

WBK12A and WBK13A Programmable Low-Pass Filter Cards



Important Notice! WaveBook/516E Users

WBK option cards for WaveBook/516E are installed at the factory per customer order. Users are not to remove or install cards for these products as the 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 WaveBook/516E contact the factory or your service representative.



Important Notice! WaveBook/516, /516A, /512A, and WBK10A Users

With exception of the WBK30 option, WBK option cards for WaveBook/516, /516A, /512A, and WBK10A are installed at the factory per customer order. Users are not to remove or install cards for these products [other than WBK30 series cards] as the 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 the factory or your service representative.

Description

The WBK12A 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 WBK10A module and provide programmable low-pass filtering over all channels. Multiple WBK12A and WBK13A 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.

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

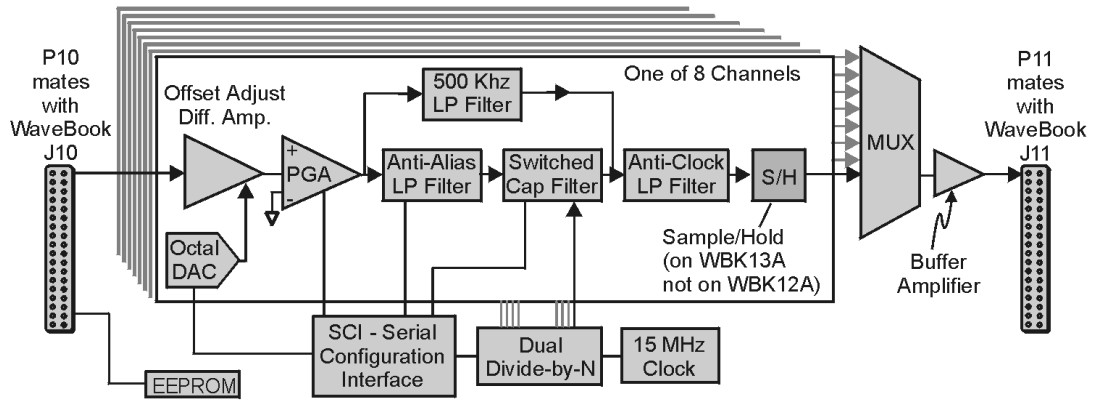
Features of the WBK12A and WBK13A include:

- **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 WBK12A and WBK13A provide 748 discrete cutoff frequencies that can be determined exactly by the formula $F_c = 300 \text{ kHz}/N$; where the integer $N = 3 \text{ to } 750$. 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.
- **Simultaneous Sample-and-Hold (SSH) (WBK13 only).** In addition to the filtering capability of the WBK12A, the WBK13A provides per channel SSH. Simultaneous sampling of all channels occurs at the start of a scan sequence.



When using a 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:

$1 \text{ MHz} / (n+1)$, where n is the number of active channels.



WBK12A and WBK13A Block Diagram

Hardware Setup

Configuration

All WBK12A and WBK13A series configurations are controlled by software. There are no hardware settings.

Installation

There is no user installation permitted. See notes on page 1.

Software Setup



Reference Notes:

- Setup information pertaining to power, expansion control, and expansion signal connections is contained in the [System Setup and Power Options](#) chapter of the *WaveBook User's Manual* (p/n 489-0901).
- For detailed WaveView information, refer to the [WaveView Document Module](#) that is included on the data acquisition CD. The document can be accessed using the <View PDFs> button on the CD's opening screen.

WBK12A and WBK13A – Specifications

Name/Function:

WBK12A, Programmable Low-Pass Filter Card
WBK13A, Programmable Low-Pass Filter Card With SSH

Number of Channels: 8

Connector: Internal to WaveBook/512A, /516, /516A, /516E, and WBK10A
 (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 $F_c = 300 \text{ kHz}/N$ where $N = 3$ to 750

Anti-Alias Frequencies: determined by software control

Accuracy: ±0.03% FS DC, for WaveBook/512A

For WaveBook/516 Series see the table on page 4 of this document module.

Offset: ±1 LSB max (for WaveBook/512A)

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) (for WaveBook/512A)

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:

Unipolar: Unipolar applies to WBK 10A only.

0 to +10 V
 0 to +5 V
 0 to +2 V
 0 to +1 V
 0 to +0.5 V
 0 to +0.2 V
 0 to +0.1 V

Bipolar: Bipolar applies to WaveBook/516, /516A, /516E, /512A, and WBK10A

-10 to +10 V
 -5 to +5 V
 -2 to +2 V
 -1 to +1 V
 -0.5 to +0.5 V
 -0.2 to +0.2 V
 -0.1 to +0.1 V

-0.05 to +0.05 V **This range applies to WBK 10A only.**

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

Accuracy and Noise Specifications

Voltage Range	WaveBook/516 Series (Alone)			WaveBook/516 Series with a WBK12A or a WBK13A (Note 3)			
	Accuracy (Note 2) One Year, 18-28°C		Input Noise LSB rms DC-500KHz (typical) (Note 4)	Accuracy (Note 2) One Year, 18-28°C		Input Noise LSB rms (typical)	
	± % reading	± % range		± % reading	± % range	1KHz Filter	Filter Bypass
0 to +10V	.012%	.008%	2	.012%	.008%	2.2	2.2
0 to +5V (10A) 0 to +4V (516)	.012%	.009%	2	.012%	.009%	2.2	2.2
0 to +2V	.012%	.012%	3	.012%	.012%	2.2	3
0 to +1V (10A only)	.012%	.018%	3	.012%	.018%	2.2	3
0 to +.5V				.018%	.033%	2.2	6
0 to +.2V				.018%	.08%	2.2	12
0 to +.1V				.018%	.16%	2.2	20
-10 to +10V	.012%	.008%	2	.012%	.008%	2.2	2.2
-5 to +5V	.012%	.008%	2	.012%	.008%	2.2	2.2
-2 to +2V	.012%	.009%	2	.012%	.009%	2.2	3
-1 to +1V	.018%	.012%	3	.018%	.012%	2.2	3.3
-.5 to +.5V (10A only)	.018%	.018%	5	.018%	.018%	2.2	6
-.2 to +.2V				.018%	.033%	2.2	12
-.1 to +.1V				.018%	.08%	2.2	20
-.05 to +.05V (10A only)				.018%	.16%	4	40

- Notes:**
1. Specifications assume differential input scan, unfiltered
 2. Accuracy specification is exclusive of noise.
 3. Unipolar ranges are unavailable for a WaveBook/516 Series with a WBK11A, WBK12A, or WBK13A option installed. Unipolar mode is available with WBK10A and any option.
 4. **Maximum limit is 1.3X typical.**

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.

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

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

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

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

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

$$\text{Fin} = 6000$$

$$\text{Falias} = 33554$$

$$\text{Fclock} = 14848$$

$$\text{Total amplitude loss} = \text{sum of both errors} = -2.188 \text{ dB.}$$

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

$$\text{E1} = -0.71446$$

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

$$\text{E2} = -1.47396$$

$$\text{E1} + \text{E2} = -2.18843$$

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

$$\text{Etot} = -2.18843$$

$$\text{Fx} := 1, 2.. 8000$$

$$\text{Fp} := 33554$$

$$\text{Fc} := 14848$$

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



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