Weehawken Tunnel Radio

Repeater System

User/Maintenance Handbook
For
G.E Transport Systems

AFL Works Order Nō.: Q112727
AFL product part Nō.'s: 50-118101 (3 Ch UHF CCE)
50-118201 (UHF Simplex CCE)
50-118301 (1 Ch UHF CCE)
80-230701 (UHF Triplexer)
80-231301 (VHF/UHF Power Supply)
80-231303 (Alarm System)

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AMENDMENT LIST RECORD SHEET

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

Document Ref:-Weehawken_UHF

INTRODUCTION

Scope

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

Purpose

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

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

Limitation of Information Notice

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

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

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

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

EC DECLARATION OF CONFORMITY

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

CE 0086

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

United Kingdom

DECLARES, UNDER OUR SOLE RESPONSIBILITY THAT THE FOLLOWING PRODUCT

PRODUCT PART NO[S] 50-118101, 50-118201, 50-118301
PRODUCT DESCRIPTION **Weehawken UHF repeater 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

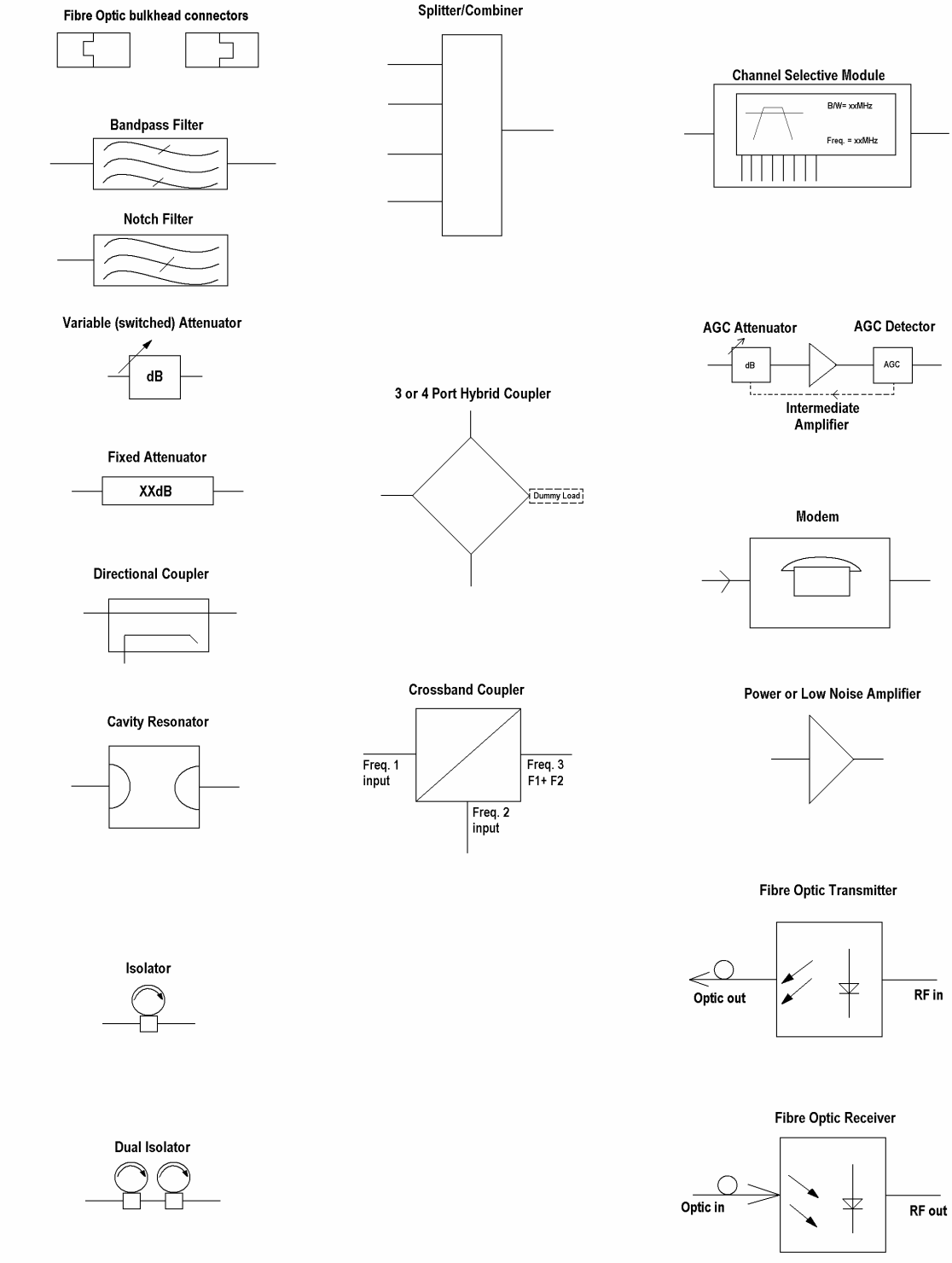
B S BARTON
TECHNICAL DIRECTOR **DATE: 08/11/2005**

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

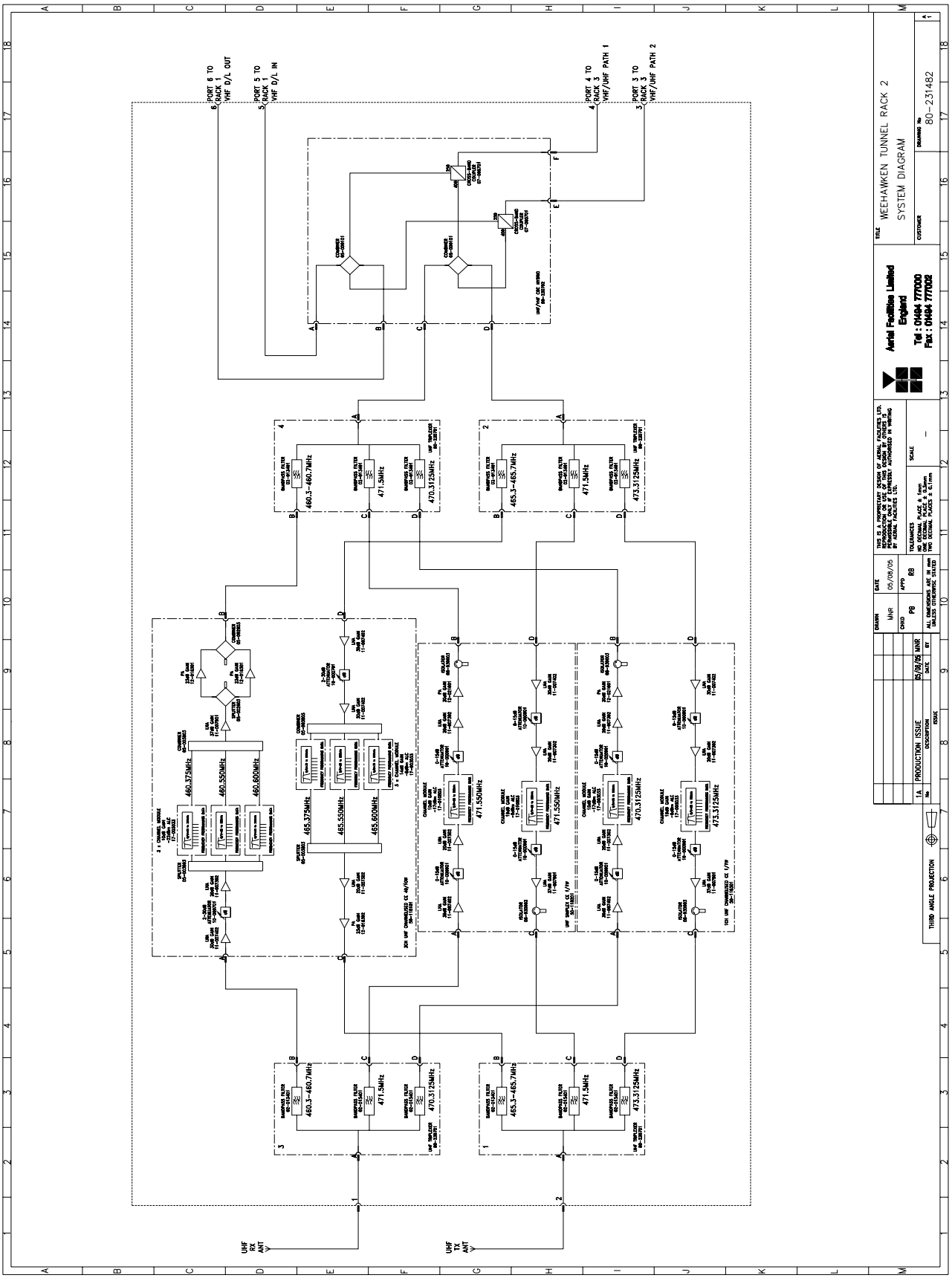
2.1 General System Description

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 UHF radio repeating system. All the hardware is built into standard 19" rack mounted cabinets which have an environmental IP rating of 54.

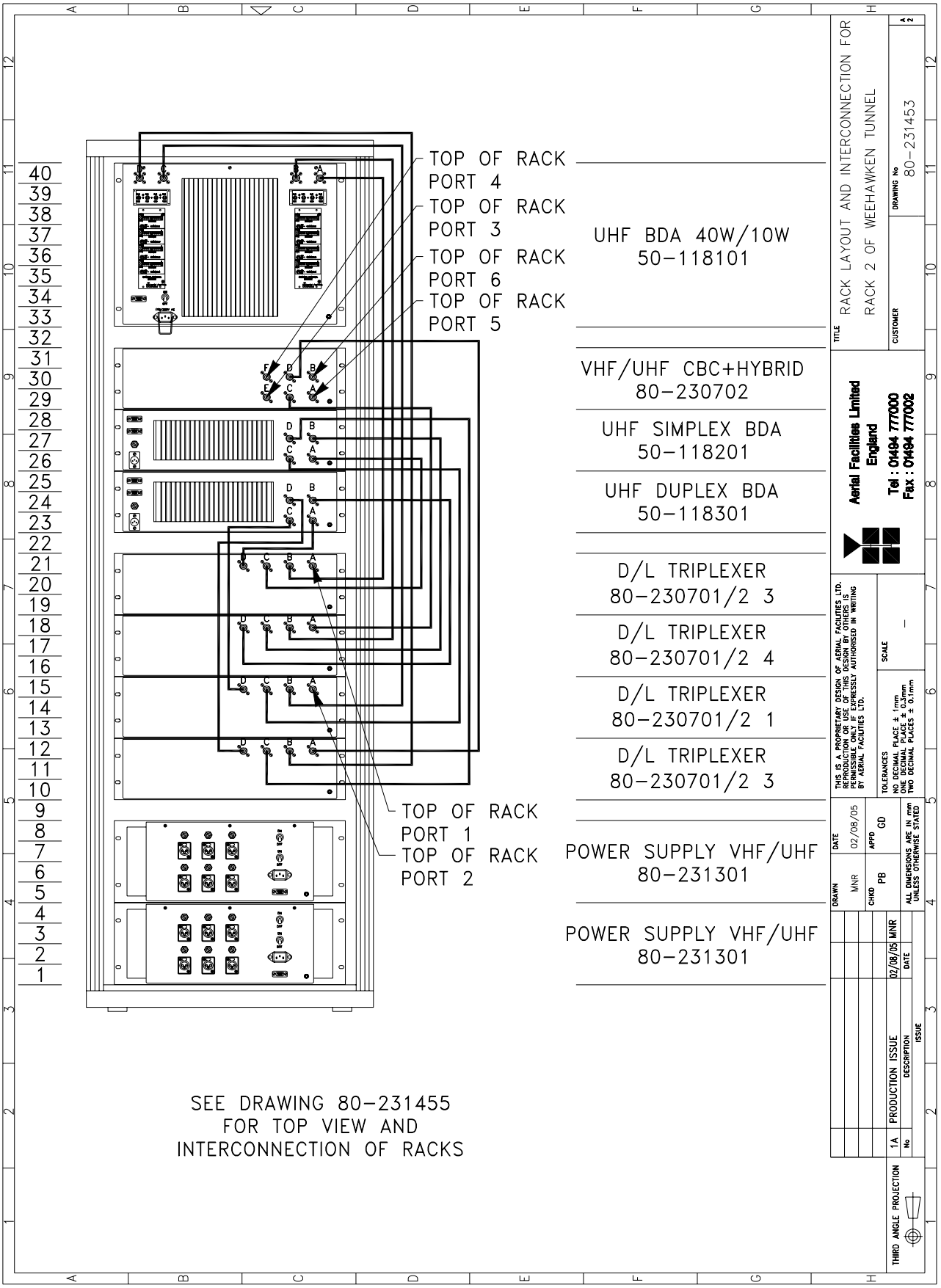
The systems in this document will be described separately, as individual shelves (UHF) and the various passive combiners, splitters and cross-band coupler shelves will be described in other documents. Every active module in the entire system has a dedicated alarm and these are series wired within the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

3. WEEHAWKEN UHF RACK DRAWINGS

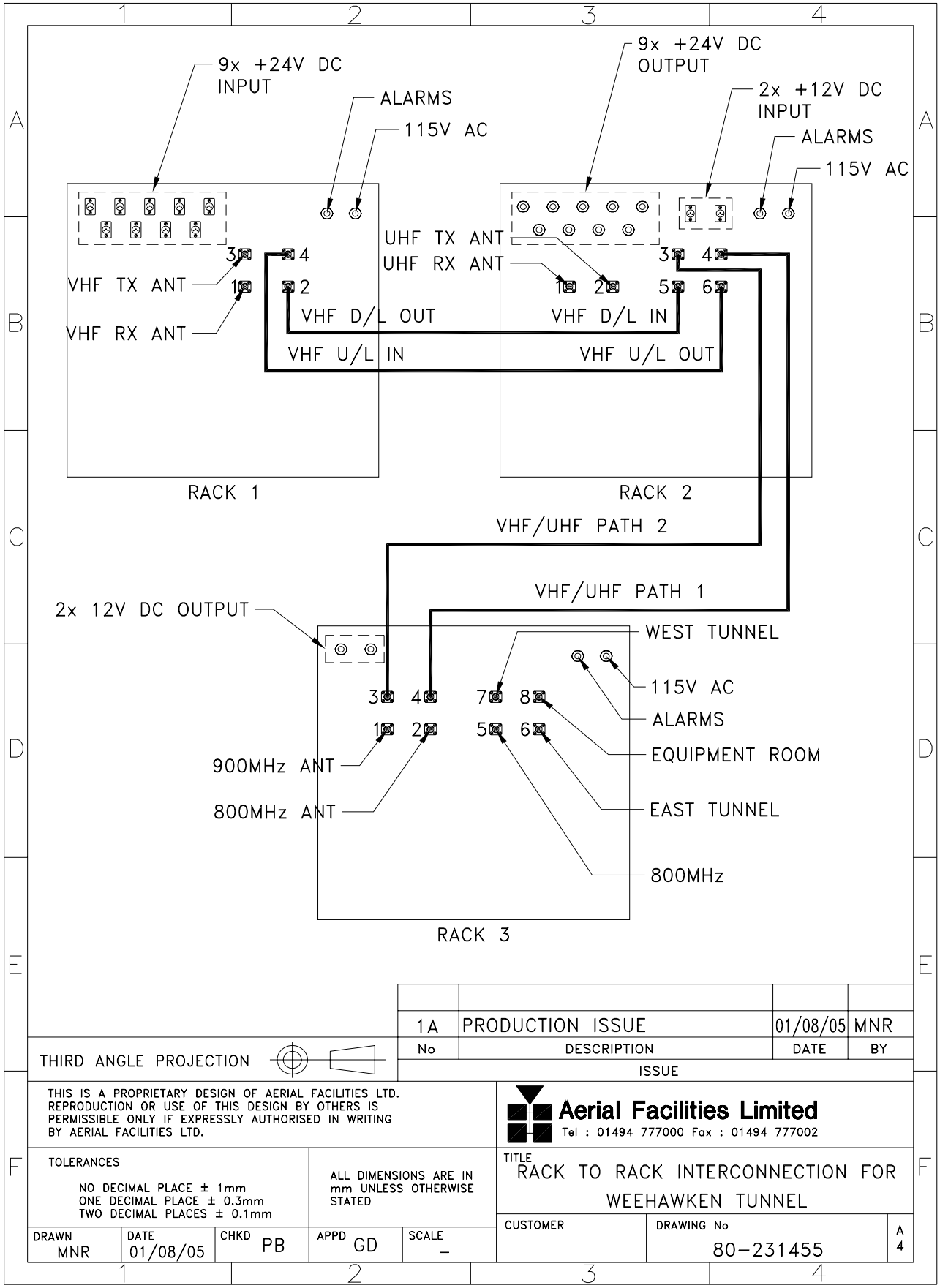
3.1 UHF Rack System Diagram, Drg. Nō. 80-231482



3.2 UHF Rack Layout and Interconnections Diagram, Drg. Nō. 80-231453



3.3 Rack to Rack Interconnections Diagram, Drg. Nō. 80-231455



3.4 Weehawken UHF System Frequencies Look-up Table

Agency	Channel Number	Uplink Tx	Downlink Rx
Jersey City Police Department	UHF CHN 1	465.3750	460.3750
Jersey City Fire Department	UHF CHN 2	465.5500	460.5500
Jersey City Fire Department	UHF CHN 3	465.6000	460.6000
Hoboken Fire Dept	UHF CHN 4	471.5500	471.5500
West New York Police Department	UHF CHN 5	473.3125	470.3125

4. UHF CELL ENHANCERS

4.1 Three Channel UHF Cell Enhancer 50-118101

4.1.1 Three Channel UHF Cell Enhancer Description

The UHF (400MHz band) cell enhancer employs three channel modules in each path for three dedicated frequencies (NJ FD x2 & NJPD). The downlink output is realised using a phased-parallel arrangement for the power amplifiers which effectively doubles their 20Watts output.

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.

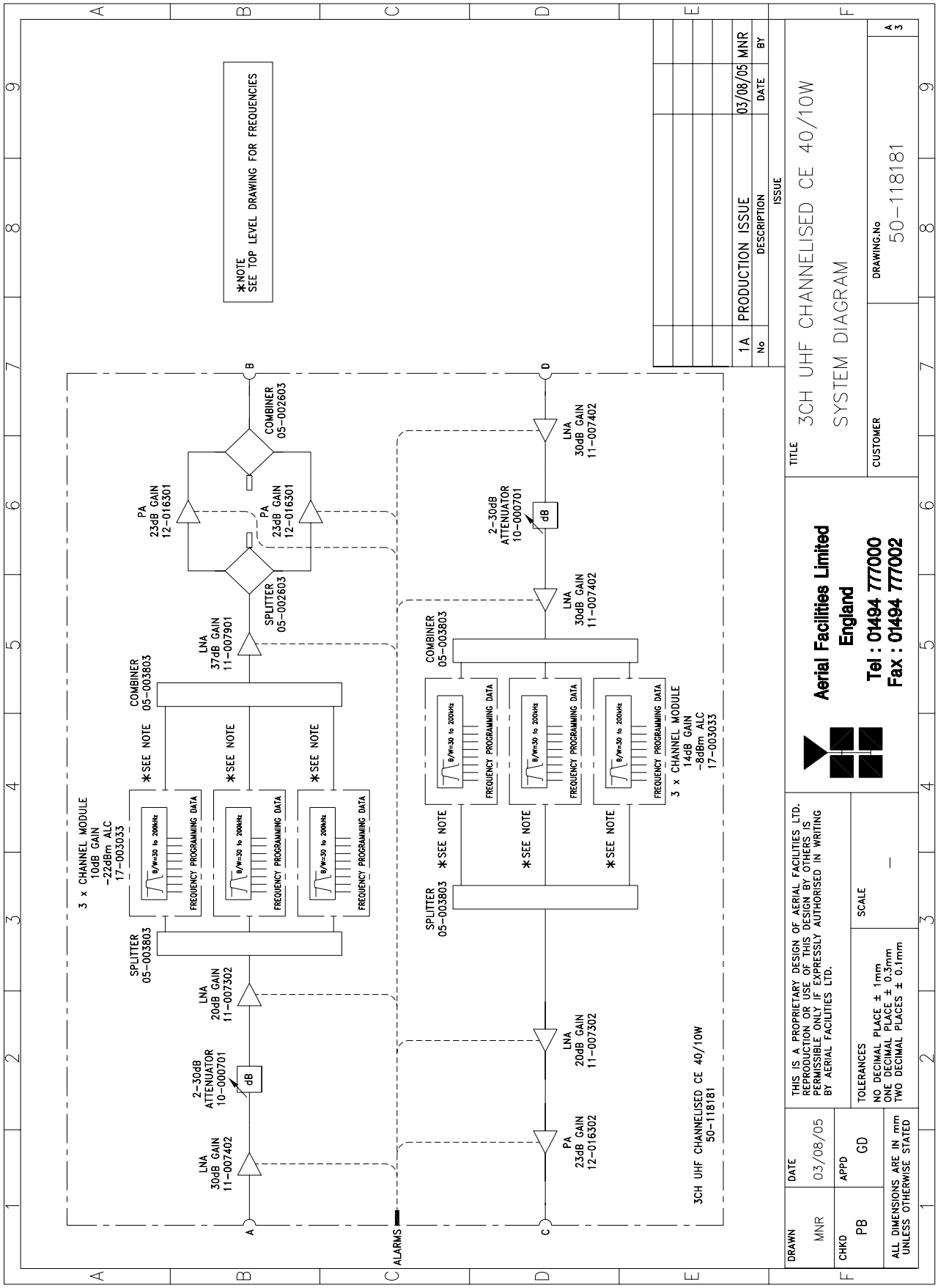
4.1.2 Three Channel UHF Cell Enhancer Electrical Specifications

PARAMETER		SPECIFICATION
Frequency range:		460.3-460.7MHz (Downlink)
		465.3-465.7MHz (Uplink)
Bandwidth:		0.4MHz
Gain:		>90dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>10.0Watts
Downlink Power:		>20.0Watts (x2)
IP3:	Uplink	+40dBm
	Downlink	+54dBm
Downlink AGC gain:		10dB
Downlink AGC level:		-22dBm
Uplink AGC gain:		14dB
Uplink AGC level:		-8dBm
Noise Figure:		<6dB (at maximum gain)
AGC:		Fitted in channel modules
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 Downlink amplifiers
		2 Uplink amplifiers
		3 Each channel module

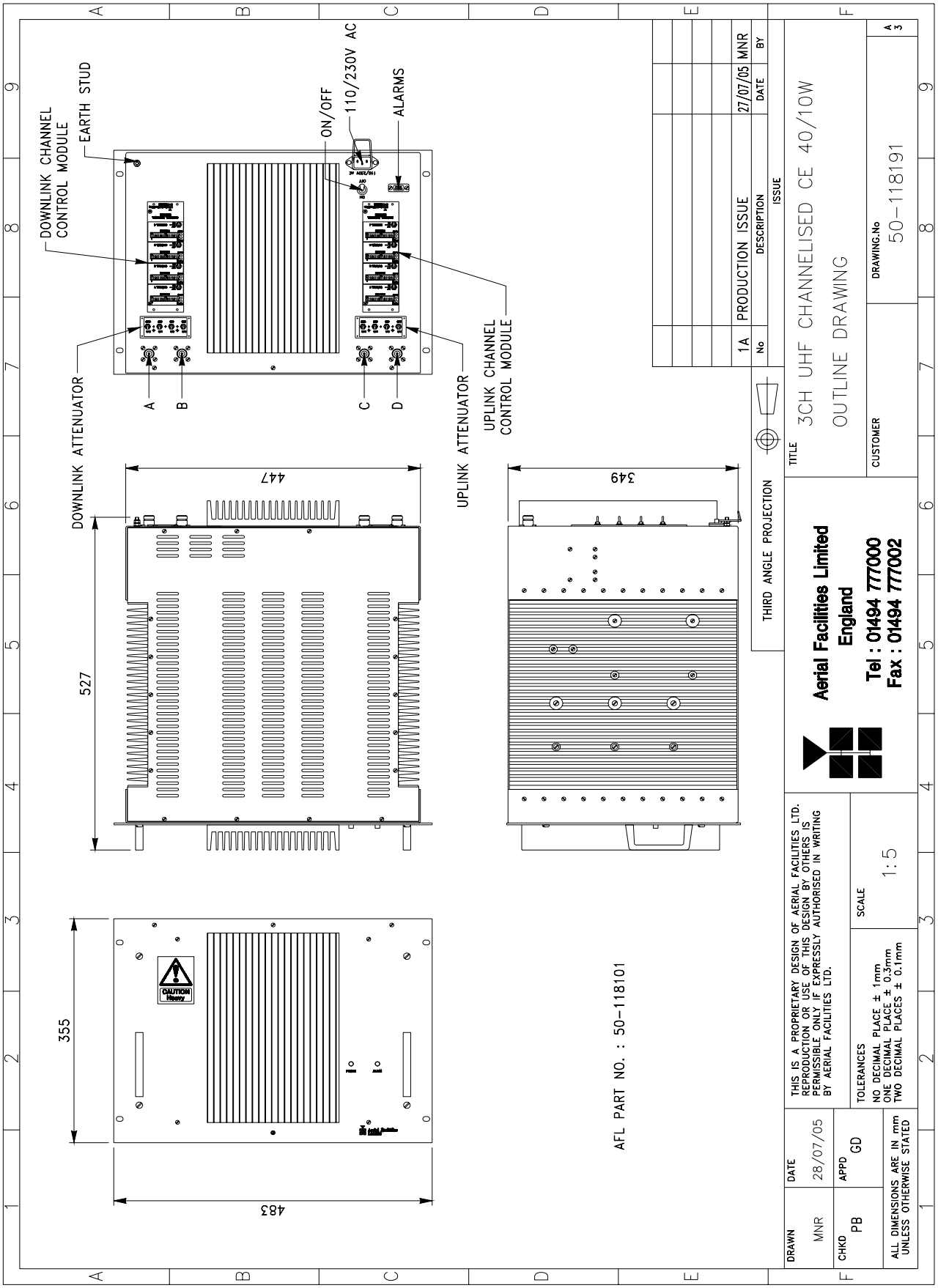
4.1.3 Three Channel UHF Cell Enhancer Mechanical Specifications

PARAMETER		SPECIFICATION
Rack	Height:	Standard Eurorack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelves:	Height:	8U
	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:		20kg (approximately)
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

4.1.4 Three Channel UHF Cell Enhancer System Diagram, Drg. Nō. 50-118181



4.1.5 Three Channel UHF Cell Enhancer Outline Drawing, Drg. Nō. 50-118191



4.1.6 Three Channel UHF Cell Enhancer 50-118101 Parts List

AFL Part Nō.	Part Description	Qty.
05-002603	UHF 3dB SPLITTER SMA	2
05-003803	3 WAY SPLITTER, UHF, ZINGER	4
10-000701	1/4W0-30dB SWITCHED ATTENUATOR	2
11-007302	LNA. 380-500MHz 20dB (C/W RELAY) GA	2
11-007402	LNA. 380-500MHz 30dB (C/W RELAY) GA	3
11-007901	AMPLIFIER TETRA 1W 37dB GAIN ASS	1
12-016301	PA 380-470MHz 20W CLASS A	2
12-016302	PA 380-470MHz 10W CLASS A	1
14-000225	CASE RAIL LONG R.S.A./R.F.A.	4
17-002101	CHANNEL CONTROL MODULE	2
17-002103	26WAY RIBBON CABLE LEAD	6
17-003033	CHAN MOD 450MHz, 15kHz (8p) BW TCXO	6
20-001601	12V RELAY BOARD	1
50-012825	CCE RACK MOUNTED HEATSINK BRACKET	4
50-012843	CCE RACK 8U CHASSIS 400mm DEEP	1
50-012844	CCE RACK LID 400mm DEEP	1
50-027720	RACK MTD CHAN C.E. MODIFIED HEATSIN	2
80-008901	12V RELAY PCB ASSEMBLY	1
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
91-510032	20A SOCKET CONTACT PIN	6
91-520001	PWR MAINS INL FIXED/SOLD.TERMS	1
91-600007	'D' 9 WAY BLACK SHELL	5
91-600014	'D' 9 WAY SOCKET S/B (NON FILTERED)	5
91-600015	'D' 9 WAY PLUG S/B (NON FILTERED)	1
91-660001	2W5 MIXED D TYPE SOCKET (7 WAY)	3
96-300054	24V 17A PSU 400W (XP BCC)	1
96-700034	LED RED 5mm IP67	1
96-700035	LED GREEN 5mm IP67	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

4.2 UHF Simplex Cell Enhancer (50-118201)

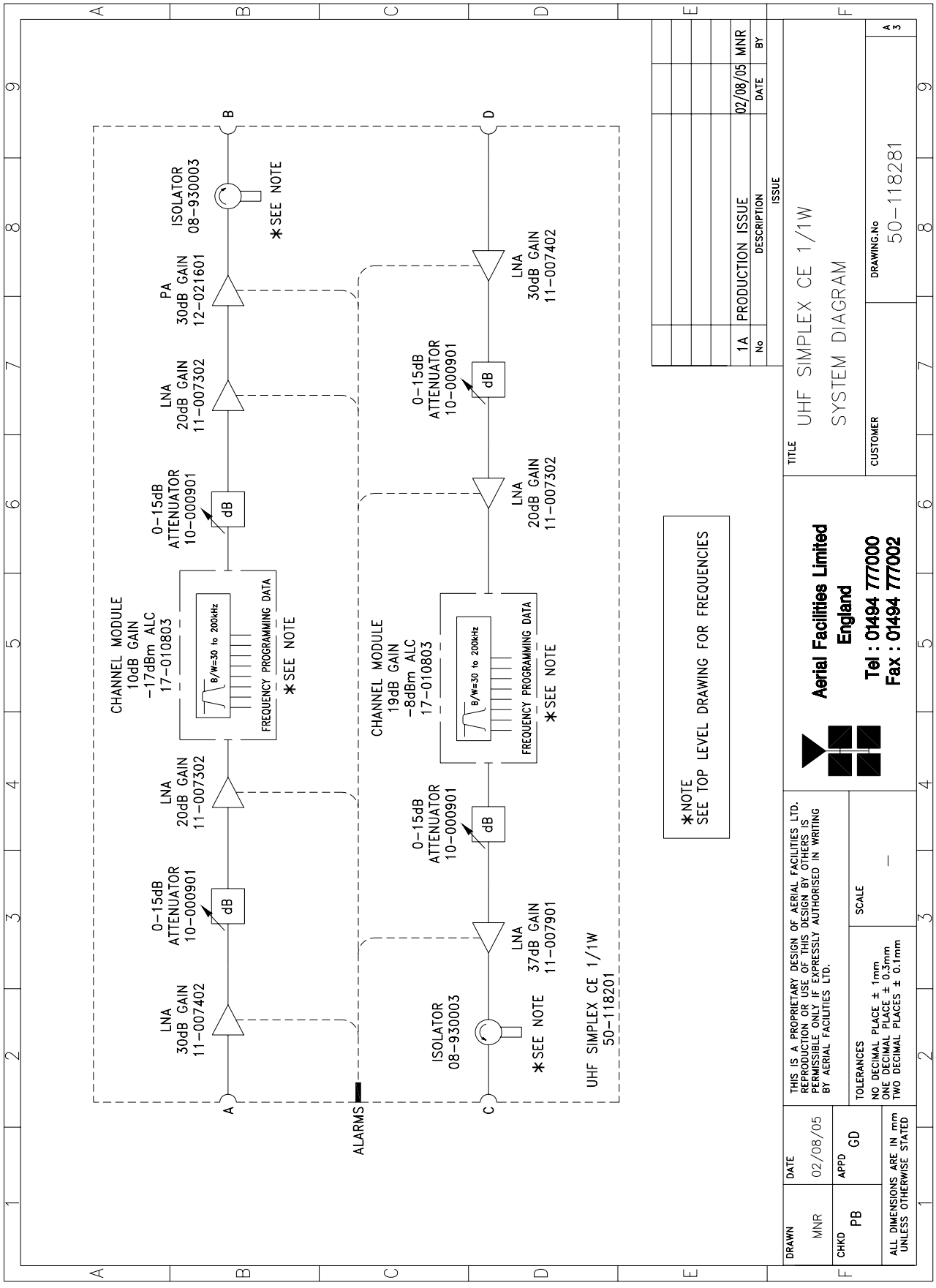
4.2.1 UHF Simplex Cell Enhancer Description

The UHF Simplex cell enhancer operates by muting the uplink channel when the downlink channel is transmitting, and vice-versa so that positive feedback between Tx and Rx amplifiers is not possible.

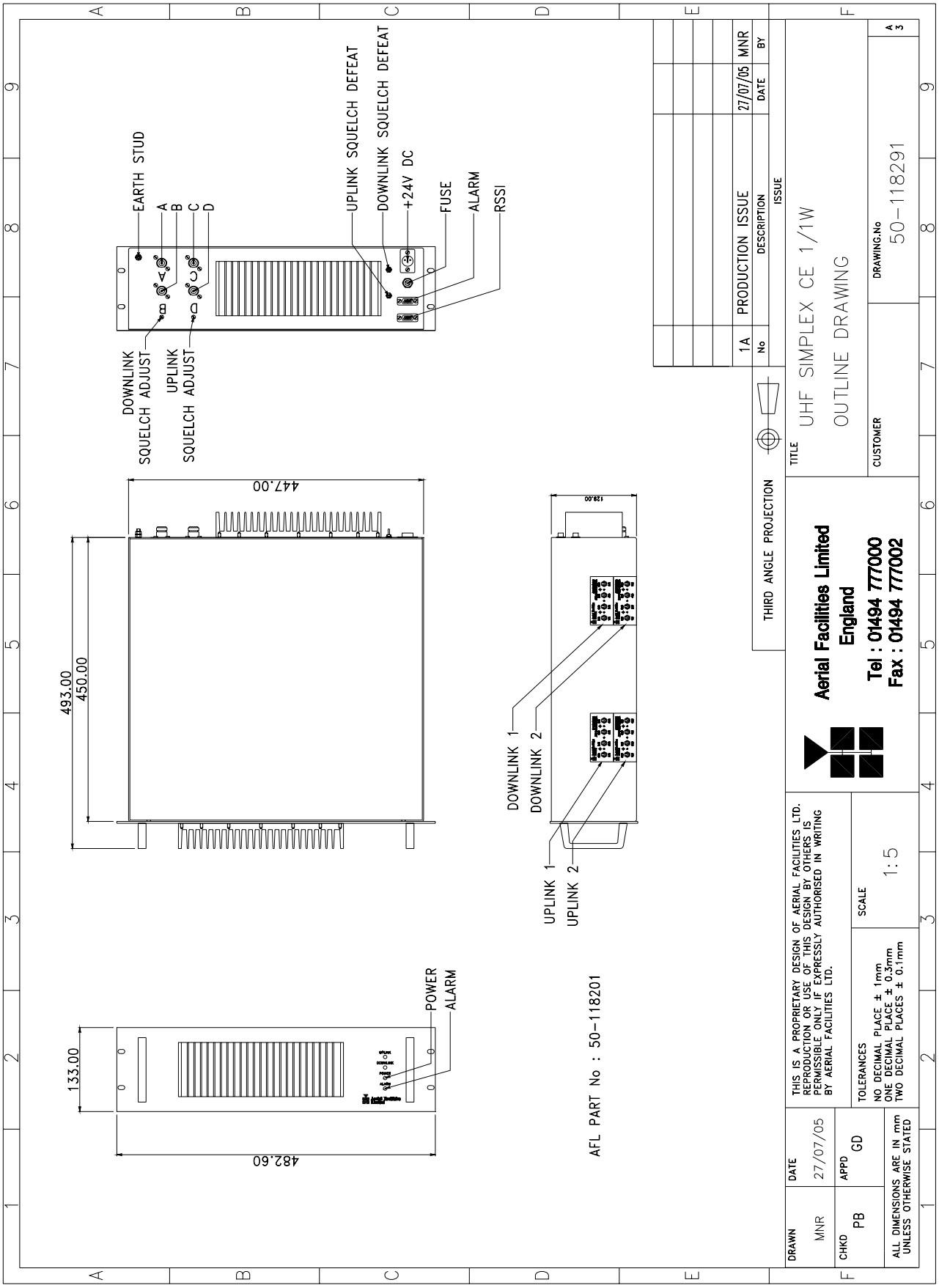
4.2.2 UHF Simplex Cell Enhancer Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		460.3-460.7MHz (Downlink)
		465.3-465.7MHz (Uplink)
Bandwidth:		0.4MHz
Gain:		>90dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>10.0Watts
Downlink Power:		>20.0Watts (x2)
IP3:	Uplink	+40dBm
	Downlink	+54dBm
Downlink AGC gain:		10dB
Downlink AGC level:		-22dBm
Uplink AGC gain:		14dB
Uplink AGC level:		-8dBm
Noise Figure:		<6dB (at maximum gain)
AGC:		Fitted in channel modules
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
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted: (volt-free contacts/TTL)		1 Downlink amplifiers
		2 Uplink amplifiers
		3 Each channel module

4.2.3 UHF Simplex Cell Enhancer System Diagram, Drg. Nō. 50-118281



4.2.4 UHF Simplex Cell Enhancer Outline Drawing



4.2.5 UHF Simplex Cell Enhancer Parts List

AFL Part Nō.	Part Description	Qty.
08-930003	2 PORT ISOLATOR 360-470MHz SMA	2
10-000901	SW. ATTENUATOR 0.25W 0-15dB	4
11-007302	LNA. 380-500MHz 20dB (C/W RELAY) GA	3
11-007402	LNA. 380-500MHz 30dB (C/W RELAY) GA	2
11-007901	AMPLIFIER TETRA 1W 37dB GAIN ASS	1
12-021601	TETRA 5W +12V AMPLIFIER	1
17-009724	EQUIP. MTG PLATE No.5	2
17-010803	CH MOD 450MHz 8p 15kHz BW+IFRX TCXO	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
80-008901	12V 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
91-510032	20A SOCKET CONTACT PIN	2
91-600001	'D'TYPE 9 WAY PLUG S/B TERM	1
91-600014	'D' 9 WAY SOCKET S/B (NON FILTERED)	6
91-620001	'D' 25 WAY SOCKET S/B TERM	2
91-660001	2W5 MIXED D TYPE SOCKET (7 WAY)	1
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

4.3 One Channel UHF Cell Enhancer (50-118301)

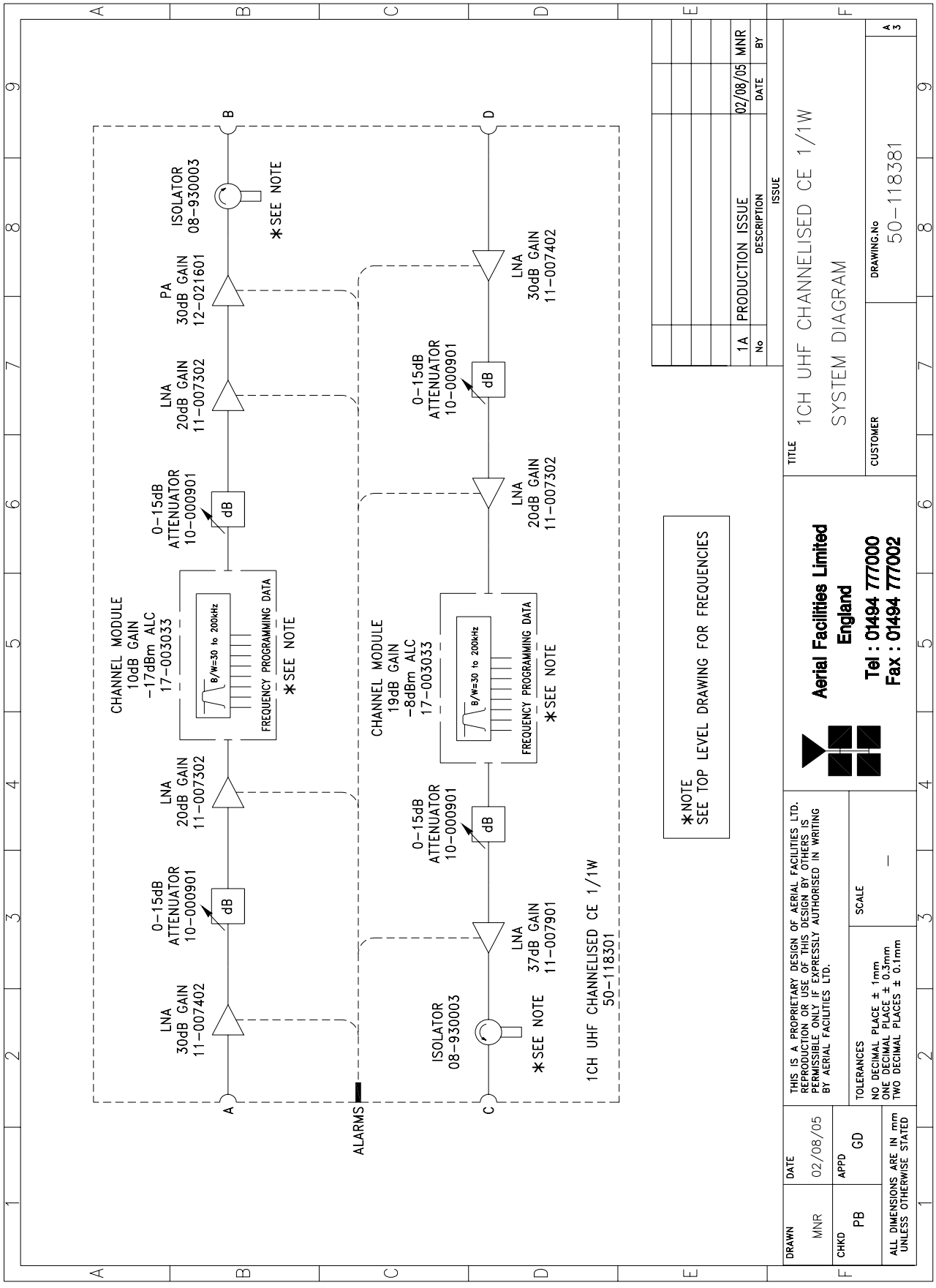
4.3.1 One Channel UHF Cell Enhancer Description

The 5W/1W single channel cell enhancer is for the West New York PD in order that this agency may communicate into and out of the Weehawken tunnel.

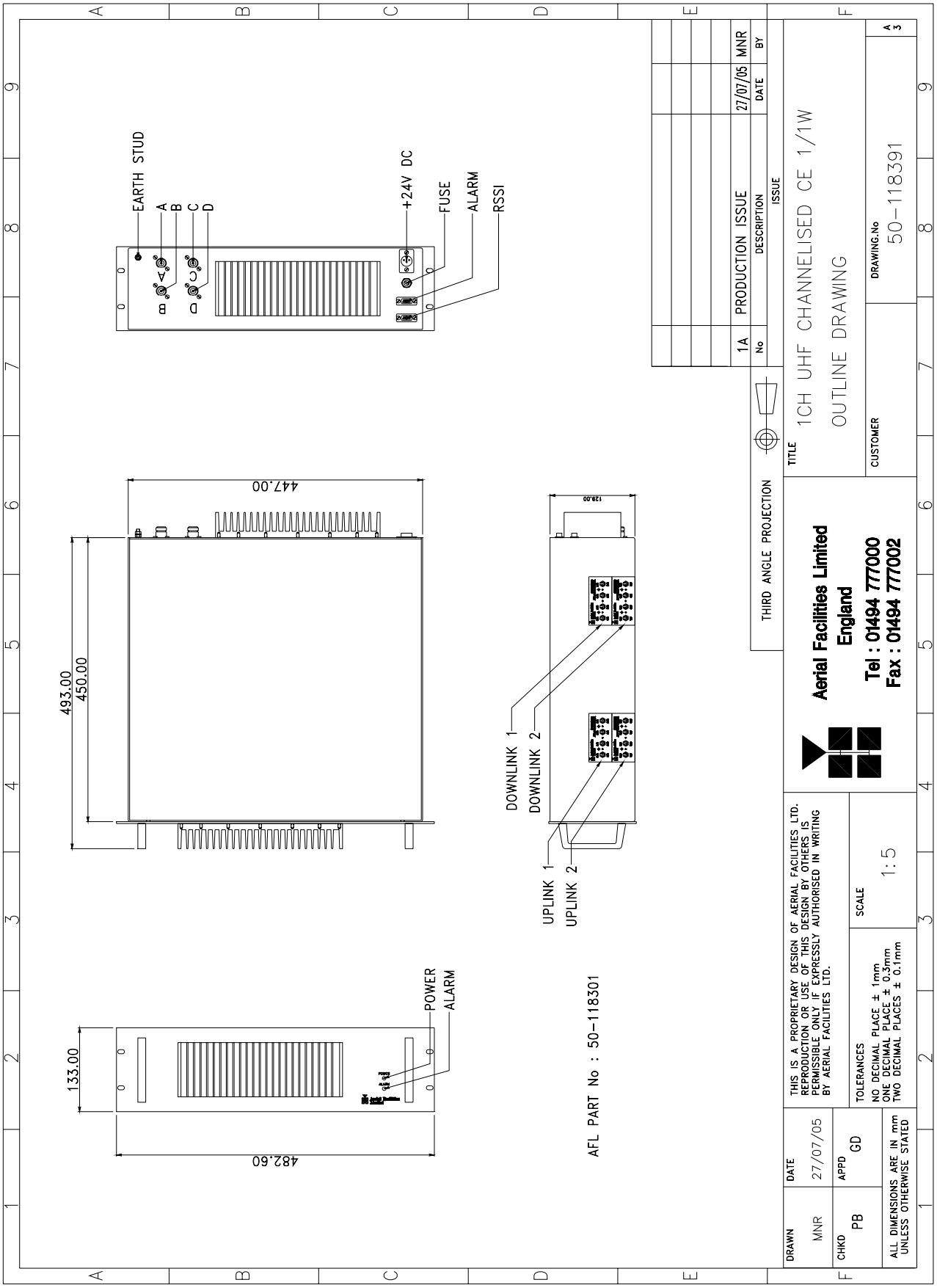
4.3.2 One Channel UHF Cell Enhancer Technical Specification

PARAMETER		SPECIFICATION
Frequencies:		470.3125MHz (Downlink)
		473.3125MHz (Uplink)
Gain:		>90dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>1.0Watts
Maximum uplink output:		+30.8dBm
Downlink Power:		>5.0Watts
Maximum downlink output power:		+37.5dBm
IP3:	Uplink	+44dBm
	Downlink	+50dBm
Downlink Ch. module AGC level:		-17dBm
Uplink Ch. module AGC level:		-8dBm
Noise Figure:		<6dB (at maximum gain)
AGC:		Fitted in channel modules
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
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia:	Painted to RAL 7035
Alarms Fitted: (volt-free contacts/TTL)		1 Downlink amplifiers
		2 Uplink amplifiers
		3 Each channel module

4.3.3 One Channel UHF Cell Enhancer System Diagram



4.3.4 One Channel UHF Cell Enhancer Outline Drawing



4.3.5 One Channel UHF Cell Enhancer Parts List

AFL Part Nō.	Part Description	Qty.
08-930003	2 PORT ISOLATOR 360-470MHz SMA	2
10-000901	SW. ATTENUATOR 0.25W 0-15dB	4
11-007302	LNA. 380-500MHz 20dB (C/W RELAY) GA	3
11-007402	LNA. 380-500MHz 30dB (C/W RELAY) GA	2
11-007901	AMPLIFIER TETRA 1W 37dB GAIN ASS	1
12-021601	TETRA 5W 12V AMPLIFIER	1
17-001107	OPEN COLLECTOR FOR SIMPLEX CONT.	1
17-003033	CHAN MOD 450MHz, 15kHz (8p) BW TCXO	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
20-001601	12V RELAY BOARD	2
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
91-510032	20A SOCKET CONTACT PIN	2
91-600001	'D'TYPE 9 WAY PLUG S/B TERM	1
91-600014	'D' 9 WAY SOCKET S/B (NON FILTERED)	6
91-620001	'D' 25 WAY SOCKET S/B TERM	2
91-660001	2W5 MIXED D TYPE SOCKET (7 WAY)	1
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. UHF PASSIVE SYSTEM COMPONENTS

5.1 UHF Triplexer (80-230701)

5.1.1 UHF Triplexer Description

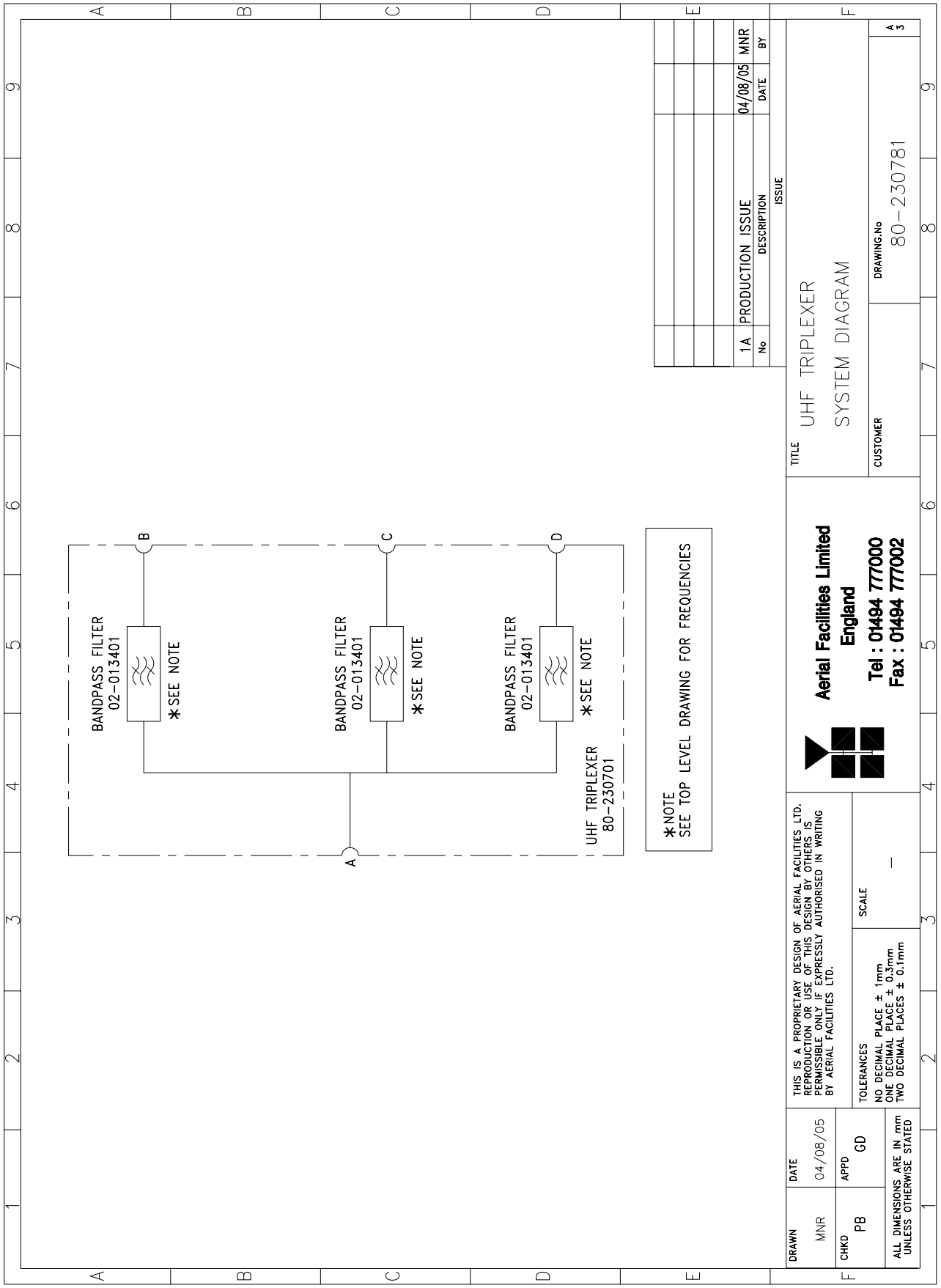
The two triplexer shelves (80-230701 & 80-230702) are the interface between the UHF cell enhancers and the tunnel leaky feeders. Two of these shelves exist, one uplink , one downlink, both hardware identical but with the band selective filters in each being tuned for uplink or downlink. Note that the semi-rigid cables which connect the three filters to the output port is a critical length harness which must not be disturbed unless it is certain that this component has failed. A replacement harness would necessitate the use of the test equipment detailed in section 8.2 to ensure specification.

No alarms are fitted to passive shelves.

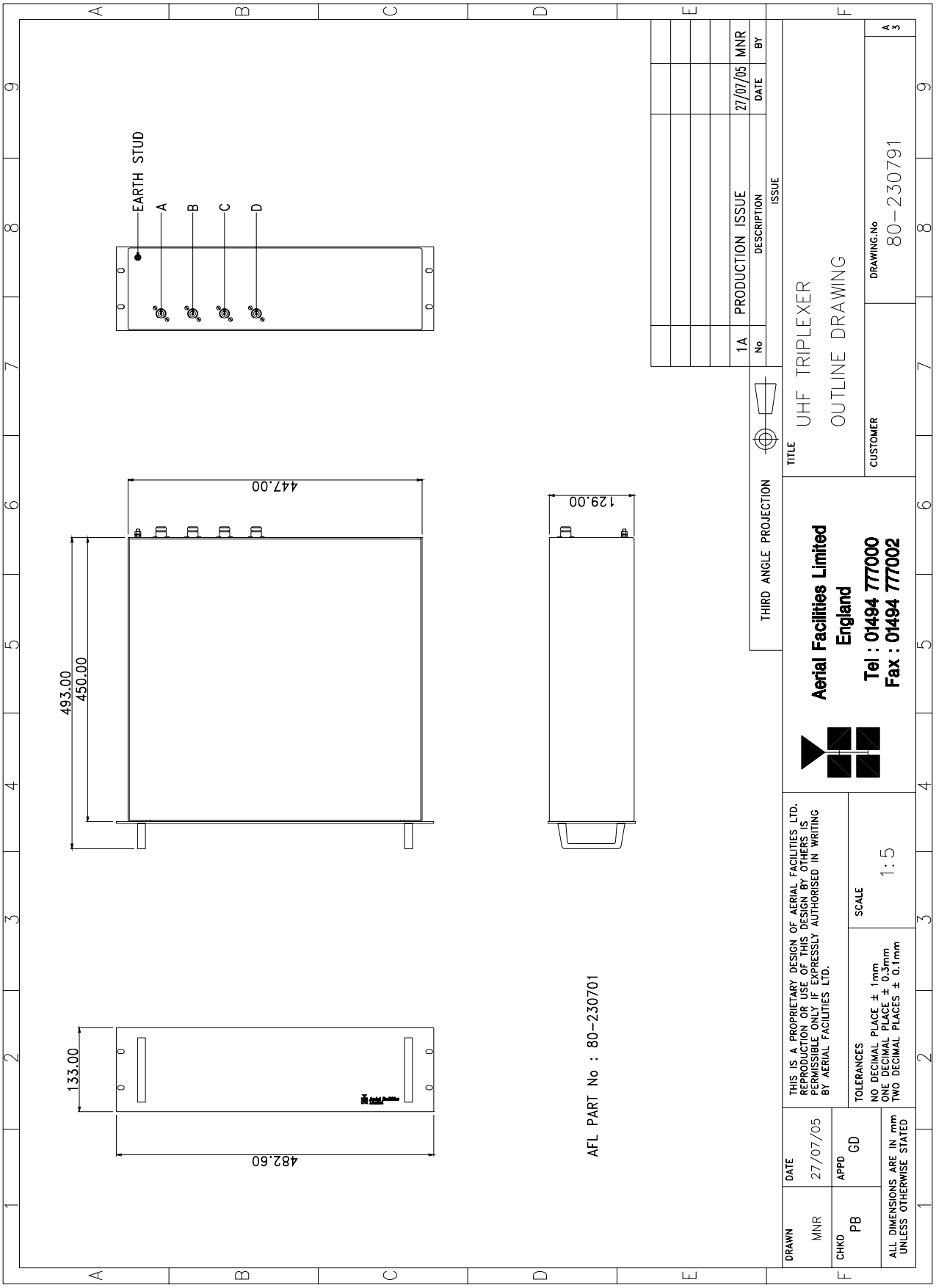
5.1.2 UHF Triplexer Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		460.3-460.7MHz (80-230701/1)
		471.5MHz (80-230701/1)
		470.3125MHz (80-230701/1)
		465.3-465.7MHz (80-230701/2)
		471.5MHz ±300kHz (80-230701/2)
		473.3125MHz ±300kHz(80-230701/2)
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
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted:		None

5.1.3 UHF Triplexer System Diagram, Drg. Nō. 80-230781



5.1.4 UHF Triplexer Shelf Outline Drawing, Drg. Nō. 80-230791



5.1.5 UHF Triplexer Parts List

AFL Part Nō.	Part Description	Qty.
02-013401	6P CL FILTER (0.5 min BW) LARGE SMA ASSY	3
19-000921K	3U CHASSIS KIT (400mm deep)	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	4
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	2

5.2 UHF Hybrid Cross-Band Coupler (80-230702)

5.2.1 UHF Hybrid Cross-Band Coupler Description

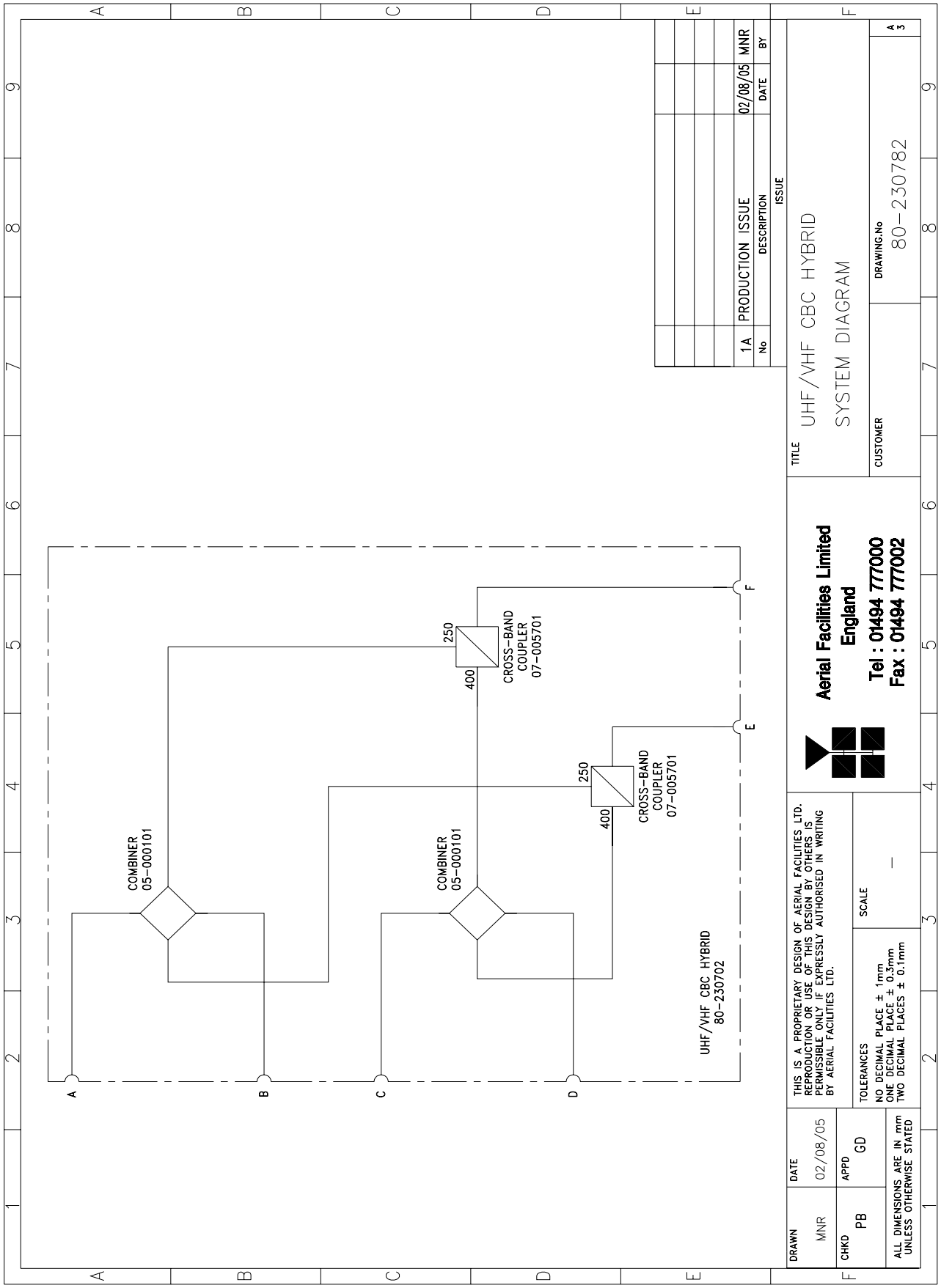
The UHF cross-band coupler shelf allows the VHF and UHF frequencies to be combined to the leaky feeder outputs using hybrid couplers which have been designed for a very low insertion loss and high rejection.

No alarms are fitted to passive shelves.

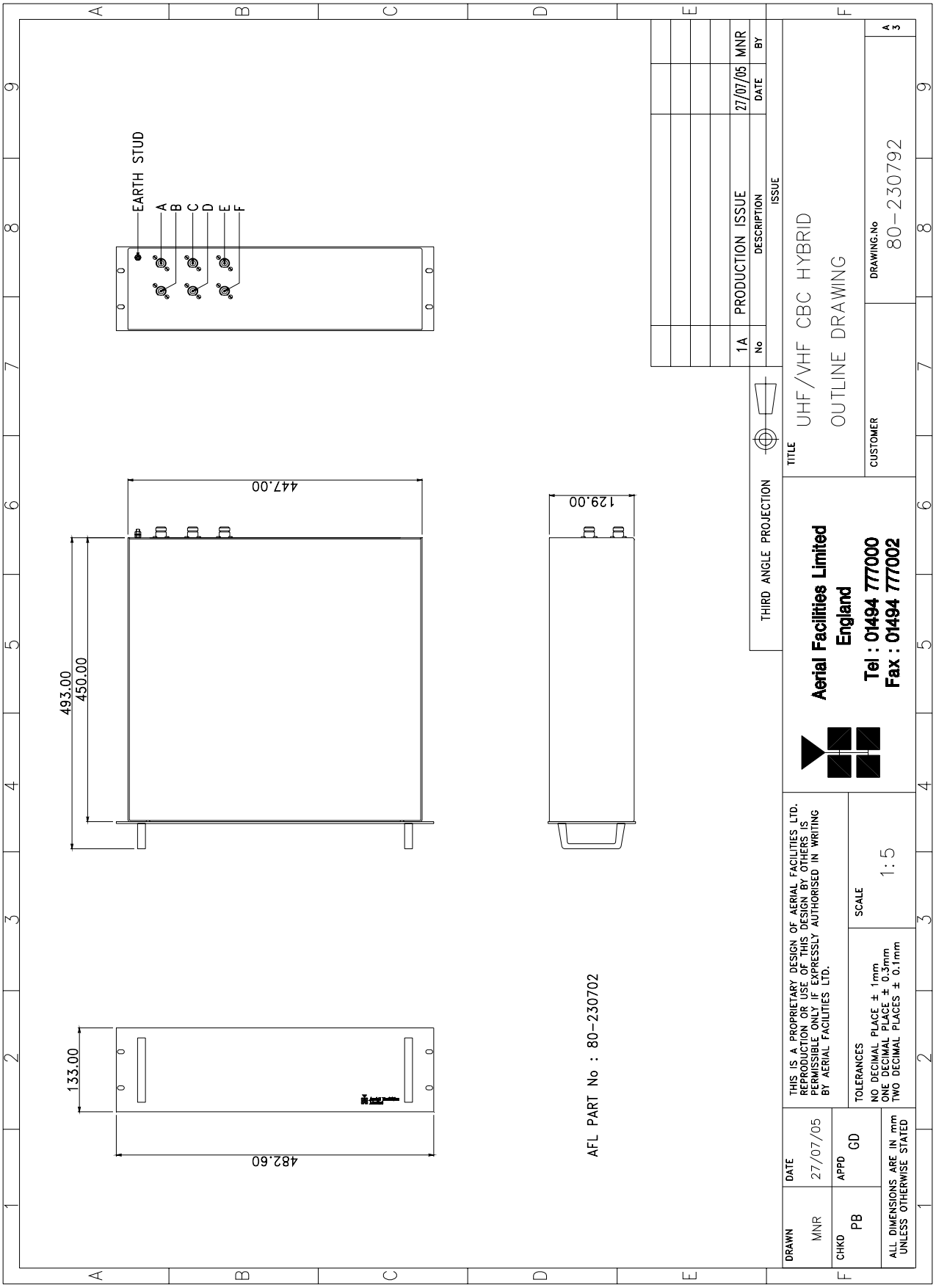
5.2.2 UHF Hybrid Cross-Band Coupler Shelf Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		>380MHz (UHF pass)
		<250MHz (VHF pass)
VSWR:		better than 1.5:1
Insertion loss:		<0.5dB
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 UHF Hybrid Cross-Band Coupler System Diagram, Drg. Nō. 80-230782



5.2.4 UHF Hybrid Cross-Band Coupler Shelf Outline Drawing, Drg. Nō. 80-230792



5.2.5 UHF Hybrid Cross-Band Coupler Parts List

AFL Part Nō.	Part Description	Qty.
05-000101	TRANSMITTER HYBD COUPL.4 PORT	2
07-005701	CROSSBAND CPLR XC 250/380 N	2
19-000921K	3U CHASSIS KIT (400mm deep)	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	6

6. POWER SUPPLIES & ALARMS

6.1 UHF Power Supply (80-231301)

6.1.1 UHF 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.

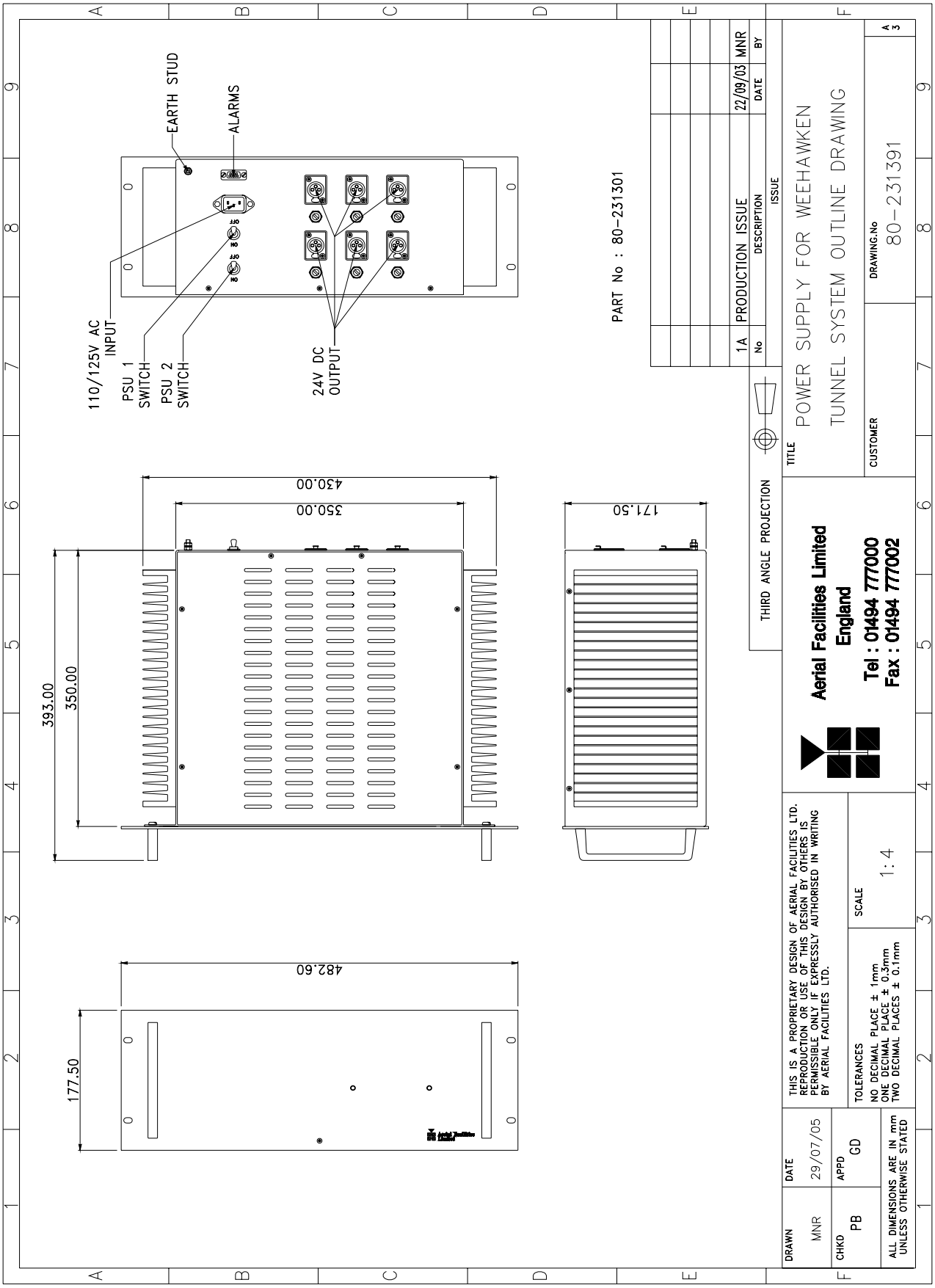
6.1.2 UHF Power Supply Technical Specification

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 Power Supply System Diagram

Not available at the time of compiling this document.

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



6.1.5 UHF 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 Bandpass Filter (02-013401)

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 combline design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports. Being passive devices, the bandpass filters should have an extremely long operational life and require no maintenance. Should a filter be suspect, it is usually most time efficient to replace the module rather than attempt repair or re-tuning.

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

7.1.2 Technical Specification

PARAMETER		SPECIFICATION
Passband:	FILTER 1	483.2-483.6MHz
	FILTER 2	486.2-486.6MHz
Insertion Loss:	FILTER 1	2.7 dB (typical)
	FILTER 2	2.7 dB (typical)
Rejection:	FILTER 1	483.2-483.6MHz > 80 dB
	FILTER 2	486.2-486.6MHz > 80 dB
Power Rating:		250Watts
Impedance:		50 ohm
VSWR:		Better than 1.2:1
Connectors:		SMA female

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 3dB UHF Splitter (05-002603)

7.3.1 Description

The 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.

7.3.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency range:	380 - 520 MHz
Bandwidth:	140 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:	0.5 Watt
Connectors:	SMA female
Size:	54 x 44 x 21 mm (including connectors)
Weight:	200 gm (approximately)

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 Crossband Coupler (07-005701)

7.5.1 Description

The purpose of a crossband coupler is to either combine/split transmission signals from different parts of the frequency spectrum.
The crossband coupler fitted here, is the means by which the separate VHF and UHF frequency band signals are mixed to form a composite RF signal.

It basically comprises of a 3 port device, two filters, one a low pass the other a high pass, that are then mixed and fed to a common output. The couplers are built into a machined aluminium casing having a centre screening wall between the filter sections and lid secured by screws at frequent intervals over its perimeter to obtain a tight seal and to ensure linearity and stability of response.

7.5.2 Technical Specification

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

7.6 Crossband Coupler (07-005705)

7.6.1 Description

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

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

7.6.2 Technical Specification

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

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

7.7.1 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.

7.7.2 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.

7.8 Low Noise Amplifiers (11-007302 & 11-007402)

7.8.1 Description

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

7.8.2 Technical Specification, 11-007302

PARAMETER		SPECIFICATION
Frequency range:		380-500MHz
Bandwidth:		<140MHz
Gain:		20-22dB
1dB Compression Point:		+23.5dB (typical)
3rd order intercept:		+36dB (typical)
Input/Output return loss:		>20dB
Noise figure:		<1.3dB
Connectors:		SMA female
Supply:		200-230mA @ 24V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.38kg
Size:		90 x 55 x 30.2 (case only)

7.8.3 Technical Specification, 11-007402

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

7.8.4 LNA 'D' Connector Pin-out details

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

7.9 1Watt Low Power Amplifier (11-007901)

7.9.1 Description

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

7.9.2 Technical Specifications

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

7.10 5Watt Medium Power TETRA Amplifier (12-021601)

7.10.1 Description

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

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

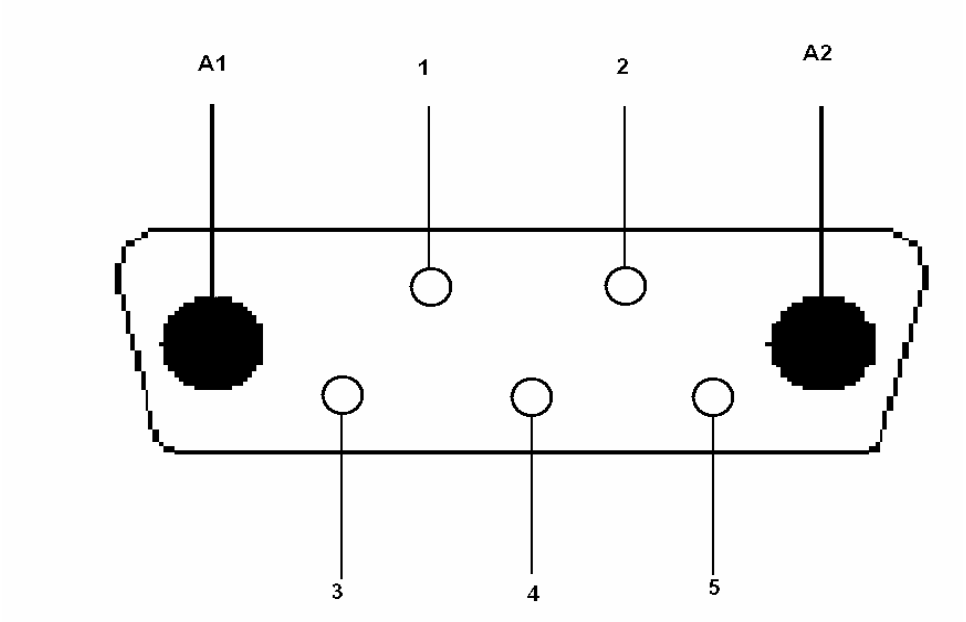
7.10.2 Technical Specification

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

7.10.3 PA 7-Way Connector Pin-outs

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

7.10.4 PA Connector Pin-Outs



7.11 10 & 20W Power Amplifiers (12-016302 & 12-016301)

7.11.1 Description

These amplifiers are Class A 20W power amplifiers operating from 380MHz to 470MHz in a 1 stage balanced configuration. It demonstrates a very high linearity and a very good input/output return loss (RL). They have a built in Current Fault Alarm Function.
They are housed is an aluminium case (Alocrom 1200 finish) with SMA connectors for the RF input/output and a D-Type connector for the power supply and the Current Fault Alarm Function. Note the large diameter DC power input pins (1 & 2) fitted to reduce volt-drop/arcing.

7.11.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		380-470MHz
Small signal gain:		23dB
Gain flatness:		±1.7dB
I/O Return loss:		>18dB
1dB compression point:		43dBm (12-016301)
		40.5dBm (12-016302)
OIP3:		54dBm (12-016301)
		53dBm (12-016302)
Supply voltage:		24V DC
Supply current:		3.7Amps (12-016301)
		2.5Amps (12-016301)
Temperature range	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		<2kg (no heatsink)

7.11.3 PA 'D' Connector Pin-out details

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

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

7.12.1 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)

7.12.2 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.

7.12.3 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

7.12.4 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

7.12.5 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.

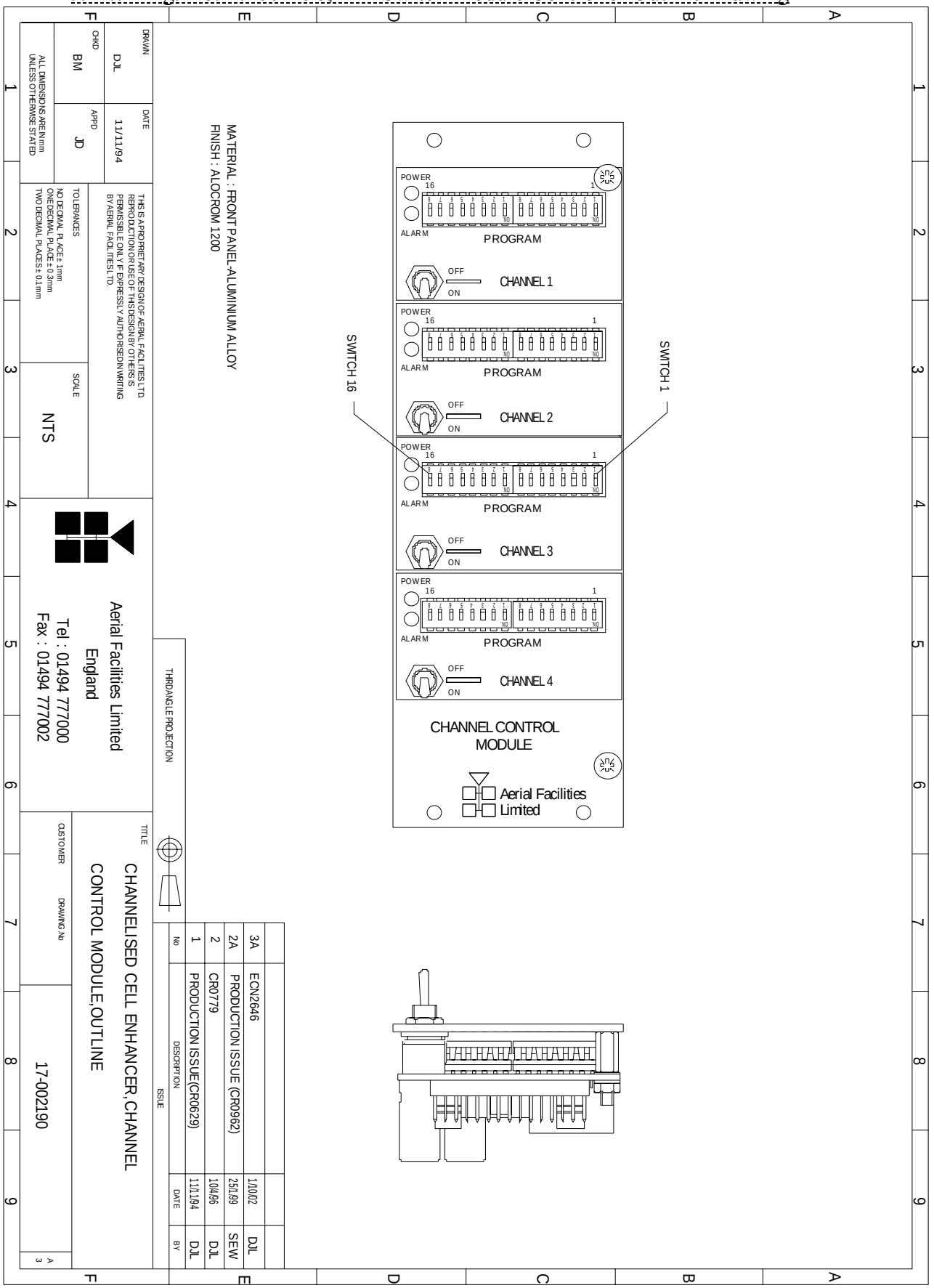
Local Oscillator Frequency	Switch settings 16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
432.600 MHz	1	0	0	0	0	1	1	1	0	0	1	1	0	0	0	0

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

7.12.6 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	**---**	**---**

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



7.13 Channel Selective Modules (17-003033 & 17-010803)

7.13.1 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.

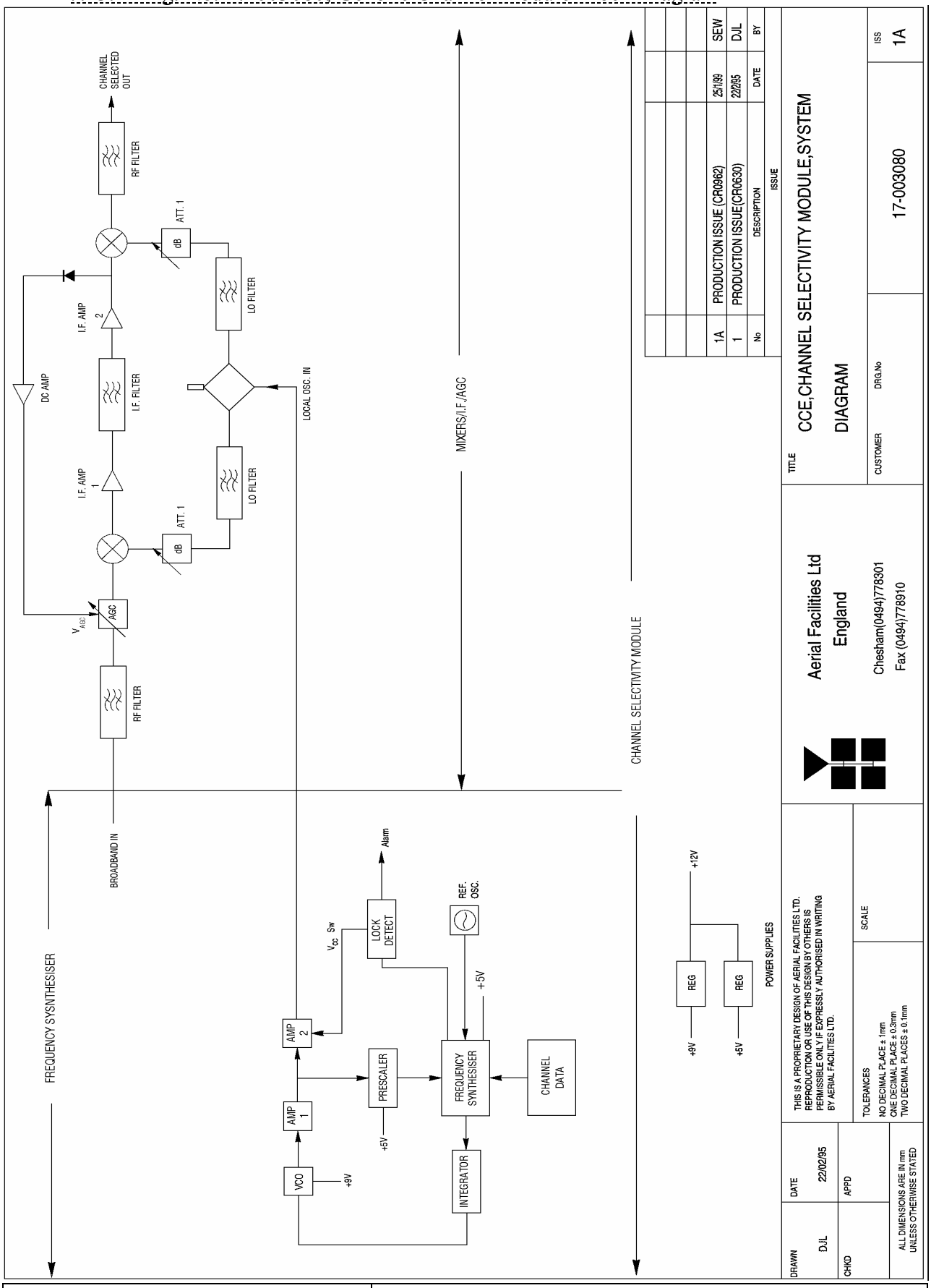
The operating frequency of each channel selectivity module is set by the programming of channel selectivity module frequencies and is achieved digitally, via hard wired links, banks of DIP switches, or via an onboard RS232 control module, providing the ability to remotely set channel frequencies.

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.

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



7.14 12 & 24V Relay Boards (20-001601 & 20-001602)

7.14.1 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.

7.14.2 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

7.15 12 & 24V Single Relay Board (80-008901 & 80-008902)

7.15.1 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.

7.16 24V, 400W Power Supply Pack (96-300054)

7.16.1 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.

7.16.2 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 or RF 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 9.2 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