# Tetrapol Band Selective Repeater

User Handbook
For
Coverage Solutions Corporation
AFL Works Order Nō.:Q110695
AFL product part Nō.:55-124801

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## AMENDMENT LIST RECORD SHEET

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## 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

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 ISO 9001: 1994 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.

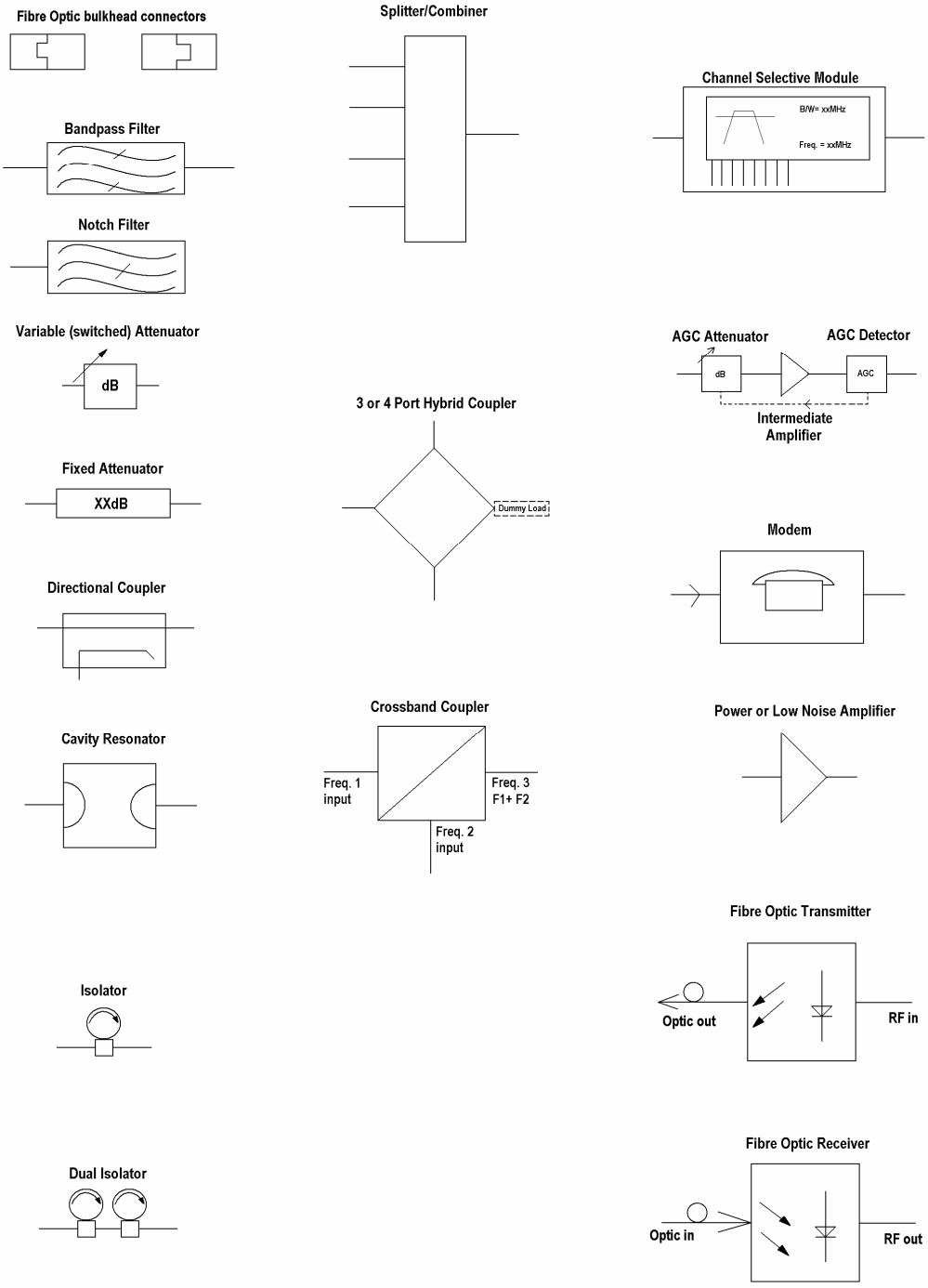
AFL has a policy of continuous product development and enhancement, and as such, reserves the right to amend, alter, update and generally change the contents, appearance and pertinence of this document without notice.

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.

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. |
| **BTS** | Base Transceiver Station |
| **C/NR** | Carrier-to-Noise Ratio |
| **Downlink (D.L.)** | RF signals transmitted from the BTS and to the MS |
| **Uplink (U.L.)** | RF signals transmitted from the MS to the BTS |
| **EMC** | Electromagnetic Compatibility |
| **GND** | Ground |
| **DC** | Direct Current |
| **AC** | Alternating Current |
| **ID** | Identification Number |
| **OIP3** | Output Third Order Intercept Point = $RF_{out}$ +(C/I)/2 |
| **LED** | Light Emitting Diode |
| **M.S.** | Mobile Station |
| **N/A** | Not Applicable |
| **N/C** | No Connection |
| **NF** | Noise Figure |
| **RF** | Radio Frequency |
| **Rx** | Receiver |
| **Tx** | Transmitter |
| **S/N** | Serial Number |

## Key to AFL RF Module Drawing Symbols




## Key to AFL RF Modules

# 1. SAFETY CONSIDERATIONS

## 1.1 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.

## 1.2 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.

## 1.3 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

The AFL Band Selective Cell Enhancer is a 2-way on-band repeater. Various models are available to cover frequency bands from 50MHz to 3000MHz with power levels up to 100Watts. Its main sphere of applications is in urban areas where the topology is such that shadows occur in the propagation pattern (for example within large buildings, conference centres and tunnels, etc.)

The Band Selective Cell Enhancer 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 Cell Enhancer are set as per the specific customer requirements.

AFL manufacture a wide range of Cell Enhancers, configured for each customer's specific requirements. Two basic physical variants are available, a rack mounted version to fit in a standard 19" rack and an environmentally sealed wall mounted version which requires no further enclosure.

This system consists of a bi-directional band selective, cell enhancer operating in the 390MHz band. It is housed in a wall-mounted environmentally protected (IP65) case powered from an externally supplied 24Volt DC source. Alarms are provided for each amplifier as a summary, volt-free relay contact pair for easy integration into an existing alarm system. A supply isolator switch is fitted inside the unit and there are D.C. and Alarm on indicators on the outside of the door.

An automatic gain control system is employed in the uplink path in an attempt to negate the overloading effect from mobiles operated close the antenna.

## 3. SPECIFICATION

### 3.1 Parts Lists

| AFL Part Nō. | Part Description | Qty. |
|---|---|---|
| 02-007306 | SDF C/L5P 380MHzVAR. >5MHz TOP SMA | 2 |
| 10-000701 | 1/4W0-30dB SWITCHED ATTENUATOR | 2 |
| 11-007302 | LNA. 380-500MHz 20dB (C/W RELAY) GA | 2 |
| 11-007401 | LNA. 380-500MHz 30dB GA | 2 |
| 11-007901 | AMPLIFIER TETRA 1W 37dB GAIN ASS | 2 |
| 12-016302 | PA 380-470MHz 10W CLASS A | 2 |
| 13-001803 | DUAL DC/DC CONVERTER 24V-12V 1A | 2 |
| 16-041401 | TETRA DUPLEXER SMA/N (ant.) CONN | 2 |
| 17-000126 | CELL ENHANCER LABEL 6 DIGIT | 1 |
| 17-001101 | CELL ENHANCER AGC DETECTOR/AMP ASS | 2 |
| 17-001201 | C/E AGC UNIT ATTENUATOR ASSY | 2 |
| 17-001520 | ENCLOSURE 620 x 420 x 250 (2 H/S) ALU | 1 |
| 17-001522 | BASE PLATE 560 x 345mm 17-001520&9020 | 1 |
| 17-004730 | ATTENUATOR MOUNTING | 1 |
| 55-019049 | 02-7302 FILTER MOUNTING BRACKET | 2 |
| 80-008902 | 24V RELAY PCB ASSEMBLY | 1 |
| 80-031820 | 20W PA HEATSINK (NEEDS 17-000526) | 2 |
| 90-200004 | DC I/P LEADS, FREE SOCKET | 1 |
| 90-400006 | ALARM LEADS | 1 |
| 91-030002 | N ADAPTOR PANEL FEMALE:FEMALE | 2 |
| 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 |
| 91-600001 | 'D'TYPE 9 WAY PLUG S/B TERM | 2 |
| 91-600014 | 'D' 9 WAY SOCKET S/B (NON FILTERED) | 6 |
| 96-700034 | LED RED 5mm IP67 INTEGRAL RES. 24V | 1 |
| 96-700035 | LED GREEN 5mm IP67 INTEGRAL RES 24V | 1 |
| 96-920011 | PROXIMITY SWITCH | 1 |
| 96-920012 | PROXIMITY SWITCH MAGNET | 1 |
| 97-300028 | DC BOX 24V ATO TYPE 2 ASSEMBLY | 1 |
| 97-400010 | BLACK PLASTIC HANDLE 37311 | 2 |
| 97-900003 | RUBBER FOOT 1 1:2' DIA. | 4 |
| 99-200017 | CAUTION HEAVY LABEL 75 x 55mm | 1 |

## 3.2 Technical Specification

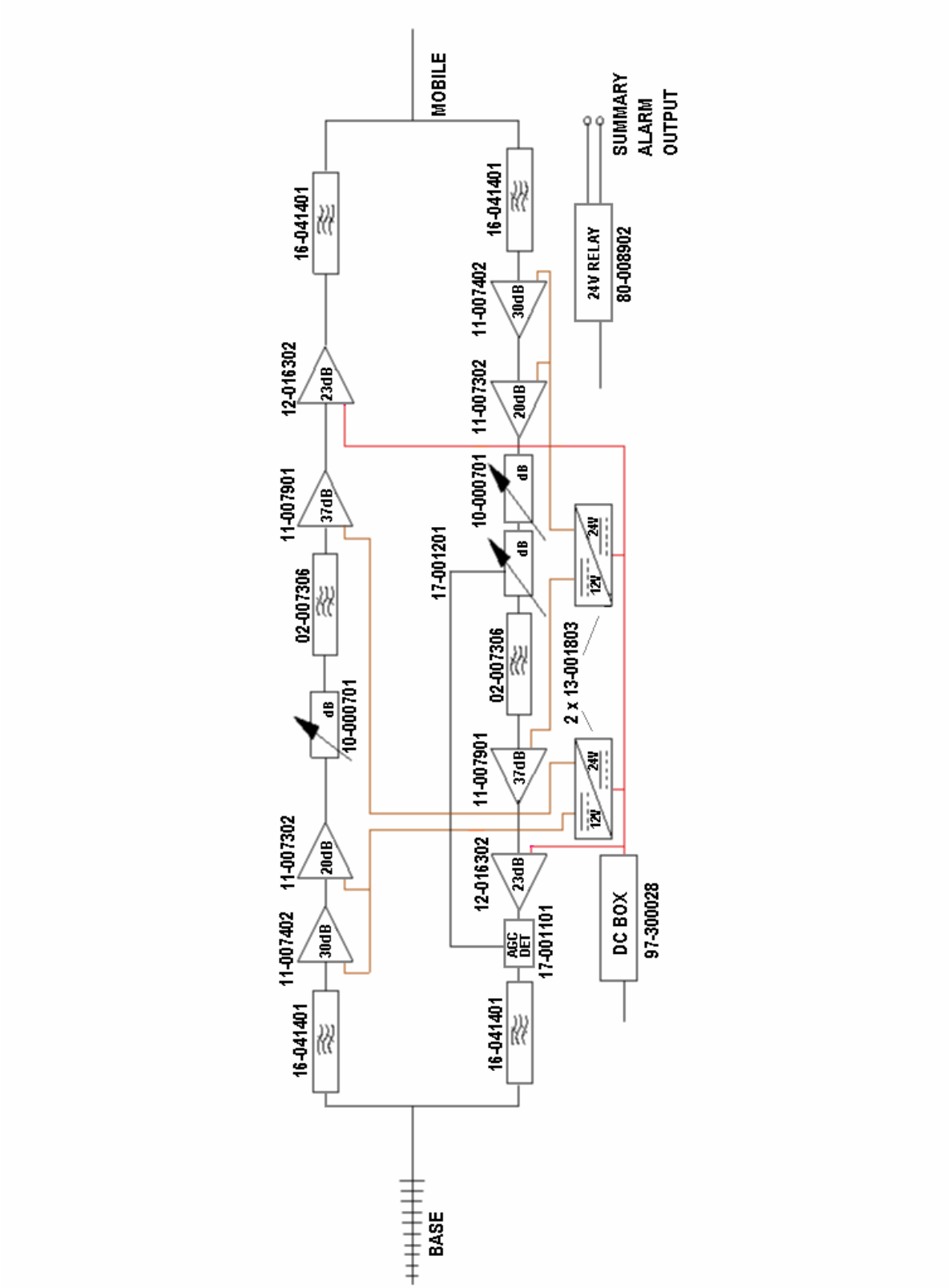
| PARAMETER | | SPECIFICATION |
|---|---|---|
| Frequency range: | | 380-425MHz (Downlink) |
| | | 390-435MHz (Uplink) |
| Bandwidth: | | 45MHz |
| Gain: | | >90dB |
| Gain Adjustment: | | 0 – 15dB (in 1dB step) |
| Uplink Power: | | >10Watts |
| Downlink Power: | | >10Watts |
| IP3: | | +52dBm |
| 1dB Compression point: | | +40dBm |
| Noise Figure: | | <5dB |
| AGC: | | Fitted in Uplink path |
| VSWR: | | better than 1.5:1 |
| RF Connectors: | | N type, female |
| Power Supply: | | 24V DC @ 8A |
| Temperature range: | operational: | -10°C to +55°C |
| | storage: | -40°C to +70°C |
| Alarms Fitted: (volt-free contacts/TTL) | | 1 PSU |
| | | 2 Amplifiers |
| | | 4 Door Intrusion |

## 3.3 Mechanical Specification

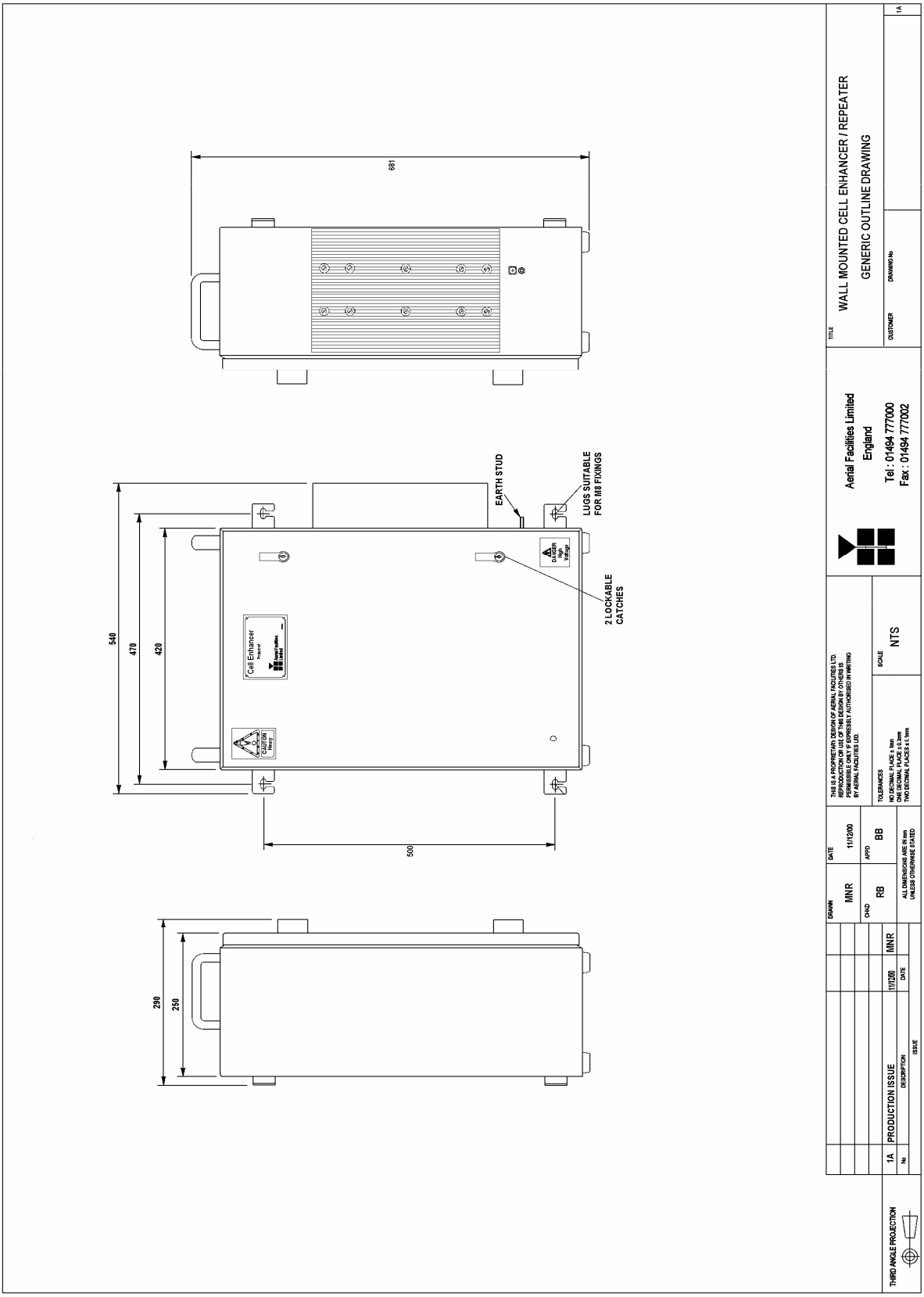
| | | |
|---|---|---|
| Case size | Height: | **620**mm |
| | Width: | **420**mm |
| | Depth: | **250**mm |
| (excluding heatsinks, connectors, handles and feet) | | |
| | Fixings: | **4** holes on **670**(w) x **457**(h)mm |
| Temperature Range: | operational: | **-10°C** to **+55°C** |
| | storage: | **-40°C** to **+70°C** |
| | Weight: | >**50**kg |
| | RF Connectors: | **N** type female |
| | Environmental Protection: | **IP65** (with door closed and all ports terminated |
| Finish: | Case: | To **RAL 7032** |
| | Heatsinks: | **Matt black** (where fitted) |
| | Handles: | **Black Technopolymer** |
| | Supply Cable: | Unit supplied with suitable supply input leads with connector and appropriate length of cable. |

## 4. SYSTEM DRAWINGS

### 4.1 System Diagram



## 4.2 Generic Wall-Mount Case Outline Drawing



## 5. SUB-UNIT MODULES

### 5.1 Bandpass Filters & Duplexer (02-007306 & 16-041401)

#### 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 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.

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

#### 5.1.2 Technical Specification (02-007306)

| PARAMETER | | SPECIFICATION |
|---|---|---|
| Response type: | | Chebyshev |
| Frequency range: | | 350 – 500MHz (tuned to spec.) |
| Bandwidth: | | >5.0 MHz (tuned to spec.) |
| Number of sections: | | 5 |
| Insertion loss: | | 1.2 dB |
| VSWR: | | better than 1.2:1 |
| Connectors: | | SMA |
| Power handling: | | 100W max |
| Temperature range | operation: | -10°C to +55°C |
| | storage: | -40°C to +70°C |
| Weight: | | 3 kg |
| Size: | | 266 x 143 x 39.5mm |

#### 5.1.3 Technical Specification (16-041401)

| | |
|---|---|
| RX Pass Band: | 380-385MHz |
| TX Pass Band: | 390-395MHz |
| Bandwidth: | 5 MHz |
| Channel Separation: | 5 MHz |
| Insertion Loss: | < 1.8 dB |
| Rejection (between channels) | >70 dB |
| Rejection at crossover: | >50 dB (+2.5MHz low band - 2.5MHz high band) |
| Return Loss: | > 20 dB (at all ports) |
| Power Handling (CW): | 20W |
| Connectors: | SMA (Tx/Rx ports) |
| | N type (Antenna ports) |
| Weight: | <6kg |

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

### 5.2.1 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.

### 5.2.2 Switched Attenuators

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

## 5.3 Low Noise Amplifiers (11-007302 & 11-007402)

### 5.3.1 Description

The low noise amplifiers used are double stage solid-state low-noise amplifiers. Class A circuitry is used in the units to ensure excellent linearity over a very wide dynamic range. The two active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on these amplifies, and in the unlikely event of failure then the entire amplifier should be replaced.

### 5.3.2 Technical Specification, 11-007302

| PARAMETER | | SPECIFICATION |
|---|---|---|
| Frequency range: | | 380-500MHz |
| Bandwidth: | | <140MHz |
| Gain: | | 20-22dB |
| 1dB Compression Point: | | +23.5dB (typical) |
| 3rd order intercept: | | +36dB (typical) |
| Input/Output return loss: | | >20dB |
| Noise figure: | | <1.3dB |
| Connectors: | | SMA female |
| Supply: | | 200-230mA @ 24V DC |
| Temperature range: | operational: | -10°C to +55°C |
| | storage: | -30°C to +70°C |
| Weight: | | <300gm |
| Size: | | 90 x 55 x 30.2 (case only) |

### 5.3.3 Technical Specification, 11-007402

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

## 5.4 1Watt Low Power Amplifier (11-007901)

### 5.4.1 Description

This amplifier is designed as a 1.0 W driver from 380 MHz to 470 MHz for the 10W output amplifier. It is a 2 stage amplifier where each stage is in balanced configuration. It demonstrates very high linearity and good input/output VSWR. There is a Current Fault Alarm Function, which indicates failure of each one of the RF transistors by various alarm output options. The amplifier is housed in an aluminium case (Alocrom 1200 finish) with SMA connectors for the RF input/output and a 9way D-type connector for DC and alarm outputs.

### 5.4.2 Technical Specifications

| PARAMETER | | SPECIFICATION |
|---|---|---|
| Frequency range: | | 380-470MHz |
| Small signal gain: | | 37.5dB |
| Gain flatness: | | ±0.5dB |
| Gain vs. temperature: | | 1.5dB |
| Temperature range: | operational: | -10°C to +55°C |
| | storage: | -40°C to +70°C |
| Input/output return loss: | | 18dB |
| Maximum output power: | | 30.4dBm (@ 1dB comp. point) |
| OIP3: | | 43dBm |
| Supply voltage: | | 10-15V DC |
| Current consumption: | | 780mA (typical) |
| Noise Figure: | | <1.75dB |

## 5.5 10W Power Amplifier (12-016302)

### 5.5.1 Description

This amplifier is a Class A 10W power amplifier from 380MHz to 470MHz in a 1 stage balanced configuration. It demonstrates a very high linearity and a very good input/output return loss (RL). It has a built-in 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.

### 5.5.2 Technical Specification

| PARAMETER | | SPECIFICATION |
|---|---|---|
| Frequency range: | | 380-470MHz |
| Small signal gain: | | 23dB |
| Gain flatness: | | ±1.7dB |
| I/O Return loss: | | >18dB |
| 1dB compression point: | | +40dBm |
| OIP3: | | +52dBm |
| Supply voltage: | | 24V DC |
| Supply current: | | 2.6Amps (Typical) |
| Temperature range | operational: | -10°C to +55°C |
| | storage: | -30°C to +70°C |
| Weight: | | <2kg (no heatsink) |

## 5.6 Dual DC/DC Converter (13-001803)

### 5.6.1 Description

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

The circuit is based upon a pair of LM257 series variable voltage regulators (LM2576, 12 & 15V & LM2575, 5V), which are each capable of supplying an absolute maximum of 1.5A output current. Note that at full output current, the dissipation of the device must remain within design 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.

### 5.6.2 Technical Specification

| PARAMETER | | SPECIFICATION |
|---|---|---|
| Operating Voltage: | | 21 – 27V DC |
| Output Voltage: | | 12V & 12V (typical) |
| Output Current: | | 1.0A (maximum per o/p) |
| Connections: | | Screw Terminal Block |
| Temperature Range | operational: | -10°C to +55°C |
| | storage | -40°C to +70°C |
| PCB Size: | | 85 x 63mm |

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

### 5.7.1 Description

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

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

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

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

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

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

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

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

### 5.7.2 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 +55°C |
| | storage: | -40°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 |

## 5.8 24V Single Relay Board (80-008902)

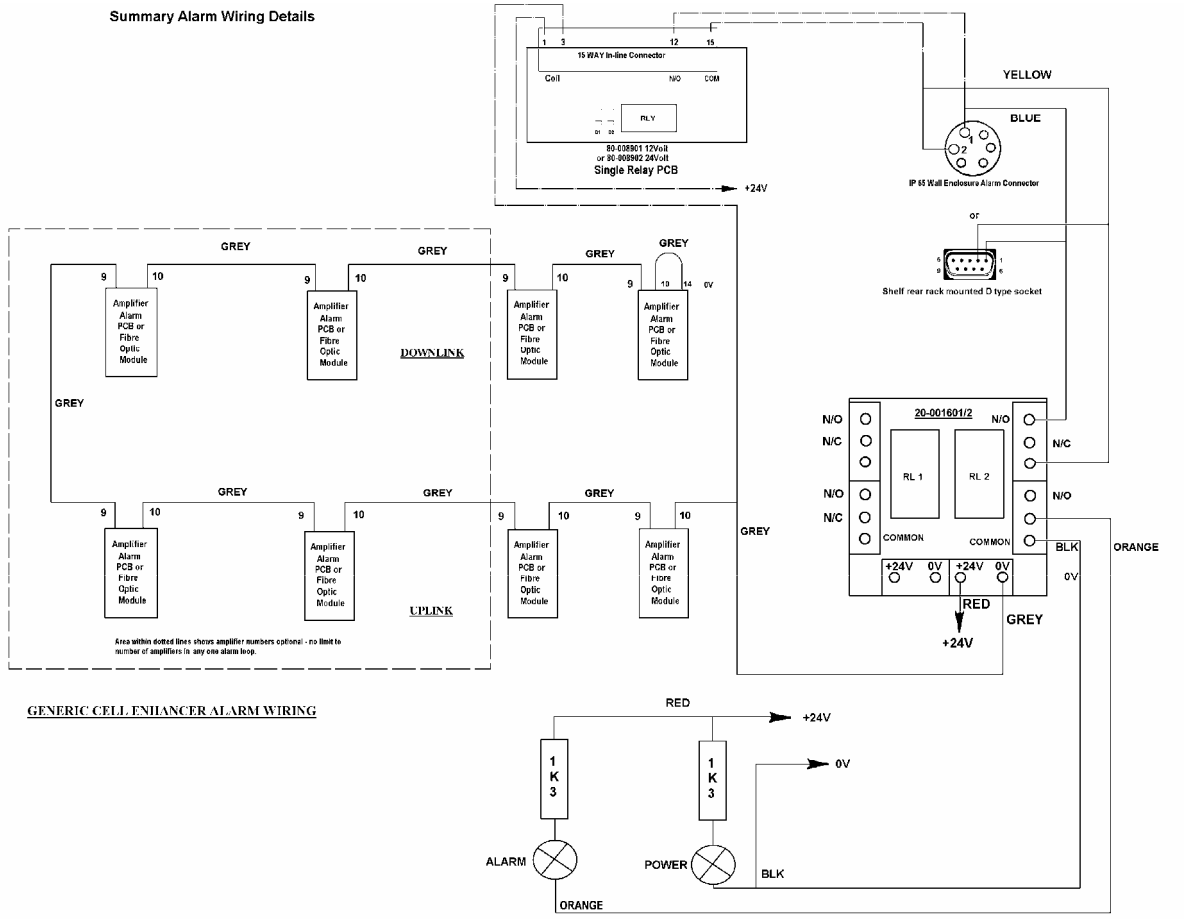
### 5.8.1 Description

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.

## 5.9 Generic Amplifier Alarm Wiring Sketch



## 6. INSTALLATION

### 6.1 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.

### 6.2 Antenna Installation & Gain Calculations

1 Most Cell Enhancers 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.)

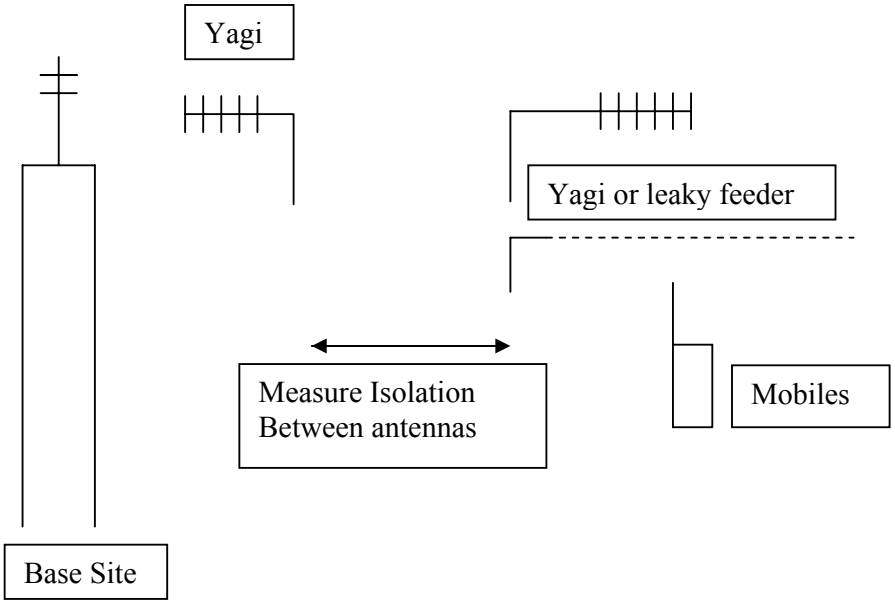
4 Ensure that the mobile facing antenna has at least 70 dB isolation from the nearest mobile. (This is usually easily achieved when using a leaky feeder.)

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.

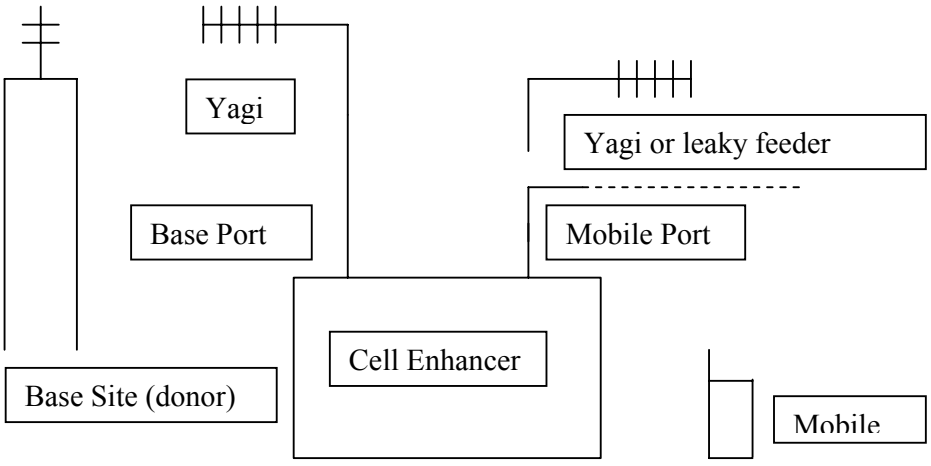
6 It is recommended that the gains are set such that the Downlink channel output levels from the Cell Enhancer are typically +30dBm per channel
(Input level + Gain = Output level).

## 6.3 Antenna Isolation

A). First set up the two antennas & measure the isolation between them.




B) Install the Cell Enhancer with its gain set 10dB below the isolation figure obtained above.



## 6.4 Wall Mount Installations

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, dry, 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. (5.1.3)

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 General Procedures

### 7.1.1 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 within 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 LED's. The green LED on the front door 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 (sect. 4.1) 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 whole unit in a systematic manner to confirm correct operation.

### 7.1.2 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.

### 7.1.3 Uplink

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

### 7.1.4 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 these types of 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 optimum operation. It is recommended that items of this type are replaced with a spare unit and the faulty unit returned to AFL for repair.

### 7.1.5 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 Service Support

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

## 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 |