Aerial Facilities Limited

Fibre Optic Master and Remote Site
User Handbook

For
R.F. Design & Integration, Inc.

AFL Works Order	**Q116270**
AFL Product Part No.	**60-212701 - 500 MHz F/O Master Site**
	60-212801 - 500 MHz F/O Remote Site

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1. INTRODUCTION

1.1. Scope and Purpose of Document

This handbook is for use solely with the equipment identified by the Aerial Facilities Limited (AFL) Part Number shown on the front cover. It is not to be used with any other equipment unless specifically authorised by AFL. This is a controlled release document and, as such, becomes a part of Aerial Facilities' Total Quality Management System. Alterations and modification may therefore only be performed by AFL.

AFL recommends that the installer of this equipment familiarise themselves 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.

1.2. Limitation of Liability Notice

This manual is written for the use of technically competent operators/service persons. No liability is accepted by AFL for use or misuse of this manual, the information contained 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 its completeness, fitness for purpose, or scope.

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

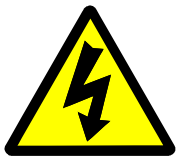
All AFL products carry a twelve month warranty from date of shipment. The warranty is expressly on a return to base repair or exchange basis and the warranty cover does not extend to on-site repair or complete unit exchange.

2. SAFETY CONSIDERATIONS

2.1. Earthing of Equipment

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

2.2. Electric Shock Hazard



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

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

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

2.3. RF Radiation Hazard

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

This condition might only occur in the event of cable disconnection, or because a 'spare' output has been left un-terminated. Either of these conditions would impair the system's efficiency. No investigation should be carried out until all RF power sources have been removed. This would always be a wise precaution, despite the severe mismatch between the impedance of an N type connector at 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.

2.4. Lifting and other Health and Safety Recommendations

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

2.5. Chemical Hazard

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

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

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

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

2.6. Laser safety

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

Do not stare with unprotected eyes or with any unapproved optical device at the fibre ends or connector faces or point them at other people, Use only approved filtered or attenuating viewing aids.
Any single or multiple fibre end or ends found not to be terminated (for example, matched, spliced) shall be individually or collectively covered when not being worked on. They shall not be readily visible and sharp ends shall not be exposed.
When using test cords, the optical power source shall be the last connected and the first disconnected; use only approved methods for cleaning and preparing optical fibres and optical connectors.
Always keep optical connectors covered to avoid physical damage and do not allow any dirt/foreign material ingress on the optical connector bulkheads.
The optical fibre jumper cable maximum bend radius is 3cm; any smaller radii may result in optical cable breakage or excessive transmission losses.
Caution: The FO units are *NOT* weather proof.

2.7. Emergency Contact Numbers

The AFL Quality Department can be contacted on:

Telephone	+44 (0)1494 777000
Fax.	+44 (0)1494 777002
e-mail	qa@aerialfacilities.com

3. MASTER SITE 60-212701

The Master Site Shelf is a 3U Rack mount shelf and provides two separate RF paths, uplink and downlink with provision to vary the gain of either path using a switched variable attenuator, one in each path. The active Fibre Optic modules in the unit are powered from an internal 12V PSU which runs from a mains feed of 110V AC

The downlink signal is received from the antenna and enters the master site via the port labelled “TX”, the signal passes through a switched variable attenuator (10-000801) providing up to 30dB of attenuation 2dB steps. After leaving the attenuator the signal is split into two equal paths by a 3dB splitter/combiner (05-002603) and each path is passed into a Fibre Optic Transmitter (20-005401) where the signal is modulated onto a laser as an optical signal for transmission to the remote site via fibre optic cable. The fibre optic signal leaves the master site via the ports labelled “F/O DL” (Fibre Optic Downlink). Only one “F/O DL” port is used, the second one being available for future expansion.

Uplink signals are received at the master site as optical signals sent from the remote site, the fibre optic cable carrying the optical signals enter the master site via the ports labelled “F/O UL” (Only one “F/O UL” port is used, the second one being available for future expansion). Upon entering the master site the optical signal is passed to a fibre optic receiver (20-005501) where the signal is demodulated into an RF signal. After leaving the fibre optic receivers the two RF signal paths are combined by a 3dB splitter/combiner (05-002603) to produce a single path which then passes through a switched variable attenuator (10-000701) providing up to 30dB of attenuation 2dB steps. After leaving the attenuator the RF signal leaves the master site via the port labelled “RX”

3.1. 60-212701 Parts List (Major Components)

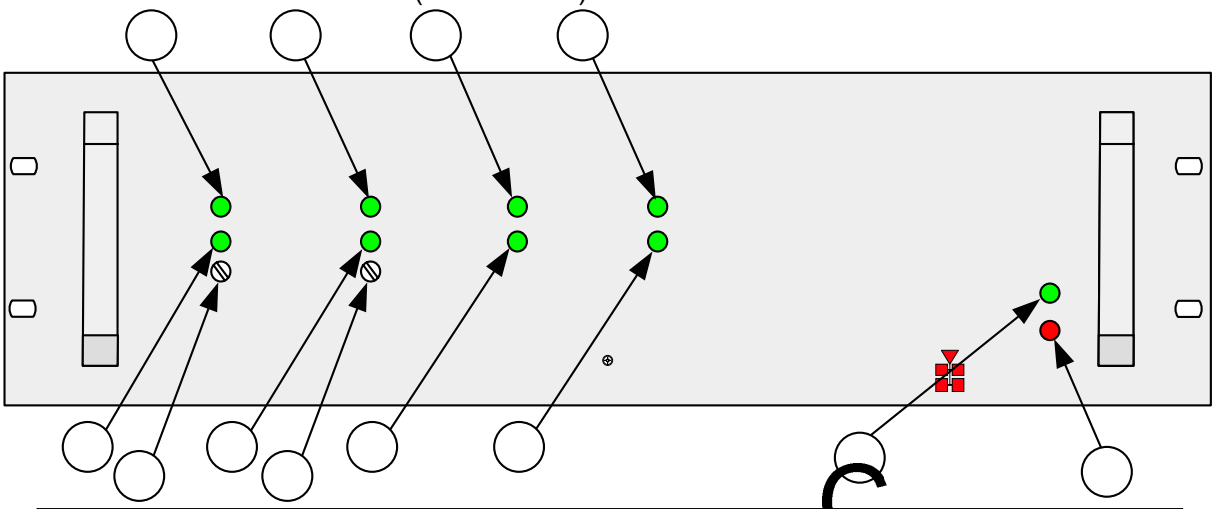
Component Part	Component Part Description	Qty Per Assembly
05-002603	UHF 3dB Splitter/Combiner	2
10-000701	Switched Attenuator 0-30dB 0.25W	1
10-000801	Switched Attenuator 0-30dB 1W	1
20-005401	Fibre Optic Transmitter (2.7GHz)	1
20-005501	Fibre Optic Receiver (2.7GHz)	1
80-008901	12V Relay Assembly	1
96-300048	PSU 50W (12V 5A)	1
96-920022	Circuit Breaker (3A)	1

The individual fibre optic TX and RX units are fitted with a pair of status indicators on their front panels. One is a green LED, which indicates that the unit is connected to a 12 Volt DC power supply. This indicator is common to both transmit and receive units. The second LED on the TX module indicates that the laser is operating (transmitting). On the RX unit the second LED indicates that a laser-light signal is being received.

When all the fibre connections are completed and power to each site is connected each fibre unit must show two illuminated indicators.

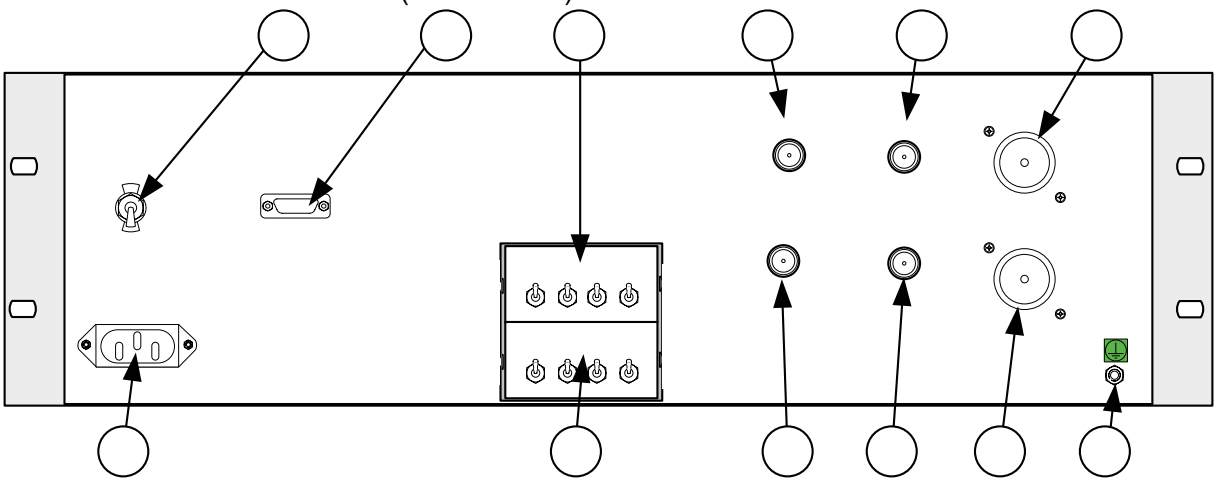
3.2. 60-212701 Diagrams

Master Site 60-212701 Front Panel (Not to scale)



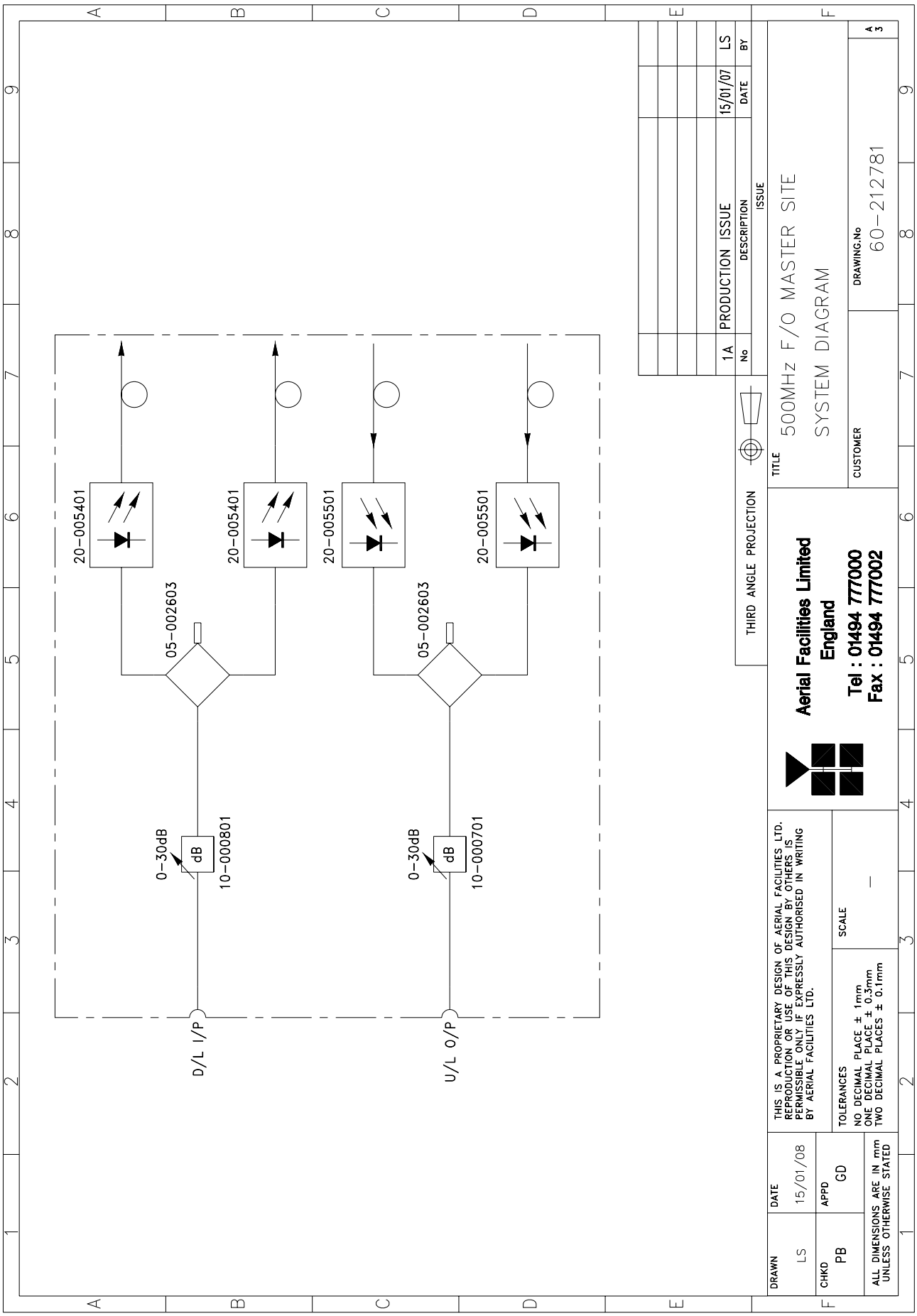
A	Green LED “Power On”
B	Red LED “Alarm”
C	Green LED Fibre Optic Receiver 1 “Power On”
D	Green LED Fibre Optic Receiver 1 “Laser On”, LED not illuminated = Alarm
E	Fibre Optic Receiver 1 Gain Adjust
F	Green LED Fibre Optic Receiver 2 “Power On”
G	Green LED Fibre Optic Receiver 2 “Laser On”, LED not illuminated = Alarm
H	Fibre Optic Receiver 2 Gain Adjust
I	Green LED Fibre Optic Transmitter 1 “Power On”
J	Green LED Fibre Optic Transmitter 1 “Laser On”, LED not illuminated = Alarm
K	Green LED Fibre Optic Transmitter 2 “Power On”
L	Green LED Fibre Optic Transmitter 2 “Laser On”, LED not illuminated = Alarm

Master Site 60-212701 Rear Panel (Not to scale)



A	RX Port – Uplink RF out to antenna	G	Earth connection
B	Fibre Optic input 2 (uplink from remote site)	H	Uplink Switched Attenuator
C	Fibre Optic input 1 (uplink from remote site)	I	Downlink Switched Attenuator
D	TX Port – Downlink RF in from antenna	J	Alarm Output
E	Fibre Optic output 2 (downlink to remote site)	K	AC Trip Switch
F	Fibre Optic output 1 (downlink to remote site)	L	AC input (110V)

3.3. 60-212701 System Diagram



3.4. 60-212701 Major Sub Components

3.4.1. UHF 3dB Splitter/Combiner (05-002603)

The 3dB Splitter/Combiner (05-002603) is a device for accurately matching two RF signals to a single port or splitting an RF signal to two ports whilst maintaining an accurate 50 load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum.

05-002603 Specification

PARAMETER		SPECIFICATION
Frequency range		380 - 520 MHz
Bandwidth		140 MHz
Ports	As Combiner	2 inputs 1 output
	As Splitter	1 input 2 outputs
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 – Combiner		0.5 Watt
Power Rating – Splitter		20 Watts
Connectors		SMA female
Size		54 x 44 x 21 mm
Weight		200 gm (approximately)

3.4.2. Switched Attenuator 0-30dB 0.25W (10-000701)

10-000701 provides attenuation from 0 - 30dB in 2 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.

10-000701 Specification

PARAMETER		SPECIFICATION
Attenuation Values		0-30dB
Attenuation Steps		2, 4, 8 and 16dB
Power Handling		0.25 Watt
Attenuation Accuracy		± 1.0 dB
Frequency Rang		DC to 1GHz
Impedance		50Ω
Connectors		SMA
VSWR		1.3:1
Weigh		0.2kg
Temperature range	operation	-20°C to +60°C
	storage	-40°C to +70°C

3.4.3. Switched Attenuator 0-30dB 1W (10-000801)

10-000801 provides attenuation from 0 - 30dB in 2 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.

10-000801 Specification

PARAMETER		SPECIFICATION
Attenuation Values		0-30dB
Attenuation Steps		2, 4, 8 and 16dB
Power Handling		1 Watt
Attenuation Accuracy		± 1.0 dB
Frequency Rang		DC to 1GHz
Impedance		50Ω
Connectors		SMA
VSWR		1.3:1
Weigh		0.2kg
Temperature range	operation	-20°C to +60°C
	storage	-40°C to +70°C

3.4.4. Fibre Optic Transmitter (2.7GHz) (20-005401)

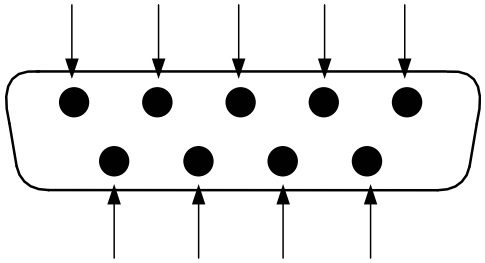
The transmitter modulates the RF signal on to a laser, which is then transmitted over a fibre optic cable to a receiver. The laser current is monitored and compensated for constant optical out put power against temperature variation and aging. Laser over-current alarm function is provided as LED output as well as open collect and voltage-free relay contacts on 9 way D-type connector.

20-005401 specification

PARAMETER	SPECIFICATION
Frequency Range (RF path)	70 - 3000 MHz
Frequency Range (Data path)	20 – 35 MHz
Available Link Gain (RF Path)	18 dB
Link Gain (DATA Path)	0 dB
Gain Flatness (entire frequency range)	±1.5 dB p-p
ΔGain vs. Temperature -20 to 70 ºC	3.5 dB
Gain adjustment range (RF Path)	30 dB
In/Out Return Loss (RF path)	10 dB Min
Output IP3 @ max gain *	37 dBm
In/Output IP3 @ 0dB Gain *	33 dBm
RF impedance	50 Ohm
Noise Figure @ 0dB gain (400MHz)	36 dB
Optical Transmit Power	2.7±0.3 dBm
Optical return loss	>50 dB
Received Power Alarm Threshold	-10 dBm(optic)
Optical wavelength	1310 nm
DC Supply Voltage	10-12 Vdc
DC Supply Current	120 mA
Operating Temperature	-20 to 70 ºC
Storage Temperature	-30 to 85 ºC
RF Connector type	SMA
Fibre optic connector type	FC/APC

Fibre Optic Transmitter (20-005401) 'D' Type Female Connector Pinouts

Pin No.	Signal Description
1	+10-12V DC Power
2	0V DC, Power Ground
3	0V DC, Power Ground
4	No Connection
5	No Connection
6	TTL Alarm, (0V=good, open coll.= fail)
7	Relay Alarm Contact (N.C)
8	Relay Alarm Contact (Common)
9	Relay Alarm Contact (N.O)



3.4.5. Fibre Optic Receiver (2.7GHz) (20-005501)

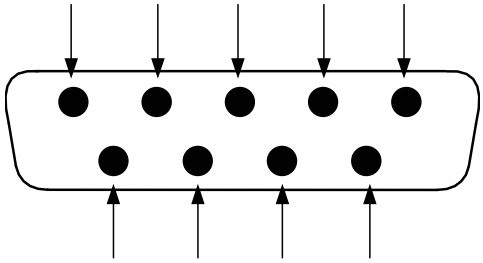
The receiver demodulates RF signals from the laser with a typical gain of 18dB and with 30dB adjustability in the RF domain. The received optical power is monitored for alarm function in case of fibre damage.

20-005501 Specification

PARAMETER	SPECIFICATION
Frequency Range (RF path)	70 - 3000 MHz
Frequency Range (Data path)	20 – 35 MHz
Available Link Gain (RF Path)	18 dB
Link Gain (DATA Path)	0 dB
Gain Flatness (entire frequency range)	±1.5 dB p-p
ΔGain vs. Temperature -20 to 70 ºC	3.5 dB
Gain adjustment range (RF Path)	30 dB
In/Out Return Loss (RF path)	10 dB Min
Output IP3 @ max Gain	37 dBm
In/Output IP3 @ 0dB Gain	33 dBm
RF impedance	50 Ohm
Noise Figure @ 0dB gain (400MHz)	36 dB
Optical Transmit Power	2.7±0.3 dBm
Optical return loss	>50 dB
Received Power Alarm Threshold	-10 dBm(optic)
Optical wavelength	1310 nm
DC Supply Voltage	10-12 Vdc
DC Supply Current	350 mA
Operating Temperature	-20 to 70 ºC
Storage Temperature	-30 to 85 ºC
RF Connector type	SMA
Fibre optic connector type	FC/APC

Fibre Optic Receiver (20-005501) 'D' Type Female Connector Pinouts

Pin No.	Signal Description
1	+10-12V DC Power
2	0V DC, Power Ground
3	0V DC, Power Ground
4	No Connection
5	No Connection
6	TTL Alarm, (0V=good, open coll.= fail)
7	Relay Alarm Contact (N.C)
8	Relay Alarm Contact (Common)
9	Relay Alarm Contact (N.O)



3.4.6. 12V Relay Assembly (80-008901)

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. Its common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.

80-008901 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 +60°C
	storage	-20°C to +70°C

3.4.7. PSU 50W (12V 5A) (96-300048)

The power supply unit is a switched-mode type capable of supplying 12V DC at 5Amps continuously. 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 adjustment potentiometer will be found close to the DC output terminals.

All the PSUs 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.

96-300048 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)
	10.5-13.8V (absolute limits)
Current:	5.0A

4. REMOTE SITE 60-212801

The Remote Site 60-212801 is composed of two rack mount chassis, one containing the filtering, and amplification modules along with the fibre optic transmitter and receiver (60-212802), the second tray is a 100 W amplifier (80-245101), part of the Downlink signal path.

60-212801 sub components

section	Component Part	Component Part Description	Qty Per Assembly
4.1.	80-245101	100W Linearised Amplifier	1
4.2.	60-212802	Remote Uplink/Downlink Tray	1

4.1. 100W Linearised Amplifier (80-245101)

100W Linearised Amplifier (80-245101) shelf is a Class A 100W TETRA Linearised Class A amplifier where 4 linearised power amplifiers are combined together in a 'phased-parallel' arrangement. Its housing is a 4U 19" Rack-mount shelf with SMA connectors for the RF input/output, 2 D-Type connectors for the alarm function and 2 DC connectors with fuses for the 24 DC supplies. Cooling is effected by fans mounted on the front panel.

It has a built in Current Fault Alarm Function with the four amplifiers in two summary alarm paths. The summary alarm on 'D' connector 'A' will show an alarm for the two amplifiers mounted on the top of the shelf (amplifier pair "A"). The summary alarm on 'D' connector 'B' will show an alarm for the two amplifiers mounted at the bottom of the shelf (amplifier pair "B")

4.1.1. 80-245101 Specification

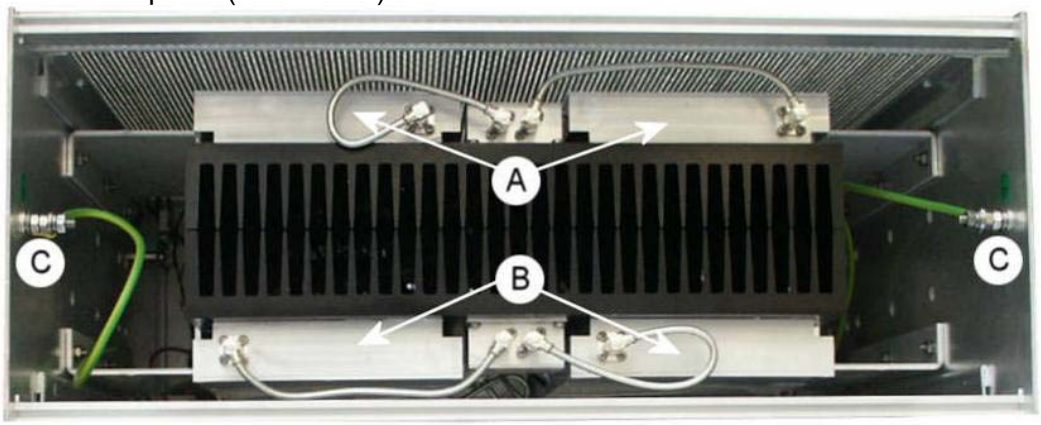
PARAMETER		SPECIFICATION
Frequency range:		440-500MHz
Small signal gain:		37dB
Gain flatness:		±0.5dB
I/O Return loss:		>18dB
1dB compression point:		+50dBm
OIP3:		+69dBm
Supply voltage:		24V DC (x2)
Supply current:		18-19Amps
Impedance:		50Ω
Environmental protection rating:		IP44
Temperature range	operational:	-10°C to +60°C
	storage:	-40°C to +70°C
Weight:		<5kg

4.1.2. 80-245101 Parts List (Major Components)

AFL Part No.	Part Description	Qty.
05-002603	UHF 3dB Splitter/Combiner	6
12-026902	25W Linearised Amplifier Module	4
80-008902	24V Relay PCB Assembly	2
96-400002	Cooling Fan	4

4.1.3. 80-245101 Photographs

100W Linearised Amplifier (80-245101) rear view

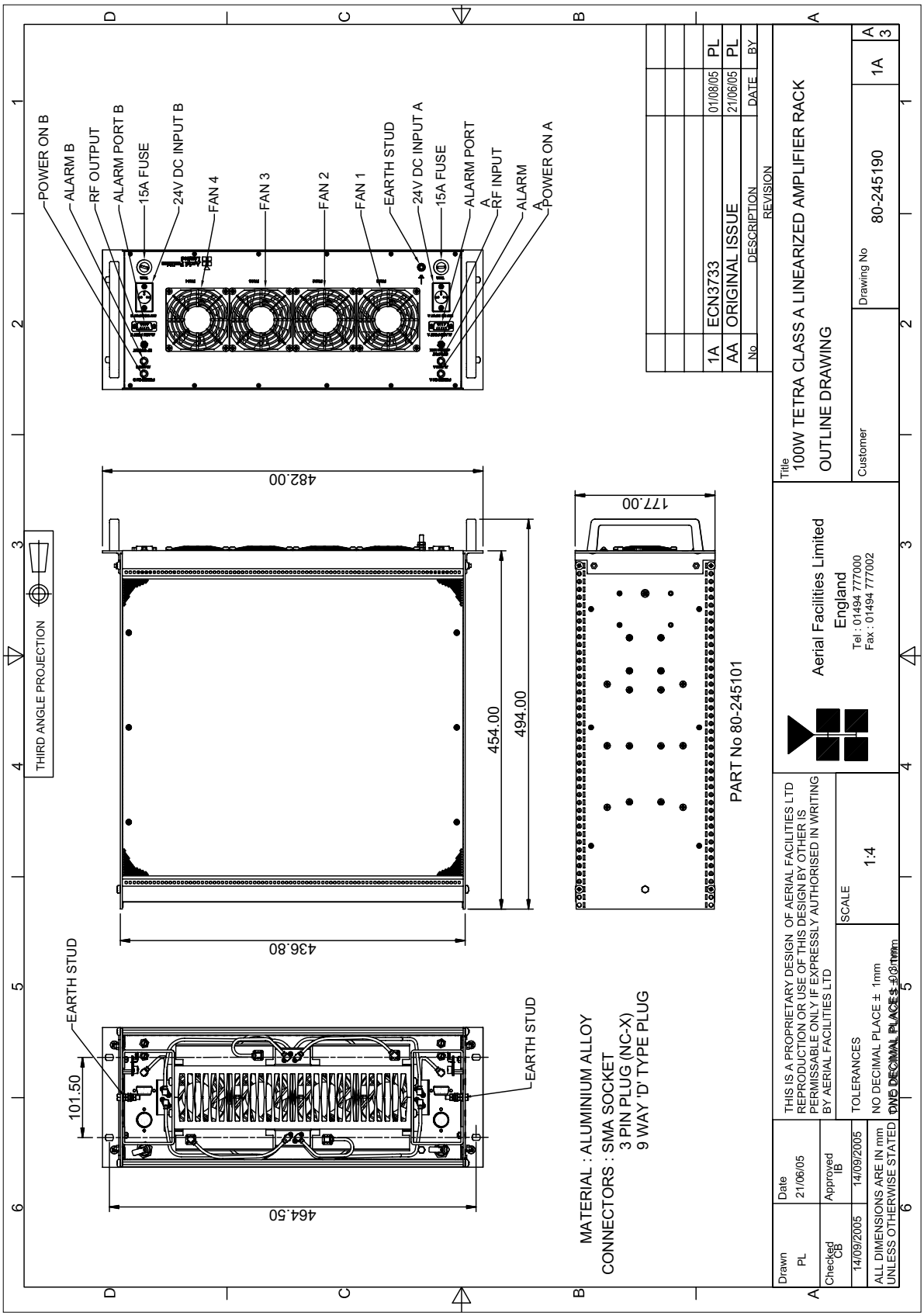


A	Amplifier pair “A”
B	Amplifier pair “B”
C	Earthing connections

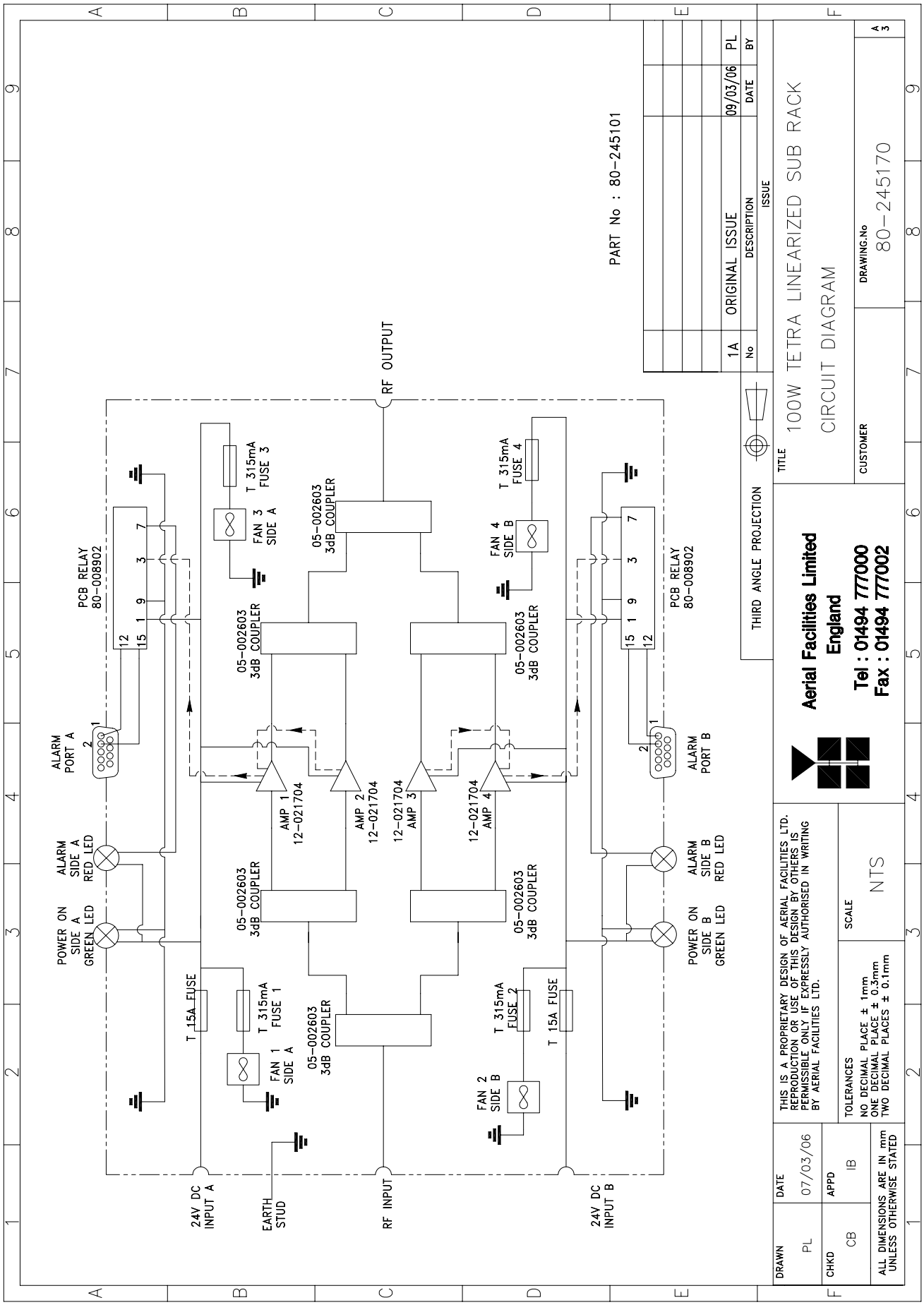
100W Linearised Amplifier (80-245101) front view

A	Green LED “Power On” Amplifier pair “A”	H	Green LED “Power On” Amplifier pair “B”
B	Red LED “Alarm” Amplifier pair “A”	I	Red LED “Alarm” Amplifier pair “B”
C	RF input from 60-212802	J	RF output to 60-212802
D	Alarm output Amplifier pair “A”	K	Alarm output Amplifier pair “B”
E	DC input Amplifier pair “A”	L	DC input Amplifier pair “B”
F	Fuse holder Amplifier pair “A”	M	Fuse holder Amplifier pair “B”
G	Earth connection for 80-245101	N	Cooling fans

4.1.4. 80-245101 Outline Drawing



4.1.5. 80-245101 System Diagram



4.1.6. 80-245101 Major Sub Components

4.1.6.1. 25W Linearised Amplifier Module (12-026902)

Linearised Power Amplifier (12-026902) 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.

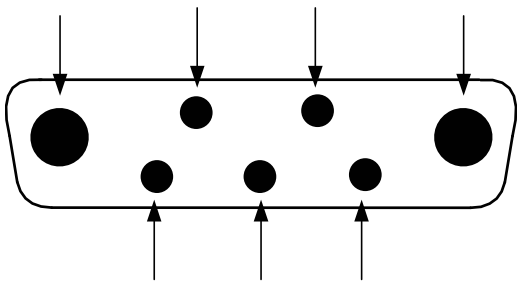
The power amplifier should require no maintenance over its operating life. Under no circumstances should the cover be removed or the side adjustments disturbed unless it is certain that the amplifier has failed; since it is critically aligned during manufacture and any re-alignment will require extensive test equipment. The module housing is an aluminium case (Iridite NCP finish) with SMA connectors for the RF input/output and a D-Type connector for the power supply and the Current Fault Alarm Function.

12-026902 Specification

PARAMETER		SPECIFICATION
Frequency range:		440-500MHz (tuned to spec.)
Bandwidth:		<60MHz (typical)
Maximum RF output:		>25Watt
Small signal gain:		37.5dB (typical)
1dB compression point:		+44dBm
3rd order intercept point:		+61dBm
Noise figure:		N/A
Return input loss:		>15dB
Return output loss:		>15dB
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		4.6Amps @ 24V DC
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		1.5 kg

PA 7-Way Connector Pin-outs

Connector Pin	Signal
A1 (large pin)	+24V DC
A2 (large pin)	GND
1	Alarm relay common
2	TTL alarm/0V good
3	Alarm relay contact (bad)
4	Alarm relay contact (good)
5	O/C good/0V bad (TTL)



4.1.6.2. UHF 3dB Splitter/Combiner (05-002603)

The 3dB Splitter/Combiner (05-002603) is a device for accurately matching two RF signals to a single port or splitting an RF signal to two ports whilst maintaining an accurate 50□ load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum.

05-002603 Specification

PARAMETER		SPECIFICATION
Frequency range		380 - 520 MHz
Bandwidth		140 MHz
Ports	As Combiner	2 inputs 1 output
	As Splitter	1 input 2 outputs
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 – Combiner		0.5 Watt
Power Rating – Splitter		20 Watts
Connectors		SMA female
Size		54 x 44 x 21 mm
Weight		200 gm (approximately)

4.1.6.3. 24V Relay PCB Assembly (80-008902)

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 screw terminals.

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

80-008902 Technical Specification

Parameter		Specification
Max. switch current		1.0Amp
Max. switch volts		120Vdc/60VA
Max. switch power		24W/60VA
Min. switch load		10.0µA/10.0mV
Relay isolation		1.5kV
Mechanical life		>2x10^7 operations
Relay approval		BT type 56
Connector details		15-way 0.1" pitch
Temperature range	operational	-10°C to +55°C
	storage	-40°C to +70°C

4.2. Remote Uplink/Downlink Shelf (60-212802)

The Remote Uplink/Downlink Shelf is an 8U Rack mount shelf and provides two separate RF paths, uplink and downlink with provision to vary the gain of either path using a switched variable (0 to 30dB) attenuator, one in each path. Each path is also fitted with an Automatic Gain Control (AGC) circuit which consists of two units, a detector/amplifier and an attenuator. Normally the attenuators in the AGC circuit are at minimum attenuation. The detector/amplifier unit monitors the RF level being delivered by the power amplifier, and when a certain threshold is reached it begins to increase the value of the attenuator to limit the RF output to the (factory set) threshold; therefore overloading of the amplifiers is avoided.

The downlink signal is received from the master site as an optical signal which is demodulated into an RF signal. The RF signal is then passed through a bandpass filter (tuned to pass the downlink bandwidth 502.4MHz to 502.8MHz) to reject out-of-band noise and then passes through the downlink AGC attenuator and into the Downlink Switched Attenuator. From the Switched Attenuator the Downlink signal passes through two low power amplifiers (1W, 15dB gain and 2W, 15dB gain) and then exits 60-212802 to go to the 100W Linearised Amplifier (80-245101). After leaving 60-212802 the downlink signal re-enters 60-212802, passing through the downlink AGC detector and a second bandpass filter before exiting the shelf via the D/L Output port

The uplink RF path enters 60-212802 at the U/L Input port and the signal passes through a bandpass filter (tuned to pass the uplink bandwidth 505.4MHz to 505.8MHz) to reject out-of-band noise. After the bandpass filter the signal passes through a 30dB Low Noise Amplifier and then into the uplink Switched Attenuator followed by the uplink AGC attenuator. After the AGC attenuator the signal passes through a second bandpass filter and then through a low power amplifier (1W, 37dB gain) followed by the uplink AGC detector. From the AGC detector the uplink signal passes into a fibre optic transmitter where the RF signal is modulated into an optical signal for transmission via fibre optic cable to the master site.

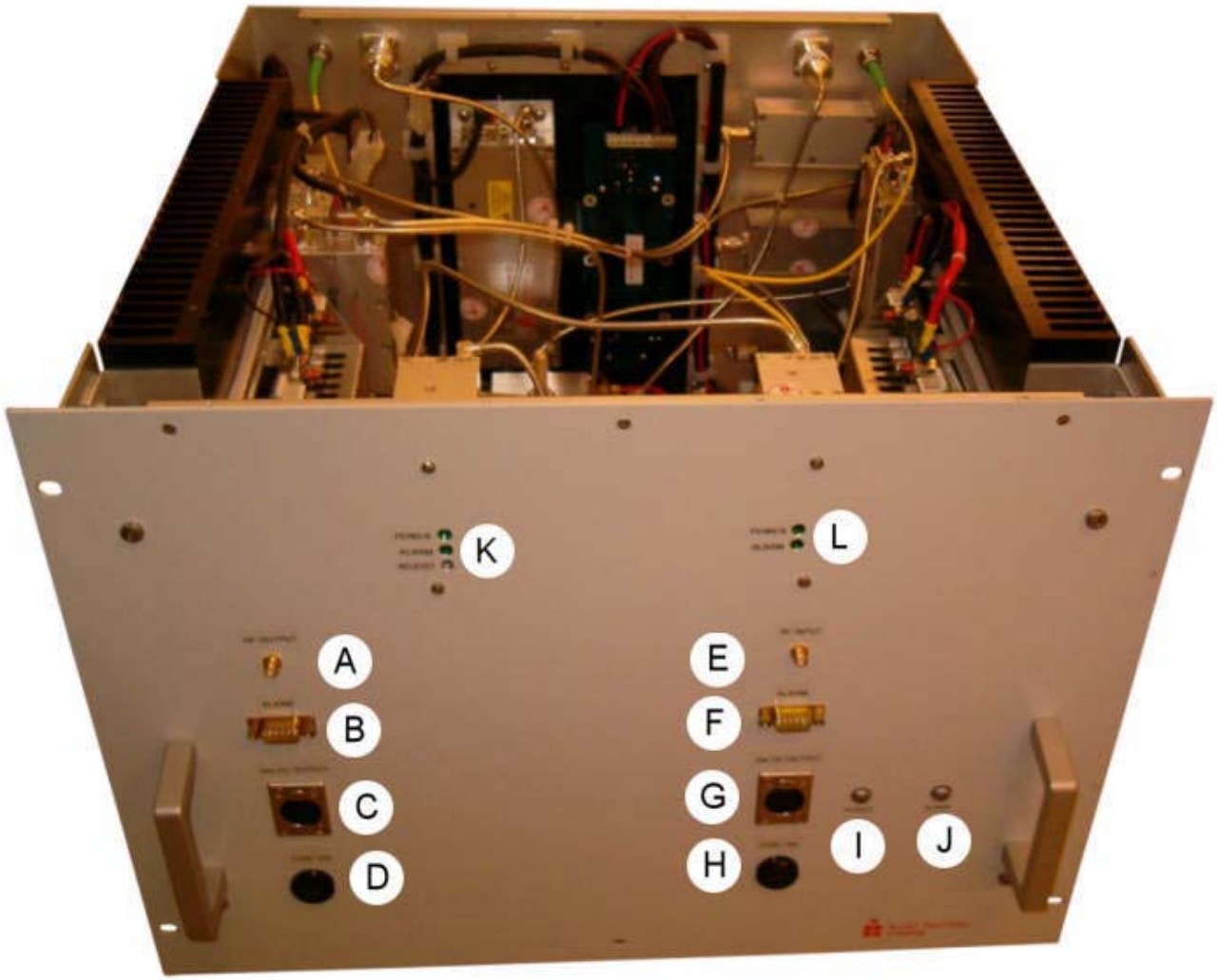
All the amplifier modules in this shelf are alarmed and the summary terminates at the rear panel mounted 9-way ‘D’ alarm connector.

4.2.1. 60-212802 Parts List (Major Components)

Component Part	Component Part Description	Qty Per Assembly
02-010901	Bandpass Filter	3
02-011204	Bandpass Filter	1
10-000701	Switched Attenuator 0-30dB 0.25W	1
10-000801	Switched Attenuator 0-30dB 1W	1
11-007402	Low Noise Amplifier	1
11-007901	Low Power Amplifier (1W)	1
12-021801	Low Power Amplifier (1W)	1
12-021802	Low Power Amplifier (2W)	1
13-003011	DC-DC Converter 24V -12V	1
13-003301	Mains Filter (8 Amp)	1
17-001109	AGC Logarithmic Detector /Amplifier	1
17-001117	AGC Detector /Amplifier	1
17-001201	AGC Attenuator	2
20-001601	12V Relay Board	1
20-001602	24V Relay Board	1
20-005401	Fibre Optic Transmitter (2.7GHz)	1
20-005501	Fibre Optic Receiver (2.7GHz)	1
80-008901	12V Relay Assembly	1
93-510077	0R02 50W Resistor Aluminium Clad	2
94-100004	60A Dual Diode	1
96-300067	PSU 600W (24V 23A)	2
96-920026	Circuit Breaker 10A	1

4.2.2. 60-212802 Photographs

Remote Uplink/Downlink Tray (60-212802) front view

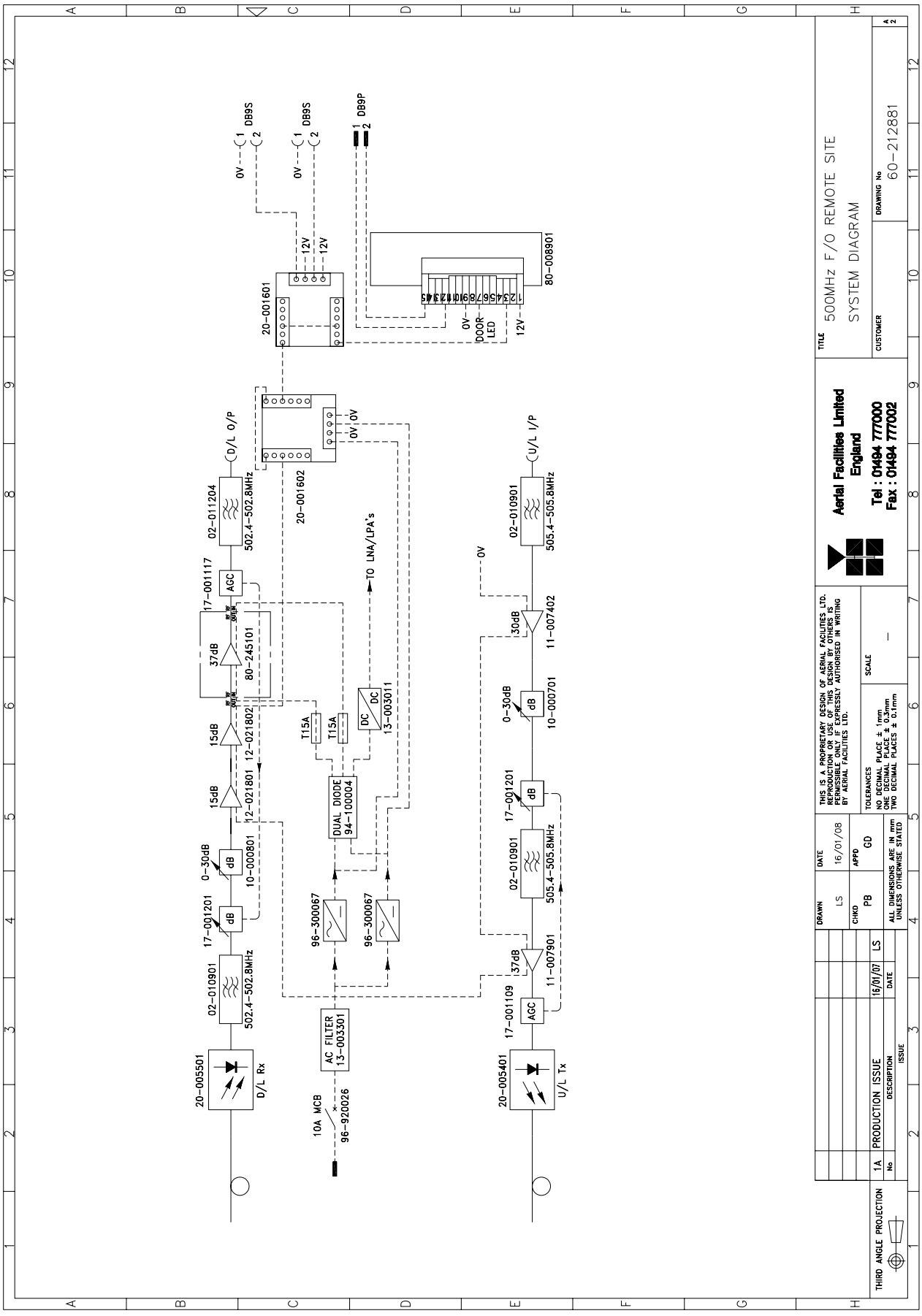


A	RF output to 100W Linearised Amplifier 80-245101
B	Alarm input from amplifier pair “A” in 80-245101
C	DC output to amplifier pair “A” in 80-245101
D	Fuse on DC output to amplifier pair “A” in 80-245101
E	RF input from 100W Linearised Amplifier 80-245101
F	Alarm input from amplifier pair “B” in 80-245101
G	DC output to amplifier pair “B” in 80-245101
H	Fuse on DC output to amplifier pair “B” in 80-245101
I	Green LED “Power On”
J	Red LED “Alarm”
K	Power On LED, Alarm LED and Gain Adjust for Fibre Optic Receiver 20-005501
L	Power On LED and Alarm LED for Fibre Optic Transmitter 20-005401

Remote Uplink/Downlink Tray (60-212802) rear view

A	Uplink Fibre Optic output to Master site
B	Uplink RF input from mobile antenna
C	Downlink Fibre Optic input from Master site
D	Downlink RF output to mobile antenna
E	Uplink switched attenuator 10-000701
F	Downlink switched attenuator 10-000801
G	Alarm Output
H	AC Trip switch
I	AC Input (110V)
J	DC Fuse
K	12V DC Auxiliary Output
L	Earth connection
M	AC power cord
N	DC, RF and Alarm interconnections for Amplifier 80-245101

4.2.3. Remote Site 60-212801 System Diagram



4.2.4. 60-212802 Major Sub Components

4.2.4.1. Bandpass Filter (02-010901)

Bandpass Filter (02-010901) is a multi-section design with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of helical & combline design respectively, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The body and 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.

02-010901 specification

SPECIFICATION	PARAMETER	
Passband Frequency	Uplink	505.4 to 505.8MHz **
	Downlink	502.4 to 502.8MHz **
Bandwidth	Uplink	400kHz **
	Downlink	400kHz **
Insertion Loss	1.2 dB (typical)	
Power Rating	50W	
Impedance	50Ω	
VSWR	Better than 1.2:1	
Connectors	SMA	
Weight	3Kg (approximately)	

**as tuned for use in 60-212802 uplink and downlink paths

4.2.4.2. Bandpass Filter (02-011204)

Bandpass Filter 02-011204 is a 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 cases and 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.

02-011204 Specification

Passband Frequency	502.4 to 502.8MHz **
Bandwidth	400kHz **
Insertion Loss	<1.0dB
Power Rating	100W
Impedance	50Ω
VSWR	1.2:1 (typical)
Connectors	SMA
Weight	3Kg (approximately)

**as tuned for use in 60-212802 uplink path

4.2.4.3. Switched Attenuator 0-30dB 0.25W (10-000701)

10-000701 provides attenuation from 0 - 30dB in 2 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.

10-000701 Specification

PARAMETER		SPECIFICATION
Attenuation Values		0-30dB
Attenuation Steps		2, 4, 8 and 16dB
Power Handling		0.25 Watt
Attenuation Accuracy		± 1.0 dB
Frequency Rang		DC to 1GHz
Impedance		50Ω
Connectors		SMA
VSWR		1.3:1
Weigh		0.2kg
Temperature range	operation	-20°C to +60°C
	storage	-40°C to +70°C

4.2.4.4. Switched Attenuator 0-30dB 1W (10-000801)

10-000801 provides attenuation from 0 - 30dB in 2 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.

10-000801 Specification

PARAMETER		SPECIFICATION
Attenuation Values		0-30dB
Attenuation Steps		2, 4, 8 and 16dB
Power Handling		1 Watt
Attenuation Accuracy		± 1.0 dB
Frequency Rang		DC to 1GHz
Impedance		50Ω
Connectors		SMA
VSWR		1.3:1
Weigh		0.2kg
Temperature range	operation	-20°C to +60°C
	storage	-40°C to +70°C

4.2.4.5. Low Noise Amplifier (11-007402)

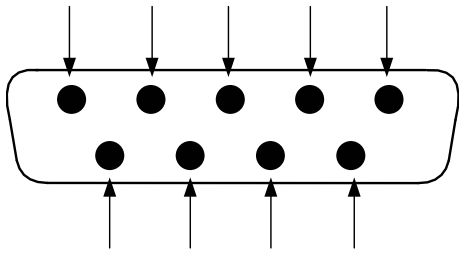
The 30dB gain low noise amplifier used is a double stage solid-state low-noise amplifier. Class A circuitry is used in the unit to ensure excellent linearity over a very wide dynamic range. The two active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments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

11-007402 Specification

PARAMETER		SPECIFICATION
Frequency range		380-500MHz
Bandwidth		<140MHz
Gain		30-32dB
1dB Compression point		+22dBm (typical)
3rd order intercept		+34-35dBm (typical)
Input/Output return loss		>20dB
Noise figure		<1.3dB
Connectors		SMA female
Supply		300-330mA @ 24V DC
Temperature range	operational	-20°C to +60°C
	storage	-40°C to +70°C

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

9-Way Pin-Out Graphical Representation



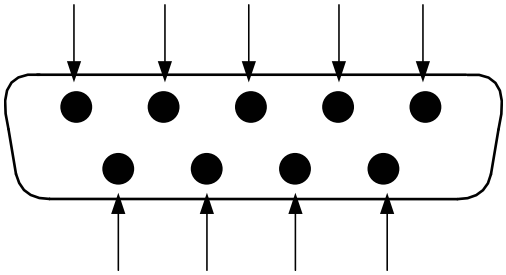
4.2.4.6. Low Power Amplifier (1W) (11-007901)

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 (Iridite NCP finish) with SMA connectors for the RF input/output and a 9way D-type connector for DC and alarm outputs.

11-007901 Specifications

PARAMETER		SPECIFICATION
Frequency range:		380-470MHz
Small signal gain:		37.5dB
Gain flatness:		±0.5dB
Gain vs. temperature:		1.5dB
Temperature range:	operational:	-20°C to +60°C
	storage:	-40°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

LNA 'D' Connector Pin-out details	
Connector pin	**Signal**
1	+ve input (10-24V)
2	GND
3	Alarm relay O/P bad
4	Alarm relay common
5	Alarm relay good
6	No connection
7	TTL voltage set
8	TTL alarm/0V (good)
9	O/C good/0V bad



4.2.4.7. Low Power Amplifier (1W) (12-021801)

The low power amplifier used is a 1 stage balanced configuration, solid-state amplifier. Class A circuitry is used in the unit to ensure excellent linearity over a very wide dynamic range. The three active devices are very moderately rated to provide a long trouble-free working life.
Its housing is an aluminium case (Iridite NCP finish) with SMA connectors for the RF input/output and a D-Type connector for the power supply and the Current Fault Alarm Function.
There are no adjustments on this amplifier, and in the unlikely event of failure then the entire amplifier should be replaced.

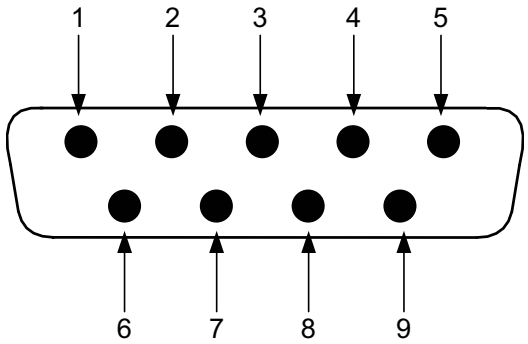
12-021801 Specification

PARAMETER		SPECIFICATION
	Temperature	-20 to +70 °C
	Frequency Range	380 - 500 MHz
	Small Signal Gain	15.5 +/- 0.5 dB
	Gain Flatness	0.7 dB p-p Max
	ΔGain vs. Temperature	0.7 dB Max
	In RL	20 dB Min
	Out RL	20 dB Min
	Output Power @ 1dB Compression Point	30.5 dBm Min
	Output 3rd Order IP	41.5 dBm Min
	Noise Figure	6 dB Max
	DC Supply Voltage	10-15 Vdc
	DC Supply Current	540 mA Max
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
	Weight:	<0.5 kg
	Size:	110.5 x 66mm x 24.6mm

Low Power Amplifier (12-021801) 9-Way Connector Pin-outs

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

9-Way Pin-Out Graphical Representation



4.2.4.8. Low Power Amplifier (2W) (12-021802)

The low power amplifier used is a 1 stage balanced configuration, solid-state amplifier. Class A circuitry is used in the unit to ensure excellent linearity over a very wide dynamic range. The three active devices are very moderately rated to provide a long trouble-free working life.
Its housing is an aluminium case (Iridite NCP finish) with SMA connectors for the RF input/output and a D-Type connector for the power supply and the Current Fault Alarm Function.
There are no adjustments on this amplifier, and in the unlikely event of failure then the entire amplifier should be replaced.

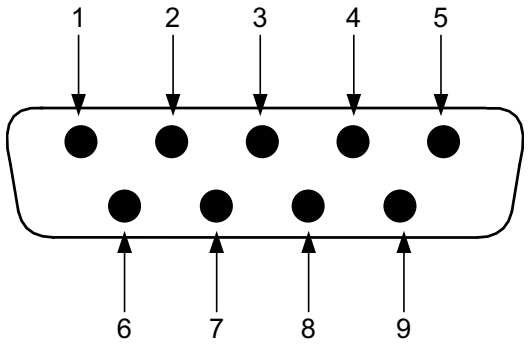
12-021802 Specification

PARAMETER		SPECIFICATION
Temperature		-20 to +70 °C
Frequency Range		380 - 500 MHz
Small Signal Gain		15.5 +/- 0.5 dB
Gain Flatness		0.7 dB p-p Max
ΔGain vs. Temperature		0.7 dB Max
In RL		20 dB Min
Out RL		20 dB Min
Output Power @ 1dB Compression Point		33 dBm Min
Output 3rd Order IP		46 dBm Min
Noise Figure		6 dB Max
DC Supply Voltage		10-15 Vdc
DC Supply Current		850 mA Max
Temperature range	operational	-20°C to +70°C
	storage	-40°C to +100°C
Weight		<0.5 kg
Size		110.5 x 66mm x 24.6mm

Low Power Amplifier (12-021802) 9-Way Connector Pin-outs

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

9-Way Pin-Out Graphical Representation



4.2.4.9. DC-DC Converter 24V -12V (13-003011)

The DC/DC converter fitted is an AFL assembled, high power PCB unit with an 8 amp at 12V output capability. 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.
In event of failure this unit should not be repaired, only replaced.

13-003011 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

4.2.4.10. Mains Filter (8 Amp) (13-003301)

The 8A Mains Filter Assembly (13-003301) has been designed to remove mains-borne interference caused by external electrical radiation.
Many filters exist which partially satisfy the criteria needed for cell enhancer power supplies (the main criteria being high continuous current) but a more cost efficient solution was realized using AFL's own manufacturing capability.

13-003301 Specification

PARAMETER	SPECIFICATION
Maximum surge current:	6.5kA (8/20)
Maximum leakage current:	<0.3mA (@ working voltage
Maximum continuous current:	8A
Maximum continuous voltage:	253V
Working voltage:	230V (nominal)
Impulse energy absorption:	420J
Ambient temperature limits:	-25°C to +85°C
Humidity:	5-95% RHNC
Case material:	ABS plastic (IP50 rated)
Maximum attenuation:	70dB (common mode 50-60Hz)

4.2.4.11. Downlink AGC Components

AGC Detector /Amplifier (17-001117)
AGC Attenuator (17-001201)

The Remote Site Uplink/Downlink Tray (60-212802) Downlink path is fitted with an Automatic Gain Control (AGC) system. The AGC system consists of two units, a detector/amplifier (part No. 17-001117) and an attenuator (part No. 17-001201). The detector/amplifier unit is inserted in the RF path on the output of the power amplifier, and the attenuator is situated in the RF before 1st stage of amplification.

Normally the attenuator is at minimum attenuation. The detector/amplifier unit monitors the RF level being delivered by the power amplifier, and when a certain threshold is reached it begins to increase the value of the attenuator to limit the RF output to the (factory set) threshold. Therefore overloading of the power amplifier is avoided.

The factory set threshold is 1dB below the amplifier 1dB compression point. Adjustment of this AGC threshold level is possible to reduce the maximum power; a 10dB range is mostly achieved. It is not recommended under any circumstances to adjust the AGC threshold to a level greater than the 1dB compression point as system degradation and signal distortion will occur.

The detector comprises of a 50Ω transmission line with a resistive tap which samples a small portion of the mainline power. The sampled signal is amplified and fed to a conventional half wave diode rectifier, the output of which is a DC voltage proportional to the RF input signal.

This DC voltage is passed via an inverting DC amplifier with integrating characteristics, to the output, which drives the attenuation control line of the corresponding AGC attenuator. This unit is fitted at some earlier point in the RF circuit.

For small signals, below AGC onset, the output control line will be close to 12V and the AGC attenuator will have minimum attenuation. As the signal level increases the control line voltage will fall, increasing the attenuator value and keeping the system output level at a constant value.
The AGC onset level is adjusted by the choice of sampler resistor R1 and by the setting of potentiometer VR1.

The attenuator comprises a 50Ω P.I.N diode, voltage-variable attenuator with a range of 3 to 30dB. The attenuation is controlled by a DC voltage which is derived from the associated AGC detector unit.

Technical Specifications

PARAMETER		SPECIFICATION
Frequency range		up to 1000MHz
Attenuation range		3 to 30dB
Attenuation steps		continuously variable
VSWR		better than 1.2:1
RF Connectors		SMA female
Power Handling	Attenuator	1W
	Detector/amp	>30W (or as required)
Temperature range	operation	-10°C to +60°C
	storage	-20°C to +70°C
Size	attenuator pcb	50 x 42 x 21mm
	detector/amp pcb	54 x 42 x 21mm
Weight	attenuator	90gm
	detector/amp	100gm

4.2.4.12. Uplink AGC Components

AGC Logarithmic Detector /Amplifier (17-001109)
AGC Attenuator (17-001201)

The Remote Site Uplink/Downlink Tray (60-212802) Uplink path is fitted with a wide dynamic range Automatic Gain Control (AGC) system. This is fitted in the Uplink path to avoid overloading the amplifiers (with the associated performance degradation) should a mobile be operated very close to the unit.

The AFL wide dynamic range Automatic Gain Control system consists of two units, a logarithmic detector/amplifier (17-001109) and an attenuator (17-001201). The logarithmic detector/amplifier unit is inserted in the RF path on the output of the power amplifier, and the attenuator is situated in the RF path between the 1st and 2nd stages of amplification.

Normally the attenuator is at minimum attenuation. The detector/amplifier unit monitors the RF level being delivered by the power amplifier, and when a certain threshold is reached it begins to increase the value of the attenuator to limit the RF output to the (factory set) threshold. Therefore overloading of the power amplifier is avoided.

The factory set threshold is 1dB below the Enhancer 1dB compression point. Some adjustment of this AGC threshold level is possible; a 10dB range is mostly achieved. It is not recommended under any circumstances to adjust the AGC threshold to a level greater than the 1dB compression point as system degradation will occur.

The detector comprises of a 50Ω transmission line with a resistive tap which samples a small portion of the mainline power. The sampled signal is amplified and fed to a conventional half wave diode rectifier, the output of which is a DC voltage proportional to the RF input signal. This DC voltage is passed via an inverting DC amplifier with integrating characteristics, to the output, which drives the attenuation control line of the corresponding AGC attenuator. This unit is fitted at some earlier point in the RF circuit.

For small signals, below AGC onset, the output control line will be close to 12V and the AGC attenuator will have minimum attenuation. As the signal level increases the control line voltage will fall, increasing the attenuator value and keeping the system output level at a constant value.
The AGC onset level is adjusted by the choice of sampler resistor R1 and by the setting of potentiometer VR1, (factory set at the time of system test) do not adjust unless able to monitor subsequent RF levels. The attenuator comprises a 50Ω P.I.N diode, voltage-variable attenuator with a range of 3 to 30dB. The attenuation is controlled by a DC voltage which is derived from the associated AGC detector unit.

Wide Dynamic Range AGC Specification

PARAMETER		SPECIFICATION
Frequency Range		up to 1000MHz
Attenuation Range		3 to 30dB
Attenuation Steps		continuously variable
VSWR		better than 1.2:1
RF Connectors		SMA female
Power Handling	attenuator	1W
	detector/amp	>30W (or as required)
Temperature Range	operation	-10°C to +60°C
	storage	-20°C to +70°C
Size	attenuator pcb	50 x 42 x 21mm
	detector/amp pcb	54 x 42 x 21mm
Weight	attenuator	90gm
	detector/amp	100gm

4.2.4.13. 12V Relay Board (20-001601)

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 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. Its common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.

20-001601 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 +60°C
	storage	-20°C to +70°C

4.2.4.14. 24V Relay Board (20-001602)

The General Purpose 24V Relay Board (20-001602) 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. Its common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.

20-001602 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		>2x107 operations
Relay approval		BT type 56
Connector details		Screw terminals
Temperature range	operational	-10°C to +60°C
	storage	-20°C to +70°C

4.2.4.15. Fibre Optic Transmitter (2.7GHz) (20-005401)

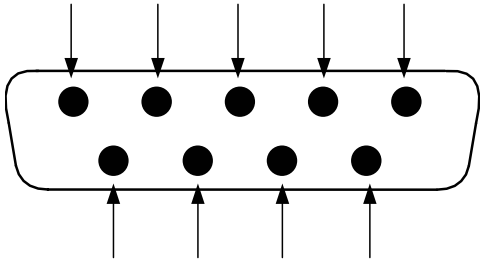
The transmitter modulates the RF signal on to a laser, which is then transmitted over a fibre optic cable to a receiver. The laser current is monitored and compensated for constant optical out put power against temperature variation and aging. Laser over-current alarm function is provided as LED output as well as open collect and voltage-free relay contacts on 9 way D-type connector.

20-005401 specification

PARAMETER	SPECIFICATION
Frequency Range (RF path)	70 - 3000 MHz
Frequency Range (Data path)	20 – 35 MHz
Available Link Gain (RF Path)	18 dB
Link Gain (DATA Path)	0 dB
Gain Flatness (entire frequency range)	±1.5 dB p-p
ΔGain vs. Temperature -20 to 70 ºC	3.5 dB
Gain adjustment range (RF Path)	30 dB
In/Out Return Loss (RF path)	10 dB Min
Output IP3 @ max gain *	37 dBm
In/Output IP3 @ 0dB Gain *	33 dBm
RF impedance	50 Ohm
Noise Figure @ 0dB gain (400MHz)	36 dB
Optical Transmit Power	2.7±0.3 dBm
Optical return loss	>50 dB
Received Power Alarm Threshold	-10 dBm(optic)
Optical wavelength	1310 nm
DC Supply Voltage	10-12 Vdc
DC Supply Current	120 mA
Operating Temperature	-20 to 70 ºC
Storage Temperature	-30 to 85 ºC
RF Connector type	SMA
Fibre optic connector type	FC/APC

Fibre Optic Transmitter (20-005401) ‘D’ Type Female Connector Pinouts

Pin No.	Signal Description
1	+10-12V DC Power
2	0V DC, Power Ground
3	0V DC, Power Ground
4	No Connection
5	No Connection
6	TTL Alarm, (0V=good, open coll.= fail)
7	Relay Alarm Contact (N.C)
8	Relay Alarm Contact (Common)
9	Relay Alarm Contact (N.O)



4.2.4.16. Fibre Optic Receiver (2.7GHz) (20-005501)

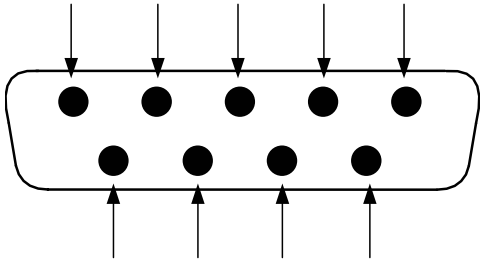
The receiver demodulates RF signals from the laser with a typical gain of 18dB and with 30dB adjustability in the RF domain. The received optical power is monitored for alarm function in case of fibre damage.

20-005501 Specification

PARAMETER	SPECIFICATION
Frequency Range (RF path)	70 - 3000 MHz
Frequency Range (Data path)	20 – 35 MHz
Available Link Gain (RF Path)	18 dB
Link Gain (DATA Path)	0 dB
Gain Flatness (entire frequency range)	±1.5 dB p-p
ΔGain vs. Temperature -20 to 70 ºC	3.5 dB
Gain adjustment range (RF Path)	30 dB
In/Out Return Loss (RF path)	10 dB Min
Output IP3 @ max Gain	37 dBm
In/Output IP3 @ 0dB Gain	33 dBm
RF impedance	50 Ohm
Noise Figure @ 0dB gain (400MHz)	36 dB
Optical Transmit Power	2.7±0.3 dBm
Optical return loss	>50 dB
Received Power Alarm Threshold	-10 dBm(optic)
Optical wavelength	1310 nm
DC Supply Voltage	10-12 Vdc
DC Supply Current	350 mA
Operating Temperature	-20 to 70 ºC
Storage Temperature	-30 to 85 ºC
RF Connector type	SMA
Fibre optic connector type	FC/APC

Fibre Optic Receiver (20-005501) ‘D’ Type Female Connector Pinouts

Pin No.	Signal Description
1	+10-12V DC Power
2	0V DC, Power Ground
3	0V DC, Power Ground
4	No Connection
5	No Connection
6	TTL Alarm, (0V=good, open coll.= fail)
7	Relay Alarm Contact (N.C)
8	Relay Alarm Contact (Common)
9	Relay Alarm Contact (N.O)



4.2.4.17. 12V Relay Assembly (80-008901)

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. Its common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.

80-008901 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 +60°C
	storage	-20°C to +70°C

4.2.4.18. 60A Dual Diode (94-100004)

The purpose of these dual diode assemblies is to allow two DC voltage sources to be combined, so that the main DC rail within the equipment can be sourced from either a mains driven PSU, or externally through an XLR connector or from dual mains driven PSUs . They are very heavy-duty diodes and they prevent any reverse current from flowing back to their source or the alternative supply rail. Combining diodes such as these will also be used if the equipment is to be powered from external back-up batteries.

4.2.4.19. PSU 600W (24V 23A) (96-300067)

The power supply unit is a switched-mode type capable of supplying 24V DC at 23.0Amps 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 PSUs 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.

96-300067 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:	23A

5. INSTALLATION

5.1 General Remarks

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

The equipment racks 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.

5.2 Electrical Connections

It is recommended that the electrical mains connection is made by a qualified electrician, who must be satisfied that the supply will be the correct voltage and of sufficient capacity.

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

Ensure that connections are kept clean and are fully tightened.

5.3 RF Connections

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

Ensure that connections are kept clean and are fully tightened.

5.4 Optical Connections

The optical input and output ports will be located on the appropriate shelf as shown in the system drawings. The ports are supplied with a green plastic cover, which must be removed prior to the connection of the fibre cable. Ensure that transmitter and receiver fibre cable are identified to prevent misconnection. At the master site, the fibre transmitters are in the downlink path with the receivers in the uplink. At the remote sites the fibre transmitters are in the uplink with the receivers in the downlink.

In the master site 60-212701 both of the RF paths have provision for a second path, the downlink RF path being split into two and fed to two fibre optic transmitters providing two optical outputs and the uplink path having two optical inputs each to its own fibre optic receiver, the resulting RF outputs being combined to produce a single RF output path. The two downlink optical paths are identical so either may be used, the same applies to the uplink, however the optical ports not in use must be capped with their green plastic covers.

Always ensure that connections are kept clean and are fully tightened.

5.5 Commissioning

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

To commission the system the test equipment detailed in Section 6.2. will be required.
Using the system diagrams and the end-to-end test specification (supplied with the equipment), 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 tray that must be investigated before proceeding with the commissioning. A green LED on each shelf illuminates, to indicate that the power supply is connected to the shelf

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

5.6 Antenna Installation & Gain Calculations

A The equipment requires 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.

B The maximum gain at which the equipment 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 equipment should be set at least 10 dB below this figure, using attenuators as described below in paragraph 5.

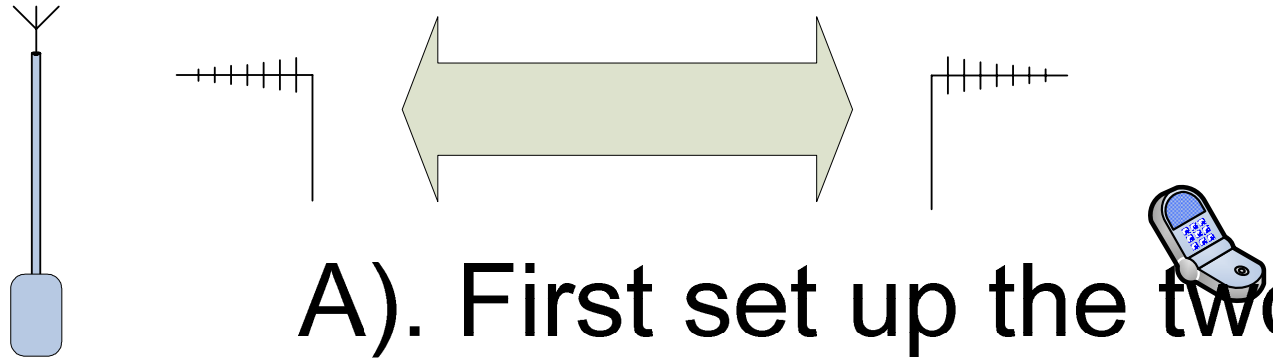
C Also measure the received signal from the donor cell at the input to the equipment (base port). The gain of the equipment downlink path should be set such the donor site will not overload the equipment amplifiers. It is recommended that the input level should be less than -50dBm at the input of the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

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

E The equipment gain is set by setting the variable switched attenuators in each path (uplink and downlink) refer to the photographs and 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.

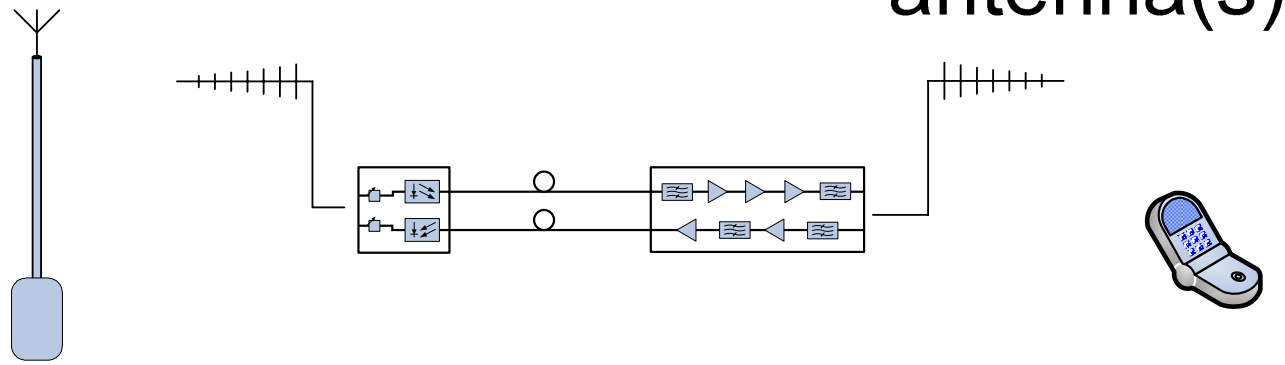
F It is recommended that the gains are set such that the Downlink channel output levels from the equipment are typically +30dBm per channel
(Input level + Gain = Output level).

5.7 Antenna Isolation



A). First set up the two a

Base facing antenna(s)



Base site (Donor)

6. MAINTENANCE

6.1. Fault Finding

6.1.1. Quick Fault Checklist

All tunnel 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.

6.1.2 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 enclosed shelves within a rack 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 shelf 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.

6.1.3 Downlink

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

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

6.1.4 Uplink

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

6.1.5 Fibre Optics

The Fibre Optic transmitters and receivers both have two LED status indicators, one on each module showing DC power and the other indicating 'Laser On' for the transmitter, and 'Carrier Being Received' for the receiver. Assuming that all of the indicators are illuminated, it will be necessary to check the RF inputs and outputs to the fibre optic units.

Typically the input to transmitter units will be at a level of between -30 and -15 dBm. The RF gain of a pair (TX to RX) units is factory set to give a 0dB gain, but this is with a short, low loss fibre. In determining the performance of the link, the insertion loss of the fibre and any power splitters fitted must be considered. A general rule of thumb figure would be around 0.5 - 1.5dB loss per Kilometre.

6.1.7 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.

6.1.8 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.

6.1.9 Service Support

Advice and assistance with maintaining and servicing this system are available by contacting Aerial Facilities Ltd., see section 2.7.

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.

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.
Optical Power Meter	1300 – 1560nM (-40 - +10dB)
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 (LNAs, general procedure):

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

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

6.3.3 Module Replacement (general):

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

6.3.4 Power Amplifiers

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

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

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

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

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

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

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

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

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

6.3.5 Low Power Amplifier Replacement

- Disconnect the mains power supply and disconnect the 24V dc supply connector for the LPA.
- Disconnect the RF input and output cables from the LPA.
- Disconnect the alarm connector.
- Remove the alarm monitoring wires from (D type connector) pins 9 and 10.
- Remove the LPA module by removing the four retaining screws, replace with a new LPA module and secure it with the screws.
- Connect the RF cables to the LPA input and output connectors. Reconnect the wires to the alarm board connector pins 9 and 10.
- 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, see section 2.7.

APPENDIX A

A.1. Glossary of Terms used in this document

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
P1dB	1dB Compression Point
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

A.2. Key to Drawing Symbols used in this document