2. OVERVIEW/SYSTEM DESCRIPTION

The Headstation BDA and the In-Line amplifier equipment is designed to be air interfaced towards the local BTS and provide a single output to an LCX antenna cable.
Automatic gain control in both paths (channel selective module in downlink path has internal AGC) keeps the signal level from overloading the amplifiers should a mobile be operated close to the LCX antenna.

Alarms are provided for each amplifier and these terminate in a RS232 compatible digital PCB with an output suitable for an off-air modem (as in this case) or a local PC running a suitable terminal emulation program. The RS232 PCB is also capable of varying the gain in each path via remotely switchable 0-30dB attenuators. This is in addition to the 0-30dB of attenuation which is available locally.

3. VHF AMPLIFIERS

3.1 VHF Headstation Bi-Directional Amplifier

3.1.1 VHF Headstation Bi-Directional Amplifier Description

See section 2.

3.1.2 VHF Headstation Bi-Directional Amplifier Electrical Specifications

PARAMETER		SPECIFICATION
Frequency range:		137-143MHz (Downlink)
		154-156MHz (Uplink)
Uplink channel frequency:		155MHz ±0.75MHz
Passband ripple:		±1.5dB
Gain:		>95dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>10Watts
Downlink Power:		>10Watts
Downlink OIP3:		+50dBm
Uplink OIP3:		+45dBm
Downlink 1dB compression point:		+38dBm
Uplink 1dB compression point:		+35dBm
In-Band Spurious noise:		<-36dBm (30kHz B/W)
AGC:	Downlink:	+37dBm
	Uplink:	+34dBm
Noise Figure:		<6dB
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +60°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 Amplifiers
		2 PSU
		3 Door Intrusion
		4 Over temperature

3.1.3 VHF Headstation Bi-Directional Amplifier Mechanical Specifications

PARAMETER		SPECIFICATION
Case size	Height:	**620**mm
	Width:	**620**mm
	Depth:	**250**mm
(excluding heatsinks, connectors, handles and feet)		
Fixings:		**4** holes on **670**(w) x **558**(h)mm
Temperature range:	Operational:	**-10°C** to **+60°C**
	Storage:	**-40°C** to **+70°C**
Weight:		**>30**kg (two-man-lift)
RF Connectors:		**N type female**
Environmental Protection:		**IP65** (with door closed and all ports terminated)
Finish:	Case:	Painted to **RAL 7035**
	Heatsinks:	**Matt black** (where fitted)
	Handles:	**Black technopolymer**
Supply Cable:		Unit supplied with suitable supply input leads with connector and appropriate length of cable

3.2 VHF In-Line Amplifier Description

The In-line amplifier is almost identical to the Headstation BDA except it has lower gain.

3.2.1 VHF In-Line Amplifier Electrical Specifications

PARAMETER		SPECIFICATION
Frequency range:		137-143MHz (Downlink)
		154-156MHz (Uplink)
Uplink channel frequency:		155MHz ±0.75MHz
Passband ripple:		±1.5dB
Gain:		>30dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>10Watts
Downlink Power:		>10Watts
Downlink OIP3:		+50dBm
Uplink OIP3:		+45dBm
Downlink 1dB compression point:		+38dBm
Uplink 1dB compression point:		+35dBm
In-Band Spurious noise:		<-36dBm (30kHz B/W)
AGC:	Downlink:	+37dBm
	Uplink:	+34dBm
Noise Figure:		<6dB
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +60°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 Amplifiers
		2 PSU
		3 Door Intrusion
		4 Over temperature

3.2.2 VHF In-Line Amplifier Mechanical Specifications

PARAMETER		SPECIFICATION
Case size	Height:	**620**mm
	Width:	**620**mm
	Depth:	**250**mm
(excluding heatsinks, connectors, handles and feet)		
Fixings:		**4** holes on **670**(w) x **558**(h)mm
Temperature range:	Operational:	**-10°C** to **+60°C**
	Storage:	**-40°C** to **+70°C**
Weight:		**>30**kg (two-man-lift)
RF Connectors:		**N type female**
Environmental Protection:		**IP65** (with door closed and all ports terminated)
Finish:	Case:	Painted to **RAL 7035**
	Heatsinks:	**Matt black** (where fitted)
	Handles:	**Black technopolymer**
Supply Cable:		Unit supplied with suitable supply input leads with connector and appropriate length of cable

4. SUB-UNIT MODULES

4.1 Bandpass Filter (01-002503)

4.1.1 Description

The bandpass filters are multi-section designs with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of helical design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports.

Being passive devices, the bandpass filters should have an extremely long operational life and require no maintenance. Should a filter be suspect, it is usually most time efficient to replace the module rather than attempt repair or re-tuning.

No adjustments should be attempted without full network sweep analysis facilities to monitor both insertion loss and VSWR simultaneously.

4.1.2 Technical Specification

SPECIFICATION		PARAMETER
Response type:		Chebyshev
Frequency range:		135 – 250MHz
Bandwidth:		3.5MHz (tuned to spec.)
Nō. of sections:		6
Insertion loss:		1.2dB
VSWR:		Better than 1.2:1
Connectors:		SMA
Power Handling:		100W maximum
Temperature range:	operate:	-10°C to +60°C
	store:	-20°C to +70°C
Weight:		3 kg
Size:		384 x 82.5 x 56.4mm

4.2 VHF 30dB Coupler (07-000108)

4.2.1 Description

The purpose of these couplers is to 'tap off' known portions (usually 15-30dB) of RF signal from transmission lines, either resistively or by induction, and to combine them, for example through splitter units for different purposes (alarms/monitoring etc.), whilst maintaining an accurate 50Ω load to all ports/interfaces throughout the specified frequency range.
In this instance, one of these couplers is used at each antenna port, with its' DC output taken to the RS232 PCB in order to monitor any power output loss to the antenna.

4.2.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency Range:		140 – 160MHz
Bandwidth:		20MHz (typical)
Insertion Loss:		<1.0dB
Rejection:		>20dB
30dB Coupling:		±1dB (in band)
Temperature Range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C

4.3 ¼Watt 0- -30dB Switched Attenuator (10-000701)

4.3.1 Switched Attenuators

The AFL switched attenuators are available in two different types; 0 – 30dB in 2 dB steps (as in this case), or 0 – 15dB in 1 dB steps. The attenuation is simply set using the four miniature toggle switches on the top of each unit. Each switch is clearly marked with the attenuation it provides, and the total attenuation in line is the sum of the values switched in. They are designed to maintain an accurate 50Ω impedance over their operating frequency at both input and output.

4.3.2 Remote Attenuators (10-001201)

The remote attenuators perform exactly the same RF function as the manually switched version. The only difference being, in the remote version, binary signals from the controller/monitor PCB are fed to the attenuator via a multi-wire (4-bit) digital signal to relays that control which attenuator network to switch into circuit. The remote attenuators are entirely passive devices and should need no regular maintenance.

4.4 VHF/UHF Low Noise Amplifier (11-006002)

4.4.1 Description

The 21dB gain low noise amplifier used is a double stage solid-state low-noise amplifier. Class A circuitry is used throughout the unit to ensure excellent linearity over a very wide dynamic range. The two active devices are very moderately rated to provide a long, trouble-free working life. There are no adjustments on this amplifier, and in the unlikely event of failure then the entire amplifier should be replaced. The amplifier features a dedicated, in-built alarm monitoring system based on class A DC biasing levels whose output is a volts-free relay contact pair that may be integrated into an existing system via the 9-way D-type interface.

4.4.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		70 – 500MHz
Bandwidth:		<430MHz
Gain:		21dB (typical)
1dB Compression Point:		+20dB (typical)
3rd order intercept:		+33dB (typical)
Input return loss:		>14dB
Output return loss:		>20dB
VSWR:		Better than 1.5:1
Noise figure:		<2.7dB
Connectors:		SMA female
Supply:		230 - 260mA @ 10 to 24V DC
Size:		88 x 50 x 34mm (ex. connectors)
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.26kg

4.4.3 LNA 'D' Connector Pin-out details

Connector pin	Signal
1	+Ve input (10-24V)
2	GND
3	Alarm Relay O/P bad
4	Alarm Relay common
5	Alarm Relay good
6	No connection
7	TTL voltage set
8	TTL alarm/0V (good)
9	O/C good/0V bad

4.5 10Watt Power Amplifier (12-002001)

4.5.1 Description

The power amplifier fitted to this unit is a multi-stage, solid state power amplifier. Class A circuitry is employed throughout the device to ensure excellent linearity over a wide dynamic frequency range. All the semi-conductor devices are very conservatively rated to ensure low device junction temperatures and a long, trouble free working lifetime.

The power amplifier should require no maintenance over its operating life. Under no circumstances should the cover be removed or the side adjustments disturbed unless it is certain that the amplifier has failed; since it is critically aligned during manufacture and any re-alignment will require extensive test equipment.

4.5.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		100 - 250MHz (tuned to spec.)
Bandwidth:		20MHz (typical, tuned to spec.)
Maximum RF output:		>10Watts
Gain:		>50dB
1dB compression point:		+40dBm
3rd order intercept point:		+50dBm
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		2.5Amps @ 24V DC
Weight:		1kg (excluding heatsink)
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C

4.6 3 Stage Amplifier Alarm Board (12-002201)

4.6.1 Description

Amplifier Alarm Boards are fitted to monitor the bias conditions of AFL Class A amplifiers which remain constant in normal operation. Any departure from normal bias conditions is a result of device failure, excess temperature, over-driving or oscillation (excessive power).

In normal operation, the Class A bias circuit of the amplifier develops a constant voltage of 1.20V across the collector current setting resistor. The Amplifier Alarm Board is a window comparator device, which is adjusted to sense a departure from this condition. Several different alarm outputs are provided to simplify interfacing, (Relay Contact, Open Collector, and TTL Logic Levels)

The basic version of the Alarm Board (12-002801) monitors a single amplifier stage. A three-stage version (12-002201) is used on complex amplifiers where three separate comparators have their outputs logically combined to a common output stage. Failure of any one stage will activate the alarms.

Note that the alarm board has a green Light Emitting Diode located near to the centre of the printed circuit board, which is illuminated on 'Good', and extinguished on 'Alarm'. It is therefore a simple matter to identify an active module failure, by searching for an Alarm Board which has its green LED extinguished. A simple test of the alarm board is possible by shorting across the monitor inputs, pins 1 and 2, 3 and 4 or across pins 5 and 6. This last monitor input is inactive if the board has been converted to a two way alarm board. (Refer to relevant amplifier alarm wiring diagram.)

1) Volt-free change over relay contacts.
2) Open collector NPN transistor pulls low on alarm.
3) TTL driver.

The use of precision voltage sources and resistors has eliminated the need for initial adjustment or calibration, and the board will function correctly with a wide variation in power supply voltage (8 to 30 volts, nominal supply is 12 or 24Volts).

There are two selectable link options on the three-way board:

LINK1 - Removed to convert to two-way alarm board.
LINK2 - Removed to isolate 0V from chassis earth.

The one way alarm board only has the 0V isolation link (LINK2) fitted.

4.6.2 Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		8 to 30V (floating earth)
Alarm Threshold:		Vcc - 1.20 volt ±15%
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		15-way 0.1" pitch
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
PCB Size:		74 x 56mm (3 stage)
		54 x 56mm (1 stage)

4.7 Single DC/DC Converter (13-001710)

4.7.1 Description

This unit it is used to derive a fixed voltage power supply rail from some higher voltage. Typically, it is used to derive 5V, 8V, 12V or 15V from a 24V input.

The circuit is based upon an LM317 variable voltage regulator, which is capable of supplying a maximum of 1.5A output current. Note that at full output current the dissipation of the device must remain in limits, bearing in mind the voltage which is being dropped across it. The maximum allowable dissipation will also depend on the efficiency of the heatsink on which the device is mounted.

The output voltage of the unit is programmed by the resistive divider which is fitted between the output terminal, the reference terminal and ground. R1 is the reference programming resistor and is fixed in all versions. R2 is fitted on 12V versions while R3, (which is in parallel with R2) is fitted on 8V and 5V versions.

4.7.2 Technical Specification

PARAMETER		SPECIFICATION
Operating Voltage:		21 – 27V DC
Output Voltages:		5.0V (13-001710)
		9.0V (13-001704)
Output Current:		1.0A (maximum per o/p)
Connections:		Screw Terminal Block
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
PCB Size:		47 x 30mm

4.8 Automatic Gain Control (17-001101, det. & 17-001201, atten.)

4.8.1 Description

The equipment is fitted with an Automatic Gain Control (AGC) system. This is generally fitted in the Uplink path (not usually needed in the downlink path, as the signal here is at an almost constant level), to avoid overloading the amplifiers (with the associated performance degradation) should a mobile be operated very close to the unit.

The AFL Automatic Gain Control system consists of two units, a detector/amplifier and an attenuator. The detector/amplifier unit is inserted in the RF path on the output of the power amplifier, and the attenuator is situated in the RF path between the 1st and 2nd stages of amplification.

Normally the attenuator is at minimum attenuation. The detector/amplifier unit monitors the RF level being delivered by the power amplifier, and when a certain threshold is reached it begins to increase the value of the attenuator to limit the RF output to the (factory set) threshold. Therefore overloading of the power amplifier is avoided.

The factory set threshold is 1dB below the Enhancer 1dB compression point. Some adjustment of this AGC threshold level is possible, a 10dB range is mostly achieved. It is not recommended under any circumstances to adjust the AGC threshold to a level greater than the 1dB compression point as system degradation will occur.

The detector comprises of a 50Ω transmission line with a resistive tap which samples a small portion of the mainline power. The sampled signal is amplified and fed to a conventional half wave diode rectifier, the output of which is a DC voltage proportional to the RF input signal.

This DC voltage is passed via an inverting DC amplifier with integrating characteristics, to the output, which drives the attenuation control line of the corresponding AGC attenuator. This unit is fitted at some earlier point in the RF circuit.

The unit contains a 12V DC regulator in the detector module, which supplies stabilised voltage to the DC amplifier and via an external cableform to the AGC attenuator.

For small signals, below AGC onset, the output control line will be close to 12V and the AGC attenuator will have minimum attenuation. As the signal level increases the control line voltage will fall, increasing the attenuator value and keeping the system output level at a constant value.
The AGC onset level is adjusted by the choice of sampler resistor R1 and by the setting of potentiometer VR1.
The attenuator comprises a 50Ω P.I.N diode, voltage-variable attenuator with a range of 3 to 30dB. The attenuation is controlled by a DC voltage which is derived from the associated AGC detector unit.

4.8.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		up to 1000MHz
Attenuation range:		3 to 30dB
Attenuation steps:		continuously variable
VSWR:		better than 1.2:1
RF Connectors:		SMA female
Power Handling:	Attenuator:	1W
	Detector/amp:	>30W (or as required)
Temperature Range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:	Attenuator pcb:	50 x 42 x 21mm
	Detector/amp pcb	54 x 42 x 21mm
Weight:	Attenuator:	90gm
	Detector/amp:	100gm

4.9 Controller/Monitor Board (17-006801)

4.9.1 Description

To meet the need for detailed control and status reporting of cell enhancers and other systems installed in inaccessible locations, AFL has developed an optional RS232C (RS232D) serial interface which may be incorporated into any of AFL's range of cell enhancers. The RS232 interface is designed primarily to be connected to a modem, which can then communicate either via a fixed or a cellular telephone link with another modem at the network control centre. As standard, the interface will control any modem that works with the Hayes command set, although it can easily be adapted to control other equipment if required.

The controller software has been written so that it is easily configured to meet specific customer interface requirements. The standard software has two data formats. Firstly, a verbose format that can be controlled from a simple terminal or terminal emulator. Secondly, a terse data format intended to be used with front-end software running on another computer to present a very user-friendly operator interface. If required, alternative data formats can be provided to enable integration with existing customer front-end software.

The RS232 interface board within the Cell Enhancer integrates all the alarm inputs from the amplifier alarm boards, as well as from relays monitoring power supply status, door open/closed status, I.F module status, and standby battery voltage status. Monitoring of forward power can also be done. All this information is combined and formatted with on-board generated data including temperature, date, time and equipment serial number.

The RS232 interface board also controls the frequencies at which the channel modules operate. These frequencies can, via a modem, be adjusted remotely. For more details, see the RS232 interface board handbook (17-006801HBKM).

4.10 24V Single Relay Board (80-008902)

4.10.1 Description

The General Purpose Relay Board allows the inversion of signals and the isolation of circuits. It is equipped with a single dual pole change-over relay RL1, with completely isolated wiring, accessed via a 15 way in-line connector.

The relay is provided with polarity protection diodes and diodes for suppressing the transients caused by "flywheel effect" which can destroy switching transistors or induce spikes on neighbouring circuits. It's common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.

Note that the board is available for different voltages (12 or 24V) depending on the type of relay fitted at RL1.

4.11 24V, 400W Power Supply Pack (96-300054)

4.11.1 Description

The power supply unit is a switched-mode type capable of supplying 24V DC at 17.0Amps continuously. Equipment of this type typically requires approximately 10.0 Amps at 24V DC, so the PSU will be used conservatively ensuring a long operational lifetime.

No routine maintenance of the PSU is required. If a fault is suspected, then the output voltage from the power supply may be measured on its output terminals. This is typically set to 24.5V using the multi-turn potentiometer mounted close to the DC output studs on the PSU PCB.

All the PSU's used in AFL Cell Enhancers are capable of operation from either 110 or 220V nominal AC supplies. The line voltage is sensed automatically, so no adjustment or link setting is needed by the operator.

4.11.2 Technical Specification

AC Input Supply	
Voltages:	110 or 220V nominal
	90 to 132 or 180 to 264V (absolute limits)
Frequency:	47 to 63Hz
DC Output Supply:	
Voltage:	24V DC (nominal)
	20 to 28V (absolute limits)
Maximum current:	17A

4.12 STPS12045TV 60A Dual Diode Assembly

4.12.1 Description

The purpose of these dual diode assemblies is to allow two (or more) DC voltage sources to be combined, so that the main 24 volt DC rail within the equipment is sourced from either the mains driven flat-pack, or externally through an XLR connector on the rear panel. The heavy-duty diodes prevent any reverse current from flowing back to their source or the alternative supply rail. Combining diodes such as these will also be used if the equipment is to be powered from external back-up batteries.

4.13 MT2834ZDXK 56kBPS Modem (96-800003)

4.13.1 Description

The modem used is a standard, 56kBPS, O.E.M, 'Hayes instruction set' unit. Used in conjunction with the Controller/Monitor board it is the output termination of all the alarm system data which is then transmitted into the regular telephone network by dial up from the BTS. More information on the set-up & use of the modem can be found in the Controller/Monitor Handbook (17-006801HBKM).