Clansman Batteries and 'Test Set Adaptor Charger DC'

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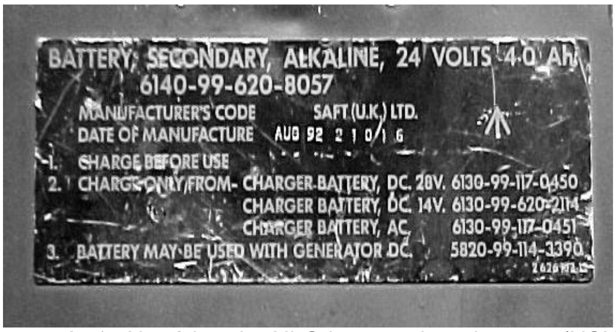
New Clansman batteries and battery refurbishments are expensive. An enthusiast owning a Clansman manpack radio has a vested interest in maintaining its rechargeable battery in the best possible condition. This note describes the range of Clansman batteries and 'Test Set Adaptor Charger DC'.

Clansman Batteries

24 Volt Batteries

The original 24 volt, 3.3 Ampere Hour (Ah) Clansman Nickel Cadmium (Ni-Cd) battery was 'BATTERY, SECONDARY, ALKALINE, 24 VOLTS 3.3 Ah', NATO Stock Number (NSN) 6140-99-620-8057. It was a secondary or rechargeable battery. Clansman portable radios predominantly, but not exclusively, used secondary batteries. The 24 volt Ni-Cd battery was used by the Clansman PRC319, 320, 344, 351 and 352 radios and with adaptors it could be used with radios such as the Plessey PTR3411. It was constructed from 20 D cells and weighed 3.54 kg. Ongoing battery development during the service life of the radios allowed the battery capacity to be increased to 4.0 Ah while still retaining its original NSN. Specialist suppliers currently offer Clansman 24 volt Ni-Cd capacities to 4.5 Ah. A new 24 volt, 4 Ah Clansman Ni-Cd battery can cost £100 upwards.



A 1 Ah, 24 volt, Ni-Cd secondary battery (NSN 6140-99-620-8058) was also available for the above radios and was normally used with the Clansman 'sandwich' hand generator.

Lithium Sulphur Dioxide non-rechargeable, primary batteries (use once and throw away) were latterly available for Clansman. They were originally classed as batteries for emergency use. The Lithium primary battery alternative for the 24 volt, 4 Ah Ni-Cd was NSN 6135-99-840-0109. It had approximately the same size as the Ni-Cd battery, a nominal voltage of 30 volts, a capacity of 16 Ah and weighed about 1 kg less than its Ni-Cd alternative. (The low weight and high capacity available from Lithium primary batteries are attractive. However, if considering buying such a battery on the surplus market bear in mind that it is not rechargeable, may have been used or be beyond its 'use by' date).

14.4 Volt Batteries

For the PRC350 the 14.4 volt secondary battery was NSN 6140-99-661-6111 and consisted of 12 Ni-Cd cells. Its 15 volt Lithium primary battery alternative was NSN 6135-99-795-4350.

12 Volt Batteries

12 volt PRC349 batteries include a 12 volt secondary battery of 10 Ni-Cd AA cells. There was also a 10 cell Manganese Alkaline primary battery and a battery cassette intended for AA pen cell primary batteries but which can use rechargeable cells.

Note

Because of the 30+ years length of service of Clansman radio equipment the above battery listing may not be exhaustive.

Ni-Cd Battery Characteristics

Characteristics claimed for Ni-Cd batteries vary between sources, and with temperature, but the following gives a rough, general guide.

- Batteries are not 100% efficient. They absorb more energy in charge than they give back on discharge. A 4.0 Ah Ni-Cd battery (i.e. one nominally capable of delivering a 1 Amp discharge for 4 hours or a 0.5 Amp discharge for 8 hours etc.) will require about 5.3 Ah of charge to deliver 4.0 Ah of discharge.

- Clansman opted for a field charging current of about 1.25 Amps. The charge rate of the Clansman DCCU14 and DCCU28 vehicle chargers was specified as being between 1.1 and 1.5 Amps while early RACAL multi chargers BCC525 and BCC526 had a specified 1.25 Amp charge current. This allowed the 24 volt 4 Ah battery to be fully recharged in just over 4 hours or the 1Ah battery to be charged in about 1 hour. 1.25 Amps is higher than normal for commercial applications but waiting 10 plus hours for a battery charge in combat conditions could be considered unreasonable.

- The main method of detecting end of charge on the RACAL BCC525 and 526 chargers was the change of cell voltage that occurs when the battery reaches full charge. However, these charger types were not generally adopted as final Clansman equipment.

- The vehicle chargers adopted for Clansman were the DCCU14 and DCCU28. These detect end of charge by the rate of increase in cell temperature that occurs when the battery reaches full charge and the energy that was charging the battery is converted into heat. A diode temperature sensor in the centre of the battery is compared with a similar sensor on the battery casing. The battery casing sensor gives a degree of ambient temperature compensation. Some sources claim this as a Plessey patent.

- The maximum voltage per cell during charge is restricted by limiting the vehicle charger output to between 31 and 32 volts DC.

- Ni-Cd batteries can suffer loss of capacity due to their "memory" characteristic. If they are not regularly fully discharged they retain memory of their part charge at the start of recharge. It then becomes difficult to obtain full capacity from the battery. The normal remedy is to discharge the battery fully before recharging. Some sources advise against a full discharge and recommend discharge only to about 1 volt per cell.

- The battery undervoltage alarm for the PRC351 is set at 19.5 volts which is 0.975 volts per cell. Consequently, if the battery is used until the radio undervoltage alarm activates and is then recharged it should be relatively free from memory effects. However, life is not like that, it would, for example, be inadvisable to start out on an operation with a partially charged battery. Consequently, a part charged battery would be recharged. Recharging from a partially charged state could lead to loss of Ah capacity due to the 'memory effect'. The DCCU14 and 28 are specifically chargers and were not designed to condition batteries.
- Ni-Cd cells lose capacity in sub zero temperatures. The radios were therefore, provided with a cold weather battery extender lead. This allows the battery to be dismounted from the radio and carried under the operator's clothing to raise its ambient temperature.
- The charge of a battery in store will leak away. The rate of leakage is temperature dependent but can be about 20% of charge per month for a Ni-Cd unit.
- New batteries, and batteries that have been in prolonged store, require to be conditioned by 2 to 4 full charge/discharge cycles before they achieve their full rated capacity.
- For optimum battery care most suppliers recommend a full discharge/charge cycle every 2 weeks.

When they reach the end of their useful service life Ni-Cd batteries permanently lose capacity so becoming unfit for service.

Sundry Data Collected Along the Way

Ni-Cd cells contain the heavy metal cadmium and consequently should not be disposed of as normal household refuse.

When assembling or fitting new cells to a battery all cells must be of the same type, age and manufacture and all must have the same charge when assembled. Mismatched charging of cells can lead to early battery failure. Replacing one or more defective cells in a battery is unlikely to be successful

Maintaining a prolonged, permanent load across a fully discharged battery can permanently damage the battery as can sudden short circuit, reverse charging and overcharging.

Suppliers warn against soldering directly to Ni-Cd cells, especially to the positive electrode. The gas vent lies below this electrode and can be damaged by heat. The normally recommended method is to spot weld nickel plated steel tags to the battery and then solder to the tag end remote from the battery using a heat shunt between the solder joint and the battery. Few enthusiasts will have access to a suitable spot welder. Direct solder connection to the battery is likely to be the only practical option when refurbishing a battery. Try to minimise battery temperature exposure.

For commercial equipment Nickel Metal Hydride (NiMH) has become an alternative to Ni-Cd. It is theoretically capable of slightly greater capacity. It has a less pronounced memory effect and lacking cadmium it is easier to dispose of. However, it still suffers from sub zero ambient temperature capacity restrictions similar to Ni-Cd, has a charge leak rate in storage about 50% greater than Ni-Cd plus it is less 'efficient' than Ni-Cd and can require about 20% more charge than Ni-Cd for a given discharge capacity.

NiMH is suitable for charge control by temperature as used on the Clansman vehicle chargers but less suitable than Ni-Cd for charge control by voltage change as used on the BCC525 and 526 and similar chargers.

When Britain adopted secondary batteries for radios in the early 1970s and fitted chargers to GS and FFR vehicles they were ahead of the pack. The US entered the Iraqi war with a plethora of portable battery powered equipment, everything from GPS to night vision to encryption gear to radios yet the US had no standard, general provision in vehicles to charge batteries in the field. Initially, the US relied predominantly on re-supply of primary batteries. Their standard HMMWV 4X4 truck did not have a battery charger let alone a cigar lighter outlet to jury rig a connection for one.

With the exception of the PRC343 (Selenia Marconi H4855) Personal Role Radio, Bowman manpack radios are reputed to depend exclusively on Lithium Ion rechargeable secondary batteries. These provide about 5.6 Ah capacity with about one third of the weight and size of equivalent Clansman Ni-Cds and can operate down to -50°C so avoiding the need for cold weather battery extender leads.

Battery Test Requirements

It would seem that to keep Clansman Ni-Cd batteries in good operational order the military could have needed two facilities that were not readily available from the standard Clansman vehicle chargers:

A means of measuring battery capacity to determine when a battery had reached the end of its reliable service life or required conditioning to recover from memory effects.

A charge/discharge conditioner to recover loss of battery capacity resulting from memory effects.

Acknowledgements

Aspects of the foregoing battery information have already been covered in excellent articles by Colin Guy and Simon Dabbs in VMARS Newsletters 27 and 44 respectively. In Newsletter 27 Colin describes refurbishing a 24 volt 4 Ah Clansman battery with new cells. In Newsletter 44 Simon provides more information and describes a discharge circuit and procedure that should condition batteries and obviate loss of battery capacity due to memory effect.

The battery information has been extended and reviewed in this note to try to construct a possible military 'wish list' for Clansman battery testing and so perhaps help understand the battery Test Set described in Part 2 of this note.

P.S. A Possible Low Cost 24V Battery

The 1 Ah, 24 volt Ni-Cd battery can power a basic PRC351 for about 3.6 hours on a 1:9 Tx:Rx mode of operation. This is too short a battery life for most enthusiasts. Specialist suppliers currently offer a 1.5 Ah version of this battery but it is costly.

The highest volume commercial sales of rechargeable batteries are in the AA pen light size. This is where battery development has been concentrated. Consequently, some AA rechargeable batteries are available with capacities up to 2.8 Ah. An AA cell weighs about 30 gms while a D cell weighs about 100 gms. The AA cell has, therefore, a significantly better power to weight ratio. High capacity AA cells can be expensive but about every 6 months the supermarket chain Lidl has offers on NiMH rechargeable cells. These include packets of 4 off 2.1 Ah AA cells at £1.99 per packet. 2.1 Ah cells would provide a PRC351 battery life of about 7.6 hours on a 1:9 Tx:Rx mode. If this is adequate for an enthusiast's needs either the 4 Ah or the 1 Ah 24 volt Clansman battery casing could be refurbished with 2.1 Ah AA NiHH cells for less than £10.

The same AA cells could be used with PRC349 battery cassette to extend its battery life between charges.

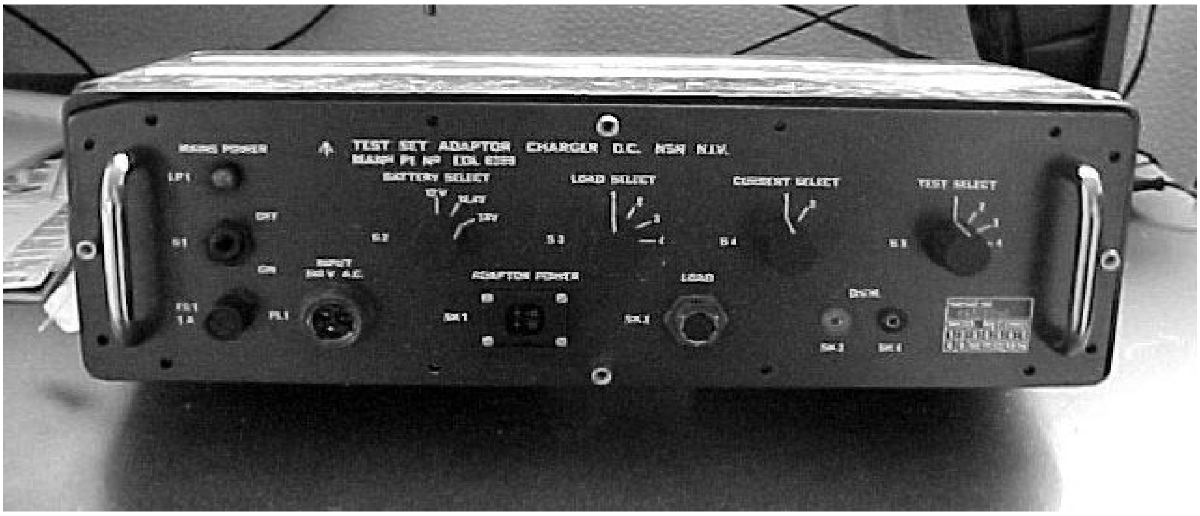


Fig.2 Test Set Adaptor Charger DC

The 'Test Set Adaptor Charger DC'

The only equipment that the writer was able to locate that looked as if it MIGHT have been intended to fulfil the battery test 'wish list' in the first part of this note is Clansman 'Test Set Adaptor Charger DC'. One was bought 4 years ago. The seller described it as a power supply and Test Set capable of charging Clansman batteries. He had no data on the unit and subsequent searches failed to locate data. The Test Set description gave the writer the fixation that it was basically a battery charger. It was used by the writer, with limited success, to charge Clansman 24 volt 4 Ah batteries (see later). However, the more the Test Set was examined the less sense it made.

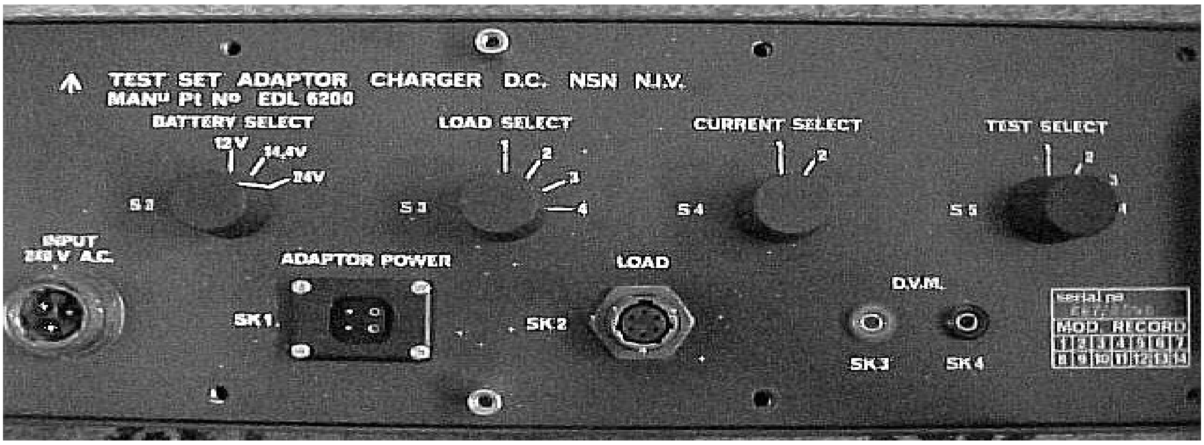


Fig.3 Test Set Controls

This note does not tell all you might ever wish to know about the Test Set. It tells what is inside the Test Set case and how its controls appear to function. It is also a warning to others not to do as the writer and lose a 24 volt Clansman battery due to overcharging by the Test Set. Should a 'Test Set Adaptor Charger DC' cross your path in a shop or at a rally you will have a better knowledge of its contents. This is not a complete story but maybe someone out there has the knowledge to provide the final detail.

First Impressions

The Test Set components are of good quality but the layout gives an unfinished impression as if the unit was from a pre-production run or part of a low volume order. It was manufactured about 1987 by EDL. The seller advised that the 'EDL' who made the Test Set are no longer in business.

The semi-conductor component types employed suggest the Test Set design date is near that of its manufacturing date. If so, the unit could have been produced to meet a requirement that was not recognised when Clansman was introduced in the early 1970s.

The adaptor interfaces are not designed for volume production but are expensively machined from solid aluminium alloy and solid glass reinforced plastic (GRP). Neither of the two adaptor interfaces have NSN numbers The Test Set panel bears the MOD arrow plus the identification 'NSN N.I.V.' (see Fig.3). Richard Hankins advises that N.I.V. means 'Not In Vocab.' i.e. that the unit was prototype or perhaps not a standard issue item when the writer's unit was manufactured.

Connections and Controls

The Test Set front panel mounts the following components as shown in Fig.3:

- Toggle switch S1 mains 'ON-OFF'. (Out of frame in Fig.3).
- 3 way rotary switch S2 'BATTERY SELECT', with positions labelled '24V', '14.4V' and '12V'.
- 4 way rotary switch S3, 'LOAD SELECT', with positions labelled '1' to '4'.
- 2 way rotary switch S4, 'CURRENT SELECT' with positions labelled '1' and '2'.
- 4 way rotary switch S5, 'TEST SELECT' with positions labelled '1' to '4'.
- A 3 way mains plug labelled, PL1, 'INPUT 240V AC'.
- A 4 way panel connector as used on the Clansman vehicle chargers labelled, SK1 'ADAPTOR POWER'.
- A 6 way Clansman type panel connector labelled SK2 'LOAD'.
- 2 off 4 mm sockets labelled 'D.M.M.' SK3 and SK4.
- LPT1 'MAINS POWER' LED (Out of frame in Fig.3).

The setting positions of 3 of the panel switches (S3, S4 and S5) are identified only by numbers. Consequently, the function of their settings is unclear. This smacks of questionable ergonomic design, especially since permanent damage can apparently be caused by incorrect switch settings.

Battery Charging?

A standard 4 core Clansman vehicle charger output lead (5995-99-117-7436) was supplied with the Test Set. It is possible to charge a 24 volt Clansman battery using the charger lead to connect between Test Set socket SK1 and the battery. To enable this S4 requires to be set to position '1' and switch S2 set to '24V'. The battery voltage can be measured on a digital volt meter (DVM) connected between terminals SK3 and SK4 with S5 set to position '1'. Charging current is measured across a 0.5 Ω, 1% shunt with S5 set to position '2'.

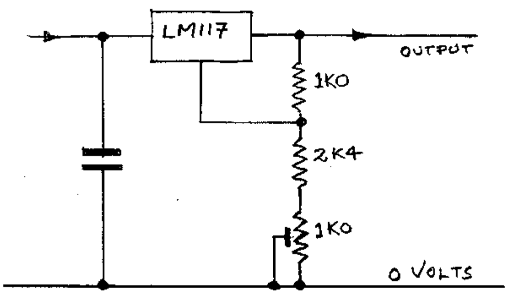


Fig.3 Basic 'Charger' Schematic

The charging circuit is basic. It consists of a mains transformer with a 30 volt, 1.6 Amp secondary winding feeding a single phase full wave silicon rectifier with a 4,700 MFD reservoir capacitor. This provides a no load DC voltage of 47 volts which feeds an LM117K TO3 voltage regulator IC.

The LM117K open circuit output is preset to 30.4 volts DC. There are no external current limiting components. However, the LM117K chip itself has inherent current and thermal limiting. This appears to limit its output current to about 1.1 Amps at a battery voltage of 24 volts. At this load current the input supply voltage to the LM117K IC falls to about 36.8 volts. Its output voltage is the voltage of the battery.

The temperature sensor leads from the 24 volt battery are shorted out in the Test Set. There is, therefore, no automatic termination of charge. Limiting the charger voltage output to 30.4 volts limits the maximum cell voltage on charge but from sad experience this does not prevent overcharging and resultant battery damage. Battery charge by the Test Set must be manually monitored and manual terminated.

It would not be prudent to 'float' an operating PRC351, or similar, (radio plus battery) on the Test Set without strict monitoring. Battery overcharging could result from prolonged float operation because the current from the Test Set can be nearly 1 amp more than the PRC351 receiver current. It was by running a PRC351 plus battery for long periods on receive and test while 'floating' on the Test Set that the writer overcharged his battery. This raised suspicion that the Test Set was not what it had been thought to be.

Battery Discharge?

The 'charging' circuit described above represents less than 30% of the Test Set internal circuitry. The major part of the Test Set consists of a large common heat sink on which are mounted 9 power resistors, three TO-220 power transistors and the 'charger' LM117K voltage regulator IC. With the exception of the LM117K all the devices on the heat sink appear intended to absorb power i.e. not to charge batteries but to dissipate/absorb power from an outside source.

Switch Functions

Circuit tracing reveals switch functions to be as follows:

o S2 'BATTERY SELECT' Switch

This switch selects the 'battery' voltage at which tests are to be performed.

- 24 volts is for the PRC351 type battery.
- 14.4 volts is for the PRC350 battery
- 12 volts is for the PRC349 battery

o S3 'LOAD SELECT' Switch (Table 3 refers)

S3 Positions '1' and '2'

With S2 set to 24V the resistor in S3 position '1' will discharge a fully charged 24 volt 4 Ah battery in about 78 hours.

Similarly, the resistor in S3 position '2' will discharge a fully charged 24 volt 4 Ah battery in about 15 hours.

For 14.4 volts the ohmic value of the resistors is reduced to accommodate the lower battery voltage.

For 12 volts the resistor values are increased to take account of the lower cell capacity of the PRC349 battery. It is further adjusted for the lower voltage of the battery.

S3 Position '3' (Table 3 refers)

With S3 in position '3' an electronic load circuit is connected. This includes a TL431M precision adjustable shunt reference IC, the 'zener' voltage of which can be preset by two external bias resistors. The critical voltage for the TL431M reference electrode is 2.5 volts. Above 2.5 volts on its reference electrode the TL431M goes into conduction. Below 2.5 volts the TL431M cuts off and passes no current.

The TL431M is low power device. To obtain the power necessary to discharge the battery it drives a TIP32A PNP 3 amp TO-220 power transistor mounted on the heatsink with a 22 Ω emitter resistor. The TL431M circuit is shown in Fig.4 and the TL431M with the TIP32A transistor in Fig.5.

The characteristics of Fig.5 differ from those of a conventional zener diode. Suppose the TL431M is biased to

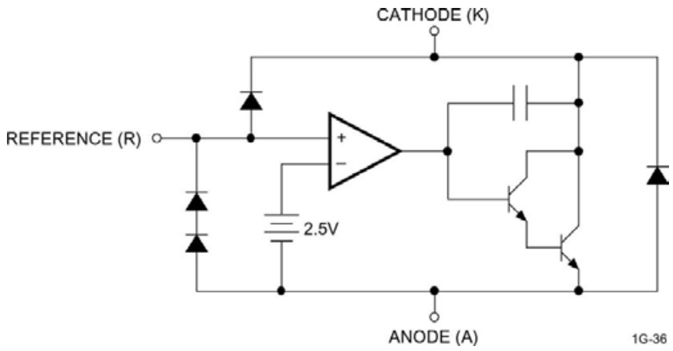


Fig.4 TL431M IC

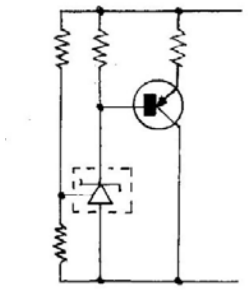


Fig.5 TL431M plus TIP32A as in Test Set

operate at 24 volts. When the applied battery voltage is 30 volts (say) the TL431M is in hard conduction with less than 4 volts across it. Hence the voltage across the 22 Ω emitter resistance of the TIP32A transistor will be about (30 – 4) = 26 volts less the base emitter voltage of the PNP transistor that will be about 0.75 volts. The voltage across the 22 Ω resistor will therefore be about 25.25 volts and the power dissipated in it will be:

(25.25/22) x 25.25 = 28.9 watts.

The resistor is only rated for 5 watts. Hence the power 'zener' circuit on position '3' of switch S3 cannot be permanently connected across a fully charged battery.

	S2=24V	**S2=14.4V**	**S2=12V**
S3=**1**	470 Ω 5W	220 Ω 5W	1K5 5W
S3=**2**	100 Ω 25W	56 Ω 25W	330 Ω 5W
S3=**3**	27.5 volts 22 Ω	15.3 volts 22 Ω	12.9 volts 22 Ω
S3=**4**	10.5 Ω 5W	8 Ω 5W	68 Ω 5W

Table 3. Loads selected by S2 in combination with S3 with S4 set to position '1

The 'zener' voltage is set by 1% bias resistors to about 1.29 volts per cell. This is a partial battery discharge level representing about a 10% battery discharge i.e. a battery with 90% charge remaining.

S3 Position '4' (Table 3 refers)

With S3 in position '4' a low value resistors is connected across the load terminals. Again the resistor power rating is too low to allow safe permanent connection across a fully charged battery. For example, in the S2=24 volt battery position the resistor is a 5 watt 10 Ω unit in series with a 1 Ω shunt. This resistor will dissipate 5 watts with about 7 volts across it. At this condition the shunt will drop 0.7 volts. Therefore, at battery voltages above 7.7 volts the resistor power rating will be exceeded. In practice once the battery is discharged below 12 volts its voltage will fall rapidly below 7.35 volts and connection at 12 volts may be permissible as a short term measure. The S3 position '4' appears to be a method of taking a partially charged battery to full discharge without having to wait for the long discharge times on the larger resistances in S3 positions '1' and '2'.

o ***S4 'CURRENT SELECT' Switch***

S4=1	CHARGE/DISCHARGE
S4=2	Possibly measurement of 'Reverse Current Drain' – See below

Table 2.

A feature of the switch settings is that when S4 is in position '2'' zener diodes are connected across the Adaptor Interfaces and are switched with the S2 switch. They are two wire ended glass zener diodes of about 600mW, type BZX55C**, one of 24 volts and the other of 12 volts. Both are fed by dropping resistors from the LM117K output voltage but they can also be energised by a 24 volt battery connected to panel connector SK1, 'ADAPTOR POWER'. The zeners produce a voltage across the load connections selected by switch S2 as shown in Table 1. The same 24 volt zener diode is used for both the 24V and 14.4V load connections.

Load	**24V**	**14.4V**	**12V**
S2=24V	24V	0V	0V
S2=14.4V	0V	24V	0V
S2=12V	0V	0V	12V

Table 1 S4 set to position '2'.

If a fully charged battery were connected to the 12V or 24V Adaptor Interface terminals these diodes could be destroyed since there are no effective current limiting resistors between Adaptor Interface terminals and the zeners. However, one of the specified parameters of the DCCU14 and 28 vehicle chargers is 'reverse current drain'. That is the current that will flow from the battery to the charger when both are connected but the charger is switched off. For both of the above chargers that current is specified as 10 mA maximum.

If (say) the 12 volt Adaptor Interface were fitted in place of a battery in a switched off PRC349 multi-charger these zeners would allow the charger reverse current drain to be measured. It then begins to look as if the Test Set was intended as a tester for the battery charger. See Figs. 6 and 7. The 12V Adaptor Interface has one set of battery type connections like a PRC349 battery. It has also a large knurled mounting bolt as if it was intended to mount like a battery. The battery is removed from the multi-charger and the Adaptor Interface is fitted in place of the battery.

o ***S5 'TEST SELECT' Switch (Table 4 refers)***

There is no installed metering on the Test Set but two 4 mm sockets are provided to connect an external digital voltmeter (DVM). S5 selects the measurement points in the circuit that DVM sockets SK3 and SK4 connect to.

S5=1	Voltage of 24V battery on charge
S5=2	Charge current 0.5Ω 1% shunt
S5=3	Load bank current 1Ω 1% shunt
S5=4	Load bank voltage

Table 4 Test Switch

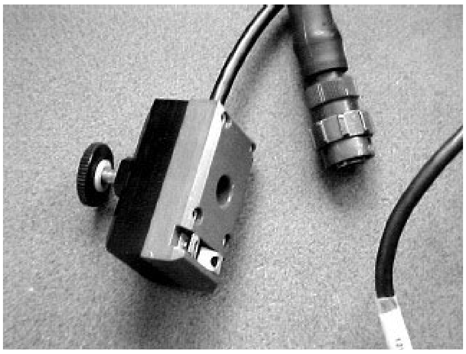


Fig.6 Adaptor Interface 12V

Fig.7 PRC349 12V multi-charger (6 batteries)

Adaptor Interfaces

The body of the 24V/14.4V Adaptor Interface is 12cm x 9cm x 7.5 cm. There are no components in its large internal space. It has a GRP top plate mounting one set of battery type terminals spaced as the 24 volt battery and another spaced as the 14.4 volt battery. This is duplicated on a GRP bottom plate so that the adaptor has two sets of 24 volt and two sets of 14.4 volt terminals. The 2 sets of 24 volt terminals are wired in parallel as are the 2 sets of 14.4 volt terminals.

The convention adopted for Clansman 24 volt batteries is that they use spring connectors like a capital 'C' turned on its back. These are recessed below the insulation of the battery terminal assembly so that the battery cannot be shorted by metal tools, or similar. The connectors on the radio or load are proud round buttons that push into the battery terminal assembly to make contact with and compress its spring clips. An indexing slot is provided in the normal battery terminal assembly to ensure that loads can only be connected with the correct polarity. A tapped hole is also provided between battery terminals to screw clamp the connector of a cold weather battery extension lead. The Adaptor Interface has no indexing slot and no tapped hole.

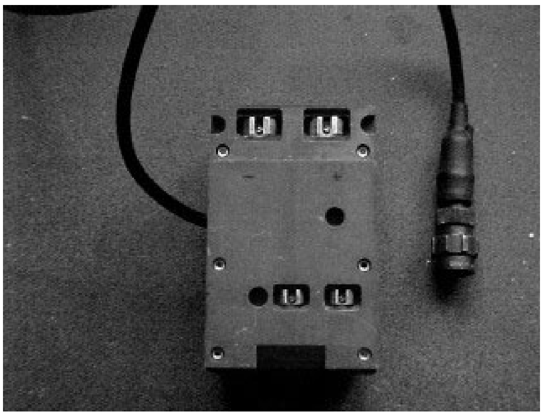


Fig.8 24/14.4V Adaptor Interface

It becomes obvious that both Adaptor Interfaces have battery type connections i.e. connections that would be expected to be part of a battery rather than a radio. In other words the Adaptor Interfaces do not appear intended to connect to batteries.

Conclusions

This exercise started with the hope that the Test Set would prove to be a battery charger and conditioner for the full range of Clansman rechargeable batteries. On present evidence this is not so. It now seems that the Test Set is a tester for Clansman chargers. The load banks appear intended to be switched onto the charger output to allow its voltage/current characteristic to be checked and plotted. Most of such measurements would be short term connect and measure, where component power restrictions identified in the text might be tolerable. Also load bank power is in most cases reduced if the load is connected to a constant current charger rather than a low internal resistance battery.

The physical design of the 24V/14.4V Adaptor Interface remains unexplained. It is not clear how it should connect to 24 volt or 14.4 volt chargers, why it required to be of large physical size and why it has dual connections for each voltage.

The battery charge and power by battery ability of the test set is probably to allow it to operate in the field when mains supplies were not available. That said this could have been accomplished with a smaller 'charger' and battery.

Despite the fact that the Test Set is not what was hoped, it is being used by the writer as a manually controlled charger for 24 volt batteries and a 24 volt battery discharge device using position '2' of S3.

Now that the Test Set internal circuitry is better understood 'head scratching' is in progress to see how it might be simply modified as a bench power supply and battery charger/conditioner for all Clansman batteries. That is a story for another day.

Apologies for what proved to be a misjudged wander through Clansman battery types in the first part of this note, but the writer learned from the exercise and it is hoped that the reader will get interest from it.

Appendix

Ancillaries

The Test Set was supplied with the following ancillaries stowed in its lid:

1. A three core mains lead with 13 amp mains plug and 3 pin socket for the unit AC power connector. This lead has no NSN.
2. '24V/14.4V Adaptor Interface'. This adaptor has no NSN number. The '24V/14.4V Adaptor Interface' has PRC351 and PRC350 battery type connectors.
3. The '12V Adaptor Interface'. The adaptor has no NSN number. This adaptor has a central fixing screw like the PRC349 battery, as if the adaptor could be used to power the set in place of a battery.
4. 5995-99-117-7436. A standard 4 core lead from a Clansman vehicle battery charger to a Clansman 24V battery

Acknowledgements

Thanks to Richard Hankins for the 'NIV' explanation.