FELIX Computer Aided Test System for Particle Impact Noise Detection

SPECTRAL DYNAMICS

32234 Paseo Adelanto, Suite G, San Juan Capistrano, CA 92675
Telephone: 760-761-0440 FAX: 949-481-9644

For over fifty years the 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 non-destructive high frequency acoustic test monitors for loose particles moving inside high reliability internal cavity electronic components such as relays, transistors, hybrids, 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 feedback controlled by electronics, monitoring the motion of the sensor, is employed.

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

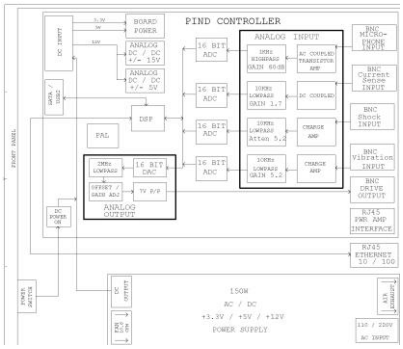
SD FELIX PIND SYSTEM

ADVANCED TECHNOLOGY THAT'S EASY TO USE

Our SD FELIX M4, featured on the cover, is the **most advanced system available today.** Combining sensors that monitor and display the shaker motion with feedback control to correct for any changes in test conditions, the SD PIND test system **generates accurate and repeatable test conditions.** Its ultra-sensitive, ultrasonic (155 kHz) sensor with multiple crystals can detect particles as smaller than 15 microns in diameter impacting the package cavity.

The multiple computer technology not only controls the motion but also allows the user to program the motion including both shock and vibration at the precise "g" level to simulate the whole range of testing requirements. The interactive Windows10 interface allows the operator to enter the desired stored test sequence or enter a new configuration with variable amplitude of shock or the amplitude duration and either vibration frequency or cavity height. The SD system then calculates the appropriate frequency and generates the proper shaker motion — automatically.

- Data is Acquired
- Data is Displayed
- Data is used for Control
- Data is Stored for Further Analysis



FOUR UNIQUE CHANNELS OF DATA ACQUISITION

The FELIX system uses four unique channels of data collection. All four channels use the same clock to digitize the data at 2.5MSamples 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 2MHz. The tiny signals created by the crystal are increased in size to be digitized without aliasing and the data is sent to the onboard Computer System on Module.

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

In a separate shock channel, the output from the measuring sensor is processed with anti-aliasing protection down to 50KHz.

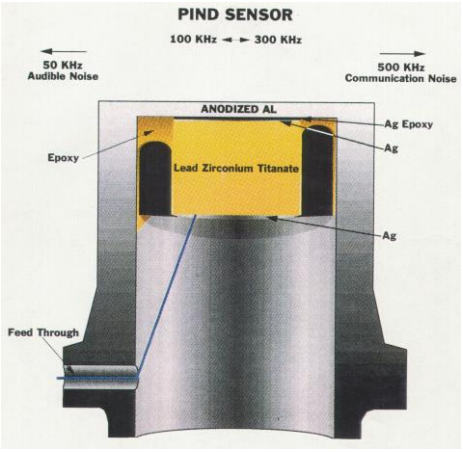
Finally, the fourth channel is the current output of the unique differential digital 600-Watt Power amplifier so that the current into the shaker can be compared to the motion measured by the sensor for the health and maintenance of the system.

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 controlled!

In the PIND Test, the particles are never measured directly. We put loose particles in motion with a vibration, keep them in motion with a 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 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.



To get 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 miliitary 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.

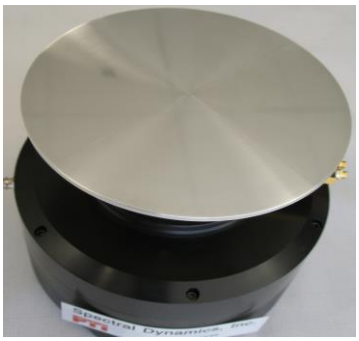
Less accurate methods of sensitivity measurement used include capacitive pickup calibration or ultrasonic white noise calibration, which can be used to measure the sensor output but are only relative measurement methods and can made accurate only by referring back to the absolute underwater calibration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

All SD 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 older 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 is down to



less than 50% at distances over 0.75 in from the impact site. For the PIND test it is then important that the lid of the part to be tested be placed a close to the crystal in the sensor as possible.

The Model 100-5S155-6 sensor 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

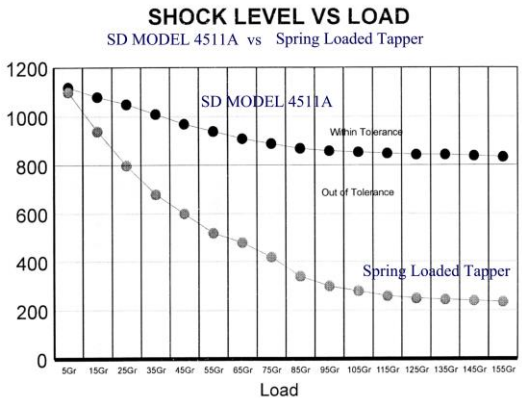
The particles are put into motion by vibrating the electronic component on top of the shaker at a fixed frequency. The accuracy of the shaker motion is required to be within 10%. For the Heavy Duty M230 shaker, with the larger 100-S140C/AL sensor the capacity is within tolerance at 130 Hz to above **420 grams**.

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 SD PIND system is the feedback control of the shock pulse. As shown below, the control holds tolerance over the entire load range while the older spring-loaded tapper actuated shock must be reset by manually adjusting the screws for any parts that weigh over 25 grams.

The SD PIND shock is programmable from 100 to 2500 g's and the display reads the calibrated value of the shock for the actual part under test. In this way the dynamic conditions are always monitored and accurate throughout the variety of test conditions.



UNIQUE FEATURES OFFER CONVENIENCE AND FLEXIBILITY

Whether you're testing electronic components for cardiac pacemakers, manned spacecraft or undersea cables, you'll enjoy the convenience and flexibility of the special features which set our system apart from any other PIND test system.

- The SD FELIX system easily exceeds the requirements of all military standards for PIND testing (U.S. MIL-STD-883, 750, 202, 39016D) and since everything is in software it can be expanded for any test configuration imaginable.
- Imbedded sensors that monitor and display the actual shaker motion with feedback control to correct for any changes in test conditions, the SD FELIX test system generates accurate and repeatable test conditions.
- The unique SD FELIX PIND shaker creates accurate shock levels by controlling the velocity of the shaker head and correcting for device differences prior to impact.
- The SD FELIX system offers a low profile, low stray magnetic field design that eliminates any need for an expensive special test bench, required for conventional shakers with external shock fixtures.
- The SD FELIX system is an all-DIGITAL system with no knobs or screws to adjust. It is **fully programmable** to your own specifications or as required by MIL standards. -allowing the user to enter different amplitudes, frequencies, and durations. There is future expansion to more complex motion environments including Random Vibration and advanced Shock conditions.
- The SD FELIX system is fully automated at the touch of a button—or optional external activation that talks to Windows 10.

PROGRAMMABLE SOFTWARE FOR MORE VERSATILITY

The FELIX system utilizes the Modern features of the Windows10 User Interface. Because it utilized a true Windows interface it is readily compatible with Windows Office. Reports, printing, and Networking are easy and simple. Also using the latest and greatest Windows software insures that the latest security features are employed.

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 35-pound 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 400 grams. At vibration frequencies of 60Hz the system can test DUTs that weigh over 400 grams.

SYSTEM INCLUDES:

4540-FELIX	Main Chassis with Four Input Channels, One Output Channel Computerized Programmable Control
4540-DPA600	Fully Differential Digital Power Amplifier 600 Watts
4540-M230	Heavy Duty 34 Force-Pound PIND Vibration and Shock Shaker
4540-FELIX	Software including Low Frequency Amplitude Protection Vibration Amplitude Automatic Adjustments Sine, Stepped Sine, and Limited Random Frequency Vibration Adjustable Shock Delay Timing 25-250 Millisecond
100-3S155-4	50 mm diameter surface Impact Sensor/Accelerometer with Three (3) Detection crystals
(3) 110-SCM4	Low Noise BNC-Microdot Cables
100-S140BM	Sensitivity Test Unit (STU)
4501-500065A	External STU Pulsar Box
W080-0410, 0330, ETHERNET	Associated Cables
SD-LAPTOP	Windows10 Pro Laptop
4501-DOT2	50mm double sided adhesive dots
LT-FELIX	Operation/Maintenance Manual
Calibration Certificate	Mil-Std 45662A, Mil-Std 883H, 750, 202
WARRANTY	One Year Return to Factory Warranty (Parts and Labor)

VIBRATION SPECIFICATIONS:

Frequency Range	25 to 250 Hz, Sinusoidal
Other Vibration Modes	Automatic Stepped Frequency from 40 to 250 Hz
Low Frequency Program	Maximum Amplitude Protection varies with Frequency

Frequency Resolution	1 Hz
Time	0.1 to 25.5 Second per Program
Time Program Resolution	0.1 Second
Amplitude	0.1 to 25.50 'G' Peak, Display on Screen
Amplitude Program Resolution	0.1 'G'
Repeatability	0.5 'G' Peak for levels above 5g, with Feedback Control 1.0 'G' Peak for levels above 5g, with Feedback Control
Maximum D.U.T. Test Weight without calibration changes	Maximum 400 Grams over the entire range Maximum 500 Grams at 60 Hz

SHOCK SPECIFICATIONS:

Method	Feedback Control of Shaker Armature Adapts Shock to D.U.T. Weight
Amplitude	Programmable 100 to 2500 'G'
Program Resolution	10 'G'
Repeatability	Within 50 'G'
Pulse Width	<100 Microsecond at 50% Amplitude 90-150 Microsecond at 10% Amplitude
Shock Delay	Settling time after Shock Programmable
Maximum D.U.T. Test Weight without calibration changes	Amplitude falls slightly with load Maximum capacity 400 Grams with 1000 g Amplitude (May require Programmed value to be increased)

MAXIMUM WEIGHT SPECIFICATION:

Shaker Limitation	500 Grams
Vibration Limitation	350 Grams w/ Sensor 40-250Hz
Shock Limitation	400 Grams may require increasing Program Value

ELECTRICAL SPECIFICATIONS:

Power requirements	Selectable 100,120,220,240 VAC +/-10% at 50 or 60 Hz
Power Consumption	Maximum 600 Watts
Power Amplifier Rating	Maximum Dynamic Load ±210 Watts RMS
Acoustic Detection Circuitry	60 dB Gain +/- 2 dB 100-200 kHz Band pass
Threshold	Dynamic
Outputs:	
Acceleration Display	LCD plot
Frequency Display	Displayed on LCD
Threshold Crossing Indicator	LCD has indicator
Shock Level Display	LCD plot
Audio	4 Watt Internal Speaker

IMPACT SENSOR SPECIFICATIONS:

Sensitivity (each crystal)	-77.5 dB +/- 3 dB re 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

100-S155-4:

Number of Crystals	Five, one in center with four mounted in a square at 50mm
Diameter	100 mm (4 in)
Weight	250 Grams
Sensitivity area	Sensitivity within 6dB over a clover leaf pattern about 70mm diameter

ACCELEROMETER SPECIFICATIONS:

Sensitivity	2.1 pc/G +/- 10% at 100 Hz
Physical	Located inside Impact Sensor

STU SENSOR SENSITIVITY	-77.5 dB +/- 3 dB ref 1V per Microbar at 155 kHz Measured using ANSI 2.1-1988, Underwater Reciprocity
EXTERNAL STU PULSER OUTPUT	250 microvolts +/- 20%

PHYSICAL SPECIFICATIONS:

Control Unit	TPD
DPA-600	TPD
M230 Shaker	10cm High X 18cm Dia (4 X 7 in)