System 1200 Newsletter – No. 44
Advanced TPS Robotics

INTRODUCTION

Robotic TPS1200 instruments are equipped with a number of digital imaging and instrument positioning devices to allow the total station instrument to autonomously recognise, identify, lock-on, track and measure a prism.

This newsletter specifically focuses (excuse the pun) on the TPS1200 ATR and LOCK functionality and also gives tips as to how to configure the ATR and LOCK functionality in order to get the best performance from a TPS1200 under a wide range of conditions.

But first, a recap on the basics of the **ATR** and **LOCK** functionality.

The **TPS1200 ATR** (**Automatic Target Recognition**) functionality searches for a prism and precisely position the crosshairs of the telescope. Remember that the crosshairs may not, and do not need to be exactly positioned on the centre of the prism – this does not matter. The ATR measures the deviation between the centre of the prism and the crosshairs to display the correct angles in the measurement screen - this speeds up the overall measurement process.

A typical application for the ATR is monitoring where the use of the ATR saves the surveyor time by accurately and automatically measuring to the centre of prisms.

For more information on ATR, read the System1200 newsletter 02_2004 and the TPS1100 newsletter 06_2002.

The **TPS1200 LOCK** functionality uses continuously determined ATR deviations to steer the telescope onto the centre of a moving prism. In addition, various prediction and positional algorithms allows the TPS1200 to follow the prism behind trees or automatically search for the prism after longer interruptions of sight.

Together with the RH1200 radio handle and RX1220 controller the TPS1200 LOCK functionality is widely used for one-man total station survey tasks.

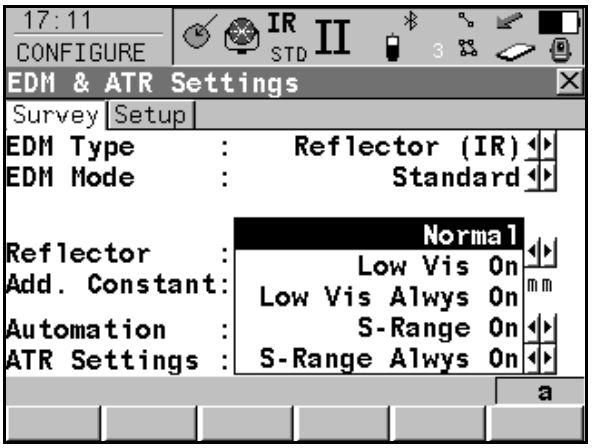
CONFIGURING THE TPS1200 ATR

The ATR must work reliably not only in bright sunshine but also when visibility is low, such as in rain or fog – and the conditions could always be changing. Many objects in a typical survey situation could look like a prism to the ATR. The picture below gives an example of how the ATR "sees" the world - would you have spotted the prism (shown by the red arrow)?

The ATR relies on advanced image processing algorithms that allow it to distinguish the light spot which represents the true prism from all the other light spots. Other light spots may be caused by a variety of things, such as sunlight reflections, car headlights, reflective items, etc.

Making the detection of the correct spot equally robust for all possible measurement conditions is a very difficult challenge - actually impossible. Optimising the image processing for one set of specific conditions may make matters worse for other conditions. There is no optimal "one-fits-all" solution.

With the introduction of TPS1200 version 4.00 onboard software, the ATR functionality can therefore be configured to fit the current survey conditions using the **ATR Settings** options in the **CONFIGURE ATR & EDM Settings** panel.



The **Low Vis** and **S-Range** (short range) modes can be activated temporarily or permanently. Temporarily means that once the instrument is

turned off and on again, the **ATR Setting** is changed back to the **Normal** mode whereas permanently means that even after the instrument is turned off and on again the **ATR Settings** is retained.

But what do these 2 modes do and when should they be used?

ATR Low Vis mode

The **ATR Low Vis** mode increases the performance of the ATR in unfavourable weather conditions such as fog, drizzle or rain – where it may be difficult for even the user to see the prism!

The ATR icon changes to show the **Low Vis** mode is activated.

ATR S-Range Mode

Up to a distance of approximately 50m and under very specific conditions and rare circumstances, the highly reflective material used on safety jackets (such as high-visibility jackets used on site or by the police) may appear similar to the spot characteristics of a distant prism.

By using the **S-Range** mode the ATR can easily distinguish between the reflective jacket and the true prism and therefore increases the "robustness" of the ATR.

Once working beyond the range of (approximately) 50 meters it is no longer needed to use the **S-Range** mode.

The ATR icon changes to show the **Low Vis** mode is activated.

It may also be useful to use the **S-Range** mode when working in one-man mode (with the **TPS1200 LOCK** mode activated) in areas with a high number of light reflections - this is described later…

TIP!

If you wish to quickly toggle between the **S-Range** mode and **Normal** mode or to quickly toggle between the **Low Vis** mode and **Normal** mode then configure a hot-key or the USER menu with the appropriate hot-key / USER menu option.

Reducing the Field of View

Under some conditions it may be an advantage to reduce the active **ATR Field of View**.

Normally, the ATR Field of View is equivalent to the telescopic field of view of 1°30' but it is possible to reduce the Field of View to one third of the normal Field of View to 30'.

This can be useful in situations when multiple prisms are located within limited horizontal or vertical spacing - such as in tunnels or working within narrow alignments – the additional unwanted prisms are less likely to fall into the field of view.

The limited Field of View can only be configured using GeoCOM commands (the Leica protocol for communicating with TPS1200 instruments).

Configuring TPS1200 LOCK

As already mentioned, another benefit of the **ATR S-Range** mode is the significantly increased performance of the **LOCK** functionality when working in areas with a high number of foreign light reflections such as sunspots from cars or reflections from vehicle number plates which may be encountered in areas of heavy traffic.

Depending on the actual conditions, using the **ATR S-Range** mode will provide an improved LOCK performance within the typical working area for street surveys with a range of up to 150-200 meters.

Note, to achieve the specified maximum ranges for both **ATR** and **LOCK** functionality, it is necessary to switch from **S-Range** mode back to the **Normal** mode.

Configuring TPS1200 Automation

Increased productivity is not only achieved with faster measurements – productivity can also be increased by minimising the "non-productive" time - the robotic functionality within TPS1200 includes a number of features designed to reduce "non-productive" time.

All the functionality described below can be configured in the **CONFIGURE Automatic Prism Search** panel.

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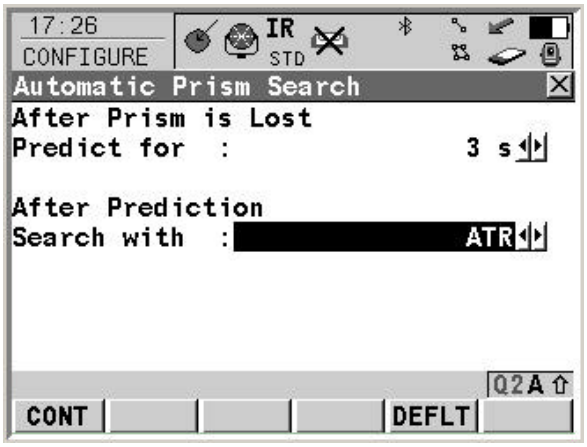

PREDICTION

During short interruptions of the line of sight (such as trees, traffic signs, cars, light poles) the TPS1200 LOCK functionality extrapolates (or predicts) the future movement of the prism based on the recent "history" of the prism path up until when the prism was "lost".

The time as to how long the instrument should predict the location of the prism can be configured using the **After Prism is Lost Predict For** setting in the **CONFIGURE Automatic Prism Search** panel.

Choose a shorter prediction time (say 1 second) when short interruptions will be common - such as passing behind trees - or a longer prediction time (say 5 seconds) for longer interruptions - such as when working in heavy traffic areas.

When the prism is lost and the prediction algorithms are being used then the **Prediction** icon is shown 

If a prism comes into the Field of View of the ATR during the prediction time then this prism is automatically locked.

If a prism does not come into the Field of View of the ATR during the prediction time then a search routine will start to find the prism.

SEARCH OPTIONS AFTER PREDICTION

In most cases the unmatched speed and reliability of PowerSearch make it the best choice for an automatic search after prediction. However, in special situations the user may prefer to use a different search option.

The **After Prediction Search with** setting in the **CONFIGURE Automatic Prism Search** panel allows TPS1200 users the flexibility to choose which search routine should be used after the prediction - the different searches are described below.

SEARCH WITH "NO SEARCH"

If the option **No Search** is chosen for the **After Prediction Search with** setting then once the prediction time has ended then the telescope movement stops and the ATR activates a mode called **ReLock** – indicated by this icon. 

Any prisms entering the Field of View of the ATR when in **ReLock** mode are automatically locked.

This search setting can be useful when surveying close to heavy traffic and the tangential movement of the prism is relatively small.

In such a situation where a high number of vehicles are constantly interrupting the line of sight but the prism has not significantly moved to the "left or right" of the instrument then the prism will always reappear in the Field of View of the ATR and will automatically be locked.

If the prism is not in the Field of View of the ATR then the easiest way to quickly find the prism again is to activate PowerSearch with a single keystroke using a hot key.

SEARCH WITH "ATR"

If the option **Search With ATR** is chosen for the **After Prediction Search with** setting then once the prediction time has ended then an ATR search is started – indicated by this icon. 

The size of the ATR is search is limited to a dynamic ATR window. A dynamic ATR window means that the size of the ATR window is automatically adapted to the "size" of the prism path which was computed during the prediction.

Using a dynamic ATR window means the ATR search covers the minimum possible area of the potential prism location - which will normally minimise the time to find the prism.

This search setting can sometimes be useful when it is likely the lost prism will be close to the Field of View – it is also very useful on instruments not fitted with PowerSearch!

SEARCH WITH POWERSEARCH

Probably the best known and most frequently used search routine is the option **Search With PS** - once the prediction time has ended then a PowerSearch is started – 

indicated by this icon.

Independent of the prediction time and the movement of the prism during the interruption then PowerSearch will search for the prism within a "window" of +/- 45° from the last known position using the full PowerSearch fan of +/-18° in the vertical plane.

But what many users do not know is that if the distance to the prism is known before the prediction period started then this "window" is also limited in depth – a 3D search box is used instead of the 2D search area. Using a search box means the likelihood of finding the "lost" prism is even more reliable - especially in environments with multiple prisms.

Remember also that if you are working in narrow environments then instead of using the automatic PowerSearch area / box described above then define a manual PowerSearch limit in the **CONFIGURE Search Windows** panel. This manually defined search window will then always be used for all PowerSearches – both after prediction and for manually activated searches.

REMEMBER

TPS1200 total station automation functions are optimally designed for one-man surveying work and to keep the reflector pole light and clean – no batteries, no cables and no hassles.

Ensure to configure your instrument for the environment and conditions in which you are working – maybe use different configuration sets to save making changes to individual settings.

Please contact your local Leica representative if there are specific topics you would like covered in these newsletters.

We welcome all suggestions for TPS1200, GPS1200, specific applications or LGO. We look forward to receive your ideas.