

# VEHICULAR REPEATERS

## FREQUENCY PLAN REQUIREMENTS FOR 700/800MHZ IN-BAND OPERATION

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**R**adio coverage is the main ingredient of every radio system, in general, and every public safety system, in particular. Unlike commercial systems in which coverage brings revenue, with public safety systems, coverage saves lives. Therefore, coverage is a *must*, not an option. It has to be where and when it's needed. Deploying a large number of base stations to blanket a whole area with a strong radio signal seems to be an obvious solution. However, in wide-area systems this solution can be very expensive. Providing portable grade coverage in geographically large systems, such as statewide, province-wide or countrywide

systems, is economically impossible.

Over the years, the land mobile radio (LMR) industry has been trying to come up with technically sound and economically feasible solutions to radio coverage problems with varying degrees of success. Such solutions as signal boosters, site extenders or vehicular repeaters have found their way into many systems around the continent. Recent developments in vehicular repeaters make them a particularly interesting solution for coverage extension. With a massive rollout of wide-area P25 systems, the DVRS (digital vehicular repeater system) has become an integral component of almost every system.

A DVRS allows portable radios to be used in areas where only mobile radio coverage is available and portable radio coverage is either intermittent or non-existent. Installed in the trunk of a car or in a fire truck, armored vehicle or ambulance, or configured as a transportable or fixed mount, the VRS extends radio communications when portable users are outside of the vehicle, inside a nearby building or in any areas with marginal portable radio coverage.

The most popular use of a DVRS is in in-band applications (see Figure 1, below). The same portable radio is used to communicate directly with the system, as well as through the DVRS when the system cannot be reached directly. Whenever system radio coverage is unavailable, portable radio users can switch to a DVRS channel and communicate via a nearby active VRS (assuming good mobile radio coverage is present).

### IN-BAND DVRS

The DVRS is a versatile, full-duplex digital repeater, designed to be seamlessly interfaced to a remote mount mobile radio. The DVRS is controlled from (and its status is displayed on) the mobile radio control head. It is equipped with all necessary filtering for interference-free operation.

When the DVRS is activated, any outbound calls (mobile radio receiving on the selected TG 1) can be repeated

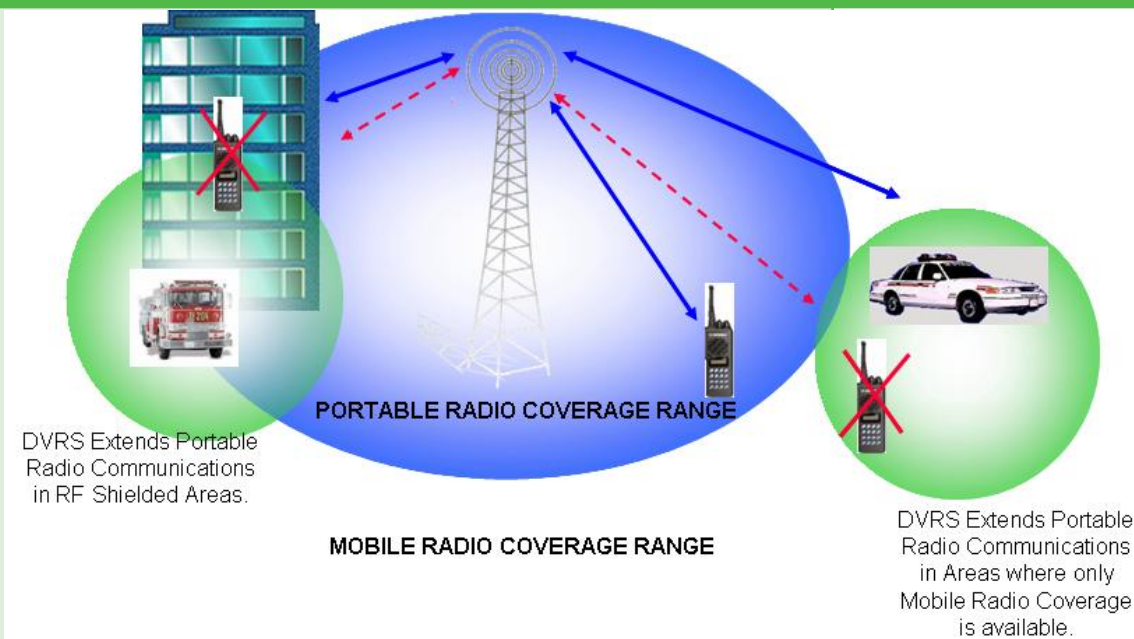


Figure 1: Portable Radio Coverage Extension with In-Band DVRS

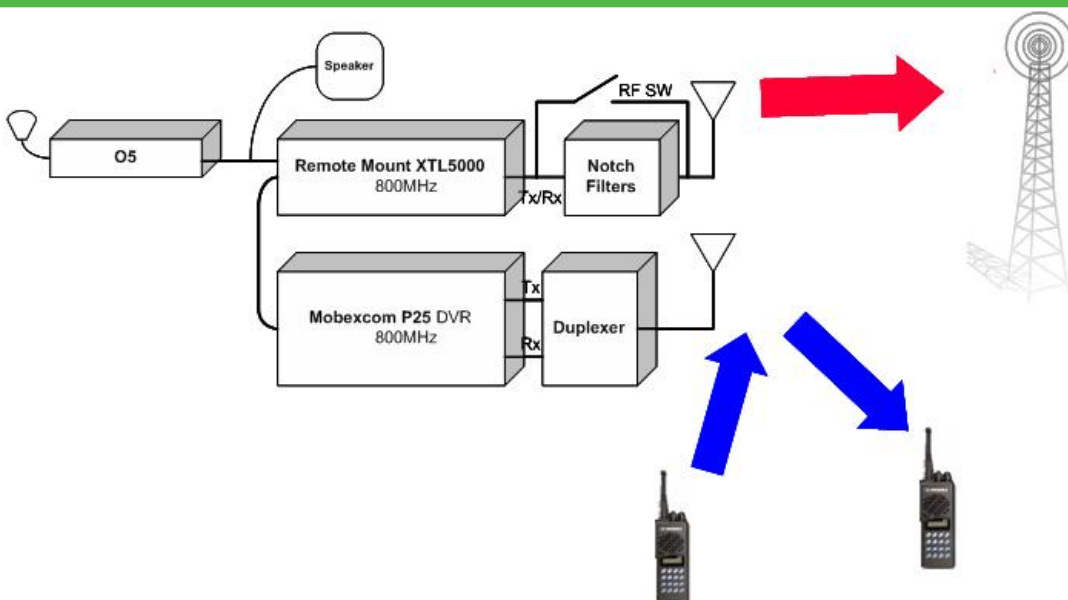


Figure 2: DVRS Conceptual Diagram

to local portable radios over the selected VR conventional digital or conventional analog channel (see Figure 2, p. 73).

Local portables can communicate with each other over the selected conventional channel as well as to system users via the mobile radio. When used in P25 digital mode, the DVRS can support multiple talk groups and provide seamless system coverage extension to the portable users within the DVRS range.

### IN-BAND VRS FILTERING

The in-band DVRS is equipped with two sets of filters (see Figure 2, p. 73):

- A duplexer, providing the necessary isolation between the DVR transmit and receive frequencies, as well as rejecting the mobile radio frequencies.
- An in-band filter installed at the output of the mobile radio, rejecting the DVR transmit and receive frequencies.

A minimum of 30-dB antenna isolation must be provided to ensure interference-free operation of both the mobile radio and the VR.

### IN-BAND FREQUENCY ALLOCATION REQUIREMENTS

For the DVRS to be configured for in-band operation, the DVRS frequencies

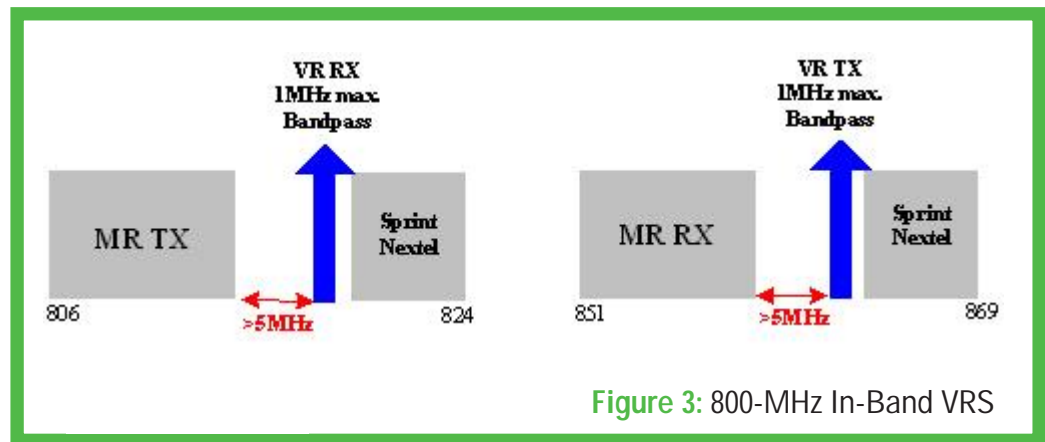


Figure 3: 800-MHz In-Band VRS

must be separated from the mobile radio frequencies by at least 3 MHz, with 5-MHz separation generally recommended. Any closer distance would require large, expensive filters that would make a mobile-based application impractical. In addition, the VRS frequencies must be typically allocated within a 1-MHz bandpass window (i.e., the spacing between the highest and lowest VRS transmit frequencies must not exceed 1 MHz). Again, any wider bandwidth would require larger and more expensive filters.

### IN-BAND VRS FREQUENCY ALLOCATION EXAMPLES

*Example 1—Big City Fire Department:* A big city fire department is using a trunking system operating in the public safety 821–824/866–869 MHz band. Due to the 800-MHz rebanding process, its trunking

system frequencies are shifted to 806–809/851–854 MHz. The fire department would like to use in-band DVRS to improve portable radio communications inside buildings.

The fire department needs to apply for several DVRS frequencies to allow for independent fireground operation during several fire incidents occurring at the same time in the city. The DVRS frequencies must meet the minimum frequency separation requirements, and the fire department is presented with the following possible scenarios:

- Use an 800-MHz VRS operating at 814–815/859–860MHz, keeping the VRS frequencies 5 MHz away from the trunking system frequencies (see Figure 3, above).
- Use a 700-MHz VRS operating at 769–775/799–805 MHz to allow for future addition of other

**The DVRS frequencies must meet minimum frequency separation requirements.**

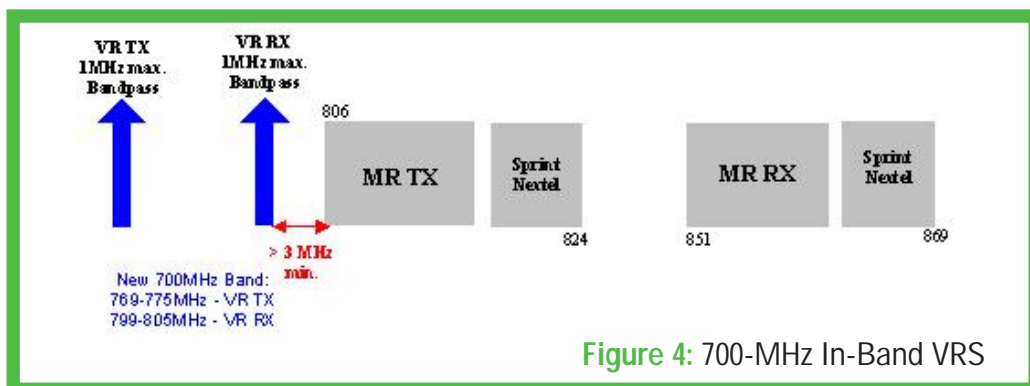


Figure 4: 700-MHz In-Band VRS

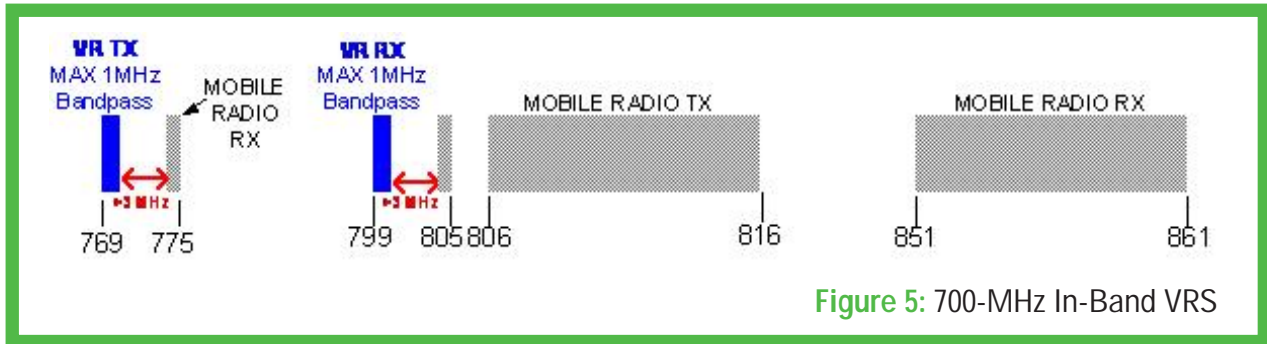


Figure 5: 700-MHz In-Band VRS

trunking systems, using 806–816/854–861 MHz, which would be used with the VRS (see Figure 4, p. 74).

*Example 2—Smaller Town Sheriff's Office:* A smaller town sheriff's office is using a trunking system operating in the public safety 821–824/866–869 MHz band. Due to the rebanding process, its trunking system frequencies are shifted to 806–809/851–854 MHz. In addition, the smaller town sheriff's office needs to be able to help out neighboring counties, which are using trunking systems operating on 806–815/851–860 MHz frequencies. The sheriff's office requires

VRS operation to improve portable radio coverage in some buildings, as well as in some rural areas where trunking system coverage is marginal.

The smaller town sheriff's office is considering one of the following scenarios:

- a. Use an 800-MHz VRS operating at 814–815/859–862 MHz, keeping the VRS frequencies 5 MHz away from the smaller town trunking system frequencies (see Figure 3, p. 74). The VRS will always be disabled when the users select a talk group from the neighboring county systems. The sheriff's office users will never be able

to use their in-band VRS with any other 800-MHz trunking systems other than the sheriff's office trunking system operating at 806–809/851–854 MHz.

- b. Use a 700-MHz in-band VRS operating at 769–775/799–805 MHz and have the VRS operation enabled on all 800-MHz trunking systems (see Figure 4, p. 74).

*Example 3—Statewide Public Safety Radio System Users:* A group of public safety agencies is using a statewide trunking radio system operating on rebanded frequencies in the 806–816/851–861 MHz band.

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## Allowing low-power VRs to use guard band seems to be a win-win solution for everybody, with a very low risk of interference.

It is also considering expanding the trunking system to the new 700-MHz range in the near future. All agencies require portable radio coverage extension in buildings as well as at the fringes of the trunking system and are considering using VRS.

They have to apply for frequencies to meet their present and future requirements and are presented with only one feasible in-band option: Allocate the low end of the new 700-MHz band (769-770/799-800) for VRS operation, and allocate the high end of the 700-MHz band (773-775/803-805 MHz) for future trunking system expansion. VRS operation will be supported with both the existing 800-MHz as well as with the future 700-MHz (high-end) trunking systems (see Figure 5, p. 76).

### CALL FOR ACTION

Although today's DVRs are highly complex, sophisticated, well controlled and much less prone to interference than older repeaters, the rules for using them have not changed. With vehicular repeaters becoming more and more popular as the most viable large area or in-building coverage extension solutions in LMR public safety systems, it becomes imperative that legislative action be taken to recognize vehicular repeaters as a mainstream coverage solution and allocate some small sub-band of the LMR frequency bands for exclusive use by those devices.

In many cases, lack of technically appropriate frequencies prevents system integrators from using this cost-effective solution. It seems that reorganization of

the 700-MHz band creates a perfect opportunity to do just that. The most logical place to position a VR-specific sub-band would be the very bottom of the new 700-MHz band or even a guard band. Allowing low-power VRs to use guard band seems to be a win-win solution for everybody, with a very low risk of interference. The original allocation of a few analog 700-MHz channels for fire-ground applications was not sufficient for wide-area systems.

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