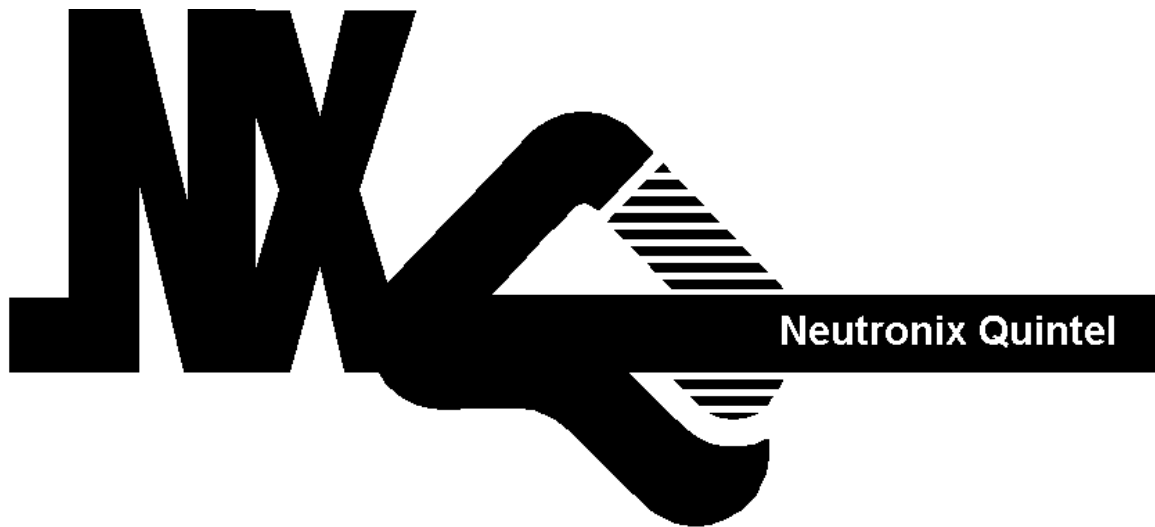




Neutronix-Quintel Q4000 Manual Rev. C

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QUINTEL MASK ALIGNER

MODEL Q4000



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for the exclusive use of the owners of QUINTEL Mask Alignment equipment
in the use, maintenance, and servicing of such equipment.
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QUINTEL CORPORATION

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PREFACE

QUINTEL CORPORATION is located in San Jose, California. Established in 1978 to provide an alternate source for OEM level product support for the Kasper and Cobilt brands of contact mask aligners, Quintel supplied a reliable source for spare parts, field service, and factory rebuilds for the equipment that the industry relied on for much of its production.

Almost immediately, it became obvious that engineered retrofit assemblies were required to improve reliability, increase flexibility, and reduce down-time for these units if they were to meet the needs of a ever more competitive industry. Utilizing the many years of industry experience of the founding personnel, Quintel introduced a series of important and ground breaking improvements for these older machines. In 1988 Quintel offered the first in a series of new designs for improved and expanded capability in contact and proximity type mask aligners.

Today QUINTEL is a leading producer of very reliable, high performance, and low maintenance contact and proximity mask alignment systems. Quintel's systems are used by device manufacturers worldwide, with a large established base throughout the US, Asia and Europe.

The engineering staff works closely with the sales and technical support personnel to continually implement the customer's special requirements. Quintel's techniques for modular design lend themselves to creating easily customized instruments that may be configured to meet widely varying material handling and exposure technique requirements. Through this form of support, QUINTEL is meeting the customer's current needs while designing systems tailored for the products of tomorrow.

WARRANTY AND SERVICE

Every Quintel mask alignment system is protected by a one-year limited warranty and is backed by our worldwide customer support network.

For warranty service or information contact QUINTEL at:
(408) 435-1995 or
Fax (408) 435- 8120.

In contacting the factory or its representatives regarding any problem encountered, please mention the following:

1. Model number of the machine,
2. Serial number of the machine. (Refer to the identification label at the rear of the machine for this information),
3. Specify part numbers of the items causing trouble, when known and applicable,
4. Any applicable configuration information (i. e. options installed on the machine, type of mask holder and chuck style being used),
5. Detailed information relating to the problem encountered, how it is observed, when it happens, etc.

1 SAFETY

1 SAFETY	.0 GENERAL		
	.1 PHYSICAL (HIGH VOLTAGE, HEAT)		
	.2 ELECTRICAL		
	.3 ENVIRONMENTAL (OZONE)		
	.4 VISUAL (ULTRA VIOLET LIGHT)		

1.0 SAFETY

The Q4000 Mask Aligner is designed to be inherently safe to use. However there are several areas which may be of concern if certain rules are not observed.

Note:

Please refer to Section 11.1 for a discussion of special tools which should be provided for personnel working with and maintaining this equipment to minimize the potential hazards.

Important:

Disconnect the main power to the aligner and call for service if the unit has

- been exposed to water or rain
- had liquid spilled on it
- been physically damaged in any way

1.1 PHYSICAL HAZARDS

In normal operation, high temperatures may be encountered in two areas

- In close proximity to the lamps used to provide illumination to the microscope, and
- In the ultraviolet lamp system which provides the exposure light to the wafer after alignment.

Caution must be exercised by maintenance personnel when replacing these lamps, primarily

by turning the power off and allowing 10 to 20 minutes for the metal surrounding the light source to cool to levels which will allow safe handling. Even after cooling down contact all parts with extreme caution.

The mercury short arc lamp in the optical head on very rare occasions may explode. This usually occurs on start-up, when thermal and mechanical stresses are at a maximum. For this reason the lamp should never be started without the cover in place, and safety glasses should be worn when adjusting the lamp with the cover off.

1.2 ELECTRICAL HAZARDS

All exposed electrical contacts within the aligner housing are at a voltage level low enough to permit accidental contact without danger. High levels of voltage are present within the perforated metal covers over the power supplies, which must never be removed without insuring that all power sources to the aligner have been disconnected.

The wire leads to the mercury short arc ultraviolet lamp do not present a hazard during normal operation or during the time that the

lamp cover is removed for adjusting the lamp position for ultraviolet illumination tuning. However these wires do carry dangerously high voltages during the few seconds that the "START" switch on the ultraviolet lamp power supply is pressed for start up. For this reason, as well as for physical protection during the initial start-up period for the lamp, the outer lamp house cover must be in place during the start-up. Personnel other than the one actually performing the maintenance work should be cautioned to stand back during the start-up.

1.3 ENVIRONMENTAL HAZARDS

The only environmental hazard presented by the Q4000 is the ozone gas generated in very small quantities by the ionization of the cooling air surrounding the mercury short arc lamp. The cooling air from the lamphouse is removed by the cooling fan attached to the rear of the aligner by a flexible tube; the exhaust of this fan is normally open to the surrounding air and is removed by the normal air exchange in the work room. The amount of ozone generated by the smaller size (200 or 350 watt) ultraviolet lamps is usually unmeasurable; if the aligner is equipped with one of the higher wattage (1000 watt) exposure systems, or with a deep ultraviolet light source it might be advisable to connect the cooling fan to a house fume exhaust system.

In the case of a mercury short arc lamp exploding, or being dropped and broken, very small quantities of metallic mercury are liberated. Normal mercury recovery techniques should be utilized to contain this very rare hazard.

Refer to Section 1- Safety and Section 11- Maintenance, for information on the handling of the lamps and the cleanup after a lamp failure.

1.4 VISUAL HAZARDS

The standard exposure illumination source in the Q-4000 Aligner is a mercury short arc ultraviolet lamp which emits radiation that is extremely dangerous to the eyes. The ultraviolet radiation causes the same problems which are experienced by snow sports participants who do not wear eye protection.

Caution:

It is imperative that rigid safety precautions be observed when working around the lamp.

Listed below are some important precautions:

- The lamp housing must be in place before the lamp is turned on and started.
- Be aware of your fellow workers and protect them
- Never allow direct radiation from the lamp to hit the eyes.
- Never place a white or metallic reflective surface where it may reflect light into the eyes.
- Never place flammable material in the optical path of the mercury arc lamp. When focused, this lamp will ignite paper within seconds.

Safety Glasses:

Safety glasses must always be worn when working around the ultraviolet mercury short arc light

If, for any reason, direct observation of the output of the mercury lamp is necessary, do so only with adequate eye and face protection, preferably a welder's hood with " SHADE 12" filters.

Whenever working around the mercury short arc ultraviolet lamp to change the bulb or to measure and adjust intensity levels, it recommended that minimal eye protection be worn. The most practical form of protection is light brown safety glasses, with wrap-around protection, which

filter out harmful infrared and ultraviolet radiation without reducing visibility.

There are two sources for this type of protection—welder's equipment sellers offer true safety glasses of this type, which arc welders normally wear under their hoods for protection against eye damage before they drop their hoods for actual welding, or quite adequate protection may be obtained from high quality glasses of the type worn for snow sports, which are designated for ultraviolet and infrared blocking. In either case check the specifications carefully before trusting your eyes to the glasses and never trust this type of protection for direct exposure to the lamps arc.

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	.1 SECTIONS		
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	.5 MODEL/OPTION IDENTIFICATION		
	.7 INDEX		

2.0 CONTENTS

This section describes the contents of this manual. It consists of sub sections which list the text sections, the illustrations, the tables and the charts used to describe the Quintel Q4000 Aligner, its operation and its maintenance.

2.1 SECTIONS

This is the Table of Contents for the text portion of the manual. There is an coding at the right of each entry, showing the applicability of each section to the installation (I), operation (O or Operator), set up (P or Process Engineer), and maintenance (M or Maintenance Engineer) of the machine.

As explained in the introduction, this book is designed so each operating level may have a manual customized to its level of activity by selecting only the sections designated in this contents page.

2.2 TABLES

Some operating characteristics are more easily understood when presented in tabular form. This Section lists these Tables, and notes the text sections to which they apply.

2.3 ILLUSTRATIONS

Illustrations are an important part of the handbook, chosen to supplement the text and clarify the instructions given.

2.4 MODEL IDENTIFICATION

This table lists the Q4000 models and the options available and their applicability.

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Model	Loading	Maximum Size	Vari-View Head	Magna-View Head	Video-View Head	Aux Video Viewing (1)	Expose Lamp 200	Expose Lamp 350	Expose Lamp 500	Infrared Viewing
Q4000-4	tray	100mmØ	X	X		X	X	X		X
Q4000-6	tray	150mmØ		X	X	X	X	X	X	X
Q4000-6	carousel	100mmØ		X	X	X	X	X	X	
Note (1) Not available with Video-View Head										

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3 INTRODUCTION

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3.0 INTRODUCTION TO THE Q4000 ALIGNER MANUAL

The Quintel Mask Alignment System is an integrated optical-mechanical, pneumatic-electrical system which allows accurate alignment of sensitized semiconductor wafers or substrates with a mask and exposes them to ultraviolet radiation to transfer the pattern of the mask to the substrate for further processing on the way to producing a semiconductor or other microelectronic device. Optical and mechanical functions of the aligner are coordinated in a manner that will allow an operator to learn the system in a few hours. The entire mask alignment procedure is designed for fast, convenient operation.

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The Mask Aligner consists of several coordinated, inter-related systems. These include the substrate loading, holding and unloading system; the mask supporting system; the substrate/mask / scan/align/ lock system; the viewing system (microscope and illuminators); and the exposing system. Each of these systems is briefly described in this section, with further expansion in later sections as required.

This section briefly mentions the options available for the Q4000. It is the intention that this manual will be customized for a particular machine, with the result that if a particular machine has an option installed on it, detailed description, set up, operation, and maintenance sections will be added to the manual for that machine. If the option is not installed these sections may be missing from the manual.

3.1 THIS MANUAL

Detail descriptions of the function, set up, operation, and maintenance of each of the above systems will be found in the appropriate section of this manual.

This instruction book is designed to give adequate information to three levels of personnel involvement. These levels are:

- Operator
- Process Engineer and Supervisor Personnel
- Maintenance Personnel

The Operator section is primarily a "how to use it" description without burdening the reader with too much "why."

The Process Engineer's book adds to the data above, including detailed information on how to set up the machine, how to keep it running at peak efficiency and what to do when it doesn't operate properly.

The Maintenance Manual is the complete book, with information on keeping the machine operating at full capacity. It includes information for diagnosing machine failures and procedures to correct them.

It is hoped that the user will recognize the need to follow the prescribed procedures with care in order to attain the ultimate performance of which the machine is capable.

3.2.0 SYSTEM DESCRIPTION

A mask alignment system is very complex when viewed in its entirety and yet when each portion of the machine is described in terms of its content and its relationship to the total system its quite easy to become familiar with the total. This section of the manual will break the machine down so the readers, even those with minimal technical knowledge, will be able to understand how the aligner functions.

3.2.1 OVERVIEW

The Quintel Q4000 Mask Aligner is a self contained system, in that all power supplies, control units, and utility control systems are mounted within the shell of the base machine.

The aligner is a “modular” device. Each operational section of the machine is built to be installed as a self contained unit, and in case of problems, replaced as a unit.

In the following sections we will explore each of the major component sub-systems, with its relationships to the other parts, starting with

3.2.2 MECHANICAL

The Quintel Q4000 mechanical system starts with a thick, very flat aluminum base plate, which provides a rigid, precise foundation upon which all of the other components are mounted.

On this base are mounted all of the controls, pneumatic systems, the support for the optical head, and the various electrical system components.

The major mechanical component of the aligner also mounts directly on the base plate.

This is the X–Y–Z–Θ stage assembly, which really is the heart of the Quintel Aligner System. The stage provides, in one mechanism, for :

- X–Y movement of the entire stage assembly in “SCAN” which allows for global movement to

permit acquisition of a required feature within the field of view of the aligning optical system. Scan is controlled by a finger tip controlled gimbal assembly on the left side of the stage.

- X –Y–Θ movement of the substrate in relationship to the mask to permit “ALIGNING” of the two images. X–Y align is controlled by a right hand finger tip controlled gimbal, which allows coarse align and fine align movements. Θ align is controlled from the left side of the machine with a micrometer control rotating the guide set.

- Z motion of the substrate to permit gross movement for “LOADING” and for movement between “SEPARATION” and “CONTACT” for alignment and final exposure.

3.2.3 ELECTRICAL

The Quintel Q4000 operates off of International Standard electrical sources. There is a main line shut off switch at the point of entry which disconnects all voltage to the machine. All operational power is reduced to 24 volts maximum so there is no chance of contacting dangerous voltages in operating the machine.

3.2.4 PNEUMATIC

Much of the actual mechanical work done by the mechanisms of the mask aligner is actually performed by pneumatic systems— air pressure moves things by means of air cylinders, or supports parts on a cushion of air to permit easy movement by hand. Vacuum applied to a cavity between two parts locks them together to prevent movement. A stream of air cools a component or a stream of nitrogen can clean and purge a work chamber—gasses under close control perform many tasks.

Within the machine are two control panels which are used to set the pneumatic controls at setup;

at the left rear is the REGULATOR PANEL and on the right side of the machine directly behind the control panel is the FLOW CONTROLS MANIFOLD.

The final component of the pneumatic control system is the array of up to twenty-four electrically operated solenoid valves, which at the direction of the control system, turn the various vacuums and air pressures off or on.

The functions of all of these devices are described in detail in the operational sections of the manual.

3.2.5 CONTROLS

There are two basic types of controls on the Q4000:

There are three control panels mounting push button switches. Each control panel and the switches it contains, and a full explanation of the function of each switch, are fully described in later sections of the manual.

And there is the “brains” of the machine—the Programmable Logic Controller (or PLC), which is a miniature computer run controller which stores within its memory what needs to be done in which sequence to perform a task.

The PLC is very simple to use and easy to learn—The operation of the PLC is fully explained later in the manual.

3.2.6 WORK HOLDER SYSTEM

All Quintel Aligners utilize a highly developed work support system. The system involves two major components- the mask holder and the substrate support or "chuck"

The **MASK HOLDER** is a very precise work holder which is designed to support the glass mask.

There is an optional adjunct to the mask holder, the **MASK CLAMP**, which provides a convenient method of placing and aligning the mask under the microscope.

The work support or **SUBSTRATE CHUCK** provides an optically flat surface to support the product during the alignment and exposure.

3.2.7 VIEWING

The Quintel Q4000 is a manual aligner in that the alignment of the mask and substrate is achieved by an operator manually moving the substrate into alignment with the mask, which is fixed in its position, with hand controls, while viewing the images of both under high magnification. This section outlines the optical devices which provide the means by which the operator sees the mask and substrate to achieve the task.

The Quintel Q4000 may be configured with either of two basic types of viewing optics:

- A special type of optical microscope known as a split field microscope in which the images of two microscopes are combined optically so half of the image in the eyepiece is one side of the substrate and half is of the other, or
- A dual camera video system, wired to a split screen monitor, which replicates the view of the optical microscope, in that one camera field fills half of the screen and the other camera fills the other half.

All of the viewing units may be adjusted for observing at different spread distances, and have binocular eyepieces for fatigue free viewing.

3.2.8 PRODUCT HANDLING

The Quintel Q4000 uses a tray load technique to place the substrate in position for aligning and exposing, in which a sliding tray pulls out for substrate loading.

An alternative loading system may be specified for high through-put production situations. Known as the Carousel Load System, this option is described elsewhere in the manual.

3.2.9 PROCESS OPTIONS

There are many process options available on the Quintel Q4000, the majority of which involve the conditions existing in the interface between the mask and the substrate. All of these are described in detail in later sections of the manual.

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3.2.10 EXPOSURE OPTICS

The Q4000 is equipped with the state of the art Quintel Q170/15 exposure system, which provides a highly efficient, controllable, optically correct means of exposing the substrate after alignment.

3.2.11 EXPOSURE TECHNIQUES

There are two optional extras available for the Q4000 which are of interest to those doing demanding work.

The first is an alternative type of power supply for the exposure lamp, which provides a feed back automatic control of the light intensity, to assure identical exposures over the life of the lamp.

The second is an optional exposure timer program which may be installed in the PLC to provide a pulsed exposure, which provides outstanding results on very fine geometries.

Both of these require no operator interface once installed and set-up.

3.3.0 SPECIFICATIONS

The mechanical and utility specifications for the Quintel 4000 Aligner are shown on the following pages.

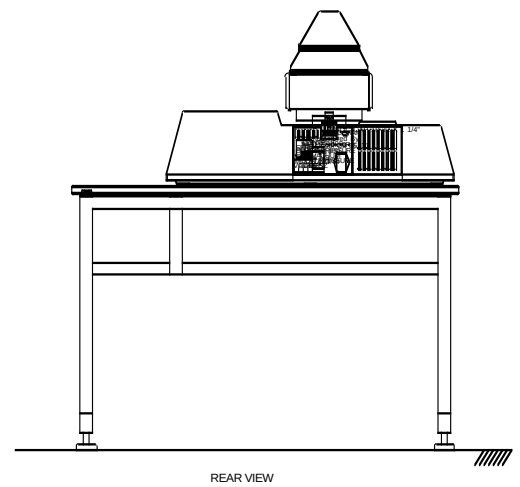
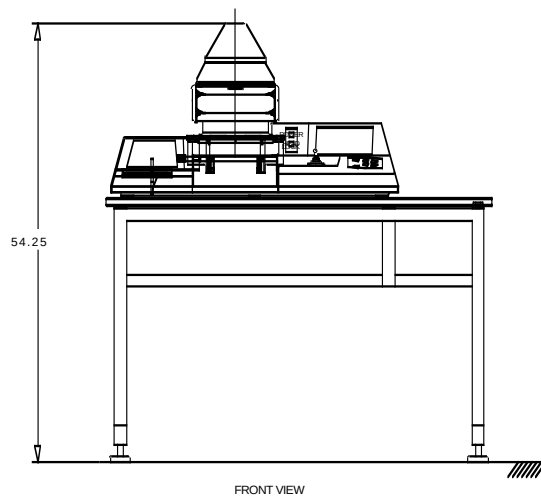
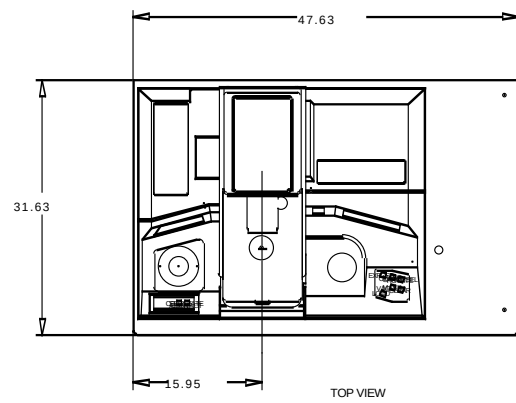


3.3.1 PHYSICAL SPACE REQUIREMENTS

The physical space requirements for the two basic configurations of the Q4000 are shown on the next pages. All accessory options fall within the envelope dimensions shown.

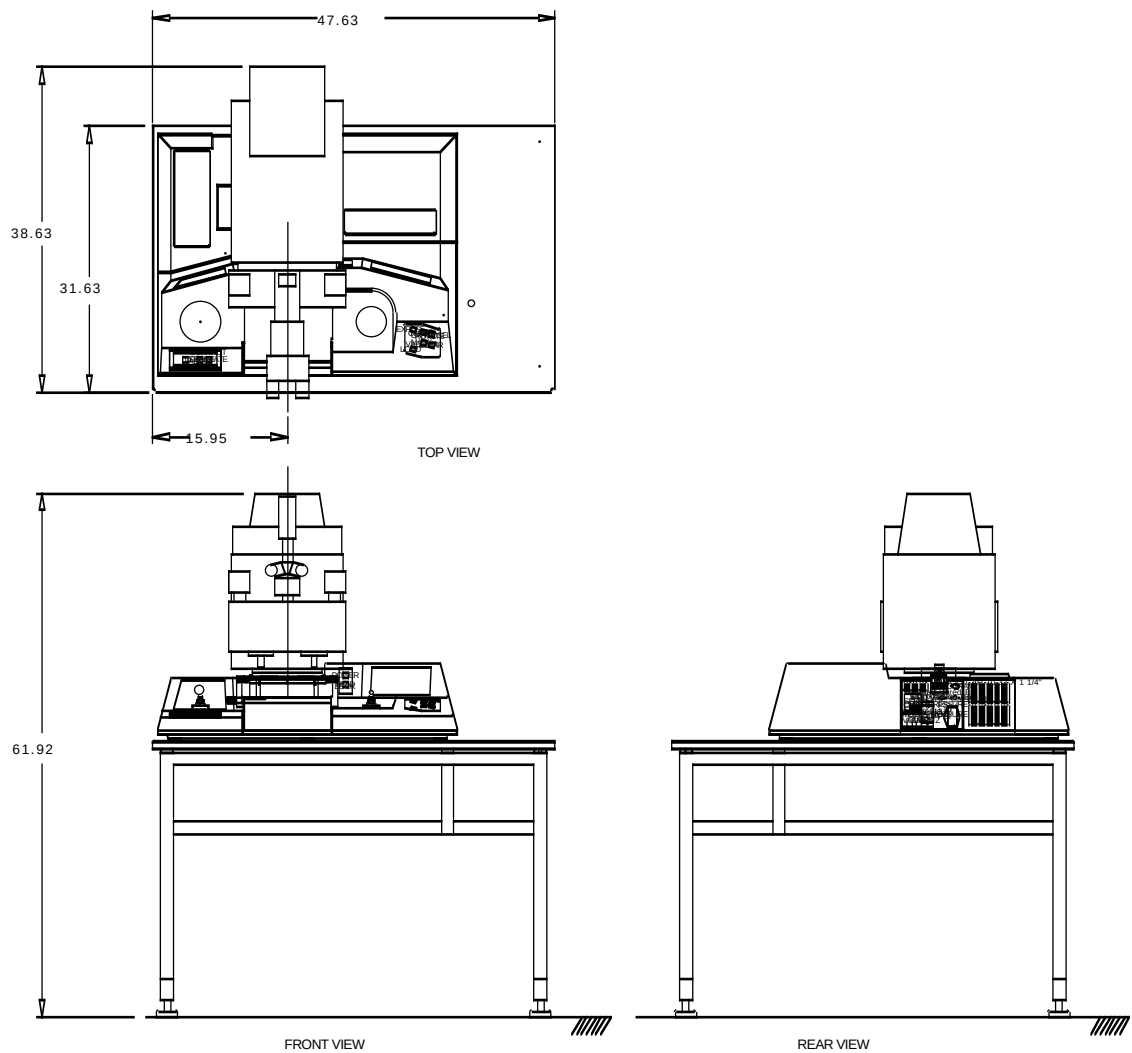
Q4000-4 MASK ALIGNER INSTALLATION

3



Q4000-6 MASK ALIGNER INSTALLATION

3



3.3.2 MACHINE ENVIRONMENT

The greatest threat to long life for the Quintel Aligner is dirt. For this reason, the instrument should be set up in an area relatively free from atmospheric contamination. Since this requirement is in general agreement with modern semiconductor device manufacturing requirements it normally presents little or no problem.

The one area of disagreement is in that of airborne free acid radicals. The atmospheric acid content which is tolerable for semiconductor processing and marginally suitable for human habitation can cause serious corrosion problems

in the mechanisms and optical surfaces of the aligner

If evidence of excessive fogging of optical surfaces or symptoms of metallic surface discoloration or corrosion presents itself, the environment in which the aligner is operating should be evaluated carefully.

The Q4000 aligner is mounted on a custom designed table which is sufficient to adequately support the instrument. The table provides vibration isolation to eliminate building vibration transmission to the instrument.

3.3.3 UTILITY REQUIREMENTS

The utility requirements for the Quintel Q4000 aligner are detailed in the following table.

While the Aligner is designed for operation under normal fabrication area conditions, it is recommended that the quality of the utility supplies be evaluated for uniformity in order to assure optimum performance from your unit.

The aligner should be attached to an electrical source which provides essentially uniform voltage— if the selected circuit also supplies heavy or fluctuating load requirements, it would be advisable to try to use another, more stable circuit.

Similarly, if the gas supplies vary in pressure during the day, it is recommended that the connection be made to a source at a higher pressure with a dedicated precision regulator to assure that a constant pressure as recommended below be available at all times.

The Q4000 regulates voltages and pressures internally to meet process requirements, but for true process control the inputs must be guaranteed.

Q4000 MASK ALIGNER UTILITY REQUIREMENTS

UTILITY	REQUIRED SOURCE	CONNECTION
ELECTRICAL:		
ALIGNER	120 Volts AC, 1.5 amp	ASA, 3-wire plug on 3 conductor cable. Selectable, to meet local requirements
	240 volts AC, 1.0 amp	For 220 operation connector must be replaced to coordinate with local requirements
MERCURY ARC LAMP POWER SUPPLY		
200/350 watt @200	120 Volts AC, 12.5 amp (Circuit Breaker)	ASA, 3-wire plug on 3 conductor cable. Selectable, to meet local requirements
200/350 watt @350	240 Volts AC, 12.5 amp (Circuit Breaker)	For 220 operation connector must be replaced to coordinate with local requirements
350/500 Watt @ 350	120 Volts AC, 18.75 amp (Circuit Breaker)	ASA, 3-wire plug on 3 conductor cable. Selectable, to meet local requirements
350/500 Watt @ 500	240 Volts AC, 18.75 amp (Circuit Breaker)	For 220 operation connector must be replaced to coordinate with local requirements
VACUUM:		
	21" Hg or better @ 1 CFM	3/8" Imperial Poly Flow
PRESSURE:		
High Pressure	70 PSI (4.8 Kg/cm ²) minimum, regulated; nitrogen, or dry filtered air, @ 0.5 CFM	1/4" Imperial Poly Flow
Low Pressure	30 PSI (2.0 Kg/cm ²) minimum, regulated, nitrogen@ 0.1 CFM	1/4" Imperial Poly Flow
		* connectors are compression type for use with polyethylene (hard wall) plastic tubing (to be supplied by the customer))

NOTES ON ELECTRICAL CONNECTIONS

The Quintel Q4000 may be configured to operate on either 120 or 240 volt supplies. The changeover requires two steps— select a cordset (electric cord and plug) with the correct plug on the end to mate with the local style electric outlet and –remove and invert the selector insert in the input device (refer to Figure 6.2 or 6.3) which revises the internal wiring of the aligner and installs the proper size and type fuse in the circuit. These simple steps completely configure the aligner for the operating voltage selected.

Configuring the ultraviolet expose lamp power supply is a little more complicated, and requires a technician's services. The voltage change requires the reconnection of the incoming line to the power transformer to the correct terminals, and removing the plug on the end of the power cord and replacing it with the correct one to fit the local outlet.

Normally these operations are completed at the factory before shipment, if the order is placed with advise of local electrical requirements for installation. The correct specification of service power is important, since it allows the final factory testing and checkout to be performed utilizing the proper operational voltage.

NOTES ON THE PNEUMATIC CONNECTIONS

Connections of the gas and vacuum services to the Q4000 are made utilizing compression type fittings manufactured by Imperial-Eastman to operate with rigid polyethylene plastic tubing, 1/4" outside diameter for the two positive pressure gasses, and 3/8" outside diameter for the vacuum supply.

If for some reason these connectors cannot be used to make the connection to the house supply systems, they can be removed and replaced with any type connector with 1/4 NPT threads. It is the customer's responsibility to provide the gas supply connection to the aligner.

3.4 GLOSSARY OF TERMS AND NAMES

NAME or Term	Description
AIR	Filtered, dehydrated, high pressure compressed air, used to operate various functions on the aligner. See also NITROGEN
ALTERNATE ACTION SWITCH or ALT/ACT SWITCH	A switch which changes state with operation– push-ON, push-OFF. See also MOMENTARY SWITCH
BARB	A small pointed male fitting used to connect a plastic hose or tube to a pneumatic device's input or output port.
CAROUSEL LOAD	Quintel's name for its high productivity load system, utilizing a reversable, two position chuck turntable
CFM	<u>C</u> ubic <u>F</u> oot per <u>M</u> inute: the unit of measure for the volume of a gas moving through a pipe, tube, or device. May also be quoted in <u>C</u> ubic <u>F</u> oot per <u>H</u> our or in (Metric) Cubic Liters per Minute
Chip	A term used to describe a small piece of substrate, frequently a broken piece of a larger unit, which must be processed in spite of its size or irregular shape.
CHUCK or SUBSTRATE CHUCK	This is the work holder for the aligner. It carries the work into the action area, provides support for it during alignment and exposure, and carries it out after completion of the process.
CONTACT	The condition in which a wafer is in physical contact with a mask. See also SEPARATE AND PROXIMITY.
Depth of Focus	The physical vertical separation between two objects at which they both are in sharp enough focus to allow alignment, typically the mask/substrate interface; larger at low powers and smaller at high powers.
DICHROIC MIRROR	A transparent mirror, designed and created to selectively reflect only certain wavelengths of light, used to reflect the usable ultraviolet light and not reflect the heat causing infrared light
Direction– Theta (Θ)	Rotational Movement about a vertical axis
Direction– X	Movement in the right or left direction
Direction– Y	Movement in the front to back direction
Direction– Z	Movement in the up or down direction

ELLIPSOIDAL MIRROR	The “dish” shaped mirror used to gather the energy from the ultraviolet expose lamp at one “focus” and imaging it at a second “focus” outside the lamp, from which point it may be optically processed and sent down to the mask to expose the substrate .
Flow control	A small valve used to limit the amount of gas passing through a tube. There are two types of flow controls used in the Quintel Q4000: NEEDLE VALVE and FLOW CONTROL (see listing elsewhere for the difference between the two types).
FLOW CONTROL	A FLOW CONTROL combines a needle valve with a one way valve to provide unrestricted flow one way with controlled flow the opposite direction. See also NEEDLE VALVE
FLY'S-EYE LENS	Popular name for a multi element lens array such as is used as an integrator in the Quintel expose system.
GUIDE SET	The GUIDE SET provides the Z direction motion of the substrate on its chuck. It combines several functions within one complex and precise unit.
Hg	The chemical symbol or abbreviation for Mercury. See also Mercury and Inches of Hg.
Inches of Mercury or Inches of Hg	The unit of measure for vacuum level, with 29.92 inches representing “perfect” vacuum. The values of concern here are 22 inches maximum down to 2 to 5
INFRARED LIGHT	The invisible light from the red end of the spectrum; near infrared is useful because it passes through silicon wafers and thus may be used, with conversion to visible light, to align images on the back of the wafer with a mask on the front side.
JOYSTICK	A controller which allows control of movement in any direction, by means of a knob/shaft mounted in a gimbal.
Leveling (of a substrate)	The planarization of a substrate to the mask upon its initial contact.
LCD	<u>L</u> iquid <u>C</u> rystal <u>D</u> isplay– the technical name for a type of screen display used to present visual alpha-numeric output from a computer.
LED	<u>L</u> ight <u>E</u> mitting <u>D</u> iode– the common colored indicator light used on control panels and switches. An electronic "light" which is very efficient, long lived, and cool in operation.

MAGNA-VIEW	Quintel's exclusive new high resolution splitfield microscope head for viewing and exposing substrates up to 6 inch diameter.
Mask Bow	Glass masks are flexible and tend to change shape under the pressure of the substrate pressing upward when loaded into contact by the guide set, by the pillow pressure under the wafer, and by chamber vacuum.
Magnification	The apparent increase in size of an object when viewed through a microscope as 100 X magnification implies that the object as viewed appears to be 100 times as large as it is in fact.
MASTER SWITCH	The main power switch, at the rear of the machine, which disconnects all power from the machine. See also POWER SWITCH.
MERCURY	The familiar liquid metal, used here as a component of the ultraviolet light source lamp and as part of a unit of measure. See also Inches of Mercury
MICRO-SWITCH™	A trademarked name used almost universally as a generic term to indicate a miniature lever operated electrical switch , used as a position sensor or motion detector.
MOMENTARY SWITCH or MOM SWITCH	A spring return switch which is active only as long as it is held down. See also ALTERNATE-ACTION SWITCH
NEEDLE VALVE	The NEEDLE VALVE is an adjustable valve which controls the flow of gas moving in either direction. see also FLOW CONTROL
NITROGEN	Pure, dry, water pumped nitrogen gas, used in the aligner in the process chamber and in other critical low pressure applications. See also AIR
PISTON	Actually GUIDE SET PISTON, the part of the guide set which moves up and down, sometimes referred to without the words "guide set"
PLC	Programmable Logic Controller- the computer based control for all of the aligner's operating sequences
POWER SWITCH	Push button switch on the upper right control panel, which, when the Power Switch is on, controls the power to the logic and operational functions of the aligner. See also MASTER SWITCH.
Pre-align	The act of pre-aligning a substrate to place it in a repeatable position on the support chuck.

PRE-ALIGNER	The device to place the wafer on its chuck in a precise pre-determined location
PSI	<u>P</u> ounds per <u>S</u> quare <u>I</u> nch; the unit of measure for air or gas pressure
Purge	To clean out a space, as to purge the expose chamber with clean dry nitrogen to remove traces of air, or cool by removing hot air with a cool stream of gas.
PROXIMITY	A condition where the separation gap between the wafer and mask has been reduced to a distance small enough for improved printing, but not enough for satisfactory alignment. See also CONTACT and SEPARATE
Q4000-4	Model number for the small format Aligner, equipped with the Vari-View optical head
Q4000-6	Model number for the large format aligner; may be equipped with either the Magna-View or Video-View optical heads
REGULATOR	An automatic valve used to reduce the pressure of a gas to a closely controlled value, adjusted by turning a knob in for a higher or out for a lower value
Resolution	Resolution is the ability to distinguish a very small object, or more commonly to distinguish that there are two objects very close together rather than only one larger object.
SEPARATE or SEPARATION	The condition in which the planarized substrate is moved away a small distance, enough that it may be moved for alignment without dragging, but still close enough for both mask and substrate to be in focus. See also CONTACT and PROXIMITY.
Short Arc Lamp	The name given to the lamp used to generate ultraviolet light for substrate exposure. Named for the small gap between two electrodes, across which electricity jumps, creating a highly concentrated, intense light
SILICON	A semiconducting element, used in almost pure form as the base of most semiconductor devices.
SILICONE	Complex chemical compounds, containing SILICON, which have been created in the laboratory. These compounds can be rubbers, plastics, or oily fluids, all exhibiting remarkable charecteristics.

SOLENOID or SOLENOID VALVE	A valve controlled by an electrical signal from the PLC or from a manual switch to turn on a gas flow.
SUBSTRATE	Used as a generic term to describe a work piece, including a round silicon wafer, or a thicker square or rectangular shape of other material, to be processed with the aligner. See also WAFER.
Theta (Θ) – Direction	Rotational Movement about a vertical axis
Toggle	To cause a action to be turned off and on alternately and repeatedly, as in toggling between contact and separate.
TOGGLE VALVE	A manually operated air valve, looks much like a common toggle switch (electrical)
Tooling	Collective term used to identify the substrate chuck, mask holder, and mask clamp, used to customize the aligner for a specific task or production job.
TRAY–LOAD	Quintel's name for its load system, utilizing a tray running in precision linear bearings, to allow the wafer chuck to be withdrawn from the work position to allow placement of a wafer directly on the chuck.
ULTRAVIOLET LIGHT	Invisible light from the blue end of the spectrum; useful as the energy for the exposure of the light sensitive coatings placed on substratesubstrate before aligning.
VARI–VIEW	Quintel's name for the small format (up to 4 inch wafers) turret type viewing and exposing head option.
VIDEO–VIEW	Quintel's name for their double CCTV, split screen video alignment system
WAFER	Technically and typically a thin slice of silicon used as the base for a semiconductor device.
X - Direction	Movement in the right or left direction
Y - Direction	Movement in the front to back direction
Z - Direction	Movement in the up or down direction

4 INSTALLATION

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4.0 INSTALLATION

This section contains information for the unpacking, inspection, and installation of a new Quintel Q4000 Mask Aligner.

Under normal circumstances, a Quintel-trained Field Service Representative will be available to supervise the unpacking, installation and initial set up of a new Quintel Aligner.

This section is broken into two parts, a preliminary installation which may be performed by the customer, and a final installation normally performed by a Quintel trained field service representative. In the event that conditions dictate that customer personnel perform these final operations, the data presented in this section must be strictly adhered to or instrument damage or malfunction may result.

4

4.1 GENERAL CONSIDERATIONS

While the Quintel Aligner is a well designed, rugged instrument, it is also a very precise, sensitive machine. As such, it must be handled properly. For example, the extremely accurate bearing system in the x-y stages of the alignment system can be seriously damaged by repeated shock loading. For this reason it is recommended

that all Quintel Mask Aligners be shipped by airfreight for long distance movement and Air Ride van for shorter distances, to minimize the chance of transportation vibration damaging these bearings. Any in-house moving should be done with care to avoid damage as well.

4.2 UNPACKING AND INSPECTION

The following procedure should be used to unpack the Q4000 Mask Aligner when it is received from the factory. Care should be exercised in unpacking and assembly of the aligner. This will help minimize the possibility of both physical damage and accidental loss of separately packaged components.

After the equipment has been unpacked, inspect the equipment for damage. If the instrument is damaged, notify the carrier and the Quintel office. Retain all shipping material for the carrier's inspection. The Quintel office will arrange for the repair or replacement of your aligner. Be sure to inventory the contents of shipment and verify that all equipment listed on the packing list was received in good order.

4.3 INSTALLATION

The installation of a Quintel Q4000 Wafer Aligner takes place in several steps.

4

4.3.1 PRELIMINARY INSTALLATION

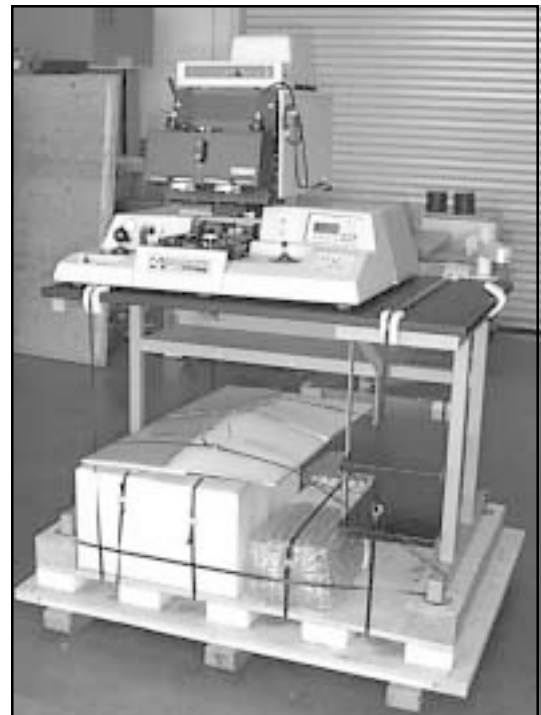
(BY CUSTOMER)



- Release the nylon straps holding the aligner to the base pallet. Push the outer cover of the clamp up all the way and release the spring loaded ratchet by pressing it up. Remove and retain the strap for future use if needed to relocate the aligner.

The following procedure should be performed by the customer:

- Release the spring clamps at the bottom of the wooden shipping container, leaving the top clamps intact; lift the entire top from the base pallet.
- Remove the plastic bag covering the aligner.



- Move the aligner to the desired working location together with all its separately packaged components. The Aligner and its table are heavy and its center of gravity is high. A team of four physically fit men should be used to lift the Aligner off its shipping platform and to roll it to its final location.



Because the Q4000 aligner base plate is not mechanically attached to the table frame (for vibration isolation reasons) it is important to pick the aligner up by the table frame when moving it.

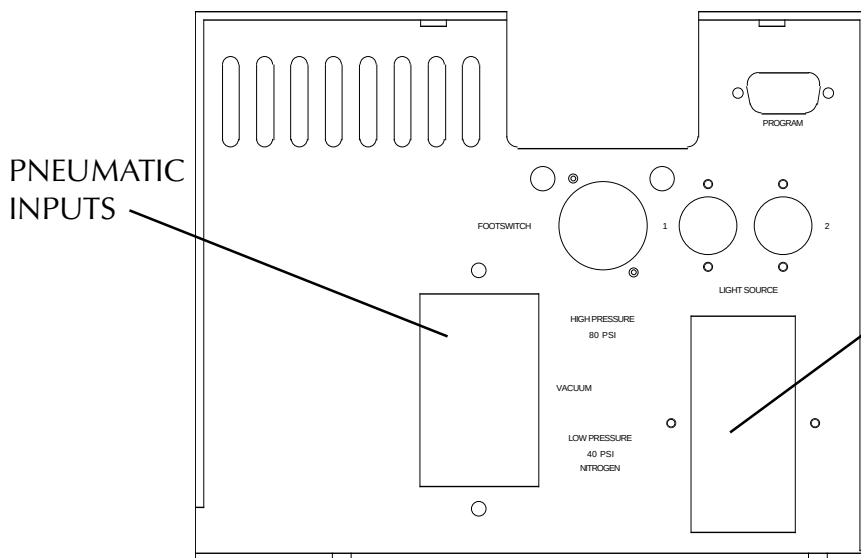
With the aligner in its final installation position, the table frame should be set up following the procedure outlined below:

- The table is shipped in its lowest position; if it is desired to install it in the higher position, block it up on one side and remove the large screws at each leg to allow the leg to drop down to its extended position. Align the screw holes and replace the screws. Remove the blocks, and repeat the operation at the other side of the table.

Lower the adjustable feet until they contact the floor and then screw them 5 turns down to free the casters.

The aligner is now ready to be levelled. See the next section for details of this procedure.

- Open the boxes or bags containing the components and parts. Verify that all of the items listed on the packing list are accounted for. Discrepancies must be reported to the factory within 48 hours of receipt of aligner.



AC POWER INPUT

- Connect AC power cord and pneumatic hoses (Specifications for utilities are set forth in Table 3.1: Utility Requirements).

4.3.2 LEVELING THE ALIGNER

It is important that the aligner, in its final location, be very carefully leveled. If the machine is out of level many of the movable parts of the system, such as the scan stage, which are supported on air bearings to make them easy to move by the operator will be unstable and will "drift downhill" by themselves. A perfectly level installation will be very stable resulting in lower operator fatigue and higher outputs.

The feet of the support table include a leveling screw so that the length of each leg may be adjusted to compensate for inequalities in the floor.



The best tool to determine how to adjust the feet is a small precision level known as a "Torpedoe Level," widely used by the building trades to install appliances, plumbing fixtures, etc.

The Q4000 table is equipped with an air flotation vibration isolation system. To place this system in operation follow the procedure outlined below:

Locate the purple hose inflation assembly in the parts box.

Following the procedure in Section 9.1, start the aligner and proceed until the front left panel indicates that the controller has placed the system in "Separate." Under the machine locate the bundle of hoses connecting to the guideset; disconnect the purple hose and install your inflation hose to the machine end connector. At the left rear Regulator Panel, note the pressure showing on Regulator 1, then increase the pressure to 20 PSI. On each of the four air isolation units between the frame and aligner base plate there is a familiar "tire inflation" type valve. Attach the inflation hose to each of these valves for 30 seconds, proceeding in a clockwise sequence. Repeat the sequence three times to insure that all are properly pressurized.

The inflation of the isolators will free the four plastic spacer units placed between the base plate and the table frame for shipping. These should be retained for use if ever it is necessary to move the aligner to a new location, or to replace one of the isolation units.

Return Regulator 1 to the setting it was previously at.

Disconnect the inflation hose under the table, and reconnect the guide set hose.

Proceed with the aligner leveling procedure following.

Leveling Procedure

Start with the feet screwed all the way in. With the level on each side of the table, determine which corner represents the highest point. Check all four sides. With a piece of tape or some other means mark the highest corner so you do not forget where your starting point is.

From that corner place the level in the center of the first side in a clockwise direction, and screw down the leg at the other end of that side until the level indicates a level condition. Move on to the next side in a clockwise direction, always

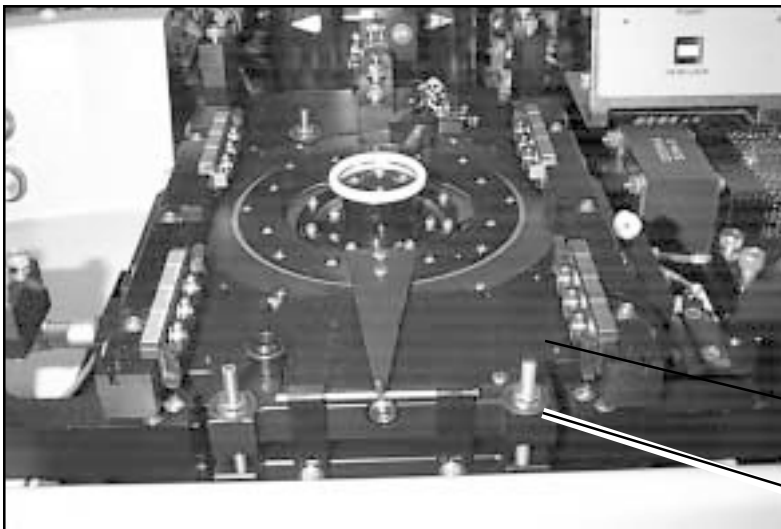
adjusting the furthest leg. When you reach the starting leg side of the table it should read level. If it doesn't, or if there is a rock in the table, go around the circle again, making minor adjustments. **DO NOT CHANGE THE START LEG ADJUSTMENT.** By the time you have completed the second circle the table should be in perfect level condition, with all feet firmly resting on the floor, and no rock in the table. Lock the adjustable legs with the lock nut provided.

4

4.3.3 FINAL INSTALLATION

While the following procedure should be performed by a Quintel-trained service

representative, circumstances may dictate that they be performed by the customer. If this is the case please adhere to the procedure closely to avoid operational problems:



Note:

It is very desirable to retain these lock down screws for future use if it ever becomes necessary to relocate the aligner. Damage to the critical stage bearings is much less likely to occur if the stage is properly locked down, even for short in house moves.

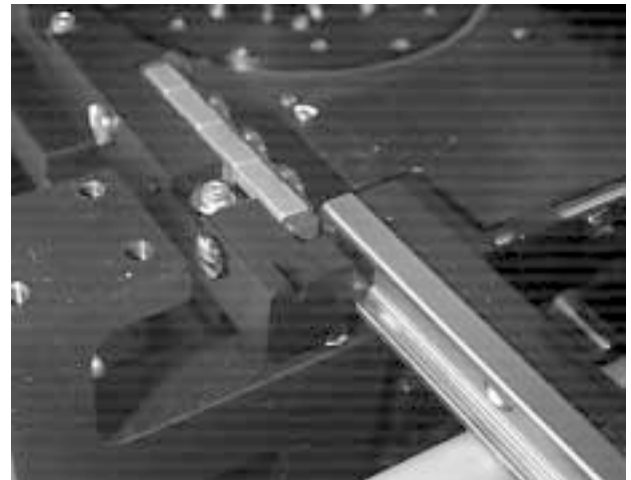
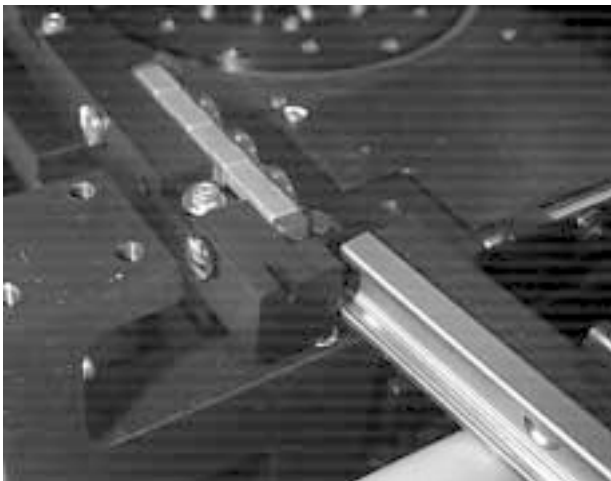
- Cut the strap holding the optical head.
- Remove the clamp restraining the optical head and rotate the head.

- Remove all packing around the stage. Carefully remove the four threaded studs securing the stage; back off the hex nuts about two turns, then unscrew the studs from their sockets in the bottom stage plate. With these units out of the way the stage assembly should be free to move. If not check for the presence of packing material.

4

- Slide the tray load assembly into position on stage plate #1, making certain that the rails on the plate engage the bearings evenly. Push the tray in until the rear stop is contacted.

- install the load tray's front stop to the left front of the load tray assembly. This is a small cylindrical part which screws down to the top stage plate about 1" in from the front edge. Access to the screw to fasten it down is through a small hole in the front of the load tray. This is done with the tray in the full "in" position.



4.4 INSTALLING THE OPTICS

Note:

Before handling or installing any of the optical components please review Section 11.3 which contains information on materials, tools and techniques for handling and cleaning optical components.

The installation of the viewing optics varies according to the system type ordered with the Quintel Q4000.

4

4.4.1 THE BASIC (VARI-VIEW) ALIGNER

The basic aligner is equipped with a turret type split field microscope. The installation of the optics package for this version is as follows:

Note:

For accessibility this procedure is best completed before the mask holder is installed although it can be accomplished in any sequence.

- From the package containing the optical components locate the following items:

The two eyepieces

The objective lenses (the quantity will vary with the configuration of the microscope)

The expose mirror

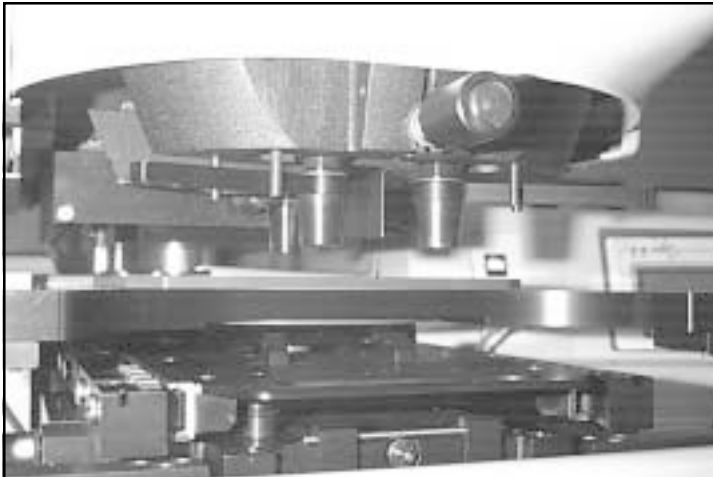
Expose mirror light shield

Stop pins (four) for the objective lens operating levers

- Select the eyepieces. Check for cleanliness, cleaning the optical surfaces with lens tissue and

lens cleaner if required. Install the eyepieces in the binocular head, rotating them until the keys engage their mating notches. The eyepieces are identical for each side and do not require special orientation.

4



Observe the format of the optical system of the turret— it may have one splitfield position, two splitfield positions, or one splitfield and one singlefield position.

- Sort the objective lens assemblies according to power as marked . By rotating the turret to its various marked power positions (high, low, and singlefield) install the objectives in the rear position to match the marking on the turrets. Screw the objectives in until about 1/8 inch of threads are exposed.

- Select the expose mirror. Unwrap it, checking for cleanliness. Install the mirror into the turret, handling it by the mounting plate to avoid getting fingerprints on the mirror surface. Fasten it into the turret with two socket head cap screws in the holes at the lower end of the mounting plate.



Move the objective levers to an outward pointing position and install the four limit pins.

Refer to Section 8.4 for detailed information on the adjustment of the optics for use.

4.4.2 THE MAGNA-VIEW ALIGNER

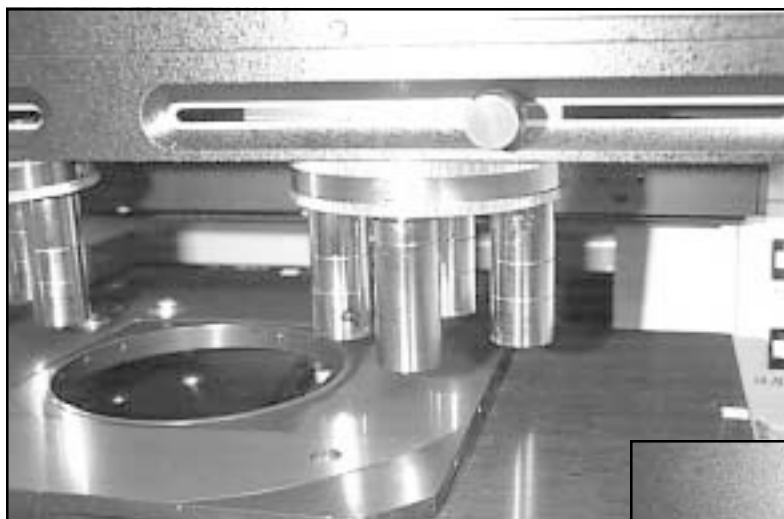
The large field aligner, generally ordered for the exposure of product larger than 100mm, is equipped with either of two special versions of the split field microscope. One of these is a dual camera video system, installation of which is discussed in the following section. The other is an optical splitfield microscope, the installation of the optics package for which is as follows:

From the package containing the optical components locate the following items:

The two eyepieces

The objective lenses (the quantity will vary with the configuration of the microscope)

- Select the eyepieces. Check for cleanliness, cleaning the optical surfaces with lens tissue and lens cleaner if required. Install the eyepieces in the binocular head, rotating them until the keys engage their mating notches. The eyepieces are identical for each side and do not require special orientation.



Caution:

The threads on the objectives are very delicate and precise, and require careful handling to insure proper installation.

Important:

Do not use any mechanical device in installing these optical components. Use of pliers or similar tools will damage the optics. If your fingers slip on the metal surfaces, use finger cots or a sheet of rubber to increase the friction and assist the installation.

- This microscope has two four position turrets to allow for objective power selection. Sort the objective lens assemblies according to power as marked . By rotating each turret to its various marked power positions install the objectives in

the center positions to match the marking on the turret (with both turrets in, for example, the 10X position, the 10X objectives would be installed in the holes nearest each other at the center of the machine). Screw the objectives in until fully seated.

4

- The Magna-View head, when ordered to expose 125mm or 150mm substrates, may, as an option, have a field lens to improve the printing characteristics. This lens is installed in a tray behind the microscope mounting plate. When the microscope pivots up this tray can slide out over the stage.

For smaller size substrates, the field lens is replaced with a mask to restrict the expose light



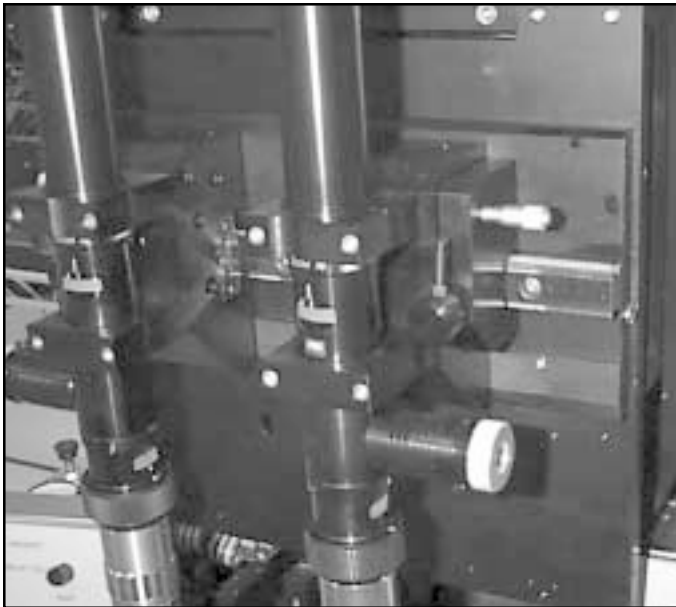
4.4.3 VIDEO -VIEW SPLITFIELD MICROSCOPE

The video version requires relatively little assembly to prepare it for operation.

- Locate the objective lenses and install them on the lower end of the microscope tubes.

- Mount the monitor on its platform. Plug the monitor into the power strip at the rear of the aligner.

- Connect the various cables to the cameras at the upper end of the microscope tubes and the monitor.. All cables are marked with identifying numbers; match the numbers when connecting.



4.4.4 VIDEO VIEWING ON OPTICAL SPLITFIELD MICROSCOPES

As an option on the Vari-View and Magna-View microscopes a single CCD camera may be installed for video viewing of the splitfield image as seen in the standard eyepieces under regular operation.

This feature is frequently used as a teaching or training tool.

The setup of the camera is similar to the Video-View except it is a single channel unit and does not allow any modification electronically of the output image except for brightness of the single image. The cable hookup is described in its own block diagram on the following page.

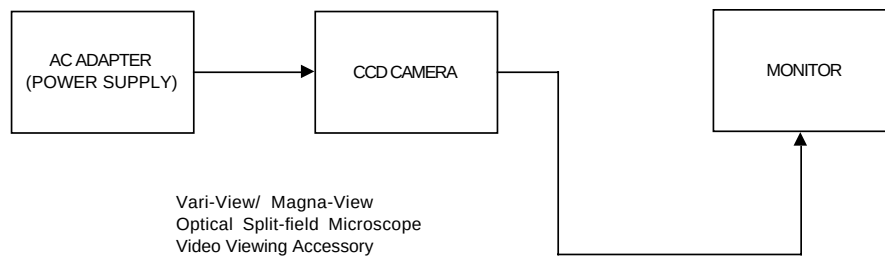
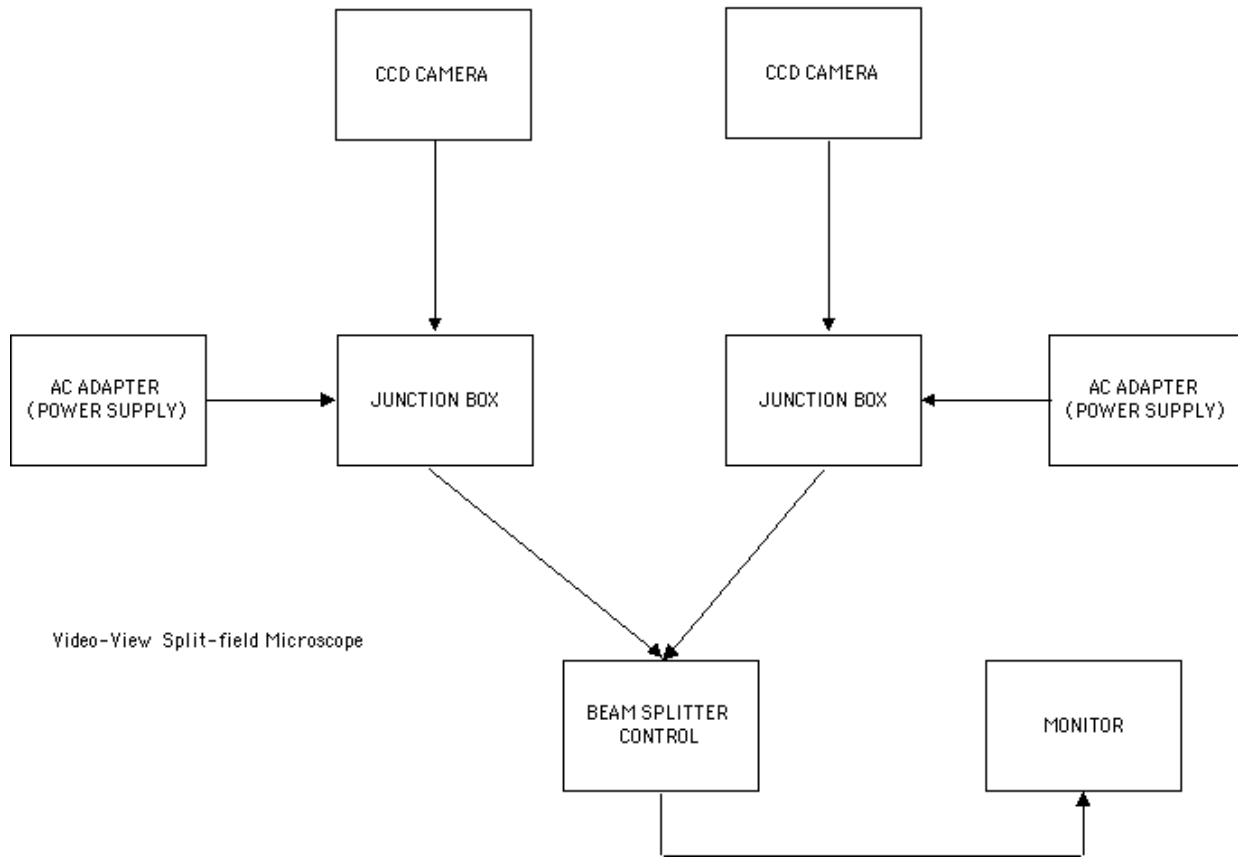
Refer to Section 8.5 for set-up and operation information.

4



VIDEO CABLE BLOCK DIAGRAM

4



4.5 MOVING THE ALIGNER

This section provides techniques for successfully moving a previously installed aligner, both for short in house moves, and for longer, more hazardous moves.

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4.5.1 MOVING THE ALIGNER- IN HOUSE MOVES

Prior to moving the aligner from one in-plant location to another, the following procedure should be followed:

- Immobilize the stage assembly by replacing the retaining clamp and bolts which were saved during the unpacking phase.
- Tie down the optical head to prevent it swinging.
- Deflate the air isolation units. Replace the plastic spacers between the base plate and frame before bleeding the air out of the units.

- Avoid jarring or vibration of the instrument during the moving process.

- The aligner on its table is top heavy so any moving or lifting must be done in such a way that it will not tip over. Because the aligner base is not mechanically attached to the table frame, to move the aligner always pick it up by the base frame.

After locating the aligner in its new location, follow the procedure in Section 4.3.2 to relevel the aligner and reestablish the air cushion vibration isolators.

4.5.2 OUT OF PLANT LOCATION MOVES

If the aligner is to be moved to another location locally, the following procedure should be used. If the instrument requires crating for long distance or overseas shipment, it is recommended that the services of a Quintel representative be used to prepare the unit for shipment.

For the turret type head:

- Remove the light shield
- Remove the remaining objective arm stop screws.
- Remove the ultraviolet exposure mirror. Wrap it in lint- free paper and place it in a plastic bag.

For all microscopes:

- Remove the objectives; wrap them in lint-free paper and place them in a container.
- Remove the microscope eyepieces. Place them in a clean eyepiece container or wrap in lint-free paper. Place them in a clean bag. Place plastic plugs in the microscope eyepiece holes. Place all screws removed in a bag.
- Place a clean plastic bag over the optical head, and tape the bag closed.
- Remove the chuck. Wrap it in protective paper and place it in a bag or a container.
- Disconnect the 4 tubes from the mask support and the tube to the mask clamp and tape them together with the chuck vacuum tube at the rear of the stage.
- Remove the mask holder support with the mask holder from the support legs; wrap in protective paper and guard against any damage to the mask holder surface.

- Remove the load tray adjustable front stop and pull the load tray straight out; wrap it in protective paper and place it in a bag or container.

- Re-install the stage clamp screws: refer to the installation procedure for more information. It will be necessary to move the individual stage plates around slightly in order to get all plates lined up so as to allow the studs to go through to their sockets in the lowest stage plate.

- Install a strap under the machine base and over the head and secure the strap.

- Remove electric cables, and air supply hoses . If machine is to be stored or shipped, protect it with a moisture proof bag. Place all components for the aligner and the aligner itself in a packing crate.

5 MACHINE FUNCTIONS

5 MACHINE FUNCTIONS	.0 INTRODUCTION		
	.1 PHYSICAL STRUCTURE		
		.1 MECHANICAL SYSTEM	
		.2 ELECTRICAL SYSTEM	
		.3 PNEUMATIC SYSTEM	
		.4 CONTROL SYSTEM	
	.2 MASK HOLDER /SUBSTRATE SUPPORT SYSTEM		
	.3 SUBSTRATE LOAD SYSTEM		
		.1 TRAY LOAD	
		.2 CAROUSEL LOAD	
		.3 CHIP LOADING	
	.4 PRE-ALIGNMENT		
	.5 VIEWING SYSTEM		
	.6 ALIGNMENT		
	.7 EXPOSURE OPTICS		
		.1 EXPOSE OPTIONS	
		.2 EXPOSURE TECHNIQUES	
		.3 COOLING	
	.8 PROCESS OPTIONS		

5.0 MACHINE FUNCTIONS

This section of the manual parallels and supplements the discussion in Section 3: Introduction with detailed descriptions of the various parts of the aligner and their functions.

The Mask Aligner consists of several coordinated, inter-related systems. These include the substrate loading, holding and unloading system; the mask supporting system; the substrate/mask scan/align/lock system; the viewing system (microscope and illuminators); and the exposing system. Each of these systems is described in this section.

With the exception of the power supply for the exposure lamp, which is bulky and heavy due to the large magnetic devices utilized in processing the lamp current, necessitating external

mounting, the aligner is a total unit, with no requirements for external power supplies, control systems, or interconnecting cables.

The aligner is a “modular” device. Each operational section of the machine is built to be installed as a self contained unit, and in case of problems, replaced as a unit. This also allows for simple customization of the machine for special situations, installation of specialized options and retrofitting of improved assemblies as they become available through Quintel's ongoing development programs.

In the following sections we will explore each of the major component sub-systems, with its relationships to the other parts, starting with the mechanical basics.

5

5.1 PHYSICAL STRUCTURE

This section provides a description of the hardware which is the aligner— the mechanical structure which supports everything, the electrical and pneumatic systems which perform the tasks required, and the control system which determines when things happen.

5.1.1 MECHANICAL SYSTEM

The Quintel Q4000 mechanical system starts with a thick, very flat aluminum base plate, which provides a rigid, precise foundation upon which all of the other components are mounted. This provides a way to guarantee that all parts of the aligner remain in their correct relationships at all times. It also dampens vibrations introduced from the external environment.

On this base plate are mounted the mechanical support components of the aligner. The largest and most noticeable of these is the mounting post for the optical head assembly. This large cylindrical unit contains a specially designed, precision tapered roller bearing, system which assures a very precise and rigid mount for the ultraviolet expose light /microscope optical assembly, and at the same time allows rotating the head out of the way to facilitate tool and

mask changes. Other parts in this category are the heavy sheet metal supports for the various control panels. and the posts installed to support some of the control sub-systems. Another major component in this first level category is the input panel mounted at the center rear of the aligner, containing all of the connections of the aligner to the outside world for utilities—compressed gasses, vacuum, and electricity to operate the machine. This is also where the identification plates for the machine are mounted

The other major mechanical component of the aligner also mounts directly on the base plate. This is the X–Y–Z–Q stage assembly, which really is the engine of the Quintel Aligner System.

Definition:

In the following discussions “X” refers to linear movement left to right, “Y” to linear movement front to back, “Z” is the vertical movement of the substrate up and down, and Q (theta) is the rotational movement of the substrate around its center

- The Scan-Align Stage Assembly

The stage assembly is actually several different mechanisms, integrated into one unit. Starting at the bottom, these mechanisms are:



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- The Scan Stage:

This is a x-y stage assembly which allows the entire stage assembly to move as a unit 0.62 inches (15.8 mm) in any X or Y direction, so that an important feature (either a specialized alignment mark, or a critical product feature) can be viewed by the microscope to judge the alignment and how it needs to be moved to accomplish the alignment to the desired accuracy.

The actual movement of the scan stage is controlled by a joystick control on the left side of the aligner, which allows accurate one hand movement of the stage in relationship to the base of the machine. A push button switch mounted in the top of the joystick electrically controls a vacuum locking system which holds the stage in location unless the operator needs to move it.

The scan stage, as well as the align stage above it, consists of two precision flat plates with unique linear ball bearings between them which allow precise movements in X and Y directions. Each pair of plates permit independent movement in one direction only; the bottom plate and its neighbor below moves in an X relationship, and the scan plates themselves move in a Y relationship.

The assembly, adjustment, and care of these bearings are one of the most critical parts of the aligner system.

- The Align Stage:

Mounted above the scan stage and resting on it is another pair of plates which allow X and Y movement for alignment. This stage carries the substrate and moves in relation to the mask, which is supported by the scan stage. The same type of bearing system controls the X and Y movement of this stage set.

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The control of the alignment movement is by a complex joystick, mounted on the right of the stage. On the Front Left Control Panel there is a momentary push button switch which controls the flow of vacuum to the align joystick so it either operates at a 3:1 ratio coarse align mode or at a 150:1 ratio fine align mode. When the machine goes into CONTACT mode both align modes are activated effectively locking the align mechanism's movement.

After alignment is completed, the entire stage assembly is locked to the base plate by a vacuum actuated lock mechanism designed to lock with absolutely no X or Y drift.

- Θ (Theta) or Rotational Movement:

Mounted in the top align stage is a large diameter rotary bearing assembly which supports the Air Bearing Guide Set. This bearing permits the Guide Set to rotate about its vertical axis, effectively rotating the substrate about its axis. This provides the rotational movement necessary for a complete alignment.

This rotational movement is controlled by a micrometer drive located on the front left side of the stage assembly. This drive is capable of a $\pm$ seven degree rotation, and works against a return spring. There is a visual indicator in the front of the stage (left side on the Carousel Load option) to guide the operator in returning the rotation to its center position when starting a new set-up..

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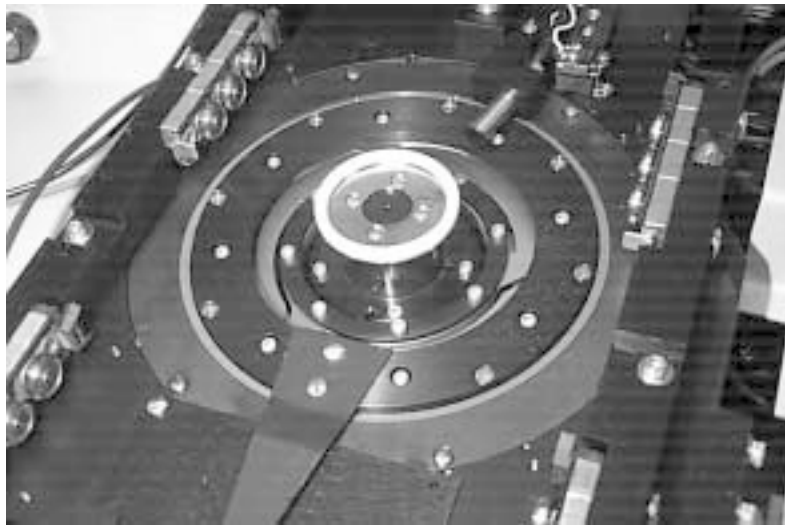
- The Guide Set:

The Guide Set, which provides all of the Z motion to the aligner, is the most complex and precise component in the aligner.

Its first function is to support the substrate chuck. The chuck is provided with a spherical ball segment on its reverse side, which mates with a conical ball seat on the top of the moveable center piston of the guide set. This combination provides

the “swivel” action to permit the substrate to level to the mask on its first contact.

Vacuum is fed to this interface to lock the two elements after leveling. For use with very fragile substrates, brittle material, or other special situations, it is also possible to introduce low pressure gas to produce a low friction leveling.



The second function is to provide the long distance move (about 1 1/8 inches) to allow the loading of a substrate into the expose chamber. The heart of the Quintel Guide Set is a full length air bearing which allows this long travel with a bearing which has no side shift, requires no lubrication (other than the clean high pressure air which provides the cushion on which the bearing moves) and as long as it is not contaminated with dirty or moist air, never needs servicing. The force to provide the load stroke for this unit is another

innovative device— a rolling diaphragm seal, which applies movement pressure in a completely non deviating, no lubrication, frictionless manner. All of the moving parts of this assembly are very light weight, so relatively low, controllable, pressures are used to lift the substrate into its first contact with the mask, thereby limiting mask damage and danger to the substrate .

After the first contact, the dynamic air bearing sleeve is locked to the separation housing, and is ready for the third function: moving the substrate into alignment separation. This is accomplished by a special linear drive mechanism mounted inside the separation housing, actuated by air pressure so varying the pressure results in different distances moved. The use of a precision regulator guarantees very repeatable separation distances (within 1 or two microns). The separation housing and guide set sleeve, acting as a unit, are still

guided by the air bearing. In addition they are stabilized by a stainless steel diaphragm system designed to be very flexible in the Z direction, and extremely stiff in the X and Y directions, resulting in what Quintel refers to as their “zero-shift” guide set. You can align in separation, move to contact or near contact and verify that your alignment has not shifted as a result of the Z motion.

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- Mask holder support:

The final function of the stage assembly is to provide a mount for the mask holder support, to hold in a stable location for alignment and exposure the mask holder and its support plate.

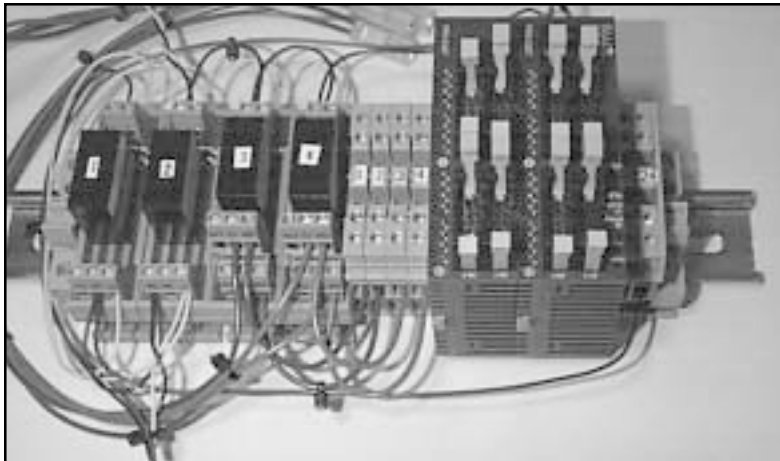
5.1.2 ELECTRICAL SYSTEM

The Quintel Q4000 operates under International Standard electrical sources, and is externally configured by means of a selectable input device to operate with either 120 volts or 240 volts. The main line is fused at the point of input. There is a main line shut off switch at the point of entry which disconnects all voltage to the machine.

The primary voltage is conducted through shielded, double insulated cables to two power supplies which supply the operational voltage for the systems at 5 and 24 volts D.C. The larger of these power supplies is dedicated to supplying 24 volt current for driving the solenoid valves which control most operations of the machine.

The smaller power supply, which is powered up at all times that the master shut off switch is on, supplies low voltage to the front panel ON switch. When the system is powered up (by pressing the front panel ON switch), it supplies voltage to the PLC (see CONTROLS), the LCD Logic Control Panel, and to the POWER MANAGEMENT SYSTEM. This system controls A.C. power to the main power supply, and low voltage to the PLC and logic panel. There is no high voltage present on any of the operator interface panels.

Additionally there is a stepdown transformer, controlled by the power management system, supplying low voltage A.C. for the microscope lights. This transformer secondary is protected by a circuit breaker, mounted on the regulator panel at the left rear of the aligner.



5.1.3 PNEUMATIC SYSTEM

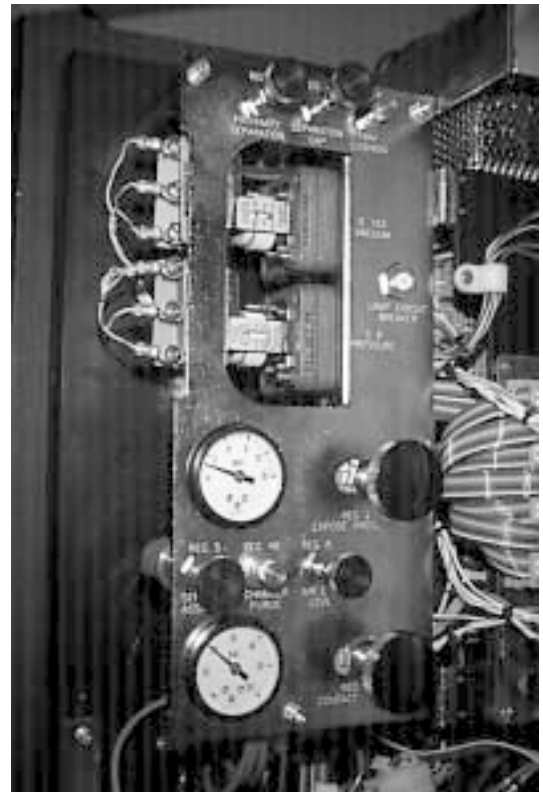
Much of the actual mechanical work done by the mechanisms of the mask aligner is actually performed by pneumatic systems— air pressure moves things by means of air cylinders, or supports parts on a cushion of air to permit easy movement by hand. Vacuum applied to a cavity between two parts locks them together to prevent movement. A stream of air cools a component or a stream of nitrogen can clean and purge a work chamber—gasses under close control perform many tasks.



Three gas utilities are required to supply the machine. At the input panel, provision is made for connection to sources for clean, dry compressed air at 90 psi for the operation of HIGH PRESSURE devices such as air cylinders. LOW PRESSURE is supplied by pure nitrogen at 40 psi for use in cleaning and conditioning the expose chamber— generally process related situations. The third connection is for VACUUM at 21 inches of mercury for locking, holding, etc.

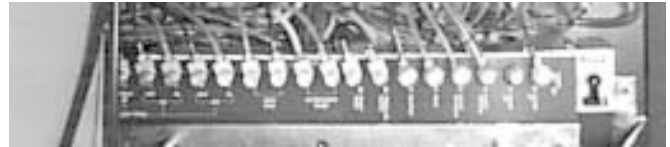
Regulators

Within the machine at the left rear is the REGULATOR PANEL, which holds seven precision pressure regulators to regulate the gas pressures used for various functions. Also mounted on this panel are a pressure switch and a vacuum switch to signal the control system when certain critical pressures are met.



Flow Controls

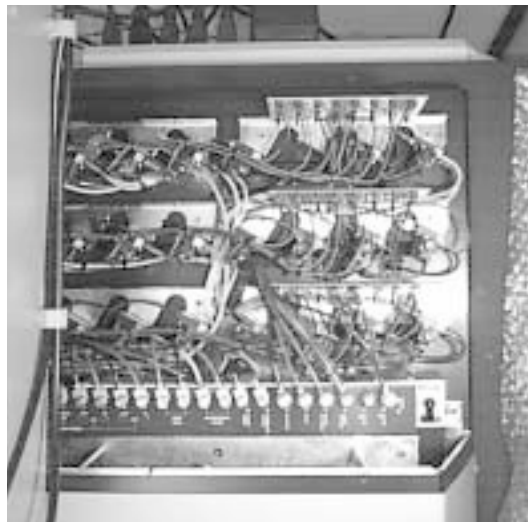
On the right side of the machine directly behind the control panel is mounted a manifold containing flow controls and needle valves used to control the rate of gas flow to various components. These controls are used extensively by the Process Technician to fine tune the operation of the machine.



Solenoids

The final component of the pneumatic control system is the array of up to twenty-four electrically operated solenoid valves, which at the direction of the control system, turn the various vacuums and air pressures off or on at the critical moments in the operation cycle.

The functions of all of these devices are described in detail in the operational sections of the manual.



5.1.4 CONTROL SYSTEM

There are two basic types of controls on the Q4000:

There are manual push button switches mounted in three control panels which initiate elementary, operator controlled, non sequenced functions, such as turning the machine on at the start of the day, or unlocking the optics head so it can be rotated out of the way to change a mask plate.

Each control panel and the switches it contains, and a full explanation of the function of each switch, are fully described in later sections of the manual.

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The second control type is the automatic PLC controller– the “brains” of the machine. The Programmable Logic Controller (or PLC), which is a miniature computer run controller, stores within its memory what needs to be done in which sequence to perform a task. The information is stored in “recipes,” all of the details of many different ways of doing things, all instantly selectable at the push of a button. For example, there are three different printing modes to choose from, each requiring a different sequence of solenoid valve operation. Selecting one mode for use automatically sets up the proper sequence with no further actions required.



The PLC is very simple to use and easy to learn– its “ window to the world” is a small LCD screen displaying a plain language message asking for instructions or choices; pressing a numbered button corresponding to a choice makes that selection, sometimes leading to another choice, until finally the desired result is shown in the window , at which point it is approved and the machine goes to work.

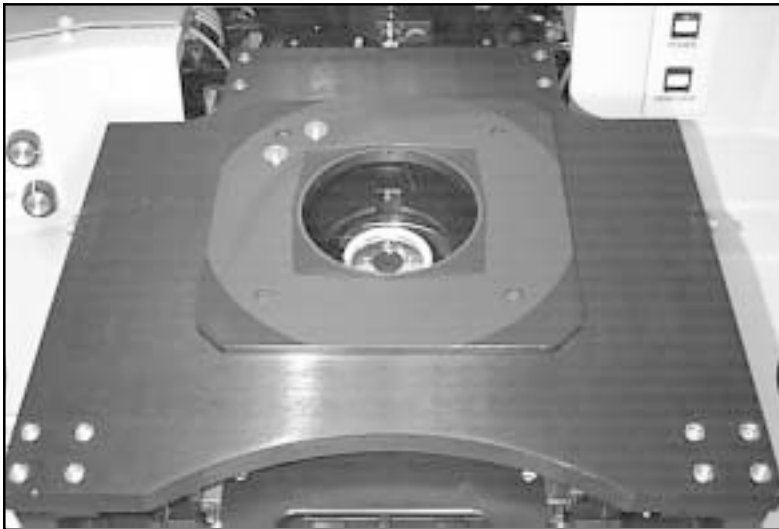
The most important thing to remember, at least in the beginning, is that nothing is ever final until the final approval is given–you can always go back and change selections until you get the answer you want.

The operation of the PLC is fully explained later in the manual, together with explanations of all of its menu choices. An easy to understand road map of the PLC's program is included in Section 9).

5.2 MASK HOLDER/SUBSTRATE SUPPORT SYSTEM

All Quintel Aligners utilize a highly developed work support system which has evolved through more than 30 years of applications work in the semiconductor industry. The system involves two major components—the mask holder and the substrate support or “chuck.” Each of these components are optimized to perform their functions while working in concert to provide complete control of the product while being loaded into the aligner, aligned, exposed and unloaded.

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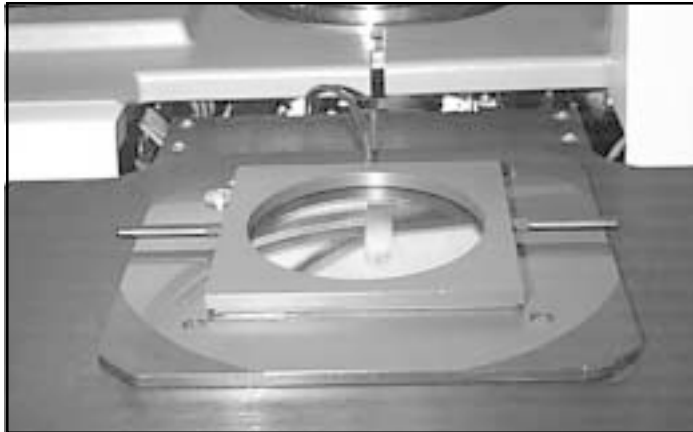


The MASK HOLDER is a very precise work holder which is designed to support the glass mask on a flat lapped surface, providing vacuum porting to clamp the mask firmly in place.

Quintel also supplies mask holders to support film masks— consult the factory for more information

The geometry of the mask holder is governed by several simple rules: the opening in the mask holder is always designed to be large enough to accommodate the physical size of the work plus the maximum allowable alignment movement of the work in relationship to the mask provided by the aligner to achieve alignment. In practice this means that the mask holder opening is, for standard tooling, 0.300 inches larger than the size of the work.

Since the standard Quintel tooling system utilizes a “top mount” mask holder, the minimum mask size which can be used on a given size substrate is controlled by the need to provide adequate hold down force to retain the mask in place when the forces of planarization and expose pressure exert an upward pressure. In vacuum contact mode of printing the chamber vacuum is especially powerful and tends to “lift” the edges of the mask. This causes instant loss of mask hold down vacuum. The rule utilized for standard design tooling requires that for round parts the mask must be 1 inch larger than the wafer and that for square substrates the mask must be 2 inches larger than the work in each direction.



There is an optional adjunct to the mask holder, the MASK CLAMP, which is a thin, precise, metal part with a vacuum port to permit vacuum clamping to the top side of the mask. The clamp serves two functions: it provides, by means of protruding handles, a convenient method of placing and aligning the mask under the microscope, and more importantly, a way of “stiffening” the mask and controlling the “mask bow”

Within reason, any mask size larger than minimum may be used on the mask holder; mask corner locating stops are provided on all mask holders, with alternate positions available for standard, nominal size masks up to the recommended maximum size. By removing the stops even larger masks may be accommodated with the mask overhanging the support.

introduced when the expose chamber and substrate are subjected to pressure, both negative and positive, during the expose cycle.

A mask clamp is most often used with small, thin masks to make them easier to handle and less subject to mask bow. Because of the extra thickness introduced they frequently cannot be used with thicker masks due to interferences with the viewing optics.

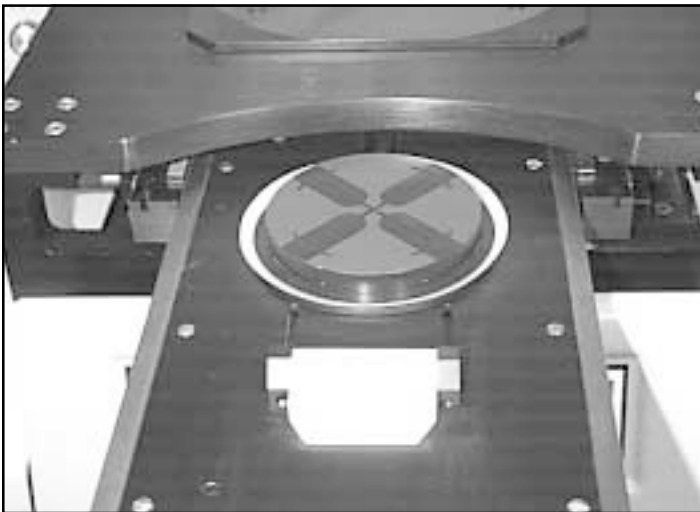
Mask clamps are generally configured to agree with the mask holder they ship with. The outside dimension should always match the mask size, and the opening the same size as the mask holder opening. When a smaller size product is being handled the opening should match the actual work size, in order to achieve optimum mask bow control. There are many size combinations available as standard designs and custom combinations are readily available.

The work support or SUBSTRATE CHUCK provides an optically flat surface to support the product during the alignment and exposure. It has a means to introduce vacuum to the work/chuck interface to hold the substrate in place during transport in and out of the expose chamber, or low pressure under the work at the moment of exposure to produce “pillow pressure” for pressure contact with the mask.

The substrate chuck normally is made to match the size of the work being supported; in no case may the work “overhang” the support surface. However, it is permissible for the work to be smaller than the support surface. In this case it is desirable to block off the vacuum ports in the surface of the chuck which are not covered by the work. (If smaller than normal work is being loaded refer also to the discussion under “mask clamps” elsewhere.)

At the perimeter the chuck base provides a thin rubber seal to complete the exposure chamber for the vacuum (hard) contact printing mode at the time of exposure. The functioning of this seal makes the height of the substrate chuck very important to the correct operation of the exposure system. In straight pressure printing the characteristic of concern is that the work support

platform and work thickness combine so that clearance is maintained between the chuck flange and mask holder. Any thicker substrate merely increases this clearance and does not affect the operation of the system up to the point where the combination actually interferes with the movement of the work into the aligner by contacting the bottom of the mask holder. The maximum thickness of substrate that can be accommodated on a standard configuration machine is 6.3mm or 0.25 inch.



In a non standard mode of operation, by moving the head of the aligner aside, removing the mask, and loading the work onto the chuck through the mask holder opening, substrates as thick as 18mm or 0.71 inch can be loaded and aligned.

For vacuum printing the rules are much more restrictive. In order to achieve a closed expose chamber it is necessary to have the seal at the perimeter of the chuck contact the underside of the mask holder. To achieve this the chuck work holding surface height is manufactured to a specific dimension for the work to be done, so the combination of the chuck and the work fall within a narrow dimensional band. There is a ± 0.010 inch tolerance to this dimension, sufficient

to accommodate normal manufacturing tolerances for wafers and substrates.

On the reverse side of the chuck is mounted a spherical ball segment, which interfaces with a conical seat on the top of the guide set to provide a means of tilting the chuck, upon initial contact with the mask, to planarize the substrate with the mask. This ball seat is subjected to very slight air pressure during planarization and is vacuum clamped at all other times to maintain the mask/substrate leveling initially achieved.

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The design of custom tooling systems is an important part of the customization services Quintel offers to its customers. There are a great number of critical characteristics which need to be observed in the design of this tooling which makes it difficult for even experienced designers to complete a system design which will operate satisfactorily. You are urged to take advantage of the expertise of Quintel's staff in creating tooling for a new product.

5.3 SUBSTRATE LOAD SYSTEM

The Quintel Q4000 is a manual load aligner, which requires the operator to remove a substrate from its carrier and place it on the work holder chuck for each product exposed. Likewise, after completion of the exposure, the operator removes it from its chuck and returns it to the finished product carrier.

The Q4000 offers two variations on how this loading is done, the choice of which depends on anticipated product volume.



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5.3.1 TRAY LOAD

In low volume applications this unload/load sequence is facilitated by the use of a “load tray,” which is pulled out towards the operator to a position where the operator may easily pick up or place the product without reaching, and the pre-alignment is performed in a easily viewed location

The substrate chuck is carried out to such a position that the substrate may be placed on the chuck surface, and by means of a simple mechanical device, prealigned on the chuck surface. When the operator is satisfied with the positioning of the substrate, the tray is pushed in

slightly, which activates the chuck top vacuum, locking the substrate on the chuck for movement into the operating position.

The tray is mounted on four precision ball bearing units for accurate guidance and easy movement. It is interlocked at the “in” position so that it cannot be moved until the substrate chuck is fully down and the chuck seated in the tray. It is provided with a cushioned “in” stop and with a magnetic restraint to hold it in the “full in” position to assure that it is properly aligned for the guide set to pick up the chuck.

5.3.2 Carousel Loader

For higher volumes the "Carousel Load" is recommended. In this second variation, the substrate chucks, two of them in this case, are supported in a "carousel arm" which rotates,

alternately moving one or the other into exposure position. If the exposure time is properly coordinated, this loading technique produces a very high through-put. With the carousel automatic loader, the operator places and prealigns a new substrate on the chuck while the preceding substrate completes its exposure cycle. When the exposure is completed, the carousel automatically moves the new substrate into place for alignment, and brings the older one out for removal and replacement with another.

The Carousel Loader is a precision tool, with numerous interlocks to assure proper sequence of operations, and precision bearings to provide accurate positioning at all times.



5.3.3 Chip Load

Chip loading, or the handling of small and/or irregularly shaped pieces of substrate is very easily accomplished with the tray load feature of the Q4000. For small pieces special chucks with only a few vacuum hold-down holes at the center can be provided, or chucks with special hole

patterns and laser marked guide patterns on the mounting surface are available for production of unusual shaped pieces of substrate material. For occasional or emergency situations, the unused vacuum holes on a standard chuck may be masked off with thin "Mylar™" type tape outside the operational area.

5.4 PRE-ALIGNMENT

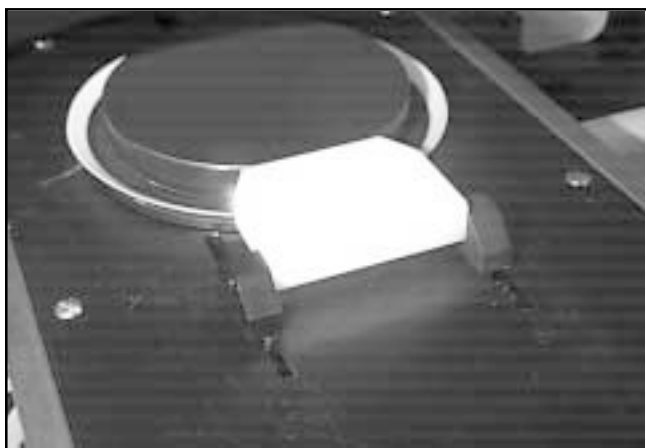
Much of the controllable portion of the production cycle and thus the effective throughput on an aligner is related to the accuracy and speed of the prealignment segment.

For round wafers or substrates with alignment flats, the Quintel Q4000 uses a time tested mechanical prealigner coupled with a “down in front” prealignment location to insure fast, accurate prealignments.

The Tray Loader and Carousel Loader both use variations of the same principle— a simple right-angle corner stop providing a flat matching edge

coupled with a side stop. The Tray Load version is mounted on a “flipper” which lays down flat on the chuck surface as a stop against which to rotate the wafer until the flat matches the alignment edge, then slide the wafer over so the round side just touches the side stop. This guide travels with the tray, so the operator may move the tray in slightly to activate the holding vacuum, then flip the prealigner back to lay flat and out of the way while the tray moves in to its load position. With a little practice an average operator can accomplish almost perfect prealignments very quickly.

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The Carousel prealigner has the same alignment features but is mounted on a spring loaded “push down to prealign” bracket, rigidly mounted to the frame of the loader. Incorporated in this “push down” is an actuator switch which, when released, tells the controller that a wafer has been placed on the chuck, and has been prealigned, ready for moving into the align and expose position.



For square or rectangular substrates Quintel chucks are equipped with “corner stops,” generally three pins arranged to provide a long side and a stop pin to locate the substrate accurately. No external prealigner is used in this case.

5.5 VIEWING SYSTEMS

The Quintel Q4000 is a manual aligner in that the alignment of the mask and substrate is achieved by an operator manually moving the substrate into alignment with the mask with hand controls, while viewing the images of both under high magnification. This section outlines the optical devices which provide the means by which the operator sees the mask and substrate to achieve the task.

The overall principle of aligning is to provide the means to see simultaneously two images, from opposite sides of the substrate. The greatest accuracy and easiest accomplishment of this alignment task is to have these two images as far apart as possible and yet to be able to see them at the same time, so the effect of any adjustment can be observed at both sides.

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The Quintel Q4000 may be configured with either of two basic types of viewing optics:

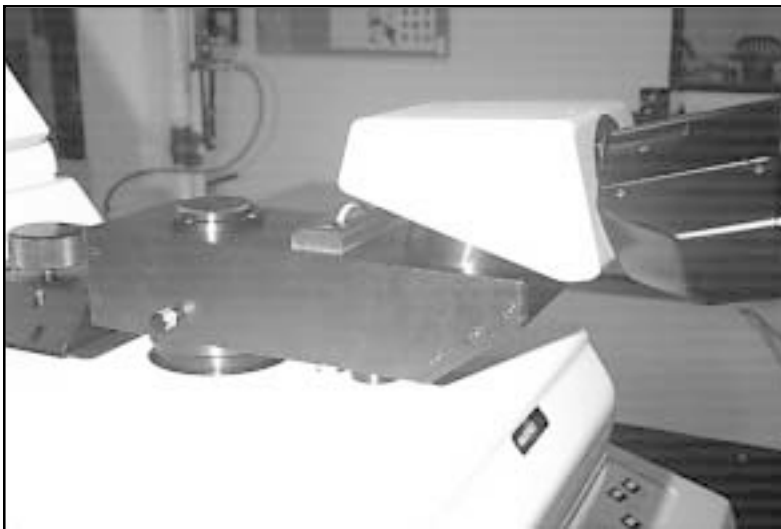
- A special type of optical microscope known as a split field microscope in which the images of two microscopes are combined optically so half of the image in the eyepiece is one side of the substrate and half is of the other. The Quintel Q4000 may be configured with either of two versions of this microscope, the smaller Vari-View, or the larger Magna-View, both of which are described below.

The Vari-View provides optical microscope style viewing for smaller size substrates (up to 100mm diameter) with a rotary turret type microscope. This unit has two stations equipped with either a low power and high power splitfield combination, or a split field and high power single field (for viewing the center of the substrate) combination. In either situation a third position contains a mirror to reflect the exposure light down to the substrate.

The second optional splitfield microscope the MAGNA-VIEW, is useful for larger size substrates (up to 150 mm diameter). This unit changes power by means of two turrets mounting multiple objective lenses. To change from viewing to exposure this microscope swings up automatically, and a mirror takes its place to reflect the exposure light down to the substrate.



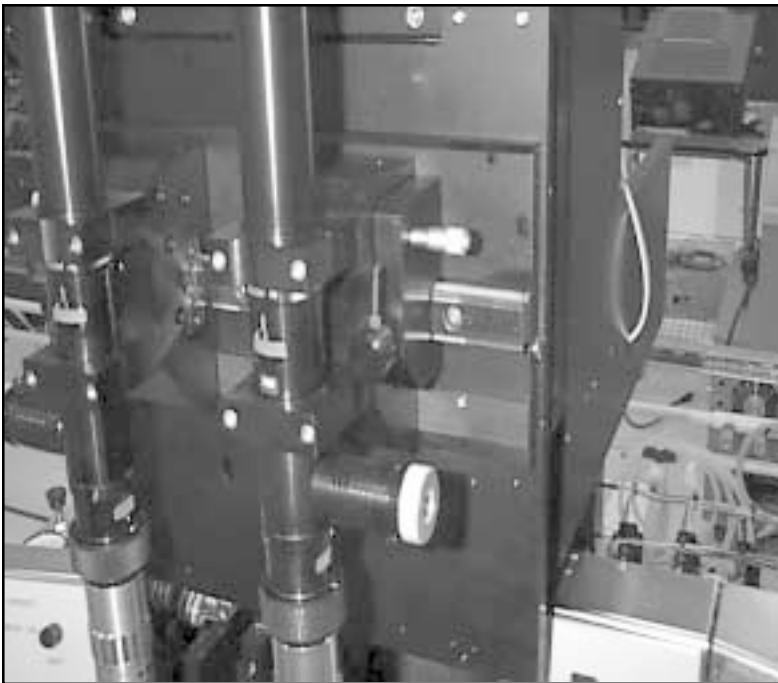
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Both of these microscopes are provided with a zoom magnification changer that allows viewing over an extended range.

All of the viewing units may be adjusted for observing at different spread distances, and have binocular eyepieces for fatigue free viewing. A wide variety of optical options are available to match the magnification of the system to the application requirements.

- The VIDEO-VIEW version is a dual camera video system, wired to a split screen monitor, which replicates the view of the optical split field microscope, in that one camera field fills half of the screen and the other camera fills the other half. The Video-View option also offers spread adjustment and zoom magnification change. The change from viewing to exposure is similar to the Magna-View optical unit.



The Video-View option also offers spread adjustment and zoom magnification change. The change from viewing to exposure is similar to the Magna-View optical unit.

5.6 ALIGNMENT

The function of an aligner is to expose aligned images of a mask on to a substrate . While all of the major components of an aligner are vital to this mission, one of the most important, if not the key component, is the stage assembly. This is the mechanical assembly which allows the mask and substrate to be moved under the microscope to a critical area, then to move the substrate in relationship to the mask to accomplish the

alignment. After the alignment is accomplished and verified, the stage must hold the alignment in an absolute relationship while the machine prepares itself for the expose phase, and completes the exposure. All of these functions must be performed to accuracies so small that we really cannot see them, even under high magnification.

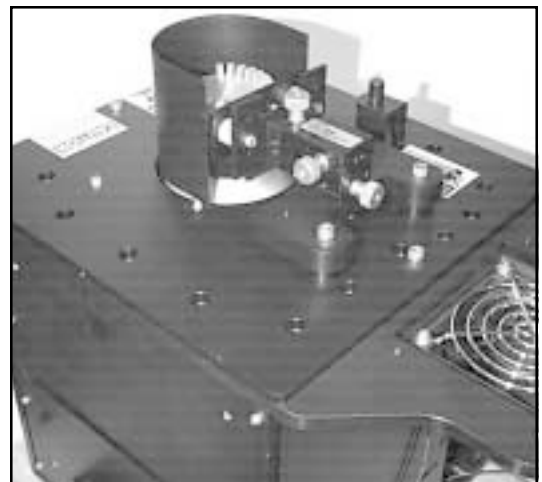
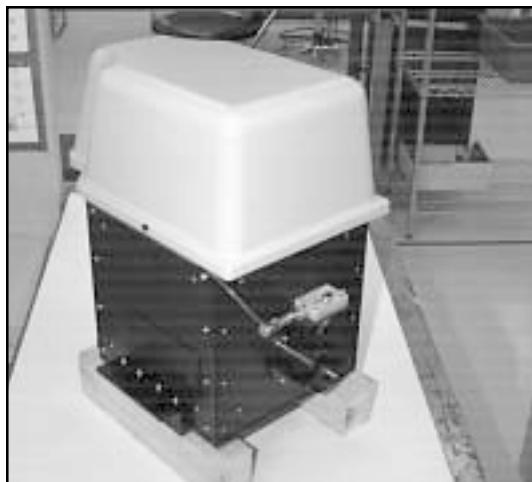
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5.7 EXPOSURE OPTICS

The Q4000 is equipped with the state of the art Q170/15 exposure system. This unit can be configured for a range of lamp sizes from 200 watts to 1000 watts. It employs an elipsoidal mirror as its initial energy gathering element, a precision X-Y-Z manipulator to permit easy and repeatable lamp positioning, a multi lens light integrator to process the light for optimum uniformity, and high efficiency dielectric mirrors

for lowest possible energy loss. All together this light source will support the most difficult production problems with ease, and it has the features that makes the job easy.

The entire light source unit is contained in a enclosed housing designed to provide maximum environmental protection to the operator and others in the area.



5.7.1 EXPOSE OPTIONS

Because process requirements result in widely varying energy and spectral specifications, there are a number of options available for the light source.

The actual light source for the exposure illumination is a lamp known as a “Mercury Short Arc” lamp. This lamp employs a quartz envelope which will withstand the high pressure and high temperatures encountered in operation of the lamp.

The cathode, or “-” end of the lamp is always mounted up with the axis of the lamp vertical. It has an end cap with a threaded protrusion for use as a means of mounting the lamp to the support, and connecting the negative electrode of the lamp to the insulated support. The support also provides a means for connecting the negative lead from the power supply to the lamp.



• Lamp Wattage:

These lamps are available in wattage values of 200, 350, 500, and 1000 watts for use in the Q4000. The lamps are not physically interchangeable and some modifications to the lamp house are necessary to go from one size to another. Also, the Vari-View head is restricted to the lower wattage lamps.

The special power supplies required to drive the lamps are manufactured in three sizes, with each size internally switchable to drive two lamp wattages: 200/350, 350/500, and 500/1000. These power supplies are also internally switchable to accommodate both U.S. and International voltages.

Wattage versus output is not linear, but a larger lamp inevitably results in more exposure energy.



• Spectral Range

Another variable with these lamps is the spectral output of the lamps. The internal configuration of the lamps may be altered at the time of manu-

facture to enhance various wavelengths. Some of these modifications require modified power supplies. If the process requirements under consideration dictate a special spectral output, consult the factory for information.

- Light Level Control

Exposure light level control is an important subject for the process engineer since it has an immediate effect on the quality of product coming from the aligner. There are a number of techniques available for consideration.

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- Feed back control:

All Quintel aligners can be equipped with a feed back light level sensing type power supply, which eliminates the variable from the aging of the lamp itself, with its inevitable reduction from initial output.

- Power supply control:

Within a narrow range each power supply can allow some increase and decrease in lamp output.

- Filtering:

An excellent, safe, and highly versatile way of modifying light outputs is to make use of optical filters to either selectively reduce the spectral output of the optical system, or by the use of neutral density filters uniformly reduce all parts of the spectral output. The major limitation to the

use of filters is that filters work, in many cases, by absorbing some of the energy in the light stream. Absorbing energy results in temperature increases within the filter itself and care must be taken to give the filter a chance to disperse this before the physical limitations of the filter are exceeded.

- Defocusing:

As mentioned in the lamp set up section, a popular method of reducing output is by "defocusing" the lamp, a technique not approved by Quintel due to the chance of creating physical hazards. However, within very narrow limits this technique could be utilized for "fine tuning." a system, recognizing the hazards of doing so.

From the point of maximum intensity, defocusing should only be done in the direction which raises the lamp in the reflector. The principal use for this is to "fill" the rear of the lens assembly with light. Never change the intensity more than 5 mw/cm² from peak intensity by defocusing.

5.7.2 EXPOSURE TECHNIQUES

There are two optional extras available for the Q4000 which are of interest to those doing demanding work.

The first is, as mentioned above, an alternative type of power supply for the exposure lamp, which provides a feed back automatic control of the light intensity, so as the lamp ages or other conditions cause the actual light output to change the power to the lamp is automatically adjusted to compensate for the change. This assures identical exposures to eliminate one of

the variables.

The second is an optional exposure timer program which may be installed in the PLC to provide a pulsed exposure, which gives an short exposure then a rest period for the work to stabilize, then another short exposure and so forth to a total exposure time before terminating the exposure. This technique provides outstanding results on very fine geometries, where intimate mask/substrate contact must be maintained and photoresist outgassing causes a loss of contact. All times— on time, off time and total exposure time as well as complex exposure patterns are under the process engineer's control.

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5.7.3 COOLING

The cooling of the exposure lamp is critical to the proper operation and long life of the light source. Under cooling and over cooling are both detrimental in their own ways. The cooling system installed on the Q4000 is designed to optimize the cooling and every effort must be made to maintain the system as installed. Do not modify any openings or baffle the inlets or outlets of any of the air circulation system. There is a controlled air flow directed at the lower lamp terminal; the flow control for this air supply is mounted on the high pressure manifold under the right hand control panel and must never be changed.

The Vari-View model head uses an external exhaust fan to remove excess heat from the lamp house. This fan unit normally sits on the floor behind the aligner table, and is connected to the aligner by a flexible hose. Check this fan unit frequently to insure that it has not had its outlet blocked

The Magna-View head uses an internally mounted fan to exhaust the heat.



5.8 PROCESS OPTIONS

There are many process options available on the Quintel Q4000, the majority of which involve the conditions existing in the interface between the mask and the substrate .

The substrate chuck, which carries the substrate into the expose chamber provides a very flat and smooth support surface for the substrate . This surface may be considered a reference plane which does not change regardless of what is done around it.

The mask, containing the pattern which we wish to transfer to the substrate , is in itself very precise, but because we require it to be thin and transparent, is not very stable. The process controls provided by the Q4000 allow the balancing of various forces to keep the interface as uniform as necessary to achieve the desired product characteristics.

The controls provided are:

- The ability to apply vacuum to the substrate / chuck interface to make the substrate as flat as possible, to introduce low pressure to this interface to force the substrate up into intimate contact with the mask.

We can vary the upwards pressure exerted by the guide set on the substrate, through the chuck, which again contributes to the contact between the substrate and the mask.

- We can introduce a controllable vacuum into the sealed chamber surrounding the mask/ substrate , which allows atmospheric pressure to counterbalance these upwards pressures, or to allow the full force of atmospheric pressure to press the mask and substrate together for a minimum gap between during exposure.

We can also setup a procedure which, after the initial leveling contact, never lets the substrate touch the mask again, and allowing the exposure to take place with a controlled gap between the two.

6 MACHINE CONTROLS

6	CONTROLS	.0 INTRODUCTION	
		.1 CONTROL PANELS	
		.1 INPUT	
		.2 UPPER RIGHT	
		.3 LOWER RIGHT	
		.4 UPPER LEFT	
		.5 LOWER LEFT	
		.6 REGULATOR	
		.7 FLOW CONTROL	
		.2 THE PLC	
		.1 CONTROL MODULE	
		.2 THE PLC CONTROL PANEL	
		.3 PLC NAVIGATION CHARTS	

6.0 MACHINE CONTROLS– INTRODUCTION

This section introduces you to the operator-machine interface for the Quintel Q4000 Aligner. The Q4000 has been carefully designed for ease of use by operators of all skill and experience levels, and for a very short learning curve. The user be completely comfortable with the operation of the machine within minutes even though it features the very latest in high tech computerized control systems.

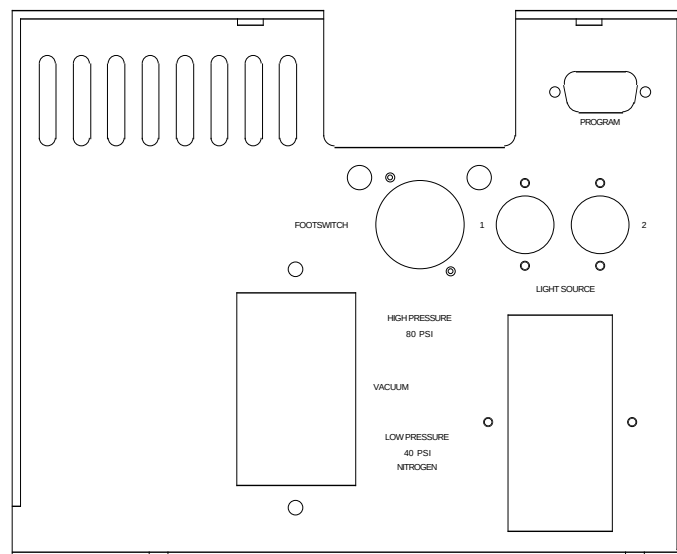
The first part of the section is devoted to the CONTROL PANELS which contain the push button switches which operate the manually controlled functions and which initiate the machine controlled sequences of the cycle. Also detailed are the various pneumatic controls to set the pressures and flow rates for the gasses which perform many of the functions of the aligner in doing its work.

The final section introduces the PLC– the programmable logic controller, which does the complex thinking and remembering for the aligner .

6

6.1 THE MANUAL CONTROL PANELS

6.1.1 THE INPUT PANEL



The INPUT panel is located at the center rear of the aligner and is the interface with all utilities required for the operation of the aligner. Looking at the rear of the machine, at the left side are the machine identification labels, containing information relating to the machine's serial number, operating voltage, electrical requirements, etc.

To the right are the three connectors for HIGH PRESSURE gas, LOW PRESSURE gas, and VACUUM.

At the far right side of the panel is the main electrical connector. This unit combines a number of functions in one unit. There is a cord connector for a line cord to plug into, a master on-off switch, which controls all power to the aligner. Below the connector is a fuse holder which contains a fuse to protect the entire machine from electrical faults; this fuse holder also serves as a means to reconfigure the system to operate off higher voltage for installation in international facilities where line voltages are double the normal U. S. standard voltage. Since these higher voltages require a different fuse value to protect the circuits the proper value fuse is installed when you change the machine configuration.

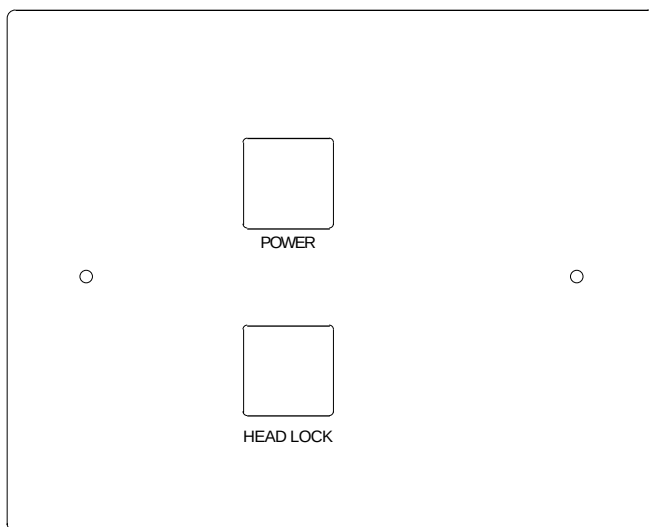
Above the power unit are three connectors for the installation of options if the aligner is configured for them. The infrared viewing option installs remote lamp controls for the fiber optic illuminators used for viewing, and a connection is provided for an optional foot switch to control a manual function normally operated by a front panel push button. Also provided here is a RS232 connector for the PLC for programming access.

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Note:

The next four panels are visible when seated at the front of the machine, and are identified by locations relating to a normally seated operator.



6.1.1 UPPER RIGHT CONTROL PANEL

This small panel contains two push button switches; the upper one is the main POWER switch which controls the power to all of the functions of the machine.

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Note:

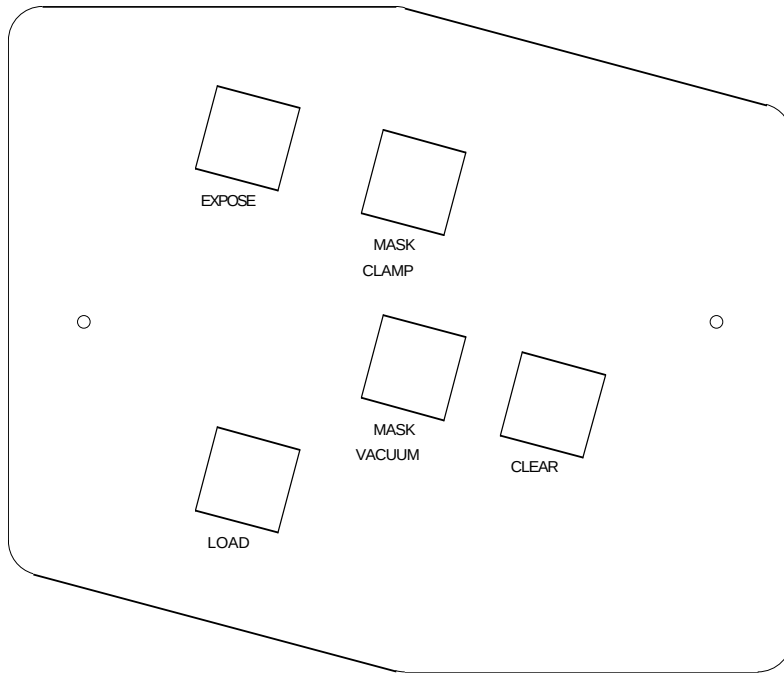
This switch will not operate until the power switch at the input panel is turned on. It should also be noted that this switch will not turn the aligner off. The off function is under PLC control in order that the machine logic is always prepared for shut down prior to actual turn off. (Shut down by turning off the main input switch, or by power failure, will not damage the machine, but it is recommended that the logic shutdown technique always be used for normal shutdown,

The second switch is a HEAD LOCK switch which un-locks the optical head, allowing it to be swung to the side to facilitate mask changing, tool replacement, cleaning or other maintenance operations. The head should always be returned to the center position and the head lock switch de-activated before any operation of the aligner is initiated.

Also mounted on this upper right panel is the PLC control panel. This control panel is described in detail in Section 6.2 below.

6.1.2 LOWER OR FRONT RIGHT CONTROL PANEL.

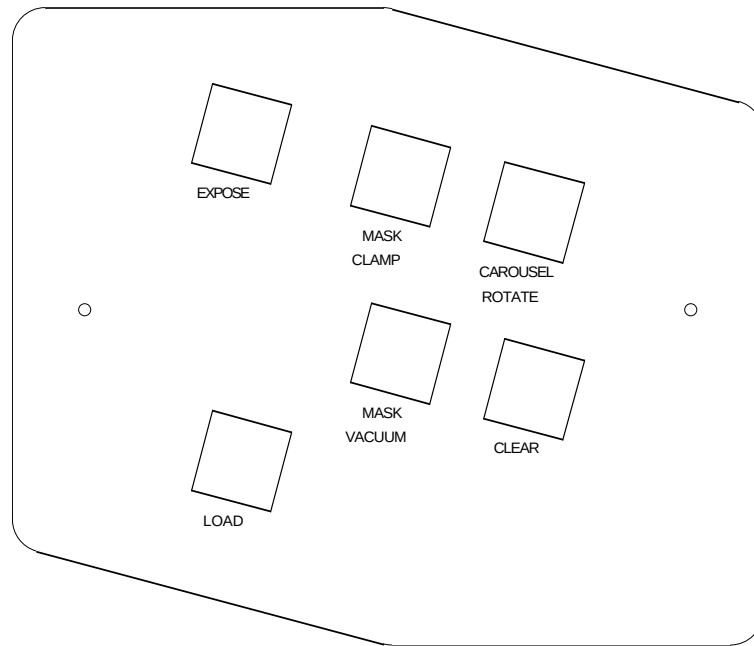
This is the main operational panel for the aligner and contains push button switches to control many of the operator initiated functions of the production cycle. Two of these, MASK CLAMP and MASK LOAD, are used to install the mask on the mask holder. MASK CLAMP controls the vacuum which holds the mask clamp to the mask. MASK LOAD controls the vacuum which holds the mask to the maskholder. Refer to the mask loading sequence for the function of these switches (Section 9.1)



LOAD initiates the planarization/alignment cycle, after the substrate has been placed on the substrate chuck, pre- aligned, and moved into place by the tray.

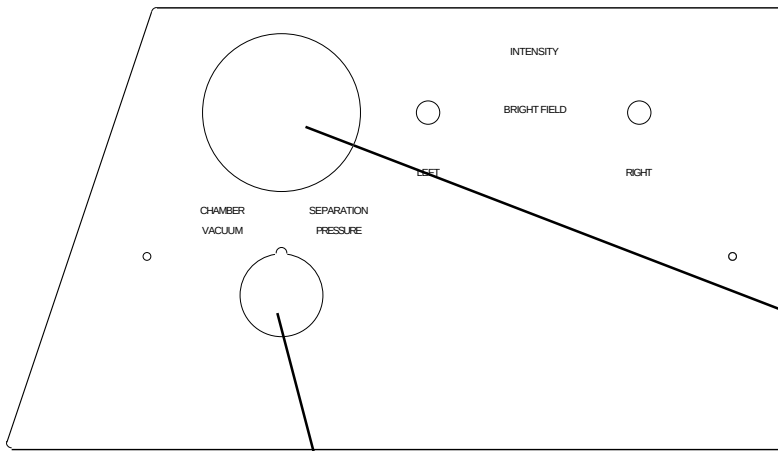
EXPOSE initiates the expose cycle, after the operator has completed the alignment of the substrate and has confirmed that the alignment is satisfactory in contact.

CLEAR is the reset or cancel control for the Q4000, and is used to return the substrate/chuck to the start condition when necessary.

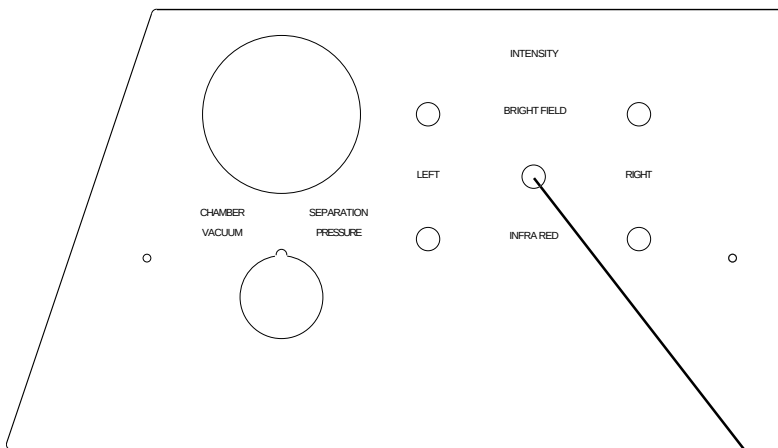


On machines equipped with the carousel load option, there is a CAROUSEL ROTATE switch to cause the load carousel to rotate without the necessity of completing an alignment and expose cycle to move a substrate chuck from the expose position to the load position. The switch is used most frequently in set up.

6.1.4 UPPER LEFT CONTROL PANEL

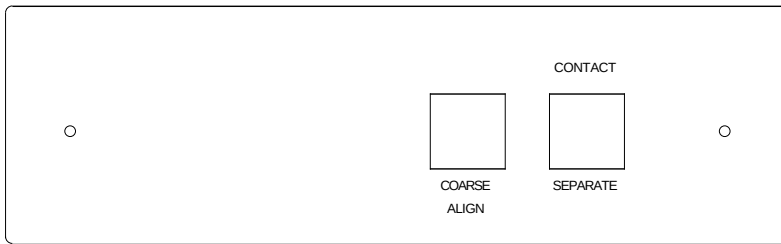


This panel contains a pressure gauge capable of reading both pressure and vacuum, and a selector valve to select a reading of either printing CHAMBER VACUUM or SEPARATION PRESSURE. The printing chamber vacuum mode is used in setting up the machine for vacuum printing (see Section 7.1.2) and the separation pressure mode is used to establish the separation distance for alignment (see Section 8.3).



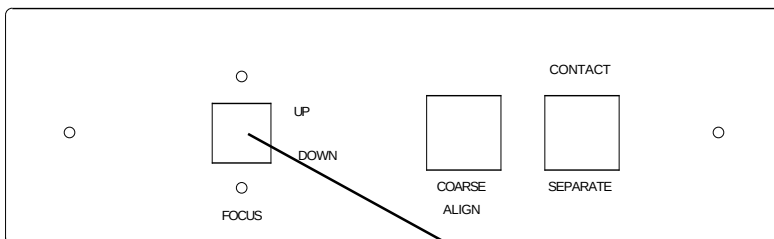
Also mounted on this panel are the controls for the microscope illuminator brightness (refer to Section 8.4.2.2). If the aligner has been equipped for infrared viewing a switch is provided to select the mode of illumination, either normal top side bright field, or bottom side through the substrate illumination, or both. In either case there are separate controls for each side of the split-field microscope.

6.1.5 FRONT LEFT CONTROL PANEL



The front left panel has a COARSE ALIGN switch which when held down moves the align joystick into a coarse align mode to provide faster movement into rough alignment; releasing the switch reverts to the fine align mode for critical alignment movement.

Also on this panel is the push on-push off switch to move the substrate chuck between CONTACT and SEPARATE for alignment and expose.

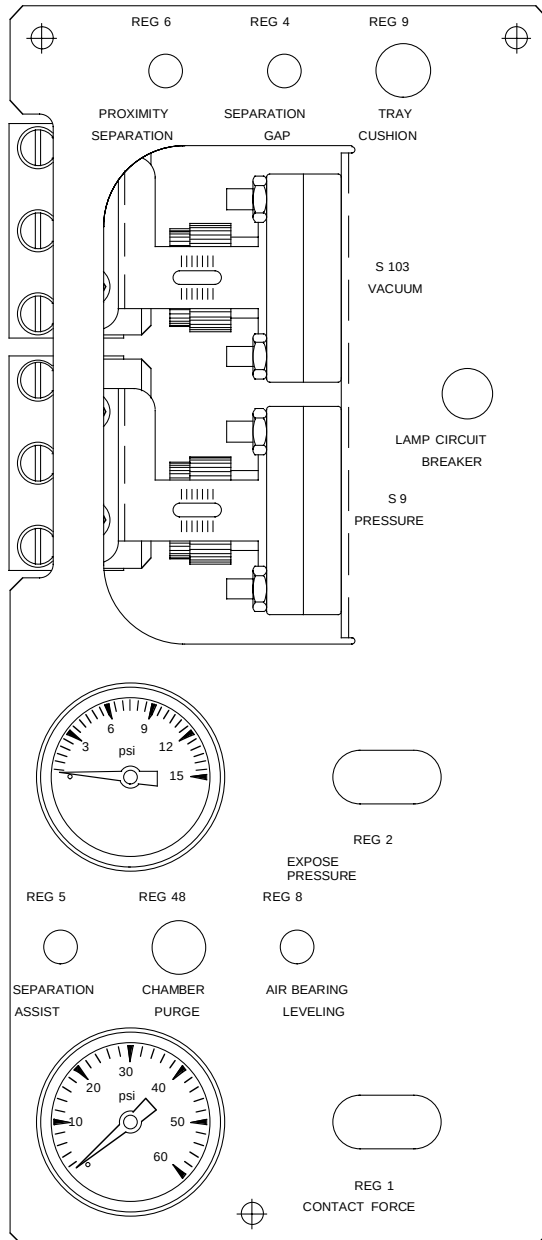


For aligners equipped with the Magna-View expose head the front left panel contains a power driven focus control. This is a center off, two direction control to provide up and down movement of the microscope with finger tip control.

Note:

The following two control panels are located under removable doors on the top of the aligner, the Regulator Panel at the rear left, and the Flow Control Panel just behind the Top Right control panel.

6.1.6 THE REGULATOR PANEL



The REGULATOR PANEL mounts all of the precision regulators used by the aligner to control the pressure of the gasses which perform the tasks required to align and expose a substrate. Starting at the front of the panel:

Regulator 1 Contact Force–
Controls the Upward Z axis force which lifts the substrate into contact with the mask.

Regulator 5 Separation Assist–
Provides air pressure to assist the chuck piston in the separation mode.

Regulator 48 Chamber Purge–
Controls the purge to the printing chamber during separation.

Regulator 8 Air Bearing Leveling–
Provides air to ball seat during initial substrate leveling at the first contact after loading.

Regulator 2 Expose Pressure–
Expose Pillow Pressure, supplies low pressure between the chuck and the substrate during exposure.

Regulator 6 Proximity Separation–
Supplies air to control substrate separation for Contact Calibration (Proximity Gap) Printing Mode.

Regulator 4 Separation Gap–
Supplies air to increase or decrease the substrate separation gap during alignment.

Regulator 9 Tray Cushion–
Pressure for the air cushion at the load tray "in" motion.

In addition to the regulators described above, the Regulator Panel also mounts three other devices:

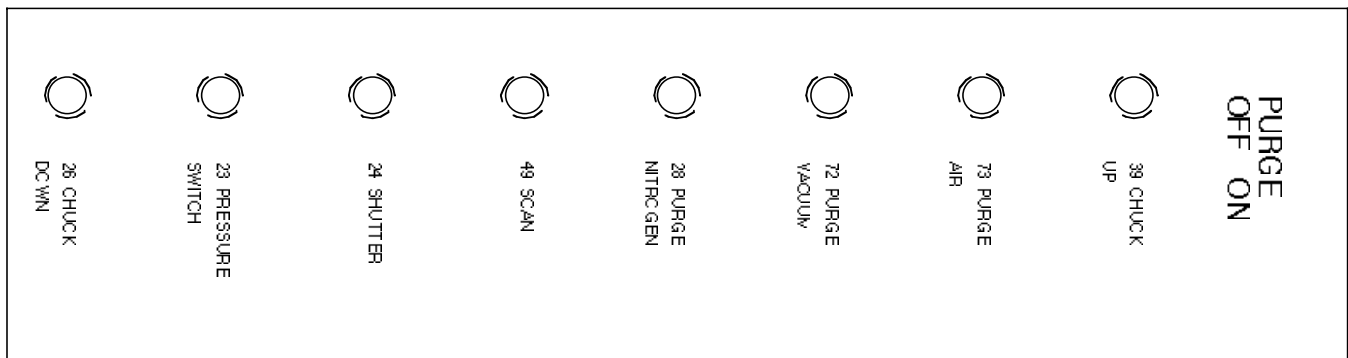
Switch 9 Pressure Switch–
Detects when the substrate has been lifted into contact with the mask.

Switch 103 Vacuum Switch–
When in vacuum printing mode, detects when the chamber vacuum has equaled to a predetermined setting, to activate the expose sequence.

Microscope Illumination Lamp Circuit Breaker– Resettable electrical circuit protection for the microscope illumination lamps.

6.1.7 FLOW CONTROL MANIFOLDS

The FLOW CONTROL MANIFOLDS mount the flow controls which control the amount of gas flowing to various operations. Air flow typically controls the speed at which tasks are performed. Starting at the far right hand end, the controls mounted on the flow control bracket are as follows:



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Toggle valve 35- Turns expose purge on or off during pressure contact expose printing.

FC 49 Scan—Controls the air bearing pressure to the Scan Cup.

FC 39 Chuck Piston Up —Controls the upward speed of the substrate chuck during leveling.

FC 24 Shutter—Controls the high pressure air to the ultraviolet light shutter cylinder.

FC 73 Chamber Vacuum—Controls the highest amount of vacuum available to the printing chamber by bleeding air into the system.

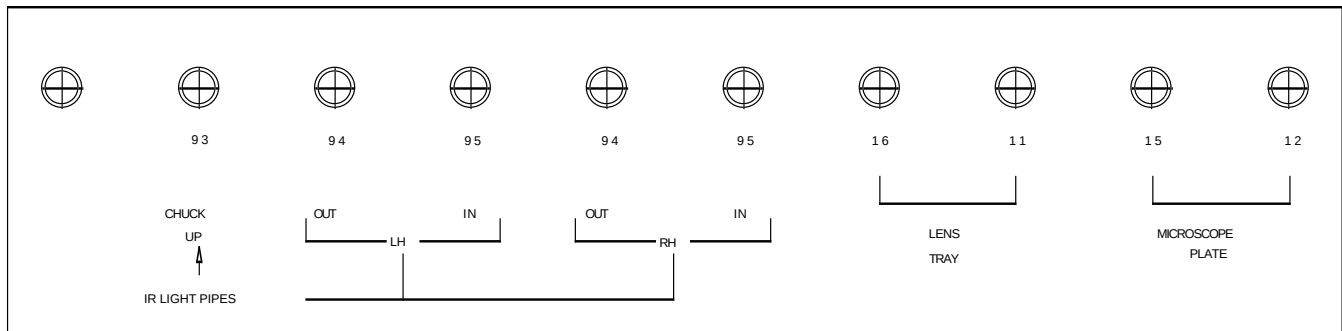
FC 23 Pressure Switch—Controls the air from Regulator 1 to the pressure switch, to adjust separation timing during substrate leveling.

FC 72 Chamber Vacuum—Controls the volume of vacuum available to the printing chamber.

FC 26 Chuck Piston Down—Controls the downward speed of the substrate chuck after expose or Clear.

FC 28 Chamber Purge—Controls the vacuum in the printing chamber by introducing a nitrogen purge into the chamber.

There is an additional flow control, mounted on the high pressure air manifold, which is factory set to control the cooling air purge to the expose lamp.



FC 12 and 15 Microscope Plate– (When equipped with Magna- View) controls the motion of the microscope mounting plate at expose.

FC 11 and 16 Lens Tray– (When equipped with Magna-View) controls the motion of the ultraviolet field lens tray at expose.

FC 94 and 95 IR Light Pipes– (When equipped with infrared viewing option) controls the movement of the bottom side illumination light pipes. Separate controls for left and right sides.

FC 93 Chuck Up– (When equipped with infrared viewing option) controls the auxiliary chuck lift cylinder.

6.2 THE PROGRAMMABLE LOGIC CONTROLLER

The PROGRAMMABLE LOGIC CONTROLLER or "PLC" is a miniature computer based device that contains a software program to interpret the operators actions and initiate the necessary sequence of machine operations to accomplish the desired task. Through internally stored programs a variety of alternate routines can be used depending on the selected mode of operation.

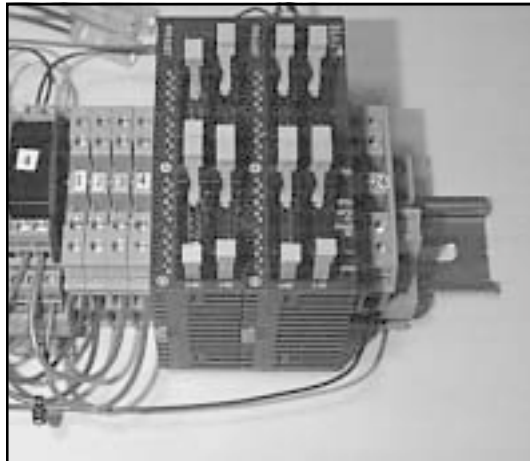
The Q4000 SYSTEM CONTROLLER actually consists of two hardware items, connected by an electrical logic cable; the first and most important to the operator is the control panel, mounted on the upper right machine panel, and the second is the PLC unit, located under the electrical distribution board at the left rear of the aligner.

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6.2.1 THE PLC CONTROL MODULE

The PLC control module is a small, totally enclosed plastic package, with a power connector, a logic interface connector, four signal input connectors, and four output connectors (only three of which are used by the Q4000). The unit requires no maintenance or operator interface for use. In operation, the unit receives

control directions from the control panel and input signals from various sensors and switches. It has an internal clock to control time intervals as needed, some dictated by the program and some, like exposure times, under operator control. The stored program gathers information from all sources, and interprets the information, activating the required actions at the proper time and in the required sequences.



Because the unit requires no access under normal operating conditions it is located in a protected position inside the aligner.

6.2.2 THE PLC CONTROL PANEL

The Control Panel, on the other hand, requires easy operator access for operating the aligner and monitoring the progress of the automatic operational events. It is also extensively used by the Process Engineer in setting up the proper process steps in preparing the aligner for production.



The Control Panel has three general areas— a LCD (Liquid Crystal Display) screen, showing a maximum of four –twenty character lines of plain english information, a numeric key pad for inputting numerical data and control functions (insert, clear, enter), and four directional arrows (up, down, left, right).

The Control Panel Display serves two purposes in operating the Q4000—

1. It guides the operator in making the settings which defines how the aligner operates and
2. In operation, it maintains a running description of what the aligner is doing at all times and at each step in the program which has been set up.

The software installed in the PLC results in a series of messages displayed on the screen. Table 6.1) "Q4000 Menu Navigation Chart" shows the entire contents of the program, and the relationship between the various screen displays. Movement between screens is controlled by either direction arrows or by selecting a numbered option ("Menu"); a small arrow in the upper right or left corner of the display indicates there is a continuation of that screen in the direction indicated (used if there are more than three choices for that option).

As an introduction to the use of the control panel we will review the steps to start up the aligner, and to turn the aligner off:

Reminder:

There are two switches on the Q4000 which control the power to the aligner. The first, the Master Switch, at the rear of the machine, turns off all power to the aligner; normally this switch is only turned off when the machine is taken out of service for some reason. The second switch, mounted on the upper right panel, is the Power Switch, which is operational only when the master switch is on, controls the power to the logic and operational features of the aligner.

With the master switch on, the power switch off and the load tray pushed in press the "POWER" button on the upper right control panel. The indicator at the switch should go on, and the control panel screen will show an initialization sequence, ending with the title page. The bottom line of the display will show the machine "state" or condition at the moment, in this case it shows "press enter."

Note:

When the aligner is first powered up, after the Master Switch has been turned off, there will be a noticeable delay in the initialization of the Control Panel— as much as 10 to 15 seconds— while the Control Panel downloads its operating system from the PLC. This delay is much less when the Master Switch has not been turned off, maintaining standby power in the system.

6

Pull out the tray to its out limit: this is "unload," which sends a signal to the PLC that this operation has been done. At this point the display changes to the main menu page and the top line of the display shows the machine state of "Load Wafer" In normal operation we would proceed to set up the aligner for new operating conditions, or proceed with loading and aligning a substrate if the machine was already set up. For our initial experience however, we will select Option 6 "Power Off," which will result in the PLC turning the power system off, and the indicator light at the power switch will gradually fade out, indicating that the machine power is off.

The actual set-up of the PLC will be discussed in Section 10 "Options for Process Control," and Section 11 "Start-up." Much of the set up procedure is the special interest of the process engineer and thus is described in the sections designated for their use. Normally the operator will be mostly concerned with the verification of settings and modifying exposure times.

The general instructions for using the PLC Control Panel are as follows:

To select an item in the menu press the number key on the display panel corresponding to the menu number of the item required.

To return to the previous menu press ENTER.

When selecting options, the selected option will be marked with an asterisk (*). To unselect an option, press the number again and the asterisk will be removed.

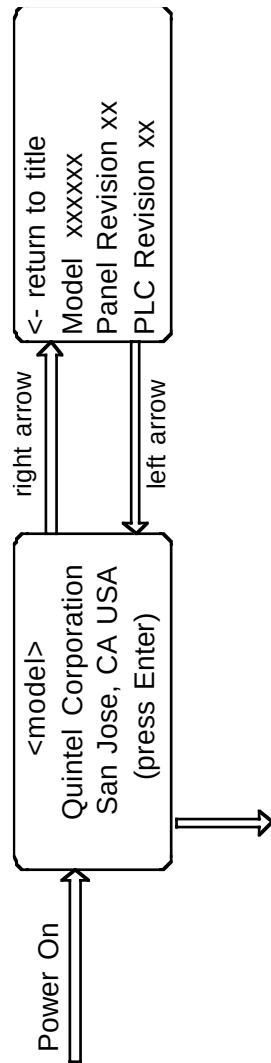
To change a numerical entry, such as a time value, begin by pressing the "0 or INS" (INSERT) button, then select the field you want to change, using the up or down arrow buttons. Next enter the desired value and finish by pressing ENTER. Enter only whole numbers or one decimal (.x) if required.

6.2.3 PLC NAVIGATION CHARTS

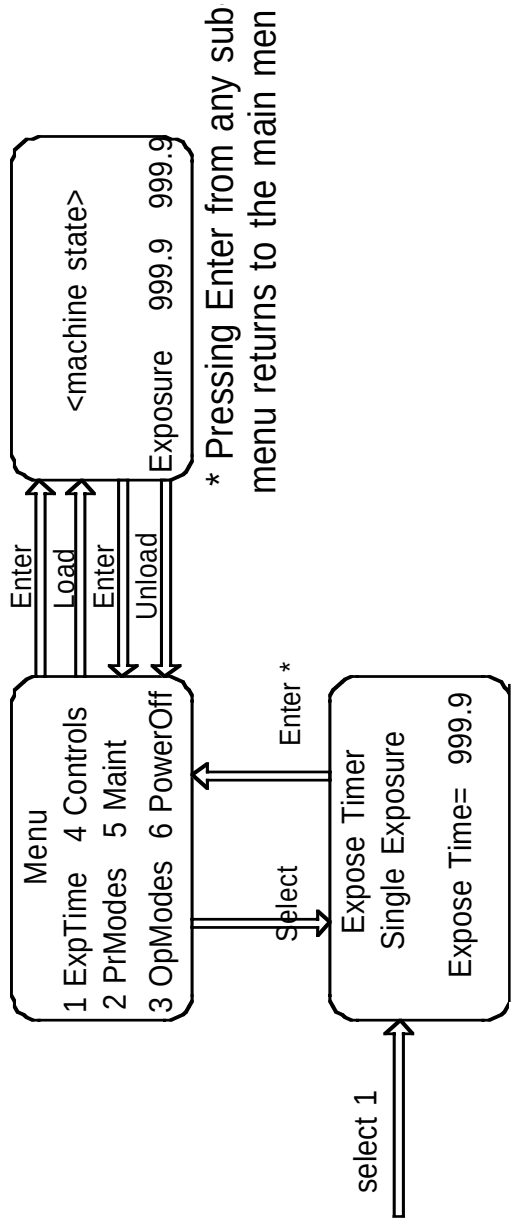
On the following pages are PLC Control Navigation Charts which graphically display the actual messages seen on the control screen at the top of each page, and at the bottom, in tabular form, an interpretation of what the message means, what the operator's response to the message should be, and what the result to be expected is.

The control is set up in classic menu fashion, in which a list of possible options is presented for selection. Pressing the number of an item will either initiate an action or will produce another screen, with more choices to be selected. A small arrow in the upper corners indicates that a continuation of the present screen is available in the direction shown. A hollow arrow between boxes is a "operator select" action, which takes you from one box to the next one. At any time pressing "ENTER" will return you to the main menu, to start over. A flashing spot on the screen is always a request for an operator input.

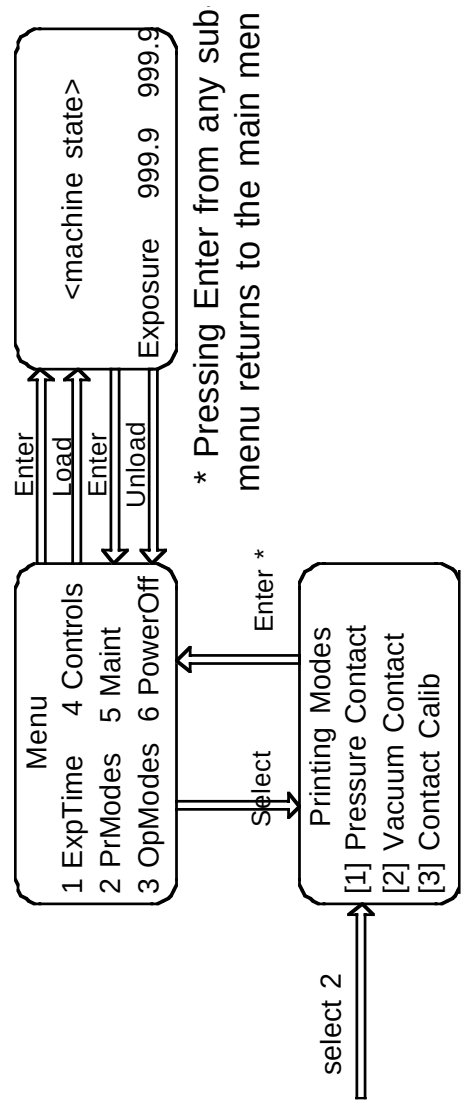
It is suggested that if you are not familiar with a menu driven system such as the Q4000's, that you spend a few minutes studying these charts, and then sit down at the machine and try the different sequences. You will find that you very quickly will become familiar with the system, and comfortable with manipulating the controls. It is virtually impossible to "break" anything, and very easy to "return to go," so you can start over if you get lost.



LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
Q4000 Quintel Corporation			Press Enter	Initial startup screen

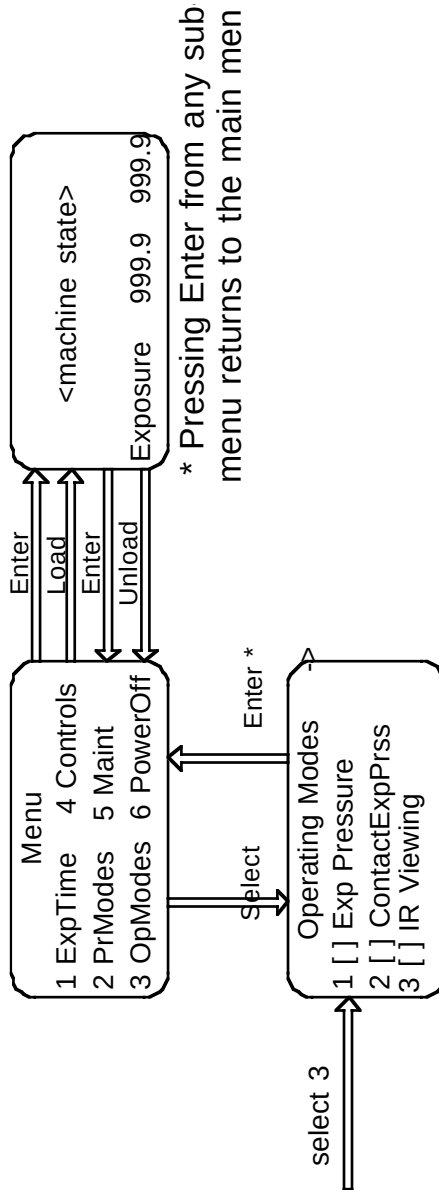


LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
Timer	Main Menu	Set ultraviolet light expose time duration	Press "Insert"; cursor blinks- Enter desired expose time	Insert desired time up to 999.9 Seconds by 0.1 Increments.

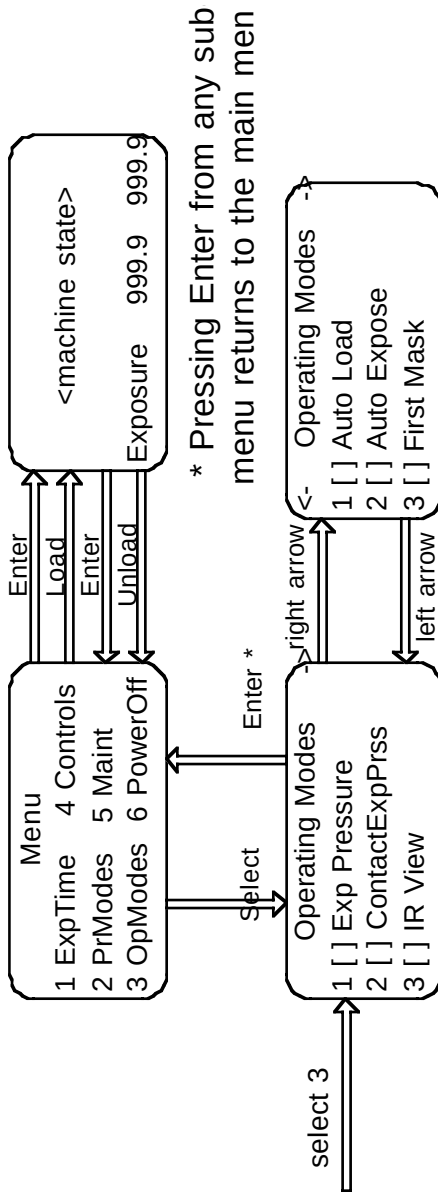


	SUB SET OF	USED FOR	ACTION	DESCRIPTION
Printing Modes	Main Menu	Set print mode	Select	
(1) Pressure Contact	Printing Modes	Select pressure contact mode	Select (1)	refer to 7.1.1.1 for details; Substrate exposed under Pressure Contact conditions.
(2) Vacuum Contact	Printing Modes	Select vacuum contact mode	Select (2)	Refer to 7.1.1.2 for details; Substrate exposed under Vacuum Contact conditions
(3)Contact Calib	Printing Modes	Select contact calibration mode	Select (3)	Refer to 7.1.1.3 for details; Substrate exposed out of contact at a predetermined gap.

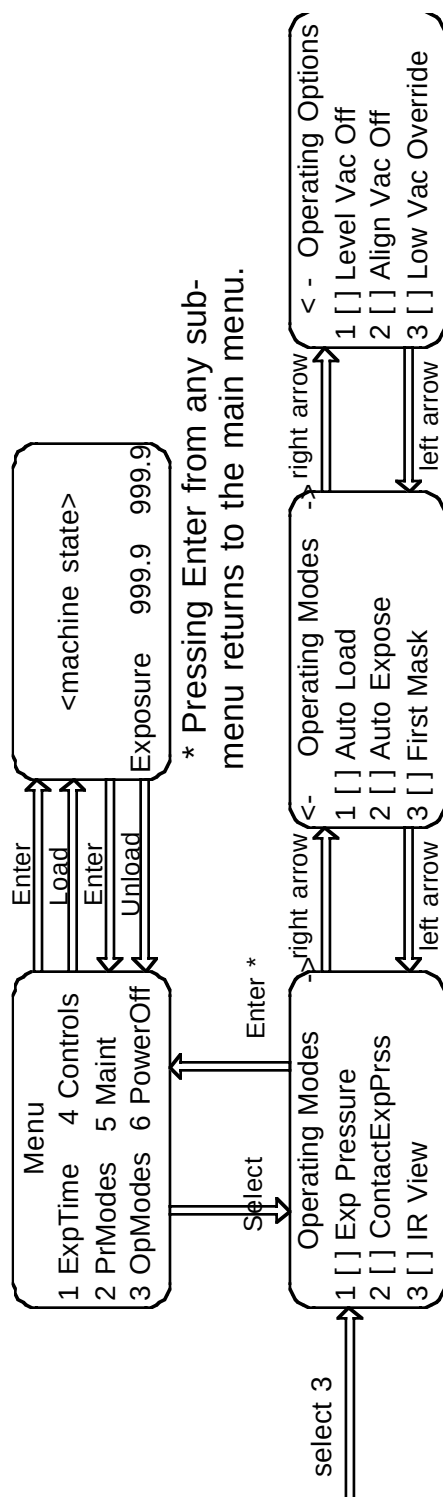
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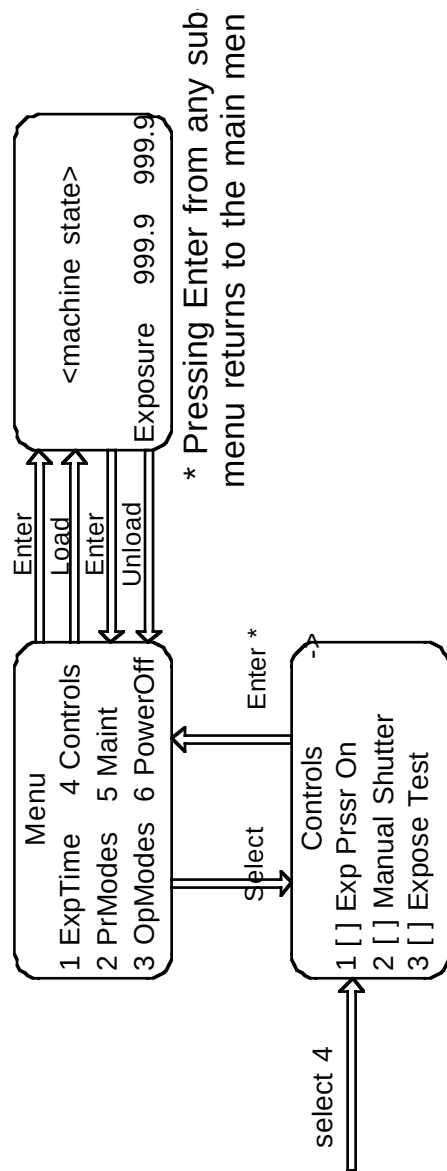
LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
Operating Modes	Main Menu	Select variations in operating sequences	Select	There are three menu windows under this selection– use right arrow to view 2nd and 3rd menus.
1 () Exp Pressure	Operating Modes	Applying chuck top pressure to back of substrate at exposure	Select	Use in pressure contact mode for highest resolution– refer to 7.1.1.1 for details
2 () Contact Expose Pressure	Operating Modes	Applying chuck top pressure to back of substrate at every contact	Select	Allows evaluation of alignment at expose pressure condition.
3 () Ir View	Operating Modes	To activate the IR viewing illumination	Select	Installs the controls which move the backside illumination system into the chuck during the alignment phase of the production cycle and automatically removes the illumination system prior to unloading the substrate .



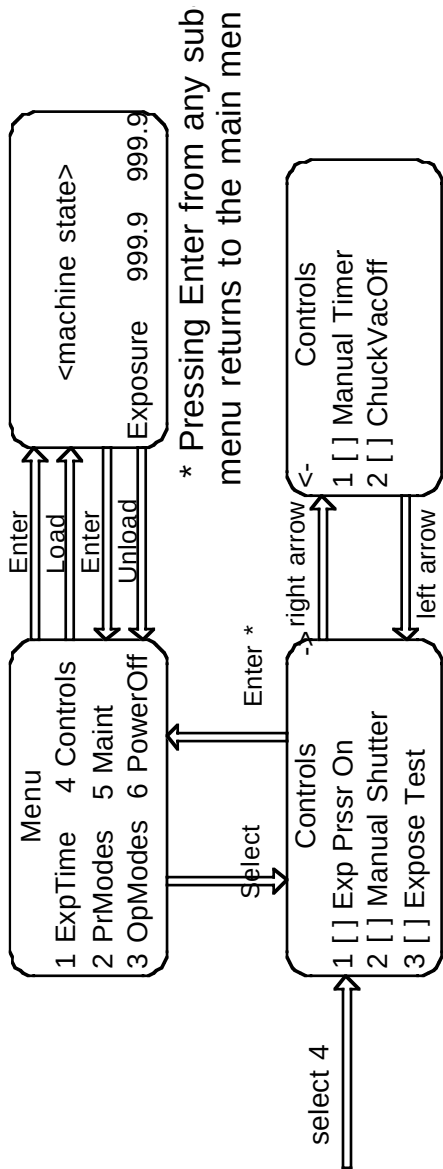
LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
1()Auto Load	Operating Modes	Short cut for quicker loading	Press "Right Arrow" In OPERATING MODES Menu For Special Abbreviated Operating Sequences	refer to 7.1.3.2 for details
2()Auto Expose	Operating Modes	Short cut for quicker exposing	Select	Refer to 7.1.3.1 for details
3()First Mask	Operating Modes	Short cut for minimum cycle	Select	Refer to 7.1.3.3 for details



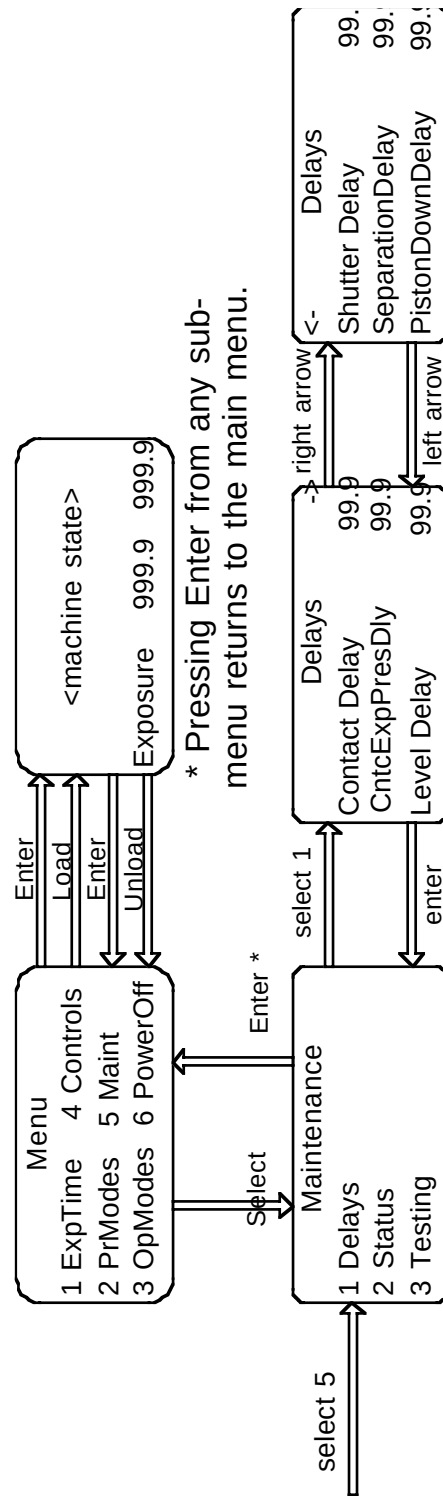
LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
			Press "Right Arrow" In OPERATING MODES Menu For Special Vacuum Applications	
1 () Level Vacuum Off	Operating Modes	Disables chamber vacuum during substrate chuck leveling	Select (1)	1. Used if mask has tendency to lose holding vacuum during leveling. 2. Used if Vacuum is required during exposure but not during alignment. No chamber vacuum applied during leveling.
2 () Align Vacuum Off	Operating Modes	Disables align vacuum in chamber during contact	Select (2)	Used as above if no vacuum is desired during alignment. No chamber vacuum applied during alignment.
3 () Low Vac Override	Operating Modes	Disables low chamber vacuum interlock	Select (3)	Used if fluctuating or very low supply vacuum causes unnecessary exposure interruption. Allows the completion of a cycle even though low vacuum exists.



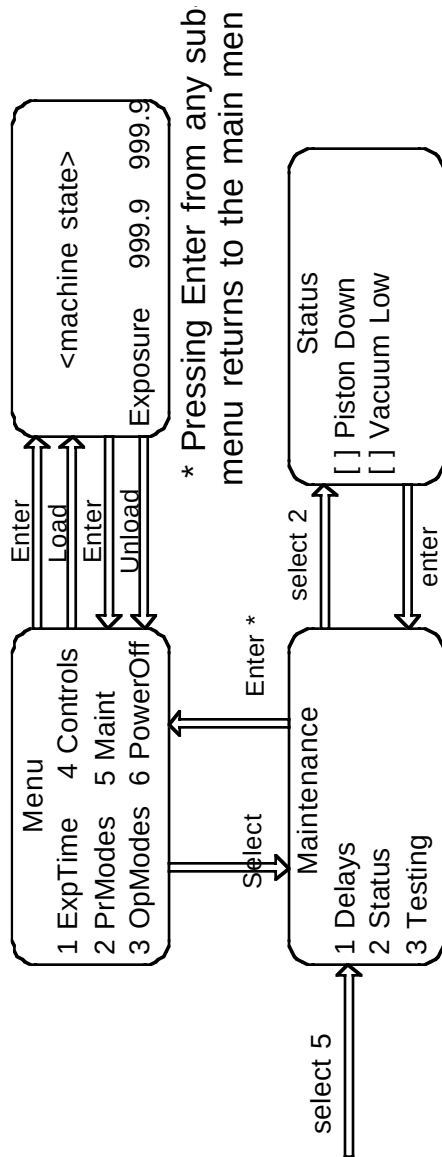
LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
Controls	Main Menu	Manual expose controls		
1 () Expose Pressure On (Exp Prsr On)	Controls	Manually turns expose pressure on for evaluating or setting levels	Acts As A Momentary "On" Valve	As long as the button is held down the chuck top pressure under the substrate is on used primarily when setting the pressure level.
2 () Manual Shutter	Controls	Manually opens the ultraviolet lamp shutter	Acts As An Alternate Action Switch	With vari-view head: with the turret in the expose position a push opens the shutter, a second push closes it. With magna-view head: with "expose test" activated, same action. Used for ultraviolet light level testing.
3 () Expose Test	Controls	To activate the automatic view-to- expose mode shift	Select	Operates the mechanism to move the expose optics into position for expose light testing. Used on magna-view only.



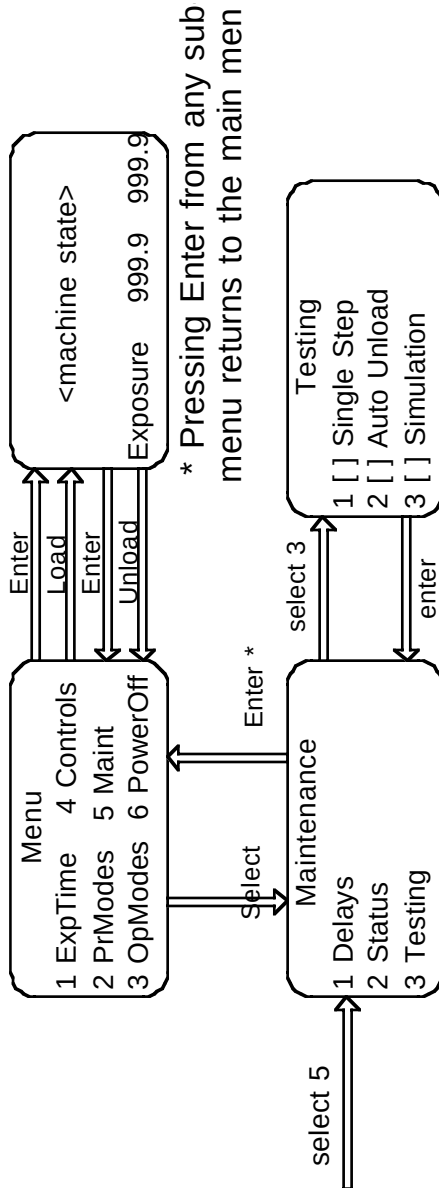
LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
			Press Right Arrow In Controls Menu To Display Second Menu	
1 ()Manual Timer	Controls	Manually initiates the expose shutter timer	Push Button	Manually activates the pre-set shutter timer for one cycle.
2 () Chuck Vac Off	Controls	To turn off chuck top vacuum	Push Button	



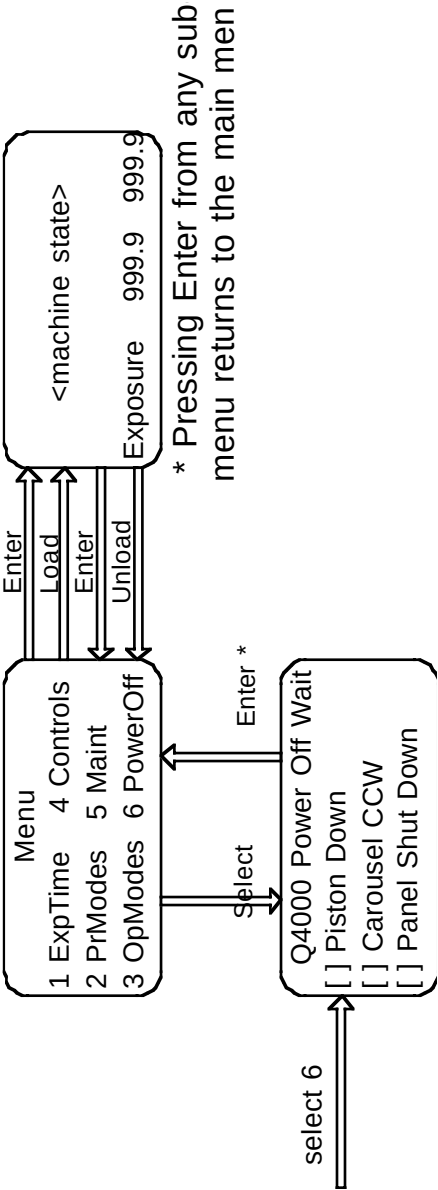
LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
Maintenance	Main Menu	To activate various utility items	Select	
1 Delays	Maintenance	To set various process delays	Select	There are six different controllable delays available . Refer to 7.3 For descriptions. Normally they are factory set and should not need adjusting



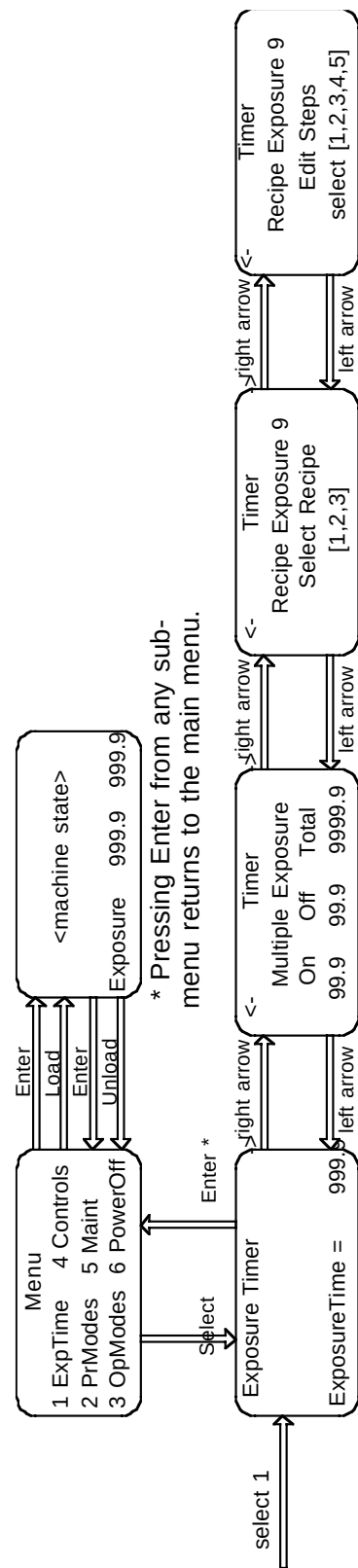
LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
2 Status	Maintenance	To observe two machine status conditions	Select	
Piston Down	Status	To Observe Piston Down Status	Indicator	Used to check and/or set the "chuck down" sensor
Vacuum Low	Status	To Observe Low Vacuum Status	Indicator	Used to check and/or set the low vacuum switch



LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
3 Testing	Maintenance	To start three testing techniques to aid diagnostic trouble shooting	Select	
1 () Single Step	Testing	Places the control in a single step mode	Select	When the system is placed in this mode pressing the "+" button advances the program one step for each push, allowing observation of events and analysis of problems at leisure.
2 () Auto Unload	Testing	Places the control in auto unload mode	Select	The machine will continue its cycle without requiring the load tray to be pulled out- allows continuous cycle testing
3 () Simulation	Testing	Places the control in a simulation mode	Select	Allows the machine to cycle even though there is no air pressure or vacuum connected. Useful in initial installation and set-up.



LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
() Piston Down	Main Menu	Indicates "Piston Down" condition with (*)	Indicator	Pre shut down condition
() Carousel CCW	Main Menu	Indicates "Coarousel CCW" condition with (*)	Indicator	Pre shut down condition, Carousel Loader only
() Panel Shut Down	Main Menu	Turns machine off for shut down		Main power system power shut off if preconditions are met



LEGEND	SUB SET OF	USED FOR	ACTION	DESCRIPTION
Timer Multiple Exposure	Timer Single Exposure	To activate the back side illumination mechanism for ir viewing	Select	Refer to 7.2.2 For description of purpose, operation, and setting of this option, if installed.

7 OPTIONS FOR PROCESS CONTROL	.0 GENERAL		
	.1 PROCESS OPTIONS IN GENERAL		
		.1 PRINTING MODES	
			.1 PRESSURE CONTACT
			.2 VACUUM CONTACT
			.3 CONTACT CALIBRATION
		.2 CHUCK PRESSURE OPTIONS	
			.1 EXPOSE PRESSURE
			.2 CONTACT EXPOSE PRESSURE
		.3 OPERATING MODES	
			.1 AUTO EXPOSE
			.2 AUTO LOAD
			.3 FIRST MASK

7 OPTIONS FOR PROCESS

	.2 EXPOSURE CONTROL		
		.1 SINGLE EXPOSE TIME CONTROL	
		.2 SEQUENTIAL PULSE EXPOSURE TIME CONTROL	
		.3 POWER CONTROL	
		.4 OPTICAL OUTPUT CONTROL	
	.3 DELAYS		
		.1 CONTACT	
		.2 EXPOSE PRESSURE	
		.3 LEVEL	
		.4 SHUTTER	
		.5 SEPARATION	
		.6 PISTON DOWN	
	.4 Z AXIS CONTROL		
	.5 MASK BOW		

7.0 OPTIONS FOR PROCESS CONTROL

This section describes the machine options available within the Q4000 operating system to assist in performing a variety of alternative tasks to produce photomechanical reproductions of precision patterns. These options include different ways of holding the mask and substrate while aligning and exposing the pattern, different ways of doing the exposures themselves, and alternatives within the process to modify or manipulate the end result. These options have been divided into Process Options and Exposure Options

7.1 PROCESS OPTIONS

The flexibility of the Q4000 system is demonstrated by the number different ways the machine can be configured to perform its tasks. These configuration variations are divided into Printing Modes, Operating Modes–Pressure, Operating Modes–Handling, and Operating Options. The two major configuration options for the basic machine, Infrared Viewing and Carousel Loading introduce two sub-sets of these options.



7.1.1 INTRODUCTION TO OPERATIONAL PRINTING MODES:

There are three Printing Modes provided in the Q4000, as follows:

Pressure Contact,
Vacuum Contact,
Contact Calib (Contact Calibration).

These modes are selected from the Print Mode Options (Menu item 2)

7.1.1.1 PRESSURE CONTACT PRINTING MODE:

This is the most frequently encountered form of Contact Printing and is used where a balance between mask life and resolution is desired. Pressure contact refers to the pressure exerted by the Air Bearing piston on the substrate , in pressing it against the mask. The Q4000 is setup for Pressure Contact using the following procedure:

- Remove the vacuum seal from the groove in the base of substrate chuck (the rubber seal is used only for vacuum printing).
- Press “2” at the Menu page to select Print Mode Options.
- Press “1” to select Pressure Contact (an asterisk will appear)

- Press Enter button to return to the menu.

- Raise the pressure on Regulator 1 to 20 PSI.

Turn the Pressure Switch (S9) counter-clockwise until it is below Piston Regulator I setting; Adjust the Pressure Switch until the aligner advances to separation. Proper adjustment of the Pressure Switch will result in a one (1) second delay between initial contact and separation.

- Select option [1] Exp Pressure (Expose Pressure) on the Operating Modes page.

- Select option [2] ContactExpPrss (Contact Expose Pressure) on the Controls page.

OPTION: SOFT CONTACT

This is an optional setting of the pressure contact printing mode to be used where extremely brittle materials are being processed, resist sticking problems are being experienced or where long mask life is more important than high resolution.

Note: Higher pressure translates to higher resolution and shorter mask life.

The Q4000 may be setup for Soft Contact using the following procedure, which involves setting the contact piston pressure to a minimum value . The following procedure is necessary in order to properly set Piston Pressure Regulator 1 to any value below 20 PSI

Set up the controls for Pressure Contact printing as above, except:

Open Flow Control 39 full

Reduce the pressure on Regulator 1 to the lowest possible pressure that will operate the piston in your application (typically 8-10 PSI).

install a mask.

Load a test substrate into soft-contact with the mask to check piston movement. Adjust piston speed with FC39 until piston moves smoothly and gently up to the mask. Clear and reload several times if necessary.

Open FC23 fully.

Turn Pressure Switch S9 clockwise several turns.

Load a substrate

Turn the Pressure Switch slowly counter clockwise until the aligner advances to separation.

Clear and reload, adjusting S9 so the aligner goes into Separation immediately after the substrate contacts the mask fully.

Adjust FC 23 for a one (1) second delay between initial Contact and Separation.

7

7.1.1.2 VACUUM CONTACT PRINTING MODE:

This is the highest resolution form of contact printing and is reserved for applications where mask life is secondary to high quality replication of mask images. The printing resolution in this mode is more limited by the process conditions of the particular application than by the mechanical limitations of the aligner.

The Q4000 is setup for Vacuum Contact Printing using the following procedure:

- Place the vacuum seal in the groove at the base of substrate chuck; the seal should be evenly mounted in the groove as evidenced by smooth, even upward angle of the outer lip around its perimeter.
- Adjust pressure on Regulator 1 to 20 PSI, if not already set .
- Select Vacuum Contact [2] option in the Print Modes Menu.
- On the Upper left panel turn the selector to Chamber Vacuum.
- Select [1] Level Vacuum Off on the Operating Options page.

- Select [2] Align Vacuum Off on the Operating Options page.

Set the chamber vacuum using the following procedure:

Load a test substrate and advance the aligner into CONTACT.

Turn off PURGE using Toggle Valve 35. Make sure that Flow Control 72 is open about 2 1/2 turns.

Read the Chamber Vacuum: this will be your maximum possible chamber vacuum.

Open Purge Air Flow Control 73 until the chamber vacuum decreases to 10 to 15 inches of mercury., about 1 1/2 turns. This establishes the maximum *allowed* chamber vacuum.

Turn on the Purge Valve 35 and adjust Flow Control 28 to achieve about 5 inches vacuum in the chamber. This is the nominal chamber vacuum value for the Q4000 for Vacuum Contact printing. Adjust these controls to achieve the printing resolution required.

7.1.1.3 CONTACT CALIBRATION PRINTING MODE

This exposure mode is used where long mask life is paramount and geometries are 5 microns and larger. In this mode, the substrate makes an initial contact with the mask to planarize the substrate to the chuck and then drops into separation. On all subsequent “contacts”, including the final contact during expose, the substrate stops short of the mask by the proximity gap selected. Upon completion of alignment, the operator advances the substrate to the print gap by pressing the CONTACT button

The following setup procedures are required:

Remove the vacuum seal from the groove in the base of substrate chuck.

Select Contact Calib [3] option in the Printing Modes Menu.

On the Upper left panel turn the selector to Separation Pressure.

Select option [11] Exp Pressure (Expose Pressure) on the Operating Modes Menu; verify that this option is “off”.

Select option [2] ContactExpPrss (Contact Expose Pressure) on the Operating Modes Menu; verify that this option is “off”.

Install the Mask Deflection Gage unit (Refer to Section 7.4)

Install a dummy substrate and reference mask and using the Single Step operating mode (from the Maintenance/Test menu) bring the substrate up into contact.

Zero the dial indicator gauge to the top of substrate.

Step the control the next “Separate” step. Using the Separate/Contact switch on the Front Left Control Panel go to “contact” and then “Separate”

7.1.2 CHUCK PRESSURE OPTIONS

There are two optional chuck pressure modes available.



7.1.2.1 EXPOSE PRESSURE-

Selecting this option puts an air cushion under the substrate during exposure.



7.1.2.2 CONTACT EXPOSE PRESSURE-

This option is similar to Expose Pressure except it activates during every contact, so the effect of the expose pressure with respect to the final alignment may be evaluated prior to exposure.

7.1.3 OPERATING MODES

The Q4000 offers three "short cut" operating modes which may be selected for use when the full operating cycle is not necessary.



7.1.3.1 AUTOEXPOSE

The system begins the expose cycle automatically when contact is achieved.

Q4000-6/Magna-view and /Video-view systems:
These systems will automatically self initiate the expose cycle.

Q4000-4/Vari-View system: The turret must be in the "expose" position for autoexpose to function.



7.1.3.2 AUTO LOAD

The system begins the align cycle when the Load Tray is pushed in, eliminating the need for the operator to push LOAD on the front right panel.



7.1.3.3 FIRST MASK

This mode eliminates the entire align portion of the program, taking the substrate into expose directly from load. It is used for the first exposure

on a blank substrate, relying on the pre-aligner to position the substrate. Obviously the set up of the mask and the pre-aligner are very important in establishing the location of the first image on the substrate to avoid problems on subsequent alignments.

7.2.0 EXPOSURE CONTROL

The amount of energy reaching the sensitive surface is controlled by two factors– the length of time that the light is on and the electrical energy driving the lamp. The Quintel Q4000 offers means to control both of these factors to help attain optimum results.

7.2.1 SINGLE EXPOSURE TIME CONTROL

The elementary time control for exposure duration is a simple timer controlled on and off. This mode of operation is set up by accessing option 1 in the Menu page, which brings up the Timer–Single Expose Menu. For the single exposure mode press the INS (insert) key (this is also the '0' key during data entry). The field which can be modified will flash. You may select a different field with the arrow keys. Press the numeric keys to change the value of the selected field. After all entries are made press the ENTER key.

7.2.2 SEQUENTIAL PULSE TIMER TIME CONTROL

The Quintel Q4000 offers, as an option a sophisticated expose control system. By pressing the right arrow button, when in the Timer-Single Expose Menu, on aligners equipped with the advanced timer option, you can access two additional timer modes. These are Multiple Exposure and Recipe Exposure.

Multiple Expose Mode

In multiple exposure mode the timer is programed for an ON time, an OFF time and a TOTAL time. The timer will alternately hold the shutter open for the ON period and hold the shutter closed for the OFF period up until the TOTAL exposure time has been reached. The OFF periods do not contribute to the accumulation of TOTAL time.

Recipe Exposure Mode

In recipe exposure mode the timer is programmed for up to 5 different sequences of ON time and OFF time. Each sequence is referred to as a 'step' in the recipe. Each step can be programmed with an ON time, an OFF time and a COUNT. The resultant TOTAL time is calculated and displayed by the timer as the operator makes the entries.

The Timer Entry Screens

The timer functions are viewed on the display in four different screens. To access the separate screens use the right and left arrow keys. The 'left-most' screen is the single exposure screen. Press the left arrow key until this screen is displayed. The next screen visible with a press of

the right arrow key is the multiple exposure screen. One more press of the right arrow key will display the recipe exposure screen. The last screen available with a press of the right arrow key is the recipe exposure programming screen, where the individual steps of the recipe can be defined.

Making Timer Entries

To set up the timer for the desired exposure, you first use the right and left arrow keys to view the appropriate setup screen. For the single and multiple exposure functions all the setup parameters are visible on one screen. The recipe exposure requires multiple screens to view all of the recipe parameters.

For the single and multiple exposure mode press the INS (insert) key (this is also the '0' key during data entry). The field which can be modified will flash. You may select a different field with the arrow keys. Press the numeric keys to change the value of the selected field. After all entries are made press the ENTER key.

For the recipe exposure there are two setup screens. The first (screen 3) selects one of three possible recipes. The next (screen 4) allows programming the exposure steps in the recipe. You must first select the step that you want to modify. Press the keys '1' through '5' to select the corresponding step '1' through '5'. Once the step is displayed you may press INS and enter values as described above for the multiple exposure mode.



7.2.3 LAMP POWER CONTROL

The basic method of controlling the electrical power to the lamp is by the selection of the wattage rating of the lamp itself together with the configuration of the power supply to match. A variety of values are available; refer to Section 5.7 for a discussion of this option.



AUTOMATIC OUTPUT CONTROL

The actual light energy put out by a lamp varies over the life of the lamp for a number of reasons, generally declining from a high when the lamp is first installed to a value of 50% of the initial at the end of its realistic life. The power supply is capable of “over-driving” the lamp to compensate for this decline. By making readings of the energy output on a daily basis and adjusting the power supply, relatively consistent energy levels may be attained with the normal “constant output” power supply.

To attain absolute control over this factor, a “feed-back” type power supply is offered, which introduces a sensor in the light stream which sends a signal, on a continuous basis, back to the power supply, which automatically compensates for the output variations. When conditions reach the point where the power supply can no longer compensate, an audible alarm sounds, warning of the need for a lamp replacement.



7.2.4 OPTICAL OUTPUT CONTROL

The final light output control is by means of optical filters, placed in the path of the light to block controlled portions of the total energy or of selected frequencies. Refer to Section 10.6 for a discussion of these options.

7.3 DELAYS

Delays are computer controlled interruptions introduced automatically at various times during the program sequence to allow time-critical functions to complete themselves before the next operation starts. An example of this might be the build-up of pressure in a chamber, which does

not take place instantly, but rather over a fraction of a second; a delay is much simpler and more reliable than trying to detect the completion of the build-up with a sensor.

Delays are generally set at the time of machine set-up and seldom need adjusting unless there is a major machine reconfiguration.

The controlled Delays provided are as follows:

7.3.1 CONTACT DELAY–

Delays chamber vacuum activation until the substrate actually contacts the mask when cycling from separation to contact, when in Vacuum Contact mode.

7.3.2 CONTACT EXPOSE PRESSURE DELAY–

If Contact Expose Pressure is selected, this delay is initiated by the end of the Contact Delay and turns on expose pressure at the end of the delay.

7.3.3 LEVEL DELAY–

When making the initial leveling contact between the substrate and the mask, this is the delay between applying the leveling air and applying the ball seat vacuum to lock the substrate chuck in its leveled position.

The delay which begins with the activation of the Head Expose Sensor and ends with the opening of the shutter; used to allow head movements to settle-out and expose pressure to be established before the actual exposure starts.

7.3.4 SHUTTER DELAY–

The delay which begins with the activation of the Head Expose Sensor and ends with the opening of the shutter; used to allow head movements to settle-out and expose pressure to be established before the actual exposure starts.

7.3.5 SEPARATION DELAY–

The delay between removing the chamber vacuum and lowering the air bearing piston into separation, to be sure that the chamber vacuum has been fully vented before trying to move the substrate away from the mask.

7.3.6 PISTON DOWN DELAY–

Tray Load: Actuated by the Chuck Motion Detector this delay allows the air bearing piston to complete its downward movement, placing the substrate chuck in the load tray, before the tray lock is released.

Carousel Load: Only effective if AutoLoad is selected, it is actuated by the Chuck Down Sensor. At completion it releases the carousel to rotate, loading the next substrate



7.4 AIR BEARING PISTON ADJUSTMENT

One of the most valuable features of the Quintel Alignment System is the absolute control over the small vertical movements of the substrate mounted on its support chuck.

For routine work on relatively coarse geometries, factory settings or visually established settings for these controls are adequate. To attain the high levels of process control possible with the Aligner system, Quintel supplies a precise measuring tool system. This tool allows direct measurement of the movement of the substrate chuck, in order to evaluate and establish alignment separation and proximity gap distances. This tool is referred to as the Mask Deflection Gauge.

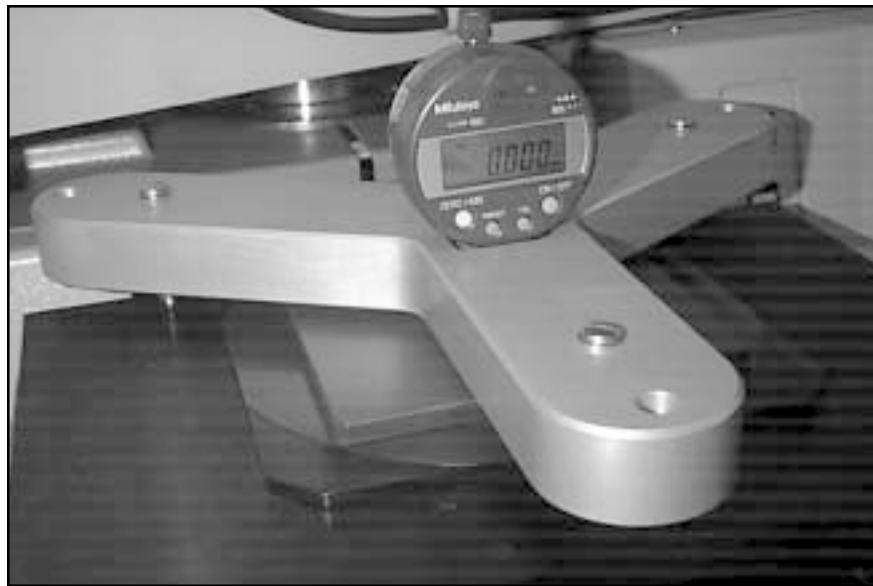
MASK DEFLECTION GAUGE.

The Mask Deflection Gauge is supplied with a very flat, rigid metal Reference Mask, which is used when an absolute reference is required. Because it has an access hole through the center, direct measurements of the substrate surface may be made, for example when it is desired to measure or set separation distances.



The Mask Deflection Gauge may also be used to measure the bending of the glass of the mask itself under contact pressure. This condition, known as "Mask Bow," may be measured and adjusted using the control capabilities of the Q4000 Aligner. Mask Bow is an important factor in the accuracy of reproduction of the mask image to the substrate. Typically, positive or "up in the center" bow results in a greater separation at the center than at the edge, causing images to spread and be progressively larger towards the center. Conversely negative bow results in edge images being larger. The control provided by the Q4000 allows the balancing of these factors, permitting attainment of near ideal conditions for the best exposures.

The measuring unit itself consists of a three legged support mounting a precision electronic measuring instrument capable of measuring down to microns. The design of the support provides three hardened spherical support legs which contact the mask support plate to provide a stable foundation for the precise measurements required.



8 START-UP	.0 INTRODUCTION		
	.1 INSTALLATION OF TOOLING		
		.1 MASK HOLDER REPLACEMENT	
		.2 SUBSTRATE CHUCK INSTALLATION	
		.3 PRE-ALIGNER ADJUSTMENT	
	.2 PROCESS CHAMBER		
	.3 SEPARATION ADJUSTMENT		
	.4 VIEWING OPTIC SET-UP		
		.1 BINOCULAR HEAD ADJUSTMENT	
		.2 MICROSCOPE FOCUSING	
			.1 VARI-VIEW
			.2 MAGNA-VIEW
			.3 VIDEO-VIEW

8 START UP

		.3 SPLIT FIELD SET-UP	
			.1 VARI-VIEW
			.2 MAGNA-VIEW
			.3 VIDEO-VIEW
		.4 SINGLE FIELD SET UP	
			.1 VARI-VIEW
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		.5 ILLUMINATOR ADJUSTMENT	
	.5 VIDEO VIEWING ON OPTICAL MICROSCOPES		
	.6 ZOOM POWER CHANGER		
	.7 EXPOSURE SYSTEM		

8.0 INTRODUCTION TO START-UP

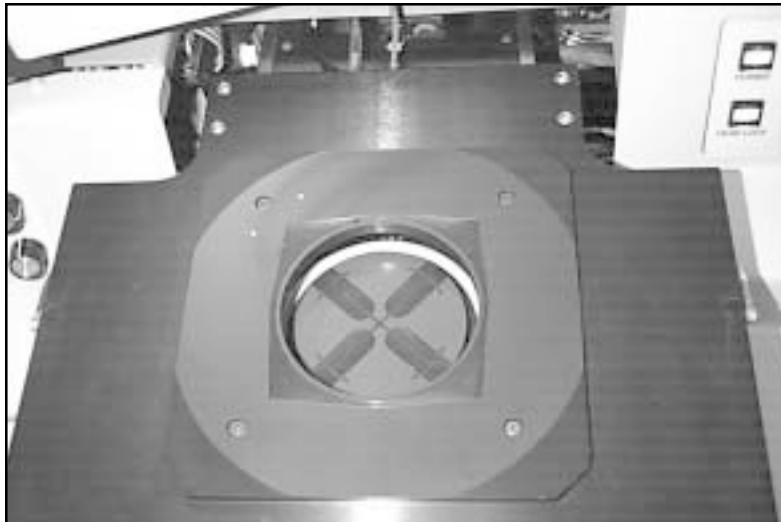
This section deals with the preparation of the aligner for operation– the installation of the proper tooling for the task at hand, setting the machine options for the process to be run, adjusting the optics for optimum viewing, and checking the exposure system to be sure it will do its job correctly.

Technology

In order to simplify the description of the installation process, we will define the parts of the mask holder assembly as follows: The MASK HOLDER is the part which actually contacts the exposure mask; it has an opening in the center which corresponds to the size of the product to be exposed, and a mask clamping surface which fits the size mask to be used. This part is

mounted in the MASK SUPPORT, which is the large plate which mounts to the aligner on four posts at the corners of the alignment stage. On the larger size wafers and substrates, those 125 mm or 150 mm in diameter, or 4 inches square for example, these two parts may be combined into an INTEGRAL MASK HOLDER.

8.1 INSTALLATION OF THE TOOLING



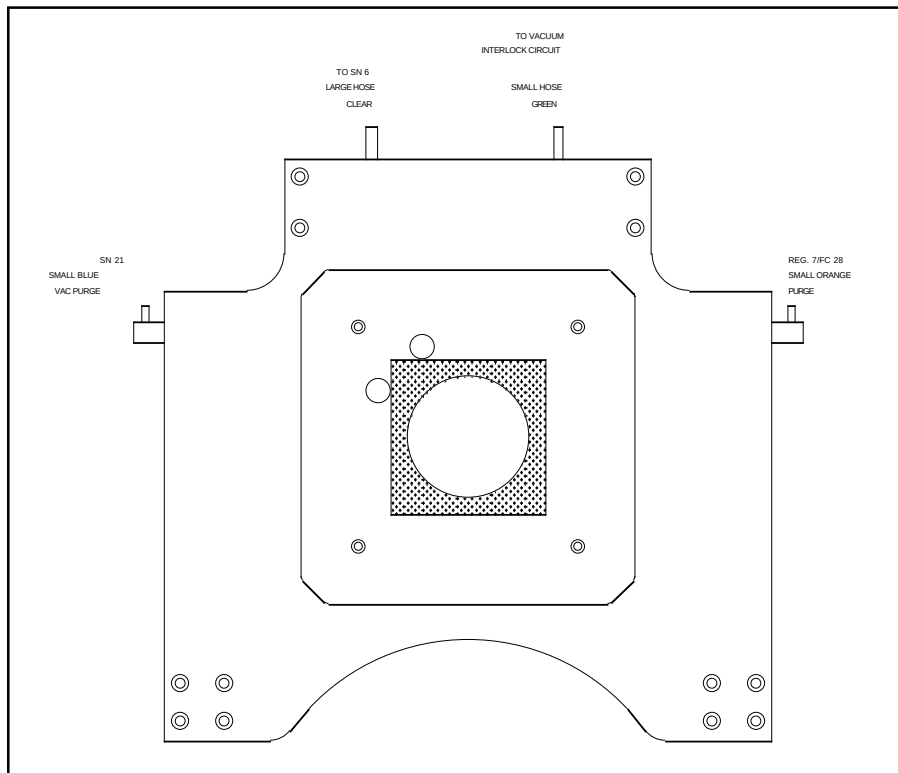
There are three major tooling components to be checked or installed when preparing the aligner for production– the mask holder and clamp, the substrate holder or “chuck,” and the pre-aligner.

The first of these, the mask holder, is supplied in three different formats or styles, all of which accomplish the same task in slightly different ways. The differences affect the way in which the tooling is changed for a different size.

8.1.1 MASK HOLDER REPLACEMENT

Verify that the proper mask holder is installed in the machine for the process requirements. If not, use the following procedure to change the mask holder:

The installation of the mask support (with the mask holder mounted in it) on the mask support legs uses four 10-32 x 5/8" Socket Head Cap Screws at each front corner and two 10- 32 x 5/8" S.H.C.S. at each rear corner of the mask support.



Connect the tubes from bundle at the rear of stage as follows:

1. Large diameter clear tube: connects to the large barb at the left rear of the mask support.
2. Small orange tube: to the angle barb at the right side of the mask support.
3. Small blue tube: to the angle barb at the left side of the mask support.
4. Small green tube: to the small barb at the center rear of the mask support.

8.1.2 SUBSTRATE CHUCK INSTALLATION

Pull the tray to its outer limit.

Install the chuck by attaching the small black hose to the back of the chuck and replacing the chuck onto the tray, carefully aligning the hose fitting with the slot in the tray. Pull the hose back from the chuck until there is only enough slack between the chuck and the clamp to allow the chuck to lift to the mask holder. Too much hose loop will prevent the chuck from seating in the tray properly.

Cycle the aligner through several load-eject cycles to be sure that the hose is free and that the chuck is seating properly in the tray.

If the new chuck represents a different wafer/substrate size, make certain that the pre-align fixture on the tray is also changed (to a different position). See Section 8.1 for adjusting techniques. 8.18.1 for adjusting techniques.



8.1.3 TRAY LOAD PRE-ALIGNER ADJUSTMENT

(This procedure applies to the set-up for round wafers with alignment flats; if setting up for square or rectangular substrates, the chuck provides the pre-alignment capability).

Carefully center the alignment stage.

Place the aligner control in “Ready” state.

To adjust the pre-aligner, pull the tray load out to its’ outer stop and place a sample wafer on the chuck with the wafer flat toward the operator.

Flip the pre-aligner block over, center the wafer flat against the block and check centering of the wafer on the chuck top.

If necessary, loosen the screws securing the pivot brackets on the underside of the load tray, and move the pre-align block in or out to accurately center the wafer on the chuck. Retighten the pivot bracket screws .

Flip the pre-align block toward the operator and push the load tray into the rear stop position.

Press the **LOAD** Switch and check the centering of the wafer to the mask.

Press the **CLEAR** Switch to lower the chuck and permit the withdrawal of the load tray to the unload position.

8



8.2 PROCESS CHAMBER

The Process Chamber is the volume immediately surrounding the mask–substrate interface. When, and only if, the aligner is configured for vacuum contact printing, the Process Chamber is a closed

volume. When it is in this condition, it provides the Process Engineer with the opportunity to completely control the environment in which the exposure is made. Refer to Section 7.1.1 for the set-up procedure to take advantage of this feature.

8.3 SEPARATION ADJUSTMENT

This adjustment controls the distance between the mask and substrate when the instrument is in separation mode. Before the substrate can be aligned, there must be enough separation between the substrate and mask for the substrate to move freely. Adjustment is effected as follows:

The aligner should be in separation mode, with the SEP light illuminated. If not return the aligner to the separation mode by pressing the SEP switch. The separation is controlled by Regulator 4; turning the knob clockwise increases the pressure and the separation, counterclockwise reduces them.

There are two methods for setting the separation; the first is strictly visual and relies on the operators judgement.

Looking through the split field microscope will show the separation taking place. Check that there is enough separation between the substrate and mask by tapping the mask holder support. Viewed through the microscope, the substrate image should "wobble" under the mask image when the mask holder is tapped. If the substrate does not move, put the instrument back into contact mode and increase the mask-substrate separation by turning the adjustment knob a few more degrees clockwise.

Do not increase the separation any more than is necessary or it will be impossible to focus the microscope sharply. Since the ability to see both the mask and substrate simultaneously depends on the depth of focus of the microscope, which is very limited at higher magnifications, minimum separations are essential.

A much more precise and repeatable method for setting separations is by the use of the Mask Deflection Gauge described in Section (XXX). By using the Metal Reference Mask and measuring the surface of a dummy substrate, the actual movement of the substrate may be measured and set to a preferred value.

Recommended separations, for the various objective lens powers, are as follows:

Objective Power	Recommended	Maximum
2 X	30µm, .0016"	100µm, .004"
5 X	20µm, .0008"	50µm, .002"
10 X	10µm, .0004"	22µm, .0009"
20 X	5µm, .0002"	14µm, .0006"

8.4 OPTICAL SYSTEM SETUP

The viewing system setup is most important in that a properly configured system assures operator comfort and productivity, resulting in more and better product. The Quintel Q4000 can be configured with a variety of optical systems, operating differently in detail, but the major considerations are all very similar.

With the two optical microscopes the operator interface is the binocular head which is discussed first; the set up is the same for both heads.

The principles of the operation of the split-field capability are the same for all types of viewing, with the exception of the techniques for adjusting the physical separation of the optics.

Microscope illumination is supplied in a variety of ways, with several alternatives for each system.

Magnification changes are different in their mechanical implementation on all of the head configurations.

Video viewing, which is a major alternative, requires some radically different techniques, even though the end result is quite similar, in that the principles of split field alignment are maintained.

8

8.4.1 OPTICAL SET-UP: BINOCULAR HEAD ADJUSTMENT

Perform this procedure whenever the instrument is installed, the operators change the optical system, or as a routine maintenance procedure (including disassembly for cleaning).

- The optical system **MUST** be adjusted to suit the individual operator, as visual acuity varies widely from person to person.

- Check eyepieces for cleanliness,

Load the aligner with a mask and substrate comparable to the work to be run on the instrument so that the focusing can be performed on a regularly viewed object,

- Place the substrate in the “contact” condition.

Adjust the separation of the binocular lenses to fit comfortably to the interpupillary spacing of the eyes. Adjust until looking through both eyepieces at once gives stereoscopic vision (with both eyes open only one image is visible).

The center scale indicates the separation of the eyepieces to a predetermined spacing (reads in millimeters). Adjust the scale on each focusing eyepiece to the same number as the number indicated by the separation scale. It is important to perform this operation before undertaking the next step.



The hairline on the split-field image must be sharply in focus. Adjust the focus of each eyepiece individually by rotating the eyepiece barrel until the hairline in the center of the image is as sharp as possible. Only slight adjustments should be required to compensate for individual eye characteristics. Make certain that focus of both eyepieces is completed before proceeding.

8.4.2 OPTICAL SET-UP: MICROSCOPE FOCUSING

The focussing of the microscope optics is critical to efficient operation of the aligner. Each model microscope used on the Q4000 has a slightly different method of focussing, and is discussed individually in the following sections.

8.4.2.1 MICROSCOPE FOCUSING WITH VARI-VIEW

The standard “Vari-View” type head has two knobs on the top of the optical head, in back of the binocular/zoom power unit. The larger knob to the right is a “Coarse Focus” control, which should be used for bringing the images into good focus. The smaller “Fine Focus” knob in the center should be used for only minimal adjusting for the best possible viewing.

Turn the optical turret to the “row and column” microscope position. Turn the fine focus adjustment knob (left side of optical head on tray load models) to focus the mask and substrate as sharp as possible.

Return the turret to the “split-field” microscope position. If the mask and substrate image is out of focus, do not touch either eyepiece or fine focus adjustments. Instead, reach under the microscope to the objectives. Focus the objectives individually by rotating each objective at its base. The right-hand objective focuses the image seen in the left half of the field; the left-hand objective focuses the image seen in the right half. The best focus point should be set half way between the substrate and the mask with machine in “separate” mode to ensure a reasonable degree of sharpness for all images.

Focusing in this way gives the best coverage for the depth of field available with the optical components installed.

The power changing lenses in the ZOOM head are “par focal”, no refocusing of optics should be required as magnification is changed

Note:

The optical configuration of this microscope results in a significant magnification variation when the distance between the two objectives is varied, so absolute magnification values must be determined by measurement at the set-up if the actual numbers are important.

Note:

If the turret is a double split-field type, equipped with both low power and medium or high power split-field objectives, repeat the focusing procedure for the alternate set of objectives.

The standard configuration for this microscope provides system magnifications from 60 X to 300 X, depending on the setting of the zoom unit. If higher or lower magnifications are required contact the factory for alternate optics.

8.4.2.2 MICROSCOPE FOCUSING WITH MAGNA-VIEW

This unit has two turrets mounting a variety of objectives with different magnifications. Both turrets have focusing knobs, to allow them to be adjusted for best focus.

The Magna-View optical head provides over all focussing by means of a remote power focus system. The control for this is a lever action switch mounted on the front left control panel.

Moving this lever up drives the microscope up or down as indicated. The center position is "off" so by moving the lever back and forth a very critical focus may be achieved.

When adjusting the individual turrets, check that the electric head focussing is approximately in the center of its travel first.

8.4.2.3 MICROSCOPE FOCUSING with VIDEO-VIEW

The Video-View microscope consists of two individual optical tubes. Each of these tubes contain three operating controls. The upper control is the magnification zoom control. Before attempting to adjust the focus of the microscope it is important to adjust the two zoom controls to the same value.

The Video-View optical head provides over all focussing by means of a remote power focus system. The control for this is a lever action switch mounted on the front left control panel. Moving this lever up drives the microscope up or down as indicated. The center position is "off" so by moving the lever back and forth a very critical focus may be achieved.

When adjusting the individual microscope tubes, check that the electric head focussing is approximately in the center of its travel first.

The next control down the tube is the coarse focus control: adjust each of these to a uniform degree of sharpness.

The final control, at the bottom of the tube is a knurled ring for fine focus, for the last adjustment for best viewing.

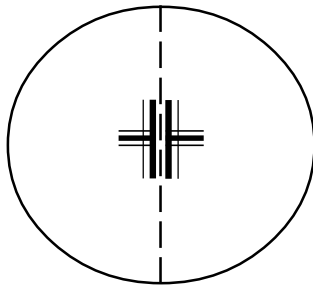
8.4.3 USE OF THE SPLIT FIELD MICROSCOPE

In adjusting the spread of the split field objectives, they should be set so that the alignment marks are as close to the split field hairline as possible

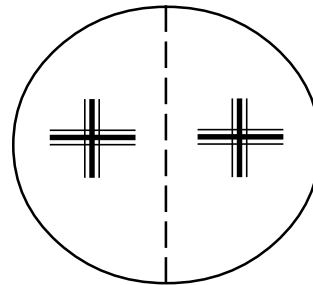
In making the setup and in training the operator, this fact should be emphasized, DO NOT allow operators to develop the habit of working in the center of the half field.

This is logical if it is remembered that the optical axis (the most sensitive and critical portion of the microscope optical system) is on the hairline. Therefore, the closer the alignment marks are to the hairline, the more accurate the alignment will be.

ALIGNMENT WITH THE SPLITFIELD MICROSCOPE



CORRECT



INCORRECT

8.4.3.1 USE OF SPLIT FIELD MICROSCOPE- VARI-VIEW

Split-field objective spacing is adjusted by pushing back the black sleeve on the control knob and rotating the knurled knob clockwise to decrease the spread and counterclockwise to increase the spread. Both objectives will move equally and symmetrically when you turn this knob.



8.4.3.2 USE OF SPLIT FIELD MICROSCOPE- MAGNA-VIEW

Each turret is locked by a small knob, which when loosened allows the optics to be moved independently. The actual movement of each side is controlled by large knurled knobs on each side of the microscope. Care must be taken to move the optics symmetrically, unless the set up specifically calls for another placement. After adjusting the placement of the splitfield objectives, lock the setting by tightening the small knobs at the front.

Caution:

Do not attempt to use the movement knobs without loosening the lock knobs, and do not over tighten the lock knobs.

8

SPREAD MOVEMENT



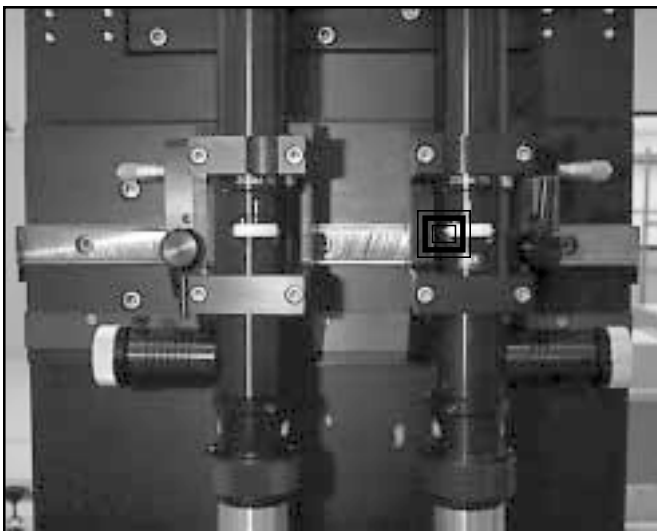
LOCK

FOCUS

8.4.3.3 USE OF SPLIT FIELD MICROSCOPE- VIDEO-VIEW

The two Video-View tubes move independently on horizontal linear bearings. By releasing the lock lever they may be manually placed in approximately the position desired. After locking the lever, a small micrometer is used to accurately place each tube over its target

Adjust the Mix Ratio knob on the Split Screen Control to evenly divide the screen between the two half fields.



SPLITFIELD MONITOR
CONTROLS



MIX RATIO CONTROL- TURN TO CENTER
POSITION FOR SPLITFIELD VIEWING WITH
BOTH CAMERAS, OR LEFT OR RIGHT FOR
FULL FRAME SINGLE CAMERA VIEWING

MIX CONTROL SWITCHES (BOTH OFF)

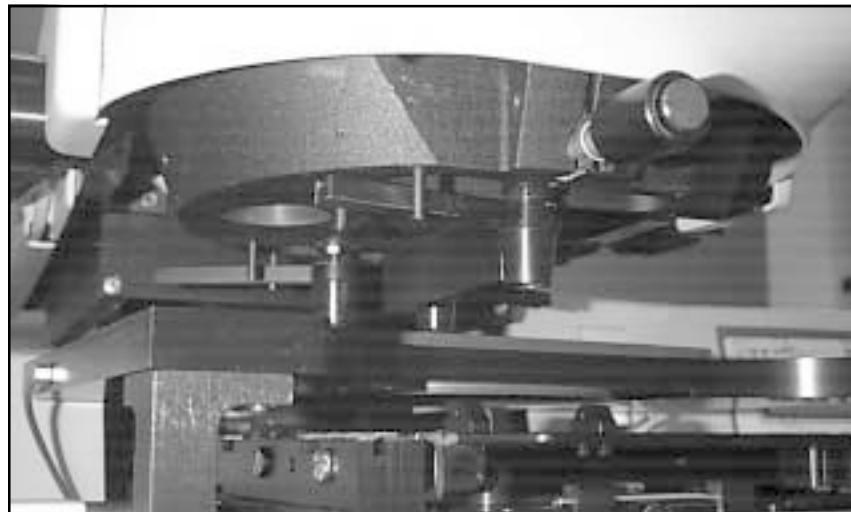
8.4.4 SINGLE FIELD OPERATION

Each optical system is capable of operation in single field mode, if it is desired to look at a full field view of the center of the substrate. This is especially useful when aligning very small substrates, which are smaller than the closest spacing of the splitfield optics.

8.4.4.1 USE OF SINGLE FIELD MICROSCOPE- VARI-VIEW

Single field viewing is accomplished two ways on the Vari- View microscope, depending on how it is equipped. There is a turret position marked "Row and Column" which accommodates a low power single field microscope. Or the turret may

be equipped with a high power singlefield microscope in the second splitfield position. In either case access is accomplished by rotating the turret to the appropriate position, with no further adjustments required.



8.4.4.2 USE OF SINGLE FIELD MICROSCOPE- MAGNA-VIEW

Setting up for single field viewing with the Magna-View involves two steps- on the front of the microscope case, the mode knob must be rotated to the full circle icon to move the split field prism out and the full field mirror in to place.

The second step is to move the right hand objective to the center position after moving the

left unit out of the way. The Magna-View microscope allows the positioning of the right hand objective any place within its travel range, so the substrate to be viewed does not need to be in the exact center of the support chuck. However, for best leveling and aligning do not rely on off center operation.



8.4.4.3 USE OF SINGLE FIELD MICROSCOPE- VIDEO-VIEW

The Video-View microscope is set up for single field operation by sliding the right hand tube over the center of the substrate and locking it in position. The Split Monitor control is adjusted to show only the right hand tube view.

8.4.5 ILLUMINATOR ADJUSTMENT

Adjust the illuminator control(s) for the most comfortable light level (moderate light levels give the best microscope resolution and less eyestrain as well as extending illuminator lamp life). Avoid operating lamps at full brilliance.

The illuminators use a Halogen Cycle type lamp operating on low voltage to provide a concentrated, high intensity light source. Since these lamps bulbs are relatively short lived (1000 hours average life at full Voltage), a few simple precautions will avoid premature failure or unnecessarily frequent replacement:

- When operating the aligner, use the lowest level conducive to accurate alignment
- When the aligner is idled, turn the lamp control down to its lowest setting.

Moving the lamp socket into or out of the lamp housing controls the critical focusing of the lamp filament image.

The infrared viewing and the Video-View versions of the Q4000 use fiber optic cables from a remote mounted light box to provide viewing illumination.

The viewing illumination may be optimized somewhat by adjusting the fiber optic cable where it enters the microscope.

Adjustment of the light source lamps in their housing is discussed in Section 8.4.

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The viewing illumination may be optimized somewhat by adjusting the fiber optic cable where it enters the microscope.

Adjustment of the light source lamps in their housing is discussed in Section 8.4.



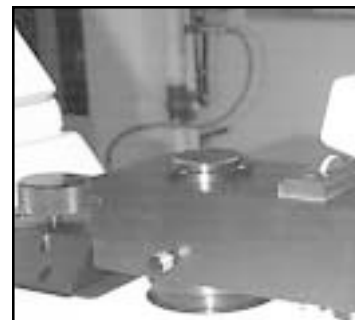
8.5 VIDEO VIEWING ON AN OPTICAL MICROSCOPE

Many times, especially in training or demonstration situations, it is useful to be able to display the alignment process to several people simultaneously on a video screen, rather than to use the actual microscope eyepieces. The Q4000 offers this option on all of the optical microscope versions.

To accomplish this it is necessary to install a camera adapter on the top of the zoom power changer unit, and set up a CCD camera to view the output of the microscope. This is different from the Video-View Microscope, in as much as

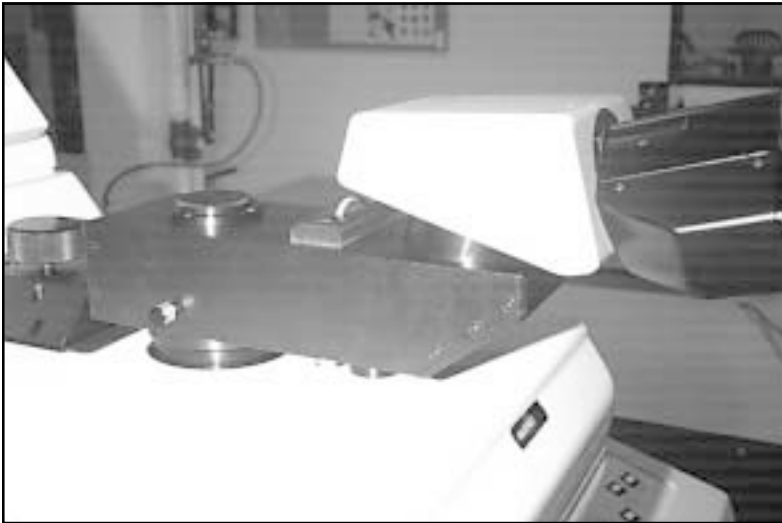
there is only one camera viewing the regular splitfield microscope, instead of two cameras feeding a split screen monitor. All of the alignment capabilities of the microscope are available, and the video set up does not interfere with using the aligner in a conventional manner.

There is a small knob on the left side of the zoom unit case which controls whether the image is directed to the normal eyepieces of the binocular head, or to the camera (it is not possible to do both simultaneously) for video viewing. Pull this knob out, to the left, for video viewing, or push it in to restore normal eyepiece function.



8.6 ZOOM POWER CHANGE HEAD

The Zoom Power Change Head is common to both the Vari-View and Magna-View microscopes. This unit allows variable magnification in the viewing of the substrate and mask between 2X and 5X, without changing objectives, and more importantly, without loss of working distance or depth of focus. The magnification is changed by means of a thumb wheel located on the top of the unit. The magnification change is parfocal, so refocusing of the head after a magnification change is not required.



8.7 EXPOSURE SYSTEM

As a preliminary to production with the Quintel Q4000, and as a routine system check the exposure system must be checked for uniformity of exposure, exposure energy levels, and exposure time settings.

The Q4000 has incorporated a precision micro-positioner lamp base which facilitates accurate X, Y & Z alignment of the mercury arc lamp to the optical path for optimum light intensity and uniformity. To adjust the arc lamp, there are three knobs located on the lamp base which control the X, Y & Z positioning of the arc lamp.

Caution:

Always observe the safety precautions discussed in Section 1 when working around the exposure light.

To adjust the arc lamp, use the following procedure:

- Depress the arc lamp START Switch, located on the ultraviolet Power Supply, momentarily (lamp starts). Allow about ten minutes for arc lamp to reach equilibrium.
- Take the external lamp house cover off.
- Move the SCAN CONTROL DISC to the center of its travel.

- Actuate the manual SHUTTER control on the PLC panel.

Vari-View head requires that the turret be in the "Expose" position for the shutter to operate.

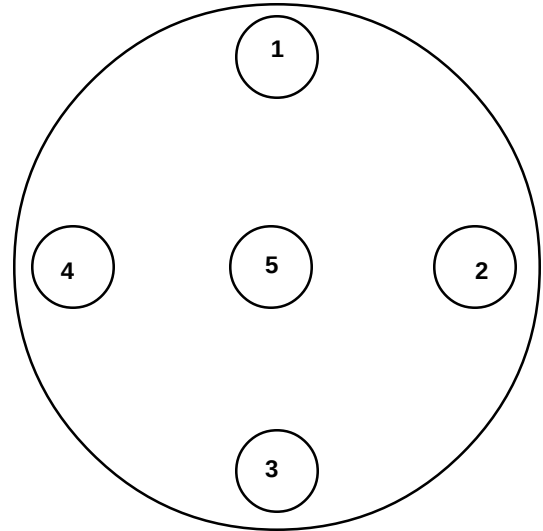
Magna-View and Video-View requires that the PLC option " Manual Expose" be activated for the shutter to operate.

8

Note:

The following discussion presupposes the use of a Quintel Q-401 UV Light Level Meter to determine light output levels and relative uniformity.

ADJUSTING LIGHT UNIFORMITY



8

- At the center position, adjust the top knob (Z axis) until maximum intensity is obtained, as measured by the ultraviolet Light Meter. Adjust the side (X axis) and front (Y axis) knobs until maximum intensity is obtained. The lamp has now been centered in the ellipsoidal reflector.

- Move the light probe to the side positions of the light pattern and check ultraviolet intensity; adjust the side knob (X axis) until best average intensity is obtained between these positions.

- Move the light probe to the front and back positions and check U.V. intensity; adjust the front knob (Y axis) until best average intensity is obtained between these positions.

- Move the light probe back through all light meter positions to recheck and adjust if necessary. The center position will usually be slightly higher and can be slightly defocused (in

the “up” direction, toward the opening in the reflector) with the “Z” axis knob to improve uniformity between the five positions.

* Repeat this sequence at least three times.

- At this point the exposure system will be at its maximum intensity and uniformity level.

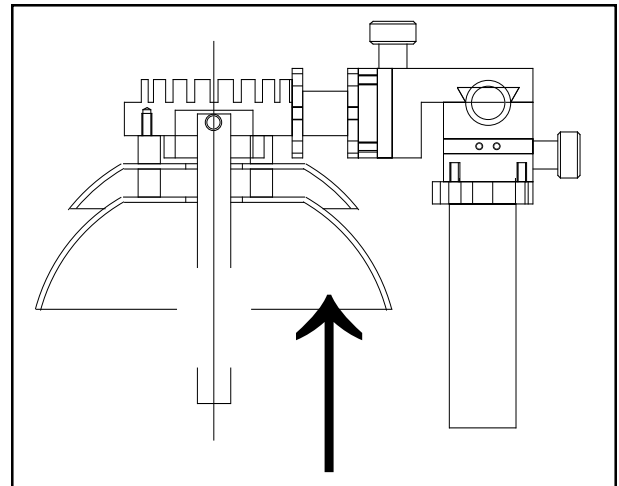
Use the following formula to calculate the uniformity.

• % Uniformity Calculation.

1. Add the Intensity Levels at positions 1 to 5.
Divide by 5 to get the Average Intensity

2. Subtract the lowest intensity from the highest intensity. Divide this number by the average intensity determined above. Multiply the resulting number by 50 to get the uniformity percentage.

• Sometimes trimming the Z axis control *slightly* off maximum intensity position will result in greater uniformity at some loss in intensity. This adjustment must always be made with an *upwards* movement of the lamp (from the point of maximum intensity) in relation to the reflector.



8

Important:

In many systems the use of “defocussing” is recommended as a means of controlling (lowering) light intensity. This technique must **never** be used with a Quintel light source, as it may cause the secondary focus to be placed on the lower end of the lamp, with disastrous results. If the light output must be lowered, refer to Section 7.2 for a discussion of the options available.

Replace lamp house cover when all adjustments are complete.

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	.2 LOAD MASK		
		.1 ALIGN MASK	
	.3 LOAD SUBSTRATE		
	.4 SCAN FOR ALIGNMENT MARKS		
	.5 ALIGN		
	.6 TRANSITION FOR EXPOSE		
	.7 EXPOSE		
	.8 UNLOAD		
	.9 SUMMARY CHARTS		
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9 OPERATION SEQUENCE

9.0 OPERATION SEQUENCE

This section describes the normal sequence of operation for the Quintel Q4000 aligner. The initial section is a summary of the sequence, while the following sections explore techniques and procedures.

There are specific versions of some paragraphs of this section for each configuration of the Q4000. These special sections are identified by a unique code for each specific application (appearing in the left margin) as follows:

VAR-T	Q4000-4 Vari-View Trayload
MAG-T	Q4000-6 Magna-View Trayload
VAR-C	Q4000-4 Vari-View Carousel load
MAG-C	Q4000-4 Magna-View Carousel load
VID-T	Q4000-6 Video-View Trayload
VAR-I	Q4000-4 Vari-View Infrared
MAG-I	Q4000-6 Magna-View Infrared

9.1 OPERATIONAL SEQUENCE SUMMARY

Review the procedures to set up and configure the aligner in Sections 7 (Options for Process) and 8 (Startup). It is assumed that the aligner has been configured and set-up as described in these sections, and is ready for operation. The procedures of this section cover the operators actions at the start of the shift, or at the time of changing to another task using the same basic configuration.

VAR-T

The steps for starting up the aligner are:

1. Power Up the aligner's systems:

- Turn on the UV Power Supply. Press the "START" Switch
- Turn on the Aligner by pressing the Power switch on the upper right panel.

2. Verify or select the printing options. Refer to Section 7.1

- Pull tray out
- Press Enter to display the main menu.
- Select or verify Printing Mode parameter.
- Set or verify the Expose Timer parameter.
- Select or verify the Operating Modes parameters.

3. Center the stages

- Complete one load cycle without a wafer or mask. Advance the aligner to Separation.
- Using the coarse align, center the chuck in the mask holder opening
- Using the Scan Control center the stage under the microscope.

4. Load the mask. Adjust the mask position (Refer to Section 9.1.5 for the adjusting procedure).

5. Adjust the optics if required (Refer to Section 8.4 for the adjusting procedure).

6. Load the substrate

- Position a substrate on the chuck.
- Pre-align the substrate
- Press 'Load' button on the lower right panel.
- Push the tray in: the piston lifts the chuck to contact, levels the substrate and then automatically drops into the Separate position.

7. Align the wafer: Scan to locate alignment marks if required; Align "X" and "Y" with right hand joystick control, Θ with left hand micrometer control

8. Press 'Contact' button on the lower left panel.

- Rotate the turret to "High Power."
- Verify that the alignment accuracy is acceptable.

9. Adjust alignment if necessary.

- Press "Separate" on left panel; realign as required; repeat Steps 7 and 8 .

10. Expose the wafer.

- Rotate the turret to the "Expose" position.
- Press the 'Expose' button on the front right panel.

- The piston will lower when the exposure is complete.

10. Unload

- Pull the tray out to unload the wafer.
- The cycle is complete.

MAG-T

The steps for setting up the aligner are:

1. Power Up the Aligner's systems:

- Turn on the UV Power Supply. Press the "START" Switch
- Turn on the Aligner by pressing the pressing the Power switch on the upper right panel.

2. Verify or select the printing options. Refer to Section 7.1

- Pull tray out
- Press Enter to display the main menu.
- Select or verify Printing Mode parameter.
- Set or verify the Expose Timer parameter.
- Select or verify the Operating Modes parameters.

3. Center the stages

- Complete one load cycle without a wafer or mask. Advance the aligner to Separation.
- Using the coarse align, center the chuck in the mask holder opening
- Using the Scan Control center the stage under the microscope.

4. Load the mask. (Refer to Section 9.1.5 for the adjusting procedure).

5. Adjust the optics if required (Refer to Section 8 for the adjusting procedure).

6. Load the substrate

- Position a substrate on the chuck.
- Pre-align the substrate
- Press 'Load' button on the lower right panel.
- Push the tray in: the piston lifts the chuck to contact, levels the substrate and then automatically drops into the Separate position.

7. Align the wafer: Scan to locate alignment marks if required; Align "X" and "Y" with right hand joystick control, Θ with left hand micrometer control

8. Press 'Contact' button on the lower left panel.

- Rotate the objective turrets to a higher power
- Verify that the alignment accuracy is acceptable.

9. Adjust alignment if necessary.

- Press "Separate" on left panel; realign as required; repeat Steps 7 and 8.

10. Expose the wafer.

- Press the 'Expose' button on the front right panel to initiate the expose cycle.
- The piston will lower when the exposure is complete.

11. Unload

- Pull the tray out to unload the wafer.
- The cycle is complete.

MAG-C

The steps for setting up the aligner are:

1. Power Up the Aligner's systems:

- Turn on the UV Power Supply. Press the "START" Switch
- Turn on the Aligner by pressing the Power switch on the upper right panel.

2. Verify or select the printing options. Refer to Section 7.1

- Press Enter to display the main menu.
- Select or verify Printing Mode parameter.
- Set or verify the Expose Timer parameter.
- Select or verify the Operating Modes parameters.

3. Center the stages

- Complete one load cycle without a wafer or mask. Advance the aligner to Separation.
- Using the coarse align, center the chuck in the mask holder opening
- Using the Scan Control center the stage under the microscope.

4. Load the mask. Refer to Section 9.1.5 for the adjusting procedure.

5. Adjust the optics if required (Refer to Section 8 for the adjusting procedure).

6. Load the substrate

- Position a substrate on the chuck.

- pre-align the substrate

- Press 'Load' button on the lower right panel.

- The carousel rotates: the piston lifts the chuck to contact, levels the substrate and then automatically drops into the Separate position.

7. Align the wafer: Scan to locate alignment marks if required; Align "X" and "Y" with right hand joystick control, Θ with left hand micrometer control

8. Press 'Contact' button on the lower left panel.

- Rotate the objective turrets to a higher power
- Verify that the alignment accuracy is acceptable.

9. Adjust alignment if necessary.

- Press "Separate" on left panel; realign as required; repeat Steps 7 and 8..

10. Expose the wafer.

- Press the 'Expose' button on the front right panel.
- The piston will lower when the exposure is complete. Carousel rotates.

11. Unload

- The cycle is complete.

VAR-C

The steps for setting up the aligner are:

1. Power Up the Aligner's systems:

- Turn on the UV Power Supply. Press the "START" Switch
- Turn on the Aligner by pressing the Power switch on the upper right panel.

2. Verify or select the printing options. Refer to Section 7.1

- Press Enter to display the main menu.
- Select or verify Printing Mode parameter.
- Set or verify the Expose Timer parameter.
- Select or verify the Operating Modes parameters.

3. Center the stages

- Complete one load cycle without a wafer or mask. Advance the aligner to Separation.
- Using the coarse align, center the chuck in the mask holder opening
- Using the Scan Control center the stage under the microscope.

4. Load the mask. Refer to Section 9.1.5 for the adjusting procedure.

5. Adjust the optics if required (Refer to Section 8 for the adjusting procedure).

6. Load the substrate

- Position a substrate on the chuck.

- pre-align the substrate

- Press 'Load' button on the lower right panel.

- The carousel rotates: the piston lifts the chuck to contact, levels the substrate and then automatically drops into the Separate position..

7. Align the wafer: Scan to locate alignment marks if required; Align "X" and "Y" with right hand joystick control, Θ with left hand micrometer control

8. Press 'Contact' button on the lower left panel.

- Rotate the turret to "High Power"

- Verify that the alignment accuracy is acceptable.

9. Adjust alignment if necessary.

- Press "Separate" on left panel; realign as required; repeat Steps 7 and 8.

10. Expose the wafer.

- Rotate the turret to the "Expose" position.
- Press the 'Expose' button on the front right panel.

- The piston will lower when the exposure is complete. Carousel rotates

11. Unload

- The cycle is complete.

VID-T

The steps for setting up the aligner are:

1. Power Up the Aligner's systems:

- Turn on the UV Power Supply. Press the "START" Switch
- Turn on the Aligner by pressing the pressing the Power switch on the upper right panel.
- Turn on the Light Box switches (2) beneath the table.
- * Turn on the Power Strip behind the table.
- Turn on the Monitor

2. Verify or select the printing options. Refer to Section 7.1

- Pull tray out
- Press Enter to display the main menu.
- Select or verify Printing Mode parameter.
- Set or verify the Expose Timer parameter.
- Select or verify the Operating Modes parameters.

3. Center the stages

- Complete one load cycle without a wafer or mask. Advance the aligner to Separation.
- Using the coarse align, center the chuck in the mask holder opening
- Using the Scan Control center the stage under the microscope.

4. Load the mask. (Refer to Section 9.1.5 for the adjusting procedure).

5. Adjust the optics if required (Refer to Section 8.4.3.3 for the adjusting procedure).

6. Load the substrate

- Position a substrate on the chuck.
- Pre-align the substrate
- Press 'Load' button on the lower right panel.
- Push the tray in: the piston lifts the chuck to contact, levels the substrate and then automatically drops into the Separate position.

7. Align the wafer: Scan to locate alignment marks if required; Align "X" and "Y" with right hand joystick control, Θ with left hand micrometer control

8. Press 'Contact' button on the lower left panel.

- Zoom the objectives to a higher power
- Verify that the alignment accuracy is acceptable.

9. Adjust alignment if necessary.

- Press "Separate" on left panel; realign as required; repeat Steps 7 and 8.

10. Expose the wafer.

- Press the 'Expose' button on the front right panel to initiate the expose cycle.
- The piston will lower when the exposure is complete.

11. Unload

- Pull the tray out to unload the wafer.
- The cycle is complete.

VAR-I

The steps for starting up the aligner are:

1. Power Up the aligner's systems:

- Turn on the UV Power Supply. Press the "START" Switch
- Turn on the Aligner by pressing the Power switch on the upper right panel.
- Turn on the Light Box switch beneath the table.
- Select "Infrared" on the upper left control panel
- Turn on the Monitor

2. Verify or select the printing options. Refer to Section 7.1

- Pull tray out
- Press Enter to display the main menu.
- Select or verify Printing Mode parameter.
- Set or verify the Expose Timer parameter.
- Select or verify the Operating Modes parameters.

3. Center the stages

- Complete one load cycle without a wafer or mask. Advance the aligner to Separation.
- Using the coarse align, center the chuck in the mask holder opening
- Using the Scan Control center the stage under the microscope.

4. Load the mask. Adjust the mask position (Refer to Section 9.1.5 for the adjusting procedure).

5. Adjust the optics if required (Refer to Section 8 for the adjusting procedure).

6. Load the substrate

- Position a substrate on the chuck.
- Pre-align the substrate
- Press 'Load' button on the lower right panel.
- Push the tray in: the piston lifts the chuck to contact, levels the substrate and then automatically drops into the Separate position.

7. Align the wafer: Scan to locate alignment marks if required; Align "X" and "Y" with right hand joystick control, Θ with left hand micrometer control

8. Press 'Contact' button on the lower left panel.

- Rotate the turret to "High Power."
- Verify that the alignment accuracy is acceptable.

9. Adjust alignment if necessary.

- Press "Separate" on left panel; realign as required; repeat Steps 7 and 8 .

10. Expose the wafer.

- Rotate the turret to the "Expose" position.
- Press the 'Expose' button on the front right panel.
- The piston will lower when the exposure is complete.

10. Unload

- Pull the tray out to unload the wafer.
- The cycle is complete.

MAG-I

The steps for starting up the aligner are:

1. Power Up the aligner's systems:

- Turn on the UV Power Supply. Press the "START" Switch
- Turn on the Aligner by pressing the Power switch on the upper right panel.
- Turn on the Light Box switch beneath the table.
- Select "Infrared" on the upper left control panel
- Turn on the Monitor

2. Verify or select the printing options. Refer to Section 7.1

- Pull tray out
- Press Enter to display the main menu.
- Select or verify Printing Mode parameter.
- Set or verify the Expose Timer parameter.
- Select or verify the Operating Modes parameters.

3. Center the stages

- Complete one load cycle without a wafer or mask. Advance the aligner to Separation.
- Using the coarse align, center the chuck in the mask holder opening
- Using the Scan Control center the stage under the microscope.

4. Load the mask. Adjust the mask position (Refer to Section 9.1.5 for the adjusting procedure).

5. Adjust the optics if required (Refer to Section 8 for the adjusting procedure).

6. Load the substrate

- Position a substrate on the chuck.
- Pre-align the substrate
- Press 'Load' button on the lower right panel.
- Push the tray in: the piston lifts the chuck to contact, levels the substrate and then automatically drops into the Separate position.

7. Align the wafer: Scan to locate alignment marks if required; Align "X" and "Y" with right hand joystick control, Q with left hand micrometer control

8. Press 'Contact' button on the lower left panel.

- Rotate the objective turret to a higher power."
- Verify that the alignment accuracy is acceptable.

9. Adjust alignment if necessary.

- Press "Separate" on left panel; realign as required; repeat Steps 7 and 8 .

10. Expose the wafer.

- Press the 'Expose' button on the front right panel.
- The piston will lower when the exposure is complete.

10. Unload

- Pull the tray out to unload the wafer.
- The cycle is complete.

9.2 MASK LOADING

Press the HEAD LOCK switch. Move the microscope head by hand away from the mask holder, to the left.

Press the Mask Load switch to release the vacuum if an old mask is in place.

Remove the old mask (if any).

Place the new mask, pattern side down, on top of the Mask holder.

Place the Mask Clamp over the top of the new mask. Press the MASK CLAMP switch. This will supply vacuum to the Mask Clamp to hold the mask against the clamp. Holding the Mask Clamp Handles, align the edges of the mask against the mask stops at the left rear and center as well as possible over the opening.

Press the MASK VACUUM switch. This will vacuum lock the mask onto the Mask holder.

9.2.1 ALIGN THE MASK

Once the mask is positioned, release the head lock switch to move the Microscope Head back into position over the mask. Lock the head. With the Microscope Head in position, verify the mask position using the optics to center the mask alignment marks in their respective fields. Use the Scan Control to adjust along the Y-axis. If adjustment is required, press the MASK VACUUM switch again and rotate the mask against the stops as required. Upon optical verification of mask position, press the MASK VACUUM switch to lock the mask in place.

The final positioning of the mask should be with the horizontal lines of the mask pattern aligned with the x axis of the aligner so it is possible to align with a die or alignment mark from each end of the same row in the field of view of the microscope.

Sometimes it is expedient to align the mask pattern to the pattern of a carefully pre-aligned substrate on the chuck, if there is a characteristic pre-alignment error on a batch of substrate

9.3 SUBSTRATE LOADING – TRAY LOAD

Use the following procedure when processing full-sized wafers.

- Pull out the tray load from the stage using the tray handle. Make sure the tray is pulled out completely, to ensure the chuck vacuum switch has been deactivated, eliminating vacuum to the chuck top.
- Place the wafer onto the chuck top surface, with the flat edge of the wafer facing the operator. Flip the wafer pre-align flat towards the wafer/chuck and align the wafer flat against the

pre-align block. If loading square or rectangular substrates, place them in their corner stops.

- Slowly push the tray inwards (about 1/2 inch), until you hear the chuck vacuum microswitch activate, supplying vacuum to the chuck surface to lock the substrate to the chuck. Flip the pre-align block back to its resting position and slide the tray in completely.

- Press the **LOAD** switch. The air bearing piston will raise the substrate on its chuck, to contact the wafer to the mask to planarize the substrate and cycle to the separation mode ready to align.

9.4 SCANNING TO LOCATE ALIGNMENT MARKS

With the optics in split field configuration, use the scan control to locate any alignment marks or patterns. For best results, the split field objectives should be positioned so that at least one alignment mark is on each side of the split field image.

Holding the scanning lock button down, move the scan control joystick until an alignment mark appears on one side of the image.

Continue to move the scan control joystick, moving the located alignment mark from place to place on its half of the split field image, but keeping the mark in view.

If, during this procedure, a second alignment mark is located on the other half of the split field image, release the scanning lock button to lock the stage in place.

If a second alignment mark does not appear on the other half of the split field image, the position of the split field objectives must be changed. Adjust the width of the separation between the split field objectives (look at the alignment marks on a wafer to estimate the separation which is needed). Repeat the foregoing procedure until at least two alignment marks have been located - one on each side of the split field image.

MAG-T
MAG-I

When using the Magna-View head it is important to use the SCAN to find the alignment marks in the "Y" direction and the objective tracking for the "X" direction

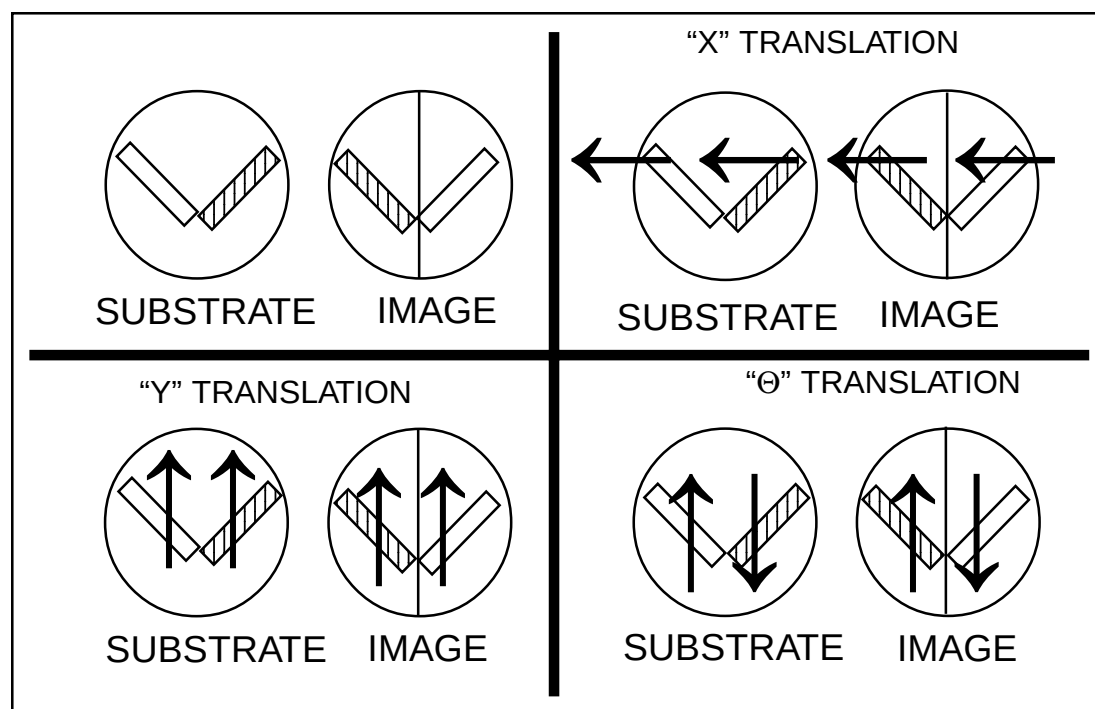
Always center the mask holder under the UV light before loading the mask. Take advantage of the objective tracking for left- right adjustments. This will keep the stage centered under the expose light. If excessive movement of the scan are required, it may be necessary to recenter the scan before exposure to achieve full coverage of the expose area.

9.5 WAFER ALIGNMENT

While individual operator preference and process requirements may suggest modification, the alignment technique outlined below will establish the basic sequence of alignment.

The Split Field Microscope is the basic visual tool used for alignment. The Split Field Microscope is two parallel optical systems, magnifying two areas opposite each other on the wafer. Although these two areas are far apart on the wafer, the Split Field Microscope shows them both at once, one on each side of the center line of the image. Figure 9.1 illustrates the image changes resulting from various alignment movements of the stage.

Frame I of figure 9.1, shows two areas on a wafer and their image in the Split Field Microscope. Notice that the split field image is a mirror image. The dashed area on the right side of the wafer is on the left side of the image you see; the shaded area actually on the left side of the wafer appears to be on the right. This is important to remember when moving the wafer for scanning or alignment. For example, the arrows in Frames 2 and 3 of Figure 9.1 show what is seen through the Split Field Microscope during X-Y motion of the wafer. The images of the two spots are reversed, but their motion is not changed in the split field image.



9.6 TRANSITION FOR EXPOSURE

VAR-T
VAR-C
VAR-I

Q4000-4 VARI-VIEW HEAD

In the interest of obtaining the best exposures, it is a good operating practice for the operator to move the scan back to a centered position after the alignment is completed and before pressing the EXPOSE button to initiate the expose cycle.

This optical head utilizes a rotating turret to move from the viewing mode to the exposure

mode. The rotation of the turret moves the microscope components from the active position above the wafer and substitutes a mirror to reflect the exposure light down onto the mask when the shutter opens. This rotation is performed manually by the operator after the alignment has been verified and the system has been placed in "Contact." For safety the system is electrically interlocked so the shutter cannot be opened until the turret is in the expose position.

Q4000-6 MAGNA-VIEW HEAD

This head uses a "swing up" technique to accomplish the change from viewing to exposing. When the "Expose" switch is pressed, after confirming the alignment, the microscope mounting plate is automatically moved up and out (towards the operator) to an angled position. A mirror, mounted to the back of this plate, is placed to reflect the exposure light down to the wafer.

Because of the larger exposure area required by this head, a field lens is used to improve the collimation and uniformity of the light. This lens is mounted in a horizontal cell, which automatically moves out over the wafer when the microscope plate moves up.

Both of these movements are automatically completed at the beginning, and reversed at the end, of the exposure cycle, with no intervention by the operator.

9

MAG T
MAG-C
VID-T
MAG-I

9.7 EXPOSURE

Exposure, the completion of the operational cycle, is for the operator, a simple push of a switch button. This operation initiates the gas flow

pattern established by the OPTIONS setup, the opening of a pneumatically operated ultraviolet expose light shutter for the time and pattern set in the controller at setup, and finally positioning of the substrate chuck in the load tray ready to be removed from the aligner for further processing.

9.8 UNLOAD

Tray Load

VAR-I
MAG-I

VAR-T
MAG-T

The unload process is simply the process of pulling the load tray out to its extreme position and removing the wafer. There are two factors to be aware of:

- The tray is interlocked so it can not be moved out until the wafer chuck is fully seated after the

expose cycle is completed.

- The wafer is locked down to the chuck until the tray has been fully extended and the “tray out” switch has been activated by the tray.

9

Carousel Load

VAR-C
MAG-C

The Carousel unload process is simply the process of removing the wafer. The wafer is locked down to the chuck until the carousel arm has completed its travel; at this point the vacuum is turned off for substrate removal.

SUMMARY CHART- Q4000-4 VARI-VIEW TRAY LOAD

	DISPLAY READS	CONTROL PANEL SWITCH	ACTION REQUIRED	RESULT
1	"LOAD WAFER"			Ready for operation
2			Load substrate	
3			Pre-align substrate	
4		Press "LOAD"		Initiates sequence
5	"PUSH TRAY IN"			Instructs action
6			Push tray in	
7	"PISTON UP"			Guide set has lifted the wafer up to the mask
8	"PRESSURE CHECK"			Allows time for the lift piston pressure to reach proper level before proceeding
9	"LEVEL AIR DELAY"			Allows the chuck to level before the locking vacuum is applied to the ball seat
10	"LOCK RING DELAY" (momentary display)			Allows the lock ring to reach full effectiveness before separation action starts.
11	"SEPARATION"			Drops the wafer into the designated separation ready for alignment
12	SEPARATION VAC DELAY (momentary, if in "VACUUM CONTACT")			Allows the purge to eliminate any chamber vacuum before the separation ring activates.
13			Perform the alignment	
14		Press "CONTACT"		Causes the piston to move the wafer into the preset contact condition to verify the
15	"CONTACT"			
16	Press "SEPARATE"			Optional: repeat steps 12, 13, and 14 as necessary to obtain optimum alignment
17		Press "EXPOSE"		Initiates exposure sequence
18	"WAIT TURRET"			Delays sequence until the optical head is manually rotated to the "expose" position
19			Rotate turret	
20	"SHUTTER DELAY"			Delay to allow system to settle before starting the exposure
21	"EXPOSURE"			Shutter opens (second line displays set expose time and elapsed time)
22				At end of expose period, shutter closes and guide set cylinder retracts
23	"PISTON DOWN"			Delay to allow the piston to retract and seat the wafer chuck in the load tray
24	"UNLOAD WAFER"			
25			Pull tray out	
26	"LOAD WAFER"			
27			Remove substrate	
28				Completes cycle

SUMMARY CHART- Q4000-6 MAGNA-VIEW TRAY LOAD

	DISPLAY READS	CONTROL PANEL SWITCH	ACTION REQUIRED	RESULT
1	"LOAD WAFER"			Ready for operation
2			Load substrate	
3			Pre-align substrate	
4		Press "LOAD"		Initiates load sequence
5	"PUSH TRAY IN"			Instructs operator action
6			Push tray in	
7	"PISTON UP"			Guide set has lifted the substrate up to the mask
8	"PRESSURE CHECK"			Allows time for the lift piston Pressure to reach proper level before proceeding
9	"LEVEL AIR DELAY"			Allows the chuck to level before the locking vacuum is applied to the ball seat
10	"SEPARATION"			Drops the chuck into the designated separation gap ready for alignment
11	"SEPARATION VAC DELAY" (momentary, if in "VACUUM CONTACT")			Allows the purge to eliminate any chamber vacuum before the separation ring activates.
12			Perform the alignment	
13		Press "CONTACT"		The air bearing piston moves the substrate into the contact with the mask
14	"CONTACT"			Allows the operator to verify alignment
15		Press "SEPARATE"	Optional: repeat steps 9, 10, and 11 as necessary to obtain optimum alignment	
16		Press "EXPOSE"		Initiates exposure sequence
17	"EXPOSE"			Delays sequence until the optical head is moved to the "expose" position
18	"SHUTTER DELAY"			Delay to allow system to settle before starting the exposure
19	"EXPOSURE"			Shutter opens (second line displays set expose time and elapsed time)
20				At end of expose period, shutter closes
21	"PISTON DOWN"			Delay to allow the air bearing piston to retract and seat the wafer chuck in the load tray
22	"UNLOAD WAFER"			
23			Pull tray out	
24	"LOAD WAFER"			
25			Remove substrate	
26				Completes cycle

SUMMARY CHART- Q4000-4 VARI-VIEW CAROUSEL LOAD

	DISPLAY READS	CONTROL PANEL SWITCH	ACTION REQUIRED	RESULT
1	"LOAD WAFER"			Ready for operation
2			Load substrate	
3			Pre-align substarte	
4				If in "AUTOLOAD" carousel motion will initiate when pre-aligner is released: Skip 6,7,8 below. If in manual load, proceed as noted
5	"CAROUSEL ROTATE"			
6		Press "LOAD"		Initiates carousel action
7	"PISTON UP"			Guide set has lifted the substrate up to the maskfor leveling
8	"PRESSURE CHECK" (momentary display)			Allows time for the lift piston pressure to reach proper level before proceeding
9	"LEVEL AIR DELAY"			Allows the chuck to level before the locking vacuum is applied to the ball
10	"LOCK RING DELAY" (momentary display)			Allows the lock ring to reach full effectiveness before separation action
11	"SEPARATION"			Drops the chuck into the designated separation gap ready for alignment
12	"SEPARATION VAC DELAY" (momentary, if in "VACUUM CONTACT")			Allows the purge to eliminate any chamber vacuum before the separation ring activates.
13			Align the substrate	
14		Press "CONTACT"		The air bearing piston moves the substrate into contact with the mask
15	"CONTACT"			Allows the operator to verify alignment
16	Press "SEPARATE"			Optional: repeat steps 12, 13, and 14 as necessary to obtain optimum alignment
17		Press "EXPOSE"		Initiates exposure sequence
18	"WAIT TURRET"			Delays sequence until the optical head is manually rotated to the "expose" position
19			Rotate turret	
20	"SHUTTER DELAY"			Delay to allow system to settle before starting the exposure
21	"EXPOSURE"			Shutter opens (second line displays set expose time and elapsed time)
22				At end of expose period, shutter closes
23	"PISTON DOWN"			Delay to allow the air bearingpiston to retract and seat the wafer chuck in the load tray
24	"LOAD WAFER"			
25			Remove substrate	
26				Completes cycle

SUMMARY CHART-Q4000-6 MAGNA-VIEW CAROUSEL LOAD

DISPLAY READS	CONTROL PANEL SWITCH	ACTION REQUIRED	RESULT
"LOAD WAFER"			Ready for operation
		Load substrate	
		Pre-align substrate	
			If in "AUTOLOAD" carousel motion will initiate when pre-aligner is released: Skip 6,7,8 below. If in manual load, proceed as noted
"CAROUSEL ROTATE"			
"PISTON UP"			Guide set has lifted the substrate up to the mask
"PRESSURE CHECK" (Momentary display)			Allows time for the lift piston Pressure to reach proper level before proceeding
"LEVEL AIR DELAY"			Allows the chuck to level before the locking vacuum is applied to the ball seat
"LOCK RING DELAY" (momentary display)			Allows the lock ring to reach full effectiveness before separation action starts.
"SEPARATION"			Drops the chuck into the designated separation gap ready for alignment
"SEPARATION VAC DELAY" (momentary, if in "VACUUM CONTACT")			Allows the purge to eliminate any chamber vacuum before the separation ring activates.
		Align the substrate	
	Press "CONTACT"		The air bearing piston moves the substrate into the contact with the
"CONTACT"			Allows the operator to verify alignment
Press "SEPARATE"		Optional: repeat steps 12, 13, and 14 as necessary to obtain optimum alignment	
	Press "EXPOSE"		Initiates exposure sequence
"EXPOSE"			Delays sequence until the optical head is moved to the "expose" position
"SHUTTER DELAY"			Delay to allow system to settle before starting the exposure
"EXPOSURE"			Shutter opens (second line displays set expose time and elapsed time)
			At end of expose period, shutter closes
"PISTON DOWN"			Delay to allow the air bearing piston to retract and seat the wafer chuck in the load tray
"UNLOAD WAFER"			
		Pull tray out	
"LOAD WAFER"			
		Remove substrate	
			Completes cycle

SUMMARY CHART- Q4000-6 VIDEO-VIEW

	DISPLAY READS	CONTROL PANEL SWITCH	ACTION REQUIRED	RESULT
1	"LOAD WAFER"			Ready for operation
2			Load substrate	
3			Pre-align substarte	
4		Press "LOAD"		Initiates sequence
	"PUSH TRAY IN"			Instructs action
		Push tray in		
5	"PISTON UP"			Guide set has lifted the substrate up to the maskfor leveling
6	"PRESSURE CHECK" (momentary display)			Allows time for the lift piston pressure to reach proper level before proceeding
7	"LEVEL AIR DELAY"			Allows the chuck to level before the locking vacuum is applied to the ball
8	"SEPARATION"			Drops the chuck into the designated separation gap ready for alignment
9	"SEPARATION VAC DELAY" (momentary, if in "VACUUM CONTACT")			Allows the purge to eliminate any chamber vacuum before the separation ring activates.
10			Align the substrate	
11		Press "CONTACT"		The air bearing piston moves the substrate into contact with the mask
12	"CONTACT"			Allows the operator to verify alignment
13	Press "SEPARATE"		Optional: repeat steps 10, 11 and 12 as necessary to obtain optimum alignment	
14		Press "EXPOSE"		Initiates exposure sequence
15	"EXPOSE"			Delays sequence until the optical head is manually rotated to the "expose" position
16	"SHUTTER DELAY"			Delay to allow system to settle before starting the exposure
17	"EXPOSURE"			Shutter opens (second line displays set expose time and elapsed time)
18				At end of expose period, shutter closes
19	"PISTON DOWN"			Delay to allow the air bearingpiston to retract and seat the wafer chuck in the load tray
20	"UNLOAD WAFER"			
21		Pull tray out		
22	"LOAD WAFER"			
23			Remove substrate	
24				Completes cycle

SUMMARY CHART-Q4000-3 VARI-VIEW WITH INFRARED VIEWING

	DISPLAY READS	CONTROL PANEL SWITCH	ACTION REQUIRED	RESULT
1	"LOAD WAFER"			Ready for operation
2			Load substrate	
3			Pre-align substrate	
4		Press "LOAD"		Initiates sequence
	"PUSH TRAY IN"			Instructs action
		Push tray in		
5	"PISTON UP"			Guide set has lifted the substrate up to the mask for leveling
6	"PRESSURE CHECK" (momentary display)			Allows time for the lift piston pressure to reach proper level before proceeding
7	"LEVEL AIR DELAY"			Allows the chuck to level before the locking vacuum is applied to the ball
8	"LOCK RING DELAY" (momentary display)			Allows the lock ring to reach full effectiveness before separation action
9	"SEPARATION"			Drops the chuck into the designated separation gap ready for alignment
10	"SEPARATION VAC DELAY" (momentary, if in "VACUUM CONTACT")			Allows the purge to eliminate any chamber vacuum before the separation ring activates.
11			Align the substrate	
12		Press "CONTACT"		The air bearing piston moves the substrate into contact with the mask
13	"CONTACT"			Allows the operator to verify alignment
14	Press "SEPARATE"			Optional: repeat steps 11, 12 and 13 as necessary to obtain optimum alignment
15		Press "EXPOSE"		Initiates exposure sequence
16	"WAIT TURRET"			Delays sequence until the optical head is manually rotated to the "expose" position
17			Rotate turret	
18	"SHUTTER DELAY"			Delay to allow system to settle before starting the exposure
19	"EXPOSURE"			Shutter opens (second line displays set expose time and elapsed time)
20				At end of expose period, shutter closes
21	"PISTON DOWN"			Delay to allow the air bearing piston to retract and seat the wafer chuck in the load tray
	"UNLOAD WAFER"			
		Pull tray out		
22	"LOAD WAFER"			
23			Remove substrate	
24				Completes cycle

SUMMARY CHART- Q4000-4 MAGNA-VIEW WITH INFRARED VIEWING

	DISPLAY READS	CONTROL PANEL SWITCH	ACTION REQUIRED	RESULT
1	"LOAD WAFER"			Ready for operation
2			Load substrate	
3			Pre-align substrate	
4		Press "LOAD"		Initiates sequence
	"PUSH TRAY IN"			Instructs action
		Push tray in		
5	"PISTON UP"			Guide set has lifted the substrate up to the mask for leveling
6	"PRESSURE CHECK" (momentary display)			Allows time for the lift piston pressure to reach proper level before proceeding
7	"LEVEL AIR DELAY"			Allows the chuck to level before the locking vacuum is applied to the ball
8	"LOCK RING DELAY" (momentary display)			Allows the lock ring to reach full effectiveness before separation action
9	"SEPARATION"			Drops the chuck into the designated separation gap ready for alignment
10	"SEPARATION VAC DELAY" (momentary, if in "VACUUM CONTACT")			Allows the purge to eliminate any chamber vacuum before the separation ring activates.
11			Align the substrate	
12		Press "CONTACT"		The air bearing piston moves the substrate into contact with the mask
13	"CONTACT"			Allows the operator to verify alignment
14	Press "SEPARATE"		Optional: repeat steps 11, 12 and 13 as necessary to obtain optimum alignment	
15		Press "EXPOSE"		Initiates exposure sequence
16	"WAIT TURRET"			Delays sequence until the optical head is manually rotated to the "expose" position
17			Rotate turret	
18	"SHUTTER DELAY"			Delay to allow system to settle before starting the exposure
19	"EXPOSURE"			Shutter opens (second line displays set expose time and elapsed time)
20				At end of expose period, shutter closes
21	"PISTON DOWN"			Delay to allow the air bearing piston to retract and seat the wafer chuck in the load tray
	"UNLOAD WAFER"			
		Pull tray out		
22	"LOAD WAFER"			
23			Remove substrate	

SUMMARY CHART – STANDARD OPERATIONS

POWER ON SEQUENCE		
		power off
press "POWER"		power on
		screen shows an initialization sequence, ending with the titlepage
	press "ENTER"	
	pull tray out	
		aligner ready to program or operate
SHUTDOWN PROCEDURE		
	press "ENTER"	from any menu
	press "POWER OFF"	plc resets itself and actuates the power down circuit
"POWER" indicator lite fades to off		power is off
EXPOSURE TIME SET PROCEDURE		
	press "ENTER"	from any menu
	press "EXP TIME"	
		ready to enter time value
	press "INSERT" then highlighted numbers as required	enters time value
	press "ENTER"	returns to main menu

10 THEORY OF OPERATION			
	.1 PNEUMATICS	.0 GENERAL	
		.1 BLOCK DIAGRAM	
		.2 SOLENOID VALVES	
		.3 REGULATORS	
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	.2 ELECTRICAL	.0 GENERAL	
		.1 BLOCK DIAGRAM	
		.2 MANUAL CONTROL SWITCHES	
		.3 ELECTRICAL DETECTORS	
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10 THEORY OF OPERATION

			.1 SCAN
			.2 ALIGN- X,Y
			.3 ALIGN- THETA
			.4 AIR BEARING GUIDE SET
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			.6 INFRARED VIEWING
	.5 VIEWING OPTICS		
		.1 SPLIT FIELD MICROSCOPE	
		.2 MAGNIFICATION	
	.6 EXPOSURE OPTICS		

10.0 THEORY OF OPERATION

This section of the manual consists of a summarization of the controls that make the aligner perform its tasks, and some remarks about the various operational sections of the aligner.

The contents are arranged in the following groups:

- Pneumatic Controls
 - Electrical Controls
 - Miscellaneous Controls
 - Mechanical
 - Viewing Optics
 - Exposing Optics
-

10.1.0 PNEUMATIC SYSTEM

This section, by means of diagrams, charts, and descriptions, explains how the pressurized gasses of the pneumatic system perform the tasks of holding, moving and controlling the various components of the alignment system in performing alignments and exposures.

By using the information of this section, in conjunction with the Pneumatic Schematic found in Section 14, the maintenance mechanic will be able to diagnose any problem with a pneumatic root.

10.1.1 PNEUMATIC BLOCK DIAGRAM

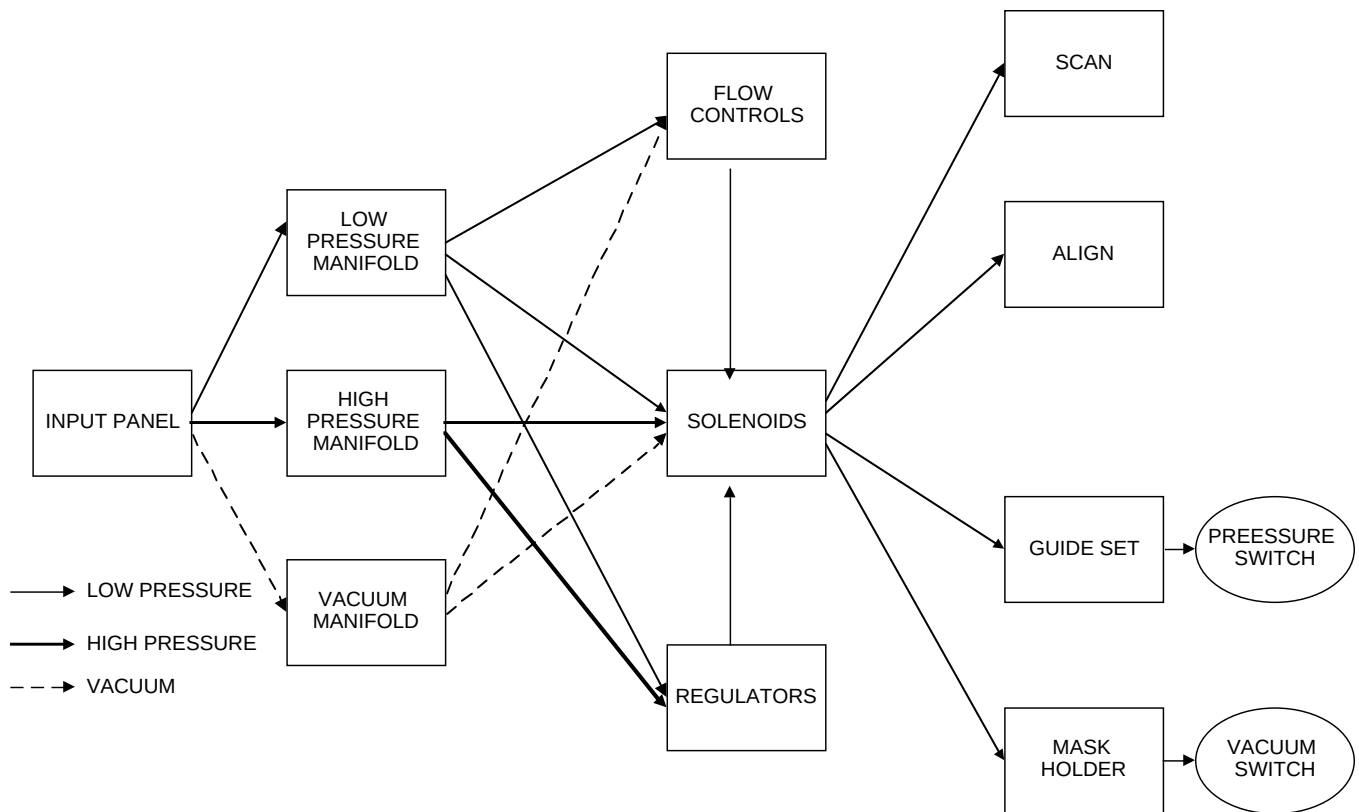
The pneumatic block diagram shown on the following page describes the general arrangement of the distribution system for the pressurized gasses that do most of the work in the Q4000.

The supply gasses come into the machine at the back input panel and are directly connected to the distribution manifolds. There is a separate manifold for high pressure air, low pressure nitrogen, and vacuum. In addition, a manifold is provided for capturing all exhaust air from the various cylinders and exhausting it through a metallic muffler, which also acts as a rough filter for the exhaust.

From these manifolds the gasses are routed to the regulators and flow controls which modify the pressures and flow rates to the proper values for each purpose, and then to the solenoid valves which turn them on and off when needed.

In the following sections are detailed charts listing all of these modifying and controlling devices and how they are connected and interact to make the Q4000 a versatile and reliable machine.

PNEUMATIC BLOCK DIAGRAM



10.1.2 SOLENOID VALVES

Solenoid valves control most of the physical operations of the aligner. The solenoids used in the Q4000 are of a type known as “miniature spool valves.” These valves are very compact, yet have a very high capacity for their size. They are very efficient, using small currents to move the internal parts which control the flow of gas through them, thus creating little waste heat and requiring small electronic components to control the electricity. Because of their efficient design, these valves are very reliable.

The basic Q4000 uses nineteen solenoids to control all of the functions of the aligner; there are five “spare” mounts, which are used to control functions of the various optional configurations. The twenty four solenoids possible to mount are arranged in three groups of eight under the right rear cover. Each solenoid is identified by a number, starting with the left rear unit as number 1. Number 1 through 8 are in the rear row, 9 through 16 in the middle, and 17 through 24 in the front.

Each group of eight solenoids is controlled by a printed circuit board which mounts, for each solenoid, a power transistor, a protective diode and a LED (light emitting diode) indicator light to tell when the drive circuit has been activated. In addition, each solenoid has an internal LED, which lights when the solenoid is actuated, and a manual actuator, which permits operation of the valve without any power being present. These indicators allow easy diagnosis of solenoid operational problems.

The Solenoid Valve Chart on the following page identifies the name of each solenoid and gives a brief description of its function. Also noted is a reference to the appropriate schematic drawing for each solenoid (see Section 14–Schematics), which describes the hookup of each solenoid and its related regulators, flow controls, etc.

SOLENOID VALVES

Solenoid number	Name	2001 Reference Number	Group	Reference Drawing	Description
Head					
1	SHUTTER	13		5000-01	Opens the expose shutter: controlled by PLC
2	HEAD LOCK	14		5000-02	Unlocks the optical head for mask holder access: controlled by manual switch on top right panel
3	SCAN	10			Unlocks the stage for scan movement: controlled by manual switch on scan joystick
Options					
4-HEAD	MICROSCOPE			5000-04	On the Q4000-6 head, supplies air to drive the microscope head to the "expose" position: controlled by PLC
5- IR	IR AIR BEARING PISTON			5000-05	Supplies air to the air bearing piston auxiliary cylinder: controlled by PLC
5- CAROUSEL	TURNTABLE			5000-08	Supplies air to drive the carousel loader to load a wafer: controlled by PLC
6- CAROUSEL	EXPOSE PRESSURE				For the second chuck on the carousel, controls the the flow of low pressure air to the chuck top: controlled by PLC
7- CAROUSEL	SUBSTRATE CHUCK VACUUM			5000-08	For the second chuck on the carousel, controls the vacuum flow to the chuck top: controlled by PLC
7-IR	LIGHT PIPES			5000-05	Supplies air to move the light pipes into view position: controlled by PLC
8-HEAD	FIELD LENS PLATE			5000-04	On the Q4000-6 head, supplies air to drive the field lens plate to the "expose" position: controlled by PLC
Note	Solenoids 5 and 7 are assigned different duties depending on the model aligner.				

Guide Set					
9	GUIDE SET AIR BEARING	8		5000-09	Supplies air to the air bearing: controlled by PLC
10	GUIDE SET LIFT	5		5000-10	Supplies air for lifting wafer to contact: controlled by PLC
11	SEPARATION ASSIST	7		5000-10	Supplies low pressure air for separation: controlled by PLC
12	GUIDE SET LOCK RING	12		5000-12	Supplies air to the lock ring after initial contact: controlled by PLC
13	GUIDE SET BALL SEAT	90			Controls vacuum to lock ball seat after leveling: controlled by PLC
14	GUIDE SET LEVELING AIR	97			Supplies low pressure air to assist leveling: controlled by PLC
15	GUIDE SET SEPARATION	20		5000-15	Supplies air for establishing separation: controlled by PLC
16	CONTACT CALIBRATE	92		5000-15	Supplies air for Contact Calibration mode: controlled by PLC
Mask Holder					
17	MASK CLAMP	9		5000-17	Controls vacuum to the Mask Clamp: controlled by manual switch on front right panel
18	MASK LOAD	6		5000-18	Controls vacuum to the Mask Holder: controlled by manual switch on front right panel
19	TRAY LOCK	91		5000-19	Supplies air to tray lock cylinder: controlled by PLC
20	CHAMBER VACUUM	21		5000-20	Controls nitrogen purge to printing chamber: controlled by PLC
21	SUBSTRATE CHUCK VACUUM	4		5000+-21	Controls the flow of vacuum to chuck top: controlled by PLC
22	EXPOSE PRESSURE	26		5000-21	Controls the flow of low pressure air to chuck top: controlled by PLC

Align					
23	COARSE ALIGN	1		5000-23	Controls vacuum for fine align mode: controlled by manual switch on front left panel
24	FINE ALIGN	2		5000-23	Controls vacuum for coarse align mode: controlled by manual switch on front left panel

10.1.3 PNEUMATIC REGULATORS

Regulators automatically control the pressure at which a gas moves through a pneumatic circuit. While the aligner is connected to high pressure and low pressure services, the actual points of use for these gasses require many different pressures to perform their tasks properly. To accomplish the reduction and control of these pressures the Q4000 utilizes eight regulators. These regulators vary in flow capacity and pressure range: they are all classified as "precision regulators" in that they are capable of controlling the output to a very exact value regardless of the input pressure.

The regulators are all mounted in a group under an access panel at the left rear of the machine. All are adjustable by means of a screw knob. Two, which require frequent adjustment to pressure values, are provided with pressure gauges; the balance are adjusted to "performance values" rather the pressure values, and do not require gauges normally.

REGULATORS

REGULAT OR NUMBER	NAME	CONNECTED TO	SOURCE	OUTPUT PRESSURE RANGE	NORMAL SETTING
1	CONTACT FORCE	Needle Valve 39	HIGH PRESSURE	0-60	10-20
2	EXPOSE PRESSURE	Solenoid 22	LOW PRESSURE	0-15	0-15
4	SEPARATION GAP	Solenoid 15	LOW PRESSURE	0-60	10-30
5	SEPARATION ASSIST	Solenoid 11	LOW PRESSURE	0-15	10-15
6	PROXIMITY SEPARATION	Solenoid 16	LOW PRESSURE	0-15	AS REQ'D
8	AIR BEARING LEVELING	Solenoid 14	LOW PRESSURE	0-15	1-2
9	TRAY CUSHION	Tray Cushion Cylinder	LOW PRESSURE	0-100	AS REQ'D
48	CHAMBER PURGE	Solenoid 20	LOW PRESSURE	0-100	AS REQ'D

10.1.4 PNEUMATIC FLOW CONTROLS

Flow controls as a general term refer to small valves which are used to limit the amount of gas which may flow through a tube in a given amount of time. In the Q4000 two types of flow control devices are used: Needle Valves, which restrict the volume regardless of the direction of gas flow, and Flow Controls, which restrict flow in one direction and permit unrestricted flow in the opposite direction. The chart following differentiates between the two types and describes the point of application for each.

Flow controls and their adjustments are very important to the proper operation of the aligner. The units installed in the Q4000 have been selected for their operating characteristics, which allow for the precision and adjustability necessary for the control of the aligners functions.

PNEUMATIC FLOW CONTROLS

NUMBER	REFERENCE DRAWING	NAME	PHYSICAL LOCATION
FLOW CONTROL			
1	5000-02	HEAD LOCK	HEAD LOCK UNIT
2	5000-02	HEAD LOCK	HEAD LOCK UNIT
11	5000-04	LENS TRAY	AUXILIARY FLOW CONTROL MANIFOLD
12	5000-04	MICROSCOPE	AUXILIARY FLOW CONTROL MANIFOLD
15	5000-04	MICROSCOPE	AUXILIARY FLOW CONTROL MANIFOLD
16	5000-04	LENS TRAY	AUXILIARY FLOW CONTROL MANIFOLD
23	5000-10	PRESSURE SWITCH	FLOW CONTROL MANIFOLD
26	5000-10	CHUCK DOWN	FLOW CONTROL MANIFOLD
28	5000-20	PURGE NITROGEN	FLOW CONTROL MANIFOLD
93	5000-05	CHUCK UP	FLOW CONTROL MANIFOLD
94	5000-05	LIGHT PIPE DRIVE OUT-LEFT	AUXILIARY FLOW CONTROL MANIFOLD
95	5000-05	LIGHT PIPE DRIVE IN-LEFT	AUXILIARY FLOW CONTROL MANIFOLD
96	5000-05	LIGHT PIPE DRIVE OUT-RIGHT	AUXILIARY FLOW CONTROL MANIFOLD
97	5000-05	LIGHT PIPE DRIVE IN-RIGHT	AUXILIARY FLOW CONTROL MANIFOLD
100		CAROUSEL CYLINDER	CAROUSEL UNIT
101		CAROUSEL CYLINDER	CAROUSEL UNIT
NEEDLE VALVE			
25	5000-01	SHUTTER	FLOW CONTROL MANIFOLD
39	5000-10	CHUCK UP (IR)	FLOW CONTROL MANIFOLD
49	5000-03	SCAN	FLOW CONTROL MANIFOLD
72	5000-20	PURGE AIR	FLOW CONTROL MANIFOLD
73	5000-20	PURGE AIR	FLOW CONTROL MANIFOLD
99		LAMP PURGE	HIGH PRESSURE MANIFOLD

10.2.0 ELECTRICAL SYSTEM

This section describes in detail all of the components of the electrical system of the Q4000. This includes the power system which provides the electricity to run all of the controls, and the controls and sensors responsible for telling the machine what is required and what the existing conditions are.

By using the information of this section, and the schematics of section 14 the maintenance mechanic will be able to understand the operation of the aligner and solve any problems which may arise in the day to day operations

10.2.1 ELECTRICAL BLOCK DIAGRAM

The accompanying block diagram describes the operation of the Q4000 in general terms, to assist in understanding the design principles used in developing the electrical control system for the aligner. Since the aligner is built around modular units it should assist in identifying at fault modules in case of a malfunction.

Power is introduced to the aligner at a module which combines a power connector, a RF (Radio Frequency) noise filter (for suppressing any disturbances created by neighboring devices which might affect the aligner), a line fuse for overload protection, a master on-off switch and a means to reconfigure the aligner for 220 volt operation.

From this input device line voltage goes to Power Supply 2, located at the rear of the machine and to the Power Control unit, a rail mounted array of relays and terminal blocks mounted under the Distribution Board.

Power Supply 2, which is "ON" whenever the Master Switch is on, supplies low (5 volt) control voltage to the POWER switch on the top right control panel, and after the POWER switch is activated, by means of a relay, power to the PLC

and its Control Panel. Until this sequence is completed the only power in the system is at the POWER switch.

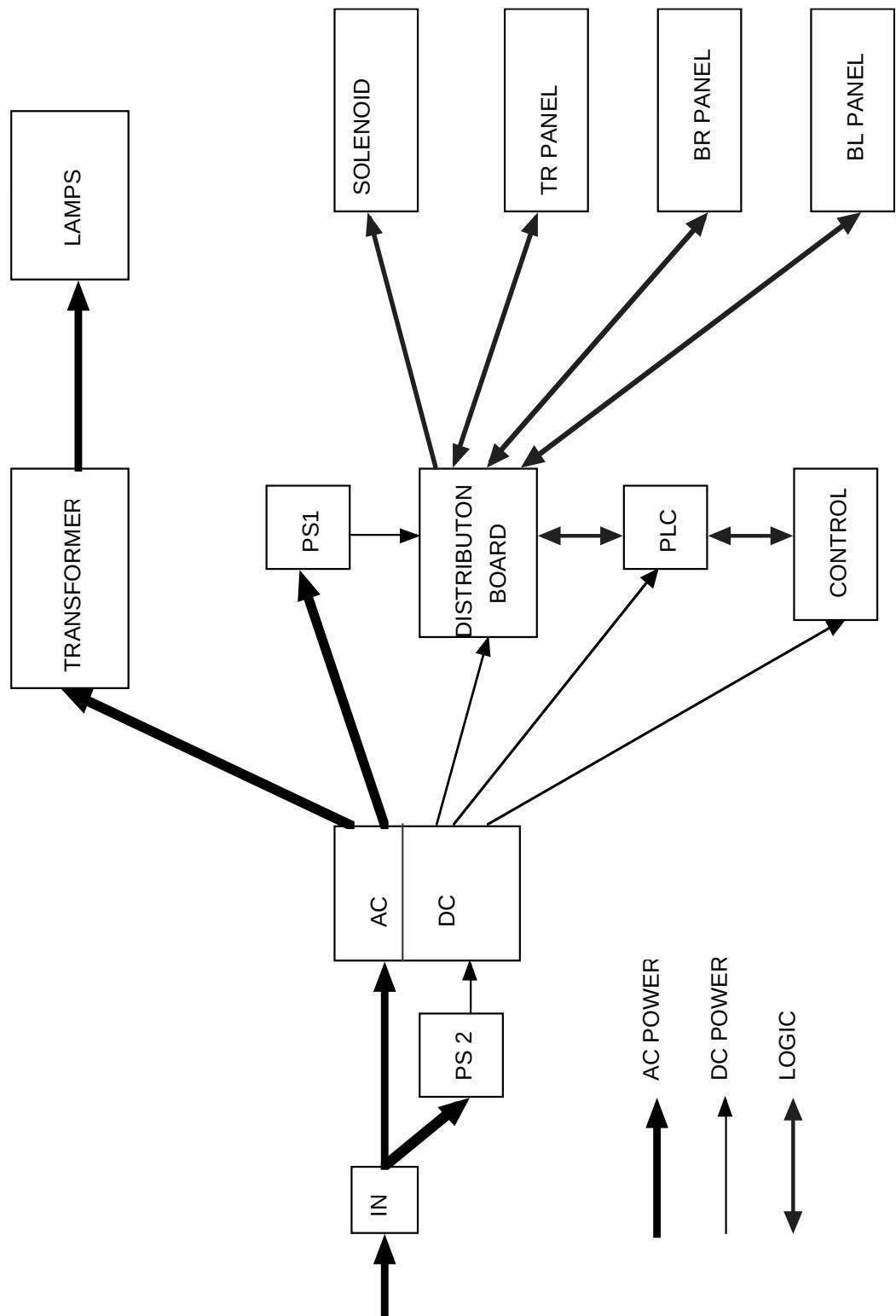
When the POWER switch is actuated, the AC relay is actuated and line power is connected to Power Supply 1 and to the transformer which supplies low voltage AC to the microscope lights. Power Supply 1 supplies 24 volt DC power to operate the solenoid valves. This power flows back to the Distribution Board and from there to the Solenoid Driver Boards

Also shown on the diagram are the major connections between the Distribution Board and the three Control Panels with their control switches, the Top Right Panel, the Front Right Panel and the Front Left Panel.

Logic connections between the PLC, its Control Panel, and the Distribution Board are also shown; not shown are the connections between the Distribution Board and the independent sensors located through out the machine; see the Detectors section (Section 10.2.3) for a complete listing of these with their locations and functions.

10

ELECTRICAL BLOCK DIAGRAM



10.2.2 MANUAL CONTROL SWITCHES

While much of the operation of the Q4000 is under the control of the PLC, there are a number of operations that the operator controls or initiates by means of manual switches. Most of these switches are push button switches mounted on the three front control panels. They feature low pressure operation with an excellent tactile feel. Where appropriate they incorporate LED indicators to confirm operation or warn of their operational condition.

One switch, the SCAN switch, is mounted in the top of the scan joystick to permit one hand operation of this simple control device. Another unique switch is the optional remote focus

control used with the Magna-View head. In this case the switch is a spring return two way operation lever action switch, with a center off position, to control the “up” and “down” motion to permit critical focussing of the microscope. This switch is mounted on the Front Left control panel.

The only other toggle action switch is the microscope illumination method select switch for the optional infra-red aligner, mounted in the top left panel.

The switches are listed and defined in the following chart.

MANUAL CONTROL SWITCHES

S N W U I M T B C E H R	NAME	TYPE	I N D I C A T O R S	LOCATION	FUNCTION
S1	POWER	MOMENTARY	1	TOP RIGHT PANEL	When master switch is on, turns power on
S50	HEAD LOCK	ALT/ACTION	1	TOP RIGHT PANEL	Unlocks head
S6	EXPOSE	MOMENTARY		FRONT RIGHT PANEL	Initiates expose cycle
S10	MASK CLAMP	ALT/ACTION	1	FRONT RIGHT PANEL	Turns off mask clamp vacuum
S105	CAROUSEL ROTATE	MOMENTARY		FRONT RIGHT PANEL	Initiates carousel rotation (carousel option only)
S2	MASK VACUUM	ALT/ACTION	1	FRONT RIGHT PANEL	Turns off mask hold vacuum
S8	CLEAR	MOMENTARY		FRONT RIGHT PANEL	Resets machine, stops action in process
S3	LOAD	MOMENTARY		FRONT RIGHT PANEL	Initiates load cycle
	FOCUS	TOGGLE(MOM)	–	LEFT FRONT PANEL	Actuates power focus (Magna-view only)
S18	COARSE ALIGN	MOMENTARY		LEFT FRONT PANEL	Shifts align to coarse mode
S4	CONTACT/SEPARATE	ALT/ACTION	2	LEFT FRONT PANEL	Toggles between contact and separate
S54	BRIGHT FIELD/INFRA-RED	TOGGLE	–	TOP LEFT PANEL	Selects viewing mode for microscope lights (infra-red only)
S17	SCAN	MOMENTARY	–	SCAN GIMBAL	Unlocks scan

10.2.3 ELECTRICAL DETECTORS

Detectors provide the feedback to the PLC to allow the controller to proceed from one step to the next, without operator action. These units all sense the completion of a task, either by the presence of an object to trigger an electronic device or by the closing of switch contacts. Included in the latter are two pressure switches, which operate mechanical switches by the presence or absence of gas pressure.

The adjusting of these detectors for proper functioning is a critical operation in the set up and maintenance of the aligner, since the automatic sequencing of the aligner depends on their operation.

The Detector chart lists all detectors used in the Q4000, their physical location, and function. They are grouped by type for easy identification.

ELECTRICAL DETECTORS

NUMBER	REFEREN CE DRAWING	NAME	LOCATION
PRESSURE SWITCH			
S9		PISTON PRESSURE	REGULATOR PANEL
S103		CHAMBER VACUUM	REGULATOR PANEL
MICRO SWITCH			
S36	08454-01	TRAY IN	CABLE ASSY-TRAY (REAR OF TRAY ASSEMBLY)
S35	08454-01	TRAY OUT	CABLE ASSY-TRAY (REAR OF TRAY ASSEMBLY)
S123		CAROUSEL PRE ALIGN	CAROUSEL HARNESS (CAROUSEL OPTION)
S16		TURRET EXPOSE	VARI-VIEW HEAD HARNESS HARNESS
S122		CAROUSEL CW DETECTOR	CAROUSEL HARNESS (CAROUSEL OPTION)
S124		CAROUSEL CCW DETECTOR	CAROUSEL HARNESS (CAROUSEL OPTION)
ELECTRONIC			
S5	08454-01	CHUCK UP	CABLE ASSY-TRAY (REAR OF TRAY ASSEMBLY)
S55		CHUCK DOWN	CAROUSEL ROTATE INTERLOCK

10.2.4 ELECTRICAL INTERCONNECTS

All AC devices are electrically grounded with a wired connection to a ground bus mounted on the Distribution Board mount plate.

Electrical interconnects within the Q4000 fall into two categories; AC and low voltage DC.

All AC power is transmitted by fully shielded, jacketed power cables, and all AC devices (power supplies, transformers, and relays are fully enclosed for maximum security.

DC power and signal lines are run in ribbon cable with insulation displacement connectors.

The interconnect cables are itemized in the accompanying chart.

ELECTRICAL INTERCONNECTS

DRAWING NUMBER	FROM	J NUMBER	TO	J NUMBER	TYPE
08552-01	PLC	J39	CONTROL PANEL	J47	HARNESS
08456-01	DC POWER TERMINAL	+	PLC	J37	HARNESS
08457-01	DC POWER TERMINAL	+	CONTROL PANEL	J35	HARNESS
008447-01	DISTRIBUTION	J1	PLC IN	IN1	RIBBON
08448-01	DISTRIBUTION	J2	PLC IN	IN2	RIBBON
08449-01	DISTRIBUTION	J3	PLC IN	IN3	RIBBON
08450-01	DISTRIBUTION	J4	PLC IN	IN4	RIBBON
08451-01	DISTRIBUTION	J23	PLC OUT	OUT1	RIBBON
08452-01	DISTRIBUTION	J24	PLC OUT	OUT2	RIBBON
08453-01	DISTRIBUTION	J25	PLC OUT	OUT3	RIBBON
08444-01	DISTRIBUTION	J18	SOLENOID DRIVER BOARD	J40	RIBBON
08445-01	DISTRIBUTION	J19	SOLENOID DRIVER BOARD	J41	RIBBON
08446-01	DISTRIBUTION	J20	SOLENOID DRIVER BOARD	J42	RIBBON
08441-01	TOP RIGHT PANEL	J22	DISTRIBUTION BOARD	J36	RIBBON
08442-01	FRONT RIGHT PANEL	J26	DISTRIBUTION BOARD	J35	RIBBON
08443-01	FRONT LEFT PANEL	J17	DISTRIBUTION BOARD	J34	RIBBON
08455-01	AC POWER TERMINAL	+	POWER SUPPLY-1	J42/+	CABLE
04846-01	VARI-VIEW HEAD HARNESS	*	LH PANEL INTERCONNECT (VV)	J48	HARNESS
08155-01	MICROSCOPE PANEL HARNESS	*	MAGNA-POWER HEAD	J48	HARNESS
04770-01	TOP LEFT PANEL (STD)	*	HEAD HARNESS	J33	HARNESS
04770-02	TOP LEFT PANEL (IR)	*	HEAD HARNESS	J45	HARNESS
04844-01	DISTRIBUTION	J5	POWER SUPPLY-2	J38	HARNESS
08505-01	DISTRIBUTION	J10	PRESSURE SWITCH	+	HARNESS
08504-01	DISTRIBUTION	J14	VACUUM SWITCH	+	HARNESS
08454-01	DISTRIBUTION	J6/J9/J16	TRAY ASSY	*	HARNESS
06603-01	INPUT- FOOTSWITCH	J44	DISTRIBUTION BOARD	J29	HARNESS
04884-01	DISTRIBUTION	J13	SCAN	+	HARNESS
04770-01	TOP LEFT PANEL (STD)	J33	HEAD	J48,J31/+	HARNESS
04770-02	TOP LEFT PANEL (IR)	J45	HEAD	J48,J31,J49,J50/+	HARNESS
04884-01	SCAN	+	DISTRIBUTION BOARD	J13	HARNESS
			+ INDICATES INDIVIDUAL WIRE CONNECTIONS; * INDICATES MULTIPLE COMPONENTS		

10.2.5 ELECTRICAL CONNECTORS

The accompanying table lists all of the connectors used in the Q4000, with details of the location, and termination point of each.

ELECTRICAL CONNECTORS

CONNECTOR NUMBER	LOCATION	CONNECTS TO	FUNCTION	TYPE
1	Distribution board	PLC in 1	PLC IN	Ribbon
2	Distribution board	PLC in 2	PLC IN	Ribbon
3	Distribution board	PLC in 3	PLC IN	Ribbon
4	Distribution board	PLC in 4	PLC IN	Ribbon
5	Distribution board	J 38,tb5	24 volt power in	Discrete
6	Distribution board	S 5	Chuck sensor	Discrete
7	Distribution board	S 122	Carousel	Discrete
8	Distribution board	S 124	Carousel	Discrete
9	Distribution board	S 35	Tray out switch	Discrete
10	Distribution board	S 9	Pressure switch (Pressure)	Discrete
11	Distribution board	S 123	Carousel prealign switch	Discrete
12	Distribution board	S 55	Piston Down Sensor	Discrete
13	Distribution board	S 17	Scan Switch	Discrete
14	Distribution board	S 103	Pressure switch (Vacuum)	Discrete
15	Distribution board	J 48	Expose interlock switch	Discrete
16	Distribution board	S 36	Tray in switch	Discrete
17	Distribution board	J 34	Front left panel	Ribbon
18	Distribution board	J 40	Solenoid 1 to 8	Ribbon
19	Distribution board	J 41	Solenoid 9 to 16	Ribbon
20	Distribution board	J 42	Solenoid 17 to 24	Ribbon
21	Distribution board	K-2	Power on	Discrete
22	Distribution board	J 36	Front right panel	Ribbon
23	Distribution board	PLC out 1	PLC out	Ribbon
24	Distribution board	PLC out 2	PLC out	Ribbon
25	Distribution board	PLC out 3	PLC out	Ribbon
26	Distribution board	J 35	Top right panel	Ribbon
27	Distribution board	J 48	Focus switch access	Discrete
28	Distribution board	J 48	Contact/separate light access	Discrete
29	Distribution board	J 44	Contact/separate function access	Discrete
30	Distribution board	K 1	Power off	Discrete
31	Distribution board	J33, 49	IR light control DC power	Discrete
32	PLC	TB5,6	DC Power	Discrete
33	Top Left Panel	J31, 49, 50, 48	Top left panel disconnect	Discrete
34	Front left panel board	J 17	Front left panel	Ribbon
35	Top right panel board	J 26	Top right panel	Ribbon
36	Front right panel board	J 22	Front right panel	Ribbon
37	PS 2	TB 1-4	PLC power in	Discrete
38	PS 2	J 5	PS 2 DC power out	Discrete
39	PLC	J 47	PLC panel logic	Cable
40	Solenoid driver board 1	J 18	Solenoid driver board 1	Ribbon
41	Solenoid driver board 2	J 19	Solenoid driver board 2	Ribbon
42	Solenoid driver board 3	J 20	Solenoid driver board 3	Ribbon
43	PLC Panel	TB5, 6	DC Power	Discrete
44	Input panel	J 29	Footswitch	Discrete
45	Load Harness	J6,9,11,12,16	Wafer load harness	Discrete

46	Input panel	Wall Power	Power in unit	Discrete
47	PLC control panel	J 39	PLC panel logic	Discrete
48	Head harness	J15, 27, 28, 33	Head cable	Discrete
49	Input Panel	J31, 33,50	IR Light Control Left	Discrete
50	Input Panel	J33, 49	IR Light Control Right	Discrete
51	Circuit breaker	J48	Illuminators	Discrete
52	Circuit breaker	T1	Illuminators	Discrete
53	Q4000-4 Head	J48	Expose detector	Discrete
54	Q4000-4 Head	J48	LH Illuminator	Discrete
55	Q4000-4 Head	J48	RH Illuminator	Discrete
56	Q4000-6 Head	J48	RH Illuminator	Discrete
57	Q4000-6 Head	J48	RH Illuminator	Discrete
58	Q4000-6 Head	J48	LH Illuminator	Discrete
59	Q4000-6 Head	J48	LH Illuminator	Discrete

10.2.6 PRINTED CIRCUIT BOARDS

The Quintel Q4000 utilizes three types of printed circuit board. They are, in two cases, used as a means of mounting active operating elements, and in the third as a interconnect device.

The Distribution Board is the main interconnect point for the aligner, where all of the incoming signals from sensors and operator controlled input switches are gathered and directed to the proper input port of the PLC. In turn, the output signals from the PLC are sent to the Distribution Board and there sorted to the proper connector to operate the relevant solenoid or indicator

The Distribution Board contains only connectors and the circuitry to interconnect them. It also contains 5 volt DC power test points for use in diagnostic testing.

The three push button control switch panels utilize printed circuit boards as a means of mounting the switches, indicator lights (LEDs and their related current limiting resistors) associated with the switches, and the connector to interconnect the switches with the Distribution Board.

The third group of boards are the Solenoid Driver Boards, a group of three identical boards, each of which has eight individual solenoid driver circuits on it. These circuits have a driver transistor, a blocking diode and a LED, together with their associated resistors, to provide the necessary circuitry to provide the 24 volt DC current to open the connected solenoid when a 5 volt DC signal is received from the PLC.

These circuit boards are all relatively simple two sided boards, and are manufactured with specification grade materials and the latest technologies for long trouble free life. All are replaceable as a modular unit if the need occurs.

The boards are fully described on the accompanying chart, together with their identifying part numbers and other information.

PRINTED CIRCUIT BOARDS

ASSEMBLY NUMBER	DRAWING NUMBER	NAME	J NUMBER	FUNCTION	LOCATION
99-04819-01	04818-01	DISTRIBUTION	J1 to J31	Receives all inputs and outputs, distributes signals as required	Left rear of the aligner, above the PLC
99-04647-01	04646-01	TOP RIGHT PANEL	J36	Mounts switches and indicators	Under the control panel
99-04653-01	04652-01	FRONT RIGHT PANEL	J35	Mounts switches and indicators	Under the control panel (Standard Version)
99-04653-02	04652-01	FRONT RIGHT PANEL	J35	Mounts switches and indicators	Under the control panel (Carousel Load Version)
99-04655-01	04664-01	FRONT LEFT PANEL	J34	Mounts switches and indicators	Under the control panel
99-08350-01	08349-01	SOLENOID DRIVER 1	J40	Mounts transistors and LEDs for solenoids 1-8	Mounts to the solenoid rack at right rear of aligner
99-08350-01	08349-01	SOLENOID DRIVER 2	J41	Mounts transistors and LEDs for solenoids 9-16	Mounts to the solenoid rack at right rear of aligner
99-08350-01	08349-01	SOLENOID DRIVER 3	J42	Mounts transistors and LEDs for solenoids 17-24	Mounts to the solenoid rack at right rear of aligner

10.3.0 MISCELLANEOUS CONTROLS

There are a few controls on the Q4000 which do not fall into the classifications presented so far. This section will discuss these.

PNEUMATIC:

Mounted on the end of the Flow Control bracket under the rear right access cover is a TOGGLE VALVE which activates or deactivates the flow of purge gas to the expose chamber.

Mounted on the Top Left Control Panel is a pressure gauge which allows the observation of either CHAMBER VACUUM or SEPARATION PRESSURE. This is a dual range gauge and is capable of indicating either vacuum or pressure, and the choice of which function is active is made by the operator turning the control valve mounted below the gauge to one position or the other.

ELECTRICAL:

Also mounted on the Top Left Control Panel are the potentiometers used to control the microscope illuminators. They are set up to individually control the left and right lamps. These controls are identified as BRIGHT FIELD INTENSITY RIGHT and BRIGHT FIELD INTENSITY LEFT.

As a part of the electrical system for the microscope illumination there is, mounted on the Regulator Panel, a CIRCUIT BREAKER to protect the lamp circuit from short circuits. This unit is resettable, after correcting the problem which caused it to trip, by pressing the button mounted in the panel.

When the Infrared option is installed, the Top Left Control Panel includes the capability to chose between BRIGHT FIELD (conventional) illumination, and back side DARK FIELD illumination for infrared alignment through the wafer. In this case there are four potentiometers mounted with a selector toggle switch mounted between them.

10.4.0 MECHANICAL SYSTEMS

This section describes the mechanical aspects of the Q4000. This is the foundation on which the machine depends for its stability, enabling it to hold the work in such a fashion that accuracies beyond visibility are routinely achieved.

10.4.1 STRUCTURE

The support structure of the Q4000 is key to the successful operation of the aligner. It consists of several components discussed in the following paragraphs.

10.4.1.1 TABLE FRAME

Note:

The Q4000 is supported by a custom design table which provides proper support for the weight of the aligner. It is provided with shelves to support accessory expose lamp power supplies and auxiliary microscope illumination sources if needed, making the aligner a self contained unit.

The legs of the table are equipped with adjustable leveling feet, to assist in installing the machine in a level condition regardless of site inequalities.

There is no direct mechanical fastening of the aligner itself to the table frame. Because of this great care must be exercised in moving the aligner. The aligner must always be lifted by grasping the table frame rather than by the aligner base.

At the top interface with the aligner base plate, the table frame is equipped with six energy absorbing mount units, which serve to isolate the aligner from building vibrations. The aligner rests on these units in restraining pockets, to assure that the table frame and aligner base always remain aligned properly.

Recent production Q4000 aligners feature an proved support table frame, incorporating air flotation vibration isolators, and adjustable height legs. Please refer to Sections 4.3.1 and 4.3.2 for information on the adjustment and operation of these features

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10.4.1.2 ALIGNER BASE

The Q4000 design is aimed at providing a maximum rigidity to insure that no uncontrolled movements may occur to interfere with the precise alignments obtained by the operator in production. The technique developed by Quintel to attain this rigidity starts with the use of a

thick, stable aluminum plate, machined to very precise flatness tolerances. On this undeviating foundation all of the various functional units of the aligner are mounted, with the assurance that the relationship between units will remain constant.



10.4.1.3 OPTICAL HEAD SUPPORT

The rigid mounting of the high power microscope used to view the product during alignment is essential to operator comfort and efficiency. To achieve this the Q4000 utilizes a heavy duty rotating mount which provides the necessary rigidity and allows the head to be rotated out of the way to permit easy access to the work station for tool changes and servicing. This post incorporates a carefully designed, preloaded tapered roller bearing system to insure trouble free operation.

10.4.2 ALIGNMENT STAGE ASSEMBLY

The heart of the Q4000 alignment system is the alignment stage. This mechanism is in reality several separate specialized devices combined into one.



10.4.2.1 SCAN STAGE

The scan stage, which utilizes the base of the aligner as one part, provides the means to move the total stage in a global fashion. This action permits the operator to pick a specific location on the work piece on which to perform the alignment operation. The scan stage moves on carefully aligned X and Y linear bearings, which allow 5/8" travel in each direction.

The scan movement is controlled by a gimbal mounted joystick control at the left side of the stage. This control allows one hand controlled

movement in any direction.

Mounted on both sides of the stage are air bearing lock units. These units, in scan mode, ride on a cushion of air to reduce drag during movement. This air bearing is controlled by pressing a push button on the joystick control. Upon release of the control button, the air pressure is instantly replaced by vacuum, locking the scan stage and preventing further movement.

The mask holder supports are mounted to the top scan stage, so it moves with the scan stage.

10.4.2.2 ALIGN STAGE

The third and fourth plates in the stage stack comprise the align stage. Here again, are X and Y linear bearings to guide the movement, this time in relation to the scan stage and its related mask holder. This provides the capability to move the substrate in relation to the mask, to perform the critical alignment.

The movements of the align stages are controlled by a complex gimbal joystick mounted on the right side of the stage assembly. This unit has built into it an ingenious method of changing the lever ratio affecting the movement to allow a rapid "coarse" alignment movement, and a much slower and more critical "fine" movement. This change is controlled by which of two concentric vacuum lock rings is energized at the base of the

gimbal. This selection is controlled by a pushbutton switch mounted for left hand operation on the front left panel. This control is available only when the aligner is in "separate" mode, when alignment movement is operational. When the aligner is placed in "contact," and no movement is desired, vacuum is applied to both lock rings simultaneously, effectively preventing any align stage movement.

As an alternative for very critical, low production, alignments, Quintel offers an alternative alignment control. This unit replaces the gimbal control with a micrometer drive, providing individual X and Y micrometers to control the movements independently. This control system is significantly slower than the gimbal control, but is capable of controlling micron level movements more easily.

10.4.2.3 ROTATIONAL ALIGNMENT

The final degree of freedom required for complete control over an alignment is the rotation of the substrate in relation to the mask. This is accomplished by a rotary bearing system mounted in the top stage plate, controlled by a micrometer mounted at the front left corner of the stage assembly.

10.4.2.4 THE AIR BEARING GUIDESET

The Quintel Air Bearing Guiderset, which provides the Z motion to the substrate for loading the product into the aligner work station, and for the ultra critical small movements between separate (where the alignment is performed) and contact (where the exposure is done), is a very complex, precise mechanism. Again it is many devices integrated into one compact unit.

The first task it performs is the relatively long movement required to drop the substrate support down to receive the new work piece, and then to lift it up to the work position. This movement is controlled by a long engagement low friction air bearing, and is driven by a zero friction rolling diaphragm air cylinder. This combination allows very low air pressures to be used for the movement for product safety.

At the top of the load movement, an air controlled lock ring clamps the air bearing sleeve to a housing containing the separation drive mechanism. This locking is done with equal radial forces in all directions, assuring the symmetry of the combined parts.

At this time the machine logic causes the combined sleeve/housing unit to be driven down into "separation." The housing is suspended, in a centered position, on a metal spring diaphragm system which allows freedom of movement in the Z direction, but is extremely stiff in the X and Y directions. This suspension, combined with the lateral stiffness of the air bearing, allows the small movements from contact to separate and back to be made with unmeasurable X and Y deviations.

Mounted to the top of the air bearing sleeve is the conical seat for the substrate chuck.

The entire guide set assembly is mounted in the rotational bearing system in the top stage plate, and moves with the stage in all of its alignment movements.

10.4.2.5 WORK HOLDER SYSTEM

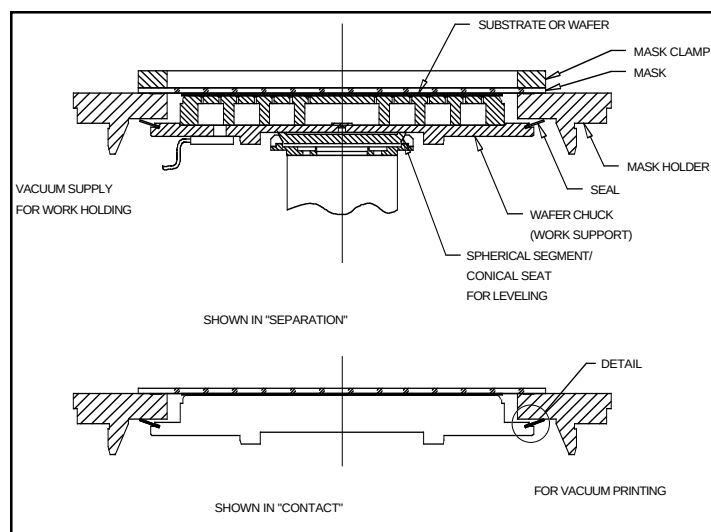
All Quintel Aligners utilize a highly developed work support system which has evolved through more than 30 years of applications work in the semiconductor industry. The system involves two major components—the mask holder and the wafer support or “chuck”. Each of these components are optimized to perform their functions while working in concert to provide complete control of the product while being loaded into the aligner, aligned, exposed and unloaded.

The MASK HOLDER is a very precise work holder which is designed to support the glass mask on a flat lapped surface, providing vacuum porting to clamp the mask firmly in place, and establishing, in conjunction with the wafer chuck, a controlled atmosphere chamber for the exposure period.

There is an optional adjunct to the mask holder, the MASK CLAMP, which is a thin, precise, metal part with a vacuum port to permit vacuum clamping to the top side of the mask. The clamp serves two functions: it provides, by means of protruding, handles, a convenient method of

placing and aligning the mask under the microscope and more importantly, a way of “stiffening” the mask and controlling the “mask bow” introduced when the expose chamber and wafer are subjected to pressure, both negative and positive, during the expose cycle.

The work support or WAFER CHUCK provides an optically flat surface to support the product during the alignment and exposure. It has a means to introduce vacuum to the work/chuck interface to hold the work in place during transport in and out of the expose chamber, or low pressure under the work at the moment of exposure to produce “pillow pressure” for pressure contact with the mask. At the perimeter it provides a thin rubber seal to complete the exposure chamber at the time of exposure. On the reverse side is mounted a spherical ball segment, which interfaces with a conical seat in the aligner to provide a means of tilting the work, upon initial contact with the mask, to planarize the work with the mask. This ball seat is subjected to very slight air pressure during planarization and is vacuum clamped at all other times to maintain the leveling achieved initially.



MASK HOLDER

The geometry of the mask holder is governed by several simple rules: the opening in the mask holder is always designed to be large enough to accommodate the physical size of the work plus the maximum movement of the work in relationship to the mask provided by the aligner to achieve alignment. In practice this means that the mask holder opening is, for standard tooling, 0.300 inches larger than the size of the work.

Since the Quintel tooling system utilizes a “top mount” mask holder, the minimum mask size which can be used on a given size wafer is controlled by the need to provide adequate hold down force to retain the mask in place when the forces of planarization and expose pressure exert an upward pressure. The rule utilized for standard design tooling requires that for round parts the mask must be 1 inch larger than the wafer and that for square substrates the mask must be 2 inches larger than the work in each direction.

Within reason, any mask size larger than minimum may be used on the mask holder, mask corner locating stops are provided on all mask holders, with alternate positions available for standard, nominal size masks up to the recommended maximum size. By removing the stops even larger masks may be accommodated with the mask overhanging the support.

WAFER CHUCK

The wafer chuck normally is made to match the size of the work being supported; in no case may the work “overhang” the support surface. However, it is permissible for the work to be smaller than the support surface. In this case it is desirable to block off the vacuum ports in the surface of the chuck which are not covered by the work. (If smaller than normal work is being loaded refer also to the discussion under mask clamps below.)

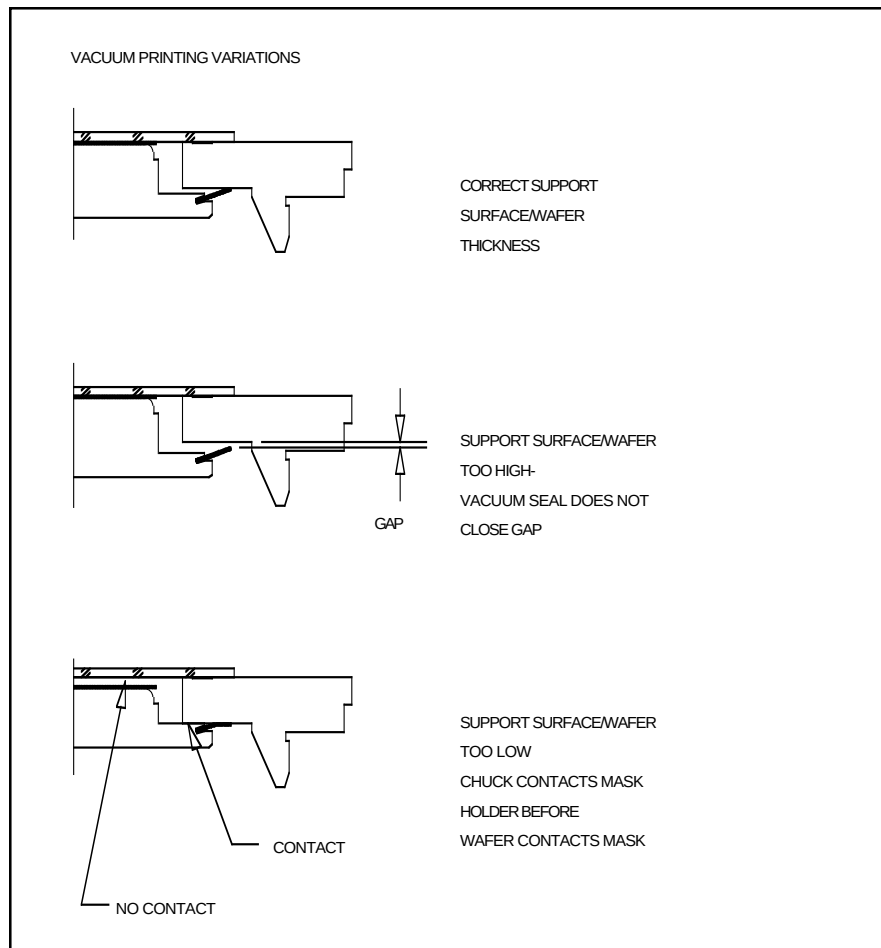
The height of the wafer chuck is very important to the correct functioning of the exposure system. In straight pressure printing the characteristic of concern is that the work support platform and work thickness combine so that clearance is maintained between the chuck flange and mask holder. Any thicker substrate merely increases this clearance and does not affect the operation of the system up to the point where the combination actually interferes with the movement of the work into the aligner by contacting the bottom of the mask holder. The maximum thickness of substrate that can be accommodated on a standard configuration machine is 6.3mm or 0.25 inch.

In a non standard mode of operation, by moving the head of the aligner aside, removing the mask, and loading the work onto the chuck through the mask holder opening substrates as thick as 18mm. or 0.71 inch can be loaded and aligned.

For vacuum printing the rules are much more restrictive. In order to achieve a closed expose chamber it is necessary to have the seal at the perimeter of the chuck contact the underside of the mask holder. To achieve this the chuck work holding surface height is manufactured to a specific dimension for the work to be done, so the combination of the chuck and the work fall within a narrow dimensional band. There is a 0.010 inch tolerance to this dimension, sufficient to accommodate normal manufacturing tolerances for wafers and substrates, and if planned for, to allow one chuck to handle two adjacent sizes of SEMI standard wafers (for example 3 inch and 100mm), but it is not possible to cover non adjacent sizes (2 inch on a 100mm chuck).

MASK CLAMP

Mask clamps are generally configured to agree with the mask holder they ship with. The outside dimension should always match the mask size, and the opening the same size as the mask holder opening. When a smaller size product is being handled the opening should match the actual work size, in order to achieve optimum mask bow control. There are many size combinations available as standard designs and custom combinations are readily available.

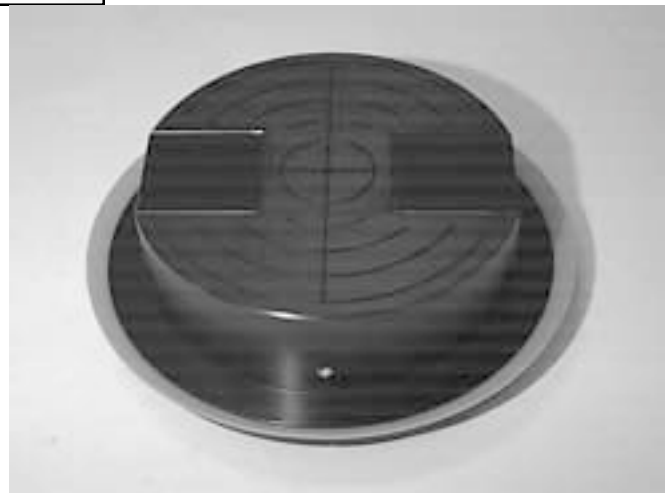
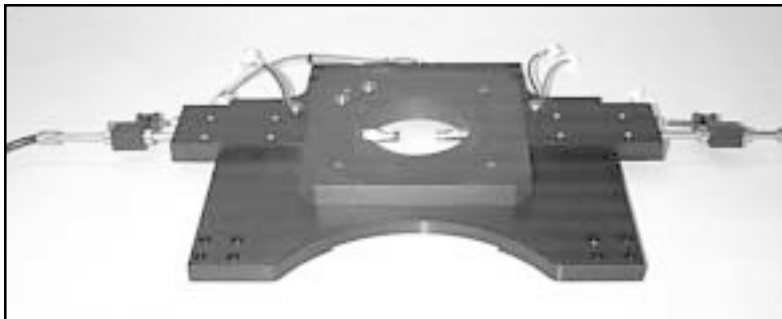


10.4.2.6 INFRARED ALIGNMENT TOOLING

For backside viewing by means of infrared illumination, the Q4000 utilizes tooling which functions in a normal fashion as far as holding and supporting the mask and wafer is concerned. The difference is that the tooling has been modified to allow the introduction of a light source under the wafer after it is in the alignment position. This is accomplished by making the tooling much thicker than normal, and creating a cavity into which a fiberoptic light cable can be introduced, allowing a bright light to be directed upwards at the back of the wafer. The light pipes are automatically inserted and withdrawn to allow the loading and unloading.

Infrared backside alignment is possible because the normal semiconductor base materials are transparent to short wave length infrared light, normally invisible to our eyes, but visible to some video cameras. By filtering out the visible light the camera can provide quite acceptable images of a pattern on the back side of a substrate loaded upside down on an aligner chuck.

The major limitation for this type of alignment is the fact that the viewing microscope objective is limited to one with sufficient depth of focus to allow viewing a mask image and a substrate image separated by the thickness of the substrate. The system performs best with relatively thin substrates and with fairly large design rule patterns. Viewing is enhanced by substrates with polished backs, and with metalized alignment patterns, but even without these enhancements good alignments are easily achieved with the infrared viewing system on the Q4000.



10.5.0 VIEWING OPTICS

This section is a brief tutorial on functioning of the optical systems (microscopes) used to assist the aligner operator in making the critical alignments required in production, descriptions of some of the terminology used in describing microscopes, and some commentary on the special characteristics needed for aligning with a microscope.

10.5.1 THE SPLITFIELD MICROSCOPE

The primary tool for the viewing of a mask and wafer for the purpose of aligning the two images is the split-field microscope. With the introduction of semiconductor devices, and the need in their manufacture to accurately overlay the image of a new mask layer onto the existing pattern from preceding manufacturing steps, the split-field microscope found a new use. This new need spurred the development of several generations of these instruments. The microscopes used on the Q4000 represent two phases of this development.

The turret type unit found in the Vari-View head is the latest iteration of a unit that was designed more than thirty years ago and has been in continuous use on thousands of mask aligners over this period. In the Q4000 version it has been modernized with new materials and methods of manufacture to produce a unit with all of the time proven features of the original and the improved performance and life characteristics to be expected from the new aspects.

The microscope on the Magna-View, on the other hand, is a new design, using the same optical principles, but with a fresh approach to the implementation to produce an enhanced product to set a new standard for quality, versatility, and performance.

Both of these microscopes are equipped with an exclusive feature not available except on Quintel Split-field Microscopes: the Vari-Power. This unit,

mounted just below the binocular eyepiece, provides a choice of from 2 X to 5 X extra magnification beyond that supplied by the objective lens and the eyepiece. It is an optical zoom unit, providing continuously variable magnification with finger-tip control.

The split-field microscope is a complex optical system. It consists of two microscopes, mounted in parallel, on adjustable sliders so the distance between the optical axes may be varied to fit the pattern on the wafer under observation.

The objectives mounted at the lower extremity closest to the wafer are conventional microscope objectives, which are focussed on the wafer. They create an image, as in a standard microscope, which is projected up towards the eyepiece. Somewhere above the objective there is a transparent mirror which reflects the illumination light down through the objective lens, creating the bright field illumination used for aligning.

From this point onwards the microscopes operate in an unconventional manner. At this point the optics are arranged to discard half of the image from each microscope, and to combine the remaining halves into a split-field image, in which the eye sees in one half of the field an image from one microscope and in the other half an image from the second microscope. Since the two microscopes are looking at the same wafer,

the split field is showing two widely separated places on the wafer. This permits the operator to make very rapid and critical adjustments of the wafer/mask relationship, particularly in the rotational Q direction.

In a normal microscope the objective creates an image which an eyepiece placed at an appropriate location can convert into an image which the eye can see. In a Quintel split-field microscope we do not do this; instead we look at this image with another complete microscope. And this microscope has the zoom Vari-Power unit in it, between the objective and the eyepiece.

With a conventional microscope the magnification of the system is normally accepted to be the product of multiplying the magnification of the objective by that of the eyepiece. In a Quintel microscope the magnification is the magnification of the objective times the zoom factor times the eyepiece value.

To understand the importance of the zoom magnification feature we need to define some of the optical characteristics of a microscope as developed by the pioneering scientists hundreds of years ago. They developed a unit of measure for a objective which is a simplified shorthand code which pretty much describes how a simple optical objective works (of course the scientists of today pull all sorts of tricks in designing modern objectives which work around the simple explanations which are handy for non- or semi-expert people to use). This handy, easy to understand tool is called Numerical Aperature or N.A. for short. It is a measure of the maximum angle covered by the light cone entering the front of the lens. If you think of this angle as being related to the distance between the lens and the object, and the diameter of the lens, you can visualize a cone of light originating at the center of the object and spreading up and out to the

maximum diameter of the lens, this is what N.A. describes as a number. Every objective lens has its own N.A. value. Now if we visualize this cone of light spreading out beyond the confines of the lens itself, and even beyond the body of the microscope, up to the level of the eyepiece, we can visualize the cone becoming very large. And if we can now somehow look at this whole cone of light, we can appreciate how a microscope magnifies. The real trick to a microscope is how the designers of the optical system fix it so we can "see" this large cone of light. But we are not really concerned with this part of the optical system. It happens.

The people who developed the idea of N.A. also developed formulas to describe certain characteristics of a microscope, using N.A. as a part of the formula. Some of these formulas are important to us, not in actual numbers but in relative size and direction of change.

The first of these is Magnification: in general the higher the magnification of an objective the smaller the N.A. We are interested in magnification, because more magnification makes a bigger image, so within limits we can see smaller objects.

The another factor we are particularly concerned with is called Working Distance. This is the physical distance between the front lens (and the mount around it) and what we are focussing on (the wafer). Remember we are looking through the mask and we must have clearance for mask clamps and so forth, so we really are restricted by this factor. The rule on this is the higher the magnification, the smaller the N.A. and the smaller the working distance. In practice we find that, even with modern "long working distance" objectives, 20 X is the highest magnification available to us with adequate working distance.

The next factor is called Depth of Focus. This is, from our perspective, how far apart can the mask and substrate be and still have both of them in good enough focus for us to align the images. This factor goes along with N.A.— the smaller the N.A. the smaller the depth of focus. From a practical standpoint most 10 X objectives are the limit for good alignment separation and good depth of focus, so a 20 X objective is really limited to verifying alignment in contact, but you will have to align at 10 X.

The last factor is Resolution or Resolving Power. This one is upside down to N.A.; the larger the N.A. the lower the resolution. It appears that higher magnification will be our best bet to be able to do more critical alignments. But we are limited by physical constraints on how much magnification we can use. (Be sure to read Section 10.5.2, Microscope Magnification, for more on this subject).

Now this is where the Vari-Power unit comes in; we are restricted by what we can use at the objective position, we need more magnification in order to see what we are aligning. The Vari-Power does it! Its what is called “empty magnification” and if we were really trying to see ever smaller objects it would not do us much good, but we are not trying to see smaller objects; we are trying to align two objects and having spaces around alignment targets bigger will work just fine.

Completing the description of the microscope; all Quintel microscopes are equipped with binocular eyepieces, so two eye operation is standard. This is highly desirable for minimizing operator fatigue.

Since it is frequently misunderstood a discussion of the proper adjustment of the eyepieces of a binocular eyepiece head seems in order. A binocular always has an adjustment for interpupillary (distance between the eyes) adjustment. In setting up the microscope for any operator this is the first adjustment to be made. After a binocular has been set up suggest that the operator remember their setting— the numbers engraved on the body are distances in millimeters. When this number has been established, set both adjustable eyepiece mounts to this same number. At this point, if the microscope itself has been properly set up, the dividing line between the split fields should be in reasonably good focus. The individual eyepieces may be slightly adjusted to accommodate minor eye differences, but these changes must be minimal. If the split field line is very unsharp there are two avenues to explore; are the operator's eyes in need of correction, or is the microscope out of adjustment? Setting up for an operator with known good eyes will settle this.

After the eyepiece adjustment is made properly, proceed to adjust the objectives for proper focus.

10.5.2 MICROSCOPE MAGNIFICATION

Microscope magnification is a very complex subject. To many people magnification equals visibility which equals good alignment. However higher magnification carries penalties which need to be carefully evaluated.

Optically, the component in the system usually assigned the task of magnification is the objective lens. However higher objective power always means less depth of focus (the ability to focus two objects separated by a small distance). Since a mask aligner depends on having the mask and wafer "separated" to allow movement for alignment, the practical magnification power allowed is 20X; any higher power has too small a depth of focus to permit movement while still being able to "see" both the mask and wafer.

Another parameter assigned to a particular objective is "resolving power," or the ability to sharply view a feature. Higher power means higher resolving power usually. However, alignment accuracy is not, to a great extent, dependant on resolution, and therefore is very difficult to quantify in terms of the optical characteristics of the viewing system.

The best proof of this is that with the conventional microscopes used for the viewing of a mask and wafer on an aligner, absolute resolution, as calculated by the formulas widely used by microscope scientists for a hundred years, is predicted to be no better than one or two micrometers with the 10x and 20x objectives used normally. In spite of this we have many documented cases of customers achieving sub micron alignments on a regular production basis.

The explanation for this is that the human eye is very good at analyzing spatial relationships, and expert process development personnel have learned to design alignment targets which take advantage of this to achieve alignments even though you theoretically can not see details at the size required. A common technique is to align to a pattern consisting of a relatively wide line centered in a space slightly wider than the width of the line; the eye, looking through a microscope at a reasonable magnification, can very accurately balance the gap on each side of the line, achieving an accuracy significantly better than it is possible to actually see.

With a video system we have a different situation, because the camera/monitor system replaces the human eye in the total system, and the resolution of the camera chip, feeding information to the monitor certainly is different in terms of alignment ability.

Because this is a new a relatively technique we do not have extensive experience to confirm what it is possible to achieve, on a practical (rather than theoretical) basis. We can only suggest that the same principles which work in a visual alignment system to achieve accurate alignments should be extended and applied to the new technique, and that alignment accuracies will be achieved by development of target systems which take advantage of spatial relationships rather than absolute resolution of the optical system.

In the Quintel Q4000 system, the microscopes are supplied with a variety of objective lenses to allow selection of the most appropriate value for the task at hand.

10.6 EXPOSURE OPTICS

The exposure optics unit of the Q4000 is state of the art for efficiency and uniformity. A discussion of the principle of operation of this unit naturally starts with a description of the light source (the lamp), the light gathering device (the reflector), and the light processing system (to produce the uniformity necessary). Along with these required optical devices, there are a number of required auxiliary items— a shutter to control the flow of the light, turning mirrors to direct the light down to the substrate, and environmental devices to control temperatures and contain the light. Each of these will be discussed in its turn, to create a total picture of the system.

The Light Source

The device almost universally utilized as a source of high intensity light high in the ultraviolet energy required for exposing the photo-resists used in producing semiconductor devices, and other items, on mask aligners is a unit known as a “mercury short arc lamp.” This lamp consists of an envelope of pure optical grade quartz, which readily transmits the ultraviolet energy we are interested in, and adequately resists the temperatures and pressures encountered. This envelope has installed in it two opposing electrodes, pointed pieces of metal which carry electricity through the walls of the envelope, to a position where the electricity can be forced to jump the small gap between them, creating an intense light as it creates this continuous “lightning bolt.” The interior of the envelope is sealed off from the outside air, and in manufacture is subjected to two operations which are critical to our use- all of the air is evacuated initially, and a very small amount of the metal mercury is placed in the cavity. Removing the trapped air does two things: first

of all it reduced the resistance for the electricity to jump the gap at start-up, and secondly it removes contaminants which might effect the operation of the lamp. The mercury, on the other hand, is a contaminant we want. Mercury, when heated to very high temperatures by the arc, emits a light that is very rich in the ultraviolet light we want. The mercury, which is a liquid metal at normal temperatures, vaporizes at operating temperatures, and even though the quantity is very small, creates very high internal pressures within the lamp.

The Reflector

The light created by the light source radiates out from the arc in all directions with equal intensity. In this form we would be able to use only a very small portion of the total in exposing a substrate. To be more efficient in our use of the light we employ a light gathering device to trap more of the light and get it to a place where we can concentrate it on the substrate. The device we elect to perform this task is a mirror in a special shape known as a “ellipsoid.” The ellipsoidal mirror is a dish shaped mirror, which if sawed in half across the center would be found to have a shape which is a portion of the oval shape known as an “ ellipse.” Remembering back to school math classes, an ellipse has two spots inside it that are called “focus points.” An elementary way of drawing an ellipse is to place two pins at the two focus spots, and dropping a loop of string a little bigger than the distance between the pins over them. If we then place a pencil inside the loop, and hold it tight against the inside of the loop, move it around, we will find that the pencil will draw an ellipse. Now, visualize using a portion of the ellipse as the shape of our mirror, and the two pieces of the string loop connecting a point on the ellipse with the two focus points as rays of light, its easy to see that if we place our light source at one focus point, the light will

travel out to the mirror point at the ellipse and will reflect back to the second focus. If we move the pencil to another point, the light will still come back to the second focus because the “string” still connects the two “pins” to the new point; this is the principle of the ellipsoidal mirror. The energy created at one focus is directed to the second. In the Quintel light source we utilize an ellipsoidal mirror a little less than half a full enclosure, because we need a way to get our light out for use, but this a much greater portion of the initial energy produced than if we had not gathered it in, and even more importantly, the light is now all going sort of the same way, instead of spreading out all over, making it more practical for further processing.

Turning Mirrors

The next step in the path to the exposure of a substrate is a mirror. Because the mercury lamp insists on living its life in an upright position, the lamp/collector combination produces its output pointing down. If we used the system this way we would be faced with two consequences: the entire system would be extremely tall, taller than a normal room ceiling would accept. You would need a stepladder to change the lamp or to adjust the system. In addition it would need to be mounted directly over the substrate for use, and would be very difficult to get out of the way when we want the alignment microscope in the same place for use.

To eliminate all of these problems a mirror (the “first turning mirror”) is placed between the two focus points, directing the light into a horizontal

path. This mirror has a very special reflective coating on it. It is selective in what it reflects; the good ultraviolet energy is almost entirely reflected while almost all of the heat producing infrared energy is allowed to go straight ahead. This destructive heat energy is absorbed by a special structure mounted below the mirror, where cooling air can pull it out of the system.

The Shutter

Near to the second focus point, where the bundle of light rays have tapered into small area, a mechanical shutter is placed, to allow us to turn the light on and off under controlled conditions. This shutter uses a single blade, mounted in a simple mechanism, which is operated by a air cylinder. It provides a very rapid operational sequence to assure accurate timing.

The Integrator

After the bundle of light has passed the second focus and the shutter and has expanded out slightly, it enters an integrating unit. This optical device has the task of “mixing” the light within the bundle, so if there is any difference in the intensity at any given point it is leveled out. The way this is accomplished is by “copying” the light many times and superimposing the copied images on top of each other, with each copy slightly shifted out of position. The mechanism that performs this is a multi-lens array, popularly known as a “flies-eye” lens. The integration is a result of any “hot” spot being covered by many other images randomly placed over it.

The Expose Mirror

After passing through the integrator the light bundle expands out to cover the exposure area, and shortly before it reaches full size, another mirror, the “expose” mirror, turns the light downwards to the mask/substrate location.

The Field Lens

Because the light coming off the expose mirror is still expanding, the rays at the margin are traveling at an angle, slight just off the central axis, but increasing the further away they are. For smaller substrates, up to 100 mm in diameter, this angle is small enough to not be of concern.

For larger images, especially at the 150 mm maximum handled by the Q4000, this angle becomes important if small patterns are to be reproduced accurately. For the larger format aligners, a “field lens” is introduced just above the expose plane, to turn the rays into a more perpendicular direction.

Cooling

The expose system uses a lot of energy in producing the light necessary for good, short exposures. Unfortunately, not all of this energy goes into producing light— a great deal of it creates heat, which must be removed from the system for safety, comfort, and equipment longevity reasons.

The mercury short arc lamp depends on being maintained at a fairly critical temperature for optimum operation. Too hot and lamp life is shortened; too cool and light output suffers. To achieve this optimum operating temperature, a cooling fan draws cooler outside air across the exposed upper lamp terminal, and a small jet of high pressure gas is directed at the lower terminal, which tends to pick up energy reflected by the gathering mirror on its way towards the second focus point. These cooling effects are very carefully controlled by the design of the equipment, and by the factory setting of the cooling jet volume.

The path of the fan created air movement, controlled by the design of the entire lamp house assembly, also removes the excessive heat trapped by the heat passing first turning mirror and the physical enclosure of the lamp chamber. Care should be taken that no changes are made to the lamp system which might alter any of the air flow characteristics.

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	.2 MATERIALS FOR MAINTENANCE		
	.3 CLEANING TECHNIQUES		
	.4 LAMP ADJUSTMENT AND REPLACEMENT		
		.1 MICROSCOPE LAMP MAINTENANCE	
		.2 EXPOSE LAMP MAINTENANCE	
			.2 EXPOSE LAMP ADJUSTMENTS
			.2 EXPOSE LAMP REPLACEMENT
	.5 OPERATIONAL MAINTENANCE		
		.1 OPERATOR MAINTENANCE	
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11 MAINTENANCE

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11.0 MAINTENANCE

This section describes the tools, materials and techniques used to maintain the Quintel Q4000 Aligner in its optimum condition for high productivity and long, trouble free operational life. It also establishes schedules for various levels of preventative maintenance.

11.1 TOOLS FOR MAINTENANCE

In addition to the normal set of maintenance hand tools usually available, there are several items highly recommended for inclusion in the Q4000 tool kit.

For handling optics without getting finger prints on the optical surfaces light weight cotton gloves are recommended. An excellent low cost source for these are the disposable cotton gloves used by morticians.

SAFETY GLASSES

Whenever working around the mercury arc lamp to change the bulb or measure and adjust intensity levels it is recommended that minimal eye protection be worn. See Section 1.4 for a discussion on eye safety and for recommendations on safety glasses.

Finger cots- the “one finger rubber gloves” are also useful for keeping finger prints off and at the same time increasing the fingers holding ability.

SUPPLIES FOR CLEANING

Lens tissue for cleaning optics- try to get the type that looks “fibrous” rather than that with a smooth almost glossy surface. A good source for this material is a professional camera shop.

HAND PROTECTION

When replacing light bulbs they are very hot when first accessed, even after the recommended cool down period. The tool kit should have in it a pair of moderately heavy cotton gloves to allow touching hot lamp bulbs without getting burns and also to guard against broken glass in case a bulb disintegrates upon removal.

Cotton swabs- obtain the long shaft, single end type rather than the household short double end style.

Lint free “clean room” wipes.

Brushes- an assortment of small and moderate size artists brushes for moving chips of broken wafers and other debris away from critical areas. Look for both soft “camels hair” and stiff bristle types.

SMALL TOOLS

For general use around the aligner a very useful tool sometimes not available in general tool sets is the "Ball End" version of the hex drivers used for socket head screws.

For cleaning around aligners it is advisable to have some type of very small vacuum cleaner, suitable for use in a clean room environment.

TEST EQUIPMENT

There are two items of test equipment discussed in the set up portions of this manual, which should be available if the aligner is to be used for technically demanding production. These are

- The MASK DEFLECTION GAUGE, discussed in Section 10.4.4
- A ULTRAVIOLET LIGHT INTENSITY METER, discussed in Section 8.5

Refer to the Spare Parts listing Section 15, for ordering information on these essential tools.

11.2 MATERIALS FOR MAINTENANCE

Materials for maintenance are of two types- cleaners and lubricants.

Cleaners

The following cleaning agents are approved for use on various parts of the Quintel Q4000 Aligner. Use of any other cleaner, or grade of cleaner is not recommended.

Optical Surfaces: Laboratory Reagent Grade Acetone (Do not use paint thinner grade, which may contain trace oil);
Commercial Lens cleaner;
Grain alcohol denatured with acetone;
Isopropyl Alcohol 91%.

DO NOT use silicone treated glass cleaning tissues, or a glass cleaner containing wax, or abrasives.

Any bare Metal or lapped flat metal surfaces (This includes chuck tops, ball seats, etc.) Use either Acetone or Alcohol.

Painted Surfaces: Use normal spray type window cleaner such as Windex™.

Lubricants:

Because hydrocarbons of all types are very non-compatible with semiconductor manufacturing, the Quintel Q4000 is designed to operate in a basically "dry" mode, with no lubrication required on most of its mechanisms.

Where there is a sliding action required, a low pressure air film is introduced as a lubricant. In the few places where there is a rotating bearing needing lubricant, such as in the align gimbal assembly, a microscopic amount (a drop on the end of a toothpick) of a low volatility grease is used. A recommended material for this is DuPont DeltroX™, which is a space age synthetic, non hydrocarbon, lubricant.

11.3 CLEANING TECHNIQUES

Cleaning any critical surface requires a method which removes the dirt without damaging the surface. The following technique has been developed to accomplish this.

1. With a soft brush gently remove any dust or dirt particles on the surface. Compressed air (clean), if available, can be used, or a rubber bulb blower is an aid.
2. Wipe with lens tissue or a lint free cloth saturated with solvent. Use a circular motion starting at the center and winding out to the edge. Use a light touch, do not scrub.
3. With another cloth dampened (not saturated) with solvent repeat the pattern of wiping.

4. Repeat step 3 if necessary.

It is essential that the cloth or lens tissue be discarded after each use. The solvent will attract dirt in the first wash down which must not be carried back to the surface, and on the final damp wipes, the solvent will absorb moisture from the air and will gradually lose its ability to evaporate cleanly.

The size and bulk of the cleaning cloth should be adjusted to fit the size of the part being cleaned. A small optical element may require a piece of lens tissue wrapped around a cotton swab, whereas a large object may need several lens tissues wadded up together. A guide is that the quantity of solvent carried by the paper should be sufficient to stay damp until the surface wipe pattern has been completed, but not so damp that the solvent does not evaporate completely almost immediately after the paper has passed by.

Be careful in any cleaning operation that excess liquids do not drip off of the part being cleaned onto another lower down part, necessitating the cleaning of that part.

11.4.0 LAMP ADJUSTMENT AND REPLACEMENT

A frequent routine maintenance item is the adjustment and replacement of lamps; in the case of the Q4000 there are only two types of lamps requiring this attention— the microscope illumination lamps, rated at 1000 hours life or on an average once every 6 months, and —the mercury short arc ultraviolet exposure lamp, with an average life of 400 hours, resulting in a lamp change perhaps every 6 to 8 weeks. Both types of lamps need adjustment for optimum operation.

CAUTION:

All of the lamps used on the Q4000 are of a type requiring very careful handling: this note applies to both the microscope illumination lamps and the exposure illumination lamps. These lamps all operate at very high temperatures and contamination on their bodies must be avoided. It is very important not to get finger prints on the glass lamp body. Handle the lamp by the metal body or terminals only. IF YOU DO TOUCH THE LAMP BODY, CLEAN IT OFF WITH ACETONE OR ALCOHOL BEFORE COVERING IT OR TURNING IT ON. Oil from finger prints on the glass, when the lamp reaches operating temperature, can seriously weaken the glass and can result in premature failure.

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CAUTION:

The lamp units on the Q4000-4 aligner properly operate at a very high temperature. Before attempting to do any work on the lamp holder the lamp unit must be turned off and allowed to cool at least 10 minutes before handling, and even then, wear hand protection to touch any metal surfaces.

SEVERE BURNS MAY RESULT IF THIS WARNING IS IGNORED.

11.4.1.0 MICROSCOPE LAMP MAINTENANCE

11.4.1.1 MICROSCOPE LAMP REPLACEMENT AND ADJUSTMENT

VARI-VIEW Q4000-4

The lamp holder is removed from the finned optical housing by unscrewing the knurled knob on the side of the housing a few turns. The lamp holder with its power cord can then be removed from the housing.

The first step in replacing the lamp is to unscrew the knurled knob on the end of the plastic cover to remove the cover and the power cord from the lamp holder. With this cover off the two wires from the lamp can be slipped from under the contacts (*do not* loosen the screws holding the contacts down).

At the other end of the lamp holder remove the threaded shield from over the lamp. With this shield removed the old lamp is free to slip out of



the support. Notice the threaded nut on the outside of the lamp: this is what positions the lamp within the lamp housing. The new lamp must have its nut adjusted so it visually matches the position of the old one. Slip the new lamp in to the housing, with the wires through the hole.



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Before placing the lamp in place, wind the wires around a pencil in a neat coil to make them easier to work with. Replace the light shield and screw it down finger tight.

Gently slip the metal wires between the contacts at the back end of the housing, one on each

contact. Arrange the wires neatly and compactly so they will not interfere when the cover is replaced. Observe the orientation of the contacts inside the cover and align them with the wire contacts on the housing; there is only one orientation possible so everything lines up. Slip the cover in place and screw the knob down finger tight.



Replace the lamp holder in the optics housing and tighten the retaining screw into the small detent in the lampholder body.

ADJUSTING LAMP FOCUS.

If the lamp replacement instructions above are carefully followed the lamp replacement should operate identically to the original lamp. If, after changing a lamp, a degraded performance is observed, either as a shadow around the perimeter of the field or as a blurred image of the lamp filament across the field, it may be necessary to adjust the lamp position inside the lamp holder by adjusting the position of the hex

nut on the lamp body *slightly*. Move the nut only one turn at a time and evaluate the result carefully. You do not need to disconnect the wires to make these adjustments; simply remove the shield from over the lamp, adjust the nut and replace the shield. Remember that this shield gets very hot very rapidly, so make your evaluations quickly to avoid excessive cool down times between changes.

MAGNA-VIEW Q4000-6

To replace the microscope illumination lamp bulb on the Q4000-6, first pull both of the electrical connections out of their sockets, then loosen the small knurled screw on the side of the housing. By turning the lamp housing slightly the retaining key will align allowing the lamp holder to be removed. The lamp is a two pin self based lamp which can be grasped and pulled straight out of its socket. Remember the cleanliness warning when replacing the lamp bulb, and grasp the new lamp with gloves or a clean cloth to place it in the socket.

This lamp holder has adjustment screws on it to allow the centering to be compensated, since the socket does not provide for precision placement of the bulb within the housing. The lamp must be adjusted to eliminate any shadowing observed in the image area.



FIBER OPTIC ILLUMINATORS

The Video-View head, and Magna-View head when equipped with special adapters, make use of fiber optic illumination. In this system the lamps are placed in a remote location, and the light is conducted up to the viewing optics by means of a flexible fiber optic cable.



The source of the light in this unit is a lamp of the same type as the direct mounted units, with the exception that the lamp is mounted in a focusing reflector to direct most of the light into the end of the fiber optic cable, thereby increasing the efficiency of the light source. In replacing these lamps, the lamp/reflector unit is replaced as a whole.



Before replacing a lamp on this type of unit remember the warnings about operating temperatures. Access to the lamps is through a door on the top of the lamp housing. Because there are line voltage connections within this housing, always disconnect the light source power cord before working within the cabinet.

It is mounted in a special support with a ejection lever which can be pressed down to force the lamp out of the retaining springs. With the old lamp pushed up it can be grasped and removed and the new one slipped into the grooves and pressed down to its operating position. The electrical connections are automatically established when you press the lamp down.

The only adjustment required on this lamp unit is to turn the lamp on and observe that the lamp light is concentrated and centered on the input end of the fiberoptic bundle inside the housing. The position of the lamp holder can be adjusted by loosening the hold-down screws. Vertical position of the lamp is controlled by the insertion of the lamp into its holder.

At the output end of the fiber optic cable its position within the adapter into the aligner may be adjusted for optimum illumination.

11.4.2.0 EXPOSE LAMP MAINTENANCE

The Expose Lamp is key to efficient production on the Q4000. There are two phases to the maintenance of this part of the system:

An ongoing program of adjustment and monitoring of the output, and the replacement of the lamp when it no longer functions properly.

11.4.2.1 EXPOSE LAMP ADJUSTMENT

The adjustment of the expose lamp for uniformity has been discussed in Section 8.6. This procedure must be performed whenever the ultraviolet lamp is replaced, and should be performed on a routine basis to obtain optimum results in production.

11.4.2.2 ULTRAVIOLET EXPOSE LAMP REPLACEMENT

Replacement of the ultraviolet expose lamp should be performed on a regular scheduled basis. The replacement schedule for the expose lamp should be set by management, based on process requirements, and a good equipment performance evaluation routine.

The life of a mercury short arc ultraviolet lamp is defined by one of three events: failure to start (obvious need to replace), catastrophic failure (explosion!, obvious need to replace), and light output falling to 50% of the initial value (not so obvious, but from a process control standpoint, very necessary).

It is recommended that the Lab maintain a "Ultraviolet Lamp Log" to record the date of installation, initial operating voltage, current, wattage, and light intensity. If periodic performance readings are taken, they should be recorded. The power supply for the lamp has, on its front panel, a elapsed time meter, so running time may also be recorded. The time of replacement and reason should be recorded to complete the record. Such information is valuable in trouble shooting lamp problems.

11.4.2.1 REMOVING THE OLD LAMP

Remove the lamp house cover.

Rotate the lamp house assembly 90° to expose the inner portion of the lamp house.

Remove the anode lead of the arc lamp from the insulated post. Always use two wrenches, one on the nut closest to the porcelain insulator, to avoid any strain on the porcelain, in loosening the nut on the lead wire.

Holding the anode end of the arc lamp remove the nut holding the lamp to the manipulator.

Remove the arc lamp through the ellipsoidal reflector.

If you are replacing a lamp which has failed due to catastrophic failure, use the techniques above to remove the anode and cathode survivors. Use a small vacuum cleaner, brushes and wipes to remove the broken quartz from the lamp house. If any globules of metallic mercury are observed remove them by approved removal techniques (avoid contact with your skin). Obviously the quartz fragments are very sharp and they should also be avoided.



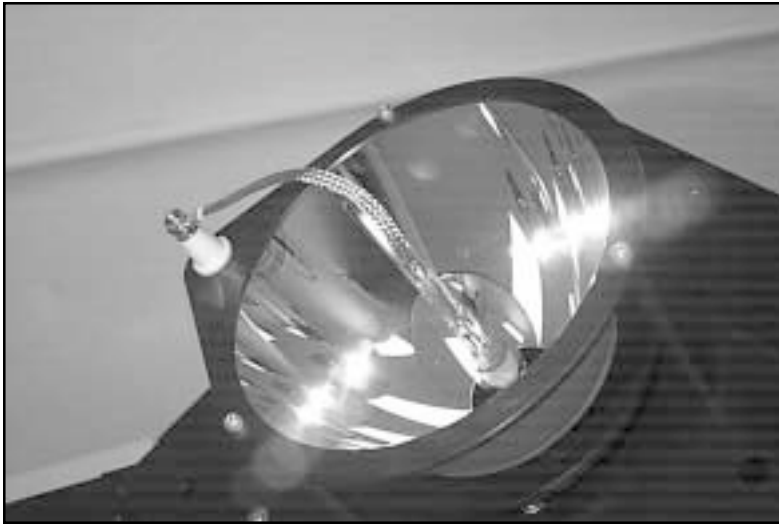
11.4.2.2 INSTALLING A NEW LAMP

To install the mercury arc lamp, use the following procedure:

- Remove the lamp house cover.

Rotate the lamp house assembly 90° to expose the inner portion of the lamp house.

Holding the anode end of the arc lamp place the arc lamp through the ellipsoidal reflector with the threaded stud through the support and fasten the cathode end of the lamp with the nut provided. Tighten to firm finger tight; tools are not necessary or recommended.



It is imperative that the anode end of the arc lamp always be installed *down* in the lamp house. Identification of the anode end is easy by observing any one of the following clues: the lamp should be marked with a "+" on the anode end, or there is a gold band around the lamp on the anode side of the enlarged portion of the bulb, or on Quintel supplied lamps, which utilize a flying lead on the anode end of the lamp to better control anode temperature, observe the

Caution:

Do not touch the quartz envelope (the enlarged portion) of the arc lamp when installing it. Touching the envelope will leave fingerprints which may damage the lamp or cause premature failure.) If the lamp is accidentally contacted carefully clean any contamination off with oil free solvent.

- Fasten the anode lead of the arc lamp to the insulated post. Always use two wrenches, one on the nut closest to the porcelain insulator, to avoid any strain on the porcelain, in tightening the nut on the lead wire.
- Visually position the arc lamp in the approximate center of the ellipsoidal reflector using the X axis (side) and Y axis (front) micro manipulator knobs.
- Rotate the lamp housing assembly back to its normal position.
- Swing the top door back into place over the top (cathode) terminal.
- Replace all external lamp house covers.

11.5 OPERATIONAL MAINTENANCE

Operational maintenance is the routine, day to day, maintenance required on a continuing basis to keep the aligner always working at its best. Much of this maintenance is intuitive, but it is always best to set up a system, with definite time intervals and job responsibilities for each task, to insure that things are not overlooked just because they are so routine.

11.5.1 OPERATOR MAINTENANCE

The operator's part of the maintenance program is primarily concerned with keeping the machine environment clean. At any time that physical contamination is apparent on or around the aligner the operator must take steps to remove it or see that it is removed, since this contamination is the main enemy of good product, high thruput, and long machine life. The operator must be very concerned with the machine interface with the product and production tools,

with the substrate supporting chuck, and the mask holder. The importance of the cleanliness of these surfaces cannot be over emphasized. Likewise the protection of these surfaces from physical damage must be a never ending concern; whenever these surfaces are exposed always avoid hitting them with forceps, scratching them with anything, or otherwise disrupting the flatness and smoothness which is vital to their proper functioning.

11.5.2 PROCESS ENGINEER MAINTENANCE

The Process Engineer is responsible for the way the aligner performs it's duties. His maintenance duties are mainly concerned with setting the operating parameters, light levels, exposure times, operating pressures, etc., and in verifying periodically, that the values determined to be

correct for the task at hand, are being maintained. If values are incorrect they must be adjusted on a timely basis or product quality will suffer.

11.6.0 ROUTINE MAINTENANCE

Routine maintenance is primarily concerned with general aligner well being. It is normally the task of the maintenance organization, and involves cleaning parts of the aligner normally not exposed in day to day operation (under covers), performing a visual inspection for parts exhibiting premature wear, physically checking that all electrical connections are tight, and generally looking into the hidden corners of the aligner for anything out of the ordinary

11.6.1 MAINTENANCE SCHEDULE

On the following pages are detailed schedules for the maintenance of the Q4000, broken down into the following categories:

As Required
Daily
Weekly
Monthly
Periodic (Semi annual, Annual)

MAINTENANCE SCHEDULES

TASK	PRIMARY RESPONSIBILITY	SECTION REFERENCE	DESCRIPTION
AS REQUIRED			
Clean mask holder	Operator	11.3, 11.6.3	When ever a mask change is required or if contamination is observed
Clean substarte chuck surface	Operator	11.3, 11.6.3	When ever contamination is observed
Clean contamination from aligner	Operator	11.3	When ever contamination is observed amd particularly after wafer breakage occurs.
Verify exposure time settings	Process Engineer	6.3	When changing jobs or whenever there is an interruption in the production process.
Replace/adjust microscope illumination lamps	Maintenance	11.4.1	As required by lamp failure
Replace exposure lamp	Maintenance	11.4.3	As required by lamp failure or light output decline or scheduled replacement

MAINTENANCE SCHEDULES

TASK	PRIMARY RESPONSIBILITY	SECTION REFERENCE	DESCRIPTION
DAILY			
All items of the preceeding section			
Observe and evaluate the performance of the aligner	Operator	11.6.6	This is the first line of defence against problems with the aligner.
Clean microscope eyepieces	Operator	11.3, 11.6.4	Normal daily maintenance item
Clean top of load tray	Operator	11.3	Normal daily maintenance item
Check the service loop on the chuck vacuum line	Process Engineer	8.1.2	Normal daily maintenance item
Using the manual expose command verify the functioning of the timer/shutter	Process Engineer	6.2.3	Normal daily maintenance item

MAINTENANCE SCHEDULES

[illegible]

MAINTENANCE SCHEDULES

TASK	PRIMARY RESPONSIBILITY	SECTION REFERENCE	DESCRIPTION
MONTHLY			
All items of the preceeding sections			
Clean all exposure system reflective surfaces	Maintenance	11.6.4, 11.4.2	Normal monthly maintenance items
Visually inspect the flys-eye lens for physical condition and contamination	Maintenance	11.4.2	Normal monthly maintenance items

MAINTENANCE SCHEDULES

[illegible]

11.6.2 REPLACING FUSES

Replacing the electrical fuses on the Q4000 is an infrequent requirement, and is most likely to be required during an extensive trouble shooting procedure when accidental overloads occur. The other triggering event is when a electrical surge overload from an external source, such as a power line overload from a lightning strike. (The Q4000 input circuit has surge protection but extreme cases may cause fuse or power supply damage)

The fuse holder for the Q4000 is a part of the power input device at the rear input panel. The removable input voltage selector tray is accessed by placing a small screwdriver in the notch and prying it out slightly. When fully removed this tray allows access, on alternate sides to either of two fuses. Depending on the voltage the aligner is configured to operate on, the fuse is either an international size fuse for operation on 220 volts, or a U. S. standard size fuse for 110 volts. Care must be taken to replace the fuse with an exact replacement, both in physical size and current carrying capacity.

Important:

If a fuse interrupts the power flow to the aligner during normal operation of the machine with no external event as a cause, immediate investigation by a qualified technician to determine the cause is necessary.



Visual inspection of the fuse will indicate the need for replacement; a good, intact fuse will exhibit a smooth, unbroken metallic strand from one end to the other in the clear body, whereas a “blown” fuse will usually show a cloudy smear on the inside of the body, or a noticeable gap in the metallic thread.



11.6.3 WORK HOLDERS

The work holders of the Q4000, the substrate support chuck, and the mask holder, are extremely precise devices, and must be carefully cared for to insure optimum performance. While these parts are manufactured with a very hard surface coating (approaching the hardness of a diamond), the metal under the thin surface coating is soft enough to be easily damaged through the coating. For this reason the parts must be continually guarded against mechanical damage, and inspected during use to detect inadvertent damage.

The surfaces of these tools, where they contact the product, are manufactured with very flat surfaces to properly support the product, and to permit vacuum holding of the product. Surface damage may disturb these tasks in two ways: the softer sub surface metal may be "raised" enough to raise the product in a local area, thereby creating a small "high pressure" spot, causing a dimensional defect in the product. Or it may create enough of a "out of contact" area to cause a break in the vacuum hold down.

The contact surfaces of both tools must be kept absolutely clean to insure proper operation. Transferred specks of photo resist are a constant threat which are easily controlled with a routine cleaning. A lint free wipe slightly dampened with an appropriate solvent should be used periodically on the substrate chuck. Every time a mask is placed in the aligner the mask holder should be wiped down, and the surface of the mask carefully inspected for dirt or smears on both sides, and cleaned if necessary.

11.6.4 OPTICS

VISUAL OPTICS

The maintenance of the visual optical system of the Q4000 is mainly a matter of keeping the optical surfaces absolutely clean. Visual acuity is easily impaired by surface dirt, and just as easily maintained in an optimum condition. Surface dirt on optics derives from two sources, neither of which can be completely controlled; atmospheric contamination causes an overall surface “film” to develop gradually, even in a carefully controlled environment such as a clean room, and whenever there is a human interface, such with the eye pieces of a microscope, there is inadvertent transfer of body oils to the viewing surfaces. Both of these cannot be controlled, but can be easily removed with routine cleaning.

EXPOSURE OPTICS

The maintenance of the efficiency of the exposure optical system again is primarily one of cleanliness, although there is an additional service life factor with the components of the system.

The reflective and transmissive surfaces of the exposure system are subject to the same atmospheric filming as the visual optics, and must be periodically cleaned for the prevention of a degrading buildup.

In addition, the reflective surfaced subjected to the intense heat and radiation of the lamp, the ellipsoidal reflector and the first turning mirror, are subject to a gradual degradation of the reflective efficiency. This change is very slow and gradual, and in many cases is not a factor for years of operation. In the case of very critical work, requiring high energy levels, it is a factor in maintaining the system in optimum condition. The only solution to this problem, if it becomes a factor, is the replacement of these optical components.

These two components are also exposed to the damaging effects of the rare but not unknown catastrophic failure of a lamp. Because of the extreme pressures within the lamps at operating condition, the failure of a lamp is a minor explosion, with the lamp envelope disintegrating into small high velocity shards. These particles inflict severe damage to the optical surfaces, but surprisingly, this visually noticeable damage causes very little degradation in the performance of the system. It is, again, only the very critical usage which will require the replacement of these optical components after a lamp failure.

11.6.5 CLEANING VACUUM LINE FILTERS

The Q4000 utilizes vacuum locking and holding in several locations. This locking and holding is accomplished by applying a vacuum to the interface between two parts which normally move in relation to each other; with the ambient air pressure removed from the interface, atmospheric pressure presses the two parts together, preventing movement.

Because absolute sealing of this interface is not possible (or even desirable, because we want the parts to move easily when we remove the vacuum) there is a certain amount of leakage present. This leakage creates an “open” vacuum system, which can attract small dirt particles. To prevent an accumulation of this dirt, which could cause operational malfunctions, each vacuum line is equipped with a small plastic in line filter. The filter element is a small disc of ultra fine wire mesh screen.

This screen must be inspected and cleaned periodically to insure that it is not blocking the

vacuum from the mechanism it is protecting. The two halves of the filter unit may be unscrewed to allow access to the screen. Carefully remove the screen and lay it flat on a piece of paper. With a fine, stiff brush remove the accumulated dirt, then, moving the brushed screen to another piece of paper blow it off with a low pressure air jet repeatedly from both sides. Be careful not to bend or kink the screen; it needs to be flat to seat properly.

If the screen has been contaminated with moisture or oil, or deformed in any way it should be replaced.

Reassemble the filter carefully and reinstall it in its vacuum line.

These filters will be found in the align gimbal lines (2 places), the scan lock line, the mask lock and mask clamp lines, and the line feeding the substrate chuck top.

11.6.6 OBSERVATION AND EVALUATION

The most powerful tool in the preventative maintenance tool box is the continual, conscious, observation of the performance of the aligner by those who are in every day contact with the aligner. When properly installed, and initially set up for operation, the aligner provides an excellent “bench mark” against which the day to day operation of the instrument may be measured. At the start of each day's work the Process Engineer and the Operator should perform a mental “check list” on how everything is performing, noting even subtle changes in a daily

log book. The Maintenance personnel will find this an invaluable tool in detecting long range trends which may be a clue to problems easily corrected when small, but more serious if left to develop. The people who work on and around the machine every day are the most likely to spot these clues, so be aware of your equipment, and evaluate its performance on an on going basis.

11.7 PERIODIC MAINTENANCE

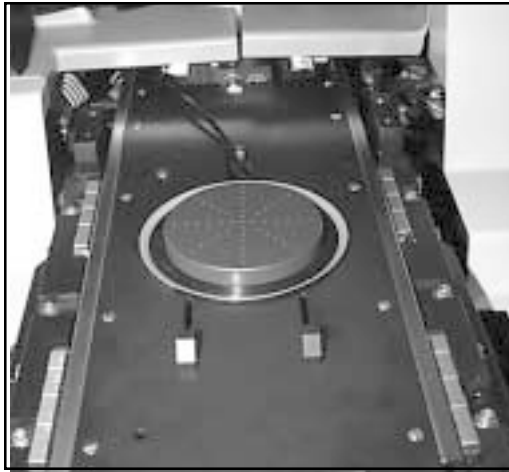
Long term periodic maintenance, which entails removing all of the machine covers, inspecting the details of the operational system, and cleaning and adjusting the mechanisms such as the align gimbal system, should only be undertaken by personnel who have undertaken advanced factory training, or by Quintel factory Field Service personnel.

11.8 AIR BEARING GUIDE SET MAINTENANCE

The Quintel Air Bearing Guide Set, which provides the critical and essential Z axis movements to the substrate, is at once the most complex and precise part of the aligner, and the most reliable and trouble free unit. As long as its requirement for absolutely clean and dry high pressure air is met, the guide set will provide years of operation without service.

Because of the need for special assembly tools and a very complex and unforgiving assembly procedure, the guide set does not lend itself to field maintenance. Quintel does provide factory training which qualifies customer personnel for the replacement of the two elastomer components which are subject to operational wear, but even this extensive training does not qualify personnel for further disassembly of the unit. Any disassembly of the unit, under any circumstances, voids the factory warranty on the unit.

Recognizing the critical nature of this part of the aligner, Quintel offers a number of time saving options for the repair or rebuilding of a guide set with a problem. If your unit is established to have a problem requiring factory service, please contact Quintel for information and instructions. Each of these options involve the removal of the problem unit and the reinstallation of another. The procedure for the removal of the guide set is as follows:

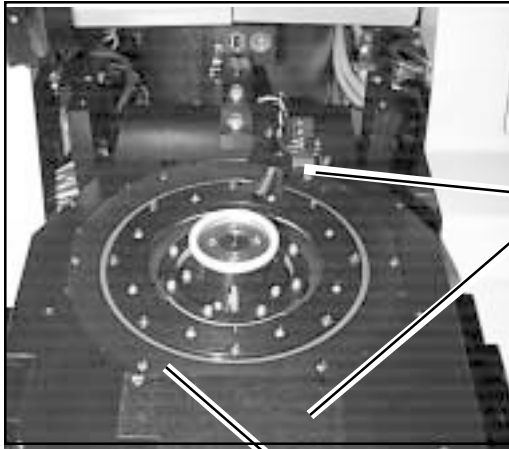


Guide Set Removal:

1 Remove the Mask Holder Assembly and the Wafer Chuck.

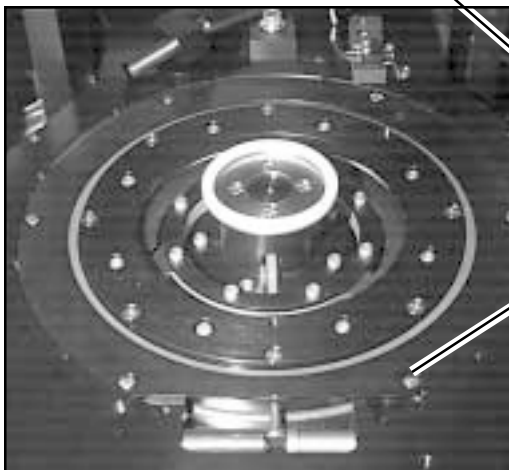
2 Remove the Tray Load Assembly: Disconnect the chuck vacuum feed hose. Remove the forward Tray Stop by accessing its screw through the hole in the top of the tray with the tray in. Remove the left and right Tray Guide Rails from the top stage plate

3. Disconnect the five quick disconnect pneumatic fittings from the bottom of the Guide Set assembly. These are located under the aligner base plate



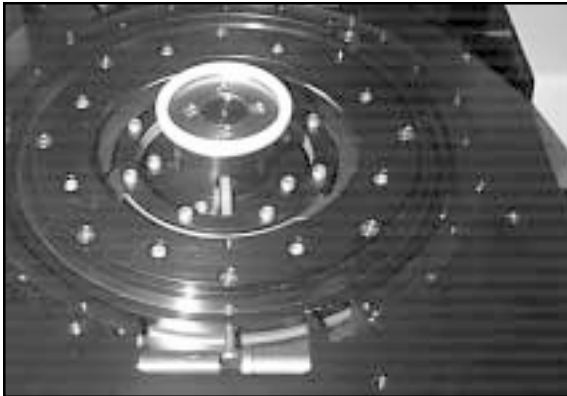
4. Remove the Chuck Rotation Cover and Chuck Motion Sensor Mount

5. Back the theta rotation micrometer up to relieve the pressure on the rotation lever on the guide set.



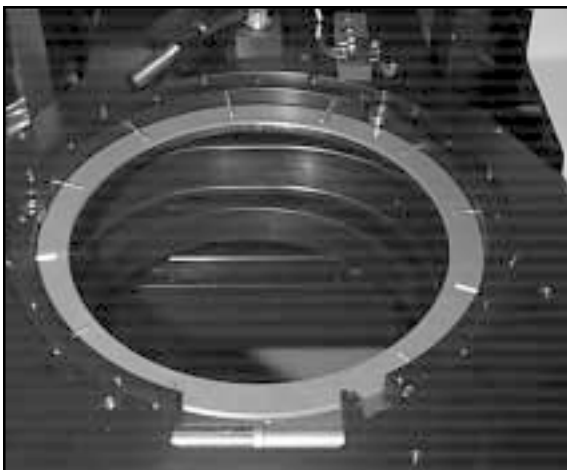
6. Remove the Bearing Retainer, the Ball Retainer and the twelve 1/8" diameter precision balls

7. Carefully remove the Bearing Block and Bearing Block Spring



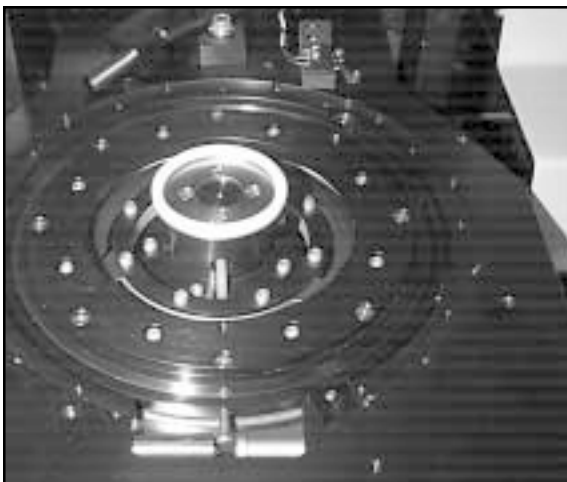
8. Lift the Guide Set assembly straight up from the Stage assembly. Try not to disturb the bearings that are under the Guide Set assembly

9. If the Guide Set is not going to be immediately replaced: Remove the Thrust Bearing Retainer and the 11 Roller Bearings from the Upper Stage Plate



INSTALLATION:

1. If they had been removed: Install the Thrust Bearing Retainer and 11 Roller Bearings. Orient the Retainer as shown in the photo.



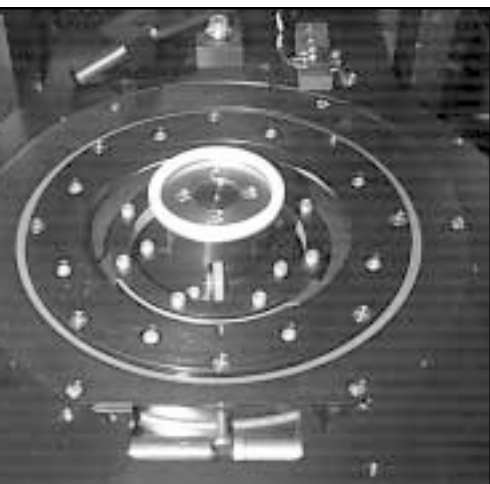
2. While holding the Theta Return Plunger, carefully install the Guide Set assembly in the Stage assembly. Try not to disturb the Thrust Bearing Retainer. The Guide Set must sit flat relative to the stage. If it doesn't sit flat the bearings have been disturbed and must be reinstalled.

3. Install the Bearing Block and Bearing Block Spring. See the diagram for correct orientation of Bearing Block and Spring.

CAUTION: The bearing in the Bearing Block is fragile. Do not crush the outer race of the bearing.

4. Install the Ball Retainer, the twelve 1/8" Diameter Precision Balls and the Bearing Retainer on the Stage assembly. See the photo for the correct orientation of the Ball Retainer.

NOTE: Do not over tighten the bearing retainer screws. If these screw are too tight, the Theta Return Plunger will not function properly. Check the Theta Return plunger operation.



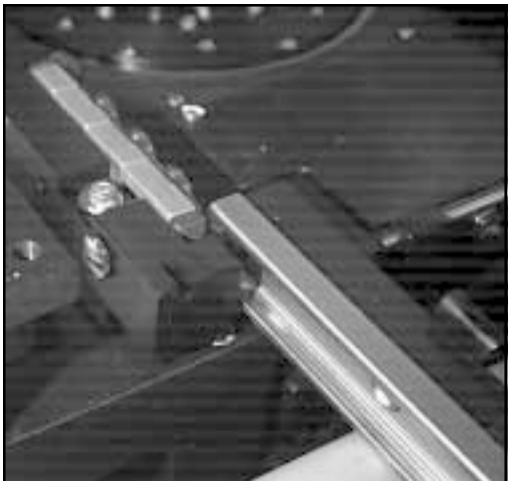
5. Install the Chuck Rotation Cover and Chuck Motion Sensor Mount.

NOTE: The Chuck Motion Sensor must aim at the center of the Guide Set Piston.

6. Connect the five quick disconnect pneumatic fittings from the bottom of the Guide Set assembly. Ensure that the colors match.

7. Install the Tray Load Guide rails.

NOTE: A Tray Load Guide Rail Alignment Tool is supplied with a replacement Guide Set assembly for field installation. This tool must be used to insure that the Tray Load assembly is adjusted so the chuck seats properly in the tray. To accomplish this, the Rear Tray Stop may also need to be adjusted. Full instructions for the use of this alignment tool accompany it.



8. Instal the Load Tray. Be careful to not fold the dust wipes when sliding the Tray into the Tray Guide Bearings.



9. Install Mask Holder assembly and Wafer Chuck.

9 TROUBLESHOOTING	.0 INTRODUCTION		
	.1 TECHNIQUES		
	.2 MECHANICAL		
	.3 ELECTRICAL		
	.4 PNEUMATIC		
	.5 CONTROL		
	.6 PROCESS		
		PRINTING PROBLEMS	

12 TROUBLESHOOTING

12.0 TROUBLESHOOTING

This section discusses the basic principles involved in analyzing a problem when the aligner does not function properly. The Q4000 is designed to make it easy to detect a fault, to follow it back to its origin, and to repair defects by replacing a subassembly rather than

component parts. The aim of the system is to get the aligner “back on line” as quickly as possible, using common sense rather than high technical skills to effect the repair.

Important:

The procedures suggested in this section should not be attempted unless the personnel involved have attended a Quintel conducted training session. Any disassembly by others will automatically void the machine's warranty.

12.1 TECHNIQUES

There are some basic rules to correcting a problem with the Q4000. The first and most important is to adopt a analytical frame of mind. Every problem starts with a false result observed in the use of the instrument. The initial step in correcting the problem is to accurately analyze the cause of the fault. This may involve several steps since the control system and mechanical components are interlocked in a complex network.

To give a example, let us analyze a simple

Problem: No exposure takes place

Question: Is the expose lamp on?

Answer: No– investigate why not.

Yes–

Question: Does the shutter open? Use the control system to try manually opening the shutter.

Answer: Yes– suggests that the fault may be in the automatic control system. Check timer settings, etc.

No– is problem pneumatic? Disconnect the hose going to the shutter and follow the pneumatic evaluation procedure. If the results are negative, go on to the electrical procedure. If the results are still negative, we need to investigate the mechanical aspects of the shutter. If the electrical signal is getting to the solenoid valve, which is turning the compressed air to operate the shutter, and the shutter is not opening, why not?

This is a very much simplified example, but demonstrates the logical approach to trouble shooting recommended for solving problems on the Q4000.

Another cardinal rule for trouble shooting is: make it a rule to always do only one thing at a time. Many times it is easy to change two things at once, and if the problem disappears, we do not know which fixed the problem, or worse something else fails, resulting in two interrelated problems to fix, with no real knowledge as to cause or effect.

The "Do one thing at a time" is of extreme importance in solving mechanical problems. If a mechanical assembly has failed, it is important to do any disassembly very cautiously, analyzing interrelationships at each step of the way, to determine why the failure occurred, what parts are at fault, and what steps should be taken to avoid a repeat of the failure.

12.2 MECHANICAL

The mechanical systems utilized in the Q4000 are, with two exceptions, simple and straight forward. Visual inspection will almost always reveal the cause of a malfunction and suggest the correction necessary.

The first exception is the alignment stage assembly. Because of the sequential assembly required for this unit, it is not recommended that customer facilities personnel attempt any disassembly or adjustment of the bearing system used in this assembly. The structure of the stage assembly is open to visual inspection by removing the surrounding covers, and may be checked for dirt or foreign objects which are obstructing free movement.

The second exception is the Air Bearing Guideset. This assembly is extremely complex and should **never** be worked on by anyone but a Quintel Factory Representative. In case of a malfunction, contact the factory to arrange for an exchange unit to be installed in your aligner. This unit is extremely reliable and probably will never need any service, but the precise techniques required to satisfactorily assemble it, plus the special tools necessary, preclude other than factory service.

12.3 ELECTRICAL

There are two electrical systems in the Q4000. The AC System, which supplies the primary power to the two DC power supplies and the lamp transformer at 120 or 240 volts is fully enclosed and shielded. The enclosures should only be removed by trained and experienced electrical service personnel, and only if preliminary trouble shooting reveals a problem with the primary supply system.

The output of the microscope lamp power transformer is at 7 volts. This power is conducted up to the optical head by way of the circuit breaker on the Regulator Panel, and the brightness control rheostats on the top left panel.

The DC power system is at 24 volts.

Normal circuit tracing with a ohmmeter will normally provide the necessary diagnostics to solve any electrical problems.

12.4 PNEUMATICS

Trouble shooting the pneumatic system is aided by the inclusion of several operating condition indicators.

Each solenoid valve has built in to it a manual operator: by pressing the small button at the top of the housing the valve may be made to operate without power to evaluate its output effect.

Built in to the valve is a LED indicator to indicate whether power has reached the solenoid from the control system.

The solenoid driver board, which connects the valves to the control system, also has an LED for each valves circuit, as a further check on the control circuit.

By following the interconnecting hoses, aided by their unique colors, and observing gas flow at

12.5 CONTROL

The control system, operated by the PLC, is at once the most complex portion of the Q4000 to trouble shoot, and because of the tools built in to it one of the easiest to evaluate.

In the Main Menu, select 5 "Maintenance," then 3 "Testing," then 1 "Single Step." When placed in this mode the aligner operates just as normal, except, instead of moving through the operating sequence automatically, it moves only one step at

a time, whenever the operator presses the "+" button on the control panel. This allows the evaluation of each step, with its valve operation, indicator light operation, or physical manifestation to be evaluated for correctness, before moving on to the next step.

12.6 PROCESS

The trouble shooting of process problems is the most difficult. Many of the problems encountered in evaluating these results are a direct result of the almost infinite number of variables affecting the end product. One of the major problems facing the aligner support personnel is the tendency to place the responsibility for true chemical, physical, or environmental process problems on the mechanical aligner. While some of these problems may be related to aligner related work holding, process chamber, or exposure light conditions, a careful evaluation must be made to

COMMON PRINTING PROBLEMS

determine that it really is the aligner that needs help.

The following is a brief check list of common process related problems and possible causes:

SYMPTOM

PROBABLE CAUSE

- | | |
|--|---|
| 1. Center of wafer "Good" - edges poor | a. Wafers warped.
b. Resist build-up on edges
c. Chuck not flat - high center.
d. Purge too low |
| 2. Center of wafer "Bad" - edges good. | a. Thick resist in center.
b. Resist build-up on back side edges.
c. Concave wafers.
d. Chuck not flat -low center.
e. Excessive mask bow.
f. Purge not adequate - oxygen effect. |
| 3. Poor contact - all over. | a. Pillow pressure delay too long
b. No purge.
c. Wrong exposure.
d. Dropping out-of-contact.
e. improper (soft) bake.
f. Dirty mask and/or wafers.
g. Exposure system needs adjusting. |
| 4. Corners closing in and bridging effect. | a. Over exposure.
b. Out-of-contact.
c. Inadequate purge and resist is lifting. |

5. Mask "Run out" images are equally misaligned in outward direction or inward direction

- a. Error in dimensional accuracy of mask, deflected during mask contact printing.
- b. Piston pressure too high
- c. Pillow pressure too high.
- d. Wafers too small in relation to exposure opening in mask holder.

6. Resist scratching, mask shows no pick-up
- caused during alignment.
- particles remaining.

- a. Separation between mask/wafer not enough
- b. Soft resist sticking to mask during contact
- c. Poor chuck leveling.

7. Misalignment in printing.

- a. Vacuum on chuck insufficient to hold wafer.
- b. Lock ring hanging up.
- c. Vacuum on alignment hand disc not holding.
- d. Mask vacuum not holding, mask moving.

8. Line widths oversize

- a. Underexposed in negative resist.
- b. Overexposed in positive resist.

9. Line widths undersize

- a. Overexposed in negative resist.
- b. Underexposed in positive resist.
- c. Warped wafers.
- d. Separation delay too long and operator tries to align before separation occurs.

13 FACTORY SUPPORT	.0 GENERAL		
	.1 WARRANTY		
	.2 INSTALLATION		
	.3 TRAINING		
		.1 ON SITE TRAINING	
		.2 FACTORY MAINTERNANCE TRAINING	
	.4 TROUBLE SHOOTING		
	.5 ON SITE MAINTENANCE		
	.6 MAINTENANCE CONTRACTS		

13 FACTORY SUPPORT

13.0 FACTORY SUPORT

It is Quintel's policy to make available to purchasers of Quintel equipment factory support at all levels necessary to keep the equipment operating in optimum condition.

Initially there is a generous factory warranty, including installation support and virtually unlimited telephone support during the warranty period. Also offered are training programs, expert field service, and overnight shipment of spare parts.

13.1 WARRANTY

Quintel offers a one year warranty on the Q4000 Mask Aligner, excluding only parts which appear on the consumable spare parts list . During this period if any defect in manufacture, assembly, or component part appears Quintel will expeditiously correct the problem.

13.2 INSTALLATION

It is recommended that the services of a Quintel Field Service Technician be utilized to perform the installation and initial setup of the aligner. Assuming that the preliminary site preparation is complete and the aligner has been uncrated and

placed at or near the final location, the installation will be completed during the first day's activities. The second day will complete the initial setup of the aligner, and permit some setup and operation training. Additional training may be scheduled; see "Training" below.

13.3 TRAINING

Quintel's field service technicians are highly trained in teaching the setup, operation and maintenance of aligners. The training programs are tailored to fit the needs and skill levels of the customer and his personnel. The two major options are discussed in the following sections.

Contact the Quintel Sales Office for additional information regarding planning, scheduling and costs for a training program to fit your needs.

13.3.1 ON SITE TRAINING

On site training, in which a Quintel representative travels to the customer's facility and conducts a multi-day training program in the customer's work place, is effective when a number of customer employees are to be trained. An example of this would be training setup and maintenance personnel covering a multi shift operation, where scheduling many people out of

the plant at one time would be prohibitive both from a travel expense and a schedule standpoint. The disadvantage to this type of training is that it of necessity must be mostly lecture and discussion, rather than hands on, because the only aligners available are production machines, not readily available for student use.

13.3.2 FACTORY MAINTENANCE TRAINING

Factory training, in which customer personnel travel to the Quintel facility for training, offers an ideal training environment. The training is conducted in the manufacturing area, so lectures and discussions can be supplemented and reinforced by moving to the assembly floor and actually performing the operations under discussion. A much broader grasp of the care of the aligner is possible in a shorter time using this technique.

Quintel training of key personnel is highly recommended, to get the most out of your Quintel alignment equipment.

13.4 TROUBLE SHOOTING

In case of a problem with your Quintel aligner, often the quickest solution is to take advantage of the telephone trouble shooting capabilities which are normally available during business hours (7:00 AM to 5:00 PM Pacific time) at the Quintel factory. It should be emphasized that the person making the call must be knowledgeable

about both the aligner and the current problem for the call to be effective. Full information regarding the model aligner and its configuration must be supplied.

13.5 ON SITE MAINTENANCE

If a problem with the aligner is beyond the abilities and/or training of customer personnel, it is possible to schedule on site maintenance by highly trained Quintel Field Service personnel. Please contact the Quintel Sales office to discuss schedules and costs.

If a service trip is scheduled, the nature of the problem will need to be thoroughly discussed to insure that the field service technician will be prepared with the proper spare parts to efficiently correct the problem.

13.6 MAINTENANCE CONTRACTS

The most effective method to insure continuous, top level, production from your Quintel aligner, is to establish a maintenance contract with Quintel, so that on a regularly scheduled basis the machine is cleaned, checked, and adjusted to factory specifications. The preventative maintenance performed under this program will extend the overall life of the aligner, and insure maximum throughput.

These contracts are generally set up on an annual basis, with the frequency of the visits negotiated after a discussion of operating schedules, technical requirements of the product being processed, and skill levels of the personnel performing interim maintenance.

Contact the Quintel Sales Office for additional information regarding planning, scheduling and costs for a service contract to fit your needs.

14 SCHEMATICS			
	.1 ELECTRICAL		
	.2 PNEUMATIC		
	.3 LOGIC		

14.0 SCHEMATICS

This section contains complete schematics for the control systems for the Q4000. They are divided into three groups, electrical, pneumatic, and control logic.

14.1 ELECTRICAL SCHEMATICS

Refer to Section 10.2, Electrical Theory of Operation, for additional information

14.2 PNEUMATIC SCHEMATICS

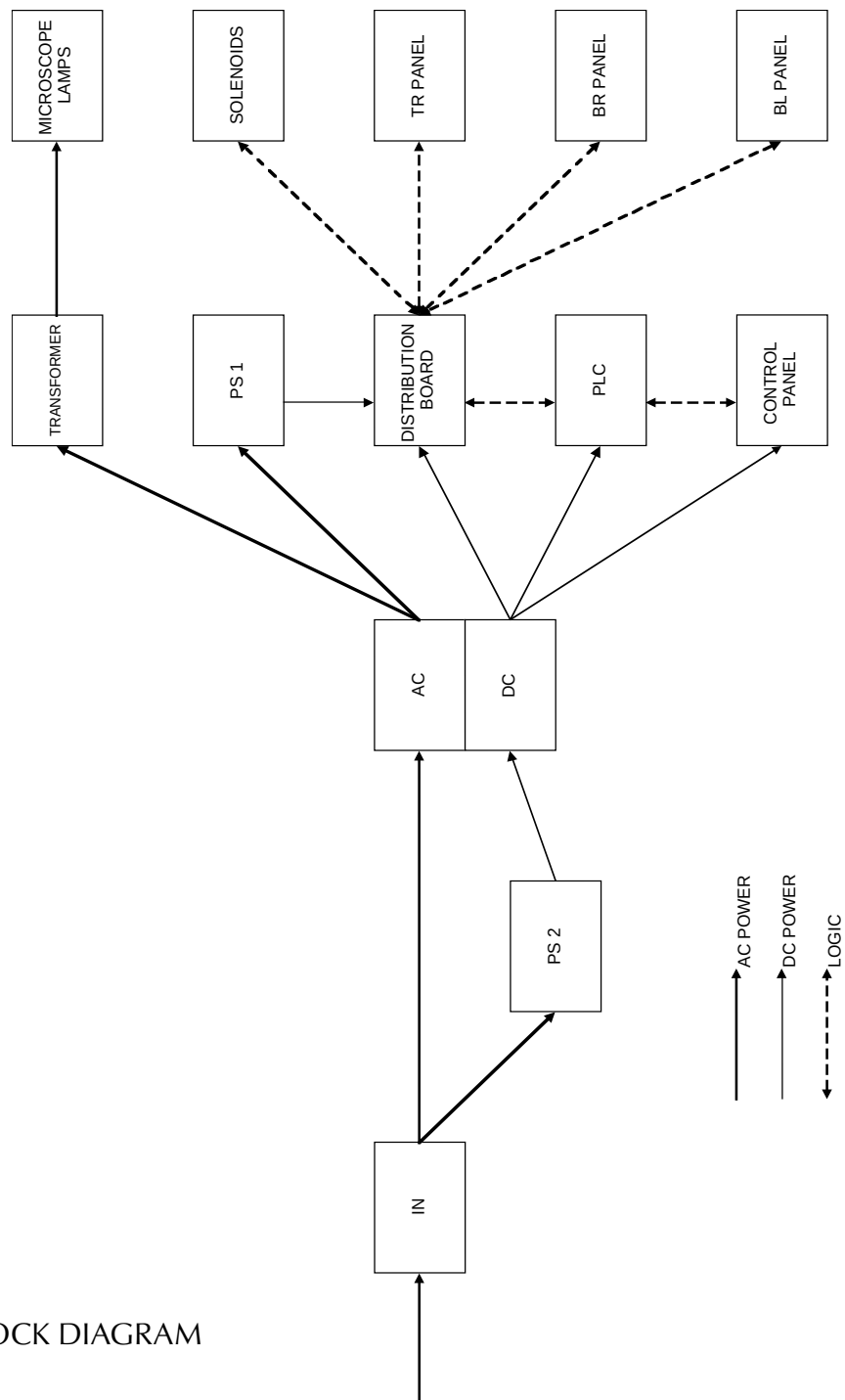
Refer to Section 10.1, Pneumatic Theory of Operation, for additional information.

14.3 CONTROL LOGIC SCHEMATIC

Included here is a Master Timing Diagram, which describes the complete operation of the aligner in terms of on/off conditions at each step.

Refer to Section 6.2, The PLC Control, for additional information.

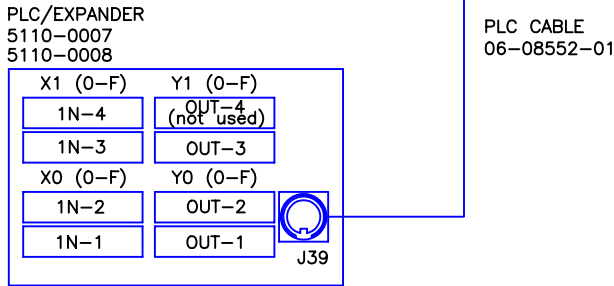
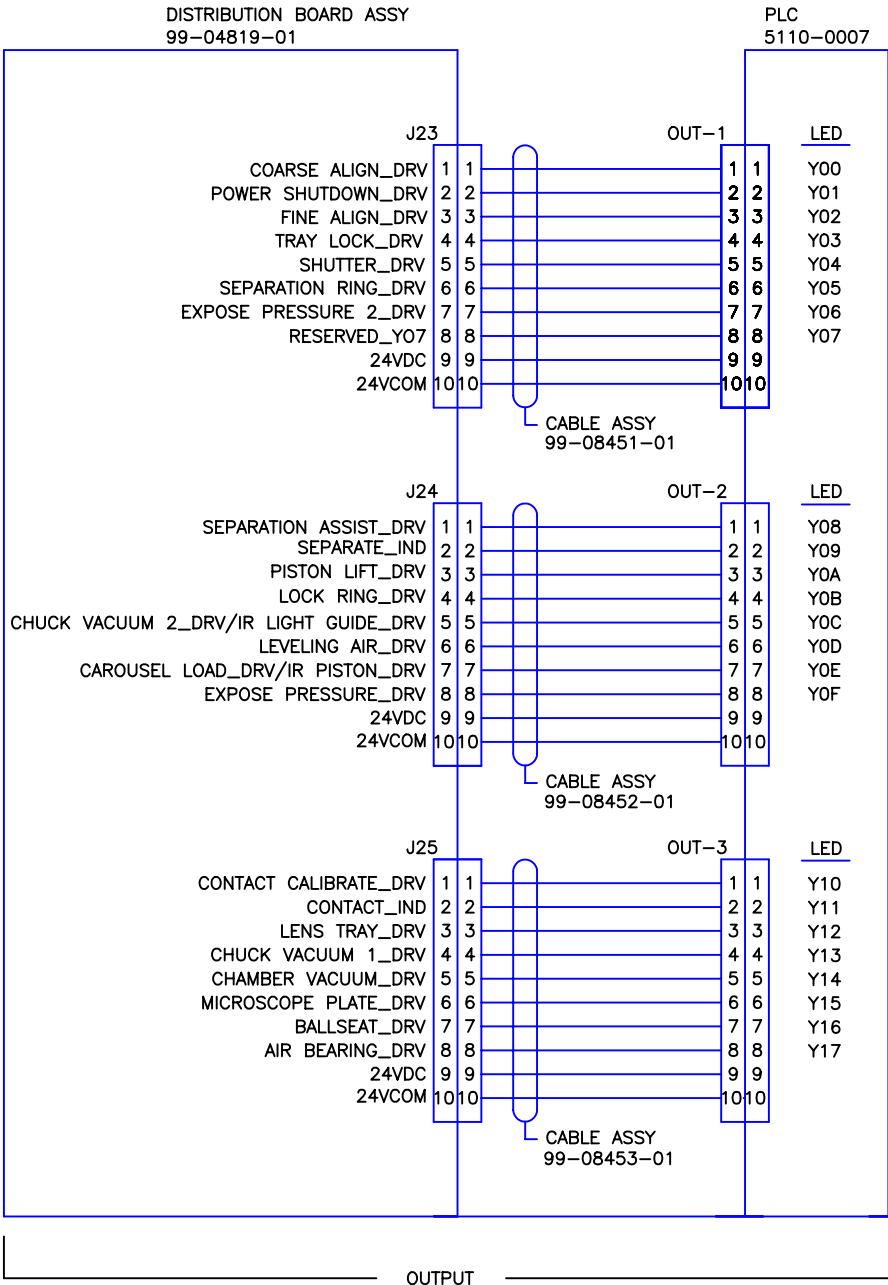
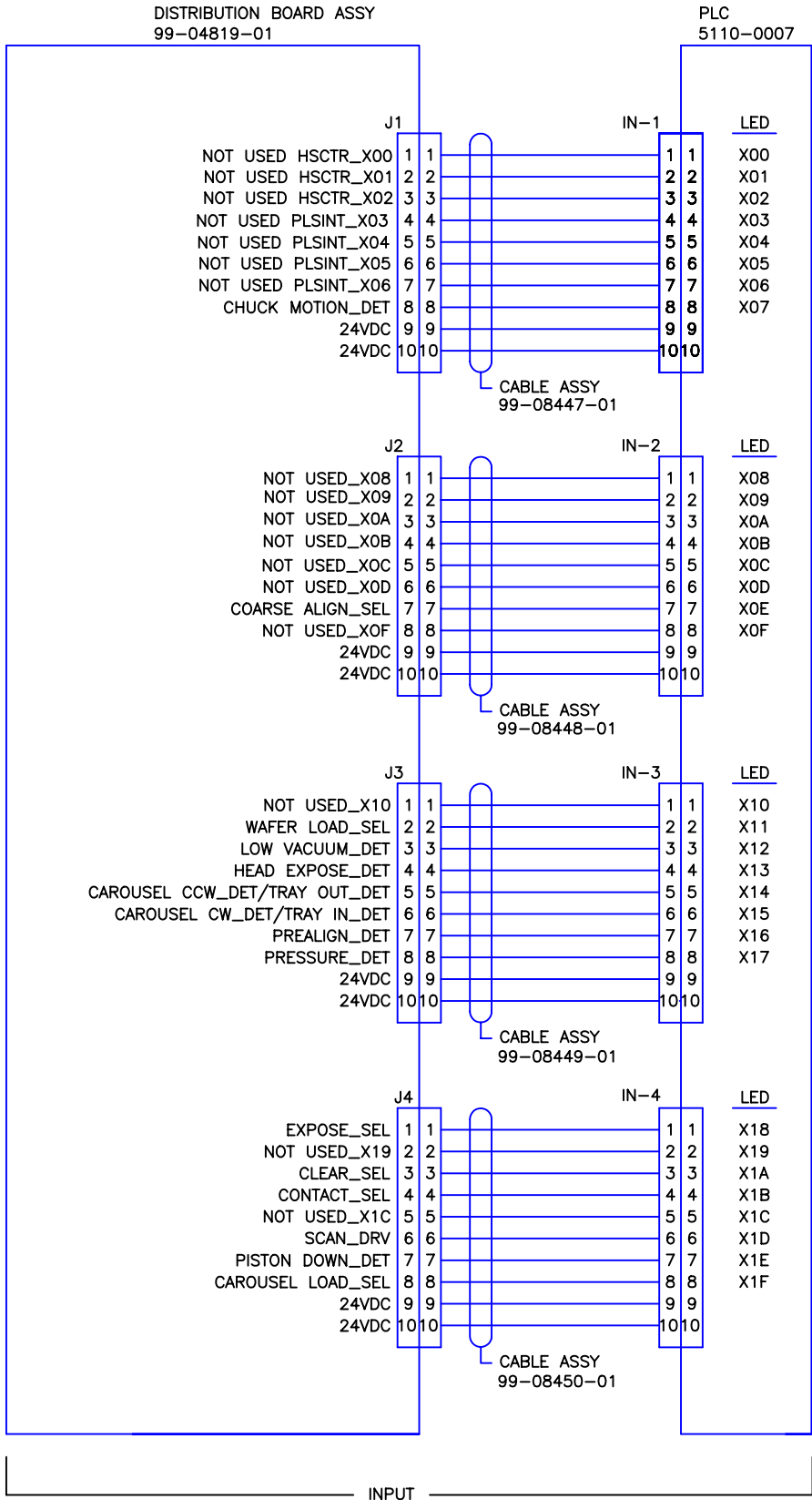
14.1 ELECTRICAL SCHEMATICS



NOTES, UNLESS OTHERWISE SPECIFIED:

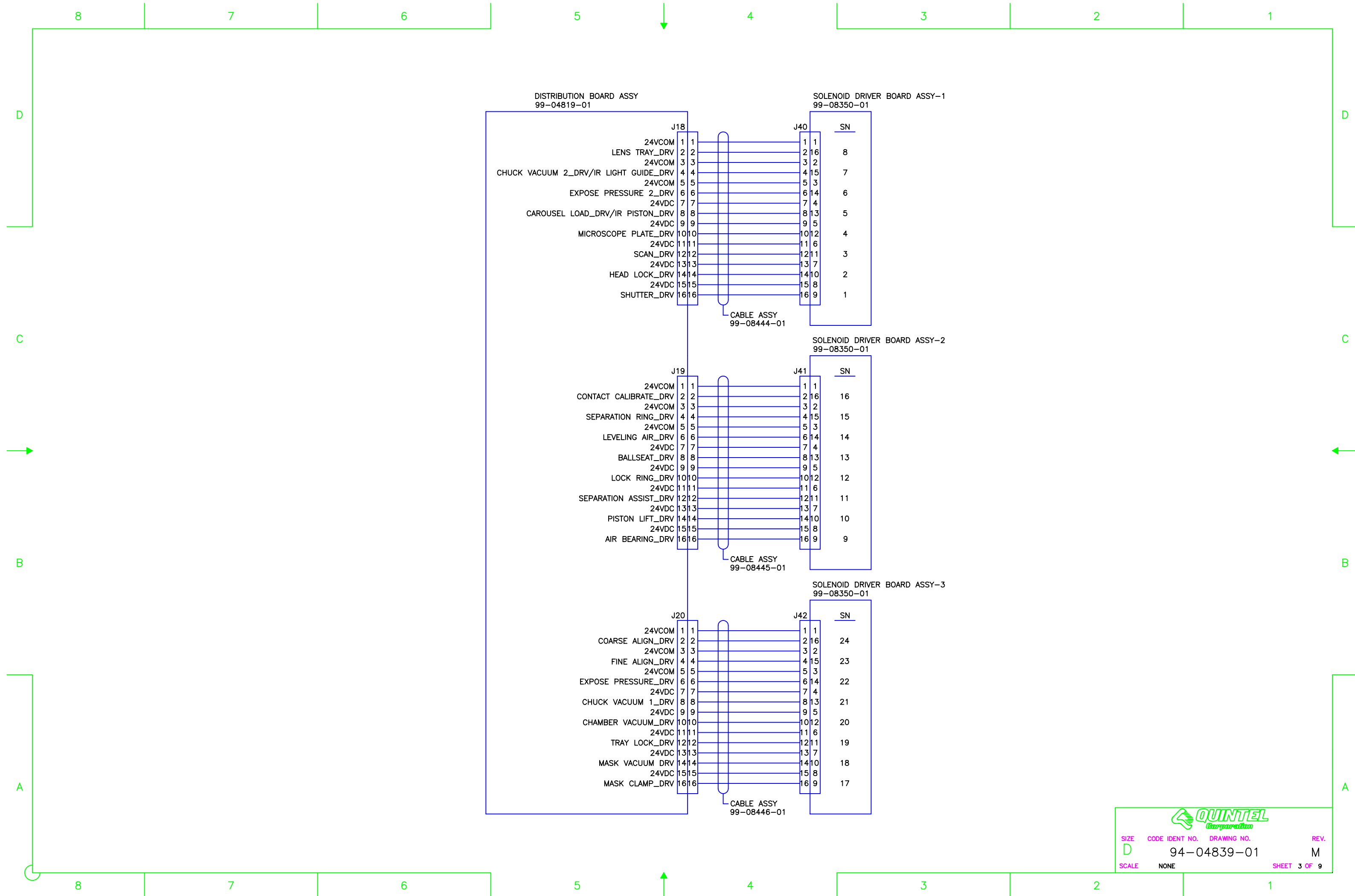
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2. - SURFACE ROUGHNESS $\sqrt{63}$

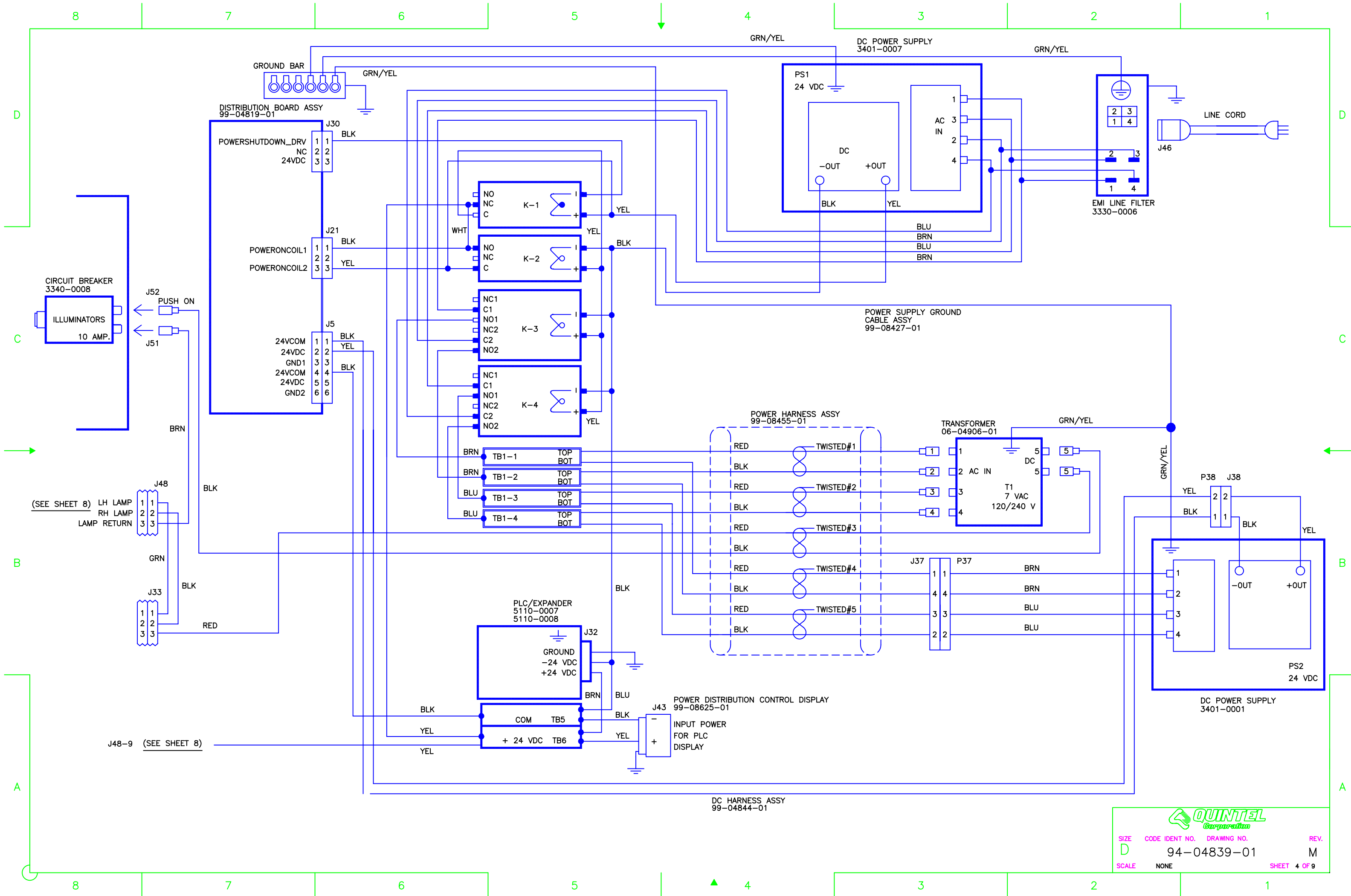
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A		INITIAL RELEASE	2/28/98	S.U.
B	00494	PRODUCTION RELEASE	5/14/98	S.U.
C	00584	P36/J36 was J38/P38, J37 was P37 P37 was J37	7/6/98	S.U.
D	00647	UPDATE DWG PER REDLINES	8/4/98	S.U.
E	00697	PER REDLINES	8/31/98	S.U.
F	00796	PER REDLINES	10/13/98	S.U.
G	00874	PER REDLINES	12/7/98	S.U.
H	01112	PER MFG REDLINES	5/18/99	S.U.
J	01139	ADDED 3 ZONE (C1) ON FOOTSWICH	6/4/99	S.U.
K	01444	PER REDLINES	3/28/00	S.U.
L	01737	REVISED SHEET 9 ASSY # 99-08666-01	6/27/01	S.U.
M	02122	CHANGED J6 AND J12 FOR F.O. SENSOR	5/12/04	K.S.

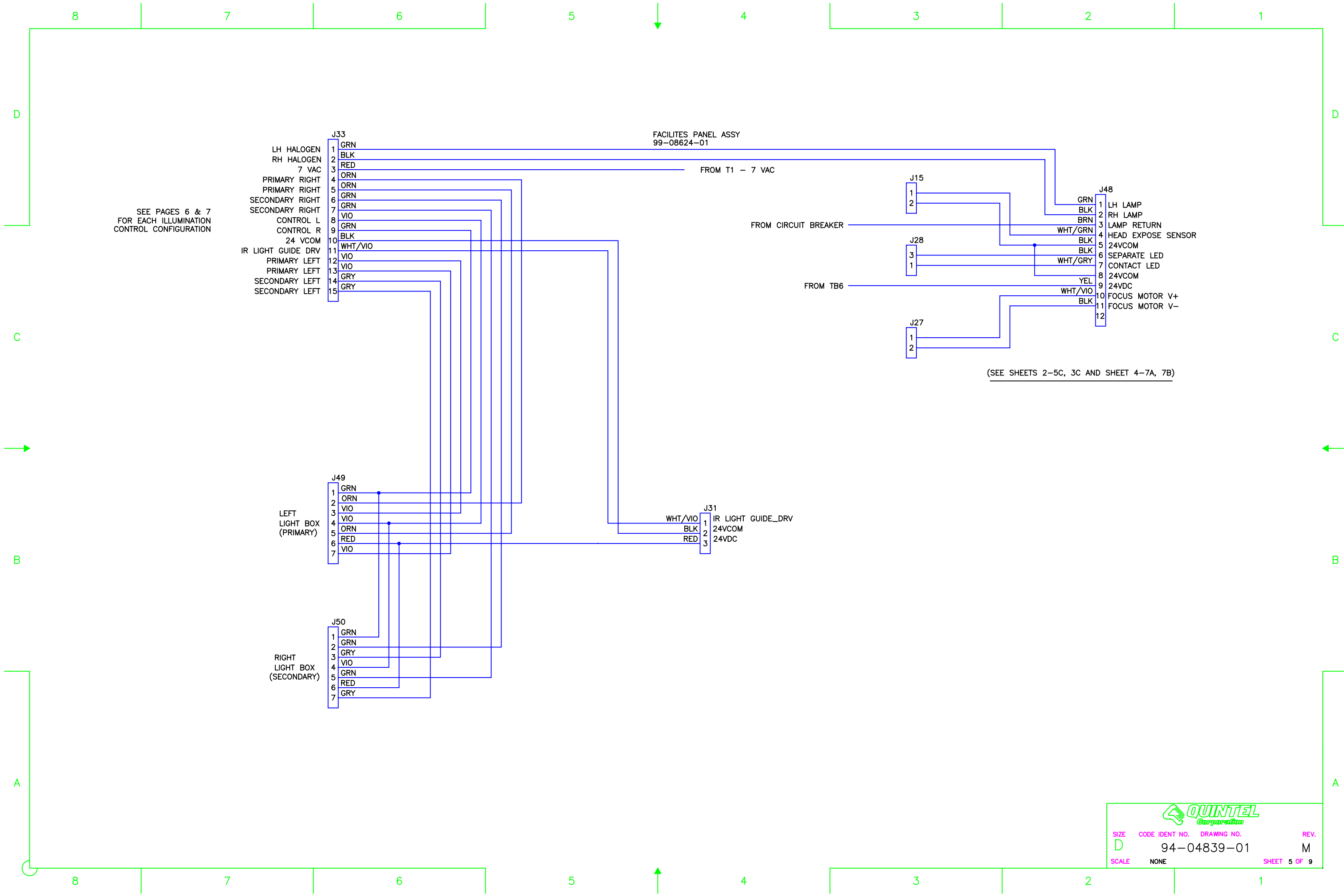


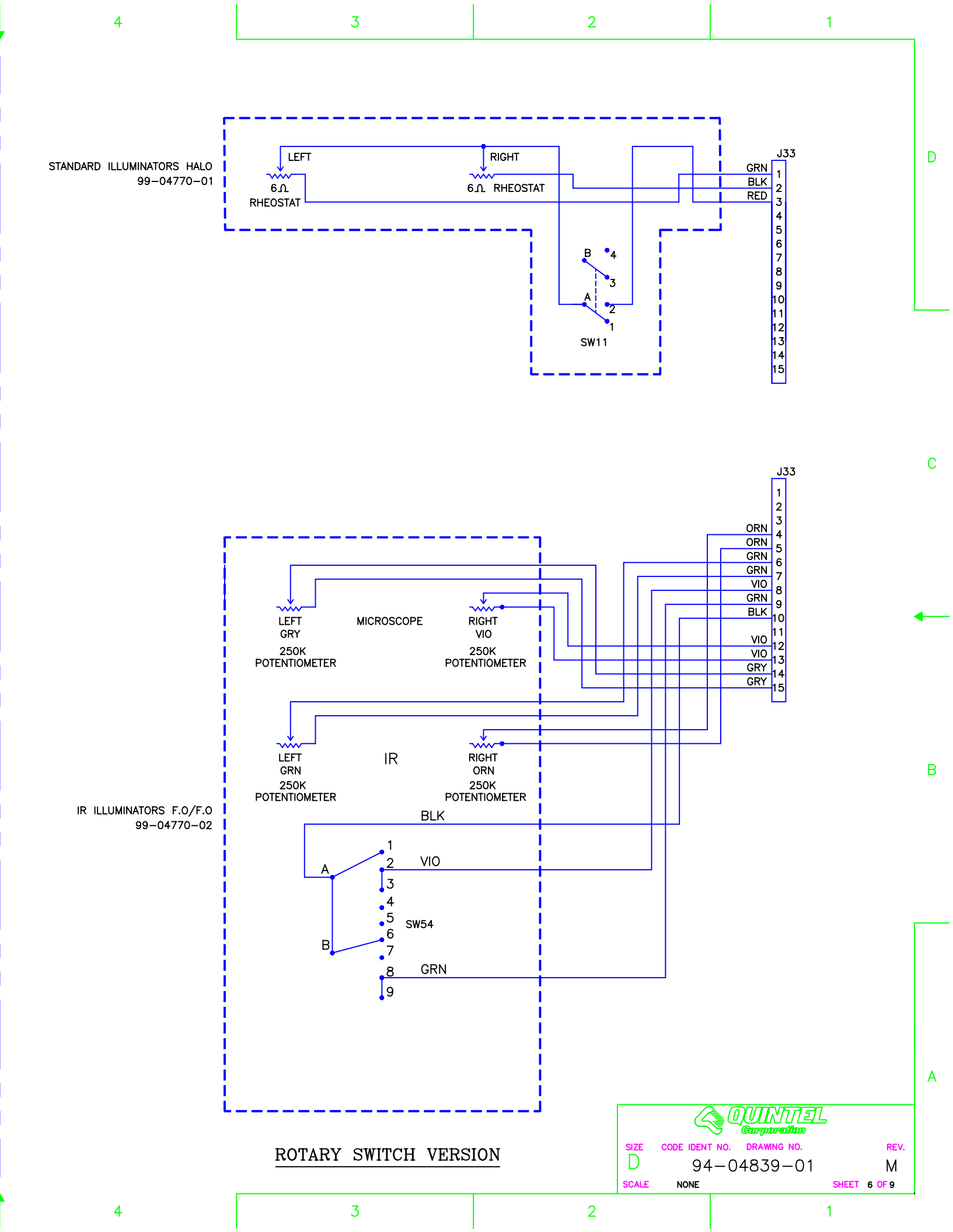
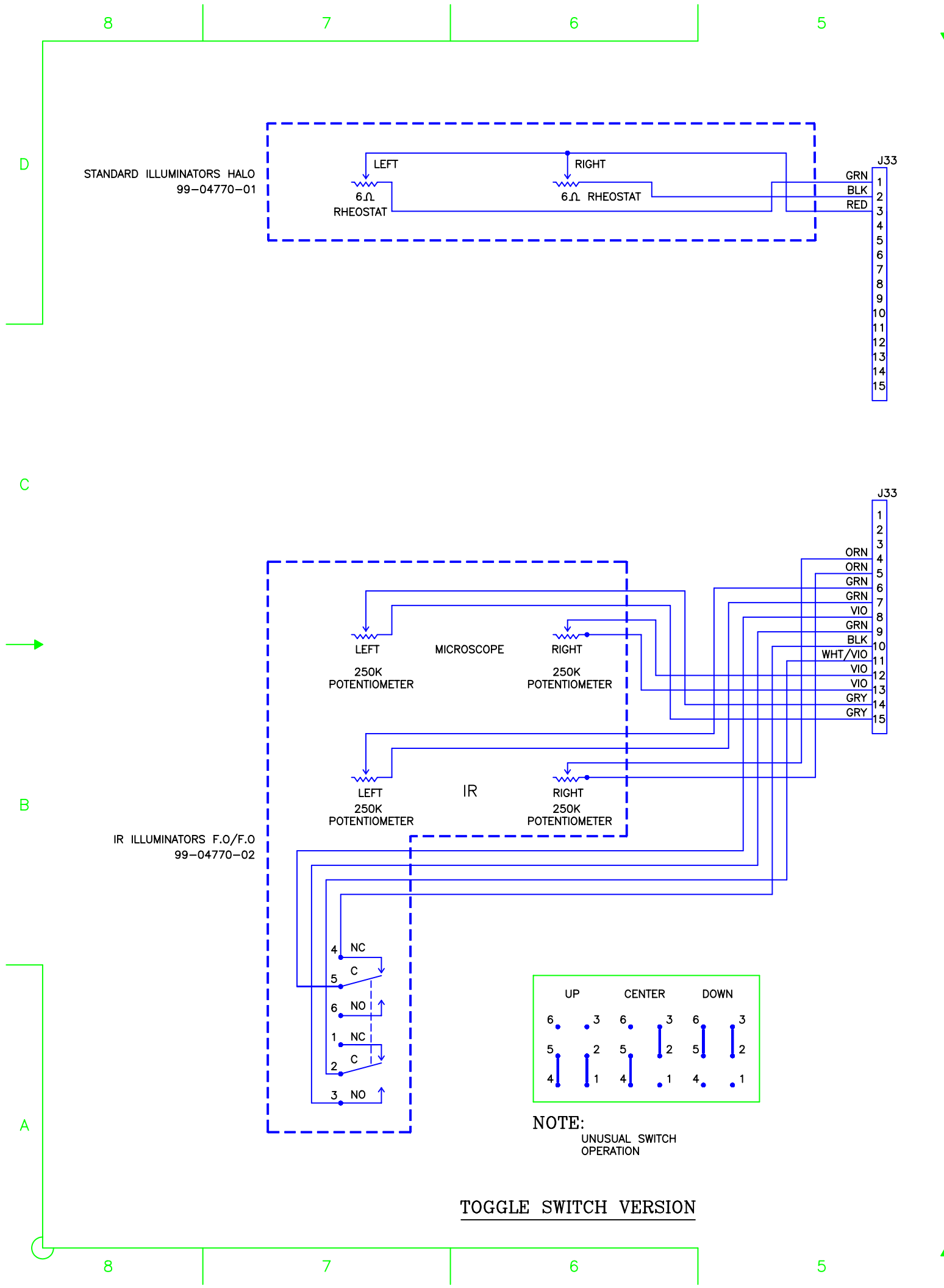
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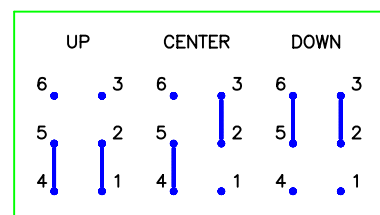
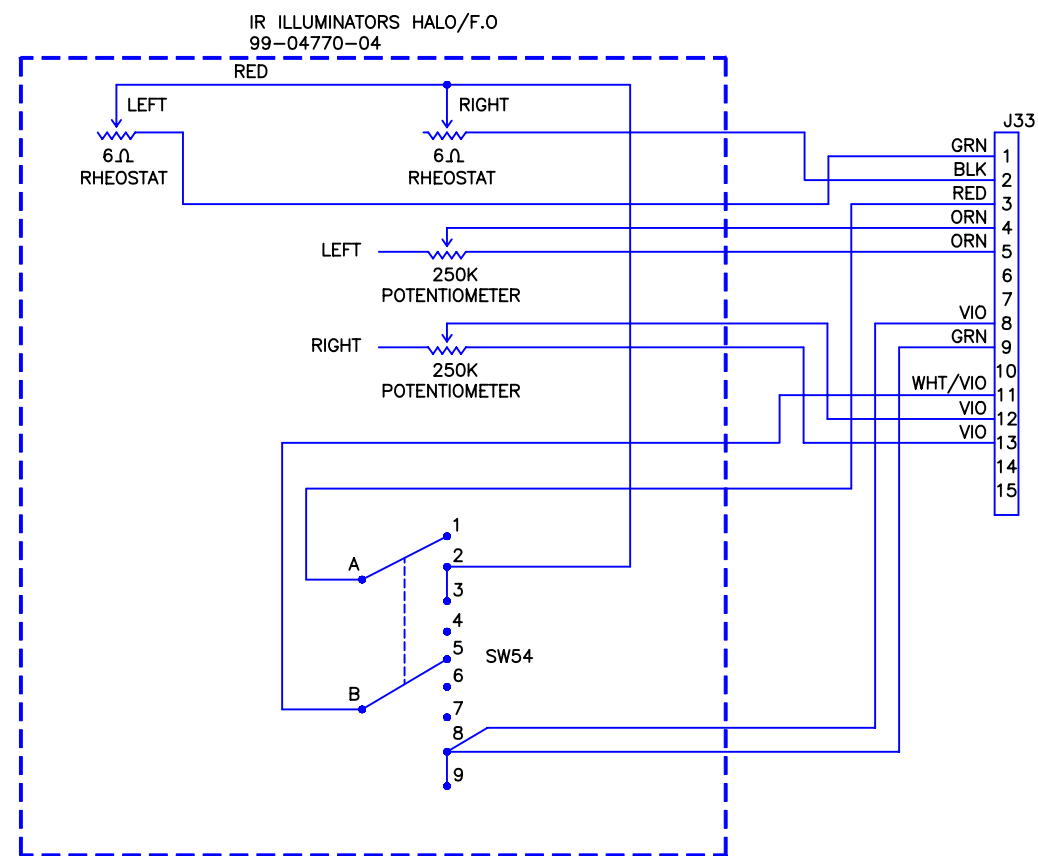
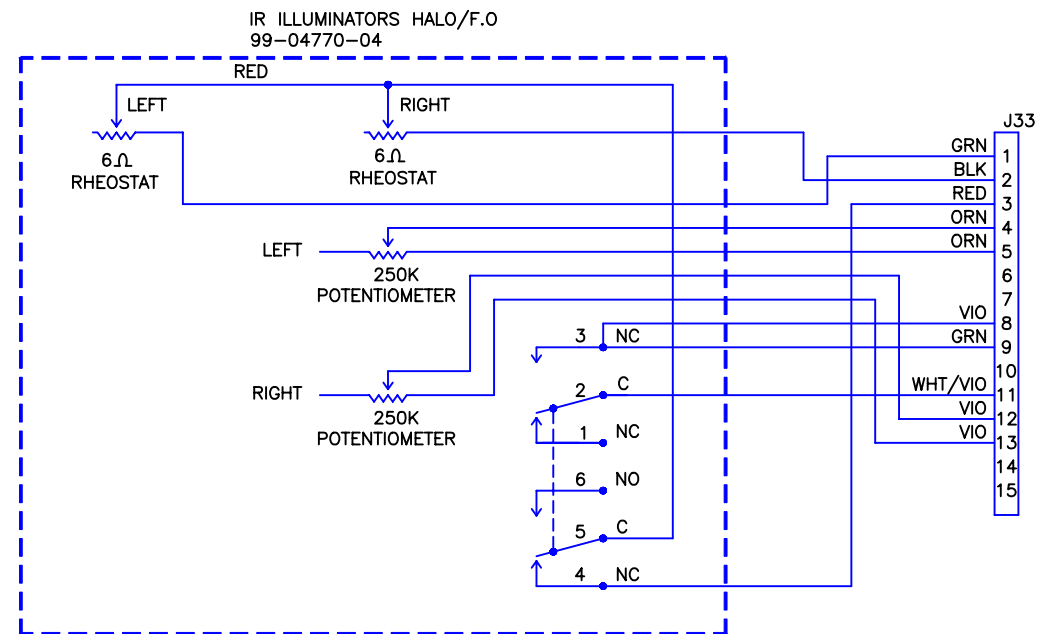
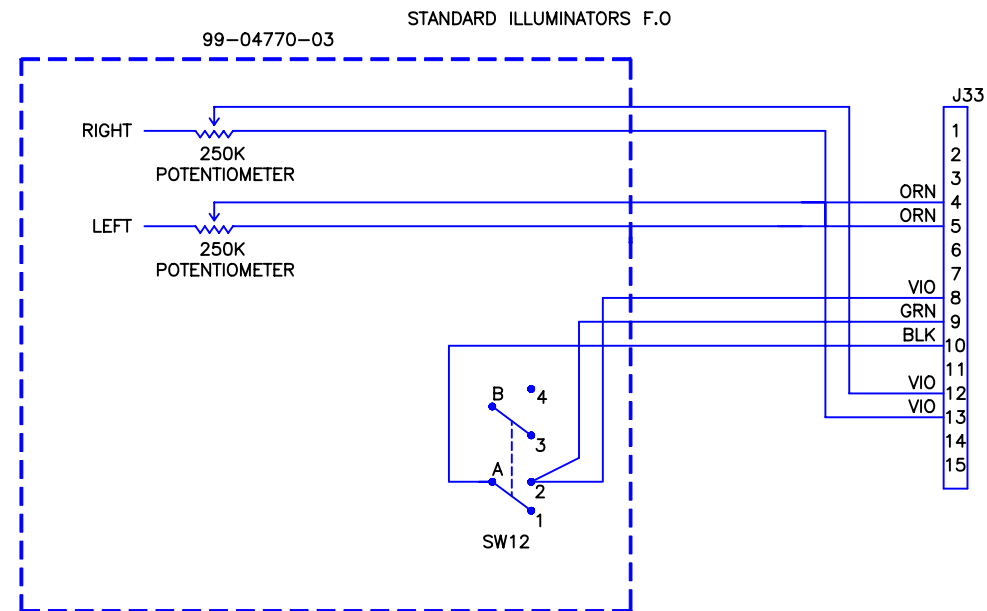
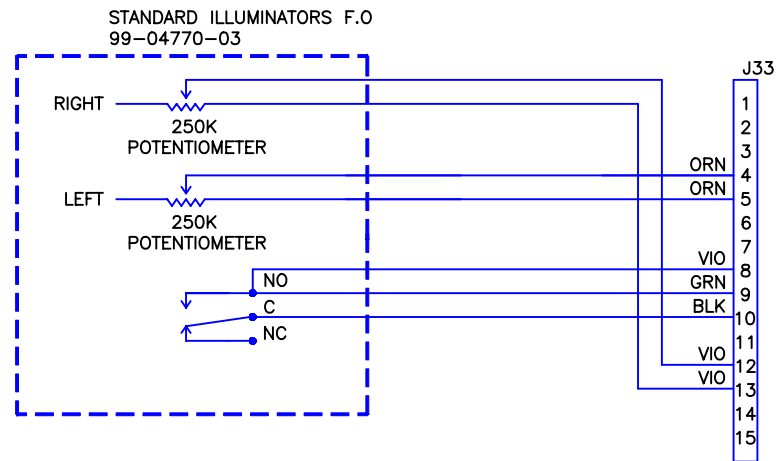
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PARTS LIST					
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MATERIAL —		APPROVED	TITLE: WIRING DIAGRAM, Q4000		
FINISH —		INTERPRET DWG. PER ANSI Y14		SIZE D	CODE IDENT NO. 94— 04839—01
		THE INFORMATION CONTAINED HEREIN IS THE SOLE PROPERTY OF QUINTEL, INC. PERMISSION TO REPRODUCE OR USE THIS INFOR- MATION MUST BE OBTAINED IN WRITING QUINTEL, INC.		DRAWING NO. M	REV. 1 OF 9
		SCALE NONE		SHEET 1 OF 9	









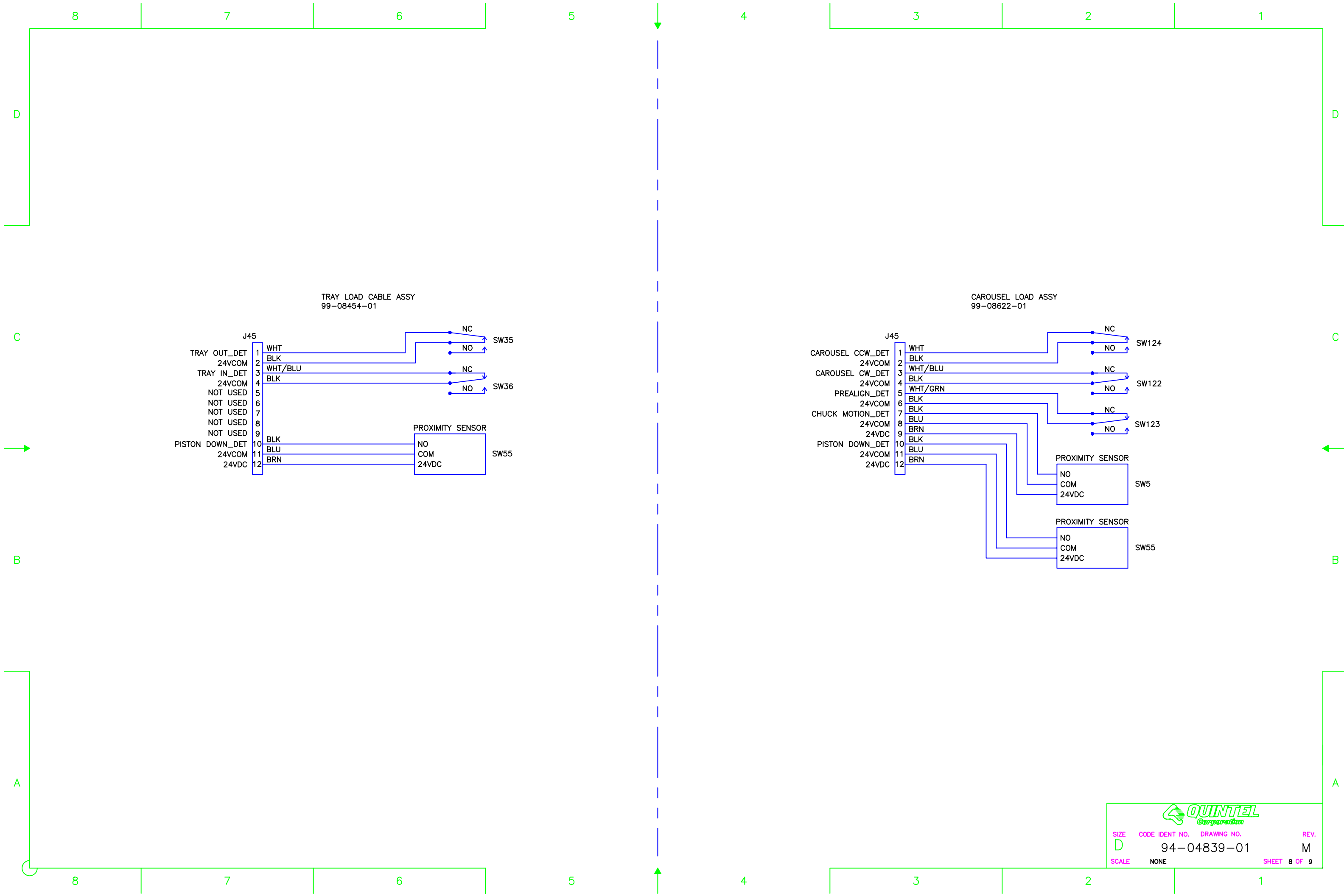


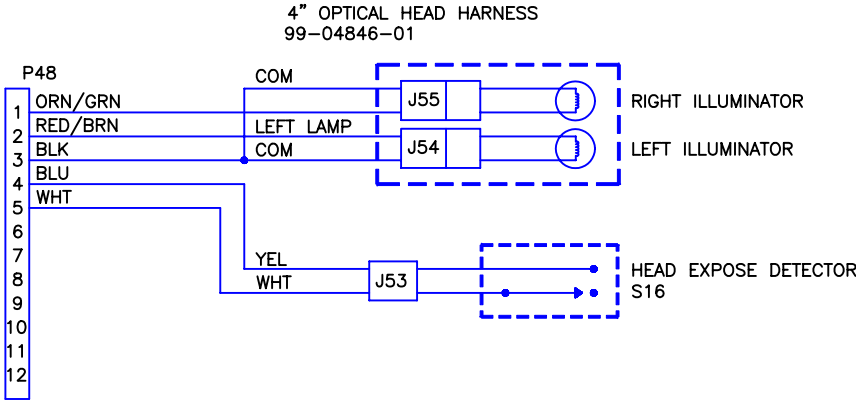
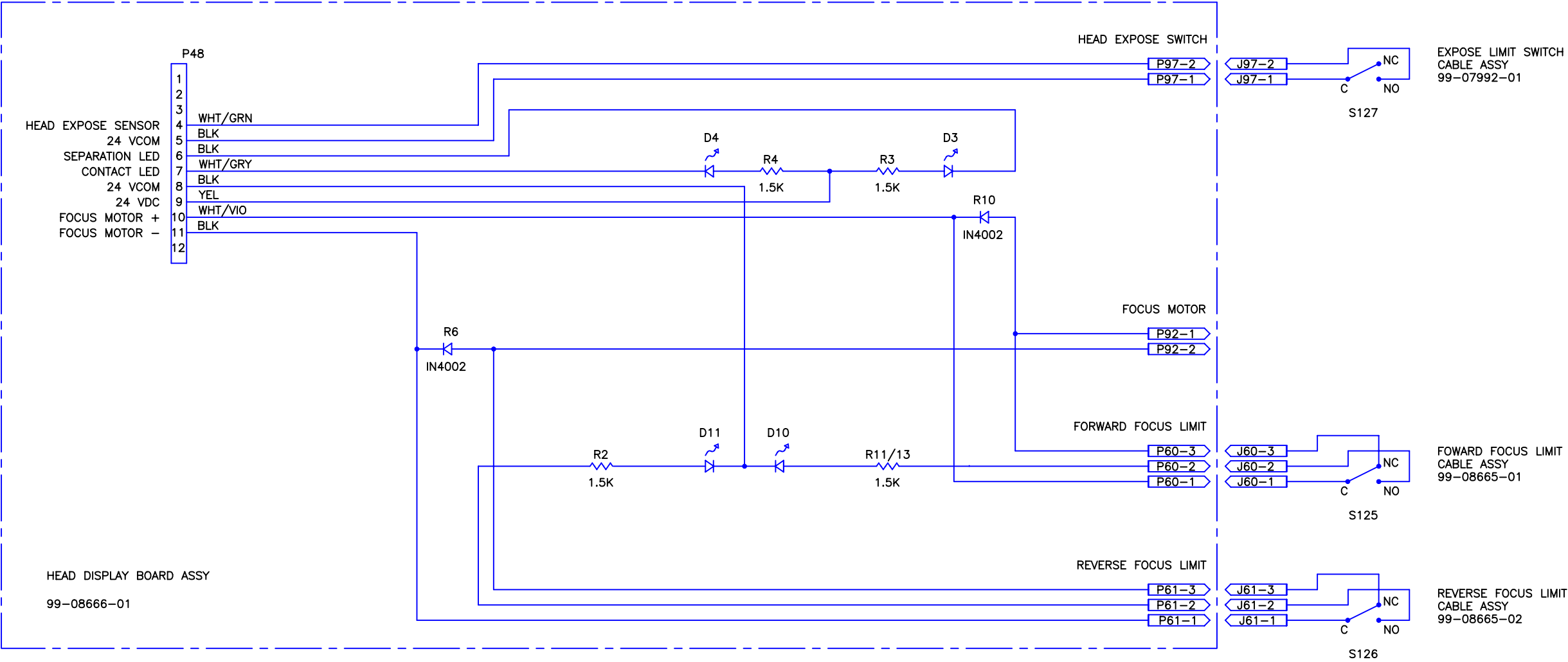
NOTE:
UNUSUAL SWITCH
OPERATION

TOGGLE SWITCH VERSION

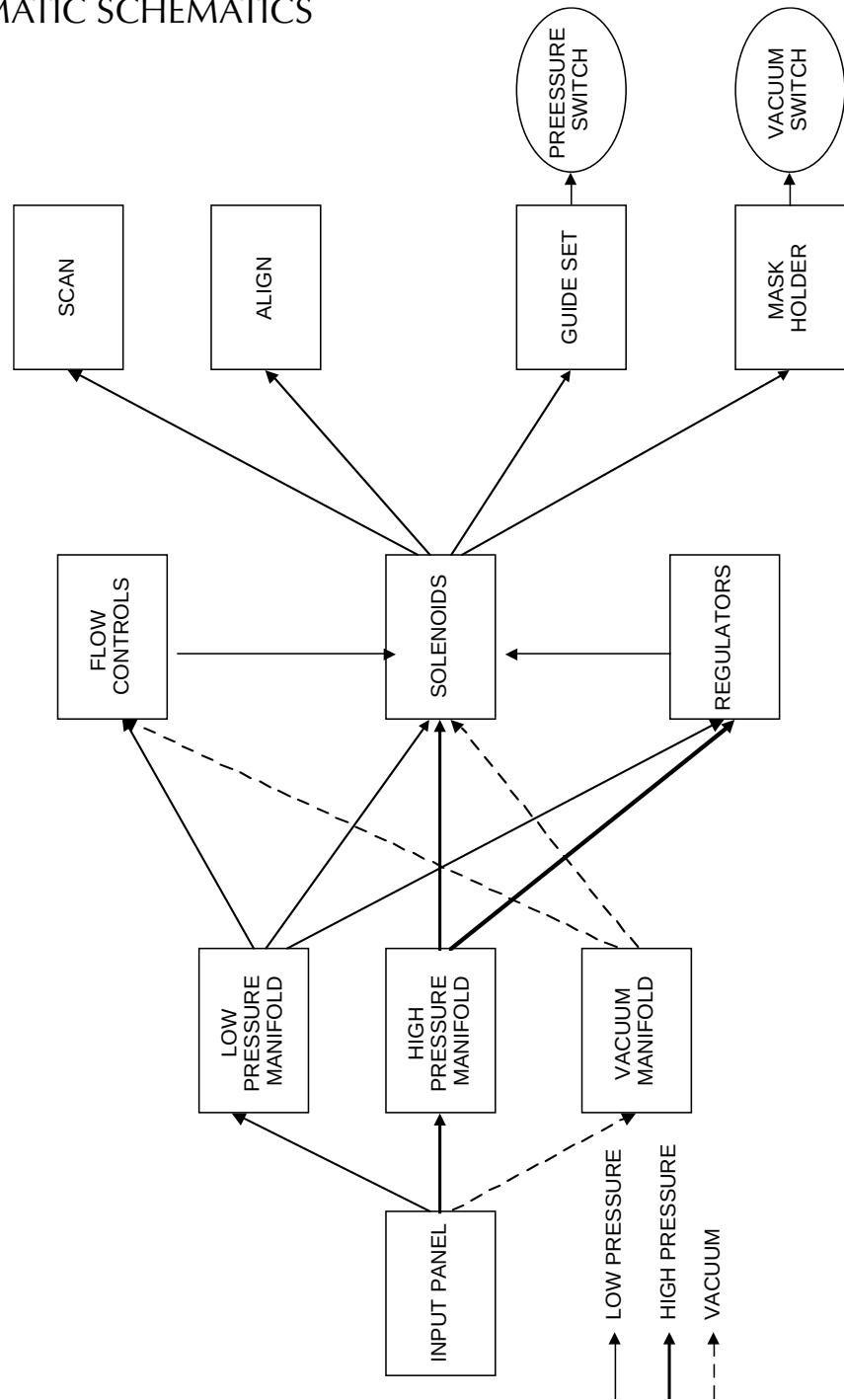
ROTARY SWITCH VERSION



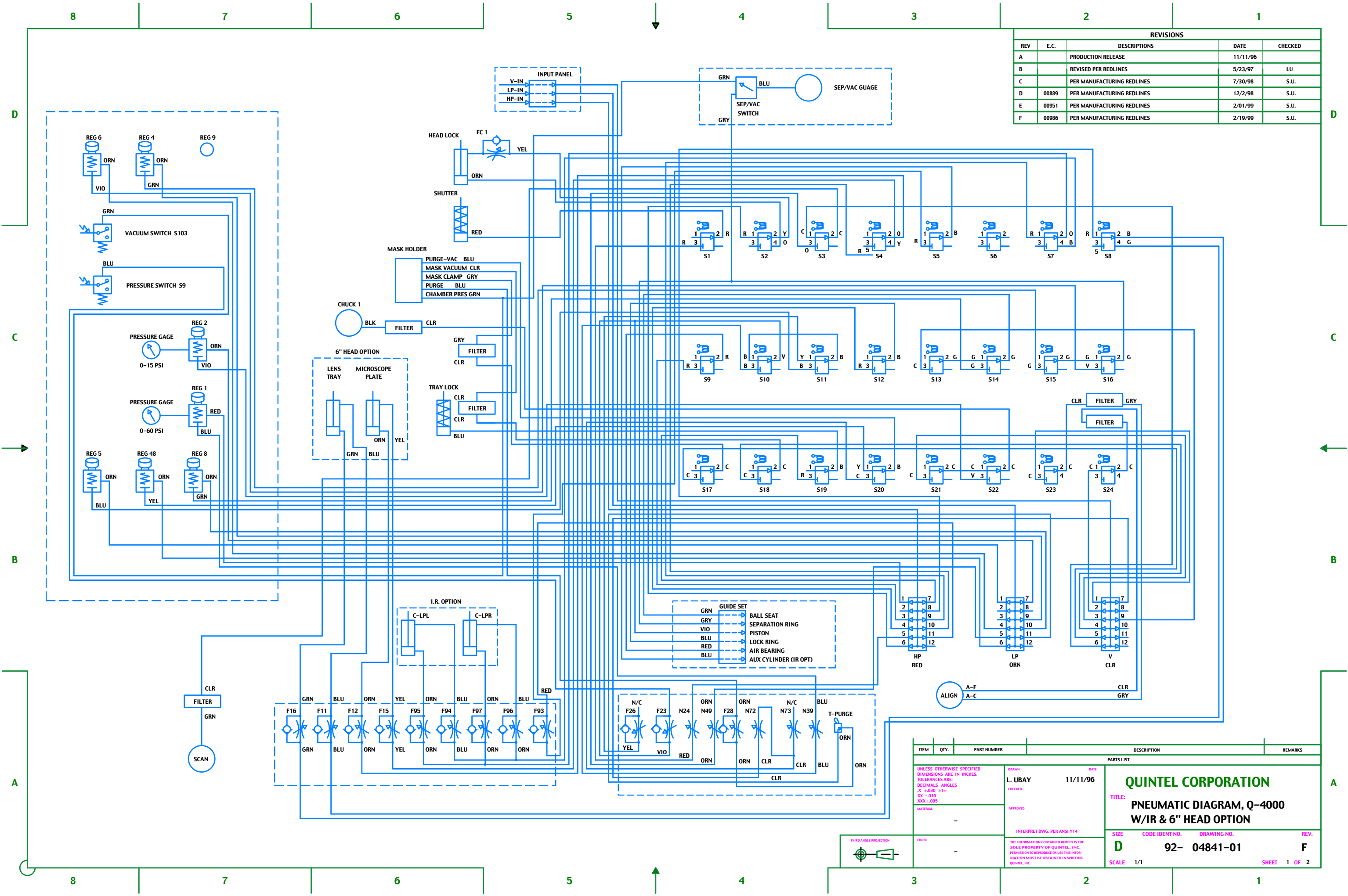


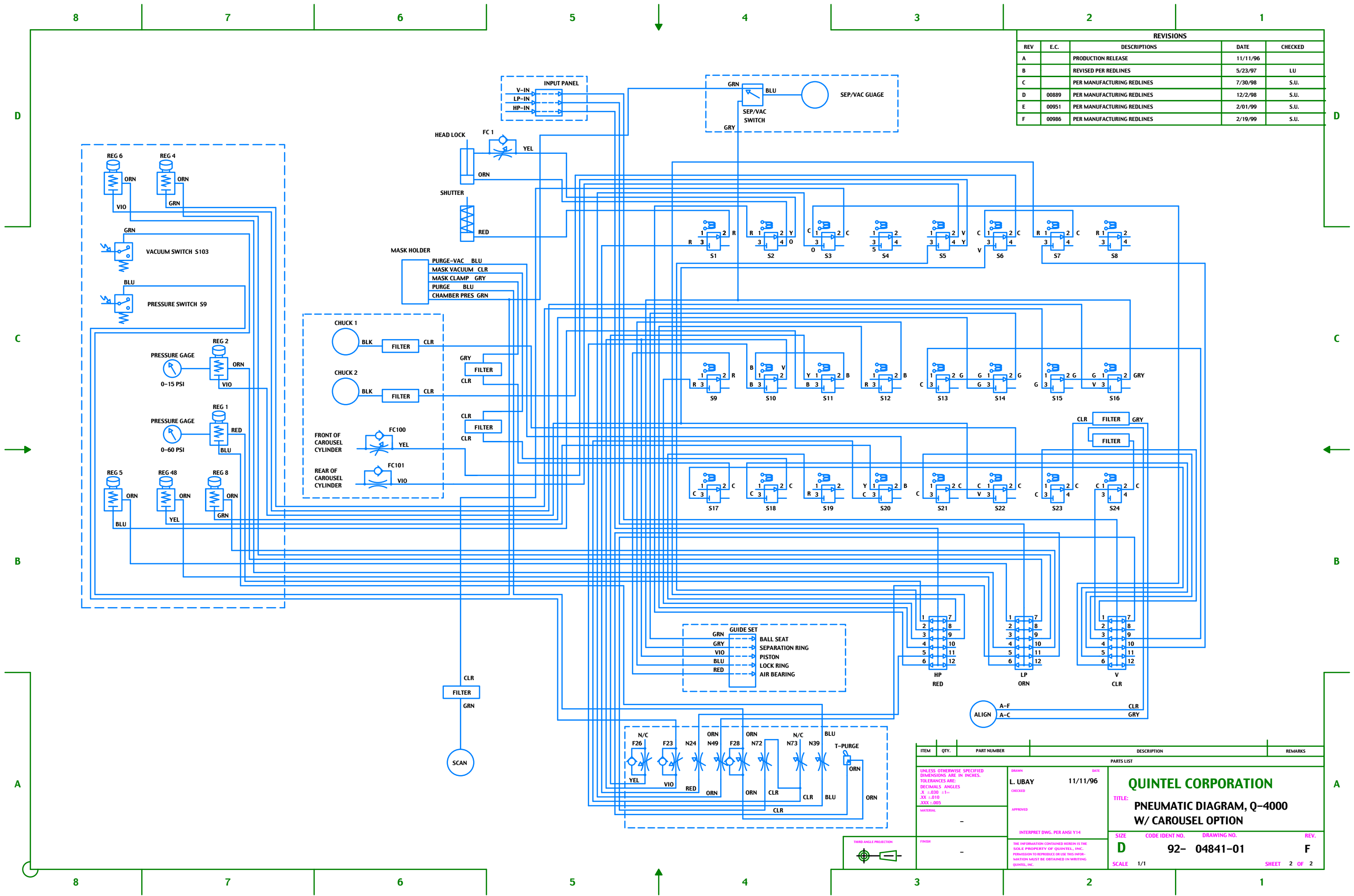


14.2 PNEUMATIC SCHEMATICS



PNEUMATIC BLOCK DIAGRAM



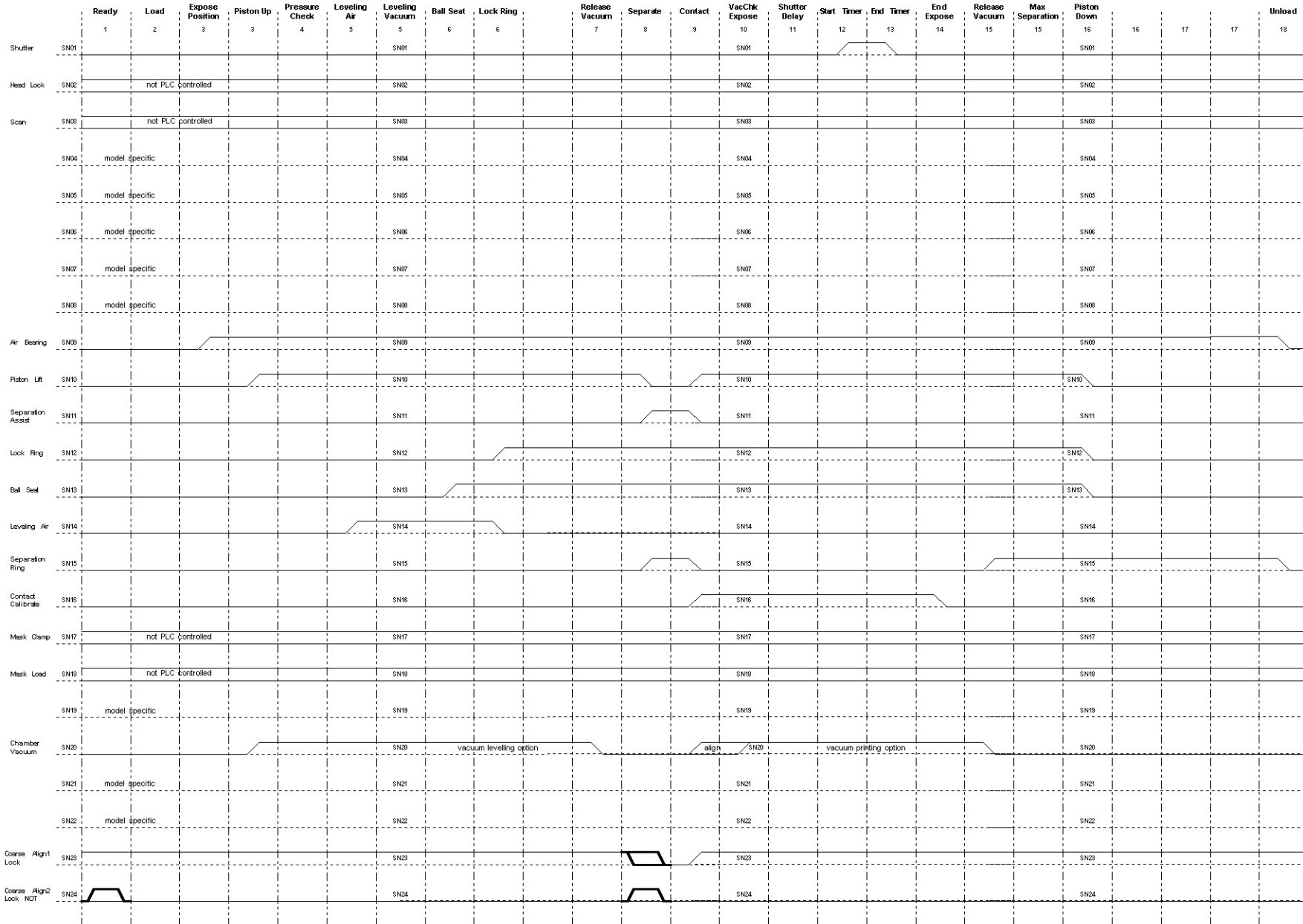


REVISIONS				
REV	E.C.	DESCRIPTIONS	DATE	CHECKED
A		PRODUCTION RELEASE	11/11/96	
B		REVISED PER REDLINES	5/23/97	LU
C		PER MANUFACTURING REDLINES	7/30/98	S.U.
D	00889	PER MANUFACTURING REDLINES	12/2/98	S.U.
E	00951	PER MANUFACTURING REDLINES	2/01/99	S.U.
F	00986	PER MANUFACTURING REDLINES	2/19/99	S.U.

ITEM	QTY.	PART NUMBER	DESCRIPTION		REMARKS
PARTS LIST					
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: DECIMALS ANGLES X .030 ±1- XX ±0.0 XXX ±.005 MATERIAL - FINISH - 					

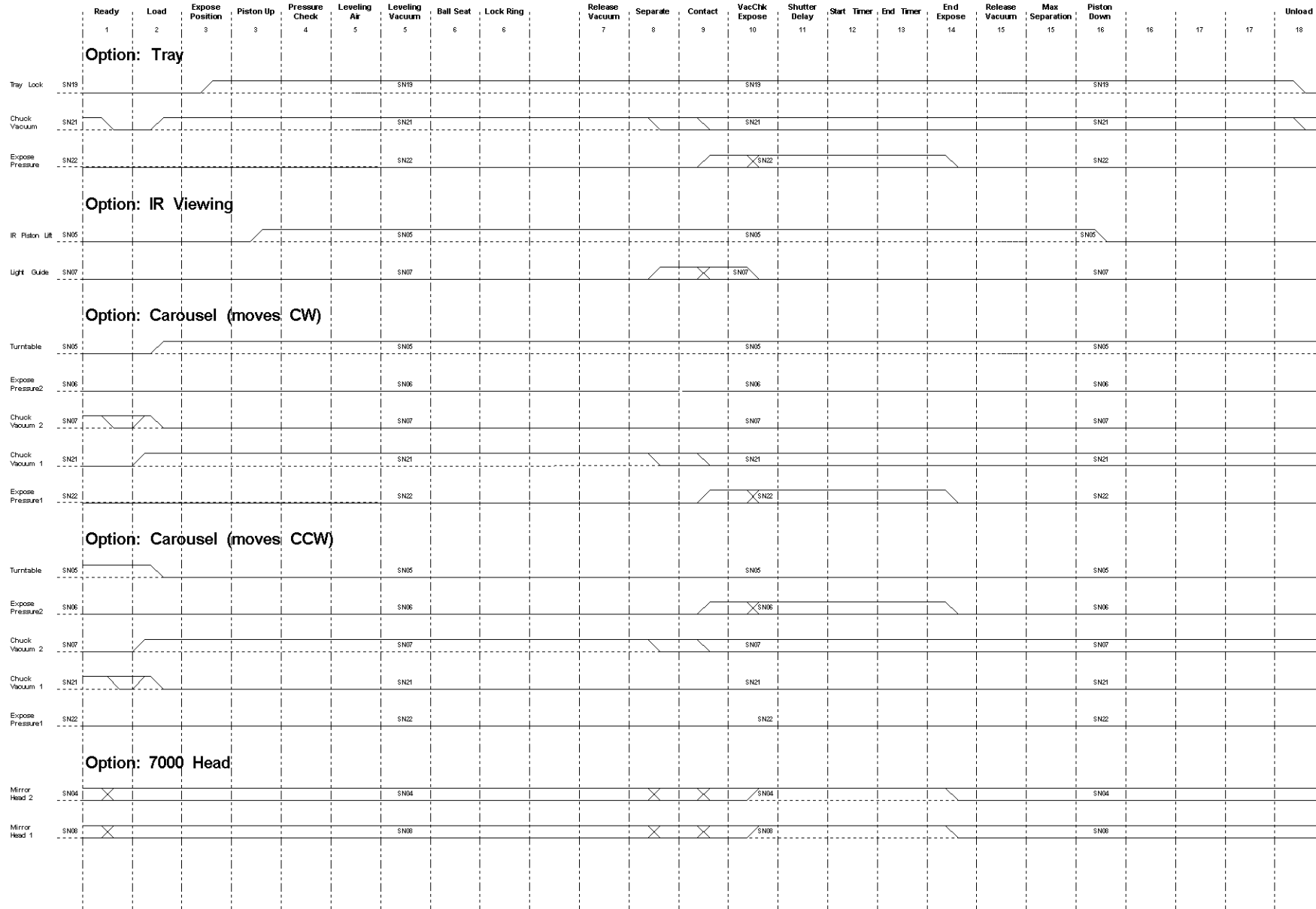
14.3 CONTROL LOGIC DIAGRAM

1998 09 22



Q4000 States - Model Specific Timing

1998 11 05



15 SPARE PARTS LISTS	.0 GENERAL		
	.1 MAINTENANCE TOOLS		
	.2 LAMPS		
	.3 ELECTRICAL		
	.4 CHUCK SEALS		
	.5 EXPOSURE OPTICS- VARI- VIEW		
	.5 EXPOSURE OPTICS- MAGNA-VIEW		

15.0 SPARE PARTS AND SPECIAL TOOLS

The Spare Parts Lists included in the manual are to serve as a guide as to the parts which should be stocked to assure uninterrupted service from your aligner. They are created for several levels of support; initially for expendable spares, such as light bulbs, which should always be on hand to support everyday production.

The comments column will provide guidance as to quantities to have on hand for immediate use. Since stock replacement for these parts are available from the factory usually on a one or two day delivery schedule, there is no need to stock large quantities.

RECOMMENDED MAINTENANCE AND SET-UP TOOLS

The following tools are highly recommended to obtain the optimum use and versatility out of the Quintel Q4000

Quintel part number	Part name	Comments
99-04475-01	Q401 UV Meter	This Quintel designed light meter accurately measures the ultraviolet light falling on the mask/substrate, and allows the accurate assesment of the uniformity of illumination over the surface. It is an essential tool for the proper setup of a replacement lamp.
99-06754-01	Mask Deflection Assembly, Digital	This precision tool is used to perform two tasks; it is used to establish the separation between the mask and the substrate for optimum alignment accuracy, and in the expose mode, it allows an evaluation of the mask bow existing and permits a real time adjustment of the various pressures and flow rates provided to adjust this error producing factor.

DESCRIPTION	QUINTEL PART NUMBER	PART NAME	NORMAL LIFE EXPECTANCY	RECOMMENDED SPARES	NOTES
MICROSCOPE ILLUMINATION					
VARI-VIEW	27-04881-01	Lamp*Modified, 4000 illuminator	2000 hours at rated voltage	2 COMPLETE SETS MINIMUM	Reduce the voltage at the lamp during idle times to greatly extend lamp life
MAGNA-VIEW	6101-0006	Lamp*halogen, 6volt. 20 watt	2000 hours at rated voltage	2 COMPLETE SETS MINIMUM	Reduce the voltage at the lamp during idle times to greatly extend lamp life
FIBER OPTIC	6180-0001	*EKE Reflector	200 hours at rated voltage	2 COMPLETE SETS MINIMUM	Reduce the voltage at the lamp during idle times to greatly extend lamp life
DESCRIPTION	QUINTEL PART NUMBER	PART NAME	NORMAL LIFE EXPECTANCY	RECOMMENDED SPARES	NOTES
EXPOSURE LAMPS					
200 WATT STANDARD	6000-2003	Lamp. 200 W, Std Flying Lead	400 hours average	5 lamps minimum	Since failure to start and catastrophic failure are not unknown as reasons to replace a lamp it is important to have adequate spares on hand to insure production continuity.
350 WATT STANDARD	6000-3503	Lamp. 350 W, Std Flying Lead	400 hours average	5 lamps minimum	Since failure to start and catastrophic failure are not unknown as reasons to replace a lamp it is important to have adequate spares on hand to insure production continuity.
350 WATT DEEP UV	6000-3507	Lamp. 350 W, DUV Flying Lead	400 hours average	5 lamps minimum	Since failure to start and catastrophic failure are not unknown as reasons to replace a lamp it is important to have adequate spares on hand to insure production continuity.
500 WATT STANDARD	500-5007	Lamp. 500 W, Std Body	400 hours average	5 lamps minimum	Since failure to start and catastrophic failure are not unknown as reasons to replace a lamp it is important to have adequate spares on hand to insure production continuity.

DESCRIPTION	QUINTEL PART NUMBER	PART NAME	NORMAL LIFE EXPECTANCY	RECOMMENDED SPARES	NOTES
EXPOSURE OPTICS- VARI-VIEW					
Ellipsoidal Mirror	6701-0004	Reflector*Ellipsoidal	Un predictable	1 set	These optical elements may be damaged by lamp failure, and do degrade over time from exposure to lamp radiation and atmospheric contamination. Several lamp failures are likely to produce visual damage to the optics, but may not affect output.
First Turn Mirror	25-05020-00	Mirror*First Turn/Expose	Un predictable	1 set	These optical elements may be damaged by lamp failure, and do degrade over time from exposure to lamp radiation and atmospheric contamination. Several lamp failures are likely to produce visual damage to the optics, but may not affect output.
Expose Mirror	25-05020-00	Mirror*First Turn/Expose	Un predictable	1 set	These optical elements may be damaged by lamp failure, and do degrade over time from exposure to lamp radiation and atmospheric contamination. Several lamp failures are likely to produce visual damage to the optics, but may not affect output.
DESCRIPTION	QUINTEL PART NUMBER	PART NAME	NORMAL LIFE EXPECTANCY	RECOMMENDED SPARES	NOTES
EXPOSURE OPTICS- MAGNA-VIEW					
Ellipsoidal Mirror	6701-0008	Reflector*Ellipsoidal	Un predictable	1 set	These optical elements may be damaged by lamp failure, and do degrade over time from exposure to lamp radiation and atmospheric contamination. Several lamp failures are likely to produce visual damage to the optics, but may not affect output.
First Turn Mirror	25-07108-00	Mirror*First Turn	Un predictable	1 set	These optical elements may be damaged by lamp failure, and do degrade over time from exposure to lamp radiation and atmospheric contamination. Several lamp failures are likely to produce visual damage to the optics, but may not affect output.
Expose Mirror	25-07389-01	Mirror*Expose	Un predictable	1 set	These optical elements may be damaged by lamp failure, and do degrade over time from exposure to lamp radiation and atmospheric contamination. Several lamp failures are likely to produce visual damage to the optics, but may not affect output.

DESCRIPTION	QUINTEL PART NUMBER	PART NAME	NORMAL LIFE EXPECTANCY	RECOMMENDED SPARES	NOTES
ELECTRICAL FUSES					
120 Volt Domestic	3310-0020	Fuse*1.5 amp type AGC	Unpredictable	10	Most often required during electrical trouble shooting
240 Volt International	3310-0019	Fuse*1.0 amp type GMA	Unpredictable	10	Most often required during electrical trouble shooting
CHUCK SEALS					
2 INCH STANDARD			Unpredictable	3 per chuck size	Thin silicone rubber seals, subject to physical damage from handling tools, cleaning accidents
3 INCH STANDARD			Unpredictable	3 per chuck size	Thin silicone rubber seals, subject to physical damage from handling tools, cleaning accidents
100mm STANDARD			Unpredictable	3 per chuck size	Thin silicone rubber seals, subject to physical damage from handling tools, cleaning accidents
125mm STANDARD			Unpredictable	3 per chuck size	Thin silicone rubber seals, subject to physical damage from handling tools, cleaning accidents
150mm STANDARD			Unpredictable	3 per chuck size	Thin silicone rubber seals, subject to physical damage from handling tools, cleaning accidents