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WaveBook User's Manual

High-Speed Portable Data Acquisition Systems

- *WaveBook/512*
- *WaveBook/512H*



the smart approach to instrumentation ™

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WaveBook User's Manual

WaveBook/512 and WaveBook/512H

High-Speed Portable Data Acquisition Systems

p/n **481-0901** Rev. **5.0**

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In this manual, the book symbol always precedes the words "Reference Note." This type of note identifies the location of additional information that may prove helpful. References may be made to other chapters or other documentation.



Tips provide advice that may save time during a procedure, or help to clarify an issue. Tips may include additional reference.

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CAUTION



Using this equipment in ways other than described in this manual can cause personal injury or equipment damage. Before setting up and using your equipment, you should read *all* documentation that covers your system. Pay special attention to Warnings and Cautions.

Note: During software installation, Adobe® PDF versions of user manuals will automatically install onto your hard drive as a part of product support. The default location is in the **Programs** directory, which can be accessed from the *Windows Desktop*. Refer to the PDF documentation for details regarding both hardware and software.

A copy of the Adobe Acrobat Reader® is included on your CD. The Reader provides a means of reading and printing the PDF documents. Note that hardcopy versions of the manuals can be ordered from the factory.



PDF
481-0901

WaveBook User's Manual, for WaveBook/512 and WaveBook/512H

After an introduction to WaveBooks and optional WBK cards and modules, this manual goes on to explain how to make signal and power connections and how to install software and product support. The document includes an operational reference and a chapter on troubleshooting and customer support. The following PDFs are companion documents.



PDF

WaveView and WaveCal

Discusses how to install and use the WaveView data acquisition program and the WaveCal calibration application.



PDF

Post Acquisition Data Analysis User's Guide

Contains at least one user's guide that pertains to a post acquisition-data analysis program. PostView, DIAdem, and eZ-View are examples of post data analysis programs.



PDF
489-0902

WBK Option Cards and Modules User's Manual

The WBK Option Cards and Modules Manual discusses each of the WBK products available at the time of print.



PDF
1008-0901

Programmer's Manual

The programmer's manual pertains to developing custom programs using Applications Program Interface (API) commands.

Note that the install CD-ROM includes WaveBook program examples.

Your order was carefully inspected prior to shipment. When you receive your order, carefully unpack all items from the shipping carton and check for physical signs of damage that may have occurred during shipment. Promptly report any damage to the shipping agent and your sales representative. Retain all shipping materials in case the unit needs returned to the factory.

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About WaveBook Documentation

Aside from the *WaveBook User's Manual* that is shipped with the product, the documentation listed on the preceding page is also important. The later is not shipped as hardcopy, unless purchased. However, during software installation, Adobe® PDF versions of the documentation are automatically installed onto your hard drive. The default location is in the **Programs** directory, accessible through the *Windows Desktop*.

Unless you have hardcopy equivalents, you should refer to the PDF version documents for details regarding both hardware and software.

The *WaveBook User's Manual for WaveBook/512 and WaveBook/512H* consists of the following chapters. The chapters contain references to the other documents as applicable. If you use the PDF version of this and the other documents, you can take advantage of the built in links to related material.

Chapter 1 – An Introduction to WaveBook and Optional WBKs

Chapter 2 – System Setup and Power Options

Chapter 3 – WaveBook Operation Reference

Chapter 4 – Software

Chapter 5 – Troubleshooting and Customer Support

Appendix A – Dimensional Drawings

Glossary

CAUTION

Using this equipment in ways other than described in this manual can cause personal injury or equipment damage. Pay special attention to all cautions and warnings.

Reference Notes:

- Information (not available at the time of publication), will be made available in **ReadMe** files, or in supplemental documentation.
- For programming-related information refer to the separate *Programmer's Manual*, p/n 1008-0901. (See PDF Note, below).
- WBK Options are covered in the companion document, *WBK Option Cards and Modules*, p/n 489-0902. The document provides details on the following:

  WBK10, WBK10H, and WBK10A Expansion Modules
  WBK11 and WBK11A Simultaneous Sample and Hold Cards
  WBK12, WBK12A, WBK13, and WBK13A Programmable Filter Cards
  WBK14 Dynamic Signal Conditioning Module
  WBK15 8-Slot 5B Signal Conditioning Module
  WBK16 Strain Gage Module
  WBK17 Counter-Input Module with Quadrature Encoder Support
  WBK20A – PCMCIA/EPP Interface Card
  WBKK21 - ISA/EPP Interface Plug-in Board
  WBK30 WaveBook Memory Option
  WBK61, WBK62 High Voltage Adapters

PDF Note: A copy of the Adobe Acrobat Reader® is included on your CD. The Reader provides a means of reading and printing the PDF documents. Note that hardcopy versions of the manuals can be ordered from the factory.

Reference Note:
For information on WaveBook/512A, WaveBook/516, or WaveBook/516A, refer to document p/n 489-0901.

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An Introduction to WaveBooks and WBKs 1

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What Are WaveBooks?

WaveBooks are high-speed portable data acquisition devices that can be used in a variety of applications, such as testing engine strain, multi-channel acoustics, mechanical integrity, and vibration/shock/strain. Features of WaveBook/512 and WaveBook/512H include:

- ***Power Options:*** Power can be supplied from an AC-to-DC adapter, battery, DBK30A rechargeable battery module, DBK34 or DBK34A uninterruptible power supply modules.
- ***Easy Connection to Notebook or Desktop PCs***.
- ***Analog Input Channels:*** BNC connectors keep input signals isolated from the chassis and commons.
- ***High-Speed Digital Inputs:*** 8 high-speed digital inputs (16 for WaveBook/516).
- ***Digital Signal Processing (DSP):*** Allows you to define a channel scan-sequence and associated gains across all channels. Also provides for real-time digital calibration on a per-sample basis.
- ***Programmable Scan Sequencing:*** A 128-location scan sequencer allows you to program the analog channel scan sequence, the associated unipolar/bipolar A/D range, and the input amplifier gain. WaveBook performs 1 MHz scanning and gain switching over both its built-in and expansion channels.
- ***Single, or Multi-Channel Triggering***
- ***Pre- and Post-Trigger Readings***

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What's the Difference Between WaveBook/512 and WaveBook/512H ?

With exception of having different range values, the WaveBook/512 and WaveBook/512H are identical. Each provides 1 MHz sampling and, with exception of the WBK17 module, supports the WBK options described shortly.

WaveBook/512 and WaveBook/512H	
Analog Input	
A/D resolution	12-bit
A/D speed	1 MHz
Sample rate	1 µs/channel
Ranges **WaveBook/512 Unipolar** **WaveBook/512 Bipolar**	 0 to +10V, 0 to +5V, 0 to +2V, 0 to +1V ±5V, ±2.5V, ±1V, ±0.5V
Ranges **WaveBook/512H Unipolar (Note 2)** **WaveBook/512H Bipolar**	 0 to +10V, 0 to +4V, 0 to +2V (Note 2) ±10V, ±5V, ±2V, ±1V
A/D accuracy	±0.025% FS
Data packing	Yes
20-kHz low-pass filter	optional
Analog input channels	8 DE
Differential amplifiers	1 (shared by all 8 inputs)
PGAs	1 (shared by all 8 inputs)
Maximum capacity	72 Channels
FIFO depth	64K samples
Total Harmonic Distortion 10Hz to 20Khz, Typical[1]	-78dB
Signal to Noise and Distortion (SINAD)[1]	-66dB
High-Speed Digital Inputs	
Digital I/O	8
Timer Input	
32-Bit Timer	None
Trigger	
Single and multi-channel	Yes

[1] For WaveBook/512 the Total Harmonic Distortion (THD) and SINAD values shown apply to the –5 to +5 V range. For WaveBook/512H the THD and SINAD values apply to the –10 to +10 V range.

[2] Unipolar ranges do not apply to WaveBook/512H when a WBK11, WBK12, or WBK13 series board is installed.

Note: Specifications subject to change without notice.

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What Are WBKs?

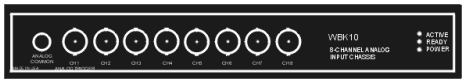
You can use various modules and option cards to expand your WaveBook system. These WaveBook options are known as WBKs.

Internally, WaveBook has room for one signal-conditioning card. Externally, you can use one or more expansion modules.

Reference Note:
The WBK option cards and modules that follow are detailed later in this user's manual. The information is provided in a companion document, the *WBK Option Cards and Modules User's Manual*, p/n 489-0902. The WBK document modules are presented in alpha-numerical order and include product specifications.

WBK Options

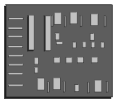
Each of the following options are detailed in the *WBK Option Cards and Modules User's Manual*, p/n 489-0902. Note that the items represented in the table are not shown to the same scale.



WBK10, WBK10H, and WBK10A
Analog Expansion Modules
8 Channels via BNC Connectors

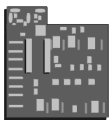
Each WBK10 series module can be used to provide WaveBook with 8 additional differential-analog-inputs. The modules are equipped with a programmable gain instrumentation amplifier (PGA) and, like the WaveBook, each has a built-in expansion bus.

Up to eight WBK10 series modules can be cascaded together for a system capacity of 72 differential channels. Each module is capable of supporting a WBK11, WBK12, or WBK13 series option card.



WBK11 and WBK11A
Simultaneous Sample & Hold Card (8 channels)

The WBK11series cards can simultaneously sample 8 channels and can be installed inside a WaveBook or in a WBK10 series module. The cards allow for concurrent (<150 ns) capture of multiple input channels and virtually eliminate channel-to-channel time skewing.

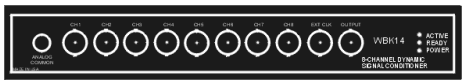


WBK12 and WBK12A
Programmable Low-Pass Filter Card
(8 channels)

WBK13 and WBK13A
Programmable Low-Pass Filter Card with SSH
(8 channels)

WBK12, WBK12A, WBK13, and WBK13A are 8-channel programmable low-pass filter cards for use with 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.



WBK14
Dynamic Signal Conditioning Module
8 Channels via BNC Connectors

The WBK14 is a dynamic analog signal input module. It enables WaveBooks to interface with piezoelectric transducers that include accelerometers, microphones, and force/pressure transducers. Each WBK14 channel has a:

- current source for transducer biasing
- high-pass filter
- programmable gain amplifier
- anti-aliasing low-pass filter
- simultaneous sample-and-hold (SSH) amplifiers



WBK15
8-Slot 5B Signal Conditioning Module
8 channels via 5B Modules

The WBK15 module provides for a diverse range of signals available through optional 5B modules. Measurement types include: LVDT, potentiometer, isolated current loop, ±10mV to ±40V inputs, linearized RTD, thermocouple, frequency-to-voltage, and strain gage.

See latest catalog or contact your sales representative in regard to the types of 5B Modules available for your application.

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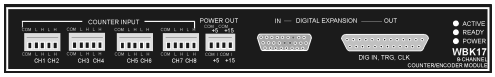


WBK16

Strain-Gage Module

8 channels via Standard Female DB9

WBK16 is an 8-channel strain-gage signal-conditioning module. Up to eight WBK16 modules (64 channels) can be accommodated by the WaveBook and scanned at 1 µs/channel. Almost all bridge configurations are supported via a bridge-completion network and software. High-gain differential-amplifier applications are also supported. Software controls bridge configuration, gain, offset, excitation voltage, polarity, filtering, and the calibration process.



WBK17

Counter-Input Module with Quadrature Encoder Support

8 channels via Removable Screw Terminal Blocks

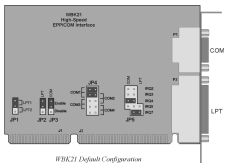
The WBK17 is an 8-channel multi-function counter/encoder module. Each of the high-speed, 32-bit counter channels can be configured for counter, period, pulse width, time between edges, or encoder modes. All channels are capable of measuring analog inputs that are digitized by a Wavebook/512A, WaveBook/516, or WaveBook/516A.

Note: WBK17 can not be used with WaveBook/512 or WaveBook/512H.



WBK20A Interface Card

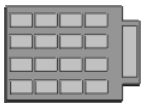
WBK20A



WBK21

WBK20A – PCMCIA/EPP Interface Card
(for linking WaveBook to a Notebook PC)
WBK21 – ISA/EPP Interface Plug-in Board
(For linking WaveBook to a desktop PC)

These devices are shipped with separate documentation and are not detailed in this manual; they are, however, discussed briefly in the *WBK20A and WBK21 Document Modules*.



WBK30

WaveBook Memory Options

WBK30 is a DRAM-based memory board that installs inside a WaveBook. There are three models of WBK30 available; each significantly increases the capacity of WaveBook's standard data buffer of 64 K samples. Capacities are as follows:

WBK30/16— 16 MB
WBK30/64— 64 MB
WBK30/128— 128 MB



WBK61 and WBK62

WBK61: High-Voltage Adapter with 200:1 Voltage Divider (1 channel)
WBK62: High-Voltage Adapter with 20:1 Voltage Divider (1 channel)

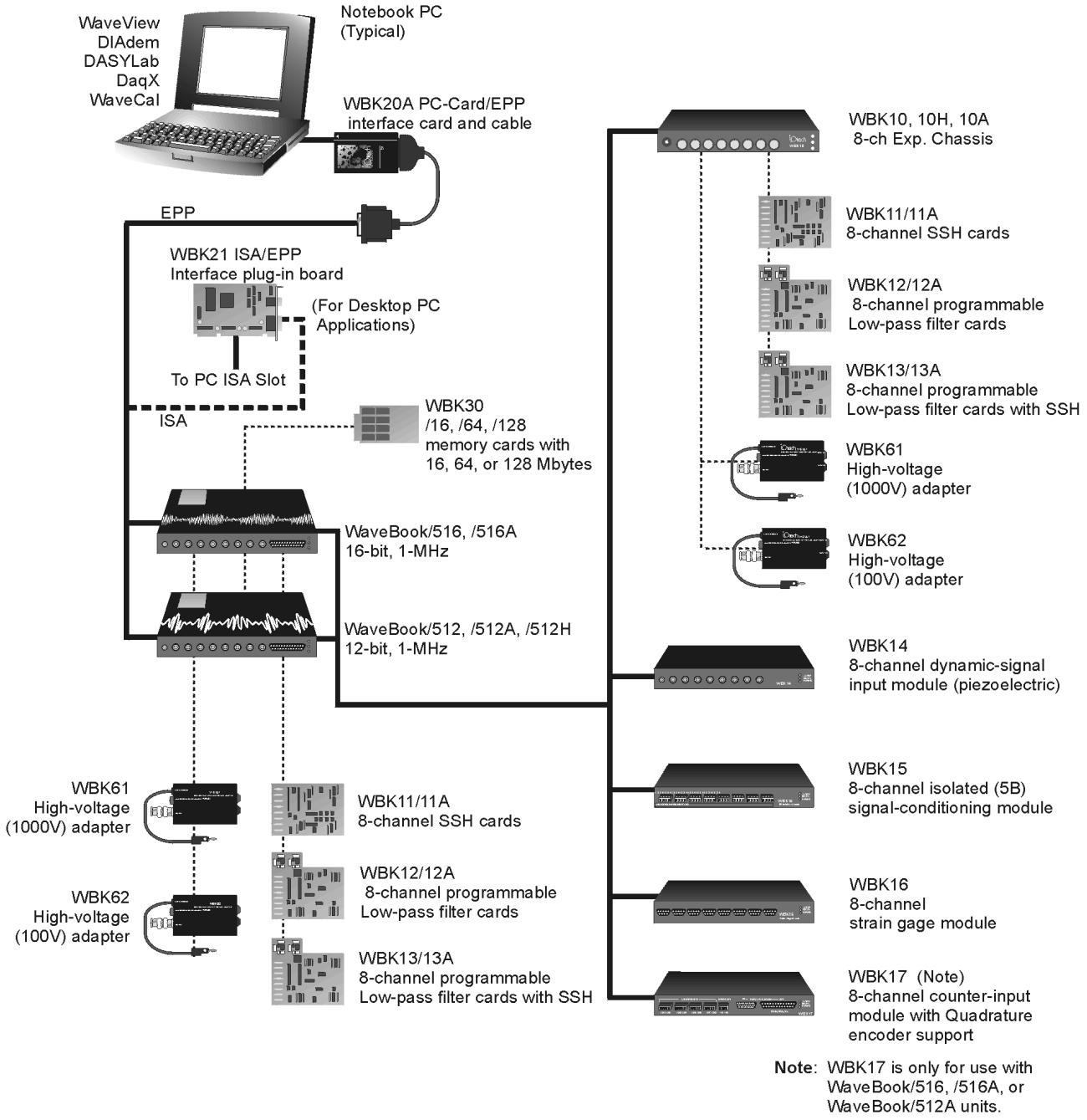
WBK61 and WBK62 are single-channel high-voltage adapters that can be used with the WaveBook or WBK10/10H/10A expansion modules. In addition, WBK61 and WBK62 can be used in conjunction with WBK11, WBK12, and WBK13 series cards.

WBK61 and WBK62 include safety-style banana-jacks for the high and low inputs, and 60-inch (152 cm) cables with probe tips and alligator clips for easy input connection.

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How Do WaveBooks and WBKs Interrelate?

WaveBooks and WBKs interrelate when they become part of the same data-acquisition system. The relationship can be broken down into *enhancement*, *expansion*, or both. The following illustrates the relationship of various system components. Detailed information and product specifications are provided in *WBK Option Cards and Modules Manual*, p/n 489-0902.



WaveBook System Components

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How Are WaveBook Systems Powered?

Input voltage to the WaveBook and to the system modules (WBK10 series, WBK14, WBK15, WBK16, and WBK17) must be in the range of 10 to 30 VDC and can come from an appropriate AC-to-DC adapter, or from a battery.

Available AC-to-DC adapters include the TR-40U (supplied), which has an input of 90-264 VAC and a output rating of 2.2 amps @ 15 VDC.

Battery options include the DBK30A, DBK34A, or other 10 to 30 VDC source such as a car battery. The DBK30A provides 14 VDC and when fully-charged has a storage capacity of 3.4 A·hr; car batteries have much higher capacities. The basic formula for battery life is:

Runtime (hr) = Battery capacity (A·hr) / Current load (A)

System cards (WBK11, WBK12, or WBK13 series) get power from their WaveBook or WBK10/10H/10A expansion module.

Before connecting your system to power, you need to know the power requirements of your specific system. A calculation method, that incorporates the use of worktables, is presented in Chapter 2.



Reference Notes:

- Chapter 2, *System Setup and Power Options*, includes examples of power connections for different WaveBook system scenarios. In these examples the included TR-40U power adapters are used.
- Chapter 3, *WaveBook Operation Reference*, includes discussion of power supplies other than the TR-40U.

Specifications - WaveBook/512 and WaveBook/512H

General
Power Consumption: 0.9A max @ 15 VDC
Input Power Range: 10 to 30 VDC
Operating Temperature: 0 to 50°C
Storage Temperature: 0 to 70°C
Humidity: 0 to 95% RH, non-condensing
Dimensions: 216 mm wide × 279 mm long × 35 mm high (8.5" × 11" × 1.375")
Weight: 1.5 kg (3.3 lb)
Fuse: user-replaceable 4-A Littelfuse # 251004

Analog Inputs
Channels: 8 differential, expandable up to 72 differential
Connector: BNC
Resolution: 12 bit
Maximum Overvoltage: ±30 VDC
Input Current: 50 nA typ, 500 nA max
Input Impedance:
Single-ended: 5 MΩ in parallel with 30 pF
Differential: 10 MΩ in parallel with 30 pF
Accuracy: ±0.025% FS
Offset: ±1 LSB max

Triggering
Single-Channel Analog Trigger:
Range: -5 to +10 VDC
Latency: 300 ns
Multi-Channel Analog Trigger (up to 72 channels):
Range: Selectable per channel to input range
Latency: 2 µs/channel, plus 4µs (max)
TTL Trigger:
Range: TTL-compatible
Latency: 200 ns
Software Trigger:
Latency: 100 µs typ

Sequencer
Programmable for channel, gain & for unipolar/bipolar range in random order
Depth: 128 location
Channel to Channel Rate: 1 µs/channel, fixed
Maximum Repeat Rate: 1 MHz
Minimum Repeat Rate: 100 seconds per scan
Expansion Channel Sample Rate: Same as onboard channels, 1 µs/channel

High-Speed Digital Inputs / General-Purpose Outputs
I/O Lines: 8, WaveBook/512
Connector: DB25 female
Sampling: Sampled with analog data
Input Low Voltage: 0.8 V max
Input High Voltage: 2 V min
Input Low Current: 500 µA
Input High Current: 300 µA

Note: Specifications are subject to change without notice.

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System Setup and Power Options 2

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CAUTION

An incorrect use of power can damage equipment or degrade performance. Prior to connecting your devices to power, calculate your system's power requirements.

This chapter pertains to setting up a WaveBook system. Topics include how to: connect a WaveBook to a PC, add option cards and modules, properly power a system, install software, and check connections with the Daq Configuration Applet. As stated in the above Caution, you will need to calculate system power requirements prior to powering the system.

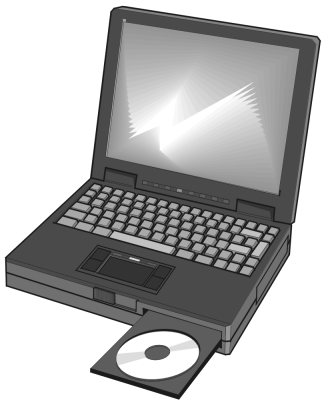
Connecting a WaveBook to a PC

PC Requirements

Notebook PCs are typically used to communicate with WaveBook acquisition hardware. However, desktop PCs can be used.

Regardless of your PC preference, the following requirements apply:

- 16MB Ram (32MB Ram recommended)
- Pentium® 90 Processor (or equivalent)
- 10 MB of Available Disk Space
- Windows Operating System (Windows95/98/Me, or WindowsNT/2000)
- Optional, but recommended: EPP (Enhanced Parallel Port), or ECP (Extended Capabilities Port)



A Notebook PC is Typically Used to Communicate with WaveBook

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Connecting the Communication Cable

WaveBook communicates with a notebook or desktop PC through the computer's parallel port. Use of an Enhanced Parallel Port (EPP) or an Extended Capabilities Port (ECP) is recommended.

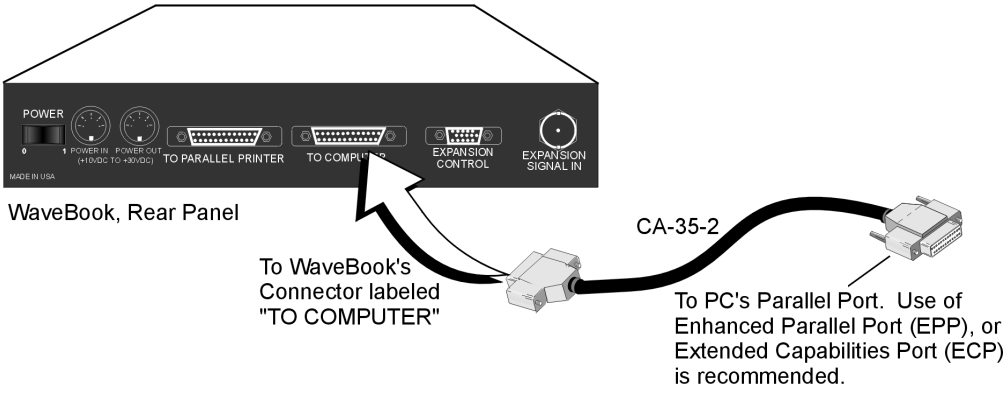
Two card options are available for use with PCs that do not have Enhanced Parallel Ports. These are:

- WBK20A PCMCIA/EPP interface-card, to be used in conjunction with a notebook's PC-Card port.
- WBK21 ISA/EPP interface-card, for use with a desktop PC.

A 2-foot CA-35-2, or a 6-foot CA-35-6 communication cable is used to connect the WaveBook to the host PC. The connection is made via a 25-pin connector labeled "TO COMPUTER," and located on WaveBook's rear panel. The other end of the cable connects the computer's PC Parallel Port.



To ensure EPP speeds are properly handled, it is important that WaveBook systems make use of a 1284-compliant cable. Standard parallel cables will not work properly, primarily due to a lack of shielding. Note that cables CA-35-2 and CA-35-6 are 1284-compliant. These are 2 and 6 foot cables, respectively.



Connecting the Communication Cable (CA-35-2)



Reference Notes:

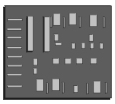
- For detailed information regarding the optional WBK20A PCMCIA/EPP interface-card, refer to the WBK20A User's Guide (p/n 274-0901). A copy of the guide is shipped with the product. A PDF version of the guide can be accessed from our web site, or from a link in the electronic version of the *WBK Option Cards and Modules User's Guide* (p/n 489-0902).
- For information regarding the optional WBK21 ISA/EPP interface-card, refer to the WBK21 installation guide [that is shipped with the card]. The WBK21 option is also discussed in the *WBK Option Cards and Modules User's Guide* (p/n 489-0902).
- Note that PDF versions of documentation are loaded onto your hard drive, as a part of product support, during software installation. The default location is the **Programs** file directory, which can be accessed from the Windows Desktop.

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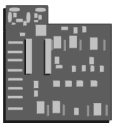
Adding WBK Option Cards

This section pertains to adding a WBK11, WBK12, or WBK13 Series card to a WaveBook/512 or to a WBK10, or WBK10H expansion module.

Important Notice Regarding WaveBook/516, WaveBook/512A, WaveBook/516A, and WBK10A: Cards for these products are installed at the factory per customer order. Users are not to remove or install cards for these 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.



WBK11, WBK11A
Simultaneous Sample & Hold Cards (8 channels each)

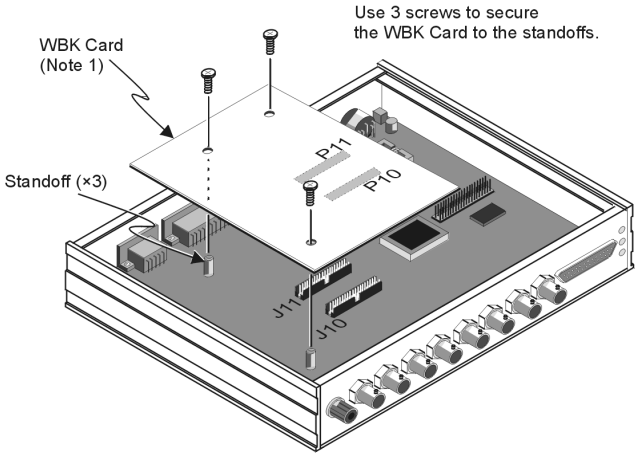


WBK12, WBK12A, WBK13, and WBK13A
WBK12, WBK12A: Programmable Low-Pass Filter Cards (8 channels each)
WBK13, WBK13A: Programmable Low-Pass Filter Card with SSH (8 channels each)

All WBK11, WBK12,WBK13, and WBK11A, WBK12A, and WBK13A configurations are controlled by software. There are no hardware settings.

The WBK Card connects to headers J10 and J11 in the base unit. The base unit can be a WaveBook/512, WaveBook/512H, WBK10 or WBK10H. The jumpers located on J10 and J11 provide signal pass-through when a WBK option card is not installed. Refer to the following figure and steps to install an option card into a WaveBook/512, WBK10, or WBK10H module.

Note: Although the figure at the right represents installation of a WBK11 into a WaveBook/512, the method used to install other WBK options into a WaveBook, WBK10, or WBK10H is the same.



Installing a WBK Option Card

WARNING

Electric shock hazard! Remove the WaveBook, and all devices connected to it, from power before removing the cover plate. Failure to do so could result in electric shock and possible death.

1. Remove all power from the unit and any connected devices.
2. **For WaveBook/512, WaveBook/512H, WBK10, or WBK10H**, remove the screw holding down the top panel (cover), and slide the panel out towards the back (see following figure).
   For other WaveBook models and WBK10A, contact the factory in regard to adding or replacing option cards.
3. Remove the stand-off screws, then remove old WBK card from J10 and J11.
   If no card was present, skip to step 4.
4. Locate the headers J10 & J11 on the main board, and remove the jumpers (if present).
   Save the jumpers in the event the SSH board needs to be removed.
5. Align the WBK card headers (P11 & P10) with the host board headers (J11 & J10), respectively.

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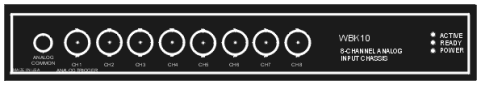
6. Verify alignment of the board. An easy way is to check that the board's screw holes are in line with the standoffs.
7. Carefully push the WBK option card down until the connectors fully mate.
8. Using three screws, secure the WBK card to the standoffs. Do not over-tighten.
9. Slide the top panel onto the unit, and secure it using the top panel screw.

Adding WBK Modules

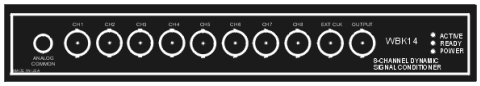
Module Options

Several WBK module options are currently available for use with WaveBook systems. This section is concerned with "how the modules are connected and powered." Functions, specs, and software issues are discussed elsewhere.

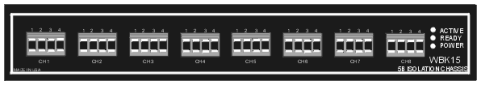
Note that each of the following module options offers 8 channels.



WBK10, WBK10H, & WBK10A
Expansion Modules



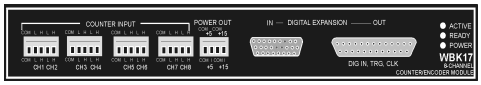
WBK14
Dynamic Signal Conditioning Module



WBK15
8-Slot 5B Signal Conditioning Module



WBK16
Strain-Gage Module



WBK17
Counter-Input Module with Quadrature Encoder Support.

WBK17 is only used with WaveBook/516, WaveBook/512A, and WaveBook/516A.

Modules Currently Available for WaveBook System Expansion

Connection basics are the same, regardless of whether the WaveBook system has one module or eight modules. Examples of various setups follow shortly.

Power requirements can vary greatly from one WaveBook system to another, and will need to be calculated on a system by system basis, before power is applied to the system. This chapter includes instructions for calculating power requirements.

Before discussing how to calculate power, we will look at the use of connectors and the types of cables used.

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Connectors and Cables

To attach a module, connections must be made for power, expansion control, and expansion signals. The following connectors and cables are used.

- WaveBook **POWER IN** – connects to a 10 to 30 VDC source.
- WaveBook **POWER OUT** – can be connected to the first module's POWER IN.
- WaveBook **EXPANSION CONTROL** – connects to the first module's EXPANSION CONTROL IN.
- WaveBook **EXPANSION SIGNAL IN** – connects to the first module's EXPANSION SIGNAL OUT.
- WBK **POWER IN** – connects to a 10 to 30 VDC source. When in a power *daisy-chain*, POWER IN connects to the previous WaveBook or WBK module's POWER OUT.
- WBK module **POWER OUT** – can be connected to the next module's POWER IN, providing the 5 amp current limit will not be exceeded. It may be necessary to use a supplemental power supply. Power requirements and discussed in the following pages.
- WBK module **EXPANSION CONTROL OUT** – connects to the next module's EXPANSION CONTROL IN.
- WBK module **EXPANSION SIGNAL IN** – connects to the next module's EXPANSION SIGNAL OUT.

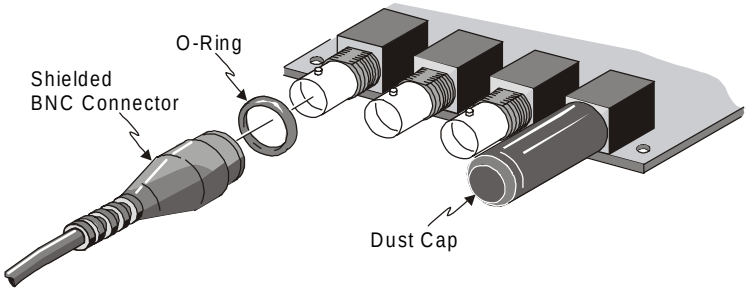


Prior to connecting your devices to power, calculate your system's power requirements as discussed in upcoming section of this chapter. Note that three examples of system setups follow shortly.



Using Shielded BNC Connectors for CE Compliance

Certain *Declarations of Conformity* identify specific cables and connectors that must be used to meet CE requirements. CE compliant BNC-equipped cards and modules have BNC connectors that are insulated from high voltage sources, including electrostatic discharges (ESD). Such voltages could enter the circuitry through the exposed conductive surface of a connector, possibly resulting in damage to components.

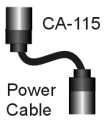


Shielded BNC Connector (with O-Ring) and PVC Dust Cap

To meet CE requirements, PVC dust caps (p/n CN-96) must cover all unused BNC connectors. When dust caps are not in place, special coaxial cables (with insulated end-connectors and rubber O-rings) must be used. Note that part number 418-0800 includes two cables (with shielded BNC connectors at each end), and four insulating O-rings.

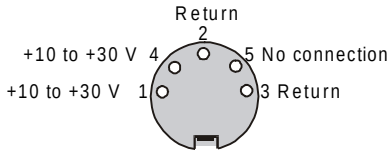
Properly installed connectors and dust caps ensure the metallic surfaces of the connectors are not exposed to undesirable electrical charges.

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CA-115 Power Cables. CA-115 cables are 6 inches long and have two 5-pin male DIN connectors. CA-115s are frequently used to link WaveBook's POWER OUT connector to a WBK expansion module's POWER IN connector. CA-115 cables are also used to link an expansion module's POWER OUT connector to the next daisy-chained module's POWER IN connector.

CA-115 cables and the device DIN5 connectors (see following figure) are limited to 5 amps at 15 VDC.

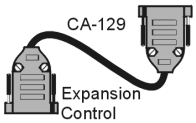


DIN 5 Power Pinout*

Power is supplied to WaveBook modules via a DIN5 type connector located on the rear panel of the device.

*The DIN5 pinout [to the left] is based on an external view of a WaveBook rear panel.

Note: An optional **CA-116** power cable is available. The CA-116 permits the system to be plugged into a vehicle cigarette lighter, allowing use of the vehicle's battery as a power supply for the WaveBook device.



CA-129 Expansion Control Cables. Control messages are carried by CA-129 expansion-control cables with HD-15, plug and socket connectors. The first expansion unit's control input is driven from the main unit's control output. Control inputs of additional WBK modules are driven from the preceding unit's control output.



CA-150 Expansion Signal Cables. Expansion signals are carried by a CA-150-1 male BNC to male BNC coaxial cable. Each WBK module drives a common parallel analog bus that carries the signals to WaveBook's Analog-to-Digital Converter (ADC). Each WBK module has EXPANSION SIGNAL IN and EXPANSION SIGNAL OUT connectors for daisy-chaining multiple units.



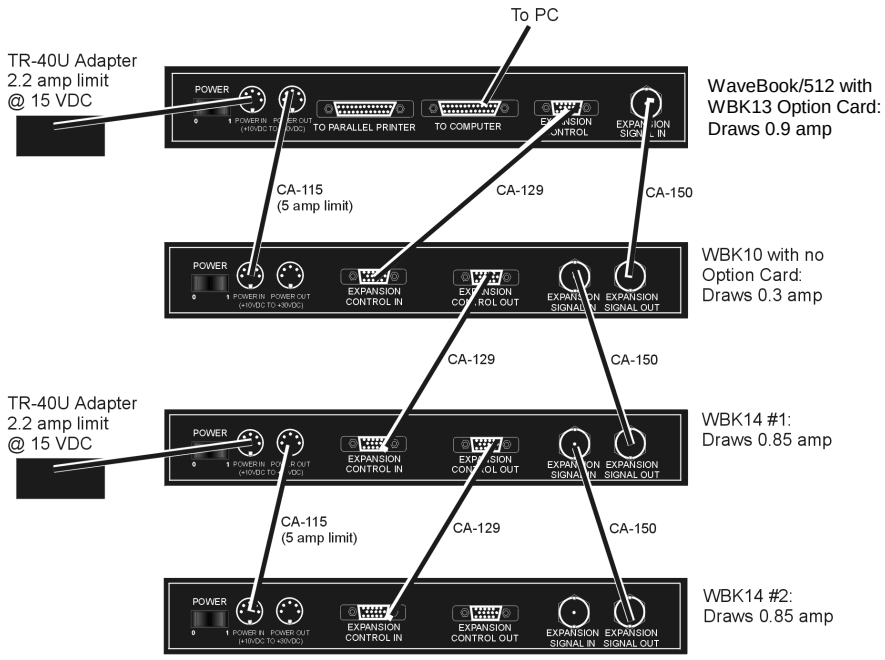
Calculate system amp load prior to creating a system daisy-chain. Although WaveBook device connectors and CA-115 power cables have 5 amp limits, TR-40Us are limited to 2.2 amps. Tables for determining amp load are provided in the following section, *Calculating System Power*.

CA-177 Strain Gage Cables. CA-177 is an optional set of eight strain-gage cables intended for use with the eight channels of WBK16. Discussions of the CA-177 strain-gage cable and bridge applications are contained in the WBK16 document module.

CA-217 Digital Expansion Cables. These 8-inch cables are used for connecting one or more WBK17s to a WaveBook/516 or WaveBook/516A. The CA-217 cable has a DB25M connector for Digital Expansion Out and a HD26M connector for Digital Expansion In. (See the following page, second figure).

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Example of a WaveBook System Daisy-Chain



A WaveBook System Drawing 2.9 amps.

Although this system draws current below the 5amp limit of the power connectors [and of the CA-115 Power Cable], the 2.9 amps does exceed the TR40U 2.2 amp limit. For this reason the WBK14s are receiving power from a second TR-40U.



Reference Note:
For information regarding calculating system power requirements, refer to the upcoming section entitled, *Connecting the System to Power*.

How Channel Numbers are Determined

The analog input channel numbers are determined by the order of connection among the WaveBook and attached WBK modules.

- Channel 0 is the WaveBook's 8-bit digital I/O port.
- Channels 1 through 8 are the WaveBook's main channels.
- Channels 9 through 16 are located on the first expansion unit connected directly to the WaveBook.
- Additional channel numbers are added consecutively (in groups of 8) with each added WBK module (see table at right).

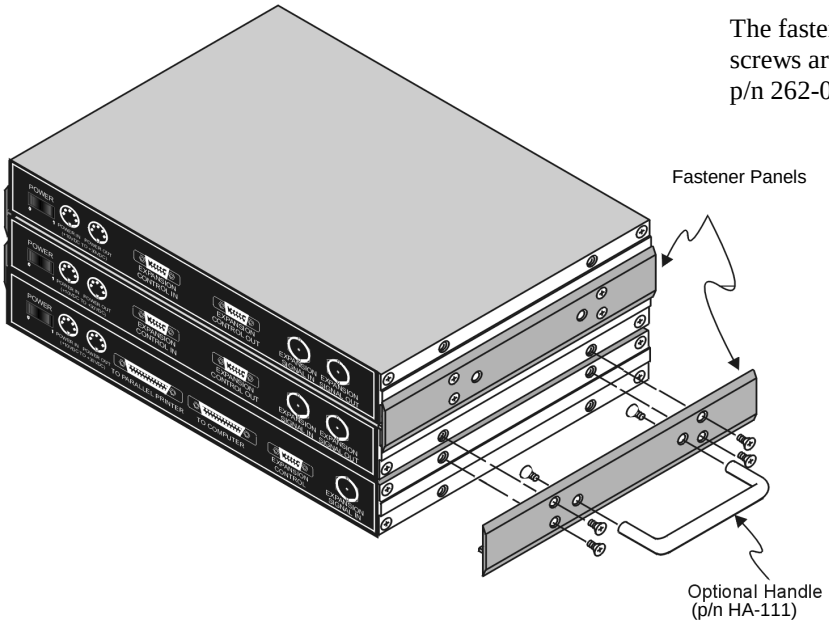
Unit*	Channel #
WaveBook	0 (dig I/O)
WaveBook	1-8
1st WBK	9-16
2nd WBK	17-24
3rd WBK	25-32
4th WBK	33-40
5th WBK	41-48
6th WBK	49-56
7th WBK	57-64
8th WBK	65-72

* WBK in the "Unit" column refers to a module such as a WBK10, WBK14, WBK15, or WBK16.

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Stacking Modules

The fastener panels and associated screws are from fastener-panel kit, p/n 262-0801.



Using Fastener Panels to Stack a WaveBook and two WBK Modules (use of the handle is optional)

WBK modules can be stacked using fastener panels, sometimes referred to as splice plates. The panels provide a means of stacking modules to create one rigid assembly. The Fastener Panel Kit, p/n 262-0801, is available from the factory and consists of two metal plates and the necessary mounting screws. A Fastener-Panel Handle (p/n HA-111) is also available from the factory. HA-111 consists of 1 handle and two mounting screws.

The previous figure illustrates the simplicity of the mounting process.

Note: When used with a WBK16, WaveBook/516, WaveBook/516A, or WaveBook/512A, fastener panels will partially block the vents on the side of the module. This partial blocking of vents does not jeopardize the cooling process.

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Calculating the System Power Requirement

CAUTION



An incorrect use of power can damage equipment or degrade performance. Prior to connecting your devices to power, calculate your system's power requirements.

CAUTION



Do not daisy-chain the power connections of more than three WBK10 series module units. Daisy-chaining a power connection to a fourth module will exceed the power connector's 5 amp current limit.

It is important to supply your system with adequate, reliable power. For this reason, you need to know your system's power requirement. Computing power use is also important when using batteries to power modules, as you will need to know a safe runtime before recharging is required.



The following statements relate to system power. They should be reviewed before proceeding.

- **Higher voltages draw fewer Amps for the same power. Remember: Watts = voltage x current (W = E*I).**
- **The TR-40U power adapter provides power that is sufficient for the WaveBooks and WaveBook modules. You do not need to make power requirement calculations unless you intend daisy-chaining units, or you have a critical battery runtime.**
- **Do not overload your power supplies. TR-40U power adapters are limited to 2.2 amps. However, you can use more than one TR-40U, as indicated in one of the upcoming daisy-chain examples.**
- **Current drawn from other sources, such as car batteries, can be estimated from the following *WaveBook Product Current Requirements* table.**

Use the current requirements and worksheet tables to calculate your system's total power requirement. Take the appropriate amperage values from the first table to fill in the second table; then perform the indicated multiplication and addition operations to calculate the amperage for all units in your system.

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WaveBook Product Current Requirements (in Amps)					
Products and Product Combinations	**DBK30A 14 VDC**	**DBK30A 28 VDC**	**DBK34A 12 VDC**	**DBK34A 24 VDC**	**TR-40U 15 VDC**
WaveBook/512 (alone)	0.43	0.20	0.52	0.23	0.40
WaveBook/512H (alone)	0.40	0.20	0.48	0.23	0.40
WBK10 (alone)	0.32	0.20	0.38	0.19	0.30
WBK10H (alone)	0.33	0.22	0.40	0.26	0.33
WBK10A (alone)	0.35	0.17	0.42	0.20	0.35
WBK11, WBK11A	0.27	0.10	0.32	0.16	0.22
WBK12, WBK12A	0.47	0.23	0.56	0.27	0.45
WBK13, WBK13A	0.57	0.28	0.68	0.33	0.50
WBK14 (alone)	0.90	0.50	1.08	0.53	0.85
WBK15 (alone)	0.13	0.08	0.16	0.09	0.12
WBK15 (typical) Note 1	0.24	0.13	0.29	0.15	0.23
WBK15 (max) Note 2	0.75	0.36	0.90	0.44	0.75
WBK16 (no excitation)	1.08	0.52	1.30	0.61	1.00
WBK16 (full excitation)	1.80	0.87	2.10	1.00	1.67
WBK16/SSH	1.20	.60	1.44	0.70	1.20
WBK30	0.01	0.005	0.01	0.006	0.01

Note 1: Typical with 8 voltage modules.
Note 2: Maximum load with 8 strain-gage modules. You may need to consult power specifications for individual 5B modules and for any excitation currents required.

Worksheet for Power Requirements					
Product	**Qty**	×	**Amps**	=	**Totals**
WaveBook/512		×		=	
WaveBook/512H		×		=	
WBK10/10H		×		=	
WBK10A		×		=	
WBK11		×		=	
WBK12		×		=	
WBK13		×		=	
WBK14		×		=	
WBK15		×		=	
WBK16		×		=	
				Maximum Amps	

It is important to supply your system with adequate, reliable power. For this reason, you need to know your system's power requirement. Knowing the power requirement is also important when using batteries to power modules, as you should know a safe *runtime*, i.e., how long you can run the system before recharging is required.

Input voltage to the WaveBook/512, WaveBook/516 and to the system modules (WBK10 series, WBK14, WBK15, and WBK16, must be in the range of 10 to 30 VDC and can come from an AC-to-DC adapter or from another source, such as a battery. System cards (WBK11, WBK12, or WBK13) get power from their host WaveBook or WBK10 series expansion module.

Available AC-to-DC adapters include the TR-40U (supplied), which has an input of 90-264 VAC and an output of 2.2 amps @ 15 VDC.

Battery options include the DBK30A, DBK34A, and other 10 to 30 VDC sources, such as car batteries. The DBK30A provides 14 VDC and when fully-charged has a storage capacity of 3.4 A·hr; car batteries have much higher capacities. The basic formula for battery life is:

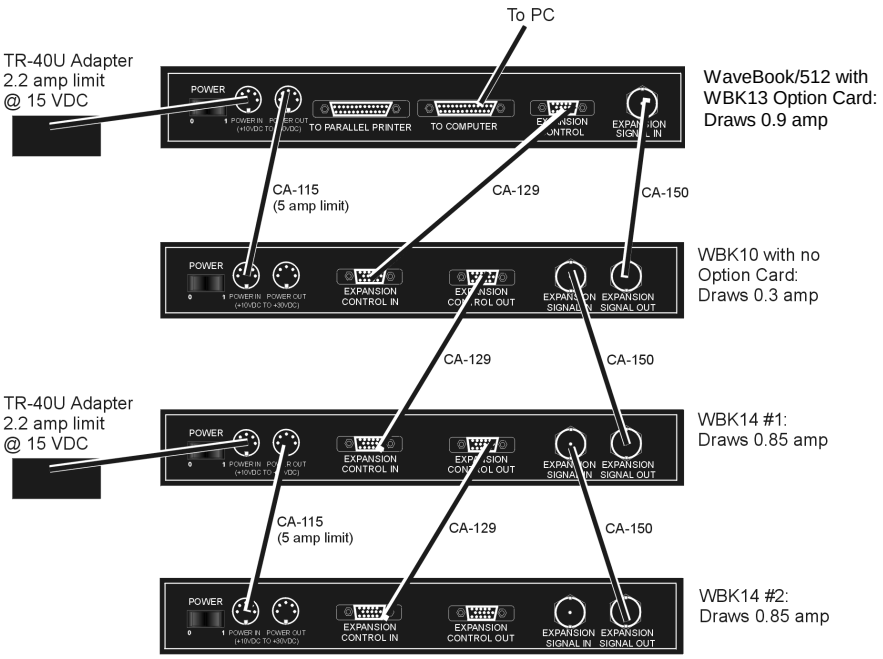
Runtime (hr) = Battery capacity (A·hr) / Current load (A)



Battery life and performance depend on various factors including battery type, condition, charge level, and ambient temperature. Be sure you consider these factors, especially when runtime is a critical.

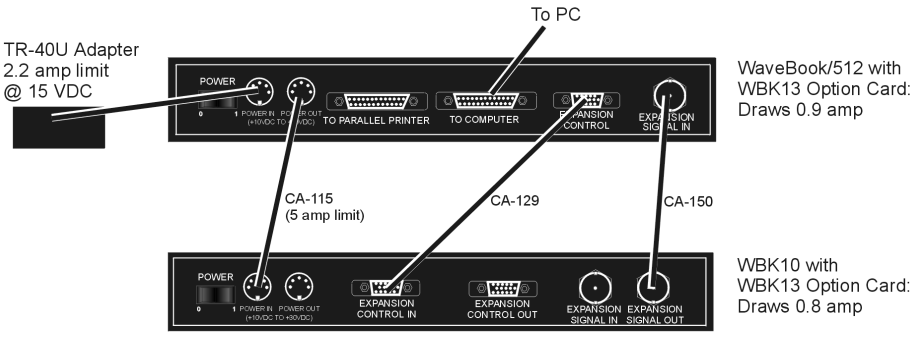
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System Examples



WaveBook System Drawing 2.9 amps.

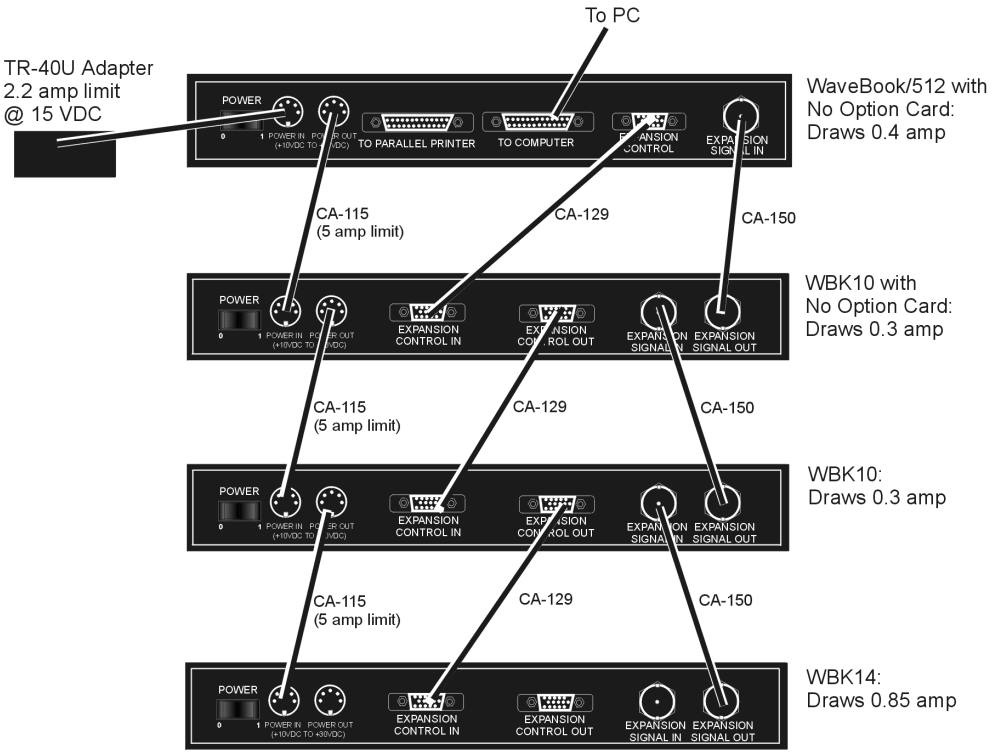
Although this system draws current below the 5amp limit of the power connectors [and of the CA-115 Power Cable], the 2.9 amps does exceed the TR40U 2.2 amp limit. For this reason the WBK14s are receiving power from a second TR-40U.



WaveBook System drawing 1.7 amps

Reference Note:
Although the preceding examples make use of TR-40U power adapters, other power sources can be used. These options are discussed in the following section entitled, *Power Supplies*.

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WaveBook System, drawing 1.85 amps

Reference Note:
Although the preceding examples make use TR-40U power adapters, other power sources can be used. These options are discussed in the following section, *Power Supplies.*

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Power Supplies

The power supplies that can be used with WaveBook setups are listed in the following table.

WaveBook Product Power Supplies		
Item	**Name/Description**	**Capacity**
TR-40U	AC Power Adapter (shipped with WaveBooks & WBK Modules)	90-264 VAC input; 2.2 A @ 15 VDC
DBK30A	Rechargeable Battery/Excitation Module (optional)	12-14 VDC, or 24-28 VDC 3.4 A-hr @ 14 VDC
DBK34A	UPS (Uninterruptable Power Supply)/Battery Module (optional)	12 VDC, or 24 VDC 5.0 A-hr @ 12 VDC
Other	10 to 30 VCD source, such as a vehicle battery.	Depends on source

DBK30A - Rechargeable Battery Module



DBK30A Front Panel

DBK30A contains two rechargeable nickel-cadmium batteries for use with WaveBook, expansion WBK modules, and transducers. DBK30A shares the same base dimensions as other WaveBook products, allowing for convenient stacking. Note that stacking can be easily accomplished with the included splice plates.

The power adapter (included) converts AC power to 24 VDC for charging DBK30A's two battery packs. Automatic charging circuits recharge the internal batteries quickly and safely. The charged battery runtime depends on the current load and mode of operation.

An internal slide switch (SW2) determines the unit's mode. The two modes are:

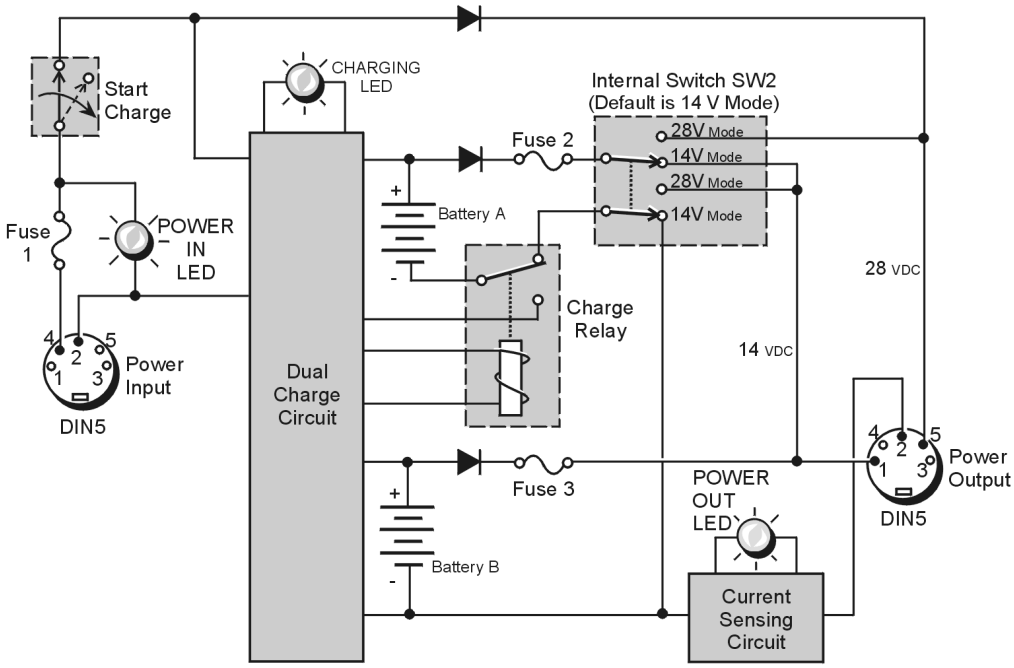
- 14 VDC Mode (default)
- 28 VDC Mode



You should check the power requirements of each component in your system, and then verify that the power source can provide sufficient power to meet your runtime requirements.

Fully charge DBK30A's batteries before use.

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DBK30A Block Diagram

14 VDC Mode (*default*)

This mode provides 14 VDC for 3.4 A-hr. The typical battery runtime is from 3 to 6 hours depending on the load. Unless 28 VDC is required, the 14 VDC mode should be used in WaveBook and WBK applications,

Unless you need 28 V, leave the unit in the 14 VDC mode. Use of the 28 VDC mode results in a lower runtime, as only one battery pack can be used for 14 VDC. When in the 14 VDC mode, both packs are used in parallel, resulting in a longer runtime for the same application.

28 VDC Mode

The 28 VDC mode actually provides *both* 14 VDC *and* 28 VDC. Loop currents for two-wire, 4-20 mA transmitters (1.7 A-hr) require 28 VDC. The battery run-time ranges from 1 to 6 hours, depending on system configuration. In this mode, 14 VDC is used for unregulated bridge excitation (for bridge-configured sensors, such as load cells), and power to WBK expansion products.

Unless you need 28 V, leave the unit in the 14 VDC mode. Use of the 28 VDC mode results in a lower runtime, as only one battery pack can be used for 14 VDC. When in the 14 VDC mode, both packs are used in parallel, resulting in a longer runtime for the same application.

Hardware Setup

Configuration

The only configuration option is the choice of modes (14 VDC, or 28 VDC). If you do not need 28 V, leave SW2 in the default position.

If you are using a pre-owned DBK30A, or are unsure of the mode selected, use the following steps to check SW2's position. Note that new units are always shipped with SW2 selected to the 14 VDC mode.

Internal switch SW2 is located on the printed circuit board, near the front center of the unit. To change or verify the mode:

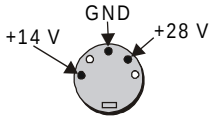
1. Remove DBK30A's cover by removing one screw and sliding the cover forward until it separates from the module.
2. Look near the front center of the circuit board and locate slide switch SW2.
3. Check SW2's selection. The silkscreen indicates the 14 and 28 VDC positions.

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4. Change the selection, if required. If you do not need 28 V, SW2 should be in the default position (14 VDC).
5. Replace the top cover, and secure with screw.

Power

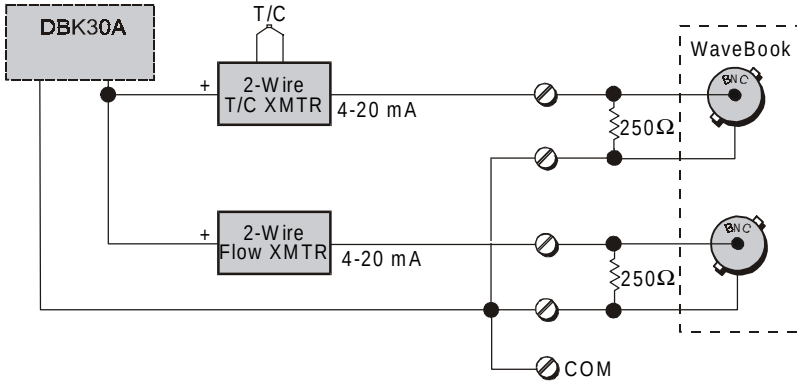
Connection. The figure shows the pinout for the POWER OUT DIN5 connector. The 28 V pin is only active in the 28 VDC mode; however, the 14 V pin is active regardless of the mode selected.



DIN5 Power Out

The CA-115 cable connects to DBK30A's POWER OUT connector and WaveBook's POWER IN connector. The cable can be used to daisy-chain a DBK30A unit to a WBK expansion module.

28 VDC Mode. The primary purpose of the 28 VDC mode is to provide power for external loop transmitters. The hookup is simple, as shown below.



Connecting Loop Transmitters

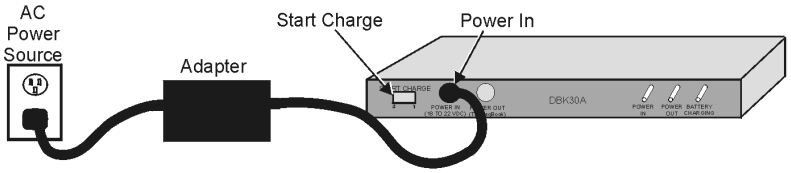
Another use of the 28 VDC mode is to provide excitation for bridge-type sensors, such as load cells (strain gages) and other devices that may be attached to 5B modules inside a WBK15.



Excitation voltage from DBK30A is not regulated by the unit, and must therefore be regulated externally. For most load cells, excitation voltage should be regulated to 10 V.

Charging. To charge the DBK30A batteries:

1. Connect the adapter to DBK30A's POWER IN connector.
2. Plug the adapter into the AC power receptacle.
   Note that the charge cycle will begin automatically whenever AC power is applied after an interruption. The charge cycle will automatically end when the batteries are fully charged.



Charging DBK30A's Batteries

3. To manually initiate a charge cycle, press the START CHARGE momentary rocker-arm switch. Note that subsequent charge cycles applied to a fully-charged DBK30A will have no ill effect. The module will sense the fully-charged status and revert to the trickle-charge state within a few minutes.

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Three LEDs on the DBK30A provide status information on the charging process or the external load.

LED Indicators & Descriptions	
POWER IN	Indicates the charger is connected to a source of AC power and to the battery module.
BATTERY CHARGING	Steady Light - Indicates the battery is in the high-current (2 A) charge mode. Flashing - One or two flashes at a time indicates the batteries are fully charged.
POWER OUT	Indicates power is flowing out to an external device, such as a WaveBook product.

CAUTION

Periodically, fully discharge the DBK30A to inhibit "lazy chemistry" (memory) in the nickel-cadmium cells. To manually discharge a battery pack, connect a WaveBook to the pack and leave it powered-on until the indicator lights go out.

Use While Charging. Both operating modes are capable of powering the WaveBook products while being charged; however, the charging current is reduced, and charging time is increased. If AC power is interrupted, a new charge cycle will begin automatically when AC power returns.

CAUTION

Even with the AC adapter, the batteries will eventually discharge under a WaveBook operating load. Charging DOES NOT BEGIN AUTOMATICALLY (except on power-up). You must manually initiate the next charge cycle. Do not expect a WaveBook powered by a DBK30A to operate as an uninterruptable power supply.

Stacking Modules

Stacking can be accomplished with splice plates, as discussed earlier in the chapter.

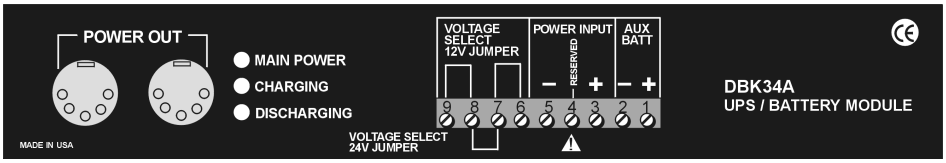
DBK30A Battery Module - Specifications

Name/Function: Rechargeable Battery Module
Battery Type: Nickel-cadmium
Number of Battery Packs: 2
Battery Pack Configuration: 12 series-connected sub-C cells
Output Voltage: 14.4 V or 28.8 V (depending on the selected mode)
Output Fuses: 2 A
Battery Amp-Hours: 3.4 A-hr (1.7 A-hr/pack)
Charge Termination: Peak detection
Charge Time: 2 hours
Charging Voltage from Supplied AC Adapter: 22 to 26 VDC @ 2 A
AC Adapter Input: 95 to 265 VAC @ 47 to 63 Hz
Size: 221 mm × 285 mm × 35 mm (11" × 8-1/2" × 1-3/8")
Weight: 2.4 kg (6 lb)

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DBK34A Vehicle UPS/Battery Module

DBK34A is similar to DBK34 in appearance and operation; but there are differences. Before proceeding with this section, verify that your device is a DBK34A. If your device does not have the "A" suffix, use the preceding section regarding the DBK34 Vehicle UPS Module instead of this section.



DBK34A Front Panel

The DBK34A can power a data acquisition system in portable or in-vehicle UPS applications (both 12 V and 24 V systems). Power storage capacity is 5 A-hr @ 12 VDC or 2.5 A-hr @ 24 VDC.

For reliable data acquisition in a vehicle, the DBK34A provides clean and consistent operating power:

- Prior to engine/generator start
- During engine start-up (battery sag due to the high-current demand of starter motor and solenoid)
- After engine turn off.
- Before and after connection to the vehicle

The DBK34A contains two sealed-lead rechargeable batteries (Gel-Packs), associated charging circuits and current indicators. Typically, these batteries can last more than 500 full cycles and up to 10 years standby lifetime at room temperature. Recharging is fast, and extreme temperature performance is good. The DBK34A can be used with the LogBook, DaqBook, WaveBook, and related DBKs and WBKs. The unit's rugged metal package has a compatible 8×11" footprint for convenient stacking with Velcro tabs and optional splice plates and handles for carrying.

Main and auxiliary power input comes from 12 or 24 VDC via a terminal block on the unit's front panel (12 or 24 V modes are set by front-panel jumpers). Automatic, temperature-compensated charging circuits recharge the internal batteries quickly and safely. For trouble-free operation, you must fully charge the batteries before use. The charged battery runtime will depend on the load and mode of operation.

During use of the internal batteries, the Charging LED blinks and a beeper sounds when battery life is almost exhausted. Within a few minutes, internal cutoff circuits disconnect the load from the batteries to prevent the possibility of deep-cycle damage.

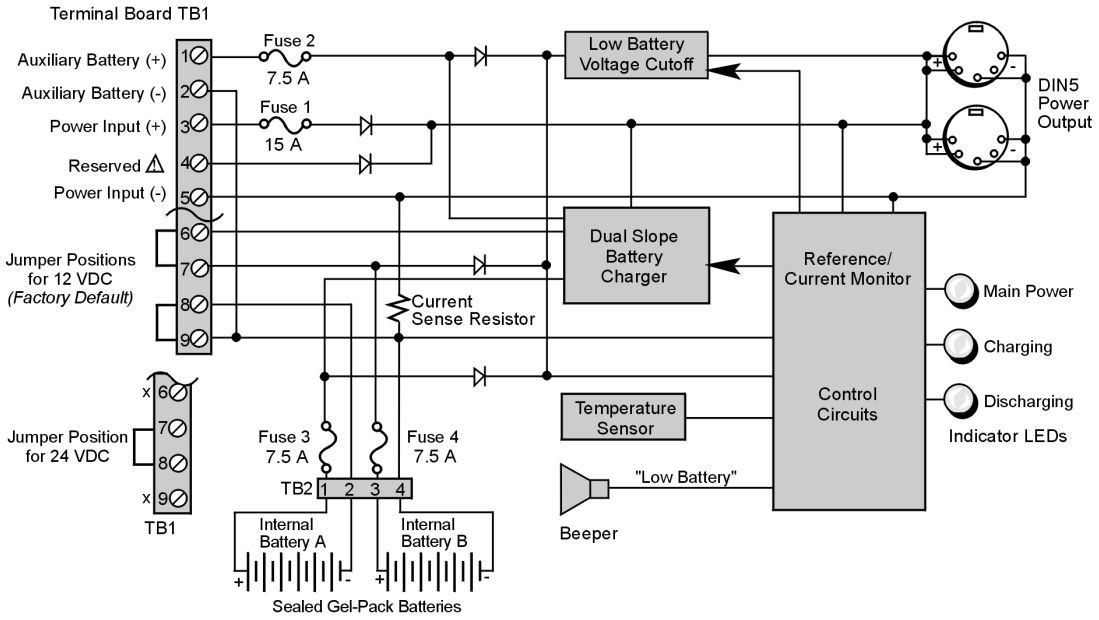
Note: Current protection is provided by four fuses. Two 7.5A fuses for the unit's internal batteries, one 7.5 A fuse for an auxiliary (external) battery, and a 15 A fuse for the power input.

Tip

You can use a CA-172 cable to connect a vehicle battery (via a cigarette lighter) to the DBK34A terminal board. The cable is six feet long, contains a cigarette lighter adapter at one end, and stripped leads (for terminal connection) at the other.

For trouble-free operation, fully charge the batteries before use. Charged battery runtime depends on the load and on the mode of operation.

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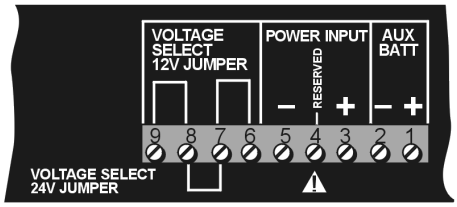


⚠ TB1's Terminal 4 is reserved for factory use and is not to be connected by the user.

DBK34A Block Diagram

Hardware Setup

Configuration for 12 Volt (Default) or 24 Volt Operation



DBK34A's Screw Terminal Board, TB1

DBK34A's screw terminal numbers read from right to left (9,8,7…3,2,1) when viewed from the front panel (see figure).

For 12 Volt Operation:

1. Remove jumper from terminals 8 and 7, if present.
2. Use a jumper to short terminals 9 and 8
3. Use a jumper to short terminals 7 and 6

For 24 Volt Operation:

1. Remove jumpers from terminals 9 and 8, if present
2. Remove jumpers from terminals 7 and 6, if present.
3. Use a jumper to short terminals 8 and 7.

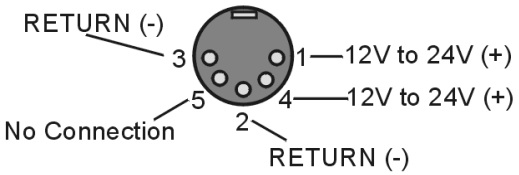
Power

Power In (12 or 24 VDC only).

- Connect MAIN POWER INPUT (+) positive to Terminal 3 of TB1.
- Connect MAIN POWER INPUT (-) negative to Terminal 5 of TB1.
- TB1's Terminal 4 is reserved for factory use and is not to be connected by the user.
- The use of an optional auxiliary battery will extend run-time. For use with DBK34A, auxiliary batteries must be of lead-acid chemistry, in the 2 to 3 A-Hr range, and of the same voltage as that set by the Voltage Select Jumpers. Auxiliary batteries charge and discharge in the same manner as the internal batteries. If an auxiliary battery is to be used, connect AUX BATT (+) *positive* to Terminal 1 (of TB1), and connect AUX BATT (-) *negative* to Terminal 2 (of TB1).

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Power Out. The pinout at the right applies to the two POWER OUT DIN5 connectors. The DBK34A package includes a short connecting cable to connect to the powered device. This cable connects the POWER OUT connector on the DBK34A and to the POWER IN connector on the WaveBook, LogBook, DaqBook, or WBK/DBK module.



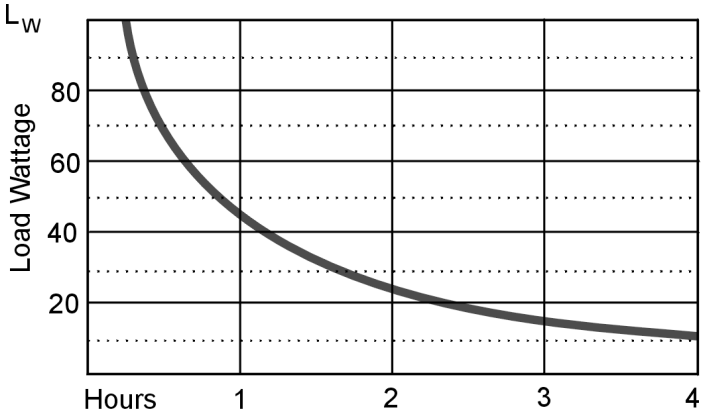
DIN5 Power Output Connector *(2 per DBK34A)*

Indicators. Three front-panel LED indicators provide power and charging status information.

LED Indicators & Descriptions	
MAIN POWER	Lights when the DBK34A power input is connected to a source of at least 12.25 VDC
CHARGING	Lights when the internal batteries are being fast-charged at a rate of 0.1 amp/cell or greater.
DISCHARGING	Lights when internal batteries (or auxiliary batteries) are discharging at a rate of 0.25A or greater.

Runtime. Approximate runtime under various loads can be computed from the storage capacity (5 A-hr in 12 V mode; 2.5 A-hr in 24 V mode) and the load (main unit and other DBKs).

The following Load Wattage vs. Hours graph is for a typical new battery that is fully charged.



DBK34 and DBK34A Load/Life Graph

Graph indicates approximate battery life under the indicated Load Wattage @ 25°C (77°F).

The following equation can be used to estimate the life of a fully charged battery for a given Load Wattage (L_W).

$$\text{Hours} \cong \frac{56 - L_W/3.33}{L_W}$$

Charging: In general, lead-acid batteries [and related Gel-Packs] require charging at 120% of drain energy (e.g., the 5 A-hr DBK34A requires a charge equal to or greater than 6 A-hr). Charging times vary; but 4 to 5 hours at 14 V is typical for a completely discharged battery; after which, charging may continue indefinitely.

Note that 16 to 18 VDC at the power input is required for optimal charging.

CAUTION

Voltage applied to a DBK34A must not exceed 30 VDC.

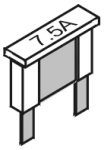
Environmental Concerns

CAUTION

DBK34A Gel-Pack batteries contain toxic materials (Pb and H_2SO_4). At the end of the battery life cycle (typically after 5 to 10 years of use), the Gel-Packs must be recycled or properly disposed of.

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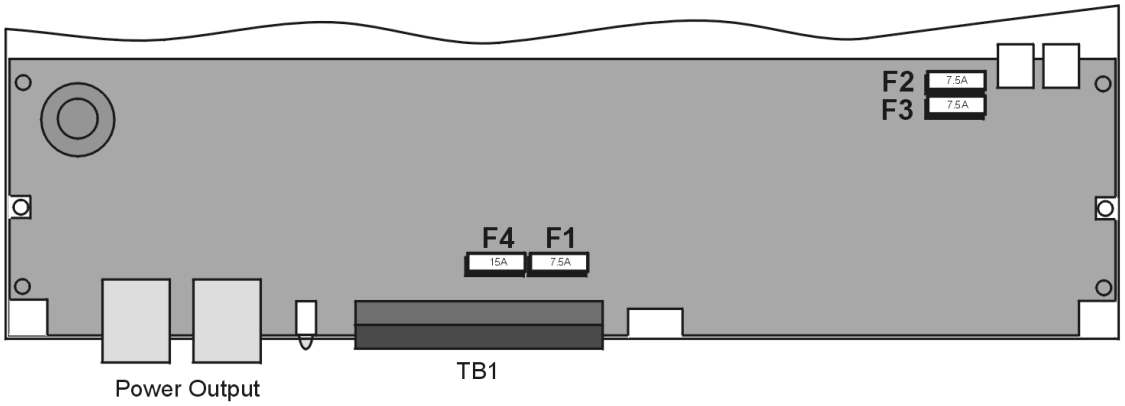
Fuse Replacement



DBK34A contains four MINI ATO fuses that can be replaced by the user. Note that you should always check your unit for blown fuses prior to sending it back to the factory for repair. This could save you time and money.

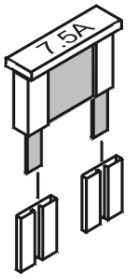
The following table indicates the probable reason that a particular fuse may have blown, and includes part numbers and fuse rating.

Fuse	Rating	Probable Cause of Blowing Fuse	Replacement Fuse
F1	7.5 A	Auxiliary Battery overload.	7.5A MINI ATO, LITTLEFUSE# 297-07.5
F2	7.5 A	Output overload.	7.5A MINI ATO, LITTLEFUSE# 297-07.5
F3	7.5 A	Output overload.	7.5A MINI ATO, LITTLEFUSE# 297-07.5
F4	15 A	Input overload.	15A MINI ATO, LITTLEFUSE# 297-015



DBK34A, Fuse Location Reference

To replace a fuse:



1. Disconnect the DBK34A from loads and from supply power.
2. Remove the DBK34A's cover plate. This requires the removal of 4 screws (2 per side).
3. Examine the fuses (F1 through F4) to see which, if any, have blown. Note that you can usually see the blown element through the fuse's transparent casing.
4. Replace the blown fuse with the appropriate replacement fuse (see preceding table). Note that the fuse value is present on top of the fuse; also, the fuses are color coded as an aid to identification.
5. Replace the DBK34A cover and secure with screws (removed in step 2).

DBK34A UPS / Battery Module - Specifications

Name/Function: Vehicle UPS Module
Battery Type: Sealed-lead rechargeable
Number of Battery Packs: 2
Battery Pack Configuration: 6 series-connected D cells
Output Voltage: 12 V or 24 V (depending on jumpers)
Output Fuses: 8 A on each internal battery (2)

Battery Capacity (Amp-Hours):
5 A-hr in 12 V mode (parallel)
2.5 A-hr in 24 V mode (series)
Operating Temperature: -20°F to 122°F (-29°C to 50°C)
Size: 8½ × 11 × 1¾ in. (216 × 279 × 44 mm)
Weight: 7.2 lb (3.27 kg)

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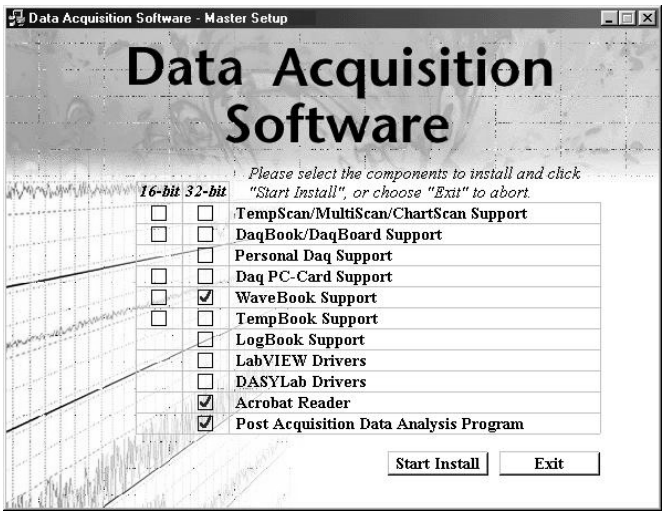
Installing Software and Product Support

WaveBook software includes *WaveView*, a Windows-based data acquisition program. For successful operation, your computer should meet or exceed the PC requirements provided at the beginning of this chapter.

Remove any previous-installed versions of WaveBook software before installing a new version.

Install software according to the following procedure.

1. Close all other programs. Insert CD-ROM and wait for the PC to auto-access the CD.
2. On the Master Setup Screen check:
   - **WaveBook Support 32-bit**
   - **Acrobat Reader**
   - **Post Acquisition Data Analysis Program.**
3. Follow the on-screen dialog boxes to complete the installation.



Master Setup Screen

Using the Daq Configuration Applet to Check Connections

The *Daq Configuration* applet, designed for 32-bit Windows 95/98/Me/NT/2000 systems, is located in the Windows *Control Panel*. It allows you to add or remove a device and change configuration settings. The included test utility provides feedback on the validity of current configuration settings, as well as performance summaries.

Device Inventory Dialog Box

Run the applet by double-clicking on the *Daq Configuration* icon in the Windows *Control Panel*.

The *Device Inventory* dialog box will open, displaying all currently configured devices. Displayed devices show their name and an icon to identify the device type. If no devices are currently configured, no devices will appear in this field.

The four buttons across the bottom of the dialog box are used as follows:

- ***Properties*:** Current configuration settings for a device can be changed by first bringing up the corresponding *Properties* dialog box. Open the *Properties* dialog box by double-clicking on the device icon or selecting the device and then clicking on the *Properties* button.

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- ***Add Device*:** The *Add Device* button is used to add a device configuration whenever a new device is added to the system. Failure to perform this step will prevent applications from properly accessing the device. Clicking on the *Add Device* button will open the *Select Device Type* dialog box.
- ***Remove*:** The *Remove* button is used to remove a device from the configuration. A device may be removed if it is no longer installed, or if the device configuration no longer applies.

Note: If a device is removed, applications may no longer access the device. However, the device can be re-configured at any time using the *Add Device* function described above.

- ***Close*:** The *Close* button may be used at any time to exit the *Daq Configuration* applet.

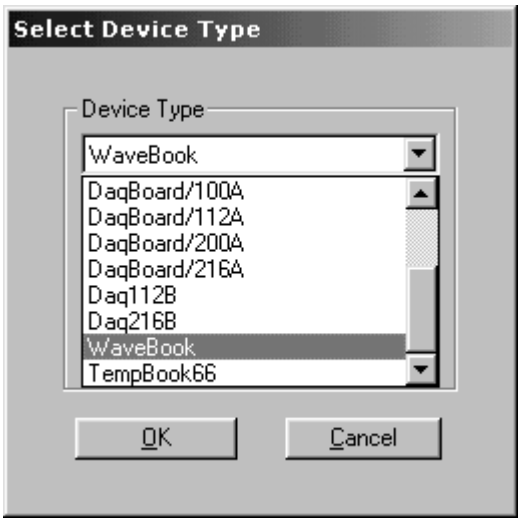


Daq Configuration - Device Inventory Dialog Box

Select Device Type Dialog Box

This dialog box opens when the *Add Device* button of the *Device Inventory* dialog box is selected.

The device type you select for configuring will appear in the main edit box. Clicking on the OK button will then open the Properties dialog box (following figure).



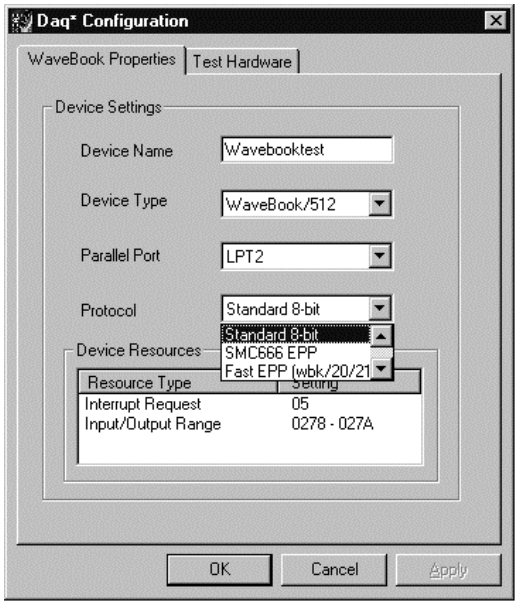
Daq Configuration - Select Device Type Dialog Box

Properties Dialog Box

This dialog box opens when the *Properties* button of the *Device Inventory* dialog box is selected, or when the *OK* button of the *Select Device Type* dialog box is selected. It displays the properties for the WaveBook device with the default configuration settings. The fields include:

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- ***Device Name*:** The *Device Name* field is displayed with the default device name. As shown, this field can be changed to any descriptive name as desired. This device name is the name to be used with the **`daqOpen`** function to open the device. This name will also be displayed in the device lists for opening the device in the WaveView and WaveCal applications.
- ***Device Type*:** The *Device Type* field indicates the device type that was initially selected. However, it can be changed here if necessary.
- ***Parallel Port*:** The *Parallel Port* field is used to set the parallel port for communicating with the WaveBook.
- ***Protocol*:** The *Protocol* field is used to set the parallel port protocol for communicating with the WaveBook. Depending on your system, not all protocols may be available. (See following Note).



Daq Configuration - Properties Dialog Box

In regard to Protocol – If you are using a WBK20A or WBK21, you must select "Fast EPP (wbk/20/21)" to achieve the best performance.

- ***Device Resources*:** The *Device Resources* field lists settings for various resources, among them Interrupt Request, Input/Output Range, and Direct Memory Access.
- ***OK:*** Click on the *OK* button to store the configuration and exit the current dialog box.
- ***Cancel:*** Click on the *Cancel* button to exit the current dialog box without storing any changes.
- ***Apply:*** Click on the *Apply* button to store the configuration. Or you can click the following tab:
- ***Test Hardware:*** Click on the *Test Hardware* tab to test the current stored configuration for the device. This selection will open the *Test Hardware* dialog box.

Test Hardware Dialog Box

Before testing WaveBook, make sure the device has been properly installed and powered-on. Make sure the parallel port cable is firmly in place on both the WaveBook and the proper LPT port in the computer.

When testing WaveBook, if the unit does not respond within 30 seconds perform the following steps:

1) **reboot the system**
2) **upon power-up, re-open the *Daq Configuration* applet**
3) **select another configuration setting**
4) **reinitiate the test**

To test the currently stored configuration for the WaveBook device, click the *Test* button. Results should be displayed in a few seconds. The test results have two components: *Resource Tests* and *Performance Tests*.

Resource Tests. The resource tests are intended to test system capability for the current device configuration. Resource tests are *pass/fail*. Test failure may indicate a lack of availability of the resource, or a possible resource conflict.

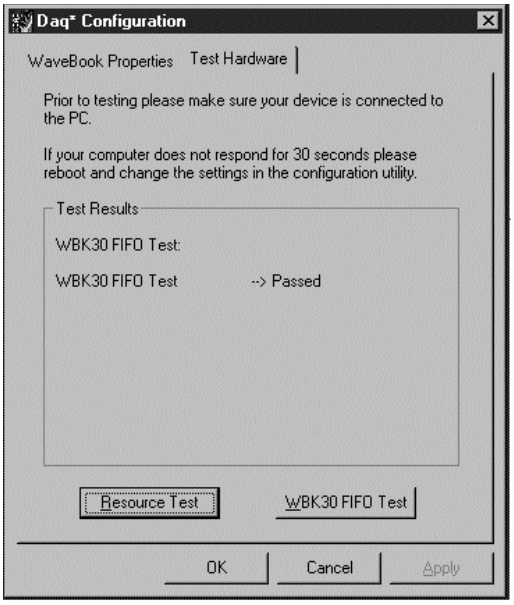
Base Address Test. This resource test checks the base address for the selected parallel port. Failure of this test may indicate that the parallel port is not properly configured within the system. See relevant operating system and computer manufacturer's documentation to correct the problem.

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Performance Tests. These types of tests are intended to check various WaveBook functions, using the current device configuration. Performance tests provide quantitative results for each supported functional group. Test results represent maximum rates the various operations can be performed. The rates depend on the selected parallel port protocol, and vary according to port hardware capabilities.

WBK30 FIFO Test. This *performance test* checks the data-storing capabilities of the optional, WBK30 memory card.

Note that the figure to the right represents results from a previous test. Initially, the screen shows no test results.



Daq Configuration - Test Hardware Dialog Box

When the test is completed successfully, the *Daq Configuration Test Dialog Box* indicates a passed condition. For example, in the above figure:

WBK30 FIFO Test → Passed.

"Passed" messages indicate that you can exit the test program and run your application.

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WaveBook Operation Reference 3

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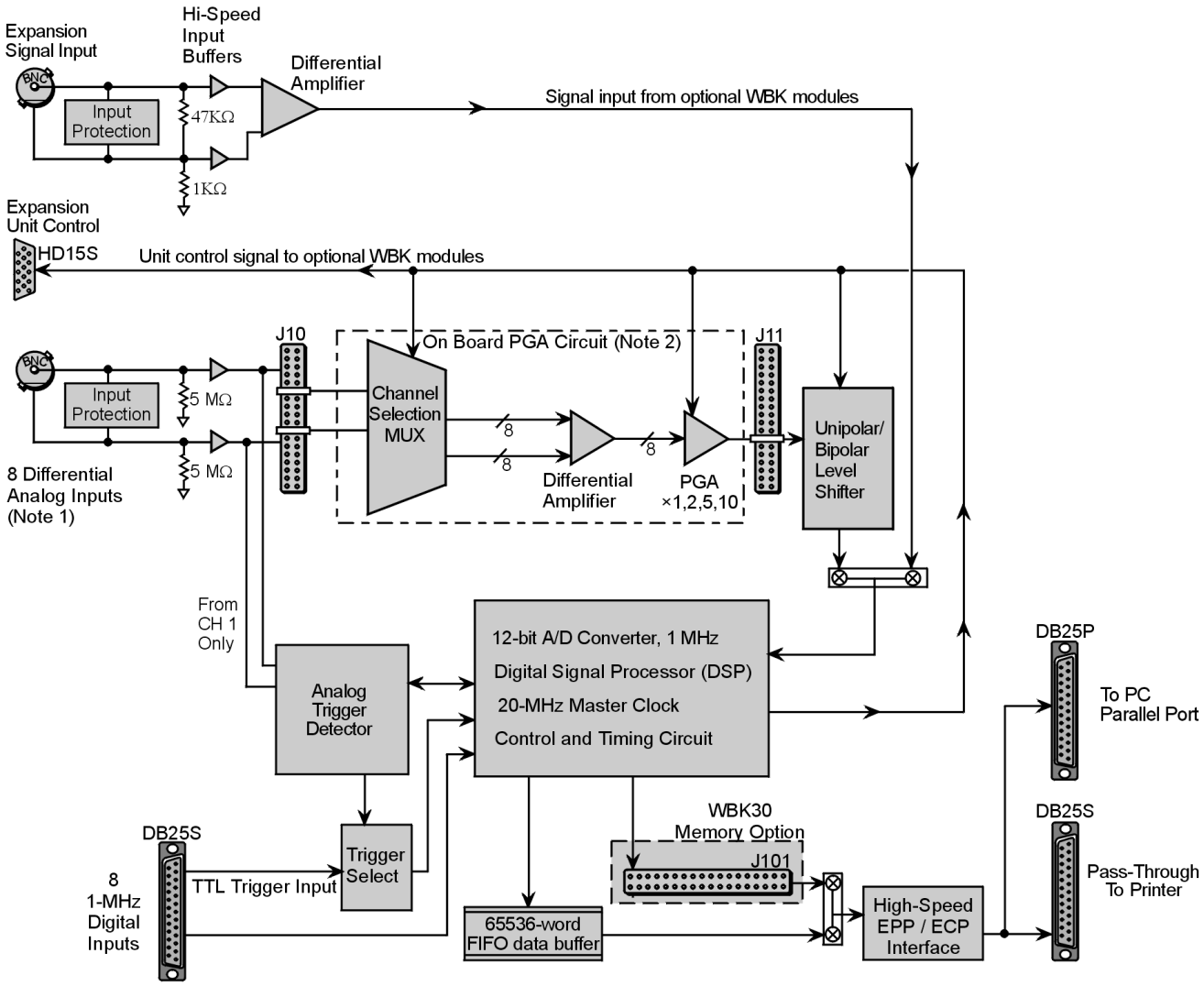


Reference Note:
For detailed information regarding the following WBK options, refer to the *WBK Option Cards and Modules User's Manual* (p/n 489-0902). A PDF version of that document is loaded onto your hard drive, as a part of product support, during software installation. The default location is the **Programs** file directory, which can be accessed from the Windows Desktop.

WBK	Description	Hardware Type
WBK10 WBK10H WBK10A	8-Channel Expansion Chassis	Expansion Module
WBK11 WBK11A	8-Channel SSH Cards	Signal Conditioning Card
WBK12 WBK12A	8-Channel Programmable Low-Pass Filter Cards	Signal Conditioning Card
WBK13 WBK13A	8-Channel Programmable Low-Pass Filter Cards with SSH	Signal Conditioning Card
WBK14	8-Channel Dynamic Signal Input Module (piezoelectric)	Expansion Module
WBK15	8-Channel Isolated (5B) Signal Conditioning Module	Expansion Module
WBK16	8-Channel Strain Gage Module	Expansion Module
WBK17*	8-Channel Counter-Input Module with Quadrature Encoder Support	Expansion Module
WBK20A	PCMCIA/EPP Interface Card (for linking WaveBook to a Notebook PC)	Interface Card
WBK21	ISA/EPP Interface Card (For linking WaveBook to a desktop PC)	Interface Card
WBK30	Memory Expansion Cards; 16 MB, 64 MB, and 128 MB	Memory Expansion Card
WBK61	1000V High Voltage Adapter with Probe	High Voltage Adapter
WBK62	100V High Voltage Adapter with Probe	High Voltage Adapter

*WBK17 can not be used with WaveBook/512 or WaveBook/512H.

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Block Diagram for WaveBook/512 and WaveBook/512H

Note 1: Each channel has input protection and connects to J10 via its own BNC connector. Channel 1 is the only channel that connects to the Analog Trigger Detector.

Note 2: An optional WBK11, WBK12, or WBK13 series board can be used in place of the on-board PGA circuit. Prior to installing an option board, jumpers on J10 and J11 must be removed to disengage the PGA circuitry.

Buffering, Amplifying, and Filtering Differential Signals

In regard to WaveBook/512 and WaveBook/512H, each of the 8 pairs of differential signals (one per BNC connector) is buffered and then switched by the channel-selection multiplexer. The selected differential pair is then converted to a single-ended signal by the programmable gain amplifier (PGA) and level-shifted to locate the desired range (within the A/D converter's fixed input range). Two offset settings are available, *unipolar* and *bipolar*. **Unipolar offset** is used for sampling signals that are *always* positive. **Bipolar offset** is used for signals that may be positive or negative. For example, when set for *unipolar* at a gain of ×5, the input span is 2 volts and the amplified signal is offset so that input voltages from 0 to +2 volts can be digitized. When set for *bipolar* operation, the offset is adjusted so that input voltages from -1.0 to +1.0 volts can be digitized

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Digitizing Signals via the A/D Converter

The signal is then switched over to the A/D converter and digitized to 12 bits in 1 μs. Note that the A/D converter's input can be switched to the expansion signal input, allowing the device to read one of 64 possible expansion channels (supplied by up to eight WBK10 expansion chassis). A *digital signal processor* (DSP) processes the digitized value and corrects the value for gain and offset errors. The DSP places the corrected result into the FIFO data buffer that holds the samples until the PC reads the data. If the sample is used for triggering, the DSP determines if a valid trigger event has occurred.

Using a Sample for Triggering

WaveBook includes low-latency analog or TTL-level triggering. The analog trigger detector examines channel 1 to determine if a trigger has occurred. The selected low-latency trigger is presented to the control-and-timing circuit that starts the acquisition after the trigger. The TTL trigger is taken directly from the digital I/O port. A detailed discussion of triggering begins on page 3-9.

Control, Timing, and Signal Processing

The control-and-timing circuit and the Digital Signal Processor (DSP)

The control-and-timing circuit, and the Digital Signal Processor (DSP) work together to coordinate activities. Every sample time, the DSP (a) reads from the scan sequence table, and (b) accordingly programs the control and timing circuit for the next sample. The control-and-timing circuit waits precisely until the start of the next sample, then selects:

- the input channel
- PGA gain
- level-shifter offset
- A/D input source

The control-and-timing circuit conveys this information to any attached expansion units and precisely controls the A/D conversion timing.

The EEPROM

The EEPROM holds the calibration information needed for *real-time* sample correction.

Reading from and Writing to the Digital I/O Port

The digital I/O port is read and written by the Digital Signal Processor to transfer bytes of digital data. It may be used as a simple 8-bit input port or as a 32-address byte-wide I/O port.

The high-speed EPP/ECP interface circuit connects the WaveBook and any attached printer to the PC via standard DB-25 connectors. When the WaveBook is active, the interface holds the printer in a stable state; and when the WaveBook is inactive, the interface connects the PC to the printer.

The WBK Options

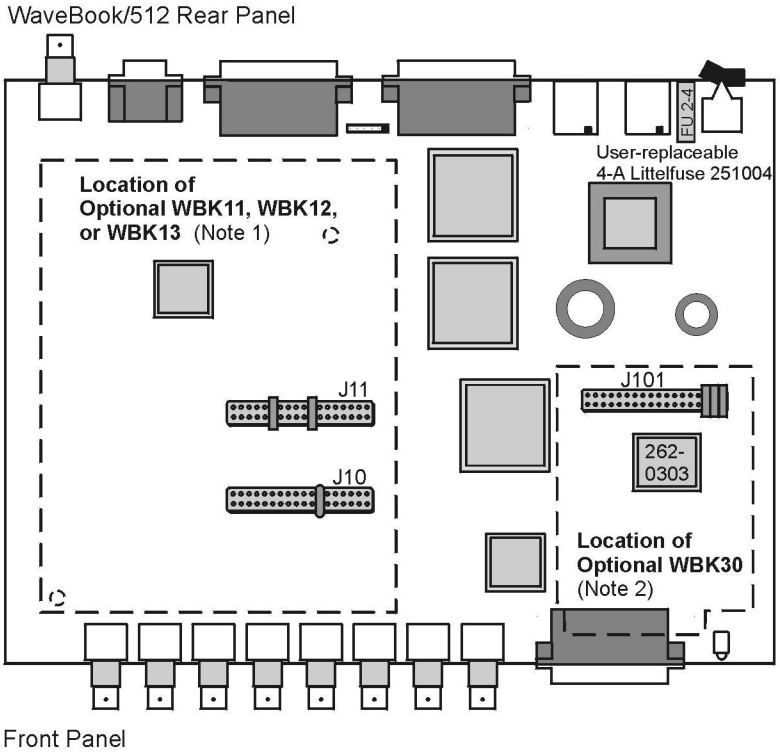
WaveBook operation can be enhanced by the use of various WBK option cards and modules. A brief synopsis of each option is presented on page 3-4, while more detailed information is provided in independent document modules. The location of WBK card options, internal to the WaveBook/512 series products, are illustrated in the following figure. The board layout includes jumper locations that the cards plug in to.



Reference Note:
The WBK option cards and modules that are listed with a synopsis, beginning on page 3-4, are detailed later in this user's manual. The detailed information is provided in the *WBK Option Cards and Modules User's Manual* (p/n 489-0902). The WBK document modules are presented in alpha-numerical order and include product specifications.

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WBK Option Cards and Modules



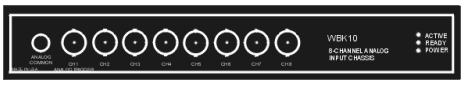
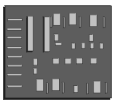
Jumper Locations for WBK Option Cards

You can use various modules and option cards to expand your WaveBook system. These WaveBook options are known as WBKs.

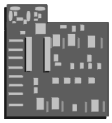
Internally, WaveBook has room for one signal-conditioning card. Externally, you can use one or more expansion modules.

Reference Note:
A brief synopsis of each WBK option follows. More detailed information is provided in the *WBK Option Cards and Modules User's Manual* (p/n 489-0902). The location of WBK card options, internal to WaveBook, are illustrated in the previous figure. The board layout includes jumper locations that the cards plug in to.

Note: The products represented in the table are not shown to the same scale.

 **WBK10, WBK10H, and WBK10A** Analog Expansion Modules *8 Channels via BNC Connectors*	Each WBK10 series module can be used to provide WaveBook with 8 additional differential-analog-inputs. The modules are equipped with a programmable gain instrumentation amplifier (PGA) and, like the WaveBook, each has a built-in expansion bus. Up to eight WBK10 series modules can be cascaded together for a system capacity of 72 differential channels. Each module is capable of supporting a WBK11, WBK12, or WBK13 series option card.
 **WBK11 and WBK11A** Simultaneous Sample & Hold Card (8 channels)	The WBK11series cards can simultaneously sample 8 channels and can be installed inside a WaveBook or in a WBK10 series module. The cards allow for concurrent (<150 ns) capture of multiple input channels and virtually eliminate channel-to-channel time skewing.

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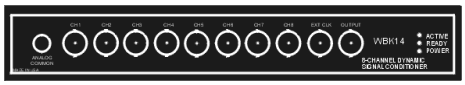


WBK12 and WBK12A
Programmable Low-Pass Filter Card
(8 channels)

WBK13 and WBK13A
Programmable Low-Pass Filter Card with SSH
(8 channels)

WBK12, WBK12A, WBK13, and WBK13A are 8-channel programmable low-pass filter cards for use with 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.

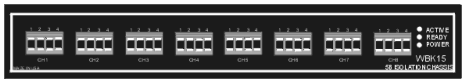
WBK13 and WBK13A cards have the additional capability of sampling all channels at the same time.



WBK14
Dynamic Signal Conditioning Module
8 Channels via BNC Connectors

The WBK14 is a dynamic analog signal input module. It enables WaveBooks to interface with piezoelectric transducers that include accelerometers, microphones, and force/pressure transducers. Each WBK14 channel has a:

- current source for transducer biasing
- high-pass filter
- programmable gain amplifier
- anti-aliasing low-pass filter
- simultaneous sample-and-hold (SSH) amplifiers



WBK15
8-Slot 5B Signal Conditioning Module
8 channels via 5B Modules

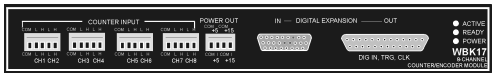
The WBK15 module provides for a diverse range of signals available through optional 5B modules. Measurement types include: LVDT, potentiometer, isolated current loop, ±10mV to ±40V inputs, linearized RTD, thermocouple, frequency-to-voltage, and strain gage.

See latest catalog or contact your sales representative in regard to the types of 5B Modules available for your application.



WBK16
Strain-Gage Module
8 channels via Standard Female DB9

WBK16 is an 8-channel strain-gage signal-conditioning module. Up to eight WBK16 modules (64 channels) can be accommodated by the WaveBook and scanned at 1 µs/channel. Almost all bridge configurations are supported via a bridge-completion network and software. High-gain differential-amplifier applications are also supported. Software controls bridge configuration, gain, offset, excitation voltage, polarity, filtering, and the calibration process.



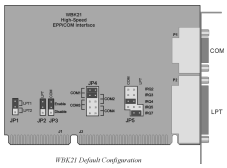
WBK17
Counter-Input Module with Quadrature Encoder Support
8 channels via Removable Screw Terminal Blocks

The WBK17 is an 8-channel multi-function counter/encoder module for use with WaveBook/512A, WaveBook/516, and WaveBook/516A systems. Each of the high-speed, 32-bit counter channels can be configured for counter, period, pulse width, time between edges, or encoder modes. All channels are capable of measuring analog inputs that are digitized by the WaveBook.

WBK17 is not used with WaveBook/512 or WaveBook/512H.



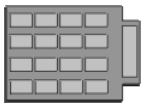
WBK20A



WBK21

WBK20A – PCMCIA/EPP Interface Card
(for linking WaveBook to a Notebook PC)
WBK21 – ISA/EPP Interface Plug-in Board
(For linking WaveBook to a desktop PC)

These devices are shipped with separate documentation and are not detailed in this manual; they are, however, discussed briefly in the *WBK20A and WBK21 Document Modules*.



WBK30
WaveBook Memory Options

WBK30 is a DRAM-based memory board that installs inside a WaveBook. There are three models of WBK30 available; each significantly increases the capacity of WaveBook's standard data buffer of 64 K samples. Capacities are as follows:

WBK30/16— 16 MB
WBK30/64— 64 MB
WBK30/128— 128 MB

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WBK61 and WBK62

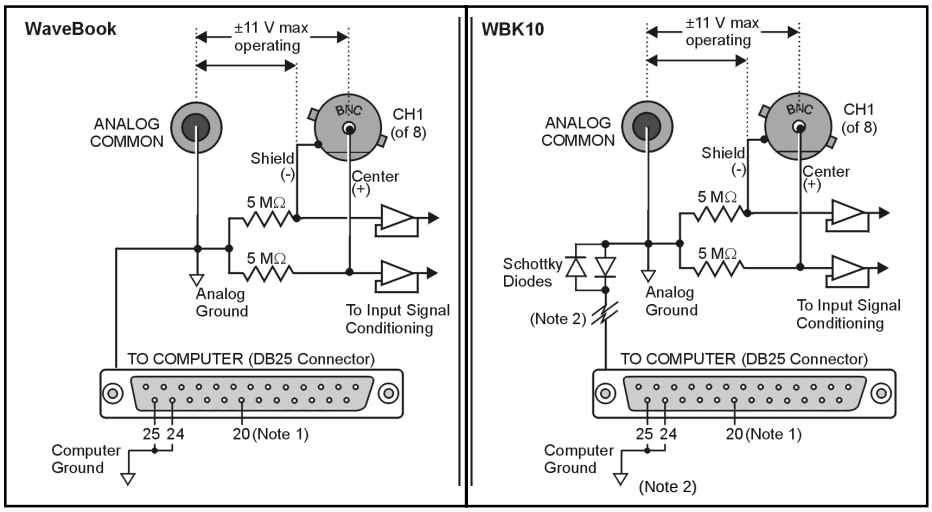
WBK61: High-Voltage Adapter with 200:1 Voltage Divider (1 channel)
WBK62: High-Voltage Adapter with 20:1 Voltage Divider (1 channel)

WBK61 and WBK62 are single-channel high-voltage adapters that can be used with the WaveBook or WBK10/10H/10A expansion modules. In addition, WBK61 and WBK62 can be used in conjunction with WBK11, WBK12, and WBK13 series cards.

WBK61 and WBK62 include safety-style banana-jacks for the high and low inputs, and 60-inch (152 cm) cables with probe tips and alligator clips for easy input connection.

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Analog Signal & Ground Connections



Channel Analog Input, BNC Signal Connections

Note 1: Pin 20 is a digital ground on WaveBook/512 and WaveBook/512H.
Note 2: WBK10's computer ground is completed via cable through Expansion Control.

For each of the eight channel analog inputs, the BNC center (+) and shield (-) are internally connected to WaveBook's binding post labeled, ANALOG COMMON. The center (+) and shield (-) each connect to ANALOG COMMON through a 5 MΩ resistor, resulting in a 10 MΩ differential input resistance (see figures). WaveBook's ANALOG COMMON connects to the computer power supply ground through the TO COMPUTER DB25 connector and cable.

- If the host computer is a desktop PC, then the computer ground will likely connect to the AC power line ground.
- If the host computer is a notebook PC, then the computer ground could be:
  (a) *floating*, for example, when operating on batteries, or
  (b) *connected to a vehicle ground*, for example, when using an automotive cigarette lighter adapter in conjunction with the vehicle's battery.

Note that a pair of Schottky diodes is used in the WBK10 to clamp the ANALOG COMMON to within 0.3V of computer ground (see figure).

WaveBook and WBK10/10H both have isolated power supplies. Power input common is isolated from ANALOG COMMON by $>10^9$ Ω in parallel with 0.1µF.



For WaveBook [or WBK10/10H] to correctly measure analog signals, each signal must be within ±11 volts of ANALOG COMMON. The following notes provide guidelines on how to achieve this.

Like WaveBooks, notebook computers are rarely connected to AC power line ground. This is true even when these devices are plugged into AC adapters.

Floating Grounds: If the computer is battery operated *and* the signal source is floating (such as an ungrounded sensor), then the internal 5 MΩ resistors *may* provide enough of a return path to ANALOG COMMON. If either the computer or the analog signal source is committed to AC power line ground, then you will require a direct connection between the signal source and ANALOG COMMON.

When in doubt, connect the signal source common to ANALOG COMMON.

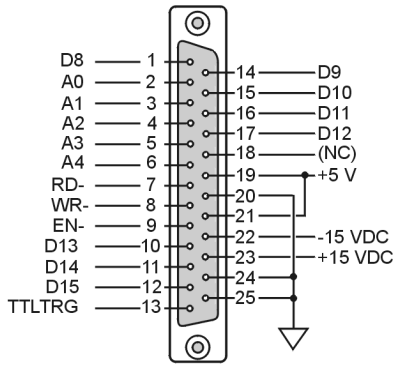
A *single-ended* signal source needs to have its common connected to ANALOG COMMON. When connecting several signal source commons to ANALOG COMMON, it is important that there is no voltage potential [between these signal source commons]. Otherwise, ground currents will circulate, leading to measurement errors.

If there is a *fixed voltage potential* between multiple signal source commons, then *only one of these signal source commons* needs connected to ANALOG COMMON. This is true *as long as* the common mode voltage of any input does not exceed ±11 volts.

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The following signals are present on the DB25F high-speed digital I/O connector of the WaveBook/512 and the WaveBook/512H.

- 8 Digital I/O Lines (D8 – D15)
- 5 Address Lines (A0 –A4)
- Active-low Digital I/O Enable output (EN-)
- Active-low Digital I/O Write Strobe (WR-)
- Active-low Digital I/O Read Strobe (RD-)
- TTL Trigger Input (TTLTRG)
- +15 V (pin 23), -15 V (pin 22), 50 mA max. (each)
- two +5 V power (pins 19 and 21), 250 mA max. (total)
- three Digital Grounds (pins 20, 24, and 25)



WaveBook/512, DB25 Pinout

Digital I/O Connections, WaveBook/512	
D8-D15	Digital I/O data lines
A0-A4	Digital I/O address lines
EN-	Active-low digital I/O enable
RD-	Active-low read strobe
WR-	Active-low write strobe
TTLTRG	TTL trigger input
+5 VDC	250 mA maximum
+15,-15 VDC	50 mA maximum (each)
Digital Grounds	Pins 20, 24, and 25

To sample just 8 digital input signals, connect them directly to the digital I/O data lines. D15 is the most significant bit, and D8 is the least. The address lines, the read and write strobes, and enable signal may all be left disconnected.

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Triggers

External signals can be used to start or synchronize the data acquisition process. WaveBook/512 and WaveBook/512H support the following trigger sources:

- ***Software Trigger.*** This trigger event is generated by a **software command from the PC without waiting for an external event**. This feature may be used to begin a data acquisition immediately or to force an acquisition to occur if the expected trigger did not occur.
- ***Digital Trigger.*** Digital (or TTL-level) triggering (either rising- or falling-edge input) is performed by **digital logic connected to the digital expansion connector**.
- ***Single-Channel Trigger.*** Single-Channel (or Channel 1 Analog) triggering (rising or falling signal level) is performed by **comparator-based analog hardware connected directly to analog input channel 1**.
- ***Multi-Channel Trigger.*** Here, the trigger event is **a combination of measured channel values**. WaveBook's Digital Signal Processor (DSP) performs multi-channel triggering. The DSP samples the specified channels; if programmable conditions are met, a trigger is generated. Multi-channel triggering examines digitized data, and the trigger latencies are much greater.

More detailed information regarding triggers follows.

Digital Trigger & Single-Channel Trigger

The input of the digital (TTL) trigger and the output of the single-channel signal-comparator are each connected directly to hardware circuits to provide low-latency triggering. WaveBook can respond to a TTL or analog trigger with a jitter (or uncertainty in latency) of no more than 100 nanoseconds (ns).

- If **not** collecting pre-trigger data, WaveBook responds to the trigger with a latency of less than 200 ns for TTL and 300 ns for analog.
- If collecting pre-trigger data, then triggers are not acted upon until the end of the current pre-trigger scan. This increases the trigger latency and jitter, but preserves the specified scan rates.

When using the single-channel trigger, the Channel 1 analog input signal is compared with a programmable voltage level to generate an internal TTL signal that is *true* if the analog input is greater than the programmable voltage level (*false* if less).

When the digital trigger is used, then the TTL trigger signal from the digital I/O connector is used directly. The resulting TTL signal is examined under program control for either a false-to-true (rising edge) or true-to-false (falling edge) transition which, when it occurs, is the trigger event.

If the system is ready for a trigger, then the trigger event will be acted upon. If the system is not ready (due to incomplete configuration or because it is still finishing the previous trigger's action), the trigger will be ignored. No indication of an ignored trigger is given.

The low-latency analog trigger compares the analog signal with a programmable voltage source. The effective range of this voltage source depends on whether or not the WBK11 SSH option is installed.

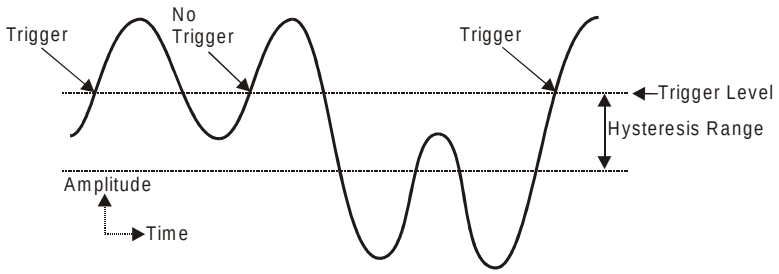
- Without SSH, the trigger threshold is settable from -5.0 to +9.996 volts with 12-bit (WaveBook/512) resolution, regardless of any channel's gain settings. This gives better than 1% resolution at even the smallest input ranges (such as 0-1 or ±0.5 volts).
- With SSH, the single-channel (Channel 1 analog) signal is first amplified by the SSH programmable gain amplifier before being compared with the programmable voltage. This allows precise trigger-level adjustment, even at high gain. The analog-trigger comparator threshold-voltage range and resolution (with SSH) are shown in the following table.

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Analog-Trigger Comparator, Ranges and Resolutions		
SSH Input Range	**Trigger Threshold Range**	**WaveBook/512 12-Bit Resolution (mV)**
0-10 or ±5	-5.0 to 9.996	3.66
0-5 or ±2.5	-2.5 to 4.998	1.83
0-2 or ±1	-1.0 to 1.999	0.732
0-1 or ±0.5	-0.5 to 0.9996	0.366
0-0.5 or ±0.25	-0.25 to 0.4998	0.183
0-0.2 or ±0.1	-0.10 to 0.1999	0.0732
0-0.1 or ±0.05	-0.05 to 0.09996	0.0366

Hysteresis

The analog trigger circuit has hysteresis that **reduces the occurrence of retriggering due to input noise**. The hysteresis level without SSH is 25 mV; the hysteresis with SSH is 1/600 of the comparator range. The next figure shows the hysteresis effect for a rising-edge trigger.



Hysteresis Effect on a Rising-Edge Trigger

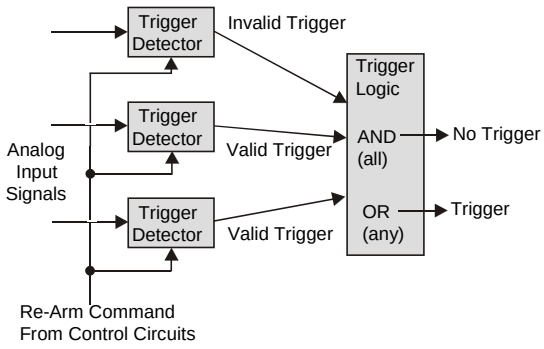
A trigger will occur when the analog input rises above the trigger level—but only after the input level has been below the hysteresis range. If the level momentarily drops just below the trigger level (perhaps due to noise) and then rises above it again, no extra triggers will be generated—the signal did not drop below the hysteresis range. After the level drops below hysteresis, it can then again produce a trigger by rising above the trigger level.

Multi-Channel Trigger

When the small hardware-limited latencies of the digital (TTL) and single-channel (Channel 1 analog) triggers are not required, the DSP chip may be used to examine the samples from one or more channels and to decide if they constitute a pre-defined trigger condition.

The DSP can sample up to 72 input channels and examine each one to determine if it meets programmed levels for a valid trigger. This multi-channel triggering is a two-step process:

1. The DSP examines each of its specified input signals to determine trigger validity.
2. After all of the channels have been examined, the DSP logically combines the individual triggers to generate the actual trigger. The DSP may be programmed to generate a trigger if *any* individual trigger is valid (OR) or if *all* triggers are valid (AND). See figure.



Multi-Channel Trigger Detection

Trigger validity in a multi-channel environment is determined by the logical relationship among three elements (*slope*, *duration*, and *initialization)* as discussed in the next section.

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Multi-Channel Trigger Types

The first step in multi-channel triggering is to examine the input signals. To determine trigger validity, WaveBook can examine each input signal in 1 of 8 ways.

Note: Each trigger type is a combination of three elements: *slope*, *duration*, and *initialization*.

Trigger Type	Slope	Duration	Initialization
Above-level	Rising	Instantaneous	Level
Below-level	Falling	Instantaneous	Level
Above-level-with-latch	Rising	Latched	Level
Below-level-with-latch	Falling	Latched	Level
Rising-edge	Rising	Instantaneous	Edge
Falling-edge	Falling	Instantaneous	Edge
Rising-edge-with-latch	Rising	Latched	Edge
Falling-edge-with-latch	Falling	Latched	Edge

Slope (above/rising or below/falling) sets whether the trigger is valid when the signal is:

- Above the trigger level (**rising**)
- Below the trigger level (**falling**).

Duration (instantaneous or latched) specifies the action to take if the signal level becomes invalid after it has been valid:

- **Instantaneous** triggers become invalid as soon as the signal does; they are used to trigger on the *coincidence of signals*, when two or more signals are *simultaneously valid.*
- **Latched** triggers remain valid until the acquisition is complete; they are used to trigger on the *occurrence of signals*, when two or more signals *have already become valid*.

The trigger duration only makes a difference in multi-channel "AND" triggering. In multi-channel "OR" triggering, WaveBook will be triggered as soon as any channel becomes valid; what happens when a channel becomes invalid does not matter. In contrast, "AND" triggering waits for all of the triggers to be valid; and so, latching can be important for rapidly changing signals.

Initialization (level or edge) specifies the sequence necessary for a signal to be a valid trigger:

- **Level** triggers become valid as soon as they reach or exceed the trigger level, even if they are already past the trigger level when the acquisition is started.
- **Edge** triggers first wait until the signal level is invalid. Then they wait for the signal to reach the trigger level before becoming valid. Thus, level triggers look for a signal level, whenever it occurs; and edge triggers look for a *rising* or *falling* transition that reaches the trigger level.

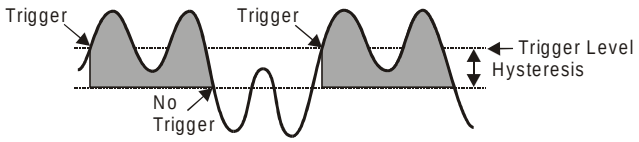
Examination of the input signals compares two specified signal levels: (a) The *trigger level* determines when the input channel is a valid trigger, and (b) the *hysteresis* is the amount by which the channel must differ from the trigger level for the channel to become invalid.

Above-Level Trigger

Rising slope

Instantaneous duration

Level initialization



This trigger is valid whenever the signal level is above the trigger level and stays valid until the signal level goes below the hysteresis range. In the figure, the channel trigger is valid during the 2 shaded intervals. Whether this condition triggers WaveBook or not, depends on the type of multi-channel triggering ("AND" or "OR") and on the state of other trigger channels. With "OR" multi-channel triggering, WaveBook will trigger when the signal first rises above the trigger level—if ready for a new trigger, WaveBook will also trigger the second time the signal rises above the trigger level. With "AND" multi-level triggering, WaveBook will not trigger until every specified trigger channel is valid. If all other trigger channels are valid, WaveBook will trigger when the signal reaches the shaded region; but if some channels are not valid, this channel will have no effect.

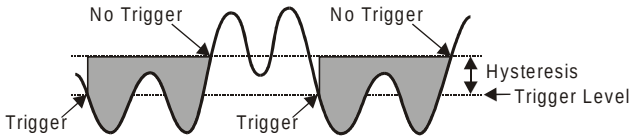
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Below-Level Trigger

Falling slope

Instantaneous duration

Level initialization



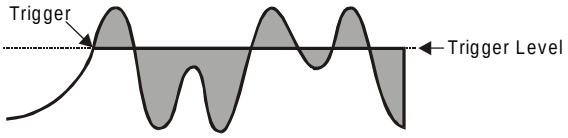
This trigger is valid whenever the signal level is below the trigger level and stays valid until the signal level goes above the hysteresis range (the reverse of above-level triggering). As with all multi-channel trigger types, WaveBook's actual trigger depends on the combination of this trigger with the other channels' trigger states.

Above-Level-With-Latch Trigger

Rising slope

Latched duration

Level initialization



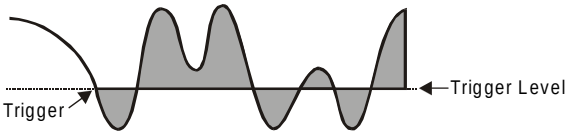
In this trigger type, the channel becomes valid when the signal level rises above the trigger level and stays valid until the acquisition is complete and WaveBook is re-armed.

Below-Level-With-Latch Trigger

Falling slope

Latched duration

Level initialization



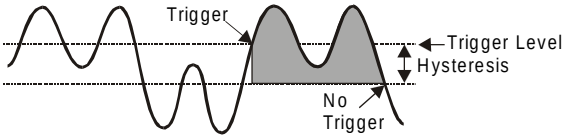
The channel becomes valid when the signal level rises above the trigger level and stays valid until the acquisition is complete and WaveBook is re-armed (the reverse of above-level-with-latch triggering). Latched triggers are often used in multi-channel "AND" triggering, where WaveBook will not trigger until all trigger channels are valid. After a latched trigger becomes valid, it stays valid (waiting for the other triggers to become valid) until WaveBook is triggered and the acquisition completes. If the trigger is non-latched instead of latched, the channel may not stay valid and WaveBook will not trigger until the channel becomes valid again and all channels simultaneously reach their trigger levels. In other words, *latched triggering is used to trigger after something has occurred, but non-latched triggering is used only during the* ***simultaneous occurrence*** *of desired signal levels.* It is possible to combine different trigger types in a single multi-channel trigger. For example, WaveBook could trigger when channel 3 is below 0.9 volts after channel 2 has gone above -1.3 volts (by configuring channel 3 for below-level triggering and channel 2 for above-level-with-latch triggering).

Rising-Edge Trigger

Rising slope

Instantaneous duration

Edge initialization



This trigger becomes valid after the signal level has been below the hysteresis range and then goes above the trigger level. This trigger becomes invalid when the signal level goes below the hysteresis range. Unlike above-level triggering, the channel cannot become valid until the signal level first goes below the hysteresis range. This prevents the false triggering that would occur if the signal were above the trigger level at the start of the acquisition.

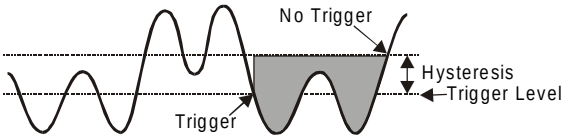
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Falling-Edge Trigger

Falling slope

Instantaneous duration

Edge initialization



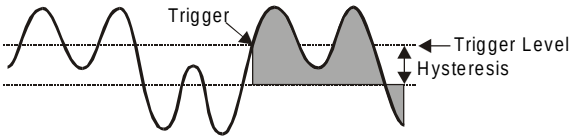
This trigger is the reverse of the rising-edge trigger: the trigger becomes valid after the signal level has been above the hysteresis range and then goes below the trigger level. This trigger becomes invalid whenever the signal level goes above the hysteresis range. This prevents the false triggering that would occur with below-level triggering if the signal was below the trigger level at the start of the acquisition.

Rising-Edge-With-Latch Trigger

Rising slope

Latched duration

Edge initialization



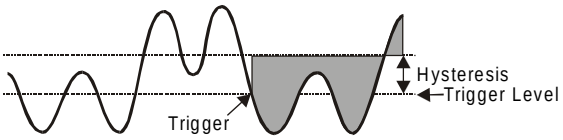
This trigger becomes valid like a rising-edge trigger: when the signal level goes above the trigger level after first being below the trigger range. However, the rising-edge-*with-latch* trigger does not become invalid, regardless of the signal level, until the acquisition is complete. Rising-edge-with-latch is used to trigger after the channel has reached the trigger level, rather than just while the channel is above the trigger level.

Falling-Edge-With-Latch Trigger

Falling slope

Latched duration

Edge initialization



This trigger is the reverse of the rising-edge-with-latch trigger: the trigger becomes valid after the signal level has been above the hysteresis range and then goes below the trigger level. The trigger remains valid until the acquisition is complete.

Trigger Latency & Jitter

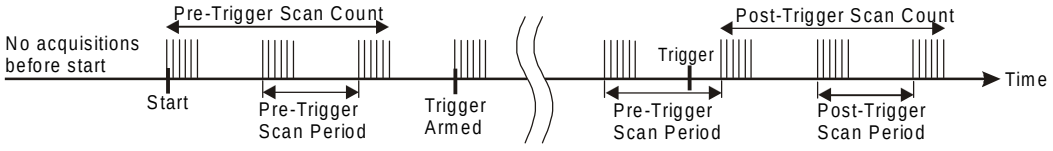
Trigger latency and jitter depend on the trigger source and the acquisition mode:

- Trigger **latency is the duration** between the valid trigger and the start of the acquisition.
- Trigger **jitter is the variation of the latency**, how much time the latency can vary from trigger to trigger.

As discussed, WaveBook has post-trigger and pre/post-trigger acquisition modes. Post-trigger modes (N-shot, N-shot with re-arm, and infinite-post-trigger) collect scans only after the trigger has occurred. They are different from the pre/post-trigger mode that collects scans both before and after the trigger. This difference affects the trigger latency and jitter.

In a post-trigger mode, WaveBook is not scanning while waiting for the trigger. Thus, it is free to respond to the trigger as soon as it occurs. This minimizes the trigger latency and jitter.

In the pre/post-trigger mode, pre-trigger data is being collected while WaveBook waits for the trigger, and WaveBook will not respond to a trigger until the current scan is complete. The pre-trigger scan period separates the first scan after the trigger from the last scan before the trigger. All the scans (up through the one immediately following the trigger) are collected at the pre-trigger rate; and all subsequent scans are collected at the post-trigger rate. This preserves the integrity of the acquisition timebase as shown in the figure below:



Pre/Post-Trigger Acquisition

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The time needed to complete the final pre-trigger scan is part of the trigger latency; and so, in the pre/post-trigger mode, the trigger latency may be greatly increased.

Not only do the trigger latency and jitter depend on the pre- vs post-trigger type of acquisition, they also depend on the trigger source: Software, digital (TTL), single-channel (Channel 1 analog), or multi-channel. The following table gives the trigger latency and jitter for each of the different trigger sources and acquisition modes:

Acquisition Type	Trigger Source	Max. Trigger Latency	Trigger Jitter	Notes
Pre-Trigger	Software	100 µs + T	100 µs + T	a, c
	Digital (TTL)	200 ns + T	50 ns + T	c
	Single-Channel	300 ns + T	50 ns + T	c
	Multi-Channel	2 * T - NS µs	T	c, d
Post-Trigger (N-Shot, N-Shot with re-arm, or infinite-post-trigger)	Software	100 µs	100 µs	a
	Digital (TTL)	200 ns	50 ns	
	Single-Channel	300 ns	50 ns	
	Multi-Channel	2 * NC + 3 µs	NC +2 µs	b

Notes: a) Software trigger latency and jitter depend greatly on the host computer's speed, operating system, and printer-port protocol. Most systems should take much less than 100 µs.

b) NC is the number of channel samples used for multi-channel triggering, from 1 to 72, as specified by the trigger configuration.

c) T is the pre-trigger scan period.

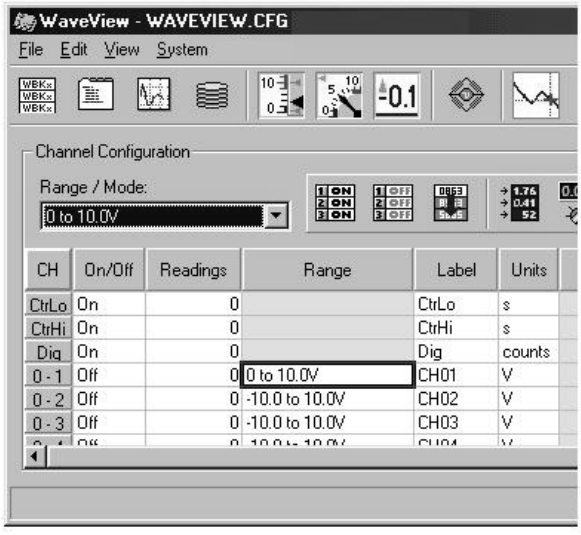
d) NS is the number of samples in a scan including, if present, the first "dummy" sample, from 1 to 128.

Programmable Features

Channels can be configured through your own custom programs or through the included *out-of-the-box* WaveView software. WaveView includes a Channel Configuration screen (following figure) that allows you to turn channels ON or OFF, select channel ranges, change channel labels, and select engineering units.



Reference Note:
The *WaveView* document module contains more detailed information. Individuals who write their own programs should refer to the **readme.txt** file [on the install CD-ROM] in regard to the location of API reference material, including program examples.



Configuring Channels from WaveView's Main Window

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Selecting a Channel's Range

You can use WaveView to select a channel's range in one of two ways.

(1) Click in a channel's *Range* cell, then select the desired range from the "Select Range" pull-down list.

(2) Continue to double-click in the applicable channel's *Range* cell to cycle through the available ranges. Stop double-clicking when the desired range is indicated.

Selecting a Channel's Units

You can use WaveView to select a channel's units in one of two ways.

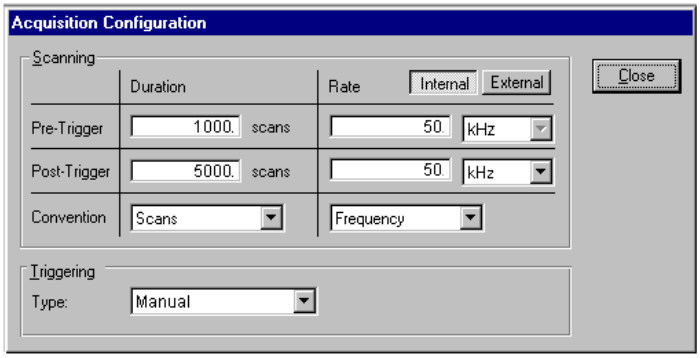
(1) Click in a channel's *Units* cell, then select the desired units from the "Select Units" pull-down list.

(2) Double-click in a channel's *Units* cell to cycle through the units. Note that after the mX+b dialog box appears you must click "OK" to continue cycling.

Note: You can use the **mX+b** equation to adjust a channel's scale and offset. You can enter user-defined units from the mX+b dialog box. An example of using **mx + b** is provided below, and on the following page.

After completing channel configuration, you can select the *Acquisition Configuration* option from WaveView's *View* menu or tool bar. The figure to the right represents the *Acquisition Configuration* dialog box. The parameters shown are a result of the values entered below the figure.

Clicking the Close button sets the acquisition parameters as the active parameters.



Acquisition Configuration Dialog Box

Triggering
Type: Manual

Scanning Duration
Convention: *Scans*
Pre-Trigger: 1000 scans
Post-Trigger: 5000 scans

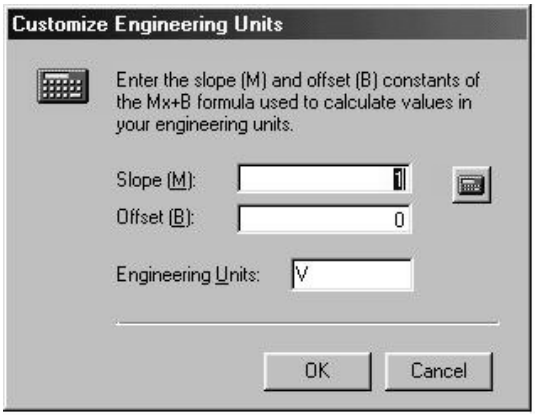
Scanning Rate
Clock: *Internal*
Convention: *Frequency*
Pre-Trigger: 50 kHz
Post-Trigger: 50 kHz

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mX +b, an Example

From the *Customize Engineering Units* dialog box (see figure at right), you can enter values for *m* and *b* components of the equation that will be applied to the data. There is also an entry field that allows you to enter a label for the new units that may result from the **mX+b** calculation.

An example of mX + b equation use follows.



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Engineering Units Conversion Using mx + b

Most of our data acquisition products allow the user to convert a raw signal input (for example, one that is in volts) to a value that is in engineering units (for example, pressure in psi). The products accomplish this by allowing the user to enter *scale* and *offset* numbers for each input channel, using the software associated with the product. Then the software uses these numbers to convert the raw signals into engineering units using the following "**mx + b**" equation:

Engineering Units = m(Raw Signal) + b **(1)**

The user must, however, determine the proper values of *scale* (**m**) and *offset* (**b**) for the application in question. To do the calculation, the user needs to identify two known values: (1) the raw signal values, and (2) the engineering units that correspond to the raw signal values. After this, the scale and offset parameters can be calculated by solving two equations for the two unknowns. This method is made clear by the following example.

Example

An engineer has a pressure transducer that produces a voltage output of 10.5 volts when the measured pressure is 3200 psi. The same transducer produces an output of 0.5 volt when the pressure is 0 psi. Knowing these facts, m and b are calculated as follows.

A - Write a pair of equations, representing the two *known* points:

3200 = m(10.5) + b **(2)**

0 = m(0.5) + b **(3)**

B - Solve for m by first subtracting each element in equation (3) from equation (2):

3200 - 0 = m(10.5 – 0.5) + (b - b) **(4)**

Simplifying gives you: **3200 = m(10)** **(5)**

This means: **m = 320** **(6)**

C - Substitute the value for m into equation (3) to determine the value for b:

0 = 320 (0.5) + b **(7)**

So: **b = - 160** **(8)**

Now it is possible to rewrite the general equation (1) using the specific values for m and b that we just determined:

Engineering Units = 320(Raw Signal) - 160 **(9)**

The user can then enter the values of m and b into the appropriate location using the facilities provided by compatible data acquisition software, for example: WaveView, DaqView, Personal DaqView, LogView, and TempView. The software uses equation (9) to calculate signal values in engineering units from that point on.

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Software 4

This chapter includes a brief summary of software that can be used for WaveBook system applications and a notice regarding calibration software. Topics include:

- **WaveView™** *Out-of-the-Box*™ Software
- **Post Acquisition Data Analysis Software**
- **Calibration Software**
- **Icon-Based Software** (DASYLab® and LabVIEW™)
- **DaqX** Language Drivers for Programmers

WaveView™ *Out-of-the-Box*™ Software

WaveView is a graphical Windows-based program for use in WaveBook applications. This program allows users to acquire data for immediate viewing or for storage to the PC's hard disk. WaveView's "spread-sheet" style interface makes it easy to set up your application quickly and begin acquiring data within minutes of completing hardware connections. No programming knowledge is required.

From *WaveView* you can:

- Set up all analog or digital input parameters.
- Acquire and save data to disk.
- View the acquisition in real-time.
- Send data to other Windows applications, such as spreadsheets and databases.
- Launch an independent, post acquisition data analysis program. Analysis programs, such as Post View, DIAdem, and eZ-View, provide a means of viewing and analyzing data that was previously acquired with WaveView.

WaveView is detailed in the *WaveView/WaveCal Document Module*, which is loaded onto your hard drive as a part of product support, during software installation. The default location is the **Programs** file directory.

Post Acquisition Data Analysis Software

Post Acquisition Data Analysis Software is included as part of the *Out-of-the-Box* application software. A document module provides information on the applicable application, for example, DIAdem, PostView, or eZ-View.

Documentation for the applicable analysis application is included in the document module entitled, *Post Acquisition Data Analysis Software.* The document module is loaded onto your hard drive as a part of product support, during software installation. The default location is the **Programs** file directory.

Calibration Software

WaveBooks are calibrated at the factory, prior to shipment. However, the units must be periodically re-calibrated. WaveCal (a WaveBook calibration application) is included as a part of WaveBook product support. The application is discussed in the *WaveView/WaveCal* document module, which is included as a part of the product support [PDF] documentation package.

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Icon-Based Software (DASY*Lab*® and LabVIEW™)

Most WaveBook users do not need to go beyond WaveView and the post acquisition data analysis program to satisfy their application needs. However, for individuals who want to customize their applications, "icon-based" programs such as DASY*Lab*® and LabVIEW™ offer a great degree of flexibility.

The installation CD includes language drivers for DASY*Lab*® and LabVIEW™. The CD also includes program examples for each. The CD does not, however, include user documentation dedicated to these software packages.

Individuals using either of these programs should refer to their DASY*Lab*® or LabVIEW™ user manuals, as applicable. You can obtain additional information from your sales representative.

DaqX, Language Drivers for Programmers

No programming knowledge is required for using WaveBook in conjunction with the included *Out-of-the-Box* software package; However, a set of language drivers is included on the install CD-ROM for individuals who want to develop their own custom applications using:

- **C/C++**
- **Visual Basic**
- **Delphi**

The CD includes program examples and a *Programmer's Manual* (p/n 1008-0901) in PDF format.

The Programmer's Manual automatically installs during software installation for WaveBook Support, and will be located in the directory you chose to install the WaveBook Support programs. The **Programs** file directory is the default location. Note that you will need to use Adobe® Acrobat Reader, to view or print the manual. We have included a copy of the reader on the CD.

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Troubleshooting and Customer Support 5

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Electrostatic Discharge (ESD), Handling Notice



The discharge of static electricity can damage some electronic components. Semiconductor devices are especially susceptible to ESD damage. You should always handle components carefully, and you should never touch connector pins or circuit components unless you are following ESD guidelines in an appropriate ESD-controlled area. Such guidelines include the use of properly grounded mats and wrist straps, ESD bags and cartons, and related procedures.

Product Care

WaveBooks and WBK options are essentially maintenance free and require a minimal amount of care. They should be treated much like other high-tech equipment. In general:

- Keep them clear of harsh chemicals and abrasive elements.
- Avoid exposing the products to extreme heat, for example, avoid setting up a WaveBook system near a boiler or furnace.
- Avoid extreme shock and vibration.
- Avoid subjecting the units to liquids and extremely fine air particulate, such as silica dust.
- Never touch circuit boards without proper ESD (Electrostatic Discharge) measures in place.

A “common-sense” approach to handling WaveBook products will go a long way in protecting them from inadvertent damage.

Note that you can use lint-free rags and Isopropyl Alcohol (Rubbing Alcohol) to clean the outer plate surfaces of WaveBook and WBK modules.



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ReadMe Files and the Install CD-ROM

The Install CD-ROM includes ReadMe Files. These files often contain late-breaking information that may not appear in the user documentation. During installation you should review the ReadMe files when prompted to by the program.

The Install CD-ROM includes:

- WaveBook Windows NT/2000 driver
- WaveBook Windows 95/98/Me driver
- **DaqX.DLL** (32-bit API) for WaveBook
- Microsoft C/C++ API support
- Microsoft VB API support
- Borland Delphi API support
- Daq* Configuration Control Panel Applet
- User documentation in Adobe® PDF format

Upon installation, the user needs to run the *Daq* Configuration* Control Panel applet. The applet is used to configure WaveBook for an appropriate LPT port. This must be performed in order for the application to access WaveBook through the Windows NT/2000, or Windows 95/98/Me driver.

Driver Support

The daqX API can be used with WaveBook, DaqBook, DaqBoard, Daq PC Card and TempBook product lines. All daqX functions share the **daq** prefix.

The API support examples can be found in the installed directory **\LANGS\WAVEBOOK**.

Connection Problems

Make sure the parallel port is operable and capable of generating interrupts. The parallel port, to which the WaveBook is to be connected, must be properly configured in order for the device to operate correctly.

Each device must be configured using the Daq*Configuration Applet [located in the Windows' Control Panel]. If a device is not configured correctly it will not be accessible from an application.

If communications cannot be established with the WaveBook or, if trying to connect causes the system to hang or crash, try the following:

- Verify that the MODULE POWER switch is set to ON and that the MODULES ON indicator is lit.
- Check to make sure that the Notebook PC communication cable is properly connected to the WaveBook's DB25 connector labeled "TO COMPUTER PARALLEL PORT."
- Check that the desired LPT port is properly configured and the base address and interrupt are recognized by the operating system.
- Check the BIOS settings for the LPT port. Make sure that the BIOS LPT protocol settings are compatible with the settings selected for the LPT port. "Compatibility mode" is recommended.
- Run the *Daq Configuration* applet from the Windows Control Panel. Make sure the device is configured to the appropriate LPT port with the appropriate protocol. Run the device test and if it fails try other protocols for the device. Be sure to click on **<Apply>** to apply the settings, before re-running the test.
- ***Windows NT/2000***: Make sure that the driver has been loaded. The installation will configure the operating system to automatically load the driver at boot-up. However, if there is a problem communicating with the device, the driver can be loaded manually by using the following start sequence from a DOS shell: **NET START WAVEBK**.
  To unload the driver manually, use the following sequence: **NET STOP WAVEBK**.
- Users of Enhanced Capabilities Ports (ECP) should refer to the *ECP Setup* section on page 5-3.

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32-Bit WaveView Issues

- The 32-bit version of WaveView uses a default scheme whereby buffer allocation is dynamic depending on the amount of physical memory on the computer. An advanced feature is available in this release to let the user have more control of the buffer allocation. Generally, better performance will be obtained by increasing the amount of RAM. This allows fewer swaps of VM (virtual memory) to the drive thus allowing the possibility of greater performance. However, VM management during acquisition configuration for large acquisitions may cause WaveView to take a significant amount of time to configure the acquisition.
- Acquisition parameters can no longer be changed during an active acquisition. The 16-bit version of WaveView allowed the changing of configuration parameters during an acquisition.
- Scope scale changes do not become effective until the focus changes. This is best accomplished by hitting **<Enter>**.
- International settings are supported, but some text boxes may not completely show the comma when it is used as the decimal place holder.
- The *Scope Mode's* print resolution is determined by the host computer's video driver. Some graphics drivers may require adjustment of the resolution and/or color palette for proper print operation. For some printers, better output is attained by changing the printer's dithering setting to "None".
- Text boxes for the filter settings may not display the proper setting if the number entered must be rounded to the nearest filter setting. This is a problem only with the number displayed and does not affect the actual filter setting passed down to the driver.
- Conversion to Snap Master format from the menu option is not supported. Snap Master format conversion does work properly when done as part of a direct-to-disk acquisition.

Windows 95/98/Me Issues

This section only applies to Windows 95/98/Me installations.

Resource Settings

If WaveBook fails to communicate or has problems transferring data, there may be a resource conflict with other devices within the system. Take the following steps if this appears to be the case.

ECP (Enhanced Capabilities Port) Setup

If the WaveBook fails to communicate in ECP mode, make certain that the WaveBook hardware is actually capable of ECP communications. This can be done as follows:

1. Locate the LPT port communications chip on the main board, near the connector that the parallel cable connects to. The chip is relatively large and is stamped "262-0301" or "262-0301, rev B." A 262-0301 rev. B" chip supports ECP, the earlier rev does not. Contact the factory in regard to upgrading. Note that most units purchased before July 2000 do not have ECP support.
2. Verify the parallel port hardware is in ECP mode. For ports built into the computer's motherboard, the port is usually configured using the computer's BIOS setup utility (accessible during computer start up). See your computer's specific documentation regarding accessing the BIOS setup utility and configuring peripherals.
3. Verify the parallel port is configured [in the Windows Control Panel] as an "ECP parallel port" and not "Parallel port."

   Windows95/98/Me users can follow the steps below in regard to locating parallel port resource information.

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Parallel Port Setup (general)

If WaveBook fails to communicate or has problems transferring data there may be a problem with the way the parallel port is configured. If this appears to be the case take the following steps:

1. Ensure that any hardware settings on the parallel port are configured properly. If unsure of proper configuration, refer to the parallel port manufacturer's documentation. If this fails to solve the problem, proceed to the next step until the problem is resolved.
2. Click the Windows desktop *Start* button; select the *Settings* menu item; then, select the *Control Panel* menu item.
3. Double-click the *System* icon.
4. Click the *Device Manager* tab.
5. If the small box to the far left of the "Ports (COM & LPT)" entry contains a "+", click once on the "+" to show all your communication and line printer ports.
6. In the Configuration utility, click once to highlight the line containing the LPT port you chose to use with WaveBook.
7. Click the *Properties* button.
8. The *Device Status* section should contain the message “This device is working properly.” If the message is not present, either the wrong I/O address is selected, or the hardware is missing or broken.
9. Click the *Resources* tab.
10. The *Resource Settings* section should contain entries for “Input/Output Range” and “Interrupt Request” with “Settings” from the table below that correspond to the LPT port chosen for WaveBook.

    Note: A “Direct Memory Access” entry may also exist for EPP or ECP printer ports.

Printer Port	Input/Output Range	Interrupt Request
LPT1	**0378-037B (or 037F)**	**7**
LPT2	**0278-027B (or 027F)**	**5**
LPT3	**03BC-03BF**	**7 (shares with LPT1)**

    If the settings do not correspond to those in the previous table, or if there is no "Interrupt Request" entry, complete steps 10a through 10b before moving on to step 11.

    a. Click on the check mark in the small box to the left of "Use automatic settings."

    b. Click on the now active drop-down combo-box to the right of "Setting based on."

    c. Click on different "Basic configuration" choices (use the up-down slide bar to the right, if needed) until the resource settings match those of your printer port in the table above.

11. The "Conflicting device list" section should contain the message "No conflicts." If this is not the case,, and a DMA conflict is described, repeat Steps 10a - 10c *but change only the DMA setting*.
12. If one or more conflicts are described in the "Conflicting device list" section, you must find the conflicting device(s) and change the conflicting resource(s) by following these steps:

    a. Take note of all conflicts, then click the *OK* button.
    b. If a window appears titled "Creating a Forced Configuration", click *Yes* to continue.
    c. Open the conflicting device type by clicking on the "+" in the small box to its left, if necessary.
    d. The conflicting device's icon should be marked with an exclamation point in a yellow circle. Click once on the device to highlight it; then click the *Properties* button.
    e. Click the *Resources* tab.
    f. Perform Steps 10a - 10c to resolve the resource conflict.
    g. Repeat Step 11 for each additional existing resource conflict.

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13. If one or more resource conflicts remain, the conflicting device(s) must either be removed or kept absolutely dormant for proper operation. Click the *OK* button to close the device properties window and return to the "System Properties" window. If a window appears titled "Creating a Forced Configuration", click the *Yes* button to continue. To remove a device, perform the following steps:

    a. If necessary, open the device type by clicking on the "+" in the small box to its left.
    b. Click once on the device to highlight it, then click the *Remove* button.
    c. Click the *OK* button to confirm the device's removal.

14. Click the *Close* button to close the "System Properties" window. Close the "Control Panel" window and any other tasks running; then shut down Windows 95/98/Me.

15. If any hardware was removed in Step 13 or if any hardware reconfigured in Step 12 requires manual reconfiguring, power off the computer and remove or reconfigure the hardware before rebooting. Otherwise, simply reboot the computer.

16. Run the Configuration utility and test WaveBook's communication. If problems persist and no resource conflicts exist, perform the following steps:

    a. Check for loose cable connections and verify the MODULE POWER indicator is ON.
    b. Verify that the computer's printer port and data cable work with a printer or other device.
    c. Verify there are no installed devices that Windows 95/98/Me does not recognize but whose resources might conflict with the WaveBook.
    d. Verify that WaveBook works on another PC (from a different manufacture if possible).

Parallel Port Troubleshooting Tips

Windows9x Users

After completing the test hardware function within the DaqConfig control panel applet. It is possible that a connection may not be made. Before doing anything else, try the following:

Recheck your parallel port cable and the power supply so you are certain that the connection is tight and power is applied

Try all of the communication protocols listed in the DaqConfig icon because it is possible that the parallel port has a communication protocol other than standard or normal mode.

If you still have not established communication, then go to control panel, system, device manager, ports, LPT1 and verify that the following things are true:

Under the general and driver sections, make sure that the parallel port is a standard parallel port with a driver installed and that no resource conflicts are present. If no driver is installed or resource conflicts are present, then you need to resolve these issues with your computer supplier or your information services department.

Under the resource section, make sure that the parallel port has an interrupt level assigned. If it doesn't you will need to add one by un-checking the use default settings box, selecting configuration one so the same base address is maintained but an interrupt level is added, and then double clicking on the interrupt level so you can add the interrupt level. Generally, 7 is reserved for parallel ports but you should pick one where no conflict exists. Reboot the computer and everything should work If you find that the parallel port is configured as an ECP parallel port, then you will need to access the bios and change the parallel port to a standard or normal mode. You can generally access the bios by pushing F2 or escape during the initial boot up of the computer. If so, you will see a computer message "Push F2 to enter setup". Change the parallel port mode from ECP to standard or normal. Reboot the computer and everything should work.

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WindowsNT Users

After completing the test hardware function within the daqconfig control panel applet. It is possible that a connection may not be made. Before doing anything else, try the following:

Recheck your parallel port cable and the power supply so you are certain that the connection is tight and power is applied

Try all of the communication protocols listed in the daqconfig icon because it is possible that the parallel port has a communication protocol other than standard or normal mode

If you still have not established communication, verify that the parallel port drivers are installed by going to control panel, devices, hardware profiles, parallel port. If the drivers are not installed, then you need to resolve this issue with your computer manufacturer. Verify that your parallel port interrupt has an interrupt level assigned to it by looking at the parallel port resources in daqconfig applet.

If it is necessary to add an interrupt level or to change to parallel port communication protocol, that must be done in the BIOS, which can generally be accessed during computer boot up. You should see the message "Push F2 to enter setup". If the parallel port is configured for ECP or EPP, change it to standard or normal and everything should be fine.

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Frequently Asked Questions

(1) Topic: Environmental Factors

Question: What Environments are WaveBook Systems Intended for?

Answer: WaveBook Systems are designed to operate within 0° to 50°C (32° to 122°F) and with a relative humidity of up to 95%RH, non-condensing. The products can be stored at temperatures within the range of -20° to +70°C (-40° to 158°F). WaveBook systems should always be protected from snow, rain, extreme dust, and harsh sun.

(2) Topic: 32-Bit API Support, DaqX

Question: I am writing my own application that interfaces to the WaveBook. Is the 32-bit enhanced mode support for Windows 95, Windows 98 and Windows NT available?

Answer: Yes, the current version of the DaqX software supports 32 bit enhanced mode programming.

Question: What is DaqX software?

Answer: DaqX software is low-level software support for application development. DaqX is installed during the installation of the WaveView application. DaqX supports Visual C++, Visual Basic, and Delphi programming environments.

Question: Where can I get the latest version of WaveView/DaqX software?

Answer: You can download the latest versions from our website. This service is free.

(3) Topic: WBK14 - Dynamic Signal Conditioning Module

Question: Why can't I use the external clock feature on the WBK14 to control my acquisition speed?

Answer: The external clock on the WBK14 is used to dynamically move the corner frequency of the filter, not pace the A/D in the WaveBook. This feature is often required in vibration applications where the filter is moved as the device under test is vibrated (or excited) at varying frequencies. Unlike the WaveBook/516 that has a special input for clocking the A-to-D, the WaveBook/512 has no provisions to do so.

Question: Is there anything special I should know about WBK14's power-up state?

Answer: At power-up the current output of the WBK14 is open circuited. It is only after being programmed that the current source is engaged.

Question: In regard to attenuation, what is the filter roll-off for the WBK14 filter?

Answer: The WBK14's Butterworth filter is down 3 dB at the corner frequency. Beyond that point, the signal attenuates at 48 dB per octave or 160 dB per decade. This is a substantial amount of attenuation for most applications.

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(4) Topic: WBK20 - PCMCIA/EPP Interface Card

Question: How do I configure the WBK20 in Windows 95 or Windows 98?

Answer: Insert the WBK20 into the PCMCIA slot. Windows 95/98 should recognize it and display a window *'New Hardware Found'* followed by a window *'Building driver data base'*.

Select the option *'Select driver from disk provided by hardware manufacturer'*. *'Install from disk'* is the next window. Provide a path to the floppy drive after you have inserted the disk that came with the WBK20. It contains a file 'IOTWBK20.INF'. Select OK.

In the next window, select 'IOtech Inc' in the left box and 'IOtech WBK20: 1 Parallel Port' in the right box. Select OK. At this time, it may ask for your Windows CD or certain diskettes. Then you will be prompted to restart the computer.

The WBK20 will show up in ControlPanel/System/Device Manager/ Ports (COM and LPT) as 'IOtech WBK20: 1 Parallel Port LPT#'. Double clicking on this will show you the resources (IRQ and I/O range).

(5) Topic: ECP and EPP

Question: My computer uses ECP. Is ECP the same as EPP?

Answer: No; ECP (Enhanced Capabilities Port) is a different protocol than EPP (Enhanced Parallel Port). If the WaveBook fails to communicate in ECP mode, make certain that the WaveBook hardware is actually capable of ECP communications. This can be done as follows:

1. Locate the LPT port communications chip on the main board, near the connector that the parallel cable connects to. The chip is relatively large and is stamped “262-0301,” or “262-0301, rev B.” A 262-0301 rev. B" chip supports ECP, the earlier rev does not. Contact the factory in regard to upgrading. Note that most units purchased before July 2000 do not have ECP support.
2. Verify the parallel port hardware is in ECP mode. For ports built into the computer’s motherboard, the port is usually configured using the computer’s BIOS setup utility (accessible during computer start up). See your computer's specific documentation regarding accessing the BIOS setup utility and configuring peripherals.
3. Verify the parallel port is configured [in the Windows Control Panel] as an "ECP parallel port" and not "Parallel port."

(6) Topic: Sampling Rates

Question: Does the WaveBook really collect data at 1 MHz and what should I expect on my PC?

Answer: Yes, the WaveBook samples at 1 MHz. But your computer may not. The PC’s performance is a function of the hardware configuration, operating system, background task, and other factors. The PC could very well be a bottleneck in regard to sampling.

Question: What transfer speeds can I expect from a standard 8-bit parallel port?

Answer: A typical computer will achieve 80K to 90K samples/sec [through-put to the PC].

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Question: I realize that the WBK20A and WBK21 are interface options. Will they improve my speeds?

Answer: In the majority of cases, by far, both products result in higher through-put [than you would see with the use of the standard 8 bit port. The exact amount varies with PC configuration. **When using the WBK21**, ISA plug-in board, 1 MHz through put is more the rule than the exception. Because this boards sits directly on the bus, most computers can handle the data rate. **The WBK20A** (PCMCIA card) plugs into the PC-card slot on the side of the notebook PC. Up until early 1997, all notebooks with these slots were PCMCIA type. In these older computers, 1 MHz was often seen, but 750-800 kHz was typical. In early 1997 notebooks started shipping with a PC card bus instead of the PCMCIA card slot. This change was almost completely transparent to PC users since the PCMCIA card plugs in and the PC Card bus is backward compatible with PCMCIA cards. However, one important change occurred. The WBK20A appears to operate slower in the new PC Card slot. With this change, 1 MHz transfer rates using the WBK20A in a PC Card slot are almost non-existent, instead, 300K to 500K samples/sec is typical.

Question: I'm using the WBK20A but because of my PC architecture, the system is still slower than I require. What else can I do?

Answer: One option is to install a WBK30 memory card. This increases the FIFO buffer inside the WaveBook. While this option does not increase transfer speeds, it does extend the length of time an acquisition can run before a buffer over flow occurs. The exact duration is a function of sampling rates and transfer speeds. For example, assume you are using a WaveBook/512 in packed mode with the WBK30/128. This option holds 128 Mbytes (64 Msamples) of data. Furthermore, let us say you are digitizing at 1 MHz and transferring data at 400 Ksample/sec via a WBK20A. In this case, you could expect to acquire data for about 1 minutes and 51 seconds. In that amount of time, you would have collected about 148.7 Msamples. This is over a quarter gigabyte of data.

(7) Topic: Calibration

Question: Should I calibrate my WaveBook system when I receive it?

Answer: No, because each WaveBook-related product is factory-calibrated to its rated accuracy before it leaves the factory.

Question: When is calibration required?

Answer: Depending on your operating guidelines, your equipment will require periodic calibration to ensure the original accuracy is maintained. We recommend that you have your WaveBook system calibrated at least once a year. In addition, calibration is required whenever a change is made to the signal path, for example, adding a WBK11 to the system.

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(8) Topic: Computers for Data Acquisition

Question: What type of computer do you recommend for use with data acquisition devices such as WaveBook?

Answer: When selecting a computer for use as a data acquisition system look for a fast parallel port, disk drives with high rotation speeds and low access times. If you are using a notebook PC, it should have a PCMCIA or PC Card slot.

We recommend that you use a PC with more than 16 Mbytes of RAM with a Windows 95 (or higher version) operating system. While RAM does not influence transfer speeds per se, it will benefit the Windows operating system in operational areas other than transfer speed.

Note that processor speed usually has less bearing on transfer rates than one might suspect, although you may want the speed for other things such as number crunching or scrolling waveforms. A 400 MHz Pentium might not transfer as fast as a 75 MHz Pentium.

(9) Topic: WaveView

Question: WaveView can communicate with my WaveBook/512, but does not detect the WBK options and does not acquire data. What could be wrong?

Answer: Most likely the parallel port interrupt WaveView is trying to use has a conflict or is not operating. Try another interrupt setting.

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Customer Support

If you want to Expand or Enhance Your WaveBook System . . .

You can visit our internet site at **http//:www.iotech.com** to find the latest accessories and WBK options that are available for your WaveBook system, or call our sales department at (440) 439-4091.

If you need to Report Problems or Request Product Support

Note: Please do not return any equipment to the factory unless it has an RMA number (Return Merchandise Authorization number). RMA numbers are issued by the factory.

To report problems or request support, call the manufacturer's Applications department. Contact information follows shortly. When you contact us, please have the following information available, as applicable:

- Hardware model numbers and software version numbers.
- Operating system, type of computer, and device information in the Windows control panel, such as interrupts and address settings for our hardware and others.
- Results of tests, such as the Daq* Configuration control panel.
- Hardware setup and software configuration.
- Information on input signals, including voltage ranges, signal impedance ranges, noise content, and common mode voltages.
- The name of a contact person from your company who can discuss the problems encountered.
- Instructions for return shipping.
- All troubleshooting notes and comments on tests performed, and all problem-related conditions.

Note: Before calling for assistance, take a few minutes to read all parts of the manual that may be relevant to the problem. Also, please review the troubleshooting material.

You can reach IOtech by one of the following means:

Phone: **(440) 439-4091**

Fax: **(440) 439-4093**

E-mail (Product Information/Sales): **sales@iotech.com**

E-mail (Technical Support): **productsupport@iotech.com**

Internet: **http//:www.iotech.com**

Mail: **IOtech, Inc. • 25971 Cannon Road • Cleveland, Ohio 44146-1833**

All equipment returned to the manufacturer must have an RMA (Return Material Authorization) number. You can obtain an RMA number by calling the Customer Service or Applications departments. When returning the equipment, use the original shipping container (or equivalent) to prevent damage. Put the RMA number on your shipping label to ensure that your shipment will be handled properly. After receiving your equipment, we will fax a confirmation form that summarizes the charges (if applicable) and expected return date.

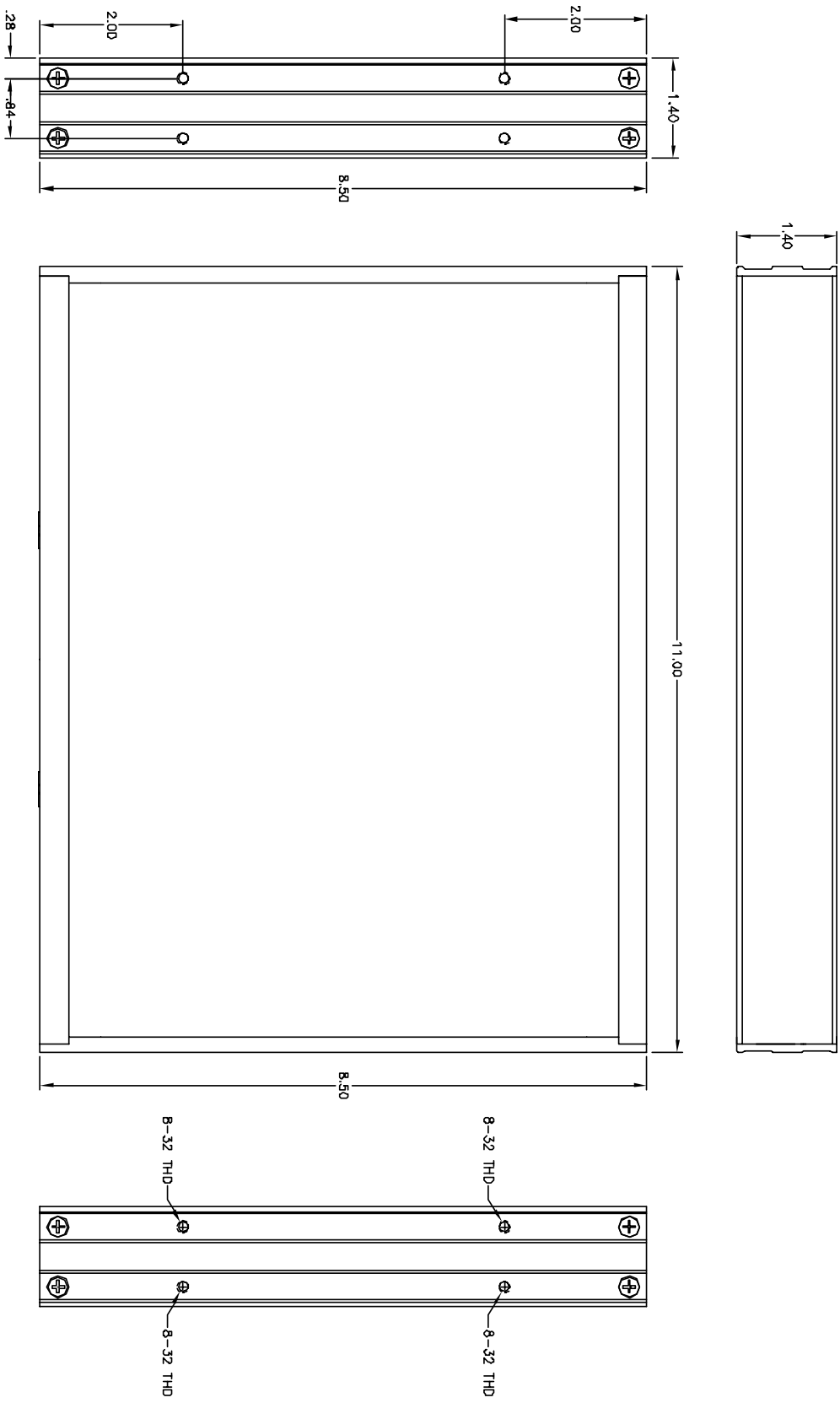
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Appendix A Dimensional Drawings

Dimensions for WaveBook/512 and WaveBook/512H



Note: Dimensions are in inches.

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Glossary

Acquisition — A collection of scans acquired at a specified rate as controlled by the sequencer.

Analog — A signal of varying voltage or current that communicates data.

Analog-to-Digital Converter (ADC) — A circuit or device that converts analog values into digital values, such as binary bits, for use in digital computer processing.

API — Application Program Interface. The interface program within the data acquisition system's driver that includes function calls specific to the acquisition hardware and can be used with user-written programs. Several languages are supported.

Bipolar — A range of analog signals with positive and negative values (e.g., -5 to +5 V); see *unipolar*.

Buffer — *Buffer* refers to a circuit or device that allows a signal to pass through it, while providing isolation, or another function, without altering the signal. *Buffer* usually refers to:

(a) A device or circuit that allows for the temporary storage of data during data transfers. Such storage can compensate for differences in data flow rates. In a FIFO (First In - First Out) buffer, the data that is stored first is also the first data to leave the buffer.

(b) A follower stage used to drive a number of gates without overloading the preceding stage.

(c) An amplifier which accepts high source impedance input and results in low source impedance output (effectively, an impedance buffer).

Buffer Amplifier — An amplifier used primarily to match two different impedance points, and isolate one stage from a succeeding stage in order to prevent an undesirable interaction between the two stages. (Also see, *Buffer*).

Channel — In reference to data acquisition, *channel* simply refers to a single *input*, or *output* entity.

In a broader sense, an *input channel* is a signal path between the transducer at the point of measurement and the data acquisition system. A channel can go through various stages (buffers, multiplexers, or signal conditioning amplifiers and filters). Input channels are periodically sampled for readings.

An *output channel* from a device can be digital or analog. Outputs can vary in a programmed way in response to an input channel signal.

Common mode — Common mode pertains to signals that are identical in amplitude and duration; also can be used in reference to signal components.

Common mode voltage — Common mode voltage refers to a voltage magnitude (referenced to a common point) that is shared by 2 or more signals. Example: referenced to common, Signal 1 is +5 VDC and Signal 2 is +6 VDC. The common mode voltage for the two signals is +5.5 VDC [(5 + 6)/2].

Crosstalk — An undesired transfer of signals between systems or system components. Crosstalk causes signal interference, more commonly referred to as *noise*.

Detection Signal — In relation to WBK17, a detection signal is one of 8 outputs of the pattern detection module. Each input channel has an associated detection signal (Detect 1 for Channel 1, Detect 2 for Channel 2, etc.) A channel's detection signal will go active high when that channel's counter value meets the setpoint criteria programmed into the pattern detection module. Detection signals can be scanned along with any other channel in the scan group.

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Digital A digital signal is one of discrete value, in contrast to a varying signal. Combinations of binary digits (0s and 1s) represent digital data.

Digital-to-Analog Converter (DAC) A circuit or device that converts digital values (binary bits), into analog signals.

DIP switch A DIP switch is a group of miniature switches in a small *Dual In-line Package* (DIP). Typically, users set these switches to configure their particular application.

Differential mode The differential mode measures a voltage between 2 signal lines for a single channel. (Also see *single-ended mode*).

Differential mode voltage Differential mode voltage refers to a voltage difference between two signals that are referenced to a common point. Example: Signal 1 is +5 VDC referenced to common. Signal 2 is +6 VDC referenced to common.

If the +5 VDC signal is used as the reference, the differential mode voltage is +1 VDC (+ 6 VDC - +5 VDC = +1 VDC).

If the +6 VDC signal is used as the reference, the differential mode voltage is -1 VDC (+ 5 VDC - +6 VDC = -1 VDC).

Encoder Mode The *encoder mode* allows the WBK17 to make use of data from optical incremental quadrature encoders. When in the *encoder mode*, the WBK17 accepts either *differential* or *single-ended* inputs and provides power for up to four encoders. When reading phase A, phase B, and index Z signals, the WBK17 provides positioning, direction, and velocity data.

ESD Electrostatic discharge (ESD) is the transfer of an electrostatic charge between bodies having different electrostatic potentials. This transfer occurs during direct contact of the bodies, or when induced by an electrostatic field. ESD energy can damage an integrated circuit (IC); so safe handling is required.

Excitation Some transducers [e.g. strain gages, thermistors, and resistance temperature detectors (RTDs)] require a known voltage or current. Typically, the variation of this signal through the transducer corresponds to the condition measured.

Gain The degree to which an input signal is amplified (or attenuated) to allow greater accuracy and resolution; can be expressed as ×n or ±dB.

Gating In relation to the WBK17, any counter can be gated by the mapped channel. When the mapped channel is high, the counter will be allowed to count, when the mapped channel is low, the counter will not count but hold its value.

Isolation The arrangement or operation of a circuit so that signals from another circuit or device do not affect the *isolated* circuit.

In reference to data acquisition, *isolation* usually refers to a separation of the direct link between the signal source and the analog-to-digital converter (ADC). Isolation is necessary when measuring high common-mode voltage.

Linearization Some transducers produce a voltage in linear proportion to the condition measured. Other transducers (e.g., thermocouples) have a nonlinear response. To convert nonlinear signals into accurate readings requires software to calibrate several points in the range used and then interpolate values between these points.

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Mapped Channel	In relation to the WBK17, a mapped channel is one of 16 signals that can get multiplexed into a channel's counter module. The mapped channel can participate with the channel's input signal by gating the counter, clearing the counter, etc. The 16 possible choices for the mapped channel are the 8 input signals (post debounce) and the 8 detection signals.
Multiplexer (MUX)	A device that collects signals from several inputs and outputs them on a single channel.
Sample (reading)	The value of a signal on a channel at an instant in time. When triggered, the ADC reads the channel and converts the sampled value into a 12- or 16-bit value.
Scan	The channels that are selected for sampling.
Sequencer	A programmable device that manages channels and channel-specific settings.
Simultaneous Sample-and-Hold	An operation that gathers samples from multiple channels at the same instant and holds these values until all are sequentially converted to digital values.
Single-ended mode	The single-ended mode measures a voltage between a signal line and a common reference that may be shared with other channels. (Also see *differential mode*).
Start of Scan	In relation to the WBK17, "start of scan" is a signal that is internal to the WBK17. It signals the start of a scan group and therefore pulses once every scan period. It can be used to clear the counters and latch the counter value into the acquisition stream.
Terminal Count	In relation to theWBK17, this signal is generated by the counter value. There are only two possible values for the terminal count: 65,535 (for a 16-bit counter) and 4,294,967,295 (for a 32-bit counter.) The terminal count can be used to stop the counter from rolling over to zero.
Ticksize	In relation to theWBK17, the ticksize is a fundamental unit of time and has four possible settings: 20ns, 200ns, 2000ns, 20000ns. For measurements that require a timebase reference like period or pulsewidth, the ticksize is the basic unit of time. The count value returned in the scan is the number of ticks that make up the time measurement.
Trigger	An event to start a scan or mark an instant during an acquisition. The event can be defined in various ways; e.g., a TTL signal, a specified voltage level in a monitored channel, a button manually or mechanically engaged, a software command, etc. Some applications may use pre- and post-triggers to gather data around an instant or based on signal counts.
TTL	Transistor-Transistor Logic (TTL) is a circuit in which a multiple-emitter transistor has replaced the multiple diode cluster (of the diode-transistor logic circuit); typically used to communicate logic signals at 5 V.
Unipolar	A range of analog signals that is always zero or positive (e.g., 0 to 10 V). Evaluating a signal in the right range (unipolar or bipolar) allows greater resolution by using the full-range of the corresponding digital value. See *bipolar*.

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