# Two Channel 400MHz

# Cell Enhancer

User Handbook
For
AFL Inc.

AFL Works Order Nō.: Q112941
AFL product part Nō.: 50-128501

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## AMENDMENT LIST RECORD SHEET

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Document Ref:-50-113901HBK

## 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.

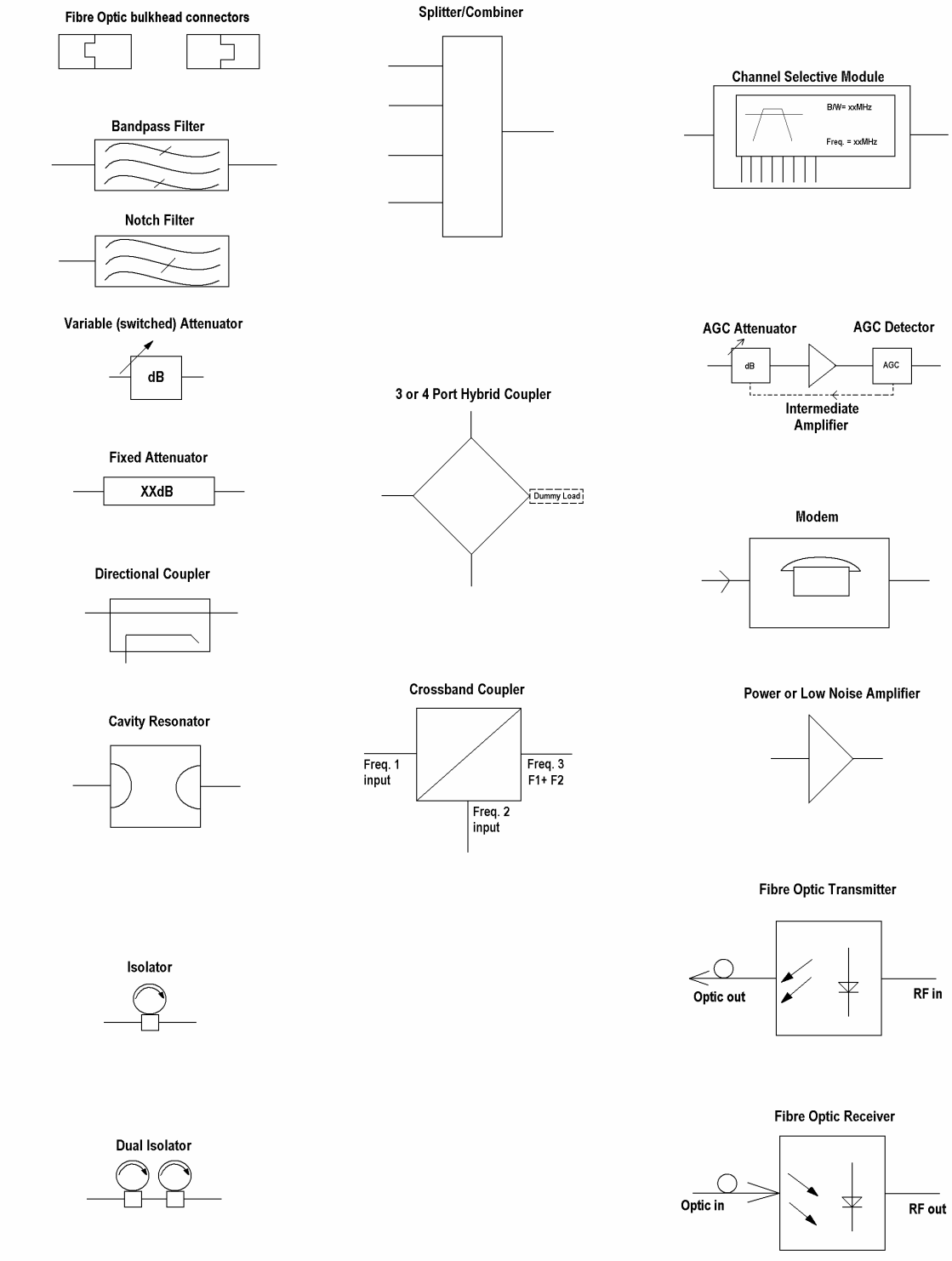
AFL has a policy of continuous product development and enhancement, and as such, reserves the right to amend, alter, update and generally change the contents, appearance and pertinence of this document without notice.

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.

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 |

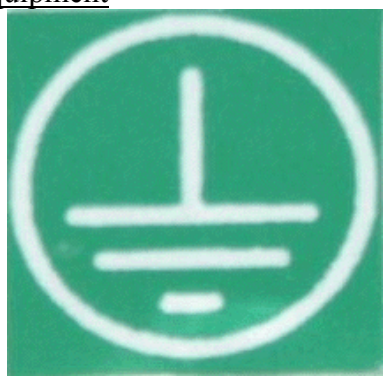
## Key to AFL RF Module Drawing Symbols




**Key to AFL RF Modules**

# 1. SAFETY CONSIDERATIONS

## 1.1 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

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

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

# 3. SPECIFICATIONS

## 3.1 Description

See section 2.

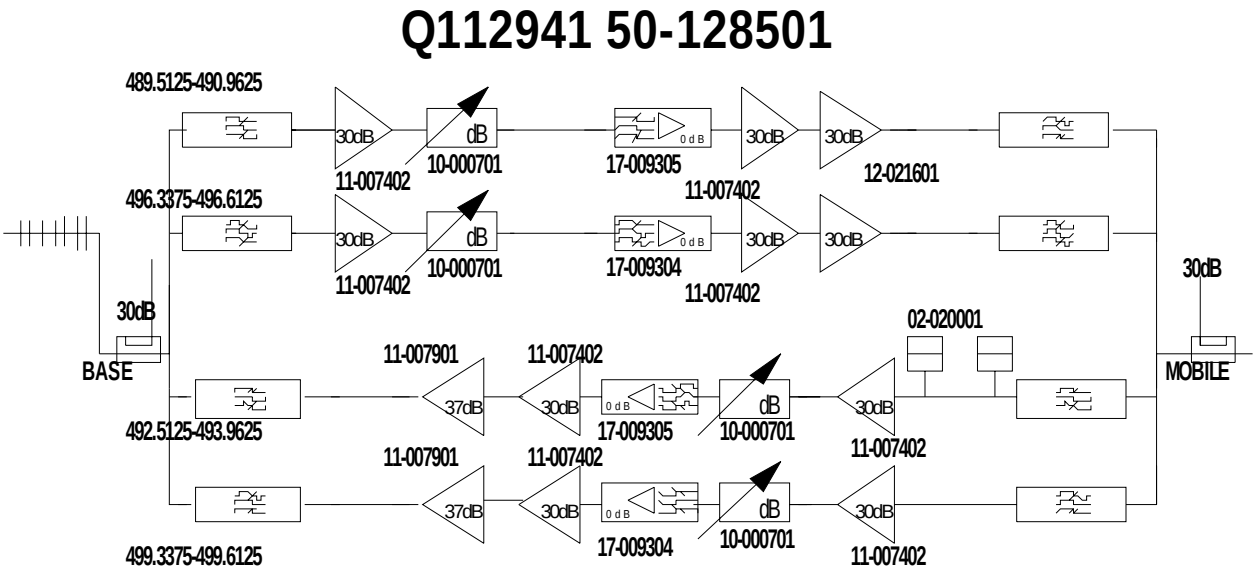
## 3.2 Electrical Specification

| PARAMETER | | SPECIFICATION |
|---|---|---|
| Frequency bands | (Area) downlink: | 489.5125-490.9625MHz |
| | (Police) downlink: | 496.3375-496.6125MHz |
| | (Area) uplink: | 492.5125-493.9625MHz |
| | (Police) uplink: | 499.3375-499.6125MHz |
| Nō. of Channels: | | 2 (one IF select 1.45MHz b/w) |
| Downlink1 bandwidth: | | 1.45MHz |
| Downlink2 bandwidth: | | 275kHz |
| Passband Ripple: | | ±1.5dB |
| Gain: | | >90dB |
| Gain Adjustment: | | 30dB in 2 dB steps |
| Uplink ALC setting: | | +28dBm |
| Downlink ALC setting: | | +35dBm |
| O/P Power/Channel @ Ant. Port | Downlink: | 28dBm |
| | Uplink: | 24dBm |
| O/P 1dB compression @ antenna port: | | 37.5dBm |
| Uplink noise: | | >5dB |
| Temperature range | operation: | -10°C to +55°C |
| | storage: | -40°C to +70°C |
| VSWR: | | Better than 1.5:1 |
| Impedance: | | 50Ω |
| Power Supply Requirement: | | 110V AC single phase |
| Alarms fitted (RS232): | | Amplifiers, PSU, Door, Temperature |

## 3.3 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 **+60°C** |
| | storage: | **-40°C** to **+70°C** |
| Weight: | | **>30**kg (approximately) |
| 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 |

3.4 System Diagram



## 3.5 Parts Lists

| AFL Part Nō. | Part Description | Qty. |
|---|---|---|
| 02-020001 | UHF 2 SECTION NOTCH FILTER SMA | 2 |
| 02-011204 | 6P TETRA C/L FILT(1.5-4MHz) SMA | 4 |
| 02-013401 | 6P CL FLTR(0.5 min BW)LARGE SMA ASSY | 4 |
| 07-012501 | POWER MONITOR UHF DUAL | 2 |
| 10-000701 | 0.25W 0-30dB SWITCHED ATTENUATOR | 4 |
| 11-007402 | LNA. 380-500MHz 30dB (C/W RELAY) GA | 8 |
| 11-007901 | AMPLIFIER TETRA 1W 37dB GAIN ASS | 2 |
| 12-021601 | TETRA 5W +12V AMPLIFIER | 2 |
| 13-001704 | VOLTAGE REGULATOR BOARD 9.0V | 1 |
| 13-001710 | VOLTAGE REGULATOR BOARD 5.0V | 1 |
| 13-003301 | MAINS FILTER 8AMP ASSEMBLY | 1 |
| 17-000126 | CELL ENHANCER LABEL 6 DIGIT | 1 |
| 17-000526 | CE 10/20W HEATSINK THERMAL GASKET | 3 |
| 17-002020 | PLEASE USE KIT 17-002020K | 1 |
| 17-002103 | 26WAY RIBBON CABLE LEAD | 4 |
| 17-003022 | MODULE PATTERNED LEAVE | 4 |
| 17-003023 | SUBRACK SIDE PANEL | 2 |
| 17-003024 | SUBRACK REAR BRACKET | 4 |
| 17-003025 | BOTTOM MODULE GUIDE | 4 |
| 17-003028 | MODULE SQUARE LEAVE | 4 |
| 17-003029 | TOP MODULE GUIDE | 4 |
| 17-005803 | CONTROLLER MONITOR BOARD 12V | 1 |
| 17-005820 | MONITOR/CONTROLLER COVER | 1 |
| 17-005821 | MON/CONTROLLER ACCESS PLT LRG | 1 |
| 17-005822 | MON/CONTROLLER ACCESS PLT SML | 1 |
| 17-009304 | UHF CHAN MOD 480-500MHz, 400kHz B/W | 2 |
| 17-009305 | UHF CHAN MOD 480-500MHz, 2 MHz B/W | 2 |
| 80-008901 | 12V RELAY PCB ASSEMBLY | 1 |
| 80-032320 | 10W PA HEATSINK | 2 |
| 80-310420 | BCC 400W POWER SUPPLY HEATSINK | 1 |
| 90-100003 | MAINS LEAD '6 AMP' | 1 |
| 90-400006 | ALARM LEADS | 1 |
| 91-030002 | N ADAPTOR PANEL FEMALE:FEMALE | 4 |
| 91-130001 | SMA ADAPT 'T' ALL FEMALE 3 GHz | 6 |
| 91-500011 | PWR 3POLE 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 | 1 |
| 91-600014 | 'D' 9 WAY SOCKET S/B (NON FILTERED) | 8 |
| 91-640004 | LARGE PIN FOR 91-660001 D SOCKET | 4 |
| 91-660001 | 2W5 MIXED D TYPE SOCKET (7 WAY) | 2 |
| 91-700015 | ICD 10 WAY IDC CONNECTOR | 1 |

| | | |
|---|---|---|
| 91-700017 | ICD 15 WAY 0.1' CONNECTOR | 3 |
| 92-120009 | M20 IP68 CABLE GLAND | 1 |
| 92-280033 | Captive Screw | 20 |
| 92-280044 | SCREW SLOTTED COLLAR | 20 |
| 92-400017 | GASKET FOR N TYPE CONNECTOR | 2 |
| 93-510041 | 27R 1.6W % RESISTOR H:P PR37 | 1 |
| 94-120003 | 1645 SCH0TTKY DIODE 16A MBR | 1 |
| 96-000017 | PP9 NiCad BATTERY | 1 |
| 96-000018 | CONNECTOR FOR PP9 BATTERY | 1 |
| 96-300057 | 15V 27A PSU 400W (XP BCC) | 1 |
| 96-700034 | LED RED 5mm IP67 | 1 |
| 96-700035 | LED GREEN 5mm IP67 | 1 |
| 96-800003 | MT2834ZDXK 56kBPS MODEM WORLD | 1 |
| 96-900018 | AC TRIP SWITCH (5 AMP M.C.B.) | 1 |
| 96-920011 | PROXIMITY SWITCH | 1 |
| 96-920012 | PROXIMITY SWITCH MAGNET | 1 |
| 97-000001 | 'SAREL' S/S HEAVY DUTY WALL BKT (4) | 1 |
| 97-000002 | BLACK MODULE CAGE RUNNER | 20 |
| 97-300010 | C/E SUPPLY INPUT COVER | 2 |
| 97-400010 | BLACK PLASTIC HANDLE 50mm HIGH | 2 |
| 97-600001 | SUBRACK FRONT HORIZ | 4 |
| 97-600002 | SUBRACK M2.5 STD TAP | 4 |
| 97-900004 | RUBBER FOOT FOR CELL ENHANCERS | 4 |
| 99-200017 | CAUTION HEAVY LABEL 75 x 55mm | 1 |

* Highlighted items appear in ‘Sub-Unit Modules’ section.

# 4. SUB-UNIT MODULES

## 4.1 UHF Notch Filter (02-020001)

### 4.1.1 Description

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

### 4.1.2 Technical Specifications

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

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

### 4.2.1 Description

The bandpass filters are multi-section designs with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of combline design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports.

Being passive devices, the bandpass filters should have an extremely long operational life and require no maintenance. Should a filter be suspect, it is usually most time efficient to replace the module rather than attempt repair or re-tuning.

### 4.2.2 Technical Specification

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

## 4.3 30dB Power Monitor (07-012501)

### 4.3.1 Description

The purpose of these couplers is to tap off known portions (usually 15-30dB) of RF signal from transmission lines at the antenna ports, either resistively or by induction, and to combine them, for example through splitter units for different purposes (alarms/monitoring etc.), whilst maintaining an accurate 50Ω load to all ports/interfaces throughout the specified frequency range. They are formally known as *directional* couplers as they couple power from the RF mainline *in one direction only*.

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

### 4.3.2 Technical Specification

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

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

### 4.4.1 General Application

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

### 4.4.2 Switched Attenuators

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

## 4.5 Low Noise Amplifier (11-007402)

### 4.5.1 Description

The 30dB gain low noise amplifier used is a double stage solid-state low-noise amplifier. Class A circuitry is used in the unit to ensure excellent linearity over a very wide dynamic range. The two active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on this amplifier, and in the unlikely event of failure then the entire amplifier should be replaced. The amplifier features a dedicated, in-built alarm monitoring system which gives a TTL 'open collector' type switched signal on alarm, this is then integrated using a built-in relay to give a volt-free contact for summation into the main alarm system.

### 4.5.2 Technical Specification

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

### 4.5.3 LNA 'D' Connector Pin-out details

| Connector pin | Signal |
|---|---|
| 1 | +Ve input (10-24V) |
| 2 | GND |
| 3 | Alarm Relay O/P bad |
| 4 | Alarm Relay common |
| 5 | Alarm Relay good |
| 6 | No connection |
| 7 | TTL voltage set |
| 8 | TTL alarm/0V (good) |
| 9 | O/C good/0V bad |

## 4.6 1Watt Low Power Amplifier (11-007901)

### 4.6.1 Description

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

### 4.6.2 Technical Specifications

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

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

### 4.7.1 Description

The power amplifier fitted to this unit is a multi-stage, solid state power amplifier. Class A circuitry is employed throughout the device to ensure excellent linearity over a wide dynamic frequency range. All the semi-conductor devices are very conservatively rated to ensure low device junction temperatures and a long, trouble free working lifetime.

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

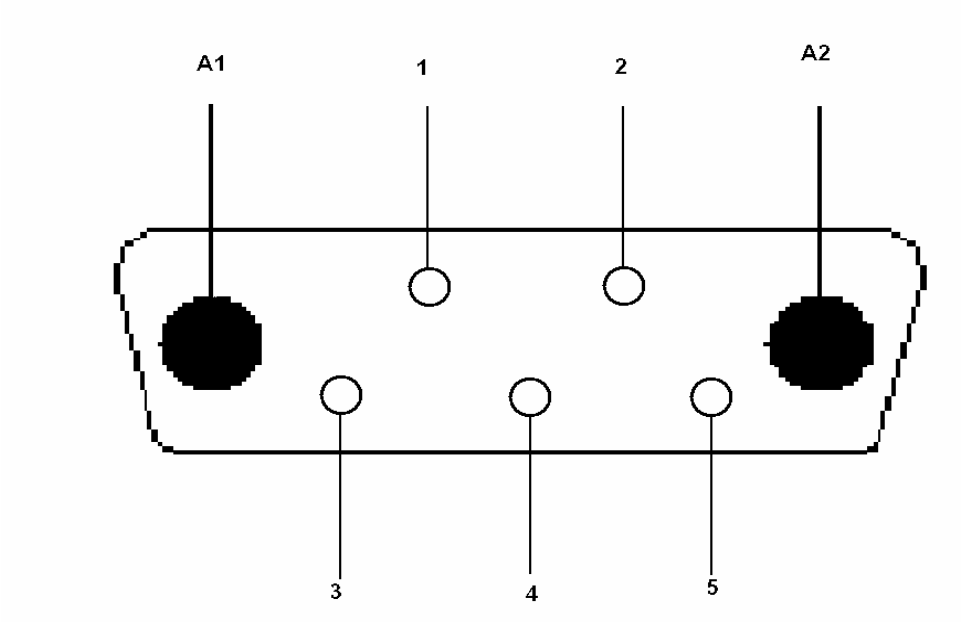
### 4.7.2 Technical Specification

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

### 4.7.3 PA 7-Way Connector Pin-outs

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

4.7.4 PA Connector (7) Pin-Outs



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

### 4.8.1 Description

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

The circuit is based upon an LM317 variable voltage regulator, which is capable of supplying a maximum of 1.5A output current. Note that at full output current the dissipation of the device must remain in limits, bearing in mind the voltage which is being dropped across it. The maximum allowable dissipation will also depend on the efficiency of the heatsink on which the device is mounted.

The output voltage of the unit is programmed by the resistive divider which is fitted between the output terminal, the reference terminal and ground. R1 is the reference programming resistor and is fixed in all versions. R2 is fitted on 12V versions while R3, (which is in parallel with R2) is fitted on 8V and 5V versions.

### 4.8.2 Technical Specification

| PARAMETER | | SPECIFICATION |
|---|---|---|
| Operating Voltage: | | 21 – 27V DC |
| Output Voltages: | | 5.0V (13-001710) |
| | | 9.0V (13-001704) |
| Output Current: | | 1.0A (maximum per o/p) |
| Connections: | | Screw Terminal Block |
| Temperature range: | operational: | -10°C to +60°C |
| | storage: | -20°C to +70°C |
| PCB Size: | | 47 x 30mm |

## 4.9 Controller/Monitor Board (17-005803)

### 4.9.1 Description

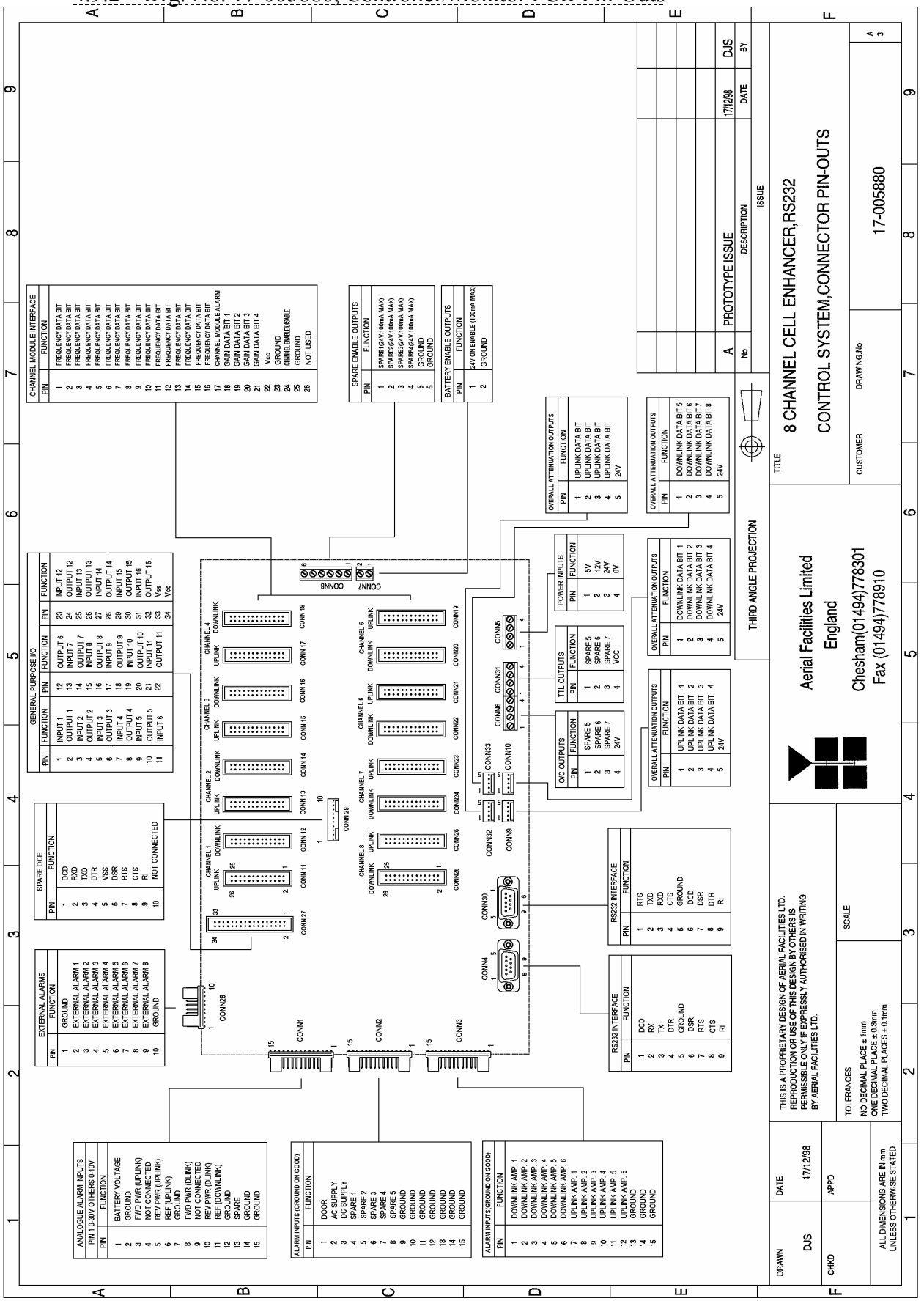
To meet the need for detailed control and status reporting of cell enhancers and other systems installed in inaccessible locations, AFL has developed an optional RS232C (RS232D) serial interface which may be incorporated into any of AFL's range of cell enhancers. The RS232 interface is designed primarily to be connected to a modem, which can then communicate either via a fixed or a cellular telephone link with another modem at the network control centre. As standard, the interface will control any modem that works with the Hayes command set, although it can easily be adapted to control other equipment if required.

The controller software has been written so that it is easily configured to meet specific customer interface requirements. The standard software has two data formats. Firstly, a verbose format that can be controlled from a simple terminal or terminal emulator. Secondly, a terse data format intended to be used with front-end software running on another computer to present a very user-friendly operator interface. If required, alternative data formats can be provided to enable integration with existing customer front-end software.

The RS232 interface board within the Cell Enhancer integrates all the alarm inputs from the amplifier alarm boards, as well as from relays monitoring power supply status, door open/closed status, I.F module status, and standby battery voltage status. Monitoring of forward power can also be done. All this information is combined and formatted with on-board generated data including temperature, date, time and equipment serial number.

The RS232 interface board also controls the frequencies at which the channel modules operate. These frequencies can, via a modem, be adjusted remotely. For more details, see the RS232 interface board handbook (17-005801HBKM).
The PCB fitted here is a 12V version of the standard 24V board, (denoted by the '03' at the end of the AFL part number) – but all the electronic functions are identical.

## 4.9.2 Drg. Nō. 17-005880, Controller/Monitor PCB Pin-Outs



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

### 4.10.1 Description

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

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

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

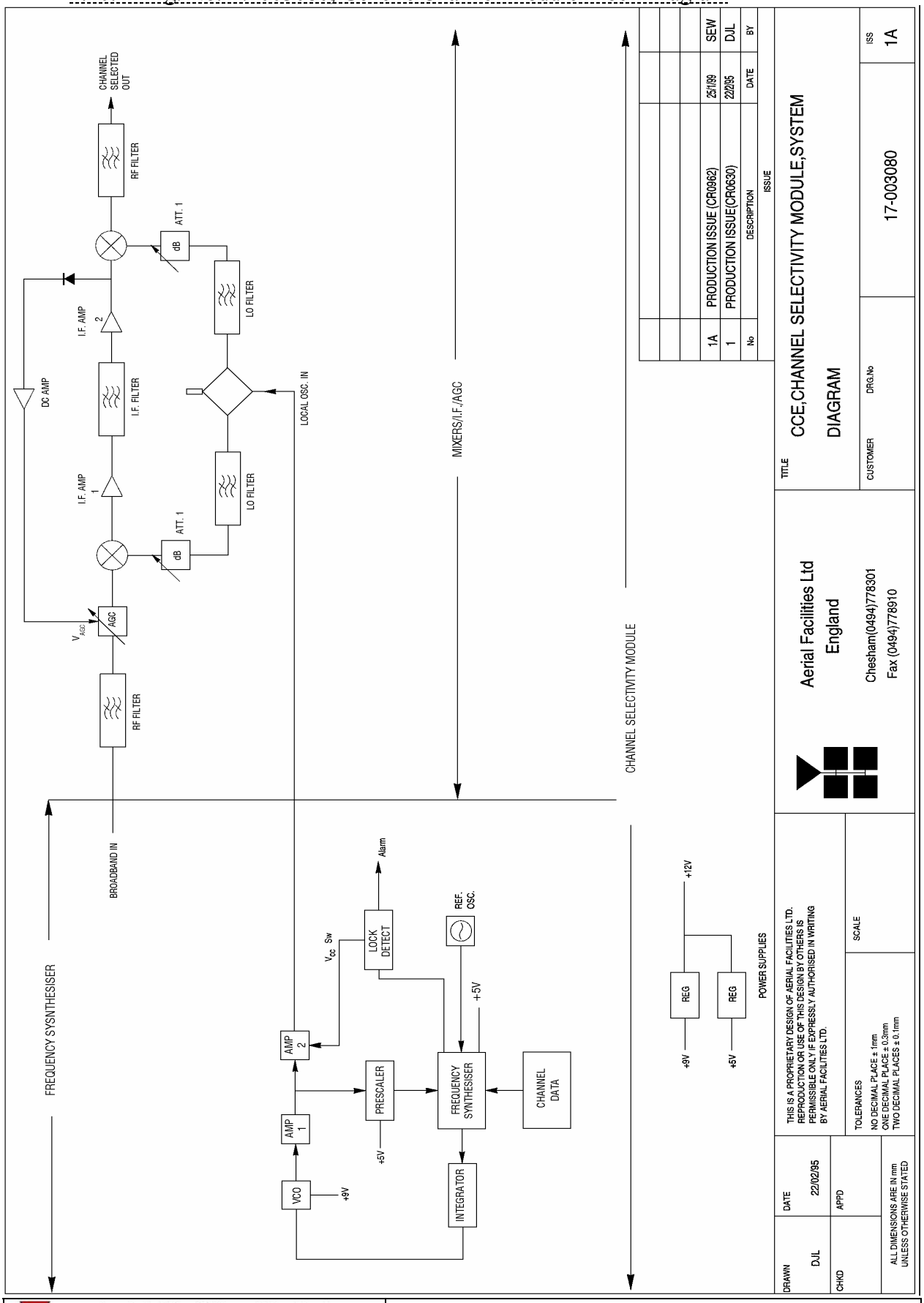
The operating frequency of each channel selectivity module is set by the programming of channel selectivity module frequencies and is achieved digitally, via hard wired links, banks of DIP switches, or via an onboard RS232 control module, providing the ability to remotely set channel frequencies.

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

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

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

## 4.10.2 Drg. Nō. 17-003080, Generic Channel Module Block Diagram



## 4.11 12V Single Relay Board (80-008901)

### 4.11.1 Description

The General Purpose Relay Board allows the inversion of signals and the isolation of circuits. It is equipped with a single dual pole change-over relay RL1, with completely isolated wiring, accessed via a 15 way in-line connector.

The relay is provided with polarity protection diodes and diodes for suppressing the transients caused by "flywheel effect" which can destroy switching transistors or induce spikes on neighbouring circuits. It's common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.

Note that the board is available for different voltages (12 or 24V) depending on the type of relay fitted at RL1.

## 4.12 PP9 NiCad Backup Battery (96-000017)

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

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

### 4.13.1 Description

The power supply unit is a switched-mode type capable of supplying 15V DC at 27Amps continuously. The amplifiers in this unit will draw approximately 12-15Amps at 15V DC, so the PSU will be used conservatively ensuring a long operational lifetime.

No routine maintenance of the PSU is required. If a fault is suspected, then the output voltage from the power supply may be measured on its output terminals. This is typically set to 15.2V. The adjustment potentiometer will be found close to the DC output terminals.

All the PSU's used in AFL Cell Enhancers are capable of operation from either 110 or 220V nominal AC supplies. The line voltage is sensed automatically, so no adjustment or link setting is needed by the operator.

### 4.13.2 Technical Specification

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

## 4.14 MT2834ZDXK 56kBPS Modem (96-800003)

### 4.14.1 Description

The modem used is a standard, 56kBPS, O.E.M, 'Hayes instruction set' unit. Used in conjunction with the Controller/Monitor board it is the output termination of all the alarm system data which is then transmitted into the regular telephone network by standard dial up. More information on the set-up & use of the modem can be found in the Controller/Monitor Handbook (17-005801HBKM).

# 5. INSTALLATION

## 5.1 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.

## 5.2 Antenna Installation & Gain Calculations

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

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

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

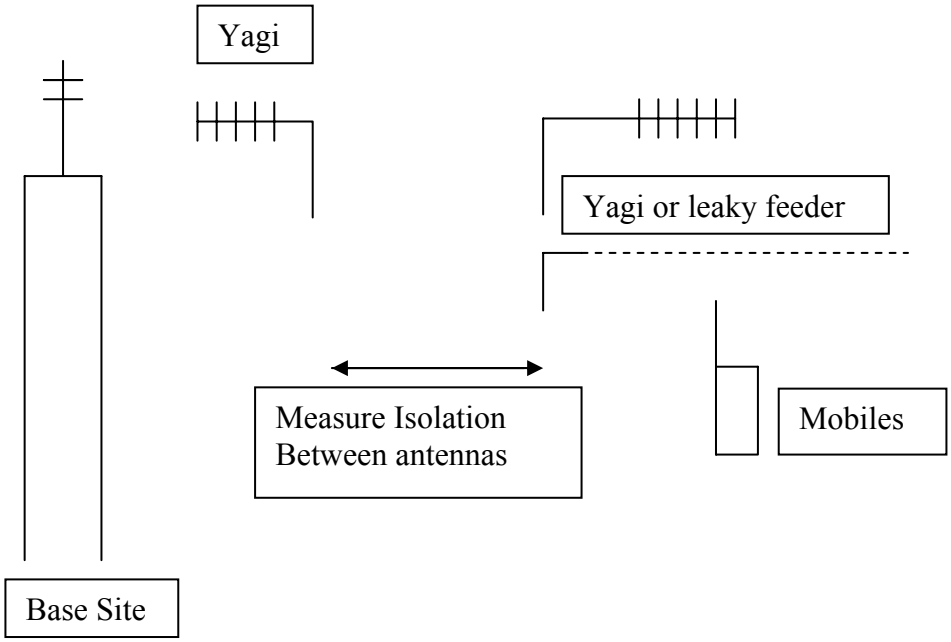
4 Ensure that the mobile facing antenna has at least 70 dB isolation from the nearest mobile. (This is usually easily achieved when using a leaky feeder.)

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

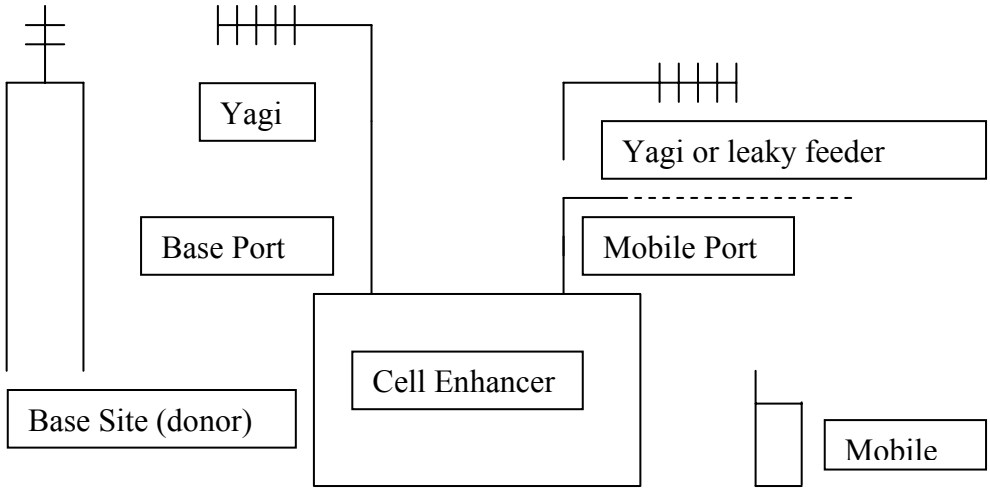
6 It is recommended that the gains are set such that the Downlink channel output levels from the Cell Enhancer are typically +30dBm per channel
(Input level + Gain = Output level).

5.3 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.



## 5.4 General Remarks

The size and weight of the wall-mount case is such that 2/3 persons may be needed to lift the equipment into position. Test the mechanical installation in the interests of safety, before any electrical, RF, or optical connections are made.

The equipment must be located on a smooth, flat, perpendicular surface, sheltered if possible, that is made from a material suitable for bearing the weight of the enclosure, (brick or concrete is recommended). If the installer is in any doubt about the suitability of a site it is advised that he/she consult with an appropriately qualified Structural Engineer.

It is also important in determining the location of the case that space is allowed for access to the front, sides and beneath the equipment to enable maintenance work to be carried out. The door must be able to fully open but not to obstruct other equipment when doing so.

The location should ideally be served with steel conduits to carry all the cables to and from the case.

## 5.5 Electrical Connections

The mains power supply is connected to the IP65 connector located on the bottom/side surface of the case. It is recommended that the connection is made by a qualified electrician, who must satisfy himself that the supply will be the correct voltage and of sufficient capacity.

All electrical and RF connections should be completed and checked prior to power being applied for the first time.

## 5.6 RF Connections

Care must be taken to ensure that the correct connections are made with particular attention made to the base station Tx/Rx ports. In the event that the base transmitter is connected to the Rx output, damage to the equipment will be done if the base station transmitter is then keyed.

Ensure that connections are kept clean and are fully tightened.

## 5.7 RS232 Setup

The RS232 controller/monitor should not need setting up as the specified configuration will have been fully tested before it leaves the factory.

Further information on the controller board's setup and remote capabilities is available in the RS232 Controller/Monitor Handbook, AFL Nō. 17-005801HBKM.

# 6. MAINTENANCE

## 6.1 General Procedures

### 6.1.1 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 new equipment have simple causes often occurring as a result of transportation, unpacking and installation. Below are listed some common problems which have resulted in poor performance or an indicated non-functioning of the equipment.

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

### 6.1.2 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 door LED's. The green LED should be illuminated, while the red alarm indicator should be off. If the alarm LED is on, then the amplifier (or any other alarmed device connected to the summary output) that is causing the fault will have to be isolated and individually tested against the original test specification. The individual amplifier modules have a green LED showing through a hole in their lid/cover, which is illuminated if the unit is working correctly, and extinguished if not.
If an amplifier is suspect, check the DC power supply to the unit. If no other fault is apparent use a spectrum analyser to measure the incoming signal level at the input and then after reconnecting the amplifier input, measure the output level. Consult with the system diagram to determine the expected gain and compare result.

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

### 6.1.3 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.

### 6.1.4 Uplink

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

### 6.1.5 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.

### 6.1.6 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.

### 6.1.7 Service Support

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

## 6.2 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. |

## 6.3 Care of Modules

### 6.3.1 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.

### 6.3.2 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).

### 6.3.3 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.

### 6.3.4 Power Amplifiers

1) Remove power to the unit. (Switch off @ mains/battery, or remove DC/alarm 'D' type 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 fins of the heatsink to threaded screw holes (or nuts and bolts), into the amplifier within the main case (side & top mounting). If the heatsink is mounted on the rear of the main case (this is very unusual), then the fixing method for the heatsink will be from within the case, otherwise the enclosure would have to be removed from the wall in order to remove the heatsink).

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

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

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

### 6.3.5 Low Power Amplifier Replacement

1 Isolate the mains power supply and disconnect the 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**

### 6.3.6 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 |