SPECTRAL DYNAMICS

Advancing Multi-exciter
Dynamic Testing since 1961

Felix™

PIND Felix™

PC controlled Test System for Particle Impact Noise Detection (PIND)

- Reliability Testing for All Types of ICs / Relays / Switches and Hybrid Electronics
- State-of-the-Art PIND testing
- Visual and audio particule detection
- Display and report of the test
- System designed and manufactured by Spectral Dynamics

UNIQUE FEATURES for CONVENIENCE and FLEXIBILITY

The PIND Felix™ easily exceeds the requirements of all military standards for PIND testing (U.S. MIL-STD-883, 750, 202,39016D).

Embedded sensors monitor and display the actual shaker motion with PC analysis to correct for any changes in test conditions.

The PIND Felix™ is fully programmable to your own specifications since everything is generated by the computer.

SYSTEM OVERVIEW

PIND sensors : Depending of the test, Spectral Dynamics can supply single crystal or multiple crystal sensors. All our PIND sensors have a complete Faraday shield around each crystal to protect the sensor from unwanted stray electrical signals.

Shaker : The unique PIND Felix™ shaker creates accurate "Active Shocks" with adjustable shock levels by controlling the velocity of the shaker head and correcting for device differences prior to impact.

Software : PIND Felix™ software allows for data collection of the vibration, shock, and acoustic channels. Each type of signal can be replayed for more in depth understanding of the interactions between the acoustic noise and the motion environment. The PIND Felix™ software is compatible with tools like Microsoft Office. Reports for presentation or printing are simple to do.

Sensibility Test Unit (STU) : A STU is supplied with the PIND Felix™ test system. This kit will routinely verify that the system is functional. The STU is not used to calibrate the sensitivity of the system, only to simulate a bad Device Under Test (DUT). MIL-STD specifies such a test needs to be carried out routinely as to verify the functionality of the system.

For over fifty years, PIND Products Group of SPECTRAL DYNAMICS, INC. has given users simple, reliable, and inexpensive tools to perform Particle Impact Noise Detection (PIND) testing to increase the reliability of electronic components.

Our high frequency acoustic test monitors for loose particles moving inside high reliability internal cavity electronic components such as relays, transistors, integrated circuits, and switches – particles that have the potential of causing short circuits and serious malfunctions in system operations.

A shaker is used as a linear motor to excite loose particles to move within the component cavity. Upon striking the lid of the cavity, some of the particle kinetic energy ($\frac{1}{2}mv^2$) is converted to a wide band acoustic pressure wave that travels through the lid, through the attachment media, and onto the top surface of the Impact Detection Sensor.
The acoustic wave is detected by the sensitive ultrasonic crystal or crystals within the sensor and converted to an electrical signal. To keep the particle moving, a very accurate shock, generated internal to the shaker and controlled by the computer, monitoring the motion of the sensor, is employed.

PIND FELIX™ SYSTEM

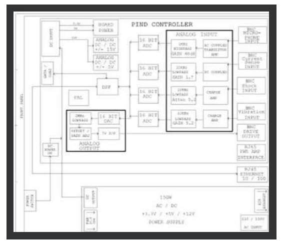
Advanced technology That's easy to use

Our PIND FELIX™ system, featured on the cover, is the most advanced system available today. Combining sensors that monitor and display the shaker motion with computer generated control to correct for changes in test conditions, the PIND FELIX™ test system generates accurate and repeatable test conditions. Its ultra-sensitive, ultrasonic (155 kHz) sensor with multiple crystals can detect particles smaller than 15 microns in diameter impacting the package cavity.

A small metal flake as shown above can cause serious malfunction in electronic components

Our technology not only creates the motion but also allows the user to program the motion including both shock and vibration at the precise amplitude and timing to simulate the whole range of testing requirements. The interactive Windows 10 interface allows the operator to enter the desired stored test sequence or enter a new configuration with variable amplitude of shock or the amplitude, timing, and frequency of the vibration. The PIND FELIX™ system has four channels used to acquire the data from the vibration, the shock, and the detection crystals as well as expansion to monitor the power amplifier.

- **Data is acquired**
- **Data is displayed**
- **Data is used for corrections**
- **Data is stored for further analysis**



Four unique channels of Data Acquisition

The PIND FELIX™ uses four unique channels of data collection. All four channels use the same clock to digitize the data at 2.5 MSamples per second.
The high-speed Acoustic channel has a center frequency of 155 kHz to minimize noise and maximize signal.

The amplification is set to 60dB and the precision fixed anti-aliasing filters are set so the 8X oversampling produces a bandwidth of over 2 MHz. Further filtering is used to limit the frequency of interest to the peak sensitivity of the sensor. The tiny signals created by the crystal are increased in size before being digitized, all without aliasing. Once digitized the data is sent to the onboard Computer System on Module (SOM).

The vibration channel features an advanced charge amplifier again with powerful anti-aliasing filters to deliver preprocessed data to the SOM for decimation and filtering down to 20 kHz and converted to the frequency domain as well as the time domain.

On the independent shock channel, the output from the measuring sensor is processed with anti-aliasing protection down to 50 kHz.

Finally, the fourth channel is designed as expansion and could be used to monitor the output current of the unique differential digital 600-Watts Power amplifier so that the current into the shaker can be compared to the motion measured by the sensor for the health and maintenance of the system.

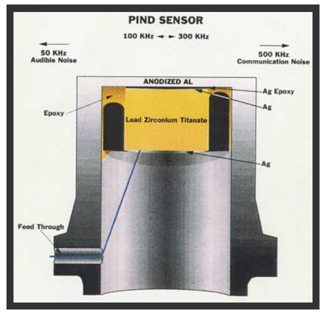
Motion is generated by the digital output channel with full anti-imaging filters which feeds the Digital Power Amplifier to generate both the vibration and the shock excitation. Yes, the shock is also computer generated!

In the PIND Test, the particles are never measured directly. We put loose particles in motion with a vibration, shock, and then detect the impacts of those particles as they contact the lid of the cavity.

PIND detection

Acoustic energy, generated by the particle impact with the cavity lid, propagates as an acoustic wave through the material until it reaches the sensor wear plate. The acoustic pressure causes it to deflect slightly pushing on the crystal, which then generates an electrical output.
Please note that if the signal is forced to propagate further such as through the substrate, it will lose significant energy.

For maximum sensitivity, Impact sensors use a piezoelectric element of Lead Zirconate Titanate (most often called PZT-5A) at peak resonance. These are simply the most sensitive detectors available capable of detecting surface displacements of less than 10^{-11} meters.



Their exact sensitivity and resonant frequency can both vary at time of manufacture and over time with use. For military specifications, the frequency of resonance is allowed to vary from 150 to 160KHz.

Single crystal sensors

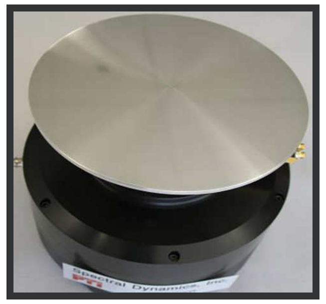
The sensor is defined in terms of its longitudinal sensitivity in the physical parameter of pressure as
-77.5dB+/-3dB ref 1V/microbar as described in the absolute calibration method of ANSI S1.2-1988, using a full-field three sensor underwater reciprocity calibration technique to accurately measure the crystal response.

Less accurate methods of sensitivity measurement used include capacitive pickup calibration or ultrasonic white noise calibration, which can be used to measure the sensor output but are only relative measurement methods and can be made accurate only by referencing the absolute underwater calibration method.

All Spectral Dynamics PIND sensors have a complete Faraday shield around each crystal to protect the sensor from unwanted stray electrical signals. This protection enhanced by the five-conductor, seven-layer flexible circuit that attaches the sensor to the shaker mounted connector eliminates the need for transient detectors with spike indicators required on other PIND systems.

The sensor peak sensitivity can be dampened by a variety of factors but the most common reason for
sensors to lose sensitivity over time is the bond that holds the crystal to the front surface wear plate will begin to micro crack with use and age.

Multiple crystal sensors



As the sensor crystal and the source of the acoustic wave get farther apart the measured energy is reduced. JEDEC Recommended Practice 114, graphically outlines the decay of detection down to less than 50% at distances over 0.75 in (1.9 cm) from the impact site.
For the PIND test it is then important that the lid of the part to be tested be placed as close to the crystal in the sensor as possible.
For instance, the Model 100-5S155-4 sensor from Spectral Dynamics incorporates five separate impact detection crystals within the single sensor. The most sensitive area of the sensor are those areas where each detection crystal is located. For testing small parts, it is important to place the part directly on one of the four target areas.

Vibration

The particles are put into motion by vibrating the electronic component on top of the shaker at a fixed frequency. The accuracy of the shaker motion is required to be within 10%. For the Heavy Duty 4501-M230 shaker, with the larger 100-5S155-4 multiple crystal sensor the capacity is within tolerance at 130 Hz to above 400 grams. Moreover, vibration levels can be increased or decreased thanks to a boost capability. Only the test is affected without any change in the calibration.

Shock

The shock is used in the PIND test to free particles that adhere to the cavity wall. The smaller particles are more prone to exhibit the property of adhesion and stop moving during the vibration cycle.

The shock amplitude must be held to within 20%. Unique to the PIND FELIX™ system is an "Active Shock". The computer controls of the shaker motion which is active during the shock until the striker in the armature collides with the shock anvil deep inside the shaker. The shock is created when the armature, which has computer controlled velocity, stops. This creates a dynamic shock pulse that travels up the sensor to the DUT. The computer control allows a programming change to shock amplitude to accommodate the larger loads. Older mechanical shocks using a spring-loaded tapper actuated shock must be reset by manually adjusting the screws for any parts that weigh over 25 grams.

The PIND shock is calibrated and programmable from 300 to 2000 g's and the display reads the calibrated value of the shock waveform during the test for the actual DUT. In addition there is a selectable boost for heavier parts or a negative boost to get lower values than the calibration range. In this way the dynamic conditions are always monitored and accurate throughout the variety of test conditions and devices being tested.

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Felix™

PIND FELIX™ SPECIFICATIONS

SPECIFICATIONS for SPECTRAL DYNAMICS MODEL FELIX™-M4 PIND TEST SYSTEM

The Felix™-M4 system is designed to test both small parts and large parts on one system. The unique 100mm diameter sensor has five (5) detection crystals and attaches onto a convective cooled low-profile Neodymium magnet shaker with a single 10/32 screw. This modular design allows for field replacement of the sensor. The system adjusts the power to the shaker to accommodate weights from 0.1 up to 360 grams. At vibration frequencies of 60 Hz the system can test DUTs that weigh over 400 grams.

System includes

2600-9702-2	Computer-based Controller and analyzer Main chassis with four input channels, one output channel computerized
2600-9701-2	DPA600 digital power amplifier 600 Watts
4501-M230	Heavy duty PIND vibration and shock shaker (34 force-pounds - 150 Newtons)
2600-9501	W10 Pro Laptop with ethernet connection
2600-FELIX	Windows 10 Software including adjustable amplitude, timing, frequency for vibration as well as adjustable amplitude for shocks.
100-5S155-4	100 mm diameter surface impact sensor / accelerometer with five crystals
100-S140BM	Sensitivity Test Unit (STU)
4501-500065-A	External STU pulser control box
2600-9455	Kit, FELIX™ accessories including:
110-SCM4-Y	BNC-microdot accelerometer cable (yellow)
110-SCM4-B	BNC-microdot acoustic sensor cable (blue)
110-SCM4	Sensitivity test unit (STU) cable (white)
W080-0211	Controller to shaker drive cable
W080-0370	Power cable for controller
1762-7042	Cable, CAT6 crossover
1762-7044	Cable, CAT6 ethernet
1923-2098	Cable, BNC-BNC jumper
LT-FELIX	Operation/maintenance manual
CH04-ACWS	4 oz bottle water soluble acoustic gel (120 ml)
4501-DOT1	22 mm double sided adhesive dots (or 50 mm adhesive dots ref. 4501-DOT2)
CALCERT	Calibration certificate

Shaker options

4501-M230	Heavy duty PIND vibration and shock shaker
4501-M230R	4501-M230 heavy duty shaker with wide pulse anvil included
4501-M230D	Heavy duty shaker with two magnets

Sensor options

100-S140C/A	Single crystal PIND sensor - 22 mm
100-S140C/AL	Single crystal PIND sensor - 50 mm
100-3S155-60	Multiple crystal PIND sensor - 60 mm Three crystals
100-5S155-4	Multiple crystal PIND sensor - 100 mm Five crystals : 1 in center with 4 mounted in a square at 50 mm

Impact sensor assembly specifications

Sensitivity (each crystal) -77.5 dB +/- 3 dB ref 1V per microbar at 155 kHz
Measured using ANSI 2.1-1988, underwater reciprocity
Cable integral four conductors fully shielded flex cable
EMI protection full Faraday shield including all cabling
Attachment fully field replaceable w/10/32 screw
Accelerometer 2.1 pc/g ±10 %, 100 Hz located inside impact sensor

Motion creation specifications

Vibration Frequency Range	25 to 250 Hz, sinusoidal
Amplitude (Amp.)	5.0 to 20.0 g peak, display on screen
Amp. Program Resolution	0.1 g
Repeatability	0.5 g pk for levels above 5g, with control
Adjust Maximum D.U.T. Test Weight without calibration changes	Maximum 400 grams over the entire range maximum 500 grams at 60 Hz
Shock creation 300-2000g Method	Active shock creation with computer control of shaker armature
Adapts Shock to D.U.T. Weight	
Amplitude	Programmable 300 to 2000 g
Repeatability	Within 50 g
Pulse Width	< 100 µsec. at 50% Amp. / 90-150 µsec. at 10% Amp.
Shock Delay	Adjustable timing
Max. D.U.T. Test Weight without calib. changes	Amplitude falls slightly with load Maximum capacity 400 grams with 1000 g amp. (may require programmed value to be increased)

Sensivity Test Unit (STU)

Sensor sensitivity	77.5 dB +/- 3 dB ref 1V per microbar at 155 kHz reference ANSI 2.1-1988.
Ext. STU pulser output	250 microvolts +/- 20 %

Maximum weight specification

Shaker limitation	500 grams
Vibration limitation	400 grams w/ sensor 40-250 Hz
Shock limitation	400 grams (may require programmed value to be increased)

Electrical specifications

Power requirements	Automatically selected from 100 to 240 VAC at 50 or 60 Hz
Power Consumption	Maximum 600 Watts
Acoustic Detection Circuity	60 dB Gain +/- 2 dB 150-160 kHz Software Band pass filter
Threshold	Dynamic adjustable

In keeping with our commitment to continuous product improvement, the information herein is subject to change.