Aerial Facilities Limited

UHF
Bi-Directional Amplifier

AFL product part No: 60-137705

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1. INTRODUCTION

Scope and Purpose of Document

This handbook is for use solely with the equipment identified by the AFL Part Number shown on the front cover. It is not to be used with any other equipment unless specifically authorised by Aerial Facilities Limited. 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 Aerial Facilities Ltd.

AFL recommends that the installer of this equipment familiarise his/herself 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.

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 it's 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

Cell Enhancers 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

Electrical shocks due to faulty mains driven power supplies.
Whilst ever potentially present in any electrical equipment, such a condition would be minimised by quality installation practice and thorough testing at:

a) Original assembly

b) Commissioning

c) Regular intervals, thereafter.

All test equipment to 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 unterminated. 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 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.

2.5 Laser Safety

General working practices adapted from EN60825-2: 2000

“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
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.

2.6 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 BDA system comprises two standard 19" rack mounted shelves:-

60-173705 (PSU & RF Amplifiers BDA shelf)
80-245102 (Stand-alone Amplifier shelf)

3.1 Technical Specification (whole system)

PARAMETER		SPECIFICATION
Downlink frequency range:		408–411MHz
Uplink frequency range:		417-420MHz
Gain:		60dB
Passband ripple:		±1.5dB
Attenuation:		0-30dB
Downlink OIP3:		+65dBm
Uplink OIP3:		+40dBm
RF levels (BDA shelf):	Base	4 Carriers -10dBm (antenna output)
	Mobile:	4 Carriers +37dBm (antenna output)
Power supply consumption:		30A max.@ 24V DC
		1.0A max @ 12V DC
Impedance:		50Ω
AGC level:		+37dBm per carrier(D/L)
		0dBm (U/L)
Alarms:		4 x LNA, 2 x LPA, & 2 x 100W PA
Summary alarm connector outputs:		Pins 1 & 2
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C

3.2 Mechanical Specification

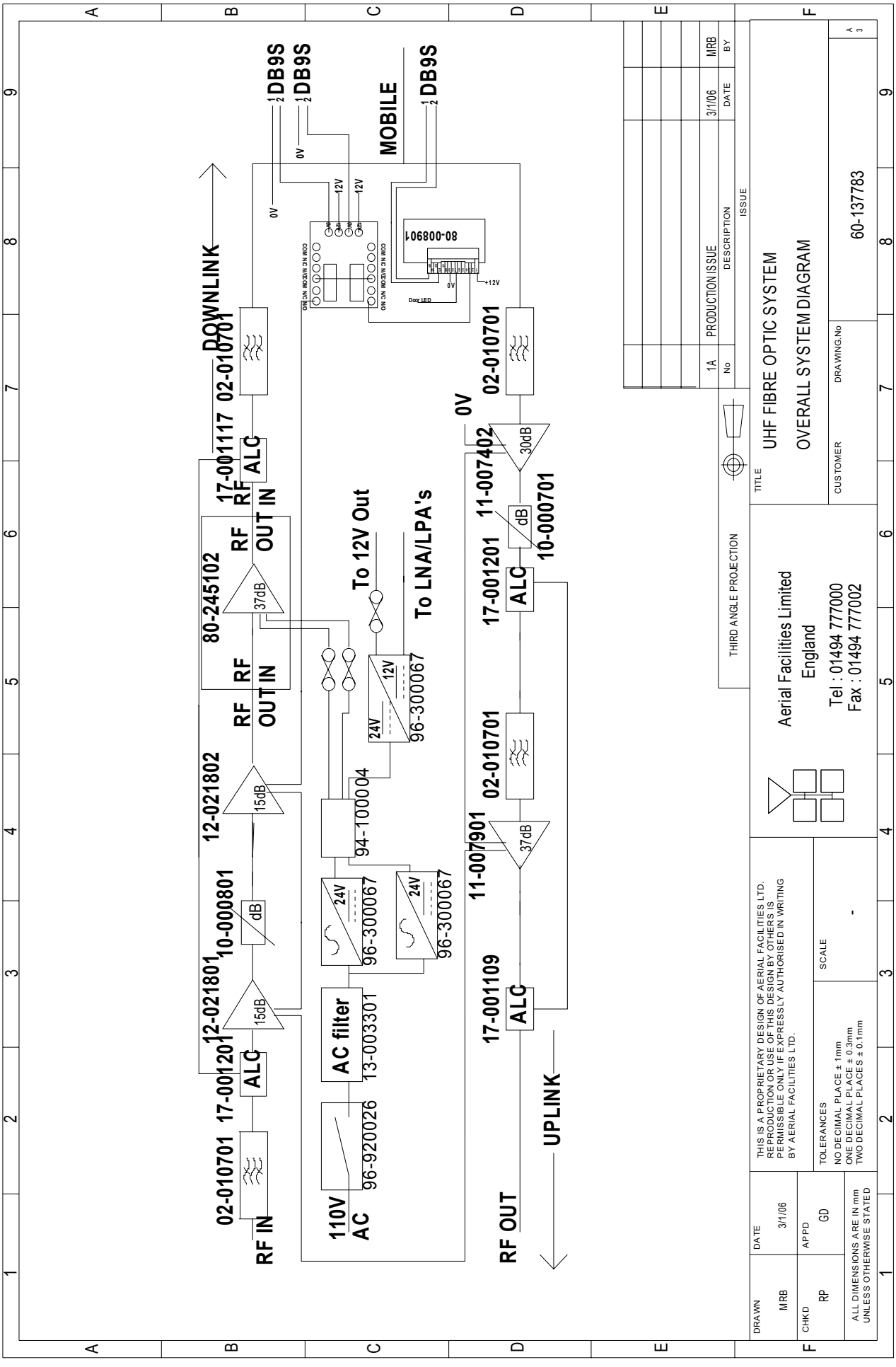
PARAMETER		SPECIFICATION
Racks	Height:	23U Standard Eurorack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelves:	Height:	8U (BDA shelf)
		4U (amplifier shelf)
	Width:	19" (482.6mm)
	Depth:	<400mm(excluding heatsinks, connectors, handles and feet)
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Weight:		<30kg (both shelves)
Humidity:		5 – 95% non-condensing
RF Connectors:		N type female & SMA
Environmental Protection:		IP44
Supply Cable:		Unit supplied with suitable supply input leads, connector and specified length of cable

3.3 Parts List

AFL Part Nō.	Part Description	Qty.
02-010701	5P C/L(V.B/W)X CPLING SMA 40mm POST	4
10-000701	1/4W0-30dB SWITCHED ATTENUATOR	1
10-000801	1W 0-30dB SWITCHED ATTENUATOR ASS.	1
11-007402K	LNA. 380-500MHz 30dB (relay) KIT	1
11-007901K	AMPLIFIER TETRA 1W 37dB GAIN KIT	1
12-021801	POWER AMPLIFIER TETRA 1W +12V	1
12-021802	POWER AMPLIFIER TETRA 2W +12V	1
13-003011	DC-DC CONVERTER 24-12V 8A PCB SUB-ASS	1
13-003301	MAINS FILTER 8AMP ASSEMBLY	1
14-000225	CASE RAIL LONG R.S.A./R.F.A.	2
17-001109	CE AGC UNIT LOG DET/AMP ASSY (12v)	1
17-001117	CELL ENHANCER AGC DETECTOR/AMP 12V	1
17-001201	C/E AGC UNIT ATTENUATOR ASSY	2
17-004730	ATTENUATOR MOUNTING	2
17-004733	SIMP.C.E ATTENUATOR COVER(RAL7032)	2
20-001601	12V RELAY BOARD	1
50-012820	CCE RACK MOUNTED 8U CHASSIS	1
50-012822	CCE RACK MOUNTED LID	1
50-012825	CCE RACK MOUNTED HEATSINK BRACKET	4
50-027720	RACK MTD CHAN C.E. MODIFIED HEATSIN	2
80-008901	12V RELAY PCB ASSEMBLY	1
80-090822	C/E 8U FRONT PANEL, AFL (RAL7035)	1
80-310420	BCC 400W POWER SUPPLY HEATSINK	1
90-100011	IEC MAINS LEAD '6 AMP' for USA	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	3
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	1
91-130005	SMA BULKHEAD ADAPTOR F/F	2
91-500005	POWER 3 PIN PLG FREE NC-X SER.	3
91-510002	3 PIN STRAIGHT FREE SOC.NC-X.	3
91-510004	3 PIN PNL.MOUNT SOCKET NC-X	3
91-520001	PWR MAINS INL FIXED/SOLD.TERMS	1
91-520010	MAINS RETAINING CLIP	1
91-600001	'D'TYPE 9 WAY PLUG S/B TERM	2
91-600005	'D' 9 WAY SOCKET S/B TERM	2
91-600014	'D' 9 WAY SOCKET S/B (NON FILTERED)	2
91-600015	'D' 9 WAY PLUG S/B (NON FILTERED)	2
91-700017	ICD 15 WAY 0.1' CONNECTOR	1
93-510077	0R02 50W RESISTOR ALUMINIUM CLAD	2
94-100004	STPS12045TV 60A DUAL DIODE	1
96-110001	FUSE HOLDER 20 X 5mm6.3A	1
96-110008	2A FUSE A:SURGE CERAMIC 20x5	1
96-110015	T 15A A/SURGE FUSE 1.25'	2
96-110034	FUSE HOLDER 16-30A, 32mm BODY ONLY	2
96-110064	FUSE HOLDER 16-30A, 32mm INSERT	2
96-300067	24V 23A PSU 600W (XP BCC)	2
96-600001	INSULATING BOOT LARGE	1
96-600002	INSULATING BOOT SMALL	3
96-600003	INSULATING BOOT D.C.	3
96-700034	LED RED 5mm IP67 INTEGRAL RES. 24V	1
96-700035	LED GREEN 5mm IP67 INTEGRAL RES 24V	1
96-920026	CIRCUIT BREAKER 10A	1
97-400005	HANDLE TYPE H6802 3U [ALLOY]	2

3.4 System Drawings

3.4.2 BDA Shelf System Diagram


DOWNLINK
UPLINK
MOBILE
1 DB9S
2 DB9S
1 DB9S
2 DB9S
0V
12V
80-008901
Door LED
+12V
02-010701
17-001117
RF
ALC
OUT IN
80-245102
37dB
12-021802
15dB
10-000801
dB
12-021801
17-001201
ALC
02-010701
RF IN
To 12V Out
To LNA/LPA's
96-300067
24V
12V
94-100004
AC filter
13-003301
96-920026
110V AC
11-007901
17-001109
ALC
37dB
02-010701
11-007402
17-001201
ALC
30dB
dB
10-000701
RF OUT
THIRD ANGLE PROJECTION
TITLE
UHF FIBRE OPTIC SYSTEM
OVERALL SYSTEM DIAGRAM
CUSTOMER
DRAWING No
60-137783
ISSUE
DESCRIPTION
DATE
BY
1A
PRODUCTION ISSUE
3/1/06
MRB
Aerial Facilities Limited
England
Tel : 01494 777000
Fax : 01494 777002
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TOLERANCES
NO DECIMAL PLACE ± 1mm
ONE DECIMAL PLACE ± 0.3mm
TWO DECIMAL PLACES ± 0.1mm
SCALE
-
DRAWN MRB
DATE 3/1/06
CHK'D RP
APP'D GD
ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED
A3

4. INSTALLATION

4.1 Initial Installation Record

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

5. FAULT FINDING & MAINTENANCE

5.1 General Fault Finding Procedures

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.
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 the mobile radio equipment to the base station is referred to as the uplink.

The first 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 LED's. The green LED on the front panel should be illuminated, while the red alarm indicator should be off.

If an Alarm is on, then that individual shelf/module must be isolated and individually tested against the original test specification.
The individual amplifier units within the shelf have a green LED showing through a hole in their piggy-back alarm board, which is illuminated if the unit is working correctly.

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.

5.2 Downlink

Confirm that there is a signal at the expected frequency and strength from the base station. 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 master site BTS input and check for output at the remote site feeder output.

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. The expected downlink output for the given input can be found in the end-to-end test specification.

5.3 Uplink

Testing the uplink involves a similar procedure to the downlink except that the frequencies used are those transmitted by the mobile equipment.

5.4 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 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.

5.5 Checking service

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 a radiating cable network and base stations that may be faulty or may have been damaged.

5.6 Service Support

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

5.7 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.

5.8 General Maintenance Procedures

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.

To prevent damage to a module, it must be withdrawn/inserted with care. The module may have connectors on its underside, which might not be visible to the service operative.

5.9 Module Removal (LNA's, general procedure):

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

1 Remove power to the unit
2 Remove all visible 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. (When the module is loose, care may be needed, as there may be concealed connections underneath).

5.10 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.,(concealed connectors may have to be connected first).
3 Replace retaining screws (if any).
4 Double-check all connections before applying power.

5.11 Power Amplifiers

1) Remove power to the unit. (Switch off @ mains/battery, or remove DC in connector)

2) Remove alarm wires from alarm screw terminal block or disconnect multi-way alarm connector.

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

If alarm board removal is not required, go to step 5.

4) There is (usually) a plate attached to the alarm board which fixes it to the amplifier, remove its retaining screws and the alarm board can be withdrawn from the amplifier in its entirety. On certain types of amplifier the alarm board is not mounted on a dedicated mounting plate; in this case it will have to firstly be removed by unscrewing it from the mounting pillars, in most cases, the pillars will not have not have to be removed before lifting the amplifier.

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.

5.12 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

5.13 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. These bags or containers are normally identified by being pink or black, and are often marked with an ESD label. Any module sent back to AFL for investigation/repair must be so protected. Please contact AFL's quality department before returning a module.

APPENDIX A

Amendment List Record Sheet

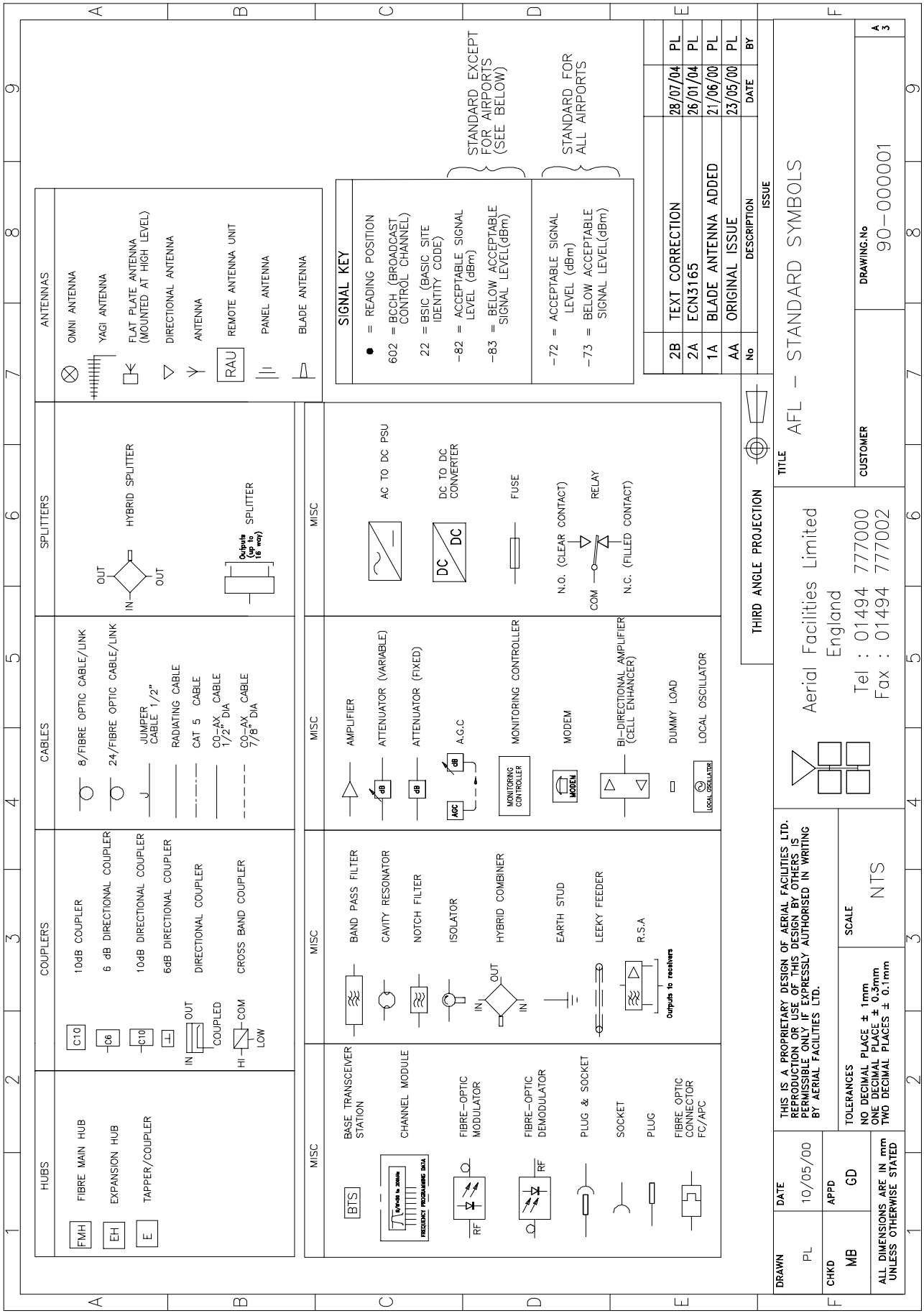
Issue No.	Date	Incorporated by	Page Nos. Amended	Reason for new issue
A	02/03/2006	CMH		1st Draft

Document Ref:-60-137705HBKM

Glossary of Terms

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 = RFout +(C/I)/2
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

Key to Drawing Symbols used in this document



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