

User Manual

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What Is Kalman Filtering?

Kalman filtering is a powerful mathematical technique that helps clean up noisy data by making smart predictions about what the "true" signal should look like. Think of it as having a very sophisticated noise-canceling system for your brain wave data.

When recording EEG (brain wave) data, the signals often contain unwanted noise from muscle movements, electrical interference, or environmental factors. Kalman filters work by continuously comparing what they expect to see with what they actually observe, then making educated guesses about the real brain activity underneath all that noise.

Our platform applies different types of Kalman filters to your EEG data, allowing you to compare which approach works best for your specific recordings and research needs. This user manual walks you through how our dashboard lets you run various Kalman filter variants, view results, and export data.

Kalman Filter Variants Explained

Our platform offers nine different Kalman filter variants, each using a unique mathematical approach to process your EEG data. These variants are built on three main algorithmic foundations (Potter, Carlson, and Bierman) combined with three different mathematical techniques (Gram-Schmidt, Givens, and Householder).

Potter Method Variants

1. Potter - Gram-Schmidt

- **Best for:** Beginners, general-purpose analysis, establishing baseline results
- **Strengths:** Highly reliable, well-tested, consistent results
- **Use for:** Standard EEG recordings, reproducible research

2. Potter - Givens

- **Best for:** Noisy data, high-precision requirements
- **Strengths:** Superior numerical stability

- **Use for:** Clinical recordings with artifacts, long sessions

3. Potter - Householder

- **Best for:** Maximum precision, research
- **Strengths:** Highest accuracy
- **Use for:** Research publications, critical medical analysis

Carlson Method Variants

1. Carlson - Gram-Schmidt

- **Best for:** Large datasets, routine analysis
- **Strengths:** Fast processing, resource-efficient
- **Use for:** Batch processing, large studies

2. Carlson - Givens

- **Best for:** Balanced speed and accuracy
- **Strengths:** Versatile, good stability
- **Use for:** Moderate-sized datasets, daily EEG work

3. Carlson - Householder

- **Best for:** High-throughput research
- **Strengths:** Efficient and precise
- **Use for:** Academic studies, professional analysis

Bierman Method Variants

1. Bierman - Gram-Schmidt

- **Best for:** Long recordings, numerical stability
- **Strengths:** Prevents accumulated errors

- **Use for:** Sleep studies, continuous monitoring

2. Bierman - Givens

- **Best for:** Challenging datasets, artifacts
- **Strengths:** Robust, handles poor-quality data
- **Use for:** Clinical environments, pediatric EEG

3. Bierman - Householder

- **Best for:** Most challenging analyses
- **Strengths:** Ultimate precision and robustness
- **Use for:** Critical decisions, high-stakes research

Quick Selection Guide

- **New to EEG?** Start with **Potter - Gram-Schmidt**
- **Noisy/challenging data?** Use **Bierman - Givens**
- **Large datasets?** Try **Carlson - Gram-Schmidt**

💡 Pro tip: Run multiple algorithms on the same data to compare performance.

Understanding Your Results

Types of Results



Visual Graphs – Easy-to-read before-and-after filtering graphs



Raw Data Files – Exportable files for deeper analysis



Frequency Analysis – Shows alpha, beta, theta, etc.

Result Codes

- **O (Original):** Raw EEG data
- **A (All):** Filtered data from all channels

- **W (WC):** Winning Combination (selected channels)
 - **N (NWC):** Non-Winning Combination
-

What You Can Do With Results



Interactive Graphs



Download Data Files



Compare Different Algorithms

Getting Started - Account & Login

1. Creating Your Account

Provide name, email, and password.

Click **Sign Up**.

2. Logging In

Use your email and password.

Sessions stay active for convenience.

Managing Your Patients

Select or create patients to organize EEG sessions.



Why It Matters

- Tracks progress over time
 - Keeps research organized
 - Maintains integrity
-

Adding New Patients

Required Info

- First Name
- Father's and Mother's surnames
- Birth Date
- Gender

 Click “ Create New Patient,” fill out the form, and click “Create Patient.”

Uploading Your EEG Data

1. Click **Add Session**
2. Create or select a session
3. Upload a **CSV** file with 14 EEG channel headers
4. Click **Upload**

Channels expected: AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4

Setting Up Your Analysis

Click **Run Kalman** to configure:

- **Session Info**
 - **Algorithm Selection**
 - **Channel Configuration** (winning combination)
-

Understanding Channel Selection

Enter a list of 14 binary values (0 or 1) for each EEG channel.

Examples

- All channels: [1,1,1,1,1,1,1,1,1,1,1,1,1,1]
- Frontal regions: [1,1,1,0,0,0,0,0,0,0,0,1,1,1]
- Left hemisphere: [1,1,1,1,1,1,1,0,0,0,0,0,0,0]

💡 Start with all 1s if unsure.

Running Your Analysis

1. Confirm settings
2. Click **Run Kalman Analysis**
3. Wait for processing
4. View confirmation and results

📋 Keep the browser open until analysis finishes.

Viewing Your Results

1. Go to **Results**
2. Select your patient
3. Browse completed sessions
4. Click a session card to expand

🔍 If missing, check patient/session, refresh, or re-run analysis.

Understanding Your Brain Wave Graphs

Amplitude Over Time

Compares raw vs. filtered signal

- Raw = noisy
- Filtered = smooth, clean

Frequency Analysis (Welch PSD)

Shows power spectrum for:

- Original
- All
- WC
- NWC

Brain Wave Bands

- **Delta (0.5-4 Hz):** Deep sleep
- **Theta (4-8 Hz):** Memory, meditation
- **Alpha (8-13 Hz):** Resting, calm
- **Beta (13-30 Hz):** Focus, alertness

Saving and Sharing Your Results

Download as CSV files:

1. **Core Filter Results**
2. **Amplitude Data**
3. **Frequency Analysis**

 **Tips:** Use descriptive filenames, keep backups, compare algorithm outputs.

Advanced Features and Customization

Experimenting with Channels

Use different "winning combinations" to explore:

- Hemispheres
- Frontal/posterior regions
- Noisy channel exclusion

Comparing Algorithms

Run multiple algorithms on the same session.

Evaluate processing speed, accuracy, and pattern clarity.



Future updates may include more filters or customization options.

Getting Help and Best Practices

Common Issues

- **No results?** Check patient, refresh, re-run
- **Analysis fails?** Check format, missing values, try another algorithm
- **Blank graphs?** Ensure processing finished, try refreshing
- **Upload problems?** Use valid CSV, no typos in headers

Tips for Success

- Use consistent names and notes
- Start with default settings
- Always compare results
- Download results right away
- Keep raw backups

- Avoid extreme values in data

 **Learn by doing:** Document everything and compare to build expertise.