

# **Aerial Facilities Limited**

## **Mission Valley Radio System + Upgrade**

**User/Maintenance Handbook  
For**

### **San Diego Association**

|                           |   |
|---------------------------|---|
| <b>AFL Works Order #</b>  | <b>Q111353 &amp; Q11740</b>   |
| <b>AFL product part #</b> | <b>50-078001 (800MHz &amp; VHF CEs)<br/>80-209302 (Battery Backup)<br/>50-078021 (Upgrade hardware)</b> |

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# **1. INTRODUCTION**

## **1.1 Scope and Purpose of document**

This handbook is for use solely with the equipment identified by the 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.

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

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

This document fulfils the relevant requirements of Article 6 of the R&TTE Directive.

## **1.2 Limitation of Liability Notice**

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

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

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

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

## 2. SAFETY CONSIDERATIONS

### 2.1 Earthing of Equipment



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

### 2.2 Electric Shock Hazard



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

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

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

### 2.3 RF Radiation Hazard



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

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

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

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

### 2.4 Lifting and other Health and Safety Recommendations



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

## 2.5 Chemical Hazard



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

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

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

PolyTetraFluoroEthylene, (P.T.F.E.) and P.T.F.E. Composite Materials

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



## 2.6 Laser safety

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

Do not stare with unprotected eyes or with any unapproved optical device at the fibre ends or connector faces or point them at other people, Use only approved filtered or attenuating viewing aids. Any single or multiple fibre end or ends found not to be terminated (for example, matched, spliced) shall be individually or collectively covered when not being worked on. They shall not be readily visible and sharp ends shall not be exposed.

When using test cords, the optical power source shall be the last connected and the first disconnected; use only approved methods for cleaning and preparing optical fibres and optical connectors.

Always keep optical connectors covered to avoid physical damage and do not allow any dirt/foreign material ingress on the optical connector bulkheads.

The optical fibre jumper cable maximum bend radius is 3cm; any smaller radii may result in optical cable breakage or excessive transmission losses.

Caution: The FO units are NOT weather proof.

## 2.7 Emergency Contact Numbers

The AFL Quality Department can be contacted on:

Telephone +44 (0)1494 777000

Fax. +44 (0)1494 777002

e-mail [qa@aerialfacilities.com](mailto:qa@aerialfacilities.com)

### **3. MASTER SITE RACKS (50-078001)**

#### **3.1 Master Site Description**

The master site system consists of three, swing-frame 19" rack cabinets which provides 800MHz Channelised (x 24) & VHF Simplex/Duplex coverage for the various concourses, platforms and tunnels with a 12V battery backup service (for the 800MHz line amplifiers) that will guarantee limited continued coverage in case of mains power failure.

#### **3.P Master Site Rack Photos**





VHF channel modules and amplifier shelves (front view, door open)



RF distribution rack (front view, door open)



800MHz rack (front view, door open)

VHF rack (rear view, door open)



800MHz rack (rear view, door open)



### 3.2 Master Site Electrical Specification

| PARAMETER   |          | SPECIFICATION                          |
|---|----------|--|
| Frequency range:  |          | 851-869MHz (Downlink)                  |
|   |          | 806-824MHz (Uplink)                    |
|   |          | 160.2-161.8MHz (Simplex/Duplex)        |
| Bandwidth:  |          | 18MHz (UHF)                            |
|   |          | 1.6MHz (VHF)                           |
| Gain:   |          | >100dB (Uplink)                        |
|   |          | >90dB (Downlink)                       |
| Gain Adjustment:  |          | 0 - 30dB (in 2dB steps)                |
| Uplink Power:   |          | >5.0Watts (UHF)                        |
|   |          | >5.0Watts (VHF)                        |
| Downlink Power  |          | >40.0Watts (UHF) *(100W upgrade)       |
|   |          | >5.0Watts (VHF)                        |
| IP3:  | Uplink   | +43dBm                                 |
|   | Downlink | +50dBm (+53dBm upgrade)                |
| Noise Figure:   |          | <6dB                                   |
| AGC:  |          | -25dBm (factory set in channel module) |
| VSWR:   |          | better than 1.5:1                      |
| RF Connectors:  |          | N type, female                         |
| Alarms Fitted:<br>(non-latching, volt-free relay<br>contacts/TTL) |          | 1 PSU's                                |
|   |          | 2 Amplifiers                           |
|   |          | 3 Channel modules                      |

### 3.3 Master Site Mechanical Specifications

| PARAMETER                 |              | SPECIFICATION   |
|---------------------------|--------------|---|
| Rack                      | Height:      | 40U Standard Eurorack (x3)  |
|                           | Width:       | 19" (482.6mm)   |
|                           | Depth:       | 600mm   |
| Shelves:                  | Height:      | See parts lists   |
|                           | Width:       | 19" (482.6mm)   |
|                           | Depth:       | <450mm(excluding heatsinks, connectors, and handles)  |
| Temperature range:        | operational: | -20°C to +60°C  |
|                           | storage:     | -40°C to +70°C  |
| Weight:                   |              | >100kg  |
| Humidity:                 |              | 5 – 95% non-condensing  |
| RF Connectors:            |              | N type female   |
| Environmental Protection: |              | IP44  |
| Finish:                   | Case:        | Alocrom 1200/Iridite NCP  |
|                           | Heatsinks:   | Black anodised aluminium  |
|                           | Handles:     | Aluminium alloy   |
|                           | Fascias      | Painted to RAL7035  |
| Supply Cable:             |              | Unit supplied with suitable supply input leads, connector and specified length of cable (where appropriate) |

### 3.4 Master Site Parts List (50-078001)

| <b>AFL Part #</b> | <b>Part Description</b>            | <b>Qty.</b> |
|-------------------|------------------------------------|-------------|
| 50-078002         | 800MHz AIR I/F + BSCE UPLINK SHELF | 1           |
| 50-078003         | 800MHz 8CH CHANNEL MOD. SHELF      | 3           |
| 50-078004         | 800MHz 40W HPA / DRIVER SHELF      | 2           |
| 50-078010/1       | VHF SIMPLEX SHELF                  | 1           |
| 50-078010/2       | VHF SIMPLEX SHELF                  | 1           |
| 50-078011/1       | VHF DUPLEX SHELF                   | 1           |
| 50-078011/2       | VHF DUPLEX SHELF                   | 1           |
| 50-078011/3       | VHF DUPLEX SHELF                   | 1           |
| 50-078011/4       | VHF DUPLEX SHELF                   | 1           |
| 50-078012         | VHF AIR I/F SHELF                  | 1           |
| 50-078013         | VHF COMBINER SHELF                 | 1           |
| 50-078014         | VHF PSU SHELF                      | 1           |
| 50-078015         | VHF/ 800 Tx MULTICOUPLER           | 1           |
| 50-078017         | 800MHz IN LINE AMPLIFIER           | 2           |
| 60-020608         | 40U SWING FRAME CABINET            | 3           |
| 80-209302         | 12V 160Ah BATTERY BACK UP STANDARD | 2           |

### 3.5 Channel Frequency Listing

| Ch. #        | User Group             | Frequencies (MHz) |                 | Status                 |
|--------------|------------------------|-------------------|-----------------|------------------------|
|              |                        | Downlink          | Uplink          |                        |
| 1            | SD Trolley             | 160.6650          | 160.9350        | Duplex                 |
| <b>2</b>     | <b>SD Trolley</b>      | <b>160.3800</b>   | <b>160.9050</b> | <b>Duplex (Note1)</b>  |
| 3            | SD Trolley             | 160.7100          | 161.4150        | Duplex                 |
| 4            | SD Trolley             | 161.2950          | 161.2950        | Simplex                |
| 5            | SD Trolley             | 161.5650          | 160.7550        | Duplex                 |
| 6            | SD Trolley             | 160.5300          | 160.5300        | Simplex                |
| 800 MHz Band |                        |                   |                 |                        |
| 1            | SD City (PD/FD)        | 860.0500          | 815.0500        | Duplex                 |
| 2            | SD City (PD/FD)        | 860.0250          | 815.0250        | Duplex                 |
| 3            | SD City (PD/FD)        | 859.0500          | 814.0500        | Duplex                 |
| 4            | SD City (PD/FD)        | 859.0250          | 814.0250        | Duplex                 |
| <b>5</b>     | <b>SD City (PD/FD)</b> | <b>858.0500</b>   | <b>813.0500</b> | <b>Duplex (Note 2)</b> |
| <b>6</b>     | <b>SD City (PD/FD)</b> | <b>858.0250</b>   | <b>813.0250</b> | <b>Duplex (Note 2)</b> |
| 7            | SD City (PD/FD)        | 857.0500          | 812.0500        | Duplex                 |
| 8            | SD City (PD/FD)        | 860.0000          | 815.0000        | Duplex                 |
| 9            | SD City (PD/FD)        | 859.0000          | 814.0000        | Duplex                 |
| <b>10</b>    | <b>SD City (PD/FD)</b> | <b>858.0000</b>   | <b>813.0000</b> | <b>Duplex (Note 2)</b> |
| 11           | SD City (PD/FD)        | 857.0250          | 812.0250        | Duplex                 |
| 12           | SD City (PD/FD)        | 857.0000          | 812.0000        | Duplex                 |
| 13           | SD City (PD/FD)        | 856.0500          | 811.0500        | Duplex                 |
| 14           | SD City (PD/FD)        | 856.0250          | 811.0250        | Duplex                 |
| 15           | SD City (PD/FD)        | 862.0500          | 817.0500        | Duplex                 |
| 16           | SD City (PD/FD)        | 862.1000          | 817.1000        | Duplex                 |
| 17           | SD City (PD/FD)        | 863.0500          | 818.0500        | Duplex                 |
| 18           | SD City (PD/FD)        | 864.0500          | 819.0500        | Duplex                 |
| 19           | SD City (PD/FD)        | 865.5000          | 820.0500        | Duplex                 |
| <b>20</b>    | <b>SDSU Security</b>   | <b>868.5750</b>   | <b>823.5750</b> | <b>Duplex (Note 4)</b> |
| <b>21</b>    | <b>SDSU Security</b>   | <b>866.3875</b>   | <b>821.3875</b> | <b>Duplex (Note 4)</b> |
| <b>22</b>    | <b>SD City (PD/FD)</b> | <b>856.1500</b>   | <b>811.1500</b> | <b>Duplex (Note 3)</b> |
| 23           | TBD                    | TBD               | TBD             | TBD                    |
| 24           | TBD                    | TBD               | TBD             | TBD                    |

Note 1: Channel 2 uplink frequency was changed to 160.9050 MHz from 161.9050MHz as required by the Authority.

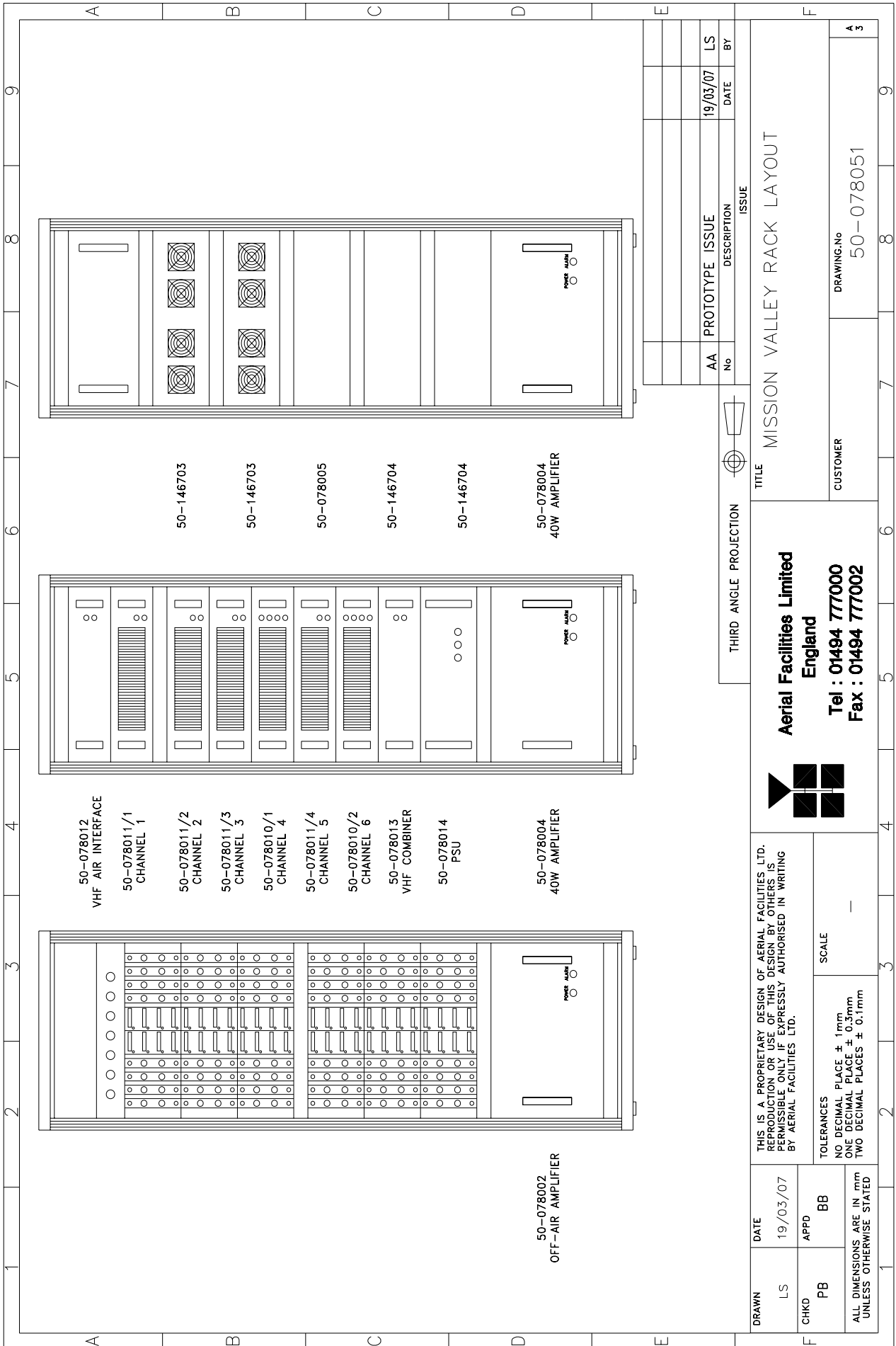
Note 2: Channel 4, 5 & 10 uplink frequency changed to 813.0500 MHz, 813.0250MHz, & 813.0000MHz from 816.050 MHz, 816.0250MHz & 816.000MHz respectively.

Note 3: Channel 22 is new frequency pair for SD City with 25KHz channel spacing.

Note 4: Channel 20 & 21 are analogue radio system with digital modulation (3600bps) and the donor site for these channels has azimuth of 150 degree. The Azimuth of CH 1 to Ch 19 and the new CH 22 is 40 degree.

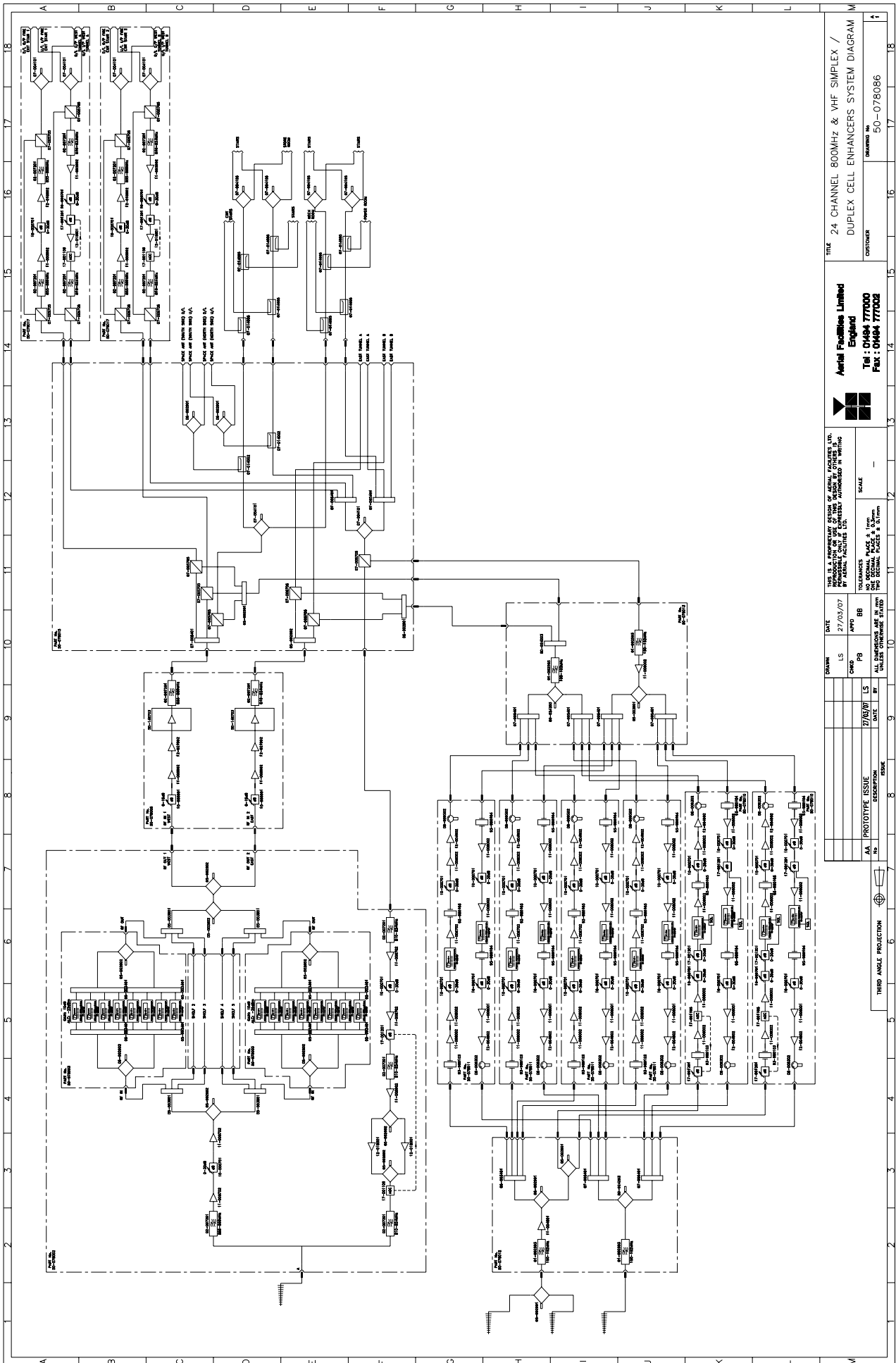
### 3.6 Master Site Drawings

#### 3.6.1 Master Site Racks Layout Drawing, Drg. # 50-078051





### 3.6.2 Master Site System Diagram, Drg. # 50-078086



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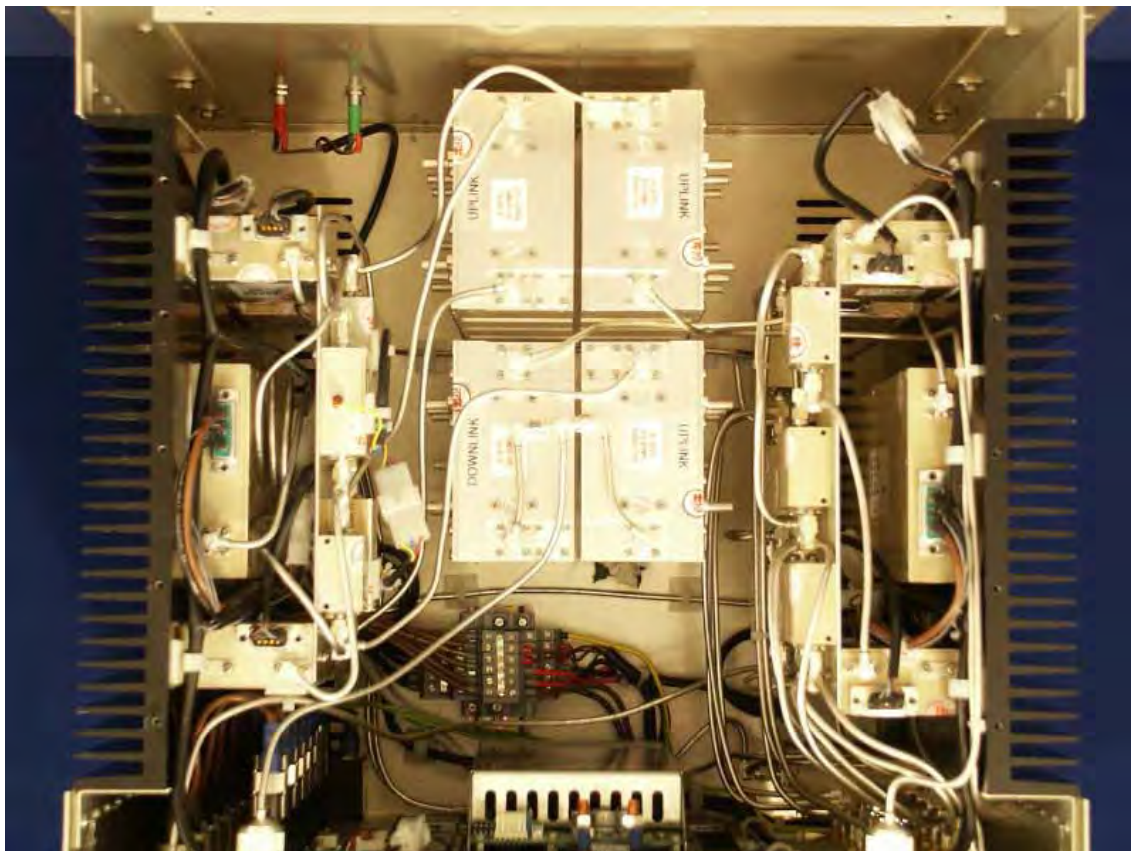
|             |                 |
|-------------|-----------------|
| DATE        | 27/03/07        |
| SCALE       |                 |
| DESIGNER    | LS              |
| CHECKED     | PB              |
| DATE        | 27/03/07        |
| SCALE       | 1:1             |
| DESCRIPTION | PROTOTYPE ISSUE |
| ISSUE NO.   | 1               |

TITLE: 24 CHANNEL 800MHz & VHF SIMPLEX /  
 DUPLEX CELL ENHANCERS SYSTEM DIAGRAM  
 CUSTOMER:

DRAWING NO: 50-078086

### 3.7 800MHz Air I/F + BSCE Uplink Shelf (50-078002)

#### 3.7.P 800MHz AIF Shelf Photographs



### 3.7.1 Description

This shelf is the interface between the system's 800MHz bi-directional tunnel amplifiers and the off-air antenna.

In the downlink direction, the incoming antenna RF is directed through a bandpass filter to a pair of 20dB gain low noise amplifiers that have a switchable 0-30dB attenuator between them. The resultant single path is then divided several times and fed out of the shelf to the channel selective modules (x 24). When the outputs from the channel modules return, they are combined and exit to the two power amplifier shelves that serve the East and West tunnel leaky feeders.

The uplink path originates from the tunnel antennas, and is band-selectively amplified and fed to a pair of 10W power amplifiers. This final amplification stage in the uplink path has an automatic gain control detector and attenuator to help negate the overloading effect of someone operating a mobile close to the LCX tunnel antennas.

Note that this shelf has its own, dedicated mains driven, 12-15V DC PSU unit.

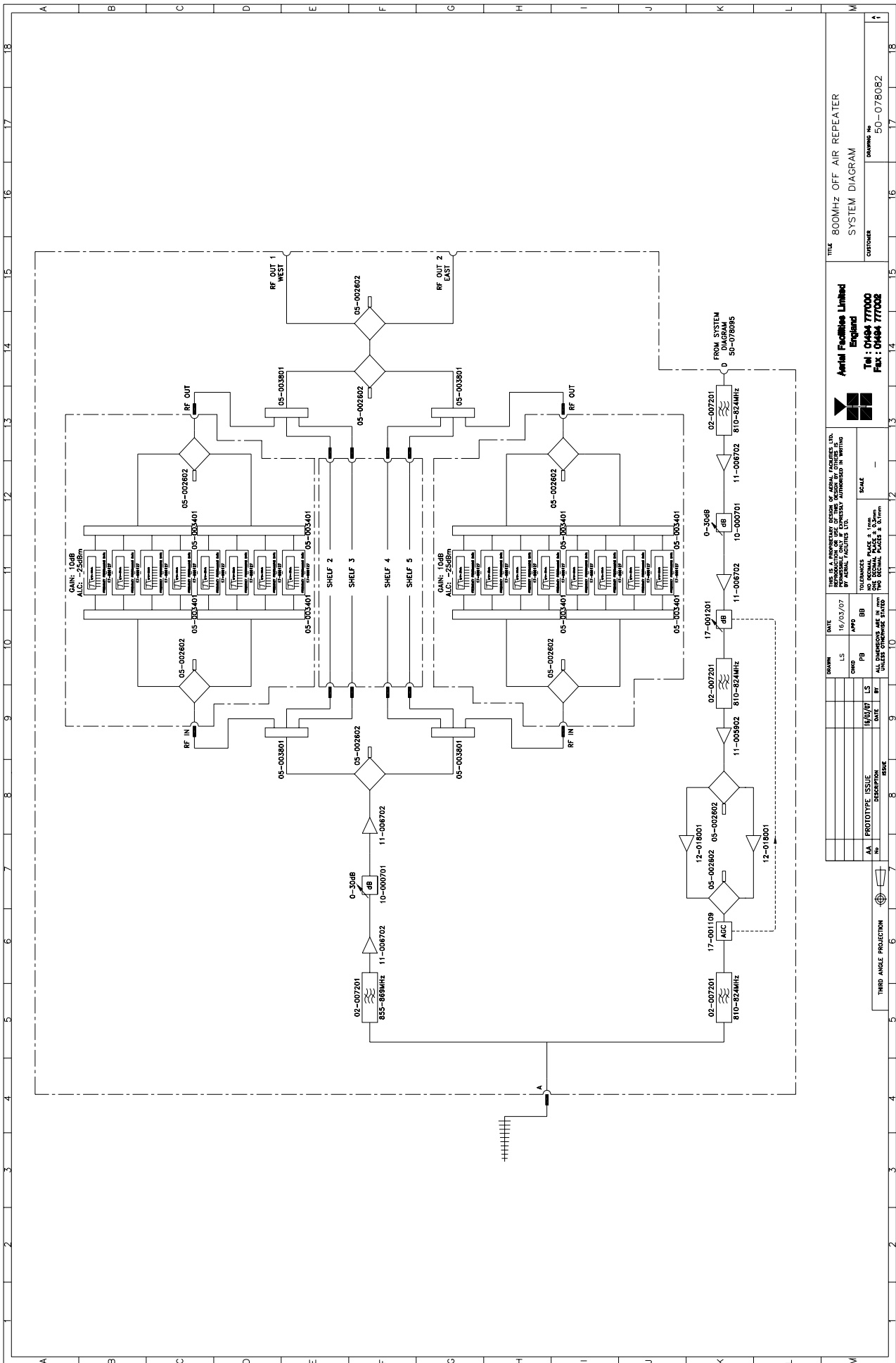
### 3.7.2 Technical Specification

| PARAMETER                 |              | SPECIFICATION                                |
|---------------------------|--------------|--|
| Frequency range:          |              | 851-869MHz (Downlink)<br>806-824MHz (Uplink) |
| Downlink output power:    |              | N/A  |
| Uplink output power:      |              | 10Watts (x2)                                 |
| AGC:                      |              | Fitted in uplink path                        |
| AGC dynamic range:        |              | >35dB  |
| Shelf dimensions          | Height:      | 8U   |
|                           | Width:       | 19" (482.6mm)                                |
|                           | Depth:       | <450mm (excluding connectors & handles)      |
| Temperature range         | operational: | -20°C to +60°C                               |
|                           | storage:     | -40°C to +70°C                               |
| Weight:                   |              | <15kg  |
| Shelf gain:               |              | 60dB (typical)                               |
| Impedance:                |              | 50Ω  |
| Humidity:                 |              | 5 – 95% non-condensing                       |
| RF Connectors:            |              | N type female                                |
| Environmental protection: |              | IP44   |
| Finish                    | Case:        | Alocrom 1200/Iridite NCP coating             |
|                           | Heatsinks:   | Black anodised aluminium                     |
|                           | Handles:     | Silver anodised aluminium alloy              |
|                           | Fascia:      | Painted to RAL7035                           |

### 3.7.3 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 02-007201  | 900MHz 8POLE 10-20MHz B/W SMA       | 4    |
| 05-002602  | 900MHz SPLITTER/COMBINER, 20W       | 5    |
| 05-003801  | 3WAY GEN.SPLIT 900MHz GEN.ASS       | 4    |
| 10-000701  | 1/4W0-30dB SWITCHED ATTENUATOR      | 2    |
| 11-005902  | 900MHz LOW NOISE AMP WITH RELAY ASS | 3    |
| 11-006702  | GA 800-1000MHz LNA 29dB (WITH RELAY | 4    |
| 12-018001  | PA 800-960MHz 10W 30dB              | 2    |
| 14-000225  | CASE RAIL LONG R.S.A./R.F.A.        | 4    |
| 17-001109  | CE AGC UNIT LOG DET/AMP ASSY (12V)  | 1    |
| 17-001201  | C/E AGC UNIT ATTENUATOR ASSY        | 1    |
| 20-001601  | 12V RELAY BOARD                     | 1    |
| 50-012820  | CCE RACK MOUNTED 8U CHASSIS         | 1    |
| 50-012822  | CCE RACK MOUNTED LID                | 1    |
| 50-012825  | CCE RACK MOUNTED HEATSINK BRACKET   | 4    |
| 50-027720  | RACK MTD CHAN C.E. MODIFIED HEATSIN | 2    |
| 80-090822  | C/E 8U FRONT PANEL, AFL (RAL7035)   | 1    |
| 80-310420  | BCC 400W POWER SUPPLY HEATSINK      | 1    |
| 91-030002  | N ADAPTOR PANEL FEMALE:FEMALE       | 4    |
| 91-130005  | SMA BULKHEAD ADAPTOR F/F            | 12   |
| 91-500025  | 3 PIN RIGHT ANGLE FREE PLUG NC-X    | 3    |
| 91-510003  | 3 PIN R.ANGLE FREE SOC.NC-X.        | 3    |
| 91-510004  | 3 PIN PNL.MOUNT SOCKET NC-X         | 3    |
| 91-510032  | 20A SOCKET CONTACT PIN              | 4    |
| 91-520001  | PWR MAINS INL FIXED/SOLD.TERMS      | 1    |
| 91-520005  | MAINS LEAD                          | 1    |
| 91-520010  | MAINS RETAINING CLIP                | 1    |
| 91-600007  | 'D' 9 WAY BLACK SHELL               | 8    |
| 91-600014  | 'D' 9 WAY SOCKET S/B (NON FILTERED) | 7    |
| 91-600015  | 'D' 9 WAY PLUG S/B (NON FILTERED)   | 1    |
| 91-660001  | 2W5 MIXED D TYPE SOCKET (7 WAY)     | 2    |
| 96-110034  | FUSE HOLDER 16-30A, 32mm BODY       | 3    |
| 96-300057  | 15V 27A PSU 400W (XP BCC)           | 1    |
| 96-700034  | LED RED 5mm IP67 INTEGRAL RES. 24V  | 1    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES 24V | 1    |
| 96-900018  | AC TRIP SWITCH (5 AMP M.C.B.)       | 2    |
| 97-400005  | HANDLE TYPE H6802 3U [ALLOY]        | 2    |
| 99-200008  | DANGER HIGH VOLTAGE LABEL 2' x 2'   | 1    |
| 99-200017  | CAUTION HEAVY LABEL 75 x 55mm       | 2    |

### 3.7.4 800MHz Off-Air Repeater System Diagram, Drg. # 50-078082



### 3.8 800MHz 8Ch. Channel Module Sub-Rack (50-078003)

#### 3.8.P 800MHz Channel Module Sub-Rack Photographs

Photographs of this sub-rack are unavailable.

##### 3.8.1 Description

The channel modules are built into a sub-rack which is the equivalent height of a 3U shelf. Each sub-rack has eight channel selective modules (3 sub-racks=24 channels) and two channel control modules that are DIP switch banks that configure the frequencies for the channel modules, see below for channel module programming.

Each channel module has an alarm (alarm which is summed to form an overall alarm pair for the whole sub-rack, that terminates at the rear-mounted 9-way alarm 'D' connector, pins 1 & 2.

##### 3.8.2 Technical Specification

| PARAMETER                 |              | SPECIFICATION                                |
|---------------------------|--------------|--|
| Frequency range:          |              | 855-869MHz (Downlink)<br>810-824MHz (Uplink) |
| Shelf dimensions          | Height:      | 3U (equivalent)                              |
|                           | Width:       | 19" (482.6mm)                                |
|                           | Depth:       | <400mm (excluding connectors & handles)      |
| Temperature range         | operational: | -20°C to +60°C                               |
|                           | storage:     | -40°C to +70°C                               |
| Weight:                   |              | <15kg  |
| Channel module gain:      |              | 10dB   |
| Channel module AGC level: |              | -25dBm                                       |
| Impedance:                |              | 50Ω  |
| DC power input:           |              | 12V @ 6.3A (fused)                           |
| Power consumption:        |              | <2.6Amps @ 12V DC                            |
| Humidity:                 |              | 5 – 95% non-condensing                       |
| RF Connectors:            |              | N type female                                |
| Environmental protection: |              | IP44   |
| Finish                    | Case:        | Alocrom 1200/Iridite NCP coating             |
|                           | Heatsinks:   | None   |
|                           | Handles:     | None   |
|                           | Fascia:      | Painted to RAL7035                           |

### 3.8.3 VHF/ UHF Programming Procedure

The operating frequency for each channel in the Cell Enhancer is programmed by 16 DIL (Dual In Line) switches. The programming switches are mounted in the Channel Control Modules which are located beside the channel modules in the module racking. The Channel Selectivity Modules are connected to the Channel Control Module via 25 way ribbon cables.

Switch 16 is at the far left of the line of switches leading down to Switch 1 at the far right of the line.

Adjacent to the DIL switches for each channel is a toggle switch to turn on and off individual channels as required. A green LED indicates the DC ON status of each channel.

A red LED shows the alarm condition for each channel. An illuminated alarm LED indicates that the synthesiser has not achieved phase lock and that the module is disabled. There is a problem which requires investigation, often a frequency programmed outside the operating frequency range.

The following information is necessary before attempting the programming procedure.

- 1) operating frequency
- 2) synthesiser channel spacing (step size)
- 3) synthesiser offset (IF)

Check that the required frequency falls within the operational frequency limits of the Cell Enhancer.

For each channel required, subtract the synthesiser offset from the required operating frequency and record the resulting local oscillator frequency.

Divide each local oscillator frequency by the channel spacing and check that the result is an integer (i.e.: no remainder).

If the synthesiser division ratio is not an integer value, check the required operational frequency and repeat the calculation checking for mistakes.

Convert the required local oscillator frequency to synthesiser programming switch state patterns according to the following table.

| Switch number | Synthesiser offset added when switch in <b>UP</b> position |
|---------------|--|
| 1             | +12.5kHz   |
| 2             | +25kHz   |
| 3             | +50kHz   |
| 4             | +100kHz  |
| 5             | +200kHz  |
| 6             | +400kHz  |
| 7             | +800kHz  |
| 8             | +1.6MHz  |
| 9             | +3.2MHz  |
| 10            | +6.4MHz  |
| 11            | +12.8MHz   |
| 12            | +25.6MHz   |
| 13            | +51.2MHz   |
| 14            | +102.4MHz  |
| 15            | +204.8MHz  |
| 16            | +409.6MHz  |

### 3.8.4 VHF/ UHF Programming Example

Frequency required: 465.5MHz

Channel spacing: 12.5kHz

Synthesiser offset: 21.4MHz

The Local Oscillator frequency is therefore:  $465.4 - 21.4 = 444.0$  MHz

Dividing the LO frequency  
by the channel spacing of:  $\frac{0.0125\text{MHz}}{0.0125} = 35520$

This is an integer value, therefore it is OK to proceed.

| Local Oscillator<br>Frequency of:<br>444.0 MHz | Switch settings |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |
|--|-----------------|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|
|  | 16              | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|  | 1               | 0  | 0  | 0  | 1  | 0  | 1  | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

Switch setting: 0 = switch DOWN (on, frequency ignored)  
1 = switch UP (off, frequency added)



### 3.8.5 900MHz Programming Procedure

Check that the required downlink and uplink frequencies fall within the operational band limits of the Cell Enhancer.

For each Downlink and Uplink channel frequency, subtract the appropriate synthesiser offset frequency from the required operational frequency and record the resulting local oscillator frequencies.

Divide each Downlink and Uplink local oscillator frequency by the synthesiser channel spacing and check that the result is an integer (i.e. no remainder).

If the synthesiser division ratio is not an integer value, check the required operational frequency and repeat the calculation checking for mistakes.

Convert the required local oscillator frequency to synthesiser programming switch state patterns according to the following table.

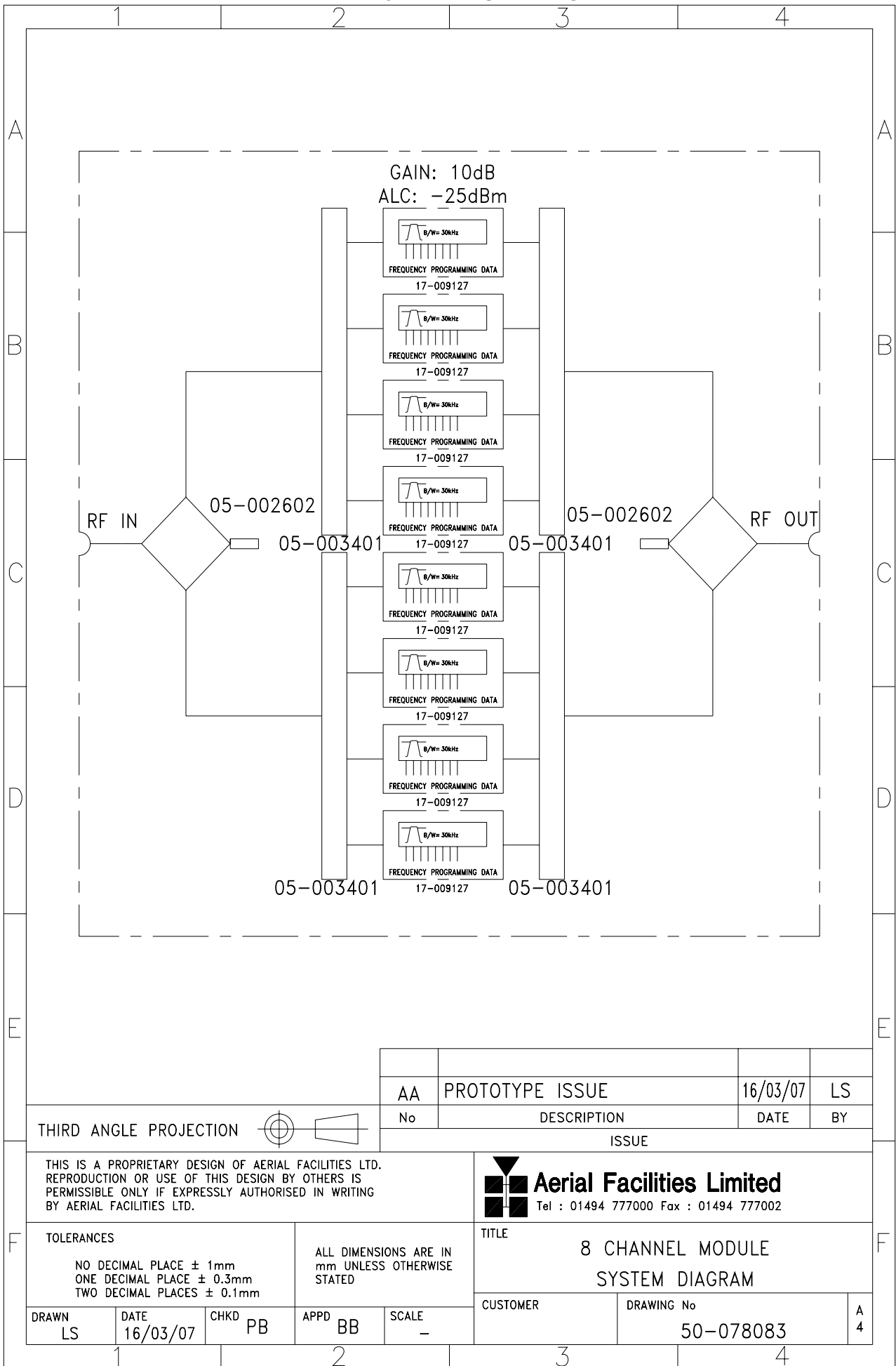
NOTE: Ensure that the correct column is used from the table below according to the synthesiser channel spacing of the particular channel modules fitted to the Cell Enhancer.

| Switch Number | Synthesiser offset added when switch in UP position |                        |
|---------------|---|------------------------|
|               | 25kHz channel spacing                               | 100kHz channel spacing |
| 1             | +25kHz  | +100kHz                |
| 2             | +50kHz  | +200kHz                |
| 3             | +100kHz   | +400kHz                |
| 4             | +200kHz   | +800kHz                |
| 5             | +400kHz   | +1.6MHz                |
| 6             | +800kHz   | +3.2MHz                |
| 7             | +1.6MHz   | +6.4MHz                |
| 8             | +3.2MHz   | +12.8MHz               |
| 9             | +6.4MHz   | +25.6MHz               |
| 10            | +12.8MHz  | +51.2MHz               |
| 11            | +25.6MHz  | +102.4MHz              |
| 12            | +51.2MHz  | +204.8MHz              |
| 13            | +102.4MHz   | +409.6MHz              |
| 14            | +204.8MHz   | +819.2MHz              |
| 15            | +409.6MHz   | -                      |
| 16            | +819.2MHz   | -                      |

### 3.8.6 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 05-003302  | 4 WAY SPLITTER GSM 900MHz           | 4    |
| 17-002101  | CHANNEL CONTROL MODULE              | 2    |
| 17-002103  | 26WAY RIBBON CABLE LEAD             | 8    |
| 17-003022  | MODULE PATTERNED LEAVE              | 8    |
| 17-003023  | SUBRACK SIDE PANEL                  | 4    |
| 17-003024  | SUBRACK REAR BRACKET                | 8    |
| 17-003025  | BOTTOM MODULE GUIDE                 | 8    |
| 17-003028  | MODULE SQUARE LEAVE                 | 8    |
| 17-003029  | TOP MODULE GUIDE                    | 8    |
| 17-009127  | CHAN MOD 810-860MHz 30KHz 8p TCXO   | 8    |
| 91-100004  | SMA PLUG ELBOW UT-85/RG405          | 32   |
| 91-500001  | POWER PLG 3 PIN PNL.MOUNT NC-X      | 2    |
| 91-510003  | 3 PIN R.ANGLE FREE SOC.NC-X.        | 2    |
| 91-600007  | 'D' 9 WAY BLACK SHELL               | 4    |
| 91-600014  | 'D' 9 WAY SOCKET S/B (NON FILTERED) | 2    |
| 91-600015  | 'D' 9 WAY PLUG S/B (NON FILTERED)   | 2    |
| 92-280033  | Captive Screw                       | 16   |
| 96-110001  | FUSE HOLDER 20 x 5mm 6.3A           | 2    |
| 96-110007  | T 1.6A A.SURGE FUSE 20mm            | 4    |
| 97-000002  | BLACK MODULE CAGE RUNNER            | 16   |
| 97-600001  | SUBRACK FRONT HORIZ                 | 4    |
| 97-600002  | SUBRACK M2.5 STD TAP                | 4    |

**3.8.7 8 Channel Module Shelf System Diagram, Drg. # 50-078083**



|       |                 |          |    |
|-------|-----------------|----------|----|
| AA    | PROTOTYPE ISSUE | 16/03/07 | LS |
| No    | DESCRIPTION     | DATE     | BY |
| ISSUE |                 |          |    |

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**TOLERANCES**  
NO DECIMAL PLACE ± 1mm  
ONE DECIMAL PLACE ± 0.3mm  
TWO DECIMAL PLACES ± 0.1mm

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED

**TITLE**  
8 CHANNEL MODULE  
SYSTEM DIAGRAM

|             |                  |            |            |            |          |                         |        |
|-------------|------------------|------------|------------|------------|----------|-------------------------|--------|
| DRAWN<br>LS | DATE<br>16/03/07 | CHKD<br>PB | APPD<br>BB | SCALE<br>- | CUSTOMER | DRAWING No<br>50-078083 | A<br>4 |
|-------------|------------------|------------|------------|------------|----------|-------------------------|--------|

### 3.9 800MHz 40Watt Power Amplifier/Driver Shelf (50-078004)

#### 3.9.P 40Watt PA Shelf Photographs



### 3.9.1 Description

The 40Watt master site power amplifier shelf concerns itself with powering the 800MHz channel information to the LCX tunnel antennas. The output from the channel module shelves is split into two and input to each of the two PA shelves. Each PA powers either the East or West tunnel leaky feeder antennas and a proportion of the LCX signal provides a feed to the 800MHz in-line amplifiers that power the fire exit stairs antennas. All amplifiers in the shelf have alarms and they terminate at the rear panel mounted 9-way 'D' connector, pins 1 & 2.

Since the Mission Valley system was first commissioned, the upgrade was designed and built using a high power shelf (50-078005) instead of the 40Watt shelf described here. Therefore, this section is shown for information only.

### 3.9.2 Technical Specification

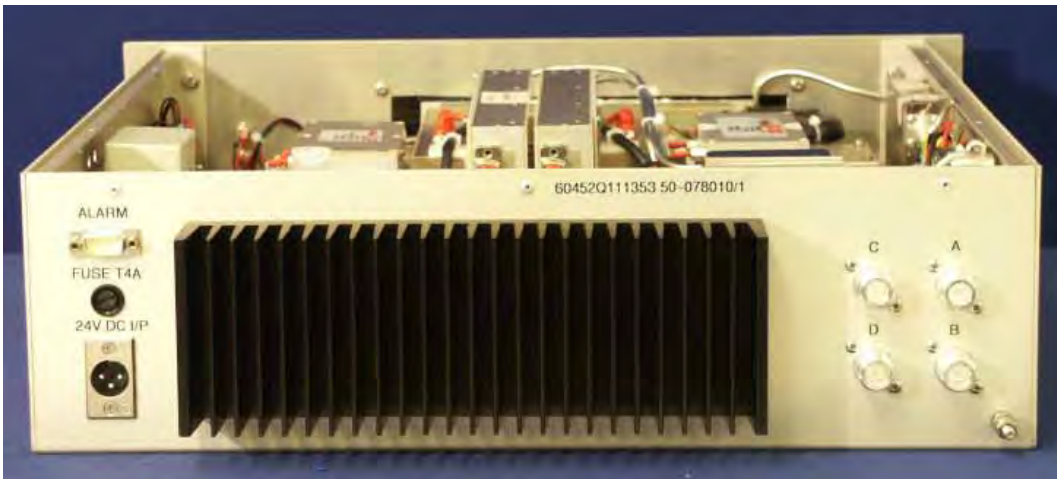
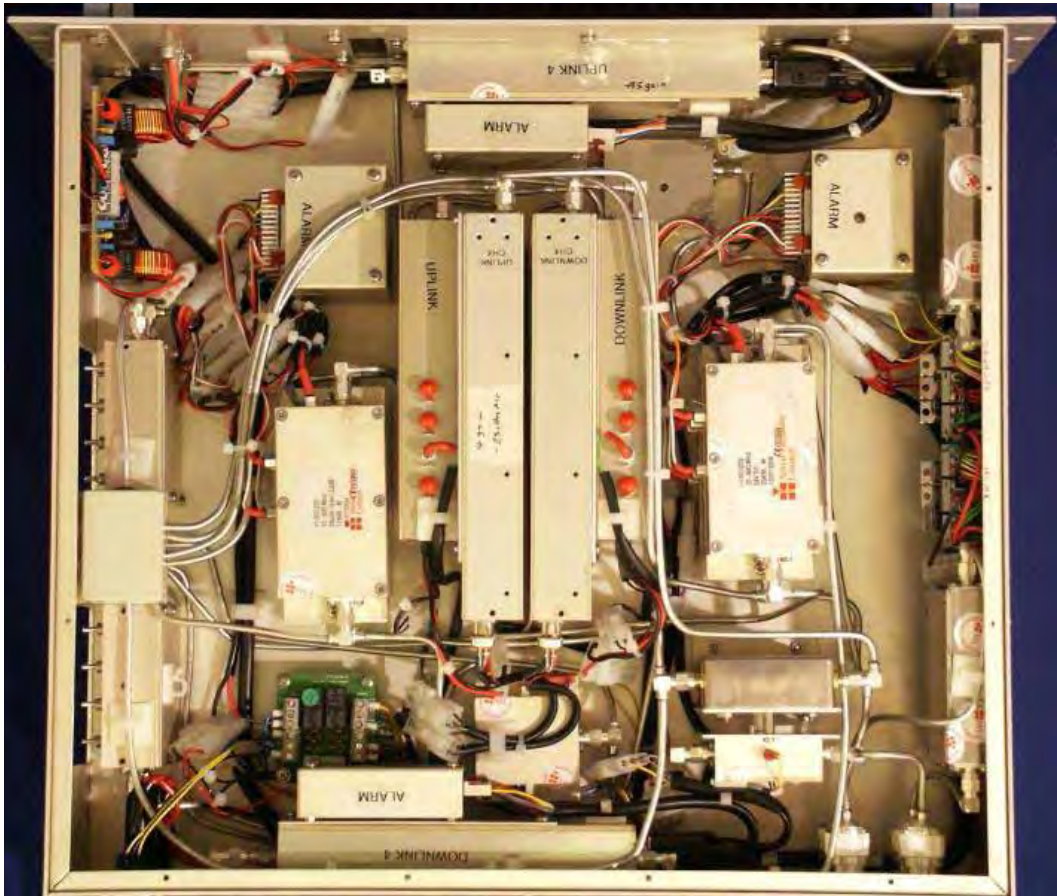
| PARAMETER                 |              | SPECIFICATION                           |
|---------------------------|--------------|---|
| Frequency range:          |              | 855-869MHz                              |
| Downlink output power:    |              | 20-40Watts                              |
| AGC:                      |              | N/A                                     |
| Shelf dimensions:         | Height:      | 8U                                      |
|                           | Width:       | 19" (482.6mm)                           |
|                           | Depth:       | <450mm (excluding connectors & handles) |
| Temperature range         | operational: | -20°C to +60°C                          |
|                           | storage:     | -40°C to +70°C                          |
| Weight:                   |              | <25kg                                   |
| Shelf gain:               |              | 30dB (typical)                          |
| Impedance:                |              | 50Ω                                     |
| Humidity:                 |              | 5 – 95% non-condensing                  |
| RF Connectors:            |              | N type female                           |
| Environmental protection: |              | IP44                                    |
| Finish                    | Case:        | Alocrom 1200/Iridite NCP coating        |
|                           | Heatsinks:   | Black anodised aluminium                |
|                           | Handles:     | Aluminium alloy                         |
|                           | Fascia:      | Painted to RAL7035                      |

### 3.9.3 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 02-007201  | 900MHz 8POLE 10-20MHz B/W SMA       | 1    |
| 05-002602  | 900MHz SPLITTER/COMBINER, 20W       | 2    |
| 10-000901  | SW. ATTENUATOR 0.25W 0-15dB         | 1    |
| 11-005802  | 900MHz DRIVER STAGE WITH RELAY      | 1    |
| 12-018002  | PA 800-960MHz 20W CLASS A           | 2    |
| 14-000225  | CASE RAIL LONG R.S.A./R.F.A.        | 2    |
| 50-012820  | CCE RACK MOUNTED 8U CHASSIS         | 1    |
| 50-012822  | CCE RACK MOUNTED LID                | 1    |
| 50-012825  | CCE RACK MOUNTED HEATSINK BRACKET   | 4    |
| 50-027720  | RACK MTD CHAN C.E. MODIFIED HEATSIN | 2    |
| 80-090822  | C/E 8U FRONT PANEL, AFL (RAL7035)   | 1    |
| 80-310420  | BCC 400W POWER SUPPLY HEATSINK      | 1    |
| 91-030002  | N ADAPTOR PANEL FEMALE:FEMALE       | 2    |
| 91-510032  | 20A SOCKET CONTACT PIN              | 4    |
| 91-520001  | PWR MAINS INL FIXED/SOLD.TERMS      | 1    |
| 91-520005  | MAINS LEAD                          | 1    |
| 91-520010  | MAINS RETAINING CLIP                | 1    |
| 91-600007  | 'D' 9 WAY BLACK SHELL               | 1    |
| 91-600014  | 'D' 9 WAY SOCKET S/B (NON FILTERED) | 1    |
| 91-600015  | 'D' 9 WAY PLUG S/B (NON FILTERED)   | 1    |
| 91-660001  | 2W5 MIXED D TYPE SOCKET (7 WAY)     | 2    |
| 96-300057  | 15V 27A PSU 400W (XP BCC)           | 1    |
| 96-700034  | LED RED 5mm IP67 INTEGRAL RES. 24V  | 1    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES 24V | 1    |
| 96-900018  | AC TRIP SWITCH (5 AMP M.C.B.)       | 1    |
| 97-400005  | HANDLE TYPE H6802 3U [ALLOY]        | 2    |
| 99-200008  | DANGER HIGH VOLTAGE LABEL 2' x 2'   | 1    |
| 99-200017  | CAUTION HEAVY LABEL 75 x 55mm       | 2    |

### 3.10 VHF Simplex Shelf (50-078010/1)

#### 3.10.P VHF Simplex Shelf Photographs



### 3.10.1 Description

The VHF simplex shelves are two-path, single frequency cell enhancers that cut the DC power (and thereby mute the amplifiers) to the opposing path whenever a signal is detected. This is achieved by using highly accurate crystal filters to set the exact channel frequency and speciality channel selective modules that react to detectors placed in each path. There are also switched attenuators before and after the channel modules in order to accurately set the RF threshold levels for correct simplex operation (this will already have been achieved at the time of final system test and should not need adjustment). Isolators at the outputs of each path protect the power stages from potentially damaging stray interference from other channels.

Each amplifier in the simplex CE shelves has an alarm as do the channel modules and the summary alarms terminate at the rear panel mounted 9-way 'D' connector, pins 1 & 2.

### 3.10.2 Technical Specification

| PARAMETER                                 |              | SPECIFICATION                    |
|---|--------------|----------------------------------|
| Simplex frequencies:                      |              | 161.295MHz (50-078010/1)         |
|   |              | 159.0-161.0MHz (50-078010/2)     |
| Gain:                                     |              | >90dB                            |
| Gain Adjustment:                          |              | 0 – 15dB (in 1dB step)           |
| Uplink Power:                             |              | >5.0Watts (typical)              |
| Downlink Power:                           |              | >5.0Watts (typical)              |
| IP3                                       | Uplink:      | +48dBm                           |
|   | Downlink:    | +48dBm                           |
| Noise Figure:                             |              | <6dB                             |
| Channel module gain:                      |              | 23dB (downlink)                  |
|   |              | 24dB (uplink)                    |
| VSWR:                                     |              | better than 1.5:1                |
| RF Connectors:                            |              | N type, female                   |
| Temperature range                         | operational: | -20°C to +60°C                   |
|   | storage:     | -40°C to +70°C                   |
| Finish                                    | Case:        | Alocrom 1200/Iridite NCP coating |
|   | Heatsinks:   | Black anodised aluminium         |
|   | Handles:     | Aluminium alloy                  |
|   | Fascia:      | Painted to RAL7035               |
| Alarms Fitted<br>(volt-free contacts/TTL) |              | 1 U/L amplifiers                 |
|   |              | 2 D/L amplifiers                 |
|   |              | 3 Channel modules                |

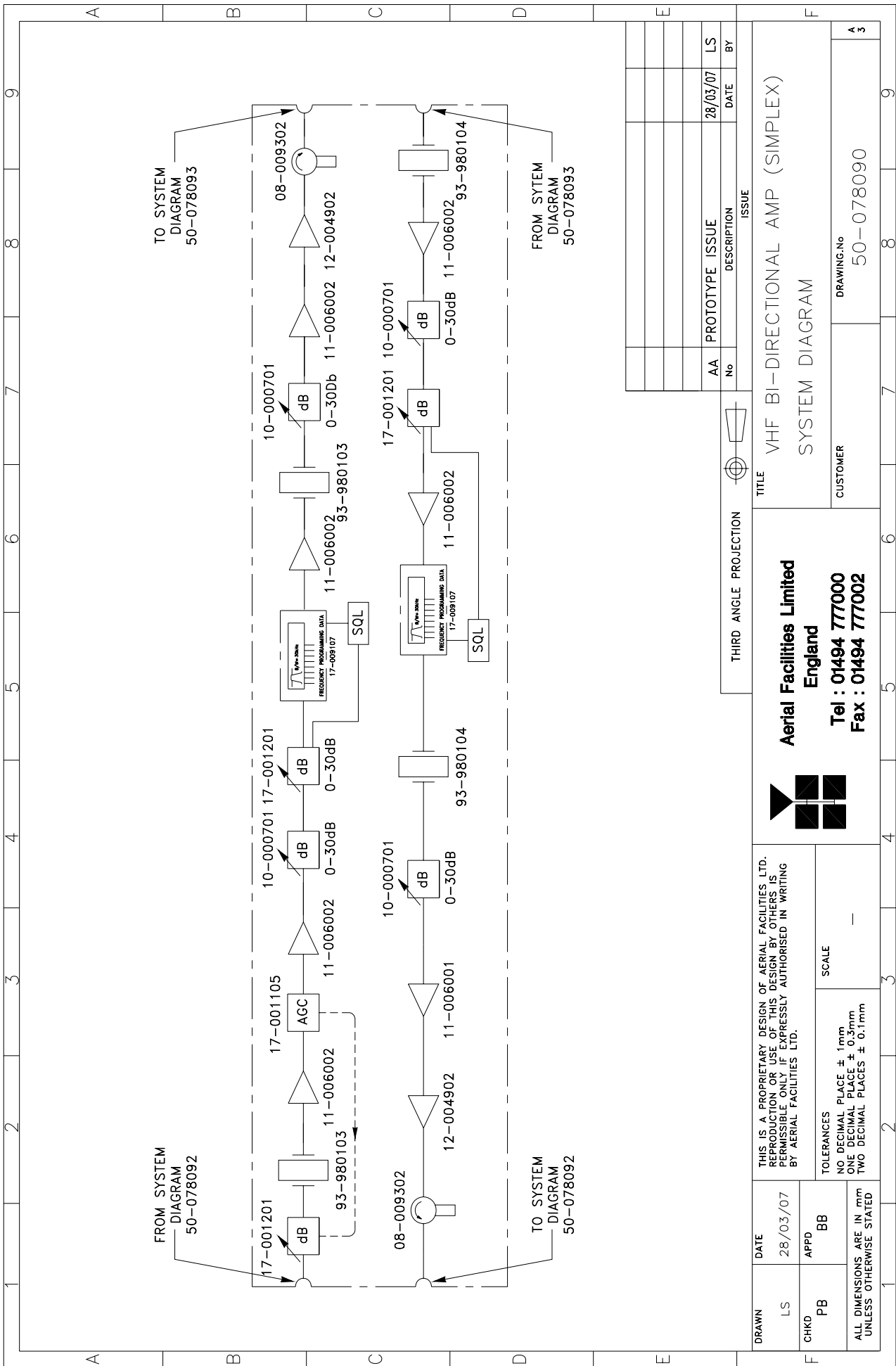


### 3.10.3 Parts List

| AFL Part #  | Part Description                      | Qty. |
|-------------|---------------------------------------|------|
| 08-930002   | 2 PORT ISOLATOR 150-300MHz SMA        | 2    |
| 10-000901   | SW. ATTENUATOR 0.25W 0-15dB           | 4    |
| 11-001202   | 10/600MHz LNA 24v SMA Alarm           | 7    |
| 12-002213   | 3 STAGE ALARM/SIMPLEXMUTE PCB SUB-ASS | 2    |
| 12-002220   | 3 STAGE ALARM PCB COVER               | 2    |
| 12-002804   | SINGLE CH. ALARM/SIMPLEX MUTE BOARD   | 7    |
| 12-002820   | SINGLE CHANNEL ALARM COVER            | 7    |
| 12-004902   | POWER AMP VHF 5W CLASS AB             | 2    |
| 13-001803   | DUAL DC/DC CONVERTER 24V-12V 1A       | 1    |
| 13-001822   | DC-DC CON 24V-5V/15V COVER            | 1    |
| 13-002811   | SIMPLEX CONTROLLER PCB ASSEMBLY       | 2    |
| 17-001201   | C/E AGC UNIT ATTENUATOR ASSY          | 4    |
| 17-002802   | SIMPLEX C.E Rx/SQUELCH & AF (SMD)     | 2    |
| 17-009135   | VHF 15Kstep CH MOD 15kHz 8P BW+IFRX   | 2    |
| 19-000826   | 2U,3U,4U 19" UNIT 400 DEEP LID        | 1    |
| 19-000921   | 3U 19" UNIT 400 DEEP CHASSIS + BKT    | 1    |
| 19-000924   | 3U 19" UNIT FRONT PANEL FAB           | 1    |
| 80-063920   | HEATSINK 2U ASS140 (5W)               | 2    |
| 91-030002   | N ADAPTOR PANEL FEMALE:FEMALE         | 4    |
| 91-500001   | POWER PLG 3 PIN PNL.MOUNT NC-X        | 1    |
| 91-510003   | 3 PIN R.ANGLE FREE SOC.NC-X.          | 1    |
| 91-600001   | 'D'TYPE 9 WAY PLUG S/B TERM           | 1    |
| 91-600014   | 'D' 9 WAY SOCKET S/B (NON FILTERED)   | 2    |
| 91-620001   | 'D' 25 WAY SOCKET S/B TERM            | 2    |
| 91-700017   | ICD 15 WAY 0.1' CONNECTOR             | 9    |
| 93-540035   | 1K3 0.25W 1% RES MRS25 M:F            | 2    |
| *93-980109  | 161.295MHz CRYSTAL FILT FAN4M52500    | 4    |
| **93-980112 | 160.530MHz CRYSTAL FILT FAN4M52500    | 4    |
| 96-110001   | FUSE HOLDER 20 x 5mm6.3A              | 1    |
| 96-300014   | PSU VOLTS ADJUSTER                    | 2    |
| 96-700017   | LED AMBER 5mm SEALED IP66             | 2    |
| 96-700034   | LED RED 5mm IP67 INTEGRAL RES. 24V    | 1    |
| 96-700035   | LED GREEN 5mm IP67 INTEGRAL RES 24V   | 1    |
| 97-400005   | HANDLE TYPE H6802 3U [ALLOY]          | 2    |

- \* = Frequency selective crystal (50-078010/1 shelf)
- \*\* = Frequency selective crystal (50-078010/2 shelf)

3.10.4 VHF Shelf System Diagram, Drg. # 50-078090



|       |                 |          |    |
|-------|-----------------|----------|----|
| AA    | PROTOTYPE ISSUE | DATE     | BY |
| No    | DESCRIPTION     | 28/03/07 | LS |
| ISSUE |                 |          |    |

|   |   |  |            |
|---|---|--|------------|
| TITLE<br><b>VHF BI-DIRECTIONAL AMP (SIMPLEX)</b><br>SYSTEM DIAGRAM  |   | CUSTOMER<br>DRAWING No<br>50-078090  |            |
| THIS IS A PROPRIETARY DESIGN OF AERIAL FACILITIES LTD.<br>REPRODUCTION OR USE OF THIS DESIGN BY OTHERS IS<br>PERMISSIBLE ONLY IF EXPRESSLY AUTHORISED IN WRITING<br>BY AERIAL FACILITIES LTD. |   | TOLERANCES<br>NO DECIMAL PLACE ± 1mm<br>ONE DECIMAL PLACE ± 0.5mm<br>TWO DECIMAL PLACES ± 0.1mm<br>UNLESS OTHERWISE STATED |            |
| DRAWN<br>LS   | DATE<br>28/03/07                                    | APPD<br>BB   | SCALE<br>— |
| CHKD<br>PB  | ALL DIMENSIONS ARE IN mm<br>UNLESS OTHERWISE STATED |  |            |

### 3.11 VHF Simplex Shelf (50-078010/2)

This second VHF simplex shelf is hardware identical to the previously described shelf (50-07801/1) in section 3.10 except for the crystal filters used to set the channel frequency.

### 3.12 VHF Duplex Shelves (50-078011/1-4)

#### 3.12.P Duplex Shelf Photographs



There are four different types of duplex shelves 50-078011/1,2,3 & 4 they differ only in the frequencies they process.

### 3.12.1 Description

The duplex shelves are part of the VHF amplification system and like the simplex shelves, have crystal filters instead of bandpass filters to set frequencies and bandwidths. There are two downlink channels and two uplink channels, the downlink paths having isolators fitted to each of the 5Watt output stages to prevent interfering reflections from the other channel.

The uplink channel modules have a dedicated noise muting circuit fitted externally to the channel module which operates when the downlink path is active.

All amplifiers have built-in alarms which are configured as a summary, volt-free relay contact pair terminating at pins 1 & 2 on the rear panel mounted 'D' type alarm connector.

### 3.12.2 Technical Specification

| PARAMETER                                  |              | SPECIFICATION                       |
|--|--------------|-------------------------------------|
| Duplex channel frequencies:                |              | 160.665MHz (50-078011/1, D/L)       |
|  |              | 160.935MHz (50-078011/1, U/L)       |
|  |              | 160.380MHz (50-078011/2, D/L)       |
|  |              | 160.905MHz (50-078011/2, U/L)       |
|  |              | 160.710MHz (50-078011/3, D/L)       |
|  |              | 161.415MHz (50-078011/3 U/L)        |
|  |              | 161.565MHz (50-078011/4, D/L)       |
| Gain:                                      |              | >90dB                               |
| Gain Adjustment:                           |              | 0 – 15dB (in 1dB steps, both paths) |
| Uplink Power:                              |              | >5.0Watts                           |
| Downlink Power:                            |              | >5.0Watts                           |
| IP3  | Uplink:      | +48dBm                              |
|  | Downlink:    | +48dBm                              |
| Noise Figure:                              |              | <6dB                                |
| AGC level:                                 |              | -2dBm (uplink & downlink)           |
| Channel module gain:                       |              | 23dB (downlink)                     |
|  |              | 24dB (uplink)                       |
| VSWR:                                      |              | better than 1.5:1                   |
| RF Connectors:                             |              | N type, female                      |
| Temperature range                          | operational: | -20°C to +60°C                      |
|  | storage:     | -40°C to +70°C                      |
| Finish                                     | Case:        | Alocrom 1200/Iridite NCP coating    |
|  | Heatsinks:   | Black anodised aluminium            |
|  | Handles:     | Aluminium alloy                     |
|  | Fascia:      | Painted to RAL7035                  |
| Alarms Fitted:<br>(volt-free contacts/TTL) |              | 1 U/L amplifiers                    |
|  |              | 2 D/L amplifiers                    |
|  |              | 3 Channel modules                   |

### 3.12.3 Parts List

| AFL Part # | Part Description                     | Qty. |
|------------|--------------------------------------|------|
| 08-930002  | 2 PORT ISOLATOR 150-300MHz SMA       | 2    |
| 10-000901  | SW. ATTENUATOR 0.25W 0-15dB          | 4    |
| 11-006002  | LNA VHF 70-500MHz WITH RELAY         | 7    |
| 12-002201  | 3 STAGE AMPLIFIER ALARM BOARD        | 1    |
| 12-002203  | 3 STAGE ALARM BOARD SIMPLEX          | 1    |
| 12-002220  | 3 STAGE ALARM PCB COVER              | 2    |
| 12-004902  | POWER AMP VHF 5W CLASS AB            | 2    |
| 13-001803  | DUAL DC/DC CONVERTER 24V-12V 1A      | 2    |
| 13-001822  | DC-DC CON 24V-5V/15V COVER           | 1    |
| 13-002812  | SWITCH VERSION OF SIMPLEX CONT.      | 1    |
| 17-001105  | CE AGC UNIT LOG DET/AMP ASSY (24V)   | 1    |
| 17-009135  | VHF 15K step CH MOD 15kHz 8p BW+IFRX | 2    |
| 19-000826  | 2U,3U,4U 19" UNIT 400 DEEP LID       | 1    |
| 19-000921  | 3U 19" UNIT 400 DEEP CHASSIS + BKT   | 1    |
| 19-000924  | 3U 19" UNIT FRONT PANEL FAB          | 1    |
| 80-063920  | HEATSINK 2U ASS140 (5W) MILCHBUCK    | 2    |
| 91-030002  | N ADAPTOR PANEL FEMALE:FEMALE        | 4    |
| 91-500001  | POWER PLG 3 PIN PNL.MOUNT NC-X       | 1    |
| 91-510003  | 3 PIN R.ANGLE FREE SOC.NC-X.         | 1    |
| 91-600001  | 'D'TYPE 9 WAY PLUG S/B TERM          | 1    |
| 91-600014  | 'D' 9 WAY SOCKET S/B (NON FILTERED)  | 7    |
| 91-620001  | 'D' 25 WAY SOCKET S/B TERM           | 2    |
| 91-700017  | ICD 15 WAY 0.1' CONNECTOR            | 2    |
| 96-110001  | FUSE HOLDER 20 x 5mm 6.3A            | 1    |
| 96-700034  | LED RED 5mm IP67 INTEGRAL RES. 24V   | 1    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES 24V  | 1    |
| 97-400005  | HANDLE TYPE H6802 3U [ALLOY]         | 2    |
| *93-980103 | 160.665MHz CRYSTAL FILT FAN4M52500   | 2    |
| *93-980104 | 160.935MHz CRYSTAL FILT FAN4M52500   | 2    |
| *93-980105 | 160.380MHz CRYSTAL FILT FAN4M52500   | 2    |
| *93-980106 | 160.905MHz CRYSTAL FILT FAN4M52500   | 2    |
| *93-980107 | 160.710MHz CRYSTAL FILT FAN4M52500   | 2    |
| *93-980108 | 161.415MHz CRYSTAL FILT FAN4M52500   | 2    |
| *93-980110 | 161.565MHz CRYSTAL FILT FAN4M52500   | 2    |
| *93-980111 | 160.755MHz CRYSTAL FILT FAN4M52500   | 2    |

\* These frequency selection crystals are different for each VHF duplex Cell Enhancer shelf.



### 3.13 VHF Air Interface Shelf (50-078012)

#### 3.13.1 Description

The VHF system is provided with three Yagi off-air antennas, two downlink, receiving downlink signals from two different directions, and one uplink, facing the nearest BTS. Bandpass filters exclude extraneous noise on the frequency bands to be processed and once filtered, the downlink signal is amplified (10dB gain) and separately split to the simplex and duplex shelves' inputs. The uplink outputs from these six VHF shelves are combined, filtered and sent directly to the uplink off-air Yagi antenna. The downlink low-noise-amplifier has an alarm, configured as a summary, volt-free relay contact pair terminating at pins 1 & 2 on the 'D' type alarm connector.

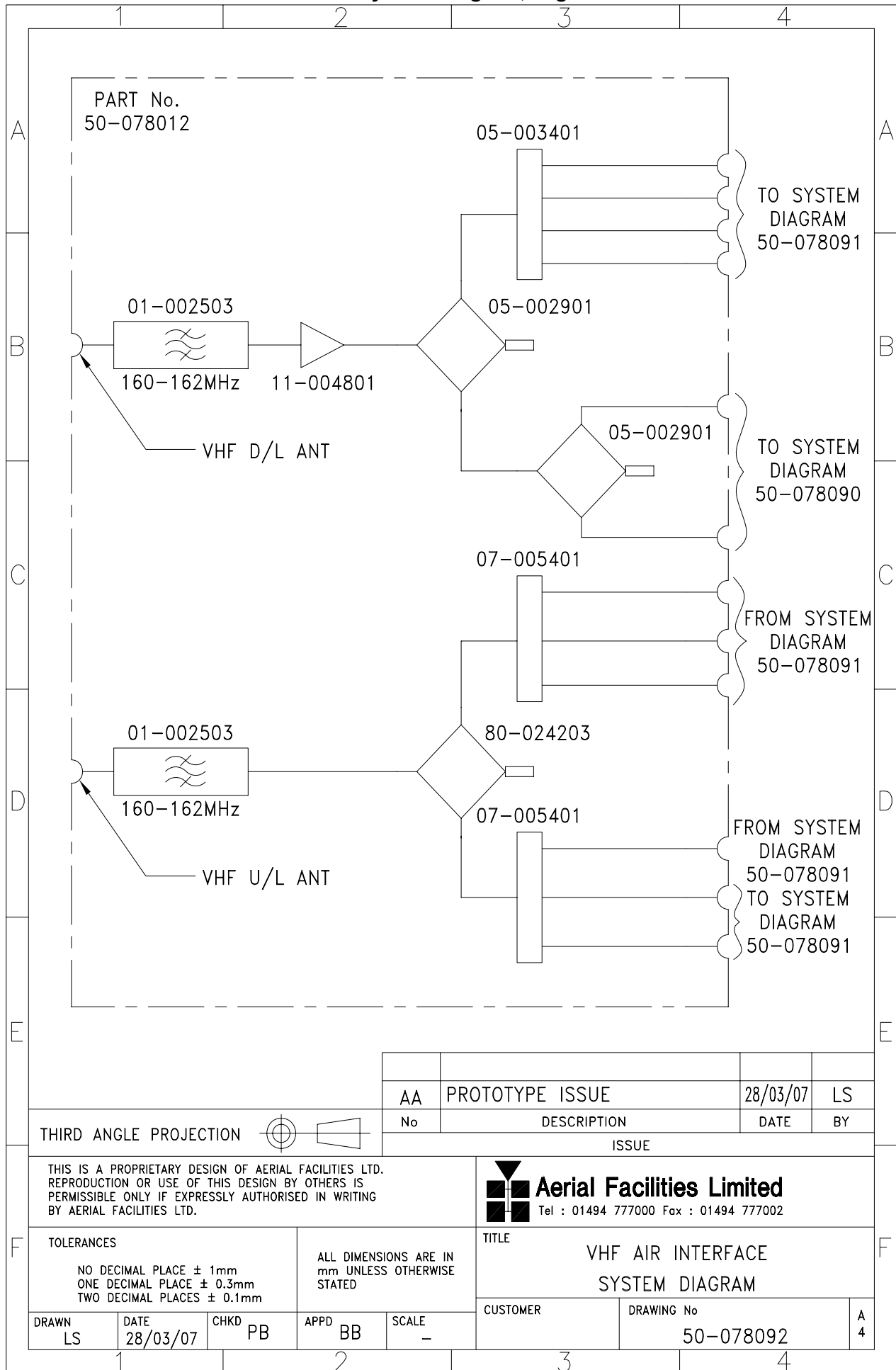
#### 3.13.2 Technical Specification

| PARAMETER         |              | SPECIFICATION             |
|-------------------|--------------|---------------------------|
| Frequency range:  |              | 160-162MHz (D/L, U/L)     |
| VSWR:             |              | better than 1.5:1         |
| Shelf size:       |              | 3U                        |
| Insertion loss:   |              | <1.5dB                    |
| Rejection:        |              | >30dB                     |
| RF connectors:    |              | N type, female            |
| Temperature range | operational: | -20°C to +60°C            |
|                   | storage:     | -40°C to +70°C            |
| Finish            | Case:        | Alocrom 1200/Iridite NCP  |
|                   | Heatsinks:   | None                      |
|                   | Handles:     | Aluminium alloy           |
|                   | Fascia:      | Painted to RAL 7035       |
| Alarms Fitted:    |              | 'D' connector, pins 1 & 2 |

#### 3.13.3 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 01-002503  | FILTER VHF H/B 6 SMA S 100W         | 2    |
| 05-002901  | 3dB BROADBAND SPLITTER SMA 1WATT    | 2    |
| 05-003401  | 4 WAY SPLITTER LOW POWER            | 1    |
| 07-005401  | 160-470MHz 3 WAY SPLITTER           | 2    |
| 11-004802  | 450MHz (10dB GAIN) LNA 12V.         | 1    |
| 12-002801  | SINGLE CHANNEL ALARM BOARD STD      | 1    |
| 13-001803  | DUAL DC/DC CONVERTER 24V-12V 1A     | 1    |
| 19-000826  | 2U,3U,4U 19" UNIT 400 DEEP LID      | 1    |
| 19-000921  | 3U 19" UNIT 400 DEEP CHASSIS + BKT  | 1    |
| 80-024203  | TRANSMITTER HYBD COUPL.3 PORT       | 1    |
| 80-063627  | 3U FRONT PANEL FOR H/S 80-063920    | 1    |
| 91-030002  | N ADAPTOR PANEL FEMALE:FEMALE       | 15   |
| 91-500001  | POWER PLG 3 PIN PNL.MOUNT NC-X      | 1    |
| 91-510003  | 3 PIN R.ANGLE FREE SOC.NC-X.        | 1    |
| 91-700017  | ICD 15 WAY 0.1' CONNECTOR           | 6    |
| 93-540035  | 1K3 0.25W 1% RES MRS25 M:F          | 2    |
| 96-110001  | FUSE HOLDER 20 x 5mm6.3A            | 1    |
| 96-700034  | LED RED 5mm IP67 INTEGRAL RES. 24V  | 1    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES 24V | 1    |
| 97-400005  | HANDLE TYPE H6802 3U [ALLOY]        | 2    |

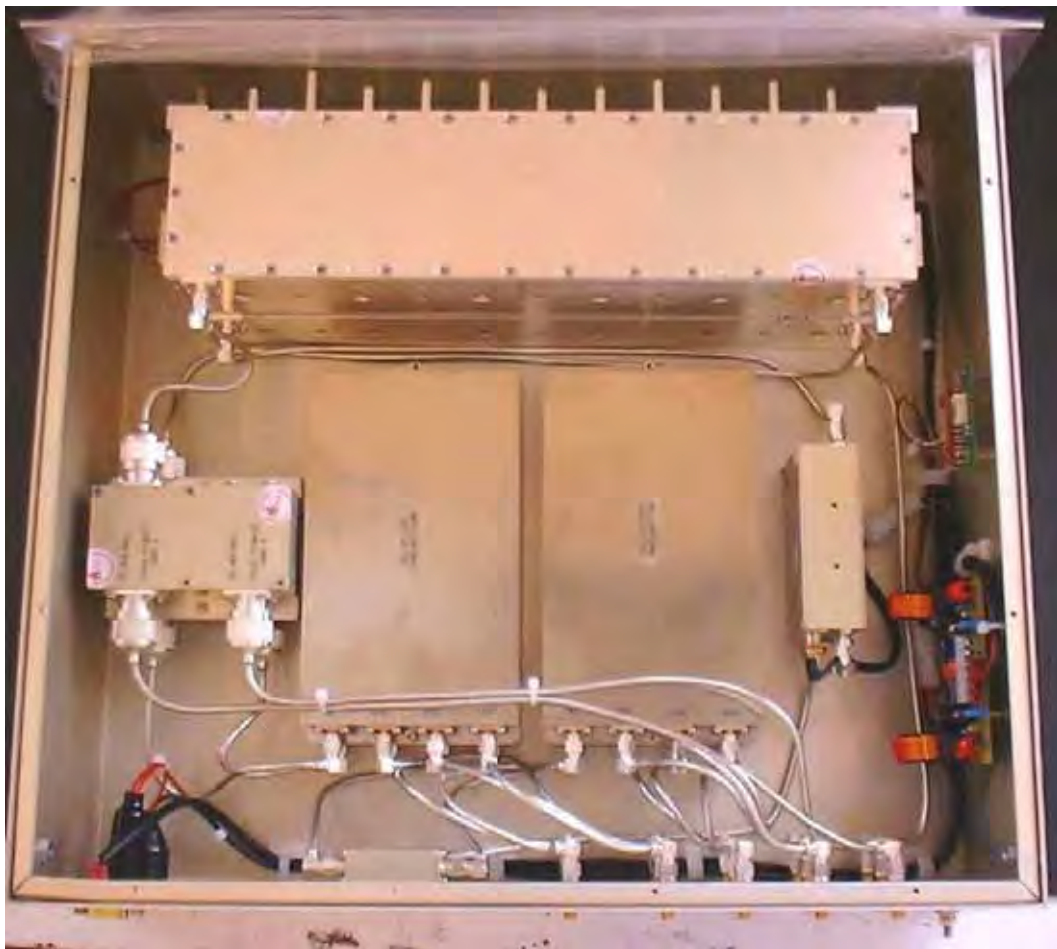
3.13.4 VHF Air Interface Shelf System Diagram, Drg. # 50-078092





### 3.14 VHF Combiner Shelf (50-078013)

#### 3.14.P VHF Combiner Photographs



### 3.14.1 Description

The purpose of the VHF combiner is to take the downlink products of all the VHF shelves and combine them together so that they may, in turn, be combined with the 800MHz signals from the cellular amplifiers to feed the tunnel antennas. The reverse is true of the uplink path where the VHF signals from each of the tunnel antennæ are coupled from the 800MHz signals, filtered, amplified, combined and then split equally for the inputs of the VHF uplink amplifiers.

The uplink low-noise-amplifier used in the shelf, has an alarm pair, configured as a summary, volt-free relay contact pair terminating at pins 1 & 2 on the 'D' type alarm connector.

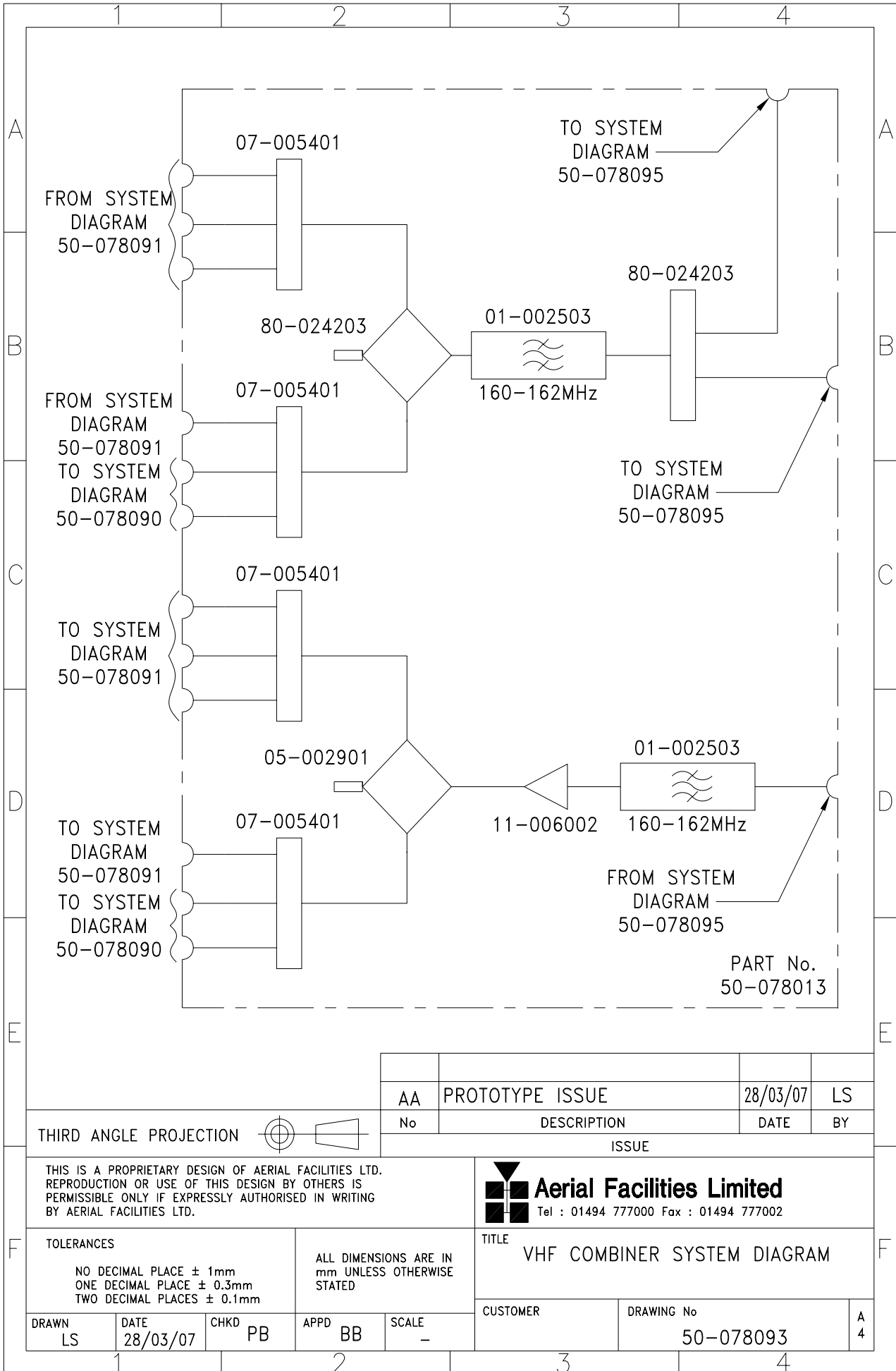
### 3.14.2 Technical Specification

| PARAMETER              |              | SPECIFICATION            |
|------------------------|--------------|--------------------------|
| Frequency ranges:      |              | 160-162MHz (D/L, U/L)    |
| VSWR:                  |              | better than 1.5:1        |
| Shelf size:            |              | 3U                       |
| Uplink amplifier gain: |              | 20dB (typical)           |
| Rejection:             |              | >30dB                    |
| RF connectors:         |              | N type, female           |
| Temperature range      | operational: | -20°C to +60°C           |
|                        | storage:     | -40°C to +70°C           |
| Finish                 | Case:        | Alocrom 1200/Iridite NCP |
|                        | Heatsinks:   | None                     |
|                        | Handles:     | Aluminium alloy          |
|                        | Fascia:      | Painted to RAL 7035      |
| Alarms Fitted:         |              | 'D' connector, pins 1& 2 |

### 3.14.3 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 01-002503  | FILTER VHF H/B 6 SMA S 100W         | 2    |
| 05-002901  | 3dB BROADBAND SPLITTER SMA 1WATT    | 1    |
| 07-005401  | 160-470MHz 3 WAY SPLITTER           | 4    |
| 11-006002  | LNA VHF 70-500MHz WITH RELAY        | 1    |
| 13-001803  | DUAL DC/DC CONVERTER 24V-12V 1A     | 1    |
| 19-000826  | 2U,3U,4U 19" UNIT 400 DEEP LID      | 1    |
| 19-000921  | 3U 19" UNIT 400 DEEP CHASSIS + BKT  | 1    |
| 80-024203  | TRANSMITTER HYBD COUPL.3 PORT       | 2    |
| 80-063627  | 3U FRONT PANEL FOR H/S 80-063920    | 1    |
| 91-030002  | N ADAPTOR PANEL FEMALE:FEMALE       | 15   |
| 91-500001  | POWER PLG 3 PIN PNL.MOUNT NC-X      | 1    |
| 91-510003  | 3 PIN R.ANGLE FREE SOC.NC-X.        | 1    |
| 93-540035  | 1K3 0.25W 1% RES MRS25 M:F          | 2    |
| 96-110001  | FUSE HOLDER 20 x 5mm6.3A            | 1    |
| 96-700034  | LED RED 5mm IP67 INTEGRAL RES. 24V  | 1    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES 24V | 1    |
| 97-400005  | HANDLE TYPE H6802 3U [ALLOY]        | 2    |

**3.14.4 VHF Combiner Shelf System Diagram, Drg. # 50-078093**



PART No.  
50-078013

|       |                 |          |    |
|-------|-----------------|----------|----|
| AA    | PROTOTYPE ISSUE | 28/03/07 | LS |
| No    | DESCRIPTION     | DATE     | BY |
| ISSUE |                 |          |    |

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**TOLERANCES**  
NO DECIMAL PLACE ± 1mm  
ONE DECIMAL PLACE ± 0.3mm  
TWO DECIMAL PLACES ± 0.1mm

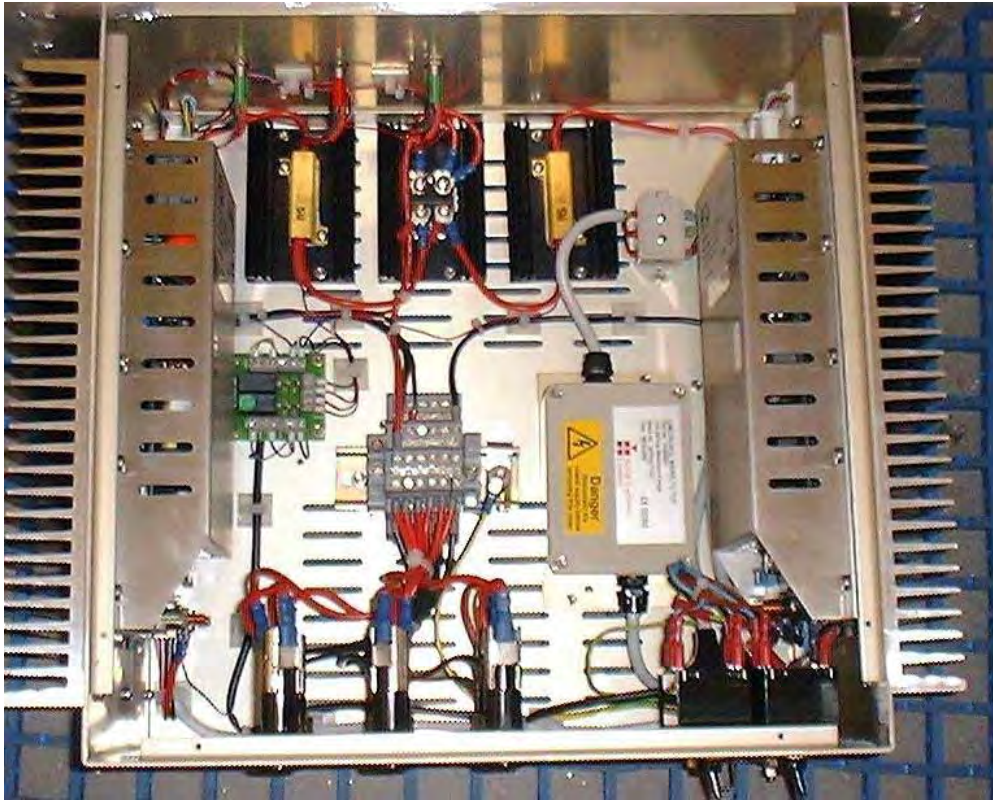
ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED

TITLE  
VHF COMBINER SYSTEM DIAGRAM

|             |                  |            |            |            |          |                         |        |
|-------------|------------------|------------|------------|------------|----------|-------------------------|--------|
| DRAWN<br>LS | DATE<br>28/03/07 | CHKD<br>PB | APPD<br>BB | SCALE<br>- | CUSTOMER | DRAWING No<br>50-078093 | A<br>4 |
|-------------|------------------|------------|------------|------------|----------|-------------------------|--------|

### 3.15 VHF PSU Shelf (50-078014)

#### 3.15.P VHF PSU Photographs



### 3.15.1 Description

The power supply shelves are separate for the VHF/UHF and 800MHz cell enhancers. The VHF/UHF supply shelf is a 24V DC shelf which supplies six, 24Volt XLR type connector outputs at a maximum total output power of 800Watts DC. These DC outputs are fused at a 10Amp rating although four of the six DC outputs will be drawing less than 5Amps each at any one time.

### 3.15.2 Technical Specification

| PARAMETER                             |              | SPECIFICATION                        |
|---------------------------------------|--------------|--------------------------------------|
| Input:                                |              | 110V AC @50/60Hz (single port)       |
| Outputs:                              |              | 6 x 24V DC @ 10A each (fused)        |
| Front panel indicators:               |              | (x 2) Green LED for 'PSU1/PSU2 ON'   |
| Fuses:                                |              | 1 x 10A each outlet socket           |
| DC Socket:                            |              | XLR                                  |
| Temperature range                     | operational: | -20°C to +60°C                       |
|                                       | storage:     | -40°C to +70°C                       |
| Finish                                | Case:        | Alocrom 1200/Iridite NCP coating     |
|                                       | Heatsinks:   | Black anodised aluminium             |
|                                       | Handles:     | Aluminium alloy                      |
|                                       | Fascia:      | Painted to RAL7035                   |
| Alarmed devices:                      |              | Either PSU failure                   |
| Alarm interface (volt-free contacts): |              | 'D' type alarm connector, pins 1 & 2 |
| MTBF:                                 |              | >50,000 hours                        |
| Earthing:                             |              | M8 stud                              |

### 3.15.3 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 13-003301  | MAINS FILTER 8AMP ASSEMBLY          | 1    |
| 20-001602  | 24V RELAY BOARD                     | 1    |
| 80-008920  | DUAL PSU HEATSINK                   | 2    |
| 80-008921  | DUAL PSU CASE                       | 1    |
| 80-008922  | DUAL PSU LID                        | 1    |
| 80-008925  | DUAL PSU FRONT PANEL                | 1    |
| 80-020632  | 2U CHASSIS LID FIXING RAIL          | 4    |
| 91-500025  | 3 PIN RIGHT ANGLE FREE PLUG NC-X    | 6    |
| 91-510004  | 3 PIN PNL.MOUNT SOCKET NC-X         | 6    |
| 91-510035  | 3 WAY MATE N LOK PLUG HOUSING       | 2    |
| 91-520001  | PWR MAINS INL FIXED/SOLD.TERMS      | 1    |
| 91-520005  | MAINS LEAD                          | 1    |
| 91-520010  | MAINS RETAINING CLIP                | 1    |
| 91-520032  | MATE N LOK SOCKET CONTACT 20/14 AWG | 6    |
| 91-600015  | 'D' 9 WAY PLUG S/B (NON FILTERED)   | 1    |
| 91-800014  | 3 WAY TERMINAL BLOCK                | 1    |
| 94-100004  | STPS12045TV 60A DUAL DIODE          | 1    |
| 96-100001  | 20 x 5mm,10A FUSE HOLDER/CARRIER    | 6    |
| 96-300054  | 24V 17A PSU 400W (XP BCC)           | 2    |
| 96-600001  | INSULATING BOOT LARGE               | 1    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES 24V | 2    |
| 96-900017  | AC TRIP SWITCH (3 AMP M.C.B.)       | 2    |
| 97-400002  | HANDLE TYPE H6803 4U.[ALLOY]        | 2    |

### 3.16 VHF/800MHz Tx Multi-coupler (50-078015)

#### 3.16.1 Description

The multi-coupler shelf interfaces the VHF/UHF and 800MHz power output signals together to drive the downlink Tx antennas and to receive the low-level signals from the uplink antennas prior to their amplification and re-broadcast back to the BTS.

This purely passive shelf is a mix of hybrid, cross-band and directional couplers which pass the downlink signals with as little insertion loss as possible and the uplink signals with as good isolation/rejection as possible. This shelf has no power source and no alarms.

#### 3.16.2 Technical Specification

| PARAMETER         |              | SPECIFICATION            |
|-------------------|--------------|--------------------------|
| Frequency ranges: |              | 160-162MHz (D/L, U/L)    |
| VSWR:             |              | better than 1.5:1        |
| Shelf size:       |              | 5U                       |
| Rejection:        |              | >30dB                    |
| RF connectors:    |              | N type, female           |
| Temperature range | operational: | -20°C to +60°C           |
|                   | storage:     | -40°C to +70°C           |
| Finish            | Case:        | Alocrom 1200/Iridite NCP |
|                   | Heatsinks:   | None                     |
|                   | Handles:     | Aluminium alloy          |
|                   | Fascia:      | Painted to RAL 7035      |
| Alarms Fitted:    |              | 'D' connector, pins 1& 2 |

#### 3.16.3 Parts List

| AFL Part # | Part Description                   | Qty. |
|------------|------------------------------------|------|
| 05-001402  | 3 CH. WILK COMB. 1W LOW PWR VHF    | 1    |
| 05-002602  | 900MHz SPLITTER/COMBINER, 20W      | 1    |
| 05-002901  | 3dB BROADBAND SPLITTER SMA 1WATT   | 3    |
| 05-003801  | 3WAY GEN.SPLIT 900MHz GEN.ASS      | 1    |
| 07-004101  | 70-1000MHz 3dB SPLITTER/COMBINER   | 1    |
| 07-005401  | 160-470MHz 3 WAY SPLITTER          | 2    |
| 07-005705  | CROSSBAND CPLR XC 250/380 SMA      | 6    |
| 07-014002  | 6dB 170-2200MHz DIRECTIONAL COUPLE | 2    |
| 19-001122K | 5U CHASSIS KIT (450mm deep)        | 1    |
| 80-024203  | TRANSMITTER HYBD COUPL.3 PORT      | 1    |
| 91-030002  | N ADAPTOR PANEL FEMALE:FEMALE      | 16   |
| 91-130005  | SMA BULKHEAD ADAPT. F/F            | 6    |



## 4. BAND SELECTIVE BI-DIRECTIONAL LINE AMPLIFIER

### 4.1 BDA Wall Assembly (50-078017)

#### 4.1.P BDA Assembly Photograph



View of Wall Case Internal (door open)



### 4.1.1 Description

The wall mounted tunnel BDA is a band-selective unit which draws its RF from the tunnel leaky feeder coaxial cable, feeding separate down and uplink ports and operating in the 800MHz frequency region with a cross-band coupled bypass to allow VHF signals to be passed through the amplifier with just a small loss. (The loss at 800MHz is considerable compared with the VHF signals, so a small amount of gain at 800MHz is required to overcome these losses, whereas the VHF signals need no boosting). The primary application for the BDA is to boost the 800MHz and VHF signals in areas of the West Tunnel and Fire Exits where coverage would otherwise be inadequate. Notice that each path has automatic gain control as the amplifier receives its input from the leaky feeder antennas for both up and downlink. This means that the signal could have large differences in level at any time which is why the AGC is needed on *both* paths.

The amplifier needs 12V DC for its supply, and this enters from the BBU unit through a rugged connector mounted on the R.H.S (viewed from front) of the case. For further notes on the use of the battery backup system, see the dedicated BBU handbook at the end of this document (appendix B).

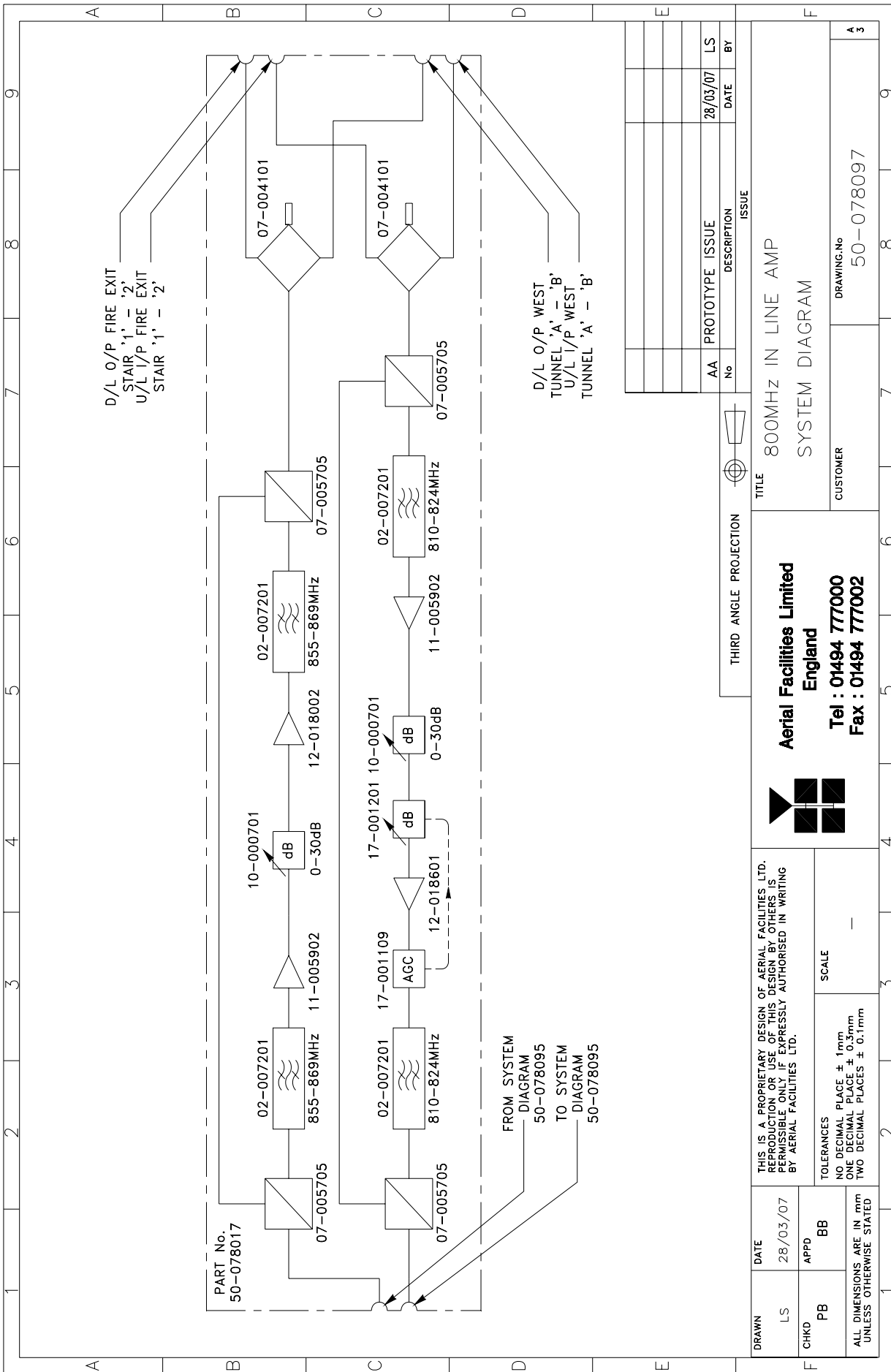
### 4.1.2 Electrical Specification

| PARAMETER                              |          | SPECIFICATION           |
|--|----------|-------------------------|
| Frequency range:                       |          | 855-869MHz (Downlink)   |
|  |          | 810-824MHz (Uplink)     |
| Bandwidth:                             |          | 14MHz (both paths)      |
| Rejection @ opposite band:             |          | 70dBc                   |
| Rejection @ 837.5MHz:                  |          | 50dBc                   |
| Gain:                                  |          | >30dB                   |
| Gain Adjustment:                       |          | 0 - 30dB (in 2dB steps) |
| Uplink 1 dB compression point:         |          | +37dBm                  |
| Downlink 1 dB compression point:       |          | +42dBm                  |
| IP3                                    | Uplink   | +44dBm                  |
|  | Downlink | +54dBm                  |
| Noise Figure:                          |          | <8dB                    |
| AGC level:                             |          | +32dBm (uplink)         |
|  |          | +33.5dBm (downlink)     |
| VSWR:                                  |          | better than 1.5:1       |
| RF Connectors:                         |          | N type, female          |
| Impedance:                             |          | 50Ω                     |
| Alarms Fitted:<br>(volt-free contacts) | 1        | Amplifiers              |

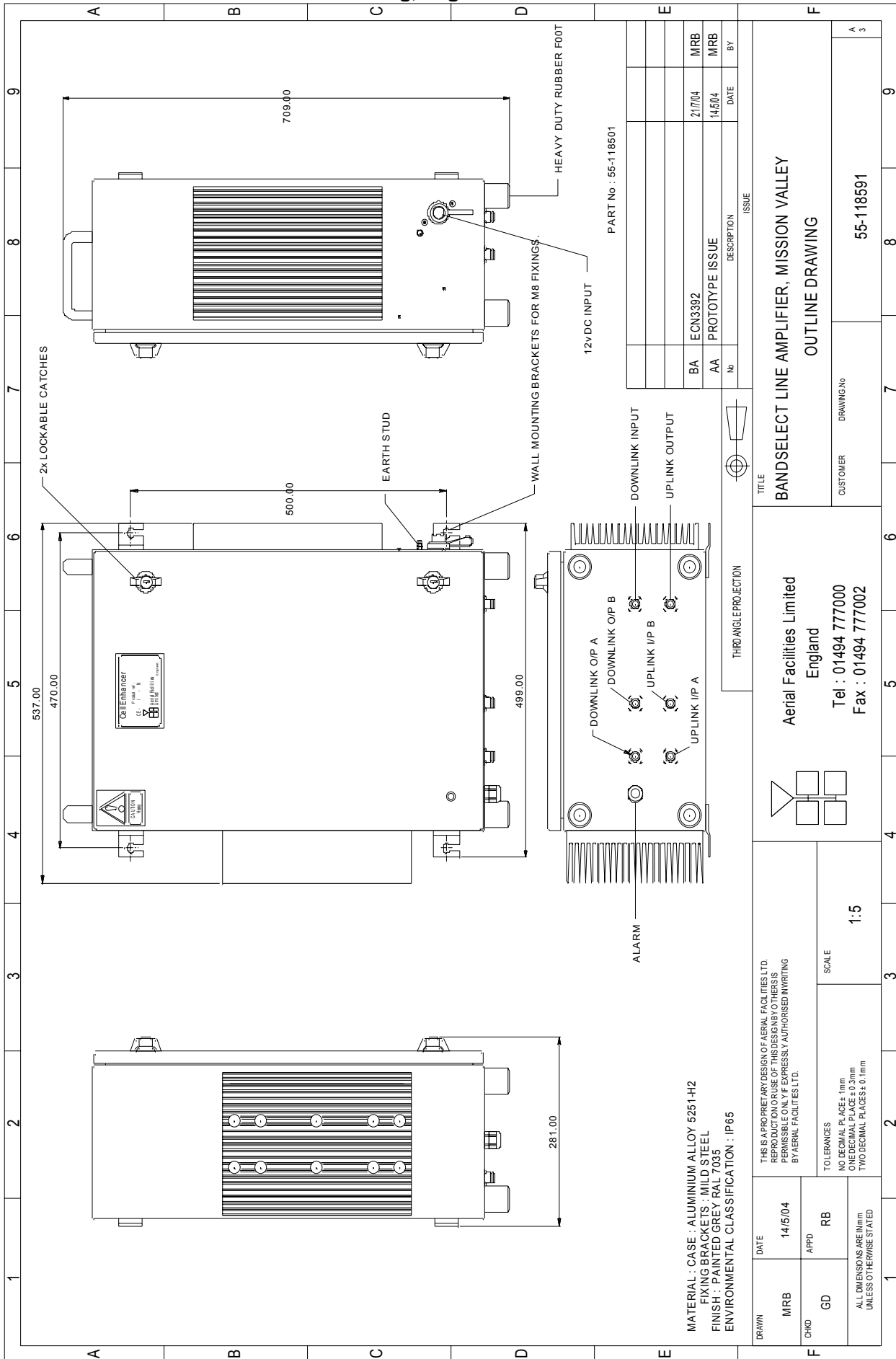
### 4.1.3 Mechanical Specification

| PARAMETER   |              | SPECIFICATION   |
|---|--------------|---|
| Case size   | Height:      | <b>620mm</b>  |
|   | Width:       | <b>420mm</b>  |
|   | Depth:       | <b>250mm</b>  |
| (excluding heatsinks, connectors, handles and feet) |              |   |
| Fixings:  |              | 4 holes on <b>470(w) x 500(h)mm</b>   |
| Temperature Range:                                  | operational: | <b>-20°C to +60°C</b>   |
|   | storage:     | <b>-40°C to +70°C</b>   |
| Weight:   |              | <b>35kg (approximately)</b>   |
| RF Connectors:                                      |              | <b>N type female</b>  |
| Environmental Protection:                           |              | <b>IP65 (with door closed and all ports terminated)</b>   |
| Finish:   | Case:        | <b>To RAL 7035</b>  |
|   | Heatsinks:   | <b>Matt black (where fitted)</b>  |
|   | Handles:     | <b>Black Technopolymer</b>  |
| Supply Cable:                                       |              | Unit supplied with suitable supply input leads with connector and appropriate length of cable (where appropriate) |

4.1.4 800MHz In-Line BDA System Diagram, Drg. # 50-078097



4.1.5 BDA Case Outline Drawing, Drg. No. 55-118691



#### 4.1.6 BDA Assembly (50-078017) Parts List

| AFL Part # | Part Description                      | Qty. |
|------------|---------------------------------------|------|
| 02-007201  | 900MHz 8POLE 10-20MHz B/W SMA         | 4    |
| 07-004101  | 70-100MHz 3dB SPLITTER/COMBINER       | 2    |
| 07-005705  | CROSSBAND CPLR XC 250/380 SMA         | 4    |
| 10-000701  | 1/4W0-30dB SWITCHED ATTENUATOR        | 2    |
| 11-005902  | 900MHz LOW NOISE AMP WITH RELAY ASS   | 2    |
| 12-018002  | PA 800-960MHz 20W CLASS A             | 1    |
| 12-018601  | POWER AMPLIFIER 900MHz 5W             | 1    |
| 17-000126  | CELL ENHANCER LABEL 6 DIGIT           | 1    |
| 17-000526  | CE 10/20W HEATSINK THERMAL GASKET     | 2    |
| 17-001109  | CE AGC UNIT LOG DET/AMP ASSY (12v)    | 2    |
| 17-001201  | C/E AGC UNIT ATTENUATOR ASSY          | 2    |
| 17-009020  | ENCLOSURE 620 x 420 x 250 (3 H/S) ALU | 1    |
| 20-001601  | 12V RELAY BOARD                       | 1    |
| 80-031820  | 20W PA HEATSINK (NEEDS 17-000526)     | 1    |
| 80-032320  | 10W PA HEATSINK (NEEDS 17-000526)     | 1    |
| 91-030002  | N ADAPTOR PANEL FEMALE:FEMALE         | 4    |
| 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    |
| 91-510032  | 20A SOCKET CONTACT PIN                | 4    |
| 91-600007  | 'D' 9 WAY BLACK SHELL                 | 4    |
| 91-600014  | 'D' 9 WAY SOCKET S/B (NON FILTERED)   | 4    |
| 91-660001  | 2W5 MIXED D TYPE SOCKET (7 WAY)       | 2    |
| 96-700034  | LED RED 5mm IP67 INTEGRAL RES         | 1    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES       | 1    |
| 97-400010  | BLACK PLASTIC HANDLE 50mm HIGH        | 2    |
| 97-900003  | RUBBER FOOT 1 1/2' DIA.               | 4    |

## 5. MASTER SITE UPGRADE

### 5.1 Master Site Upgrade Rack Assembly (50-078021)

#### 5.1.1 Master Site Upgrade Rack Description

This upgrade to the Mission Valley radio repeater system is concerned only with the 800MHz band of frequencies, which, in the original specification could carry up to 24 channels of cell data simultaneously. The added hardware for this upgrade will increase the number of available channels from 24 to 43 but the number of 19" racks remains at three (the original 40W amplifier shelves will not now be needed and three new channel module shelves will be added).

The cellular amplifier is in addition to the 24 channels already in existence, the increase (19 channels, 6 x 8ch. sub-racks) is designed to alleviate radio congestion to the local BTS and to extend the number of possible simultaneous uses. Because of the increased channel density, a pair of 80-100Watt power amplifier shelves (50-146703), instead of the original 40Watt pair, are the main source of downlink RF power in the system to maintain the effective power/channel. Only the downlink path is channelised, the uplink path is band-selective and its traffic is limited only by the total carrier power available.

All shelves have active device alarms and these are configured as a volt-free, relay contact pair summary per shelf, terminating in the 9-way 'D' connector on the rear panel, pins 1 & 2.

The VHF system needs no upgrade at this time, so the VHF hardware remains the same.

#### 5.1.2 Master Site Upgrade Rack Electrical Specification

| PARAMETER                    | SPECIFICATION                                |
|------------------------------|--|
| Frequency ranges:            | 855-869MHz (Downlink)<br>810-824MHz (Uplink) |
| VSWR:                        | better than 1.5:1                            |
| DC power supply:             | +24V   |
| Power consumption:           | 600Watts                                     |
| AC power input:              | 230V AC (nominal)                            |
| Alarms Fitted:               | 1 All amplifier shelves                      |
| (summary volt-free contacts) | 2 PSU shelf                                  |

#### 5.1.3 Master Site Upgrade Rack Mechanical Specification

| PARAMETER                 | SPECIFICATION   |                             |
|---------------------------|---|-----------------------------|
| Rack                      | Height:   | 40U Swingframe cabinet (x1) |
|                           | Width:  | 600mm                       |
|                           | Depth:  | 600mm                       |
| Temperature range         | operational:  | -20°C to +60°C              |
|                           | storage:  | -40°C to +70°C              |
| Weight:                   | >100kg  |                             |
| Humidity:                 | 5 – 95% non-condensing  |                             |
| RF connectors:            | N type female   |                             |
| Environmental protection: | IP44  |                             |
| Supply cable:             | Unit supplied with suitable supply input leads, connector and specified length of cable |                             |

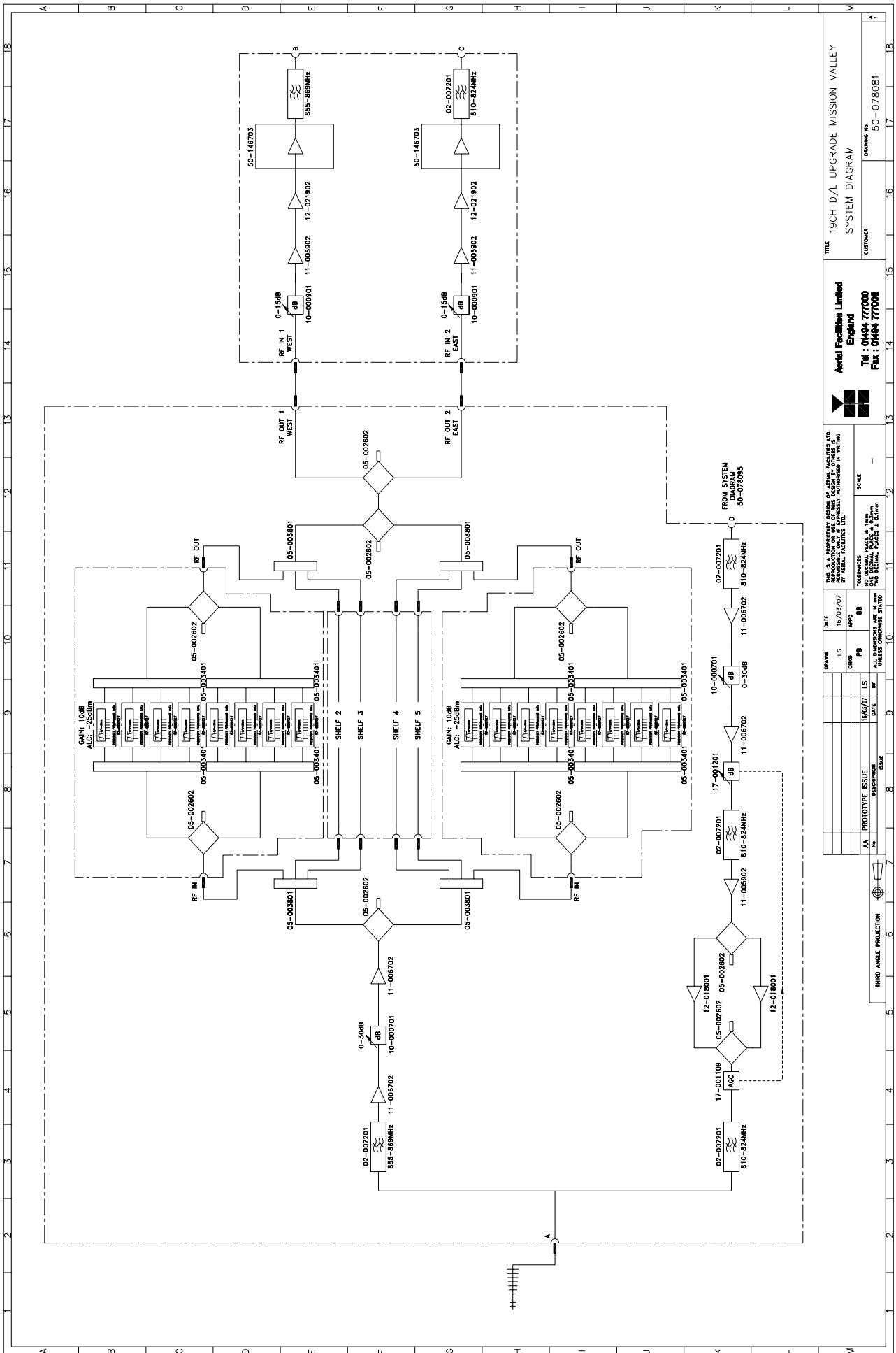
### 5.1.6 Master Site Upgrade Rack Assembly (50-078021) Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 12-018002  | PA 800-960MHz 20W CLASS A           | 2    |
| 17-009127  | CHAN MOD 810-860MHz 30KHz 8p TCXO   | 19   |
| 50-078005  | 800MHz 80W HPA INTERFACE            | 1    |
| 50-078023  | CHANNEL SHELF UPGRADE MISSIONVALLEY | 6    |
| 50-146511  | CHANNEL MODULE PSU                  | 1    |
| 50-146703  | 800MHz CHN SELECT POWER AMPLIFIER   | 2    |
| 50-146704  | 800MHz CHANNEL SELECTIVE PSU        | 2    |
| 60-020608  | 40U SWING FRAME CABINET             | 1    |
| 97-500167  | RITTAL TS EARTHQUAKE KIT            | 1    |
| 97-500168  | RITTAL TS BASE/PLINTH SEISMIC 4     | 1    |
| 99-000082  | PALLET 900 x 900 x 7ply FOR RACKS   | 1    |

### 5.1.6a Upgrade Channel Module Shelf/Sub-Rack 50-078023 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 05-002602  | 900MHz SPLITTER/COMBINER, 20W       | 2    |
| 05-003302  | 4 WAY SPLITTER GSM 900MHz           | 4    |
| 17-002101  | CHANNEL CONTROL MODULE              | 2    |
| 17-002103  | 26WAY RIBBON CABLE LEAD             | 8    |
| 17-003022  | MODULE PATTERNED LEAVE              | 8    |
| 17-003023  | SUBRACK SIDE PANEL                  | 2    |
| 17-003024  | SUBRACK REAR BRACKET                | 2    |
| 17-003025  | BOTTOM MODULE GUIDE                 | 8    |
| 17-003028  | MODULE SQUARE LEAVE                 | 8    |
| 17-003029  | TOP MODULE GUIDE                    | 8    |
| 91-130005  | SMA BULKHEAD ADAPTOR F/F            | 2    |
| 91-500001  | POWER PLG 3 PIN PNL.MOUNT NC-X      | 1    |
| 91-510003  | 3 PIN R.ANGLE FREE SOC.NC-X.        | 1    |
| 91-600007  | 'D' 9 WAY BLACK SHELL               | 2    |
| 91-600014  | 'D' 9 WAY SOCKET S/B (NON FILTERED) | 1    |
| 91-600015  | 'D' 9 WAY PLUG S/B (NON FILTERED)   | 1    |
| 92-280033  | Captive Screw                       | 16   |
| 96-100001  | 20 x 5mm,10A FUSE HOLDER/CARRIER    | 1    |
| 96-110012  | T 10A A.SURGE FUSE 20mm             | 1    |
| 97-000002  | BLACK MODULE CAGE RUNNER            | 16   |
| 97-600001  | SUBRACK FRONT HORIZ                 | 2    |
| 97-600002  | SUBRACK M2.5 STD TAP                | 42   |

# 5.1.7 Master Site Upgrade System Diagram, Drg. # 50-078081



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 THIS IS A PRELIMINARY DESIGN AND IS NOT TO BE USED FOR  
 CONSTRUCTION WITHOUT THE EXPRESS AUTHORITY OF AERIAL FACILITIES LTD.

| NO. | DESCRIPTION     | DATE     | BY | CHKD | APP'D | DATE     |
|-----|-----------------|----------|----|------|-------|----------|
| AA  | PROTOTYPE ISSUE | 16/03/07 | LS | PB   | BB    | 16/03/07 |

SCALE: —  
 ALL DIMENSIONS ARE IN UNLESS OTHERWISE STATED  
 UNLESS OTHERWISE STATED

THIRD ANGLE PROJECTION

FROM SYSTEM DIAGRAM 50-078095

19CH D/L UPGRADE MISSION VALLEY SYSTEM DIAGRAM

Aerial Facilities Limited  
 England  
 Tel : 01464 77000  
 Fax : 01464 77008

CUSTOMER: 50-078081  
 DRAWING No: 50-078081

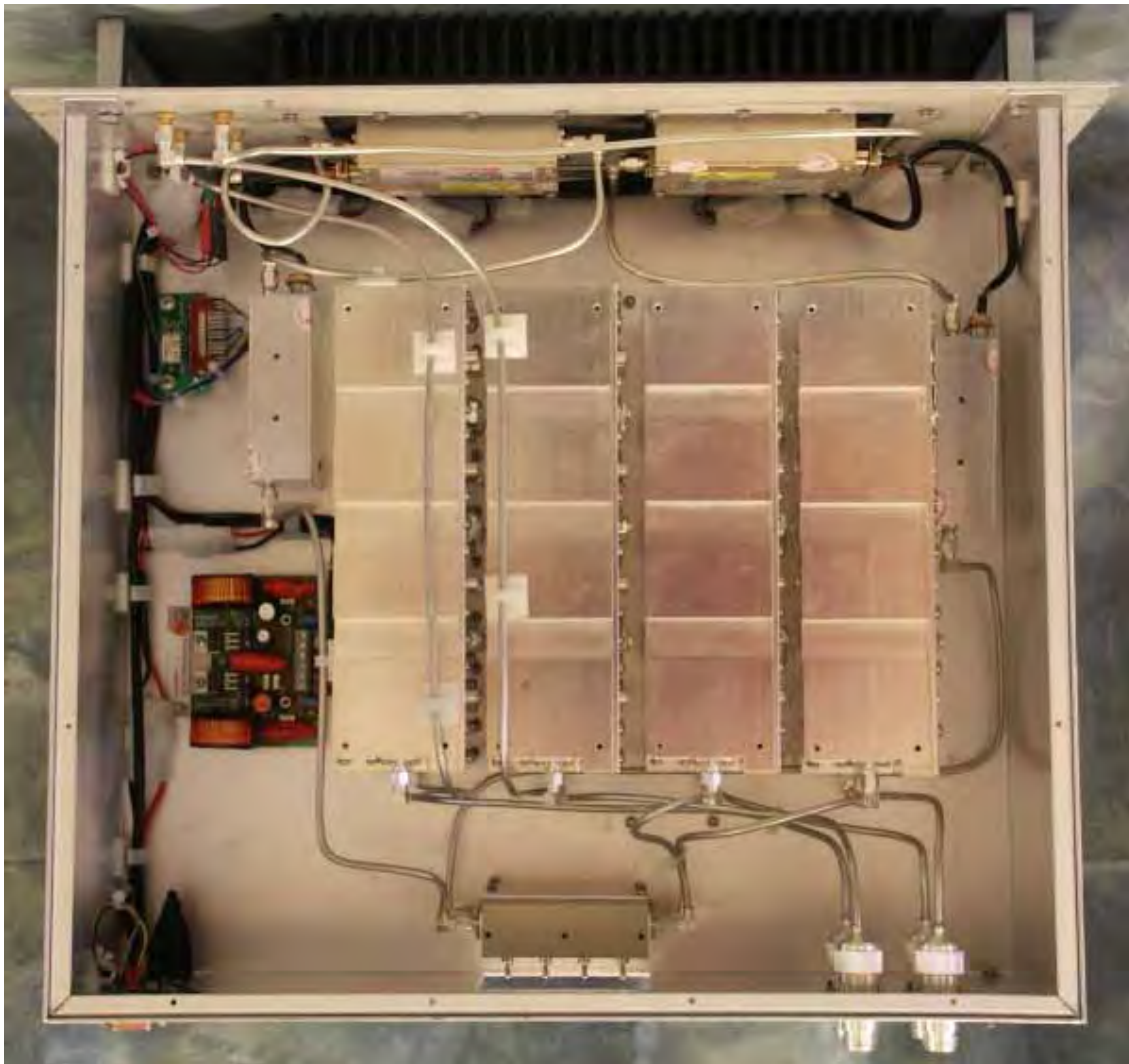


## 5.2 Upgrade Channel Frequencies

| Chan # | Tx Frequency | Rx Frequency | Type  | Modulation |
|--------|--------------|--------------|-------|------------|
| 1      | 868.4125     | 823.4125     | C.C.  | Analog     |
| 2      | 868.1375     | 823.1375     | C.C.  | Analog     |
| 3      | 868.0750     | 823.0750     | Voice | Analog     |
| 4      | 867.9125     | 822.9125     | Voice | Analog     |
| 5      | 867.6375     | 822.6375     | Voice | Analog     |
| 6      | 867.6125     | 822.6125     | Voice | Analog     |
| 7      | 867.4125     | 822.4125     | Voice | Analog     |
| 8      | 867.3875     | 822.3875     | Voice | Analog     |
| 9      | 867.1375     | 822.1375     | Voice | Analog     |
| 10     | 866.9125     | 821.9125     | Voice | Analog     |
| 11     | 866.8875     | 821.8875     | Voice | Analog     |
| 12     | 866.6375     | 821.6375     | Voice | Analog     |
| 13     | 866.4125     | 821.4125     | Voice | Analog     |
| 14     | 866.1375     | 821.1375     | Voice | Analog     |
| 15     | 866.0375     | 821.0375     | BSI   | Analog     |
| 16     | 868.6000     | 823.6000     | Voice | Analog     |
| 17     | 867.0625     | 822.0625     | Voice | Analog     |
| 18     | 866.4375     | 821.4375     | Voice | Analog     |
| 19     | 868.4375     | 823.4375     | Voice | Analog     |

### 5.3 Master Site HPA Interface Shelf (50-078005)

#### 5.3.P HPA Interface Shelf Photographs



### 5.3.1 Description

These new high power (80Watts) amplifier shelves have been introduced in place of the 40W amplifiers originally supplied. The higher power amplifiers are needed to maintain sufficient power per channel for the 800MHz cellular repeater as there are now 19 extra channels. This shelf has two amplifiers, a low noise amplifier and a low power (2W) amplifier which acts as a driver for the high power shelf (50-146703). A 0-15dB switched attenuator at each of the two inputs allows accurate balancing of the signal through the high power stages. As with all other shelves, alarms exist for all the amplifiers and they terminate on the rear panel 'D' connector as a summary, volt-free relay contact pair, pins 1 & 2.

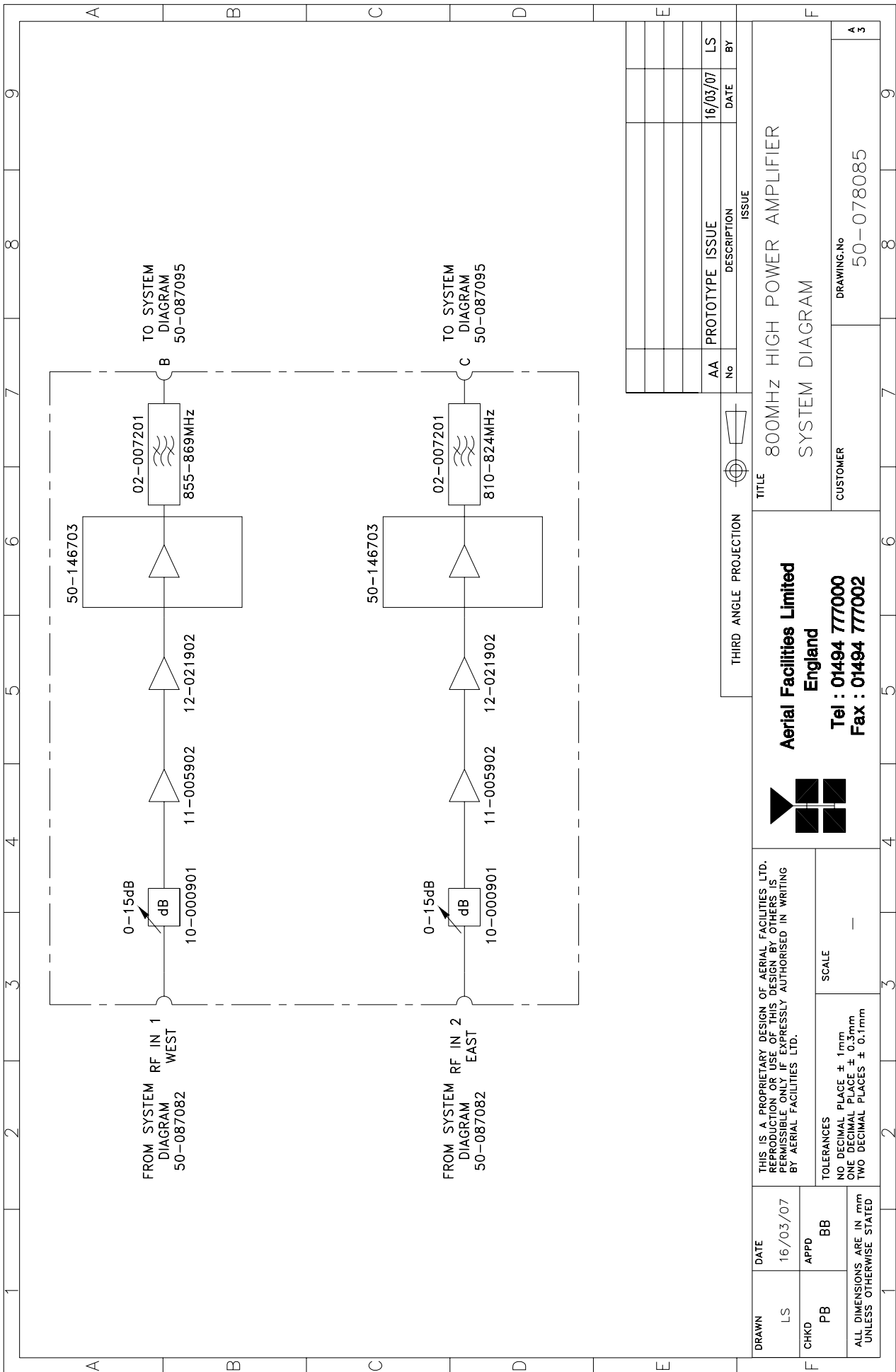
### 5.3.2 Technical Specification

| PARAMETER                 |              | SPECIFICATION                           |
|---------------------------|--------------|---|
| Frequency range:          |              | 855-869MHz (Downlink)                   |
| Downlink output power:    |              | 2W (driver for HPA)                     |
| Uplink output power:      |              | N/A                                     |
| Shelf dimensions          | Height:      | 3U                                      |
|                           | Width:       | 19" (482.6mm)                           |
|                           | Depth:       | <450mm (excluding connectors & handles) |
| Temperature range         | operational: | -20°C to +60°C                          |
|                           | storage:     | -40°C to +70°C                          |
| Weight:                   |              | <15kg                                   |
| Shelf gain:               |              | 50dB (typical)                          |
| Impedance:                |              | 50Ω                                     |
| Humidity:                 |              | 5 – 95% non-condensing                  |
| RF Connectors:            |              | N type female                           |
| Environmental protection: |              | IP44                                    |
| Finish                    | Case:        | Alocrom 1200/Iridite NCP coating        |
|                           | Heatsinks:   | Black anodised aluminium                |
|                           | Handles:     | Silver anodised aluminium alloy         |
|                           | Fascia:      | Painted to RAL7035                      |

### 5.3.3 Parts List

| AFL Part #  | Part Description                    | Qty. |
|-------------|-------------------------------------|------|
| 02-007201   | 900MHz 8POLE 10-20MHz B/W SMA       | 4    |
| 10-000901   | SW. ATTENUATOR 0.25W 0-15dB         | 2    |
| 11-005902   | 900MHz LOW NOISE AMP WITH RELAY ASS | 2    |
| 12-005920   | 3U 10W PWR AMP HEATSINK             | 1    |
| 12-021902   | POWER AMPLIFIER 900MHz 2W +12V      | 2    |
| 13-001803   | DUAL DC/DC CONVERTER 24V-12V 1A     | 1    |
| 19-000921KL | 3U chassis kit 400 deep with led    | 1    |
| 80-008901   | 12V RELAY PCB ASSEMBLY **NO LED**   | 1    |
| 91-030002   | N ADAPTOR PANEL FEMALE:FEMALE       | 4    |
| 91-130005   | SMA BULKHEAD ADAPTOR F/F            | 4    |
| 91-500001   | POWER PLG 3 PIN PNL.MOUNT NC-X      | 2    |
| 91-510003   | 3 PIN R.ANGLE FREE SOC.NC-X.        | 2    |
| 91-600007   | 'D' 9 WAY BLACK SHELL               | 1    |
| 91-600014   | 'D' 9 WAY SOCKET S/B (NON FILTERED) | 4    |
| 91-600015   | 'D' 9 WAY PLUG S/B (NON FILTERED)   | 1    |
| 94-100004   | STPS12045TV 60A DUAL DIODE          | 1    |

5.3.4 HPA Interface Shelf System Diagram, Drg. # 50-078085

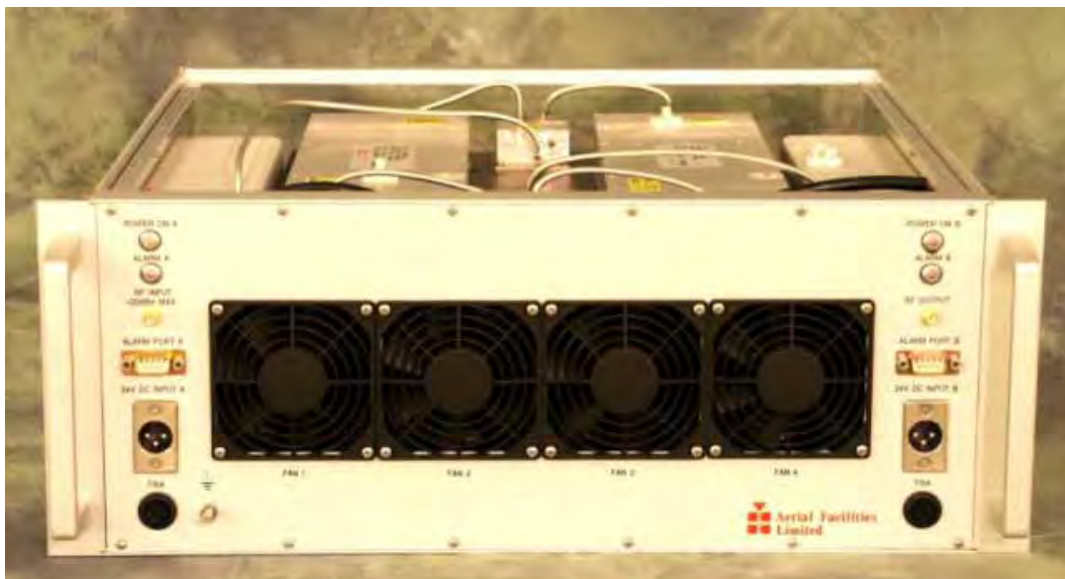


|    |           |             |          |    |    |
|----|-----------|-------------|----------|----|----|
| AA | PROTOTYPE | ISSUE       | 16/03/07 | LS | BY |
| No |           | DESCRIPTION | DATE     |    |    |
|    |           |             |          |    |    |
|    |           |             |          |    |    |
|    |           |             |          |    |    |

|  |  |            |  |
|--|--|------------|--|
| THIRD ANGLE PROJECTION   |  | TITLE      |  |
| 800MHZ HIGH POWER AMPLIFIER SYSTEM DIAGRAM   |  | CUSTOMER   |  |
| Aerial Facilities Limited<br>England   |  | DRAWING No |  |
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| TOLERANCES<br>NO DECIMAL PLACE ± 1mm<br>ONE DECIMAL PLACE ± 0.5mm<br>TWO DECIMAL PLACES ± 0.1mm<br>UNLESS OTHERWISE STATED   |  | SCALE      |  |
| -  |  | -          |  |

## 5.4 High Power Amplifier Shelf (50-146703)

### 5.4.P High Power Amplifier Shelf Photographs



### 5.4.1 Description

This amplifier is a Class A, fan cooled, 80W power amplifier in the frequency range 851 to 866MHz, built into a 4U standard rack space unit. The fan-cooled amplifier is provided with an improving linearity pre-distortion type correction circuit to give improved Output Intermodulation Intercept Point (OIP3) and is housed in an aluminium case having an Iridite NCP finish. SMA connectors are used for the RF input and output ports.

The amplifier has a 2 x NC-X connectors for the power supply and a Current Fault Alarm Function via 2 x 9-way D connectors (pins 1 & 2/amplifier). The unit operates from a 24V –Ve ground power supply.

### 5.4.2 Electrical Specifications

| PARAMETER                        |            | SPECIFICATION                        |
|----------------------------------|------------|--------------------------------------|
| Frequency range:                 |            | 851-866MHz                           |
| Bandwidth:                       |            | <30MHz                               |
| Gain:                            |            | 36dB (typical)                       |
| Gain Flatness:                   |            | <0.5dB                               |
| 1dB Compression Point:           |            | +49dBm (typical)                     |
| 3 <sup>rd</sup> order intercept: |            | +69dBm (typical)                     |
| Input/Output return loss:        |            | >15dB                                |
| Connectors:                      |            | SMA female                           |
| Supply:                          |            | 18A @ 24V DC                         |
| Weight:                          |            | 8kg                                  |
| Size:                            |            | 4U 19" Rack Mount 460mm Depth        |
| Alarms:                          |            | 2 x 9-way 'D' connectors, pins 1 & 2 |
| Temperature range:               | operation: | -20°C to +60°C                       |
|                                  | storage:   | -40°C to +70°C                       |

### 5.4.3 Parts List

| AFL Part # | Part Description                    | Qty. |
|------------|-------------------------------------|------|
| 05-002602  | 900MHz SPLITTER/COMBINER, 20W       | 6    |
| 05-002622  | SPLITTER/COMBINER AUX. MTG PLATE    | 6    |
| 12-023301  | PA 851-866MHz 20W LINEARIZED +24V   | 4    |
| 80-008902  | 24V RELAY PCB ASSEMBLY **NO LED**   | 2    |
| 80-245121  | CLASS A LINEARIZED HEATSINK         | 2    |
| 80-245122  | 100WTETRA LINEARIZED H'SINK MTG BKT | 2    |
| 80-245123  | 100WTETRA LINEARIZED SIDE PANEL     | 2    |
| 80-245124  | 100WTETRA LINEARIZED RACK LID       | 2    |
| 80-245125  | 100WTETRA LINEARIZED FRONT PANEL    | 1    |
| 80-245126  | 100WTETRA LINEARIZED DUCT END PLATE | 2    |
| 80-245128  | 100WTETRA LINEARIZED DUCT MTG BLOCK | 4    |
| 80-245129  | 100WTETRA LINEARIZED LID MTG BKT    | 4    |
| 80-245130  | 100WTETRA LINEARIZED DUCT TOP COVER | 1    |
| 80-245131  | 100WTETRA LINEARIZED DUCT BOT COVER | 1    |
| 80-245132  | CLASS A LINEARIZED AMP CABLE TIDY   | 2    |
| 90-010021  | RF CABLE SUPFLEX SMA R/A MALE 100mm | 4    |
| 90-010024  | RF CABLE SUPFLEX SMA R/A MALE 400mm | 2    |
| 90-010026  | RF CABLE SUPFLEX SMA R/A MALE 150mm | 6    |
| 90-010027  | RF CABLE SUPFLEX SMA R/A MALE 250mm | 2    |
| 91-130005  | SMA BULKHEAD ADAPTOR F/F            | 2    |
| 91-500001  | POWER PLG 3 PIN PNL.MOUNT NC-X      | 2    |
| 91-600015  | 'D' 9 WAY PLUG S/B (NON FILTERED)   | 2    |
| 91-600019  | 'D'15 WAY SHELL (2W7)               | 4    |
| 91-640004  | LARGE PIN FOR 91-660001 D SOCKET    | 8    |
| 91-660001  | 2W5 MIXED D TYPE SOCKET (7 WAY)     | 4    |
| 91-700017  | ICD 15 WAY 0.1' CONNECTOR           | 2    |
| 91-700036  | MISC 3 WAY PLUG HOUSING             | 4    |
| 91-700037  | MISC 4 WAY PLUG HOUSING             | 2    |
| 91-700038  | MISC PLG PIN FOR 3WAY HOUSING 14AWG | 32   |
| 91-700039  | MISC 3 WAY SOCKET HOUSING           | 6    |
| 91-700040  | MISC 4 WAY SOCKET HOUSING           | 2    |
| 91-700042  | MISC SOC.PIN FOR 3WAY HOUSING 14AWG | 12   |
| 96-100004  | 32mm 20A (16A max load) FUSE HOLDER | 2    |
| 96-110005  | 315mA FUSE GLASS A/SURGE 20X5       | 4    |
| 96-110015  | T 15A A/SURGE FUSE 1.25'            | 2    |
| 96-110040  | BULGIN IN-LINE FUSEHOLDER 20mm      | 4    |
| 96-400002  | 80 X 80MM 24V DC FAN SUNON          | 4    |
| 96-400003  | PLASTIC FINGER GUARD 80X80mm        | 4    |
| 96-600003  | INSULATING BOOT D.C.                | 2    |
| 96-700034  | LED RED 5mm IP67 INTEGRAL RES. 24V  | 2    |
| 96-700035  | LED GREEN 5mm IP67 INTEGRAL RES 24V | 2    |
| 97-400002  | HANDLE TYPE H6803 4U.[ALLOY]        | 2    |
| 97-600004  | 19" SUBRACK REAR RAIL               | 2    |
| 97-600005  | 19" SUBRACK FRONT RAIL              | 2    |
| 97-600008  | 19" SUBRACK TAPPED STRIP            | 2    |
| 97-600016  | 19" 4U SUBRACK MOUNTING FLANGE      | 2    |

## 6. INSTALLATION

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

### 6.1 General Remarks

The equipment racks that these master site shelves will be fitted into must be located on a flat, level surface that is made from a material suitable for bearing the weight of the rack assembly. If the installer is in any doubt about the suitability of a site it is recommended that he consult with an appropriately qualified Structural Engineer.

It is important in determining the location of the rack within the room that space is allowed for access to the front and rear of the equipment. To enable maintenance to be carried out, the doors must be able to fully open.

The location must be served with a duct to allow the entry of cables into the unit.

The mains power supply is connected to the terminal strip located on the bulkhead at the rear of the equipment at floor level. 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 connection should be completed and checked prior to power being applied for the first time.

### 6.2 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 of the rack, 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.

### 6.3 Commissioning

Once all connections are made the equipment is ready for commissioning.

Using the system diagrams and the end-to-end test specification, the equipment should be tested to ensure correct operation.

On initial power up the system alarm indicators on the front panels of the equipment should be checked. A red LED illuminated indicates a fault in that particular tray that must be investigated before proceeding with the commissioning. A green LED on each shelf illuminates, to indicate that the power supply is connected to the shelf

In the event that any part of the system does not function correctly as expected, check all connections to ensure that they are to the correct port, that the interconnecting cables are not faulty and that they are tightened. The majority of commissioning difficulties arise from problems with the interconnecting cables and connectors.



## 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 shelves within an environmentally protected enclosure (rack).

Transmissions from the main base stations are passed through 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 LEDs. 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 or FO 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 a module 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.<br>3mm flat bladed screwdriver.<br>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 (LNAs, 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 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

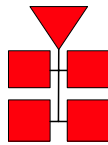
## A.1 Glossary of Terms used in this document

|                            |  |
|----------------------------|--|
| Repeater or Cell Enhancer  | A Radio Frequency amplifier which can simultaneously amplify and re-broadcast Mobile Station and Base Transceiver Station 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 Enhancement Management System   |
| C/NR                       | Carrier-to-Noise Ratio   |
| DAB                        | Digital Audio Broadcasting   |
| 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   |
| LCX                        | Coaxial Leaky Feeder   |
| LNA                        | Low Noise Amplifier  |
| LPA                        | Low Power Amplifier  |
| MOU                        | Master Optical Unit  |
| MS                         | Master Site  |
| MST                        | 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  |
| TTL                        | Transistor-Transistor Logic, a common type of digital circuit.   |
| Tx                         | Transmitter  |
| Uplink (U/L)               | RF signals transmitted from the MS to the BTS  |
| VSWR                       | Voltage Standing Wave Ratio  |
| WDM                        | Wave division multiplex  |

# A.2 Key to AFL RF Module Drawing Symbols

|  |   |  |   |  |   |   |   |  |  |
|--|---|--|---|--|---|---|---|--|--|
| 1  | 2 | 3  | 4 | 5  | 6 | 7   | 8 | 9  |  |
| <b>HUBS</b><br>FIBRE MAIN HUB<br>EXPANSION HUB<br>TAPPER/COUPLER   |   | <b>COUPLERS</b><br>10 dB COUPLER<br>6 dB DIRECTIONAL COUPLER<br>10 dB DIRECTIONAL COUPLER<br>6 dB DIRECTIONAL COUPLER<br>DIRECTIONAL COUPLER<br>CROSS BAND COUPLER   |   | <b>CABLES</b><br>8/ FIBRE OPTIC CABLE LINK<br>24/ FIBRE OPTIC CABLE LINK<br>JUMPER CABLE(1/2")<br>RADIATING CABLE<br>CAT 5 CABLE<br>CO- AX CABLE 1/2" DIA<br>CO- AX CABLE 7/8" DIA             |   | <b>SPLITTERS</b><br>HYBRID SPLITTER<br>SPLITTER   |   | <b>ANTENNAS</b><br>OMNI ANTENNA<br>YAGI ANTENNA<br>FLAT PLATE ANTENNA ( MOUNTED AT HIGH LEVEL)<br>DIRECTIONAL ANTENNA<br>ANTENNA<br>REMOTE ANTENNA UNIT<br>PANEL ANTENNA<br>BLADE ANTENNA  |  |
| <b>MISC</b><br>BASE TRANSMITTER STATION<br>CHANNEL MODULE<br>FIBRE OPTIC MODULATOR<br>FIBRE OPTIC DEMODULATOR<br>PLUG & SOCKET<br>SOCKET<br>PLUG<br>FIBRE OPTIC CONNECTOR FC/APC                     |   | <b>MISC</b><br>BAND PASS FILTER<br>CAVITY RESONATOR<br>NOTCH FILTER<br>ISOLATOR<br>HYBRID COMBINER<br>EARTH STUD<br>LEEKY FEEDER<br>R. S.A<br>Outputs to receivers   |   | <b>MISC</b><br>AMPLIFIER<br>ATTENUATOR VARIABLE<br>ATTENUATOR FIXED<br>A.G.C<br>MONITORING CONTROLLER<br>MODEM<br>BI- DIRECTIONAL AMPLIFIER ( CELL ENHANCER)<br>DUMMY LOAD<br>LOCAL OSCILLATOR |   | <b>MISC</b><br>AC TO DC PSU<br>DC TO DC CONVERTER<br>FUSE<br>N.O. ( CLEAR CONTACT)<br>RELAY<br>N.C. ( FILLED CONTACT) |   | <b>SIGNAL KEY</b><br>= READING POSITION<br>602= BCCH BROADCAST CONTROL CHANNEL<br>22 = BSIC( BASIC SITE IDENTITY CODE)<br>-82 = ACCEPTABLE SIGNAL LEVEL(dBm)<br>-83 = BELOW ACCEPTABLE SIGNAL LEVEL(dBm)<br>-72 = ACCEPTABLE SIGNAL LEVEL(dBm)<br>-73 = BELOW ACCEPTABLE SIGNAL LEVEL(dBm) |  |
| <b>MISC</b><br>THIS IS A PROPRIETARY DESIGN OF AERIAL FACILITIES LTD<br>REPRODUCTION OR USE OF THIS DESIGN BY OTHERS IS PERMISSIBLE ONLY IF EXPRESSLY AUTHORISED IN WRITING BY AERIAL FACILITIES LTD |   | <b>TOLEANCES</b><br>NO DECIMAL PLACE #1mm<br>ONE DECIMAL PLACE #0.3mm<br>TWO DECIMAL PLACES #0.1 mm<br>UNLESS OTHERWISE STATED   |   | <b>SCALE</b><br>NTS  |   | <b>TITLE</b><br>AFL- STANDARD SYMBOLS   |   | <b>TEXT CORRECTION</b><br>2B 28/07/04 PL<br>2A ECN8165 26/01/04 PL<br>1A BLADE ANTENNA ADDED 21/06/00 PL<br>AA ORIGINAL 23/05/00 PL<br>No ISSUE DESCRIPTION DATE BY  |  |
| <b>DRAWN</b><br>PL 10/05/00<br>CHKD MB GD<br>ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED  |   | <b>THIS IS A PROPRIETARY DESIGN OF AERIAL FACILITIES LTD<br/>                 REPRODUCTION OR USE OF THIS DESIGN BY OTHERS IS PERMISSIBLE ONLY IF EXPRESSLY AUTHORISED IN WRITING BY AERIAL FACILITIES LTD</b> |   | <b>SCALE</b><br>NTS  |   | <b>TITLE</b><br>AFL- STANDARD SYMBOLS   |   | <b>CUSTOMER</b><br>90-000001   |  |
| 1  | 2 | 3  | 4 | 5  | 6 | 7   | 8 | 9  |  |

### A.3 EC Declaration of Conformity



# Aerial Facilities Limited

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

## CE0086

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

DECLARES, UNDER OUR SOLE RESPONSIBILITY THAT THE FOLLOWING PRODUCT:  
PRODUCT PART NO[S] 50-078017 & 50-078021  
PRODUCT DESCRIPTION Mission Valley Tunnel radio repeater equipment

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: 22/01/2007



**A.4 Amendment List Record Sheet**

| <b>Issue No.</b> | <b>Date</b> | <b>Incorporated by</b> | <b>Page Nos. Amended</b> | <b>Reason for new issue</b>                 |
|------------------|-------------|------------------------|--------------------------|---|
| A                | 04/01/06    | CMH                    |                          | 1 <sup>st</sup> Draft                       |
| 1                | 31/07/06    | CMH                    |                          | 1 <sup>st</sup> Issue                       |
| 2A               |             | CMH                    |                          | Incorporated all hardware into one document |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |
|                  |             |                        |                          |   |

Document Ref: 50-078021HBKM

## A.5. Waste Electrical and Electronic Equipment (WEEE) Notice



The Waste Electrical and Electronic Equipment (WEEE) Directive became law in most EU countries during 2005. The directive applies to the disposal of waste electrical and electronic equipment within the member states of the European Union.

As part of the legislation, electrical and electronic equipment will feature the crossed out wheeled bin symbol (see image at left) on the product or in the documentation to show that these products must be disposed of in accordance with the WEEE Directive.

In the European Union, this label indicates that this product should not be disposed of with domestic or "ordinary" waste. It should be deposited at an appropriate facility to enable recovery and recycling.

## **APPENDIX B Initial Equipment Set-up Calculations**

| <b>GENERAL INFORMATION</b> |  |                      |  |
|----------------------------|--|----------------------|--|
| Site Name:                 |  | Client Name:         |  |
| Date:                      |  | AFL Equip. Model No. |  |

| <b>ANTENNA SYSTEMS</b>     |       |      |         |          |
|----------------------------|-------|------|---------|----------|
|                            | Model | Gain | Azimuth | Comments |
| <b>A</b> - Service Antenna |       |      |         |          |
| <b>B</b> – Donor Antenna   |       |      |         |          |
|                            | Type  | Loss | Length  | Comments |
| <b>C</b> – Service Feeder  |       |      |         |          |
| <b>D</b> – Donor Feeder    |       |      |         |          |

| <b>INITIAL PARAMETERS</b>                    |     |
|--|-----|
| <b>E</b> – CE Output Power                   | dBm |
| <b>F</b> – Antenna Isolation                 | dB  |
| <b>G</b> – Input signal level from donor BTS | dBm |
| Operating Voltage                            | V   |

| <b>DOWNLINK CALCULATIONS</b>           |                      |       |
|--|----------------------|-------|
| Parameter                              | Comments             | Value |
| Input signal level ( <b>G</b> )        |                      | dBm   |
| CE max. o/p power ( <b>E</b> )         |                      | dBm   |
| Gain setting                           | E - G                | dB    |
| <b>ISOLATION REQUIRED</b>              | Gain + 10dB          | dB    |
| Service antenna gain ( <b>A</b> )      |                      | dB    |
| <b>SERVICE ANTENNA FEEDER LOSS (C)</b> |                      | dB    |
| <b>EFFECTIVE RADIATED POWER (ERP)</b>  | 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.

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

## APPENDIX C - BATTERY BACKUP

### C.1 GENERAL DESCRIPTION

The 80-209302 Battery Backup Unit is designed to complement AFL's extensive range of Cell Enhancers and provide for continued operation during mains power failure.

The Battery Backup Unit is mounted in a single environmentally-protected case. NOTE: Although battery back-up units are fitted in an IP65 case, they are open to the local environment via coarsely filtered grill apertures which are necessary to allow the escape of gasses from the batteries when they are being charged or discharged. Handles are provided for carrying the unit and the door is fitted with locks. All the power and alarm connections are via rugged IP68 sealed connectors.

The Battery Backup Unit contains a switch-mode power supply module (SMPSU), the batteries, a battery charger and the associated control circuitry. In particular a low-voltage cut-off is fitted to shut the system down after extended operation to prevent deep discharge of the batteries.

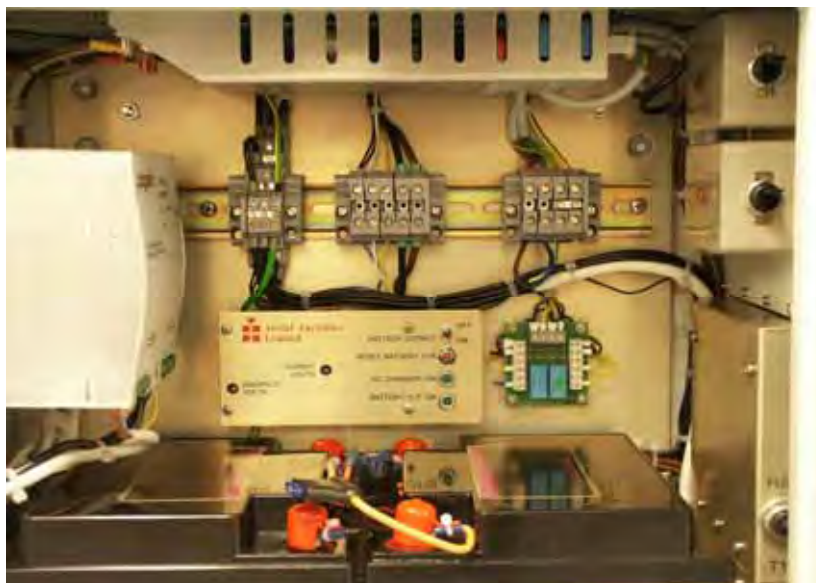
The Battery Backup Unit is fitted as standard with two alarms, a combined power supply and charger alarm and an intruder alarm. The intruder alarm operates when the enclosure door is opened. Both alarm circuits are volt-free contacts which are normally closed and become open circuit in a fault condition. The Battery Backup Unit can be fitted with a more comprehensive alarm and monitoring alarm system if required. In these cases the Battery Backup Unit can also be fitted with alarms for AC failure, temperature, etc. and be interfaced for use with the Cell Enhancer remote alarm reporting system.

When the Battery Backup Unit is used as the default power source for the Cell Enhancer, the Cell Enhancer only requires a 12V DC supply input. This has the effect of removing the power supply from the Cell Enhancer case, therefore saving on cost, weight and most importantly reducing heat generation within the Cell Enhancer case.

The Battery Backup Unit is designed to provide typically four hours autonomy in the event of mains supply failure. However, this will vary depending on the load presented by the Cell Enhancer and the size of the batteries fitted.

The circuit diagram and schematic contained in this handbook are based on the standard model. All Battery Backup Units are capable of being customised to individual customers requirements for battery capacity, alarms etc. and the drawings may differ from those included in this manual.

## C.2. BATTERY BACKUP PHOTOGRAPHS



### C.3. SPECIFICATION

#### C.3.1 Technical Specification

| PARAMETER                  | SPECIFICATION  |
|----------------------------|--|
| Input Voltage:             | Main SMPSU:-<br>90 Vac to 264 Vac Universal Input.<br>Battery Charger:-<br>93-132 Vac and 187-264 Vac<br>Switch selectable |
| Input Frequency:           | 47 to 63 H   |
| Input Current:             | <2.0 A typical at 230 Vac (8.0A maximum when charging batteries after extended mains outage at 110 Vac)                    |
| Rating Of SMPSU:           | 27A at 30°C, 21A at 55°C.  |
| Output (Load) Voltage:     | +12.5V DC  |
| Output (Load) Current:     | 9A (typical)*  |
| Battery Run Time:          | 8 hours (typical)*   |
| Batteries:                 | 4 x 12V, 40Amp/hour*   |
| Low Voltage Cut-off Point: | 10.5V  |
| Standard Alarms:           | 1: Power supply alarms<br>2: Door open alarm   |
| Optional Alarms Available: | 3: AC supply failure alarm<br>4: Temperature alarm   |

\* The load current will vary depending on the exact model of Cell Enhancer being driven from the power supply. Although 9 Amps is a typical figure, models with higher power amplifiers or more gain draw more current. This will be reflected in the battery run time.

#### C.3.2 Mechanical Specification

| PARAMETER   | SPECIFICATION   |
|---|---|
| Case size   | Height: <b>620mm</b>  |
|   | Width: <b>420mm</b>   |
|   | Depth: <b>250mm</b>   |
| (excluding heatsinks, connectors, handles and feet) |   |
| Fixings:  | 4 holes on <b>470(w) x 500(h)mm</b>   |
| Temperature Range:                                  | operational: <b>-30°C to +55°C</b>  |
|   | storage: <b>-40°C to +70°C</b>  |
| Weight:   | <b>75kg (approximately)</b>   |
| RF Connectors:                                      | <b>N type female</b>  |
| Environmental Protection:                           | <b>IP65 (with door closed and all ports terminated)</b>   |
| Finish:   | Case: <b>To RAL 7035</b>  |
|   | Heatsinks: <b>Matt black (where fitted)</b>   |
|   | Handles: <b>Black Technopolymer</b>   |
| Supply Cable:                                       | Unit supplied with suitable supply input leads with connector and appropriate length of cable (where appropriate) |

### C.3.3 Technical Description

AFL Cell Enhancer/repeater equipment often requires backup against failure of the mains AC supply. Since the equipment runs on a 12V DC supply the most efficient method of providing backup is by a bank of dry lead acid batteries of adequate capacity.

The Battery Backup Power Supply Unit incorporates a 400 Watt DC power supply and a Charger/Regulator with a bank of two 12V 40AH batteries connected in parallel. The 400 Watt SMPSU power supply will provide 12V DC to power the repeater under normal running conditions from the mains supply. The batteries will provide 12V DC if the mains supply fails.

To reach maximum capacity the batteries need a charging voltage of 13.5V and this is provided by a commercially available TRACO type TIS300-124 power supply with an output current capability of 10A maximum. The disadvantage with lead acid batteries is the high terminal voltage during charging. AFL repeaters employ a diode combiner to sum the 12V DC output of the SMPSU DC power supply and the battery bank DC output. The diode combiner is used to achieve "no break" changeover on mains failure, however, if during charging the battery output has a greater voltage than the SMPSU DC power supply the repeater will draw current from the batteries and not the SMPSU. A further disadvantage is that the power dissipation in the repeater amplifiers is 30% greater with a 13.5V supply and some power amplifier devices are rated to 14V maximum collector voltage leaving little margin for safety.

To overcome these problems the Battery Backup Power Supply must regulate the battery voltage to be slightly below that of the SMPSU. At the same time when the AC supply is off and the equipment is running from batteries the voltage drop across the regulator must be a minimum to achieve maximum backup time as the batteries discharge.

A further requirement is to prevent the effect known as "deep discharge" which shortens battery life. This means the load must be disconnected from the batteries when they become discharged to a terminal voltage of approximately 10.5V.

The charger power supply charges the 2 series connected batteries through blocking diodes. The diodes prevent unwanted current flows between circuit elements. The battery charger DC output is connected through the Battery Output ON/OFF switch to the Charger Control Board via a diode where it powers the low voltage disconnect comparator. The comparator senses the battery voltage via a potential divider and compares it to a fixed 5V reference. Adjustment of the potentiometer VR1 sets the minimum battery voltage at which the low voltage disconnect relay remains energised and the output to an 18V regulator is enabled.

In the absence of an AC input the supply to the comparator is maintained from the batteries via a second diode through the contacts of the low voltage disconnect relay. When the comparator releases the low voltage disconnect relay the comparator supply is interrupted. The low voltage disconnect relay will then remain de-energised (Battery Output Off) until either the AC supply returns or the Reset pushbutton is pressed. On actuation of the Reset pushbutton the output will be restored provided the battery voltage exceeds the comparator threshold set by the potentiometer VR1.

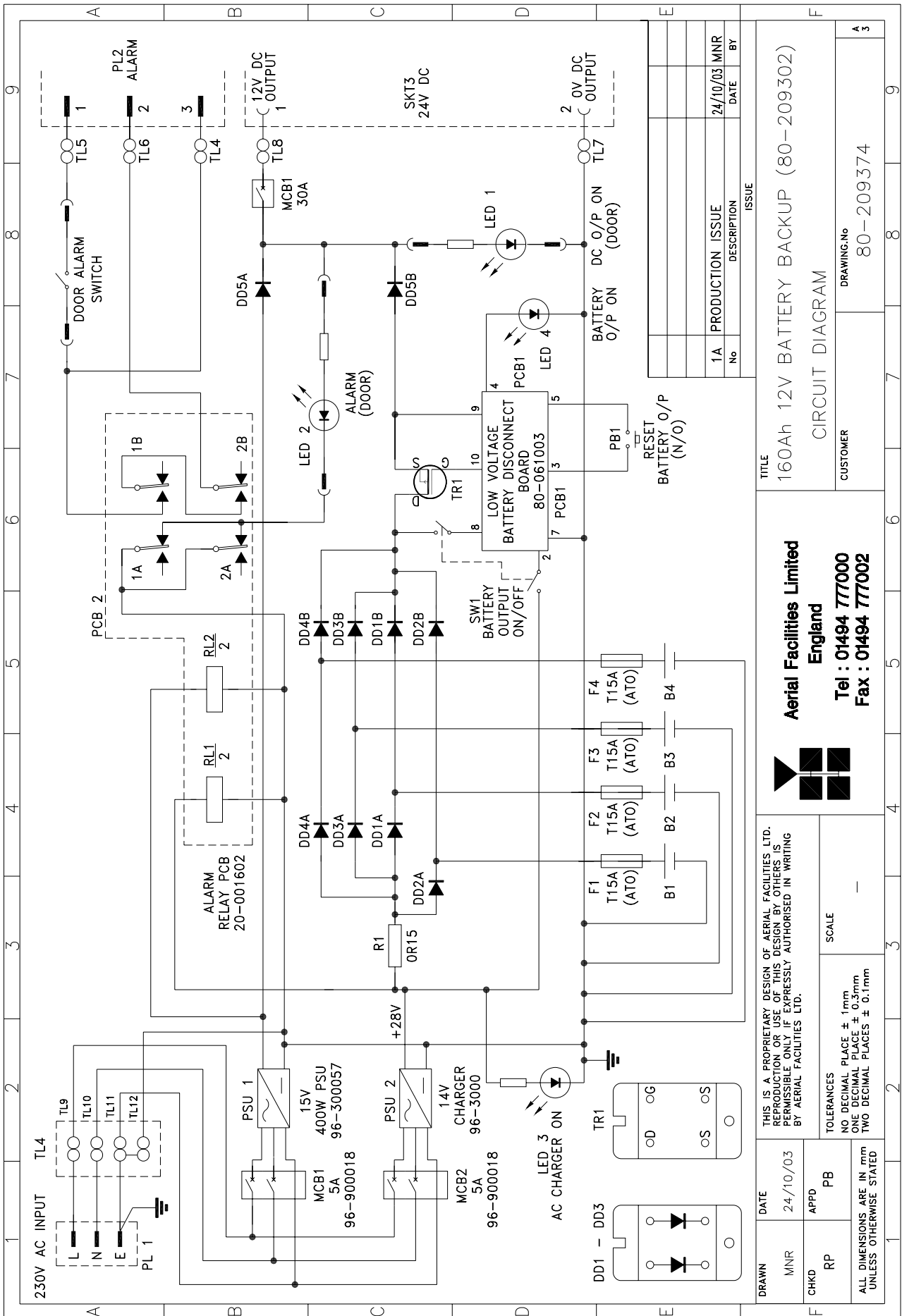
Output from the low voltage disconnect relay is routed to the 9V regulator which provides a stabilised 9 Volt output determined by two divider resistors. This supply feeds a voltage doubler circuit configured from a square wave multi-vibrator and two chopper field effect transistors. Two diodes form the voltage doubling rectifier so that in normal operation approximately 33 Volts is available across doubler circuit capacitors.

The 16 Volt supply is routed via the control element transistor to the gate of a Power MOSFET which is the series pass element for regulating the 13.5V battery voltage to 12.5 Volts at the final output. The FET is chosen for its ability to pass high currents (>30A) with a very low voltage drop (100mV). To achieve this performance requires that the gate is at least 6V more positive than the drain & source terminals. This is the reason for the Voltage doubler supply for driving the gate.

The output voltage is sensed by a second potential divider and compared with the reference voltage from a zener diode to drive the control element transistor for the gate voltage of the pass element. Adjustment of the second potentiometer VR2 sets the output voltage to the required value.

# C.4. GENERAL DRAWINGS

## C.4.1 Drg. No. 80-209374, 160Ah 12V Battery Backup Circuit Diagram



| No | DESCRIPTION      | DATE     | BY  |
|----|------------------|----------|-----|
| 1A | PRODUCTION ISSUE | 24/10/03 | MNR |

|            |  |                                      |  |
|------------|--|--------------------------------------|--|
| TITLE      |  | 160Ah 12V BATTERY BACKUP (80-209302) |  |
| CUSTOMER   |  | CIRCUIT DIAGRAM                      |  |
| DRAWING.No |  | 80-209374                            |  |

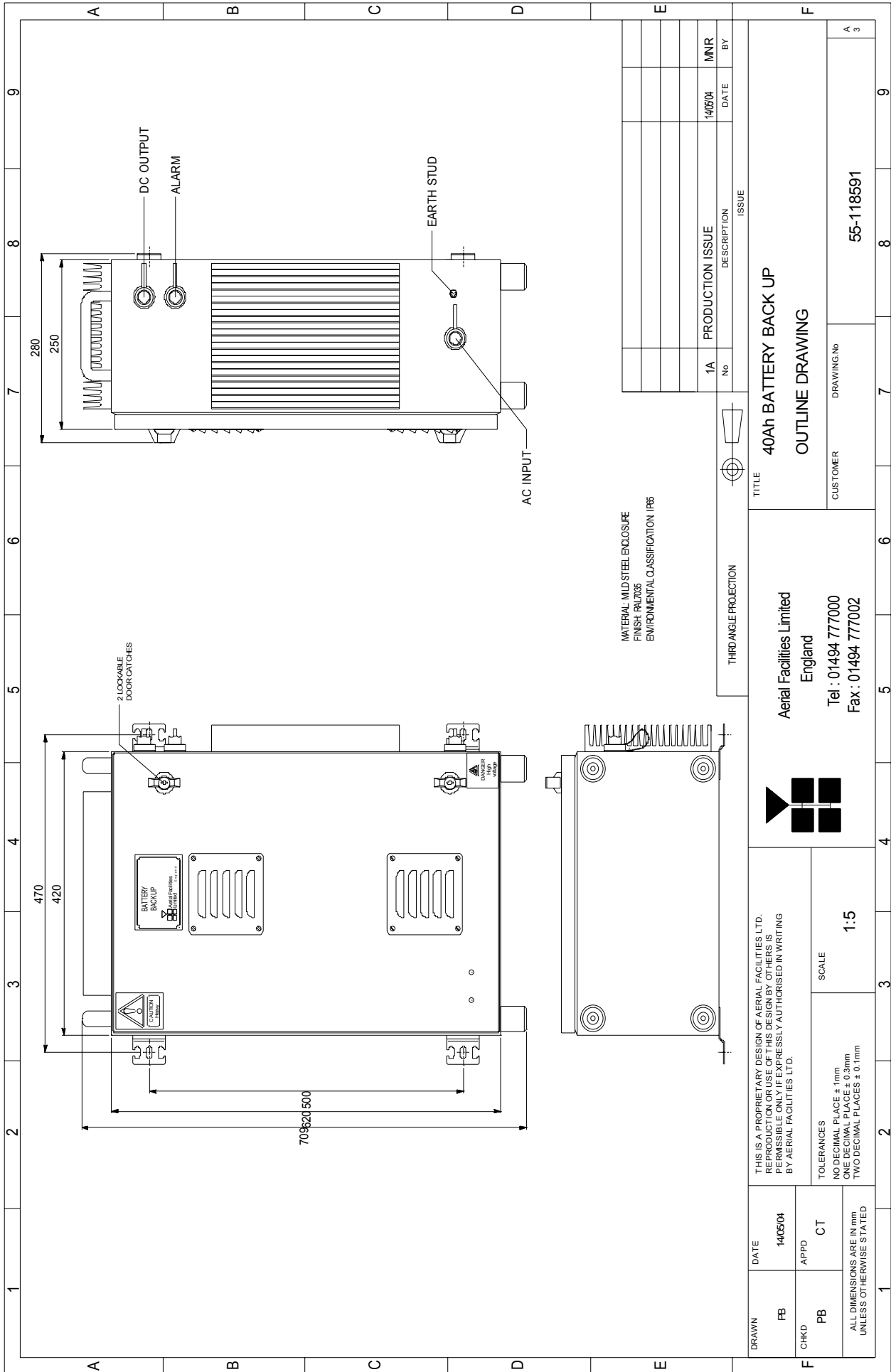
**Aerial Facilities Limited**  
**England**  
**Tel : 01494 777000**  
**Fax : 01494 777002**

|  |     |       |          |
|--|-----|-------|----------|
| DRAWN  | MNR | DATE  | 24/10/03 |
| CHKD   | RP  | APPD  | PB       |
| TOLERANCES                                       |     | SCALE |          |
| NO DECIMAL PLACE ± 1mm                           |     | -     |          |
| ONE DECIMAL PLACE ± 0.5mm                        |     |       |          |
| TWO DECIMAL PLACES ± 0.1mm                       |     |       |          |
| ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED |     |       |          |

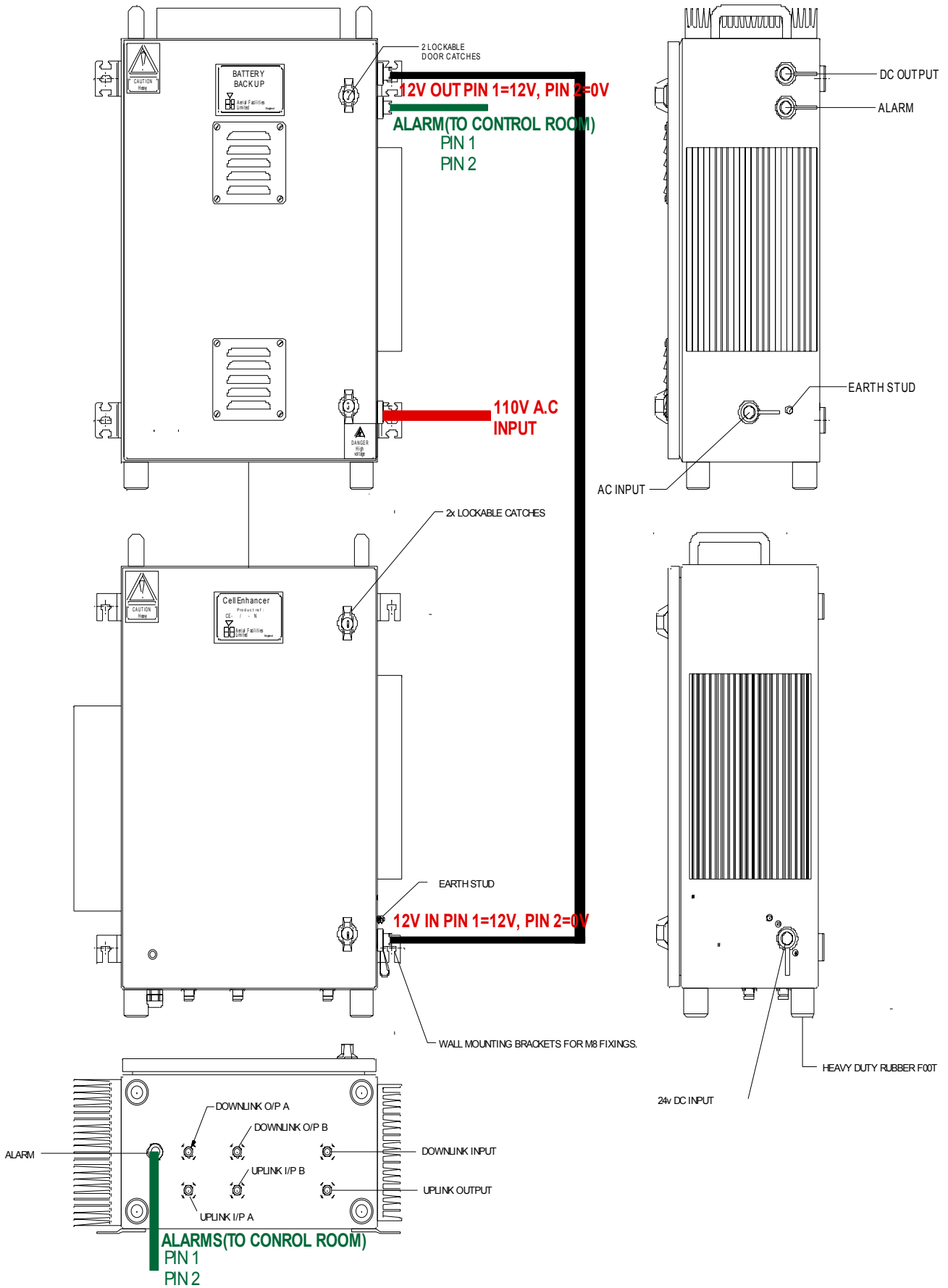




### C.4.3 Battery Backup Case Outline Drawing



### C.4.4 BBU/Amplifier Power Wiring And Alarms Diagram



## **C.5. BBU ALARMS & MONITORING SYSTEM**

### **C.5.1 Description**

The Battery Backup is fitted with a two alarm outputs. The Summary Alarm (Pins 1 & 2) has normally closed, volt free, contacts which open when either the SMPSU output fails and/or the battery charger output fails and/or the door to the Battery Backup is opened.

## **C.6. INSTALLATION**

### **C.6.1 Battery Backup Unit Installation**

The procedure for installing and commissioning an AFL Cell Enhancer Battery Backup Unit is generally as follows:

- 1 Fix the Battery Backup Unit in the chosen position.
- 2 Connect a suitable mains power supply to the Battery Backup Unit.
- 3 Connect the DC cable from the Battery Backup Unit to the Cell Enhancer.
- 4 Switch the Battery Backup Unit on by switching on the two circuit breakers and the battery output switch on the internal indicator panel.
- 5 Test the Cell Enhancer to ensure correct operation from the Battery Backup Unit.

### **C.6.2 Power Supply Input Voltage Selection**

The SMPSU module used within the AFL Cell Enhancer Battery Backup Unit is capable of operation at any voltage between 90 Vac and 264 Vac. The battery charger power supply (Traco) must be switched to either 115 or 230V nominal AC supplies. The supply changeover switch is located on the top surface of the battery charger supply near to the front of the battery backup case. This slide switch is recessed within the supply and can be operated by a small screwdriver.

## **C.7. MAINTENANCE**

### **C.7.1 General Comments**

The AFL Cell Enhancer Battery Backup Unit requires no routine maintenance. If a failure is suspected it is possible with the aid of the block schematics (see section 3) to locate any defective unit.

It should be borne in mind that a failure indicated by the alarm system could actually be a failure in the alarm system! It is always worth checking that there really is a genuine problem by AC and DC voltage measurements before starting to dismantle parts of the system. Lead-acid batteries should be inspected every year for general condition the same way an auto battery would be regarded.