

## Application Note 1

# Bore Alignment with the L-706 Laser

### L-706 Applications

- Engine Crankcase Bores
- Bar Turning Machine
- Compressor Bores
- Stern Tube Shaft Bearings
- Tube Support Plate Bores

Designed for high-accuracy bore alignments, the L-706 offers the most accurate, yet easy to use laser alignment system. With high resolution, capability to measure a wide range of bore diameters, and our patented A-514 self-centering bore adapters, the L-706 is the best bore alignment system on the market.

The L-706 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: aluminum can-making machinery, bar-turning machines, bore straightness checks for cylinders, engine-block crankshaft bore alignment, stern tube alignment, tail rotor bearing alignment for helicopters, and tube support plate

bores for heat exchangers. If your specific application isn't listed, call us and we will work with you to solve your unique alignment problems.



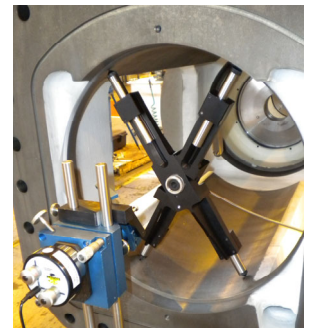
## Bore Alignment Applications

### Bar Turning Machines

The L-706 is aligned to the bore reference inside a bar-turning machine using a simple fixture that simulates the bar. The A-510 target is placed in the fixture and the L-706 is aligned to the references inside the machine. The bar fixture with the A-510 is then moved along the rails and they are aligned to cutting head. The data is live so the tech can just watch the R-1307 while the rails are being adjusted. When they read zero, the point is aligned!

### Compressor Bore Alignment

The L-706 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 in-cut away in. 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 in. (0.01 mm) can be achieved. The alignment is up to 50% faster than and twice as accurate as tight wire methods.



### Engine Cam/Crankshaft Bore Alignment

The L-706 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-706 and L-111 Laser stand are mounted outside the engine block and aligned to the reference bores using our A-512 Self-Centering Target and the A-514A, B and C adapters. The A-512/A-514 adapters quickly position the target in the bore 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-706 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 L-111 and L-102, aligned to the stern tube bearings and then shooting into the gearbox using our T-261A 4-Axis Target to check the gearbox shaft alignment, or b) fixtured onto the gearbox shaft, aligned to the rotation axis and the laser beam is shot down into the stern tube to check the alignment of the bearings to the shaft axis. By using our T-261A 4-Axis Target, the L-706 system 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!



### **Tube Support Plate Bores for Heat Exchangers**

We worked with several heat exchanger manufacturers to adapt our L-706 Bore Alignment systems to align the bores for tube support plates for heat exchangers. We developed the T-219 target along with a customized bore adapter to check the alignment of small bores in the support plates. We also developed a specialized adapter for the L-706 to fit into the tube sheet reference bores and special software to monitor the alignment. Once the laser is aligned to the reference, our software monitors reference targets throughout the alignment to make sure the laser did not drift as the temperature changes, a common problem for long-distance alignments.

### **Customized Bore Alignment Solutions**

If you have a special bore alignment application that requires some customization, please let us know. We are always looking for new applications and have worked with many customers in the past to offer a customized solution to challenging bore alignment applications. Give us a call!

## **The L-706 Bore Laser System**

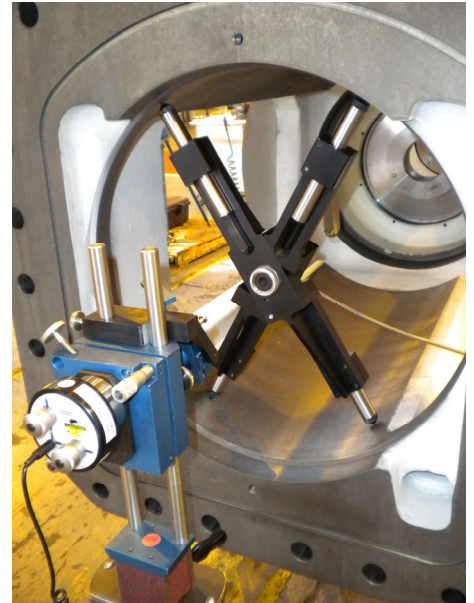
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### **L-706 Bore Laser**

The L-706 Bore Laser is a battery-operated, visible light laser that mounts magnetically in a bore fixture or mounting. It is suitable for almost all bore applications. The laser has two mounting surfaces: 0.7498 in. (19.04 mm) and 2.2498 in. (57.14 mm). The laser beam is centered to both mounting ODs to within .0003 in. (0.08 mm). The L-706 Laser is equipped with 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 meters).

### **Fast Setup and Even Faster Measurements**

With simplified fixturing and self-centering targets, the 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 and take a measurement, bore straightness data can be taken and analyzed in 30 minutes or less in most cases. This means 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-706 Bore Alignment System!



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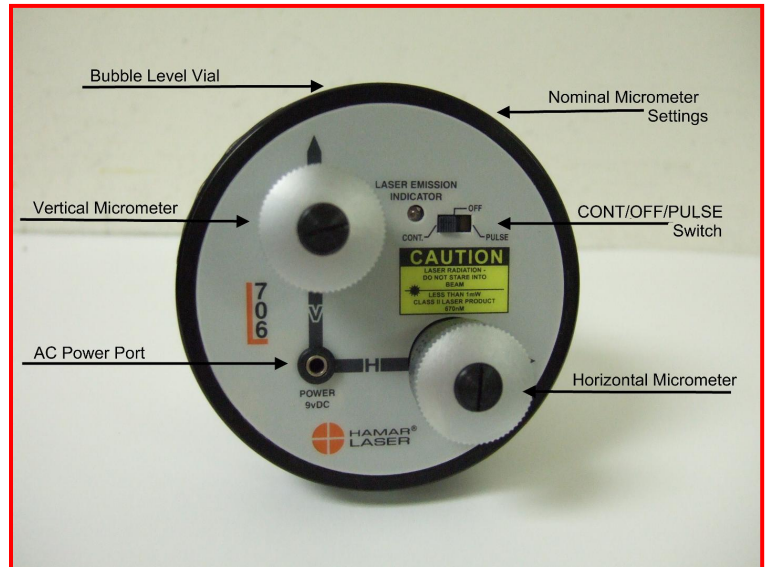
## Superior Design Reduces Customer-Supplied Fixturing Costs

The L-706 Laser has been designed with a standard aerospace tooling diameter of 2.25 in. (57.15 mm). Since the laser beam is concentric to the OD to within .0005 in. (.0127 mm), a simple flat face and .750 in. (19.05 mm) hole on center is all that is needed to hold the laser (powerful magnets hold the laser flush to the face).

## Operational Features of the L-706 Bore Laser

The following describes the operational features of the laser. These features include bubble level vial orientation, micrometer values and settings, ON/OFF switches and the external battery pack.

- **The ON/OFF slide switch** has a lighted LED to indicate that power is ON.
- **The Pulse/Continuous switch** selects the laser mode compatible with the readout/interface being used.
- **Micrometer controls** are provided for the adjustment of the laser beam's angle in the horizontal and vertical axes to steer the laser to the measuring detector during setup. The L-706 has an angular adjustment resolution of .001 in 100 feet (0.025 mm in 30 meters). Each laser has a **NOMINAL** setting for both the V-Vertical and the H-Horizontal micrometer controls (see the **Nominal Settings** label on the outer flange). The nominal settings are determined at the factory and correlate to values for the laser beam when it is perpendicular to both the 2 in. and 4 in. mounting faces. When a laser is mounted in the gearbox or bore adapter, vertical and horizontal micrometers should be *set in the nominal positions* to facilitate the alignment and measurement process.
- **Bubble level vials** on the laser mounting flange are used to orient the laser at either 12:00 or 6:00 during our NORMIN procedure to take out mounting errors. In addition, the levels also orient the L-706's angular adjustments to the bore's vertical and horizontal axes, speeding up the laser setup.



## System Handles Large Range of Bores

Any bore, from 3.75 in. (92.25 mm) up to 50 in. (1,270 mm) or more, can easily be measured with our L-706 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 in. (50.8 mm) to 3.75 in. (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 in. (18 mm).

## High Resolution and Accuracy

When used with our R-1307 Readouts and Bore9 Software, the L-706 system provides a resolution of .00002 in. (0.0005 mm). Under good environmental conditions, the L-706 Laser is accurate to .004 in. (0.1 mm) over the whole range. By carefully following the NORMIN procedure, accuracies of .0003 in. (0.0075 mm) in 10 feet (3.1 meters) can be achieved.

## 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-706 can be used for applications up to 110 feet (33 m). The fine-adjustment micrometers can steer the laser beam in the horizontal and vertical axes to .001 in. (0.03 mm) in 110 feet (33 m). It can either be mounted in customer-supplied fixturing or used with our L-111 Laser Stand and L-102 Laser Beam Translator to be mounted outside the bore. The L-111 and L-102 have coarse angular and fine centering adjustments to align the beam to reference bores.

## Simple Readouts, Optional Software

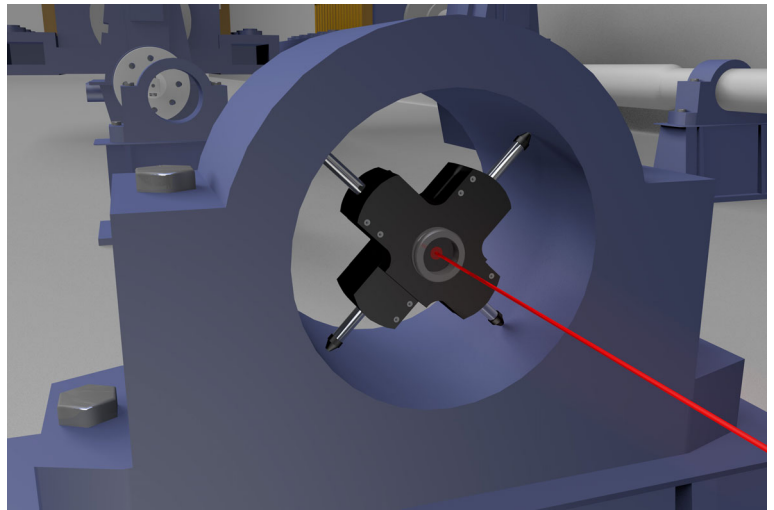
The L-706 Bore Alignment System comes with simple H & V axis readouts that are extremely easy to use. There is no complicated software to learn in order to use the system, which minimizes training requirements. For those who want to document the alignment and produce a report, there is no easier bore alignment program to use than our Bore9 software.

## 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 400 feet (120 M) to 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.

## Patented Self-Centering Target & Adapters – The Key to the System

The A-512 2-Axis Bore Target has a 10x10 mm PSD and is designed specifically for our A-514 line of self-centering bore adapters. This unique feature allows our target to be inserted into a bore 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). Insert the target into the bore and make sure it is oriented at 12:00 and in seconds you have a measurement. The target is concentric to its housing to within .0003 in. (0.0075 mm). When used with the A-514 adapters, the sensor is centered to the bore within .0006 in. (0.015mm). Another unique feature of our A-514 adapters is they can handle a fairly large range of bore diameter changes of up to .020 in. or 0.5 mm. This means you don't need to worry about bore diameter changes to get accurate measurements.



*A-512 Target and A-514 Self-Centering Bore Adapter mounted in a shaft bearing*

## Live Alignment Data Saves Even More Time

As with all of our laser alignment systems, 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!



*R-1307 Readout*



*R-1307KS Readout Stand*



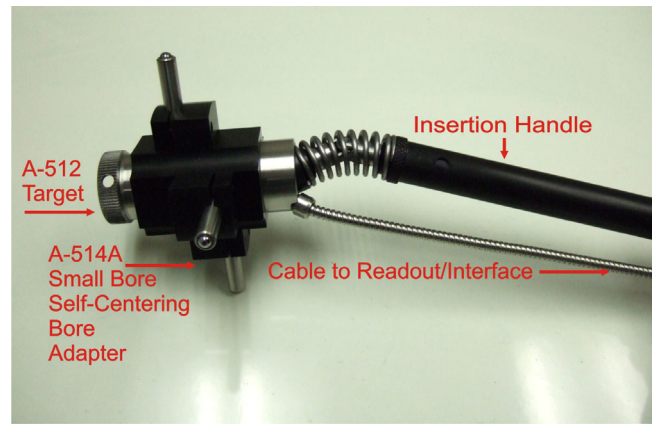
*A-910-2.4ZB Computer Interface*



### Model A-512 2-Axis Self-Centering Target

The A-512 Target *unit* is comprised of a target cell, a bore adapter, and an insertion handle. The target is inserted into the bore to sense the position of the laser beam. Laser beam position data is displayed on a readout. As the bore is adjusted, the readouts display data in real time.

The target cell is a position-sensitive photo cell surrounded by a stainless-steel housing. When the laser beam hits the sensor, the electronics find the center of energy of the beam at a very high resolution and accuracy. The effective cell range is  $\pm .100$  in. (2.5 mm), and changes in the x and y axis positions of the target can be displayed on a digital readout with a resolution of .0001 in. or 0.001 mm.



The A-512 2-Axis Bore Target's self-centering capability allows our target to be inserted into a bore 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). Insert the target into the bore, ensure it is oriented at 12:00, and in seconds you have a measurement. The target is concentric to its housing to within .0003 in. (0.0075 mm). When used with the A-514 adapters, the sensor is centered to the bore within .0006 in. (0.015mm). Another unique feature of our A-514 adapters is they can handle a fairly large range of bore diameter changes of up to .020 in. or 0.5 mm. This means you don't need to worry about bore diameter changes to get accurate measurements.

When using the A-512 Target with the A-514A and A-514B adapters, two types of insertion handles may be used. One is a solid stainless-steel handle intended for individual bores. The other is a pole for long, continuous bores such as extruder barrels or gun barrels. The solid stainless steel handle is designed for the weight of the handle to firmly lock the target into place. The pole type is designed with a spring and a universal joint at the rear of the target, which locks the target into place.

### The A-514 A, B and C Self-Centering Laser and Bore Adapters for the A-512 Target

The A-514 self-centering laser and bore adapters accurately and quickly position the laser and target on the bore centerline. The adapters can be centered to the bore to within .0005 in. (0.0127 mm). The adapters have adjustable legs that allow them to be used for bore diameters ranging from 3.75 in. (95 mm) to 40 in. (1M) and the A-514B and A-514C come with counterweights to prevent the assembled system from tipping.



Three sizes are available, as follows:

- **A-514A** for bores from 3.75 in. (95 mm) to 6.75 in. (172 mm)
- **A-514B** for bores from 6.5 in. (165 mm) to 17.5 in. (445 mm)
- **A-514C** for bores from 17.0 in. (432 mm) to 40.0 in. (1 M)

**Note:** For bores over one meter, half-bores, or where bore surfaces are worn or rough, the T-218 Two-Axis Universal Target and T-225L Large Bore Flange are used. The T-218 has a prism that flips out of the way, allowing the laser beam to pass unobstructed through the target without removing it, which proves useful for aligning multiple bores over long distances. For half-bores, the T-218 is used with the A-502A Half-Bore and A-501A Bore Sweep Fixtures.

### The A-514GS and A-514GL Leg-Setting Gage

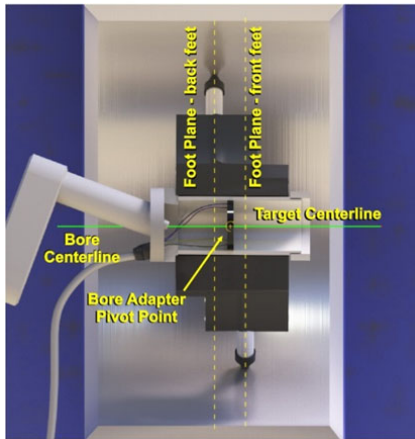
The gages are used to set the A-514 Adapter legs to the correct bore diameter. The gages are available in two sizes, depending on the size of the bore being measured. The A-514GS is used with the small (A-514A) or medium (A-514B) bore adapters. The A-514GL can be used for all three adapters and must be purchased if using the large bore adapter.



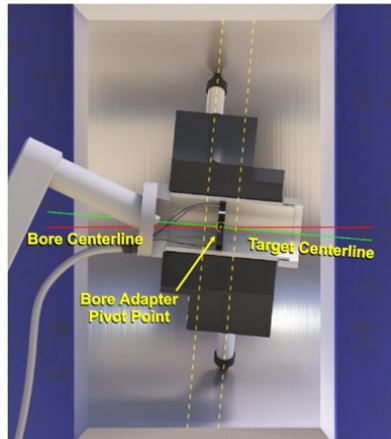
## How the A-512 Target and A-514 Adapters Work

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. 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°. 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 in-jam in. into the bore, finding the center automatically. The weight of the handle keeps the target centered in the bore.

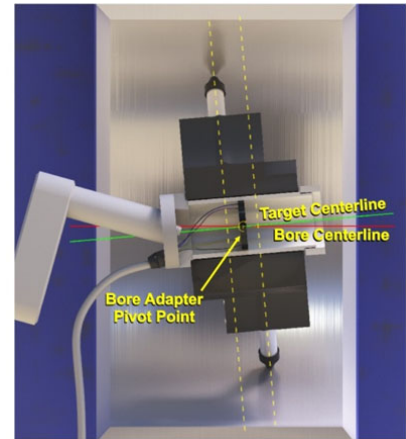
### How the A-512 and A-514 Self-Centering Adapters Work



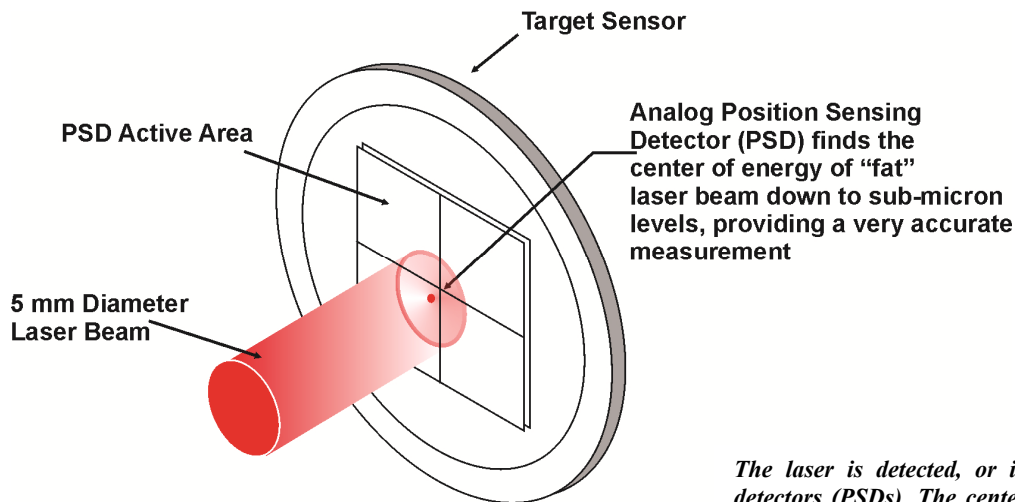
**A-512/A-514 Target & Adapter  
Adapter OD = Nominal Bore ID**



**Bore ID > Nominal ID  
Target Tilts Forward  
PSD Is Still Centered**



**Bore ID < Nominal ID  
Target Tilts Back  
PSD Is Still Centered**



*The laser is detected, or intercepted, by position-sensing detectors (PSDs). The center of energy of the laser spot is detected and converted to an electrical signal proportional to its location on the surface of the target. This signal is converted into a calibrated reading, using a variety of hand-held readouts or computer interfaces for use with our software.*

## Alignment System Features

- Fast and simple setup
- Built-in horizontal and vertical angular adjustments for quick referencing
- Simple fixturing to mount the laser into the reference bore
- Visible laser beam straight to .0001 in. in 10' (0.0025 mm in 3 meters) or .001 in. 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)
- Self-centering target, accurate to .0003 in. (0.0075 mm) , vastly simplifies measurement process
- System handles a large range of bore IDs from 3.75 in. (92.25 mm) up to 40 in. (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. Complete system weighs less than 15 lbs (6.804 kg).
- 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 in. (38.1 mm)

## Recommended System Configuration

- L-706 Long Distance Bore Laser
- L-111 Laser Adjustment Stand
- L-102 Axis Laser Beam Translation Fixture
- A-512 2-Axis Bore Target
- A-514A Small-Bore, Self-Centering Adapter for 3.5 in. to 6.75 in. diameter bores
- A-514B Medium-Bore, Self-Centering Adapter for 6.5 in. to 17.5 in. diameter bores
- 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

- A-514C Large-Bore, Self-Centering Adapter for 17 in. to 40 in. diameter bores
- A-514GL Large Leg-Setting Gage for A-514 A, B and C Adapters
- A-514CXL X-Large Bore Self-Centering Adapter for 17 in. to 50 in. diameter bores
- A-510 2-Axis Bore Target
- 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



**A-514 A, B, C  
Bore Adapters**



**T-218 Target**



**T-1218 Target**



**T-1220 Target**