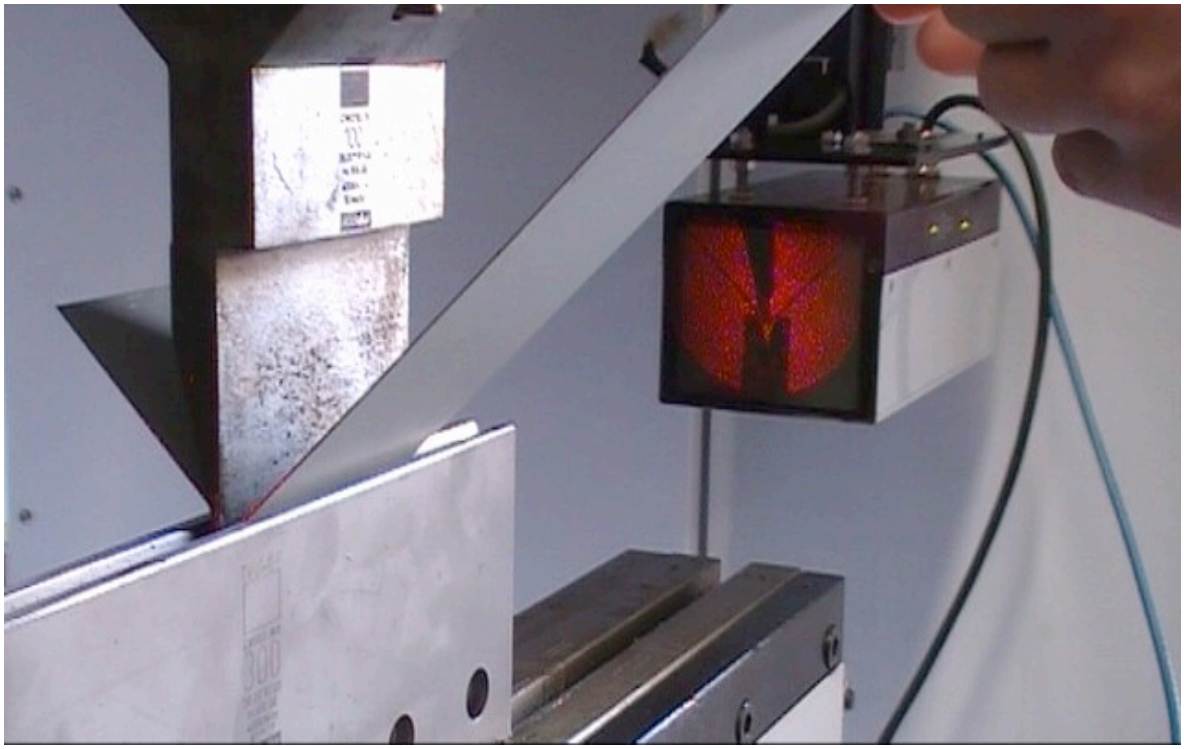
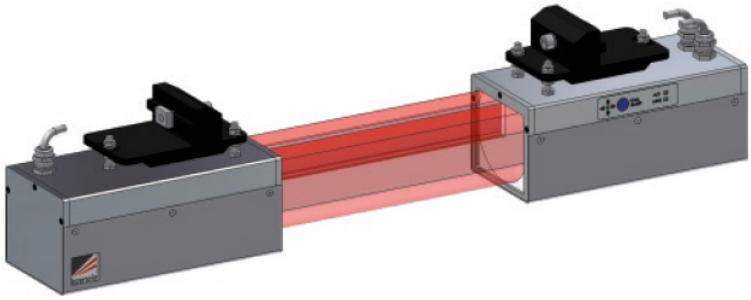
IMG System Overview



What is IMG

Imaging “IMG” is a hardware and software system that through its block laser and imaging technology can be used to perform either a.) angle confirmation b.) angle control or c.) both. In addition to these productivity features, the system also includes highly developed protection to press brake operators with increased press brake performance by vastly reducing slow speed distances. Hardware is comprised of a laser transmitter and camera receiver, which are mounted to the upper beam of the press brake. Software can either be installed and operated on an external industrial computer or integrated into the press brake CNC. CNC integration allows for a more unified workflow and accurate control during angle measurement.



How IMG works

The IMG system directs a block of laser light around and extending below the tip of the punch and down the length of the upper beam. Guarding is automatically performed by the system for operator fingers or hands entering the area around the upper tool allowing work to be performed in high speed as the tools close. The receiver is configured to provide guarding for operator safety and to provide imaging to measure angles of bent material. This image can be triggered at any point by the IMG-100. From these images we can determine the

angle (at any point of imaging) of the outside surface and the inside surface of the image produced. Ideally in a perfect bend these two angles would be the same. However because the image is taken from the end of the work piece a difference can, on some occasions be seen between these two surfaces if the piece was bent inconsistently (Warped) due to Y^1 and Y^2 being different, crowning being incorrect, or that simply the sheet metal being used had bends in it before being pressed, or was inconsistent in material thickness.

WHAT CAN THE PRESS OPERATOR DO WITH THIS INFORMATION?
IMG-100 can provide two main processes

1. Angle Confirmation
This is the process of confirming to the operator the actual finished angle of the work piece, on each bend step or selected bend steps (also, indication of any Warp) as against programmed expected angles.

2. Bend Angle Control
This is the process of working with the CNC system to check the bending as it is being performed and ensure through imaging at varying points and control through the CNC, that the correct angle is produced each time and/or the bend is redone if the bend was not correct.

Angle Confirmation
This system is generally the easiest to integrate. The aim of angle confirmation is to obtain the final angle for bent material and ensure that this angle has not changed due to variations in material thickness, grain direction, machine variations or other environmental factors.

The first step in the angle confirmation process is to learn the position of “end of relaxation”. This is the position the punch has travelled up to after BDC (Bottom Dead Centre) where the bent piece has sprung back – relaxed – to the finished angle. The IMG system uses this position to have a very small pause during the up movement to take an image, used for calculating the actual angle achieved – not just the theoretical angle asked for by the CNC.

Best accuracy for this “end of relaxation” can be achieved by learning the position for different angles and materials. If the position of the beam is too low the material is still clamped between the punch and die. Alternatively if the beam is too high the material is released and free to move, which can result in blurred images and incorrect angle measurement.

Modes of Operation - Learning
Learning mode raises the upper beam from the decompression point after BDC very slowly (approx 2-5mm/sec). The IMG system captures images one after another during this upward slow movement and compares each angle result against the previous result. When the angle stops changing, this position is determined to be the end of relaxation. This position is then stored by the IMG as the pause position (end of relaxation) for the final angle. The angle is also measured at BDC and the final angle at end of relaxation (EOR) can also be compared to give a spring back value. The learning mode is performed for each angle on a work piece.

After the learning stroke has been performed for all bends this slow speed after decompression is no longer required. Only the slight pause at the end of relaxation is activated. Continuous final angle results on every bend or selected bends are then available from the IMG system.

If an additional bend angle was entered, the IMG system would request to go into learning mode for the first bend of this new bend angle to determine the end of relaxation position for this angle. This position is stored by the IMG software.

All "end of relaxation points" are stored by the IMG system during machine run time and are reset when the IMG

system is switched off. If the same part was being bent again the same bending program is selected. However, the simple confirmation for the relaxation positions needs to be performed again. This is required because material thickness or other influences on bending accuracy may vary from job to job or day to day.

Modes of Operation - Preset
When learning mode is not used then a preset mode can be used. In this mode the beam will move up from BDC and capture an image at a predetermined position between BDC and the pinch point. As long as the material is not moving accurate angles can be obtained using preset mode.

Modes of Operation – Angle Confirmation
After the learning mode has been used on each bend of the first part then the angle confirmation mode only needs to be used for production. Angle Confirmation mode temporarily slows/pauses the beam during up movement so that an image capture can be performed by the IMG system. This pause position can be the end of relaxation position (EOR) learnt by the IMG system, or a preset position, using either preset or learning modes, as mentioned above. This pause in movement is not an actual stop. It is a de-acceleration to a slow speed (2-5mm/s) and then reaccelerating to normal up speed. This is virtually unnoticeable because it happens just after decompression and has negligible effect on the machine movement or cycle time.

Using angle confirmation then ensures that the operator will always know if the actual bend angle achieved has changed from the angle requested by the CNC due to variations in material thickness, grain direction and other machine or environmental effects than can cause variations in bends.

HOW TO MAKE USE OF ANGLE CONFIRMATION

An Example:
(i) A piece is programmed to be made.

(ii) A test piece is completed to ensure it is correct – The angle confirmation system can be used to check each bend and adjust the bend depths to achieve the actual desired bend angles.

(iii) There needs to be 500 pieces produced

(iv) The CNC has been notified by the IMG of all the correct points of imaging and therefore imaging and angle measurement can be done on every bend in the program if required.

(v) The acceptable tolerance can be set for all the bend angles – Set in 0.5° steps.

The tolerance for acceptable Warp angle can also be set – 0.5° steps.

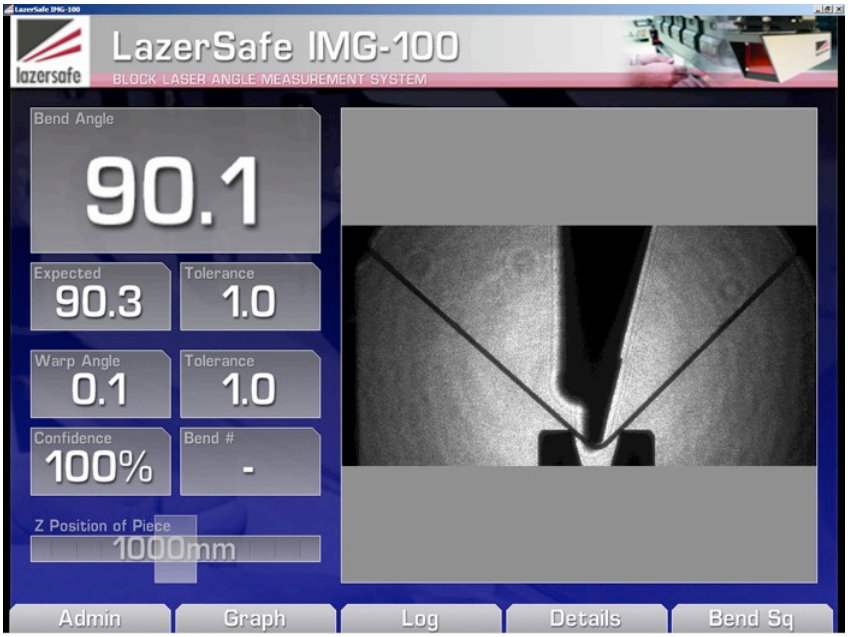
(vi) Proceed with producing 500 parts.

(vii) The IMG-100 will continually display on its screen the actual bend angles achieved alongside the expected angle.

eg. Expected Angle 60°
Actual Angle 60.8°

If the tolerance was set to 1.0° for this bend – OK
If Actual Angle displayed was 61.3° a visual alarm is shown.

This ensures the operator makes any necessary adjustments before completing all pieces and finding that many parts have drifted out of acceptable tolerance. There may have been a change in material, or the machine may vary after 100 pieces for example. A change can be made before having to reject or redo the remaining 400 pieces.



Sample IMG-100 screenshot

Displayed in the image above are four important pieces of information, which include the measured bend angle, warp angle, confidence and tolerance.

BEND ANGLE CONTROL

There are a number of ways that IMG-100 can combine with the CNC and its available programs to do this form of bending.

There is some experience with this process existing now from existing complex and expensive angle measuring devices combined with extra hardware and software installed with CNC systems. The major advantage of using IMG-100 in this situation is that it is far less complicated and far less expensive as it is taking advantage of the hardware provided by Lazer Safe for operator guarding and its extra software capability. No separate measuring devices and associated mounting systems need to be added.

Methods generally involve the tool descending and bending the work piece at a point above the BDC requested for the expected angle, releasing a measured amount and using images and measurements to calculate the “corrected” BDC for the required angle. Laser Safe is also working on a special prototype mode that can produce one off parts (such as - High value or the first part on a production run) using a similar method but without the need of extra parts or software such as strain gauges, and other control modules to automatically pass the required BDC positions to the CNC

This form of bending needs some collaboration between the Press brake manufacturer, the CNC provider and Lazer Safe.

EXPECTATIONS AND LIMITATIONS OF BENDING AND RECORDING FINISHED RESULTS

This imaging system provides information to the press brake operator that has not normally been this readily and easily available before. It will be found that the reliability of bend consistency can be greatly increased, and that

setting up expected bend angles is easier and faster. It will not be unusual for the operator to see much more variation in bend angles that he was aware of before, having this constant readout of angles.
To take full advantage of the imaging system is also to understand the aims of the particular bending being undertaken, and set the system tolerances relevant to these tasks.

For example, small intricate parts require higher accuracy 0.3° - 0.4° which gives the most accurate part fit possible. Improving the accuracy of the measurement by a further 0.1° or more does not provide any reasonable difference in part fit. When measuring down to this degree with metal parts, even variations on how the piece is held in your hand can move it far more that this. To help measuring accuracy with these small parts it is helpful if the bend can be done towards the receiver end of the machine (particularly on long machines) when and if possible.

On longer parts, large flange lengths and/or long overall lengths less accuracy will still give excellent part fit. It will be found that variation in bend angles with presses without this information available will have variations often measured in degrees, not points of a degree. This type of information also needs to be kept in mind when taking advantage of the warp angle (variations in bend angle over the length of the part) information that this system gives as well.

Therefore in general it is important to set realistic tolerances for the parts being bent suitable to the size and end use of the part.

BASIC SPECIFICATION & CAPABILITIES

MACHINE LENGTH – UP TO 4M

Expected Accuracy -	Within 2m of Receiver	0.2° - 0.3
	-	Within 3 – 4m of Receiver	0.3° - 0.7°

Larger Dies can reduce the above accuracy by 0.1° - 0.2°

For example – DIES ABOVE 40mm width and ‘V’ width of 25mm – Note - Max approx 50mm width and 35mm ‘V’

BOX BENDING can also reduce accuracy

LIMB LENGTH
On small dies high accuracy down to 10mm (from top edge of Die)
Larger Dies high accuracy down to 20mm (from top edge of Die)

DO’S AND DON’TS

a) **Work with shortest length tools possible for bending task –** Using shorter length tools decreases distortion from airflow around the tools.
b) **Measure closer to the receiver –** A shorter distance between the measured piece and the receiver increases accuracy.
c) **Avoid direct sunlight on the receiver –** Direct sunlight may “wash out” the captured image, reducing the receiver’s ability to detect the material accurately.
d) **Minimize airflow around the press –** Particularly where there is a large thermal differential between the air and the tools. It is recommended that solid end screens and rear screens are installed to reduce airflow. The location of heaters, air conditioners and large open doors can affect accuracy

If any of these factors, affect the imaging and angle calculation by the IMG system then this will be indicated to the operator by the “confidence” indicator. This indicates 100% through to 0% on each bend. This ensures the operator knows the measurement is either fully reliable, or through to an angle measurement that should not be relied on. The system is capable of this because it looks at specific key indicators in the image.

ATTACHED VIDEO

We have also attached a video that shows angle confirmation and its “learning mode” in operation on a press brake. This is not a marketing quality video but simply a working demonstration from our own test facilities.

If you are unable to play the video with Windows Media Player you can download a codec pack to enable this, http://www.majorgeeks.com/Vista_Codec_Package_d5326.html