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 VHF radio repeating system. All the hardware (except the River Portal remote BDA) 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 (VHF) 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 rack cabinet.

3.5 Weehawken VHF System Frequencies Look-up Table

Agency	Channel Number	Uplink Tx	Downlink Rx
Jersey City Medical Center - EMS	VHF CHN 1	153.7850	153.7850
North Hudson Regional Fire and Rescue	VHF CHN 2	154.3250	154.3250
NJ Statewide Police (SPEN)	VHF CHN 3	154.6800	154.6800
Jersey City Medical Center - EMS	VHF CHN 4	155.2350	155.2350
Jersey City Medical Center - EMS	VHF CHN 5	155.2800	155.2800
North Hudson Regional Fire and Rescue	VHF CHN 6	158.8650	154.1450
Weehawken Township	VHF CHN 7	159.0900	159.0900
Weehawken Township	VHF CHN 8	159.2100	159.2100
New Jersey Transit Police Dept.	VHF CHN 9	161.5200	160.8300

4. BAND SELECTIVE VHF CELL ENHANCERS

4.1 VHF Simplex BDA (55-154701)

4.1.1 VHF Simplex BDA Description

The simplex shelves are part of the VHF amplification and have crystal filters instead of bandpass filters to set bandwidths. There are two downlink bands and three uplink bands, the downlink paths having isolators fitted to each of the 5Watt output stages to prevent two outputs from interfering with each other. 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.

Note that the control circuitry is omitted from the system diagram for reasons of clarity and simplification.

4.1.2 VHF Simplex BDA Electrical Specification

PARAMETER		SPECIFICATION
Frequency range:		153.75-155.3MHz (Downlink1)
		159.0-161.0MHz (Downlink2)
		153.75-155.3MHz (Uplink1)
		158.85-159.3MHz (Uplink2)
		161.5-162.0MHz (Uplink)
Gain:		>90dB
Gain Adjustment:		0 – 15dB (in 1dB step)
Uplink Power:		>5.0Watts
Downlink Power:		>5.0Watts
IP3:	Uplink	+48dBm
	Downlink	+48dBm
Noise Figure:		<6dB
AGC level:		-2dBm (uplink & downlink)
Channel module gain:		23dB (downlink)
		24dB (uplink)
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 U/L amplifiers
		2 D/L amplifiers
		3 Channel module

4.1.3 VHF Simplex BDA Mechanical Specification

PARAMETER		SPECIFICATION
Rack	Height:	Standard Eurorack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelves:	Height:	3U
	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:		<15kg
Humidity:		10 – 90% 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 (where appropriate)

4.2 VHF Duplex BDA (55-154801)

4.2.1 VHF Duplex BDA Description

The duplex shelves are part of the VHF amplification and like the simplex shelves, have crystal filters instead of bandpass filters to set bandwidths. There are two downlink bands and three uplink bands, the downlink paths having isolators fitted to each of the 5Watt output stages to prevent reflections from interfering with the other channel.
The uplink channel module has a dedicated noise muting circuit fitted externally to the channel module which operates when the downlink path is active.

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.

4.2.2 VHF Duplex BDA Electrical Specification

PARAMETER		SPECIFICATION
Frequency range:		153.75-155.3MHz (Downlink1)
		159.0-161.0MHz (Downlink2)
		153.75-155.3MHz (Uplink1)
		158.85-159.3MHz (Uplink2)
		161.5-162.0MHz (Uplink)
Gain:		>90dB
Gain Adjustment:		0 – 15dB (in 1dB step)
Uplink Power:		>5.0Watts
Downlink Power:		>5.0Watts
IP3:	Uplink	+48dBm
	Downlink	+48dBm
Noise Figure:		<6dB
AGC level:		-2dBm (uplink & downlink)
Channel module gain:		23dB (downlink)
		24dB (uplink)
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 U/L amplifiers
		2 D/L amplifiers
		3 Channel modules

4.2.3 VHF Duplex BDA Mechanical Specification

PARAMETER		SPECIFICATION
Rack	Height:	Standard Eurorack
	Width:	19" (482.6mm)
	Depth:	600mm (800 optional)
Shelves:	Height:	3U
	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:		<15kg
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 (where appropriate)

5. VHF SPLITTERS/COMBINERS

5.1 VHF Downlink Crystal Splitter (80-230801)

5.1.1 VHF Downlink Crystal Splitter Description

The crystal splitter shelf is used in the downlink path to isolate the VHF channel frequencies at the inputs to the cell enhancers which amplify them. These frequencies are initially processed by bandpass filters which eliminate spurious frequencies prior to being passed by the crystal filters which have a much narrower bandwidth than the filters before amplification by their respective channel selective modules.
Being passive shelves, no alarms are present.

5.1.2 VHF Downlink Crystal Splitter Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
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

5.2 VHF Downlink Combiner (80-230901)

5.2.1 VHF Downlink Combiner Description

The VHF downlink combiner shelf is the interface between the downlink VHF cell enhancers and the tunnel leaky feeder outputs. It consists of a number of two-to-one hybrid couplers which combine the outputs to two bandpass filters which only allow the specified VHF band to pass.
Being a passive shelf, no alarms are present.

5.2.2 VHF Downlink Combiner Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
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

5.3 VHF Uplink Crystal Splitter (80-231001)

5.3.1 VHF Uplink Crystal Splitter Description

The uplink VHF crystal splitter shelf is the complement to the downlink crystal combiner shelf and uses the uplink frequency bands instead of the downlink bands.
Being a passive shelf, no alarms are present.

5.3.2 VHF Uplink Crystal Splitter Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
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

5.4 VHF Uplink Combiner (80-231101)

5.4.1 VHF Uplink Combiner Description

This shelf is the interface between the uplink VHF cell enhancers and the Tx antenna output port. The outputs of all the cell enhancers are first combined by combinations of two-to- one hybrid combiners which feed a triplexer filter array, which in turn, couple these three signals to the Tx antenna output port.
This being a passive shelf, no alarms are present.

5.4.2 VHF Uplink Combiner Technical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		153.75-155.30MHz (D/L)
		159.0-161.0MHz (D/L)
VSWR:		better than 1.5:1
Insertion loss:		<1.5dB
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/VHF Power Supply (80-231301)

6.1.1 UHF/VHF 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/VHF 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/VHF 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 VHF High Band Bandpass + Notch Filter (01-003105)

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 helical 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. The bandpass filters fitted here have a notch filter as the final tuned element in their construction to completely eliminate unwanted frequencies close to the band edge.
The notch reject filters should require no routine maintenance, being totally passive devices. If a filter is suspected of failure, no invasive measures are recommended as even opening the case of the device could render it unusable.

7.1.2 Technical Specification

PARAMETER		SPECIFICATION
Passband:		155 - 160 MHz
Insertion Loss:		1.6 dB (typical)
RF Connectors:		SMA
Power Rating:		100 Watt
Impedance:		50Ω
VSWR:		Better than 1.2:1
Temperature range	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:		348x102x55mm (case only)

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 3 Port Tx Hybrid Coupler (05-000103)

7.3.1 Description

The transmitter hybrid couplers provide isolation from unwanted reflected frequencies to/from the leaky feeder antennas. They are 4 port devices with the one unused port terminated internally with a 50 Ω dummy load.

Being passive devices, the hybrid couplers should be maintenance free over their entire lifetime and have an extremely high MTBF figure. It is not recommended that the top cover be removed or any of the internal components needlessly touched, since the original factory alignment/tuning would be extremely hard to reproduce in a 'field' environment.

7.3.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency Range:	140-170 MHz
Bandwidth:	±10% of f_o
Insertion Loss:	3.2dB
Impedance:	50Ω
V.S.W.R:	1.2:1
Input to input isolation:	>20dB
Connectors:	Type N Standard
Dimensions:	140 x 120 x 35mm
Power rating:	25Watts
Weight:	0.5kg

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 2-Port RF Isolator (08-930002)

7.5.1 Description

The purpose of fitting an isolator to the output of a transmitter in a multi-transmitter environment is such that each output is afforded a degree of isolation from every other. Were this not to be the case, two simultaneous transmissions could interfere to create intermodulation products, especially in the non-linear power amplifier output stages of the transmitters. Whilst this effect would not affect the intelligibility of the two original transmissions, a further two new transmissions would be created which could themselves cause interference to third party users.

The ferrite isolator is a ferro-magnetic device, which has directional properties. In the forward direction, RF arriving at the input is passed to the output with minimal attenuation. In the reverse direction, RF arriving at the output due to reflected power from a badly matched load, or due to coupling with another transmitter, is routed into an RF load where it is absorbed. The isolator therefore functions to prevent reflected RF energy reaching the power amplifier where it could cause intermodulation products or premature device failure.

7.5.2 Technical Specification

PARAMETER	SPECIFICATION
Frequency range:	100-300MHz
Bandwidth (% of centre frequency):	2
Isolation:	35dB (typical)
Insertion loss:	0.25dB (typical
V.S.W.R:	1.15:1 (typical)
Maximum power:	200Watts (per carrier)
Connector:	SMA
Weight:	200gm (approximately)

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

7.6.1 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.

7.6.2 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.

7.7 3 Stage Amplifier Alarm Board (12-002201)

7.7.1 Description

Amplifier Alarm Boards are fitted to monitor the bias conditions of AFL Class A amplifiers which remain constant in normal operation. Any departure from normal bias conditions is a result of device failure, excess temperature, over-driving or oscillation (excessive power).

In normal operation, the Class A bias circuit of the amplifier develops a constant voltage of 1.20V across the collector current setting resistor. The Amplifier Alarm Board is a window comparator device, which is adjusted to sense a departure from this condition. Several different alarm outputs are provided to simplify interfacing, (Relay Contact, Open Collector, and TTL Logic Levels)

The basic version of the Alarm Board (12-002801) monitors a single amplifier stage. A three-stage version (12-002201) is used on complex amplifiers where three separate comparators have their outputs logically combined to a common output stage. Failure of any one stage will activate the alarms.

Note that the alarm board has a green Light Emitting Diode located near to the centre of the printed circuit board, which is illuminated on 'Good', and extinguished on 'Alarm'. It is therefore a simple matter to identify an active module failure, by searching for an Alarm Board which has its green LED extinguished. A simple test of the alarm board is possible by shorting across the monitor inputs, pins 1 and 2, 3 and 4 or across pins 5 and 6. This last monitor input is inactive if the board has been converted to a two way alarm board. (Refer to relevant amplifier alarm wiring diagram.)

1) Volt-free change over relay contacts.
2) Open collector NPN transistor pulls low on alarm.
3) TTL driver.

The use of precision voltage sources and resistors has eliminated the need for initial adjustment or calibration, and the board will function correctly with a wide variation in power supply voltage (8 to 30 volts, nominal supply is 12 or 24Volts).

There are two selectable link options on the three-way board:

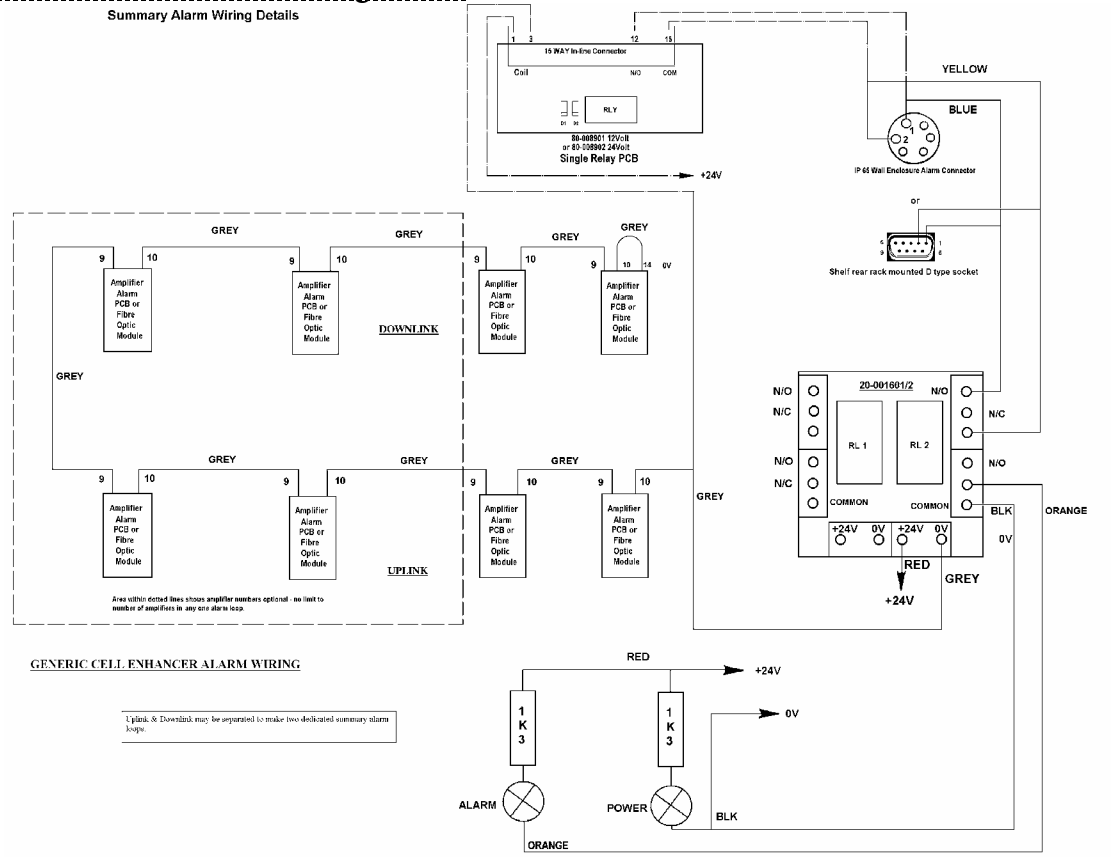
LINK1 - Removed to convert to two-way alarm board.
LINK2 - Removed to isolate 0V from chassis earth.

The one way alarm board only has the 0V isolation link (LINK2) fitted.

7.7.2 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:		15-way 0.1" pitch
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
PCB Size:		74 x 56mm (3 stage)
		54 x 56mm (1 stage)

7.7.3 Generic Alarm Wiring Sketch



7.8 3 Stage Alarm/Simplex/Mute PCB (12-002213)

7.8.1 Description

In systems using simplex channel switching, it is necessary to be able to distinguish between a 'normal' switching operation and erroneous modes where faults in the detector circuitry may cause data errors but not necessarily fire the alarms. The simplex alarm/mute board is designed to differentiate between normal and spurious switching signals for single or multiple stage amplifiers.

7.9 5Watt Low Power Amplifier (12-004902)

7.9.1 Description

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

7.9.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		80-260MHz
Bandwidth:		20MHz (tuned to specificatic
Maximum RF output:		>5.0 Watt
Gain:		40dB
1dB compression point:		+34dBm
3rd order intercept point:		+44dBm
Noise Figure:		<2.4dB
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		500mA @ 24V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.5 kg
Size:		167 x 52 x 25mm

7.10 Dual DC/DC Converter (13-001803)

7.10.1 Description

This unit is employed where it is necessary to derive two fixed voltage power supply rails from some higher voltage. Typically it is used to derive 5, 8, 12 or 15V from a 24V input.

The circuit is based upon a pair of LM257 series variable voltage regulators (LM2576, 12 & 15V & LM2575, 5V), which are each capable of supplying an absolute maximum of 1.5A output current. Note that at full output current, the dissipation of the device must remain within design limits, bearing in mind the voltage which is being dropped across it. The maximum allowable dissipation will also depend on the efficiency of the heatsink on which the device is mounted.

7.10.2 Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		21 – 27V DC
Output voltage:		12V & 12V (typical)
Output current:		1.0A (maximum per o/p)
Connections:		Screw Terminal Block
Temperature range	operational:	-10°C to +60°C
	storage	-20°C to +70°C
PCB Size:		85 x 63mm

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

7.11.1 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)

7.11.2 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.

7.11.3 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

7.11.4 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

7.11.5 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)

7.11.6 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	**---**	**---**

7.12 Channel Selective Modules (17-009143 & 17-009127)

7.12.1 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.

7.13 12 & 24V Relay Boards (20-001601 & 20-001602)

7.13.1 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.

7.13.2 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

7.14 12 & 24V Single Relay Board (80-008901 & 80-008902)

7.14.1 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.

7.15 24V, 400W Power Supply Pack (96-300054)

7.15.1 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.

7.15.2 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