AN IMPROVED MEAN FILTER METHOD FOR REMOVING SATURATION EFFECTS FROM PYROTECHNIC SHOCK PULSES

By Tom Irvine
Email: tomirvine@aol.com

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This is a work in progress.

Introduction

Shock measurements from pyrotechnic events may have time histories with spurious baseline shifts due to saturation or some other cause. Spurious low-frequency transients may also appear on the data for similar reasons.[1]

A mean filter method for removing saturation effects was introduced in Reference 1. This method is appropriate for signals with mild saturation. A more robust method is needed for signals with moderate or even severe saturation effects.

The “improved method” uses a mean filter with a variable window size and with a single pass. The windows size and center times are select via random number generation with optimization. The goals are to bring the positive and negative SRS curves together and to meet an initial ramp, which is specified via engineering judgment. Further judgment is required to determine whether the method remove any “good” portions of the data.

Example

Linear shape charge is used as a device to separate two stages of a certain rocket vehicle. The charge generates high-frequency pyrotechnic shock energy as an unwanted by-product.

A ground test of this separation system was performed so that shock measurements could be made. A sample raw time history from a source accelerometer is shown in Figure 1. The raw data has spurious noise spikes and a baseline shift.

The time history with the spikes removed is shown in Figure 2. Further editing is required to remove the spurious baseline shift. A shock response spectrum is calculated from the time history in Figure 2 as an intermediate step.

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[1] These effects can be minimized by using an accelerometer with a mechanical lowpass filter.

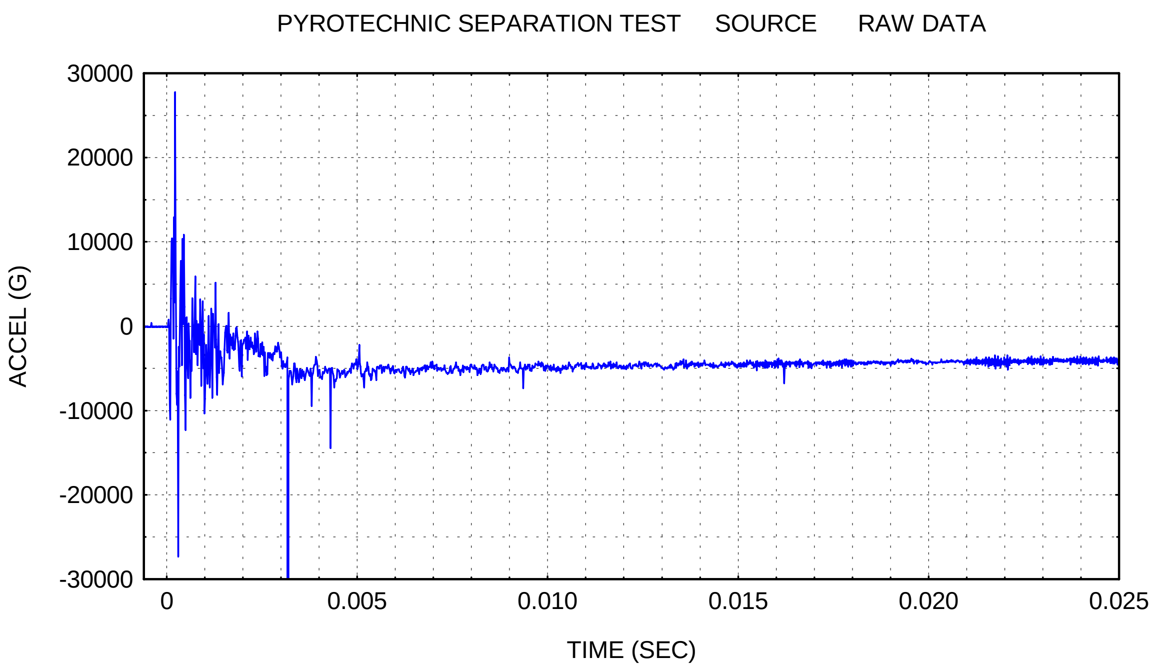

Figure 1.

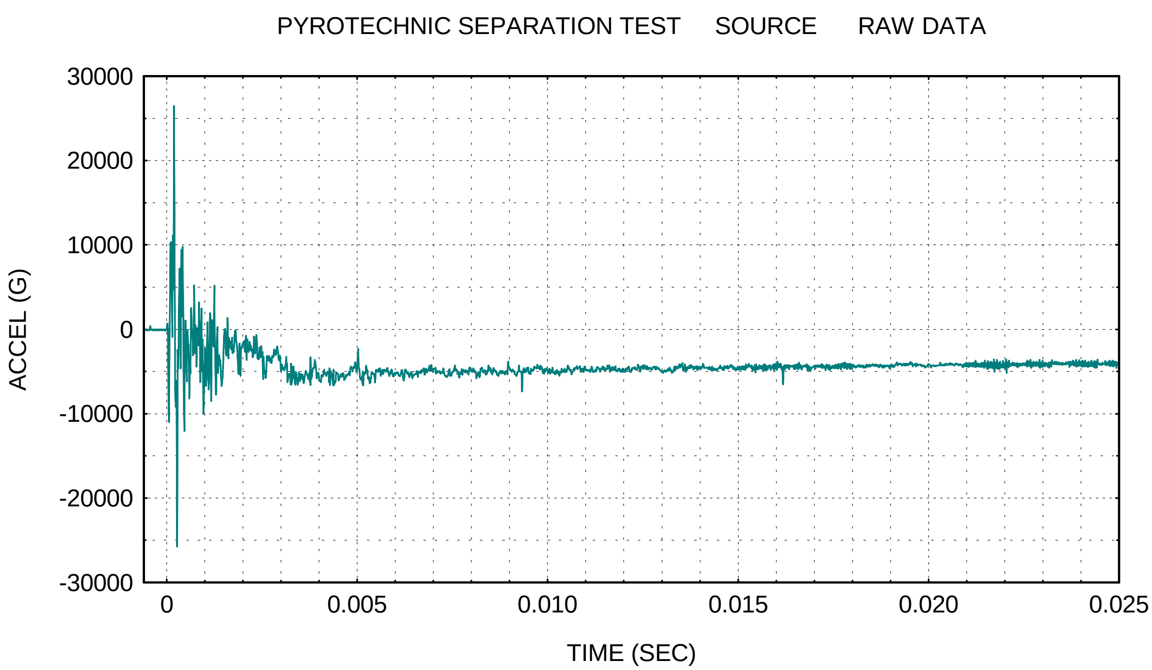

Figure 2.

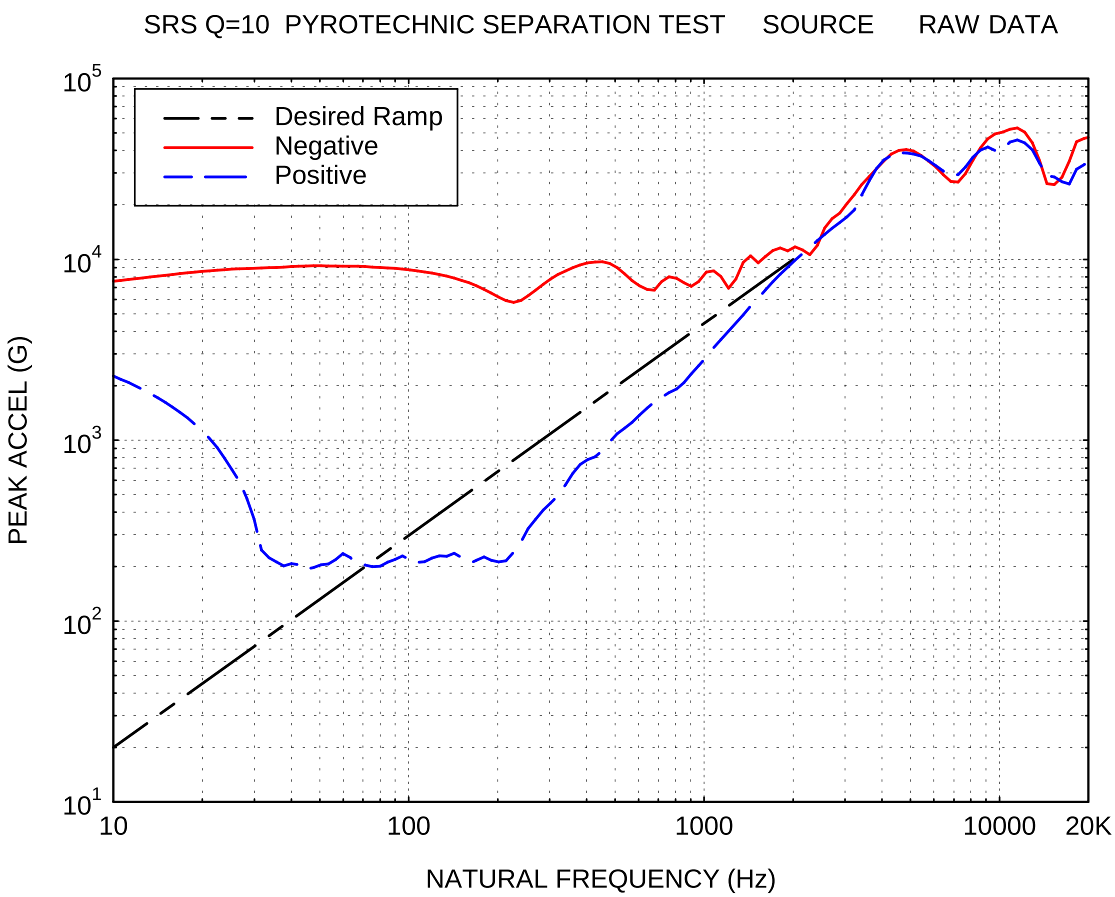

Figure 3.

The shock response spectrum of the time history with the spikes removed is shown in Figure 3.

The baseline shift causes vast differences in the positive and negative curves below 1000 Hz. Furthermore, the ramp from 10 to 1000 Hz should have a slope of 6 dB/octave or perhaps greater.

The desired slope is chosen on the basis of “engineering judgment” as 7.1 dB/octave.

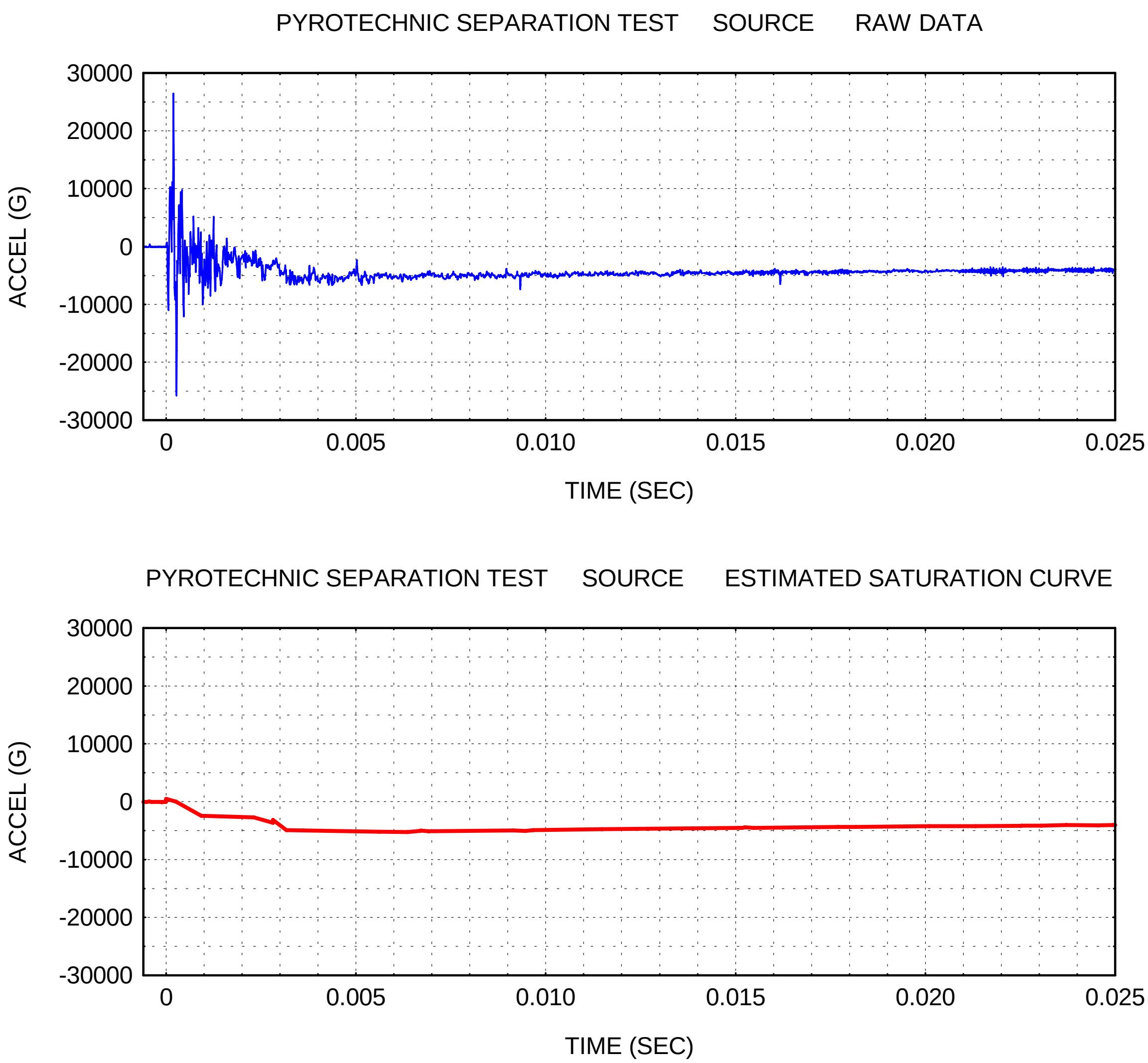

Figure 4.

The “improved method” is used to identify the saturation or baseline shift as shown in Figure 4.

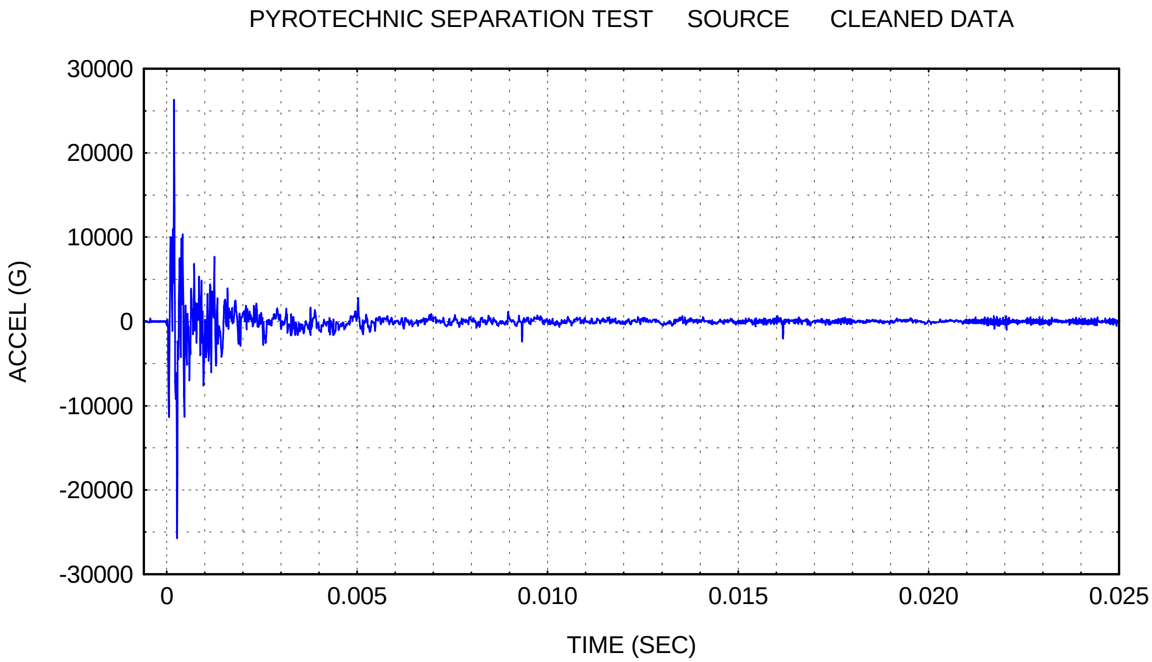

Figure 5.

The cleaned data is equal to the raw data with both the spurious spikes and baseline shift removed. The resulting time history is "plausible."

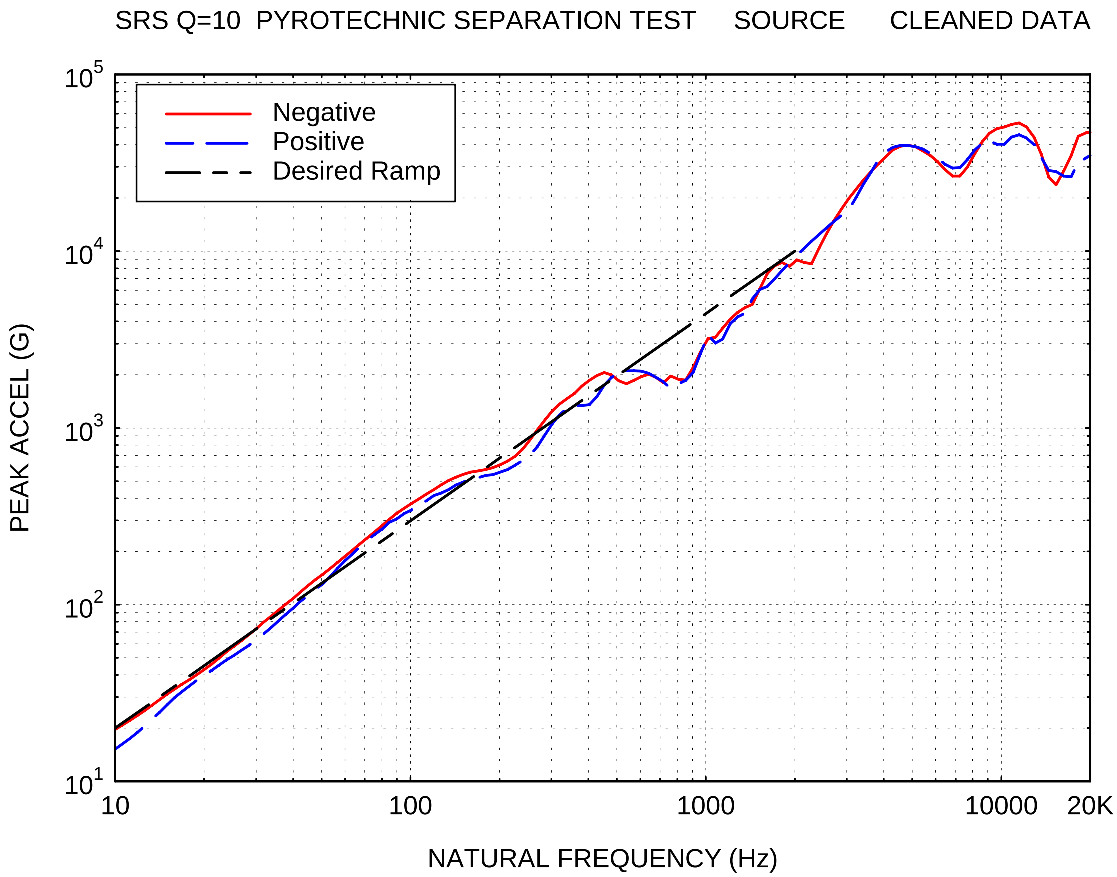

Figure 6.

The shock response spectrum of the “cleaned data” is shown in Figure 6. The SRS curves are likewise plausible.

Reference

1. T. Irvine, A Mean Filter Method for Removing Saturation from Pyrotechnic Shock Pulses, Vibrationdata, 2008.

APPENDIX A

Here are the processing parameters for the example:

Program: sat_remove5.cpp, ver 2.0, June 12, 2008

Input File: pyro_sat.txt

dmax weight = 1

slope weight = 1.5

number of trials = 16000

arbitrary integer = 23

first coordinate: 10 20

second coordinate: 2000 10000

maximum exponent = 2.2

maximum number of points for curve-fit = 100