Weehawken Tunnel Radio

VHF Repeater System

User/Maintenance Handbook
For
G.E Transport Systems

AFL Works Order Nō.: Q112727

AFL product part Nō.'s:
55-154701 (VHF Simplex BDA)
55-154801 (VHF Duplex BDA)
80-230801 (VHF Crystal Splitter)
80-230901 (VHF D/L Combiner)
80-231001 (VHF U/L Crystal Splitter)
80-231101 (VHF U/L Combiner)
80-231301 (VHF/UHF Power Supply)

Table of Contents

AMENDMENT LIST RECORD SHEET

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

Document Ref:-Weehawken_VHF

INTRODUCTION

Scope

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

Purpose

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

This handbook has been prepared in accordance with BS 4884, and AFL's Quality procedures, which maintain the company's registration to BS EN ISO 9001:2000 and to the R&TTE Directive of the European Parliament. Copies of the relevant certificates and the company Quality Manual can be supplied on application to the Quality Manager.
This document fulfils the relevant requirements of Article 6 of the R&TTE Directive.

Limitation of Information Notice

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

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

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

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

EC DECLARATION OF CONFORMITY

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

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

CE 0086

United Kingdom

DECLARES, UNDER OUR SOLE RESPONSIBILITY THAT THE FOLLOWING PRODUCT

PRODUCT PART NO[S] 55-154701, 55-154801
PRODUCT DESCRIPTION **Weehawken VHF amplifier system**
IN ACCORDANCE WITH THE FOLLOWING DIRECTIVES:

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

HAS BEEN DESIGNED AND MANUFACTURED TO THE FOLLOWING STANDARD[S] OR OTHER NORMATIVE DOCUMENT[S]:

BS EN 60950	**Information technology equipment. Safety. General requirements**
ETS EN 301 489-1	**EMC standard for radio equipment and services. Part 1. Common technical requirements**

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives.
SIGNED

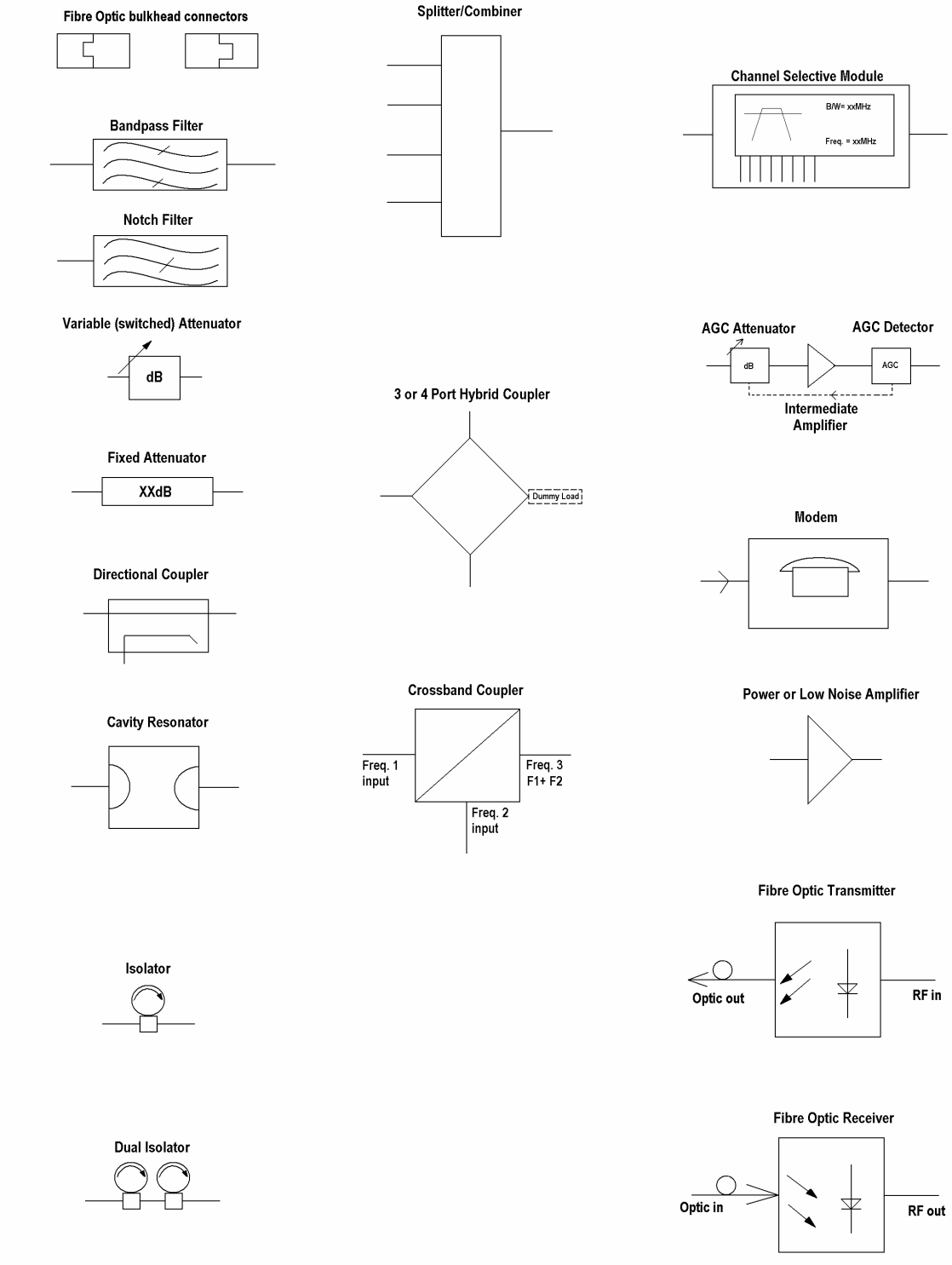
B S BARTON
TECHNICAL DIRECTOR **DATE: 08/11/2005**

Glossary of Terms

Repeater or Cell Enhancer	A Radio Frequency (RF) amplifier which can simultaneously amplify and re-broadcast Mobile Station (MS) and Base Transceiver Station (BTS) signals.
Band Selective Repeater	A Cell Enhancer designed for operation on a range of channels within a specified frequency band.
Channel Selective Repeater	A Cell Enhancer, designed for operation on specified channel(s) within a specified frequency band. Channel frequencies may be factory set or on-site programmable.

AC	Alternating Current
AGC	Automatic Gain Control
BBU	Battery Backup Unit
BTS	Base Transceiver Station
CEMS	Coverage Enhanced Management System
C/NR	Carrier-to-Noise Ratio
DC	Direct Current
Downlink (D/L)	RF signals Tx from the BTS to the Master Site
FO	Fibre Optic
GND	Ground
ID	Identification Number
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LPA	Low Power Amplifier
MOU	Master Optical Unit
M.S.	Mobile Station
MTBF	Mean Time Between Failures
N/A	Not Applicable
N/C	No Connection
OFR	On Frequency Repeater
OIP3	Output Third Order Intercept Point = RF_{out} +(C/I)/2
PA	Power Amplifier
RF	Radio Frequency
RSA	Receiver/Splitter Amplifier
Rx	Receiver
S/N	Serial Number
Tx	Transmitter
Uplink (U/L)	RF signals transmitted from the MS to the BTS
VSWR	Voltage Standing Wave Ratio
WDM	Wave division multiplex

Key to AFL RF Module Drawing Symbols



Key to AFL RF Modules

1. SAFETY CONSIDERATIONS

1.1 Earthing of Equipment

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

1.2 Electric Shock Hazard

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

a) Original assembly

b) Commissioning

c) Regular intervals, thereafter.

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

1.3 RF Radiation Hazard

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

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

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

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

1.4 Chemical Hazard

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

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

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

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

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

1.5 Emergency Contact Numbers

The AFL Quality Department can be contacted on:

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

2. OVERVIEW/ SYSTEM DESCRIPTION

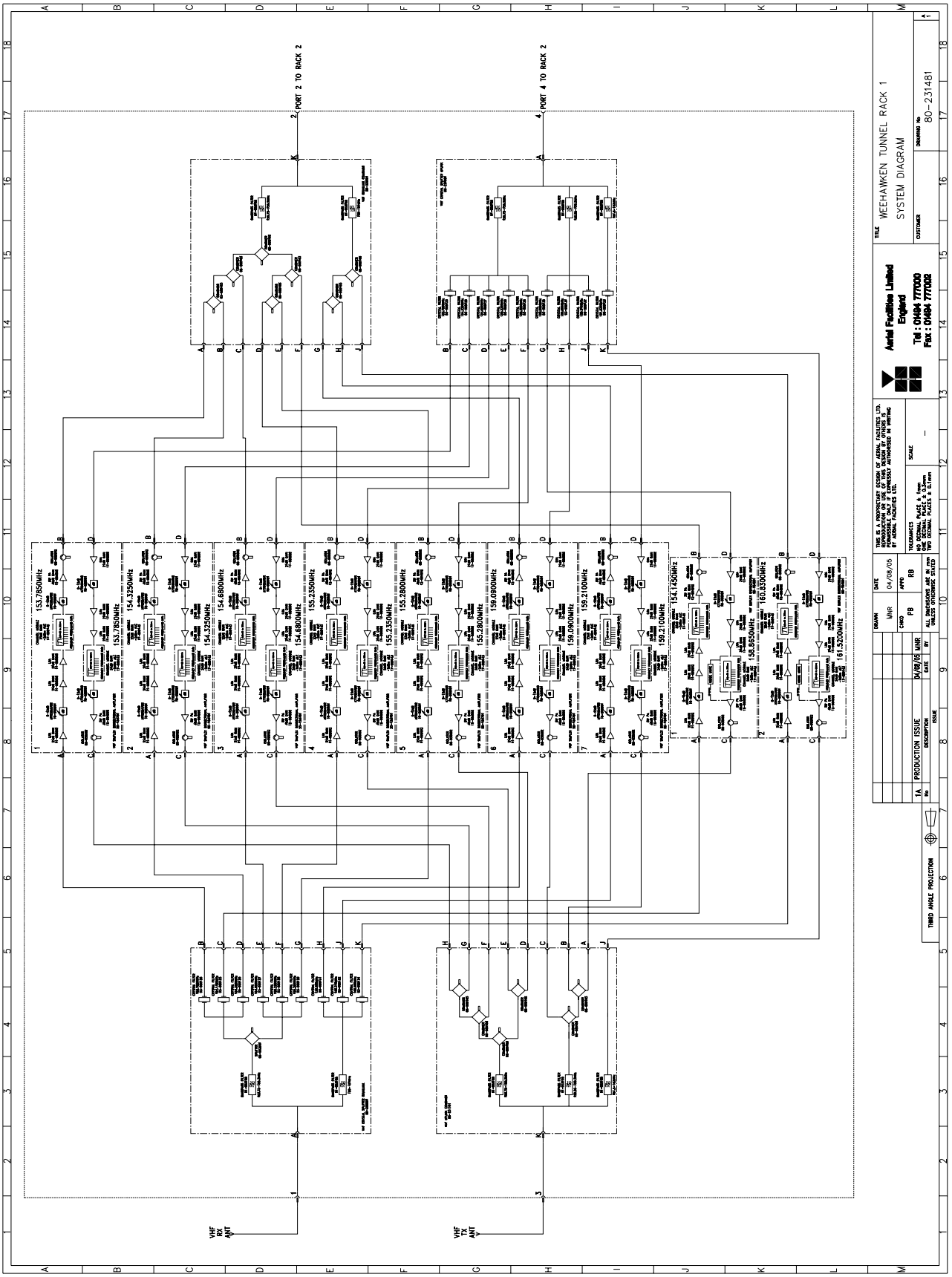
2.1 General System Description

The Weehawken tunnel radio system is designed to amplify various bands of radio frequencies, in either channelised or band selective modes. This handbook is dedicated to the VHF radio repeating system. All the hardware (except the River Portal remote BDA) is built into standard 19" rack mounted cabinets which have an environmental IP rating of 54.

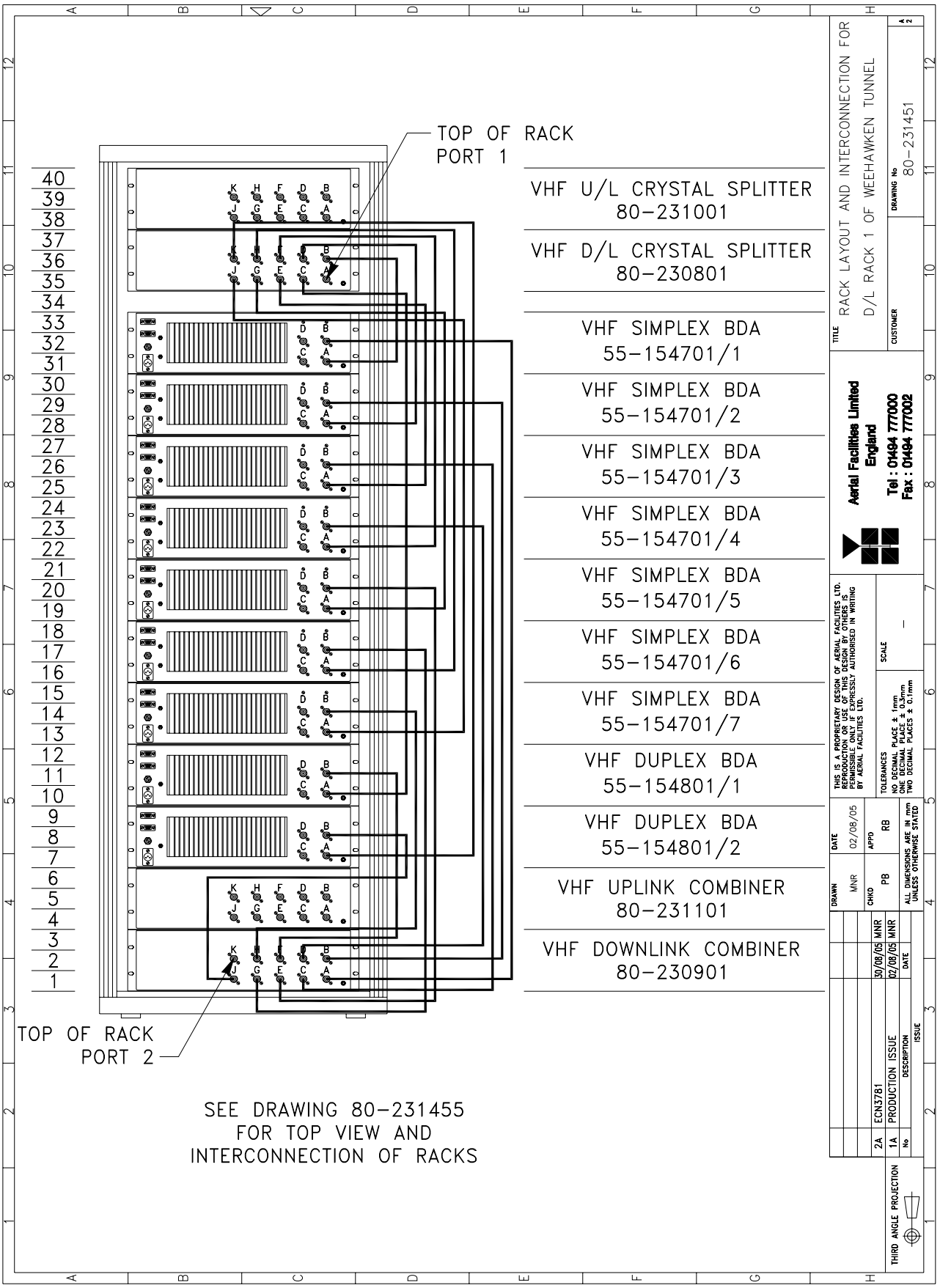
The systems in this document will be described separately, as individual shelves (VHF) and the various passive combiners, splitters and cross-band coupler shelves will be described in other documents. Every active module in the entire system has a dedicated alarm and these are series wired within the shelves to a relay which gives a volt-free output pair for each shelf which is wired to a 'krone-block' termination in the rack cabinet.

3. VHF REPEATER SYSTEM

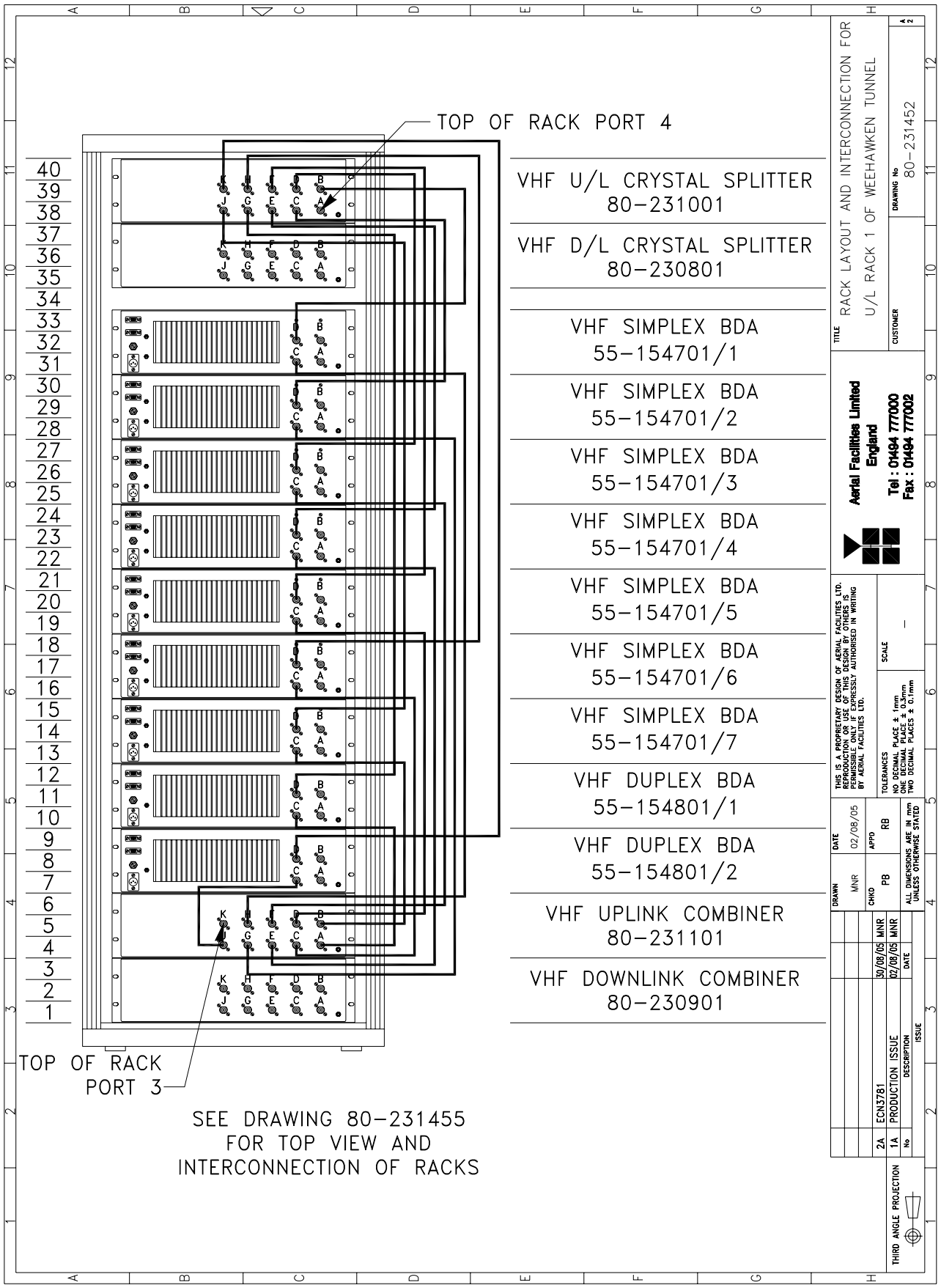
3.1 VHF System Diagram, Drg. Nō. 80-231481



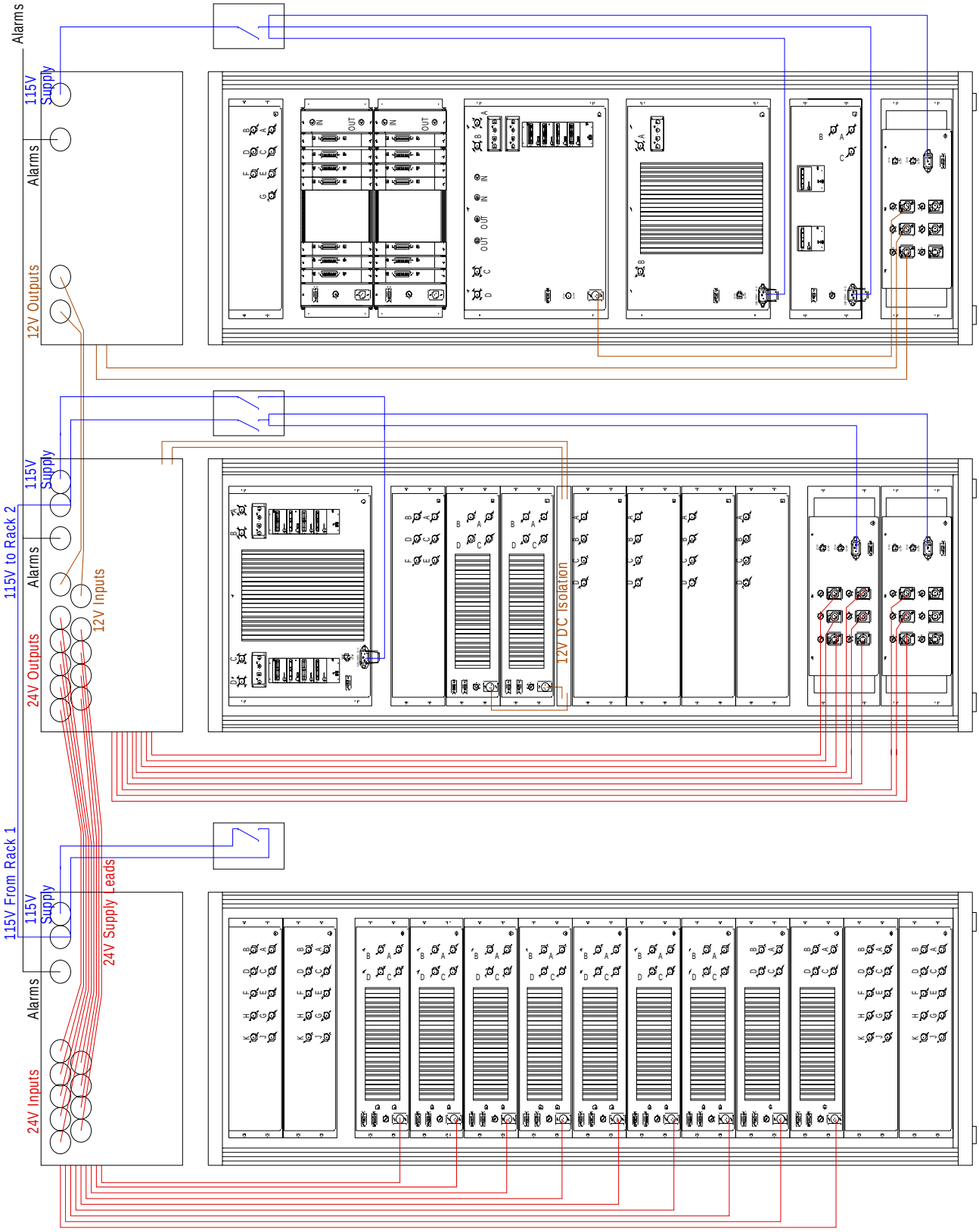
3.2 VHF Rack Layout and Downlink Interconnections Diagram, Drg. Nō. 80-231451



3.3 VHF Rack Layout and Uplink Interconnections Diagram, Drg. Nō. 80-231452



3.4 Power Distribution Sketch



3.5 Weehawken VHF System Frequencies Look-up Table

Agency	Channel Number	Uplink Tx	Downlink Rx
Jersey City Medical Center - EMS	VHF CHN 1	153.7850	153.7850
North Hudson Regional Fire and Rescue	VHF CHN 2	154.3250	154.3250
NJ Statewide Police (SPEN)	VHF CHN 3	154.6800	154.6800
Jersey City Medical Center - EMS	VHF CHN 4	155.2350	155.2350
Jersey City Medical Center - EMS	VHF CHN 5	155.2800	155.2800
North Hudson Regional Fire and Rescue	VHF CHN 6	158.8650	154.1450
Weehawken Township	VHF CHN 7	159.0900	159.0900
Weehawken Township	VHF CHN 8	159.2100	159.2100
New Jersey Transit Police Dept.	VHF CHN 9	161.5200	160.8300

4. BAND SELECTIVE VHF CELL ENHANCERS

4.1 VHF Simplex BDA (55-154701)

4.1.1 VHF Simplex BDA Description

The simplex shelves are part of the VHF amplification and have crystal filters instead of bandpass filters to set bandwidths. There are two downlink bands and three uplink bands, the downlink paths having isolators fitted to each of the 5Watt output stages to prevent two outputs from interfering with each other. All amplifiers have built-in alarms which are configured as a summary, volt-free relay contact pair terminating at pins 1 & 2 on the 'D' type alarm connector.

Note that the control circuitry is omitted from the system diagram for reasons of clarity and simplification.

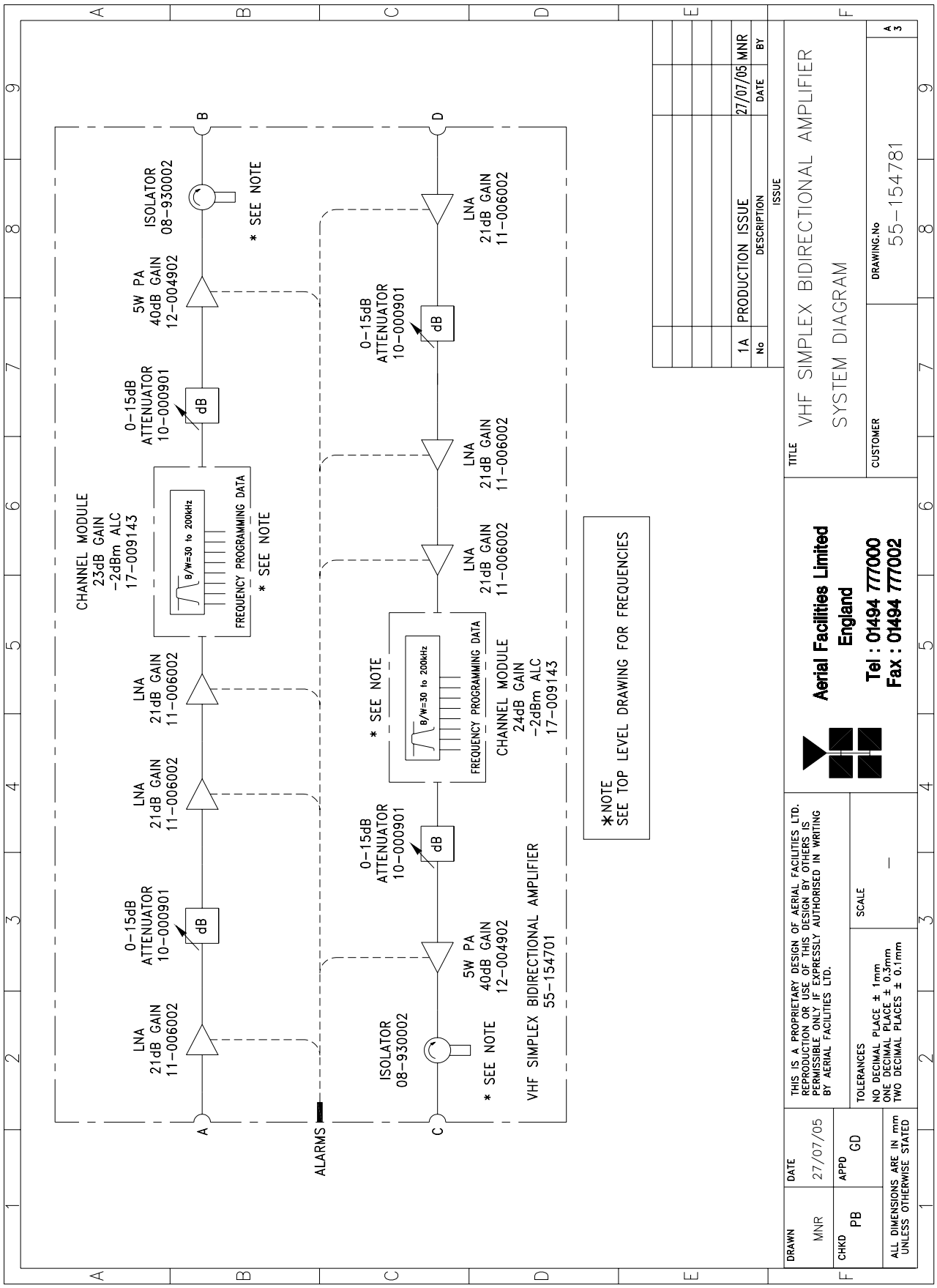
4.1.2 VHF Simplex BDA Electrical Specification

PARAMETER		SPECIFICATION
Frequency range:		153.75-155.3MHz (Downlink1)
		159.0-161.0MHz (Downlink2)
		153.75-155.3MHz (Uplink1)
		158.85-159.3MHz (Uplink2)
		161.5-162.0MHz (Uplink)
Gain:		>90dB
Gain Adjustment:		0 – 15dB (in 1dB step)
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:	-10°C to +55°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 U/L amplifiers
		2 D/L amplifiers
		3 Channel module

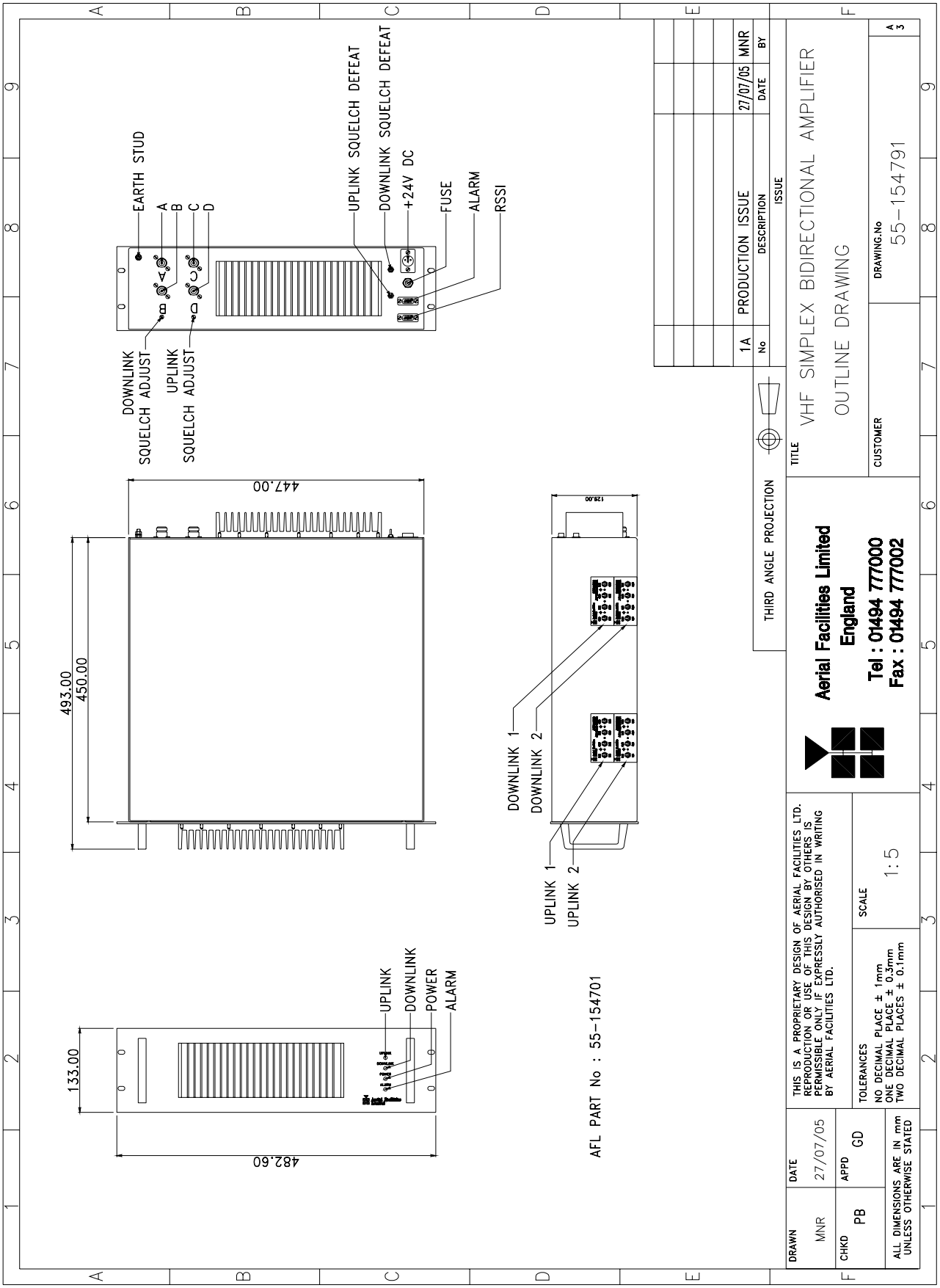
4.1.3 VHF Simplex BDA Mechanical Specification

PARAMETER		SPECIFICATION
Rack	Height:	Standard Eurorack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelves:	Height:	3U
	Width:	19" (482.6mm)
	Depth:	<400mm(excluding heatsinks, connectors, handles and feet)
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Weight:		<15kg
Humidity:		10 – 90% non-condensing
RF Connectors:		N type female
Environmental Protection:		IP54
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Supply Cable:		Unit supplied with suitable supply input leads, connector and specified length of cable (where appropriate)

4.1.4 VHF Simplex BDA System Diagram Drg. Nō. 55-154781



4.1.5 VHF Simplex BDA Shelf Outline Diagram Drg. Nō. 55-154791



4.1.6 VHF Simplex BDA Shelf Assembly (55-154701) Parts List

AFL Part Nō.	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	6
12-002213	3 STAGE ALARM/SIMPLEX MUTE PCB SUB-ASS	2
12-002220	3 STAGE ALARM PCB COVER	2
12-002826	ALARM BOARD ACRYLIC LENS	2
12-004902	POWER AMP VHF 5W CLASS AB	2
13-001803	DUAL DC/DC CONVERTER 24V-12V 1A	2
17-009143	VHF 10Kstep CH MOD 15kHz 8p BW+IFRX	2
17-009724	EQUIP. MTG PLATE No.5	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
20-001602	24V RELAY BOARD	2
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)	5
91-620001	'D' 25 WAY SOCKET S/B TERM	2
91-700017	ICD 15 WAY 0.1' CONNECTOR	2
93-540035	1K3 0.25W 1% RES MRS25 M:F	2
96-110001	FUSE HOLDER 20 x 5mm6.3A	1
96-600002	INSULATING BOOT SMALL	1
96-600003	INSULATING BOOT D.C.	1
96-700017	LED AMBER 5mm SEALED IP66	2
96-700034	LED RED 5mm IP67	1
96-700035	LED GREEN 5mm IP67	1
97-400005	HANDLE TYPE H6802 3U [ALLOY]	2

4.2 VHF Duplex BDA (55-154801)

4.2.1 VHF Duplex BDA Description

The duplex shelves are part of the VHF amplification and like the simplex shelves, have crystal filters instead of bandpass filters to set bandwidths. There are two downlink bands and three uplink bands, the downlink paths having isolators fitted to each of the 5Watt output stages to prevent reflections from interfering with the other channel.
The uplink channel module has 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 'D' type alarm connector.

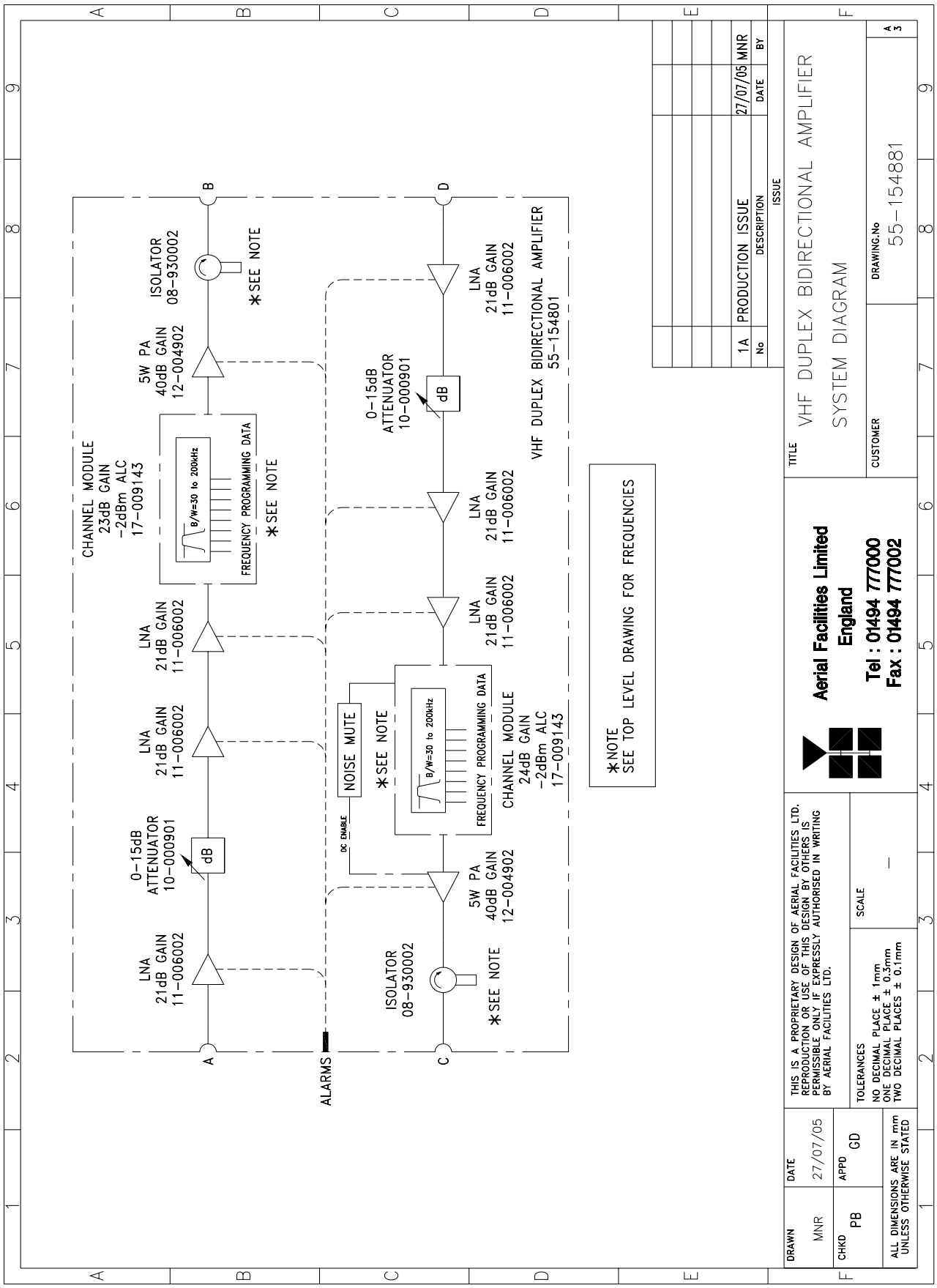
4.2.2 VHF Duplex BDA Electrical Specification

PARAMETER		SPECIFICATION
Frequency range:		153.75-155.3MHz (Downlink1)
		159.0-161.0MHz (Downlink2)
		153.75-155.3MHz (Uplink1)
		158.85-159.3MHz (Uplink2)
		161.5-162.0MHz (Uplink)
Gain:		>90dB
Gain Adjustment:		0 – 15dB (in 1dB step)
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:	-10°C to +55°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 U/L amplifiers
		2 D/L amplifiers
		3 Channel modules

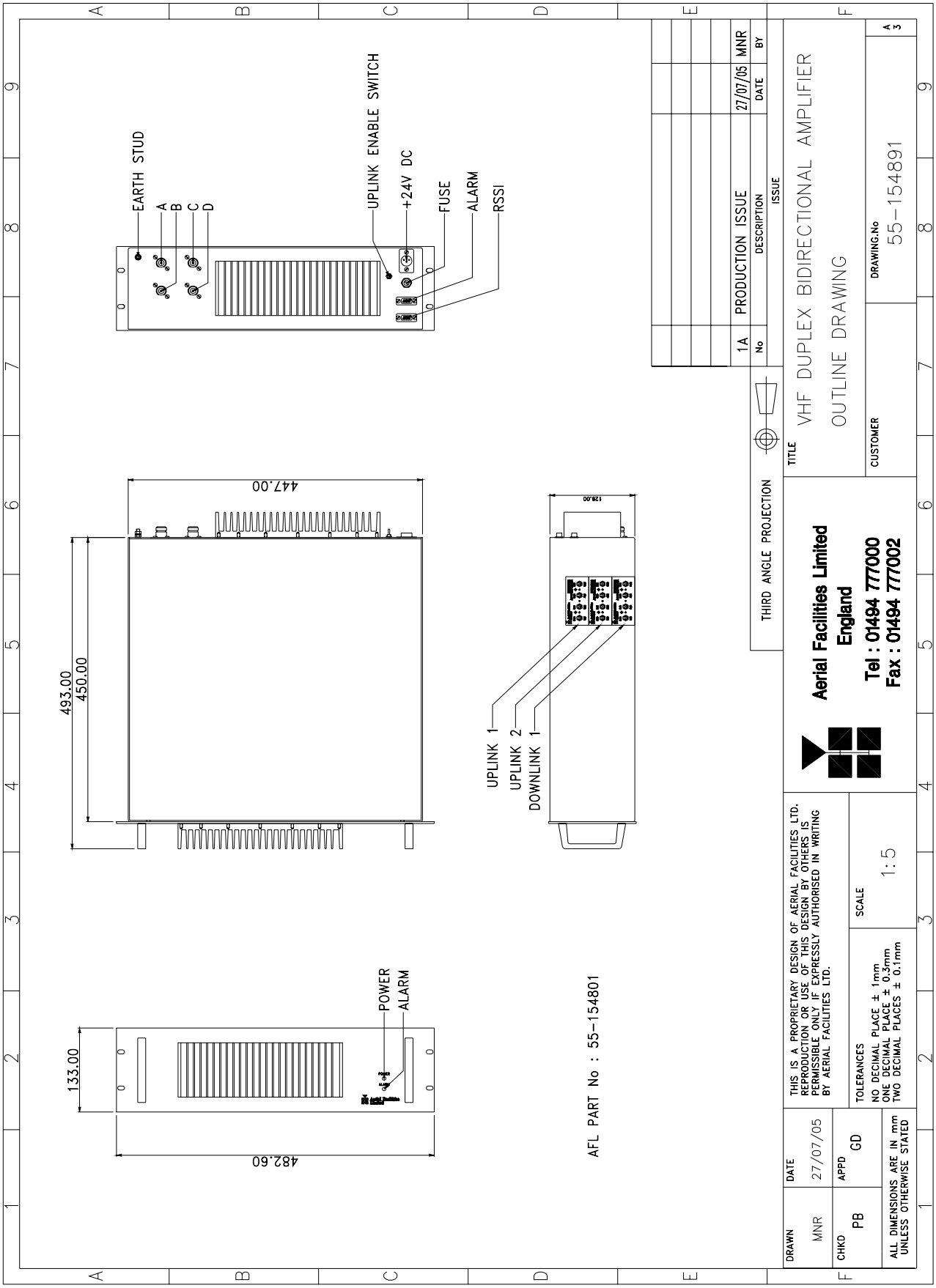
4.2.3 VHF Duplex BDA Mechanical Specification

PARAMETER		SPECIFICATION
Rack	Height:	Standard Eurorack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelves:	Height:	3U
	Width:	19" (482.6mm)
	Depth:	<400mm(excluding heatsinks, connectors, handles and feet)
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Weight:		<15kg
Humidity:		5 – 95% non-condensing
RF Connectors:		N type female
Environmental protection:		IP54
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia:	Painted to RAL 7035
Supply Cable:		Unit supplied with suitable supply input leads, connector and specified length of cable (where appropriate)

4.2.4 VHF Duplex BDA System Diagram 55-154801



4.2.5 VHF Duplex Shelf Outline Drawing, Drg. Nō. 55-154891



4.2.6 VHF Duplex BDA Shelf Assembly (55-154801) Parts List

AFL Part Nō.	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	6
12-002201	3 STAGE AMPLIFIER ALARM BOARD	1
12-002213	3 STAGE ALM/SIMPLEXMUTE PCB SUB-ASS	1
12-002220	3 STAGE ALARM PCB COVER	2
12-002826	ALARM BOARD ACRYLIC LENS	2
12-004902	POWER AMP VHF 5W CLASS AB	2
13-001803	DUAL DC/DC CONVERTER 24V-12V 1A	2
17-001105	CE AGC UNIT LOG DET/AMP ASSY (24V)	1
17-001107	OPEN COLLECTOR FOR SIMPLEX CONT.	1
17-009143	VHF 10Kstep CH MOD 15kHz 8p BW+IFRX	2
17-009725	EQUIP. MTG PLATE No.6	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
20-001601	12V RELAY BOARD	1
80-008902	24V RELAY PCB ASSEMBLY	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
91-600007	'D' 9 WAY BLACK SHELL	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	3
96-110001	FUSE HOLDER 20 x 5mm6.3A	1
96-600002	INSULATING BOOT SMALL	1
96-600003	INSULATING BOOT D.C.	1
96-700034	LED RED 5mm IP67	1
96-700035	LED GREEN 5mm IP67	1
97-400005	HANDLE TYPE H6802 3U [ALLOY]	2

5. VHF SPLITTERS/COMBINERS

5.1 VHF Downlink Crystal Splitter (80-230801)

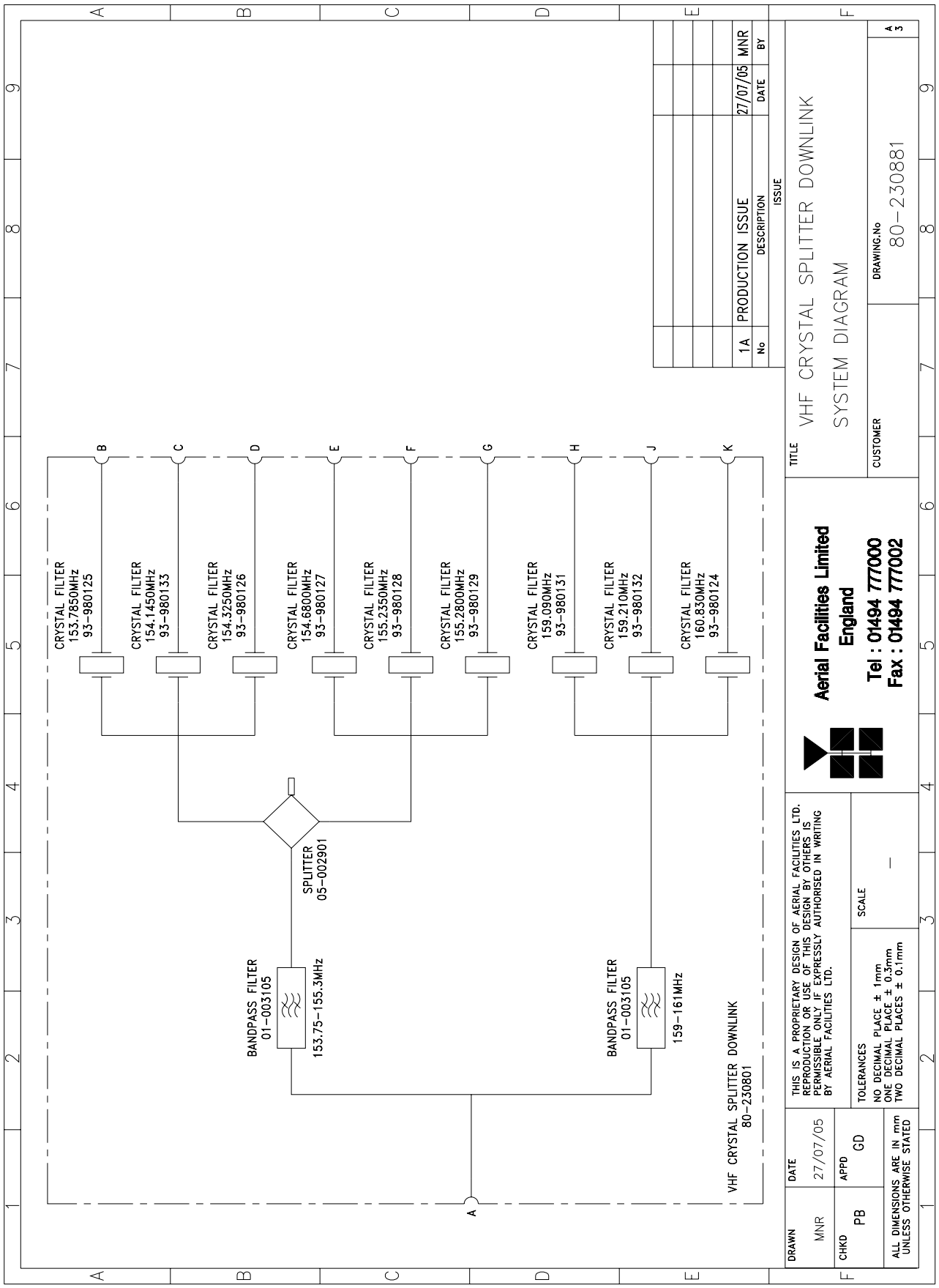
5.1.1 VHF Downlink Crystal Splitter Description

The crystal splitter shelf is used in the downlink path to isolate the VHF channel frequencies at the inputs to the cell enhancers which amplify them. These frequencies are initially processed by bandpass filters which eliminate spurious frequencies prior to being passed by the crystal filters which have a much narrower bandwidth than the filters before amplification by their respective channel selective modules.
Being passive shelves, no alarms are present.

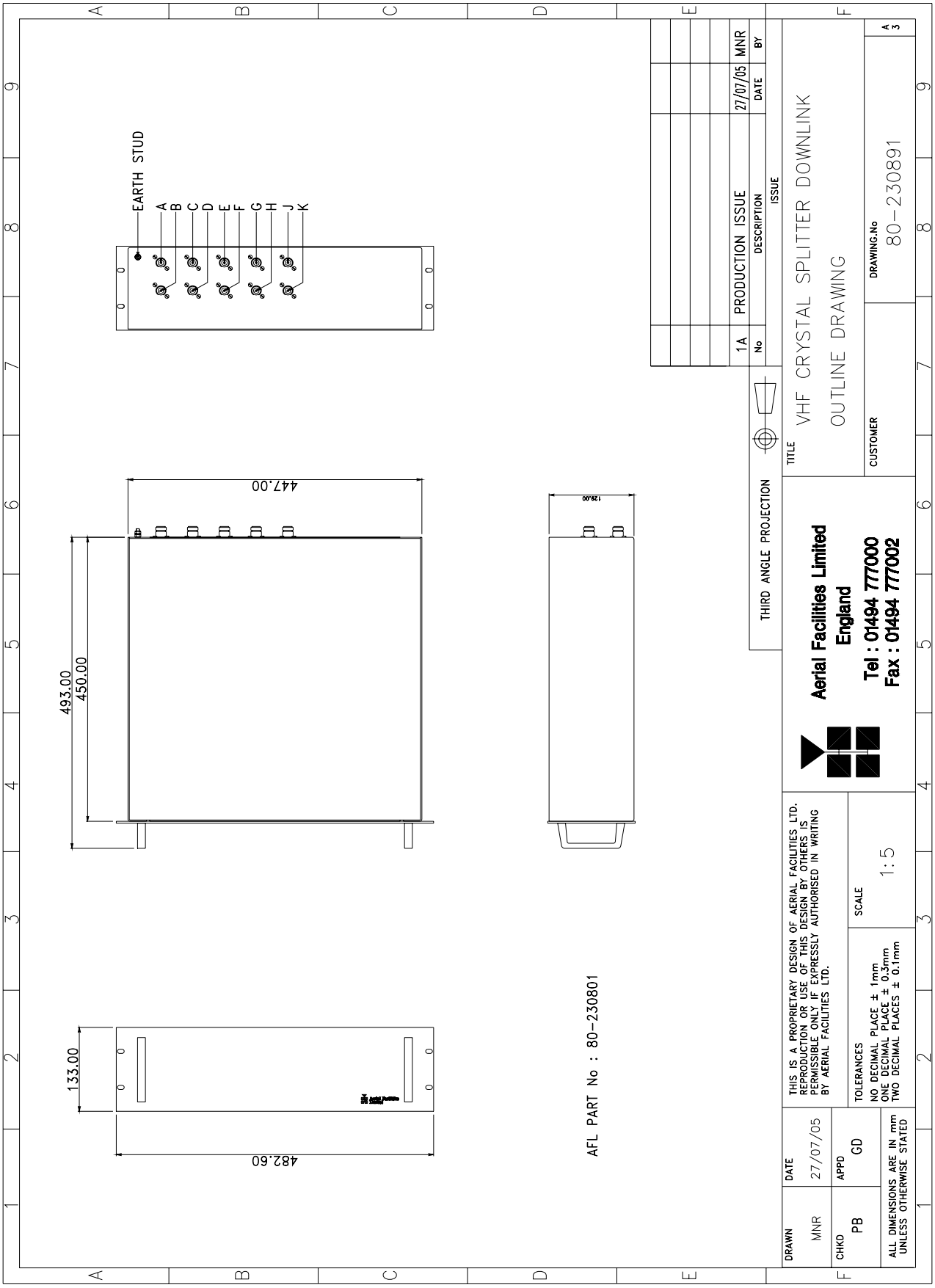
5.1.2 VHF Downlink Crystal Splitter Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
Rejection:		>30dB
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted:		None

5.1.3 VHF Downlink Crystal Filter System Diagram, Drg. Nō 80-230881



5.1.4 VHF Downlink Crystal Filter Shelf Outline Drawing, Drg. Nō. 80-230891



5.1.5 VHF Downlink Crystal Filter Shelf Parts List

AFL Part Nō.	Part Description	Qty.
01-003105	SD NOTCH FILT.N 6 SECT.VHF H/B SMA	2
05-002901	3dB BROADBAND SPLITTER SMA 1WATT	1
19-000921K	3U CHASSIS KIT (400mm deep)	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	10
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	7
93-980124	160.830MHz CRYSTAL FILT FAN4M52500	1
93-980125	153.785MHz CRYSTAL FILT FAN4M52500	1
93-980126	154.325MHz CRYSTAL FILT FAN4M52500	1
93-980127	154.680MHz CRYSTAL FILT FAN4M52500	1
93-980128	155.235MHz CRYSTAL FILT FAN4M52500	1
93-980129	155.280MHz CRYSTAL FILT FAN4M52500	1
93-980131	159.090MHz CRYSTAL FILT FAN4M52500	1
93-980132	159.210MHz CRYSTAL FILT FAN4M52500	1
93-980133	154.145MHz CRYSTAL FILT FAN4M52500	1

5.2 VHF Downlink Combiner (80-230901)

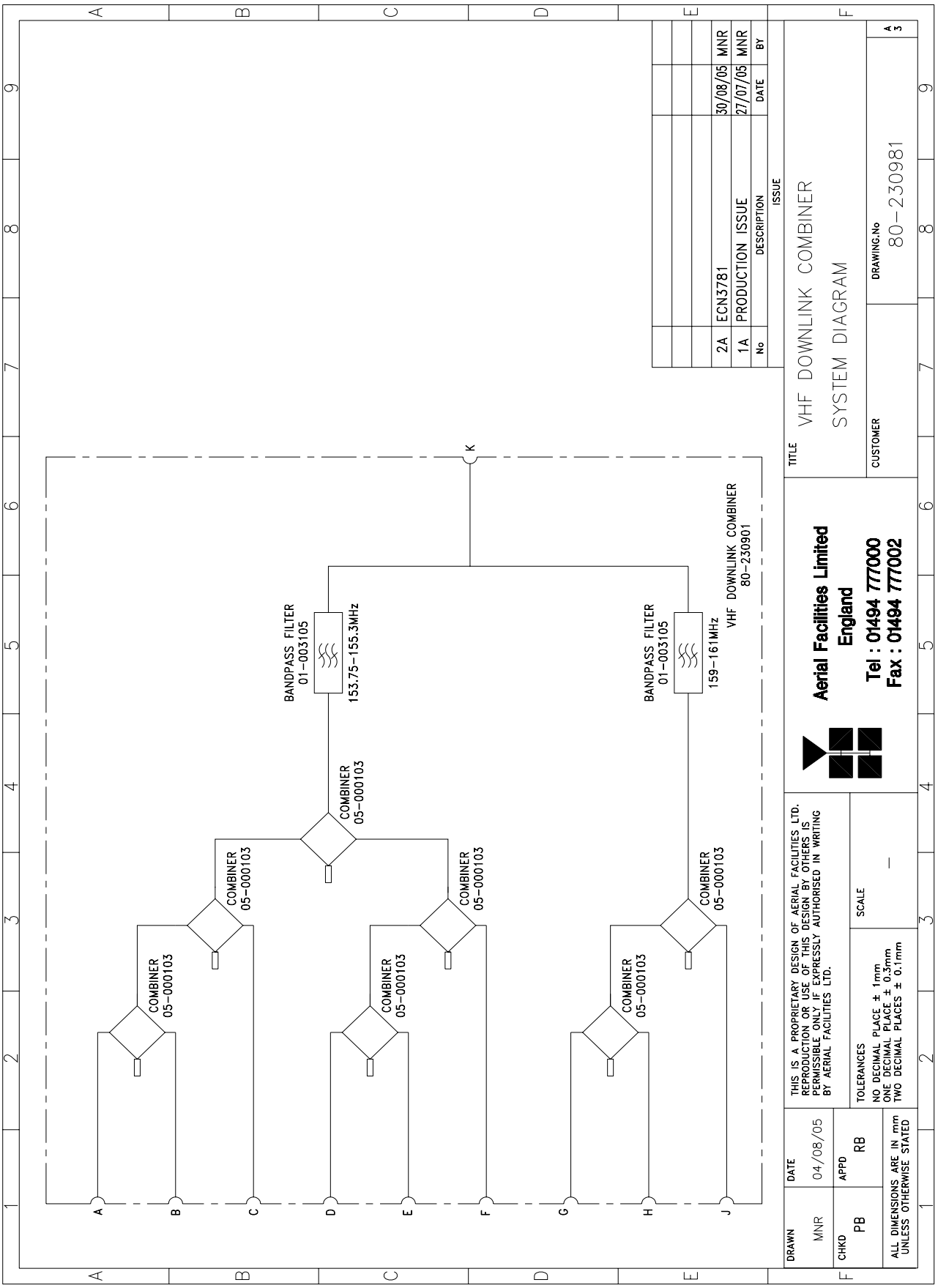
5.2.1 VHF Downlink Combiner Description

The VHF downlink combiner shelf is the interface between the downlink VHF cell enhancers and the tunnel leaky feeder outputs. It consists of a number of two-to-one hybrid couplers which combine the outputs to two bandpass filters which only allow the specified VHF band to pass.
Being a passive shelf, no alarms are present.

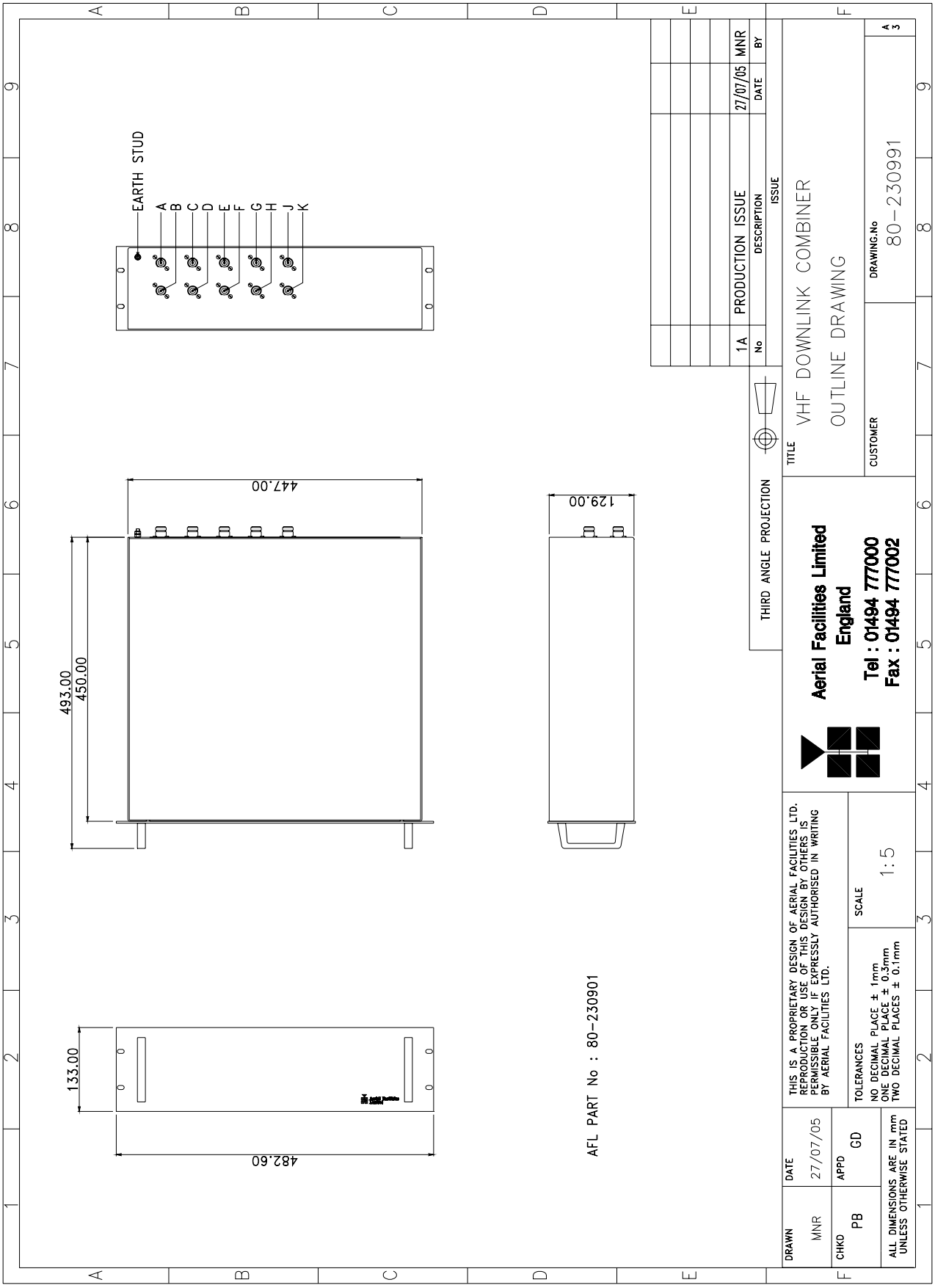
5.2.2 VHF Downlink Combiner Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
Rejection:		>30dB
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted:		None

5.2.3 VHF Downlink Combiner System Diagram, Drg. Nō. 80-230981



5.2.4 VHF Downlink Combiner Shelf Outline Drawing, Drg. Nō. 80-230991



5.2.5 VHF Downlink Combiner Parts List

AFL Part Nō.	Part Description	Qty.
01-003105	SD NOTCH FILT.N 6 SECT.VHF H/B SMA	2
19-000921K	3U CHASSIS KIT (400mm deep)	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	10
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	1
05-000103	TX HYBRID COUPLER 3 PORT NO HTSINK	7

5.3 VHF Uplink Crystal Splitter (80-231001)

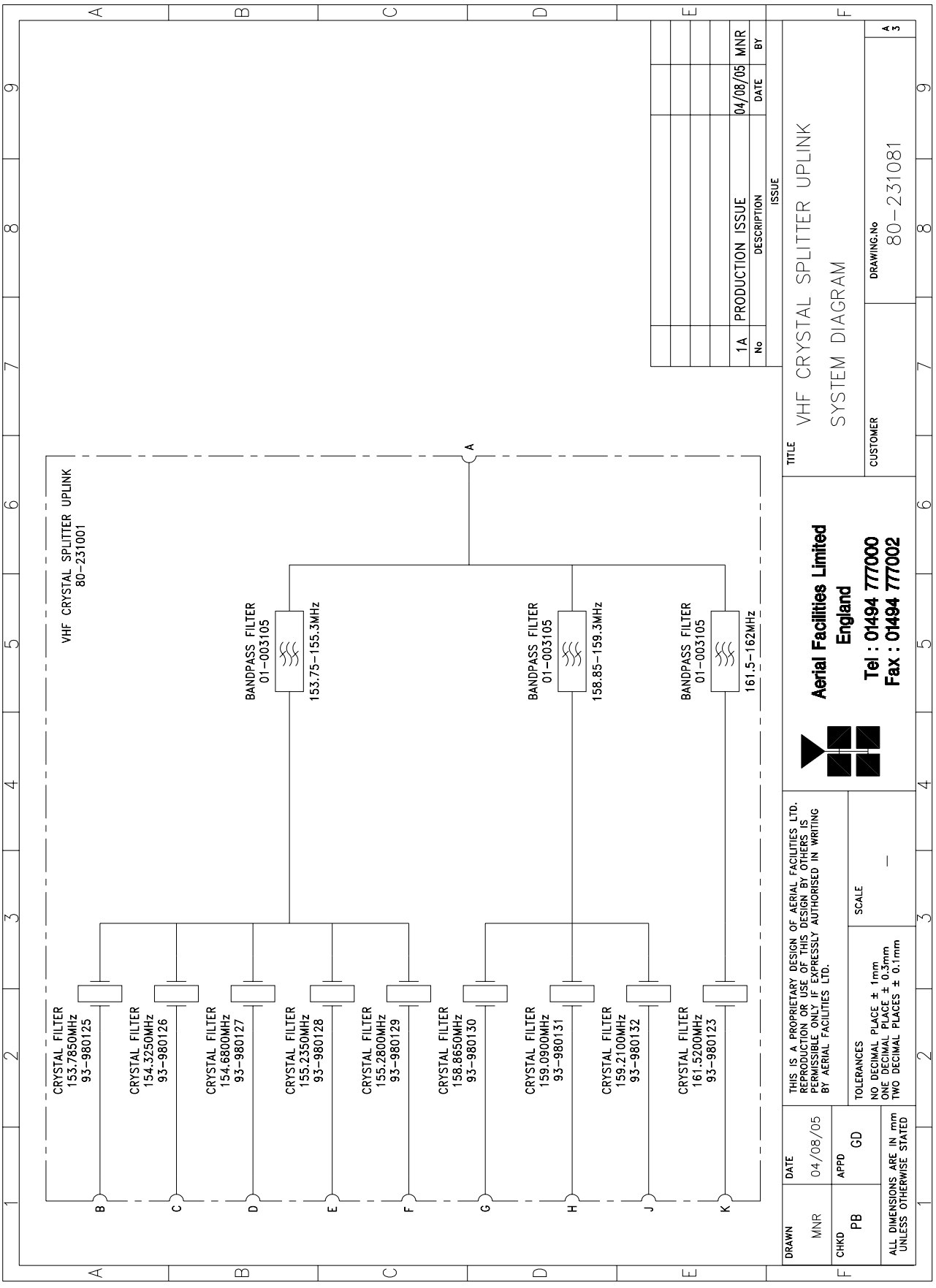
5.3.1 VHF Uplink Crystal Splitter Description

The uplink VHF crystal splitter shelf is the complement to the downlink crystal combiner shelf and uses the uplink frequency bands instead of the downlink bands.
Being a passive shelf, no alarms are present.

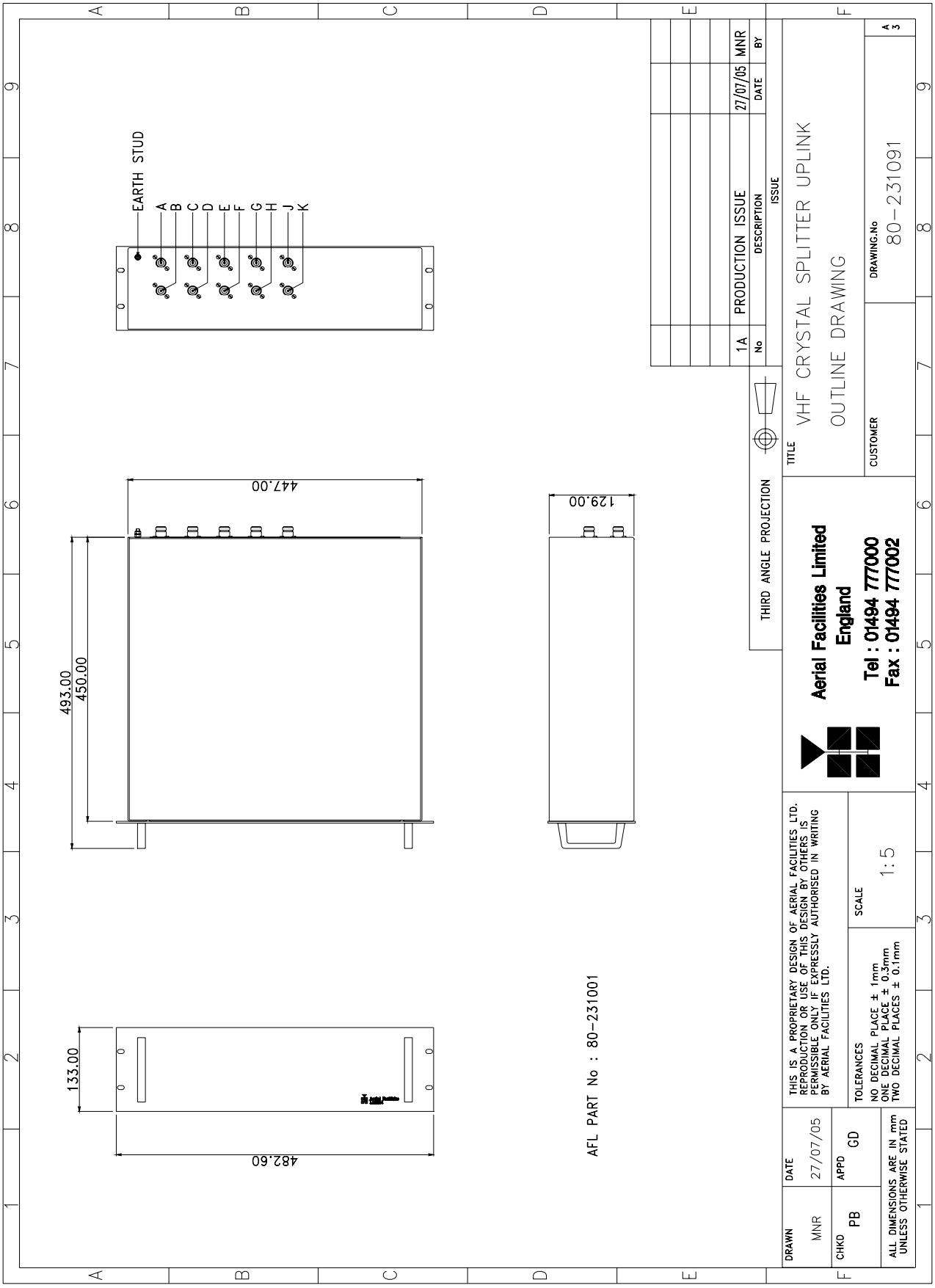
5.3.2 VHF Uplink Crystal Splitter Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
Rejection:		>30dB
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted:		None

5.3.3 VHF Uplink Crystal Splitter System Diagram, Drg. Nō. 80-231081



5.3.4 VHF Uplink Crystal Splitter, Drg. Nō. 80-231091



5.3.5 VHF Uplink Crystal Splitter Parts List

AFL Part Nō.	Part Description	Qty.
01-002503	FILTER VHF H/B 6 SMA S 100W	2
01-003105	SD NOTCH FILT.N 6 SECT.VHF H/B SMA	1
05-002901	3dB BROADBAND SPLITTER SMA 1WATT	1
19-000921K	3U CHASSIS KIT (400mm deep)	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	10
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	8
93-980123	161.520MHz CRYSTAL FILT FAN4M52500	1
93-980125	153.785MHz CRYSTAL FILT FAN4M52500	1
93-980126	154.325MHz CRYSTAL FILT FAN4M52500	1
93-980127	154.680MHz CRYSTAL FILT FAN4M52500	1
93-980128	155.235MHz CRYSTAL FILT FAN4M52500	1
93-980129	155.280MHz CRYSTAL FILT FAN4M52500	1
93-980130	158.865MHz CRYSTAL FILT FAN4M52500	1
93-980131	159.090MHz CRYSTAL FILT FAN4M52500	1
93-980132	159.210MHz CRYSTAL FILT FAN4M52500	1

5.4 VHF Uplink Combiner (80-231101)

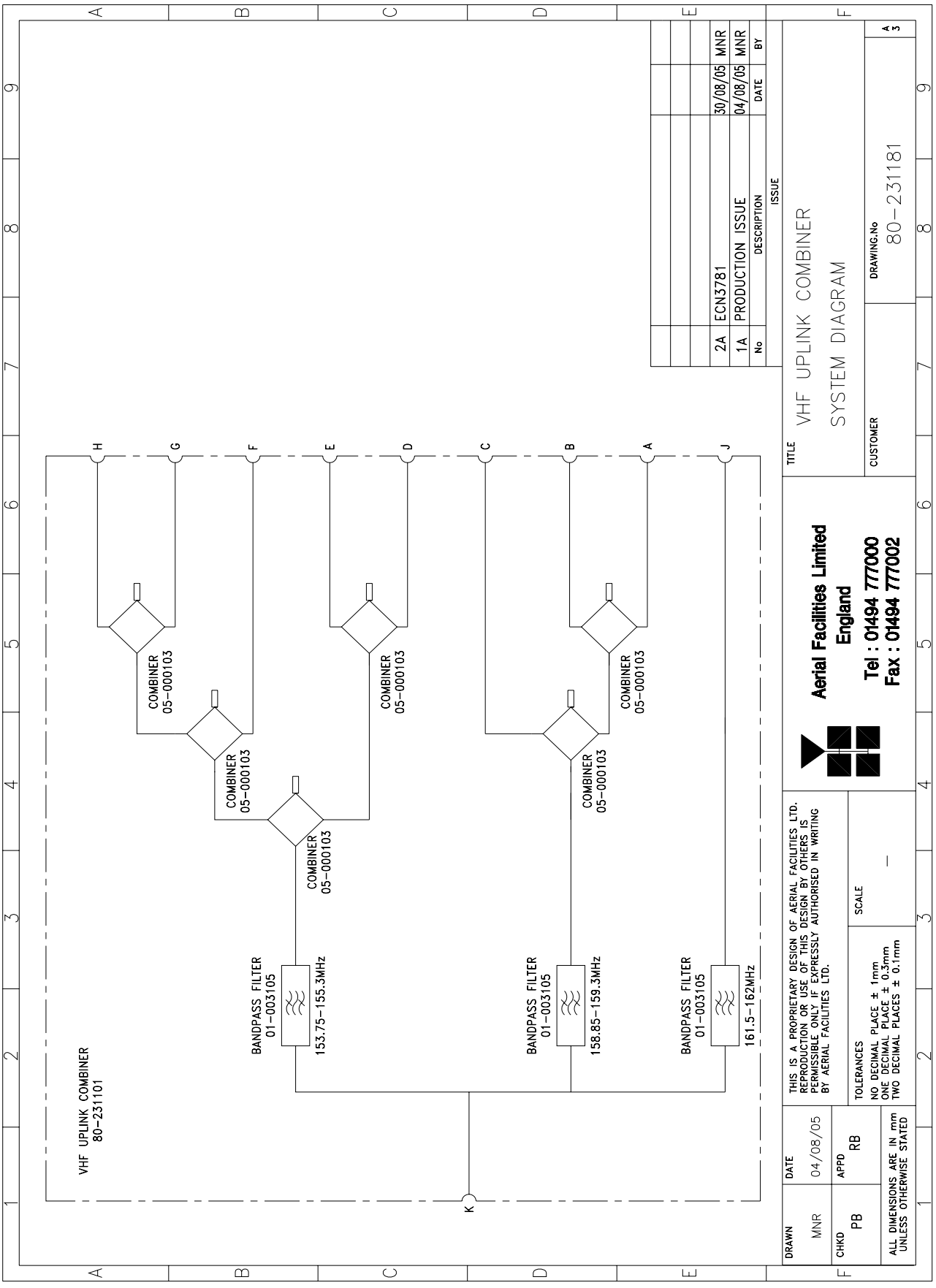
5.4.1 VHF Uplink Combiner Description

This shelf is the interface between the uplink VHF cell enhancers and the Tx antenna output port. The outputs of all the cell enhancers are first combined by combinations of two-to- one hybrid combiners which feed a triplexer filter array, which in turn, couple these three signals to the Tx antenna output port.
This being a passive shelf, no alarms are present.

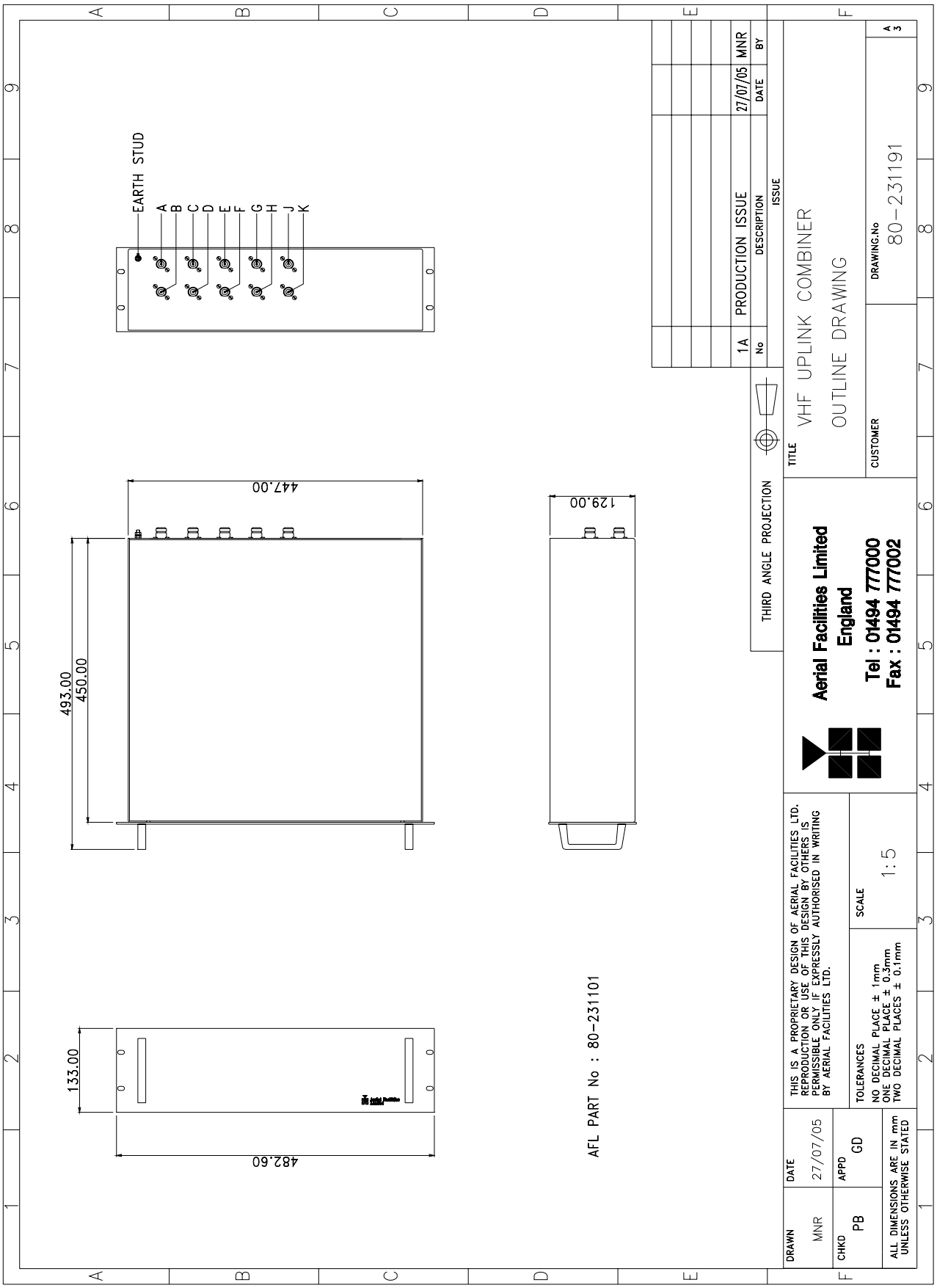
5.4.2 VHF Uplink Combiner Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
Rejection:		>30dB
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted:		None

5.4.3 VHF Uplink Combiner System Diagram, Drg. Nō. 80-231181



5.4.4 VHF Uplink Combiner Shelf Outline Drawing, Drg. Nō. 80-231191



5.4.5 VHF Uplink Combiner Parts List

AFL Part Nō.	Part Description	Qty.
01-002503	FILTER VHF H/B 6 SMA S 100W	2
01-003105	SD NOTCH FILT.N 6 SECT.VHF H/B SMA	1
19-000921K	3U CHASSIS KIT (400mm deep)	1
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	2
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	10
05-000103	TX HYBRID COUPLER 3 PORT NO HTSINK	6

6. POWER SUPPLIES & ALARMS

6.1 UHF/VHF Power Supply (80-231301)

6.1.1 UHF/VHF Power Supply 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 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 at any one time.

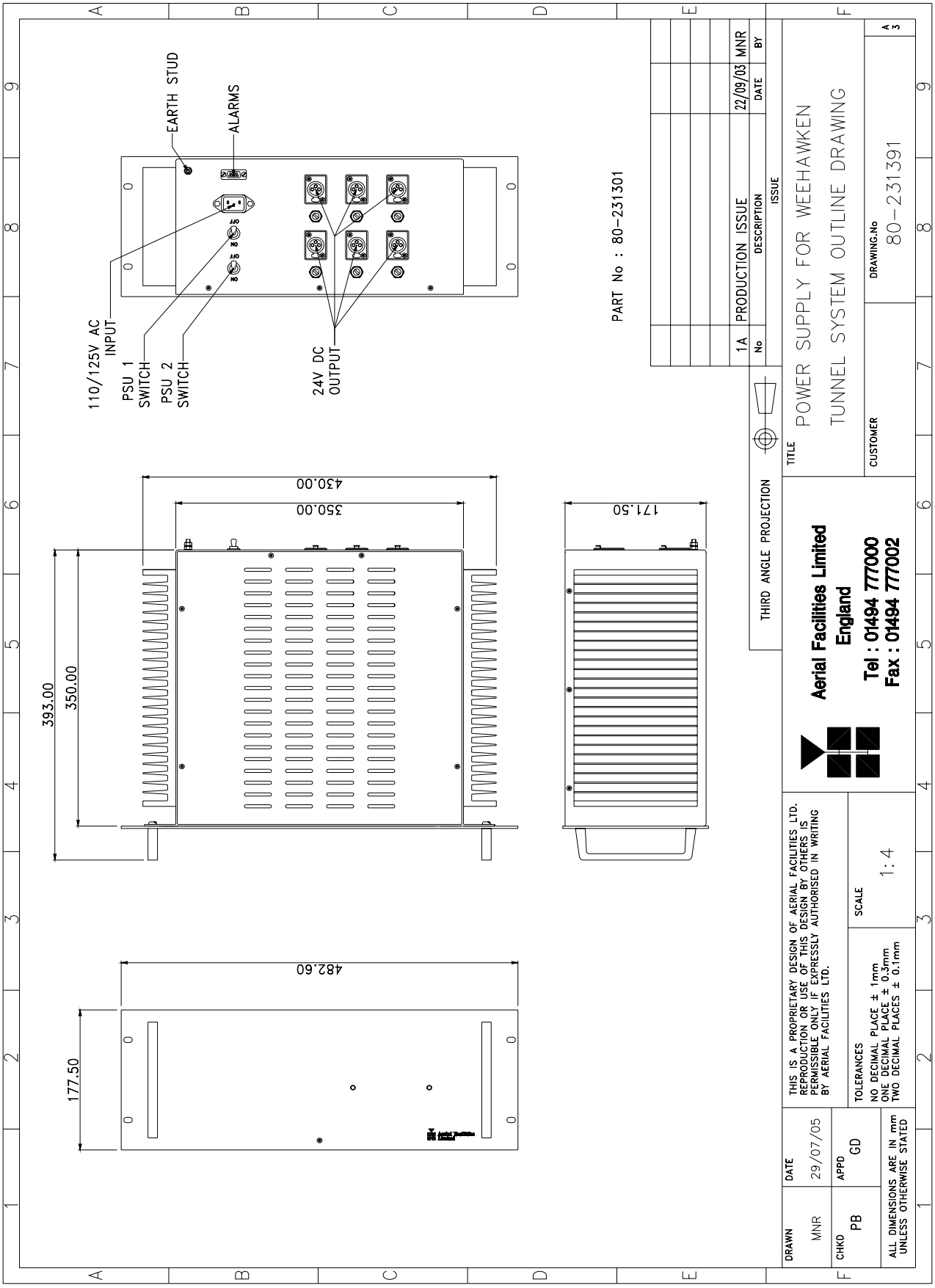
6.1.2 UHF/VHF Power Supply Technical Specification

PARAMETER		SPECIFICATION
Input:		110V AC @50/60Hz (single port)
Outputs:		6 x 24V DC @ 10A each
Front panel indicators:		(x 2) Green LED for 'PSU1/PSU2 ON''
Fuses		1 x 10A each outlet socket
DC Socket		XLR
Temperature range	operational:	-10°C to +55°C
	storage:	-40ºC to +70ºC
Alarmed devices:		Either PSU failure
Alarm interface (volt-free contacts):		'D' type alarm connector, pins 1 & 2
MTBF:		>50,000 hours
Earthing:		M8 stud

6.1.3 UHF/VHF Power Supply System Diagram

Not available at the time of compiling this document.

6.1.4 UHF/VHF Power Supply Outline Drawing, Drg. Nō. 80-231391



6.1.5 UHF/VHF Power Supply Parts List

AFL Part Nō.	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
91-800015	TRIPLE DECK TERMINAL BLOCK	8
91-800016	TRIPLE DECK TERMINAL JUMPER	6
91-800017	TRIPLE DECK TERMINAL END	1
91-800028	DIN RAIL END-STOP	2
91-800031	SYMETRIC 35 x 7.5mm DIN RAIL	0
92-900014	DIN RAIL (TOP HAT) EARTH CLAMP M5	1
93-510077	0R02 50W RESISTOR ALUMINIUM CLAD	2
94-100004	STPS12045TV 60A DUAL DIODE	1
95-100007	TX.FERRITE ISOL.HT.SINK B/ANOD	3
96-110034	FUSE HOLDER 16-30A, 32mm BODY ONLY	6
96-110064	FUSE HOLDER 16-30A, 32mm INSERT	6
96-300054	24V 17A PSU 400W (XP BCC)	2
96-600001	INSULATING BOOT LARGE	1
96-700034	LED RED 5mm IP67	1
96-700035	LED GREEN 5mm IP67	2
96-920023	5A CIRCUIT BREAKER (ETA)	2
97-400002	HANDLE TYPE H6803 4U.[ALLOY]	2

6.2 Alarm/Monitor Shelf (80-231303)

6.2.1 Alarm/Monitor Shelf Description

The alarm shelf acts as an alarm concentrator for all the alarms in the system. Firstly, within each shelf containing active components, the individually alarmed modules are 'summed' and presented to that shelves' 9-way alarm connector as a volt-free relay contact pair. These alarm contact pairs are wired to the krone block in the lower rack space and from there the pairs are presented to the alarm shelf. At the alarm shelf the pairs are summed together to form an overall system alarm. In this way a system alarm may be broken down to scrutinise the shelf alarm and ultimately to the individual modules' alarms.
This shelf has its own dedicated mains-driven power 12V DC supply.

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

6.2.2 Alarm/Monitor Shelf Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		12V (floating earth)
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		25 Way 'D' Connector
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C

6.2.3 Alarm/Monitor Shelf Parts List

AFL Part Nō.	Part Description	Qty.
19-000724	1U 19" UNIT FRONT PANEL FAB	1
19-000725	1U 19" UNIT 400 DEEP CHASSIS + BKT	1
19-000826	2U,3U,4U 19" UNIT 400 DEEP LID	1
20-001601	12V RELAY BOARD	4
91-520003	POWER SWITCHD/FUSED MAINS INL.	1
91-520005	MAINS LEAD	1
91-520010	MAINS RETAINING CLIP	1
91-600014	'D' 9 WAY SOCKET S/B (NON FILTERED)	8
91-600015	'D' 9 WAY PLUG S/B (NON FILTERED)	8
96-300072	12V POWER SUPPLY TML15112C	1
96-600001	INSULATING BOOT LARGE	1
96-700034	LED RED 5mm IP67	8
96-700035	LED GREEN 5mm IP67	1

7. SUB-UNIT MODULES

Note that the sub unit modules are tabled in part number order – the modules pertinent to any particular shelf will be found in the parts list under the heading of that shelf.

7.1 VHF High Band Bandpass + Notch Filter (01-003105)

7.1.1 Description

The bandpass filters are multi-section designs with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of helical design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports. The bandpass filters fitted here have a notch filter as the final tuned element in their construction to completely eliminate unwanted frequencies close to the band edge.
The notch reject filters should require no routine maintenance, being totally passive devices. If a filter is suspected of failure, no invasive measures are recommended as even opening the case of the device could render it unusable.

7.1.2 Technical Specification

PARAMETER		SPECIFICATION
Passband:		155 - 160 MHz
Insertion Loss:		1.6 dB (typical)
RF Connectors:		SMA
Power Rating:		100 Watt
Impedance:		50Ω
VSWR:		Better than 1.2:1
Temperature range	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:		348x102x55mm (case only)

7.2 Tx Hybrid Coupler (05-000101)

7.2.1 Description

The Hybrid Combiner used is a device for accurately matching two or more RF signals to single or multiple ports, whilst maintaining an accurate 50Ω load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum. Any unused ports will be terminated with an appropriate 50Ω load.

7.2.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		f_o ± 10% (50 – 500 MHz)
Bandwidth:		f_o ± 10%
Inputs/Outputs:		2 each
Insertion Loss:		<3.3 dB
Isolation between Input/Output ports:		>27 dB
Return Loss (VSWR) – Input/Output:		1.3:1
Impedance:		50 Ω
Temperature range	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
MTBF:		>180,000 hours
Power Rating – Splitter:		Up to 150 Watts (load dependant)
Power Rating – Combiner:		Available up to 100 Watts
Environmental:		IP54
Connectors:		'N' female
Dimensions:		118 x 102 x 35 mm (incl. connectors)
Weight:		0.5 kg

7.3 3 Port Tx Hybrid Coupler (05-000103)

7.3.1 Description

The transmitter hybrid couplers provide isolation from unwanted reflected frequencies to/from the leaky feeder antennas. They are 4 port devices with the one unused port terminated internally with a 50 Ω dummy load.

Being passive devices, the hybrid couplers should be maintenance free over their entire lifetime and have an extremely high MTBF figure. It is not recommended that the top cover be removed or any of the internal components needlessly touched, since the original factory alignment/tuning would be extremely hard to reproduce in a 'field' environment.

7.3.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency Range:	140-170 MHz
Bandwidth:	±10% of f_o
Insertion Loss:	3.2dB
Impedance:	50Ω
V.S.W.R:	1.2:1
Input to input isolation:	>20dB
Connectors:	Type N Standard
Dimensions:	140 x 120 x 35mm
Power rating:	25Watts
Weight:	0.5kg

7.4 1 Watt 3dB Broadband Splitter (05-002901)

7.4.1 Description

The 1 Watt, 3dB Splitter/Combiner used is a device for accurately matching two or more RF signals to single or multiple ports, whilst maintaining an accurate 50Ω load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum. Any unused ports will be terminated with an appropriate 50Ω load.

7.4.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency range:	100 - 520 MHz
Bandwidth:	380 MHz
Inputs:	1
Outputs:	2
Insertion Loss:	3.5 dB (typical)
Isolation:	>18 dB
Return Loss (VSWR) – Input:	Better than 1.3:1
Return Loss (VSWR) – Output:	Better than 1.3:1
Impedance:	50 ς
Power Rating – Splitter:	20 Watts
Power Rating – Combiner:	1.0 Watt
Connectors:	SMA female
Size:	54 x 44 x 21 mm (including connectors)
Weight:	200 gm (approximately)

7.5 2-Port RF Isolator (08-930002)

7.5.1 Description

The purpose of fitting an isolator to the output of a transmitter in a multi-transmitter environment is such that each output is afforded a degree of isolation from every other. Were this not to be the case, two simultaneous transmissions could interfere to create intermodulation products, especially in the non-linear power amplifier output stages of the transmitters. Whilst this effect would not affect the intelligibility of the two original transmissions, a further two new transmissions would be created which could themselves cause interference to third party users.

The ferrite isolator is a ferro-magnetic device, which has directional properties. In the forward direction, RF arriving at the input is passed to the output with minimal attenuation. In the reverse direction, RF arriving at the output due to reflected power from a badly matched load, or due to coupling with another transmitter, is routed into an RF load where it is absorbed. The isolator therefore functions to prevent reflected RF energy reaching the power amplifier where it could cause intermodulation products or premature device failure.

7.5.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency range:	100-300MHz
Bandwidth (% of centre frequency):	2
Isolation:	35dB (typical)
Insertion loss:	0.25dB (typical
V.S.W.R:	1.15:1 (typical)
Maximum power:	200Watts (per carrier)
Connector:	SMA
Weight:	200gm (approximately)

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

7.6.1 General Application

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

7.6.2 Switched Attenuators

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

7.7 3 Stage Amplifier Alarm Board (12-002201)

7.7.1 Description

Amplifier Alarm Boards are fitted to monitor the bias conditions of AFL Class A amplifiers which remain constant in normal operation. Any departure from normal bias conditions is a result of device failure, excess temperature, over-driving or oscillation (excessive power).

In normal operation, the Class A bias circuit of the amplifier develops a constant voltage of 1.20V across the collector current setting resistor. The Amplifier Alarm Board is a window comparator device, which is adjusted to sense a departure from this condition. Several different alarm outputs are provided to simplify interfacing, (Relay Contact, Open Collector, and TTL Logic Levels)

The basic version of the Alarm Board (12-002801) monitors a single amplifier stage. A three-stage version (12-002201) is used on complex amplifiers where three separate comparators have their outputs logically combined to a common output stage. Failure of any one stage will activate the alarms.

Note that the alarm board has a green Light Emitting Diode located near to the centre of the printed circuit board, which is illuminated on 'Good', and extinguished on 'Alarm'. It is therefore a simple matter to identify an active module failure, by searching for an Alarm Board which has its green LED extinguished. A simple test of the alarm board is possible by shorting across the monitor inputs, pins 1 and 2, 3 and 4 or across pins 5 and 6. This last monitor input is inactive if the board has been converted to a two way alarm board. (Refer to relevant amplifier alarm wiring diagram.)

1) Volt-free change over relay contacts.
2) Open collector NPN transistor pulls low on alarm.
3) TTL driver.

The use of precision voltage sources and resistors has eliminated the need for initial adjustment or calibration, and the board will function correctly with a wide variation in power supply voltage (8 to 30 volts, nominal supply is 12 or 24Volts).

There are two selectable link options on the three-way board:

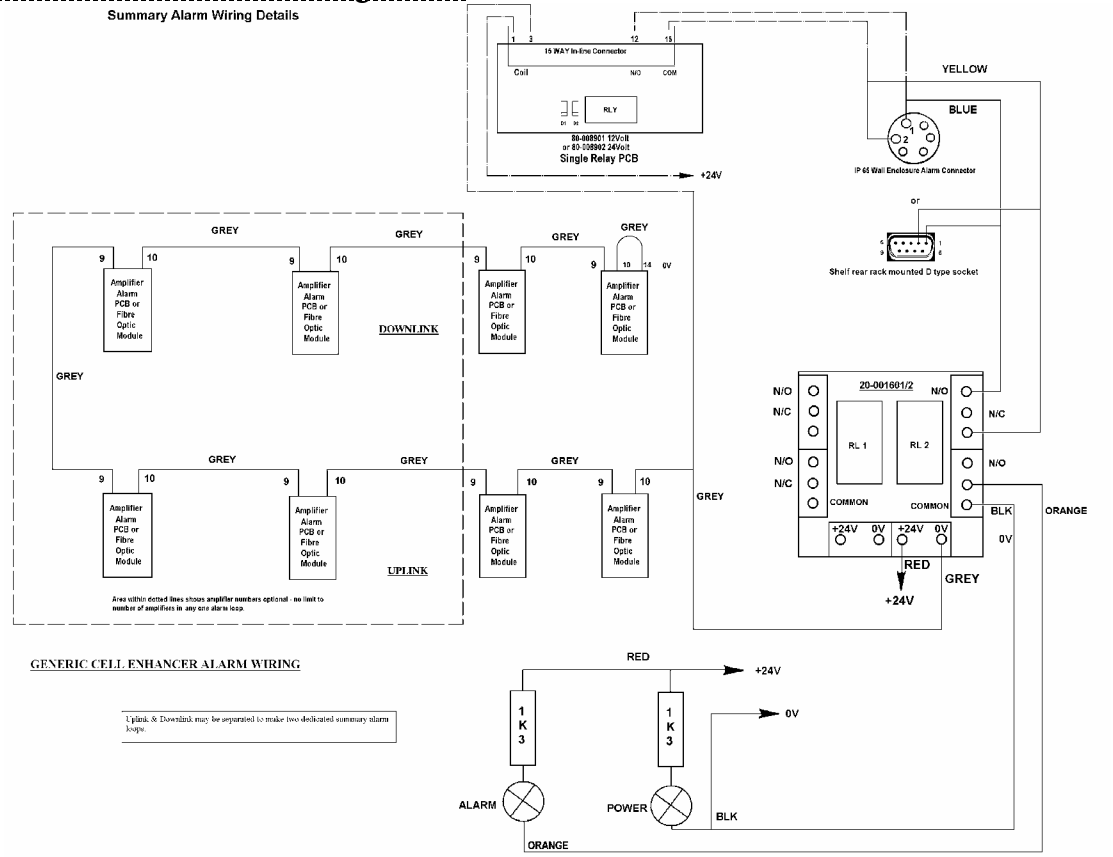
LINK1 - Removed to convert to two-way alarm board.
LINK2 - Removed to isolate 0V from chassis earth.

The one way alarm board only has the 0V isolation link (LINK2) fitted.

7.7.2 Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		8 to 30V (floating earth)
Alarm Threshold:		Vcc - 1.20 volt ±15%
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		15-way 0.1" pitch
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
PCB Size:		74 x 56mm (3 stage)
		54 x 56mm (1 stage)

7.7.3 Generic Alarm Wiring Sketch



7.8 3 Stage Alarm/Simplex/Mute PCB (12-002213)

7.8.1 Description

In systems using simplex channel switching, it is necessary to be able to distinguish between a 'normal' switching operation and erroneous modes where faults in the detector circuitry may cause data errors but not necessarily fire the alarms. The simplex alarm/mute board is designed to differentiate between normal and spurious switching signals for single or multiple stage amplifiers.

7.9 5Watt Low Power Amplifier (12-004902)

7.9.1 Description

The low power amplifier used is a triple stage solid-state low-noise amplifier. Class AB circuitry is used in the unit to ensure excellent linearity over a very wide dynamic range. The three active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on this amplifier, and in the unlikely event of failure then the entire amplifier should be replaced.

7.9.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		80-260MHz
Bandwidth:		20MHz (tuned to specificatic
Maximum RF output:		>5.0 Watt
Gain:		40dB
1dB compression point:		+34dBm
3rd order intercept point:		+44dBm
Noise Figure:		<2.4dB
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		500mA @ 24V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.5 kg
Size:		167 x 52 x 25mm

7.10 Dual DC/DC Converter (13-001803)

7.10.1 Description

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

The circuit is based upon a pair of LM257 series variable voltage regulators (LM2576, 12 & 15V & LM2575, 5V), which are each capable of supplying an absolute maximum of 1.5A output current. Note that at full output current, the dissipation of the device must remain within design limits, bearing in mind the voltage which is being dropped across it. The maximum allowable dissipation will also depend on the efficiency of the heatsink on which the device is mounted.

7.10.2 Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		21 – 27V DC
Output voltage:		12V & 12V (typical)
Output current:		1.0A (maximum per o/p)
Connections:		Screw Terminal Block
Temperature range	operational:	-10°C to +60°C
	storage	-20°C to +70°C
PCB Size:		85 x 63mm

7.11 D.I.P Channel Control Module (17-002101)

7.11.1 Description

The operating frequency for each channel in each repeater is programmed by 16 DIL (Dual In Line) switches. The programming switches are mounted in the Channel Control Module. The Channel Selectivity Modules are connected to the Channel Control Module via multi-way ribbon cables.

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 power 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)

7.11.2 Programming Procedure

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.

7.11.3 12.5kHz step size switch functions

Switch Number	Synthesiser offset added when switch in UP 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

7.11.4 25kHz step size switch functions

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

7.11.5 Programming Example

Frequency required: 454.000MHz

Channel spacing: 12.5kHz

Synthesiser offset: -21.4MHz

The Local Oscillator frequency is therefore:
454.000 – 21.4 = 432.600MHz

Dividing the LO frequency by the channel spacing of 0.0125MHz:

$$\frac{432.600}{0.0125} = 34608$$

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

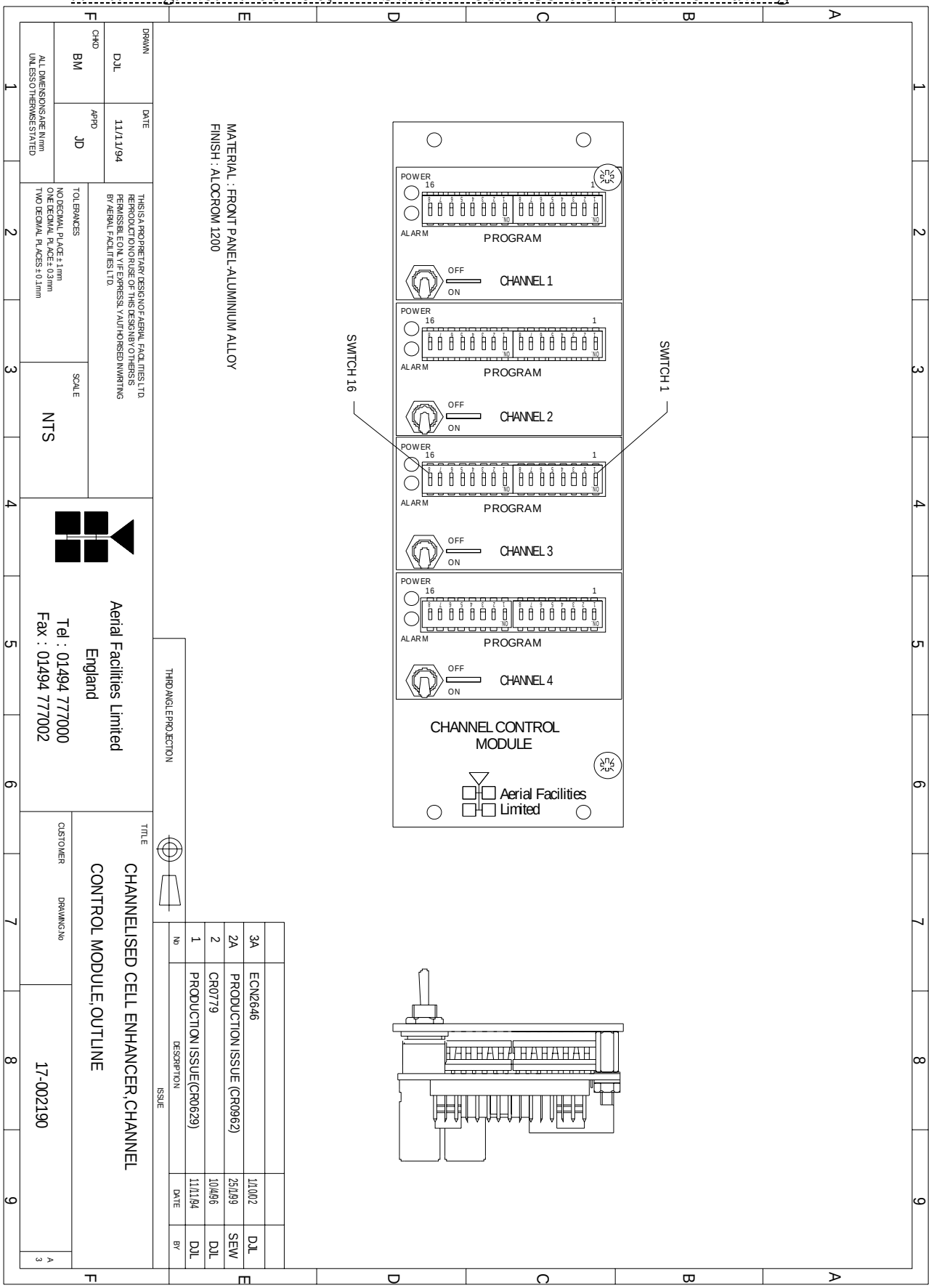
Local Oscillator Frequency	Switch settings 16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
432.600 MHz	1	0	0	0	0	1	1	1	0	0	1	1	0	0	0	0

Switch setting: 0 = switch DOWN (ON, frequency ignored)
1 = switch UP (OFF, frequency added)

7.11.6 17-002101 Controller Module DIP Switch Connector Data

IDC PIN	25-way Connector	Function (12.5kHz steps)
1	**13**	**Freq. bit 1 (12.5kHz)**
2	**25**	**Freq. bit 2 (25kHz)**
3	**12**	**Freq. bit 3 (50kHz)**
4	**24**	**Freq. bit 4 (100kHz)**
5	**11**	**Freq. bit 5 (200kHz)**
6	**23**	**Freq. bit 6 (400kHz)**
7	**10**	**Freq. bit 7 (800kHz)**
8	**22**	**Freq. bit 8 (1.6MHz)**
9	**9**	**Freq. bit 9 (3.2MHz)**
10	**21**	**Freq. bit 10 (6.4MHz)**
11	**8**	**Freq. bit 11 (12.8MHz)**
12	**20**	**Freq. bit 12 (25.6MHz)**
13	**7**	**Freq. bit 13 (51.2MHz)**
14	**19**	**Freq. bit 14 (102.4MHz)**
15	**6**	**Freq. bit 15 (204.8MHz)**
16	**18**	**Freq. bit 16 (409.6MHz)**
17	**5**	**Module alarm**
18	**17**	**Gain bit 1**
19	**4**	**Gain bit 2**
20	**16**	**Gain bit 3**
21	**3**	**Gain bit 4**
22	**15**	**+5V**
23	**2**	**0V**
24	**14**	**Switched 12V**
25	**1**	**0V**
26	**---**	**---**

7.11.7 Drg. Nō. 17-002190, DIP Switch Module Controller Outline Drawing



7.12 Channel Selective Modules (17-009143 & 17-009127)

7.12.1 Description

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

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

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

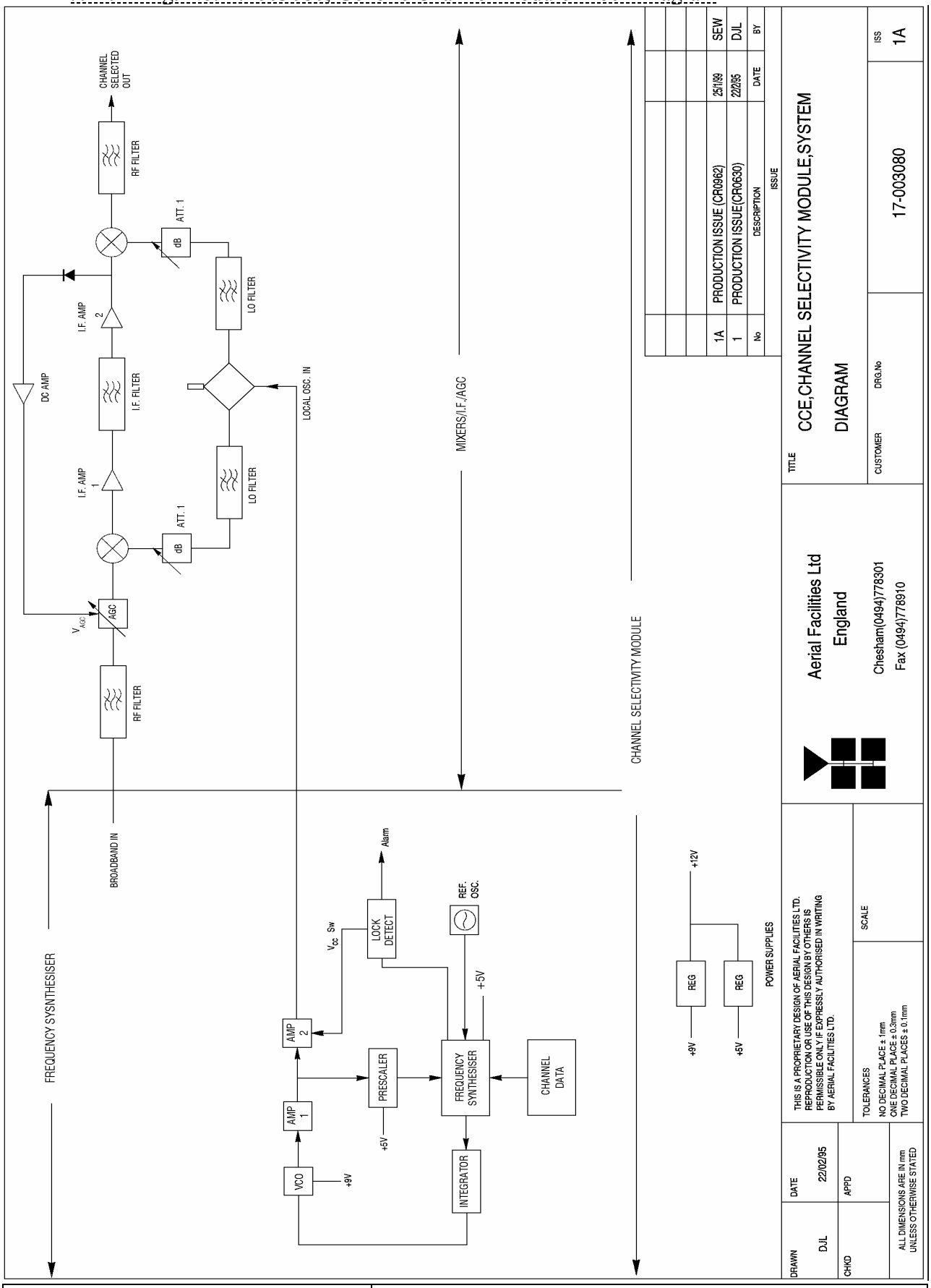
The operating frequency of each channel selectivity module is set by the programming of channel selectivity module frequencies and is achieved digitally, via hard wired links, banks of DIP switches, or via an onboard RS232 control module, providing the ability to remotely set channel frequencies.

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

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

The channel selectivity module is extremely complex and, with the exception of channel frequency programming within the design bandwidth, it cannot be adjusted or repaired without extensive laboratory facilities and the necessary specialised personnel. If a fault is suspected with any channel selectivity module it should be tested by substitution and the complete, suspect module should then be returned to AFL for investigation. The channel selective modules fitted to the VHF cell enhancers in the Weehawken system are all hard-wired and therefore not adjustable, however, the modules fitted to the UHF and 800MHz enhancers have DIP switch controller modules fitted, allowing the set frequency to be changed on site. There is no functionality to change the frequencies remotely.

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



7.13 12 & 24V Relay Boards (20-001601 & 20-001602)

7.13.1 Description

The General Purpose Relay Board allows the inversion of signals and the isolation of circuits. It is equipped with two dual pole change-over relays RL1 and RL2, with completely isolated wiring, accessed via screw terminals.
Both relays are provided with polarity protection diodes and diodes for suppressing the transients caused by "flywheel effect" which can destroy switching transistors or induce spikes on neighbouring circuits. It's common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.
Note that the board is available for different voltages (12 or 24V) depending on the type of relays fitted at RL1 and RL2.

7.13.2 Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		8 to 30V (floating earth)
Alarm Threshold:		Vcc - 1.20 volt ±15%
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		Screw terminals
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C

7.14 12 & 24V Single Relay Board (80-008901 & 80-008902)

7.14.1 Description

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

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

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

7.15 24V, 400W Power Supply Pack (96-300054)

7.15.1 Description

The power supply unit is a switched-mode type capable of supplying 24V DC at 17.0Amps continuously. Equipment of this type typically requires approximately 10.0 Amps at 24V DC, so the PSU will be used conservatively ensuring a long operational lifetime.

No routine maintenance of the PSU is required. If a fault is suspected, then the output voltage from the power supply may be measured on its output terminals. This is typically set to 24.5V using the multi-turn potentiometer mounted close to the DC output studs on the PSU PCB.

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

7.15.2 Technical Specification

AC Input Supply	
Voltages:	110 or 220V nominal
	90 to 132 or 180 to 264V (absolute limits)
Frequency:	47 to 63Hz
DC Output Supply:	
Voltage:	24V DC (nominal)
	20 to 28V (absolute limits)
Maximum current:	17A

8. INSTALLATION

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

8.1 General Remarks

The size and weight of the equipment racks mean that they represent a significant topple hazard unless they are securely bolted to the floor though the mounting holes in the base of the unit. In the interests of safety this should be done before any electrical, RF, or optical connections are made.

The equipment 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 rack.

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.

8.2 RF Connections

All RF connections are made to the cable termination, located on the bulkhead at the rear of the equipment at floor level. 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.

8.3 Commissioning

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

To commission the system the test equipment detailed in Section 10.2 will be required.
Using the system diagrams and the end-to-end test specification, the equipment should be tested to ensure correct operation. Typical RF levels that are not listed in the end-to-end specification, such as input levels to the fibre transmitters are detailed in the maintenance section of this manual.

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 shelf 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.

9. MAINTENANCE

9.1 Fault Finding

9.1.1 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.

9.1.2 Fault Isolation

In the event that the performance of the system is suspect, a methodical and logical approach to the problem will reveal the cause of the difficulty. The System consists of modules fitted in a wall-mounted, environmentally protected enclosure.
Transmissions from the main base stations are passed though the system to the mobile radio equipment; this could be a handheld radio or a transceiver in a vehicle. This path is referred to as the downlink. The return signal path from the mobile radio equipment to the base station is referred to as the uplink.

The first operation is to check the alarms of each of the active units and determine that the power supplies to the equipment are connected and active.
This can be achieved remotely (via CEMS, the RS232 Coverage Enhancement Management System, if fitted), or locally with the front panel LED's. The green LED on the front panel should be illuminated, while the red alarm indicator should be off. If an Alarm is on, then that individual module must be isolated and individually tested against the original test specification.
The individual amplifier units within the shelf have a green LED showing through a hole in their piggy-back alarm board, which is illuminated if the unit is working correctly. If an amplifier is suspect, check the DC power supply to the unit. If no other fault is apparent use a spectrum analyser to measure the incoming signal level at the input and then after reconnecting the amplifier input, measure the output level. Consult with the system diagram to determine the expected gain and compare result.
In the event that there are no alarms on and all units appear to be functioning it will be necessary to test the system in a systematic manner to confirm correct operation.

9.1.3 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.

9.1.4 Uplink

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

9.1.5 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.

9.1.6 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.

9.1.7 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.

9.2 Tools & Test Equipment

The minimum tools and test equipment needed to successfully service this AFL product are as follows:-

Spectrum analyser:	100kHz to 2GHz (Dynamic range = 90dB).
Signal Generator:	30MHz to 2GHz (-120dBm to 0dBm o/p level).
Attenuator:	20dB, 10W, DC-2GHz, (N male – N female).
Test Antenna:	Yagi or dipole for operating frequency.
Digital multi-meter:	Universal Volt-Ohm-Amp meter.
Test cable x 2:	N male – N male, 2M long RG214.
Test cable x 2:	SMA male – N male, 1m long RG223.
Hand tools:	Philips #1&2 tip screwdriver.
	3mm flat bladed screwdriver.
	SMA spanner and torque setter.

9.3 Care of Modules

9.3.1 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.

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

The following *general* instructions should be followed to remove a module:

1 Remove power to the unit
2 Remove all visible connectors (RF, DC & alarm)
3 Release module retaining screws.
4 Slowly but firmly, pull the module straight out of its position. Take care not to twist/turn the module during withdrawal. (When the module is loose, care may be needed, as there may be concealed connections underneath).

9.3.3 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.

9.3.4 Power Amplifiers

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

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

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

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

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

5) If the amplifier to be removed has a heatsink attached, there may be several different ways it can have been assembled. The most commonly used method, is screws through the front of the heatsink to threaded screw holes (or nuts and bolts), into the amplifier within the main case. If the heatsink is mounted on the rear of the main case (e.g., against a wall in the case of wall mounted enclosures), then the fixing method for the heatsink will be from within the case, (otherwise the enclosure would have to be removed from the wall in order to remove the heatsink).

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

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

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

9.3.5 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

9.3.6 Module Transportation:

To maintain the operation, performance and reliability of any module it must be stored and transported correctly. Any module not installed in a whole system must be kept in an anti-static bag or container. These bags or containers are normally identified by being pink or black, and are often marked with an ESD label. Any module sent back to AFL for investigation/repair must be so protected. Please contact AFL's quality department before returning a module.

APPENDIX A INITIAL EQUIPMENT SET-UP CALCULATIONS

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

ANTENNA SYSTEMS				
	Model	**Gain**	**Azimuth**	**Comments**
A - Service Antenna				
B – Donor Antenna				
	Type	**Loss**	**Length**	**Comments**
C – Service Feeder				
D – Donor Feeder				

INITIAL PARAMETERS	
E – CE Output Power	dBm
F – Antenna Isolation	dB
G – Input signal level from donor BTS	dBm
Operating Voltage	V

DOWNLINK CALCULATIONS		
Parameter	**Comments**	**Value**
Input signal level (**G**)		dBm
CE max. o/p power (**E**)		dBm
Gain setting	**E - G**	dB
Isolation required	(Gain + 10dB)	dB
Service antenna gain (**A**)		dB
Service antenna feeder loss (**C**)		dB
Effective radiated power (ERP)	**E+A-C**	dBm
Attenuator setting	CE gain-gain setting	dB

If the input signal level in the uplink path is known and steady, use the following calculation table to determine the gain setting. If the CE features Automatic Gain Control the attenuator should be set to zero and if not, then the attenuation setting for both uplink and downlink should be similar.

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