User's Manual

DSPbR Series ™

Rebroadcast Repeater/Booster.

Base Line release 1.0

Australian Provisional Patent Application No. 2009905291

Note:

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions;

    (1) This device may not cause harmful interference, and

    (2) This device must accept any interference received, including interference that may cause undesired operation.

The user is cautioned that changes and/or modifications not approved by the responsible party could void the user's authority to operate the equipment.

Note:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at their own expense.

Note:

Operation of this equipment pursuant to Part 90 of the FCC rules should be identified by selecting "Part 90 Operation" in the GUI Channel Configuration screen, thereby limiting the per-channel RF output power and preventing frequency-translating operation.

Notice

For further information or help with this product contact your nearest RFI sales office or through the following;

Within Australia dial:	1300 000 RFI (1300 000 734)
International:	+61 7 3621 9400
Sales email:	vicsales@rfi.com.au
Technical support email:	support@rfi.com.au

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Revision History

Name	Revision	Date
Hedley Boyd-Moss	A	10/06/2010
Scott Alford	B	10/7/2010

1. GENERAL

1.1 Used abbreviations

ALC	Automatic Level Control
BPF	Band Pass Filter
BPFM	Band Pass Filter Module
BTS	Base Transceiver Station
CAN	Controller Area Network
CAT5/6	Category 5 or 6 (Ethernet cable – standard wiring)
CLI	Command Line Interface
CSC	Central System Controller
DL	Downlink
DSP	Digital Signal Processor
DSPbR	Digital Signal Processor based Repeater
ETSI	European Telecommunication Standards Institute
GPS	Global Positioning System
GUI	Graphical User Interface
IF	Intermediate Frequency
MS	Mobile Station
PSU	Power Supply Unit
Ref Gen	Reference Generator
Rev	Revision
RF	Radio Frequency
RFBE	Radio Frequency Back End
RFFE	Radio Frequency Front End
RSSI	Receive Signal Strength Indication
RTC	Real Time Clock
RU	Rack Units
Rx	Receiver
TLM	Through Line Module
Tx	Transmitter
UL	Uplink
VSWR	Voltage Standing Wave Radio

Table 1 - Abbreviations

1.2 Tables and Figures List

1.3 Health and Safety warnings

Only suitably qualified people should be allowed to install and commission this equipment after comprehending and becoming familiar with all the safety and installation instructions contained in this manual. It will be assumed that a qualified person will have a fundamental knowledge of the objectives and use common sense where safety warnings are not necessary explicit.

The unit is heavy and appropriately considered a two-man lift. Handles are provided on the equipment to assist in removal of the unit from the packaging and during installation.

On unpacking the equipment, familiarise yourself with equipment, reading and following all warning labels attached to the equipment. Please ensure that the warning labels are kept in a legible condition and replace if necessary.

Ensure all general, regional and site-specific installation and safety regulations are adhered to when working on high voltage installations, as well as regulations covering use of tools and personal protective equipment.

It is the responsibility of the network operator or service provider to have in place and implemented, an applicable and legally complaint Heath and Safety policy, detailing prevention measures to avoid health hazards which may be associated with radiation from the antenna(s) connected to this equipment. Please ensure familiarisation and compliance to country specific regulations on RF exposure.

Ensure all adjustable repeater settings comply with intended use and applicable regional regulatory requirements.

Please note that only the authorised licence holder for the respective frequencies or frequency range is allowed to operate this equipment.

Ensure that access to this equipment is restricted to qualified personnel only.

There is no On/Off switch on the unit – it becomes active as soon as AC or DC power is connected via the provided AC mains cable or DC power source.

Do not allow the unit or any associated equipment to become wet or to be subjected to temperatures outside the specified operating temperature range.

Do not operate the unit near any flammable substances or in a flammable atmosphere.

Ensure that all connectors are fully mated.

Use this equipment only for the purpose specified by RF Industries Pty Ltd. Do not carry out any modifications or attempt any module repairs. All modules in this unit are not intended to be field repairable and should be returned to RF Industries for service or repair.

When engaged in upgrading or maintaining the unit, please note that the RF Front End and RF Back End modules are "Hot Swappable" accessible from the rear of the sub rack frame using the provided module extraction tool. Should an upgrade or maintenance require any further deconstruction or access to the equipment, the AC or DC power supply should be disconnected and appropriately isolated.

Although the modules and exposure of the interconnect sockets / pins have been designed to significantly reduce the risk of electro static discharge (ESD), precautions must be observed during installation and maintenance to protect all the modules within the equipment. An equipment earthing M6 stud is provided at the rear of the sub-rack frame.

Owing to probable power dissipation within the equipment, the exposed rear portion of the equipment may reach relatively high temperatures. Please take the necessary precautions when servicing or removing any RFBE modules, filters, transmitter combiners or unscrewing any terminated RF coaxial cables.

There is a level of surge protection built into the PSU of the DSPbR, however additional site specific lighting protection, voltage surge protection and earth bonding is required to reduce the risk of damage. We recommend the use of adequate coaxial lighting protection and earth bonding through grounding kits on the RF feeder cables prior to termination into the respective RF termination connectors on the repeater. AC or DC mains should also be afforded surge protection, along with the IP Ethernet connection into the repeater.

The DSPbR sub rack frame must be well bonded to the 19" rack earth/grounding connection point.

An AC mains supply resettable circuit breaker is mounted on the front of the DSPbR between the two fans. There is no fuse replacement required. Should this AC resettable circuit breaker "pop-out" under operational conditions, a PSU failure alarm will be activated. It is strongly recommended that an investigation be made prior to resetting the circuit breaker as to the possible reasons why the circuit breaker was activated.

Ensure that this User's Manual is available to maintenance personal who are required to maintain the equipment.

1.3 About RF Industries Pty Ltd

RF Industries Pty Ltd has over thirty years of experience providing RF coverage products and solutions. Designing and manufacturing state of the art "on air" RF rebroadcast repeaters, in both the traditional PMR / LMR and Cellular bands. The company maintains a strong technical advantage and in-depth knowledge to providing both custom and "off the shelf" rebroadcast repeater coverage solutions for different RF technologies and modulation schemes.

RF Industries DSPbR can provide coverage in almost every application including filling in outdoor shadow areas, extending outdoor coverage from a donor cell, tunnels, subways, hospital buildings, large commercial, business and retail buildings and shopping centres, university campuses, airports, railways stations and sports stadiums, the applications are numerous.

RF Industry designs and manufactures hand portable, mobile and base station antennas, antenna combining systems, and supplies system components, lighting protection products, RF coaxial cables and connectors.

RF Industries is a proudly Australian company with an international reach supplying products and field engineering services to over 50 countries around the globe.

All products are thoroughly tested at pre-determined stages i.e. after final modular or system configuration, ensuring reliable operation from the time of installation into a long service history.

Contact Details;

Within Australia Dial: 1300 000 RFI (1300 000 734)

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2. PRODUCT INTRODUCTION.

2.1 Application

The RF Industries DSPbR (Digital Signal Processor based Repeater) Series is designed as a multi-channel, multi-band expandable rebroadcast repeater/booster used for extending network coverage in either outdoor or indoor applications.

Ideal for cost effective expansion of a network coverage boundary or to provide multi-site coverage footprint from a single site infrastructure – without the need for large-scale site developments with dedicated backhauls.

2.2 Product Overview

The DSPbR is a modulation transparent, channel bandwidth adaptive, spectrally clean, high power channel selective rebroadcast repeater/booster. The DSPbR strengths lie in its modular upgradability and user-friendly adaptable connectivity options for configuration and alarm reporting. The DSPbR can be used to rebroadcast both analogue and most digital modulation schemes.

Sub Rack Frame

The DSPbR is built into a standard 19" 4RU sub rack frame with top, bottom and side covers.

DSP technology

The RF Industries DSPbR uses Digital Signal Processing technology, replacing traditional fixed hardware used in IF filtering such as crystal filters with software defined digital filtering providing flexibility and real time optimisation. When a migration of technology is required, whilst using a DSPbR rebroadcast repeater/booster this is simply achieved through a configuration change via the web based browser interface where a number of the specifications can be re-configured such as channel filter profile, uplink and downlink frequencies, output power or gain. The DSP capability allows for up to 8 bi-directional channels in a single sub rack frame. Up to six individual configuration dependent bands can be accommodated, each band having a fixed bandwidth of 20MHz.

The frequency agility of the DSPbR within the predetermined band of the respective RF module allows for either "on-air" rebroadcast of the incoming frequency or translation of the incoming frequency to a different rebroadcast frequency across a number of bands and channels.

The DSPbR can be used for frequency shifting or bridging a number of channels to a second DSPbR unit remotely sited from a host BTS to extend the BTS frequencies without facing input to output isolation problems when broadcasting on the same frequency. The major advantage in not having to rebroadcast "on frequency" is

that the gain through the repeater can be considerably increased and the cell extension afforded greater coverage and signal strength.

A useful feature using this technology is the choice of setting receiver gating on a respective channel. This can be set to open above a fixed dBm input level, or at a pre-determined level above a dynamic input noise level or simply disabled keeping the receiver channel open.

Modulation integrity

The DSPbR does not demodulate the rebroadcast signal and the modulated carrier integrity is left unchanged whether encrypted or not, effectively allowing modulation scheme and multiplexing methodology transparency. A library of optimised IF Filter profiles ensure low group delay characteristics in digital modulation schemes without compromising emission standards.

Web browser configuration and alarm status reporting

Customer specific repeater configuration is possible via the RJ45 IP Ethernet socket connection from either the front or rear of the sub rack. This can be achieved either locally with the use of an IP Ethernet jumper cable or remotely, having connected the unit into an IP Ethernet network.

Two levels of access are provided, which are user name and password protected. The first elementary level provides access to the status screens only. The second level provides access to all screens, which include status, configuration, and maintenance screens.

Entering the factory default IP address will bring up a log in screen and once the required level of user name and password has been entered, the relevant screens will be accessible.

Configurable channel specific settings include uplink and downlink channels, receive and rebroadcast frequencies across band or in-band as required, selecting technology applicable channel bandwidth profiles, uplink and downlink RF output power levels, uplink and downlink channel gain and optional styles of receiver gating.

Names or references can be allocated to input and output frequencies of the respective uplinks and downlinks.

Frequency Bands

The DSPbR is designed to accommodate any number of selected frequency bands between 400 and 870MHz.

Modular Construction

The DSPbR hardware is modular in construction and designed to provide exceptional installation and channel expansion efficiency, allowing hot-swappable hardware upgrades to increase the number of repeater channels up to a maximum of eight bi-directional channels or up to 16 separate transmitters in a single 19" 4RU sub rack frame.

The RFFE and RFBE modules are bolted to their respective BPF modules or TL Module, slid into the mating connectors of the centrally located motherboard via top and bottom mounted guide rails within the allocated slot and screw fastened into the sub rack frame using the module fastening facility.

Modules

The DSPbR has the following modules;

AC or DC Power Inlet

AC or DC PSU.

CSC - Central System Controller

DSP - Digital Signal Processor

Ref Gen + Aux– Reference Generator + Auxiliary module, includes GPS and optional cell modem.

RFFE – RF Front End (band specific)

RFBE – RF Back End (band specific)

BPFM – Band Pass Filter (band specific, bolted to input of RFFE and output of RFBE)

TLM - Through Line Module (optional)

Cxxx-8 Combiner Filter Unit (band specific / optional)

The RFFE and RFBE are limited to a 20MHz bandwidth. One RFFE can feed a number of RFBE's, each RFBE capable of rebroadcasting channels with typical channel spacing's of 6.25, 12.5 or 25 kHz.

Band specific BPFM's fit directly onto the input of the RFFE modules and output of the RFBE modules and the 8 Channel combiner filter unit replaces the BPFM's fitting directly onto the RFBE modules.

There are no internally fitted coaxial interconnect cables. All modules are provided with guided slide fit and fasten connectivity.

An RFFE module is partitioned into Side "A" and Side "B". Two separate RFFE's boards can therefore be accommodated within a single RFFE module. Fitting both sides of the module with RFFE's boards is optional and dependent on the required configuration and prospect of future upgradability.

Each RFBE and corresponding BPFM module is internally partitioned into Side "A" and Side "B", effectively providing two RFBE's per RFBE module. The BPFM must correspond in terms of frequency compatibility with the RFBE. Fitting both sides of the module with RFBE's is optional and dependent on the required configuration and prospect of future expandability and upgradability.

A four channel single band non-frequency translating DSPbR will use a single RFFE board (side "A" of the RFFE module) for the uplink and a single RFFE board (side "B" of the same RFFE module) for the downlink. The full 20 MHz bandwidth of both RFFE boards will be converted from analogue to digital and individual channels are processed through their respective IF filter profiles and then converted back to analogue and fed into the respective uplink and downlink RFBE boards.

The Ref Gen + Aux/GPS module is primarily purposed to provide a reference signal against which the DSPbR is referenced. A reference signal can be sourced via the onboard GPS receiver or from a 10MHz external reference. A multiband cellular modem option is also available fitted to the Ref Gen+ Aux board for SMS alarm notification. It will be possible using a firmware upgrade in the future, to bridge an IP network with the cellular modem in a TCP/IP session where an IP network is not available on site.

The DSP module is partitioned into Side "A" and Side "B" boards, populated according to the number of channels and bands that require processing.

The CSC module is fitted with the non-replaceable back-up lithium ion batteries. The CSC module controls and manages all processing requirements, including providing a CAN bus extension to facilitate multi-rack configurations.

Internal or external uplink and downlink combining

The downlink and uplink RFBE RF outputs can be either internally (8-Channel combiner filter unit contained within sub rack frame) or externally combined.

An internal 8 channel combiner filter unit option is available which has been designed to fit directly to the outputs of the RFBE modules, replacing the channel specific Band Pass Filter Modules (BPFM's). The transmitter combiner however has a real estate footprint which extends over a total of four consecutive RFBE modules (8 RFBE channels). The combiner unit fits within the spatial confines of the sub rack frame.

An Internal combiner filter unit is available in all bands. A single combiner can be fitted to either the outputs of the uplink RFBE's and or downlink RFBE's.

External combining can be provided outside of the sub rack frame.

Where external combining is the preferred option, the individual outputs via the RFBE – BPFM's are extended to the rear of the sub rack frame where they can be fed via coaxial cables into an external combiner.

This allows for various options of combiners to be selected and optimised for the frequency combinations in use.

A Through Line Module (TLM) can be used to extend the output of a RFBE to the rear of the sub rack frame without incurring the additional loss of a BPFM. This module is only used when an external combiner provides sufficient band pass filtering.

It must be noted that the internal combiner filter option is not subject to frequency changes within the 20MHz band of the unit, however the external combiner, depending on type, may be restricted to fixed frequencies.

External Duplexer

Where uplink or downlink paths require combining into a single feeder network or antenna, an external duplexer will be required. RF Industries have a number of 19" rack mountable duplexer types and options available for most frequency, power and bandwidth requirements.

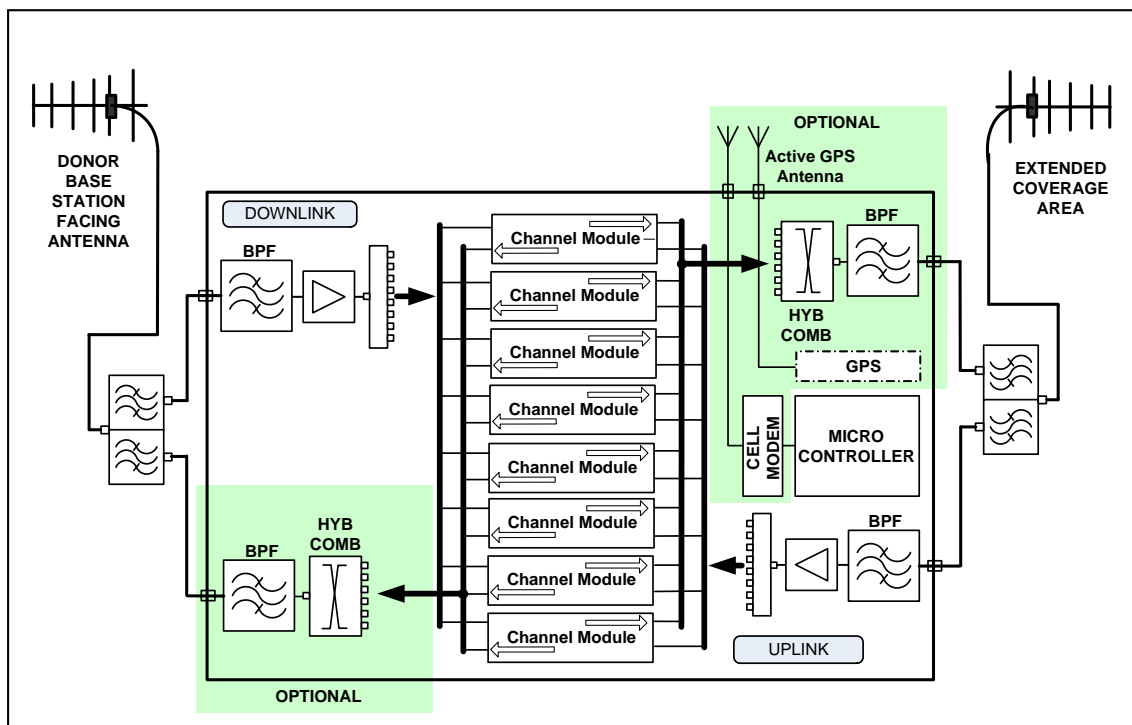There is currently no internal duplexer option available for the DSPbR.

Figure 1 - Typical DSPbR Functional Block Diagram

2.3 Product Specifications

The DSPbR Series repeater is designed for configuration in a number of popular bands.

RFFE and RFBE modules with corresponding BPFM's for both up and downlinks are currently available in the following RF bands; 400-420MHz, 450-470MHz, 470-490MHz, 805-825MHz and 850-870MHz

RF Industries will be adding bands to the current list during our program of continued development. Please contact our offices for an update on band availability if your required band is not already listed.

Electrical Specifications (across all bands)

Model Reference	DSPbR Series
Frequency Ranges	Contact RFI for latest list
Max number of channels – single 4RU sub rack frame	8 bi-directional (1 to 2 bands) 16 uni-directional (1 to 2 bands)
Max number of channels – multi-racks	Please consult with RFI
Synthesiser Offset	0.00kHz or 6.25kHz
Mode of Operation	Full Duplex, translating or non-translating
DSP channel filter profile options (current)	9 (12.5kHz) & 15kHz (25 kHz)
Channel Spacing	12.5kHz and 25kHz
Receiver Sensitivity	-118dBm (typical)
Adjacent Channel Selectivity	NB 60dB / WB 70dB
Intermodulation Immunity	> 70dB
Uplink Channel Gain (+40dBm per Ch 1dB steps)	50-130dB
Downlink Channel Gain (+45dBm per Ch 1dB steps)	55-135dB
Adjustable downlink / uplink Output Power without internal combining unit fitted (RFBE module output) – 1dB increments. Refer to Table 3 for maximum power limits with internal combiner fitted.	400-490MHz Bands +30dBm (1W) to +45dBm (35W) 805-870MHz Bands +30dBm (1W) to +43dBm (20W)
Output ALC range	100dB (channel independent)
Noise Figure (no ALC, max gain)	< 6dB
Tx Spurious and Harmonic Emissions	< -30dBm @+45dBm output
PA Class of operation	AB
Frequency Translating Error	< 10 Hz, 0 Hz typical
System Impedance	50 Ohm
Maximum Input power no damage	+10dBm
Ref Gen – GPS antenna feed voltage	+ 6V

Power Supply Options	48VDC /110-240VAC
Power Consumption (max – fully configured)	1500W

Internal Combiner

Typical Insertion Loss	11dB
Maximum input power per channel	Refer to Table 3.

Typical Power AC / DC power consumption figures

1 x Bi-directional (UL 42dBm & DL + 45dBm) channels UL 100% DL 100% / UL 100% DL Gated	283W / 259W
2 x Bi-directional (UL 42dBm & DL + 45dBm) channels UL 100% DL 100% / UL 100% DL Gated	405W / 375W
4 Bi-directional (UL 42dBm & DL + 45dBm) channels UL 100% DL 100% / UL 100% DL Gated	649W / 553W
6 Bi-directional (UL 42dBm & DL + 45dBm) channels UL 100% DL 100% / UL 100% DL Gated	893W / 749W
8 Bi-directional (UL 42dBm & DL + 45dBm) channels UL 100% DL 100% / UL 100% DL Gated	1137W / 945W

Mechanical

Sub Rack Frame Height	4RU Height (179mm)
Sub Rack Frame Depth (including connectors)	440mm
RFFE input and RFBE output termination connectors	N (F)
Ref Gen – GPS Antenna termination connector	SMA (F)
Ref Gen – Cell Modem Antenna Termination connector	SMA (F)
Ref Gen – Ext Ref Input and Output termination connectors	SMA (F)
AC Power supply socket type	IEC320-C19
DC Power supply terminal	Phoenix HDFK 16A
Finish – 19" Rack Front Panel	Black

Weights

2 bi-directional (UL & DL) channels no internal combining	19.7kgs
4 bi-directional (UL & DL) channels no internal combining	24.8kgs
6 bi-directional (UL & DL) channels no internal combining	29.9kgs
8 bi-directional (UL & DL) channels no internal combining	35kgs
For DL or UL Internal combining only (2-8Ch) add -	1.25kgs
For DL and UL Internal combining (2-8Ch) add -	2.5kgs
Weight (fully configured 8 bi-directional channels) + UL and DL internal combining	37.5kgs

Environmental

Mounting	Indoor only
Active Cooling (fan speed variable with temperature)	2 x 119x119x34mm fans
Temperature Range	-30° C to +60° C

Connectivity

Ethernet connection points	1 x front - CSC module
	1 x rear - Ref Gen module
USB Type "B" connector port	1 x front panel - CSC module..
RS232 DB9 connector - socket	1 x front panel - CSC module.
Internal / External Alarm DB15 connector - socket	1 x rear panel - Ref Gen module.
RJ11 CAN Bus interconnect	1 x front panel - CSC (Master).
	2 x front panel - CSC (Slave).
GPS +6VDC antenna termination connector	SMA (F) – Ref Gen module
10MHz clock – internal reference generator (GEN MON)	SMA (F) - Ref Gen module
10MHz clock – external reference (EXT REF)	SMA (F) – Ref Gen module
Cellular modem antenna connector	SMA (F) – Ref Gen module
Wireless	GSM/GPRS/UMTS Cell modem

Indicators – CSC Module LCD Display (front panel)

LCD	RFI Logo
(Screen sequences with each mode button press).	Current IP Address/Subnet
	/Gateway/MAC address.
	Set Date and Time.
	PSU rail voltage / batt voltage.
	Modules detected and enabled.
	Module temperatures.
	RSSI level per channel.
Power on	Green LED CSC front panel
Critical Alarm	Alarm 1 Red LED
Minor Alarm	Alarm 2 Red LED
Ethernet traffic on RJ45 Ethernet Port	Flashing Orange/Green LED's

Table 2 – DSPbR Generic Product Specifications

3. FUNCTIONAL DESCRIPTION.

3.1 General

The DSPbR Series repeater is based on the use of a DSP engine to provide unprecedented flexibility in providing software defined channel specific filter profiles, channel characteristic parameter configuration and alarm reporting.

Built on a modular platform for ease of upgradability and configuration options, the DSPbR Series provides the user a very flexible and ultimately cost effective product, the idea of which is to provide an easy upgrade path when a user is motivated to follow ever changing technology migration paths. Change; which effectively incorporates improved features, has been shifted from physical hardware to firmware upgrades. The hardware has been minimised to a technologically achieved minimalist platform with more attention paid to processing speeds and power within the DSP FPGA platform.

Engineering connectivity flexibility into the hardware platform has opened numerous possible hardware configurations stretching across nominated RF front ends (uplink or downlink receivers) to RF back ends (uplink or downlink RF Tx PA's) and where required across different bands within the DSPbR series.

Expanding capability even further, a single sub rack frame can be daisy chained using CAN bus interconnection to allow for additional sub rack frames to be added, expanding the number of channels and cross band capability. Where an additional sub rack frame is added to an existing unit, the first sub rack frame will be nominated as the "Master Unit" and concurrent sub rack frame or frames - the "Slave Units". This essentially applies to the CSC within the respective units.

This flexibility unlocks numerous configuration options, allowing for simple "on frequency" re-broadcast to frequency translating rebroadcast within or across into a different nominated band.

DSPbR configuration has been facilitated through the use of an on-board web browser via the front or rear mounted Ethernet port.

Alarm reporting is fundamentally achieved through SMS messaging via the onboard cellular modem option. Further to this, current development through a firmware upgrade will provision for SNMP north bound traps to be sent via either the Ethernet connection connected directly to an IP network or via the cell modem in a call initiated IP session.

In addition, critical and minor alarms activate two relays respectively with isolated N/O or N/C contact potentials, which are wired via the DB15 socket at the rear of the unit (Ref Gen + Aux module).

Please note that there will be a state change on start-up as the relays are energised and held. Relay "1" is activated on notification of any major alarm and relay "2" is activated on notification of any minor alarm.

The DSPbR hardware architecture requires a level of understanding in order for the configuration options to be understood. The following sections provide an elementary explanation of the hardware architecture within the repeater.
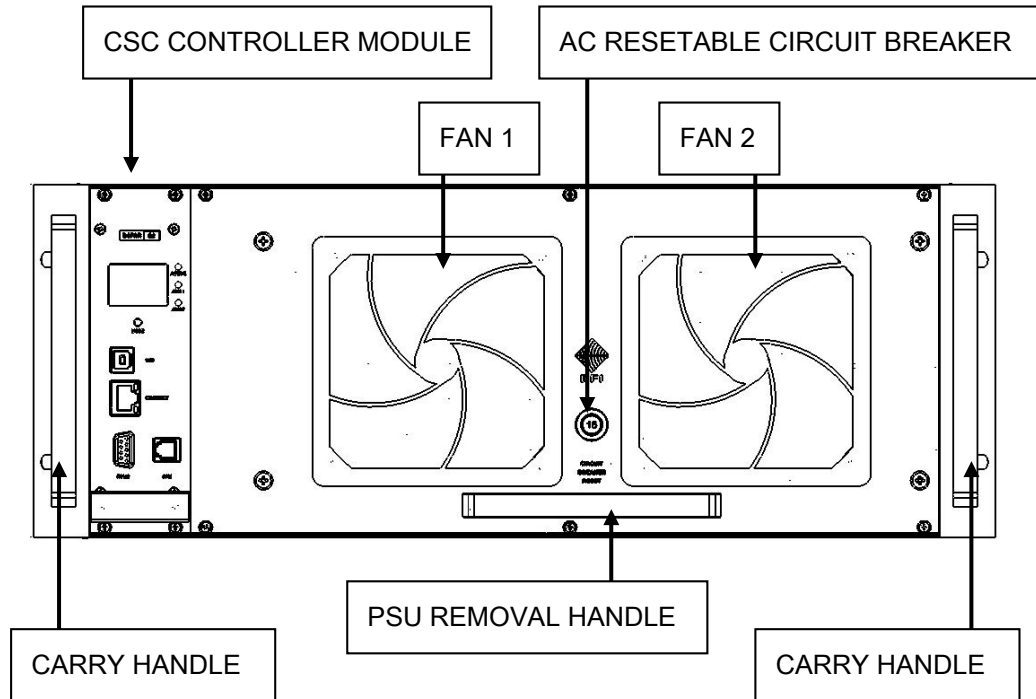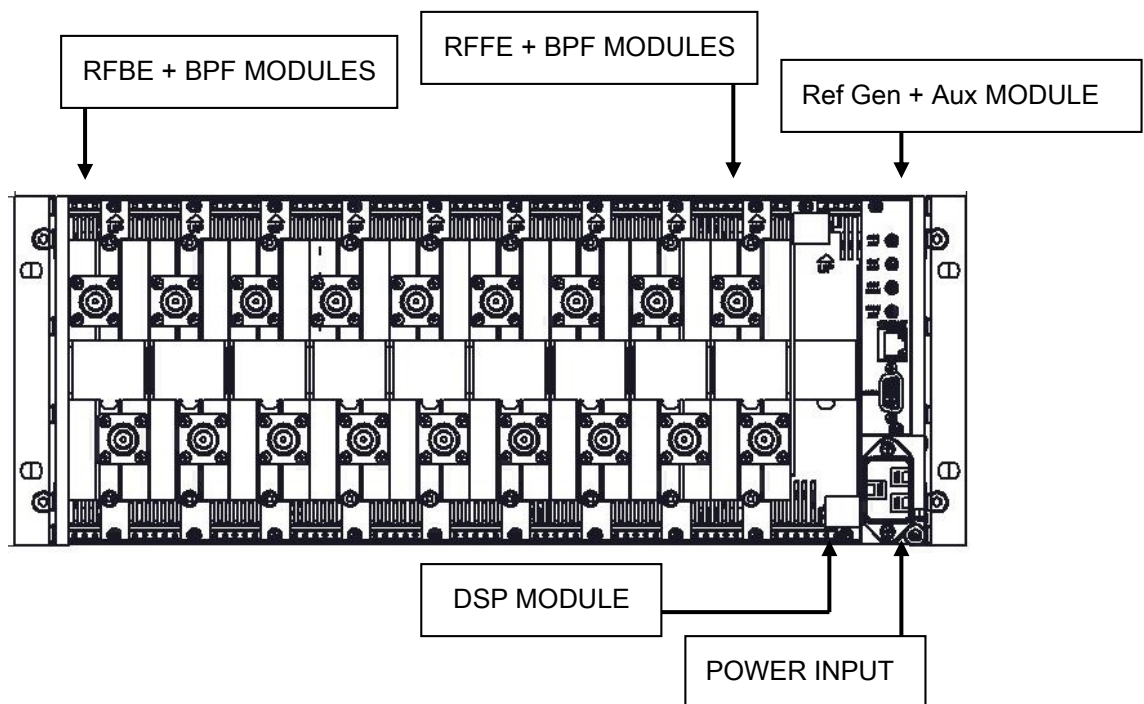

Figure 2 – DSPbR Front View

Figure 3 – DSPbR Rear View

3.2 Sub Rack Frame

The DSPbR hardware platform is built into a standard 4RU 19" sub rack frame, which together with its top, bottom and side covers, module guide rails and centrally located interconnect motherboard, is known as the DSPbR sub rack frame. This sub rack frame is identical for both master and slave units when more then one sub rack frame is employed. The sub rack frame is characterised by the two solid carry handles protruding from the front of the unit. All modules connect into the centrally located motherboard set within the sub rack frame via guided slide rails. Each pair (top and bottom rails) are allocated slot numbers.

The motherboard is considered integral to the sub rack frame and therefore its removal is not intended. The majority of the motherboard connections cater for a level of RFBE and RFFE inter-changeability. This is detailed in Appendix "A" Slot Architecture - Typical Configurations.

3.3 Modules

The DSPbR Series repeater has been designed on a modular level and as such the modules are configurable to essentially cater for power supply and band options with channel expandability.

The base line modules, without which the unit would not function, are the PSU Inlet modules, Power Supply Unit PSU, either 110-240VAC or 48VDC, Central System Controller - CSC, Reference Generator - Ref GEN + Aux, Digital Signal processor - DSP, and at least a one RF Front End RFFE and corresponding RF Back End RFBE. A BPFM is bolted onto an RFFE for insertion and or removal from the sub rack frame as one unit. The output of the RFBE is bolted onto either a BPFM or TLM (Through Line Module) for insertion and or removal from a sub rack frame as one unit.

The motherboard within the sub rack frame connects modules such that band options and channel expandability is optimised. The PSU and CSC modules are located and removed from the front of the sub rack frame. The Ref Gen + Aux, DSP, RFFE and RFBE modules with corresponding BPFM's are located and accessible from the rear.

The rear of the sub rack frame is divided up from the left (looking at the sub rack frame from the rear) into slot positions. There are 10 available slot apertures counting slots 1 to 10 from the left of the sub rack frame to the right. The extreme right fixed module is the Ref Gen + Aux underneath which the PSU inlet module is located. The DSP Module is located in the 10th slot. RFBE modules are accommodated in slots 1 to 8. Slots 7, 8 and 9 are designed to accommodate RFFE modules. Slots 7 and 8 are therefore dual purpose.

RFBE and RFFE (+ BPF) modules are "hot swappable" and can be removed or inserted without powering down the DSPbR. Upon positive connection following insertion of RFFE and or RFBE modules into a DSPbR slot, the CSC will automatically interrogate the respective module recording hardware/firmware version and serial