2. OVERVIEW/SYSTEM DESCRIPTION

This equipment is designed to enhance one 275kHz spaced channel in the 400MHz UHF band, and one IF select channel having 1.45MHz bandwidth also in the 400MHz band using 5 and 1Watt amplifiers on the downlink and uplink paths respectively.

An RS232 controller/monitor together with a modem is fitted to provide remote monitoring of all active alarms and to allow remote re-configuration of channel module frequencies. See the RS232 controller/monitor handbook (17-005801HBKM) for more details on this feature.

4. SUB-UNIT MODULES

4.1 UHF Notch Filter (02-020001)

4.1.1 Description

The notch reject filters fitted here are tuned to eliminate the unwanted channel frequencies of the band 1 amplifier (where the filters are fitted in the band 2 path and vice-versa).
The filters should require no routine maintenance, being totally passive devices. If a filter is suspected of failure, no invasive measures are recommended as even opening the case of the device could render it unusable.

4.1.2 Technical Specifications

PARAMETER	SPECIFICATION
Passband1	492.5-494 & 490.6MHz
Passband2	481-489 & 496.3-496.6MHz
Stopband1:	496.3 & 496.5MHz
Stopband2:	492.5-494, 496.3-496.6 & 494-494.5MHz
Insertion Loss:	0.6dB typical
Rejection:	40dB typical
Power Rating	50 Watt
Impedance	50Ω
VSWR	Better than 1.22:1

4.2 Bandpass Filters (02-011204 & 02-013401)

4.2.1 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 combline 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.

4.2.2 Technical Specification

Passband:	FILTER 1	489.5-491 MHz	(02-011204)
	FILTER 2	496.3-496.7 MHz	(02-013401)
	FILTER 3	492.5-494 MHz	(02-011204)
	FILTER 3	499.3-499.7 MHz	(02-013401)
Insertion Loss:	FILTER 1	3.0 dB	(02-011204)
	FILTER 2	3.5 dB	(02-013401)
	FILTER 3	3.0 dB	(02-011204)
	FILTER 3	3.5 dB	(02-013401)
Isolation:	FILTER 1	MAX(>40dB)	(02-011204)
	FILTER 2	MAX (>40dB)	(02-013401)
	FILTER 3	MAX (>40dB)	(02-011204)
	FILTER 4	MAX (>40dB)	(02-013401)
Impedance:		50 ohm	

4.3 30dB Power Monitor (07-012501)

4.3.1 Description

The purpose of these couplers is to tap off known portions (usually 15-30dB) of RF signal from transmission lines at the antenna ports, 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. They are formally known as *directional* couplers as they couple power from the RF mainline *in one direction only*.

Various constructional techniques are used depending on the specification required. These include microstrip, stripline, coaxial cable and capacitive types.

4.3.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		350 – 550MHz
Insertion Loss:		<0.3dB
Coupling level:		-30dBc
Rejection:		N/A
Weight:		<200gms
Connectors:		N type, female
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C

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

4.4.1 General Application

In many practical applications for Cell Enhancers etc., the gain in each path is found to be excessive. Therefore, provision is made within the unit for the setting of attenuation in each path, to reduce the gain.

4.4.2 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.

4.5 Low Noise Amplifier (11-007402)

4.5.1 Description

The 30dB gain low noise amplifier used is a double stage solid-state low-noise amplifier. Class A circuitry is used in 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 which gives a TTL 'open collector' type switched signal on alarm, this is then integrated using a built-in relay to give a volt-free contact for summation into the main alarm system.

4.5.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		380-500MHz
Bandwidth:		<140MHz
Gain:		30-32dB
1dB Compression Point:		+22dBm (typical)
3rd order intercept:		+34-35dBm (typical)
Input/Output return loss:		>20dB
Noise figure:		<1.3dB
Connectors:		SMA female
Supply:		300-330mA @ 24V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.38kg
Size:		90 x 55 x 30.2 (case only)

4.5.3 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

4.6 1Watt Low Power Amplifier (11-007901)

4.6.1 Description

This amplifier is dedicated to be a 1.0 W driver from 380 MHz to 470 MHz. It is a 2 stage amplifier where each stage is in balanced configuration. It demonstrates very high linearity and good input/output VSWR. There is a Current Fault Alarm Function, which indicates failure of each one of the RF transistors by various alarm output options. The amplifier is housed in an aluminium case (Alocrom 1200 finish) with SMA connectors for the RF input/output and a 9way D-type connector for DC and alarm outputs.

4.6.2 Technical Specifications

PARAMETER		SPECIFICATION
Frequency range:		380-470MHz
Small signal gain:		37.5dB
Gain flatness:		±0.5dB
Gain vs. temperature:		1.5dB
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Input/output return loss:		18dB
Maximum output power:		30.4dBm (@ 1dB comp. point)
OIP3:		43dBm
Supply voltage:		10-15V DC
Current consumption:		780mA (typical)
Noise Figure:		<1.75dB

4.7 5Watt Medium Power Tetra Amplifier (12-021601)

4.7.1 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.

4.7.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		380-470MHz (as required)
Bandwidth:		10-40MHz (typical, tuned to spec.)
Maximum RF output:		>5Watts
Gain:		>30dB
1dB compression point:		+37.5dBm
3rd order intercept point:		+50dBm
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		1.9Amps @ 12V DC
Weight:		1kg (excluding heatsink)
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C

4.7.3 PA 7-Way Connector Pin-outs

Connector Pin	Signal
A1 (large pin)	+12V DC
A2 (large pin)	GND
1	Alarm relay common
2	TTL alarm/0V good
3	Alarm relay contact (bad)
4	Alarm relay contact (good)
5	O/C good/0V bad (TTL)

4.8 Single DC/DC Converters (13-001704 & 13-001710)

4.8.1 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.

4.8.2 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

4.9 Controller/Monitor Board (17-005803)

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 (17-005801HBKM).
The PCB fitted here is a 12V version of the standard 24V board, (denoted by the '03' at the end of the AFL part number) – but all the electronic functions are identical.

4.10 Channel Selective Modules (17-009304 & 17-009305)

4.10.1 Description

The channel selectivity module is employed when the Cell Enhancer requirement dictates that very narrow bandwidths (single operating channels), must be selected from within the operating passband. One channel selectivity module is required for each channel.

The Channel Selectivity Module is an Up/Down frequency converter that mixes the incoming channel frequency with a synthesised local oscillator, so that it is down-converted to an Intermediate Frequency (IF) in the upper HF range. An eight pole crystal filter in the IF amplifier provides the required selectivity to define the operating passband of the Cell Enhancer to a single PMR channel. The same local oscillator then converts the selected IF signal back to the channel frequency.

Selectivity is obtained from a fixed bandwidth block filter operating at an intermediate frequency (IF) in the low VHF range. This filter may be internal to the channel selectivity module (Crystal or SAW filter) or an externally mounted bandpass filter, (LC or Helical Resonator). Various IF bandwidths can therefore be accommodated. A synthesized Local Oscillator is employed in conjunction with high performance frequency mixers, to translate between the signal frequency and IF.

The operating frequency of each channel selectivity module is set by the programming of channel selectivity module frequencies and is achieved digitally, via hard wired links, banks of DIP switches, or via an onboard RS232 control module, providing the ability to remotely set channel frequencies.

Automatic Level Control (ALC) is provided within each channel selectivity module such that the output level is held constant for high level input signals. This feature prevents saturation of the output mixer and of the associated amplifiers.

Alarms within the module inhibit the channel if the synthesised frequency is not locked. The synthesiser will not usually go out of lock unless a frequency far out of band is programmed.

The channel selectivity module is extremely complex and, with the exception of channel frequency programming within the design bandwidth, it cannot be adjusted or repaired without extensive laboratory facilities and the necessary specialised personnel. If a fault is suspected with any channel selectivity module it should be tested by substitution and the complete, suspect module should then be returned to AFL for investigation.

4.11 12V Single Relay Board (80-008901)

4.11.1 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.

4.12 PP9 NiCad Backup Battery (96-000017)

The NiCad rechargeable battery fitted in this system is trickle-charged from the main 12V supply by a diode and resistor and powers the RS232 controller/monitor board and the telephone line modem in the case of a power failure. This gives the controller and modem sufficient time to dial out and alert the control centre of the new (failure) status of the

4.13 15V Switch-Mode PSU (96-300054)

4.13.1 Description

The power supply unit is a switched-mode type capable of supplying 15V DC at 27Amps continuously. The amplifiers in this unit will draw approximately 12-15Amps at 15V 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 15.2V. The adjustment potentiometer will be found close to the DC output terminals.

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.

4.13.2 Technical Specification

AC Input Supply:	
Voltage:	110 or 220V nominal
	90 to 132 or 180 to 264V (absolute limits)
Frequency:	47 to 63Hz
DC Output Supply:	
Voltage:	15V DC (nominal)
	12-17V (absolute limits)
Current:	27.0A

4.14 MT2834ZDXK 56kBPS Modem (96-800003)

4.14.1 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 standard dial up. More information on the set-up & use of the modem can be found in the Controller/Monitor Handbook (17-005801HBKM).