

# Terms and Definitions

## Inspection Methods:

**Pulse-echo:** Also called Reflected Mode. A transducer emits an ultrasonic signal into a sample and sound reflects off the sample back up to the transducer. One transducer is used for both emission and detection. The amount of sound reflected, the time it takes to return and the polarity of the signal can all be measured and stored in the computer. Pulse-echo works on the principal that sound reflects whenever a sudden change in density occurs, generally at material interfaces. The amount of density change determines the quantity and polarity of the sound reflected. The greater the change, the stronger the signal returned. Whatever sound does not reflect back travels through the part to the next interface encountered. The computer measures the time the various signals are returned, therefore depth specific information can be determined.

**Through transmission:** Also called Thru Mode, Through Scan or T-scan. A transducer above the sample emits an ultrasonic signal into a sample. Sound transmits through the sample and is detected by another transducer placed below the sample. All resultant data is transposed into one imaging plane, therefore data is obtained from the entire thickness of the sample and no depth-specific information can be determined. Through Scan works on the principal that if a defect is encountered at any depth within the part, the ultrasound is reflected and no signal is obtained from the receiver. Typically, these areas appear black in the corresponding image, while good material appears white or light gray. Through transmission imaging is primary used as a confirmation technique for pulse-echo data as no depth information can be obtained.

\* Simultaneous Pulse-echo/Through transmission image (PETT) and simultaneous Pulse-echo/Pulse-echo (PEPE), from both sides of the sample is available as optional equipment.

## Data Collection Types:

**C-scan:** A C-scan is a depth-specific slice (z held constant) of the x-y plane. The depth to be imaged is defined by the operator through the use of an electronic “gate”. Variations in the amount, polarity or time it takes for sound to reflect off the interface being imaged can be displayed variations in color in generated C-scan image. Bond integrity, material variation, cracks and so on can be imaged using this image type. This is the most common imaging type.

**B-scan:** A B-scan is a slice of either the x-z or y-z plane. Which plane is to be imaged is defined by the operator through the use of an electronic “gate”. Generally only used to look for package cracks or suspect non-planarity issues.

**A-scan:** An A-scan is an oscilloscope waveform when the transducer has x and y held constant. The start of the waveform is farthest left point on the waveform. Traveling left to right along the waveform represents sound traveling deeper in the z direction of the sample. This is the “raw data” used to create B-scan or C-scan.

## Imaging Techniques:

**Interface Scan:** The most common imaging technique. The operator places an electronic “gate” on the A-scan at the particular depth that is of interest. A C-scan is then generated only from ultrasonic data arriving from that particular interface. Information about bond integrity, cracking and so forth can be obtained using this technique.

**Material or Bulk Scan:** This C-scan imaging technique is used when a region of material is of primary interest. An electronic “gate” is placed on the A-scan usually between two interfaces so any anomaly contained within a particular material is imaged. A bulk scan can also describe when multiple interfaces are superimposed to form a single image. Information about porosity, cracks and material variation can best be imaged using this technique.

**Loss of Back Wall:** This C-scan imaging technique is used when an electronic “gate” is placed on the A-scan on an interface actually below the interface of interest. Air gaps found in any interface above will result in no signal reaching the interface being imaged. As a result the image is typically black in areas where there is a defect above and white or gray where all previous interfaces are well bonded. Typically used to confirm and verify the existence of defects suspected using other techniques. Also valuable technique for crack detection.

**TAMI Scan™:** This imaging technique involves the acquisition of numerous C-scan interface scans each at a uniform depth deeper within the sample. Typically, the operator places an electronic “gate” starting at the first interface of interest. A TAMI region is then selected spanning the entire region of the sample that is of interest. The computer then automatically generates many C-scan images each at a different depth within the sample. As a result many interfaces can be imaged with only one scan needed. Commonly used to obtain an accurate defect depth measurement or to ease the need to interpret the A-scan waveform.

## C-Scan Types:

**Peak Amplitude:** Imaging type where only the strength (typically measured in decibels) of the ultrasound returned is measured. Also used for through transmission imaging. A greater density change between materials causes more ultrasound to reflect from that interface and less to transmit further into the sample. Generally, greater reflections are displayed as brighter in the image.

**Phase Inversion:** Imaging type where only the polarity or phase (typically measured as positive, negative or zero) of the returned ultrasonic signal is measured. If the sound travels from a less dense material into a more dense material, a negative signal is returned. A positive signal is produced when the sound travels from a more dense into a less dense material. A complex mathematical algorithm can then be invoked that can automatically display red or yellow whenever an air gap is detected. Typically only used when imaging the top or backside of plastic integrated circuits. Only works when using the Interface imaging technique.

**Time-of-Flight (TOF):** Imaging type where only the time it takes for sound to travel to a particular interface and back is measured. Generally, if the interface being imaged is non-planar, relative to the surface of the sample, the shallowest areas are displayed as brighter in the image. Used primarily when non-planarity or thickness measurements are of interest. Only works when using the Interface imaging technique.

## Gate Types:

**Front Surface Follower(FSF):** Used as a trigger to help stabilize the position of the other subsequent gates. Effectively “tracks” movement of the front surface of the sample allowing for data gates to move dynamically to the variations on the front surface of the sample. System configuration settings do permit the FSF Gate to act as a regular data gate, however factory default settings turn this capability off.

**SubSurface Follower(SSF):** Works exactly the same as the FSF gate. Primarily used when internal sample geometry creates a non-planar interface above the interface of interest. When using a SSF gate, be sure all other gates are set to “track” the SSF gate instead of the FSF gate.

**Data Gate 1:** Used for generating a peak amplitude and/or TOF images in C-scan mode. Left and right vertical sides determine the depth (time) of the resultant C-scan image. Upper and lower sides determine the amplitude threshold setting. If the highest amplitude signal within the gate does not exceed the height of the data gate, no data is recorded. To create a TOF images using a data gate, the TOF button must be check marked.

**Data Gate 2:** Works exactly the same as Data Gate 1.

**TAMI Region:** OPTIONAL feature and not available on all Sonix system. Used to generate multiple peak amplitude images in C-scan mode. Requires Data Gate 1 to be enabled. TAMI region automatically starts at the left edge of the data gate. The length of the TAMI region determines the number of C-scan images generated. Date gates are placed end-to-end (user selectable) until the entire TAMI region is spanned. One peak amplitude C-scan image is generated for every data gate.

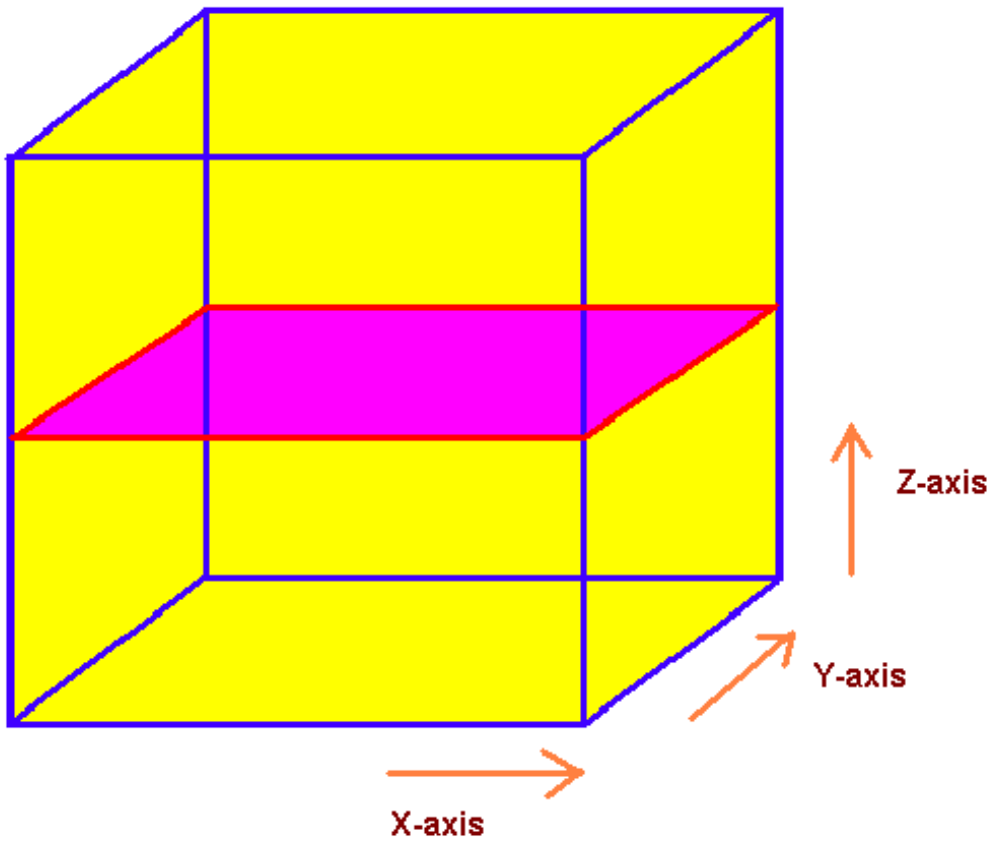
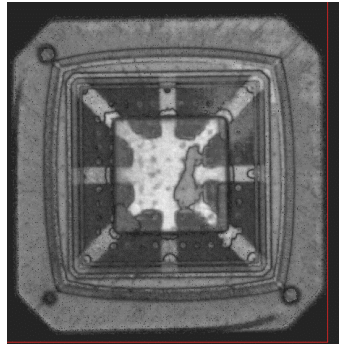
**Phase Gate 1:** Used for generating a phase inversion image in C-scan mode. Just like a data gate, left and right vertical sides determine the depth(time) of the resultant C-scan image. As well, the upper and lower sides determine the amplitude threshold setting. When viewing the “Expert Mode” of the phase gate setting, options allow for changes in the phase consideration and categorization settings. However, virtually all applications do not require changes in the Expert settings to be made.

**Phase Gate 2:** Works exactly the same as Phase Gate 1.

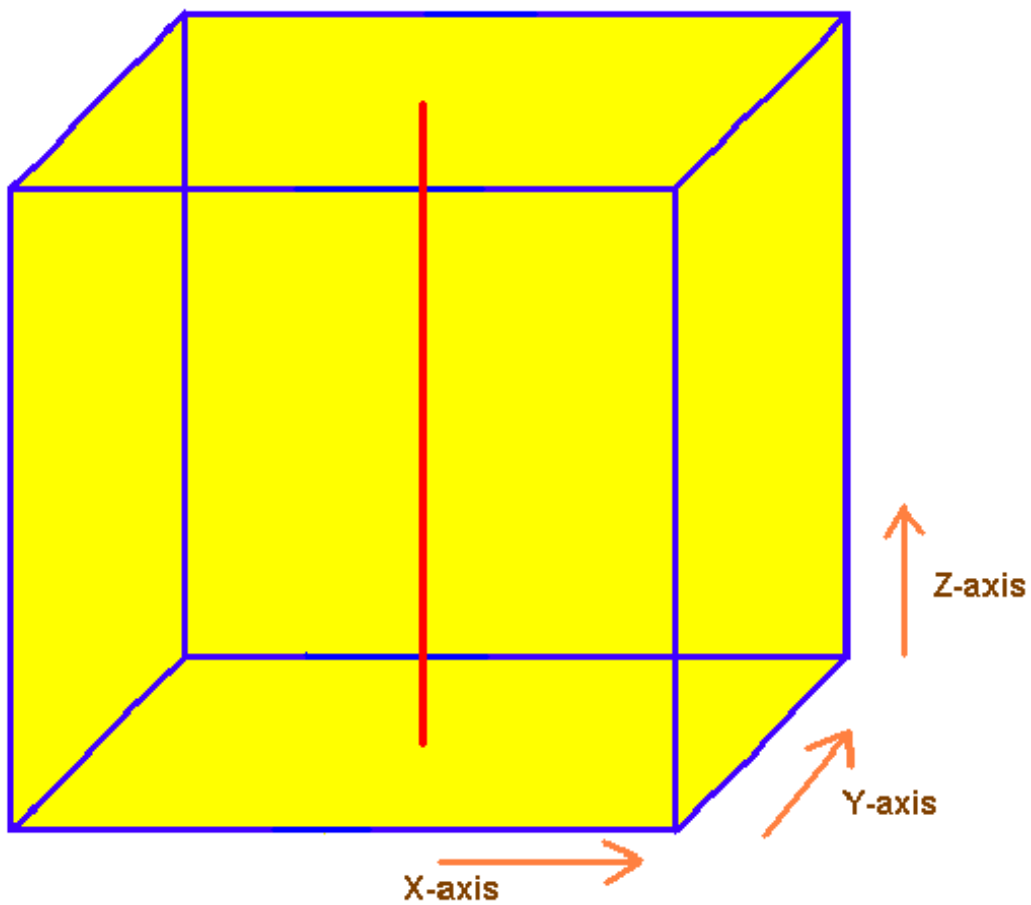
**B-Scan Gate:** Used for generating a B-scan, cross-sectional image of the sample. Left and right anchors on the gate determine the location and thickness of the B-scan slice. Requires a C-scan image to have already been performed.

**FFT Gate:** Used for Fast Fourier Transform functions to be perform on a section of the ultrasonic signal. Left and right anchors of the FFT gate determine what section of signal is analyzed.

# C-Scan



# A-scan



# B-scan

