Paragon™ Series

Site Preparation Guide

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Revision A

NOTICE

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The Paragon system is manufactured by Laser Imaging Systems GmbH & Co. KG, Prüssingstraße 41, 07745 Jena, Germany, and by Orbotech Ltd., P.O. Box 215, Yavne, Israel 81002. The system complies with the following standards:

EN 60825, EN 60204

21 CFR CH.I (4-1-92 EDITION) & 1040.10

The Paragon system is a Class 1 laser product.

CE

Contents

Chapter 1

Introduction

About This Guide

This guide provides site preparation information for the Paragon™ Series. It is the customer's responsibility to ensure that the site at which the system is installed conforms to all instructions and guidelines described in this document, so as to enable proper system installation and full system performance.

Please contact the local Orbotech representative with any questions regarding the site preparation procedure.

About the Paragon™ Series

The Paragon Series includes Paragon-6000/8000/8800 and Paragon-9000 models.

The Paragon is a laser direct imaging system that receives PCB data from CAM workstations and plots it directly on resist-coated panels.

Loading and unloading of the PCBs is done manually. The standard configuration is a standalone system, as illustrated in Figure 1.1.

Paragon-6000/8000/8800

Paragon-9000

Figure 1.1 Paragon Series Laser Direct Imaging Systems

The Paragon is capable of exposing large format images on inner and outer layers, SBU and flex PCBs.

The system is compatible with the existing production processes, operating in a yellow room environment; it can expose all UV-sensitive dry or liquid resists, with a wide range of substrate thicknesses. Clean room conditions prevail in the internal imaging area of the system, ensuring that both the panels and the optical elements are not contaminated during the printing process.

Intended Use

The Paragon Series is intended for the manufacturing of printed circuit boards. It is designed to allow exposure of UV-sensitive resists, films, and similar materials typical of the circuit board industry. However, because of the numerous interrelations between substrate and laser imaging as the exposing technique, the system may only be used with such UV-sensitive materials that have been specifically approved by the manufacturer.

A list of approved materials can be found in the "Table of Tested Resists" on page 65. For the most updated information, contact your Orbotech representative.

Substrate dimensions with resist supported by the Paragon Series are described in Table 1.1.

Table 1.1 Substrate dimensions with resist

Model	Max. Substrate Size	Max. Image Size	Max. Substrate Thickness
Paragon-6000/ 8000/8800	635.0 mm x 812.8 mm 25 in x 32 in	609.6 mm x 812.8 mm 124.24 in x 32 in	8 mm 0.315 in
Paragon-9000	635.0 mm x 812.8 mm 25 in x 32 in	508 mm x 508 mm 20 in x 20 in	3 mm 0.118 in

The machine must not be used in any way other than specified in this manual or in the *Paragon User Guide*.

Safety Considerations

The Paragon Series is a Class 1 laser product containing high-voltage power supplies and laser light sources. There is no danger to persons or equipment when the system is operated in accordance with the directions provided by Orbotech in this and other publications. All high-voltage power supplies and laser sources are located behind protective panels. During system service, with panels removed, the system may reach **Class 4 laser radiation**. Under those conditions, the imager room should have fireproof walls and furniture and should be locked from the inside. During service a red warning light on the outside of the room should be activated, and all personnel in the vicinity of the system must wear protective goggles. For a description of the safety requirements in the site, refer to Chapter 3— **Facility Physical Requirements**.Do not remove any of the system's protective panels.

Professional heavy-equipment movers should be employed to unload the system and transfer it to the site. The customer is responsible for providing necessary equipment such as forklifts with extra extension or cranes for the unloading and unpacking of the equipment. Size and weight of system units is listed in Table 2.1 on page 8.

System installation, disassembly, maintenance and repair must be performed only by authorizes Orbotech customer support engineers, in order to comply with all applicable safety requirements regarding the use of laser devices.

Laser Safety

The Paragon Series is classified as a Class 1 laser product, in compliance with EN60825-1 standard.

Laser Definition

A *Coherent Paladin 355* Class 4 laser is used as main light source.

The *Paladin* is a 355 nm diode (UV) pumped solid-state mode-locked laser, with the following specifications:

Main Wavelength	355 nm (350-360 nm UV light)	quasi-cw power of 10 W
Secondary Wavelengths:	1064 nm (1060-1070 nm UV light)	quasi-cw power less 0.2 W
	532 nm (520-540 nm green light)	quasi-cw power less 0.2 W
Minimal Beam Diameter	0.05 mm	
Minimal Beam Divergence	0.5°	
Pulse Rate	80 MHz	
Pulse Energy	125 nJ	
Pulse Length	5 ... 20 ps	
Max Power	10 W	

The imager unit should be located in a room that can be closed off during periodic maintenance and repair. At the user level, the imager is a Class 1 laser device (no special protection needed) during all standard operations. However, during certain service procedures, Class 4 will be reached, and therefore a warning light must be installed (see Chapter 3).

System installation, disassembly, maintenance, and repair must be performed only by authorized Orbotech customer support engineers, in order to comply with all applicable safety requirements regarding the use of laser devices.

Orbotech recommends that you provide laser safety training to all employees who work on or around the laser system so that these employees understand the bio-effects of lasers and laser radiation.

Full eye protection by safety goggles is required when machine is open during service/maintenance (i.e. laser reaches Class 4) in compliance with standard DIN/EN207. (See “Safety Goggles” on page 12).

Fire Equipment

Portable fire extinguishers must be on hand and in visible location in the direct vicinity of the machine. Recommended type: carbon dioxide (CO_2).

Caring for Your System

- Only materials which have been approved by the manufacturer may be used with the system.
- The system must not be used for temporary storage of any objects. The shielding panels have a load capacity of up to 10 kg, designed for carrying necessary work materials.
- Do not place any objects on the movable cover plates.
- Leaning, sitting, or stepping on the system is strictly forbidden.
- The machine must not be used in any way other than specified in this manual or in the *Paragon User Guide*.

Noise Level

The system’s noise level is 70 dB (A).

Chapter 2

Paragon Series Physical Description

Configuration

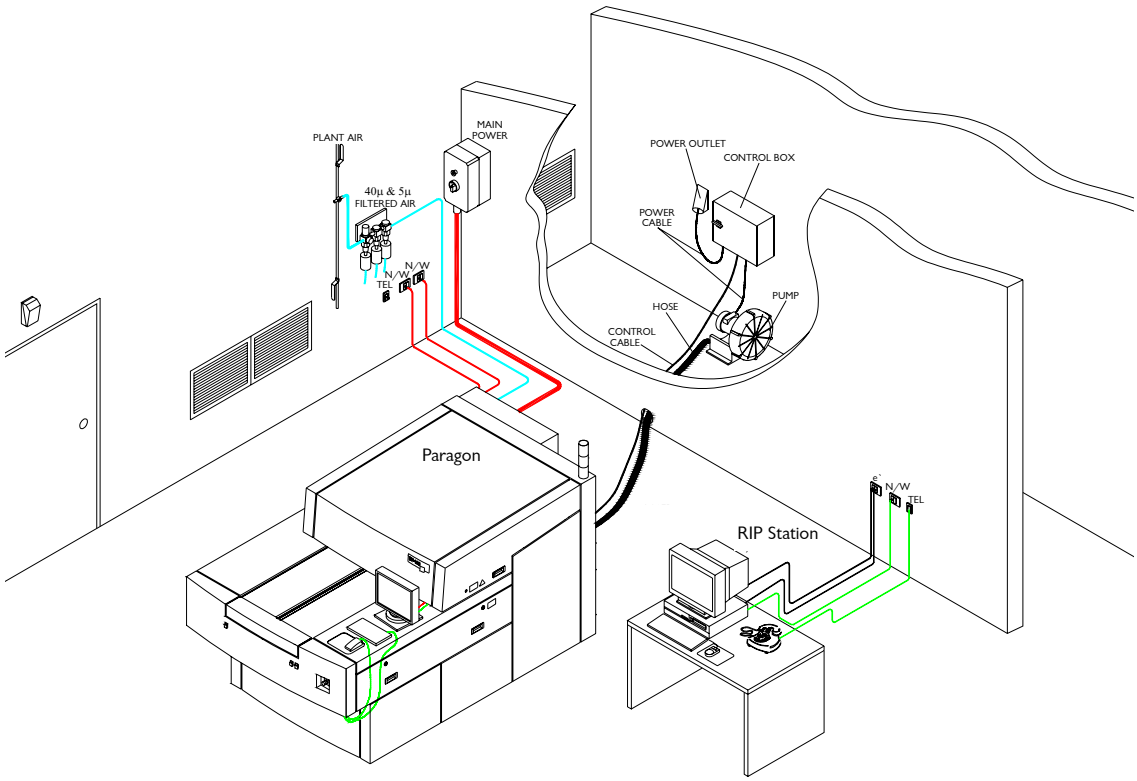


Figure 2.1 Paragon Series Site

The Paragon comprises the following main units:

- Laser Imager Unit - including Power Connection Unit/Box and Transformer.
- Vacuum System - comprising Vacuum Pump & Control Box
- RIP workstation with a Raster Image Processor (RIP)

The imager unit is connected to the workstation via Fast Ethernet. It should be located in a yellow light room (as with standard contact printers) with clean room conditions of class 100,000 or better (US-Federal-Standard 209E).

Size and Weight

Table 2.1 lists weight and size information for the standard Paragon units.

Table 2.1 Size and Weight of Standard Paragon Units (ready for operation)

Unit	Width	Depth	Height	Weight
Paragon Series Imager (i.e. basic unit)	1654 mm 65.12 in	3163 mm 124.5 in	1780 mm 70.0 in	2550 kg 5622 lbs
Vacuum Pump* (in separate room)	334 mm 13.15 in	314 mm 12.36 in	337 mm 13.27 in	20 kg 44 lbs
Control Box (Vacuum) (mounted on wall, at height 39.4 in/1 m from floor)	300 mm 11.81 in	160 mm 6.30 in	400 mm 15.75 in	5.1 kg 11.24 lbs
RIP Workstation** (monitor, kbd, computer)	410 mm 16.14 in	700 mm 27.56 in	420 mm 16.54 in	15 kg 33 lbs

***** Dimensions refer to pump only (no add-ons included). Add-ons increase *Depth* dimension by 400 mm (15.75 in).

****** Measurements do not include a table on which the workstation is placed. The customer must supply this table. RIP workstation measurements are liable to change without notice.

Hose Lengths

Table 2.2 lists information on the size of the hoses.

Table 2.2 Paragon Series Hose Lengths

Hose	Length (standard supplied)		Diameter
Compressed air line (from the machine to plant air supply)	10 m	33 ft	0.39 in (10 mm) outside

Note

For vacuum pump hoses refer to Table 6.3, "Vacuum Pipe Lengths & Inner Diameters," on page 32.

Chapter 3

Facility Physical Requirements

Safety Requirements

Note

The customer is responsible for ensuring conformance with local safety regulations. As such, the requirements below can only be considered to be recommendations.

Warning

When the Paragon Series cover doors are removed (servicing mode), the laser becomes a Class 4 hazard. In this situation, the laser beams diffused reflection is extremely hazardous. Goggles must be worn. Service must only be performed by an Orbotech qualified engineer.

The Paragon Series should be installed in a room that can be isolated to safeguard against laser hazards. These hazards can only arise during periodic maintenance and service, in specific situations (hood open and interlock neutralized). The safeguards described below are required during such service procedures, and do not have to be activated during normal usage of the system.

Preventing Access to the Imager Room during Service

The imager room door should have a lock that can be locked from the inside to prevent access to the room. A box with a key to be used for entry in case of emergency should be located next to the door, on the outside.

Safety Goggles

When the Paragon imager is open, as during service and maintenance, all personnel who come in contact with the machine must wear safety goggles.

Warning

The Paragon imager reaches Class4 laser radiation when open.

Full eye protection by safety goggles is required, in compliance with DIN/EN207 standard. The customer is responsible for providing safety goggles for his operators.

If the Paragon Series is installed in an open space (not recommended), a method must be available to completely isolate the unit from the rest of the room during servicing procedures (example: appropriate laser safety curtains).

External Warning Light

A red warning light should be placed on the outside of the imager room, above the entrance. The light will be activated under certain service conditions—when the laser is on, the hood up and the imager safety interlock neutralized. The Paragon provides a 24V DC max. 500 mA for the red light (see Figure 3.1, on page 13).

Note

It is the responsibility of the customer to provide and install a warning light as described above.

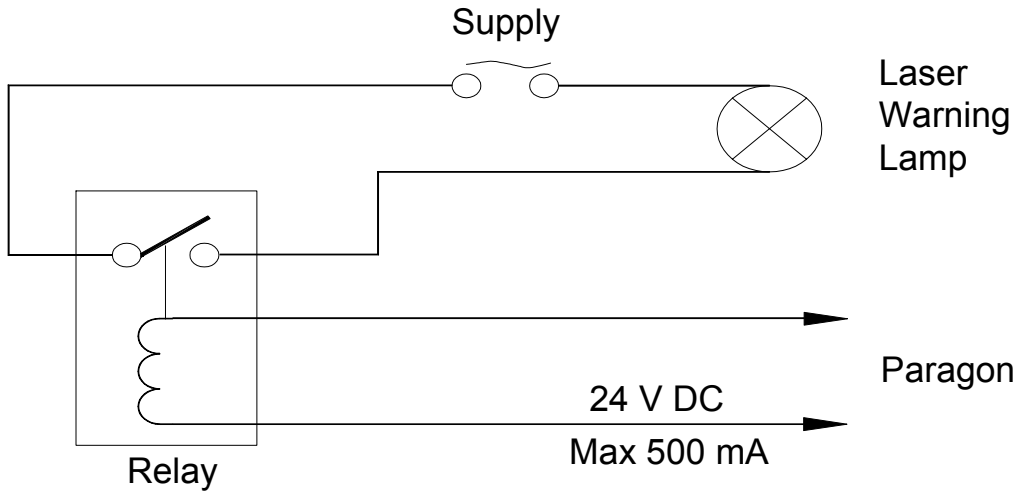


Figure 3.1 External Warning Light

Height Requirements

Height of the system with the hood raised is 2648 mm (104.3 in). We recommend a ceiling height of at least 2750 mm (108.3 in).

During installation, the machine height may vary within a vertical range of approx. 120 mm (4.7 in). Achievable height levels are:

- Between 910 mm (35.8 in) and 1030 mm (44.6 in) for the machine table.
- Between 981 mm (38.6 in) and 1101 mm (43.3 in) for the upper edge of the machine shielding (mouse and keyboard placement level).

Where a different height is required, a pedestal can be used in the operator area or additional steel plates can be put beneath the machine's support legs.

Warning

Avoid potential hazards with the pedestal by taking precautions such as skid-proof surface, easily perceivable edges, sufficient size, etc.

Figures 3.2 and 3.3 (on pages 17 and 18), show system dimensions.

Floor Area

Figure 3.4, on page 19, shows dimensions and minimum recommended working areas for the system's units.

Working and Maintenance Area

The minimal floor space clearance required as work and maintenance areas for each unit is shown in Figure 3.4, on page 19.

Operator's Working Area

The user determines the floor space required for the operator. Refer to Figure 3.4, on page 19, for dimensions of the recommended working area.

Pump Room

The pump room requires a minimum floor space of 500 x 1000 mm (19.7 x 39.4 in).

Other Storage

Storage shelves and cabinets, as well as filing cabinets and other furniture, should be provided for storing digital data storage media and manuals.

Access – Doors and Hallways

Access through the plant hallways to the unpacking area should enable unrestricted transportation of the crates. We recommend unpacking the system outside the working area, in order to protect the clean environment conditions. Once it is unpacked, the system can be wheeled into the working area.

A minimum door width of 1800 mm (71 in) and height of 2010 mm (79 in) is required for the entrance to the working room.

Floors, Walls, Ceilings and Furniture

The floor must have sufficient strength to support the Paragon Series system, which weighs approximately 2450 kg (5401 lbs). Floor strength of 1800 Kg/m² is required, as contact areas between system legs and the floor are small.

The floor supporting the system must be level, with a maximum permissible incline of 5 mm per 1 m (1 in per 16 ft.). Ground floor location is recommended.

The system should not be located near heavy machinery that causes high shock or vibration levels.
According to the DIN-EN 60721-3-3, class 3M3, the permissible sinusoidal floor vibrations are defined by:

- Max. amplitude of floor movement: 1.5 mm at 2 ~ 9 Hz.
- Max. acceleration: 5 m/s² at 9 ~ 200 Hz.

Surface Coverings and Coatings

All surfaces should be matte (non-reflective). The following should be provided where possible:

Walls—painted with epoxy, or other low-porosity, non-shedding, washable paint.

Ceiling—painted in the same manner as the walls, or covered with non-shedding ceiling tiles.

Floors—covered with antistatic tile, rubber, or linoleum. Carpeting is not allowed.

Furniture—should be resistant to static buildup. Cloth-covered seats are preferable to plastic-ones. The feet of the furniture should **not** be insulated from the ground, for example by rubber caps.

Yellow Room Illumination

Safe lighting should be as per specifications of the resist manufacturer, for example *Encapsulite Gold 10*.

Normal illumination should also be provided for maintenance and service procedures.

System and Site Dimensions

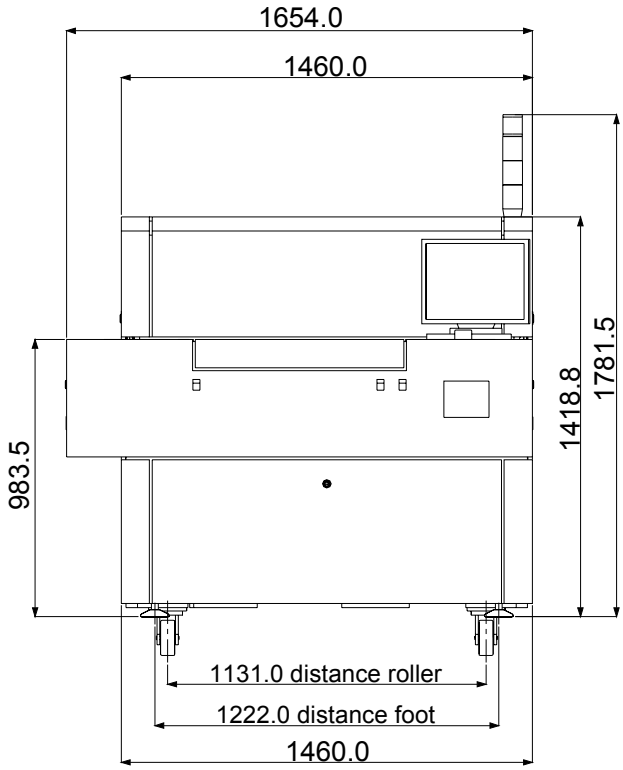


Figure 3.2 System Dimensions—Front View

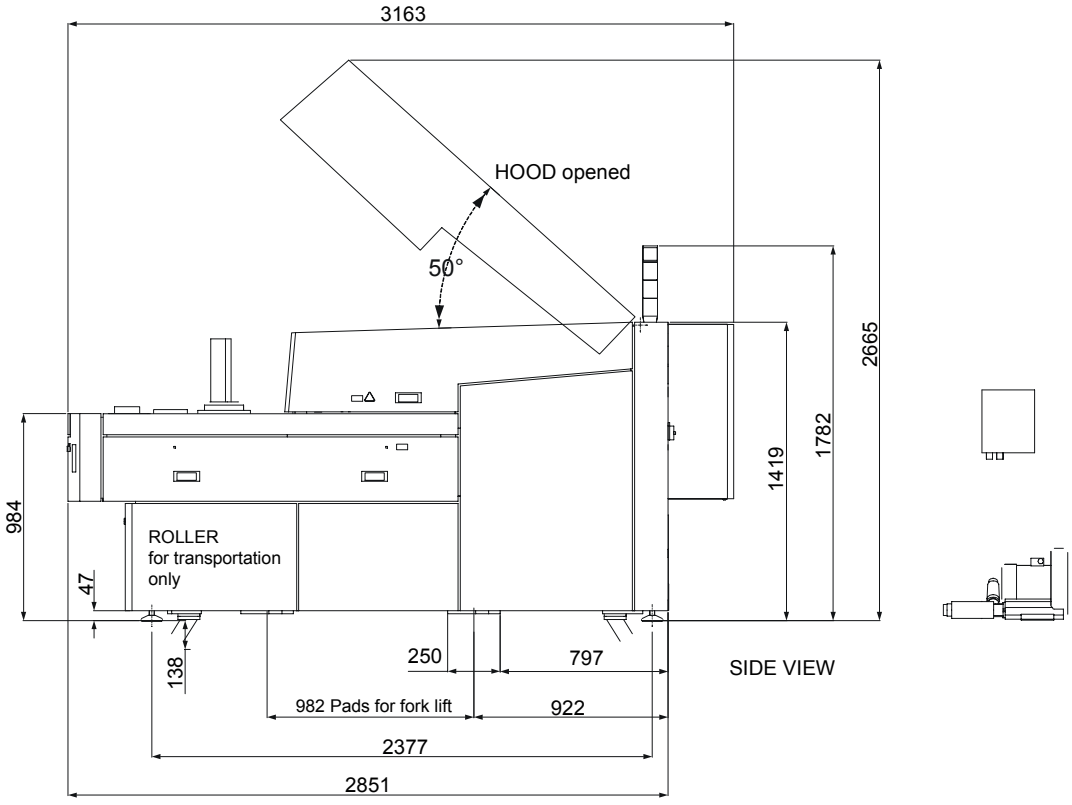


Figure 3.3 System Dimensions—Side View

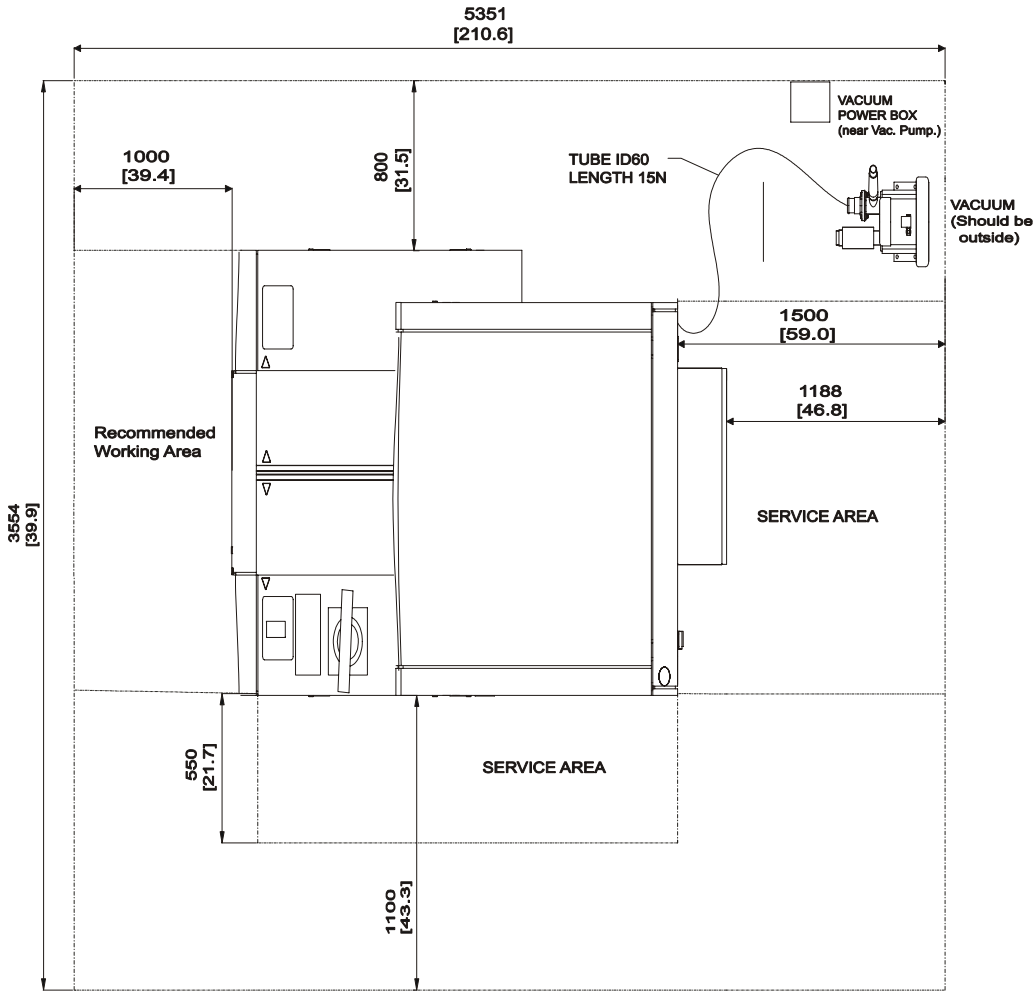


Figure 3.4 Site Dimensions—Standard Configuration

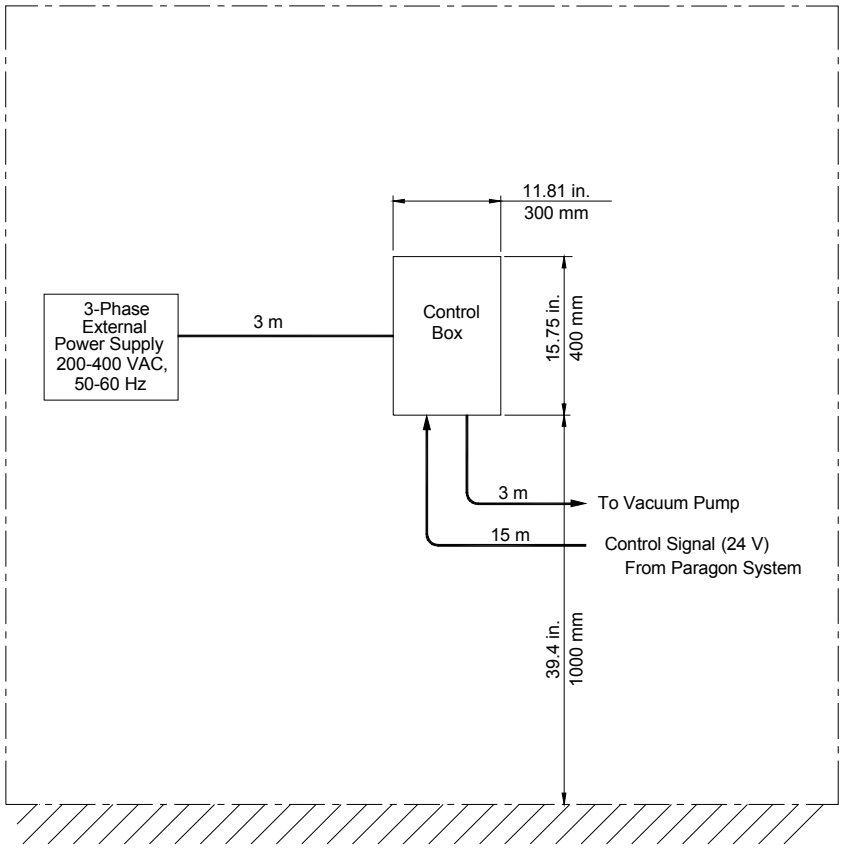


Figure 3.5 Mount Description for Vacuum Control Box

Chapter 4

Environment & Climate

Clean Room

Paragon installation requires a separate room, with separate air conditioning.

Clean room level class 100K or better (class 10K is recommended) according to ISO 14644 is required in order to reach the specified system specifications. The air of the clean room may contain some organic chemicals, within restricted levels (refer to “Ambient Air Conditions” on page 23).

Recommendations:

- Ceiling-to-floor (laminar) filtered airflow to reduce particulate contamination.
- Class 10K clean room (per Fed Spec 209E).
- Inline AMC(*)/Chemical filtration system.

Note

(*) AMC = Airborne Molecular Contamination

- Dedicated standalone air makeup system that is free from organic chemicals and ammonia that may attack system components.

Climate Control

Room climate control must be designed so that operating temperatures and humidity, as described in Table 4.1 on page 22 and Table 4.2 on page 23, are maintained when the system operates at full power (see

Table 4.3 on page 23). Do not supply electrical power for the climate control system from the same source as the system.

The customer needs to install a temperature/humidity meter in the room.

Caution

The air flow should not be directed toward the machine.

Room Temperature

Table 4.1 Operating and Storage Temperatures

Unit	Operating Temperature	Storage Temperature*
Paragon Series	20° C to 23° C (68° F to 73° F)	0° C to 35° C (32° F to 95° F)

***** Storage temperature allowed only when in original packaging.

Caution

In order to achieve the specified system performance, the imager room temperature must be set within the above range, and must not fluctuate more than ±2° C from the set point during operating hours.

Vacuum room

The vacuum room must be ventilated. Temperature in the vacuum room should not exceed 35° C.

Humidity

Table 4.2 Operating Humidity

Unit	Operating Humidity	Storage Humidity*
Paragon Series	50% to 60%	10% to 80%, non-condensing

* Storage humidity allowed only when in original packaging.

Heat Dissipation

Table 4.3 Maximum Heat Dissipation for System Units

Unit	Heat Dissipation
Paragon Imager	4 kW (228 BTU/minute) - To air
Pump	1.5 kW (114 BTU/minute) - To air

Ambient Air Conditions

Note

Prior to installation of the system, we will perform an analysis of the AMC level in the room to ensure that it meets the environmental requirements for the Paragon Series.

Maximum AMC levels for the Paragon Series room environment are:

- Total concentration of Condensables: (According to SEMI F21-95 standard, organic components with b.p. > 150°C) $< 50\ \mu g/m^3$
- Total amount of Glycol and Glycol-derivated compounds: $< 20\ \mu g/m^3$

The ambient air must be free of chlorine and other chemical compounds that contain chlorine, such as HCl or any salt compounds.

All these conditions must be met. If they are not, take countermeasures such as isolation of sources or supply of filtered air.

Chapter 5

Electricity

Power Requirements

Table 5.1 Power Requirements for the Paragon Series machine

Paragon Series, 3 Φ + neutral + ground	**400 V (Europe)**	**480 V (USA)**	**200 V (Japan)**
Voltage	400 V ±10%	480 V ±10% 208 V ±10%	200 V ±6%
Frequency	50±1 Hz	60±1 Hz	50/60 ±1 Hz
Current	3 x 10 A	3 x 10 A 3 x 20 A	3 x 20 A
Maximum power consumption	4 kVA	4 kVA	4 kVA

Note

- The Paragon Series machine comes with a 10 m connecting cable, that must be connected to a general clamp at the rear wall close to the machine.
- The transformer, when required, is located inside the Paragon Series machine.

Table 5.2 Power Requirements for the Pump

Pump, 3 Φ + ground	400 V (Europe)	208 V (USA)	200 V (Japan)
Voltage	400 V ±10%	208 V ±10%	200 V ±10%
Frequency	50±1 Hz	60 Hz	50/60 Hz
Current	3 x 4 A	3 x 8 A	3 x 8 A
Maximum power consumption	1.5 kVA	1.5 kVA	1.5 kVA

Grounding

The Paragon Series ground should be connected to a special ground line, which is connected to the building ground. **A fixed installation to the ground has to be provided before switching on the system.** Ground connection impedance must be < 0.5 Ohms.

Voltage Transients

Table 5.3 shows allowable voltage transients. This should be tested when all machinery and air conditioning units are operating normally and the system is turned on.

Unless the following spec can be met by current on-site electrical installations, a line conditioner is required.

Table 5.3 Allowable Voltage Transients

Transient Duration (msec)	Transient Amplitude (Volts)
<5	<2000

Electrical Protection

An automatic, slow-blow 3-phase circuit breaker should be installed in series to the power line.

Table 5.4 Requirements for the circuit breaker

Unit	400 V (Europe)	480 V / 208 V (USA)	200 V (Japan)
Machine	16 A	16 A / 32 A	30 A
Pump	16 A	16 A	15 A

Power Connectors

The electrical supply must have a lockable main switch. The customer is responsible for providing this switch, as well as circuit breakers and receptacles according to prevailing local standards.

The customer must provide a power outlet for the servicing, which will be connected to the same power line as the machine.

Chapter 6
Vacuum Pump

Orbotech supplies a 3-Phase 50 or 60 Hz vacuum pump with the following specs and dimensions:

Table 6.1 3-Phase 50 Hz Vacuum Pump Specs

Curve No.	Motor			Weight approx. (kg)
	Rated		Degree of protection	
	Output (kW)	Current (A)		
20H	1.3	6.6Δ/3.8Y	IP55	20

Table 6.2 3-Phase 60 Hz Vacuum Pump Specs

Curve No.	Motor			Weight approx. (kg)
	Rated		Degree of protection	
	Output (kW)	Current (A)		
25H	1.5	6.9Δ/4.0Y	IP55	20

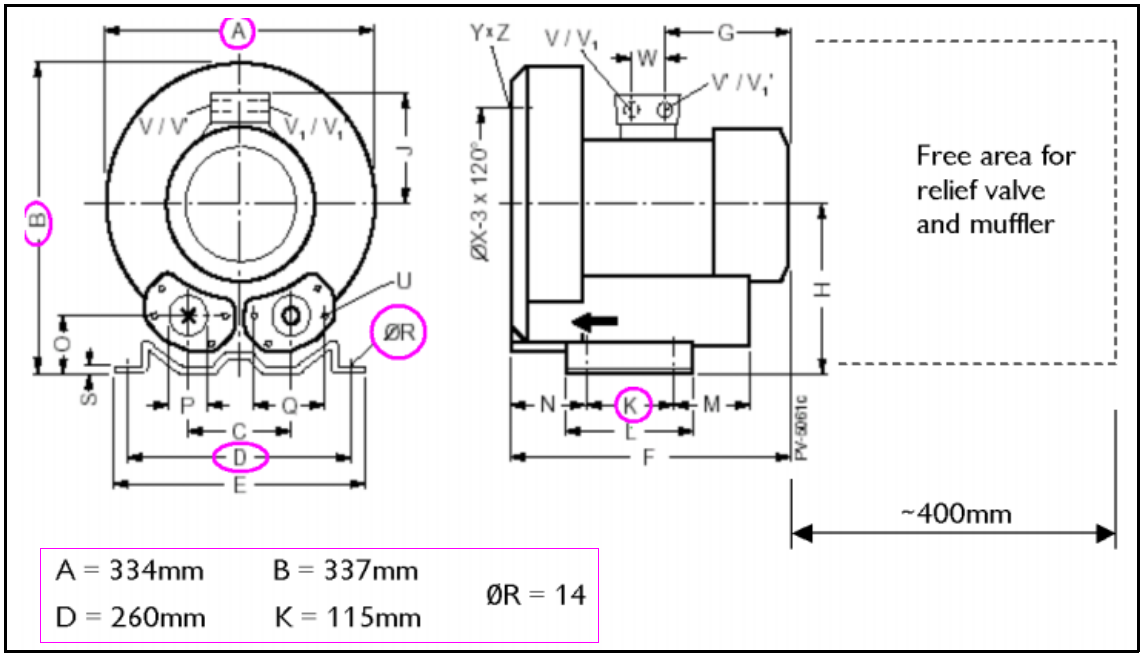


Figure 6.1 Vacuum Pump dimensions

Note

The dimensions D, H, K & ØR are relevant for pump mounting. Use M8 or bigger.

Orbotech supplies the vacuum pump together with:

- a 15 m flexible vacuum hose/pipe (Paragon to Pump)
- a 15 m control cable (Paragon to Control Box)
- two 3 m power cables (Control Box to Pump and to power outlet)

All preparations required for installation, and the installation itself, are the responsibility of the customer. The vacuum pump should be installed in an isolated environment due to its noise level.

Note

Important: ensure this separate room is ventilated!

Maximum allowed ambient air temperature is 40° C (104° F).

Maximum allowed distance between system and pump is 40 m (132 ft.):

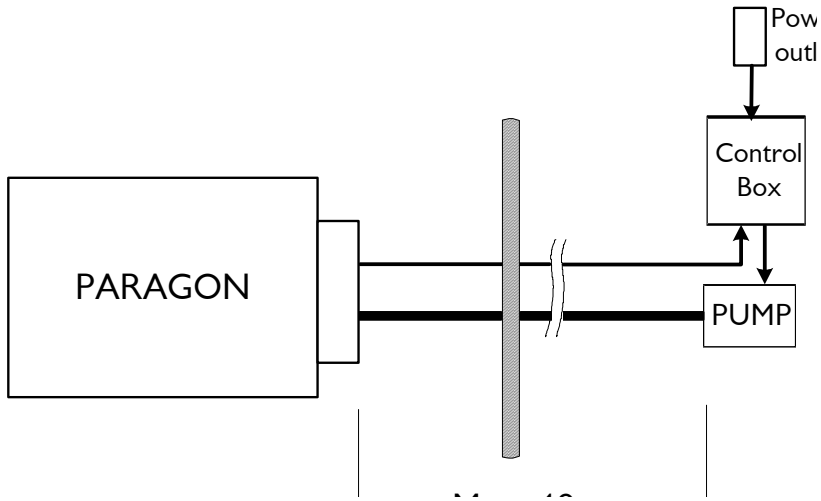


Figure 6.2 Vacuum pump—distance from Paragon Series

Smooth plastic water installation piping is recommended.

Vacuum pipe lengths and corresponding inner diameters are specified in Table 6.3 below.
Pipe routing should enable access to all connection points for maintenance in case of leakage.

Table 6.3 Vacuum Pipe Lengths & Inner Diameters

Vacuum Pipe Length	Corresponding Inner Diameter
40 m (132 ft.) - maximum allowed length	10.16 cm (4 inch)
30 m (98 ft.)	7.62 cm (3 inch)
20 m (66 ft.)	7.62 cm (3 inch)
15 m (49 t.) - supplied by Orbotech	6.35 cm (2.5 inch)

Chapter 7

Communication

Phone Lines

A phone line should be installed near the system for troubleshooting and for remote instructions to operators by Orbotech personnel. The customer will supply the telephone. A second external analog line must be available for remote diagnostics via modem. **Both lines should have direct outside dialing**.

Network

The customer is responsible for preparing four *Ethernet* network connection points in the immediate vicinity of the system.

The connecting points are required for:

- Paragon Series basic unit
- RIP workstation
- Service

FTP communication is required for sending out the log files from the Paragon Series to the Response Center, for System Performance Analysis.

Note

A Service Network Drop is strongly recommended. It will be used for a VPN for Diagnostics through Remote Access.

Chapter 8
Air

Compressed Air

Table 8.1 shows the requirements for compressed air at the site.

Table 8.1 Compressed Air Requirements

Pressure	0.7 ~ 1.0 MPa (7 - 10 bar)[a]
Air supply rate	200 liters/minute
Quality	Dry (water: 0.03 g/m³) Filtered (dust: 0.1 µm, 0.1 mg/m³) Free of oil (oil: 0.01 mg/m³)
Tube connectors	10 mm (outside diameter)

a. An internal Air Booster can be added to the system when the required pressure of 7 bar cannot be provided. Minimum pressure: 5 bar

It is the customer's responsibility to maintain filtering of the outside supply to ensure an oil-free compressed air supply.

Filtration and Control

Compressed air must be sufficiently clean to prevent it from causing malfunction or damage. A filtration system similar to the one in Figure 8.1 is recommended.

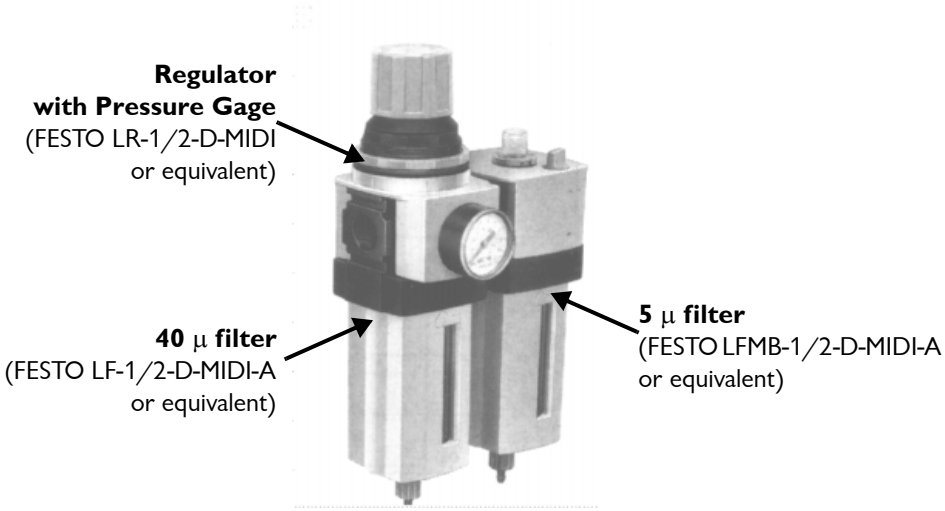


Figure 8.1 Recommended Air Filtration System

Chapter 9

Shipment and Delivery

Shipping Information and Responsibility

Orbotech or its agents will arrange shipment to the customer's facilities. It is the customer's responsibility to provide Orbotech with delivery instructions. The customer is responsible for transporting system units to a suitably prepared installation site, and verifying that the units can be freely moved into the installation site. Orbotech engineers will advise and instruct the customer on site preparation.

Caution

Equipment should be unpacked by authorized Orbotech engineers only.

Crates

The Paragon Series arrives in two wooden crates. Crates' approximate sizes and weights are given in Table 9.1 below.

Table 9.1 Shipping Crate Sizes

Unit	Width	Depth	Height	Weight
Paragon Imager[a]	3310 mm 130.3 in	1860 mm 73.2 in	1980 mm 78 in	3000 kg 6614 lbs
Accessories[b]	1310 mm 51.6 in	1200 mm 47.2 in	1110 mm 43.7 in	230 kg 507 lbs

a. Includes the Laser Head
b. Including Power Vacuum & Control box

Equipment

The customer should provide necessary equipment such as forklifts or cranes for unloading of equipment.

- Forklift—capable of lifting 5000 kg / 11024 lbs; with a 220 cm (86 inch) extension
- Pallet jack
- J-Bar

Personnel

The customer must furnish professional riggers to unload the crates and transfer them to the site. The riggers will assist Orbotech personnel in unpacking the equipment.

No equipment should be unpacked before the arrival of Orbotech personnel.

Clearances

Check crate delivery routes and remove all obstructions. Ensure that all doors and hallways along the delivery route are large enough to provide sufficient clearance, that elevators (if needed) have the required capacity, and that corridors are free of slopes or sharp bends.

Appendix A
Customer Site Preparation Checklist

Safety Issues	Complete	Pending	Date	Notes
A red warning light installed outside the imager room, above the entrance.				
Portable carbon dioxide fire extinguishers near the system.				
Imager room has fireproof walls and furniture.				
Protective goggles available in imager room.				

Compressed Air Issues	Complete	Pending	Date	Notes
Air line pressure: 0.7 ~ 1.0 MPa (7 - 10 bar)				
Air supply rate of 200 liters/minute				
Quality: dry (water 0.03 g/m^3) filtered (dust: 0.1 µm, 0.1 mg/m^3) free of oil (oil: 0.01 mg/m^3) free of chlorine				
10 mm ϕ tube connectors				

Electrical Issues	Complete	Pending	Date	Notes
Requirements for the Paragon Series machine (as listed in Table 5.1 on page 25).				
Main electrical power supply has a switch.				
Maximum voltage transient of <5 msec, <2000 V				
Automatic slow blow circuit breaker installed in series in each power line.				
Ground connection impedance less than 0.5 Ohms.				
Electrical power for air conditioning is from different source than the system.				
Requirements for the Pump (as listed in Table 5.2 on page 26).				

Imaging Room Issues	Complete	Pending	Date	Notes
Image room size at least: 3.55 W x 5.80 L x 2.80 H (meters) 11.7 W x 19.0 L x 9.2 H (feet)				
The door is at least 1800 mm (71 in) wide and 2010 mm (79 in) high.				
Room isolated to safeguard against laser hazards.				
Room doors have a lock that can be locked from the inside.				
A box with a key for emergency entry is located outside the room.				
Paint in room is non-shedding and washable.				

Imaging Room Issues (cont.d)	Complete	Pending	Date	Notes
The ceiling is painted with epoxy, or other low-porosity, non-shedding, washable paint, or covered with non-shedding ceiling tiles.				
Room is in Clean Room 100,000 class or better (according to US Federal Std. 209E).				
Clean room conditions are prepared prior to system installation.				
All surfaces have a non-reflective matte finish.				
The system is not located near heavy machinery.				
The amplitude of movement of vibrations is less than 1.5 mm at 2 ~ 9 Hz.				
The acceleration of vibrations is less than 5 m/s^2 at 9 ~ 200 Hz.				
Floor strength is at least 1800 kg/m^2.				
Floor incline no more than 5 mm per meter (1 in per 16 ft.).				
The floor is covered with anti-static tile, rubber or linoleum. No carpeting.				
The Imaging room is its own room with its own environment (i.e. not part of a bigger room).				

Pump Room Issues	Complete	Pending	Date	Notes
Pump room size at least: 0.5 x 1 (meters) 1.64 x 3.28 (feet)				
Pump room is its own room with its own environment (must be ventilated!).				
Pump installed and connected.				

Pump Room Issues (cont.d)	Complete	Pending	Date	Notes
Control box installed and connected.				
Hoses routed correctly and accessible for maintenance.				

Imaging Room Environment Issues	Complete	Pending	Date	Notes
Room temperature with machine in operation: 20° C ~ 23° C ± 2° C (68°F ~ 73°F).				
Room temperature with machine in original packing: 0° C ~ 35° C (32° F ~ 95° F).				
Temperature sensors installed in room.				
Room humidity with machine in operation: 50% ~ 60%.				
Room humidity with machine in original packing: 10% ~ 80% non-condensing.				
Humidity sensors installed in room.				
Ventilation: ceiling-to-floor or walls-to-floor filtered laminar airflow.				
VOC air sampling				

Pump Room Environment Issues	Complete	Pending	Date	Notes
Room temperature: max. 40° C				

Furniture Issues	Complete	Pending	Date	Notes
Storage shelves and cabinets available for storage of digital media and manuals.				

Furniture Issues (Cont.d)	Complete	Pending	Date	Notes
Furniture is resistant to static buildup.				
The feet of the furniture are not insulated from the ground.				
All furniture surfaces have a non-reflective matte finish.				

Access and Transport Issues	Complete	Pending	Date	Notes
Easy access for movement of crates, through the hallways, to the imaging room from the storage room.				
Unpacking space outside the work area.				
Forklift and crane available for movement and installation.				

Communications Issues	Complete	Pending	Date	Notes
Three ethernet network connection points are available near the system.				
A phone line with IDD is installed near the system.				
A second phone line with IDD is installed for remote diagnostics via modem.				

RIP Workstation Issues	Complete	Pending	Date	Notes
Table-top space is allocated for workstation.				
A 1 KW UPS is recommended.				

Material Issues	Complete	Pending	Date	Notes
Proof Paper				
Antifoam according to the LDI producer*				
Small pump to add antifoam into the developer*				
LDI photoresist				
6 liters of steam-distilled water				
Table tooling hole dimensions were sent to Orbotech for OK.				
LDI resist passed successfully all the processing tests (including contact printing).				

* Depends on technology and resist

Checked by: Orbotech Representative: _____ Date: _____

Customer Representative: _____ Date: _____

Appendix B

Paragon CCD Registration

CCD Registration Purposes

Paragon registration is done by two high-precision CCD cameras. These cameras can be moved:

- in Z direction (focus), to adapt to different panel thicknesses
- in X direction (from left to right) to cover arbitrary target positions inside the active CCD area.

In Paragon machines, CCD registration is used for:

- **Panel alignment -** to adapt to unavoidable tilts and shifts in panel positioning
- **Print scaling** - to fit the print to panel size variations caused by production tolerances and temperature gradients
- **Side recognition** - to avoid misprints caused by operator mistakes when placing the panel on the stage
- **Panel identification** using data matrix code - to select dedicated exposure data (optional machine license required)

CCD Registration Modes

There are 2 CCD registration modes:

- On-the-fly (triggered) registration
- Static registration

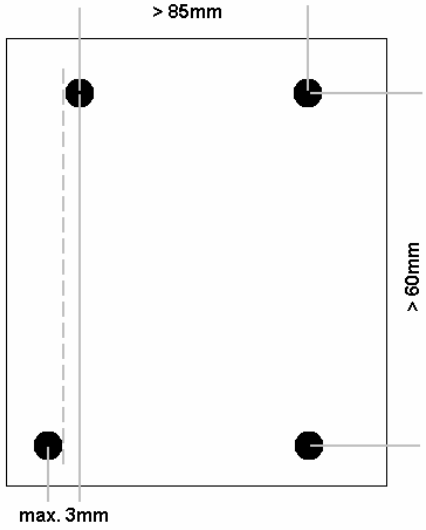
On-the-fly Registration (Triggered Mode)

On-the-fly registration is the preferred registration type. This is because registration is performed as the stage passes the CCD cameras when it is moving from load position to print start position, and not as a separate process that stops stage motion.

To perform on-the-fly registration, CCD cameras first move to the expected target focus and X positions and stay at these positions. When a print starts, the stage moves in Y direction and *triggers* the cameras as the expected target Y positions are passed. That is why this mode is also called *triggered* mode.

Special requirements

- Maximum asymmetry in X is 3 mm
- X distance must be more than 85 mm to prevent camera collision
- Y distance must be more than 60 mm; the stage will already move slower than the normal 1 m/s if target Y distance is less than 300 mm



Pros and Cons

- Triggered mode is fast and allows high throughput
- Some limitations in target distance and X positioning

Note

If on-the-fly registration is selected but not all requirements are met, static registration is used automatically.

Static Registration

Static registration is performed by stopping the stage at expected target positions and measuring the target positions with the CCD cameras.

To perform static registration, the CCD cameras first move to the expected focus position. The stage moves to the first expected target Y position and stops. If necessary, the CCD cameras then move to the required target X positions. When everything is aligned, the current targets under the cameras are measured. Then, the stage and the cameras move along to the next target positions in the same way.

Special requirements

None.

Pros and Cons

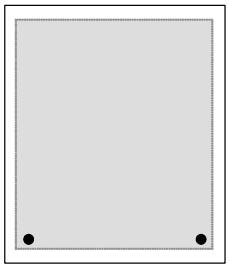
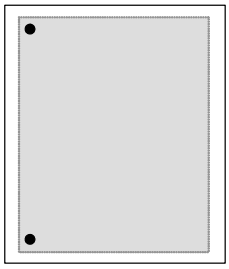
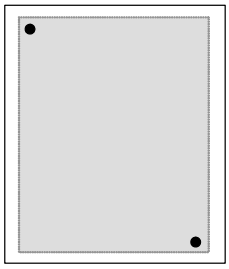
- Static mode is absolutely flexible regarding target positions and distances.
- Additional mechanical positioning of stage and CCD cameras slows down the registration process and decreases the throughput.

Possible Target Configurations

2 Targets

2-target registration is normally used to for panel alignment only. Full scaling or side recognition information cannot be gathered from 2 targets.

Table B1 2-target registration options

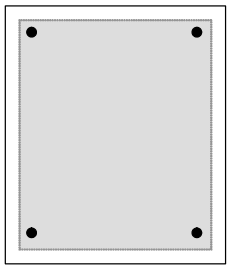
Description	Example
Horizontal: The targets are placed horizontally inside the print area.	
Vertical: The targets are placed vertically inside the print area.	
Diagonal: The targets are placed diagonally inside the print area.	

4 Targets

Four targets are placed inside the corners of the rectangular print area. With four targets, full scaling and side recognition information can be created.

This is the preferred configuration for production.

Table B-2 4-target registration

Description	Example
The targets are placed inside the corners of the print area.	

Panel Side Recognition

The side recognition feature of the Paragon CCD system can prevent misprints caused by wrong panel placement. This includes detection of:

- wrong side on top
- wrong panel orientation

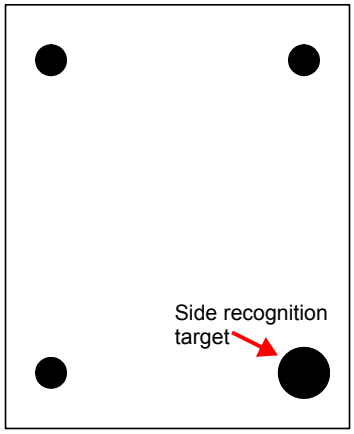
If a side recognition fault is detected, the system warns in advance before printing, enabling correction of the error.

Side Recognition by Target Size

When using target size to perform side recognition, one and only one of the four targets can be a different size than the others. The system can detect the difference and decide which side of the current panel is face up.

Note

This side recognition mode can only be performed with *circular* and *mixed* targets. To use a wider range of target types, use **side recognition by target position**.



Side Recognition by Target Position

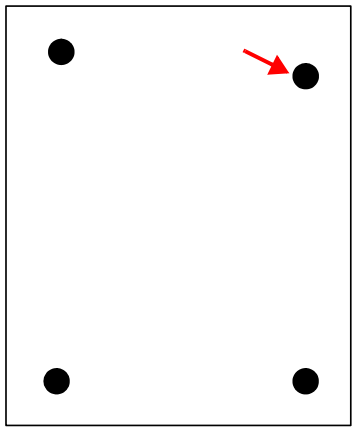
When using the target positions to perform side recognition, at least one target must be positioned in an asymmetrical position. The system considers the relative target positions and distances, and compares them to the expected target positions.

Note

To ensure side recognition, positions must differ by at least 0.5 mm.

Tip

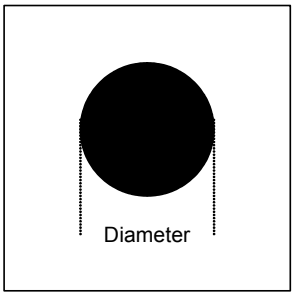
To use on-the-fly registration mode, targets must be aligned on the X-axis. Otherwise, you will need to use static registration, which will reduce throughput.



CCD Target Catalog

Circle

Diagram



Application

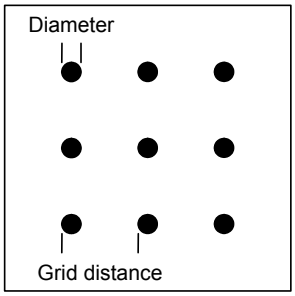
Drilled Through	Printed	Micro Via	UV Marker
✓	✓		

Parameters

Parameter	Minimum	Maximum	Recommended
Diameter	0.5 mm	5 mm	**2 mm**

3 x 3 Matrix

Diagram



Application

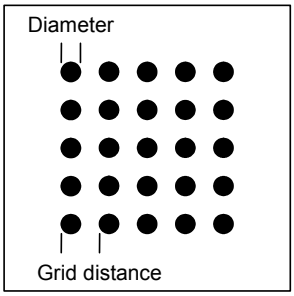
Drilled Through	Printed	Micro Via	UV Marker
✓	✓		

Parameters

Parameter	Minimum	Maximum	Recommended
Diameter	0.3 mm	1 mm	**0.5 mm**
Grid distance	0.6 mm	2 mm	**1.5 mm**

5 x 5 Matrix

Diagram



Application

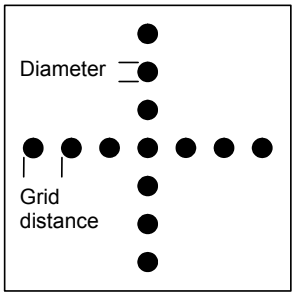
Drilled Through	Printed	Micro Via	UV Marker
✓	✓		

Parameters

Parameter	Minimum	Maximum	Recommended
Diameter	0.3 mm	0.75 mm	**0.5 mm**
Grid distance	0.6 mm	1.5 mm	**1 mm**

Dot Cross

Diagram



Application

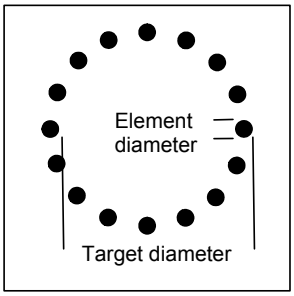
Drilled Through	Printed	Micro Via	UV Marker
✓	✓		

Parameters

Parameter	Minimum	Maximum	Recommended
Diameter	0.1 mm	0.75 mm	**0.25 mm**
Grid distance	0.25 mm	1.5 mm	**0.5 mm**
Row/column extent	3	25	**9**

Circular Multi Dots

Diagram



Application

Drilled Through	Printed	Micro Via	UV Marker
✓	✓	✓	

Parameters

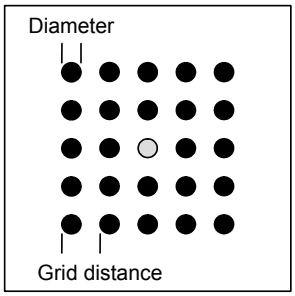
Parameter	Minimum	Maximum	Recommended
Element Diameter	0.15 mm	0.75 mm	**0.3 mm**
Target Diameter	1 mm	5 mm	**3 mm**
Dot Count	5	40	**16**

Micro Vias

Note

The center element is optional.

Diagram



Application

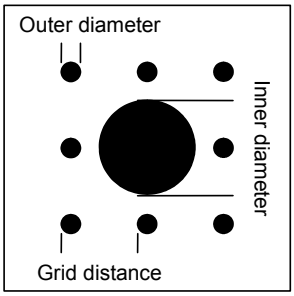
Drilled Through	Printed	Micro Via	UV Marker
		✓	

Parameters

Parameter	Minimum	Maximum	Recommended
Element Diameter	0.1 mm	0.5 mm	**0.2 mm**
Grid Distance	0.4 mm	1.5 mm	**0.6 mm**

Mixed Matrix

Diagram



Application

Drilled Through	Printed	Micro Via	UV Marker
✓	✓	✓	

Parameters

Parameter	Minimum	Maximum	Recommended
Outer Diameter	0.1 mm	0.5 mm	**0.2 mm**
Inner Diameter	0.5 mm	4 mm	**1.5 mm**
Grid Distance	0.5 mm	2.5 mm	**1.5 mm**

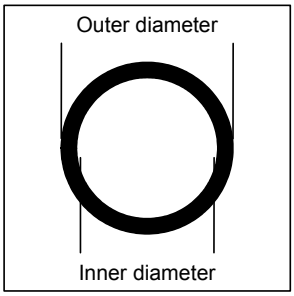
Note

The center element can be a **through hole** or a **printed pad**. The outer elements should be **micro vias**.

The target positions, as described by the center and by the outer elements, are weighted by user-defined factors and are merged for the final target position. That way, two different processes on the panel can be combined

Ring/Donut

Diagram



Application

Drilled Through	Printed	Micro Via	UV Marker
	✓	✓	

Parameters

Parameter	Minimum	Maximum	Recommended
Outer Diameter	0.9 mm	5 mm	**2 mm**
Inner Diameter	0.5 mm	4.6 mm	**1.6 mm**

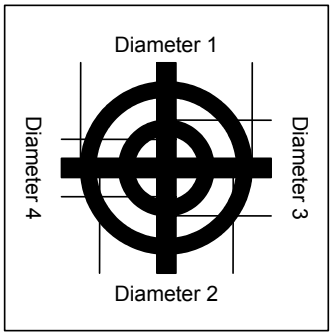
Note

Entering a value for the inner diameter is optional.

The ring can also be created as overlapping micro vias.

Graticule

Diagram



Application

Drilled Through	Printed	Micro Via	UV Marker
	✓		

Parameters

Parameter	Minimum	Maximum	Recommended
Diameter 1	1.7 mm	5 mm	**2 mm**
Diameter 2	1.3 mm	4.6 mm	**1.6 mm**
Diameter 3	0.9 mm	4.2 mm	**1 mm**
Diameter 4	0.5 mm	3.8 mm	**0.8 mm**

Note

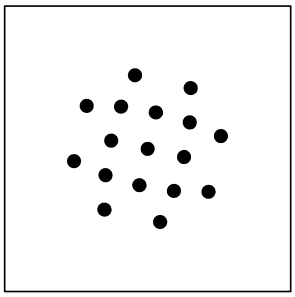
The horizontal and vertical cross lines should only slightly exceed the outer circle diameter.

UV Marker

UV markers are created by dedicated hardware built into Paragon machines. This hardware exposes the pattern shown above onto the current resist of the bottom side during regular exposure of the top side. The color change of the exposed resist is used for later registration of the bottom side.

This target is only used for special applications using an additional software license. For detailed information please contact Orbotech.

Diagram



Application

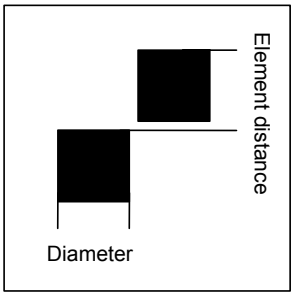
Drilled Through	Printed	Micro Via	UV Marker
			✓

Parameters

None

Butterfly

Diagram



Application

Drilled Through	Printed	Micro Via	UV Marker
	✓		

Parameters

Parameter	Minimum	Maximum	Recommended
Size	0.2 mm	2 mm	**1 mm**
Element Distance	0.2 mm	3 mm	**1 mm**

Note

Normally the element distance is equal to the size of the elements. Sometimes the production process shrinks the elements homogenously, for example by etching, and the elements get smaller while a gap is created between them. The elements are not allowed to overlap.

Appendix C
Table of Tested Resists

A list of resists that have been tested for use in the Paragon systems is provided in the following table.

Note

The table contains currently tested materials and is reviewed periodically. For the most updated information, contact your Orbotech representative.

Orbotech's DP100SL/Paragon - Table of Tested Resists (conv., LDI and solder mask)

Important Comments:

Updated: 9.12.2008

This list should serve as an overview about tested resists with Orbotech's DP100SL/Paragon system. Every test is a snapshot for a specific machine in a specific environment (specific resist batch + machine state + developer line). None of the parts of this process are really stable long term. Especially with the resist we found substantial differences over time. Therefore, please use this as a reference guide to which resist could be imaged with DP100SL and Paragon. For an updated information and before making any conclusions, please contact Orbotech technical staff.

Vendor	Resist	Sensitivity mJ/cm²	Thickness microns	Resist Type	UV Marker	Resolution Class (1 mil or 2 mil)	Product use
Asahi	SUNFORT AQ-1558	36 - 48	20	dry	Yes	1 mil	
	SUNFORT AQ-2058	35 - 50	20	dry	Yes	1 mil	
	SUNFORT AQ-3058	55	30	dry	Yes	2 mil	
	SUNFORT AQ-3096	40 - 55	30	dry		1 mil	
	SUNFORT AQ-4096	40 - 80	40	dry	Yes	2 mil	
	SUNFORT AQ-209	45 - 60	25	dry		15 micron SAP	
	SUNFORT PSF-42-25	21 - 33	25	dry	Yes	15 micron SAP	
	UFG-255	100 - 150	25	dry		10 micron SAP	
	YQ40SD	112 - 196	40	dry	Yes	2 mil	
	SUNFORT ASG-302	140 - 180	30	dry		1 mil	
	SUNFORT ASG-254	150 - 250	25	dry	Yes	1 mil	
	SUNFORT ASG-253	40-55	25	dry		1 mil	
	SUNFORT ADH-151	6-10	15	dry	Yes	1 mil	
	SUNFORT ADH-252	36 - 58	25	dry	Yes	15 micron SAP	
Du Pont	Riston LUV 520	4 - 6	20	dry	Yes	1 mil	LDI
	Riston LUV 530	9 - 10	30	dry	Yes	2 mil	LDI
	Riston LUV 540	10	40	dry	Yes	2 mil	LDI
	Riston LDI 330	13	30	dry	Yes	2 mil	LDI
	Riston LDI 350	19	50	dry	Yes	3 mil	LDI
	Riston LDI 7030	14 - 23	30	dry	Yes	1 mil	LDI Orbotech
	Riston LDI 7040	14 - 30	40	dry	Yes	2 mil	LDI Orbotech
	Riston FX 915	20	15	dry		2 mil	
	Riston FX 930	60	30	dry		2 mil	
	Riston FX 940	65-120	40	dry	Yes	2 mil	
	JSF-115 (DMDF)	70-100	15	dry		1 mil	
	JSF-120 (DMDF)	110-140	20	dry		1 mil	
	JSF-125 (DMDF)	100-170	25	dry	Yes	15 micron SAP	
	PM-250	33 - 55	50	dry	Yes	2 mil	
	ES-102	18	30	dry	Yes	2 mil	
	Riston 9420	70	40	dry		3 mil	

Vendor	Resist	Sensitivity mJ/cm²	Thickness microns	Resist Type	UV Marker		
Elga Europe	Ordyl U920E	25-30	20	dry	Yes	1 mil	
	Ordyl U930E	11-18	30	dry	Yes	2 mil	
	Ordyl AM 140	13 - 23	40	dry	Yes	2 mil	
	Ordyl AR 240S	15 - 23	40	dry	Yes	2 mil	
Eternal	ETERTEC HT-712	30 - 40	30	dry		2 mil	
	ETERTEC HT-310	32 - 40	25	dry	Yes	2 mil	
	ETERTEC HQ-6112	36 - 60	30	dry		2 mil	
	ETERTEC HT-1615	26	38	dry		2 mil	
	ETERTEC E-9012	10 - 18	30	dry	Yes	2 mil	
	ETERTEC TP-901-15	12 - 35	40	dry	Yes	2 mil	
	ETERTEC TP-904-15	16 - 21	30	dry	Yes	2 mil	
	ETERTEC TP-905-15	20 - 34	40	dry	Yes	2 mil	
	ETERTEC TP-1001-15	9 - 15	40	dry	Yes	2 mil	
Eternal (former Shipley)	Laminar 2000 UD 730	10 - 15	30	dry	Yes	2 mil	LDI
	Laminar 2000 UD 740	16	40	dry	Yes	2 mil	LDI, Patter Plating
	Laminar 2000 UD 750	20	50	dry	Yes	3 mil	LDI
	Laminar 5032	50	30	dry	Yes	2 mil	
	FL 13	44-48	33	dry		2 mil	
Hitachi Chemical	Photec SL-1040	30	40	dry	Yes	2 mil	
	Photec SL-1129	12	30	dry		2 mil	LDI
	Photec SL-1138	14	40	dry		2 mil	LDI
	Photec SL-1229EC	15 - 36	30	dry		2 mil	
	Photec SL-1238EC	13 - 25	40	dry		2 mil	
	Photec SL-1338	13 - 23	40	dry	Yes	2 mil	LDI
	Photec RY-3210	50	10	dry		1 mil	
	Photec RY-3219	90 - 140	20	dry		1 mil	
	Photec RY-3325	110-140	25	dry		15 micron SAP	
	Photec RY-3315	80	15	dry		1 mil	
	Photec RY-3310	85-95	10	dry		1mil	
	Photec RY-3525	180 - 270	25	dry	Yes	1mil	
	Photec RD-1015	18-22	15	dry		1mil	
	Photec RD-1020		20	dry		1mil	
	Photec RD-1125EE	40 - 60	25	dry	Yes	15 micron SAP	
	Photec RD-1225EC	36 - 56	25	dry	Yes	10 micron SAP	
	Photec H-6840M	20 - 25	40	dry		3 mil	
	HM-4075	120-160	75	dry		2 mil	
	Photec H-7025	26 - 52	25	dry	Yes	2 mil	
	Photec H-N240	24 - 56	40	dry	Yes	2 mil	
	Photec H-Y920	18 - 30	20	dry		1 mil	
	Photec H-S930	35	30	dry		2 mil	
Huntsman	Probimage 2020	40	10	liquid		1 mil	

Vendor	Resist	Sensitivity mJ/cm²	Thickness microns	Resist Type	UV Marker	Resolution Class (1 mil or 2 mil)	Product use
Nichigo Morton	25X017	55 - 75	25	dry		15 micron SAP	
	25A265	42 - 66	25	dry	Yes	15 micron SAP	
	15A265	36 - 52	15	dry	Yes	15 micron	
	NIT-215	80-104	15	dry	Yes	15 micron	
	NIT-2325	120-290	25	dry		1 mil	
	NIT-3025	250 - 300	25	dry		1 mil	
Kolon	KS-7730	24 - 30	30	dry		2 mil	
	KP-2640	30 - 80	40	dry	Yes	2 mil	
	KI-7130	18 - 26	30	dry		2 mil	
	KJ-1030	35-40	30	dry		2 mil	
	NM-5100	450 - 750	100	dry		2 mil	
Mac Dermid	AQUAMER DI 213	9	33	dry	Yes	2 mil	
	AQUAMER DI 315	15	38	dry	Yes	2 mil	
	AQUAMER MI 112	35-45	30	dry		2 mil	
Peters	HR 2054 RC	80-90	10	liquid	Yes	1 mil	
Alcotech	Alcotech APR68	40+	10	liquid		1 mil	
Tokyo Ohka	Ordyl U-840	16-20	40	dry		2 mil	
SOLDER MASK							
HUNTSMAN	Probimer77 LDI	30-50		liquid		Screen printable version	
Coates	Imagecure XV501T-4 LDI Version	30-45		liquid		Screen printable version	
Taiyo	HDI1000F	30-40		liquid		Limited use by 2-3 customers	
Peters Lackwerke	ELPEMER SD 2467 SM-LDI	70		liquid			
Hitachi	FZ-2025	50-120	25	dry		< 2 mil	

semi additive resist	1 mil resist	2 mil resist	3 mil resist

Yes	tested in LIS
Yes	in use by customer