SECTION 1

ABSTRACT

ABSTRACT

The BW-LPD-DAQ4000 **P**article **I**mpact **N**oise **D**etection System provides a nondestructive means of identifying devices containing loose particles. The system subjects the device to the physical stimulus of shock and vibration while listening for noise generated by the particle as it impacts with the case of the device. The system features a fully-programmable test system on a PC to provide advanced capability essential in complying with dynamic specifications.

B&W Engineering Corp. is proud to present the next generation in **P**article **I**mpact **N**oise **D**etection (**PIND**). With the advent of low cost high performance data acquisition and control products, B&W has created the new paradigm in **PIND**. The ease of use of the BW-LPD-DAQ4000 software and the workhorse reliability of over 30 years of the shaker and sensors ensure this **PIND** tester will be on the job for many years.

Right from the start of **PIND** testing B&W patented the first MIL-STD compliant system outperforming the competition by over 30% better detection rate as tested by the NBS (now National Institute of Science and Technology) in a well known 1978 study (NBSIR 78-1590 NASA)

Until now there has been no significant improvement to the PIND test systems. Now the particle (or interference) is recorded in digital format and can be easily recalled for post test analysis. This advancement finally provides the ability to distinguish a particle from other noise that the **PIND** system has detected. The optional Transient Detector is another failsafe, detecting interference from stray RF and other sources.

The PC interface can generate test reports with percent defective per run, serial, part and lot numbers. The many other advantages of a PC control include intuitive operation, unlimited test profiles, and mixed frequency tests. The versatile Manual Mode is useful for experiments and can apply a vibration sweep (to find resonances that make particle type noise) and apply shocks simultaneous with or without vibration.

SECTION 2

THEORY OF OPERATION

THEORY OF OPERATION

The BW-LPD-DAQ4000 **P**article **I**mpact **N**oise **D**etection System is dedicated to the detection of very small particles, on the order of a .001" gold ball. Loose particles have resulted in mission failures, usually manifested as a short circuit. The System comprises individual components to the requirements of PIND testing. This approach prevents the system from testing in excess of those requirements and eliminates the possibility of major over (or under) testing. The theory of operation is discussed on the system level in this section.

In general, the PIND test requirements are three-fold. The system subjects a Device Under Test (DUT) to sinusoidal vibration and simultaneously mechanically shocks while listening for particle impacts. The vibration typically has a peak magnitude of 20 G with a frequency range from 40 Hz to 250 Hz. The shocks are approximately 1000 G in magnitude and have a duration of less than 100 microseconds (µs).

Loose particle impacts within the DUT provide the signal for which a detector "listens." The presence of these impacts indicates a defective device which fails to satisfy the PIND test. The "listening" is accomplished via a coupled ultrasonic transducer resonant at 155 KHz. This transducer is a piezo-electric device and is mounted within the BW-004 PIND Shock Test Fixture. The 155 KHz signal gain (between the transducer input to the amplifier and the indicating oscilloscope) should be set at 60 dB. The oscilloscope is used for visual display of particulate noise; an audio amplifier and speaker are used for aural indications. In addition, a threshold detector circuit latches on a red FAIL indicator whenever a preset spike voltage is exceeded. Various means for testing system sensitivity may be employed; examples are the BW-012 Sensitivity Test Unit (STU), specially seeded DUT's, function generators, and simple pulse generators.

Since the passband of the detector circuitry is in the radio frequency (RF) range, environmental electrostatic discharge (ESD) and stray RF signals can result in false detections. Consequently, a separate RF detector the TRANSIENT DETECTOR with a remotely mounted sensor has been utilized to "listen" for the presence of these signals. This transducer/detector combination is identical to that used for the particle detection. When its preset threshold voltage is exceeded by anomalous stimuli, this detector circuit indicates said event by illuminating a separate yellow indicator labeled INF (interference). In order to minimize spurious transients, power for the PIND system should be supplied from a source void of switching circuits, and the use of a line filter is recommended. Ample thought and care should be taken when selecting a location for the PIND tester.

A detailed discussion of each system element ensues. Any components substituted for the B&W system components must be capable of interfacing with the remainder of the system in a manner equal to the original items. No attempt is made to state all of the ways these substitute components can degrade system performance. However, it is worthy to note that system generated spikes may appear as a particle impact and trigger the failure indicators. Contact B&W for technical assistance if component substitutions cannot be avoided.

The individual component discussion shall commence with the interface between the DUT and the test system transducer since it is one determinant to a successful test. The 155 KHz transducer is mounted on the upper assembly of the PIND Shock Test Fixture (Patent No. 4184372) and directly couples to a wide band amplifier of approximately 30 dB gain contained in the housing around the transducer. To facilitate system gain verification, a miniature coaxial connector is present to couple directly to the amplifier through a 0.0047 MFD capacitor. The output from the amplifier has low impedance in order to assure that a flex cable may be employed to transmit the signal from the fixture. Consequently, the noise generated by the use of high impedance, coaxial connections is reduced. This upper section of the Shock Test Fixture is mounted on rubber grommets to isolate the transducer package from mechanical noise.

The object that secures the transducer to the mounting plate also functions as the anvil which receives the co-test shock. This design allows direct transmission of the shock pulse through the transducer body to the DUT mounted on the transducer platen.

The lower portion of the Shock Test Fixture serves many functions. It provides an interface with the vibration shaker armature, a terminal board to be mounted off the vibration platform, and flex leads for power in and signal out of the Shock Test Fixture. The co-test shock device is also located on this plate. This mechanism consists of a solenoid with an armature spring/hammer assembly which loads when the solenoid energizes. The solenoid force must be sufficient to secure the armature in a locked condition throughout the applied vibration level and range. When de-energized, the hammer strikes the anvil located on the upper assembly containing the transducer, amplifier, and DUT. Since spring deflection is constant, and the spacing between hammer and anvil prior to release is constant, the shock pulses will be essentially constant.

To assist in the recapture of the armature of the solenoid during applied sine vibration, the power supply charges a 2200 MFD capacitor via an 18 volt potential. A high current inrush results in armature recapture when the solenoid relay contacts are closed. Series resistors reduce this current to about 0.9 amperes in order to reduce the power required to hold the armature closed. A mechanical relay, A3RL1, regulates the solenoid control voltage. This relay will only operate momentarily regardless of the length of time the manual shock button is depressed. The panel controls provides for selection of either manual or automatic shock mode as described below.

B&W Engineering Corp.'s new PIND System features a PC controller with a high speed data acquisition device. This controller regulates both the mechanical shock sequence and vibration interval for the testing. When the "AUTO" features of the system are employed, any number of pre-programmed PIND tests may be automatically performed. These sequences can consist of a multitude of shock sets; each set provides between one and four mechanical shocks. Automatic functions also include closed-loop vibration control, UUT S/N and Lot number, date and time and percent defective per run for automatic test report generation which can be edited with practically any text editor such as Excel. Operation in the "MANUAL" mode allows for frequency and acceleration sweeps, application of shocks at will and other useful experimentation.

The programmable PC controller/timer circuit regulates the activation of the co-test shock portion of the Shock Test Fixture. The interval between automatic shock sets may be set from a minimum of one second and no maximum delivery rate of the individual shocks within each set at 100 milliseconds. Manual shock sets may be arbitrarily delivered by clicking the "Manual Shock" pushbutton when shocks are desired.

This PIND system automatically controls the generation of vibration when the unit is in the "AUTO" mode. If the test includes a pre-test shock set, oscillation begins at the end of the last shock in the set. Otherwise, the vibration will commence immediately with the initiation of the test. In either case, the oscillation continues throughout the test. If the test ends with the activation of the "TEST COMPLETE" indicator, the shaking will terminate with the illumination. If the Failure "ABORT" function is activated, the vibration will terminate about 3 additional seconds after the failure is detected. Depression of the footswitch or "STOP" pushbutton will instantly inhibit the vibration.

***** CAUTION *****

THERE IS NO REVERSE POLARITY PROTECTION PROVIDED IN THE BW-004 ASSEMBLY. IF THE CABLE IS IMPROPERLY CONNECTED, DAMAGE MAY RESULT.

The wide band signal output of the Shock Test Fixture amplifier is connected to the 155 KHz input, Sensor #1 (through 5 optional). Power to the Shock Test Fixture is supplied from the BW-004 D/C POWER connector located on the rear panel.

The A3A3 Power Supply PCB which is located within the Control Console provides power and control for the Shock Test Fixture. The A3A4 Amplifier PCB has the capability to process the signal information received from the particle transducer. This signal data is first amplified through a high pass amplifier to remove low frequency signals and then a bandpass amplifier to achieve a peak gain at 155 KHz. The bandpass amplifier also experiences a 20 dB decrease above 75 and below 300 KHz. The output of this amplifier stage, the ultrasonic audio, is fed to the DAQ input from the A3A4 output. The 60 dB gain adjustment is performed by comparing two signals produced by a function generator. The first signal is produced by inserting a 60 dB attenuator between J1 of Shock Test Fixture and a function generator tuned for a sinusoidal signal with a 40 mV, peak-to-peak amplitude and a frequency to generate the maximum display on the system oscilloscope (approximately 155 KHz). This display is then compared to the un-attenuated output of the unadjusted function generator applied directly to the oscilloscope "Y" axis. Adjust A4R8 as required to obtain the desired gain. This potentiometer tunes the overall gain of the ultrasonic audio to 60 dB.

The ultrasonic audio is also delivered to a voltage comparator through a buffer in the DAQ, when the audio level exceeds its preset threshold level the red FAIL indicator comes on. The threshold level is easily adjusted in the software from 0-ininite (15mVP per MIL-STDs). One method employed to set the proper threshold sensitivity involves the use of a function generator. The function generator is connected to J1 of the Shock Test Fixture and both A4R3 and A4R8 are adjusted until the 60dB gain is obtained. The desired threshold level causes the red FAIL to illuminate. Similar results can also be achieved by using the BW-012 STU. In this case, the STU power supply is utilized to produce a single pulse (magnitude of which may be verified on an oscilloscope) directly into Shock Test Fixture (J1). Alternatively, the STU method may be employed; however, the pulse height should be varied with the digital voltage control of the STU power supply.

***** CAUTION *****

WHEN THROUGH USING CONNECTIONS TO BW-004, (J1), BE SURE AND REPLACE TIGHTLY THE TOP CAP ON J1. IT IS RECOMMENDED A SMALL AMOUNT OF SILICON GREASE IS USED INSIDE THE CAP.

The ultrasonic audio is also applied to the low pass filter that removes 155 KHz signals and audible bursts are amplified which drives the PC speakers and delivered to the Audio Output on the PC for additional speakers or headphones. Audio volume control is provided by the PC to adjust the listening level.

The co-test shock operates a double throw (DPDT) relay RL1 on the Power Supply Board A3A3. This relay in turn activates the shock solenoid by opening a set of closed contacts. The opening of the relay is delayed in order to diminish the effects of ringing generated by the shock pulse. The ringing must be allowed to decay before audio and threshold activation to prevent sound bursts and false failures. This delay can be adjusted from 150 to 250 ms and can be checked with a calibrated oscilloscope connected to the recorder "out" connector. Relay RL1 also receives a signal from the PC Controller. When it is configured in this manner, the use of the footswitch or start button control resets the state of the PIND tester and threshold detectors to prepare for the next test. Consequently, a DUT can be removed and a new DUT installed for the same test without any human interaction with the system controls.

The BW-100-C Vibration Shaker was selected for its stability and low inherent noise. It can also provide the necessary output without requiring additional cooling under normal loads. The voice coil of the shaker has an impedance of approximately 0.9 ohm and is driven by the BW-PA-4000 Power Amplifier. An accelerometer, Dytran Model 3097A1 (or equivalent with a sensitivity of 10 mV/G), is mounted on the Shock Test Fixture. It terminates in a BNC panel connector which is mounted on the terminal block. This connector is attached via coax cable to the Vibration Accelerometer BNC port on the back panel of the Control Console. The accelerometer signal is directed to the current source which is located on the A3A3 Power Supply Board. The output of the accelerometer is used to drive the horizontal trace on the PIND screen labeled "ACCELERATION."

Acceleration meter calibration is performed inside the System Configuration screen. When the shaker is operating with a 10 Gs at 40 Hz (as seen on the optical wedge located on the Shock Test Fixture), this acceleration should be adjusted until 10.0 is displayed. The G level of the shaker is changed by the Acceleration control on the Manual screen. The maximum level attainable is determined by the factory preset level.

The DAQ also provides the frequency control for the Power Vibration Amplifier. The sine wave is generated by the DAQ software; consequently, overall distortion is generally less that 5% and less than 0.1% with the higher frequency harmonics. Frequency limits are preset to 40-250 Hz. The option to 27Hz will limit acceleration to 10Gs in order to prevent accidental shaker overtravel during frequency adjustment beyond this desired range. Output from the vibration oscillator is controlled by a closed-loop circuit that maintains control of the shaker vibration level; it enables the change between two levels to occur as a ramp function without any overshoot. The input to the amplifier escalates to the desired level in less than one second.

When the system is in the "MANUAL" mode, operation of the footswitch precludes the shaker from vibrating. It also mutes the audio and resets the threshold detector. The vibration is terminated automatically at the end of the test or upon application of the footswitch if testing is being done in the "AUTO" mode.

Digital readout of frequency and acceleration is constantly displayed on the PIND screen during test.

If you have any questions or problems, please call B&W Engineering Corp. or visit our web-site for demo videos or to ask for technical assistance.

B&W ENGINEERING PROVIDES SIMULTANEOUS SHOCK WITH VIBRATION RELATED TO THE CO-TEST SHOCK MODE

In any discussion on PIND testing, the difference between various manufactures' test equipment and the test results is one of the belabored points. Actually, some of this problem is a direct result of the two methods of testing allowed by MIL-STD-883, TM2020. The original release of TM2020 required that the co-test shock stimulus be applied simultaneously with the level and frequency of vibration stimulus. One test equipment supplier provided this exact requirement - the second, due to the mechanics of his tester, stopped vibration, induced the "co-test" shock, then reinduced the vibration. The specification was then modified to allow a "perturbed" vibration during the co-test shock of up to 250 ms. Tests on the two variations of the co-test shock were run, and, although the number of capture of defective parts firmly favored the simultaneous co-test shock and vibration method, the persons responsible for the specification claimed the difference between the two methods as insignificant. The specification was then changed to include either method.

As more and more obligations to PIND testing are contracted, the more discrepant answers appear between the two types of co-test shocks. Earlier testing found large particles because of general lack of attention on the part of vendors to produce clean parts, and these (.003 dia. gold ball and larger) are readily detected by either co-test shock means. As cleanliness provisions took hold, smaller and smaller particles had to be detected. When the particle mass approaches that of a .001 inch diameter gold ball, the simultaneous co-test shock method may outperform the perturbed vibration shock by 100%. At this time, a vendor with a perturbed vibration co-test shock machine may fail at a high rate if his customer is checking incoming parts on simultaneous vibration and co-test shock machine.

SIMULTANEOUS SHOCK DETECTS MORE PARTICLES

According to Newton's 1st law, a body in motion tends to stay in motion and a body at rest tends to stay at rest. B&W designed the optimum PIND system with a patented co-test shock apparatus that truly shocks simultaneously with vibration that keeps the smallest particles moving long enough to be detected, and a degaussing magnet to allow detection of ferrous particles that would otherwise be immobilized by the magnetic field of the shaker.

Unfortunately the MIL-STDs were changed to allow the inferior shock technique of a non-simultaneous shock ("perturbed"), allowing the shaker to stop, shock itself into its stops with a thud and resume vibration. Even the shock duration was changed to a non-standard reference to 50% of amplitude instead of 10% as with all other shock duration measurements. This technique allows smaller particles to re-adhere before the vibration resumes, is more destructive to the device under test by over-stressing it causing micro-cracks, compromising wire bonds and other latent mechanical defects, and ultimately breaks the shaker with costly repairs and downtime.

The shock is the single most important part of the PIND test to detect the smallest particles. Small particles have a very high resonance frequency, so a high frequency shock is the most effective at knocking them loose while stressing the device under test the least. One PIND manufacturer has made the claim that an isolated test at lower frequency, higher amplitude shock at 40% of device maximum was more effective (if you cannot shock simultaneously). This claim does not agree with facts or physics.

The highest frequency mechanical shock is generated by impacting harder materials at higher velocities. For the purposes of PIND testing the minimum shock pulse duration possible is about 50 microseconds. The MIL-STD used the < less than requirement intending to minimize the shock duration, there is no such thing as a Zero Time shock except in theory and it would have infinite Amplitude. This duration will extend naturally as mass is added, so the larger package's response to an identical shock to a smaller mass will be longer commensurate with the mass, material and geometries, creating what is referred to as the Transfer Function.

Newton's First Law

Law I: Every body persists in its state of being at rest or of moving uniformly straight forward, except in so far as it is compelled to change its state by forces applied.

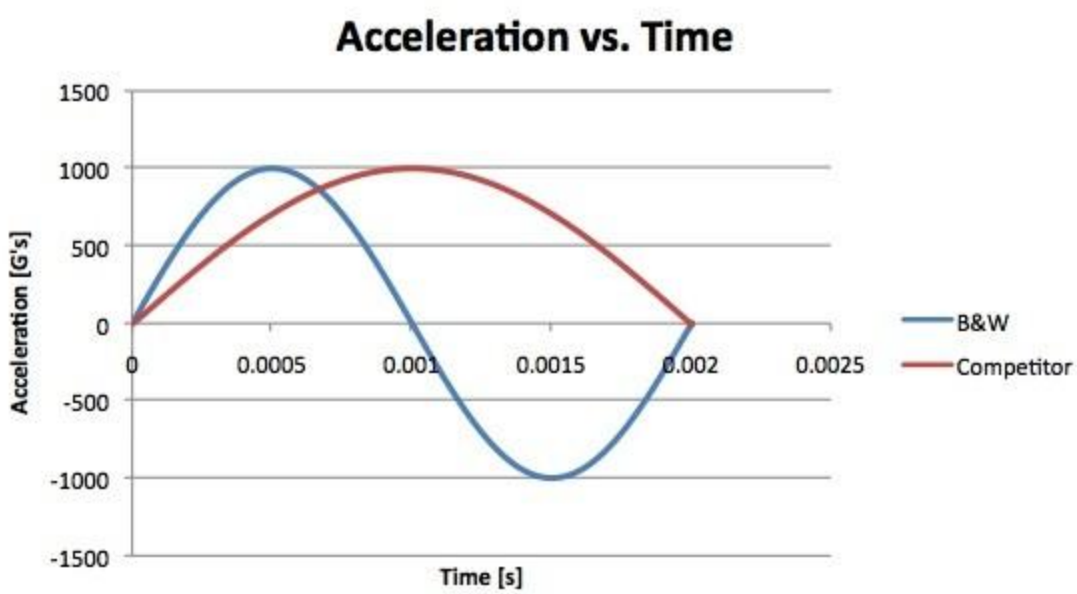
This law states that if the net force (the vector sum of all forces acting on an object) is zero, then the velocity of the object is constant. Mathematically stated:

$$\sum \mathbf{F} = 0 \Rightarrow \frac{d\mathbf{v}}{dt} = 0.$$

Consequently:

An object that is at rest will stay at rest unless an unbalanced force acts upon it.

An object that is in motion will not change its velocity unless an unbalanced force acts upon it.



Newton's Second Law

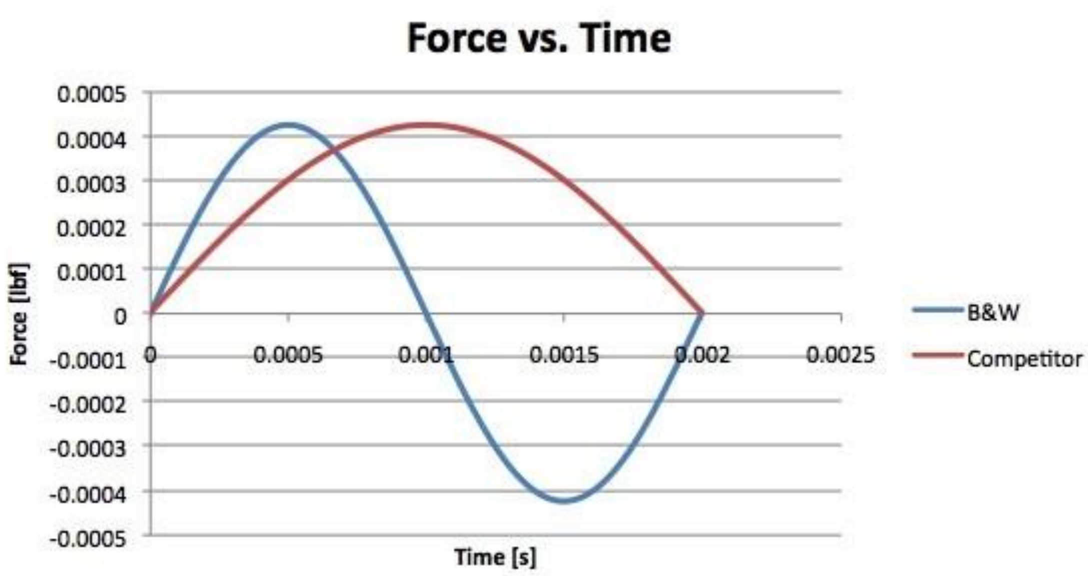
Law II: The second law states that the net force on a particle is equal to the time rate of change of its linear momentum p in an inertial reference frame:

$$\mathbf{F} = \frac{\mathrm{d}\mathbf{p}}{\mathrm{d}t} = \frac{\mathrm{d}(m\mathbf{v})}{\mathrm{d}t},$$

Where, since the law is valid only for constant-mass systems, the mass can be taken outside the differentiation operator by the constant factor rule in differentiation. Thus,

$$\mathbf{F} = m\,\frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t} = m\mathbf{a},$$

where F is the net force applied, m is the mass of the body, and a is the body's acceleration. Thus, the net force applied to a body produces a proportional acceleration. In other words, if a body is accelerating, then there is a force on it.



The Kinetic energy vs. Force remains constant given the same shock amplitude only over a shorter time period the Force vs. Time.

IMPULSE

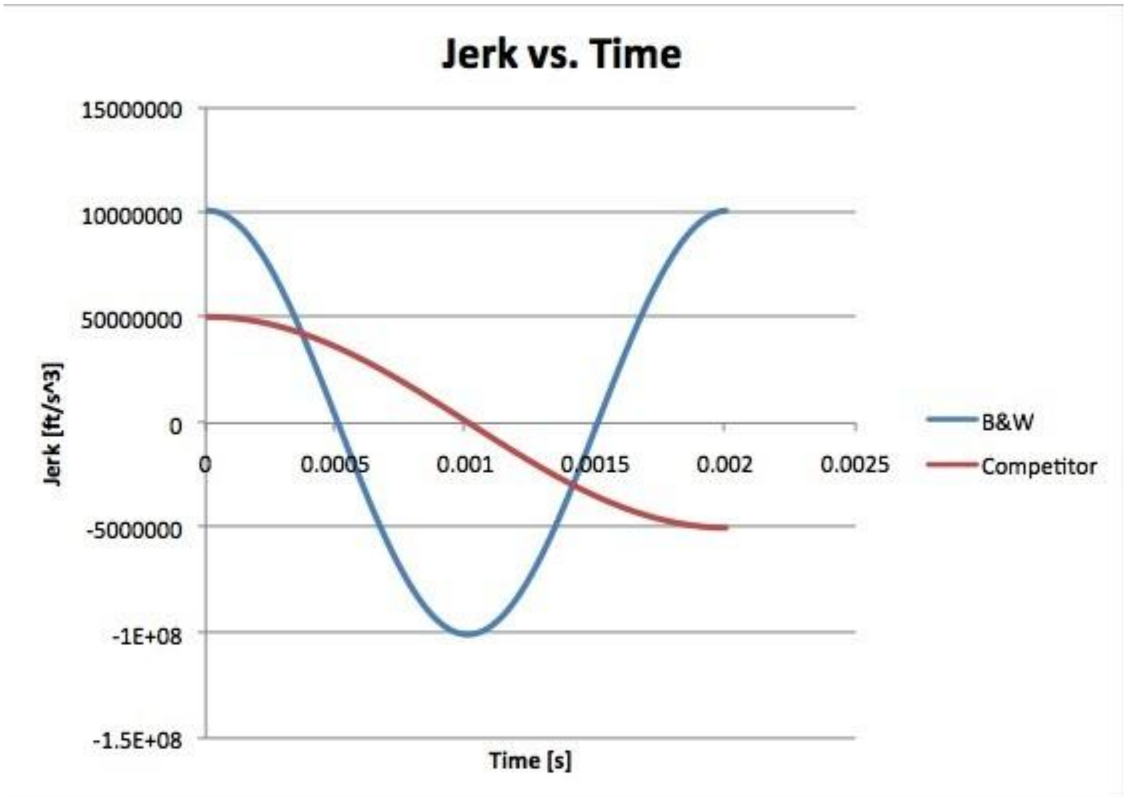
An impulse J occurs when a force F acts over an interval of time Δt, and it is given by

$$\mathbf{J} = \int_{\Delta t} \mathbf{F}\,\mathrm{d}t.$$

Since force is the time derivative of momentum, it follows that

$$\mathbf{J} = \Delta\mathbf{p} = m\Delta\mathbf{v}.$$

This relation between impulse and momentum is closer to Newton's wording of the second law. Impulse is a concept frequently used in the analysis of collisions and impacts.



This graph compares Acceleration Change over short time. As the time decreases the Velocity Change over time increases by a factor of 2, 1,000,000 ft/sec3 @ 50 microseconds vs. 500,000 ft/sec @ 100 microseconds.

These graphs show that the shorter duration reduces the energy applied (safer) while maintaining equal amplitude. A shorter duration shock is both more effective at knocking particles loose while reducing the stress applied to the device avoiding possible unintended consequences of micro-cracks or other latent failures caused by mechanical shock, a major source of failure for some devices, especially delicate MEMS, crystal oscillators, implantable medical devices, etc. Shocking these devices at 40% of design maximum 12 times per PIND test up to 5 times for a possible total of 60 shocks is clearly an unnecessary risk.

In summary, the higher change in velocity generates a more effective shock to loosen tiny particles and the simultaneous shock with vibration tends to keep them in motion according to Newton's 1st and 2nd laws.

SECTION 3

EQUIPMENT SET-UP PROCEDURE

Introduction

This User Manual provides instructions for setting up and using the BW-LPD-DAQ4000 Particle Impact Noise Detector (PIND) test system. Topics covered in this manual include the following:

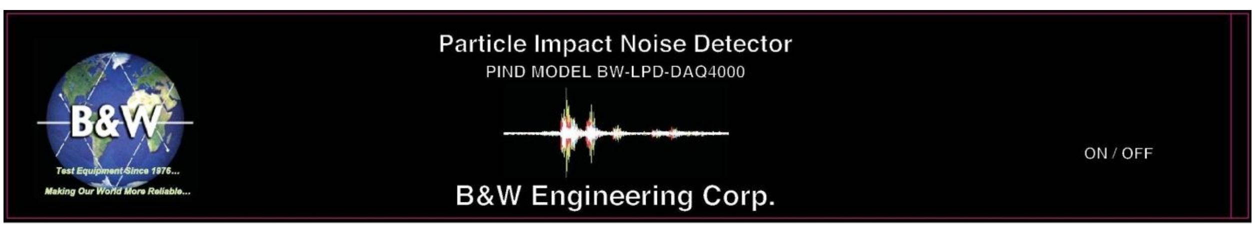
- Hardware Connections
- User Interface
- Operating instructions

Your system comes preconfigured from the factory with all hardware and required software installed on the included computer needed to conduct PIND testing. We recommend that this computer NOT be connected to your network during testing to avoid potential timing issues and operating system changes that could impact the performance of your PIND test system.

Each component has been calibrated at the factory for optimal performance. Should you have multiple PIND test systems at your location, it is imperative that the individual PIND test system components ***not*** be interchanged between PIND test systems. This will lead to an out-of-calibration condition and you could permanently damage your PIND test system components.

**There are two useful videos that you can access via our website:
1 – Bench Set-Up & 2 – Controller Set-Up

The system is turned on with a single switch on the Front Panel, then turn on the PC.



PIND Controller Front Panel

Hardware Connections

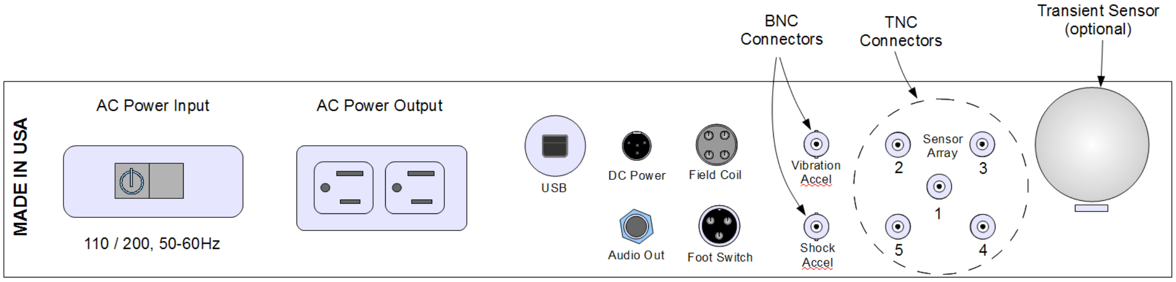


Figure 1 – PIND Controller Back Panel

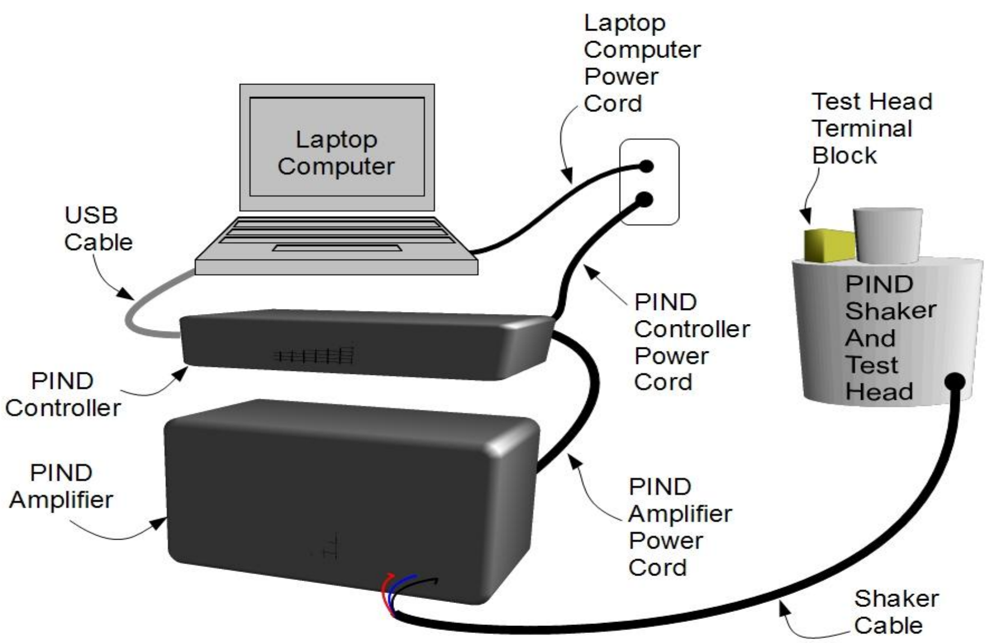


Figure 2 – PIND Test System Components

Follow the below procedure to make all PIND Test System interconnections.

a. Connect the USB cable from the PIND test system laptop computer to the USB “D” style connector of the PIND Controller. The USB cable is used to communicate with and control the PIND test system.

b. Connect the DC power cable to the PIND Controller back panel and to the Test Head Terminal Block.

c. Connect the Vibration Accelerometer cable to the BNC connector labeled *Vibration* Accel on the PIND Controller back panel and the BNC connector on the Test Head Terminal Block.

d. Connect the Sensor cable(s) to the TNC connector(s) labeled 1 – 5 on the PIND Controller back panel (Sensor Array) and the corresponding TNC connector(s) on the Test Head Terminal Block.

Note: *If you have a one sensor system, always connect your cable to the sensor 1 connections.*
In a two sensor system, connect your cables to connectors 1 and 2 ensuring each cable is paired correctly by the corresponding sensor number.
Otherwise, connect all five sensor cables ensuring each cable is paired correctly by the corresponding sensor numbers 1 – 5.

e. If your system uses an externally powered field coil, connect the field coil cable to the Field Coil connector on the PIND Controller back panel and to the external Field Coil Control Unit.

f. Connect the audio cable to the Audio Out connector on the PIND Controller back panel and to the Audio In connector on the back of the PIND Amplifier.

g. Connect the Foot Switch cable to the Foot Switch connector on the PIND Controller back panel and place the foot switch in a convenient location for user comfort. The foot switch is used to initiate a PIND test. It can also be used to interrupt a test in progress.

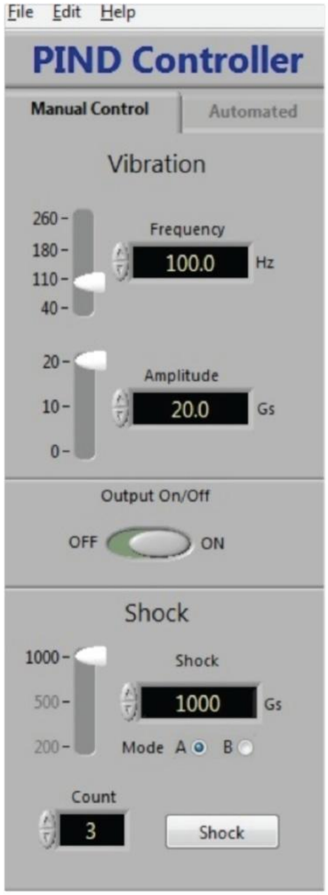
h. Ensure the front and back panel power switches are in the off position on the PIND Controller. Connect the AC power cord of the PIND Controller to a clean 110 Volt AC power source then turn on the power switch on the back panel of the PIND Controller.

i. Connect the AC power cord from the PIND Amplifier to one of the available AC Power Outputs on the back panel of the PIND Controller. This allows the user to energize both the PIND Controller and PIND Amplifier by toggling the front panel power switch on the PIND Controller.

SECTION 4

OPERATING PROCEDURE

PIND CONTROLLER MANUAL MODE



The versatile Manual Mode is useful for experiments and can apply a vibration frequency sweep (to find resonances that make particle type noise) and apply shocks simultaneous with or without vibration. The shock level, count and application can be chosen. In Manual Mode the user has complete control over Vibration frequency and acceleration level and the shock.

1. Turn the ON/OFF switch to “ON” mode on the BW-USB-DAQ4000 Particle Impact Noise Detection Interface.

2. Next turn on the PC and launch the BW-LPD-DAQ4000 program by double clicking on the B&W icon.

3. In order to perform the Detection System Analysis, locate the three components which comprise the BW-012 Sensitivity Test Unit (STU). There is an Auto Test named “STU TEST” in the PIND/Files Folder. Select this test.

(a) Once “START” is clicked you will have several seconds to perform the test as follows:
(b) Verify the THRESHOLD LEVEL to select the desired threshold level (15 millivolts per MIL-STDs)
(c) Connect the BW-155 Ultrasonic Transducer to the BW-012 Power Supply via the BW-012 Cable.
(d) Attach the faces of the Ultrasonic Transducer and the BW-004 PIND Shock Test Fixture transducer using an appropriate coupling medium.
(e) Rotate the voltage adjust knob until the display reads "250."
(f) Momentarily depress the MICRO pushbutton several times.
(g) When the switch makes contact, verify that:
(1) The red FAIL lamp illuminates. (Use the RESET pushbutton to turn off the lamp.)
(2) The oscilloscope display exhibits a >20mVP deflection in the system noise.
(3) The noise has a temporary volume increase.
(h) If all of these criteria are satisfied, then the Detection System Analysis is complete. Use footswitch or START to reset.

If you are going to run an automated test, select the auto test file from the PIND\files folder.

4. If the Transient Detector is both present and desired, perform the same test on the TRANSIENT SENSOR on the back panel of the BW-USB-DAQ4000 and observe YELLOW INF display on PIND screen.

5. The magnitude of the vibration is presented on the ACCELERATION display in G. Adjust the ACCELERATION CONTROL virtual knob to attain the suitable vibration amplitude. The vibration may be promptly discontinued by depressing and holding the footswitch; it will resume upon release of the switch.

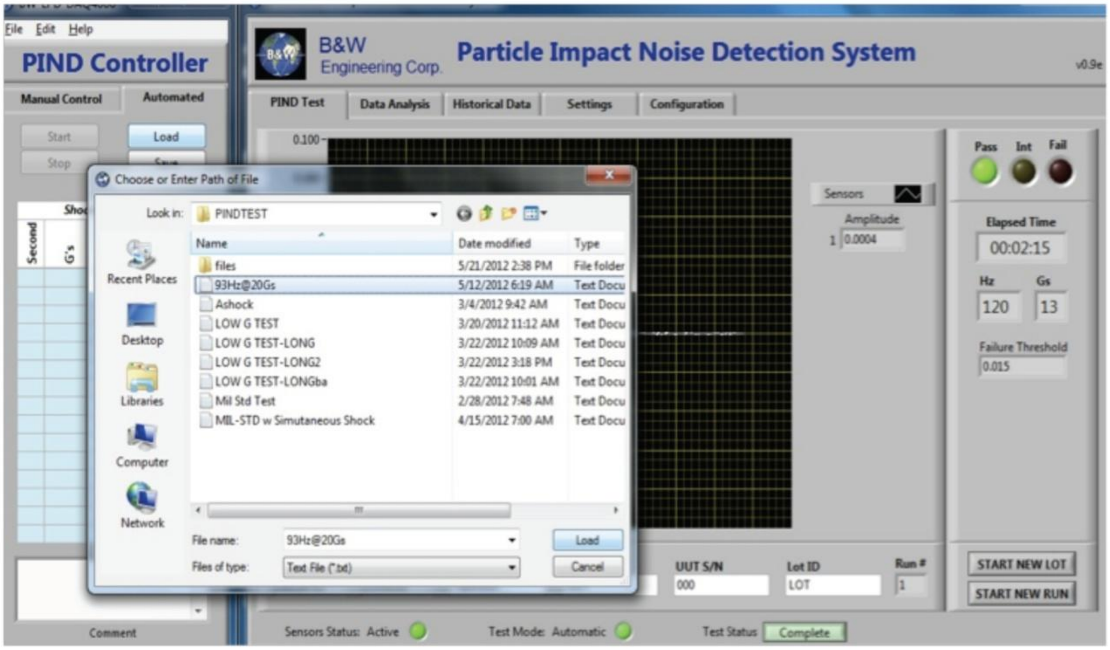
   CAUTION: Do <u>not</u> exceed 10 G for frequencies below 40 Hz or 22 G overall. Shaker damage may result.

6. With the footswitch depressed (to impede the vibration), the device to be tested (DUT) may be attached to the Shock Test Fixture platen. The two recommended attachment mediums for small test devices are 50A4084 Ultrasonic Couplant and BW-TD-085 Ultrasonic Tape Dots. The BW-004A Clamp for BW-004 Test Fixture is recommended for larger or unusual shaped devices.

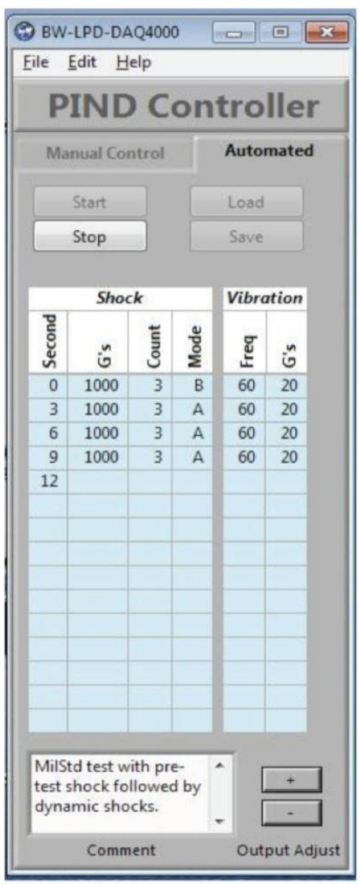
7. For manual shock sets,
   (a) Click the MANUAL SHOCK pushbutton.
   Manual shock sets may be dispensed at a rate of one per system clock cycle. This cycle is factory-preset to one second unless otherwise noted or user adjusted and ranges between one-quarter and four seconds.
   (b) Select the number of shocks per set. This quantity is displayed by the "COUNT" display and may be adjusted 1-4.
   (c) The OUTPUT ON/OFF button or footswitch can be used to suspend the vibration and detection at any time. The vibration may also be stopped by reducing the ACCELERATION control until 00.0 is displayed.

AUTOMATED PIND TESTS PROCEDURE

Select a file from the Automated LOAD screen or create a new PIND test routine on this screen.



To write a new TEST PROCEDURE follow the diagram below. To change just the frequency it is not necessary to write a new test, just change the frequency and save with new name.



Or you can make the following selections below:

Example 1:

SAVE: Opens a file save dialog box
LOAD: Opens a file open dialog box

Parameter Limits:

Shock:
G's – 200, 500, 100
Count – 1,2,3,4
Mode – A, B

- Mode A Shock is simultaneous with vibration.
- Mode B Shock stops the vibration briefly (<250 milliseconds).

Vibration:
Frequency – 40 – 260Hz in 1Hz increments
G's – 0 – 20Gs in .1G increments

Example 2:

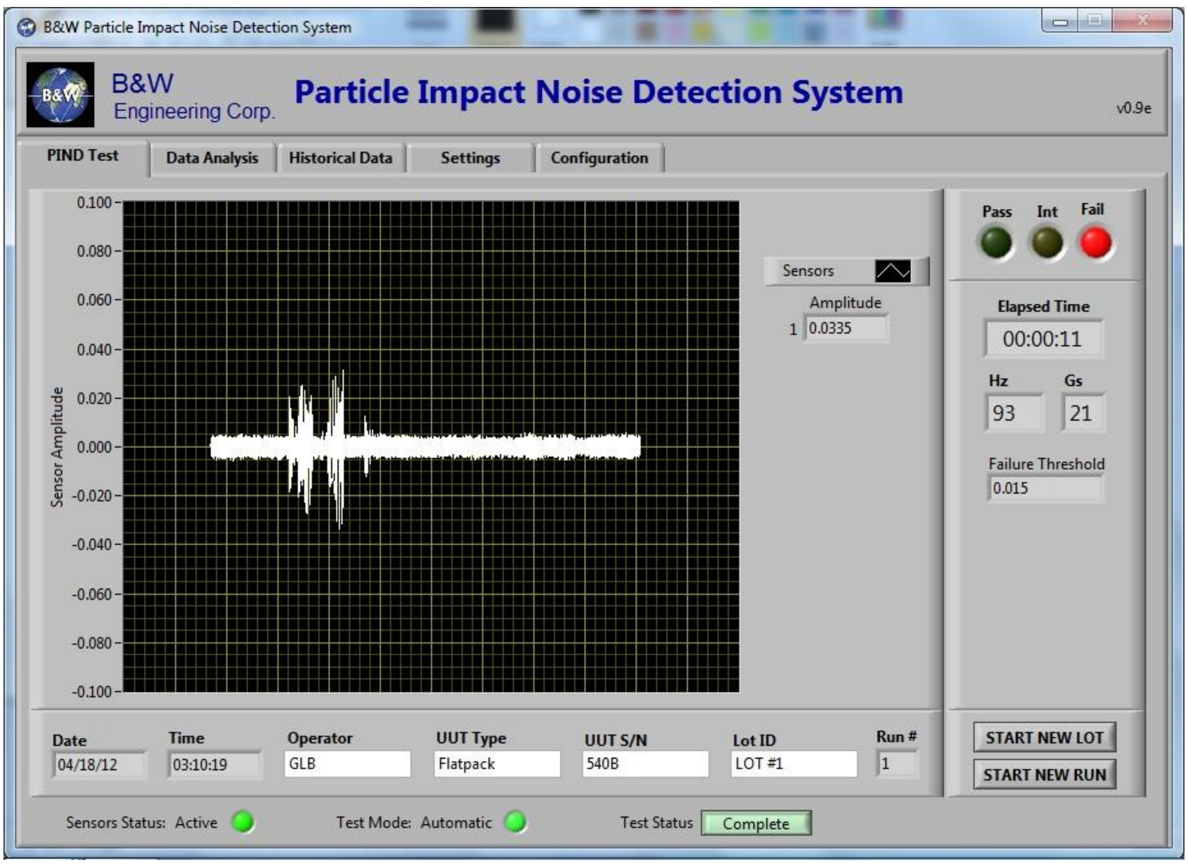
- When configured with solenoid shock, use shock mode B in first step to administer pre-shock.
- When configured with solenoid shock, all shock will be administered at the same pre-calibrated G force; typically 1000 G's.
- A Value of 0 (zero) for Vibration G's terminates a test.
- Vibrations entry is not allowed for any step without a second (left column) entry.
- Unless left blank, step times must be increased by at least one second for each entry.
- When using the armature, the behavior is the same as mode B.
- Unless muted, vibration is continuous (same Hz and G's) until the next vibration step is executed.

User Interface

The **PIND** Software graphical user interface is comprised of the following screens:

- **The PIND Test** screen provides a user interface for the PIND test operator
- **The Data Analysis** screen provides a user interface for real-time accelerometer and sensor data analysis
- **The Historical Data** screen provides a user interface for the analysis of historical data collected during the PIND tests
- **The Settings** screen provides user interface for system configuration

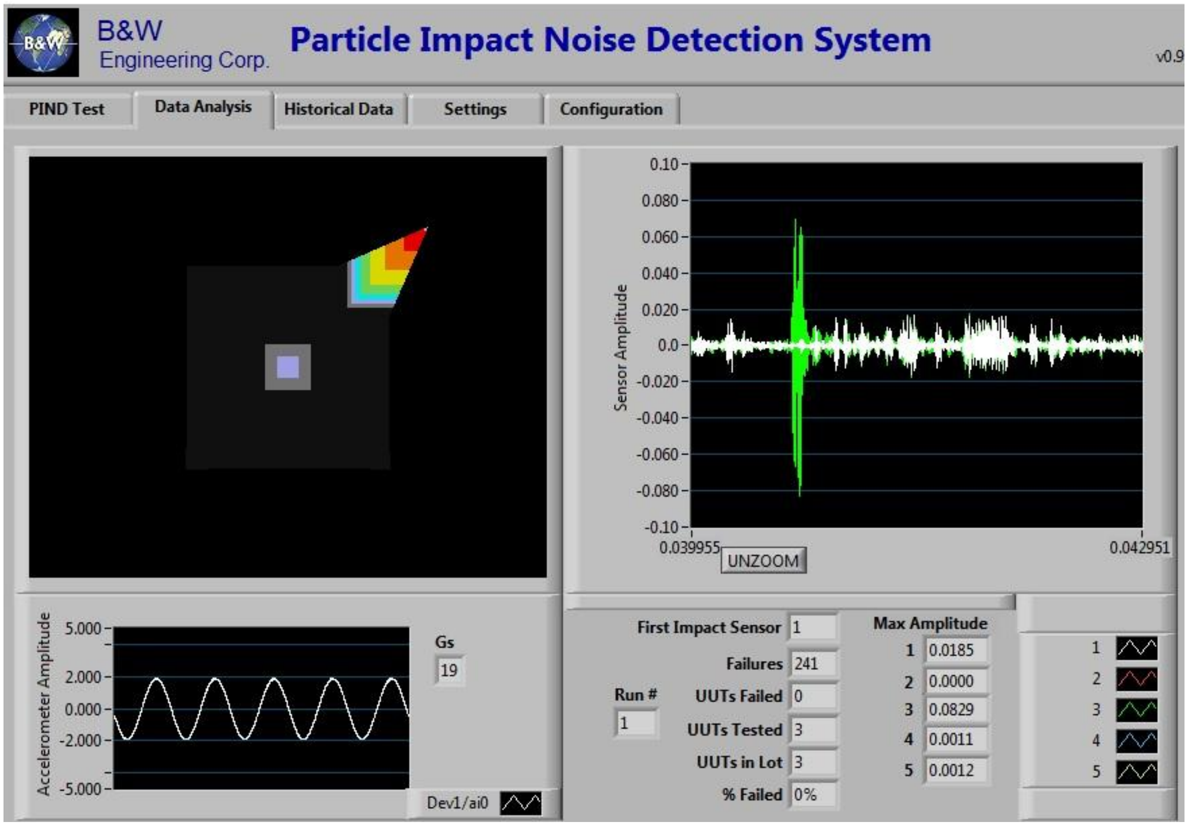
PIND Test Screen



The PIND Test Screen features the following controls and indicators:

- XY Graph – Similar to an oscilloscope in XY mode where the Accelerometer amplitude is mapped to the X axis of the graph and the Sensors amplitude is mapped to the Y axis of the graph.
- Date Indicator – Displays the calendar date of the PIND test
- Time Indicator – Displays the beginning time of the PIND test
- Operator Control - Optional PIND Test operator name (by default is set to "XXX")
- UUT Type Control – Optional UUT type (by default is set to "UUT")
- UUT S/N Control – Optional UUT serial number (by default is set to "000")
- Lot ID Control – Optional LOT ID (by default is set to "LOT")
- Run # Indicator – Displays the current Run number
- Amplitude Limit Indicator – Displays the currently set sensor amplitude limit value (Volts)
- Max Amplitude Indicators – Display the current amplitude readings for particle sensors (Volts)
- Elapsed Time Indicator – Display the elapsed PIND test time (Seconds)
- Acceleration Indicator – Displays the current acceleration of the shaker (G
- Frequency Indicator – Displays the current frequency of the shaker (Hz)
- Fail LED Indicator (Red) – Lights if the PIND Test fails
- Pass LED Indicator (Green) – Lights if the PIND Test passes
- Int LED Indicator (Yellow) – Lights if interference is detected during the PIND test
- Start New Lot Button – If clicked starts a new LOT test sequence
- Start New Run – If clicked, increments Run number

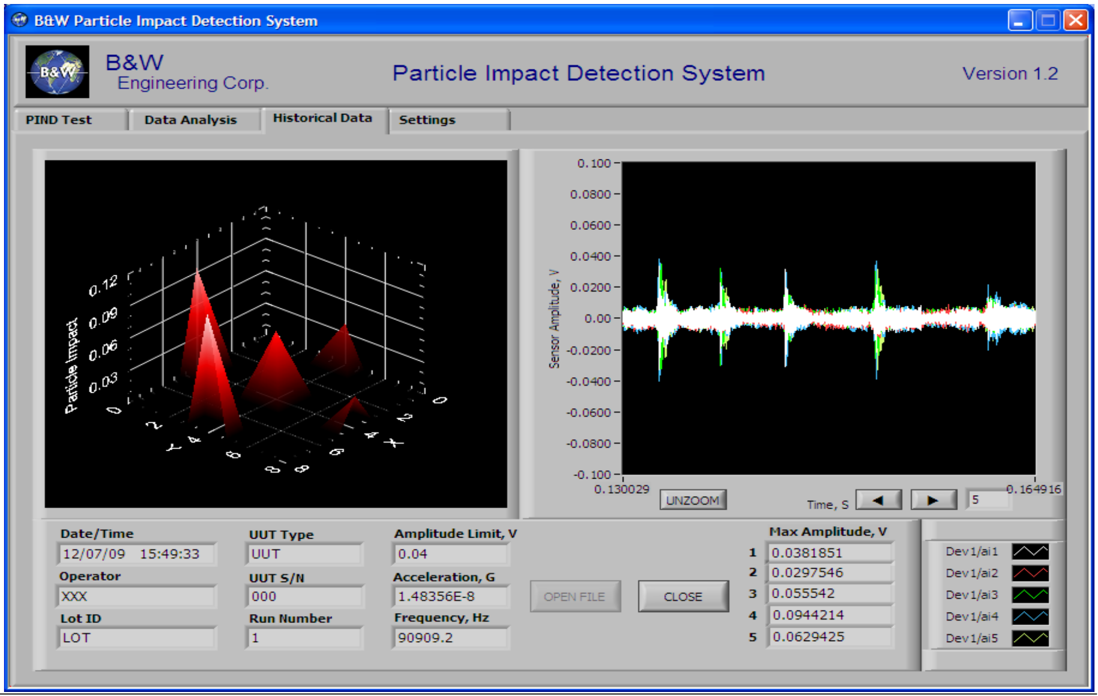
Data Analysis Screen



The Data Analysis Screen features the following controls and indicators:

- Particle Impact Graph – 3D particle impact real-time data
- Accelerometer Amplitude Graph – Accelerometer real-time data
- Acceleration Indicator – Displays the current accelerometer readings in volts (this data is used to calibrate the accelerometer)
- Amplitude Indicator – Displays the current accelerometer amplitude reading
- Sensor Amplitude Graph – Real-time amplitude data from 5 particle sensors
- Failures Indicator – Displays the number of failures occurred during the current PIND test
- UUTs in LOT Indicator – Displays the calculated number of UUTs in LOT
- UUTs Tested Indicator – Displays the current number of tested UUT
- UUTs Failed Indicator – Displays the number of UUTs failed during the current PIND test
- Max Amplitude Indicators – Displays the real-time amplitude readings from 5 sensors

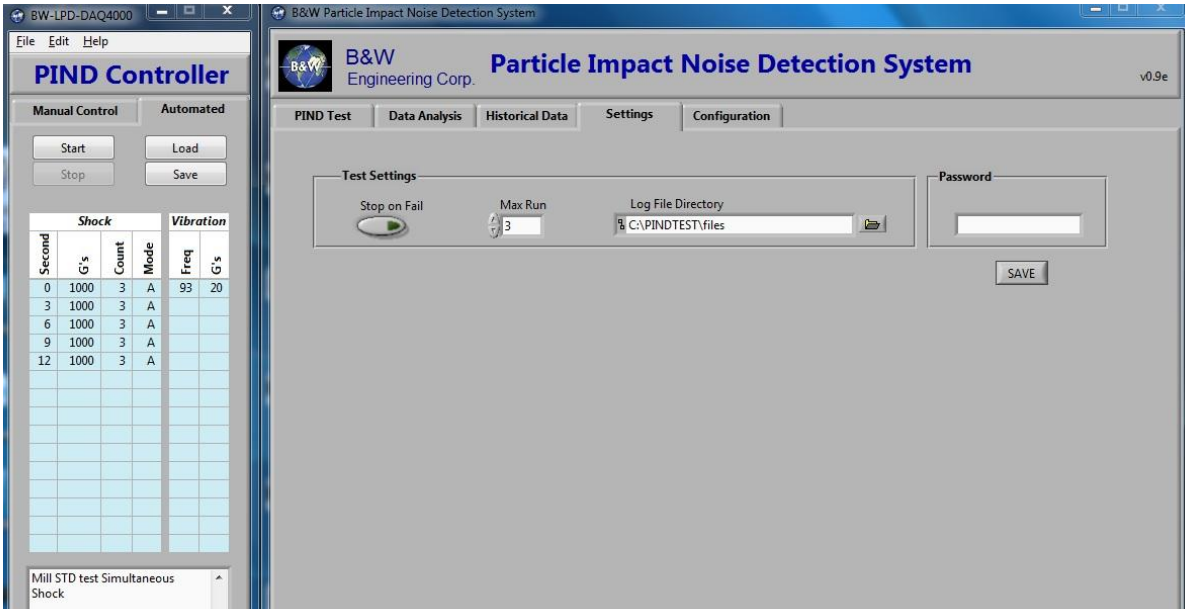
Historical Data Screen



The Historical Data Screen features the following controls and indicators:

- Open File Button – When clicked, opens a dialog box with a list of data files
- Close Button – When clicked, closes the currently opened data file
- Sensor Amplitude Graph – Displays time domain sensor data from the chosen file
- Next and Previous Buttons (on Sensor Amplitude graph) – Navigate to the next or previous data
- Particle Impact Graph – 3D particle impact data that corresponds to the Sensor Amplitude graph
- Max Amplitude Indicators – Displays the maximum sensor amplitude for the chosen data
- Date/Time Indicator – Displays the date and time of the PIND test Operator indicator – displays the name of the PIND test operator LOT ID indicator – displays the LOT ID of the PIND test
- UUT Type Indicator – Displays the UUT type of the PIND test
- UUT S/N Indicator – Displays the S/N of the UUT
- Run # Indicator – Displays the Run number
- Amplitude Limit Indicator – Displays the amplitude limit setting for the selected PIND test
- Acceleration Indicator – Displays the shaker acceleration for the selected PIND test
- Frequency Indicator – Displays the shaker frequency for the selected PIND test

Settings Screen

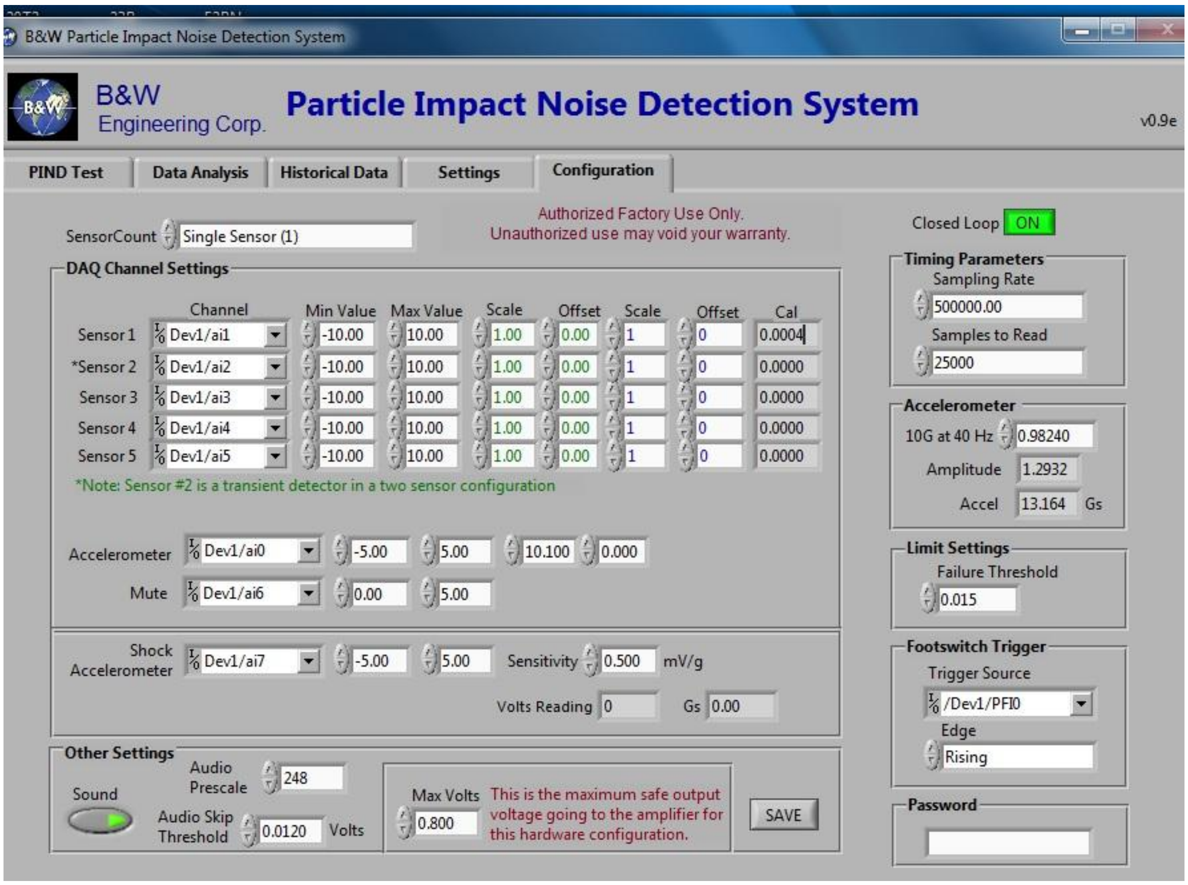


DAQ Channel Settings Controls （DAQ Card setting parameters）

- In the Settings Screen is the “Stop on Fail button” which ends the automatic test if a detection above the threshold is received
- The maximum number of Runs can be selected
- Shows the Log File Directory location
- The user can enter a password to protect access to the screen

Configuration Screen

The configuration screen is password protected to prevent inadvertent changes to the system and its' calibration. This screen should only be accessed by B&W personnel or other trained technicians for the calibration of this system.



- Channel List Box – A list of DAQ analog channels to choose from
- Min Value – Expected minimum value for the acquired data (Volts)
- Max Value – Expected maximum value for the acquired data (Volts)
- Scale – Configurable gain for the selected channel (default value = 1)
- Offset – Configurable offset (Volts) for the selected channel (default value = 0)
- Mute Line List Box – DAQ channel used for PIND Mute line monitoring

Test Settings Controls (PIND Test setting parameters)

- Sound Switch – If selected, the sound alarm will be generated on a PIND test failure
- Stop on Fail Switch – If selected, the data acquisition will stop 3 seconds after a failure is detected during the PIND test
- Test Time – Duration of the PIND test (in seconds)
- Run # - Maximum number of Runs during the PIND test sequence
- File Directory – File directory where PIND files are located

Timing Parameters controls (Data Acquisition timing parameters)

- Sampling Rate – data acquisition sampling rate (Samples per second)
- Samples to Read – number of samples per buffer during the data acquisition (Samples)

Accelerometer controls (Accelerometer settings)

- 10G @ 40 Hz acceleration – accelerometer reading when the shaker is operating at 10G @ 40 Hz, used for calibration of the accelerometer

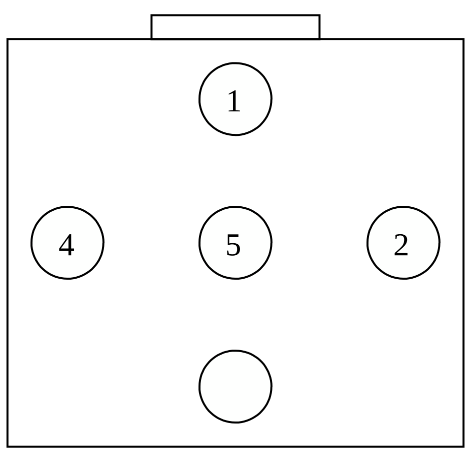
Limit Settings control – sensor amplitude limit value (Volts)

Footswitch Trigger control (Settings for footswitch interface)

- Source – selects the DAQ line mapped to the footswitch
- Edge – selects the edge (Rising or Falling) of the footswitch trigger signal when the footswitch is released

Sensors and DAQ Card Channels

The Particle Impact Sensors are located on the PIND sensor plate as follows:



The sensors and control lines are mapped to the DAQ card channels as follows:

Sensor	DAQ Card Channel
Accelerometer	ai0
1	ai1
2	ai2
3	ai3
4	ai4
5	ai5
Transient Detector	ai6
Mute Line	ai7
Footswitch	PF10

The DAQ card channels are configured using the *DAQ Channel Settings* controls on the *Settings* Tab.

A unique DAQ channel must be selected for each Particle Impact sensor (1 to 5), the Transient sensor, the Accelerometer and the MUTE Signal. The valid DAQ channel names are *ai0* to *ai7*.

There are several parameters that can be configured for seven of the eight channels.

For the Particle Impact sensor channels, the user could define the corresponding *Min value* (Volts), *Max value* (Volts), *Scale* coefficient and *Offset* (Volts). The *Scale* coefficient is the gain value for the channel and the *Offset* is the positive or negative voltage offset.

The Sensor Amplitude values are calculated as follows:

*Amplitude = Measured Amplitude * Scale + Offset.*

This step is not required if the sensor amplifiers are properly calibrated.

For the Transient Sensor and Accelerometer channels, the user can define the corresponding *Min* value (Volts) and *Max* value (Volts).

One of the DAQ card channels is used for the PIND device Mute Line monitoring. The *Mute Line* (output from the DB-9 connector on the rear panel of the PIND device) needs to be monitored in order to mute the sensor channels during the shocker operation.

Limit Settings

The PIND test status will be determined by comparing the acquired particle sensor amplitude values with the limit value defined by the *Limit Settings Amplitude* control on the *Settings* Tab.

Footswitch Trigger Settings

The PIND test is activated by the operator using a footswitch hooked up to PIND System. The DAQ card trigger input must be properly configured to be associated with the corresponding line of the DB-9 connector located on the back panel of the PIND System.

The *Source* control defines the DAQ card trigger line (by default it is set to PFI0).

The *Edge* control makes it possible to set trigger on either Rising or Falling edge (default value is Rising edge).

Test Settings

The *Test Time* control is used to define the test time of the PIND system in seconds (the default value is 12 sec).

The *Run #* control is used to define the maximum test sequence Run number of the PIND system (the default value is 1).

The *File Directory* control defines the location of the data directory where the PIND data files will be stored.

The *Stop on Fail* switch defines how long the PIND test runs after a failure is detected. If the switch is set to the "OFF" position, a failure doesn't impact the test time interval. If the switch is set to the "ON" position, the PIND test will stop 3 seconds after a failure is detected.

Accelerometer Settings

The *10G @ 40 Hz Acceleration* control is used to calibrate the Accelerometer channel.

Calibration procedure:

- Set the PIND system to 10G acceleration and 40 Hz frequency
- Run the PIND test
- While the PIND test is running, switch to *Data Analysis* screen and copy the value displayed in *Acceleration* indicator then paste the value to the *10G @ 40 Hz Acceleration* control located on the Settings screen, then click on *SAVE* button to save the value

Timing Parameter Settings

Sampling Rate control is used to set the DAQ sampling rate (Samples per second).

Samples to Read control defines the number of samples to read per iteration.

PIND Test

The following explains the PIND Test procedure:

1. Verify that the PIND system and the PIND software are up and running
2. Verify that the PIND software is configured properly
3. Switch to PIND Test screen
4. If needed, fill in the optional Operator, UUT Type, UUT S/N and Lot ID fields
5. Install the Unit Under Test (UUT) on the PIND system shaker head and verify that the UUT is installed correctly
6. Start the PIND test using footswitch
7. Wait until the test is finished. The PIND Test screen LED indicators will indicate the PIND test status (PASS, FAIL or Interference detected during the test)
8. Repeat steps 5 – 8 for each UUT

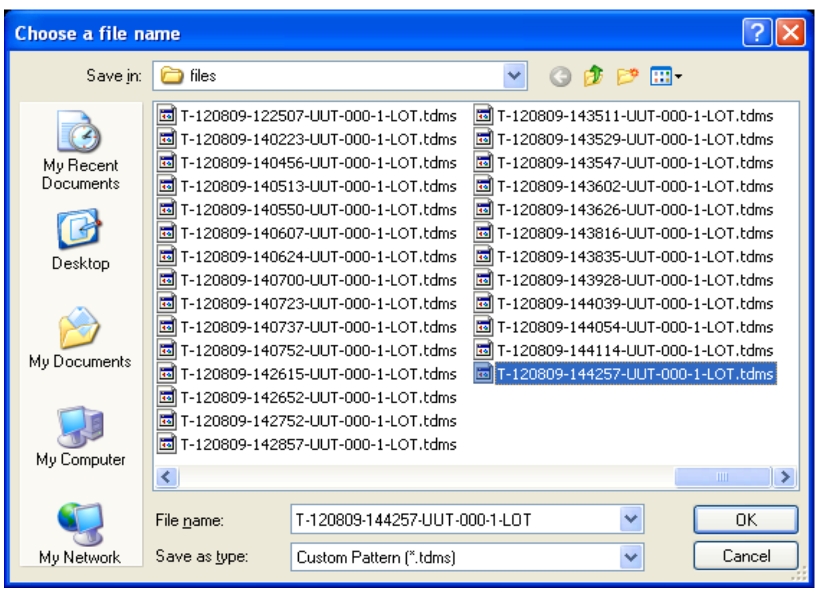
Data Analysis

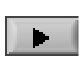
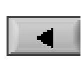
If a failure has occurred during the PIND test the acquired PIND data is recorded to data files in TDMS file format. The TDMS files are located in the specified PIND file directory and have the following naming convention:

T-<Date>-<Time>-<UUT Type>-<UUT S/N>-<Run #>.TDMS

The following explains how to work with PIND data files:

1. Verify that the PIND software is up and running
2. Switch to *Historical Data* screen
3. Click *Open File* button to open a historical data file
4. Using the popup dialog box, choose the corresponding PIND data file:



5. Using the  (*Next*) and  (*Previous*) buttons located on the Sensor Amplitude graph, navigate to the desired particle impact waveform
6. Zoom operation could be performed on waveform graph using the left mouse button. Use the *Unzoom* button to undo the zoom
7. When data analysis is done, click on the *Close* button to close the file

<u>Log Files</u>

The PIND Test results are always recorded to log files. The log files are located in the specified PIND file directory and have the following naming convention:

LOG-<Date>-<LOT ID>.csv

The LOG files have Comma Separated Values (CSV) format supported by spreadsheet applications such as Microsoft Excel.

For each PIND test one new record is added to the LOG file in the following format:
<Date>,<Time>,<Operator>,<UUT Type>,<UUT S/N>,<Run #>,<PIND Test Status>

The comma separated LOG record fields are as follows:

- Date – PIND Test date
- Time – PIND Test time
- Operator – PIND Test operator name
- UUT Type – Type of the Unit Under Test
- UUT S/N – Serial Number of the Unit Under Test
- Run # - PIND Test Run Number
- PIND Test Status – PASS or FAIL

Sample Test Report

PARTICLE IMPACT NOISE DETECTION
TEST LOG

DATE TESTED:	09/05/12
OPERATOR:	Operator
UUT TYPE:	UUT
LOT ID:	LOT
SYSTEM S/N:	123
VIB ACCEL S/N:	23
SHOCK ACCEL S/N:	25
SENSOR(S) S/N:	21
RESULTS LOG:	LOG-090512-LOT.csv

	RUN 1	
	PASS	FAIL
S/N	50%	50%
000	x	
001		x
002	x	
003		x
004	x	
005		x
TOTAL	3	3

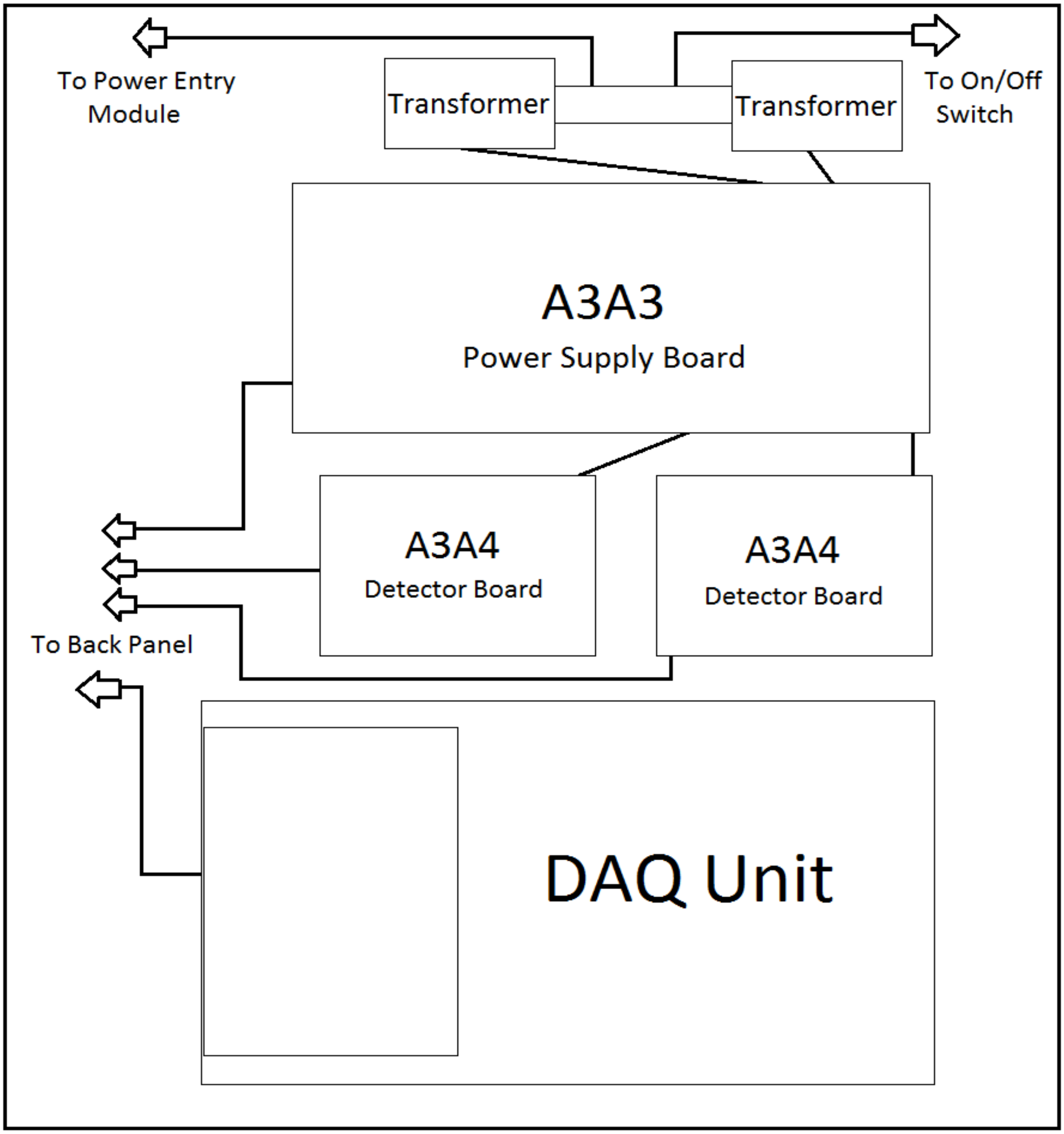
SECTION 5

BW-USB-DAQ4000 CHASSIS

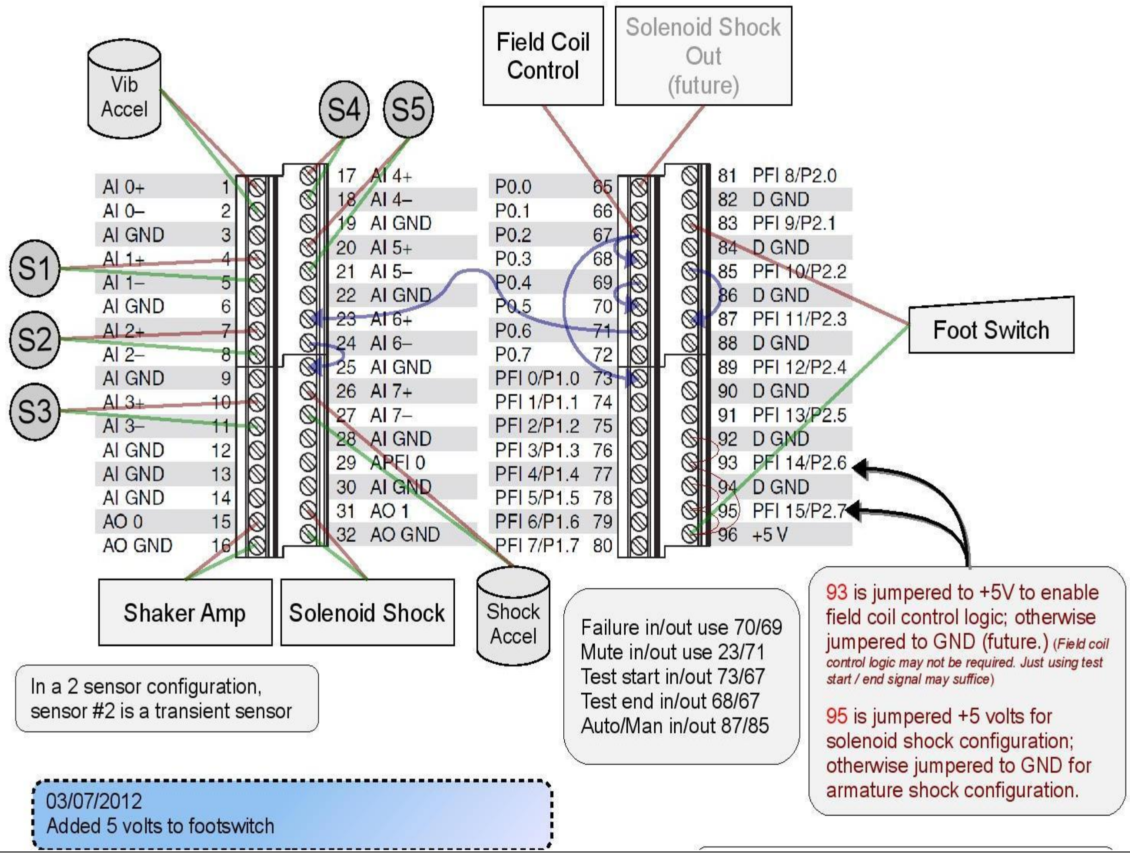
BW-LPD-DAQ4000: Parts List

Item ID	Component Description	Units
1/4IN MONO PHONE CONNECTOR	Mono Phone Connector (**Sine Out**)	1
10/32 SHOCK ACCEL CONNECTOR	10-32 micro jack to solder terminal (**Shock Accel**)	1
10CK3	Power Entry Module (**AC Power Input**)	1
3 PIN MALE RECEPTACLE	3 Pin Male Receptacle (**Foot Switch**)	1
4 PIN MALE RECEPTACLE	4 Pin Male Receptacle (**DC Power**)	1
A3A3 DAQ4000	Stuffed A3A3 Board for the DAQ4000.	1
A3A4 DAQ4000	Stuffed A3A4 for the DAQ4000	1-5
BACKWIRE OUTLET	20A 125V Backwire Outlet (**AC Power Output**)	1
BNC CONNECTOR 50 OHM	Bulkhead Jack RF Connector (**Vibration Accel**)	1
DAQ4000 CHASSIS	Chassis for the BW-LPD-DAQ4000	1
NAUSB-W	Feed Through USB 2.0 (**USB**)	1
NI USB-6356, X-SERIES DAQ	National Instruments DAQ Unit	1
NKUSB-1	Locking USB Cable 1m	1
ON/OFF 15A 125-250V	ON/OFF Switch	1
P8180	Transformer	2
TNC CONNECTOR	TNC RF Connector (**Sensor Array**)	1-5
TRANSIENT DETECTOR	Transient Detector (**Optional**)	1

BW-USB-DAQ4000 Chassis Block Diagram



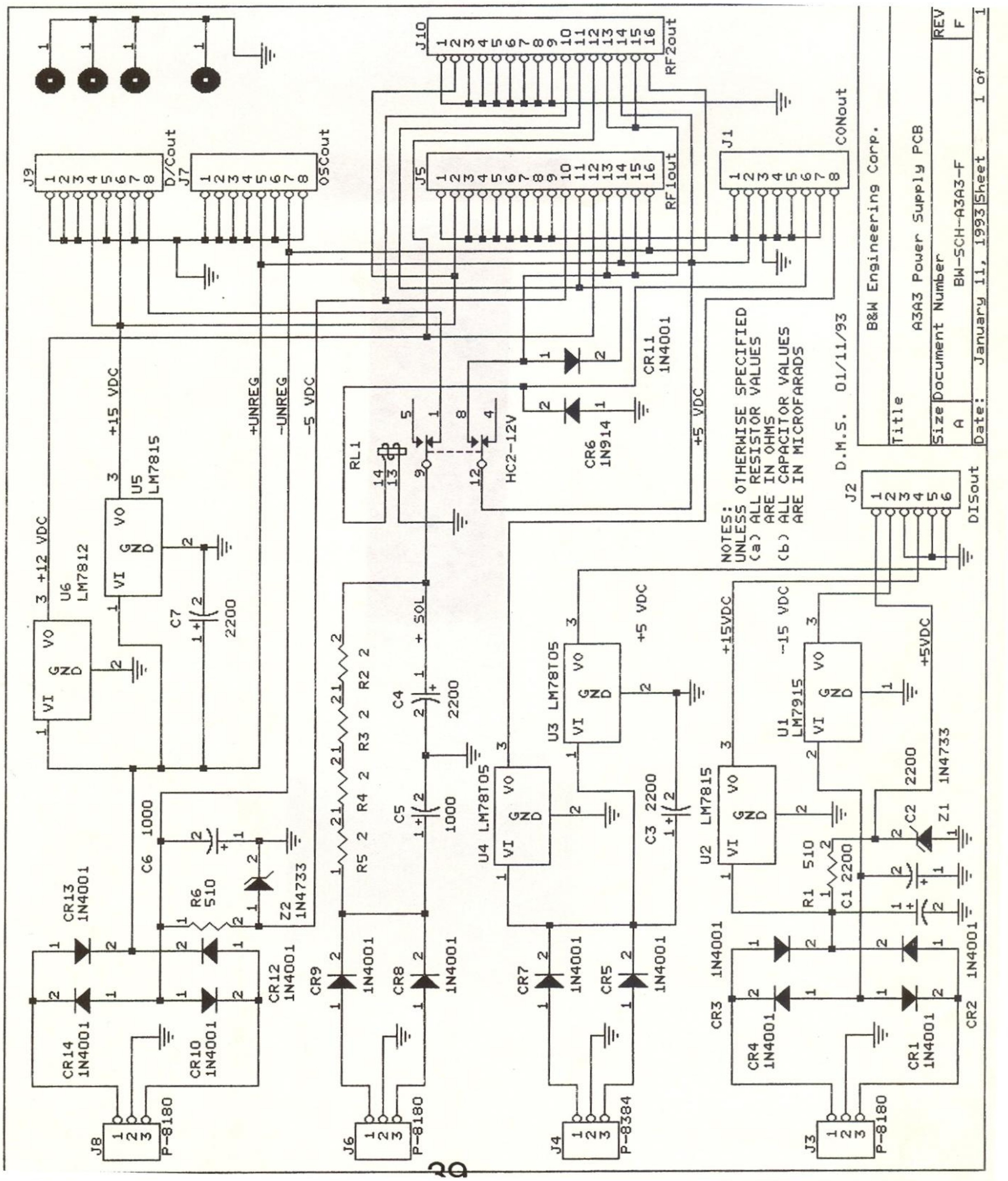
<u>**USB Wiring Diagram**</u>



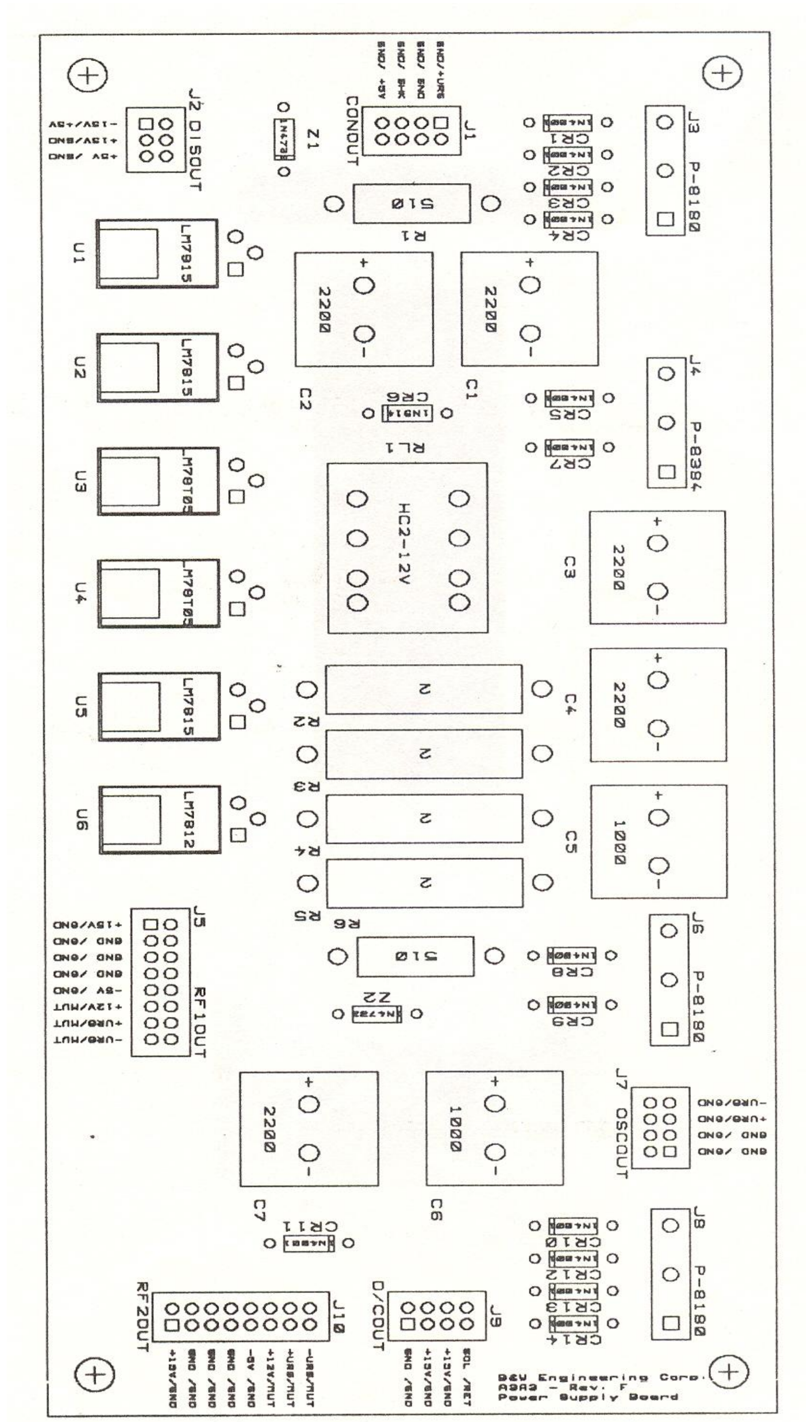
SECTION 6

A3A3
POWER SUPPLY PCB

A3A3 SCHEMATIC



A3A3 PARTS LOCATION



A3A3 PARTS LIST

CIRCUIT BOARD ASSEMBLY A3A3 REV. F

REFERENCE DESIGNATOR	DESCRIPTION
A3C1	Electrolytic Cap., 2200 MFD, 25V Rad.
A3C2	Electrolytic Cap., 2200 MFD, 25V Rad.
A3C3	Electrolytic Cap., 2200 MFD, 25V Rad.
A3C4	Electrolytic Cap., 2200 MFD, 25V Rad.
A3C5	Electrolytic Cap., 1000 MFD, 25V Rad.
A3C6	Electrolytic Cap., 1000 MFD, 25V Rad.
A3C7	Electrolytic Cap., 2200 MFD, 25V Rad.
A3CR1 To CR5	Diode, 1N4001
A3CR6	Diode, 1N4148
A3CR7 To CR14	Diode, 1N4001
A3Z1 And Z2	Zener Diode, 5.1V, 1N4733A
A3U1	Integrated Circuit, MC7915ACT
A3U2	Integrated Circuit, MC7815ACT
A3U3	Integrated Circuit, MC78T05ACT
A3U4	Integrated Circuit, MC78T05ACT
A3U5	Integrated Circuit, MC7815ACT
A3U6	Integrated Circuit, MC7812ACT
A3R1	Resistor, 510Ω, 1 W
A3R2 To R5	Resistor, 1.5Ω, 5 W*
A3R6	Resistor, 510Ω, 1 W
A3RL1	Relay, DPDT, HC2-HP-DC12VDC
A3J1	Strip Header, DIP, 8 Position
A3J2	Strip Header, DIP, 6 Position
A3J5	Strip Header, DIP,16 Position
A3J7	Strip Header, DIP, 8 Position
A3J9	Strip Header, DIP, 8 Position
A3J10	Strip Header, DIP,16 Position

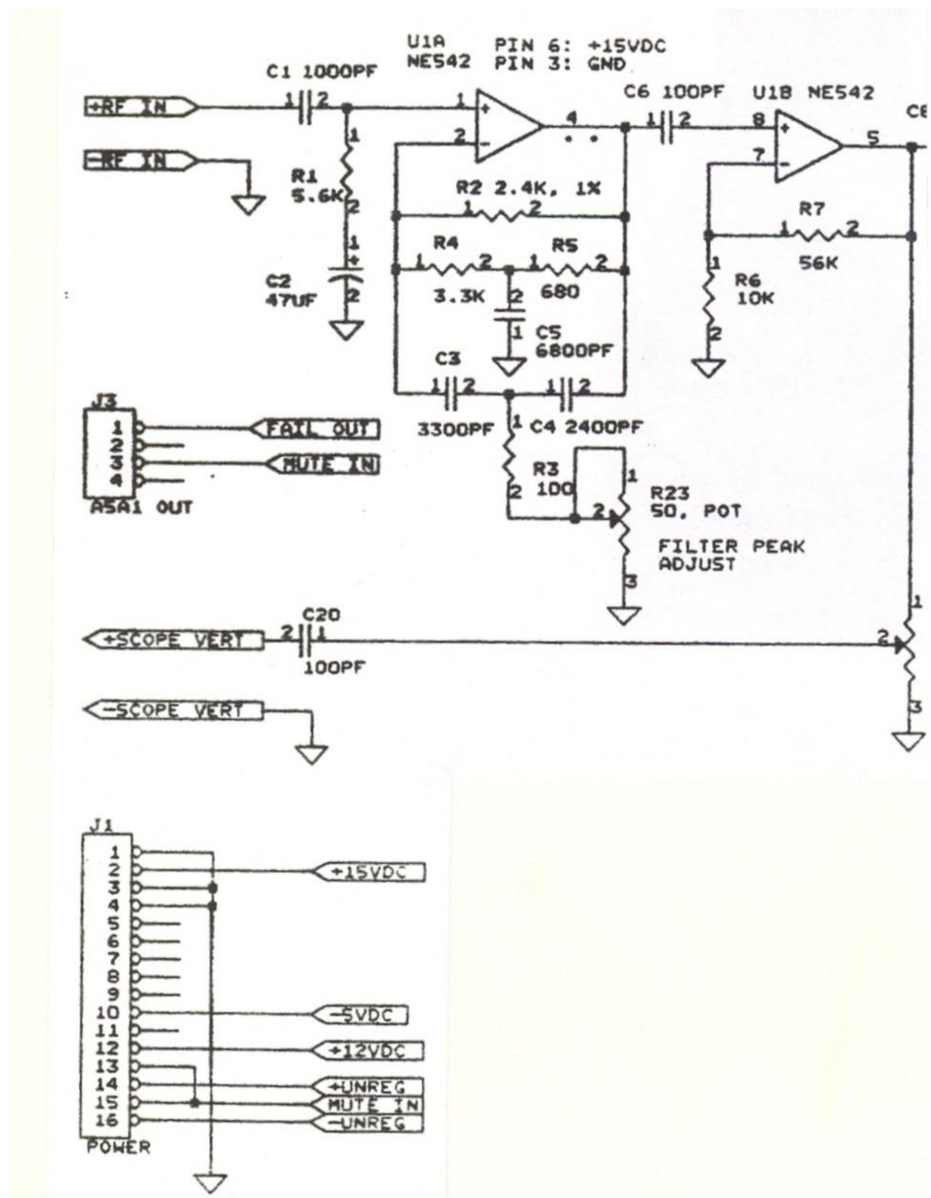
* May be 2.0Ω, 5W

Rev. 08/01/12

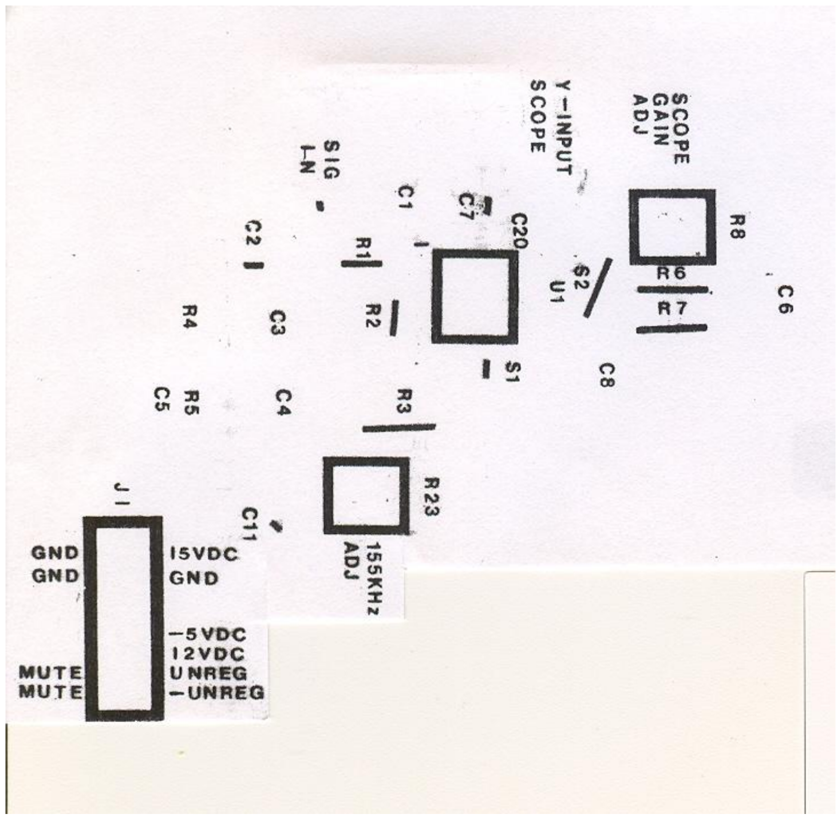
SECTION 7

A3A4 AMPLIFIER PCB

A3A4 SCHEMATIC



A3A4 PARTS LOCATION



A3A4 PARTS LIST

CIRCUIT BOARD ASSEMBLY A3A4

REFERENCE DESIGNATOR	DESCRIPTION
A4C1	Ceramic Cap., 100 pF, 50V-Rad.
A4C2	Tantalum Cap., 4.7 MFD,25V-Rad.
A4C3	Silver Mica., 330 pF, 50V-Rad.
A4C4	Silver Mica., 240 pF, 50V-Rad.
A4C5	Silver Mica., 680 pF, 50V-Rad.
A4C6	Ceramic Cap., 100pF, 50V-Rad.
A4C7	Tantalum Cap., 10 MFD, 35V-Rad.
A4C8	Ceramic Cap., 100 pF, 50V-Rad.
A4R1	Resistor, 56KΩ, ¼ W
A4R2	Resistor, 26.2KΩ, ¼ W
A4R3	Resistor, 1KΩ, ¼ W
A4R4	Resistor, 3.3KΩ, ¼ W
A4R5	Resistor, 6.8KΩ, ¼ W
A4R6	Resistor, 10KΩ, ¼ W
A4R7	Resistor, 56KΩ, ¼ W
A4R8	Potentiometer, 10KΩ, 60dB Gain Adjust
A4R23	Potentiometer, 500Ω, Amplifier Peak Adjust
A4J1	Strip Header, DIP, 16 position

Rev. 08/01/12

SECTION 8

BW-004
PIND SHOCK TEST FIXTURE

BW-004 OPERATION

***** CAUTION *****

FAILURE TO FOLLOW THESE INSTRUCTIONS PRECISELY MAY
VOID THE WARRANTY AND RESULT IN FALSE FAILURE INDICATIONS.

1. **VIBRATION SHAKER**

The Shock Test Fixture is designed to mate with a surface of 2.400 inches minimum diameter, which is flat to within 0.005 inches.

Mounting is accomplished by using 10-32 cap screws. These screws should be torqued according to the accepted standard for 10-32 screws.

The top of the vibration shaker must provide a stable, flat area which is adjacent to the fixture/shaker head. It is this surface to which the terminal block (which carries the electrical connections from the fixture) may be mounted. If the shaker configuration does not provide such a mounting surface, a special mounting bracket must be installed. In addition, the vibration shaker shall not induce any motion or noise other than the desired sine output required by the PIND test specifications. Any mechanical clicking, thumping or scraping emanating from the vibration shaker may induce false failure indications.

2. **MOUNTING THE BW-004 TRANSDUCER/AMPLIFIER CO-TEST SHOCK FIXTURE**

Make certain that both the shaker head and the base of the fixture are free from any foreign matter.

Orient the fixture on the bull circle pattern in such a manner as to preclude damage during normal use.

Allowing for a thread engagement of 3/16 inches minimum install No.10 cap screws and torque as specified. **CAUTION MUST BE EXERCISED** to preclude damage being inflicted on the flex leads, spring diaphragm, or other portions of the fixture during the screw installation.

The terminal block must be located in such a manner to permit the flex leads being parallel to the top of the shaker when the shaker is at zero G. Normally a spacer will be required between the terminal block and the top of the shaker in order to achieve this parallel condition. The spacer may be attached by means of double backed tape. **IT IS IMPORTANT** that the terminal block be stuck on the spacer first. The spacer, with terminal block mounted, must be positioned so that the flex lead has some slack, however when the shaker head is at the bottom limit of its excursion the lead must not come in contact with the shaker, fixture or any adapters which may be used. Should the lead contact any object during vibration, there may be false failure indications as well as damage to the leads.

3. See PARTS LOCATION section for the interconnections and wiring diagram.

This fixture has been designed for operation in conjunction with the PIND Amplifier and Stimulus Control. It is not recommended that other electronic systems be used.

4. **GENERAL**

Do not operate the shaker, with Shock Test Fixture, at over 22 G peak (or more than 1/4 inch displacement, whichever is limiting), nor lower than 35 Hz or more than 225 Hz unless at reduced levels.

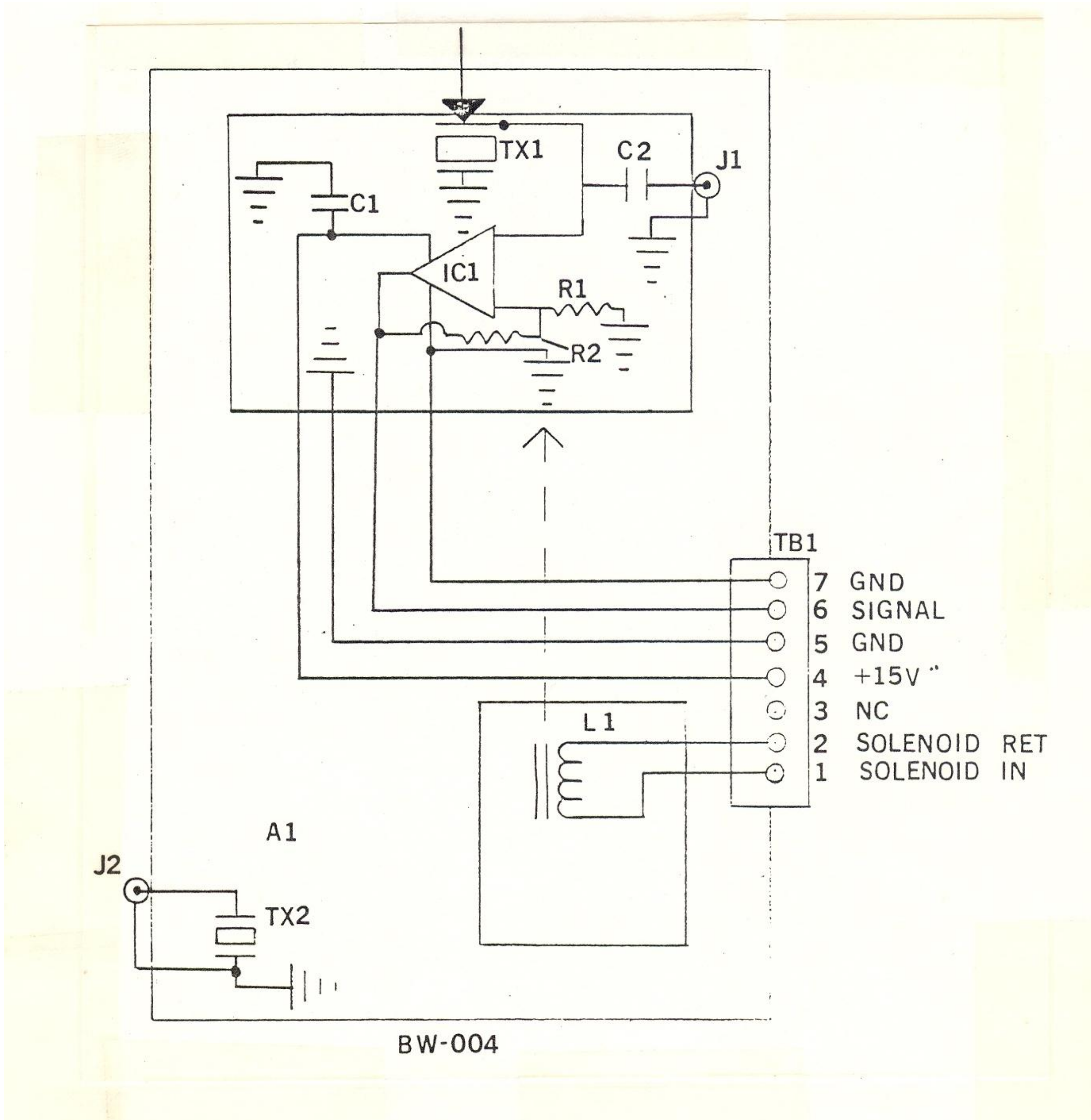
5.**BW-004 TRANSDUCER/AMPLIFIER CO-TEST SHOCK FIXTURE ADJUSTMENT/CALIBRATION FOR SHOCK**

The Shock Test Fixture develops its pre and co-test shock by releasing a magnetically captured hammer that is spring loaded to strike the anvil directly under the "PIND" test transducer. The spacing between hammer and anvil before release is related to the "G" force applied to the anvil. These are adjustable using a 3/8 inch open end wrench. Reduce the spacing if the shock is high, increase the spacing if low. With the system turned OFF, the hammer and anvil should barely touch. Do not adjust the spacing energized to greater than .050 inches. The adjustments should be made equally so both the spring diaphragm and the upper ring are maintained parallel with the base.

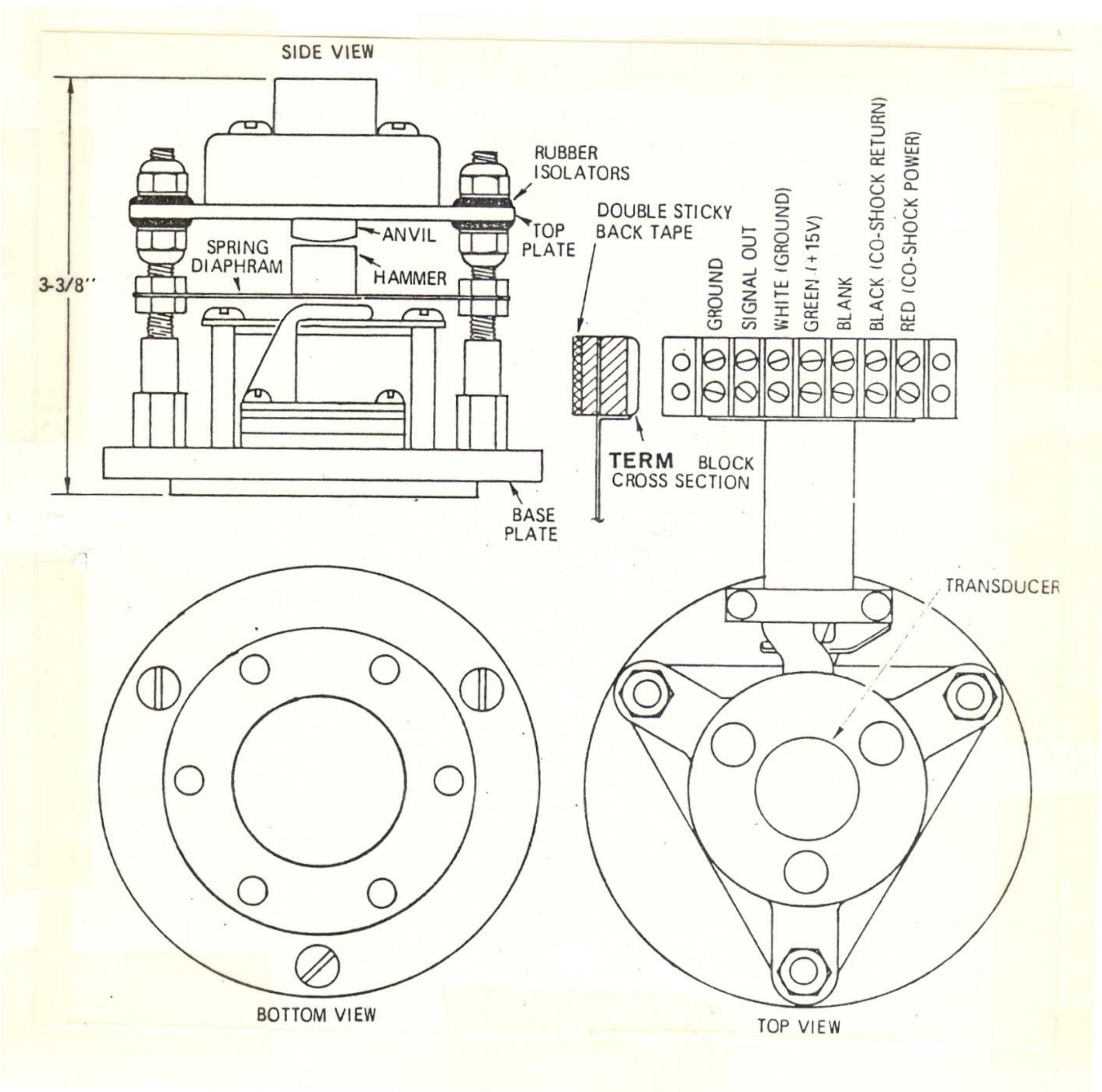
The upper portion of the fixture, containing the transducer/amplifier, is held in place and isolated from the bottom portion of the fixture (and the shaker) by three rubber vibration isolators. The amount of compression of the isolators determines the frequency at which the top portion of the fixture resonant point is 600 Hz +/- 100 Hz. If the adjustment is attempted, be sure to recheck the clearance between hammer and anvil and shock level.

NOTE: All adjustments are made in accordance with the above when your fixture is shipped from the factory. It is recommended that should you have any difficulty with the fixture, you return it to the factory for rework or adjustment. Factory repair is strongly recommended if the amplifier circuitry, which is potted in the housing around the transducer, requires replacement or repair. Make sure that knurled cap of micro-dot connector is screwed down tight in order to preclude it generating noise during vibration.

BW-004 SCHEMATIC



BW-004 PARTS LOCATION



SECTION 9

ACCELEROMETER

SECTION 10

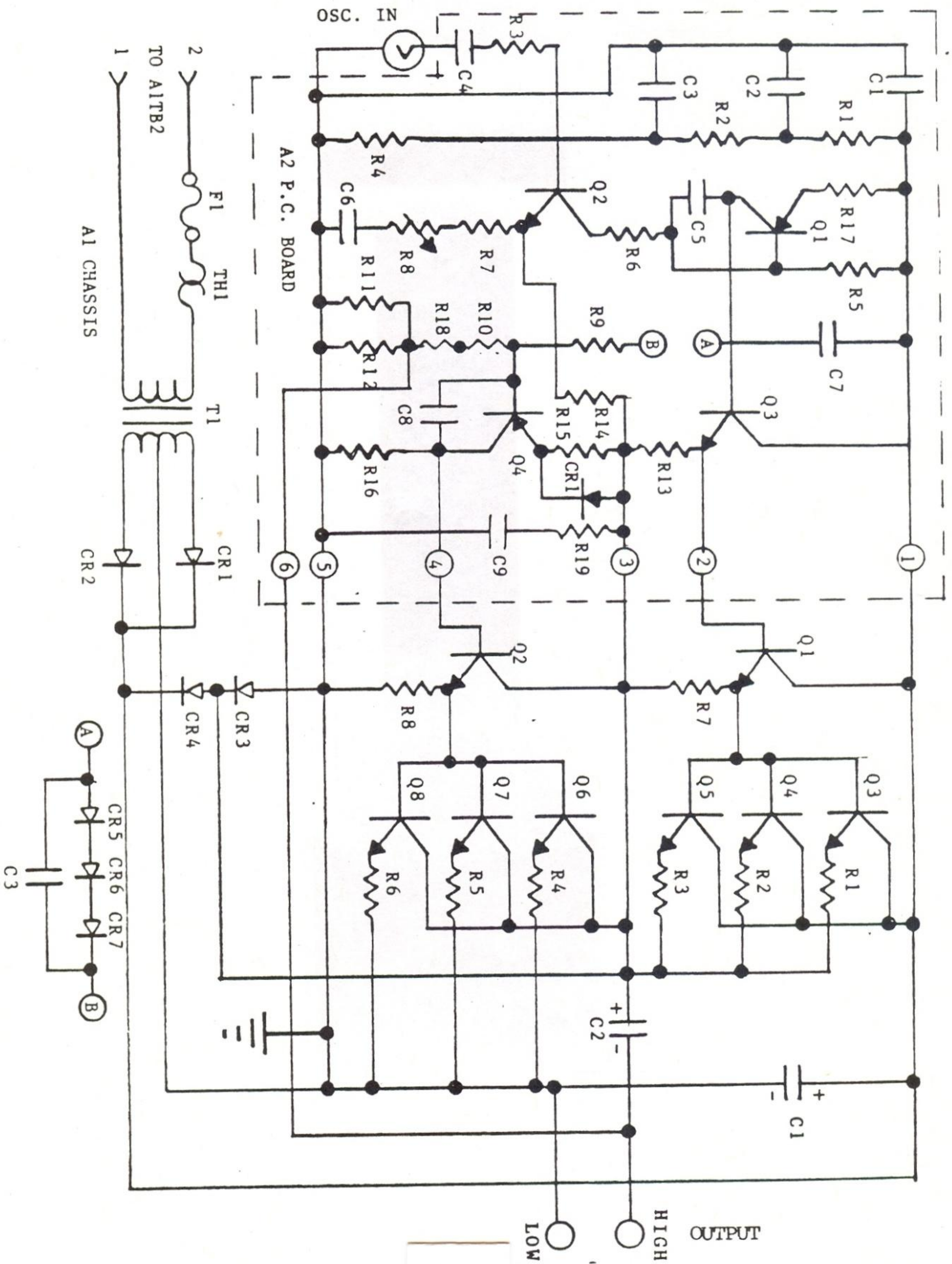
BW-PA-4000
POWER AMPLIFIER

B&W Engineering

POWER AMPLIFIER MODEL BW-PA-4000

AC INPUT:	110/220 VAC, 50/60 Hertz, less than 5 amps
AUDIO INPUT:	Audio input less than 0.6 VRMS, 20 to 10,000 Hertz
AUDIO OUTPUT:	Greater than 240 Watts into 0.9 ohm load.
DISTORTION:	Less than 2% at full load

** The Model BW-PA-4000 Audio Amplifier is designed for use in the B&W Engineering PIND Tester System.


OSC. IN
A2 P.C. BOARD
TO A1TB2
A1 CHASSIS
OUTPUT
HIGH
LOW

B&W Engineering Audio Amplifier, 240 Watt

Model BW-PA-4000
Assembly A1- Main Chassis

QUANTITY	REFERENCE DESIGNATOR	DESCRIPTION
2	A1C1, C2	CAPACITOR, 18,000 MFD, 75V
1	A1C3	CAPACITOR, 10 MFD, 50V
2	A1CR1, CR2	DIODE, 25AMP, 100V, (in single
2	A1CR3, CR4	case)
3	A1CR5, CR6, CR7	DIODE, 1N5401
1	A1DL1	DIODE, 1N4002
1	A1F1	DIAL LAMP, 117 VAC
1	A1FN1	FUSE, 4 AMP
1	A1J1	COOLING FAN, 117 VAC
3	A1J2, J3, J4	SHORTING, 1/4" PHONO JACK
8	A1Q1, Q2, Q3, Q4, Q5, Q6, Q7,	LARGE BANANA JACK SOCKET
6	Q8	TRANSISTOR, 2N3055(tested &
2	A1R1, R2, R3, R4, R5, R6	matched)
2	A1R7, R8	RESISTOR, 0.1 OHM, 10 WATT
1	A1T1	RESISTOR, 47 OHM
1	A1TH1	TRANSFORMER, 4000-F201
		THERMOSTAT, 85 DEGREE C

B&W Engineering Audio Amplifier, 240 Watt

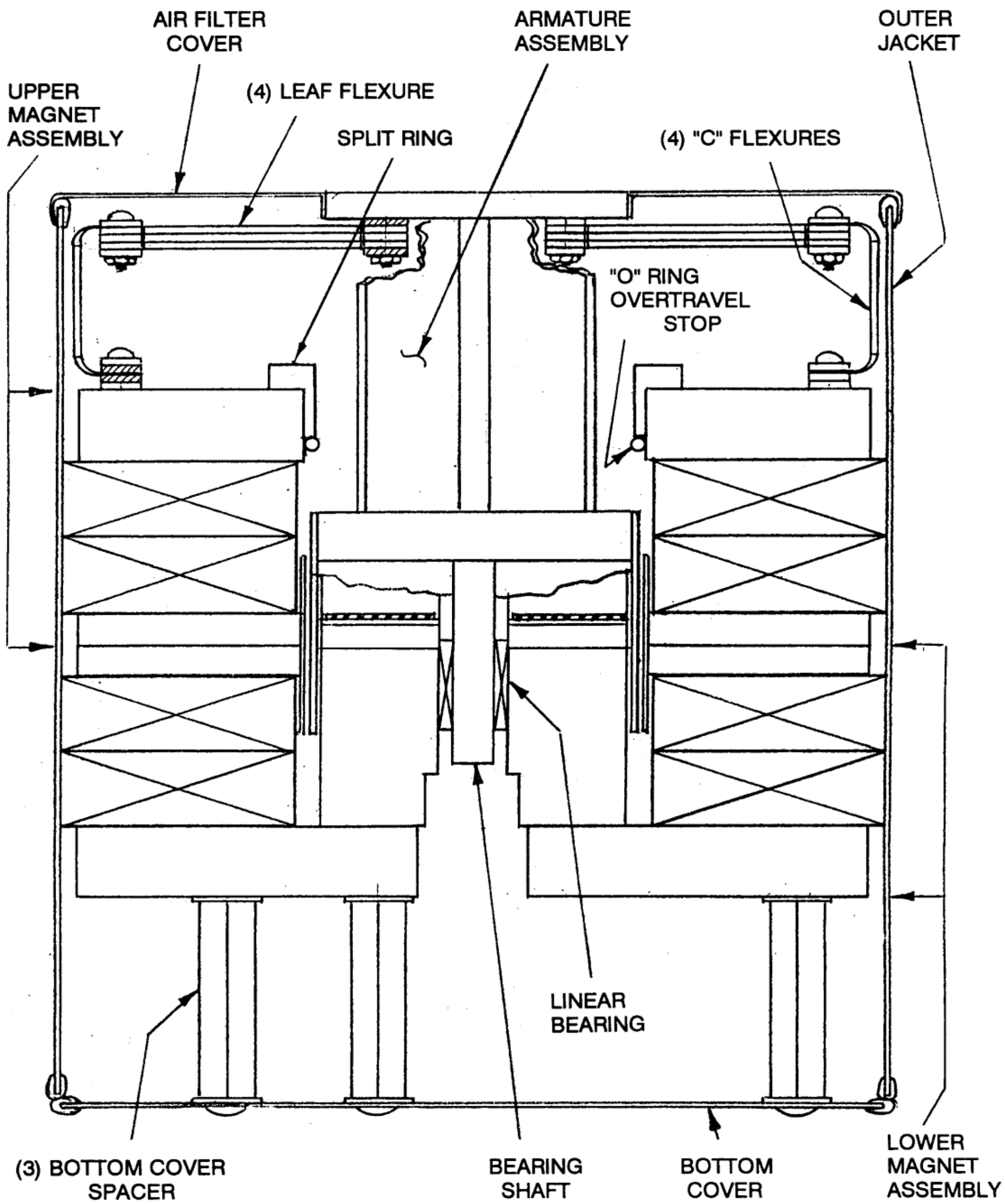
Model BW-PA-4000
Assembly A2- Circuit Board

QUANTITY	REFERENCE DESIGNATOR	DESCRIPTION
1	A2C1	CAPACITOR, 0.47 MFD, 100V
1	A2C2	CAPACITOR, 10 MFD, 50V
1	A2C3	CAPACITOR, 0.003 MFD, 100V
1	A2C4	CAPACITOR, 2.2 MFD, 50V
1	A2C5	CAPACITOR, 150 PFD, 100V
1	A2C6	CAPACITOR, 100 MFD, 50V
2	A2C7, C8	CAPACITOR, 0.0047 MFD, 50V
1	A2C9	CAPACITOR, 0.1 MFD, 100V
2	A2C10, C11	CAPACITOR, 0.005 MFD, 100V
1	A2CR1	DIODE, 1N4002
2	A2Q1, Q4	TRANSISTOR, TIP-30B
1	A2Q2	TRANSISTOR, 2N3568
1	A2Q3	TRANSISTOR, TIP-29B
1	A2R1	RESISTOR, 100K OHM, ½ WATT
1	A2R2	RESISTOR, 150K OHM, ½ WATT
1	A2R3	RESISTOR, 2.7K OHM, ½ WATT
1	A2R4	RESISTOR, 330K OHM, ½ WATT
2	A2R5, R6	RESISTOR, 3.3K OHM, ½ WATT
1	A2R7	RESISTOR, 180 OHM, ½ WATT
1	A2R8	POTENTIOMETER,1K OHM ½ WATT
4	A2R9, R15, R17, R19	RESISTOR, 13 OHM, ½ WATT
2	A2R10, R18	RESISTOR, 1.5K OHM, ½ WATT
2	A2R11, R12	RESISTOR, 1K OHM, ½ WATT
2	A2R13, R16	RESISTOR, 390 OHM, ½ WATT
1	A2R14	RESISTOR, 10K OHM, ½ WATT
1	A2R19	POTENTIOMETER 50K OHM

SECTION 11

VIBRATION SHAKER

VIBRATION SHAKER SCHEMATIC



GENERAL

The BW-100 vibrator is an electrodynamic vibration generator for laboratory and general industrial applications. The unit features a center gap permanent magnet field structure for high efficiency; a linear low stiffness suspension system for low distortion and low frequencies; near critical damping of the suspension system for low distortion at high frequencies; a single coil armature for simplicity, reliability and ease of maintenance; and, an overall design which has been optimized for high force output in relation to body size and weight.

ELECTRODYNAMIC PRINCIPLE

The electrodynamic principal of a vibration generator is identical to that of a loud speaker. It differs in physical characteristics in the following area:

1. The vibrator must have a table to which the specimen can be attached.

The table must have a suspension system which is capable of supporting the weight of a reasonable size of test package and resist motions in all directions other than the desired axis of motion.

SYSTEM CONSIDERATIONS

Acceleration capability is dependent on the system force and the total weight of the armature and all items attached to the table.

$$\text{Acceleration g peak} = \frac{\text{System Force = lbs. peak}}{\text{Wt. armature in lbs. + Wt. of test item}}$$

$$\text{Acceleration g peak} = \frac{\text{100 (example)}}{\text{0.66 lbs. (arm) + 0.34 lbs. (example)}} = \text{100 g peak}$$

The vibration may be bolted to a bench or additional inertia mass if desired. For many tests, particularly with light weight test packages, the vibrator may be operated on isolation pads. Additional isolation between the vibrator and the ground can be provided for vertical operation by the B&W Model BW-019 ISOBASE.

The amplifiers used in the systems are commercial single channel audio units. The cable which is attached to the vibrator has been terminated to match the amplifier. The vibrator table and magnet structure are grounded by the center wire in the cable. The center wire should be attached to the amplifier case which is grounded by the amplifier power cable. The three banana plugs should be inserted in the amplifier so that the wires are connected to the corresponding red, blue and black terminals.

Overall system power requirements at idle are extremely low because of the permanent magnet field and the design of the amplifiers. The output transistors do not carry bias current as in other designs. The result is that at idle, the power dissipation for the vibrator/amplifier combination will not exceed 15-40 watts for the system.

SECTION 12

CALIBRATION PROCEDURES

CALIBRATION PROCEDURES

Many of the organizations which utilize the BW-LPD-DAQ000 Particle Impact Noise Detection Systems have established metrology methods and procedures, the contents of this section are offered by B&W Engineering Corp. as a guideline. The operation and calibration procedures covered in this manual exclusively consider the requirements of MIL-STD-883 TM2020 and MIL-STD-750 TM2052 and, consequently, may not be in strict agreement with other specifications created by other organizations.

1.0 AMBIENT ENVIRONMENT DURING CALIBRATION

1.1	Temperature	-	72° ± 5° F
1.2	Pressure	-	Normal atmospheric
1.3	Input Power Source	-	117 ± 5 Vrms @ 60 Hz 230 ±10 Vrms @ 50 Hz
1.4	Location	-	Metrology laboratory environment with low acoustical and electromagnetic noise levels.
1.5	Equipment warm-up	-	1 minute minimum

CALIBRATION PROCEDURES
(continued)

2.0 LIST OF FUNCTIONS TO BE CALIBRATED

2.0.1 Power Supply Verification

2.1 Control of Vibration Shaker
- 2.1.1 Frequency Display
- 2.1.2 Acceleration Display
- 2.1.3 Overall Distortion

2.2 Oscilloscope Presentation
- 2.2.1 General

2.3 Co-Test Shock and Ancillary Functions
- 2.3.1 Level and Duration of Shock
- 2.3.2 Muting of Audio and Threshold Detection

2.4 155 KHz Presentation
- 2.4.1 Amplifier Peak and Bandwidth
- 2.4.2 Gain and Noise Level
- 2.4.3 Adjustment of Threshold Detector

2.5 Sensitivity Test Unit and System Check Out
- 2.5.1 General

2.6 BW-155 STU Transducer
- 2.6.1 General

2.7 Automatic Test Set-up
- 2.7.1 Timing Function and Sequence
- 2.7.2 Co-Test Shock Control

2.8Ultrasonic Transducer
- 2.8.1Ultrasonic Transducer Calibration

FUNCTION:	**Power Supply Verification**	**CP# 2.0.1**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 00**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

Digital Volt Meter with an accuracy of 1% and a basic sensitivity of 100 µV.

PROCEDURE

Use the voltmeter to verify that the line voltage falls within the range of 117 ± 5 Vrms @ 60Hz and 230 ± 10Vrms @ 50Hz.

Remove the cover of the PIND system console. With the system turned on, confirm that the following potentials are generated:

A3A3 Power Supply Board

Voltage	Range	Location
+5VDC	+5.5VDC - +4.5VDC	U4 Pin 3 (LM7805)
+15VDC	+14.5VDC - +15.5VDC	U5 Pin 3 (LM7815)
+12VDC	+11.5VDC - +12.5VDC	U6 Pin 3 (LM7812)
-5VDC	-5.5VDC - -4.5VDC	Z1 Anode
-UNREG	-21VDC - -17VDC	CR4 Anode
+UNREG	+17VDC - +21VDC	CR3 Cathode

NOTE

Any of the four mounting studs for the A3A3 Power Supply Board may be used as reference ground.

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**Oscillator/Amplifier Control of Vibration Shaker - Frequency Readout**	**CP# 2.1.1**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 03**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

Digital Frequency Meter (DFM) capable of ± 1 Hz in the range of 27 Hz to 270 Hz

PROCEDURE

Connect the DFM to the SINE OUTPUT. Increase the ACCELERATION CONTROL knob to obtain 10 G acceleration (DO NOT EXCEED 10 G BELOW 40 Hz). The digital display of FREQUENCY on the front screen shall agree with the DFM readout within 5% ± 1 digit.

Vary the frequency from minimum to maximum and observe digital readout accuracy as stated above.

NOTE

Adjustments are made by rotating the internal potentiometer A2R22 located on the

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**Oscillator/Amplifier Control of Vibration Shaker - Acceleration Readout**	**CP# 2.1.2**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 03**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

An accelerometer, an amplifier, and a readout device, all of which shall be capable of measuring acceleration levels of 0 G to 20 G peak within the 27 Hz to 250 Hz range.

PROCEDURE

Attach the Calibration Accelerometer to the PIND Shock Test Fixture (may be temporarily attached to one of the 10-32 studs). Within the frequency range from 27 Hz to 250 Hz and peak amplitudes between 10 G and 20 G (DO NOT EXCEED 10 G BELOW 40 Hz DAMAGE TO SHAKER MAY RESULT), the digital ACCELERATION display on the front panel shall agree with the test accelerometer readout to within 5% ± 1 G.

NOTE

Operating procedure employs an optical wedge to verify that:

(a) 44 Hz @ 10 G = 0.100" Double Amplitude (DA)
(b) 40 Hz @ 20 G = 0.245" DA
(c) 63 Hz @ 20 G = 0.099" DA
(d)100 Hz @ 20 G = 0.039" DA

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**Oscillator/Amplifier Control of Vibration Shaker - Overall Distortion**	**CP# 2.1.3**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 02**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

An Accelerometer/Amplifier capable of 0 G to 20 G peak from 27 Hz to 250 Hz, and a Distortion Analyzer or an Oscilloscope capable of reading 10% distortion in the range of 27 Hz to 250 Hz.

PROCEDURE

Attach the Calibration Accelerometer to the PIND Shock Test Fixture (SEE NOTE). Connect the output of the Calibration Accelerometer to its amplifier and the output to the Distortion Analyzer or Oscilloscope. Using the frequency control and the ACCELERATION CONTROL knob, establish a level of 20 G acceleration recommended calibration frequencies are 100 Hz and 200 Hz with a maximum distortion of 20%.

If significant distortion is encountered check mounting and cabling. SINE output from Controller is adjusted in the Configuration Screen. If distortion is present it may be due to a mechanical failure, check for loose hardware and/or contact B&W for assistance.

NOTE

It is recommended the Calibration Accelerometer be temporarily attached to one of the 10-32 studs of the PIND Shock Test Fixture.

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**Oscilloscope Presentation - General**	**CP# 2.2.1**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 00**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

Sine wave generator with a minimum of 1VRMS output.

PROCEDURE

Apply a 40 mVP-P @ 155KHz signal to the Sensor #1 input (#s 3 & 4) on the USB-6356. Record and return Scale settings to 1.0 and observe 40mVP-P on PIND screen. Repeat for channels 2-5 if selected in Configuration Screen. Return Scales to original settings.

NOTE

The vertical sensitivity is to be set at 20 mV per centimeter per MIL-STDs. The vertical gain control can be measured to 20 mV per centimeter by use of the BW-012 set to 20 mV. The horizontal sensitivity is approximately 0.5 - 1.0 Volts per cm, set for 4-8 divisions @ 10-20 G.

B&W ENGINEERING CORP.	CALIBRATION PROCEDURE	
FUNCTION:	**Co-test Shock and Ancillary Functions - Level and Duration of Shock**	**CP# 2.3.1**
RECOMMENDED CALIBRATION CYCLE: 6 months	**REVISION 04**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

A Shock type Accelerometer with a natural resonance above 100 KHz, an associated Amplifier capable of reading shock levels from 500 G to 1500 G peak with a duration of <100 μS, and a calibrated Oscilloscope. The accelerometer weight shall not exceed 10 grams. Output of the Amplifier will be displayed on the Oscilloscope. The overall test system accuracy shall be 5% on shock level.

PROCEDURE

Mount the Calibration Accelerometer on the platen (top surface) of the transducer of the PIND Shock Test Fixture by means of 50A4084 Ultrasonic Couplant, BW-TD-085 Ultrasonic Tape Dots, or equivalent. Activate the co-test shock device by depressing the MANUAL SHOCK button with the system in the MANUAL and single shock modes. Read the output of the Shock type Accelerometer on the Oscilloscope. Shock pulses of 800 G to 1200 G peak, approximately half-sine, and less than 100 μS duration should occur in each operation of the PIND Shock Test Fixture. The Shock Gs should agree within 5% of the Shock Level display in the Configuration screen.

NOTE

Wait at least 1 second between operations of the MANUAL SHOCK button.

See B&W Engineering Corp. Maintenance Manual for mechanical adjustments of the co-test shock solenoid of the PIND Shock Test Fixture.

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**Co-test Shock and Ancillary Functions - Muting of Audio and Threshold Detection**	**CP# 2.3.2**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 03**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

Calibrated oscilloscope with synchronization

PROCEDURE

Attach scope probe to Mute signal (pin 63 of USB-6356). Place the shock mode selector in the "MANUAL" position and "1" shock. Click the SHOCK button each time a shock pulse is desired. Adjust your oscilloscope trigger level such that the shock pulse display lines up with the left graticule. The threshold detector and audio circuits are muted whenever shocks occur. Provided the trigger of the oscilloscope has been properly set a return to 0mV should occur before 250 mSec have elapsed (150 mSec typical). 250 mSec maximum is allowed per MIL-STD-883C Notice 5 TM 2020.6 and subsequent revisions.

NOTE

A muting period of approximately 100 ms is required to allow all circuits to recover from the shock pulse. Shorter periods can cause false triggering of the threshold detector. It is advisable that this period not be reduced to lower than 100 ms.

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**155 KHz Presentation - Amplifier Peak and Bandwidth**	**CP# 2.4.1**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 05**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

Function Generator tunable to 50 KHz through 350 KHz, with calibrated attenuation, sine wave output. Note: The calibrated attenuation must have 60 dB minimum and include at least one 20 dB step. A frequency counter may be required if the frequency calibration of the function generator cannot be determined within 2%.

PROCEDURE

Connect the output of the function generator to the input of the 60 dB attenuator (may be internal on some function generators). Connect the output of the attenuator to the input jack (10-32 Microdot) located on the BW-004 PIND Shock Test Fixture through cable (BNC to 10-32 microdot) supplied with the BW-012. While observing the noise output of the system on PIND screen oscilloscope display, adjust the frequency of the function generator to peak output but limit the signal input so that the peak is 40 mVP-P on the oscilloscope. The peak should be 155 KHz ± 5 KHz. Increase the input signal by 20 dB and detune the function generator on the low side of 155 KHz until the oscilloscope level reaches 40 mV. The frequency shall be greater than 75 KHz. Tune the function generator to the high side of 155 KHz until the oscilloscope level reaches 40 mV. The frequency shall be less that 300 KHz.

B&W ENGINEERING CORP.	CALIBRATION PROCEDURE	
FUNCTION:	**155 KHz Presentation - Gain and Noise Level - System Final Check Out**	**CP# 2.4.2**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 05**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

Same as used for 155 KHz Presentation - Amplifier Peak and Bandwidth

PROCEDURE

Connect the output of the function generator to the input of the 60 dB attenuator (may be internal on some function generators). Connect the output of the attenuator to the input jack (10-32 Microdot) located on the BW-004 PIND Shock Test Fixture through cable supplied with the BW-012. While observing the noise output of the system on PIND oscilloscope display, adjust the frequency of the function generator to peak output but limit the signal input so that the peak is 40 mVP-P (signal plus noise) on the oscilloscope. Without disturbing any of the gain adjustments, connect the output of the function generator directly to your oscilloscope input. If the level is 40 mVP-P (signal plus noise), the system has an overall gain of 1000 {$20LOG_{10}(1000)=60$ dB}. If it is not within ± 2 dB, adjust the signal level to exactly 40 mVP-P, then reconnect the function generator to the input of the 60 dB attenuator. Adjust the Scale in the Configuration screen for that channel to obtain exactly 40 mVP-P (signal plus noise) on the oscilloscope. Disconnect all external cables, not part of the working system and observe the system noise on PIND oscilloscope display. It should be less than 20 mVP-P.

SYSTEM FINAL CHECKOUT

Operate the vibration shaker at 20 G peak acceleration from 40 to 250 Hz and periodically activate the co-test shock device. Note that the noise level does not exceed 20 mVP-P, for any combination of these stimuli, (after passage of the shock pulse), and that the threshold detector lamp does not light.

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**155 KHz Presentation - Adjustment of Threshold Detector**	**CP# 2.4.3**
RECOMMENDED CALIBRATION CYCLE: 1 Year	**REVISION 05**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

Same as used for 155 KHz Presentation - Amplifier Peak and Bandwidth

PROCEDURE

Connect the output of the function generator to the input of the 60 dB attenuator (may be internal on some function generators). Connect the output of the attenuator to the input jack (10-32 Microdot) located on the BW-004 PIND Shock Test Fixture through cable supplied with the BW-012. While observing the noise output on PIND screen oscilloscope, adjust the frequency of the function generator to peak output but limit the signal input to 40 mVP-P (signal plus noise) on the oscilloscope. Reduce the signal to zero. Reset the threshold detector. Gradually increase the signal until the signal plus noise reaches the specified level (SEE NOTE). Set the Failure Threshold in the Configuration screen to .015V (15 millivolts). Reduce the signal, reset the threshold detector, then increase the signal until the Fail indicator turns red. Readjust the threshold sensitivity as required to attain the specified level.

NOTE

Typical specified levels per MIL-STD are:

15 +/- 1 mVP above ground (ground is considered to be the mid point of system noise).

20 +/- 1 mVP above ground.

5 +/- 1 mVP above system noise.

NOTES

This calibration adjustment requires a function generator that does not introduce noise or spikes into the system. An isolation transformer may be required in the power input of the generator if power line spikes present a problem. Any increase in noise when the generator is connected to the input of the system is not acceptable.

*The BW-012 may be used as a noise/spike free signal generator. To use the BW-012 as a signal generator, connect the BW-012 directly to the input connector on the BW-004. Use the "MICRO" button to generate a single D.C. pulse and adjust pulse height with the ten turn potentiometer. Adjust the system as above in "Procedure" except press the "MICRO" button to obtain a single pulse. As the level of the signal is determined by its coincidence with an additive or subtractive noise pulse, there will be some apparent variation in the signal. Pulse signals which are equal to or greater than the specified level should trip the threshold detector FAIL indicator, signals that are less than the specified level should not. Adjust the threshold sensitivity as required.

*Not a recommended procedure. Consider as a last resort technique only.

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**Sensitivity Test Unit and System Check Out - General**	**CP# 2.5.1**
RECOMMENDED CALIBRATION CYCLE: (See Note 1)	**REVISION 03**	**ISSUE DATE 08/22/2012**

REQUIRED EQUIPMENT

BW-012 Sensitivity Test Unit (or "STU" of TM 2020)

PROCEDURE

This test to be performed with no vibration (acceleration = 00.0 G). An Automated test can be made called STU Test that contains no vibration or shocks and about 5 seconds to complete the STU test. Check the system with BW-012 STU with the test transducer mounted face to face (use ultrasonic couplant #50A4084, tape dots BW-TD-085, or equivalent) and coaxial with the transducer of the BW-004, set the potentiometer on the BW-012 to 250 and activate the "MICRO" switch. Verify low level simulated particle signal pulse detection on PIND screen oscilloscope (approximately 10 mV above noise level), an audible "click" from the speaker, and lighting of the threshold detector red FAIL indicator, on those pulses that exceed the specified level of CP# 2.4.3.

NOTE

When the polarity switch is in the "POS" position, the BW-012 output is the same as the "STU."

Note 1:1. Work shift change
2. System shut down for any reason
3. Change of operators

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**BW-012 STU - General**	**CP#** **2.6.1**
RECOMMENDED CALIBRATION CYCLE: 1 year	**REVISION** **01**	**ISSUE DATE** **08/22/2012**

REQUIRED EQUIPMENT

Digital Volt Meter with an accuracy of 1% and a basic sensitivity of 100 μV.

PROCEDURE

a. Connect the BNC output of the BW-012 to a Digital Volt Meter. Observe that the dial readout of the digital potentiometer of the BW-012 reads the D.C. level selected by the "MICRO" or "MILLI" switch, in the polarity selected. The voltage shall be within 10% of the indicated readout over the full range. A specific check for accuracy of the BW-012 shall be made at 250 μV.

b. Calibration of the supplied transducer can only be accomplished by the manufacturer at this time. It is suggested that purchase order include the following statement:

Transducer Model # _______________, Serial # _______________ is herein returned for recalibration. If found within original specification, please return with latest calibration data. If found out of original specification, please contact ____ for instructions.

NOTE
The BW-012 uses a 1.5 volt "C" battery that should be replaced annually.

B&W ENGINEERING CORP.	CALIBRATION PROCEDURE	
FUNCTION:	**Automatic Shock** **Timing Function and Sequence**	**CP#** **2.7.1**
RECOMMENDED CALIBRATION **CYCLE: 1 Year**	**REVISION** **03**	**ISSUE DATE** **08/22/2012**

REQUIRED EQUIPMENT

Oscilloscope
A Stop Watch

PROCEDURE

Set the "AUTOMATED" test. Depress footswitch. Release footswitch and observe pre-test shock (1 or 3 shocks may be selected.) After "specified duration" (3 ± 1 seconds per TM2020.6, .7, and .8), observe the first co-test shock(s). Observe second and third co-test shock(s) after "specified durations." Then, observe "TEST COMPLETE" status after the "specified duration" after the third co-test shock.

NOTE

When 3 shocks are selected the duration is measured from after the final shock in a set to the first shock in the ensuing set.

See the Programming AUTOMATED Tests section of this manual for details.

B&W ENGINEERING CORP.	**CALIBRATION PROCEDURE**	
FUNCTION:	**Ultrasonic Transducer and the PIND system.**	**CP# 2.8.1**
RECOMMENDED CALIBRATION CYCLE: 1 year	**REVISION 02**	**ISSUE DATE 11/12/12**

REQUIRED EQUIPMENT

Sine Wave Generator tunable from 150 to 160 KHz, variable output from 0 to 3.5 volts peak. Calibrated oscilloscope, minimum 500 KHz bandwidth. Capacitance Probe BW-023-1 and battery pack, BW-023-2. Note: if the generator is not readable to 1 KHz, a frequency counter will be required. Sine Wave Generator BW-SWG-100 is recommended but not mandatory. Aluminum foil tape. Interconnecting BNC cables and tees. A D.C. voltmeter, accurate between 70 and 100 volts, 20,000 Ω per volt. Feelers gauge of .006”.

PROCEDURE

This test is to be performed on a PIND test system that is in calibration in all other respects.

Remove the cover from the battery pack, BW-023-2, and measure the battery voltage AT THE BATTERY TERMINALS. Record this voltage and reinstall the cover.

If the transducer has a ceramic face, apply aluminum foil or foil tape to face to provide grounding plane. Apply the foil to the platen, wrinkle free. Make sure that foil is flat and that no dirt particles have been trapped under the foil.

Place the capacitor probe, probe side facing the Transducer. If a clamp, BW-004A, is available, install this to hold the probe in place. Use other holding techniques if this is not available.

If the "shorted probe indicator" lamp lights, it signifies the probe has touched the transducer. This must be remedied before the test can proceed. If the lamp is left lighted for very long, it will discharge the batteries in the power supply.

Connect output of the sine wave generator to BNC tee with one side connected to the "IN" jack of BW-023-2 and the other to calibrated oscilloscope. Add another tee to include frequency counter if required.

The test is to prove the sensitivity of the test transducer in terms of microbars. A reverse process will be used in this calibration that lends itself to the levels used and the small signal linearity of the equipment. Since 20 mV peak has been used as a reference to determine the 60 dB gain of the system, this becomes our reference point for this test. For this reference of 20 mV peak on the system oscilloscope, derived through 60 dB gain, the following points of reference are made:

Transducer Limits Re 1 volt/microbar	Microbars Required for 20 mV peak
-74.5 dB	0.106 µbars
-80.5 dB	0.210 µbars

Note: The above limits are those currently used in MIL-STD-883, TM2020.

The Capacitor Probe is used as an ultrasonic loud speaker to excite the diaphragm area of the test transducer. The formula to convert the electrical force applied into microbars is as follows:

Formula "A" $\text{Microbars}_{RMS} = 8.854\text{x}10^{-7}\text{*}(0.7071 * V_1 * V_2 / R^2)$
where V_1 is the polarizing voltage
V_2 is the signal voltage (peak)
R is the distance in centimeters between the two surfaces

Note: For a typical test setup where the polarizing voltage is 90 volts and the probe is spaced 0.006 inches (convert to cm in formula), you can use the chart supplied to determine microbars directly. You can then use the graph supplied to show the transducer response in dB down from 1 volt/microbar. The .006” air gap shall be verified with the .006” feelers gauge every 6 months.

With all equipment turned on and warmed up (5 to 10 minutes) set the signal generator to 155 KHz and increase or decrease its amplitude until 20 mV peak a.c. signal is presented on the system's oscilloscope. Vary the signal generator from 150 to 160 KHz and record the minimum and maximum peak voltages required to obtain 20 mV on the system oscilloscope.

Use the chart and the graph if the equipment complies with a typical system. If not, use Formula "A" and the graph. If your transducer is within -74.5 to -80.5 dB down from 1 volt per microbar in the frequency range of 150 to 160 KHz, it is within specification.

SECTION 13

TROUBLE-SHOOTING GUIDE

TROUBLE-SHOOTING GUIDE

PROBLEM	SOLUTION
When the system is activated, nothing happens; i.e., indicators do not light.	Verify that the unit is plugged into an active electrical outlet. Check the system for blown fuses.
The shaker does not vibrate.	Rotate the ACCELERATION CONTROL KNOB clockwise. The POWER AMPLIFIER may be lacking power or its connection to the control console. SHAKER not connected to POWER AMPLIFIER. If in MANUAL mode, switch to RUN. If in AUTO mode, press START to clear end of test.
ACCELERATION Display does not reflect CONTROL KNOB adjustments.	Verify that vibration accelerometer is connected to the control console. Function may require calibration.
The system does not shock when button is pressed.	Check the D/C POWER cable that connects the control console to the Shock Test Fixture. In Manual mode, shocks only delivered by pressing the MANUAL SHOCK button. In Auto mode, one may only use the MANUAL START button to initiate shock sets. Verify that COUNT display is not zero and the desired program is being used.
The AUDIO section does not emanate any system noise.	Rotate the AUDIO CONTROL knob clockwise to increase the volume. Since the ambient system noise is rather low, tap the transducer of the PIND Shock Test Fixture to increase the noise level. If in the automatic mode, the sound is disabled when the test sequence ends
The TEST TIME indicator does not illuminate.	The TEST TIME is displayed only in the AUTO mode.
The automatic tests terminate (continue) when a failure/spike is encountered.	The STOP on FAIL function is active (dormant). Toggle the switch.

TROUBLE-SHOOTING GUIDE

(continued)

PROBLEM	SOLUTION
The TEST COMPLETE indicator does not illuminate.	Verify that the system is in the AUTO mode. Verify that the automatic test has completed its sequence (without a particle/spike detection in ABORT MODE).
The YELLOW INTERFERENCE led is always lit.	Something may be touching the sensor. The testing environment may be noisy. The detection signal cable is not connected (FAIL only).
The FAIL/INTERFERENCE lamp never lights.	These functions are disabled after each automatic test. The function may be switched off or not present (TRANSIENT detector only).
The INTERFERENCE detector is activated for no apparent reason.	Verify that TRANSIENT DETECTOR SENSOR (mounted on the back of the control console) is unencumbered. Since the transducer is mounted to the control console, a detection may occur if either the transducer is touched or activity occurs on the case during a test; e.g., pressing switches, taping case.
Footswitch does not initiate automatic test.	Confirm that the system is in the AUTO mode and the desired program has been selected. Verify the footswitch is attached to the REMOTE FOOTSWITCH connector on the back of the control console.
The System Oscilloscope does not display the 12 - 20 mVP-P system noise.	Each division should represent 20mV. The input to this channel, A or Y (Vertical), must be attached to the connector on the control console.
The System Oscilloscope does not experience horizontal deflections proportional to the vibration level.	Verify that the signal is centered on the screen. Each division should represent 500mV. The input to this channel, must be attached to the USB 6356 connector on the control console.
In the AUTO mode, the pre-programmed shock sets occur too quickly (slowly).	The sequence of shock sets may be simply reprogrammed to reflect the desired rate. See Operation Procedure 10(a).

SECTION 14

WARRANTY

B&W ENGINEERING CORP.

Statement of General Conditions of Warranty

B&W Engineering Corp. (hereinafter referred to as B&W) warrants its Particle Impact Noise Detection System (hereinafter referred to as PIND) to be free of defects in material and workmanship for a period of three hundred and sixty-five (365) days after shipment to the customer. This warranty does not cover B&W equipment unless it is properly installed and operated in accordance with current B&W instructions and manuals of B&W, and maintained by the purchaser in accordance with the provisions of such instructions and manuals.

Warranty is limited to supplying the purchaser with replacement or repair of any part or parts which in B&W's opinion are defective. Commercial products purchased by B&W installed and made a part of B&W's PIND will carry the original manufacturer's warranty only. B&W reserves the sole right to determine whether defective parts or products will be repaired or replaced.

Maintenance service and service beyond that specified herein shall be provided at B&W's prevailing Service Rate or by Service Contract Agreement.

Warranty is expressly in lieu of any and all other warranties or representations, expressed or implied, and of any obligations or liabilities of B&W to the purchaser arising out of the use of said products, and no agreement or understanding varying or extending the same shall be binding upon B&W unless in writing and signed by an authorized officer of B&W.

Warranty shall not apply to any product which in the judgment of B&W has been subjected to misuse or neglect, or has been repaired or altered by the purchaser.

B&W reserves the right to make changes in design or additions to, or improvements in, the PIND at any time without imposing any liability on itself to install the same in any product manufactured or supplied prior hereto.

This warranty does not include reimbursement for customer assembly, disassembly, setup or teardown time. All packing and shipping costs related to warranty return items shall be borne by the purchaser.