



Professional Broadcast Equipment

AR SERIES 2

All-Chemistry Charging Systems



Instruction Manual



PAG ACS



*Advanced Charging System

- ▶ Back in the early 1980s PAG's Research & Development team conducted a full study into the behaviour patterns of Nickel-Cadmium batteries used in the television industry.
- ▶ This study turned out to be far more complex than anyone had originally imagined, but it enabled PAG to develop the most advanced and sophisticated microcomputer-controlled charging system available in the world today.
- ▶ This charging system is faster, more accurate, and significantly increases, rather than decreases, the duty cycle life of any battery charged with it.
- ▶ The system has been further enhanced to enable the charging of Nickel-Metal Hydride and Lithium-Ion batteries.
- ▶ PAG are proud to have labelled this system **PAG ACS - Advanced Charging System** and have incorporated it into the **AR Series 2** range of chargers.

PAG ACS

ensures greater flexibility, reliability and full control over the battery charging process.

PAG ACS

detects faulty batteries immediately.

PAG ACS

detects fully charged batteries within 20 seconds.

PAG ACS

maintains the balance of individual cells thereby removing the most common cause of battery failure.

PAG ACS

automatically provides an adaptive maintenance charge after full charge. This is designed to keep batteries in peak condition and ready for instant use.

PAG ACS

accommodates batteries of varied voltages, capacities and cell chemistries.

PAG ACS

longer battery life = fewer discarded batteries = cleaner environment.



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SECTION 1

SAFETY RULES

- 1.1 This manual contains important safety and operating instructions. Please read these fully and note all warnings before using the charger. Please follow all instructions and retain this manual for future reference.
- 1.2 AR Series 2 chargers are not intended for any use other than the charging of batteries as detailed in Section 2 - 'Specification'.
- 1.3 **IMPORTANT:** Use only on AC supplies 100-250V, 50/60Hz. Supply connection to the unit should be made using only the standard lead supplied with this equipment.
- 1.4 Protect the power cord from being walked on or pinched, particularly at plugs. Unplug this apparatus during lightning storms or when unused for long periods of time.
- 1.5 Ensure that the ventilation slots are not obstructed when in use, e.g. do not site the charger on a deep pile carpet, or cover when in use.
- 1.6 **WARNING:** Indoor use only. To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.
- 1.7 Although the charger is reverse polarity and short circuit protected, extreme care should always be taken not to short circuit the battery itself. Rechargeable batteries can deliver power at a very high rate, and short circuiting even a partially charged battery could result in a fire or personal injury. PAG supplies a range of connector leads for most charging requirements, and does not accept responsibility for any other form of charging connection.
- 1.8 Do not disassemble the power supply. There are no user-serviceable parts inside. Incorrect re-assembly may result in a safety hazard.
- 1.9 **Double Insulation:** When servicing use only identical replacement parts.
- 1.10 Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, such as supply cord or plug is damaged, liquid has been spilled, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped. In this event you should seek advice from your nearest PAG Dealer, or direct from PAG Ltd., London, by telephoning +44 (0)20 8543 3131, or emailing service@paguk.com.

SECTION 2

SPECIFICATION

2.1 AR Series 2 Model Range:

Model No. 9792 AR124PLD:

- ▶ Four sequential charging channels.
- ▶ Four PAGlok and four PP90 (2.1mm) connectors.
- ▶ Built-in discharger.

Model No. 9793 AR124NPD:

- ▶ Four sequential charging channels.
- ▶ Four NP-type and four PP90 (2.1mm) connectors.
- ▶ Built-in discharger.

2.2 Range of Batteries Charged:

- ▶ Nickel-Cadmium batteries having nominal voltages of between 4.8V and 14.4V, and nominal capacities of between 1Ah and 10Ah.
- ▶ Nickel-Metal Hydride batteries of reputable manufacture having nominal voltages of between 4.8V and 14.4V, and nominal capacities of between 1Ah and 10Ah.
- ▶ PAG Lithium-Ion batteries.

2.3 Battery Connections:

PAGlok: Patented, Professional PAG locking connector compatible with all PAGlok batteries. Incorporates self-cleaning military-type beryllium-copper leaf contacts.

NP: Polarised connector suitable for Ni-Cd, Ni-MH and PAG Li-Ion NP-type batteries. Incorporates superior blade-type beryllium-copper contacts.

PP90: Polarised connector suitable for PP90 (2.1mm) coaxial DC power connectors. NOTE: centre pin negative.

2.4 Main Charge Program:

- ▶ Auto Mode: automatically selects the correct charge current.
- ▶ Manual selection: 2A, 3A or 4A charge current.
- ▶ Li-Ion voltage-charge program: only available with PAG intelligent batteries or suitable PAG intelligent adaptor. PAG intelligent batteries automatically over-ride the Auto Mode or Manual selection, and control their own charge regime.

2.5 Discharge-then-Charge Program:

This program discharges the battery, automatically determining the fully-discharged condition, and then fully charges it. The discharge capacity and the subsequent charge loaded into the battery can be displayed on the screen.

2.6 Recovery Charge:

This special program conditions the battery for a period of one hour. The charger will then automatically enter the Main Charge program, which will run until the battery is fully charged. This program also recovers PAG Li-Ion batteries which have been over-discharged to the point where the internal safety protection circuit has tripped.

2.7 Ancillary Charging Programs:

The following programs may be automatically entered after charging:

- ▶ Balancing Charge.
- ▶ Self-adjusting Maintenance Charge (not applied to PAG Li-Ion batteries).

2.8 Self Test Program:

The internal microcomputer constantly monitors the battery under charge or process as well as the operation of the charger's own functions which will be shut down to a safe condition should any of the tests fail.

2.9 Mains Input:

100-139V or 140-250V ~ autoselected. Frequency 50-60Hz. Maximum power consumption 120W.

2.10 Output Protection:

Charger protected against short circuit, open circuit, excess battery voltage and reverse battery voltage.

2.11 AC Mains Failure Protection:

Should mains failure occur during a charging program, or whilst the charger is connected, it will shut down to a safe condition.

2.12 User Interface:

The LCD screen has a display area of 94mm x 18mm, which displays 2 lines of text, with 24 characters per line.

The screen incorporates electro-luminescent backlighting with on/off control via the front panel soft function switch. This switch also provides for the selection of programs and interrogation of charge and discharge data.

2.13 Safety:

Designed to comply with electrical safety standard BS EN 60065 & UL6500.
NOTE: U.K. mains leads are fitted with a 1" fuse to BS1362 rated 5A as standard.

2.14 European Union Directives:

Complies with the following EU Directives:

- ▶ EMC Directive 89/336/EU.
- ▶ Low Voltage Directive 73/23/EU.

2.15 Operating Temperature Range:

0°C to 40°C (+32°F to +104°F).

2.16 Overall Dimensions:

9792 AR124PLD:

81.5mm high (90mm with feet extended) x 168mm wide x 240mm deep.
(3.2", 3.5" with feet extended, x 6.6" x 9.5" approx.).

9793 AR124NPD:

78mm high x 142mm wide x 240mm deep. (3.1" x 5.6" x 9.5" approx.).

2.17 Weight:

9792 AR124PLD: 1.23kg (2.70lbs approx.).

9793 AR124NPD: 1.07kg (2.35lbs approx.).

2.18 Typical Battery Charging Times:

| Battery Capacity | Charge Time 2A | Charge Time 3A | Charge Time 4A |
|------------------|-----------------|-----------------|----------------|
| 1Ah | 30mins | 20mins | 15mins |
| 2Ah | 60mins | 45mins | 30mins |
| 4Ah | 120mins | 90mins | 60mins |
| 5Ah | 150mins | 105mins | 75mins |
| 7Ah | See Section 4.5 | 150mins | 105mins |
| 10Ah | See Section 4.5 | See Section 4.5 | 150mins |

These times are approximate only, and assume the battery is fully discharged. Charging times will be less if the battery is already partially charged.

NOTE: PAG intelligent batteries communicate with the charger, and automatically optimise the charging output (independently of the manual selection) to enhance performance and safety. The above charging times do not apply to these batteries.

SECTION 3

INSTALLATION

- 3.1 All AR Series 2 fast chargers are fitted with a mains input socket conforming to CEE22 (IEC socket). This is situated on the back panel. Mains connection to the charger should only be made using the lead supplied with this equipment.
- 3.2 AR Series 2 chargers have been designed for use on AC mains supplies worldwide, and automatically accept supplies in the range 100-139V or 140-250V ~ autoselected. Mains supply frequency must be in the range 50-60Hz.
- 3.3 AR Series 2 chargers may be operated from a vehicle 12V battery using the PAG Vehicle Battery-Power Converter, Model No. 9774.
- 3.4 **PAG TECHNICAL SALES AND INFORMATION:**
For further information contact PAG Technical Sales and Information by telephoning +44 (0)20 8543 3131 or contact your nearest PAG Authorised Service Centre.

SECTION 4

OPERATING INSTRUCTIONS

4.1 POWERING UP

IMPORTANT: Note section 4.10, Supply Failure. The charger remembers the status of batteries when the mains supply is disconnected. If the charger has been previously disconnected from the supply with 'charged' batteries connected, it is important to connect the charger to the supply BEFORE connecting another set of batteries.

Connect the charger to a suitable supply using the standard lead. The LCD screen will illuminate and briefly display the PAG logo and charger model before entering normal operating mode. With no batteries connected, all channels will indicate 'absent'.

AR Series 2 chargers may be disconnected from the supply at any time in complete safety and without damage to the charger or any batteries connected.

4.2 THE SCREEN

The screen displays two lines of information. The top line indicates battery status, and the lower line indicates battery voltage, charge loaded, and discharge capacity. The lower line also confirms charge rate selection.

Battery status is indicated by means of text messages. Where the battery is not undergoing a process, these messages are displayed in a steady state. Where the battery is undergoing a process, the message blinks. Due to space considerations, text messages are abbreviated on the four-channel models. Indications are as follows:

| Indication: (2 Channel) | Indication: (4 Channel) | Appearance: | Status: |
|----------------------------|----------------------------|-------------|--|
| ABSENT | ABST | Continuous | No battery connected |
| WAITING | WAIT | Continuous | Waiting in queue for charge |
| CHARGING | CHRG | Blinking | Charging in progress |
| BALANCE | BLNC | Blinking | Balance charge in progress |
| READY | DONE | Continuous | Program completed |
| FAULTY | FAIL | Continuous | Battery unsuitable for processing |
| RECOVERY | RCVY | Blinking | Recovery charge in progress |
| WAITING/°C | WAIT/°C | Alternate | Waiting - battery too hot or cold |
| CHARGING/NiMH | CHRG/NiMH | Alternate | Charging of PAG NiMH in progress |
| CHARGING/Liion | CHRG/Liion | Alternate | Charging of PAG Li-Ion in progress (or other Li-Ion via PAG Intelligent Charge Adaptor). |
| | DCHG | Blinking | Discharging in progress |
| | DCWT | Continuous | Waiting for discharge |

4.3 THE FUNCTION BUTTON

Operating modes and display options are selected by means of the Function button, the operation of which can be summarised as follows:

Hold in while connecting supply: selects charge rate menu.

Hold in while connecting battery: selects Discharge-then-Charge program.

Hold in during normal operation: turns backlight on/off.

Press once: displays discharge capacity then charge current loaded.

Press twice: Recovery Charge program (channel 1). Further button presses move the selection to the other channels.

4.4 SCREEN ILLUMINATION

The screen will automatically illuminate:

- ▶ At power-up.
- ▶ If the Function button is operated.
- ▶ If a battery is connected or disconnected.

The illumination will remain on for a period of forty seconds following the last activity, and will then be automatically extinguished.

The illumination can be set to OFF mode. Hold the Function button in. The screen will illuminate. Continue holding the button in until the illumination is extinguished (six seconds). The illumination can be returned to ON mode by holding the button in until the screen illuminates (six seconds).

NOTE: The charger automatically defaults to illumination ON mode when it is disconnected from the supply and then reconnected.

4.5 CHANGING THE CHARGE RATE

IMPORTANT: DO NOT CHANGE THE SETTING FROM AUTO MODE UNLESS THERE ARE GOOD REASONS FOR DOING SO, AND THE IMPLICATIONS OF CHARGING AT THE ALTERNATIVE RATE ARE FULLY UNDERSTOOD.

Auto Mode: The charger is set to the Auto Mode before leaving the factory. Auto Mode automatically selects the most appropriate charge rate for all specified batteries, and it is designed so that even at the lowest rate it can charge batteries up to 10Ah capacity.

2A charge rate: Nickel-Cadmium or Nickel-Metal Hydride batteries of reputable manufacture having nominal voltages of between 4.8V and 14.4V, and nominal capacities of between 1Ah and 5Ah. Batteries with a capacity in excess of 5Ah will not be fully charged.

3A charge rate: Nickel-Cadmium batteries of reputable manufacture, having nominal voltages of between 4.8V and 14.4V, and nominal capacities of between 2Ah and 8Ah. Nickel-Metal Hydride batteries of reputable manufacture, having nominal voltages of between 4.8V and 14.4V, and nominal capacities of between 5Ah and 8Ah. Batteries with a capacity in excess of 8Ah will not be fully charged.

4A charge rate: Nickel-Cadmium batteries of reputable manufacture, having nominal voltages of between 4.8V and 14.4V, and nominal capacities of between 2Ah and 10Ah.

NOTE: PAG intelligent batteries automatically over-ride the Auto Mode or Manual selection, and control their own charge regime.

Hold the Function button in while connecting the charger to the supply. The screen will display the instruction "HOLD FOR SETUP V x.xxLi". Continue to hold the button for a few seconds until the set-up screen appears. The screen will now display the instruction "CHARGE CURRENT SET TO AUTO. PRESS BUTTON TO CHANGE". Press the Function button to choose between the AUTO mode or 2A, 3A or 4A rate. The displayed rate will be selected 5 seconds after the last button activity. The screen will now display the instruction "SETTING SAVED. PLEASE WAIT FOR RESTART". The selection will be stored in memory, and will become the default charge rate for both the Main Charge program and the Discharge-then-Charge program.

4.6 CONNECTING A BATTERY

AR Series 2 chargers are intelligent, requiring only the battery positive and negative connections (no thermal sensors are necessary). Some batteries can be connected directly to the charger; other batteries should be connected to the charger using the appropriate adaptor leads. The first battery to be connected, irrespective of the channel chosen, will be the first battery selected.

NOTE: All AR Series 2 chargers offer a choice of connector on each channel. Batteries may be connected to either but not both connectors at the same time. Connection of a battery to a front panel PP90 (2.1mm) socket will disconnect the alternative connector (depending upon model) for that channel.

4.7 MAIN CHARGE:

Charger set to Auto Mode: connect the battery to the charger. A period of analysis lasting a minimum of 30 seconds is required before the correct charge rate is determined, and the display will then indicate the rate by flashing 'AU' and the charge rate (2A, 3A, or 4A) alternately. PAG intelligent batteries control their own charge rate, and are identified separately. Charging will then automatically commence. A 'charging' indication will blink once every second to show that the charging program is being executed, and the on-charge battery voltage will be displayed.

Charger set to Manual Selection: the display will indicate the the charge rate, and charging will automatically commence. PAG intelligent batteries control their own charge rate, and are identified separately. A 'charging' indication will blink once every second to show that the charging program is being executed, and the on-charge battery voltage will be displayed. A 'waiting' indicator will be displayed on any other channel that has a battery connected. The balancing process is indicated by 'balance'. At the end of the program the screen will display a 'ready' indication.

The charge current loaded into the battery can be viewed at any time during charge by pressing the Function button once. The screen will first display the discharge capacity and then the charge current loaded, for all channels. The charge current loaded into the battery can be a useful

guide as to the battery's fitness for use. If a fully discharged battery only accepts a small amount of charge current against its rated capacity the battery will require further investigation.

4.8 DISCHARGE-THEN-CHARGE

Hold the Function button in while connecting a battery. This will select the Discharge-then-Charge program for that channel and indicate the selection on the screen. A 'waiting for discharge' indication will be displayed if the charger is currently occupied on another channel.

The battery will be automatically discharged to the correct end voltage, and will then be charged. The screen will indicate 'discharge' or 'charging' respectively.

The discharge capacity can be viewed at any time by pressing the Function button once. If the battery was fully charged at the start of the program, this figure will give a useful indication of battery capacity.

4.9 RECOVERY CHARGE

IMPORTANT: SELECTION OF RECOVERY CHARGE IS A PRIORITY COMMAND, AND WILL TEMPORARILY SUSPEND OPERATIONS ON ANY OTHER CHANNEL.

Press the Function button twice. The screen will indicate the selection and any further operation of the button will move the recovery indication to the next channel. The selection will skip over any channel on which the Discharge-then-Charge program has been selected. A dwell time of over five seconds on the selected channel will allow the Recovery Charge program to be initiated. After a period of one hour the charger will automatically enter the Main Charge program, which will run until the battery is fully charged. If a battery is severely faulty, and has not responded to treatment by the Recovery Charge program, it will be indicated as faulty when the Main Charge program is entered, and will not be charged. Rejected batteries should be investigated.

4.10 SUPPLY FAILURE

If the AC mains power fails during operation, the charger will shut down safely; no damage will occur to either the charger or the batteries.

When the mains power is restored the charger will default to the Main Charge program. Batteries which had been identified as 'charged' or 'faulty' before the supply failure, and which had not been removed, are recorder, and the charger will not attempt to charge these batteries (note: this does not apply to PAG Li-Ion batteries). The charger will then fully charge the remaining batteries.

4.11 GENERAL

The charger continuously monitors the status of all channels and provides this information to the screen.

If the charger detects a severely faulty battery while a program is running, a 'faulty' indication will be displayed. This could be caused by one of several conditions, such as a very old or damaged battery, a short circuit battery, or an excessively high or low voltage battery. An 'absent' indication will be displayed if a battery becomes open circuit while being charged. Conditions that could cause this include a blown battery fuse, a battery's internal thermal cutout operating, intermittent connections, or a disconnected battery.

The charger will not attempt to process batteries which are indicated as 'faulty', or which have completed a program. If a battery is disconnected, the status will revert to the 'absent' state. Another battery can now be connected to the free channel without affecting any of the other channels.

To the charger there is no difference between a disconnected battery and one that is open circuit. If the charger indicates that a battery is disconnected even though it appears to be plugged in, check the battery fuse and any leads and adaptors before suspecting the charger of a fault.

Each battery will be charged to its maximum available capacity, and no advantage is to be gained from attempting to charge it further. Although re-application is safe, repeated attempts to overcharge a battery may overheat the battery, resulting in a shortened life.

SECTION 5

SERVICING & REPAIRS

- 5.1 **WARNING:** To reduce the risk of electric shock, do not attempt any servicing or repairs unless you are qualified to do so. Refer all servicing or repairs to qualified servicing personnel. The Power Supply contains advanced electronics that do not require periodic maintenance. Consequently there are no user serviceable parts inside.
- 5.2 Qualified electronics engineers who wish to gain access to internal assemblies should note that parts of the power circuit retain a high voltage even after the mains supply has been disconnected. Wait for a period of five minutes following disconnection before commencing disassembly.
- 5.3 When the charger is correctly connected to a mains supply and the display is not functioning, it is an indication that a supply fuse has become open circuit. Equipment supplied for use in the UK is supplied with a standard UK mains lead, complete with a moulded, fused plug. If this fuse has become open circuit it should be replaced by another of the correct rating (see 'Specification' section 2.13).

USE ONLY A FUSE OF THE CORRECT RATING. If the replacement of the fuse fails to correct the above symptoms, do not attempt further fuse replacement. It is likely that a fault has developed.

Seek advice from your nearest PAG dealer or direct from PAG Ltd., London, by telephoning +44 (0)20 8543 3131, or emailing service@paguk.com.

- 5.4 AR Series 2 chargers feature a fail-safe shutdown mode. In the unlikely event of an internal malfunction, an error message will be displayed on the screen to show that the charger is in shutdown mode. This could be the result of any number of undesirable situations from which the system is protecting itself, such as the obstruction of ventilation slots causing inadequate cooling, or the microcomputer's detection of an internal fault. In these cases the charger should be disconnected from the supply, any obstruction of the air vent system removed, and the unit allowed to cool before reconnecting to the supply. Should the charger re-enter the fail-safe shutdown mode, more detailed investigation is required. Make a note of the error message, and seek advice from your nearest PAG dealer or direct from PAG Ltd., London, by telephoning +44 (0)20 8543 3131, or emailing service@paguk.com.
- 5.5 Unqualified personnel should not attempt further investigation (see paragraph 5.1 above). Any such interference would invalidate the guarantee and invariably cause more damage than the original fault.

SECTION 6

WARRANTY

- 6.1 Notwithstanding any provision of any agreement the following warranty is exclusive: PAG Limited warrants each AR Series 2 charger it manufactures to be free of defects in material and workmanship under use and service for **TWO YEARS** from the date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operation.
- 6.2 In the event of failure of a product covered by this warranty, PAG Limited will repair and calibrate equipment returned to an authorised service facility within the period of the warranty, provided the warrantor's examination discloses to its satisfaction the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any equipment returned within this period, said repairs or replacements will be made without charge.

If the failure has been caused by misuse, neglect, accident or abnormal conditions of operation, repairs will be billed at a nominal cost. In such a case, an estimate will be submitted before work is started, if requested.

- 6.3 The foregoing warranty is in lieu of all other warranties, express or implied, including but not limited to any implied warranty or merchantability, fitness or adequacy for any particular purpose or use. PAG Limited shall not be liable for any special, incidental, or consequential damages, whether in contract, tort, or otherwise.

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