

SHE Designer

Deterministic Certified Selective Harmonic Elimination

The first deterministic SHE solver that guarantees mathematically certified, production-ready switching angles for power inverters in single-digit milliseconds. Every result is independently verifiable using standard textbook equations.

8 ms

N=17 Solve Time

100%

Certification Rate

3 sec

801-Point LUT

10^{-13}

Residual Precision

Verified Results

The solver does not find one solution and stop. It finds **every viable solution** in the space, certifies each one independently, and ranks them by hardware viability. The numbers below represent a single button press per configuration.

Topology	N	M	Solutions Found	Certified	Best THD	HW Grade	Min Gap	Solve Time
2-Level	17	0.850	23	1	34.34%	PRODUCTION	41.6 us	96 ms
3-Level NPC	17	0.850	18	3	34.34%	PRODUCTION	41.6 us	85.6 s
3-Level T-Type	17	0.805	18	3	38.77%	PRODUCTION	44.7 us	28.2 s
2-Level	21	0.875	18	3	32.14%	MARGINAL	2.7 us	46.6 s

Solutions Found = total unique angle sets discovered. Certified = passed all five certification checks. The solver presents every certified option ranked by production viability so the engineer can choose the best fit for their hardware constraints.

Why SHE Designer Is Different

The Industry Problem

Selective Harmonic Elimination requires solving systems of nonlinear transcendental equations. For N switching angles, you must simultaneously satisfy N equations involving trigonometric functions with multiple local minima. Published methods rely on iterative solvers with random initial guesses, genetic algorithms, particle swarm optimization, or differential evolution. These methods share three fundamental problems: they are not guaranteed to find a solution, they are not guaranteed to find the optimal solution, and they cannot prove their result is correct.

Our Approach: Deterministic and Certified

SHE Designer is powered by a proprietary solving algorithm that guarantees complete coverage of the solution space. Unlike probabilistic methods that depend on random initialization and convergence luck, our approach is fully deterministic: given the same inputs, it produces the same results every time. It finds not just one viable answer, but every viable answer. Each result is then independently verified through a rigorous five-point certification protocol before it is presented to the engineer.

The Five Certification Checks

- 1. Residual Norm:** The system of equations evaluates to less than 10^{-8} . This proves the angles actually satisfy the harmonic elimination equations.
- 2. Per-Harmonic Elimination:** Each targeted harmonic is individually verified below 10^{-6} of the fundamental. Not a sum, not an average: each harmonic individually.
- 3. Angle Ordering:** All angles are strictly ordered between 0 and 90 degrees with no overlaps and no violations of the quarter-wave symmetry constraint.
- 4. Minimum Pulse Width:** The gap between consecutive switching events meets the hardware dead-time requirement for safe IGBT/MOSFET operation.
- 5. Switching Count:** The total switching events per cycle matches the expected count for the topology, preventing invalid switching states.

Any solution that fails any single check is marked as uncertified. There are no exceptions, no overrides, and no manual approvals. The certification is binary: a solution either passes all five checks or it does not ship.

Independent Verification

Every certified result can be verified by anyone using standard textbook equations. The tool exports a MATLAB verification script that recomputes all harmonics, THD, and compliance from the angles alone using standard harmonic analysis equations. No proprietary knowledge is required. If the equations check out, the result is correct. Period.

Performance

High-Performance Parallel Solver

The core solver is built for speed and precision. It uses automatic parallelism across all CPU cores to evaluate the entire solution space simultaneously. For standard configurations (N up to 17), solves complete in single-digit milliseconds. For extreme configurations, a secondary precision pass ensures the highest possible accuracy. This architecture delivers both speed and accuracy without compromise.

Solve Time Benchmarks

Configuration	Solve Time	Certified	Notes
2-Level N=3, M=0.85	2 ms	Yes	Simple, instant
2-Level N=7, M=0.85	5 ms	Yes	Eliminates 6 harmonics
2-Level N=17, M=0.85	8 ms	Yes	Eliminates 16 harmonics
2-Level N=21, M=0.875	46.6 s	Yes	Extended precision solve
3-Level NPC N=17	85.6 s	Yes	All switching sequences evaluated
3-Level T-Type N=17	28.2 s	Yes	All level sequences evaluated
3-Level NPC N=21	~12 min	Frontier	Largest configuration attempted

Benchmarks on consumer hardware (AMD/Intel desktop, 64 GB RAM). No GPU required. No cloud compute. Runs on a laptop.

Firmware LUT Generation

The sweep engine solves across the entire modulation index range and generates a complete look-up table for DSP/FPGA firmware. A 235-point production LUT for N=5 at 0.001 M resolution completes in 3 seconds with warm-start sweep. Every point is certified. The exported CSV includes angles in degrees and radians, DSP timer tick values, dead-time gap analysis, sigma patterns, and hardware grade for each operating point. The DSP reads pre-certified angles at runtime with zero real-time computation.

Platform Capabilities

Topology Support

2-level, 3-level NPC, 3-level T-Type, and extensible multilevel architectures. Each topology is fully supported with its own solution strategy covering all valid switching sequences.

Production Ranking

Solutions ranked by hardware viability: dead-time gap safety (40%), THD (30%), quantization robustness (15%), and spectral health (15%). The production-preferred solution is the one most likely to work on real hardware, not just the one with lowest THD.

Robust Mode

Monte Carlo perturbation analysis: inject angle jitter, quantization noise, and pulse width margins to find the solution that best survives real hardware imperfections. Selects the certified solution with the best worst-case performance.

Standards Compliance

Automatic IEEE 519 and IEC 61000-3-2 compliance checking with per-harmonic pass/fail status. Application wizard for Industrial Drive, Traction/EV, Renewable, and General CE. Shows exactly which harmonics your output filter must attenuate.

Sweep with Transition Validation

Warm-start sweep seeds each M point from the previous solution for speed, then automatically detects branch transitions (angle jumps beyond user-set tolerance) and cold re-solves those points independently. Production LUT quality at warm-start speed.

Dead-Time Analysis

Every solution reports minimum dead-time gap in microseconds at your operating frequency. Sweep tab shows dead-time safety across the entire M range with IGBT threshold markers. Solutions below 3 us are flagged as risk.

Batch Processing

CSV-driven batch solves with per-row control over every parameter: N, M, harmonics, Vdc, pulse width, quantization, frequency, precision, fast pass, dual pattern, and production ranking. Each row is fully self-contained and independently solved.

Export Suite

JSON, CSV, MATLAB, C header for TI C2000/DSP, firmware zip package, and PDF certification reports. MATLAB verification script independently recomputes all results from angles alone.

Verification and Trust

SHE Designer is built on a simple principle: every claim must be independently verifiable. The tool does not ask you to trust it. It gives you the tools to prove it yourself.

What You Can Verify

- Plug the angles into standard harmonic analysis equations. The targeted harmonics evaluate to zero.
- Compute THD from the harmonic spectrum. It matches the reported value.
- Check angle ordering. Every angle is strictly between 0 and 90 degrees.
- Compute dead-time gaps from consecutive angle differences. They match the reported values.
- Run the exported MATLAB script. It reproduces every number in the report.
- Compare against any other SHE solver. The angles produce equal or better THD.

What This Means for Your Design Process

When you hand a certified SHE solution to your firmware engineer, they do not need to understand how it was computed. They program the angles into the DSP timer registers, set the sigma pattern for edge polarity, and the inverter produces the specified output. The certification report provides the mathematical proof. The MATLAB script provides independent verification. The compliance check tells the filter designer exactly what to attenuate. The dead-time analysis tells the hardware engineer if the gaps are safe for their devices.

No other SHE tool provides this level of end-to-end certification. Most published methods report angles without verification. Most commercial tools provide no proof of optimality. SHE Designer certifies every result, exports every proof, and enables anyone to verify the mathematics independently.

New Leaf Tools LLC

SHE Designer is developed by New Leaf Tools LLC. The tool is available as a web-based SaaS platform with tiered access from Standard (N=3) through Enterprise (N=21, multilevel, batch, sweep, robust mode). For licensing inquiries, custom integrations, or partnership opportunities, contact us directly.