

3000LE

Installation, Commissioning and Service Manual



Directive 93/42/EEC

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This manual describes the installation, commissioning and service procedures of the **3000LE** Ophthalmic Nd: YAG laser.

Although all care has been taken in the preparation and checking of this manual there is no guarantee that all information is correct. For the purpose of product improvement the information provided in this manual is subject to change without notice.

This product was designed and manufactured in Australia by Ellex Medical Pty Ltd.

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Revision C

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Cautions

Use of controls or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Use caution in assessing patients who have glass intraocular lenses implanted. Treatment of such patients with pulsed Nd:YAG lasers can result in cracked or pitted glass IOLs. Posterior capsulotomies are contra-indicated for such patients, except for those whose medical condition precludes invasive surgery. If laser treatment is selected, use low energies and extreme care. Special care is also necessary for patients who have plastic IOLs. Refer to the professional information section of this manual.

This Nd:YAG laser system should be used only by fully trained, qualified physicians.

We strongly recommend that this Service Manual be read in its entirety before servicing the product.

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This manual describes the use, maintenance, service and repair requirements for the Alcon Ophthalmic Laser System, model **3000LE**. It is intended for the use of service personnel.

The manual contains the following information:

- ⇒ an introduction to the **3000LE** and an explanation of how it works
- ⇒ routine operation, maintenance, calibration, alignment and fault-finding information
- ⇒ descriptions of the instrument modules and replacement procedures
- ⇒ specifications
- ⇒ appendices containing lists of spare parts and consumables, drawings, forms, and other useful information
- ⇒ a glossary and explanation of abbreviations and acronyms used
- ⇒ a comprehensive index

Caution

<i>Before using the instrument for the first time, you should read the safety requirements outlined in Chapter 2, and then become familiar with the controls. These are described in detail in Chapter 3.</i>

CONVENTIONS

The following symbols and conventions are used:

- | | |
|----------------------------|--|
| $\Rightarrow, \rightarrow$ | a list item |
| $\bigcirc, \bullet$ | an action to take |
| 1. | a step in a procedure requiring many steps |
| <i>italics</i> | a new term, emphasis, or a cross-reference |

Pay particular attention to the information contained within boxes like this one. They contain notes of particular significance to the performance of the instrument.

Caution

Attention to information in boxes like this is necessary to avoid situations that could cause injury or equipment failure.

1.1 INTRODUCING THE 3000LE

The **3000LE** is a surgical laser instrument designed for the use of ophthalmologists in performing posterior capsulotomies, posterior membranectomies, and other surgical procedures that seek to rupture or disrupt a structure within the eye.

The **3000LE** is supplied with a specially designed table and chin rest support.

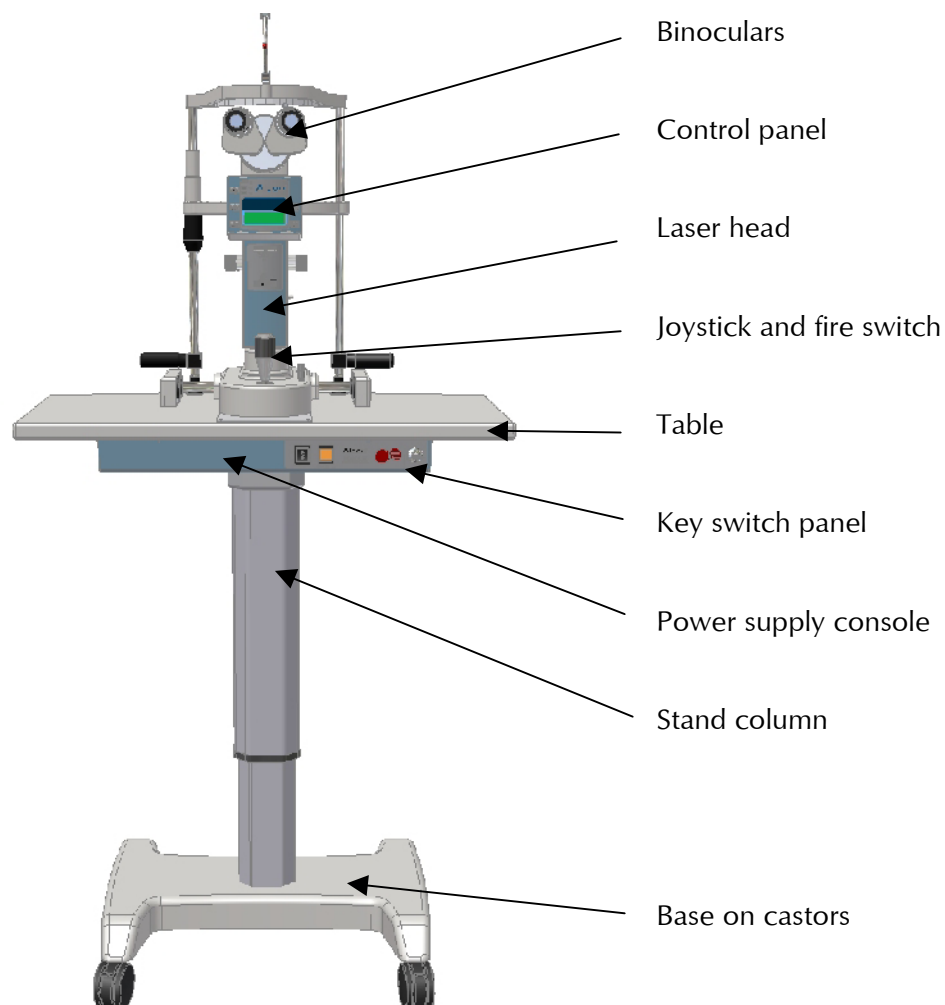
The instrument is illustrated in *Figure 1-1*. Also see the **3000LE** System Diagrams included at the rear of this manual.

Caution

Use of controls or adjustments or performance of procedures other than those specified in this manual may result in hazardous radiation exposure.

U.S. Law restricts this device to sale to, or on the order of, a physician.

Figure 1-1 General view of the 3000LE



(Units with serial numbers before 4000 are slightly different to the unit shown.)

1.2 COMPONENTS

The major components and accessories of the **3000LE** are indicated on *Figure 1-1*:

- ⇒ *laser head* — containing the laser and optics, and incorporating a control panel
- ⇒ *binoculars*
- ⇒ *table* — incorporating a key switch panel (on the underside) in units with serial numbers pre-4000
- ⇒ *power supply console* — under the table and including the key switch panel, in units with serial numbers from 4000 only
- ⇒ *joystick and fire switch* — used to move the slit lamp and fire the laser
- ⇒ *stand column*
- ⇒ *base on castors*

The laser head components are installed inside a cast metal housing, which is sealed to maintain a clean dry atmosphere.

Refer to *Chapter 3* for a complete functional description of the instrument and its components. Electrical and mechanical drawings are bound in the rear of this manual.

1.3 THEORY OF OPERATION

When the instrument is ready for firing and the fire switch (on top of the joystick) is pressed, the microprocessor initiates a series of safety checks. If these are successful, it then opens the safety shutter and sends a signal to the treatment laser power supply. This supplies pulses of electrical power to the laser, which converts them to pulses of laser energy.

The opened shutter allows the pulses of laser energy to enter a beam expander, which converts the 3 mm (0.12 in) diameter laser beam to 27 mm (1.06 in) diameter. The expanded beam is then reflected 90 degrees and enters an objective lens, which focuses the beam to a high-energy spot of approximately eight microns (μm) in diameter (full width half maximum (FWHM)).

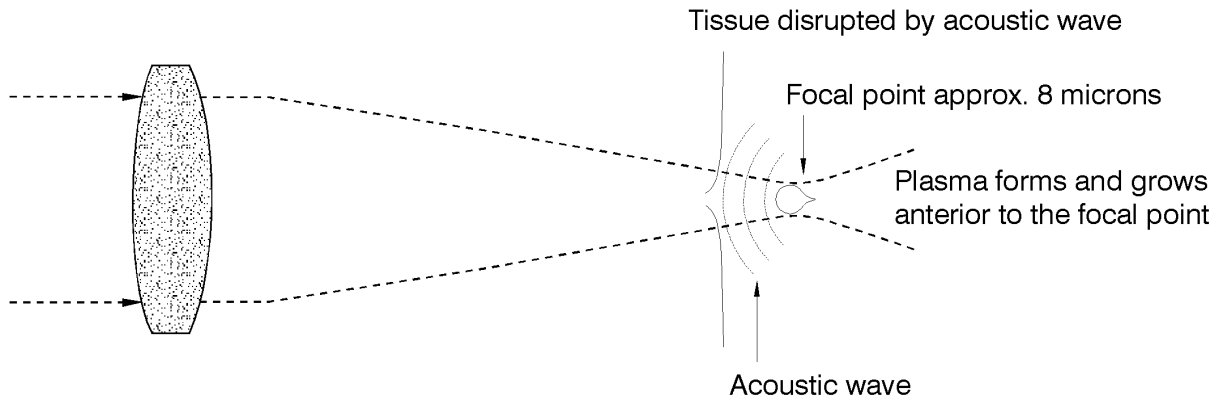
The beam of the **3000LE**, like that of other ophthalmology surgical lasers, is made up of short, individual pulses of focused infrared light with a wavelength of 1064 nm. The focused spot can be accurately positioned on the membrane or tissue within the patient's eye with the aid of a slit lamp microscope and a 'twin dot' aiming system.

The energy of the laser pulses is readily adjustable, and is normally set at the lowest possible effective level in order to minimize unwanted side effects such as retinal detachment. (These side effects and contra-indications for the use of the instrument are covered in depth in the **3000LE** Operator's Manual.)

1.3.1 The photodisruptive effect

The eight-micron spot produces a small ionization site (plasma) at the focal point. This creates an acoustic wave that disrupts nearby tissue in a process known as the 'photo-disruptive effect'.

Figure 1-2 Plasma formation



Once formed, the plasma absorbs and scatters further incident light, and this shields the underlying structures from damage. The beam divergence after the focal point also protects the retina from damage that could otherwise occur by the absorption of concentrated treatment energy.

As the treatment energy is increased, the size of the plasma formed also increases, which causes a larger, stronger acoustic wave. To avoid the possibility of the plasma entering the intraocular lens (IOL) and causing cracking or chipping, and to allow the accompanying shock wave to grow to its most effective size, the treatment beam may be offset further behind the membrane to be penetrated (and hence also posterior to the focal plane of the slit lamp, which is focused on the membrane). A posterior YAG offset control allows you to select the amount of offset required.

1.3.2 Aiming beams

A visible red diode dual beam laser is used to aim the treatment laser beam. The aiming beams are coaxial with the treatment beam and the laser is focused when the two aiming beams coincide to form one spot.

During installation of the laser head on the slit lamp, this low power diode laser light is set to focus on the same plane as the slit lamp (that is, it is parfocal with the slit lamp).

1.4 WHAT IS A LASER?

LASER is an acronym for *Light Amplification by Stimulated Emission of Radiation*.

In its most basic form a laser is a device that converts electrical energy to light. The conversion efficiency is quite low; of the order of 1-4%, but the light produced is quite different from other sources such as fluorescent tubes or the sun. The differences are:

- ⇒ *coherence* — all the waves are exactly in phase, with no interference between waves, so there is no loss of energy
- ⇒ *monochromaticity* — the range of wavelengths or energies present is extremely small

All other sources of light or heat have a broad range of energy (or wavelengths). Since lasers have a narrow range a beam can be selected with a wavelength well matched to the absorption properties of the tissue of interest, for best effect.

- ⇒ *collimation* — the beam does not diverge and can therefore travel a long way and still have a small spot size

1.4.1 Stimulated emission

The laser beam is produced by the process of *stimulated emission* (see Figure 1-3). During this process atoms are excited above their ground state by an energy source (a flash lamp in the **3000LE**). When the excited atoms return to their ground state they emit photons, which are then reflected by mirrors back and forth over the laser medium within the laser cavity.

When a photon hits an already excited atom in the laser medium the atom emits another photon. In other words, one photon enters and two leave, both in the same direction as that of the incoming photon, and both with exactly the same phase in relation to each other (that is, coherent), and with the same wavelength.

1.4.2 Medical advantages

For medical use the differences between laser light and other sources offer the following major advantages in their clinical applications:

- ⇒ significantly higher power densities at the target tissue
- ⇒ ability to match the wavelength to the absorption properties of the tissue of interest for a desired effect
- ⇒ ease of focusing a parallel beam to small spot size

These same properties also give laser radiation a greater potential to cause injury than light from other sources.

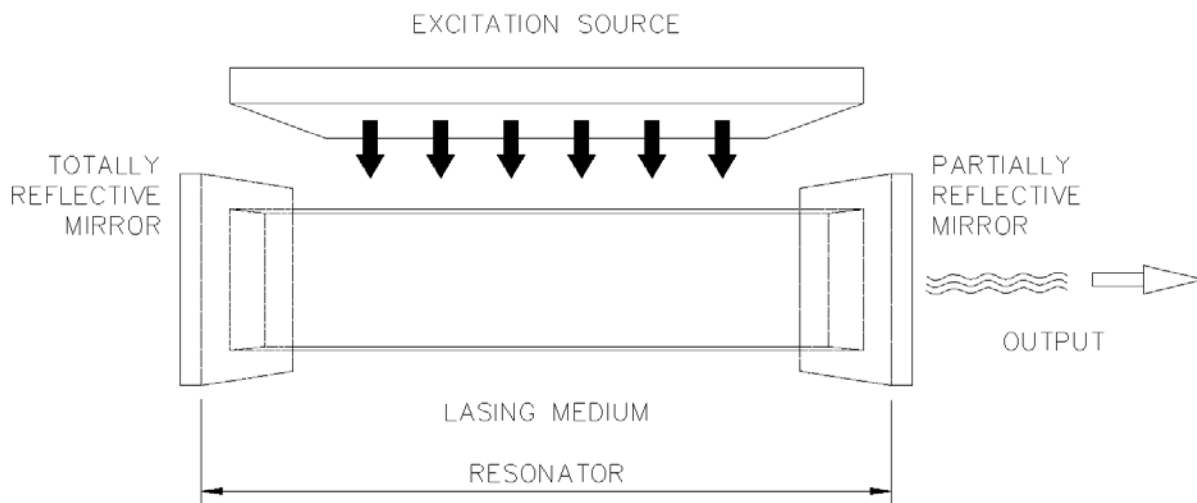
1.5 ELEMENTS OF A LASER

A laser has three major components:

- ⇒ *laser medium* — a solid, liquid or gas where the energy from the source is absorbed and photons are emitted
- ⇒ *energy source or pump* — such as a flash lamp
- ⇒ *resonant laser cavity* — in which the photons are reflected back and forth, producing pulses of laser light

Figure 1-3 illustrates the components of a typical laser. The modules making up the laser system are described in detail in *Chapter 12*.

Figure 1-3 Typical laser components



1.5.1 Laser medium

The laser (or lasing) medium used in the **3000LE** is a solid-state crystal of Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG).

1.5.2 Energy source or pump

The energy source for the **3000LE** is a flash lamp containing ionized gas. It receives pulses of electrical energy, which are conducted by the ionized gas, causing a discharge of high voltage energy. The energy is released as a bright flash of light. The laser medium absorbs and re-emits certain wavelengths, forming the laser beam by the process of stimulated emission (see *Section 1.4.1*).

1.5.3 Laser cavity

The cavity contains the flash lamp, the laser medium, and a series of totally and partially reflective mirrors that reflect the photons and allow a polarized beam of laser light to exit. (See *Section 3.1* for a description of the laser beam path.)

1.5.4 Pulsed operation and Q-switching

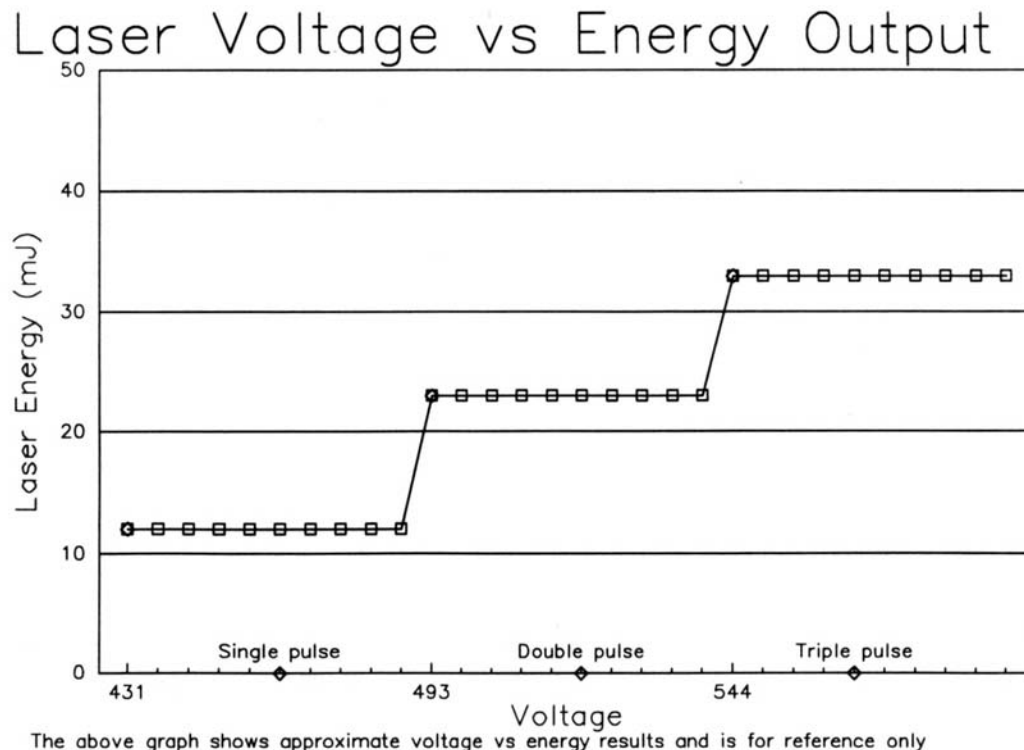
The **3000LE** uses a pulsed mode of operation commonly called Q-switching. In this system a component called a Q-switch is added to the laser system to cause the laser to produce a short pulse (of the order of a few nanoseconds) each time the laser is fired.

The Q-switch can produce a number of laser pulses for a single firing of the flash lamp. The number of pulses emitted is proportional to the energy input to the flash lamp, which is provided by a conventional capacitor-charging power supply.

The main discharge capacitor is a 50 microfarad 900 V pulsed device. The energy entering the flash lamp is proportional to the square of the capacitor voltage and characteristic, as shown in the illustration below, which shows flash lamp voltage versus Nd:YAG energy output.

It is important that when the laser is being operated the voltage to the flash lamp must be set correctly to prevent the possibility of too few or too many pulses.

Figure 1–4 Flash lamp voltage vs Nd:YAG energy output



1.6 INTENDED USES

The **3000LE** ophthalmic laser is intended to be used for dissection of the posterior capsule of the eye (posterior capsulotomy), dissection of the pupillary membrane of the eye (posterior membranectomy), as well as other surgical procedures such as iridotomy (opening a hole in the iris).

Like all Nd:YAG ophthalmic laser surgery, there are risks involved and use of the laser may be contra-indicated for patients with certain pre-existing ocular pathologies. Objective assessment of candidate patients for this procedure must be done in light of the risks, which are discussed in detail in the Operator's Manual supplied with the instrument.

1.7 GENERAL DESCRIPTION OF TREATMENTS

Treatment procedures are dealt with in detail in the Operator's Manual supplied with the instrument.

In summary, the laser is focused on the membrane or tissue of the patient's eye using the aiming beams. The energy level is set initially to the lowest possible, then the laser is fired.

If the capsule is tough or scarred, higher energy shots may be required, but the energy is increased in small increments and the minimum number of shots required to obtain an adequate opening is used.

Once an opening has been established, it is enlarged as required until it is of adequate size.

1.8 CLINICAL EFFECTS

The **3000LE** has a cutting or disrupting effect with the capability to damage any tissue or structure on which the beam is focused.

Unlike other lasers commonly used in ophthalmology (such as argon, krypton and ruby laser coagulators), it does not rely on thermal effects.

Caution

<i>Since the laser is designed to damage tissues, make sure it is focused only on tissues that are to be operated on. Do not focus it on or near iris blood vessels because the shock wave may produce bleeding and induce astigmatism. The beam should never enter the eye at greater than 30 degrees from the visual axis.</i>
--

The **3000LE** is a precision medical instrument and is very safe when correctly used. This chapter describes the safety standards and features of the system and the warnings and precautions that apply.

We strongly recommend that you read and understand this Chapter and Chapter 3 before you install, service, maintain or use this instrument.

2.1 SAFETY CLASSIFICATION AND WARNINGS

The **3000LE** is classified as a Class 3B/IIIb laser product in compliance with:

- ⇒ IEC standard 825-1-1993
- ⇒ USA standards 21CFR 1040.10, 21CFR 1040.11-1999

In accordance with this safety classification the following laser safety warnings apply.

Caution

Nd:YAG Laser Emission Warning

Invisible laser radiation is emitted from the laser aperture when the system is in laser READY mode and the fire switch is pressed. Do not look into the beam. Do not expose tissue to the beam.

Any other personnel in the area should wear protective glasses to eliminate the risk of eye damage from stray or accidental emissions.

Caution

Reflection Warning

Objects that can reflect visible light will also reflect 1064 nm laser light. Avoid placing reflective materials such as glass, metal and polished plastic in the laser beam.

Caution***Explosion Hazard Warning***

Do not use the treatment laser in the presence of flammable anesthetics or volatile organic fluids as the focused beam may cause ignition.

Some materials, such as cotton wool saturated with oxygen, may be ignited by the high temperatures produced by the focused beam. The solutions of adhesives and flammable solutions used for cleaning and disinfecting should be allowed to evaporate before the laser equipment is used.

Caution***Aiming Laser Emission Warning***

Visible laser radiation is emitted from the laser aperture when the system is switched ON and the laser on/off switch is in the ON position. Do not stare into the beam unless under the control of a qualified surgeon.

Caution***Electromagnetic compatibility***

This device may be affected by external RF sources (such as cell phones) in the vicinity during operation.

2.2 SAFETY FEATURES

The **3000LE** includes a number of safety features. Some are provided in accordance with the requirements of the appropriate standards, but the **3000LE** includes safety features in addition to these.

2.2.1 Features relating to standards

The safety features built into the **3000LE** comply with the following standards:

European Medical Device Directive (MDD)

⇒ 93/42/EEC for CE marking.

Electrical standards

⇒ International Electrotechnical Commission (IEC) standard 601-1 1988

Laser product standards

⇒ International Electrotechnical Commission (IEC) standard 825-1 1993

⇒ USA standards 21CFR 1040.10, 21CFR 1040.11 and ANSI Z136.1-1986

⇒ British standard BS4803

⇒ Australian/New Zealand standard AS/NZS 2211-1997

The safety features provided in accordance with these standards include those described in the following table:

Table 2-1 Safety features

Feature	Description
Lockable Power On key switch	The laser can only be turned on with the correct key. The key cannot be removed while in the ON position, so the laser cannot operate without the key in place. When the system is on the control panel display is illuminated. <i>When not in use, protect the instrument from unauthorized use by removing the key.</i>
Emergency Laser Stop switch	This is a red mushroom-shaped button mounted on the key switch panel. When pushed in it cuts power to all functions.
Laser ON/OFF push button	During normal operation this illuminated push button switch is in the ON position (depressed and lit), indicating that the aiming laser is on and emitting light. When released, it immediately switches off the laser power supplies and eliminates any risk of laser irradiation.
Laser READY/STANDBY indicator	Once the power is turned on with the key switch, the Emergency Laser Stop switch and laser ON/OFF buttons are in the ON position, the display is illuminated and the STANDBY indicator is lit. The system must be manually switched to laser READY mode before the treatment laser is ready to fire.
Safety interlock	This is a user-installed feature. A socket is provided on the stand base (units with serial numbers pre-4000) or under the power supply console (units with serial numbers from 4000) for connection to a theater door interlock switch. When the door is opened the aiming beams are switched off and user controls are disabled. The treatment laser cannot fire while the door is open. These functions are returned two seconds after the door is closed or interlock otherwise satisfied. The unit is supplied with a shorting plug to bypass the interlock if it is not required. A recommended wiring diagram for the interlock is supplied in <i>Chapter 5</i> .
Safety shutter	A spring-loaded safety shutter is mounted in the laser head to keep the treatment laser optical path blocked unless the system is manually switched to laser READY mode and the fire switch is pressed.
Protective housings	Protective housings on the laser and optical system, as well as the control and display systems, are fully sealed to prevent the operator being inadvertently exposed to laser emission or high voltage shock. The protective housings cannot be opened without special tools and should never be opened except by the Ellex Service Representative.
Location of controls	All the operator controls are positioned so that there is no risk to the operator of inadvertent laser exposure.

Feature	Description
Ocular filters	The operator viewing port on the laser and optical system modules contains an infrared absorbing glass safety filter to limit the exposure level to the operator's eyes to below Class 1 limits. Any standard slit lamp viewing accessory can be used with the 3000LE slit lamp without hazard.
FDA and IEC compliance labels	For location and illustrations of the safety compliance labels see <i>Figures 2-1, 2-2 and 2-3</i> and <i>Tables 2-3 and 2-4</i>.
Electrical leakage protection	In units with serial numbers before 4000, an isolation transformer is built into the base. This ensures that the complete instrument, including the slit lamp power supply meets the requirements of IEC 601-1 for earth leakage protection. Units from serial number 4000 onwards do not have an isolation transformer, but a switched mode power supply (SMPS) is built into the power supply console to provide electrical leakage protection to meet the requirements of IEC 601-1.
Strain relief	A metal strain relief is attached to the mains power connector. When the power cord has been connected, this strain relief ensures that the cord is held in position and not accidentally removed. (To remove the power cord, lift the strain relief.)

2.2.2 Additional safety features

The **3000LE** is equipped with safety features in addition to the mandatory requirements, as shown in the table below:

Table 2–2 Additional safety features

Feature	Description
Self-test	When the system is first turned on it automatically performs a self-test program to confirm the safe and correct operation of the internal modules. During this procedure the microprocessor fires seven ¹ test shots with the shutter closed. If this test routine is satisfied the LCD is cleared and the energy of the last test shot is displayed. If a malfunction is detected an error code is displayed and the laser cannot be fired. See <i>Chapter 11</i> for a description of error codes.
STANDBY mode	When the self-test routine is successfully completed the system automatically switches into STANDBY mode. In this mode the aiming laser is made operable, as are all the controls, but the fire switch is disabled. To operate the fire switch laser READY mode must be manually selected. This minimizes the risk of accidental firing during patient set up. The shutter remains closed until the fire switch is pressed. Pressing the fire switch opens the shutter long enough for the treatment laser to fire. The shutter then closes.
Shutter monitor	A dual sensor shutter monitor checks the correct opening and closing of the shutter. In the event of a shutter malfunction the laser fire switch is disabled and an error code is shown on the display. See <i>Chapter 11</i> for a discussion of error codes.
Automatic test fire	Every time an energy setting is changed, either by the thumbwheel or by selection of the number of pulses, an automatic test fire occurs. During this test fire the shutter remains closed so there is no risk of exposing the patient or operator to laser radiation. Following a test fire, the resultant energy is shown on the display.
Manual test fire	A manual test fire is provided so that the operator can manually fire the laser by pressing the ENERGY TEST push button. During firing, the safety shutter remains closed, preventing treatment laser emission. After the test fire the resultant energy is shown on the display.

¹ Seven shots for software version 3.2 and later, five shots for version 2.2 and earlier.

2.3 SAFETY PRECAUTIONS

The safety precautions in this section must be clearly understood and followed by anyone using or servicing this equipment.

2.3.1 Treatment beam safety precautions

In normal use, the user is protected from hazards while in the normal operating position because the instrument is fitted with protective infrared absorption filters.

Caution

Nd:YAG Laser Emission Warning

Invisible laser radiation is emitted from the laser aperture when the system is in laser READY mode and the fire switch is pressed. Do not look into the beam. Do not expose tissue to the beam.

Any other personnel in the area should wear protective glasses to eliminate the risk of eye damage from stray or accidental emissions.

Viewing through all slit lamp optical accessories including camera adaptors and co-observation tubes is safe for the viewing eye because the built-in filter provides protection.

Protection at an optical density (OD) of at least 5 at 1064 nanometers (nm) must be provided for the eye that is not directly viewing through the accessory. The optical density is marked on safety glasses in a form such as:

⇒ OD 5 at 1064 nm

⇒ Neodymium – YAG

Glasses without such a marking are not suitable for eye protection. Suitable glasses are available as an accessory.

During service the protective housing may need to be removed to provide access to modules. Ensure that eye protection with an optical density of (OD) of at least 5 at 1064 nm is provided.

Caution

Reflection Warning

Objects that can reflect visible light will also reflect 1064 nm laser light. Avoid placing reflective materials such as glass, metal and polished plastic in the laser beam.

2.3.2 Aiming beam safety precautions

The aiming beam inside the system is a Class 2, 670 nm (nominal) red diode laser with power less than 1 milliwatt (mW). For such a laser the blink reflex is considered sufficient protection. Precautions are advisable to protect people in whom normal aversion responses are impaired or disabled.

The two diode aiming beams are attenuated to 100 microwatts (μW) maximum (200 μW in total for the two beams) before the exit aperture of the instrument. Even though damage to the retina from the aiming laser is most improbable, it is advisable not to stare into the system unless under controlled conditions.

Caution***Aiming Laser Emission Warning***

Visible laser radiation is emitted from the laser aperture when the system is switched ON and the laser on/off switch is in the ON position. Do not stare into the beam unless under the control of a qualified surgeon.

2.3.3 Fire safety precautions

The energy density of the focused treatment beam is high enough to ignite flammable liquids or gases, so the system should not be used in the presence of these materials.

Caution***Explosion Hazard Warning***

Do not use the treatment laser in the presence of flammable anesthetics or volatile organic fluids as the focused beam may cause ignition.

Some materials, such as cotton wool saturated with oxygen, may be ignited by the high temperatures produced by the focused beam. The solutions of adhesives and flammable solutions used for cleaning and disinfecting should be allowed to evaporate before the laser equipment is used.

2.3.4 Physical safety precautions

Do not use or service this instrument unless you understand the potential hazards inherent in laser technology.

Never place your hands, arms, or any other body parts or tissue in the path of the treatment laser beam.

When the instrument is unattended, turn it off and remove the key and store it in a safe place.

2.4 ELECTRICAL SAFETY PRECAUTIONS

Caution

Danger! High Voltage.

Switch off the instrument and disconnect it from mains power before servicing. Re-connect to power only if it is necessary for the particular servicing procedure involved.

Caution

Do not attempt to service the instrument if you are not familiar with precautions against electrical shock.

Ensure all safety precautions against electrical shock are followed as the laser system is powered from a 100 – 120 V AC or 220 – 240 V AC supply. Voltages of up to 12 kV are generated internally.

Caution

This system contains high voltage capacitors. Check that the capacitors have been discharged by the automatic dump circuit or bleed resistors before servicing.

2.5 SAFETY LABELS

This section contains a facsimile of every safety label and voltage/power rating attached to the **3000LE** together with its location. This information is provided in compliance with:

- ⇒ Australian/New Zealand Standard AS/NZS 2211-1997
- ⇒ European Standard IEC 601-1-1998
- ⇒ FDA guidelines

Figure 2-1: Safety labels and positions – 240 V model (S/N pre-4000)

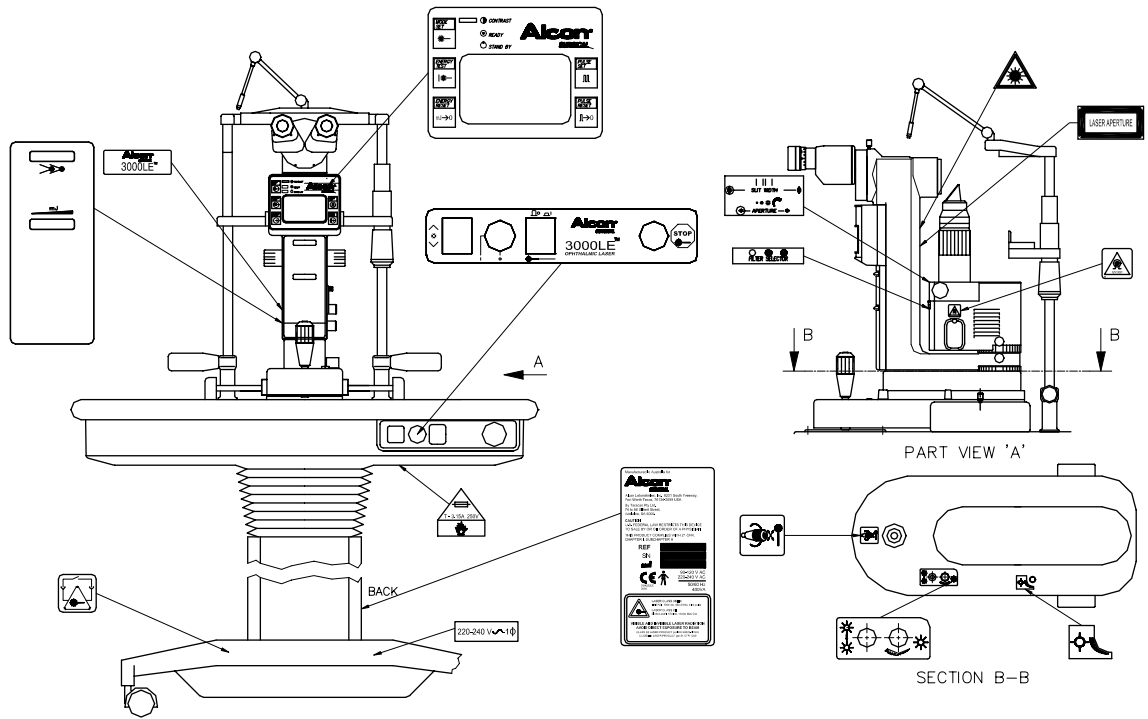


Figure 2-2: Safety labels and positions – 120 V model (S/N pre-4000)

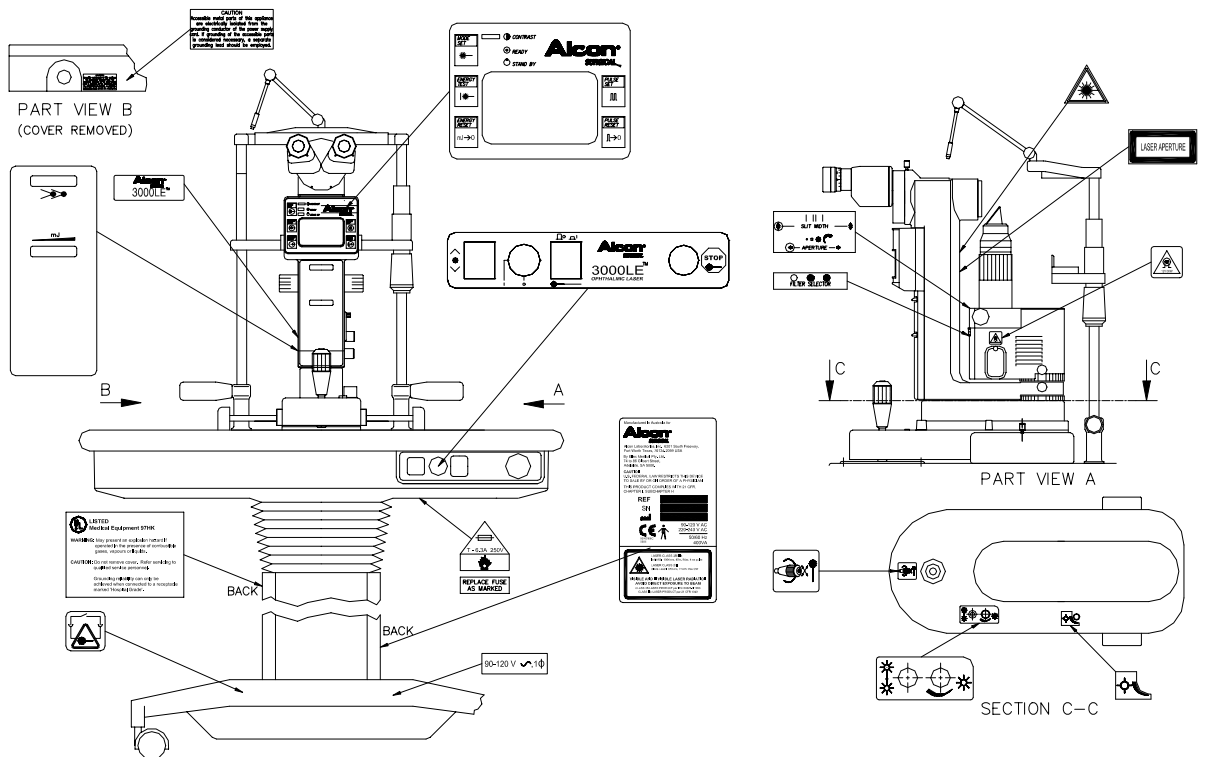
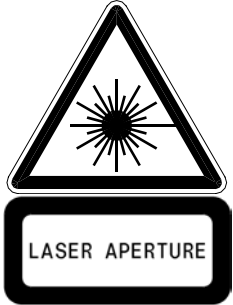
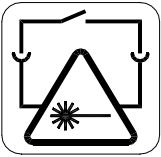
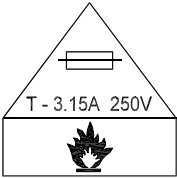
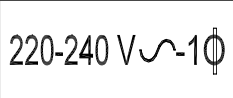
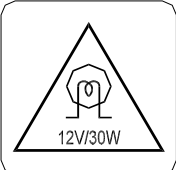
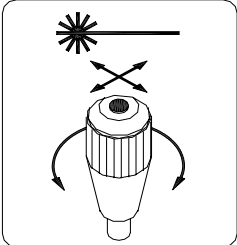
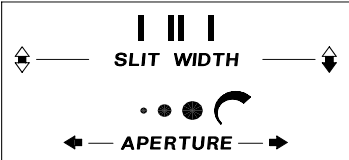
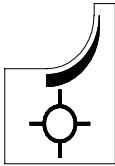
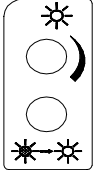


Table 2-3 Safety label descriptions (S/N pre-4000)

Label	Explanation
	Warning label indicating laser radiation hazard and class of treatment and aiming beam lasers. Complies with IEC 825-1 (1993). Explanatory label showing the position of the laser aperture. Complies with IEC 825-1 (1993) 1040-11 (a) (3).
	Label indicating the safety interlock connector.
Manufactured in Australia for Alcon SURGICAL Alcon Laboratories, inc. 6201 South Freeway, Fort Worth Texas, 76134-2099 USA By Taracan Pty Ltd. 258 Halifax Street, Adelaide, SA 5000. CAUTION U.S. FEDERAL LAW RESTRICTS THIS DEVICE TO SALE BY OR ON ORDER OF A PHYSICIAN THIS PRODUCT COMPLIES WITH 21 CFR, CHAPTER I, SUBCHAPTER H REF [redacted] SN [redacted]   90-120 V AC 220-240 V AC 50/60 Hz 400VA  VISIBLE AND INVISIBLE LASER RADIATION AVOID DIRECT EXPOSURE TO BEAM CLASS 3B LASER PRODUCT per IEC 60825-1:1993 CLASS IIIb LASER PRODUCT per 21 CFR 1040	Compliance label. Symbol indicating compliance with the Medical Device Directive (MDD) for CE marking. Compliance label showing type B equipment symbol. This symbol indicates that the equipment provides protection against electric shock through the limiting of leakage current and the provision of a protective earth connection. Warning label indicating laser radiation hazard and class of treatment and aiming beam lasers.
	Label indicating the mains voltage range for the 240V model and the type and rating of user accessible fuses.
	The sine wave symbol indicates AC voltage. The 1Ø symbol indicates single phase mains supply voltage.

Label	Explanation
	Label relating to the type of bulb that is fitted to the Slit Lamp.
	Label indicating the position of the laser fire button and the joystick operation.
	Symbol indicating the mains on position of the key switch.
	Symbol indicating the mains off position of the key switch.
	Symbol indicating the Emergency Laser Stop switch.
	Symbol indicating the treatment beam energy level adjustment thumbwheel.
	Symbol indicating the posterior offset adjustment thumbwheel.
	Label indicating the slit width and aperture size controls for the slit lamp.
	Label indicating the slit lamp filter selection control.
	Label indicating the aiming beam intensity.
	Label indicating the slit lamp illumination intensity control and the illumination boost control.

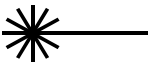
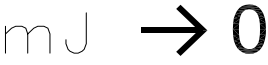
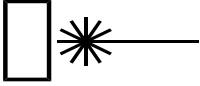
Label	Explanation
	Symbol on the control panel indicating that the laser system is in STANDBY mode.
	Symbol on the control panel indicating that the laser system is in READY mode.
	Symbol on the switch panel indicating the laser system on/off push button.
	Symbol on the control panel indicating the total energy reset button.
	Symbol on the control panel indicating the total pulses reset button.
	Symbol on the control panel indicating the pulse selection button.
	Symbol on the control panel indicating the contrast control.
	Symbol on the control panel indicating the energy test button.
	Symbol on the table up/down rocker switch on the key switch panel.

Figure 2-3 Safety labels and positions (S/N from 4000)

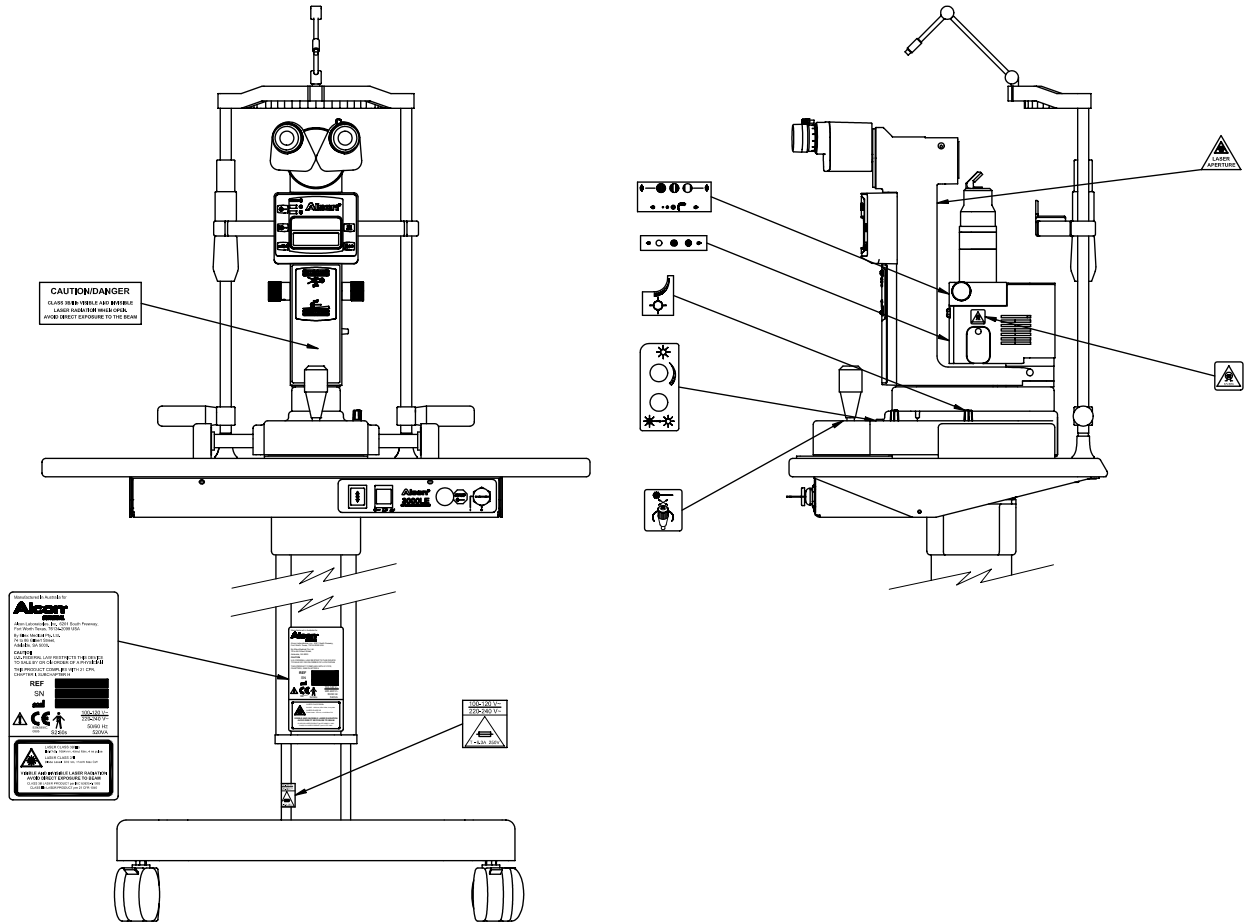
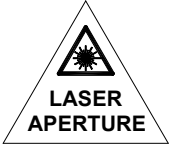
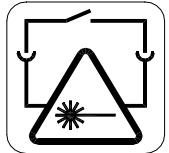
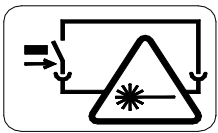
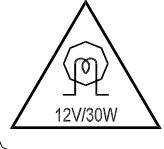
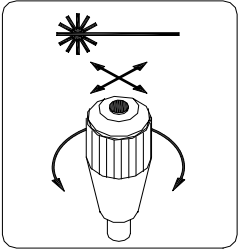
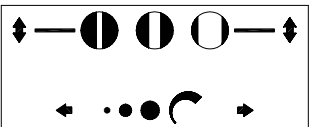
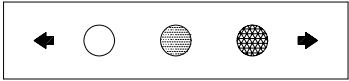
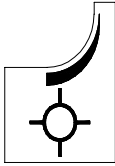
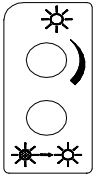
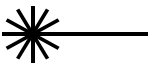


Table 2-4 Safety label descriptions (S/N from 4000)

Label	Explanation
	Warning label indicating the position of the laser aperture.
	Label indicating the safety interlock connector.
	Label indicating the accessories interlock connector. (Normally factory disabled.)

Label	Explanation
Manufactured in Australia for Alcon Alcon Laboratories, Inc. 6201 South Freeway, Fort Worth Texas, 76134-2099 USA By Ellex Medical Pty. Ltd. 74 to 86 Gilbert Street, Adelaide, SA 5000. CAUTION U.S. FEDERAL LAW RESTRICTS THIS DEVICE TO SALE BY OR ON ORDER OF A PHYSICIAN THIS PRODUCT COMPLIES WITH 21 CFR, CHAPTER I, SUBCHAPTER H REF [REDACTED] SN [REDACTED]    100-120 V~ 220-240 V~ 93/42/EEC 0805 50/60 Hz S2:60s 520VA  LASER CLASS 3B/IIb Nd:YAG: 1064 nm, 45mJ Max, 4 ns pulse LASER CLASS 2/II Diode Laser: 670 nm, <1mW Max CW VISIBLE AND INVISIBLE LASER RADIATION AVOID DIRECT EXPOSURE TO BEAM CLASS 3B LASER PRODUCT per IEC 60825-1:1993 CLASS IIb LASER PRODUCT per 21 CFR 1040	Compliance label. Symbol indicating the user must read and understand the Operator's Manual before using the system. Symbol indicating compliance with the Medical Device Directive (MDD) for CE marking. Compliance label showing type B equipment symbol. This symbol indicates that the equipment provides protection against electric shock through the limiting of leakage current and the provision of a protective earth connection. Denotes stand column height adjustment motor is suited for limited duration service of 60 seconds to prevent overheating Warning label indicating laser radiation hazard and class of treatment and aiming beam lasers.
100-120 V~ 220-240 V~  T - 6.3A 250V	Voltage label indicating the mains supply voltage range and the type and rating of user accessible fuses.
 12V/30W	Label relating to the type of bulb that is fitted to the Slit Lamp.

Label	Explanation
	Label indicating the position of the laser fire button and the joystick operation.
	Symbol indicating the mains on position of the key switch.
	Symbol indicating the mains off position of the key switch.
	Symbol indicating the Emergency Laser Stop switch.
	Symbol indicating the treatment beam energy level adjustment thumbwheel.
	Symbol indicating the posterior offset adjustment thumbwheel.
	Label indicating the slit width and aperture size controls for the slit lamp.
	Label indicating the slit lamp filter selection control.
	Label indicating the aiming beam intensity.
	Label indicating the slit lamp illumination intensity control and the illumination boost control.
	Symbol on the control panel indicating that the laser system is in STANDBY mode.
	Symbol on the control panel indicating that the laser system is in READY mode.

Label	Explanation
	Symbol on the switch panel indicating the laser system on/off push button.
	Symbol on the control panel indicating the total energy reset button.
	Symbol on the control panel indicating the total pulses reset button.
	Symbol on the control panel indicating the pulse selection button.
	Symbol on the control panel indicating the energy test button.
	Symbol on the table up/down rocker switch on the key switch panel.

2.6 CALCULATING NOMINAL OCULAR HAZARD DISTANCE

The nominal ocular hazard distance (NOHD) for the **3000LE** is 5.5 meters (18 feet).

The nominal ocular hazard distance is calculated from the output energy, beam divergence and diameter, and the maximum permissible exposure energy. The calculation is made using formulae from the Australian Standard AS/NZS2211.1:1997 (page 74), the equivalent American Standard ANSI Z1361-1986 (page 66) and EN60825-1:1993 (page 143).

3.1 LASER AND OPTICAL SYSTEMS

The laser and optical system is a pre-aligned system that produces a focused beam of pulsed Nd:YAG light with the following characteristics:

- ⇒ wavelength 1064 nm
- ⇒ high quality pulse of energy up to approximately 15 mJ per pulse (45 mJ for triple pulse)
- ⇒ 3 mm (0.12 in) beam diameter
- ⇒ well polarized (ratio: 100:1)
- ⇒ 4 ns pulse width, directed along the optical axis of the system
- ⇒ spot size 11 microns (calculated 84% energy in this diameter; full width half maximum (FWHM) spot size 8 microns)
- ⇒ focal length 92 mm (3.6 in), working distance 55 mm (2.17 in), and a cone angle of 16 degrees
- ⇒ twin beam diode laser aiming system
- ⇒ adjustable posterior offset up to 250 microns between the Nd:YAG and the diode focus

Figure 3-1 shows the position of the laser within the system.

Figure 3-2 is an optical block diagram.

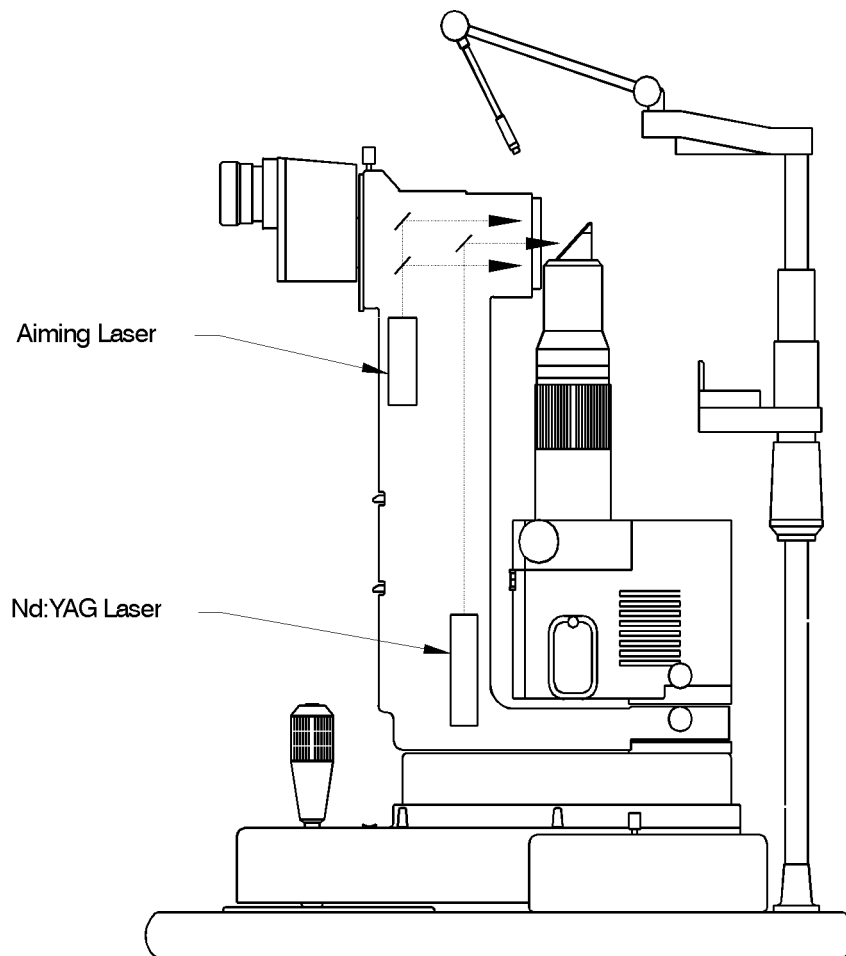
Figure 3-3 is a control block diagram.

The laser and optics follow three distinct paths:

- ⇒ *treatment beam path* — the path of the Nd:YAG laser beam used for treating the patient
- ⇒ *aiming beam path* — the path of the dual red diode laser beam used for aiming the laser beam
- ⇒ *viewing path* — the path from the eye of the patient to the eye of the operator

These paths are described later in this chapter and are illustrated in the optical block diagram.

Figure 3–1 **Position of the laser within the system**



3.1.1 Optical system components

The optical system of the **3000LE** comprises the following major components:

- ⇒ Nd:YAG laser module
- ⇒ aiming lasers
- ⇒ attenuator module with energy monitor module attached
- ⇒ beam expanding telescope
- ⇒ folding mirror module
- ⇒ objective lens
- ⇒ safety shutter
- ⇒ binoculars
- ⇒ CSO slit lamp
- ⇒ pulse detector

The relationship between these components is illustrated in the optical block diagram (*Figure 3-2*) and the control block diagram (*Figure 3-3*). Refer also to the drawings included at the rear of the manual. The functions of these modules and components are described in the remainder of this chapter. Procedures for testing and replacing them, along with further details about them are included in *Chapter 12*.

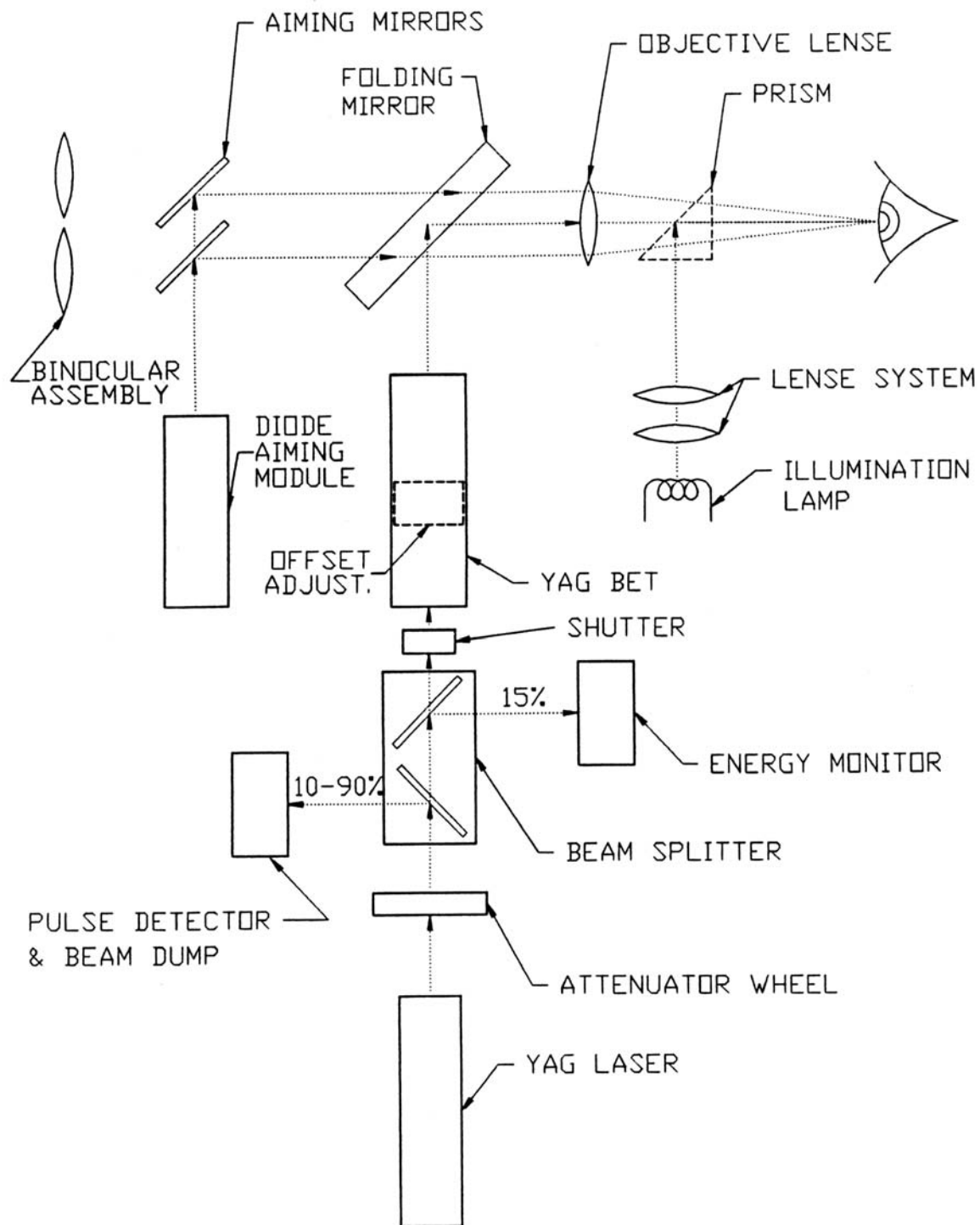
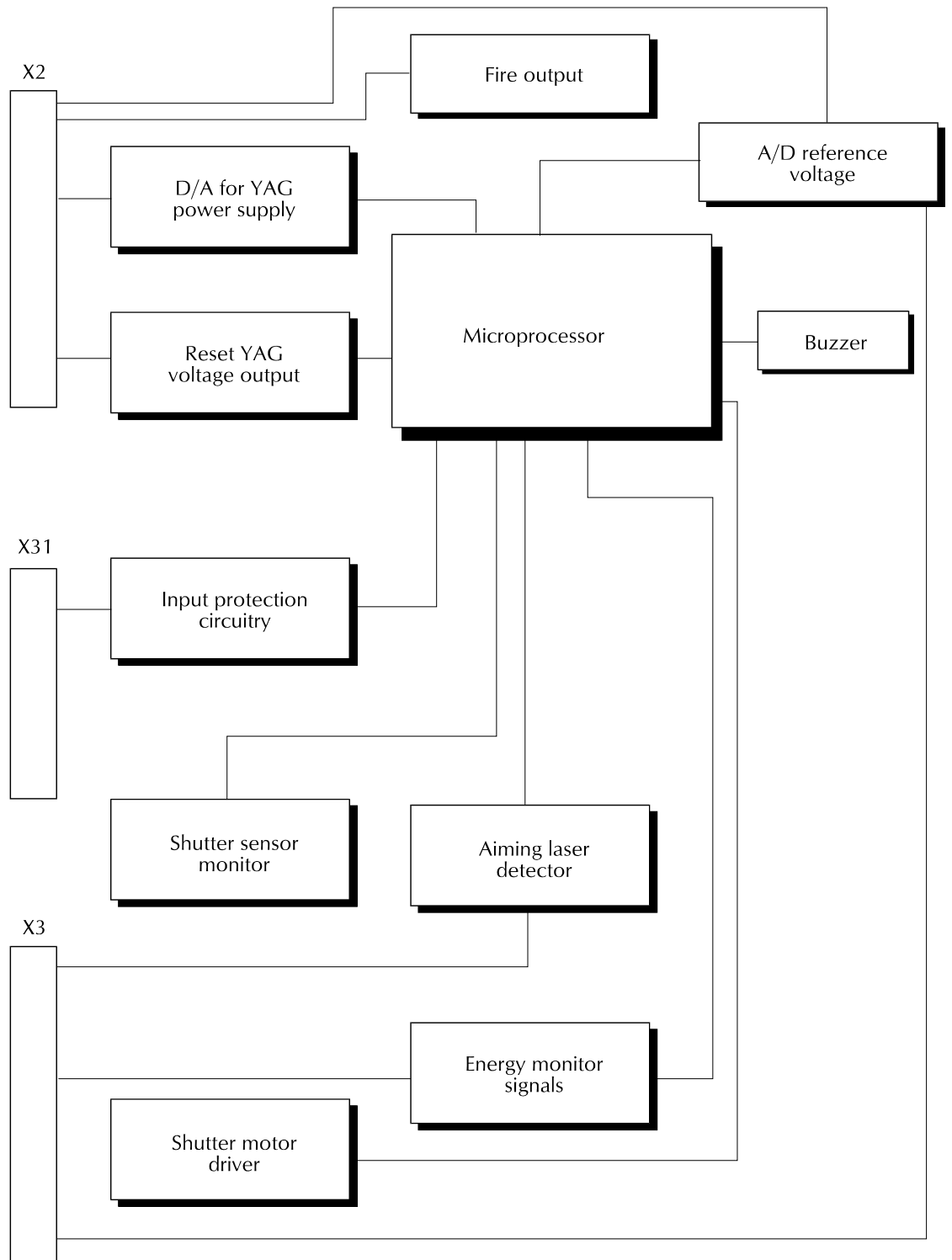
Figure 3-2 Optical block diagram

Figure 3-3 Control block diagram

3.1.2 Illumination system

The illumination system includes a 30W halogen lamp. The light from this lamp is delivered to the viewing plane through various lenses and prisms.

3.1.3 Nd:YAG treatment beam path

Pulses of laser light leave the Nd:YAG module where they are created and enter polarization-sensitive optics within an attenuator module. These optics transmit only the required energy level.

The operator selects the energy level using the energy thumbwheel on the laser head. The thumbwheel rotates one of the polarization-sensitive elements. The reflected energy enters the pulse detector and is absorbed. The detector is interrogated by the microprocessor to measure the number of pulses emitted from the laser.

The transmitted energy passes through an energy monitor beam splitter, where a further 15% is reflected to the energy monitor for a direct reading of the laser energy. The beam then enters the shutter. When the shutter is closed a total beam block absorbs the incident energy, but when it is open the beam passes through to a beam expanding telescope (BET).

The shutter contains a *flash filter* to remove visible light from the beam and prevent it from disturbing the patient when the laser is fired. The flash filter transmits the Nd:YAG wavelength with minimal loss.

The beam expanding telescope enlarges the beam diameter from 3 to 27 mm, which allows the beam to be focused to a small spot by the objective lens.

After leaving the beam expander the beam is reflected 90° to be coaxial with the surgeon's viewing axis. It is focused by the objective lens to an 11 micron diffraction limited spot. (8 microns FWHM).

Internal shutter

An internal shutter prevents pulses from the treatment laser from reaching the objective lens and being emitted unless the laser is in READY mode.

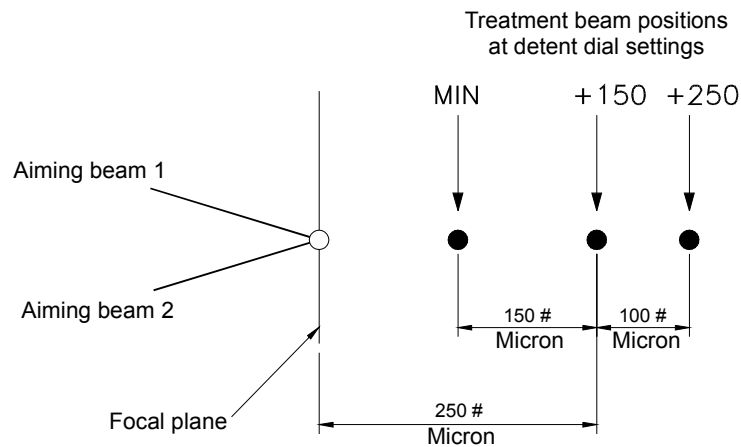
Measurement of pulse energy

When a pulse is fired the energy is measured by an internal energy monitor and displayed on an LCD on the control panel. After the set number of pulses (one, two or three) is fired the shutter closes. The laser can be fired again after a minimum time of one second.

Posterior Nd:YAG offset

The **3000LE** has an adjustable posterior YAG offset of 100 to 250 microns between the treatment laser focus and aiming beams, as shown in *Figure 3-4*, below. This offset is adjusted using the Posterior YAG offset thumbwheel on the front of the laser head. The normal initial setting is 150 microns.

Figure 3-4 **Posterior YAG offset**



Note that distances shown reflect measurements in air.

3.1.4 Diode aiming beam path

The **3000LE** is aimed by means of a visible red diode laser beam. This low power laser is coaxial with the Nd:YAG treatment beam and is delivered from the objective lens as two beams of converging spots that are parfocal with the slit lamp focal plane.

The diode aiming module, like the laser module, is pre-aligned in its carriage so that the beam lies on the aiming beam optical axis. The module contains:

- ⇒ laser diode and collimating lens
- ⇒ laser diode drive circuit including a 5 V regulator and a monitor signal output that connects to a PCB on the attenuator module
- ⇒ aiming beam focusing adjustment to enable the aiming beams to be focused in the viewing plane

The beam leaves the module and hits an aiming beam mirror, which reflects approximately 50%. The remainder is reflected by a second mirror, which is totally reflective. In each case the reflected light is coaxial with the treatment beam. The two beams are then focused by the objective lens into the viewing plane.

The intensity of the aiming beams is controlled by a knob at the base of the slit lamp, at the right hand side.

Small focal point adjustments can be made with the spring-loaded lens at the top of the diode aiming module to ensure the aiming beams are smallest when the system is focused. Refer to *Chapter 6* for further information.

The X-Y position of the aiming beam can be adjusted with the hex nut adjustments on the aiming mirror arms. Refer to *Chapter 6* for details.

These two adjustments enable you to accurately position the two beams on top of each other, and the treatment beam, and to ensure they are focused in the correct plane.

If the treatment and aiming beams are not centered in the illumination slit, an adjustment can be made to correct this.

3.1.5 Viewing path

The viewing path consists of a binocular assembly (delivered with 12.5 x eyepieces), safety filter, folding mirror and objective lens. The magnification of this standard system is 16 times.

The right hand eyepiece has a crosshair. The treatment and aiming beams should be centered in the cross. If they are not, refer to *Section 6.1* for the adjustment procedure.

Optical filters in the view path between the binoculars and folding mirror module limit the infrared exposure to the operator's eyes to a level below the Class 1 safety limit.

When the treatment laser is turned off the instrument can be used as a normal diagnostic slit lamp (see *Section 7.3.1*).

3.2 KEY SWITCH PANEL

The key switch panel is located on the right hand side, under the front edge of the table in units with S/N pre-4000, and on the power supply console in later units. The panel is covered by a durable polycarbonate membrane that provides a sealed, flush surface for protection and ease of cleaning.

Figure 3-5 Key switch panel (units S/N pre-4000)

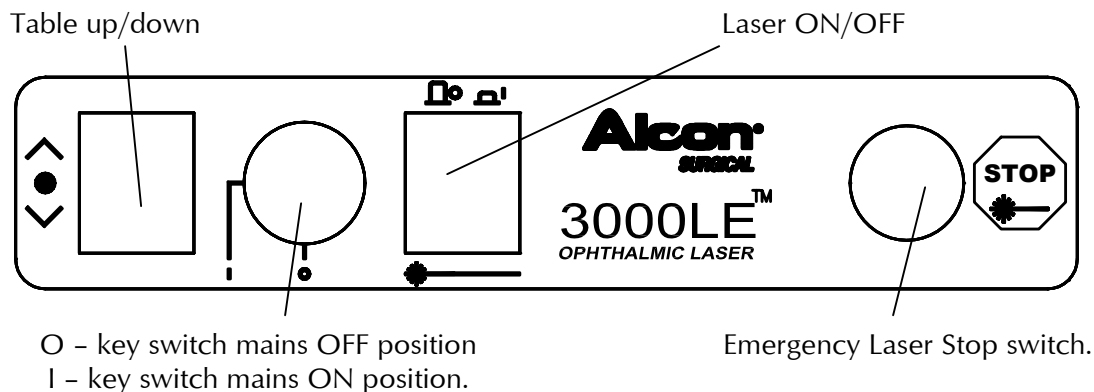
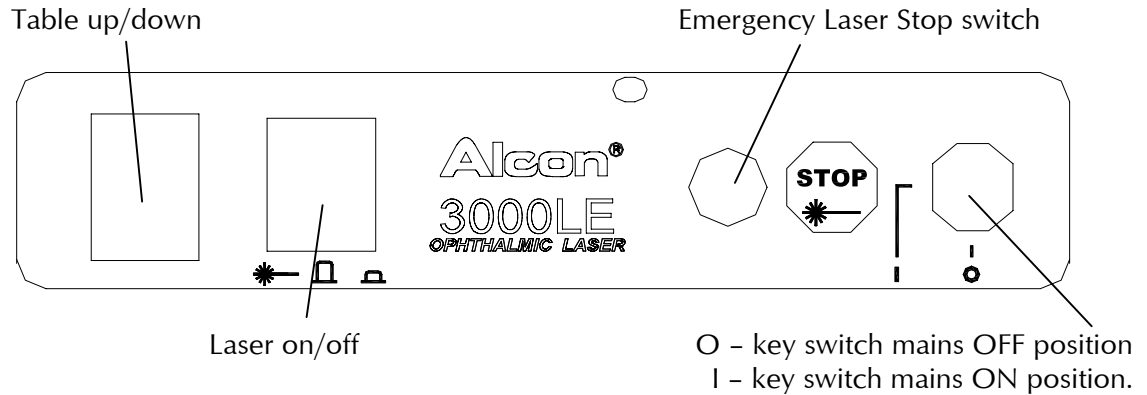


Figure 3–6 Key switch panel (units from S/N 4000)

3.2.1 Table up/down

This is a rocker switch with a spring return to the center (OFF) position. It controls the raising and lowering of the slit lamp table.

To raise the table push the switch above the center pivot. To lower the table, push the switch below the center pivot. When the switch is in the center, the table remains in position and cannot move.

The switch is illuminated when the key switch is turned on.

3.2.2 Key switch

The key switch is the main power switch for the **3000LE**. The key cannot be removed while in the ON position.

When the key is ON the slit lamp illumination is switched on and the laser can be fired provided the Emergency Laser Stop switch and laser ON/OFF button (both on the control panel) are in the ON positions and the laser is in READY mode.

3.2.3 Laser ON/OFF button

This is an illuminated push ON/push OFF switch. With the switch in the ON (down) position and the key switch turned on, the laser ON/OFF switch is illuminated, warning that laser emission is possible after a 20 second delay.

The laser ON/OFF switch does not control the slit lamp illumination.

To use the slit lamp as an observation lamp without any laser emission, turn the key switch ON and the laser ON/OFF switch OFF.

3.2.4 Emergency Laser Stop switch

The Emergency Laser Stop switch immediately shuts down the treatment and aiming beam lasers and cuts the power supplies.

The button is an approved 'mushroom' type. Push the button in to activate the Emergency Laser Stop. Turn in the direction of the arrows to release and allow the laser to operate.

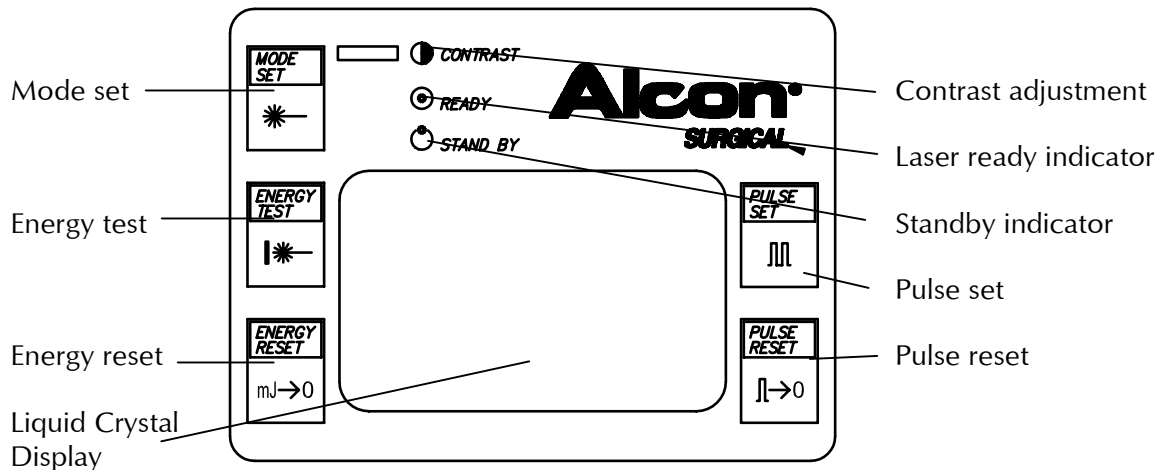
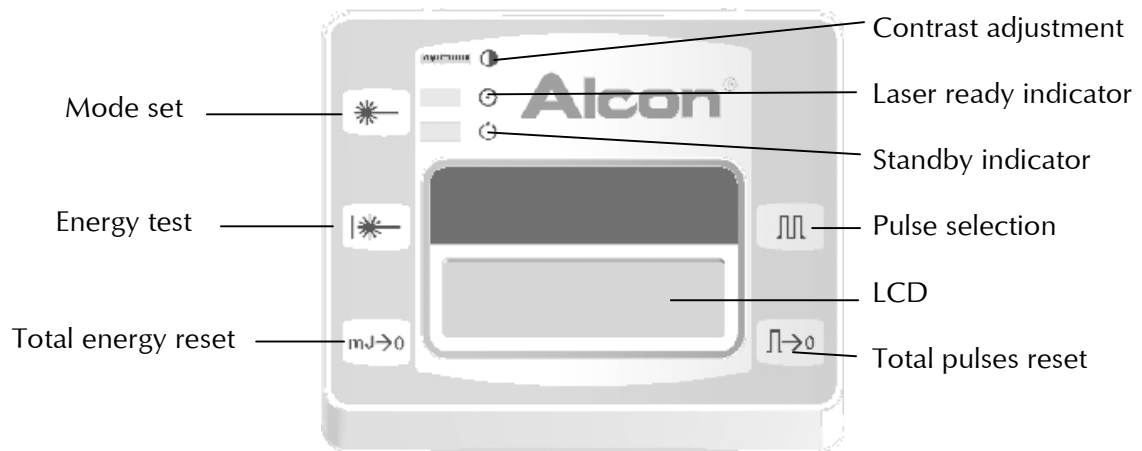
3.3 CONTROL PANEL

The control panel with its Liquid Crystal Display (LCD) (see *Figures 3-7, 3-8* and *3-9*) is located on the binocular support arm. It is covered by a durable polycarbonate membrane that provides a sealed, flush surface for protection and ease of cleaning. Each tactile push button beeps when pressed so the operator knows a setting has been changed.

A microprocessor mounted inside the control panel monitors and controls the function of the critical components. If a fault occurs it prevents the fire switch on the joystick from functioning and shows an error message on the LCD. (See *Chapter 11* for a description of the error codes.)

Avoid turning the instrument off and on rapidly. Allow at least five seconds after turning off before turning the instrument on again to allow the microprocessor to restart properly. If the display does not appear after a rapid turning off and on, turn the system off, wait for at least five seconds, then turn on.

Extreme cases of electrostatic discharge can cause segments of the LCD to go blank. If this happens, turn the mains power off then on again.

Figure 3-7 Control panel (units S/N pre-4000)**Figure 3-8 Control panel (units S/N from 4000)**

3.3.1 Mode set control

The MODE SET control is a membrane push button that selects the laser's mode of operation. The modes are:

- ⇒ *READY* – laser READY mode – laser ready to fire
- ⇒ *STANDBY* – laser STANDBY mode – operational but a shutter blocks the laser beam if fired

This button is also used to select the service engineering test modes used during calibration, alignment and fault finding. These modes are described in Chapter 11.

3.3.2 Contrast adjustment

This adjustment allows the operator to adjust the viewing angle of the LCD so that it gives the best contrast and can be seen clearly.

3.3.3 Laser READY indicator

The laser READY indicator shows that the instrument is in READY mode and is fully enabled and ready to fire treatment laser pulses.

3.3.4 STANDBY indicator

The amber STANDBY indicator indicates that the laser is in STANDBY mode and the safety shutter is blocking the treatment beam path.

In this mode the aiming laser is switched on and the treatment laser control switches will operate. The treatment laser can be fired with the ENERGY TEST button but because the shutter remains closed there is no emission.

STANDBY mode allows the operator to prepare for surgery and fully test the system without hazard.

3.3.5 Energy test button

The energy test button fires a test shot with the safety shutter closed. This tests the system function and displays the resultant energy on the ENERGY DISPLAY without delivering a treatment laser pulse from the laser aperture. This allows the user to prepare for surgery and fully test the system without hazard.

3.3.6 Energy reset button

This membrane push button resets the cumulative energy total register. It should be pressed before each procedure so the total energy delivered in a procedure is displayed.

Caution

<i>In laser READY mode dangerous laser radiation is emitted from the laser aperture when the fire switch on the joystick is pressed.</i>
--

3.3.7 Pulse set button

This membrane push button selects whether the laser fires single, double or triple pulse bursts when the fire switch is pressed.

When the system is switched on, single pulse mode is automatically selected. Pressing the switch once selects double pulse mode and pressing it again selects triple pulse mode. Pressing it once more selects single pulse mode again. The current selection is shown on the LCD at the Pulses Display (see Figure 3-9).

Every time the pulse set button is pressed an automatic test fire occurs with the shutter in the closed position.

3.3.8 Pulse reset button

Pressing this membrane switch clears the PULSES TOTAL register and resets the display to read zero.

Press this switch before each procedure so the cumulative total pulses during the procedure is displayed for reference.

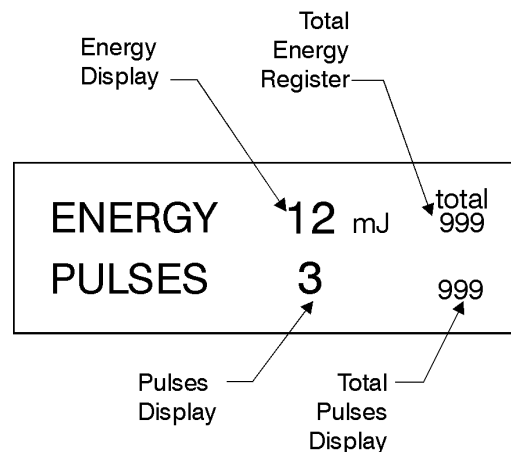
3.3.9 Liquid crystal display

When the laser has been fired this display indicates the total measured energy of the shot just fired to within $\pm 10\%$ of the actual energy. The energy is displayed at full brightness.

After a change in the energy selected, the display indicates the predicted energy set by the operator. The display is dimmed to indicate the energy is a prediction.

The LCD is illustrated below:

Figure 3-9 Liquid crystal display



Energy display

In laser READY mode part of the display shows the energy delivered when the laser is fired.

In STANDBY mode or test fire mode, or following a change in pulse selection or treatment beam energy, it shows the energy that would have been delivered if the shutter had been open.

The display is accurate to within 20% of the true energy.

Total energy register

The total energy register displays the cumulative total energy used during a procedure. The display is calibrated in millijoules (mJ) and rounded to the nearest millijoule.

This display is only incremented when a shot is fired with the shutter open, and allows the surgeon to see how much energy was delivered to the patient.

Pulses display

This part of the display shows '1', '2' or '3', indicating the selection of single, double or triple pulses per shot.

Total pulses register

The cumulative total pulses fired is recorded by this register. In single pulse mode the register increments in single units; in double pulse mode it increments two units at a time, and in triple pulse mode the register increments three units for each shot.

3.4 SOCKETS AND FUSES

The connections, sockets and fuses are:

- ⇒ theater door interlock connector
- ⇒ footswitch connector (S/N pre-4000), accessories interlock (4000 on)
- ⇒ fuses
- ⇒ power connector

In units with serial numbers before 4000, the mains fuse is located in the key switch panel and a secondary is in the base of the stand. Connections and sockets are all located in the base of the stand.

In units with serial numbers from 4000 onwards, the mains fuse is located in a removable holder at the top of the IEC mains input socket at the bottom of the stand, and there is no secondary fuse. The theater door and accessories interlocks are on the underside of the power supply console, and the mains socket is at the bottom of the stand.

3.5 ENERGY, AIMING AND FIRING CONTROLS

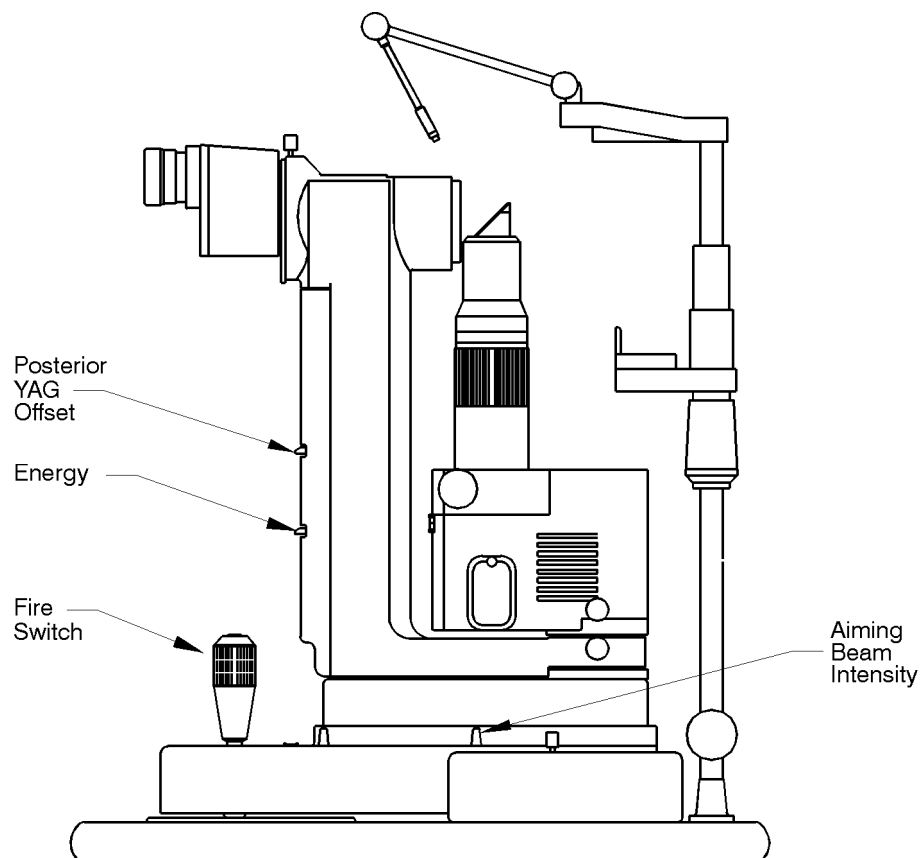
The following controls are available in addition to those located on the key switch panel and control panel:

- ⇒ aiming beam intensity
- ⇒ treatment beam energy
- ⇒ posterior YAG offset
- ⇒ fire switch

3.5.1 Aiming beam intensity control

The aiming beam intensity control is located on the right side at the base of the slit lamp (see below). (See also *Figure 3-11* for location and identification of other items.)

Figure 3-10 Energy, firing and intensity controls



The aiming beam intensity control varies the aiming beam intensity up to a maximum of 200 microwatts total output for the two beams.

3.5.2 Treatment beam energy control

The treatment laser energy is controlled by a continuously variable thumbwheel, located on the front of the laser head. The control adjusts the laser output energy from 0.3mJ to 10 mJ (typical).

As the thumbwheel is rotated the energy display on the LCD shows the approximate energy at that position. When an energy level is selected the system performs an automatic test fire at the new thumbwheel position and the energy display shows the actual energy level.

The value may vary slightly from the initial indicated position, but this is not a fault condition.

If the delivered energy deviates from the last test fire energy by more than $\pm 17\%$ the unit will beep twice in rapid succession to alert the operator, but the system can be used normally. If this warning occurs frequently, or if the delivered energy is more than double the last test fire energy, an E12 error will be displayed and the system will shut down. See *Chapter 11* for details of this error code.

This feature is only available for software version 3.2 and above.

3.5.3 Posterior YAG offset

The offset control is located immediately above the energy select thumbwheel, and adjusts the focal position of the treatment laser in relation to the aiming lasers. The offset control is continuously variable between minimum and +250 microns, with detents at MIN, +150 and +250 microns.

The posterior YAG offset control allows the physician to change the Nd:YAG energy focus in relation to the aiming beams as energy levels are altered. As energy is increased the offset should be increased to ensure that no damage occurs to the IOL.

An increase in IOL pitting is possible when silicon IOLs are used. We advise caution when using silicon IOLs and recommend using +250 offset position. If pitting persists, defocus the laser further posterior manually.

The **3000LE** is factory adjusted to provide optimum performance at 1.5mJ energy output with +150 microns offset. Thus, if a lower energy is selected (such as 0.5mJ) the offset control should be reset to MIN offset position. Conversely, if energy is increased the offset should be increased to +250 microns. (See *Figure 3-4*.)

3.5.4 Fire switch

The fire trigger switch is located on top of the joystick. This switch is only active when all the following conditions are met:

- ⇒ key switch is in the ON position
- ⇒ laser ON/OFF switch is in the ON position and illuminated red
- ⇒ Emergency Laser Stop switch is off (released)
- ⇒ system is in laser READY mode

The fire switch should be released quickly after each firing action. If not, the system will automatically return to STANDBY mode giving an audible warning. The system can be manually returned to READY mode once the fire switch has been released.

Caution

When the fire switch is pressed, with the unit in laser READY mode, dangerous laser radiation is emitted from the aperture.

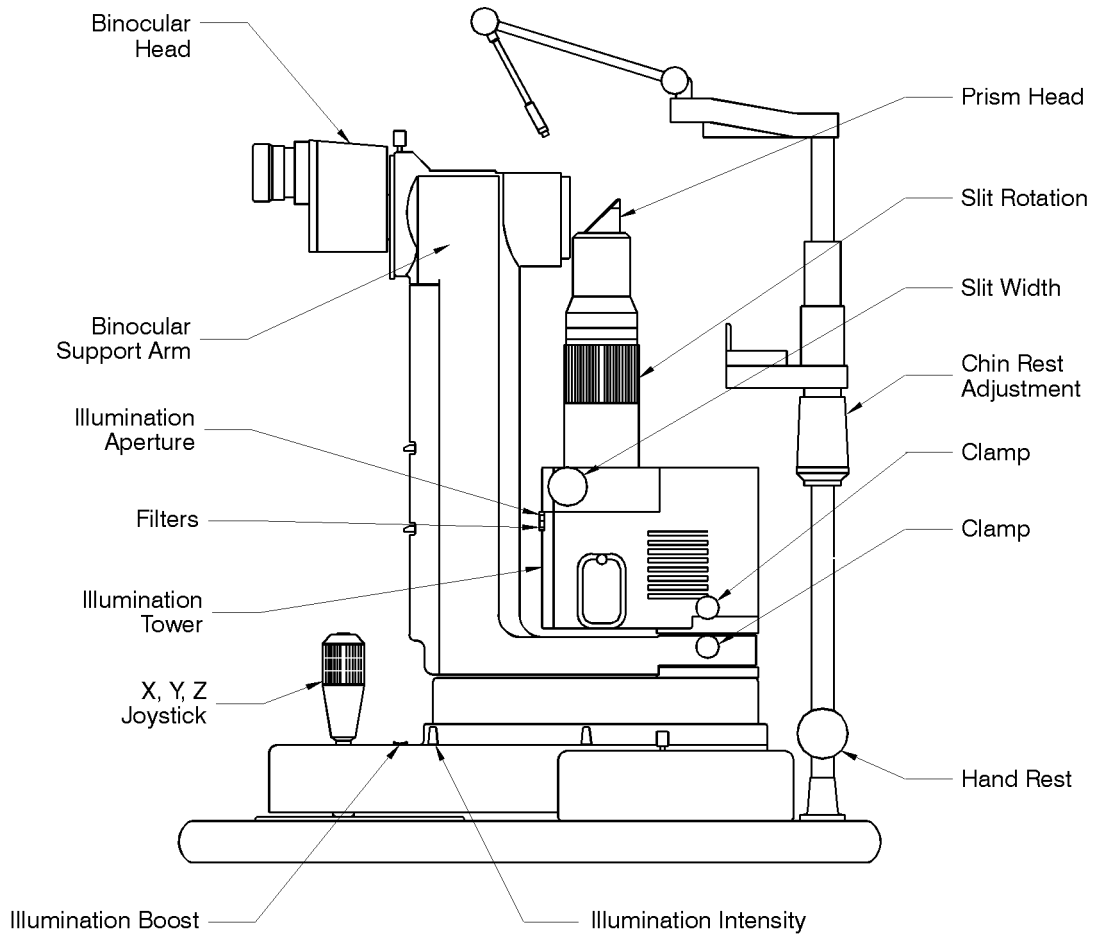
3.6 SLIT LAMP AND CONTROLS

In the **3000LE** the slit lamp is a standard CSO type, modified by the replacement of the standard slim-line binocular head support arm and magnification changer, with a special enlarged support arm containing all the laser optics. All slit lamp features and controls remain unchanged.

Refer to Appendix D for information on Nikon -type slit lamps.

The standard **3000LE** is supplied with fixed magnification of 16 x using 12.5 x eyepieces. An optional three-step magnification changer (12 x, 16 x and 28 x) can be fitted between the binocular head and the support arm. See *Section 13.10* for specifications of the optional accessories.

A general view of the slit lamp and its components is shown below:

Figure 3-11 General view of slit lamp***Illumination on/off***

The halogen lamp illumination is controlled by the key switch on the key switch panel.

X, Y, Z joystick movement

The main unit can be moved backwards, forwards, left and right by manipulating the joystick. The unit moves in the direction of the joystick. To adjust the unit height, rotate the joystick.

Illumination intensity

The brightness can be adjusted by the illumination intensity control on the laser head/slit lamp base. Turning clockwise increases the brightness and turning counter-clockwise reduces the brightness. This knob only adjusts the brightness. To switch the illumination lamp on or off use the key switch on the key switch panel.

If high illumination is not required, keep the lamp at minimum intensity to reduce heat build-up. Do not leave the illumination intensity at maximum for more than ten minutes.

Illumination boost

The illumination boost is a non-locking push button that overrides the illumination intensity to give maximum illumination while pressed.

Slit width control

The slit is opened and closed by rotating the inner section of the slit adjustment control on either side of the illumination tower. The control can be rotated 90 degrees clockwise to close and counter clockwise to open.

Rotation of slit

The slit can be rotated by turning the knurled black section of the illumination tower. This control adjusts the slit rotation through 180 degrees — 90 degrees either side of the vertical position.

Illumination aperture

Various illumination fields are available, and can be selected by turning the illumination field adjustment turret (which is the top wheel on the front of the illumination tower). A continuously variable aperture and the following illumination fields are available: 0.5 mm, 5 mm, 8 mm and 12 mm.

Filters

Blue, green or ND filters are available, and selected by turning the filter turret, which is the top wheel on the front of the illumination tower.

Clamp

The clamp screws for the illumination part, the microscope and the cross slide table are located at the right side of the main unit (viewed from the operator's side). Turn the screws clockwise to clamp each part.

Hand rest

The position of the hand rest can be set at any level. Turn it counter clockwise to loosen. Turn the screw clockwise tightly when it is fixed at the preferred angle. Make certain that the end of the screw of the hand rest is placed in the groove of the chin rest support.

Illumination tower

The illumination tower can be moved either side of the center position approximately 60 degrees when the slit lamp is in the forward position and 120 degrees when in the backward position.

Binocular support arm

This arm can be moved approximately 20 degrees to either side of the center position so that the operator can view difficult parts of the eye.

4.1 ELECTRICAL SYSTEM DESCRIPTION

This section describes the electrical and electronic functions and event sequences of the **3000LE**. A control block diagram is shown in *Figure 3-3*.

4.1.1 Electrical power cord

The **3000LE** is fitted with an IEC approved power cord connection socket in the key switch panel in units with S/N pre-4000 and in the base of the stand in units with S/N from 4000.

A hospital grade power cord is provided, but without a plug attached. International plug requirements vary and you should find a local plug supplier to supply a plug that complies with local standards.

Once connected, the power cord is held in place with a metal strain relief to ensure that the cord is not accidentally dislodged from the connector.

4.1.2 Theater door interlock

The interlock is an optional accessory, and therefore not normally supplied.

The interlock socket (which accepts a standard three-pin DIN plug) is located at the base of the stand in units with S/N pre-4000 and at the top of the stand in units with S/N from 4000. It is intended for use with an optional theater door circuit to disable the laser when the door is opened.

The interlock is a safety feature. If the interlock is fitted and the theater door is opened, the treatment and aiming beam lasers are disabled and the shutter is closed. A beeper in the unit sounds until the door is closed. The controls and lasers will not function until two seconds after the interlock connection is re-established.

A pre-wired DIN plug is supplied to act as a blanking plug if the interlock is not required. If the theater door interlock is to be installed the blanking plug is removed and a DIN plug connected and wired to a micro-switch circuit fitted to the room door. The circuit diagram is included among the electrical drawings at the rear of this manual.

4.1.3 Fuses

In units with S/N pre-4000 the mains fuse is located in the key switch panel and a secondary is in the base of the stand.

In units with S/N from 400, the mains fuse is located in a removable holder at the top of the IEC mains input socket at the bottom of the stand, and there is no secondary fuse.

4.1.4 Key switch

The key switch located on the key switch panel controls the mains power on/off to the **3000LE**. When the key switch is in the ON position power is applied to the laser system and the slit lamp.

The key cannot be removed from the switch when it is in the ON position.

4.1.5 Emergency Laser Stop switch

When this button (on the key switch panel) is pulled out to the ON position, it is activated, the control panel display is illuminated and power is supplied to the microprocessor.

The Emergency Laser Stop switch is connected in series with the key switch. Both must be ON before the treatment laser can be used.

4.1.6 Accessory interlock

The accessory interlock is used when connecting an accessory on the laser. The interlock allows the **3000LE** to be disabled whenever the accessory is being used, to avoid damaging the accessory.

4.2 START-UP AND INITIALIZATION PROCESSES

The following self-testing and initialization steps occur when the key switch and Emergency Laser Stop switch are both turned ON. They are controlled and monitored by the microprocessor.

- The display lights up all segments for two seconds.
- The system is set to single pulse mode.
- The microprocessor checks that the shutter is closed.
If the shutter is open, the microprocessor shuts down the laser system and displays an error code.
- If the shutter is closed the microprocessor checks that the Nd:YAG storage capacitor is charged.
- As soon as the capacitor is fully charged the power supply sends a 'charging complete' signal to the microprocessor.
- The microprocessor sends signals ordering an auto test fire of seven test shots to be fired.

The shutter is closed during test firing.

- The sampled energy from the last test fire is displayed on the LCD.
- The microprocessor checks for any over-pulse condition (see *Chapter 10*).
If an over-pulse is detected, the system shuts down and an 'E04' error message is displayed.

The system automatically adjusts the YAG voltages and corrects for this condition (for version 3.2 software and above).

- The microprocessor checks the aiming laser detector signal to ensure that the aiming laser is operational.

After performing the initial set up and test fire described above, the microprocessor continually monitors the following:

- ⇒ the five display controls
- ⇒ treatment energy selection
- ⇒ aiming laser detector signal
- ⇒ pulse selection
- ⇒ posterior YAG offset selection
- ⇒ fire switch operation

If the operator changes any of these controls the microprocessor detects the change and responds accordingly.

The aiming laser detector signal is a status signal, which is not controlled by the operator. It is a safety feature to ensure that the treatment laser cannot be fired if the aiming laser is not operational.

4.3 FIRING PROCESSES

When the start-up and initialization processes are complete and all required conditions are met, the laser is ready to fire. It is fired by pressing the fire switch on the joystick or the system test fire button. Whenever an attempt is made to fire, the following processes occur:

- The microprocessor reads the fire instruction.
- The microprocessor sends a 'fire' signal to the YAG trigger module
- The Nd:YAG trigger module sends a high voltage trigger pulse to the flash lamp in the YAG laser.

Two sensors inside the Nd:YAG attenuator module detect the shutter position. If the shutter malfunctions the microprocessor shuts down the Nd:YAG power supply, disables the unit and displays an error code.

- The flash lamp converts the energy in the storage capacitor into a flash of light.
- This flash in turn energizes the laser rod.
- The shutter motor opens the shutter.

4.4 PULSE MODES

The system can be set to single, double or triple pulse mode. If the number of pulses is increased the microprocessor sends a control voltage to the Nd:YAG power supply module, which increases the required voltage of the storage capacitor accordingly.

If the number of pulses is decreased the microprocessor sends a signal to the Nd:YAG power supply module, which discharges the storage capacitor in three seconds and re-charges it to the required level.

INSTALLATION AND COMMISSIONING**5.1 INSTALLATION/COMMISSIONING PROCEDURES**

The installation described here assumes the unit has been delivered to the location where it will be unpacked, assembled and used.

Installation consists of:

- Checking the shipping carton and unpacking the contents to determine if any damage has occurred during shipping.
- Assembling the unit.
- Commissioning the unit.

5.2 TOOLS AND MATERIALS

The following tools and materials are recommended for the installation, commissioning and servicing of the **3000LE**:

- ⇒ 1.5 mm (0.06 in) ball driver
- ⇒ Phillips head screwdrivers; small, medium and large
- ⇒ flat blade screwdrivers; small, medium and large
- ⇒ set of hex wrenches (Allen keys), metric and imperial
- ⇒ jeweler's flat blade screwdriver
- ⇒ penlight flashlight
- ⇒ 22 mm (0.9 in) box wrench for chin rest nuts
- ⇒ target jig
- ⇒ burn paper
- ⇒ alignment jig
- ⇒ binocular offset jig
- ⇒ model eye
- ⇒ model eye membranes
- ⇒ saline solution
- ⇒ modified 5 mm (0.2 in) nut driver
- ⇒ medium adjustable spanner
- ⇒ voltmeter with 1000 V DC range and leads
- ⇒ testing cable
- ⇒ container of AR grade ethanol
- ⇒ cotton buds such as Q-tips
- ⇒ optical lens tissues
- ⇒ silastic adhesive (or equivalent)
- ⇒ spirit level

5.3 INSPECTING THE CARTON

Before unpacking the unit, inspect the shipping carton for any signs of damage. If damage exists contact the freight company and Alcon Laboratories Inc to make arrangements to allow the installation to proceed with the minimum of delay.

5.4 OPENING THE CARTON

Caution

Only authorized Alcon personnel are permitted to unpack the unit from its shipping carton.

Unauthorized opening of the carton will void the warranty.

If the unit has been unpacked by unauthorized personnel, record this on the commissioning sheet. Under such circumstances the warranty is provisionally voided and the matter should be referred to the factory for discussion with the customer. If no damage or loss is evident you may continue with the installation if the customer accepts the voided warranty.

The customer's signed acceptance of the voided warranty is required.

5.5 LIST OF CONTENTS

The **3000LE** is normally supplied in a shipping carton with the contents packed as listed here².

Do not unpack the carton yet.

Main carton

- ⇒ base assembly
- ⇒ table assembly
- ⇒ key (taped to table top)
- ⇒ column assembly
- ⇒ slit lamp box
- ⇒ chin rest box
- ⇒ accessories box
- ⇒ installation forms
- ⇒ certificate of conformance

² Packing arrangements may differ for units with serial numbers pre-4000.

Slit lamp box

- ⇒ laser module assembly
- ⇒ target
- ⇒ chin support pads
- ⇒ shaft
- ⇒ gears, washers and screws
- ⇒ gear covers
- ⇒ binocular body including eyepieces (12.5 x and 12.5x C)
- ⇒ 20 mm semi-delay fuses 6.3A for 120/240 V
- ⇒ spare globes for fixation lamp
- ⇒ halogen globe 12 V, 30W
- ⇒ spare key
- ⇒ Allen key set
- ⇒ Allen key 5.0 mm AF

Chin rest box

- ⇒ chin rest assembly with fixation lamp
- ⇒ handles
- ⇒ power cable — general purpose 250 V
- ⇒ Operator's Manual
- ⇒ dust cover

Footswitch box

Contains only the footswitch and its cable.

Mag changer box

Contains the magnification changer.

Accessories

Any accessories ordered are packed in the accessories box.

5.6 UNPACKING THE CONTENTS

Refer to the list of contents while unpacking the components.

Caution

Take extreme care throughout the following procedures not to jar the optical assembly or scratch any paintwork.

Before unpacking the unit, inspect the shipping carton for any signs of damage. If damage exists contact the freight company and Alcon Laboratories Inc to make arrangements to allow the installation to proceed with the minimum of delay.

Retain the shipping carton, boxes and packing materials as these may be used for later transportation.

Ensure the serial number of the laser head is identical to that of the control console.

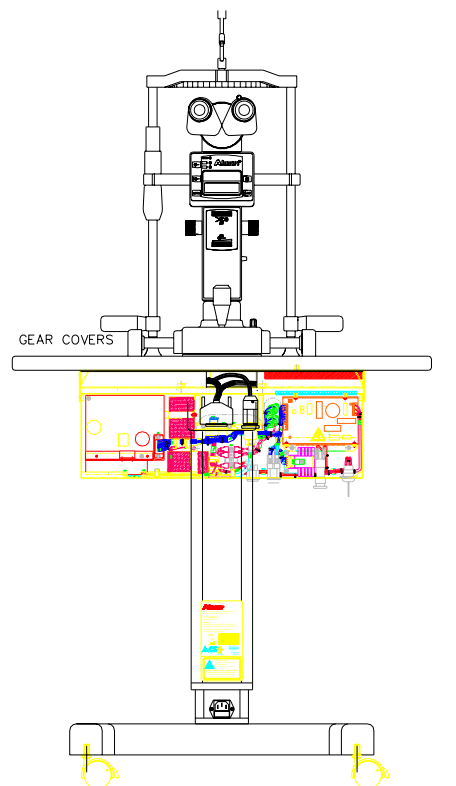
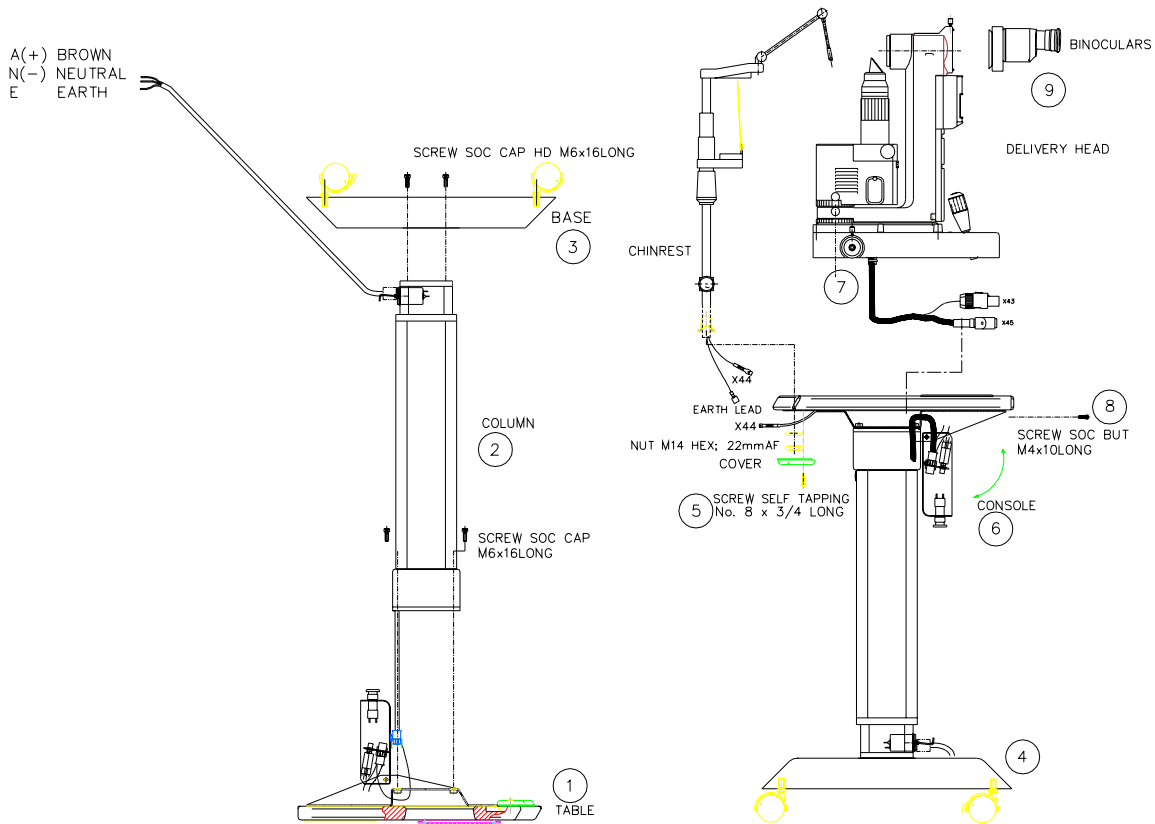
5.7 STAGES IN ASSEMBLY

The equipment is assembled in the following stages:

- ⇒ assemble the table and column
- ⇒ locate and level the table top
- ⇒ assemble the chin rest
- ⇒ check mains voltage
- ⇒ assemble the optical components
- ⇒ connect the safety interlock
- ⇒ connect to mains power
- ⇒ mains power cable attachment
- ⇒ footswitch adaptation (optional accessory)
- ⇒ head band long (optional accessory)
- ⇒ magnification changer (optional accessory)

Refer to *Figure 5-1* during installation.

Figure 5-1 Installation diagrams



5.8 ASSEMBLING THE TABLE, BASE AND STAND

To assemble the column to the table:

- Place the table top down on the bubble wrapping.
- Screw the column to the underside of the table as shown at 1 in *Figure 5-1*, ensuring the colored spots match and the X48 connector is inserted into the hole in the channel.

5.8.1 Fitting the base

To fit the base:

- Screw the base to the column as shown at 3 in *Figure 5-1*, matching the colored spots.

5.8.2 Positioning and leveling the unit

To position the unit:

- Lift the unit into its upright position.
- Position the table in the location required by the customer.
- Check and level the castors as required (3 in *Figure 5-1*).
- Lock the castors.
- Check that the table cannot rock.
- Check the table is level in each direction.

The table top is leveled at the factory and will not normally require adjustment.

5.9 ASSEMBLING THE CHIN REST

Units with S/N pre-4000

To fit the chin rest to the table top in these units:

- Raise the table to its full height.
- Remove and carefully lower the bottom cover of the table.
- Feed the legs and cable through the table, ensuring the chin rest is facing the patient side of the table.
- Loosely place the earthing connector on the leg with the cable and a washer and nut on each of the chin rest legs protruding through under the table.

The cable will need to be fed through the washer, nut and box wrench while tightening the appropriate leg.

- Tighten both nuts.
- Feed the electrical lead inside the chassis and connect to its mating part, which is part of the under-table wiring loom X44.

On systems supplied with the Laserex slit lamp the fixation lamp earth lead (X27) should be attached to the slit lamp earth point.

- Ensure that the chin rest may be adjusted smoothly and freely over its full range of movement.

Units with S/N from 4000

In these units the chin rest is supplied from the factory mounted onto a bracket. To assemble it to the table top:

- Fit the chinrest to the table (see 5 in *Figure 5-1*).
- Connect X44 and the earth lead.
- Fit the cover.
- Ensure the chin rest can be raised and lowered smoothly.

5.10 CHECKING MAINS VOLTAGE

Caution

Do not plug in the unit until you have confirmed the correct voltage.

The laser system is powered from either a 100 - 120 V AC or 220 - 240 V AC supply. Before continuing the assembly, check that the operating voltage of the unit is compatible with local mains voltage.

If changing the mains voltage after assembly, switch the system off and unplug from the mains before changing.

Units with serial numbers pre-4000

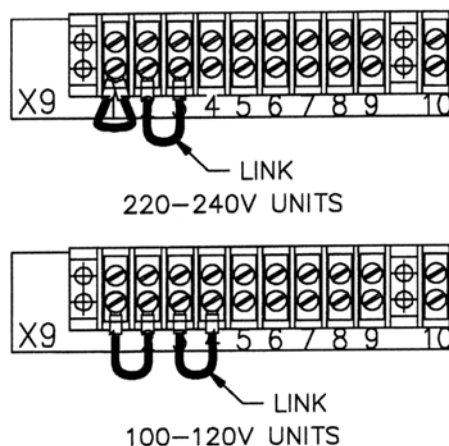
In these units the operating voltage is stated on a label on the key switch panel next to the mains fuse.

If the operating voltage indicated is incorrect for the local supply, change the voltage taps as follows:

Caution

The voltage must only be checked or changed when the optics are not fitted to the table. Inverting the table while optics are in place may cause damage or misalignment.

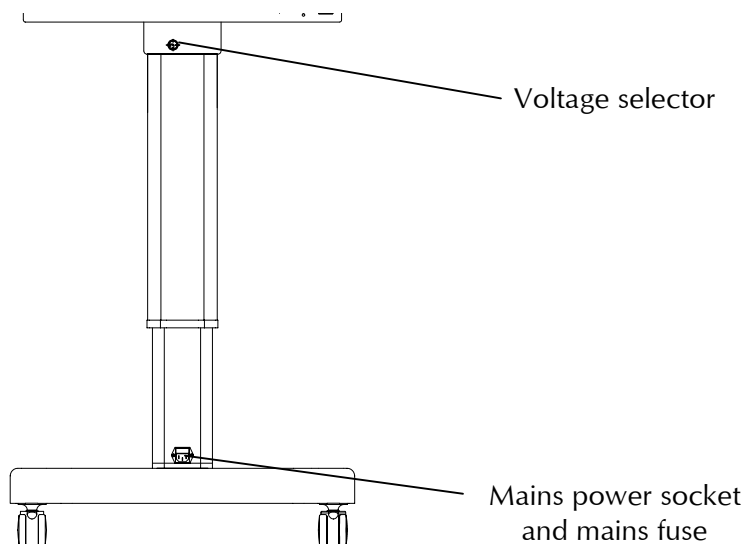
- Invert the table and chassis assembly.
- Remove the bottom cover to expose the connector labeled X9.
- Check against *Figure 5-2* to confirm the voltage setting.
- Re-set the links as necessary.
- Replace the base cover.
- Return the unit to the upright position.
- Replace fuses with correct type.

Figure 5-2 Mains tap settings***Units with serial numbers from 4000***

In these units the operating voltage is stated on a label on the base of the stand next to the mains power cable socket.

If the operating voltage indicated is incorrect for the local supply, change the voltage setting as follows:

- Using a slotted screwdriver, rotate the voltage selector switch at the top of the stand column (at the same side as the inlet socket — see below) to align the arrow with the required voltage (100 - 120 V or 220 - 240 V AC).

Figure 5-3 Table and stand

5.11 ASSEMBLING THE OPTICS

Units with S/N pre-4000

Before carrying out the optical assembly, make sure that the table is set up, the cross slide tracks are attached and the mains voltage is correctly selected.

Caution

Take extreme care throughout the following procedures not to jar the optical assembly or scratch any paintwork.

Assemble the optics as follows:

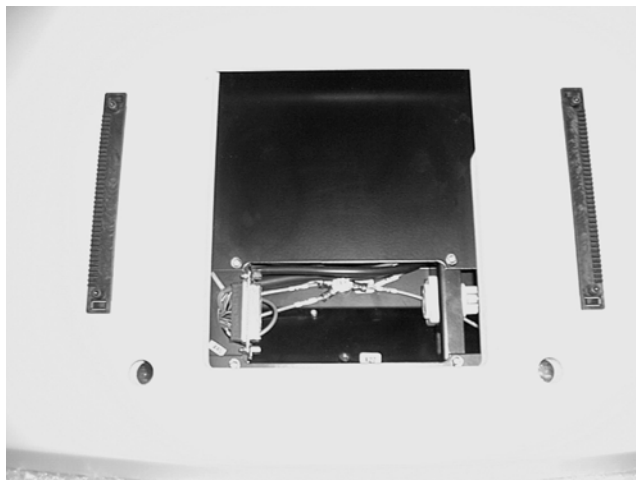
- Remove the insert tray on the table.
- Gently remove the laser head from its foam container.

Do not remove the plastic wrapping until the assembly is complete.

Assembling the cross slide

- Feed the cross slide through the unit.
- Locate, press and screw on both end caps.
- Lower the unit on to the table, ensuring that the gears on the end caps mesh evenly and smoothly with the tracks on the table (shown below).

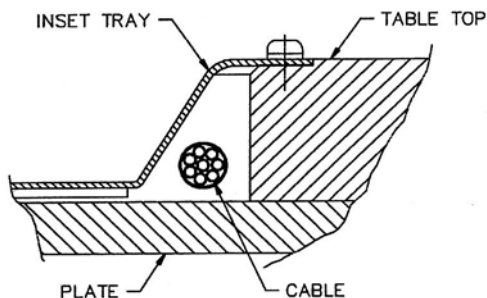
Figure 5-4 **Optical assembly before connections**



Cabling and connections

- Feed the cable through the gap in the table top to its destination, as shown below.

Figure 5-5 Cable positioning



- Connect all plugs.
- Ensure the X43 cable connector is plugged in correctly by inserting the connector to its socket and turning it clockwise until you hear a click.
- Connect ground cable (X27).
- Tighten all locking screws.
- Move the optical head assembly through its extremities and ensure the cable is correctly positioned and is not kinked or strained.

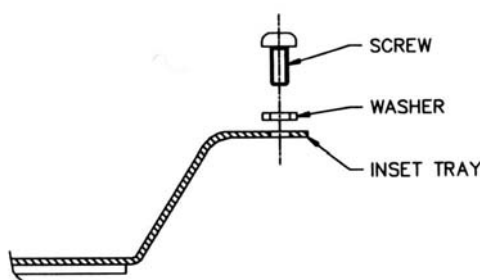
Figure 5-6 Optical assembly after connections



Assembling the inset tray

- Gently slide the inset tray under the unit, lifting the slit lamp slightly to give more clearance.
- Ensure that the cable is tucked against the edge of the cut-out section under the flange of the plate.
- Lightly screw the inset tray down with M3 x 6 long screws, referring to *Figure 5-7* for position.
- Ensure the laser head can move freely without scratching the inset tray.
- Tighten the inset tray screws lightly tightened above.

Figure 5-7 Tray screw configuration



Installing the rail covers and laser head

- Install the rail covers (which snap onto the rails).
- Remove the plastic wrapping from the laser head.
- Attach the binoculars and eyepieces to the laser head.
- Re-attach the bottom cover of the table.

Units with S/N from 4000

Before carrying out the optical assembly, make sure that the mains voltage is correctly selected.

Caution

Take extreme care throughout the following procedures not to jar the optical assembly or scratch any paintwork.

Assemble the optics as follows:

- Gently remove the delivery head from its foam container.
Do not remove the plastic wrapping until the assembly is complete.

Assembling the cross slide

The cross slide is now assembled to the base of the slit lamp as follows:

- Remove the cross slide shaft from the foam container.
- Remove one of the black gearwheels using the Allen key provided.
- While holding the delivery head, feed the cross slide through the base of the slit lamp (ensuring the locking screw is not blocking the shaft).
- Re-attach the second gearwheel to the shaft with the screw and washer.

Caution

Ensure that the gear wheel is correctly keyed into the slot in the end of the cross slide shaft before tightening the screw.

- Hold the delivery head above the center of the table and feed the two delivery head cable connectors (high voltage and 'D') through the slot in the right hand side of the metal tray under the hole in the table top, and on to the power supply console area.
- Lower the slit lamp on to the table and locate the cross slide gears on the gear tracks.

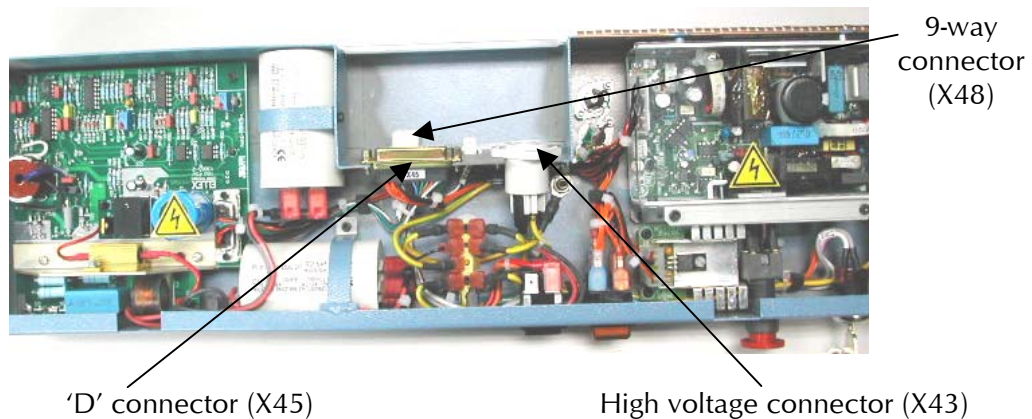
Connecting the high voltage and signal cables

The high voltage and signal cables can now be connected to the power supply console, as follows:

- Remove the two screws holding the power supply console in place, and allow it to drop down, taking care to support it with one hand to avoid any damage.
- Take the blue and white high voltage connector, which is now within the power supply console area (under the table), and plug it into the mating socket and rotate to lock in place (see *Figure 5-8*).
- Check the 9-way connector (X48) is in place (see above).
- Push the 'D' connector (X45) into its socket in front of the 9-way connector, and finger-tighten the slide retaining screws.
- Lift the power supply console back into position and screw in place.

The slit lamp must be able to move freely, without catching on the cables:

- Ensure the cross slide locking screw on the right hand side of the delivery head base is loosened, then check that the slit lamp can move smoothly in all directions without catching on the cables.
- Push the gear covers over the cross slide track on each side.

Figure 5–8 Power supply console connections***Assembling the binoculars to the slit lamp***

- Attach the binoculars to the slit lamp, securing with the locking screw.

5.12 INSTALLING THE INTERLOCK OR PLUG

The safety interlock connector is factory installed with a blanking plug. If the blanking plug is not fitted the laser will beep continuously until the blanking plug is installed. The customer is responsible for deciding how the system is to be interconnected. To connect to an external safety interlock door switch, the blanking plug must be removed and the switch connected using a suitable two core cable (such as two core mains figure eight flex or speaker wire).

At the customer's request the safety interlock may be bypassed; the customer must accept responsibility for that decision.

In units with S/N pre-4000 the interlock connector is on base of the stand.

In units with S/N from 4000 onwards the interlock connector is on the underside of the power supply console (see *Figure 5–9*).

If the theater door interlock is not installed:

- Ensure that the blanking DIN plug is installed in the safety interlock port and fastened down with the screw collar.

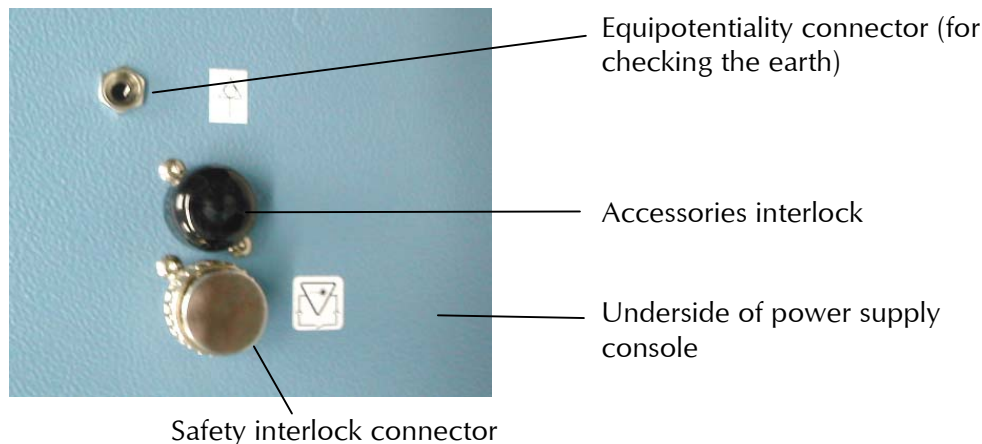
The safety interlock should only be bypassed on customer request, and the customer must accept responsibility for that decision. Make a note to this effect on the acceptance sheet.

If the interlock is to be installed:

- Remove the blanking plug.
- Install a DIN plug connected and wired to a microswitch circuit fitted to the room door.

The circuit diagram is included among the electrical drawings at the rear of this manual.

Figure 5-9 Console connections (S/N from 4000)



5.13 OTHER INSTALLATION PROCEDURES

The mains power cable must be installed along with any accessories purchased, such as the footswitch and the magnification changer.

5.13.1 Installing the mains power cable

The system may be provided with a mains electricity lead that is not terminated. This lead should be terminated using a locally approved plug by a qualified electrician. The power cord may be held in place with a metal strain relief to ensure the cord is not accidentally dislodged from the connector. To remove the power cord, lift the strain relief and remove cord.

For units with S/N pre-4000, plug the cable into the socket in the base of the stand and connect it to the mains power, ensuring that the unit is set to the correct operating voltage.

For units with S/N from 4000, plug the cable into the socket bottom of the stand and secure with the metal clip. Bend the cable under the base and fix in place with the two black clips in the middle and at the side under the base.

5.13.2 Installing the footswitch adaptation (accessory)

A footswitch adaptation package is available to enable the use of a footswitch with the **3000LE**. The footswitch itself is not provided with the package. Since each customer's requirements are different, the customer or service representative now sources the appropriate footswitch.

The footswitch, when connected, does not fire the laser. To fire the treatment laser when the footswitch has been connected, press the footswitch and use the joystick fire switch. If the footswitch is not pressed the joystick fire switch will not fire the treatment laser.

To install the footswitch adaptation:

- Disconnect the **3000LE** unit from the mains power.

Units with S/N pre-4000:

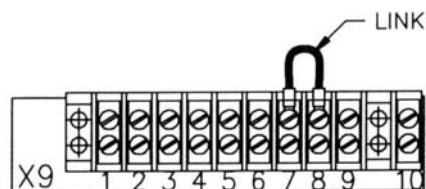
- Carefully lay the unit over so that you can gain access to the under side of the stand.

You will have to remove the slit lamp assembly to safely access this area. Inverting the table while optics are in place may cause damage or misalignment.

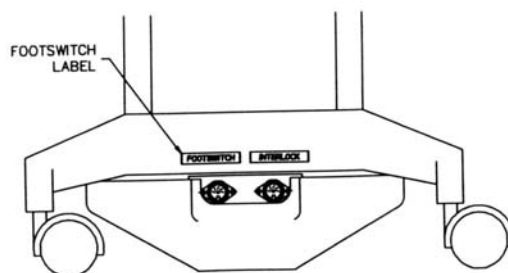
- Remove the plastic cover from under the stand by undoing the two socket head screws.
- Locate and remove the shorting link across terminals 7 and 8 (see below), ensuring that the other terminals are correctly installed.

The link should be replaced with both ends terminated in one terminal so that it may be used in the future.

Figure 5-10 Footswitch connections



- Remove the plastic cap that covers the footswitch socket on the base of the stand.
- Replace the plastic cover under the base.
- Return the stand to its normal upright position.
- Position the footswitch label, as shown below:

Figure 5-11 Label position**Units with S/N from 4000**

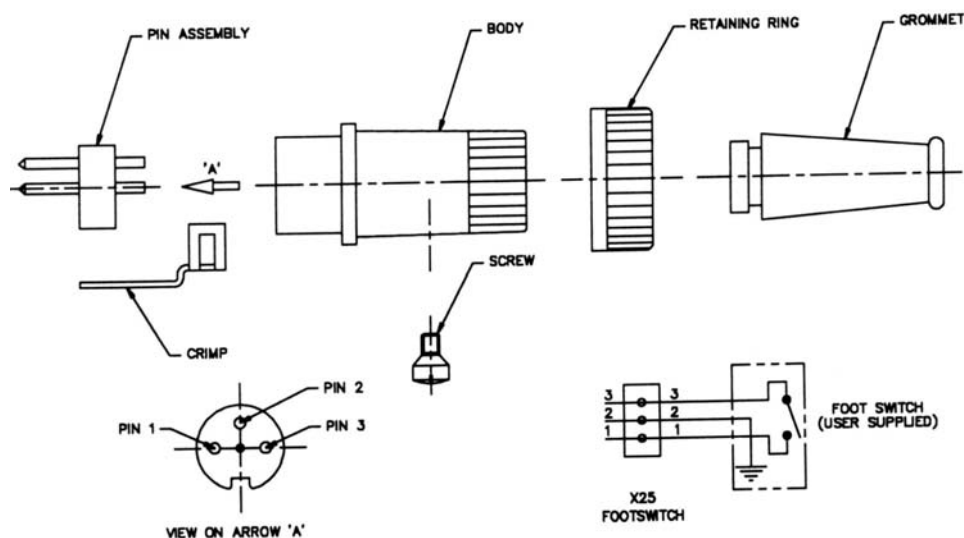
In later units the footswitch is attached to the accessories interlock on the underside of the power supply console, beneath the table, as shown in Figure 5-9. To adapt the system for use with a footswitch, cut link number 3 on the accessories interlock connector (X25) — see the Schematic drawing in the rear of this manual.

Attach the footswitch label supplied with the footswitch adaptation kit to the underside of the power supply console, beside the accessories interlock.

Wiring the footswitch

- Referring to Figure 5-12, wire the selected footswitch and cable (supplied by the customer) to the correct terminations.
- Ensure the footswitch is earthed.
- If the slit lamp was removed, reinstall it.
- Connect the footswitch to the laser unit.
- Re-connect to power and start up the system as usual.

Once installed, the footswitch acts as an interlock for the joystick fire switch. If the footswitch is not connected or not pressed the laser cannot be fired.

Figure 5-12 Footswitch plug connection

5.13.3 Fitting the magnification changer (accessory)

CSO and Avimo type magnification changers are available for use with this system³. Both types are available in 3-position and 5-position.

Preparing for installation

Before fitting the magnification changer to the laser head:

- Check that the objective lens, binocular, and eyepieces have been fitted and focused.
- Align the eyepiece crosshairs and aiming spots to an alignment mark on the chin rest target, or use the offset jig.
- Remove the magnification changer from its re-useable package.
- Review the supplier checklist supplied with the unit for accuracy and completeness.

Fitting the magnification changer

- Remove the binoculars with the eyepieces in place.
- Fit the magnification changer.
- Re-fit the binocular assembly.

Checking the magnification changer for alignment

All magnification changers are optically aligned and focused in the factory, so only minor adjustments to the alignment should be necessary. If you are unable to obtain a satisfactory alignment, return the magnification changer to the factory.

- Set the magnification changer to the 16x position and check if the aiming spot is in the center of the view area.
- Rotate the magnification changer for different settings and observe the focus of the aiming spot.

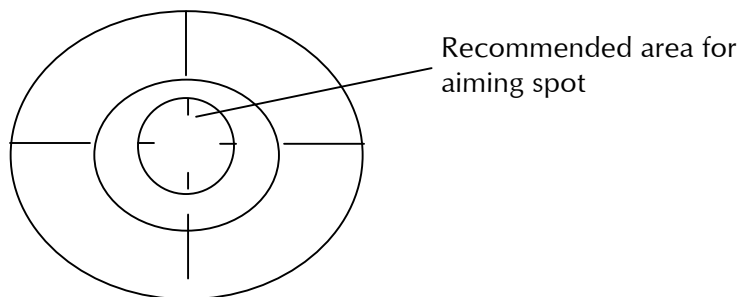
Normally, the focus has been inspected at the factory. If it is out of focus at any setting, the magnification changer should be rejected.

- Check if the aiming spot is always in the center of view area at different magnification settings.

The vertical and horizontal displacements of the aiming spot will normally be observed.

³ Avimo types sold after July 2001.

- Verify that the aiming spot is within the recommended area (as indicated below) for all magnification setting



If this is the case, no further adjustments may be necessary.

If the displacements of the aiming spot is significant, then alignment is required.

Adjusting the alignment

- *For an Avimo type only:* remove adjusting screws from bottom of binocular and place them in the bottom of the magnification changer.

It is important that the magnification changer and the binocular faces remain flat to each other. All the adjustment should be made between the magnification changer and the casting face.

The aiming spot centre position in the viewing area can be adjusted by four screws: two on the top of the casting head and two on the magnification changer (see *Figures 5-13 and 5-14*).

- Adjust these screws to move the aiming spot as close to the centre of the viewing area as possible at each magnification setting.
- Ensure the slit is closely aligned with the crosshairs at vertical and horizontal positions (this may slightly vary from one magnification position to another).

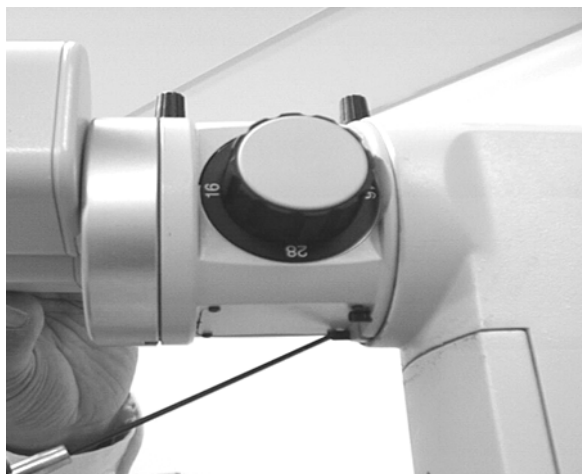
Figure 5-13 Casting head adjusting screws



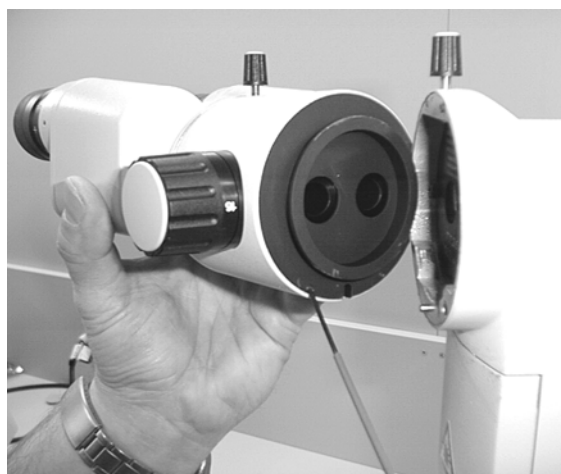
(CSO type)



(Avimo type)

Figure 5-14 Magnification changer adjusting screws

(CSO type)



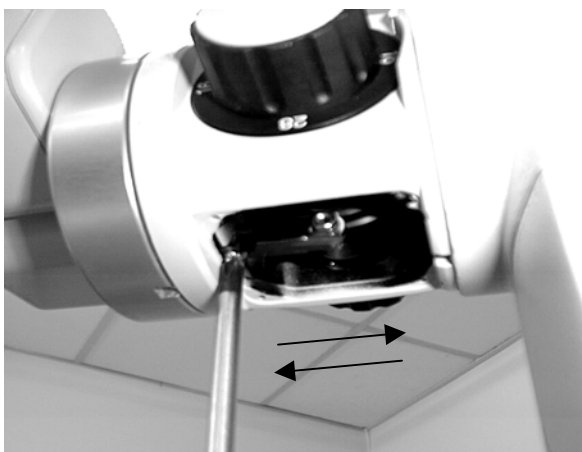
(Avimo type)

Adjusting vertical displacement

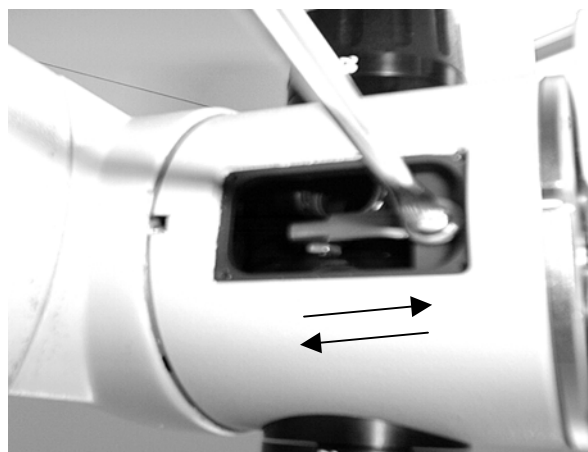
If there is still some variance you can adjust the vertical displacement by removing the bottom plate on the magnification changer (four screws) and adjusting the detent spring. To do this:

- Release the detent screw and either pull or push the detent spring (see below), moving the spring a little at a time and retightening the screw each time.

This can be done while observing through the binoculars.

Figure 5-15 Magnification changer detent spring

(CSO type)



(Avimo type)

- When you are satisfied, place a small spot of nail varnish on the screw to secure it in position.
- Re-fit the bottom plate.
- Moving the gold detent spring in the directions of the arrows above will allow the repositioning of the aiming beam in the vertical plane.

The horizontal adjustment is difficult and should be realigned at the Ellex factory.

All magnification changers have been optically aligned and focused in the factory, so only minor alignment adjustment should be required. If you are unable to obtain a satisfactory alignment return the magnification changer to the factory.

We recommend that once a magnification changer has been fitted and aligned it should not be removed, or re-alignment will be necessary.

The instrument is now installed and the optical alignment check can be carried out.

5.13.4 Adjusting the binoculars

The binocular eyepieces are fitted with rubber eyecups. If you wear spectacles, fold the eyecups back.

Adjust the interpupillary distance of the binocular head as necessary.

To adjust the eyepieces to suit your eyesight:

- Looking into the eyepiece with the reticule, turn the eyesight adjusting ring counter-clockwise and clockwise until the reticule in the field of view becomes clear.
- Mount the target to the chinrest.
- Move the slit lamp until the target is seen clearly through the eyepiece with the reticule.
- Look into the other eyepiece with no reticule and turn its eyesight adjusting ring until the same target is seen most clearly through the eyepiece.

5.14 OPTICAL ALIGNMENT CHECK

Before carrying out an optical alignment check, set up a burn paper and check the burn pattern produced by the laser is circular. If the pattern is non-circular to a major extent, the laser module may be out of alignment and should be returned to the factory for re-alignment.

Check that the aiming spots are of even brightness and are completely circular. If the spots are not circular, the fault must be rectified before continuing.

Procedure

To carry out the optical alignment check:

- Insert a new membrane in the model eye and fill the model eye with sterile water.
- Attach the model eye to the chin rest.
- Look through the binoculars and observe the aiming spots at the center of the membrane.
- Move the slit lamp back and forth with the joystick until the two spots converge.
- Move the slit lamp slightly back and forth from this position *while observing the aiming spots* and check that they move apart by the same amount when the slit lamp is moved forward as they do when the slit lamp is moved backward by the same distance.

The focus should be sharpest when the spots are exactly converged. If the two spots will not converge, optical alignment must be performed, refer to *Section 6.3*.

Checking the treatment beam

- Switch the system into READY mode and select an energy setting that provides 1.3 to 1.5 mJ energy, since this is where the laser is most commonly used.
- Set the posterior YAG offset thumbwheel to the +150 μm setting.
- Aim the laser at the center of the membrane and fire the treatment laser.

If the laser is fired off center on a model eye with a curved front lens it will make the treatment laser appear to be misaligned to the aiming laser. A flat lens will not produce this effect.

- Ensure that the hole created in the membrane is coaxial and parfocal with the converged aiming spots.

If it is not, proceed to the optical alignment procedure in *Section 6.3*. If satisfactory the system is ready for use. Proceed to the commissioning checks (see below).

Caution

We strongly recommend that you read Chapter 2 and Chapter 3, before you use this instrument for the first time.

5.15 COMMISSIONING CHECKS

The following checks should be carried out after installation to verify that the system is operating satisfactorily:

- ⇒ stand check
- ⇒ aiming accuracy check
- ⇒ air breakdown check
- ⇒ energy monitor check

5.15.1 Stand check

The stand has a motor and drive gearbox mechanism for raising and lowering the table.

To check the stand:

- Use the Table Up/Down switch on the key switch panel to raise and lower the table and ensure it raises and lowers smoothly and freely.
- Ensure there is no twisting motion of the table.

If operation is satisfactory proceed to the Air Breakdown Check (see *Section 6.7*). If not, adjust the table as stated in *Appendix A*.

5.15.2 Aiming accuracy check

Refer to *Section 8.5* for instructions.

5.15.3 Air breakdown check

The air breakdown check is a simple test to allow the doctor and technician in the field to have an *indication* of the reliability of the laser cavity and overall performance of the system.

Definition

Air breakdown is defined as plasma formation in the air (noticeable as a visible spark *and/or* a distinctive, audible 'crack' sound).

The 50% air breakdown value is the minimum energy value where this will occur five times when ten shots are fired into the air at 3-4 second intervals. For a new laser in its early life stage 50% air breakdown should occur at less than or equal to 4.0 mJ. This reading may increase as the unit ages.

Procedure

To carry out this check:

- Ensure you are wearing safety glasses and that the objective lens is clean.
- Place the unit in a position where the objective lens is facing a dark background
- Clear all objects, including the model eye, jigs and targets, away from the path of the laser.

For repeatable results ensure the laser has not been subjected to successive firing and is in a relatively cold, unused condition.

- Plug into power and switch the unit on.
- Set the energy to read 3 mJ (plus or minus 0.2 mJ).
- Fire the unit ten times at 3-4 second intervals while observing the laser spark or the distinctive click sound.
- Adjust the energy *up* if fewer than five of the ten shots produce air breakdown, or *down* if more than five shots produce air breakdown.

The test is complete when five out of ten shots cause air breakdown. Verify the energy at this point using an energy meter.

5.15.4 Energy monitor check

The energy monitor calibration should be checked when the unit is first installed, and when the energy monitor module, attenuator module or microprocessor module is changed. The calibration should be checked routinely at least once every twelve months. Refer to *Chapter 6* for the complete calibration procedure.

Equipment required

The following equipment is required:

- ⇒ appropriate eye protection (Optical Density at least 5.0 @1064 nm)
- ⇒ calibrated laser energy meter to measure Nd:YAG laser energy, with a pulse width of 4 ns, within an energy range of 0.2 mJ to 45 mJ, such as: Molelectron JD500 or EM500, Coherent FieldMaster, Ophir Nova, Ophir Energy Meter model 03A-P-CAL-DG-P/E. OR: Laser Precision Energy Meter model LP-7610 with detector head RjP-735 and attenuator RkA-312. OR: an equivalent energy meter

Any meter used to calibrate the laser energy must be traceable to N.I.S.T. (U.S. National Institute of Standards and Technology).

- ⇒ appropriate clamps to fix energy detector to the chin rest stand
- ⇒ burn paper, Kodak linagraph CAT 198 6140
- ⇒ energy calibration check record sheet

Procedure

To carry out the energy monitor checks:

- Turn the system on.
- Turn the ENERGY thumbwheel to maximum energy.
- Select SINGLE PULSE mode and enable.
- Fire the laser three or four times while turning the energy monitor adjustment potentiometer gain clockwise (through the energy meter calibration hole on the back of the control panel assembly) to maximum.
- Check that when the laser is fired the reading on the energy monitor is between 15 and 30 mJ. (If it is not, repair or replace the attenuator module.)
- Position the detector head of an appropriate calibrated energy meter (see above) in front of the **3000LE** and clamp the detector head to the chin rest support. (Place in approximately the same position as a patient's eye.)

Caution

Do not fire the laser yet as it may damage the detector.

- Select laser STANDBY mode.
- Check that SINGLE PULSE mode is still selected.
- Ensure the aiming spots cover approximately 80% of the detector aperture.
- Lock the slit lamp at this position.
- Set to READY mode.
- Turn the external energy meter on.
- Turn the energy thumbwheel to maximum.
- Fire the laser.
- Confirm that the delivered energy display on the **3000LE** is within $\pm 15\%$ of the external energy meter reading.
- Repeat this procedure at several energy settings ranging from minimum to maximum settings.
- If the energy display is with $\pm 15\%$ of the external energy meter reading, the energy monitor check is complete.
- If the energy display is out by more than $\pm 15\%$, perform a full calibration procedure (see Section 6.5), then reset the YAG voltage (see Section 11.4.2).

6.1 STEPS IN ALIGNMENT AND CALIBRATION

Alignment and calibration of the **3000LE** takes place in the following stages:

- ⇒ pre-calibration check
- ⇒ optical alignment
 - slit lamp alignment
 - aiming beams alignment
 - YAG offset focus check
 - slit alignment
 - cross hair alignment
- ⇒ attenuator set up
 - shutter stop check
 - energy prediction adjustment
 - half wave plate setting
- ⇒ energy monitor calibration
- ⇒ voltage reset
- ⇒ final calibration check
- ⇒ air breakdown check

6.1.1 Equipment required

The following equipment is required:

- ⇒ complete **3000LE** system
- ⇒ pair 20 x eyepieces (optional)
- ⇒ offset alignment tool
- ⇒ binocular offset jig
- ⇒ model eye
- ⇒ membranes
- ⇒ saline solution
- ⇒ hex wrenches (Allen keys)
- ⇒ 2 mm, 2.5 mm, 1.5 mm (0.08, 0.1, 0.06 in) ball driver
- ⇒ cross head jeweler's screwdriver
- ⇒ small flat blade screwdriver
- ⇒ burn paper: Kodak linagraph; cat 198 6140
- ⇒ double sided adhesive tape
- ⇒ 5 mm (0.2 in) nut driver (modified)
- ⇒ extension cable for control panel

6.2 CARRYING OUT A PRE-CALIBRATION CHECK

Carry out a quick preliminary calibration of the energy monitor before proceeding further to ensure that the system is functioning correctly and giving approximately the correct energy readings.

Follow the procedure outlined in *Section 6.5*. At this point the calibration does not need to be accurate, but it must be giving approximately correct readings.

6.3 OPTICAL ALIGNMENT

The objective of optical alignment is to accurately align the following three optical systems to the optical axis of the illumination slit lamp:

- ⇒ viewing (slit lamp binoculars)
- ⇒ treatment laser (Nd:YAG)
- ⇒ aiming laser (Diode)

6.3.1 Equipment required

Equipment required is listed in *Section 6.1.1*.

6.3.2 Procedure

Ensure that the laser system is operating correctly before proceeding. Check that the burn pattern is circular. If it is non-circular to a major extent, the laser module may be out of alignment and should be returned to the factory for re-alignment.

Check also that the aiming spots are of even brightness and are completely circular. If they are not circular the fault must be rectified before continuing. If all is well, proceed as described in the following sections.

Taking shortcuts in this procedure will result in misalignment. Always follow every step in this procedure if the alignment is to be adjusted.

6.3.3 Aligning the slit lamp

To begin aligning the slit lamp:

- Turn the laser off by pressing the Laser ON/OFF button, but leave the key switch ON.
- Remove the front cover of the unit by releasing the countersunk socket head screw underneath it with a 2 mm (0.08 in) hex wrench.

Caution

There are dangerous voltages inside the laser head when the system is on.

An extension cable can be used on the control panel to allow free access to the laser head modules.

Attaching the offset alignment tool and binocular offset jig

- Using double-sided tape, attach a clean piece of burn paper to the target on the offset alignment tool.
- Attach the offset alignment tool to the top of the laser head using the tool attachment jig mounting holes.
- Remove the binoculars by undoing the knurled clamping screw on the top of the laser head.
- Remove the laser safety filter plate by undoing the two socket head retaining screws with a 2.5 mm (0.1 in) Allen key.

A safety filter is built into the binocular offset jig.

- Attach the binocular offset jig to the laser head as you would attach the binoculars.
- Attach the binoculars to the offset jig.

Adjusting the eyepieces

The right eyepiece has a cross hair (reticule), and the left eyepiece is plain. Adjust the right eyepiece first then the left, as follows:

- Verify both ocular eyepieces are as far “in” as possible.
- Turn the right eyepiece dioptre adjusting ring to its maximum ‘+’ position.
- Using your left eye, look into the right eyepiece and slowly turn the dioptre adjusting ring clockwise until the cross hair appears as sharp as possible.
- Note the dioptre setting on the eyepiece and adjust the left eyepiece to the same setting.
- Repeat the procedure using your right eye.

The eyepieces are now set.

Adjusting the slit —center of rotation

- Set the slit to its minimum visible width in the vertical position.
- While looking through the binoculars, swing the slit lamp illumination tower 30 degrees around its central position.
- Adjust the target on the offset alignment tool backwards or forwards, while swinging the slit-lamp until the slit appears to be stationary, or as close as possible to stationary.

This point is known as the center of rotation of the slit lamp.

If the slit moves in one direction from center and not in the opposite direction when the tower is swung, the prism assembly may need adjustment. To do this, loosen the prism locking screws and rotate the prism until the slit position remains central when the tower is swung. This may cause the slit to be slightly off vertical, which can be corrected by loosening the three screws holding the Illumination Tower into the Illumination Base and rotating the tower to compensate for the rotation of the prism.

Adjusting the focus

To adjust the focus of the objective lens:

- Open the slit to its maximum width.
- Remove the two plugs covering the objective lens locking screws.
- Loosen the two objective lens locking screws.
- While viewing the burn paper surface through the binoculars, adjust the focus by rotating the objective lens assembly housing so that the background comes into sharp focus.

Do not touch the optical surface of the lens with your fingers.

The cross hairs must also be in focus. If they are not the eyepieces will have to be adjusted and the above focusing procedure repeated.

If the slit lamp is rotated 30 to 60 degrees from center, the shadows produced on the burn paper may make focusing easier.

6.3.4 Aligning the aiming beams/YAG coaxiality

To align the aiming beams:

- Turn the laser unit on by pressing the Laser ON/OFF switch to the ON position.
- After the seven shot warm up put the laser into READY mode.

Caution

There are dangerous voltages inside the laser head.

Checking and adjusting the focus

- Use the ENERGY thumbwheel to set the energy to minimum.
- Fire the laser once onto the burn paper and examine the burn mark through the binoculars.

If the burn mark is too large to accurately judge the center of the burn, the Beam Expander focus should be adjusted. To do this, loosen the focus locking screw and adjust the focus slightly in either direction (see *Figure 6-1*).

- Move the burn paper to a new position on the target and fire the laser on a clean section of the paper.

If the burn mark is larger than before, adjust the focus in the opposite direction. If the burn mark is smaller than before, continue to adjust the focus in the same direction until the center of the burn mark can be accurately judged.

- Examine the aiming spots through the binoculars.

If the spots are small enough so that the centers can accurately be judged, then no aiming beam focus adjustment is necessary at this stage. If the spots have blurry edges the Diode Aiming Module focus should be adjusted.

- Verify that only one focused aiming beam spot is on the target, and the aiming beam is in sharp focus.

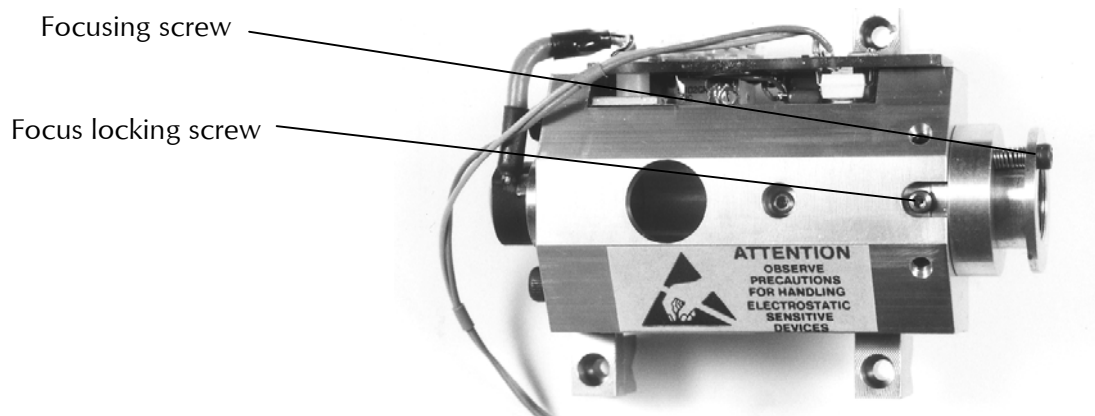
If this is correct, perform the YAG offset focus test (see *Section 6.3.5*). If not, perform the next step below.

- To focus the aiming beams, loosen the focus locking screw and rotate the focusing screw. (See *Figure 6-1*.)

The adjusting screw can be reached from above through the binocular opening with a 1.5 mm (0.06 in) ball driver.

- Adjust the focus to achieve the smallest aiming beam spots.
- Tighten the focus locking screw.

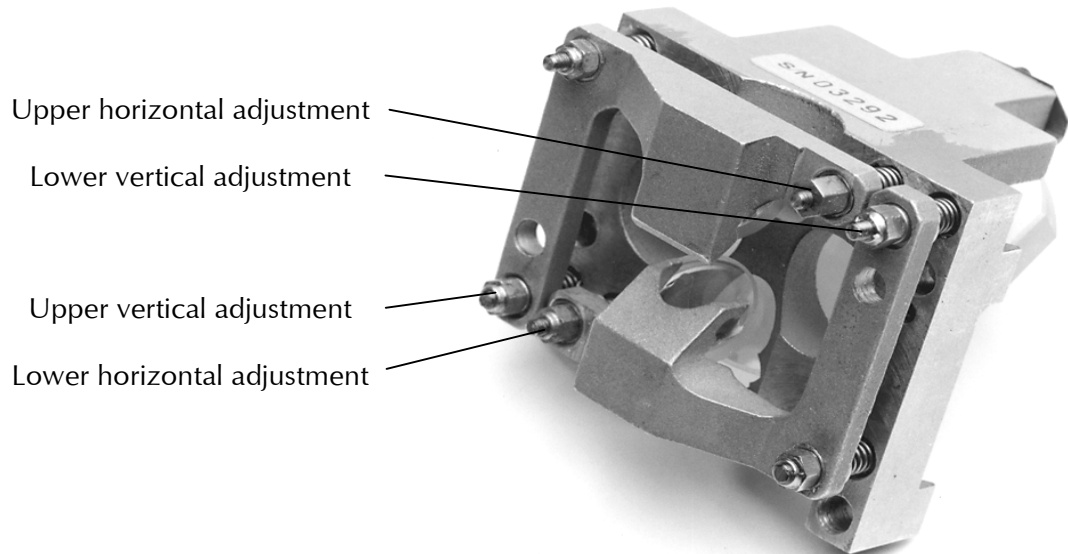
Figure 6-1 Diode aiming module



Aligning the beams to the laser burn

- Align the lower aiming beam to be centered on the laser burn by adjusting the lower arm on the Folding Mirror Module.
- Align the upper aiming beam to coincide with the lower aiming beam at the center of the laser burn by adjusting the upper arm on the Folding Mirror Module (see below).

Figure 6-2 Folding mirror module



- To be certain that both aiming spots are in the center of the burn, gently push down on the offset alignment tool while looking through the binoculars.

The aiming spots should separate but still be vertically aligned. Any horizontal displacement means that the spots are not correctly aligned.

When the offset alignment tool is returned to the upper position, you should see the spots move back on top of each other again, otherwise, more adjustment is required.

- Make very fine adjustments with the focusing screw.
- Check the focus as described above after each adjustment of the focusing screw.
- When the focus has been set, tighten the focus locking screw and re-check the aiming spot focus. If the focus has moved at all, repeat this step.

Final checks

- Re-check the focus of both the treatment laser and the aiming spots, adjusting if necessary.

If the treatment beam or aiming beam focus is adjusted at this stage, the alignment of the aiming spots to the treatment laser must also be checked.

- When the focus and alignment of both the aiming and treatment lasers have been accurately set and the focus locking screws for both lasers have been tightened, apply a small amount of nail varnish or similar to both focus locking screws and all four of the folding mirror arm adjusting screws.

6.3.5 YAG offset focus test**Caution**

The YAG beam is offset posterior to the aiming beam. This allows the surgeon to properly focus the YAG treatment on the posterior capsule rather than the intraocular lens (IOL). Always advise the surgeon after adjusting the offset.

To test the YAG offset focus:

- Turn the laser off by pressing the Laser ON/OFF switch.
- Attach black vinyl tape to the target surface.
- Ensure the slit lamp optical and eyepieces are focused at the alignment jig target surface.
- Turn the laser on by pressing the Laser ON/OFF switch.
- Turn the aiming beam attenuator knob counter-clockwise for minimum intensity.
- Record the horizontal micrometer value at the aiming beam/slits focal point (for reference).

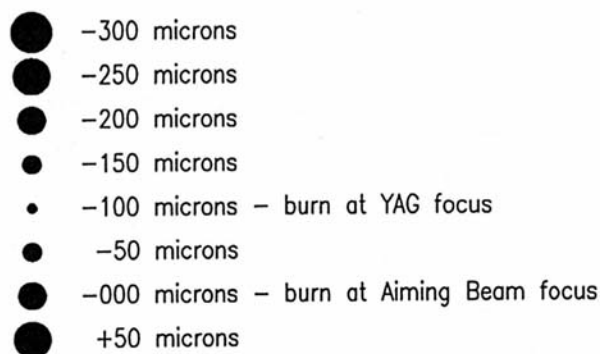
Each increment on the micrometer changes the distance by 10 microns.

Checking the burn pattern

- Set the displayed energy to 0.6mJ.
- Set the posterior offset dial to MIN.
- Move the horizontal micrometer 300 microns posterior to the aiming beam/slits focus.
- Adjust the vertical micrometer so that the aiming beam is near the top of the black vinyl tape.
- Arm and fire the laser eight times, moving the horizontal micrometer anterior 50 microns, and the vertical micrometer up approximately 150 microns after each shot, to allow space for the next shot.

The fifth burn from the top should be the smallest (see below). This represents the YAG focal point 100 microns posterior to the aiming beam/slits focus. Note that the seventh burn brings you back to the aiming beam/slits focus.

Figure 6–3 Burn pattern



If the YAG focus is not 100 microns posterior to the aiming beam/slits focus, proceed to the next step.

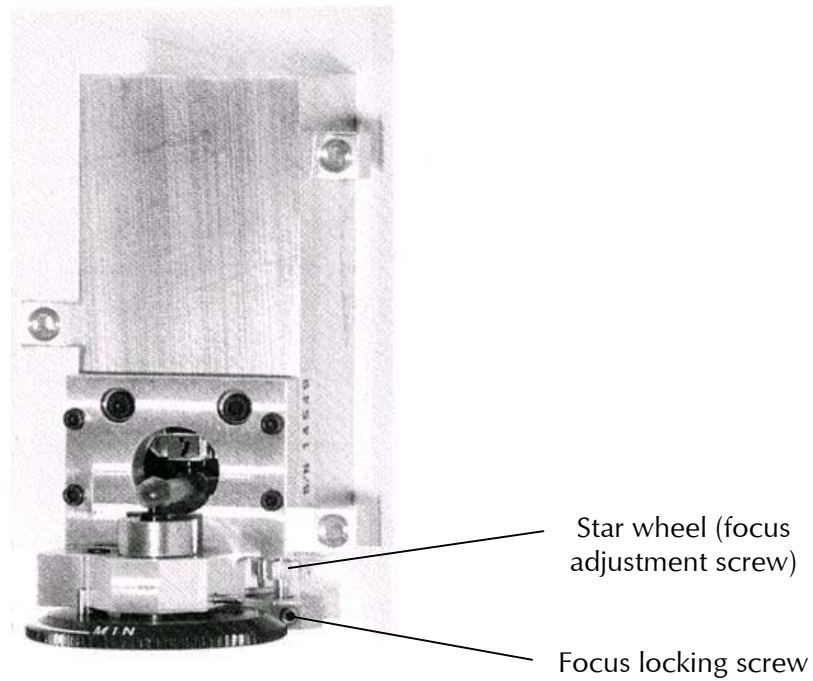
If the YAG beam is focused, proceed to *Section 6.3.7*.

- Loosen the focus locking screw $\frac{1}{2}$ turn (see *Figure 6–4*).
- Rotate the star wheel as appropriate to shorten or lengthen the focal length, then arm and fire the laser eight more times and re-check the burns.

Slight adjustments will result in a significant change in YAG focus.

- Tighten focus locking screw and secure with nail polish or similar.

Figure 6-4 **YAG beam expander module**

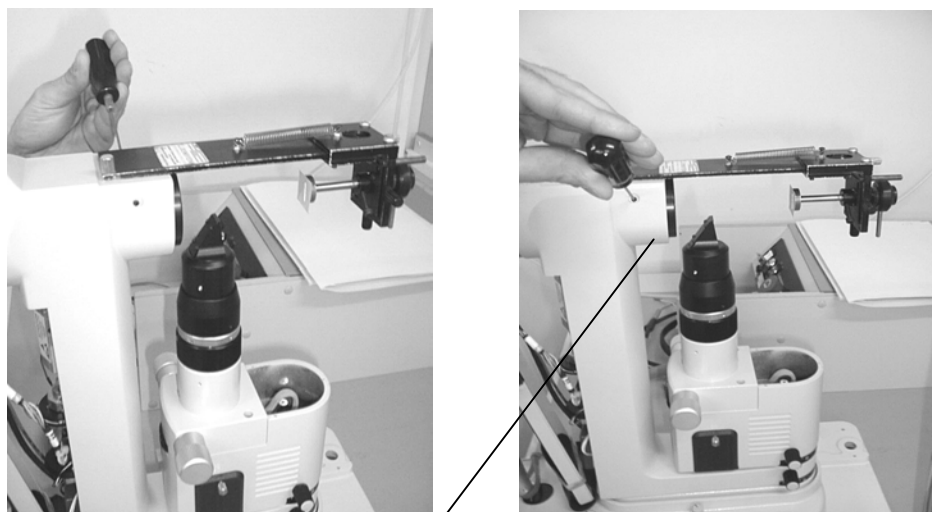


6.3.6 **Aligning the slit**

Nikon slit lamp

- Reduce the illumination slit width to the minimum visible vertical width.
- Look through the binoculars and check that the aiming beam lines up with the slit.

If not, carefully translate the objective lens with the two top and one lower objective lens locking screws until the aiming beam is lining up with the illumination slit. Refer to *Figures 6-5* and *6-6*.

Figure 6-5 Adjusting the top objective lens screws

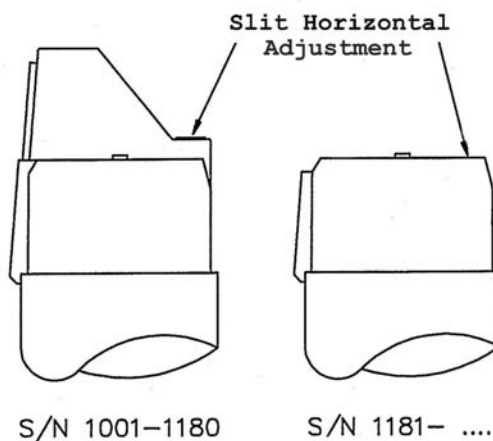
Bottom screw

Make several small adjustments to avoid loosening the objective lens. If the objective lens becomes loose it may move forwards or backwards and change the focus of the system.

- Rotate the slit to the horizontal position.

The aiming beam should be lined up with the horizontal slit. If not, carefully move the slit up/down by adjusting the screw on top of the illumination tower, with a flat blade screwdriver.

Repeat these procedures until the aiming beam is centered in both the horizontal and vertical slit.

Figure 6-6 Nikon illumination tower

CSO slit lamp

- Reduce the illumination slit width to the minimum visible vertical width.
- Look through the binoculars and check that the aiming beam lines up with the slit.

If not, carefully translate the objective lens with the two top and one lower objective lens locking screws until the aiming beam is lining up with the illumination slit. Refer to *Figures 6-5 and 6-7*.

Make several small adjustments to avoid loosening the objective lens. If the objective lens becomes loose it may move forwards or backwards and change the focus of the system.

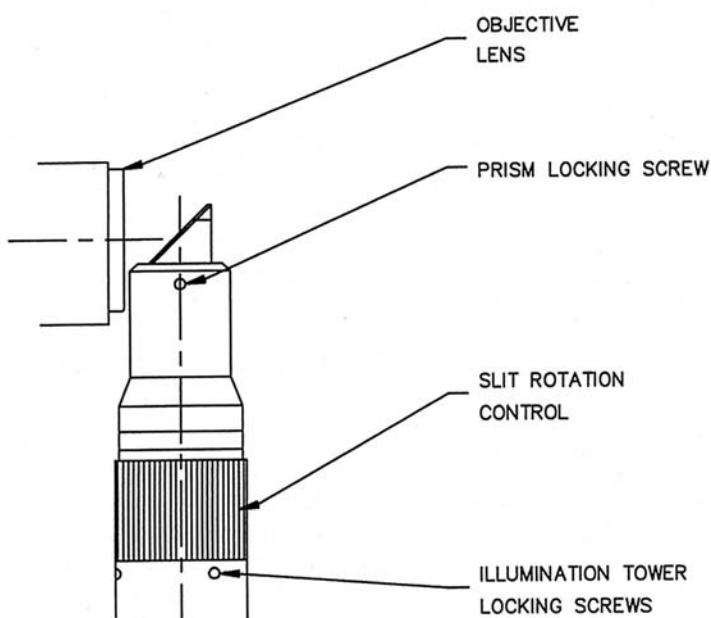
If the slit is a long way off the aiming spots it may not be possible to move the aiming beam to the illumination slit by translating the objective lens. In this case:

- Centralize the objective lens, then loosen the locking screws on the prism mount, then turn the prism left/right until the vertical slit is lined up with the aiming beam.

This may cause the vertical slit to be slightly off vertical (not a straight vertical line), which can be corrected by loosening the three screws holding the illumination tower and rotating the tower to compensate for the rotation of the prism.

- Tighten the locking screws.

Figure 6-7 CSO illumination tower



Checking horizontal alignment

- Rotate the slit to the horizontal position and ensure the aiming beam should be lined up with the slit.
- If not, loosen the locking screws on the prism mount. Move the slit to the aiming beam by moving the prism up/down.
- Tighten the locking screws.
- The previous four steps interact with each other. Repeat these steps until the aiming beam and slit line up vertically and horizontally.

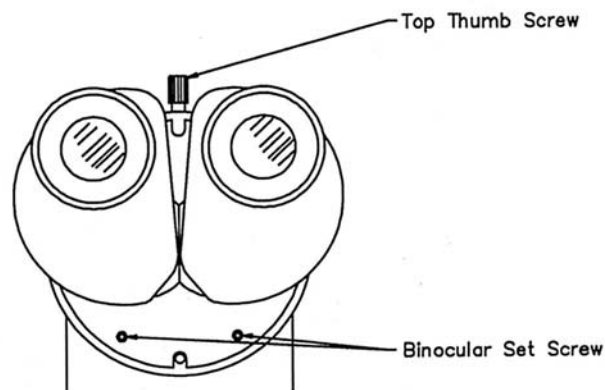
This completes the alignment for the **3000LE**.

6.3.7 Cross-hair alignment

This procedure ensures the aiming beam is centered in the cross hairs in the eyepiece by adjusting the binocular set screws.

- Remove the binocular assembly from the binocular support arm by loosening top thumbscrew.

Figure 6–8 Binocular assembly



- Turn the binocular set screws located at the binocular base counter-clockwise until they are flush with the binocular assembly base.
- Replace the binocular assembly to the binocular support arm without tightening the thumbscrew.
- If the aiming beam is not centered on the cross hairs, gently move the binocular assembly in and out and from side to side to determine whether tightening the left or right set screw will move the beam in the right direction. (Tightening both affects vertical position.)
- Tighten one or both set screws as appropriate until the aiming beam is centered in the cross hairs.

Caution

Do not over-tighten the set screws. Doing so drives screws into the aluminum casting, damaging its surface.

- Tighten the thumbscrew to secure the binocular assembly in place.

6.4 SETTING UP THE ATTENUATOR

The attenuator is set up in two stages:

- ⇒ checking the shutter stop
- ⇒ adjusting the energy prediction
- ⇒ setting the half wave plate

6.4.1 Checking the attenuator shutter

This procedure ensures that the shutter stop screw on the attenuator shutter is present and correctly set. If this screw is missing, laser emission is possible during the start up sequence, before the fire button is pressed.

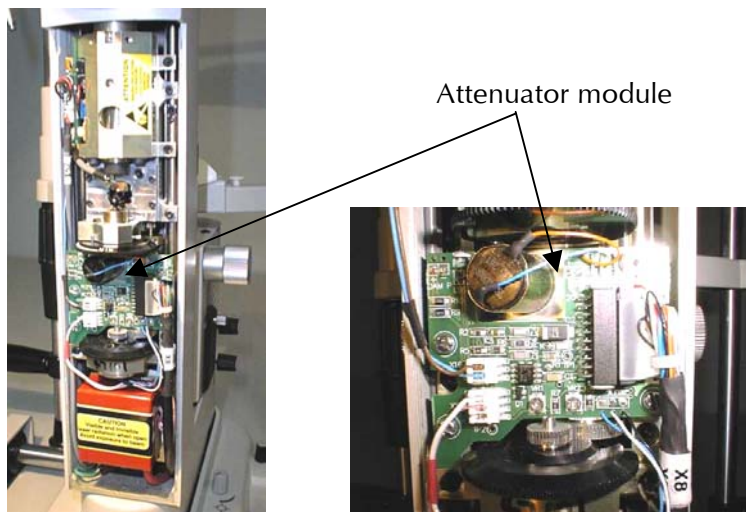
To gain access to the attenuator:

- Switch the system off and remove power.
- Raise the laser head to its highest position using the joystick.
- Remove the countersunk screw holding the laser head front cover in place using a 2 mm Allen key or the special 2 mm tool provided in the toolkit.

(Hold the panel in place until the screw is removed and then lift the panel away bottom first.)

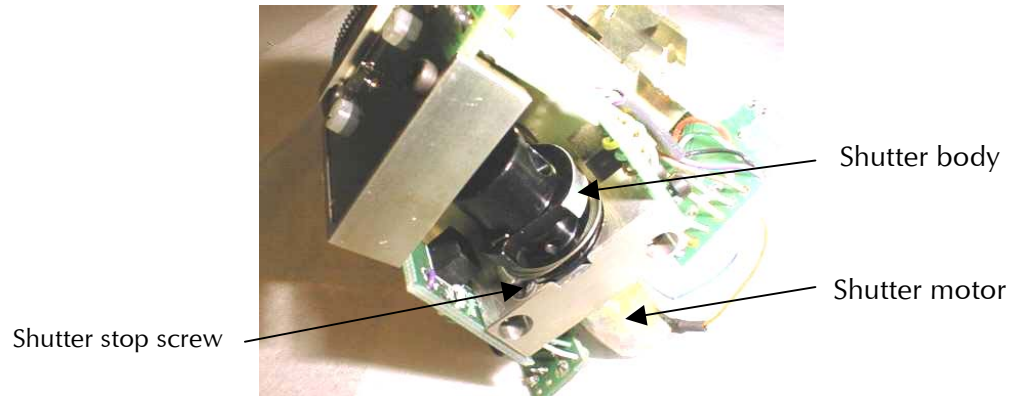
- Put the panel and screw in a safe place until required.
- Identify the attenuator module by referring to *Figure 6–9*.

Figure 6–9 Attenuator module



Locating and checking the shutter stop screw

- Disconnect the attenuator's three electrical connectors.
- Using a 2mm Allen key, remove the three screws securing the module to the laser head rails.
- Locate the shutter stop screw, referring to the illustration below:

Figure 6-10: Shutter stop screw

The stop is made up of a setscrew with a rubber buffer fitted to it. The stop does not need to be removed from the shutter assembly to examine it. Check the integrity of the stop screw; which should not be loose, out of position or damaged in any way.

If the stop is loose, out of position or damaged, contact the Customer Service Department for advice.

If the stop is satisfactory, no further action is required.

- Refit and reconnect the attenuator module.
- Re-connect to mains power.
- Continue the alignment and calibration procedures described in this chapter.

If you have any queries regarding the procedure, or need further information, please do not hesitate to contact the Customer Service Department.

6.4.2 Adjusting the energy prediction

The energy prediction is the value displayed while the ENERGY thumbwheel is being moved. When it stops moving the system carries out a test fire and displays the actual energy. If the actual energy is more than double or less than half of the predicted value, a warning message is displayed to indicate the energy calibration of the prediction could be in error and should be checked.

This applies only to software version 3.2.

The range of prediction values is adjusted automatically when a voltage reset is carried out (see *Section 11.4.2*), but the minimum energy prediction point may need to be manually adjusted, as described below. (Refer to *Figure 6-11*.)

To make this adjustment:

- Switch off the system.
- Remove the front cover of the laser head by raising it using the joystick, then removing the screw at the bottom of the cover.
(Pull the lower end of the cover out first.)
- Disconnect the cable on the back of the control panel on the laser head, and connect the extension cable.
Have the laser head/control panel on a flat surface or table.

Checking predicted energies

- Turn on the system.
- Allow it to complete the start-up self-tests.
- Move the ENERGY thumbwheel to the right and compare the predicted energy level with the actual energy of the test shot fired.

The prediction should be within 30% of the actual value. If it is, confirm that prediction and actual energies are within 30% at other thumbwheel positions.

- Move the ENERGY thumbwheel to minimum and note the prediction value displayed before the test fire value.

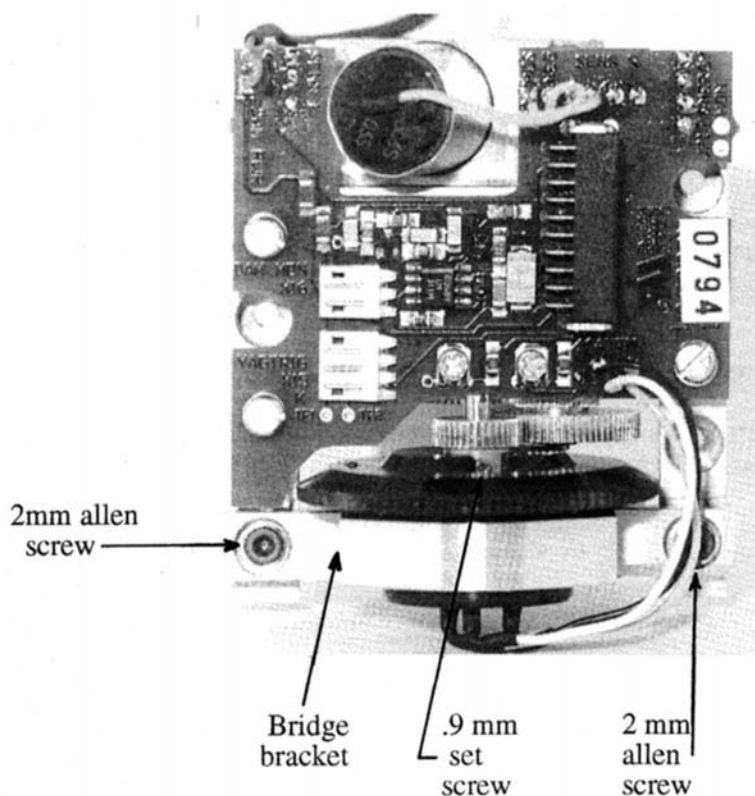
The prediction value should be 0.3 mJ. If it is, and if the predicted and actual energies are within 30%, no further adjustment is necessary.

If it is not, or if the predicted and actual energies differed by more than 30%, continue the adjustment.

Making the adjustment

- While holding the thumbwheel in place, loosen the grub screw securing the thumbwheel gear to the potentiometer shaft.
Use a 0.035 inch hex wrench (Allen key) (Excelite P19, 0.89 mm).
- Using a small flat blade screwdriver, adjust the potentiometer setting using the slot in the top of the shaft.
- Once an adjustment has been made, tighten the grub screw.
- Move the thumbwheel to the right then back to minimum.
- Check the prediction value.
- Repeat this process until the prediction is 0.3 mJ, then check the prediction is within 30% over the full range.
If not, reset the voltage, as described in *Section 11.4.2*.

Figure 6-11 Adjusting the attenuator



6.4.3 Setting the half wave plate

If the energy measured on an external energy meter is not within 0.266 and 0.433 mJ at the minimum energy position of the thumbwheel the mechanical position of the half wave plate inside the attenuator module may need to be adjusted.

To check this setting:

- Position the detector head of an appropriate energy meter about 60 mm (2½ in) in front of the objective lens of the laser head and clamp it to the chin rest support.
- Adjust the position of the detector head until both the aiming beams are on the active area of the head and are approximately 10 to 15 mm (0.4 to 0.6 in) apart.
- Set the ENERGY thumbwheel to minimum.
- Fire the laser.
- Check that the energy measured by the external energy meter is between 0.266 and 0.433 mJ.

If it is, no further adjustment is necessary. If it is not, continue as follows:

- Locate the bracket that mounts the ENERGY thumbwheel and potentiometer on to the attenuator module.
- Set the thumbwheel to minimum energy and loosen the two 2 mm (0.08 in) hex wrench screws at each end of the bracket until the thumbwheel gear and the half wave plate gear separate from each other.
- Fire the laser repeatedly while using a small flat blade screwdriver to rotate the half wave plate gear slightly until a value of 0.266 to 0.433 mJ is obtained on the external energy meter.

Turning the gear to the right decreases the energy output.

- Gently move the bracket back into place so the gears mesh together.
- Verify that the external reading is still correct.
- Tighten the two screws.

Re-check that the external reading is still correct.

6.5 CALIBRATING THE ENERGY MONITOR

In the **3000LE** the only calibration procedure required is to calibrate the energy monitor, as described below.

Caution

Observe all safety precautions during calibration.

The energy monitor should be re-calibrated whenever the laser module, energy monitor module, attenuator module, control panel (microprocessor) or YAG cavity is changed.

We recommend that the calibration be checked and re-calibrated at least annually.

6.5.1 Equipment required

The following equipment is required:

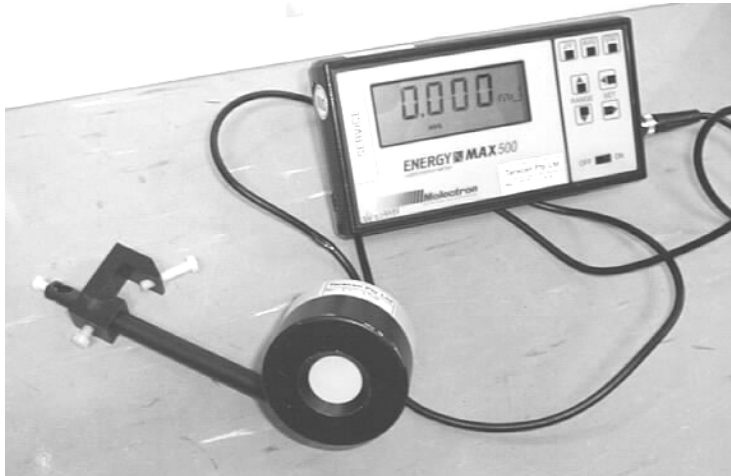
- ⇒ appropriate eye protection (Optical Density at least 5.0 at 1064 nm)
- ⇒ calibrated laser energy meter (see *Figure 6-10*) to measure Nd:YAG laser energy, with a pulse width of 4 ns, within an energy range of 0.2 mJ to 45 mJ, such as:

Molelectron JD500 or EM500, Coherent FieldMaster, Ophir Nova, Ophir Energy Meter model 03A-P-CAL-DG-P/E. OR: Laser Precision Energy Meter model LP-7610 with detector head RjP-735 and attenuator RkA-312

OR: an equivalent energy meter

Any meter used to calibrate the laser energy must be traceable to N.I.S.T. (U.S. National Institute of Standards and Technology).

- ⇒ appropriate clamps to fix the energy detector to the chin rest stand
- ⇒ burn paper: Kodak linagraph CAT 198 6140

Figure 6–12 Energy meter

6.5.2 Steps in calibration

The calibration is carried out in the following steps, which are all described in this section:

- Adjust the upper energy calibration.
- Adjust the lower energy calibration.
- Verify the system calibration by comparing displayed readings against those of an external energy meter.

Record calibration results for future reference.

6.5.3 Preparing for calibration

Record all calibration results for future reference.

To calibrate the energy monitor:

- Record the following information:
 - date
 - name of person performing the calibration
 - **3000LE** serial number
 - energy meter type
 - energy meter calibration status

Record this information only for the final calibration, after optical alignment has been completed.

6.5.4 Adjusting the upper energy range calibration

Adjust the upper energy range as follows:

- Remove the cover of the laser head.
- Hold up the cover carefully, without disconnecting the cables from the back of the micro/display module, and locate the ENERGY thumbwheel setting that gives 8 mJ average on the external meter by turning the thumbwheel and firing the laser several times.
- Turn the control module (microprocessor/display module) over carefully without disconnecting the cables. ..
- Adjust the potentiometer on the microprocessor marked 'GAIN' until the internal display matches the external meter.
- Rotate the thumbwheel to maximum output (fully to the right).
- Compare the internal and external energy readings and adjust the GAIN potentiometer if they differ by more than 15%.
- Rotate the thumbwheel to give an energy of 4.6 to 5.0 mJ on the external meter and again check that the reading is within 15%.
- Vary the energy between 4.6 and maximum and check that all values are within 15% of the external meter reading, making small adjustments to the GAIN potentiometer if required.

6.5.5 Adjusting the lower energy range calibration

Continue with the calibration as follows:

- Adjust the ENERGY thumbwheel to give an energy reading of 4.0 mJ on the external meter.
- Adjust the potentiometer marked 'OFFSET' until the internal reading is within 15%.
- Rotate the thumbwheel to 1.0 mJ and check the internal reading is within 15%, adjusting the OFFSET potentiometer if required.
- Rotate the thumbwheel to minimum and check the internal reading is within 15%, adjusting the OFFSET potentiometer if required.

If the energy measured on the external meter is not between 0.266 and 0.433 mJ at the thumbwheel's minimum energy position, adjust the half wave plate position (see Section 6.4.2).

- Check that all values between minimum and 4.0 mJ are within 15%.
- Check that all values between minimum and maximum are correct within 15%.
- Complete a copy of the calibration record sheet after the system has been calibrated, and retain for future reference.

6.5.6 Checking the lower energy range calibration

This procedure aims to check the exact energy at which the internal meter reading changes from 0.3 mJ to 0.4 mJ or 0.4 mJ to 0.5 mJ. This point is the *changeover* point. If the changeover point is not set correctly it is possible to get an internal meter reading of, for example, 0.4 mJ when the thumbwheel is set at the minimum, 0.3 mJ, since the internal meter reading changes by increments of 0.1 mJ.

The following example demonstrates the procedure for finding the changeover point between 0.3 mJ and 0.4 mJ, but the procedure is the same for the other changeover points. Figures quoted are examples only.

The external energy meter is required for this procedure.

- Set the ENERGY thumbwheel to the minimum (0.3 mJ).
- Prepare a blank table for the readings and calculations, as shown below:

Table 6–1 Calibration table blank

	Internal energy readings		Difference (column 3)
	0.3 mJ (column 1)	0.4 mJ (column 2)	
External energy meter readings			

Values in the 0.3 mJ column will increase; values in 0.4 mJ will decrease.

- Fire the laser and note the internal and external energy meter readings.

If the internal reading is 0.3 mJ and the external is 0.244 to 0.265, the half wave plate needs readjustment before proceeding. See Section 6.4.2.

- Enter the external energy meter reading in column 1 if the internal meter reading is 0.3 mJ, or column 2 if the internal meter reading is 0.4 mJ.

Entries made in the table are called Most Critical Measurements.

Obtaining and tabulating readings

- Fire the laser again (without moving the thumbwheel) and note the internal and external energy readings.
 - if the internal reading is 0.3 mJ and the external reading is greater than any entry in column 1 – enter in column 1
 - if the internal reading is 0.4 mJ and the external reading is less than any existing entry in column 2 – enter in column 2
 - if neither applies, discard the reading and fire again

If necessary, move the ENERGY thumbwheel slightly between firings if all readings are being discarded.

- Each time a reading qualifies to be recorded in the table, calculate the difference between the largest reading in column 1 and the smallest in column 2, and enter it in column 3.

If the difference is ≤ 0.008 mJ, the changeover point has been found, and is halfway between the readings in columns 1 and 2.

- Repeat the process until the changeover point is found.
- Repeat the process to find the changeover points above 0.4 mJ and 0.5 mJ.

Table 6–2 Calibration table example

	Internal energy readings		Difference (column 3)
	0.3 mJ (column 1)	0.4 mJ (column 2)	
External energy meter readings	0.316 1	0.378 3	3 – 2 = 0.046
	0.332 2	0.373 4	4 – 2 = 0.041
	0.341 7	0.368 5	5 – 2 = 0.036
	0.343 8	0.365 6	6 – 2 = 0.033
	0.350 9	0.357 10	6 – 7 = 0.024
			6 – 8 = 0.022
			6 – 9 = 0.015
			10 – 9 = 0.007

The changeover point is therefore halfway between readings 9 and 10, or 0.354.

Checking the changeover point and range

The value found for the changeover point should now be checked against the table below to ensure it falls within the ideal range. (If it does not, see below.)

Table 6-3 Ideal changeover point

Internal meter range	Ideal changeover point (mJ)
0.3 to 0.4 mJ	0.340 to 0.360
0.4 to 0.5 mJ	0.425 to 0.461

If the changeover point is not in the ideal range, the energy offset must be adjusted and the process repeated until an ideal changeover point is obtained.

Adjusting the energy offset

The energy offset is adjusted via the low energy gain potentiometer on the microprocessor PCB (marked OFFSET on the micro cover).

After adjustment, repeat the low energy calibration check and if still not acceptable, adjust the potentiometer further and repeat the process until the calibration is acceptable.

If the low energy calibration needed adjustment, re-check the upper energy calibration again. Similarly, if the upper energy calibration is adjusted, the lower energy calibration must be re-checked.

If an acceptable calibration cannot be found, adjust the offset potentiometer on the attenuator. (In some older models, the attenuator PCB potentiometer is not present. In these models the microprocessor adjustment is adequate.)

6.5.7 Checking calibration for the entire energy range

After adjusting the calibration in the upper and lower energy regions (as described in the previous sections), check the calibration over the entire range of energy settings to ensure internal energy measurements are within 15% of external measurements of the output laser energy. Check the energy monitor calibration at minimum output laser energy, then at 0.6, 1.0, 2.0, 3.0, 5.0, 6.0, 8.0 and 10 mJ.

Since the internal energy meter displays values with a resolution of 0.1 mJ, calibration for energies less than 1.0 mJ should be confirmed by taking a number of external energy readings at each energy setting and checking they all correspond to the ranges shown below.

Table 6-4 Calibration ranges for energy <1 mJ

Internal meter reading (mJ)	External meter readings (mJ)
0.3	0.244 to 0.359
0.4	0.340 to 0.460
0.5	0.425 to 0.575
0.6	0.510 to 0.690
0.7	0.595 to 0.805
0.8	0.680 to 0.920
0.9	0.765 to 1.035

If the internal reading is 0.3 mJ and the external is 0.244 to 0.265, the half wave plate needs readjustment. See Section 6.4.2. In this case, re-calibrate after the half-wave plate adjustment.

When the calibration is completed and is acceptable at high and low energies, and across the entire energy range, complete a copy of the Calibration Record Sheet and retain for future records.

If the system cannot be calibrated contact Alcon Service Department.

6.6 RESETTNG THE VOLTAGE

The YAG voltage should be reset after optical alignment and final calibration. Refer to Section 11.4.2 for instructions.

6.7 AIR BREAKDOWN TEST

As a final check, carry out an air breakdown test as follows:

- Clear all objects away from the path of the laser, including model eye, jigs and targets.

For repeatable results the laser should be in a relatively cold, unused condition and should not have been subjected to successive firing.

- Ensure you are wearing approved safety glasses.
- Ensure the objective lens is clean.
- Place the unit in a position where the objective lens is facing a dark background.
- Plug the unit into the power supply and switch on.
- Set the energy to read 3 ± 2 mJ.
- Ensure single pulse mode is selected.
- Fire the laser into the air at increasing energy levels until an audible (or visible) breakdown is heard or seen.

To ensure a repeatable result fire at three to four second intervals while observing the laser spark (ionizing) and the distinctive crack sound (not always audible).

- Make very slight increases or decreases in power until no less than five out of ten shots cause breakdown at a given energy level.

Adjust the energy up if more than five of ten shots fail, or down if less than five.

The point at which 50% of ten shots cause air breakdown is the minimum air breakdown position, and the energy level at this point should be less than or equal to 4.0 mJ.

- Once the minimum breakdown position is found, place a calibrated energy meter on the chin rest assembly.
- Pull the slit lamp back and forth until the diode aiming beam is focused on the front of the detector.
- Push the slit lamp further forward until the two beams are approximately 6 mm ($\frac{1}{4}$ in) apart.

Make sure the head of the energy meter is parallel to the direction of the slit lamp.

- Without changing the energy setting, record the average of ten sequential shots.

This value is the minimum air breakdown energy level. It gradually increases over time, but should always be less than or equal to 4.0 mJ.

7.1 MODES OF OPERATION

The **3000LE** has the following modes of operation:

- ⇒ STANDBY mode – automatically selected when the instrument is turned on and prevents accidental firing of the treatment laser
- ⇒ READY mode – selected when mode switch is pressed; allows the treatment laser to be fired when the joystick fire switch is pressed
- ⇒ firing mode – selected when the fire switch is pressed when the system is in READY mode

If a footswitch is installed the laser cannot be fired unless the footswitch is depressed first, then the joystick fire switch is pressed.

STANDBY and READY modes are selected using the MODE SET button on the laser head control panel.

There is a further mode used in calibration and fault-finding. This is the service engineering test mode, described in *Section 11.4*.

7.2 PREPARING THE INSTRUMENT - CLEANING AND DISINFECTION

The **3000LE** needs regular routine cleaning and disinfection to ensure continued efficient operation. Contact areas may also need to be cleaned and disinfected between patients to avoid cross-contamination, even though the use of the **3000LE** involves only brief skin contact. The contact areas are the chin rest, head rest and steadying handles.

The health care facility owning the instrument is responsible for determining the level of cleaning and disinfection of patient contact areas required between patients. It is also responsible for appropriate training of staff in cleaning and disinfection, for routine cleaning, and for ensuring that chemicals used are compatible with the instrument.

Steam sterilization and heat disinfection are not recommended, and no component of the instrument should be immersed in liquid.

Refer to the **3000LE** Operator's Manual for further information.

Caution

Avoid using flammable anesthetics or oxidizing gases such as nitrous oxide (N₂O) and oxygen near the laser as the high temperatures produced in normal laser use may ignite materials such as cotton wool, when saturated with oxygen. Allow all solvents and flammable solutions used for cleaning and disinfecting to evaporate before using the laser.

7.3 USING THE INSTRUMENT

The instrument cannot be operated unless the key switch on the Key Switch panel is turned to the ON position. This panel is located on the right hand side, below the level of the table.

7.3.1 Using as a slit lamp

To use the system as an observational slit lamp:

- Ensure the Laser ON/OFF switch is in the OFF position.
- Ensure the Emergency Laser Stop switch is OFF (pulled out).
- Plug the power cord fully into the socket in the base of the table and into the mains supply source.
- Insert the key in the key switch and turn to ON.

The table up/down switch illuminates to indicate that the slit lamp is on.

The slit lamp illumination and fixation lamp will operate. Adjust the illumination intensity as required.

If high intensity is not required, set the lamp to minimum intensity to reduce heat build-up. Do not leave at maximum intensity for longer than ten minutes.

Note that the state of the theater door interlock or other safety interlocks do not affect operation of the slit lamp.

Refer to the Operator's Manual for full instructions on using the assembly in this mode.

Off-axis illumination

For off-axis illumination, move the illumination tower to the proper angle to provide the desired effect.

On-axis illumination

Some slit lamps have been modified to allow the laser to be used with on-axis illumination. Refer to the slit lamp documentation for further information.

7.3.2 Using as a treatment laser system

Refer to the Operator's Manual for full instructions on using the laser system for treating patients. The information included here is for completeness only, and is not intended to provide operating instructions for surgical procedures.

To turn on the laser and prepare for firing:

- Ensure the Emergency Laser Stop switch on the control panel is ON (pulled out).
- Plug the power cord fully into the socket in the base of the table and into the mains supply source.
- Insert the key in the key switch and turn to ON.
- Press the laser ON/OFF switch to the ON position.

The Laser ON/OFF switch is illuminated, the STANDBY indicator lights, the aiming beams are turned on and the control display is lit.

Caution

This instrument emits dangerous laser radiation. Please read Chapter 2 before using the 3000LE for the first time.

STANDBY mode is automatically selected after a series of start-up tests, including seven⁴ test shots with the shutter closed. This routine takes approximately 30 seconds, during which you may hear clicks as the laser fires. At the end of the test the display resets all registers to zero and displays the energy of the last test shot.

The number of pulses is automatically set to one, which is indicated on the LCD (see *Figure 3-9*). The energy display indicates the current attenuator energy setting, which is set by the ENERGY thumbwheel.

- Select the minimum slit lamp illumination intensity that still provides good visualization.

The best depth perception is achieved when the slit lamp illumination is positioned off axis to the aiming lasers.

Setting pulse mode

The laser can fire in single, double or triple pulses, with single being the default. To select double or triple pulses:

- Press the PULSE SET button to select the number of pulses required.
Each time the PULSE SET button is pressed a test shot is fired and the energy of the test shot is displayed. The LCD shows the new number of pulses. No further change to the pulse selection is possible until the test fire and updates are complete.

Setting the pulse energy

For safety, always select the minimum energy required to perform a procedure unless experience dictates otherwise.

- Use the ENERGY thumbwheel on the laser head to change the energy level for the treatment laser, if required.
The approximate energy at the selected thumbwheel position is displayed on the LCD. The laser fires a test shot with the shutter closed, then the LCD is updated with an accurate energy level.

This may vary slightly from the initial indicated value but this is not a fault condition.

⁴ Seven shots for software version 3.2 and later, five shots for version 2.2 and earlier.

Adjusting the posterior YAG offset

As the energy of the laser is increased it is advisable to increase the YAG offset (see *Figure 3-4*) because at higher energy settings the plasma produced at the laser's focal point elongates anteriorly along the beam axis. This elongation increases the chance of pitting the intraocular lens (IOL). An offset level greater than the minimum position ensures the plasma is created further behind the lens, and thus reduces this risk.

An increase in IOL pitting is possible when silicon IOLs are used. We advise caution when using silicon IOLs and recommend using +250 offset position. If pitting persists, defocus the laser further posterior manually.

See *Section 1.3* for a discussion on plasma formation.

To set the offset:

- Turn the POSTERIOR YAG OFFSET thumbwheel to the desired level.

Setting the posterior YAG offset to +150 at about 1.2 – 1.5 mJ will minimize the risk of pitting the IOL.

Preparing to fire

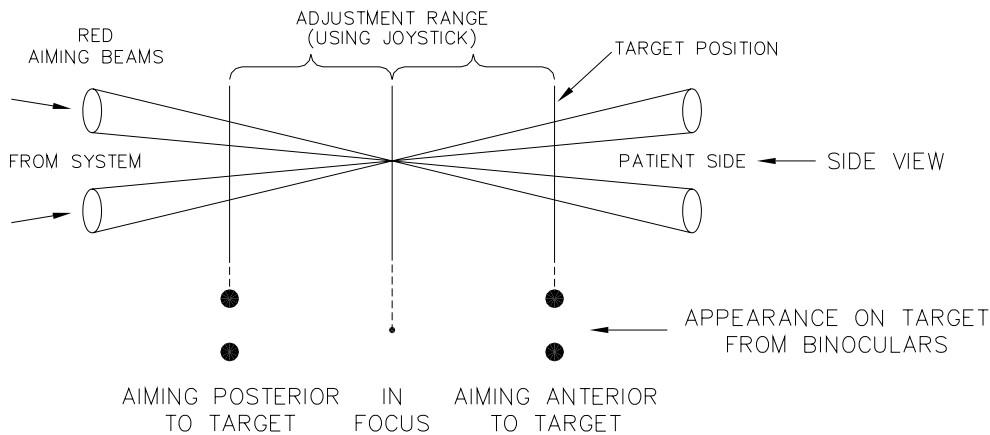
To prepare to fire the laser, either for treatment or for a test shot:

- Press the MODE SET button on the laser head to select READY mode. The LASER READY light comes on and the STANDBY light switches off.
- Press the ENERGY RESET and PULSE RESET buttons to set the registers to zero.
- Ensure the target (such as burn paper or model eye for service procedures) is correctly set on the test jig.

Aiming the laser

To aim the **3000LE** move the slit lamp microscope towards the target until the target is in focus. Fine-tune the focus by carefully manipulating the joystick until the two red aiming dots coincide. (See *Figure 7-1*.)

Adjust the intensity of the aiming beam to the minimum setting that provides good spot contrast on the target background. This control is at the base of the slit lamp, on the right. (See *Figure 3-10*.)

Figure 7-1 Dual diode aiming beams

7.3.3 Test-firing the laser

A test fire may be performed at any time and in either STANDBY or READY mode. It is completely safe, since the shutter is closed.

To perform a manual test fire:

- Press the ENERGY TEST button.

The energy delivered is shown on the LCD.

The energy delivered for successive test fires at the same setting may vary by as much as 10%, but this is normal for Nd:YAG lasers.

7.3.4 Firing the laser

The laser can only be fired when the instrument is in READY mode. When the laser is set up as required, press the MODE SET button to enter this mode from STANDBY mode.

Caution

When the fire switch is pressed with the unit in laser READY mode, dangerous laser radiation is emitted from the aperture.

To fire the laser when in READY mode:

- Press the joystick fire switch.
- Release the switch quickly.

If a footswitch is installed, press and hold it down before pressing the joystick fire switch.

If the switch is not released quickly after each firing action the system automatically returns to STANDBY mode, giving an audible warning. The system can be returned to READY mode manually once the fire switch has been released.

A click will be heard as the shutter operates. The LCD is updated to show the total energy delivered (rounded off to the nearest one tenth of a millijoule) and the total number of pulses fired.

In single pulse mode the registers increment by one pulse and one unit of energy per firing. They increment by two units in double pulse mode and by three units in triple pulse mode.

If required, record the total energy and total pulses readings and clear the registers ready for the next procedure by pressing ENERGY RESET and PULSES RESET.

To return to STANDBY mode and prevent inadvertent firing:

- Press MODE SET.

7.3.5 Emergency Laser Stop

Press the Emergency switch to turn off the laser and cut the power supplies in the event of an emergency.

To release, pull the button out.

7.3.6 Turning off the laser

To turn off the laser in non-emergency conditions:

- Press the Laser ON/OFF switch to OFF.
- Turn the key switch to OFF.
- Remove the key and store safely for future use.

Always remove the key when the instrument is not in use to prevent unauthorized access.

To remove the power cord, lift the strain relief and remove the cord.

If the theater door interlock option is fitted, the laser is turned off automatically if the door is opened.

7.4 RELOCATING THE UNIT

To avoid injury, we recommend two people be used to guide the unit during relocation.

The aiming accuracy of the **3000LE™** must always be checked when the unit has been relocated.

To move the unit a short distance:

- Tighten the three clamp screws (See *Figure 3-10*) on the laser head before moving the unit.
- Ensure all floor surfaces and rough terrain are traversed carefully to avoid the possibility of the slit lamp/laser head assembly becoming dislodged or jumping off its tracks.

If the **3000LE™** must be transported by trolley or vehicle the laser head assembly must be disconnected and removed from the table and transported inside the foam box in which it arrived.

Transportation that requires disassembling the **3000LE™** is not recommended, and must be carried out by the Alcon service representative. If it is necessary, the laser head must be removed and replaced after transportation. The alignment of the system must be verified after re-installation.

*Damage to the **3000LE™** occurring while it is being transported by unauthorized personnel is not covered by the Alcon warranty*

8.1 ROUTINE CARE SCHEDULE

The **3000LE** has been designed to provide trouble-free operation with a minimum of down time. As a result very little user maintenance is required, but the routine maintenance procedures described here should be carried out at the recommended prescribed intervals.

The following table outlines the procedures required for routine care and cleaning of the **3000LE**, as carried out by the operator. The annual service call procedures are dealt with in *Chapter 9*, but these routine care procedures should always be carried out during these service visits.

Table 8–1 Routine care schedule

Procedure	Minimum frequency
Cleaning the 3000LE	As regularly as necessary. Frequency depends on the requirements laid down by the health service owning/operating the instrument.
Cleaning the external optics	Depends on the requirements laid down by the health service owning/operating the instrument, but at least every twelve months.
Checking aiming accuracy	Twelve months.
Checking optical alignment	Twelve months.
Checking the calibration	Twelve months.
Replacing fuse	As required.

8.2 ROUTINE CARE PROCEDURES

Most of the routine care procedures are described in the remaining sections of this chapter. They are:

- ⇒ cleaning the **3000LE** — *Section 8.3*
- ⇒ cleaning the external optics — *Section 8.4*
- ⇒ checking aiming accuracy — *Section 8.5*
- ⇒ replacing fuse — *Section 8.6*
- ⇒ checking the calibration — *Section 5.15.4*
- ⇒ checking optical alignment — *Section 6.3*

8.3 CLEANING THE CASING

To clean the system at any time, wipe over with a damp cloth, avoiding any optical surfaces.

Caution

<i>Ensure that the power is switched off before cleaning.</i>

Clean the display panel with a damp cloth, but avoid pressing too hard.

Caution

<i>Do not use solvents to clean the 3000LE.</i>
--

When the equipment is not in use, always cover it with the dust cover.

8.4 CLEANING THE EXTERNAL OPTICS

The slit lamp objective lens, the oculars, and the slit lamp window must be kept clean or performance is compromised. The operator should check these optics regularly – the decision on frequency required is the responsibility of the health service owning/operating the instrument.

The external optics should always be cleaned during any service visit.

8.4.1 Equipment required

The following equipment is required:

- ⇒ lint-free optical tissues (available from a photographic store)
- ⇒ cotton swabs (Q-tips or similar)
- ⇒ pure or AR grade ethanol or methanol

8.4.2 Method

To clean the optics:

- Turn off the system.
- Unplug from the power source.
- Moisten an optical tissue or cotton swab in the solvent.
- Using a linear stroke, gently wipe the moistened tissue or swab *once* across the optical surface.

Caution

Never use dry tissues or swabs as this may damage the optical surface.

- Discard the tissue or swab.
- Repeat the process, using one tissue or one swab per wipe, then discarding and using a fresh one for the next wipe.

8.5 CHECKING AIMING ACCURACY

The aiming beams pass through the same delivery system as the treatment beam and are coaxial with it, and they therefore provide a good method of checking the integrity of the delivery system. If the aiming beam spot is not present at the distal end of the delivery system, or if its intensity is reduced or it looks diffused, the delivery system may not be working properly or may be damaged.

It is critical to ensure the laser's aim is accurate by following the procedure described below at least every three months, or more frequently as considered necessary by the operator.

The aiming accuracy should always be checked during any service visit.

8.5.1 Equipment required

Photographic burn paper (Kodak linagraph direct printer or equivalent) is required for this procedure.

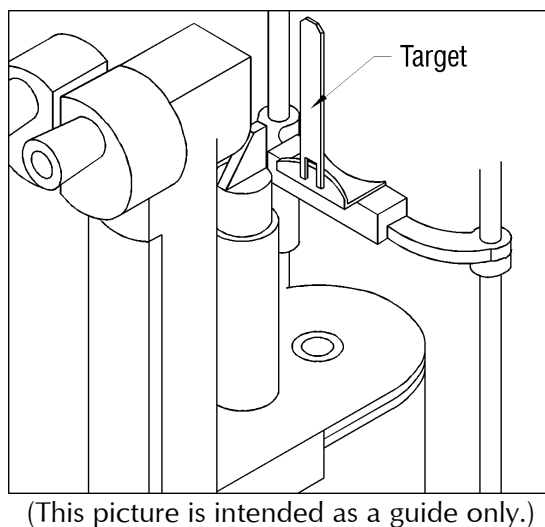
8.5.2 Method

To check the aiming accuracy:

- Attach (with double-sided tape) a piece of photographic burn paper to the alignment target.
- Mount the target on the chin rest so it is vertical, as shown below:

The alignment target is supplied with the system, and is usually kept in the accessories drawer.

Figure 8–1 Alignment target in position



(This picture is intended as a guide only.)

Adjusting the slit lamp

- Turn on the slit lamp to illuminate the burn paper target.
- Adjust the eyepieces to suit your eyesight.

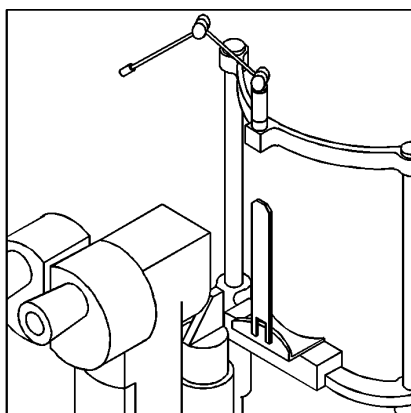
The rubber eye caps are designed to be folded back if you wear spectacles.

- Adjust the slit lamp to obtain full circle illumination and low intensity.
- Turn on the laser, which should be in STANDBY mode to activate the aiming beams.
- View the aiming beams through the binoculars and confirm that they converge to form one spot on the paper attached to the target as shown in section (d) of Figure 8-2.

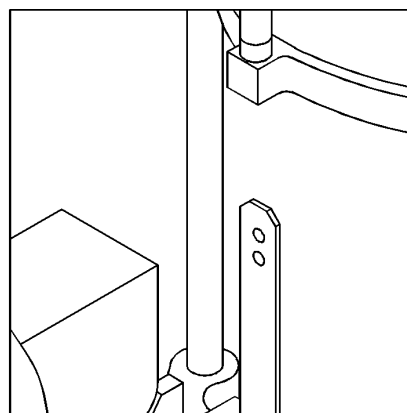
If they do not, move the slit lamp.

- Lock the slit lamp in this position.

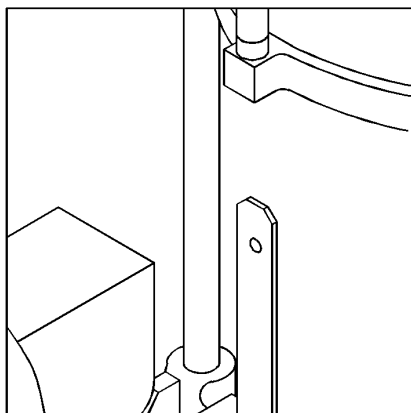
Figure 8-2 Checking aiming accuracy



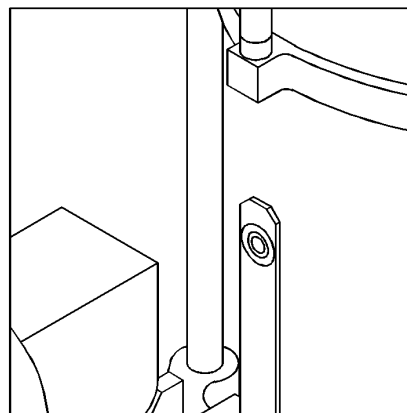
(a) Test target in place.



(b) Aiming beam not in focus.



(c) Aiming beam in focus.



(d) Burn mark after firing the treatment laser.

(These pictures are intended as guides only.)

If the aiming beams do not converge as shown, check the optical alignment. (Refer to *Section 6.3.*)

Caution

If the aiming beams cannot be made to coincide, the system must not be used on patients. Re-align the instrument (see Chapter 6), or return it to the factory for re-alignment

- When the beams are converged, select READY mode.
- Select minimum power.
- Check that the aiming beams are still converged to one spot.
- Fire the laser once on to the burn paper.
- Inspect the burn mark through the binoculars to verify that it is concentric with the aiming beam spot. See part (d) of *Figure 8-2*.

The test can be repeated if necessary on another area of the burn paper.

Caution

If the aiming beam is not centered in the burn mark, the system must not be used on patients. Re-align and calibrate the instrument (see Chapter 6), or return it to the factory for re-alignment and calibration.

8.6 REPLACING THE FUSE

The mains fuse fitted to the **3000LE™** is 6.3A rating for 100 V-120 V AC or 220 V-240 V AC operation.

In units with serial numbers before 4000, the mains fuse is located in the key switch panel and a secondary is in the base of the stand.

In units with serial numbers from 4000 onwards, the mains fuse is located in a removable holder at the top of the IEC mains input socket at the bottom of the stand, and there is no secondary fuse.

Caution

Turn the power off and disconnect the power cord from the wall outlet before inspecting or replacing the fuse.

If a fuse blows, replace only with one of the correct type (slow blow) and rating, as follows:

- Turn off the instrument.
- Disconnect from power sources.
- Replace the fuse, ensuring that the correct type and rating of fuse is used.

The internal power supply is protected against overload, so the fuse should rarely need replacement. A blown fuse is likely to indicate an internal fault.

MAINTENANCE PROCEDURES

Maintenance information may also be provided as service bulletins after this manual is issued. Please check the service bulletins in the appendix for any additional information on maintenance procedures.

9.1 MAINTENANCE SCHEDULE

The following table outlines the procedures required for preventive maintenance for the **3000LE**. These are normally carried out during the annual service visits. During these visits all procedures described in *Chapter 8* should also be carried out.

Table 9–1 Maintenance schedule

Procedure	Min. frequency	Ref. Section
Clean the optics	Twelve months	8.4
Shot count and serial register	Twelve months	11.4.4
Location and leveling of the system	Twelve months	5.8.2
Stand procedure	Twelve months	9.7
Check optical alignment	Twelve months	6.3
Check the calibration	Twelve months	5.15.4 Energy monitor check and 6.5
Check attenuator shutter	Twelve months	6.4.1
Verify correct function of the system	Twelve months	9.3
Check ground resistance	Twelve months	9.4

9.2 REPLACING THE SLIT LAMP HALOGEN LAMP

The only maintenance requirement is to replace the halogen lamp if it fails. On every service visit ensure that a new lamp is available.

To change the lamp:

- Switch off the system and wait a few minutes for the lamp to cool down.
- Open the cap at the right side of the illumination tower to gain access to the lamp.
- Remove the lamp using a cloth or gloves.

Do not touch the glass surface of the new halogen lamp directly with your fingers as this may shorten its life.

- Set the new lamp so that its groove matches precisely with the lamp housing.
- Ensure the new lamp is clean and free from oil and dust, and clean if necessary using ethanol on a clean swab or tissue.

Ensure that a spare lamp is always available. The lamp need not be replaced unless it fails.

9.3 VERIFY CORRECT PERFORMANCE

To check the general performance of the instrument, carry out the following:

- Set up an appropriate external energy meter.
See *Section 5.15.4* for specifications of a suitable meter and instructions for setting it up.
- Turn the instrument off.
- Wait ten seconds then turn it back on.
- Check that no error occurs after initialization.

An error code should appear. Refer to *Section 11.2* for a description of the error codes and their meanings.

Checking energy readings

- Press the MODE SET button to select READY mode.
- Set the laser energy to maximum using the ENERGY thumbwheel.
- Record the predicted energy displayed on the LCD, and ensure that the test fire energy is within $\pm 30\%$ of the predicted energy.
- Ensure the external energy monitor is in position.
- Press the fire switch to fire the laser.
- Record the energy displayed on the LCD and the external meter reading.

The two readings should be within 15% of each other. If they are not, the instrument should be re-calibrated. Refer to *Chapter 6*. If the instrument cannot be successfully calibrated, contact the Alcon Service Department.

9.4 CHECKING GROUND RESISTANCE

To check ground resistance, use a multimeter to make the following checks:

- Check the resistance between the earth pin of the mains socket on the instrument and any metal part of the table or console that is protectively earthed.
- Check the resistance between the earth pin of the mains socket on the instrument and the slit lamp.

Ground resistance should not exceed 0.1 ohm at any point.

9.5 CHECKING THE ALIGNMENT

Refer to the procedure described in *Section 6.3*.

9.6 CHECKING THE CALIBRATION

Refer to the procedure described in *Section 6.5*.

9.7 ROUTINE STAND TESTING

This procedure only applies to units with serial numbers before 4000.

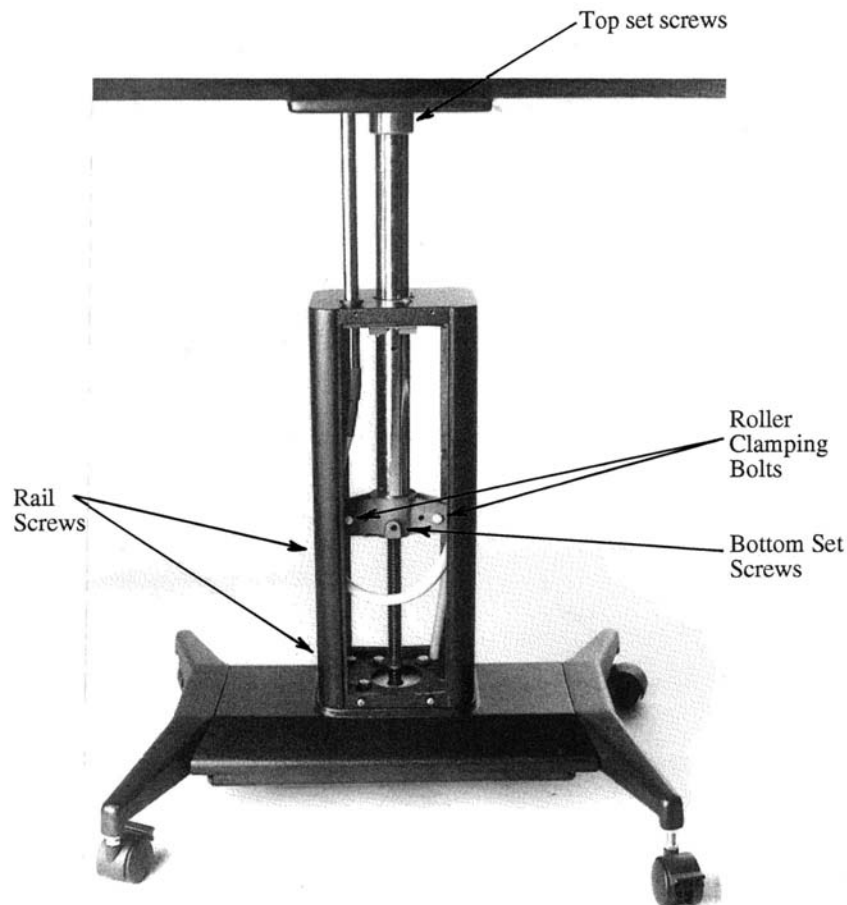
We recommend that a preventive maintenance check for correct smooth operation of the up/down travel of the tabletop be carried out at least every twelve months.

If the movement of the tabletop is not acceptable, it is essential that the following procedure be carried out, since maladjustments may result in injury to patients.

The stand column has a motor driven electric lift mechanism for raising and lowering the table. The motor, drive gearbox mechanism, mains isolation transformer, mains input voltage connection, mains voltage selector and interlock connector are under the base of the stand.

After removing the front and rear covers from the stand it is easy to see the main table support column, the screw drive mechanism with its track rollers and the electrical cable transfer conduit.

Figure 9-1 Stand



To assure that the table operates smoothly, several adjustments can be made to take up free play caused by wear.

To eliminate a twisting movement of the table in relation to the stand (see Figure 9-1):

- Tighten the two setscrews holding the table to the top of the stand.
- Tighten the two setscrews holding the bottom of the stand to the track roller clamp assembly.
- If twisting movement still exists, tighten the roller clamping bolts. Take care not to tighten them too much as they need to be able to rotate while moving up and down on the inside rails.

To eliminate chattering as the table is raised and lowered:

- Watch the rollers to verify that they turn continuously as the table is operated up and down.
If they stop at any time adjust the appropriate rail, since the inside rails must be in full contact with the roller at all times.
- If a roller has a 'dead' spot, loosen the appropriate rail securing screws.
- Tighten the setscrews in the rail to move the rail towards the roller.
- Re-tighten the rail securing screws.
- Check the operation of the rollers and repeat the procedure as necessary.

Caution

If the rollers are adjusted too tightly the table can be raised with smooth movement, but as the table is lowered the weight of the table cannot overcome the friction of the rollers on the rails and the table may drop suddenly causing damage. Also, if rollers are too tight they may get flat spots and cause unsteady movement of the table.

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Fault finding information may also be provided as service bulletins after this manual is issued. Please check the bulletins in Appendix E for any additional information.

10.1 GENERAL SYSTEM CHECKS

If the **3000LE** malfunctions this section will help you diagnose the fault. If you need further assistance to diagnose a fault contact Alcon Technical Support.

10.1.1 Electrical power cord

The **3000LE** power cord is plugged into the key switch panel (S/N pre-4000) or the base of the stand (S/N from 4000). Ensure that the power cord is plugged fully into the socket and into the mains supply source.

10.1.2 Interlocks

Ensure that the connectors are inserted correctly if being used and that a shorting plug is firmly in place for an interlocks that is not being used.

10.1.3 Fuse

The user-accessible fuse is located behind the key switch panel just below the level of the table in units with serial numbers pre-4000, and at the bottom of the stand in units with serial numbers from 4000 onwards. When replacing a fuse ensure that the correct type and rating is used. Refer to *Section 8.6* for the replacement procedure.

Ensure the unit is turned off and disconnected from power sources before replacing fuses.

10.1.4 Error codes

The system has a built-in microprocessor that monitors the critical system components. If a system malfunction occurs an error code appears on the display. In this condition the laser fire switch is disabled and the unit defaults to STANDBY mode.

If the error has occurred for the first time, reset the system by turning the power key switch OFF, waiting for five seconds then switching it on again.

If the error code disappears and the system functions normally, the fault was momentary and you may continue to use the system.

If the same error code appears again refer to the troubleshooting table (below) and *Chapter 11* to try to identify the cause.

The system will shut down until the fault is rectified.

10.2 TROUBLESHOOTING TABLE

The following table outlines the faults you may encounter and their possible causes and remedies:

Table 10-1 Troubleshooting guide

Fault	Possible causes	Remedy
System will not turn ON (no indication of power).	Not properly prepared for use.	Plug in mains power and main cable between laser head and control console.
		Turn key switch, pull Emergency Laser Stop switch out.
	Cable disconnected or loose.	Check cables to mains and between control console and laser head.
	Fuse blown.	Check fuse (with power removed).
	Internal fuse blown.	Replace the power supply unit.
No display after turning on.	If the control panel display looks frozen and the function keys are not working after turning the system on, the microprocessor may have been turned on too quickly after turning it off.	Turn the power off, wait at least five seconds, then turn on again.

Fault	Possible causes	Remedy
No slit lamp illumination.	Cable not plugged in.	Check cables to and between laser head and control console are firmly plugged in.
	No power.	Turn power on at wall.
	Key switch off.	Turn on key switch.
	Slit closed.	Open slit.
	Contact between receptacle of lamp house and pins of halogen lamp are loose.	Check contacts.
	Fuse blown.	Replace fuse.
	Lamp blown.	Replace lamp, see <i>Section 9.2</i> .
	Power supply cord faulty.	Replace cord.
	Bad illumination control PCB.	Replace illumination control PCB.
	Emergency Laser Stop switch was pushed in.	Pull Emergency Laser Stop switch out.
No aiming beam, error message E07.	Fault in laser diode or power supply.	Refer to <i>Section 11.2.2</i> .
	Faulty diode aiming module (DAM).	Replace DAM.
	X16 not connected properly.	Check X16.
	No power to DAM.	Check for +12 VDC at X32 and at X50A.
No aiming beam, no error message.	Slit lamp tower is blocking the laser aperture.	Swing tower through another 10 degrees.
	Faulty diode aiming module (DAM) and faulty attenuator module.	Replace both modules.
	Aiming beam path blocked inside housing.	Turn system off, remove DAM and folding mirror module and inspect beam path.

Fault	Possible causes	Remedy
Aiming beam out of focus	Eyepieces not correctly set.	Mount target and adjust each eyepiece separately while the two beams are coincident.
	Eyepieces not inserted fully into the binoculars.	Check insertion is correct.
	Dirty objective lens.	Clean objective lens.
	System out of focus.	Adjust DAM focus — see <i>Section 12.3.5</i> .
	Objective lens not focused correctly.	Carry out optical alignment.
Laser fires but poor effect in eye.	Dirty objective lens.	Clean objective lens.
	Slit lamp tower is clipping treatment beam.	Swing tower out of beam path (for high tower prism only).
	System out of focus.	Re-focus system.
	YAG optical path dirty.	Check and clean YAG module mirror, attenuator optics, YAG beam expander and folding mirror optics as required.
	Faulty YAG module.	Replace module.
Slit illumination and table operate, but nothing else; no display.	X2 not connected to control module.	Connect X2 to control module.
	Emergency Laser Stop switch is ON.	Release Emergency Laser Stop switch.
	Faulty control module.	Replace control module.
	DC power supply faulty.	Replace DC power supply unit.
Slit illumination and table operate, display appears, but nothing else operates	X5 not connected to YAG power supply.	Connect X5 to YAG power supply.
	YAG power supply faulty.	Replace YAG power supply.
Slit lamp microscope does not focus.	Eyepieces not correctly set.	Confirm that eyepieces are correctly inserted and adjust eyepieces to suit user's eyes.
Slit lamp illumination is blurred.	Lamp not properly seated in slit lamp housing.	Lift bulb housing cover and re-seat lamp. If this does not correct the problem, replace the lamp. See <i>Section 9.2</i> .

Fault	Possible causes	Remedy
System switches from READY mode to STANDBY mode.	Joystick fire switch held down for more than 0.5 seconds.	Release fire trigger switch faster.
Segments of the LCD blank.	Source of extreme electrostatic discharge nearby.	Turn mains power off then on again.
System beeps twice in rapid succession.	Energy deviation warning. The delivered energy has deviated by more than 20% from the energy of the last test fire.	The system can be used normally with additional attention being paid to the energy setting. Check the calibration.
CALIBRATION CHECK message displayed.	Actual energy is out from predicted energy. Energy prediction out of calibration.	Perform the energy prediction adjustment procedure. (Section 6.4.2.)
Low YAG laser energy	Attenuator not set correctly.	Set attenuator to correct setting.
	YAG optical path dirty.	Check and clean YAG module mirrors, attenuator optics, YAG beam expander, folding mirror and objective lens optics as required.
	Energy meter not calibrated.	Calibrate energy meter.
	Faulty YAG laser.	Replace YAG laser module.
No YAG laser energy (0.0) but operates flashlamp.	Under-pulsing.	Reset YAG voltages.
	Faulty YAG power supply.	Check for 350 V to 900 V output from X10; replace YAG power supply.
	Faulty trigger module.	Replace trigger module.
	Faulty energy meter.	Replace energy monitor or attenuator module if energy is detected at objective lens but control panel display energy is 0.0.
	Faulty YAG laser.	Replace YAG laser module.

Fault	Possible causes	Remedy
No YAG laser energy (0.0), shutter operates but flashlamp does not fire	X15 not connected.	Connect X15.
	X43 not connected.	Connect X43.
	Trigger not correctly connected to YAG module.	Check trigger to YAG module connections.
	X13 (power) connectors to trigger not inserted properly.	Ensure both connectors are pushed firmly into trigger module.
	Break in X13 to X43 cable (YAG power supply to trigger cable).	Check continuity of cable. If a fault is found, contact Alcon.
	Faulty YAG power supply.	Check for 350 V to 900 V output from X10.
	Faulty control module.	Replace control module.
	Faulty trigger module.	Replace trigger module.
	Faulty YAG laser.	Replace YAG laser module.
P01 status flag (only displayed in operator test mode)	Energy decrease >20%.	Re-calibrate energy (see <i>Section 6.5</i>).
P02 status flag (only displayed in operator test mode)	Threshold voltage shift 30 to 55 volts.	Reset voltages (see <i>Section 11.4.2</i>).
P03 status flag	5000 shots fired. (10000 shots fired for v3.2 software)	Operator Test (see <i>Section 10.4</i>).
E01 error (only displayed in operator test mode and system auto calibration)	Single pulse voltage >860 volts.	Replace YAG laser module.
E02 error (only displayed in operator test mode and system auto calibration)	Quadruple pulse voltage >860 volts.	Replace YAG laser module.
E03 error (only displayed in operator test mode)	Single pulse voltage has changed by more than 55 volts.	Reset voltages.
E04 error	Over-pulsing.	Reset voltages.

Fault	Possible causes	Remedy
E05 error	X3 not connected to control module.	Connect X3.
	Shutter malfunction; right sensor senses shutter not fully closed.	Replace attenuator module.
	Faulty control module.	Replace control module.
E06 error	Shutter malfunction; left sensor senses shutter not fully closed.	Replace attenuator module.
	Loose X8 connector to attenuator module.	Re-seat X8 connector.
E07 error	If aiming beam visible: loose X8 connector, faulty microprocessor board or DAM malfunction.	Check X8 connector. Replace microprocessor board. Replace DAM.
	If aiming beam not visible: loose X52 connector or DAM malfunction.	Check X52 connector. Replace DAM.
E08 error	Shutter motor not operating. Shutter malfunction; left sensor senses shutter not fully closed.	Replace attenuator module.
E09 error	Shutter malfunction; right sensor senses shutter not fully closed.	Replace attenuator module.
E10 error	Over-pulsing and pulses detector malfunction.	Replace attenuator module.
E11 error	No energy or incorrect energy detected.	Replace attenuator module. Replace YAG laser module.
E12 error	More than double energy delivered than set.	Replace attenuator module.

10.3 STATUS FLAGS

Status flags indicate that one or more operating parameters has changed. They do not prevent system use but signal the user that changes have been made to the operating characteristics of certain modules in the unit. Refer to the table below:

Table 10–2 Status flags

Flag	Meaning	Action required
PO1	Energy deterioration — single pulse operating voltage has changed by 30-55 V and energy has degraded by more than 20%.	This flag indicates minor changes to the operating characteristics of the laser module and is only displayed at the end of the operator test. Clear it by switching the system off and on again. Normal operation continues.
PO2	Single pulse operating voltage has changed by 30-55 V from the last calibration	This flag indicates minor changes to the operating characteristics of the laser module and is only displayed at the end of the operator test. Clear it by switching the system off and on again. Normal operation continues.
PO3	Treatment laser count has increased by 10 000 ⁵ shots.	This flag occurs when 10 000 treatment laser shots have been fired, and is displayed during normal operation. It does not indicate an error or unsafe condition has occurred, and the system may continue to be used. Carry out the procedure below to clear this flag.

10.3.1 Clearing the P03 status flag

To clear the P03 status flag and verify correct operation of the system:

- Turn the system on.

During the test fire the system may display a flashing P03 message.

- At the end of the warm-up tests start the operator test (Section 10.4).
It is not necessary for the operator test to run its full time. As soon as the test has been initiated, turn the system off.
- Turn the system on again.
- Set to READY mode.
- Fire 15 shots by pressing the joystick fire switch.

The P03 status flag will now be cleared and the system is ready for use. The status flag will reappear when 10 000⁵ shots have been fired.

⁵ 10 000 for software version 3.2 and later; 5 000 for version 2.2 and below.

10.4 OPERATOR TEST

The operator test confirms that the system is operating correctly by checking the single, double and triple pulse voltages and the average maximum energy from the laser in single pulse mode. The operator test is also part of the procedure to clear the P03 status flag (see above).

This test is used for diagnostic purposes and may be carried out to allow an initial diagnosis of a fault by the service engineer and a decision whether or not to arrange a service visit. It cross-references previously stored parameters from the last calibration with the present values.

The test is normally carried out if one of the following conditions occurs:

- ⇒ a P03 status flag appears (see *Section 10.4.1*)
- ⇒ an E04 error code appears (indicating the laser has over-pulsed)
- ⇒ the maximum energy of the system has decreased
- ⇒ the system performance appears to have decreased (meaning, for example, that more energy is regularly required to perform posterior capsulotomy or membranectomy procedures than expected)

During the test the microprocessor compares these measured values with those stored in the memory and the new average energies are calculated and stored if the result of the test is PASS, P01 or P02. The possible results of the test are:

PASS	No fault condition in voltages or energy.
P01	Energy for single pulse mode has degraded 20% or more since the last calibration.
P02	Operating voltage for a particular pulse setting has changed by 30-55 V since the last calibration.
E01	Single pulse threshold voltage exceeded 600 volts.
E02	Quadruple pulse threshold voltage exceeded 860 volts.
E03	Single pulse voltage has changed by at least 55 volts.

If one of the error codes E01, E02 or E03 is displayed the laser would certainly need to be checked on site by the service engineer, and it is highly likely that it would need to be changed for another laser module.

If one of the status flags, P01 or P02 is displayed the characteristics of the laser module have changed since calibration. The action taken will depend on how much difficulty the client is experiencing with the system. A service call may be justified, or the status flags may be logged and arrangements made to call the client in two months to determine if the system has deteriorated further.

10.4.1 Test procedure

The test takes up to one hour to complete.

To initiate the test:

- Turn the system on.
- Wait until the start-up processes are complete.
- Set to READY mode.
- Set the ENERGY thumbwheel to maximum (completely to the right).
- Press ENERGY TEST and MODE SET simultaneously.

The word 'DIAGNOSTIC (ENG)' appears on the LCD and remains for the duration of the test. The figure '350' appears and increments during the test to indicate the temporary setting of the Nd:YAG laser voltage.

At this point the system can be left idle for approximately one hour to complete the test.

10.4.2 PASS result

If successful, the control panel LCD will display the word 'PASS'.

- Turn the system off using the Laser ON/OFF switch or turning the key switch off.
- Restart the system.

The system can now be used normally and should be working satisfactorily.

10.4.3 P01 or P02 result

If the result shown on the LCD is a flashing P01 or P02 status flag this indicates there is some degradation in the unit, but it is not an unsafe condition. To clear these status flags, turn the system off then on again.

The system can then be used normally, but it has suffered some deterioration and should be checked.

10.4.4 E01, E02 or E03 result

If the result shown on the LCD is a flashing E01, E02 or E03 error code the laser module should be checked and there is a high probability that it will need to be replaced.

11.1 VIEWING ERROR CODES AND SYSTEM MESSAGES

The **3000LE** microprocessor monitors all important system components. If an irregularity occurs during operation the system is disabled and an error message appears on the LCD in the Pulses Total register.

The laser fire switch is disabled and the instrument will shut down and will not accept operator commands until the fault is rectified. Refer to Section 11.4 for instructions on using test modes to diagnose the cause of the fault.

If this occurs, turn the instrument off, wait a few seconds then turn it back on. A self-diagnostic routine checks the system performance. If this test does not find any errors, the condition is deemed temporary and the instrument can be used.

11.2 ERROR CODES

The following table lists the error codes and their meanings.

Table 11–1 Error codes⁶

Message	Cause	Error
E01	A Nd:YAG single pulsing voltage has exceeded 600 volts	Single pulse threshold voltage limit exceeded
E02	A Nd:YAG quadruple pulsing voltage has exceeded 860 volts	Quadruple pulse threshold voltage limit exceeded
E03	A Nd:YAG pulsing voltage has changed by at least 55 volts	Single pulse voltage shift limit exceeded
E04	Pulse count error	More pulses detected than set
E05	Shutter malfunction	Sensor 1 indicates not fully closed
E06	Shutter malfunction	Sensor 2 indicates not fully closed
E07	Aiming laser malfunction	No output detected
E08	Shutter malfunction	Sensor 1 indicates not fully open
E09	Shutter malfunction	Sensor 2 indicates not fully open
E10	Pulse detector malfunction	No pulses detected
E11	Energy monitor malfunction	Fault within the attenuator module
E12	Attenuator malfunction	More than double energy delivered than set

E01, E02 and E03 are error flags. The unit should not be used for normal operation until the problem is rectified.

⁶ Refer to Chapter 10 for information on the status flags P01 to P03.

11.2.1 E04 error on initial start up

If an E04 error occurs when the system is first turned on, it will not be possible to enter any of the diagnostic or engineering test modes. To eliminate the pulse detector from counting over-pulses the YAG laser trigger must be disconnected so that the YAG laser does not pulse at all. To do this:

- Turn off the system and disconnect from the power.
- Raise the slit lamp to maximum height.
- Remove the front control panel by undoing the countersunk screw at the bottom of the cover with a 2 mm (0.08 in) hex wrench (Allen key).
- Disconnect X15 on the attenuator PCB.

This is the twisted pair of wires connecting the trigger module to the attenuator module PCB. Disconnecting will temporarily disable the YAG laser.

- Re-connect to power and turn the system on.
The system will carry out its seven-shot⁷ warm up procedure (without firing the shots, as the laser is now disabled), after which 0.0 will appear on the energy monitor.
- With the system still on, re-connect X15.
- Re-set the YAG voltage (see *Section 11.4.2*).
- Carry out the Operator Test (see *Section 10.4*).

11.2.2 E07 error code

An E07 error means that the aiming beams are not detected and the Diode Aiming Module (DAM) has failed. To check this module and determine if it is faulty:

- Turn off the system and disconnect from power sources.
- Remove the front cover panel.
- Disconnect the DAM monitor wires from the attenuator module.

These are the blue and brown wires from the DAM to connector X16 on the attenuator PCB.

- Connect a 1.5 k Ω jumper (supplied in the service kit) into the X16 connector on the attenuator PCB.

This will bypass the DAM monitor circuit and allow the unit to operate without the DAM.

You may just short across these two pins if a 1.5 k Ω jumper is not available.

⁷ Five shots for software version 2.2 and below.

Verifying correct operation

- Re-connect to power and turn on the system.
- After the seven-shot⁸ warm-up routine, verify the following:
 - no error messages appear
 - it is possible to select laser READY mode
 - there is a dim red light output from the DAM
(if there is no light output, verify there is a 12 V DC input to the DAM)
 - the aiming beam intensity control can adjust the aiming beam intensity
(if the intensity is not adjustable the DAM is faulty)

Refer to *Section 12.3.5* for further information on this module.

11.3 SYSTEM MESSAGES

The following table lists the system messages you may encounter, and their meanings.

Table 11–2 System messages

System message	Meaning
CHECK CALIBRATION (For v3.2 software only.)	The energy of a test fire is greatly different to the energy that should be obtained at a particular thumbwheel position. If predicted energy is >2 times or <1/2 of test fire energy the system can be used, with additional attention being paid to the energy delivered, but only if the predicted energy value is 1 mJ or greater (single pulse), 2 mJ or greater (double pulse) or 3 mJ or greater (triple pulse). Check the calibration.

⁸ Five shots for software version 2.2 and below.

11.4 SERVICE ENGINEERING TEST MODES

Special service engineering diagnostic modes allow the service engineer to perform a range of system diagnostics and to:

- ⇒ inspect the current single, double and triple pulse voltages
- ⇒ inspect the current average energy levels
- ⇒ calibrate the single, double and triple pulse operating voltages
- ⇒ store the new average energies
- ⇒ view and record or reset the shot count and treatment laser serial number

Caution

The operating parameters of the system can be changed as a result of this test mode. Note the initial parameters on the record sheet provided before you do any calibration work.

11.4.1 Inspecting the YAG laser voltage and energy

To enter test mode and view the YAG laser voltage and energy for single, double and triple pulse mode:

- Simultaneously press and hold down the MODE SET, ENERGY RESET and ENERGY TEST buttons.

The LCD should display DIAGNOSTIC (ENG) **not** DIAGNOSTIC (USER). If the latter is displayed, switch the machine off then on and try again.

The operating voltage is displayed on the three-digit TOTAL PULSE display. The mean average energy, for the maximum energy setting is displayed on the ENERGY DISPLAY. This is a five-digit number where the two large digits comprise the integer parts and the fractional part consists of the remaining three.

- Press the PULSE SET button to scroll between single, double and triple pulse data.
- Record this information before calibrating the instrument.

To leave test mode:

- Press ENERGY TEST, ENERGY RESET and MODE SET simultaneously.

The system will then reset. If it does not reset after one attempt, wait for five seconds before trying again.

11.4.2 YAG laser voltage and energy reset

This procedure allows the voltages for the system to be set automatically by the microprocessor, rather than manually setting via trimpots.

The procedure takes up to about 20 minutes for version 3.2 software (over one hour for version 2.2 software and below).

This voltage calibration procedure should be carried out when:

- ⇒ an over-pulse error E04 error code is displayed
- ⇒ a laser and/or attenuator module is exchanged
- ⇒ the laser system has degraded and needs to be recalibrated

The purpose of the voltage setting algorithm is to determine the maximum and minimum laser voltages at which the system will fire five out of five shots for single, double and triple pulses. (For v3.2 software only.) The process begins by determining the minimum single pulse voltage.

When the calibration procedure begins, the microprocessor resets the laser voltage to 350 volts then increments the voltage in 5-volt steps (6-volt steps for v3.2 software), firing the laser at each. The microprocessor interrogates the pulses detector to find the voltage at which a single pulse is detected.

The microprocessor then determines the maximum single pulse voltage. It increments the voltage in 2-volt steps (3-volt steps for v3.2 software) and finds the voltage at which five out of five shots produce a single pulse.

The microprocessor adds 40 V (70 V for v3.2 software) and then increments the voltage again in 4-volt steps (6-volt steps for v3.2 software), interrogating the pulse detector for a double pulse. The process continues until all thresholds are found.

Once determined, the microprocessor calculates the lasing voltages and stores them in its EEPROM. Then, using these stored voltages, the microprocessor fires the laser ten times at the stored single, double and triple pulse voltage to determine the average maximum energy for the three pulse settings. It stores the ten-shot averages in its memory.

Procedure

To carry out this process and recalibrate the voltages:

- Set the ENERGY thumbwheel to maximum.
- Simultaneously press and hold down the MODE SET, ENERGY RESET and ENERGY TEST buttons to enter service engineering test mode.
- Press MODE SET momentarily and release.
- Hold MODE SET down for a minimum of three seconds until the unit beeps.

When the MODE SET button is released the control panel displays the message 'DIAGNOSTIC (ENG)'.

In the PULSES section of the panel, the pulse should be 1 and the number 350 should appear in the TOTAL PULSES display.

The message 'DIAGNOSTIC (ENG)' remains for the duration of the calibration and the figure 350 increments throughout to indicate the temporary setting of the Nd:YAG laser voltage.

When completed the system resets itself with the updated operating conditions, and will return to STANDBY mode.

11.4.3 Manually adjusting the YAG voltage

The YAG voltage must be adjusted manually if:

- ⇒ the unit is constantly giving an E04 error, even after a voltage reset
- ⇒ the laser cavity is replaced
- ⇒ the microprocessor/display module is replaced

This procedure allows the user to manually enter the YAG voltage for each pulse setting instead of performing the YAG voltage/energy reset procedure.

Procedure

To manually adjust the YAG voltages:

- Turn the system off.
- Press and hold down the MODE SET button.
- Turn the system on.
- Release the MODE SET button as soon as you hear a beep.
The system now displays a YAG voltage reading and the pulse setting.
- Turn the energy adjustment thumbwheel to change the YAG voltage setting to the desired value.
- Press the PULSE SET button to store the set value and go to the next pulse setting.

At the end of the third pulse setting the system will reboot and go through the normal initialization and then return to normal operating mode.

11.4.4 Inspecting laser module serial number and resetting the shot count

The microprocessor records the laser module serial number and shot count to aid the service engineer in maintaining the unit. The serial number and shot count are factory set, so at installation there is no need to adjust these settings, but the serial number should be checked and recorded in the installation documents. They should both be checked during each regular service visit.

Every 10 000⁹ shots a status flag (P03) alerts the user that this number of shots has been reached.

The shot count and the serial number only need to be altered if the laser module is replaced.

To view the shot count/serial number at any time:

- Press PULSE SET and MODE SET simultaneously.

Figure 11–1 Serial number and shot count

DIAGNOSTIC (SET)	
shot cnt	ser.no.
01119	6920

To leave this mode:

- Press PULSES SET and MODE SET simultaneously.

Changing the serial number

The laser serial number must be changed whenever a laser module is replaced, and must *only* be changed at this time.

To modify the serial number:

- Record the current shot count information for future reference.
- Press PULSES SET and MODE SET simultaneously.

The serial number consists of four digits, which are displayed as shown above.

⁹ 10 000 for software version 3.2 and later; 5 000 for version 2.2 and below.

To make changes:

- Press PULSES RESET to increment the first digit by one.
- Press the PULSE SET button to activate the next digit.

When the changes are complete, reset the system. To do this:

- Press PULSE SET and MODE SET simultaneously.

Changing the laser shot count

To reset the treatment laser shot counter:

- Press the PULSES SET and MODE SET buttons simultaneously to view the shot count (see *Figure 11-1*).
- Press ENERGY RESET to reset the shot counter.
- Press PULSE SET and MODE SET simultaneously to reset the system.
- Press MODE SET to set the unit to READY mode.
- Fire 15 shots by pressing the joystick fire button.
- Begin an operators test by pressing MODE SET and ENERGY TEST simultaneously.
- Wait approximately two seconds after first laser test fire.
- Turn the system off then on again.
- Place the system into READY mode.
- Fire 15 shots.

The system is now ready to be used.

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FIELD REPAIR AND MODULE REPLACEMENT**Important Note**

Module replacement information may also be provided as service bulletins after this manual is issued. Please check the service bulletins in the appendix for any additional information on module replacement procedures.

12.1 OVERVIEW

The **3000LE** ophthalmic YAG laser is a module-based system with eight binocular support arm modules mounted in the binocular support arm, three modules mounted in the table and two additional modules.

If a fault occurs in the system, identify the fault to a specific module then replace that module.

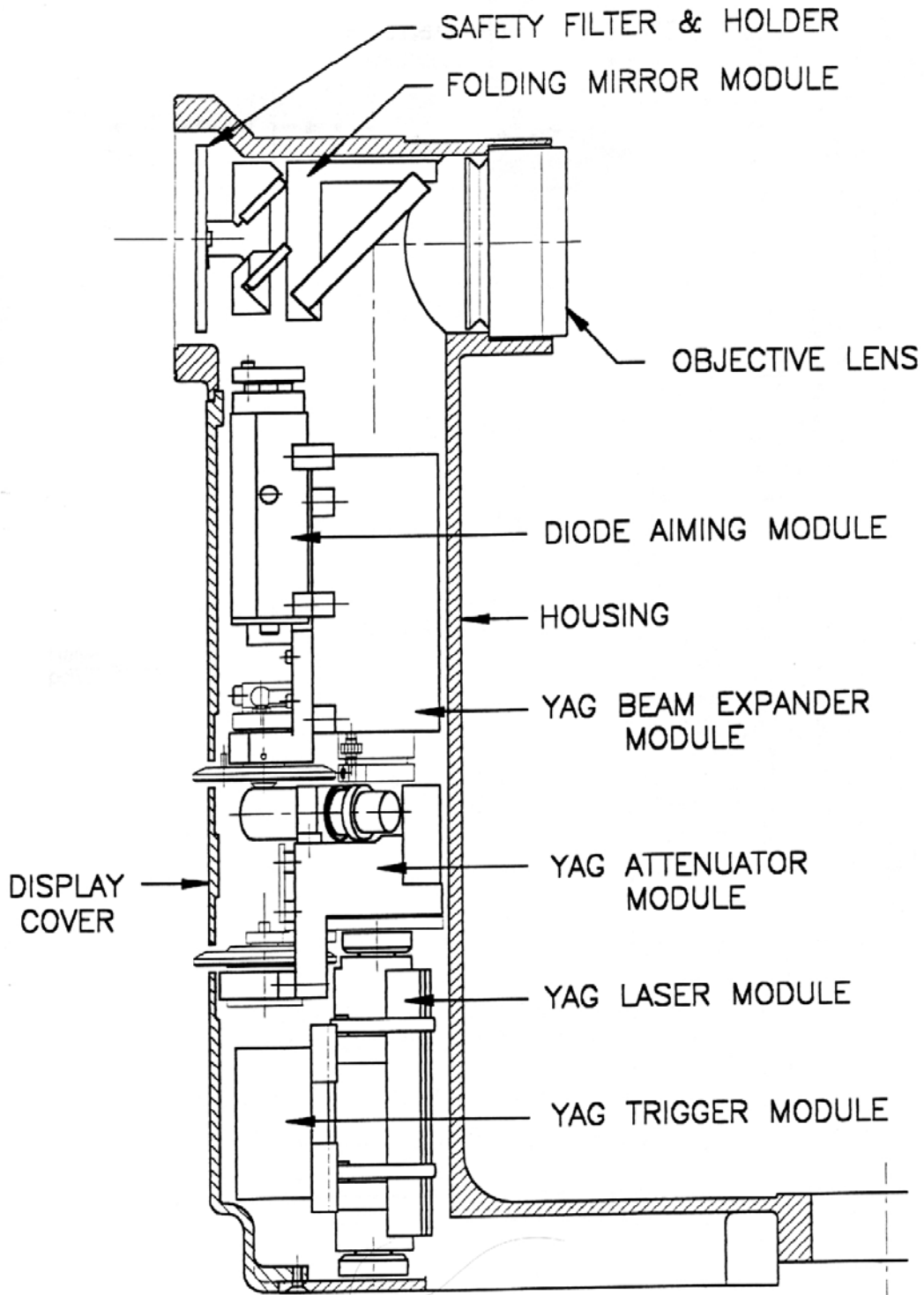
Caution

If you replace any binocular support arm modules you must check the system alignment and calibration before using the instrument again. See Chapter 6 for instructions.

Each module section within this chapter includes a description of checks to be made to determine whether the module is working correctly. Some of these checks may be made with the laser operational and before it is dismantled.

Figure 12-1 shows the positions of the binocular support arm modules in the laser head unit.

Figure 12-1 Binocular support arm modules



(Control panel not shown.)

12.2 MODULES

There are eight binocular support arm modules:

- ⇒ YAG laser (cavity) module
- ⇒ trigger module
- ⇒ diode aiming module (DAM)
- ⇒ attenuator module
- ⇒ energy monitor module
- ⇒ YAG beam expander module (BET)
- ⇒ folding mirror module
- ⇒ microprocessor/display module

There are four table modules (in recent units):

- ⇒ switch panel module
- ⇒ YAG power supply module
- ⇒ DC power supply unit module
- ⇒ voltage regulator module (units with serial numbers after 4000 only)

Additional modules are:

- ⇒ chin rest assembly (all units)
- ⇒ isolating transformer (serial numbers before 4000 only)

12.3 BINOCULAR SUPPORT ARM MODULES

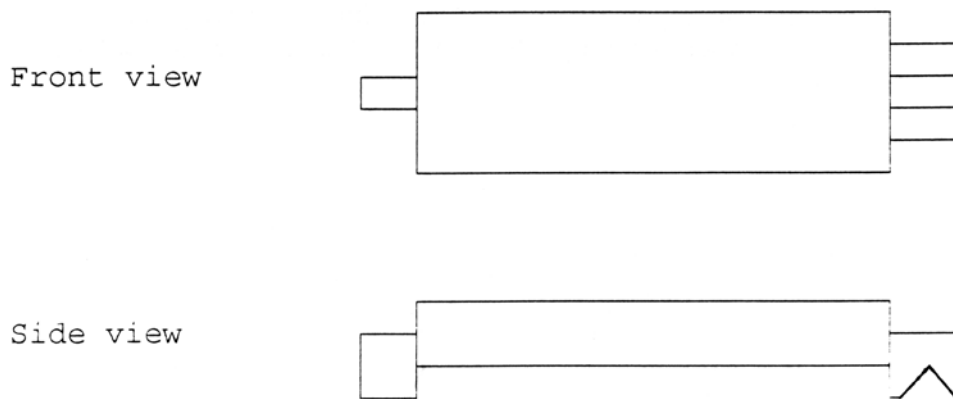
Caution

High voltages and dangerous laser radiation are accessible inside the housing so great care should be taken when opening the laser head.

The binocular support arm modules are mounted in the binocular support arm on a set of accurately machined and positioned rails, which define the position of the optical axes of both the treatment and aiming beams.

Each module except the DAM is designed with two feet (V grooves) on the right, and one foot (flat) on the left for mounting on the rails (see below).

Figure 12-2 Module mounting rails



The axis of the module is then either machined accurately with respect to the V and flat, or aligned with the use of special jigs to the V and flat. For example, the optical axis of the laser is aligned to the laser module carriage on a factory jig and the module is then factory set to prevent movement of the laser with regard to the V and flat.

This gives two advantages over competitors' systems:

- ⇒ interchangeability of modules between **3000LE** units
- ⇒ minimal re-alignment needed when changing modules

The following sections contain detailed procedures for replacing the binocular support arm modules in the system. Replacement should be approached at a module level rather than a component level.

12.3.1 Access to binocular support arm modules

To gain access to the binocular support arm modules, which are located in the binocular support arm:

- Turn the system off.
- Use a 2 mm (0.08 in) hex wrench (Allen key) to remove the counter-sunk screw at the bottom of the binocular support arm (holding the display cover in place).
- Lift off the cover.

The cover comes out from the bottom first. Place it on something soft to avoid damaging it or the table.

- Disconnect connectors X1 and X2 from the rear of the display cover and place it on the table next to the slit lamp.

12.3.2 Attenuator module

The major details of the attenuator module are described in the table below, and it is illustrated in *Figure 12–3*. See also the block diagram in *Figure 12–4*.

Table 12–1 Attenuator module details

Parameter	Details
Attenuator	Type: Rotating polarizer continuously variable Position detector: 0-5 volt output at pins 1 and 2 of X8 connector
Shutter	Drive voltage: 12 V DC
	Drive current: 1.1 A up to and including serial no. 1494 and 1496, 7, 8, 9, 1500, 02 and 1504 350 mA serial no. 1495, 1501, 1503, 1505 and after
	Shutter return: torsion spring
	Position detector: two sensors LED/photodiode detector
Over-pulse detector	Photo-diode detector
Energy monitor module	See <i>Section 12.3.6</i>

Theory of operation

The attenuator module is an optical assembly that controls the proportion of the YAG laser energy output delivered to the treatment site. The YAG laser module output is fixed and the energy is optically 'attenuated' to control the amount delivered.

The laser beam is generated from the YAG laser module as a polarized beam. It passes through a half wave plate that rotates the polarization of the beam. The thumbwheel of the attenuator is connected to the half wave plate, which serves as a beam attenuator. Rotating the thumbwheel rotates the half wave plate. The beam then passes through a polarizing beam splitter, which allows only one plane of polarization to pass through.

The portion of the beam rejected by the polarizing beam splitter is sent to a detector on the front of the module to test for an over-pulse condition (pulse detector).

The beam that passes through the polarizing beam splitter has now been attenuated and passes through another beam splitter that samples off 15% of the beam and directs it into the energy monitor to read the energy level of the attenuated laser beam.

Figure 12-3 Attenuator and energy monitor modules

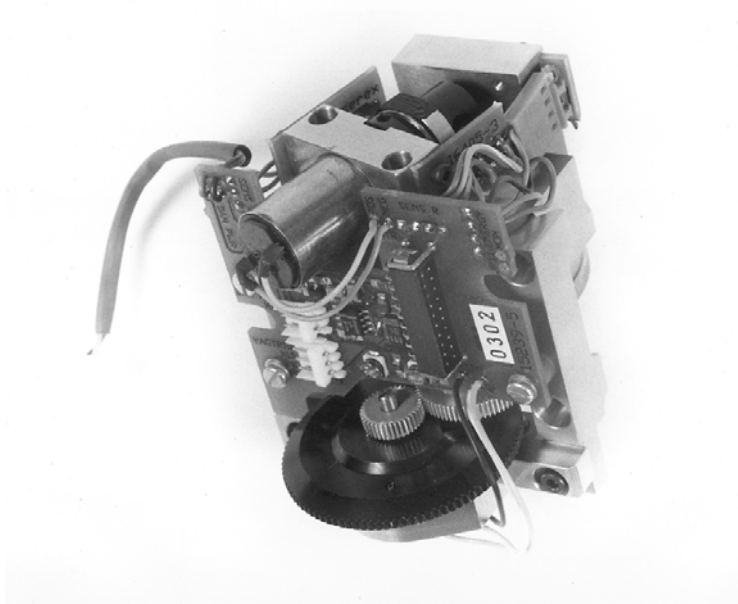
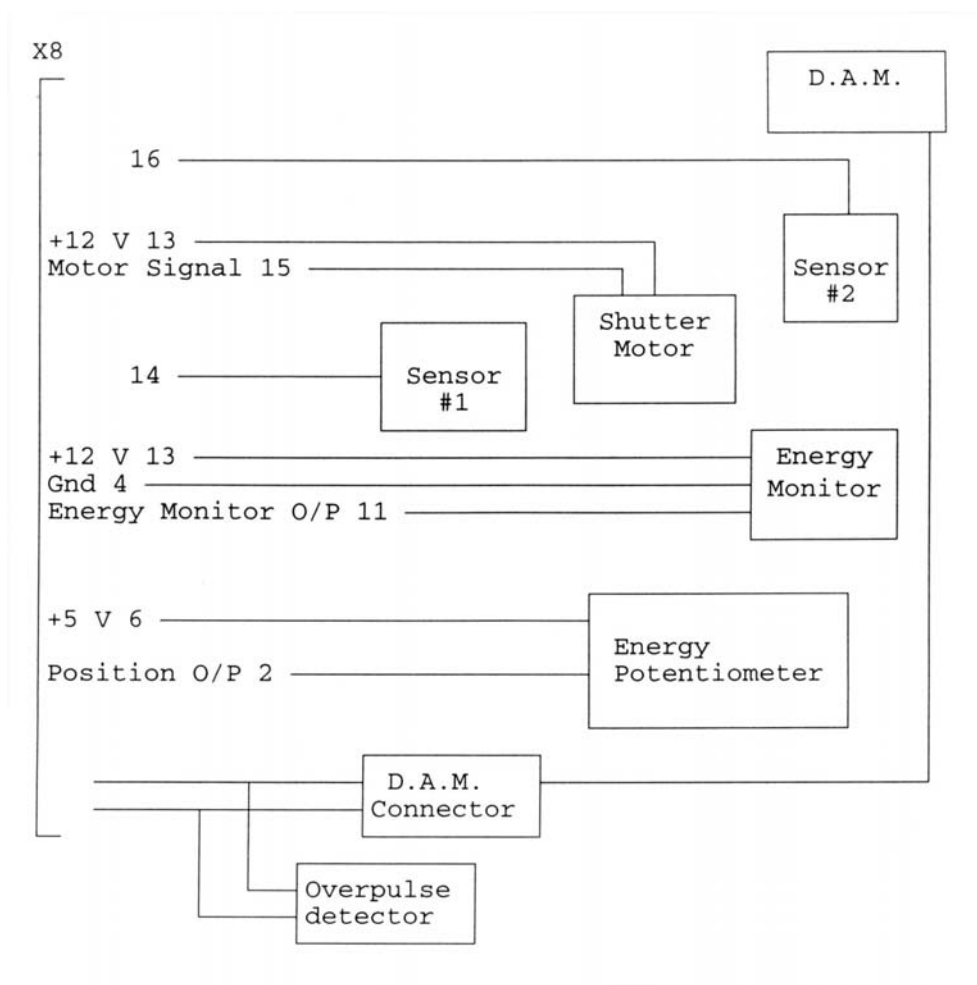


Figure 12-4 Attenuator module and interconnection block diagram***Determining proper operation***

To determine the proper operation of the attenuator module make the checks described in the following table.

Table 12-2 Attenuator module checks

Check	Description
Input	Check that all connectors are connected properly and that there is no interference with the shutter and return spring. Verify that the coils of the return spring do not cross over each other. Verify 12 volts are applied to the shutter motor when the fire switch is activated.
Output	Verify that the shutter opens when the fire switch is activated. Verify that the voltage (0-5 V DC) on X8-2 and X8-6 changes as the thumbwheel is rotated.

Replacement procedure

The attenuator is attached to the laser head housing by three 2 mm (0.08 in) screws. To remove the module:

- Disconnect X8, the 20-way cable to the microprocessor.
- Disconnect the aiming laser detect circuit from the X16 connector on top of the attenuator module PCB.
- Disconnect the trigger leads from the X15 connector on the bottom of the attenuator module PCB.
- Disconnect the DAM +12 V DC from the X50 connector on the DAM.
- Using a 2 mm (0.08 in) hex wrench (Allen key), remove the three screws securing the module to the rails.

Do not loosen the two screws on either side, just below the thumbwheel.

- Gently lift out the module, noting the position of the cables under the module.

To insert the replacement module, reverse the above procedure. Make sure the cables are correctly positioned under the module or the alignment may be affected. After installing the replacement, perform the energy prediction/half wave plate adjustments, and reset the YAG voltages, re-calibrate the YAG output energy monitor and confirm the optical alignment (see *Chapter 6*).

12.3.3 YAG laser (cavity) module

The major details of the YAG laser (cavity) module are described in the table below and illustrated in *Figure 12-5*.

Table 12-3 YAG laser module details

Parameter	Details
Type	Q-switched Neodymium doped Yttrium Aluminum Garnet (Nd:YAG)
Q-switch	Solid state
Mode structure	Fundamental TEM ₀₀
Maximum output energy	<45 mJ
Typical optical single pulse width (FWHM) (Full Width Half Maximum)	4 ns
Wavelength	1064 nm
Trigger voltage	-12 kV
Associated (Pulse Forming Network) PFN	50 μ F (V max = 900 V) 25 μ H
PFN pulse width (700 V)	95 μ s
Cooling	Convective air

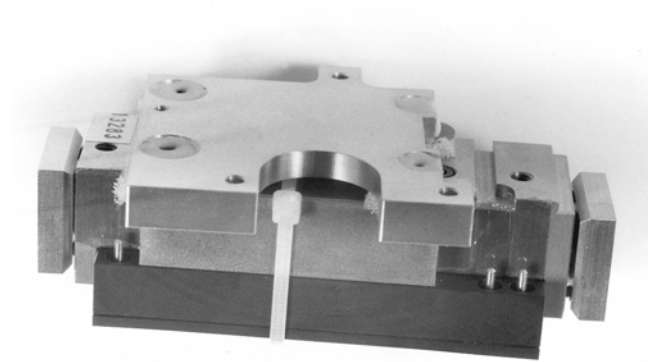
Theory of operation

The YAG laser body contains a flash lamp to optically pump a solid-state crystal material made of Yttrium, Aluminum and Garnet. A high voltage is applied to the anode and cathode connections of the flash lamp.

When the fire button is pressed the microprocessor sends a signal to the trigger module. This signal fires a pulse inside the trigger module, which produces a 12 kV trigger pulse to the trigger connection of the flash lamp.

This trigger pulse ionizes gas inside the flash lamp, which causes the gas to electrically conduct, discharging the high voltage from the cathode to the anode. The energy is released as a bright flash from the flash lamp.

Various portions of the emitted wavelength spectrum are absorbed by the laser rod, which re-emits the light. The light bounces backward and forward between the laser mirrors, forming a pulsed laser light.

Figure 12-5 YAG laser (cavity) module***Determining proper operation***

To determine the proper operation of the YAG laser module make the checks described in the following table.

Table 12-4 YAG laser module checks

Check	Description
Flash lamp	During the seven-shot ¹⁰ warm up and any time the laser is fired, the flash lamp flashes to provide optical energy to the YAG crystal. Since the YAG crystal gets its energy from the flash lamp, check that the flash lamp flashes every time the fire button is pressed. This is seen as a white flash lighting inside the laser cavity. If the flash lamp fires intermittently or not at all, the module should be replaced.
Energy output	The single pulse energy output (maximum energy setting) should be between 10 and 15 mJ. Energy levels lower than this indicate laser degradation or obstruction of the beam.
Air breakdown	Air breakdown can be seen as a blue flash approximately 92 mm (3.6 inches) from the objective lens, which is where the YAG beam is focused. See <i>Section 5.17.3</i> . When new, the laser causes air breakdown at approximately <4 mJ. If the system does not consistently break the air down at 6 mJ or below, replace the YAG laser module.
Laser module test	See below.

¹⁰ Seven shots for software version 3.2 and later, five shots for version 2.2 and earlier.

Laser module test (burn pattern)

The burn pattern produced by the laser is a good indication of the beam quality and general condition of the laser. A burn that is 10 to 14 mm (0.4 to 0.55 in) in diameter is best for this purpose. It may be necessary to use triple pulse, maximum energy setting to get a dark burn. To test the burn pattern:

- Set the system to maximum energy, single pulse.
- Clear any targets or other obstacles from the front of the slit lamp.
- Place a piece of burn paper in front of the slit lamp at the point where the two aiming beams form a single spot.
- Move the paper closer to the slit lamp until the beams separate to about 1 mm (0.04 in) apart.
- Fire the laser to get a burn on the paper.
- Move the paper closer until the beams are about 5 mm (0.2 in) apart then make a burn on a different area of the paper.
- Repeat at 10 mm (0.4 in) apart.

Each burn should appear as a group of well-defined concentric circles that look like a 'target'. If the edges are not well defined, are not circular, or there are section missing, there is some laser degradation or obstruction of the laser beam (such as that caused by dirty optics).

Replacement procedure***Important Note:***

The use of non-standard, unauthorized and modified parts would render invalid the comprehensive product and public liability insurance we have for our products and would leave the users of the unauthorized part unprotected.

Please be aware that all system optics, safety monitoring and detecting systems and software are designed for our laser cavity, which is produced in our factory. In addition, the continuous improvements we make to our products, including laser cavities, are considered with reference to the entire laser system.

The YAG laser cavity module is usually replaced with the trigger module (described in *Section 12.3.4*). To remove and replace the module:

- Remove the attenuator as described in the previous section.
- Using a 2 mm (0.08 in) hex wrench remove the three screws fixing the module to the housing rails.
- Gently withdraw the module partway with the trigger module attached.
- Disconnect the black and red high voltage cables plugged into the bottom of the trigger module.
- Unscrew the green earth wire on the module, using a Phillips head screwdriver.
- If the module is being returned *without* the trigger module, remove the two screws (2.5 mm [0.1 in] hex wrench) fixing the trigger to the YAG laser module and remove the wires going from the trigger module to the side of the YAG laser body.

To insert the replacement module, reverse the above procedure. Make sure the cables are correctly positioned under the YAG laser (cavity) module or re-assembly may be difficult and the alignment may be affected. Reset the YAG laser voltages (see *Section 11.4.2*). Verify energy prediction and half wave plate settings, and check energy monitor calibration (see *Section 6.5*), and confirm the optical alignment (see *Section 6.3*).

12.3.4 Trigger module

The major details of the trigger module are described in the table below and illustrated in *Figure 12-6*.

Table 12-5 Trigger module details

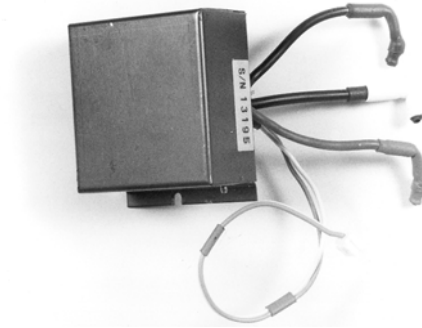
Parameter	Details
Input voltage	350 to 900 V DC
Input trigger signal	Active low to fire (>15 mA)
Output trigger voltage	12 kV (typical)
Output pulse width	1 μ s (typical)

Theory of operation

The trigger module transfers the voltage (350–900 V DC) from the power supply to the laser flash lamp anode and cathode connections. A thick wire connects the 12 kV output pulse from the trigger module to the flash lamp trigger connection.

There are two low voltage inputs to the trigger module. Both are at +5 V DC. One is momentarily switched to ground, which then fires a pulse, producing the 12 kV output pulse to trigger the flash lamp.

Figure 12–6 Trigger module



Determining proper operation

To determine the proper operation of the trigger module make the checks described in the following table.

Table 12–6 Trigger module checks

Check	Description
Input	To verify there is high voltage input to the trigger module, connect the laser head cable assembly between the power supply output socket (X43), under the inset tray and the laser head. Monitor the YAG power supply output voltage to verify high voltage output is between 350 and 900 V DC. Verify that both low voltage inputs are at 5 V DC, (X15-1 & X15-2). One of these inputs drops to 0 volts momentarily when the fire button is pressed.

Check	Description
Output	<i>This is difficult and dangerous to measure.</i> At this stage we recommend that a new trigger module be installed to determine proper operation of the original trigger module. The outputs of the original module can be checked if necessary. There should be 350 to 900 V DC between the anode and cathode connections at the YAG laser. These are the two thinner output wires from the trigger module, X17-1 & X17-3. When the fire button is pressed there should be a 12 kV output pulse from the trigger module, X17-2, to the YAG laser module. This is the thickest wire. We strongly recommend that the output voltages are not investigated as special test equipment is required, and in any case this module has no serviceable components.

Replacement procedure

The trigger module is mounted on the laser (cavity) module, and the two modules are usually replaced as separate units. To remove the trigger module by itself:

- Remove the attenuator as described in *Section 12.3.2*.
- Remove the YAG laser module with trigger module attached, as described in *Section 12.3.3*.
- Disconnect the three wires going from the trigger module to the side of the YAG laser module.

Wiring connections are:

- *thin black lead —top connector on laser module (cathode)*
- *thick black lead —middle connector (cathode trigger)*
- *red lead —lower connector (anode)*

- Using 1.5 and 2.5 mm (0.06 and 0.1 in) hex wrenches, remove the two screws fixing the trigger to the YAG laser module.
- Gently lift out the module.

To insert the replacement module, reverse the above procedure. Make sure the cables are correctly positioned or re-assembly may be difficult and the alignment may be affected. Confirm the optical alignment (see *Section 6.3*).

12.3.5 Diode aiming module (DAM)

The major details of the diode aiming module are described in the table below and illustrated in *Figures 12-7 and 12-8*.

Table 12-7 Diode aiming module (DAM) details

Parameter	Details
Type	Semi-conductor laser diode continuous wave (CW)
Safety class	II
Wavelength	670 nm
Input	12 V DC, 100 mA
Power output	Continuously variable to a maximum 200 μ W
Mode	Fundamental

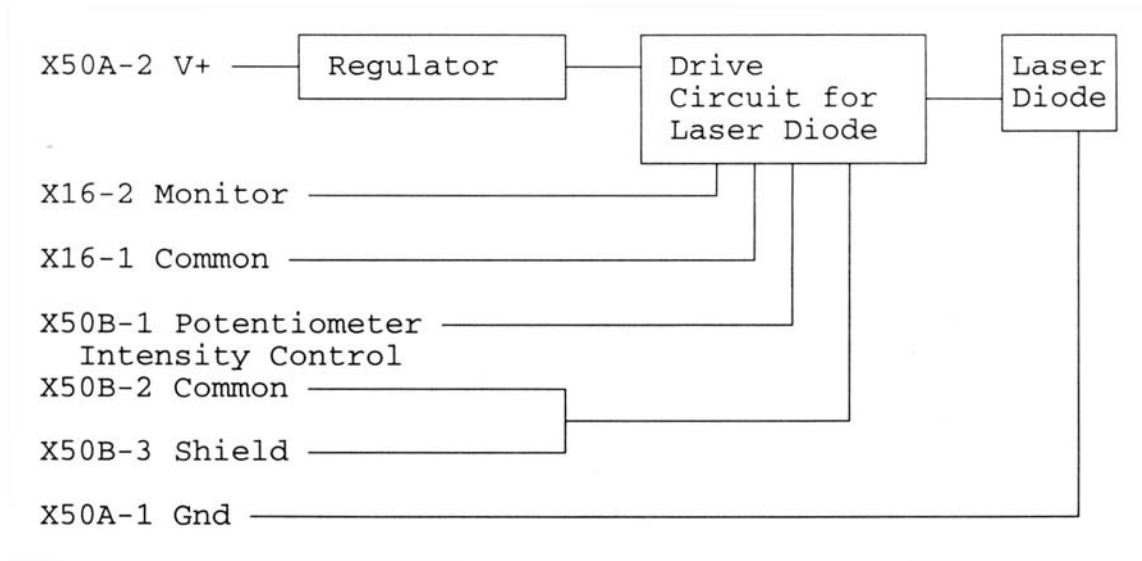
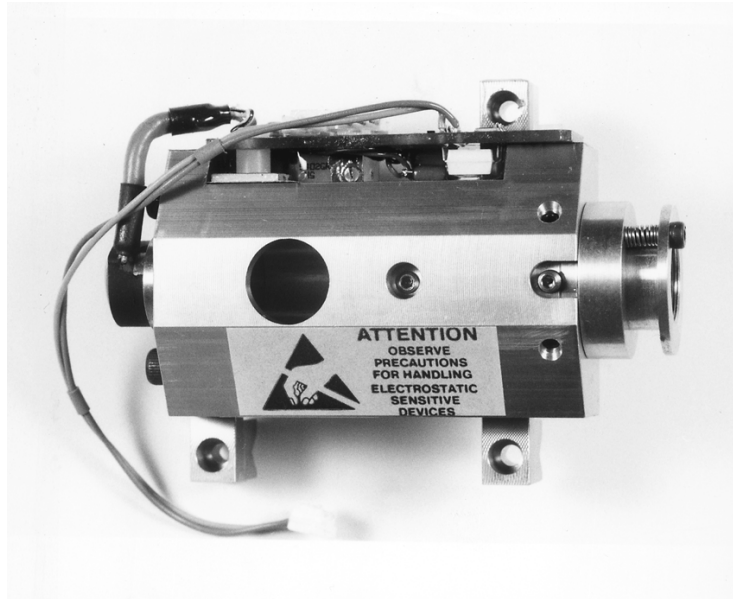
Theory of operation

This module consists of a diode laser, beam monitor, collimator lens and associated circuitry. Power input comes from 12 volts applied at X50A-2 and 0 volts (ground) on X50A-1. This is regulated to 5 volts to power the laser diode.

The diode emits a 0.5 mm (0.02 in) diameter red laser beam. The beam is then put through a 14 times beam expander that expands the beam to 7 mm (0.3 in) diameter. The final focus of the aiming beams is accomplished by adjusting the position of the top lens of this beam expander.

Circuitry within the module regulates the voltage and current to the laser diode, monitors the output of the laser diode, and controls the intensity of the laser diode output.

The intensity is controlled by the potentiometer positioned on the slit lamp base and connected to the DAM via the three-pin connector, X50B.

Figure 12-7 Diode aiming module block diagram**Figure 12-8 Diode aiming module*****Determining proper operation***

To determine the proper operation of the diode aiming module make the checks described in the following table.

Caution

The DAM is a static sensitive device. Take care when handling this module. The circuit board should not be touched or handled at any time without taking adequate ESD precautions.

Table 12–8 Diode aiming module checks

Check	Description
Input	Verify the +12 V DC input on X50A-2 and 0 volts (ground) on X50A-1
Output	Visually confirm a dual red light output from the module. <i>Do not look directly into the module output.</i>
Control	Check the resistance between pins 1 and 2 on X50B varies as the intensity control knob is rotated.

If the laser diode is damaged it may still emit a low level output of red light but the module will draw greater than 100 mA current. In this case replace the module.

To check the diode aiming module and determine if it is faulty:

- Turn off the system and disconnect from power sources.
- Remove the front cover of the binocular support arm.
- Disconnect the DAM monitor wires from the attenuator module.

These are the blue and brown wires from the DAM to connector X16 on the attenuator PCB.

- Connect a 1.5 k Ω jumper (supplied in the service kit) into the X16 connector on the attenuator PCB.

This will bypass the DAM monitor circuit and allow the unit to operate without the DAM.

You may just short across these two pins if a 1.5 k Ω jumper is not available.

- Re-connect to power and turn on the system.
- After the seven¹¹-shot warm-up routine, verify the following:
 - no error messages appear
 - it is possible to select laser READY mode
 - there is a dim red light output from the DAM
(if there is no light output, verify there is a 12 V DC input to the DAM)
 - the aiming beam intensity control can adjust the aiming beam intensity
(If the intensity is not adjustable the DAM is faulty)

¹¹ Seven shots for software version 3.2 and later, five shots for version 2.2 and earlier.

Replacement procedure

To remove the DAM module:

- Disconnect the aiming laser detect circuit from the X16 connector on top of the attenuator module printed circuit board.
- Disconnect X50A and X50B connectors from the DAM circuit board.
- Using a 2 mm (0.08 in) hex wrench undo the three screws securing the DAM to the rails.
- Gently lift out the module.

To insert the replacement module, reverse the above procedure. After installing the replacement, check the aiming beam laser focus and alignment (see *Chapter 6*).

12.3.6 Energy monitor module

The major details of the energy monitor module are described in the table below and illustrated in *Figure 12-9*.

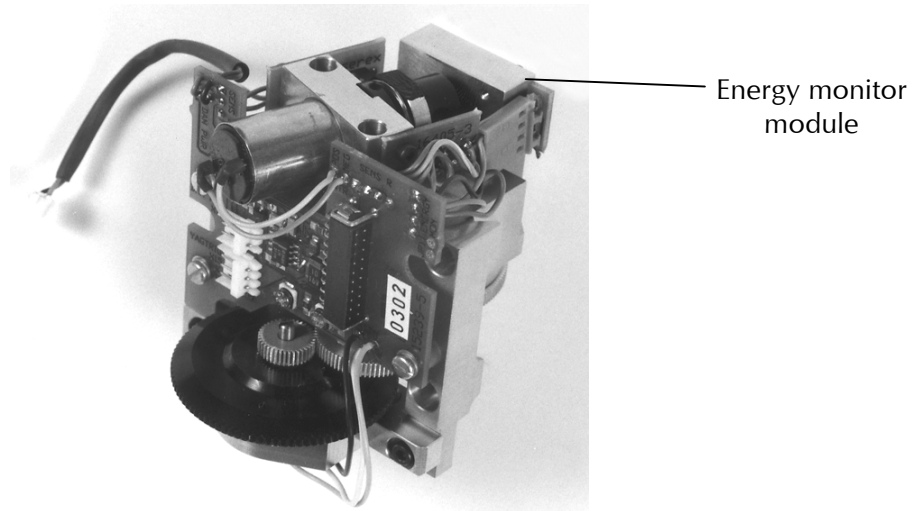
Table 12-9 Energy monitor module details

Parameter	Details
Type	Photo-diode detector
Supply voltage	+12 V DC, -8 V DC
Transfer function	0.1 V/mJ

Theory of operation

A 15% sample of the attenuated laser beam is directed into the energy monitor module, where it passes through various filters then on to a photo-diode detector. The detector output is amplified, and this signal is sent to the control module, where it is calibrated to read actual system output.

Figure 12-9 Attenuator and energy monitor modules



Determining proper operation

To determine the proper operation of the energy monitor module make the checks described in the following table.

Table 12-10 Energy monitor module checks

Check	Description
Input: optical	Verify that the YAG laser is firing by verifying there is air breakdown at maximum energy setting or that it is possible to obtain a burn pattern on burn paper. Verify the inputs: +12 V DC on X19-4 -8 V DC on X19-1 GND on X19-2
Output	Verify signal voltage is 0.1 V/mJ on X19-3 and signal ground on X19-2. There should be an energy display reading corresponding to the actual energy output. <i>Calibration is adjusted by the Gain and Offset trimpots at the back of the microprocessor/display module (see Chapter 6).</i>

Replacement procedure

To remove this module:

- Remove the attenuator module (see *Section 12.3.2*).
- Disconnect the electrical connector between the attenuator module and the energy monitor module.
- Using a flat blade screwdriver, undo the two screws securing the energy monitor module to the attenuator module.
- Inspect all optics for cleanliness or damage, cleaning if necessary.

Installation of the replacement is the reverse of the procedure above. Before assembly, ensure all wires are free of rail mounts and screws. Ensure wires are free from kinks and crimping.

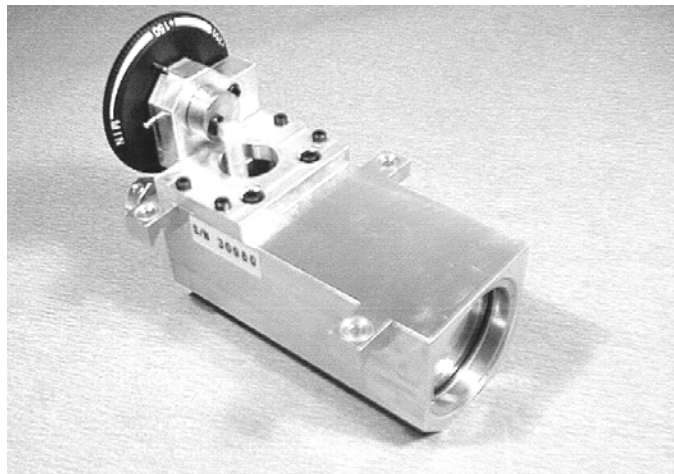
Re-calibrate the display and actual energy (see *Section 6.5.3*).

After installing the replacement, perform the standard test procedure (STP) for the 3000LE.

12.3.7 Beam expanding telescope (BET) module

The beam expanding telescope is an optical module that accepts the 3 mm (0.12 in) diameter laser beam and expands it to approximately 27 mm (1.07 in) in diameter. It is illustrated below:

Figure 12–10 BET module



Due to the inverse relationship between diameter of the beam entering the objective lens and focused spot size, the laser beam is expanded to the largest possible size to decrease the focused spot size and increase the performance of the instrument.

This module incorporates a star wheel adjusting mechanism that allows the laser focus to be adjusted with respect to the aiming beam and viewing focal planes. The focus adjustment is locked with a 2.5 mm (0.1 in) nylon tipped socket set screw.

The BET module provides an offset control that is adjusted using the YAG POSTERIOR OFFSET thumbwheel. The posterior defocus can be accurately set by changing the optical separation of the positive and negative lens sets in the beam expanding telescope with the adjusting star wheel. It allows repeatable positioning of the focuses at the three indent positions.

Replacement procedure

To remove the beam expander module:

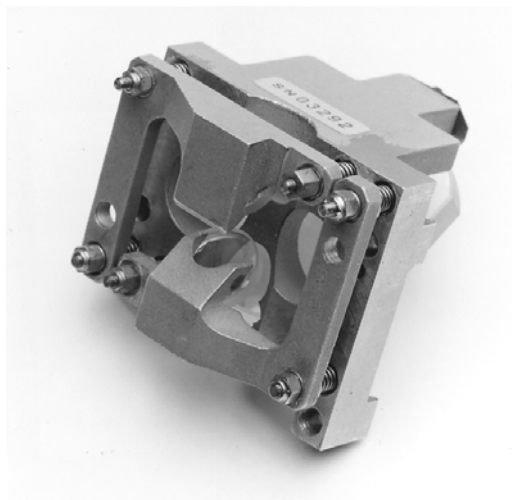
- Remove the diode aiming module as described in *Section 12.3.5*.
- Using a 2 mm (0.08 in) hex wrench, remove the three screws fixing the module to the rails.
- Gently lift out the module.

To insert the replacement module, reverse the above procedure. After replacement, check the treatment beam alignment and focus (see *Section 6.3*).

12.3.8 Folding mirror module (FMM)

The folding mirror module bends both the YAG laser and aiming beams through 90 degrees to be coaxial with the operator's viewing axis and so they can exit the system through the objective lens. It is illustrated below:

Figure 12-11 Folding mirror module



The module consists of two systems:

- ⇒ laser folding mirror
- ⇒ aiming beam alignment mirrors

The YAG laser folding mirror is the largest optic in the module and reflects the expanded YAG laser beam through 90 degrees. The mirror is highly reflective at the YAG laser wavelength yet transmits the visible aiming laser wavelengths. This mirror is not adjustable.

The aiming beam alignment mirrors are the two smaller mirrors in the module. The mirror closest to the diode aiming module reflects approximately 50% of the incident light and the remainder is totally reflected from the second mirror. Both these mirrors are mounted at 45 degrees on adjustable arms, which allows the position of each arm to be set separately with respect to the YAG laser beam. Refer to *Section 6.3.4* for the aiming beam alignment procedure.

Replacement procedure

This module does not normally need to be replaced in the field, but can be removed as follows:

- Remove the diode aiming module, as described in *Section 12.3.5*.
- Remove the YAG beam expander module, as described in *Section 12.3.7*.
- Remove the binoculars by undoing the knurled screw on top of the binocular mount.
- Using a 2.5 mm (0.1 in) hex wrench, undo the two screws securing the safety filter plate to the laser head, and remove the plate.
- Using a 2 mm (0.08 in) hex wrench, undo the three screws securing the folding mirror module to the rails.

These screws can be reached through holes in the aiming beam steering arms.

- Pull the module towards you as far as it will go, pulling it off the locating pins that hold it on to the rails.
- When the module is loose, drop it down to the center section of the support arm to remove it.

Take care not to touch any of the optics with your fingers.

To install the replacement module, reverse the above procedure. Check the optical alignment after installation (see *Section 6.3*).

12.3.9 Microprocessor/control panel

The major details of the microprocessor and control panel are described in the table below. Refer to *Figure 3-3* for the Control Block Diagram and to *Figures 3-7* and *3-8* for illustrations of the control panel.

Table 12-11 Microprocessor/display module details

Parameter	Details
Microprocessor controller inputs	
Power	+12 V DC
Shutter sense	Detects whether shutter is properly opened or closed
Cap charged	Indicates the storage capacitor has reached the set voltage. The system cannot be fired until the capacitor is fully charged.
Energy monitor	Provides a measure of the laser output energy.
Interlock	Disables the lasers if the interlock circuit is opened.
Aiming beam	Indicates functionality of the aiming laser.
Microprocessor controller outputs	
Voltage control	Sets the voltage of the storage capacitor.
Shutter sense	Supplies +5V power to shutter sensors. The 5.12 V is generated on board the microprocessor circuit.
Laser fire	Fires the trigger module.
Reset voltage	Discharges the storage capacitor when the user selects a pulse mode with fewer pulses, or if the system shuts down.
Laser off	Disables the entire YAG power supply if the system malfunctions.
Display control and data lines	

Determining proper operation

To determine the proper operation of the microprocessor control module make the checks described in the following table:

Table 12-12 Microprocessor/control panel checks

Check	Description
Input	Verify that all connectors are properly connected and that the fuses are not blown. Verify that power is being applied to the module.
Output	Check for proper operation of the function switches, that is, that the control panel is not 'locked up'.

Faults in the microprocessor/display module are determined mostly by a process of elimination determining that the fault does not lie with any other modules.

To check for any faults or status of the system, initiate the Operator Test. (See Section 10.4.)

Liquid Crystal Display (LCD)

The LCD is a 132 x 22 dot addressable liquid crystal display. The viewing area is centrally backlit with LEDs mounted behind the LCD. The LCD has on-board display drivers, and the microprocessor supplies the information and power for the LCD via the 20-line data bus.

Both the microprocessor and LCD are CMOS devices, and as such are static-sensitive. Extreme cases of electrostatic discharge can possibly cause segments of the LCD to go blank. This condition is remedied by switching the mains power off then on again. Ensure correct anti-static precautions are followed.

Replacement procedure

Refer to the control block diagram in *Figure 3-3*. To replace the microprocessor /control panel module:

- Enter Service Engineering mode and record the stored YAG voltage and energy values for each pulse setting (see *Section 11.4.1*).
- Record the laser module serial number and record the shot count (see *Section 11.4.4*).
- Remove the M3 screw connecting the earth to the base of the display cover.
- Remove the three M3 screws that mount the shield plate to the display cover.
- Carefully withdraw the shield plate from the display cover.

There are now two M2 x 5 mm screws and 'O' rings holding the LCD in place, and two M3 x 10 mm spacers locking the microprocessor in place. Since the microprocessor and LCD are hard-wired together, both sets must be removed before the module can be removed from the display cover.

- Remove the microprocessor and LCD fixing screws.
- Gently lift out the module from the cover and disconnect the flexible lead from the membrane panel.
- Manually enter the YAG voltage and energy values for each pulse setting recorded in the first step (see *Section 11.4.3*).
- Re-enter the laser module serial number and reset the shot counter (see *Section 11.4.4*).

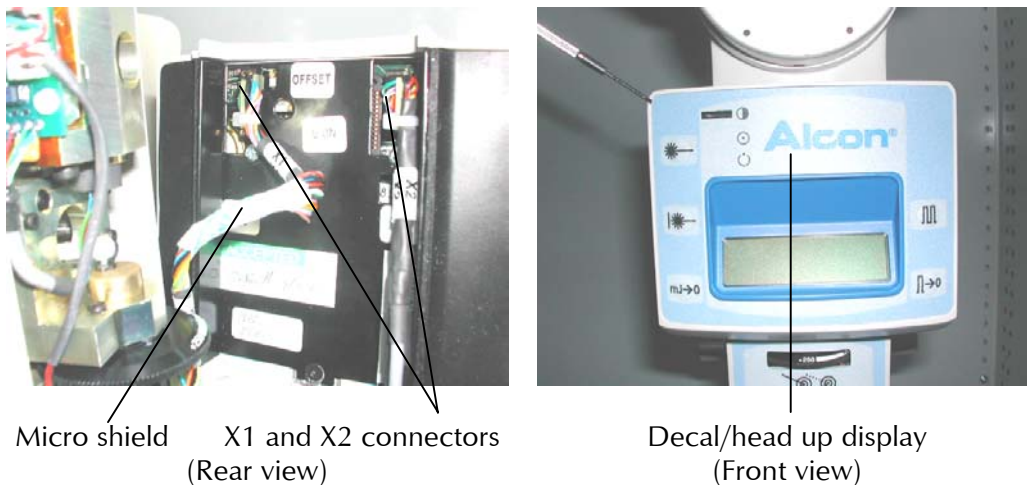
To insert the replacement module, reverse the above procedure. Ensure that the thumbwheel adjustments for the viewing contrast and the laser READY/STANDBY LEDs fit correctly into their apertures.

Replacing the decal/head up display (S/N from 4000 only)

To replace the decal/head up display on the front of the control panel:

- Disconnect the system from the mains power supply (unplug power cord).
- Disconnect the binocular assembly from the laser head.
- Raise the laser head to its highest position by rotating the joystick clockwise.
- Remove the front panel by removing the locking screw located at its bottom using a 2mm special Allen key and gently pulling it out.
- Gently pull the front panel out, then disconnect the X1 and X2 connectors from the microprocessor PCB and remove the microprocessor PCB shield — see below.

Figure 12-12 Removing the decal/head up display



- Remove the microprocessor PCB display from the front panel by removing its securing screws and posts and gently lifting it out.
- Remove the decal head up display by lifting it up on one of its edges using a small screwdriver and gently peeling it off.

Tip: Evenly apply heat to the decal with a heat gun. This will melt the glue underneath the decal making it easier to be peeled off and will leave a smoother surface for the replacement decal to be placed on.

Install and reconnect the microprocessor and decal head up display by reversing the removal procedure. Connect power and ensure the buttons function correctly.

We recommend alignment and calibration checks should be carried out, as described in *Chapter 4*.

12.3.10 Replacing the laser head cable (S/N from 4000)

The laser head must be disassembled in order to remove and replace the cable. Note the arrangement of the modules and the cable before removing the modules, as the replacement cable must be arranged in the same configuration.

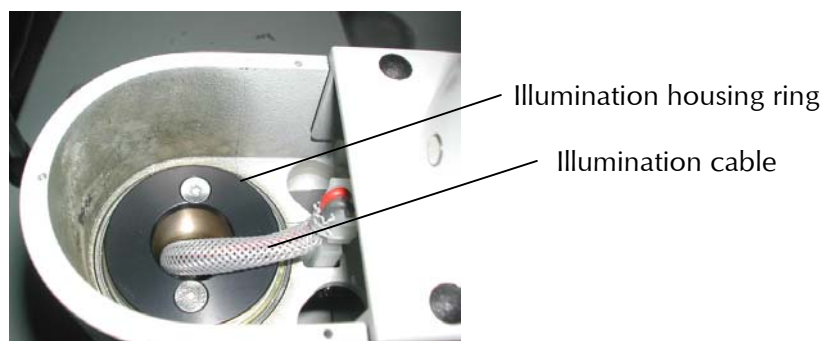
Disassembling the laser head

- Disconnect the system from the mains power by unplugging the power cord.
- Disconnect the binocular assembly from the laser head.
- Raise the laser head to its highest position by rotating the joystick clockwise.
- Remove the front panel by removing the locking screw located at its bottom using a 2 mm special Allen key and gently pulling it out.
- Disconnect and remove all laser head modules (cavity, attenuator, DAM, BET) using a 2 mm Allen (Hex) key, placing them in a safe place until further required.

Some laser head modules are susceptible to damage from electrostatic discharges, so all precautions must be in place.

- Remove the illumination housing top cover plate.
Take note of the three spacers between the cover plate and the Illumination housing assembly as the spacers are small and can be easily misplaced.
- Unplug the slit lamp illumination cable and remove the housing ring by removing its two securing screws and lifting it out — see below.
- Loosen the slit lamp illumination tower locking clamp and lift the assembly off the shaft.
- Remove the Illumination lamp intensity and the aiming beam intensity caps and knobs, removing the knobs using a Collet tool supplied in the toolkit.

Figure 12–13 Slit lamp illumination cable

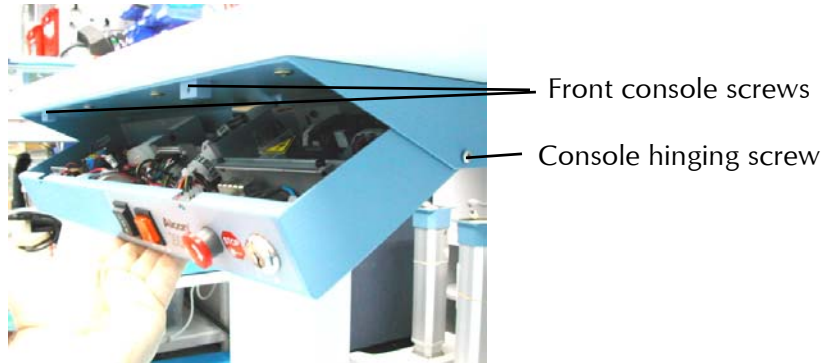


Gaining access to the cables

Gain access to the cables by lowering the power supply console as follows:

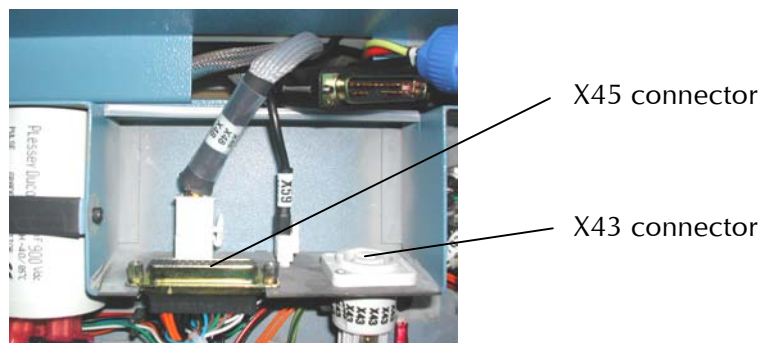
- Remove the two screws supporting the front of the console to the table chassis using a 2.5 mm Allen (hex) key, ensuring to support the console with one hand to avoid it from falling and any other possible damage.
- Once the front screws have been removed carefully lower the console down — see below.

Figure 12-14 Lowering the power supply console



- When accessible, disconnect the X45 and X43 laser head cables from the console, which allow it to be separated from the table — see below.

Figure 12-15 Disconnecting laser head cables

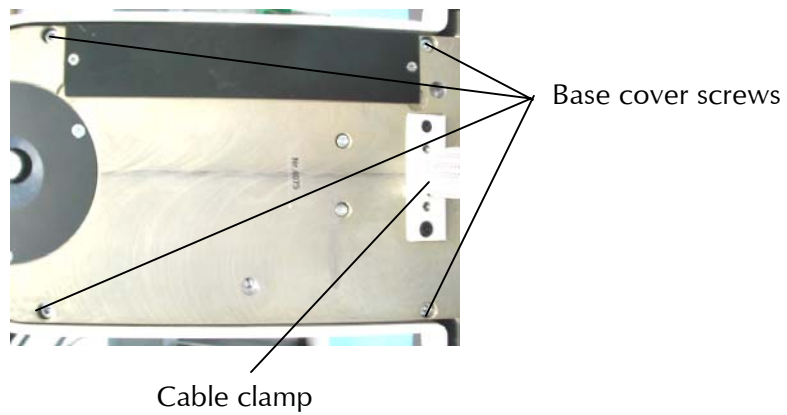


Accessing the laser head base

Once the cables are disconnected, the laser head and slit lamp base can be accessed as follows:

- Lift the laser head/slit lamp off the table and place it on a flat soft surface such as bubble wrap or antistatic mat to avoid damage.
- Remove the cross-shaft locking knob and the cross shaft and then place the laser head on its side.
- Loosen the base cover by removing its four screws using a 3 mm Allen (hex) key – see below.

Figure 12-16 Loosening base cover

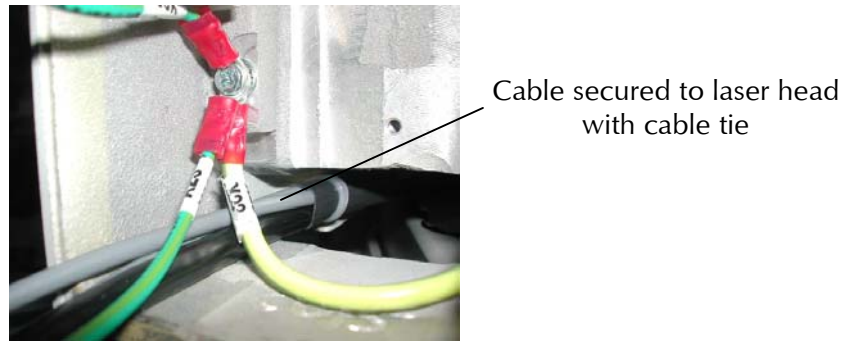


Removing the laser head cable

To remove the cable:

- Cut off the cable tie securing the cable to the cable clamp at the base of the laser head / slit lamp and remove the clamp using 2.5 mm and 3 mm Allen (hex) keys.
- Disconnect the earth cables from the back wall of the laser head, and cut off the cable tie securing the cables to either lower side part of the laser head – see Figure 12-17.

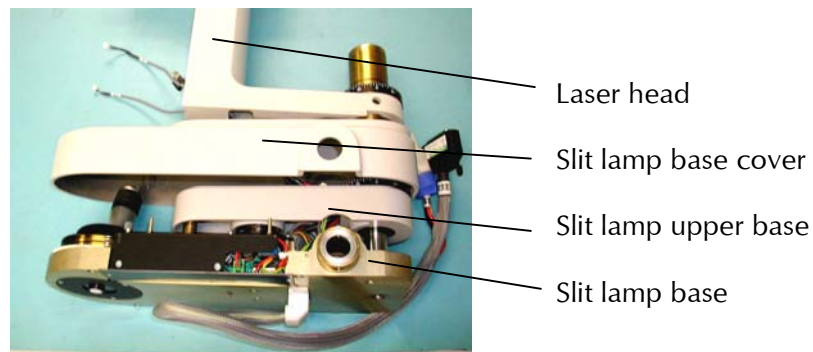
Figure 12-17 Disconnecting earth cables



Gaining access to the cables

- Loosen the laser head locking knob and separate the laser head from the base by lifting it off the shaft, then remove the base cover.

Figure 12-18 Separating the laser head from the base



- When the base cover is removed unscrew the X22 earth cables from the base, unplug the X47 cable from the dimmer PCB, and disconnect the X56 cables from the joystick wiper block.

Note the wire orientation on the wiper block as well as cable arrangements within the base as the replacement cable will have to be installed in the same configuration.

- Cut off the cable ties securing the cables to the base and pull the cables out from the laser head base end.

Installing the replacement cable

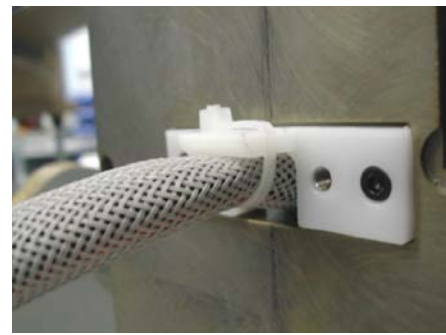
Visually inspect the replacement laser head cable to ensure no damage occurred during transportation, before installing it as follows:

- Insert the cables through the hole in the base and arrange cables to suit their connection points within the base (X22, X56 and X47 cables).
- Slide the rest of the cables through the hole in the base cover upper (X2, X50, X13 and X23 cables) and arrange them as follows:
 - Position the X13 and X23 cables at the right hand side (when observing the slit lamp from the front).
 - Position the X2 and X50 at the left hand side after coming out of the opening in the base upper cover (when observing the slit lamp from the front).
 - With a ruler or measuring tape arrange the cables so that the length between the tip of each connector and the base upper cover stop clamp will be:
 - ⇒ X13 and X23 cables approximately 150 mm
 - ⇒ X50 cable approximately 340 mm
 - ⇒ X2 approximately 360 mm
- Fix the cables temporarily to the base upper cover with a piece of masking or sticky tape — see below.
- Secure the cables within the laserhead base with the cable ties then refit the base cover and the base cable clamp ensuring that the cable is secured to the clamp with a cable tie — see below.

Figure 12–19 Installing the cables

Arranging the cables after exiting from the base upper cover

Cable secured to the base cable clamp with cable tie



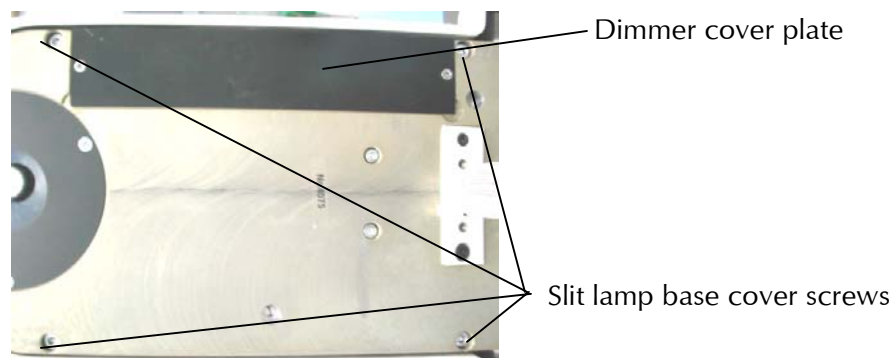
Measure the cable length from this point

12.3.11 Replacing the Dimmer PCB (S/N from 4000)

The Dimmer PCB controls the aiming beam intensity and illumination lamp intensity and is connected to these knobs at the base of the laser head/slit lamp assembly. To replace this PCB:

- Disconnect the system from the mains (by disconnecting the power cord from the stand).
- Raise the laser head to its highest position by rotating the joystick clockwise.
- Remove the caps from the Aiming Beam Intensity and Illumination Lamp Intensity knobs.
- Remove the knobs by loosening their collets using a Collet knob tool.
- Remove the two screws supporting the front of the console to the table chassis using a 2.5 mm Allen (hex) key, supporting the console with one hand to avoid it from falling and any other possible damage.
- Once front screws have been removed carefully lower the console down — see *Figure 12-14*.
- When accessible, disconnect the X45 and X43 laser head cables from the console, which allow the table and laser head to be separated — see *Figure 12-15*.
- Lift the laser head off the table and place it on a flat soft surface such as bubble wrap or antistatic mat to minimize any chance of damage and misalignment.
- Loosen the cross shaft locking knob and then remove the cross shaft.
- Place the laser head on its side and loosen the base cover by removing its four screws using a 3 mm Allen (hex) key — see below.

Figure 12-20 Slit lamp base



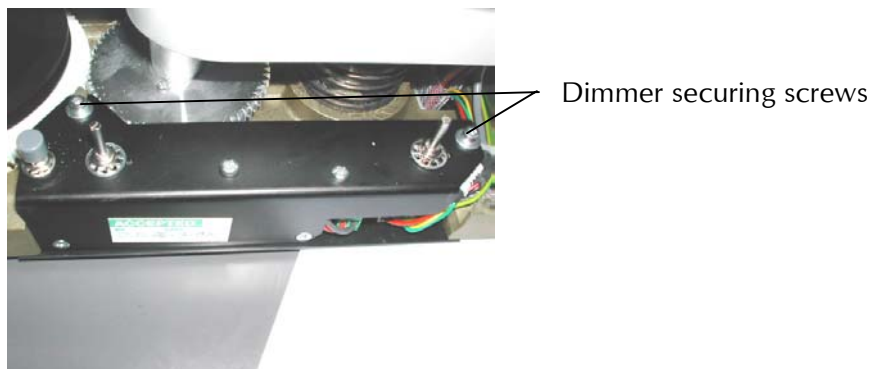
Removing the dimmer assembly

To remove the dimmer assembly:

- Remove the dimmer cover plate and lift the base cover up as far as it will go to get access to the dimmer assembly screws.

Note the dimmer assembly is secured to the base by two screws. Slots in the dimmer assembly allow it to be easily slid away from the base when the securing screws are loosened – see below.

Figure 12-21 Dimmer assembly with base cover removed



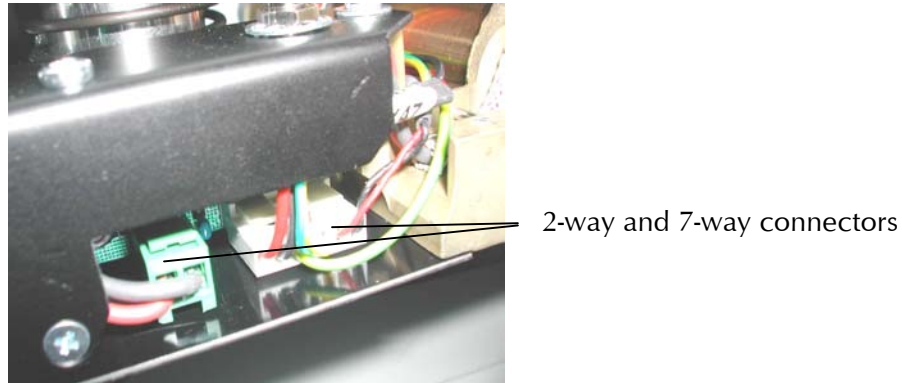
(Photo is for orientation view only)

- Using a ball ended 2.5 mm Allen (hex) key, access the dimmer assembly securing screws through the holes in the base cover for the aiming beam and illumination intensity knobs, and loosen the screws by approximately three or four turns – see below.

Figure 12-22 Holes in base cover for access to dimmer screws



- Once the dimmer assembly is loosened, unplug the two connectors from the dimmer PCB (2-way and 7-way connectors), and then gently pull the dimmer out – see below.

Figure 12-23 2-way and 7-way dimmer connectors**Installing the replacement dimmer**

- Install the replacement dimmer assembly by reversing the removal procedure.
- Reconnect the laser head and connect to power.
- Ensure the dimmer functions operate correctly.

We recommend alignment and calibration checks should be carried out, as described in *Chapter 4*.

12.4 TABLE MODULES

The table modules are contained under the table top (units with S/N pre-4000) or in the power supply console under the table top (S/N from 4000).

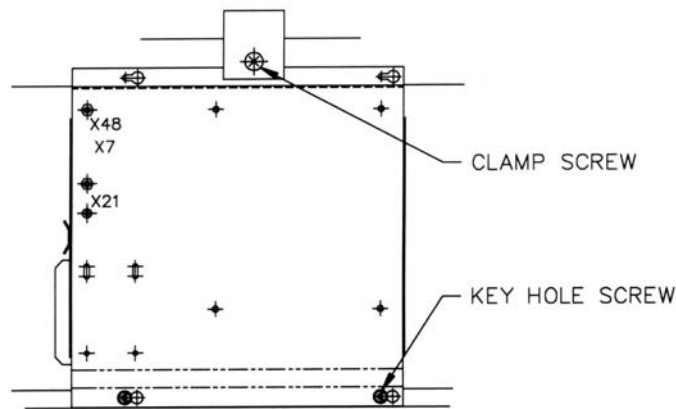
12.4.1 Access to table modules

Caution

High voltages and dangerous laser radiation are accessible inside the power supply console so great care should be taken when opening the console.

Units with S/N pre-4000

As with the binocular support arm modules, the repair philosophy of the table modules is also module based. Access to the table modules is via the plastic cover mounted under the table with quick-fit turn clips. The DC power supply and the YAG laser power supply are both mounted on keyhole slot and lock mechanisms (shown below):

Figure 12-24 Power supply mounting

(Bottom View)

To gain access to the table modules in these units:

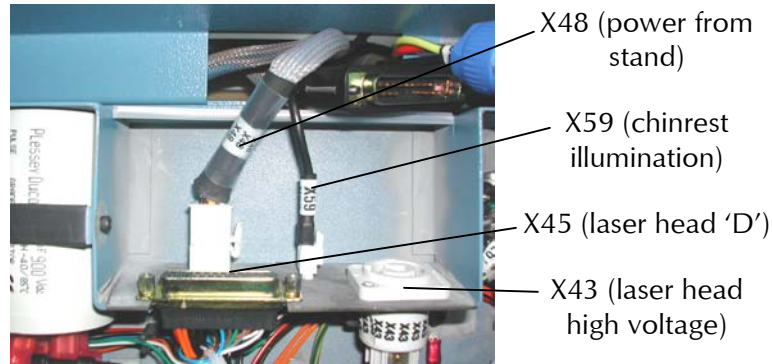
- Raise the table up to its highest setting.
- Unplug the system.
- Using a flat blade, undo the ¼ turn fasteners securing the plastic bottom cover to the under side of the table top.

Units with S/N from 4000

In later units the table modules are in a separate power supply console under the table. These modules can be accessed by unscrewing and hinging it down, but it is normally easier to replace modules if the console is removed entirely.

Lowering the console

- Switch off the system and unplug from the mains.
- Remove the screws at the front of the console and hinge the console down, supporting it with one hand to avoid damage (see *Figure 12-14*).
- Disconnect the control module from the power supply console.
- Disconnect the X43, X45, X48 and X59 cables from the console, which allow it to be separated from the table.

Figure 12–25 Power supply console connections**Removing the console**

To remove the console entirely:

- Remove the rear hinging screws on either side of the console while supporting it with one hand to stop it falling.
- Once the console is separated from the table place it on a soft steady area such as bubble wrap or an antistatic mat to ensure it will not get scratched.

As with the laser head modules, the repair philosophy of the table modules is also module based.

12.4.2 Key switch panel module

The key switch panel is the master control for the system. The switches are functionally independent of the microprocessor and control the flow of power to the major sub-systems.

The panel has three connectors, which mount on the inside of the chassis, as listed below:

Table 12–13 Key switch panel connectors

Check	Description
X6	Delivers the 220-240 V AC and connector for the Emergency Laser Stop switch, key switch, table up/down switch, laser on/off switch and the interlock connector. See the connectivity diagram for more details.
X33	Delivers the 220-240 V AC to the DC power supply module.
X60	Delivers the interlock signal to the microprocessor/LCD module.

The control switches protrude through the switch panel label. The layout is as shown in the following illustration:

Figure 12-26 Key switch panel (S/N pre-4000)

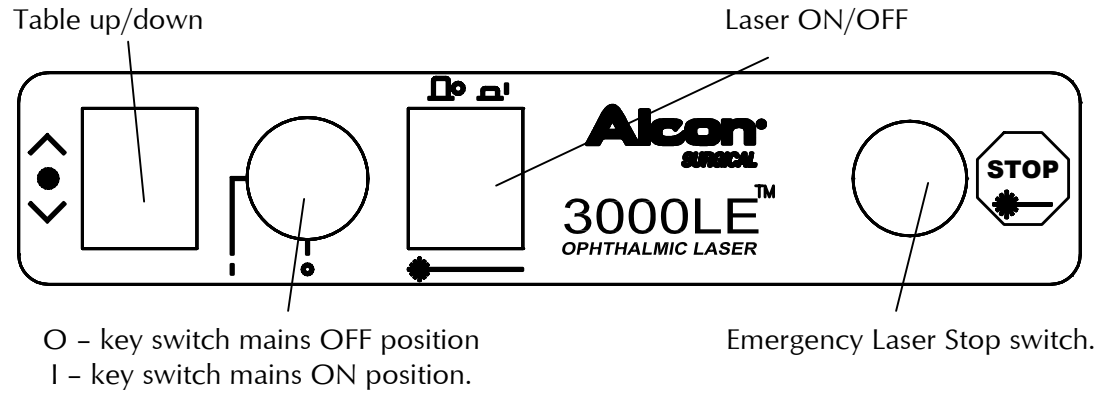
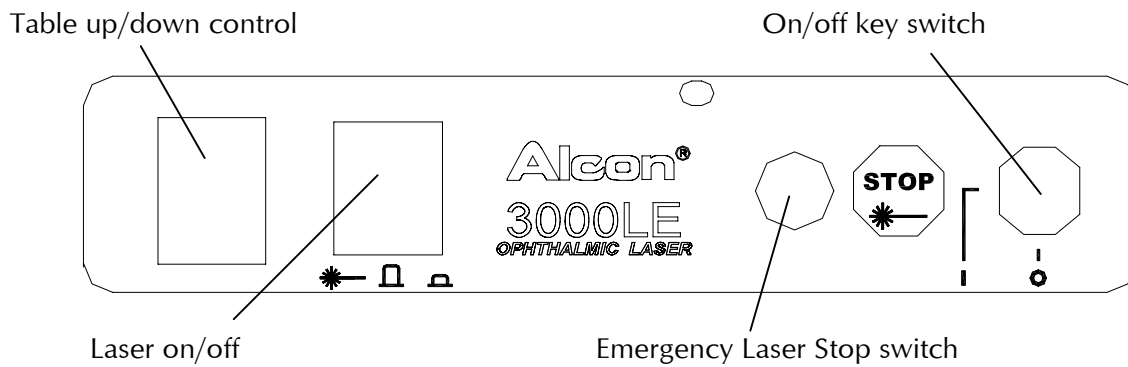


Figure 12-27 Key switch panel layout (S/N from 4000)



The panel also houses the fuses for the system. Refer to *Section 13.4* for fuse specifications.

Replacement procedure — units S/N pre-4000

The fuses can be replaced easily without removing the key switch panel, but ensure the unit is switched off before doing this.

To remove this module:

- Raise the table to its maximum height.
- Unplug the system.
- Using a flat blade, undo the ¼ turn fasteners securing the plastic bottom cover to the under side of the table top.
- Disconnect the cables going to the control panel underneath the table top.
- Remove the YAG power supply module.
- Using a 3 mm hex wrench, undo the four M4 socket head cap screws attaching the panel to the chassis assembly.
- Using a small adjustable spanner, undo the 3 mm (0.12 in) nut used to attach the panel earthing wires to the chassis.

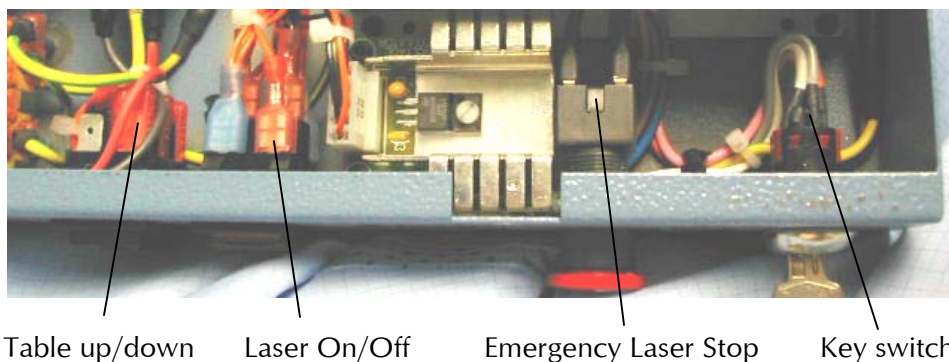
To install the replacement reverse the removal procedure.

Replacement procedure — units S/N from 4000

On these units the key switch panel is part of the power supply console under the table. Components on the key switch panel are removed individually as required. Refer to *Figure 12-28*.

- Remove the power supply console as described in *Section 12.4.1*.

Figure 12-28 Key switch panel connections



To replace the Table Up/Down or Laser On/Off switch:

- Disconnect and pull off the connectors.
- Push down the four black plastic clips on the switch and pull the switch out.

All four clips must be pressed in at once to enable the switch to be withdrawn. It is usually easiest to push the top clips in and lever the switch partly out, then push the bottom clips in and lever the bottom of the switch out.

Replacement is the reverse of the removal procedure, but it is important when replacing the Laser On/Off switch that all four connectors be pushed onto the posts simultaneously.

To replace the Emergency Laser Stop switch:

- Disconnect and pull off the connectors.
- Unscrew and remove the locking ring.
- Pull the switch out.

Replacement is the reverse of the removal procedure.

To replace the Key switch:

- Unsolder and pull off the connectors.
- Undo the locking nut.
- Pull the switch out.

Replacement is the reverse of the removal procedure.

12.4.3 Chin rest assembly

Refer to *Section 5.9* for information on the chin rest assembly. The assembly is removed by a reversal of the installation procedure.

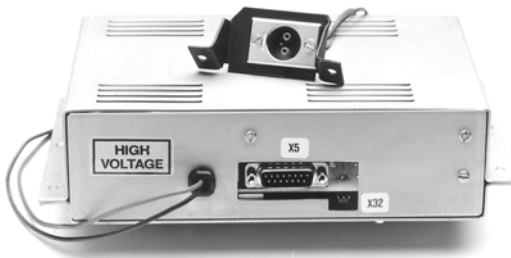
12.4.4 YAG power supply module

The YAG power supply module inputs and outputs are described in the table below. The unit is shown in *Figure 12–29*.

Table 12–14 YAG power supply I/Os

Input/Output	Details
Inputs	+12 V DC
V Control	5 V DC max
Laser ON/OFF	TTL high or low
Reset	TTL high or low
Outputs	
Capacitor charge voltage	900 V max
Capacitor	50 μ F
Charge times	500 V, 0.5 s 700 V, 0.7 s 900 V, 0.8 s
Ready	TTL high or lows

Figure 12–29 YAG power supply module (pre S/N 4000)



(YAG PSU with old-style connector)



(YAG PSU with later style connector)

Figure 12-30 YAG power supply module (S/N 4000 and later)

Theory of operation

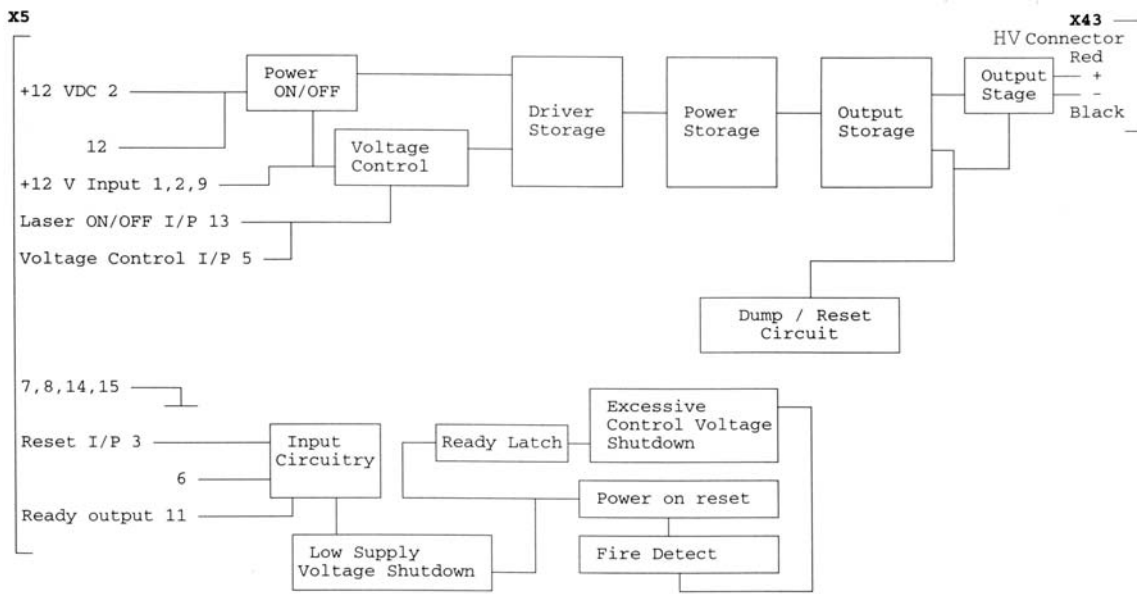
The YAG power supply (YAG PSU) converts a 12 V DC input into a high voltage that is used to charge a storage capacitor. The energy from the storage capacitor is supplied to the flash lamp, which is controlled by the trigger module.

The laser operates on single, double and triple pulse modes, which are differentiated by different voltage levels output from the storage capacitor. The capacitor voltage is determined by the voltage level of the input 'V CONTROL' input from the microprocessor.

When the system is turned on power is applied via the '+12 V INPUT' to the 'Power on/off' section of the supply. The 'LASER ON/OFF' line is used by the microprocessor. When the microprocessor is powered up and determines that no faults exist the 'LASER ON/OFF' line goes low, turning on V2, which then activates the relay K1 charging up capacitor C13 (the main storage capacitor in the OUTPUT STAGE).

If the microprocessor detects a fault the 'LASER ON/OFF' line goes high, shutting the YAG power supply down, and the 'RESET I/P' line goes high turning on V7. This in turn pulls the D line low, which turns off V27 (DUMP/RESET CCT) and turns on V29, which discharges C13 through the DUMP/RESET CCT.

When the fire switch is pressed, the microprocessor sends a signal to the Trigger module and the YAG laser is triggered to fire. This causes the main storage capacitor (C13) to discharge across the flash lamp. The storage capacitor immediately starts to charge up again. The 'FIRE DETECT' section of the power supply detects when the capacitor is charged. This turns V8 on, which pulls the 'READY O/P' line low. This low 'READY O/P' line tells the microprocessor that the YAG power supply is ready to be fired again.

Figure 12–31 YAG power supply block diagram***Determining proper operation***

To determine the proper operation of the YAG power supply module, make the checks described in the following table.

Table 12–15 YAG power supply module checks

Check	Description
Inputs	
+12 V Input	+12 V DC on X5-1 and X5-2
V Control I/P	0-5 V DC on X5-5
Laser ON/OFF	TTL low on X5-13
Reset I/P	TTL low on X5-3
Outputs	
Ready O/P	TTL low on X5-11
High Voltage O/P	350-900 V DC

Connect the interconnecting cable assembly between the power supply high voltage output (X43, under the inset tray) and the cable going to the laser head. Verify that there is high voltage (350 to 900 V DC) on X43-1 & X43-2.

Replacement procedure (units S/N pre-4000)

To replace the YAG power supply unit:

- Raise the table to its maximum height.
- Unplug the system.
- Slide the slit lamp as far as possible towards you and lock in position.
- Using a Philips screwdriver, undo the six screws securing the inset tray to the top of the table.
- Carefully remove the inset tray.
- Disconnect the X43 connector plug.
- Undo the two screws securing the X43 socket to the table and drop it through the opening.
- Using a flat blade, undo the ¼ turn fasteners securing the plastic bottom cover to the underneath of the table top.
- Disconnect the cables going to the YAG power supply module.
- Using a 2.5 mm (0.1 in) hex wrench, loosen the four screws securing the YAG power supply module to the underside of the table.
- Withdraw the module from the key slots.

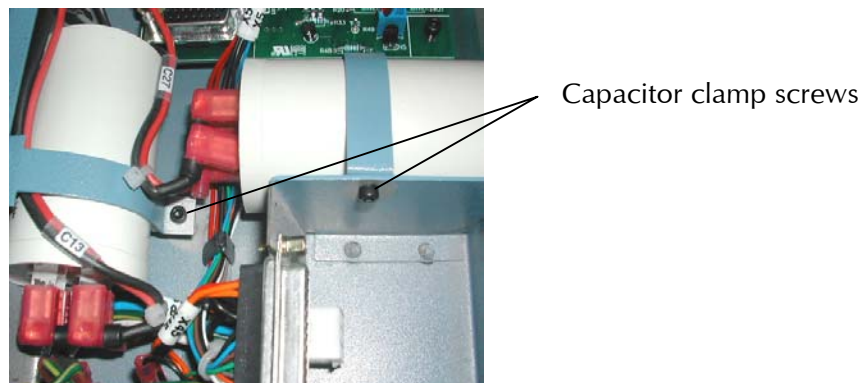
Installation of the replacement power supply unit is the reverse of the removal procedure. After installing a replacement, reset the YAG laser voltage (see *Section 11.4.2*).

Replacement procedure (units S/N from 4000)

To remove this module:

- Remove the power supply console as described in *Section 12.4.1*.
- Disconnect the X5 connector from the YAG power supply unit PCB by removing its two screws using a 3/32" Allen (hex) key.
- Loosen the capacitor clamps by removing its securing screws using a 2.5 mm Allen (hex) key – see below.

Figure 12–32 YAG PSU capacitors mounted to console

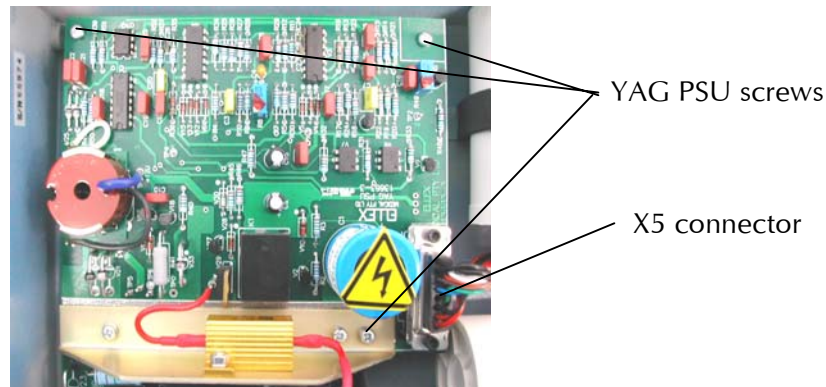


Removing the PSU

- Remove the X43 connector by removing its two securing screws using a Philips head screwdriver and lifting it out.
- Remove the YAG PSU by removing its three securing screws using a Philips head screwdriver and gently lifting it out (see below).

Take note of the YAG PSU cables and capacitor arrangements in the console since you will need to fit the replacement in the same configuration.

Figure 12–33 YAG power supply unit PCB



Installing the replacement PSU

- Install the replacement YAG PSU using the reverse of the above procedure.
- Before closing and securing the power supply console to the table, ensure all electrical connections have been fitted properly.
- When the console is secured, power the system and ensure it operates correctly.
- Perform a Voltage Reset test as follows, to ensure the YAG PSU is operating correctly (see also *Section 11.4.2*):
 - Set the ENERGY thumbwheel to maximum.
 - Simultaneously press and hold down the MODE SET, ENERGY RESET and ENERGY TEST buttons to enter service engineering test mode.
 - Press MODE SET momentarily and release.
 - Hold MODE SET down for a minimum of three seconds until the unit beeps and the test starts automatically.

We recommend alignment and calibration checks should be carried out, as described in *Chapter 4*.

12.4.5 DC power supply module

The DC power supply module inputs and outputs are described in the table below. It is illustrated in *Figure 12-34*.

Table 12-16 DC power supply I/Os

Input/Output	Details
Input	220 to 240 V AC 50/60 Hz
Output	+12 V DC -12 V DC (not used) +5 V DC (not used) 18 V AC (slit lamp illumination)

The DC supply module is a switch- mode power supply that converts AC mains to the low DC voltages required by the rest of the system. It includes an interconnection PCB. In units earlier than serial number 4000, this module includes a transformer to supply the voltage for the slit lamp illumination. In units from serial number 4000 onwards a voltage regulator converts 15 V DC to the 12 V DC required by the slit lamp.

Determining proper operation

To determine the proper operation of the DC power supply module, make the checks described in the following table.

Table 12-17 DC power supply module checks

Check	Description
Input	Verify that the input to the DC power supply is 220 to 240 V AC. Even if the mains input voltage to the system is only 100 to 120 V AC it is transformed into 220-240 V AC going into the DC power supply. The input to the DC power supply should always be 220-240 V AC and can be measured on X20-4 and X20-7.
Outputs	Verify that all of the output voltages are present. Verify +12 V DC on X21-1, X21-2, X21-5 and X21-6. Verify 18 V AC on X48-3 and X48-4. If no output can be measured, with current input applied, the module should be replaced.

Figure 12-34 DC power supply module (pre S/N 4000)

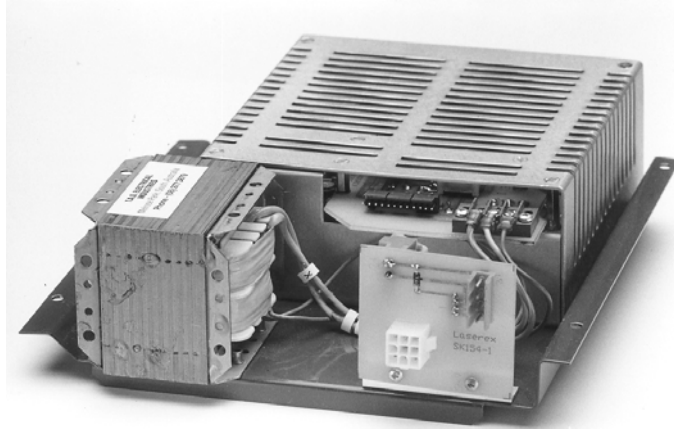


Figure 12-35 DC power supply module (from S/N 4000)



DC power supply module

Key switch panel

Replacement procedure (units S/N pre-4000)

To remove this module:

- Raise the table to maximum height.
- Unplug the system.
- Using a flat blade screwdriver, undo the ¼ turn fasteners securing the plastic bottom cover to the underside of the table top.
- Disconnect the cables going to the DC power supply module.
- Using a 2.5 mm (0.1 in) hex wrench, loosen the four screws securing the low voltage power supply module to the underside of the control console and withdraw the module from the key slots.

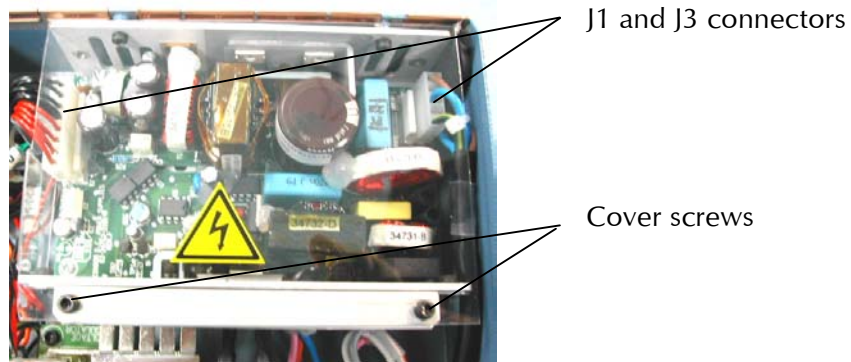
To install the replacement reverse the removal procedure. Switch on the system, and verify correct operation.

Replacement procedure (units S/N from 4000)

To remove this module:

- Remove the power supply console as described in *Section 12.4.1*.
- Remove the clear plastic cover from the DC PSU by removing its two securing screws using a 2.5 mm Allen (Hex) key (see below).
- Unplug the J1 and J3 connectors from the DC PSU PCB board.

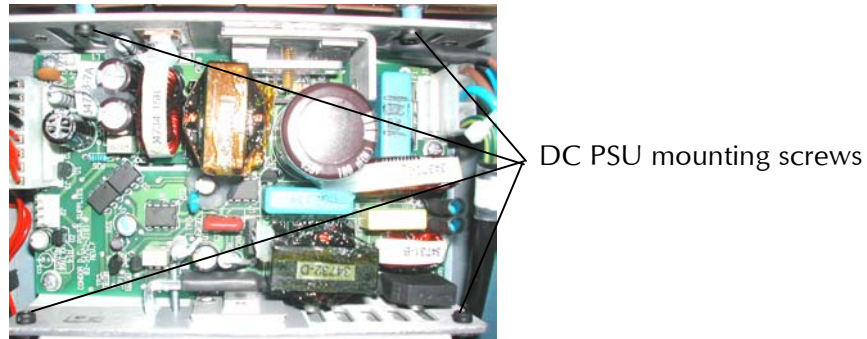
Figure 12-36 DC PSU safety clear cover



Removing and replacing the DC PSU

- Remove the DC PSU from the console by removing its four securing screws using a 2.5mm Allen (Hex) key and gently pulling it out (see below).

Figure 12–37 DC PSU mounting screws



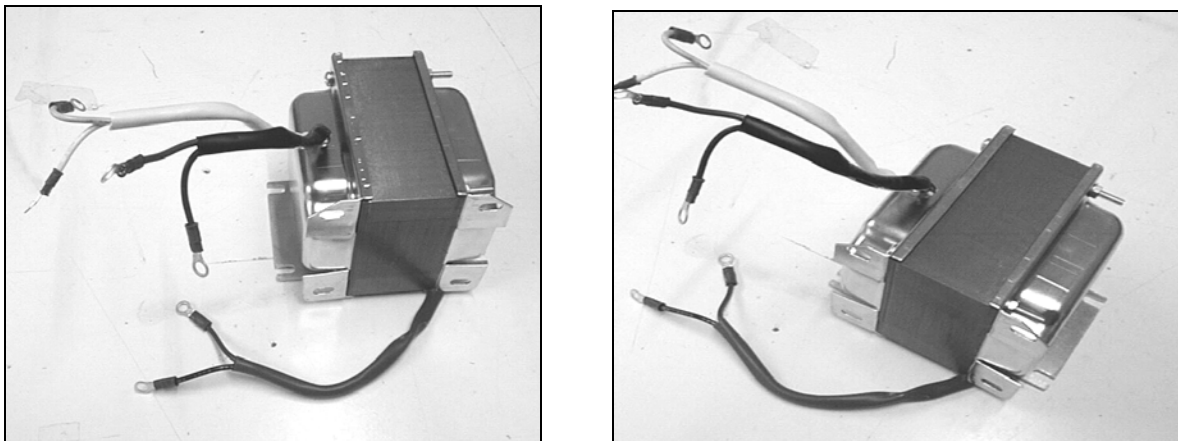
Replacement is the reverse of the removal procedure.

Before closing and securing the power supply console to the table, ensure all electrical connections have been fitted properly. When the console is secured, power the system and ensure it operates correctly. We recommend alignment and calibration checks should be carried out, as described in *Chapter 4*.

12.4.6 Transformer (units S/N pre-4000 only)

The isolating transformer is under the base of the stand. It is illustrated below:

Figure 12–38 Transformer



To replace the transformer:

- Unplug the system.
- Remove the laser head/slit lamp assembly from the table.
- Turn the unit on its side on the floor to access the bottom of the stand base.
- Using a 4mm Allen key driver, remove the two screws that secures the plastic cover on the base of the stand and take the plastic cover off.
- Unscrew the isolating transformer wirings from the X9 terminal block at positions 1, 2, 3, 4, 5 and 7.
- Using a Philips head screwdriver, remove the four screws on the base of the isolating transformer and the two screws on its side bracket.
- Lift the isolating transformer out.

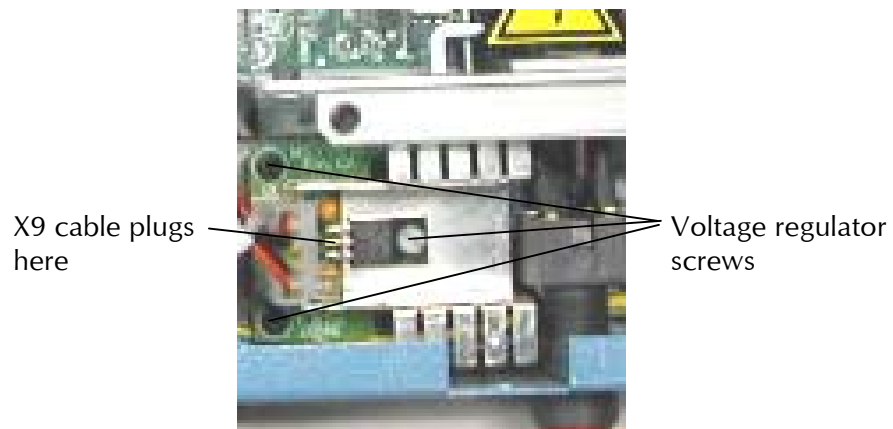
The replacement is the reverse of the above removal procedure.

12.4.7 Replacing the voltage regulator (S/N from 4000 only)

To remove this module:

- Remove the power supply console as described in *Section 12.4.1*.
- Disconnect the X9 cable from the connector marked X1 on the voltage regulator PCB.
- Remove the voltage regulator from the console by removing its three securing screws using a 2.5 mm Allen (hex) and a flat head screwdriver then gently pulling it out — see below.

Figure 12–39 Replacing the voltage regulator



Replacement is the reverse of the removal procedure.

Before closing and securing the power supply console to the table, ensure all electrical connections have been fitted properly. When the console is secured, power the system and ensure it operates correctly. We recommend alignment and calibration checks should be carried out, as described in *Chapter 4*.

12.5.8 Replacing the table top (S/N from 4000 only)

To remove the table top:

- Remove the power supply console as described in *Section 12.4.1*.
- Remove the two screws securing the chin rest cover.
- Disconnect and remove the chin rest using a 22 mm tube spanner, and place it in a safe place until further required.
- Ensure the replacement tabletop is undamaged, then remove the skid plate and rails from the original table and refit them to the replacement — see below.
- Disconnect the table top from the stand column by removing its four securing screws using a 5 mm Allen (hex) key and lifting it off.
- Remove the table chassis from the table by unscrewing its eight securing screws using a Philips head screwdriver and lifting it out — see below.

Figure 12-40 Removing the table top



Installing the replacement

- Place the replacement table top upside down on a soft surface such as bubble wrap to prevent scratching and denting.
- Re-fit the chin rest cable so that the X44 connector extends to the point where the chin rest mounting hole starts — see *Figure 12-41*.
- Fit the table chassis to the table top, ensuring that the chin rest cable is not jammed between the chassis and the table top, and the X48 cable extends through the hole in the chassis — see below.

Figure 12-41 Removing the table top

Re-install the console and laser head/slit lamp by reversing the removal procedures, then power the system and ensure it operates correctly.

We recommend alignment and calibration checks should be carried out, as described in *Chapter 4*.

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13.1 TREATMENT LASER

Table 13–1 Treatment laser specifications

Parameter	Details
Type	Q-switched Neodymium Yttrium Aluminum Garnet Nd:YAG
Safety class	3B
Wavelength	Near infrared 1064 nanometers (nm)
Air breakdown	≤ 4 mJ
Test cell breakdown	$> 50\%$ at 1 mJ
Q-switch	Solid state
Pulse width	4 nanoseconds
Mode structure	Fundamental, diffraction limited
Energy selector	≤ 0.3 to ≥ 10 millijoules, continuously variable
Maximum energy	45 millijoules at triple pulse. Single pulse energy is generally less than 15 mJ
Burst mode	1, 2 or 3 pulses per shot with a pulse separation of approximately 20 microseconds
Repetition rate	2.0 Hz in single pulse mode 1.8 Hz in double pulse mode 1.6 Hz in triple pulse mode
Spot size	8 microns FWHM (Full Width Half Maximum) calculated 84% of energy contained within 11 microns diameter
Cone angle	16 degrees (nominal)

Parameter	Details
Beam divergence	16°, solid cone angle; tolerance + 0° to -1.6°
Nominal ocular hazard distance (NOHD)	5.5 meters (18 feet)
Focusing system	Continuously variable posteriorly ($\pm$ 75 microns). Tolerance from minimum setting to + 250 microns
Safety filter	Schott KG-3 Optical density = 3 at 1064 nm
Binoculars	Removable with set screws to enable cross hair adjustment
Chin rest	Adjustable, vertical travel 50 mm (2 in)

13.2 AIMING LASER

Table 13-2 Aiming laser specifications

Parameter	Details
Type	Semi-conductor laser diode Continuous wave (CW) Twin spot, intersecting beams
Safety class	2
Wavelength	670 nm (nominal)
Power output	Continuously variable intensity up to 200 microwatts maximum (total of two beams)

13.3 SLIT LAMP SPECIFICATIONS

Table 13–3 Slit lamp specifications

Parameter	Details
CSO type	CSO slit lamp with special binocular support arm containing laser optical and electronic assemblies.
Nikon type	Nikon CS2-LDS slit lamp modified with special binocular support arm containing laser optical and electronic assemblies.
Microscope	Model Galilean type stereoscopic microscope
Objective lens	1.25 x
Eyepiece lens	12.5 x, dioptre adjustable in range ± 5 D (one with KOWA-style cross hair reticule) Optional 20 x, dioptre adjustable in range ± 5 D
Total magnification	16 x (12.5 x eyepiece) 25 x (optional 20 x eyepiece)
Interpupillary distance adjustment	55-75 mm (2.2 to 3 in)
Working distance	55 mm (2.2 in)
Focal length	92 mm (3.6 in)
Slit lamp source	
Slit width	0–14 mm (0–0.55 in)
Illumination view field	0.5 mm, 1 mm, 3 mm, 5 mm, 10 mm, 14 mm (0.02, 0.04, 0.12, 0.2, 0.4, 0.55 in)
Slit rotation	360 degrees endless
Illuminating angle	180 degrees at horizontal plane 90 degrees for right/left Continuous slit inclination 0-20°
Mirror rotation	6 degrees each for right/left (click stop at 0)
Filter	Green, cobalt-blue, ND (28%) filter
Bulb	Halogen lamp of 12 V, 30 W pre-centered bulb
Fixation lamp	Green LED

Parameter	Details
Cross slide table	
Vertical adjustment of main unit	30 mm (1.2 in)
Fine horizontal movement	By tilting joystick lever, fine movement of 15 mm (0.6 in) is possible
Coarse horizontal movement	By moving the slit lamp base, coarse movement of 102 mm (4 in) longitudinal and 108 mm (4.25 in) lateral travel is possible

13.4 POWER SUPPLY

Table 13-4 Power supply specifications

Parameter	Details
Supply voltage	100 – 120 V AC or 220 – 240 V AC
Supply frequency	50/60 Hz
Mains fuse	6.3 A 250 V slow-blow The fuse is located in the mains inlet in the key switch panel (units with S/N pre-4000) or the bottom of the stand (units with S/N from 4000). We recommend the following brands of fuses if they are to be replaced: Beswich/Bussmann UL no. E575865
Internal fuse	630 mA slow-blow fuse for both 100 – 120 and 220 – 240 V AC operation (units with S/N pre-4000 only). The fuse is located in the base.
Shock protection	Class 1 (IEC 601-1 6.8.1)  TYPE B EQUIPMENT <i>Type B equipment provides protection against electric shock by limiting the leakage current and by the provision of a protective earth connection.</i>

13.5 TABLE

Table 13–5 Table specifications

Parameter	Details
Type	Center stand (pedestal)
Adjustment	Electric lift, motor driven
Height	770–1020 mm (30–40 in)
Work area	744 x 425 mm (29 x 17 in)
Castors	Lockable on operator side
Connectors	Interlock connector

13.6 FOOTSWITCH

Table 13–6 Footswitch specifications

Parameter	Details
Footswitch type	Not provided with standard instrument. Different requirements by users has led to the user or service representative sourcing an appropriate footswitch, if required

13.7 COOLING

Table 13–7 Cooling specifications

Parameter	Details
Type	Air convection

13.8 WEIGHT

Table 13–8 Weight specifications

Parameter	Details
Packed weight (approx)	75 kg (165 lb) (S/N pre-4000) 58 kg (128 lb) (S/N from 4000)
Unpacked weight (approx)	60 kg (132 lb) (S/N pre-4000) 34 kg (lb) (S/N from 4000)

13.9 SLIT LAMP ACCESSORIES

Table 13–9 Slit lamp accessories

Parameter	Details	Part Number
Magnification changer	3 position	MC-3000
Beam splitter	X 2 plugs	L-0100-0834
Photographic camera adaptor	35 mm (1.4 in)	
Video camera adaptor	Suits Sony DXC107AP Panasonic GPKR22E	
Observation tube	Without eyepiece	L-300-123
Eyepiece for observation tube	(x 12.5)	L-0100-0941
Slit lamp globe halogen	12 volts	

13.10 ACCESSORIES

Table 13–10 Accessories

Accessory	Details	Part Number
Model eye kit	Includes one packet of 25 membranes	300-3040-001
Membranes	Packet of 25	
Safety glasses		8065-6786-05
Footswitch plug		300-3012-001
Eyepiece to suit CSO type slit lamp	12.5 x	

Accessory	Details	Part Number
Eyepiece with reticule to suit CSO type slit lamp	12.5 x	
Accessories interlock plug	Interlock can be connected to a footswitch or a second laser delivery system mounted on the slit lamp.	
Magnification changer to suit CSO type	3-position: 12 x, 16 x, 28 x. (Standard magnification 16 x.)	
Magnification changer to suit CSO type	5-position: 6 x, 10 x, 16 x, 30 x, 45 x. (Standard magnification 16 x.).	
Beam splitter to suit CSO type	X2 plugs	.
Co-observation tube to suit CSO type	Includes one eyepiece.	
Camera adaptor to suit CSO type	Photographic 35 mm (1.4 in)	
Camera adaptor to suit CSO type	Video, to suit Sony DXC107AP or Panasonic GPKR222E	
Nikon tonometer mount		Nikon part AAB0112
Nikon applanation tonometer		Nikon part AAB001AL
Service Manual		300-3057-001
Operator's Manual		300-3056-001

Caution

The use of non-Alcon approved or supplied accessories or replacement parts is not recommended and may lead to situations that cause bodily injury.

The use of non-approved accessories or replacement parts may also void the warranty.

13.11 ENVIRONMENTAL CONDITIONS

The following environmental conditions are recommended to avoid system degradation during transport and storage.

Table 13-11 Environmental conditions for transport and storage

Parameter	Details
Ambient temperature range	-10°C to +40°C (-14°F to +104°F)
Humidity range	10% to 75% RH (non-condensing)
Atmospheric pressure range	700 hPa to 1060 hPa

The following environmental conditions are recommended to avoid system degradation during operation.

Table 13-12 Environmental conditions for system operation

Parameter	Details
Ambient temperature range	+10°C to +40°C (-14°F to +104°F)
Humidity range	30% to 75% RH (non-condensing)
Atmospheric pressure range	700 hPa to 1060 hPa

13.12 PRODUCT LIFETIME

The **3000LE** has a design life of at least seven years from the date of manufacture. The system is of modular construction so that the correct operation can be maintained by parts replacement. If the system is no longer required, it can be disposed of as described below.

13.13 PRODUCT DISPOSAL

The **3000LE** contains no parts that require special disposal after use. It contains no toxic or radioactive elements that would adversely affect a dismantler or the area of disposal. The product is largely non-biodegradable and recycling of the base materials is recommended. Contact local authorities to determine the correct method of disposal.

The following list indicates the composition of the major elements of the **3000LE** to assist recycling.

Table 13-13 Component materials

Base materials	Component parts
Steel	Power supply console chassis Laser module body Slit lamp cross-slide and bearings Chassis top plate Stand base Chin rest posts and pillars
Copper	Transformer (units earlier than S/N 4000 only) Wiring
Aluminum	Laser head casting Nd:YAG power supply unit enclosure DC power supply unit enclosure Stand column Optics module bodies Slit lamp knobs and components
Wood	Table
Plastic	Slit lamp base body Stand base cover Chin rest and headband Joystick skid plate Insulation in wiring, terminals, transformers and electrical components
Glass	Optics within laser head Optics within slit lamp

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SPARE PARTS LIST AND SERVICE TOOL KIT

A1 SPARE PARTS

Spare parts shown in *italics* in the table below apply to units with serial numbers 4000 or later. The remaining spare parts apply to all units.

Table A-1 Major spare parts list

Part No	Description	Qty
300-3004-001	FGS YAG CAVITY	1
300-3006-001	FGS DAM	1
300-3009-001	FGS ATTENUATOR	1
300-3021-001	FGS BET	1
300-3141-001	FGS FOLDING MIRROR	1
300-3005-001	FGS TRIGGER	1
300-3087-001	FGS YAG ENERGY MONITOR	1
300-3089-001	FGS LX CHIN REST	1
300-3038-001	FGS LX FIXATION LAMP GLOBE	3
	FGS SLITLAMP GLOBE HALOGEN 12V	1
300-3036-001	FGS ALCON 3000LE TOOL KIT	1
300-3096-001	FGS LX ILLUM CONTROL ASSY TYPE B	1
300-3039-001	FGS MODEL EYE CAPSULES	2
	FGS BURN PAPER	1
300-3133-001	FG 3000LE V3.2 SOFTWARE	1
300-3136-001	FGS 3000LE MICRO/DISPLAY ASSY V3.2	1
300-3115-001	FGOODS SHUTTER MOTOR	1
300-3064-001	SPARE JOYSTICK WIPER BLOCK	1
300-3090-001	SPARE FILTER YAG BEAM SAFETY	1
300-3040-001	SPARE MODEL EYE	1
300-3071-001	SPARE TISSUE CLIPS	10

Part No	Description	Qty
300-3101-001	SPARE OBJECTIVE LENS	1
300-3063-001	SPARE JOYSTICK	1
300-3093-001	SPARE SWITCHLOCK 90 DEG ROTATE	1
	SPARE ILLUMINATION TOWER	1
300-3072-001	SPARE TARGET CHINREST OPHTHALMIC	1
300-3042-001	SPARE MOD NUT DRIVER 5 mm A/F	1
300-3044-001	SPARE ALLEN KEY SPECIAL 2 mm A/F	1
300-3034-001	SPARE BINOCULAR OFFSET TOOL	1
300-3064-001	SPARE BINOCULAR ASSEMBLY	1
	SPARE DUST COVER	1
300-3119-001	SPARE CHIN REST PAPER	2
5110-0255	SPARE FUSE PACK DIA 5 X 20 3.15A 250 VAC SEMI	50
300-3134-001	SPARE KIT RETROFIT X43 PLUG	1
300-3014-001	SPARE KEY PACK SPARE SWITCHLOCK	3
	SPARE EYEPIECE PAIR	1 set
	SPARE KIT GEAR WHEEL	1 set
	SPARE KIT CONNECTOR X43	1 set
300-3051-001	SPARE CABLE EXTENSION X2 3000LE/LX	1
300-3052-001	SPARE CABLE EXTENSION X8 3000LE/LX	1
300-3046-001	SPARE SPANNER 22 mm BOX PACK	1
	SPARE DC PSU 3000LE/LT5106	1
	SPARE YAG PSU 3000LE	1
	SPARE TABLE TOP 3000LE	1
	SPARE SWITCH EMERGENCY	1
	SPARE KIT, PACKAGING, 3000LE	1
	SPARE CABLE LASER HEAD 3000LE	1
	SPARE SWITCH, PUSH BUTTON. ILLUM	1
	SPARE KIT, CASTORS, 3000LE	1 set
	SPARE DECAL, HEAD-UP DISPLAY, 3000LE	1
	SPARE SWITCH, 2 POS, UP/DOWN	1
	SPARE CABLE SIGNAL, 3000LE	1
	SPARE STAND, 3000LE	1
	SPARE COLUMN, STAND (C/W TFMR)	1
	MANUAL, SERVICE 3000LE	1
	SPARE VOLTAGE REGULATOR, 3000LE	1
	SPARE COVER, BASE, STAND	1

This Appendix lists the drawings associated with the **3000LE**. The drawings are bound in the rear of this manual in the order shown here.

B1 BILL OF MATERIALS

Table B-1 Bill of materials S/N pre-4000

Item	Part No	Description	Qty	Unit
001	3313911	MASSY STAND MODULE CE	1	EACH
002	3315116	MASSY CHASSIS COVER 3000	1	EACH
003	3325125	MASSY TABLE, 3000	1	EACH
004	3125330	FASSY LASER HEAD 3000 CSO	1	EACH
005	2717739	MOD CHINREST LASEREX	1	EACH
006	2127030	TRAY INSET 3000 GRAY	1	EACH
013	3600003	BELLOWS BLACK - OIT	1	EACH

Table B-2 Bill of materials S/N from 4000

Item	Part No	Description	Qty	Unit
001	3334140	MASSY COLUMN, STAND	1	EACH
002	3334150	MASSY BASE, STAND	1	EACH
003	3134200	FASSY CONSOLE	1	EACH
004	3334130	MASSY TABLE, 3000	1	EACH
005	3134160	FASSY LASER HEAD 3000 CSO	1	EACH
006	2720710	MOD CHINREST LQ5106/3000LE	1	EACH

B2 SYSTEM DIAGRAMS

Table B-3 System diagrams S/N pre-4000

Drawing number	Description
13504	MASSY, PLATE MOUNTING
13505	MASSY, STAND MODULE
15120	MASSY, CONTROL PANEL 3000LE
15206	CASSY, CHASSIS LOOM
15215	CASSY, X7 X33 3000
15261	KIT, LABEL 3000LE, 240V
15262	KIT, LABEL, 3000LE, 115V
17739	MOD CHINREST LASEREX
25125	MASSY, TABLE 3000 CSO
25160	FASSY, DISPLAY COVER 3000LE
25177	FASSY SYSTEM 3000 CSO
25218	CASSY, LASER HEAD 3000 CSO
25330	FASSY LASER HEAD 3000 CSO
25331	MASSY LASER HEAD 3000 CSO

Table B-4 System diagrams S/N from 4000

Drawing number	Description
3334150	MASSY, BASE, STAND
3334140	MASSY, COLUMN, STAND
3134200	FASSY, CONSOLE
3234210	CASSY, SIGNAL, CONSOLE
3234220	CASSY, POWER, CONSOLE
6134120	KIT, LABEL 3000LE
2720710	MOD CHINREST
3334130	MASSY, TABLE 3000LE
3134180	FASSY, DISPLAY COVER 3000LE
3134110	FASSY SYSTEM 3000LE
3234190	CASSY, LASER HEAD 3000LE
3134160	FASSY LASER HEAD 3000LE
3334170	MASSY LASER HEAD 3000LE

B3 ELECTRICAL DIAGRAMS

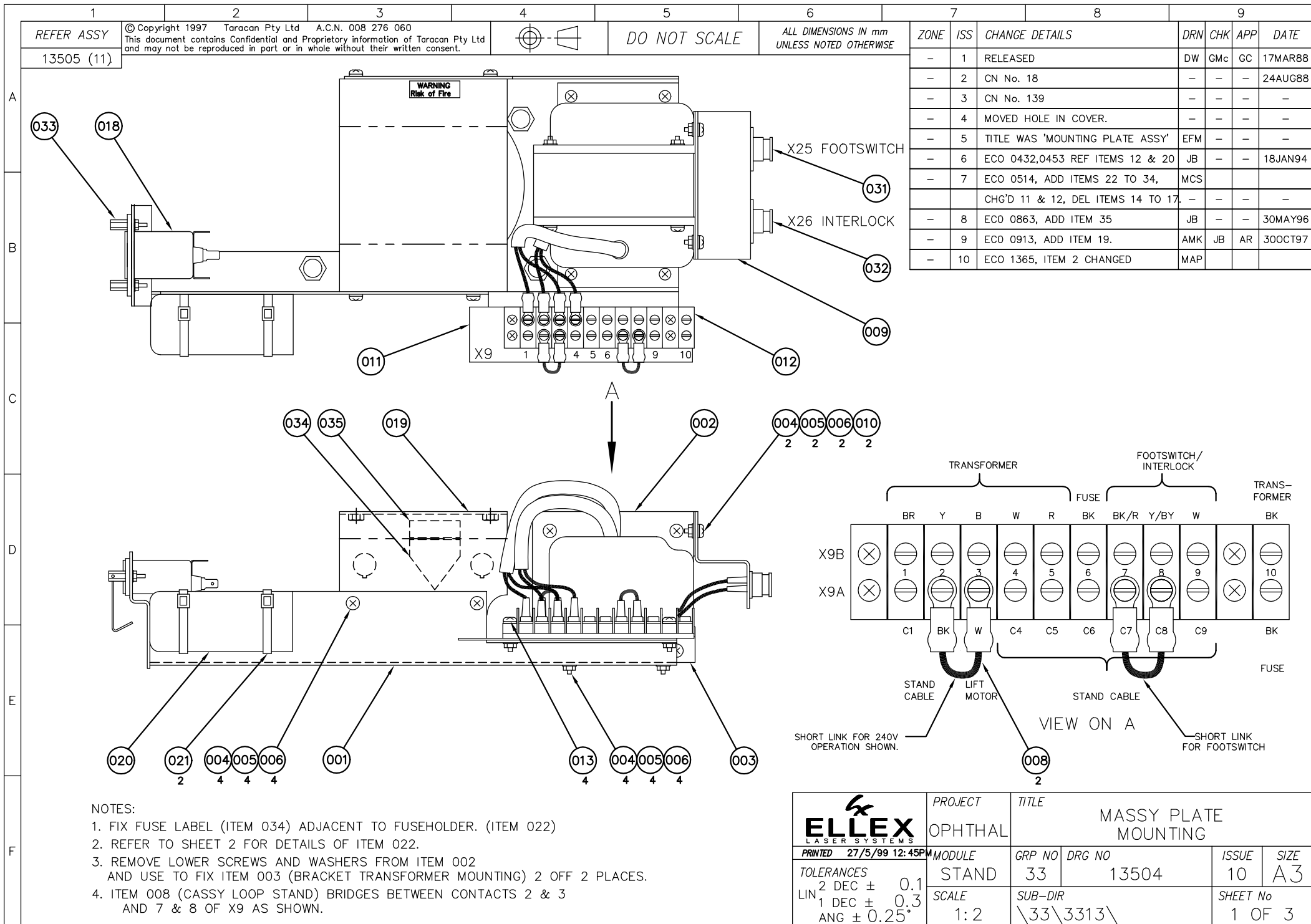
Table B-5 Electrical diagrams S/N pre-4000

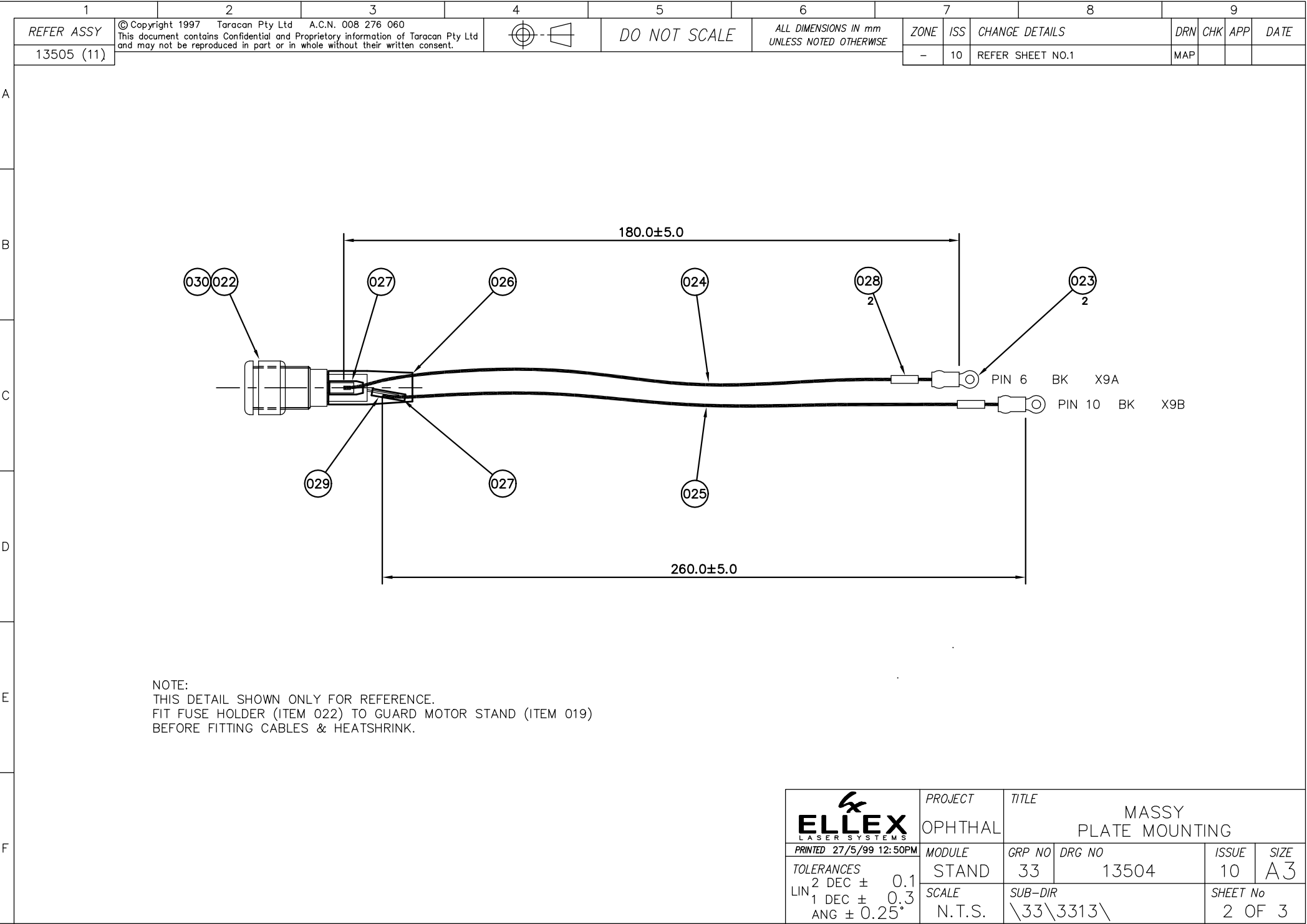
Drawing number	Sheet	Description
15271		INTERCONNECTION DIAGRAM 3000
17092	1	WIRING SCHEMATIC 3000

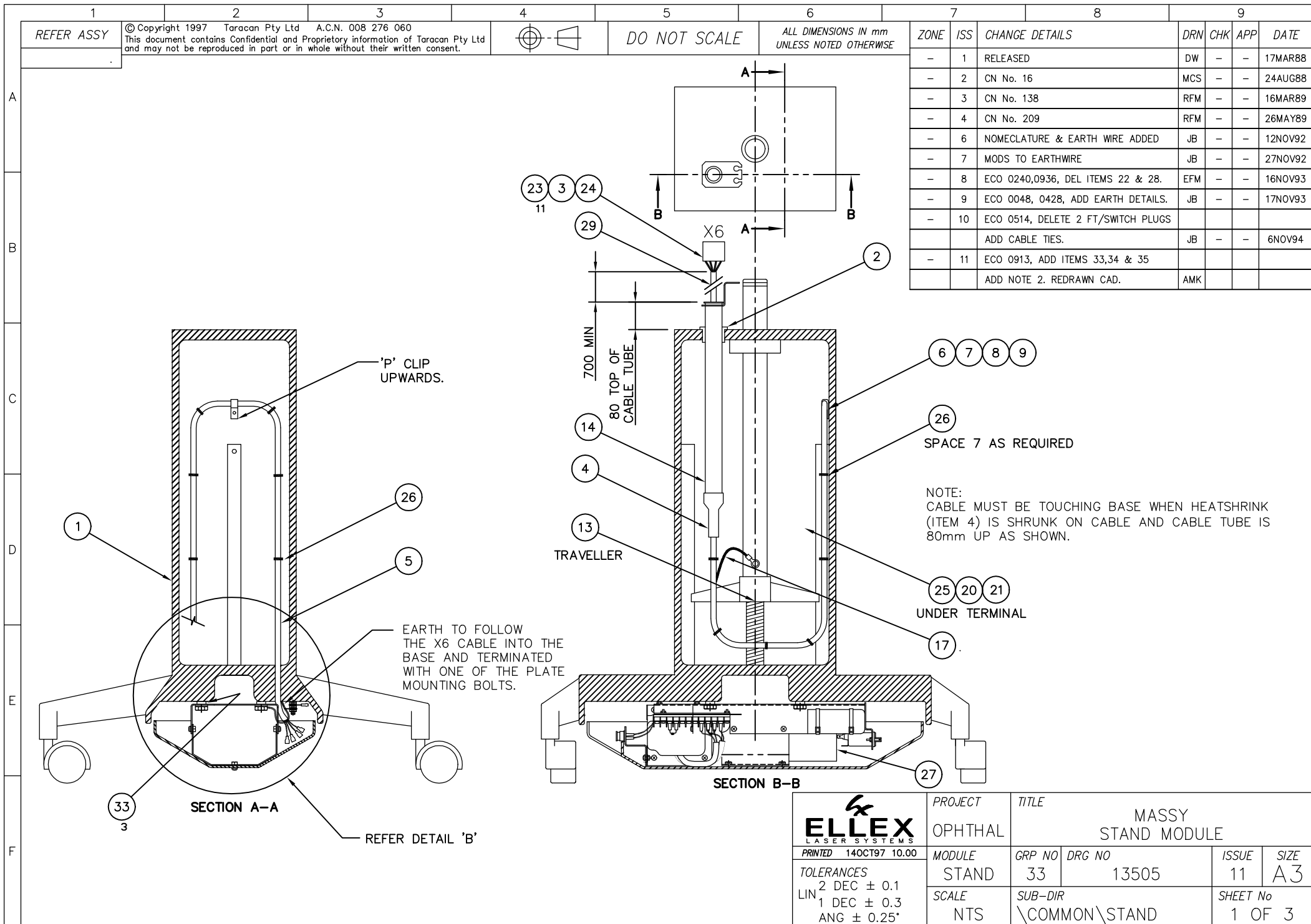
Table B-6 Electrical diagrams S/N from 4000

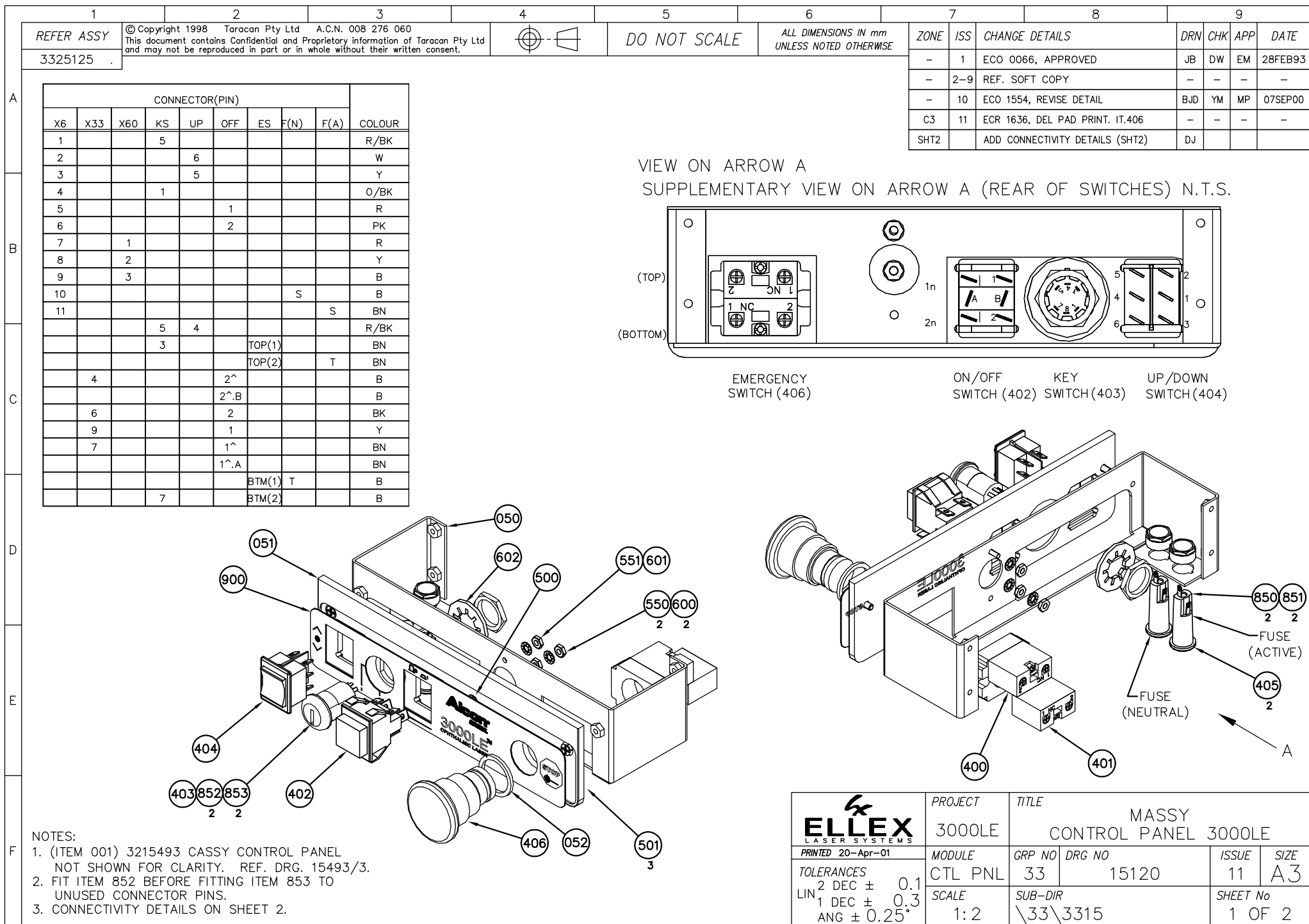
Drawing number	Sheet	Description
8434111	1	SCHEMATIC, ELECTRICAL SYSTEM 3000LE

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REFER ASSY. No. 15125

DO NOT SCALE

NOTE: -
REFER TO SHEET NO.2 FOR
PIN-PIN CONNECTIVITY.

CHANGE DETAILS

ISSUE A
RELEASED
J.B. 16/07/92

ISSUE 1
ECO NO. 0187
MOD BRACKET
J.B. 28/07/92

UNLESS OTHERWISE
STATED ALL DIMENSIONS
ARE IN MILLIMETRES

X45

X60

X5

X44

X21

X48

HOLE REF	No OFF	SIZE
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 Laserelex SYSTEMS SOUTH AUSTRALIA				SCALE N.T.S.		TITLE CASSY 3000 CHASSIS LOOM	
MATERIAL REFER SHEET NO.3		DRWN.	J.B.	DATE 16/07/92		A3	
		CHKD.					
FINISH — CLEAN		APPD.				PART/DRG NO. 15206	
		TOLERANCES UNLESS OTHERWISE STATED 2 PLACES DEC.± 0.10 1 PLACE DEC.± 0.3 ANGULAR ± 0.25°				ISSUE NO. 1	
						SHEET NO. 1 OF 3	

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REFER ASSY. No. 15125

DO NOT SCALE

CHANGE DETAILS

REFER
SHEET NO.1

ITEM NO.	CONNECTOR(PIN)						COLOUR	LENGTH
	X45	X21	X5	X48	X44	X60		
	1							
1	2	5					PK	450
1	3	6					R	450
1	4	7					V	450
1	5	8					V/Y	450
1	6		3				BK	350
1	7		5				B	350
1	8		6				BN	350
1	9		11				G	350
1	10		13				GY	350
1	11		14				O	350
1	12		15				O/W	350
	13							
2	14			1			R	340
3	15				1		B	185
2	16			2			BK	340
	17							
	18							
	19							
	20							
1	21					1	BN	530
1	22					2	G	530
1	23					3	GY	530
	24							
3	25				2		W	185
1		1	1				W	760
1		2	2				Y	760
1		9	8				BK	760
1		10	7				B	760

UNLESS OTHERWISE
STATED ALL DIMENSIONS
ARE IN MILLIMETRES

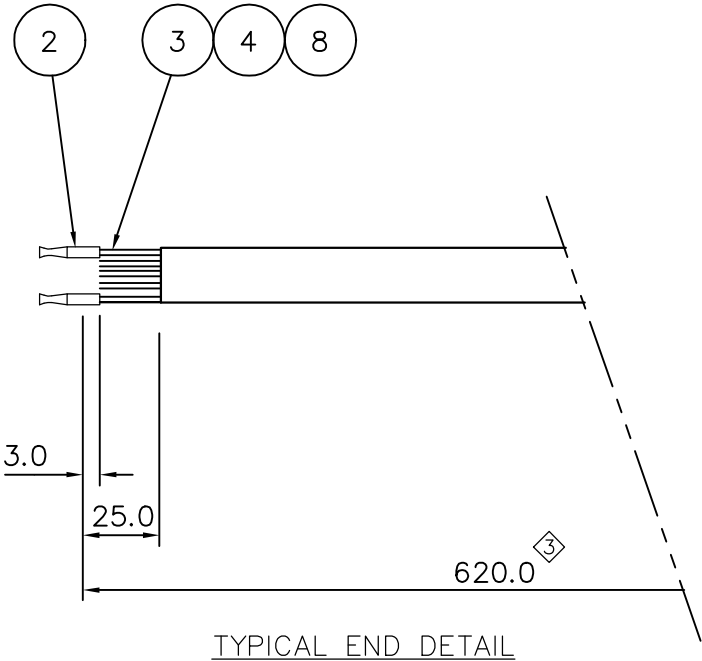
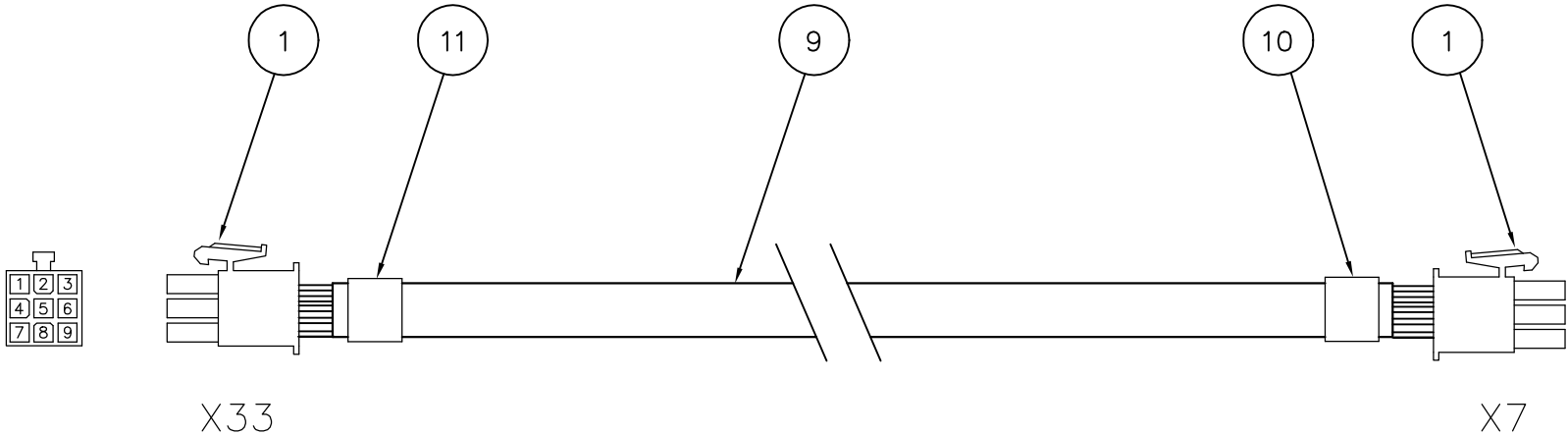
HOLE REF	No OFF	SIZE
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 SOUTH AUSTRALIA <u>MATERIAL</u> REFER SHEET NO.3 <u>FINISH</u> — —			SCALE N.T.S.	<u>TITLE</u> CASSY 3000 CHASSIS LOOM	
	DRWN.	J.B.	DATE 16/07/92		
	CHKD.				
	APPD.				
			<u>TOLERANCES</u> <u>UNLESS OTHERWISE STATED</u> 2 PLACES DEC.± 0.10 1 PLACE DEC.± 0.3 ANGULAR ± 0.25°		
			A3	<u>PART/DRG NO.</u> 15206	
			<u>ISSUE NO.</u> 1	<u>SHEET NO.</u> 2 OF 3	

REFER ASSY. No. 15125

DO NOT SCALE
ALL DIMENSIONS IN mm
UNLESS NOTED OTHERWISE

ZONE	ISS	CHANGE DETAILS	DRN	CHK	APP	DATE
-	A	RELEASED	J.B.			27/07/92
-	1	ECO 0106	J.B.	DW	EM	07/05/93
-	2	ECO 0486 & 0525, DEL EARTH				
-		WIRE, LENGTH WAS 560.0, SLEEVE				
-		WAS SPIRAL WRAP	J.B.	EM	DW	13/04/94
-	3	ECO 0677, LENGTH WAS 580.0.	J.B.			



TYPICAL END DETAIL

CONN		COLOUR	LENGTH
X7	X33		
1			
2	2	W	620
3	3	W	620
4	4	B	620
5			
6	6	B	620
7	7	BN	620
8			
9	9	BN	620

 S Y S T E M S	TITLE CASSY X7 X33 3000		
	A3	PART/DRG NO. 15215	
		ISSUE NO. 3	SHEET NO. 1 OF 2

1	2	3	4	5	6	7	8	9						
REFER ASSY 3025268 (003)	© Copyright 1998 Taracan Pty Ltd A.C.N. 008 276 060 This document contains Confidential and Proprietary information of Taracan Pty Ltd and may not be reproduced in part or in whole without their written consent.				DO NOT SCALE	ALL DIMENSIONS IN mm UNLESS NOTED OTHERWISE	ZONE -	ISS 12	CHANGE DETAILS ECR 1554, REDRAWN, CE MARK		DRN DL	CHK BJD	APP MP	DATE 18SEP00

Alcon 3000LE™

MODE SET: CONTRAST, READY, STAND BY

ENERGY TEST, ENERGY RESET, mJ → 0

PULSE SET, PULSE RESET, 11 → 0

Alcon 3000LE™

OPHTHALMIC LASER

STOP

SLIT WIDTH, APERTURE

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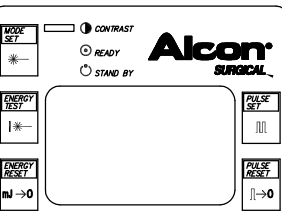
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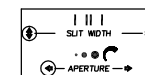
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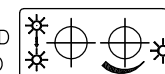


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90-120 V $\sim$, 1 ϕ ☐ CHECKED
☐ VERIFIED
 PLACE ABOVE
 POWER SOCKET

**PART VIEW B
(COVER REMOVED)**

☐ CHECKED
☐ VERIFIED

Alcon 3000LE™

☐ CHECKED
☐ VERIFIED

**DANGER – Laser radiation when open
AVOID DIRECT EXPOSURE TO BEAM**

☐ CHECKED
INNER

MODE SET
☐ CONTRAST
☐ READY
☐ STAND BY

ENERGY TEST
☐

ENERGY RESET
mJ → 0

T-6.3A 250V
REPLACE FUSE AS MARKED

OUTER
☐ CHECKED
☐ VERIFIED

OUTER
☐ CHECKED
☐ VERIFIED

BACK

BACK

UNIT S/N:

WARNING: May present an explosion hazard if operated in the presence of combustible gases, vapours or liquids.

CAUTION: Do not remove cover. Refer servicing to qualified service personnel.
Grounding reliability can only be achieved when connected to a receptacle marked "Hospital Grade".

630mA 250V SLOW BLOW FUSE
REPLACE FUSE AS MARKED
WARNING
Risk of Fire

PLACE ABOVE INTERLOCK CONNECTOR
☐ CHECKED
☐ VERIFIED

INNER
☐ CHECKED

Manufactured in Australia for

Alcon

ANALOG

Alcon Laboratories Pty. Ltd., 80/82 South Fremont,
Forth Street, Tel Aviv 50100 ISRAEL

By ERM Method Pp. Ltd.
74 St Albans Street,
CARPENTERS, ALBA 5000.

U.S. FEDERAL LAW RESTRICTS THIS DEVICE
TO SALE BY OR ON ORDER OF A PHYSICIAN
THIS PRODUCT COMPLIES WITH 21 CFR,
CHAPTER I, SUBCHAPTER B

REF _____
SN _____

CE

80-120 V AC
220-240 V AC
50/60 Hz
400VA

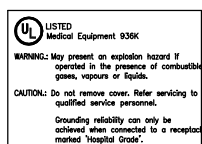


LASER CLASS II/III
CLASS II/III LASERS: 1000 mW, visible light, 4 or 6 pulses
CLASS II/III LASERS: 1000 mW, visible light, 4 or 6 pulses

VISIBLE AND INVISIBLE LASER RADIATION
ALONE DIRECT EXPOSURE TO BEAM
OR LASER RADIATION MAY CAUSE EYE INJURY
SEE USER'S MANUAL FOR PREVENTION OF EYE INJURY

OUTER	INNER
☐ CHECKED	☐ CHECKED
☐ VERIFIED	☐ VERIFIED

OUTER	INNER
☐ CHECKED	☐ CHECKED
☐ VERIFIED	☐ VERIFIED

☐ CHECKED
☐ VERIFIED

PLACE ABOVE
INTERLOCK
CONNECTOR
☐ CHECKED
☐ VERIFIED



INNER
☐ CHECKED

NOTES:

1. LABELS DENOTED 'REF' ARE STANDARD TO ALL UNITS AND ARE ITEMISED ON OTHER ASSEMBLIES, THEY ARE INCLUDED FOR REFERENCE ONLY.

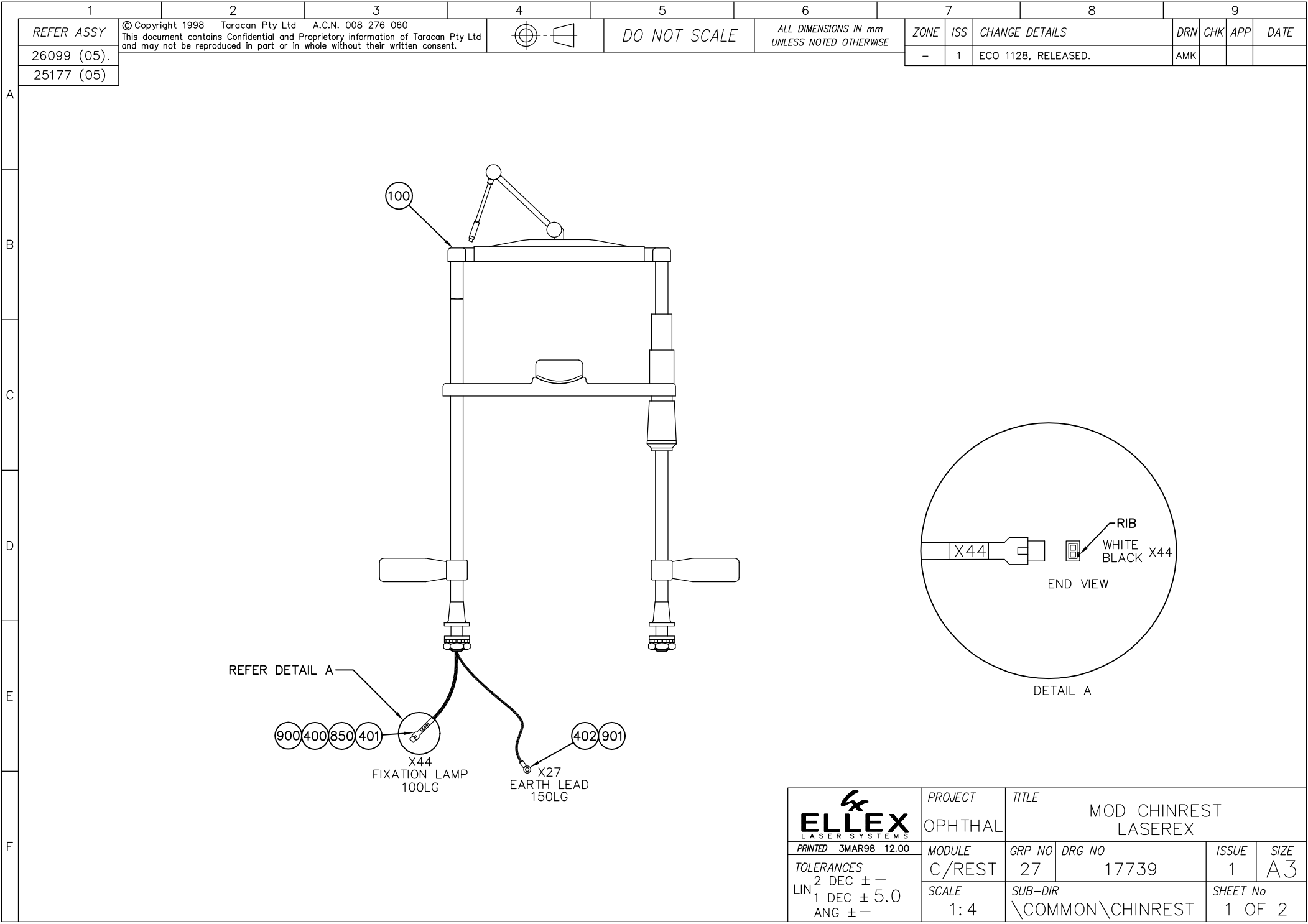
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LABELLING CHECKED BY:	
SIGNATURE:	DATE:
LABELLING VERIFIED BY:	
SIGNATURE:	DATE:



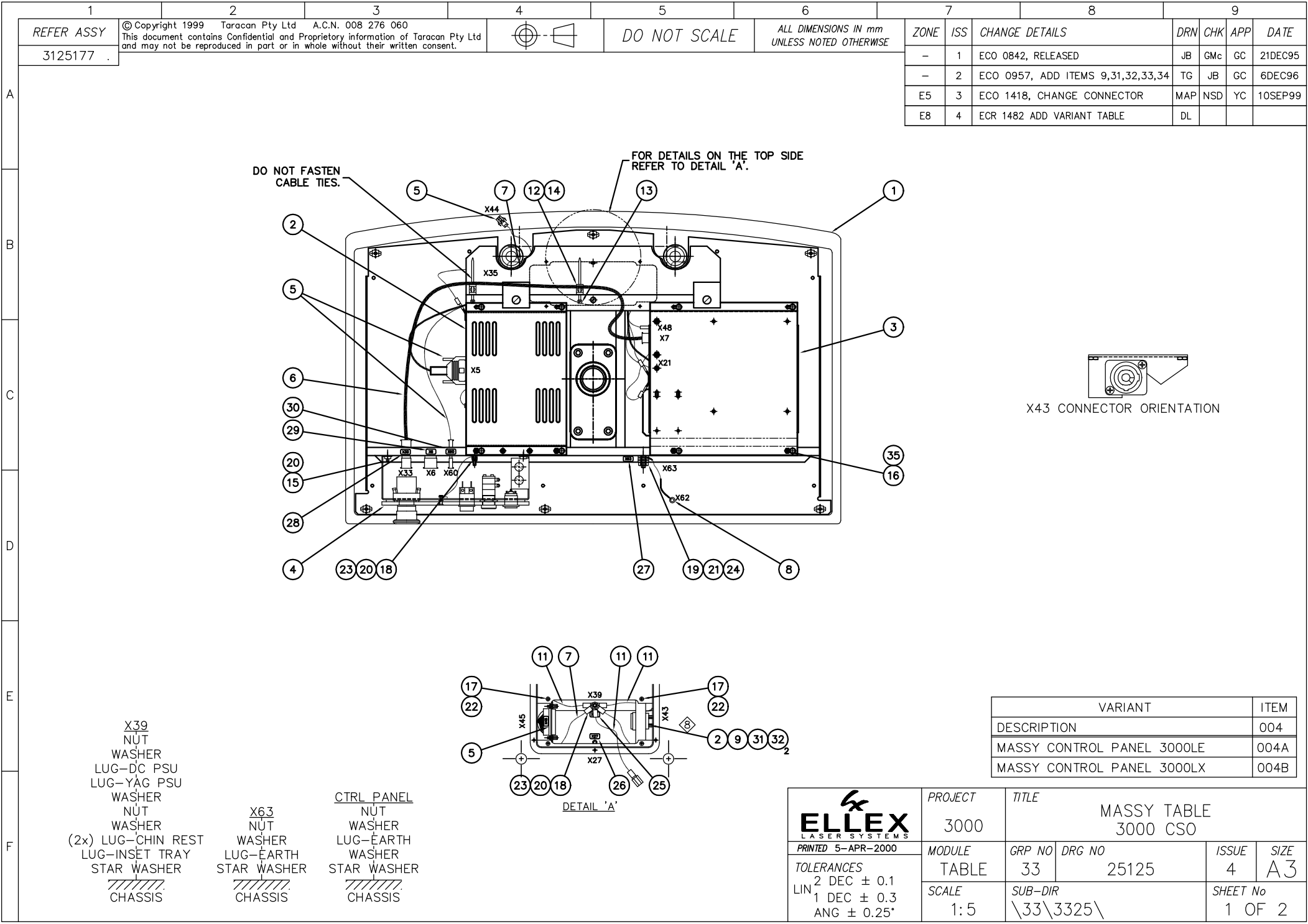
PRINTED 28/08/00

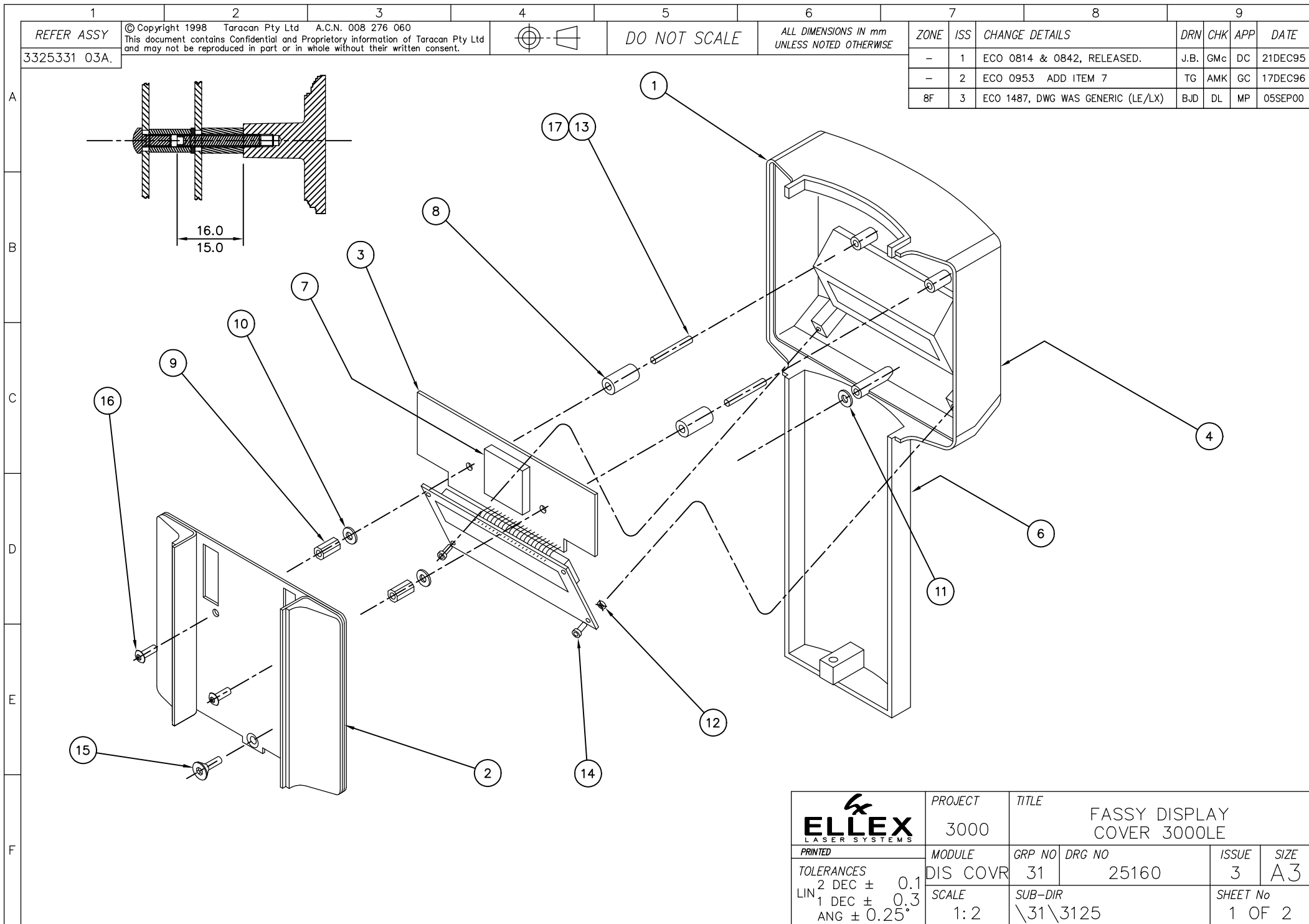
TOLERANCES
LIN 2 DEC $\pm$ —
1 DEC $\pm$ —
ANG $\pm$ 0.25°

PROJECT	TITLE			
3000LE	KIT LABEL 3000LE 115V, UL			
MODULE	GRP NO	DRG NO	ISSUE	SIZE
KIT LBL	61	15262	13	A3
SCALE	SUB-DIR		SHEET No	
N.T.S	\61\6115\		1 OF 2	

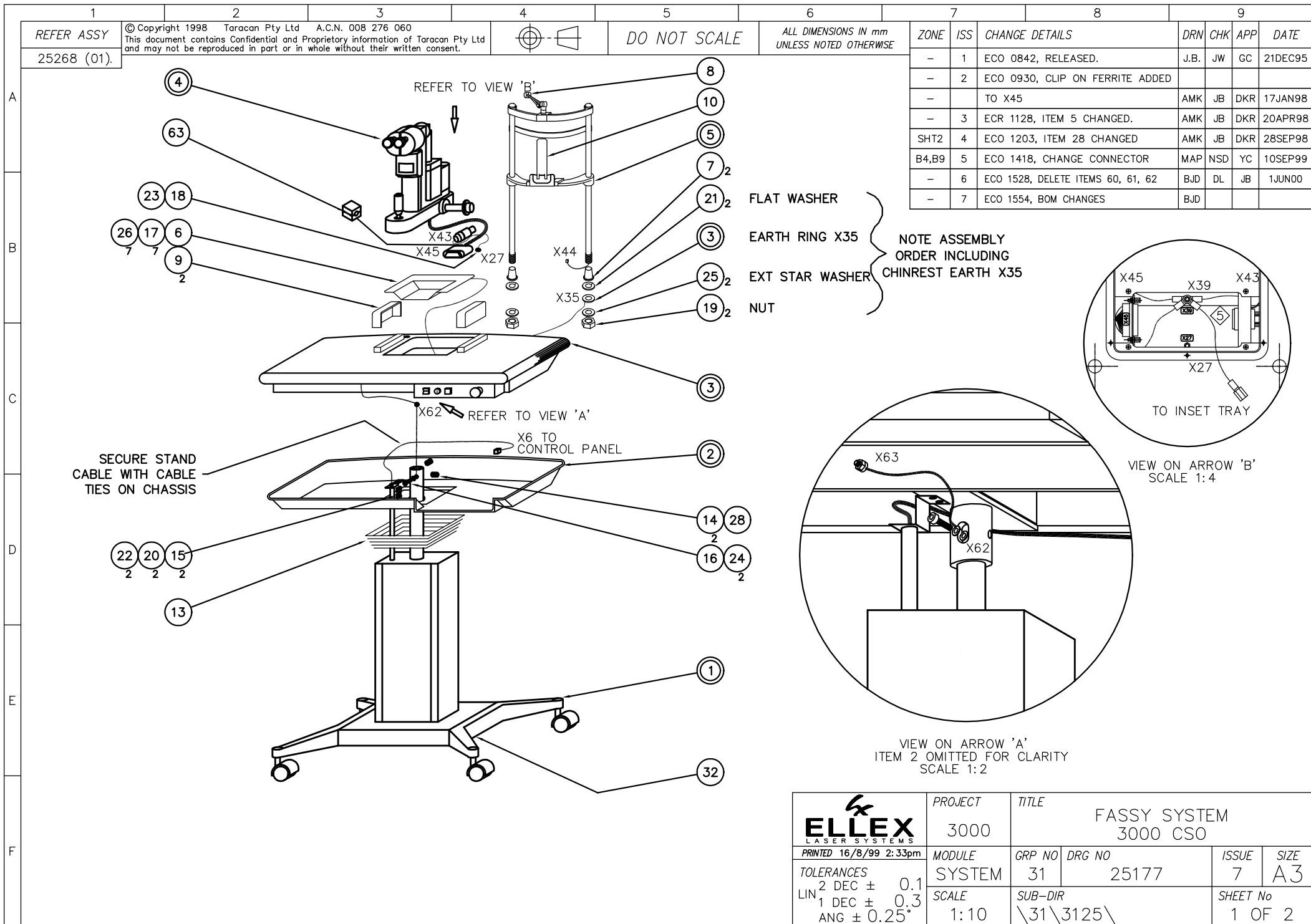


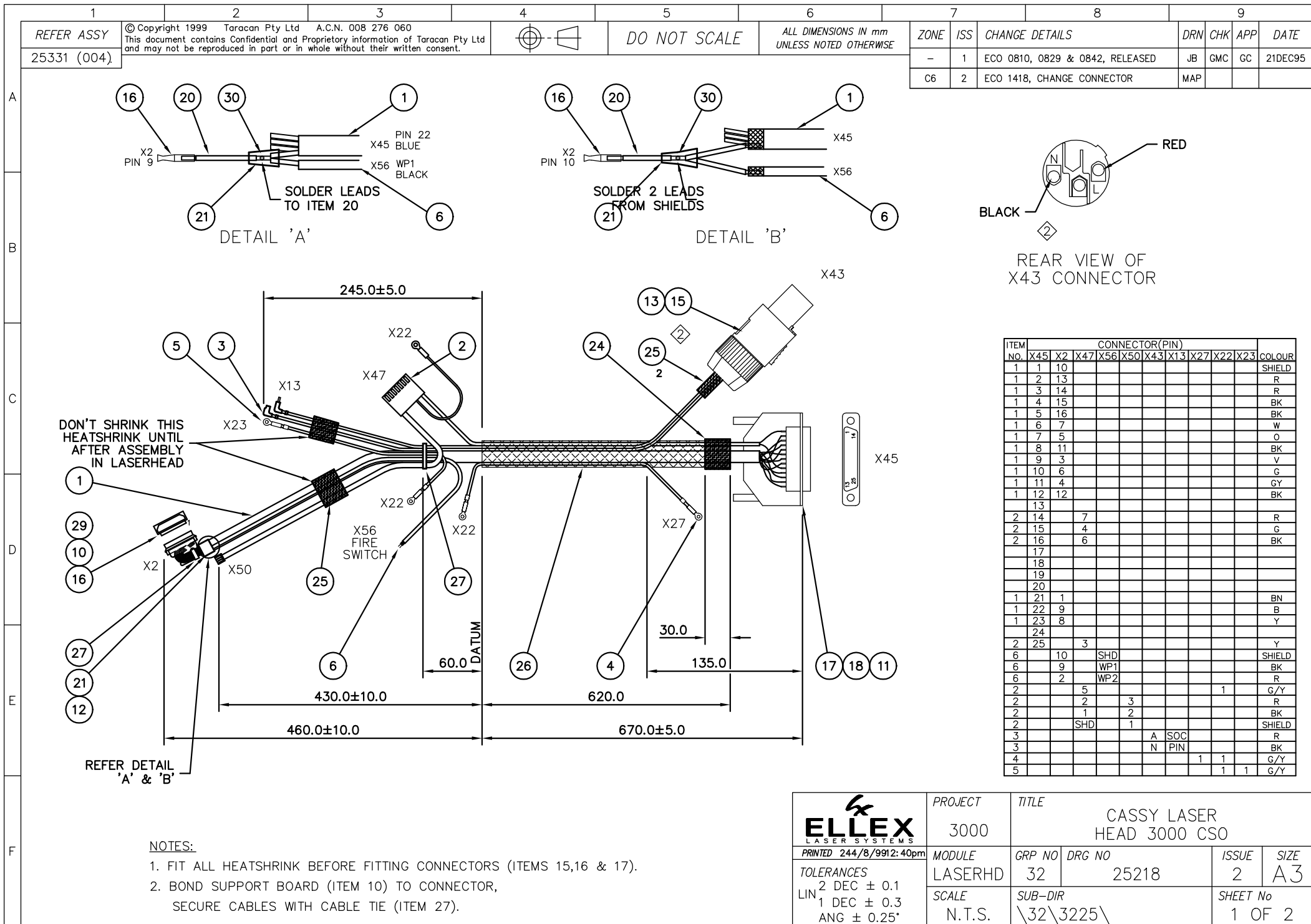
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	OPHTHAL	MOD CHINREST LASEREX				
PRINTED 3MAR98 12.00	MODULE	GRP NO	DRG NO	ISSUE	SIZE	
TOLERANCES LIN 2 DEC ± — 1 DEC ± 5.0 ANG ± —	C/REST	27	17739	1	A3	
	SCALE	SUB-DIR			SHEET No	
	1: 4	\COMMON\CHINREST			1 OF 2	





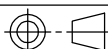
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	3000	FASSY DISPLAY COVER 3000LE			
PRINTED	MODULE	GRP NO	DRG NO	ISSUE	SIZE
TOLERANCES	DIS COVR	31	25160	3	A3
LIN 2 DEC ± 0.1	SCALE	SUB-DIR		SHEET No	
1 DEC ± 0.3	1:2	\31\3125		1 OF 2	
ANG ± 0.25°					





3125330 01.

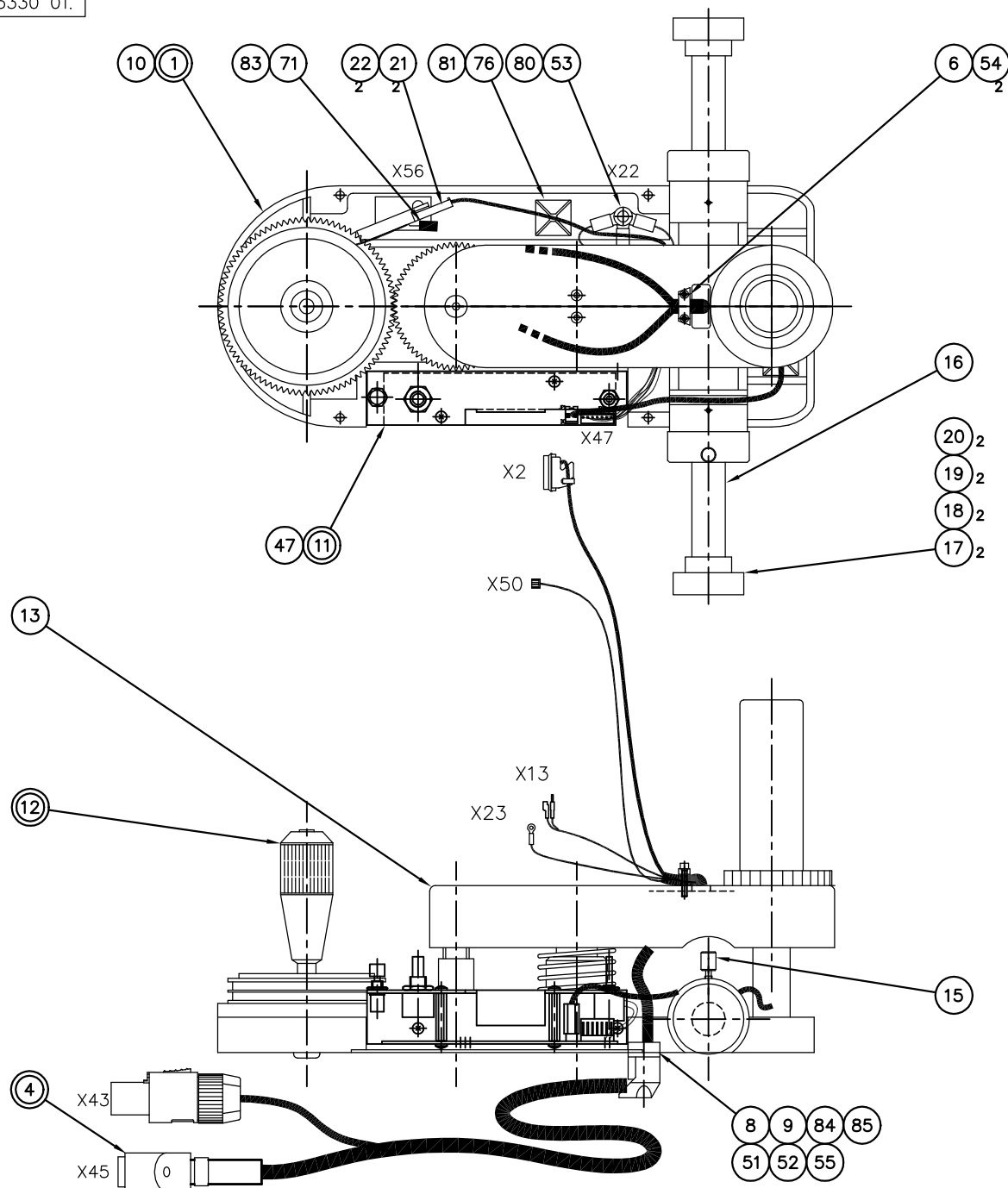
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DO NOT SCALE

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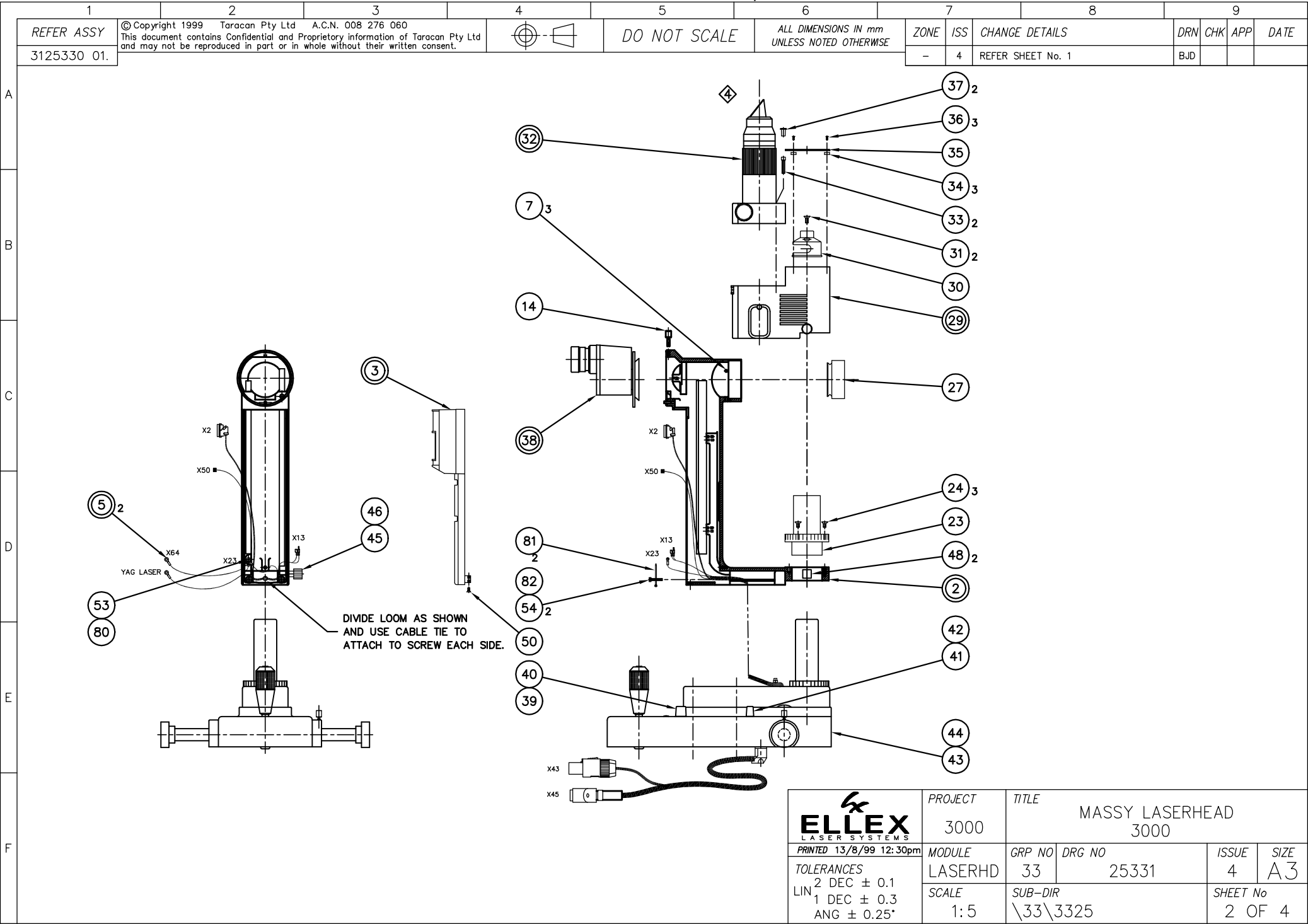
<i>ZONE</i>	<i>ISS</i>	<i>CHANGE DETAILS</i>	<i>DRN</i>	<i>CHK</i>	<i>APP</i>	<i>DATE</i>
—	1	ECO 0798, 0810, & 0842 RELEASED	JB	GMc	GC	21DEC95
F2	2	ECO 1418, SHOW CONNECTOR	MAP	NSD	YC	10SEP95
6E	3	ECO 1487, ADD VARIANT TABLE	BJD	DL	MP	5SEP00
—	4	ECR 1616 DEL ITEM 49	BJD			

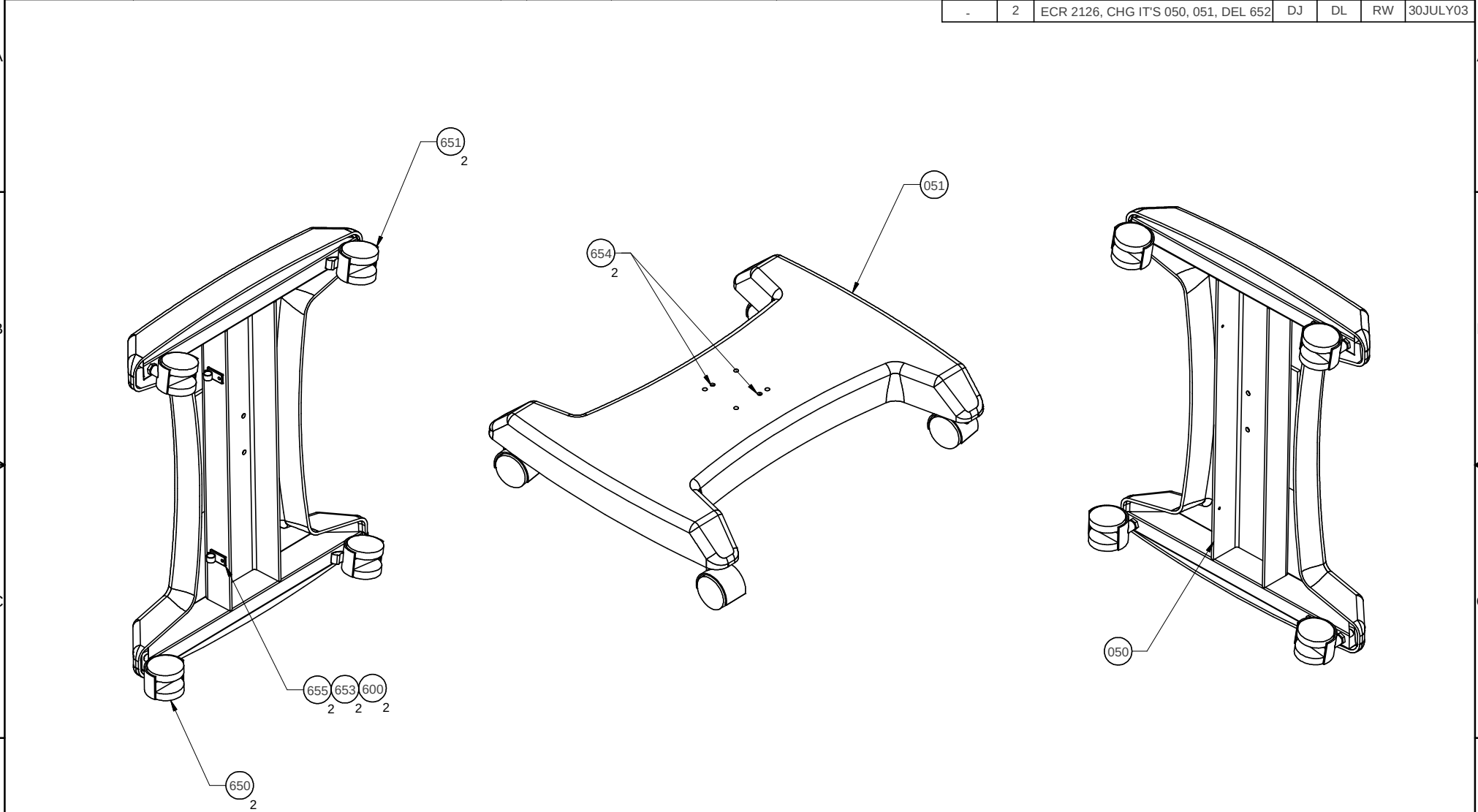


X47	FUNCTION
1	DAM (R)
2	DAM (T)
3	FIX (+)
4	FIX (-)
5	GND 0V
6	AC INPUT
7	AC INPUT

VARIANT	ITEM
DESCRIPTION	003
FASSY DISPLAY COVER 3000LE	003A
FASSY DISPLAY COVER 3000LX	003B

 PRINTED 13/8/99 12:30pm TOLERANCES LIN 2 DEC ± 0.1 1 DEC ± 0.3 ANG ± 0.25°	PROJECT 3000	TITLE MASSY LASERHEAD 3000				
	MODULE LASERHD	GRP NO 33	DRG NO 25331		ISSUE 4	SIZE A3
	SCALE 1:2.5	SUB-DIR \\33\\3325			SHEET No 1 OF 4	





 Ellexmedical	PRODUCT:	TITLE: MASSY, BASE, STAND				
	3000LE					
PRINTED:	MODULE:	GRP No:	DRG No:	ISSUE:	A3	
TOLERANCES:	STAND	33	34150	2		
LINEAR 2 DEC. ±	SCALE:	SUB-DIRECTORY:		SHEET No:		
LINEAR 1 DEC. ±						
ANGULAR ±						
	1:5	P:\3000 Assemblies		1 OF 2		

3134110

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UNLESS NOTED OTHERWISE

ZONE

ISS

CHANGE DETAILS

DRN

V | CHK

K APP

DATE _____

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1

ECR2332. ADD 411.601. 401 QTY WAS 8

8	DJ
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	MLB
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DL

01JULY03

A

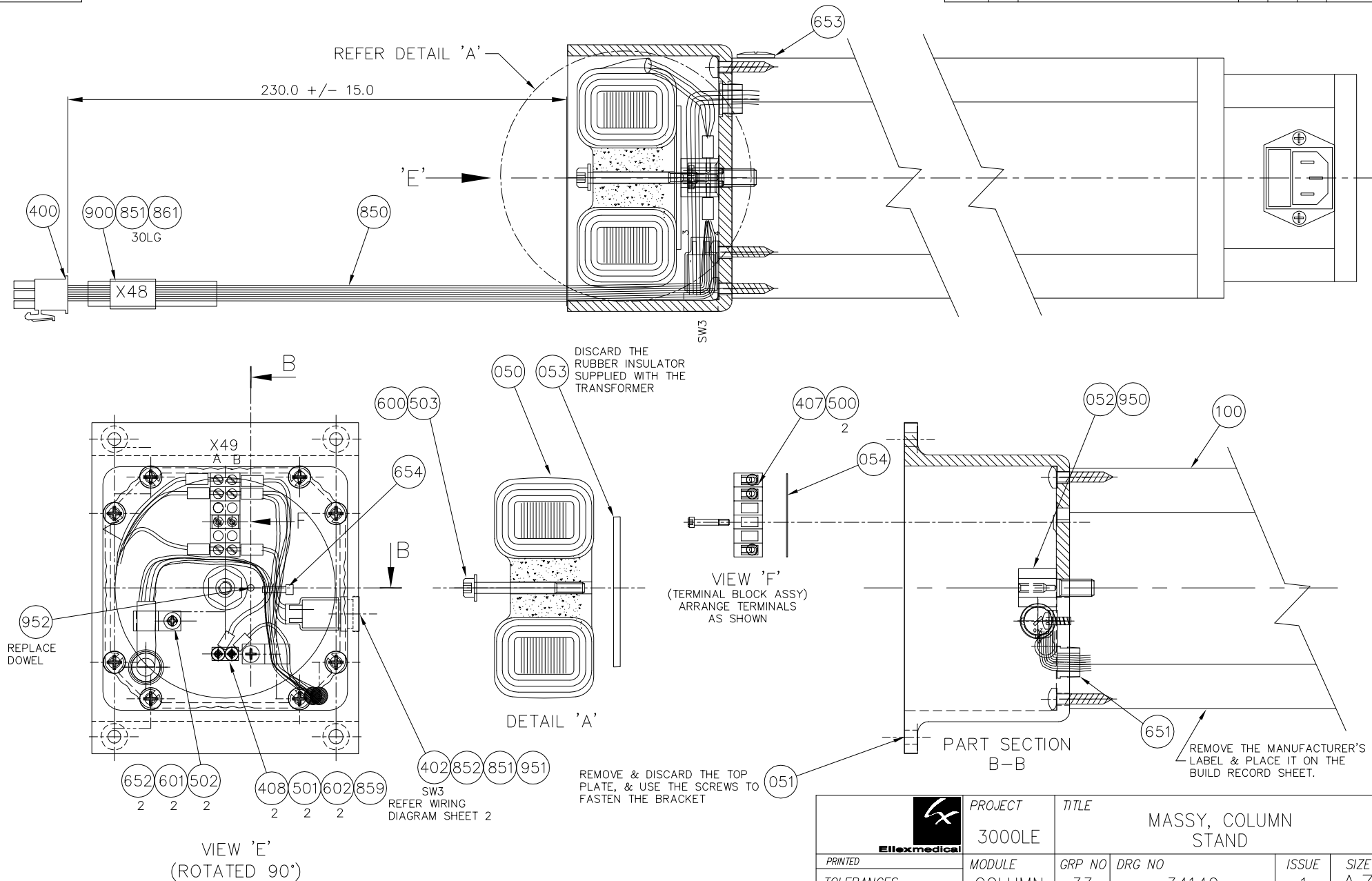
B

C

D

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F



PROJECT

30001 F

	<i>MODULE</i>
--	---------------

COLUMN

SCALE

N.T.S.

	<i>TITLE</i>
--	--------------

MASSY, COLUMN
STAND

GRP NO

33

SUB-DIR

| \ 33 \

PG NO

34140

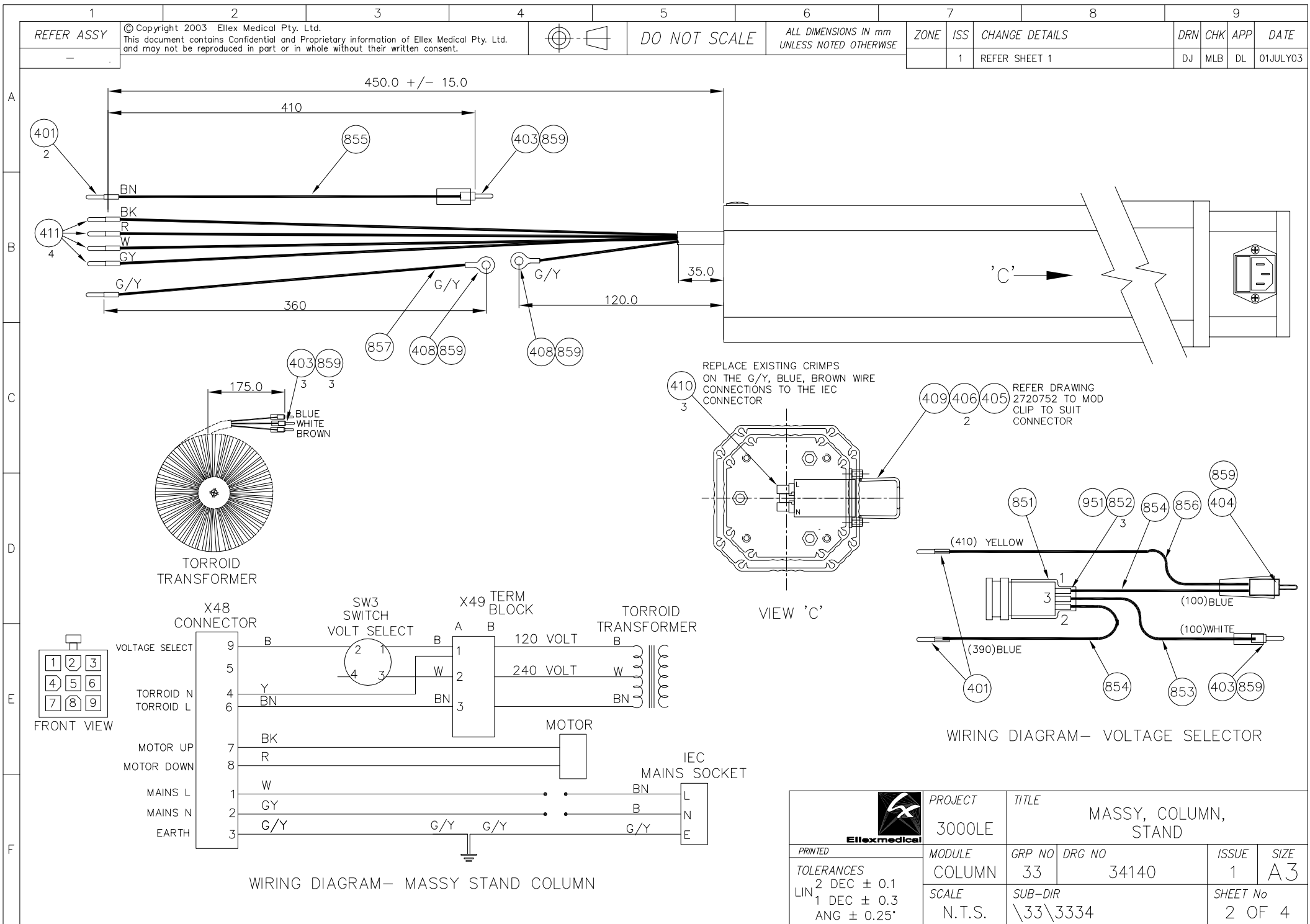
34

ISSUE

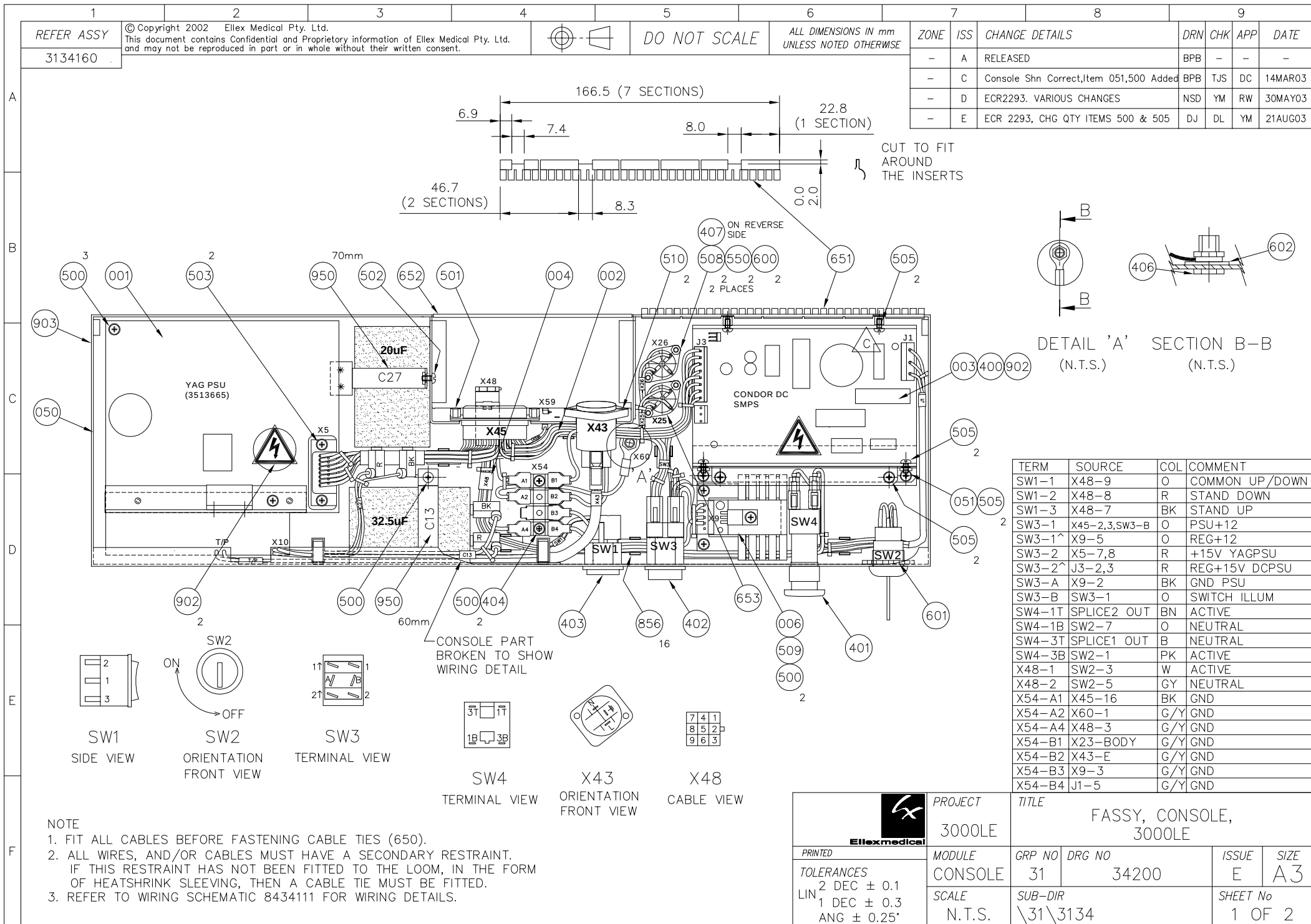
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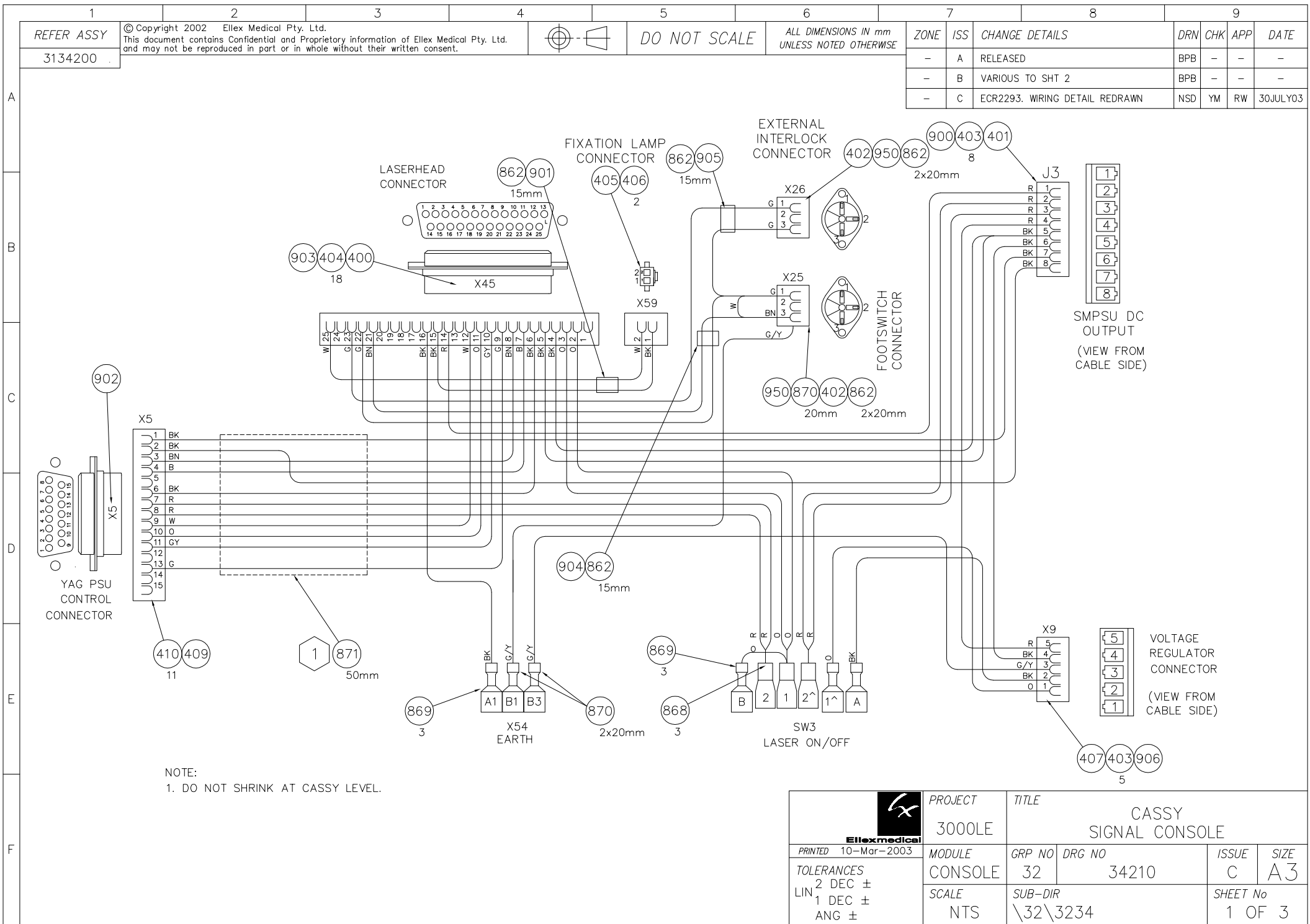
	SHEET No
--	----------

1 OF 4



	PROJECT	TITLE			
	3000LE	MASSY, COLUMN, STAND			
	MODULE	GRP NO	DRG NO	ISSUE	SIZE
	COLUMN	33	34140	1	A3
TOLERANCES LIN 2 DEC ± 0.1 1 DEC ± 0.3 ANG ± 0.25°	SCALE	SUB-DIR		SHEET No	
	N.T.S.	\33\3334		2 OF 4	

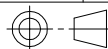




 PRINTED 10-Mar-2003 TOLERANCES 2 DEC ± LIN 1 DEC ± ANG ±	PROJECT 3000LE	TITLE CASSY SIGNAL CONSOLE			
	MODULE CONSOLE	GRP NO 32	DRG NO 34210	ISSUE C	SIZE A3
	SCALE NTS	SUB-DR 32/3234		SHEET No 1 OF 3	

3134200

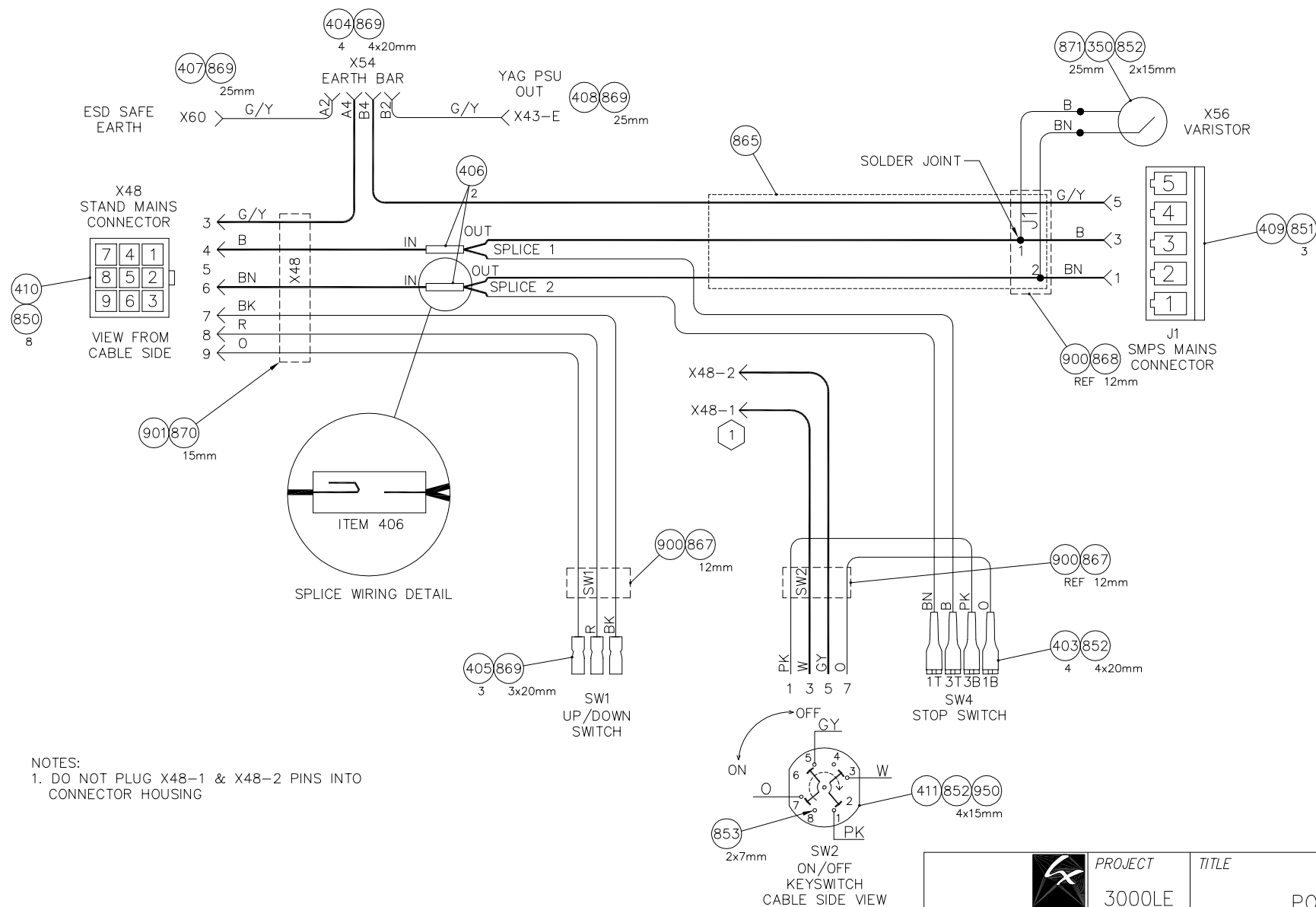
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DO NOT SCALE

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UNLESS NOTED OTHERWISE

ZONE	ISS	CHANGE DETAILS	DRN	CHK	APP	DATE
-	A	RELEASED	BPB	TJS	DC	9JAN03
-	B	ECR2293. VARIOUS CHANGES	NSD	YM	RW	30JULY03



- NOTES:
1. DO NOT PLUG X48-1 & X48-2 PINS INTO
CONNECTOR HOUSING

 Ellexmedical	PROJECT		TITLE			
	3000LE		CASSY POWER CONSOLE			
PRINTED 23-MAY-2003	MODULE	GRP NO	DRG NO		ISSUE	SIZE
TOLERANCES	CONSOLE	32	34220		B	A3
LIN 2 DEC ±	SCALE	SUB-DIR			SHEET No	
1 DEC ±	NTS	\32\3234\			1 OF 3	
ANG ± 0.25°						

1	2	3	4	5	6	7	8	9					
REFER ASSY —	© Copyright 2002 Ellex Medical Pty. Ltd. This document contains Confidential and Proprietary information of Ellex Medical Pty. Ltd. and may not be reproduced in part or in whole without their written consent.				DO NOT SCALE	ALL DIMENSIONS IN mm UNLESS NOTED OTHERWISE	ZONE —	ISS 1	CHANGE DETAILS ECR 2126, RELEASED	DRN DJ	CHK DL	APP RW	DATE 22AUG03

CHECKED ☐

VERIFIED ☐

INNER
CHECKED ☐

CAUTION/DANGER
 CLASS II LASER RADIATION
 CLASS II LASER RADIATION
 LASER RADIATION WHEN OPEN
 AVOID DIRECT EXPOSURE TO THE BEAM

CHECKED ☐

VERIFIED ☐

CHECKED ☐

VERIFIED ☐

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UNIT S/N:

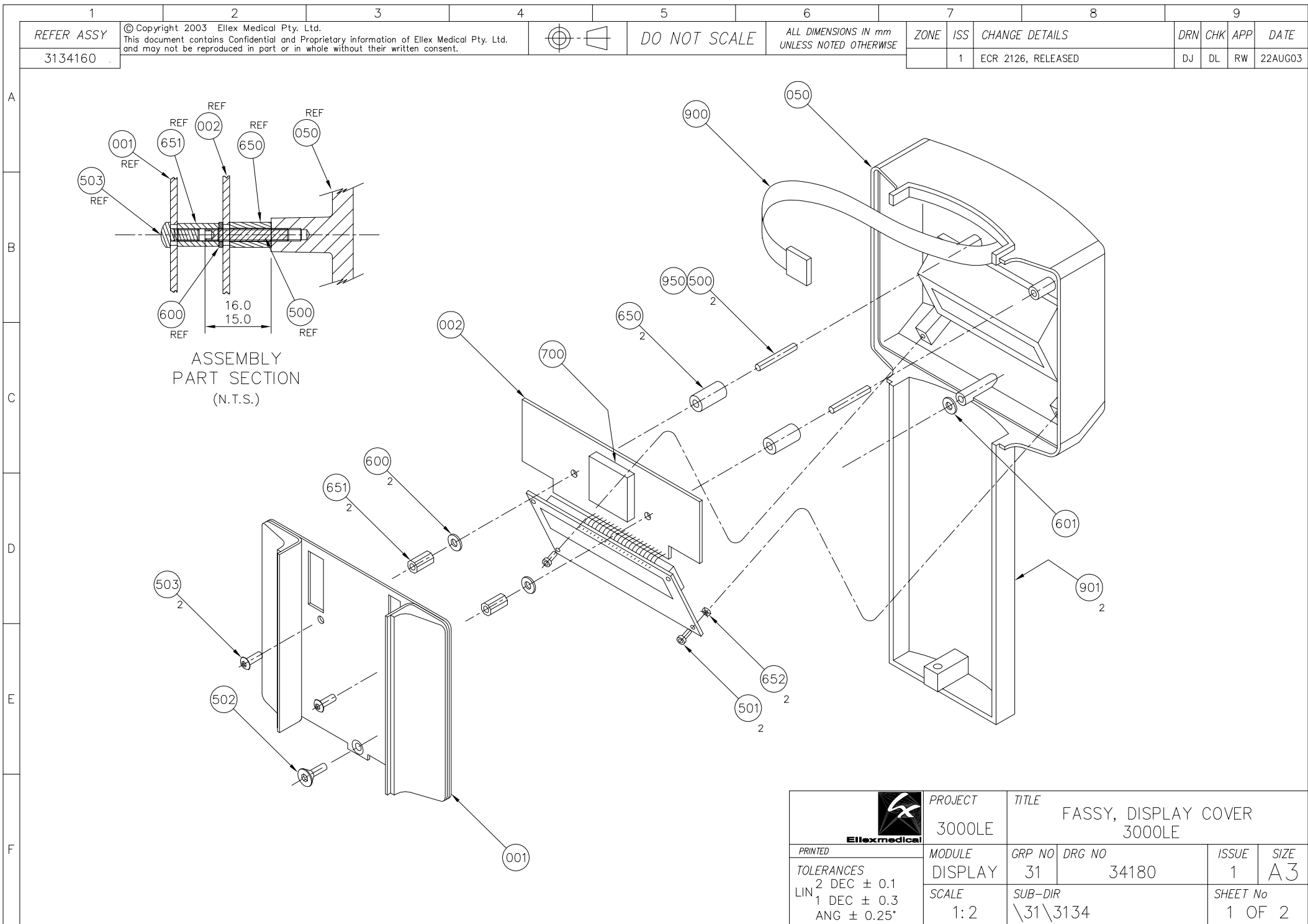
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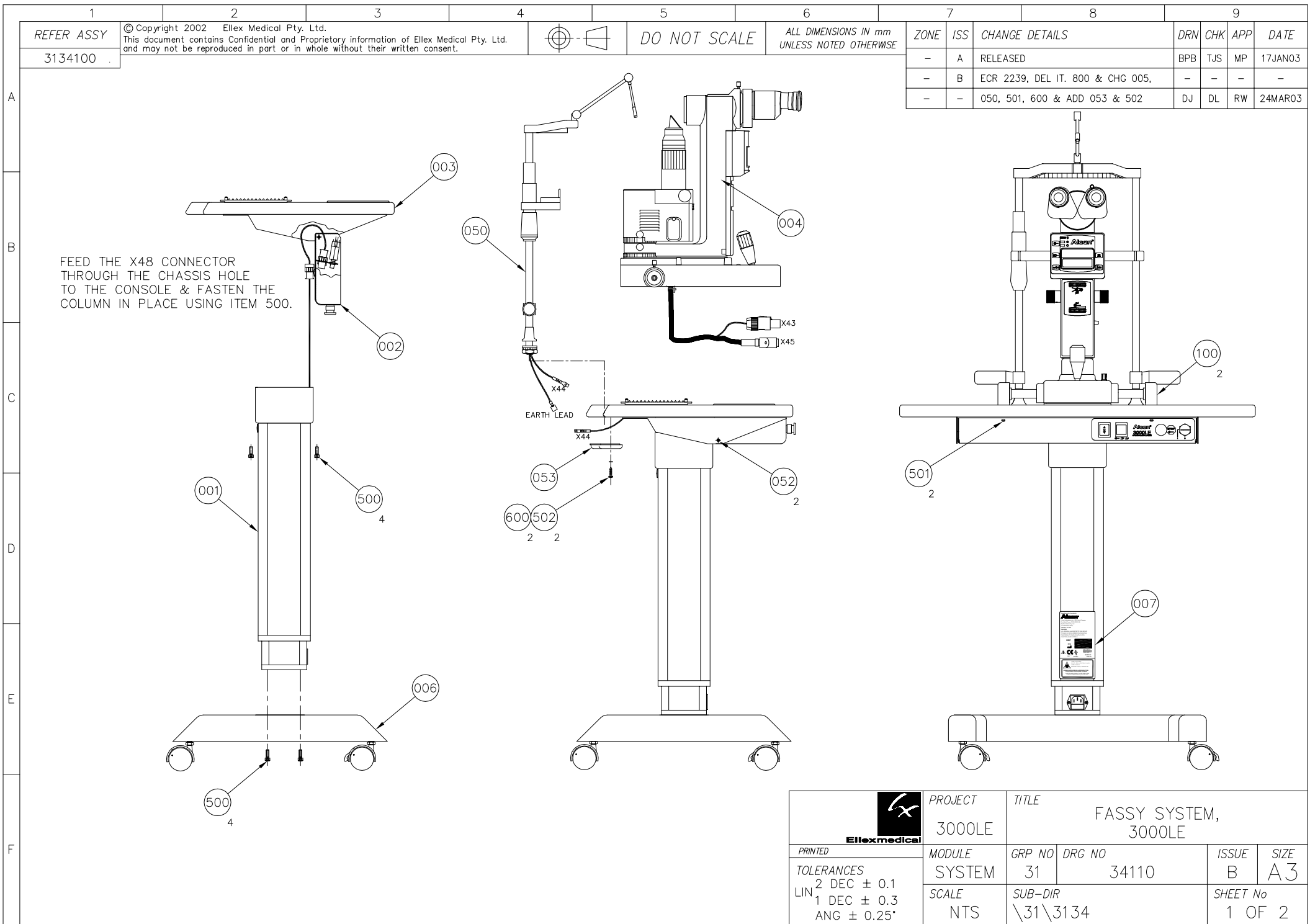
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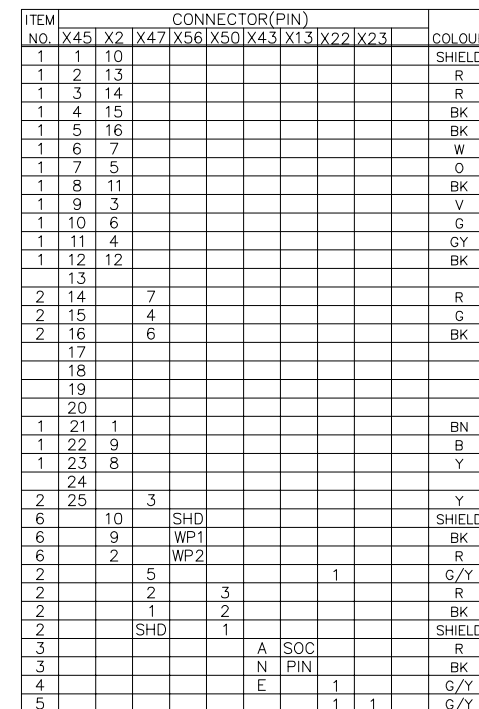
LABELLING VERIFIED BY:

SIGNATURE: _____ DATE: _____

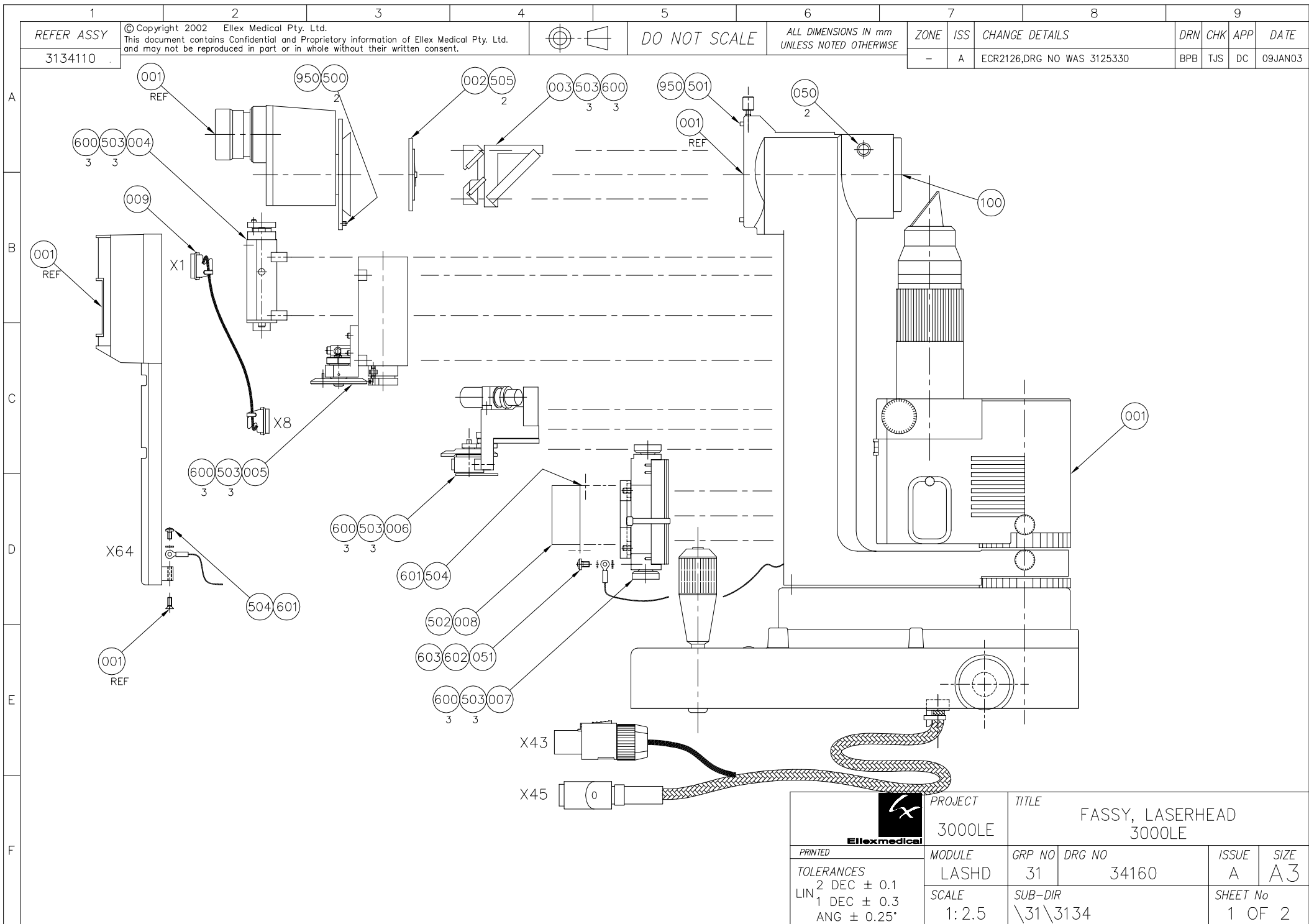
	PROJECT	TITLE			
	3000LE	KIT LABEL, 3000LE			
PRINTED —	MODULE	GRP NO	DRG NO	ISSUE	SIZE
TOLERANCES	KITLAB	61	34120	1	A3
LIN 2 DEC ± 0.1	SCALE	SUB-DIR			SHEET No
1 DEC ± 0.3	N.T.S	\61\6134			1 OF 2
ANG ± 0.25°					



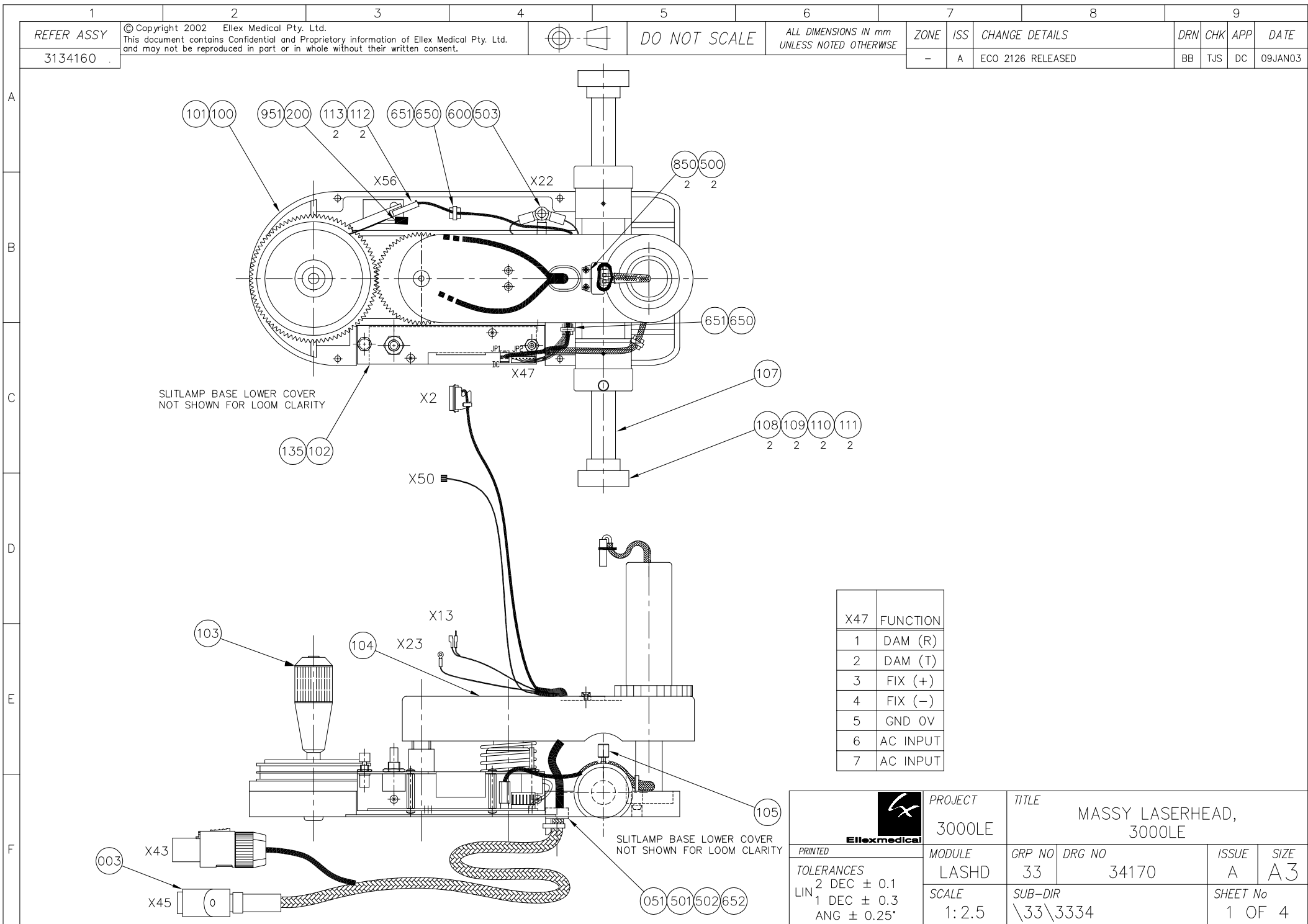


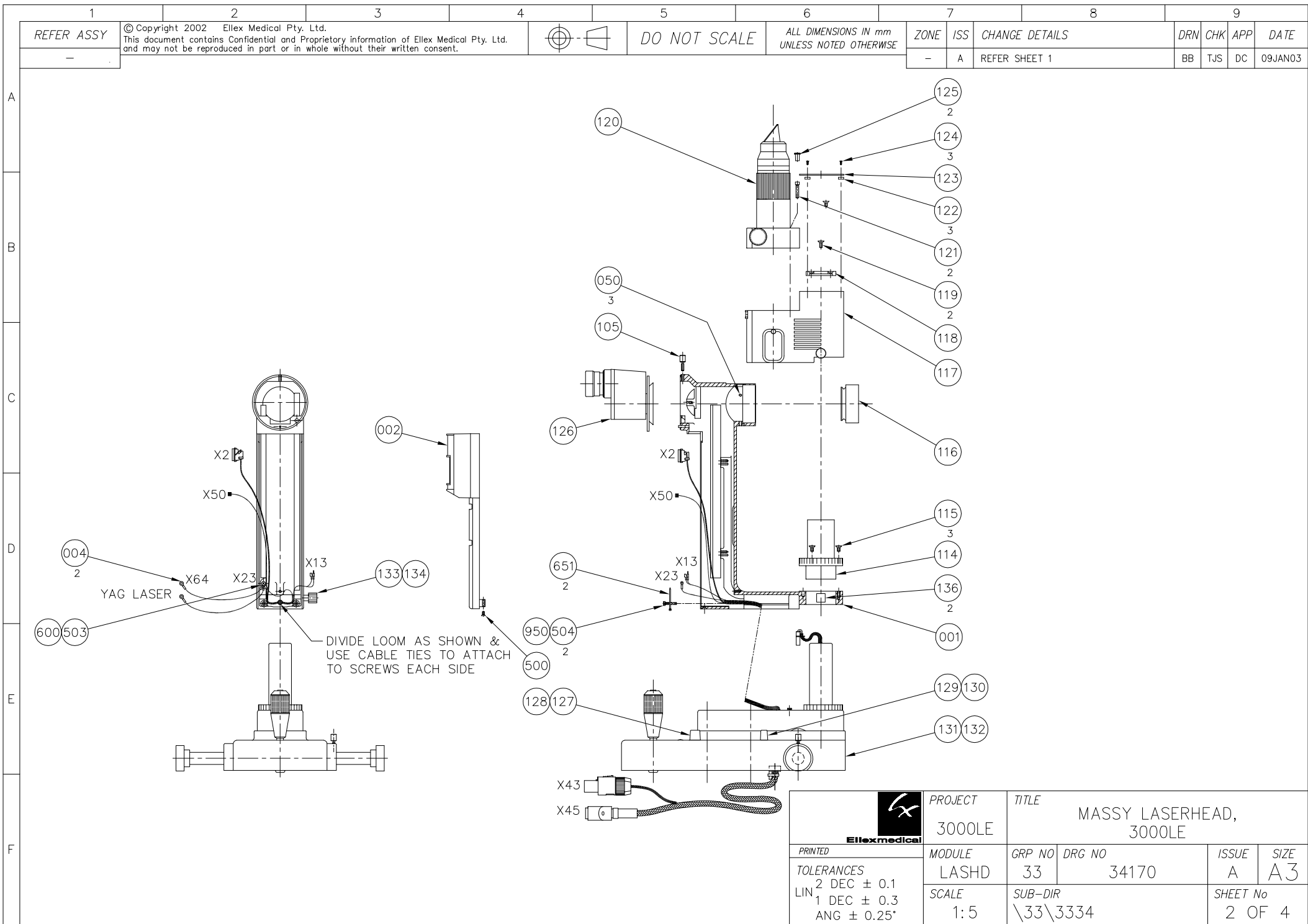


0



	PROJECT		TITLE			
	3000LE		FASSY, LASERHEAD 3000LE			
	PRINTED	MODULE	GRP NO	DRG NO	ISSUE	SIZE
	TOLERANCES	LASHD	31	34160	A	A3
LIN	2 DEC ± 0.1 1 DEC ± 0.3 ANG ± 0.25°	SCALE 1:2.5	SUB-DIR \31\3134		SHEET No 1 OF 2	

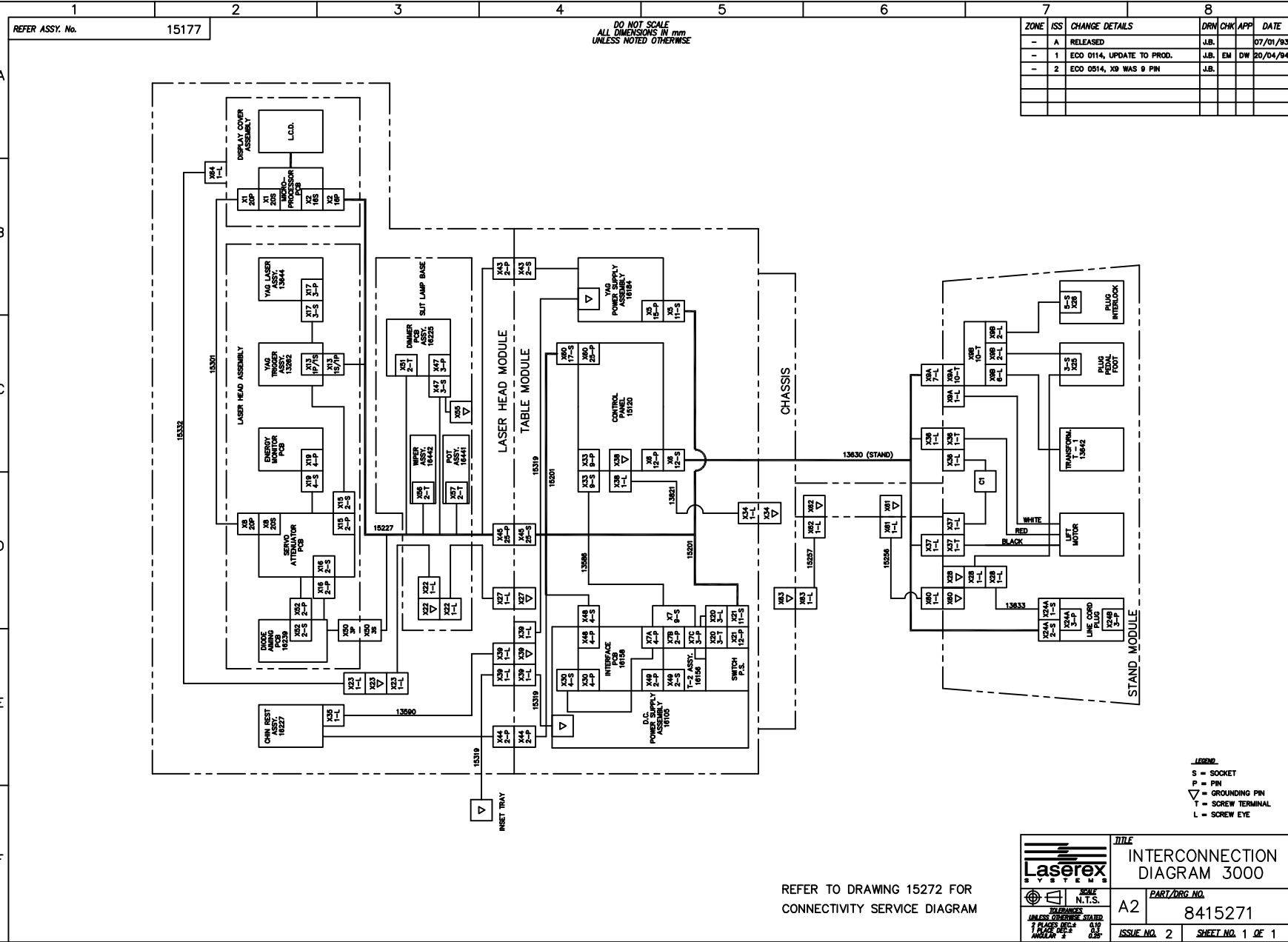


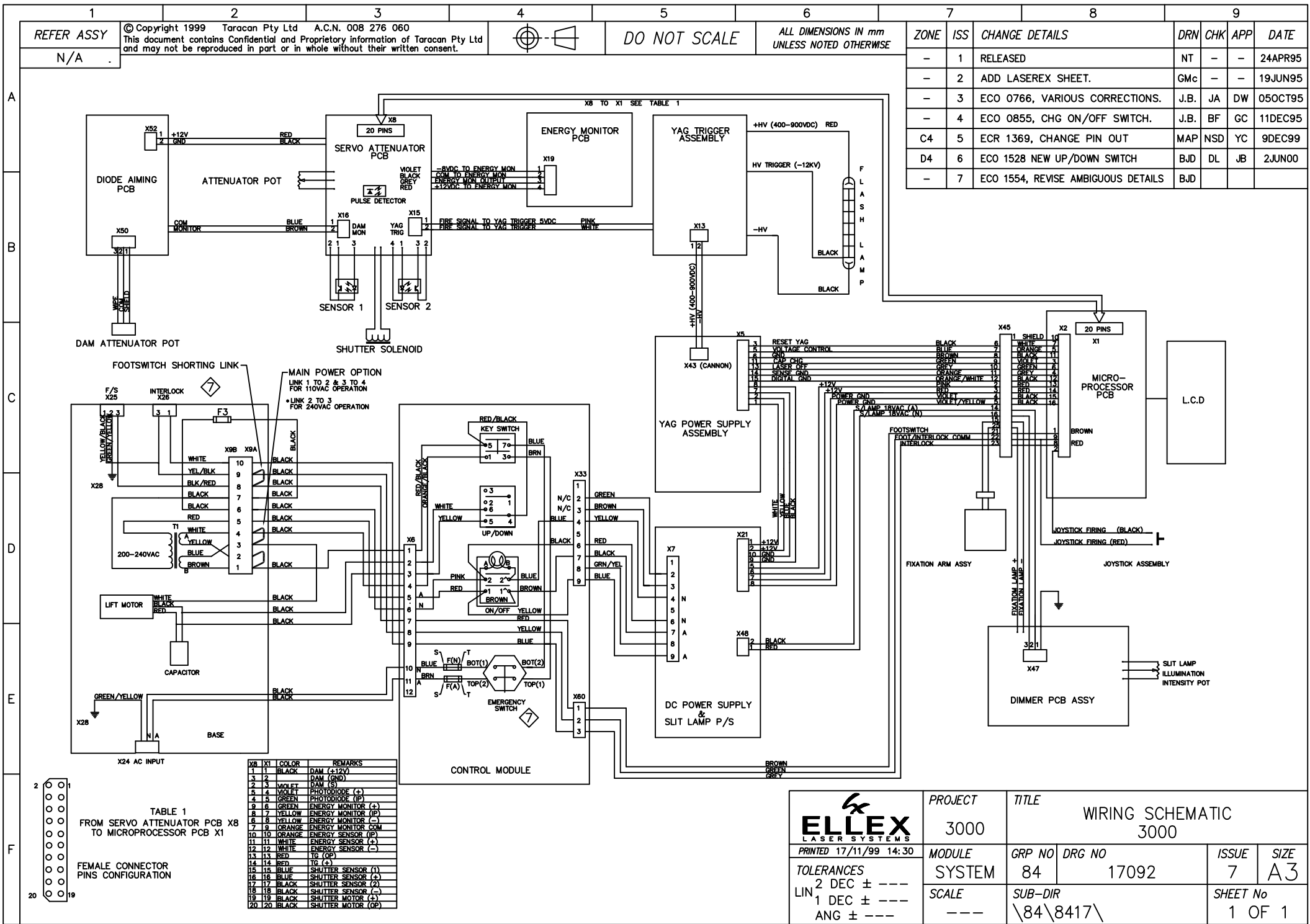


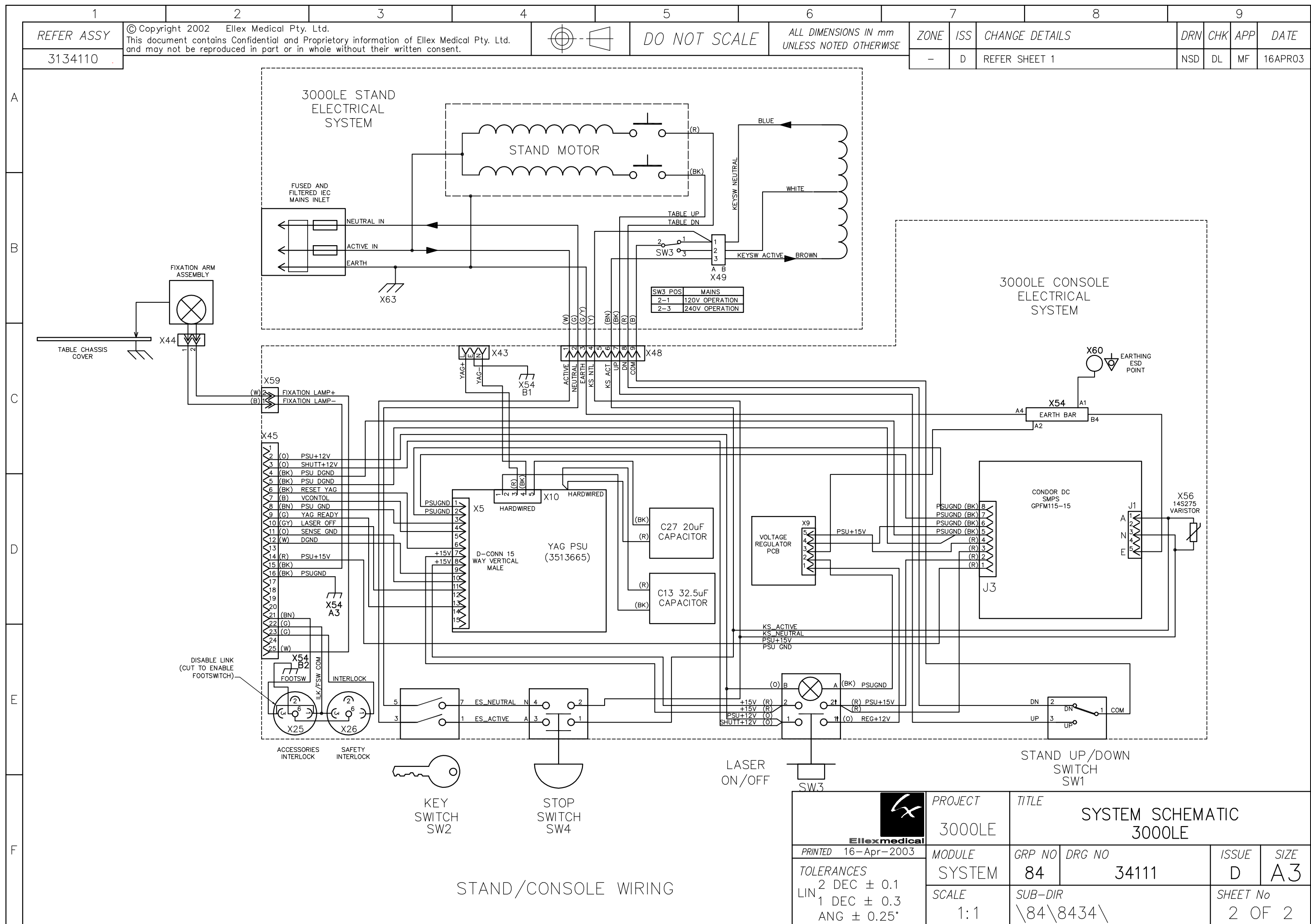
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ORIG
CTRL
PROD
INSP

PUR
ENG
DMR
ECR







C1 PARAMETERS

This section is not applicable to the 3000LE.

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NIKON SLIT LAMP INFORMATION

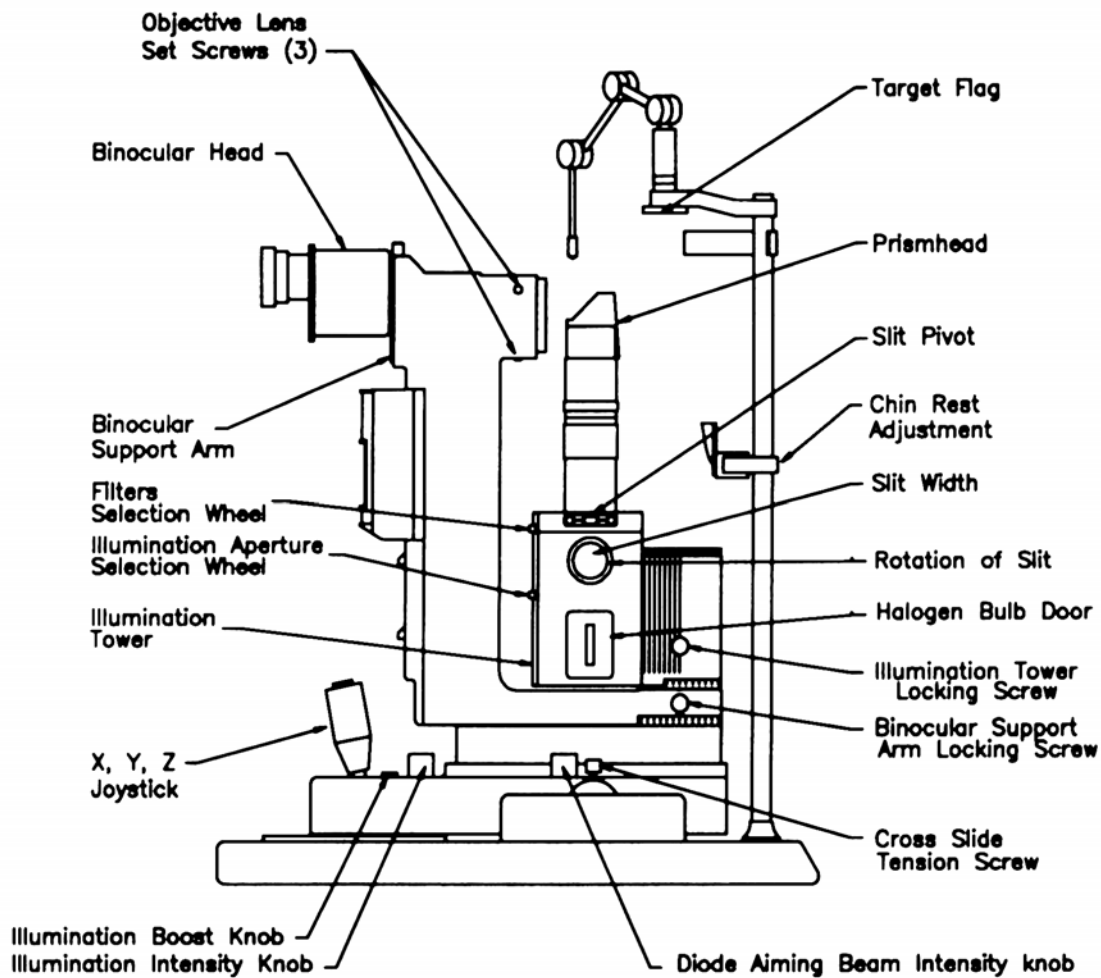
This Appendix includes information relevant to the Nikon slit lamp, which is used on some old installations.

D1 NIKON SLIT LAMP AND CONTROLS

In previous installations of the **3000LE** the slit lamp was a standard Nikon CS2-LDS type, modified by the replacement of the standard slim-line binocular head support arm and magnification changer, with a special enlarged support arm containing all the laser optics. All Nikon slit lamp features and controls remained unchanged.

The **3000LE** with Nikon slit lamp was supplied with fixed magnification of 16 x using 12.5 x eyepieces. An optional three-step magnification changer (10 x, 16 x and 25 x) may be fitted between the binocular head and the support arm. See the Operator's Manual for details of the optional accessories.

A general view of the slit lamp and its components is shown below:

Figure D-1 General view of slit lamp***Illumination on/off***

The halogen lamp illumination is controlled by the key switch on the key switch panel.

Spectacle wearer

The eyepieces are fitted with rubber eyecups. If you wear spectacles, fold the eyecups back.

Interpupillary distance adjustment

Adjusts the interpupillary distance of the binocular head.

Eyesight adjustment

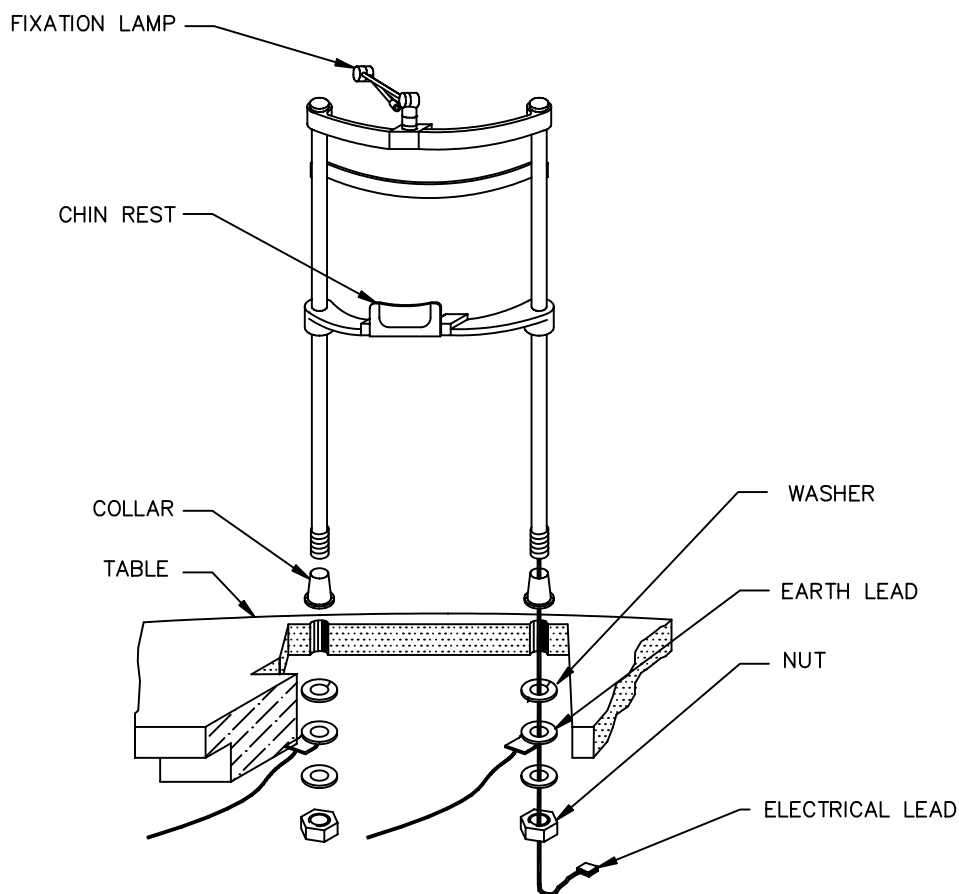
To adjust the slit lamp for your eyesight:

- Look into the eyepiece with cross hair (reticule) and turn the eyesight adjusting ring clockwise and counter-clockwise until the cross hair in the field of view becomes clear.
- Operate the joystick while viewing into the eyepiece with the cross hair, and raise the unit until the target is seen most clearly through the eyepiece.
- Stop the movement of the unit and tighten the clamp screws.
- Look into the other eyepiece with no cross hair and turn its eyesight adjusting ring until the same target is seen most clearly through the eyepiece.

Chin rest adjustment

Adjust the chin rest height for the patient's eye by rotating the chin rest height adjustment knob. Align the eye of the patient between the marks on the chin rest support. Refer to the illustration below.

Figure D-2 Chin rest assembly diagram



X, Y, Z joystick movement

The main unit can be moved backwards, forwards, left and right by manipulating the joystick. The unit moves in the direction of the joystick. To adjust the unit height, rotate the ring below the joystick handle.

Illumination intensity

To adjust the brightness use the illumination intensity control on the cross-slide table. Turning clockwise increases the brightness and turning counter-clockwise reduces the brightness. This knob only adjusts the brightness. To switch the illumination lamp on or off use the key switch on the control panel.

If high illumination is not required, keep the lamp at minimum intensity to reduce heat build-up. Do not leave the illumination intensity at maximum for more than one hour.

Illumination boost

The illumination boost is a non-locking push button that overrides the illumination intensity to give maximum illumination while pressed.

Slit width control

The slit is opened and closed by rotating the inner section of the slit adjustment control on either side of the illumination tower. Rotating the control clockwise closes the slit; rotating counter-clockwise opens the slit.

Rotating the slit

To rotate the slit turn the outer section of the slit adjustment control, on either side of the illumination tower. There are click stops for the vertical and horizontal positions of the slit. (Note that the inner section will rotate simultaneously.)

Illumination aperture

To select an illumination field turn the illumination field adjustment turret (the bottom wheel on the front of the illumination tower). The following illumination fields are available: 0.5 mm, 1 mm, 2 mm, 3 mm, 5 mm, 10 mm and 14 mm.

Filters

To select the blue, green or ND filters, turn the filter turret, which is the top wheel on the front of the illumination tower.

Swing of slit

The illumination light can be swung by the slit swinging lever, located on the right hand side of the illumination tower.

Clamp

The clamp screws for the illumination part, the microscope and the cross slide table are located at the right side of the main unit (viewed from the operator's side). Turn the screws clockwise to clamp each part.

Hand rest

The position of the hand rest can be set to any level. Turn it counter-clockwise to loosen. Turn the screw clockwise tightly when it is fixed at the preferred angle. Make certain that the end of the screw of the hand rest is placed in the groove of the chin rest support.

Illumination tower

The illumination tower can be moved either side of the center position approximately 60 degrees when the slit lamp is in the forward position and 120 degrees when in the backward position.

Illuminating angle

The illuminating angle can be tilted from 0° to 20° continuously by rotating the ring on the light tower.

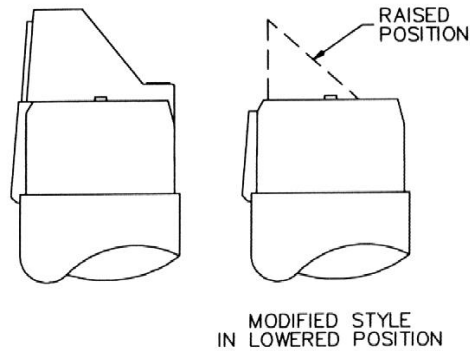
Binocular support arm

This arm can be moved approximately 16 degrees to either side of the center position so that the operator can view difficult parts of the eye.

Prism head

The model **3000LE** has either an existing angled prism head or a modified flat prism head, as shown in the illustrations below.

Figure D-3 **Nikon modified illumination tower**

**Caution**

For on-axis illumination with the Nikon slit lamp the prism must be in the fully down or 20° position. Failure to do this will cause misalignment and reflection of the delivery and aiming beams.

SERVICE BULLETINS

This Appendix is reserved for the inclusion of service bulletins released after the manual is issued. This information ensures that the manual is kept up to date at all times.

An up-to-date list of service bulletins is issued each time the bulletins are updated or new ones are added.

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SYSTEM ENERGY MONITOR CALIBRATION RECORD SHEET

Date:.....	
Name:.....	Signature:.....
System & model:	Serial No.
Energy Meter Used:.....	Meter Calibration Status:

Attenuator setting	Energy reading (mJ)								Av.	Pass/Fail
Min setting	Display									
	Meter									
0.6 mJ	Display									
	Meter									
1.0 mJ	Display									
	Meter									
4.0 mJ	Display									
	Meter									
4.5 mJ	Display									
	Meter									
5.0 mJ	Display									
	Meter									
9.0 mJ	Display									
	Meter									
Max Setting	Display									
	Meter									

'Display' refers to system Energy Display. 'Meter' refers to calibrated external meter.

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GLOSSARY

The following terms are associated with laser technology. Not all of these terms appear in this manual, but they are included here for completeness.

Term	Description
Active medium	A material in which lasing (stimulated emission) will take place under the proper kind of excitation. Includes solids, gases, dyes and other liquids.
Aiming beams	Low-power beams of light from a medical laser system to indicate where and over what area the high-power laser treatment beam will contact the tissue to be irradiated.
Amplification	An optical process that intensifies the laser beam in the resonator (optical cavity) of a laser. As the radiation is reflected back and forth between the mirrors at the end of the cavity, it is amplified through stimulated emission on each trip through the active medium.
Anode	The positive electrode in the laser, which attracts electrons from its opposite, the negative cathode.
Axis or optical axis	The optical center line passing through a hand piece, lens system, laser tube, or optical fiber.
Beam diameter	The width of the 'working' portion of a laser beam. About 86% of the power is contained in this area (unless the beam has an irregular pattern).
Brewster windows	Transparent windows at the ends of gas laser tubes that are mounted at Brewster's angle to allow radiation to pass through them with minimum optical losses (that is, minimum reflection).
Cathode	The negative electrode in a laser tube.
Class 1 equipment	Equipment that provides protection against electric shock by providing an earth system that prevents accessible metal parts from becoming live.

Term	Description
Class 2 laser	Laser safety classification — laser that emits visible radiation that can be continuous wave (CW) or pulsed, with a maximum power of 1 mW. This is not considered safe, but aversion reflexes such as the blink reflex normally afford eye protection.
Class 3B laser	Laser safety classification — laser that emits visible or invisible radiation and for which direct viewing of the beam is always considered hazardous. Viewing of diffuse reflections is normally safe as long as a minimum viewing distance of 130 mm and a maximum viewing time of ten seconds is maintained.
Coherent light or Coherence	Collimated, or parallel rays of light of the same wavelength and phase. In other words, laser light.
Depth of field	The working range for a laser beam either side of the focal point. The depth of field depends on the focal length of the objective lens in the laser head, the laser wavelength, and laser beam diameter. For small spot sizes with high power densities, the depth of field is very small.
Electromagnetic wave	A radio wave, visible light, ultraviolet ray, X-ray, gamma ray, infrared ray or other wave traveling outward from a changing electric field.
Energy density	The amount of energy incident upon a surface divided by the area of the surface being irradiated. Usually given in terms of joules per square centimeter (J/cm ²).
Energy meter	A meter used to measure the energy of the treatment laser beam.
Focal length	The distance from the center of a lens, lens system or mirror to the point of principal focus.
Focal point	The point at which a laser beam produces the smallest spot size.
Focus	To adjust the placement of a lens or the focal length of a combination of lenses for the best resolution of an image; also, the point at which a laser beam produces the smallest spot size (focal point).
Frequency	The number of vibrations made by an electromagnetic wave (such as light in one second; specified in hertz (Hz); the frequency of a wave is inversely proportional to its wavelength.
Gain	Same as amplification; usually used to indicate the efficacy of a lasing medium.
Gaussian	The normal distribution curve, exemplified by a laser beam in the 'fundamental' mode (see TEM). The intensity of the light across the beam is least at the edges and rises smoothly at a maximum at the center.
Irradiation	Exposure to radiation, such as light, heat or X-rays.

Term	Description
Laser	An acronym for L ight A mplification by S timulated E mission of R adiation. A simple laser is an optical cavity with mirrors at both ends and a solid, liquid or gaseous lasing medium between the mirrors. Atoms molecules, or ions in this medium are stimulated to high energy levels by intense light or an electrical discharge, as they return to the normal ground state, they give off photons of radiation. The continuation of this process builds up a standing wave of coherent radiation that forms the laser beam.
Light	Visible electromagnetic radiation; the wavelength range from about 400 to 750 nanometres (nm). Sometimes also used to refer to infrared and ultraviolet radiation, both of which are outside the visible range.
Micron or Micrometer	One-millionth of a meter (1×10^{-6} m). The more precise term is micrometer.
Mode	Describes the standing-wave pattern in the laser cavity and determines the cross-sectional intensity (or shape) of a laser beam (see TEM). Also used to describe types of system operation, such as pulsed mode or CW mode.
Monochromatic light	Light of single color or wavelength. The colors produced by laser light are the purest obtainable, but no light is totally monochromatic, and even these colors are composed of a narrow band of wavelengths instead of a single one.
Nanometer (nm)	One-billionth of a meter (1×10^{-9} m).
Nanoseconds (ns)	One-billionth of a second (1×10^{-9} s).
Nd: YAG Laser	A laser that uses a crystalline rod composed of yttrium, aluminum and garnet doped with neodymium as the active medium. May be either a pulsed or CW laser. Often referred to simply as a 'YAG' laser.
Optical amplification	An optical process that intensifies the laser beam in the resonator (optical cavity) of a laser. The radiation is reflected back and forth through the active medium by the mirrors at the ends of the cavity. During this process it is amplified, by stimulated emission.
Optical fiber or fiber optic	A filament of optical material such as glass or quartz that can carry light long distances without significant losses.
Optical pumping	See "Pump or pumping".
Output coupler or transmitter	The mirror in the laser cavity through which the output beam is transmitted. This mirror is partially reflective and partially transmissive, while the mirror at the other end of the cavity is usually made as reflective as possible.
Output power	The amount of power (energy per second) contained in the laser beam, measured in watts (W).
Parfocal	When the focus point of two or more objective lenses lies on the same plane they are said to be parfocal.

Term	Description
Photon	The basic 'element' of light in quantum theory. It exhibits both wave and particle behavior and has motion but no charge or rest mass.
Power density	The amount of optical power incident upon a surface divided by the area of the surface been irradiated. Usually specified as watts per square centimeter (W/cm ²).
Power meter	An instrument used to measure the power in a laser beam. There are several different kinds, and the one used depends upon the type of laser and its maximum power.
Pulse energy	The energy contained in a single, brief emission (pulse) of laser radiation, measured in joules (J).
Pump or pumping	The means employed to excite the lasing medium, such as an electrical discharge or a flash of light. The latter case is referred to as 'Optical pumping'.
Repetition interval	The time interval between successive laser pulses, usually given in seconds (s) or milliseconds (ms).
Repetition rate	The frequency with which laser pulses are emitted, given as pulses per second (pps).
Resonator	An assembly consisting of the laser rod or tube, the mirrors and the supporting structures for them.
Stimulated emission	The process by which an excited atom, ion or molecule is triggered into emitting a photon by another photon passing close by. The emitted photon has the same wavelength, phase and direction as the triggering photon, and hence is coherent with it.
Threshold energy	The point at which just enough energy has been supplied to the active medium for lasing to begin.
Transmitter	See "Output coupler".
Transverse electromagnetic mode (TEM)	The cross-sectional intensity (or shape) of a laser beam. Many shapes are possible but only a few are generally used. Subscript number (TEM ₀₀ , TEM ₀₁ , and so on) identify the mode of the beam; generally, the lower the numbers, the smaller the spot to which the beam can be focused.
Type B equipment	Equipment that provides protection against electric shock by limiting the leakage current and by providing a protective earth connection.
Wavelength	The distance from crest to crest in an electromagnetic wave; usually given in nanometers (nm), micrometers (μm) or in older texts, in Ångstroms (Å).
Window	A glass seal with plane-parallel sides that allows light to pass through an optical system but keeps out contaminants.

ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are referred to in this manual:

Acronym or abbreviation	Meaning
BET	Beam expanding telescope
COP	Computer operating properly
COR	Center of rotation
CW	Continuous wave
DAM	Diode aiming module
EMC	Electromagnetic compatibility
FMM	Folding mirror module
FWHM	Full width half maximum
IOL	Intraocular lens
LCD	Liquid crystal display
PCB	Printed circuit board
PFN	Pulse forming network
PSU	Power supply unit
TEM	Transverse Electromagnetic Mode (see glossary entry)
YAG	Yttrium Aluminum Garnet

UNITS OF MEASUREMENT

The following units of measurement are referred to in this manual:

Unit	Description
A	Amperes (current)
Å	Ångstrom (10^{-10} meters)
Hz	Hertz (frequency)
J, mJ	Joules, millijoules (10^{-3} Joules) (energy)
J/cm ²	Joules per square centimeter (energy density)
mm, µm, nm	Millimeters (10^{-3} m), micron or micrometer (10^{-6} m), and nanometer (10^{-9} m)
ns	Nanosecond (10^{-9} s)

Unit	Description
Pa, hPa	Pascal, hectopascal (10^2 Pascal)
pps	Pulses per second
V, V AC, V DC	Volts, Volts — alternating current, Volts — direct current
W, mW	Watts, milliwatts (10^{-3} W) (power)
W/cm ²	Watts per square centimeter (power density)

SAFETY REFERENCES

The following safety standards apply:

AS2211	1991	Laser safety
AS2500	1995	Guide to the safe use of electricity in patient care
IEC 601-1	1998	Safety of medical electrical equipment
IEC 825	1993	Radiation safety of laser products, equipment classification, requirements and user's guide
FDA 21CFR 1040	1997	Performance standards for light - emitting products
FDA 21CFR 1040.10	1997	Performance standards for Laser products
FDA 21CFR 1040.11	1997	Performance standards for Specific purpose laser products

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3000LE Service Manual Issue 4.0

Although all care has been taken in the preparation and checking of this manual there is no guarantee that all information is correct. If you have found any errors omissions or ambiguities in this manual, please enter details here, including Chapter, Section and page number and Fax this form to Ellex Medical Service Department on +61-8-8104 5210.

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