

Technical specification – Stationary 3D measuring machine *kolibri 1500*

Brief description of measuring system

kolibri 1500 is a robust fully-automated 3D digitizer for measuring large and heavy components that works on the basis of digital self-calibrating fringe projection. Two cameras capture different structured light patterns. With the help of triangulation, similar to the human stereo vision, the exact 3D coordinates can be calculated for each single camera point. The patented use of additional stationary cameras enables a complete highly accurate surface digitizing without reference markers (that have to be fixed on object's surface), matching procedures, or a special object positioning.

A special *MULTIview-technology* enables a self-calibrating measurement process where the absolute position and setting of cameras and projector is not relevant. The system is therefore inured to changes of environmental conditions (thermal fluctuations). Precise engineering mechanics is not necessary.

The highly accurate 3D data of the measuring objects can be used for the following applications:

- Global 3D deviation to CAD data
- Section based analysis and 2D/3D dimensioning
- Geometrical dimensioning and tolerancing (GD&T)
- Wall thickness inspection
- Reverse engineering

The 3D digitizers are used mainly for first-article, low-batch or serial inspection of cast and forged components, quality control of tools, CAD/CAE-applications as well for reverse engineering in rapid prototyping and digital mock-up.



Figure 1: Optical 3D measuring machine *kolibri 1500*

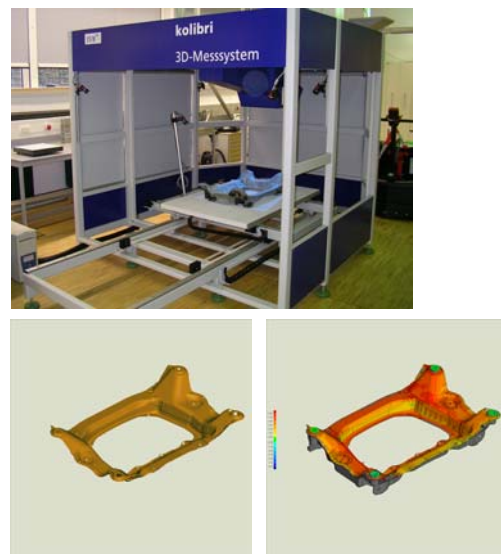
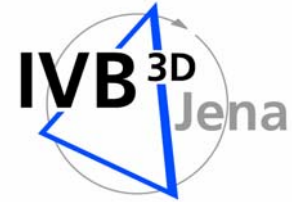


Figure 2: Measuring of automotive steel frames



The *kolibri 1500* works with pre-installed measuring schedules that enable a high reproducibility of the measuring results. The user can select the number of the required projector positions, the x-y-steps and the number of cameras. Dependent on the selected measuring program the complete measurement time is between 2 and 40 minutes. The pre-installed measuring schedules cover a broad range of measuring tasks. The user interface is easy to use and requires only a couple of steps to begin the measurement process.

The final measuring result is highly-defined 3D point cloud of the object's surface. The point cloud can be triangulated and post-processed with standard 3D-evaluation software for quality inspection, reverse engineering, geometrical dimensioning and tolerancing etc. *kolibri* systems work well with software solutions from the company GEOMAGIC Inc.

The application fields of the 3D measuring system are mainly in quality inspection, reverse engineering and rapid prototyping:

Quality inspection*	Reverse engineering**
<ul style="list-style-type: none"> • Generation of geometric models (STL data) by triangulation 	
<ul style="list-style-type: none"> • Colour indicated comparison between CAD model and as-built part • Align models using the method of choice – datums, 3-2-1, reference point systems best fit • Geometrical dimensioning and tolerancing • Gap & flush, edge comparison • Wall thickness inspection • Industry specific solutions, e.g. turbines, automotive industry • Automated creation of inspection reports • Easy data transfer per ASCII, Excel, CSV etc. 	<ul style="list-style-type: none"> • Creating of water tight models for rapid prototyping and digital manufacturing • Automated conversion of complex polygon models to precise NURBS-Models for CAD-, CAM- and CAE-systems • Model editing capabilities include creation of tunnels and holes • Smoothing of surfaces and boundary edges, offsets and shell surfaces in preparation for digital manufacturing • Industry specific solutions, e.g. aerospace, automotive industry, dental industry, medicine, art and archaeology

* requires e.g. 3D-evaluation software Geomagic Qualify

** requires e.g. 3D-evaluation software Geomagic Studio

The measuring principles and system are patented by the Fraunhofer Gesellschaft. IVB as development partner of the Fraunhofer Institute for Applied Optics and Precision Engineering in Jena develops, manufactures and distributes the measuring machines.

System components

The system equipment consists of the following components:

Rotating sensor unit	<ul style="list-style-type: none"> Rotating sensor unit for projection of fringe pattern from different directions Sensor head consists of digital DMD projector to produce fringe patterns and two cameras with adequate objectives
Cameras	<ul style="list-style-type: none"> 4 - 8 stationary cameras, fixed on measurement rack or object stage
Rack	<ul style="list-style-type: none"> Robust measurement rack with covers
Movable x-y-stage	<ul style="list-style-type: none"> Object stage, movable in y-x-direction The measurement field size of the projector is approx. Ø 440 mm. To enable measurements of larger components the object stage will be moved under the sensor unit for a further measurement cycle (step) The particular measurements are automatically mapped into one coordinate system by a stationary (step) camera
Soft- und Hardware	<ul style="list-style-type: none"> PC for system control (4 engines, control of the projector and 6-10 cameras) Scanner-Software under Windows XP 19 " monitor, keyboard, mouse
Artefacts	<ul style="list-style-type: none"> Certified dumbbell with sphere distance of L = 200mm Certified plane 400mm x 400mm

The measuring system will be provided according to the following technical dates and performance parameters.

Installing conditions

Required space	5.0 x 4.0 m ² (L x W)
Dimensions	3.5 x 2.4 x 2.2 m ³ (L x W x H)
System weight	1,200 kg
Electricity	115-230V, 16A, 50Hz
Positioning place	Oscillations/ vibrations of the building or the air can affect the functionality of the system. The customer is responsible to quantify these affects and in case to install an oscillation isolation
Temperature	15.... 25°C

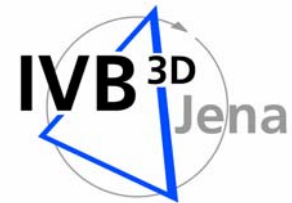
Measuring field size

Dimensions of object stage	1.500 mm x 1.000 mm
Single measuring volume of sensor unit	Ø 440 mm, height 250 mm
Max. measuring volume with x-y-translation	1.500 mm x 1.000 mm x 50-300mm (L x W x H)

Special object clamping systems are not part of the offer.

Requirements for the measuring object

Surface structure of the measuring object	Non-transparent or non-diffusely reflecting surface
Maximum weight of measuring object	600 kg



Measurement period up to the 3D record

Automatic data record until generation of 3D point cloud	2-40 min, depends on the dimensions of the object, the complexity of the object surface and the required measuring accuracy
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Measuring accuracy

Regarding to fringe-projection measuring systems one has to distinguish between the terms resolution and measuring accuracy. The fringe-projection of *kolibri 1500* projects a continuous metrics in the space. A single camera pixel is thereby up to 40 times more precise than its size on the measuring object. The resolution – means the distance of two camera pixels on the measuring object – is defined by the number of camera pixels and the observed measuring field. Is the resolution to low small details cannot be fixed (see also appendix 2 for classification „smallest feature“).

The measuring accuracy is nearly the same in all 3 space directions.

Point distance	0.3 - 0.4 mm
Accuracy (sphere-spacing-error)	$\Delta L \pm 25 - 50 \mu\text{m}$
Noise	$\sigma = 20 \mu\text{m}$

System computer

Processor	\geq Pentium 4 dual core 3,0 GHz
RAM	4 GB
Hard disc	\geq 160 GB
Operating system	Windows XP
Graphics card	Dual-head
Screen	19" flatscreen
Rack	19" industry rack

The PC is a component of the measuring system. It may not look like an "office computer", foreign software and changes of basic windows settings can lead to functional failures. We recommend using a separate PC for data evaluation, office applications and the integration in a company network.

Cameras

Resolution (cameras of the sensor unit)	SXGA – 1,392 x 1,040
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