WBK12, WBK12A, WBK13, WBK13A - Programmable Low-Pass Filter Cards

An Important Notice for WaveBook/516 and WBK10A Users:
Cards for the WaveBook/516 and the WBK10A are installed at the factory per customer order. Users are not to remove or install cards for these two products as the applicable cards are not "plug-and-play" for these devices and erroneous signal values could result. If you desire to remove or add a card to these products, contact your service representative.

Description

WBK12, WBK12A, WBK13, and WBK13A are 8-channel programmable low-pass filter cards for use with 1-MHz WaveBook data acquisition systems. These cards install directly into a WaveBook or WBK10 series module and provide programmable low-pass filtering over all channels. Multiple WBK12 series and WBK13 series cards can be installed in one system for up to 72 channels. All of the cards' low-pass filters and cutoff frequencies are configured via software.

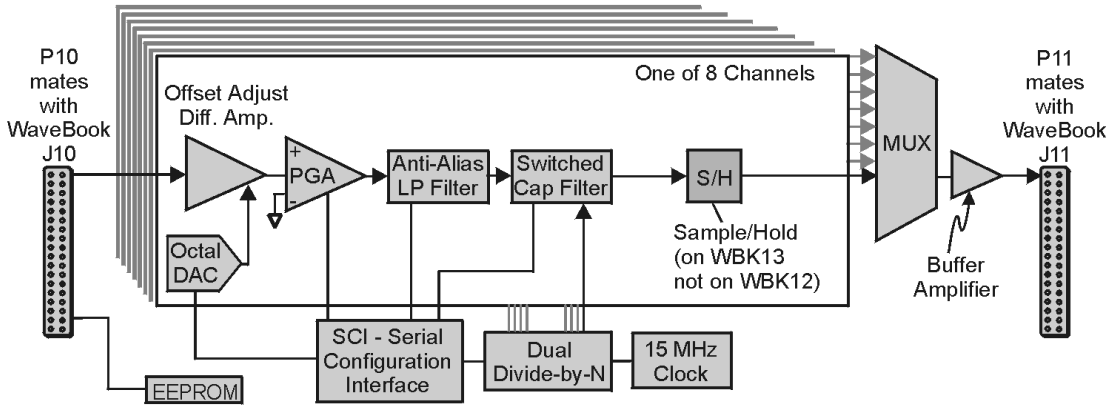
WBK13 and WBK13A cards have the additional capability of sampling all channels at the same time. If more than one WBK13 series card is installed [within one system] all channels will be sampled within 100 ns of each other.

Features of the WBK12, WBK12A, WBK13, and WBK13A include:

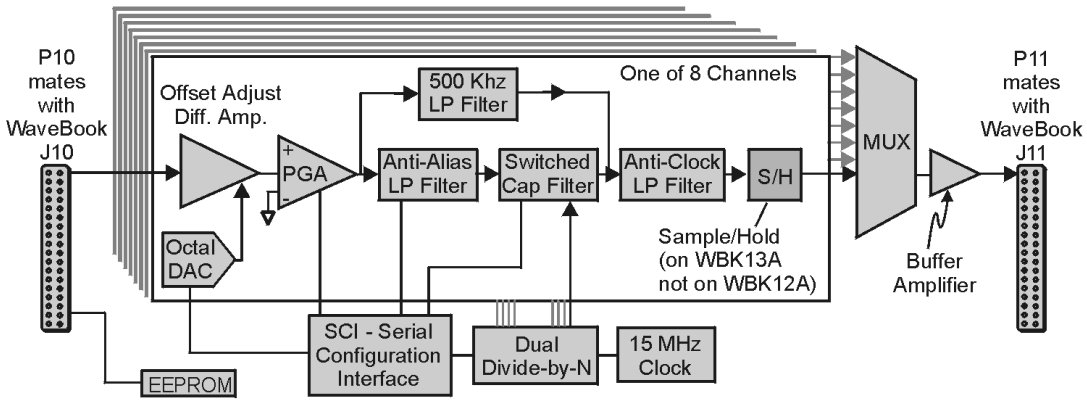
- ***Anti-Alias Low-Pass Filters.*** Each card provides 8 input channels, arranged in two 4-channel banks; the filter and cutoff frequency configurations are applied per bank. The cards' filters can be configured as either an 8-pole elliptic filter with cutoff frequencies of 400 Hz to 100 kHz, or an 8-pole linear-phase filter with 400 Hz to 50 kHz cutoff frequencies.
- ***500 Khz Low Pass Filter.*** You can individually configure channels to bypass the programmable filter. The bypass option results in a 1-pole low-pass filter at approximately 500 kHz.
- ***Cutoff Frequencies.*** The WBK12 and WBK13 provide 748 discrete cutoff frequencies that can be determined exactly by the formula *Fc = 300 kHz/N;* where the integer *N = 3 to 750*. Alternatively, you can configure any channel to bypass the programmable filter entirely, resulting in a 1-pole low-pass filter at about 500 kHz.
- ***Programmable-Gain Amplifiers.*** The cards' programmable-gain instrumentation amplifiers can be software selected to various gains on a per channel basis. The gains are set prior to the beginning of an acquisition sequence and cannot be changed during an acquisition. Note that WBK12/13 gain specifications are provided in Chapter 12.
- ***Simultaneous Sample-and-Hold (SSH) (WBK13 only).*** In addition to the filtering capability of the WBK12, the WBK13 provides per channel SSH. Simultaneous sampling of all channels occurs at the start of a scan sequence.

When using WaveBook with an SSH channel enabled, the per-channel sample rates are reduced. The rate reduction is the same as that which would occur if another channel were added. The per-channel rate (with SSH enabled) is:

1 MHz / (n+1), where ***n*** is the number of active channels.



WBK12 and WBK13 Block Diagram



WBK12A and WBK13A Block Diagram

Hardware Setup

Configuration

All WBK12 and WBK13 series configurations are controlled by software. There are no hardware settings.

Installation

The WBK12 and WBK13 series cards connect to headers J10 and J11 in the base unit. The base unit can be a WaveBook/512, WaveBook/512H, WaveBook/516, or a WBK10 series module. The jumpers located on J10 and J11 provide signal pass-through when the option card is not installed.

Reference Notes:
The installation procedure is detailed in chapter 3 of the *WaveBook User's Manual*.

Software Setup

Reference Note:
For software setup information, refer to the "Software Setup" section in chapter 3 of the *WaveBook User's Manual*. For detailed *WaveView* information, refer to the *WaveView Document Module*.

WBK12 and WBK13 – Specifications

Name/Function:
WBK12, Programmable Low-Pass Filter Card
WBK13, Programmable Low-Pass Filter Card With SSH
Number of Channels: 8
Connector: Internal to WaveBook/512 and WBK10 (two 36-pin sockets mate with 36-pin connectors)
Programmable Gain Amplifier Ranges: ×1, 2, 5, 10, 20, 50, and 100
Switched Capacitor Filter Cutoff Frequencies Range: 400 Hz to 100 kHz
Number of Cutoff Frequencies: 1024
Filter Grouping: 4 channels each in 2 programmable banks
Low-Pass Filter: Software selectable, 8-pole elliptic filter
Low-Pass Filter Type: Software selectable, elliptic or linear phase

Low-Pass Filter Frequency Cutoff Range: 100 kHz, 75 kHz, 60 kHz...400 Hz, bypass defined as Fc = 300 kHz/N where N = 3 to 750
Anti-Alias Frequencies: determined by software control
Accuracy: ±0.05% FS DC
Offset: ±1 LSB max
Aperture Uncertainty: 75 ps max
Voltage Droop: 1 mV/ms max (0.01 mV/ms typ)
Maximum Signal Voltage: ±5.00 VDC (×1)
THD: -65 dB (-70 dB typ)
Noise: 3 counts (RMS)
DC Offset: ±2.5 mV (2 LSB) max at any cutoff frequency
Number of Cutoff Frequencies Simultaneously Set: two, one for each 4-channel bank of inputs
Weight: 0.14 kg (0.3 lb)

Software Selectable Cutoff Frequencies	
Octave (kHz)	**Number of Cutoff Frequencies**
0.400 to 0.780	512
0.780 to 1.570	256
1.57 to 3.15	128
3.15 to 6.3	64
6.3 to 12.5	32
12.5 to 25	16
25 to 50	8
50 to 100	5

Input Voltage Ranges:
Before a scan sequence begins, the input voltage ranges can be programmed via software. The ranges can be expanded as follows:

WaveBook/512 & WBK10	**WaveBook/512H & WBK10H**	**WaveBook/516 & WBK10A**
Unipolar:	**Unipolar**:	**Unipolar**: (WBK 10A only)
0 to +10 V	Unipolar does not apply to WaveBook/512H or WBK10H	Unipolar does not apply to WaveBook/516
0 to +5 V		0 to +10 V
0 to +2 V		0 to +5 V
0 to +1 V		0 to +2 V
0 to +0.5 V		0 to +1 V
0 to +0.2 V		0 to +0.5 V
0 to +0.1 V		0 to +0.2 V
		0 to +0.1 V
Bipolar:	**Bipolar**:	**Bipolar**:
-5 to +5 V	-10 to +10 V	-10 to +10 V
-2.5 to +2.5 V	-5 to +5 V	-5 to +5 V
-1 to +1 V	-2 to +2 V	-2 to +2 V
-0.5 to +0.5 V	-1 to +1 V	-1 to +1 V
-0.25 V to +0.25 V	-0.5 to +0.5 V	-0.5 to +0.5 V
-0.1 V to +0.1 V	-0.2 to +0.2 V	-0.2 to +0.2 V
-0.05 to +0.05 V	-0.1 to +0.1 V	-0.1 to +0.1 V
		-.05 to + .05 V (WBK 10A only)

Programmable Gain Amplifier Gain Ranges: ×1, 2, 5, 10, 20, 50, 100

Predicting Amplitude Loss

The following equations can be used to predict the amplitude loss when passing a signal through either the anti-alias or clock suppression filter.

Definition of equation terms:

Fin is the signal to be measured.
Falias is the cutoff frequency of the anti-alias filter.
Fclock is the cutoff frequency of the clock suppression filter.

$$Err = 20 \cdot \log\left(\frac{1}{\sqrt{1 + \frac{Fin}{Falias}}}\right)$$

$$Err = 20 \cdot \log\left(\frac{1}{\sqrt{1 + \frac{Fin}{Fclock}}}\right)$$

Total error, in dB, due to both filters is :

$$Etot = 20 \cdot \log\left[\left(\frac{1}{\sqrt{1 + \frac{Fin}{Falias}}}\right) \cdot \left(\frac{1}{\sqrt{1 + \frac{Fin}{Fclock}}}\right)\right]$$

As an example, with the switched capacitor filter set to 10,000 Hz. and the input frequency set to 6000 Hz.

Fin = 6000
Falias = 33554
Fclock = 14848
Total amplitude loss = sum of both errors = -2.188 dB.

$$E1 := 20 \cdot \log\left(\frac{1}{\sqrt{1 + \frac{6000}{33554}}}\right)$$

$$E1 = -0.71446$$

$$E2 := 20 \cdot \log\left(\frac{1}{\sqrt{1 + \frac{6000}{14848}}}\right)$$

$$E2 = -1.47396$$

$$E1 + E2 = -2.18843$$

$$Etot := 20 \cdot \log\left[\left(\frac{1}{\sqrt{1 + \frac{6000}{33554}}}\right) \cdot \left(\frac{1}{\sqrt{1 + \frac{6000}{14848}}}\right)\right]$$

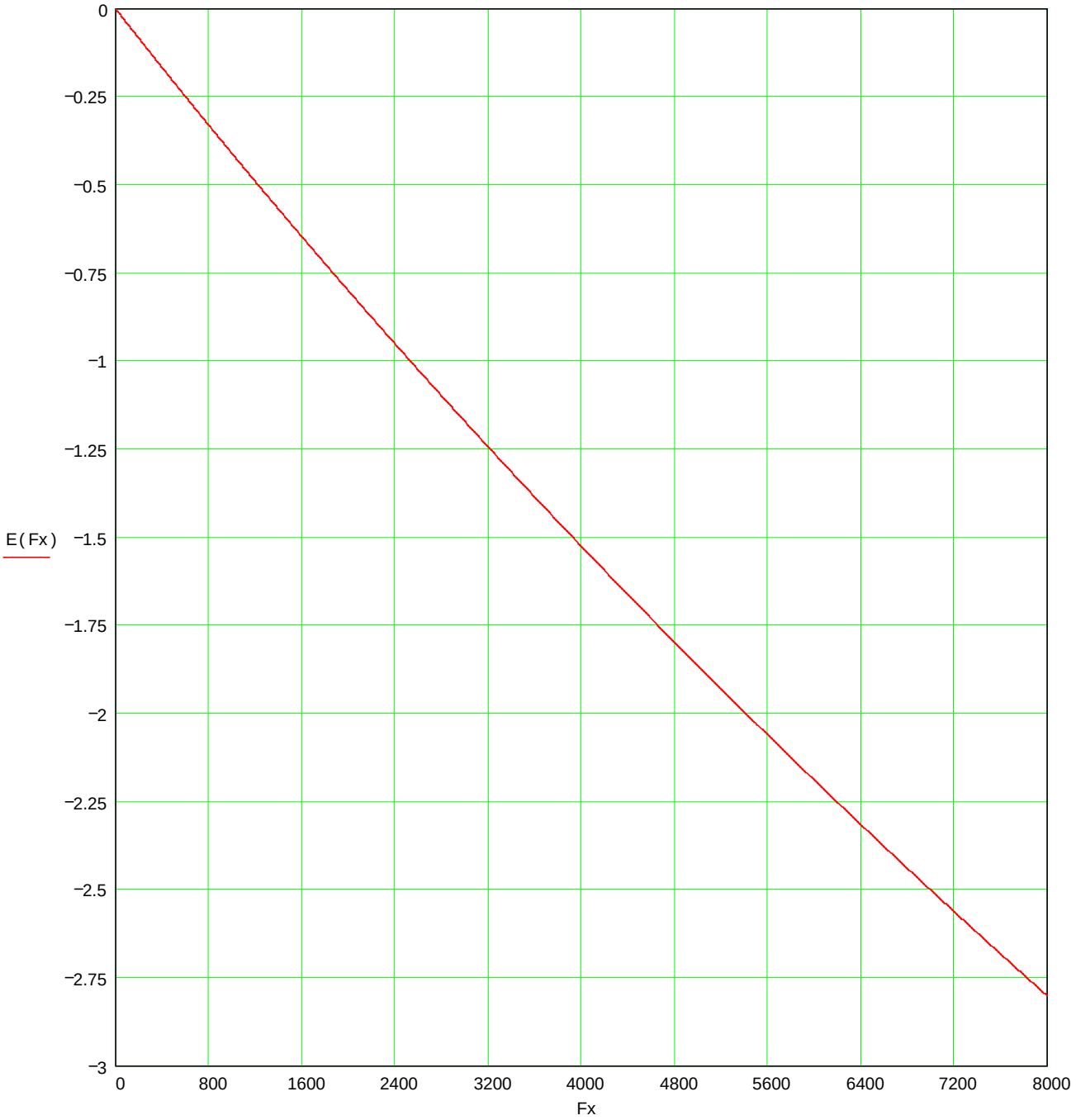
$$Etot = -2.18843$$

$$Fx := 1, 2 .. 8000$$

$$Fp := 33554$$

$$Fc := 14848$$

$$E(Fx) := 20 \cdot \log\left[\left(\frac{1}{\sqrt{1 + \frac{Fx}{Fp}}}\right) \cdot \left(\frac{1}{\sqrt{1 + \frac{Fx}{Fc}}}\right)\right]$$



WBK12A & WBK13A, Amplitude Loss in dB due to Anti-alias and Clock Filters

Input signal is swept from 1 to 8000 Hz
switched capacitor filter frequency = 8,000 Hz
anti-alias filter cutoff = 33.554 Hz
clock filter = 14,848 Hz


Notes