DADiSP / CFC

Channel Frequency Class Module

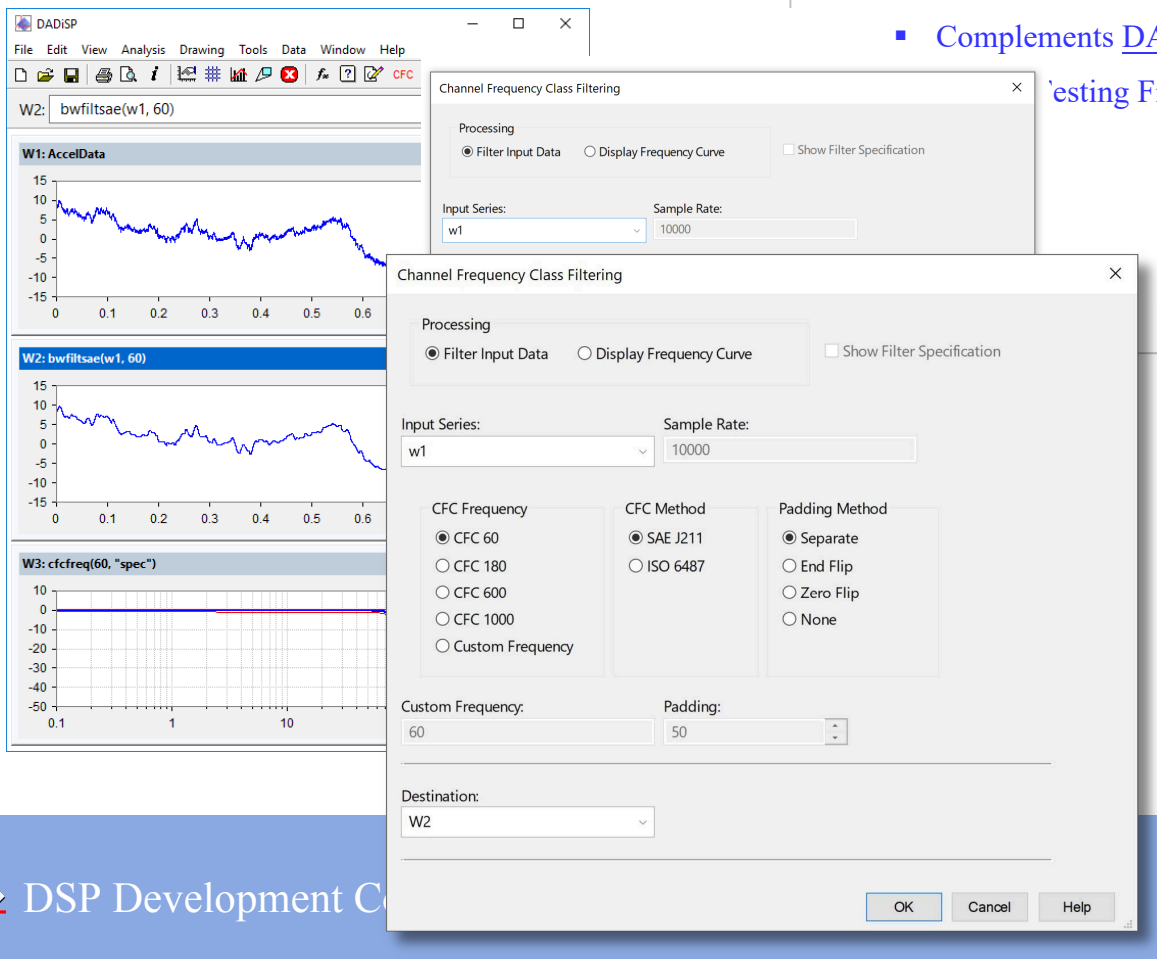
DADiSP/CFC implements SAE J211 and ISO 6487 phaseless 4 pole Channel Frequency Class (CFC) digital filters widely used in impact and crash test analysis.

The CFC Module supports all four channel frequency classes, CFC 60, CFC 180, CFC 600 and CFC 1000. User defined CFC frequencies outside these classes are also supported.

Input data is processed by the CFC filter in one step, where the filter is designed as per the selected specification and the data is filtered in the time domain with a high precision phaseless Butterworth digital filter.

KEY FEATURES

- Simple Dialog Box User Interface
- Conforms to SAE J211 and ISO 6487 Specifications
- Supports CFC 60, CFC 180, CFC 600 and CFC 1000 Filter Classes.
- Supports Custom CFC Frequency Classes
- One Step Design and Data Processing
- High Precision Digital Phaseless Butterworth Filter Realization
- Optional Endpoint Padding Methods
- Direct NHSTA Implementation for Fast Processing of Big Data
- Complements DADiSP/ISO 2631 for 'esting Filter Needs



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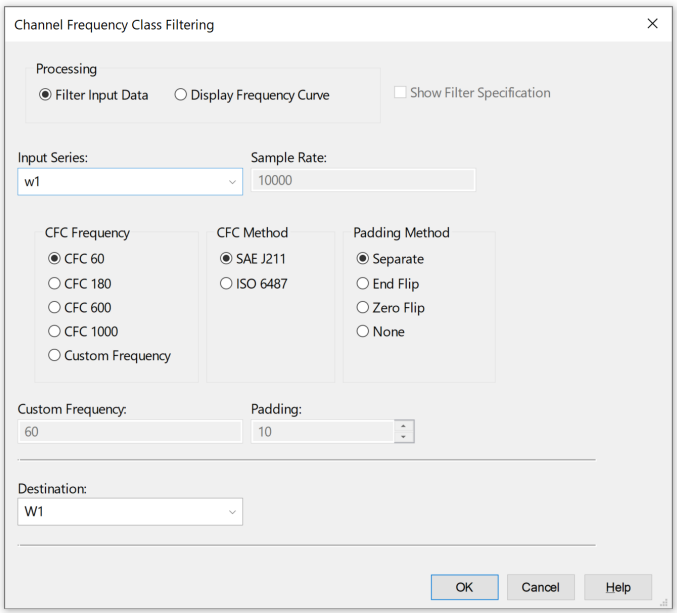

The Society of Automotive Engineers and the international ISO outline methods for assessment of injury potential from impacts and jolts. Testing typically requires the analysis of accelerations and forces generated during impact tests and obtained from transducers mounted in human-like manikins and test forms.

The SAE J211 standard requires signals from impact tests to be filtered using one of four channel frequency classes (CFC) of low-pass filters and specifies acceptable frequency response for each filter class. The four filters are designated as CFC 60, 180, 600, and 1000. The specification was derived from an analog Butterworth filter prototype where the cut-off frequency is set to 5/3 times the CFC frequency. The filter classes are typically employed in the impact test scenarios below:

SAE J211, ISO 6487 Filter Classes and Application

Structural Instrumentation	Accelerometers	Total Vehicle Comparison/Simulations/Sleds	CFC60
		Component Analysis	CFC600
		Integrations (velocity/displacement)	CFC180
	Load cells	Steering Column	CFC600
		Barrier Force/Seat Belt Load Cells	CFC60
Dummy Instrumentation	Head	Accelerations	CFC1000
	Neck	Forces	CFC1000
		Moments	CFC600
	Thorax	Spine Accelerations	CFC180
		Rib Accelerations	CFC1000
		Sternum Accelerations	CFC1000
		Deflections	CFC600
	Lumbar	Forces/Moments	CFC1000
	Pelvis	Accelerations/Forces/Moments	CFC1000
	Femur/Lower Leg	Forces/Moments	CFC600
		Displacements	CFC600

Digital Implementation

The DADiSP/CFC Module implements a 4 pole digital Butterworth low pass filter by passing the data forward and then backward through a 2 pole filter. The resulting series has no phase shift and corresponds to either the SAE J211 or ISO 5487 CFC filter specification.

The 2 pole filter is realized efficiently in the time domain with a simple difference equation:

$$y[n] = b1\ y[n-1] + b2\ y[n-2] + a0\ x[n] + a1\ x[n-1] + a2\ x[n-2]$$

where the aN and bN coefficients are derived from the 2 pole digital Butterworth filter designed using the Bilinear Transform method.

Segment Padding

To mitigate the non-causal effects of the filter on data with large transients, the beginning and end segments of the input can be padded with a mirror image. The new initial conditions for the filter equation are then computed and the padded data is filtered.

Fast Computation

The DADiSP/CFC Module applies a CFC filter using a fast and direct algorithm originally developed by the National Highway Traffic Safety Administration (NHTSA). The method automatically applies the necessary segment padding and is extremely efficient for very large datasets.

Flexible Analysis

The DADiSP/CFC module supports all four standard frequency classes. Custom frequency classes are also supported. Both the SAE J211 and ISO 6487 standards are available and multiple segment padding methods may be selected.

One Step Processing

The design and processing of data with a CFC filter is accomplished in one easy step. Both an interactive dialog box interface and simple command line functions are provided. For example, to process acceleration data in Window 1 with a SAE J211 compliant CFC 60 filter:

```
bwfiltsae(w1, 60)
```

To use an ISO 6487 CFC filter:

```
bwfiltiso(W1, 60)
```

The dialog box interface makes selecting and processing data with a CFC filter as simple as a mouse click.

DADiSP / CFC Functions

DADiSP/CFC includes several simple stand-alone functions to design and process data with CFC filters.

CFC Functions

bwfiltiso	CFC filtering with data padding as specified by ISO 6487 and implemented by the NHTSA algorithm.
bwfiltsae	CFC filtering with data padding as specified by SAE J211 and implemented by the NHTSA algorithm.
cfc	Generic Channel Frequency Class filtering with optional scale and data padding methods.
cfcfreq	Diplays the frequency response of a CFC filter.
cfciso	CFC filtering with optional data padding as specified by ISO 6487.
cfcsae	CFC filtering with optional data padding as specified by SAE J211.CFC filtering with data padding as specified by ISO 6487 and implemented by the NHTSA algorithm.