



Aprisa **SR+**



Product Description

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RoHS and WEEE compliance

The Aprisa SR+ is fully compliant with the European Commission's RoHS (Restriction of Certain Hazardous Substances in Electrical and Electronic Equipment) and WEEE (Waste Electrical and Electronic Equipment) environmental directives.

Restriction of hazardous substances (RoHS)

The RoHS Directive prohibits the sale in the European Union of electronic equipment containing these hazardous substances: lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs).

4RF has worked with its component suppliers to ensure compliance with the RoHS Directive which came into effect on the 1st July 2006.

End-of-life recycling programme (WEEE)

The WEEE Directive concerns the recovery, reuse, and recycling of electronic and electrical equipment. Under the Directive, used equipment must be marked, collected separately, and disposed of properly.

4RF has instigated a programme to manage the reuse, recycling, and recovery of waste in an environmentally safe manner using processes that comply with the WEEE Directive (EU Waste Electrical and Electronic Equipment 2002/96/EC).

4RF invites questions from customers and partners on its environmental programmes and compliance with the European Commission's Directives (sales@4RF.com).

Compliance General

The Aprisa SR+ radio predominantly operates within frequency bands that require a site license be issued by the radio regulatory authority with jurisdiction over the territory in which the equipment is being operated.

It is the responsibility of the user, before operating the equipment, to ensure that where required the appropriate license has been granted and all conditions attendant to that license have been met.

Changes or modifications not approved by the party responsible for compliance could void the user's authority to operate the equipment.

Equipment authorizations sought by 4RF are based on the Aprisa SR+ radio equipment being installed at a fixed location and operated in point-to-multipoint or point-to-point mode within the environmental profile defined by EN 300 019, Class 3.4. Operation outside these criteria may invalidate the authorizations and / or license conditions.

The term 'Radio' with reference to the Aprisa SR+ User Manual, is a generic term for one end station of a point-to-multipoint Aprisa SR+ network and does not confer any rights to connect to any public network or to operate the equipment within any territory.

Compliance European Telecommunications Standards Institute

ETSI compliance pending for the Aprisa SR+.

Compliance Federal Communications Commission

FCC compliance pending for the Aprisa SR+.

Compliance Industry Canada

IC compliance pending for the Aprisa SR+.

RF Exposure Warning



WARNING:

The installer and / or user of Aprisa SR+ radios shall ensure that a separation distance as given in the following table is maintained between the main axis of the terminal's antenna and the body of the user or nearby persons.

Minimum separation distances given are based on the maximum values of the following methodologies:

1. Maximum Permissible Exposure non-occupational limit (B or general public) of 47 CFR 1.1310 and the methodology of FCC's OST/OET Bulletin number 65.
2. Reference levels as given in Annex III, European Directive on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC). These distances will ensure indirect compliance with the requirements of EN 50385:2002.

Frequency (MHz)	Maximum Power (dBm)	Maximum Antenna Gain (dBi)	Minimum Separation Distance (m)
300	+ 37	15	2.5
330	+ 37	15	2.5
400	+ 37	15	2.5
470	+ 37	15	2.3
520	+ 37	15	2.2
850	+ 37	28	7.7
960	+ 37	28	7.2

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1. Introduction

The 4RF Aprisa SR+ Radio

The 4RF Aprisa SR+ is a point-to-multipoint digital radio providing secure narrowband wireless data connectivity for SCADA, infrastructure and telemetry applications.

The radios carry a combination of serial packet data and Ethernet data between the base station, repeater stations and remote stations.

The Aprisa SR+ is configurable as a point-to-multipoint base station, a remote station or a repeater station.



Product Overview

Network Coverage and Capacity

In a simple point-to-multipoint network, an Aprisa SR+ base station can communicate with up to a practical limit of 150 remote stations.

The Aprisa SR+ has a typical link range of up to 60 km, however, geographic features, such as hills, mountains, trees and foliage, or other path obstructions, such as buildings, tend to limit radio coverage. Additionally, geography may reduce network capacity at the edge of the network where errors may occur and require retransmission. However, the Aprisa SR+ uses Forward Error Correction (FEC) which greatly improves the sensitivity performance of the radio resulting in less retries and minimal reduction in capacity.

Ultimately, the overall performance of any specific network will be defined by a range of factors including the geographic location, the number of remote stations in the base station coverage area and the traffic profile across the network. Effective network design will distribute the total number of remote stations across the available base stations to ensure optimal geographic coverage and network capacity.

Automatic Registration

On start-up, the remote station transmits a registration message to the base stations which responds with a registration response. This allows the base station to record the details of all the remote stations active in the network.

If a remote station cannot register with the base station after multiple attempts (RF LED flashing red) within 10 minutes, it will automatically reboot. If a remote station has registered with the base station but then loses communication, it will automatically reboot within 2 minutes.

Remote Messaging

There are two message types in the Aprisa SR+ network, broadcast messages and unicast messages. Broadcast messages are transmitted by the base station to the remote stations and unicast messages are transmitted by the remote station to the base station. These messages are commonly referred to as uplink (unicast remote to base) and downlink (broadcast base to remote).

All remotes within the coverage area will receive broadcast messages and pass them on to either the Ethernet or serial interface. The RTU determines if the message is intended for it and will accept it or discard it.

Product Features

Functions

- Point-to-Point (PTP) or Point-to-Multipoint (PMP) operation
- Licensed frequency bands:
 - UHF 330-400 MHz
 - UHF 400-470 MHz
 - UHF 928-960 MHz
- Channel sizes - software selectable:
 - 12.5 kHz
 - 25 kHz
- Adaptive modulation: QPSK to 64 QAM
- Half duplex or full duplex RF operation
- Ethernet data interface and RS-232 asynchronous multiple port options
- Software selectable dual / single antenna port options (dual antenna port for external duplexers or filters)
- Data encryption and authentication
- Terminal Server
- Build-configuration / flexibility of interface ports (3+1, 2+2, 4+0)
- Radio and user interface redundancy (provided with Aprisa SR+ Protected Station)
- Protected Station fully hot swappable and monitored hot standby
- Complies with international standards, including ETSI RF, EMC, safety and environmental standards

Performance

- Typical deployment of 30 remote stations from one base station with a practical limit of a few hundred remote stations
- Long distance operation
- High transmit power
- Low noise receiver
- Forward Error Correction
- Electronic tuning over the frequency band
- Thermal management for high power over a wide temperature range

Usability

- Configuration / diagnostics via front panel Management Port USB interface, Ethernet interface
- Built-in webserver with full configuration, diagnostics and monitoring functionality, including remote station configuration / diagnostics over the radio link
- LED display for on-site diagnostics
- Dedicated alarm port
- Software upgrade and diagnostic reporting via the Host Port USB flash drive
- Over-the-air software distribution and upgrades
- Simple installation with integrated mounting holes for wall, DIN rail and rack shelf mounting

Architecture

The Aprisa SR+ Architecture is based around a layered TCP/IP protocol stack:

- Physical
 - Proprietary wireless
 - Standard RS-232 and Ethernet
- Link
 - Proprietary wireless (channel access, ARQ, segmentation)
 - Standard Ethernet
- Network
 - Standard IP
 - Proprietary automatic radio routing table population algorithm
- Transport
 - Standard TCP, UDP
- Application
 - Proprietary management application software

Security

The Aprisa SR+ provides security features to implement the key recommendations for industrial control systems. The security provided builds upon the best in class from multiple standards bodies, including:

- IEC/TR 62443 (TC65) 'Industrial Communications Networks - Network and System Security'
- IEC/TS 62351 (TC57) 'Power System Control and Associated Communications - Data and Communication Security'

The security features implemented are:

- Data encryption
 - Counter Mode Encryption (CTR) using Advanced Encryption Standard (AES)
- Data authentication
 - Cipher Block Chaining Message Authentication Code (CBC-MAC) using Advanced Encryption Standard (AES)
- Data payload security
 - CCM Counter with CBC-MAC integrity (NIST special publication 800-38C)
- Secured management interface protects configuration
- Address filtering enables traffic source authorization
- Proprietary physical layer protocol and modified MAC layer protocol based on standardized IEEE 802.15.4
- Licensed radio spectrum protects against interference

Interfaces

Antenna Interface

- 2 x TNC, 50 ohm, female connectors
Software selectable single or dual antenna port operation.

Ethernet Interface

- 2, 3 or 4 ports 10/100 base-T Ethernet layer 2 switch using RJ-45
Used for Ethernet user traffic and product management.

RS-232 Interface

- 2, 1 or 0 RS-232 asynchronous ports using RJ-45 connector
Used for RS-232 asynchronous user traffic only.

USB Interfaces

- 1 x Management Port using USB micro type B connector
Used for product configuration with the Command Line Interface (CLI).
- 1 x Host Port using USB standard type A connector
Used for software upgrade and diagnostic reporting.

Alarm Interface

- 1x Alarm Port using RJ-45 connector
Used for monitoring and control of protection switches.

AUX Interface

- 1x Port using a QMA female connector
Reserved for future use.

Mounting

The Aprisa SR+ has four threaded holes (M4) in the enclosure base and two holes (5.2 mm) through the enclosure for mounting.

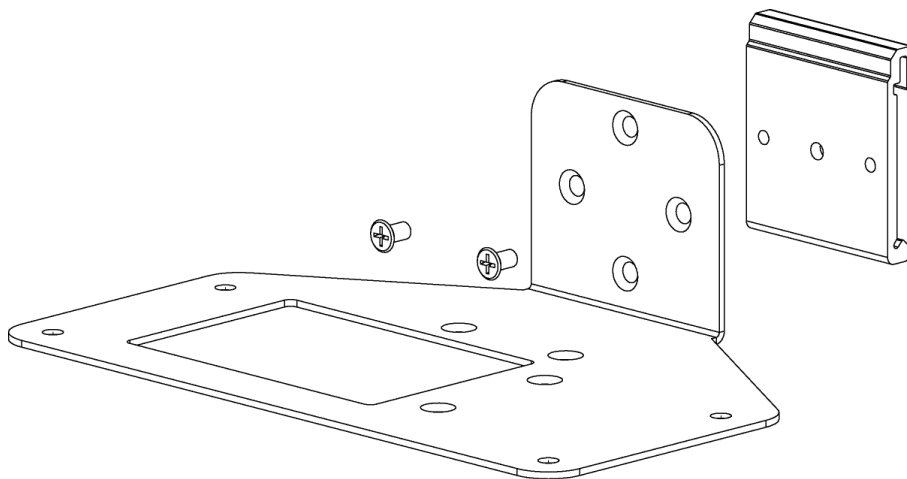
Mounting options include:

- DIN rail mounting with the Aprisa SR+ DIN Rail Mounting Bracket
- Rack shelf mounting
- Wall mounting
- Outdoor enclosure mounting

DIN Rail Mounting

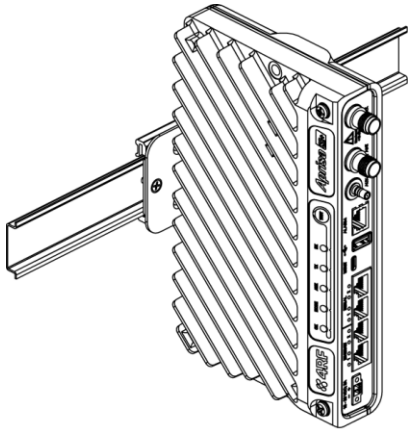
The Aprisa SR+ has an optional accessory to enable the radio to mount on a standard DIN rail:

Part Number	Part Description
APSA-MBRK-DIN-SQ	4RF SR Acc, Bracket, DIN Rail, Aprisa SR+

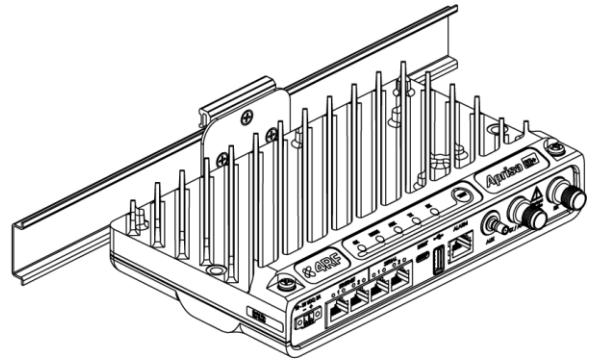


The Aprisa SR+ DIN rail mounting bracket can be mounted in four positions on a horizontal DIN rail:

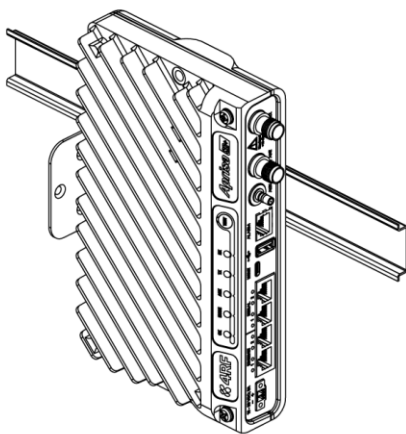
- Vertical Mount (vertical enclosure perpendicular to the mount)
- Horizontal Mount (horizontal enclosure perpendicular to the mount)
- Flat Vertical Mount (vertical enclosure parallel to the mount)
- Flat Horizontal Mount (horizontal enclosure parallel to the mount)



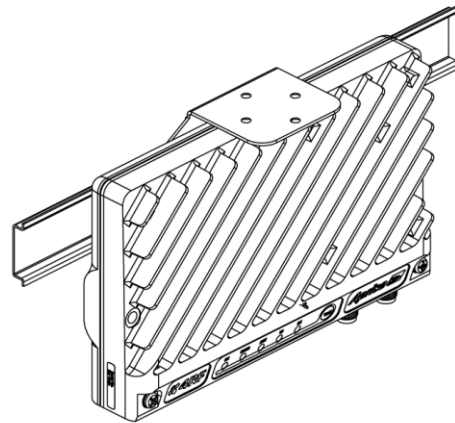
Vertical Mount



Horizontal Mount



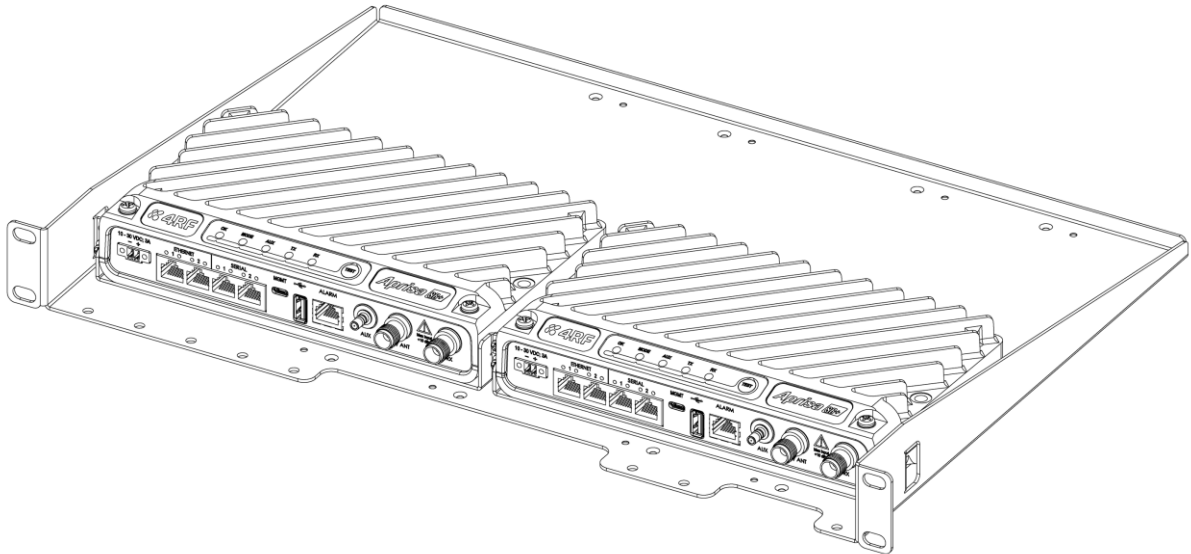
Flat Vertical Mount



Flat Horizontal Mount

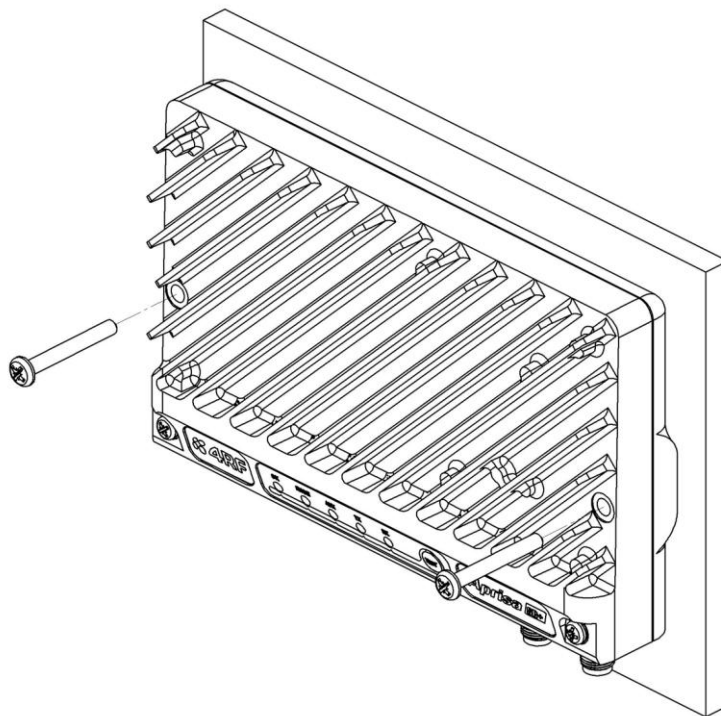
Rack Shelf Mounting

The Aprisa SR+ can be mounted on a rack mount shelf using the four M4 threaded holes in the Aprisa SR+ enclosure base. The following picture shows two Aprisa SR+ radios mounted on 1 RU rack mount shelf.



Wall Mounting

The Aprisa SR+ can be mounted on a wall using the two holes through the enclosure (5.2 mm diameter). Typically, M5 screws longer than 35 mm would be used.



2. Product Options

Interface Ports

The standard Aprisa SR+ provides multiple interface port options for combinations of Ethernet and RS-232 serial. The product shown below is the two Ethernet ports plus two RS-232 serial ports.



Interface Port Option

4 Ethernet ports and no RS-232 serial ports

3 Ethernet ports and 1 RS-232 serial port

2 Ethernet ports and 2 RS-232 serial ports

Part Number

APSQ-N400-SSC-HD-40-ETAA

APSQ-N400-SSC-HD-31-ETAA

APSQ-N400-SSC-HD-22-ETAA

Protected Station

The Aprisa SR+ Protected Station provides radio and user interface protection for Aprisa SR+ radios when configured as a base station. The RF ports and interface ports from two standard Aprisa SR+ radios are switched to the standby radio if there is a failure in the active radio.



Option Example

Part Number	Part Description
APSQ-R400-SSC-FD-22-ETAA	4RF SR+, PS, 400-470 MHz, SSC, Full Duplex, 2E2S, ET, AA

The Aprisa SR+ Protected Station is comprised of an Aprisa SR+ Protection Switch and two standard Aprisa SR+ radios mounted in a 2U rack mounting chassis.

The Aprisa SR+ Protected Station is full monitored hot-standby and fully hot-swappable. All interfaces (RF, data, etc.) are continually monitored on both the active and standby radio to ensure correct operation. The standby radio can be replaced without impacting traffic flow on the active radio.

The Aprisa SR+ radios can be any of the currently available Aprisa SR+ radio frequency bands, channel sizes or interface port options.

By default, the Aprisa SR+ Protected Station is configured with the left hand radio (A) designated as the primary radio and the right hand radio (B) designated as the secondary radio.

Each radio is configured with its own unique IP and MAC address and the address of the partner radio.

On power-up, the primary radio will assume the active role and the secondary radio will assume the standby role. If, for some reason, only one radio is powered on it will automatically assume the active role.

Operation

In normal operation, the active radio carries all RS-232 serial and Ethernet traffic over the radio link and the standby radio is unused with its transmitter turned off. Both radios are continually monitored for correct operation and alarms are raised if an event occurs.

The active radio sends regular 'keep alive' messages to the standby radio to indicate it is operating correctly. In the event of a failure on the active radio, the RF link and user interface traffic is automatically switched to the standby radio.

The failed radio can then be replaced in the field without interrupting user traffic (see Aprisa SR+ User Manual).

Switch Over

The switch over to the standby radio can be initiated automatically, on fault detection, or manually via the Hardware Manual Lock switch on the Protection Switch or the Software Manual Lock from SuperVisor.

Additionally, it is possible to switch over the radios remotely without visiting the station site, via the remote control connector on the front of the Protection Switch.

Configuration Management

The Primary and Secondary radios are managed with the embedded web-based management tool, SuperVisor, by using either the Primary or Secondary IP address. Configuration changes in one of the radios will automatically be reflected in the partner radio.

To ensure all remote stations are registered to the correct (active) base station, changes to the Network Table are automatically synchronized from the active radio to the standby radio. The Network Table is only visible on the active radio. This synchronization does not occur if the Hardware Manual Lock is active.

Data Driven Protected Station

The Aprisa SR+ Data Driven Protected Station provides radio and RS-232 serial port user interface protection for Aprisa SR+ radios when configured as a base station.

Option Example

Part Number	Part Description
APSQ-D400-SSC-FD-22-ETAA	4RF SR+, PD, 400-470 MHz, SSC, Full Duplex, 2E2S, ET, AA

The Aprisa SR+ Data Driven Protected Station shown is comprised of two standard Aprisa SR+ dual antenna port option radios and two external duplexers mounted on 19" rack mounting shelves (as shown above).

The Aprisa SR+ radios can be any of the currently available Aprisa SR+ radio frequency bands, channel sizes or single / dual antenna port options.

By default, the Aprisa SR+ Data Driven Protected Station is configured with the left hand radio (A) designated as the primary radio and the right hand radio (B) designated as the secondary radio.

Each radio is configured with its own unique IP and MAC address and the address of the partner radio.

On power-up, the primary radio will assume the active role and the secondary radio will assume the standby role. If, for some reason, only one radio is powered on it will automatically assume the active role.

Operation

In normal operation, the active radio carries all RS-232 serial and Ethernet traffic over the radio link and the standby radio is unused with its transmitter turned off. Both radios are continually monitored for correct operation and alarms are raised if an event occurs.

Both the active and standby radios send regular 'keep alive' messages to each other to indicate if they are operating correctly. In the event of a failure on the active radio, the RF link and user interface traffic is automatically switched to the standby radio.

The failed radio can then be replaced in the field without interrupting user traffic.

3. Specifications

RF Specifications

ETSI Compliant

Frequency Bands

Broadcast Band	Frequency Band	Frequency Tuning Range	Synthesizer Step Size
UHF	300 MHz	330-400 MHz	6.250 kHz
UHF	400 MHz	400-470 MHz	6.250 kHz
UHF	900 MHz	928-960 MHz	6.250 kHz

Channel Sizes

Channel Size	Gross Radio Capacity			
	64 QAM	16 QAM	QPSK	4-CPFSK
12.5 kHz	60.0 kbit/s	40.0 kbit/s	20.0 kbit/s	9.6 kbit/s
25 kHz	120.0 kbit/s	80.0 kbit/s	40.0 kbit/s	19.2 kbit/s

Transmitter

Average Power output Note: The Peak Envelope Power (PEP) at maximum set power level is +41 dBm.	64 QAM	0.01 to 1.25 W (+10 to +34 dBm, in 1 dB steps)
	16 QAM	0.01 to 2.5 W (+10 to +35 dBm, in 1 dB steps)
	QPSK	0.01 to 5.0 W (+10 to +37 dBm, in 1 dB steps)
	4-CPFSK	0.01 to 10.0 W (+10 to +40 dBm, in 1 dB steps)

When the transmitter power is set from SuperVisor, it sets the output power of the preamble sent with every transmit burst. The actual power per modulation will be:

Preamble Average Power	SuperVisor Setting
QPSK Average Power	SuperVisor Setting
16 QAM Average Power	SuperVisor Setting -2 dBm
64 QAM Average Power	SuperVisor Setting -3 dBm
Peak Power	+41 dBm

Note: The Aprisa SR+ transmitter contains power amplifier protection which allows the antenna to be disconnected from the antenna port without product damage.

Adjacent channel power	< - 60 dBc
Transient adjacent channel power	< - 50 dBc
Spurious emissions	< - 37 dBm
Attack time	< 1.5 ms
Release time	< 1.5 ms
Data turnaround time	< 10 ms
Frequency stability	± 1 ppm
Frequency aging	< 1 ppm / annum
Synthesizer lock time	< 1.5 ms (5 MHz step)

Note: The demo Aprisa SR+ (model number SQ D400-002) has a maximum transmitter power of 5 W with a peak power of +37 dBm. It also does not support 4-CPFSK modulation.

Maintenance > Test Mode

TRANSMITTER

PRBS Test Enabled

When active, the transmitter outputs a continuous PRBS signal. This can be used for evaluating the output spectrum of the transmitter and verifying adjacent channel power and spurious emission products.

Deviation Test Enabled

When active, the transmitter outputs a sideband tone at the deviation frequency used by the CPFSK modulator. This can be used to evaluate the local oscillator leakage and sideband rejection performance of the transmitter.

CW Test Enabled

When active, the transmitter outputs a continuous wave signal. This can be used to verify the frequency stability of the transmitter.

Test Mode Timeout (s)

This parameter sets the Transmitter Test Mode timeout period. The radio will automatically exit Transmitter Test Mode after the Timeout period. The default setting is 10 seconds.

Receiver

			12.5 kHz	25 kHz
Receiver sensitivity	BER < 10 ⁻²	4-CPFSK	-115 dBm	-112 dBm
	BER < 10 ⁻²	QPSK	-115 dBm	-112 dBm
	BER < 10 ⁻²	16 QAM	-109 dBm	-106 dBm
	BER < 10 ⁻²	64 QAM	-103 dBm	-99 dBm
	BER < 10 ⁻⁶	4-CPFSK	-108 dBm	-105 dBm
	BER < 10 ⁻⁶	QPSK	-108 dBm	-105 dBm
	BER < 10 ⁻⁶	16 QAM	-102 dBm	-99 dBm
	BER < 10 ⁻⁶	64 QAM	-96 dBm	-92 dBm
Adjacent channel selectivity			> 60 dB	> 66 dB
Co-channel rejection max coded QPSK			> -5 dB	
Co-channel rejection max coded 64 QAM			> -20 dB	
Intermodulation response rejection			> 70 dB	
Blocking or desensitization			> 84 dB	
Spurious response rejection			> 75 dB	

Modem

Forward Error Correction	Variable length concatenated Reed Solomon plus convolutional code
Adaptive Burst Support	Adaptive FEC Adaptive modulation

Data Payload Security

Data payload security	CCM* Counter with CBC-MAC
Data encryption	Counter Mode Encryption (CTR) using Advanced Encryption Standard (AES) 128, 192 or 256
Data authentication	Cipher Block Chaining Message Authentication Code (CBC-MAC) using Advanced Encryption Standard (AES) 128, 192 or 256

Interface Specifications

Ethernet Interface

The Aprisa SR+ radio features an integrated 10Base-T/100Base-TX layer-2 Ethernet switch.

To simplify network setup, each port supports auto-negotiation and auto-sensing MDI/MDIX. Operators can select from the following preset modes:

- Auto negotiate
- 10Base-T half or full duplex
- 100Base-TX half or full duplex

The switch is IEEE 802.3-compatible. It passes VLAN tagged traffic.

General	Interface	RJ-45 x 2 (Integrated 2-port switch)
	Cabling	CAT-5 UTP, supports auto MDIX (Standard Ethernet)
	Maximum line length	100 metres on cat-5 or better
	Bandwidth allocation	The Ethernet capacity maximum is determined by the available radio link capacity.
	Maximum transmission unit	Option setting of 1522 or 1536 octets
	Address table size	1024 MAC addresses
	Ethernet mode	10Base-T or 100Base-TX Full duplex or half duplex (Auto-negotiating and auto-sensing)
Diagnostics	Left Green LED	Off: no Ethernet signal received On: Ethernet signal received
	Right Green LED	Off: Indicates no data traffic present on the interface Flashing: Indicates data traffic present on the interface

RS-232 Asynchronous Interface

The Aprisa SR+ radio's ITU-T V.24 compliant RS-232 interface is configured as a Cisco® pinout DCE. The interface terminates to a DTE using a straight-through cable or to a DCE with a crossover cable (null modem).

The interface uses two handshaking control lines between the DTE and the DCE.

General	Interface	ITU-T V.24 / EIA/TIA RS-232E
	Interface direction	DCE only
	Maximum line length	10 metres
Async parameters	Standard mode data bits	7 or 8 bits
	Standard mode parity	Configurable for None, Even or Odd
	Standard mode stop bits	1 or 2 bits
	Interface baud rates	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 bit/s
Control signals	DCE to DTE	CTS, RTS, DSR, DTR

Protection Switch Specifications

RF Insertion Loss	< 0.5 dB
Remote Control inputs	Logic 4700 ohms pullup to +3.3 VDC

Power Specifications

Power Supply

Aprisa SR+ Radio

Nominal voltage	+13.8 VDC (negative earth)
Input voltage range	+10 to +30 VDC
Maximum power input	30 W
Connector	Molex 2 pin male screw fitting 39526-4002

Aprisa SR+ Protected Station

Nominal voltage	+13.8 VDC (negative earth)
Input voltage range	+10 to +30 VDC
Maximum power input	35 W
Connector	2x Molex 2 pin male screw fitting 39526-4002

Aprisa SR+ Data Driven Protected Station

Nominal voltage	+13.8 VDC (negative earth)
Input voltage range	+10 to +30 VDC
Maximum power input	35 W
Connector	2x Molex 2 pin male screw fitting 39526-4002

Power Consumption

Aprisa SR+ Radio

Mode	Power Consumption (10 W radio with 4-CPFSK modulation)
Transmit / Receive	< 35 W for 10 W transmit power
	< 25.0 W for 1 W transmit power
Receive only	< 6 W full Ethernet traffic activity
	< 4.5 W no Ethernet traffic activity

Aprisa SR+ Protected Station and Aprisa SR+ Data Driven Protected Station

Mode	Power Consumption (10 W radios with 4-CPFSK modulation)
Transmit / Receive	< 42 W for 10 W transmit power
	< 32.0 W for 1 W transmit power
Receive only	< 14.5 W full Ethernet traffic activity
	< 11.5 W no Ethernet traffic activity

Power Dissipation

Aprisa SR+ Radio

Transmit Power	Power Dissipation (10 W radio with 4-CPFSK modulation)
10 W transmit power	< 25 W
1 W transmit power	< 24 W

Aprisa SR+ Protected Station and Aprisa SR+ Data Driven Protected Station

Transmit Power	Power Dissipation (10 W radios with 4-CPFSK modulation)
10 W transmit power	< 32 W
1 W transmit power	< 31 W

General Specifications

Environmental

Operating temperature range	-40 to +70° C
Storage temperature range	-40 to +80° C
Operating humidity	Maximum 95% non-condensing
Acoustic noise emission	No audible noise emission

Mechanical

Aprisa SR+ Radio

Dimensions	Width 210 mm Depth 130 mm (146 mm with TNC connectors) Height 41.5 mm
Weight	1.25 kg
Colour	Matt black
Mounting	Wall (2 x M5 screws) Rack shelf (2 x M4 screws) DIN rail bracket

Aprisa SR+ Protected Station

Dimensions	Width 432.6 mm Depth 372 mm (388 mm with TNC connectors) Height 2U plus external duplexer (if used)
Weight	12 kg (includes the 2 radios)
Colour	Matt black
Mounting	Rack mount (2 x M6 screws)

Compliance

Radio	EN 300 113-2
EMI / EMC	EN 301 489 Parts 1 & 5
Safety	EN 60950-1:2006
Environmental	ETS 300 019 Class 3.4

4. Management

SuperVisor

The Aprisa SR+ contains an embedded web server application (SuperVisor) to enable element management with any major web browser (such as Mozilla Firefox, Microsoft® Internet Explorer).

SuperVisor enables operators to configure and manage the Aprisa SR+ base station radio and repeater / remote station radios over the radio link.

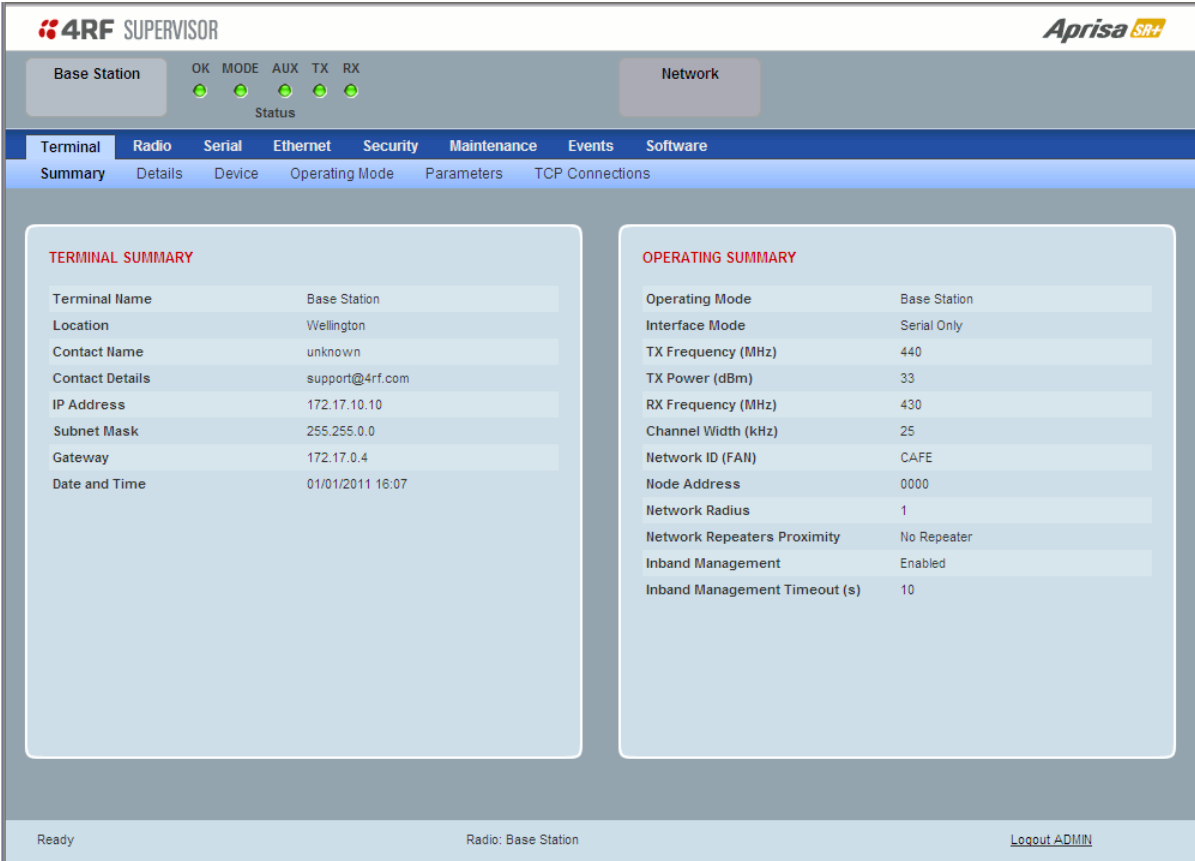
The key features of SuperVisor are:

- Full element management, configuration and diagnostics
- Manage the entire FAN (Field Area Network) from the Base Station (remote management of elements)
- Managed network software distribution and upgrades
- Performance and alarm monitoring of the entire network, including RSSI, alarm states, time-stamped events, etc.
- View and set standard radio configuration parameters including frequencies, transmit power, channel size, modulation, channel access, serial port settings and Ethernet port settings
- Set and view security parameters
- User management

The following are three examples of SuperVisor screens:

Viewing the Aprisa SR+ Terminal Settings

The SuperVisor software enables operators to view the terminal settings:



4RF SUPERVISOR **Aprisa SR+**

Base Station OK MODE AUX TX RX Network
● ● ● ● ●
 Status

Terminal Radio Serial Ethernet Security Maintenance Events Software

Summary Details Device Operating Mode Parameters TCP Connections

TERMINAL SUMMARY

Terminal Name	Base Station
Location	Wellington
Contact Name	unknown
Contact Details	support@4rf.com
IP Address	172.17.10.10
Subnet Mask	255.255.0.0
Gateway	172.17.0.4
Date and Time	01/01/2011 16:07

OPERATING SUMMARY

Operating Mode	Base Station
Interface Mode	Serial Only
TX Frequency (MHz)	440
TX Power (dBm)	33
RX Frequency (MHz)	430
Channel Width (kHz)	25
Network ID (FAN)	CAFE
Node Address	0000
Network Radius	1
Network Repeaters Proximity	No Repeater
Inband Management	Enabled
Inband Management Timeout (s)	10

Ready Radio: Base Station [Logout ADMIN](#)

Configuring the Aprisa SR+ Terminal Details

The SuperVisor software enables operators to set the terminal details including:

- Terminal Name
- Location
- Contact Name
- Contact Details
- Current Date

Configuring the Aprisa SR+ RF Network Details

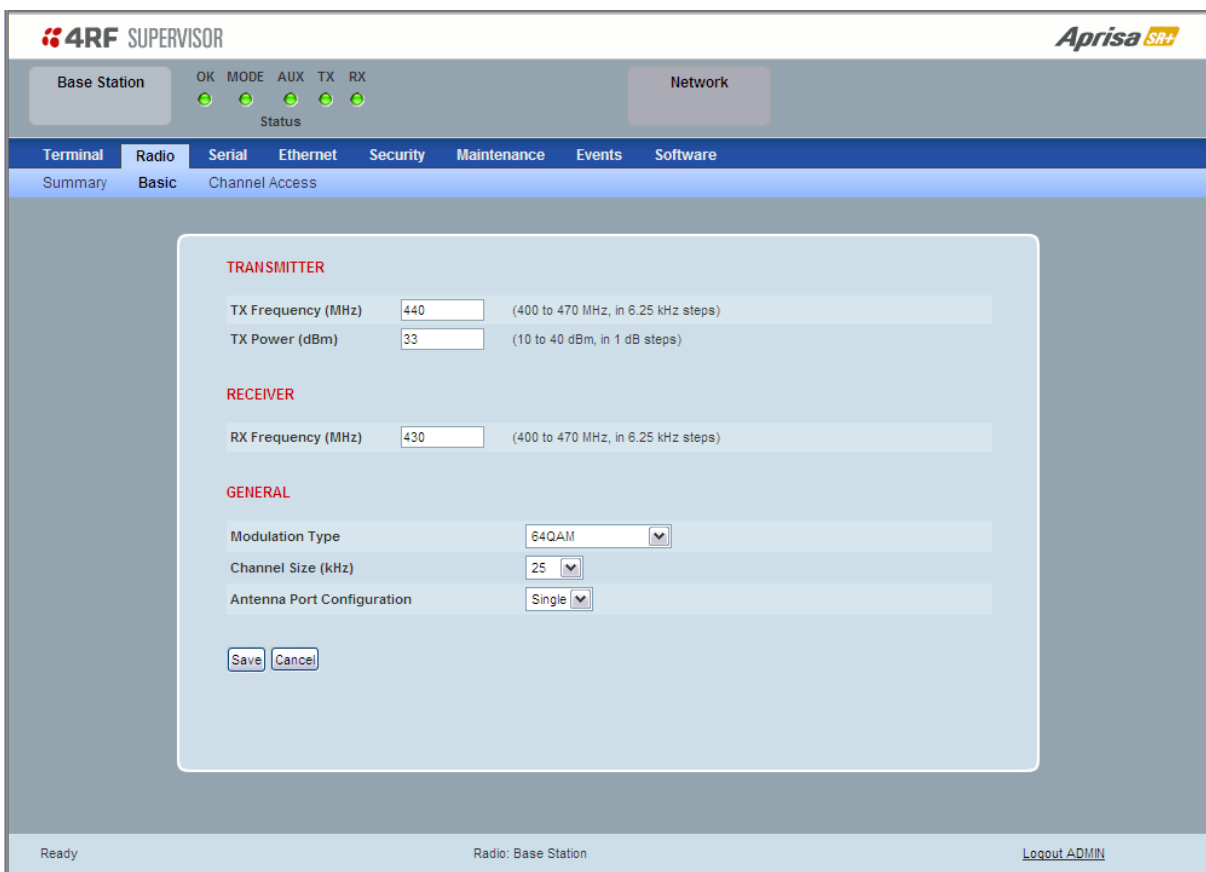
The SuperVisor software enables operators to set the RF Network Details including:

- Network ID (FAN) (Field Area Network)
 - four hex chars
 - network ID of this base station node and its remote nodes
- Network Radius
 - sets the maximum number of hops in this network
- Network Repeaters Proximity
 - sets the proximity of repeaters in this network
- Inband Management
 - enables Inband Management of remotes / repeaters
- Inband Management Timeout (sec)
 - sets the Inband Management timeout period

Configuring the Aprisa SR+ Radio Settings

The SuperVisor software enables operators to set the radio settings including:

- TX Frequency - sets the Transmit frequency in MHz
- TX Power - sets the Transmit Power in dBm
- RX Frequency - sets the Receive frequency in MHz
- Modulation Type - sets the Modulation Type QPSK to 64 QAM
- Channel Size - sets the Channel Size 12.5 kHz or 25 kHz
- Antenna Port Configuration - sets the Antenna Port Configuration to single port or dual port



4RF SUPERVISOR **Aprisa SR+**

Base Station OK MODE AUX TX RX Network
Status

Terminal **Radio** Serial Ethernet Security Maintenance Events Software

Summary **Basic** Channel Access

TRANSMITTER

TX Frequency (MHz) (400 to 470 MHz, in 6.25 kHz steps)

TX Power (dBm) (10 to 40 dBm, in 1 dB steps)

RECEIVER

RX Frequency (MHz) (400 to 470 MHz, in 6.25 kHz steps)

GENERAL

Modulation Type ▼

Channel Size (kHz) ▼

Antenna Port Configuration ▼

Ready Radio: Base Station Logout ADMIN

Command Line Interface

The Aprisa SR+ has a Command Line Interface (CLI) which provides basic product setup and configuration. This interface can be accessed via an Ethernet Port (RJ-45) or the Management Port (USB micro type B). The Terminal menu is shown in the following picture:

```
MPA APRISASR-MIB-4RF >>ls Terminal
+-----+
|S.NO|ATTRIBUTE NAME          |ATTRIBUTE VALUE  |
+-----+-----+-----+
|1   |termName                 |Base Station     |
|2   |termLocation             |Wellington       |
|3   |termContactName          |unknown          |
|4   |termContactDetails       |support@4rf.com  |
|5   |termTimeFormat           |time24h (1)     |
|6   |termDateFormat           |ddmmyyyy (1)    |
|7   |termDateTime             |2011-1-1.16:22:38.0|
|8   |termEthController1IpAddress|172.17.10.10    |
|9   |termEthController1SubnetMask|255.255.0.0     |
|10  |termEthController1Gateway  |172.17.0.4      |
|11  |termRfNwkPanId           |CAFE             |
|12  |termRfNwkRadius          |1                |
|13  |termInbandManagementEnabled|true (1)         |
|14  |termInbandManagementTimeoutSec|10              |
|15  |termRfNwkRepeaterProximity|noRepeater (0)  |
+-----+-----+-----+
MPA APRISASR-MIB-4RF >>
```

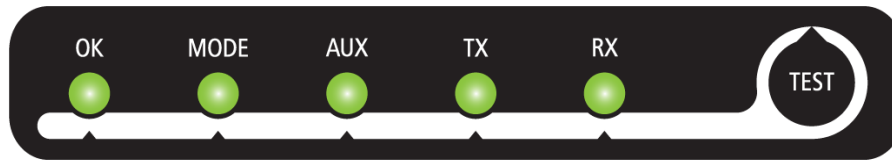
SNMP

In addition to web-based management (SuperVisor) and the Command Line Interface, the Aprisa SR network can also be managed using the Simple Network Management Protocol (SNMP). MIB files are supplied, and these can be used by a dedicated SNMP Manager, such as Castle Rock's SNMPC, to access most of the radio's configurable parameters.

For communication between the SNMP manager and the radio, Access Controls and Community strings must be set up as described in the Aprisa SR+ User Manual .

LED Display Panel

The Aprisa SR+ has an LED Display panel which provides on-site alarms / diagnostics without the need for PC.



Normal Operation

In normal radio operation, the LEDs indicate the following conditions:

	OK	MODE	AUX	TX	RX
Solid Red	<i>Alarm present with severity Critical, Major and Minor</i>			<i>TX path fail</i>	<i>RX path fail</i>
Flashing Red				<i>Radio not connected to a base station</i>	<i>Radio not connected to a base station</i>
Solid Orange	<i>Alarm present with Warning Severity</i>				
Flashing Orange		<i>Tx Data or Rx Data on the USB management or data port</i>	<i>Diagnostics Function Active</i>		
Flashing Green				<i>RF path TX is active</i>	<i>RF path RX is active</i>
Solid Green	<i>Power on and functions OK and no alarms</i>	<i>USB interface OK</i>	<i>Processor Block is OK</i>	<i>Tx path OK</i>	<i>Rx path OK</i>

LED Colour	Severity
Green	No alarm - information only
Orange	Warning alarm
Red	Critical, major or minor alarm

Single Radio Software Upgrade

During a radio software upgrade, the LEDs indicate the following conditions:

- Software upgrade started - the OK LED flashes orange
- Software upgrade progress indicated by running RX to OK LEDs
- Software upgrade completed successfully - the OK LED solid orange
- Software upgrade failed - any LED flashing red during the upgrade

Network Software Upgrade

During a network software upgrade, the AUX LED flashes orange on the base station and all remote stations.

Test Mode

In Test Mode, the LED Display panel presents a real time visual display of the RSSI. This can be used to adjust the antenna for optimum signal strength.

OK LED	MODE LED	AUX LED	TX LED	RX LED	RSSI
●	●	●	●	●	≥ -80 dBm
●	●	●	●	○	-84 dBm to -81 dBm
●	●	●	○	○	-88 dBm to -85 dBm
●	●	○	○	○	-92 dBm to -89 dBm
●	○	○	○	○	-96 dBm to -93 dBm
●	●	●	●	●	-100 dBm to -97 dBm
●	●	●	●	○	-104 dBm to -101 dBm
●	●	●	○	○	-108 dBm to -105 dBm
●	●	○	○	○	-112 dBm to -109 dBm
●	○	○	○	○	-116 dBm to -113 dBm
●	●	●	●	●	< RSSI threshold
●	●	●	●	●	No response received

5. Applications

This section describes sample Aprisa SR+ radio applications.

The following applications are described:

- Basic point-to-multipoint application
- Advanced point-to-multipoint application with repeaters
- Multi-interface point-to-multipoint application

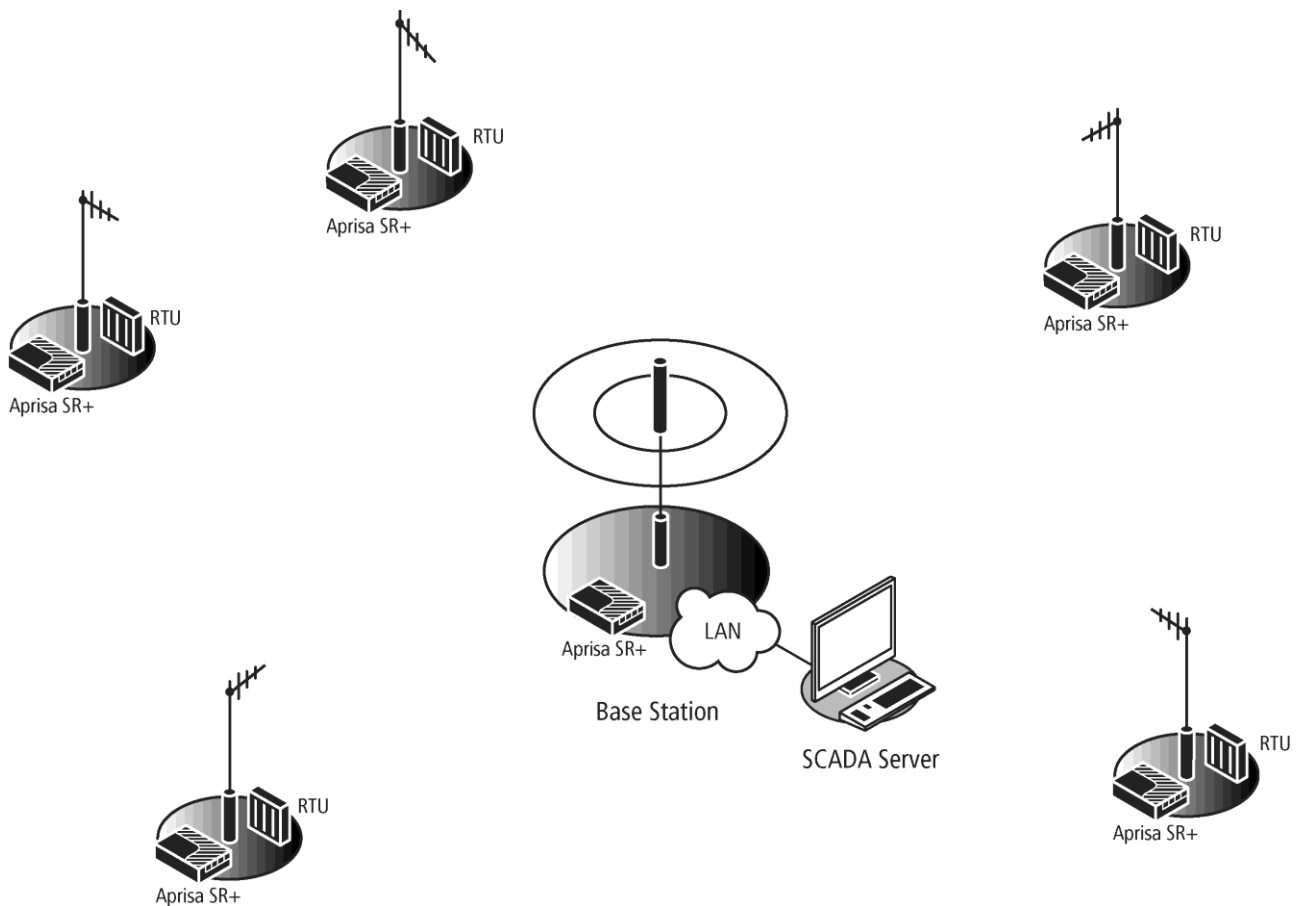
Basic point-to-multipoint application

Single base station with Ethernet SCADA data inputs to multiple geographically remote sites with Ethernet RTUs requiring control and data acquisition.

The base station receives Ethernet frames from the SCADA server LAN and broadcasts all Ethernet frames to all remote stations

Each remote site receives Ethernet frames from the RTU and unicasts over the air to the base station.

The base station uses an omni directional antenna to provide wide coverage and the remote stations are fitted with directional Yagi antennas to provide higher gain.



Advanced point-to-multipoint application with repeater

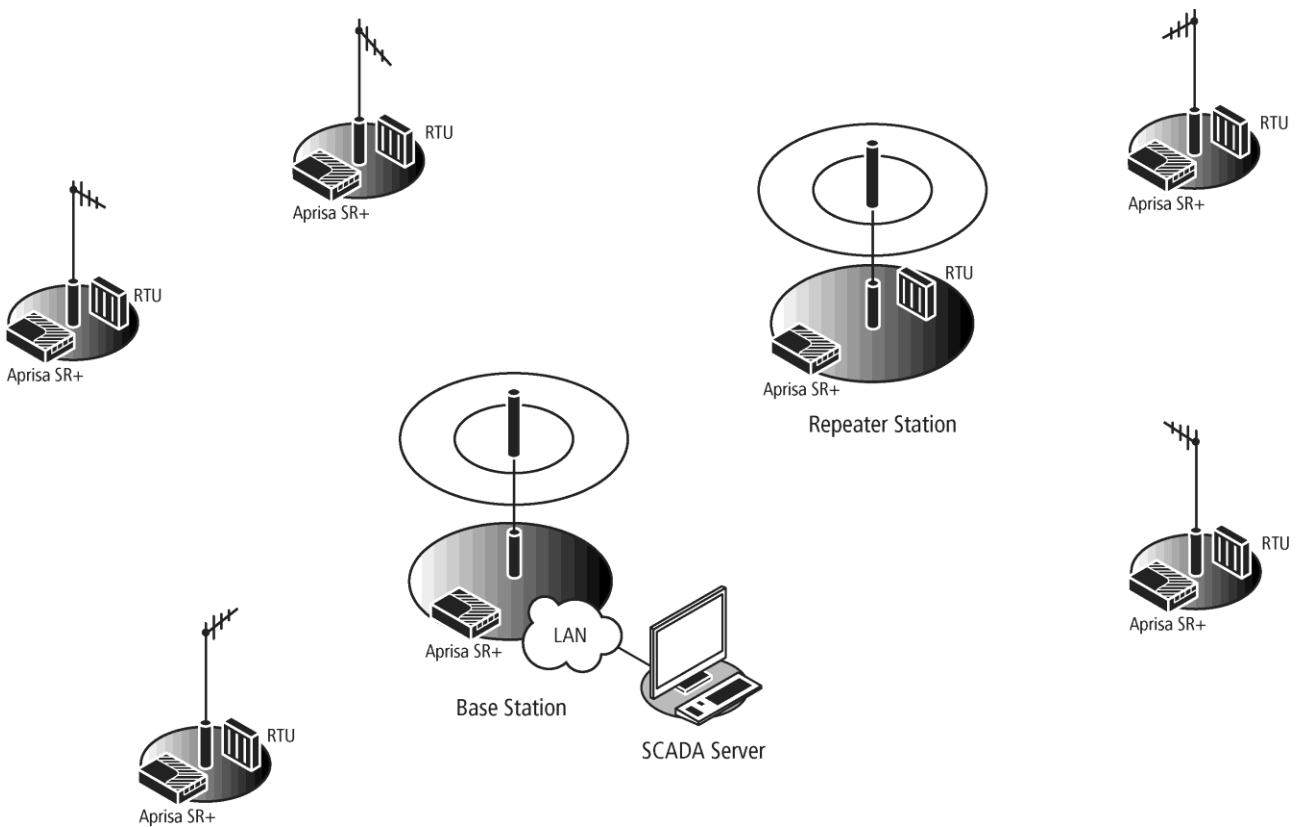
Single base station with Ethernet SCADA data inputs to multiple geographically remote sites with Ethernet RTUs requiring control and data acquisition. A repeater is deployed to service remote sites beyond the reach of the base station.

The base station receives Ethernet frames from the SCADA server LAN and broadcasts all Ethernet frames to the repeater and its remote stations.

Three remote sites have direct radio communication with the base station but the other two remote sites operate via the repeater site.

Each remote site receives Ethernet frames from the RTU and unicasts over the air to the repeater / base station.

The base station and the repeater station use an omni directional antenna to provide wide coverage and the remote stations are fitted with directional Yagi antennas to provide higher gain.



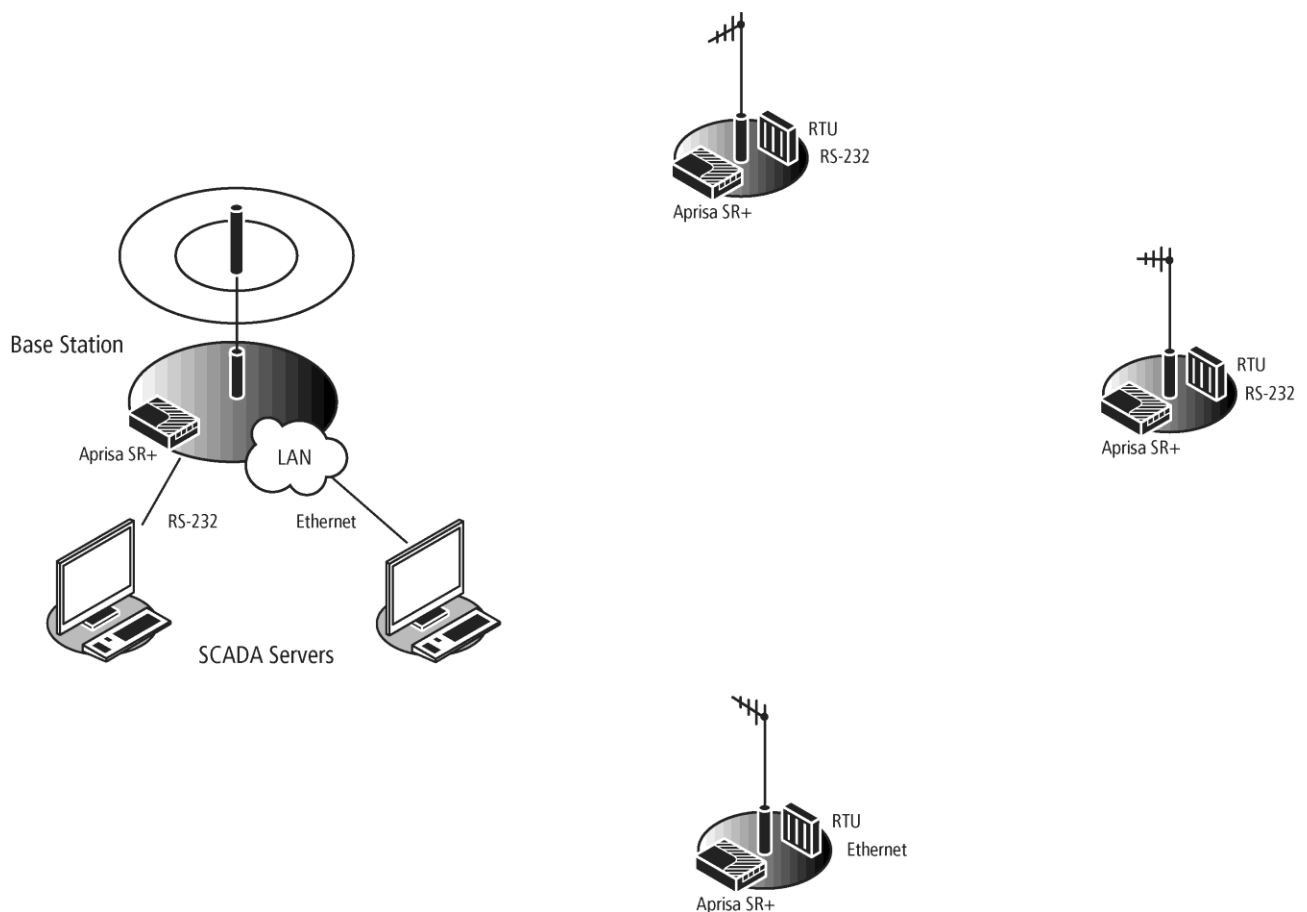
Multi-interface point-to-multipoint application

Single base station with Ethernet and RS-232 SCADA data inputs to multiple geographically remote sites with Ethernet and RS-232 RTUs requiring control and data acquisition.

The base station receives Ethernet / RS-232 frames from the SCADA servers and broadcasts all frames to all remote stations

Each remote site receives Ethernet / RS-232 frames from the RTU and unicasts over the air to the base station.

The base station uses an omni directional antenna to provide wide coverage and the remote stations are fitted with directional Yagi antennas to provide higher gain.



6. Architecture

Product Description

There are three components to the wireless interface: the Physical Layer (PHY), the Data Link Layer (DLL) and the Network Layer. These three layers are required to transport data across the wireless channel in the Point-to-Multipoint (PMP) configuration. The Aprisa SR+ DLL is largely based on the 802.15.4 MAC layer using a proprietary implementation.

Physical Layer

The Aprisa SR+ supports one or two frequency $\frac{1}{2}$ duplex RF operation or full duplex two frequency RF operation.

The $\frac{1}{2}$ duplex RF operation eliminates the need for an external duplexer.

The full duplex RF operation requires the use of an external duplexer connected to the radio's dual antenna ports (TX and RX).

The Aprisa SR+ is a packet based radio. Data is sent over the wireless channel in discrete packets / frames, separated in time. The PHY demodulates data within these packets with coherent detection.

The Aprisa SR+ PHY provides carrier, symbol and frame synchronisation predominantly through the use of preambles. This preamble prefixes all packets sent over the wireless channel which enables fast synchronisation.

Remote nodes are predominantly in receive mode with only sporadic bursts of transmit data. This reduces power consumption.

Data Link Layer / MAC layer

The Aprisa SR+ PHY enables multiple users to be able to share a single wireless channel; however a DLL is required to manage data transport. The two key components to the DLL are channel access and hop by hop transmission.

Channel Access

The Aprisa SR+ radio has two modes of channel access, Access Request and Listen Before Send.

Access Mode	Function
Access Request	Channel access scheme where the base stations controls the communication on the channel. Remotes ask for access to the channel, and the base station grants access if the channel is not occupied.
Listen Before Send	Channel access scheme where network elements listen to ensure the channel is clear, before trying to access the channel.

Access Request

This scheme is particularly suited to digital SCADA systems where all data flows through the base station. In this case it is important that the base station has contention-free access as it is involved in every transaction. The channel access scheme assigns the base station as the channel access arbitrator and therefore inherently it has contention-free access to the channel. This means that there is no possibility of contention on data originating from the base station. As all data flows to or from the base station, this significantly improves the robustness of the system.

All data messages are controlled via the AG (access grant) control message and therefore there is no possibility of contention on the actual end user data. If a remote station accesses the channel, the only contention risk is on the AR (access request) control message. These control messages are designed to be as short as possible and therefore the risk of collision of these control messages is significantly reduced. Should collisions occur these are resolved using a random back off and retry mechanism.

As the base station controls all data transactions multiple applications can be effectively handled, including a mixture of polling and report by exception.

Listen Before Send

The Listen Before Send channel access scheme is realized using Carrier Sense Multiple Access (CSMA). In this mode, a pending transmission requires the channel to be clear. This is determined by monitoring the channel for other signals for a set time prior to transmission. This results in reduced collisions and improved channel capacity.

There are still possibilities for collisions with this technique e.g. if two radios simultaneously determine the channel is clear and transmit at the same time. In this case an acknowledged transaction may be used. The transmitter requests an ACK to ensure that the transmission has been successful. If the transmitter does not receive an ACK, then random backoffs are used to reschedule the next transmission.

Hop by Hop Transmission

Hop by Hop Transmission is realized in the Aprisa SR+ by adding a MAC address header to the packet. For 802.15.4, there are 2 addresses, the source and destination addresses.

Network Layer

Packet Routing

Packet routing is realized in the Aprisa SR+ by adding a network address header to the packet. This contains source and destination addresses. For the Network Layer, there are 2 addresses, the address of the originating radio and the address of the terminating radio (i.e. end to end network). This is required for routing packets across multiple hops e.g. PMP with repeaters.

The Aprisa SR+ uses an automated method for performing address assignment and routing information.

There are two types of packets: unicast and broadcast. Only the base station sends broadcasts which are received by all remote stations. User packets are not interpreted as the radio link is transparent.

Traffic

- Data originating on the base station is broadcast to all repeater stations and remote stations
- Data originating on a remote station is unicast to the base station only
This can be via multiple repeater stations.
- Data originating on a repeater station is unicast to the base station only
- Data originating on a base station serial port is terminated on remote station serial ports only
- Data originating on a base station Ethernet port is terminated on remote station Ethernet ports or serial ports (Terminal Server mode)

User Traffic

User traffic is prioritized depending on the Serial and Ethernet Data Priority options.

If the Serial and Ethernet Data Priority options are equal, then first come first served is invoked.

Repeater stations repeat traffic also on a first come first served basis.

Management Traffic

Ethernet Management Traffic is also prioritized relative to user traffic.

Security

The Aprisa SR+ provides security features to implement the key recommendations for industrial control systems. The security provided builds upon the best in class from multiple standards bodies, including:

- IEC/TR 62443 (TC65) 'Industrial Communications Networks - Network and System Security'
- IEC/TS 62351 (TC57) 'Power System Control and Associated Communications - Data and Communication Security'

The security features implemented are:

- Data encryption
 - Counter Mode Encryption (CTR) using Advanced Encryption Standard (AES)
- Data authentication
 - Cipher Block Chaining Message Authentication Code (CBC-MAC) using Advanced Encryption Standard (AES)
- Data payload security
 - CCM Counter with CBC-MAC integrity (NIST special publication 800-38C)
- Secured management interface protects configuration
- Address filtering enables traffic source authorization
- Proprietary physical layer protocol and modified MAC layer protocol based on standardized IEEE 802.15.4
- Licensed radio spectrum protects against interference

Product Architecture

The following are the key components of the Aprisa SR+ design:

Dual high performance $\Sigma\Delta$ fractional-N synthesizers to allow for full duplex operation

- 2x output frequency VCO for minimal pulling during transmit
- Wideband design electronically tunes over entire band
- Proven ultra low noise and spurious technology with over 50dB of SNR easily achieved

Direct quadrature mixer with integrated Cartesian Feedback Loop

- The Cartesian Feedback Loop improves the efficiency and linearity of the entire transmitter chain for non-constant envelope modulation systems
- Simple IQ modulation line up reduces part count and improves MTBF
- No mixing stages so no spurious responses present at the transmitter output

Digital control loops used for controlling power amplifier current and transmit output power, allows for faster ramping and settling times with less error

- Tx turn-on time limited primarily by PA ramping
- Robust, closed-loop power control - fast, accurate power ramp up and down

Uses the latest high ruggedness N-Channel RF Power LDMOS transistors for the power amplifier

- High efficiency (>50% PAE at 10W)
- Very low thermal resistance (1.0°C/W)

Direct IQ down-conversion

- Excellent Intermodulation distortion characteristics as channel filter can be placed directly after the mixer without impacting noise figure
- Digital channel filtering allows for multiple bandwidths with the same hardware
- Low parts count and no crystal filters help to keep receiver performance extremely stable over temperature

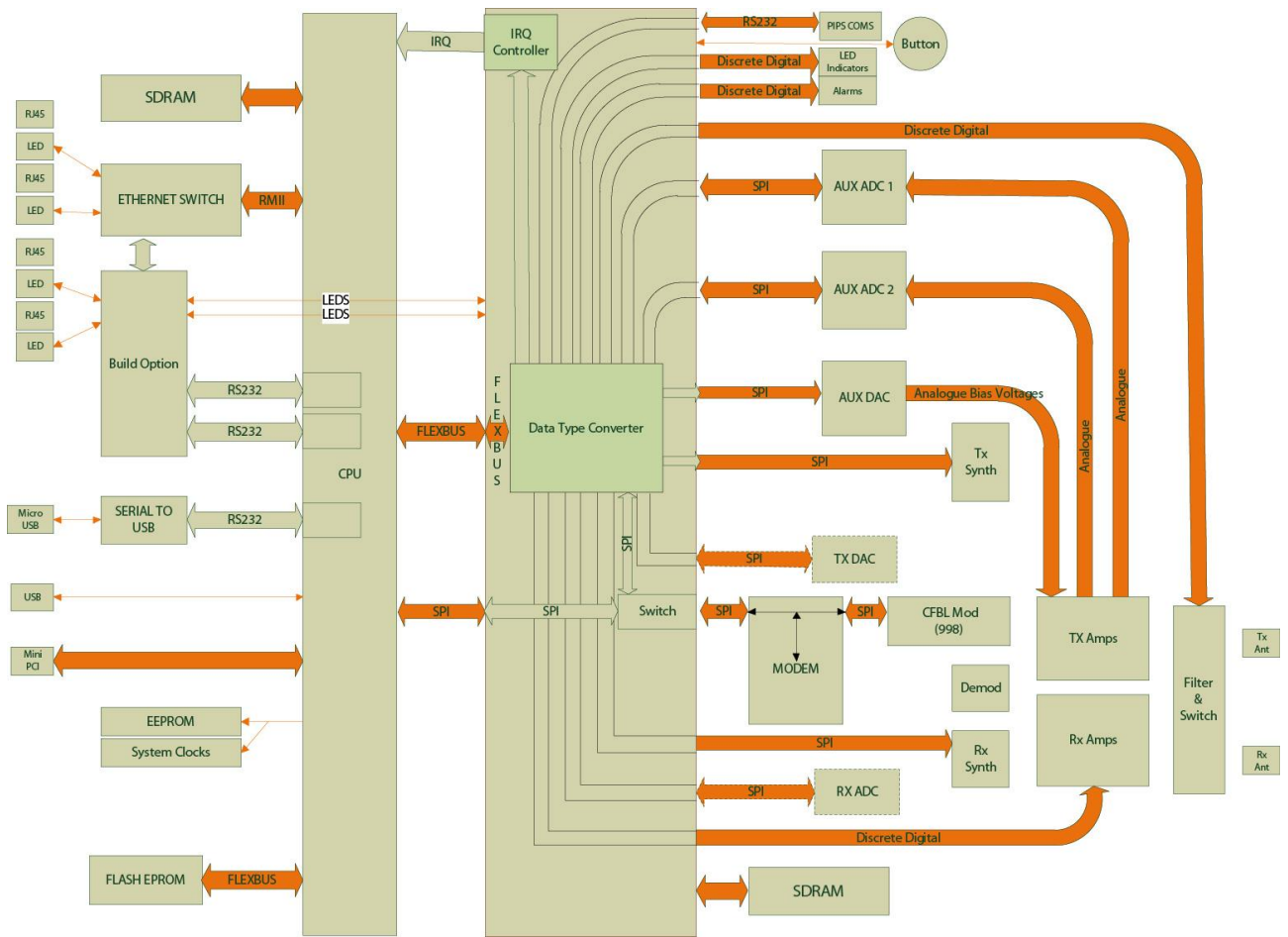
Integrated heat sink

- Limits number of mechanical interfaces
- Fin design optimized for natural convection

Monitoring and software control

- Temperature control loop shuts down the transmitter when the temperature exceeds continuous operation at 70°C
- Monitoring of RSSI and PA current to ensure the RF hardware is functioning to specification

Aprisa SR+ Block Diagram



7. Contact Us

For further information or assistance, please contact Customer Support or your local 4RF representative.

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