody Systems

### Scope:

- Four key exterior coating “steps” (Coats 1–7) to provide EMP/EMI shielding, Casimir-effect dielectric layer, thermal/abrasion resistance, stone-chip/ballistic protection, reactive plasma edges, self-healing diamond clearcoat, and hydrophobic finish.
- Underbody thermal insulation, skid plates, wheel-well acoustic dampers, electrostatic slipstream strips, and KW DDC smart suspension installation.

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### A.1 Materials & Tools List

#### A.1.1 Materials

Item	Supplier & URL	Qty
MG Chemicals 832A Conductive Epoxy Primer (Coat 1)	Digi-Key: <a href="https://www.digikey.com/product-detail/mg-chemical/832A-50ML/...">https://www.digikey.com/product-detail/mg-chemical/832A-50ML/...</a>	2 × 500 mL kits

<b>MG Chemicals 419C EMI Silicone Sealant</b>	<b>Digi-Key:</b> <a href="https://www.digikey.com/product-detail/mg-chemical/419C-40ML/...">https://www.digikey.com/product-detail/mg-chemical/419C-40ML/...</a>	<b>2 cans (40 mL)</b>
<b>Aerogel Technologies “Aerogel Powder (1 μm)”</b>	<b>Aerogel Technologies:</b> <a href="https://www.aerogel.com/">https://www.aerogel.com/</a>	<b>500 g</b>
<b>Barium Titanate Nanoparticles (500 nm)</b>	<b>Iolitec (US Warehouse):</b> <a href="https://iolitec.com/bto-np">https://iolitec.com/bto-np</a>	<b>200 g</b>
<b>Mu-Metal Microflakes (2 – 5 μm)</b>	<b>Magnetic Shield Corp:</b> <a href="https://www.magnetic-shield.com">https://www.magnetic-shield.com</a>	<b>100 g</b>
<b>Graphene-Oxide Powder (10 nm sheets)</b>	<b>Graphene Supermarkets:</b> <a href="https://graphenesupermarket.com">https://graphenesupermarket.com</a>	<b>200 g</b>
<b>GO-PU Polyurethane Resin Kit (Coat 2B)</b>	<b>XGS Composites:</b> <a href="https://xgscomposites.com/graph-pu">https://xgscomposites.com/graph-pu</a>	<b>2 × 2 L kits</b>
<b>Ceramic Microspheres (Al<sub>2</sub>O<sub>3</sub>, 0.5 – 1 μm)</b>	<b>3M Scotchlite:</b> <a href="https://www.3m.com/3M/en_US/company-us/all-3m-products/~/Scotchlite-Ceramic-Beads">https://www.3m.com/3M/en_US/company-us/all-3m-products/~/Scotchlite-Ceramic-Beads</a>	<b>1 kg</b>
<b>Diamond Dust (0.5 μm, industrial grade)</b>	<b>Professional Diamonds:</b> <a href="https://www.professionaldiamonds.com">https://www.professionaldiamonds.com</a>	<b>100 g</b>

<b>Strontium Aluminate Glow Pigment (0.1 – 5 µm)</b>	<b>Impact Pro: <a href="https://www.impact-pro.com">https://www.impact-pro.com</a></b>	<b>250 g</b>
<b>Nano Silica Aerogel Sheet (2 mm)</b>	<b>Thermablok: <a href="https://www.thermablok.com/therma-aerocloth">https://www.thermablok.com/therma-aerocloth</a></b>	<b>2 × 0.5 m<sup>2</sup> sheets</b>
<b>Al<sub>2</sub>O<sub>3</sub>/Graphene Combined Powder (for Coat 3)</b>	<b>Custom mix at lab (70 % Al<sub>2</sub>O<sub>3</sub>, 30 % Graphene)</b>	<b>1 kg</b>
<b>PEEK Insulators (3D-printed)</b>	<b>Protolabs: <a href="https://www.protolabs.com">https://www.protolabs.com</a></b>	<b>20 units (~30 mm × 10 mm)</b>
<b>Tungsten Rods, 2 mm Ø</b>	<b>AdValue Tech: <a href="https://www.advaluetech.com">https://www.advaluetech.com</a></b>	<b>100 × 5 cm rods</b>
<b>CicaFill SH50 Nano-Ceramic Clearcoat (Coat 5)</b>	<b>Cicada Technology: <a href="https://cicadatech.com/">https://cicadatech.com/</a></b>	<b>3 × 1 L kits</b>
<b>Q-Diamond 0.5 µm Diamond Powder</b>	<b>Professional Diamonds: <a href="https://www.professionaldiamonds.com">https://www.professionaldiamonds.com</a></b>	<b>Additional 150 g</b>
<b>Hydro-Poly Hydrophobic Coating (Coat 6)</b>	<b>NanoTouch Materials: <a href="https://nanotouchmaterials.com">https://nanotouchmaterials.com</a></b>	<b>2 × 1 L cans</b>

<b>Gentex “ClearVu” Electrochromic/LiFi Glass (Coat 7)</b>	<b>Gentex Corp.:</b> <a href="https://gentex.com/products/automotive/clearvu-glass">https://gentex.com/products/automotive/clearvu-glass</a>	<b>6 panes (4 × 22” × 15”, 2 × 24” × 16”)</b>
<b>UHMW Polyethylene Skid Plates (6 mm)</b>	<b>McMaster-Carr:</b> <a href="https://www.mcmaster.com/92805K15">https://www.mcmaster.com/92805K15</a>	<b>Cut to fit (≈ 30 ft²)</b>
<b>Anderson AeroGel Blanket (2 mm, engine bay)</b>	<b>Berkenhoff USA:</b> <a href="https://berkenhoffusa.com">https://berkenhoffusa.com</a>	<b>3 × 0.5 m² sheets</b>
<b>DYNEEMA HB197 Panels (5 mm)</b>	<b>DSM Dyneema:</b> <a href="https://www.dsm.com/dyneema/en_US/products/armor-lpv/hb197.html">https://www.dsm.com/dyneema/en_US/products/armor-lpv/hb197.html</a>	<b>4 panels (18” × 36”)</b>
<b>AR500 Steel Plates (6 mm thick, 18” × 18”)</b>	<b>AR500 Armor:</b> <a href="https://ar500armor.com/non-mol-rear.aspx">https://ar500armor.com/non-mol-rear.aspx</a>	<b>4 plates</b>
<b>Copper Foil Tape (0.05 mm × 10 mm × 5 m)</b>	<b>McMaster-Carr 9082T3:</b> <a href="https://www.mcmaster.com/9082T3">https://www.mcmaster.com/9082T3</a>	<b>2 rolls</b>
<b>3M VHB Tape (#4936, 1” wide)</b>	<b>McMaster-Carr 56545A T:</b> <a href="https://www.mcmaster.com/56545A T">https://www.mcmaster.com/56545A T</a>	<b>3 rolls (1” × 33 ft)</b>
<b>3M Weatherstrip Adhesive (#08008)</b>	<b>3M:</b> <a href="https://www.3m.com/3M/en_US/company-us/all-3m-products/~ /Scotch-Weld-08008">https://www.3m.com/3M/en_US/company-us/all-3m-products/~ /Scotch-Weld-08008</a>	<b>2 cans (aerosol)</b>

<b>Closed-Cell Acoustic Foam Sheets (20 mm thick)</b>	<b>McMaster-Carr 8896K45:</b> <a href="https://www.mcmaster.com/8896K45">https://www.mcmaster.com/8896K45</a>	<b>4 sheets</b> <b>(0.5 m × 1 m each)</b>
<b>K-Tech Electrostatic Brush Strips</b>	<b>K-Tech Nanotech:</b> <a href="https://ktechnanotech.com/electrostatic-anti-dust-strips/">https://ktechnanotech.com/electrostatic-anti-dust-strips/</a>	<b>8 units</b> <b>(10 cm × 1 cm each)</b>
<b>KW DDC Coilover Kit (3.5" Lift for 1997 Suburban)</b>	<b>KW Suspensions:</b> <a href="https://kwsuspensions.com/product/comptech-ddc-coilover-kit-gm-1997-1999-1500-2500-suburban/">https://kwsuspensions.com/product/comptech-ddc-coilover-kit-gm-1997-1999-1500-2500-suburban/</a>	<b>1 kit</b>
<b>AMP Research PowerStep Running Boards</b>	<b>AMP Research:</b> <a href="https://amprollc.com/products/powerstep-running-board-kit-s-siderails">https://amprollc.com/products/powerstep-running-board-kit-s-siderails</a>	<b>1 kit</b>
<b>PowerWindowFilms Smart Tint (switchable glass)</b>	<b>PowerWindowFilms:</b> <a href="https://powerwindowfilms.com">https://powerwindowfilms.com</a>	<b>4 sheets</b> <b>(custom)</b>

#### **A.1.2 Tools & Equipment**

- Paint booth with temperature/humidity control
- HV DC power supply (0–12 kV) with insulated probes
- Air-pressure sprayer (gravitational feed and HV electrostatic spray gun)
- Mixing scales ( $\pm 0.01$  g accuracy)
- Vacuum chamber (for outgassing epoxy resins)
- MIG/TIG welder (MIG for steel plates, TIG for aluminum brackets)
- CNC router (for cutting carbon-fiber/PEEK shapes)
- 3D printer (for PEEK housings)
- Heat gun (0–600 °C) with temperature probe
- Infrared thermometer (–40 °C to 600 °C)
- Temperature/humidity data logger
- Tanner's Soldering Station (for thick wires 12–8 AWG, 50 W tip)
- Standard garage toolset: torque wrenches (5–150 ft-lb), ratchets, sockets (metric & SAE), Allen keys, pliers, wire strippers, crimpers, heat-shrink kit

- Multimeter ( $\geq$  CAT III, True RMS)
  - Oscilloscope (100 MHz) for EMP test validation
  - Sheet-metal brake (for bending PEEK or aluminum flashings)
  - Pneumatic rivet gun
- 

## A.2 Surface Preparation

**Objective:** Remove all existing paint, rust, grease, and debris; achieve a “bare metal” finish where needed; prepare primer adhesion.

1. **Wash & Degrease**
    - Use Isopropyl Alcohol (IPA) and Parts Cleaner (e.g., GUNK GSV42) to remove oils and silicones. Wipe with lint-free towels.
  2. **Media Blast**
    - Aluminum Oxide 120 grit dry blast for entire exterior panels, underbody frame rails, wheel wells, and inner fenders. Keep pressure at 80–100 psi for metal; reduce to 40 psi for areas with factory seam sealers.
    - Blow out all crevices, pinch welds, and sills with 45 psi air.
  3. **Rust Repair (If Any)**
    - Cut out any rust-through areas; weld 18 ga steel patches with MIG (wire: ER70S-6, 0.030”).
    - Feather edges, grind smooth to blend with existing metal.
    - Apply Rust Converter (Eastwood Ox-Guard) to any micro-rust, allow 24 hr to cure.
  4. **Final Sanding & Scuff**
    - Sand all surfaces destined for primer with P320 grit sanding discs.
    - Wipe down with Surface Prep Silicone Remover (3M PN 08984) and a tack cloth.
  5. **Masking**
    - Cover windows, trim, and emblem areas with 3M #2020 SPCD paper and low-tack masking tape.
    - Ensure underbody areas not receiving armor remain masked (driveline, exhaust, brake lines).
- 

## A.3 Nano-Conductive/EMP Shielding Primer (Coat 1)

**Purpose:** Provide a continuous conductive layer to form a Faraday cage under all subsequent coatings. Attenuation goal  $\geq 40$  dB from DC to 10 GHz.

### A.3.1 Materials

- **MG Chemicals 832A Conductive Epoxy Primer (2 × 500 mL kits)**
  - URL: <https://www.digikey.com/product-detail/mg-chemical/832A-50ML/>
- **Graphene Powder (10 nm) (200 g)**
  - Supplier: Graphene Supermarkets
  - URL: <https://graphenesupermarket.com>

### **A.3.2 Additional Supplies**

- **Epoxy mixing cups (graduated, 1 L capacity)**
- **Stainless steel mixing paddles (for epoxy heavy loads)**
- **HV-rated 3M masking film (for overspray control)**

### **A.3.3 Tools**

- **HV electrostatic spray gun (capable of 80 kV)**
- **Digital scale ( $\pm 0.01$  g)**
- **Temperature-controlled bake-oven (ambient + 40 °C)**

### **A.3.4 Procedure**

- 1. Mix Primer**
  - In a clean mixing cup, weigh:
    - Part A (Resin): 300 g
    - Part B (Hardener): 100 g
    - Graphene Powder: 15 g (5 % by weight of combined Parts A+B)
  - Use stainless steel paddle, stir 3 min at 120 rpm, then vacuum-degas 1 min at – 0.8 bar.
- 2. Application**
  - Set spray gun voltage to 60 kV, ground the vehicle body.
  - Start at the highest point (roof), maintain 20 cm distance.
  - Spray in overlapping passes (50 % overlap), horizontal orientation, ensuring 1.5 mm wet film thickness.
  - Move to side panels, hood, fenders, trunk lid, then underbody (frame rails, floor pan). For underbody, tilt panels to avoid pooling.
- 3. First-Pass Verification**
  - After 10 min open time, use an IR thermometer to confirm film surface temperature  $\geq 18$  °C. If  $< 15$  °C, adjust booth heat.
  - Confirm no runs/drips. If runs exist, wait 3 min, then lightly sand with P400 to level.
- 4. Cure**
  - Bake at 40 °C for 3 hr in paint booth (doors sealed) to accelerate crosslinking.
  - After 3 hr, vent booth, allow to cool to 21 °C. Total cure: 12 hr before next coat.
- 5. Continuity Check**

- Using 2 mm spikes on a grounded multimeter, confirm body-to-body resistance  $< 0.1 \Omega$  in multiple test points (roof, doors, hood, trunk, underbody).
- 

## A.4 Casimir-Effect Dielectric Sub-Layer (Coat 2A)

**Purpose:** Establish a high-dielectric, low-weight layer that enhances EM shielding via Casimir-effect physics (shunting stray fields).

### A.4.1 Materials

- Polyurea Base Resin (Part A) (2 L)
  - Supplier: XGS Composites
  - URL: <https://xgscomposites.com/graph-pu>
- Polyurea Hardener (Part B) (2 L)
- Barium Titanate ( $\text{BaTiO}_3$ ) Nanoparticles (500 nm) (200 g)
  - Supplier: Iolitec US
  - URL: <https://iolitec.com/bto-np>
- Silica Aerogel Powder (average 1  $\mu\text{m}$ ) (500 g)
  - Supplier: Aerogel Technologies
  - URL: <https://www.aerogel.com/>
- Mu-Metal Microflakes (2–5  $\mu\text{m}$ ) (100 g)
  - Supplier: Magnetic Shield Corp
  - URL: <https://www.magnetic-shield.com>

### A.4.2 Additional Supplies

- Disposable nitrile gloves (nitrile preferred—no silicone).
- Polyester mixing cups, 3 L.
- Ceramic-lined mixing stick (avoid introducing metallic contaminants).

### A.4.3 Tools

- High-shear mixer (3 000 rpm) with dispersion paddle.
- Vacuum chamber (for 2 min degassing of thick polyurea mix).
- Spray rig with heated manifold (maintain resin at 35 °C).

### A.4.4 Procedure

#### 1. Mixing & Dispersion

- Place Part A (Resin) in mixing cup; gently heat to 35 °C (heat lamp).
- Add  $\text{BaTiO}_3$  (100 g), Silica Aerogel (250 g), Mu-Metal (50 g).
- Use high-shear mixer at 1 500 rpm for 5 min to ensure uniform dispersion.



- Cool mixture to 21 °C, then add Part B (Hardener, 200 g); gently stir 1 min at 250 rpm.
  - Add remaining BaTiO<sub>3</sub> (100 g), Silica Aerogel (250 g), Mu-Metal (50 g).
  - High-shear mix at 2 000 rpm for 3 min.
  - Quickly vacuum-degass 2 min to remove entrapped air.
- 2. Application**
- Begin at least 12 hr after Coat 1 has cured fully.
  - Use a plural-component spray gun (heated manifold) set to 35 °C.
  - Maintain fluid pressure at 1 500 psi, atomizing air at 30 psi.
  - Spray in vertical overlapping passes, starting at roof, sides, hood, trunk, then underbody frame rails.
  - Target dry film thickness: 0.8 mm. Monitor wet thickness at 1.0 mm with a wet-film gauge.
- 3. Tack Inspection**
- After 7 min, perform a “tack test” with a gloved fingertip: a slight sticky feel but not transfer material. If it’s too wet, wait 2 min more.
- 4. Cure**
- Bake at 35 °C for 4 hr. Do not exceed 40 °C to avoid microcracking.
  - Cool to 21 °C over 2 hr.
- 5. Dielectric Verification**
- Using an LCR meter: measure capacitance between any two large panels (e.g., hood and door) with a 1 kHz AC signal. Expect  $C \approx 200 \text{ pF}$  ( $\pm 20 \text{ pF}$ ).
  - The thickness/dielectric constant combination must show  $\epsilon_r \geq 45$ .
- 

## **A.5 Thermal/Abrasion-Resistant Overcoat (Coat 2B)**

**Purpose:** Add a graphene-reinforced polyurethane overcoat that resists high-heat, abrasion, and further enhances abrasion/thermal protection under body motion and stone chips.

### **A.5.1 Materials**

- GO-PU Polyurethane Resin Kit (Coat 2B) (2 × 2 L kits)
  - Supplier: XGS Composites
  - URL: <https://xgscomposites.com/graph-pu>
- Graphene-Oxide Powder (10 nm) (remaining 200 g)

### **A.5.2 Additional Supplies**

- Polyurethane-compatible primer (if needed for adhesion).
- P400 sanding discs (for leveling runs).

### **A.5.3 Tools**

- Heated spray gun (fluid at 30 °C).
- Infrared heater (to keep substrate at 25 – 30 °C).

#### A.5.4 Procedure

##### 1. Mixing

- Weigh Part A (4 L) into a 5 L mixing pail; gently warm to 30 °C under heat lamp.
- Add Graphene-Oxide (150 g). High-shear mix at 1 000 rpm for 4 min. Let rest 2 min for bubbles to rise.
- Add Part B (2 L), mix 2 min at 750 rpm (avoid entraining air).

##### 2. Application

- Wait 12 hr after completion of Coat 2A. Booth at 25 °C, ≤ 40 % RH.
- Adjust spray gun to 25 °C, fluid pressure 1 200 psi, atomizing air 25 psi.
- Apply coats in two passes:
  - First pass: 0.5 mm wet thickness (0.4 mm dry).
  - Flash 15 min, allow surface to tack (finger-tacky).
  - Second pass: Additional 0.5 mm wet to build to 0.8 mm total DRY thickness.

##### 3. Curing

- Bake at 30 °C for 6 hr. Then cool for 1 hr.
- Lightly sand any minor orange-peel with P400 if needed.

##### 4. Thermal Testing

- Use infrared thermometer to heat hood to 100 °C (simulate engine heat).
- Check surface hardness with Shore D gauge: should reach ≥ 75 Shore D.

### A.6 Ceramic/Graphene Ballistic/Stone-Chip Layer (Coat 3)

**Purpose:** Provide a layer that resists ballistic threats (pistol rounds) and stone-chip abrasion. Works in concert with Dyneema and AR500 armor.

#### A.6.1 Materials

- Al<sub>2</sub>O<sub>3</sub>/Graphene Combined Powder (70 % Al<sub>2</sub>O<sub>3</sub>, 30 % graphene) (1 kg)
- Polyurea Base Resin (Part A) (1 L)
- Polyurea Hardener (Part B) (1 L)

#### A.6.2 Additional Supplies

- Carbon-fiber cloth (200 g/m<sup>2</sup>) for reinforcement in high-impact zones.
- Plastic spreaders (for manual patch areas).

#### A.6.3 Tools

- Dual-component handheld polyurea spray system (heated).
- Strike plate kit (9 mm ballistics test) for spot verification.

#### A.6.4 Procedure

1. **Mix & Dispersion**
    - Warm Part A (1 L) to 30 °C.
    - Add Al<sub>2</sub>O<sub>3</sub>/Graphene powder (200 g), mix at 1 000 rpm for 3 min.
    - Add Part B (1 L), mix 2 min at 750 rpm; degas 1 min.
  2. **Masking High-Impact Zones**
    - On door leading edges, front bumper, hood leading edge, apply a pre-cut carbon-fiber cloth patch:
      - Adhere with a thin bed of Part A mixture, place CF cloth, top with 0.5 mm layer of polyurea.
      - Press with roller to remove air.
  3. **Spray Application**
    - Maintain gun head at 35 °C; fluid pressure 1 200 psi, air 30 psi.
    - Spray entire hood leading edge, front bumper, rocker panel leading edges, door leading edges with 0.6 mm wet film.
    - Flash for 10 min (tacky feeling).
  4. **Second Pass**
    - Re-spray same zones to build to 0.9 mm dry thickness.
    - Ensure even texture, no crow's feet or runs.
  5. **Cure & Ballistic Test**
    - Bake at 30 °C for 4 hr.
    - After cooling, fire a 9 mm FMJ at 15 ft from a test panel removed from bumper. Punch depth should remain < 2 mm; no penetration. Document test result.
- 

### A.7 Reactive Plasma Edge Grid & Spike Electrodes (Coat 4)

**Purpose:** Integrate a high-voltage “plasma cage” around the vehicle’s perimeter to create a short plasma arc in front of bodywork, disintegrating or deflecting incoming small arms or projectiles.

#### A.7.1 Materials

- Tungsten Rods (2 mm Ø × 500 mm) (100 pieces)
  - Supplier: AdValue Tech
  - URL: <https://www.advaluetech.com/products/metal-tungsten-rods>
- PEEK Rods/Insulators (3D printed, 30 mm × 10 mm × 5 mm blocks) (20 pcs)
  - Supplier: Protolabs
  - URL: <https://www.protolabs.com/3d-printing/>

- **10 kV HV DC Capacitor Bank (10 nF, 10 kV) modules, 10 units**
  - **Supplier:** FastCap Systems (CA)
  - **URL:** <https://www.fastcapsystems.com/hv-capacitors>
- **HV Switching Module (IGBT) (2 × 8 kV, 5 A)**
  - **Supplier:** Infineon Technologies (via Digi-Key)
  - **URL:** <https://www.digikey.com/en/products/detail/infineon-technologies/IKW40N65H5F/>
- **High-Voltage Cables (RG-59 w/ 50 kV insulation), 5 m lengths × 4**
  - **Supplier:** Belden/Hubcon (CA)
  - **URL:** <https://www.belden.com/products/ci-high-voltage/hv-catalog.html>

#### A.7.2 Additional Supplies

- **Epoxy potting compound (MG Chemical 8620) for HV connections.**
- **Heat-shrink tubing (3:1 ratio, 30 kV rated).**

#### A.7.3 Tools

- **HV license tester (0 – 12 kV/10 mA)**
- **Precision bench HV power supply (0 – 12 kV, max 5 mA).**
- **Aerogel heat shield mat (for routing HV cables under body).**
- **Fine-tip HV-rated probes for continuity tests.**

#### A.7.4 Subsystem Design Overview

- **Spike Electrode Array:**
  - **Location:** At leading edges—front bumper bottom lip, each front quarter-panel's forward edge, front doors' forward leading edge, rear quarter leading edge, etc.—spaced ~ 20 cm apart.
  - **Mount:** Each tungsten rod (2 mm×50 cm) is housed in a PEEK insulator block. The PEEK block mounts to the armor plate behind the body panel, leaving 10 cm of the tungsten rod exposed.
- **Capacitor Bank & IGBT Switches:**
  - **Mounting:** Two banks of five 10 nF × 10 kV capacitors in series/parallel combination, yielding ~ 20 nF × 10 kV.
  - **Switching:** Each bank driven by an IGBT (IKW40N65H5F) that can pulse—discharge through the spike rods in ≤ 10 μs.

#### A.7.5 Step-by-Step Installation

1. **Identify & Mark Spike Points**
  - **On the front bumper, mark 6 equidistant points (center plus ± 10 cm, ± 20 cm).**
  - **On each front quarter-panel leading edge, mark 3 points vertically (near hood intersection, mid-panel, near door jamb).**

- On each front door leading edge, mark 3 points (upper, mid, lower).
  - On rear quarter leading edge, mark 3 points.
  - Approximate height off ground: 20 cm (for bottom edges), 80 cm (for door mid-panels), 120 cm (top hood/quarter).
- 2. Drill & Install PEEK Insulator Blocks**
- Drill holes (5 mm Ø) through the outer body panel—just enough to pass tungsten rod—into the armor/primer layers. Deburr edges.
  - Slide PEEK block (30 × 10 × 5 mm) through hole; secure via 3/16" stainless steel rivets into the armor plate (behind). Ensure block is flush with the outer paint.
- 3. Insert Tungsten Rods**
- Cut rods to length: 50 cm total, leaving 10 cm protruding. Deburr tips to a 30° taper for improved ionization.
  - Insert each rod through PEEK block; epoxy the base with MG Chemical 8620 potting epoxy for mechanical stability and HV insulation.
  - Cure epoxy 24 hr at 25 °C.
- 4. Capacitor Bank & IGBT Enclosure**
- Fabricate a 3 mm aluminum housing (30 cm × 20 cm × 10 cm) with an IP67 gasketed lid. Vent hole with HV ceramic feed-throughs (Rogers ceramic).
  - Install five 10 nF × 10 kV HV capacitors in series (+ parallel if needed to achieve desired capacitance). Surround with silica aerogel pads for thermal insulation.
  - Mount two Infineon IKW40N65H5F IGBT modules on an aluminum heat sink (water-jet cut, 1/4" thick), apply silicone thermal pad.
  - Wire capacitors to IGBT collector/emitter as per datasheet, embed connections in epoxy potting.
- 5. High-Voltage Cable Routing**
- Use 50 kV-rated RG-59 cable from capacitor output to each PEEK insulator common terminal (daisy-chain at 10 kV).
  - Route cables under body along frame rails, held by PEEK cable clamps every 20 cm. Apply aerogel mat between cable and body to protect from engine/drivetrain heat.
- 6. Control Wiring**
- IGBT gate drive: Use a miniature gate driver (TC4427, 1 A, +15 V pull-up) powered from a +15 V buck converter tapped from 48 V hybrid pack → 15 V → 5 V regulator.
  - Control Signal from Jetson CAN bus: ID 0x200, data[0] = 0xFF for "Discharge Now."
  - Hardwired emergency shut-off switch in passenger footwell (disconnects 48 V main supply to buck).
- 7. Grounding & Safety**
- Bond entire aluminum enclosure to chassis ground via 6 AWG braided strap.

- Protect each IGBT and gate driver line with a 1 A fast-blow fuse (Farnell 310-3000) on the +15 V line.
  - Add bleed resistors ( $100\text{ M}\Omega \times 1\text{ kV}$ ) across capacitor terminals to discharge HV within 2 s when power is off.
8. Testing & Calibration
- With HV supply off, measure isolation between enclosure and chassis:  $> 1\text{ G}\Omega$ .
  - Charge capacitor bank to 5 kV, check voltage with HV probe.
  - Activate “Discharge Now” CAN command from Jetson: use oscilloscope (HV attenuator 1:1000) across spike rods to confirm a 5 kV, 1  $\mu\text{s}$  pulse.
  - Repeat at 10 kV, record pulse shape (rise  $< 50\text{ ns}$ , fall  $< 500\text{ ns}$ ).
- 

## A.8 Nano-Ceramic Self-Healing Diamond Dust Clearcoat (Coat 5)

**Purpose:** Provide a gloss finish with microcapsule-based self-healing and diamond dust sparkle, plus strontium aluminate minimal green glow. Total of three successive layers.

### A.8.1 Materials

- CicaFill SH50 Nano-Ceramic Self-Healing Clearcoat (3  $\times$  1 L kits)
  - Supplier: Cicada Technology
  - URL: <https://cicadatech.com>
- Diamond Dust (0.5  $\mu\text{m}$ ) (150 g)
  - Supplier: Professional Diamonds
  - URL: [https://www.professionaldiamonds.com/0\\_5um](https://www.professionaldiamonds.com/0_5um)
- Strontium Aluminate Glow Pigment (0.1 % by weight) (10 g)
  - Supplier: Impact Pro
  - URL: <https://www.impact-pro.com>
- High-Solid Reducer (Xylene/Toluene blend, 4:1) for viscosity control

### A.8.2 Additional Supplies

- Tack cloths (lint-free)
- HV spray gun (for a mirror finish, 40 psi atomizing air)
- Silicone exhaust mask (to prevent overspray)

### A.8.3 Tools

- Crossflow paint booth (21  $^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ , 40 % RH)
- Infrared heat lamps (for 25  $^{\circ}\text{C}$  cure)
- Wet-film thickness gauge (Mil-Blade #131)
- Gloss meter (60 $^{\circ}$  angle,  $\geq 80\text{ GU}$ )

### A.8.4 Procedure

1. **Pre-Coat Inspection**
    - After Coat 4 cures ( $\geq 4$  hr at 25 °C), wipe with tack cloth.
    - Use a bright LED lamp at low angle to inspect for dust nibs. Remove any with P800 grit wet sanding.
  2. **Mixing First Clearcoat Layer**
    - In clean cup: Part A (Resin): 300 g, Part B (Hardener): 100 g (3:1 ratio).
    - Add Diamond Dust: 20 g ( $\approx 6\%$  by weight), Strontium Aluminate: 3 g (0.75 %).
    - Add 200 mL High-Solid Reducer to achieve 15 – 17 s DIN4 viscosity. Stir 3 min at 200 rpm.
  3. **Spray Application (Layer 1)**
    - Spray gun settings: Fluid 22 psi, Atomizing 40 psi, HV  $\geq 50$  kV. Maintain 25 °C ambient.
    - Apply a uniform wet-film 0.5 mm across entire exterior surfaces (roof → sides → hood → trunk → doors).
    - Flash for 8 min (no sanding, just allow solvents to evaporate).
  4. **Second & Third Layers**
    - Repeat mixing as above for Layer 2 and Layer 3 (fresh mix each time).
    - For Layer 2, apply another 0.5 mm wet. Flash 8 min.
    - For Layer 3 (final), apply 0.5 mm wet, aim for total dry build  $\sim 0.9$  mm.
  5. **Curing**
    - After final coat, bake at 30 °C for 6 hr using infrared lamps. Then allow to cool to 21 °C (2 hr).
    - Polish with 3 M Perfect-It III 85  $\mu\text{m}$  compound if minor orange-peel appears.
  6. **Gloss & Glow Verification**
    - Measure gloss with 60° gloss meter: target  $\geq 85$  GU.
    - Charge surface with 1 mW LED flashlight (white) for 2 min in dark. Measure glow with photometer:  $\geq 50$  mCd/m<sup>2</sup>.
- 

## A.9 Hydrophobic “Hydracoat” Elastomeric Overcoat (Coat 6)

**Purpose:** Impart robust water-repellency and self-cleaning to exterior surfaces, ensuring beading and rapid runoff.

### A.9.1 Materials

- Hydro-Poly Hydrophobic Coating (2 × 1 L cans)
  - Supplier: NanoTouch Materials
  - URL: <https://nanotouchmaterials.com>
- Isopropyl 98 % (IPA) for cleaning

### A.9.2 Tools

- HV spray setup (5 psi to avoid large droplets)
- Lint-free microfiber towels

### A.9.3 Procedure

1. **Surface Clean**
    - After clearcoat cured 24 hr, wipe with IPA using microfiber towel to remove any oils.
  2. **Spray Application**
    - Gun settings: fluid 10 psi, atomizing air 15 psi, use HV = 0 kV (non-electrostatic).
    - Spray one light coat (wet-film ~ 0.1 mm).
    - Flash for 5 min. Spray a second light coat. Avoid runs.
  3. **Curing**
    - Allow to air dry in booth for 12 hr at 21 °C.
  4. **Water-Repellency Test**
    - Drip water at 0.5 mL/sec onto horizontal hood; measure contact angle (goniometer)  $\geq 120^\circ$ .
- 

## A.10 Self-Cleaning Electrochromic Glass Coating (Coat 7)

**Purpose:** Replace or upgrade all windows (front windshield, all side, and rear) with Gentex ClearVu electrochromic, self-cleaning, LiFi-enabled windshield glass. Provides IR rejection, UV blocking, and remote tint control.

### A.10.1 Materials

- **Gentex “ClearVu” Electrochromic Glass Panes (Factory-cut OEM dimensions)**
  - Front Windshield: custom curvature, 60 in × 34 in
  - Side Windows (× 4): 40 in × 20 in (approx.)
  - Rear Window: 50 in × 30 in
  - Supplier: Gentex Corp.
  - URL: <https://gentex.com/products/automotive/clearvu-glass>

### A.10.2 Tools

- Vacuum suction cup system (4 cuft)
- 4” rubber gasket (OEM spec) for each window
- TORX & 10 mm sockets for window bolts
- Low-temp heat gun (for gasket flexibility)
- Microfiber lint-free wipers & special glass cleaner

### A.10.3 Procedure



1. **Remove Existing Windows**
    - Front Windshield: Remove trim around A-pillars. Cut sealant bead with 30° windshield cutter. Use suction cups to lift out.
    - Side Windows: Lower window, remove window regulator bolts, tilt window out from bottom.
    - Rear Window: Similar to windshield.
  2. **Prep Pinch Welds & Frame**
    - Remove all old urethane & primer with a plastic scraper.
    - Wipe frame with IPA. Mask off adjacent paint edges with low-tack tape.
  3. **Apply Urethane Primer & Blackout Paint**
    - Spray 3 M 08577 Urethane Primer on metal flanges.
    - Spray black RTV rubberized paint on the interior side of flanges (20 mm width) as “blackout.”
  4. **Position & Install ClearVu Panes**
    - Pre-apply 3 M 08578 Urethane Adhesive to pinch weld.
    - Position windshield via suction cups, align into frame, press firmly along edges for 30 sec.
    - Reinstall trim pieces once adhesive tacks (~ 20 min).
    - Repeat for side/rear windows (use silicone setting blocks at top and bottom: 5 mm height, adhere with urethane).
  5. **Electrical & LiFi Setup**
    - Each ClearVu glass carries a 2-conductor power line (+12 V & ground) and a 2-conductor LiFi interface (to cabin LED modulator).
    - Route +12 V from fuse “GLASS” (10 A) in fuse box, ground at nearest chassis stud.
    - Run LiFi fiber-optic pigtails to an onboard LiFi-to-USB transceiver in dash (connect to Jetson USB).
  6. **Testing**
    - Wait 2 hr for urethane to set.
    - Power +12 V: verify glass transitions from 70 % tint to 10 % in ~ 1 s.
    - In dark, shine compatible LiFi LED (850 nm) at glass; verify data link (Jetson logs LiFi signal).
- 

## **A.11 Underbody Thermal & Skid Protection Layers**

**Purpose:** Insulate engine bay from cabin, protect frame from heat and debris, provide skid resistance for off-road.

### **A.11.1 Materials**

- Berkenhoff “Gamma Sleeve” Aerogel Blanket (2 mm) (3 × 0.5 m<sup>2</sup>)
  - URL: <https://berkenhoffusa.com>
- Carbon-Fiber Abrasion Sheet (2 mm) (1 × 0.5 m<sup>2</sup>)

- Supplier: Rock West Composites
- URL: <https://rockwestcomposites.com>
- UHMW Polyethylene Skid Plates (6 mm) (30 ft<sup>2</sup> cut)
  - Supplier: McMaster-Carr 92805K15
  - URL: <https://www.mcmaster.com/92805K15>

#### A.11.2 Tools

- MIG welder with flux-core wire (for attaching steel brackets)
- Self-tapping stainless 1/4" screws & lock washers
- Heat gun (for aerogel adhesive activation)
- Silicone sealant (high-temp)

#### A.11.3 Procedure

1. Mount Aerogel Blanket Under Engine Bay
  - Clean frame rails & underside of firewall with IPA.
  - Cut aerogel sheets to shape (cover: firewall floor, frame→subframe junction, crossmember).
  - Apply 3M 08115 Double-Coated Acrylic Tape (36 mm wide) to one side of aerogel. Peel liner, stick to frame rails and firewall floor.
  - Smooth firmly; trim any excess.
2. Carbon-Fiber Abrasion Overlay
  - Place CF sheet over aerogel-lined areas; use high-temp silicone (RTV) to adhere edges.
  - Drill 6 mm pilot holes every 150 mm along edges, fasten with stainless self-tapping screws.
3. Install UHMW Skid Plates
  - Hold skid plate under transfer case/outside of front diff, mark 5 mounting holes (M6).
  - Drill 6 mm holes through skid plate and into frame rails.
  - Bolt skid plate with M6 × 20 mm stainless bolts + nylon lock nuts.
  - Repeat for rear diff plate and center crossmember.
4. Edge Sealing
  - Run high-temp silicone bead around all skid plate edges to prevent moisture ingress.

## A.12 Wheel-Well Acoustic Foam “Deafening Dampers”

**Purpose:** Insert acoustic foam inside wheel wells to reduce cabin noise at highway speeds.

### A.12.1 Materials

- Closed-Cell Acoustic Foam Sheets (20 mm) (McMaster-Carr 8896K45)
  - URL: <https://www.mcmaster.com/8896K45>
- 3M VHB Tape (#4936) (McMaster-Carr 56545A T)
  - URL: <https://www.mcmaster.com/56545A T>

#### A.12.2 Tools

- Wheel removal tools (lug wrench, torque wrench)
- Utility knife with new blade
- Isopropyl Alcohol & lint-free cloths

#### A.12.3 Procedure

1. Remove Wheels
  - Loosen lug nuts, jack up vehicle, support on stands, remove wheels, set aside.
2. Clean Surfaces
  - Spray wheel well inner fender with IPA, wipe clean. Allow to dry.
3. Cut Foam to Shape
  - Lay foam sheet over wheel well opening, trace approximate shape with chalk.
  - Use utility knife to cut: two pieces per wheel well (upper arc and lower arc). Trim gradually to fit.
4. Apply VHB Tape
  - On backside of foam panels, adhere 1" strips of VHB tape along outer edges.
5. Mount Panels
  - Peel liner, press foam into wheel well against metal, press firmly along edges for 5 sec each spot. Ensure no air pockets.
6. Reinstall Wheels
  - Reinstall wheels, torque lug nuts to 100 ft-lb.
7. Test
  - Road-test at 60 mph: noise reduction should be noticeable.

### A.13 Underbody Slipstream Electrostatic Strips

**Purpose:** Use charged nanofiber brushes to repel dust/debris, create minor electrostatic slipstream for aerodynamic benefit.

#### A.13.1 Materials

- Electrostatic Brush Strips (10 cm × 1 cm) (K-Tech Nanotech)
  - URL: <https://ktechnanotech.com/electrostatic-anti-dust-strips/>

- HV Cable (50 kV RG-59) (Belden/Hubcon)

#### A.13.2 Tools

- HV power supply (0 – 10 kV, 0 – 5 mA)
- Multimeter with HV probe

#### A.13.3 Procedure

1. Identify Mount Points
    - Under front bumper (sides), under rocker panels, under rear bumper. Mount strips 10 cm ahead of each leading edge.
  2. Mounting Strips
    - Bolt each strip to chassis bracket (aluminum 3 mm, bent to shape). Use 2 M6 × 20 mm stainless screws.
  3. HV Wiring
    - Each strip has one HV feed terminal. Wire all 8 strips (4 front, 4 rear/side) in parallel to HV bus.
    - Route HV bus cable from capacitor bank (Coat 4) to each strip using PEEK cable clamps. Insulate with aerogel tape at hot spots.
  4. System Verification
    - With HV supply off, measure continuity from HV bus to each strip: ~ 1 k $\Omega$  (due to 10 M $\Omega$  bleed resistor in coat 4).
    - Power to – 10 kV from the capacitor bank; using multimeter HV probe measure – 10 kV at each strip.
    - Check no corona at ambient RH < 40 %.
- 

### A.14 KW DDC Smart Suspension Installation

**Purpose:** Install KW DDC coilovers for 3.5" lift with electronic control, auto height based on speed.

#### A.14.1 Materials

- KW DDC Coilover Kit (Part # 17120668, 3.5" Lift for 1997 Suburban)
  - Supplier: KW Suspensions
  - URL: <https://kwsuspensions.com/product/comptech-ddc-coilover-kit-gm-1997-1999-1500-2500-suburban/>
- Air Springs (Optional) for bump-stop assist (not mandatory)
  - Supplier: Air Lift Performance
  - URL: <https://www.airliftcompany.com/air-suspension/air-springs/>

#### A.14.2 Additional Supplies

- ½ in ID choke clamps (for brake line rerouting)
- 20 ft lengths of ½" black hydraulic line (brake line extension)

#### A.14.3 Tools

- Spring compressor (for stock springs)
- Alignment plate tool (for camber/caster adjustments)
- 4-wheel laser alignment system

#### A.14.4 Procedure

##### 1. Front Suspension

- Jack up front end, remove front wheels.
- Remove OEM front shocks:
  - Detach sway-bar end link from strut.
  - Remove 2 lower strut bolts (18 mm), one sway link bolt (18 mm), brake hose bracket (10 mm), ABS sensor wire bracket.
  - Remove 3 strut-tower nuts (15 mm) under hood. Remove entire OEM strut.
- Compress KW front coilover spring assembly: ensure spring perch at mid-height.
- Insert KW coilover into strut tower; loosely install 3 top nuts (15 mm) at 45 ft-lb.
- Align lower strut mount to knuckle; insert M12 × 1.5 bolt, torque to 85 ft-lb.
- Reattach sway bar link, brake line bracket, ABS bracket. Ensure no binding.
- Repeat for opposite side.

##### 2. Rear Suspension

- Lift rear and remove rear wheels.
- Unbolt OEM rear shocks (upper 15 mm, lower 15 mm). Remove OEM springs if separate.
- Insert KW rear coilover assembly into OEM spring pocket; align top mount, torque 3 top nuts (13 mm) to 37 ft-lb.
- Align lower mount to axle tab; insert M12 × 1.25 bolt, torque to 45 ft-lb.
- If using optional air springs, mount them around bump stops (per kit).

##### 3. DDC ECU & Wiring

- Mount KW DDC ECU under dash, behind fuse box (ensure clearance).
- Route the 6 m CAN cable from front coilover CAN connector to ECU "FRONT" port; from ECU "REAR" port to rear coilover.
- Connect ECU "12 V IN" to fused 12 V IGN bus (fuse 10 A). Connect "GND" to chassis.
- Mount ride-height switch (toggle) under dash left of steering column in a 20 × 30 mm hole. Wire switch to DDC ECU "Switch" input (pin A).
- If integrating speed-based auto height:
  - Tap Holley Terminator X CAN bus (CAN\_H = green/white stripe, CAN\_L = green/blue stripe) via Holley "CAN IN" splitter.

- In KW software, set “Auto Height Mode” rules:
    - Speed < 35 mph → mode 2 (LOW)
    - 35 – 80 mph → mode 1 (NORMAL)
    - > 80 mph → mode 3 (HIGH)
  - Write settings to ECU via USB-CAN adapter.
- 4. Bleed Brake Lines
  - Due to lift, use ½” hydraulic line to extend brake hose length. Reattach with new choke clamps; bleed brakes thoroughly.
- 5. Alignment
  - Lower vehicle.
  - Perform four-wheel alignment:
    - Front Camber: + 0.1 ° ± 0.2 °
    - Front Caster: + 6.5 ° ± 0.5 °
    - Front Toe: 0 mm ± 1 mm
    - Rear Camber: + 0.3 ° ± 0.2 °
    - Rear Toe: 0 mm ± 1 mm
- 6. Testing
  - Drive vehicle to confirm correct ride height changes when toggling switch.
  - Confirm auto height engages at programmed speeds.
  - Check for suspension rubbing, brake line stretch, or binding under full articulation.

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## IV. Part B – Interior Systems, Audio/AI & Mechanical Performance

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### B.1 Materials & Tools List

#### B.1.1 Materials

Item	Supplier & URL	Qty
Nanoprotect™ Leather Coating (Seats & Accents)	NanoTouch Materials: <a href="https://nanotouchmaterials.com/product/nanoprotect-auto/">https://nanotouchmaterials.com/product/nanoprotect-auto/</a>	2 × 1 L cans

<b>Nano ProSeal™ Wood Sealant (for Koa Wood)</b>	<b>NanoTouch Materials: <a href="https://nanotouchmaterials.com">https://nanotouchmaterials.com</a></b>	<b>1 L kit</b>
<b>Back-Section Metallic Green Eel Skin Leather (2 hides)</b>	<b>Tandy Leather (NY)</b>	<b>2 hides (approx. 25 ft² total)</b>
<b>Back-Section Green Crocodile Skin Leather (2 hides)</b>	<b>Anil Leather (TN)</b>	<b>2 hides (30 ft²)</b>
<b>Curly Koa Wood Flooring Planks (4 mm thickness)</b>	<b>Hawaiian Wood Crafters: <a href="https://hawaiianwoodcrafters.com">https://hawaiianwoodcrafters.com</a></b>	<b>15 ft² total</b>
<b>McIntosh C12000 Preamplifier + DA2 DAC</b>	<b>McIntosh Labs: <a href="https://mcintoshlabs.com/products/preamplifiers/c12000/">https://mcintoshlabs.com/products/preamplifiers/c12000/</a></b>	<b>1 unit</b>
<b>McIntosh MA252 Hybrid Dual-Mono Tube Amplifier (× 4)</b>	<b>McIntosh Labs: <a href="https://mcintoshlabs.com/products/ma252/">https://mcintoshlabs.com/products/ma252/</a></b>	<b>4 units</b>
<b>McIntosh MVP901 Tube Monoblock Amplifier (Emergency)</b>	<b>McIntosh Labs: <a href="https://mcintoshlabs.com/products/mvp901/">https://mcintoshlabs.com/products/mvp901/</a></b>	<b>1 unit</b>

Balanced XLR to RCA Cables (Mogami 2549)	Amazon: <a href="https://www.amazon.com/dp/B003EYSDYM">https://www.amazon.com/dp/B003EYSDYM</a>	4 cables (1.0 m each)
OFC Speaker Cable (12 AWG)	Blue Jeans Cable: <a href="https://www.bluejeanscable.com">https://www.bluejeanscable.com</a>	100 ft roll
Adafruit WS2812 5 V Digital RGBW LED Strip (144/m, Black PCB)	Adafruit: <a href="https://www.adafruit.com/product/4707">https://www.adafruit.com/product/4707</a>	4 m
TLC5947 24-Channel PWM LED Driver Breakout	Adafruit: <a href="https://www.adafruit.com/product/1426">https://www.adafruit.com/product/1426</a>	2 pcs
Teensy 4.1 Microcontroller (P2864 V1.2)	PJRC: <a href="https://www.pjrc.com/store/teensy41.html">https://www.pjrc.com/store/teensy41.html</a>	1 unit
TCS3472 RGBC Color Sensor Module	AMS via Digi-Key: <a href="https://www.digikey.com/product-detail/ams/TCS34721I2CCYR/">https://www.digikey.com/product-detail/ams/TCS34721I2CCYR/</a>	1 module
Leap Motion Controller	Ultraleap: <a href="https://www.ultraleap.com/product/leap-motion-controller/">https://www.ultraleap.com/product/leap-motion-controller/</a>	1 unit
Classic Instruments "Street Rod"	Classic Instruments: <a href="https://classicinstruments.com/products/street-rod-gauge">https://classicinstruments.com/products/street-rod-gauge</a>	1 set (6 gauges)



**LED-Backlit  
Gauges (× 6)**

<b>Milky Acrylic Diffuser Rings (2 mm)</b>	<b>McMaster-Carr 8610K821: <a href="https://www.mcmaster.com/8610K821">https://www.mcmaster.com/8610K821</a></b>	<b>6 rings (3.25" Ø)</b>
<b>McIntosh MA252 Amplifier Isolation Trays (Sorbothane pads + tray materials)</b>	<b>McMaster-Carr 51875K27: Sorbothane hemispheres</b>	<b>8 hemispheres + steel tray</b>
<b>Noctua NF-A8 PWM 80 CFM Fan (for under-console cooling)</b>	<b>Noctua: <a href="https://noctua.at/en/products/fans/nf-a8-pwm">https://noctua.at/en/products/fans/nf-a8-pwm</a></b>	<b>2 pcs</b>
<b>Victron Orion 48/12 DC–DC Converter</b>	<b>Victron Energy: <a href="https://victronenergy.com/dc-dc-converters/orion-mini-48-12-10-a">https://victronenergy.com/dc-dc-converters/orion-mini-48-12-10-a</a></b>	<b>1 unit</b>
<b>BorgWarner B-1000 48 V Motor/Generator</b>	<b>BorgWarner: <a href="https://borgwarner.com/products/48v">https://borgwarner.com/products/48v</a></b>	<b>1 unit</b>
<b>Battle Born 48 V 50 Ah LiFePO<sub>4</sub> Battery Pack</b>	<b>Battle Born: <a href="https://battlebornbatteries.com">https://battlebornbatteries.com</a></b>	<b>1 pack</b>
<b>Holley Terminator X LS EFI Kit (wiring harness)</b>	<b>Holley: <a href="https://holley.com/products/terminator-x-ls/">https://holley.com/products/terminator-x-ls/</a></b>	<b>1 kit</b>

<b>Edelbrock 60841 Aluminum Cylinder Heads (CARB E.O.: DG-5)</b>	<b>Edelbrock:</b> <a href="https://www.edelbrock.com/products/cylinder-heads">https://www.edelbrock.com/products/cylinder-heads</a>	<b>1 pair</b>
<b>Comp Cams 54-454-11 Thumpr Camshaft + Springs</b>	<b>Comp Cams:</b> <a href="https://www.compcams.com/products/thumpr-cams">https://www.compcams.com/products/thumpr-cams</a> hafts	<b>1 set</b>
<b>Hooker BlackHeart Headers (CARB E.O.: D-650-14)</b>	<b>Hooker:</b> <a href="https://www.hookercar.com/">https://www.hookercar.com/</a>	<b>1 pair</b>
<b>MagnaFlow 90928 Catalytic Converters (CARB E.O.: D-161-118)</b>	<b>MagnaFlow:</b> <a href="https://www.magnaflow.com/">https://www.magnaflow.com/</a>	<b>2 pcs</b>
<b>Borla 400× Cat-Back Exhaust (CARB E.O.: D-550-45)</b>	<b>Borla:</b> <a href="https://www.borla.com/">https://www.borla.com/</a>	<b>1 kit</b>
<b>Be Cool 60675 Aluminum Radiator</b>	<b>Be Cool:</b> <a href="https://www.becoolradiators.com">https://www.becoolradiators.com</a>	<b>1 unit</b>
<b>SPAL 5TSC-12D Electric Thermostat</b>	<b>SPAL:</b> <a href="https://www.spalusa.com">https://www.spalusa.com</a>	<b>1 unit</b>

<b>Flex-A-Lite 301 Electric Cooling Fan</b>	<b>Flex-A-Lite: <a href="https://www.flex-a-lite.com">https://www.flex-a-lite.com</a></b>	<b>1 unit</b>
<b>Frostbite SB6 4L80E Transmission Cooler</b>	<b>Frostbite: <a href="https://frostbitecooling.com">https://frostbitecooling.com</a></b>	<b>1 unit</b>
<b>Setrab 2629 Engine Oil Cooler</b>	<b>Setrab: <a href="https://www.setrabusa.com">https://www.setrabusa.com</a></b>	<b>1 unit</b>
<b>Sanden SD7H15 e-A/C Compressor</b>	<b>Sanden: <a href="https://www.sanden.com">https://www.sanden.com</a></b>	<b>1 unit</b>
<b>Holley 15-160 In-Tank Fuel Pump</b>	<b>Holley: <a href="https://www.holley.com">https://www.holley.com</a></b>	<b>1 unit</b>
<b>Aeromotive 13109 Fuel Pressure Regulator</b>	<b>Aeromotive: <a href="https://aeromotiveinc.com">https://aeromotiveinc.com</a></b>	<b>1 unit</b>
<b>NGK TR6IX Iridium Spark Plugs (× 8)</b>	<b>NGK: <a href="https://www.ngksparkplugs.com">https://www.ngksparkplugs.com</a></b>	<b>8 pcs</b>
<b>Performance Automatic 4L80E Transmission Kit</b>	<b>Performance Automatic: <a href="https://www.performanceautomatic.com">https://www.performanceautomatic.com</a></b>	<b>1 kit</b>
<b>TCI 2800 rpm Torque Converter</b>	<b>TCI: <a href="https://www.tciperformance.com">https://www.tciperformance.com</a></b>	<b>1 unit</b>

### B.1.2 Tools & Equipment

- MIG welder with ER70S-6 wire (for heads, exhaust, subframe patches)
  - TIG welder for aluminum (radiator bracket)
  - Engine hoist (for head removal/installation)
  - Balanced 2-post lift (for engine/trans removal)
  - ½" Air impact gun & torque wrench (up to 300 ft-lb)
  - Alignment machine (four-wheel)
  - Fuel line flaring kit (3/8" AN)
  - Transmission jack (4L80E removal/installation)
  - Brake bleeder kit (vacuum)
  - Oscilloscope (for EFI and sensor pull-ups)
  - Battery charger (48 V & 12 V)
  - Python-configured laptop for Holley Terminator X tuning
  - Flow bench (for dyno cam verification)
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## B.2 Interior Nano-Coatings & Exotic Finishes

**Objective:** Transform the cabin into a luxurious, futuristic environment using genuine exotic leathers, koa wood flooring, carbon-fiber accents, and nano-coatings for antimicrobial, scratch resistance, and UV protection.

### B.2.1 Materials

Item	Supplier & URL	Qty
Nanoprotect™ Leather Coating (2 × 1 L)	NanoTouch Materials: <a href="https://nanotouchmaterials.com">https://nanotouchmaterials.com</a>	2 L
Nano ProSeal™ Wood Sealant (1 L kit)	NanoTouch Materials: <a href="https://nanotouchmaterials.com">https://nanotouchmaterials.com</a>	1 L
Metallic Green Back-Section Eel Skin Leather (2 hides)	Tandy Leather: <a href="https://tandyleather.com">https://tandyleather.com</a>	2 hides (~ 25 ft²)

<b>Back-Section Green Crocodile Leather (2 hides)</b>	<b>Anil Leather: <a href="https://anilleather.com">https://anilleather.com</a></b>	<b>2 hides (~ 30 ft<sup>2</sup>)</b>
<b>Carbon-Fiber Cloth (200 g/m<sup>2</sup>, 2 × 0.5 m<sup>2</sup>)</b>	<b>Rock West Composites: <a href="https://rockwestcomposites.com">https://rockwestcomposites.com</a></b>	<b>1 m<sup>2</sup></b>
<b>3M Scotchgard™ Stain Protector (Seats/Carpet)</b>	<b>3M: <a href="https://www.3m.com">https://www.3m.com</a></b>	<b>1 can</b>
<b>Koa Wood Flooring Planks (4 mm thick)</b>	<b>Hawaiian Wood Crafters: <a href="https://hawaiianwoodcrafters.com">https://hawaiianwoodcrafters.com</a></b>	<b>15 ft<sup>2</sup></b>
<b>Vinyl Ribbed Backing for Wood Floor (Rubber)</b>	<b>McMaster-Carr: <a href="https://www.mcmaster.com/7471K31">https://www.mcmaster.com/7471K31</a></b>	<b>15 ft<sup>2</sup></b>
<b>3M VHB Double-Coated Tape (#5952)</b>	<b>McMaster-Carr: <a href="https://www.mcmaster.com/5952K21">https://www.mcmaster.com/5952K21</a></b>	<b>2 × 1" rolls</b>
<b>3M 2200 Vibration Damping Mat (Under Wood Floor)</b>	<b>3M: <a href="https://www.3m.com/3M/en_US/company-us/all-3m-products/~3M-Vibration-Damping-Adhesive-2200/">https://www.3m.com/3M/en_US/company-us/all-3m-products/~3M-Vibration-Damping-Adhesive-2200/</a></b>	<b>15 ft<sup>2</sup></b>

### **B.2.2 Tools**

- Upholstery pneumatic stapler (Surebonder PT 200)
- Leather stretchers & clamps
- Wood router (for floor edges)
- Belt sander (for smoothing koa planks)
- Heat gun (for leather seams & vinyl application)
- Laser projector for alignment of stripes/panels
- Pneumatic press (for VHB tape adhesion under koa)
- Vacuum cleaner with HEPA filter (for dust control)

### **B.2.3 Procedure**

#### **1. Interior Strip-Out**

- Remove OEM seats, door panels, center console, floor carpets, headliner, dashboard inserts. Label all harnesses. Store fasteners in labeled bags.

#### **2. Koa Wood Flooring Installation**

- Subfloor Prep
  - Clean bare metal floor. Sand any high spots.
  - Install 3M 2200 vibration mat covering entire floor area. Press with pneumatic roller.
- Cut & Fit Planks
  - Lay out koa planks (fitted to contours): each plank  $\approx$  4 mm thick, 50 mm wide. Use laser projector to align straight lines.
  - Router edges at 45° bevel to avoid sharp edges. Test fit pieces dry.
- Adhesion
  - On underside of each plank edge, apply 3M VHB #5952 tape (one strip along each long edge).
  - Peel liner, press each plank onto vibration mat, using pneumatic press (20 psi) for 10 sec per plank.
- Trim & Finish
  - Use belt sander at 120 grit to smooth transitions. Vacuum dust thoroughly.
  - Apply Nano ProSeal™ wood sealant: 2 coats, 10 min between; wipe excess.

#### **3. Dashboard & Door Panel Accents**

- Carbon-Fiber Accent Inserts
  - CNC-cut CF cloth into pieces matching gauge cluster bezel, door trim inserts, center console lid.
  - Lay CF cloth on vacuum table; apply two layers of 2 mm CicaFill SH50 clearcoat between layers. Vacuum bag at – 0.8 bar for 30 min. Cure 12 hr at 25 °C.
  - Trim cured CF to final shape with a fine carbide router bit.
- Install CF Panels
  - Peel adhesive liner (3M VHB 1") on CF rear; press to cleaned plastic interior surface. Apply even pressure 15 sec.

#### **4. Seat Upholstery (Eel & Croc Leather)**

- Seat Frame Prep
  - Inspect seat frames; reinforce with 16 ga steel plates under cushion area to support mass.
  - Install foam pad sets: 4" memory foam base, 2" gel memory foam top. Cover with fire-retardant barrier (Nomex cloth).
- Cut Leather Patterns
  - For each seat, measure cushion & back contour. Add 5 cm seam allowance.

- Use industrial pattern:
    - Center panel: eel skin (metallic green).
    - Side bolsters: black eel leather to complement green center.
    - Accent piping: gold eel skin 1 cm strips.
    - Door side panel inserts: green crocodile.
  - Stitching
    - Use Pfaff 1245 industrial sewing machine with 0.8 mm needle. Stitch gauge 8.12 nylon thread (heavy duty).
    - Stitch patterns: two parallel seams on bolsters, diamond-quilted pattern on back panel (20 mm diamond).
  - Install Leather
    - Stretch leather over foam; secure underside with pneumatic staples (Surebonder, every 30 mm in the back).
    - Tuck corners neatly; use heat gun at 80 °C to stretch fish-mouth areas.
- 5. Upholstered Center Console & Door Panels
  - Cover console lid top with matching metallic green eel, accent sides with black eel.
  - Door inserts: carve out 12" × 8" area, glue croc leather above, staple flaps underneath.
- 6. Nanoprotect™ Coating Application
  - After all leather is installed, spray Nanoprotect™: hold gun 20 cm away, apply 2 light coats (wet at 0.1 mm), flash 5 min between. Allow 30 min cure.
- 7. Final Touches
  - Use 3M Scotchgard™ on carpets around wood floor edges.
  - Reinstall headliner (see Part C.11).

---

## B.3 Infotainment & AI Core Installation

**Objective:** Mount and wire the NVIDIA Jetson AGX Orin with Teensy microcontrollers, Leap Motion sensor, CAN bus, USB peripherals, ensuring seamless control of lighting, audio, security, and gesture interactions.

### B.3.1 Materials

Item	Supplier & URL	Qty
NVIDIA Jetson AGX Orin 32 GB	Connect Tech: <a href="https://connecttech.com/jetson-agx-orin/">https://connecttech.com/jetson-agx-orin/</a>	1 unit

<b>Teensy 4.1 Microcontroller (P2864)</b>	<b>PJRC:</b> <a href="https://pjrc.com/store/teensy41.html">https://pjrc.com/store/teensy41.html</a>	<b>1 unit</b>
<b>Leap Motion Controller</b>	<b>Ultraleap:</b> <a href="https://ultraleap.com/product/leap-motion-controller/">https://ultraleap.com/product/leap-motion-controller/</a>	<b>1 unit</b>
<b>Adafruit TLC5947 24-Channel PWM Driver (× 2)</b>	<b>Adafruit:</b> <a href="https://www.adafruit.com/product/1426">https://www.adafruit.com/product/1426</a>	<b>2 units</b>
<b>AMS TCS3472 RGBC Color Sensor</b>	<b>Digi-Key:</b> <a href="https://www.digikey.com/product-detail/ams/TC-S34721I2CCYR/">https://www.digikey.com/product-detail/ams/TC-S34721I2CCYR/</a>	<b>1 unit</b>
<b>SparkFun MCP2515 CAN Bus Breakout</b>	<b>SparkFun:</b> <a href="https://www.sparkfun.com/products/14611">https://www.sparkfun.com/products/14611</a>	<b>1 unit</b>
<b>USB-C to USB-A Cables (30 cm, shielded)</b>	<b>Amazon:</b> generic shielded cable	<b>2 pcs</b>
<b>Cat6 Shielded Ethernet Cable (3 m)</b>	<b>Monoprice:</b> <a href="https://www.monoprice.com">https://www.monoprice.com</a>	<b>1 cable</b>
<b>12 V → 5 V 2 A Buck Converter (LM2596)</b>	<b>Amazon:</b> <a href="https://www.amazon.com/dp/B01001G1ES">https://www.amazon.com/dp/B01001G1ES</a>	<b>1 unit</b>
<b>12 V → 15 V 2 A Buck Converter</b>	<b>Amazon:</b> generic (for IGBT gate driver)	<b>1 unit</b>



<b>CAN Transceiver (MCP2562)</b>	<b>Adafruit:</b> <a href="https://www.adafruit.com/product/2471">https://www.adafruit.com/product/2471</a>	<b>1</b> <b>unit</b>
<b>5 V → 3.3 V LDO Regulator</b> <b>(e.g., AMS1117)</b>	<b>Digi-Key:</b> <a href="https://www.digikey.com/product-detail/ams/AMS1117-3.3/">https://www.digikey.com/product-detail/ams/AMS1117-3.3/</a>	<b>1</b> <b>unit</b>

### B.3.2 Tools

- Soldering station (60 W, temperature-controlled)
- Wire crimpers (for 22 – 18 AWG)
- Heat-shrink tubing set (2:1 ratio, 3 mm and 5 mm)
- Digital storage oscilloscope (50 MHz)
- Laser label printer (for wiring harness IDs)
- RJ45 crimp tool (for CAN/Ethernet connectors)
- Kevlar sleeves (for high-flex harness sections)

### B.3.3 Procedure

#### 1. Mount NVIDIA Jetson AGX Orin

- Location: Under front passenger seat, on a custom aluminum bracket fabricated from 3 mm anodized 6061 T6 plate (200 × 150 × 3 mm).
- Vibration Isolation: Four M8 × 1.25 × 15 mm aluminum standoffs with rubber-coated springs (Sorbothane feet) between Orin's baseplate and bracket.
- Grounding: Attach a 6 AWG braided grounding strap from Orin's chassis to the vehicle's firewall ground stud.
- Power:
  - Connect VIN 48 V + to Victron Orion-Tr 48 → 12 V converter (fused at 10 A).
  - Orin's onboard 12 V rail receives 12 V from Orion output; verify 12.0 – 12.5 V.
  - Add 0.1 mF decoupling cap across 12 V rails near Orin.
- Cooling:
  - Create a vent hole (50 × 40 mm) under bracket, cover with fine stainless mesh to protect from debris.
  - Attach a small 50 mm brushless 12 V fan (Noctua NF-A6 PWM) under Orin's heatsink. Connect to 12 V IGN circuit via NTC temp switch at 60 °C.

#### 2. Mount Teensy 4.1 Module

- Location: Behind glovebox, secured to a small aluminum panel (100 × 80 × 2 mm).
  - Power:
    - Tap 12 V IGN + to LM2596 12 V → 5 V regulator; output 5 V to Teensy VIN (fuse 2 A).
    - Ground to chassis stud near firewall.
  - I<sup>2</sup>C & PWM Wiring:
    - Solder TCS3472 SCL/SDA to Teensy pins 19/18 (I2C). Add pull-ups (4.7 kΩ to 3.3 V).
    - Solder 6 PWM outputs (pins 2–7) to TLC5947 drivers (address select pins set accordingly).
  - CAN Integration:
    - Solder MCP2562 CAN transceiver to Teensy's TX1/RX1 (pins 17/16).
    - Crimp CAN\_H (green/white stripe) and CAN\_L (green/blue stripe) to RJ45 connectors.
    - Connect RJ45 to Cat6 cable → Jetson's CAN bus via SparkFun MCP2515 on Jetson side.
- 3. Mount Leap Motion Controller**
- Location: Overhead console, just above rearview mirror height.
  - Cut a 4" × 2" aperture in headliner's micro-perforated leather. Use razor to avoid tearing.
  - Mount Leap Motion flush with headliner using double-sided tape; secure with 2 screws into 3D-printed bracket behind headliner.
  - Route USB-A cable from Leap Motion to Jetson's USB hub (under passenger seat). Use Kevlar sleeve for protection.
- 4. TCS3472 Ambient Light Sensor**
- Location: A-pillar left side, ~ 10 cm above dash.
  - Cut 20 × 20 mm hole in plastic trim. Press TCS3472 board so lens aperture is flush.
  - Wire SDA/SCL/GND/VCC to Teensy 4.1. Use 100 Ω series resistors on SDA/SCL.
  - Cover sensor lens with 2 mm diffusing window (clear polycarbonate) to protect from dust.
- 5. CAN Bus & Ethernet Setup**
- Connect SparkFun MCP2515 CAN transceiver on Teensy to Cat6 CAN bus cable.
  - At Jetson end, use SparkFun MCP2515 SPI → CAN interface hat. Connect SPI pins (MOSI = pin 10, MISO = pin 12, SCK = pin 13, CS = pin 4).
  - Install Jetson's CAN kernel modules (sudo apt-get install can-utils). Configure /etc/network/interfaces for can0 at 500 kbps.
  - Test: candump can0 should show ID 0x200 (Coat 4 discharge), ID 0x123 (lighting), etc., if modules send heartbeat frames.
- 6. Jetson Software & Services**
- OS Setup

- Ubuntu 20.04 LTS with NVIDIA JetPack 5.0.2 (contains CUDA 11.8, TensorRT).
    - Install Python 3.8, pip3 install colour-science can-python sconspygame.
  - Color Manager Service (color\_manager.py)
    - Reads RGBC from TCS3472 via I<sup>2</sup>C. Converts to CIE xy (using colour-science library).
    - Publishes 0x123 CAN frames: [R, G, B, W, Mode, Reserved...].
    - Listens for 0x124 frames for user overrides ("SetColor"). Supports calibration.
  - Gesture Service (gesture\_control.py)
    - Uses Ultraleap Orion SDK; Python binding to detect gestures.
    - On "Swipe Left," sends CAN 0x125 [0x01] for "Next Track."
    - On "Swipe Right," sends CAN 0x125 [0x02] for "Prev Track."
    - On "Palm Up/Down," sends CAN 0x125 [0x03]/[0x04] for "Volume Up/Down."
  - Security & EMP Controller
    - Service (emp\_controller.py) listens on CAN 0x200 for "Discharge" commands; logs pulses.
    - Contains safety interlocks: if "HV\_OVR" (HV undervoltage) or "SystemTemp > 70 °C," block pulses.
  - Audio Routing
    - C12000 preamp's USB Audio is recognized as ALSA device. Use pulseaudio to route system audio to C12000.
    - Configure ~/.asoundrc to set Jetson's audio out to C12000.
- 7. Final Verification of Infotainment**
- Power Up: Apply vehicle battery 12 V & hybrid 48 V to the system.
  - Test CAN: On PC: candump can0 to verify Teensy 'Alive' frame (0x321) every 1 s.
  - Test Gestures: Execute python3 gesture\_control.py, wave hand—observe "Command detected: Next" on Jetson console.
  - Test Color Manager: Place a known 6500 K LED lamp on TCS3472; verify CAN frame sets gauge backlight to neutral white.
  - Test Leap Motion: Hover hand 5 cm above sensor, ensure detection (green LED on device).

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## B.4 Retro Analog-Dial Gauge Cluster & LED Backlight

**Objective:** Replace factory cluster with a fully analog "retro" gauge set, add individually addressable RGBW LED backlighting precisely controlled via Teensy/CAN.

### B.4.1 Materials

Item	Supplier & URL	Qty
Classic Instruments Street Rod Gauges (6 pcs)	Classic Instruments: <a href="https://classicinstruments.com/products/street-rod-gauge">https://classicinstruments.com/products/street-rod-gauge</a>	1 set
Adafruit Digital LED Strip – RGBW 144 LED/m (5 m)	Adafruit: <a href="https://www.adafruit.com/product/4707">https://www.adafruit.com/product/4707</a>	4 m
TLC5947 24-Channel PWM Driver Breakout (× 2)	Adafruit: <a href="https://www.adafruit.com/product/1426">https://www.adafruit.com/product/1426</a>	2 units
AMS TCS3472 RGBC Light Sensor Module	Digi-Key: <a href="https://www.digikey.com/product-detail/ams/TCS34721I2CCYR/">https://www.digikey.com/product-detail/ams/TCS34721I2CCYR/</a>	1 unit
2 mm Milky Acrylic Diffuser Rings (3.25" Ø)	McMaster-Carr 8610K821: <a href="https://www.mcmaster.com/8610K821">https://www.mcmaster.com/8610K821</a>	6 rings
Wiring Harness Components (8 conductor, 22 AWG)	Belden: <a href="https://www.belden.com/products/ci-cable/audio-cable">https://www.belden.com/products/ci-cable/audio-cable</a>	10 m
Molex 22-pin Connector Kit (for gauge cluster)	Molex: <a href="https://www.molex.com/molex/products">https://www.molex.com/molex/products</a>	2 kits

#### B.4.2 Tools

- Razor knife & wire strippers (for LED strip cut)
- Soldering iron (60 W) with 0.8 mm tip
- Heat-shrink tubing (2:1, 3 mm)

- Multimeter (True RMS)
- CV-Linear adjust potentiometer (5 k $\Omega$ ) for LED brightness trimming
- DC bench supply (5 V, 2 A) for bench-testing LED circuits

#### B.4.3 Procedure

##### 1. Remove OEM Instrument Cluster

- Detach trim bezel via plastic prying tool (start at bottom corners).
- Disconnect electrical connectors (horn wire, speedo cable, gauge cluster harness).
- Remove 4 7 mm bolts, slide cluster out.

##### 2. Prepare Gauge Harness

- On workbench, lay out Classic Instruments 6 gauge panel. Identify each pad:
  - Speedometer (0 – 120 mph)
  - Tachometer (0 – 8 k rpm)
  - Fuel (E – F)
  - Water Temp (100 – 260 °F)
  - Oil Pressure (0 – 100 psi)
  - Voltmeter (8 – 18 V)
- Crimp Male blade terminals to factory wiring:
  - Splice factory VSS (white/green) to “Speedo IN.”
  - Splice Holley TACH OUT (purple) to “Tacho IN.”
  - Fuel sender (purple/white) to “Fuel IN.”
  - Water-temp (pink) to “Temp IN.”
  - Oil-pressure sender (new VDO sender, black/yellow) to “Oil IN.”
  - Battery 12 V (red) to “Volt IN.”
- Connect ground to gauge cluster housing (black).

##### 3. Mount Gauge Panel

- Insert Classic gauge panel into dash opening.
- Secure with four 7 mm bolts to original studs.

##### 4. LED Backlight Installation

- Cut LED Strips into 10-LED Segments
  - Each segment ~ 7 cm length (10 pixels).
  - Solder a 20 cm length of 4-conductor cable (5 V, GND, Data, CLK) to each strip end.
- Install Diffuser Rings
  - Peel protective film from each 2 mm milky acrylic ring; place behind gauge lens. Use small drops of clear RTV to hold.
- Mount LED Strips
  - Stick one 10-pixel strip behind each gauge, evenly around inner bezel (ensure full 360° coverage).
  - Use small nylon zip-ties to secure strip to cluster housing flanges.
- Wire to TLC5947 Drivers

- Mount two TLC5947 boards on a small standoff board behind cluster, tucked into dash cavity.
  - Daisy-chain two drivers: connect Dout of first to Din of second.
  - Connect 5 V & GND from LM2596 5 V regulator (fused 2 A).
  - For each LED strip, assign 4 PWM channels (R, G, B, W). Solder connections.
5. Install TCS3472 RGBC Color Sensor
- In A-pillar trim, cut 20 × 20 mm hole. Insert sensor behind lens opening. Use RTV to seal edges.
  - Run four-conductor cable (SDA, SCL, 3.3 V, GND) to Teensy.
6. Teensy & CAN Wiring
- Mount TLC5947 drivers + Teensy 4.1 on aluminum panel behind glovebox. Secure with M3 standoffs.
  - Connect Teensy's 5 V → TLC5947 VCC; Teensy GND → TLC5947 GND.
  - Connect Teensy pins 2–7 to first 6 channels of TLC5947 (RGBW for gauge 1, gauge 2).
  - Connect pins 8–13 to next 6 channels (gauge 3, gauge 4).
  - Use second TLC5947 for last 4 gauges (2 channels remain unused for future expansion).
  - Wire SPI (SCK = pin 13, MOSI = pin 11, LATCH = pin 10, GND & 5 V).
  - Connect CAN TX1/RX1 (pins 17/16) to MCP2562 transceiver, out to RJ45 to CAN bus.
7. Calibration & Testing
- Power on Teensy with 5 V. In Arduino IDE: upload gauge\_backlight.ino:

```
#include <SPI.h>
```

```
#include <TLC5947.h>
```

```
#include <FlexCAN_T4.h>
```

```
FlexCAN_T4<CAN1, RX_SIZE_256, TX_SIZE_16> Can1;
```

```
CAN_message_t msg;
```

```
const int latchPin = 10, clockPin = 13, dataPin = 11;
```

```
TLC5947 tlc = TLC5947(1, latchPin, clockPin, dataPin);
```

```
void setup() {
```

```

tlc.begin();

Can1.begin();

Can1.setBaudRate(500000);

Can1.enableFIFO();
}

void loop() {
  if (Can1.read(msg)) {
    if (msg.id == 0x123) {
      uint8_t R = msg.buf[0];
      uint8_t G = msg.buf[1];
      uint8_t B = msg.buf[2];
      uint8_t W = msg.buf[3];
      for (int i = 0; i < 24; i += 4) {
        tlc.setPWM(i + 0, R * 16);
        tlc.setPWM(i + 1, G * 16);
        tlc.setPWM(i + 2, B * 16);
        tlc.setPWM(i + 3, W * 16);
      }
      tlc.write();
    }
  }
}

```

- On Jetson, run `color_manager.py`: ensures TCS3472 readings produce correct CIE xy to R,G,B,W conversion.

- Verify by shining different colored lights in cabin and observing gauge backlight change.
8. Reinstall Dashboard Trim
- Reattach weatherstrip around gauge. Fit bezel, press clips. Confirm no rattles.

---

## B.5 McIntosh Audio System Integration (MA252 Amplifiers)

**Objective:** Install and integrate multiple McIntosh MA252 hybrid tube amplifiers to power front, rear, and subwoofer channels, all controlled by the McIntosh C12000 preamp (plus DA2 DAC) fed by the Jetson AI.

### B.5.1 Materials

Item	Supplier & URL	Qty
McIntosh C12000 Preamplifier + DA2 DAC	McIntosh Labs: <a href="https://mcintoshlabs.com/products/preamplifiers/c12000/">https://mcintoshlabs.com/products/preamplifiers/c12000/</a>	1 unit
McIntosh MA252 Hybrid Tube Amplifier	McIntosh Labs: <a href="https://mcintoshlabs.com/products/ma252/">https://mcintoshlabs.com/products/ma252/</a>	4 units
McIntosh MVP901 Fusion Tube Monoblock Amplifier (PA/Emerg.)	McIntosh Labs: <a href="https://mcintoshlabs.com/products/mvp901/">https://mcintoshlabs.com/products/mvp901/</a>	1 unit
Balanced XLR → RCA Cables (Mogami 2549's)	Amazon: <a href="https://www.amazon.com/dp/B003EYSDYM">https://www.amazon.com/dp/B003EYSDYM</a>	4 pcs
OFC Speaker Cable (12 AWG)	Blue Jeans Cable: <a href="https://www.bluejeanscable.com">https://www.bluejeanscable.com</a>	100 ft roll



<b>Sorbothane Hemispheres (1") for Vibration Isolation</b>	<b>McMaster-Carr 51875K27:</b> <a href="https://www.mcmaster.com/51875K27">https://www.mcmaster.com/51875K27</a>	<b>8 pcs</b>
<b>Accuride 9301 Heavy-Duty Drawer Slide Rails</b>	<b>McMaster-Carr 72575K29:</b> <a href="https://www.mcmaster.com/72575K29">https://www.mcmaster.com/72575K29</a>	<b>2 sets</b>
<b>Aluminum Sheet, 16 ga (mounting tray)</b>	<b>McMaster-Carr 8557K39:</b> <a href="https://www.mcmaster.com/8557K39">https://www.mcmaster.com/8557K39</a>	<b>1 × 2 ft</b>
<b>Noctua NF-A8 PWM 80 CFM Fan (× 2)</b>	<b>Noctua:</b> <a href="https://noctua.at/en/products/fans/nf-a8-pwm">https://noctua.at/en/products/fans/nf-a8-pwm</a>	<b>2 pcs</b>
<b>Heat-shrink Tubing (3 mm, 30 kV)</b>	<b>McMaster-Carr 5512K33:</b> <a href="https://www.mcmaster.com/5512K33">https://www.mcmaster.com/5512K33</a>	<b>1 roll</b>
<b>10 A Slow-Blow ANL Fuses</b>	<b>Eaton Bussmann:</b> <a href="https://www.eaton.com/us/en-us/catalog/electrical-circuit-protection/fuses/automotive.html">https://www.eaton.com/us/en-us/catalog/electrical-circuit-protection/fuses/automotive.html</a>	<b>6 pcs</b>
<b>6 AWG Braided Ground Strap</b>	<b>McMaster-Carr 5566K15:</b> <a href="https://www.mcmaster.com/5566K15">https://www.mcmaster.com/5566K15</a>	<b>1 pc</b>
<b>10 AWG 3-Conductor Inverter Cable (for 120 VAC)</b>	<b>Monoprice:</b> <a href="https://www.monoprice.com">https://www.monoprice.com</a>	<b>20 ft</b>
<b>Middle-of-Road AC Distribution Block (4 circuit)</b>	<b>Eaton Bussmann:</b> <a href="https://www.eaton.com">https://www.eaton.com</a>	<b>1 unit</b>

## B.5.2 Tools

- Metric/SAE socket & wrench set (up to ¾")
- 16 ga & 18 ga MIG wire (for minor bracket work)
- ½ in construction adhesive (for mounting brackets)
- Heat gun (300 °C) for heat-shrink
- Multimeter (True RMS, 0–300 V, 0–10 A)
- 120 VAC receptacle plate (for under console)
- Digital clamp meter (to measure idle/peak currents)
- D-sub soldering jig (for DB-25 audio interface if needed)

## B.5.3 System Architecture Overview

- Front Channels (L/R):
  - McIntosh MA252 #1 (Left channel) → front left door component + tweeter
  - McIntosh MA252 #2 (Right channel) → front right door component + tweeter
- Rear Channels (L/R):
  - McIntosh MA252 #3 (Left-rear) → rear left door component + exciter
  - McIntosh MA252 #4 (Right-rear) → rear right door component + exciter
- Subwoofer Stage:
  - Two MA252 units bridged (Mono): subwoofer 1 & subwoofer 2 (sealed 12" enclosures)
- Emergency PA/Backup:
  - McIntosh MVP901 (Dedicated tube amplifier) wired to front exterior horn & cabin speakers for "panic mode."
- Signal Chain:
  - Jetson (software → USB audio via DA2) → C12000 preamp → MA252 amps → speakers
  - AUX inputs (Bluetooth, optical) also fed to C12000.

## B.5.4 Step-by-Step Installation

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### B.5.4.1 Fabricate & Mount Amp Tray

1. Cut & Bend Tray
  - Take 16 ga 6061-T6 aluminum sheet (150 × 300 mm). Bend two 30 mm flanges on long edges to add rigidity.
  - Drill four 8.5 mm holes in each corner to match Sorbothane pad foot pattern on MA252's bottom.
2. Install Sorbothane Feet
  - Press-fit 4 × 1" Sorbothane hemispheres onto each MA252's feet. Apply small dab of silicone to ensure adhesion.
3. Mount Tray Under Center Console

- Remove center console rear section. Clean mounting area.
  - Weld two 3 mm steel brackets (40 × 10 × 3 mm) to the Suburban's crossmember under console. Spacing 250 mm apart.
  - Bolt aluminum tray to these brackets using M8 × 1.25 × 20 mm cap-head bolts + nylon lock nuts. Ensure tray is level and 30 mm clearance above floor.
- 4. Ventilation Cutouts**
- Cut two 80 × 40 mm openings in tray's front edge (for fan intake).
  - Install two Noctua NF-A8 fans underneath tray (blowing downward) secured with M3 × 10 mm screws. Connect to 12 V IGN line via thermistor switch (40 °C turn-on, 30 °C turn-off).
- 

#### **B.5.4.2 Power Wiring (120 VAC)**

- 1. Inverter to Tray**
- From Victron Phoenix 48 V → 120 VAC inverter (located in cargo area), run 10 AWG 3-conductor cable through grommeted hole in floor.
  - Secure cable along frame rail with P-clips every 200 mm.
- 2. Fuse Block**
- Mount a 4-circuit AC distribution block (Eaton Bussmann) near tray. Label circuits: "MA252 #1," "MA252 #2," "MA252 #3," "MA252 #4."
  - Each circuit has a slow-blow 10 A ANL fuse.
- 3. Receptacle Installation**
- On the tray's back left panel, mount two standard NEMA 5-15R receptacles in a duplex faceplate. Wire from distribution block hot & neutral to receptacles, ground to chassis.
- 

#### **B.5.4.3 Grounding & Signal Cable Routing**

- 1. Ground Strap**
- Attach 6 AWG braided strap from tray's steel bracket to firewall ground stud (used by OEM battery). Verify continuity (< 1 mΩ).
- 2. Balanced Audio Cables**
- C12000 outputs (XLR) → MA252 inputs (RCA) via 1 m Mogami 2549 XLR-to-RCA adaptors.
  - Route cables along passenger kick panel (tucked under carpet), secure with zip ties every 150 mm. Leave 50 mm slack at each amp for tube removal.
- 3. Speaker Wiring**
- Use 12 AWG OFC cable from each MA252's binding post terminals to speaker terminal block under rear seat. Label each speaker run.

- Front Left Component: 4  $\Omega$  impedance, connect +/- accordingly.
  - Front Right Component
  - Rear Left Component + Rear Left Exciter (parallel)
  - Rear Right Component + Rear Right Exciter (parallel)
  - Subwoofers: Two 12" sealed enclosures (each 4  $\Omega$ ); Ma252 amp #3 & #4 bridged in mono: tie + from both channels to sub + terminal; tie – from both channels to sub –.
- 

#### B.5.4.4 MA252 Placement & Connection

1. Positioning
    - Place each MA252 on tray atop Sorbothane feet (4 feet per amp). Space them so front panels are flush with console rear opening.
    - Leave 10 cm clearance at top for ventilation.
  2. AC Power
    - Plug each MA252 into fused 120 VAC receptacle.
    - Check idle current: ~ 1.2 A at 120 VAC per amp.
  3. Signal Connection
    - Connect RCA cables from C12000 to each MA252 input (Front L, Front R, Rear L, Rear R).
    - Verify each amp's volume pot is turned fully CCW (minimum).
  4. Test Startup
    - Power on C12000 (12 V IGN "ACC"). Wait 90 s for tubes to warm up. Each MA252's power LED should glow blue.
    - Play 1 kHz sine wave at –20 dBFS from Jetson. Increase gain on C12000 slowly. On each MA252, slowly turn volume up until measurable output on speakers.
- 

#### B.5.4.5 MVP901 Emergency PA Integration

1. Mounting
  - Fabricate a smaller Sorbothane-isolated bracket on the same tray to hold the MVP901. Slot behind MA252 #1, offset to not obstruct front.
2. AC & Signal
  - Wire MVP901 to the third duplex receptacle (120 VAC).
  - Create a fail-over RCA cable from C12000's "Aux 4" to MVP901 input.
3. Horn & Microphone
  - Mount a high-power 120 dB waterproof horn in front bumper (behind grill). Wire horn + to MVP901 "Speaker A" output through 25  $\Omega$  resistor (limit current).

- Connect portable Talk-Box PTT mic (hardwired) to MVP901 mic input; mount PTT switch under dash.
- 4. Emergency Mode
  - Program Jetson: on CAN ID 0x200, data[1] = 0x06 triggers MVP901 volume 12 (max) and auto plays pre-recorded “Attention!” from USB stick on C12000 “Aux 4.”

---

#### B.5.4.6 Acoustic Verification & Tuning

1. Front Stage
  - Play pink noise through front channels, measure SPL at driver ear at 85 dB–88 dB. Adjust MA252 gain trim (rear panel small trimmer).
2. Rear Stage
  - Play pink noise, measure at rear seat: 82 dB–85 dB. Fine-tune gain.
3. Subwoofer
  - Play 50 Hz sine wave, measure 95 dB near sub. Set crossover on C12000 to 80 Hz.
4. Crossover & Equalization
  - In C12000, set 12 dB/octave high-pass at 80 Hz for front/rear, low-pass at 80 Hz for subs.
  - Use “Room Correction” microphone (provided) at driver seat, run C12000’s auto EQ.

---

### B.6 Hybrid 48 V “e-Assist” Drive System

**Objective:** Replace OEM 253 A alternator with a 48 V belt-driven motor/generator (M/G) to provide torque assist, regenerative braking, and 48 V DC for auxiliary systems.

#### B.6.1 Materials

Item	Supplier & URL	Qty
BorgWarner B-1000 48 V E-Assist Motor/Generator	BorgWarner: <a href="https://borgwarner.com/products/48v">https://borgwarner.com/products/48v</a>	1 unit

<b>Battle Born 48 V 50 Ah LiFePO<sub>4</sub> Battery Pack</b>	<b>Battle Born:</b> <a href="https://battlebornbatteries.com">https://battlebornbatteries.com</a>	<b>1 pack (4 cells)</b>
<b>Victron Orion-Tr 48 → 12 V DC-DC Converter</b>	<b>Victron Energy:</b> <a href="https://victronenergy.com">https://victronenergy.com</a>	<b>1 unit</b>
<b>BMS &amp; 48 V Battery Disconnect Switch</b>	<b>Orion BMS:</b> <a href="https://orionbms.com">https://orionbms.com</a>	<b>1 unit</b>
<b>Motor-Generator Belt &amp; Pulleys (48 V E-Assist Kit)</b>	<b>BorgWarner:</b> included in kit	<b>1 set</b>
<b>High-Current 48 V Wiring Harness (10 AWG, 80 A rating)</b>	<b>Belden:</b> custom order	<b>5 m</b>
<b>100 A Contactor (48 V DC)</b>	<b>Eaton:</b> <a href="https://www.eaton.com">https://www.eaton.com</a>	<b>1 unit</b>
<b>200 A System Fuse (Class T)</b>	<b>Eaton Bussmann:</b> <a href="https://www.eaton.com">https://www.eaton.com</a>	<b>1 unit</b>

### **B.6.2 Tools**

- Crank puller & harmonic balancer puller (for alternator removal)
- 5 /16" hex driver & torque wrench (for alternator bracket)
- 13 mm & 15 mm wrench (for belt tensioner)
- 200 A crimp tool & lugs (for 10 AWG cable)
- Battery room vent fan (for under-hood battery pack)
- Insulated gloves ( $\geq 1$  kV rating)

### **B.6.3 Procedure**

- 1. Remove OEM Alternator**
  - Disconnect negative battery terminal (– 12 V) to avoid shorts.
  - Remove serpentine belt: use 15 mm wrench on belt tensioner, slip belt off alternator pulley.

- Unbolt alternator (3 × 15 mm bolts), unplug main 12 V output (red cable), unplug field/Ign lead.
  - Remove alternator.
- 2. Mount BorgWarner B-1000 M/G**
- Install BorgWarner bracket (supplied) in place of alternator. Align to block's threaded holes.
  - Bolt M/G to bracket using M10 × 1.5 × 35 mm bolts, torque to 40 ft-lb.
  - Align serpentine belt path: install new 48 V pulley onto M/G shaft, torque nut to 60 ft-lb.
- 3. Belt & Tension Adjustment**
- Route serpentine belt through M/G pulley → water pump → AC compressor → crank pulley → tensioner → M/G.
  - Ensure 12 mm deflection at mid-span. Adjust Mech tensioner accordingly.
- 4. 48 V Battery Pack & BMS**
- Under rear cargo floor, mount Battle Born 4 × 12 V LiFePO<sub>4</sub> cells in custom aluminum enclosure.
  - Mount Orion BMS to side of enclosure. Connect cell leads in series (12 V × 4 = 48 V).
  - Install 200 A Class T fuse between battery positive and contactor.
  - Mount 100 A contactor (for isolating pack) on firewall near fuel tank housing.
- 5. Wiring**
- Run 10 AWG 48 V cable from BMS "Pack+" to contactor, then to M/G "B+" terminal.
  - Connect M/G "B-" to battery negative terminal (use 6 AWG braided strap).
  - Connect M/G control harness (supplied) to location:
    - Phase wires (3 × 20 AWG) to M/G.
    - CAN & control cables to Jetson via CAN bus to handle torque-assist requests.
- 6. DC-DC Converter (Victron Orion)**
- Mount Orion under passenger seat near Jetson mount.
  - Connect input 48 V from battery[+] (through 100 A contactor) and battery[-].
  - Set output to 13.8 V (use onboard dip switches). Connect Orion output to 12 V house bus (fuse 40 A).
- 7. Control Integration**
- Install Jetson service (eassist\_controller.py):
    - Monitors vehicle speed, throttle input (Holley data), decides torque-assist at low rev.
    - Sends CAN commands to M/G (ID 0x300) with target current.
  - Wire M/G's CAN port to CAN bus. Use 120 Ω termination at BMS end.
  - Verify BMS communicates via CAN (ID 0x301) every 100 ms with pack voltage, cell voltages.
- 8. Testing**

- Reconnect 12 V battery.
- Turn ignition to “ACC”: verify BMS powers on (LED sequence).
- Start engine: at idle, measure Rpm. On slight throttle (10 %), Jetson should send “Assist = 5 A” until 1 000 rpm.
- Use DVOM to measure M/G output current (phase & DC): confirm ~ 5 A charging at 13.8 V.

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## B.7 Engine & Drivetrain Performance Upgrades

**Objective:** Increase horsepower, torque, and efficiency while retaining CARB compliance. Install aftermarket heads, cam, intake, exhaust, and tune EFI for flex-fuel.

### B.7.1 Materials

Item	Supplier & URL	Qty
Edelbrock 60841 Aluminum Cylinder Heads (CARB EO DG 5)	Edelbrock: <a href="https://www.edelbrock.com/products/cylinder-heads">https://www.edelbrock.com/products/cylinder-heads</a>	1 pair
Comp Cams 54-454-11 “Thump” Camshaft + Springs	Comp Cams: <a href="https://www.compcams.com/">https://www.compcams.com/</a>	1 kit
Hooker BlackHeart Headers (D –650 –14 EO)	Hooker: <a href="https://www.hookercar.com">https://www.hookercar.com</a>	1 pair
MagnaFlow 90928 Catalytic Converters (D –161 –118 EO)	MagnaFlow: <a href="https://www.magnaflow.com">https://www.magnaflow.com</a>	2 pcs
Borla 400× Cat-Back Exhaust (D –550 –45 EO)	Borla: <a href="https://www.borla.com">https://www.borla.com</a>	1 kit



<b>K&amp;N 77-2585KP CAI (Cold Air Intake, CARB EO D –269 –39)</b>	<b>K&amp;N: <a href="https://www.knfilters.com">https://www.knfilters.com</a></b>	<b>1 kit</b>
<b>Holley 558-106 MAF Sensor + Innovate LC-2 Wideband Kit</b>	<b>Holley: <a href="https://www.holley.com">https://www.holley.com</a></b>	<b>1 kit</b>
<b>Holley Terminator X LSA LS EFI Kit + 550-987 4L80E Harness</b>	<b>Holley: <a href="https://www.holley.com">https://www.holley.com</a></b>	<b>1 kit</b>
<b>MSD 85517 HEI Distributor + MSD 8461 6-Plus Ignition Box</b>	<b>MSD Ignition: <a href="https://www.msdisignition.com">https://www.msdisignition.com</a></b>	<b>1 set</b>
<b>MSD 33456 Super Conductor Spark Plug Wires</b>	<b>MSD Ignition: <a href="https://www.msdisignition.com">https://www.msdisignition.com</a></b>	<b>1 set</b>
<b>K&amp;N 63-5004 Cold Air Intake (Backup) for reference</b>	<b>K&amp;N: <a href="https://www.knfilters.com">https://www.knfilters.com</a></b>	<b>1 kit</b>
<b>Be Cool 60675 Aluminum Radiator</b>	<b>Be Cool: <a href="https://www.becoolradiators.com">https://www.becoolradiators.com</a></b>	<b>1 unit</b>
<b>SPAL 5TSC-12D Electric Thermostat &amp; Fan</b>	<b>SPAL: <a href="https://www.spalusa.com">https://www.spalusa.com</a></b>	<b>1 unit</b>
<b>Frostbite SB6 4L80E Transmission Cooler</b>	<b>Frostbite: <a href="https://frostbitecooling.com">https://frostbitecooling.com</a></b>	<b>1 unit</b>
<b>Setrab 2629 Engine Oil Cooler</b>	<b>Setrab: <a href="https://setrabusa.com">https://setrabusa.com</a></b>	<b>1 unit</b>

<b>Sanden SD7H15 e-A/C Compressor</b>	<b>Sanden: <a href="https://www.sanden.com">https://www.sanden.com</a></b>	<b>1 unit</b>
<b>Holley 15-160 In-Tank Fuel Pump</b>	<b>Holley: <a href="https://www.holley.com">https://www.holley.com</a></b>	<b>1 unit</b>
<b>Aeromotive 13109 Fuel Pressure Regulator</b>	<b>Aeromotive: <a href="https://aeromotiveinc.com">https://aeromotiveinc.com</a></b>	<b>1 unit</b>
<b>NGK TR6IX Iridium Spark Plugs (× 8)</b>	<b>NGK: <a href="https://www.ngksparkplugs.com">https://www.ngksparkplugs.com</a></b>	<b>8 pcs</b>
<b>Performance Automatic 4L80E Transmission Rebuild Kit</b>	<b>Performance Automatic: <a href="https://www.performanceautomatic.com">https://www.performanceautomatic.com</a></b>	<b>1 kit</b>
<b>TCI 2800 rpm Torque Converter</b>	<b>TCI: <a href="https://www.tciperformance.com">https://www.tciperformance.com</a></b>	<b>1 unit</b>

### **B.7.2 Tools**

- Engine hoist (3 000 lb capacity)
- Valve spring compressor
- Degree wheel & dial indicator (for cam installation)
- TDC marking tool
- Engine stand (for head work)
- TIG welder (for header install)
- IR thermometer (for checking manifold temps)
- OBD-II CAN interface (for Holley tuning)
- Dyno (for final calibration and emissions test)

### **B.7.3 Procedure**

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#### **B.7.3.1 Cylinder Head Installation (Edelbrock 60841)**

## **1. Preparation**

- Park vehicle on lift; drain coolant, remove radiator, fan shroud, upper radiator hose.
- Remove air-box, throttle body, and intake manifold (disconnect MAF, TB, PCV hoses).
- Label and remove exhaust manifolds.

## **2. Remove OEM Heads**

- Mark #1 cylinder TDC using TDC tool & pointer. Turn crank CCW 2 full turns to TDC #6.
- Remove rocker arm covers, push-rod removal: mark each rod with index.
- Remove rocker pedestals & shafts. Pull valves out by rotating cam lobe.
- Remove head bolts in sequence (reverse torque): 18 mm, start at center, spiral outward.
- Lift off OEM heads carefully; inspect block deck for warpage ( $< 0.002''$ ).

## **3. Prepare Block Deck**

- Clean deck with a plastic scraper, wipe with acetone.
- Apply ARP Ultra-Torque assembly lube on head bolt threads. Inspect deck D-shape rings for cleanliness.

## **4. Head Gasket & Head Installation**

- Place Fel-Pro 1015 MLS head gaskets on aligned dowels (Molykote on both gasket faces).
- Position Edelbrock 60841 head. Finger-tight each ARP 254-1001 12×1.25 in head bolt.
- Torque using sequence:
  1. 30 ft-lb
  2. 60 ft-lb
  3. 90 ft-lb
  4. +90° turn each bolt (4 passes of 90°).

## **5. Rockers & Pushrods**

- Install new Comp Cams premium 7 mm chromoly pushrods (straight-length 7.800").
- Drop each pushrod into lifter bore; verify straight fit.
- Install comp-cam hydraulic roller lifters (Pre-lubed).
- Install Comp Cams XXL series rocker shafts (13 shaft, 3/8 stud).
- Set rocker arm preload (lash) at 0.020" to start (adjust with 5/16" crowding nuts).

## **6. Valvetrain Check**

- Rotate engine by hand; ensure no binding.
- Verify valve lash at TDC (both intake & exhaust have 0.020").

---

### **B.7.3.2 Camshaft Installation (Comp Cams Thumpr)\*\***

#### **1. Cam Prep**

- Lay cam on a soft cloth; apply Permatex Ultra Black paste on lobes.
  - 2. **Lobe Orientation & Timing**
    - Position #1 intake lobe at lobe center (3 o'clock). Use degree wheel & dial gauge on #1 intake valve.
    - Align key on cam sprocket to timing mark: line up "Key mark" with timing pointer at TDC.
  - 3. **Install Cam & Timing Chain**
    - Slide cam into block carefully (lubed journals).
    - Install timing gear on crank snout; install chain; align chain link colors to timing marks.
    - Install cam sprocket; torque bolts to 70 ft-lb in a star pattern.
  - 4. **Install Timing Cover & Oil Pump**
    - Reinstall oil pump pickup base, align O-ring.
    - Slip timing cover gasket (Fel-Pro) & cover, torque 9 cover bolts to 15 ft-lb.
- 

#### **B.7.3.3 Intake & Exhaust Installation**

1. **Cold Air Intake (K&N 77-2585KP)**
    - Attach velocity stack adapter to mass-air-meter (Holley MAF).
    - Secure K&N filter into fender well via supplied bracket.
    - Tighten hose clamps snug; avoid over-torquing.
  2. **Headers & Exhaust**
    - Clean cylinder head exhaust flange with wire wheel.
    - Slip Hooker BlackHeart headers into place; use Fel-Pro 1415 Graphite Gasket per CDC.
    - Bolt head flange hardware: M10 × 1.5 × 25 mm flanged button head, torque to 40 ft-lb in sequence.
    - Attach O2 sensors (LS2 wideband) to primary tube bung; torque to 30 ft-lb.
    - Route MagnaFlow 90928 cats & Borla 400× cat-back:
      - Connect cats to header collectors (3 in dia.), tighten V-band clamps.
      - Slide Borla mid-pipe, muffler, and tailpipe, align to tail section; tighten 2.5 in band clamps.
  3. **Exhaust Leak Check**
    - Start engine at idle; check joints with soapy water for leaks. Re-tighten if necessary.
- 

#### **B.7.3.4 Radiator & Cooling Upgrades**

1. **Radiator Removal**
  - Drain coolant. Remove radiator mounting brackets, fan shroud, lower fan (if OEM).

## **2. Be Cool 60675 Radiator Install**

- Place radiator in core support. Use M8 × 1.25 × 20 mm bolts, torque to 20 ft-lb.
- Reinstall SPAL 5TSC-12D electric thermostat housing in factory location. Mount SPAL fan to radiator (use supplied brackets).

## **3. Wiring & Fan Control**

- Tap SPAL fan power lead to 12 V IGN circuit (fuse 20 A).
- Connect SPAL fan ground to chassis.
- Install Coolant Temp Sensor (Holley) at thermostat housing; route to Holley processor.

## **4. Frostbite SB6 Trans Cooler**

- Install under front bumper (bolt to frame rail).
- Use 5/16" AN tubing to run from transmission cooler lines to Frostbite unit.
- Tighten fittings to 20 ft-lb.

## **5. Setrab 2629 Engine Oil Cooler**

- Mount on driver's side frame rail, just below radiator.
- Run 3/4" engine oil feed and return lines with 45° AN hose ends.
- Torque AN fittings to 15 ft-lb.

## **6. Sanden SD7H15 A/C Compressor**

- Remove OEM A/C compressor. Install Sanden with supplied bracket.
- Use new R-134a lines and O-rings; apply PAG 46 oil (50 mL).
- Evacuate and charge with 34 oz R-134a.

## **7. Coolant Fill**

- Fill with 50 / 50 Redline Water Wetter & distilled water.
- Bleed air using bleeder port on thermostat housing. Run engine until thermostat fully opens (~ 200°F). Top off.

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### **B.7.3.5 EFI & Transmission Control (Holley Terminator X)\*\***

#### **1. Terminator X ECU Mount**

- Mount ECU behind glovebox (universal bracket to OEM dash panel). Secure with 4 M6 bolts.

#### **2. 4L80E Harness**

- Route and tie harness to engine wiring loom. Use protective convoluted sleeve. Clip connectors:
  - TCC solenoid (gray connector), shift solenoids (BL1 = yellow, BL2 = green), reverse light switch (blue).
- Connect "Power In" 12 V to fused IGN (10 A). Ground to chassis.

#### **3. Fuel System**

- Install Holley 15-160 high-flow pump in tank (Rust-free marine aluminum pump).
- Use AN-8 feed line (3/8" ID) from tank to engine bay.

- Mount Aeromotive 13109 regulator on firewall (vertical). Use AN-6 return line to tank.
  - Use 3/8" stainless hardline from regulator to fuel rail.
  - 4. MAF & Wideband**
    - Install Holley MAF sensor (558-106) in cold-air intake's rubber coupler.
    - Mount Innovate LC-2 wideband controller under driver's seat; sensor bung in #6 cylinder primary tube (weld bung).
  - 5. Wiring Sensors**
    - Temperature sensors:
      - Use Holley 3-bar MAP sensor (crank case): Connect to black/white on harness.
      - Use Holley coolant temp (in thermostat housing) to Holley harness pink/white.
    - Oil pressure: Install VDO 0-100 PSI sender into head port; connect to Holley oil press input (purple/red).
  - 6. Spark & Ignition**
    - Install MSD 85517 HEI distributor (magnetic pickup).
    - Route MSD 33456 wires to each spark plug. Torque plugs to 13 ft-lb.
    - Mount MSD 8461 6-Plus ignition box under drivers' kick panel, fuse at 5 A.
  - 7. Initial ECU Flash & Tuning**
    - Connect Holley USB CAN cable to laptop. Launch Holley EFI software v2.0.
    - Input engine parameters: 454 ci, compression ratio 10:1, cam specs (lift/duration).
    - Set fuel type: "Flex Fuel E85."
    - Calibrate TPS (%), IAC, and set MAF parameters (use K&N MAF table).
    - Estimate VE at 100 inHg, 196° C. Enter "350 HP" safety margin.
  - 8. 4L80E Tuning**
    - In Holley software, set transmission type: "4L80E" buffered.
    - Program shift points:
      - 1→2 @ 18 mph, 2→3 @ 38 mph, 3→4 @ 62 mph.
      - Overdrive lock-up @ 20 % throttle, release @ < 15 % throttle.
    - Save tune, "Write to ECU."
  - 9. Test & Verify**
    - Start engine, check idle at 850 rpm. Adjust idle screw on throttle body.
    - Use Holley Data Log: check O<sub>2</sub> lambda 0.98–1.02 at cruise, 0.90–0.95 under WOT.
    - Test drive: verify smooth shifts, no knock, coolant temp stable.
- 

## B.8 Underbody Thermal & Skid Protection (Recap)

- Installed Aerogel Blanket + CF Abrasion (Section A.11).
- Installed UHMW skid plates (Section A.11).

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## B.9 Electrified Accessories & Power Distribution

**Objective:** Wire, install, and verify all high-current 48 V and 12 V accessory systems (e-assist, A/C, generator, lights).

### B.9.1 Materials & Tools

- See sections A.7, B.6, C.10, and C.11 for detailed materials lists (Honda generator, Renogy solar, Victron MPPT & inverter).
- High-current fuse blocks, eyelet terminals, 6 AWG & 10 AWG cables.
- Bus bars (Aluminum, 0.25" × 30 cm) for 12 V and 48 V distribution.
- Circuit breakers (100 A for 48 V feed, 50 A for generator input, 20 A for inverter).

### B.9.2 Procedure

1. **48 V BMS & M/G Hookup (from Section B.6)**
  - Confirm all fuses in place.
  - Use multimeter to verify 52 V pack nominal.
  - Test motor assist at idle and under light throttle.
2. **Victron Orion-Tr (48 → 12 V)**
  - Mount under passenger seat near Jetson.
  - Connect 48 V battery + to Orion "IN+," "IN-" to battery -.
  - Set output dip switch to 13.8 V. Connect Orion "OUT+" to a 12 V bus bar, fused at 40 A.
3. **Honda EU3000iS Generator**
  - Tractor mount in rear cargo area on anti-vibration mounts.
  - Install 120 VAC output cable to inverter panel in cargo.
  - Secure exhaust away from body with heat shield.
  - Fill generator with 10 W-30 oil, prime, test run.
4. **Renogy 200 W Solar Panels (× 2)**
  - Mount flush on roof rack (back), angled 10° aft.
  - Wire in parallel to Renogy Rover 40 A MPPT, mounted under rear seat.
  - Rover output to 48 V battery pack positive (fuse 50 A), negative to pack negative.
5. **Victron Phoenix 48 → 120 VAC Inverter (5 kW)**
  - Mount near generator in cargo. Connect plus to 48 V battery post (via 100 A breaker) and minus to ground.
  - Output to the 4-circuit AC block for MA252s and AC outlets.
6. **DC Distribution Panel**
  - Install in engine bay fuse box area. Include:
    - 20 A fuse for 12 V IGN bus
    - 15 A fuse for Orin (12 V)
    - 10 A fuse for teensy/LED (12 V)

- 10 A fuse for security ECU (12 V)
    - 10 A fuse for Fire suppression solenoid
  - Label each fuse clearly.
7. Grounding
- All 12 V negatives land on a common 6 GA bus bar under hood.
  - All 48 V negatives land on a separate 6 GA bus bar near battery pack.

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## B.10 Interior Climate & Comfort Systems

Objective: Install heated/cooled seating, cabin aromatherapy, and ambient zone controls.

### B.10.1 Materials

Item	Supplier & URL	Qty
Heated Seat PTC Film Kit (for Front & Rear Seats)	Heat Tech: <a href="https://www.heattechinc.com">https://www.heattechinc.com</a>	5 kits (2 front, 3 rear)
Cooled Seat Ventilation Blowers (2" fans × 6)	Spal: <a href="https://www.spalusa.com">https://www.spalusa.com</a>	6 units
Aromatherapy Diffuser System (Ultrasonic)	PerfumeAir Tech: <a href="https://www.perfumeairtech.com">https://www.perfumeairtech.com</a>	1 kit
Cabin Humidity Sensor & Controller	Sensirion: <a href="https://www.sensirion.com/">https://www.sensirion.com/</a>	1 unit
PTC Door Mirror Heaters	Dorman: <a href="https://www.dormanproducts.com">https://www.dormanproducts.com</a>	2 units
Digital Climate Control Module (Retrofittable)	Dakota Digital: <a href="https://www.dakotadigital.com">https://www.dakotadigital.com</a>	1 unit



## **B.10.2 Tools**

- Upholstery staple gun
- Dremel tool (for trim openings)
- Drill & hole saw kit (for aromatherapy vents)
- 22 AWG wiring for sensor wiring
- 14 AWG wiring for PTC +12 V feeds

## **B.10.3 Procedure**

### **1. Heated & Ventilated Seats**

- Under each foam cushion, remove existing foam pad to cut channel for PTC heater film.
- Place the PTC film evenly under foam; cover with heat-resistant mesh. Patch foam on top.
- Drill 2 in holes under seat cushion for blower installation (use honeycomb grille). Mount fans blowing upward into seat cushion with rubber grommet for seal.
- Wire PTC +12 V feed to fused 10 A on DC panel (“Seat Heat”), ground to chassis.
- Wire each blower +12 V to fused 5 A line (“Seat Vent”), ground accordingly.
- Connect signals to digital climate control module in dash (Dakota Digital) via CAN. Map AUX “SeatHeat L/R,” “SeatVent L/R,” “SeatHeat Rear Center.”

### **2. Aromatherapy Diffuser**

- Cut two 50 mm holes in center console rear panel.
- Mount PerfumeAir ultrasonic module; fill reservoir with essential oil.
- Wire module to fused 2 A “Aroma” circuit (ignition-switched).
- Install small hose to vent into cabin footwells.

### **3. Cabin Humidity & Control**

- Mount Sensirion SHT35 sensor behind dashboard vent (out of direct sunlight).
- Wire I<sup>2</sup>C (SDA = pin 19, SCL = pin 18) to Teensy; power from 3.3 V (LM1117).
- Configure cabin\_climate.py on Jetson to monitor humidity; if RH > 75 %, activate “Seat Vent” blowers at 50 % duty cycle.

### **4. Door Mirror Heaters**

- Cut loop heater wires behind OEM mirror glass; solder Dorman PTC heater pads (use high-temperature epoxy).
- Wire to fused 5 A “Mirror Heater” circuit (ign) and ground to mirror bracket.

### **5. Climate Control**

- Replace OEM vacuum-actuated HVAC system with Dakota Digital HVAC panel.
- Connect temperature blend, mode doors to vacuum solenoid kit (Bosch 4 solenoid manifold + 6 ft vacuum hose).
- Mount vacuum manifold near firewall; wire solenoids to Dakota module (4 units).

- Provide +12 V fused 5 A to module.

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## V. Part C – Secret-Agent Security, Safety & Advanced Connectivity

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### C.1 Materials & Tools List

#### C.1.1 Materials

Item	Supplier & URL	Qty
Viper SmartStart Biometric Immobilizer Kit	Directed Electronics: <a href="https://directed.com/vehicle-security/viper-smartstart-biometric-system">https://directed.com/vehicle-security/viper-smartstart-biometric-system</a>	1 kit
Compustar CM25-U Ultrasonic Interior Sensor Kit	Compustar: <a href="https://compustar.com/products/">https://compustar.com/products/</a>	1 kit
Passive RF Scabbard Pouches (Faraday)	RF Lakes: <a href="https://www.rfsolutions.co.uk">https://www.rfsolutions.co.uk</a>	2 pcs
Fireboy Xintex FE-36 Clean Agent Cylinder (163121)	Fireboy-Xintex: <a href="https://www.fireboy-xintex.com">https://www.fireboy-xintex.com</a>	1 unit (2 lb)
Res-Q-Me Window Breaker & Seatbelt Cutter	Lifehammer: <a href="https://www.lifehammer.com/product/lifehammer-survival-tool/">https://www.lifehammer.com/product/lifehammer-survival-tool/</a>	1 unit

<b>Adventure Medical Trauma Pro Kit</b>	<b>Adventure Medical Kits:</b> <a href="https://www.adventuremedicalkits.com">https://www.adventuremedicalkits.com</a>	<b>1 unit</b>
<b>ZOLL AED Plus Defibrillator</b>	<b>ZOLL:</b> <a href="https://www.zoll.com/products/defibrillators/aed-plus">https://www.zoll.com/products/defibrillators/aed-plus</a>	<b>1 unit</b>
<b>Inogen One G4 O<sub>2</sub> Concentrator</b>	<b>Inogen:</b> <a href="https://www.inogen.com/portable-oxygen-concentrators/inogen-one-g4/">https://www.inogen.com/portable-oxygen-concentrators/inogen-one-g4/</a>	<b>1 unit</b>
<b>18 ga Aluminum for Vault Brackets (250 × 200 mm)</b>	<b>McMaster-Carr 89025K45:</b> <a href="https://www.mcmaster.com/89025K45">https://www.mcmaster.com/89025K45</a>	<b>2 sheets</b>
<b>Microlam S-913 EMI/RFI Shielding Foil</b>	<b>Microlam Corp.:</b> <a href="https://www.microlamcorp.com/products/microlam-s-913">https://www.microlamcorp.com/products/microlam-s-913</a>	<b>1 roll (0.5 m<sup>2</sup>)</b>
<b>McMaster 7241K71 Plano Waterproof Box (for PTS &amp; Midbox)</b>	<b>McMaster-Carr:</b> <a href="https://www.mcmaster.com/7241K71">https://www.mcmaster.com/7241K71</a>	<b>1 unit</b>
<b>BlackVue DR750S-2CH Dashcam System</b>	<b>BlackVue:</b> <a href="https://www.blackvue.com/products/dr750s-2ch">https://www.blackvue.com/products/dr750s-2ch</a>	<b>1 kit</b>
<b>Rove R2 4K 360° Interior Camera</b>	<b>Rove:</b> <a href="https://rovecam.com/products/rove-r2-4k-interior-cam">https://rovecam.com/products/rove-r2-4k-interior-cam</a>	<b>1 unit</b>

<b>EdgeLUX 10 W 940 nm IR LED Module</b>	<b>Mouser:</b> <a href="https://www.mouser.com/ProductDetail/edgelux/IR-LED-10W-940NM">https://www.mouser.com/ProductDetail/edgelux/IR-LED-10W-940NM</a>	<b>2 pcs</b>
<b>Mean Well LDD-H 24 V → 12 V 1 A LED Driver (× 2)</b>	<b>Mean Well:</b> <a href="https://www.meanwellusa.com/productPdf.aspx?i=626#">https://www.meanwellusa.com/productPdf.aspx?i=626#</a>	<b>2 units</b>
<b>Escort MAX Ci 360° Radar Detector</b>	<b>Escort Inc.:</b> <a href="https://www.escortradar.com/products/max-ci">https://www.escortradar.com/products/max-ci</a>	<b>1 unit</b>
<b>Arduino Nano Every Microcontroller</b>	<b>Arduino:</b> <a href="https://www.arduino.cc/en/Main/ArduinoBoardNanoEvery">https://www.arduino.cc/en/Main/ArduinoBoardNanoEvery</a>	<b>1 unit</b>
<b>Mini RF Noise Generator Module (2.4 GHz, 10 mW)</b>	<b>RF Solutions:</b> <a href="https://www.rfsolutions.co.uk/product/network-test/equipment/rf-noise-generator/">https://www.rfsolutions.co.uk/product/network-test/equipment/rf-noise-generator/</a>	<b>1 unit</b>
<b>Excelitas XLM2-940 nm 5 W IR LEDs (× 4)</b>	<b>Mouser:</b> <a href="https://www.mouser.com/ProductDetail/Excelitas/XLM2-940NM-5W">https://www.mouser.com/ProductDetail/Excelitas/XLM2-940NM-5W</a>	<b>4 pcs</b>
<b>Falcon Fiber-Reinforced Brake Line Extensions (½" ID)</b>	<b>Goodridge:</b> <a href="https://www.goodridge.com">https://www.goodridge.com</a>	<b>4 pcs</b>
<b>O-Ring Kit (Window Seal for Skylight)</b>	<b>GM OEM:</b> GM dealer order, P/N varies by production date	<b>1 kit</b>

<b>Dorman 926-987 Skylight Motor &amp; Cable Kit</b>	<b>Dorman:</b> <a href="https://www.dormanproducts.com/p-926987-sunroof-motor-assembly.aspx">https://www.dormanproducts.com/p-926987-sunroof-motor-assembly.aspx</a>	<b>1 unit</b>
<b>Milwaukee 6-Tool CNC Holesaw Kit (1" – 4")</b>	<b>Milwaukee:</b> <a href="https://www.milwaukeeetool.com">https://www.milwaukeeetool.com</a>	<b>1 set</b>
<b>Titan Evo Composition Headliner Fabric (Alcantara)</b>	<b>Titan Evo:</b> <a href="https://titanevo.com">https://titanevo.com</a>	<b>4 yd</b>
<b>ADAU1467 MEMS Beamforming Mic Module</b>	<b>Digikey:</b> <a href="https://www.digikey.com/product-detail/en/analog-devices-inc/ADAU1467/ADAU1467-WURZRL">https://www.digikey.com/product-detail/en/analog-devices-inc/ADAU1467/ADAU1467-WURZRL</a>	<b>1 modul e</b>
<b>Sennheiser Digital 9000 Wireless Mic System (× 2 receivers + 2 transmitters)</b>	<b>Sennheiser:</b> <a href="https://en-us.sennheiser.com/wireless-microphone-system-9000">https://en-us.sennheiser.com/wireless-microphone-system-9000</a>	<b>1 kit</b>
<b>LG 32UN880-B UltraFine 32" 4K IPS Monitor</b>	<b>LG:</b> <a href="https://www.lg.com/us/monitors/lg-32un880-b-ultrafine-monitor">https://www.lg.com/us/monitors/lg-32un880-b-ultrafine-monitor</a>	<b>1 unit</b>
<b>Logitech Brio 4K Pro Webcam</b>	<b>Logitech:</b> <a href="https://www.logitech.com/en-us/products/video-collaboration/brio.html">https://www.logitech.com/en-us/products/video-collaboration/brio.html</a>	<b>1 unit</b>
<b>FireBlock Leather Fire Extinguisher Holster</b>	<b>FireBlock by Warwick:</b> <a href="http://www.fireblockbywarwick.com/custom-holster">http://www.fireblockbywarwick.com/custom-holster</a>	<b>1 pc</b>

<b>WolfPack Armor Carbon-Fiber First-Aid Enclosure</b>	<b>WolfPack Armor:</b> <a href="https://www.wolfpackarmor.com/carbon-fiber-first-aid">https://www.wolfpackarmor.com/carbon-fiber-first-aid</a>	<b>1 unit</b>
<b>5 mm × 2 m Copper Foil Tape</b>	<b>McMaster-Carr:</b> <a href="https://www.mcmaster.com/9082T3">https://www.mcmaster.com/9082T3</a>	<b>1 roll</b>
<b>Corcom 10 A Ferrite Filters (Through-Hole)</b>	<b>Palomar Engineers:</b> <a href="https://palomar-engineers.com/product-type/ferrite-filters/">https://palomar-engineers.com/product-type/ferrite-filters/</a>	<b>10 pcs</b>
<b>Schott KR17G Ni-Zr Low-E Laminated ITO Glass (× 6 panes)</b>	<b>Schott AG:</b> <a href="https://uschott.com/products/architecture/residential-low-e-glass">https://uschott.com/products/architecture/residential-low-e-glass</a>	<b>6 panes</b>
<b>PowerWindowFilms Smart Tint (For Rear Skylight)</b>	<b>PowerWindowFilms:</b> <a href="https://powerwindowfilms.com">https://powerwindowfilms.com</a>	<b>1 sheet</b>

### C.1.2 Tools & Equipment

- HV DC power supply (0–12 kV) with insulated probes and ground rod
- HV probe multimeter (0–30 kV range)
- Oscilloscope (500 MHz) + HV attenuator (1:1000)
- TIG welder (for vault mounting under frame rails)
- MIG welder (for minor bracket welds)
- 1" hole saw & 4" hole saw
- Kevlar-reinforced cable ties, PEEK cable clamps
- Locking pliers & vice grips
- Heat gun & heat-shrink (3:1, rated 30 kV)
- CAN-bus CANalyzer or candump utility
- RFID keypad installation jig (for vault)
- Digital camera (for documenting each step)

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### C.2 Biometric & Multimodal Immobilizer

**Objective: Install Viper SmartStart with fingerprint/vein reader, shock & tilt sensors, and integrate with vehicle's CAN for start/stop interlock.**

### **C.2.1 Materials**

<b>Item</b>	<b>Supplier &amp; URL</b>	<b>Qty</b>
<b>Viper SmartStart Biometric Kit</b>	<b>Directed Electronics:</b> <a href="https://directed.com/vehicle-security/viper-smartstart-biometric-system">https://directed.com/vehicle-security/viper-smartstart-biometric-system</a>	<b>1 kit</b>

### **C.2.2 Tools**

- 10 mm & 13 mm sockets
- Drill (8 mm & 12 mm bits)
- Panel removal tool (for trim)
- T-15 Torx (for dash panel removal)
- CG-100 soldering iron (for vehicle wiring)
- Zip ties & heat-shrink

### **C.2.3 Procedure**

- 1. Dashboard Access**
  - Remove lower knee panel: 2 Philips screws under dash, carefully pull panel toward you.
  - Unbolt glovebox, remove to create extra space for wiring.
- 2. Mount Biometric Fingerprint Reader**
  - Location: Under dash, left of steering column, 40 mm × 40 mm hole at knee level.
  - Use 8 mm hole saw to cut opening in lower dash plastic.
  - Insert fingerprint reader module; fasten with supplied bracket & screws.
- 3. Install Shock & Tilt Sensors**
  - Shock Sensor: Mount under driver's seat (under cushion): use 2 M6 × 1 × 16 mm bolts to chassis.
  - Tilt Sensor: Mount on floor under passenger gloved tray (protected by skid plate).
- 4. Main Control Module**
  - Mount Viper control module behind glovebox (use supplied Velcro strip).
  - Connect harness:
    - Red (12 V constant) to battery positive (fuse 15 A).
    - Yellow (12 V IGN) to IGN bus (fuse 5 A).
    - Black (Ground) to chassis near accelerator pedal.

- Plug shock sensor lead to “Shock” port, tilt sensor lead to “Tilt” port, fingerprint reader harness to “Biometric IN.”
- 5. **Starter Interlock & Starter Relay**
  - Locate starter solenoid positive lead on steering column. Cut and insert Viper’s “Starter kill” relay harness:
    - White (To Ign wire): spliced to cut line.
    - Red/White (To Solenoid): runs to solenoid.
    - Confirm no continuity before arming.
- 6. **Shock & Tilt Sensitivity**
  - Adjust shock sensor sensitivity with trim pot on top (rotate CW for more sensitive).
  - Adjust tilt sensor: trim pot to medium.
- 7. **Programming & Testing**
  - Use Viper smartphone app: pair via Bluetooth.
  - Enroll fingerprint: 3 scans from center of pad. Enroll 2 additional backup fingerprints.
  - Test lock/unlock, remote start (if applicable), immobilizer function.
  - Ensure vehicle does not crank without fingerprint “OK.”
  - Test shock detection: tap vehicle panel lightly, alarm should trigger if armed.
  - Test tilt: jack up one corner 5 cm, alarm should trigger.

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## C.3 Ultrasonic Interior Motion & Passive RF Shielding

**Objective:** Install Compustar CM25-U interior sensors and provide Faraday pouches for passive RF (GPS) shielding.

### C.3.1 Materials

Item	Supplier & URL	Qty
Compustar CM25-U Kit	Compustar: <a href="https://www.compustar.com/products/ultrasonic-anti-carjacking-protection/">https://www.compustar.com/products/ultrasonic-anti-carjacking-protection/</a>	1 kit
RF Labs Passive Scabbard Pouches	RF Solutions: <a href="https://www.rfsolutions.co.uk/product/network-test/equipment/signal-scabbard">https://www.rfsolutions.co.uk/product/network-test/equipment/signal-scabbard</a>	2 pcs



### C.3.2 Tools

- Drill (10 mm & 20 mm bits)
- 14 AWG & 22 AWG wiring (shielded)
- Zip ties, adhesive mounts

### C.3.3 Procedure

1. Install CM25-U Control Module
    - Location: Under passenger side floor, behind kick panel (dry area). Secure with supplied Velcro strip.
    - Connect module's red lead to fused 12 V ACC (5 A), black to chassis ground.
  2. Mount Ultrasonic Pods
    - Front Pod: Under driver footwell, mount facing upward toward dash (use supplied bracket).
    - Rear Pod: Under rear passenger footwell (left side), mount facing upward to rear seats.
  3. Wiring
    - Run sensor harness to module: shielded 4-conductor cable. Label each pod.
    - Connect module "arm/disarm" wire to Viper's "AUX A1" (pending). When Viper "Armed," CM25 is active.
  4. Passive RF Scabbard Pouches
    - Place 2 pouches inside hidden vault (C.4).
    - Instruct user: to block all RF from device, place it fully inside pouch before closing vault.
  5. Testing & Sensitivity
    - Arm system via Viper. Wave hand near windshield; interior motion alarm should sound if motion > 30 cm.
    - Place a small RF tracker beacon inside the passenger seat; wrap in scabbard pouch. Confirm no GPS fix can lock.
- 

## C.4 Hidden Vault Fabrication & Installation

**Objective:** Build an EMP-shielded hidden vault (18 × 10 × 6 in) between frame rails for secure storage.

### C.4.1 Materials

Item	Supplier & URL	Qty
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<b>2 mm Aluminum Sheet (6061 T6) (250 × 200 mm pieces)</b>	<b>McMaster-Carr 89025K45:</b> <a href="https://www.mcmaster.com/89025K45">https://www.mcmaster.com/89025K45</a>	<b>2 pieces</b>
<b>Microlam S-913 EMI Foil (250 × 200 mm piece)</b>	<b>Microlam Corp.:</b> <a href="https://www.microlamcorp.com/products/microlam-s-913">https://www.microlamcorp.com/products/microlam-s-913</a>	<b>1 roll</b>
<b>RFID Keypad (125 kHz EM) with mag-lock (V-Lock)</b>	<b>Cushcraft Security:</b> <a href="http://www.cushcraftsecurity.com/v-lock-rfid">http://www.cushcraftsecurity.com/v-lock-rfid</a>	<b>1 unit</b>
<b>M6 × 1 × 20 mm Stainless Bolts + Nylock Nuts</b>	<b>McMaster-Carr: P/N 91279A140</b>	<b>8 pcs</b>
<b>Marine-Grade Silicone RTV Sealant (High temp)</b>	<b>McMaster-Carr: P/N 46625A35</b>	<b>1 tube</b>

#### C.4.2 Tools

- TIG welder (for aluminum bracket welds)
- 6 mm & 8 mm drills (for mounting holes)
- CNC router or jigsaw (for vault cutout)
- Multimeter (50 MHz) for continuity testing

#### C.4.3 Procedure

##### 1. Vault Shell Fabrication

- **Cut Aluminum Panels**
  - Cut two side panels (Al sheet 2 mm, 20 × 9 in), two end panels (20 × 6 in), top panel (18 × 10 in), bottom panel (18 × 10 in).
- **EMI Foil Lining**
  - Line interior of each panel with Microlam S-913 foil: cut foil to match panel dimensions, adhere with silicone RTV. Overlap seams by 20 mm.
- **Weld Enclosure**
  - Tack-weld side & end panels using TIG (Aluminum filler rod ER4043) at corners. Keep heat low (~ 80 A).

- Weld top to sides, then bottom last. Maintain 2 mm continuous seams.
  - Grind welds flush with 120 grit ceramic wheel.
- 2. Access Hatch
  - Cut 18 × 9 in aperture in top panel. Twist hinge side (Al piano hinge, 18 in) to allow top panel to fold open.
  - On front edge, install Cushcraft “V-Lock” RFID mag-lock with bracket.
  - Fit top panel to hinge; weld hinge to side panel and attach lock mount.
- 3. Mount Vault Under Vehicle
  - Frame Rail Survey
    - Use inspection camera to verify space between frame rails (18 in L × 10 in W × 6 in H) between rear seat crossmember & gas tank.
  - Install Aluminum Brackets
    - Fabricate two L-brackets (3 mm Al, 8 × 8 in). Weld one end to frame rail (underneath), oriented horizontally. Ensure straight.
  - Bolt Vault
    - Place vault onto brackets; drill through bracket & vault bottom with 6 mm bit.
    - Bolt with M6 × 1 × 20 mm bolts + nylock nuts. Four bolts per bracket.
- 4. RFID Keypad & Power
  - Run 18 AWG +12 V (fused 1 A) from interior fuse panel (labeled “Vault RFID”) to keypad.
  - Ground keypad to vault chassis (drill 8 mm hole; use M6 bolt).
- 5. Electromagnetic Testing
  - With vault closed and locked, apply 1 kV AC at 60 Hz between interior foil and exterior foil; measure < 1 Ω.
  - Place small UHF GPS beacon inside; attempt GPS fix; beacon should not transmit outside.

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## C.5 Camera Network (Dash & 360° Interior)

**Objective:** Install discreet front/rear dashcams and 360° interior camera for full coverage, all wired to Jetson for recording, live streaming, and event logging.

### C.5.1 Materials

Item	Supplier & URL	Qty
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<b>BlackVue DR750S-2CH Dashcam + Hardwire Kit</b>	<b>BlackVue:</b> <a href="https://www.blackvue.com/products/dr750s-2ch">https://www.blackvue.com/products/dr750s-2ch</a>	<b>1 kit</b>
<b>Rove R2 4K 360° Interior Camera</b>	<b>Rove:</b> <a href="https://rovecam.com/products/rove-r2-4k-interior-cam">https://rovecam.com/products/rove-r2-4k-interior-cam</a>	<b>1 unit</b>
<b>16 GB High-Endurance MicroSD Card (× 2)</b>	<b>SanDisk:</b> <a href="https://www.sandisk.com">https://www.sandisk.com</a>	<b>2 pc</b>
<b>4 Pin Hardwire Kit (for DR750S)</b>	<b>BlackVue:</b> included in kit	<b>1 kit</b>
<b>USB 3.0 High-Endurance Cable (Type-C to Male Micro-B)</b>	<b>Amazon:</b> generic shielded cable	<b>1 pc</b>
<b>3 M Adhesive Zip-Tie Mounts (#18219A35)</b>	<b>McMaster-Carr:</b> <a href="https://www.mcmaster.com/18219A35">https://www.mcmaster.com/18219A35</a>	<b>10 pcs</b>

### **C.5.2 Tools**

- Drill (2 mm & 6 mm bits)
- Heat-shrink tubing (3:1, 3 mm & 5 mm)
- Plastic trim removal tools
- Multimeter (for power verification)
- Torx T20 & T25 bits

### **C.5.3 Procedure**

- 1. Front Dashcam (BlackVue DR750S)**
  - Mounting
    - Clean windshield area behind rearview mirror.
    - Use supplied adhesive bracket; adhere DR750S camera behind mirror aligning with center of windshield.
  - Hardwiring

- Remove driver's A-pillar trim (pull gently).
    - Drill 6 mm hole near A-pillar's base to pass hardwire cable.
    - Connect DR750S "red" wire to fused "ACC" 12 V (quick splice to fuse "ACC").
    - Connect "yellow" wire to constant 12 V (battery +; splice to fuse "BATTERY").
    - Connect "black" to chassis ground (bolt to unsanded body panel).
  - Video Out to Jetson
    - Use USB 3.0 micro-B port: run 1 m high-endurance shielded USB 3.0 cable to Jetson USB port.
  - Test
    - Thumb drive with video cuts. Insert, record test clip, retrieve.
  - 2. Rear Dashcam (BlackVue)
    - Mount rear camera under cargo headliner (12 cm × 5 cm) using adhesive. Aim at rear window.
    - Tuck cable into headliner, down C-pillar, under trim, to front DR750S hardware kit.
  - 3. 360° Interior Camera (Rove R2)
    - Mounting
      - Remove headliner panel: remove six 10 mm bolts, pull down headliner enough to reach mounting location (center, above front seats).
      - Cut 120 × 40 mm hole; insert Rove R2. Glue with silicone RTV.
    - Power & Data
      - Connect 12 V "PARKING MIRROR" fused 5 A to R2's red wire.
      - Ground R2 black wire to chassis.
      - Connect R2's USB output (mini-B) to Jetson's USB hub.
  - 4. Configuration & Software
    - On Jetson, install BlackVue API (pip3 install blackvue).
    - Write camera\_manager.py to:
      - Monitor storage usage.
      - Record continuous 1080p at 30 fps from front/rear, 4K interior at 15 fps.
      - On "Panic" push, upload last 60 s to cloud via Starlink.
- 

## C.6 Fire Suppression & Emergency Tools Integration

Objective: Integrate FE-36 clean agent system, fire blanket, Res-Q-Me tools, and ensure accessibility yet hidden behind luxury appointments.

### C.6.1 Materials

Item	Supplier & URL	Qty
Fireboy Xintex FE-36 Cylinder & Control Kit	Fireboy Xintex: <a href="https://www.fireboy-xintex.com">https://www.fireboy-xintex.com</a>	1 unit
1 m of FE-36 Delivery Hose (+ nozzle)	Fireboy Xintex: included	1 unit
Res-Q-Me Window Breaker & Seatbelt Cutter	Lifehammer: <a href="https://www.lifehammer.com/product/lifehammer-survival-tool/">https://www.lifehammer.com/product/lifehammer-survival-tool/</a>	1 unit
Fire Blanket (32" Kevlar Weave, spring-loaded)	McMaster-Carr 7889A74: <a href="https://www.mcmaster.com/7889A74">https://www.mcmaster.com/7889A74</a>	1 pc

#### C.6.2 Tools

- Drill (8 mm & 12 mm bits)
- Silicone sealant (Hi-temp)
- 14 AWG wiring & 5 A fuse holder
- Zip ties & metal clamp brackets

#### C.6.3 Procedure

##### 1. Mount FE-36 Cylinder

- Location: Behind driver's side rear seat, under carpeting.
- Fabricate Bracket:
  - Use 16 ga steel angle bracket (50 × 50 mm) welded to frame rail.
  - Drill 6 mm holes in cylinder bracket collar; bolt to angle bracket with M6 × 1 × 20 mm SS bolts, torque 8 ft-lb.
- Route Delivery Hose
  - Run 1 m hose along B-pillar, through firewall, outlet nozzle into engine bay. Secure hose with PEEK clamps.
- Control & Activation
  - Install manual pull T-handle under steering column (< 10 cm from driver's left knee) in a 20 × 20 mm hole.

- Wire a 14 AWG +12 V (fused 5 A) from “ACC” bus to solenoid. Connect ground to chassis.
  - Thermal link (set at 175 °F): mount in engine bay near intake manifold.
2. Res-Q-Me & Seatbelt Cutter
    - Mount near driver’s door side kick panel: cut a 60 × 40 mm hole; install rubber-coated clip for Res-Q-Me tool.
    - Ensure “Cut Here” decal is visible.
  3. Fire Blanket Deployment
    - Under passenger footwell (behind kick panel), mount spring-loaded canister containing Kevlar fire blanket.
    - Drill 20 × 20 mm hole in kick panel; install “Step To Deploy” foot pedal.
    - Pulling foot pedal releases blanket into footwell.
  4. Testing
    - Ignite small propane torch under hood (controlled) to trigger thermal link; verify FE-36 discharges.
    - Yank T-handle manually; verify agent flow.
    - Press foot pedal: blanket pops into footwell.

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## C.7 First-Aid, Defibrillator & O<sub>2</sub> Integration

**Objective:** Integrate first-aid & trauma kit, portable defibrillator, and O<sub>2</sub> concentrator behind luxury panels.

### C.7.1 Materials

Item	Supplier & URL	Qty
Adventure Medical Trauma Pro Kit	Adventure Medical Kits: <a href="https://www.adventuremedicalkits.com">https://www.adventuremedicalkits.com</a>	1 kit
WolfPack Armor Carbon-Fiber First-Aid Enclosure	WolfPack Armor: <a href="https://www.wolfpackarmor.com">https://www.wolfpackarmor.com</a>	1 unit
ZOLL AED Plus Defibrillator & Accessories	ZOLL: <a href="https://www.zoll.com/products/defibrillators/aed-plus">https://www.zoll.com/products/defibrillators/aed-plus</a>	1 unit

<b>Kevlar-lined Leather Defibrillator Pouch</b>	<b>Custom from FireTech: <a href="https://firetechcomposites.com">https://firetechcomposites.com</a></b>	<b>1 unit</b>
<b>Inogen One G4 O<sub>2</sub> Concentrator</b>	<b>Inogen: <a href="https://www.inogen.com">https://www.inogen.com</a></b>	<b>1 unit</b>
<b>Leather-covered O<sub>2</sub> Cannula Dock</b>	<b>Custom from Master Upholstery (CA)</b>	<b>1 unit</b>

### **C.7.2 Tools**

- **Drill (10 mm & 20 mm bits)**
- **Rivet gun & rivets (blind, #6)**
- **14 AWG wire (oxygen concentrator power)**
- **RJ45 Ethernet cable for remote monitoring**

### **C.7.3 Procedure**

- 1. Install First-Aid Enclosure**
  - **Under cargo floor (beneath koa wood floor), cut a 12 × 8 in rectangle.**
  - **Insert WolfPack Armor carbon-fiber box (10 × 6 × 4 in). Secure with concealed push-latch.**
  - **Place Adventure Medical Trauma Pro Kit inside enclosure.**
- 2. Defibrillator Mount & Pouch**
  - **Behind driver's kick panel: cut 10 × 6 in opening.**
  - **Install leather-trimmed Kevlar pouch; secure with two M6 × 1 × 20 mm bolts through inner bracket.**
  - **Place ZOLL AED Plus in pouch; route paddle cables to front dash cavity.**
- 3. Inogen O<sub>2</sub> Concentrator Dock**
  - **Under glovebox on passenger side: create 6 × 4 in recess.**
  - **Fit leather-covered dock; bolt through floor with M6 × 30 mm screws.**
  - **Place O<sub>2</sub> concentrator; route nasal cannula tubing under carpet to driver seat (quick disconnect PK1 connector).**
- 4. Power & Wiring**
  - **AED: 120 VAC power from inverter (120 V "Emergency AC" circuit).**
  - **O<sub>2</sub> Concentrator: +12 V fused 15 A from house bus. Ground to chassis.**
  - **Install an "Emergency Power" toggle switch under dash to power O<sub>2</sub>.**
- 5. Testing**
  - **Turn ignition OFF, toggle emergency switches:**
    - **Check AED self-test (green light).**



- Check O<sub>2</sub> pump runs—verify flow  $\geq 2$  L/min.

## C.8 EMP/EMI Hardening (Interior & Wiring)

**Objective:** Wrap the interior cabin, wiring harnesses, and critical modules with Faraday-like shielding to block EMP, reduce EMI in and out.

### C.8.1 Materials

Item	Supplier & URL	Qty
Copper Foil Tape (0.05 mm × 10 mm × 5 m)	McMaster-Carr 9082T3: <a href="https://www.mcmaster.com/9082T3">https://www.mcmaster.com/9082T3</a>	2 rolls
MG Chemicals 419C EMI Silicone Sealant (40 mL)	Digi-Key: <a href="https://www.digikey.com/product-detail/mg-chemical/419C-40ML/">https://www.digikey.com/product-detail/mg-chemical/419C-40ML/</a>	2 tubes
Corcom 10 A Ferrite Filters (Through-Hole)	Palomar Engineers: <a href="https://palomar-engineers.com/product-type/ferrite-filters/">https://palomar-engineers.com/product-type/ferrite-filters/</a>	10 pcs
22 AWG & 18 AWG Teflon-Insulated Wires (shielded)	Belden: <a href="https://www.belden.com/products/ci-cable">https://www.belden.com/products/ci-cable</a>	10 m
3M EMI Gasket (Silver G-10429)	McMaster-Carr: <a href="https://www.mcmaster.com/8339A46">https://www.mcmaster.com/8339A46</a>	1 ft

### C.8.2 Tools

- Foam roller (for tape adhesion)
- Heat gun (for silicone flow)
- Wire loom (PEEK sleeve)
- Pliers (for installing ferrites on cables)

### C.8.3 Procedure

1. **Copper Foil Seams**
  - Under headliner: peel back headliner cloth from roof bows.
  - Apply Cu foil tape along roof perimeter seams (25 mm overlap). Press firmly with foam roller.
  - Overlap joints by 10 mm; seal edges with MG Chemical 419C.
2. **Door Panel Interiors**
  - Remove door cards. Line interior cavity with Cu foil (entire inner metal skin).
  - Overlay door harness's connector area with 3M G-10429 EMI gasket for door harness pass-through.
3. **Dashboard & Kick Panels**
  - Under dash, wrap entire firewall side (behind dash) with Cu foil, extending to cowl.
  - Under driver's kick, wrap footwell sides with Cu foil.
4. **Wiring Harness Ferrites**
  - On every major harness (Holley ECU power, Jetson Orin power, M/G CAN), snap on a Corcom 10 A ferritering near entry to protected area.
  - For USB & audio cables entering Jetson enclosure, wrap with foil shielding and use a ferrite at entry.
5. **Verification**
  - Using handheld RF generator (1 MHz–2 GHz sweep) outside vehicle, measure interior RF field: should be  $\leq -80$  dBm across bands with all windows closed.
  - Use Gauss meter inside cabin to confirm magnetic shielding:  $< 0.5$  mG external field transmits.

---

## C.9 License-Plate IR & RF Jamming System

**Objective:** Install an Escort MAX Ci radar detector that triggers a 940 nm IR floodlight behind a hinged license-plate bracket, plus optional 2.4 GHz noise emitter.

### C.9.1 Materials

Item	Supplier & URL	Qty
Escort MAX Ci 360° Radar Detector	Escort: <a href="https://www.escortradar.com/products/max-ci">https://www.escortradar.com/products/max-ci</a>	1 unit

<b>Arduino Nano Every Microcontroller</b>	<b>Arduino:</b> <a href="https://www.arduino.cc/en/Main/ArduinoBoardNanoEvery">https://www.arduino.cc/en/Main/ArduinoBoardNanoEvery</a>	<b>1</b> <b>unit</b>
<b>EdgeLUX 10 W 940 nm IR LED Modules (× 2)</b>	<b>Mouser:</b> <a href="https://www.mouser.com/ProductDetail/edgelux/IR-LED-10W-940NM">https://www.mouser.com/ProductDetail/edgelux/IR-LED-10W-940NM</a>	<b>2</b> <b>pcs</b>
<b>2.4 GHz Mini RF Noise Generator (10 mW)</b>	<b>4RF Solutions:</b> <a href="https://www.rf-solutions.co.uk/product/network-test/equipment/rf-noise-generator">https://www.rf-solutions.co.uk/product/network-test/equipment/rf-noise-generator</a>	<b>1</b> <b>unit</b>
<b>Welded Stainless Steel Hinged License Plate Bracket</b>	<b>McMaster-Carr 1123K45:</b> <a href="https://www.mcmaster.com/1123K45">https://www.mcmaster.com/1123K45</a>	<b>1</b> <b>unit</b>
<b>M3 Screw Kit (for Arduino mount)</b>	<b>McMaster-Carr 91265A029:</b> <a href="https://www.mcmaster.com/91265A029">https://www.mcmaster.com/91265A029</a>	<b>8</b> <b>pcs</b>
<b>5 V → 5 V buck converter (for LED power)</b>	<b>LM2596 module: Amazon generic</b>	<b>1</b> <b>unit</b>
<b>MOSFET IRLZ44N (100 V, 47 A) (for LED switching)</b>	<b>Digi-Key:</b> <a href="https://www.digikey.com/product-detail/peace-of-mind/IRLZ44N">https://www.digikey.com/product-detail/peace-of-mind/IRLZ44N</a>	<b>2</b> <b>pcs</b>
<b>10 kΩ Pull-Down Resistors (for MOSFET gate)</b>	<b>Digi-Key: generic</b>	<b>5</b> <b>pcs</b>

<b>2 mm Insulated Copper Wire (24 AWG)</b>	<b>Belden: generic</b>	<b>10 m</b>
<b>5 A Slow-Blow Fuse Holder (inline)</b>	<b>Littelfuse: <a href="https://www.littelfuse.com">https://www.littelfuse.com</a></b>	<b>1 unit</b>
<b>12 V 24 AWG Relay (12 V coil, SPDT)</b>	<b>Omron: <a href="https://www.omron.com">https://www.omron.com</a></b>	<b>1 unit</b>

### C.9.2 Tools

- Drill (6 mm & 8 mm bits)
- Soldering station (25 W, fine tip)
- Heat-shrink tubing (3:1, 3 mm & 5 mm)
- Multimeter & oscilloscope (for TTL verification)
- Wire strippers & crimpers (24–16 AWG)

### C.9.3 Procedure

1. Install Escort MAX Ci
  1. Mounting
    - Under dash to left of steering column (using supplied bracket). Ensure unobstructed view of windshield.
    - Run coax cable to stealth antenna (mounted behind grill, 40 cm from hood's centerline).
  2. Power & Ground
    - Connect "Red" to Ign SW IGN (12 V ACC) (fuse 10 A).
    - Connect "Yellow" to 12 V Constant (BATT) (fuse 10 A).
    - Connect "Black" to chassis ground (bare metal).
2. Mount Arduino Nano Every
  1. Location: Under passenger dash behind glovebox (use small PEEK bracket).
  2. Secure with 4 M3 × 0.5 × 10 mm screws.
  3. Connect 5 V from LM2596 buck (fused 2 A) to VIN. Ground to chassis.
3. EdgeLUX IR LED Installation
  1. Prepare Hinged Plate Bracket
    - Remove factory plate. Weld aluminum hinge to top of stainless frame such that plate flips upward 120°.
    - Attach plate to hinge, ensure smooth travel.
  2. Mount IR LED

- Drill two 5 mm holes behind top center of plate (30 mm apart).
  - Bolt two EdgeLUX modules (10 W 940 nm each) at 30° downward angle. Use M4 × 0.7 × 25 mm SS bolts, torque 6 ft-lb.
  - Solder LED's + (red) wire to insulated 12 V feed (fuse 5 A), – (black) to chassis ground.
4. Connect Radar-to-Arduino TTL
    1. Escort MAX Ci has a “K-Band Alert” TTL output on harness pin “Out” (white/green). Splice this to Arduino pin D2 (Arduino ground to chassis).
    2. Pull-down resistor (10 kΩ) from D2 to GND on Arduino.
  5. MOSFET & RF Noise Emitter Wiring
    1. IR LED Switching
      - Tie LED module +12 V to always +12 V (fuse 5 A).
      - Connect LED – to drain of IRLZ44N MOSFET. Source → ground. Gate driven by Arduino pin D9 via 100 Ω resistor. Add 10 kΩ gate → GND.
    2. Optional RF Noise Emitter
      - Mount “Mini RF Noise Gen” behind IR LEDs (in plate cavity).
      - Feed 5 V to RF GEN via LM2596 buck (fused 1 A).
      - Connect RF GEN “TX Enable” line to Arduino D10.
  6. Arduino Firmware

```

const int radarPin = 2;

const int irGatePin = 9;

const int rfGatePin = 10;

void setup() {

  pinMode(radarPin, INPUT);

  pinMode(irGatePin, OUTPUT);

  pinMode(rfGatePin, OUTPUT);

  digitalWrite(irGatePin, LOW);

  digitalWrite(rfGatePin, LOW);

}

void loop() {

  if (digitalRead(radarPin) == HIGH) {

    digitalWrite(irGatePin, HIGH);

    digitalWrite(rfGatePin, HIGH); // optional
  }
}

```

```

    delay(500); // 0.5s pulse

    digitalWrite(irGatePin, LOW);

    digitalWrite(rfGatePin, LOW);

}

delay(50); // poll 20 × / s

}

```

- Compile & upload via micro-USB.

#### 7. Testing

- Power up Escort: ensure LED on console glows green.
- Use K-Band hand-held radar at ~ 50 ft; when Escort beeps, Arduino toggles D9 HIGH → IR LED flood for 0.5 s.
- Use smartphone camera (1080p) to confirm plate is invisible.
- If RF generator used, confirm no interference with vehicle radios, and output  $\leq 10$  mW at 2.4 GHz.

---

## C.10 Underbody IR Strobes Installation

**Objective:** Install 940 nm IR strobe modules under front/rear, to blind NVG cameras.

### C.10.1 Materials

Item	Supplier & URL	Qty
Excelitas XLM2-940 nm 5 W IR LED Modules (× 4)	Mouser: <a href="https://www.mouser.com/ProductDetail/Excelitas/XLM2-940NM-5W">https://www.mouser.com/ProductDetail/Excelitas/XLM2-940NM-5W</a>	4 pcs
Mean Well LDD-H 24 V → 12 V 1 A LED Driver Modules (× 4)	Mean Well: <a href="https://www.meanwellusa.com/productPdf.aspx?i=626">#</a>	4 pcs

<b>Arduino Nano Every (existing from C.9)</b>	<b>Arduino:</b> <a href="https://www.arduino.cc/en/Main/ArduinoBoardNanoEvery">https://www.arduino.cc/en/Main/ArduinoBoardNanoEvery</a>	<b>1 unit</b>
<b>24 V → 12 V Buck Converter (for Mean Well input) (× 4)</b>	<b>Amazon: generic LM2596 module</b>	<b>4 units</b>
<b>10 kΩ Pull-Down Resistors (for LED driver enable)</b>	<b>Digi-Key: generic</b>	<b>8 pcs</b>
<b>10 m Heat-Shrink Tubing (3:1, 30 kV rating)</b>	<b>McMaster-Carr: <a href="https://www.mcmaster.com/5512K33">https://www.mcmaster.com/5512K33</a></b>	<b>1 roll</b>

### C.10.2 Tools

- 2 mm dia drill bit (pilot holes)
- 5 mm hole saw (for cable pass)
- Soldering station (25 W)
- Kevlar cable sleeves
- 12 AWG wiring for 24 V supply

### C.10.3 Procedure

#### 1. Mount IR LED Housings

- **Front Bumper Undertray (2 modules):**
  - Remove front bumper lower valance.
  - Identify 2 locations behind lower grille openings ( ≈ 20 cm from center).
  - Drill 8 mm pilot holes, bolt PEEK mounting bracket for each LED. Angle module to 15° downward, 30° outward.
- **Rear Bumper Undertray (2 modules):**
  - Similarly, mount 2 modules under rear bumper (≈ left/right corners), angled 45° downward.

#### 2. 24 V Power Supply Routing

- From vehicle's 48 V pack, tap into 24 V buck converter (set to 24 V out) fused at 5 A.

- Run 12 AWG + wire from buck → distribution point under front bumper, split to 2 Mean Well drivers.
  - For rear, run a separate 12 AWG + from buck to rear bumper area.
3. Mean Well LDD-H Driver Configuration
- For each module:
    - Input +: from 24 V buck. Input – → ground.
    - LDD-H “SET” potentiometer → adjust current to 500 mA (max for 5 W LED).
    - EN (enable pin): wire to Arduino pin D11 (shared for both front modules), with a 10 kΩ pull-down to ground.
    - Output + → IR LED +; Output – → IR LED –. Heat sink LDD-H, ensure thermal pad.
4. Arduino Code Update
- Add new pin const int irUnderPin = 11; in existing sketch.
  - Modify code (see C.9).
5. Wiring
- Connect Arduino D11 → 10 kΩ to each LDD-H EN.
  - Connect grounds together (LED – → LDD-H – → Arduino GND).
  - Use Kevlar sleeves on 24 V lines underbody.
6. Testing
- Power 24 V buck; with Arduino idle, D11 LOW, ensure no LED emission.
  - Trigger D11 HIGH (via button on Arduino or simulated radar signal): measure 0.5 s strobe, verify 940 nm IR visible through NVG or camera.

---

## C.11 AR HUD & Interactive Controls

**Objective:** Install a Continental AR-HUD module on windshield and integrate gesture/TCS3472 lighting controls.

### C.11.1 Materials

Item	Supplier & URL	Qty
Continental AR-HUD Module	Continental Automotive: <a href="https://continental-automotive.com/en/arsolutions/hud">https://continental-automotive.com/en/arsolutions/hud</a>	1 unit



<b>OLED Touchscreen (7", 800 × 480) for dash controls</b>	<b>Adafruit:</b> <a href="https://www.adafruit.com/product/2718">https://www.adafruit.com/product/2718</a>	<b>1 unit</b>
<b>4 × PWM-Capable Pushbuttons (LED backlit)</b>	<b>SparkFun:</b> <a href="https://www.sparkfun.com/products/15944">https://www.sparkfun.com/products/15944</a>	<b>4 pcs</b>
<b>Custom 3D-Printed Enclosure for HUD CPU</b>	<b>Protolabs:</b> <a href="https://www.protolabs.com/3d-printing/">https://www.protolabs.com/3d-printing/</a>	<b>1 unit</b>
<b>RJ45 &amp; USB C Tethers (10 ft) for HUD data/power</b>	<b>Amazon: generic Cat6 &amp; USB cable</b>	<b>1 each</b>

### C.11.2 Tools

- 30 mm hole saw (for dash install)
- 20 mm hole saw (for pushbuttons)
- Plastic laminate adhesive (for HUD bracket)
- Calibration 3 × 3 grid pattern (print)

### C.11.3 Procedure

#### 1. Windshield AR-HUD Installation

##### 1. Mounting Plate

- Clean inside windshield (driver side).
- Apply 3M VHB #4936 foam tape to HUD plate.
- Align plate so HUD projects at driver's eye level (20 ° downward reflect). Press firmly for 30 sec.

##### 2. Brackets

- Attach mounting bracket to dash top via two M5 × 0.8 × 15 mm screws into dash foamboard. Use metal bushings to distribute load.
- Slide HUD module onto bracket rail.

#### 2. HUD CPU & Cables

1. Mount CPU in 3D-printed enclosure under center console (forward).
2. Run HDMI (or DisplayPort) cable to HUD module; secure with velcro.
3. Connect power (12 V IGN fused 5 A) to CPU; ground to chassis.

#### 3. Calibration

1. Power on HUD. On Jetson: run `./hud_calibrate.py`:

- Displays a 3 × 3 white grid on Jetson screen.
  - Adjust HUD remote tilt until each point aligns with printed calibration grid taped to dashboard.
  - Save calibration file to /home/ubuntu/HUD/calib.txt.
4. Dash-Mounted Touchscreen & Buttons
1. Cut Dash Panel
    - In left center dash panel, cut 150 × 100 mm rectangle for 7" OLED screen.
    - Below, cut 10 mm holes for 4 pushbuttons (aligned horizontally).
  2. Mount Controls
    - Insert touchscreen; secure with brackets. Connect to Jetson via USB C (power from 5 V buck, HDMI/DSI from Orin).
    - Pushbuttons: solder each to 22 AWG wire (ground & signal). Signal lines to Teensy (pins 14–17). Ground to chassis.
  3. Label Buttons (UV-etched panel)
    - “Mode,” “Volume,” “Next,” “Back.”
  4. Teensy Firmware Update
    - In existing gauge\_backlight.ino, add:

```
const int btnMode = 14; // toggle lamp mode
```

```
const int btnVolUp = 15; // gesture override
```

```
const int btnNext = 16; // next track
```

```
const int btnBack = 17; // prev track
```

```
void setup() {
```

```
  // existing code...
```

```
  pinMode(btnMode, INPUT_PULLUP);
```

```
  pinMode(btnVolUp, INPUT_PULLUP);
```

```
  pinMode(btnNext, INPUT_PULLUP);
```

```
  pinMode(btnBack, INPUT_PULLUP);
```

```
}
```

```
void loop() {
```

```

// existing CAN processing...

// button checks:

if (digitalRead(btnMode) == LOW) {

    // cycle lighting mode: send CAN 0x124, data[0]++

    delay(200); // debounce

}

if (digitalRead(btnVolUp) == LOW) {

    // send CAN 0x125 [0x03] for vol up

    delay(200);

}

if (digitalRead(btnNext) == LOW) {

    // send CAN 0x125 [0x01]

    delay(200);

}

if (digitalRead(btnBack) == LOW) {

    // send CAN 0x125 [0x02]

    delay(200);

}

// existing Radar to IR code...

}

```

#### 4. Testing

- Power on Jetson; launch `gesture_control.py` and `color_manager.py`.
  - On touchscreen: test UI:
    - “Lighting Mode” toggles gauge/ambient lighting modes.
    - “Audio Track” scrubbing, “Volume” slider.
  - Press buttons: ensure correct CAN frames emitted and Jetson responds.
-

## C.12 Final QA, Testing & Alignment

**Objective:** Validate integration of all systems (electronic, mechanical, defensive, audio, environmental) and certify for performance, safety, and reliability.

### 1. Paint & Armor QA

- **Primer Continuity:** Check multiple spots with 4-Wire Resistivity (target < 0.05  $\Omega$ ).
- **Dielectric Constant:** Re-measure between hood & door cust; CIE at 1 kHz: 0.2 nF.
- **Ballistic Test:** With magazine 9 mm FMJ @ 15 ft: no penetration in Coat 3 zone.
- **Reactive Arc Verification:** Trigger discharge via Jetson “Discharge Now”; confirm 5 kV pulse across spike electrodes, visible plasma at rods.

### 2. Suspension Dump Test

- **Raise vehicle to full bump travel;** inspect coilovers for binding.
- **Lower to full droop:** confirm springs settle, no bottoming.

### 3. Alignment

- **Four-wheel alignment** (see A.14). Confirm front camber, caster, toe within specifications.

### 4. Engine & EFI

- **Start engine; allow warm-up. Monitor:**
  - **Idle stability:** 850 rpm  $\pm$  25 rpm
  - **O<sub>2</sub> sensors:** stable at lambda 0.98–1.02
  - **No check-engine codes.**
- **Drive on dyno:** log torque curve, ensure 450 ft-lb @ 3 000 rpm. Confirm emissions < CARB limits (HC < 150 ppm, CO < 1 %).

### 5. e-Assist & Hybrid

- **Verify at idle:** B-1000 M/G in generator mode, charging 48 V pack.
- **On acceleration < 30 mph:** B-1000 supplies 3 kW torque, smoother acceleration.
- **Run regen:** back-off throttle, confirm ~ 5 A regen current to pack.

### 6. Audio System

- **Play reference audio** (24-bit 44.1 kHz). Measure THD+N: < 0.01 %.
- **Test front/rear/sub splash:** ensure correct levels, minimal distortion.
- **Emergency “Panic” mode:** test that PTT mic activates MVP901, broadcast through horn at 120 dB.

### 7. Security Systems

- **Test biometric immobilizer:**
  - **With car off,** attempt start → no crank until fingerprint recognized.
  - **Remove fingerprint reader harness** → no start.
- **Test ultrasonic interior detection:**
  - **Arm system,** simulate motion in cabin → alarm triggers.
- **Test passive RF scabbard:**

- Place small cell phone inside pouch → no signal (use phone's radio test app).

#### 8. Cameras & HUD

- Drive at night: test underbody IR strobes via Jetson "Discharge Now" command; NVG user to verify "blinding."
- Test dash-cameras: record front, rear, interior loops. Play back on Jetson.
- Activate AR HUD: confirm clear overlay is stable with speed & navigation data.

#### 9. Emergency Systems

- Fire suppression: place small propane torch under hood, wait for thermal link → FE-36 discharge.
- Fire blanket: step on pedal → blanket deploys.
- AED test mode: power on, check self-test battery health.
- O<sub>2</sub> concentrator: run at 2 L/min, check readings.

#### 10. Final Inspection

- Check all fluid levels (engine oil, trans fluid, coolant, A/C).
- Inspect wheels/tire torque: 100 ft-lb for wheels; 80 ft-lb for lug studs.
- Inspect underbody: ensure no loose cables or harnesses.
- Verify nanocoatings intact on leather, wood, exterior.

## VI. Part D – Additional Optional Upgrades

*(For future-proofing; optional but recommended for ultimate capability.)*

### D.1 Magnetic-Levitation Steering Rim

- Proto-Mag MagLev Steering Rim (fits standard GM column).
- Supplier: Proto-Mag Corp: <https://prot-mag.com/products/levitating-steering-rim>
- Installation:
  1. Remove OEM steering wheel (record steering angle).
  2. Mount magnetic stator ring using custom bracket.
  3. Align Proto-Mag rim with O-ring seal to stator.
  4. Connect power (12 V, fused 3 A) to magnetic coil driver under dash.
  5. Install control module to maintain stable "floating" at idle.

### D.2 Self-Cleaning Ionic Glass & Smart Tint

- Gentex ClearVu (already installed). For rear skylight: apply PowerWindowFilms Smart Tint between LiFi film and interior headliner.

Procedure (Rear Skylight)

1. Remove rear skylight glass (Section A.10).
2. Place ITO LiFi film on inner side, overlay Smart Tint sheet on interior side.
3. Reinstall glass with OEM gasket. Wire Smart Tint's 12 V + to fused 5 A "Glass Tint" circuit.
4. Test tint: with 12 V applied, glass transitions to opaque; power off → clear.

### D.3 Nanoperf "Smart Mesh" Seat Overlays

- Schoeller SmartTex Nanoperf Fabric overlay for seats.
- Supplier: Schoeller: <https://www.schoellertextiles.com/en/products/smarttex>
- Installation:
  1. After leather installation, stretch a layer of Nanoperf fabric over seats.
  2. Re-staple edges beneath seat pan using upholstery stapler.

### D.4 AR-Enabled Heads-Up Display

- Already installed in Part C.11. For future, add facial recognition shutter for privacy.

### D.5 EV-Axle Pre-Bracket Kit

- Zelectric EV Axle Bracket (for future electric rear differential).
- Supplier: Zelectric Motors: <https://zelectric.com/ev-axle-kits>
- Installation:
  1. Weld L-bracket mounts under frame rails near rear differential crossmember.
  2. Verify bolt pattern (4 × M12 × 1.5 holes) lines up with Zelectric axle.

---

## VII. Appendices

---

### A. Torque Specifications

Component	Torque	Fastener
Cylinder head bolts (ARP 254-1001)	30 ft-lb, 60 ft-lb, 90 ft-lb + 4 × 90°	M12 × 1.25

<b>Rocker arm nuts (3/8" stud, 3/8" nut)</b>	<b>35 ft-lb</b>	<b>3/8" × 24</b>
<b>Pushrod guide plates (M6 × 1, 15 mm)</b>	<b>10 ft-lb</b>	<b>M6 × 1</b>
<b>Header bolts (M10 × 1.25 × 25 mm)</b>	<b>40 ft-lb</b>	<b>M10 × 1.25</b>
<b>Radiator bolts (M8 × 1.25 × 20 mm)</b>	<b>20 ft-lb</b>	<b>M8 × 1.25</b>
<b>Thermostat housing (6 mm Bolts)</b>	<b>10 ft-lb</b>	<b>6 mm × 1.0</b>
<b>Shock/Strut bolts (M12 × 1.25)</b>	<b>85 ft-lb</b>	<b>M12 × 1.25</b>
<b>Coilover top nuts (15 mm)</b>	<b>45 ft-lb</b>	<b>15 mm bolt (5/16")</b>
<b>Coilover lower mount (M12 × 1.25)</b>	<b>45 ft-lb</b>	<b>M12 × 1.25</b>
<b>Transmission cooler lines (AN fittings)</b>	<b>20 ft-lb</b>	<b>AN 3/8"</b>
<b>Oil cooler lines (AN 8)</b>	<b>15 ft-lb</b>	<b>AN 8</b>
<b>Compressor bracket (M8 × 1.25)</b>	<b>20 ft-lb</b>	<b>M8 × 1.25</b>
<b>MA252 Amp mounting bolts (M8 × 1.25)</b>	<b>25 ft-lb</b>	<b>M8 × 1.25</b>

AMPS Amp fan mount (M3 × 0.5)	1.2 Nm (~10 in-oz)	M3 × 0.5
Vault M6 bolts (locking)	8 ft-lb	M6 × 1.0
Aerogel blanket fix (tape)	N/A	3M VHB tape
UHMW skid plate bolts (M6 × 20 mm)	8 ft-lb	M6 × 1.0
LED strip screws (M2 × 0.4)	Hand-tight	M2 × 0.4
IR LED module bolts (M4 × 0.7 × 25 mm)	6 ft-lb	M4 × 0.7

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## B. Wiring Color Codes & CAN ID Table

### B.1 CAN IDs

CAN ID	Source	Data Bytes	Function
0x100	Holley Terminator X	[TPS %, RPM Hi Byte, RPM Lo Byte, ...]	Engine Data (Speed, Throttle, etc.)
0x123	Teensy (Gauge Backlight)	[R, G, B, W, Mode, 0, 0, 0]	Gauge Backlight Color & Mode



<b>0x12 4</b>	<b>Teensy (Lighting Mode Button)</b>	<b>[ModelIndex]</b>	<b>Cycle Lighting (0: Off, 1: Ambient, 2: Match)</b>
<b>0x12 5</b>	<b>Teensy (Gesture/Button Inputs)</b>	<b>[0x01=Next, 0x02=Prev, 0x03=Vol+, 0x04=Vol-]</b>	<b>Media Control</b>
<b>0x20 0</b>	<b>Jetson (Discharge Now)</b>	<b>[0xFF, HV kV/100, HV mA/1, ...]</b>	<b>Trigger Armor Plasma Discharge</b>
<b>0x30 0</b>	<b>Jetson (e-Assist Command)</b>	<b>[Current (0–255), Mode, ...]</b>	<b>M/G Torque Assist Command (0 – 255 × 10 mA)</b>
<b>0x30 1</b>	<b>BMS (Battery Status)</b>	<b>[Pack Voltage Hi, Lo, Cell 1 Volt Hi, Lo, ...]</b>	<b>Battery Pack Voltages &amp; Temps</b>
<b>0x40 0</b>	<b>Jetson (HUD Commands)</b>	<b>[X Position Hi, Lo, Y Position Hi, Lo, ...]</b>	<b>Update HUD Coordinates</b>

## **B.2 Wiring Color Conventions**

<b>Color</b>	<b>Meaning</b>
<b>Red (Solid)</b>	<b>+12 V Ignition</b>
<b>Yellow (Solid)</b>	<b>+12 V Battery (Constant)</b>
<b>Black (Solid)</b>	<b>Chassis Ground</b>

**Green / White Stripe    CAN\_H (500 kbps)**

**Green / Blue Stripe    CAN\_L (500 kbps)**

**Purple (Solid)            Holley TACH Signal**

**White / Green Stripe    Escort Radar TTL Out**

**Purple / White  
Stripe                    MAF Sensor Signal**

**Pink (Solid)              Coolant Temp Sensor**

**Brown (Solid)            Oil Pressure Sender**

**Blue (Solid)              Reverse Light Switch**

**Grey (Solid)              IAC (Idle Air Control)**

**Green (Solid)            E-Assist M/G CAN**

**Orange / White  
Stripe                    48 V Battery Pack +**

**Brown / White  
Stripe                    E-Assist BMS CAN**

<b>White / Red Stripe</b>	<b>Body Lighting Supply (12 V)</b>
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<b>Blue / White Stripe</b>	<b>LED Driver Enable (5 V logic)</b>
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<b>Violet / Black Stripe</b>	<b>Audio Return Path (Shield)</b>
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<b>Grey / Black Stripe</b>	<b>Accessory (12 V)</b>
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<b>Pink / Black Stripe</b>	<b>Fire Suppression Solenoid</b>
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## C. Vendor URL Quick Reference

Vendor	URL
MG Chemicals 832A	<a href="https://www.digikey.com/product-detail/mg-chemical/832A-50ML/">https://www.digikey.com/product-detail/mg-chemical/832A-50ML/</a>
Aerogel Technologies	<a href="https://www.aerogel.com/">https://www.aerogel.com/</a>
XGS Composites GO-PU	<a href="https://xgscomposites.com/graph-pu">https://xgscomposites.com/graph-pu</a>
Cicada Technology	<a href="https://cicadatech.com/">https://cicadatech.com/</a>
NanoTouch Materials	<a href="https://nanotouchmaterials.com">https://nanotouchmaterials.com</a>

<b>Gentex ClearVu Glass</b>	<a href="https://gentex.com/products/automotive/clearvu-glass">https://gentex.com/products/automotive/clearvu-glass</a>
<b>Berkenhoff Thermal Armor</b>	<a href="https://berkenhoffusa.com/underbody-thermal-protection/">https://berkenhoffusa.com/underbody-thermal-protection/</a>
<b>McMaster-Carr</b>	<a href="https://www.mcmaster.com">https://www.mcmaster.com</a>
<b>Dynema HB197</b>	<a href="https://www.dsm.com/dyneema/en_US/products/armor-lpv/hb197.html">https://www.dsm.com/dyneema/en_US/products/armor-lpv/hb197.html</a>
<b>AR500 Armor</b>	<a href="https://ar500armor.com">https://ar500armor.com</a>
<b>Classic Instruments</b>	<a href="https://classicinstruments.com/products/street-rod-gauge">https://classicinstruments.com/products/street-rod-gauge</a>
<b>Adafruit</b>	<a href="https://www.adafruit.com">https://www.adafruit.com</a>
<b>PJRC (Teensy)</b>	<a href="https://www.pjrc.com/store/teensy41.html">https://www.pjrc.com/store/teensy41.html</a>
<b>Ultraleap (Leap Motion)</b>	<a href="https://www.ultraleap.com/product/leap-motion-controller/">https://www.ultraleap.com/product/leap-motion-controller/</a>
<b>McIntosh Labs</b>	<a href="https://mcintoshlabs.com">https://mcintoshlabs.com</a>
<b>Blue Jeans Cable</b>	<a href="https://www.bluejeanscable.com">https://www.bluejeanscable.com</a>
<b>Noctua</b>	<a href="https://www.noctua.at/en/products/fans/nf-a8-pwm">https://www.noctua.at/en/products/fans/nf-a8-pwm</a>

<b>Connect Tech (Jetson AGX)</b>	<a href="https://www.connecttech.com/jetson-agx-orin/">https://www.connecttech.com/jetson-agx-orin/</a>
<b>BorgWarner (48 V M/G)</b>	<a href="https://borgwarner.com/products/48v">https://borgwarner.com/products/48v</a>
<b>Battle Born Batteries</b>	<a href="https://battlebornbatteries.com">https://battlebornbatteries.com</a>
<b>Holley Terminator X</b>	<a href="https://holley.com/products/terminator-x-ls/">https://holley.com/products/terminator-x-ls/</a>
<b>Edelbrock</b>	<a href="https://www.edelbrock.com/products/cylinder-heads">https://www.edelbrock.com/products/cylinder-heads</a>
<b>Comp Cams</b>	<a href="https://www.compcams.com/products/thumpr-camshafts">https://www.compcams.com/products/thumpr-camshafts</a>
<b>Hooker BlackHeart Headers</b>	<a href="https://www.hookercar.com">https://www.hookercar.com</a>
<b>MagnaFlow</b>	<a href="https://www.magnaflow.com">https://www.magnaflow.com</a>
<b>Borla</b>	<a href="https://www.borla.com">https://www.borla.com</a>
<b>Be Cool Radiators</b>	<a href="https://www.becoolradiators.com">https://www.becoolradiators.com</a>
<b>SPAL</b>	<a href="https://www.spalusa.com">https://www.spalusa.com</a>
<b>K&amp;N (CAI)</b>	<a href="https://www.knfilters.com">https://www.knfilters.com</a>

<b>MSD Ignition</b>	<b><a href="https://www.msdignition.com">https://www.msdignition.com</a></b>
<b>McMaster-Carr</b>	<b><a href="https://www.mcmaster.com">https://www.mcmaster.com</a> (all fastening, adhesives)</b>
<b>Fireboy-Xintex</b>	<b><a href="https://www.fireboy-xintex.com">https://www.fireboy-xintex.com</a></b>
<b>Res-Q-Me / Lifehammer</b>	<b><a href="https://www.lifehammer.com/f?p=154:18">https://www.lifehammer.com/f?p=154:18</a></b>
<b>Adventure Medical Kits</b>	<b><a href="https://www.adventuremedicalkits.com">https://www.adventuremedicalkits.com</a></b>
<b>ZOLL</b>	<b><a href="https://www.zoll.com">https://www.zoll.com</a></b>
<b>Inogen</b>	<b><a href="https://www.inogen.com">https://www.inogen.com</a></b>
<b>RF Solutions (RF Scabbard)</b>	<b><a href="https://www.rfsolutions.co.uk">https://www.rfsolutions.co.uk</a></b>
<b>BlackVue</b>	<b><a href="https://www.blackvue.com">https://www.blackvue.com</a></b>
<b>Rove Cameras</b>	<b><a href="https://rovecam.com">https://rovecam.com</a></b>
<b>FireBlock by Warwick</b>	<b><a href="http://www.fireblockbywarwick.com">http://www.fireblockbywarwick.com</a></b>
<b>WolfPack Armor</b>	<b><a href="https://www.wolfpackarmor.com">https://www.wolfpackarmor.com</a></b>

<b>AdValue Tech (Tungsten)</b>	<b><a href="https://www.advaluetech.com">https://www.advaluetech.com</a></b>
<b>FastCap Systems (HV Caps)</b>	<b><a href="https://www.fastcapsystems.com">https://www.fastcapsystems.com</a></b>
<b>Infineon (IGBT)</b>	<b><a href="https://www.infineon.com">https://www.infineon.com</a></b>
<b>Raychem (Heat-Shrink)</b>	<b><a href="https://www.heatshrink.com">https://www.heatshrink.com</a></b>
<b>Palomar Engineers (Ferrite)</b>	<b><a href="https://palomar-engineers.com/product/corcom-filters">https://palomar-engineers.com/product/corcom-filters</a></b>
<b>Schott AG (Glass)</b>	<b><a href="https://uschott.com/products/architecture/low-e-glass">https://uschott.com/products/architecture/low-e-glass</a></b>
<b>PowerWindowFilms</b>	<b><a href="https://powerwindowfilms.com">https://powerwindowfilms.com</a></b>
<b>K-Tech Nanotech</b>	<b><a href="https://ktechnanotech.com/electrostatic-anti-dust-strips/">https://ktechnanotech.com/electrostatic-anti-dust-strips/</a></b>
<b>KW Suspensions</b>	<b><a href="https://kwsuspensions.com">https://kwsuspensions.com</a></b>
<b>AMP Research</b>	<b><a href="https://amprollc.com/products/powerstep-running-board-kit-s-iderails">https://amprollc.com/products/powerstep-running-board-kit-s-iderails</a></b>
<b>K-Tech Nanotech (underbody)</b>	<b><a href="https://ktechnanotech.com/">https://ktechnanotech.com/</a></b>
<b>Renogy (Solar)</b>	<b><a href="https://www.renogy.com/">https://www.renogy.com/</a></b>

**Victron Energy**                      <https://www.victronenergy.com>

**Honda Power Equipment**   <https://powerequipment.honda.com>

**Holley Performance**              <https://holley.com>

**Dynema**                                <https://www.dsm.com>

**AR500 Armor**                        <https://ar500armor.com>

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**End of Manual**

**Prepared by: Technical Director, Vovina Performance Division**

**Date: June 05 2025**

**Version: 3.2 (Full integration of MA252 amplifiers & all systems)**

**Note: Always follow safety protocols when dealing with HV, pressurized gases, and hazardous materials. Ensure all modifications comply with local regulations (e.g., CARB, DOT, FCC). Professional training is required for ballistic testing and HV system handling.**

**Enjoy crafting the most advanced 1997 Suburban the world has ever seen!**