2. OVERVIEW/ SYSTEM DESCRIPTION

2.1 General System Description

The Weehawken tunnel radio system is designed to amplify various bands of radio frequencies, in either channelised or band selective modes. This handbook is dedicated to the UHF radio repeating system. All the hardware is built into standard 19" rack mounted cabinets which have an environmental IP rating of 54.

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

3.4 Weehawken UHF System Frequencies Look-up Table

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

4. UHF CELL ENHANCERS

4.1 Three Channel UHF Cell Enhancer 50-118101

4.1.1 Three Channel UHF Cell Enhancer Description

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

All amplifiers have built-in alarms which are configured as a summary, volt-free relay contact pair terminating at pins 1 & 2 on the 'D' type alarm connector.

4.1.2 Three Channel UHF Cell Enhancer Electrical Specifications

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

4.1.3 Three Channel UHF Cell Enhancer Mechanical Specifications

PARAMETER		SPECIFICATION
Rack	Height:	Standard Eurorack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelves:	Height:	8U
	Width:	19" (482.6mm)
	Depth:	<400mm(excluding heatsinks, connectors, handles and feet)
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Weight:		20kg (approximately)
Humidity:		5 – 95% non-condensing
RF Connectors:		N type female
Environmental Protection:		IP54
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Supply Cable:		Unit supplied with suitable supply input leads, connector and specified length of cable

4.2 UHF Simplex Cell Enhancer (50-118201)

4.2.1 UHF Simplex Cell Enhancer Description

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

4.2.2 UHF Simplex Cell Enhancer Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		460.3-460.7MHz (Downlink)
		465.3-465.7MHz (Uplink)
Bandwidth:		0.4MHz
Gain:		>90dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>10.0Watts
Downlink Power:		>20.0Watts (x2)
IP3:	Uplink	+40dBm
	Downlink	+54dBm
Downlink AGC gain:		10dB
Downlink AGC level:		-22dBm
Uplink AGC gain:		14dB
Uplink AGC level:		-8dBm
Noise Figure:		<6dB (at maximum gain)
AGC:		Fitted in channel modules
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted: (volt-free contacts/TTL)		1 Downlink amplifiers
		2 Uplink amplifiers
		3 Each channel module

4.3 One Channel UHF Cell Enhancer (50-118301)

4.3.1 One Channel UHF Cell Enhancer Description

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

4.3.2 One Channel UHF Cell Enhancer Technical Specification

PARAMETER		SPECIFICATION
Frequencies:		470.3125MHz (Downlink)
		473.3125MHz (Uplink)
Gain:		>90dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink Power:		>1.0Watts
Maximum uplink output:		+30.8dBm
Downlink Power:		>5.0Watts
Maximum downlink output power:		+37.5dBm
IP3:	Uplink	+44dBm
	Downlink	+50dBm
Downlink Ch. module AGC level:		-17dBm
Uplink Ch. module AGC level:		-8dBm
Noise Figure:		<6dB (at maximum gain)
AGC:		Fitted in channel modules
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia:	Painted to RAL 7035
Alarms Fitted: (volt-free contacts/TTL)		1 Downlink amplifiers
		2 Uplink amplifiers
		3 Each channel module

5. UHF PASSIVE SYSTEM COMPONENTS

5.1 UHF Triplexer (80-230701)

5.1.1 UHF Triplexer Description

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

No alarms are fitted to passive shelves.

5.1.2 UHF Triplexer Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		460.3-460.7MHz (80-230701/1)
		471.5MHz (80-230701/1)
		470.3125MHz (80-230701/1)
		465.3-465.7MHz (80-230701/2)
		471.5MHz ±300kHz (80-230701/2)
		473.3125MHz ±300kHz(80-230701/2)
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted:		None

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

5.2.1 UHF Hybrid Cross-Band Coupler Description

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

No alarms are fitted to passive shelves.

5.2.2 UHF Hybrid Cross-Band Coupler Shelf Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		>380MHz (UHF pass)
		<250MHz (VHF pass)
VSWR:		better than 1.5:1
Insertion loss:		<0.5dB
Rejection:		>30dB
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Finish:	Case:	Alocrom 1200
	Heatsinks:	Matt black
	Handles:	Silver anodised alloy
	Fascia	Painted to RAL 7035
Alarms Fitted:		None

6. POWER SUPPLIES & ALARMS

6.1 UHF Power Supply (80-231301)

6.1.1 UHF Power Supply Description

The power supply shelves are separate for the VHF/UHF and 800MHz cell enhancers. The VHF/UHF supply shelf is a 24V DC shelf which supplies six, 24Volt XLR connector outputs at a maximum total output power of 800Watts DC. These DC outputs are fused at a 10Amp rating although four of the six DC outputs will be drawing less than 5Amps at any one time.

6.1.2 UHF Power Supply Technical Specification

PARAMETER		SPECIFICATION
Input:		110V AC @50/60Hz (single port)
Outputs:		6 x 24V DC @ 10A each
Front panel indicators:		(x 2) Green LED for 'PSU1/PSU2 ON''
Fuses		1 x 10A each outlet socket
DC Socket		XLR
Temperature range	operational:	-10°C to +55°C
	storage:	-40ºC to +70ºC
Alarmed devices:		Either PSU failure
Alarm interface (volt-free contacts):		'D' type alarm connector, pins 1 & 2
MTBF:		>50,000 hours
Earthing:		M8 stud

6.1.3 UHF Power Supply System Diagram

Not available at the time of compiling this document.

6.2 Alarm/Monitor Shelf (80-231303)

6.2.1 Alarm/Monitor Shelf Description

The alarm shelf acts as an alarm concentrator for all the alarms in the system. Firstly, within each shelf containing active components, the individually alarmed modules are 'summed' and presented to that shelves' 9-way alarm connector as a volt-free relay contact pair. These alarm contact pairs are wired to the krone block in the lower rack space and from there the pairs are presented to the alarm shelf. At the alarm shelf the pairs are summed together to form an overall system alarm. In this way a system alarm may be broken down to scrutinise the shelf alarm and ultimately to the individual modules' alarms.
This shelf has its own dedicated mains-driven power 12V DC supply.

As all the alarms in the system are 'held closed loops', should any power supply fail, the main system alarm will be triggered.

6.2.2 Alarm/Monitor Shelf Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		12V (floating earth)
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		25 Way 'D' Connector
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C

7. SUB-UNIT MODULES

Note that the sub unit modules are tabled in part number order – the modules pertinent to any particular shelf will be found in the parts list under the heading of that shelf.

7.1 Bandpass Filter (02-013401)

7.1.1 Description

The bandpass filters are multi-section designs with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of combline design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports. Being passive devices, the bandpass filters should have an extremely long operational life and require no maintenance. Should a filter be suspect, it is usually most time efficient to replace the module rather than attempt repair or re-tuning.

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

7.1.2 Technical Specification

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

7.2 Tx Hybrid Coupler (05-000101)

7.2.1 Description

The Hybrid Combiner used is a device for accurately matching two or more RF signals to single or multiple ports, whilst maintaining an accurate 50Ω load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum. Any unused ports will be terminated with an appropriate 50Ω load.

7.2.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		f_o ± 10% (50 – 500 MHz)
Bandwidth:		f_o ± 10%
Inputs/Outputs:		2 each
Insertion Loss:		<3.3 dB
Isolation between Input/Output ports:		>27 dB
Return Loss (VSWR) – Input/Output:		1.3:1
Impedance:		50 Ω
Temperature range	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
MTBF:		>180,000 hours
Power Rating – Splitter:		Up to 150 Watts (load dependant)
Power Rating – Combiner:		Available up to 100 Watts
Environmental:		IP54
Connectors:		'N' female
Dimensions:		118 x 102 x 35 mm (incl. connectors)
Weight:		0.5 kg

7.3 3dB UHF Splitter (05-002603)

7.3.1 Description

The 3dB Splitter/Combiner used is a device for accurately matching two or more RF signals to single or multiple ports, whilst maintaining an accurate 50Ω load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum. Any unused ports will be terminated with an appropriate 50Ω load.

7.3.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency range:	380 - 520 MHz
Bandwidth:	140 MHz
Inputs:	1
Outputs:	2
Insertion loss:	3.5 dB (typical)
Isolation:	>18 dB
Return Loss (VSWR) – Input:	Better than 1.3:1
Return Loss (VSWR) – Output:	Better than 1.3:1
Impedance:	50 ς
Power Rating – splitter:	20 Watts
Power Rating – combiner:	0.5 Watt
Connectors:	SMA female
Size:	54 x 44 x 21 mm (including connectors)
Weight:	200 gm (approximately)

7.4 1 Watt 3dB Broadband Splitter (05-002901)

7.4.1 Description

The 1 Watt, 3dB Splitter/Combiner used is a device for accurately matching two or more RF signals to single or multiple ports, whilst maintaining an accurate 50Ω load to all inputs/outputs and ensuring that the VSWR and insertion losses are kept to a minimum. Any unused ports will be terminated with an appropriate 50Ω load.

7.4.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency Range:	100 - 520 MHz
Bandwidth:	380 MHz
Inputs:	1
Outputs:	2
Insertion Loss:	3.5 dB (typical)
Isolation:	>18 dB
Return Loss (VSWR) – Input:	Better than 1.3:1
Return Loss (VSWR) – Output:	Better than 1.3:1
Impedance:	50 ς
Power Rating – Splitter:	20 Watts
Power Rating – Combiner:	1.0 Watt
Connectors:	SMA female
Size:	54 x 44 x 21 mm (including connectors)
Weight:	200 gm (approximately)

7.5 Crossband Coupler (07-005701)

7.5.1 Description

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

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

7.5.2 Technical Specification

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

7.6 Crossband Coupler (07-005705)

7.6.1 Description

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

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

7.6.2 Technical Specification

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

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

7.7.1 General Application

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

7.7.2 Switched Attenuators

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

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

7.8.1 Description

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

7.8.2 Technical Specification, 11-007302

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

7.8.3 Technical Specification, 11-007402

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

7.8.4 LNA 'D' Connector Pin-out details

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

7.9 1Watt Low Power Amplifier (11-007901)

7.9.1 Description

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

7.9.2 Technical Specifications

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

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

7.10.1 Description

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

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

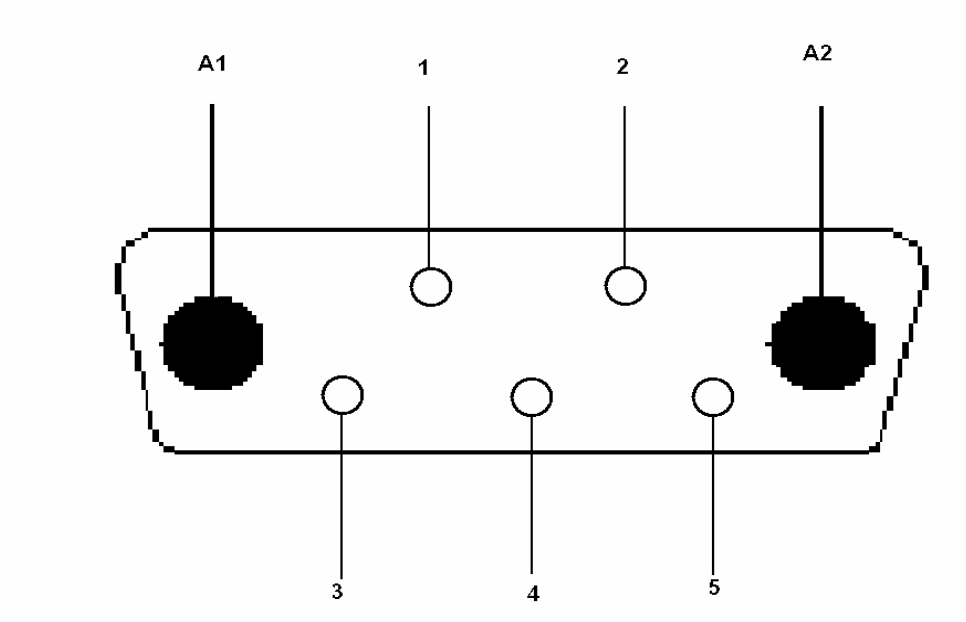
7.10.2 Technical Specification

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

7.10.3 PA 7-Way Connector Pin-outs

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

7.10.4 PA Connector Pin-Outs



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

7.11.1 Description

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

7.11.2 Technical Specification

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

7.11.3 PA 'D' Connector Pin-out details

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

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

7.12.1 Description

The operating frequency for each channel in each repeater is programmed by 16 DIL (Dual In Line) switches. The programming switches are mounted in the Channel Control Module. The Channel Selectivity Modules are connected to the Channel Control Module via multi-way ribbon cables.

Adjacent to the DIL switches for each channel is a toggle switch to turn on and off individual channels as required. A green LED indicates the power status of each channel.

A red LED shows the alarm condition for each channel. An illuminated alarm LED indicates that the synthesiser has not achieved phase lock and that the module is disabled. There is a problem which requires investigation, often a frequency programmed outside the operating frequency range.

The following information is necessary before attempting the programming procedure.

1) operating frequency
2) synthesiser channel spacing (step size)
3) synthesiser offset (IF)

7.12.2 Programming Procedure

Check that the required frequency falls within the operational frequency limits of the Cell Enhancer.

For each channel required, subtract the synthesiser offset from the required operating frequency and record the resulting local oscillator frequency.

Divide each local oscillator frequency by the channel spacing and check that the result is an integer (i.e: no remainder).

If the synthesiser division ratio is not an integer value, check the required operational frequency and repeat the calculation checking for mistakes.

Convert the required local oscillator frequency to synthesiser programming switch state patterns according to the following table.

7.12.3 12.5kHz step size switch functions

Switch Number	Synthesiser offset added when switch in UP position
1	+12.5kHz
2	+25kHz
3	+50kHz
4	+100kHz
5	+200kHz
6	+400kHz
7	+800kHz
8	+1.6MHz
9	+3.2MHz
10	+6.4MHz
11	+12.8MHz
12	+25.6MHz
13	+51.2MHz
14	+102.4MHz
15	+204.8MHz
16	+409.6MHz

7.12.4 25kHz step size switch functions

Switch Number	Synthesiser offset added when switch in UP position
1	+25kHz
2	+50kHz
3	+100kHz
4	+200kHz
5	+400kHz
6	+800kHz
7	+1.6MHz
8	+3.2MHz
9	+6.4MHz
10	+12.8MHz
11	+25.6MHz
12	+51.2MHz
13	+102.4MHz
14	+204.8MHz
15	+409.6MHz
16	+819.2MHz

7.12.5 Programming Example

Frequency required: 454.000MHz

Channel spacing: 12.5kHz

Synthesiser offset: -21.4MHz

The Local Oscillator frequency is therefore:
454.000 – 21.4 = 432.600MHz

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

$$\frac{432.600}{0.0125} = 34608$$

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

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

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

7.12.6 17-002101 Controller Module DIP Switch Connector Data

IDC PIN	25-way Connector	Function (12.5kHz steps)
1	**13**	**Freq. bit 1 (12.5kHz)**
2	**25**	**Freq. bit 2 (25kHz)**
3	**12**	**Freq. bit 3 (50kHz)**
4	**24**	**Freq. bit 4 (100kHz)**
5	**11**	**Freq. bit 5 (200kHz)**
6	**23**	**Freq. bit 6 (400kHz)**
7	**10**	**Freq. bit 7 (800kHz)**
8	**22**	**Freq. bit 8 (1.6MHz)**
9	**9**	**Freq. bit 9 (3.2MHz)**
10	**21**	**Freq. bit 10 (6.4MHz)**
11	**8**	**Freq. bit 11 (12.8MHz)**
12	**20**	**Freq. bit 12 (25.6MHz)**
13	**7**	**Freq. bit 13 (51.2MHz)**
14	**19**	**Freq. bit 14 (102.4MHz)**
15	**6**	**Freq. bit 15 (204.8MHz)**
16	**18**	**Freq. bit 16 (409.6MHz)**
17	**5**	**Module alarm**
18	**17**	**Gain bit 1**
19	**4**	**Gain bit 2**
20	**16**	**Gain bit 3**
21	**3**	**Gain bit 4**
22	**15**	**+5V**
23	**2**	**0V**
24	**14**	**Switched 12V**
25	**1**	**0V**
26	**---**	**---**

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

7.13.1 Description

The channel selectivity module is employed when the Cell Enhancer requirement dictates that very narrow bandwidths (single operating channels), must be selected from within the operating passband. One channel selectivity module is required for each channel.

The Channel Selectivity Module is an Up/Down frequency converter that mixes the incoming channel frequency with a synthesised local oscillator, so that it is down-converted to an Intermediate Frequency (IF) in the upper HF range. An eight pole crystal filter in the IF amplifier provides the required selectivity to define the operating passband of the Cell Enhancer to a single PMR channel. The same local oscillator then converts the selected IF signal back to the channel frequency.

Selectivity is obtained from a fixed bandwidth block filter operating at an intermediate frequency (IF) in the low VHF range. This filter may be internal to the channel selectivity module (Crystal or SAW filter) or an externally mounted bandpass filter, (LC or Helical Resonator). Various IF bandwidths can therefore be accommodated. A synthesized Local Oscillator is employed in conjunction with high performance frequency mixers, to translate between the signal frequency and IF.

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

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

Alarms within the module inhibit the channel if the synthesised frequency is not locked. The synthesiser will not usually go out of lock unless a frequency far out of band is programmed.

The channel selectivity module is extremely complex and, with the exception of channel frequency programming within the design bandwidth, it cannot be adjusted or repaired without extensive laboratory facilities and the necessary specialised personnel. If a fault is suspected with any channel selectivity module it should be tested by substitution and the complete, suspect module should then be returned to AFL for investigation. The channel selective modules fitted to the VHF cell enhancers in the Weehawken system are all hard-wired and therefore not adjustable, however, the modules fitted to the UHF and 800MHz enhancers have DIP switch controller modules fitted, allowing the set frequency to be changed on site. There is no functionality to change the frequencies remotely.

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

7.14.1 Description

The General Purpose Relay Board allows the inversion of signals and the isolation of circuits. It is equipped with two dual pole change-over relays RL1 and RL2, with completely isolated wiring, accessed via screw terminals.
Both relays are provided with polarity protection diodes and diodes for suppressing the transients caused by "flywheel effect" which can destroy switching transistors or induce spikes on neighbouring circuits. It's common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.
Note that the board is available for different voltages (12 or 24V) depending on the type of relays fitted at RL1 and RL2.

7.14.2 Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		8 to 30V (floating earth)
Alarm Threshold:		Vcc - 1.20 volt ±15%
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		Screw terminals
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C

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

7.15.1 Description

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

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

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

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

7.16.1 Description

The power supply unit is a switched-mode type capable of supplying 24V DC at 17.0Amps continuously. Equipment of this type typically requires approximately 10.0 Amps at 24V DC, so the PSU will be used conservatively ensuring a long operational lifetime.

No routine maintenance of the PSU is required. If a fault is suspected, then the output voltage from the power supply may be measured on its output terminals. This is typically set to 24.5V using the multi-turn potentiometer mounted close to the DC output studs on the PSU PCB.

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

7.16.2 Technical Specification

AC Input Supply	
Voltages:	110 or 220V nominal
	90 to 132 or 180 to 264V (absolute limits)
Frequency:	47 to 63Hz
DC Output Supply:	
Voltage:	24V DC (nominal)
	20 to 28V (absolute limits)
Maximum current:	17A