Technical Description

Status: November 6th, 2006

1 Machine EOSINT P 390

The machine is mounted on a solid frame. All required units are integrated into a single housing. The system´s process control computer is built as a separate unit and can thus be located wherever convenient. The process chamber is 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 Basic data

- Dimensions P 390 with exchangeable frame (w x d x h)	1230 mm x 1175 mm x 2100 mm
- Weight	approx. 1060 kg
- Dimensions switch gear cabinet	610 mm x 790 mm x 2100 mm
- Dimensions control terminal	950 mm x 700 mm x 1550 mm
- Operation temperature range	20 – 25 °C
- Electric mains requirements (3-phase system)	400 V +6 %/-10 % at 50 Hz; CEE 5 pole
- Main fuses	3 x 32 A
- Average power consumption	approx. 2 kW
- Compressed air connection during building process	20 m³/h at 6 bar
- Water cooling (if operated without laser cooling)	5,7 l/min, 18-20 °C, ± 0,1 °C
- Diameter of suction nozzle	100 mm
- Exhaust flow rate	20 m³/h
- Required floor space	see installation requirements
- Compressed air consumption	approx. 20 m³/h at 7 bar
- Standard pressure	7 bar

EOS GmbH - Electro Optical Systems

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

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

- 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 ≤ 0.1 mg/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
- Wave length of laser 10.6 µm
- Laser radiation power (at time of delivery) 50 W
- Minimum radiation power within warranty period 40 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 system´s control computer and digital signal processing.

- Exposed area 350 x 350 mm
- Scanning speed up to 6 m/s
- Positioning accuracy of laser beam ± 0.05 mm

The laser beam is guided by means of divergence optics and flat-field lenses.

- Diameter of focused beam (variable) < 0.6 mm
- Divergence ratio 3.5:1
- Focal length of flat-field lenses 500 mm
- Aperture of the scanners 20 mm

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Robert-Stirling-Ring 1
D-82152 Krailling / München
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Telefax: +49 (0)89 / 893 36-285
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1.3 Recoating unit

Recoating system for generation of a new powder layer, fed by powder supply container, surface equalisation with overflow container.

- Minimum layer thickness 0.1 mm
- Layer thickness variation < 0.05 mm

Left and right powder supply containers with powder fluidisation and dispenser units

- Capacity of container about 45 litres each

Vertical control of process platform via precision spindle drive

- Repetition accuracy over a 300 mm distance ± 0.05 mm

1.4 Heating, process chamber

Building process heaters in the upper and lower building chamber are operated separately. Both heater circuits are separately controlled.

- Infrared radiator (short wave) 3.2 kW
- Readout of actual/set value via digital display

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

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

- Total air consumption (Vn) about 10 m³/h
- Purity of N_2 > 99 %
- N_2 output rate (Vn) at purity 99 % < 1.5 m³ at 6 bar

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D-82152 Krailling / München

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1.6 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. The heating integrated into the side walls of the unloading chamber optimises the process temperature during the building process.

With the lifter the job can easily be removed from the system shortly after the built has been completed. By using two containers in exchange, the non-productive times of the system are minimised.

Exchangeable frame (2 units)

- Built height available 620 mm
- Lifter adapted to the exchangeable frame

1.7 Process computer with process software

The process computer with process software (PSW) controls the laser-sintering process and the system's monitoring and control components.

1.7.1 Process computer

Industrial-type PC with Pentium processor and VGA graphics display, Ethernet interface, keyboard, mouse, VGA colour monitor integrated into the control terminal.

1.7.2 Process control software PSW

The EOSINT P 390 production process is fully controlled by the PSW which includes the Inline-Control System. PSW takes control over the process and the monitoring and control devices of the system. Using the process software, the building process (job) is prepared, protocolled and filed. The PSW offers its users optimised exposure strategies which allow among others highest level of detail resolution.
With this software data can also be displayed in a graphical layer format directly on the machine.

The Inline-Control System continually monitors the production process allowing a more effective system operation with less failures.

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Robert-Stirling-Ring 1
D-82152 Krailling / München
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Telefax: +49 (0)89 / 893 36-285
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Among others, areas that are controlled and protocolled are:

- Door locking state, state of safety circuit
- Temperatures in lower and upper process chamber
- Exposure (laser), dispensing process and movement of wiper
- Left and right dispenser units
- Movement of building platform (along vertical axis)
- Powder level in left and right hopper (after the message ”empty”, 300 additional layers are carried out; the machine stops if the ”empty” state is not cleared)
- Level of overflow containers
- Function of motion motors
- Compressed-air pressure

The PSW requires the data input format SLI according to EOS specifications. A PC with operating system Windows 2000/XP is a prerequisite for running the current version of the PSW.

For more details please refer to the Operation manual.

1.7.3 EOSTATE

EOSTATE is a status control and reporting software. It allows to monitor the built status of several machines in a local network, showing:

- Current job
- Actual and remaining built height
- Message status of machine PSW
- Machine status

EOSTATE generates built reports of all reachable machines and their jobs built. Reports for the full job as well as for single parts built are available.

1.8 Standard accessories

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

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D-82152 Krailling / München
Telephone: +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 constant 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 constant behaviour for use as end products or spare parts in small series

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D-82152 Krailling / München
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Telefax: +49 (0)89 / 893 36-285
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- 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.

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 heavy 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

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Robert-Stirling-Ring 1
D-82152 Krailling / München
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Telefax: +49 (0)89 / 893 36-285
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- 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.

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
Telephone: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
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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". 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 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 IBM compatible PC is required for this data pre-processing. The equipment should meet the following requirements:

- Processor	> 1 GHz, Pentium IV 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 NT 4.0, 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.

3.1 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.

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München
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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)

3.2 EOS PSW Off-line including EOSTATE

The PSW Off-line comprises a second licence for the process software (PSW) to be operated on a separate PC. This enables jobs to be prepared without using the machine PC, thereby enabling maximum utility of the EOSINT System for part building.

Note: the PSW Off-line must always be the same release as the PSW installed on the machine.

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 EOSINT 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

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D-82152 Krailling / München
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- 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 systems 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 an EOSINT P 390 System:

- Materialise Magics RP licensed version
- Magics module EOSPACE
- Magics maintenance to ensure compatibility for future versions of Magics
- EOS RP-Tools 5.02 Standard edition with modules SLIVIEW, SLICER, SLIFIX, SKINCORE and SLICONV (single non-expiring licence)
- EOS PSW Off-line (single non-expiring licence)

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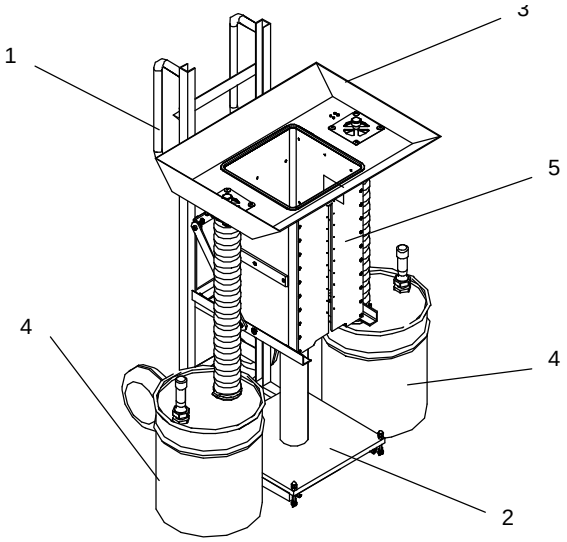
4 IPCM Options

4.1 Unpacking stand US P3

The unpacking stand US P3 allows the easy removal of the parts from the exchangeable frame system. The lifter positions the exchangeable frame over the base unit. There the building platform is fixed to the base unit, and the frame slowly moves down step by step lowering the lifter. The loose powder pours into the tray fixed to the exchangeable frame before.

- 1 Lifter
- 2 Base Unit
- 3 Tray
- 4 Powder container
- 5 Exchangeable frame



4.2 Sieving machine SM P3 *)

The sieving machine SM P3 sieves the powder after the unpacking. It is fed manually and separates between foreign bodies, powder agglomerates and reusable powder.

Technical data sieving machine:

- Voltage 400 V
- Frequency 50 Hz
- Weight of motor 7 kg

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

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4.3 Unpacking and sieving station UAS P3 with integrated cleaning and powder regaining system *)

The unpacking station supports the user in easily separating the built parts from loose powder, and to separate between waste powder and powder that will be recycled. The station has an interface to the exchangeable frame system as well as an interface for automated powder transportation to the powder feeding system (4.6). A plexiglas cover as well as a construction that minimised dropping powder and by this minimises dust allows an ergonomic and easy work.

- Dimensions (w x d x h) 1200 mm x 700 mm x 1700 mm
- Weight approx. 280 kg
- Electric mains requirements CEE 400 V / 16 A; 5 poles

4.4 Powder conveying system 2 x 200 l PCS P3 (2x200) *)

The powder conveying system PCS P3 (2x200) supplies powder to the reservoir bin integrated into the machine. It is controlled by its own control unit measuring the actual powder amount in the reservoir bins and starts or stops according to the feeding process. The system has two separate containers for about 200 l. One container stores the new powder, the second the recycled powder. The integrated dispensing unit mixes the powder in the required concentration and conveys it into the machine. It is not necessary to have a powder conveying system to run the machine successfully. However, it reduces man power effort and ensures a constant powder quality.

- Weight (empty) approx. 150 kg
- Weight (filled with PA 2200) approx. 350 kg
- Dimensions (w x d x h) 1480 mm x 1170 mm x 1470 mm
- Electric mains requirements CEE 400 V / 10 A
- Container volume 2 x 200 l

4.5 Powder conveying system 2 x 400 l PCS P3 (2x400) *)

The powder conveying system PCS P3 (2x400) supplies powder to the reservoir bin integrated into the machine. It is controlled by its own control unit measuring the actual powder amount in the reservoir bins and starts or stops according to the feeding process. The system has two separate containers for about 400 l. One container stores the new powder, the second the

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D-82152 Krailling / München
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Telefax: +49 (0)89 / 893 36-285
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recycled powder. The integrated dispensing unit mixes the powder in the required concentration and conveys it into the machine. It is not necessary to have a powder conveying system to run the machine successfully. However, it reduces man power effort and ensures a constant powder quality.

- Weight (empty)	approx. 160 kg
- Weight (filled with PA 2200)	approx. 560 kg
- Dimensions (w x d x h)	1890 mm x 1350 mm x 1550 mm
- Electric mains requirements	CEE 400 V / 10 A
- Container volume	2 x 400 l

4.6 Recycled powder conveying RPC P3/P7 *)

The recycled powder conveying RPC P3/P7 conveys recycled powder from a pre-connected component via a spiral hose into the recycled powder container of a powder conveying system. A maximum of two recycled powder conveyings can be connected to one powder conveying system.

4.7 Recycled powder conveying extension RPX P3/P7 *)

The recycled powder conveying extension RPX P3/P7 allows to connect a further sieving station or unpacking and sieving station or system to the recycled powder conveying. The component ensures an automatic return transport of the recycled powder.

4.8 Powder conveying 1st/2nd extension PCX1 P3 / PCX2 P3 *)

With the powder conveying 1st/2nd extension PCX P3, a 2nd/3rd system can be connected to a powder conveying system. The machines are thus integrated into the IPCM powder cycle. The powder, which is conveyed by the powder conveying system, is transported via the extension powder conveying into the dosage bins of the connected EOSINT P machines.

A maximum of three EOSINT P 390 Systems can be connected to one powder conveying system with 2 x 200 l using two extensions powder conveying.

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D-82152 Krailling / München
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4.9 Twin connection powder conveying TC P3

The twin connection powder conveying TC P3 is needed if a second powder conveying system is to be connected to a system. This is e.g. the case if the machine is to built with two different powders.

4.10 Powder exchange set PEX P3

The powder exchange set PEX P3 consists of the containers keeping powder during the process in the system, including the feeding system to the recoating unit. An additional unit is recommended if the system is regularly used with different material classes i.e. polyamides and polystyrenes. In this case the down time due to cleaning efforts is minimised using the exchange containers and at the same time process stability is assured (the exchangeable frames are not included).

*) These components are suitable for installation in Zone 22, conform to 1999/92/EG (ATEX) guideline

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5 Further Options

5.1 Laser cooling systems, water-air heat exchanger, type P411

A new cooling system has been developed especially for the use with EOSINT P Systems. A very constant temperature is guaranteed for all actively cooled components (laser, scanner, pyrometer) resulting in higher beam point stability, even temperature distribution and even laser power, all leading to improved part quality.

Technical Data:

- Refrigerating capacity	1100 W
- Dimensions (w x d x h)	380 mm x 450 mm x 665 mm
- Weight	approx. 72 kg
- Electric mains requirement	CEE 400 V / 16 A
- Voltage	400 V 3~/N/PE ± 10 %
- Frequency	50 / 60 Hz
- Fuse protection	1 x 16A
- Connected load	2.5 kW

Please note that the three-phase plug is hooked up for single phase only.

5.2 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

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- Max. load 350 kg
- Light 2 x 18 W
- Ventilator motor 0.55 W
- Electric mains requirements 230 V / 50 Hz / 0.6 W

5.3 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

5.4 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 suppressor and 3-phase-high power turbine.

- Dimensions (w x d x h) 920 mm x 580 mm x 1270 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 / 46 l
- Weight 88 kg

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D-82152 Krailling / München
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6 Services

6.1 Set-up and installation

6.1.1 System EOSINT P 390

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

Installing the EOS RP-Tools from CD ROM can easily be done by the user. To run the installation local administrator rights are required. The operation language can be selected between German, English, French or Italian. The use of the software is protected by a password provided by EOS.

The installation of Magics RP from CD ROM includes EOSPACE, also requires administrator rights and can be done by the customer. The license password is provided by Materialise.

6.2 Documentation

6.2.1 EOSINT P 390

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

- Installation conditions
- Operation
- Troubleshooting, maintenance and spare parts
- Software reference PSW
- Accessories and options

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6.2.2 Software

EOS RP-Tools 5.02 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 possesses a language switch between German, English, French or Italian version.

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 System EOSINT P 390

To ensure that the machine is operated properly, basic training for operation of machine, its accessories and operating software is included in the purchase price.

Basic training includes:

- Basics of laser-sintering technology
- Machine use
- Handling of accessories
- Process description and control
- Data pre-processing (EOS RP-Tools)
- Part fabrication
- Post-processing (finishing) of parts

Basic training for two participants lasts four days and will be held at EOS GmbH´s premises in Krailling, Germany. About 4 to 6 weeks after installation, a one-day start-up visit at the customer´s site will be made. A training manual in English language is handed over to the participants.

Upon special agreement, EOS GmbH is pleased to offer its customers additional training or workshops to gain deeper knowledge about the process chain and its optimisation.

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6.3.2 Software

Due to the comprehensive user manual a training for EOS RP-Tools is not necessary. Customers purchasing the software with an EOSINT System will get an introduction into the use of the software during the basic system training.

Training for Magics RP and modules is provided by Materialise at its premises or at customer´s site. For higher efficiency it is recommended to participate in a Magics training at Materialise before starting the training course at EOS.

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

6.4 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.

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