



Professional Broadcast Equipment

# 30V AR Series

Ni-Cd & Ni-MH Battery Chargers



## 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 in the world.
- ▶ A charging system that is faster, terminates charge more accurately, and one that significantly increases, rather than decreases, the duty cycle life of any battery charged using it.
- ▶ PAG is proud to have labelled this system **PAG ACS Advanced Charging System** and has incorporated it into the **30V AR Series** of single and four-channel 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.*



**Professional Broadcast Equipment**

# **30V AR Series**

Autoranging Fast-Chargers for  
12 to 30V Ni-Cd & Ni-MH batteries

## **Instruction Manual**

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## SECTION 1

### SAFETY

- 1.1 This manual contains important safety and operating instructions. Please read these fully before using the 30V AR Series fast-charger.
- 1.2 The charger is rated for indoor use only. Do not expose it to water.
- 1.3 The charger is not intended for any use other than the charging of Nickel-Cadmium and Nickel-Metal Hydride batteries as detailed in Section 2: Specification.
- 1.4 The charger is extremely rugged and designed for arduous service conditions. It should not be used, however, if it has received a severe drop or blow, or been otherwise damaged in any way. The charger should be returned to your local PAG Dealer, or direct to PAG Ltd. London for service or repair.
- 1.5 Do not disassemble the charger. There are no user-serviceable parts inside. Incorrect reassembly may result in a safety hazard.
- 1.6 Ensure that the ventilation slots are not obstructed when in use, e.g. do not site the charger on a deep pile carpet or similar surface.
- 1.7 Disconnect the charger from the supply before attempting any cleaning.
- 1.8 Use the charger on a suitable AC supply. See 'Specification' Section 2.
- 1.9 Do not use an extension cord for the supply unless absolutely necessary. If an extension cord is used, ensure that it is properly wired, has a conductor cross-sectional area of at least 0.5mm and a length of less than 30 metres. Suitable extension cords should be classified as follows. Domestic and light commercial application: H05 W-F. Industrial application: H05RR-F OR H05RN-F.
- 1.10 **WARNING:**  
Although the charger is short circuit protected, extreme care should be taken not to short circuit the battery itself. Batteries can deliver power at very high rates, and a short circuit could result in fire and personal injury. Do not connect the charger to the battery by means of bare wires or crocodile clips.

## SECTION 2

### SPECIFICATION

#### 2.1 Description:

30V AR Series: microcomputer-controlled fast-chargers, incorporating PAG ACS (Advanced Charging System).  
Model No. 9763 AR301 (single channel).  
Model No. 9765 AR304 (four channel).

#### 2.2 Range of Batteries Charged:

Nickel-Cadmium and Nickel-Metal Hydride batteries of reputable manufacture, having nominal voltages of between 12V and 30V, and nominal capacities of between 1.7Ah and 10Ah.

#### 2.3 Battery Connections:

AR301 - 1 x XLR4

AR304 - 4 x XLR4

**Note:** pin 1 neg pin 4 pos.

#### 2.4 Main Charging Programs:

Fast-charge program under microcomputer-control. Recovery charge program manually selectable.

#### 2.5 Ancillary Charging Programs:

Balancing charge; self-adjusting maintenance charge (automatically entered after charging).

#### 2.6 Self Test Program:

The microcomputer constantly monitors the operation of the charger, which is shut down to a safe condition should any of the tests fail.

#### 2.7 Input Supply:

100-135V or 180-265V AC, auto-selected. Frequency 50Hz to 60Hz.  
Maximum power consumption 240W.

#### 2.8 Output Protection:

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

#### 2.9 A.C. 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.

**2.10 Safety:**

Designed to comply with electrical safety standards EN60335-1 and EN60335-2-29 Class 2 (double insulated) U.K. mains lead fitted with 1" fuse to BS1362 rated 5A.

**2.11 Operating Temperature Range:**

0°C to 40°C (+32°F to +104°F).

**2.12 Overall Dimensions:**

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

**2.13 Weight:**

1.07kg (2.35lbs approx.).

**2.14 Typical Battery Charging Times:**

Battery Capacity	Charge Time*
2Ah	0.5 hour
4Ah	1.0 hour
6Ah	1.5 hours
7Ah	1.75 hours
8Ah	2.0 hours
10Ah	2.5 hours

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

## SECTION 3

### INSTALLATION

- 3.1 30V AR Series fast-chargers are fitted with an 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 standard lead supplied with this equipment.
- 3.2 30V AR Series chargers have been designed for use on AC mains supplies worldwide and automatically accept supplies from 100-135V or 180-265V AC, auto-selected. Mains supply frequency must be in the range 50Hz to 60Hz.

### PROGRAM DESCRIPTION

#### 4.1 **Main Charging Program:**

Fast-charge program, under microcomputer control.

#### 4.2 **Ancillary Charging Programs:**

Balancing charge, adaptive maintenance charge (automatically executed after charging), Recovery Charge.

#### 4.3 **Self-Test Program:**

The microcomputer constantly monitors the operation of the charger, which is shut down to a safe condition should any of the tests fail.

#### 4.4 **THE FAST-CHARGE PROGRAM**

The fast-charge program charges the battery at a rate of 4 Amperes. This continues until the charger detects that the battery is fully charged. The software developed to do this is the most powerful and complex part of the charger design.

To perform properly batteries must be charged by exactly the right amount. Undercharging gives less than full capacity and consequently short running times, whereas overcharging can permanently damage the battery.

AR Series chargers cater for a wide range of battery types, voltages and capacities, as well as the variation of battery characteristics found between cell manufacturers. To ensure that the fast charge current is stopped at the correct time, and in order to detect the many varied problems associated with faulty batteries, the PAG ACS microcomputer uses a combination of several cut-off algorithms. This gives dependable operation in all cases.

#### 4.5 **THE BALANCING CHARGE PROGRAM**

When the fast charging phase has been completed, the charger may switch over automatically to its balancing charge program. Investigations by PAG Ltd. have shown that imbalance between cells (caused by slight differences in cell charge acceptance and capacity) can be cumulative without the ability to address cell imbalance. The duration of the balancing charge is dependent upon information gained on individual cell condition during the initial analysis phase of the fast-charge program. A battery in any state of charge may be applied to the charger. If the PAG ACS determines that a battery is in a satisfactory state of balance, it will not have the above balancing charge applied.

#### **4.6 THE MAINTENANCE CHARGE PROGRAM**

Batteries once charged, tend to self-discharge. The rate varies with the type, size and temperature of the cell, and no one maintenance rate is ideal in all cases. AR Series chargers feature a special adaptive maintenance charge which is automatically executed when all the connected batteries have been charged.

#### **4.7 THE RECOVERY CHARGE PROGRAM**

Batteries which have been over-discharged may be rejected by the charger and indicated as faulty; batteries in this condition are unsuitable for fast-charging. To overcome this condition, the charger incorporates an ancillary Recovery Charge program. The selector switch for this program is located on the front panel and its operation initially allows the user to select the required output channel.

## **SECTION 5**

### **OPERATING INSTRUCTIONS**

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- 5.1 The AR Series are intelligent chargers, only requiring the battery positive and negative connections (no thermal sensors necessary). Batteries should be connected to the charger using the appropriate adaptor leads, when necessary. The first battery to be connected, irrespective of the channel chosen, will be the first battery to be charged.
- 5.2 Fast-charging will automatically commence and the yellow indicator will blink once every second to show that the charging program is being executed. The red STANDBY indicator will light on any other channel that has a battery connected.
- 5.3 When a battery is almost charged, the charger may give a balancing charge, indicated by CHARGING and READY indicators flashing alternately. This indicates that the battery is virtually fully charged and may be disconnected at this time if it is needed urgently. However, it is advantageous to leave it connected because this balancing charge keeps the cells balanced with respect to each other, and maintains the battery capacity at its maximum to prolong its useful life. If the battery was already fully charged when connected to the charger, the balancing charge program is omitted and the green READY indicator lights. A green READY indicator shows that a battery has received as much charge as it can safely accept.

- 5.4 The charger will now select the battery connected to the next channel, and the charging process will be repeated.
- 5.5 When all connected batteries have been processed, a maintenance charge is applied. Batteries may be removed, and others connected at any time, without affecting the operation of the charger.
- 5.6 The charger will continue to monitor the status of all charging channels. It will not attempt to fast-charge batteries which are READY or FAULTY. If a battery is now disconnected, the status will revert to the ABSENT/FAULTY state. If a new battery is connected to the free channel, the status will change to STANDBY and the charging sequence will be initiated automatically. The order in which batteries are connected is therefore immaterial; the charger will ensure that all batteries are charged in due course.
- 5.7 If the charger detects a severely faulty battery while the charging program is running, the ABSENT/FAULTY indicator will flash. 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. The ABSENT/FAULTY indicator will be lit if the battery becomes open circuit while being charged. Conditions that could cause this include: a blown battery fuse, a battery's internal thermal cut-out operating, intermittent battery connections, or a disconnected battery.
- 5.8 Operation of the Recovery switch is shown by the STANDBY and CHARGING indicators flashing alternately, and any further operation of the switch within five seconds moves the recovery indication to the next channel. A dwell time of over five seconds on the selected channel will allow the Recovery Charge program to be initiated; this will over-ride the charging process on any other channel. When the Recovery Charge has been completed the charger will automatically enter the fast-charge program, which will run until the battery is fully charged; the charger will then select the next channel in sequence for normal fast-charge. If a battery is severely faulty, and has not responded to treatment by the Recovery Charge program, it will be rejected and indicated as faulty when the fast-charging program is entered. While channel selection is in progress, or if an attempt is made to engage Recovery Charge on a channel where no battery is connected, the normal activity of the charger is not interrupted.
- 5.9 The charger cannot tell the difference between a disconnected battery and one that is open-circuit. If the charger indicates that a battery is disconnected even though it is plugged in, check the battery fuse, adaptor and lead before suspecting the charger of a fault.

- 5.10 The charger will not recognise the connection of a battery which has a voltage substantially outside of its range.
- 5.11 When a battery is known to be fully charged already, it is not advisable to attempt to fast-charge it further. The charger will detect this situation and will stop fast-charging after a short time: up to 1 minute for small capacity batteries and up to 15 minutes for larger capacity batteries. This does not mean that the battery is losing its charge, but results from the finite response time of the cells to overcharging. Although it is safe if this happens occasionally, repeated attempts to overcharge a battery may cause internal damage to one or more of the cells, resulting in a shortened life. The charger will charge a battery to its maximum available capacity and no advantage is to be gained from trying to charge it further.
- 5.12 If the AC mains power fails during charging the charger will shut down safely, and no damage will occur to either the charger or to any connected batteries. No record is kept of the status, including Recovery Charge, of each channel. When power is restored the charger will start to analyse each channel in sequence.

The analysis will take a few minutes for each channel, and the process will continue until an uncharged battery is reached. Normal charging will then be resumed.

- 5.13 If the charger should become too hot (perhaps through the ventilation slots becoming obstructed) the microcomputer will shut the charger down and this will be shown by the indicators cycling continuously. In this event the charger should be disconnected from the supply and any obstructions removed. The charger should be allowed to cool before reconnecting to the supply.

## SECTION 6

### FAULT FINDING

- 6.1 All AR Series chargers contain advanced electronics which do not require periodic maintenance. Consequently there are no user serviceable parts inside.
- 6.2 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.
- 6.3 When the charger is correctly connected to a mains supply and the ABSENT/FAULTY indicators are not lit, it is possible that a fuse has become open circuit.
- 6.4 Equipment supplied for use in the UK will be supplied with a standard UK mains lead, terminated with a fused plug. If this fuse has become open circuit it should be replaced by another of the correct rating (see Specification Section 2.10) **USE ONLY A FUSE OF THE CORRECT RATING.**
- 6.5 If replacement of an open circuit fuse fails to correct the fault described in paragraph 6.3 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.
- 6.6 Unqualified personnel should not attempt further investigation. Any such interference would invalidate the guarantee and could cause more damage than the original fault. (See paragraph 6.1 above).

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**PAG** ™  
Professional Broadcast Equipment



## EU DECLARATION OF CONFORMITY

We **PAG Ltd.**  
**London, England.**

hereby declare that the products described below conform to the relevant requirements of the appropriate EU Directives. This declaration shall cease to be valid if modifications are made to the products without our approval.

PRODUCT: PAG 30V AR Series Battery Chargers

MODELS: 9763 & 9765

APPLICABLE EU DIRECTIVES:

EMC DIRECTIVE 89/336/EU  
LOW-VOLTAGE DIRECTIVE 73/23/EU  
CE MARKING DIRECTIVE 93/68/EU

HARMONISED STANDARDS APPLIED: GENERIC:  
EN 50081 - 1 (EMISSIONS)  
EN 50082 - 1 (IMMUNITY)

PRODUCT SPECIFIC:  
EN 55022 - B  
EN 60555 - 2/3  
IEC 801 - 2/3/4  
EN 60335 - 1  
EN 60335 - 2 - 29

Signed for and on behalf of PAG Ltd.



Alan Lavender  
Chief Executive

Date: 26.05.96