

## Technical description EOS M 100

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### Technical description

Date: November 2015

#### 1 EOS M 100

The machine comprises a process chamber with recoating system, cartridge extraction system, building platform system and platform heating module, an optics system with laser, a process gas management system and a process controller with process control software. The machine components are integrated into a robust machine frame comprising a stable frame construction. During building the process chamber is secured by a lock. The machine meets the requirements of laser safety class 1. The system carries the CE designation.



Fig. 1: EOS M 100 system

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### 1.1 Basic data

- Dimensions (W x D x H) 800mm x 950mm x 2250mm
- Weight Approx. 580kg (without powder filling)
- Power connection 200 - 240 V at 50/60 Hz
- Mains fuse protection 13 A
- Maximum power consumption 1.7KW
- Inert gas supply (Argon or Nitrogen) 4,000 hPa, 50 l/min

For detailed information including the required floor space, connections and environmental conditions (temperature and atmospheric humidity range etc.) please see the Installation Conditions.

### 1.2 Modules

A modular design of the EOS M 100 system allows the quick and easy exchange of the 6 modules:

- Laser
- Optics
- Z-axis
- Filter system
- Dosage unit
- Powder unit

#### 1.2.1 Laser

The laser generates the laser beam to melt together and solidify the material.

- Yb (Ytterbium) fibre laser
- Wavelength 900 – 1200 nm
- Nominal power 200 W

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### 1.2.2 Optics

The optics combines the scanner and the focusing lens. It positions the laser beam to melt together and solidify the material. The laser beam emitted by the laser is steered with the aid of a fiber optic, beam expander optics, a scanner mirror and a focusing lens. All optical surfaces have special coatings that ensure effective beam steering.

#### 1.2.2.1 Scanner

The scanner is a high speed rotating mirror deflection system comprising precision galvanometer scanners with temperature compensation, deflection mirrors of maximum reflectivity, integrated servo electronics and interface electronics, digital data transmission from the control computer and a digital signal processor. It also incorporates an integrated home-in sensor, which detects and corrects any scanner drift at regular intervals. In this way high position stability of the laser beam is maintained, even under varying environmental conditions or in case of high thermal load due to long exposure times or large building jobs.

- Exposure area diameter 100 mm
- Exposure speed up to 7000 mm/s
- Repeatability, scanner position < 22  $\mu$ rad

#### 1.2.2.2 Focussing lens

The focusing lens is a so-called F-Theta lens that focuses the laser beam on a flat plane. Below the F-Theta lens is a window that is kept free of dirt deposits by a lens-clearing nozzle.

- Diameter of the laser beam in the building area 40  $\mu$ m
- Focal length of the F-Theta lens (flat plane optic) 163 mm

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### 1.2.3 Z-axis with building platform

The building platform is fastened in the process chamber to the platform carrier using under pressure. This construction allows the exposure of the whole building platform area, as no fixation screws are necessary. The parts are built on the building platform that can be separated from the parts after the building process. M

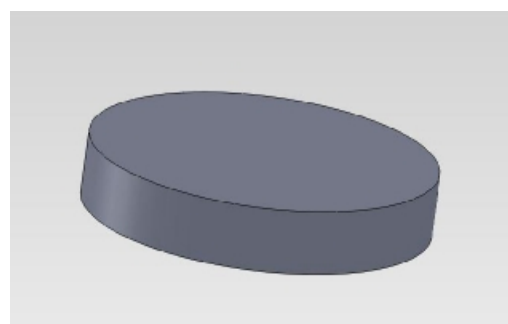


Fig. 2: Building platform

The building platforms can be used several times by re-machining the surface.

DirectBase platforms are available in various materials and specifications:

Name	Material	Nominal thickness	Properties
DirectBase S15	1.1730 steel	15 mm	Ground surface

### 1.2.4 Filter system

The filter system consists of a pre filter (F9) and a main filter (H13). The pre filter contains a particle separator. Both reactive and non-reactive materials can be processed with this filter system. Furthermore customer individual adaptations like metal free filters are available on request.

The volume stream is controlled by the machine software for best user-friendliness.

- Gas stream volume 0,6 – 2 m<sup>3</sup>/h

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### 1.3 Recoating system

The recoating system produces the layers of powder that are then to be solidified. Its components are a recoating element, a recoater arm, a powder container and a linear drive that moves the recoater arm in the horizontal direction. Powder is provided from the powder container continuously for every layer. Surplus powder is transported to a collection box.

- Travel speed 20 – 200 mm/s

The part is built on the building platform, which is attached to the building platform carrier.

The building platform carrier is moved in the vertical direction by a stepper motor. The elevation is transformed over a fine thread shaft and a planetary gear to ensure the highest positioning accuracy.

- Repeatability of the position  $\leq \pm 2 \mu\text{m}$
- Maximum building height 80 mm incl. building platform thickness

### 1.4 Cartridge system

The powder needed comes from an individual placed and locked powder bin. This powder bin is prepared and filled outside of the machine and can be removed together with the not used powder after the job is finished.

### 1.5 Camera

With an integrated camera in the process chamber, the building process can be observed via network (USB camera with webcam function).

- Camera 1.3 MegaPix

### 1.6 Standard accessories

A set of standard equipment for cleaning, as well as tools for job starts and removal of parts is included.

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### 2 Part Property Management (PPM) module

#### 2.1 PPM parameter sets

The so-called Part Property Profiles (PPPs) allow standardisation of the properties of laser sintered parts.

The characteristics of the individual PPPs are derived from typical requirement profiles. In the manufacturing world, each part has different specific quality-related requirements in relation to surface finish quality, accuracy and resolution of detail to meet. As a rule, apart from quality objectives it is also necessary to meet cost objectives. The PPPs, to which parameter sets correspond, therefore address different requirement profiles. In one case the emphasis is on costs, in another case optimal quality characteristics or also carefully balanced compromises.

#### 2.2 IndustryLine

The following parameter set is available for the EOS M 100:

EOS parameter sets M100	Layer thickness
SP2_030_DentalM100 1.0	30 µm

#### 2.3 ParameterEditor

The modification of existing exposure parameters in order to optimize parts results is possible with the ParameterEditor packages. These parameters are based on an EOS proved parameter set. The start values of the exposure type can be adapted until the results wanted are reached.

ParameterEditor packages include:

- ExposureEditor licence
- FlexLine parameter sets
- Start values which can be customized using the ExposureEditors

Following ParameterEditor packages are currently offered for EOS M 100:

- 316L ParameterEditor (20µm)

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### 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".

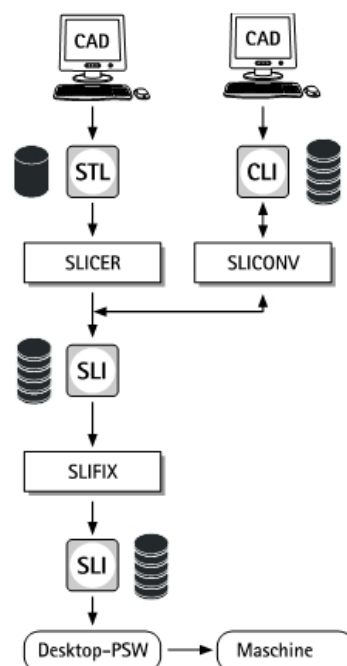


Fig. 3: Data preparation process

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.

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

- Processor At least dual core processor
- Memory 32-bit version  $\geq$  4 GB; 64-bit version  $\geq$  8 GB



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- Free space for EOS software > 500 MB free space
- Additional free space for files > 50 GB free space
- Graphic board > 128 MB recommended, open-GL
- Network interface Gigabit Ethernet
- Network protocol TCP/IP
- Operating system Windows 7 (32- or 64-bit, not higher)
- Disk drives DVD-ROM
- Monitor 1280 x 1024 pixels

It is only possible to use the 32-bit software version on a 32-bit operation system and the 64-bit version on a 64-bit operation system. 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, as described in the following, available for the data preparation on the PC.



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### 3.1 EOSPRINT Desktop Software

EOSPRINT comprises a process-control-software on a separate data preparation processor. So job orders can be prepared independent from the machine processor. This enables a maximum workload.

- Operating system Microsoft Windows 7

The software comes together with a network floating license (one license to operate multiple machines; part of the delivery).

### 3.2 EOS RP-Tools - EOS software for generating and editing layer data

EOS RP-Tools is a software package that allows the conversion of part data in the STL or CLI format into the EOS-specific SLI format as is required for the subsequent building process. To make the process optimisation easier, layer data for solid bodies can be divided into skin and core data.

EOS RP-Tools comprises the modules:

- SLIVIEW: Graphic user interface for the visualisation of the layer data
- SLICER: Generation of two-dimensional layer data from three-dimensional STL data
- SLIFIX: Automatic repair of the most common data errors in layer data such as overlaps, double contours and inverted polygon orientations
- SKINCORE: Breakdown of solid part data into separate data sets for a definable skin and a core on a two-dimensional basis.
- SLICONV: Automatic data conversion from CLI to EOS SLI and vice versa (in each case either ASCII or binary)
- RADIUS: Generation of a radial transition between platform plane and part to homogenise the internal stresses, as well as the generation of a structure open to the platform on the usage of the skin & core algorithm.  
Comment: From PSW V3.2 this functionality is also included in the PSW.

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

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

From Version EOS RP Tools 6.2 onwards the software can also be used as a network licence (network floating licence). EOS RP Tools is available as 32-bit and 64-bit version.

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### 3.3 Magics RP

Magics RP is a software package for data preparation based on STL data. It is available for all common Windows operating systems and covers the requirements for data preparation for EOS M 100 systems:

- Parts visualisation in the STL format
- Process-compatible positioning of the parts on the building platform
- Repair and editing functions in the STL format
- Quality assurance on the STL files
- Reinforcement and supports (depending on the parts geometry) with the use of the additional SG module
- Import of IGES, VDA, CATIA and Unigraphics data using additional modules

### 3.4 CAMbridge

CAMbridge is a software package for data preparation for dental restoration applications. It is available for every actual windows operating system (Vista, Win XP, Win 2000, Win 7) and covers the needs of data processing for EOSINT M 270 Dental or EOS M 100:

- part visualisation
- automated generation of support structures
- automated detachable ID tags
- automated positioning on the building platform
- fast and simple creation of a job-file for PSW

Note: A special dental training for production of dental restorations is obligatory due to statutory requirements, e.g. for production of medical devices.

EOS recommends the use of the optional data preparation software CAMbridge with the Dental package.

### 3.5 Software recommendations

To operate a EOS M 100 the following software packages are recommended:

For the production of parts that do not require support structures:

- EOS RP-Tools (unlimited network licence)

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- EOS PSW Offline (unlimited network licence)

For the production of parts that require support structures, also:

- Third party software e.g. Materialise Magics RP licence version with additional SG module
- To ensure compatibility with future versions of Magics a maintenance contract can be concluded with Materialise.

### 4 Inert gas supply

Depending on the material used, the machine is operated either with nitrogen or argon atmosphere.

For a successful job the machine provides the following required components.

- Connection to external nitrogen gas bottle(s), battery of bottles or in-house network that is to be provided by the user (see Installation Conditions)
- Expanded and redundant monitoring of the residual oxygen content in the process chamber
- Expanded safety circuit including automatic interruption of the building process if a defined residual oxygen content is exceeded Services.

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### 5 Options

Depending on the application, various steps may be necessary for the post-treatment of the parts for which additional equipment may be required. The equipment needed most frequently as well as the contact addresses for manufacturers of this equipment are summarised as follows. Further details and recommendations as well as information on operation are available on request in the EOS application notes, training documents etc.

#### 5.1.1 Wet separator



This vacuum cleaner collects powder and dust etc. drawn up in a liquid and therefore offers the greatest possible safety. It is suitable for usage with all EOS materials, including reactive powders, as well as flammable and even explosive dusts. It is only allowed to use this vacuum cleaner for EOS titanium and aluminium powder materials.

Fig.: Wet separator *Ruwac NA35 D1 B1*

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### 5.2 Micro shot-peening

Micro shot-peening is a post-treatment method that makes it possible to very quickly and easily improve the surface quality, both for direct usage and as the basis for further polishing. It can generally be recommended for all materials. Depending on the application, the following packages are recommended. Detailed recommendations for some applications are given in the application note "Surface finishing of DMLS parts". In applications that require high metallurgical purity, e.g. medical implants, shot-peening medium and handling of the parts must be chosen accordingly.

Please note that EOS does not supply any media or spare parts apart from the packages offered. These products should be ordered directly from Iepco ([www.iepco.ch](http://www.iepco.ch)) or a local dealer. Contact addresses can be provided on request.

#### 5.2.1 Micro shot-peening basic package

For the majority of DirectTool® and DirectPart® applications compacting and shot-peening using a basic package is sufficient, this package comprises:

- 2 micro shot-peening machines IEPCO Peenmatic 750S, each with rotating table
- 1 fine shot-peening nozzle Micropeen 250 (integrated in a Peenmatic 750S)
- 5 kg shot-peening medium IEPCONORM A (test quantity)
- 25 kg shot-peening medium IEPCONORM B-4
- 25 kg shot-peening medium IEPCONORM C

#### 5.2.2 Micro shot-peening upgrade package Micropeen 250

For fine slots that are not accessible with Iepconorm B-4, the finer Iepconorm B-2 can be used with a Micropeen 250 fine nozzle. However here caution is required to prevent damage to other surfaces due to the larger amount of material removed. The related upgrade package comprises:

- 1 fine shot-peening nozzle Micropeen 250 + unit for mounting the second Peenmatic 750S micro shot-peening system
- 25 kg shot-peening medium IEPCONORM B-2

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### 5.2.3 Micro shot-peening premium package

For the best quality on injection moulding inserts the work steps cleaning, compaction, shot-peening and smoothing are recommended. For this purpose we recommend the premium package, comprising:

- 3 micro shot-peening machines IEPCO Peenmatic 750S, each with rotating table, two of which with fine shot-peening nozzle Micropeen 250
- 25 kg shot-peening medium IEPCONORM A
- 25 kg shot-peening medium IEPCONORM B-4
- 25 kg shot-peening medium IEPCONORM C

### 5.2.4 Micro shot-peening dental package

For the best quality dental prosthetic elements the cleaning work step is recommended. For this purpose we recommend the dental package, comprising:

- 1 micro shot-peening machine IEPCO Peenmatic 750S, with rotating table
- 25 kg shot-peening medium IEPCONORM C

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### 5.3 Thermal post-treatment

Depending on the material and application, thermal post-treatment can be recommended, e.g. for post-hardening or stress reduction. In particular with the materials EOS StainlessSteel, CobaltChrome and Titanium, thermal post-treatment is recommended. More detailed advice is available on request. For all these materials we can recommend the following equipment:

Electrically heated chamber furnace of type H 41/H with controller C 250

- Furnace chamber dimensions (W x D x H): 350 x 500 x 250 mm
  - External dimensions (W x D x H): 840 x 1100 x 1320 mm
  - Weight: 260 kg
  - Elec. connection rating: 15.0 kW
  - Connection voltage: 400 V
  - Tmax. 1280 °C
- Inert gas annealing box with inert gas supply
  - Loading plate for N 41/H
  - Loading truck CW 1

Or a smaller furnace of type L 9/12/P330

- Furnace chamber dimensions (W x D x H): 230 x 240 x 170 mm
- External dimensions (W x D x H): 440 x 550 x 570 mm
- Weight: 45 kg
- Elec. connection rating: 3.0 kW
- Connection voltage: 230 V
- Tmax. 1200 °C

This equipment can be ordered directly from the following supplier:

Nabertherm GmbH  
Bahnhofstrasse 20  
D-28865 Lilienthal/Bremen

[www.nabertherm.de](http://www.nabertherm.de)  
Tel: +49 (0) 4298 922-0  
Fax: +49 (0) 4298 922-129

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### 5.4 Laser power measurement with PocketMonitor

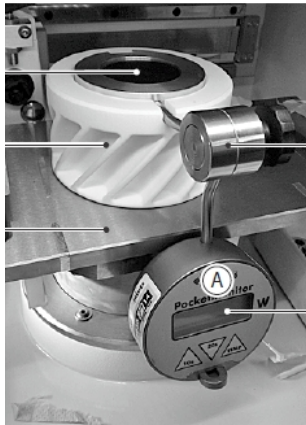


Fig.: PocketMonitor (A) with bracket for EOS M100

This option enables the user to measure the laser power directly in the process chamber. The measuring tool is easy to use and very precise, e.g. for a measurement of the laser power before and after a job.

The measuring device is inserted into the EOS M100 in a bracket and put into an exact centric position with the help of positioning holes on the platform carrier.

For the EOS M 100, EOS M 290 , EOSINT M 280 systems and EOSINT M 270 Dual Mode we can recommend the following equipment:

- Laser power measuring device type PocketMonitor PMT 05P
  - Performance range: 25 to 500 W
  - Exactness of measurement within the specified performance range: 4 %
  - Measuring time with 200W laser: 20 sec
- Laser-sintered holder for measuring tool (please see above picture)

The PocketMonitor can also be ordered directly from the following supplier (pls. see below).

Note: Please include „PMT 05P – Configuration for EOS“ in the order.

PRIMES GmbH

[www.primes.de](http://www.primes.de)

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D - 64319 Pfungstadt

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### 6 Services

#### 6.1 Installation

##### 6.1.1 EOS M 100 system

The system price includes installation at the customer in accordance with the stipulated regulations. For information on the installation requirements, please see the Installation Conditions. The qualification and commissioning of the system for one material by our service engineers is included in the system price. For the qualification and commissioning of further materials, if ordered at the same time as the system, approx. one day service per material is required. Each material qualification typically uses two building platforms as well as a small amount of the related powder material.

##### 6.1.2 Software

The installation of EOS RP-Tools from USB stick is straightforward and can be undertaken in a few minutes. Local administrator rights are necessary to run the installation routine. The following languages can be selected for the software user interface: German, English, French and Italian. The usage of the software is protected with a password that is assigned by EOS as a function of the modules ordered..

#### 6.2 Documentation

##### 6.2.1 EOS M 100 system

A complete, CE-compliant documentation is supplied with the system. This documentation includes:

- Installation Conditions
- Operating Instructions
- Troubleshooting, Maintenance and Spare parts
- Software reference EOSPRINT (PSW)
- Accessories and Options

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### 6.2.2 Software

A CE-compliant user manual for EOS RP-Tools is included in the scope of delivery. The user manual can be supplied directly in German, English, French and Italian; for other languages please ask for delivery time and costs.

The scope of delivery for Materialise Magics RP and its modules includes a manual in German or English. The language is selected during the installation. The software has an online help.

### 6.3 Training

#### 6.3.1 EOS M 100 system

To ensure the machine is operated correctly, the basic training course for machine operation, machine accessories and software is included in the sale price.

The basic training course includes:

- Basic principles of the technology
- Machine operation
- Handling the accessories
- Process depiction and control\*
- Data preparation (EOS RP-Tools)
- Part preparation\*
- Finishing the parts

\* For one material, e.g. EOS StainlessSteel

The basic training course for up to three participants covers five days and takes place on the premises of EOS GmbH in Krailling. If more than one material is ordered, an additional training course may be required (arranged on request). A training manual in English is provided to the participants.

The basic training course requires basic knowledge of the operation of a PC including Microsoft Windows.

To reinforce and optimise the process chain we would be pleased to offer further training courses (e.g. follow-up training at customer site) or workshops.

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### 6.3.2 Software

The supply of a comprehensive operator manual for EOS RP-Tools makes an additional training course unnecessary. Customers who procure the software together with an EOS system will receive an instruction as part of the basic training course.

Training courses for the various Magics modules are offered by Materialise both on its premises and at the customer site. For reasons of efficiency, it is strongly recommended to attend a Magics training course at Materialise prior to starting the EOS system basic training course.

### 6.4 Service program

To retain the availability of the system, EOS offers numerous contract options in its service program that address the specific requirements of the operating organisation.

For a detailed list of the services in the contract options please see our separate information on this aspect.

The information corresponds to the latest findings. The information is not intended to assure specific properties of the product or suitability for a specific application.

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