Application Notes

Aligning Continuous Casters and Steel Mill Rolls

System Recommendation

Continuous Casters
L-740 Ultra-Precision Leveling Laser

Steel
L-743 Ultra-Precision Triple Scan Alignment System

One of the more time-consuming tasks in maintaining continuous-caster steel mills is setting the correct caster roll pass line. Unlike using optics that requires at least 2 operators, the L-740 only requires one operator, and since the laser automatically sweeps a reference plane, it is a very simple process to measure and set the heights of caster segment rolls. The heights can be set using precision inserts with our targets, as the tolerance of the centerline of the target to its base has been accurately controlled.

In addition, all the rolls of a segment can be checked from one setup. Furthermore, the laser can be set up between two segments and both of them can be checked at the same time from the same setup.

The flatness of the laser plane is the most important factor in determining the overall accuracy of the system for measuring flatness. No one surpasses the flatness of our laser planes. In a 180º sweep, our L-740's laser plane is flat to within ½ an arc second, (0.00003"/ft or 0.0025mm/M) and in a 90º sweep, the laser plane becomes even flatter to within ¼ of an arc second (0.000015"/ft or 0.001 mm/M).

PSDs (Position Sensing Detectors) are one of the critical components of our laser alignment systems. It is this PSD that senses the laser beam and turns it into a digital signal. This greatly reduces the man-to-man variability found in optical measurements because sophisticated electronics determine the measurement rather than the human eye. By relying on the PSD to produce highly repeatable measurements, our L-740 makes it much easier to hand off an alignment project from one crew to the next.

The L-740 Ultra-Precision Leveling Laser for Continuous Caster Alignment

The L-740 Ultra-Precision Leveling System offers the fastest, most accurate way of setting the pass line elevations on caster segments. With wireless targets offering resolutions down to 0.00002" (0.0005 mm), automatically sweeping laser planes and high-powered alignment software, the L-740 is the ideal alignment tool for caster segment applications.

Wireless Targets and Readouts

Hamar Laser's new Extended Range targets (A-1532 and A-1533) have a resolution of 0.001" (0.02 mm) and built-in readouts. With up to 3" of measuring range and height gage measuring capabilities, they are perfect for most steel mill alignment applications. For higher accuracy applications, our UniTargets (A-1519, A-1519HR and A-1520) have up to a 1" (25 mm) measuring range, resolutions as low as 0.00002" (0.0005 mm) and can be used up to 100 feet (30.5 meters) from the readout (R-1309), which uses a Cassiopeia PDA, color software and a wireless receiver to display up to four targets simultaneously. Depending on the target, 4, 6 or even 10 targets can all be used at the same time. This allows the use of multiple work crews to speed alignments.

Continuously Sweeping Lasers and Live Data Reduces Downtime

Continuously sweeping lasers and live data output create a powerful combination to align segments up to 70% faster than traditional methods. By providing live alignment data, misalignment errors can be quickly and easily fixed without having to change the setup. This is a tremendous benefit, especially if you are used to using an interferometer, where the entire length of and axis must be measured before the straightness or flatness can be determined and the data provided is not even live.

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Laser Planes Have 200' Range

One of the most powerful features of the L-740 is the automatically rotating laser plane with a range of 100 feet (30.5 meters) in radius. That means even the largest segments (or several segments) can be checked with one setup.

Alignment System Features

- Continuously sweeping laser plane with operational range of 100' (30.5 meters) in radius.
- Diode lasers 2 times more stable than HeNe based laser systems.
- Laser plane is flat to ½ an arc second (0.00003"/ft or 0.0025mm/M) in 180º sweep and 1/4 arc second (0.000015"/ft or 0.001 mm/M) in 90º sweep.
- Includes Pitch/Roll/Yaw base with coarse and fine adjustments.
- Completely self contained.
- Uses A-1519HR Single-Axis Wireless Target with 1" Range and 0.0001" (0.0025 mm) resolution for higher accuracy applications.
- Battery or AC powered.
- Backlit levels accurate to 1 arc second (0.00006"/ft or 0.005mm/M).
- Typical setup time 20 minutes or less.
- Standard Targets: A-1519 Single-Axis, Wireless Target with 1" (24.5 mm) Measuring Range and 0.0005" (0.013 mm) Resolution.

How the Alignment System Works

A word of caution: If the machine is going to be aligned, rather than just measured, then it is important to put the laser on an instrument stand. If the laser is on the same machine bed or table that is to be aligned, adjusting it will most likely move the laser and affect the setup.

To level a surface, the laser is first put on an instrument stand or stable mounting surface and leveled in two axes. Next, a single-axis target is placed on 1 reference point and zeroed (done electronically by pressing a button on the target or readout). The target is then moved to a measurement point on the surface, where it displays the deviation of that point from the reference point. If the display shows a "+," the measurement point is *higher* than the reference point. If it displays a "-," the point is *low* relative to the reference point.

If the measurement point happens to have an adjustment pad under it, it can then be adjusted, using the target and readout as a live digital indicator, until the display shows zero. The measurement point is then in the same level plane as the reference point.

Recommended System Configuration

L-740 Ultra-Precision Leveling Laser
A-1519 Single-Axis Wireless Target (1" range and .0005" resolution)
R-1309 Cassiopeia PDA Readout (with Read9 Software and IR Receiver)
A-909 Shipping Case

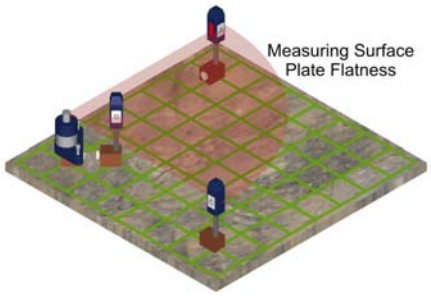
Optional Accessories

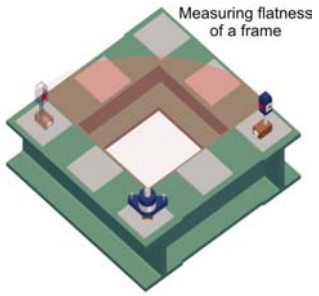
T-1519HR Single-Axis Wireless Target (1" range and .0001" resolution)
A-1520 Single-Axis Wireless Target (.250" range and .00002" resolution for higher accuracy applications)
S-1388 Plane5 Software
A-908 Wireless Data Receiver for Laptop
R-342 Notebook Computer
R-1342 Toughbook Laptop

Using Reference Points Instead of Level

To use reference points instead of levels, the laser is mounted as described above. Next, three reference points are chosen on the surface and the laser is "bucked in"[1] (or made parallel) to these points, using 1, 2 or 3 single-axis targets. Finally, the targets are moved to other points on the surface and deviations from the reference points are measured and displayed on the readout.

Using Plane5 Flatness Software to Collect and Analyze Data





Hamar Laser's Plane5 software can be used to quickly analyze almost any layout for flatness or straightness (and squareness when used with our squareness lasers). Squares, rectangles, frames, circles, rings, and up to four sets of ways can all be easily analyzed, and the alignment data is automatically downloaded by using our wireless data receiver, the A-908 for analysis and reporting. If the user is simply taking data, Plane5 uses a least-squares, best-fit algorithm to eliminate any slope errors in the data from the laser not being parallel to the surface. What this means is that you do not have to buck the laser into reference points to check the flatness, which saves about 10 minutes of setup time.

[1] **BUCK-IN**—Adjusting a laser plane or line to be parallel to the surface being measured (a table top, a surface plate, or a way surface). Three points are required to buck-in a laser plane to a reference surface. Two points are needed to buck-in a straight-line laser to a reference line (i.e., centerline).

How the Plane5 Flatness Software Works

1. Place the laser on the surface and roughly level, making the laser plane approximately parallel to the surface.
2. Set up the target on one point and zero. The grid pattern is then laid out in Plane5 and on the surface itself. For repeatability, it is important to mark the data points on the surface.
3. Move the target along the surface and press the spacebar to record each data point. The software can be set to average up to 25 readings per data point, however 5 to 10 readings is usually good enough even for the highest grade of surface plates. Once all the points have been taken, the software automatically calculates the flatness data and it can be reviewed in the report section of the software.

The L-743 Ultra-Precision Triple Scan Roll Alignment System for Steel Mill Rolls

Our lasers offer the precision and time savings to meet the ever-tightening tolerances of the steel industry. Our L-743 Ultra-Precision Triple Scan Roll Alignment System is one of only two lasers in the world (L-733 is the other) to offer three automatically rotating laser planes, which creates a powerful tool to not only *measure* but also *fix* almost any misalignment problem in continuous caster mills.

Less Manpower Needed for Alignments

The L-743 Roll Alignment System reduces alignment manpower. Wireless targets and automatically rotating laser planes make setting up the laser at each machine section a one-man job, freeing up technicians for other critical work during shut downs. The wireless readout displays both reference/benchmark targets simultaneously, allowing the operator to quickly buck-in to the benchmarks. Traditional optics usually require at least two men to work the instrument

Multiple Targets and Laser Planes Reduces Downtime

With multiple laser planes and multiple targets, the L-743 can take the place of at least two sets of optics. Once the laser is setup, multiple technicians can each use a target to realign the mill during planned or unplanned outages. This can save tremendous amounts of time and can bring the mill up that much sooner.

Set Roll Pass Line Faster with Fewer Technicians

One of the more time-consuming tasks in maintaining continuous-caster steel mills is setting the correct caster roll pass line. Unlike using optics that requires at least two operators, the L-743 only requires 1 operator, and since the laser automatically sweeps a reference plane, it is a very simple process to measure and set the heights of a caster segment rolls. The heights can be set using precision inserts with our targets, as the tolerance of the centerline of the target to its base has been accurately controlled.

Another timesaving feature of the L-743 is that all the rolls of a segment can be checked from one setup and the operator who set the laser up can start doing the measurements himself! Furthermore, the laser can be setup between 2 segments and both of them can be checked at the same time from the same setup.

Easy Squareness and Plumb Measurements for Segment Pins

The L-743 has 3 automatically sweeping laser planes, one horizontal and 2 vertical, which are all square to each other to within 1 arc second (0.00006"/ft or 0.005 mm/M). This means that complex tasks like checking the squareness of the pins to the face of the caster is an easy job for the L-743. This greatly reduces the setups needed to measure squareness when using optics. The L-743 can also be used to easily check the plumbness of the segment pins in the mill itself, as the vertical laser planes have 100 feet (30.5 meters) radius and are plumb when the laser is leveled.

Recommended System Configuration

L-743 Ultra-Precision Triple Scan Laser
A-1519 Single-Axis Wireless Target (1" range and .0005" resolution)
L-106 Instrument Stand and case
A-909 Shipping Case

Optional Accessories

A-1532 Universal Scan Target (3" range and .001" resolution)
A-1531 Universal Scan Target (1.5" range and .001" resolution)
A-1533 Universal Scan Target (3" range, swivel head and .001" resolution)
S-1388 Plane5 Software
R-1309 Cassiopeia PDA Readout with Read9 Software and IR receiver
A-908 IR Wireless Receiver

No Need for Optics' Recalibration After Plumb Measurements

Unlike some optics that usually require time-consuming recalibration of the levels each time plumb is checked, the L-743 can simultaneously check level and plumb from a single setup. This is because the squareness measuring capability is built into the instrument. Furthermore, the levels usually only require calibration once a month.

Alignment System Features

- 3 continuously rotating laser planes with operational range of 100' (30.5 meters) in radius.
- Instant on with virtually no warm-up
- Planes are mutually square to 1 arc sec (0.00006"/ft or 0.005mm/M).
- Levels accurate to 1 arc second (0.00006"/ft or 0.005mm/M).
- Uses A-1520 Single-Axis Wireless Target with 1 Micron (.00004") resolution for higher accuracy applications.
- Battery or AC powered
- Completely self-contained
- Laser planes flat to ½ arc seconds (0.00003"/ft or 0.0025mm/M) in 180º sweep and 1/4 arc second (0.00001"/ft or 0.0008mm/M) in 90º sweep).
- Includes Pitch/Roll/Yaw base with coarse and fine adjustments and lighted levels.
- Standard target: A-1519HR Single-Axis Wireless Target with 1" Measuring Range and .0001" Resolution.
- System uses Windows 95/98/XP-based software for quickly recording and analyzing machine geometry data
- Typical setup time 20 minutes or less

How the Alignment System Works

Setting Roll Pass Lines

Assuming the caster segment is level to Earth, the following method can be used for checking the elevation of the rolls (i.e., checking the pass line) of a caster segment.

1. Place the laser on an instrument stand so that the laser plane is approximately 6" higher than the highest elevation of the roll and level using the built-in level vials.
2. Place an A-1532 Single-Axis Target (A-1519, A-1519HR, or A-1533 can also be used) on the roll with the highest elevation and is zero out by pressing the zero button. If more than one target is going to be used for the measurements, then zero those targets on the same exact point as the first target.
3. After zeroing the target (or targets), place it on another roll or point on the same roll and the elevation relative to the first roll will be displayed. This is a very quick way of checking both the actual elevations and the parallelism of the rolls to each other. The A-1533 can detect up to 3" of elevation changes. Since the readings are live, the rolls can be adjusted to the correct elevation using the readout as a digital indicator.

If there are elevation changes greater than 3", the BASE mode on the target can be selected, which will display the actual reading from the base of the target to where the laser is hitting it. Precision spacers, either provided by Hamar or the user, are used to span the distance from the roll or other surface to the laser plane. Add the spacers to the reading in the BASE mode and the actual dimension from the roll or other surface to the laser plan is determined.

If the segment has not been leveled, then the L-743 can still be used to check the elevations. The procedure is almost the same as above with the only exception being that the laser is "bucked-in"[1] to the 3 reference points on the segment. The reference points can be the segment mounting pads or 3 of the rolls themselves. The bucking-in process is very similar to that of optics.

Checking Parallelism of Caster Segment Location Pins

This procedure is for checking the upper and lower locating pins for the segments in the mill itself.

1. Place a fixture for holding the laser over the mill at the top set of pins. Place the laser approximately in the center between the two pins and level.
2. Fixture the targets on the locating pins horizontally and square to one of the vertical laser planes using the Top Dead Center[2] method. Adjust the vertical laser plane using the azimuth adjusting knob so that the same readings appear on both targets. This means the laser is parallel to the locating pins and is also plumb to Earth since the laser has been leveled.
3. Zero a measuring target on one of the reference pins and place on one of the lower locating pins. Use the Top Dead Center Method[2] to square the target to the laser beam, and the resulting measurement of the first lower pin is how far out of plumb it is to the upper pin. The difference between the 2 lower-pin measurements is a measure of how far out of parallel the upper pins are to the lower pins. Since the targets provide live alignment data, they can then be used to adjust the pins, if possible, to bring them into alignment.

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[2] **TOP DEAD CENTER METHOD** -- Used when measuring the parallelism or levelness of rolls. With the target facing the laser, the roll is rotated slightly back and forth until the highest point is determined, which is the top dead center of the roll. This should be used when tight tolerances are needed or when it is difficult to determine if the target is near top dead center, usually when measuring vertical rolls.