



RS500 DATASHEET

Preliminary

### Description

The Radioscape RS500 multi-standard Digital Radio module for consumer products comprises a multi-band RF tuner, a baseband processor and provides decoded audio output. The RS500 can be used as a master device, running a customizable user interface and directly interfacing to displays and buttons or as a slave device using USB, I<sup>2</sup>C or SPI control interfaces.

In addition to Digital Radio Mondial (DRM) and Digital Audio Broadcast (DAB) radio standards, the RS500 also supports AM (long, medium & shortwave) and FM.



### Features

**Radio features** (✓ Included, □ Option)

- DAB Band III reception ✓
- DAB L-band reception ✓
- DRM reception ✓
- FM with RDS reception ✓
- AM reception with AMSS ✓

**Hardware interfaces** (✓ Included, □ Option)

- External serial (I<sup>2</sup>C) control ✓
- External serial (SPI) interface ✓
- USB interface ✓
- Serial digital audio output ✓
- Stereo analogue audio output □
- S/PDIF digital audio output □
- MMC/SD Card Support ✓
- Pin compatible and dimensions identical to RS300L ✓

**Software features** (✓ Included, □ Option)

- Customizable User interface ✓
- Digital radio Rewind ✓
- Electronic program guide (DAB) ✓
- Timer recording to MMC/SD (integrated with EPG) □
- MP3 playback from MMC/SD □
- WMA playback from MMC/SD □
- USB Mass storage class access to MMC/SD □
- CD mechanism support □
- Real-time clock with capacitor back-up □

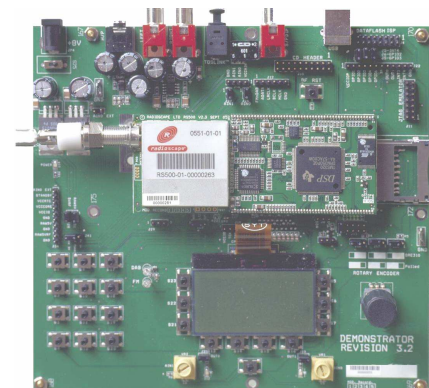
### Applications

Mains and portable digital radio, HiFi receivers, CD players and Boomboxes..

### Ordering information

The RS500 is RoHS compliant.

An Evaluation Kit is available for the RS500, including a motherboard, one RS500 module, power supply, USB cable, programming software and documentation.

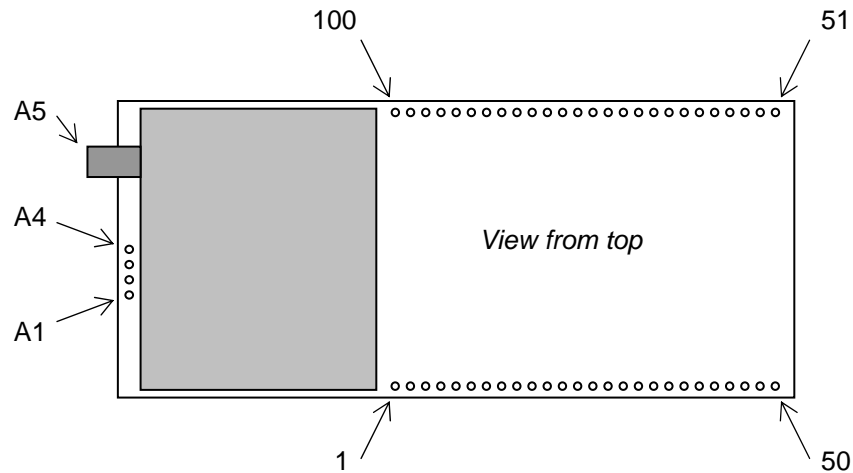


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## Signal definitions

### Block Diagram



### Pin Table

Pin	Signal Name	Type	Description
1	AGND	S	Analogue Ground connection.
2	RAW5VRF	S	5V supply – power source for RF front-end.
3	AGND	S	Analogue Ground connection.
4	CPLDTCK	I	CPLD JTAG TCK connection. No connect for normal operation.
5	CPLDTMS	I	CPLD JTAG TMS connection. No connect for normal operation.
6	CPLDTDO	O	CPLD JTAG TDO connection. No connect for normal operation.
7	CPLDTDI	I	CPLD JTAG TDI connection. No connect for normal operation.
8	GND	S	Ground connection.
9	RAW5V	S	5V supply. Main power source for all digital components when on-board 5V to 3.3V regulator fitted, otherwise no connect if power supplied directly to VCCIO (3.3V) pin.
10	GND	S	Ground connection.
11	VCCIO	S	3.3V supply rail. Driven by on-board 5V to 3.3V regulator if fitted, otherwise supply externally instead of RAW5V.
12	GND	S	Ground connection.
13	BUSOP0	O	Bus Output Bit 0. Drives key matrix in typical application.
14	BUSOP1	O	Bus Output Bit 1. Drives key matrix in typical application.
15	BUSOP2	O	Bus Output Bit 2. Drives key matrix in typical application.
16	BUSOP3	O	Bus Output Bit 3. Drives key matrix in typical application.
17	BUSOP4	O	Bus Output Bit 4. Drives key matrix in typical application.
18	BUSOP5	O	Bus Output Bit 5. Drives key matrix in typical application.
19	BUSOP6	O	Bus Output Bit 6. Drives key matrix in typical application.
20	BUSOP7	O	Bus Output Bit 7. Drives key matrix in typical application.
21	GND	S	Ground connection.
22	EMU0	I	DSP JTAG EMU0 signal. No connect for normal operation.
23	EMU1	I	DSP JTAG EMU1 signal. No connect for normal operation.
24	TDO	O	DSP JTAG TDO signal. No connect for normal operation.
25	TDI	I	DSP JTAG TDI signal. No connect for normal operation.
26	TRST	I	DSP JTAG TRST signal. No connect for normal operation.
27	TCK	I	DSP JTAG TCK signal. No connect for normal operation.
28	TMS	I	DSP JTAG TMS signal. No connect for normal operation.
29	GND	S	Ground connection.

Pin	Signal Name	Type	Description
30	NRST	O	Active-low system reset signal.
31	GND	S	Ground connection.
32	SDA	I/O	SDA line for communication with external I <sup>2</sup> C-compatible devices. No connect if I <sup>2</sup> C not used.
33	SCL	I/O	SCL line for communication with external I <sup>2</sup> C-compatible devices. No connect if I <sup>2</sup> C not used.
34	GND	S	Ground connection.
35	INT0	I	DSP Interrupt 0 line. Connects to key matrix in typical application.
36	INT1	I	DSP Interrupt 1 line. Connects to key matrix in typical application.
37	INT2	I	DSP Interrupt 2 line. Connects to key matrix in typical application.
38	INT3	I	DSP Interrupt 3 line. No connect if not required.
39	INT4	I	DSP Interrupt 4 line. No connect if not required.
40	GND	S	Ground connection.
41	MMC1CLK	O	DX port of McBSP1 of DSP, supporting MMC/SD card interface. No connect if not required.
42	MMC1DAT3	I/O/Z	FSX port of McBSP1 of DSP, supporting MMC/SD card interface. No connect if not required.
43	MMC1DAT0	I/O/Z	CLKX port of McBSP1 of DSP, supporting MMC/SD card interface. No connect if not required.
44	MMC1DAT1	I/O/Z	DR port of McBSP1 of DSP, supporting MMC/SD card interface. No connect if not required.
45	MMC1DAT2	I/O/Z	FSR port of McBSP1 of DSP, supporting MMC/SD card interface. No connect if not required.
46	MMC1CMD	I/O/Z	CLKR port of McBSP1 of DSP, supporting MMC/SD card interface. No connect if not required.
47	GND	S	Ground connection.
48	VCCRTC	S	1.6V supply rail for Real-time clock. Provided to allow external battery backup, if 'Supercap' not fitted on module.
49	VCCCORE	S	1.6V supply rail for DSP core. Only supply externally if 3.3V to 1.6V regulator is not fitted on the module.
50	GND	S	Ground connection.
51	GND	S	Ground connection.
52	SPIDR	I	Receive data line for SPI port, connecting to DR pin of McBSP2 on DSP.
53	SPIDX	O/Z	Transmit data line for SPI port, connecting to DX pin of McBSP2 on DSP.
54	SPICLK	I/O/Z	Clock line for SPI port, connecting to CLKX pin of McBSP2 on DSP.
55	SPISCS	I/O/Z	Synchronisation line for SPI port, connecting to FSX pin of McBSP2 on DSP.
56	GND	S	Ground connection.
57	GPIO6	I/O/Z	GPIO6 pin on DSP. No connect if not required.
58	GPIO4	I/O/Z	GPIO4 pin on DSP. Input for Infra-red remote in typical application.
59	GPIO3	I/O/Z	GPIO3 pin on DSP. No connect if not required.
60	GPO	O	General Purpose output, from latch on RS500. No connect if not required.
61	GND	S	Ground connection.
62	USBDP_CON	I/O	USB differential transmit/receive positive signal. Connect directly to USB connector if USB interface required.
63	USBDN_CON	I/O	USB differential transmit/receive negative signal. Connect directly to USB connector if USB interface required.
64	USBPWR_CON	S	USB 5V power connection. Connect directly to USB connector if USB interface required.
65	GND	S	Ground connection.
66	GPIO2	I/O/Z	GPIO2 pin on DSP. No connect if not required.
67	GPIO1	I/O/Z	GPIO1 pin on DSP. Can be used as an output, but must not be

Pin	Signal Name	Type	Description
			used as an input. No connect if not required.
68	OUT0	O	General-purpose output from latch on module. No connect if not required.
69	OUT1	O	General-purpose output from latch on module. No connect if not required.
70	FMNDAB	O	Logic-level output from module. High during FM/AM reception (32kHz audio sample rate) and Low during DAB/DRM reception (48kHz audio sample rate).
71	GND	S	Ground connection.
72	DFRST	OD	Active-low DataFlash Reset signal. Holding DataFlash reset during booting allows the DSP boot-loader to attempt USB boot. No connect if USB booting not required.
73	NC1	Z	No Connect 1. Reserved, do not connect.
74	NC2	Z	No Connect 2. Reserved, do not connect.
75	EXTCS	O	Chip-select signal for external slave SPI device. No connect if not required.
76	CD_SEL	O	CD Select status, driven low to indicate CD input selected. No connect if not required.
77	CD_SCLK	I	Serial (bit) clock for data transfer from CD mechanism. No connect if not required.
78	CD_DATA	I	Serial data line from CD mechanism. No connect if not required.
79	CD_FSYNC	I	Frame synchronisation signal for data transfer from CD. No connect if not required.
80	GND	S	Ground connection.
81	LCDA0	O	General-purpose output, used as Register Select address line for LCD interface.
82	LCDCS	O	SPI chip-select for serial LCD Interface.
83	GND	S	Ground connection.
84	AMCLK_IN	I	External Audio Master Clock input for when CD input selected. No connect if not required.
85	GND	S	Ground connection.
86	SPDIF	O	Optional S/PDIF output if AK4353 audio DAC fitted.
87	GND	S	Ground connection.
88	AudioMCLK	O	12.288MHz Master Clock output for external audio DAC.
89	DACLK	O	32 x Fs Bit Clock output for external Audio DAC.
90	DADAT	O	Serial Data output for external Audio DAC.
91	DALR	O	Left/Right Clock output for external Audio DAC. 48kHz during DAB/DRM and 32kHz during FM/AM reception.
92	GND	S	Ground connection.
93	AGND	S	Analogue Ground connection.
94	AIN0	I	Input to DSP ADC 0. Supports analogue potentiometer or battery voltage measurement in typical application. Connect to AGND if not used.
95	AIN1	I	Input to DSP ADC 1. Supports analogue potentiometer in typical application. Connect to AGND if not used.
96	AGND	S	Analogue Ground connection.
97	AOUTL	O	Capacitively coupled analogue audio output, left channel.
98	AGND	S	Analogue Ground connection.
99	AOUTR	O	Capacitively coupled analogue audio output, right channel.
100	AGND	S	Analogue Ground connection.

**Types:***S* – Supply (Power/Ground)*I* – Input*O* – Output*Z* – High impedance*OD* – Open Drain Output

## Specifications

### Baseband characteristics

#### DAB

Modes: Decodes all DAB modes (I, II, III, IV with auto-detection).  
 Audio: Decodes all DAB audio modes (mono, dual mono, stereo and joint stereo).  
 24 & 48kHz MPEG decoding with improved DAB error concealment.

Service linking: Other Ensemble Services, Frequency Information  
 Service Linking across all bands

Enhanced Features: Multiple channel decoding  
 Time Shift Recording (Review Function)  
 MP2 record and playback to MMC card  
 FIC and MSC decoding with decoded data made available for enhanced development.  
 Fixed and variable PAD decoding (F-PAD, X-PAD).  
 Support for multiple audio and data channel decoding.

#### DRM

Modes: A, B, C, D  
 SDC Coding: QAM-4 and QAM-16  
 MSC Coding: QAM-16 and QAM-64  
 Spectral Occupancies: 0 (4.5kHz), 1 (5kHz), 2 (9kHz), 3 (10kHz), 4 (18kHz), 5 (20kHz)  
 Interleaving: Long (2s) and short (400ms)  
 Protection Levels: 0 to 3, equal and unequal error protection  
 AFS: Gathers frequency information from current service  
 Text message: Decodes text message for current service from MSC  
 Audio coding combinations supported:

Codec	Coding Rate	SBR	CRC	Channels	Max Bit Rate Bits Per Second *
<b>AAC</b>	12kHz	N	N/A	Mono	13980
	24kHz	Y	N/A	Mono	19980
	24kHz	Y	N/A	Mono	36480
	24kHz	Y	N/A	Stereo	36480
	24kHz	Y	N/A	Parametric Stereo	36480
<b>CELP</b>	8Khz	N	N/A	Mono	12200
	8Khz	Y	N/A	Mono	23800
	16kHz	N	N/A	Mono	13700
	16kHz	Y	N/A	Mono	24860
<b>HVXC</b>		N	N/A	Mono	4000
		Y	Present	Mono	5760
		Y	Present	Mono	6520

\* This is the maximum possible bit rate. The actual bit rate achieved will be reduced depending on the number of features enabled on the receiver.

## Power Supply

The RS500 module provides separate supply pins for RF and digital 5V supplies. In practice, a common 5V regulated supply can be used, but some filtering of the RF 5V supply is recommended (eg a ferrite bead and large decoupling capacitor near the module supply pin).

For standard low-cost applications, linear regulators are fitted on the module to produce the 3.3V logic-level rail (VCCIO) and 1.6V DSP core voltage rail (VCCCORE) from the digital 5V input. If lower power consumption is required, one or both of these regulators can be omitted from the module and external switching regulators with higher efficiency can be used to power the VCCIO and VCCCORE rails.

Parameter	Condition	Min	Typical	Max	Unit
Voltage regulation	Single 5V supply	4.9	5.0	5.1	V
Voltage ripple			10		mV p-p
Current consumption			500		mA

## Environmental & Physical

Parameter	Condition	Min	Typical	Max	Unit
Operating Temperature Range		-10		70	°C
Storage Temperature Range		-40		85	°C

## RF Specifications

Parameter	Condition	Min	Typ	Max	Unit
Input Impedance (nominal)	VHF and L-Band Antenna connection		50		Ω
<b>DAB</b>					
Band III RF frequency range		174		240	MHz
L-band RF frequency range		1452		1492	MHz
Adjacent Channel Selectivity	Measurement to EN50248	35	40		dB
Far-off selectivity	Measurement to EN50248	45	55		dB
Sensitivity	Band III Measurement to EN50248	-96	-99		dBm
	L-Band Measurement to EN50248	-95	-98		
Maximum Input Signal for a BER of 10 <sup>-4</sup>	Band III	-15	-10		dBm
	L-Band	-20	-15		
Frequency Grid (RF front-end frequency select step size)			16		KHz
Acquisition Sensitivity			-102		dBm
<b>DRM</b>					
RF frequency range		0.1485		27	MHz
Blocking			60		dB
Far-off Selectivity			60		dB
Sensitivity		8			dBuV
Dynamic Range		76			dB



<b>FM</b>					
RF frequency range		87.5		108	MHz
RF sensitivity	(S+N)/N = 26dB		2		uV
RF limiting sensitivity			1.2		uV
Large signal handling capacity			500		mV
(S+N)/N	Ultimate signal to noise ratio	62			dB
THD	Deviation 22.5kHz		0.3		%
<b>AM</b>					
RF Frequency Range		0.1485		27	MHz
RF Sensitivity	(S+N)/N = 26dB		3		uV
Large signal handling capacity			300		mV
(S+N)/N	Ultimate signal to noise ratio	50			dB
THD				2	%

### Digital Logic Signals

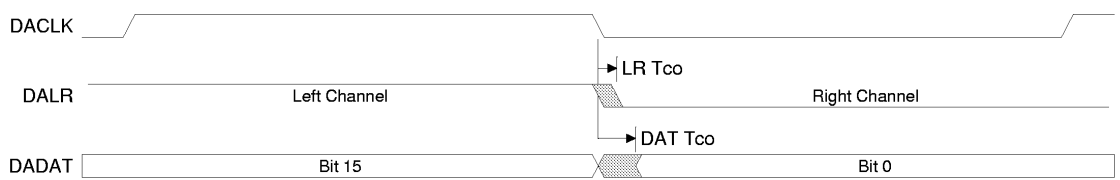
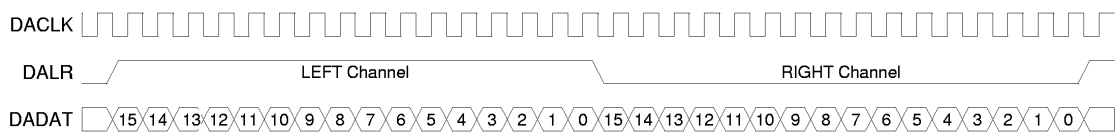
Parameter	Condition	Min	Typical	Max	Unit
High-level input voltage		2.2		3.6	V
Low-level input voltage		-0.3		0.8	V
High-level output current				-4	mA
Low-level output current				4	mA

### Digital Audio Timing

Note that DACLK frequency is 32 x Fs.

i.e. For DAB, DACLK = 32 x 48kHz = 1.536 MHz

For FM, DACLK = 32 x 32kHz = 1.024 MHz



0ns <= LR Tco <= 2ns  
 0ns <= DAT Tco <= 10ns



### Antenna

The RF front-end utilises low-cost down-converter and synthesizer circuitry, and supports DAB (Band III and L-band) and FM signal reception via a single antenna connection. Higher frequency DRM/AM signals are also received via the DAB/FM antenna connector, while a separate interface supporting a ferrite rod antenna is used for lower frequency DRM/AM signal reception.

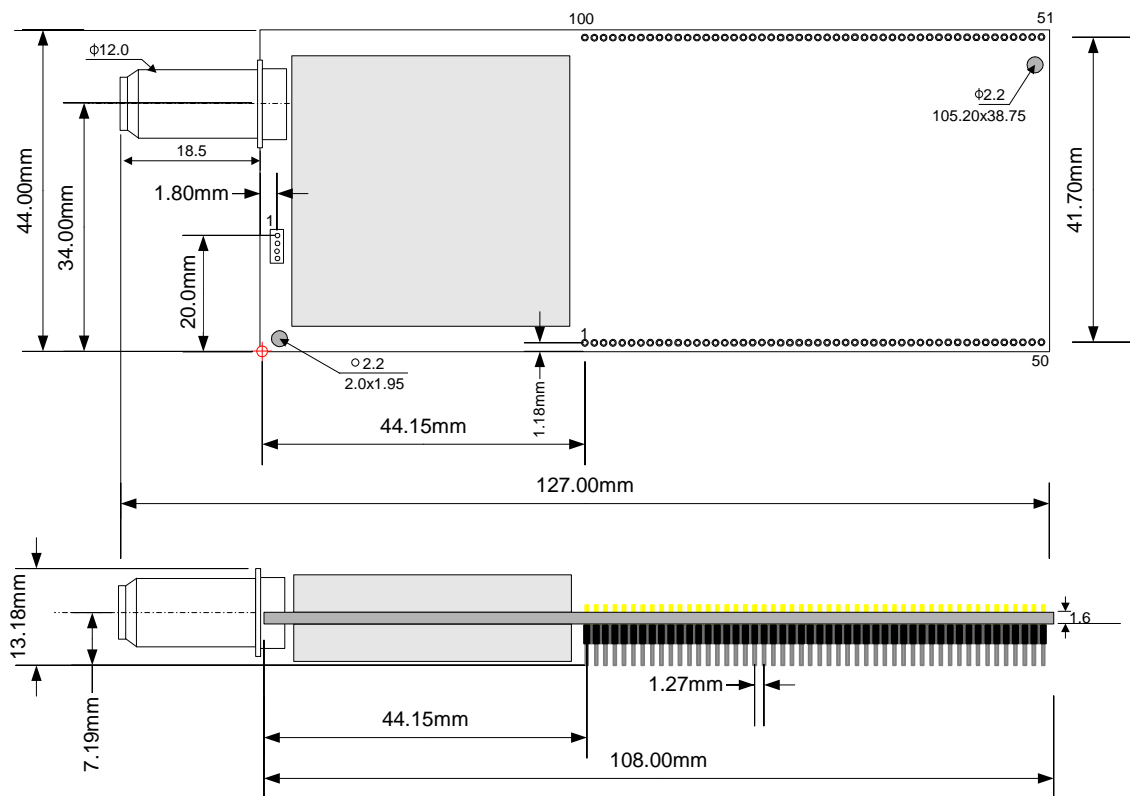
A ferrite rod antenna is recommended for the following frequency bands:

- 150 – 289 kHz (LW)
- 525 – 1720 kHz (MW)

### Display & User interface

The standard RS500 module software incorporates user interface functions supporting pushbuttons, a rotary encoder and a 128-by-64 bit-mapped monochrome LCD display. Alternatively, the receiver can be controlled externally via an I<sup>2</sup>C interface or USB.

### Dimensions & Connectors



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## Contact Information

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