Designed specifically for those applications where it is hard to mount a bore laser externally, such as stern tube bearings, the L-708 offers the ability to be inserted directly into a bore for very fast, high-accuracy bore alignments. With high resolution, the capability to measure a wide range of bore diameters, and our patented A-514 self-centering bore adapters, the L-708 is the best choice for hard-to-fixture bore alignment applications.

The L-708 also offers a variety of target options, including self-centering, see-through, 2-axis and 4-axis targets, hand-held readouts, and Windows®-based software to display and analyze alignment data. The system handles a wide variety of bore alignment applications, including: bore straightness checks for cylinders and large gun barrels, engine-block crankshaft bore alignment, and stern tube bearing bore alignment. If your specific application isn’t listed, call us and we will work with you to solve your unique alignment problems.

The L-708 Bore Laser System

**L-708 Bore Laser**

The L-708 Bore Laser is a battery-operated, visible light laser that mounts magnetically in a bore fixture or mounting. It has been designed to be inserted into our A-514 Self-Centering Bore Adapters so it can be inserted into a reference bore, saving setup time. The laser has a mounting surface of 1.2498" (31.745 mm) and the laser beam is centered to this OD to within .0003" (0.08 mm). The L-708 Laser is equipped with coarse and fine angular adjustments necessary to set the laser beam to the center of the far reference target. It is used for applications up to 110 feet (33 M). The L-708LD Long-Distance Bore Laser can be used out to 200 feet (60 M).

**Fast Setup and Even Faster Measurements**

With simplified fixturing and self-centering targets, the L-708 system can be set up in as little as 15 minutes. Since it literally takes less than a minute to insert the target/adapter into a bore to take a measurement, in most cases bore straightness data can be taken and analyzed in 30 minutes or less. This means that even the longest bore application can be measured in just minutes versus hours for optics, tight wire or other laser systems. Nothing is faster than the L-708 Bore Alignment System!

**System Handles Large Range of Bores**

Any bore, from 3.75" (92.25 mm) up to 40" (1,016 mm) or more, can easily be measured with our L-708 Bore Laser System. The system offers three bore adapters and a leg-setting gage to set the adapters to the nominal bore ID. For bores from 2.0" (50.8 mm) to 3.75" (92.3 mm), we offer our A-510 Target and A-510STA Self-Centering Adapter Hub and M-705CL Customized Measuring Legs. We even offer bore targets that can measure bore alignment down to .70" (18 mm).
High Resolution and Accuracy
When used with our R-1307 Readouts, the L-708 system provides a resolution of .00002" (0.0005 mm). The system is accurate to .0012" (0.03 mm) and repeatable to .0002" (0.005 mm). Under good environmental conditions, the L-708 Laser is accurate to .004" (0.1 mm) over the whole 100 foot (30 m) range. By mounting the laser externally with L-111 Laser Stand and carefully following the NORMIN procedure, accuracies of .0003" (0.0075 mm) in 10 feet (3.1 meters) can be achieved.

Patented Self-Centering Target & Adapters – The Key to the System
The A-512 2-Axis Bore Target and the L-708 Bore Laser are designed specifically for our A-514 line of self-centering bore adapters. This unique feature allows the laser and target to be inserted into reference bores without any mechanical setup, such as bore sweeping or the need to rotate the target to determine mounting errors (a common problem with most other systems). All you need to do is insert the laser, target and their A-514 bore adapters into the reference bores and make sure they are oriented at 12:00. In just a couple minutes, the laser will be set up and ready to take measurements. Then it takes just seconds to measure each internal bore for alignment. The laser and target are concentric to their housings to within .0003" (0.0075 mm). When used with the A-514 adapters, the target and laser are centered to the bore within .0006" (0.015 mm) accuracy.

Another unique feature of our A-514 adapters is they can handle a fairly large range of bore diameter changes of up to .020" or 0.5 mm. This means you don’t need to worry about bore diameter changes to get accurate measurements.

Live Alignment Data Saves Even More Time
As with all of our laser alignment system, the A-512 Bore Target provides live alignment data via our R-1307 readouts. This means once the target is installed in a bore and you are ready to align it, you just watch the readout continuously update as you adjust the bore, supporting pillow blocks or bearing sleeves. When the readings are zero, you’re done!

Simple Readouts, Optional Software
The L-708 Bore Alignment System comes with simple H & V axis readouts that are extremely easy to use. There is no complicated software to learn in order to use the system, which minimizes training requirements. For those who want to document the alignment and produce a report, there is no easier bore alignment program to use than our Bore9 software.

Measure Bore Angle in Seconds
To check for bore angle relative to the centerline, just take a measurement at the front or back of the bore and any difference shows the angle! Adjust the front and back of the bore to read zero and it’s aligned! Also with our unique design, our target only needs a few inches of bore width to take a measurement.
**Long Range and High-Resolution Angular Adjustments**
The L-708 can be used for applications up to 110 feet (33 M). The L-708LD can be used for applications up to 200 feet (60 M). The fine-adjustment micrometers can steer the laser beam in the horizontal and vertical axes to .0014" (0.036 mm) in 200 feet (60 M). It can either be mounted in our A-514 Self-Centering Adapters or used with our L-111 Laser Stand and L-102 Laser Beam Translator to be mounted outside of the bore. The L-111 and L-102 have course angular and fine centering adjustments to align the beam to reference bores.

**Wireless Data Downloading and Transfer**
For long-distance applications, the R-1307 Readout can be configured with a 2.4GHz Zigbee® radio and transmit its data up to 150 feet (45 M). The data can be received by a second R-1307, which is very useful when bucking-in (setting up) the laser to reference targets that are at distances greater than 15 feet, or it can also be received by the A-910-2.4ZB Computer Interface for automatic downloading into our Bore9 Software.

**Alignment System Features**
- Built-in coarse and fine horizontal and vertical angular adjustments for quick referencing
- Designed to fit into reference bores using our A-514 Self-Centering Bore Adapters to save time and simplify the setup.
- L-708 has a range of 100' (30 M). L-708LD has a range of 200' (60 M).
- Visible laser beam straight to .0001" in 10' (0.0025 mm in 3 meters) or .001" in 100' (0.025 mm in 30 meters)
- R-1307-2.4ZB Readout supports both wireless and cabled targets with a wireless range up to 150 feet (45 meters) with wireless range up to 150' (45 M).
- System resolution of .00002" (0.0005 mm)
- Self-centering target, accurate to .0012" (0.03 mm) and repeatable to .0002" (0.005 mm)
- For higher accuracy applications (.001") the L-708 can be mounted externally using the L-111 Laser Stand with the L-102 Beam Translator
- System handles a large range of bore IDs from 3.75" (92.25 mm) up to 40" (1,016 mm)
- Windows-based Bore9 software with large color graphics to record and analyze bore straightness and alignment data.
- Dynamic or live display of component misalignment
- Portable enough to fit into small carrying case.
- Laser runs for up to 8 hours on a standard, replaceable 9-volt battery
- Optional A-510SM Small-Bore Target easily accommodates bores as small as 1.5" (38.1 mm)

**Recommended System Configuration**
- L-708 Bore Laser with coarse and fine angular adjustments
- A-512 2-Axis Bore Target
- A-514A Small-Bore, Self-Centering Adapter for 3.5" to 6.75" diameter bores (quantity 2)
- A-514B Medium-Bore, Self-Centering Adapter for 6.5" to 17.5" diameter bores (quantity 2)
- A-514GS Small Leg-Setting Gage for A-514 A and B Adapters
- R-1307B-2.4ZB 2-Axis Combination Readout
- A-814 Shipping Case

**Optional Accessories**
- L-708LD Long Distance Bore Laser for applications up to 200' (60 M)
- A-514C Large-Bore, Self-Centering Adapter for 17" to 40" diameter bores
- A-514GL Large Let-Setting Gage for A-514 A, B and C Adapters
- A-514CXL X-Large Bore Self-Centering Adapter for 17" to 50" diameter bores
- A-510 2-Axis Bore Target
- A-510SM Customized, 2-Axis, Small-Bore Target and Adapter
- A-510STA Self-Centering Adapter Hub
- A-510LTA Self-Centering Adapter Hub for large bores
- M-705CL Set of 4 Customized Legs for A-510STA
- A-510SM Customized, 2-Axis, Small-Bore Target and Adapter
- T-1218 2-Axis Bore Target with 20x20 mm PSD
- T-1220 2-Axis Bore Target with See-Through capability 20x20 mm PSD
- T-1240 2-Axis Self-Centering Bore Target with See-Through capability for Self-Centering Bore adapters 20x20 mm PSD
- T-218 2-Axis Universal See-Through Target
- T-225L Large Bore Flange for T-218 Target
- T-231AL 25' Target Extension Cable
- A-910-2.4ZB Wireless Data Receiver
- S-1403 Bore9 Software
Bore Alignment Applications

Compressor Bore Alignment
The L-708, combined with the L-111 Laser Stand and L-102 Laser-Beam Translator, are mounted outside of the compressor bore and our special version of the A-514 Self-Centering Bore adapter is used on the top and bottom 60 degrees of the “cut away” bores on the compressor to align the laser to the near and far bores. The target/adapter are then moved to the cross-head and other components to check and align the bores. With care, accuracies of 0.0005” (0.01 mm) can be achieved. The alignment is up to 50% faster and two times more accurate than tight wire methods.

Engine Cam/Crankshaft Bore Alignment
The L-708 Bore Alignment Laser System has provided several automotive and diesel-engine manufacturers with a fast, reliable method of measuring the crankshaft bore for both straightness. The laser system has proven to decrease inspection times significantly and virtually eliminated dedicated, expensive gauging. The laser and target are adaptable to most crankshaft bore applications.

The L-708 and A-514 Self-Centering Bore Adapter are mounted inside the first reference bore of the engine block. The A-512 Target and second A-514 Adapter are mounted in the far reference bore and connected to the R-1307 Readout. The laser angle is adjusted until it reads zero. Now the laser is “bucked-in” (aligned to the references) and the A-512/A-514 is moved to internal bores for ultra-fast and accurate alignment checks. Setup time takes about 10-15 minutes and the entire alignment check can easily be done in less than 30 minutes.

Our Bore9 software documents the bore alignment, offering a step-by-step guide through the process, bore-to-bore and overall alignment tolerances and a report that shows if the bores are in or out of alignment.

Stern Tube Alignment
The L-708 is also ideal for measuring the straightness of stern-tube bearing bores in marine applications. The laser can be used with two references: a) from the outside of the ship using the A-514 Self-Centering Bore adapter to mount it in either the aft strut bore or the aft stern tube bore, and then aligned to the forward stern tube bearing (or intermediate shaft bearing) and then shooting into the gearbox, or b) fixtured onto the gearbox shaft, aligned to the rotation axis and the laser is shot down into the stern tube. If the L-708 is combined with our T-261A 4-Axis Target and aligned to the stern tube bearings, it can calculate the shaft rotation axis alignment to the stern tube in four axes simultaneously, minimizing the number of moves during the final engine alignment!
How the Alignment System Works

General Setup
To perform alignments, the L-708 Laser and A-512 Target must be inserted into their A-514 Self-Centering Bore Adapters. But first, both the laser and target A-514 adapter legs must be set to the nominal bore diameter using the A-514GS Leg-Setting Gage. The required accuracy for setting the legs to the bore diameter is not very high: about 0.05 mm. The key to achieving alignment accuracy for the A-514 adapters is to make all the legs the same length, which is easy to do with the A-514GS. The reason that setting the legs to the exact bore ID is not critical is because the A-514 Adapters can handle a large range of bore diameter changes: up to .020” (0.5 mm) and still give accurate alignment results.

Once the A-514 legs are set for both adapters, then the L-708/A-514 Adapter are inserted into the first (near) reference bore. The A-512/A-514 target/adapter are then placed in the second (far) reference bore and the R-1307 Readout is connected. Next, the angular adjustments on the L-708 are adjusted to tilt the laser beam to center it to the A-512/A-514. The laser is now concentric to the end bores and the A-512/A-514 target/adapter are moved to the inner bores for alignment checks. Since the laser provides live data, any alignment errors can be adjusted and the user can watch the readings update live in the readout.

How the A-512 Target and A-514 Adapters Work
The A-512 Target is designed so that the PSD is centered axially between the four feet of the A-514 Adapter, two of which are offset axially from the other two (see the graphic on Page 2). 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 45º. This means even if the bore diameter changes, the A-514 will still self-center giving an accurate measurement of the bore's alignment. To insert the target into the bore, attach the handle to the target and tip the target forward, which allows it to easily slide into the bore. Release the handle/insertion pole and the target/adapter "jam" into the bore, finding the center automatically (see picture bottom right). The weight of the handle keeps the target centered in the bore.

Measuring Bore Alignment
The A-512 target is then placed in the desired bore for measurement, and once it is properly centered, the readout displays the bore misalignment. To truly align a bore to a centerline, two sets of readings are needed: one in the front and one in the back of the bore. The average of these two sets of reading indicates how far off center the bore is relative to the reference bores. The difference between the readings is how much angle the bore has to the reference bore centerline. To align a bore, both ends of the bore must be adjusted to zero, an easy task given that the readings from the target are live.
High-Tolerance Bore Alignment

For high-tolerance bore alignment applications, the remaining target sensor concentricity error (T SCE) must be calculated using the NORMIN method. TSCE is calculated by taking two readings, one with the target at the 12 o'clock position and a second at 6 o'clock (horizontal and vertical calculations are done separately). The second reading is added to the first and the result is divided by 2. This is the TSCE and shows how far off the center of the target is from the center of the bore. This calculation creates an offset that can then be subtracted from all subsequent bore measurements to get the true misalignment number. Our Bore9 software can easily calculate TSCE and even automatically remove it from the displayed reading.

Using Bore9 Software

Hamar Laser’s new Bore9 software supports all of Hamar's past and present bore alignment equipment to create a powerful tool for measuring and aligning up to 50 bores. This comprehensive and easy-to-use program measures bore straightness (axis centering) and diameter change when using our targets in measuring mode.

Bore9 features an easy 5-step process (described briefly below) that guides the user through the alignment process from setup to results. These results can be plotted, saved, and exported to an Excel spreadsheet.

- **In Step 1 – Bore Setup**, the user enters setup information for the alignment check such as number of bores, distance between bore, bore diameters and bore straightness tolerances.
- **In Step 2 - Target Mounting Error**, an easy procedure is followed to remove mounting errors. Mounting errors must be compensated for in order to achieve accurate results in bore and spindle work. Bore9 uses the NORMIN method developed by Hamar Laser to quickly and precisely cancel out these errors and eliminate the need for complicated, expensive fixtures. The word NORMIN is a contraction of NORMal-INverted, which briefly describes the method.
- **In Step 3 – Laser Setup**, on-screen instructions guide the user through setting up the laser and making it parallel to reference points.
- **In Step 4 – Record Data**, bore straightness data is recorded. There are several different sets of data that can be taken in this step.
- **In Step 5 – Results**, results of the recorded data are plotted on a graph and a least-squares, best-fit data algorithm is applied to generate the straightness results and to determine if they are in or out of tolerance. Plot data can be changed to reflect the position of the centerline of the bores relative to the end bores, selected bore numbers, the laser beam or a “Best Fit” line. The data for each point is recalculated automatically based upon which references are chosen. Reports are also generated in this step and can be customized to the four different bore references. Comments may be added and the report can be printed with a summary, a graph of the vertical and horizontal straightness, comments and a table showing the recorded data.
Bore Alignment Procedure Using the L-708, A-512, A-514 and Bore9

The L-708 Bore Laser provides a straight reference line to which any bore can be aligned and measured and allows centering to .0012" (0.03 mm). Setup is fast and easy. The A-514 Self-Centering Bore Adapters for both the laser and target are put on a leg-setting gage to adjust the legs to the desired bore radius. The L-708 and A-512 Targets are inserted into their bore adapters and then the laser and target assemblies are inserted into the two reference bores where they self-center. The laser’s angular adjustments are used to set/tilt the laser to zero on the target, establishing the reference bore centerline. The target can be moved (or second target added) to inner bores for alignment checks. Since the alignment data in the readout updates in real time, any errors can be adjusted using the target as a live indicator.

Step 1: Setup

a. Open Bore9 and select the target and computer interface. Note that Bore9 is not required, but it is recommended.

b. Enter the number of bores, the distance between the bores, the bore diameters, and select the alignment tolerances. Note that you can select bore-to-bore alignment tolerance as well as an overall tolerance.

c. Measure the nominal Bore ID. Use the A-514G Leg-Setting Gage to set the legs of the A-514 Bore Adapters for both the laser and target to the nominal Bore ID.

d. Insert the L-708 into the first A-514 Bore Adapter and insert the laser/adapter into the first (near) reference bore. Ensure that the level vial on top of the adapter is level. This orients the laser’s Vertical and Horizontal adjustment axes to the Vertical and Horizontal axes of the bores.
e. Insert the A-512 Bore Target into the second A-514 Bore Adapter and then insert the target/adapter into the second (far) reference bore. Ensure that the level vial on top of the adapter is level. This orients the target’s Vertical and Horizontal adjustment axes to the Vertical and Horizontal axes of the bores. Connect the R-1307 Readout and power it on.

![Image of target and adapter orientation](image)

**Step 2: Target Mounting Error**

a. Rotate the target 180 degrees (INVERTED position) and reinsert into the near bore. Press **Record** to record data for the target in the INVERTED position. A Mounting Error Offset will be calculated and applied to each target reading. This will remove any remaining centering errors in the target and adapter.

*Note: Step 2: Target Mounting Error of the Bore9 program may be skipped if measuring bore straightness or alignment tolerances are greater than .0005” (0.013 mm).*

![Image of target mounting error](image)

**Step 3: Laser Buckin**

a. Select the laser mounting by clicking the Internal Mount graphic. Click **Next**.

b. Select the target to use for the laser setup. Click **Next**.

![Image of laser mounting setup](image)
c. Follow the on-screen instructions to perform the laser setup.

c. Insert Laser and Self-Centering Bore Adapter into 1st end bore.

d. Insert Target with Bore Adapter into 2nd end bore.

e. Adjust Horizontal and Vertical Micrometers on Laser to adjust (tilt) the laser until the display shows zero.

d. Steer the laser using the Pitch (V) & Yaw (H) adjustment knobs on the L-708 so the reading on the R-1307 is zero. The laser is now concentric to the centerline of the two end (reference) bores.

e. Click Finish to go to Step 4—Record Data.
Step 4: Record Data

a. Move the A-512 Target/A-514 Adapter to the inner bores to measure for alignment and press **Record**. Continue moving the target to each bore until all data is taken.

Step 5: Results

a. **Step 5—Results** displays a graph of the results and a summary of the alignment.
Bore9 Sample Report

Bore9 Report

Project: Bore9

Report Issued By:

Company Name:
Address:
City, State Zip:
Phone/Fax:
Company DBA:

Machine Information:

Factory Name:
Machine Information:
Notes:

Alignment Results:

Alignment Check | Value | Tolerance (+/-) | RF | Slope | Ball Thrust | Thrust
--- | --- | --- | --- | --- | --- | ---
Vertical Alignment (X99) | 0.95 | 0.9 | 0.03 | X
Horizontal Alignment (Y99) | 0.24 | 0.05 | 0.00 | X
Vertical Bore To Bore (Max) | 0 | 0 | 0.00 | X
Horizontal Bore To Bore (Max) | 0.0 | 0 | 0.00 | X

Setup Information:

Number of Bore9s: 1
Distance between bores: 12.096
Laths: 0
Overall Tolerance: 0
Bore to Bore Tolerance: 0
Target Intersection: X=1.1997-0.0000, Y=1.1997-1.4
Serial Number:
Calibration Date: 1/1/991

Result Graphs:

Slide View: Vertical Center (Laser)

Top View: Horizontal Center (Laser)

Alignment Data:

Bore F | Diam | V X99 | H X99 | V Y99 | H Y99 | V Z99 | H Z99 | RF | Slope | Ball Thrust | Thrust
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
1 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
2 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
3 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
4 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
5 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
6 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
7 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
8 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
9 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
10 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
11 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
12 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
13 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
14 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
15 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
16 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
17 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
18 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
19 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
20 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
21 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
22 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
23 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
24 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
25 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]

Alignment Data (Continued):

Bore F | Diam | V X99 | H X99 | V Y99 | H Y99 | V Z99 | H Z99 | RF | Slope | Ball Thrust | Thrust
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
26 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
27 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
28 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
29 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]
30 | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value] | [value]

Graphs and tables are included in the report, showing alignment data and results for Bore9 operations.