Electronic Packaging

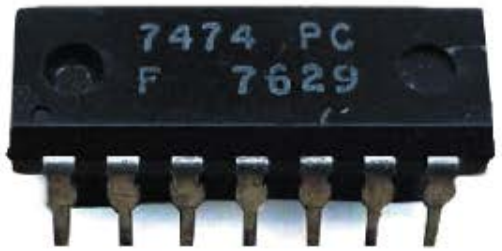
- Primary function is to provide electrical connectivity from the semiconductor device to a Printed Wiring Board (PWB) or Printed Circuit Board (PCB):
  - Provides a path for power to be applied to the chip
  - Provides a way for data signals to be transmitted into and out of the chip
- Secondary function is to house and protect the chip from harsh environmental conditions.
- Also provides a pathway for dissipating heat generated by the chip.

Types of Electronic Packaging

Through-Hole Devices

Long leads are inserted through holes in the printed circuit boards.

DUAL IN-LINE PACKAGE (DIP)



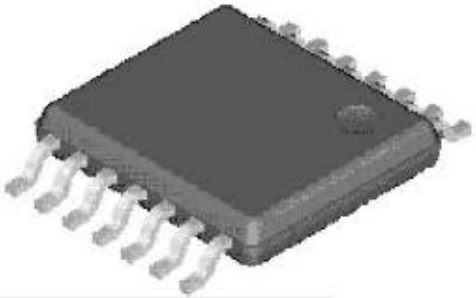
J-LEAD PACKAGE

Types of Electronic Packaging

Surface Mount Technology (SMT)

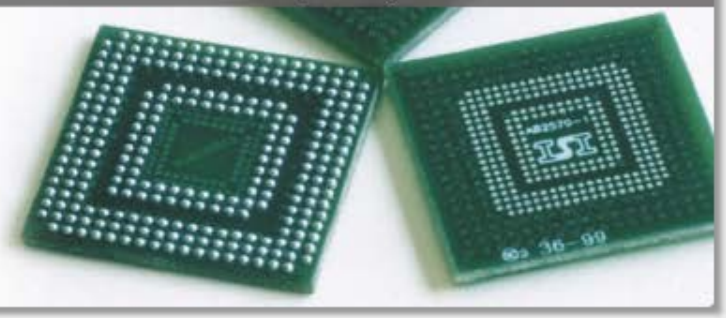
Electronic packages mount directly to rectangular pads on the surface of the printed circuit boards.

GULLWING *(Small Outline Package)*



QUAD FLAT PACK (QFP)

BALL GRID ARRAY (BGA)



Types of Electronic Packaging

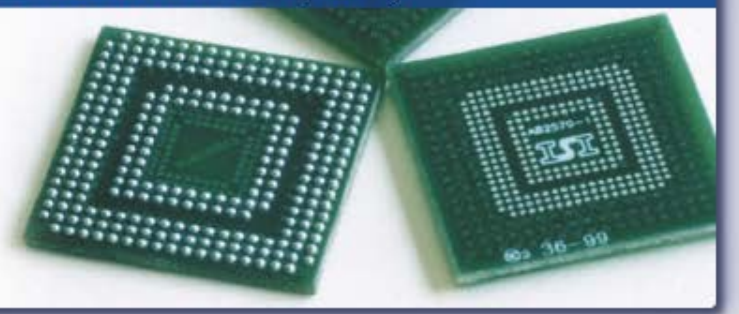
Surface Mount Technology (SMT)

Electronic packages mount directly to rectangular pads on the surface of the printed circuit boards.

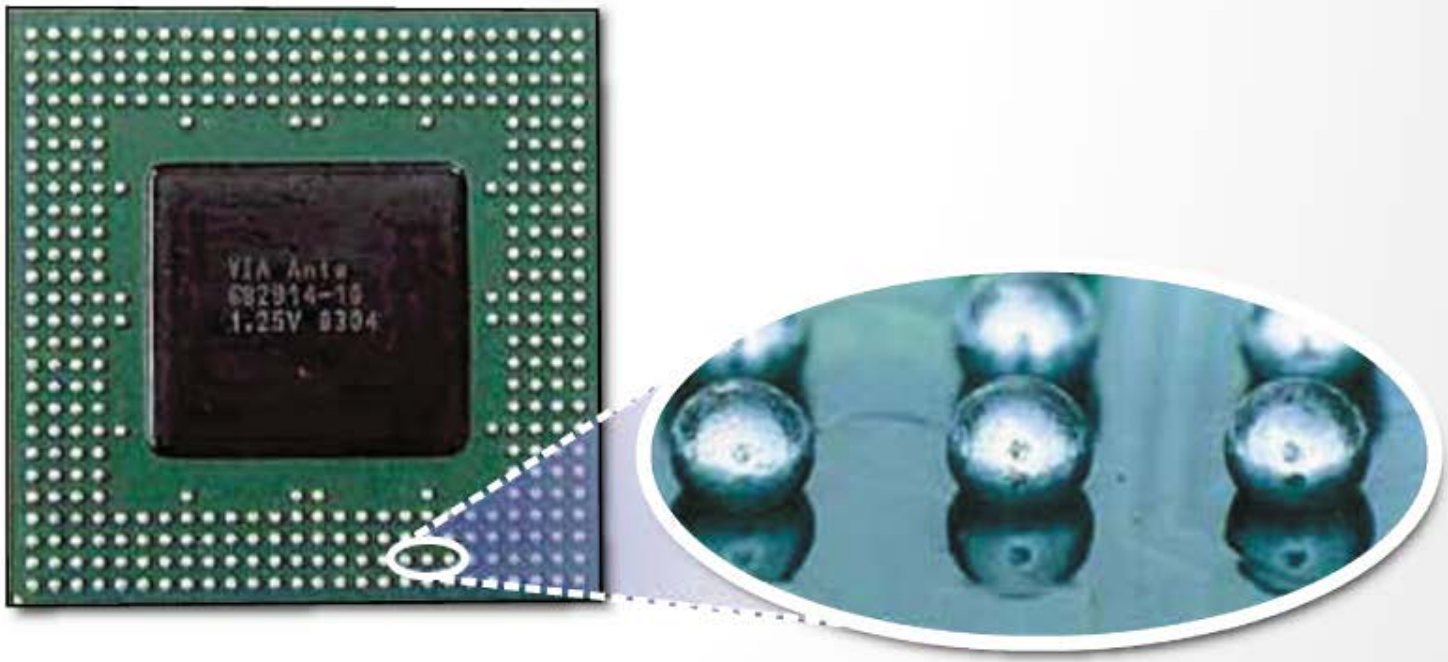
GULLWING *(Small Outline Package)*

QUAD FLAT PACK (QFP)

BALL GRID ARRAY (BGA)



Billions of BGAs Are Produced Every Year

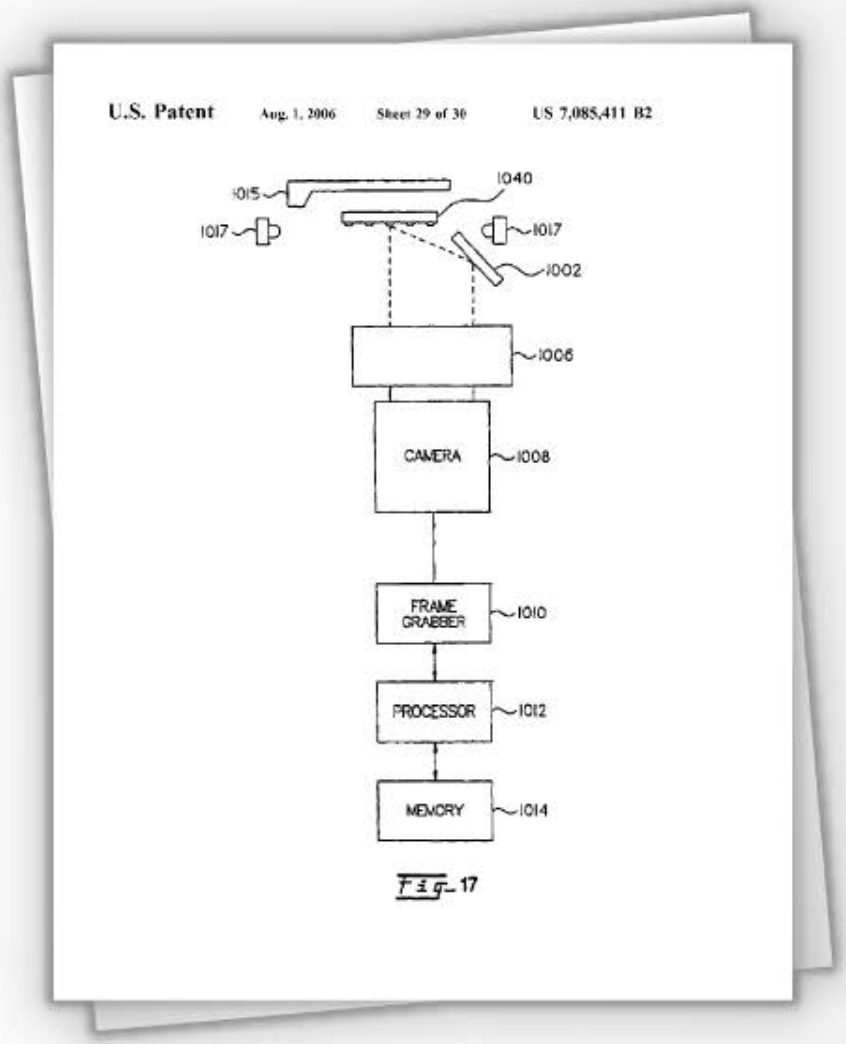


The Need for a Method and Apparatus to Inspect BGAs

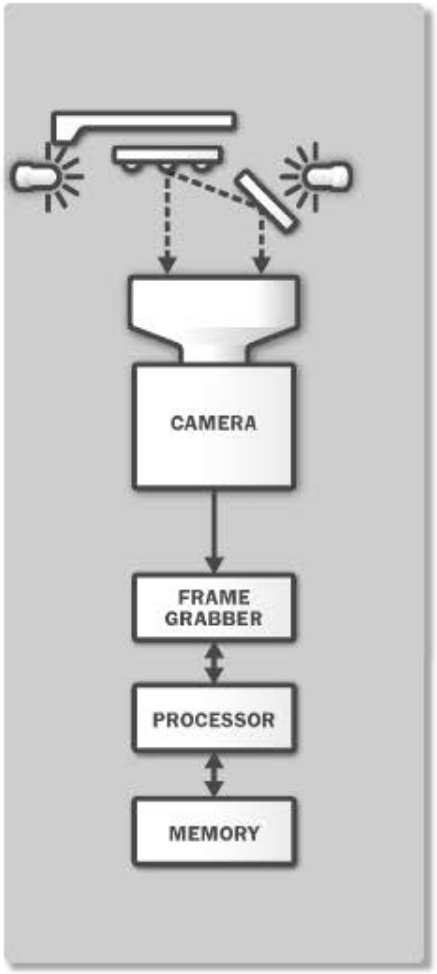
- All of the solder balls on the BGA must be positioned in a precise location and be exactly the same height.
- Minute differences in location or height in any one ball in the array can render the BGA useless.
- It is not economical to repair BGAs, therefore a defective BGA usually means the entire electronic device must be discarded.
- A fast and efficient method of inspecting BGAs to identify defective packages was needed.

Method of Inspecting BGA Part Disclosed in the '411 Patent

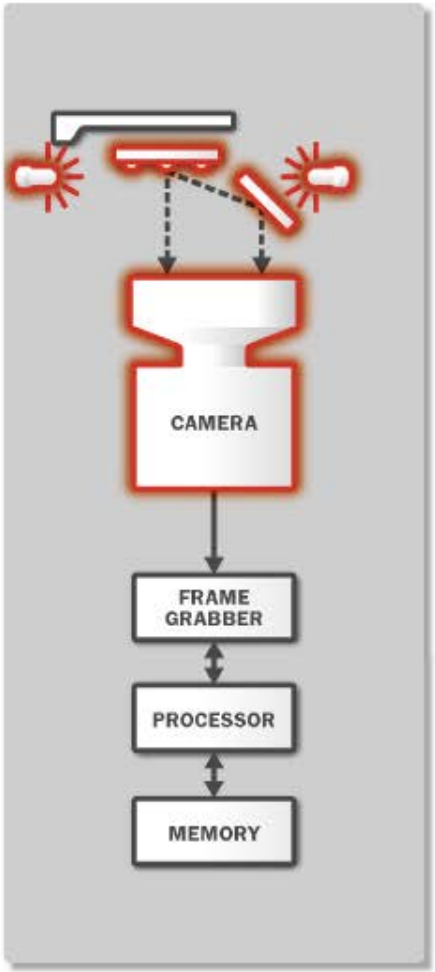
FIGURE 17 OF THE '411 PATENT

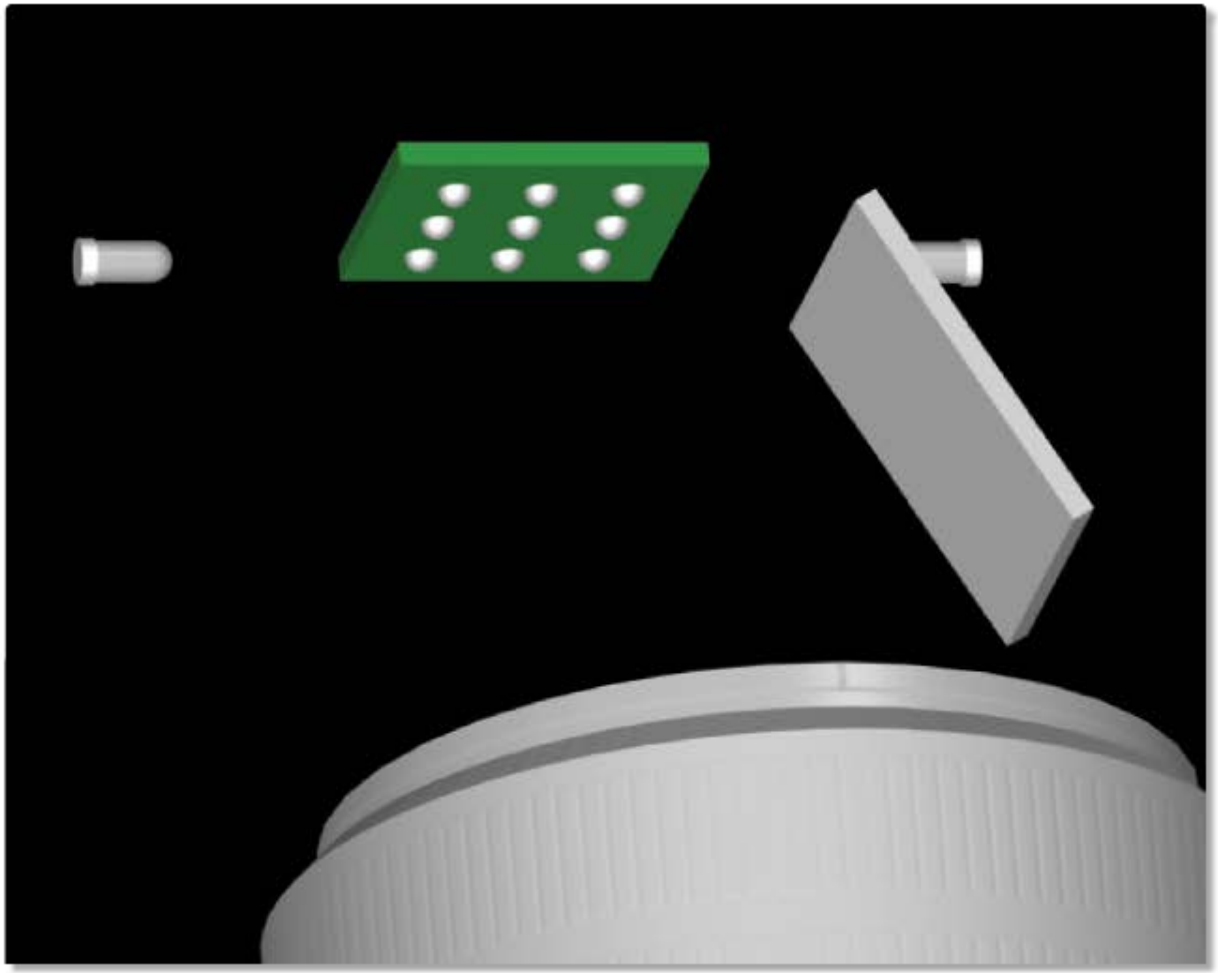


Method of Inspecting BGA Part Disclosed in the '411 Patent

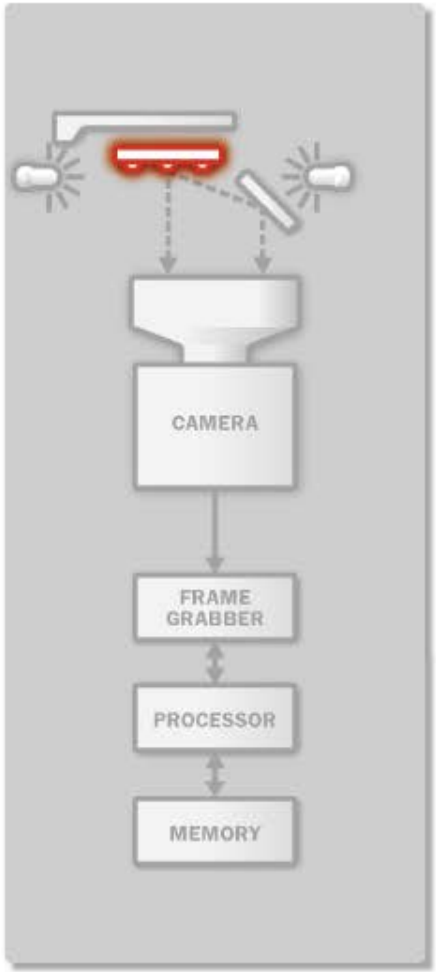


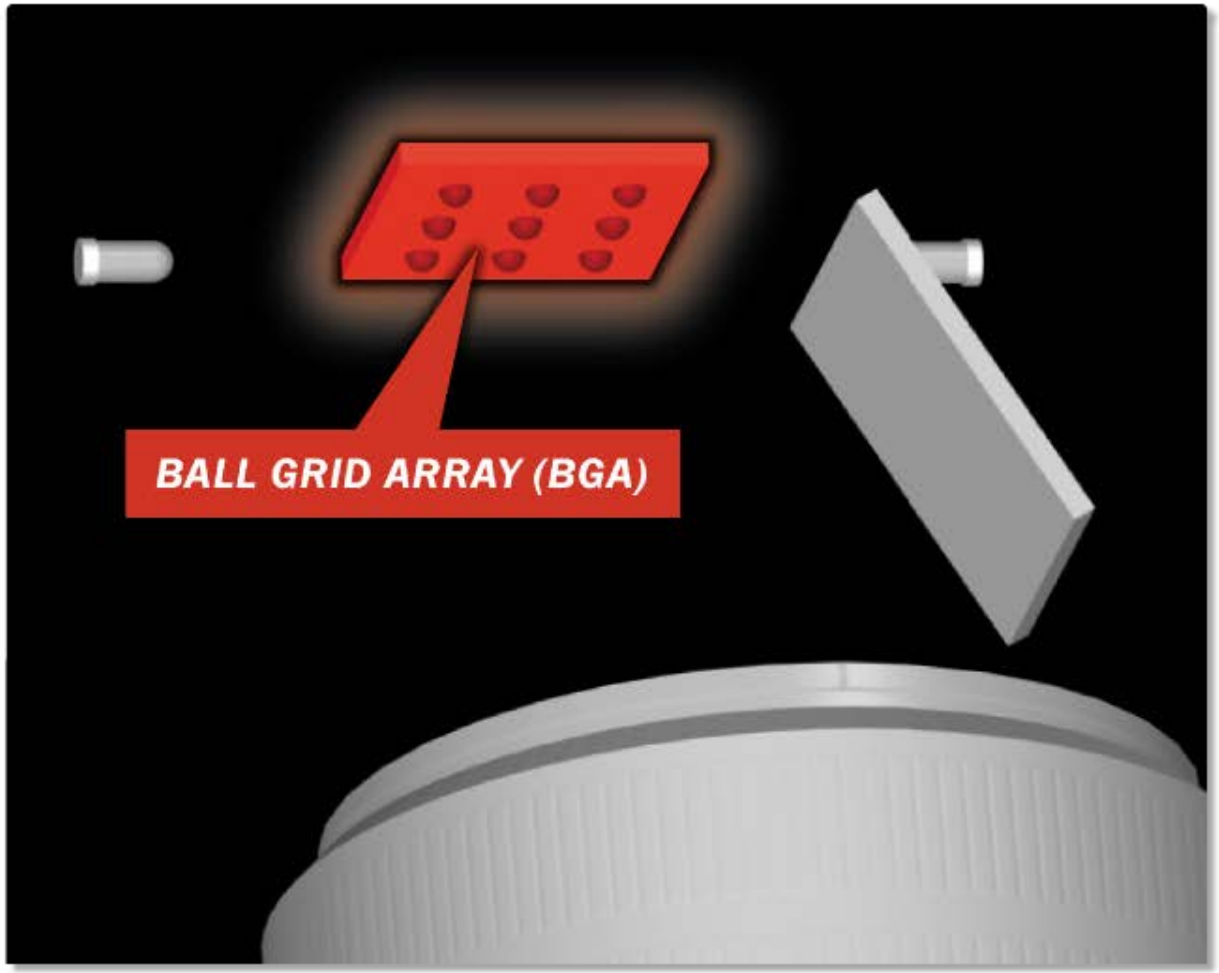
Method of Inspecting BGA Part Disclosed in the '411 Patent



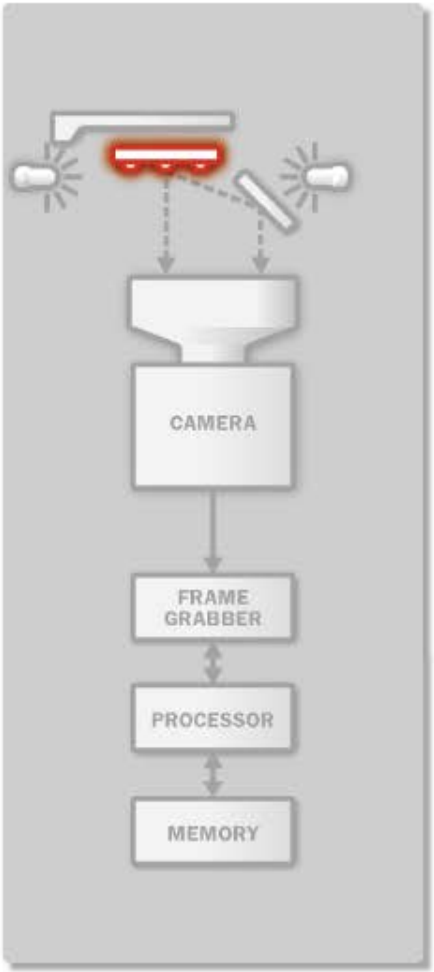


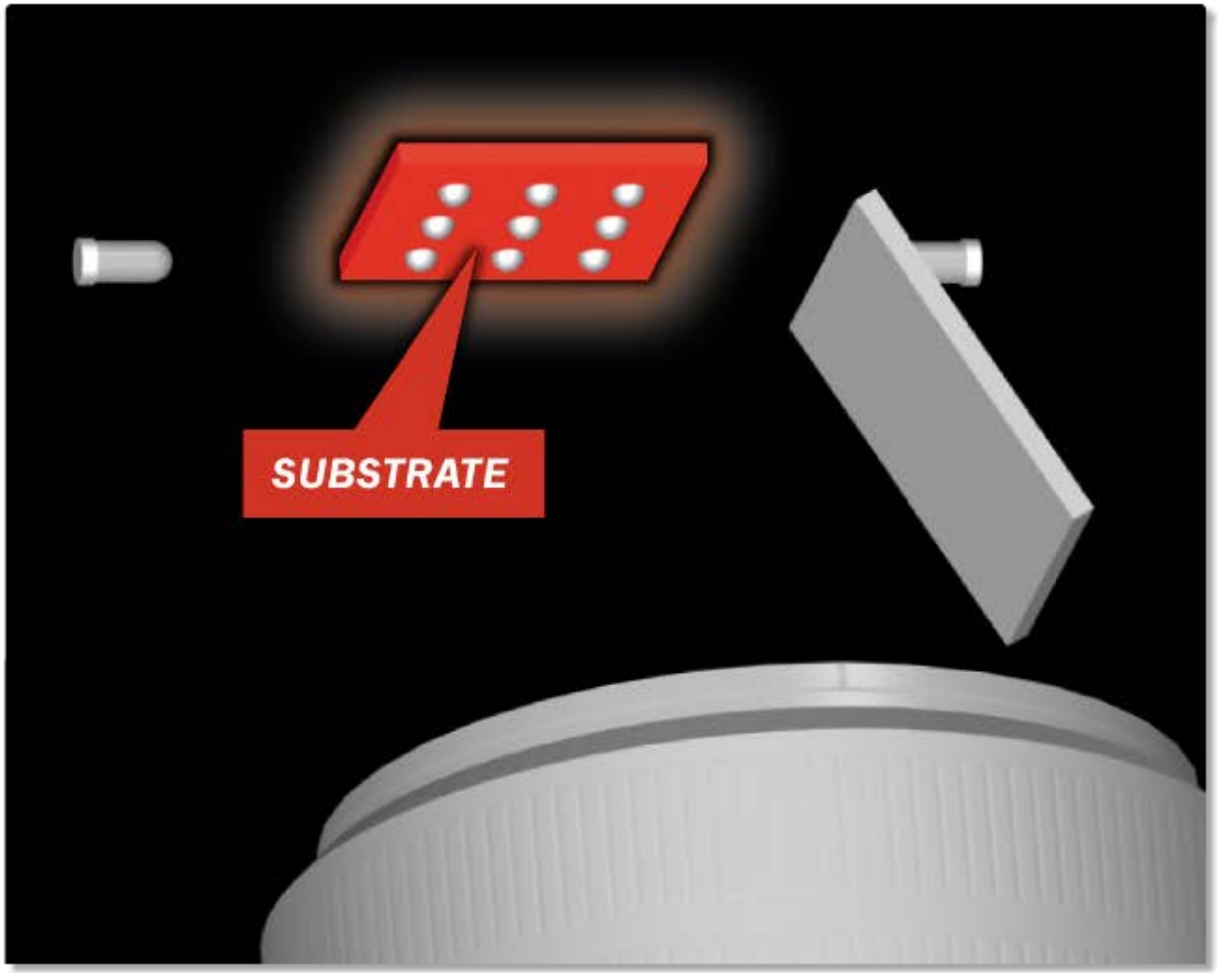
Method of Inspecting BGA Part Disclosed in the '411 Patent



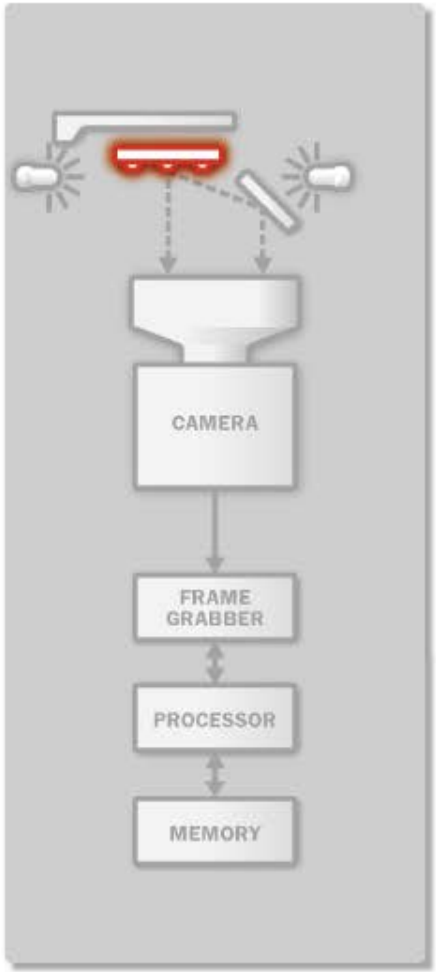


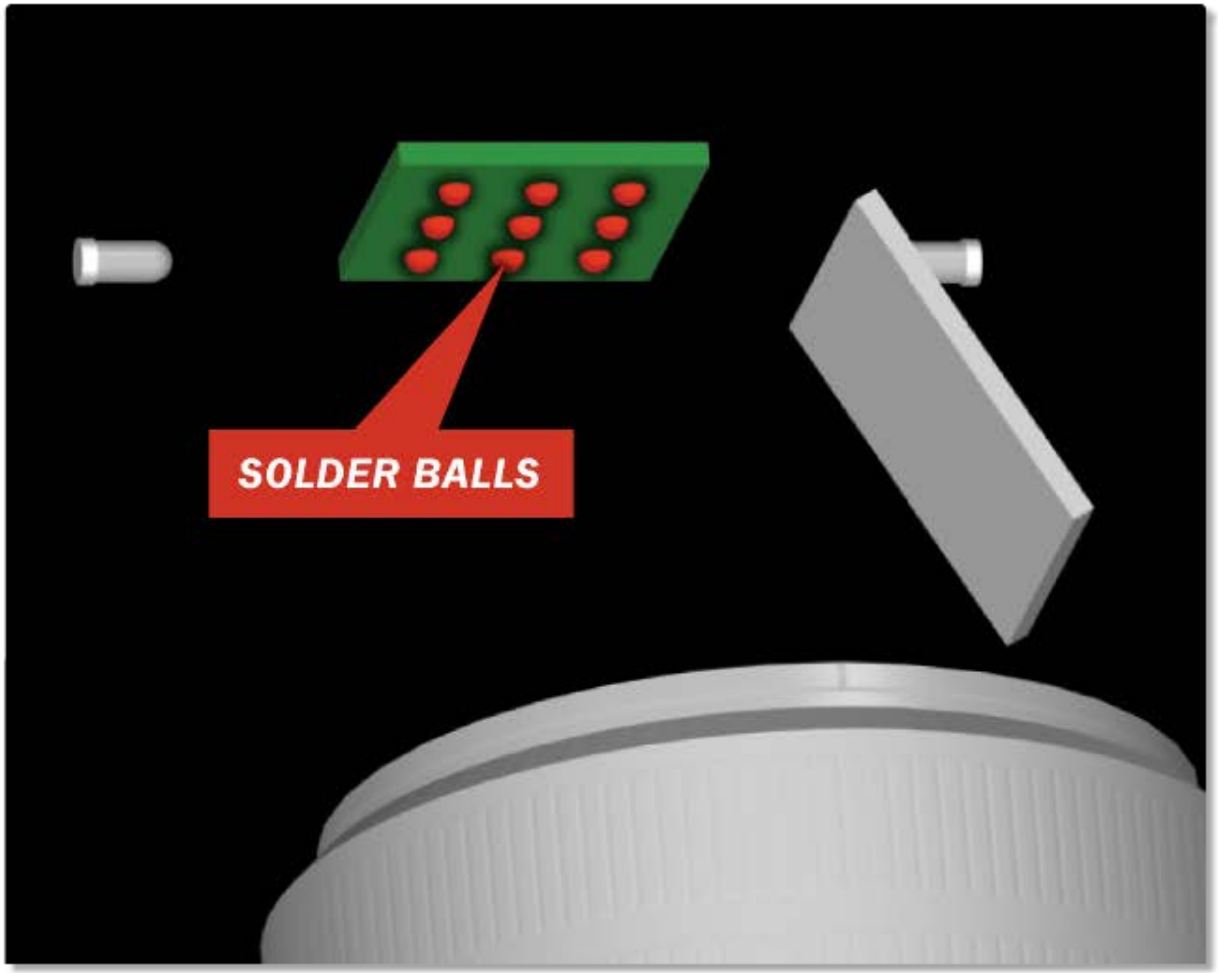
Method of Inspecting BGA Part Disclosed in the '411 Patent



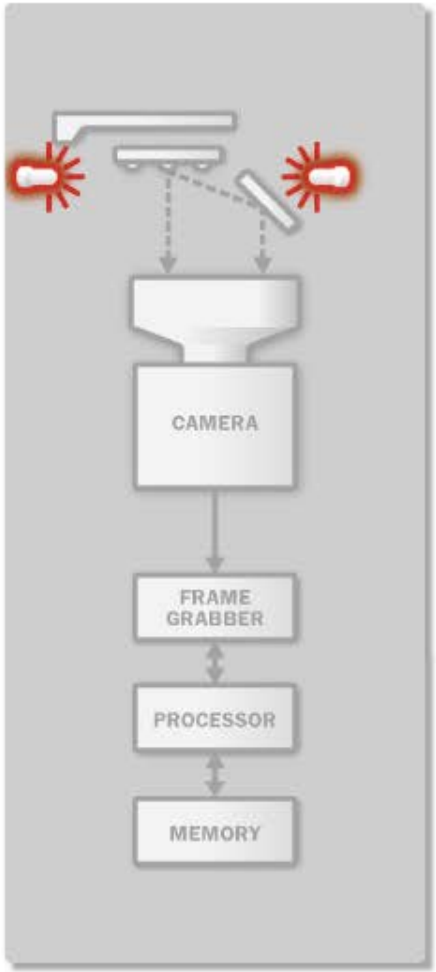


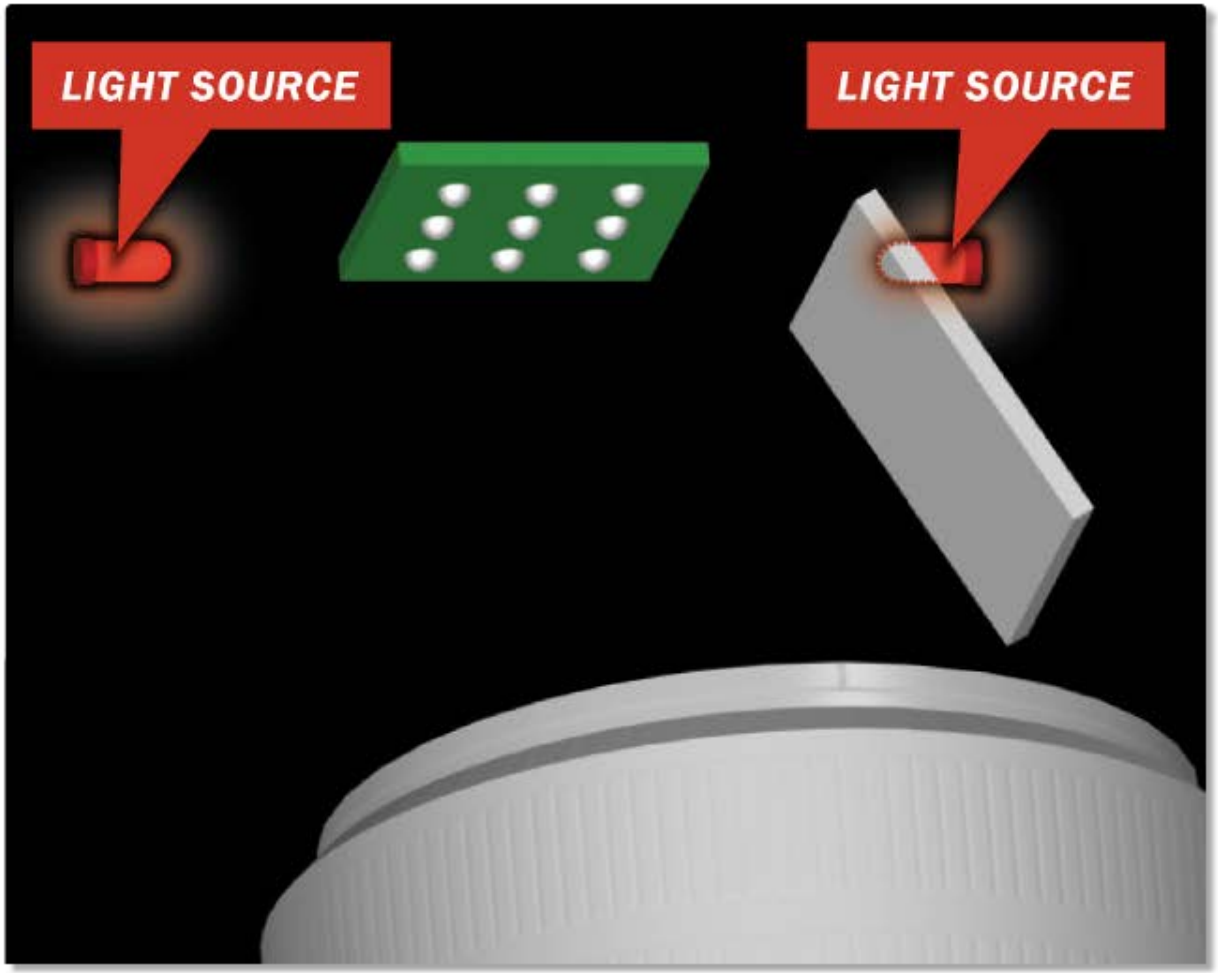
Method of Inspecting BGA Part Disclosed in the '411 Patent



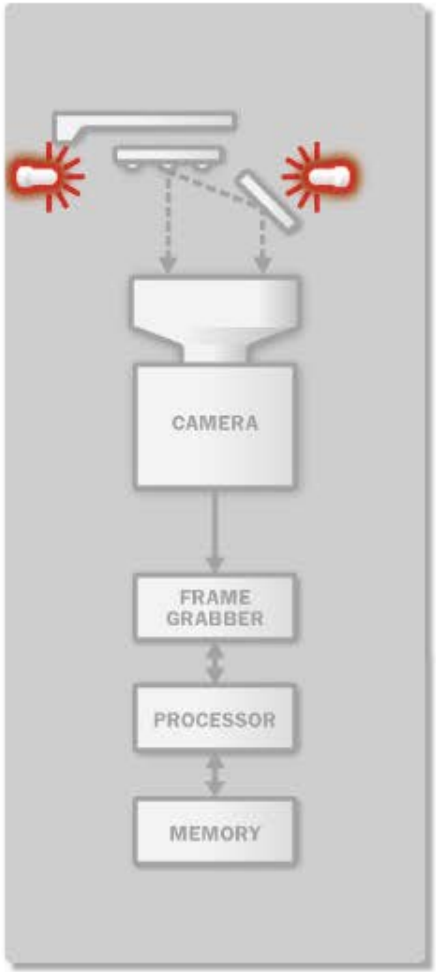


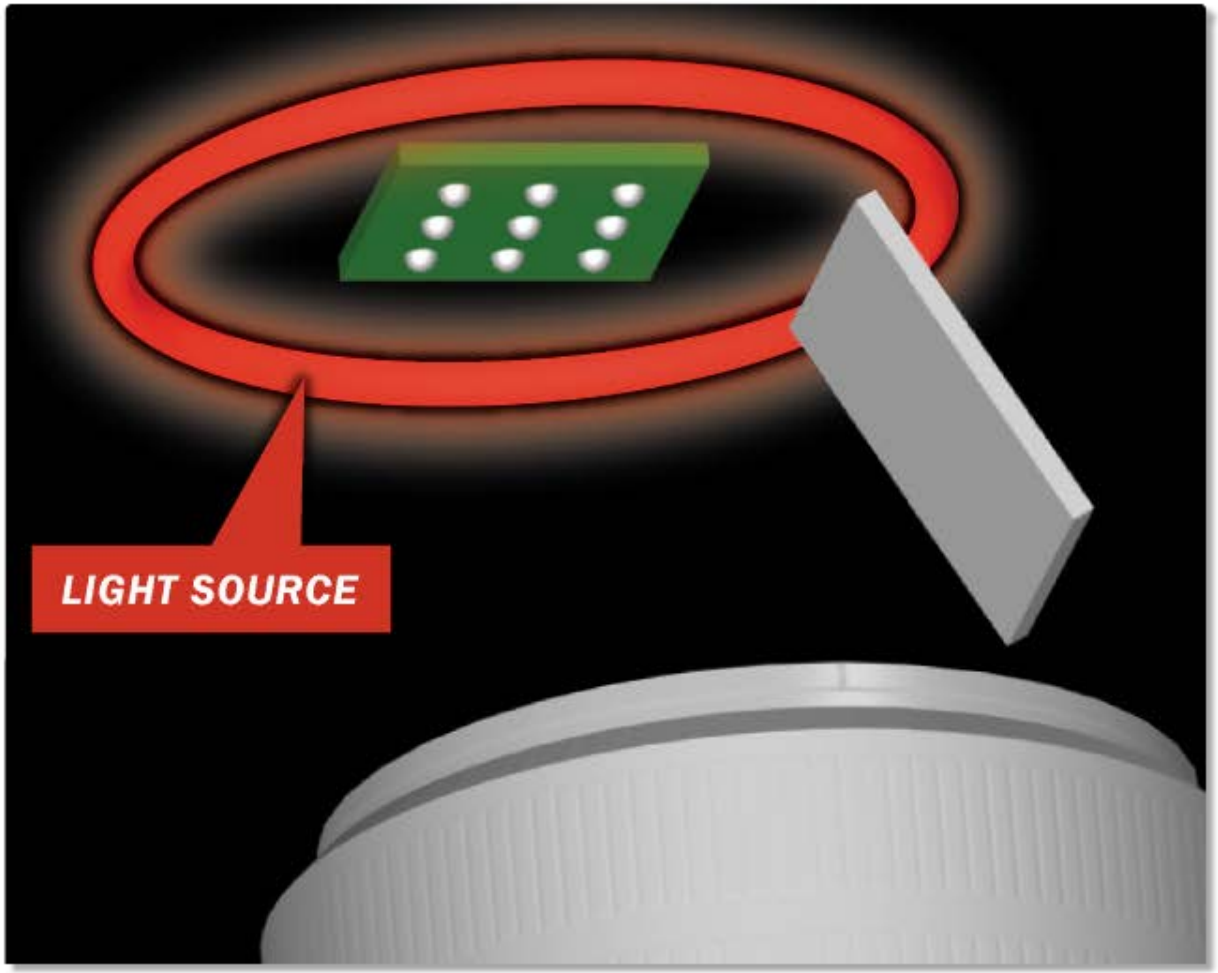
Method of Inspecting BGA Part Disclosed in the '411 Patent



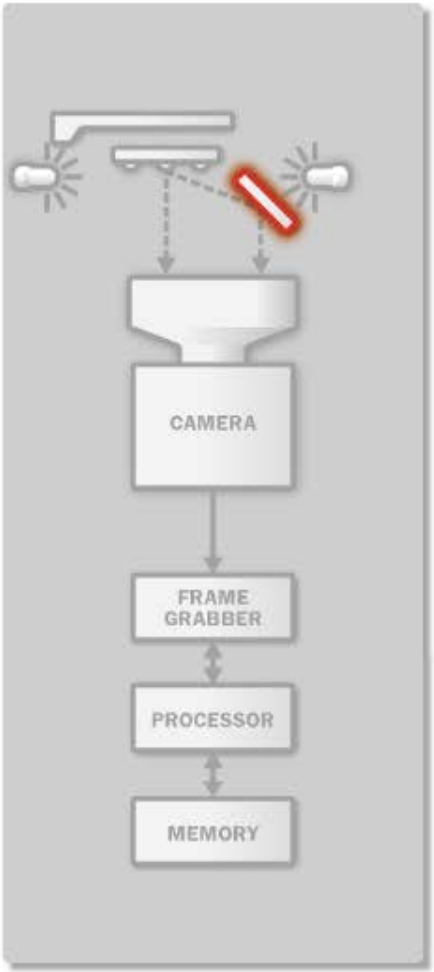


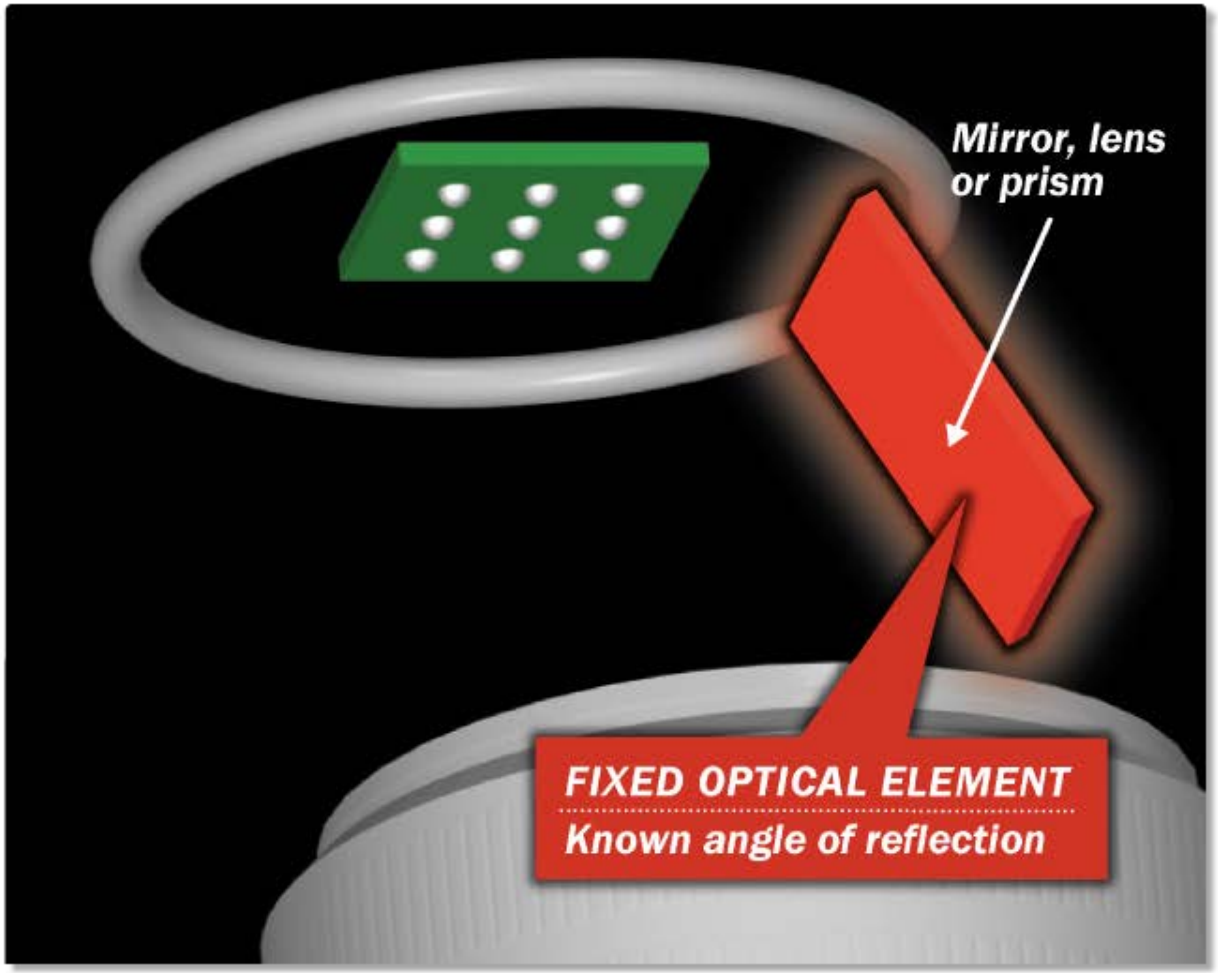
Method of Inspecting BGA Part Disclosed in the '411 Patent





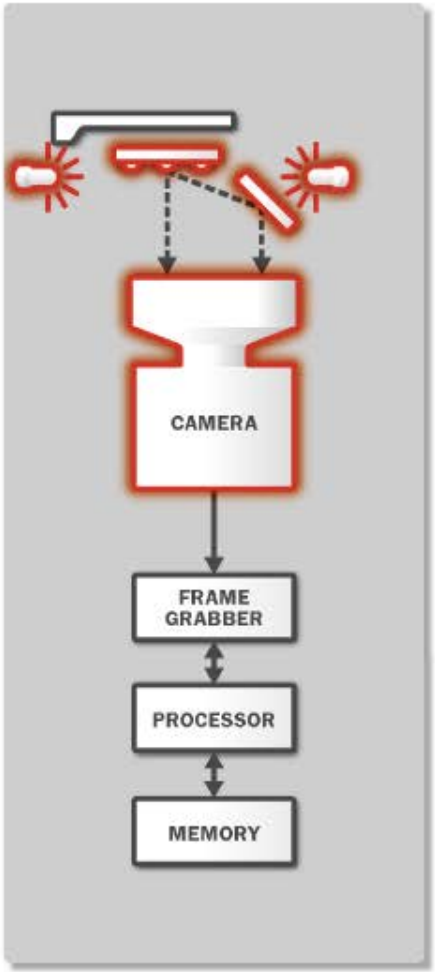
Method of Inspecting BGA Part Disclosed in the '411 Patent

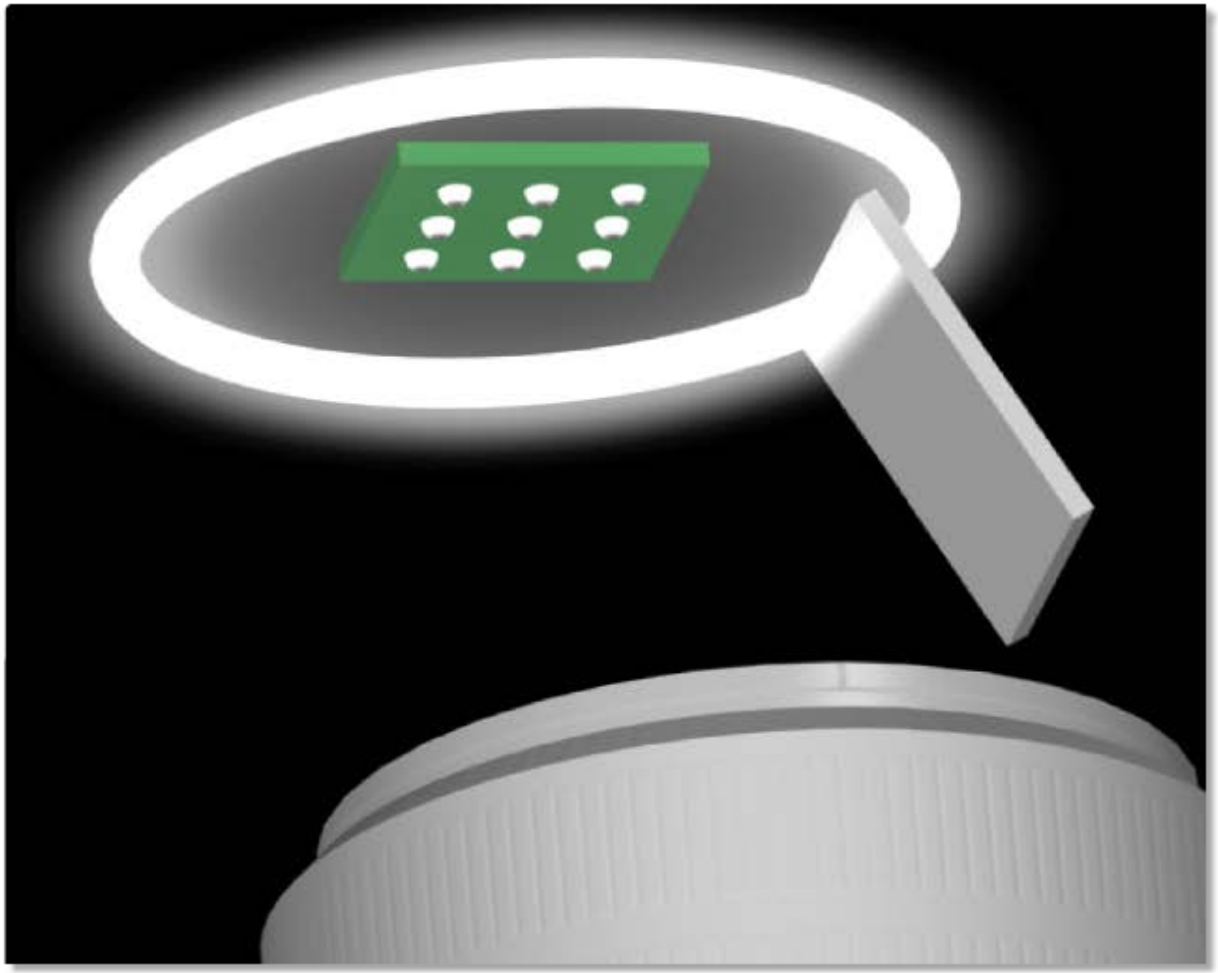




Method of Inspecting BGA Part Disclosed in the '411 Patent

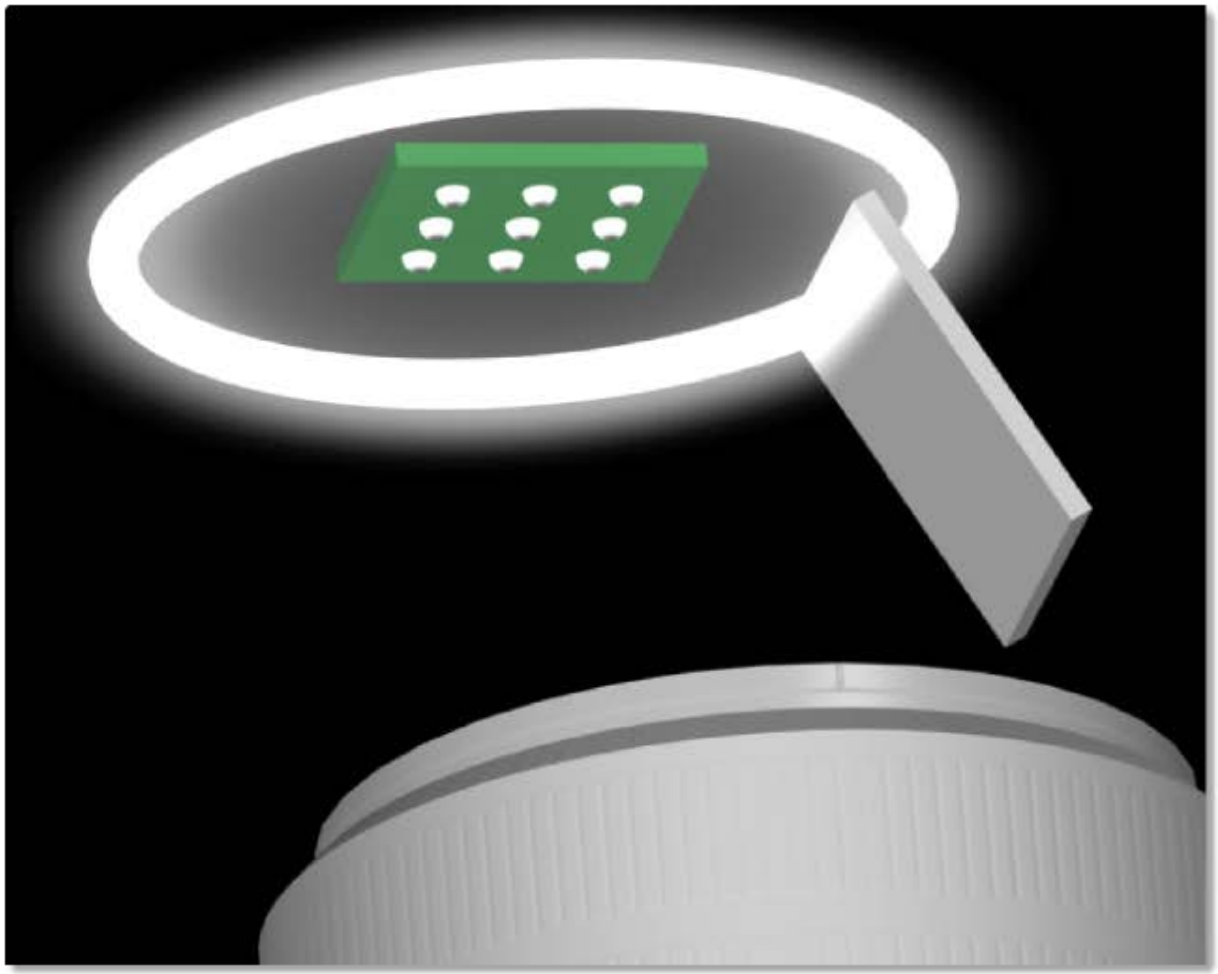
ILLUMINATING THE BGA





Method of Inspecting BGA Part Disclosed in the '411 Patent

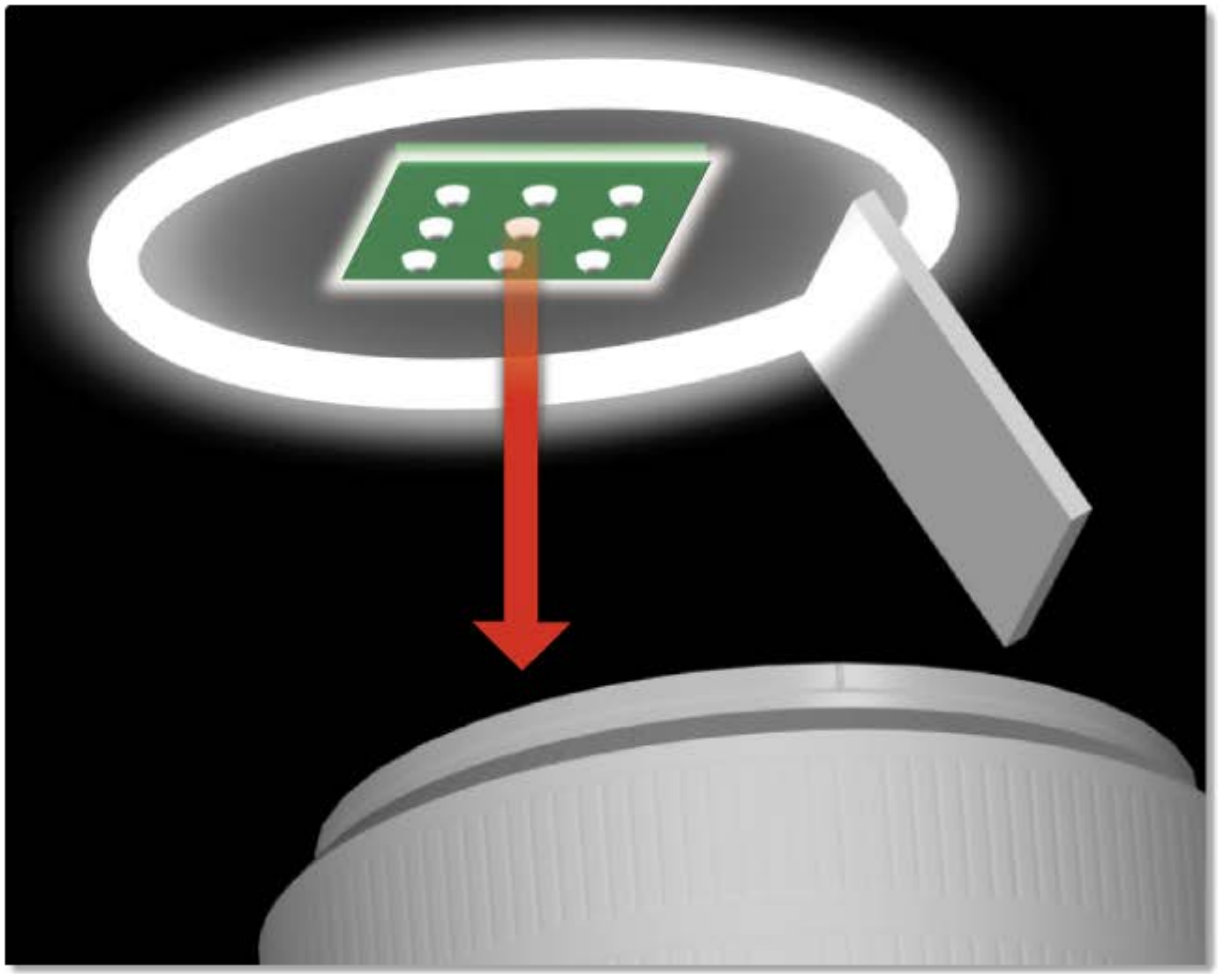
ILLUMINATING THE BGA



FRAME GRABBER

Method of Inspecting BGA Part Disclosed in the '411 Patent

IMAGING THE BOTTOM VIEW OF THE BGA

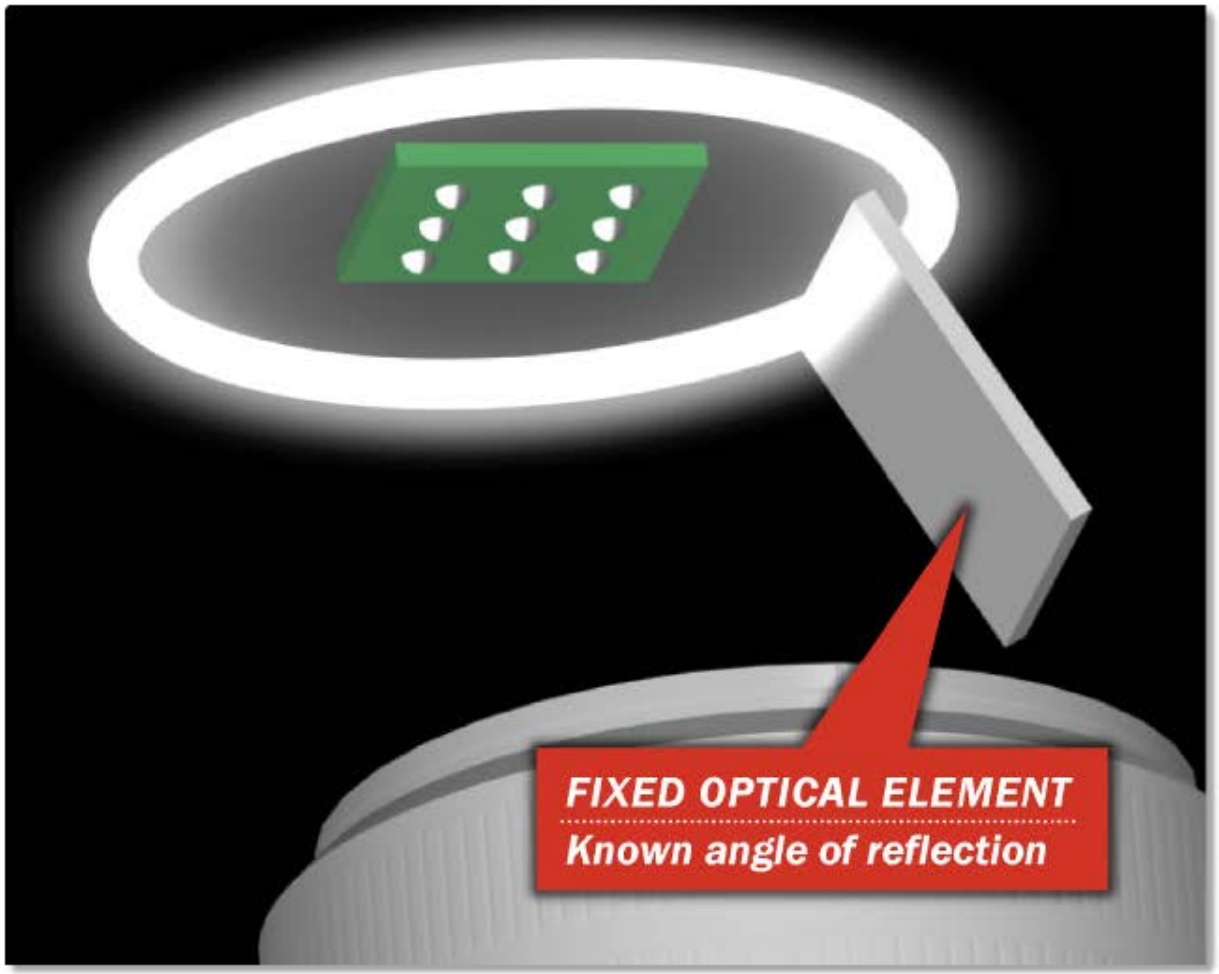


FRAME GRABBER

BOTTOM VIEW

Method of Inspecting BGA Part Disclosed in the '411 Patent

IMAGING THE SIDE VIEW OF THE BGA

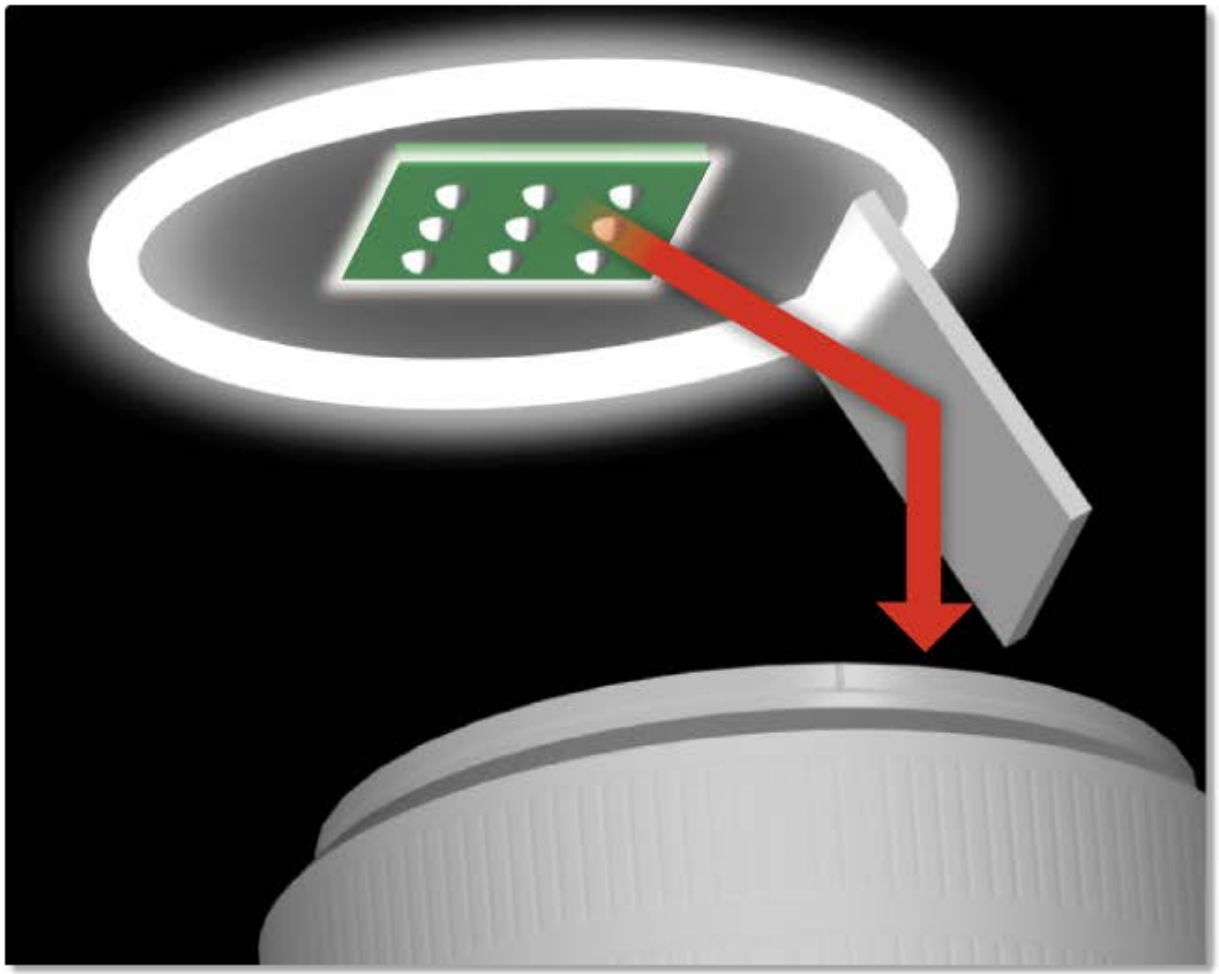


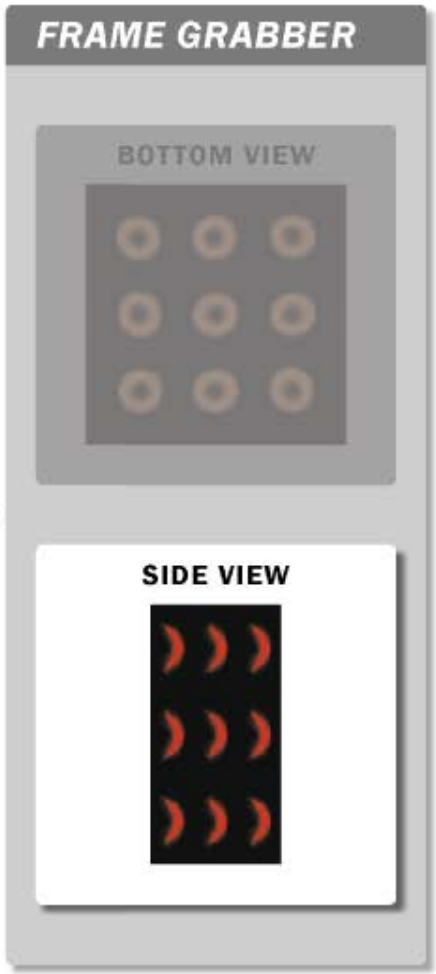
FRAME GRABBER

BOTTOM VIEW

Method of Inspecting BGA Part Disclosed in the '411 Patent

IMAGING THE SIDE VIEW OF THE BGA





Method of Inspecting BGA Part Disclosed in the '411 Patent

FINDING A SINGLE PIXEL POSITION LOCATING A LEAD

FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

PROCESSOR

C Language:

- **FindBlobCenter:**
  Finds the X, Y center of the pixels that have a value greater than THRESHOLD in the region (X1, Y1) to (X2, Y2).

Method of Inspecting BGA Part Disclosed in the '411 Patent

FINDING A SINGLE PIXEL POSITION LOCATING A LEAD

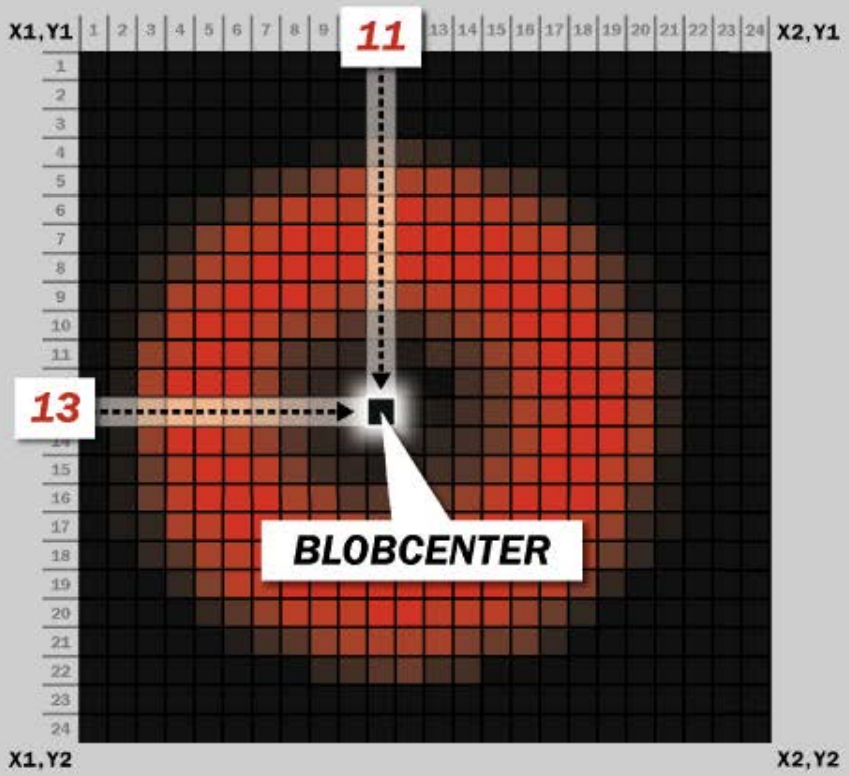
FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

PROCESSOR

FindBlobCenter:



Method of Inspecting BGA Part Disclosed in the '411 Patent

FINDING A SINGLE PIXEL POSITION LOCATING A LEAD

FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

PROCESSOR

C Language:

- **FillBallCenter:**
  Using the coordinates of the approximate center found in FindBlobCenter, the region of lower grayscale values is converted to a region of high grayscale values.
- **FindBallCenter:**
  Finds the X, Y center of the BGA ball using grayscale values.

Method of Inspecting BGA Part Disclosed in the '411 Patent

FINDING A SINGLE PIXEL POSITION LOCATING A LEAD

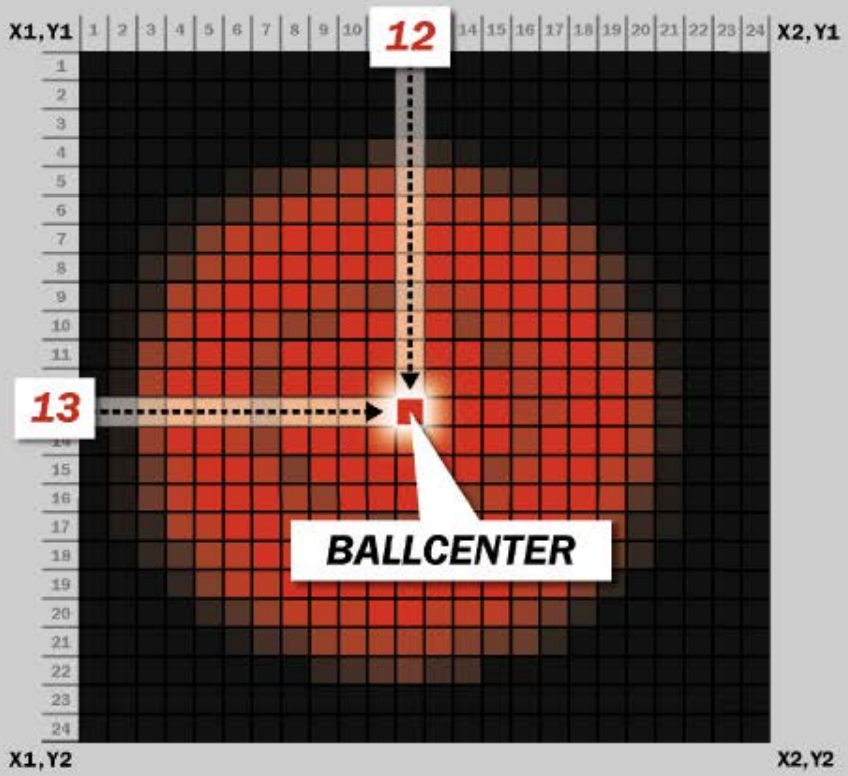
FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

PROCESSOR

FindBallCenter:



Method of Inspecting BGA Part Disclosed in the '411 Patent

FINDING A SINGLE PIXEL POSITION LOCATING A LEAD

FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

PROCESSOR

C Language:

- **FindCrescentTop:**
  Finds the X, Y top position of a BGA crescent.

Method of Inspecting BGA Part Disclosed in the '411 Patent

FINDING A SINGLE PIXEL POSITION LOCATING A LEAD

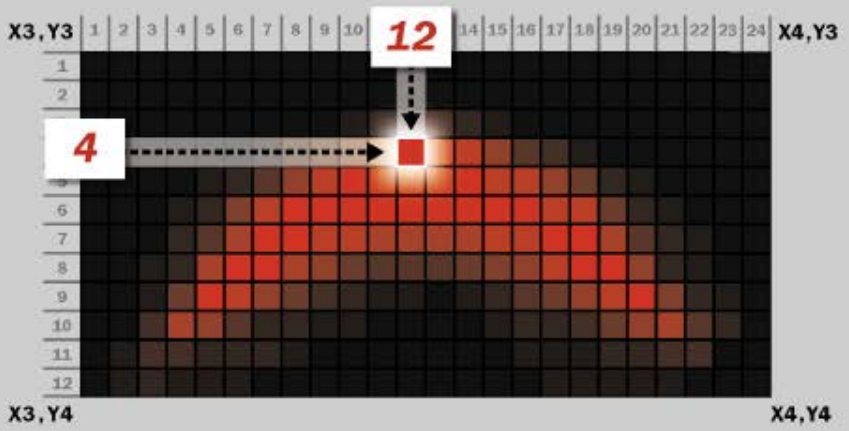
FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

PROCESSOR

FindCrescentTop:



Finding a Single Pixel Position Locating a Lead

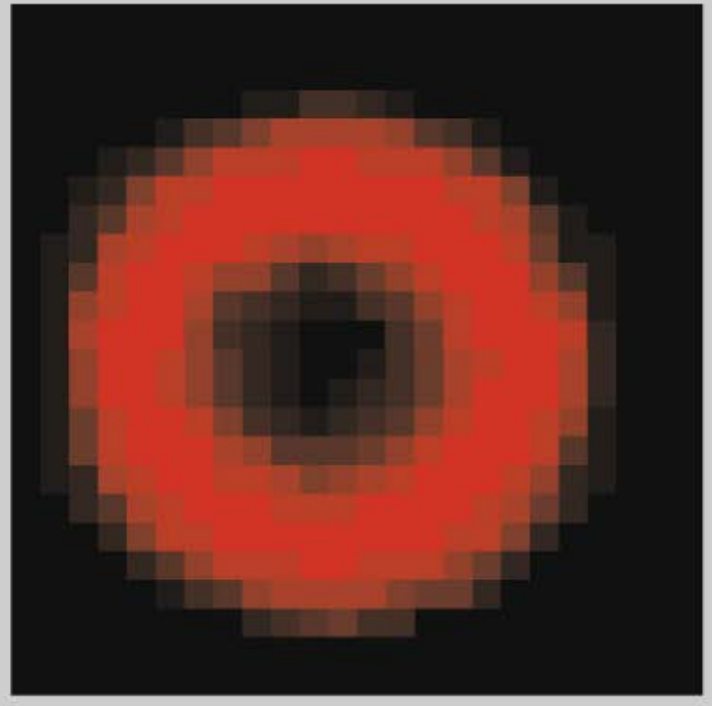
FindBlobCenter

FRAME GRABBER

BOTTOM VIEW

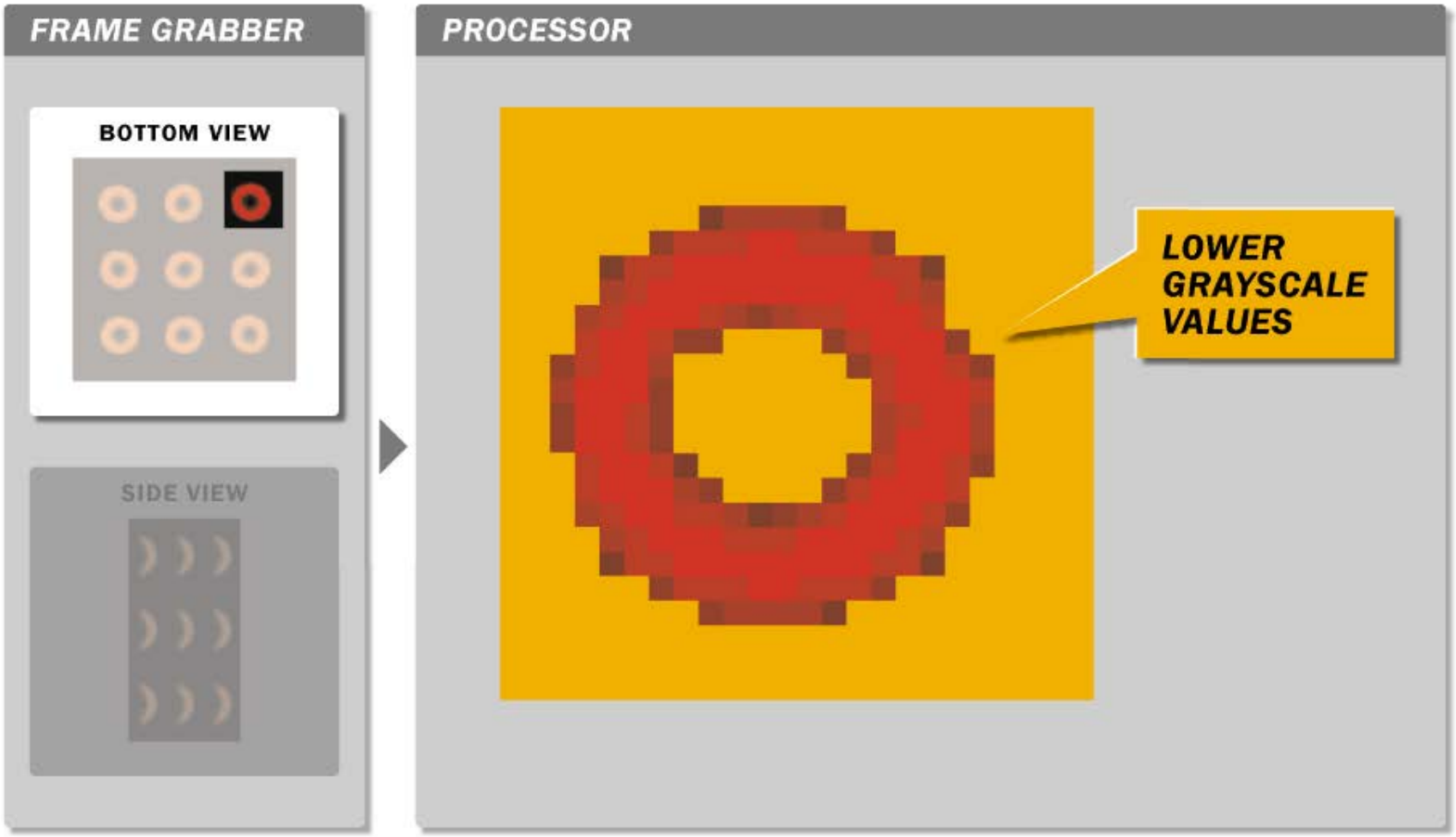
SIDE VIEW

PROCESSOR



Finding a Single Pixel Position Locating a Lead

FindBlobCenter



Finding a Single Pixel Position Locating a Lead

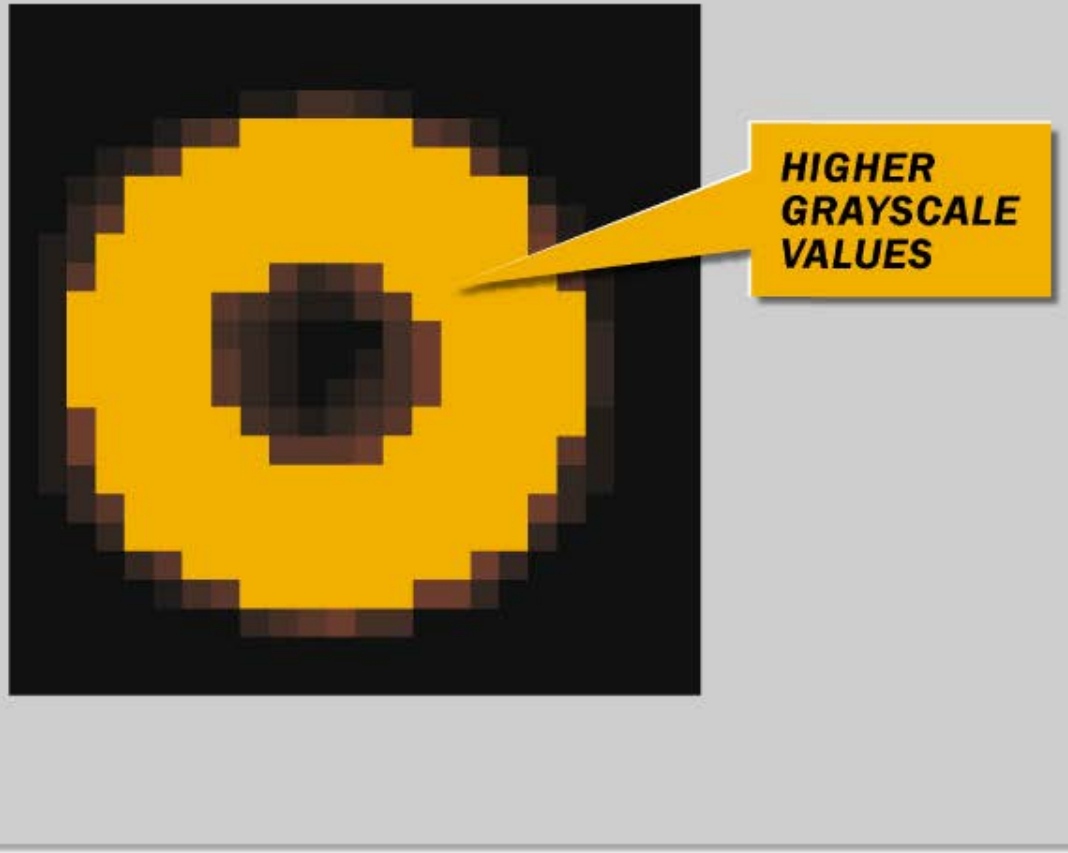
FindBlobCenter

FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

PROCESSOR



Finding a Single Pixel Position Locating a Lead

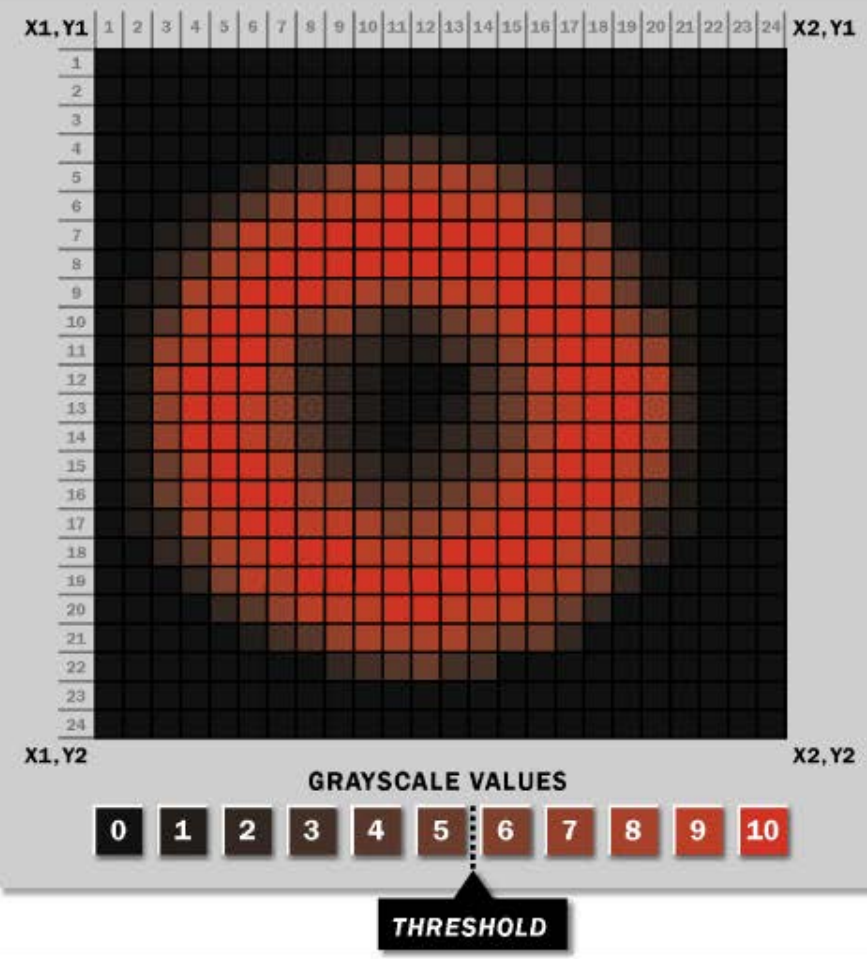
FindBlobCenter

FRAME GRABBER

BOTTOM VIEW

SIDE VIEW

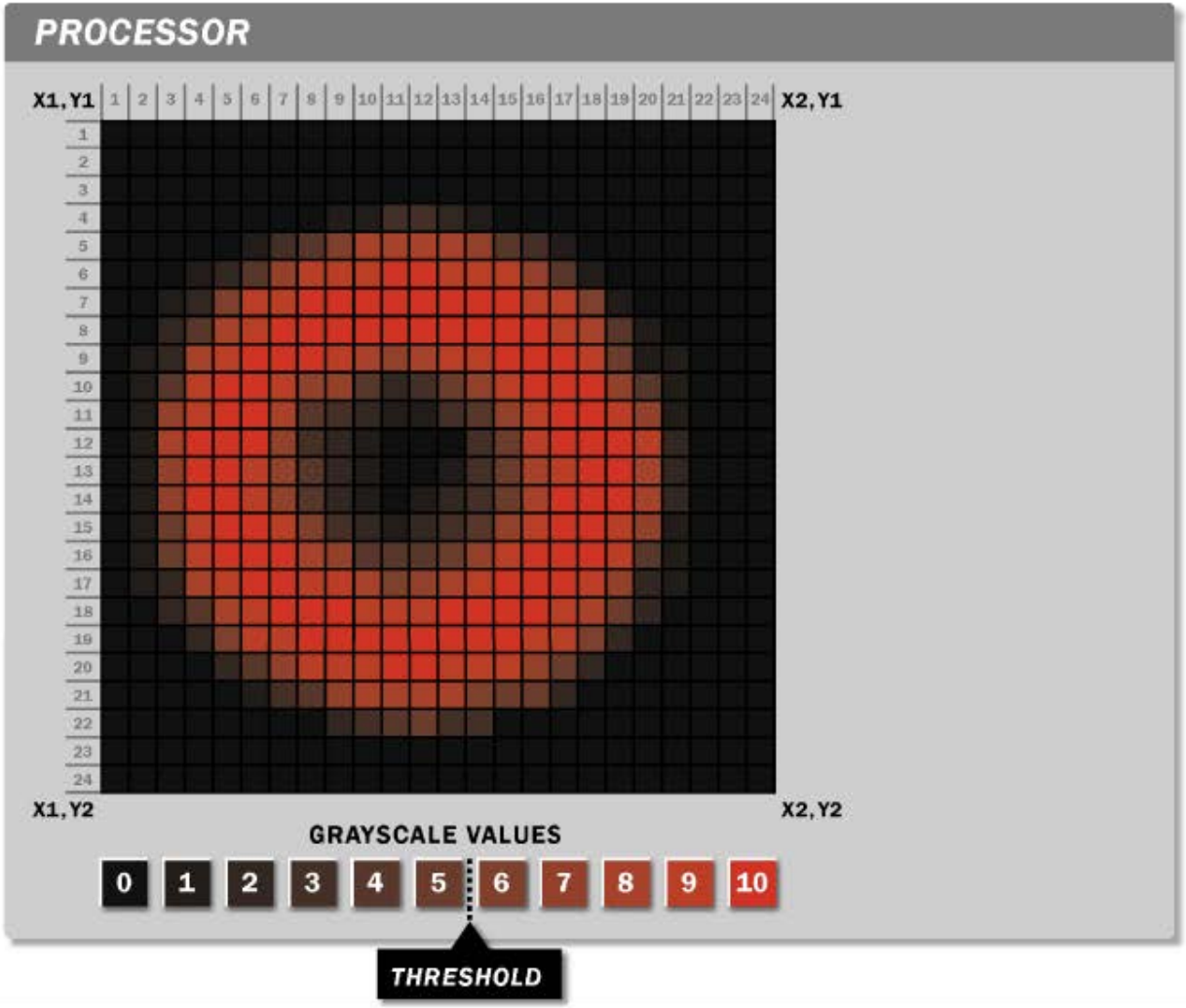
PROCESSOR



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

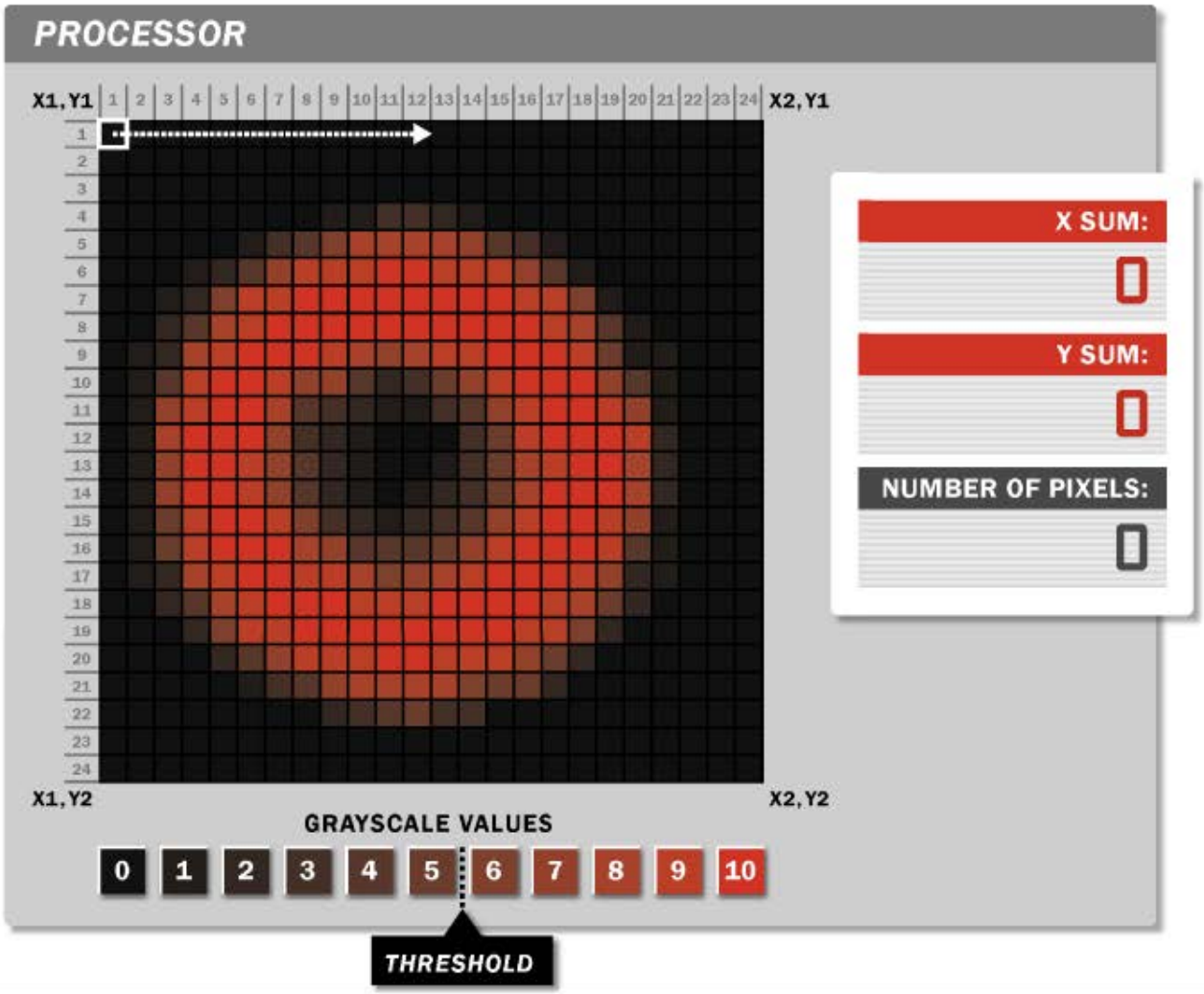
For every pixel with a grayscale value above THRESHOLD, keep track of the number of pixels found and their corresponding X and Y coordinates.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

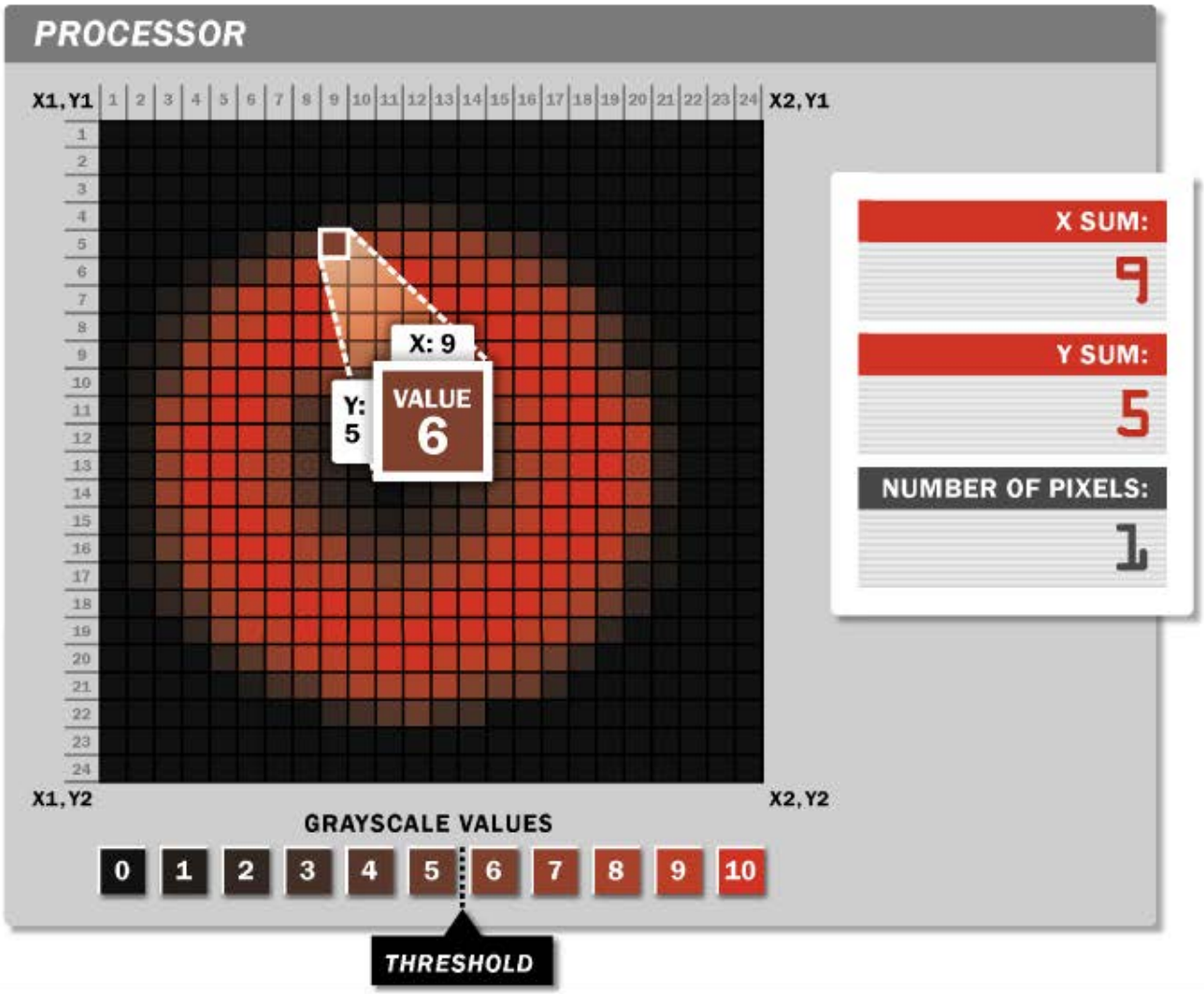
If a pixel grayscale value is ***below*** THRESHOLD, it is skipped.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

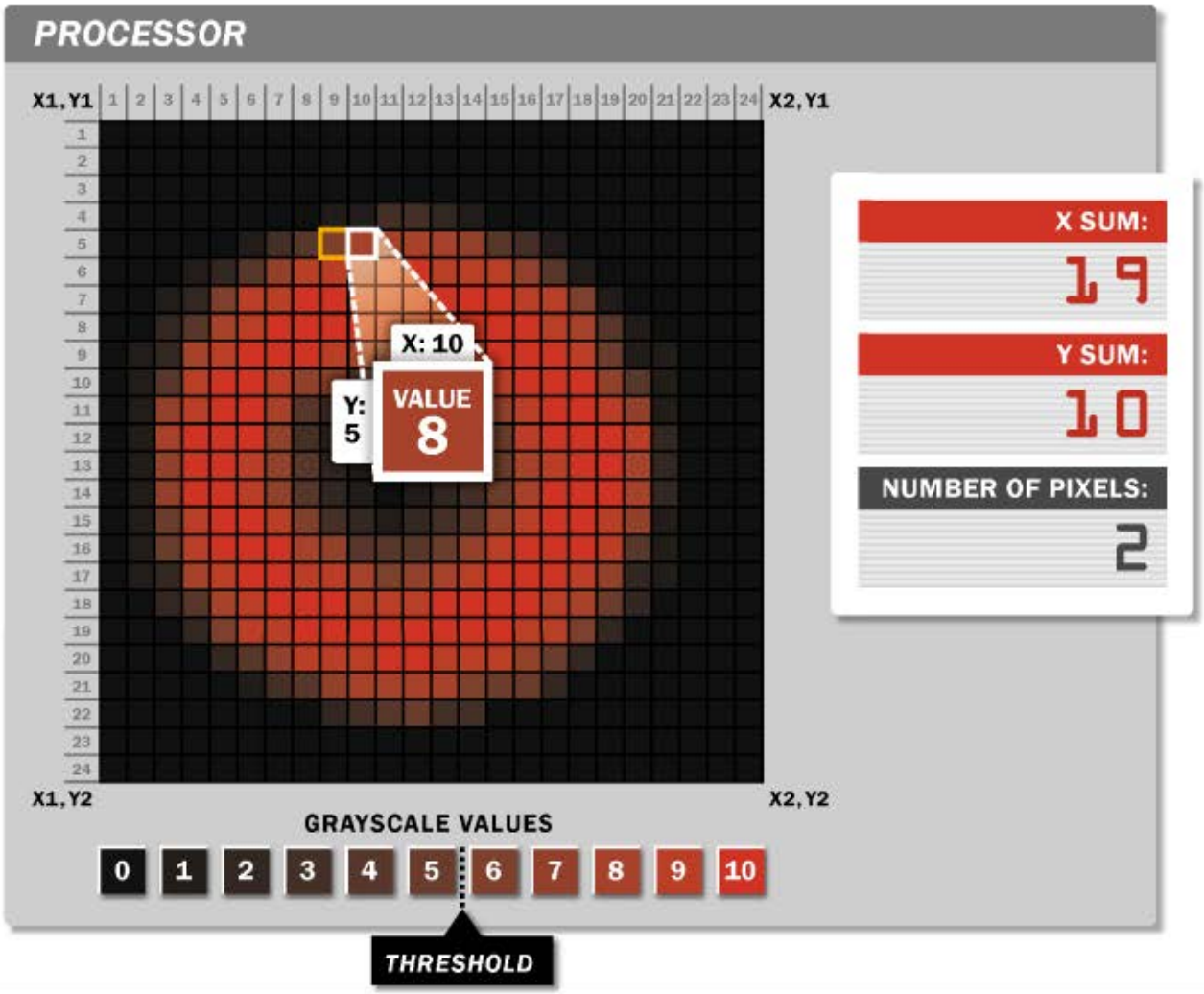
If a pixel grayscale value is ***above*** THRESHOLD, the pixel is counted and its corresponding X and Y coordinates are recorded.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

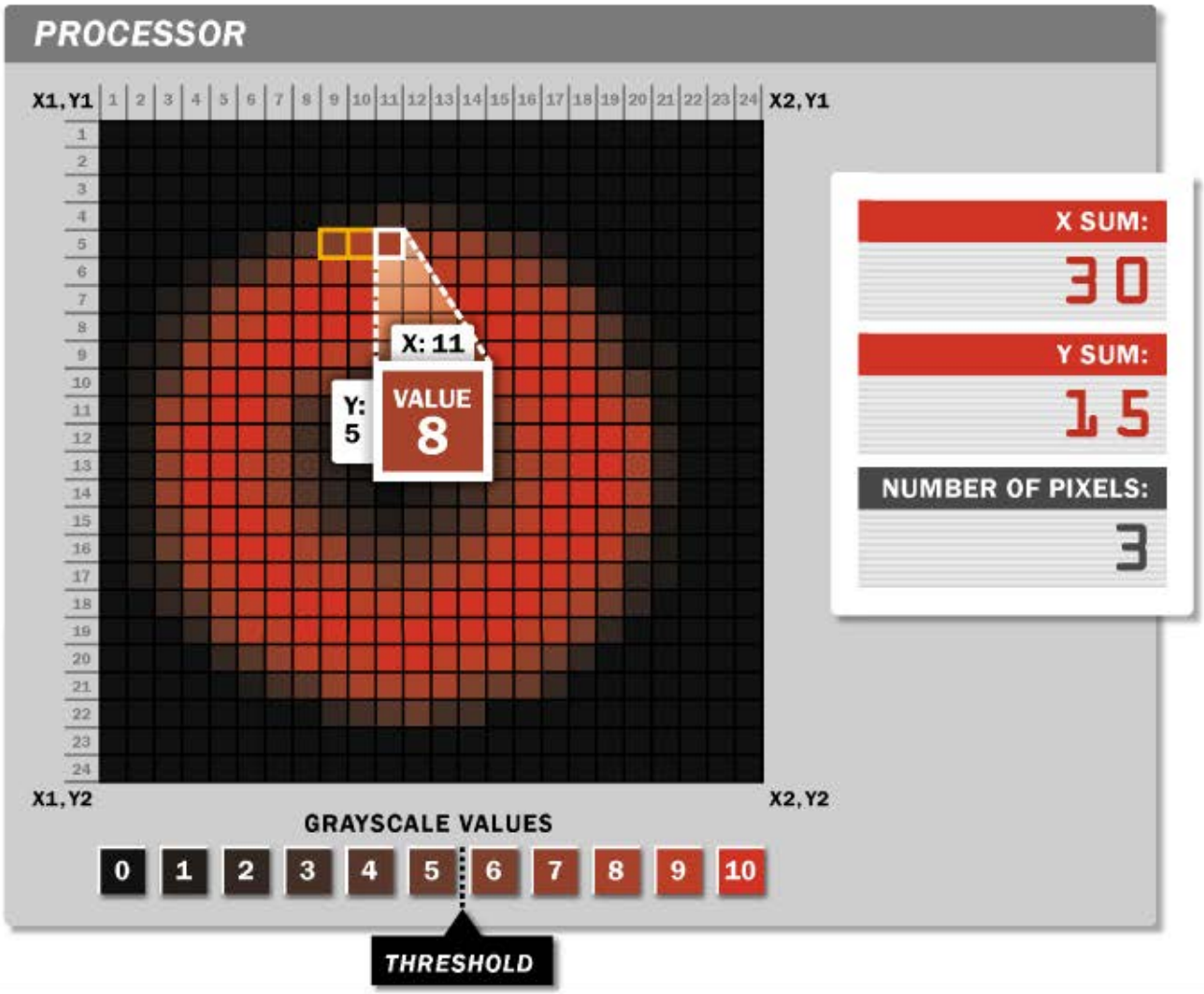
For each additional pixel with a grayscale value ***above*** THRESHOLD, the pixel is counted and its corresponding X and Y coordinates are added to the previous total.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

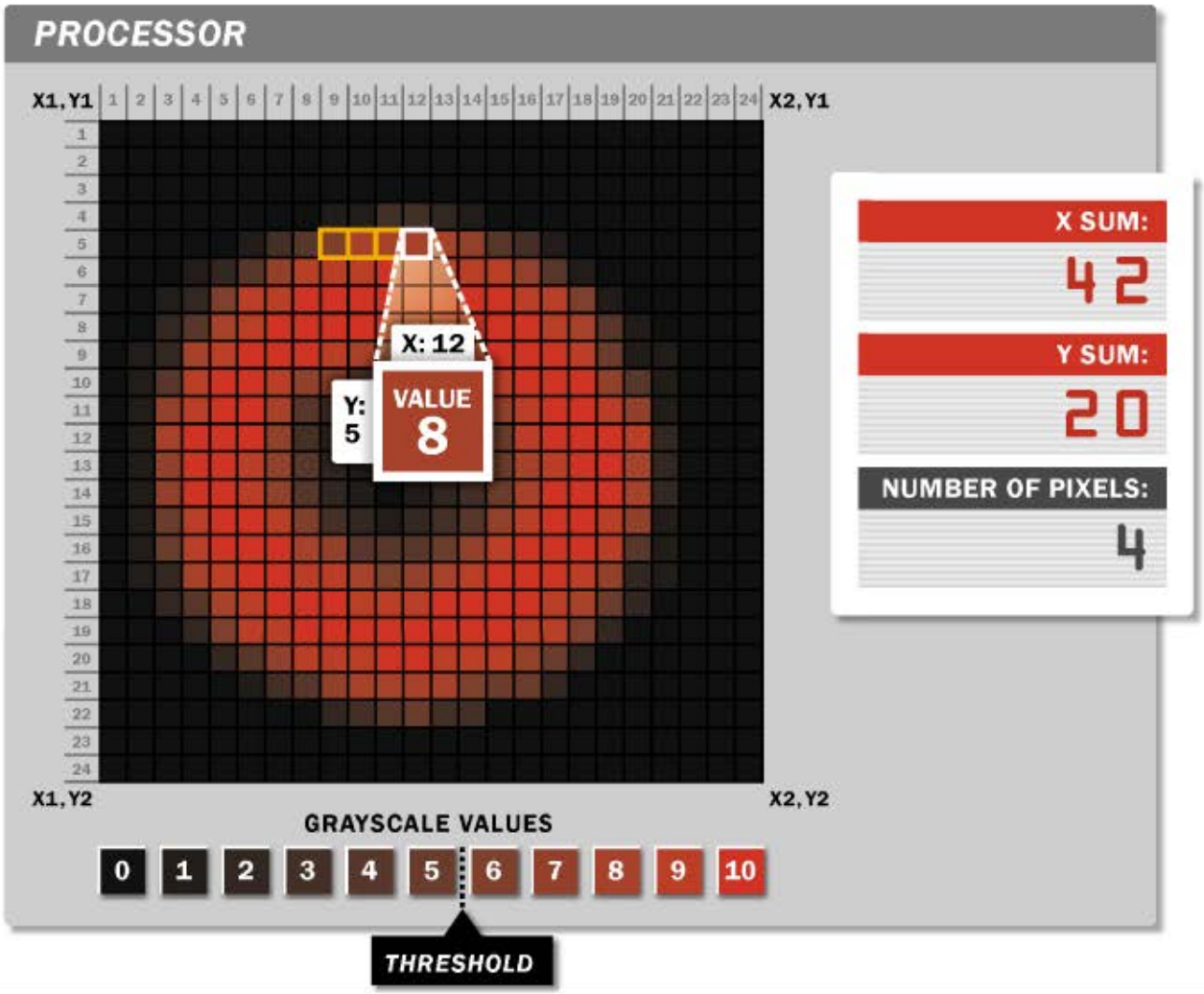
For each additional pixel with a grayscale value ***above*** THRESHOLD, the pixel is counted and its corresponding X and Y coordinates are added to the previous total.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

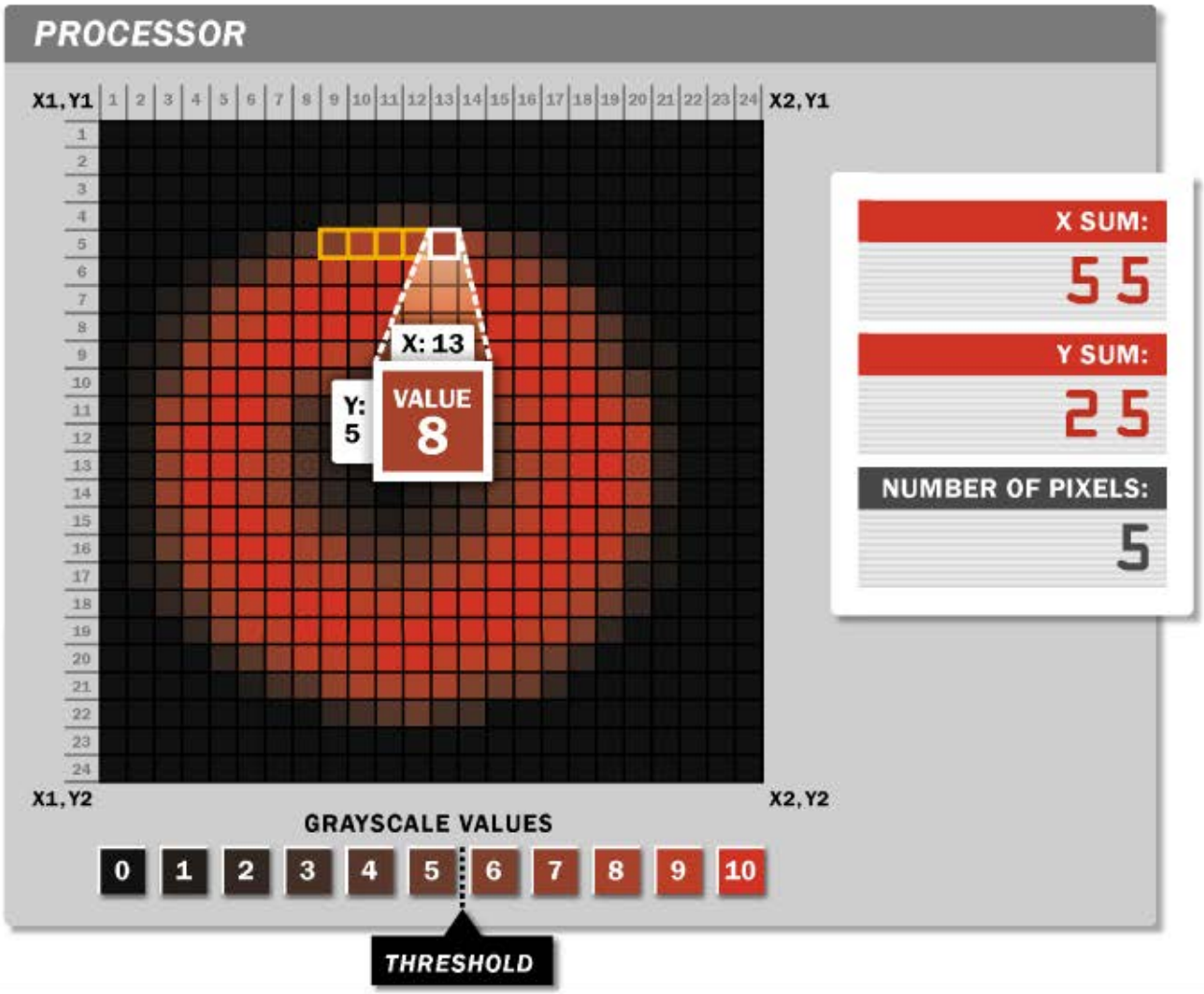
For each additional pixel with a grayscale value ***above*** THRESHOLD, the pixel is counted and its corresponding X and Y coordinates are added to the previous total.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

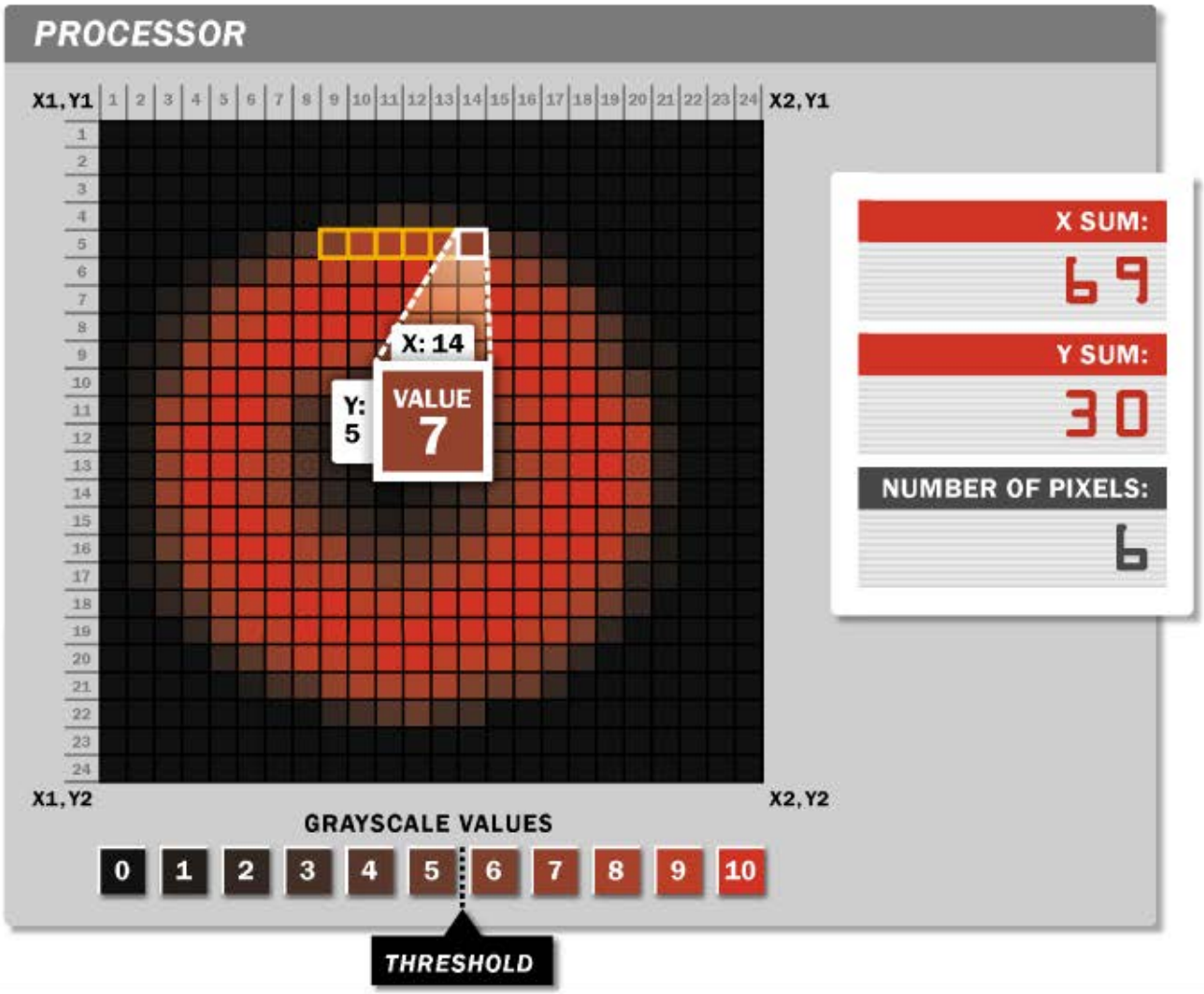
For each additional pixel with a grayscale value ***above*** THRESHOLD, the pixel is counted and its corresponding X and Y coordinates are added to the previous total.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

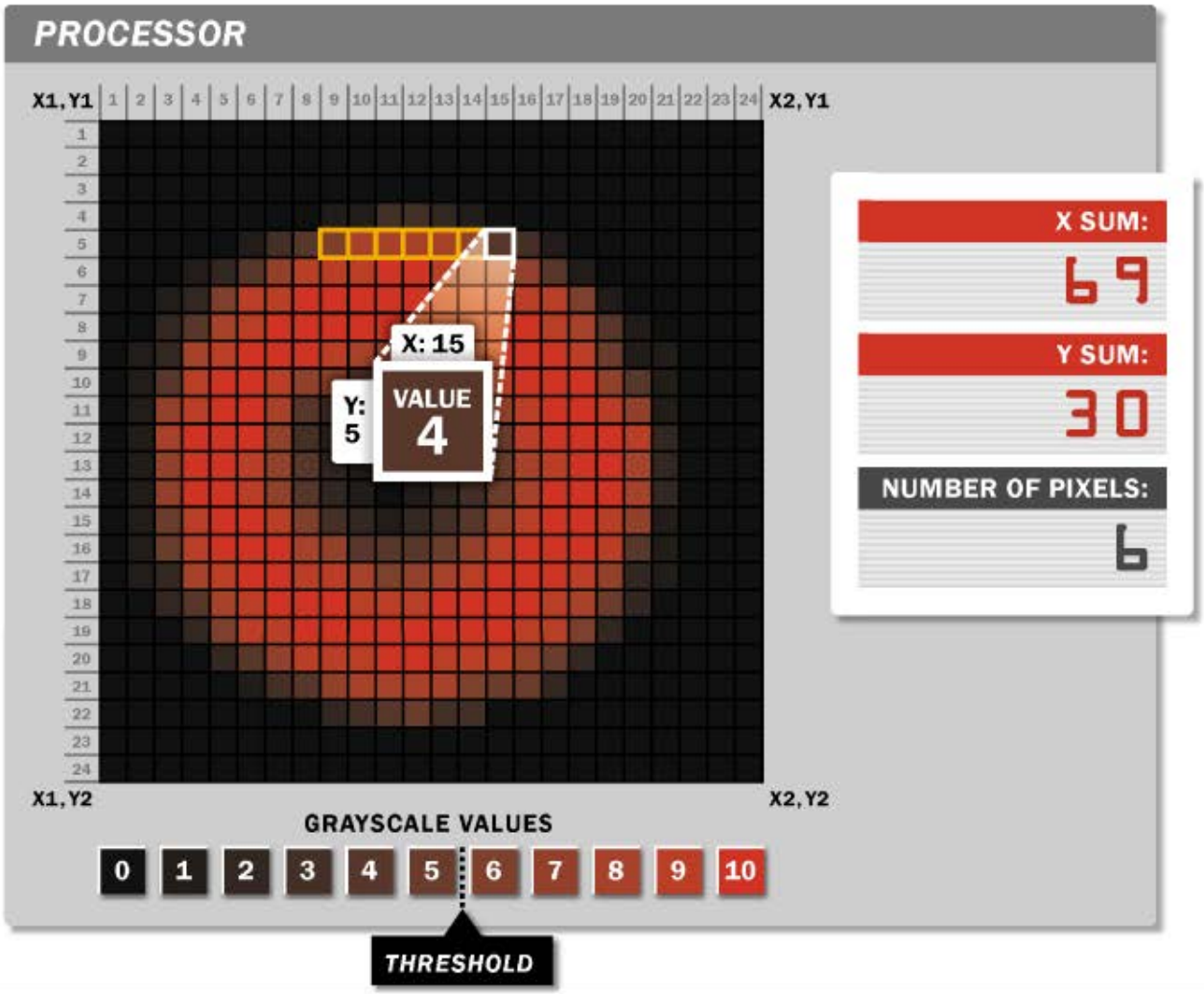
For each additional pixel with a grayscale value ***above*** THRESHOLD, the pixel is counted and its corresponding X and Y coordinates are added to the previous total.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

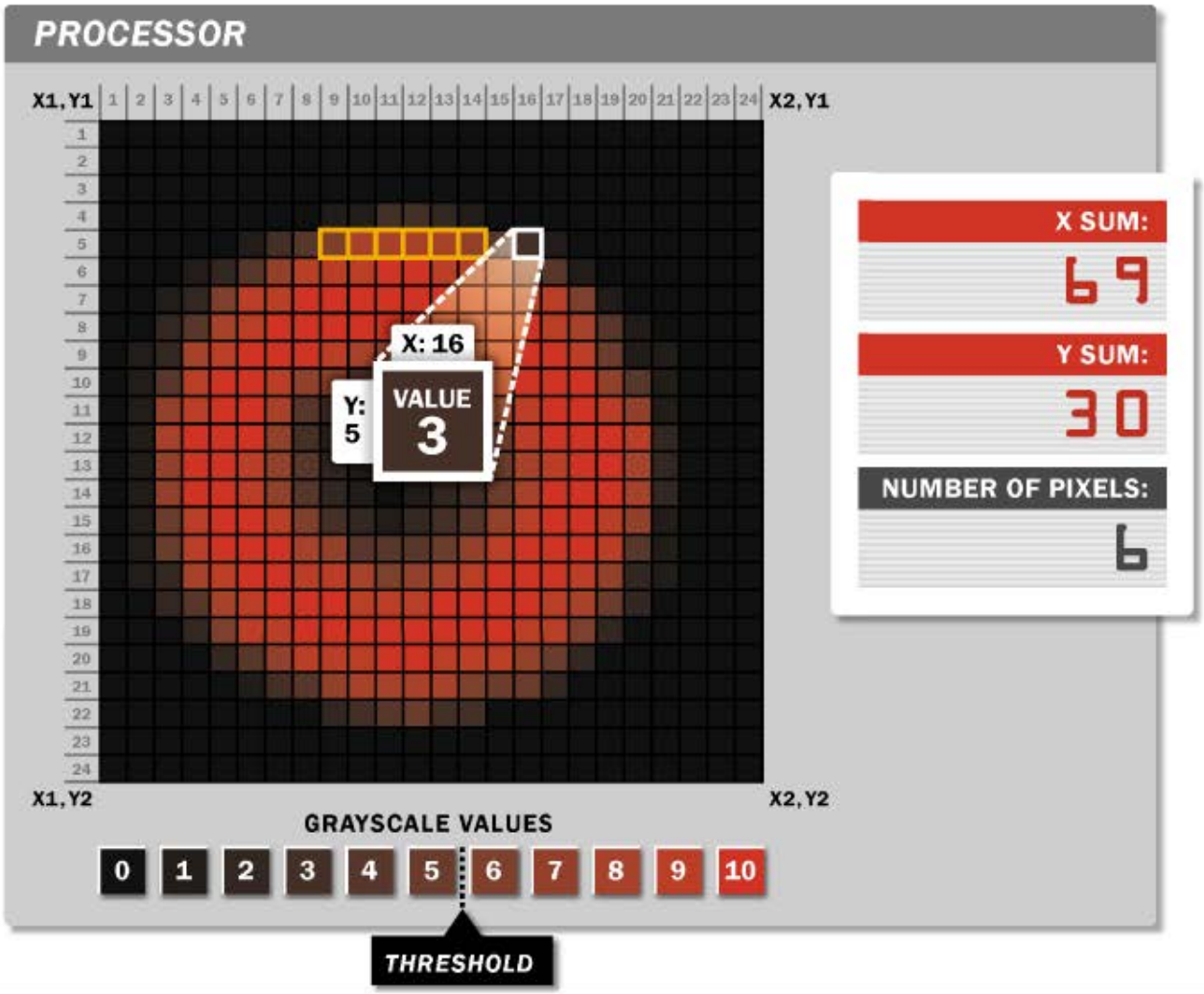
Pixels with a grayscale value ***below*** THRESHOLD, are skipped.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

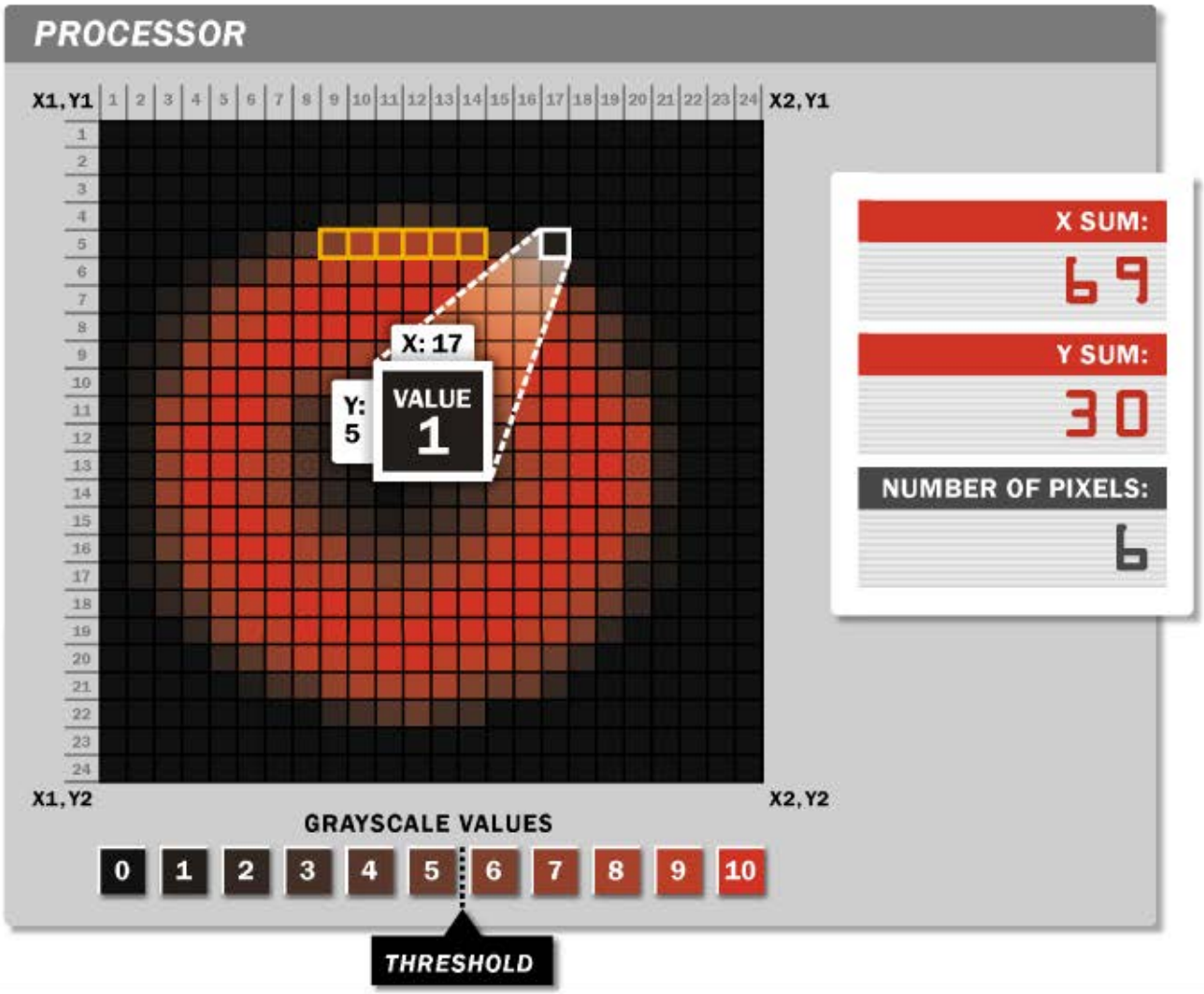
Pixels with a grayscale value ***below*** THRESHOLD, are skipped.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

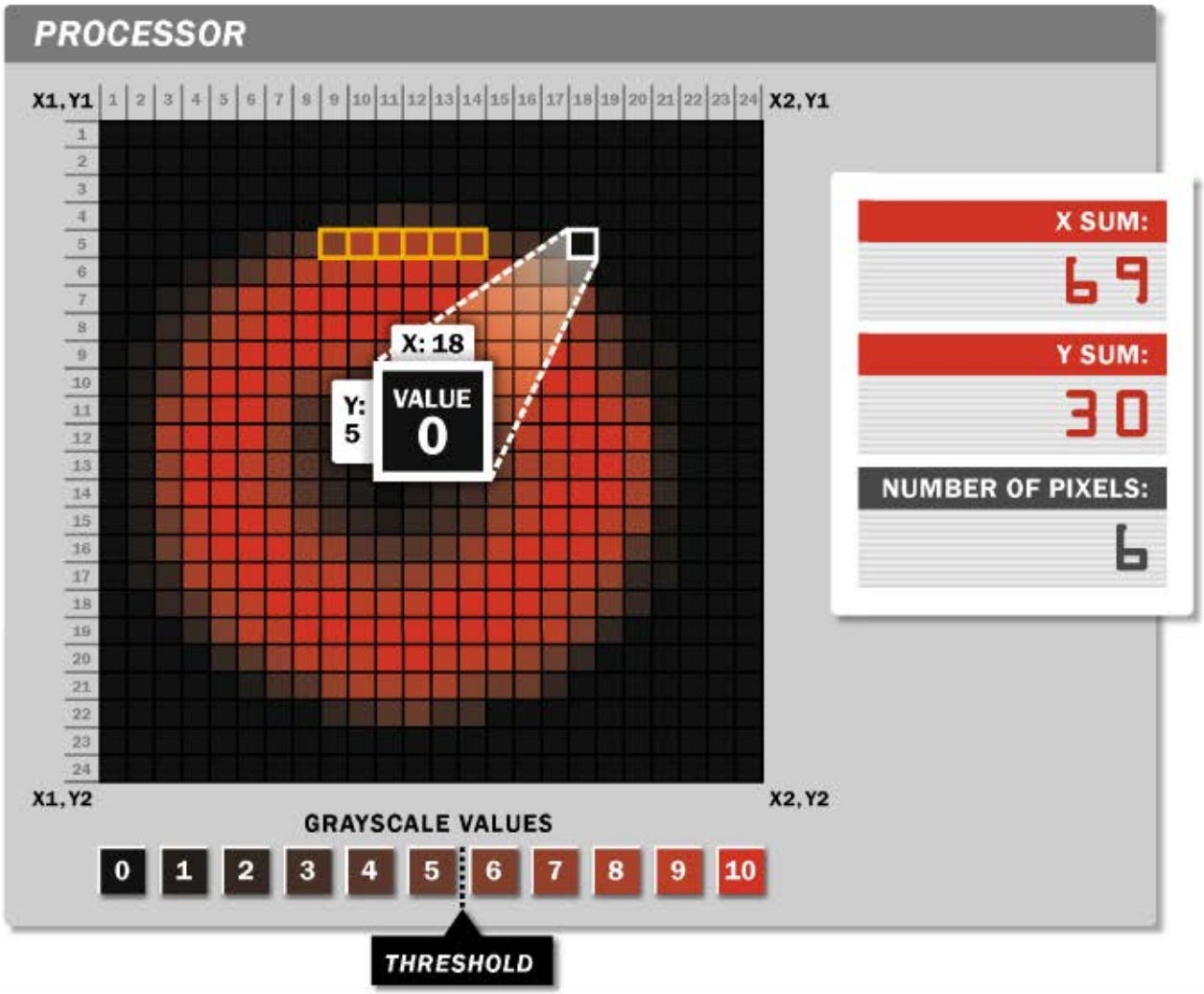
Pixels with a grayscale value ***below*** THRESHOLD, are skipped.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

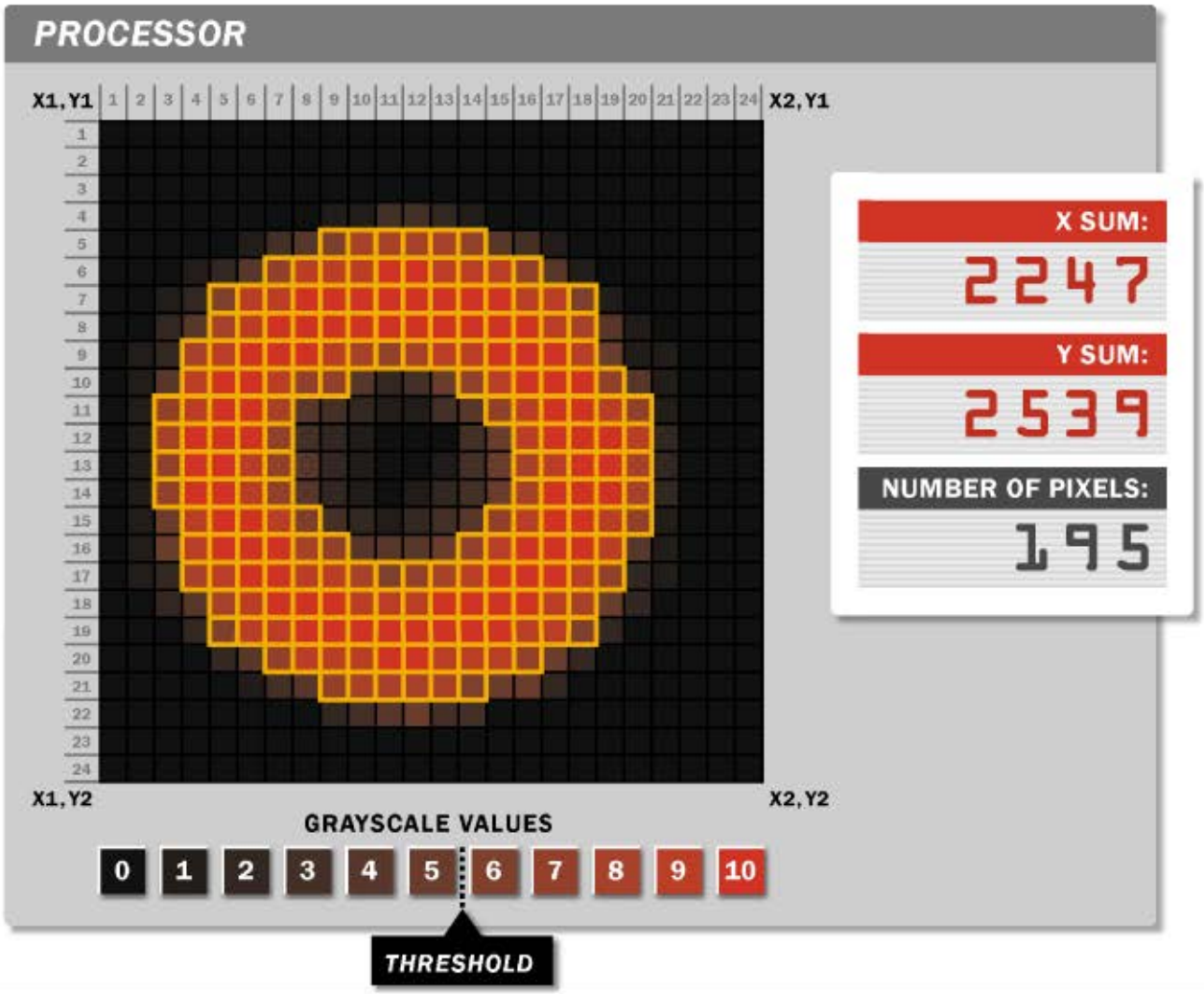
Pixels with a grayscale value ***below*** THRESHOLD, are skipped.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

Every pixel with a grayscale value ***above*** THRESHOLD is counted and its corresponding X coordinate and Y coordinate is added to obtain X SUM and Y SUM.



Finding a Single Pixel Position Locating a Lead

FindBlobCenter

After the entire region of interest is scanned column-by-column, row-by-row, the X SUM and Y SUM are divided by the number of pixels above THRESHOLD to ***FindBlobCenter.***