



LIGHTS CAMERA ACTION LLC

**USER'S MANUAL**

FOR

**RH-300**

**UNDERWATER RADIATION HARDENED  
CAMERA SYSTEM**

**CONTROL UNITS TYPE CCU300**

LIGHTS CAMERA ACTION LLC

## USER'S MANUAL

FOR

# RH-300

## UNDERWATER CAMERA SYSTEM

CONTROL UNITS TYPE CCU300

The camera and controls are manufactured in the United Kingdom  
for Lights Camera Action LLC

**FOR SERVICE or TECHNICAL SUPPORT**

Please contact Lights Camera Action LLC at:



(480) 345-0642



(480) 345-0644

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### WARNING

This equipment operates from a 240V or 120V mains supply in addition, voltages are generated within the unit which may be as high as 850V DC. Although every care has been taken to minimise the hazards to the user, removing the covers of either the camera or control unit can expose **POTENTIALLY LETHAL VOLTAGES**.

The equipment should never be operated with the covers removed except by skilled personnel who are aware of the hazards involved.

The equipment **MUST** always be properly earthed, using a correctly wired 3 pin plug. In the U.K., a 13 amp fused plug should be used, the wiring code for which is as follows:

<b>BROWN WIRE</b>	<b>LIVE</b>
<b>BLUE WIRE</b>	<b>NEUTRAL</b>
<b>GREEN/YELLOW WIRE</b>	<b>EARTH</b>

In other countries, the appropriate standard of practice for mains operated equipment should be strictly adhered to.

### CAUTION

Modern pickup tubes are comparatively robust and in normal use will give service for many thousands of hours. However, some sensible precautions should always be observed, particularly in the case of low light systems embodying intensified tubes. Additional information in this respect is included in the manual as appropriate.

- 1) **NEVER POINT THE CAMERA AT THE SUN, WHETHER IT IS OPERATING OR NOT, AS THIS CAN QUICKLY DESTROY THE PHOTOSENSITIVE SURFACE.** Avoid as far as possible including other bright sources of illumination in the picture.
- 2) Certain tubes, notably antimony trisulphide vidicons, can suffer image burn-in if allowed to view the same scene for long periods; it is therefore advisable to keep the lens capped or stopped down when not in use.

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### WARRANTY

All products of LIGHTS CAMERA ACTION LLC are guaranteed against defects in materials or workmanship, provided that such defects are not caused by misuse.

This guarantee is valid for a period of twelve months after the date of supply or, in the case of certain components such as pickup tubes, for the period specified by the relevant manufacturer.

Any faulty equipment returned carriage paid to our premises during this period will be repaired or replaced at our discretion free of charge.

On certain equipment, extended periods of warranty can be offered at additional cost.

**No other guarantee whatsoever is expressed or implied: under no circumstances are we liable for consequential damages.**

**Any attempt by the user to repair or to interfere with the interior of the equipment in any way without our express consent in writing will invalidate the guarantee.**

# LIGHTS CAMERA ACTION LLC

## USER'S MANUAL

### RH-300 MINIATURE RADIATION HARDENED CAMERA CONTROL UNIT CCU300

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## USER'S MANUAL

for

Radiation Hardened Underwater Camera System, comprising:

RH-300 Underwater Radiation Tolerant Cylindrical Camera .....	Drg. No DA7425
(Zoom version) UTC346 B-L .....	Drg. No. DA7419
Control Unit CCU300 .....	Drg. No. DA6869
Radiation Tolerant Cable, Camera to CCU .....	Drg. No. DES6870

### 1. INTRODUCTION

The heart of the system is the RH-300, an extremely compact cylindrical camera using a hybrid 2/3" Chalnicon / Pasecon tube and a special ultra-compact scanning coil assembly providing very high performance for inspection in restricted areas or in any application where space is at a premium and very high quality images are required. The camera has been designed to withstand high levels of nuclear radiation, and a sample has survived a test at a total dose of  $1.15 \times 10^8$  Rads (1.15MGy) at a dose rate of 2.7 MRad/Hr (27 KGy/Hr).

The camera is contained in a robust stainless steel housing with a fused silica front faceplate; it is fitted with a 9 mm wide angle lens (UTC346) or a 8-24mm zoom lens (UTC346B-L) having motorised focus, iris and zoom, allowing the camera to view objects from infinity to 50 mm from the front faceplate. All connections to the unit are made via a 19 pole Lemo hermetically sealed connector at the rear.

The camera operates in conjunction with a special Control Unit, type CCU300; this is housed in a 2U rack-mounting module, with the controls on the front panel and the connectors at the rear.

The Control Unit contains the circuits for video processing, sync and scan generation and the power supplies, including the high voltage inverter for the tube gun potentials.

The Control Unit allows fully automatic operation of both lens iris and video gain, and an additional control gives the user a range of settings for the detection level, between the Peak and Average of the scene being viewed. Both gain and iris can alternatively be operated manually, which may prove beneficial in unusual situations, such as when attempting to view in dark areas with a bright light source shining into the lens.

The unit operates from a 100V, 50 - 60Hz mains supply, and the sync generator is crystal controlled, but locks automatically to an external sync source if this is applied to the GENLOCK socket.

The line scanning standard can be set for either European CCIR (625 lines) or USA EIA RS170 (525 lines). A link switch on the Sync/Power board DE2877 in the CCU sets the line standard, but a small adjustment is also required to the HEIGHT control within the camera to preserve the correct aspect ratio.

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## IMPORTANT NOTICE

**THIS EQUIPMENT OPERATES FROM POTENTIALLY LETHAL MAINS VOLTAGES; IN ADDITION, HIGH VOLTAGES ARE GENERATED WITHIN THE CONTROL UNIT, AND ARE ALSO PRESENT IN THE CAMERA. ALWAYS DISCONNECT THE MAINS SUPPLY BEFORE REMOVING ANY COVERS OR ATTEMPTING ANY SERVICING WORK. SUCH WORK SHOULD BE CARRIED OUT ONLY BY SKILLED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED**

## 2. CAMERA UTC346 - GENERAL INFORMATION

### 2.1 CONSTRUCTION/ACCESS FOR SERVICING

The RH-300 underwater camera assembly is mounted in a stainless steel housing with a sealed fused silica faceplate. The whole functional assembly is attached to the rear bulkhead, screwed into the housing at the rear and sealed with an “O” ring.

If access to the interior is required, it is only necessary to remove the camera from the outer cover by unscrewing it using a spanner on the flats on the rear flange; the camera can then be operated for setting up or fault diagnosis with easy access to all circuits.

All the camera circuits are contained on two plug-in surface-mount cards, which are coupled via cableforms and miniature connectors to a mother board at the rear of the unit carrying the main sealed connector. The focus, iris and zoom motors (Model B-L only) are located behind these two boards and plug into the mother board. Mechanical coupling to the lens functions is by miniature gears and shafts.

2.1.1 The Scan/Focus board, DE5140, can be withdrawn for repair or replacement by first removing the four slotted countersunk M1.6 screws, then unplugging it from the cableform connecting it to the mother board, and finally uncoupling the 6 pole Datamate connector carrying the flexible coil lead, taking care to avoid stressing the flexible.

2.1.2 In order to remove the Video/Tube Supplies board, DE7002, it is first necessary to remove the small gold plated screen (one screw).

Replacement is carried out in the reverse order, first fitting the tube base. Take care that the earthing pin engages with its socket and that the target contact reaches the target ring. Replace the front screen.

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### 2.2 FUNCTIONAL MODULE DESCRIPTIONS

2.2.1 DE6861 MOTHER BOARD - This board acts as an interface between the waterproof connector and the various elements of the camera; it also contains a +6.3V regulator to act as an interference-free supply for the VIDEO/TUBE SUPPLIES board.

2.2.2 DE5140 SCAN/FOCUS BOARD - Generates the horizontal and vertical scanning waveforms and contains the drive circuits to produce the necessary linear current waveforms in the respective coils; the focus current, generated in the CCU, is also routed through this board. Potentiometers control Height, Width, Shift in both planes and Horizontal Linearity to compensate for slow start to the horizontal scan due to losses in the tube electrode structure and the mumetal shield. A 6 pole connector interfaces with the coil assembly.

2.2.3 DE7002 VIDEO/TUBE SUPPLIES - Contains the low-noise preamplifier to convert the minute current signal from the tube target into a voltage, and a differential amplifier to produce equal and opposite signals to drive the balanced pair in the cable coupling the camera to the Control Unit. The unit also includes the divider networks and decoupling components for the tube electrodes including a focus potentiometer, a cathode blanking waveform amplifier and a beam current stabiliser to maintain constant beam current during the tube's life. The special miniature tube base is wired directly to this board.

Controls on this board are for adjustment of target voltage (RV1), beam current (RV2) and beam focus (RV3).

2.2.4 DA1959H SCANNING COIL ASSEMBLY - Special ultra-compact scanning yoke containing printed-circuit coils for horizontal and vertical deflection.

2.2.5 N3128 CHALNICON TUBE - High sensitivity over the full visible range of light; high resolution and very low dark current. No other tube type should be fitted without first referring to Custom Cameras Limited.



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## 3. CONTROL UNIT CCU300 - GENERAL INFORMATION

### 3.1 CONSTRUCTION/ACCESS FOR SERVICING

The Control Unit is constructed in a 2U rack-mounting cabinet with front and rear panels carrying the controls and connectors respectively. Access to the interior is obtained by removing the lid, as described below:

Loosen the 4 countersunk screws at the rear of the lid. The lid can now be slid rearwards, exposing the functional assembly.

The rear panel carries a mother board which acts as an interface for both the functional printed circuit boards and the external connectors; the circuit boards, are retained by quick-release push-pull fasteners.

The main controls are mounted on a printed circuit panel which is connected via a ribbon cable and an IDC connector which plugs into the right-hand board. The zoom and focus controls connect via a ribbon cable to a plug on the Mother Board.

The power supply assembly is mounted on the base plate; connection to the mains input, the supply switch and the functional assembly are all made using connectors, so that the unit may easily be removed for servicing or replacement.

Should it ever be desired to gain access to the rear of the mother board, it is only necessary to remove the 4 corner fixing screws, the 3 screws retaining the LEMO connector mount and the 3 BNC connector nuts, and the complete assembly may be detached from the rear panel.

### 3.2 DESCRIPTIONS OF FUNCTIONAL MODULES

3.2.1 The functions of the three "daughter boards" are as follows, from left to right:

3.2.1.1 DE6339 SYNC/POWER BOARD - Generates all the sync, blanking and timing waveforms for the camera, and also the high voltages required by the tube.

3.2.1.2 DE2878 VIDEO PROCESSING BOARD - Accepts the balanced video signals from the camera and converts them into a standard composite video waveform suitable for application to a monitor, including the functions of black level clamping, aperture correction, peak white limiting, blanking and (variable) gamma correction. The board also contains the AGC circuits, with facilities for external auto/manual gain control switching.

3.2.1.3 DE4851 CONTROL/INTERFACE BOARD - Controls the Auto/Manual gain and Auto/Manual iris functions of the system and acts as an interface with the front panel controls and lamps.. The ALC aiming level and the speed of response of the iris motor can be set from this board.

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3.2.3 DA4459 MAIN POWER SUPPLY UNIT - This is the assembly to the left hand side of the unit; it includes printed circuit board DE4459, a toroidal mains transformer, rectifying and smoothing circuits and regulators to produce +12V, -12V and +8V for the circuits in the Control Unit and +8V, -6.3V for the camera; the camera supplies are remotely stabilised to minimise dissipation in the camera head, dedicated conductors in the cable providing feedback references for the actual voltages at the camera.

MAINS RANGE ADJUSTMENT A 2-position switch located towards the rear edge of the board, adjacent to the transformer wires, allows the mains range to be set to either 90-110V (UP) or 180-220V (DOWN).

3.2.4 DE4528 LED ILLUMINATOR CURRENT SUPPLY This unit provides a variable constant-current supply for cameras equipped with an LED array for illumination. It operates in conjunction with a switched resistor assembly with a control on the front panel to vary the lamp brightness over a range of 10:1.

The unit has its own mains range switch similar to that on the main power supply board described above.

**PLEASE ENSURE THAT THE CORRECT RANGE IS SELECTED ON BOTH UNITS, OR DAMAGE MAY RESULT**

### 3.3 CONNECTORS

The rear panel of the unit carries all the connectors; 2 independent video outputs are provided which may be used simultaneously to drive different peripheral units such as monitors, video tape recorders or hard copy units.

A GENLOCK input allows the unit to be synchronised with an external source of negative - going sync. pulses or normal composite video, with an amplitude between 200mV and 5V, to CCIR 625 lines, 50 Hz, interlaced standard or EIA 525 lines, 60 Hz. Standard, depending on model.

The camera connector is a 26 pole LEMO Series B type.

The mains supply is coupled into the unit via a standard IEC type connector: the cores of the mains lead supplied carry the standard colour code, VIZ:-

BROWN	LIVE
BLUE	NEUTRAL
YELLOW/GREEN	EARTH

**PLEASE NOTE THAT FOR SAFETY REASONS IT IS ESSENTIAL THAT THIS EQUIPMENT BE EARTHED EFFICIENTLY.**

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### 3.4 CONTROLS - DESCRIPTION AND OPERATION

3.4.1 MODE group: AUTO/MANUAL GAIN push buttons and GAIN control.  
AUTO/MANUAL IRIS - linked to IRIS OPEN/CLOSE controls in the next group  
AGC RESPONSE control.

For most applications, it is advisable to select both AUTO modes, when the lens iris and video gain will adjust automatically to compensate for varying illumination levels and scene reflectance, the circuit automatically optimising the action of each control to give the best picture quality in all normal circumstances. The response of the sensing circuit may be adjusted between PEAK and MEAN by the AGC RESPONSE potentiometer. A mid-position will normally prove satisfactory for this control, but some types of scene may benefit from variation. For instance, if it is desired to observe detail in a small, bright highlight area, a setting nearer PEAK should cause the gain to reduce and provide a better rendering of this, whereas if shadow detail is paramount, it will be rendered more satisfactorily with a setting closer to MEAN (with some loss of detail in bright areas).

The MANUAL settings may be selected to give the user complete control; note, however, that if one function is set to MANUAL and the other to AUTO, the automatic control will attempt to compensate for any manual changes made in the other function.

When the lighting level permits, it is best to set the GAIN to minimum and vary the IRIS setting to give the desired effect; if the light level is inadequate, slowly advance the gain control until a satisfactory picture is obtained.

3.4.2 LENS group: FOCUS NEAR – FAR  
ZOOM IN-OUT  
IRIS OPEN - CLOSE

The FOCUS control action varies according to the type of lens fitted to the camera: with a 9mm wide-angle lens, it allows the camera to be set to view scenes ranging from Infinity to approximately 50mm in front of the camera, but note that because the mechanism uses a cam action, the focus continually cycles, so that the NEAR and FAR buttons may be reversed. The depth of focus (i.e. the range of distances which appear sharp at a given setting) depends on the iris setting which, in turn, depends on the lighting level - the brighter the lighting, the greater the depth of field.

In the case of zoom lenses, (Z model only) the focus control has most effect when zoomed IN, i.e. in the “telephoto” state. If the focus is set in this condition, it will be maintained over the full range of zoom. The minimum object distance for the 8-24mm zoom lens is similar to that for the wide-angle lens.

The IRIS controls are active only when MANUAL mode is selected. See 3.4 above for more details of its use.

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## 4. OPERATING INSTRUCTIONS

### 4.0 PRECAUTIONS

**1. BEFORE CONNECTING OR DISCONNECTING ANY PART OF THE SYSTEM, ALWAYS ENSURE THAT THE SUPPLY IS SWITCHED OFF.**

**2. NEVER ALLOW THE CAMERA TO POINT TOWARDS THE SUN, WHETHER IT IS OPERATING OR NOT, AS THE FOCUSED SOLAR IMAGE CAN IRREPARABLY DAMAGE THE SENSITIVE LAYER OF THE TUBE.**

### 4.1 CONNECTION

Carefully unpack the equipment and ensure that all the items are present as listed at the beginning of the INTRODUCTION, Section 1, and that no obvious damage has been sustained in transit.

Connect the camera to the CCU using the cable supplied; ensure that the CCU connector is pushed fully home until a distinct "click" is felt; screw the waterproof connector for the camera fully home and tighten firmly – the correct torque setting is 2 Newton-metres, but firmly tightening by hand is normally sufficient to ensure sealing. Connect one of the video output sockets at the rear of the CCU to a good quality monitor and ensure that the monitor is terminated in 75 ohms.

Connect the mains supplies to the monitor and Control Unit. Note that the mains conductors in the cables supplied are colour coded to the relevant British Standard, i.e.

BROWN	LIVE
BLUE	NEUTRAL
YELLOW/GREEN	EARTH

**CHECK THAT THE MAINS SUPPLY CORRESPONDS WITH THE RANGE SELECTED IN THE CCU (SEE SECTION 3.2.3).**

### 4.2 OPERATION

Position the camera securely on a suitable surface with the red dot on the connector uppermost.

Switch on the supplies; the unit starts with the GAIN in AUTO mode and the IRIS in MANUAL to avoid needless driving of the iris motor in the absence of a picture. An internal delay circuit initially inhibits the high voltage supply to the tube to allow the cathode to reach its correct operating temperature, so that no picture will be visible for approximately 45 seconds, but the monitor should be seen to pull into lock. Note that the ON lamp shows YELLOW during this warm-up phase, and reverts to GREEN when normal operation is established.

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At the end of this delay period, the IRIS reverts to AUTO mode and a picture should appear; adjust the lens focus to achieve a well focussed image. The iris and gain will adjust automatically to suit the ambient light level, but it may be worth experimenting with the AGC RESPONSE control, particularly if the picture contains bright highlights. It should be possible to vary the displayed picture between one extreme where the detail in the highlights is visible and the darker areas are of low contrast (PK setting) and at the other extreme (AV setting) the shadow detail is clearly visible but the highlights are overloaded and containing no useful information.

If both AUTO modes are selected, the picture contrast should remain approximately constant over a light intensity range of at least  $10^3:1$ , though at very low illumination levels where the video gain is high, the picture quality will deteriorate somewhat.

If the camera is changed for a spare one, using the same CCU, it may be necessary to readjust the CAMERA FOCUS control within the CCU to achieve a critical focus; to facilitate this operation, the camera should be set to view a scene containing very fine detail, particularly vertical lines; ensure also that the lens is focussed.

For further information on the use of the various controls, see Section 3.4.

## 5. SPECIFICATION

<b>VIDEO SIGNALS</b>	2 independent output signals, each 1V composite, to CCIR standard. Video is aperture corrected, black level clamped and peak white clipped at 1.2V pk-pk. Gamma variable; normally set to 0.7.
<b>SYNC SYSTEM</b>	625 lines, 50 fields / second, 2:1 interlace, to CCIR specification. Alternative, 525 lines, 60 Fields / second (EIA RS170). Internal crystal lock, with external Genlock option (200mV to -5V, negative-going sync pulses).
<b>SENSITIVITY (SCENE ILLUMINATION, F1.4 LENS)</b>	37 Lux for full quality pictures (40db Sig/Noise) 2.5 Lux For Usable Pictures (20db Sig/Noise)
<b>RESOLUTION</b>	MTF >10% at 700 TV Lines Limiting resolution >700 TV lines (centre of picture) >450 TV lines (worst corner)

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<b>SUPPLY</b>		90 - 110V or 200 – 240V, 50/60 Hz.	
<b>OPTICAL INTERFACE</b>		Integral lens with motorised focus and iris; either 9mm fixed focal length or 8 – 24mm zoom. Object distance from to approximately 50 mm from camera faceplate.	
<b>CABLE</b>		Miniature Multipair, diameter <8.5 mm Max. Length 100 M. Min. bend radius approx. 75 mm.	
<b>POWER</b>	<b>CAMERA</b>	<4W	
<b>CONSUMPTION</b>	<b>SYSTEM</b>	Approximately 25W	
<b>OPERATING TEMPERATURE</b>		0 C to +45 C (Recommended)	
<b>MAX. OPERATING DEPTH</b>		50 Metres (5 bars)	
<b>DIMENSIONS</b>	<b>CAMERA</b>	9mm lens: 34 mm diameter x 270 mm long Zoom Lens: 40mm diameter x 286mm long	(Connector unmated)
	<b>CCU</b>	Standard 2U rack-mounting module 285mm deep.	
<b>WEIGHT (Approx)</b>	<b>CAMERA</b>	(In air) 550g (Fixed lens version); 1.2Kg (Zoom lens version)	
	<b>CCU</b>	4.1Kg	

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Appendix i

## ELECTRONIC ITEMS LISTS (REPLACEABLE ITEMS)

### **CAMERA TYPE UTC346 UTC346 B-L**

(9mm Lens, 35mm Dia) Drg. No. DA6966  
(8-24mm zoom, LEDs, 40mm dia.) Drg. No. DA6862

Mother Board	DE6861
Scan/Focus	DE5140
Video/Tube Supplies	DE7002
Scanning Coil assy.	DA1959
Pickup Tube	HAMAMATSU N3128 (CHALNICON)

### **CONTROL UNIT TYPE CCU305-ZL**

**DRG. NO. DA6869**

Main Power Supply Board	DE4459P
LED illuminator drive board (if fitted)	DE4528
Mother Board	DE5514
Sync/Power Board	DE6339
Video Processing	DE2878
Control/Interface Board	DE4851

### **INTERCONNECTING CABLE**

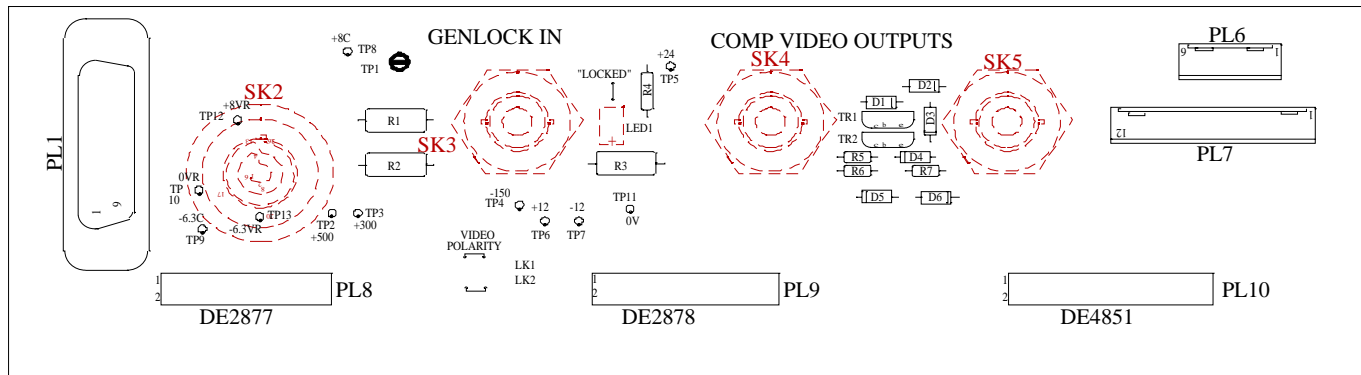
**Drg. No. DES6870**

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Appendix ii

## CCU MOTHER BOARD LAYOUT SHOWING TEST POINTS

FOR NORMAL VIDEO, FIT LK1 & LK2 IN THEIR LEFT HAND POSITIONS



MOTHER BOARD FOR RH-300

CONTROL UNIT

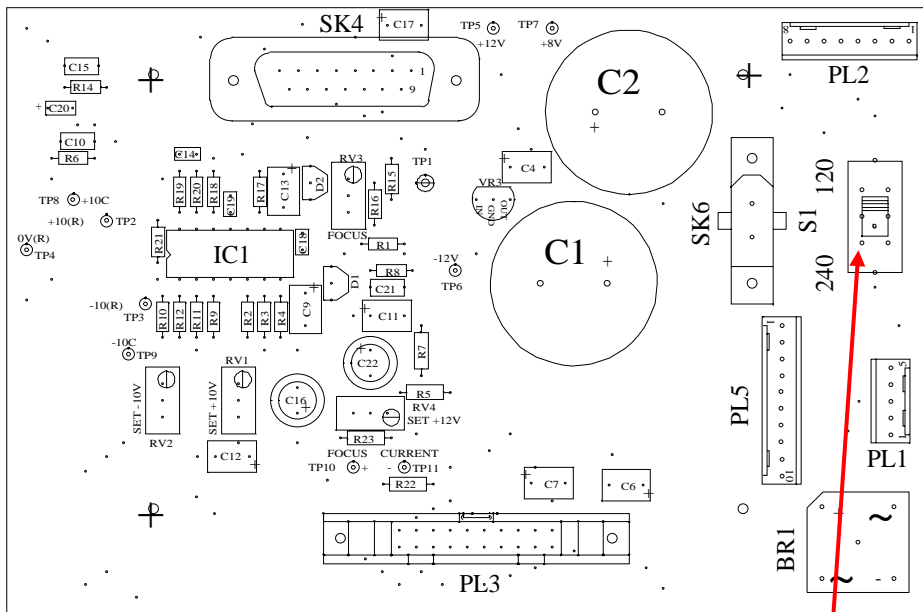
DE5514

ISS:2 17/12/98



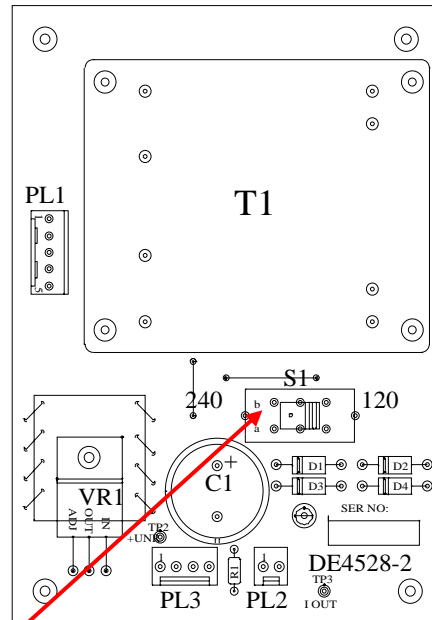
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## MAIN POWER SUPPLY BOARD



DE4459 ISS:4 21/5/2001 MULTIPLE POWER SUPPLY

## LED SUPPLY BOARD



DE4528 ISS:2 6/8/2001 LED POWER SUPPLY

**MAINS RANGE SWITCHES**

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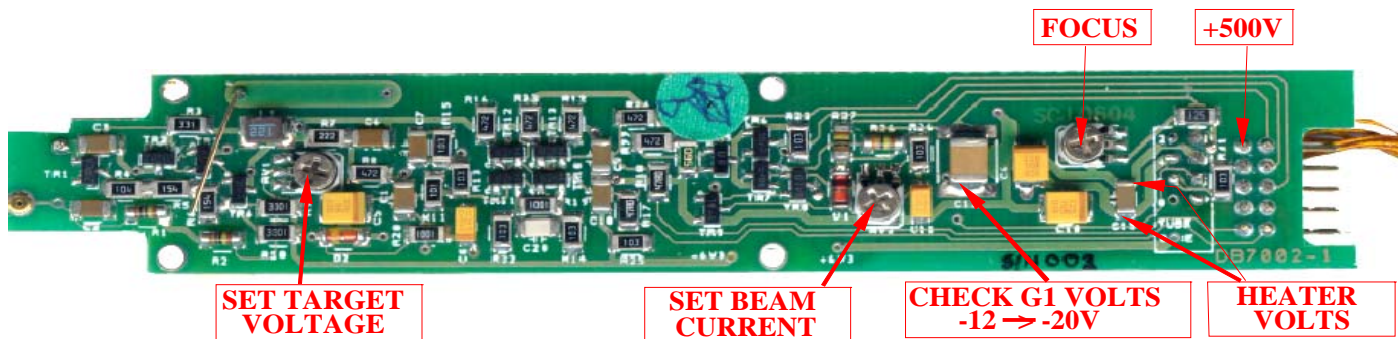
Appendix iii

## CAMERA BOARDS: LAYOUTS & TEST POINTS

DE7002

HEAD AMPLIFIER VIEW

TEST POINTS & CONTROLS



DE5140

SCAN BOARD VIEW

TEST POINTS & CONTROLS

