Aerial Facilities Limited

Baltimore Transit
Radio Repeater System

User/Maintenance Handbook (1)

for

Intelect Corp.

AFL Works Order: Q113737
AFL product part No.: 60-166101
comprising:
PRESTON (60-166301) & OCC (60-166401)

1. INTRODUCTION

Scope and Purpose of this 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 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.

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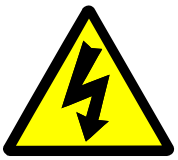
2. SAFETY CONSIDERATIONS

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 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 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, do not allow any dirt/foreign material ingress on the optical connector bulkheads and always keep optical connectors covered to avoid physical damage.
The optical fibre jumper cable maximum bend radius is 3 cm (1 ¼"), any smaller radii may result in optical cable breakage or excessive transmission losses.

Caution: Do not get the Fibre Optic units wet, they 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	mail to:qa@aerial.co.uk

3. EQUIPMENT OVERVIEW/SPECIFICATIONS

The Baltimore repeater system consists of several items of hardware:-

Master Site Preston UHF Air Interface Channelised Amplifier (60-166101, rack mounting)
Master Site OCC UHF Air Interface Channelised Amplifier (60-166201, rack mounting)
Preston Six-Way Fibre Optic Master Site (60-166301, rack mounting)
OCC Six-Way Fibre Optic Master Site (60-166401, rack mounting)
Remote Site High Power UHF Bi-Directional Amplifier (60-166501, wall mounting)
MOCE Site Air Interface Repeater (60-166801, wall mounting)
6 x 114Ah Battery Backups (80-333201, wall mounting)

There are two master sites, one at PRESTON and one at OCC, each has a 19" rack cabinet containing the four off-air receiving shelves, which also contain the power supplies and the DC/DC converters (12V) for the FO shelf.

The master site equipment receives off-air transmissions which it channelises, (15 channels) and sends this downlink signal data to six fibre optic RX modules. Remotely sited cell enhancers receive this FO data, demodulate and amplify it and feed it to local LCX antennas.

At the remote sites, the same leaky feeder antennas receive mobile signals, band selectively amplify them and send this uplink data back by FO to the master site where it is demodulated, channelised and broadcast on the same air interface antenna that received the downlink signal.

Existing in the current system are bi-directional amplifiers in the 800MHz bands. These signals are catered for using specialist cross-band couplers so that the 800MHz signals bypass the 490MHz system path with negligible loss.

20dB couplers fitted at various points in the system 'tap-off' a signal suitable for monitoring the RF power in any path.

Each active device is alarm monitored and these alarms are available either as separate volt-free relay contact pairs, in groups (e.g. all downlink power amplifiers), or as an alarm summary of the whole system with locally visible indications (LEDs).

Six 114Ah battery backup systems ensure no loss of coverage should mains power fail. At the time of writing this document no information was available on which items of the system were to be fitted to the battery backups.

3.1 Master Site Equipment

3.1.P Master Site Photographs

3.2 PRESTON (60-166301) & OCC (60-166401) Master Sites Description

The equipment is divided into functional parts;

The Master Site equipment is supplied in two, 43U standard size (19”) rack cabinets with eight shelves containing all the electronics to fulfil the required coverage. There is an off-air channelised amplifier which feeds seven fibre transmitters for remote RF distribution with a complementary uplink path from the remote sites being received in the same shelf by seven FO receiver/modems. The master site also has the ability to vary the RF attenuation to each path remotely, via a binary switching arrangement with the actuating wiring being available on a ‘krone-block’ connector mounted in the lower rack space.

The two master sites are very similar and so only the PRESTON site will be specified – the two parts lists are identical.

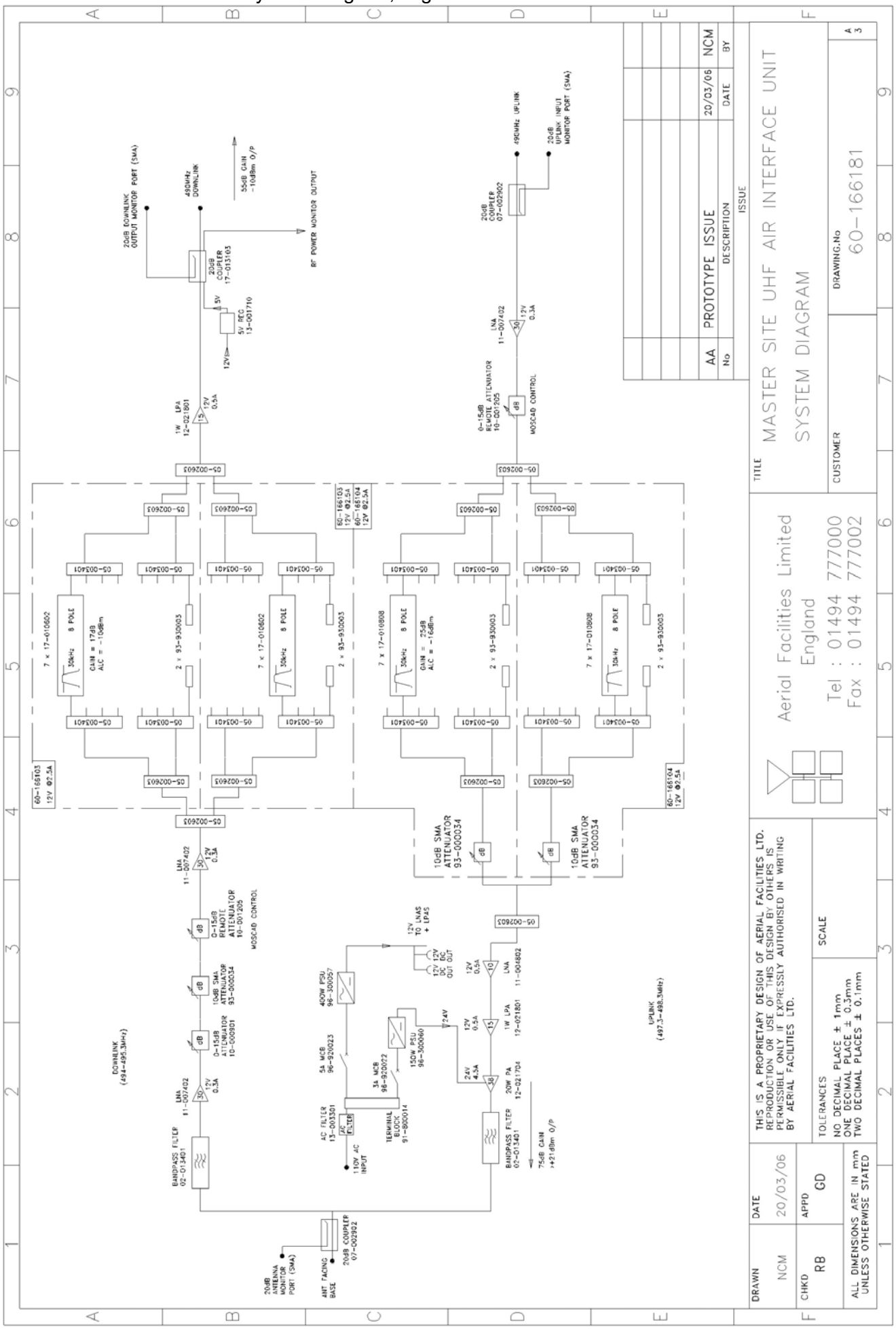
Alarms are provided for all the active modules, individually and in summary form as volt-free normally-closed relay contacts.

3.3 Master Site Technical Specifications

PARAMETER		SPECIFICATION
Frequency range:		494.3-495.3MHz (Downlink)
		497.3-498.3MHz (Uplink)
Bandwidth:		1.0MHz
Number of FO RX outputs		7
Number of FO RX inputs		7
Number of RF channels:		15
Downlink air interface gain:		55dB
Uplink air interface gain:		75dB
Manual Gain Adjustment:		0-15dB (in 1dB steps)
Remote gain adjustment:		0-15dB (in 1dB steps)
Rejection at opposing band:		> 60dB
Downlink1dB Compression Point:		> +42.5dBm
Downlink 3rd Order Intercept Point:		> +56dBm
Uplink 1dB Compression Point:		> +30.5dBm
Uplink 3rd Order Intercept Point:		> +43dBm
Noise Figure:		<6.0dB at any gain setting
Impedance:		50 ohms
RF Connectors:		N type, female
Power Supply:		110V AC (nominal)
Power consumption:		<8A (@ 12V)
Temperature range:	operational:	-10°C to +60°C
	storage:	-40°C to +70°C

3.4 Master Site Mechanical Specifications

PARAMETER		SPECIFICATION
Rack	Height:	43U Standard 19” Rack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelf sizes:	Height:	See parts lists
	Width:	19" (482.6mm)
	Depth:	<400mm(excluding heatsinks, connectors, handles and feet)
Temperature range:	operational:	-10°C to +60°C
	storage:	-40°C to +70°C
Weight:		>100kg
Humidity:		10 – 90% non-condensing
RF Connectors:		N type female
FO connectors		FC/APC
Environmental Protection:		IP44
Shelf finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised
	Fascia:	Painted to RAL 7035
Supply Cable:		Unit supplied with suitable supply input leads, connector and specified length of cable


MASTER SITE UHF AIR INTERFACE UNIT
SYSTEM DIAGRAM
DRAWING.No 60-166181
CUSTOMER
TITLE
Aerial Facilities Limited
England
Tel : 01494 777000
Fax : 01494 777002
AA PROTOTYPE ISSUE 20/03/06 NCM
No DESCRIPTION DATE BY
ISSUE
DRAWN NCM 20/03/06
CHKD RB APPD GD
SCALE
TOLERANCES
NO DECIMAL PLACE ± 1mm
ONE DECIMAL PLACE ± 0.3mm
TWO DECIMAL PLACES ± 0.1mm
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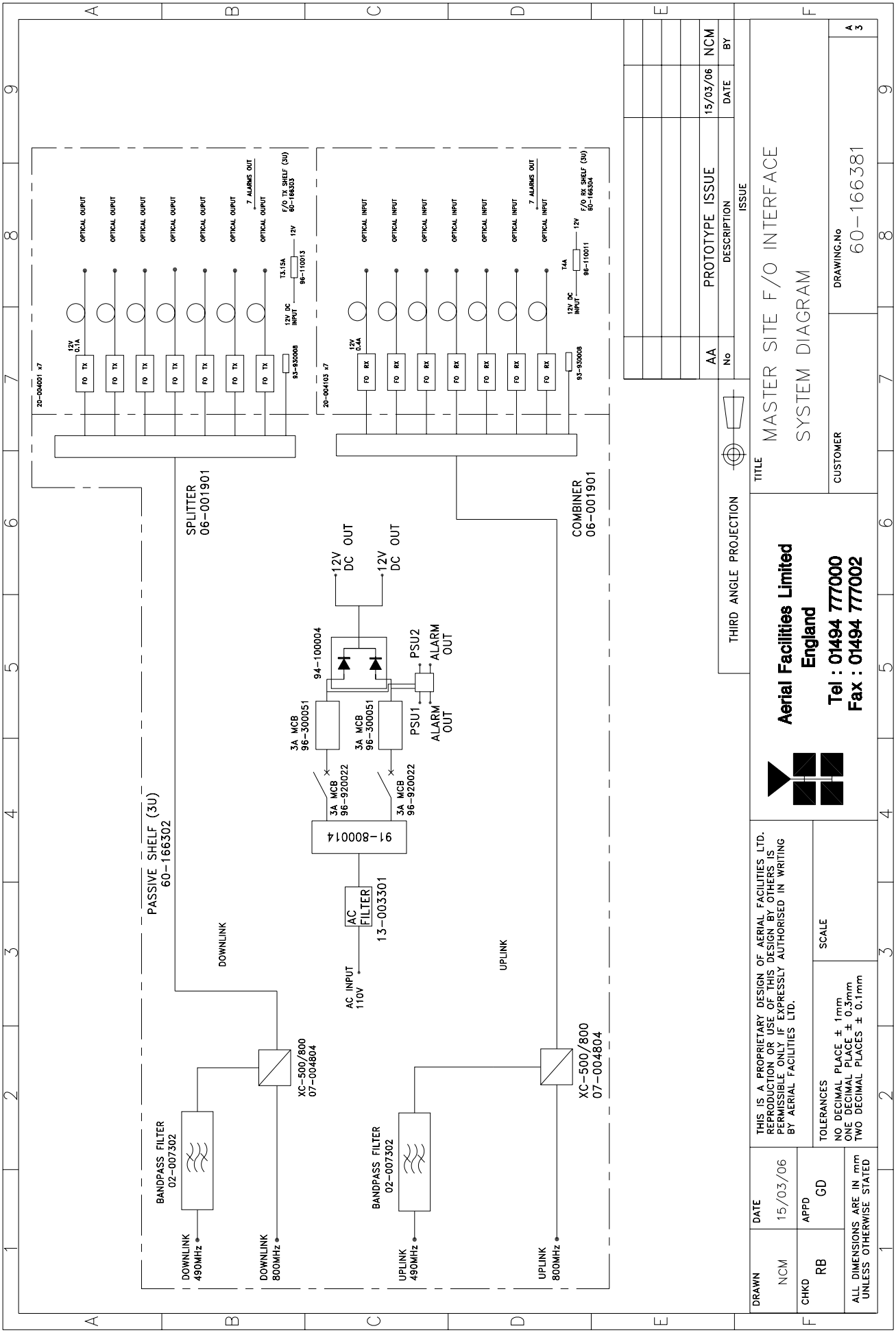
A3
20dB DOWNLINK OUTPUT MONITOR PORT (SMA)
490MHz DOWNLINK
35dB GAIN -10dBm O/P
20dB COUPLER 17-015103
RF POWER MONITOR OUTPUT
5V REG 13-001710
1W LPA 12-021801
490MHz UPLINK
20dB UPLINK INPUT MONITOR PORT (SMA)
20dB COUPLER 07-002902
LNA 11-007402
0-15dB REMOTE ATTENUATOR 10-001205
MOSCAD CONTROL
60-166103 12V @2.5A
60-166104 12V @2.5A
7 x 17-010602
GAIN = 17dB ALC = -10dBm
7 x 17-010808
GAIN = 25dB ALC = -16dBm
2 x 93-930003
10dB SMA ATTENUATOR 93-000034
12V TO LNAS + LPAS
12V 12V DC OUT OUT
400W PSU 96-300057
5A MCB 96-920023
3A MCB 96-920022
150W PSU 96-300060
TERMINAL BLOCK 91-800014
AC FILTER 13-001301
110V AC INPUT
20W PA 12-021704
BANDPASS FILTER 02-013401
75dB GAIN +21dBm O/P
DOWNLINK (494-495.3MHz)
UPLINK (497.3-498.3MHz)
20dB ANTENNA MONITOR PORT (SMA)
ANT FACING BASE


MASTER SITE F/O INTERFACE
SYSTEM DIAGRAM
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Aerial Facilities Limited
England
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Fax : 01494 777002
PROTOTYPE ISSUE
15/03/06
NCM
DESCRIPTION
DATE
BY
ISSUE
AA
No
SPLITTER
06-001901
COMBINER
06-001901
PASSIVE SHELF (3U)
60-166302
OPTICAL OUPUT
OPTICAL INPUT
7 ALARMS OUT
F/O TX SHELF (3U)
60-166303
F/O RX SHELF (3U)
60-166304
12V DC INPUT
12V DC OUT
94-100004
PSU1
PSU2
ALARM OUT
3A MCB
96-300051
3A MCB
96-920022
91-800014
AC FILTER
13-003301
AC INPUT
110V
DOWNLINK
UPLINK
BANDPASS FILTER
02-007302
XC-500/800
07-004804
DOWNLINK
490MHz
DOWNLINK
800MHz
UPLINK
490MHz
UPLINK
800MHz
DRAWN
NCM
DATE
15/03/06
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SCALE
TOLERANCES
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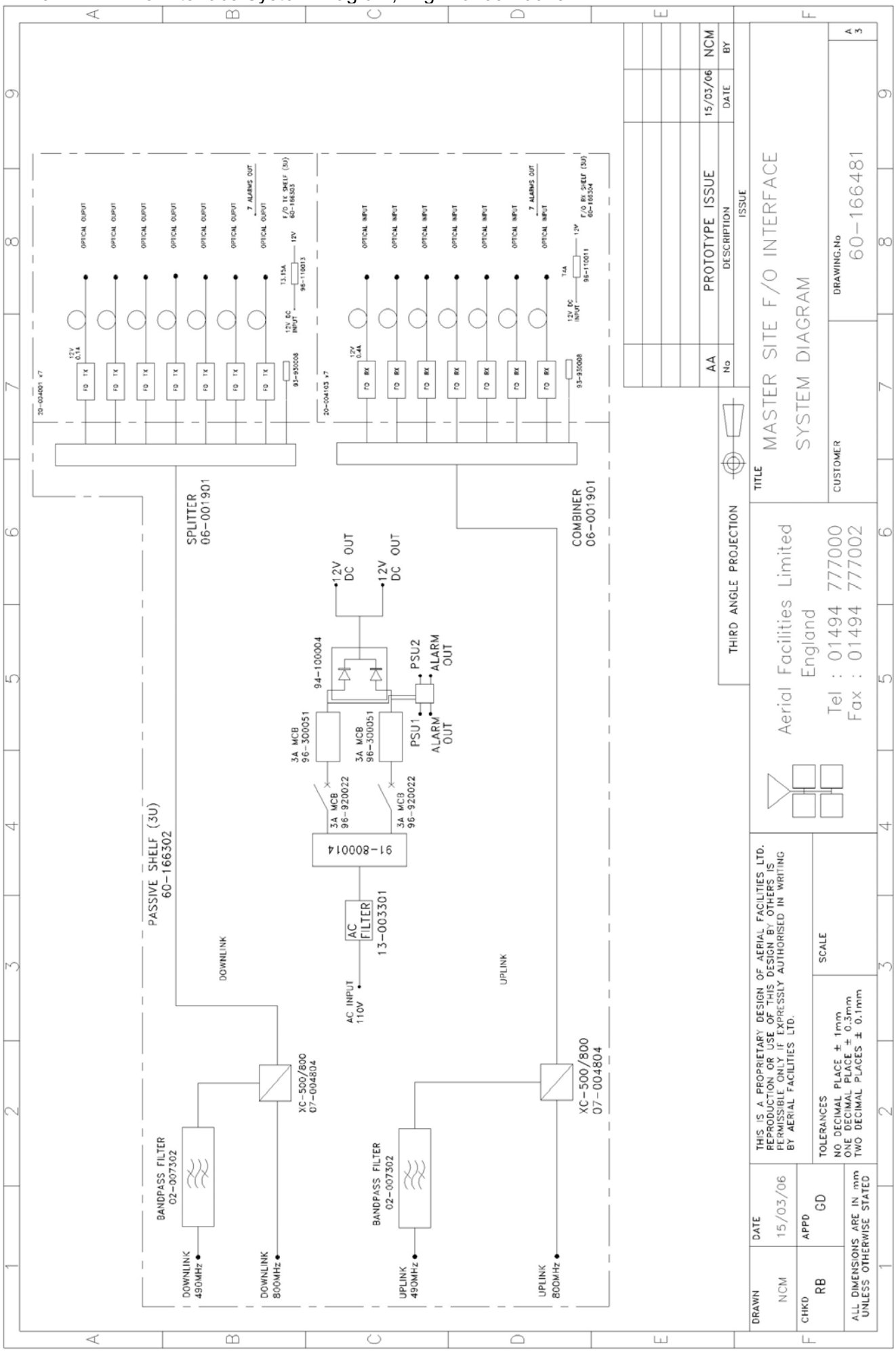
PASSIVE SHELF (3U)
60-166302
SPLITTER
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COMBINER
06-001901
DOWNLINK
UPLINK
BANDPASS FILTER
02-007302
BANDPASS FILTER
02-007302
XC-500/800
07-004804
XC-500/800
07-004804
DOWNLINK
490MHz
DOWNLINK
800MHz
UPLINK
490MHz
UPLINK
800MHz
AC FILTER
13-003301
AC INPUT
110V
91-800014
3A MCB
96-920022
3A MCB
96-920022
3A MCB
96-300051
3A MCB
96-300051
94-100004
PSU1
PSU2
ALARM OUT
ALARM OUT
12V DC OUT
12V DC OUT
OPTICAL OUPUT
7 ALARMS OUT
OPTICAL INPUT
7 ALARMS OUT
F/O TX SHELF (3U)
60-166503
F/O RX SHELF (3U)
60-166504
95-110013
95-110011
95-950008
95-950008
12V DC INPUT
12V DC INPUT
FO TX
FO RX
20-004091 x7
20-004103 x7
AA
No
PROTOTYPE ISSUE
DESCRIPTION
15/03/06
DATE
NCM
BY
ISSUE
THIRD ANGLE PROJECTION
TITLE
MASTER SITE F/O INTERFACE
SYSTEM DIAGRAM
CUSTOMER
DRAWING.No
60-166481
A3
Aerial Facilities Limited
England
Tel : 01494 777000
Fax : 01494 777002
DRAWN
NCM
DATE
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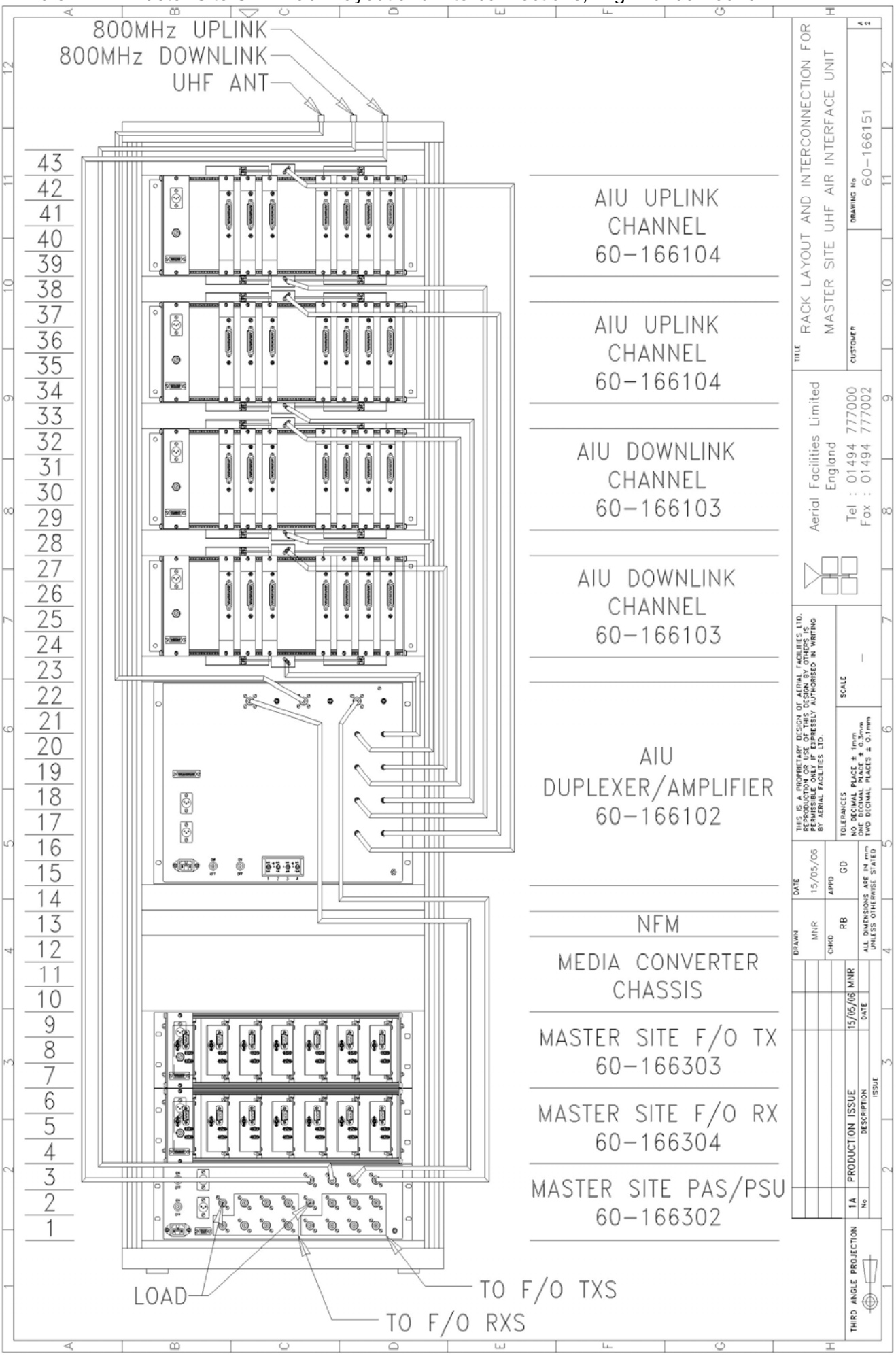
800MHz UPLINK
800MHz DOWNLINK
UHF ANT
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4
3
2
1
AIU UPLINK CHANNEL 60-166104
AIU UPLINK CHANNEL 60-166104
AIU DOWNLINK CHANNEL 60-166103
AIU DOWNLINK CHANNEL 60-166103
AIU DUPLEXER/AMPLIFIER 60-166102
NFM
MEDIA CONVERTER CHASSIS
MASTER SITE F/O TX 60-166303
MASTER SITE F/O RX 60-166304
MASTER SITE PAS/PSU 60-166302
LOAD
TO F/O TXS
TO F/O RXS
TITLE
RACK LAYOUT AND INTERCONNECTION FOR MASTER SITE UHF AIR INTERFACE UNIT
CUSTOMER
DRAWING No
60-166151
A2
Aerial Facilities Limited
England
Tel : 01494 777000
Fax : 01494 777002
DRAWN MNR DATE 15/05/06
CHKD RB APPD GD
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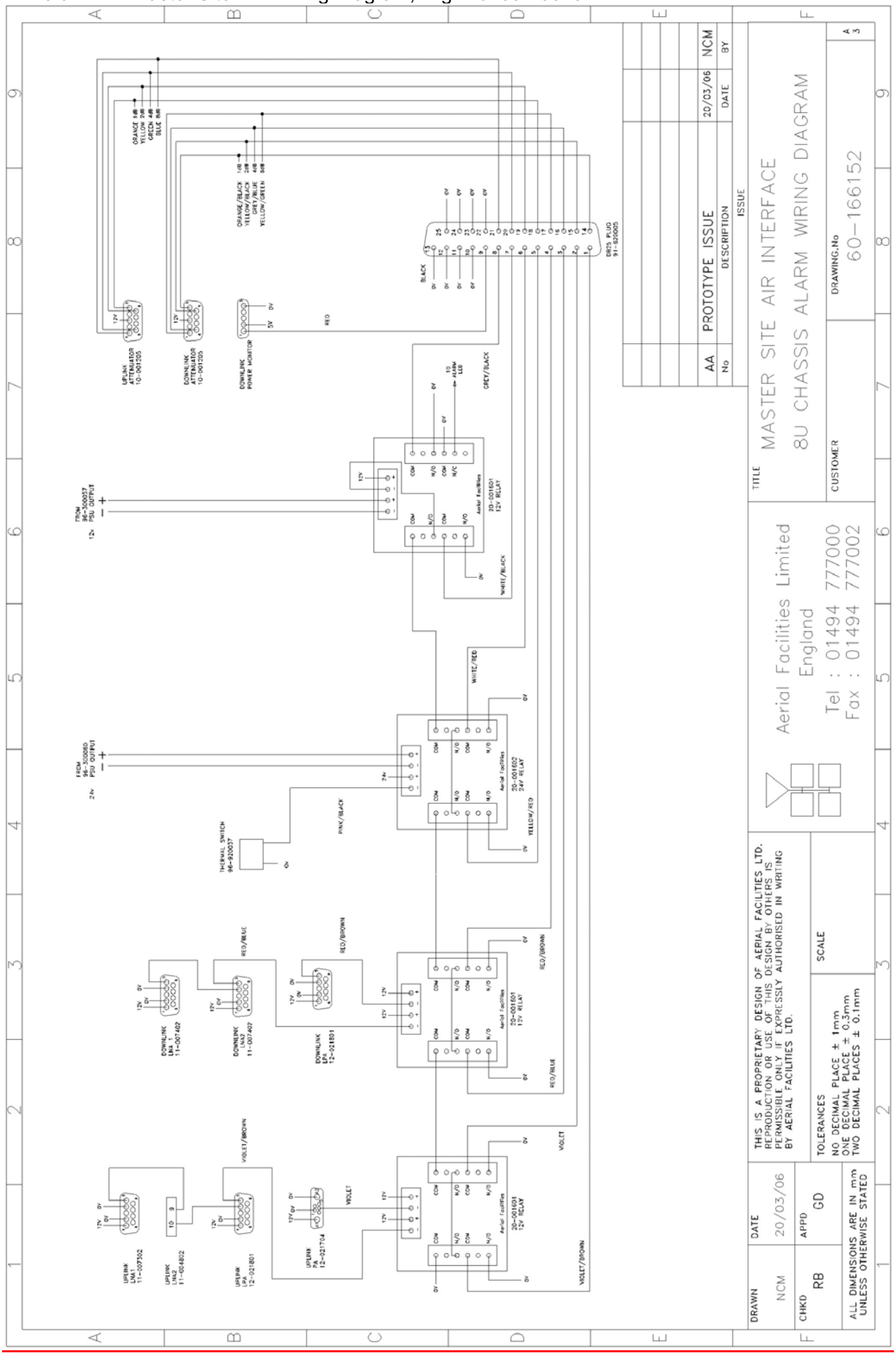
MASTER SITE AIR INTERFACE
8U CHASSIS ALARM WIRING DIAGRAM
DRAWING.No 60-166152
CUSTOMER
TITLE
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DATE
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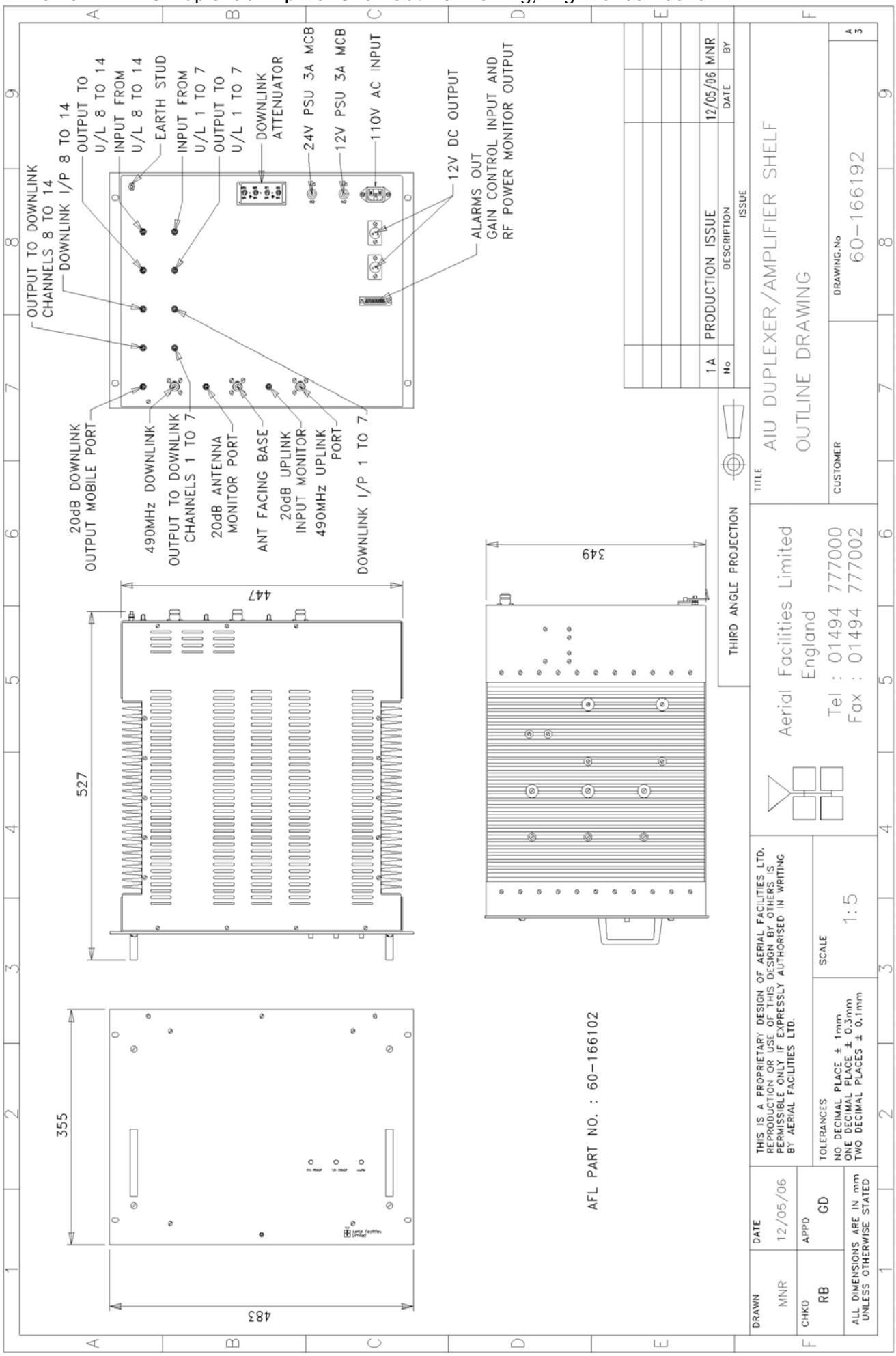
OUTPUT TO DOWNLINK CHANNELS 8 TO 14
DOWNLINK I/P 8 TO 14
OUTPUT TO U/L 8 TO 14
INPUT FROM U/L 8 TO 14
EARTH STUD
INPUT FROM U/L 1 TO 7
OUTPUT TO U/L 1 TO 7
DOWNLINK ATTENUATOR
24V PSU 3A MCB
12V PSU 3A MCB
110V AC INPUT
12V DC OUTPUT
ALARMS OUT
GAIN CONTROL INPUT AND
RF POWER MONITOR OUTPUT
20dB DOWNLINK OUTPUT MOBILE PORT
490MHz DOWNLINK
OUTPUT TO DOWNLINK CHANNELS 1 TO 7
20dB ANTENNA MONITOR PORT
ANT FACING BASE
20dB UPLINK INPUT MONITOR
490MHz UPLINK PORT
DOWNLINK I/P 1 TO 7
447
527
355
483
349
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OUTLINE DRAWING
CUSTOMER
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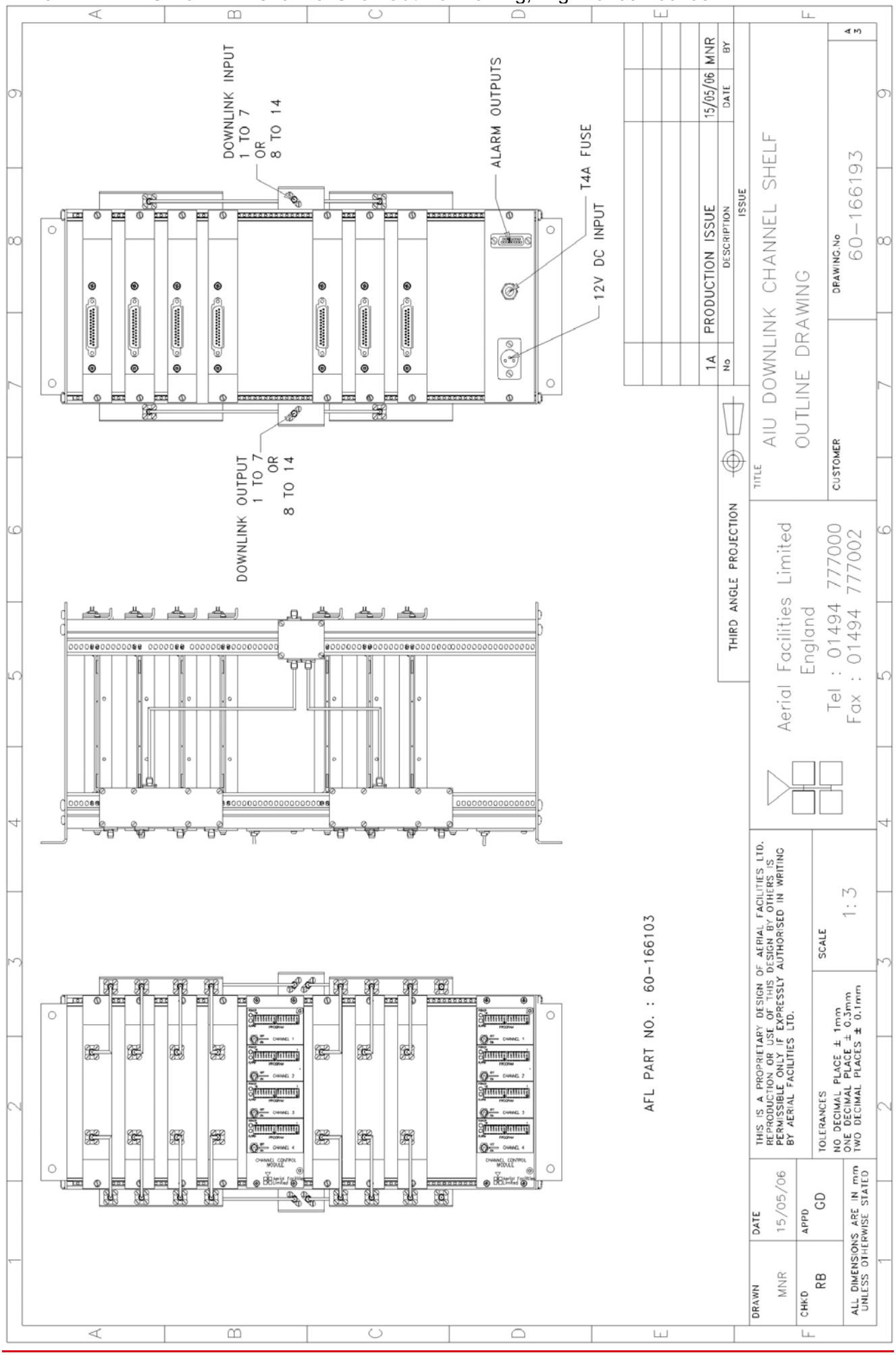
DOWNLINK INPUT
1 TO 7
OR
8 TO 14
ALARM OUTPUTS
T4A FUSE
12V DC INPUT
DOWNLINK OUTPUT
1 TO 7
OR
8 TO 14
AFL PART NO. : 60-166103
1A PRODUCTION ISSUE 15/05/06 MNR
No DESCRIPTION DATE BY
ISSUE
THIRD ANGLE PROJECTION
TITLE
AIU DOWNLINK CHANNEL SHELF
OUTLINE DRAWING
CUSTOMER
DRAWING No
60-166193
A3
Aerial Facilities Limited
England
Tel : 01494 777000
Fax : 01494 777002
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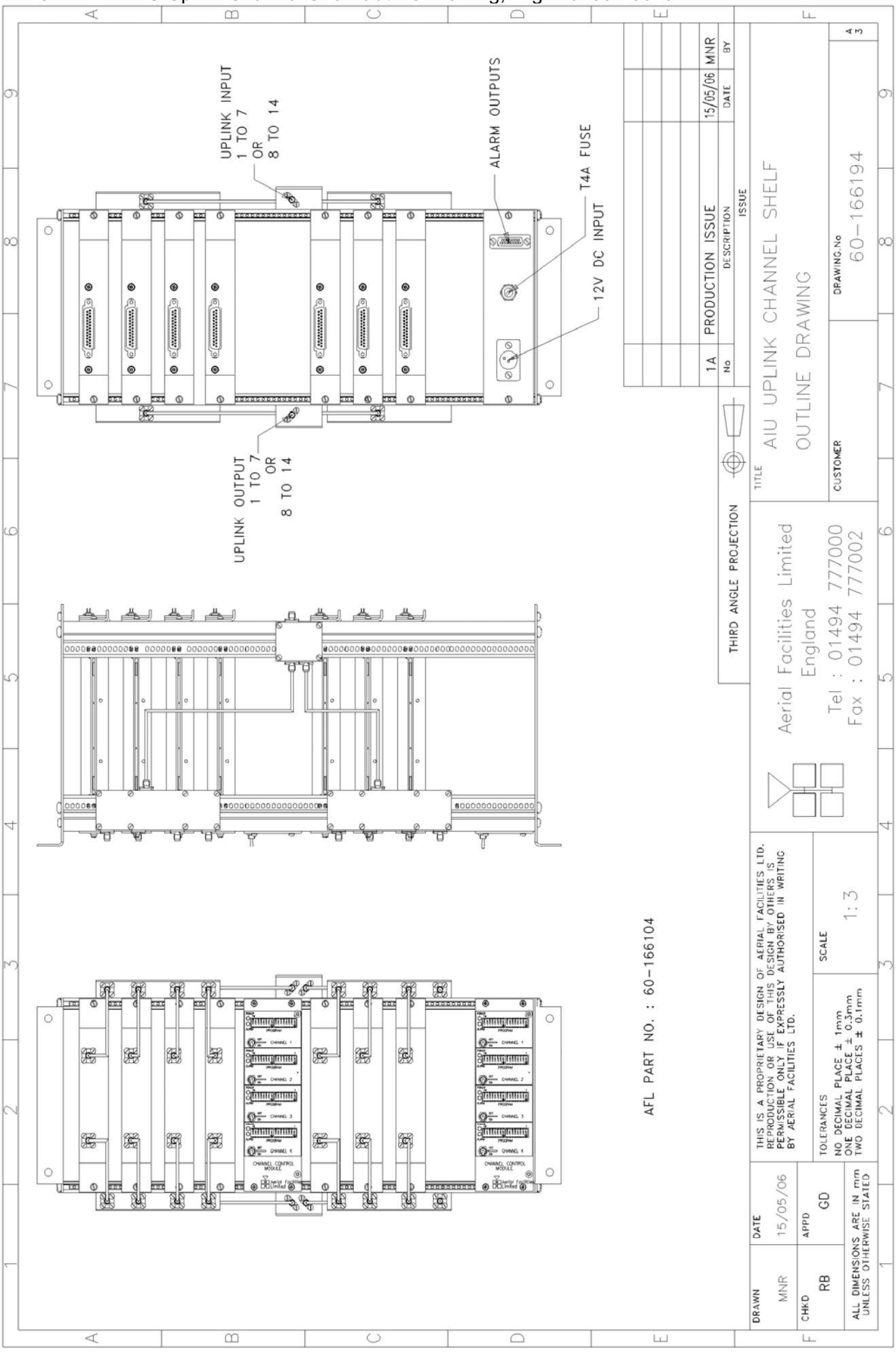
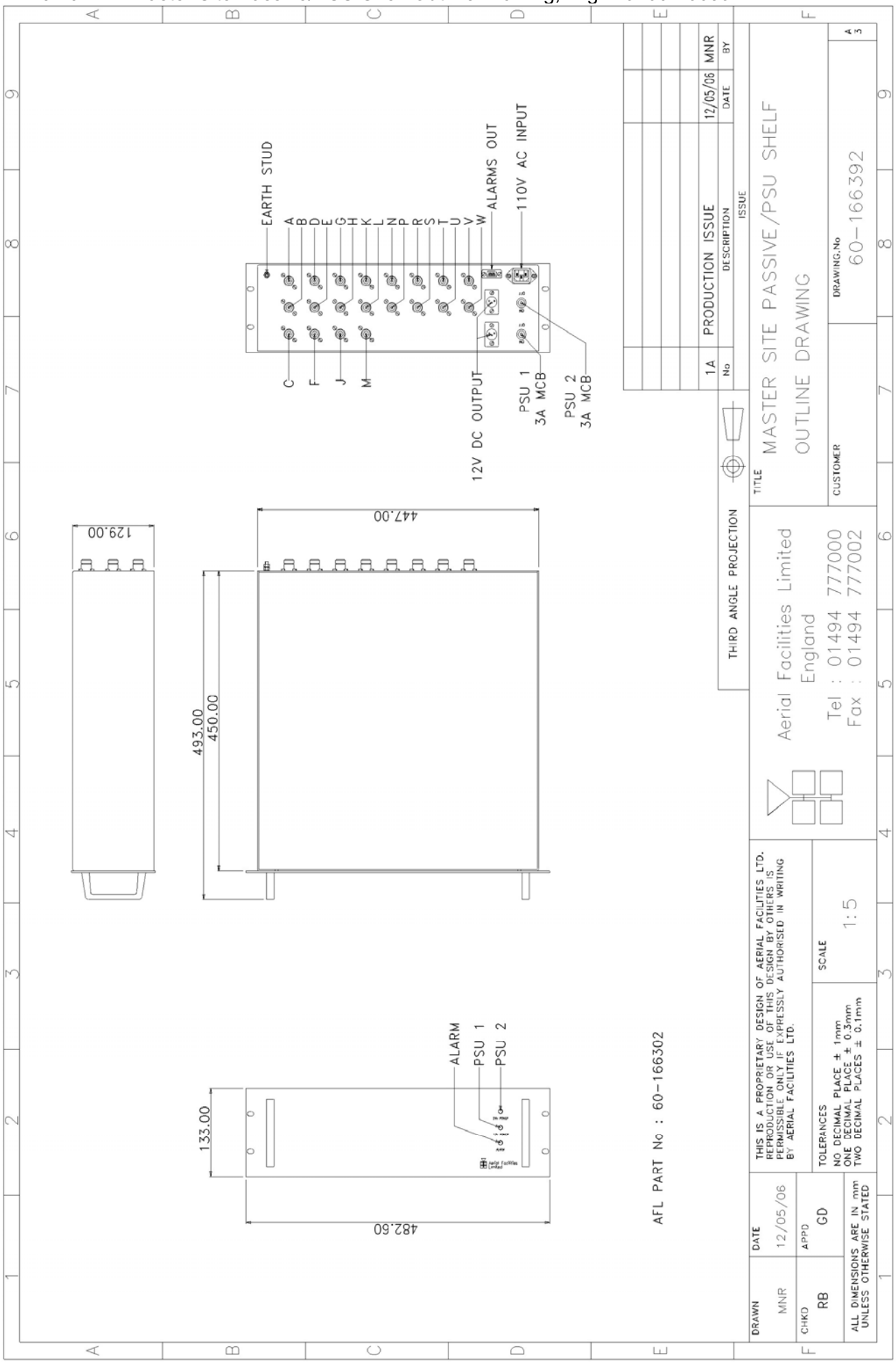
TOLERANCES
NO DECIMAL PLACE ± 1mm
ONE DECIMAL PLACE ± 0.3mm
TWO DECIMAL PLACES ± 0.1mm
SCALE
1:3
DRAWN MNR DATE 15/05/06
CHKD RB APPD GD
ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED

3.12 AIU Uplink Channel Shelf Outline Drawing, Drg. No. 60-166194




EARTH STUD
A
B
D
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G
H
K
L
N
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R
S
T
U
V
W
ALARMS OUT
110V AC INPUT
C
F
J
M
12V DC OUTPUT
PSU 1
3A MCB
PSU 2
3A MCB
129.00
447.00
493.00
450.00
ALARM
PSU 1
PSU 2
133.00
482.60
AFL PART No : 60-166302
1A
PRODUCTION ISSUE
12/05/06
MNR
No
DESCRIPTION
DATE
BY
ISSUE
THIRD ANGLE PROJECTION
TITLE
MASTER SITE PASSIVE/PSU SHELF
OUTLINE DRAWING
CUSTOMER
DRAWING.No
60-166392
A3
Aerial Facilities Limited
England
Tel : 01494 777000
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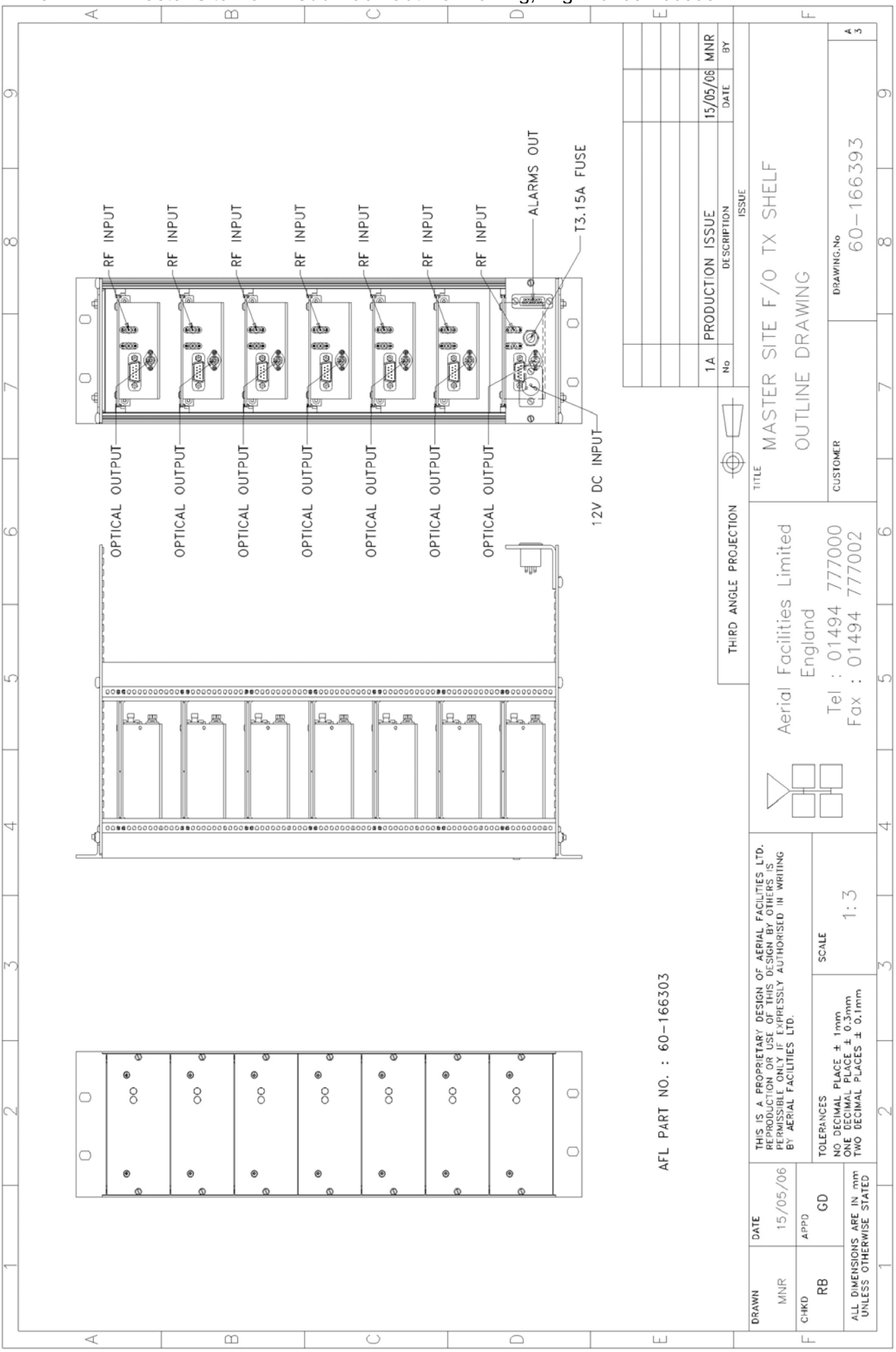
ONE DECIMAL PLACE ± 0.3mm
TWO DECIMAL PLACES ± 0.1mm
SCALE
1:5
DRAWN
MNR
DATE
12/05/06
CHKD
RB
APPD
GD
ALL DIMENSIONS ARE IN mm
UNLESS OTHERWISE STATED


RF INPUT
RF INPUT
RF INPUT
RF INPUT
RF INPUT
RF INPUT
RF INPUT
ALARMS OUT
T3.15A FUSE
OPTICAL OUTPUT
OPTICAL OUTPUT
OPTICAL OUTPUT
OPTICAL OUTPUT
OPTICAL OUTPUT
OPTICAL OUTPUT
OPTICAL OUTPUT
12V DC INPUT
AFL PART NO. : 60-166303
1A PRODUCTION ISSUE 15/05/06 MNR
No DESCRIPTION DATE BY
ISSUE
THIRD ANGLE PROJECTION
TITLE
MASTER SITE F/O TX SHELF
OUTLINE DRAWING
CUSTOMER
DRAWING.No 60-166393
A3
Aerial Facilities Limited
England
Tel : 01494 777000
Fax : 01494 777002
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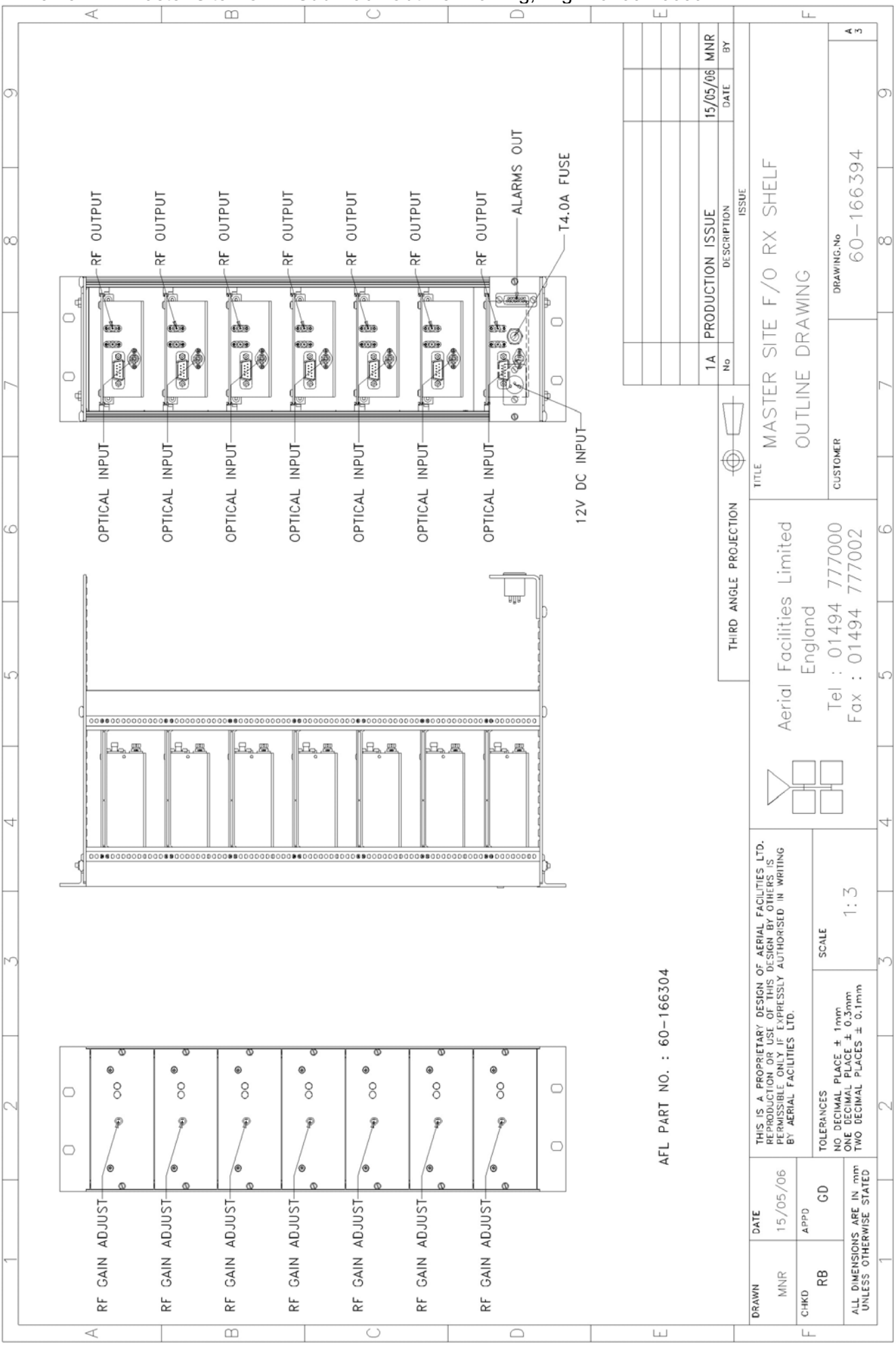
TOLERANCES
NO DECIMAL PLACE ± 1mm
ONE DECIMAL PLACE ± 0.3mm
TWO DECIMAL PLACES ± 0.1mm
SCALE 1:3
DRAWN MNR DATE 15/05/06
CHKD RB APPD GD
ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED


RF OUTPUT
ALARMS OUT
T4.0A FUSE
OPTICAL INPUT
12V DC INPUT
RF GAIN ADJUST
AFL PART NO. : 60-166304
1A PRODUCTION ISSUE 15/05/06 MNR
No DESCRIPTION DATE BY
ISSUE
THIRD ANGLE PROJECTION
TITLE
MASTER SITE F/O RX SHELF
OUTLINE DRAWING
CUSTOMER
DRAWING.No
60-166394
A3
Aerial Facilities Limited
England
Tel : 01494 777000
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ONE DECIMAL PLACE ± 0.3mm
TWO DECIMAL PLACES ± 0.1mm
SCALE
1:3
DRAWN MNR DATE 15/05/06
CHKD RB APPD GD
ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED

3.16 Master Site Racks Parts List

AFL Part No.	Part Description	Qty.
60-166103	AIU DOWNLINK CHANNEL SHELF	2
60-166104	AIU UPLINK CHANNEL SHELF	2
60-166301**	**MASTER SITE F/O INTERFACE PRESTON**	**1**
80-054020	600mm DEEP SUPPORT BRACKET	18
91-030002	N ADAPTOR PANEL FEMALE:FEMALE	1
91-100001	SMA PLUG RG223.RG58 %	16
92-120009	M20 IP68 CABLE GLAND	2
97-500059	SCHROFF BUSBAR 2 WAY INSULATED 1.9m	1
97-500060	SCHROFF BUSBAR MOUNTING KIT	2
97-500175	ELDON 43U 600 x 600 RACK (VENTED LID)	1

Note: The shelf marked ** will be labelled 60-166401 in the OCC master site rack; they are electrically similar; the different part numbers merely signify in which rack the shelf resides.

4. INSTALLATION & COMMISIONING

4.1 Initial Installation Record

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

4.2 Antenna Installation & Gain Calculations

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

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

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

4 Ensure that the mobile facing antenna has at least 70 dB isolation from the nearest mobile. (This is normally easily achievable when using a leaky feeder antenna, but usually requires positional adjustment when using a Yagi.)

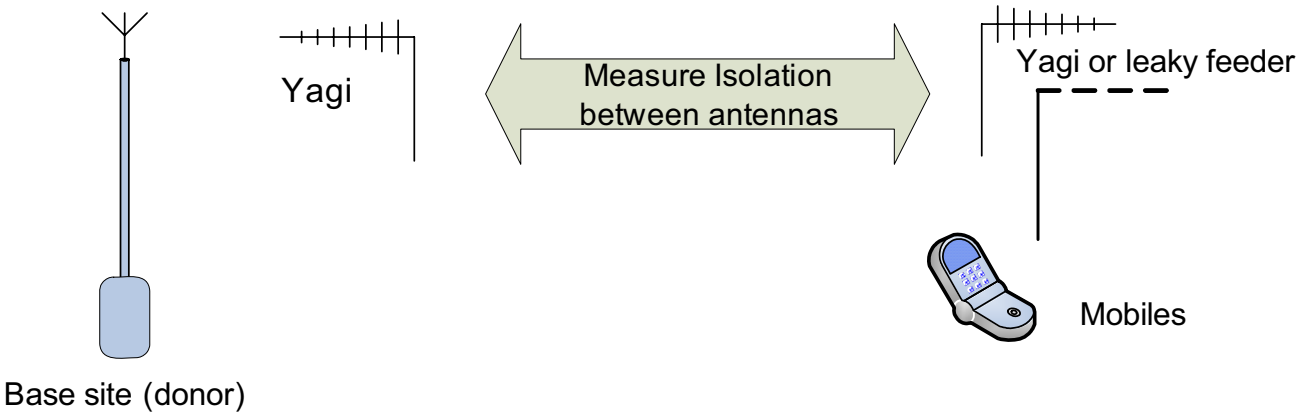
5 The Cell Enhancer gain is fixed by setting the attenuation in each path (uplink and downlink) between the first two amplifier stages (see markings within the Cell Enhancer or layout drawings for the exact attenuator locations). Note that the uplink (mobile to base) and downlink (base to mobile) path gains are set independently. This allows the paths to have different gains if required to set the correct output power levels. The attenuation added into the path is a direct reflection of the active switch positions, i.e. switch 2 (2dB) and switch 4 (8dB) would add 10dB into the path.

6 It is recommended that the gains are set such that the Downlink channel output levels from the Cell Enhancer are typically +20dBm.

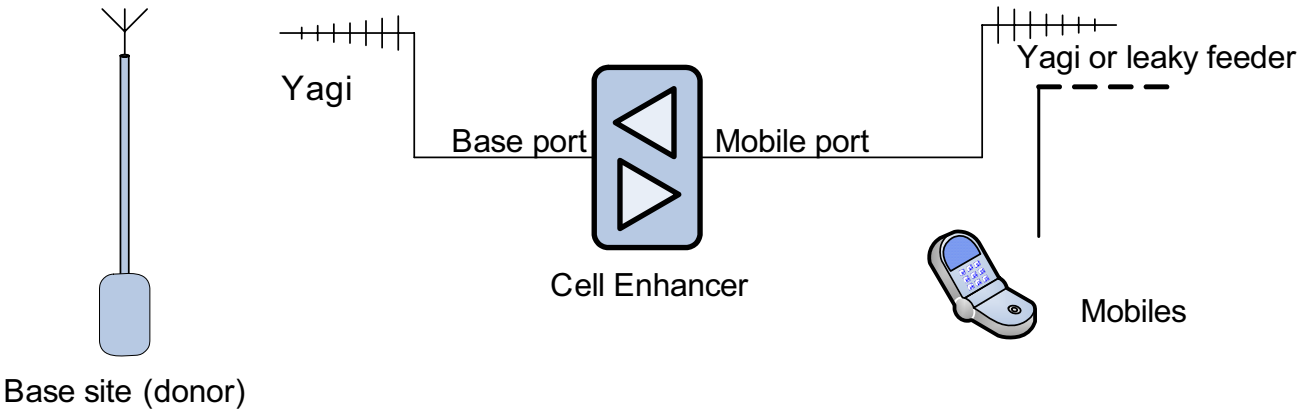
(Input level **+** Gain **=** Output level).

4.3 Antenna Isolation

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



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



4.4 Rack Mounted Equipment

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

The equipment must be located on a flat, level surface that is made from a material suitable for bearing the weight of the rack assemblies. 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 front doors of each rack must be able to open fully. In this AFL system, all RF, optical and power interfaces are located on the rear panels of the shelves; the cable interfaces to external equipment, mains, LCX feeds, fibre cables etc., is from the floor area.

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

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

4.5 Optical Connections

The optical input and output ports will be located on the appropriate E/O shelf as shown in the rack layout drawing and the system layout drawing. 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 remote sites the fibre transmitters are in the uplink with the receivers in the downlink. Observe optical safety precautions in section 1. when handling fibre optic components.

The individual fibre optic 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 RX 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.

Ensure that connections are kept clean and are fully tightened.

4.6 Wall Mounted Equipment

The procedure for installing and commissioning a wall-mounted Bi-Directional Amplifier unit is generally as follows:

3 Fix the unit in the chosen position. Ensure the mounting site is a straight, smooth, perpendicular surface (brick or concrete recommended). Mounting bracket centres/dimensions will be found in the specifications section (3.3). After fixing, mechanically test the installation before proceeding.

4 Fix the two antennas (antenna isolation should already have been performed see section 4.2) and connect them to the BDA.

5 Connect a suitable mains and/or battery power supply to the unit.

6 Connect the alarm interface connectors.

7 Calculate the attenuation settings required for the uplink and the downlink paths, and set the attenuators as described elsewhere in this document.

8 Double-check all RF and power connections ***before*** switching the BDA mains on with the small switch located inside the unit on the lower right hand side of the case.

9 Alarms may not settle for several seconds after switch-on, but they should extinguish after a short time (up to 15 seconds).

Make test calls via the equipment to ensure correct operation, if possible monitoring the signal levels during these calls to ensure that the uplink and downlink RF levels are as anticipated.

4.7 RF Connections

Care must be taken to ensure that the correct connections are made with particular attention made to the optical TX/RX ports.

Ensure that connections are kept clean and are fully tightened.

4.8 RF Commissioning

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

To commission the system the test equipment detailed in Section 5.1 will be required.
Using the system diagrams and the end-to-end test specification, the equipment should be tested to ensure correct operation.

On initial power up the system alarm indicators on the front panels of the equipment should be checked. A red LED illuminated indicates a fault in that particular shelf that must be investigated before proceeding with the commissioning. A green LED on each shelf illuminates, to indicate that the power supply is connected to the shelf.

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

5. FAULT FINDING / MAINTENANCE

5.1 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.

5.2 Basic Fault Finding

In the event that the performance of the system is suspect, a methodical and logical approach to the problem will reveal the cause of the difficulty. The system consists of separate modules in a wall-mounted 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 mobile radio equipment to the base station is referred to as the uplink.

The first fault finding 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 LEDs. The green LED on the door should be illuminated, while the red alarm indicator should be off. If an alarm is on, then that individual module must be isolated and individually tested against the original test specification. The individual amplifier units have a green LED showing through a hole in their cover/lid, which is illuminated if the unit is working correctly. (Without active power supplies there can be no alarm LED indicators, however without DC power, the fail-safe summary alarm system [normally closed relay contacts] will be an open circuit, thereby activating any externally connected system.)

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.

5.3 Quick Fault Checklist

All AFL equipment is individually tested to specification prior to despatch. Failure of this type of equipment is not common. Experience has shown that a large number of fault conditions relating to 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/ports 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 faults at the base station.
Modems fitted with incorrect software configuration/and or PIN No.'s.
Changes to channel frequencies and inhibiting channels.
Hand held radio equipment not correctly set to repeater channels.
Hand held radio equipment not correctly set to base station.

5.4 Downlink

Confirm that there is a signal at the expected frequency and strength from the base station(s). 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.

5.5 Uplink

Testing etc. of the uplink paths is similar to the downlink paths, except for the frequencies involved.

5.6 Fault repair

Once a faulty component has been identified, a decision must be made on the appropriate course to carry out a repair. A competent engineer can quickly remedy typical faults such as faulty connections or cables. The exceptions to this are cable assemblies connecting bandpass filter assemblies (duplexers) 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.
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 antennas and base stations that may be faulty or may have been damaged.

5.7 Service Support

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

5.8 Care of Modules

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. Good engineering practices should be observed at all times.

To prevent damage to a module, it must be withdrawn/inserted with care.

5.9 Module Removal (LNAs, general procedure):

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

1) Remove power to the unit
2) Remove all 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.

5.10 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.
3) Replace retaining screws (if any).
4) Double-check all connections before applying power.

5.11 Power Amplifiers

1) Remove power to the unit. (Switch off at mains/battery)

2) Disconnect multi-way alarm ‘D’ type connector

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

4) 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.

5.12 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 (D type connector).
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

Test equipment should always be used to verify the performance of any new module fitted to the system before broadcasting in the public domain.

5.13 Module Transportation:

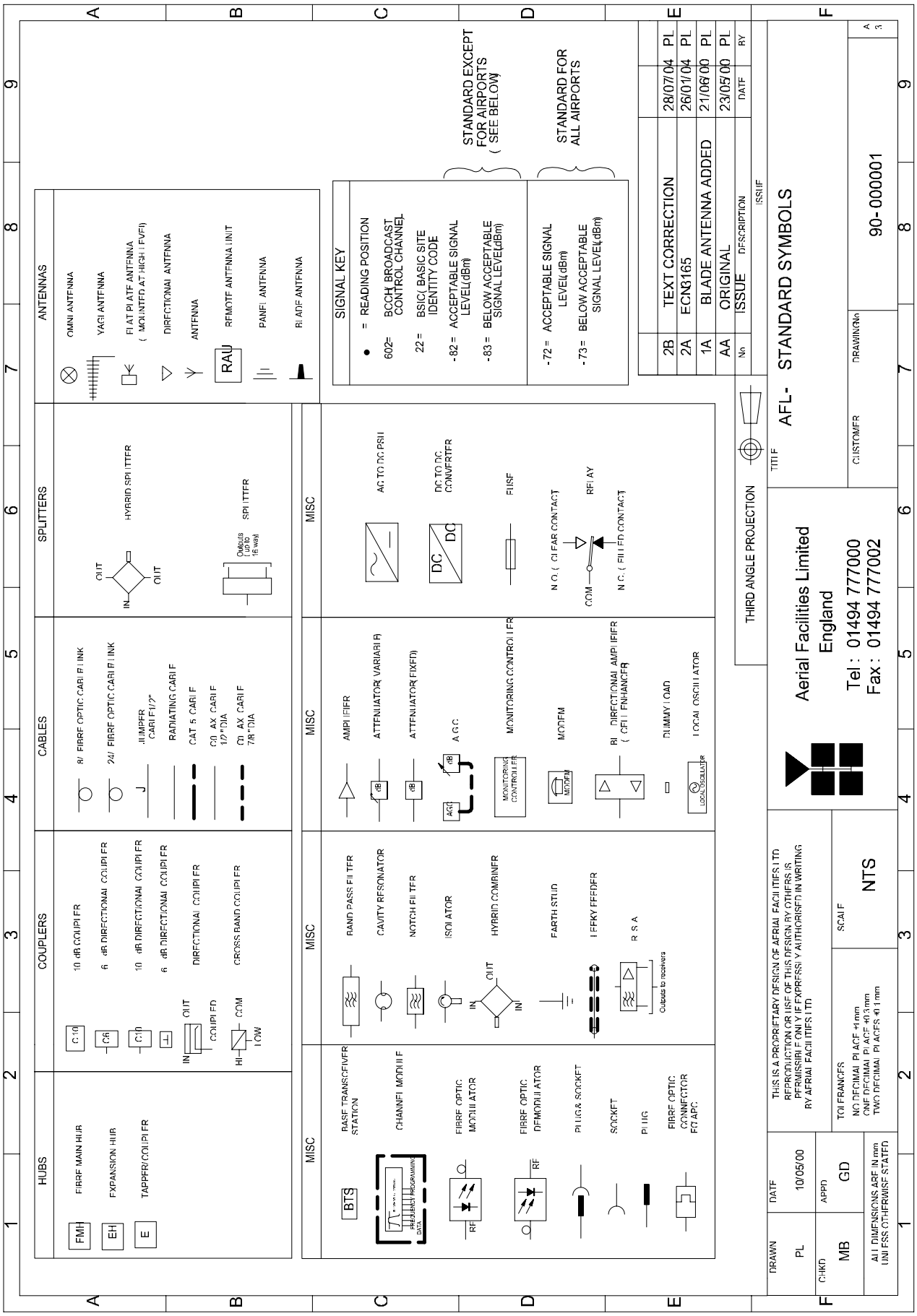
To maintain the operation, performance and reliability of any module it must be stored and transported correctly. Any module not installed in a whole system must be kept in an anti-static bag or container. Any module sent back to AFL for investigation/repair must be so protected. Please contact AFL's quality department before returning a module.

6 APPENDIXES

6.1 Glossary of Terms used in this document

Repeater or Cell Enhancer	A Radio Frequency amplifier which can simultaneously amplify and re-broadcast Mobile Station and Base Transceiver Station 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 Enhancement Management System
C/NR	Carrier-to-Noise Ratio
DAB	Digital Audio Broadcasting
DC	Direct Current
Downlink (D/L)	RF signals RX from the BTS to the Master Site
FO	Fibre Optic
GND	Ground
ID	Identification Number
LED	Light Emitting Diode
LCX	Coaxial Leaky Feeder
LNA	Low Noise Amplifier
LPA	Low Power Amplifier
MOU	Master Optical Unit
M/S	Master Site
MS	Mobile Station
MTBF	Mean Time Between Failures
N/A	Not Applicable
N/C	No Connection
OFR	On Frequency Repeater
OIP3	Output Third Order Intercept Point = RF_{out} +(C/I)/2
PA	Power Amplifier
RF	Radio Frequency
RSA	Receiver/Splitter Amplifier
RX	Receiver
S/N	Serial Number
TTL	Transistor-Transistor Logic, a common type of digital circuit.
TX	Transmitter
Uplink (U/L)	RF signals transmitted from the MS to the BTS
VSWR	Voltage Standing Wave Ratio
WDM	Wave division multiplex

6.2 AFL RF Module Drawing Key



6.3 EC Declaration of Conformity

Aerial Facilities Limited

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

Aerial Facilities Limited
Aerial House
Asheridge Road
Chesham
Buckinghamshire HP5 2QD
United Kingdom

CE0086

DECLARES, UNDER OUR SOLE RESPONSIBILITY THAT THE FOLLOWING PRODUCT:

PRODUCT PART NO[S]	60-166101
PRODUCT DESCRIPTION	Baltimore Transit radio repeaters

IN ACCORDANCE WITH THE FOLLOWING DIRECTIVES:

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

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

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

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

B S BARTON
TECHNICAL DIRECTOR

DATE: 16/02/2006

Registered Office: Aerial House, Asheridge Road, Chesham, Buckinghamshire, HP5 2QD England Registered No. 4042808 (England)
www.aerialfacilities.com

6.4 Amendment List Record Sheet

Issue No.	Date	Incorporated by	Page Nos. Amended	Reason for new issue
A	09/02/2006	CMH		1st Draft
1		CMH		1st Issue

Document Ref:-60-166101HBKM