RADAMEC BROADCAST SYSTEMS

ADVANCED ROBOTIC CONTROL

RP2A

Technical Manual

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ROBOTIC PEDESTAL

TECHNICAL MANUAL

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001	Harvey Thompson	Original Issue	June 2000
002	Ben Hannaford	Added reference to modified Crab / Steer mechanism **P10/11 (3.2)**	30 April 03

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NOTICES

WARNINGS

1. There are high voltage sources in the units, do not connect to a power source with the covers removed
2. The motor mechanisms controlling the camera position and lens movements are high-powered. Keep fingers clear.
3. There is a risk of injury from remotely controlled equipment. Warn personnel to stand clear.
4. Before operating the system, ensure that the camera equipment and attachments are properly secured.

CAUTIONS

1. Ensure that counterbalancing requirements are within specification. If the payload has been altered in any way, the appropriate modification procedures must be complied with.
2. Before driving the payload in any direction, ensure that the projected area is free from obstructions e.g. video prompt device may foul the pedestal.
3. Ensure that the tilt locking pin is withdrawn and stored, and the pan and tilt brakes are disengaged.
4. Ensure that the pedestal column locking pin is withdrawn, when the system is powered and running.

SECTION 1. INTRODUCTION

The Robotic Pedestal, RP2A, incorporates all the features and facilities necessary for high calibre News, Current Affairs and Magazine type programmes. It is designed specifically to support the latest generation ENG/EFP cameras and its small size provides the manoeuvrability essential for multiple camera positioning in multiple set studios.

All drive and navigation electronics are housed within the unit with interconnection to the control panels via a serial data link. Manual operation of height and floor movement is available using a pan-bar mounted joystick. Other manual movement, including steer from the steering ring, pan and tilt using pan-bars, is incorporated into the pedestal design providing an extremely versatile unit for the most demanding application.

1.1 Brief Description

All the necessary axes of movement are provided in the RP2A unit. The pedestal itself provides movement over the studio floor area on an X/Y basis and height control using a two stage telescopic column. Pan and tilt movement is provided by a pan and tilt head mounted on the column platform. Control of lens zoom and focus is achieved by a Lens Interface Unit, generally mounted on the side of the pan and tilt head. This interface unit is designed to drive high quality servos fitted to the ENG lenses, or configured to drive the internal manufacturers lens servos. Control of two other analogue functions is also available from the pedestal, for example, to control camera iris and black level and four relays can be switched for voltage free contact closure facilities.

A single channel system comprises: -

1. Touch Control Panel (TCP) operating system, comprising an Operators Control Panel, a Panel Control Unit and a Touchscreen.

2. Base station

3. Pedestal (RP2A) with pan and tilt head, lens interface unit and lens servos if fitted.

4. Interconnecting Cables e.g.
   A Serial Data Link, usually RS422, connects the Operators panel to the Base Station. A floor cable connects the Base Station to the Pedestal. A Head Cable connects Pan and Tilt Head and Lens Interface Unit to the Pedestal.

Up to three operators panels may be connected to each Base station and up to eight pedestals via each individual base station can be connected in a multi-drop fashion to each of the three panels. The maximum configuration is therefore eight RP2A robots controlled by three Operators panels.

1.1.1 Operators Control Panel

This panel allows the operator to control one pedestal (or static camera channel) at a time. The pedestal controls, comprising X and Y position and height trim are provided by a single three-axis joystick. This joystick and ancillary push buttons are mounted on the left side of the panel. Moving the joystick forward and backward moves the RP2A forward and backward in the Y direction. Moving the joystick side-to-side moves the RP2A side to side in the X direction. Moving the joystick in both axes moves the RP2A diagonally. Hence RP2A movement directly mimics joystick movements. Rotation of the knob controls column height. The Right hand side of the panel contains another 3 axes joystick where forward and backward movement controls the tilt movement of the pan

and tilt head and side-to-side movement controls pan. Rotation of the knob controls zoom. Focus is controlled with a separate rotational encoder control.

Push buttons are available to select up to eight cameras, for storing and recalling shots, entering fade times and for initiating Cut and Fade movements. A stored shot when recalled will move all axes i.e. Pan and Tilt, Zoom and Focus, Height and Floor position to the positions when the shot was stored. All axis move in unison and directly to the stored shot position.

1.1.2 Base Station

The Base Station is usually mounted on a studio wall near to the floor. A multicore cable connects the base station to the RP2A carrying power and serial data from up to three operators panels and one Cue Computer. The unit is powered from the mains supply and outputs plus and minus 21 volts approx to power the RP2A.

1.1.3 Pedestal

All the necessary electronics needed to control the movement of the pedestal are contained within the pedestal. These electronics also control height, pan, tilt, zoom and focus. Analogue voltages to control iris and black level are also derived within the RP2A and are accessed from the Base Station. In order to recall shot positions on the studio floor, the RP2A needs to know its location and how far it is travelling. Targets are positioned, usually at the rear of the studio, at known locations. The RP2A can ‘see’ these targets and is able to work out where it is positioned on the floor with respect to them. Its orientation can also be calculated so that a correction can be applied to the pan axis to preserve accurate picture framing. The RP2A calculates the distance from its current position and moves off in the relevant direction.

Distance is measured using either the targets, or an encoder coupled to the drive system. When the correct distance is covered, as calculated by the RP2A the movement is stopped.

SECTION 2. SAFETY

Three levels of safety are provided with RP2A to protect studio furniture and personnel.

2.1 Infra Reds.

A proximity system using an infrared technique prevents RP2A from coming too close to other pedestals and studio furniture, or personnel.

In some circumstances, it is necessary to move RP2A very close to other studio objects. To allow for this, the proximity detection system can be partially overridden. When an obstacle is detected the maximum speed the pedestal can move is reduced significantly (the speed can be pre-programmed) so that a safe approach speed is achieved. To prevent sudden speed change if movement on air is required, the proximity detection system can be completely overridden during a fade movement.

2.2 Bumpers.

To prevent damage or injury under these circumstances, a bumper system is employed. If an obstruction is detected, the pedestal stops immediately. The bumpers can also be overridden from the operators panel if an RP2A is required to push no more than its own floor cable from its path.

Note: In both cases, only floor movement is inhibited leaving other axes to drive away from the obstruction either by use of the joystick or by selection of an appropriate shot.

2.3 Emergency Stop.

If a pedestal breakdown occurs where the control system has failed to stop the pedestal movement, two emergency stop buttons are provided on the pedestal. Depression of either one of these, or buttons located in other areas of the studio (and/or control room) the RP2A will stop immediately in every axis by removal of power to the motors.

SECTION 3. HANDLING AND INSTALLATION

3.1 Unpacking.

RP2A is shipped in a single palette based box. Before attempting to unpack the RP2A be sure to read the following section, heeding the warnings and cautions.

To remove the pedestal from the crate the four sides and lid can be removed as one by releasing the fixing screws around the base. Then remove the plastic foam packing pieces. At this point, check the pedestal for any physical damage incurred during shipment, which should be reported as soon as possible. The RP2A is removed from the palette by using the supplied ramp. The ramp hooks into the notch, located under the rear baton. This will allow the pedestal to be simply rolled onto the studio floor. If an alternative ramp is necessary, it must be a gentle gradient to avoid the pedestal grounding on its base.

At this stage, the steering ring can be used to manoeuvre the RP2A down the ramp and to a suitable floor location.

WARNING

1. **Ensure the transit stud is securely in position by checking that the nut located at the centre of the head platform is tight. DO NOT REMOVE THE STUD AT THIS STAGE.**
2. **Make no attempt to lift or drag the RP2a by the steering ring or by either the Manual / Servo or Crab / Steer knobs.**

CAUTION

High Pressure Balance Springs. Never release height locking pin without applying sufficient weight to height mechanism.

When the RP2A is at a convenient location on the floor, ensure the column locking pin is in position. Carefully remove the transit studding, which goes through the centre of the column (which is used to secure all parts of the column during transit).

With all available balance weights placed on the height tray apply your weight to the height column while the pin is removed. For heavy duty RP2As (110kg payload) it is advisable to have at least 3 people on hand to assist with this operation. Gently allow the column to rise until the end of travel position is reached.

RP2A is fully manually operable enabling it to be positioned in the same way as a manual pedestal. Two knobs at the front allow it to be switched between manual or servo and steer or crab. If the manual/servo is on servo then lift and turn it towards manual, now turn the steering ring until it engages with the steer mechanism.

3.2 Manual Positioning.

Iss. 002 ▶ If it is required to steer the pedestal rather than crabbing, then the knob at the front can be turned and lowered to enter steer mode. Turn and lower the crab/steer knob to the steer position, then rotate the steer ring until the rear wheels are felt to disengage from the steer mechanism (this will occur when the two rear wheels are pointing ‘straight ahead’). Once in steer mode the steering ring will only steer the front wheel, allowing the pedestal to be rotated. To return to crab, simply reverse the changeover procedure by turning and lifting the crab/steer knob to the ‘Crab’ position, then rotate the steer ring to

engage all three wheels. Note that the pedestal must be in crab operation when using remote servo control. **◄ Issue 002**

3.3 System Interconnection.

Included in the system drawing manual is a System Schematic Diagram (HK999-xxx-xxx). This drawing shows all units and cables that connect them together. You should refer to this diagram throughout the installation process. Once the Touch Control Panel is installed the RP2A units can be added.

The pedestal itself has only one external connection, which is to the Base Station. The Base Station is a combination of Power Supply for Pedestal and routing for the systems serial communications. Both of these groups of signals are passed in a single multicore floor cable, which plugs into the rear panel of RP2A and should be clamped in a cable clamp provided to avoid excessive strain on the connector. A second connector on top of the pedestal provides connection via a flexible cable to the Pan and Tilt Head as well as the lens interface.

The Base Station itself has a number of possible incoming connections; the first is AC power, which it uses to derive the DC power for the pedestal.

CAUTION

Disconnect AC power before opening Base Station Cover.

The Base Station also has provision for up to three serial communication connections coming from the control panels in the system. Each connection has an in and an out to allow other pedestals to receive the communications in a ‘daisy chain’ style. The last base station of the chain must have the termination device connected to the out connector to ensure the serial line is sufficiently terminated.

3.4 Target Installation.

The pedestals navigation is based on bar coded targets positioned around the studio. Within the pedestal base is a CCD line scan camera, which enables the individual codes to be read. Although RP2A is perfectly capable of operating outside the viewing range of these targets it is desirable to provide as many targets as possible to reduce the area of floor out of view of targets. It is important that the position of all targets is exactly the same as the positions RP2A expects. The pedestal will be programmed with the positions of every target in the studio and the system is sensitive enough to detect position to within a fraction of a millimetre. So positioning must be done carefully and as accurately as possible following the target map provided for your studio. Should it be necessary to change the original map then this can be done in the systems configuration EPROM, covered later. It is possible to switch between a maximum of 16 pre-stored maps, for changing sets etc. However two maps have special functions. Map 0 allows the RP2A to operate without targets and so navigation is by ‘dead reckoning’ only. The other map, Map F inhibits X Y movement but allows all other axes to operate normally. This map basically simulates the action of a manual pedestal with remote control of height, pan and tilt etc.

3.5 Base Station.

As described earlier, the base station acts as a junction box and power supply for the pedestal. RP2A will at all times be connected to the base station via the floor cable, for this reason it should be positioned such that the cable will not interfere with other pieces of equipment in the studio. Each base station has an AC power connection as well as a number of serial data lines, depending on the number of panels and other pedestals in the system. Instructions regarding the connection of these cables are given in System Schematic Diagram.

On some systems there is a Remote Emergency Stop switch. Typically this will be connected to all of the base stations serially and will be positioned in a prominent position on the studio wall and / or in the control room. Pressing this switch will immediately shut down all pedestals connected to it.

3.6 Loading and Balancing

Before attempting to switch the RP2A on, the load must be applied to the column. The column will be fully extended at this stage. Engage the locking pin by lifting the column to its absolute maximum extent (some manual help may be needed to do this). Mount the pan and tilt head, camera, lens etc. Disengage the locking pin (the column will need to be fully extended again to do this). The column should now fall gently to approximately its mid position. If necessary, add or remove balance weights to the weight tray to achieve this.

When you are familiar with the operation of RP2A, switch it on and move the column using the Pan-Bar Joystick in Local Mode (or the joystick mounted on the Operator's Panel in Remote mode) to its highest position at maximum speed whilst observing the deflection of the Load Indicator on the Local Panel. Then move the column to its lowest position at the same speed and note the deflection, which will be in the opposite direction. Add or remove balance weights until the deflections for up and down are about the same. (If the deflection is higher on the way up, remove weights. If it is higher on the way down, add weights).

SECTION 4. OPERATION.

4.1 Switching On, General.

Before applying power to the RP2A it is essential to observe the notices at the beginning of this manual.

With the RP2A switched off but connected to a powered Base Station, charge will be maintained on the internal batteries.

4.1.1 Initial set-up for Remote Operation.

The RP2A must be orientated with its rear panel parallel to its targets so that the internal camera has a clear view of three targets minimum. Before applying power carry out the following checks: -

1. Studio Emergency Stop Switches must be released.
2. RP2A Emergency Stop Switches must be released.
3. The CRAB/STEER knob must be in the CRAB position (ensure all three wheels are engaged).
4. The MANUAL/SERVO knob must be in the SERVO position.
5. The LOCAL/REMOTE switch must be in the REMOTE position.
6. The MAP SELECT switch on the local panel must be set to the correct map setting.

4.1.2 Power Up

The Power Isolation switch on the side panel must be in the ON (UP) position. Switch ON the power switch on the local control panel. All the panel indicators will illuminate as the processor carries out its start-up tests. Press the reset switch on the local control panel. The wheels will STEER to their home (straight ahead) position. The POWER GOOD and WATCHDOG indicators will remain illuminated. The targets seen will also be indicated. The STEER + and - indicators will not be illuminated if the RP2A is correctly orientated.

4.1.3 Panel Controls

1. General

The panel controls for the RP2A are incorporated on the Operators Control Panel. Thus the controls can be assigned to cameras together with the other trim controls and keys. Camera selection keys are also situated on this panel.

The trim controls and push-button keys are included in the TCP self test facility.

2. Trim Controls

The panel incorporates a three function joystick which provides control over the X, Y and height movements of the RP2A. Displacements of the controls from their neutral positions cause movement at a rate proportional to displacement.

X: Joystick Left-Right Pedestal moves left or right

Y: Joystick Forwards-Backwards Pedestal moves Forwards or Backwards

Height: Twist knob on joystick. Pedestal rises for clockwise rotation.

3. Push Button Keys

Five illuminated keys are provided on the panel specifically for the RP2A. Their functions are as follows: -

Override: Manual override key allows the RP2A to be moved closer to an obstruction after meeting an IR VIOLATION.

Joystick Enable: Joystick Enable key, push on, push off, must be illuminated for the RP2A to be guided across the floor.

Bumper Disable: This key can be made latching or non-latching using the configuration EPROM.

IR Disable: To disable the IR system altogether.

Pan Follow: This key when enabled will cause the X - Y joystick orientation to follow the heads pan direction

4. Displays

The RP2A will cause the Touchscreen status section to display additional operator messages related to RP2A operation.

UNREF: Indicates the RP2A has not seen any or sufficient targets.
ORIENT: Indicates the RP2A has tested out of alignment with the targets.
IR: Indicates the RP2A has detected an obstruction.
VIOLATION: Indicates the RP2A has touched an obstruction.
E/STOP: Indicates the RP2A Emergency Stop Button has been pressed.

4.2 Trim Controls.

4.2.1 Summary of Operation.

1. Select required RP2A.
2. Select coarse (Off air, X4, Key illuminated) or fine (On Air) movement.
3. Operate trim controls as required.

4.2.2 Joystick Control.

Each joystick function incorporates a central dead zone. Any joystick movement within this zone will not result in any RP2A movement. Outside the 'dead zones' the speed of movement of a function will increase with joystick displacement from its central position. Direction of travel of the RP2A follows the direction of movement of the joystick. Each function is profiled allowing fine control for initial joystick displacement and coarse control for near maximum displacement.

4.2.3 Zoom Correction.

Zoom Correction is a facility, which allows Pan & Tilt speeds to be related to the zoom angle such that the control sensitivity remains apparently constant as the picture width changes with zooming.

When the X4 key is illuminated the zoom correction is disabled and rapid pan & tilt movements can be achieved independently of the zoom angle.

4.3 Shot Control.

4.3.1 General.

Shots may be stored and recalled as part of the normal TCP procedures. There are no rule changes when a pan and tilt head is mounted on a RP2A.

4.3.2 Storing Shots.

Shots may be stored provided the RP2A is referenced by seeing sufficient targets (a minimum of three) to establish its position within the set. A warning will be given on the touchscreen display if an attempt is made to store a shot before the RP2A is referenced.

4.3.3 Recalling Shots.

Shots will be recalled independently of whether the RP2A can see its targets, assuming that it has referenced previously. They will be recalled accurately even if the RP2A twists while moving. The twist or change in orientation can be detected by the navigation system and an orientation error correction is applied to the pan axis of the head.

4.4 Obstructions.

If a RP2A meets an obstruction whilst moving across the floor it will stop. The Touchscreen will display IR Violation or Bumper Violation according to the sensor involved.

It will be possible to move away from the obstruction under joystick or shot control. If the IR (infrared) sensors detect an obstruction it will be possible to move closer at a slow speed under joystick or shot control with the OVERRIDE key illuminated. Alternatively the IRs can be switched off using the I/R Disable key. If an EMERGENCY STOP key is pressed panel control will be disabled and the display will indicate EMERGENCY STOP.

4.5 Manual Control.

A camera on a RP2A can be operated manually by setting the LOCAL/REMOTE switch on the lens interface unit (normally mounted on a pan bar or the head) to the LOCAL position. In order to move the RP2A in the operational crab mode, the pan-bar joystick must be activated. To do this, switch the biased switch located at the base of the pan-bar joystick. The red LED, which previously was flashing, will now illuminate continuously. Movement of this joystick will cause the RP2A to move in X, Y and Height in a similar way to the normal operator's panel joystick. If steer (not crab) is required then the manual steering ring is used. To use this, control must be changed over from CRAB to STEER by operating the CRAB/STEER knob on the RP2A. It is necessary for the ring to be rotated to the correct alignment before the mechanism will change from one mode to the other. The knob must be lifted to change from STEER to CRAB and pushed down for change from CRAB to STEER.

Only the head will return to panel operation if the LOCAL/REMOTE switch is set to REMOTE without resetting the manually operated knobs. For full remote control, the CRAB/STEER the knob must be in the CRAB position and the MANUAL/SERVO knob must be in the SERVO position with the steering ring not operating. The RP2A must then be referenced to the targets, see sect 4.1.

4.6 Self Test of RP2A Functions.

4.6.1 General.

The RP2A controls can be tested when the self-test function bar is selected on the touchscreen. For more information see the Touch Control Panel operators manual also supplied with your system.

Section 5. MAINTENANCE AND FAULT FINDING.

5.1 Routine Maintenance Tasks.

RP2A is based on the highest quality electronic and mechanical components, which should give many years of trouble free operation with minimal routine maintenance. The main purpose of most of the recommended maintenance tasks is simply to keep the various sensitive areas clean and free from excessive dirt or grease. The list below shows which areas and devices should be periodically inspected and cleaned if necessary, the frequency depends on the environment in which the pedestal is operating but typically they would be carried out approximately every two months.

1. General
2. Navigation camera and lens
3. Infra red transmitters and receiver filters
4. All PCBs
5. Manual/Servo and Crab/Steer sensing switches
6. Bumper strip
7. Drive Wheels
8. Height Mechanism

5.1.1 General Mechanical Maintenance.

Despite the large number of precision mechanical components there is very little oiling, greasing or adjusting to keep the pedestal in perfect running order. All the bearings and gearboxes are sealed and lubricated for life without the need for any further oiling. Tenacious grease is used on all the chains and should not require re-applying providing the grease has not rubbed off while in contact with some other surface.

5.2 Navigation camera and lens.

Using a dry lint free cloth, dust the camera lens but avoid using excessive pressure as this could scratch or move the position of the lens. If necessary a damp cloth can be used but it should be followed by a dry cloth to remove any smears.

5.3 Infrared transmitters and receiver filters.

With the main covers removed, access is gained to the infrared transmitters around the pedestal. Each one has a small lens, which should be gently wiped to remove any dirt or grease that may have accumulated on it. To give the correct safety zones these devices are angled at about 45 degrees downwards. The receiver lenses are always accessible around the base of the pedestal and can similarly be gently dusted. Check each zone for correct operation.

5.4 All PCBs.

The electronics are housed in the lower section of the pedestal in a hinged card cage. With the cage hinged outwards the cards should be removed individually and any dirt carefully removed with the suitable cleaning fluid specifically for electronic components should be used, do not use water.

Always ensure that a card returns to its original position with the cage, there are colour codes on the cards and cage to assist in this.

5.5 Manual/Servo and Crab/Steer sensing switches.

Positioned around the two changeover knobs, just below the top covers are two micro switches, which sense the current state of each knob. These should be inspected and cleaned if necessary using a duster or electrical cleaning fluid.

5.6 Bumper Strip.

The bumper strip is designed to sense collision with another object and is therefore manufactured to withstand repeated bumps. All the strips should be inspected for excessive damage or for looseness in their fixing which will affect their efficiency to protect the pedestal. As the strip is arranged in short sections, if replacement is necessary usually only a small piece will be required.

5.7 Driving Wheels.

The smooth and precise movement of the pedestal is greatly dependent on the condition of the wheels and tyres. It is recommended that every month the wheels should be inspected for damage or, more likely, debris stuck on the tyre. The easiest method of doing this is to remove one of the infrared receiver modules on each wheel housing. This will expose a viewing hole through which the wheels can be examined. To remove an I/R unit, first take off its cover then remove the four hexagon steel pillars holding it in place. The unit can now be moved to one side on its wiring. Remove any debris that may have accumulated (e.g. floor marking tape). If there is significant damage to any of the tyres of wheels then it may be necessary to repair or replace that wheel. Refit I/R units on completion of check ensuring that all cabling is pulled out from the wheel turret.

5.8 Height Mechanism.

The height mechanism has precision roller bearings to ensure smooth and straight movement without ‘cork screw’. The roller bearings themselves are sealed and will not require lubricating, however, the flat runner surface on each column is very lightly oiled, mainly to protect it from rust and if this oil is removed by contact then it should be re-oiled. Always use a light grade oil and avoid applying excessive amounts.

Height Balance

This check should be carried out regularly, if any significant change to the load has been made then it will be necessary to add or remove trim weights from the weight tray accordingly, just as on a conventional pedestal. Refer to sec. 3.6.

SECTION 6. MECHANICAL MAINTENANCE.

WARNING

1. **Remotely controlled equipment may move suddenly and without prior warning. Stand well clear at all times.**
2. **Dangerous mechanisms in pedestal. Switch off power at both switches and the base station before removing covers.**

CAUTION

1. **Before removing payload, height columns must be lowered and locking pin inserted.**
2. **Plastic track precision potentiometers can be damaged by excess current. Use only ohmmeters having short circuit current rating not exceeding 10mA.**
3. **Height is counter balanced with gas springs, which contain nitrogen under high pressure. Do not attempt to open them and do not damage their rods. If removed they should be stored in the rod down position to keep their seals lubricated.**
4. **Do not release nitrogen from the gas springs in an attempt to enable the payload to be reduced. The pressures are matched in sets of springs.**

NB Nuts and screws are ISO metric unless otherwise stated.

TOOLS & EQUIPMENT

1. Normal workshop tools
2. Digital multi-meter. Short circuit current of resistance range must not exceed 10mA.
3. Power supply 0-30VDC at 5A.

6.1 Fault Diagnosis.

Since the RP2A pedestal is designed for both robotic and manual operation erratic jerky or noisy operation can be checked both manually and under robotic control.

Problems with height operation can be caused by the payload being either too heavy or too light or through loss of pressure in one or both of the gas springs. The range of payloads is 130 kg, 110 kg, 90 kg and 70 kg including balance weights. Make sure the RP2A is switched off. Having ensured that the payload is correct for the gas springs used, the column should settle to approximately its mid position. Operate height manually and check that the effort required to raise to the top is about the same as that required lowering it to the bottom. If it is necessary to remove weight to equalise operation, one or more gas springs may be faulty or one of the gas spring cables may be broken, causing only one pair of springs to be operating. When operating in remote mode, the deflection of the Balance Meter located on the local panel should deflect an equal amount when the column moves up and when it moves down. Trim weights may need to be added or removed to achieve this. (The deflection need not be exactly the same up and down but as near as possible. The deflection must always be less than full scale).

Problems with height when under robotic control could also be caused by a faulty motor, reset potentiometer or electro-magnetic clutch, as well as the servo amplifier or servo processor card.

Unsatisfactory operation of drive and steer may be caused by a faulty motor or a slack or broken drive belt or a fault in the servo amplifier. With regard to drive the electro magnetic clutches could also require attention.

Fuses protect all RP2a functions. If a complete failure of any one function occurs, which is obviously not mechanical, these should be checked first.

6.2 Decommissioning The Pedestal.

1. Switch off the two RP2A power switches and base station power switch.
2. Remove the lower rear grey cover and unplug the RP2A floor cable.

At this point, it would be advisable if at all possible to take the pedestal to the area where the work will be carried out.

3. Unplug and remove the head cable.
4. With the height in mid position remove the white top covers, front section first.
5. Lower the height to its bottom most position and locate the height locking pin in the column.
6. Insert the tilt locking pin on the head and remove the payload.
7. Unbolt the pan and tilt head and remove from the pedestal and remove any balance weight on the weight tray.
8. Add a full complement of trim weights to the weight tray and firmly grasp the weight tray of the RP2A with at least 2 people (4 people if the RP2A is a 110kg version), push down against the gas springs, release the height locking pin and raise the height column slowly. With the column at the top and the trim weights removed the locking pin should be re-inserted. It is not uncommon to have difficulty at this point as the cables will settle and stretch after the original installation requiring you to push the height up further to locate the pin.
9. Raise the pedestal onto a working surface or trolley, if suitable lifting equipment is available.
10. Remove the remaining side covers.
11. Remove the electronic cards from the card frame, notice the colour coding on the edge of each card and on the card frame.
12. Disconnect all terminals from the on-board batteries.

13. Unplug the BNC and 15 way D type from the back of the linescan camera.
14. Unscrew the 5 or 6 retaining screws on the upper plate, which retain the linescan camera sub assembly, taking great care not to let the camera and mirror drop. The alignment of this mirror to the camera lens is critical and care should be taken in how this is handled and the mirror surface should be kept clean.
15. Unscrew the 4 retaining screws on the lower plate for the lamp assembly, disconnect the two Molex connectors and remove the unit. Again care should be taken with the lamps as they are halogen and will crack when powered if any grease from hands or equipment contaminates the surface.
16. Unscrew the left hand bolt that retains the battery clamp, loosen the right hand bolt, lift the clamp and slide the batteries out of their tray one at a time, paying attention to the order in which they are removed.
17. Remove the battery tray by unscrewing the earth strap Allen bolt, to the left of the batteries, and unscrewing the 4 countersunk screws under the batteries. Lift the tray away and support it, it cannot be removed from the pedestal.

CAUTION

Do not attempt to remove gas springs, cables or chains without carrying out the safety procedures set out in the following paragraphs covering height servicing.

6.3 Gas Spring Replacement.

NOTES

1. If the gas springs are being replaced because of problems with height performance, it is recommended that both be renewed. Although oil leaking out may be visible on a gas spring rod the external appearance is not, generally speaking, a reliable indication of the condition of the springs.

2. The adapter at the top end of each gas spring is machined to match that spring and must not be interchanged between springs.

3. The above procedure may be carried out if it is required to change the payload to any other specified weight. A matched pair of the appropriate gas springs must be obtained from the factory for this purpose.

4. Under no circumstances should gas be released from springs in an attempt to balance lighter loads.

CAUTION

1. Ensure that locking pin is fully engaged before proceeding.

2. If it is necessary to remove the top most column tube, which supports the steering ring & weight tray, it is vital that safety procedures to be found in subsequent paragraphs of this manual are carried out.

6.3.1 Procedure.

Caution: - This procedure should only be carried out by experienced personnel.

The RP2A has two high-pressure gas springs fitted to it for the purpose of balancing the payload on the height column. There are four main types of RP2A, which support the following payloads, 70kg, 90kg, 110kg and 130kg. As a result there are four types of gas spring available to match these loads. This section explains how these springs are changed, the procedure being the same for all RP2As.

The RP2A column should be driven to its highest position. Remove the payload carefully, then insert the height locking pin. If the pin will not go in then lift the column manually until the pin will go in.

Under no circumstances carry out the procedure, which follows, without ensuring the height locking pin is in the up position.

1. Remove the top white covers of the RP2A.
2. Locate one of the two gas springs, which are positioned either side of the height column.
3. Using a 2mm Allen key, loosen the locking screw clamping the pin which secures the top of the gas springs in the location on the centre tube of the column.
4. Using a small hammer, gently remove the securing pin.
5. Lift out the gas spring.
6. Fit the new gas springs in place of the old ones.
   Note: Gas springs must be replaced in pairs.
7. Using a small hammer, replace the securing pin.
8. Tighten the locking screw.
9. Replace covers and release the height locking pin.

6.4 Adjusting Chain Tension.

6.4.1 Drive.

1. Switch off battery power. Remove rear metal cover, unplug all cables and raise height column so that top covers can be removed.
2. The drive chain tension is adjusted by means of a chain sprocket whose housing is secured by three M6 hex counter-sunk screws in slots in its mounting plate. This assembly is located at the front of the pedestal on the left hand side.
3. The three fixing screws, which are located underneath the slotted plate, should be loosened enough to allow the sprocket housing to move when adjusted but tight enough to hold it against the chain tension.
4. The sprocket housing should now be tapped in the appropriate direction, using a hammer and a suitable block of wood. When the chain tension is correct the three M6 screws must be fully tightened. Chain tension should be checked at the centre of the rear run (adjacent to the local control panel) where total side movement should be 10.0mm.

6.4.2 Steer.

Adjusting the steer chain tension is similar to the procedure for adjusting the drive chain. In the case of steer however, the adjusting sprocket and its slotted palate both move during adjustment and the fixing screws which are on top this time, are two M6 hex skt screws and one hex head screw. This assembly is located at the front of the pedestal right-hand side. Chain tension should be checked at the centre of the rear run, (adjacent to the local control panel) where total side movement should be 10.0mm.

NOTE
After adjusting the steer chain tension it is important that the wheel alignment is checked and if necessary adjusted, as described in the following paragraphs.

6.5 Checking and Adjusting Wheel Alignment.

The pedestal should be raised off the floor on two-inch thick wooden blocks. Alignment is checked by placing a steel straight edge against the front and one pair of rear wheels at a time.

In order to see the wheels it is necessary to remove the I/R receiver units mounted on the corner tubes. Both front units must be removed together with the outer ones only on each rear tube. To remove an I/R unit, first take off its cover then remove the four hexagon steel pillars holding it in place. The unit can now be moved to one side on its wiring.

With the pedestal in ‘crab’ mode turn the steering ring so that the steel straight edge can be placed against the side of a front wheel and one rear wheel. The straight edge must be long enough to bridge

right across both front and rear wheel. If the straight edge sits flat against the sides of the front and rear wheels alignment is correct. If this is not the case then the rear wheel assembly must be adjusted. This is done by loosening the six M4 hex skt screws clamping the steer chain sprocket so that the rear wheel assembly can be rotated until the straight edge is flat against the front and rear wheels. Fully tighten the six M4 screws and re-check alignment.

Turn the steering ring the other way and repeat the above procedure on the other rear wheel assembly, after which all three wheel assemblies will be correctly aligned. Replace the I/R receivers and their covers and remove the wooden blocks, if used, to complete the alignment procedure.

NOTE

Do not attempt to adjust the front wheel assembly, as this will cause the wheel to be out of line in the straight-ahead position. Following wheel alignment the navigation repeatability should be checked and adjusted if necessary, see sect 7.5.

6.6 Top Lifting Cables.

6.6.1 Removal.

Switch off battery power, remove rear cover and unplug all cables. With payload still in position, raise the height column so that the top covers may be removed. The height column must now be raised to its full height and the payload removed. Insert the locking pin to lock the column in the raised position so that it will not collapse while work is being carried out.

1. Ensure that the locking pin is fully engaged before proceeding
2. Note that the top, smallest diameter, column is only supported by the two lifting cables and is not supported by the locking pin.
3. Select MANUAL and turn the steering ring until the wheels are straight ahead. This is the position where either crab or steer may be selected. Undo the two top screws in the coupling at the top of the telescopic steer shaft and lower the shaft.
4. In order to remove the top lifting cables, it will be necessary to remove the top column tube. This will be easier if the weight tray and steering ring are removed before proceeding. Remove any trim weights and then undo the eight hex socket head screws around the pan and tilt mounting plate. This plate together with the weight tray can now be lifted off. Undo the eight socket head screws around the steering ring plate and the ring and its plate can also be lifted off.

Work on one cable only at a time. Undo the second cable only if an assistant is holding the top column tube up by means of the other cable, as described below.

5. Select a cable to work on and remove the four M6 hex skt screws holding the vertical slotted bar on the outside of the large fixed column tube. This releases the tension on the cable. Moving up to the pulley, remove the four M6 hex socket screws holding the pulley assembly and its cable guard in position. Pull the whole assembly out of its recess and slide it down the cable.
6. There should now be enough slack in the cable to allow the vertical bar to be pulled out sufficiently for the bar to be removed from the cable by undoing the M8 hex socket head screw at the centre of the bar. **Note which way up the bar is before removing it.**
7. The cable end released should be pulled up from in between the fixed and middle tubes and pulley assembly and cable guide replaced, making sure that the cable is located properly in the pulley groove.
8. An assistant is now required to pull on this cable so that the top column tube will not collapse when the other cable is removed. Pulling on the cable will be made easier if a metal bar is passed through the cable loop.

9. With the assistant taking the strain release the second cable in exactly the same manner as the first one. However, when the cable is pulled up from between the fixed and middle tubes, the pulley assembly and cable guard should be removed instead of being replaced. The assistant should now lower the top column tube an inch or so to enable the top end stop block to be removed. This block is located inside the top of the middle tube and is secured by two counter-sunk screws.
10. The top column tube should now be lowered down inside the middle tube by means of the cable until it is on its lower end stop. The first pulley assembly and cable guard should now also be lowered.
11. The top column can now be lifted up and out of the middle tube while the assistant feeds the cables through the pulley holes in the middle tube and ensures that they do not get caught up. With the top tube assembly on the bench the two cables should now be removed.

6.6.2 Replacing Top Lifting Cables.

The procedure for fitting replacement top lifting cables is the reverse of that for removing old ones; the following points however, should be noted.

1. With the new cables attached to the top tube assembly, and the top tube re-inserted into the middle tube, the cable ends can be pulled through the pulley holes and one pulley screwed into position. At this point it is important to remember that an assistant uses this cable to raise the top tube enough for the top end stop block to be refitted inside the middle tube. This is necessary so the top tube cannot be raised too high, which could cause damage to the pulley or cable.

2. With the assistant now pulling the top tube up hard against the top end stop, proceed with fitting the other cable using the reverse of the procedure described previously.

3. To tension the cable, the four hex socket head screws clamping the vertical bar should be tightened sufficiently to hold the bar against the cable tension. Tap the vertical bar downwards with a wooden block and hammer until the total movement at the mid point of the exposed cable is 6 to 8mm, then finally tighten the four screws. The assistant may now release the other cable so that it can be fitted and tensioned in a similar manner. Refit the pair of gas springs removed for access together with the steering ring, weight tray and pan and tilt interface plate.

4. When reconnecting the telescopic steering tube, ensure that the wheels are in turn are in the straight-ahead position i.e., where either “crab” or “steer” can be selected. Turn the steering ring until one of the two markers is at the front then lift the telescopic tube into position and tighten the coupling screws.

5. With the top covers replaced, the locking pin can now safely be released prior to pulling down the height column for the payload to be replaced.

6.7 Replacing Drive Clutches.

Switch off the battery power, remove the rear metal cover, and unplug all cables.
Raise the height column and remove the top covers. It is not necessary to remove the payload for this particular servicing operation.

Remove the M3 (hex socket head) clutch coil locating screw (and nut if fitted).
Remove the slotted M3 fixing screw, large washer, and spacer from the centre of the clutch.

Note the position of the clutch power wires in the terminal block. Remove the necessary cable ties and disconnect the clutch power wires. The clutch coil assembly may now be pulled off the shaft (it may be a tight fit due to the key). Take care not to drop the locating key into the Turret assembly as the clutch is removed.

The lower clutch plate and spacer collar does not normally require changing, and re-assembly can be commenced at this point. It may be changed as below if desired.

Note and keep safe the lower spacer between the clutch coil and lower plate. This appears identical to the upper spacer but is actually a different size, and must go back in the same place. It is machined to a precise size to set the clutch gap.

Remove the three slotted screws and washers fixing the lower plate to the top of the wheel assembly and lift off the lower plate.

Refitting is a reversal of removal, taking care to replace the correct spacer and to tie up the power wires away form the chain/sprocket area.

6.8 Replacing Motors.

6.8.1 Drive Motor.

Owing to the necessity of lacing and sheathing wiring during manufacture, to keep it clear of moving parts, it is recommended that motor, tacho and encoder wires be cut when the motor is removed. They should be cut such that in line crimp connectors can be used when fitting the new motor/tacho. Before starting motor removal it is essential to power down the RP2A and base station. Then remove both the side covers and swing out the card frame to gain access to both sides of the motor.

Having dealt with the wiring as described above, the motor should be removed complete with its mounting plate. Remove the four M6 hex head screws securing to motor and plate to the four pedestals. The motor and its mounting plate may now be removed together with the drive belt.

Note the position of the pulley on the motor shaft, loosen its grub screw and pull it off the shaft. Note the position of the motor terminals with respect to the mounting plate and remove it from the motor.

Fit the mounting plate to the new motor in the correct position. Push the pulley the correct distance down the motor shaft, ensuring that the grub screw is in line with the flat on the motor shaft before tightening it.

With the belt around the motor pulley insert the motor into its position and fit the outer loop of the drive belt around the large pulley. Fit the four m6 hex head screws loosely through the mounting plate and into their pillars. Push the motor in, away from the large pulley, to tension the belt and tighten the four hex head screws.

The motor, tacho and encoder wires may now be cut to a suitable length and connected into the pedestal wiring using in line crimp connectors.

6.8.2 Steer Motor.

The comments already mentioned concerning the Drive Motor wiring apply equally to the steer motor, its tacho and encoder. It is therefore recommended that the same procedure for removal and replacement be adopted.

To gain access switch off battery power, remove rear metal cover, unplug floor cable and raise the height column sufficiently for the front top cover to be removed take off the right hand metal side cover, disconnecting the fan wires if necessary.

Having dealt with the wiring as described under drive motor replacement, the steer motor is removed complete with its mounting plate, toothed belt, both pulleys and four spacer pillars. Along the edge of the top plate, adjacent to the steer motor are three hex screws. There is a fourth one about 100mm in from the centre of the three. If these four are removed from the pillar into which they screw the whole steer motor assembly, as described above, can be lifted out.

With the unit on a suitable work surface, ensure that the gear pinion, which will be covered in grease, is not contaminated. Note the position of the toothed pulley on the motor shaft, loosen its grub screw, pull it off and remove the key from the motor shaft.

Fit the key to the shaft of the new motor, locate the toothed pulley in the correct position on the shaft and tighten the grub screw. Apply some light grease to the toothed belt and pulleys and fit the new motor to its mounting plate, ensuring that the cable gland is in the correct position. Replace the steer belt and fully tighten the four motor fixing screws while tensioning the belt.

The steer motor unit may now be re-fitted to the pedestal top plate by means of the four M8 hex head screws. Before these screws are finally tightened the gear pinion must be meshed into the large gear. The gear mesh is correct when minimum backlash, with no tight spots, is achieved through one full revolution of the large gear.

The motor, tacho and encoder wires may now be cut to a suitable length and connected into the pedestal wiring using in line crimp connectors.

6.8.3 Height Motor.

Switch off battery power, remove rear metal cover and un-plug all cables. With payload in position, raise the height column so that the top covers may be removed.

Un-plug all the cables from the control panel and remove it by undoing the four counter-sunk screws near its corners. Note that one of these screws is longer that the others and must be replaced in the correct position.

It is recommended that the motor and tacho wiring be dealt with in the same manner as discussed for the drive and steer motors, although there is no encoder to disconnect.

Moving to the lower end of the motor, the clamp screws at each end of the drive coupling should be loosened and the coupling pushed down the gearbox shaft until it is clear of the motor shaft. The four M6 hex socket head screws fixing the motor to its mounting plate should now be removed and the motor lifted clear. Do not disturb the screws fixing the motor mounting plate to its pillars.

Note: If desired, the navigation camera and lights may be removed, as described earlier to give improved access while remove the height motor.

Fitting the replacement motor is a reversal of removing the old one. When inserting the new motor, ensure that its spigot locates correctly in the recess on its mounting plate.

The motor and tacho wires should be cut to length and connected into the pedestal wiring using in line crimp connectors, before finally replacing the control panel and if removed, the line scan camera and lights.

6.9 Height Gearbox.

Removing the height gearbox is a major operation, which requires the assistance of at least one other person at various times.

Before any work is carried out on the height system all operations in sect 6.2 " Decommissioning the pedestal" must be carried out.

CAUTION

1. The importance of ensuring that the locking pin is fully inserted when the height column is in the raised position cannot be over emphasised.

2. Do not work on the top (smallest diameter) column tube without reference to sect 6.6, as it is only supported by the top lifting cables and not by the locking pin.

6.9.1 Removal.

1. Release both gas springs see sect 6.2.

2. Now remove the floor cable bracket and the two IR receiver PCBs from the bottom plate. Also disconnect the clutch wires from the terminal block.

3. Slacken the height chain by loosening the four M6 black hex screws clamping the sprocket block, then undo the M8 hex screw on top of the block by a turn or two until the chain is slack enough for its spring link to be removed. Note that access to two of the clamping screws is through holes in the height potentiometer plate. Pull back the released end of the chain into the column tube by rotating the sprocket and gears.

4. Loosen the screws at each end of the motor coupling and slide it down the gearbox shaft. Undo the five M8 hex head screws fixing the height gearbox to the bottom plate and remove the complete unit from the pedestal. This operation is tricky and involves moving the wiring around to get the gearbox into a suitable position where it can be removed between the two rear corner tubes.

6.9.2 Replacement.

The procedure for replacement is a reversal of the removal procedure with special attention to the following points:

1. Liberally coat the chain and sprocket, and if necessary the gears, with Rocol Tufgear 8S before refitting the gearbox in the pedestal.

2. Engage the length of chain from inside the column tube onto the chain sprocket.

3. Rotate the sprocket so that the spare chain is drawn upon the sprocket,

4. When the end of the chain appears take hold of it with your other hand and pull it out and upwards until the vertical chain run is taut. The two ends of the chain can now be brought together and the spring link replaced. Ensure that the spring clip is replaced on the right hand side of the chain.

5. The M8 hex adjuster screw on the top sprocket block should now be tightened until the height chain is lightly tensioned. Fully tighten the four M6 hex clamping screws. Check that the height potentiometer is correctly meshed. Note that the height chain cannot be correctly tensioned at this stage, but it is important that it is done as soon as the locking pin is released and the payload installed.

6. Using a digital resistance meter, measure the resistance of the feedback potentiometer between the upper terminal, marked “11” and the lower terminal, marked “12”. Make sure the resistance is **between 2.3kΩ and 2.7kΩ.**

7. Adjust the rotation of the pot. (before the gears are tightened onto their shafts), so that the resistance measured between the middle terminal marked “10” and the lower terminal (marked “12”) is **between 190Ω and 210Ω.**
Fix the gears on their shafts.

8. With the payload in position and the height column fully raised the slack in the height chain will have increased. Loosen the four M6 hex clamping screws on the top sprocket block just enough to allow the M8 hex screw on the top to be adjusted. Tighten this screw until the slack that can be felt on the inside chain run is approx. 5 - 10 mm. Re-tighten the four clamping screws and check the height manual movement over its full range to ensure all is satisfactory.

6.9.3 Replacing the height clutch.

In order to replace the height clutch it is necessary to remove the height gearbox as described in sect 6.9.1.

During initial assembly the worm gearbox output shaft was accurately aligned with the drive pinion shaft by careful location and shimming of the mounting plate, which attaches the gearbox to the base plate. When removing this plate, carefully note the position of any shims and scribed location lines, as exact replacement is essential.

1. Loosen the grub screws holding the clutch armature to the pinion shaft. Remove the three M8 pan head screws under the base plate, which secure the worm gearbox mounting plate. The gearbox and clutch can now be pulled off the pinion shaft. The clutch may now be pulled off the worm gearbox shaft.

2. Check the Oilite bearing has been fitted to the new clutch, it should protrude by approx. 3mm. Check that the spacer between the clutch and the gearbox is in place, then push the bearing end of the clutch onto the gearbox shaft. Make sure that the pin locates in the hole on the clutch coil arm and ensure the spacer is fitted between the two clutch halves. Replace the worm gearbox and slide the clutch armature and rotor until both spacers are in light contact with their respective interfaces. Then tighten the grub screws in the armature spigot and check the air gap, which should be 0.2mm.

3. The height gearbox can now be refitted as described in sect 6.9.2.

6.10 Replacing the height potentiometer.

Make sure the column is fully raised. Switch off battery power and base station, remove rear metal cover and unplug floor cable.

Note the potentiometer wiring and unsolder it at its terminals. Remove the four M4 hex socket screws and lift off the pot, mounting plate and gear. Note the position of the gear on the pot shaft, before loosening its clamp screw (Imperial size) and pulling the gear and clamp off the pot shaft. Next separate the pot from its mounting plate by removing the three clamps, note the position of the pot terminals.

Position and refit the new pot to its mounting plate and re tighten the fixing clamps. Replace the gear and clamp in the previously noted position and tighten the clamp.

Replace the unit on the RP2A, ensuring that when the gears are meshed the gear clamp screw is accessible. Move the pot mounting plate to mesh the gears for minimum backlash, and then tighten the four mounting plate fixing screws. Loosen the gear clamp on the pot.

Using a digital resistance meter, measure the resistance of the feedback potentiometer between the upper terminal, marked “11” and the lower terminal, marked “12”. Make sure the resistance is **between 2.3kΩ and 2.7kΩ.**

Adjust the rotation of the pot. (before the gears are tightened onto their shafts), so that the resistance measured between the middle terminal marked “10” and the lower terminal (marked “12”) is **between 190Ω and 210Ω.**

Check that the gears are in line and fully tighten the clamp screws. Then reconnect the pot wires to their respective terminals. Replace the covers, floor cable and restart the RP2A.

SECTION 7. ELECTRICAL MAINTENANCE.

7.1 FUSE REPLACEMENT.

Power to the servo amplifiers is controlled by the following fuses, which can be found at the side of the pedestal base adjacent to the main power switch, behind the side cover: -

Supply	Positive		Negative
Pan	F1	-	F7
Tilt	F2	-	F8
Height	F3	-	F9
Drive	F4	-	F10
Steer	F5	-	F11

Power to the Electronics card cage is controlled by the following fuses, located as above: -

Electronics F6 - F12

All these fuses are 5AT (5 amp, slow blow), 20 X 5mm.
Note: The fuses should be identified on the inside of the side cover.

Fuses F13 and F14 are 20 amp fast acting automotive types and can be found in the wiring loom behind the main power switch. Their main purpose is to prevent damage to wiring in the event of a short across the Base Station connector pins, or floor cable and to prevent battery discharge.

7.2 BATTERY REPLACEMENT.

The on board batteries are housed on a tray located adjacent to the main power switch, behind the side cover. They are on continuous charge whilst the pedestal is connected to a powered Base Station. Their purpose is to account for power surges when a pedestal accelerates or decelerates. With the pedestal stationary the voltages measured across the battery terminals should be as follows:

Batteries B1 & B2	+20.7 volts
Batteries B3 & B4	-20.7 volts

If these voltages are not maintained then the batteries must be replaced. They must be replaced in pairs B1+B2 and B3+B4. They are standard Gel type sealed lead-acid batteries for deep cycle applications. B1 and B3 are rated at 6 volts and B2 & B4 are rated at 12 volts, 5.7 Ah.

The batteries can be bench tested by connecting to a constant voltage dc supply, set to 6.9v for the 6 volt battery and to 13.8v for the 12 volt battery. A ‘good’ battery will draw a high current initially, dropping rapidly to milliamps as the battery voltage settles down.

7.3 Servo Amplifiers.

Pan, Tilt and Drive servo amplifiers are located on the top chassis plate above the battery tray. The Height servo amplifier is located on the top chassis plate above the electronics card cage. The Steer servo amplifier is located on the base plate adjacent to the steer motor, in front of the electronics card cage. Each amplifier is labelled with the axis it is driving. Each amplifier is fixed by 4 captive screws with long hexagonal heads. When replacing a servo amplifier the correct ribbon cable and spade tags must be connected according to the wiring diagrams.

Servo amplifier operation can be monitored at the pedestal local control panel. There are LED indicators for each of the 5 functions. The +VE and -VE direction indicators will illuminate (alternately) when a function is moving to show there is an output to a motor. The AMP indicator will illuminate if a function stalls to show that the current limiting is operating for motor protection. Lack of these indicators when a function should be operating will indicate a faulty amplifier.

7.3.1 Setting Up.

7.3.1.1 Servo Performance.

Analogue circuits are employed to drive the servos for each function. These circuits are combined on the servo amplifiers and the servo processor card (found in the electronics card cage). Pan, tilt and height operate as position servos whilst steer and drive operate as velocity servos. The performance of each function can be adjusted by means of the gain links A to D in table 1 and the tacho adjustment trim pots on the front edge of the servo processor card:

Pan	-	VR11	Steer	-	VR41
Tilt	-	VR21	Drive	-	VR51
Height	-	VR31			

Table 1 indicates the preferred gain settings. The gain settings may be changed to aid performance if necessary.

TABLE 1 - SERVO PROCESSOR CARD LINKS

Pan	J11	P	J12	B
Tilt	J21	P	J22	B
Height	J31	P	J32	A
Steer	J41	V	J42	D
Drive	J51	V	J52	D

7.3.1.2 Servo Amplifiers.

The Servo Amplifiers have facilities to insert configuration components to suit the application. The preferred component values are shown in table 2.

A filter PCB is mounted above the servo amplifier and this must be remove to gain access to the components shown below.

TABLE 2 - SERVO AMPLIFIER CONFIGURATION

Component reference	PAN	TILT	HEIGHT	DRIVE	STEER	FUNCTION
C3	**0.1uF**	**0.1uF**	**0.1uF**	**0.1uF**	**0.1uF**	
C11	**47K**	**47K**	**47K**	**47K**	**22nF**	
C12	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	
C41	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	
R40	**1K**	**1K**	**3K9**	**Not fitted**	**Not fitted**	**Cont. Current**
R11	**100K**	**100K**	**47K**	**3K9**	**39K**	**Servo Gain**
R6	**220k**	**220k**	**220k**	**220k**	**220k**	**Tacho Gain**
R7	**220k**	**220k**	**220k**	**220k**	**220k**	**Tacho Gain**
R12	**Not fitted**	**Not fitted**	**Not fitted**	**100K**	**100K**	
R1	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	
R42	**6K8**	**6K8**	**10K**	**18K**	**10K**	**Peak Current**
R20	**47K**	**47K**	**47K**	**47K**	**100K**	
R61	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	**Not fitted**	

NB The component used for C11 in most cases is a 47K resistor (not a capacitor)

7.4 Infrared Detectors.

The RP2A Pedestal employs an Infrared proximity detector system to sense when it moves near to another substantial object for collision avoidance. LED infrared emitters provide an angled curtain of light around the pedestal with an effective range of 0.4 metres approximately. The light is modulated with each pedestal being set to 1 of 8 codes so that a pedestal will only act upon reflections of its own emissions. In the event of a suspected failure, each emitter diode may be checked using a DVM diode checker for correct operation. A visible red LED is associated with each transmitter strip located around the perimeter of the upper plate in the RP2A base. The top covers need to be removed to gain access to the transmitters. If the LED is illuminated then it is very likely that all the transmitters on that strip are functioning correctly.

7.4.1 Emitter Coding.

The emitter coding is set by the SW1 on the Miscellaneous & Safety card in the card cage which sets the code from 0 to 7 in hex.

7.4.2 Receiver Coding.

There are 8 IR Receiver cards, 5 mounted to the bottom chassis plate and 3 mounted in pods on the wheel housings. Each of these has a SW1 corresponding to the code selected on the Miscellaneous & Safety card.

7.4.3 Adjusting Sensitivity.

There are 8 zones around the pedestal corresponding to the 8 IR Receiver cards. These are indicated on the diagram on the Local Control Panel. However, there are only 6 emitter zones since 2 each cover 2 receiver zones, that is the 2 long sides. The intensity of the IR curtain can be adjusted for each of these 6 zones by means of trim pots RV1-6 on the Miscellaneous & Safety card. Each trim pot and its corresponding Receiver zones is as follows:-

TRIM POT	ZONE
RV1	1
RV2	2&3
RV3	4
RV4	5
RV5	6
RV6	7&8

The sensitivity for each zone can be set by driving the pedestal towards a suitable object placed in that zone until the pedestal stops. The corresponding trim pot is adjusted and the exercise repeated until the pedestal stops at the required distance from the object. This is repeated for each zone. Clockwise rotation of the trim pots increases sensitivity. It is often found useful to increase the sensitivity until IR violations are obtained with no objects in view i.e. reflections from the floor. Then reduce the sensitivity until no IR violation is found.

7.5 Steer Reference Alignment.

When an RP2A is powered up in servo mode the steer axis rotates to find its reference direction, since steer axis rotation is measured via an incremental encoder on the servo motor. The reference direction is set by aligning a disc slot with a slotted opto-switch. This is located on the wheel assembly to the right of the Local Control Panel. There is a fine adjustment on the position of the opto-switch for setting the reference direction (the steer/home position). Final alignment is best carried out on a studio floor, with the payload fitted, after installation of the pedestal.

The following procedure should be followed to ensure that a pedestal will steer correctly between stored shots. The pedestal should be placed 1 to 2 metres from a line of targets such that it can ‘see’ 3 targets, with its rear panel parallel to the targets, i.e. Steer + / - indicators not lit.

This near position is stored and alignment marks are put on the floor and the pedestal. The pedestal is then driven to a far position at least 5 metres from the targets, perpendicular to the targets, i.e. with NO (minimal) ‘X’ movement. This far position is stored and alignment marks put on the floor and the pedestal.

The pedestal is returned to the near ‘shot’ and its alignment checked against the marks. CUT to the far ‘shot’ and check the alignment against the marks. If there is a significant misalignment the opto-switch position must be adjusted. Switch power OFF then ON again to re-reference the steer axis then repeat this routine until the pedestal CUTS from the near to the far ‘shot’ with no significant misalignment.

SECTION 8. CIRCUIT DESCRIPTIONS.

8.1 Pedestal Wiring HK807-005-2001W (4 sheets).

The pedestal interconnections are centred on the electronics card rack in the base of the pedestal with power supplied via the internal batteries. The diagram of connections is divided into 4 separate sheets.

Sheet 1 is a block diagram for the interconnections of the remaining sheets. It illustrates the signal routing from the electronics card rack to each of the servo mechanisms and to the various sensors around the pedestal. It shows how power is distributed from the internal batteries, including power switching and battery protection. Note the external connections to the Head/Lens, the Base Station and the Test Set.

Sheet 2 shows details of all the wiring from the electronics card frame to the external connectors, servo amplifiers, line scan camera, local panel, safety sensors and batteries.

Sheet 3 shows details of all the wiring between the servo amplifiers, relays, motor/generators and position sensors. It also shows wiring to clutches, micro switches, bumper strips and infrared receivers.

Sheet 4 shows details of power wiring inter connections, fuses and switches all centred on the batteries.

8.2 Analogue Card HK705-034-2001 (8 Sheets).

The Analogue card is located in the control electronics card rack in the base of the pedestal. It has a YELLOW identification colour.

the circuit diagram covers 8 separate sheets. The card interfaces to the digital buses of the card rack to provide digital to analogue an analogue to digital conversion for signals to and from the Servo Processor card. The card is connected to the +15v logic and to the +/-15v analogue supply rails.

Sheet 1 is a block diagram for the interconnections of the remaining sheets. It also shows regulation for -5v and +/- 12v supplies for card use.

The upper circuit block of sheet 2 shows 16 channels of analogue inputs, a 16 channel multiplexer and buffer leading to a 12 bit analogue to digital converter. These inputs are the 5 position signals and 5 position error signals (for pan, tilt, height, steer and drive respectively) from the servo processor card, provision for zoom and focus position feedback and 4 spare inputs. The lower circuit block shows the reference voltage generation, +/- 5v for card use and +/- 10v for system use.

Sheet 3 shows the BUD interface circuits and generation of chip select signals via a FPGA device for card use.

Sheets 4 to 7 have identical circuits, each showing 4 channels of 12 bit digital to analogue converters. Sheet 4 shows channels 5 to 8, that is; steer, drive, zoom and focus respectively. Sheet 5 shows channels 9 to 12, that is; iris, black and 2 spare respectively. The channels of sheets 6 and 7 are spare. The circuits show the test points for monitoring the analogue signal outputs (range +/- 10v).

Sheet 8 shows 4 x 16bit D/As for Pan, Tilt, Height, and Spare.

Components relating to the spare output channels are not fitted to the card. Jumper links on the card are set in the factory and must not be changed.

8.3 SERVO PROCESSOR CARD HK705-028-2001X.

The servo processor card is located in the control electronics card rack in the base of the pedestal. It has an ORANGE identification colour.

The circuit diagram covers 5 separate sheets. The card provides analogue signal processing for each of the functions pan, tilt, height, steer and drive with a separate sheet for each function. All functions have identical circuits but sheet 1 also shows the power rails, LOCAL/REMOTE signal input, test box signal input and analogue switches for zoom and focus signals. The card is connected to +/- 15v power rails.

Block 1 of the circuit buffers and filters the demand signal from the digital to analogue converter card and this can be connected its input is switched in automatically by the analogue switch.

Block 2 is a differential buffer for a position feedback signal from the controlled function and its output can be monitored at TP12 (range +/- 10v). It also generates a screen driver signal to minimise noise problems from the cables.

Block 3 sums the demand and position signals to generate a position error signal which is then amplified. Link J11 is set to P for a position controlled function or to V for a velocity controlled function when the demand signal can bypass this stage. Block 3 also generates an error monitoring signal for the digital processor cards.

Block 4 buffers and scales the tacho signal from the motor/generator and its output can be monitored at TP14 (range +/- 10v). Trim potentiometer VR11 provides signal adjustment with CW motion increasing the signal.

Block 5 sums the block 3 output and tacho feedback signals to generate and amplify a velocity error signal to output to the servo amplifier. This signal can be monitored at TP15 (range +/- 10v). The gain of the block 3 signal can be varied according to function by the setting of the J12 link. When the system is switched to LOCAL the block 3 output is disconnected and the stage gain is reduced via the analogue switch so that the function can be operated manually.

block 6 generates an error monitoring signal for the digital processor cards. This signal is time delayed so that only a persistent error signal is detected. This block is normally disabled by omitting a resistor.

Pan, tilt and height are position controlled whilst steer and drive are velocity controlled with respect to this card. See link settings in sect 7.3.1.1 & 2.

8.4 PWM AMPLIFIER HK140-094-0001.

The main part of this amplifier is manufactured by Elmo Motion Control Ltd., but an additional filter pcb, HK707-475-0001 is mounted on top of the amplifier to remove the switch mode component of the output drive to the motor. This board also provides convenient terminations and connections.

8.5 PAN BAR JOYSTICK UNIT HK705-065-2001X.

This pan bar mounted control is provided for local servo operation of pedestal X-Y-height when the RP2A is switched to LOCAL. Pushing left or right moves the pedestal left and right, moving the joystick forwards and backwards, moves the pedestal forwards and backwards. It should be noted that these directions are with respect to the head position, twisting the joystick raises and lowers height

column. It may be necessary to reset the joystick using the switch located on the base after re-powering the RP2A.

IC 4 provides a stabilised 5v supply.
IC 3 provides the +2.5v reference for the joystick.
IC 1 encodes the joystick offset information and sends it in TTL data format to IC 2 where it is converted to RS422 format. The data is then sent to the Navigation and master processor card in the RP2A.

8.6 SERIAL/TARGET PCB HK705-025 2001T.

The serial card is split into two independent sections: serial processing and target acquisition. The former section handles serial communications and calculates the dead-reckoning co-ordinates of the Pedestal. It has a BLUE identification colour.

8.6.1 Serial Processing.

1. Reset (Drawing HK705-025-2001T sht 2 of 8)

IC7 provides a reset signal to the main CPU IC9, DSP IC30 and UPP IC20. If the 5V supply is inadequate for any reason then the CPU will not start up. At least 4.75V is necessary. Any voltage drop below this figure is likelyto reset the CPU.

Link LK1 position 1-2 enables other boards on the PL2 bus to reset the serial PCB. This option is normally off (position 2-3).

2. CPU (Drawing HK705-025-2001X sht 3 of 8)

The 80188 CPU generates a clkout signal on TP3 of 12MHz. Buffered active low read and write lines may be monitored on TP1 and TP2. LED9 flashes at 1Hz to indicate successful startup of the program. A reset out signal from the CPU resets the octart.

After a reset, the CPU waits first for a steer home index pulse then a 180 degree move of the steer home disc. After that the main software loop starts up and allows access with an RS232 monitor.

3. SHADOW RAM (Drawing HK705-025-2001X sht 4 of 8)

It is possible to fit shadow ram onto the card for the sole purpose of debugging software. The SHADEN line can be forced low to run code from the shadow ram which enables the use of breakpoints, once the program has been downloaded. SHADEN comes from a parallel output port pin on the octart and must be high for the CPU to start up.

4. OCTART (Drawing HK705-025-2001W sht 5 of 8)

Four channels of RS422/RS485 plus two channels of RS232 serial data are controlled by the octart IC14. One of the RS232 channels is made available on the 9-way ‘D’ connector PL3 and may be used as a monitor port to interrogate both dual-port rams and drive the monitor program. Note that pins 2,3 and 7 are used. Each RS422 channel has a tri-colour led associated with it to show reception and transmission of data.

Led5 flashes at 1Hz after completion of steer home. It is driven by a software task and indicates all is well. Switch SW3 is used to select the pedestal’s camera number; normally 1 to 8 are chosen uniquely but addresses 0 and 9-F have been selected for special software versions.

The octart has digital inputs and outputs. One output is used to reset the DSP if the dsp’s watchdog has not incremented. Interrupts from various sources are fed to the CPU via the octart. These are dual-port ram interrupts and the UPP interrupt. The latter interrupt occurs every 10 pulses from the drive servo motor encoder; the dead-reckoning system relies on these.

5. UPP (Drawing HK705-025-2001X sht 8 of 8)

Led6 flashes at 1Hz once the UPP has been programmed by the CPU. Led7 is normally off and is illuminated when the internal watchdog times out. Steer and drive motor encoder quadrature pulses control two up/down counters inside the UPP. An interrupt UPP INT is generated every 10 drive counts.

Five supply rail voltages are digitized by the UPP. The resistor dividers R3-R12 are chosen to provide plus 2.5V when the supplies are correct. A PWM output is used to control the target illumination level. The PWM has a 1kHz prf and its mark/space ratio is controlled. Link LK5 must be in as it enables the dc restorer circuitry.

A SYNC/INT pulse is generated every 25 or 50ms which tells the CCD line-scan camera to output a line of data. For the 2ms data transfer period, the PWM output is suspended to prevent interference to the data.

6. TARGET ACQUISITION. (Drawing HK705-025-2001W sht 7 of 8)

The 2048 element CCD line-scan camera requires two pulse trains: a pixel clock of 1MHz and a line synchronizing pulse. The pixel clock is obtained by dividing the 4MHz clock from the UPP (IC20) in both a D-type latch (IC38) and also the EPLD (IC27). Sync pulses are generated by the UPP and one occurs every 25 or 50ms, depending on how long the DSP chip (IC30) needs to process a scan line. Both signals are converted into two-phase RS-422 to drive the camera. The camera returns the pixel clock and a sync pulse VALID IN. Links LK2 and LK3 are only fitted for single-ended sources; the line-scan camera has differential outputs so the links are not used.

It is helpful to regard the DSP sub-system as a slave unit. It will not function until fed with CLK IN and VALID IN which are generated when the UPP has been initiated by the CPU (IC9). It must be stressed that if for any reason the UPP cannot be set up then the DSP section will just sit

in an infinite loop waiting for a sync pulse return from the line-scan camera.

If these two signals are correct then the DSP digitises the camera's video, scans the 2048 values for targets and updates dual-port ram (IC37) with the start pixel of each detected target. Most of the circuitry is quite straightforward but the digitising section is not obvious and so is explained.

To digitise a scan line as quickly as possible several techniques have been used. Firstly a flash 8-bit ADC converts the input video on receipt of a CONV pulse which comes from the EPLD. This pulse is derived from CLK IN and triggers the conversion at the centre of each pixel. The EPLD then generates a pulse to latch the ADC's output data into either a low or a high latch (ICs 31 & 32). When two pixels have been converted and stored in both latches an interrupt is fed into the DSP; both latches are read as a single 16-bit read. This halves the number of interrupts per line. After about 1024 interrupts the DSP stops the conversion routine and can process the data now stored in fast memory (ICs 33 & 34). Light is integrated in the CCD array during the DSP process phase. Processing ends the cycle by updating the dual-port ram and waiting until the next sync pulse comes along.

The flash converter needs input amplitudes of 0 to -2.0V therefore the video input is inverted and amplified by op-amp IC29. A minus 5V power supply comes from dc-dc converter PSU1. This supply drives both the op-amp and ADC, and is also regulated at -2V by TR1 and ZD1 to supply the resistor network inside the ADC.

SW4 is used to select boot program from dual-port ram, or from the boot EPROM (IC35). It is possible to further select which half of IC35 to boot from; currently only the lower half is programmed, so the switch must be set correctly. These correct positions are marked on the PCB. A reset signal is sent to the DSP via AND gate IC8B. Reset either comes from power-up or from the serial CPU if it has seen no change in the dual-port ram watchdog location.

Some test points are provided to assist fault-finding. TP9 is 0V, TP5 is -5V and TP6 is inverted CCD video. LED8 is connected to TP7 and this test point shows the DSP waiting for sync, reading the array or processing data when the voltage is low, toggling every 2ms or high respectively. TP45 is a 10MHz clock output from the DSP.

8.7 NAVIGATION/MCP PCB HK 705-024-2001W.

The navigation card is split into two separate processor sections, master control and maths processing. It has a RED identification colour.

8.7.1. Master processor.

1. RESET (Drawing HK705-024-2001W sht 3 of 12)

IC27 provides a reset signal to the main CPU IC1. If the 5V supply is inadequate for any reason then the CPU will not start up. At least 4.75V is necessary. Any voltage drop below this figure is likely to reset the CPU.

This drawing also shows IC25, the power supervisory chip, which intercepts memory writes when the 5V rail is below 4.75V. A lithium battery powers battery-backed ram under these conditions. Resistor R13 must not be fitted. Its purpose is to provide a small trickle charge current if NiCd rechargeable battery is used instead of a lithium one.

2. CPU (Drawing HK705-024-2001X sht 4 of 12)

The 80188 CPU generates a clkout signal on TP5 of 12MHz. Buffered active low read and write lines may be monitored on TP3 and TP4. A reset out signal from the CPU resets the duart IC17 and PIO IC6.

After a reset, the CPU waits for the serial card to report a steer home complete flag in dual port ram. After that the main software loop starts up and allows access with an RS232 monitor.

Two spare hex rotary switches are mapped into I/O space on PCS1. The PIO is also mapped into I/O space but with PCS0. All other peripherals are mapped into memory space using MCS controls. The PIO outputs a pulse on PC7 to maintain a watchdog timer IC24. It also drives the LEDs on the local panel with a serial data stream and reads back MAP SELECTION from it.

3. SHADOW RAM (Drawing HK705-024-2001X sht 6 of 12)

It is possible to fit shadow ram onto the card for the sole purpose of debugging software. The SHADEN line can be forced low to run code from the shadow ram which enables the use of breakpoints, once the program has been downloaded. SHADEN comes from a parallel output port pin on the duart and must be high for the CPU to start up.

4. DUART (Drawing HK705-024-2001T sht 5 of 12)

The DUART has two serial channels. The first is for an RS232 monitor; there are two 9-way ‘D’ connectors in parallel: PL3 on the Nav PCB and also the connector on the local panel. The second channel operates as an RS422 link for use with the Cue Computer.

8.7.2. Maths processor.

1. CPU (Drawing HK705-024-2001X sht 9 of 12)

Test points TPs 6,7 and 8 are on buffered read, write and 12MHz clock out lines. The CPU obtains its reset from the master CPU.

2. MATHS CO-PROCESSOR (Drawing HK705-024-2001T sht 10 of 12)

An EPLD is used to generate 68000-bus compatible signals to operate the maths co-processor IC37. The co-processor is clocked at 20MHz which can be conveniently measured on pin 1 of the EPLD. IC37 is a Motorola 68882-20, and was chosen because of its superior tan/ atan capability compared with Intel co-processors.

3. DUART (Drawing HK705-024-2001T sht 11 of 12)

The DUART IC39 works in a similar way to IC17. It controls shadow ram in the same manner as the other CPUs. It also is able to reset the maths co-processor. One of its serial channels is brought to 9-way ‘D’ plug PL4 on this PCB, and may be used with an RS232 monitor for testing purposes.

8.8 MISCELLANEOUS PCB HK 705-029-2001X.

The miscellaneous/safety card provides regulated plus and minus 15V and 5V power rails, drives relays and handles the safety sensors viz. IR detectors and bumper switches. There is no processing power on this PCB; all latches are controlled by the navigation PCB. It has a WHITE identification colour.

1. REGULATORS (Drawing HK705-029-2001X sht 7 of 7)

The 5V supply is generated by a switch-mode dc-dc converter IC10. Its output may be checked using test points TP11 (+v) and TP12 (0v). All 5V logic is powered from this supply.

Four linear regulators provide clean +/-15V supplies to power the analogue/digital converters, 10V references, lens interface unit, head clutches and the FET amplifiers. Note that the regulators, heat sinks and wire wound resistors R5, R9, R14 and R18 are likely to get hot. Test points TP5 and TP7 are on the two +15V supplies and TP6 and TP8 on the -15V supplies.

***2.** IR TRANSMITTER (Drawing HK705-029-2001T sht 4 of 7)*

SW1 is used to set the between 0 and 7 for the IR emitters. The output of IC5 may be checked at TP4 and will consist of a 38KHz carrier and switch code gap. Oscillation at 4MHz may be checked for on pins 16 and 17 of IC5, but beware that the 'scope probe's capacitance can affect the oscillator.

3. IR DRIVERS (Drawing HK705-029-2001X sht 6 of 7)

The transmitter signal is fed to 6 IR drivers TR3, TR5, TR7, TR9, TR11 and TR13. These transistors feed high current pulses through 6 chains of series-connected IR emitters. A multi-turn pot enables the current in each chain to be independently adjusted to minimise false triggering.
Re-triggerable monostables monitor drive current for diagnostic purposes.

4. IR LOGIC (Drawing HK705-029-2001X sht 3 of 7)

IR receivers from all zones are fed into latch IC3 and gate IC1. If any zone's receiver detects sufficient IR, TP1 rises and IC6 sends an interrupt to the navigation CPU via the motherboard. The same procedure is followed in the case of bumper hits but these are monitored on TP2. The three latches IR, BUMPER and IR FAIL are clocked by this interrupt to store its cause so that it may be subsequently read by the CPU. Test point TP3 is the clock signal.

5. RELAY LOGIC (Drawing HK705-029-2001X sht 5 of 7)

A series chain of local and remote emergency stop switches connects one end of RL9's coil (E/S RET) to 0V when all the contacts are made. When pressed, the white reset button on the local panel feeds 20V to RL9's coil (E/S RES-) thus energising the relay. Contacts 9 and 13 feed 20V in parallel with the reset button to keep the relay self-latched on and feed power to coils of relays RL1-5. These relays enable pan, tilt, height, drive and steer servos. If any emergency stop switch is pressed, relay RL9 will immediately turn off and cause relays 1-5 to disengage.

There are two clutch relays RLs 7 and 8. RL8 is controlled by a local/remote switch; all the others are controlled from the bus.The state of relay 1-5 and 9 may be read by latch IC12.

The monitor program on the navigation CPU can access the Miscellaneous cards ports as follows:
address = cardseg + msc_card + index

cardseg =	30000H
msc_card =	1000H

index:

0000 infrareds	CS1
0100 bumpers	CS2
0200 aopouts	CS4
0300 aopins	CS5
0400 latch_saf	latch
0500 irfails	CS3

8.9 IR RECEIVER PCB HK 705-483-0001/2.

The IR receiver sends a signal to the Miscellaneous/Safety card when modulated IR energy is received with the correct code.

Decoder ICI is fed from IR detector IC2 and other similar detector connected to PLB (HK705-484-0001/2). The IR detector is housed in a compact 3 pin package complete with integral lens. Circuitry is incorporated within it capable of receiving a modulated 38kHz signal and converting it to a logic pulse train output which is fed to IC1.
The Hex switch SW1 is used to select the appropriate code. The decoder uses a 1MHz crystal on its “osc.” pins. Oscillation may be checked with a ‘scope probe, but it must be remembered that probe capacitance can affect oscillation.

SECTION 9. PROBLEMS & SOLUTIONS.

The following pages contain various likely problems and possible solutions.

Note: Conditions for start up under remote control:

N.B. Check the following 6 points BEFORE following the Problems & Solutions guide:

1. Release studio emergency stop switches (*including emergency stop link on the Base Station, if a remote emergency stop switch is not fitted)*
2. Release RP2A emergency stop switches
3. Crab/Steer in CRAB
4. Manual/Servo in SERVO
5. Local/Remote switch in REMOTE
6. Power isolation switch ON

Conditions for navigation system to operate; internal camera to be able to see 3 targets min. Rear panel parallel to targets, STEER + / - indicators OFF. Correct MAP selected on Local Control Panel. Targets currently set according to MAP. Target illumination lamps operating.

Symptom	Check	Correction
Unit will not power up. No lights on local panel, cooling fan not running.	Check battery connections are ok	Re-connect batteries
	Check all fuses are ok	Replace if necessary
	Check battery voltage	Replace batteries (See Sec 7.2)
	Check battery charging voltage	Replace base station
	Check floor cable	Replace / Repair floor cable
Unit powers on but will not start after E/Stop Reset is pressed	Check manual/servo knob is in servo	Put into Servo
	Check steer/crab knob is in crab	Put into Crab
	Check head cable is properly connected to Base and Head	Connect Head Cable
	Check indicators on serial card	Replace Serial Card
	Check indicators on Navigation Card	Replace Navigator Card

Symptom	Check	Correction
Unit powers on but will not start after E/Stop Reset is pressed *(Cont.)*	Check emergency stop buttons are not pressed	Release E Stop buttons
	Check relays and clutches engage (audible click)	Replace Miscellaneous Card
	Check 'Watch Dog Lights' are not on, if not.....	
	Check voltage on batteries	If less than 20.7, replace batteries and/or:
	Check voltage on batteries and base station as above.	Base Station Adjust charging voltage.
Unit continues to steer after start up	Check steer index disc is intact.	Replace disc
	Check photo-detector is intact and connected properly.	Replace/reconnect
	Check index signal is present on Serial Card if it is then.....	Replace Serial Card
	Check that a valid map is set	Select correct map (Maps 0 - 4) for targets used
Unit starts but does not respond to operator's panel	Check camera is selected on operators panel.	Select camera
	Check unit does not have same camera identity as another connected to same panel.	Change camera identity # to an unused one between 1&8 compatible with your panel.
	Check TCP system is switched on.	Switch on TCP System.
	Check operators panel is functioning.	See section.....in TCP Manual.
	Check the IR system has not been violated	Remove obstruction and/or override IR system from operators panel
	Check the Bumper has not been violated.	Remove obstruction and /or override Bumpers.

Symptom Check Correction

Unit starts but does not Respond to operator's panel *(Cont.)*	Check IR system is not being activated by floor system reflections.	Reduce power to IR See section 7.4.3
	Check joystick has been selected on Operators Panel if only X Y does not respond check that comm-unication has been estab-lished between TCP system and RP2A.	Select 'Joystick Enable'
	Check green LED(s) are flashing on RP2A local panel marked 'PANEL'.	
	Check Operators Panel comms LED is flashing green and red. If none of the above are ok check comms cables.	Restart RP2A Replace/remove serial cable from PCU to Base Station.
	Check if other cameras respond when selected if not check Panel.	Repair/replace panel.
	Check that camera selec-tion button illuminates when selected. If not check serial data cables.	Replace/repair serial cable from Panel to Base Station.
Unit starts but only responds to joystick and will not store or recall shots.	Check that RP2A is not un-referenced (message appears on touchscreen and green LED on Local Panel.)	Move RP2A about 2m in front of targets. Make sure three or more targets are visible as displayed on local panel. Re-start RP2A in this position.
	Check that 'Orientation' message is not present. If so re-orientate RP2A.	Put RP2A in manual and manoeuvre it in view of the target (at least 3) so that the steer + and - red LEDs are extinguished. Restart RP2A.
	Check that none of the axes is outside assoc-iated limits.	Using trim controls, put all axes P,T,Z,F,H (and camera functions) to approx mid position. Re-try.

Symptom	Check	Correction

Unit starts but only responds to joystick and will not store or recall shots *(cont.)*	Check that the selected map corresponds to the actual target configur-ation	elect correct map from he local panel and re-tart RP2A.
RP2A appears to function correctly, but one or more axes do not move	Check there are no physical restraints i.e. trapped cables, locking pins etc. Check you are not against an end stop for the particular axis	Remove restraints or locking pins.
	Check that 'Limits' are set correctly (especially if limits have been set via the TCP system)	Correct or remove appropriate limits. (Clear limits set in TCP system, with camera selected)
	Check the relevant fuse(s) are ok if not.....	Check wiring and Replace the fuse(s)
	Check local panel for Amp drive	Change amp
Navigation accuracy is poor	Check that RP2A can accomplish a long move in X or Y in cut modes without running out of time ie. the time display on the touchscreen has finished counting down before RP2A has stopped.	Reduce the tacho adjust-ment for Drive on the Servo Processor PCB using the procedure. Sect 7.3.1
	If the RP2A consistently arrives either to the left or right of the expected shot position then adjust the Steer Index.	Adjust the Steer Index using the procedure in sect 7.5
	Check the wheel alignment.	Use procedure in sect 6.5
	Check that the targets are correctly positioned and not damaged.	Correct target positions and target condition.
	Check that the steer chain is tensioned correctly.	Use procedure in sect 6.4.2

Symptom	Check	Correction
Navigation accuracy is poor	Check that each of the elec-	Replace/Repair clutch.

(Cont.)	tric drive clutches are engaging correctly. Make sure each one clicks when E/Stop reset is pressed after switch on.	Sect 6.7
	Check that at least three targets are visible as indicated on the local panel. If not then check following.	Remove obstacles.
	Check that the navigation camera is not being obscured by cables etc.	Ensure cables are kept clear of RP2A rear area.
	Check both navigation	Replace lamps.
	lamps are illuminated.	
	Check that the lens on the navigation camera is secure and that it is set to f 5.6 and 4m focus.	Replace camera and send back to Radamec for re-cal.
X Y movement is absent	Check you are not in map F (static pedestal mode).	Select another map
	Check you have selected 'Joystick Enable' on Operators Panel.	Select Joystick Enable
	Check there are no IR or	Remove obstacle.
	Bumper violations.	
	Check the Manual/Servo control on the RP2A base is in servo.	

SECTION 10. RP2A SPECIFICATION.

X,Y Positional Repeatability	±15mm /m*
Maximum Drive Velocity	250mm/sec
Minimum Drive Velocity	3mm/sec
Height Repeatability	±3mm
Height Range	650mm to 1420mm
Maximum Height Velocity	60mm/sec
Minimum Height Velocity	2mm/sec
Maximum Pedestal Load	RP2A 70kg RP2AH 100kg
Maximum Residual Angular Error	10 minutes of arc*
Power Requirement (for battery trickle charge)	230V AC, 50Hz, 5A or 115V AC, 60Hz, 10A
Plinth Dimension	730mm x 840mm x 535mm high
Weight	220kg

* Dependent on studio conditions and distance traveled.

SECTION 11 TARGET MAPPING.

11.1 RP2A Target Mapping - worked example

Navigation System

The RP2 uses a CCD line scan camera to scan the studio wall for the location of bar coded 'targets'. These targets must be mounted very precisely, and the exact positions measured (within 0.5 mm) and programmed into the configuration EPROM.
Using the angles measured from the camera signal and the programmed target position information, the RP2 can calculate its position using 'triangulation'.

The targets are made of strips of black screwed onto a white 'retro reflective' material.
To give good visibility over ambient lighting, the targets are illuminated by two series connected lamps in the rear of the RP2, which are automatically controlled by the RP2 for optimum intensity, depending on distance from the targets.
Each target must have a unique code number and a 5 bit binary code is used.

The coding system is as follows: -

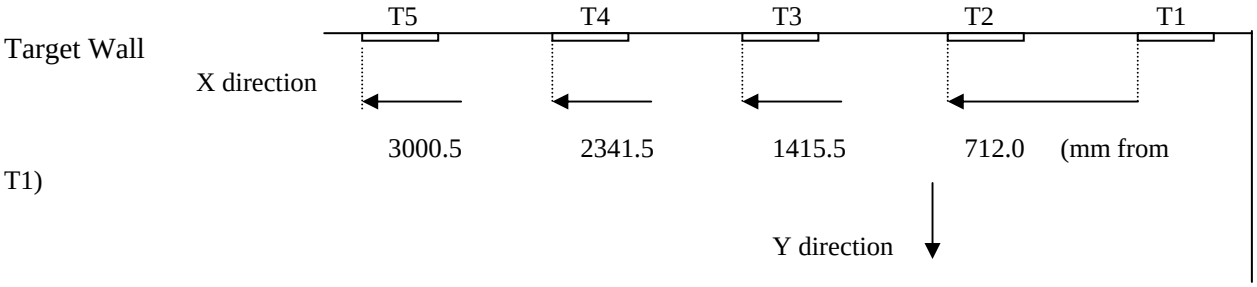
Start bit Data bits (5) Parity check bit (odd)

Logic zero is represented by a transition from white to black.
Logic one is represented by a transition from black to white.
The start bit consists of a 4x width white bar, followed by a single black bar.

The optical navigation system on the RP2 needs to see three targets at suitable angles in order to calculate its position and orientation precisely. Three is therefore the minimum required and a typical system may have many more but in any calculation three are used.
The maximum view angle of the line scan camera is 70 degrees, so any targets outside this area will not be seen. This means that as the RP2 gets nearer the targets there will be a position where it cannot see three targets. The distance away will depend on the target spacing.
At the nominal recommended spacing of 0.5 metres, the minimum distance to see three targets will be about 1 metre. In a very large studio, the targets may need to be spaced wider than 0.5 metres.

The minimum usable angle between two adjacent targets to give accurate navigation is 10 degrees. Thus there will be a position as the RP2 moves away from the targets where the angle between two targets becomes too small to use. This will be at about 3 metres for three targets spaced at 0.5 metres.

Ideally the targets should be mounted along a precise straight edge e.g. a metal angle bar, and fixed firmly to the studio floor. This means that only an 'X offset' measurement is required. A 'Y offset' may be used, but in practice is extremely difficult to measure to the required precision.
The targets should be checked with a spirit level for vertical alignment in both planes, and adjusted as necessary.



Measurements & calculations

Measure and note the distance in millimetres of each target from target 1 (or the rightmost target). The measurements should be made on the leading edge of each target, which is the left hand edge of the wide white strip on the left hand side of the target.

An offset must be applied to the measured distances, to ensure that the RP2 never gets into a 'negative number position', as the system cannot cope with such values.
An offset of 5 metres is normally used for both X and Y values, but in some cases this may have to be increased e.g. if the studio wall is more than 5 metres to the right of the rightmost target.

Typical values may look like this (based on 0.7 metre spacing): -

TARGET	**X position**	**X position**
	(Measured)	(With 5m offset)
1	0 mm	5000 mm
2	712.0 mm	5712.0 mm
3	1415.5 mm	6415.5 mm
4	2341.25 mm	7341.25 mm
5	3000.5 mm	8000.5 mm

These measurements are for the X axis only. We can also make measurements in the Y axis, but this is usually constant because the targets are normally mounted on a straight wall. A fixed 5000 mm is therefore normally used for the Y position.

The measurements made must then be converted into Hexadecimal code, for entry into the configuration EPROM.

TARGET	X position	X Hex value	X Hex value		Y Hex value	Y Hex value
	(With 5m offset)	(Whole mm)	(Part mm)		(Whole mm)	(Part mm)
					= 5000 mm	
1	5000 mm	1388	0000		1388	0000
2	5712.0 mm	1650	0000		1388	0000
3	6415.5 mm	190F	8000		1388	0000
4	7341.25 mm	1CAD	4000		1388	0000
5	8000.5 mm	1F40	8000		1388	0000

The whole mm part is calculated as normal, but the fractional part has a different method as follows. Only four steps are required to give the 0.25 mm resolution and these are: -

0.0 mm	0000 Hex
0.25 mm	4000 Hex
0.5 mm	8000 Hex
0.75 mm	C000 Hex

Programming Target Positions

Each target co-ordinate is stored as four WORDS (64 bits), i.e. - two 16-bit WORDS per X or Y position. The scaling in the software is such that an X or Y position of 7FFF:FFFF (the most significant bit MSB must always be zero) equates to 32 metres giving a resolution of 1/65,536 mm. This scaling also greatly simplifies the programming as the most significant word is in millimetres and the least significant word in fractions of a millimetre.

There is provision for 16 maps in the system.
Map 0 is a 'non-target' map, using only dead reckoning intended for test purposes.
Map F (15) is a special 'static' mode (no X/Y), which uses no targets or any navigation.

However for convenience of programming, there is provision in the Configuration EPROM for programming all 15 Maps, with Map 1 starting at memory address 1100H, Map 2 at 1200H, Map 3 at 1300H, etc. Thus, locations 1000 to 1FFF contain the data for 16 maps.

Map structure - locations for Map 1, targets 1 & 2

Address	**Data**	
1100	Part mm - X axis	**Target 1**
1102	Whole mm - X axis	
1104	Part mm - Y axis	
1106	Whole mm - Y axis	
1108	Part mm - X axis	**Target 2**
110A	Whole mm - X axis	
110C	Part mm - Y axis	
110E	Whole mm - Y axis	

The Target data calculated above must be programmed into the appropriate locations, but must be entered **'Byte reversed', and 'Word reversed'**. This is because the Intel processor reads the data in reverse!!

e.g. referring to the values calculated above: -

	CALCULATED	**VALUES**	**BYTE/ WD**		**REVERSED VALUES**	
TARGET	X Hex value	X Hex value				
	(Whole mm)	(Part mm)	Word 1	Word 2	Word 3	Word 4
1	1388	0000	00	00	88	13
2	1650	0000	00	00	50	16
3	190F	8000	00	80	0F	19
4	1CAD	4000	00	40	AD	1C
5	1F40	8000	00	80	40	1F

So in the programmer memory, the data would appear as follows: -

Target	**Address**	**X Data**	**X Data**	**Y Data**	**Y Data**
1	1100	0000	8813	0000	8813
2	1108	0000	5016	0000	8813
3	1110	0080	0F19	0000	8813
4	1118	0040	AD1C	0000	8813
5	1120	0080	401F	0000	8813

Programming Map Configuration

Once all the targets have been programmed into the relevant maps, it is necessary to define which targets in which maps have been programmed so that un-programmed addresses are ignored.

The master map definition is stored from memory address 2000H in the Configuration EPROM, and consists of 32-bits (= 4 bytes = 2 words) per map, with each bit being set to 1 if a target has been defined and set to 0 if it hasn't. The Least Significant Bit (LSB) represents Target 1 and the MSB Target 32.

For example:

If Map 1 has targets 1,2,3,4,5,9 and 20 defined:

Bit Mask = 0000 0000 0000 1000 0000 0001 0001 1111 (Targets 1-32. LSB = T1)

= 00 08 01 1F (= 4 hexadecimal bytes)

Remembering that in the EPROM the least significant byte is stored first: -

Address	**Data**
2000	1F
2001	01
2002	08
2003	00

Selecting the Target Map

The 'Local Panel' on the RP2 Pedestal has a rotary map selector switch built onto the p.c.b. located under the Perspex cover. The switch positions are labelled 0-F, relating to maps 0 - 15, and is accessed via a hole marked 'MAP SEL'. The switch position can easily be changed using a small screwdriver.

Map 0 (Position 0) should not normally be used as this disables the target acquisition facility leaving the RP2 Pedestal to navigate in dead reckoning mode only. Thus all positions are RELATIVE to the start up position only.

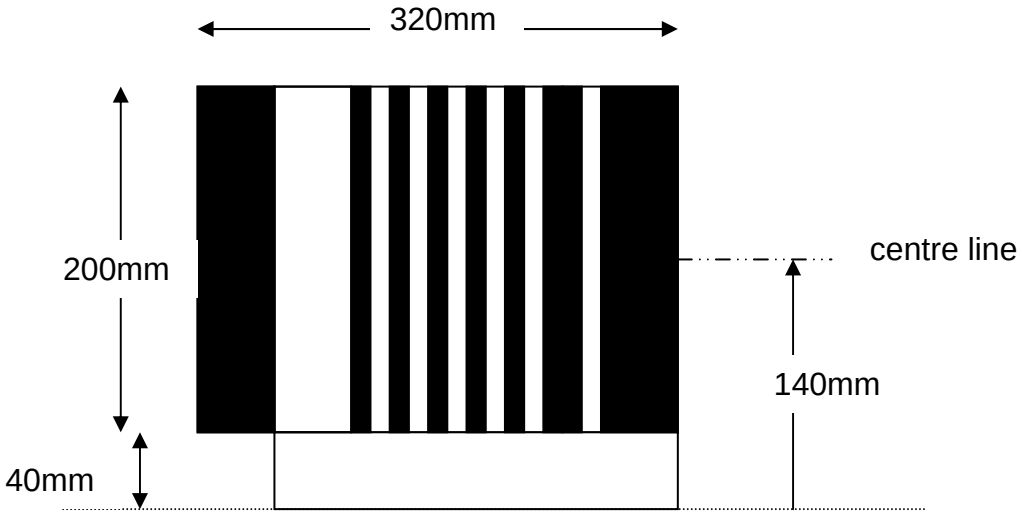
Maps 1-4 and F, (Positions 1-4) operate as already described.

Maps 5-E are not implemented at present.

Once a new map has been selected, it is important that the RP2 Pedestal is temporarily powered down as the map selection is only read at power on.

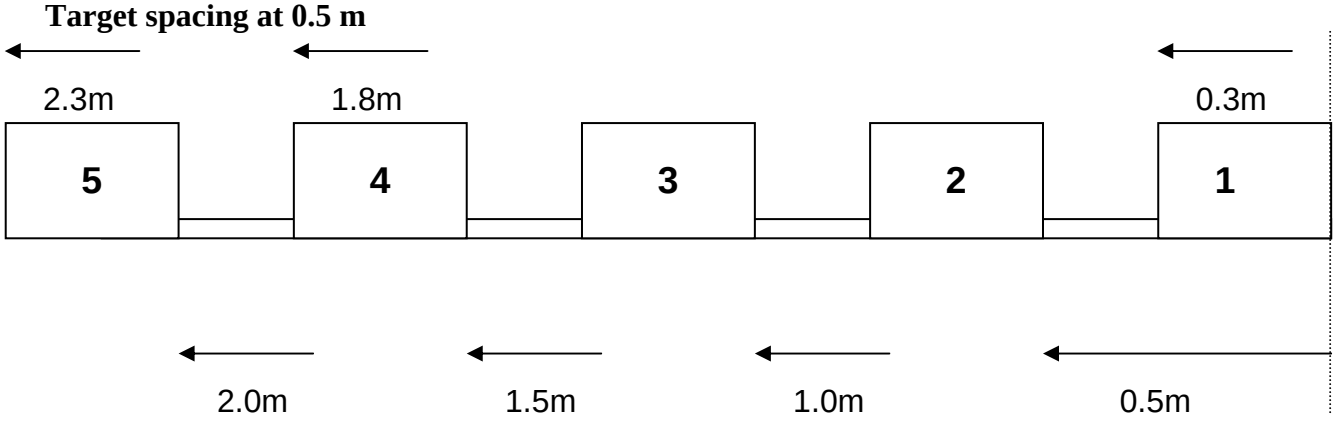
11.2 RP2A Target Details

Target number one (code zero) shown

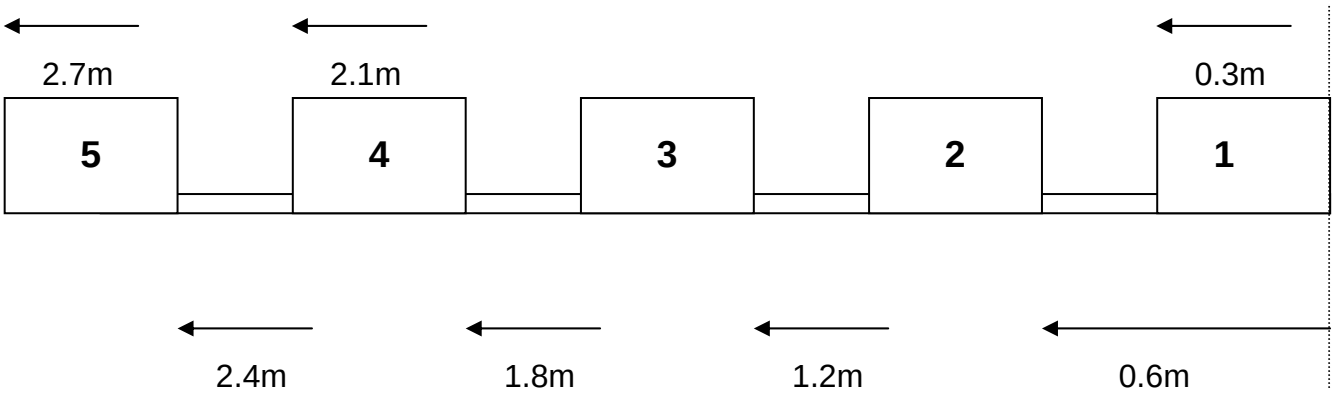


Full size target shown – some are reduced size (65 + 150 mm)

Target spacing at 0.5 m



Target spacing at 0.6 m



Target spacing	TARGET NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Bar end
0.4	0	0.4	0.8	1.2	1.6	2	2.4	2.8	3.2	3.6	4	4.4	4.8	5.2	5.5
0.45	0	0.45	0.9	1.35	1.8	2.25	2.7	3.15	3.6	4.05	4.5	4.95	5.4	5.85	6.15
0.5	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	6.8
0.55	0	0.55	1.1	1.65	2.2	2.75	3.3	3.85	4.4	4.95	5.5	6.05	6.6	7.15	7.45
0.6	0	0.6	1.2	1.8	2.4	3	3.6	4.2	4.8	5.4	6	6.6	7.2	7.8	8.1
0.65	0	0.65	1.3	1.95	2.6	3.25	3.9	4.55	5.2	5.85	6.5	7.15	7.8	8.45	8.75
0.7	0	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7	7.7	8.4	9.1	9.4

Target position and spacing data in metres.

APPENDIX I MOTHERBOARD TAG DETAILS.

The table below shows the details of the tag connections used on the motherboard, which is located at the rear of the card frame.

TAG No.	Reference	Wire number & Colour	Function
1	Nav. Lamp supply	1	Lamp supply (pulsed, wrt -VB)
2	Nav. Lamp – 0VB	2	Lamp supply 0V
3	0VL, 0VS, 0VP, 0VB	113 Yellow	to 0Vp wire 170
4	-VB IN	154 Grey	to fuse 12
5	+VB IN	137 Orange	to fuse 6
6	E/S return	5 Pink	E-Stop switches
7	0VL	68 White	0VL (to steer micro-switches)
8	5VL	67 Red	+5VL (to steer micros-witches)
9	n/a		
10	-VB IN	265 Grey	(linked to Tag4, –Vbin) –ve to 10mF Cap. In card frame
11	+VB IN	266 Yellow	0VP to 10mF Cap. in card frame

APPENDIX II ROUTINE MAINTENANCE SCHEDULE

The following is a list of routine maintenance tasks, which should be carried out in accordance with the recommended schedule.

1. Line scan Camera Lens.
Clean dust etc. off with a soft lens brush. Take care not to disturb the camera from its mounting.

2. Wheels.
Raise the pedestal off the floor as detailed in the manual and support on 2-inch (5cm) wooden batons behind the front wheel and in front of the rear wheels. Remove the I/R Receiver PCB Remove any dirt and debris from the wheel assemblies and clean the tyres using a moist cloth.

CAUTION
Extreme care should be taken when lifting the RP2a. At least two people are required.

3. Safety Systems.
Check all Emergency Stop Buttons, I/R and Bumper systems for correct operation.

4. PCBs.
Remove any dirt and dust from the PCBs and card frame area.

5. Height Column.
a) Wipe height guides with a cloth moistened in light oil. Do not pour oil on the guides.
b) Lubricate the lifting chain with a light oil.

Note: Do not use a graphite or Molybdenum Disulphide grease on the chains.

6. Drive and Steer Chains.
Tenacious grease is used on these chains and should not need reapplying. Ensure chains are free from any mechanical obstruction and any debris that may adhere.

7. Gas springs .
Check the height balance. If the payload appears to be too heavy (excessive indication on the local panel 'Load Indicator'), then remove the gas springs (carefully) and check for compression with body weight applied. If any compression is perceptible, a new set of gas springs must be fitted.

8. Pan and Tilt Head.
a) Check head is still in balance, and adjust if necessary.
b) Head backlash check. Adjust belt tension if any backlash is noticeable.

RP2a Routine Maintenance Schedule

REF	**ITEM**	**3 months**	**6 months**	**12 months**
1	L/S Camera lens	◊	♦	
2	Wheels	◊	♦	
3	Safety Systems	◊	♦	
4	PCBs	◊	♦	
5	Height Column		◊	♦
6	Drive & Steer Chains		◊	♦
7	Gas Springs	◊	♦	
8	Pan & Tilt Head		◊	♦

Key

♦ Schedule for normal requirements

◊ Schedule for extreme climates / operation