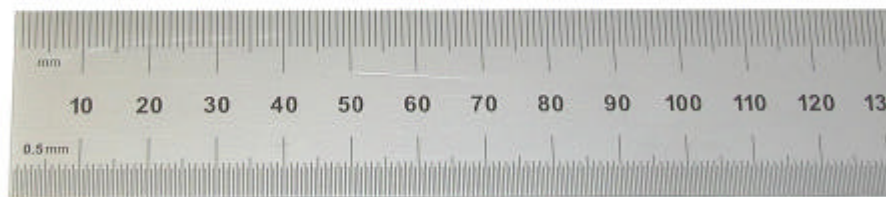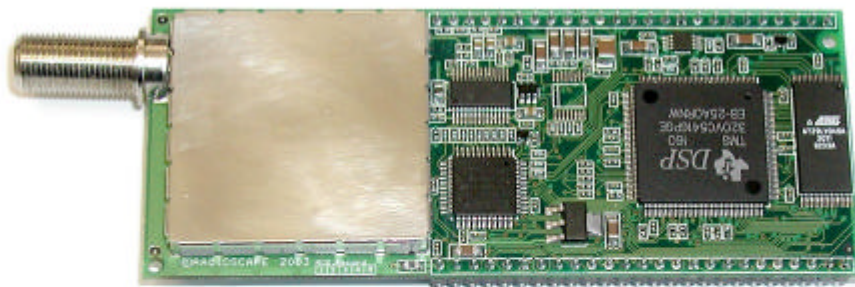RadioScape Ltd.

Using the RS200 Module

Create feature-rich, low-cost digital radio products in record time using RadioScape's RS200 module

The RS200 Module – Introduction

The RS200 is a low-cost, integrated digital radio (DAB) tuner module, which additionally provides fully integrated support for FM/RDS operation. The RS200 greatly simplifies digital radio product design, enabling manufacturers to create their own DAB products with the minimum of additional components. In fact, a complete consumer product would require the addition of only a single 5V power supply, antenna, keypad, display and audio output stage. All the complexities of the digital signal decoding, including a fully-functional HMI (user interface) are dealt with by the module.

The RS200 includes a wide variety of interfacing options. 'Out of the box' it can support the direct connection of a keypad, rotary encoder, and a 2x 16 (or 2 x 20) character LCD display, for which the RS200 acts as master. Although no additional Microcontroller is required to produce a fully functioning radio with the RS200, it is possible to connect one if desired, through the use of the I^2C option.

The use of additional external components allow sophisticated value-added features in more advanced designs, such as the timed recording and replay of audio programs to flash, and adding rewind and pause to the currently playing audio programme.

This application note briefly considers a number of possible digital radio implementations possible using the RS200 module. These are intended as a guide only – further detailed information is available from RadioScape Ltd. upon request.

Key Features of the RS200 Module

Some of the key features of the RS200 module are as follows (please refer to the datasheet for detailed parametric information):

- A standalone digital radio module – just needs an antenna, power supply and audio output to create a fully functioning radio. Includes a state-of-the-art digital radio (DAB) baseband chip, from Texas Instruments, utilising specially customised software written by RadioScape Ltd.
- Excellent sensitivity. With its leading edge RF and baseband software design, the RS200 exhibits a typical sensitivity figure of -99dBm, making it easily one of the most sensitive digital radio receivers on the market.
- Digital FM support. In addition to the Eureka-147 digital radio (DAB) mode, the RS200 also supports the decoding of conventional FM stations, handled with the same hardware (no additional tuner) to keep costs low. Sophisticated digital signal processing is used to ensure high-quality stereo/mono sound and robust frequency tracking. The HMI provided with the module deals with both FM and DAB in a unified manner, to simplify the system design and provide a better user experience.
- Integrated RDS decoder. In FM mode, the RS200 automatically demodulates and decodes any RDS information present in the broadcast, allowing station name, program type etc. to be displayed. RDS information is fully integrated into the supplied HMI.
- Full-featured HMI 'in the box'. Every end product requires a human machine interface (HMI). Unlike other DAB receivers, (which require an external Microcontroller), the RS200 comes supplied with a fully featured HMI that *directly* supports interfacing to a rotary controller, push buttons, and a 2x16 character

LCD. This HMI can easily be customised to provide simple modifications (such as e.g. ensuring a manufacturer's name appears on the LCD at start-up).

- Support for I^2C /SPI control. For those wishing to connect the RS200 to an external system (as may be required when e.g. adding DAB to a 'boombox' product, where a Microcontroller is already present), the optional I^2C /SPI support, together with the 'VIADAB' API, enable the RS200 to be driven in a fully slaved mode. All features available to the internal HMI are also available through the external serial interface.

- Fast parallel interface. In addition to the serial control interfaces, the RS200 module also provides an easy-to-interface parallel port for high speed data transfer. This allows digital PCM audio, MPEG audio frames, and data services to easily be streamed off the chip, for example to an external PCI bridge or USB Microcontroller. Full external control of the receiver is also possible through the parallel interface.

- Support for IR remote control. With the addition on a simple IR receiver, the module can be driven from an external RC-5 remote control unit.

- Real-time clock. The RS200 can provide a battery-backed RTC function, for use in clock radios etc. This can automatically acquire the current time from the digital radio signal, where supported

- S/PDIF output. This can optionally be provisioned, to allow output of digital audio to industry standard devices.

- Serial digital audio. Although the module can be provisioned with an onboard stereo audio DAC, some users will want to use existing system DACs, codecs ,or sample rate converters, and the serial digital audio output, which includes a left/right clock, data clock and serial data line, makes this straightforward to achieve.

- Only a single supply voltage (5V) required. Unlike some DAB products, the RS200 only requires a single supply of 5V for both DAB and FM operation, making it straightforward to provision within a system design. [1]

- Compact size. While the RS200 is ideal for Hi-Fi products, its miniature dimensions (110mm x 44mm x 15mm) and low power consumption (330 mA at 5V typical) also make it suitable for portable and mobile products.

We can now consider a number of examples of how compelling digital radio products may easily be constructed using the RS200 module, ranging from a simple stand-alone radio, to a PC peripheral.

Sample Radio Designs

General System Considerations and Requirements

The great advantage of the RS200 module is that all the complex RF and baseband circuitry, and baseband and HMI software, required for a digital radio is supplied ready assembled and tested. This reduces time to market and development cost, and allows manufacturers to concentrate on adding value to their product.

The additional circuitry required to produce a complete product from the RS200 can be very simple and inexpensive, provided that certain good-practice guidelines are followed. Care should be taken to ensure that the 5V power supplies are clean and well regulated,

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[1] Note that while it is possible to use a single 5V supply with the RS200, best practice would suggest using a separately regulated supply for each of its RF and baseband 5V inputs, to minimise interference with the RF.

and good grounding and shielding should be provided. This will preserve the high-performance of the RF and audio frequency parts of the design, and will minimise any problems with EMC. Although a single 5V line can be used for both the RF and baseband components, better performance will be achieved if the RF has its own supply or a separate regulator.

As mentioned, the module contains a built-in HMI, which can utilise hardware general-purpose inputs and outputs on the module. These interfaces can be gluelessly connected to the user interface peripherals with just a few passive components. It is possible to use the module in a radio with absolutely no modification of the on-board software (or merely extremely simple modifications to provide a manufacturer's name on the display, for example).

A Simple Stand-Alone Radio

Only a very few additional components are required to produce a fully functional DAB/FM radio using the RS200 module, as illustrated in the block diagram below.
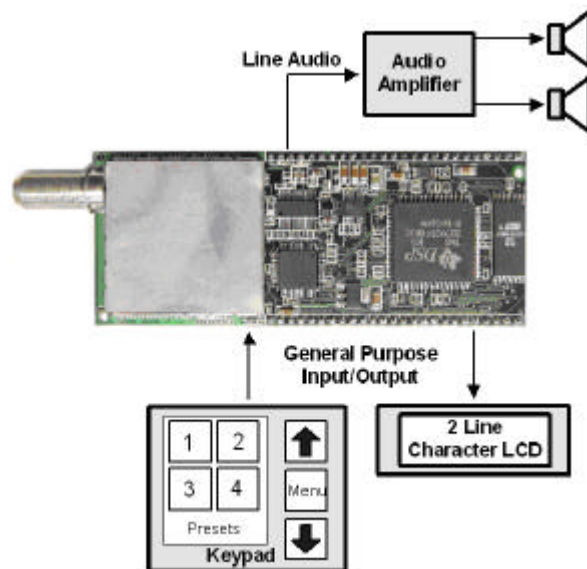
The additional components required are power supply, audio amplifier, speakers/case buttons and LCD. Note that the configurations of the buttons and display are only examples, and can easily be changed (either by the manufacturer or by RadioScape's FAEs) to suit the desired industrial design.

The built-in HMI provides support for the following features:

- Tuning / service selection

- Volume

- Switching between DAB/FM

- Service database (stores available services, to allow users to tune by name)

- Signal quality indication

- Fast scanning to locate available services

- DLS (text accompanying audio services)

- Display of RDS, with station name, program type etc.

- Presets for both DAB and FM

- Non-volatile storage for volume, multiplex, FM channel etc.

A detailed description of the HMI is available from RadioScape on request, together with design documents to assist users in interfacing external controls.

Hi-Fi Tuner / Midi System

For this more sophisticated design, the RS200 is slaved to an external Microcontroller using an I^2C bus. This Microcontroller handles HMI display and keypad, and also controls the other main components of the system, such as audio mixer, CD transport, etc. Note that comprehensive control and status query is possible across the I^2C bus, but that data service or audio payload transfer requires use of the parallel port interface (due to the relatively low bandwidth of the I^2C serial bus). The overall configuration of the system is shown in the block diagram below:
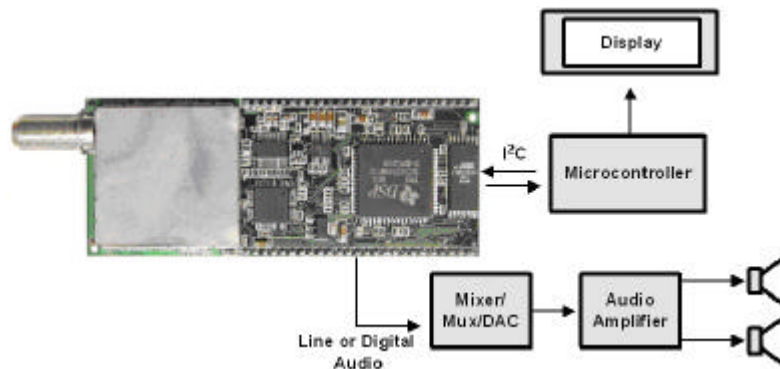
There are a number of options available for output of digital audio:

- The RS200 module with its on-board stereo audio DAC is capable of producing line-level audio output, suitable for connection to a number of standard devices such as mixers, amps etc.

- Serial digital audio (LR clock, serial clock and data) is available, to directly drive DACs, codecs and sample-rate converter chips.

- A S/PDIF interface enables the use of optical and co-ax transmitters, for transmission to high-end DAC units etc.

- The un-decoded MPEG frames are also available through the parallel port of the RS200. This allows recording and/or rendering using an external MPEG chip.

The RS200 is an ideal module for use in a Hi-Fi or Midi tuner design, because it supports high-quality FM, in addition to 'true' digital radio (DAB).

USB Receiver

As mentioned, the RS200 module has a parallel interface, providing a high-speed data channel from the core of the baseband processor. Across this interface it is possible to transfer data services, compressed MPEG audio frames and also control information and status.

The availability of the parallel interface makes possible sophisticated receivers designed to be connected to other computing devices, such as PDAs or PCs. One example here would be a USB-based receiver for connection to a Windows PC. It requires only a small amount of glue logic to interface a USB Microcontroller (such as the ScanLogic SL11R) to the RS200's parallel port, thereby creating a DAB/FM radio peripheral that may be connected to a host computer. RadioScape can provide firmware for the SL11R, and PC-side software, including USB drivers and application UI, as an option to speed up development. RadioScape's PC-side UI provides:

- Full program information, displayed graphically.

- Display of electronic programme guide (EPG), where available.

- Download of MOT carousels / broadcast web sites, where available.

- Recording of programme content, and scheduling of recordings ahead of the time of transmission. Where the EPG service is available, 'one click' recording straight from the audio schedule is provided.

- Recordings can be made in either MPEG 1 layer 2 (the DAB native format) or in the popular MP3 format (RadioScape's PC-side software automatically transcodes the audio).

PCI Card

A variation on this concept is to mount the RS200 module on a PCI card, thereby providing a low-cost, full function receiver that provides an excellent differentiator for PC manufacturers.

Once again, the parallel interface port of the RS200 module is used to move control commands onto the module, and to ship status information and audio/data payload from it back to the host PC.

Of particular interest for this application is the Texas Instruments PCI2040 PCI bridge. This can be gluelessly interfaced to the RS200 module. The module power supply can be derived from the PCI bus, and audio playout can either be directly from the card (via e.g. a line out off the module), or (more likely) via the PC's sound system. Once again, for

manufacturers interested in further reducing design costs and time-to-market, RadioScape has a detailed system design available for a card using the PCI2040 bridge.
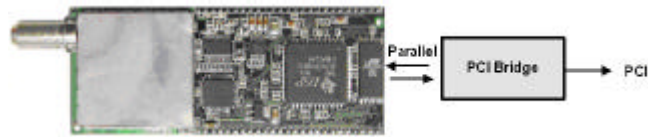
PC-side PCI drivers and user interface (offering features similar to the USB-based product above) are also available from RadioScape as an additional option.

Conclusion

As illustrated in this application note, the RS200 module is a flexible, low-cost DAB/FM receiver module, designed to minimize design cost, complexity and time-to-market. Because it even includes a fully functional HMI, and is easy to interface to external peripherals (from a push-button, through an LCD, up to an external processor if desired), the RS200 represents a very low-risk, low-cost route to manufacturers wishing to develop a range of DAB radios, or augment an additional design (such as a Midi system) with a DAB function. And because the RS200 is based upon the Texas Instruments DRE200 digital radio processor, with specially written software and RF design by RadioScape, manufacturers are assured that their products will have robust performance, reliability, and compliance with the complex international digital radio standards.

RadioScape has a team of design services engineers (and field application engineers) ready to assist manufacturers to bring products to market based upon the RS200 module. RadioScape also has available a number of existing reference designs and technology components (such as drivers and HMI elements) to cut the design time as much as possible for our licensees.

If you are interested in receiving further information on the RS200 please contact:

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