Radiometrix

Hartcran House, 231 Kenton Lane, Harrow, HA3 8RP, England

Tel: +44 (0) 20 8909 9595, Fax: +44 (0) 20 8909 2233

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Application note 013

Multiple channel radios. What are they for, and how do you use them ?

By Myk Dormer - Senior RF design engineer, Radiometrix

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If you browse the catalogues of any of the major telemetry module suppliers, you will become familiar with the two main classes of conventional radio module: the inexpensive, short range, high data rate **wideband** units, and the far longer ranged, but lower speed, **narrowband** types.

But closer inspection will show a few of the wideband, and a higher proportion of the narrowband units, offer **multiple channel** operation. It's obvious what this facility is (the ability of the radio to operate on one of a range of pre-programmed channel frequencies, usually generated by a phase locked frequency sysnthesizer), but the implications, and potential uses, of multiple channel radio deserve examination:

A UHF Multi channel NBFM transceiver

Multiple channel units do not require custom channel crystals (or resonators) to be sourced, and there is no need to keep stock of frequency variants for a given band.

By selecting (manually or automatically) an unoccupied channel, in-band interferers which would otherwise jam a single channel link can be avoided

Several links can operate simultaneously in the same area. (within mutual interference limits set by the adjacent channel, blocking and intermodulation performance of the receivers)

In making good use of the multi channel function, there are a number of choices:

- Factory set-up of operating channel frequency to customer order. The radio is treated as a single channel unit by the end-user, but the channel is programmed according to the customer order, at final test or goods dispatch.
- Manual channel selection. The user sets the operating channel (either by means of a physical switch on the unit, or by sending a command to the radio's serial port from an external controller, which is usually a simple set-up program running on a laptop or pda). This gives the user absolute control over the operating channel of each unit, but requires him to adhere to a consistent band plan, and if possible conduct a simple survey of occupied channels at installation.
- Automatic channel selection. This simple-sounding option requires the application's processor to command the radio module to operate on a given channel at power-on.

  (This is the tip of a very large iceberg: At it's simplest this can be an automation of the manual selection process, with channel being selected according to the identity of the unit communicated with. More sophisticated techniques include forms of unoccupied channel detection and interference avoidance (see note 1), right up to true frequency hopping methods, which usually require specifically designed radio hardware.)

For the user, the choice must be made between the low cost of a single channel unit, and the higher cost (and usually greater size) of the more capable and sophisticated multiple channel module.

Note: Some examples of automatic channel select algorithms. All have their strengths, and weaknesses.

a) Band scanning: The master/controller conducts a scan of the signal level (by monitoring the RSSI level of the receiver) in each available channel in turn on power up or reset. It then selects an unoccupied channel, changes frequency to it, and commences to transmit.
The slave/remote unit(s) scan the available channels on power up, looking for a valid transmit burst from the master on each channel. When found, the remote remains on that channel. If no master transmissions have been received within a given time out period, the remote repeats the scan process.

This method is best used in high reliability control systems, where a constant master transmission is allowable (ie. industrial machine controllers). It requires a transceiver in the master unit, but receive only in the slaves. During scan periods, the slave unit must enter a fail safe/stop mode.

b) Command channel: As in method (a) the master/controller begins with a band scan. It identifies a usable channel. It, transmits an 'acquire command burst (which includes the selected operating channel) on a pre-determined command channel before moving frequency to the operating channel, and listening for an 'acknowledge' burst from the remote. After a given time out period without a valid acknowledge burst, the master restarts the process.

The slave/remote unit listens on the command channel until an 'acquire burst is received, then moves to the operating channel and transmits an 'acknowledge'. From this point on the master and slave alternately exchange command and acknowledge bursts. In the event of either unit failing to receive a burst within it's time out period, the entire process is repeated.

This method requires transceivers at both command and remote ends, and can only synchronise one remote to the master. If the acquire burst duty cycle is kept short, then multiple systems can use the same command channel, and the system gives positive indication of signal reception by the remote. Unfortunately, a fixed interferer on the command channel will disable the system.

c) Semi-automatic band scan: In this method the remote (receiving) unit conducts a band scan on reception of a user command (a specific 'reset' button, or on power up). It then outputs the identity of a suitable, unoccupied channel via a secondary bi-directional data link (a serial cable, or an infra red link) to the controller (transmitting) device. After a successful 'handshake' between the units, both change frequency to the new channel.

This method is an automation of the user site survey process, and requires only minimal additional hardware. It requires manual intervention in the event of a new interferer appearing in band.

Radiometrix Ltd

Hartcran House
231 Kenton Lane
Harrow,
Middlesex
HA3 8RP
ENGLAND
Tel: +44 (0) 20 8909 9595
Fax: +44 (0) 20 8909 2233
sales@radiometrix.com
www.radiometrix.com

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