

TRUE Grade

Fukuda FRE-203XT

User Guide



KEY INFORMATION

Specification

Brand	Fukuda
Product Type	Rotating Laser Level
Levelling Type	Fully Self Levelling
Detector Range	Up to 500m Diameter (250m either side of Laser)
Accuracy	±2.8mm at 30m (100ft)
Beam Colour	Red Beam
Beam Type	Rotating Dot
Levelling Axis	Horizontal & Vertical Levelling
Facilities	90° Squaring, Scan, Plumb (Up), Plumb (Down)
Usage	Indoor & Outdoor
Battery	Rechargeable Battery Pack or use Alkaline Batteries
Runtime	Up to 20 Hours (Approx)
Slope / Gradient	Dual Grade using Keypad or included Remote Control
Mounting Thread	5/8" Standard Surveying
Laser Rating	Class 2
Durability	Excellent
IP Rating	IP66 - Dust tight / Protected against powerful jets of water
Warranty	Automatic 3 Year Warranty

INTRODUCTION

Thank you for purchasing the Fukuda FRE-203XT True Grade rotary laser kit.

These instructions are intended to explain the general basics of operating this equipment.

Please read them carefully.

For any more information, or if the laser requires calibration or repair; then please contact our Service Department by Telephone: **08000 869 769** or Email: **sales@laser-level.co.uk**

Overview

The Fukuda FRE-203XT replaces the extremely reliable outgoing Fukuda FRE-208 True Grade laser, to which it shares many of its internal components. It builds upon this foundation to incorporate many new features and improvements which it shares with the other FRE-203X series lasers.

The FRE-203XT is a TRUE GRADE laser where the user can easily input the exact % of slope required. The instrument will then simply set the laser beam to that slope. This can be in one axis only (single grade) or in two axis X & Y together for dual grading. A radio linked Remote Control with a 100m range makes this quick & easy.

The laser also has plumb up & plumb down, red laser dot beams. By mounting the instrument on its side, called "lay-down" this gives a squaring facility. i.e. 90-degree site setting out - a very useful feature.

Constructed with a waterproof housing, an automatic drift system and the facility of radio controlled Dual grade - has made this the Grade laser of choice for Groundworks Contractors. This is another model in the Fukuda range which is extremely robust, having a drop-test specification of 1 metre onto concrete. The top glass "lighthouse" is protected by a metal die cast cover, whilst a robust roll cage adds increased durability.

The FRE-203XT is also suitable for indoor use, where the rotating speed can be reduced to improve visibility of the laser beam by eye; together with a concentrated beam, SCAN facility.

SAFETY

Read the following safety instructions before attempting to operate this Laser Level Kit.

Keep these instructions in a safe place or store in the Laser's carry case for future reference.

- Do not remove warning labels from the product.
- The FRE-203XT is a class 2 laser product (<1 mW; 630 - 685nm)



WARNING

Never look into the laser beam or direct it to the eyes of other people. Always operate the Laser Level in a way that prevents the beam from getting into people's eyes.

Using the FRE-203XT differently than described in the user guide, may result in unsafe operation.

WHAT'S INCLUDED IN THE KIT

The Fukuda FRE-203XT Kit includes the following items. Your contents may vary if the kit was customised at point-of-purchase to upgrade or remove items.



Fukuda FRE-203XT

Horizontal, Vertical, 90° Squaring
& TRUE Grade (X & Y)



FRD600R Laser Detector

Laser Detector / Receiver
With Staff Mounting Clamp



RC203XT Remote Control

Radio remote Control For
Setting Gradients & Slopes



Battery Packs & Charger

Rechargeable Battery (pre-
installed in base of laser), Spare
Alkaline Battery & UK Charger



Red Target & Glasses

Red Laser Target & Red Laser
Enhancement Glasses



Tripod & Staff

Surveying Tripod &
Measuring Staff
(Colours / Brand may vary)



Carry Case

Foam Lined Carry Case

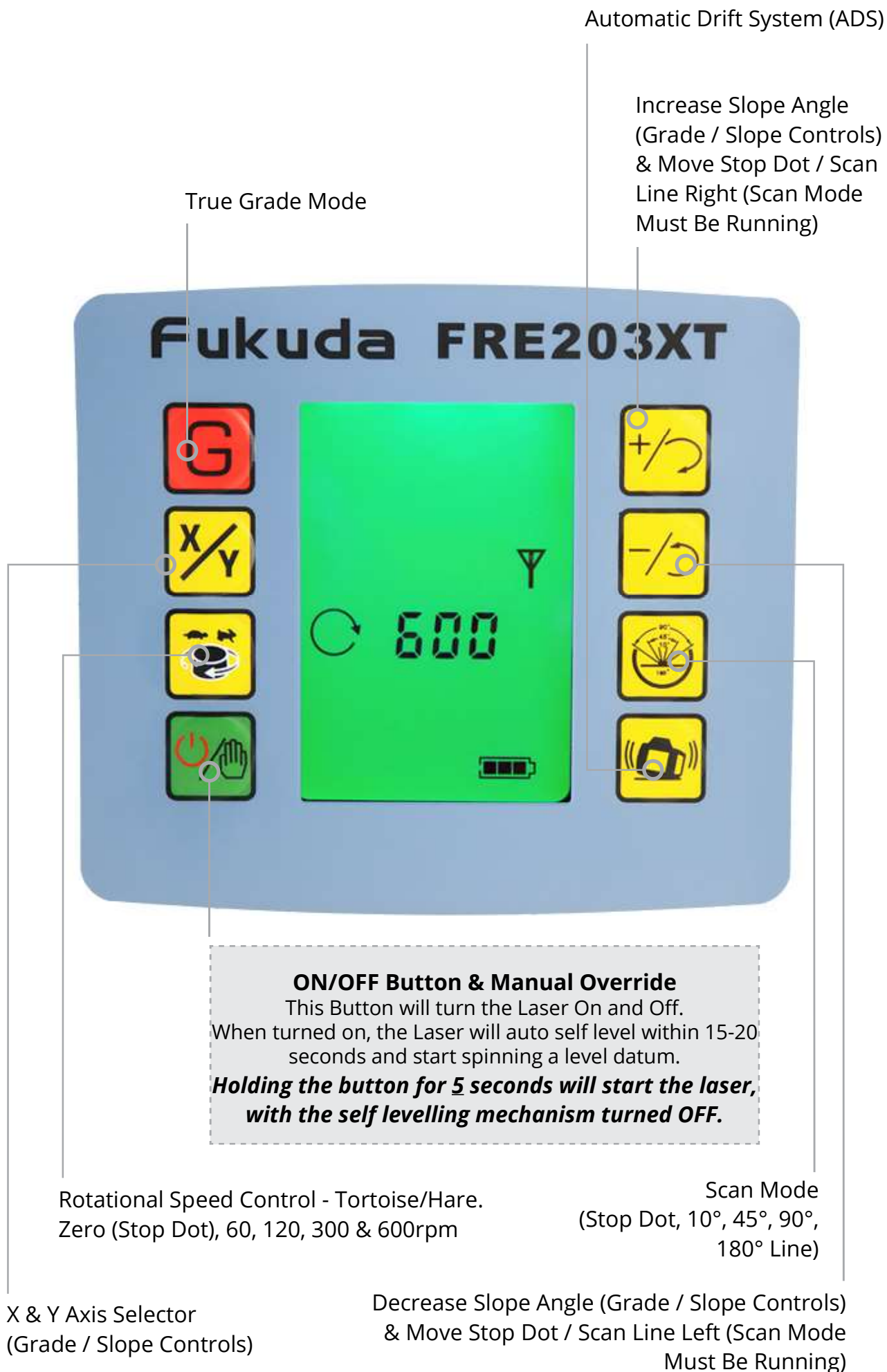
LASER OVERVIEW



LASER OVERVIEW (CONTINUED)



KEY PAD OVERVIEW



REMOTE CONTROL OVERVIEW

The Fukuda FRE-203XT Radio Remote Control enables the user to remotely (up to 100m), adjust the following settings: Rotational speed, Scan angle & position as well as inputting a gradient or slope as a %. ***It cannot be used to turn the Laser ON or OFF (a feature not available on any Fukuda laser level system).***

TIP - it is often better to use the Remote Control rather than the FRE-203XT's keypad, to avoid disturbing the laser's sensitive self levelling mechanism.



Power Supply & Battery Replacement

- The FRE-203XT remote is powered by 2 x AAA alkaline batteries which will be pre-installed.
- When required, open the rear battery compartment and fit 2 x AAA alkaline replacement batteries, taking care to ensure correct polarity.

LASER DETECTOR OVERVIEW

The FRE-203XT Kit is available with either the standard FRD600R Detector or the upgraded FRD800R Detector with mm/inch display. The overview below shows the standard FRD600R.



Power Supply & Battery Replacement

- The FRD600R Detector is powered by 1 x 9v PP3 alkaline battery which will be pre-installed.
- When required, open the rear battery compartment and fit 1 x 9v PP3 alkaline replacement battery, taking care to ensure correct polarity.

LASER DETECTOR OVERVIEW (CONTINUED)



Using The Detector

- Press the **ON/OFF** button once and the FRD600R will power on.
- Clamp the Detector onto the front face of the measuring staff and face towards the Laser. If you are above the horizontal datum, a down arrow will be shown. Below the horizontal datum an up arrow will be shown and when you are completely level or on the same datum, a horizontal line will be shown on the display. When you have established the horizontal datum, you can then use the mm scale on the rear of the measuring staff (which is zero mm at ground level) to either measure a uniform distance down or a uniform distance up, to then set your base level, deck level, ground level etc.

CHARGING & BATTERIES

The FRE-203XT is supplied with a Fukuda 4.8V Ni-MH Rechargeable Battery, a Fukuda 6V Alkaline Battery (Non-rechargeable) and a 5.6 Volt UK Plug, 900mA charger. Typically only the rechargeable battery pack is used, with the alkaline battery pack being used as a back-up power source.

Mains Charger

The 5.6 Volt UK Plug, 900mA charger (Input 100-240V AC 50/60Hz. Output DC 5.6V 900mA, centre pin + polarity) is for indoor use only. If the charger becomes damaged, stop using immediately and purchase a replacement. ***Never use a generic charger with this laser.***

- The general procedure to adopt is use the laser during the day & charge-up overnight. You cannot damage the system by “over-charging” the batteries.
- When the charger is plugged into a 230V mains supply (but not connected to the Laser), the red LED on the charger will flash once per second, when operating correctly.
- Plug the charger into the charging port located on the battery pack or underneath the control panel on the front face of the laser. Both allow the battery to charge.
- When charging, the red LED on the charger will stop flashing and be illuminated continuously.
- The LED will change to green when there is sufficient charge in the battery.
- The FRE-203XT can be operated with the charger connected to the mains supply, if required and is approved on site.
- The Mains Charger will charge most batteries in around 7 hours to give approximately 20 hours of continuous use. It takes 4 to 5 charge/discharge cycles for these battery packs to reach their maximum capacity.

Rechargeable Battery Pack

- Prior to first use, we recommend that you fully charge the battery pack for around 7-8 hours.
- The battery pack contains 4 x “sealed for life” Ni-MH type C, 4000mAh, 1.2V cells. Please note that this battery pack can be charged either in or outside of the laser.
- **Important:** Do **NOT** allow battery to go completely flat before recharging.

Alkaline Battery Pack (Non-rechargeable)

- The Alkaline Battery Pack is designed to be a backup power source if the main rechargeable battery has not been charged.
- The battery pack contains 4 x type C, 1.5V alkaline batteries. These are readily available from all good hardware stores / supermarkets.
- **Important:** Do **NOT** attempt to recharge this battery, otherwise serious damage will occur.

INSTRUCTIONS

Horizontal Levelling



WARNING

Never operate Laser in front of glazing or any shiny surfaces!
See page 29 for further details.



1. Position Laser

Place the FRE-203XT on a firm, generally level surface or screw onto the 5/8" thread of the surveying tripod. You do not need to independently level the surface or tripod, but it does need to be within ± 5 deg of true horizontal.



2. Power On

Press the **ON/OFF** button once and the FRE-203XT will power on and begin automatically self-levelling horizontally. This process takes around 15-20 seconds.

When the levelling process is complete, the laser beam will start spinning at 600rpm, indicating a level datum.

No other button needs to be pressed for the laser to self level.



3. Pick Up The Levels

Clamp the Detector onto the front face of the measuring staff and face towards the Laser. If you are above the horizontal datum, a down arrow will be shown. Below the horizontal datum an up arrow will be shown and when you are completely level or on the same datum, a horizontal line will be shown on the display.

There is also a corresponding audible tone and LED indicators.



4. Read The Levels

When you have established the horizontal datum, you can then use the mm scale on the rear of the measuring staff (which is zero mm at ground level) to either measure a uniform distance down or a uniform distance up, to then set your base level, deck level, ground level etc.

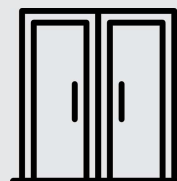
INSTRUCTIONS

Vertical Levelling



WARNING

Never operate Laser in front of glazing or any shiny surfaces!
See page 29 for further details.



1. Position Laser

Place the the FRE-203XT on the rear lay-down mount on a firm, generally level surface. The mount is located on the opposing side of the keypad.

You do not need to independently level the surface but it does need to be within ± 5 deg of true horizontal.



2. Power On

Press the **ON/OFF** button once and the FRE-203XT will power on and begin automatically self-levelling vertically. This process takes around 15-20 seconds.

When the levelling process is complete, the laser will start spinning at 600rpm, indicating a vertically level datum.

No other button needs to be pressed for the laser to self level.



3. Pick Up The Vertical

Turn the Detector onto it's side (landscape mode) and face towards the Laser. The up and down arrows used for horizontal levelling will then become left and right arrows. The Detector will accurately pinpoint the vertical datum and the arrows on screen will indicate which direction to go. When in alignment, it will display a vertical black line. You can then walk forward of your position continually marking the datum. This method can be

used instead of a string line or to align a datum on the vertical. e.g. I-section steels, fence posts, timber frame structures, racking etc.

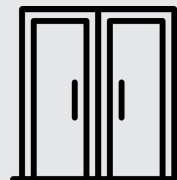
INSTRUCTIONS

90° Squaring



WARNING

Never operate Laser in front of glazing or any shiny surfaces! See page 29 for further details.



1. Position Laser & Power On

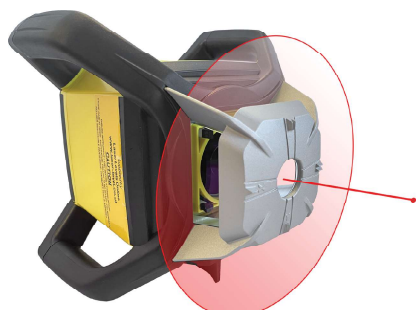
Take the FRE-203XT off the tripod and lay on a firm surface, at ground level on the rear lay-down mount. The mount is located on the opposing side of the keypad. The laser should be placed over your intended corner point. Then press the **ON/OFF** button once to turn on the level and wait for the laser to self-level before pressing holding the **ON/OFF** button for **5** seconds until the “hand” is shown on the display.



2. Pick Up The Vertical

With the Laser prism now spinning (like the wheel of a car), turn the Detector onto it's side (landscape mode) and face towards the Laser. The up and down arrows used for horizontal levelling will then become left and right arrows. The Detector will accurately pinpoint the vertical datum and the arrows on screen will indicate which direction to go. When in alignment it will display a vertical black line. You can then walk up to 250m

forward of your position continually marking the datum. When this is complete, you will have marked out the first part of the 90° and you can now return to the laser to begin setting out the second part.



3. Pick Up The Laser Dot

The second part of the 90° is achieved by marking the position of the red laser dot that is fired from the centre of the lighthouse.

The laser dot cannot be picked up with your detector.

You need a target plate. Our recommendation is to use a small piece of around 300mm long white contiplus board, 6-9" wide or similar. Using a black marker pen, draw a vertical line down the middle of the board. The white

surface is an ideal target to “pick-up” the red dot at distance, even in bright sunlight. Hold the end face of the target board down onto the ground, align the dot onto the black line and mark the position accordingly at appropriate intervals. **This has set 90 degree squaring.** If you had an aerial or top down view, you would see a perfectly set out “L” shape or corner without using a Set Square or 3/4/5 Triangle calculation.

User Tip

Please see page **27** for a more in depth guide to 90° Squaring.

USING THE LASER

Power On



- Press the ON/OFF button once and the FRE-203XT will power on and begin automatically self-levelling. This process takes around 15-20 seconds. When the levelling process is complete, the laser will start spinning at 600rpm, indicating a level datum.
- ***No other button needs to be pressed for the laser to self level.***

Power Off



- Press the OFF button once and the FRE-203XT will power off.
- If the Laser has been put into grade mode, scan or the rotational speed set at zero, switching off the laser and turning it back on again will automatically return the laser to the default fully self levelled state, running at 600rpm.

Rotational Speed Control - Tortoise/Hare



- Press the Rotational Speed Control button on the face of the laser or on the remote to cycle through the 5 rotational speeds.
- The rotational speeds are Zero (Stop Dot), 60rpm, 120rpm, 300rpm & 600rpm.
- For Indoor work, we suggest using slower speeds, where the laser beam is easier to see by eye; but for Outdoor Groundworks – run the FRE-203XT at its maximum speed of 600rpm; which gives the best working range when used with the supplied Laser Detector.
- The default rotational mode is 600rpm when the laser self levels after being turned on.

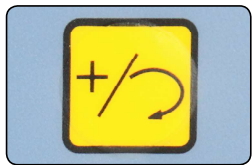
Scan Mode



- Press the Scan Mode button on the face of the laser or on the remote to cycle through the 5 scan modes. Each mode adjusts the angle of the beam.
- The scan modes allows the user to set a Stop Dot, 10°, 45°, 90°, 180° Line.
- The scan mode is typically only used indoors and enables the user to see the beam better in a specific position.
- ***The Detector cannot pickup the Laser beam when in scan mode.***
- Pressing the Rotational Speed Control button once will turn off scan mode and return the laser to rotating at 600rpm.

■ USING THE LASER (CONTINUED)

Increase Slope Angle & Move Stop Dot / Scan Line Right - Dual function button



- When the FRE-203XT is in Scan mode or set at 0rpm, the Rotate Stop Dot / Scan Line **Right** button can be pressed to rotate the position of the laser prism either clockwise.
- This is useful to position the stop dot or line on a specific point in the room.
- This button is also used to Increase Slope Angle in True Grade & Manual mode.

Decrease Slope Angle & Move Stop Dot / Scan Line Left - Dual function button



- When the FRE-203XT is in Scan mode or set at 0rpm, the Rotate Stop Dot / Scan Line **Left** button can be pressed to rotate the position of the laser prism counter clockwise.
- This is useful to position the stop dot or line on a specific point in the room.
- This button is also used to Decrease Slope Angle in True Grade & Manual mode.

Manual Override (Hand Symbol)



- Press and hold the **ON/OFF** button for **5** seconds until the “**Hand**” is shown on the display. When the hand is displayed the self levelling system will be turned off. The Laser will continue to rotate but the laser will no longer be outputting a level datum.
- This mode is typically enabled when the laser is being used to do **MANUAL** Gradients and Slopes (See X & Y Axis Selector on page 17) or when you want to manually adjust the squaring feature to align with an existing datum.
- Pressing and holding the **ON/OFF** button for **2** seconds until the “**hand**” is no longer shown on the display will turn the self levelling system back on. The Laser head will stop and adjust to a level datum and then begin rotating at 600rpm. The laser is now running in self levelling mode once more.

USING THE LASER (CONTINUED 2)

X & Y Axis Selector



In combination with:



- When the laser is in Manual Override mode, press the X & Y Axis Selector button and “X” will be shown on the display.
- Pressing either the Increase Slope Angle or Decrease Slope Angle button(s) will now adjust the position of the laser beam in the X axis only.
- To change to the Y axis, press the X & Y Axis Selector button again and “Y” will now be shown on the display.
- Pressing either the Increase Slope Angle or Decrease Slope Angle button(s) will now adjust the position of the laser beam in the Y axis only.
- If the laser is in “lay down” and you are doing 90 degree squaring, ensure the Axis selector is set on “X” and then use the **Plus** or **Minus** buttons to align the laser with an existing datum.

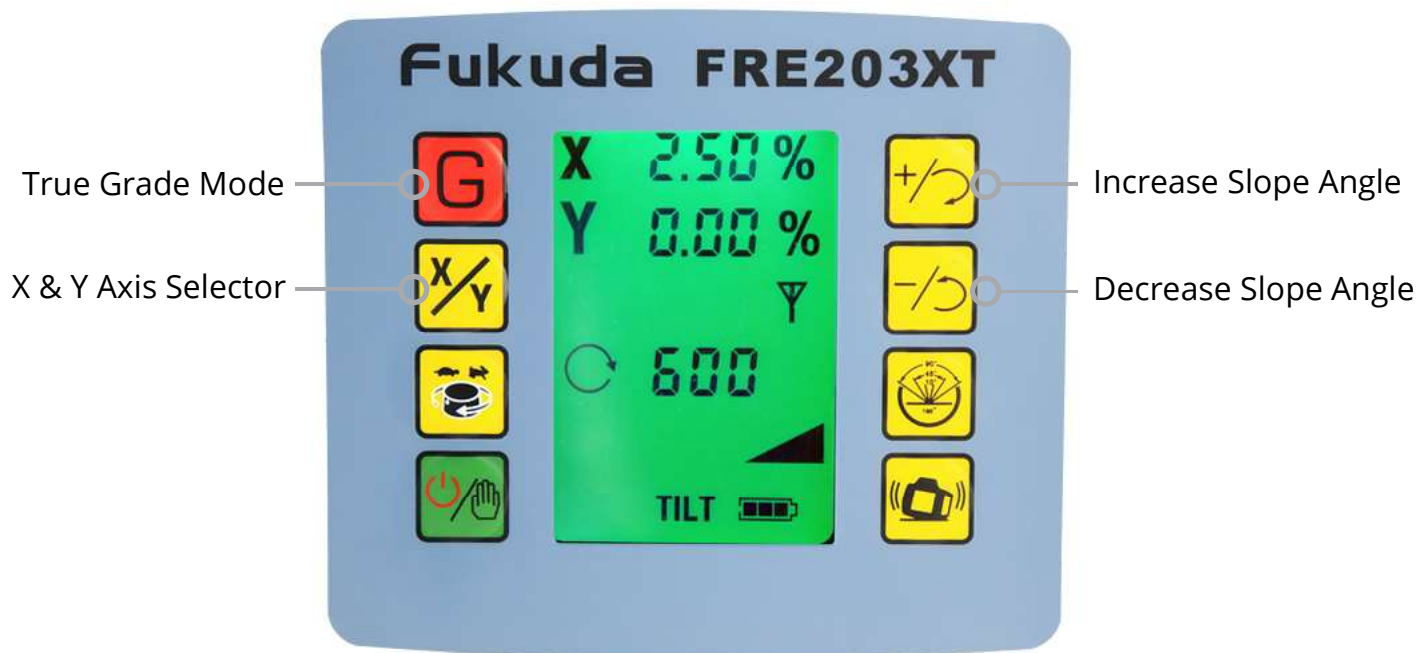
Automatic Drift System (ADS)



- If the FRE-203XT is running in self levelling mode, press the Automatic Drift System (ADS) button on the face of the laser to turn on the Automatic Drift System.
- Once activated “TILT” will be shown on the display. ADS is now ON.
- If for example, the FRE-203XT is knocked or caught by a gust of wind, the laser prism will stop rotating, the spirit level bubble icon will start flashing and a warning triangle will be displayed to show an alarm condition. There will also be an audible warning. Check that your datums have not altered and if all is ok; press the ADS button again & the laser will reset to AUTO level. You will then need to press ADS again to turn ADS back on. This function is used to alert users that the laser has been disturbed. If this mode has not been turned on and the laser is disturbed, it is possible that although a level datum will be continue to be produced it may be at a different height than before.
- ***The ADS function can be activated in TRUE grade mode but not when setting Manual grades or slopes.***

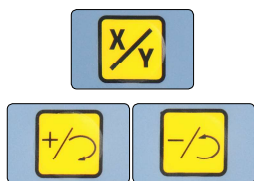
USING THE LASER (CONTINUED 3)

TRUE Grade Mode



- Press the red "G" button once and the FRE-203XT will enter "True Grade" mode.
- The X axis indicator will begin flashing to indicate it is ready for a % to be input into the X axis.

In combination with:



- Please see page **23** for the Gradient Conversion Chart.
- Using the keypad or remote control, press either the Increase / Decrease Slope Angle button until the desired % is displayed on screen.
- When complete, press the X & Y Axis Selector button once and repeat the process to enter a % in the Y axis. If you only want to enter a value in the X axis simply leave Y set at **0.00%**.
- To finally confirm the % entered in either the X, Y or both axis, press the X & Y Axis Selector button once more.
- The laser prism will then tilt to the correct angle and then begin rotating at 600rpm.
- To return to Auto level, the red "G" button once. The laser prism will stop rotating and will then adjust to true level. It will then automatically restart rotating, auto levelled.

■ USING THE LASER (CONTINUED 4)

True Grading

- The FRE-203XT is a TRUE DUAL GRADE laser level. This means that the laser can be switched to "Manual" (red "G" button to over-ride the level sensors) and then it is very easy for the User to set a slope (fall/grade) in the X axis only, Y axis only or both together.
- The maximum single slope range is +/- 10.00% ie. 1:10.
- For X & Y axis alignment, please see the markings on the TOP COVER of the laser.

Setting Single Axis Slope - Set a grade in the X axis

- This example sets a grade in the X axis.
- Press the ON/OFF button once and the FRE-203XT will power on and begin automatically self-levelling.
- Press the red **"G"** button on the Remote Control or laser's keypad & the **"X"** axis flashes on the screen. Using the + or - buttons, set the % gradient value required.
- The same buttons can be found on the Remote Control. Press the X/Y button TWICE. The laser will stop, adjust to this angle of slope, then rotate again.
- To return to Auto level, switch the laser OFF & ON again via the green button, to reset the % values to zero. The Laser will wait to find true level, then automatically restarts rotating, auto levelled.

Setting Y Axis Slope - Set a grade in the Y axis

- This example sets a grade in the Y axis.
- Press the ON/OFF button once and the FRE-203XT will power on and begin automatically self-levelling.
- Press the red **"G"** button on the Remote Control or laser's keypad & the **"X"** illuminates on the screen.
- Press the X/Y button ONCE only to scroll down to a flashing **"Y"**. Using the + or - buttons, set the % gradient value required.
- The same buttons can be found on the Remote Control. Press X/Y button ONCE again. The laser will stop, adjust to this angle of slope, then rotate again.
- To return to Auto level, switch the laser OFF & ON again via the green button, to reset the % values to zero. The Laser will wait to find true level, then automatically restarts rotating, auto levelled.

Setting Both X & Y Axis Slopes (Dual Grade)

- Proceed as above, but enter values for both X% & Y% (recommended 8% max.)

■ USING THE LASER (CONTINUED 5)

Manual Grading

Although the FRE-203XT is usually used in True Grade mode (where the user enters a specific gradient or slope as a %), there is also the option to operate the FRE-203XT in Manual grading mode. The procedure for manual grading is as follows:

Procedure

Mount the laser on a firm, generally level surface.

Observe the symbols on the green power button. Normal operation is a single press - for TRUE grade use. The "Hand" symbol denotes MANUAL grading.

On the laser's keypad, press and hold the green power "Hand" button for 3-5 secs. A "Hand" symbol is shown on the display & the laser rotates. To switch MANUAL operation OFF - a single press of the green button is required.

With the "Hand" symbol ON, press X/Y button once - "X" is shown on the display. (Also note the X & Y direction markings on the laser's top cover.)

Press either the + or - buttons to slope (grade) the spinning beam, manually, in the "X" axis.

Press the X/Y button again, if you require grading in the "Y" axis as well. The FRE-203XT can set single or dual grades, as required.

The maximum single slope that can be set is 1m fall over a distance of 10m.
i.e. 1 in 10 or 10%.

To revert back to normal operation, press the green button again. The "Hand" symbol switches off; the laser stops, auto levels then restarts rotating.

HOW TO SET SLOPES (FALLS/GRADES)

Working Example (when you know the % grade to set)

The following description in this guide, explains the general principles of setting a Slope (Fall/Grade), using the FRE-203XT, when you know the % grade to set.

Equipment

You will need the FRE-203XT laser level, the radio remote control, a surveying tripod, measuring staff (rod) with mm scale and a laser detector/receiver. It is not essential but having the remote control for the laser level is preferable.

Site Conditions

There are many different work site scenarios. As an example, we are assuming that you are outside, on a site with a clear field of view and planning to set drainage falls.

All above ground and below ground drainage pipes should be laid to an adequate gradient. The fall in a pipe is defined as the vertical height by which the pipe drops over a known distance, as an example a 2.5% gradient is a fall of 1m over 40m or 1:40. (1 in 40).

Typically, surface water or foul water drainage pipes are set between 1:40 to 1:80.

If a gradient is too steep i.e. steeper than 1 in 40, the liquid may run faster than the solids in a foul water pipe thus leaving the solids stranded, which could then block the pipe. Conversely, if a gradient is not steep enough (usually less than 1 in 110), then the pipe may still block, if the solids slow down and become stranded.

Procedure

Place the FRE-203XT horizontally on the surveying tripod, switch it ON and allow it to auto (self) level. The tripod height is unimportant.

Position your extended measuring staff on the ground next to the laser & clamp the detector to pick-up the red rotating beam with a continuous tone on the detector.

Setting a 1:40 gradient:

Note the axis direction of the gradient to be set, via the laser's top cover markings.

In this example, the Y axis in line with the laser's keypad is to face down the slope.

Press the red grade button, X axis flashes. Press X/Y Axis Selector button ONCE only so that the Y axis flashes. Using the + button input the 2.5% grade value. To fine adjust, use the + or - buttons.

Important: The Y grade value must show a PLUS value, to ensure the slope is set down from the front face of the laser.

Press X/Y button again. The laser will stop rotating, adjust to the 2.5% grade then restart. If the laser is switched off, this value is lost.

Keep the detector clamped in place on the measuring staff & by moving away from the laser, keeping a continuous tone on the detector, the ground can be cut away at the base of the staff, following the 2.5% grade (1:40 slope) set by the laser.

User Tip

Use the remote control for convenience and it also prevents disturbance to the laser.

Use the included "Gradient Conversion Chart" on page **23** to set other slopes.

HOW TO SET SLOPES (FALLS/GRADES)

Working Example (when you know the % grade to set) - Continued

Once this 1:40 fall is set, the User can use this inclined laser beam as a datum to set the depth of either the crown of the drainage pipe or the Invert level, anywhere in range of the laser – along that same axis.

Invert level of a pipe – is the level taken from the bottom of the inside of the pipe.

Crown of a pipe – is the Invert level plus the internal diameter of the pipe plus the pipe wall thickness. It may be necessary to use this in calculations when level measurements are taken from the crown of a pipe.

Manhole / Access Chambers:

A manhole or access chamber is required to gain access to a drainage system for un-blocking, cleaning, rodding or inspection. (Land drainage systems excluded). They can be manufactured in PVC, masonry or pre-cast concrete.

When setting appropriate drainage gradients, it is important to allow for the depth down to either the crown of the pipe (or the Invert level) from ground level, when using these manholes.

Dual Grading:

The FRE-203XT laser level with dual grading facility can be used for setting out driveways, car-parks or areas with slopes (falls) in BOTH the X & Y axis.

The same procedure is adopted as above for drainage runs, except a second step in the process is undertaken to set the laser to a fall in the other axis, to complete the dual grade setting-out.

Cut & Fill Machine control work:

If slopes of more than 10% (1:10) are required, which is outside the range of electronic adjustment of the rotary laser's prism; then simply switch the laser to Manual (HAND symbol) & fit a "Laser Grade Adapter" between the top face of the tripod & the base of the laser. Then set the required slope.

Search our website for more details.

GRADIENT CONVERSION CHART

Ratio to Percentage

Grade	%	Grade	%	Grade	%	Grade	%	Grade	%
1:10	= 10.000	1:50	= 2.000	1:90	= 1.112	1:250	= 0.400	1:750	= 0.134
1:11	= 9.090	1:51	= 1.960	1:91	= 1.098	1:255	= 0.392	1:775	= 0.130
1:12	= 8.334	1:52	= 1.924	1:92	= 1.086	1:260	= 0.384	1:800	= 0.126
1:13	= 7.692	1:53	= 1.886	1:93	= 1.076	1:265	= 0.378	1:825	= 0.122
1:14	= 7.142	1:54	= 1.852	1:94	= 1.064	1:270	= 0.370	1:850	= 0.118
1:15	= 6.668	1:55	= 1.818	1:95	= 1.052	1:275	= 0.364	1:875	= 0.114
1:16	= 6.250	1:56	= 1.786	1:96	= 1.042	1:280	= 0.358	1:900	= 0.112
1:17	= 5.882	1:57	= 1.754	1:97	= 1.030	1:285	= 0.350	1:925	= 0.108
1:18	= 5.556	1:58	= 1.724	1:98	= 1.020	1:290	= 0.344	1:950	= 0.106
1:19	= 5.264	1:59	= 1.694	1:99	= 1.010	1:295	= 0.338	1:975	= 0.102
1:20	= 5.000	1:60	= 1.666	1:100	= 1.000	1:300	= 0.334	1:1000	= 0.100
1:21	= 4.762	1:61	= 1.640	1:105	= 0.952	1:310	= 0.332		
1:22	= 4.546	1:62	= 1.612	1:110	= 0.910	1:320	= 0.312		
1:23	= 4.348	1:63	= 1.588	1:115	= 0.870	1:330	= 0.304		
1:24	= 4.166	1:64	= 1.562	1:120	= 0.834	1:340	= 0.294		
1:25	= 4.000	1:65	= 1.538	1:125	= 0.800	1:350	= 0.286		
1:26	= 3.846	1:66	= 1.516	1:130	= 0.770	1:360	= 0.278		
1:27	= 3.704	1:67	= 1.492	1:135	= 0.740	1:370	= 0.270		
1:28	= 3.572	1:68	= 1.470	1:140	= 0.714	1:380	= 0.264		
1:29	= 3.448	1:69	= 1.450	1:145	= 0.690	1:390	= 0.256		
1:30	= 3.334	1:70	= 1.428	1:150	= 0.666	1:400	= 0.250		
1:31	= 3.226	1:71	= 1.408	1:155	= 0.646	1:410	= 0.244		
1:32	= 3.126	1:72	= 1.388	1:160	= 0.626	1:420	= 0.238		
1:33	= 3.030	1:73	= 1.370	1:165	= 0.606	1:430	= 0.232		
1:34	= 2.942	1:74	= 1.352	1:170	= 0.588	1:440	= 0.228		
1:35	= 2.858	1:75	= 1.334	1:175	= 0.572	1:450	= 0.222		
1:36	= 2.778	1:76	= 1.316	1:180	= 0.556	1:460	= 0.218		
1:37	= 2.702	1:77	= 1.298	1:185	= 0.540	1:470	= 0.212		
1:38	= 2.632	1:78	= 1.282	1:190	= 0.526	1:480	= 0.208		
1:39	= 2.564	1:79	= 1.266	1:195	= 0.512	1:490	= 0.204		
1:40	= 2.500	1:80	= 1.250	1:200	= 0.500	1:500	= 0.200		
1:41	= 2.438	1:81	= 1.234	1:205	= 0.488	1:525	= 0.190		
1:42	= 2.380	1:82	= 1.220	1:210	= 0.476	1:550	= 0.182		
1:43	= 2.326	1:83	= 1.204	1:215	= 0.466	1:575	= 0.174		
1:44	= 2.272	1:84	= 1.190	1:220	= 0.454	1:600	= 0.166		
1:45	= 2.222	1:85	= 1.176	1:225	= 0.444	1:625	= 0.160		
1:46	= 2.174	1:86	= 1.162	1:230	= 0.434	1:650	= 0.154		
1:47	= 2.128	1:87	= 1.150	1:235	= 0.426	1:675	= 0.148		
1:48	= 2.084	1:88	= 1.136	1:240	= 0.416	1:700	= 0.142		
1:49	= 2.040	1:89	= 1.124	1:245	= 0.408	1:725	= 0.138		

Formula:

$\frac{\text{Distance in height}}{\text{Distance}} \times 100 = \text{Percentage Grade}$

Example: Find 1 in 19.5

$= \frac{1}{19.5} \times 100 = \mathbf{5.128\%}$

HOW TO SET SLOPES (FALLS/GRADES)

Working Example (when you do NOT know the % grade to set)

Use diagrams in conjunction with written example on page 25.

Diagram 1

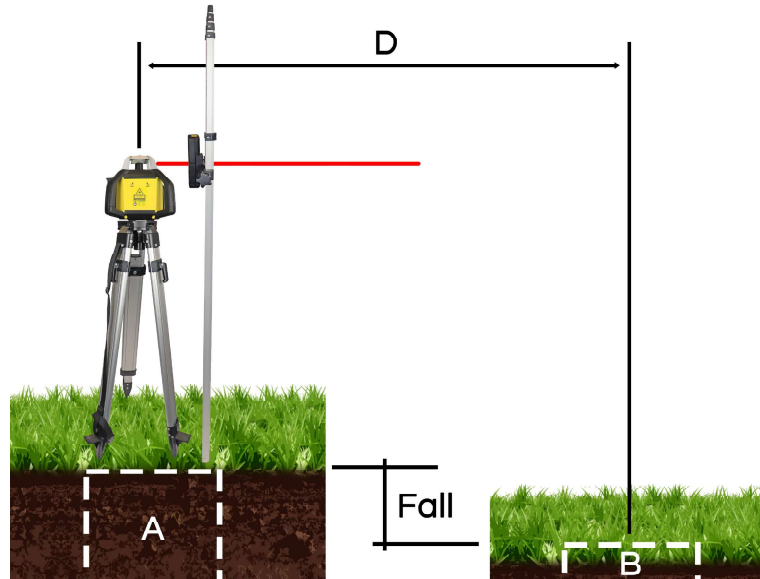


Diagram 2

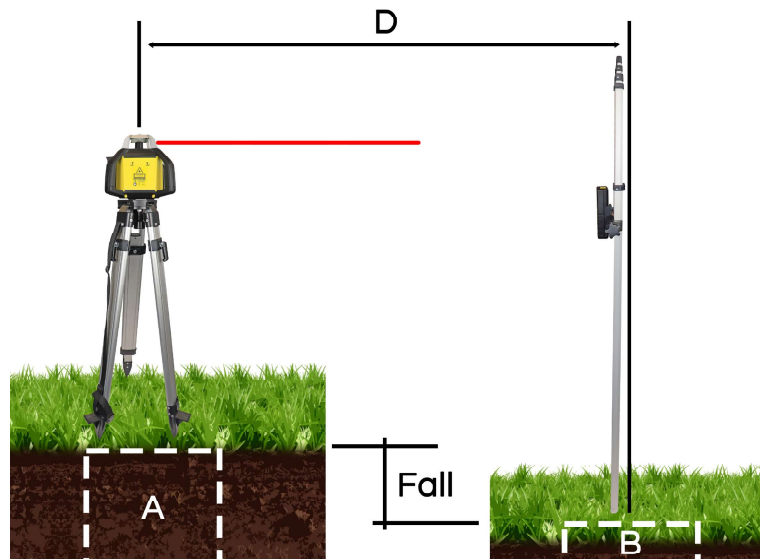
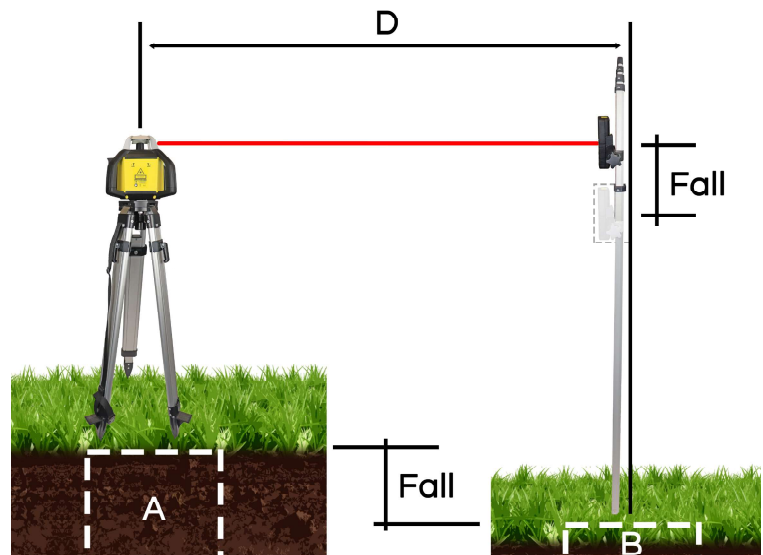


Diagram 3



HOW TO SET SLOPES (FALLS/GRADES)

Working Example (when you do NOT know the % grade to set)

The following description explains the general principles of setting a Slope (Fall/Grade), using the FRE-203XT, when you do NOT know the % grade to set.

Equipment

You will need the FRE-203XT laser level, the radio remote control, a surveying tripod, measuring staff (rod) with mm scale and a laser detector/receiver.

Site Conditions

There are many different work site scenarios. As an example, we are assuming that you are outside, on a site with a clear field of view and planning to set drainage falls.

See Diagram 1

A is a manhole cover with surveying tripod and attached FRE-203XT laser level.

B is a second manhole cover at a lower position, located the distance of "**D**" apart and by a fall of "**F**".

The planned sitework is to set a slope on the laser level to assist in digging a drainage channel to join A to B.

Procedure

First measure distance **D**.

Next, attach the FRE-203XT on the surveying tripod, switch it ON and allow it to auto (self) level.

The tripod height is unimportant. Face keypad (Y axis) towards cover **B**.

Position your extended measuring staff on the ground next to the laser & clamp the detector to pick-up the red rotating beam with a continuous tone on the detector.

Note & record the mm height from the measuring staff.

To determine & set fall F:

Before moving position from cover **A**, press the green HAND button on laser for 3-5 seconds to change the laser to Manual.

Do NOT un-clamp detector. Move position and place extended measuring staff over the centre of cover B, holding it vertically. (**See diagram 2**). Un-clamp detector and move it up the measuring staff to pick-up the laser beam with a continuous tone. (**See diagram 3**) Record the new height value. The site Fall is this value minus the value taken before at cover **A**.

Return the detector down to the lower position again & clamp tight. See diagram 2.

Using the remote control, press the X/Y **twice**. A "Y" axis symbol will show on the laser's keypad but not on the remote control. Instead, it shows that you are in Manual mode.

Hold the + button to move the laser beam down the measuring staff until a continuous tone is heard. **The laser is now set at the desired Fall.**

HOW TO SET SLOPES (FALLS/GRADES)

Working Example (when you do NOT know the % grade to set) - Continued

If the laser is switched off, this value is lost.

Keep the detector clamped in place on the measuring staff & by moving between covers A & B, keeping a continuous tone on the detector, the ground can be cut away at the base of the staff, following the grade set by the laser.

Obviously allowance must be made for the actual depth of the pipes' exit & entry positions in each manhole.

As an example, if distance "D" is 10m (10,000mm) & "F" is 125mm, from the formula shown at the bottom of the "Gradient Conversion Chart":

(Distance in height / distance) x 100 = Percentage Grade.

i.e. $125/10,000 \times 100 = 1.25\%$

From the chart on page 23, this is a 1:80 Grade (fall) used typically for a foul drain run.

HOW TO SET 90° SQUARING

Working Example

The following description in this guide, explains the general principles of setting-out 90 degree squaring when using the FRE-203XT. It speeds up the classic 3/4/5 triangle method, giving better accuracy and alignment over much longer distances.

Equipment

You will need the FRE-203XT laser level, the laser detector (receiver), a target plate and preferably a remote control. You do **not** need a tripod or staff.

Site Conditions

There are many different work site scenarios. As an example, we are assuming that you have laid a concrete pad or completed your strip foundations (footings) and are ready to set out in one corner, 90 degree (squaring) for brickwork, blocks or timber framing, over a datum *mark*.

Procedure

Place the FRE-203XT in “lay-down” over your corner datum *mark*, on the concrete surface & switch ON. Wait for it to auto (self) level, then press and **hold** the On/Off button for **5** seconds until the “**hand**” appears on the display. The self levelling mechanism will then have been turned off. As this procedure is using “alignment” rather than “levelling” it is more convenient to use the laser in its Manual mode.

Next, remove the bracket from your laser detector. Switch the detector ON and lay it on its SIDE over a distant mark along one side of the concrete slab or strip footing. The pick-up window must be facing the rotating beam of the laser level. Using the remote control, press X/Y button ONCE, then the MINUS or PLUS buttons to direct the spinning beam to receive a continuous audible tone on the detector. This has aligned the laser beam exactly on the distant mark. Next, observe the laser dot projecting from the rotating prism. This is now parallel with the concrete slab or footings along the other axis. Laser prisms are optically cut to split one laser beam - to accurately set 90 degrees. i.e. Rotating beam in one axis and laser dot in the other, setting squaring.

The laser dot **cannot** be picked up with your detector. You need a target plate.

Our recommendation is to use a small piece of around 300mm long white contriplus board, 6- 9 ins wide or similar. Using a black marker pen, draw a vertical line down the middle of the board. The white surface is an ideal target to “pick-up” the red dot at distance, even in bright sunlight. Hold the end face of the target board down onto the concrete footings, align the dot onto the black line and mark the concrete accordingly at appropriate intervals.

This has set 90 degree squaring.

User Tip

Do not mount the FRE-203XT in “lay-down” on a surveying tripod. It must be positioned directly onto the working surface. If mounted on a tripod, it can potentially introduce an error or inaccuracy to the 90 degree squaring procedure.

CHECKING THE CALIBRATION

Controlled Test

If you believe the FRE-203XT is not giving accurate datums (after ensuring you have completely ruled out refraction of the laser beam explained on page **29**), please carry out the following controlled test in your office, or another indoor location.

- Position the FRE-203XT laser on it's tripod in the **middle** of your office, garage, workshop etc... somewhere where you have space (10m or similar).
- Ensure there is no glazing or reflective surfaces in line of sight of the laser beam. This is to prevent the Refraction of the laser beam (See Refraction Issues section on page **29** for further details).
- Turn off all the lights and press the **ON/OFF** button once and the FRE-203XT will power on and begin automatically self-levelling horizontally.
- ***No other button needs to be pressed for the laser to self level.***
- This self levelling process takes around 15-20 seconds and then the prism will start spinning and will project a red beam 360 degrees around the room.
- With the laser level keypad facing your chest (towards you) walk to the left hand wall and mark the position of the laser beam on the wall.
- With the laser level keypad facing your chest (towards you) walk to the right hand wall and mark the position of the laser beam on the wall.
- Walk back to the laser and carefully twist the laser level round so the laser keypad now faces the left wall.
- ***Be extremely careful not to overly disturb the laser when twisting it round to the point the tripod position moves or is kicked.***
- The laser will momentarily stop and re-start when turned round. This is normal. The laser will then self level again and project a red beam 360 degrees around the room.
- Walk to the datum marks on both the left and right wall. You should see that the beam is hitting these marks.
- **If it is hitting the datum marks then the laser is operating correctly.**

If it's not hitting the datum mark's...

(and you have 100% ruled out Refraction and have not enabled Manual override)

Please contact the Service Department: **08000 869 769** who will be able to advise how to send it for repair / calibration.

REFRACTION ISSUES

Product types: All Rotary and Cross line laser levels

Although there will always be the 0.1% of products that develop a fault, 99.9% of the technical enquiries we receive relating to “incorrect levels”, “random positions”, “out-of-level” or “Detector not picking up the beam correctly” transpire to being Refraction of the laser beam.

Laser levelling equipment is used by many different industries in various work-site environments. Users should be aware of the possibility of refraction problems, when using this type of equipment.

“Refraction” is the phenomenon where light is transmitted but moves direction when it passes from one medium to another e.g. through air then glass or water. This is why a pond of water appears shallower than it actually is or when you shine a torch at a window and the beam bounces off to another position. In the same way, this refraction can affect the correct setting-out, when using laser beams.

An easy example to understand is if, for example, a rotary laser is operated with a double-glazed window behind it. The true level position can be refracted and the deviation can be appreciable, even over small distances. In some instances, a double beam position can occur and the wrong level marked.

Our advice is to be aware of this and take appropriate care when setting out with your laser level, **both** indoor & outdoors.

A simple *fix* (if the laser cannot be moved or lowered) is to position a simple brown cardboard cover over the laser level on the side towards the refraction surface.

The following surfaces can potentially be problematic:

All glazing - single, double or treble glazed units. Patio / Bi-fold glass doors etc.

Glazed office partitioning.

Vehicle or Site Plant - glass windows & windscreens. (Curved windows are the worst)

Panel van sides - wet surfaces.

Mirrors & mirrored surfaces.

Stainless steel, shiny aluminum panels & reflective Celotex panels

Water – fountains, water displays, rivers, dams and weirs etc.

In addition, please be aware of the effects of amber & green warning beacons on plant & equipment. This “strobe effect” is a known problem and can affect all types of laser detectors to give erratic readings.

Our main advice is just to be site-aware when using laser levelling equipment, to ensure the reliable and accurate setting-out of your jobs.

It's also important to understand that refraction of the beam, occurs with all lasers regardless of cost and or brand purchased.

■ TROUBLE SHOOTING

Error	Cause & Solution
Will Not Power On	<p><u>Check Batteries</u></p> <p>Often lasers are sent to Service Centres with the following User battery mistakes:</p> <p>Standard batteries that are dead / Rechargeable batteries that are flat and need charging and Polarity errors i.e. batteries of either type that have been fitted incorrectly. Always double-check. It's well worth trying another set of new batteries and do not mix different types nor mix old batteries with new. Sometimes even new sealed batteries are faulty, so always try two sets.</p> <p>Bare in mind that new lasers with rechargeable batteries will not have been fully charged. Follow the User Manual to give them a full charge, before assuming the laser is defective.</p>
Not Charging	<p><u>Incorrect Charger</u></p> <p>It's common for Service Centres to receive lasers in for repair with either no charger or the wrong charger. Using a non-original charger can cause serious damage to the batteries, internal charge circuit or the laser itself. We always recommend contacting us to purchase the correct OEM charger, if yours has been mislaid. Do not risk buying an often cheaper equivalent to find it causes problems. Its false economy.</p> <p>Ensure that all users are aware of which batteries are fitted so that in error, a charger is not plugged into a laser level fitted with standard batteries, which could cause serious damage.</p>
Random Or Incorrect Levels	<p><u>Site Refraction</u></p> <p>Not every user is aware that laser levels, both Rotary and Line lasers can be affected by reflective surfaces on the work site. Customers report to the Service Centre that the detector (laser receiver) is faulty because it is picking up the laser beam in random positions. 99.9% of the time this is due to site Refraction. It's too easy to conclude the laser is faulty rather than understanding what site conditions can cause this phenomenon. However, it is very easy to eliminate the problem by making sure that laser beam reflections cannot be bounced back to the detector. As an example, if your site has large glass windows (Bi-fold doors / UPVC Windows) make sure you set-up the laser level so that when you hold the detector, the glass is behind you and the detector, so it cannot reflect on to it. Basically look out for & position your laser, being aware of all reflective surfaces like glass and shiny wet surfaces. It is also important to understand that the laser has a range of 500m diameter and spins 360 degrees. As such the refraction can be being caused by something outside the boundaries of your location.</p>

■ TROUBLE SHOOTING (CONTINUED)

Error	Cause & Solution
Laser Will Not Self-Level	<p><u>Outside Levelling Range Or Impact Damage</u></p> <p>If the FRE-203XT is positioned outside of it's self levelling range of ± 5 degrees the rotating laser prism will tilt over to one side (to try and locate a level position) and then time-out.</p> <p>Re-position the FRE-203XT so that is is within ± 5 degrees of level and try again.</p> <p>If it's within ± 5 degrees of level and the prism remains tilted over to one side, turn the laser OFF and On again and try again. If the laser will still not self level, it may have received an impact which has affected the self levelling system.</p> <p>Please contact the Service Department: 08000 869 769 who will be able to how to send it for repair.</p>
Laser Not Holding It's Charge	<p><u>Battery Issue</u></p> <p>Check the battery pack. The battery pack may require charging or need to be replaced due to age and/or a high number of charging cycles.</p> <p>Check the battery compartment for signs of damage and ensure that the compartment is clean and that the battery terminals are not corroded.</p>
Detector Not Detecting The Laser Beam	<p><u>Multiple Causes</u></p> <p>Check the batteries in the detector. They may be low and need replacing.</p> <p>Check the FRE-203XT is spinning and producing a visible red beam. You will be able to see the beam on your hands when placed in front of the protective lighthouse.</p> <p>Check the line of sight and ensure there is no obstructions.</p> <p>Check that the laser level and detector are within the operating range. If you are too close to the laser it may not pickup the beam. You need to be at least 3m away.</p> <p>Check that the protective lighthouse glass is clean and free of dust and dirt at all times.</p>
Laser Will Not Power Off	<p><u>Poor Storage Conditions</u></p> <p>If the FRE-203XT will not turn OFF, it is typically due to poor storage (stored away wet, stored in a cold unheated building or vehicle) etc. which has caused internal condensation to build up and affect the main circuit board.</p> <p>Safely dry the Laser and accessories out thoroughly and try again. If this does not resolve the issue, please contact the Service Department: 08000 869 769 who will be able to advise how to sending it for repair.</p>

CARE & MAINTENANCE

Protecting The FRE-203XT Kit

- The Fukuda FRE-203XT is precision levelling equipment and should be treated as such. Always handle with care and transport within the carry case provided.
- Always turn the laser level off when transporting or moving around the job site.
- Ensure the laser & accessories are clean and dry before storing in the case.
- If wet, dry well before storing and store the case and contents at room temperature. Failure to do so may void warranty.
- ***NEVER store the Fukuda FRE-203XT Kit in a van, car or an unheated location (workshop / shed / garage / lockup etc.) overnight. The Fukuda FRE-203XT Kit is designed to work in cold and wet conditions but it's the storage of the product when not in use that is critical. Keeping it in a secure heated building increases the usable life of the product and reduces the possibility of theft.***
- When the laser level is not in use or is being stored long term, it is highly recommended to remove the battery pack from the base of the laser as well as the batteries in the remote control and detector.
- Ensure the protective lighthouse glass is clean and free of dust and dirt at all times.
- Only use the supplied charger with the laser. The 5.6 Volt UK Plug, 900mA charger (Input 100-240V AC 50/60Hz. Output DC 5.6V 900mA, centre pin + polarity) is for indoor use only. If the charger becomes damaged, stop using immediately and purchase a replacement. ***Never use a generic charger with this laser.***
- Always check the accuracy of the laser level before precision levelling is attempted. Failure to do so may result in inaccurate levels. See page **28** for further details.
- If the FRE-203XT has received a heavy impact or has been dropped, please ensure the calibration is checked.
- There are no user serviceable parts inside the FRE-203XT. Warranty void if tampered.

MAGNETIC MACHINE DETECTORS

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