

## Application Notes

# Extruder Alignment

### System Recommendations

L-705 Laser Borescope for Extruders  
L-700 Twin Barrel Extruder  
Alignment System



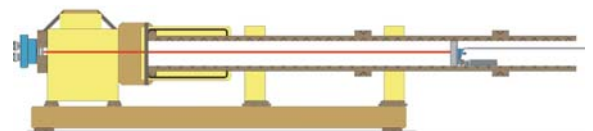
L-705 Laser Borescope Alignment System for Extruders

The L-705 Laser Borescope is unparalleled for ease of use and fast extruder alignments. It is also highly accurate, which can help to triple the life of extruder barrels and screws. With barrels costing up to \$5,000 and screws even higher, the L-705 Laser Borescope alignment system can pay for itself very quickly. It can further save money by reducing the electrical consumption of the motor. We've had one customer use a forklift to pull out the screw from one extruder and after laser alignment, slide it back in by hand!

Any bore from 1.5" (38 mm) to 14" (356 mm) can easily be measured with our L-705 Laser Borescope. The heart of the system is our patented A-510 2-Axis Self-Centering Target that automatically finds the center of the bore with no moving parts. This allows nearly instantaneous bore measurements for alignment or straightness.

## The L-705 Laser Borescope Alignment System

In most cases, an extruder can be completely aligned in less than 1½ hours, including setup! With simplified fixturing and self-centering targets, the alignment system can be set up and misalignment data taken in as little as 10 minutes. And in most cases, bore straightness data can be taken and analyzed in 15 minutes or less using our Bore8 software. Compared with optics that can take 2 hours just to set up, the L-705 can bring your extruders back on line, producing parts in record time.



Extruder Alignment with the L-705 Bore Laser System

### Simple Fixturing for Fast Setup

The L-705 Laser has been designed with a .750" (19 mm) mounting stud and flat face with magnets to hold it flush to fixturing. Since the laser beam is concentric to the OD to within .0005" (0.01 mm), a simple flat face and .750" (19 mm) hole on center is all that is needed to hold the laser (the extruder package includes a self-centering chuck fixture). In fact, the laser replaces the first reference target that a typical borescope would need.

### Long Range and High Accuracy

The L-705 Laser Borescope has a range of 100 feet (30 M), and under good environmental conditions, it is accurate to .001" (.025 mm) over the whole range. By carefully following the NORMIN procedure described below, accuracies of .0002" (.005) in 10 feet (3 M) can also be achieved.



A-510 Target and Bore Adapters



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## Patented, Self-Centering Target

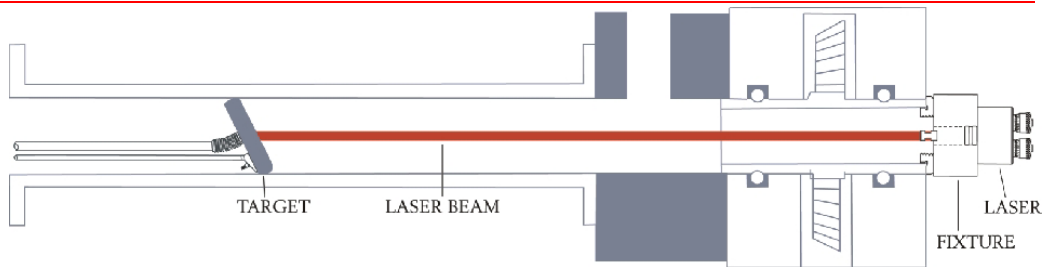
Hamar Laser has developed the world's first self-centering target (A-510) that uses no moving parts. It takes just seconds to position the target in the barrel for an accurate measurement down to .0005" (0.01 mm). See *How the Alignment System Works* for more information.

## Barrel Wear Measurements

The A-510A Bore Adapter can be placed on the A-510 Target in two ways. With the adapter placed on the target in Self-Centering Mode, it will center itself into the barrel. By inserting the A-510A in Measuring Mode, the adapter will measure diameter changes in the bore. To measure barrel wear/diameter changes, a measurement is taken with an inside micrometer of a reference bore, usually at the free end of the barrel. The A-510 target and adapter in Measuring Mode are inserted into the reference bore. A measurement is taken with the target in the NORMal position and in the INverted position. The two readings are averaged and the result is the starting measurement for the laser. At each subsequent measuring point, two sets of readings, NORMal and INverted, are taken and averaged. Subtract the result from the reference measurement and the diameter change is produced.

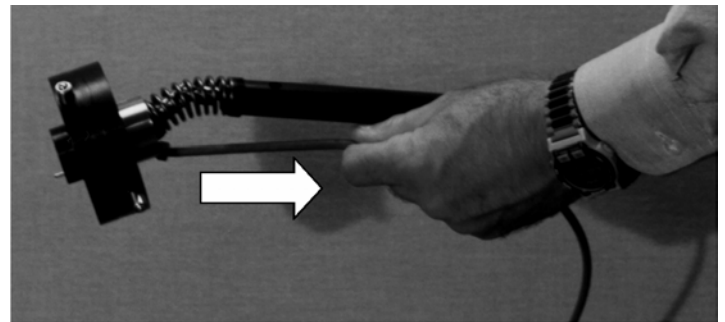
## How the Alignment System Works

The L-705 Laser is mounted into the gearbox through-hole (counter bore) by using our A-705 self-centering chuck, which has a specially adapted plate with a .750" (19 mm) hole that is centered to the feet to within .0005" (0.01 mm). The laser projects the axis of rotation of the extruder gearbox using a method we call the NORMIN (NORMal and INverted) procedure.



L-705 Borescope Setup

The A-510 and A-510A are designed so that the PSD (Position Sensing Detector) is centered axially between the four feet of the adapter, two of which are offset axially from the other two. This, in effect, puts the PSD on the pivot point of the adapter and allows the angle of incidence to the laser beam to vary by up to 45°. The A-510 takes advantage of this property by making the adapter slightly larger than the bore. To insert the target into the barrel, a spring-loaded pole is attached to the target and the target cord is pulled. This tips the target forward, allowing it to easily slide into the bore. When the cord is released, the target and adapter "jam" into the bore, finding the center automatically. The weight of the pole keeps the target centered in the bore.

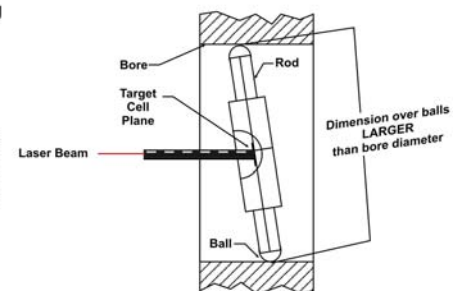


Inserting the Target

The A-510 2-Axis Bore Target and A-510A Bore Adapter are specially designed to find the center of the bore, without any moving parts, to a tolerance of .0005" or 0.01 mm (with care, tolerances of .0002" or .005 mm can be achieved). The bore adapters are customized for each barrel diameter, but can handle a small range of diameter variance.

## Self-centering Extruder Target Principle

If both balls at the ends of the rod are contacting the bore, then the middle of the rod is exactly in the middle of the bore. If a bore is slightly larger or smaller, the angle of the rod will change, but not the center. Thus, a laser target located at the rod center will always be centered in the bore. The target cell's calibration does not change with the angle.



No moving parts – Perfect Center!

## L-705 System Features

- Virtually instantaneous setup
- Built-in horizontal and vertical angular adjustments for quick referencing
- Target uses lightweight, customized bore adapters
- Self-centering target, accurate to .0002" (0.005 mm), vastly simplifies measurement process
- Easily accommodates bores as small as 1.5" (38 mm)
- Live display of component misalignment
- Portable enough to fit into small carrying case. Entire system weighs less than 15 lbs. (6.8 kg)
- Large digital display eliminates long cables
- Laser beam straight to .0001" (.0025 mm) accuracy in 10' (3 M) or .001" (.025mm) accuracy in 100' (30 M)
- Battery operated

## The Procedure

To perform an alignment, Hamar Laser's NORMIN procedure is used to put the laser beam on the axis of rotation of the gearbox, which is then projected down the barrel to the target. It works like this:

1. Insert the laser and the self-centering laser fixture into the gearbox counter bore and the A-510 Target into the free end of the barrel. Write down the H (horizontal) and V (vertical) readings.
2. Rotate the gearbox by hand until the laser is inverted, using the built-in levels to determine the inverted position. Write down the second set of readings.
3. Average the horizontal values for NORMAl and INVerted, and then average the vertical values. The results determine the setpoints for the horizontal and vertical axes (see example below).
4. Turn the angular adjustment micrometers until the setpoints display on the readout.
5. The reading produced from the NORMIN procedure is then a measure of the misalignment of the free end of the barrel to the gearbox axis of rotation. Leaving the laser and target in the barrel, the barrel can then be shimmed or moved until the readout displays .000" in both axes. If there is more than one adjustment point for the barrel, the target can be inserted into that point and it can be shimmed or moved until the readout reads .000".

## Example

*Laser at 0 degrees (12 o'clock)*

V Reading +.015"  
H Reading -.030"

*Laser at 180 degrees (6 o'clock)*

V Reading +.005"  
H Reading +.002"

*Setpoint =*

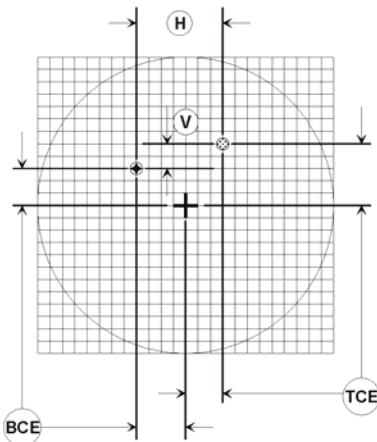
$$\frac{V_N + V_I}{2} = \frac{.015 + .005}{2} = +.010''$$

$$\frac{H_N + H_I}{2} = \frac{-.030 + .002}{2} = -.014''$$

## The NORMIN Method

The Relationship of the Three "Centers"

- You are seeking the *bore* center relative to the laser beam (BCE).
- The readout information provides the *target* center relative to the laser beam.
- The NORMAl reading is taken with the target cable *down*.
- The INVerted reading is taken with the target cable *up* (180°).



- + True Bore Center
- ⊕ Laser Beam Center
- ⊕ Target Center
- H Horizontal Reading (Readout)
- V Vertical Reading (Readout)
- TCE Target Center Error (Target Center to Bore Center)
- BCE Bore Center Error (Bore Center to Laser Beam Center)

### The Relationships

$$BCE = (\text{Normal reading} - \text{Inverted reading}) + 2$$

$$TCE = (\text{Normal reading} + \text{Inverted reading}) + 2$$

$$\text{Normal Reading} = TCE + BCE$$

## Recommended System Configuration

- L-705 Bore Laser
- A-510 2-Axis, Self-centering Target
- A-510A Extruder Target Adapter (2"-4" bores)
- A-705 Chuck-style Gearbox Adapter
- R-307 2-Axis LCD Readout
- A-510E Pole Extension
- T-231A 25' Target Extension Cable
- A-909A Shipping Case
- A-909B Pole Case

## Optional Accessories

- R-307V 2-Axis Large Number LED Readout
- A-510B Extruder Target Adapter (4"-8" bores)
- A-510C Extruder Target Adapter (8"-12" bores)
- A-510D Extruder Target Adapter (12"-14" bores)
- S-1380 Read8 Software w/Bore8
- R-358 Computer Interface

## The L-700 Alignment System for Twin-Barrel Extruders

Using components from several different systems, Hamar Laser has developed a package to align twin-barrel extruders as quickly and accurately as possible. Our L-700 Spindle Laser and A-510 2-Axis Self-Centering Bore Target create a powerful package to align twin-barrel extruders up to 70% faster than conventional or optical borescope methods. With an accuracy of  $\pm .0002$ " (.005 mm) and our optional alignment software, the L-700 is the perfect extruder alignment tool.

The alignment of the twin-barrel extruders has never been easy. Traditional methods, such as using indicators to line up the outside of each barrel section, are subject to large stack-up errors and make the assumption that the outside of the barrel is parallel to the center line of the bore. Given the long length of the barrel, a slight error of .001" (.025 mm) to .002" (.05 mm) for each section can add up to .015" (.38 mm) or more misalignment at the free end of the barrel.

The L-700 laser virtually eliminates indicator stack-up errors by projecting the axis of rotation of the gearbox drive shaft out to 100 feet (30 M). This provides a single reference from which each section of the barrel can then be aligned. A target accuracy of .0002" (.005 mm) means very accurate alignment of each section of the extruder can be achieved.

Since the target can simultaneously show a live display of both horizontal and vertical readings, you can start aligning each section of the extruder without changing the setup or moving the laser. When the readout reads zero in the front and back (if desired) of the bore of an extruder section, it is aligned.

### L-700 System Features

- Simple fixturing to mount the laser onto the drive shaft projecting its axis of rotation to 100 (30' M)
- Vertical and horizontal controls for both angle and center for adjustment of laser to shaft's precise axis of rotation
- Self-centering target comes with pole for insertion into long bores
- .0002" (.005 mm) target accuracy with live measurement data in two axes (vertical and horizontal center)
- Visible light beam
- Hand-held LCD or large-display LED readouts show alignment data in 2 axes
- Laser runs for up to 8 hours on a standard, replaceable 9-volt battery
- Windows-based software with large, color graphics
- Compact and rugged (4" L x 2.9" H x 1.75" W or 101 mm x 73 mm x 44 mm)



L-700 Twin Barrel Extruder Alignment System

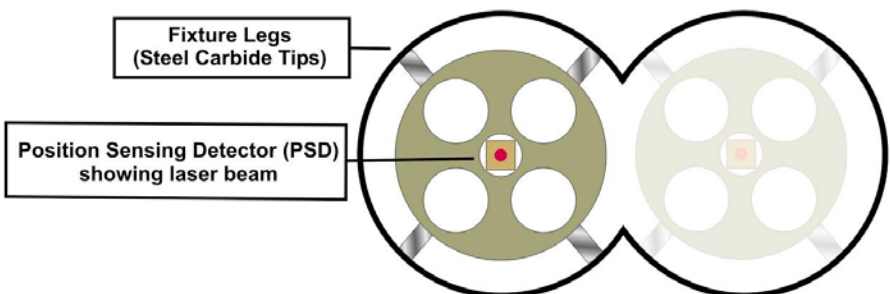
## How the Alignment System Works

The L-700 Laser is affixed to the gearbox output shaft using a self-centering chuck with a specially designed plate that has a .500" (12 mm) hole (matches stud on back of laser) that has been aligned to the feet. The laser is attached to the chuck and it is placed over the output shaft. A 2-axis target and the NORMIN procedure are used to position the laser beam on the axis of rotation of the gearbox shaft. When removed, the laser will project the gearbox shaft centerline out to 100 feet (30 M).

A customized adapter (A-510A, B or C) and pole are attached to the A-510 Target and the assembly is inserted into the free end of the barrel. The target automatically centers itself and it immediately provides a horizontal and

## Aligning Twin Barrel Extruders

**A-510B Adapter in Twin Barrel Extruder (Front View)**  
Outside Diameter (OD) of A-510B adapter is slightly larger than the Inside Diameter (ID) of the barrel



vertical measurement of alignment. If the twin-barrel is under construction, the system can be used to align each section of the barrel. This is a much better alignment method than using indicators on the outside of the barrel or relying on pins and manufacturing to perform the alignment, both of which are subject to significant stack up errors.

If the extruder to be aligned is already installed, the A-510 target can be inserted into the barrel and positioned over adjustment points. The digital readout displays the misalignment numbers dynamically. Simply adjust the barrel until the readout reads zero and that section is aligned. If there is radial adjustment in each individual barrel section, then the same procedure can be followed for the other bore.

### Using the Bore8 Software

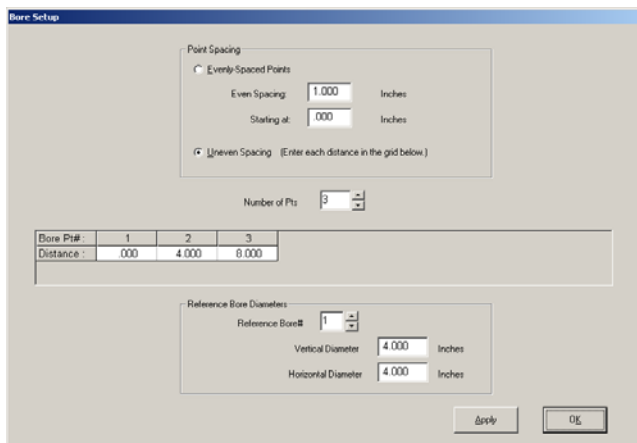
Bore8 is a new alignment module that has been added to Read8, Hamar Laser's multi-purpose alignment software. Bore8 measures and displays the alignment of multiple bores. The program not only measures bore straightness, but it can also measure bore diameter by using one of the bores as a reference. The program can accommodate a minimum of three and a maximum of 30 bores. Data can be plotted and presented relative to the two end bores, relative to *any* two bores, relative to the best fit centerline or relative to the laser beam. Data can be viewed from both center and slope perspective, and provision is made for recording data in both the NORMAL and INverted target positions.

### Recommended System Configuration

- L-700 Spindle Alignment Laser
- A-510 2-Axis, Self-centering Target
- A-510A Extruder Target Adapter (2"-4" bores)
- R-307 2-Axis LCD Readout
- A-909A Shipping Case

### Optional Accessories

- S-1380 Read8 Software
- R-358 Computer Interface
- R-342 Laptop Computer or R-1342 Shop-hardened Laptop Computer
- R-307V 2-Axis Large Number LED Readout
- A-510B Extruder Target Adapter (4"-8" bores)
- A-510C Extruder Target Adapter (8"-12" bores)
- A-510D Extruder Target Adapter (12"-14" bores)
- A-510E Target Pole Extension
- T-231A 25' Target Extension Cable



**Bore Setup (showing unevenly spaced points to be measured) and resulting plot**

