Aerial Facilities Limited

Two Channel UHF Repeater

For

Inner Wireless Inc.

AFL Works Order: Q115559

AFL product part #: 50-187601

Table of Contents

1. INTRODUCTION

Scope and Purpose of Document

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

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 Liability Notice

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

Furthermore, AFL does not warrant the absolute accuracy of the information contained within this manual, or 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.

2. SAFETY CONSIDERATIONS

2.1 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.

2.2 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.

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 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.

2.4 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.

2.5 Laser Safety

General working practices adapted from EN60825-2: 2000

“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
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.

2.6 Emergency Contact Numbers

The AFL Quality Department can be contacted on:

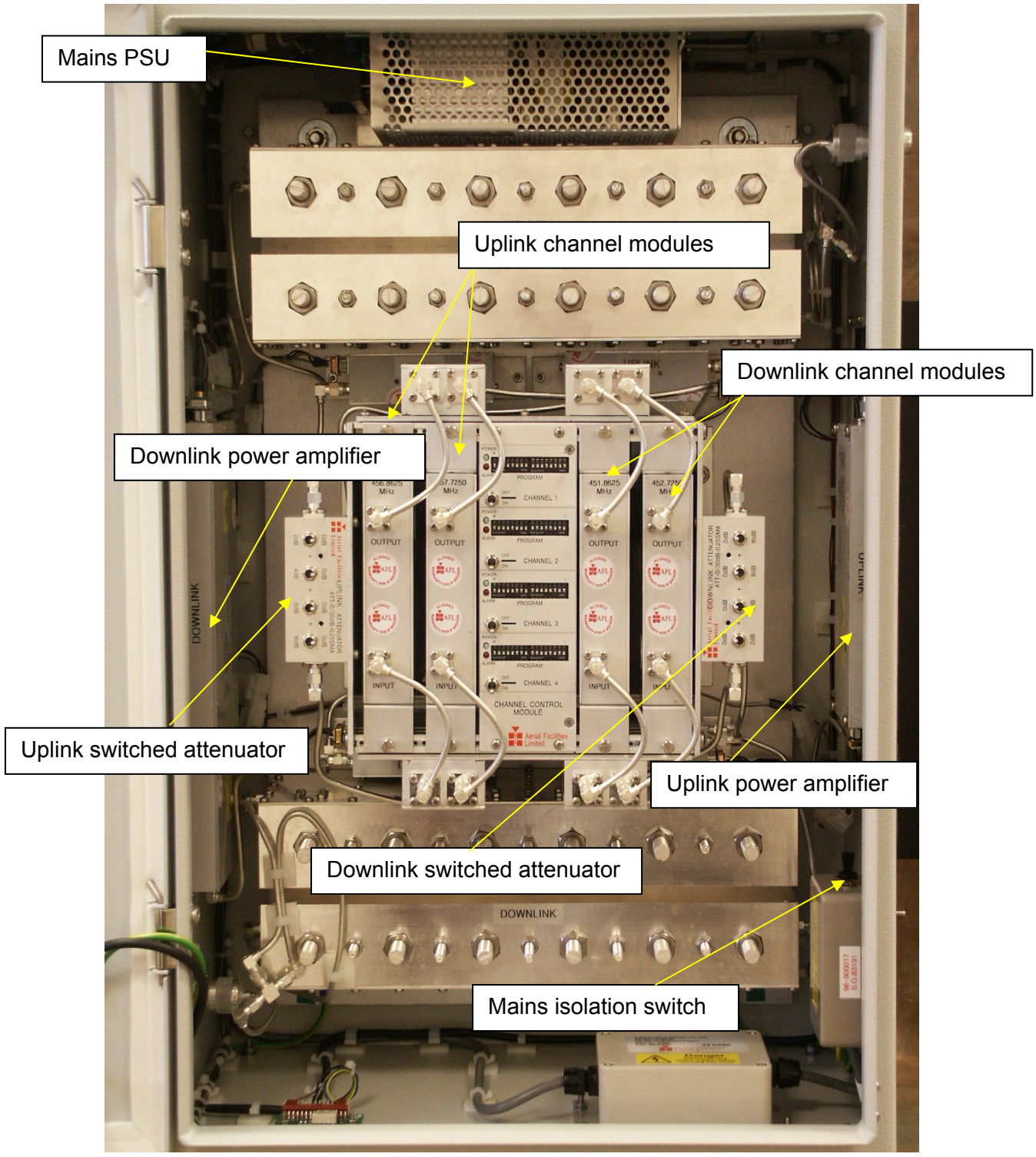
Telephone	+44 (0)1494 777000
Fax	+44 (0)1494 777002
e-mail	qa@aerialfacilities.com

3. EQUIPMENT OVERVIEW

3.P Photographs

External front view, door closed

Photographs continued.....



Internal view, door open

View of R.H.S Ports & Earthing bolt

View of L.H.S (Base) Ports

3.1 Description

The cell enhancer is constructed within an environmentally protected case which may be either free-standing or (usually) permanently secured to a vertical wall.

The unit is an on-frequency, two-way repeater which draws its downlink input from an off-air antenna, amplifies the signal through a pair of channel selective modules, (the modules 'pick-out' the channel from within the frequency band, subjecting it to automatic gain, phase-locked tuning using a set of 16 DIP switches to digitally control the channel frequency). Downlink output to the mobile antenna is approximately 10Watts and the uplink output to the base antenna is approximately 5Watts.

The whole system is powered from a mains-driven PSU module which supplies 12V DC from 115V AC mains at a power not exceeding 150Watts. No battery backup is fitted to this system.

All active devices have in-built alarm circuitry which terminates as volt-free, relay contact pairs on an internal connector. These pairs may be wired in series to produce a single pair that is the 'sum' of all the alarmed devices in the system.

3.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		451.5-453.0MHz (Downlink)
		456.5-458.0MHz (Uplink)
Bandwidth:		1.5MHz
Passband ripple:		±1.5dB
Gain:		>90dB (typical)
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>5Watts
Downlink Power:		>10Watts
Third order intercept point(OIP3):		54dBm (downlink)
		50dBm (uplink)
1dB compression point:		40.3dBm (downlink)
		37.5dBm (uplink)
AGC:	Downlink:	-21dBm
	Uplink:	-20dBm
Chan module gain:	Downlink:	10dB (downlink)
	Uplink:	15dB (uplink)
Noise Figure:		<6dB
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +60°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 Amplifiers
		2 PSU

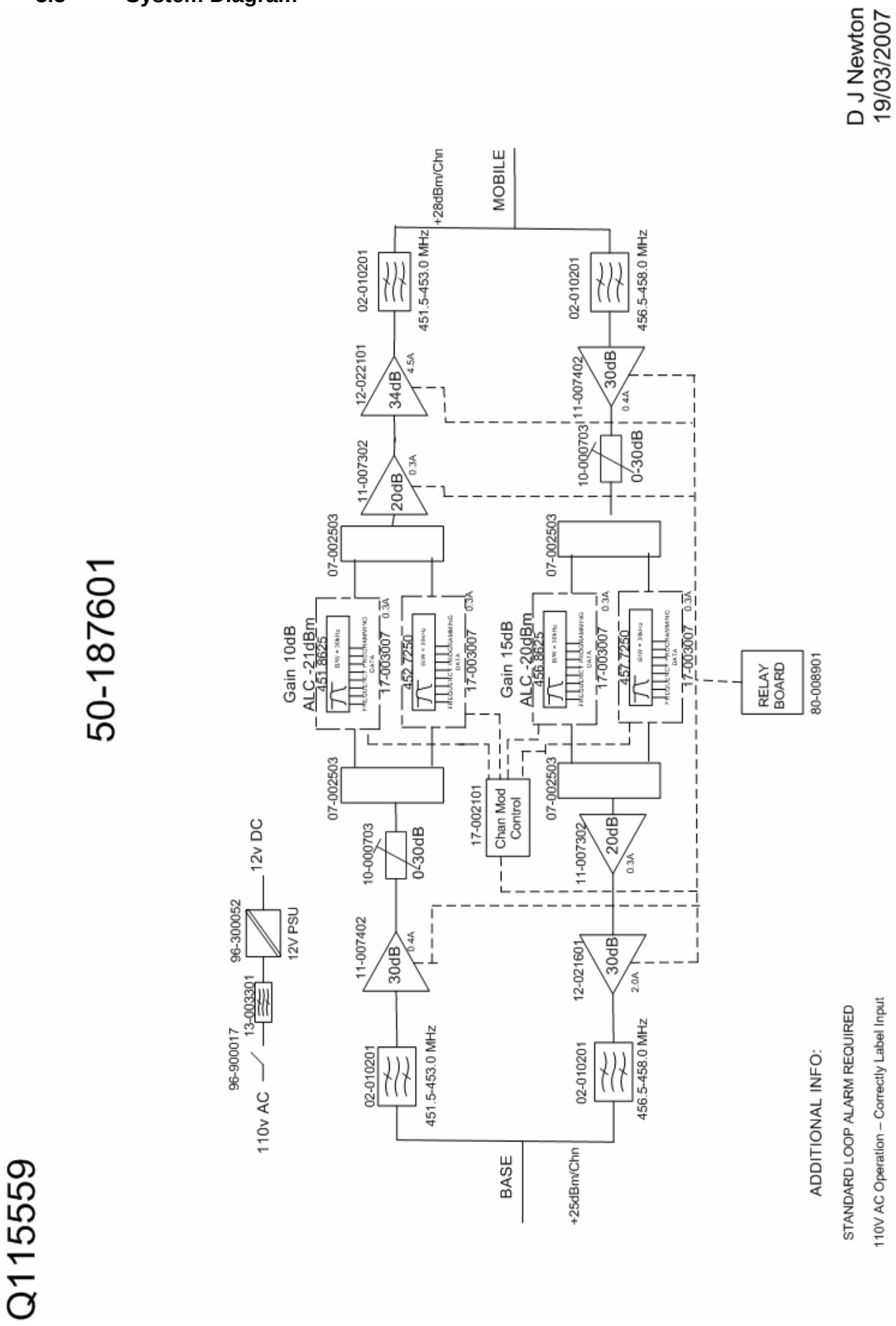
3.3 Mechanical Specification

PARAMETER		SPECIFICATION
Case size	Height:	**620**mm
	Width:	**420**mm
	Depth:	**250**mm
(excluding heatsinks, connectors, handles and feet)		
Fixings:		4 holes on **470**(w) x **500**(h)mm
Temperature Range:	operational:	**-10°C** to **+60°C**
	storage:	**-40°C** to **+70°C**
Weight:		**25**kg (approximately)
RF Connectors:		**N** type female
Environmental Protection:		**IP65** (with door closed and all ports terminated)
Finish:	Case:	To **RAL 7032/5**
	Heatsinks:	**Matt black** (where fitted)
	Handles:	Black Technopolymer
Supply Cable:		Unit supplied with suitable supply input leads with connector and appropriate length of cable

3.4 Parts List

AFL Part #	Part Description	Qty.
02-010201	6P C/L FILTER 380-500 <4 MHz SMA	4
07-002503	2 WAY SPLITTER 50/500MHz SMA	4
10-000703	1/4W 0-30dB SWITCHED ATTENUATOR	2
11-007302	LNA. 380-500MHz 20dB (C/W RELAY) GA	2
11-007402	LNA. 380-500MHz 30dB (C/W RELAY) GA	2
12-021601	TETRA 5W +12V AMPLIFIER	1
12-022101	PA 380-470MHz 10W CLASS A +12V	1
13-003301	MAINS FILTER 8AMP ASSEMBLY	1
17-000126	CELL ENHANCER LABEL 6 DIGIT	1
17-000526	CE 10W HEATSINK THERMAL GASKET	3
17-001522	BASE PLATE 560 x 345mm 17-001520&9020	1
17-001523	GREY RAL7032 H/SINK BLANKING PLATE	1
17-002101	CHANNEL CONTROL MODULE	1
17-002103	26WAY RIBBON CABLE LEAD	4
17-003007	CHAN MOD 450MHz, 30kHz B/W 8 pole	4
17-003022	MODULE PATTERNED LEAVE	4
17-003023	SUBRACK SIDE PANEL	2
17-003024	SUBRACK REAR BRACKET	2
17-003025	BOTTOM MODULE GUIDE	4
17-003029	TOP MODULE GUIDE	4
17-009020	ENCLOSURE 620 x 420 x 250 (3 H/S) ALU	1
80-008901	12V RELAY PCB ASSEMBLY **NO LED**	1
80-032320	10W PA HEATSINK	2
90-100009	CABLE 3CORE MAINS '6 A' USA COLOURS	1
90-400006	6 pin BULGIN ALARM LEAD	1
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	2
91-130001	SMA ADAPT 'T' ALL FEMALE 3 GHz	2
91-500011	PWR 3POLE PNL PLUG SEALED IP68	1
91-500015	PWR CON CAP SEALED with INT. THREAD	2
91-500016	PWR 6POLE PNL PLUG SEALED IP68	1
91-600005	'D' 9 WAY SOCKET S/B TERM	4
91-600007	'D' 9 WAY BLACK SHELL	4
91-600019	'D'15 WAY SHELL (2W7)	2
91-640004	LARGE PIN FOR 91-660001 D SOCKET	4
91-660001	2W5 MIXED D TYPE SOCKET (7 WAY)	2
91-700017	ICD 15 WAY 0.1' CONNECTOR	1
92-280033	Captive Screw	8
96-300052	JWS150-12/A PSU (COUTANT LAMBDA)	1
96-700034	LED RED 5mm IP67 INTEGRAL RES. 24V	1
96-700035	LED GREEN 5mm IP67 INTEGRAL RES 24V	1
96-900017	AC TRIP SWITCH (3 AMP M.C.B.)	1
97-000002	BLACK MODULE CAGE RUNNER	8
97-300010	C/E SUPPLY INPUT COVER	1
97-400011	BLACK POLYMIDE HANDLE 120mm	2
97-400012	SCHROFF BLACK DOOR LOCK 20234 024	2
97-600002	SUBRACK M2.5 STD TAP	2
97-900004	RUBBER FOOT FOR CELL ENHANCERS	4

3.5 System Diagram



4. SUB-UNIT MODULES

4.1 Bandpass Filter (02-010201)

4.1.1 Description

The bandpass filters are multi-section designs with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of combline design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports.

Being passive devices, the bandpass filters should have an extremely long operational life and require no maintenance. Should a filter be suspect, it is usually most time efficient to replace the module rather than attempt repair or re-tuning.

4.1.2 Technical Specification

PARAMETER		SPECIFICATION
Response type:		Chebyshev
Frequency range:		451.5-453.0MHz (downlink)
		456.5 – 458.0MHz (uplink)
Bandwidth:		1.5 MHz
Number of sections:		6
Insertion Loss:		1.2 dB
VSWR:		better than 1.2:1
Connectors:		SMA
Power handling:		100W max
Temperature range	operation:	-20°C to +60°C
	storage:	-40°C to +70°C
Weight:		3 kg (typical)

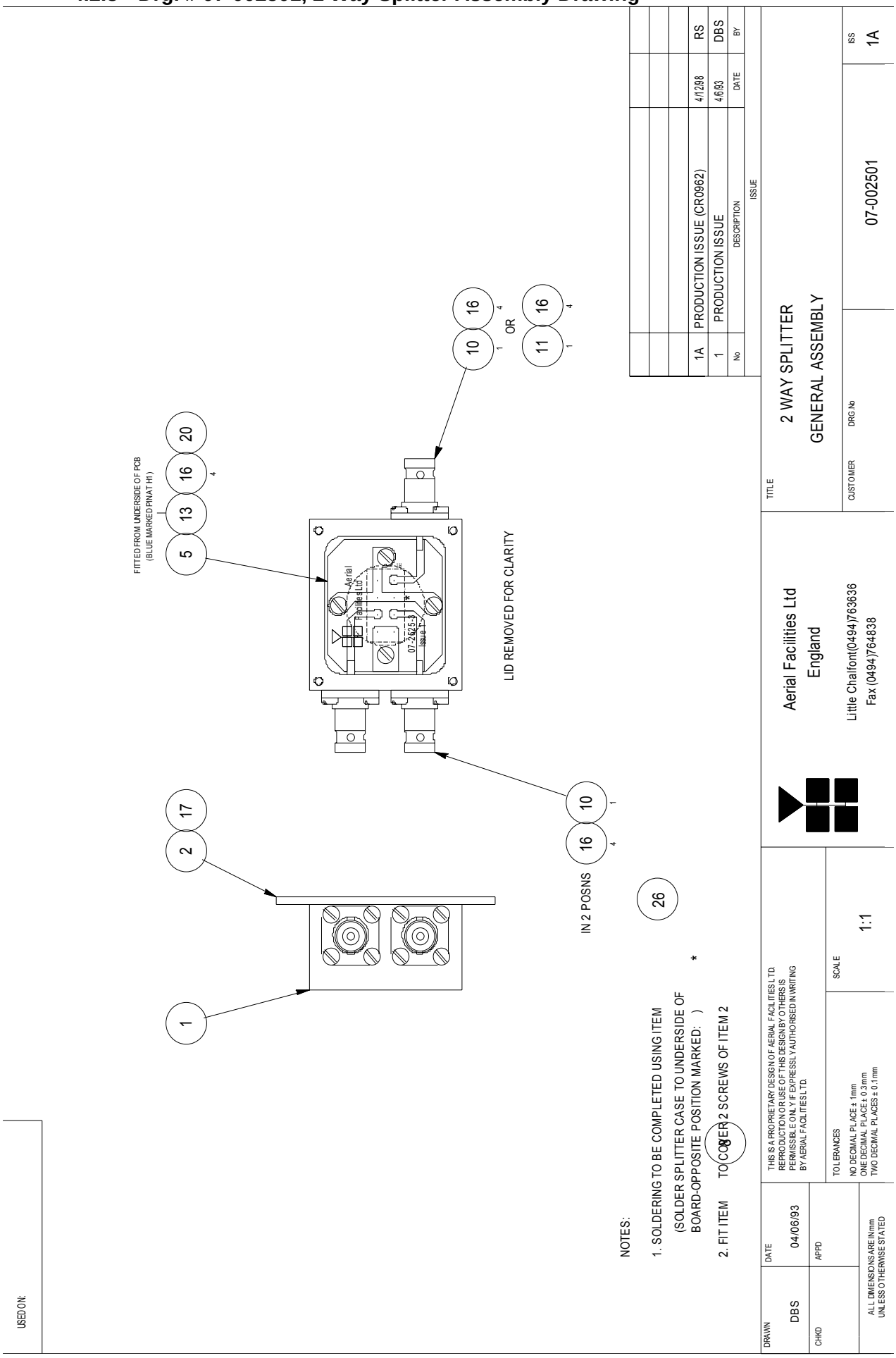
4.2 Two-Way Splitter (07-002503)

4.2.1 Description

This wideband, 2 way hybrid splitter, is an AFL stock item with many years of reliable service. The successful construction of such a device, relies largely on a PCB developed within a rigid specification, skilled assembly and testing. Insertion loss quoted is typical, any unit will be within 5% of this figure.

4.2.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency Range		50 – 500MHz
Split ratio		1:2
Insertion Loss		3.2dB (typical)
Isolation		>20dB
Power rating		1.0 Watt
VSWR		Better than 1.3:1
Available connectors		BNC, N type, SMA
Weight		200gms (approximately)
Temperature range	operation:	-20°C to +60°C
	storage:	-40°C to +70°C


NOTES:
1. SOLDERING TO BE COMPLETED USING ITEM 26
(SOLDER SPLITTER CASE TO UNDERSIDE OF BOARD-OPPOSITE POSITION MARKED: *)
2. FIT ITEM 8 TO COVER 2 SCREWS OF ITEM 2
IN 2 POSNS
LID REMOVED FOR CLARITY
OR
FITTED FROM UNDERSIDE OF PCB (BLUE MARKED PIN AT H1)
1A PRODUCTION ISSUE (CR0962) 4/12/98 RS
1 PRODUCTION ISSUE 4.6.93 DBS
No DESCRIPTION DATE BY
ISSUE
2 WAY SPLITTER
GENERAL ASSEMBLY
07-002501
1A
Aerial Facilities Ltd
England
Little Chalfont(0494)763636
Fax (0494)764838
DRAWN DBS 04/06/93
CHKD
APPD
SCALE 1:1
TOLERANCES
NO DECIMAL PLACE ± 1mm
ONE DECIMAL PLACE ± 0.3mm
TWO DECIMAL PLACES ± 0.1mm
ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED
THIS IS A PROPRIETARY DESIGN OF AERIAL FACILITIES LTD.
REPRODUCTION OR USE OF THIS DESIGN BY OTHERS IS PERMISSIBLE ONLY IF EXPRESSLY AUTHORISED IN WRITING BY AERIAL FACILITIES LTD.
USED ON:

4.3 0.25Watt 0- -30dB Switched Attenuator (10-000703)

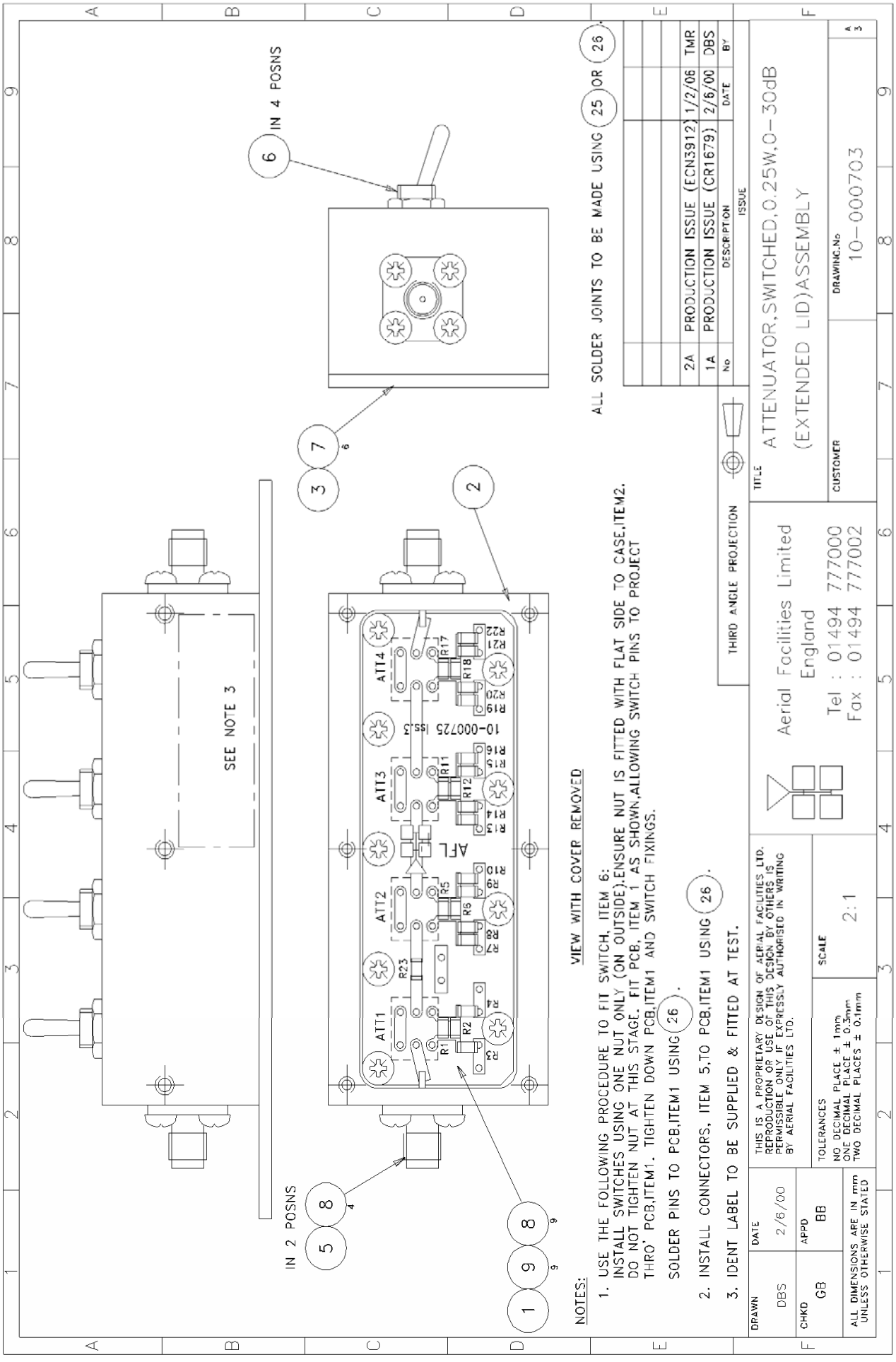
4.3.1 General Application

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.

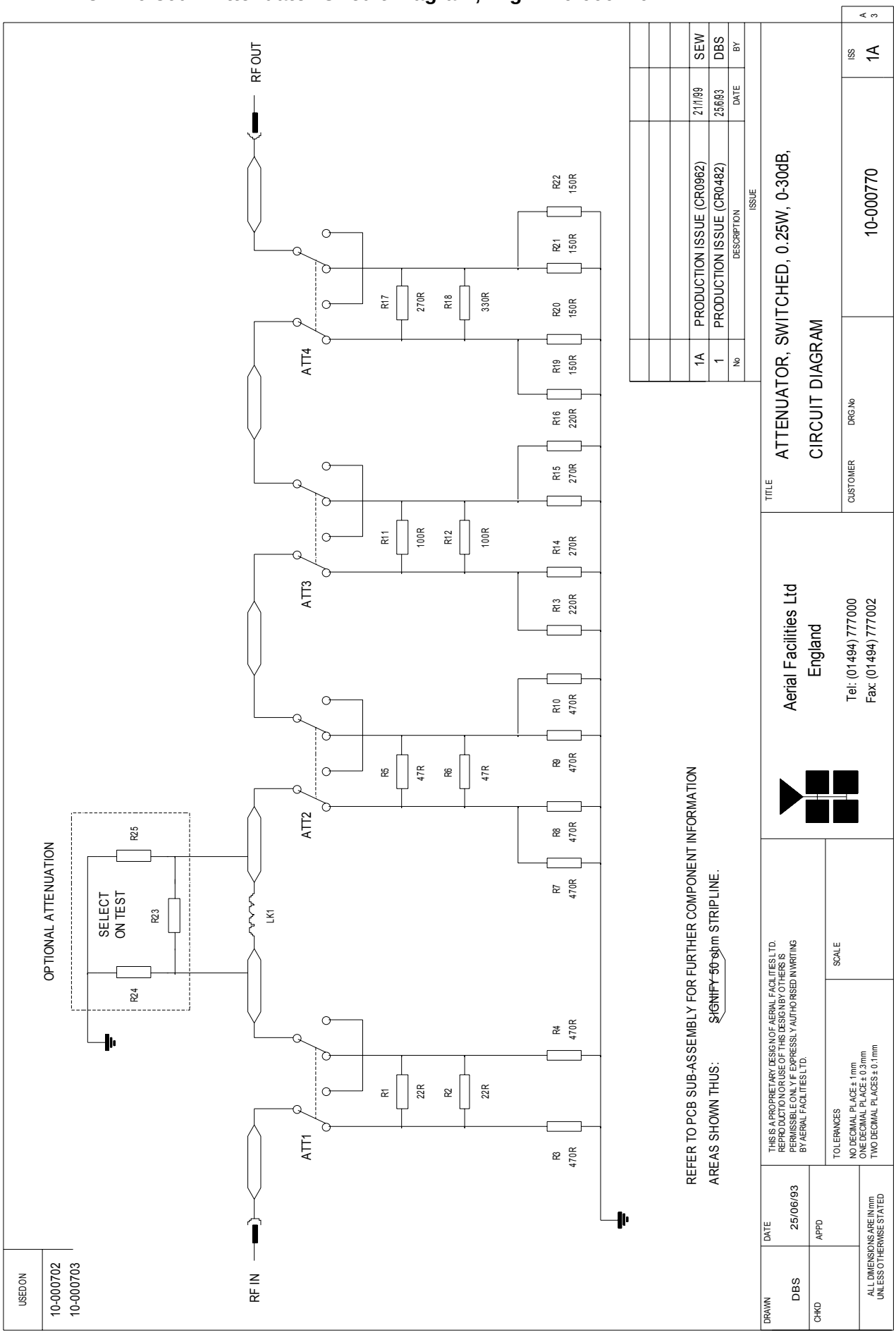
4.3.2 Switched Attenuators

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.

4.3.3 Switched Attenuator Assembly Drawing, Drg. # 10-000703



4.3.4 0-30dB Attenuator Circuit Diagram, Drg. # 10-000770



4.4 11-007302 & 11-007402 Low Noise Amplifiers

4.4.1 Description

The low noise amplifiers used are double stage solid-state low-noise amplifiers. 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 these amplifiers, and in the unlikely event of a failure then the entire amplifier should be replaced. Note that the two amplifiers use similar DC/bias circuits.

4.4.2 Technical Specification (11-007302)

PARAMETER		SPECIFICATION
Frequency range:		380-500MHz
Bandwidth:		<140MHz
Gain:		20-22dB
1dB Compression point:		+23.5dB (typical)
3rd order intercept:		+36dB (typical)
Input/Output return loss:		>20dB
Noise figure:		<1.3dB
Connectors:		SMA female
Supply:		200-230mA @ 24V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		<300gm
Size:		90 x 55 x 30.2 (case only)

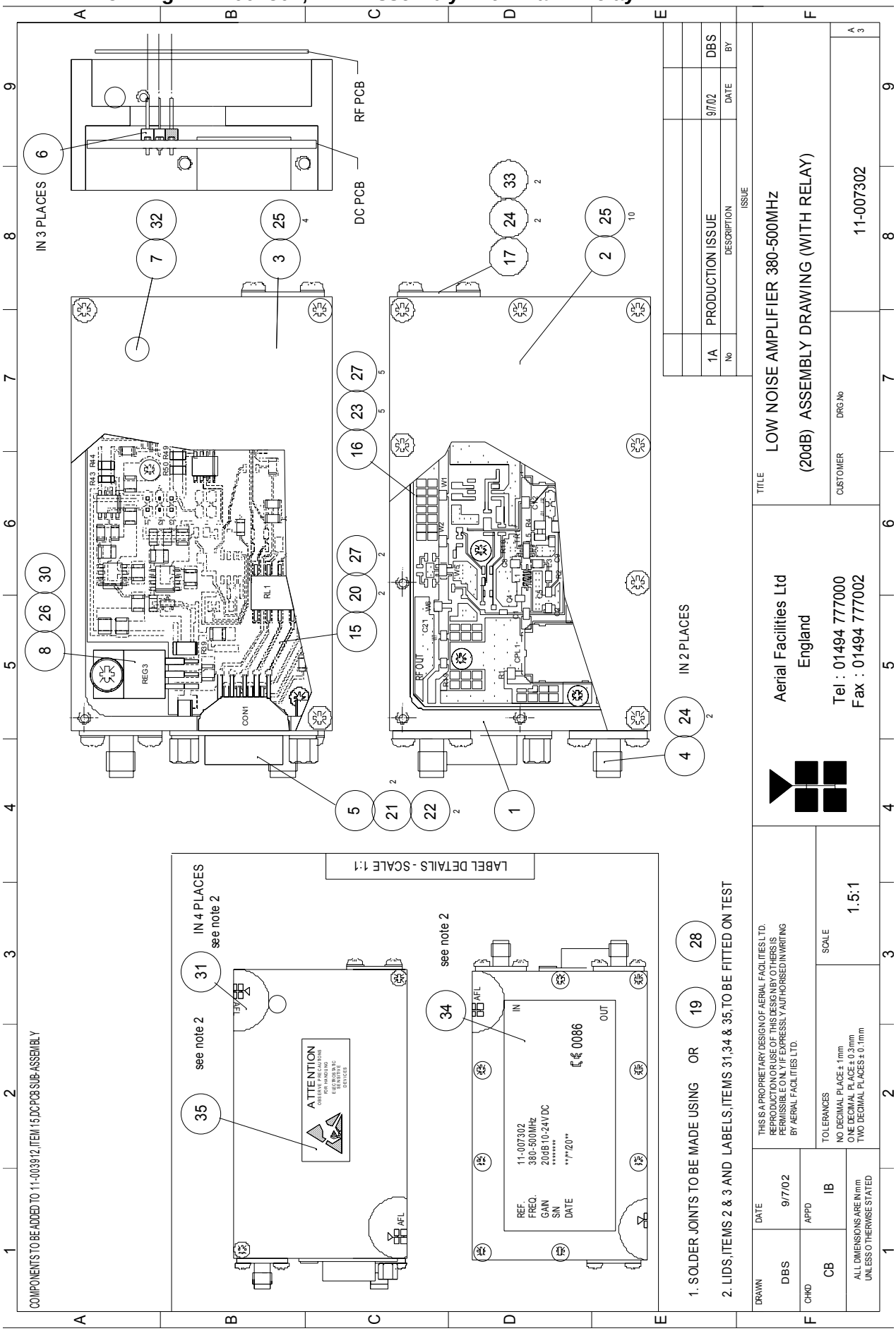
4.4.3 Technical Specification (11-007402)

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

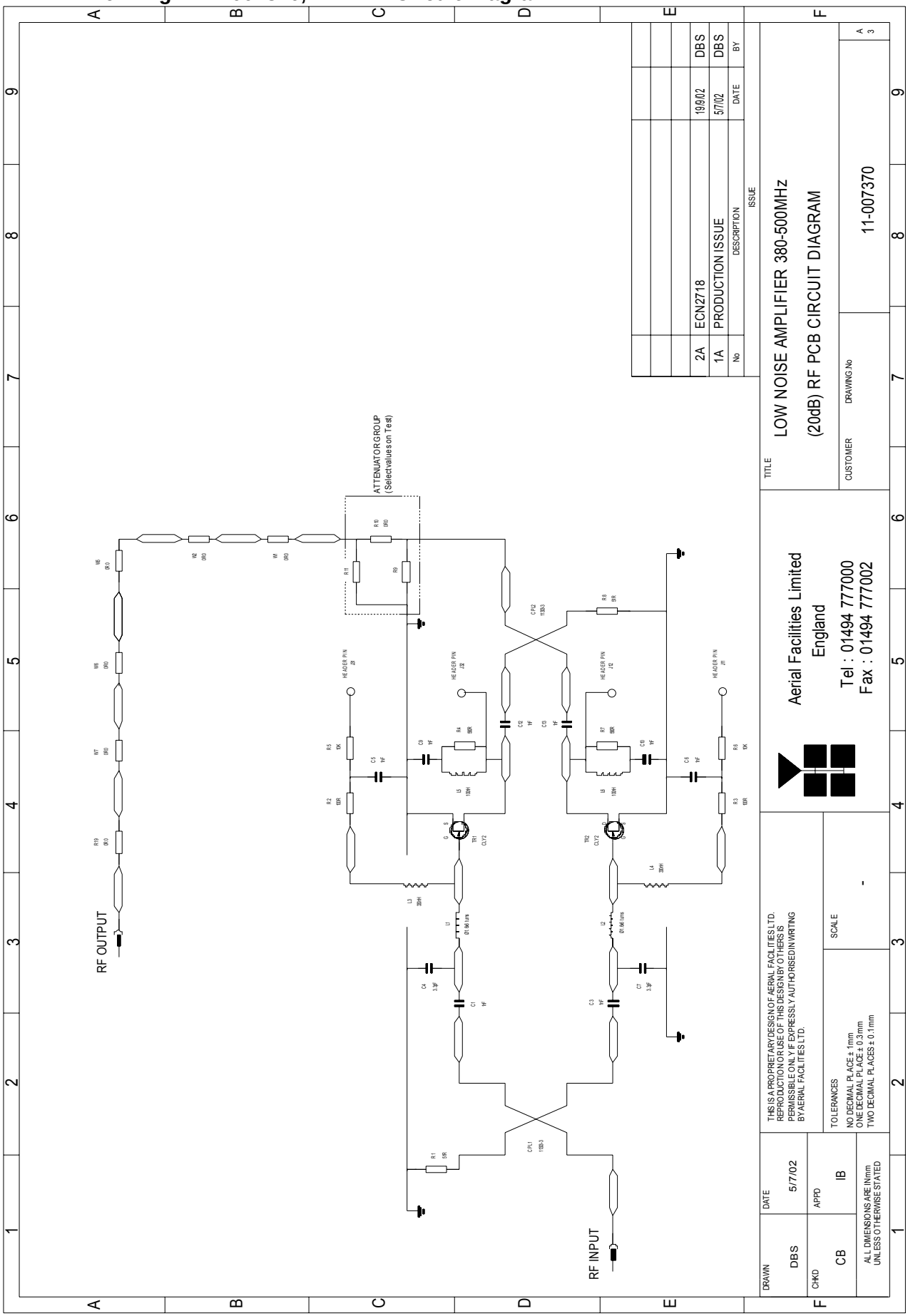
4.4.4 LNA ‘D’ Connector Pin-out details

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

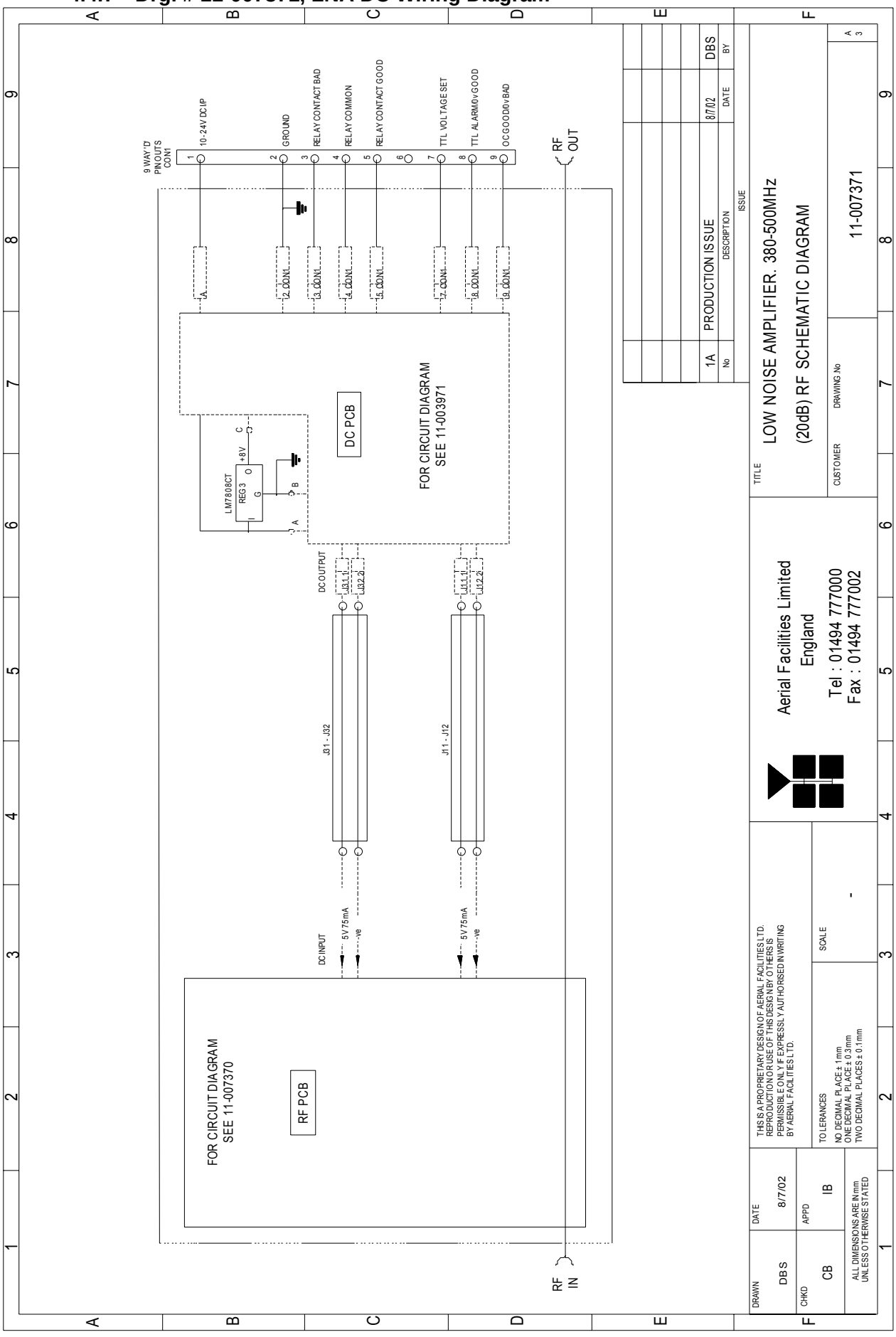
4.4.5 Drg. # 11-007302, LNA Assembly With Alarm Relay



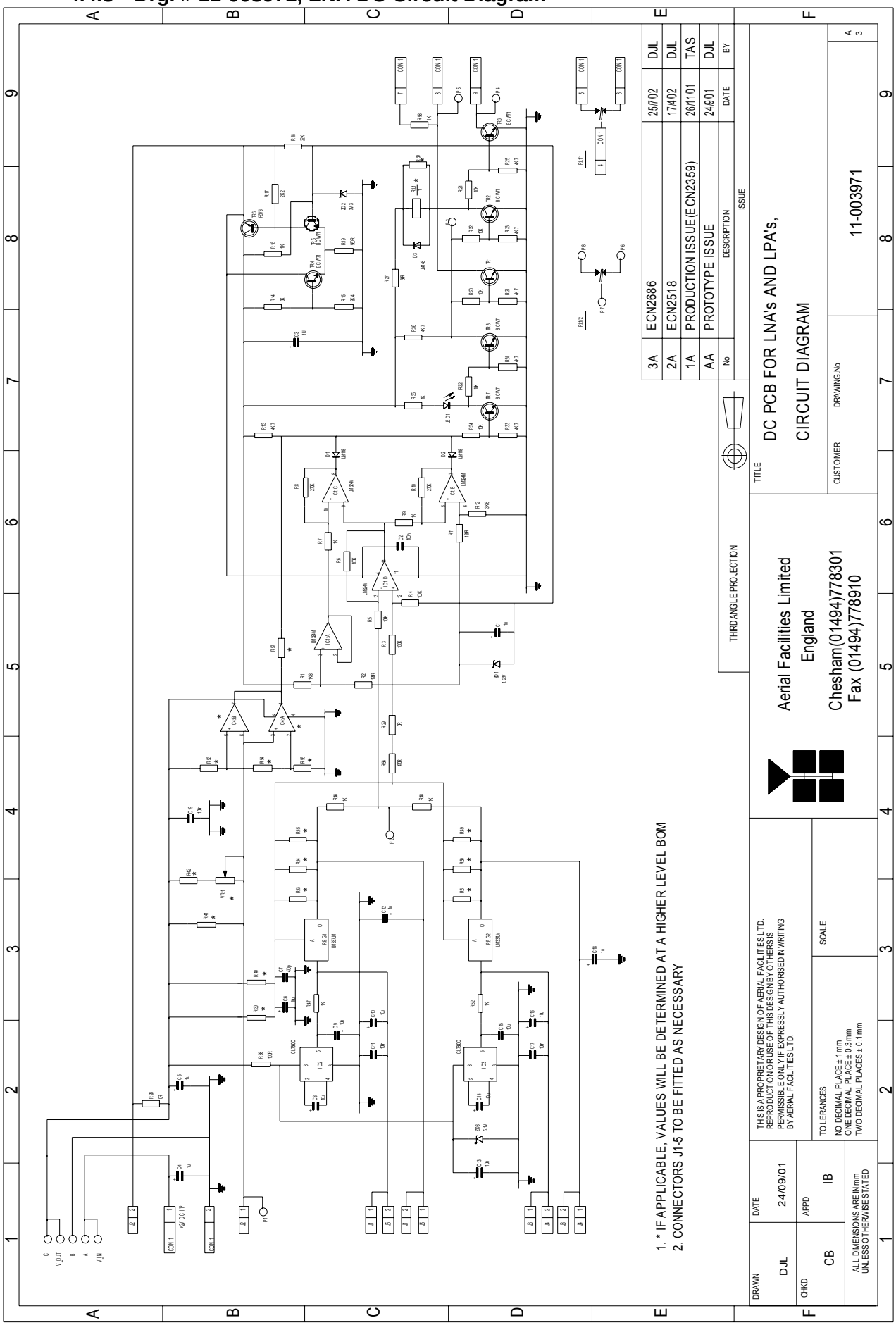
4.4.6 Drg. # 11-007370, LNA RF Circuit Diagram



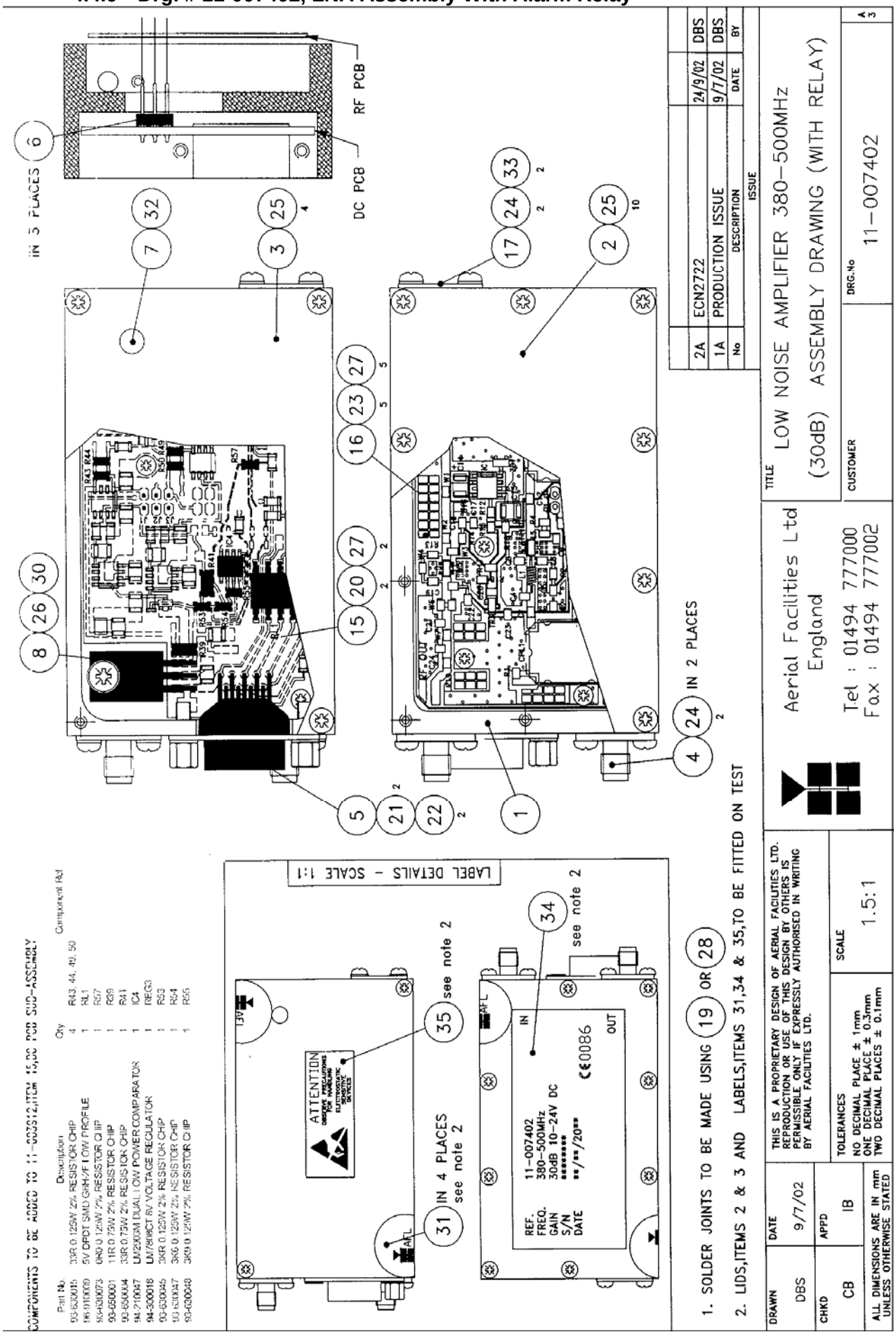
4.4.7 Drg. # 11-007371, LNA DC Wiring Diagram



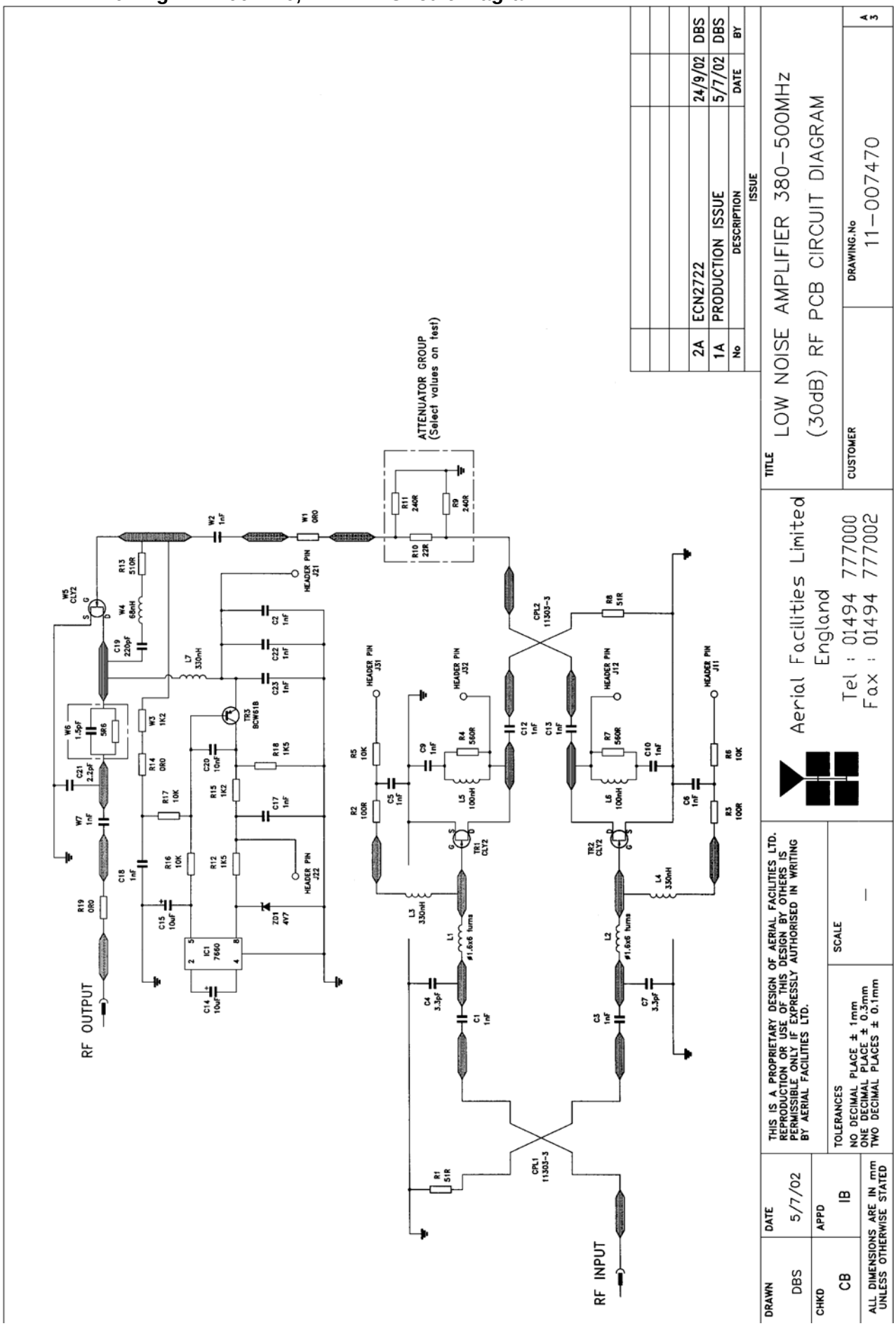
4.4.8 Drg. # 11-003971, LNA DC Circuit Diagram



4.4.9 Drg. # 11-007402, LNA Assembly With Alarm Relay



4.4.10 Drg. # 11-007470, LNA RF Circuit Diagram



4.5 12-021601 5Watt Medium Power Tetra Amplifier

4.5.1 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.

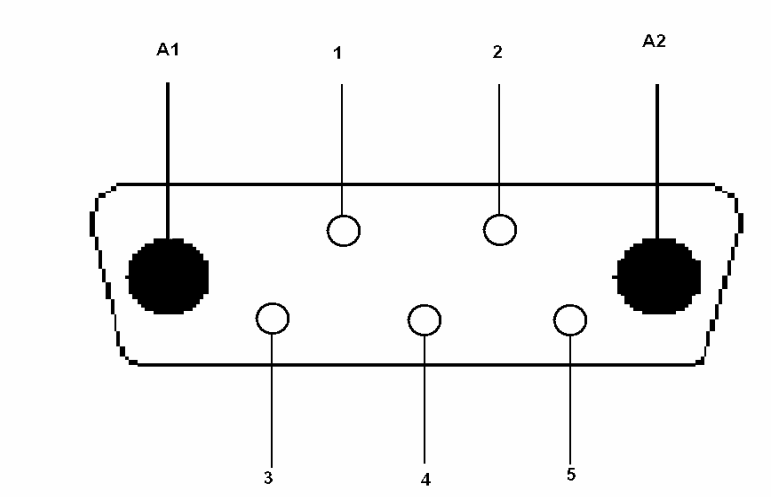
4.5.2 Technical Specification

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

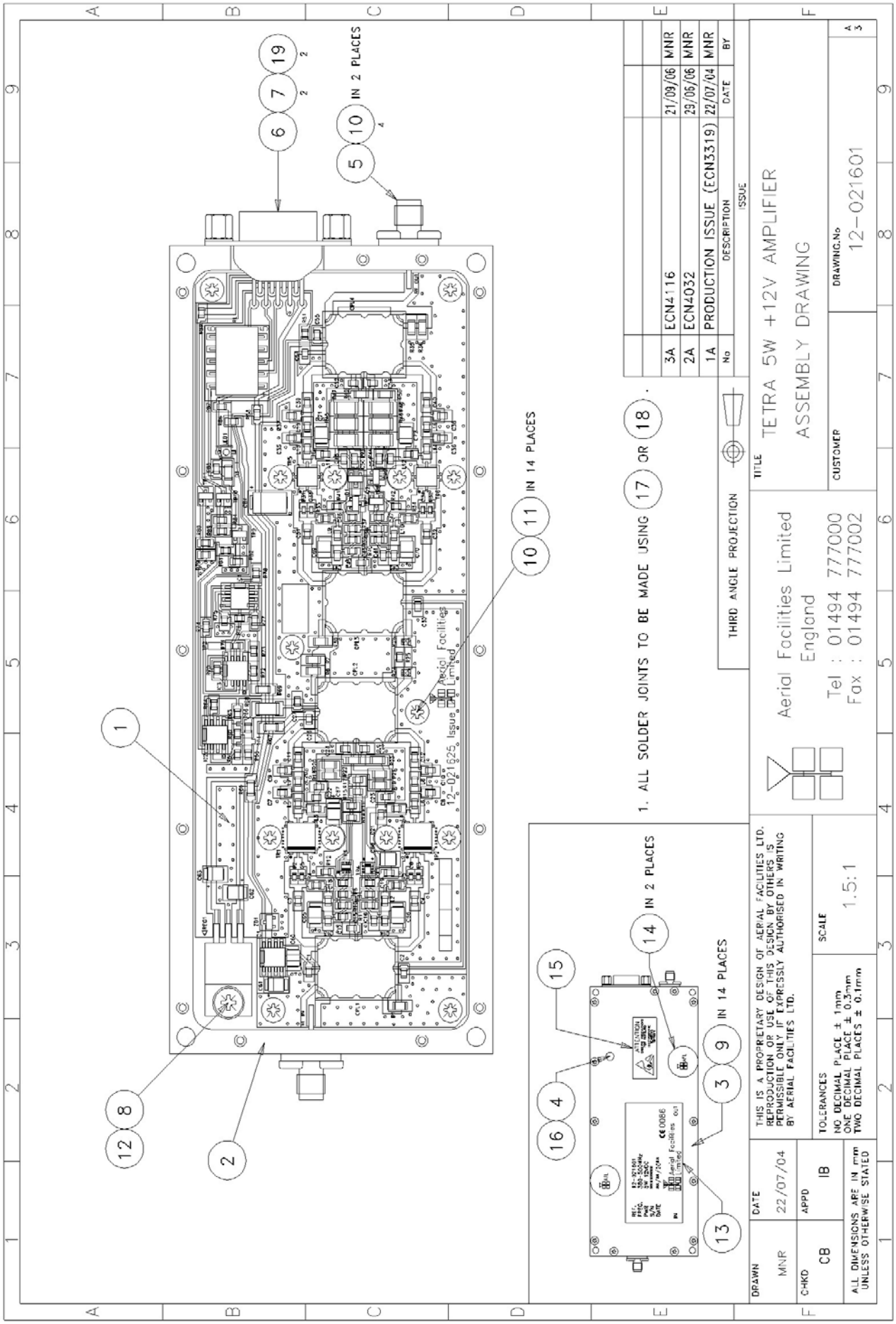
4.5.3 PA 7-Way Connector Pin-outs

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

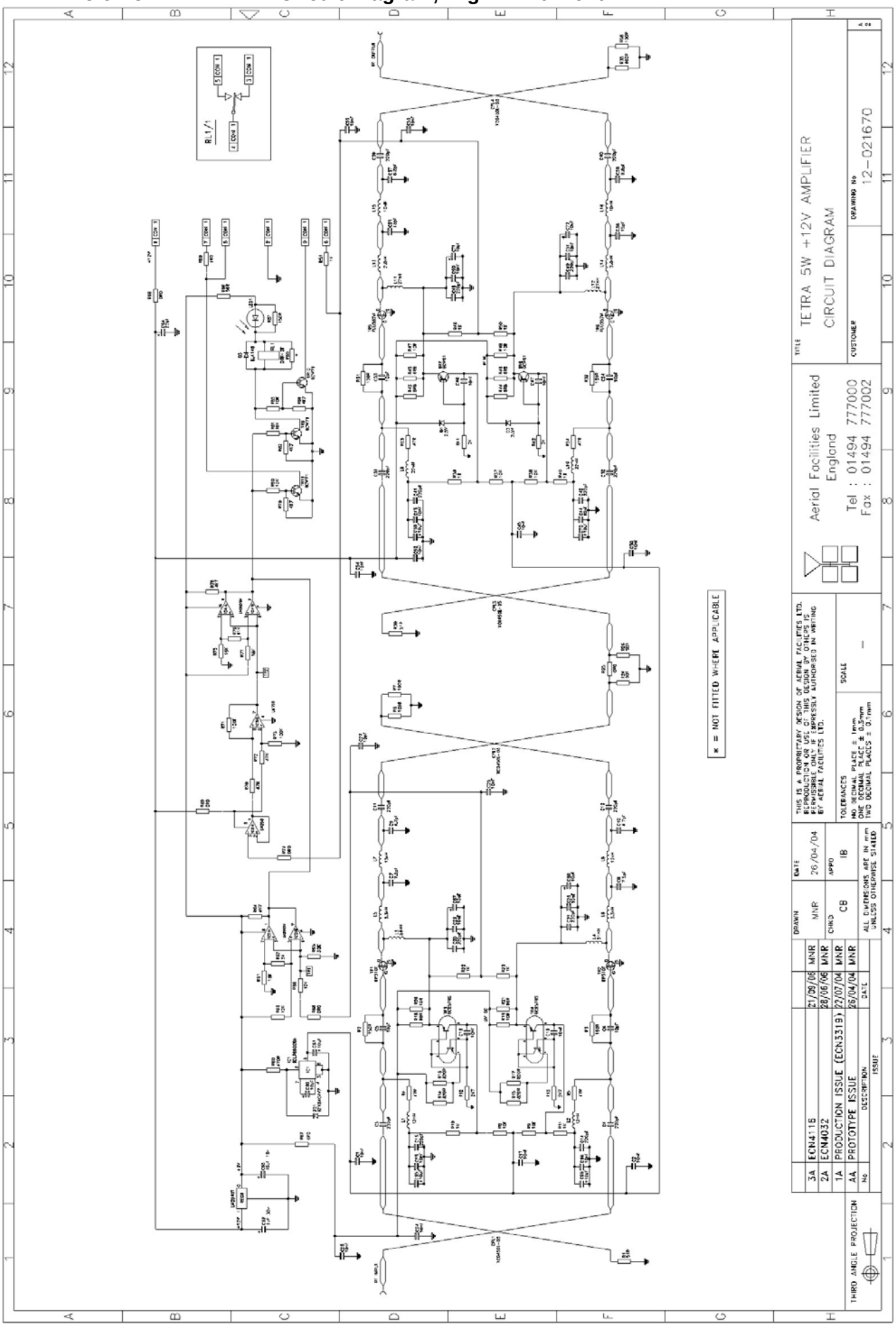
4.5.4 PA Connector Pin-Outs



4.5.5 5W TETRA PA Assembly Drawing, Drg. # 12-021601



4.5.6 5W TETRA PA Circuit Diagram, Drg. # 12-021670



4.6 12-022101 10Watt Power Tetra Amplifier

4.6.1 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.

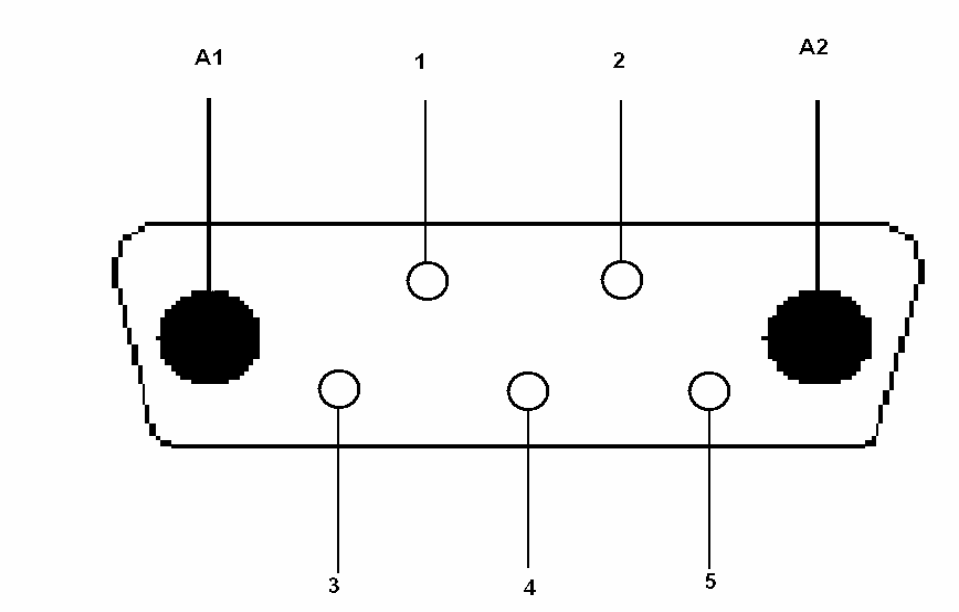
4.6.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		380-470MHz (as required)
Bandwidth:		10-40MHz (typical, tuned to spec.)
Maximum RF output:		>10Watts
Gain:		>34dB
1dB compression point:		+40.3dBm
3rd order intercept point:		+54dBm
Return loss:		>18dB
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		4.3A @ 12V DC
Weight:		1kg (excluding heatsink)
Alarm:		Load current alarm (relay contacts)
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C

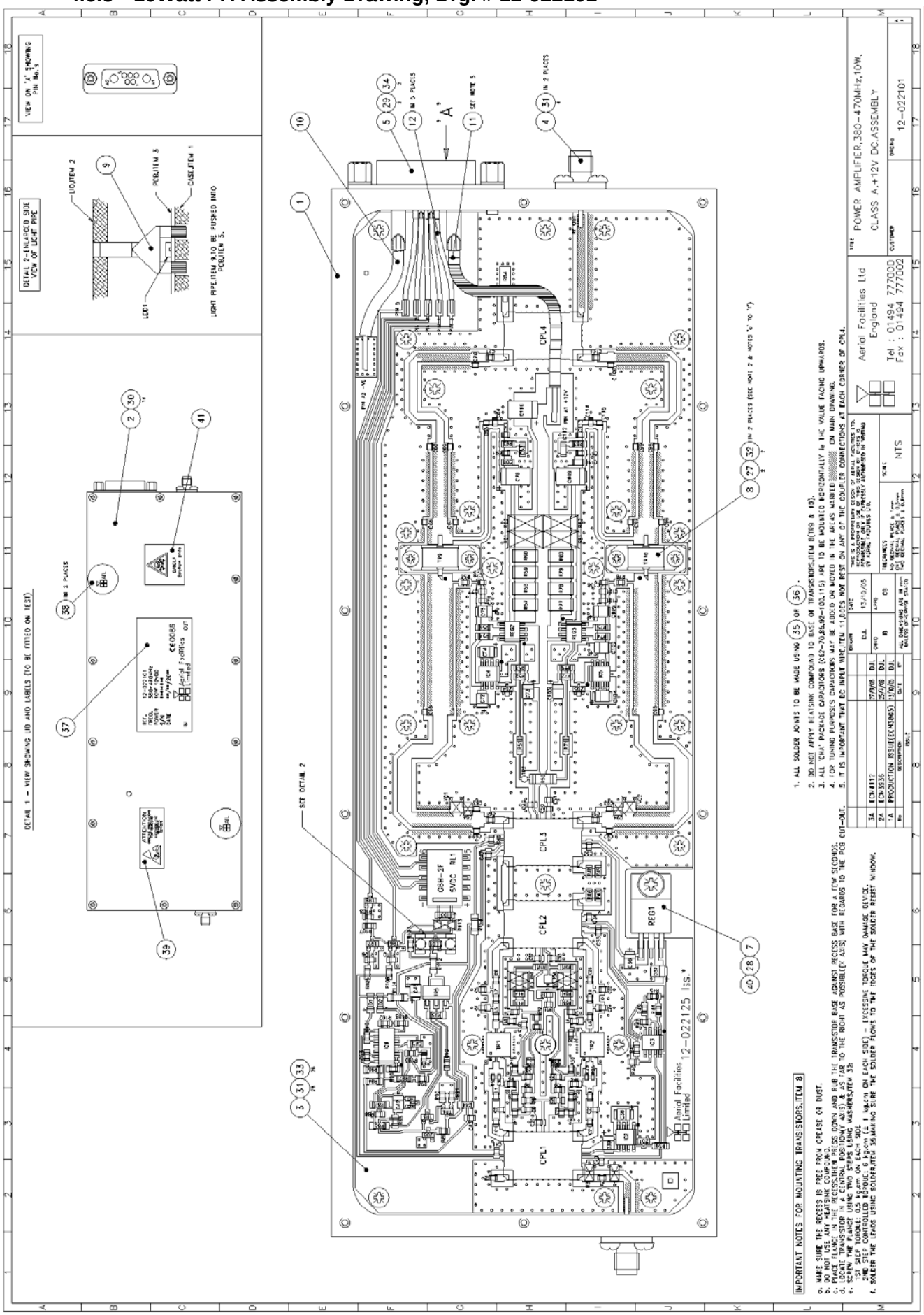
4.6.3 PA 7-Way Connector Pin-Outs

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

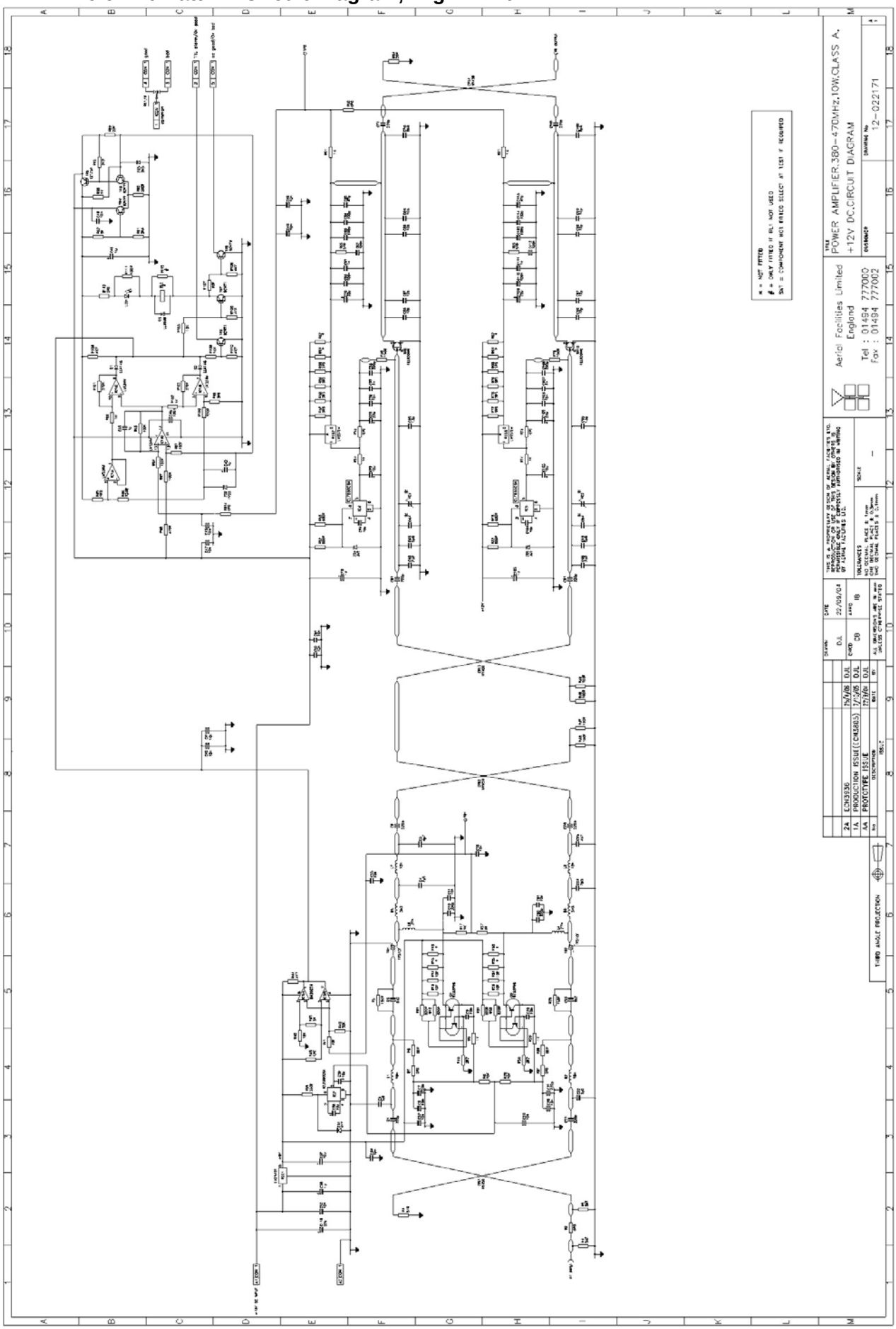
4.6.4 PA Connector Pictorial Pin-Outs



4.6.5 10Watt PA Assembly Drawing, Drg. # 12-022101



4.6.6 10Watt PA Circuit Diagram, Drg. # 12-022171



4.7 8A Mains Filter Assembly (13-003301)

4.7.1 Description

The AFL 10A mains filter assembly 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.

4.7.2 Technical 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% (non-condensing)
Case material:	ABS plastic (IP50 rated)
Maximum attenuation:	70dB (common mode 50-60Hz)

4.8 Channel Control Module (17-002101)

4.8.1 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'.

4.8.2 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	---	---

4.8.3 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

4.8.4 VHF/ UHF Programming Example

Frequency required: 465.5MHz

Channel spacing: 12.5kHz

Synthesiser offset: 21.4MHz

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

Dividing the LO frequency by the channel spacing of: 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)

4.9 Channel Selective Module (17-003007)

4.9.1 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.

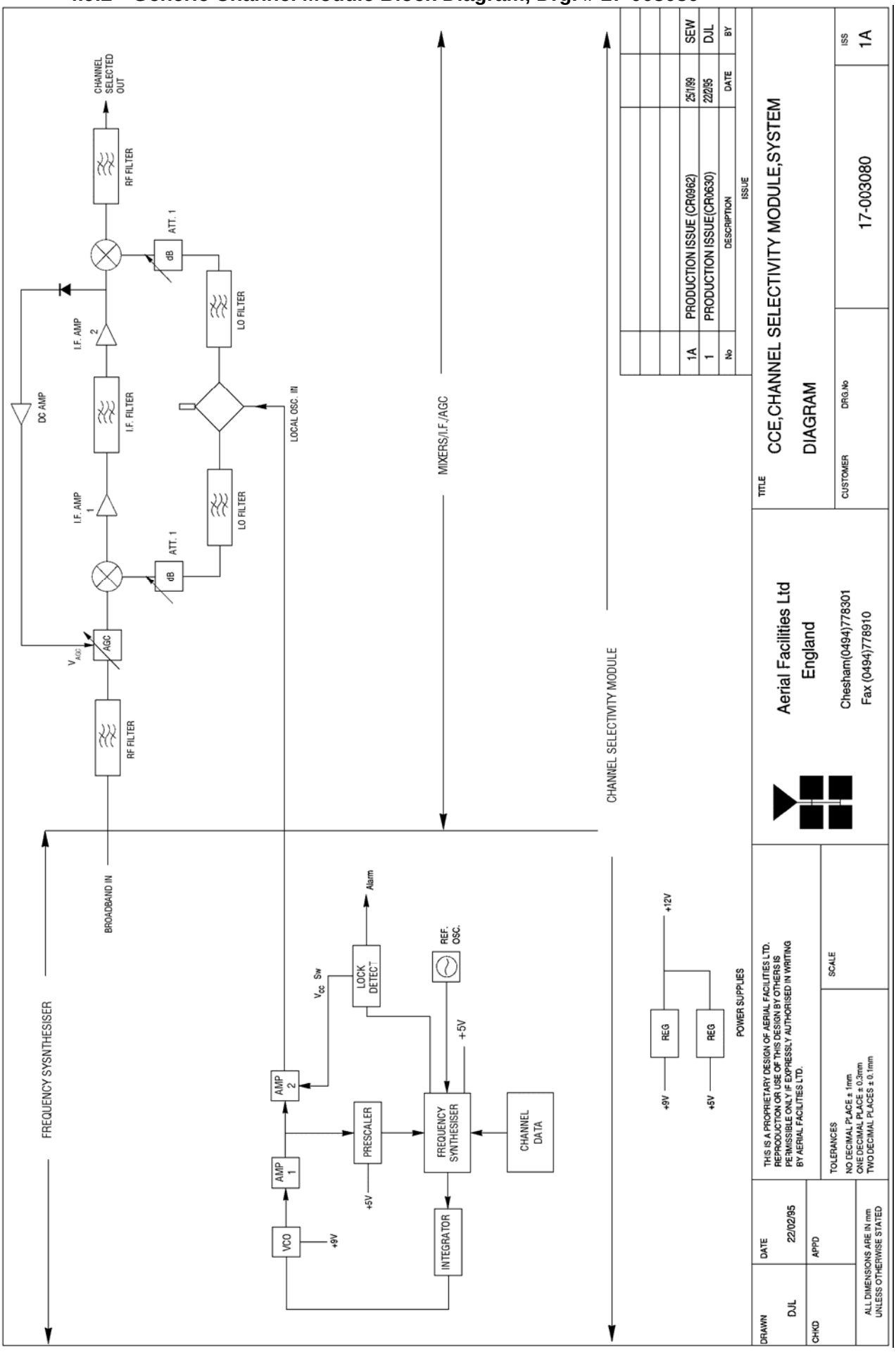
The operating frequency of each channel selectivity module is set by the programming of channel selectivity module frequencies and is achieved digitally, via hard wired links, banks of DIP switches, or via an onboard RS232 control module, providing the ability to remotely set channel frequencies.

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.

4.9.2 Generic Channel Module Block Diagram, Drg. # 17-003080



4.10 12V Single Relay Board (80-008901)

4.10.1 Description

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

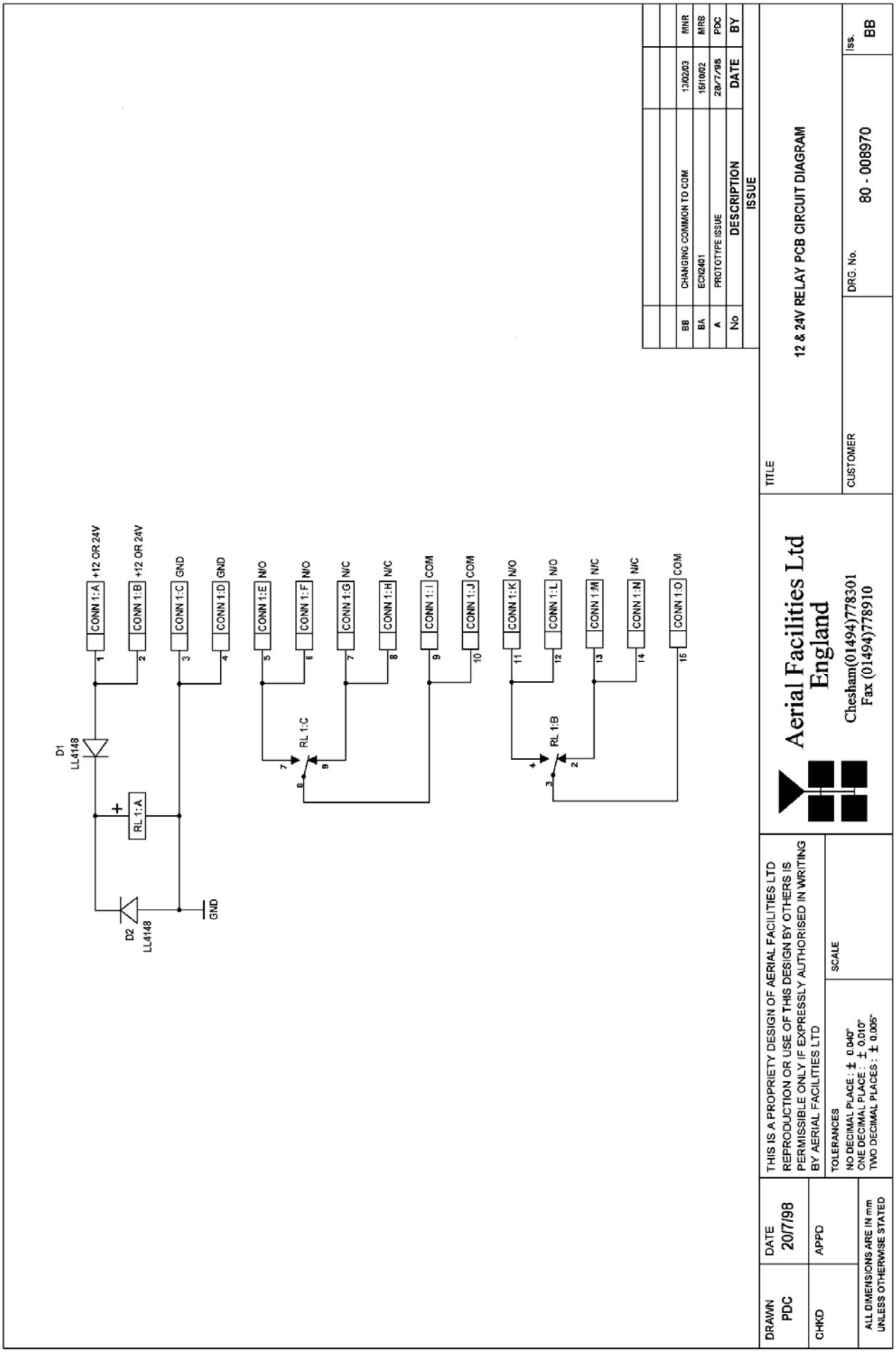
The relay is provided with polarity protection diodes and diodes for suppressing the transients caused by "flywheel effect" which can destroy switching transistors or induce spikes on neighbouring circuits. It's common use is to amalgamate all the alarm signals into one, volts-free relay contact pair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

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

4.10.2 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 +60°C
	storage:	-20°C to +70°C

4.10.3 12 or 24V Relay PCB Pin-Outs, Drg. # 80-008970



4.11 12V Switch-Mode PSU (96-300052)

4.11.1 Description

The power supply unit is a switched-mode type capable of supplying 12V DC at 12.5Amps continuously. This unit will draw approximately 7-8Amps at 12V DC, so the PSU's will be used conservatively ensuring a long operational lifetime.

No routine maintenance of the PSU's 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 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.

4.11.2 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)
	10.5-13.8V (absolute limits)
Current:	12.5A

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.

6. FAULT FINDING & MAINTENANCE

6.1 General Fault Finding Procedures

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.
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/module must be isolated and individually tested against the original test specification.
The individual amplifier units within the shelf have a green LED showing through a hole in their piggy-back alarm board, which is illuminated if the unit is working correctly.

If an amplifier is suspect, check the DC power supply to the unit. If no other fault is apparent use a spectrum analyser to measure the incoming signal level at the input and then after reconnecting the amplifier input, measure the output level. Consult with the system diagram to determine the expected gain and compare result.

In the event that there are no alarms on and all units appear to be functioning it will be necessary to test the system in a systematic manner to confirm correct operation.

6.2 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.

6.3 Uplink

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

6.4 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.

6.5 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.

6.6 Service Support

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

6.7 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.

6.8 General Maintenance Procedures

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.

6.9 Module Removal (LNA's, general procedure)

The following general rules 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).

6.10 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.

6.11 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.

6.12 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

6.13 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

Amendment List Record Sheet

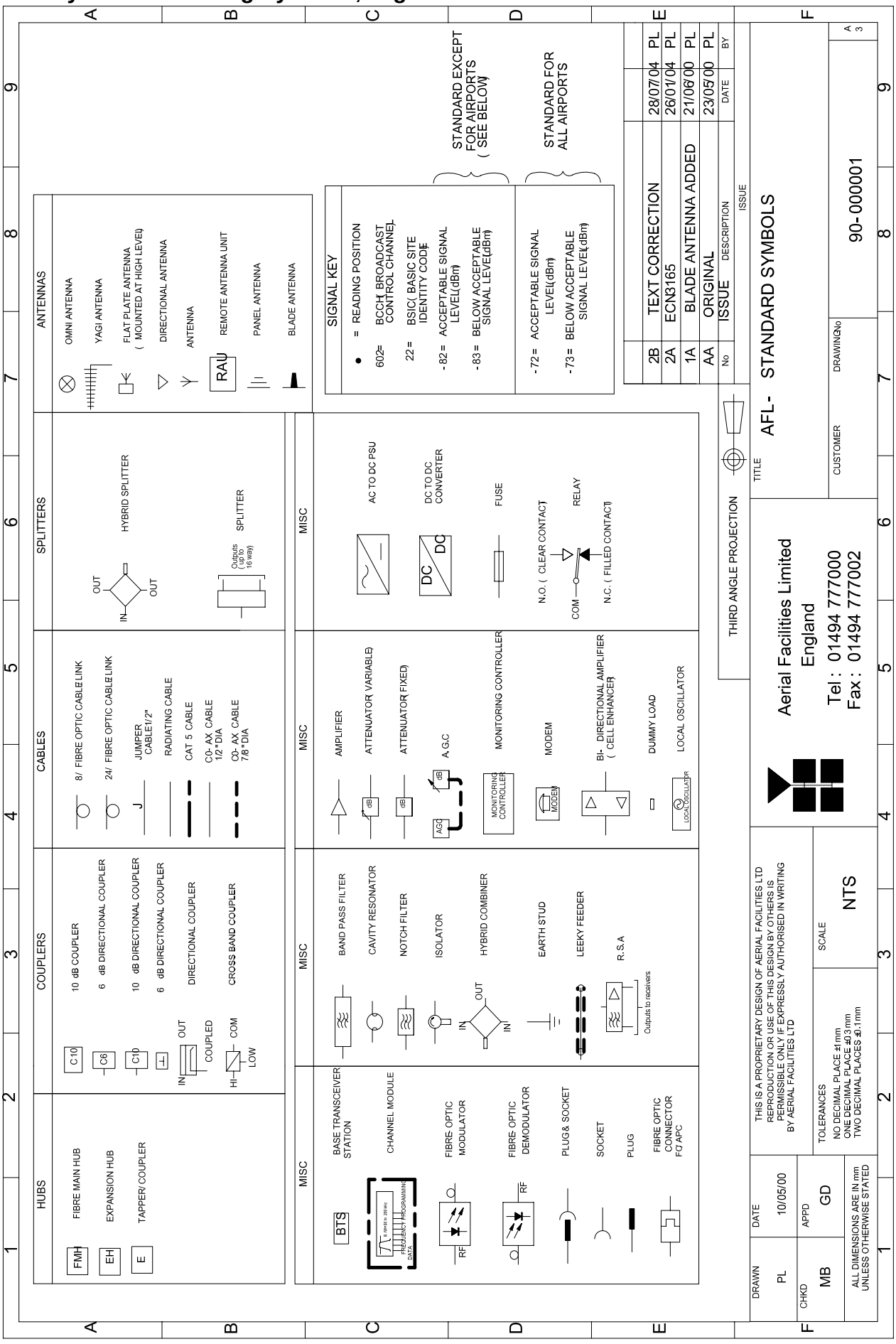
Issue No.	Date	**Incorporated by**	**Page Nos. Amended**	**Reason for new issue**
A	22/05/2007	CMH		1st Draft

Document Ref:-50-187601HBKM

Glossary of Terms

Repeater or Cell Enhancer	A Radio Frequency (RF) amplifier which can simultaneously amplify and re-broadcast Mobile Station (MS) and Base Transceiver Station (BTS) signals.
Band Selective Repeater	A Cell Enhancer designed for operation on a range of channels within a specified frequency band.
Channel Selective Repeater	A Cell Enhancer, designed for operation on specified channel(s) within a specified frequency band. Channel frequencies may be factory set or on-site programmable.
AC	Alternating Current
AGC	Automatic Gain Control
BBU	Battery Backup Unit
BTS	Base Transceiver Station
CEMS	Coverage Enhanced Management System
C/NR	Carrier-to-Noise Ratio
DC	Direct Current
Downlink (D/L)	RF signals Tx from the BTS to the Master Site
FO	Fibre Optic
GND	Ground
ID	Identification Number
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LPA	Low Power Amplifier
MOU	Master Optical Unit
M.S.	Mobile Station
MTBF	Mean Time Between Failures
N/A	Not Applicable
N/C	No Connection
OFR	On Frequency Repeater
OIP3	Output Third Order Intercept Point = RFout +(C/I)/2
PA	Power Amplifier
RF	Radio Frequency
RSA	Receiver/Splitter Amplifier
Rx	Receiver
S/N	Serial Number
Tx	Transmitter
Uplink (U/L)	RF signals transmitted from the MS to the BTS
VSWR	Voltage Standing Wave Ratio
WDM	Wave division multiplex

Key to AFL Drawing Symbols, Drg. # 90-000001



APPENDIX B

Initial Equipment Set-Up Calculations

General Information

Site Name: Client Name:
Date: AFL Equip. Model No.

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