Weehawken Tunnel Radio

Remote Repeater System

User/Maintenance Handbook
For
G.E Transport Systems
AFL Works Order Nō.: Q112727
AFL product part Nō.'s:
55-154901 (800MHz BS BDA)
80-231302 (800MHz Power Supply)
80-231303 (Alarm System)

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AMENDMENT LIST RECORD SHEET

Issue Nō.	Date	Incorporated by	Page No.'s Amended	Reason for new issue
A	05/09/2005	CMH		1st Draft

Document Ref:-Weehawken_River_Portal

INTRODUCTION

Scope

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.

Purpose

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 Information 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.

EC DECLARATION OF CONFORMITY

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

CE 0086

AERIAL FACILITIES LTD
Aerial House
Asheridge Road
Chesham
Bucks HP5 2QD

United Kingdom

DECLARES, UNDER OUR SOLE RESPONSIBILITY THAT THE FOLLOWING PRODUCT

PRODUCT PART NO[S] 55-154901
PRODUCT DESCRIPTION **Weehawken tunnel remote amplifier**
IN ACCORDANCE WITH THE FOLLOWING DIRECTIVES:

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

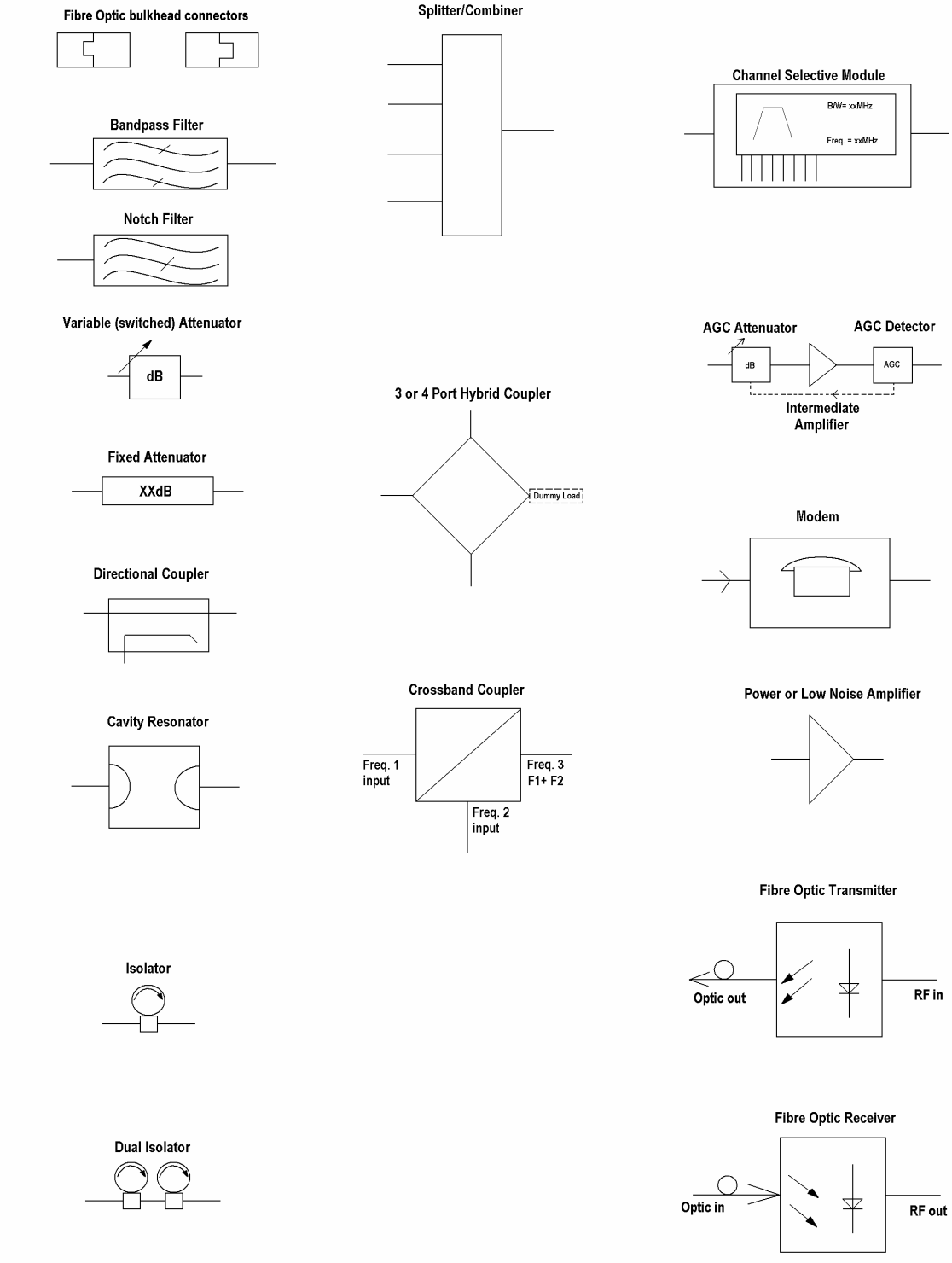
B S BARTON
TECHNICAL DIRECTOR **DATE: 08/11/2005**

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 = RF_{out} +(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 AFL RF Module Drawing Symbols



Key to AFL RF Modules

1. SAFETY CONSIDERATIONS

1.1 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.

1.2 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.

1.3 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.

1.4 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.

1.5 Emergency Contact Numbers

The AFL Quality Department can be contacted on:

Telephone	+44 (0)1494 777000
Fax	+44 (0)1494 777002
e-mail	qa@aerial.co.uk

2. OVERVIEW/ SYSTEM DESCRIPTION

2.1 General System Description

The Weehawken tunnel radio system is designed to amplify various bands of radio frequencies, in either channelised or band selective modes. This unit amplifies all the RF bands to the 'River Portal' area in a band-selective mode with AGC in the uplink direction. All the hardware is built into a standard environmentally protected cabinet which has an IP rating of 65.

The system described in this document is 'stand-alone' and needs no other equipment apart from a +12V DC power supply. Every active module in the entire system has a dedicated alarm and these are series wired within the unit to a relay which gives a volt-free output pair which is wired to a 'krone-block' termination and ultimately to a pair of wires in an external port connector (alarm connector, pins 1 & 2).

3. MULTI-BAND SELECTIVE CELL ENHANCER (RIVER PORTAL)

3.3 Band Selective BDA (55-154901)

3.3.1 Band Selective BDA Description

The band selective BDA which covers the 'River Portal' site carries two downlink paths and one uplink path, all with automatic gain control on the last amplification stage in each path. Cross band couplers are fitted to the input and output to facilitate a low frequency bypass of the 800MHz BDA allowing the lower frequency signals to pass unhindered.
All amplifiers have built-in alarms which are configured as a summary, volt-free relay contact pair terminating at pins 1 & 2 on the 'D' type alarm connector.

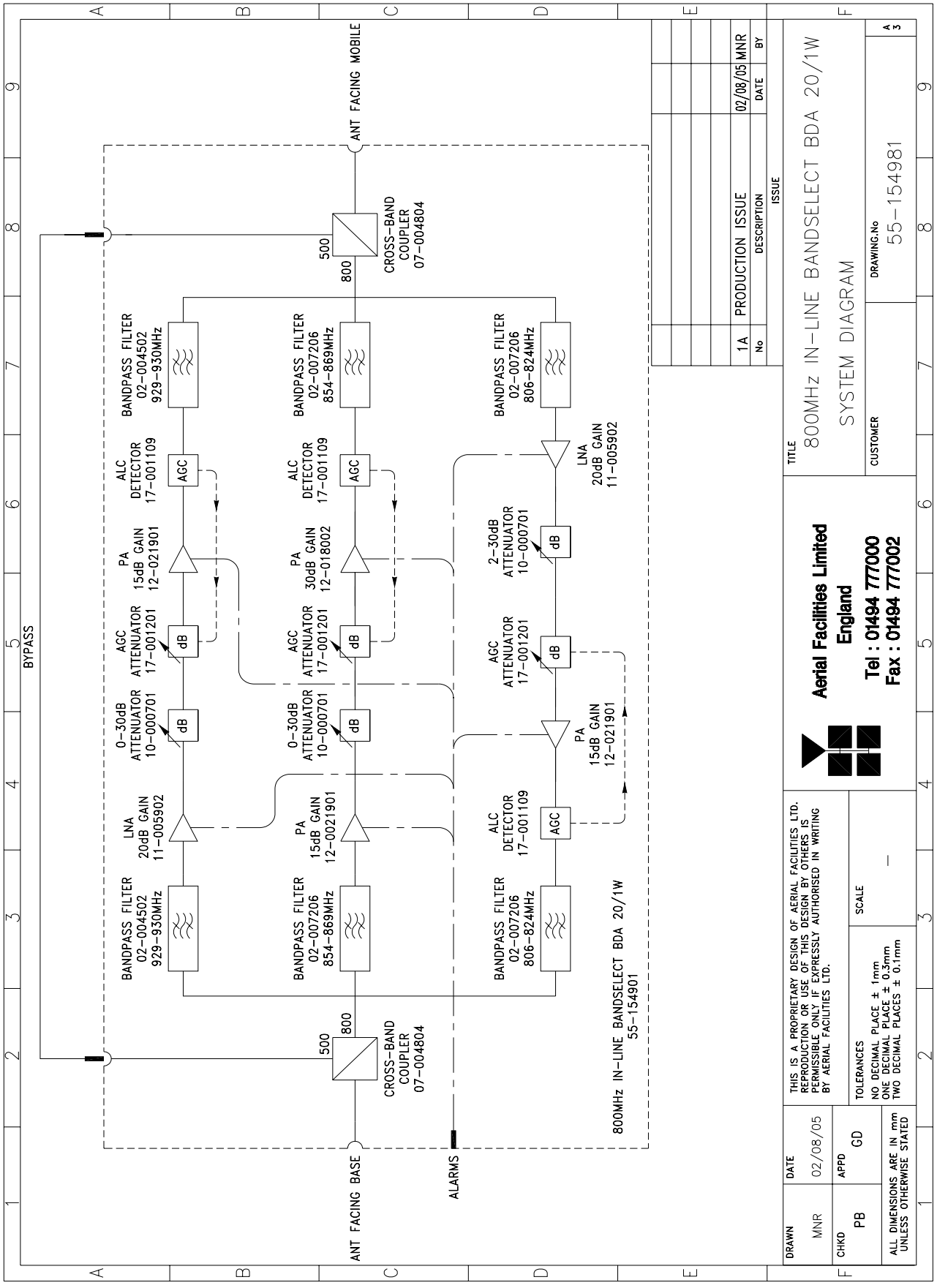
3.3.2 Band Selective BDA Electrical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		929-930MHz (Downlink)
		854-869MHz (Downlink)
		806-824MHz (Uplink)
Gain:		>35dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink power:		>1.0Watts (806-824MHz path)
Downlink power:		>1.0Watts (929-930MHz path)
Downlink power:		>20.0Watts (854-869MHz path)
IP3:	Uplink	+43dBm (806-824 & 929-930MHz paths)
	Downlink	+56dBm (854-869MHz path)
Noise Figure:		<6dB (at maximum gain)
AGC:		Fitted to all paths
DC Power supply:		12V DC (externally supplied)
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 Downlink amplifiers
		2 Uplink amplifiers

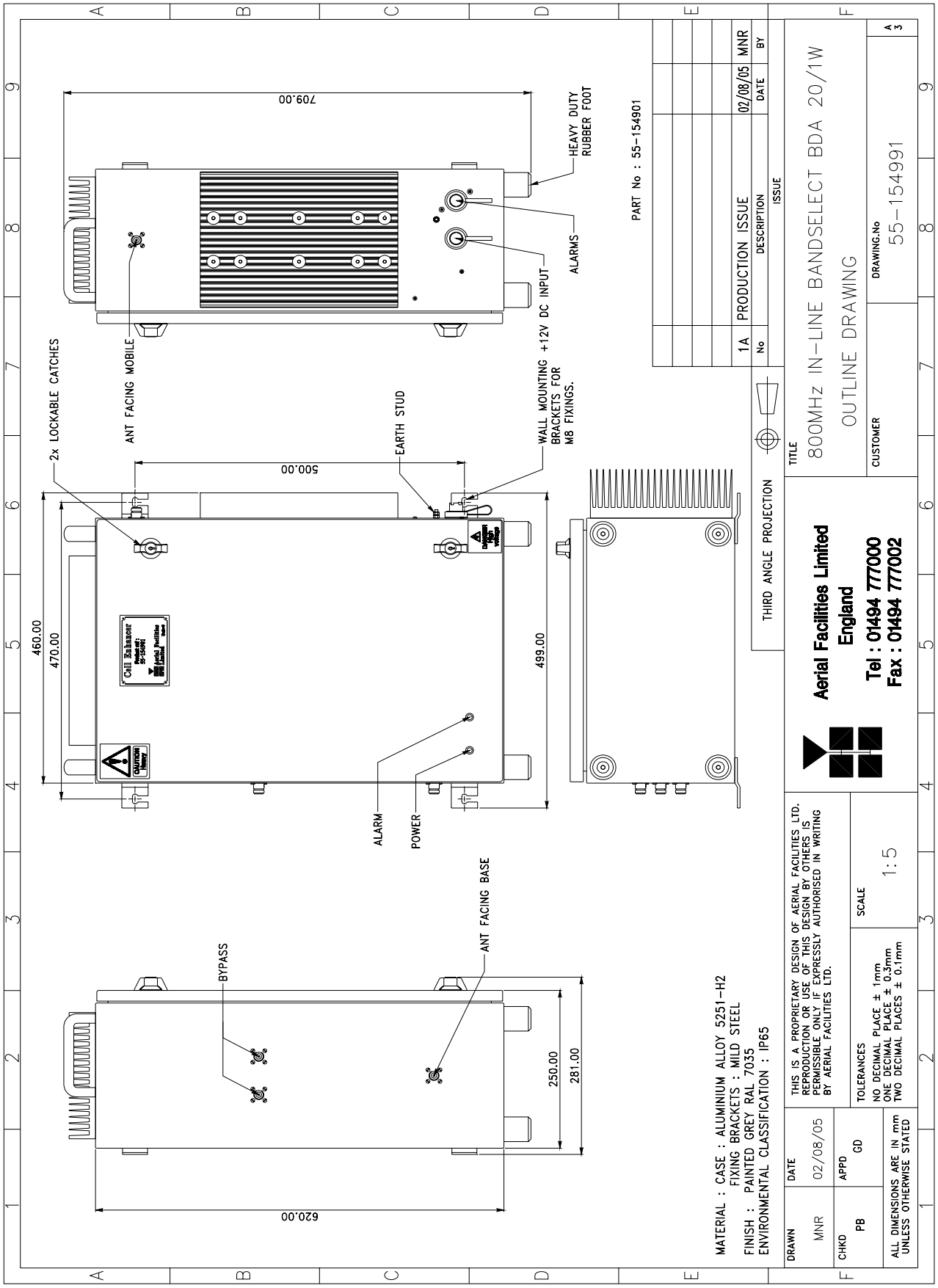
3.3.3 Band Selective BDA Mechanical Specification

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 **+55°C**
	Storage:	**-40°C** to **+70°C**
Weight:		**>30**kg
RF Connectors:		**N type female**
Environmental Protection:		**IP65** (with door closed and all ports terminated)
Finish:	Case:	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

3.3.4 Band Selective BDA System Diagram 55-154981



3.3.5 Band Selective BDA Outline Drawing, Drg. Nō. 50-118181



3.3.6 Weehawken System Frequencies Look-up Table

Agency	Channel Number	Uplink Tx	Downlink Rx
Jersey City Medical Center - EMS	VHF CHN 1	153.7850	153.7850
North Hudson Regional Fire and Rescue	VHF CHN 2	154.3250	154.3250
NJ Statewide Police (SPEN)	VHF CHN 3	154.6800	154.6800
Jersey City Medical Center - EMS	VHF CHN 4	155.2350	155.2350
Jersey City Medical Center - EMS	VHF CHN 5	155.2800	155.2800
North Hudson Regional Fire and Rescue	VHF CHN 6	158.8650	154.1450
Weehawken Township	VHF CHN 7	159.0900	159.0900
Weehawken Township	VHF CHN 8	159.2100	159.2100
New Jersey Transit Police Dept.	VHF CHN 9	161.5200	160.8300
Jersey City Police Department	UHF CHN 1	465.3750	460.3750
Jersey City Fire Department	UHF CHN 2	465.5500	460.5500
Jersey City Fire Department	UHF CHN 3	465.6000	460.6000
Hoboken Fire Dept	UHF CHN 4	471.5500	471.5500
West New York Police Department	UHF CHN 5	473.3125	470.3125
New Jersey Transit Bus Data System	800 CHN 1	809.2875	854.2875
New Jersey Transit Bus Data System	800 CHN 2	809.4875	854.4875
Township of North Bergen Police	800 CHN 3	810.7375	855.7375
City of Union City	800 CHN 4	821.3500	866.3500
New Jersey Transit Trunked Radio System	800 CHN 5	821.4625	866.4625
New Jersey Transit Trunked Radio System	800 CHN 6	821.4875	866.4875
New Jersey Transit Trunked Radio System	800 CHN 7	821.9625	866.9625
New Jersey Transit Trunked Radio System	800 CHN 8	821.9875	866.9875
City of Union City	800 CHN 9	822.1625	867.1625
New Jersey Transit Trunked Radio System	800 CHN 10	822.4625	867.4625
New Jersey Transit Trunked Radio System	800 CHN 11	822.4875	867.4875
New Jersey Transit Trunked Radio System	800 CHN 12	822.9625	867.9625
New Jersey Transit Trunked Radio System	800 CHN 13	822.9875	867.9875
City of Union City	800 CHN 14	823.1875	868.1875
City of Union City	800 CHN 15	823.2125	868.2125
New Jersey Transit Trunked Radio System	800 CHN 16	823.4625	868.4625
New Jersey Transit Trunked Radio System	800 CHN 17	823.4875	868.4875
New Jersey Transit Paging	900 CHN 1		929.5875
New Jersey Transit Paging	900 CHN 2		929.6125

3.3.7 Band Selective BDA (55-154901) Parts List

AFL Part Nō.	Part Description	Qty.
02-004502	4P C/L SD FILTER 920MHz (3MHz B/W) SMA	2
02-007206	900MHz 8POLE 15-25MHz B/W "SMA"	4
07-005705	CROSSBAND CPLR XC 250/380 SMA	2
10-000701	1/4W0-30dB SWITCHED ATTENUATOR	3
11-005902	900MHz LOW NOISE AMP WITH RELAY ASS	2
12-018002	PA 800-960MHz 20W CLASS A	1
12-021901	POWER AMPLIFIER 900MHz 1W +12V	3
17-000126	CELL ENHANCER LABEL 6 DIGIT	1
17-000526	CE 10W HEATSINK THERMAL GASKET	2
17-001109	CE AGC UNIT LOG DET/AMP ASSY (12V)	3
17-001201	C/E AGC UNIT ATTENUATOR ASSY	3
17-001527	C/E HS 2.00mm ALUM BLANKING PLATE	1
17-001528	GASKET 20W HEATSINK/BLANKING PLATE	1
17-009020	ENCLOSURE 620 x 420 x 250 (3 H/S) ALU	1
80-008901	12V RELAY PCB ASSEMBLY	1
80-031820	20W PA HEATSINK	1
80-032320	10W PA HEATSINK	1
80-122701	BBU to CE DC CABLE, 2pole IP68 BULGIN	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	2
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	4
91-500013	PWR 2POLE PNL PLUG SEALED IP68	1
91-500015	PWR CON CAP SEALED with INT. THREAD	2
91-500016	PWR 6POLE PNL PLUG SEALED IP68	1
91-510032	20A SOCKET CONTACT PIN	2
91-600007	'D' 9 WAY BLACK SHELL	5
91-600014	'D' 9 WAY SOCKET S/B (NON FILTERED)	5
91-660001	2W5 MIXED D TYPE SOCKET (7 WAY)	1
91-700017	ICD 15 WAY 0.1' CONNECTOR	1
96-700034	LED RED 5mm IP67	1
96-700035	LED GREEN 5mm IP67	1
97-400010	BLACK PLASTIC HANDLE 50mm HIGH	2
97-900003	RUBBER FOOT 1 1:2' DIA.	4

4. ALARMS

4.1 Alarm/Monitor System

4.1.1 Alarm/Monitor Description

The alarm system acts as an alarm concentrator for all the alarms in the unit. Firstly, within each active component, the individually alarmed modules are 'summed together' and presented to the outside world as a volt-free, relay contact pair (pins 1 & 2 in the IP65 alarm connector.

As all the alarms in the system are 'held closed loops', should the power supply fail, the main system alarm will be triggered.

4.1.2 Alarm/Monitor Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		12V (floating earth)
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:		25 Way 'D' Connector
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C

5. SUB-UNIT MODULES

5.1 Bandpass Filter (02-004502)

5.1.1 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 slot coupled, folded 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.

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

5.1.2 Technical Specification

PARAMETER		SPECIFICATION
Response Type		Chebyshev
Frequency Range:		751-862MHz (tuned to spec.)
Bandwidth:		12MHz (tuned to spec.)
Number of Sections:		5
Insertion Loss:		1.2 dB
VSWR:		better than 1.2:1
Connectors:		SMA female
Power Handling:		100W max
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		3 kg (typical)

5.2 Bandpass Filter (02-007206)

5.2.1 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 slot coupled, folded 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.

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

5.2.2 Technical Specification

PARAMETER		SPECIFICATION
Response Type		Chebyshev
Frequency range:		800 - 950MHz (tuned to spec.)
Bandwidth:		25MHz (tuned to spec.)
Number of sections:		8
Insertion Loss:		1.2 dB
VSWR:		better than 1.2:1
Connectors:		SMA female
Power Handling:		100W max
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		3 kg (typical)

5.3 Crossband Coupler (07-005705)

5.3.1 Description

The purpose of a crossband coupler is to either combine/split transmission signals from different parts of the frequency spectrum.

It basically comprises of a 3 port device, two filters, one a low pass, the other a high pass feeding a common output. In this case, a VHF spectrum signal source is to be combined with a band 2 FM source, (many other combinations are also possible). The couplers are built into a machined aluminium casing having a centre screening wall between the filter sections and lid secured by screws at frequent intervals over its perimeter to obtain a tight seal and to ensure linearity and stability of response.

5.3.2 Technical Specification

PARAMETER		SPECIFICATION
Passband	250 MHz:	70-250MHz
	380 MHz:	380-960 MHz
Power Rating:		50 Watts (CW)
Number of Input ports:		2
Number of Output ports:		1
Insertion loss:		0.5 dB
Isolation:		> 50 dB 70-250MHz > 50 dB 380-960MHz (15 dB typical Return loss 500-960)
Impedance:		50 ohm
Connectors:		SMA- female

5.4 ¼Watt 0- -30 & 0-15dB Switched Attenuator (10-000701 & 10-000901)

5.4.1 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.

5.4.2 Switched Attenuators

The AFL switched attenuators are available in two different types; 0 – 30dB in 2 dB steps, 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.

5.5 Low Noise Amplifier (11-005902)

5.5.1 Description

The Gallium-Arsenide low noise amplifier used in the unit is a double stage, solid-state low noise amplifier. Class A circuitry is used throughout the units to ensure excellent linearity and extremely low noise over a very wide dynamic range. The active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on these amplifiers, and in the unlikely event of a failure, then the complete amplifier should be replaced. This amplifier features its own in-built alarm system which gives a volt-free relay contact type alarm that is easily integrated into the main alarm system.

5.5.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		800 – 960MHz
Bandwidth:		<170MHz
Gain:		19.5dB (typical)
1dB Compression point:		21dBm
OIP3:		33dBm
Input/Output Return Loss:		>20dB
Noise Figure:		1dB (typical)
Power consumption:		190mA @ 24V DC
Supply voltage:		10-24V DC
Connectors:		SMA female
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:		90 x 55 x 30.2mm
Weight:		0.28kg

5.6 Low Noise Amplifier (11-006702)

5.6.1 Description

The Gallium-Arsenide low noise amplifiers used in the system are double stage, solid-state low noise amplifiers. Class A circuitry is used throughout the units to ensure excellent linearity and extremely low noise over a very wide dynamic range. The active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on these amplifiers, and in the unlikely event of a failure, then the complete amplifier should be replaced. This amplifier features its own in-built alarm system which gives a volt-free relay contact type alarm that is easily integrated into the main alarm system.

5.6.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency Range:		800 – 1000MHz
Bandwidth:		<200MHz
Gain:		29dB (typical)
1dB Compression Point:		20dBm
OIP3:		33dBm
Input/Output Return Loss:		>18dB
Noise Figure:		1.3dB (typical)
Power Consumption:		180mA @ 24V DC
Supply Voltage:		10-24V DC
Connectors:		SMA female
Temperature Range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:		90 x 55 x 30.2mm
Weight:		290gms (approximately)

5.6.3 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

5.7 20W Power Amplifier (12-018002)

5.7.1 Description

This amplifier is a Class A 20W power amplifier from 800-960MHz in a 1 stage balanced configuration. It demonstrates a very high linearity and a very good input/output return loss (RL). It has built in a Current Fault Alarm Function.
Its housing is an aluminium case (Alocrom 1200 finish) with SMA connectors for the RF input/output and a D-Type connector for the power supply and the Current Fault Alarm Function.

5.7.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		800-960MHz
Small signal gain:		30dB
Gain flatness:		±1.2dB
I/O Return loss:		>18dB
1dB compression point:		42.8dBm
OIP3:		56dBm
Supply voltage:		24V DC
Supply current:		5.0Amps (Typical)
Temperature range	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		<2kg (no heatsink)

5.7.3 PA 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)

5.8 800MHz 1Watt Low Power Amplifier (12-021901)

5.8.1 Description

The low power amplifier used is a triple 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 three 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.

5.8.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		800-960MHz
Bandwidth:		20MHz (tuned to specificatic
Maximum RF output:		>1.0 Watt
Gain:		15dB
1dB compression point:		+30.5dBm
3rd order intercept point:		+43dBm
Noise Figure:		<6dB
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		500mA @ 10-15V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.5 kg
Size:		167x52x25mm

5.8.3 LPA 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)

5.9 Wide Dynamic Range AGC (17-001109, det. & 17-001201, atten.)

5.9.1 Description

The equipment is fitted with a wide dynamic range 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 wide dynamic range Automatic Gain Control system consists of two units, a detector/amplifier and an attenuator. The logarithmic 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, (factory set @ time of system test) do not adjust unless able to monitor subsequent RF levels.
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.

5.9.2 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

5.10 12V Single Relay Board (80-008901)

5.10.1 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.

5.10.2 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:		Screw terminals
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C

6. INSTALLATION

6.1 Wall Mounted Equipment

The procedure for installing and commissioning a wall-mounted Bi-Directional Amplifier unit is generally as follows:

1 Fix the unit in the chosen position. Ensure the mounting site is a straight, smooth, perpendicular surface (brick or concrete recommended).

2 Fix the two antennas and connect them to the BDA.

3 Connect a suitable mains and/or battery power supply to the unit.

4 Calculate the attenuation settings required for the uplink and the downlink paths, and set the attenuators as described elsewhere in this document.

5 Switch the BDA mains on with the small switch located inside the unit on the lower right hand side of the case.

6 Make test calls via the equipment to ensure correct operation, if possible monitoring the signal levels during these calls to ensure that the uplink and downlink RF levels are as anticipated.

7. MAINTENANCE

7.1 Fault Finding

7.1.1 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 tunnel 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 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 and feeder system.
- Base transmissions not present due to fault at the base station.
- Modems fitted with incorrect software configuration.
- Changes to channel frequencies and inhibiting channels.
- Hand held radio equipment not set to repeater channels.
- Hand held radio equipment not set to correct base station.

7.1.2 Fault Isolation

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 fitted in a wall-mounted, environmentally protected 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 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 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.

7.1.3 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.

7.1.4 Uplink

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

7.1.5 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.

7.1.6 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 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.

7.1.7 Service Support

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

NOTE

Individual modules are not intended to be repaired on site and attempts at repair will invalidate active warranties. Company policy is that individual modules should be repaired by replacement. Aerial Facilities Ltd maintains a high level of stock of most modules which can usually be despatched at short notice to support this policy.

7.2 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.

7.3 Care of Modules

7.3.1 General Comments

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.

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

The following *general* instructions 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).

7.3.3 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.

7.3.4 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.

7.3.5 Low Power Amplifier Replacement

1 Disconnect the mains power supply and disconnect the 24V dc supply connector for the LPA.
2 Disconnect the RF input and output cables from the LPA.
3 Disconnect the alarm connector.
4 Remove the alarm monitoring wires from (D type connector) pins 9 and 10.
5 Remove the LPA module by removing the four retaining screws, replace with a new LPA module and secure it with the screws.
6 Connect the RF cables to the LPA input and output connectors. Reconnect the wires to the alarm board connector pins 9 and 10.
7 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

7.3.6 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 INITIAL EQUIPMENT SET-UP CALCULATIONS

GENERAL INFORMATION			
Site Name:		Client Name:	
Date:		AFL Equip. Model Nō.	

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