3D Documentation

Architecture

Publisher: FARO Europe GmbH & Co.KG, Lingwiesenstrasse 11/2,
D-70825 Korntal-Münchingen, Tel: +49 7150 9797-0, Fax: +49 7150 9797-44,
info@faroeurope.com, www.faro.com
Concept design: Proesler Kommunikation, Shella van Putten, Alberto Castiglioni
Editors: Proesler Kommunikation
Graphics and layout: Vanessa Sevil Kizilelma, Lisa Hummel, Melissa Wagner

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Introduction

The optimum tool for renovations and quality assurance

Complete and accurate 3D building models are an essential working basis for architects and planners. The FARO Laser Scanner Focus^{3D} offers valuable support as it quickly and reliably captures actual data for building projects – both existing and new builds.

A few minutes is all it takes to set up and attach the FARO Focus^{3D} to a tripod. Its laser beam scans the surrounding area in three dimensions, capturing spatial and surface shapes to the nearest millimetre, however complex they are. Digital data is made available quickly and in a great level of detail, and can be imported into all CAD software solutions popular in the construction and real estate industries. This data serves as the basis for 2D and 3D plans and views, for visualisations and for working with building information modelling (BIM).

The FARO Focus^{3D} is ideally suited to laying this groundwork with utmost precision. For example, the data can be used to help with building-related planning and checks during construction, can support quality assurance measures and form the basis for optimum calls for tender regarding subsequent works. This significantly lessens the high liability risk that exists during construction work on existing buildings in particular.

Thanks to its usability and performance, the FARO Laser Scanner Focus^{3D} is known as one of the best laser scanners. This brochure is designed to give a concise overview of its potential applications and particular advantages.

Documentation

Areas of use for the FARO Focus3D

Accurate measuring for building renovations: The FARO Focus3D guarantees highly accurate, complete, fast and thus cost-saving measuring of buildings. Working with existing buildings where there are no current plans allows the unit to exploit its full potential. It captures around one million points per second and generates dense point clouds in just a few minutes, which can be converted via CAD software into intensely detailed 3D plans of the current environment. Building activities can be planned in an exact spatial CAD model.

Quality assurance: The FARO Laser Scanner Focus3D documents excavation pits, shells and buildings in three dimensions to quickly and comprehensively map the project status. Data can then easily be compared against CAD plan data. The device thus supports quality of execution during construction and simplifies the final inspection. Precise execution is immensely important in particular for complex, free-form components, for formwork elements in concrete structures, in positioning structurally sensitive supports and in steel structures.

Documenting damage to buildings and establishing legal certainty: In addition to technical or legal documentation, the FARO Focus3Doffers seamless monitoring of construction progress. It is also ideal for documenting damage to buildings, such as after a component failure or soil movement. It accurately captures spatial data and generates 3D photo documentation at the same time. This makes it easier to compile comprehensive evidence and to calculate the value of the damage, whilst offering high legal certainty for principals, subcontractors and property owners.

Surveying historic buildings: Plans are rarely still available for historic buildings. With the FARO Focus3D , accurately measuring the typically irregular or distorted building fabric on-site is quick and easy. Laser scanning is also ideal for documenting or reconstructing design and construction details. For example, if a project to protect a work of historical significance runs over a longer period, with several building phases, then it is enough to measure the object once.

Communication and visualisation

Areas of use for the FARO Focus3D

Designing and visualising interior spaces: The laser scanner lets you quickly and completely measure even complex interior spaces. Based on the results, you can visualise planned building activities, design variants, alternative use concepts or interior designs, such as for shops. Visualisations in the form of renderings, animations or views from various perspectives are no problem for this laser scanner.

Secure imports to CAD systems: FARO SCENE scan software merges scans almost fully automatically. Once point clouds have been prepared in SCENE, the 3D data can be imported into popular CAD systems, such as Autodesk Revit, AutoCAD Architecture or Bentley MicroStation. Scan data can be translated into orthophotos and imported into all other CAD systems as 2D images.

Sharing data: FARO SCENE WebShare and SCENE WebShare Cloud solutions make scan project data available on a web server. All project partners can access the data either via their default browser or in the cloud. Measurements within the scans can also be carried out online at any time.

Support for BIM: When working with building information modelling (BIM), you need exact spatial data regarding the actual status of a building. The FARO Focus3D helps you document complex structures accurately and at low cost. Data can be directly imported into BIM software, such as Autodesk Revit Architecture, or via a suitable interface into Archicad and Vectorworks.

Easy to use

Thanks to its intuitive control concept with touchscreen display, the FARO Focus^{3D} is as easy to use as a digital camera.

Accurately measuring foundation excavations

More reliable planning and costing

Excavating material from building pits and accurately calculating volumes and masses on the construction site is always rife with uncertainty. Common measurement methods utilise two-dimensional images and can only approximate the actual volumes since they often capture excavations at single points at best. In larger building projects, however, slight bumps and barely perceptible rises in the ground affect the quantity of earth to be moved by quite a few cubic metres, which can easily lead to a significant rise in costs.

The FARO Focus^{3D} offers a precise and convenient method of calculating the actual volume. This lightweight unit is quick to set up on-site and captures the situation with high precision both before and after excavations. Contrary to conventional measurement methods, the scanner always delivers an exact 3D image showing the current status. If the key coordinates, as defined during planning, as well as the pit depth to be excavated are input, then it is possible to accurately calculate the expected volume in advance. Corresponding calculator programmes can be used to easily determine the exact mass of earth moved. The result is a high level of planning and cost reliability.

On average, a 360° scan using the FARO Laser Scanner Focus^{3D} takes between 2 and 15 minutes. The individual scans identified for a project can be automatically merged using the scan processing software SCENE. The data can then be imported into popular CAD software solutions and processed further.

Advantages

- Reliable measuring with a range of up to 330 metres
- Optimum functionality in full sunlight
- Fast capture with a 360-degree radius
- Three-dimensional, photo-realistic images

High cost efficiency

Small and compact: this device lets you capture actual data quickly and accurately. Offering a massive range of functions, the FARO Focus^{3D} delivers maximum value for money – no other 3D laser scanner is as affordable.

Accurately surveying complex buildings

Solid basis for renovations

Outdated building documentation made renovation work on the former Reichsbahngebäude [German State Railway Building] in Augsburg much more of a challenge. Built in the late 1930s, today it serves as the District Administration Office. The remodelling work was extensive and included renovating the roof, installing an air conditioning system and re-designing the conference room. The building also needed a new fire protection concept and new emergency exit routes.

Because the existing plans were of such poor quality, the building had to be completely re-measured. It was a massive undertaking, covering a gross floor space of around 35,000 square metres spread across five floors and three basement levels, with around 100 offices on each of the upper floors. Not only that, but it was necessary to document the multi-branch, multi-level underground protection routes and tunnels, plus a number of outdoor facilities and the building's façade. Planners accomplished this Herculean task with the help of the FARO Focus^{3D}.

Areas captured included recesses for radiators, windows and doors along with their opening direction, floor coverings and built-in elements. Importing the individual scan data was fast and automated thanks to SCENE scanner software. After an easy, direct import into the RealWorks software solution, the 3D point clouds were customised and modelled. Engineers imported the resulting data into the planning software Nemetscheck-Allplan, and then generated exact 2D floor plans, cross-sections and views as a basis for the ongoing and future building activities.

The principal now possesses a three-dimensional copy of the current building data, which has been thoroughly prepared and is now available for building information modelling or facility management.

Advantages

- Fast documentation of interior and exterior spaces
- High reliability with complex building structures
- Delivery of accurate actual data
- Easy import into CAD programs

Visualising different usage concepts

High flexibility for planners

Survey data for the Steinlein Hall in Berlin was fully captured via FARO Focus^{3D} as part of renovation and revitalisation efforts. In order to clarify the hall's future use, the project developer needed both the dimensions and a visualisation of the building.

Given its size, measuring the Steinlein Hall would take many individual scans. Seven individual colour scans, captured in just three hours, were sufficient to fully survey the interior space. As a special bonus, integrated sensors in the FARO Laser Scanner Focus^{3D} assign an orientation to the data during the scanning process. This is achieved with an electronic compass inside the unit. When documenting multiple storeys, the height sensor makes it easier to position individual scans within the model as a whole. Through this software, the individual scans were quickly and pretty much automatically translated into a complete, digital, overarching spatial model of the building.

The scan processing software provided the architect with dimensions for distances and areas, as well as views from various perspectives inside and outside the building. The three-dimensional point cloud for the hall was imported directly into CAD planning software for the next steps in the process. In addition to the spatial model there were also 360° colour panoramas in photo quality. These allowed for detailed visual and geometric analyses.

Data was uploaded online using the WebShare software so that, for example, specialist planners could access the building data and project information using their default web browser. Potential tenants and investors had access to a photo-realistic view of the building, giving them a tour-like experience of the building and its potential uses. Measurements could even be taken directly in the scans – as optimum support for planners and marketers.

Advantages

- Full capture of complex structures
- Fast rendering of different views
- Visualisation of various use concepts
- Photo-realistic images

Outstanding speed

High precision and speed make the FARO Focus^{3D} far superior to measurements taken by hand. Sources of error are mitigated early on, which improves planning and construction quality and also saves money.

Optimum preparation for roof renovations

Support for accurate project planning

Despite several refurbishment attempts, the ageing flat roof of an apartment block in Hanover could not be made permanently watertight. The residents' association therefore decided to replace it with a low-maintenance pitched roof. This was a challenging task for the architects as the numerous roof penetrations and the complex building geometry called for precise preparation of the construction work. 50 irregularly distributed chimneys, vents and skylights had to be taken into consideration during project planning and then accurately positioned in the new roof structure. In addition, the six angled sub-segments of the 120-metre-long residential building made planning the new pitched roof more difficult. This meant the architects needed incredibly precise measurements of the existing building as a basis for accurate project planning.

The service provider took just two hours to accurately capture the entire roof with a FARO Laser Scanner Focus^{3D}. After positioning markers, eleven individual scans were also carried out at ten-metre intervals. After thorough analysis, the finished measurements were passed on to the architects. As a result, the architects received all the necessary sections for project planning alongside an accurate, true-to-deformation, true-to-scale 2D floor plan. Subsequent random samples were more than sufficient for the on-site measurement checks. The FARO Focus^{3D} thus delivered significant advantages in terms of quality and efficiency of the planning process. The carpenter was even able to prepare the replacements and support points entirely on the basis of the scan data.

Upon completion of the project planning, to save costs the old supported cold roof was built over with a cantilever plank truss construction. The residents' association will also be pleased about the low maintenance costs of the new roof: in future this will be limited to cleaning the gutters.

Advantages

- Fast digitalisation of complex structures
- Accurate documentation of the current status
- Easy creation of 2D and 3D models
- Solid foundation for project planning

Accurately capturing historic buildings

Precision when identifying building damage

Clearly visible cracks had begun to form in the masonry at the front of the San Michele Arcangelo church in the centre of Borgo di Terzo, near Bergamo. They pointed to significant damage to the building, which was erected in 1735, and first required accurate surveying.

Exact measurements are enormously important, especially in structural interventions. They form the foundation for structural analysis using the finite element method (FEM). 3D laser scanning is ideally suited to this accurate method of recording existing conditions. Spatial data that can be used for structural analysis with standard software solutions is quickly and easily available. The Engineering Department at the University of Bergamo deployed the FARO Laser Scanner as a basis for the impending structural optimisation. The building interior space was documented in the space of a single day. A graphical approach was chosen to filter and interpolate the scanning data for the detailed investigations before the renovation. This enabled the use of normal architectural procedures for the building analysis. These procedures included, for example, the systematic investigation of crack patterns in the masonry or a comparison of the actual geometry of a vault deformed under its own weight against its ideal geometry.

Experts were eventually able to discover the reason for the observed damage thanks to the 3D documentation: the timber roof framework had settled as a result of earlier restoration. Both a tie anchor and upper spines resting on the vault were affected. This led to severe damage to the underlying masonry.

First, the current load distribution in the vault was evaluated and distribution following the planned restoration was checked, using FEM analysis. It clearly showed that both the arched buttress supports and the corresponding anchors needed renovating. As soon as reinforcement measures had been incorporated into the FEM model of existing conditions, there were clear and significant improvements in the entire structural condition.

Advantages

- Delivery of accurate actual data
- Accurate analysis of building damage
- Fast delivery of reliable planning data
- Long-term archive for survey data

Major mobility

Weighing just 5.2 kilograms and measuring 24 x 20 x 10 cm, with a range of up to 130 m or 330 m, integrated GPS receiver and the option to work in full sunlight – the FARO Focus^{3D} is the ideal tool for mobile working on construction sites. The unit is completely autonomous: no need for extra equipment, cables or a laptop.

BIM – a simple tool for complex situations

Reliable basis for faultless operations

Building information modelling (BIM) can be used to link, improve the quality of, and even speed up building and operational processes. One key prerequisite is that operations-relevant building data be continuously updated, for example, for rebuild and renovation projects. BIM delivers a digital model that supports continuous updating, storage and exchange of building data.

BIM uses either a 3D-based new build plan or three-dimensional documentation of the existing building. If there is no three-dimensional planning data available, or if the data has to be adapted or updated due to changes in the building, then high-performance 3D laser scanners such as the FARO Focus^{3D} can be hugely valuable.

Among those that have benefited from this approach: the operators of the Derek Crothall Building on the Hull Campus at Lincoln University. This 1960s edifice comprises two blocks with curtain walls connected to a concrete service tower. The left-hand block overhangs the entrance. A BIM model was required for an upcoming larger-scale renovation project and included three elements: a model built according to the cadastral map and reference points, topographical measurements of the building surroundings, and documentation of all of its supply lines.

It took around 400 scans to document the entire building. With the resulting point cloud in hand, the modelling team was able to reproduce an exact BIM model in Revit. Unlike manual laser measuring equipment or reflectorless stations, the FARO Focus^{3D} convinces with its precision, time savings and the simplicity of imports into Revit.

Advantages

- Easy measuring of interior and exterior areas
- Enormous range for large spaces
- Fast provision of digital survey data
- Easy integration with CAD programs

Good to know

- Scan data is easily imported into various popular CAD programmes.
- Images can be realised in 2D or 3D at any time.
- Operators only need around 2 to 3 days' training in how to use the FARO Focus^{3D}.

Seamless data integration with …

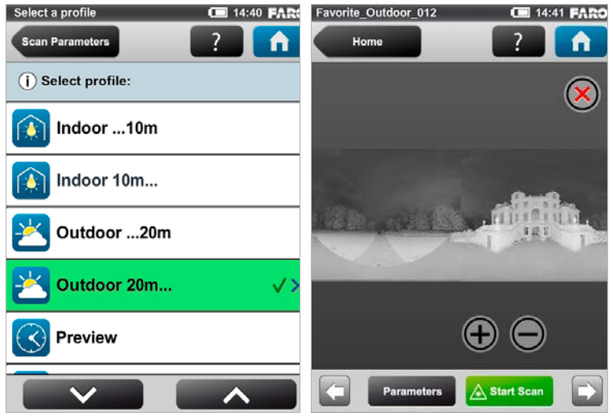
AutoCAD Architecture, Autodesk REVIT, Bentley MicroStation, Nemetschek Allplan, ArchiCAD, Rhino, AutoCAD Civil 3D, PolyWorks Surveyor, Carlson, MicroSurvey, JRC 3D Reconstructor, ATS RR Tunnel, Amberg TMS, AVEVA PDMS, Intergraph PDS, AutoCAD Plant 3D and many more.

FARO Laser Scanner Focus^{3D}

Five steps of 3D documentation

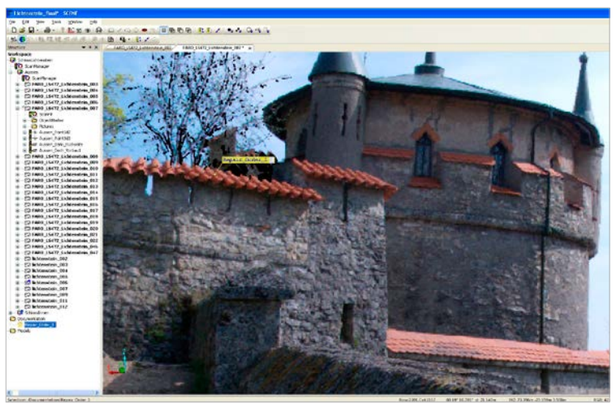
1. Setup

After only two minutes setup time, the FARO Focus^{3D} is ready to scan: It can be easily and quickly mounted on a tripod – just like a normal camera. No external devices such as laptops or batteries are required. Before the first scan is started, all scan positions need to be defined for complete digital capture of surfaces and structures.



2. Recording data

The project can be created in advance on the PC in the office and the individual settings pre-defined. Alternatively both can be carried out directly on the FARO Focus^{3D} with its easy-to-use touchscreen. The FARO Focus^{3D} is well- known for its short measuring times: it takes between two and fifteen minutes for a 360-degree scan, depending on the required resolution, depth of detail, colour or black-and-white scan.

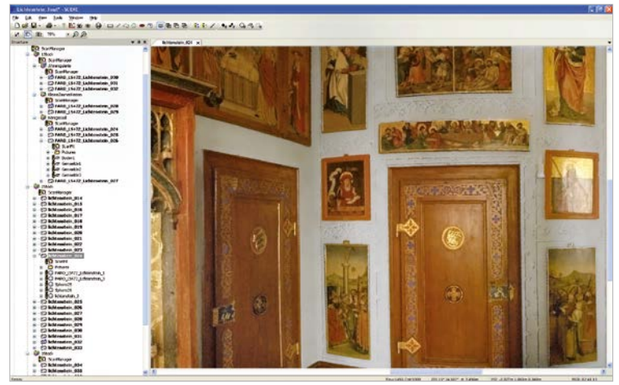


3. Data analysis in SCENE

The individual scans of a project can be combined almost automatically with the help of the SCENE software. In SCENE it is also possible to remove any irrelevant scan information and reduce the data volume. The compass integrated in the FARO Focus^{3D}, the GPS, the altitude sensor and the dual-axis compensator greatly reduce manual post-processing.

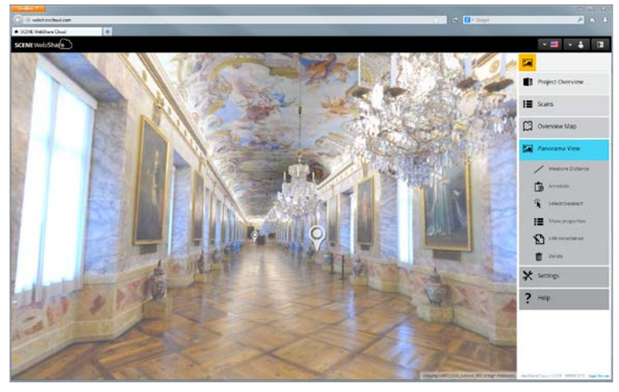
4. Wide-ranging applications

The SCENE software enables the scan data to be transferred to all commonly available CAD software solutions for the design and the construction of plants and facilities. The scan data is thus available for 2D applications and 3D visualisations of all kinds.



5. Global collaboration

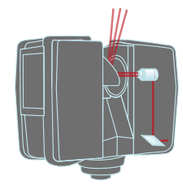
With SCENE WebShare Cloud, laser scans and additional information such as CAD drawings, photographs or floor plans can quickly be shared via the internet with the push of a button. That makes collaboration with others involved in the project much easier. WebShare Cloud access is carried out via a standard internet browser. Direct measurements can also be done there. In this way all the project partners can work on data simultaneously, which significantly speeds up the processes.



Measuring method

Distance

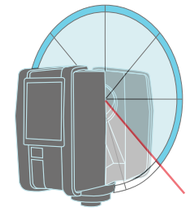
The laser scanner transmits a laser beam, which is reflected by an object back to the scanner. The distance is measured with millimetre precision by means of the phase difference between the transmitted and received beams.



Vertical angle

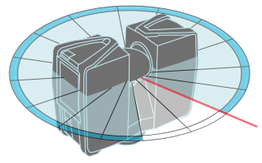
The mirror directs the laser beam through the space in a vertical direction.

The angle is recorded at the same time as the distance measurement.



Horizontal angle

The laser scanner turns horizontally through 360° while scanning. The horizontal angle is recorded at the same time as the distance measurement.



Defining the 3D coordinates

Distance, vertical angle and horizontal angle result in polar coordinate (d, α, β), which are converted into cartesian coordinates (x, y, z).

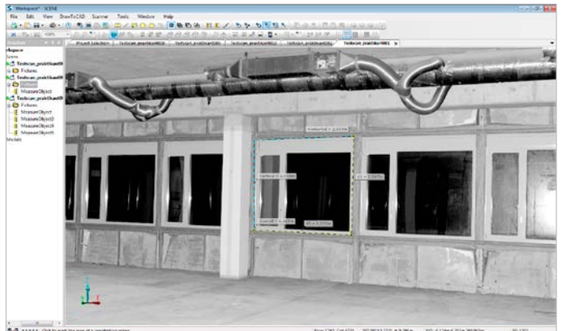
Product information

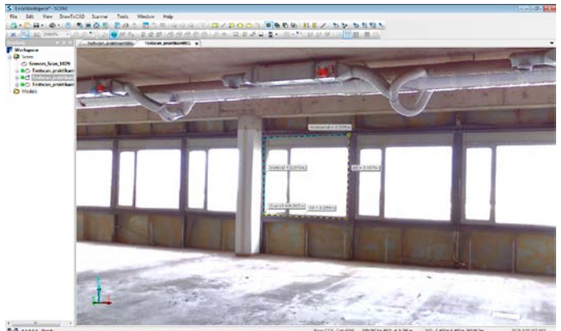
FARO Laser Scanner Focus^{3D} X 330 and Focus^{3D} X 130

- Range: Focus^{3D} X 330: 0.6m – 330m; Focus^{3D} X 130: 0.6 – 130m
- Size: 24 x 20 x 10cm;
- Weight: 5.2kg
- Scan duration, standard scan: b/w: approx. 2min, colour: approx. 5min
- Systematic distance error: ± 2mm
- Can be operated without any external devices
- Intuitive touchscreen
- Integrated colour camera with automatic, parallax-free colour overlay for photo-realistic 3D colour scans
- High-performance lithium-ion battery for recordings up to 5 hours; charging while in operation possible
- SD-card for easy and secure data transfer to the PC
- GPS, integrated compass, altitude sensor and dual-axis compensator simplify the combination of scans
- Seamless integration into AutoCAD Architecture, Autodesk REVIT, Bentley MicroStation, Nemetschek Allplan, ArchiCAD, Rhino, AutoCAD Civil 3D, PolyWorks Surveyor, Carlson, MicroSurvey, JRC 3D Reconstructor, ATS RR Tunnel, Amberg TMS, AVEVA PDMS, Intergraph PDS, AutoCAD Plant 3D and many others applications.

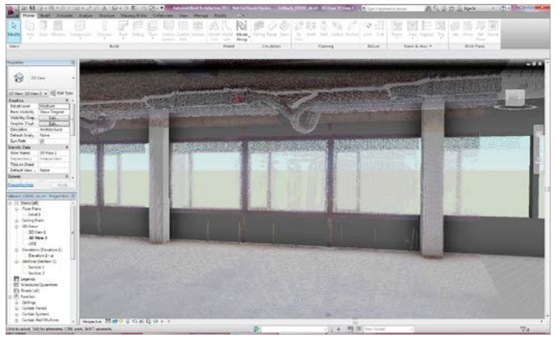
SCENE to CAD

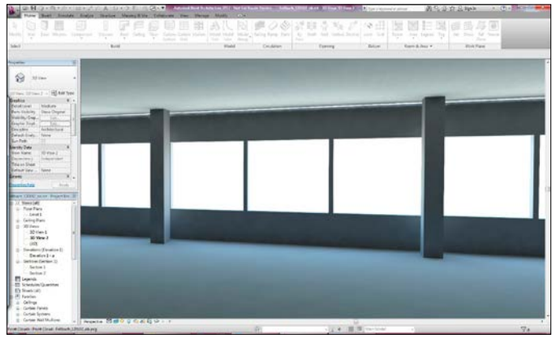
From the production of a point cloud to the CAD model





The individual scans of a project can be automatically combined in the SCENE software. The recorded scenery can be viewed in three dimensions in SCENE and measurements can be taken with simple tools directly in the scan data. All the scans are also available in colour and as high-contrast intensity images. In SCENE it is also possible to remove any irrelevant scan information and reduce the data volume.





After the scan data has been prepared in SCENE, it can be transferred with no difficulty to a large number of commonly available CAD systems (such as Autodesk Revit, AutoCAD Architecture and Bentley MicroStation). There the scan data can be immediately used to produce plans of existing buildings or for the planning of conversions and extensions.

3D Documentation

Architecture

GLOBAL HEADQUARTERS
FARO Technologies Inc.
250 Technology Park
Lake Mary, FL 32746
USA
info@faro.com

www.faro.com

EUROPEAN HEADQUARTERS
FARO EUROPE GmbH & Co. KG
Lingwiesenstr. 11/2
D-70825 Korntal-Münchingen
Germany
T: +49 7150 97 97 0
F: +49 7150 97 97 44
info@faroeurope.com

DISTRIBUTION (EMEA)
FARO Swiss Holding GmbH
Wiesengasse 20
CH-8222 Beringen
Switzerland
distribution@faroeurope.com
www.faro.com/distributors
Tel: +49 7150 9797 400

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