12 Channel VHF Repeater

User Handbook
For
W.O.W
AFL Works Order Nō.:Q112547
AFL product part Nō.:50-122501

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AMENDMENT LIST RECORD SHEET

Issue Nō.	Date	Incorporated by	Page No.'s Amended	Reason for new issue
A	29/03/05	CMH		1st Draft
1		CMH		1st Issue

Document Ref:-50-122501HBK

INTRODUCTION

Scope

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

Purpose

AFL recommends that the installer of this equipment familiarise his/herself with the safety and installation procedures contained within this document before installation commences.

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

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

Limitation of Information Notice

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

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

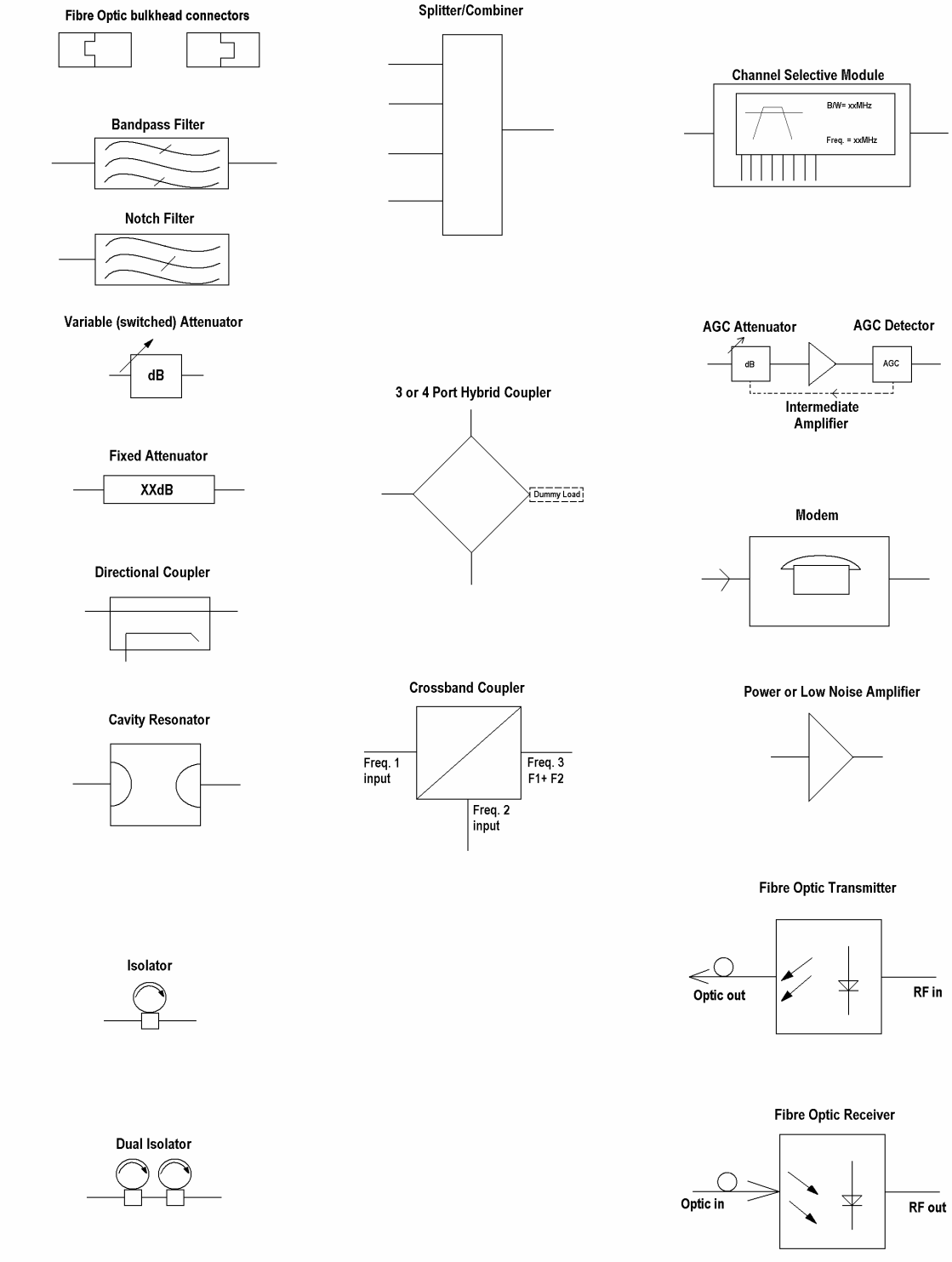
AFL has a policy of continuous product development and enhancement, and as such, reserves the right to amend, alter, update and generally change the contents, appearance and pertinence of this document without notice.

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

Glossary of Terms

Repeater or Cell Enhancer	A Radio Frequency (RF) amplifier which can simultaneously amplify and re-broadcast Mobile Station (MS) and Base Transceiver Station (BTS) signals.
Band Selective Repeater	A Cell Enhancer designed for operation on a range of channels within a specified frequency band.
Channel Selective Repeater	A Cell Enhancer, designed for operation on specified channel(s) within a specified frequency band. Channel frequencies may be factory set or on-site programmable.
BTS	Base Transceiver Station
C/NR	Carrier-to-Noise Ratio
Downlink (D/L.)	RF signals transmitted from the BTS and to the MS
Uplink (U/L.)	RF signals transmitted from the MS to the BTS
EMC	Electromagnetic Compatibility
GND	Ground
DC	Direct Current
AC	Alternating Current
ID	Identification Number
OIP3	Output Third Order Intercept Point = RF_{out} +(C/I)/2
LED	Light Emitting Diode
M.S.	Mobile Station
N/A	Not Applicable
N/C	No Connection
NF	Noise Figure
RF	Radio Frequency
Rx	Receiver
Tx	Transmitter
S/N	Serial Number

Key to AFL RF Module Drawing Symbols



Key to AFL RF Modules

1. SAFETY CONSIDERATIONS

1.1 Earthing of Equipment

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

1.2 Electric Shock Hazard

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

a) Original assembly

b) Commissioning

c) Regular intervals, thereafter.

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

1.3 RF Radiation Hazard

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

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

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

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

1.4 Chemical Hazard

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

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

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

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

Many modules/components in AFL equipment contain P.T.F.E. as part of the RF insulation barrier.

This material should never be heated to the point where smoke or fumes are evolved. Any person feeling drowsy after coming into contact with P.T.F.E. especially dust or fumes should seek medical attention.

1.5 Emergency Contact Numbers

The AFL Quality Department can be contacted on:

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

2. OVERVIEW/SYSTEM DESCRIPTION

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

The Channel Selective Cell Enhancer is a 2-port device for direct connection to two antennas, usually a highly directional Yagi or similar aligned towards the base (donor) site and an omni-directional antenna to cover the mobiles. The frequency bands that are passed by the Cell Enhancer are set as per the specific customer requirements.

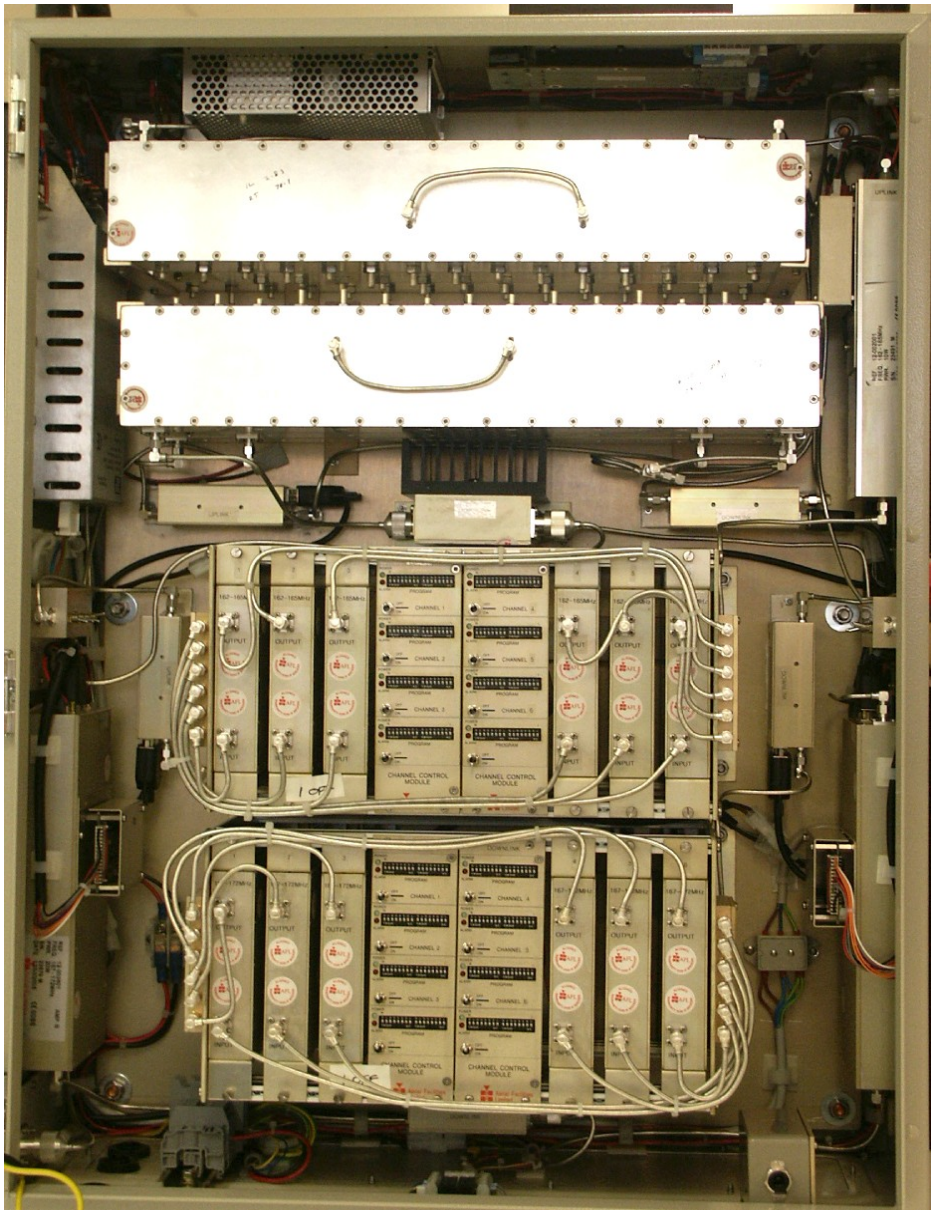
AFL manufacture a wide range of Cell Enhancers, configured for each customer's specific requirements. Two basic physical variants are available, a rack mounted version to fit in a standard 19" rack and an environmentally sealed wall mounted version which requires no further enclosure.

The rack-mounted version is usually supplied in 3 units, a power supply unit and 2 RF units (one containing each path). Each shelf/tray unit containing active modules has a ‘D.C. on’ indicator on the front panel and the PSU also has an ‘A.C. on’ indicator.

The wall-mounted version is supplied in a single environmentally-protected case. Handles are provided for carrying the unit and the door is fitted with locks. A supply isolator switch is fitted inside the unit and there are ‘.DC. on’ and ‘Alarm on’ indicators on the outside of the door.

3. SPECIFICATION

3.P Cell Enhancer Case Internal Photograph



3.1 Description

The system consists of separate modules mounted within a lockable, environmentally protected enclosure. It is designed to amplify twelve bi-directional channels (six uplink, six downlink) of mobile signals operating in the VHF waveband. All twelve channel selective modules are configurable for any frequency (within the channel modules' designed range) set by the DIP switches on the channel control modules – see section 4.8 for channel frequency calculation examples. Alarms are provided for each amplifier and channel selective module which are wired as a volt-free, relay isolated summary loop, terminating at pins 1 & 2 in the external connector. The 'normal' condition is that each active device 'holds' a local relay closed, (so if power fails, the alarms become active) making a fail-safe system.

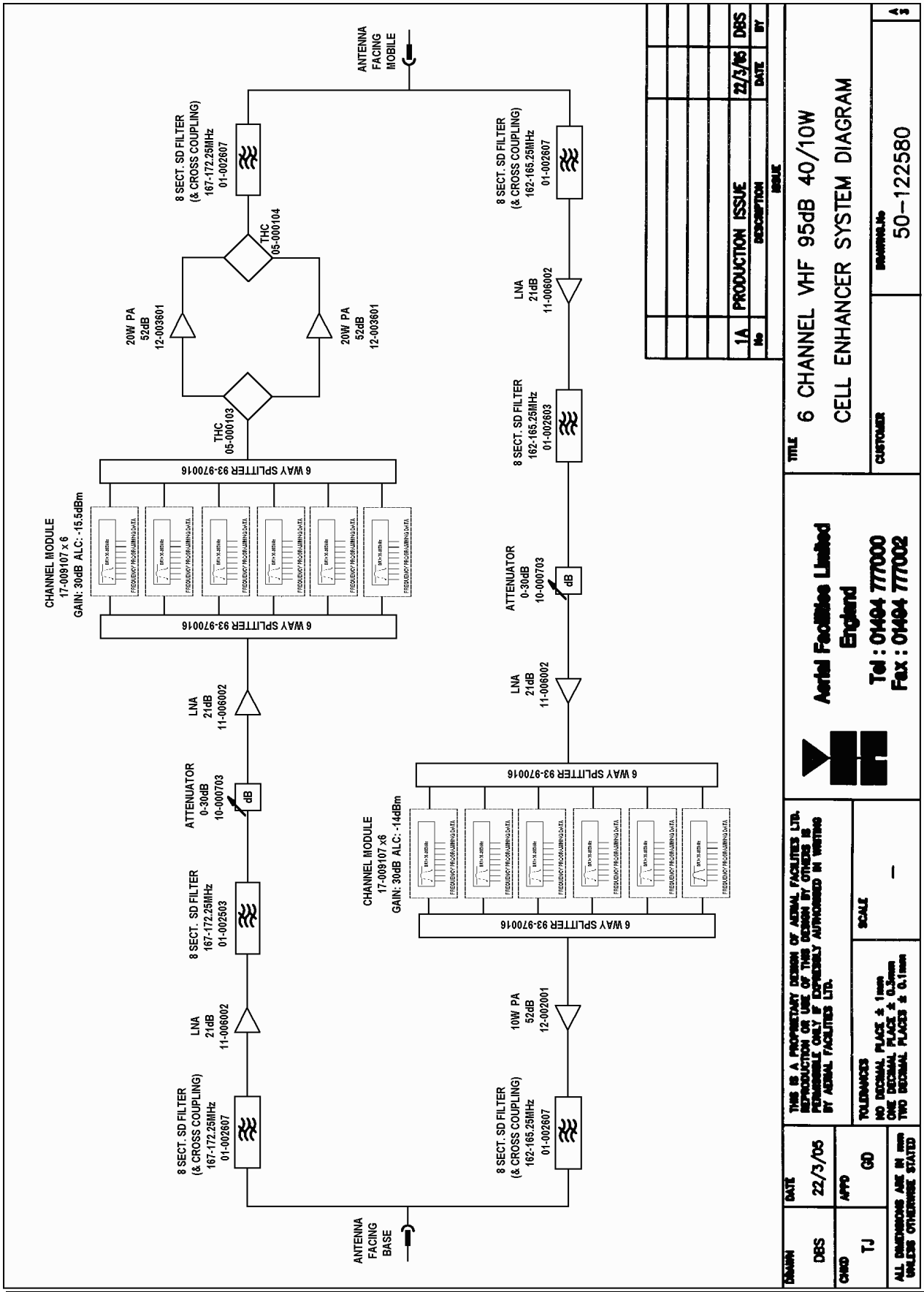
3.2 Electrical Specification

PARAMETER		SPECIFICATION
Frequency range:		167.0-172MHz (Downlink)
		162.0-165MHz (Uplink)
Channel module frequencies:		Unspecified
Bandwidth:		3MHz uplink 5MHz downlink
Channel ripple:		<±1.5dB
Gain:		>95dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Spurious noise (in-band 30kHz):		<-13dBm (U/L & D/L)
Uplink Power:		>10.0Watts
Downlink Power:		>40.0Watts
DownlinkO/P power/channel:		+24dBm
UplinkO/P power/channel:		+18dBm
Channel module gain:		30dB
Channel module ALC:		-15.5dBm (downlink)
		-14dBm (uplink)
PA 1 dB compression point:		+44dBm (downlink)
		+38dBm (uplink)
PA IP3:		+56dBm (downlink)
		+50dBm (uplink)
Noise Figure:		<6dB
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Input supply power:		110 or 230V ac
Temperature range:	operational:	-10°C to +60°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 Amplifiers
		2 Channel modules

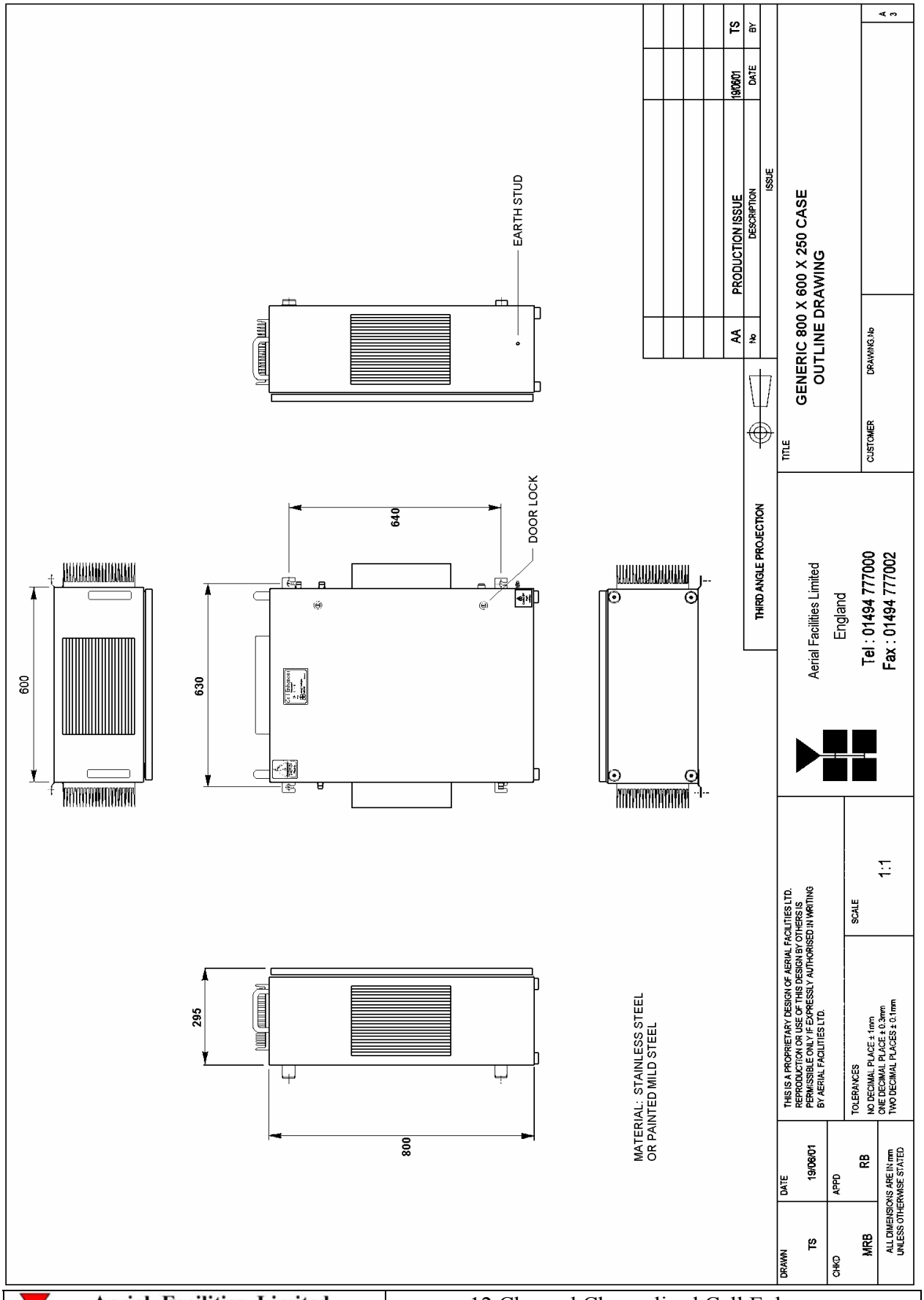
3.3 Mechanical Specification

Case Size:	Height:	**800**mm
	Width:	**600**mm
	Depth:	**250**mm
(excluding heatsinks, connectors, handles and feet)		
Fixings:		**4** holes on **630**(w) x **640**(h)mm
Weight:		**80**kg (approximately)
RF Connectors:		**N type female**
Environmental Protection:		**IP65** with door closed and ports terminated
Finish:	Case:	To **RAL 7035**
	Heatsinks:	**Matt black**
	Handles:	**Black technopolymer**
Temperature Range:	operational:	**-20**°C to +**60**°C
	storage:	**-40**°C to +**70**°C
Supply cord:		Unit supplied with 3-pin IP68 connector for customer interface with AC input.

3.4 System Diagram, Drg. Nō. 50-122580



3.5 Generic System Case Outline Drawing



3.5 Parts List

AFL Part Nō.	Part Description	Qty.
05-000103	TX HYBRID COUPLER 3 PORT NO HTSINK	1
05-000104	TX HYBRID COUPLER 3 PORT W/HEATSINK	1
10-000703	1/4W0-30dB SWITCHED ATTENUATOR	2
11-006002K	LNA VHF 70-500MHz KIT	4
12-002001K	PWR AMP 10W 100-250MHz SMA KIT	1
12-003601K	POWER AMP.150MHz 20W KIT	2
13-003011	DC/DC CONVERTER.18-36in 12v out 8.3A	1
13-003020	DC/DC CONVERTER 24-12V HEATSINK	1
17-000526	CE 10/20W HEATSINK THERMAL GASKET	4
17-002101	CHANNEL CONTROL MODULE	4
17-002103	26WAY RIBBON CABLE LEAD	12
17-003022	MODULE PATTERNED LEAVE	12
17-003023	SUBRACK SIDE PANEL	4
17-003024	SUBRACK REAR BRACKET	12
17-003025	BOTTOM MODULE GUIDE	12
17-003028	MODULE SQUARE LEAVE	12
17-003029	TOP MODULE GUIDE	12
17-009106	160MHz VHF CHAN MOD, 30kHz (8p)	12
20-001602	24V RELAY BOARD	1
80-031820	20W PA HEATSINK	2
80-310420	BCC 400W POWER SUPPLY HEATSINK	2
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	2
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	2
91-800027	DIN RAIL NON-FUSED TERMINAL BLOCK	9
91-800028	DIN RAIL END-STOP	4
91-800029	DIN RAIL TERMINAL BLOCK PARTITION	3
92-120009	M20 IP68 CABLE GLAND	3
93-970016	6 WAY SPLITTER 1-500MHz SMA	4
94-100004	STPS12045TV 60A DUAL DIODE	2
96-100006	FUSE HOLDER ATO IN-LINE	1
96-110057	25A ATO FUSE	1
96-300051	JWS100-12/A PSU	1
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
97-100109	CASE 800 x 600 x 250 SAREL(FEC 650-754)	1
97-400010	BLACK PLASTIC HANDLE 50mm HIGH	2
97-600001	SUBRACK FRONT HORIZ	4
97-600002	SUBRACK M2.5 STD TAP	24
97-900004	RUBBER FOOT FOR CELL ENHANCERS	4
99-200017	CAUTION HEAVY LABEL 75 x 55mm	1

4. SUB-UNIT MODULES

4.1 3 Port Tx Hybrid Couplers (05-000103 & 05-000104)

4.1.1 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. The '104' version has higher power capability due to an attached heatsink.

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.

4.1.2 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 (05-000103)
	100W (05-000104)
Weight:	0.5kg

4.2 ¼Watt 0- -30dB Switched Attenuator (10-000703)

4.2.1 General Application

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

4.2.2 Switched Attenuators

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

4.3 VHF/UHF Low Noise Amplifier (11-006002)

4.3.1 Description

The 21dB gain low noise amplifier used is a double stage solid-state low-noise amplifier. Class A circuitry is used throughout the unit to ensure excellent linearity over a very wide dynamic range. The two active devices are very moderately rated to provide a long, trouble-free working life. There are no adjustments on this amplifier, and in the unlikely event of failure then the entire amplifier should be replaced. The amplifier features a dedicated, in-built alarm monitoring system based on class A DC biasing levels whose output is a volts-free relay contact pair that may be integrated into an existing system via the 9-way D-type interface.

4.3.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		70 – 500MHz
Bandwidth:		<430MHz
Gain:		21dB (typical)
1dB Compression Point:		+20dB (typical)
3rd order intercept:		+33dB (typical)
Input return loss:		>14dB
Output return loss:		>20dB
VSWR:		Better than 1.5:1
Noise figure:		<2.7dB
Connectors:		SMA female
Supply:		230 - 260mA @ 10 to 24V DC
Size:		88 x 50 x 34mm (ex. connectors)
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.26kg

4.3.3 LNA 'D' Connector Pin-out details

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

4.4 10Watt Power Amplifier (12-002001)

4.4.1 Description

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

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

4.4.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		100 - 250MHz (tuned to spec.)
Bandwidth:		20MHz (typical, tuned to spec.)
Maximum RF output:		>10Watts
Gain:		>50dB
1dB compression point:		+40dBm
3rd order intercept point:		+50dBm
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		2.5Amps @ 24V DC
Weight:		1kg (excluding heatsink)
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C

4.5 20Watt Power Amplifier (12-003601)

4.5.1 Description

The 20Watt power amplifier fitted to this unit is a multi-stage, solid state power amplifier. Class A circuitry is employed throughout the device to ensure excellent linearity over a wide dynamic frequency range. All the semi-conductor devices are very conservatively rated to ensure low device junction temperatures and a long, trouble free working lifetime.

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

4.5.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency Range:		88 - 108MHz
Bandwidth:		20MHz (typical, tuned to spec.)
Maximum Output Power:		>20W
Gain:		44dB
1dB Compression Point:		<+43dBm
3rd Order Intercept Point:		<+54dBm
VSWR:		better than 1.45:1
Connectors:		SMA female
Supply:		4.8A @ 24V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:		276 x 78 x 40mm (case only)
Weight:		1.5 kg (excluding heatsink)

4.6 DC/DC Converter, 24V in, 12V 8A out (13-003011)

4.6.1 Description

The DC/DC converter fitted is an O.E.M high power PCB unit with an 8 amp @ 12V output capability. The regulator exists within this unit because of the need to supply 12V DC to the channel modules; if the unit is being supplied with power by the external 24V DC rail, there would be only be 24V in the system and the channel modules would have no power. The circuit is basically an O.E.M semiconductor regulator (one side of which has a heatsink mounting plate, usually bolted to the casing of a Cell Enhancer) and smoothing components built onto a printed circuit board with screw block terminations.
Note: no circuit diagram of this O.E.M. regulator is available. This unit should not be repaired, only replaced.

4.6.2 Technical Specification

PARAMETER		SPECIFICATION
Input Voltage Range:		18-28V DC
Output Voltage:		12V±0.5V
Max. Current Load:		8.0Amps
Temperature range:	operation :	-10°C to +60°C
	storage:	-20°C to +70°C
Size(PCB):		190 x 63mm
Weight (Loaded PCB):		291gms

4.7 Channel Control Module (17-002101)

4.7.1 Description

The purpose of the channel control modules is to change the channel selective module frequencies by means of a series of D.I.P switch banks, each switch corresponding to a different 'frequency bit'.

4.7.2 Technical Specification

Below shows the pin assignments for each switch on a channel control module.

IDC PIN	25-way Connector	Function
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	N/C
19	4	
20	16	
21	3	
22	15	+5V
23	2	0V
24	14	Switched 12V
25	1	0V
26	---	---

4.7.3 VHF/ UHF 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.

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

4.7.4 VHF/ UHF Programming Example

Frequency required: 465.5MHz

Channel spacing: 12.5kHz

Synthesiser offset: 21.4MHz

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

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

$$\frac{444.0}{0.0125} = 35520$$

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

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

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

4.8 Channel Selective Module (17-009106)

4.8.1 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.

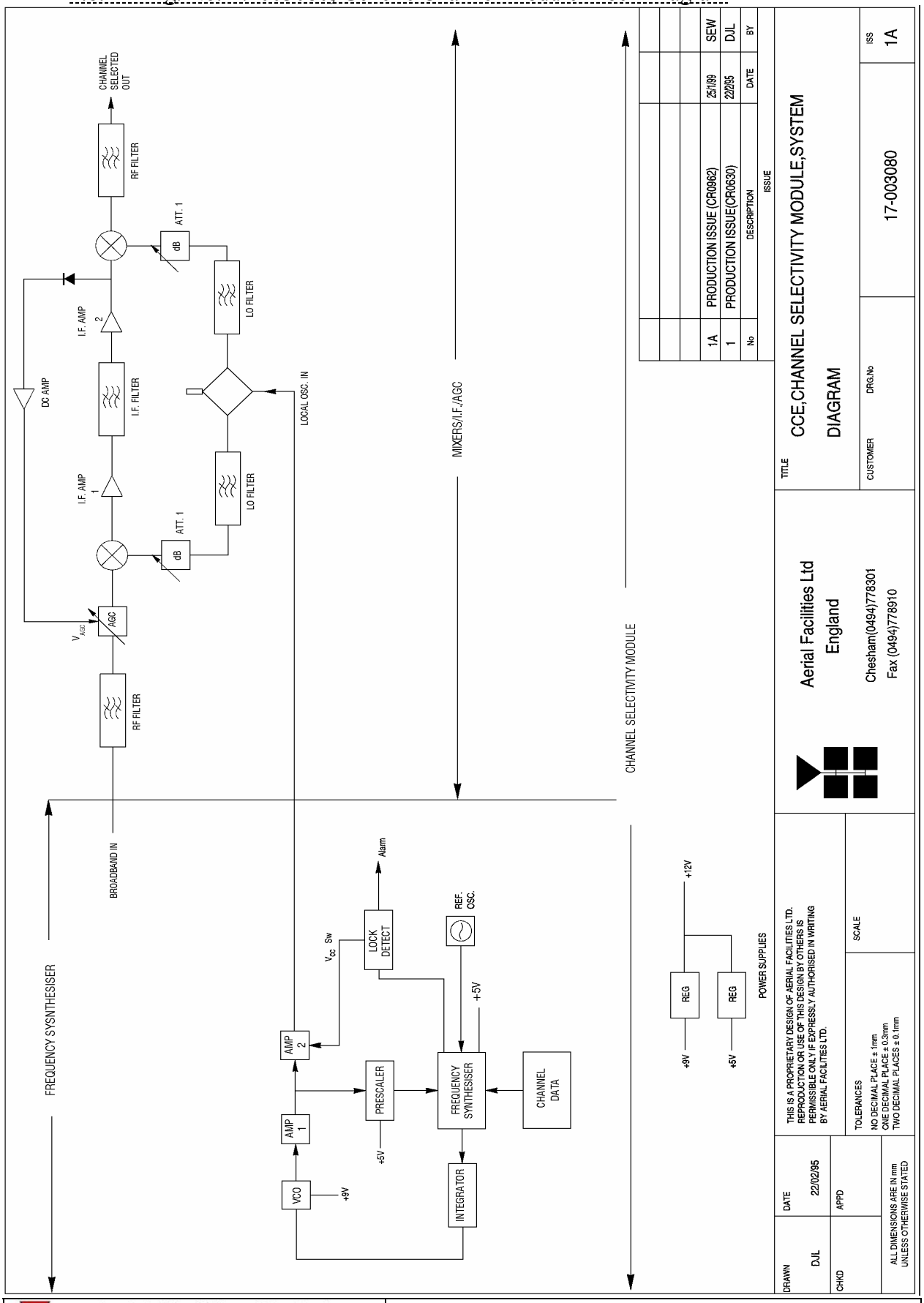
Automatic Level Control (ALC) is provided within each channel selectivity module such that the output level is held constant for high level input signals. This feature prevents saturation of the output mixer and of the associated amplifiers.

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.

Operators note: None of the channel modules is frequency pre-programmed, they must all be set using the method described in section 4.8.

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



4.9 24V Relay Board (20-001602)

4.9.1 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.

4.9.2 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

4.10 Six-Way Splitter (93-100004)

4.10.1 Description

The wide range, low power, hybrid splitter/combiner provides the means to divide the signal into six before the channel modules & re-combine the six signals into one after processing.

Being passive devices, the receivers 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 should the unit be suspected of failure, replacement with a new unit is usually the most cost effective solution.

4.10.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency Range:		50-500MHz
Rx/Rx Isolation:		>20dB
Typical Insertion Loss:		10.5 dB
VSWR:		1.3:1
Impedance:		50Ω
Output Connectors:		N Type
Input Connectors:		N Type / BNC
Temperature range	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Dimensions:		145 x 64 x 37mm (case only)

4.11 STPS12045TV 60A Dual Diode Assembly (94-100004)

4.11.1 Description

The purpose of these dual diode assemblies is to allow two (or more) DC voltage sources to be combined, so that the main 24 volt DC rail within the equipment is sourced from either the mains driven SMPU, or externally through an XLR connector on the rear panel. When the DC is sourced externally, the heavy-duty diodes prevent any reverse current from flowing back to their source or the alternative supply rail. Combining diodes such as these would also be used if the equipment is to be powered from external back-up batteries.

4.12 JWS100-12/A PSU (96-300051)

4.12.1 Description

The mains power supply unit used to power the channel selective modules is a switched-mode type capable of supplying 12V DC at 8.5Amps continuously, (the cell enhancer draws approximately 5.0Amps from this 12V supply under normal conditions).

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 12.2V. The output voltage may be varied using the multi-turn adjustment potentiometer mounted close to the DC output terminals.

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

4.12.2 Technical Specification

AC Input Supply:	
Voltage:	110 or 220V nominal
	90 to 132 or 180 to 264V (absolute limits)
Frequency:	47 to 63Hz
DC Output Supply:	
Voltage:	12V DC (nominal)
	10-14V (absolute limits)
Current:	8.5A

4.13 24V, 400W Power Supply Pack (96-300054)

4.13.1 Description

The main 24V power supply unit is a switched-mode type capable of supplying 24V DC at 17.0Amps continuously. Equipment of this type typically requires approximately 12.0 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.

4.13.2 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

5. INSTALLATION

5.1 Initial Installation Record

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

5.2 Antenna Installation & Gain Calculations

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

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

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

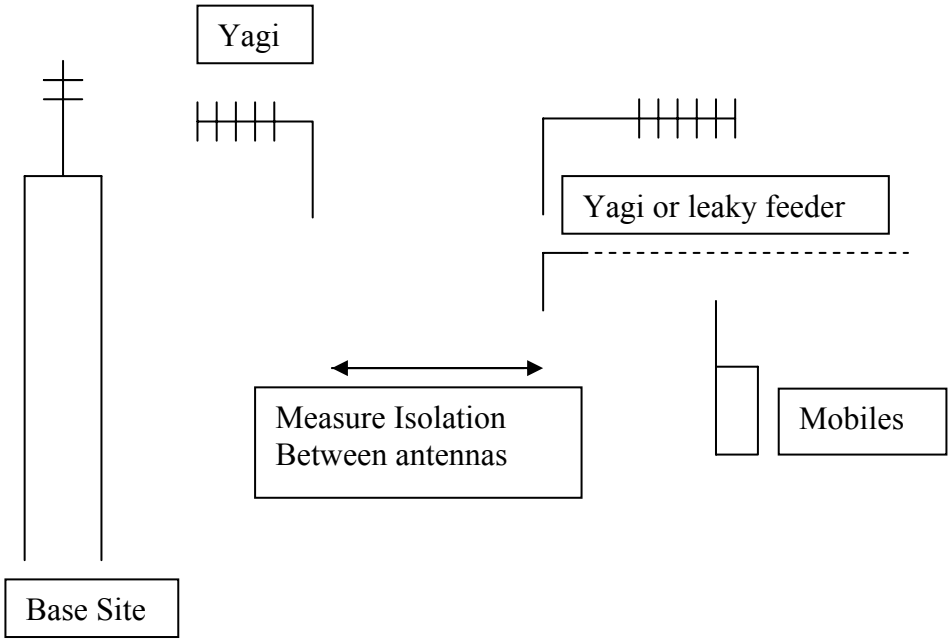
4 Ensure that the mobile facing antenna has at least 70 dB isolation from the nearest mobile. (This is usually easily achieved when using a leaky feeder.)

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

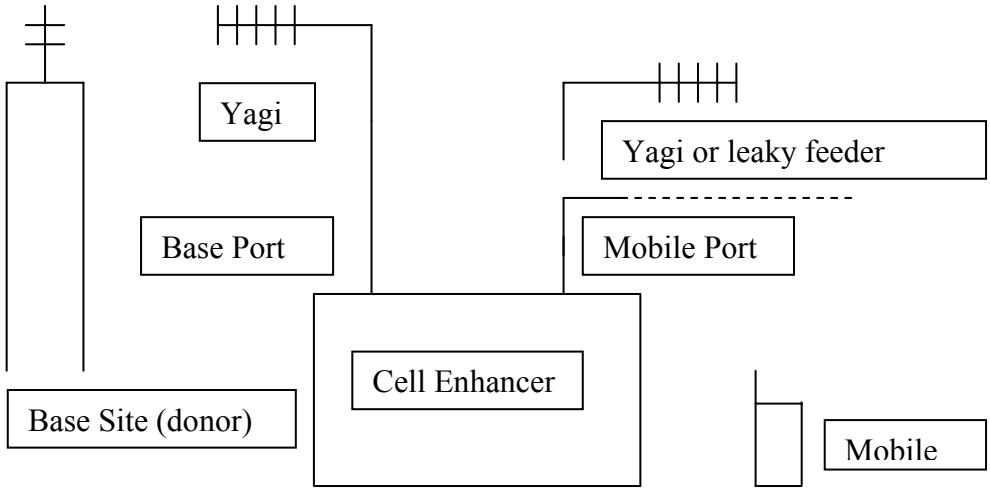
6 It is recommended that the gains are set such that the Downlink channel output levels from the Cell Enhancer are typically +30dBm per channel
(Input level + Gain = Output level).

5.3 Antenna Isolation

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



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



6. MAINTENANCE

6.1 General Procedures

6.1.1 Fault Finding

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

The first operation is to check the alarms of each of the active units and determine that the power supplies to the equipment are connected and active.
This can be achieved remotely (via CEMS, the RS232 Coverage Enhancement Management System, if fitted), or locally with the front panel LED's. The green LED on the door should be illuminated, while the red alarm indicator should be off.

If an Alarm is on, then that module must be isolated and individually tested against the original test specification. Note that channel modules will alarm if their channel frequency (set by the channel controller DIP switches) is set to a non-valid frequency.
The individual amplifier units within the unit have a green LED showing through a hole in their lid, 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.

6.1.2 Downlink

Confirm that there is a signal at the expected frequency and strength from the base station. If this is not present then the fault may lay outside the system. To confirm this, inject a downlink frequency signal from a known source at the master site BTS input and check for output at the remote site feeder output.

If a signal is not received at the output it will be necessary to follow the downlink path through the system to find a point at which the signal is lost. The expected downlink output for the given input can be found in the end-to-end test specification.

6.1.3 Uplink

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

6.1.4 Fault repair

Once a faulty component has been identified, a decision must be made on the appropriate course to carry out a repair. A competent engineer can quickly remedy typical faults such as faulty connections or cables. The exceptions to this are cable assemblies connecting bandpass filter assemblies that are manufactured to critical lengths to maintain a 50-ohm system. Care should be taken when replacing cables or connectors to ensure that items are of the correct specification. The repair of component modules such as amplifiers and bandpass filters will not usually be possible in the field, as they frequently require specialist knowledge and test equipment to ensure correct operation. It is recommended that items of this type are replaced with a spare unit and the faulty unit returned to AFL for repair.

6.1.5 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.

6.1.6 Service Support

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

6.2 Tools & Test Equipment

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

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

6.3 Care of Modules

6.3.1 General Comments

Many of the active modules contain semiconductor devices utilising MOS technology, which can be damaged by electrostatic discharge. Correct handling of such modules is mandatory to ensure their long-term reliability.

To prevent damage to a module, it must be withdrawn/inserted with care. The module may have connectors on its underside, which might not be visible to the service operative.

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

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

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

7.3.3 Module Replacement (general):

1 Carefully align the module into its location then slowly push the module directly straight into its position, taking care not to twist/turn it during insertion.
2 Reconnect all connectors, RF, alarm, power etc.,(concealed connectors may have to be connected first).
3 Replace retaining screws (if any).
4 Double-check all connections before applying power.

6.3.4 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.

6.3.5 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

6.3.6 Module Transportation:

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

APPENDIX A INITIAL EQUIPMENT SET-UP CALCULATIONS

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

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

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

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

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

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