Aerial Facilities Limited

UHF Bandselective Bi-Directional Amplifier
90dB 40/5W
User/Maintenance Handbook

For

Pacific Wireless Communications L.L.C.

AFL Works Order	**Q116107**
AFL Product Part No.	**55-199102**

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1. INTRODUCTION

1.1. Scope and Purpose of Document

This handbook is for use solely with the equipment identified by the Aerial Facilities Limited (AFL) Part Number shown on the front cover. It is not to be used with any other equipment unless specifically authorised by AFL. This is a controlled release document and, as such, becomes a part of Aerial Facilities' Total Quality Management System. Alterations and modification may therefore only be performed by AFL.

AFL recommends that the installer of this equipment familiarise themselves with the safety and installation procedures contained within this document before installation commences.

The purpose of this handbook is to provide the user/maintainer with sufficient information to service and repair the equipment to the level agreed. Maintenance and adjustments to any deeper level must be performed by AFL, normally at the company's repair facility in Chesham, England.

This handbook has been prepared in accordance with BS 4884, and AFL's Quality procedures, which maintain the company's registration to BS EN ISO 9001:2000 and to the R&TTE Directive of the European Parliament. Copies of the relevant certificates and the company Quality Manual can be supplied on application to the Quality Manager.
This document fulfils the relevant requirements of Article 6 of the R&TTE Directive.

1.2. Limitation of Liability Notice

This manual is written for the use of technically competent operators/service persons. No liability is accepted by AFL for use or misuse of this manual, the information contained therein, or the consequences of any actions resulting from the use of the said information, including, but not limited to, descriptive, procedural, typographical, arithmetical, or listing errors.

Furthermore, AFL does not warrant the absolute accuracy of the information contained within this manual, or its completeness, fitness for purpose, or scope.

AFL has a policy of continuous product development and enhancement, and as such, reserves the right to amend, alter, update and generally change the contents, appearance and pertinence of this document without notice.

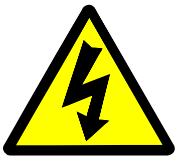
All AFL products carry a twelve month warranty from date of shipment. The warranty is expressly on a return to base repair or exchange basis and the warranty cover does not extend to on-site repair or complete unit exchange.

2. SAFETY CONSIDERATIONS

2.1. Earthing of Equipment

Equipment supplied from the mains must be connected to grounded outlets and earthed in conformity with appropriate local, national and international electricity supply and safety regulations.

2.2. Electric Shock Hazard



The risk of electrical shocks due to faulty mains driven power supplies whilst potentially ever present in any electrical equipment, would be minimised by adherence to good installation practice and thorough testing at the following stages:

a) Original assembly.
b) Commissioning.
c) Regular intervals, thereafter.

All test equipment must be in good working order prior to its use. High current power supplies can be dangerous because of the possibility of substantial arcing. Always switch off during disconnection and reconnection.

2.3. RF Radiation Hazard

RF radiation, (especially at UHF frequencies) arising from transmitter outputs connected to AFL's equipment, must be considered a safety hazard.

This condition might only occur in the event of cable disconnection, or because a 'spare' output has been left un-terminated. Either of these conditions would impair the system's efficiency. No investigation should be carried out until all RF power sources have been removed. This would always be a wise precaution, despite the severe mismatch between the impedance of an N type connector at 50Ω, and that of free space at 377Ω, which would severely mitigate against the efficient radiation of RF power. Radio frequency burns could also be a hazard, if any RF power carrying components were to be carelessly touched!

Antenna positions should be chosen to comply with requirements (both local & statutory) regarding exposure of personnel to RF radiation. When connected to an antenna, the unit is capable of producing RF field strengths, which may exceed guideline safe values especially if used with antennas having appreciable gain. In this regard the use of directional antennas with backscreens and a strict site rule that personnel must remain behind the screen while the RF power is on, is strongly recommended.

Where the equipment is used near power lines or in association with temporary masts not having lightning protection, the use of a safety earth connected to the case-earthing bolt is strongly advised.

2.4. Lifting and other Health and Safety Recommendations

Certain items of AFL equipment are heavy and care should be taken when lifting them by hand. Ensure that a suitable number of personnel, appropriate lifting apparatus and appropriate personal protective equipment is used especially when installing Cell Enhancers above ground e.g. on a mast or pole.

2.5. Chemical Hazard

Beryllium Oxide, also known as Beryllium Monoxide, or Thermalox™, is sometimes used in devices within equipment produced by Aerial Facilities Ltd. Beryllium oxide dust can be toxic if inhaled, leading to chronic respiratory problems. It is harmless if ingested or by contact.

Products that contain beryllium are load terminations (dummy loads) and some power amplifiers. These products can be identified by a yellow and black "skull and crossbones" danger symbol (shown above). They are marked as hazardous in line with international regulations, but pose no threat under normal circumstances. Only if a component containing beryllium oxide has suffered catastrophic failure, or exploded, will there be any danger of the formation of dust. Any dust that has been created will be contained within the equipment module as long as the module remains sealed. For this reason, any module carrying the yellow and black danger sign should not be opened. If the equipment is suspected of failure, or is at the end of its life-cycle, it must be returned to Aerial Facilities Ltd for disposal.

To return such equipment, please contact the Quality Department, who will give you a Returned Materials Authorisation (RMA) number. Please quote this number on the packing documents, and on all correspondence relating to the shipment.

PolyTetraFluoroEthylene, (P.T.F.E.) and P.T.F.E. Composite Materials
Many modules/components in AFL equipment contain P.T.F.E. as part of the RF insulation barrier. This material should never be heated to the point where smoke or fumes are evolved. Any person feeling drowsy after coming into contact with P.T.F.E. especially dust or fumes should seek medical attention.

2.6. Laser safety

General good working practices adapted from EN60825-2: 2004/ EC 60825-2:2004

Do not stare with unprotected eyes or with any unapproved optical device at the fibre ends or connector faces or point them at other people, Use only approved filtered or attenuating viewing aids.
Any single or multiple fibre end or ends found not to be terminated (for example, matched, spliced) shall be individually or collectively covered when not being worked on. They shall not be readily visible and sharp ends shall not be exposed.
When using test cords, the optical power source shall be the last connected and the first disconnected; use only approved methods for cleaning and preparing optical fibres and optical connectors.
Always keep optical connectors covered to avoid physical damage and do not allow any dirt/foreign material ingress on the optical connector bulkheads.
The optical fibre jumper cable maximum bend radius is 3cm; any smaller radii may result in optical cable breakage or excessive transmission losses.
Caution: The FO units are *NOT* weather proof.

2.7. Emergency Contact Numbers

The AFL Quality Department can be contacted on:

Telephone	+44 (0)1494 777000
Fax.	+44 (0)1494 777002
e-mail	qa@aerialfacilities.com

3. EQUIPMENT OVERVIEW

The AFL UHF Bandselective, Bi-Directional Amplifier (BDA) (55-199102) is a 2-way on-band repeater. The equipment is supplied in a four-point, wall-mounting, environmentally protected (IP65) aluminium alloy lockable case. All RF ports and connectors are also IP65 standard making the entire enclosure and connecting ports weatherproof. Handles are provided for carrying the unit and the door is fitted with locks. A supply isolator switch is fitted inside the unit and there are D.C. and Alarm On indicators on the outside of the door.

The UHF Bandselective, BDA (55-199102) is a 2-port device for direct connection to two antennas, usually a highly directional Yagi or similar aligned towards the base (donor) site and an omni-directional or leaky feeder antenna to cover the mobiles. The frequency bands that are passed by the BDA are set as per the specific customer requirements.

Each active sub-module of the BDA carries its own volt-free, alarm relay contact interface which may be easily integrated into any such summary system. In addition to this, over temperature and door intrusion alarms are also fitted.

The Uplink signal enters at the ‘Mobile’ port, passes through a bandpass filter (02-010701) tuned to the uplink band (415 - 418MHz) and then is amplified by the uplink path of Bi-Directional Amplifier (17-017301) before passing through a second bandpass filter (02-010701)
The signal then passes through a second amplification stage (30dB gain 5Watt,), the signal then passes through a third bandpass filter (02-010701) before exiting the unit at the ‘Base’ port

The Downlink signal enters at the ‘Base’ port and is passed through a bandpass filter (02-010701) tuned to the downlink band (406 - 409MHz), the signal then passes through the downlink path of Bi-Directional Amplifier (17-017301) and a second bandpass filter (02-010701) before being split into two equal paths by 3dB Splitter/Combiner (05-002603). Each separate path is then passed through a further amplification stage, each path pasing through a Linearised Power Amplifier (12-026901). After exiting the amplifiers the two separate signals are recombined by a second 3dB Splitter/Combiner (05-002603) before passing through a third bandpass filter (02-010701) and then exiting the unit at the "mobile" port

The uplink and the downlink paths are fitted with signal attenuators providing an attenuation range of 0 to 30 dB per path, adjustable in 2dB steps. The attenuators themselves are integral to the sub module Bi-Directional Amplifier (17-017301) and are controlled by toggle switches mounted inside the case of the Bandselective, BDA (55-199102)

3.1. UHF Bandselective, BDA (55-199102) List of major sub modules

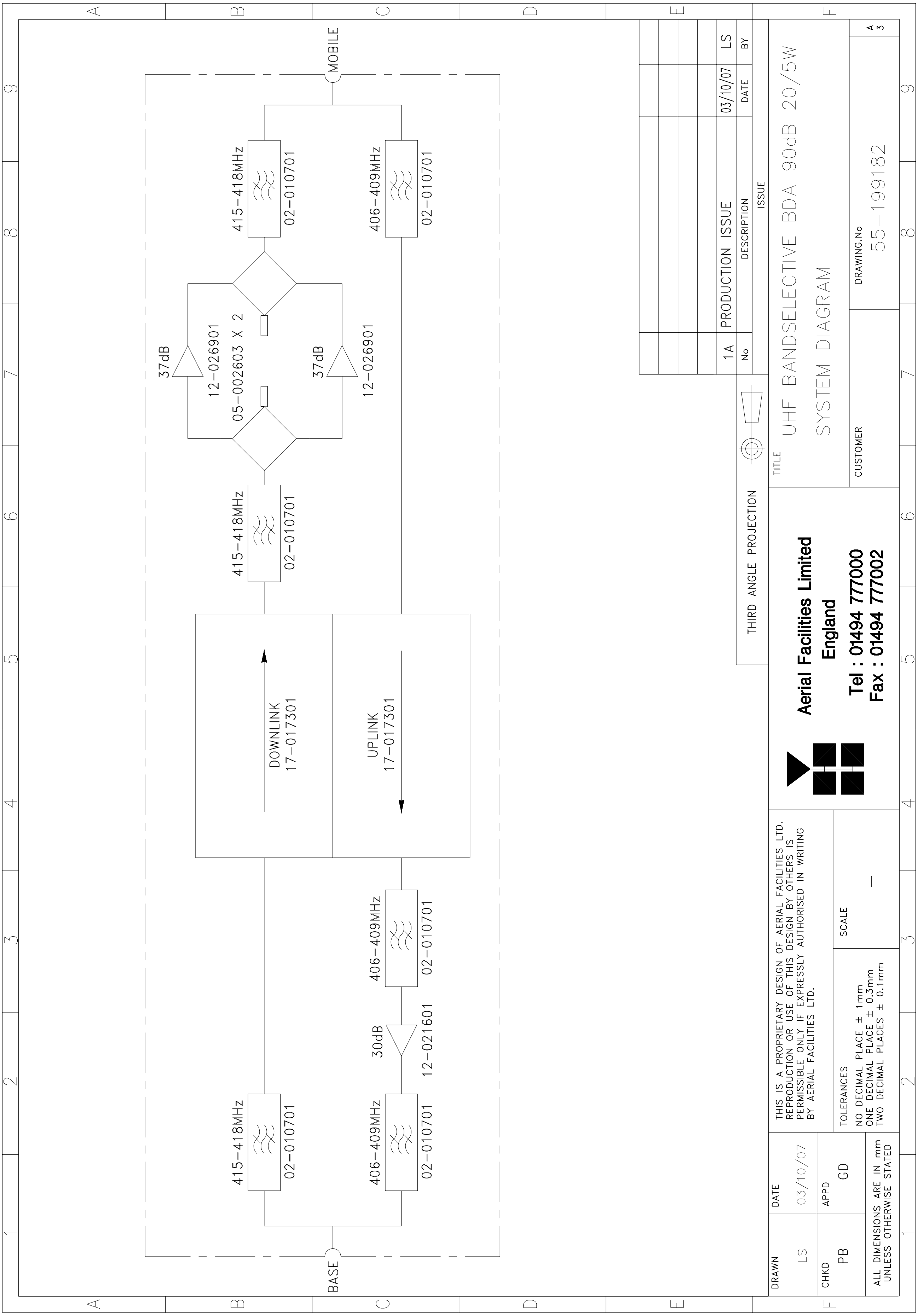
Component Part	Component Part Description	Qty Per Assembly
02-010701	Bandpass FIlter	6
05-002603	3dB Splitter/Combiner	2
10-001725	Remote Attenuator Switch Assembly	2
12-021601	5 Watt Tetra Amplifier	1
12-026901	Linearised Power Amplifier	2
13-001714	Voltage Regulator	2
13-003011	DC/DC Converter	1
17-017301	Bi-Directional Amplifier	1
80-008901	12V (Single) Relay Board	1
96-300054	24V Switch-Mode PSU	1

3.2. UHF Bandselective, BDA (55-199102) Specification.

Parameter		Specification
Passband	Uplink	415 - 418MHz
	Downlink	406 - 409MHz
Passband gain		90dB
Power Amplifier	Uplink	5 Watt
	Downlink	40 Watt
Passband Ripple		<±1.5 dB
I/P Return Loss		> 14dB
1dB Compression	Uplink	+35dB
	Downlink	+45dB
OIP3	Uplink	+48dBm
	Downlink	+62dBm
Noise Figure		<4dB (max.gain)
In Band Spurious Noise 30kHz Bandwidth		< -13 dBm (at 90dB gain)
Uplink ALC Setting		1dB below 1dB Comp.
Switched Attenuator (U/L & D/L)		2 dB steps 2-30dB (± 1dB)
Power Supply Current Rating		400W , 17A @ 24VD.C.
Alarm Output Type		Local Alarms
AC Supply Voltage		110V AC
RF Connectors		N type female
Temperature range:	operation:	-20°C to +60°C
	storage:	-40°C to +70°
Case Size (excludes h/sinks handles etc.)		620x420x250 mm

3.3. UHF Bandselective, BDA (55-199102) System Schematic

Drawing Number: 55-199182

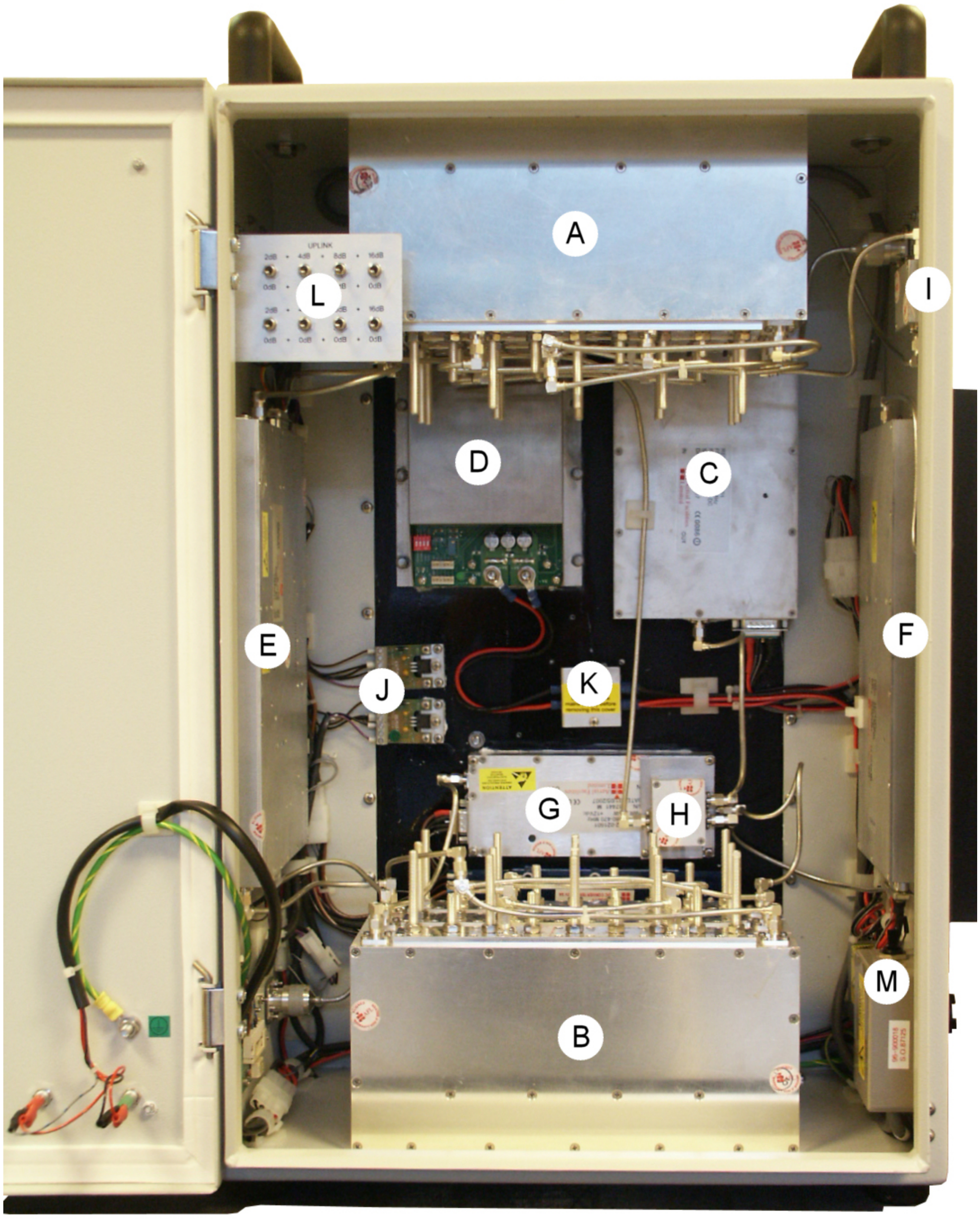


3.4. Photographs

3.4.1. Front of case – door closed

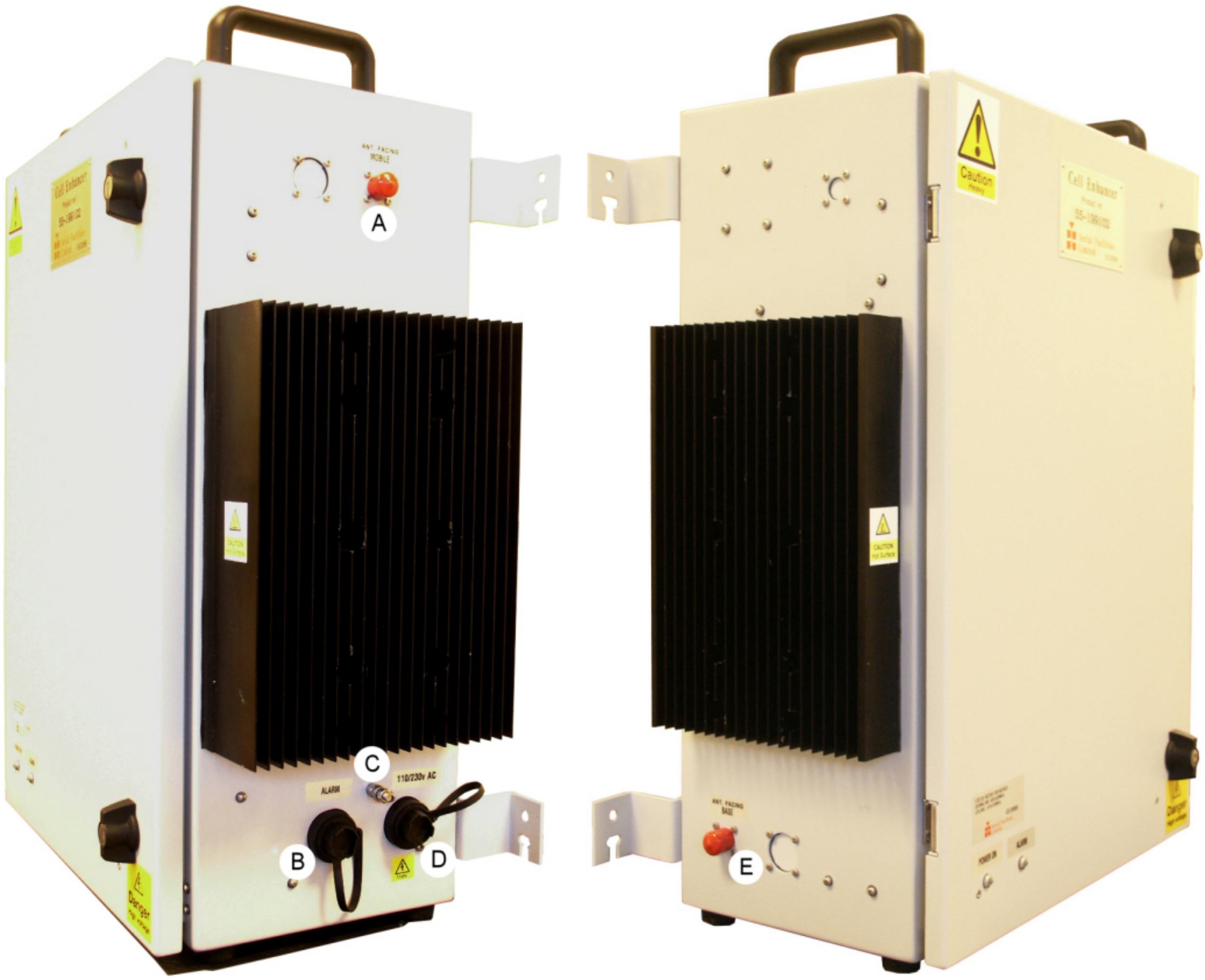
A	Green LED “Power On”
B	Red LED “Alarm”

3.4.2. Front of case – door open



A	Bandpass Filters (02-010701)
B	Bandpass Filters (02-010701)
C	Linearised Power Amplifier (12-026901) (Downlink)
D	24V Switch-Mode PSU (96-300054)
E	Bi-Directional Amplifier (17-017301)
F	Linearised Power Amplifier (12-026901) (Downlink)
G	5 Watt Tetra Amplifier (12-021601) (Uplink)
H	3dB Splitter/Combiner (05-002603)
I	3dB Splitter/Combiner (05-002603)
J	Voltage Regulators (13-001714)
K	DC/DC convertor (13-003011)
L	Attenuator control switches, Uplink top row – Downlink bottom row
M	Mains On/Off switch

3.4.3. Right Hand and Left Hand sides



A	Antenna Facing Mobile Port
B	Alarm Output
C	Earth Connection
D	AC Input
E	Antenna Facing Base Port

4. UHF BANDSELECTIVE, BDA (55-199102) SUB MODULES

4.1. Bandpass Filter (02-010701)

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.

02-010701 Specification

PARAMETER		SPECIFICATION
Response type:		Chebyshev
Frequency range:		415 - 418MHz (uplink)
		406 - 409MHz (downlink)
Bandwidth:		3 MHz
Number of sections:		5
Insertion loss:		1.7 dB (typical)
VSWR:		better than 1.2:1
Connectors:		SMA
Power Handling:		100W max
Temperature range	operation:	-20°C to +60°C
	storage:	-40°C to +70°C
Weight:		3 kg (typical)

4.2. 3dB Splitter/Combiner (05-002603)

The 3dB Splitter/Combiner (05-002603) is a device for accurately matching two RF signals to a single port or splitting an RF signal to two ports whilst maintaining an accurate 50 Ω load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum.

05-002603 Specification

PARAMETER		SPECIFICATION
Frequency range:		380 - 520 MHz
Bandwidth:		140 MHz
Ports	As Combiner	2 inputs 1 output
	As Splitter	1 input 2 outputs
Insertion loss:		3.5 dB (typical)
Isolation:		>18 dB
Return Loss (VSWR) – Input:		Better than 1.3:1
Return Loss (VSWR) – Output:		Better than 1.3:1
Impedance:		50 Ω
Power Rating – Combiner:		0.5 Watt
Power Rating – Splitter:		20 Watts
Connectors:		SMA female
Size:		54 x 44 x 21 mm
Weight:		200 gm (approximately)

4.3. Remote Attenuator Switch Assembly ('10-001725')

The remote attenuator switch assembly is used to control the amount of signal attenuation in the sub-module, Bi-Directional Amplifier (17-017301). The switch assembly is mounted on the inside of the Bandselective BDA (55-199102) case and consists of four miniature toggle switches, one row for uplink and one row for downlink, built around the remote attenuator switch PCB (10-001725)

The switch assembly allows attenuation settings from 0 – 30dB in 2 dB steps The attenuation is simply set using the four miniature toggle switches. Each switch is clearly marked with the attenuation it provides, and the total attenuation in line is the sum of the values switched in. The attenuators that the switches control are integral to sub-module Bi-Directional Amplifier (17-017301).

4.4. 5 Watt Tetra Amplifier (12-021601)

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.

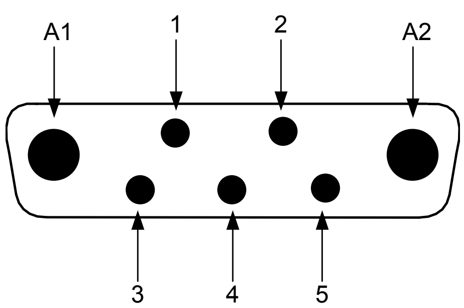
The unit housing is an aluminium case (Iridite NCP finish) with SMA connectors for the RF input/output and a D-Type connector for the power supply and the Current Fault Alarm Function.

12-021601 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

7-Way Connector Pin-out details	
Connector Pin	**Signal**
A1 (large pin)	+10-24V 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)

7-Way Pin-Out Graphical Representation



4.5. Linearised Power Amplifier (12-026901)

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.

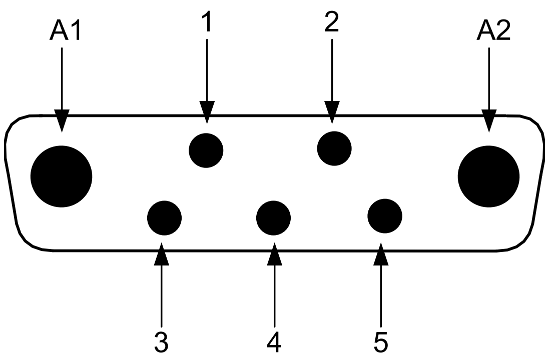
The power amplifier should require no maintenance over its operating life. Under no circumstances should the cover be removed or the side adjustments disturbed unless it is certain that the amplifier has failed; since it is critically aligned during manufacture and any re-alignment will require extensive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

12-026901 Specification

PARAMETER		SPECIFICATION
Frequency range:		380-440MHz (tuned to spec.)
Bandwidth:		<60MHz (typical)
Maximum RF output:		>25Watt
Small signal gain:		37.5dB (typical)
1dB compression point:		+44dBm
3rd order intercept point:		+61dBm
Noise figure:		N/A
Return input loss:		>15dB
Return output loss:		>15dB
VSWR:		better than 1.5:1
RF Connectors:		SMA female
Supply:		4.6Amps @ 24V DC
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		1.5 kg

12-026901 7-Way Connector Pin-outs	
Connector Pin	**Signal**
A1 (large pin)	+24V 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)

7-Way Connector Graphical Representation



4.6. Voltage Regulator Board 9.0V (13-001714)

This unit it is used to derive a fixed voltage power supply rail from some higher voltage. In this instance it is used to derive 9V from a 12V input.

The circuit is based upon a fixed voltage regulator, which is capable of supplying a maximum of 2.0 A 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.

13-001714 Specification

PARAMETER		SPECIFICATION
	Operating voltage:	12V DC
	Output voltages:	9.0V
	Output current:	2.0A (maximum per o/p)
	Connections:	Screw Terminal Block
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
	PCB Size:	30.5 x 38.1mm

4.7. DC/DC Converter, 24V in, 12V 8A out (13-003011)

The DC/DC converter fitted is an AFL assembled, high power PCB unit with an 8 amp at 12V output capability. The circuit is basically an O.E.M semiconductor regulator (one side of which has a heatsink mounting plate, usually bolted to the casing of a Cell Enhancer) and smoothing components built onto a printed circuit board with screw block terminations.
In event of failure this unit should not be repaired, only replaced.

13-003011 Specification

PARAMETER		SPECIFICATION
Input Voltage range:		18-28V DC
Output voltage:		12V±0.5V
Max. current load:		8.0Amps
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Size(PCB):		190 x 63mm
Weight (Loaded PCB):		291gms

4.8. Bi-Directional Amplifier (17-017301)

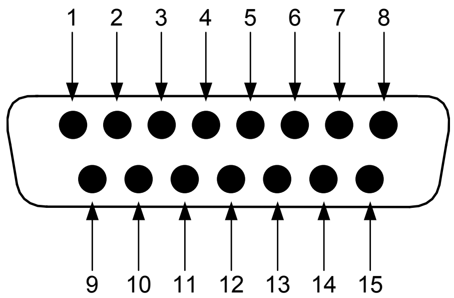
This module is a Bi-Directional Amplifier (up-link and down-link). All the amplifier stages are of balanced type and there is additionally digital attenuation, automatic level control (ALC) in the uplink path and also Current Fault Alarm Function circuitry, which indicates failure of each RF transistor in various ways – open collector, closed collector (TTL) and a relay to indicate the failure by voltage free change over contacts.
The module is housed in an aluminium case (Iridite NCP finish) with SMA connectors for the RF input/output and a D-type connector for power supply and Current Fault Alarm Function.

Specification 17-017301

PARAMETER	SPECIFICATION
Frequency Range MHz	380-430
Gain	64 - 66 dB
Gain Flatness	2.0 dB
∆Gain vs. Temp.	2.5 dB Max
ALC dynamic Range	≥ 28 dB Min
ALC o/p power level	29 ± 0.5 dBm Min
Input Return Loss	≤ 15 dB Min
Output Return Loss	≤ 18 dB Min
P1dB	≥ 30 dBm Min
OIP3	≥ 41 dBm Min
Noise Figure	≤ 1.7 dB Max
DC Supply	9.0V ± 0.5 at 1120 mA Max
Max RF Input	+15dBm
Storage temperature	-40 to +100 ºC
Operating temperature	-20 to +70 ºC
Dimensions	291.0 x 165.6 x 28.5 mm

BDA 'D' Connector Pin-out details	
Connector pin	**Signal**
1	+ve input (9V)
2	+ve input (9V)
3	GND
4	GND
5	Alarm relay good
6	Alarm relay common
7	Alarm relay O/P bad
8	Attenuator In
9	Detector Out
10	Digital Attenuator Bit 1
11	Digital Attenuator Bit 2
12	Digital Attenuator Bit 3
13	Digital Attenuator Bit 4
14	Not Used
15	Not Used

15-Way Pin-Out Graphical Representation



4.9. 12V (Single) Relay Board (80-008901)

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.

Specification 80-008901

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:	Screw terminals
Temperature range	operational:	-10°C to +60°C
	storage:	-20°C to +70°C

4.10. 24V Switch-Mode PSU (96-300054)

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 PSUs 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.

96-300054 Specification

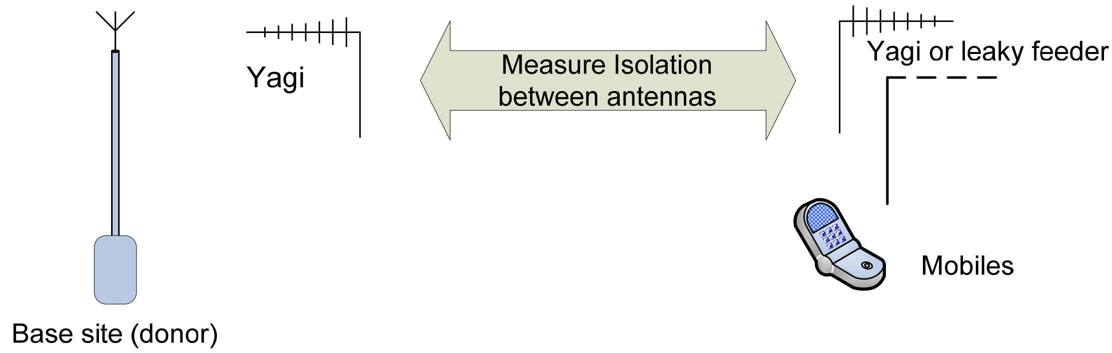
AC Input Supply	
Voltages:	110 or 220V nominal
	90 to 132 or 180 to 264V (absolute limits)
Frequency:	47 to 63Hz
DC Output Supply:	
Voltage:	24V DC (nominal)
	20 to 28V (absolute limits)
Maximum current:	17A

5. INSTALLATION & COMMISIONING

5.1. Antenna Installation & Gain Calculations

1 Most Cell Enhancer require two antennas, one a highly directional Yagi or similar directed towards the donor cell base station, and one a leaky feeder, omni-directional antenna or Yagi to cover the area in which the mobiles are to be served.

2 The maximum gain at which the Cell Enhancer can be set is limited by the isolation that can be achieved between these two antennas. Therefore when the antennas have been installed, inject a signal (at a known power level) into one of them and measure the signal level received by the other antenna on a spectrum analyser. The isolation can then be calculated as the difference between these two figures. The gain in each path of the Cell Enhancer should be set at least 10 dB below this figure, using attenuators as described below in paragraph 5.

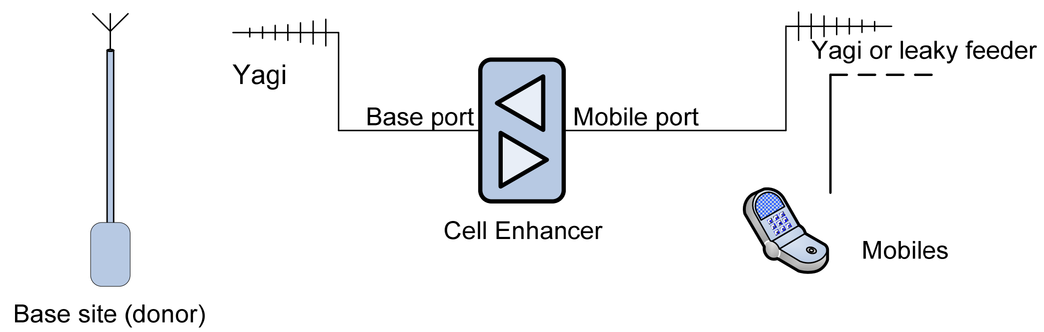


3 Also measure the received signal from the donor cell at the input to the Cell Enhancer (base port). The gain of the Cell Enhancer downlink path should be set such the donor site will not overload the Cell Enhancer amplifiers. It is recommended that the input level should be less than -50dBm at the input of the Cell Enhancer (Base Port). (This figure is assuming maximum gain, and may be increased by the value of the attenuator fitted in the downlink path.)

4 Ensure that the mobile facing antenna has at least 70 dB isolation from the nearest mobile. (This is usually easily achieved when using a leaky feeder.)

5 The Cell Enhancer gain is set by setting the attenuation in each path (uplink and downlink) between the first two amplifier stages (see markings within the Cell Enhancer or layout drawings for the exact attenuator locations). Note that the uplink (mobile to base) and downlink (base to mobile) path gains are set independently. This allows the paths to have different gains if required to set the correct output power levels.

6 It is recommended that the gains are set such that the Downlink output levels from the Cell Enhancer are typically +44dBm. (Input level + Gain = Output level).



5.2. Initial Installation Record

When this equipment is initially commissioned, please use the equipment set-up record sheet in Appendix B This will help both the installation personnel and AFL should these figures be needed for future reference or diagnosis.

6. FAULT FINDING / MAINTENANCE

6.1. Tools & Test Equipment

The minimum tools and test equipment needed to successfully service this AFL product are as follows:-

Spectrum analyser:	100kHz to 2GHz (Dynamic range = 90dB).
Signal Generator:	30MHz to 2GHz (-120dBm to 0dBm o/p level).
Attenuator:	20dB, 10W, DC-2GHz, (N male – N female).
Test Antenna:	Yagi or dipole for operating frequency.
Digital multi-meter:	Universal Volt-Ohm-Amp meter.
Test cable x 2:	N male – N male, 2M long RG214.
Test cable x 2:	SMA male – N male, 1m long RG223.
Hand tools:	Philips #1&2 tip screwdriver.
	3mm flat bladed screwdriver.
	SMA spanner and torque setter.

6.2. Basic Fault Finding

In the event that the performance of the system is suspect, a methodical and logical approach to the problem will reveal the cause of the difficulty. The System consists of modules in a wall-mounted enclosure.

Transmissions from the main base stations are passed though the system to the mobile radio equipment; this could be a handheld radio or a transceiver in a vehicle. This path is referred to as the downlink. The return signal path from mobile radio equipment to the base station is referred to as the uplink.

The first fault finding operation is to check the alarms of each of the active units and determine that the power supplies to the equipment are connected and active. This can be achieved remotely (via CEMS, the RS232 Coverage Enhancement Management System, if fitted), or locally with the front panel LEDs. The green LED on the front panel should be illuminated, while the red alarm indicator should be off. Note that passive only shelves will have no DC power or alarm indicators. If an Alarm is on, then that individual shelf must be isolated and individually tested against the original test specification. The individual amplifier units within any shelf have a green LED showing through a hole in their cover, which is illuminated if the unit is working correctly. (Without active power supplies there can be no alarm LED indicators, however without DC power, the fail-safe summary alarm system [normally closed relay contacts] will be an open circuit, thereby activating any externally connected system.)

If an amplifier is suspect, check the DC power supply to the unit. If no other fault is apparent use a spectrum analyser to measure the incoming signal level at the input and then after reconnecting the amplifier input, measure the output level. Consult with the system diagram to determine the expected gain and compare result.

In the event that there are no alarms on and all units appear to be functioning it will be necessary to test the system in a systematic manner to confirm correct operation.

6.3. Quick Fault Checklist

All AFL equipment is individually tested to specification prior to despatch. Failure of this type of equipment is not common. Experience has shown that a large number of fault conditions relating to installations result from simple causes often occurring as result of transportation, unpacking and installation. Below are listed some common problems which have resulted in poor performance or an indicated non-functioning of the equipment.

- Mains power not connected or not switched on.
- External connectors not fitted or incorrectly fitted.
- Internal connectors/ports becoming loose due to transport vibration.
- Wiring becoming detached as a result of heavy handling.
- Input signals not present due to faults in the aerial or feeder system.
- Base transmissions not present due to faults at the base station.
- Modems fitted with incorrect software configuration/and or PIN Nos.
- Changes to channel frequencies and inhibiting channels.
- Hand held radio equipment not correctly set to repeater channels.
- Hand held radio equipment not correctly configured to base station.

6.4. Downlink

Confirm that there is a signal at the expected frequency and strength from the base station(s). If this is not present then the fault may lay outside the system. To confirm this, inject a downlink frequency signal from a known source at the BTS input and check for output at the antenna output port.

If a signal is not received at the output it will be necessary to follow the downlink path through the system to find a point at which the signal is lost.

6.5. Uplink

Testing etc. of the uplink paths is similar to the downlink paths, except for the frequencies involved.

6.6. Fault repair

Once a faulty component has been identified, a decision must be made on the appropriate course to carry out a repair. A competent engineer can quickly remedy typical faults such as faulty connections or cables. The exceptions to this are cable assemblies connecting bandpass filter assemblies (duplexers) that are manufactured to critical lengths to maintain a 50-ohm system.

Care should be taken when replacing cables or connectors to ensure that items are of the correct specification. The repair of component modules such as amplifiers and bandpass filters will not usually be possible in the field, as they frequently require specialist knowledge and test equipment to ensure correct operation. It is recommended that items of this type are replaced with a spare unit and the faulty unit returned to AFL for repair.

Following the repair of any part of the system it is recommended that a full end-to-end test is carried out in accordance with the test specification and that the coverage is checked by survey.
It is important to bear in mind that the system includes antennas and base stations that may be faulty or may have been damaged.

6.7. Service Support

Advice and assistance with maintaining and servicing this system are available by contacting Aerial Facilities Ltd. see section 2.7.

6.8. Care of Modules

Many of the active modules contain semiconductor devices utilising MOS technology, which can be damaged by electrostatic discharge. Correct handling of such modules is mandatory to ensure their long-term reliability. Good engineering practices should be observed at all times.

To prevent damage to a module, it must be withdrawn/inserted with care.

6.9. Module Removal (LNAs, general procedure):

The following *general* rules should be followed to remove a module:

1) Remove power to the unit
2) Remove all connectors (RF, DC/alarm)
3) Release module retaining screws.
4) Slowly but firmly, pull the module straight out of its position. Take care not to twist/turn the module during withdrawal.

6.10. Module Replacement (general):

1) Carefully align the module into its location then slowly push the module directly straight into its position, taking care not to twist/turn it during insertion.
2) Reconnect all connectors, RF, alarm, power etc.
3) Replace retaining screws (if any).
4) Double-check all connections before applying power.

6.11. Power Amplifiers

1) Remove power to the unit. (Switch off at mains/battery)

2) Disconnect multi-way alarm ‘D’ type connector

3) Carefully disconnect the RF input and output coaxial connectors (usually SMA)

4) If the amplifier to be removed has a heatsink attached, there may be several different ways it can have been assembled. The most commonly used method, is screws through the front of the heatsink to threaded screw holes (or nuts and bolts), into the amplifier within the main case. If the heatsink is mounted on the rear of the main case (e.g., against a wall in the case of wall mounted enclosures), then the fixing method for the heatsink will be from within the case, (otherwise the enclosure would have to be removed from the wall in order to remove the heatsink).

When the heatsink has been removed, the amplifier may be unscrewed from the main casing by its four corner fixings and gently withdrawn.

Fitting a new power amplifier module will be the exact reverse of the above.

Note: **Do not forget to apply fresh heatsink compound to the heatsink/main case joint and also between the amplifier and the main case.**

5) If the amplifier to be removed has a heatsink attached, there may be several different ways it can have been assembled. The most commonly used method, is screws through the front of the heatsink to threaded screw holes (or nuts and bolts), into the amplifier within the main case. If the heatsink is mounted on the rear of the main case (e.g., against a wall in the case of wall mounted enclosures), then the fixing method for the heatsink will be from within the case, (otherwise the enclosure would have to be removed from the wall in order to remove the heatsink).

When the heatsink has been removed, the amplifier may be unscrewed from the main casing by its four corner fixings and gently withdrawn.

Fitting a new power amplifier module will be the exact reverse of the above.

Note: Do not forget to apply fresh heatsink compound to the heatsink/main case joint and also between the amplifier and the main case.

6.12. Low Power Amplifier Replacement

Disconnect the mains power supply and disconnect the 24V dc supply connector for the LPA.
Disconnect the RF input and output cables from the LPA.
Disconnect the alarm connector.
Remove the alarm monitoring wires from (D type connector) pins 9 and 10.
Remove the LPA module by removing the four retaining screws, replace with a new LPA module and secure it with the screws.
Connect the RF cables to the LPA input and output connectors. Reconnect the wires to the alarm board connector pins 9 and 10.
Reconnect the DC supply connector and turn the mains switch on.

Note: Tighten SMA connectors using only a dedicated SMA torque spanner. If SMA connectors are over-tightened, irreparable damage will occur. . *Do not use adjustable pliers to loosen/tighten SMA connectors.*

Also take care not to drop or knock the module as this can damage (or misalign in the case of tuned passive modules) sensitive internal components. Always store the modules in an environmentally friendly location

Test equipment should always be used to verify the performance of any new module fitted to the system before broadcasting in the public domain.

6.13. Module Transportation:

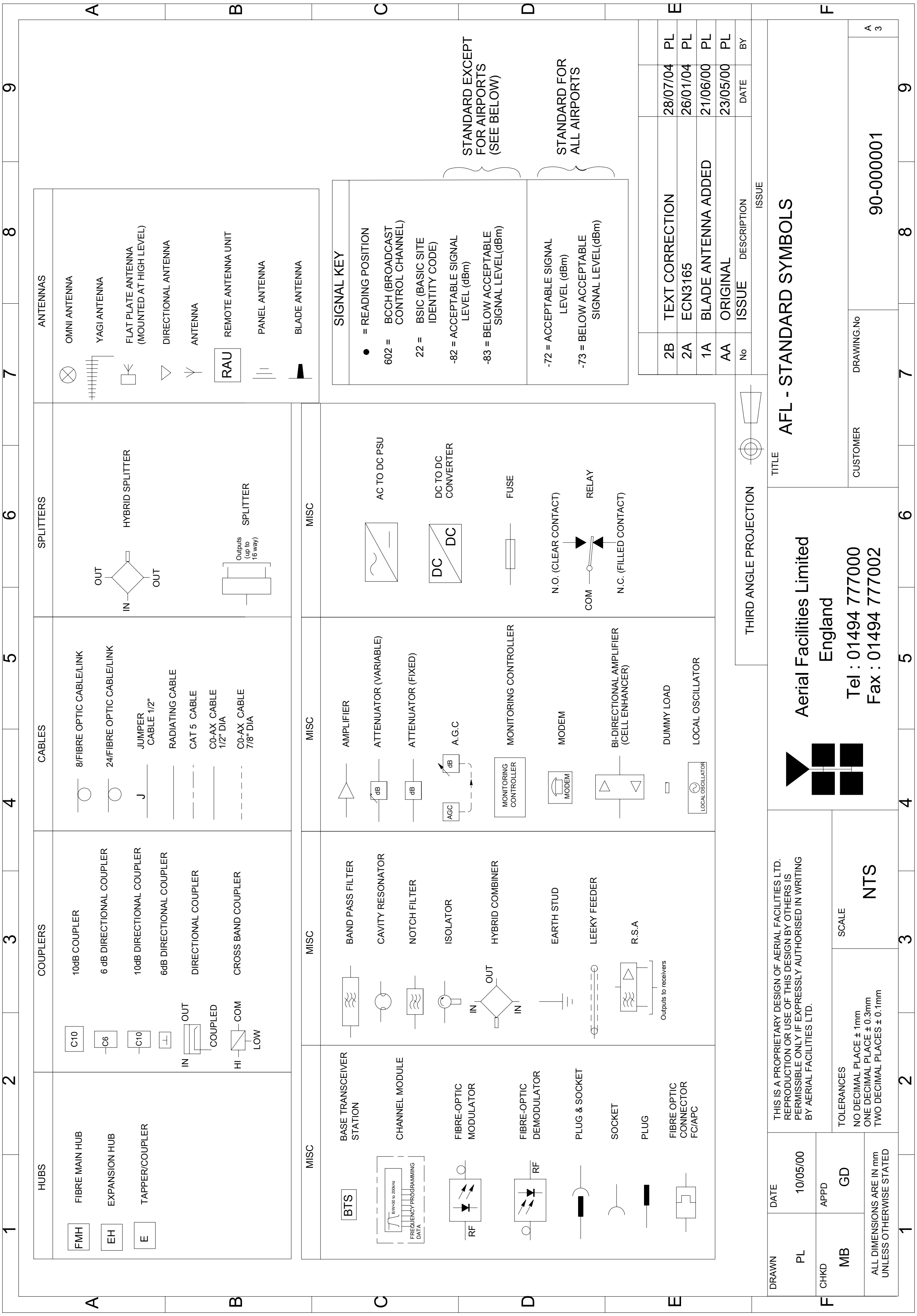
To maintain the operation, performance and reliability of any module it must be stored and transported correctly. Any module not installed in a whole system must be kept in an anti-static bag or container. Any module sent back to AFL for investigation/repair must be so protected. Please contact AFL's quality department before returning a module, see section 2.7.

APPENDIX A

A.1. Glossary of Terms used in this document

Repeater or Cell Enhancer	A Radio Frequency (RF) amplifier which can simultaneously amplify and re-broadcast Mobile Station (MS) and Base Transceiver Station (BTS) signals.
Band Selective Repeater	A Cell Enhancer designed for operation on a range of channels within a specified frequency band.
Channel Selective Repeater	A Cell Enhancer, designed for operation on specified channel(s) within a specified frequency band. Channel frequencies may be factory set or on-site programmable.
AC	Alternating Current
AGC	Automatic Gain Control
BBU	Battery Backup Unit
BTS	Base Transceiver Station
CEMS	Coverage Enhanced Management System
C/NR	Carrier-to-Noise Ratio
DC	Direct Current
Downlink (D/L)	RF signals TX from the BTS to the Master Site
FO	Fibre Optic
GND	Ground
ID	Identification Number
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LPA	Low Power Amplifier
MOU	Master Optical Unit
M.S.	Mobile Station
MTBF	Mean Time Between Failures
N/A	Not Applicable
N/C	No Connection
OFR	On Frequency Repeater
OIP3	Output Third Order Intercept Point
P1dB	1dB Compression Point
PA	Power Amplifier
RF	Radio Frequency
RSA	Receiver/Splitter Amplifier
RX	Receiver
S/N	Serial Number
TX	Transmitter
Uplink (U/L)	RF signals transmitted from the MS to the BTS
VSWR	Voltage Standing Wave Ratio
WDM	Wave division multiplex

A.2. Key to Drawing Symbols used in this document



A.3. EC Declaration of Conformity

Aerial Facilities Limited

In accordance with BS EN ISO/IEC 17050-1&-2:2004

Aerial Facilities Limited
Aerial House
Asheridge Road
Chesham
Buckinghamshire HP5 2QD
United Kingdom

CE0086

DECLARES, UNDER OUR SOLE RESPONSIBILITY THAT THE FOLLOWING PRODUCT:

PRODUCT PART NO[S]	55-199102
PRODUCT DESCRIPTION	UHF Bandselective Bi-Directional Amplifier

IN ACCORDANCE WITH THE FOLLOWING DIRECTIVES:

1999/5/EC and	The Radio & Telecommunications Terminal Equipment Directive Annex V its amending directives

HAS BEEN DESIGNED AND MANUFACTURED TO THE FOLLOWING STANDARD[S] OR OTHER NORMATIVE DOCUMENT[S]:

BS EN 60950	Information technology equipment. Safety. General requirements
ETS EN 301 489-1	EMC standard for radio equipment and services. Part 1. Common technical requirements

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives.

SIGNED

B S BARTON
TECHNICAL DIRECTOR

DATE: 01/10/2007

Registered Office: Aerial House, Asheridge Road, Chesham, Buckinghamshire, HP5 2QD England Registered No. 4042808 (England)
www.aerialfacilities.com

A.4. Amendment List Record Sheet

Issue No.	Date	Incorporated by	Page Nos. Amended	Reason for new issue
A	26/09/2007	AJS		Draft
1	05/10/2007	AJS		First Issue

Document Ref. 55-199102HBKM

APPENDIX B

Initial Equipment Set-Up Calculations

General Information			
Site Name:		Client Name:	
Date:		AFL Equip. Model No.	

Antenna Systems				
	Model	Gain	Azimuth	Comments
A - Service Antenna				
B – Donor Antenna				
	Type	Loss	Length	Comments
C – Service Feeder				
D – Donor Feeder				

Initial Parameters	
E – CE Output Power	dBm
F – Antenna Isolation	dB
G – Input signal level from donor BTS	dBm
Operating Voltage	V

Downlink Calculations		
Parameter	Comments	Value
Input signal level (G)		dBm
CE max. o/p power (E)		dBm
Gain setting	E - G	dB
Isolation required	(Gain + 10dB)	dB
Service antenna gain (A)		dB
Service antenna feeder loss (C)		dB
Effective radiated power (ERP)	E+A-C	dBm
Attenuator setting	CE gain-gain setting	dB

If the input signal level in the uplink path is known and steady, use the following calculation table to determine the gain setting. If the CE features Automatic Gain Control the attenuator should be set to zero and if not, then the attenuation setting for both uplink and downlink should be similar.

Uplink Calculations		
Parameter	Comments	Value
Input signal level		dBm
CE max. o/p power (E)		dBm
Gain setting		dB
Required isolation		dB
Donor antenna gain (B)		dB
Donor antenna feeder loss (D)		dB
Effective radiated power (ERP)	E+B-D	dBm
Attenuator setting	(CE gain-gain setting)	dB