Wireless Stations D16 and D17, and their Antecedents

Alister J Mitchell GM3UDL

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Abstract

This article presents the results of an investigation which began with the loan of a technical handbook for the D17 station by Andy Jackson G8JAC. This proved that the D17 was, in fact, a jammer built by MEL, but the manual also provided leads to a whole series of high power systems, including the D16. Dave Prince joined in the hunt from Australia and provided photographs of equipment in his collection, some of which appear below. Thanks are due to Andy for making the manual available, to Dave for the photographs and for scanning the other MEL manuals and to other members of the group for additional information.

Figure 1: The SL42 VHF Amplifier system, rack mounted.

Although the initial investigation which provided the basis for the first version of this article concerned the Wireless Station D17, it has become clear that this was, in fact, the last in a series of similar stations. These systems will be described in their chronological order and only in sufficient depth to give the reader an overview. For those interested in the technical details, the equipment handbooks are available for download on the Wireless-Set-No19 group's archive site www.royalsignals.org.uk.

History

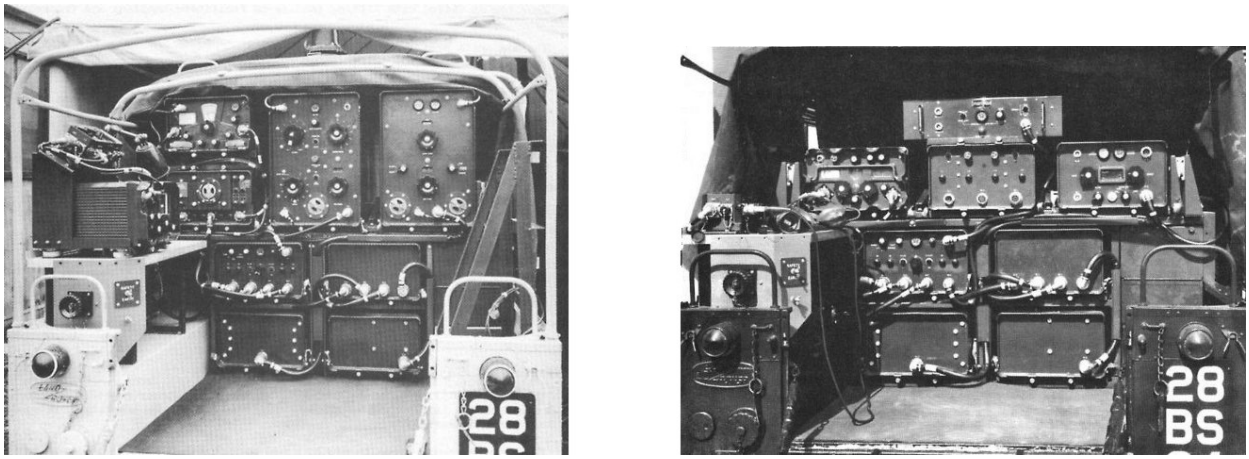
In the early 1960s, Mullard Equipment Ltd. of Crawley, Sussex (re-badged as MEL in 1963/4) produced a number of component units from which could be built various high power RF amplifier systems. It is clear from the documentation that this equipment was designed for military communications use.

The first in the series, in 1962, was an HF amplifier system designated SL56 and made up of:

Power Amplifier	L343
Aerial Tuning Unit	L342
Power Control Unit	L348/01
Transformer Unit	L347
Rectifier Unit	L345
Smoothing Unit	L346

The amplifier covered 2 – 24Mhz and could produce 1kW on CW and CFS, or 500W AM into a variety of omnidirectional aerials. The system was adopted by the British Army as the Amplifier, RF No 9 which, when driven by a C11/R210[1], produced the C11 HP (see Figure 2a). Also in 1962, a combined HF and VHF station designated SL71 was produced and this seems to have been an early version of the HF/VHF station SL72 (see below).

It is interesting to note that the SL56 was also used by the RAF, packaged in Airtech fibreglass containers suitable for air transportation. It has been speculated that this may have been part of the RAF response to the requirement to provide long distance communications, before the global satellite communications network came on stream.



(a) C11 High Power (b) C42 High Power

Figure 2: The Army versions of the SL56 and SL42.

In 1963, MEL produced a low VHF amplifier covering 23 – 60Mhz and designated SL42 (see Figure 1), capable of providing 1kW on CW, CFS or FM into yagi and discone aerials. The SL42 system comprised:

Power Amplifier	L454
Standing Wave Indicator	L456
Power Control Unit	L348/01
Transformer Unit	L347
Rectifier Unit	L345
Smoothing Unit	L346

Note that only the Amplifier and SWI units differ from the SL56. Once again the amplifier was adopted by the Army, this time as Amplifier, RF No 10, capable of being driven by the C42 or C45[2] to produce the high power versions of these sets (see Figure 2b).

1964 saw the introduction of an HF/VHF station built from the parts used in the SL56 and SL42, designated SL72 by MEL and known as the D16 by the Army. The station was installed in a 1-ton Austin K9 truck and consisted of the four power supply units, HF Amplifier plus ATU, VHF Amp with SWI, C11, C42 and C45 drive units and a gamma match VHF aerial mounted on the truck roof. Power was derived from a towed 6kVA AC mains generator set.

Additional equipment included RA17 and R213 communications receivers, Marconi TF1067/1 heterodyne frequency meter, REH-3WD tape recorder, L587 Radio Set Control and a standard C45 (known as the "command set") for local communication. The L587 was capable of feeding the drive units with various audio sources, or setting up a rebroadcasting relay using the command set, and could automatically switch the station to transmit, based on a timer. The operational use, if any, of this last feature in the D16 is unclear – but it will be seen to be of use in the D17. The earlier SL71 station mentioned above was similar

[1] Also manufactured by MEL.

[2] As with the C11, these were MEL products.

to the SL72 except that unit construction appears to have been lighter, with pressed, rather than diecast panels. In addition, no command set was supplied and the connectors used were Plessey Mk 4B.

The final station in this series appeared in 1966 and was designated SL73 by MEL and D17 by the Army. It was like the D16 but with four notable exceptions:

1. The station included a frequency doubler unit and an additional VHF power amplifier, adding a third frequency range, 60 – 120Mhz.
2. Mounted on the truck roof, as well as the gamma-match aerial, was a directional conical helix VHF aerial.
3. The C42 and C45 drive units were modified to permit either ±25kHz (standard) or ±125kHz deviation operation.
4. A white noise generator with selectable bandwidths was provided as an additional modulation source.

The inclusion of this last unit is the clue to the D17's purpose — it was a jammer (although nowhere is this mentioned in the manual).

The remainder of the article supplies more detail on the D16 and D17 stations.

The HF Stations

The HF section of the D16 and D17 consisted of a driver unit (a standard C11 transmitter) and a power amplifier covering 2 to 24MHz, feeding an assortment of aerials via an aerial tuning unit. An anomaly is immediately apparent – the C11 only covers from 2 to 16MHz, so it appears that the HF station could not transmit in the frequency range 16 to 24MHz. Note however that the lower range of the VHF station starts at 23MHz, so the gap was 7MHz, from 16 to 23MHz.

Several HF aerials were supplied with the station, notably an 8 or 16 foot whip, a 16 foot Vee aerial, a 34 foot vertical and an open wire. Type F rods were available for the 8 and 16 foot aerials and there are suggestions that other wire aerial types, such as dipoles, may have been used.

A Racal RA-17 receiver covering 500KHz to 30MHz was supplied, a considerable improvement over the R210 receiver supplied with the SL56/03 HF station.

The major components of the HF station transmitter were:

C11	Standard wireless set, used as a drive unit.
L343/01	Power Amplifier, three QY4-400 beam power tetrodes in parallel. Can run in Class AB, Class C, etc., switch selectable.
L342	Aerial Tuning Unit, including dummy load.
L344	AC power supply for C11.

The units making up the power supply for the power amplifier unit are listed below under Common Equipment, as all PAs use the same supply. The Power Amplifier and Aerial Tuning Units are shown in Figure 3.

Table 1: Specification (HF Station)

Frequency range	Driver (C11) 2 - 16MHz, Amplifier 2 - 24MHz
Modes	A1, A3, A3a, F1
Output Power	A1/F1 : 1kW* A3 : 500W Carrier A3a : 1kW p.e.p.* *Below 3.5MHz on short aerials, power is 600W on A1/F1 and 600W p.e.p. on A3a.
Duty Cycle	$>$ 3.5MHz, continuous $<$ 3.5MHz on short aerials, 3 minutes in 15
Harmonic Suppression	$>$ 50dB
Noise & Hum	-40db relative to 90% modulation
Non-linear Distortion	$<$ 7% at 90% modulation
Intermodulation Products	-30dB in Class C on 2-tone test
Input Power	$\approx$ 4kVA
Drive Power	25W Direct or 50W via built in Attenuator

(a) L343 - PA (b) L342 - ATU

Figure 3: The specialised components of the HF Station.

The VHF Stations

In the range 23 – 60Mhz, the VHF sections of the D16 and D17 were very similar and will be described first. Drive for the station was generated by standard C45 and C42 wireless sets providing approximately 15W of RF drive in the ranges 23 - 38MHz and 36 - 60MHz respectively. However, in the D17, the transmitters of both sets were modified to change the Lo/Hi power switches into deviation controls, permitting the deviation to switched between ±25KHz and ±125KHz. The output from the appropriate drive unit fed the L454 which gave between 800W and 1kW using three QY3-125 beam power tetrodes in parallel.

Both VHF stations were equipped with an R213 communications receiver, the service version of the Eddystone type 770R, which covered 19 to 165MHz in 6 bands. Because of this wide coverage, no additional receiver was needed in the D17.

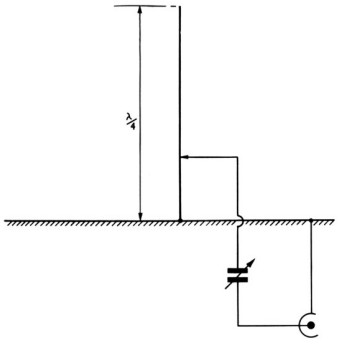


Figure 4: Gamma-Match Aerial Circuit

The aerial supplied for use in the range 23 - 60MHz was the L526 Gamma-Match Aerial, the theoretical circuit of which is shown at Figure 4. This aerial had as its radiating element a quarter wave vertical with an adjustable feed point which was arranged to give standard gamma matching. The physical construction of the aerial was, however, relatively complicated, as may be seen in Figure 5. The length and matching could both be adjusted, the radiator length by means of calibrated telescopic sections and the matching by means of a handwheel inside the vehicle, which allowed the position of the drive point to be varied.

It seems that in the D16, a vertical reflector element was mounted behind the radiator element but that in the D17, it was found that a more satisfactory arrangement was to use the reflector screen which formed part of the the conical helix aerial (see below) instead. Three 8 foot horizontal radials were also provided to improve the radiation pattern of the aerial.

As has been mentioned, the D17 was equipped to transmit in the range 60 – 120Mhz and this required a frequency multiplier and an additional power amplifier. The L459 amplifier, driven by the L629 frequency multiplier (doubler), provided more than 500W from 60 to 120Mhz using a pair of 4CX-300A power tetrodes in push-pull.

For the higher range 60 - 120MHz, the L509 Conical Helix Aerial was used. This was an unbalanced, untuned dipole with a circularly polarised radiation pattern providing a unidirectional transmission beam. The circuit of the aerial is shown in Figure 6(a) and the front view of the aerial mounted on an Austin K9 truck is shown in Figure 6(b).

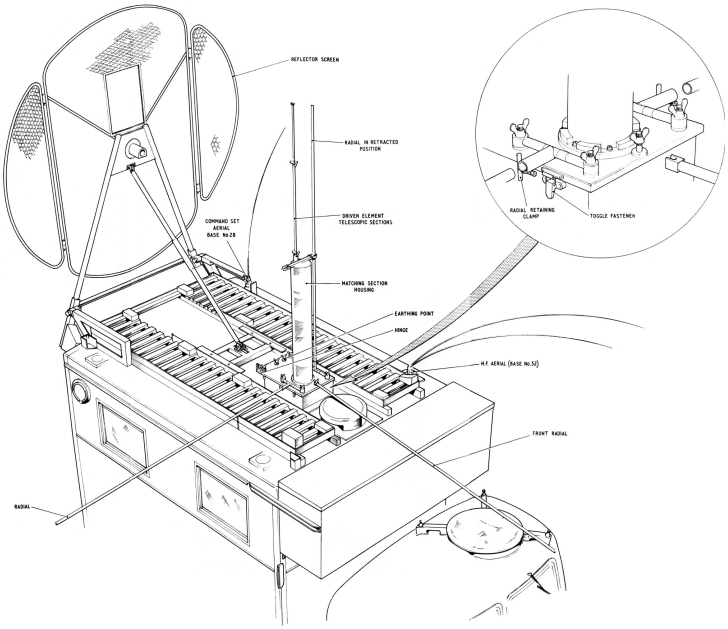
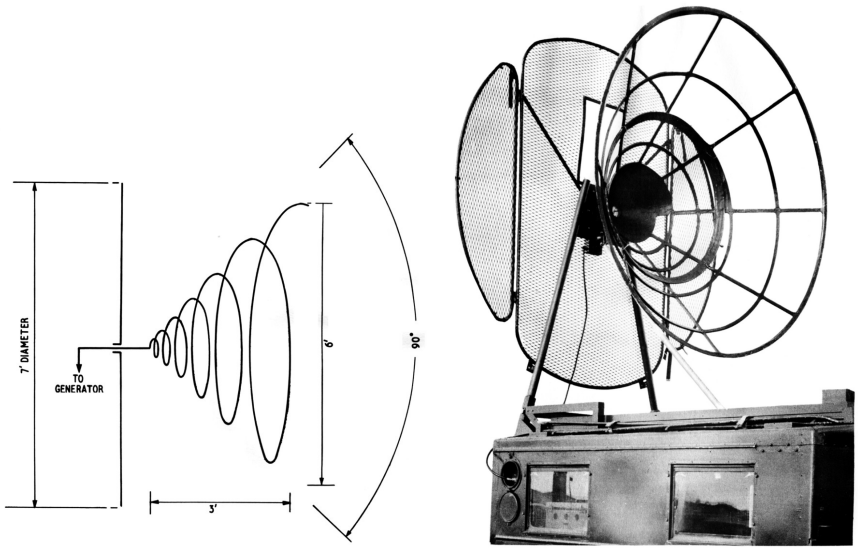


Figure 5: The Gamma-Match Aerial



(a) Circuit (b) Aerial in position

Figure 6: Conical Helix Aerial

The circular reflector screen, 7ft in diameter, consisted of a framework of aluminium tubing covered with expanded aluminium mesh. Around the periphery of the frame, seven sockets were provided to accommodate 4ft radials. The framework was supported at the centre by a single strut, hinged midway along its length to permit horizontal stowage. In the stowed position, the two sections of the reflector screen, which would otherwise overhang the vehicle sides, were folded inwards over the roof.

The cone was constructed in two parts, of moulded glass fibre, and provided a rigid conical framework to carry a 0.25 inch silver plated copper tube aerial element. At any given frequency, the maximum radiation was mainly from that part of the helix whose circumference was equal to one wavelength at the given frequency. In order to keep the reflected wave phase relationship approximately similar to that of the radiated wave, the screen is fixed behind the apex at a point which maintains this relationship throughout the frequency range. By this means, directivity (which is usually towards the apex) is now reflected in the direction required. Typical performance figures were a beamwidth of over 80°, a front to back power ratio of 10dB and a gain of 6dB when spurious values were eliminated.

The major components of the VHF station transmitter are listed below:

C45 No1 Mk2 Wireless Set, 23 - 38MHz, used as drive unit.
C42 No1 Mk2 Wireless set, 36 - 60MHz, used as drive unit.
(In the D17 the C42 and C45 drive units were modified for switchable deviation).

L454 Power Amplifier (23 - 60MHz), three QY3-125 beam power tetrodes in parallel. Runs in Class C for FM & CW.
L456 Standing Wave Indicator (23 - 60MHz).
L459 (D17 only) Power Amplifier (60 - 120MHz), two 4CX-300A power tetrodes in push-pull.
L629 (D17 only) Amplifier, Frequency Multiplier (output 60 - 120MHz).
L455 AC power supply for C45 or C42.

(a) L454 - PA (Incomplete)

(b) L456 - SWI

Figure 7: The specialised components of the D16 VHF Station.

Table 2: Specification (VHF Station)

Frequency ranges	23 - 60MHz and 60 - 120MHz
Modes	A1, F1, F3
Output Power	23 - 38MHz : 1kW
	38 - 60MHz falls linearly to 800W
	60 - 120MHz : $>$ 500W
Duty Cycle	Continuous
Noise & Hum	-40dB below carrier
Input Power	$\approx$ 3kVA
Drive Power 23 - 60MHz	15W, 72Ω for $>$ 500W output
Drive Power 60 - 120MHz	35W, 75Ω*
	*30 - 60MHz via L629 frequency multiplier

Common Equipment

PA Supplies

All the Power Amplifiers were designed to run off the same power supplies, which were switched to the amplifier appropriate to the frequency in use. Table 3 shows the major supplies generated by the power supply system, from an AC input of 110-115v or 220-230v at between 45 and 60Hz. The arrangements for generating the PA power supplies in the D17 were very complex, as it was possible to switch not only between amplifier units but also to change their operating conditions. Four units were involved:

L348/02 Control Unit. Managed the PA power supply system and contained circuitry which provided supplies other than EHT.
L347/01 Transformer Unit. Generated 3kV AC from the mains input.
L345/01 EHT Rectifier Unit – four CV1835 (3B28) Xenon-filled diodes.
L346 Smoothing Unit – choke input filter and hum stopper.

Comparing the pictures of the power supply components in Figure 8 with those in the Army C11 HP and C42 HP installations (Figure 2), it will be noted that the latter shows no obvious signs of the fan vent covers (the yellow flaps). Why this should be is not known at present.

In the D17, Transformer Unit L628 was provided for use when operating from 110-115v AC mains, to supply the 250v AC required for the fans in the L459 upper VHF band power amplifier unit. Note also that in the D17 the heater supply to the L343 HF power amplifier is built into that unit, whereas the heater supply for the two VHF power amplifiers are obtained from the L348/01 power supply control unit.


(a) L348 - Control


(b) L347 - Transformer


(c) L345 - Rectifier


(d) L346 - Smoothing

Figure 8: The power supply components.

Table 3: PA Supplies

EHT	2.5kV DC
Bias Supply	-250v DC*
Screen-grid	+500v DC Stabilised*
	* Nominal
Relays & Blowers	24v DC
VHF PA Heaters	5.6v AC 28A

Ancillary Equipment

Tape Recorder

The stations were equipped with a twin track 0.25 inch portable tape recorder/reproducer type REH-3 which could be used to supply a modulating signal.

Command Wireless Set

A standard C45 wireless station with Aerial Tuning Unit and DC power supply was provided for normal command and control communications. The set was connected to the L587 station control unit by means of the Type O Adaptor Unit, 1 Set, and was supplied by 24v storage batteries which permitted it to be used on the move. A mains driven battery charger was provided.

L549 Noise Modulator (D17 only)

This unit generated white noise signals with selectable bandwidths, as follows:

0.3KHz	-	3KHz
0.3KHz	-	20KHz
0.3KHz	-	70KHz
10KHz	-	20KHz
10KHz	-	70KHz

In operation, the station could produce the following maximum deviations for these bandwidth settings. However, it should be noted that in the 60 – 120MHz range, where the L629 Multiplier was in use, the maximum deviations shown were doubled:

Bandwidth	Deviation
0.3 – 70KHz	±150KHz
10 – 70KHz	±140KHz
0.3 – 20KHz	±80KHz
10 – 20KHz	±57KHz
0.3 – 3KHz	±29KHz

The noise generator was originally intended for use with the C42 and C45 driver sets, which were modified to permit operation with low (±25KHz) and high (±150KHz) deviation. However, the C11 driver set could also be fed with the noise signal, although it was noted that because of the audio response shaping circuits in the C11, only the 0.3KHz - 3KHz setting could be successfully used.

Station Control

The L587 Control, Radio Set managed the overall operation of both stations and provided the following functions:

- HF/VHF transmitter selection.
- Transmitter on/off switching.

- Transmitter modulation source, Voice/Tape/Ext. The Ext. setting allowed for connection of the noise modulator in the D17.
- Transmitter mode, Normal/Auto. The Auto function allowed the operator to set up automatically controlled on/off transmitter switching.
- Headphone monitoring, RA17/R213/Driver/C45 Com./Tape. The Driver position allowed the operator to monitor the modulating signal and the C45 Com. position permitted control of the C45 command set.
- Split headphone mode put the C45 command set on one earphone and the output of the monitoring selector on the other.
- Rebroadcast. The output of the RA17 or R213 receivers could be rebroadcast over the C45 command set.

Relevant Documents

The following documents are available for download from the Wireless-Set-No19 archive site at www.royalsignals.org.uk

Document No.	Title
1494	Radio Station D16/D17 Technical Handbook Modification Instruction EMER B537
1562	Radio Station D17 (MEL Type SL73) Equipment Handbook 802-7-66
1587	High Power Amplifier SL42 (Australia), Equipment Manual, 586-1-63
1588	High Power Amplifier SL56, Equipment Manual, 567-12-62
1589	Type SL56/03 Installation with C11/R210, Instruction Manual, 632-3-63
1565	RAF C11 HP, Extracts from AP116A-0112-1, November 1974

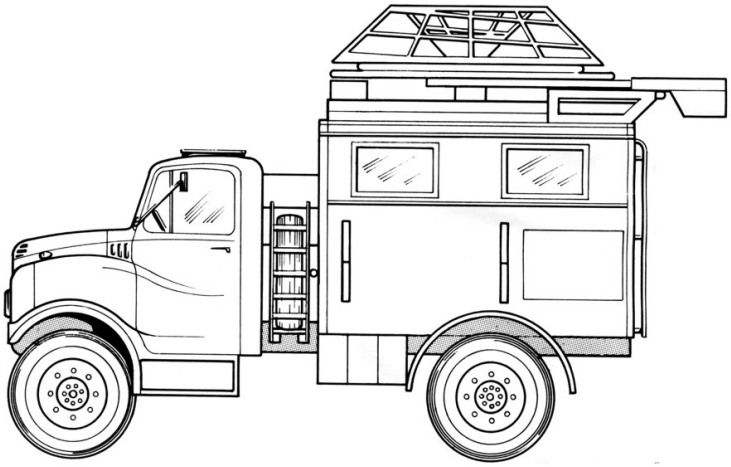


Figure 9: D17 in 1-ton Truck showing stowed VHF aerials.