Technical Description

Status: April 16th, 2007

1 Machine FORMIGA P 100

The machine is mounted on a solid frame construction. All required units are integrated into a single housing. The process chambers are secured by interlock.
Requirements of laser safety class 1 are met. For exhaustion of vapours a suction nozzle is provided. The system carries the CE designation.

1.1 Basis data

- Dimensions FORMIGA P 100 (incl. powder container and display) (w x d x h)	1320 mm x 1067 mm x 2204 mm
- Transport dimensions (excl. powder container and display) (w x d x h)	1320 mm x 988 mm x 1950 mm
- Weight	approx. 600 kg
- Operation temperature range	20 – 25 °C
- Electric mains requirements Europe (3-phase system with neutral conductor)	400 V +6 %/-10 % at 50/60 Hz; CEE 5-pole
- Main fuses Europe	3 x 16 A
- Electric mains requirements USA (3-phase system with neutral conductor)	208 V ±10 % at 50/60 Hz; Connection to external main switch
- Main fuses USA	min. 3 x 25 A, max. 3 x 40 A
- Electric mains requirements Japan (3-phase system without neutral conductor)	200 V ±10 % at 50/60 Hz; RST-Net
- Main fuses Japan	min. 3 x 25 A; max. 3 x 35 A
- Average power consumption at manufacturing process	approx. 6 kW
- Diameter of suction nozzle	100 mm
- Exhaust flow rate	20 m³/h

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

- Required floor space	see installation requirements
- Compressed air consumption	approx. 20 m³/h at 7 bar
- Standard pressure	7 bar
- Minimum pressure	6 bar
- Maximum pressure	10 bar
- Compressed air temperature	max. 10 °C above ambient air temperature

Quality of compressed air in accordance with DIN ISO 8573:

- Solids	Class 1 (particle size ≤ 0.1 µm, Particle density ≤ 0.1mg/m³)
- Water content	Class 4 (compressed air saturation point ≤ 3 °C)
- Oil content	Class 1 (oil concentration ≤ 0.01 mg/m³)

1.2 Exposure unit

- CO_2 laser	30 W
- Wave length of laser	10.6 µm
- Laser radiation power at time of delivery (nominal power)	min. 30 W
- Minimum radiation power within warranty period (12 months)	28 W

Laser beam scanning (Scanner)

High-speed rotating mirror scanning system uses precision galvanometer scanners with temperature compensation, integrated servo- and interface electronics, digital data transfer from the systems control computer and digital signal processing.

- Exposed area	200 x 250 mm
- Scanning speed	up to 5 m/s
- Positioning accuracy of laser beam	± 0.05 mm

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

Laser beam with divergence optics and flat-field lenses

- Diameter of focused beam	< 0.5 mm
- Divergence ratio	3.5:1
- Focal length of flat-field lenses	440 mm
- Aperture of the scanners	20 mm

1.3 Recoating unit

Radial recoating system for the generation of a new powder layer and fed by a powder supply container. An overflow container is not required for FORMIGA P 100 as no excess material occurs.

- Minimum layer thickness	0.05 mm
- Layer thickness variation	0.01 mm

Supply container (2 units)

- Capacity of container	about 15 litres each

1.4 Heating

The building process heaters are operated separately for the upper process chamber and the lower unloading chamber. Both heater loops separately are controlled and observed.

- Area heating	2.4 kW

1.5 Nitrogen generator NG-3H (integrated protective gas generator with cooling system)

The protective nitrogen generator separates compressed air into nitrogen and oxygen. Nitrogen is used for cooling the optics and as a protective gas for the process. Oxygen is allowed to flow into the ambient in order to prevent high nitrogen concentrations from becoming hazardous for the operating personal.

- Total air consumption (Vn)	ca. 10 m³/h
- Purity of N_2	> 99 %

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

- N_2 output rate (Vn) at purity of 99 % < 1.5 m³ at 6 bar

1.6 Vertical displacement device of working platform over precision spindle drive

The vertical displacement of the working platform is required for the continuous building process. By lowering the working platform the construction of three-dimensional parts becomes possible.

The precision spindle is required herewith for the value to be kept exactly, which corresponds at the same time to the particular layer thickness of the parts to be constructed.

- Vertical repetition accuracy over a 300 mm distance ± 0.05 mm

1.7 Exchangeable frame system

The exchangeable frame serves as a frame during the building process. The exchangeable frame system contains two exchangeable frames with an integrated building platform. In using two containers in exchange, the non-productive times of the system are minimised.

- Exchangeable frame (2 units)
- Built height available 330 mm

1.8 Machine operation

The laser-sintering system FORMIGA P 100 has an integrated operating unit with touch-screen. The ergonomic user interface enables the adjusting of the machine parameters, the preparation of the building process and the selection of the jobs.

1.9 Standard accessories

Accessories for cleaning, gloves for heat protection, tools for removal of parts.

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

2 Materials

2.1 PrimePart

- Very fine functional polyamide for design models with high detail resolution and smooth surfaces
- For load-bearing functional prototypes with durable flexible features
- For creating master patterns to be used in vacuum casting and for fast production of design prototypes
- Excellent long-term behaviour for use as end products or spare parts in small series
- Parts made of PrimePart withstand high-temperature painting and metal coating
- Parts made of PrimePart are biocompatible according to ISO 10993-1
- PrimePart is in compliance with the EU Plastics Directive 2002/72/EC for the use with food at contact conditions up to 24 hours at 20 °C (exception: high alcoholic foodstuff).
- PrimePart requires a lower refresh rate, which results in a reduction of powder consumption by up to 40 % compared with precision polyamide PA 2200, while other material properties remain unchanged.

For detailed descriptions please see material data and safety data sheets.

2.2 Precision polyamide PA 2200

- Very fine functional polyamide for design models with high detail resolution and smooth surfaces
- For load-bearing functional prototypes with durable flexible features
- For creating master patterns to be used in vacuum casting and for fast production of design prototypes
- Excellent long-term behaviour for use as end products or spare parts in small series
- Parts made of PA 2200 withstand high-temperature painting and metal coating
- Parts made of PA 2200 are biocompatible according to ISO 10993-1
- PA 2200 is in compliance with the EU Plastics Directive 2002/72/EC for the use with food at contact conditions up to 24 hours at 20 °C (exception: high alcoholic foodstuff).

For detailed descriptions please see material data and safety data sheets.

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

2.3 Precision polyamide PA 3200 GF

- Glass-filled fine polyamide for design models with high detail resolution and excellent surface quality
- For load-bearing functional prototypes with excellent strength and stiffness
- For creating master patterns to be used for vacuum casting and thermally heavily used parts
- Excellent long-term constant behaviour for use as end products or spare parts in small series
- Parts made of PA 3200 GF withstand high-temperature painting and metal coating

For detailed descriptions please see material data and safety data sheets.

2.4 Fire retardant PA 2210 FR

- Typical application of PA 2210 FR is the manufacture of flame resistant parts with high mechanical properties.
- PA 2210 FR contains a chemical flame retardant. In case of fire a carbonating coating arises at the surface of the part, isolating the plastic below. PA 2210 FR is free of halogens.
- Excellent long-term constant behaviour for use as end products or spare parts

For detailed descriptions please see material data and safety data sheets.

2.5 Alumide

- Aluminium-filled polyamide 12-powder for the production of models constructions, tool inserts for small series, end products and spare parts
- Parts built in Alumide distinguish themselves by their well-balanced ratio of density and rigidity as well as by their outstanding optic surface quality and dimensional accuracy
- The metallic-looking parts can be finished by grinding, polishing or coating. Due to the good machining properties of the material, parts can be finished by milling, drilling or turning

For detailed descriptions please see material data and safety data sheets.

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

2.6 PrimeCast 101

- For producing sacrificial patterns and master patterns for plaster investment casting and vacuum casting with excellent dimensional accuracy, very high surface quality, good strength and exceptional finishing properties
- Patterns offer smooth surfaces which can easily be polished to mirror-like surface after resin infiltration
- PrimeCast 101 has a minimum ash residue content

For detailed descriptions please see material data and safety data sheets.

2.7 CarbonMide

- Carbon fibre filled Polyamide PA 12
- CarbonMide has outstanding mechanical properties characterised by extreme stiffness and strength
- Typical applications are fully functional prototypes with high end finish for wind tunnel tests or other aerodynamic applications
- Due to an orientation of the fibres during recoating the mechanical properties vary in the three different axis directions

For detailed descriptions please see material data and safety data sheets.

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

3 Data preparation

Pre-processing of CAD data is necessary to create the SLI data which are required for the laser-sintering process. The main requirement is the conversion of three-dimensional (3D) structures into a sequence of two-dimensional (2D) layers called "slices". Further requirements depend on the individual process chain from CAD design to the sintering process and may contain the needs of repairing, cutting or scaling of 3D structures.

Initial format for generation of the 'slices' is always the STL format, that approximates the part geometry by a net of triangles. Several software packages are capable to convert data of e.g. IGES, VDA-FS, STEP, CATIA, PRO/E or other formats into the STL format.

An PC is required for this data pre-processing. The equipment should meet the following requirements:

- Processor	> 2 GHz, min. Pentium IV (or similar) recommended
- RAM	512 MB (> 1024 MB recommended)
- Graphic board	> 128 MB recommended, open-GL
- Network interface	RJ45/100BaseTX
- Network protocol	TCP/IP
- Operating system	Windows 2000 or XP
- Disk-drives	CD-ROM
- Monitor	17" (1024x768 true colour)

For additional demands e.g. on processor performance or RAM, especially with simultaneous use of external data processing software, please refer to the corresponding supplier documents.

Various software packages are available for data preparation on a PC, as described below.

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

3.1 EOS Desktop-PSW - die **FORMIGA process control software**

The EOS Desktop-PSW is an integral component of the system. This is the process control software, which imports the EOS specific SLI-format layer data, allows the positioning within the available build volume as well as the assignment of exposure parameters. The software calculates the exposures to be performed and sends these as a packet to the machine.

The EOS Desktop-PSW provides optimized exposure strategies as well as a high level of detail resolution. The software requires a PC running on Windows 2000 or XP (see table hardware advises of chapter 3 'Data preparation').

A single seat licence is part of the delivery.

3.2 EOS RP-Tools - the EOS software for generating and manipulating layer data

EOS RP-Tools is a software package which allows part data in STL format or in CLI format to be converted into the EOS-specific SLI format required for the subsequent building process. Layer data of solid bodies can be separated into skin and core data to facilitate process optimisation.

The EOS RP-Tools consists of the modules:

- SLIVIEW: graphical user interface for visualising layer data
- SLICER: generates two-dimensional layer data out of three-dimensional STL data
- SLIFIX: automatic repair of the most common data errors in layer data such as overlaps, double contours and inverted polygon-orientation
- SKINCORE: separates massive part data into one data set for a definable Skin and a Core on a two-dimensional basis. Note: with PSW V3.3 this functionality is also included in the PSW.
- SLICONV: automatic data conversion from CLI to EOS SLI and vice versa (either ASCII or binary)

Data input format	STL, CLI (ASCII or binary), EOS SLI
Data output format	EOS SLI, CLI (ASCII or binary)

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

3.3 Materialise Magics RP

Magics RP is a software package for data pre-processing based on STL data. It is available for all current Windows operating systems and covers the needs of data pre-processing for the FORMIGA P 100 systems:

- Visualisation of parts in STL format
- Process compatible placement of parts
- Repairing and editing functions
- Quality assurance of STL files
- Import of IGES, VDA, CATIA and various other data using additional modules
- Part assembly and quality control after building using additional Rapid Fit module in combination with hardware assembling kit

3.4 EOSPACE

The EOSPACE software automatically performs a positioning of all parts to be built in a way that the build envelope is used to its full extend and at the same time the build height of the job is minimised. The placement is based on the real part surfaces, so parts can be nested into each other. However, a minimum space between the parts can be chosen and is guaranteed in order to assure process stability and part quality. By this, full use is made out of the system's productivity.

This product is integrated within Materialise Magics RP and requires the most recent version of Magics (minimum V9.05). Further agreements to ensure the compatibility for future versions of Magics have to be concluded directly with Materialise.

3.5 Software recommendations

The following software is recommended to run a FORMIGA P 100 System:

- Materialise Magics RP licensed version
- Magics module EOSPACE
- Magics maintenance to ensure compatibility for future versions of Magics

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

4 IPCM options

4.1 Unpacking and processing station FORMIGA P 100 (UAP P1)

In the unpacking station the built parts are taken out of the exchangeable frame and are freed from the loose powder. Recyclable powder and waste powder are separated from one another. The station has an interface to the exchangeable frame and a filler plug for new powder. By the integrated weighing unit new and recycled powder can be filled into the supply containers in the required amount.

4.2 Mixing station (MS P1)

The mixing station serves for homogenising the recycled powder. Through rotation movements of the powder bin, used and fresh powder are mixed to assure an homogenous distribution.

To run the machine successfully it is not necessary to operate a mixing station. However, it is recommended as standard equipment, as it reduces man power effort and ensures a constant powder quality.

- Dimensions (w x d x h) 700 mm x 500 mm x 1000 mm

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

5 Further options

5.1 Normfinish sand-blasting cabinet for post-treatment of surfaces on sintered parts

Blasting cabinet with pneumatic blasting system, dust-free blasting area and cartridge filter

- Work area (w x d x h)	1110 mm x 800 mm x 860 mm
- Total dimensions incl. motor (w x d x h)	1260 mm x 1230 mm x 1990 mm
- Dimensions of door (w x h)	690 mm x 795 mm
- Height	860 mm
- Weight	265 kg
- Max. load	350 kg
- Light	2 x 18 W
- Ventilator motor	0.55 W
- Electric mains requirements	230 V / 50 Hz / 0.6 W

5.2 Miniature blasting system type Micro-Tip I for post-treatment of small parts

- Dimensions (w x d x h)	200 mm x 200 mm x 230 mm
- Hard-metal nozzle	1.2 mm
- Compressed air supply requirements	6 bar

5.3

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

5.4 Nilfisk industrial vacuum cleaner for suction at source, machine cleaning and spillage pick-up

Industrial Vacuum Cleaner offering a three-phase motor with IP 54 protection, ignition-free construction, built-in sound suppresser and 3-phase-high power turbine.

- Dimensions (w x d x h)	920 mm x 1270 mm x 580 mm
- Rated power	1900 W
- Airflow	86 l/sec
- Vacuum	14.7 kPa
- Suction power	480 W
- Sound level	76 dB(A) / 20 µPA
- Main filter area	16.000 cm^2
- Dust bag / tank capacity	46 l / 46 l
- Weight	88 kg

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

6 Services

6.1 Set-up and installation

6.1.1 FORMIGA P 100 System installation

The system is set up and installed ready for use at the customer's site according to given specifications. For set-up and installation requirements see corresponding machine-specific installation requirements available from EOS.

6.1.2 Software installation

Installing the EOS Desktop-PSW from CD ROM can easily be done by the user within minutes. To run the installation local administrator rights are required. The use of the software is protected by a password provided by EOS.

The installation of Magics RP from CD ROM includes EOSPACE; it also requires administrator rights and can be done by the customer. The license password is provided by Materialise depending on the purchased modules.

6.2 Documentation

6.2.1 FORMIGA P 100 System documentation

Full documentation in accordance with CE-conformity is provided, including:

- Installation conditions
- Machine basics
- Accessories and options

6.2.2 Software documentation

EOS Desktop-PSW is provided with a user manual according to CE. The manual can be delivered in German, English, French and Italian language immediately; for other languages please ask for delivery time and costs. The software provides the possibility to change-over between the German, English or French version at run-time.

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

Materialise Magics RP is provided with a user manual and a comprehensive online help in German or English language to be selected during installation. The operation language is English or German, also to be selected during installation.

EOSPACE module in Magics contains a separate online help.

6.3 Training

6.3.1 Basic introduction

After installation and function control through the technical service, the customer is instructed to the basic functions of the machine by the service engineer.

Due to the simplified machine concept the operation of the machine can be acquired through the customer by means of the enclosed handbook „Basic training“.

Installation, function control and instruction of the customer lasts approx. 1 day.

6.3.2 Basic training

For interested customers, EOS offers optionally a 3-day basic training following the installation through the service engineer.

Basic training includes:

- Basics of laser-sintering technology
- Machine use
- Handling of accessories
- Part fabrication
- Service and maintenance

6.3.3 Expert training

EOS offers a expert training as a follow-up training to the "basic training". Afterwards further software functions get opened to the “expert” so that the customer receives the freedom to adapt and to tune his machine to special applications.

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

The training lasts approx. 2 - 3 days and is carried out by an expert customer trainer.

Expert training includes:

- Setup of exposure parameters
- Optimising of building results
- Optimisation for special applications

6.3.4 Service training

With the aim to enable customers to perform minor services by themselves, EOS offers a 3-day service training.

Training requirements:

- Basic training
- Expert training
- Tele-service contract

Service training includes:

- Change of optic components
- Adjustment of laser beam
- Measuring of laser power
- Creation of calibration grid
- Basic mechanical settings
- Service and maintenance

6.4 Software training

Due to the comprehensive user manual a training for EOS Desktop-PSW is not necessary. A short introduction into the use of the software will be given during the basic introduction. A more detailed course will be held during the basic training.

Training for Magics RP and modules is provided by Materialise at its premises or at customer site. For higher efficiency it is recommended to participate in a Magics training at Materialise

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

before starting the basic training course.

Due to the online help in EOSPACE a training is not necessary. Customers purchasing the software with an FORMIGA P 100 System will get an introduction into the use of the software during the basic training.

6.5 Service programme

To maintain the system's continuous availability, EOS offers different contract options in its service programme. The options take into account the individual requirements of the operator.

For detailed information about the services offered under the contract options please refer to our separate offer.

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telefon: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info