

DG711 and DG511 Pipe Laser User Guide



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DG711 and DG511 Pipe Laser

User Guide



Version 1.6
Part Number 1281-0100
Revision C
September 2007

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Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

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EEC regulatory notice

Application of 89/336/EEC Council Directive(s)	
Manufacturer's name	Trimble Navigation Limited
Manufacturer's address	5475 Kellenburger Road Dayton, Ohio 45424-1099, U.S.A.
European representative address	Trimble GmbH Am Prime Parc 11 65479 Raunheim, Germany
Model number(s)	DG711 and DG511
Conformance to directive(s)	EC Directive 89/336/EEC using EN55022 and EN50082-1
Equipment type/environment	ITE/residential, commercial and light industrial
Product standards	Product meets the limit B and methods of EN55022 Product meets the levels and methods of IEC 801-2, 8 kV air, 4 kV contact IEC 801-3, 3 V/m 26 to 1000 MHz 80%, @ 1 kHz IEC 801-4, ac leads 2 kV

Notice to Our European Union Customers

For product recycling instructions and more information, please go to: www.trimble.com/environment/summary.html

Recycling in Europe

To recycle Trimble WEEE, call: +31 497 53 2430, and ask for the "WEEE associate," or

mail a request for recycling instructions to:

Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL



Safety Information

For detailed installation and operating instructions, follow the instructions given in this manual for this laser.

Laser Safety

The maximum radiant power output of this laser is less than 5 mW. Use only the targets supplied with this product.

Controls are listed on the radiation control drawings.



Warning – Use of controls or adjustments performance of procedures other than those specified may result in higher dosage of laser exposure.

To help you comply with your government regulations, a laser safety kit is supplied with every laser. This kit contains operator qualification cards and a sign that should be posted near the laser whenever it is in use.

As with any visible laser device, observe the following safety rules:

- Never look directly into a laser beam or point the beam into the eyes of others. Set the laser at a height that prevents the beam from shining directly into people's eyes.
- Do not remove any warning signs from the laser.
- Make sure that only properly trained people use this product.
- If service is required, which results in the removal of the outer protective cover, factory-trained personnel must perform this.

Certification

The IEC and the United States Government Center of Devices for Radiology Health (CDRH) has classified this laser as a Class 3R/3A laser product. This laser complies with IEC/EN 60825-1:2001, CDRH 21 CFR 1040.10 and 1040.11.

Queries

Address any questions you may have about laser safety to:

Trimble

5475 Kellenburger Road
Dayton, Ohio 45424-1099

U.S.A.

Attention: Quality Assurance
Group, Laser Safety Officer

Phone (937) 233-8921 ext 824 or
(800) 538-7800

Fax (937) 233-9661

Labels

The labels required for this product are:

Certification and Identification:



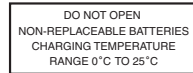
Non-Interlocked Protective
Housing:



Danger Logotype:



Battery:



Aperture:



Warning and Cautions

Warnings and Notes in the text indicate a level of danger or concern. Ensure that you follow the instructions that accompany these alerts:



Warning – A Warning indicates a hazard or an unsafe practice that could result in *minor* injury or property damage.

Note – A Note indicates important information unrelated to safety.

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Introduction

CHAPTER

1

Thank you for choosing from the Trimble family of precision pipe lasers. You've just made a wise investment in field-proven products made by Trimble, the world's leading manufacturer of laser-based leveling, alignment, and grade-control systems.

The pipe laser is an easy-to-use tool that provides underground contractors line, elevation, and grade control for installing storm, sanitary, or other gravity-flow pipe. This system can also be used for tunneling, boring, pipe alignment, or any other application requiring line, elevation, and grade control.

The pipe laser projects a highly visible red beam of laser light in a direction at a predetermined (grade) for the alignment of gravity-flow pipe. The laser light is intercepted by a target. To align the pipe, you need to position it so that the pipe laser's beam is centered in the target.

Included in this manual is information about setting up, using, maintaining, and troubleshooting the laser system. Use the manual now to learn basic skills, and use it later for reference. For the best performance of your laser system, follow the maintenance and care recommendations in this manual. Be sure to keep this manual in a convenient place for easy referencing.

Your comments and suggestions are welcome; please call the Trimble Construction Division listed below for your local, authorized Trimble office.

Trimble Construction Division
5475 Kellenburger Road
Dayton, Ohio 45424-1099
U.S.A.

Phone: (937) 245-5600
(800) 538-7800

Fax: (937) 233-9004
www.trimble.com

Claim for Damage in Shipment

The pipe laser system generally includes a pipe laser, remote control, laser target, optional external power cable, operator's manual, laser safety kit, carrying case, rechargeable batteries, and battery recharger. The components vary depending on the system that you purchase.

You should inspect your pipe laser system as soon as you receive it. It has been packaged for safe delivery. If it is damaged in any way, immediately file a claim with the carrier or, if insured separately, with the insurance company.

Owner's Record

Be sure to record the serial number of each component in the space provided below. Refer to these numbers if you need to contact your Trimble dealer regarding any of these products.

Serial Number _____

Model # _____

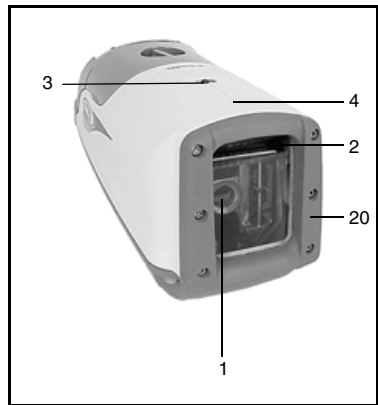
Features and Functions

CHAPTER

2

Laser

- 1** Beam-Exit Window – provides a clear window for the laser beam to exit the pipe laser.
- 2** Front and Rear Remote Receiver Window – receives signals from models RC501 and RC502 Remote Control to perform various keypad functions.
- 3** Line-Axis Pivot Marker and LED – identifies the pivot point for the pipe laser's line system. The LED lights for 15 minutes after turning on the pipe laser or pressing a control-panel button. The LED also allows you to align a transit over the top of the pipe laser.



- 4** Alignment Markers – correspond with the line system of the pipe laser. Use them with the Line Center feature to align the laser with a distant control point.

5 Liquid Crystal Display (LCD) – shows the power, grade, battery, out-of-level, line position, and status of the pipe laser.

6 Backlight/Lock Button – activates the LCD's backlight and line-pivot LED. If you simultaneously press this button along with one of the line control or grade buttons, it locks/unlocks the control panel, so that the grade and line system are not unintentionally changed.

7 Power Button – turns the pipe laser on/off. Press and hold the button for about 2 seconds to turn the unit off.

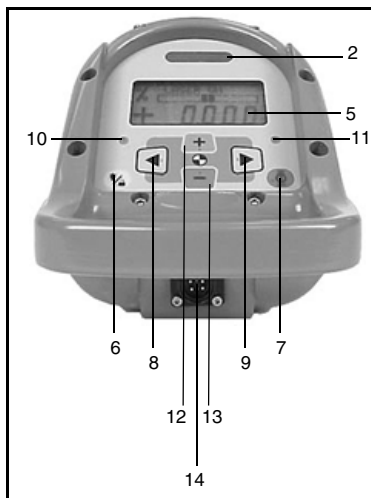
8 Left Line-Control Button – moves the laser beam to the left¹. To center the line, this button has to be pressed simultaneously with the right line.

9 Right Line-Control Button – moves the laser beam to the right¹. To center the line, this button has to be pressed simultaneously with the left line.

10 Negative Grade LED – lights red to show that you have entered a negative grade into the pipe laser.

11 Positive Grade LED – lights green to show that you have entered a positive grade into the pipe laser.

12 Increase Button – increases the grade.¹ To zero the grade and change the grade in quick change mode, press and hold this button simultaneously with the decrease button.



13 Decrease Button – decreases the grade¹. To zero the grade and change the grade in quick change mode, press and hold this button simultaneously with the increase button.

¹: Use this button in combination with others for further operations.

14 External Power Receptacle – allows the pipe laser to be powered by an optional external 6–16 VDC power source.

15 5/8-11 Threaded Mount – allows the pipe laser to be attached to various setup accessories.

16 Grade-Axis Pivot Marker – identifies the pivot point for the pipe laser's grade system.

17 Battery Pack – contains non-replaceable Ni-MH batteries, or a pack that can hold four replaceable D-Cell alkaline batteries to power the pipe laser (depending on model).

18 Handle – allows you to carry the pipe laser easily and provides a safety-rope tie-off.

19 Armor Plated Housing – plated with a special, hardened military material for unsurpassed ruggedness and reliability.

20 Protective Rubber Bumper – protects the front end of the unit by safeguarding the exit window.



Remote Controls

Model RC501, 3-Button Remote Control

1 Power – turns the pipe laser on/off. Press and hold the button for about 2 seconds to turn the unit off.

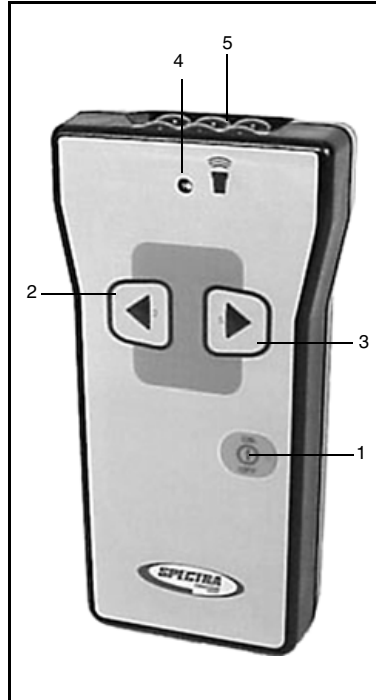
2 Left Line-Control Button – allows you to move the laser beam to the left.

3 Right Line-Control Button – allows you to move the laser beam to the right.

Note – Line Center – Press Left Line-control and Right Line-Control simultaneously to center the line.

4 Status LED - flashes four times per second when a line button is pressed or once per second to indicate that the internal battery is low.

5 Emission Window – provides an opening for the infrared signals to exit from so that the remote control and pipe laser can communicate with each other.



Model RC502, 7-Button Remote Control

1 Power – turns the pipe laser on/off. Press and hold the button for about 2 seconds to turn the unit off.

2 Grade-Enable LED – flashes when the grade-enable function is activated.

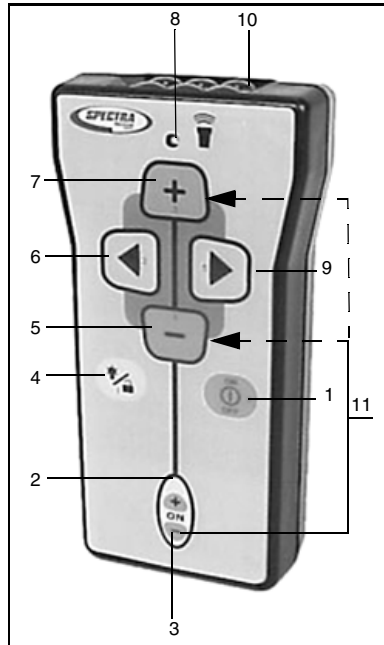
3 Grade-Enable Button – activates/deactivates the increase and decrease button. Deactivating the grade-enable function prevents the pipe laser grade value from accidentally being changed.

4 Backlight/Lock Button – activates the pipe-laser LCD's backlight. If this button is pressed simultaneously with one of the line control or grade buttons, it locks/unlocks the control panel so that the line and grade system do not get accidentally changed.

5 Decrease Button – allows you to decrease the grade.

6 Left Line-Control Button – allows you to move the laser beam to the left.

7 Increase Button – allows you to increase the grade.



8 Status LED – flashes four times per second when a control button is pressed or once per second to indicate that the internal battery is low.

9 Right Line-Control Button – allows you to move the laser beam to the right.

10 Emission Window – provides an opening for the infrared signals to exit from so that the remote

control and pipe laser can communicate with each other.

11 Grade Bump – If the Grade Enable button and either Grade button are pressed simultaneously, the grade changes by one increment. This function enables small grade changes for matching to existing grade.

Preparation Before Operation

CHAPTER

3

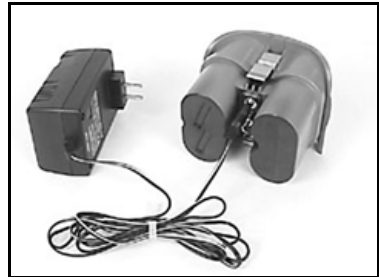
Powering the Laser

Ni-MH Batteries

Installing/Removing the batteries

- 1 Turn the battery-pack knob counterclockwise. Lift the battery pack from the pipe laser.
- 2 Plug the battery-pack in place and turn the battery knob

clockwise.



Optional Alkaline Battery Pack

- 1 Turn the battery-pack knob counterclockwise. Lift the battery pack from the pipe laser.
- 2 Pull out on the top of the side clips then push down on them to release them from the side-clip catches.

3 Pull on the top housing to separate it from the bottom housing. Make sure to detach latches from bottom housing.

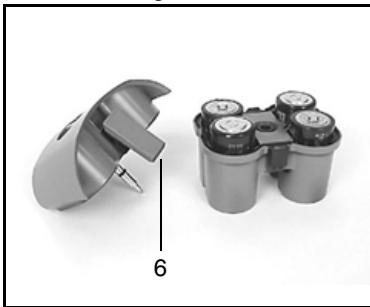
4 Install/remove the batteries.

Note – When installing the batteries, ensure that you take note of the positive (+) and negative (-) diagram inside of the housing.

Note – The pipe laser has reverse polarity protection. If the batteries are put in wrong, no damage occurs to the pipe laser but it does not work. Allow it one minute to recover after the batteries have been installed correctly.

5 Put the top housing back on the bottom housing.

7 Put the battery pack in place and turn the battery-pack knob clockwise.



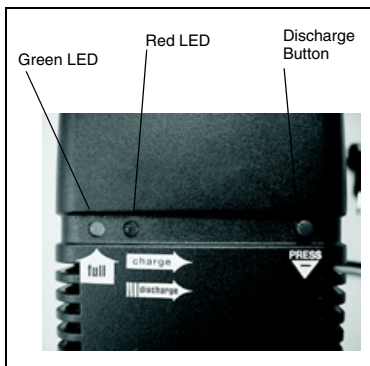
6 Position the side clips so that they hold the top and bottom housings together securely.

Smart Charger

The charger, to be used ONLY with the Ni-MH battery pack, starts charging automatically as soon as a battery pack is installed and the charger is plugged in. The LEDs on the charger indicate the condition shown in Table 3.1.

Table 3.1 LED condition

LED condition	Description
Red LED On	Batteries are charging
Green LED on	Batteries are fully charged, and the charger has switched to trickle charge
Flashing red LED	Battery-contact detection (test phase) Battery-pack reversed Battery pack broken, open or unsuitable cells The batteries are discharging after pressing the discharge button



Discharge Button: Pressing the button for approximately 2 seconds the charger automatically discharges the battery and switches over to charging. The process of discharging the battery before charging should be performed every three months to help prevent loss of battery capacity due to frequent partly discharging.

Charging Time:

Table 3.2 shows the approximate charging time for 4 to 10 batteries with a 7500 mAh capacity.

Table 3.2 Charging time

# of Cells	Cell Capacity	Approximate Charging Time
4	7500 mAh	10 Hours with smart charger
4	7500 mAh	14 Hours with 12V Cigarette Lighter Charger Model P22

Recharging the batteries

Note – A sealed Ni-MH battery pack is offered in most standard models (P23/P23B).

- 1 Turn the battery-pack knob counterclockwise. Lift the battery pack from the pipe laser.
- 2 Plug the battery recharger's single-socket plug into the battery pack's recharging receptacle.
- 3 Plug the battery recharger into an appropriate outlet.

Note – The charger takes 10 hours to charge the batteries to full capacity.

Note – To extend battery life, the charger discharge function should be performed after every three months of charging.



Warning – Do not charge the batteries above 45°C (113°F).

External Power Cable P21

In case the internal batteries become discharged and you do not have spare batteries available, you can also power the pipe laser using an optional external power cable. This can be achieved by using a DC regulated automotive or motorcycle battery with the supplied optional external power cable on some models. The internal batteries will not recharge while you're using the external power cable.

While using the optional external power cable and 12-V DC battery to power the pipe laser, you can remove the internal batteries and the pipe laser will continue to operate. The battery pack however has to be in place in order to cover the contacts.

Connecting/Disconnecting the external power cable



Warning – To avoid damaging the pipe laser and to prevent the possibility of creating a spark at the battery, make sure the pipe laser is off before connecting/disconnecting the external power cable to/from the pipe laser.



Warning – Do not connect the pipe laser to a power generator where over-voltage can occur. Do not start the vehicle while the pipe laser is connected to the external battery.



Warning – An electrical shock risk may occur if you connecting/disconnecting the power plug or power cable from the pipe laser with wet hands. Make sure your hands are dry when performing this task.

- 1 Turn the external-power-receptacle cap counterclockwise enough to remove it from the external power receptacle. Removing the cap exposes the receptacle.
- 2 Connect the alligator clips to a 12-V dc automotive or motorcycle battery noting the correct polarity (red = positive, black = negative).
- 3 Insert the plug into the receptacle on the laser.
- 4 To disconnect the external power cable from the pipe laser, remove the plug from the pipe laser first and then remove the alligator clips from the battery.

Optional Features

The DG511/711 has various optional features that your salesman or service personnel may configure according to your individual needs.

For more information, contact your Trimble dealer.

Getting Started

CHAPTER

4

Press the On/Off button to turn on the Laser. Press and hold the button for about 2 seconds to turn the unit off.

If your laser displays a language other than what you need, consult your salesman or service center for re-configuration.

The following languages are available:

- English
- Dutch / Netherlands
- French / Francais
- German / Deutsch
- Italian / Italiano
- Japanese
- Portuguese
- Spanish / Espanol
- Swedish /Svensk
- Finnish / Suomi

Table 4.1 contains a list of the DG511/711 feature options.

Table 4.1 DG511/711 feature options

DG711	DG511	Main Features Options	Description	
✓	✓	Service Check	Selects user calibration interval reminder	
✓	✓	Grade Display	Floating	Displays three (3) significant digits on grades less than 10%, 2 digits on grades greater than 10% Example: 1.234% 12.34%.
			Fixed	Displays two (2) digit grade. 1.23% or 12.34%
			Per Mille	Displays grade in millimeters per meter. 12.34‰
			Rise/Run Slope	Displays grade as Rise / Run = 1.234 rise over 100 ft run
✓	✓	Grade Entry	Step and Go	“Step” through grade with single grade button actuation or “Go” through grade changes at an increasing rate.
			Digit Select –	Enables an individual grade “Digit” to be “Selected” and changed until the required grade is entered.

Table 4.1 DG511/711 feature options (Continued)

DG711	DG511	Main Features Options	Description
✓	✓	Quick Grade Mode (Grade Zero)	Enables instant resetting of the grade to “Zero” by holding both grade buttons simultaneously. Continuous holding of both grade buttons puts the unit in Quick Grade mode.
✓	✓	Grade Lock	Prevents any changes to the grade system.
✓		Line Set/Check	Moves the laser vertically to its maximum limit, which aids in setting line.
✓	✓	Language	Sets user’s local language. For more information, see page 19.
✓		Line Alert	Flashes the laser beam two times per second if the unit is disturbed after a 5 minute set up period.
✓	✓	Line Center	Automatically centers Line system when line is moved to a reference point.
✓		Line Limit	Enables complete movement of the laser to the left or right line limit.
✓	✓	Line Lock	Locks out line system controls once the required line setting is reached.
✓	✓	Low Batt Warning	Flashes laser two times a second indicating the low battery condition.

Table 4.1 DG511/711 feature options (Continued)

DG711	DG511	Main Features Options	Description
✓	✓	Steep Grade	Disables the self-leveling system but keeps the laser beam turned on for applications where you need to manually point the laser beam at steeper grades than allowed by the self-leveling system.
✓	✓	Name	Displays owner's name as entered by local dealer.
✓		Power Saver (Standby)	Turns the laser beam off when not being used to conserve battery life, but keeps all other systems operational.
✓	✓	Roll Vial Warn	Flashes the laser beam once per second and the LCD displays that the unit is beyond its roll leveling range.
✓		Security	When active, the Laser prompts you for a four-digit password before it will operate. An incorrect password turns the unit off.
✓	✓	Status	When activated, the LCD indicates which functions have been activated and displays the status of those activated functions.
✓	✓	Auto Shut Down	The unit automatically turns off after 15 minutes of an out-of-level condition.
✓	✓	Calibration Option	Changes factory default calibration settings.

Table 4.1 DG511/711 feature options (Continued)

DG711	DG511	Main Features Options	Description
✓		Grade Bump	The RC502 Remote Control can be used to change current grade setting by one value where matching of an existing grade is required.
✓	✓	Rental Timer	Shows the number of hours the unit was rented. It can be set to 00000 hours for new rental customers.
✓		Line Scan	Causes the line system to move completely to the left or right limit without the need for the operator to continuously hold down the line switches.

Optional Features Operating Instructions

Table 4.2 details operation instructions for the optional features.

Table 4.2 **Optional features**

Option	Operating Instructions
User preferences	
Language	No instructions required.
Service Check	At the preset time (3, 6, 12, or 24 months) a message will appear on the display informing the user that a unit inspection is recommended.
System Status	Quickly press and release the ON/OFF button to display the system's status.
Name	The entered name will appear for 3 seconds when first turned on.
Security	The selected 4-digit password must be entered when prompted on power up, or the laser will turn itself off.

Table 4.2 Optional features (Continued)

Option	Operating Instructions
Line Preferences	
Line Set / Check	<ol style="list-style-type: none"> <li data-bbox="317 348 917 496">1 The manhole should be placed and dirt for the 1st 2 pipe joints excavated. A stake indicating the pipeline direction should be placed at the end of the excavation (usually this is done when the job is initially laid out). <li data-bbox="317 502 917 559">2 Place the unit in the manhole outlet, without the first pipe joint installed. <li data-bbox="317 565 917 748">3 To adjust the laser before line set, at the laser press and release the ON/OFF and "+" GRADE buttons (buttons 3 and 6) in sequence. Adjust the roll of the unit until the roll indicator is centered. Press and release the ON/OFF button to resume normal operation. <li data-bbox="317 753 917 999">4 To start line set using the remote, first press and release the grade enable key. Then, simultaneously, press and release the ON/OFF and "+" GRADE button. Once the laser beam approaches the line grade stake, use the remote control to adjust the beam up or down (Buttons 3 and 4) or left and right (buttons 2 and 5) until it is centered on the line stake. <li data-bbox="317 1005 917 1136">5 Press and release the ON/OFF button on the remote (button 6) to take the unit out of the line set/check mode and resume normal operation at your desired grade. Setup is complete.

Table 4.2 Optional features (Continued)

Option	Operating Instructions
Line Alert	The laser beam will blink twice every second, followed by a 1 second pause, if the laser receives a bump or excessive vibration after its initial setup, indicating line may need reset. To reset to normal operation, press any button on the laser or remote control.
Line Scan	To move the line position to the extreme right or left (such as a severe dogleg right or left manhole setup), simultaneously press the ON/OFF and LINE RIGHT (button 5) or LINE LEFT (button 2) buttons.
Line Reference	To set a second line point and save it, move the line to the desired location and press line buttons (#2 and 5) along with the decrease button (#4) and hold for 1 second. Press buttons #2 and #5 for 1 second to move the move line to the the saved position.
Grade Preferences	
Grade Display Fixed*	Displays grade as a percent, to 2 decimal places (1.23% or 12.34%)
Grade Display Per Mille*	Displays grade as millimeters rise or fall in 1 meter (12.34‰)
Grade Display Slope*	Displays grade as the straight calculation of rise over run (0.01234, or a 1.234 rise over a 100 run).
Grade Display* Floating	Displays grade as a percent, to 3 decimal places under 10% and 2 decimal places at 10% and over (1.234% or 12.34%).

Note – Only one Grade Display Mode can be selected.

Table 4.2 Optional features (Continued)

Option	Operating Instructions
Grade Entry, Step and Go	Press the + GRADE (button 3) or - GRADE (button 4) and grade will increase or decrease accordingly. The longer each button is held down the faster grade will increase or decrease.
Grade Entry, Digit Select	<ol style="list-style-type: none"> 1 Press the + GRADE (button 3) or - GRADE (button 4) to initiate a grade change. All grade digits will appear and the grade polarity (+ or -) sign will blink. 2 Use the + GRADE or - GRADE buttons to change the blinking character to the desired polarity or digit. 3 Use the LEFT or RIGHT line buttons (button 2 or button 4) to select which digit to change. 4 When all digits have been changed to the desired amount, press button 1 (backlight button) to store the new value and resume normal operation.
(Grade Zero) Quick Change Mode	<ol style="list-style-type: none"> 1 Press and hold both grade buttons to zero the grade. 2 Continuous holding of the grade buttons increments grade in 1% increments, until 10% is reached. 3 Once 10% is reached, grade increments in 5% increments until 40% is reached. 4 Once 40% is reached, grade reverts to -15%. 5 Once -15% is reached, grade reverts to -10%. 6 Once -10% is reached, grade increases in 1% increments until 0% is reached. Once 0% is reached, the process repeats.

Table 4.2 Optional features (Continued)

Option	Operating Instructions
Steep Grade	Press and hold button 1 for five seconds until "STEEP GRADE" appears. Use button 3 or 4 to manually point the beam up or down, and button 2 or 5 (line buttons) to move the beam left or right to the desired position.
Grade Bump	The RC502 Remote Control is used to change current grade setting by one value where matching of an existing grade is required.
Power Management	
Low Battery Warning	Flashes the laser 2 times per second to indicate batteries are getting low.
Power Saver (Standby)	On the RC502 remote control, press buttons 1 and 6 simultaneously. The laser beam will turn off while all internal functions remain on, typically doubling the battery life. To restore the laser beam to instantly begin to work, press buttons 1 and 6 simultaneously again.
Auto Shut Down	The unit automatically turns off after 15 minutes of an out-of-level condition.

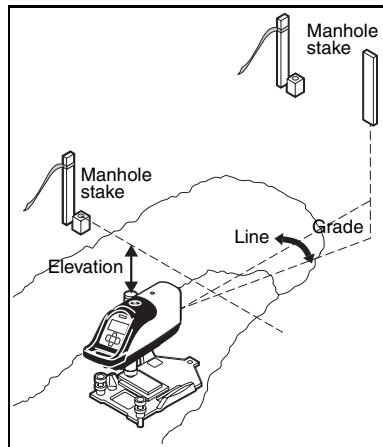
Applications and Setups

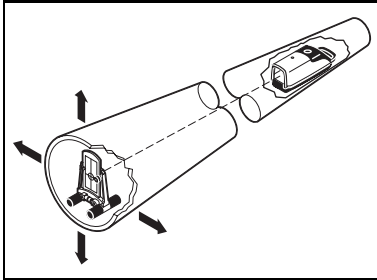
CHAPTER

5

This chapter describes three fundamentals for using the Model DG511/711 to install gravity flow pipe; they are **Grade**, **Elevation**, and **Line**, otherwise known as **G-E-L**.

To install gravity flow pipe, the pipe is set to a percentage of **Grade** that has been determined by some engineered plans. The gravity flow pipe is designed to be set to some engineered **Elevation**. Finally, the gravity flow pipe will be installed between two designed points, therefore defining **Line**.





The process for setting up the Model DG511/711 remains the same. The laser beam shall be sloped to match the plans. The Elevation of the pipe or cut to invert is given from the plans at which the laser shall be used to control that elevation, and finally set the laser on Line to match the orientation of the pipe run.

After all have been set, installing pipe is accomplished by inserting a laser target into new pipe sections and then aligning the pipe until the laser targets' bull's-eye is centered on the beam.

Grade

Grade establishes the slope of the pipe and is generally displayed in percent (%). A rise of 1 m (1ft) over a run of 100 m (100 ft) equals 1.00%.

After setting Grade into the unit, the laser automatically slopes the beam to match the slope of the pipe and maintains its slope if disturbed.

***Note** – Some engineering plans list the pipe's grade on a per foot or per meter basis. Before using your Model DG511/711, transfer the engineered slope information into the Laser according to the Grade Display Mode feature. Consult your salesman or service personnel for Grade Display Mode configuration.*

Elevation

Depending on the application and jobsite conditions, you can set the laser to an elevation that matches the centerline of the pipe, at some distance above the pipe's invert, or set it over the top of the pipe.

When setting the laser, a surveyed manhole grade hub must be available to set the laser at the proper elevation and the pipe will be installed at the correct elevation.

Line

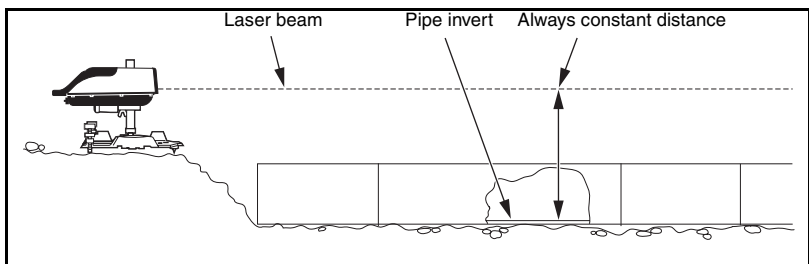
Line ensures proper direction of the pipe run between manholes according to the engineered plans.

Once Grade, Elevation, and Line are set, the laser will be projected at the proper grade, elevation, and line for the pipe run. After a little practice, it normally takes about 5 minutes to set up the laser and start laying pipe.

Setup, Step-by-Step

Set Grade

- 1 Press the positive or negative grade button to set the Laser at the correct grade as determined by the engineered plans.
- 2 Engineering plans sometimes list the pipe rise/fall on a per foot or per meter basis. To ensure that the correct grade display format is entered into your DG511/711, see the Grade Display mode information in Table 4.1 on page 20.



Set Elevation for Small In-the-Pipe or Pre-cast Inverts

1 The laser automatically centers in the 150 mm (6 inch) diameter pipe and pre-cast inverts without additional accessories.











2 The laser automatically centers in 200 mm (8 inch) diameter pipe with the 1238 mounting plate.

3 Use the following chart to determine how to set up the laser so the laser beam is centered in the following pipe sizes.

Table 5.1 Mounting Plates Setups

Pipe Diameter	Required Mounting Accessories				
	1228	1230/1237	1238	1249	Setup
150 mm or 6 inch	None				1
200 mm or 8 inch	Legs Up		✓		2
225 mm or 9 inch	Legs Up			✓	3
250 mm or 10 inch	Legs Up	✓			4
300 mm or 12 inch	Legs Down	✓			5
400 mm or 15 inch	Legs Down	✓			6

Illustration

Setup	1228	1230/1237	1238	1249
1				
2				
3				
4				
5				
6				

Elevation of Flat Bottom Manholes

1 When a laser is to be set on a flat surface where the laser beam is not centered in the pipe, use model 1230/1237 Heavy Duty Trivet Plate and 1239 Universal Fixed Pole.

2 Using this system, the elevation of the laser beam can be set by either measuring down from a grade offset hub outside the trench or up from the floor of the manhole to the beam.

3 The 1239 Universal Fixed Trivet has both cm/mm and tenths/hundredths scales for setting the beam elevation.

1230/1237 Heavy Duty Invert Plate

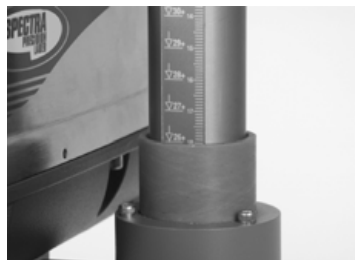
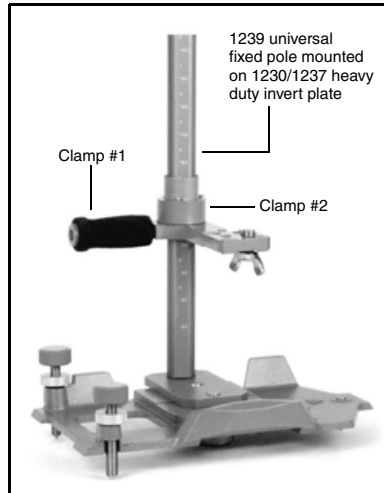
The invert plates model 1230 (English) and 1237 (Metric) are one piece cast aluminum support plates that provides automatic self-centering of the Laser in 250 mm (10 in.), 300 mm (12 in.) or 400 mm (15 in.) pipe diameters. The invert plates are used along with the 1239 Universal Fixed Pole for setups on the manhole bottom, outside of the manhole or in pipes larger than 400 mm (15 in.) diameter.

1239 Universal Fixed Pole

The 1239 Universal Fixed Pole supports a laser at a predetermined elevation above the invert. Use the 1239 with the 1228 Universal Adjustable Invert Plate, 1230/1237 Heavy Duty Invert Plates, or 1244 T-Bar Assembly.

Features:

- 1 Pole Clamp #1 – slides onto the vertical pole and is secured with the pole clamp's handle.
- 2 Top Pole Scale (TPS) – determines the distance between the top of the pole to the center of the laser beam.
- 3 Mounting Plate Scale (MPS) – determines the distance between the center of the laser beam and the bottom of the Model Mounting Plate. This scale is represented with down arrows next to the scale numbers.



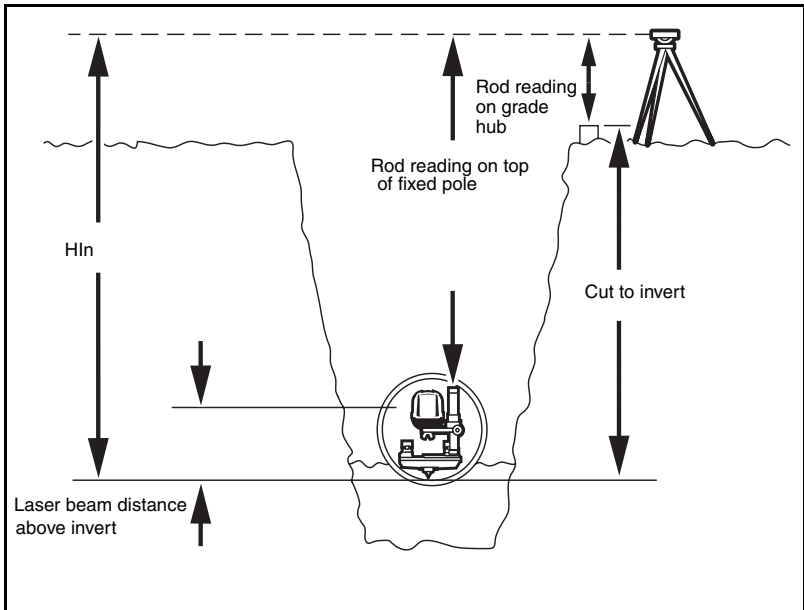
Method 1: Using the Top Pole Scale (TPS)

Grade rod set on top of the Fixed Pole.

Note – First decide the laser beam’s elevation above the invert.

- 1 Record the “cut-to-invert” information from the grade hub.
- 2 Set up an automatic level and measure its elevation (HI) above the grade hub.

- 3 Set a grade rod on top of the Fixed Pole and record the measurement with the automatic level.
- 4 Subtract the desired laser beam elevation above the pipe’s invert.
- 5 Calculate the TPS setting.



The laser is now at the proper working elevation.

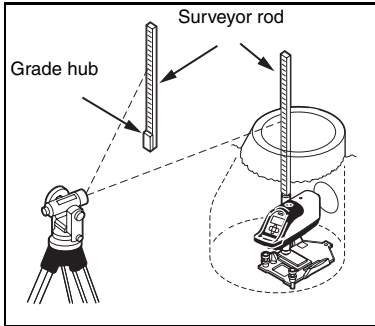
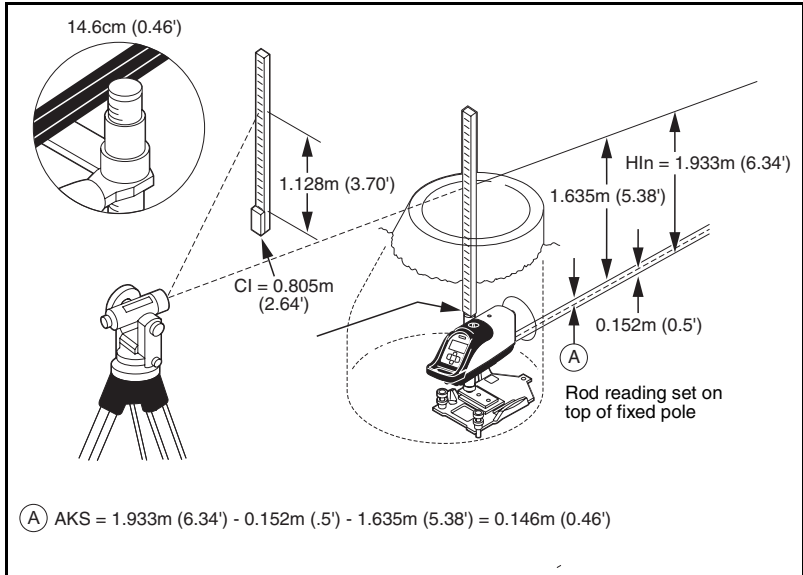


Table 5.2 Example 1: Setting the Grade Rod on top of the Top Pole Scale

Step	Description	Metric	Ft / Inch
Step 1	Decide what elevation the laser beam shall be used above the invert.	0.152 m	0.5 ft
Step 2	Record the "Cut to Invert" information from the grade hub.	0.805 m	2.64 ft
Step 3	Measure the elevation (HI) of the optical instrument above the grade hub.	1.128 m	3.70 ft
Step 4	Subtract the measured distance from the optical instrument to the top of 1239 Universal Fixed Pole	-1.635 m	-5.38 ft
Step 5	Subtract the desired elevation of the laser beam above the pipe's invert.	-0.152 m	-0.50 ft

Table 5.2 Example 1: Setting the Grade Rod on top of the Top Pole Scale (Continued)

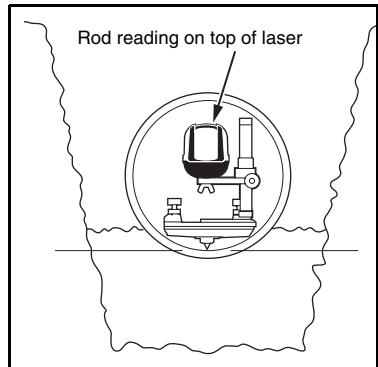
Step	Description	Metric	Ft / Inch
Step 6	Calculated TPS =	0.805 m	2.64 ft
		1.128 m	3.70 ft
		-1.635 m	-5.38 ft
		-0.152 m	-0.50 ft
		0.146 m	0.46 ft
Step 7	Adjust the pole clamp until the reading edge is aligned with the TPS reading (0.146 m or 0.46 ft)		
Step 8	The laser beam is now set at your desired working elevation (152.4 mm / 6 inches / 0.5 ft) above the invert of the proposed pipe.		



Method 2: Setting Grade Rod on Top of Laser

Note – Using this method, the offset distance of 70 mm (0.23 ft) between the top of the Laser housing and the center of the laser beam will be used.

- 1 Decide what elevation of the laser beam shall be used above the invert.
- 2 Record the “cut-to-invert” information from the grade hub.



- 3 Set up an automatic level and measure the elevation of the automatic level above grade hub.
- 4 Add elevation measurement of instrument to “cut-to-invert” from grade hub.
- 5 Subtract the desired working of elevation of laser beam above invert.
- 6 Subtract the beam offset (70 mm / 0.23 ft).
- 7 Calculate new rod reading.
- 8 Set the rod on top of the laser and adjust the elevation of the laser until the correct rod reading is observed.

9 The laser beam is now at the proper working elevation.

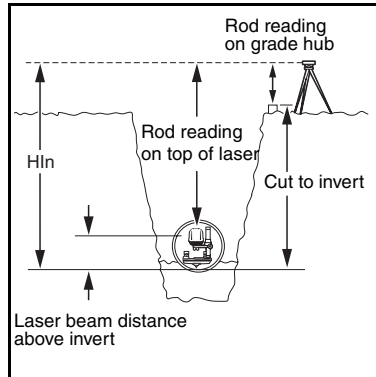


Table 5.3 Example 2: Setting Grade Rod on Top of Laser

Step	Description	Metric	Ft / Inch
Step 1	Decide what elevation the laser beam shall be used above the invert.	0.152 m	0.5 ft
Step 2	Record the “cut-to-invert” information from the grade hub.	0.805 m	2.64 ft
Step 3	Measure the elevation (HI) of the optical instrument above the grade hub.	1.128 m	3.70 ft
Step 4	Add elevation measurement of instrument to “cut-to-invert” from grade hub.	1.635 m	5.38 ft

Table 5.3 Example 2: Setting Grade Rod on Top of Laser

Step	Description	Metric	Ft / Inch
Step 5	Subtract the desired elevation of laser beam above the pipe's invert.	-0.152 m	-0.50 ft
Step 6	Subtract beam offset (70 mm / 0.23 ft).	-.070 m	-0.23 ft
Step 7	Calculated Rod Reading =	0.805 m 1.128 m -0.152 m -0.070 m 1.711 m	2.64 ft 3.70 ft -0.50 ft -0.23 ft 5.61 ft
Step 8	Set the rod on top of the Laser and adjust elevation until the correct rod reading is observed.	1.711 m	5.61 ft
Step 9	The laser beam is now set at your desired working elevation (152.4 mm / 6 inches / 0.5 ft) above the invert of the proposed pipe.		

Setting Line

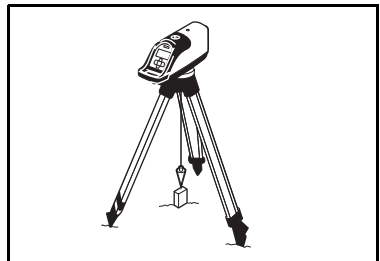
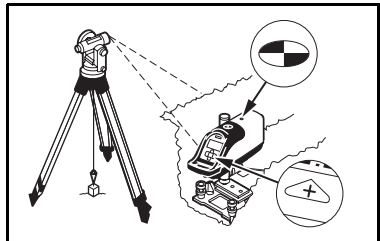
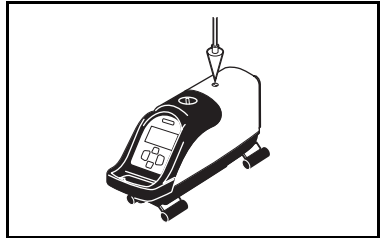
The principle for setting line is always the same. The laser is positioned over the starting point of the pipe run then aimed to the second control point on line. The further your second point is from the laser, the more accurate your line will be.

First Point Setup (Using Plumb-bob)

Whether using the laser in the invert or attached to the various mounting plates the goal is to always set the laser's line axis bull's-eye target over the vertical centerline of the pipe.

This is accomplished by one of the following methods:

- 1 Place the bull's-eye target under a plumb bob that has been transferred from an offset grade hub.
- 2 If using a transit or theodolite, align the bull's-eye target to the vertical cross hair of the transit's telescope.
- 3 If the bull's-eye target cannot be seen, use the plus sign on the positive grade button to align the target to the vertical cross hair of the transit.
- 4 In an over-the-top setup, set the laser on a tripod and plumb bob them over the first grade stake.



1211 Laser Plummet Line Setting

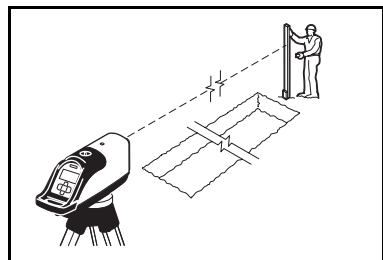
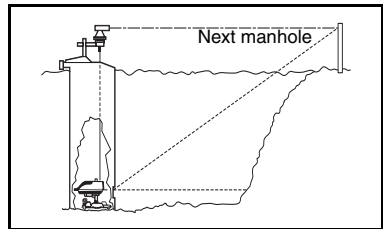
The laser plummet may be used in place of the Plumb-bob by attaching it under the tripod or manhole mount.

- 1 Position the laser plummet over the laser's bull's-eye reflective target into the manhole mount or tripod replacing the 5/8 x11 attachment thread.
- 2 Quickly turn the product upside down to activate the compensator and turn the power switch "on".
- 3 If the bull's-eye target cannot be seen, align the Laser Plummet to the plus sign on the positive grade button on the keypad or anywhere along the center of the laser.
- 4 In an over-the-top setup, set the laser on a tripod and align the Laser Plummet over the first grade stake.

Second Far-Point Alignment

- 1 Simultaneously press both Left and Right Line buttons to center the laser's $\pm 10^\circ$ of line travel.
- 2 Press either Line button to align the laser beam to the second control point. If using a wireless remote control, point the remote towards the laser and press the appropriate line button.

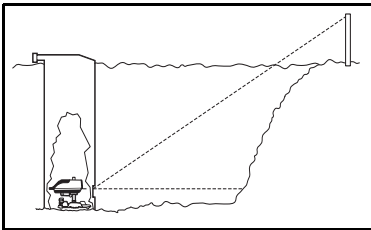
Note – Line speed increases the longer you press the line button. To slow the line speed, release the line button then press again.



Setting Line with the Line Set/Check Feature

The Line Set / Check feature, available with the DG711, can be used to align the beam to a forward grade hub by moving the laser to its maximum leveling limit then returning it to the original grade setting. Line Set/Check is beneficial for setting line if a manhole mount or transit is not available.

Note – Before using Line Set/Check, the Laser must be accurately positioned for cross-axis roll to ensure that the laser beam will track plumb. Consult your salesman or service personnel to activate the Line Set/Check feature.



Activating the Cross Axis Roll Option

1 Quickly press and release the ON/OFF button to enter the Laser's Status mode.

2 While the Battery gauge is displayed, press and release either Grade button to display the Laser's cross axis roll position.

3 If the Laser is being used in a pre-cast invert, roll the unit until the cross-axis roll indicator is centered and display indicates two arrows pointing at each other (roll center) instead of multiple arrows pointing to the left or to the right.

4 Quickly press and release the ON/OFF button to return to the grade display.

5 If the Laser is being used with a 1228 on a flat surface, the Laser must be attached perpendicular (90°) to the 1228 Universal Mounting Plate.

6 The footscrews used with the 1230/1237 plate can be used to help center the roll indicator and display indicates two arrows pointing at each other.

Activating Line Set/Check Raise

1 Simultaneously press the ON/OFF and the “+” Grade button to activate Line Set/Check.

Note – For RC502 7-Button Remote Control users, the \pm Grade enable key must be pressed and the Red Grade enable LED must be blinking before the remote will activate Line Set/Check.

2 To stop Line Set/Check as it approaches the line point, press either Grade button.

3 To continue raising grade, simultaneously press the ON/OFF and the “+” Grade button.

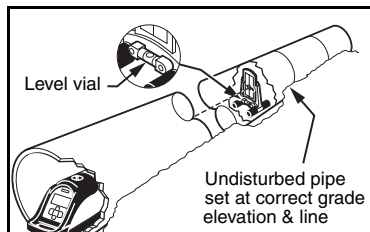
4 If you overshoot and wish to lower grade, simultaneously press the ON/OFF and the “-” Grade button.

5 Once the line position is set, press and release the ON/OFF button to return the laser beam to your original grade setting.



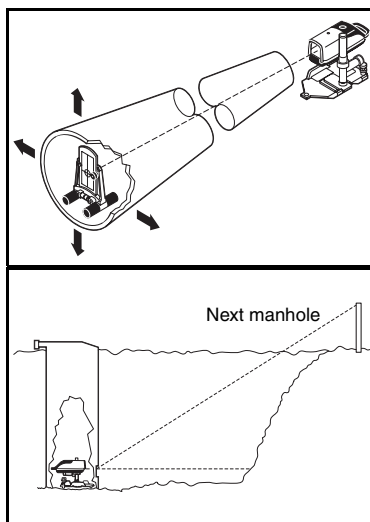
Activating Line Set/Check Lower

- 1 Use Line Set/Check Lower when the laser is set on a tripod for over the pipe applications.
- 2 Simultaneously press the ON/OFF and the “-” Grade button to activate Grade Lower.



Laying Pipe/Setup

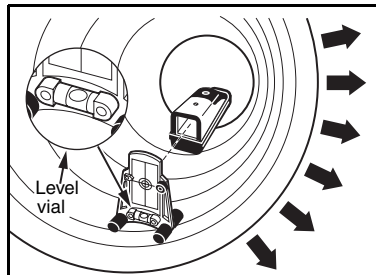
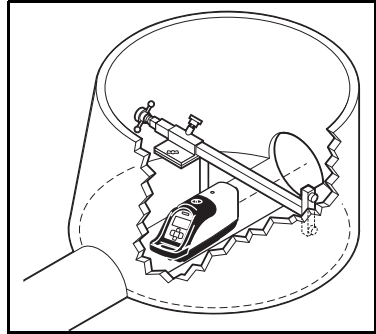
- 1 First Day Setups – Use the line buttons to align the laser to the next manhole.
- 2 Second day setups – Select a target that can establish the centerline or distance above the invert in your pipe. Set the target in the last pipe checked to the correct grade, elevation, and line.
- 3 Align the laser to the target using the line buttons on the laser or using the wireless remote.
- 4 Lay Pipe – set the target in each new section of pipe and adjust the pipe until the laser intersects the target's bull's-eye.

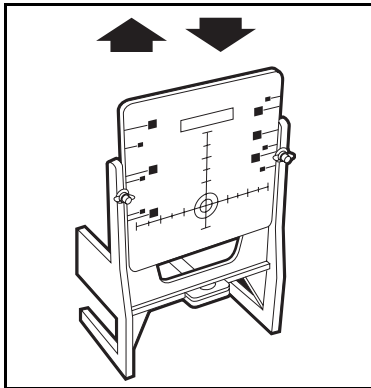
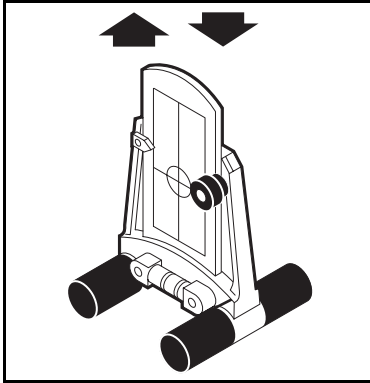


Large Pipe

The laser can be set directly on the flow line using the various mounting plates or a 1244 T-bar for increased stability and an unobstructed flow line.

- 1 Set Grade Elevation, and Line into the Laser for large pipe applications.
- 2 Set an adjustment pipe target so that the targets' bull's-eye is at the same distance above the invert as your laser.
- 3 Place the pipe target in the last section of the pipe that has been checked to be at the correct grade, elevation and line.
- 4 Adjust the pipe target until it's level vial reads level.
- 5 Align the laser to the target's bull's-eye using the line buttons on the laser or the Wireless Remote.
- 6 Lay Pipe – Set the target in each new section of the pipe and adjust the pipe until the laser intersects the target's bull's-eye while the target is level.



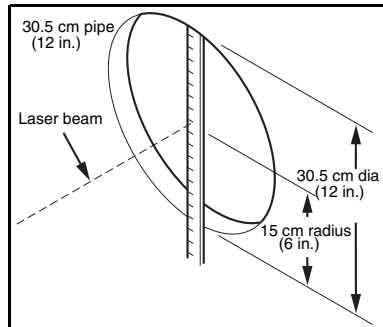
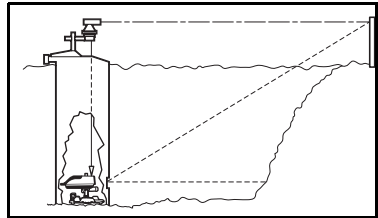


In a Manhole

The laser can be set up in a manhole using a transit to accurately set line. The transit is plumbed over the laser on a mount that clamps to the manhole. The

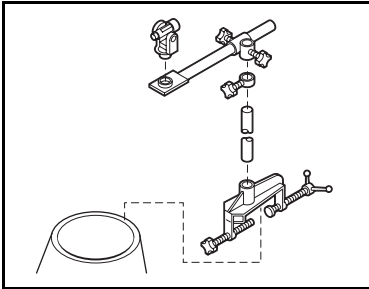
laser is projected down the center of the pipe.

- 1 Set the laser support in the manhole and attach it to the support.
- 2 Adjust the laser to the chosen height above the invert and on the vertical centerline of the exit hole for the proposed pipe.
- 3 Point the laser towards the next manhole.
- 4 Hold an engineering rule on the vertical centerline and adjust the laser's height to the desired height above the invert.



Line (transit method)

1 Set a manhole mount and transit on the manhole.



2 Clamp the manhole mount base to the side of the manhole to establish a stable transit support.

3 Secure the vertical arm into the manhole mount base.

4 Assemble the horizontal arm, horizontal clamp, and vertical support clamp to the vertical arm and position over the top of the laser.

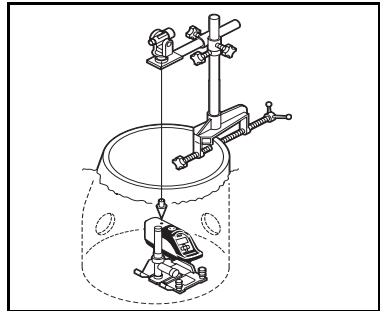
5 Attach your transit to the $5/8 \times 11$ threaded adapter in the horizontal arm.

6 Transit Alignment – You may position your transit over the laser's bull's-eye target in one of the following methods:

a Use the Laser Plummet and if your transit is equipped with

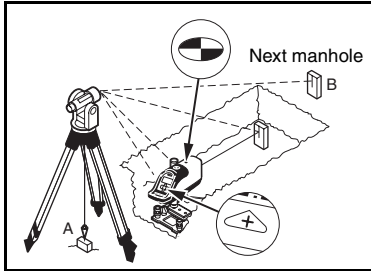
an optical plummet, adjust the horizontal arm to position the transit's optical plummet over the laser's bull's-eye target.

b Plumb Bob: If your transit does not have an optical plummet, suspend a plumb bob from the transit, and align it over the laser's bull's-eye target.

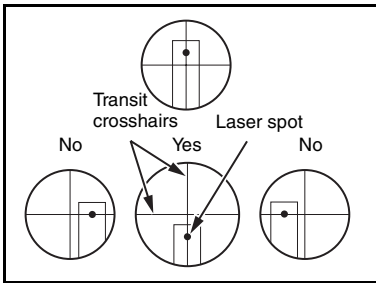


7 After rough positioning the transit over the bull's-eye target, use the transit's leveling base to accurately adjust the transit to the bull's-eye target.

8 Once the transit is set over the laser's bull's-eye target, sight the transit on the centerline of the next manhole and lock the scope on line.



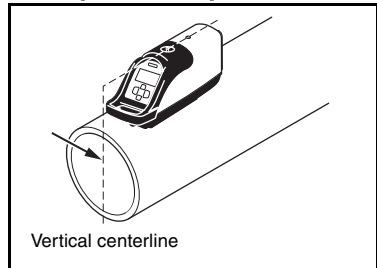
- 9 Plunge the scope into the trench and set a stake on line 6–8 m (20–25 ft) from the first manhole.
- 10 Use the line buttons to intersect the stake with the laser beam.
- 11 Look through the transit at the stake and readjust the beam until it is aligned with the vertical crosshair of the transit.



- 12 Lay pipe – Set the pipe target in each new section of pipe and adjust the pipe until it intersects the target's bull's-eye.

Note – This method assumes that the manhole was set at the correct elevation. If there is any question as to the manhole accuracy, check the manhole and pipe invert elevation and transfer an offset to check the line of pipe entering or exiting the manhole.

On Top of the Pipe

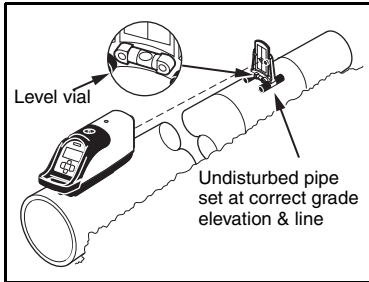


- 1 Line – Set the laser until it is over the vertical centerline of the pipe and pointing toward the next manhole.

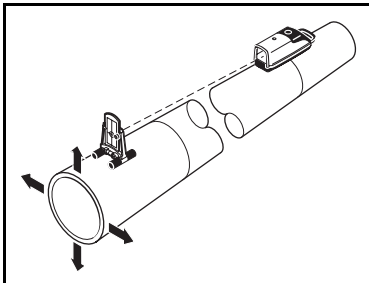
Note – It may be necessary to support the Laser with extra gravel, dirt, or sub-base material.

- 2 Set an adjustable pipe target (Model 936 or 956) so that the target's bull's-eye is at the same distance above the pipe as your laser beam.

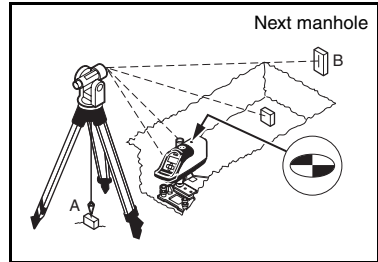
3 Place the pipe target on top of the last section of pipe that has been checked to be at the correct grade, elevation, and line.



- 4** Adjust the pipe target until its level vial reads the target is level.
- 5** Align the laser to the targets' bull's-eye using the line buttons on the laser or the Wireless Remote.
- 6** Lay Pipe – Set the target on top of each new section of pipe and adjust the pipe until the laser intersects the targets' bull's-eye while the target is level.



Open Excavations



- 1** Set a transit over the first point on the proposed pipeline behind the manhole where the pipe run starts.
- 2** Align the transit to the next manhole and lock the transit on line.
- 3** Plunge the transit into the open excavation where the manhole will be placed.
- 4** Set the mounting plate and the 1239 Universal Fixed Pole on stable sub-base material in the open excavation and on line.
- 5** Grade – Enter grade into the Laser.
- 6** Attach the laser to the 1239 Universal Fixed Pole.
- 7** Sight through the transit at the laser.

8 Adjust the laser and the mounting plate until the bull's-eye target or "+" symbol on the positive grade button is aligned with the transit's vertical crosshair.

9 Elevation – Determine the correct elevation for the invert of the proposed pipe.

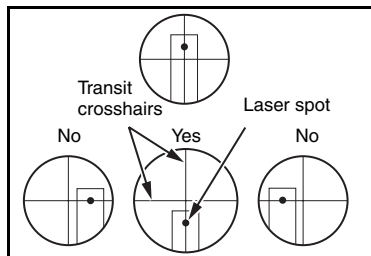
10 Determine if you wish to set the laser beam on the centerline of the pipe or at a constant distance above the flow line.

11 Adjust the laser until you are at the chosen height above the invert.

12 Set an adjustable pipe target (Model 936 or 956) so that the target's bull's-eye is at the same distance above the invert as your laser beam.

13 Plunge the transit into the open excavation and set a stake on line 6–8 m (20–25 ft) from the next manhole.

14 Line – Look through the transit at the next stake; align the laser to the vertical crosshair of the transit using the Line buttons on the laser or the Wireless Remote



15 Lay Pipe – Set the target in each new section of pipe and adjust the pipe until the laser intersects the target's bull's-eye while the target is level.

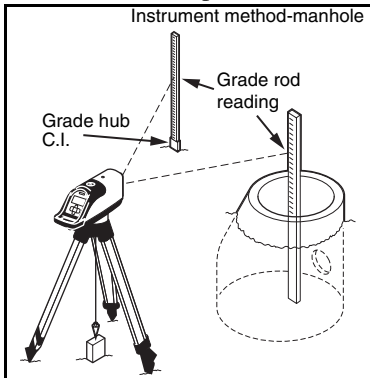
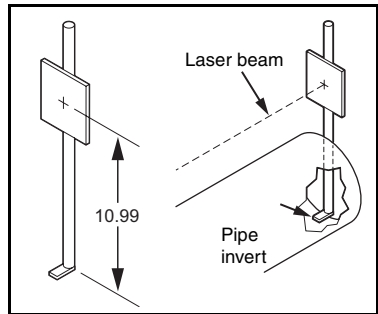
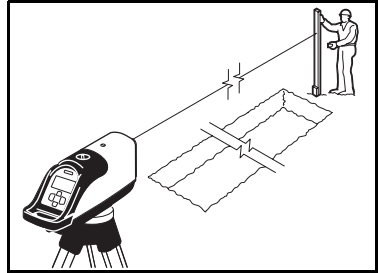
Over the Top

The laser can be set on a tripod or mounting plate above the excavation on the pipe itself. A laser target is mounted on a pole and is adjusted to give the correct distance from the beam to the pipe invert. For accurate line control, a level vial can be attached to the pole to ensure that the target is held vertically. This is an excellent setup for shallow cuts for trenches where water is present.

1 Attach the laser to a tripod having a 5/8 inch x 11 thread.

- 2 Set the tripod and laser on line behind the first manhole and ensure the system is level.
- 3 Suspend a plumb bob from the tripod or use a Laser Plummet over the first point.
- 4 Transfer the elevation into the manhole using a level, transit, or with your laser set to 0.00% grade.
- 5 Set a stake on the centerline of the pipe so the top of the stake is at invert elevation.
- 6 Use the wireless remote to position the beam on the rod as you take your readings.
- 7 Add your grade rod reading to your cut-to-invert reading.
- 8 Set a target on rod at this distance. For example:

Rod reading = 6.48
 Cut-to-invert = 4.51
 Set to = 10.99



DG511/711 Additional Accessories

CHAPTER

6

1211 Laser Plummet

Replaces the 5/8-11 bell housing in manhole mounts or tripods, and provides a self plumbed laser dot that can be quickly positioned over the plumb point. This greatly reduces first day setup time.

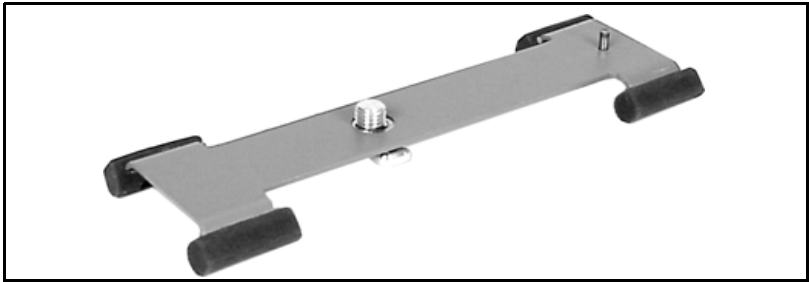
The 1211 has a self-plumbing range of 10 degrees, a bright 635-nm beam, safety lanyard, shock bumpers, and operates off two AAA batteries (included). The 1211 includes operating instructions and a carrying pouch with belt loop.

Note – You must turn the 1211 upside down then right-side up just prior to each use. For setup and operating instructions, see the 1211 operator's manual.



1238/1249 Mounting Plates

Allows the laser to automatically center in an 200 mm (8 inch) diameter pipe using 1238 mounting plate and 225 mm (9 inch) diameter pipe using a 1249 mounting plate.



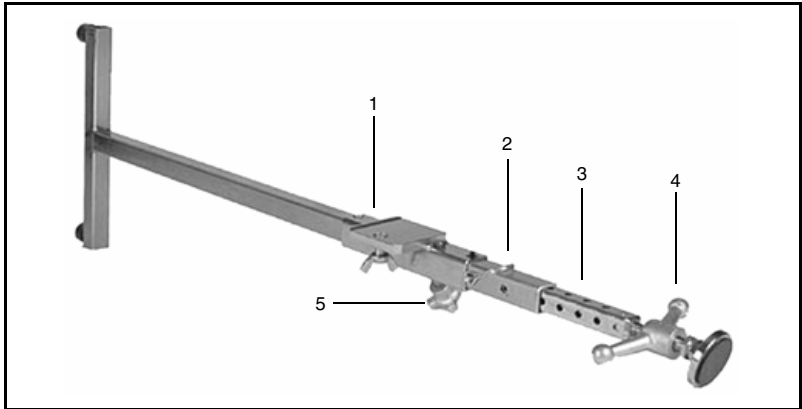
1244 and 1244-1 T-Bars

The 1244 T-Bar is a mounting support system for using a laser in large diameter pipe, manholes, or open excavated trenches where high stability and a variable elevation adjustment is required.

Use the 1244 with a 1239 Universal Fixed Pole for precast invert setups for unobstructed flowlines.

Also use the 1244 in large diameter pipe to place the laser beam parallel to the pipe's centerline.

Pipe Diameter Application	Recommended T-Bar
1.07 to 2.03 m (42 – 80 inch)	1244
0.83 to 1.58 m (33 – 66 inch)	1244-1

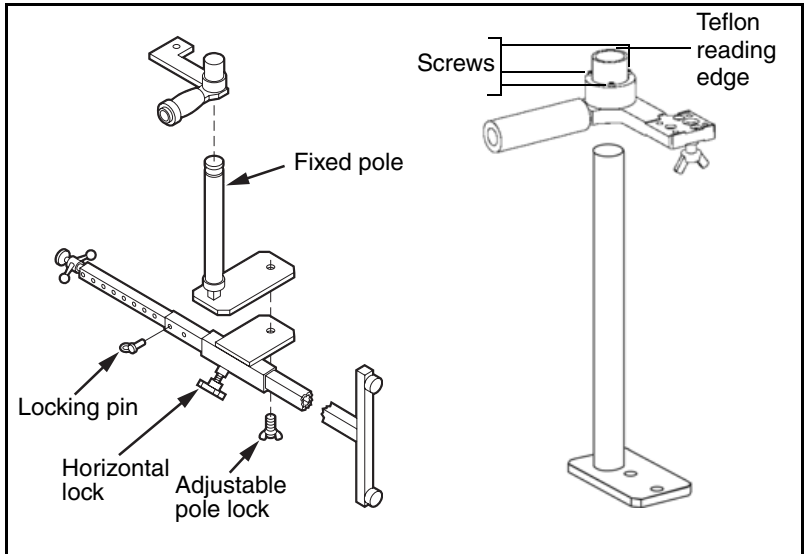


Note – Both models can be shortened for use in smaller diameter pipes and manholes. The speed release handle provides 13 cm (5 inches) of fine adjustment range.

Features

- 1** Mounting Plate – supports the laser or the 1239 Universal Fixed Pole.
- 2** Locking Pin – holds the extension bar in place.
- 3** Extension Bar – allows for 25 mm (one-inch) coarse adjustments in the T-Bar's overall length.
- 4** Speed Release Handle – tightens the T-Bar into place and allows for quick release.
- 5** Horizontal Lock Knob – allows the mounting plate to slide freely along the extension bar and positions the laser on line.

Reverse the Teflon reading edge assembly when used with the T-Bar by unthreading the three screws fastening the assembly to the pole clamp. Reverse the unit wing nut capturing screw on the pole clamp as necessary based on whether the pole is mounted above or below the T-Bar.

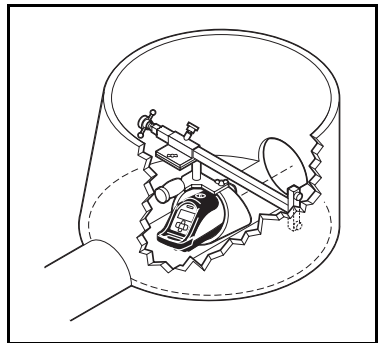
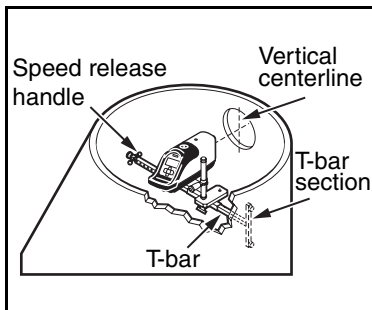
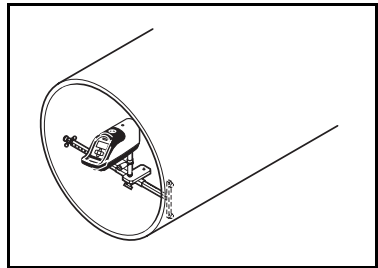
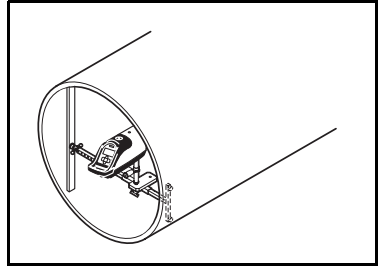


Setup Instructions

- 1 Attach the vertical pole to the T-Bar.
- 2 Adjust the length of the T-Bar using the locking pin to fit your setup.

Note – The “T” section of the bar must be vertical.

- 3 Use the speed release handle to secure the T-Bar in the manhole or large pipe at a position that enables the vertical pole to support the laser at the predetermined elevation.
- 4 Loosen the horizontal lock knob to allow the laser and mounting plate to be adjusted to the line of the pipe.



Pipe Targets

The correct target you use depends on the elevation of the laser beam above the pipe invert and your personal preference.

Pipe Diameter Application	Recommended Pipe Target
150 – 300 mm (6 – 12 inches)	956 Target w/small Pipe Target
350 – 500 mm (15 – 21 inches)	956 Target w/large Pipe Target
400 – 800 mm (15 – 30 inches)	936 Target
greater than 800 mm (30 inches)	936 Target

Through the Pipe Applications

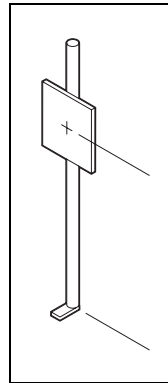
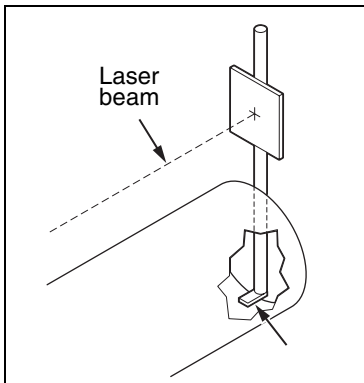
For pipes with a diameter of 500 mm (21 inches) or less, the laser beam is normally projected on the centerline of the pipe. When the target is calibrated to the pipe's diameter, the target may be used in any orientation in the pipe to maintain the target's bull's-eye on center with the pipe.

When the laser is set above the flow-line other than the pipe's centerline, the target must be leveled in the pipe. If the target is not level, the pipe may be placed off line or grade.

Over the Top Applications

For over the top setups you need to assemble a target from a 25 x 25cm (10 x 10 in.) red or white Plexiglas.

You need a couple of u-bolts, and a 20 mm ($\frac{3}{4}$ in.) rigid or thick walled plastic pipe of a length to match your setup.



Model 936 Adjustable Pipe Target

The 936 Adjustable Pipe Target centers the laser beam in 400–800 mm (15–30 in.) diameter pipes when the target is aligned to the scale on the target's frame.

1 2 x 4 Mount – used where a 2 x 4 supports the target in a large pipe when the laser beam is 400 mm (15 in.) above the pipe inverts. Cut a 2 x 4 to a length and place in the pipe so the 936 intersects the laser beam on the bull's-eye.

2 Pipe Bore Mount – used when the laser beam is near the top of the pipe. The target hangs upside down in the pipe and is adjusted until the beam intersects the target bull's-eye. This frees the pipe of obstructions in the flow line.

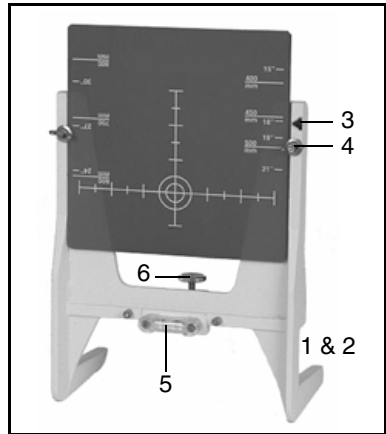
3 Reference Arrow – calibrates the target scales for the diameter of pipe in which the laser is centered.

4 Target Clamps – secure the target into position.

5 2-Way Level Vial – provides a level reference for the 936 whether it is used upright or inverted. A level target is required where the

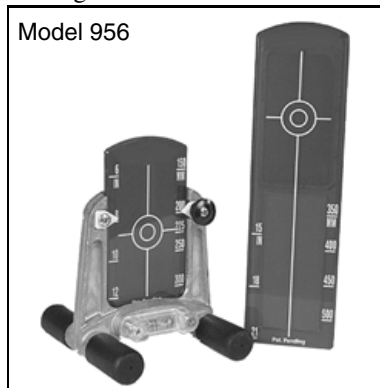
elevation of the beam is at some distance above the invert other than the pipe's centerline.

6 Lock – secures the target frame to a 2 x 4 when the 936 is being used in large diameter pipe.



Model 956 Optically Enhanced Universal Target

The 956 adjustable Pipe Target centers the laser beam in 150 to 500 mm (6 to 21 inches) diameter pipes when the proper target element is aligned to the scale on the target's frame.



Model 1212 LineLevel

The 1212 LineLevel is a rugged optical instrument that performs as a precision automatic level and a line transfer unit for the installation of gravity flow pipe.



1232 Precast Invert Adapter

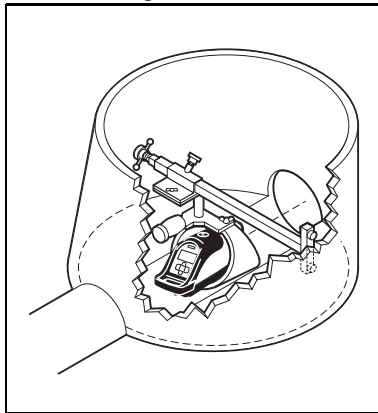
The 1232 Precast Invert Adapter is used with a 1244 T-Bar and 1239 Universal Fixed Pole when the laser is positioned slightly above flowline of a precast invert.

Model 1232



Setup instructions

- 1 Install the 1232 onto the 1239 Universal Fixed Pole.
- 2 Install these components onto a 1244 T-Bar Assembly.
- 3 Set the 1244 T-Bar with the adjustable pole in the manhole with the horizontal slide assembly over the invert.
- 4 Adjust the elevation of the pole clamp so the laser is placed at the desired elevation over the flow line.
- 5 Place a grade rod on top of the Laser housing to set elevation.



Model 1214 Line String Adapter

The 1214 Line String Adapter is a machined aluminum clip with an adhesive bottom, which is applied over the laser's line pivot bull's-eye target and used with a plumb bob target and used with a plumb bob for setting the laser on line.



- 5 Move your arm until the two plumb bob strings are parallel.
- 6 Turn your hand until both plumb bob strings are in line with each other, and in line with the next manhole's hub.



Operating instructions

- 1 Remove the paper from the adhesive pad on the 1214.
- 2 Press the 1214 over the line pivot bull's-eye target on the Laser making sure the open slot is facing the front of the Laser.
- 3 Loop a plumb bob string through the slot on the 1214.
- 4 Standing in a manhole, or above an open cut, loop the plumb bob about 30 cm (one foot) over your hand.

7 Keep the strings parallel and in line with the next manhole, and adjust the Laser's laser spot on line with the two strings.



Refraction

CHAPTER

7

1 Refraction is the bending of light at the interface of two substances caused by a difference in the speed of light. Shooting a laser beam through a pipe having gas and varying temperatures can be compared to shining a flashlight beam into a pool of water and seeing the light bend.

2 Refraction of the laser is preceded by what appears to be a flaming of the laser spot at the edges. When this occurs, it is time to mix the air within the pipe by some external means such as a blower. This occurs on sunny days when a hot pipe is placed in a cool ditch. The pipe bottom cools first and the warmer air in the upper

half of the pipe causes the laser beam to refract down towards the cooler air.

3 Solvent fumes can also cause refraction from the glue used at joints, or on very cold days when a cold pipe is placed in a warm trench.

4 Refraction is a small diameter pipe problem. When small diameter pipe is set, it is recommended to place the hot-sun-baked side of the pipe down in the trench so that it will cool faster against the earth. This helps create temperature stability in the pipe.

5 Generally, refraction of the laser beam occurs at the last four or five joints of the pipe. This is because the last few sun-baked

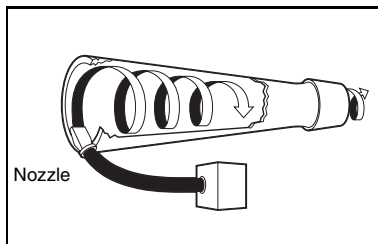
joints of the pipe have not had a chance to cool in the shade of, and against the earth of the trench.

6 If possible, always back-fill the pipe as you go. The earth is a great temperature stabilizer as it surrounds the pipe. The earth tends to stabilize the temperature of the pipe and the air inside. Use of a blower in conjunction with back-filling accelerates temperature stabilization. Always back-fill immediately unless the jobsite condition makes it impossible.

7 To fully minimize the effects of refraction, it is advisable to use a blower after the pipe run exceeds 15 m (50 ft). Operate the blower at a speed that minimizes the effects of refraction. As the pipe length increases, increase the speed of the blower.

8 When using a blower, make sure it is taking in fresh air through the intake. On the discharge end, the nozzle should be angled to bounce the air off the side of the

pipe thereby creating a spiral or corkscrew effect.



9 If possible, mount the nozzle on the side of the pipe or in the invert. Avoid attaching the nozzle at the top of the pipe unless there is no other choice, as this will push the warmer gas through the pipe. If a strong wind is blowing down the pipe and fighting the blower, it may not be needed.

10 In large diameter pipe, 45 cm (18 inches) and larger, it is better to position the blower nozzle off the invert below the laminar surface of the gas. If this is insufficient, three alternatives are possible. Use two electric blowers, a Homelite Model III-B (or equivalent) gas driven blower or a short blast of air from an air compressor, to clean out the line.

11 If the beam still can not be controlled, have your backhoe excavate five buckets full and then one or two empty buckets as if it were bailing water. The blower is pushing heavy fumes in the pipe that can not get out of the trench without someone's help. Cast the empty bucket on the low side of the surface or on the downwind side of the cut.

12 Another solution is to have a Homelite III-B blower (or equivalent) at the cut end of the trench pulling these fumes from the cut as the electric blower blows them out of the pipe. This method does not tie up production and gets the job done more efficiently.

13 In summary, if all of the above fail to solve this problem, use the laser in an over-the-top setup.

Model 929 Blower Operating Instructions



- 1** Use a separate 12-volt automotive battery to power the blower.
- 2** Point the nozzle into the pipe to create a corkscrew effect. This is the most effective way to create temperature stabilization.
- 3** Ensure the air intake is not blocked and the 929 is not set in water. The support handle/cord wrap bracket is on the opposite side of the air intake. This handle can hook over a manhole step to keep the unit out of water in the pipe.

4 Start the blower with the first section of pipe. Use the table on the blower to determine the blower speed from the length and size of pipe being installed. Although very unlikely, be aware too much air can also cause refraction.

DG511/711

Troubleshooting

CHAPTER

8

Table 7.1 will help in troubleshooting your unit. It lists possible problems, symptoms, and solutions. If the problem goes beyond what is described on this chart, contact your service center for more information.

Table 8.1 Troubleshooting

Problem	Symptom	Inspect	Solution
Laser does not come on	No laser beam	Dead or low battery	Change to known good battery
Laser does not self-level	Beam flashing*	Time allowed for laser to self-level Out of level range Unstable setup	Allow laser to operate for about 5 minutes prior to self-leveling. Roll laser to within its $\pm 3^\circ$ roll leveling range. Provide more stable setup.

Table 8.1 Troubleshooting (Continued)

Problem	Symptom	Inspect	Solution
Laser does not respond to remote control	Line does not move left or right	Line-lock indicator (status display).	Unlock line or use the lasers line buttons.
		Out of range. Remote control must be within 150 m (500 ft) when standing in front of the pipe laser and 10 m (30 ft) from behind.	Move the remote control within range.
		Blocked signal. If too many obstructions are in the way of the remote control's signal, or the pipe laser's collector windows are dirty, or the remote control's emission window is dirty, the line will not operate.	Remove obstruction and clean windows.
		Emission indicator does not blink or seems dim.	Return the remote control to an authorized service center.
	Line moves in only one direction	Line movement is at limit range.	Reset laser within line movement range.

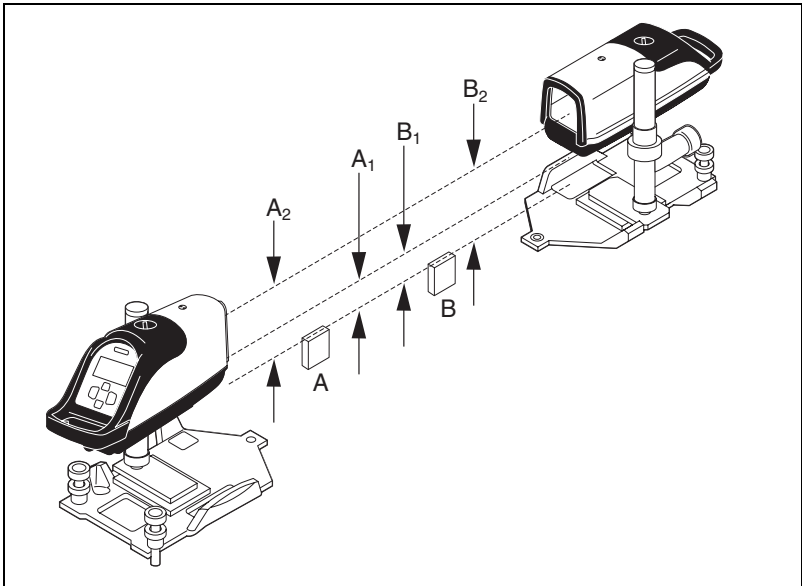
Table 8.1 Troubleshooting (Continued)

Problem	Symptom	Inspect	Solution
Grade does not respond to grade control	Grade will not change	Grade-lock indicator (status display).	Unlock grade.
Laser beam is high or low	Doesn't match existing pipe	Grade, elevation, or line is incorrect on existing pipe.	Use a known accurate instrument to check existing pipe.
		Unstable setup.	Provide more stable setup.
		Check refraction.	Use a blower or other method to stabilize air temperature in pipe.
		Calibration.	Calibrate the laser.

Note – Flash rate is about one flash per second.

Error Code	Meaning	Action
001	Minimum operating temperature for the laser has been exceeded	Do not operate the pipe laser below –20°C (–4° F). Call authorized service center.
002	Maximum operating temperature for the laser has been exceeded	Do not operate the pipe laser above 60° C (140° F). Call authorized service center.
004	Laser current has exceeded preset maximum	Return the pipe laser to an authorized service center for repair.
016	Grade motor has jammed.	Check calibration or call authorized service center.
032	Grade flags failed initialization.	Return pipe laser to authorized service center for repair.
064	Fatal Laser	Return the pipe laser to authorized service center for repair.
128	Internal battery Corrupt	Return pipe laser to authorized service center for repair.

Checking the Calibration



Checking the calibration of your pipe laser is easy. All you need is an engineer's rule and your pipe laser:

- 1 Select a level road, parking lot or field whose rise is not more than 10 cm in 30 m (4 inches in 100 ft).
- 2 Choose two points (A and B) about 30 m (100 ft) apart. The distance does not have to be measured, but the points must be found, so mark them well.
- 3 Set up the pipe laser just behind the lowest point and rough level.
- 4 Turn on the pipe laser and let it warm up for about 10 minutes.
- 5 Set the grade counter to 0.000%.
- 6 Aim the laser beam so that it passes over points A and B. Allow the pipe laser to self-level.

7 Accurately measure the elevation to the center of the beam at point A and record the elevation as A1 in a table like the one shown below:

	Point A	Point B
Second Reading	A2	B2
First Reading	A1	B1
Difference	A2 - A1	B2 - B1
Error in 30 m (100 ft)	$\frac{(A2 - A1) - (B2 - B1)}{2}$	

- 8 Accurately measure the elevation to the center of the beam at point B and record the elevation as B1.
- 9 Move the pipe laser behind point B and aim the laser beam so that it passes over points A and B. Allow the pipe laser to self-level.
- 10 Accurately measure the elevation to the center of the beam at point B and record the elevation as B2.
- 11 Accurately measure the elevation to the center of the beam at point A and record the elevation as A2.

12 Subtract the A1 and B1 elevation readings from A2 and B2 elevation readings.

Note – Your laser is in calibration if the difference between $A2 - A1$ equals $B2 - B1$.

Note – If $A2 - A1$ is greater than $B2 - B1$, the laser beam is shooting high and you should readjust the laser's calibration bringing the beam to level.

Note – If $A2 - A1$ is less than $B2 - B1$, the laser beam is shooting low and you should readjust the laser's calibration bringing the beam to level.

Note – If the error is greater than 6.4 mm/30 m (0.02 ft in 100 ft), return the pipe laser to an authorized Trimble service center.

Adjusting the Calibration

The goal to adjusting the pipe laser's calibration is to make the beam level, half the distance of the total error. This will be the true calibration point of the unit.

1 Enter the Calibration feature option by simultaneously pressing the power, decrease, and backlight/lock buttons (buttons 1, 4, 6).

2 Press the backlighting/lock button to enter the selection.

Note – To change the displayed calibration constants when you are in the Level Cal. mode, use the left- or right-line control button

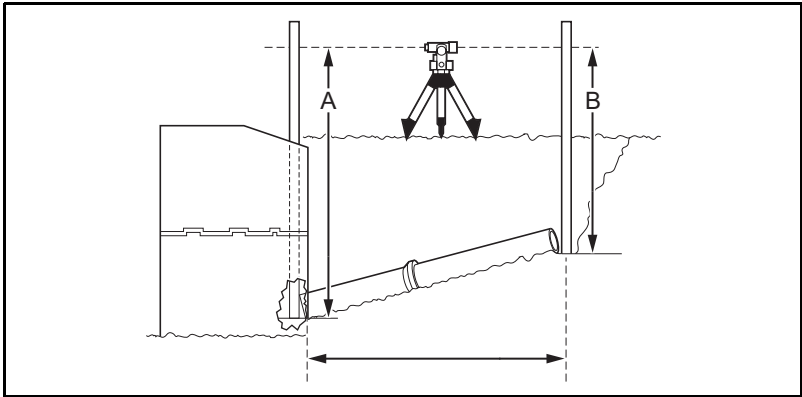
Note – For every 10 digits changed, the beam's elevation changes 1.6 mm/30 m (1/16 inch per 100 ft).

Note – The maximum adjustable range is ± 120 digits or ± 19 mm/30 m ($\pm 3/4$ inch per 100 ft).

3 When the pipe laser is calibrated, press the backlight/lock button to set the calibration.

Note – The laser beam will move to the new calibration point AFTER the calibration option is exited and the normal grade display returns. The laser will NOT move during calibration. Verify that the calibration is correct AFTER exiting the calibration menu.

Grade Check



After the first 8–15 m (25–50 ft) of pipe has been laid, it is recommended that you make a grade check to ensure that the setup is correct, and that the system is properly operating.

The illustration shows a method for checking grade.

- 1 Using a transit level, or an automatic level and a grade rod, take a reading at the beginning of the pipe “A”.
- 2 Using the same instruments, obtain a level reading at the end of the pipe “B”.

3 The difference between the readings equals the rise over the run.

4 In terms of % of grade, rise divided by the run times 100 equals the percent of grade.

Note – The user of this equipment is expected to follow all operating instructions and make periodic checks on the proper grade, elevation, and line of the pipe as it is being laid. Trimble or its representatives assumes no responsibility for improperly laid pipe.

Example

Table 9.1 Grade check chart

	Metric	Ft / Tenths
Rod Reading at "A"	4.801 m	15.74 ft
Rod Reading at "B"	3.749 m	12.289 ft
Rise or Difference (A – B)	1.052 m	3.451 ft
Distance from A to B	44.196 m	145 ft
Rise divided by Run	0.0238	0.0238
Rise divided by Run times 100 = Laser Setting	2.38%	2.38%
Rise according to engineering plans	$(2.38\% * 44.196 \text{ m}) =$ 1.052 m	$(2.38\% * 145 \text{ ft}) =$ 3.451 ft

The pipe is laid correctly when the rod reading "A" minus rod reading "B" equals the rise according to the engineering plans.

Maintenance and Care

CHAPTER

10

You will get years of service from the leveling system by following the maintenance and care recommendations in this manual. Carry the laser in its moisture-resistant, field-tested carrying case to safely move the laser from one job to another.

However well the product is designed, mishaps do occur. The most common problems associated with these are covered in the following areas.

Storage



Warning – Do not store the laser in a wet carrying case. If the case gets wet, open it and let it dry before storing the laser.



Warning – Remove the batteries from the laser when storing it for more than 30 days.

Battery Disposal

Some countries, states, and local areas have regulations regarding the disposal of rechargeable batteries. Be sure that replaced batteries are disposed of properly.

System Cleaning

Use only a good-quality glass cleaner and a soft cloth to clean all external optical components. A dry cloth used on the laser's/IR remote control's optical components or displays could scratch or damage these surfaces.

Blow off any loose debris before cleaning any surfaces to prevent scratching of optical surfaces. Monthly, wipe off with a moist, clean cloth any dust or dirt from the laser's outer surface, inside the battery housing. Clean all corroded battery contacts with a pencil eraser or baking soda solution.

Laser Specifications

CHAPTER

11

Table 11.1 and Table 11.2 contain the operational specification for the DG711 and DG511 Pipe Laser.

Table 11.1 Specifications

Performance Specifications		
	DG511	DG711
Grade Range	-15% to +40%	
Self-Leveling Range	Longitudinal: Over the entire grade range (no rough leveling required) +/- 3 degrees: Cross Axis	
Line Range	20°	
Line Center	Yes	
Grade Zero	Yes	
Line Set/Check		Yes
Line Alert		Yes
Temperature Compensation	+/- 30 arc sec. over entire operating range on DG711	

Table 11.1 Specifications (Continued)

Accuracy, Self-Leveling (level)	+/- 10 arc seconds = +/- 1.6 mm at 30 m (1/16 in. at 100 ft)	
Maintenance Interval Notification	Yes	
Warranty Period	1 Year	2 Years
Laser Classification		
Laser Source – Visible laser diode	Laser Wavelength 635 nm	
Laser output	4.5 – 5 mW (maximum allowable)	
Laser classification USA and Canada	3A	
Laser classification International	3R	
General Specifications		
Weight	3.6 kg (8.0 lbs.)	
Length	37.5 cm (14.75 inches)	
Diameter	14 cm (5.5 inches)	
Housing Material	Hard Anodized Aluminum	Nickel Plated Die Casting
Battery type and life	Alkaline / 40 hours; Ni-MH / 64 hours	
Battery pack	Sealed (Ni-MH), 0-Ring replaceable Removable (Alkaline)	
Battery Charge Time	10 hrs using the smart charger 14 hrs using the cigarette lighter adapter	
Operating voltage	6–16 Vdc	

Table 11.1 Specifications (Continued)

Operating temperature	-20° to 60° C (-4° to 140° F)
Storage Temperature	-30° to 60° C (-23° to 140° F)
Waterproof	Continuous Submersion at 3 m (10 ft.)

Table 11.2 Remote Control Specifications

	Model RC501-3-Button	Model RC502-7-Button
Wireless Remote Specifications		
Through the Pipe Range	225 m (750 ft)	225 m (750 ft)
Front / Over the Top Range	150 m (500 ft)	150 m (500 ft)
Rear Range	10 m (30 ft)	10 m (30 ft)
Battery life (normal operation)	2 Years / 24 months	3 Years / 36 months
Functions	Line Adjust Laser On/Off	Line Grade/Adjust Line Set/Check Grade Bump Laser On/Off
Waterproof	3 m (10 ft)	
Impact Resistance	1.5 m (5 ft) drop onto concrete	
Signal and Battery Indicator	Red flashing LED @ 4 Hz	
Operating Temperature	-20° to 50° C (-4° to 122° F)	
Storage Temperature	-30° to 65° C (-23° to 149° F)	

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