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Futurecom Systems Group, ULC

VR Functional Description

Applies to: DVR-LX®, DVR & VRX1000

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Manual Revisions

Rev #	Date	Notes & References
0	November 23, 2020	Original Release
1	February 2021	Update for SR2021.1
2	August 2021	RM-OTAP information added
3	November 2021	Update for SR2021.4: Primary / Secondary Feature
3.2	January 2022	Forced Analog
4	June 2022	Update for SR2022.2
4.2	August 2022	Talkgroup
4.3	December 2022	NAC Linking Update
4.4	March 2023	AVRA Update
4.5	August 2023	Update for SR2023.2

Foreword

Futurecom Vehicular Repeater (**VR**) is designed to be seamlessly interfaced to:

- Remote Mount APX Series **MSU** with or without control head

When the VR is interfaced to a Remote Mount Motorola APX Mobile Radio, the complete equipment package is referred to as Digital Vehicular Repeater System (**DVRS**).

For requirements on compatible Mobile and Portable radios visit the Futurecom website: Home → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Firmware Upgrades → Compatibility Charts

For details on the APX series Mobile or Portable Radios operation, please refer to the applicable Manuals available from Motorola.

For details on how to operate a VR, please refer to the Vehicular Repeater (VR) User's Guide Template available on the Futurecom website → Support Portal → Documentation and Software → DVR-LX/DVR/VRX1000 → User Guide.

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Key Terminology

TERM	DESCRIPTION
VR	Futurecom line of Vehicular Repeaters. It applies to any of the following products: DVR, DVR-LX® and VRX1000.
DVRS	When a Vehicular Repeater (DVR/DVR-LX®/VRX1000) is interfaced with an MSU, the complete equipment package is referred to as a Digital Vehicular Repeater System (DVRS).

Documentation Conventions

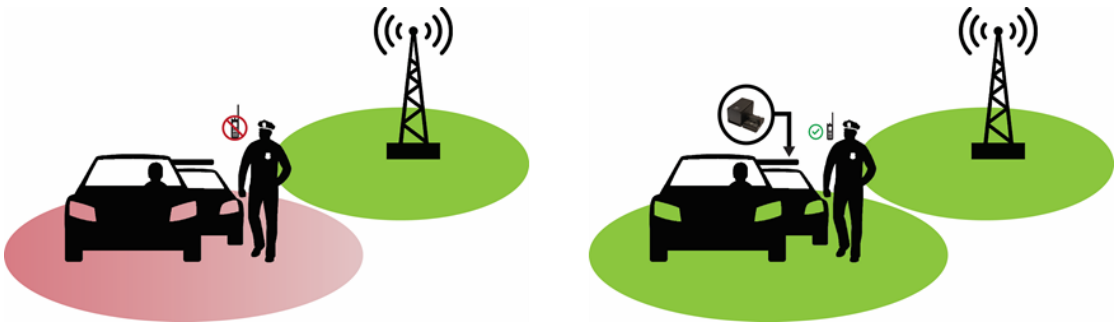
The following table provides information on conventions used throughout the document.

Convention	Description	Examples
Blue, Italic, Bold text	Feature license required or limitations of feature	Rackmount with 50-watt amplifier – DVR-LX ***Limitations:*** • Primary/Secondary feature not available • Transmit Power fixed at 50 watts • Busy Lockout not available GPS DRIVEN DEACTIVATION ***Feature License – GPS Driven Deactivation*** *required to enable this feature*

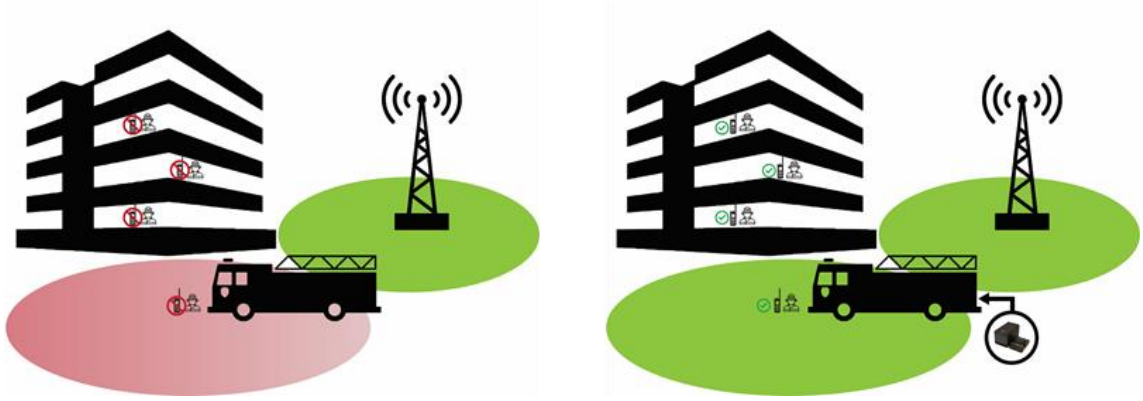
Introduction

The P25 Digital Vehicular Repeater System (**DVRS**) allows Portable Subscriber Units (**PSU**) to be used in areas where only Mobile Subscriber Unit (**MSU**) coverage is available and PSU coverage is either intermittent or nonexistent.

Installed in the trunk of a car, fire truck, armored vehicle, ambulance or configured as a Suitcase Mount or Fixed mount VR, the DVRS extends radio communications when the PSU users are outside of the vehicle, inside a nearby building or in any PSU marginal coverage areas.



POLICE VEHICLE MOUNT SCENARIO: PSU COVERAGE RANGE- WITHOUT vs WITH VR



FIRE VEHICLE MOUNT SCENARIO: PSU COVERAGE RANGE- WITHOUT vs WITH VR

The DVRS not only extends voice (clear or encrypted) communications but also supports key Trunking system features and can be configured to provide various advanced options to the PSU Users.

Hardware Platforms

Vehicle Mount – DVR-LX, VRX1000

This configuration involves installation of the control head in the front of the vehicle for user access; the VR and MSU are installed in the trunk, back seat or other space in the vehicle.

Suitcase Mount – DVR-LX

The DVRS is packaged in a durable suitcase and includes all necessary electronics and filtering. The unit can be easily deployed in the field and is powered up either by plugging into an AC outlet or by using an optional battery backup kit. The battery backup kit is also packaged in a suitcase for ease of transportation.

The Suitcase Mount model requires two or more antennas - one or more connected to the MSU and one to the VR. The MSU antennas need to be strategically deployed to ensure reliable link between the MSU and the Radio System Infrastructure. The VR antenna needs to be positioned to provide optimum radio coverage for the portable radio users.

Rackmount – DVR-LX

The rackmountable tray fits in a standard 19" rack. It seamlessly integrates with Motorola Solutions APX™ mobile radios to provide reliable RF backhaul.

Rackmount with 50-watt amplifier – DVR-LX

The DVR-LX® Rackmount Repeater the same but provides a 50 watt amplifier to fill challenging coverage gaps.

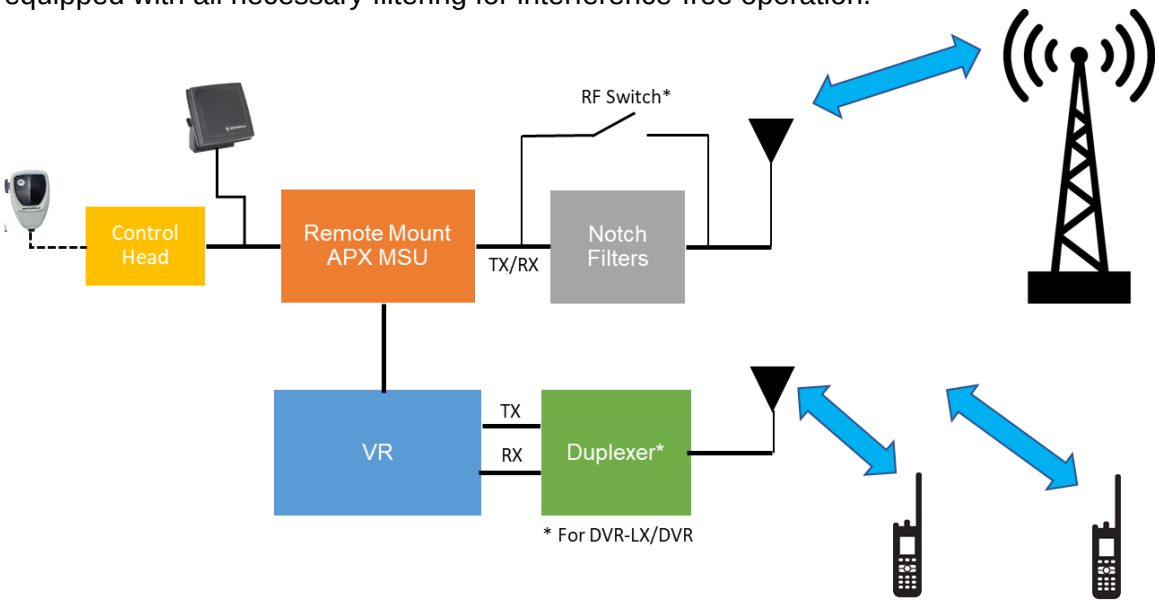
Limitations:

- Primary/Secondary feature not available
- Transmit Power fixed at 50 watts
- Busy Lockout not available
- Simplex operation not available due to sensitivity loss

VEHICLE MOUNT , SUITCASE MOUNT AND RACKMOUNT

DVRS Principle of Operation

The P25 VR is a versatile, digital repeater[1], designed to be seamlessly interfaced to a Remote Mount APX MSU (see **DVRS: VR Compatible APX Mobile Radios**[2] list). The VR is controlled from (and its status is displayed on) the MSU Control Head and is equipped with all necessary filtering for interference-free operation.



Note: RF Switch is standard with DVR/DVR-LX and optional for VRX1000

Figure 1 DVRS Conceptual Diagram

When the VR is activated in SYSTEM mode, any Outbound Calls on **TG X** (selected on the local PSUs) are repeated to the local PSUs over the selected VR conventional digital channel (***CH1 TG X***). When a local PSU switched to **CH1 TG X** makes a call, the VR repeats it locally on **CH1 TG X** as well as to the system by keying up the MSU on **TG X**.

NOTE:
Simplex VR operation is also supported and is programmable per channel or imposed by VR model selection.

[1] DVR/DVR-LX are full duplex VR while VRX1000 is simplex only
[2] Latest list published on Futurecom website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Compatibility Chart

Frequency Band of Operation

Depending on the frequency band of operation of the APX Mobile Subscriber Unit (MSU) and VR, the VR models are classified as follows:

- **In-Band** – when the MSU and VR operate in the same frequency band.
- **Cross-Band** – when the MSU and VR operate in different frequency bands.

Cross-Band

Cross-Band VR models do not include any filters on the MSU side since the MSU and VR are not intended to simultaneously operate in the same frequency band. In single band MSU configurations the MSU and VR operate in different frequency bands. In dual band MSU configuration either the MSU & VR operate in 3 different frequency bands or one of the MSU frequency bands is locked out when VR operation is enabled as shown on **Figure 2**.

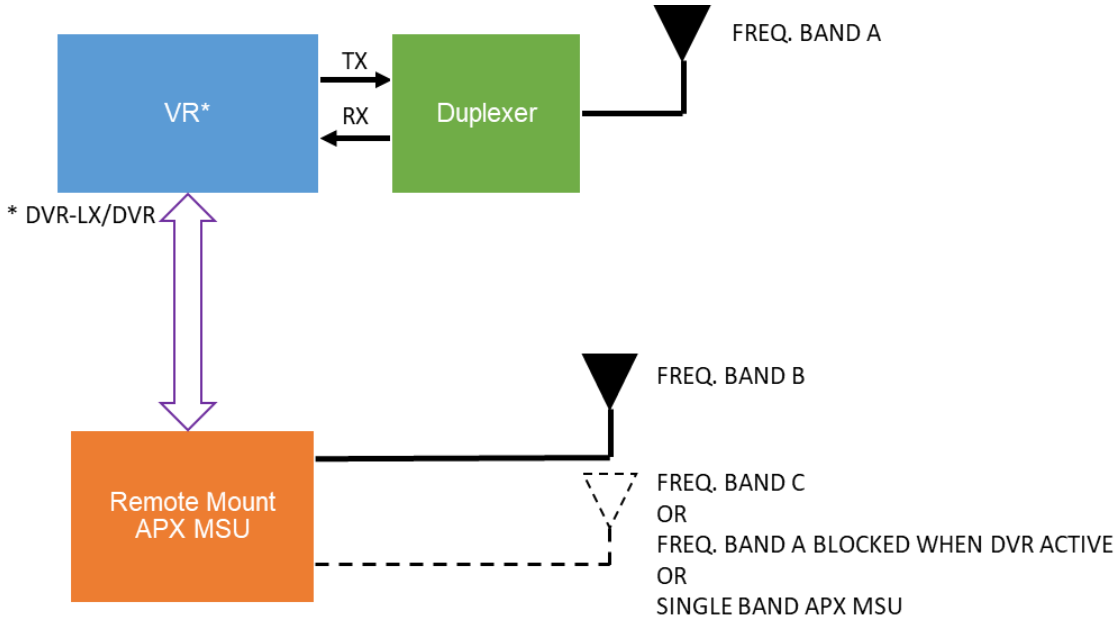


Figure 2 Cross-Band DVR / DVR-LX - Conceptual Diagram

The cross-band DVR / DVR-LX typically includes a duplexer which can accommodate full duplex and simplex VR operation as shown on **Figure 2.** The cross-band duplexer however has a limited pass-band window and is tuned to the VR frequencies provided on the purchase order.

To ensure interference-free performance when using VR with APX 8500 Mobile Radio, additional equipment or isolation may be required. Please refer to the VR Ordering Guides or contact Futurecom.Sales@motorolasolutions.com for more information.

As an option, a cross-band DVR / DVR-LX can be configured for simplex **only** operation as shown. In this case the DVR / DVR-LX does not utilize any filters.

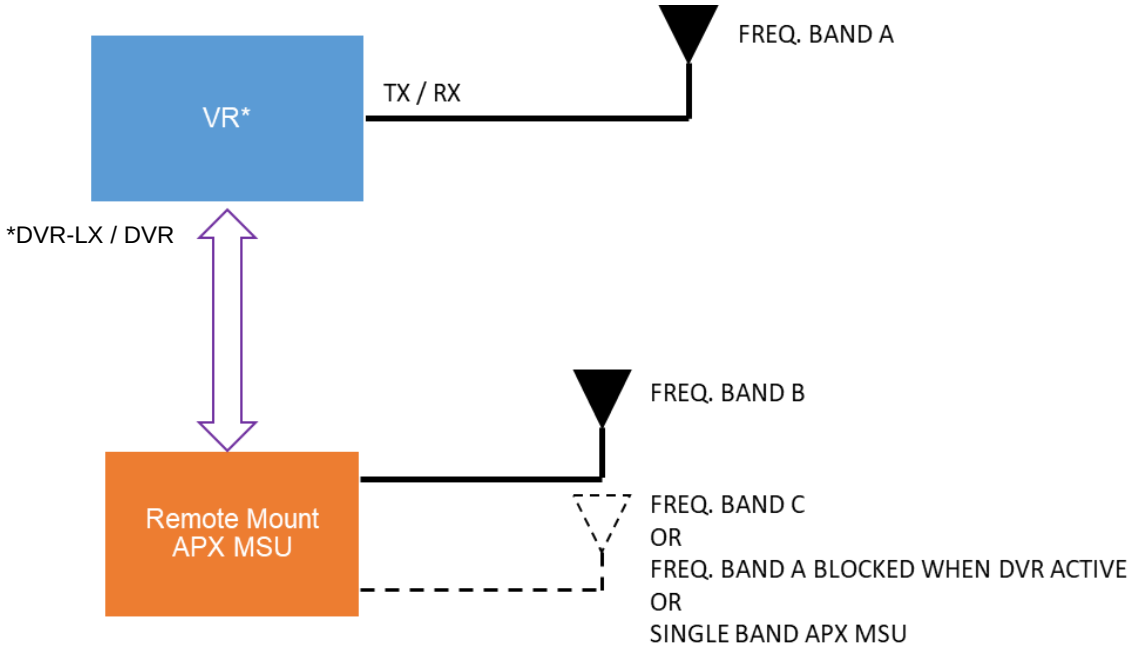


Figure 3 Cross-Band Simplex DVR-LX / VRX1000 - Conceptual Diagram

APX 8500 may require interface kit. Please refer to the VR Ordering Guides.

NOTE:
The vehicular (side-by-side) mount Cross-Band VR can be interfaced to a High Power MSU, however, the transmit power of the MSU must be reduced to comply with the maximum power restrictions described in the RF Safety Booklet 8F083X03, which is provided with the VR.

IMPORTANT!
The VR is shipped equipped with custom filters tuned to the specified frequency range provided by the Customer. Programming the VR / MSU to operate on frequencies outside of the original specified bands may result in intermittent or complete loss of communications. Frequency changes may require filter retuning or replacement.

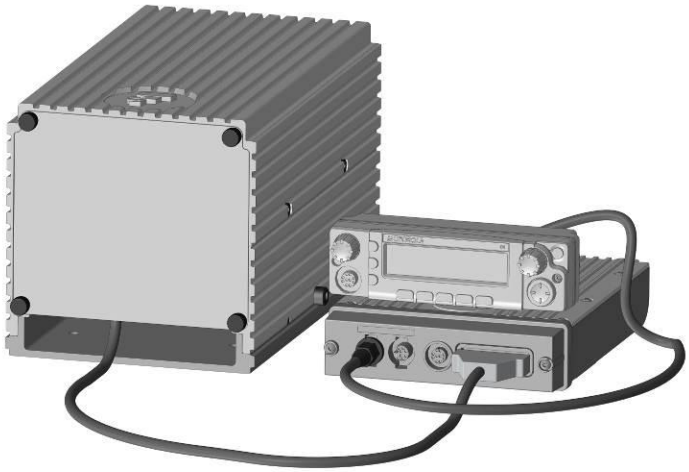


Figure 4 Vehicular Mount Cross Band DVRS Model – Full Duplex & Simplex Capable

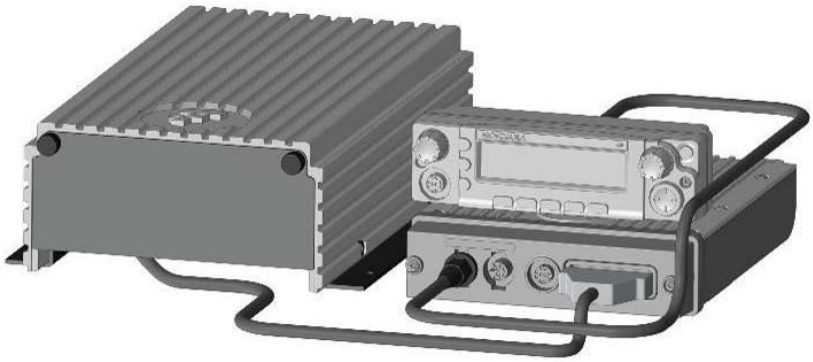


Figure 5 Vehicular Mount Cross Band DVRS Model - Simplex Only Capable

In-Band

The in-band VR models are equipped with two sets of filters that are required to ensure interference-free operation when both the MSU and VR are transmitting and receiving simultaneously in the same frequency band. The DVR / DVR-LX are full duplex capable repeaters, equipped with a duplexer, which provides sufficient isolation to prevent desense during VR repeat activation. The VR filters also provide 40 dB isolation on the mobile radio transmit / receive frequencies. The filters installed at the output of the MSU are designed to provide 40 dB isolation on the VR transmit and receive frequencies.

IMPORTANT!
The above filtering isolation must be complemented by 30dB minimum antenna isolation (between the VR and mobile radio antennas) to ensure interference-free operation. It is recommended that the mobile antenna is mounted on the roof of the vehicle while the VR antenna is mounted on the trunk. Each VR is equipped with custom filters tuned to the specified frequency bands – note the frequency range specified on the filter labels. Programming the VR / mobile radio to operate on frequencies outside of the original specified bands may result in intermittent or complete loss of communications. Frequency changes may require filter retuning or replacement.

The RF Switch by-passes the in-band mobile notch filter when a “DVR-Disabled” talkgroup or channel is selected **(Figure 6** In-Band DVR / DVR-LX - Conceptual Diagram and **Figure 7).** This allows the MSU to operate over its full bandwidth and prevents loss in transmit power. If the RF Switch is not utilized, the MSU utilizing the same band as the VR will not function on certain frequencies or could have a loss in transmit power.

The RF Switch is internally mounted in the DVR/DVR-LX mobile notch filter assembly or a stand alone RF Switch for the VRX1000.

When a “VR – Enabled” TG is selected on the MSU CH, the RF Switch automatically connects the extra filters between the MSU antenna port and the MSU antenna to ensure interference-free operation. The complex in-band filtering is only feasible if sufficient frequency gap is present between the VR frequencies and the MSU frequencies associated with the “VR - Enabled” TGs. For more information on the feasible filtering options, please refer to the VR Ordering Guides. As an option, an in-band DVR / DVR-LX can also be configured as simplex only (**Figure 7**). The simplex in-band configuration however still requires DVR in-band filters.

IMPORTANT!
In all In-Band VR configurations, the MSU Transmit power must not exceed 50 Watts on DVRS Enabled MSU Modes due to the in-band filters power rating. The in-band filters connected to the MSU have typical insertion loss of 1.5dB.

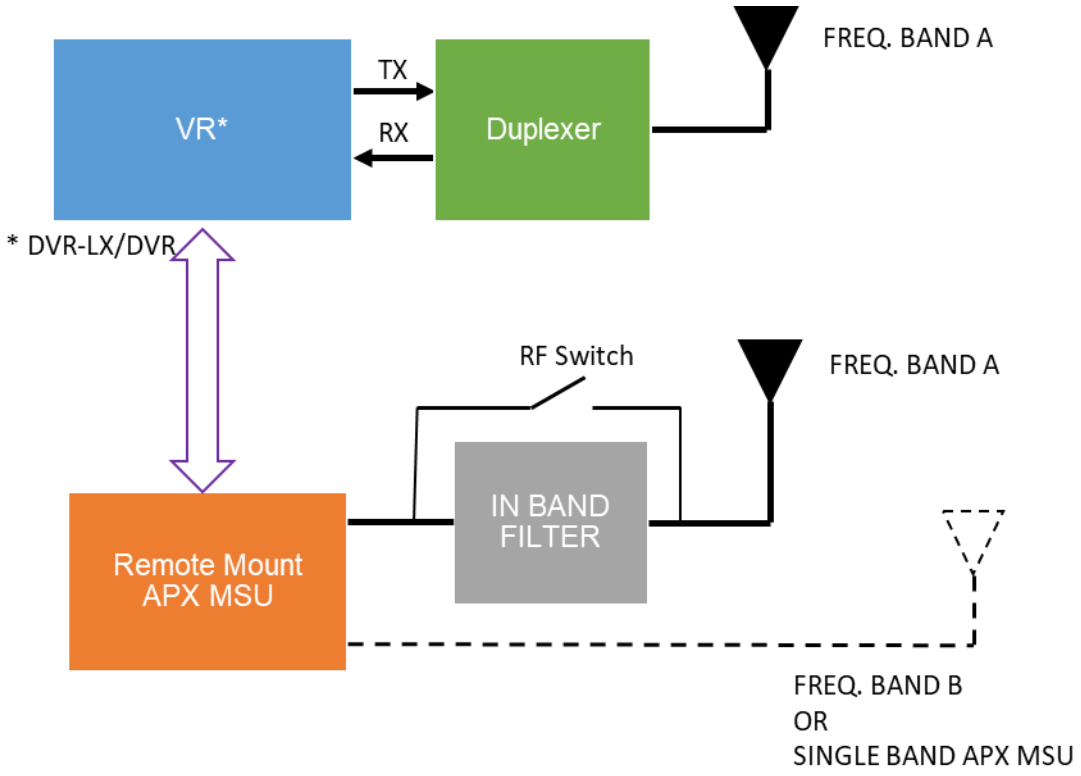


Figure 6 In-Band DVR / DVR-LX - Conceptual Diagram

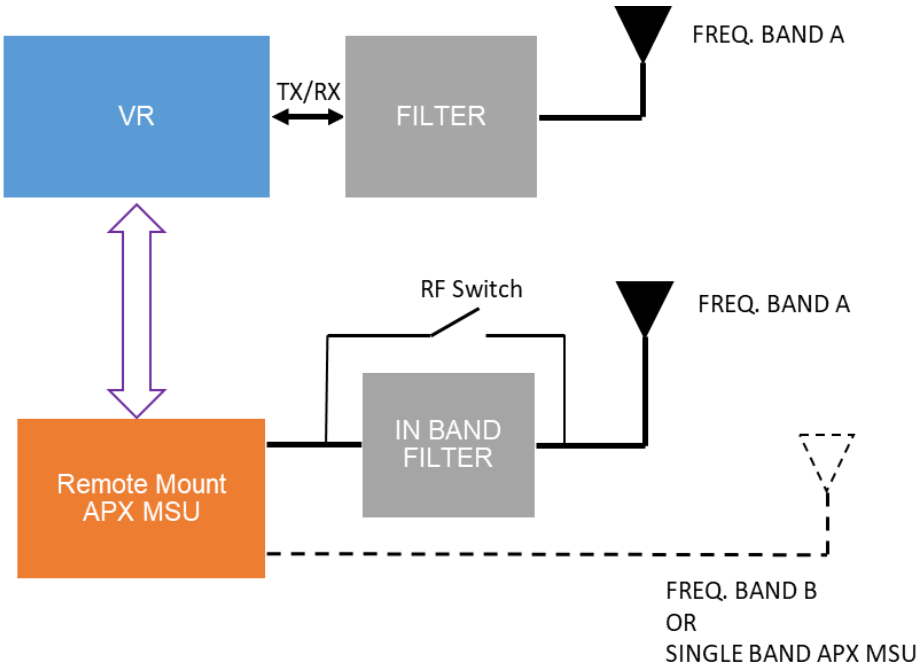


Figure 7 In-Band Simplex DVR / DVR-LX / VRX1000 - Conceptual Diagram

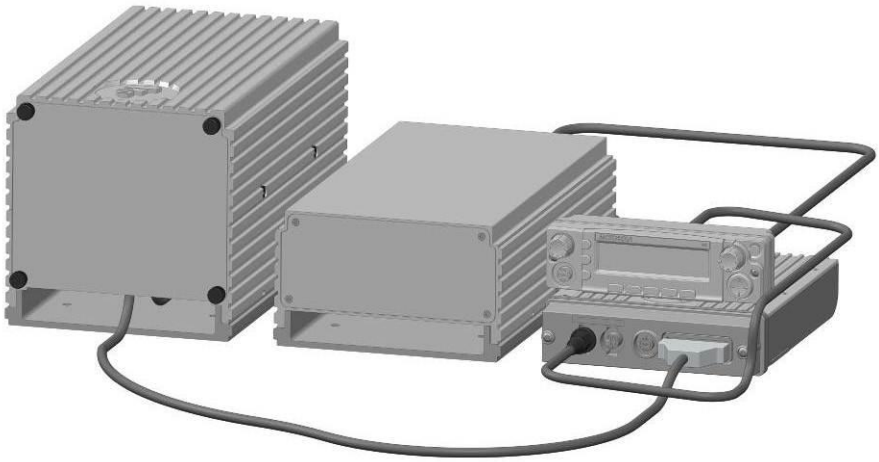


Figure 8 Vehicular Mount In-Band 700 or 800MHz DVRS Model - Full Duplex & Simplex Capable

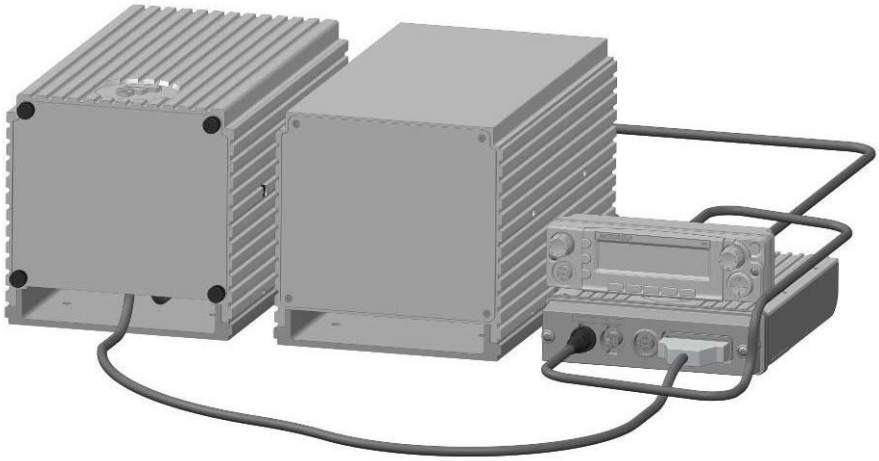


Figure 9 Vehicular Mount In-Band VHF or UHF DVRS Model - Full Duplex & Simplex Capable

Band Locking

When both the MSU and VR are configured to operate in the same frequency band, two in-band sets of filters are required. (one placed at the MSU Antenna port and another placed at the VR Antenna port). The frequency specific in-band filters are required to prevent interference when the VR and MSU.

When the in-band filter is not present ('MSU RF Bypass switch' in the FRC Hardware setup screen is unchecked), the Band Lock feature must be enabled (by using the FRC) to prevent VR operation on MSU channels that are explicitly using the same frequency band as the VR. On MSU channels where the frequency band is not explicitly known such as in multi-site Trunking systems, the MSU will be prevented from using frequencies in the same band while the VR is active (i.e. in SYSTEM or LOCAL mode). In this case the MSU will no longer allow roaming to sites using the locked-out band. If the MSU is currently on a Trunking site that uses the locked-out band, the MSU will roam to another site. If no other sites are available, the MSU will become 'Out Of Range'. When the VR is inactive (OFF mode), the MSU frequency band is unlocked.

If Band Locking is disabled in the Futurecom Repeater Configurator, the MSU is allowed to roam to any site regardless of the frequency band. A typical in-band application that may require Band Locking to be disabled is the Fixed DVRS application when the MSU and VR antennas are mounted in such way as to provide minimum 70dB of isolation and in-band filtering is not required.

For MSU conventional channels where the band is known and fixed, the VR restricts access to channels using the locked-out frequency band.

If Band locking is enabled in the VR and SCAN is enabled in the MSU, the MSU will skip over any channels in the scan list that are configured to operate in the same frequency band as the VR.

IMPORTANT!
A 700MHz VR interfaced to an APX MSU operating on 800MHz as well as an 800MHz VR interfaced to an APX MSU operating on 700MHz are considered In-Band applications and either In- Band filters must be provided, or band locking must be enabled (if the MSU is dual band and VR operation can be supported on the non 700/800MHz band).
The above is also valid for any of the UHF Bands – if the MSU operates on any of the UHF ranges, an UHF VR interfaced to it will require in-band filters to be installed or band locking to be enabled.

DVRS Features by PSU Type – Motorola Infrastructure

When the PSU User is out of System Radio Coverage, the PSU can be switched to a dedicated VR channel so that the PSU can communicate via the VR. The features available to the PSU User depend on the PSU type, programming and selected mode.

The table below specifies what features are supported by the different PSU types on Motorola Infrastructure only.

PSU FEATURE SUPPORT BY DVRS	DVRS Enabled PSU [Note 5]	Generic P25 PSU	Analog PSU
Adaptive Power Control	Yes	Yes [Note 6]	No
Announcement Group	No	No	No
Call Alert/ Page	Yes	Yes	No
Dynamic Regrouping	Yes	No	No
Emergency Call / Alarm	Yes	Yes	Yes
Emergency ID Pass through	Yes	Yes	Yes [Note 2]
End to End digital on TDMA P25 Phase 2	Yes	No	No
Group Calls	Yes	Yes	Yes
Leading / Trailing Tones (sent over the air)	No	No	Yes
Local Mode Indication	Yes	No	No
NAC Linking	Yes [Note 13]	No	No
P25 Encryption	Yes	Yes	No
P25 Trunking OTAR	Yes	No	No
Patch	Yes	No	No
Personnel Accountability (Network Server)	Yes [Note 11]	No	Yes [Note 12]
Personnel Accountability (Local)	No	Yes [Note 12]	Yes [Note 12]
Phone Interconnect	[see Note 9]	No	No
Private Calls	Yes	No	No
PSU Authentication	Yes	No	No
PSU Emergency Revert	Yes	Yes	Yes
PSU Group Services	Yes [Note 7]	No	No
PSU Hot Mic	Yes [Note 4]	No	No
PSU LOCATION	Yes	No	No
PSU PTT ID	Yes	Yes	Yes [Note 2]
PSU SCAN	Yes [Note 8]	Yes	Yes
Radio Check / Radio Inhibit	Yes	Yes	No
Registration / Deregistration	Yes	Yes [Note 1]	Yes [Note 3]
Remote VR Activation by PSU	Yes (Call Alert)	Yes (Call Alert)	Yes (DTMF)
Remote VR Activation by PSU Emergency Alarm	Yes	Yes	Yes (MDC1200)
Selector Lock / Unlock	No	No	No
SmartConnect	Yes	No	No
System Status Broadcast (Failsoft, Out Of Range, Site Trunking)	Yes	No	No
Talkgroup Proxying / Translation	Yes	Yes	No
Talk Permit Tones (generated by PSU)	Yes	No	No
Trunking System 8-Digit Portable ID	Yes [Note 14]	No	No

Table 1 DVRS Features (Motorola Infrastructure) vs Type of PSU

Note 1 When selecting a VR Mode on the Generic P25 PSU, it registers upon first Group Call. Generic PSU is deregistered after a preprogrammed timer counting the period of inactivity expires.
Note 2 Supported only with MDC1200 capable portables.
Note 3 Analog PSU is registered on the P25 system with its MDC1200 ID.
Note 4 Requires firmware R12.00.13 or later in the XTS 'DVRS Enabled' PSU and R07.00.05 or later if using APX 'DVRS Enabled' PSU.
Note 5 The PSU models that can be programmed as DVRS Enabled are described in DVRS: VR Compatible XTS/APX Portable Radios list in Compatibility Matrix.
Note 6: Motorola Solutions XTS or APX series PSUs in non DVRS Enabled mode
Note 7: Group Services are supported on APX 'DVRS Enabled' PSUs only (R14.50.00 or later in PSU/MSU) and FDMA Systems only.
Note 8: Must have Conventional Scan feature loaded as well as PSU Scan option enabled on all VR channels that will be used by PSUs with Conventional Scan option enabled
Note 9: Phone Interconnect is not supported on VRX1000, but available on DVR or DVR-LX
Note 10: Supported on FDMA Systems only
Note 11: Must be Motorola P25 Trunking System with APAA server available on the Motorola network
Note 12: Must have local accountability client with RF modem
Note 13: Digital VR Channels only
Note 14: Support of 8 digit portable IDs requires DVRS enabled portables. Generic portables only support 7 digits

'DVRS Enabled' PSUs

For a list of portable radios have firmware that allows enhanced communications with the VR and support of an extended list of features visit the Futurecom website:
Home → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Firmware Upgrades → Compatibility Charts

All other P25 capable PSU models, or the above models with either older firmware versions or when not programmed as **'DVRS Enabled'**, can only be programmed as 'P25 Generic' since they are not capable of extended communications with the VR.

'DVRS ENABLED' PSU FEATURE SUPPORT	HARRIS P25 Trunked FDMA	CASSIDIAN P25 Trunked FDMA
Automatic Revert to TA when no VR	Yes	Yes
Data	Not Supported	Not Supported
FNE NO COMMS indication through DVRS	Yes	Yes
In Car Monitor	Yes	Yes
Limited Features support on P25 TDMA FNE	Yes (Group Voice, PTT-ID and Emerg Alarm/Call)	Not Supported
MSU MIC PTT with VR ON	Yes	Yes
MSU Votescan	Not Supported	Not Supported
NAC Linking	Yes	Yes
Out Of Range / Site Trunking indication on PSU	Yes	Yes
Personnel Accountability	Not Supported	Not Supported
PSU Adaptive Power Control	Yes	Yes
PSU Call Alert Page	Yes	Yes
PSU Dynamic Regrouping	Not Supported	Not Supported
PSU Emergency Call / Alarm	Yes	Yes
PSU Emergency ID Pass Through	Yes	Yes
PSU Group Calls	Yes	Yes
PSU Hot Mic	Yes	Yes
PSU LOCATION	Yes	Yes
PSU OTAP	Not Supported	Not Supported
PSU P25 Encryption	Yes	Yes
PSU P25 Trunking OTAR	Yes - Limited	Yes
PSU Patch & Simulselect	Yes	Yes
PSU Phone Interconnect	Yes	Yes
PSU Private Call II [3]	Yes	Yes
PSU PTT ID	Yes	Yes
PSU Radio Check / Radio Inhibit	Yes	Yes
PSU Registration / Deregistration	Yes	Yes
PSU Scan	Yes - Limited	Not Supported
PSU Status / Message	Yes	Yes
PSU Talkgroup Proxying / Translation	Yes	Yes
Remote MSU Channel Steering via PSU Call Alert Page to VR ID	Yes	Yes
Remote VR Activation by PSU Call Alert Page to VR ID	Yes	Yes
Remote VR Activation by PSU Emergency Alarm Retries	Yes	Yes
SmartConnect	Not Supported	Not Supported
Talk Permit Tones (generated by PSU)	Yes	Yes
VR Local Mode Indication on PSU	Yes	Yes
VR OOR indication on PSU	Yes	Yes

Table 2 'DVRS Enabled' PSU Features Support on Non-Motorola Infrastructure

[3] PCII Support only; Enhanced Private Calls are only supported on Motorola Infrastructure.

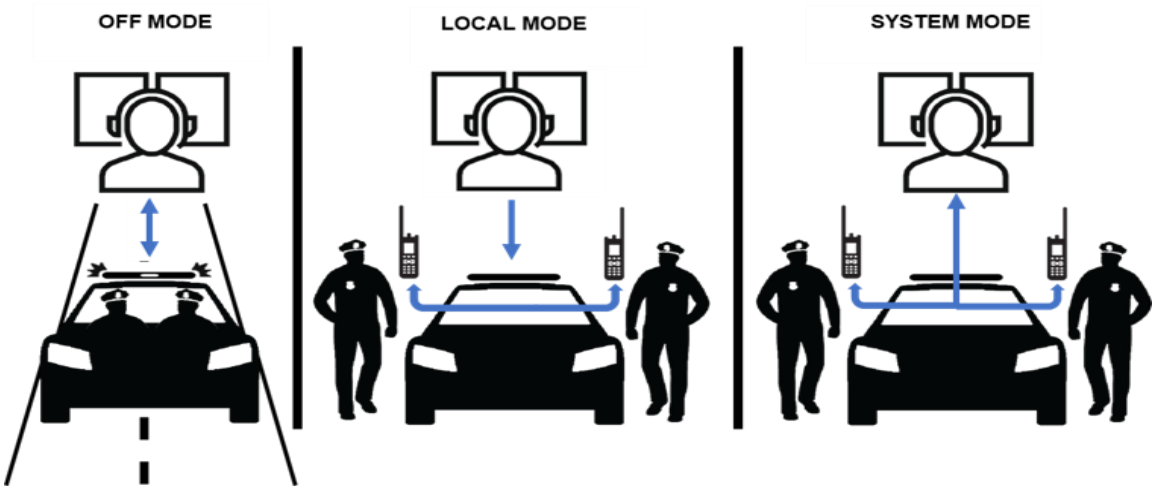
DVRS Operation and Basic Features

VR Status Display

The VR Status is displayed on the MSU Control Head. The VR current mode and channel alias are displayed on the top line (for example VR SYS CHAN1) and the VR Status icon indicates if a VR is transmitting, receiving, is a Primary or a Non-Primary etc.

VR Modes of Operation

When a 'DVRS Enabled' TG / Channel is selected on the control head, the VR can be switched to one of the following modes – OFF, LOCAL or SYSTEM.



OFF mode is used when the VR repeat is not required (for example while the PSU user is in the vehicle driving).

LOCAL mode is used in some tactical applications when only portable-to-portable communications are required. Inbound calls are not repeated to the system in the **LOCAL** mode, i.e., the calls received by the VR are repeated locally but the MSU does not key up. As an option, the VR can be programmed to repeat system outbound calls to the local PSU Users.

SYSTEM mode enables full VR repeat – locally and to the system. Outbound calls received by the mobile radio are repeated by the VR to the local PSUs over the VR channel. Inbound calls received by the VR are repeated locally (portable-to-portable) as well as to the system users (by keying up the mobile radio). As an option the VR can be programmed to key up only the MSU while the VR is in the SYSTEM mode.

When a 'DVRS Enabled' TG / Channel is selected on the APX MSU control head, the VR can be switched to one of the following modes – OFF, LOCAL or SYSTEM.

OFF Mode

ACTIVITY	OFF MODE ACTION
Control Head Display	VR OFF <DVR CH Name>
DVRS Button Press	Short high-pitched tone. VR Control Mode is accessible.
MSU Receiving from System	VR does not repeat audio received by MSU. MSU Speaker Audio present.
MSU User PTTs the MSU Microphone	MSU Keys up. VR does not key up.
PSU Activity on DVR channel	VR Transmit Function Disabled i.e. No VR repeat. No Speaker Audio.

Table 3 OFF Mode Operation

SYSTEM Mode

ACTIVITY	SYSTEM MODE ACTION
Control Head Display	VR SYS <DVR CH Name>
DVRS Active Tones	If programmed, a short high-pitched 'DVRS Enabled' tone is repeated every few seconds (5-255 sec. programmable) in the MSU Speaker regardless of the Primary / Secondary Status of the VR.
DVRS Button Press	Short high-pitched tone. VR Control Mode is accessible.
MSU User PTTs the MSU Microphone	Both VR and MSU key up. VR may be programmed not to key up!
MSU Receiving from System	VR repeats audio received by MSU to PSU Users of the designated VR Channel. Speaker Audio is present.
PSU Activity on DVR channel	PSU audio is repeated locally by VR as well as by the MSU to the System. MSU Speaker Audio is present if In-Car Monitor is enabled in the MSU.

Table 4 SYSTEM Mode Operation

LOCAL Mode

ACTIVITY	LOCAL MODE ACTION
Control Head Display	VR LOC <DVR CH Name>
DVRS Active Tones	If programmed, a short high-pitched 'DVRS Enabled' tone is repeated every few seconds (5-255 sec. programmable) in the MSU Speaker regardless of the Primary / Secondary Status of the VR.
DVRS Button Press	Short high-pitched tone. VR Control Mode is accessible.
MSU Receiving from System	VR may be programmed to repeat audio received by MSU to the PSU Users over the VR Channel when the VR is idle. Speaker Audio is present.
MSU User PTTs the MSU Microphone	VR keys up. MSU may or may not key up depending on MSU programming.
PSU Activity on DVR channel	PSU audio is repeated locally by VR. Speaker Audio is present if In-Car Monitor is enabled in the MSU.

Table 5 LOCAL Mode Operation

NOTE:
If the selected VR channel attribute is programmed as Simplex, the local voice repeat VR function is not available. If proxying and In-Car Monitor are enabled and the TG selected by the local PSU is different from that selected on the MSU, then Inbound or Outbound speaker audio will depend on the MSU ICM setting ('ICM Selected' or 'ICM All') as well as the ICM trigger as described in the **In Car Monitor** section of this document.

Mode Change Notification

If “Generate Status on VR Mode Change” is enabled for a given DVRS Profile (in the APX MSU) , the MSU will send a mode change status to indicate the current VR mode (OFF, SYSTEM, LOCAL) when the VR mode changes. Only the Console Dispatcher can interpret those status messages:

DVR MODE	STATUS VALUE
OFF	1
LOCAL	2
SYSTEM	3

If “Generate Status on VR Mode Change” is enabled for a given DVRS Profile (in the APX MSU), and **ALTERNATE** mode is selected, this provides similar functionality with the following differences:

- No control head status display
- No acknowledgement tones
- Reserved for VR generated status only - no ability for user to send status via control head
- Limitation for Console on Conventional System - no ability for Console to query status

Selecting VR Mode and Channel

When a ‘DVRS Enabled’ TG / Channel is selected on the MSU, the user may enter the ‘DVRS Control Mode’ by pressing the DVRS button on the control head and change the VR Mode / Channel if such selection is enabled by the VR programming.

The VR mode and channel may be programmed to be ‘Strapped’ to the specific MSU TG/Channel. In this case, selecting a specific MSU TG / Channel on the control head would automatically force the VR to revert to a pre-programmed VR Mode and/or Channel. *For example, selecting a ‘DVRS Enabled’ TG named ‘DISPATCH’ on the MSU may automatically force the VR to switch to VR Channel 1, SYSTEM Mode.*

NOTE:
Depending on the specific VR personality programming, the VR channel selection may be restricted to a short list of allowed VR channels (or no channel selection options at all). If Channel Strapping is enabled then the VR will always land on the specified Strapped VR channel first even when more than one channel is on its allowed channels list.

Activating the VR via the MSU Control Head

The VR mode of operation and status can be changed from the ‘DVRS’ button as programmed in the APX MSU. The VR channel can be controlled by pressing the ‘DVRS’ Button and subsequently pressing the up / down navigation keys to scroll through the available channel selection.

Automatic VR Activation (AVRA)

The VR can be activated automatically (switched from OFF or LOCAL to SYSTEM Mode) if one of the VIP inputs on the MSU control head is wired to the desired trigger source – portable charger switch or door switch or custom manual switch. When AVRA is enabled in the VR, the user still has the option of manually changing the VR mode from the MSU Control Head or remotely.

Note that not all portable chargers provide a switch to support AVRA functionality.

The AVRA feature depends on the VR programming as shown below:

AVRA Configuration (as programmed in VR)	System Mode Allowed	VIP Input	Current VR Mode	New VR mode
Activation / Deactivation	True	Asserted	OFF	SYSTEM
Activation / Deactivation	False	Asserted	OFF	LOCAL
Activation / Deactivation	True	Asserted	LOCAL	SYSTEM
Activation / Deactivation	False	Asserted	LOCAL	LOCAL
Activation / Deactivation	True	Asserted	SYSTEM	SYSTEM
Activation / Deactivation	True/False	De-asserted	ANY	OFF
Activation Only	True	Asserted	OFF	SYSTEM
Activation Only	False	Asserted	OFF	LOCAL
Activation Only	True	Asserted	LOCAL	SYSTEM
Activation Only	False	Asserted	LOCAL	LOCAL
Activation Only	True	Asserted	SYSTEM	SYSTEM
Activation Only	True/False	De-asserted	ANY	NO CHANGE
Toggle	True	Asserted 1st	OFF	SYSTEM
Toggle	False	Asserted 1st	OFF	LOCAL
Toggle	True/False	Asserted 2nd	LOCAL	OFF
Toggle	True	Asserted 2nd	SYSTEM	OFF
Toggle	True/False	De-asserted	ANY	NO CHANGE

Table 6 AVRA Functionality

IMPORTANT!
The VR can be activated via AVRA only if a 'DVRS Enabled' TG / Channel is selected on the MSU.

GPS DRIVEN DEACTIVATION

Feature License – GPS Driven Deactivation *required to enable this feature.*[4]

A VR must always be deactivated (switched to OFF mode) before driving to/away from an incident- driving with the VR activated (in SYSTEM or LOCAL mode) may cause interference at ongoing incidents. Users may find it desirable to have a VR automatically deactivate when it is known that the unit is moving or has moved. One way this can be accomplished is by utilizing the GPS functionality present in the MSU. If a GPS receiver is present in the MSU, and its use is licensed appropriately in the MSU and VR, then the VR can make use of the GPS receiver to trigger the change of the VR's mode to OFF.

Through configuration parameters, the VR can be set up to automatically change its mode to OFF in one of the following situations:

- Speed Only: VR has exceeded a configured speed threshold
- Distance Only: VR has travelled beyond a configured distance threshold
- Speed or Distance: VR has exceeded a configured Speed threshold OR a configured Distance threshold
- Speed and Distance: VR has simultaneously exceeded configured speed AND distance thresholds

Starting Location: The VR's starting location is set to be the location at which the VR becomes active (placed into LOCAL or SYSTEM mode). To establish an accurate location fix, this starting location is determined when the speed reaches 5 miles per hour.

Audible Notification: A configurable setting exists to determine whether a GPS Driven Deactivation of the VR generates a notification tone to the user via the MSU speaker.

Feature Combinations: In addition, this feature may work in conjunction with the AVRA feature to automatically provide VR mode changes. There are three possible combinations:

1) AVRA Activate with GPS Deactivate
2) AVRA Activate with AVRA or GPS Deactivate
3) AVRA Activate with AVRA followed by GPS Deactivate
    - GPS Timeout option available

[4] See firmware version & options requirement in Compatibility Chart (Futurecom website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Compatibility Chart)

Primary / Secondary Preference: When two Primary VRs are within range of each other, one VR will remain Primary and one will become Secondary. Any PSUs that were previously communicating through the Secondary VR must now switch over to the winning Primary unit. This switch of PSUs from one VR to another results in a temporary loss of communication. To minimize the disruption at an ongoing scene, the user is able to configure a preference so that a stationary Primary VR will remain Primary when a moving Primary VR comes within range.

Enabling the GPS Driven Deactivation feature means that a moving Primary VR may come in range of a stationary Primary VR. If it is determined that this scenario should not be left to the random selection of which VR remains Primary, the user has the option to configure a preference for Stationary VRs. The result is a Stationary VR will remain Primary and a moving VR will become Secondary thus minimizing disruption at the scene of the stationary VR.

USE CASES

Each of the combinations of the GPS Driven Deactivation and AVRA features may involve any of the four GPS Driven Deactivation methods, resulting in a number of different scenarios. This provides a lot of flexibility for each customer to find the scenario that works best for their operating procedures. The tables below identify each of the scenarios and potential use cases for each.

GPS DEACTIVATION TYPE	USE CASE
Speed Only	A user desires the VR to remain active and maintain communication when driving slowly at an incident. When the configured speed threshold is exceeded, the VR will assume the vehicle is leaving the incident and will deactivate.
Distance Only	A user desires the VR to remain active and maintain communication when driving within a certain distance of an incident. When the configured distance threshold is exceeded, the VR will assume the vehicle is leaving the incident and will deactivate.
Speed or Distance	A user desires the VR to remain active and maintain communication when driving around at an incident. When either the configured speed or distance threshold is exceeded, the VR will assume the vehicle is leaving the incident and will deactivate. This would prevent a vehicle from driving away from an incident slowly (under the speed threshold) without ever deactivating the VR.
Speed and Distance	A user desires the VR to remain active and maintain communication when driving around at an incident. When the configured speed and distance thresholds are exceeded at the same time, the VR will assume the vehicle is leaving the incident and will deactivate. This would allow a vehicle to temporarily exceed the speed or distance thresholds without deactivating the VR.

SCENARIO	USE CASE
GPS Deactivate Only	A user desires the VR to automatically deactivate when the vehicle leaves an incident but has chosen not to install AVRA.
AVRA Activate with GPS Deactivate	A user desires the VR to automatically activate by a pre-defined action such as opening driver's door (AVRA) and automatically deactivate when the vehicle leaves an incident (GPS).
AVRA Activate with AVRA or GPS Deactivate	A user desires the VR to automatically activate by a pre-defined action such as opening driver's door (AVRA) and automatically deactivate when the vehicle leaves an incident. The automatic deactivation is driven by a pre-defined action such as insertion of the user's PSU into the vehicle's charger (AVRA) OR when the vehicle leaves an incident (GPS). It may be known that users do not always put their radios into the charger immediately (might just throw it on the seat), so this OR configuration provides complimentary (AVRA/GPS) means of determining that a user is leaving the incident.
AVRA Activate with AVRA followed by GPS Deactivate	A user desires the VR to automatically activate by a pre-defined action such as opening driver's door (AVRA) and automatically deactivate when the vehicle leaves an incident. The automatic deactivation will only occur when a pre-defined action occurs such as putting the car in Drive (AVRA) followed by driving a certain speed or distance away (GPS). This allows the user to get into the car and drive a short distance without deactivating the VR, thus allowing for repositioning of a vehicle at the incident with no break in communication. There is also a GPS Timeout option available that will deactivate the VR by an AVRA action alone when GPS is not available for a programmable amount of time. This option can be useful if operating in an environment where GPS is less reliable (e.g., common use in tunnels, parking garages, or urban canyons). In these situations, users may wish to allow some extended time before giving up on GPS confirmation of movement.

NOTE: If any of the conditions for deactivation are not met, the repeater will remain active regardless of GPS thresholds. Refer to the table below for more details.

Configuration for Deactivation	Condition(s) to be Met	Example of When Repeater Remains Active Regardless of GPS Thresholds
GPS Deactivate Only	• GPS signal available • GPS threshold exceeded	GPS signal is not available
AVRA or GPS Deactivate	• GPS signal available • GPS threshold exceeded	GPS signal is not available
	OR	AND
	• AVRA (going into drive, portable in charger, etc)	User reactivates repeater after AVRA deactivates
AVRA followed by GPS Deactivate	• AVRA (going into drive, portable in charger, etc) FOLLOWED BY • GPS threshold exceeded OR if GPS signal not available, GPS Timeout timer expires	User reactivates repeater after AVRA deactivates

EMERGENCY HANDLING

GPS Deactivate Only: When the specified GPS threshold(s) are reached, VR switches its mode to OFF unless VR is actively handling an Emergency. If an Emergency is in effect, then GPS Driven Deactivation of the VR is blocked; VR resets its location at the end of the Emergency and then resumes awaiting the GPS threshold(s) to be met.

AVRA Activate with GPS Deactivate: If an Emergency is in effect, then GPS Driven Deactivation is blocked; VR waits until the Emergency has ended or for a new AVRA Activate trigger or for user to initiate a VR keypad action, at which time VR resets its GPS location and resumes awaiting the GPS threshold(s) to be met.

AVRA Activate with AVRA or GPS Deactivate: If an Emergency is in effect, then AVRA/GPS Driven Deactivation is blocked; VR waits for the Emergency to end before taking further action. Notable interactions with Emergency include:

- If AVRA Activate trigger occurs during the Emergency, VR remains active and resets its GPS starting location.
- If the Emergency ends due to user pressing DVRS button on control head, then VR remains active and resets its GPS starting location.
- If the Emergency ends due to all PSUs exiting Emergency or due to VR's Emergency Timeout timer and the AVRA Deactivate trigger is still asserted, then the prior AVRA Deactivate trigger which was blocked by the Emergency is considered valid and VR deactivates (sets its mode to OFF).

  NOTE: If only GPS threshold was exceeded before or during the Emergency, once the Emergency ends, the VR remains active and the GPS starting location is reset.

AVRA Activate with AVRA followed by GPS Deactivate: If an Emergency is in effect, then AVRA/GPS driven deactivation is blocked; VR waits for the Emergency to end before taking further action. Notable interactions with Emergency include:

- If AVRA Activate trigger occurs during the Emergency, VR remains active and resets its GPS starting location.
- If the Emergency ends due to user pressing DVRS button on control head, then VR remains active and resets its GPS starting location.
- If the Emergency ends due to all PSUs exiting Emergency or due to VR's Emergency Timeout timer and the AVRA Deactivate trigger is still asserted, then the prior "AVRA followed by GPS" event which was blocked by the Emergency is considered valid, and VR deactivates (sets its mode to OFF).

Remote Activation of the VR

Via Call Alert (Page) to VR

NOTE:
This feature requires the use of a P25 PSU and implies Digital or Forced Analog VR Mode of operation.

To remotely activate a VR, the PSU user can send a Call Alert (Page) with the ID of the specific VR. Upon receipt of a Call Alert (Page) from the PSU the VR will (in Classic or Flexible Operation, depending on programming):

Classic Operation

- Switch from OFF or LOCAL mode to SYSTEM mode (unless it is already in the SYSTEM mode). If the selected VR / MSU channel is programmed as LOCAL only, the VR will switch from OFF to LOCAL mode.
- Force the MSU to revert to a TG selected (if programmed).
- Switch to Primary Status and force any other Primary VR to become a Secondary unless there is a Permanent Primary (on the same VR channel) already present in the same area.
- Recommended for Vehicular Deployment use

Flexible Operation

- Cycle through a pre-configued set of modes (OFF, LOCAL, SYSTEM). Each subsequent Call Alert moving the VR to a new mode.
    - If the selected VR / MSU channel is programmed as LOCAL/SYSTEM only, modes cycling will adhere to this constraint.
- Force the MSU to revert to a TG selected & corresponding pre-programmed mode (if programmed).
- Switch to Primary Status and force any other Primary VR to become a Secondary unless there is a Permanent Primary (on the same VR channel) already present in the same area.
- Recommend for Fixed Location Deployment use

Via PSU Emergency Alarm

The VR switches from OFF to SYSTEM mode after a programmable number of Emergency Alarm attempts sent by a PSU are successfully received by the VR and are not serviced by another (Primary) DVRS.

Via PSU DTMF Tones

To remotely activate a VR (Analog Mode), the PSU user can send a preprogrammed DTMF sequence, which can be received by VR in the PSU radio coverage area.
Upon receipt of the preprogrammed DTMF sequence from the PSU the VR will:

- Switch from OFF or LOCAL mode to SYSTEM mode.
- Switch to Primary Status unless there is already a Primary / Permanent Primary VR (on the same VR channel) already present in the same area.

DTMF Activation is supported on Analog or Mixed mode VR channels only.

Via System / Dispatcher Call Alert Page to MSU

The dispatcher can send a Call Alert (Page) to a specific MSU ID, which in turn causes VR mode change in the following order: **OFF-SYS-LOC-OFF**.

The MSU can be programmed to support one of the following configurations:

- Call Alert / Remote Activation Disabled – the MSU does not respond to any Call Alert requests
- Call Alert Enabled – the MSU responds to Call Alerts addressed to its ID and does NOT initiate VR mode change
- Remote Activation Enabled – the MSU will acknowledge Call Alerts addressed to its ID and will initiate VR mode change provided the source ID of the Call Alert is programmed in the “VR Remote Activation IDs” table.

Dispatchers can receive notification of the change - Refer to **Mode Change Notification** for details.

The dispatcher can’t force a Non-Primary VR to become a Primary and can’t activate a VR when a ‘VR Disabled’ mode is selected on the control head.

‘DVRS Enabled’ Mobile Radio TGs / Channels

VR operation may be enabled (by the VR and MSU programming) on selected mobile radio Talkgroups / Channels and disabled on others.

When the user selects a **‘DVRS Enabled’** TG / Channel on the MSU control head, the VR operation is enabled in the following manner:

- The VR automatically enters the pre-programmed VR Mode/Channel associated (‘Strapped’) with the selected MSU TG / Channel if VR Strapped Operation is programmed in the VR.

OR

- The user may change the VR Mode / Channel (if ‘strapping’ is not enabled) by pressing the assigned **DVRS** Button and entering the ‘VR Control Mode’.
- The VR can be activated and used to repeat messages between the system users of the TG/Channel Selected on the MSU and the PSU users on the selected VR Channel.
- If enabled in the VR personality, **‘DVRS Enabled’** tones will be heard every few seconds (5-255 sec. programmable) in the MSU speaker, regardless of the Primary / Secondary status.

‘DVRS Disabled’ Mobile Radio TGs / Channels

VR operation may be enabled on selected Mobile Radio Talkgroups / Channels and disabled on others.

When the user selects a **‘DVRS Disabled’** TG / Channel on the control head:

- Pressing the DVRS button results in a VR Invalid Option Tone (single low-pitched tone).
- VR operation is prohibited i.e. all VR functions are disabled.
- Call Alert Page from the Local PSU, sent on the last used VR channel, can steer the MSU to a ‘VR Enabled’ mode if programmed accordingly.

In Car Monitor (ICM)

The ICM feature allows the MSU to monitor PSU voice traffic and is configurable in the MSU codeplug as follows:

- ICM is enabled / disabled globally in the MSU via the 'ICM Allowed' field
- If 'ICM Allowed' is programmed in the MSU then ICM operation is further configured on a per MSU channel basis via the 'ICM Allowed' codeplug field.
- ICM functionality is further configured to be triggered by either HUB on / off transitions OR via Menu Item / Button on the MSU control head or keypad Mic.

When ICM functionality is configured to be triggered via HUB on/off then 'ICM Selected' operation takes place when the MSU microphone is placed on HUB, 'ICM All' operation will take place when the MSU microphone is taken off HUB.

For details on how to program the ICM functionality and options in the MSU, please refer to the corresponding Motorola documentation.

When the MSU is operating on a Trunking FNE with ICM enabled the following configurations are available:

- 'ICM Selected' – the MSU speaker unmutes to PSU audio matching its selected TG ID (digital VR channel) or all qualified analog PSU audio (analog VR channel).
- 'ICM All' – the MSU speaker unmutes to all PSU audio regardless of the TG ID (digital VR channel) or all analog PSU audio (analog VR channel).

When the MSU is operating on a conventional FNE with ICM enabled the following configurations are available:

- 'ICM Selected' and MSU configured for Selective Squelch – the MSU speaker will unmute only to PSU audio matching its selected TG (digital VR channels) or qualified analog audio (analog VR channels)
- 'ICM Selected' and MSU configured for Normal Squelch – the MSU speaker will unmute to any PSU TG audio (digital VR channels) or qualified analog PSU audio (analog VR channels).
- 'ICM All' – the MSU speaker unmutes to all PSU audio

Proxied Private Calls are never heard on the MSU speaker regardless of the Hang Up Box (HUB) status.

NOTE:
Inbound Private calls to the MSU are not supported. Outbound Private Calls to the MSU are heard on the MSU Speaker.

Primary / Secondary Operation Basics

See Futurecom → Home → Support →Documentation and Software → White Papers → VR Introduction to Primary/Secondary Feature for additional information

The VR has a built-in simulcast prevention mechanism, which prevents more than one VR to transmit on the same frequency, at the same time, in the same location.

NOTE:
The algorithm is intended to operate in stationary, same scene scenarios only. It cannot be applied to moving vehicles. **Moving vehicles must either have the VR switched OFF or 'VR Disabled' MSU mode selected.**
Exception:
With the application of a GPS Driven Deactivation feature license, a moving Primary VR within a limited range is possible. Refer to the ***GPS DRIVEN DEACTIVATION*** section for details on this feature.

The VRs are capable of communicating with each other and negotiating which VR is a Primary, i.e. elected to repeat, and which VRs are on Secondary for as long as there is a Primary.

The simulcast prevention algorithm has two phases:

- Primary / Secondary Phase
- Busy Lockout Phase

During the 'Primary / Secondary' phase, the VRs exchange P25 messages on their Rx frequency. When a VR is activated (switched to System or Local mode), it sends a query – "Is there a Primary?" If it receives a Primary (or Permanent Primary) 'Heart Beat', then the VR assumes Secondary state. If no Primary Heart Beat is received, the VR becomes the Primary and starts sending 'Primary Heart Beats' notifying other VRs of its status.

The 'Secondary' VRs monitor any VR-related activity while in a standby mode and execute Primary / Secondary checks periodically.

The 'Primary' VR services any communication requests in the area and 'communicates' its status to the other VRs periodically.

The Busy Lockout phase serves as an added protection by forcing the Primary VR not only to periodically communicate with the other VRs in the area (using its Rx frequency) but also to check for any activity on its Tx frequency prior to every repeat. To accommodate the dynamically changing "real life" environment, i.e. VRs arriving or leaving the scene at random time, VR channel / mode changes, Permanent Primary activation, Remote VR steering, etc., the Primary / Secondary algorithm has several built-in layers, configurable in the VR programmed personality.

The **Primary/Secondary Setup→Permanent Primary→Status** field is disabled by default and should be used only in special applications such as at remote, fixed VR installations, during testing or by selected public safety personnel.

The Primary / Secondary state of a VR is re-evaluated every time one of the following takes place:

- Change of VR Channel Frequency
- Change of VR Mode
- Remote Activation of another VR
- Selecting a VR Disabled TG / Channel on the O5
- Powering down a VR
- Detected presence or absence of another Primary/Permanent Primary
- User initiated change to Permanent Primary state

	PRIMARY	SECONDARY	PERMANENT PRIMARY	STANDBY PERMANENT PRIMARY
DEFINITION	An active VR which has won the Primary / Secondary negotiation. Responsible for handling communication at a scene.	An active VR which has lost Primary / Secondary negotiation.	An active VR with a higher priority than a Primary VR. Takes over communication at a scene and all other units become Secondary.	An active VR in Permanent Primary state which has lost Primary / Secondary negotiation.
SELECTION	Automatic	Automatic	Automatic or user initiated via configured button press.	Automatic
DISPLAY	**Steady** 	**Flashing** 	**Steady** 	**Flashing** 

Table 7 Primary VR Definitions

NOTE:
As an option, an external light may be placed on the top of the vehicle, which can be used to indicate which VR is the currently selected Primary.

Limitations:
This feature is not applicable for a Rackmount DVR-LX with a 50-watt amplifier. See **Rackmount with 50-watt amplifier – DVR-LX.**

Permanent Primary Activation
Depending on the programming, there are two ways a VR may become a Permanent Primary:

- VR always operates as a Permanent Primary

OR

- VR may become Permanent Primary through a user initiated button press on the MSU control head

Permanent Primary Deactivation

If programmed, a VR may leave the Permanent Primary state through a user initiated button press on the MSU control head.

Purchasable Software Options

VR is continually updated to provide more functionality and value. VR firmware, and Futurecom Repeater Configurator (FRC) are available for download at Futurecom's web site (www.futurecom.com).

Certain capabilities of VR can be enabled by purchasing software options initially, or in the future as needs change (e.g. Authentication and Over-the-Air Programming Capability). Fielded units can activate these features after installing enablement keys provided by Futurecom. For information regarding activation of purchasable software options after initial product delivery please contact Futurecom.Sales@motorolasolutions.com.

There are many configuration aspects of the VR that are specific to a user's detailed system deployment. Information such as the repeater's channel frequencies, access codes (PL/DPL/NAC), and RF thresholds may be sensitive, and desired to be kept private by the owner. To facilitate this, each VR can be password-protected by its administrator. VR units are shipped without a password, but a password can be easily set within each VR using the Futurecom Repeater Configurator (FRC). Once a VR has a password set, it's configuration data is protected, and can only be read from or written to the VR by someone having that unit's password.

If template or DCD files are created by Futurecom Repeater Configurator for a VR, those files can be encrypted, and protected using a user-provided passphrase. These methods allow VR configuration parameters to remain private, even when a unit is left unattended, or shipped for service.

RM-OTAP (Over The Air Programming)

The RM-OTAP feature enables operator to perform firmware and configuration update on each VR unit using Motorola Radio Management via the Mobile Radio. Configuration update can be saved as DCD file and then imported into Motorola Radio Management for later deployment.

In addition, this feature ensures automatic updating of firmware and configuration when VR is replaced in a DVRS installation. For more information on how to use the feature

and which Mobile Radios support this functionality, please refer to the RM-OTAP User Guide on the Futurecom website.

***Feature License – RM-OTAP** required to enable this feature[5].*

SmartConnect In-Vehicle Range Extension

This feature makes the DVRS compatible with the Motorola SmartConnect feature. The SmartConnect feature provides the ability of a portable to connect to the ASTRO System via the DVRS through LTE/SAT/Wifi.

Limitations:

- PSU ID and TG are not proxied to the System for Inbound group calls, both regular and patched. The PSU ID and TG is translated to the MSU ID and TG.
    - During system call voice is repeated locally on the System Wide TG 0xFFFF.
    - Outbound group calls are repeated to the PSU on the System Wide TG 0xFFFF
- Private calls and packet data are blocked in system mode
- All proxy PSU initiated signaling features will be blocked except Emergency Alarm and Cancel Service

***Feature License – SmartConnect In-Vehicle Range Extension** required to enable this feature[6].*

PSU Scan

The PSU Scan feature enables an enhanced PSU to support conventional scan feature while DVRS is configured as its system type. Affiliated PSU will be able to hear other radio traffic on other Trunking Talkgroups and on other conventional channels. The increased awareness of events in the area increases user's safety and enhances user's ability to react to events.

Configuration Notes:

1) Scan List configured through CPS that used for a DVRS Personality shall not be used / shared with a Conventional Personality (non-DVRS Personality)

[5] See firmware version requirement in Compatibility Chart (Futurecom website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Compatibility Chart

[6] See firmware version requirement in Compatibility Chart (Futurecom website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Compatibility Chart)

2) All VR channels that will be used by PSUs with Conventional Scan feature need to have the corresponding Repeater Channel Setup→PSU Scan field set to “Yes”.

Feature License – PSU Conventional Scan *required to enable this feature.*[7]

Scan can be enabled or disabled for each VR channel using the Futurecom Repeater Configurator.

When Scan is enabled on the Conventional **‘DVRS Enabled’** Portable some features are blocked by the scanning Portable.

Blocked features:

- System status indication
  - FNE (System) Out of Range status display
  - VR Out of Range status display
  - Failsoft status display
  - Site Trunking status display
  - Imbalanced Coverage status display
  - Local Mode display
- Dynamic Regroup
- Location On PTT (LOPV)
- Private Call Decode
- Phone Call Decode
- Data Activity (e.g Context Activation, KMF commands)
- Hub Suspend (off hook) for Mobile
- Priority Channel Marking
- PSU Monitoring

[7] See firmware version & options requirement in Compatibility Chart (Futurecom website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Compatibility Chart)

MSU Scan

Supported MSU Scan Types

The MSU Scan feature is allowed while the VR is active (System or Local Mode) if the MSU Scan type is configured as one of the following:

- Trunking Scan
- Conventional Scan
- Mixed Conventional Voting Scan
- Legacy Voting Scan
- Multi System Scan
- Priority Monitoring

The MSU does not support any other modes of scan operation, apart from those listed above, while the VR operates in SYSTEM or LOCAL mode. In such unsupported cases, the MSU will automatically suspend scan operation when the VR is set to SYSTEM or LOCAL mode of operation and resume it when the VR is OFF.

NOTE:
The LPSU calls will be repeated on the MSU Selected Channel.

DVRS Enabled / Disabled Rules while MSU Scan is enabled

The Selected VR channel settings are used across all MSU scan channels except when the VR operation is Disabled for the given MSU channel.

If the VR selected channel is Digital and the MSU scans to an analog channel, the VR will become temporarily disabled.

If the Selected MSU channel is programmed as VR Disabled, the VR operation will remain disabled even if the MSU scans to a channel which is VR Enabled.

The VR will become temporarily disabled if the MSU lands on a channel that is programmed as VR Disabled. In this scenario the VR will not handle Outbound calls received by the MSU but will still repeat Inbound PSU calls by reverting the MSU to its selected channel.

Outbound Calls (received by MSU from the FNE) with MSU Scan Enabled

If the MSU is configured to only unmute to a specific TG ID or NAC, only the audio containing the specified TG ID or NAC will be proxied by the VR to the PSU.

Individual call signaling (Page, Call Alert, Message, Radio inhibit etc.) originating from a secondary (not MSU selected) channel is not proxied by the VR to the PSU. Emergency Alarm / Call originating from a secondary channel are supported through the VR.

Inbound Calls (received by DVRS from PSU) with MSU Scan Enabled

MSU Talkback and Designated TX are not supported when a PSU makes a call through the VR while the MSU has SCAN enabled. The MSU always moves back from the landed to the selected channel when the PSU initiates a call through the VR.

Talkback and Designated TX are supported only for MSU initiated calls.

MSU ISSI Roaming

The NGI (New Generation Interoperability) feature and VR feature will be allowed such that a VR MSU enabled subscriber may also be enabled for InterWACN-Roaming in the subscriber codeplug. When the MSU roams to a foreign System the VR will display “VR Limited” to indicate to the user the limited functionality available.

When the MSU has roamed to the foreign system, the following features are *not supported* by the local PSU:

- Private Call
- Telephone Interconnect
- Call Alert
- Dynamic Regrouging
- Radio Check
- Multisystem Scan
- Selector Lock
- Status
- Message
- Remote Monitor
- Reprogram Request

Unsupported PSU Features

The following PSU features are not presently supported by the VR or **DVRS Enabled** PSUs:

- Hearclear
- DTMF Hot Keypad
- Securenet
- Soft ID
- QCII
- Singletone
- Conventional OTAR
- Over-the-Air-Channel Reassignment (OTACR)
- Over-the-Air Channel Steering (OTACS)
- Over-the-Air Programming (OTAP)
- Priority Channel PTT
- PSU Reprogram request / Selector Lock
- PSU Smart PTT
- PSU Announcement Group operation
- PSU Phase II P25 conventional operation

NOTE:
The unsupported PSU features list provided above may NOT include ALL unsupported features. Please contact Motorola for specific feature support information.

NOTE (for VRX1000):
Due to FCC Exposure licensing limitations, when the User PTTs the MSU Microphone, only one of the transmitters is allowed to be keyed up (VRX1000 or MSU) as described in ~~**Table 4** SYSTEM Mode OperationandOperation and~~ **Table 4.**

P25 Digital Mode Operation

This chapter provides details on the DVRS Digital P25 mode of operation.

The P25 Digital mode assumes the following:

- APX MSU Programmed for DVRS Operation
- P25 FDMA only mode is selected on the MSU
- P25 PSU programmed for DVRS operation (Local PSU)
- DVRS Enabled mode selected on the Local PSU
- VR channel is programmed in the VR for Digital (or Mixed) Mode of Operation

NOTE:
The **Local PSU** notation throughout this chapter refers to a P25 PSU which is used to communicate with / through the VR.

'DVRS Enabled' type **Local PSU** refers to the models described in ***DVRS: VR Compatible XTS/APX Portable Radios*** when programmed for DVRS operation.

Some of the Digital mode DVRS features described are only available in P25 'DVRS Enabled' type PSUs and not available in Generic P25 PSUs (refer to ***DVRS: VR Compatible XTS/APX Portable Radios*** list).

A **System PSU** refers to a P25 PSU which has a P25 Mode (Trunking or Conventional) selected and communicates directly with the P25 Trunking or Conventional System, i.e. without a DVRS.

In in-band DVRS applications, the **Local** and **System PSU**s may be of the same model and personality. When a 'DVRS Enabled' P25 Mode is selected, the PSU is referred to as **Local PSU**. When a P25 System TG / Channel is selected, the PSU is referred to as **System PSU**.

In cross-band DVRS applications, the **Local PSUs** operate in different frequency band from the system infrastructure, i.e. from the **System PSUs**.

PSU Affiliation

When a local PSU User selects a VR Enabled Mode, the local PSU is affiliated via an active primary VR if:

- The VR is programmed for digital (or mixed) mode on the selected VR channel.
- The same digital VR channel is selected on both the PSU and the VR.

Generic P25 PSU is registered during the first group call made after switching to the **DVRS Enabled** mode. **'DVRS Enabled'** P25 PSU starts automatic affiliation process upon selection of VR Enabled mode (no PTT required to start affiliation process).

IMPORTANT!
The maximum number of PSUs that can get affiliated at a given time with one VR is 256.

Group Calls

Inbound and Outbound Group Calls are supported by the DVRS.

MSU Priorities

MSU Proxy Request Priority Level	Proxy Request
LOW	Idle (incl. in Emergency Call, not receiving audio) Group Voice Receive (all group call types, including hangtime while on trunked voice channel) Packet Data
MEDIUM	Transmitting Signaling features (call alert, status etc.) Individual Calls (unit to unit and Phone)
HIGH	Emergency Alarm Emergency Call Transmit Emergency Call Receive MSU Mode Change, Power Down

Table 8 MSU Proxy Request Priorities

PSU Proxy Request Priorities

PSU Proxy Request Priority Level	Proxy Request
HIGH	Emergency Alarm Emergency Call
LOW	All other Proxy Requests

Table 9 PSU Proxy Request Priorities

MSU Voice and Signaling Proxy Interactions

The MSU handles interactions with a PSU voice or signaling proxy request from the VR based on the following general priority rules:

- MSU Emergency overrides all proxies including PSU emergency alarm / emergency call.
- PSU Emergency overrides all MSU non-emergency proxies
- MSU PTT and signaling features (call alert, status etc) override all PSU non-emergency proxies
- PSU non-emergency proxies override MSU receive

Talkgroup Matching

The Talkgroup Matching feature requires that the local PSU and MSU have the same selected talkgroup for successful PSU communications.

NOTE: The TG Matching feature overrides TG Proxying/TG Translation/UID Translation features.

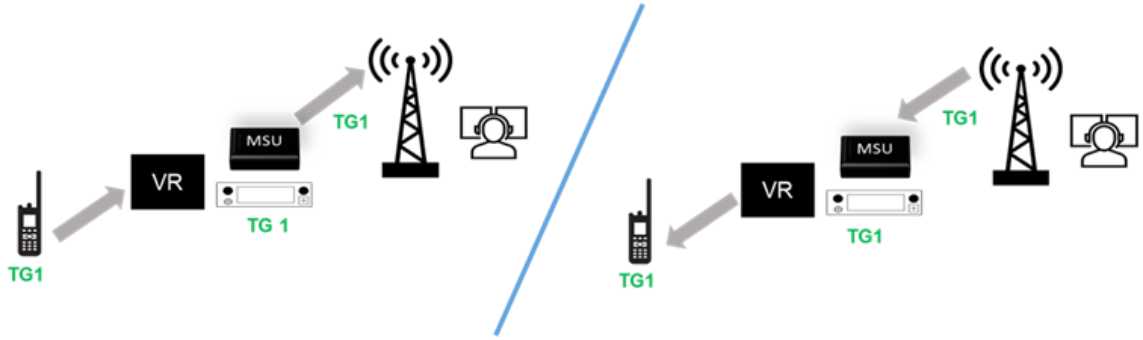


Figure 10: Talkgroup Matching

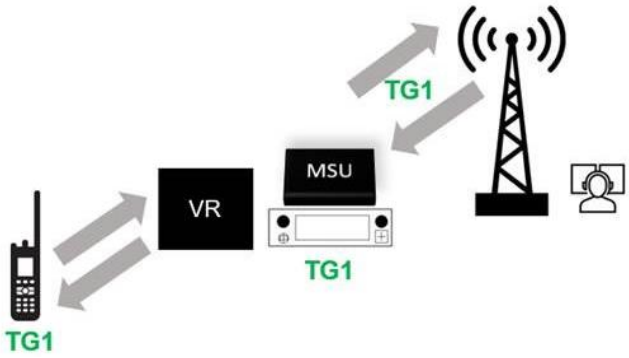


Figure 11: Talkgroup Matching - Successful PSU Communication

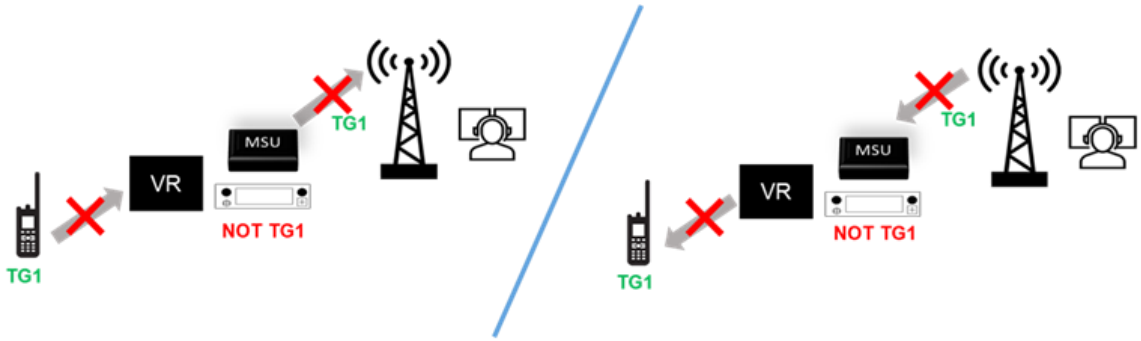


Figure 12: Talkgroup Matching - Unsuccessful PSU Communication

USE CASE
The Talkgroup Matching feature is used to support legacy operation, prior to the introduction of Talkgroup Proxying and Talkgroup Translation.

Talkgroup Proxying

The Talkgroup Proxying feature ensures that local PSU calls are sent to the system via the DVRS on the PSU talkgroup, regardless of the MSU selected talkgroup.

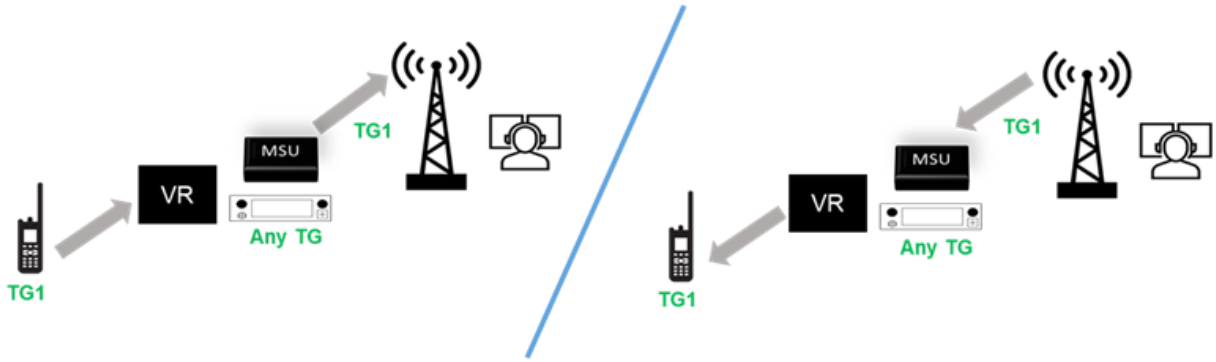


Figure 13: Talkgroup Proxying - Successful PSU Communication

USE CASE
The Talkgroup Proxying feature is typically used with a permanent DVRS covering a valley, for example, where different agencies may use the DVRS at different times. It allows users to communicate on their desired talkgroup without needing access to the mobile to change its talkgroup.

Talkgroup Translation

The Talkgroup Translation feature ensures that local PSU calls (inbound calls) are sent to the system via the DVRS on the MSU selected talkgroup, regardless of the PSU selected talkgroup. Calls from the system (outbound calls) received on the currently selected MSU talkgroup are repeated ‘as is’ without any translation. The local PSU must be configured for Normal Squelch to hear system calls.

System Allocation of PSU Talkgroup IDs
System design must ensure that the PSU talkgroup(s) to be used for the Talkgroup Translation feature is outside the range of talkgroups used on the Trunking system.

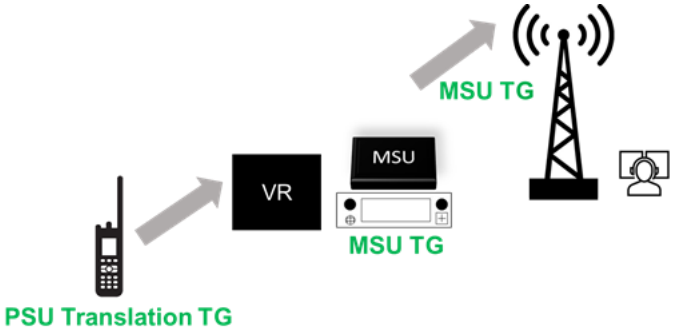


Figure 14: Inbound Communication - Talkgroup Translation

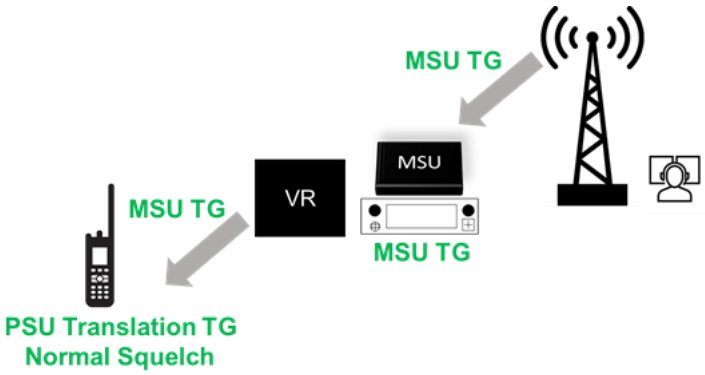


Figure 15: Outbound Communication - Normal Squelch

USE CASE
The Talkgroup Translation feature is typically used to simplify the end user PSU operation. By allowing the PSU to be on a Translation Talkgroup, the end user does not need to spend time changing channels on the PSU. Instead, this can be controlled by the Primary DVRS- typically setup as a command center.

Unit ID Translation

The Unit ID Translation feature allows portables on a digital channel to operate like ones do on an analog channel. Their transmissions will come into the network on the mobile selected talkgroup and using the mobile ID. They will hear transmissions from the network on the mobile selected talkgroup. While this may seem like a step backwards (making a digital mobile repeater work like an analog one) it can be useful.

Feature Interaction

The Unit ID Translation feature overrides some aspects of the TG Proxying and TG Translation features and may result in unexpected behaviour for the channels this is enabled on. Refer to the following figures for an illustration of how each feature combination impacts the behaviour.

Also note that this feature is not compatible with PSU Authentication. Portables attempting to access the network via the DVR will be denied.

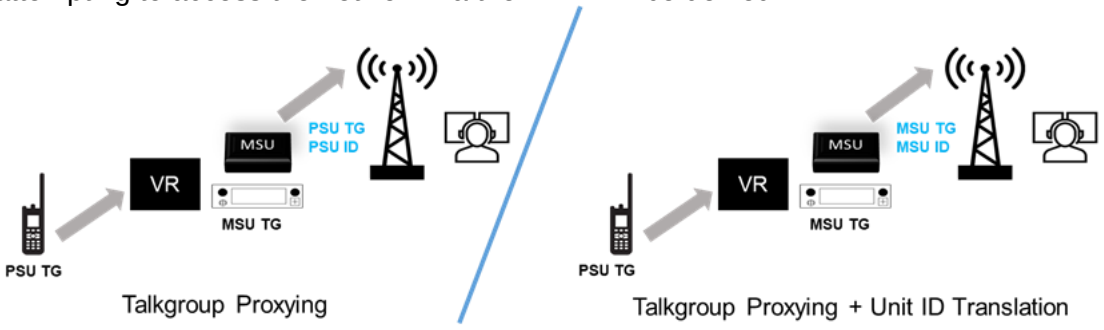


Figure 16: Impact of Unit ID Translation on Talkgroup Proxying - Inbound Communication

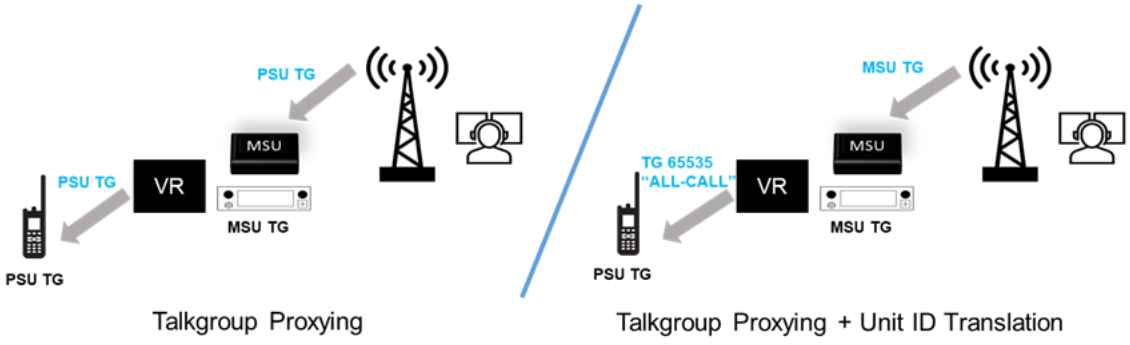


Figure 17: Impact of Unit ID Translation on Talkgroup Proxying - Outbound Communication

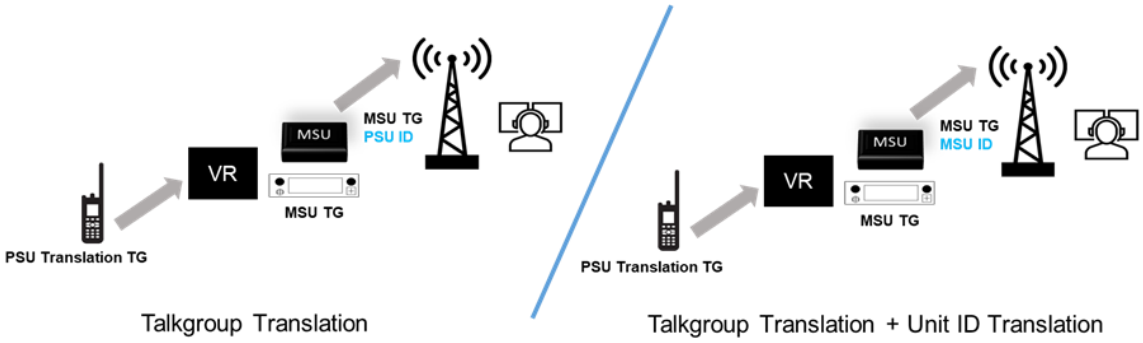


Figure 18: Impact of Unit ID Translation on Talkgroup Translation - Inbound Communication

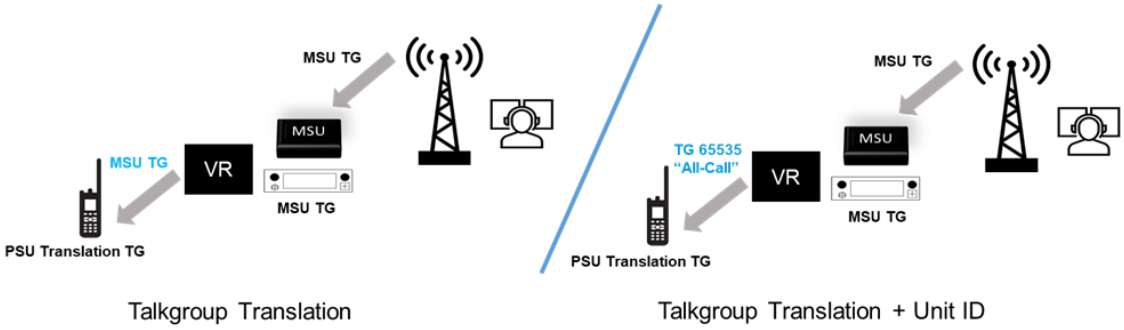


Figure 19: Impact of Unit ID Translation on Talkgroup Translation - Outbound Communication

USE CASE

The Unit ID Translation feature is typically used when 700MHz interoperability channels are utilized to allow access to a trunking network. As these interoperability channels are digital (all other bands are analog), all guest PSUs communicating through a DVRS at a disaster or large event would normally need to have unique IDs provisioned on the network. This can be a monumental task and often time does not allow for it to occur.

Failing to program all these guest portables can lead to several problems:

- It is very unlikely that the guest portables have conventional talkgroups programmed, so will default to talkgroup 1. The result is that the portables appear on talkgroup 1 on the trunking side, rather than the desired talkgroup.
- Many portables use a P25 ID that means something on their home system, but may be invalid or conflict with another user on the network the DVR is accessing
- The portables may not have a P25 ID on the interoperability channels, so use the default ID 1. There is a good chance this will not be valid on the network. But if somehow it is, and there are multiple potables defaulting to ID 1, it will lead to duplicate IDs on the system. This is undesired as the system may struggle to handle multiple portables with the same ID, potentially resulting in termination of their transmissions or other unexpected behaviour.

Private Calls

Private Calls or Selective Calls (Local to Local PSU; Local to System PSU; System to Local PSU) are supported on **'DVRS Enabled'** PSUs only. Generic P25 PSU mode does not support private calls via VR.

PSU Talk Permit Tones

'Go Ahead' tones are generated in the **'DVRS Enabled'** PSUs.
Different tones are generated to indicate if the VR is in LOCAL or SYSTEM mode or the call is P25 Encrypted.

As a programmable option LOCAL mode tones can be generated when the system is busy and only local repeat is available. Alternatively, the PSU user can get 'System Busy' tones and be forced to wait for system grant (see **'Digital System Setup Menu'** in the **VR Programming** section).

Generic P25 PSU mode does not support Talk Permit Tones when operating through the VR.

Status Broadcast

If enabled by its programming, the VR transmits Status Broadcasts that can be received only by **P25 'DVRS Enabled'** PSUs:

- FNE Out of Range
- DVR Local only status
- Site Trunking
- IV&D Data Enabled / Disabled status

NOTE:
Only a **Primary** VR can transmit Status Broadcasts.

The status indication is passed to the local PSU every time the status changes. If there is no change to the status, the VR sends status indication to the local PSUs at a preprogrammed time interval. The VR also sends a network status notification every time a local PSU is affiliated with the system via VR.

If the FNE enters Failsoft mode, the MSU proxies the Failsoft message (if failsoft is enabled in the MSU). The VR stops sending Status Broadcast to the local **'DVRS Enabled'** PSUs and periodically transmits Failsoft message instead.

The above indication is only available on **P25 'DVRS Enabled'** PSUs and is not available to Generic P25 PSUs.

NOTE:
Status notification is not supported if the VRX1000 does not have P25 Enhanced Trunking Features Installed.

Local Mode Indication

When the VR is operating in the Local Mode, the **'DVRS Enabled'** PSU User can see "**LOCAL ONLY**" message displayed on the PSU screen if status broadcast is enabled in the DVR as described in the 'Status Broadcast' paragraph. The above indication is only available on **'DVRS Enabled'** P25 PSUs and is not available to Generic P25 PSUs.

NOTE:
Local Mode Indication is not supported if the VRX1000 does not have **P25 Enhanced Trunking Features** Installed.

Radio Check / Inhibit

Radio Check and Radio Inhibit functions are passed through the VR to the Local PSU when the VR is in the SYSTEM or LOCAL mode. Those functions are available to both **'DVRS Enabled'** and Generic P25 PSUs when the MSU is operating on a P25 trunked or P25 conventional mode. If the MSU gets inhibited, the VR switches to 'VR Disabled' mode of operation.

P25 Trunking OTAR

P25 Over The Air Rekeying (OTAR) is supported through the VR when the local PSUs are of the **'DVRS Enabled'** type, the VR is in the SYSTEM mode and the MSU is on a P25 Trunking mode. OTAR is not supported if Generic P25 PSUs are used and / or if the MSU is on a P25 conventional channel.

NOTE:
P25 Trunking OTAR is supported on VRX1000 if P25 Enhanced Trunking Features is installed.

Patch

When several TGs are patched on the system side (using the Trunking group-regrouping function), the VR ensures the patching is matched on the local PSU side when **'DVRS Enabled'** PSUs are used, the VR is in the SYSTEM or LOCAL mode and the MSU is on a P25 Trunking TG.

MSU Patch is supported as follows:

- Inbound call from PSU on TG Translation enabled TG will be translated to the patch supergroup and repeated locally and to the system.
- Outbound call will be repeated as is (with the supergroup TG ID).

NOTE:
Patch is not supported on 'Generic P25' PSUs or if the VRX1000 does not have **P25 Enhanced Trunking Features** Installed.

Dynamic Regrouping

The Dynamic Regrouping feature allows a dispatcher to remotely redirect subscribers to operate on a designated TG without any intervention from the subscriber unit operator.

This is done by remotely assigning a new TG for the subscriber to operate on. When the subscriber receives the request, it automatically switches to the assigned zone / channel. The VR extends this functionality to the **'DVRS Enabled'** local PSUs when the VR is in the SYSTEM or LOCAL mode and the MSU is operating on a P25 Trunked channel.
PSU Reprogram request (PSU requesting to be dynamically regrouped or ungrouped) and Selector Lock / Unlock (disabling / enabling the zone/channel selection functionality while a PSU is dynamically regrouped) are not presently supported via the VR.

NOTE:
Dynamic Regrouping is not supported on Generic P25 PSUs or if the VX1000 does not have Option **P25 Enhanced Trunking Features** installed.

Phone Interconnect

Phone Interconnect is supported on local P25 **'DVRS Enabled'** PSU when the VR is on a full duplex P25 channel (digital or mixed mode) and the MSU is on a P25 Trunked mode. Phone Interconnect requires the VR to be in the SYSTEM or LOCAL mode.

Phone Interconnect is only supported on **'DVRS Enabled'** P25 PSUs and is not available to Generic P25 PSUs.

NOTE:
Local PSU Phone Interconnect is not supported on the VRX1000.

Adaptive Power Control

The VR can be programmed to send P25 messages to the Local PSUs to adjust their transmit power depending on the received signal strength from the VR and thereby to conserve the PSU battery. Enabling this feature is NOT recommended in applications where multiple PSUs are used with a single simplex mode VR since it will affect the PSU-to-PSU communications range.

NOTE:
Adaptive Power Control is supported on both 'Generic P25' PSUs as well as on **'DVRS Enabled'** PSUs.

Digital Audio Buffering

Audio buffering is supported by the VR to eliminate loss of messages / parts of messages due to the inherent delays associated with acquiring system access. The Digital Audio Buffer in the VR is programmable up to 1800ms.

P25 Encryption

The VR transparently passes the P25 encryption algorithms used by the subscriber and fixed network equipment. A transmission from a local portable would go through to the system with the MSU TG and the Encryption Key.

For example:
Local PSU: TG A, Encryption Key A
Repeater TG Translation Table List: TG A
MSU: TG B, Encryption Key B
Call from Local Portable will be proxied to the System with TG B, Encryption Key B

When the VR is on a P25 digital channel, inbound digital audio from a local PSU is handled according to the following table:

Local PSU Call	MSU Secure Strapping	Receiving Local PSUs	Receiving FNE
P25 Clear	Clear or Secure	P25 Clear	P25 Clear
P25 Encrypted	Clear or Secure	P25 Encrypted	P25 Encrypted

Table 10 Inbound P25 Encryption Rules

While the VR is on a digital channel, outbound digital audio originating from the FNE is handled according to the following table:

Call from FNE	MSU Secure Strapping	Receiving Local PSUs
P25 Clear	Clear or Secure	P25 Clear
P25 Encrypted	Clear or Secure	P25 Encrypted

Table 11 Outbound P25 Encryption Rules

While the VR is on a digital channel, outbound digital audio originating from the MSU is handled according to the following table:

MSU Mode	MSU Secure Strapping	Receiving Local PSUs
Digital P25	Clear	P25 Clear
Digital P25	Secure	P25 Encrypted

Table 12 MSU MIC PTT P25 Encryption Rules

The MSU interfaced to the VR will unmute to Inbound or Outbound Encrypted P25 calls ONLY if the MSU contains the key used for encryption in its Encryption Key List.

NOTE:
In case of VRX1000, assuming it's in Local mode and programed to transmit / MSU not to transmit in Local mode.

P25 Encryption Updates

The VR transparently passes the P25 encryption algorithms used by the subscriber and fixed network equipment. When Talkgroup Translation is enabled, the MSU is responsible for the translation of the PSU Encryption Key to the appropriate System Encryption Key.

Talkgroup Proxying/Matching: Transmission from local PSU goes through to the system with the PSU TG and Encryption Key.

Talkgroup Translation: Transmission from local PSU goes through to the system with the MSU TG and Encryption Key.

Talkgroup Translation Example

Local PSU: TG A, Encryption Key A
Repeater TG Translation Table List: TG A
MSU: TG B, Encryption Key B
Call from Local Portable will be proxied to the System with TG B, Encryption Key B

Remote VR Activation and Steering by PSU Call Alert (Page)

A P25 PSU may be programmed to send a Call Alert (Page) and preprogrammed Network ID (NAC) to a specific VR and thereby remotely change:

- VR Mode (from OFF or Local to System)
- VR Status (Secondary / Primary)
- Selected TG / Channel on MSU

The VR is addressed by sending a call alert (page) with the specific programmed VR's ID.

NOTE:
All VRs should have unique IDs programmed in the digital mode settings menu if the remote control feature is to be used. If no VR ID is programmed, the VR will assume the ID of the MSU currently interfaced to it. Remote activation and steering are supported when the MSU ID = VR ID.

The remote VR status change will not be successful if there is a Permanent Primary already present in the area.

Emergency in Digital Mode

The **'DVRS Enabled'** P25 PSU can be programmed to block the launch of the Emergency feature if the P25 Trunking system is in Failsoft mode (when 'Emergency Blocked in Failsoft' is enabled).

The **'DVRS Enabled'** P25 PSU can be programmed to use the programmed 'Fallback Revert Talkgroup' while in Emergency and when on the dynamic Talkgroup channel without an assigned dynamic working group.

Emergency Alarm

When an affiliated local PSU issues an emergency Alarm, the active Primary DVR will process the emergency to the system as follows:

- If enabled in the VR, the local PSU Emergency ID will be displayed on the MSU control head of the current Primary VR. The PSU Emergency ID will also appear on the display of the other local PSUs if they are programmed accordingly. The local PSU Emergency ID may also be displayed on the dispatch console.

- Depending on its programming, the VR sends back an Emergency ACK to prevent the PSU from re-sending the Emergency either right after the VR decodes the Emergency request or after FNE/ Console ACK has been received

- All Secondary VRs in the area are monitoring the number of emergencies issued by Local PSUs according to the **'Attempts Timeout'** and **'Attempts Counter'** settings programmed in the VRs. If the number of detected but unserviced Emergency Attempts exceeds the counter, the Secondary VRs will go through Primary / Secondary voting to select a new Primary that will process the Emergency Alarm to the FNE.

- If a VR is in the OFF Mode when it receives an Emergency Alarm from a local PSU, the VR will switch to System Mode after the **'Attempts Counter'** is exceeded, affiliate the PSU and process the Emergency to the system.

- If a VR is on a 'VR Disabled' Mode and it receives an Emergency from a local PSU with a valid steering NAC then after the **'Attempts Counter'** is exceeded, the DVRS will steer to the corresponding 'VR Enabled' MSU mode, switch to SYSTEM mode, affiliate the PSU and pass the Emergency to the System.

Emergency Call

Emergency Call operation provides the user with access to a voice resource on a priority basis. The user's Emergency Call has priority over all other types of call traffic.

Upon receipt of an Emergency Call from a local PSU, the VR will process the call locally as well proxy the call to the FNE. The VR also updates Control Head display to indicate the PSUs Emergency Call condition. Upon PSU Cancellation of the Emergency Call, the VR will clear its emergency display. The VR will also proxy the PSU emergency cancellation to the P25 FNE.

Emergency Hot MIC enables automatic emergency voice transmission without having to press the PSU PTT. PSU Emergency Hot Mic is supported only on **'DVRS Enabled'**

PSUs. Only the **'DVRS Enabled'** PSU waits for Emergency Alarm ACK before requesting a voice channel. If Emergency Hot MIC is enabled in Generic P25 PSUs, the PSU will send emergency alarm and immediately enter the call phase, which prevents consistent emergency processing.

If the MSU interfaced to the VR is placed in Emergency Call, the VR will proxy the call to all Local PSUs that are in the VR proxy list.

Emergency Revert through VR

The VR can be configured to revert local PSUs that have entered emergency by mode steering the MSU to a preconfigured zone/channel.

When the VR is programmed for emergency revert and the MSU is not already in Emergency, the VR steers the MSU to the preprogrammed zone/channel upon receiving and Emergency Alarm / Call from the PSU.

When the VR receives emergency cancellation from the PSU, it steers the MSU back to the original zone / channel, provided the MSU is not in emergency and the user has not manually changed the MSU channel.

Emergency Revert through PSU

The PSU can be configured to revert to a preprogrammed talkgroup or zone / channel when it enters Emergency. With the Talkgroup revert option, the PSU does not change its mode but rather stays on the currently selected channel and performs all emergency related voice and signaling by using the Revert Talkgroup ID. Talkgroup revert is only supported on the APX **'DVRS Enabled'** PSUs.

Emergency operation during TG Translation

Emergency operation is affected by TG Translation as follows:

- **Inbound Emergency Alarm** received by the VR on TG X will be translated and repeated locally on all translated TG IDs that are selected on local PSUs, which are currently affiliated with the VR. The Emergency Alarm is also translated to the ID of the TG selected on the MSU and forwarded to the system.

- **Outbound Emergency Alarm** received by the MSU on the MSU selected TG (TG Y) will be translated and repeated to the local PSUs on all translated TG IDs that are selected on Local PSUs (affiliated with the VR).

- **Inbound Emergency Call** on TG X will be translated by the VR to the ID of the TG selected on the MSU and will be repeated locally on the translated TG.

- **Outbound Emergency call** received on TG Y selected on the MSU will be repeated by the VR to the local PSUs on TG Y.

If Emergency Revert is programmed in the local PSU then:

- If the revert TG is on the VR TG Translation list, then the Emergency will be translated to the ID of the TG that is selected on the MSU. Emergency Alarm will be repeated locally on all Translation enabled TG IDs that are selected on Local PSUs (affiliated with the VR).
- If the revert TG is not in the VR TG Translation list then the emergency will be proxied and the inbound, outbound and local repeat will be on the new emergency revert TG.

- If the MSU (interfaced to the Primary VR) is placed in Emergency and programmed to revert in Emergency then a subsequent Local PSU emergency will also be translated and declared on the MSU's emergency revert TG.

Fireground (FG) Signaling

The Fireground deployment consists of a fleet of subscribers communicating with an Incident Commander position using digital signaling and either analog or digital voice.

If Fireground (FG) signaling is enabled in the local PSUs and on the selected full duplex VR channel, the VR repeats locally the FG messages received from the Local PSUs to the FG terminal. FG Emergency signaling received from the local PSU can be either repeated locally, sent to the system or both (as programmed in the VR).

NOTE:
Only '**Generic P25'** PSUs support Fireground operation.

PSU IV&D

The VR supports IV&D for only one PSU at any time. The use of PSU IV&D requires P25 **'DVRS Enabled'** PSUs, a VR in LOCAL or SYSTEM mode operating on a P25 digital or Forced Analog/Forced Analog All channel, and MSU operating on a P25 Trunked mode. Voice operation and signaling (such as call alert etc.) initiated from the MSU or PSU take priority over data operation.

PSU Location Reporting

Location Reporting is supported on **'DVRS Enabled'** PSUs when the MSU is operating on a P25 Trunked mode. This feature relies on PSU IV&D functionality described above.

PSU Call Alert

PSU call alert is supported via the VR when the MSU is operating on a P25 trunked or P25 conventional mode and when the PSU is either P25 **DVRS Enabled** or **P25 Generic**.

PSU Message

The Message feature is supported on all types of P25 PSUs when the MSU is operating on a P25 Conventional mode only.

PSU Status Update and Status Request

The PSU Status Update & Status Request features are supported on all types of P25 PSUs when the MSU is operating on a P25 Conventional or P25 Trunked mode.

Automatic PSU Revert to Talk Around (TA)

The VR Enabled PSU can be programmed to automatically revert to TA if it goes outside of the VR radio coverage range. The PSU automatically reverts to normal full duplex operation as soon as it re-enters the VR radio coverage range. If using a simplex VR channel, the simplex PSU can be programmed to automatically revert to TA so that it can transmit even when the PSU is out of the range of the VR. This way, simplex PSU-to-PSU calls will be allowed regardless of the presence or absence of the VR

NOTE:
VR Channel is automatically revert to TA in case of VRX1000

PSU Group Services

Pre-requisites for PSU Group Services support via VR:

- APX series **'DVRS Enabled'** PSUs with Firmware R14.50.00 or later
- P25 Trunked FNE with firmware 7.16 or later
- VR with firmware R1.22 / MSU R14.50.00 or later
- VR in SYSTEM or LOCAL Mode, Digital Channel Selected
- MSU that VR is interfaced to receiving Group Services while on P25 Trunked **FDMA** Mode

The following Group Services can be supported by the VR:

Group Text

Group text is an unconfirmed message that is sent to all members of a talkgroup. The VR passes the Group Text messages to the local PSUs. If the Local **'DVRS Enabled'** PSU users want to receive only Group Text Messages sent to the PSU selected Talkgroup, then the PSU must be programmed for 'Selective Squelch' instead of the default 'Normal Squelch'. If programmed for 'Normal Squelch', the Local PSU will receive all Group Text Messages proxied by the VR regardless of the Talkgroup currently selected on the PSU.

NOTE:
The above also applies to voice calls in general – if the Local PSU users want their PSUs to only unmute to the PSU selected Talkgroup, then they need to program 'Selective Squelch' in the PSU. If they are using the default 'Normal Squelch' setting, the PSUs will unmute to all calls proxied by the VR regardless of the incoming call Talkgroup.

Group Alias Update

Group Alias update is a message sent to a given TG while on a voice channel to alert the receiving radio of the transmitting radio's alias/ID configured in the Provisioning Manager on the console. The updated Group Alias data is received by the members of the TG and their Unified Call List (UCL) is updated. The VR passes the Group Alias Update to the Local **'DVRS Enabled'** PSUs so that their UCLs can get the update even while they are not directly connected to the trunked system but are proxied via the VR.

NOTE:
The updated Alias will be displayed on the receiving PSU only when the PSU is directly affiliated on the Trunking system. When affiliated through the VR, the PSU will still display the Unit ID of the transmitting PSU but it will not display the programmed or the updated Alias for that transmitting Unit ID.

NOTE:
When the MSU is operating on TDMA mode, the MSU may receive group services but will not proxy those to the VR / Local PSUs.

Personnel Accountability

Personnel Accountability feature allows the user to respond to the group or individual evacuation command from the incident commander through FNE. When the subscriber receives the EVAC command, plays an alert and display, corresponding to the command type in the packet. The user presses PTT to stop playing alert and display and then sends back EVAC ACK to FNE through DVRS.

For feature compatibility with PSU types please refer to Table 1 DVRS Features (Motorola Infrastructure) vs Type of PSU.

NOTE:
The evacuation command includes group and individual target and can be transmitted on control channel or working channel.

VR PSU Authentication

The VR proxies the Authentication process to the **'DVRS Enabled'** LPSUs.
It is recommended to disable BL; since due to the System Authentication timing, the VR may process messages/emergency alerts from a non-authenticated duplicate ID LPSU. When using remote activation of the VR via Call Alert/Page, it may take up to 10 seconds for the LPSU to be Authenticated.

Feature License – Authentication required to enable this feature.[8]

[8] See firmware version requirement in Compatibility Chart

Encrypted PSU Data

This feature encrypts PSU Data, through the VR, while MSU is on a P25 trunked system. It offers VR users end to end security for their location information.

NAC Linking

When two VRs are on a scene, they negotiate a Primary / Secondary relationship to avoid conflicts. (See Primary / Secondary Operation Basics).
One VR becomes the Primary unit and is responsible for all communications between the local PSUs and the system. In some situations, a single PSU is in range of multiple VRs where the VRs are located far enough apart from each other that they are both acting as Primary units. The purpose of the NAC Linking feature is to link a PSU with only one VR at a given time. Using the P25 NAC code, a PSU negotiates with available VRs and selects one Primary VR to connect to- ideally this is the closest. Only that VR sends communications between the PSU and the system. As a PSU moves out of range of its linked VR, it checks in the area for additional Primary VRs and then links to another available Primary unit. If no Primary VRs are within range, the PSU goes into Talkaround and communicates directly with other local PSUs. (refer to Motorola documentation regarding Talkaround feature)

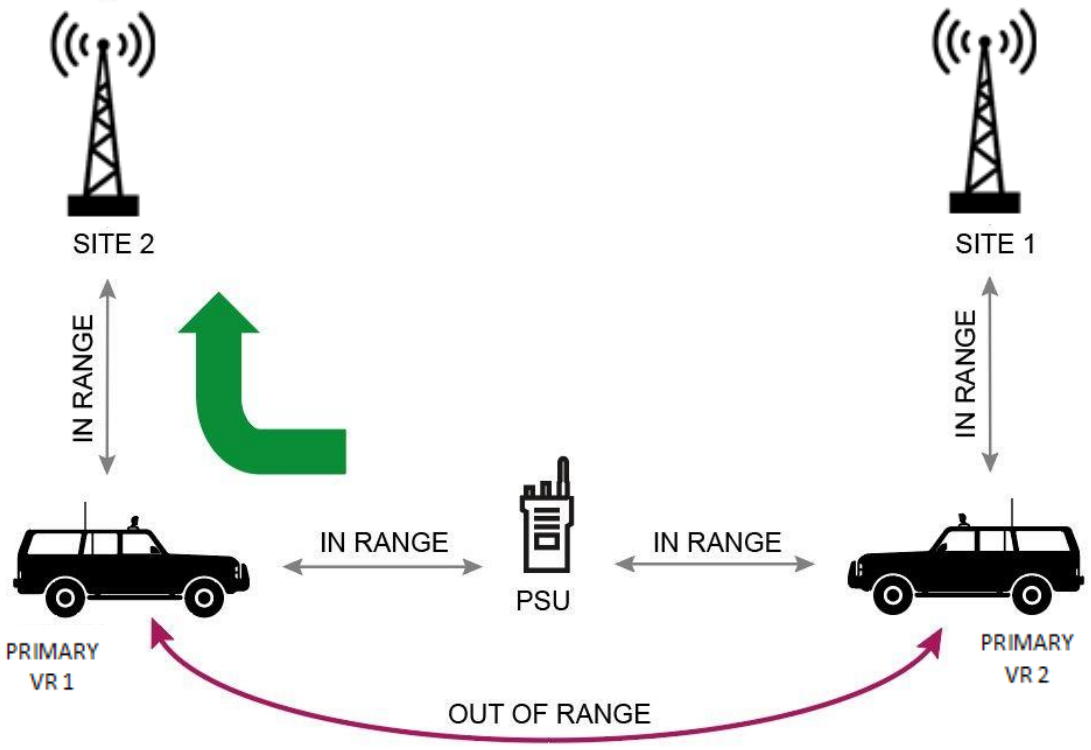


Figure 20: NAC Linking Feature

The NAC Linking feature is provided on a per VR channel basis. This provides versatility and allows the VR to be used by DVRS enabled portables on NAC Linking enabled channels and generic (non-DVRS enabled) portables on NAC Linking disabled channels.

Compatibility Mode automatically downgrades NAC Linking operation when presence of older, non-NAC linking capable PSUs are detected. Once downgraded, VR would handle both types of PSUs by using default/programmed Rx/Tx NACs. NAC Linking operation will automatically resume on subsequent VR activation (VR channel change, Mode change from Off to Local/System or power-up).

This separation of channels by portable type is also useful with shared DVRS units. For example, a shared rackmount DVRS unit used to fill a coverage hole can be configured with different channels per agency and does not require all PSUs to be DVRS enabled portables that support the NAC Linking feature.

The NAC Linking feature can be used when the VR is operating on digital channels or forced analog channels. When applying NAC Linking to a Forced Analog channel, it only improves operation when the MSU is utilizing a P25 (trunking or conventional) system.

When NAC Linking is being used, switching the MSU between P25 and non-P25 systems may require the VR to re-link with all associated PSUs.

VR System Topologies

The following table provides an overview of all possible VR system configurations and whether each is supported. The rest of the document provides details on the supported system topologies.

PSU Type	VR Ch	System Configuration				
		System Type				
		Analog Conv.	P25 Conv.	Type II Trunking	P25 Trunking	P25 Trunking
		MSU Channel Type				
		Analog	Digital	Analog/Digital	Digital FDMA	Digital TDMA
Analog	Analog	Yes	Yes	Yes	Yes	Yes
	Digital	No	No	No	No	No
	Mixed	Yes	Yes	Yes	Yes	Yes
	Forced Analog	No	No	No	No	No
	Forced Analog All	No	No	No	No	No
P25 Generic	Analog	No	No	No	No	No
	Digital	No	Yes	No	Yes	No
	Mixed	No	Yes	No	Yes	No
	Forced Analog	No	No	No	No	No
	Forced Analog All	No	No	No	No	No
P25 DVRS Enabled	Analog	No	No	No	No	No
	Digital	No	Yes	No	Yes	Yes
	Mixed	No	Yes	No	Yes	Yes
	Forced Analog	Yes	Yes	Yes	Yes	Yes
	Forced Analog All	Yes	Yes	Yes	Yes	Yes

Table 13 VR System Topologies

Type II Trunking OR 3600 Baud System,

- *The mobile to site link in a 3600 system for the voice channel can be either analog or digital. The analog/digital selection is based on the configuration of the subscriber modulation map in the provisioning manager which sets up to 32 ranges separately for subscriber IDs and TGIDs.*
- *Type II digital voice is not compatible with the VR's P25 digital voice*

Digital Mode – Summary of Features

Digital Channel Type on DVR/DVR-LX w P25 Trunking Mode Selected

The operation described below assumes a VR Digital mode conventional channel and P25 Talkgroup are selected on the DVR/DVR-LX and MSU respectively.

FEATURE	DVR/DVR-LX **OFF** Mode	DVR/DVR-LX **SYSTEM** Mode	DVR/DVR-LX **LOCAL** Mode
Status Display on MSU CH	**VR OFF <DVR CH>**	**VR SYS <DVR CH>**	**VR LOC <DVR CH>**
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying / Translation	No	Yes	Yes
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	Yes	Yes
MSU Microphone PTT	Keys up MSU only	As programmed	As programmed
Inbound Group Call	No	Yes	Yes (Local Side)
Inbound Private Call	No	Yes	Yes
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm & Call	Yes (after activation)	Yes	Yes
PSU Emergency Revert	Yes (after activation)	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes	Yes
PSU Remote VR Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	No	Yes	No
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	Yes	Yes
PSU P25 Trunking OTAR	No	Yes	Yes
PSU Patch	No	Yes	Yes
PSU Dynamic Regrouping	No	Yes	Yes
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	Yes (FDX only)	Yes (FDX only)
PSU Adaptive Power Control	No	Yes	Yes
Audio Buffering	No	Yes	Yes
P25 Encryption	No	Yes	Yes
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
PSU Status / Message	No	Status only	Status only
PSU Group Services	No	Yes	Yes
PSU PTT ID	No	Yes	Yes
LOP(Location on PTT)	No	Yes	Yes
PSU Authentication	No	Yes	Yes

Table 14 Digital Channel Type on DVR/DVR-LX w P25 Trunking Mode Selected on MSU

Digital Channel Type-VRX1000 (P25 Operation) & Generic P25 PSUs w P25 Trunked (FDMA) Mode Selected

When only **P25 Operation** option is enabled, in addition to all Analog mode features**,** the VRX1000 also supports basic P25 functionality with P25 Generic PSUs. **'DVRS Enabled'** PSUs are blocked and require **P25 EnhancedTrunking Features** option to be enabled through the VRX1000

FEATURE	VRX1000 **OFF** Mode	VRX1000 **SYSTEM** Mode	VRX1000 **LOCAL** Mode
PSU Affiliation	No	No	No
Talkgroup Proxying / Translation	No	Yes	Yes
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	Keys up MSU only	As programmed [9]
Inbound Group Call	No	Yes	No
PSU PTT ID Pass Through	No	Yes	Yes
Inbound Private Call	No	No	No
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	No	No
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes	Yes
PSU Remote VR Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	No	No	No
PSU Local Mode Indication	No	No	No
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	No	No	No
PSU Patch	No	No	No
PSU Dynamic Regrouping	No	No	No
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	NA
PSU P25 Encryption	No	Yes	Yes
PSU Scan	Yes	Yes	Yes
PSU Group Services			
PSU Announcement Group	No	No	No
PSU Status / Message	No	Status only	Status only
PSU Authentication			

Table 15 Digital Channel Type-VRX1000 (*P25 Operation*) & Generic P25 PSUs w P25 Trunked (FDMA) Mode Selected on MSU

[9] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.

Digital Channel Type-VRX1000 (P25 Enhanced Trunking Features) w P25 Trunked (FDMA) Mode Selected

When **P25 Enhanced Trunking Features** option is enabled on VRX1000 with **'DVRS Enabled'** PSUs.

FEATURE	VRX1000 **OFF** Mode	VRX1000 **SYSTEM** Mode	VRX1000 **LOCAL** Mode
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying / Translation	No	Yes	Yes
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	Yes	Yes
MSU Microphone PTT	Keys up MSU only	Keys up MSU only	As programmed [10]
Inbound Group Call	No	Yes	No
PSU PTT ID Pass Through	No	Yes	Yes
Inbound Private Call	No	Yes	Yes
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes	Yes
PSU Remote VR Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	No	Yes	No
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	Yes	Yes
PSU P25 Trunking OTAR	No	Yes	Yes
PSU Patch	No	Yes	Yes
PSU Dynamic Regrouping	No	Yes	Yes
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	Yes	Yes
Audio Buffering	No	Yes	NA
PSU P25 Encryption	No	Yes	Yes
PSU Scan	Yes	Yes	Yes
PSU Group Services	No	Yes [11]	Yes [11]
PSU Announcement Group	No	No	No
PSU Status / Message	No	Status only	Status only
PSU Authentication	No	Yes	Yes

Table 16 Digital Channel Type-VRX1000 (*P25 Enhanced Trunking Features*) w P25 Trunked (FDMA) Mode Selected on MSU

[10] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.
[11] Group services supported on APX Series 'DVRS/VRX1000 Enabled' PSUs

Digital VR Mode with P25 Conventional Mode Selected on MSU

Digital Channel Type on DVR/DVR-LX w P25 Conventional Mode Selected

The operation described below assumes a VR Digital mode conventional channel and P25 Conventional mode are selected on the DVR/DVR-LX and MSU respectively.

FEATURE	DVR/DVR-LX **OFF** Mode	DVR/DVR-LX **SYSTEM** Mode	DVR/DVR-LX **LOCAL** Mode
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying / Translation	No	Yes	Yes
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	As programmed	As programmed
Inbound Group Call	No	Yes	Yes (Local Side)
Inbound Private Call	No	No	No
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm & Call	Yes (after activation)	Yes	Yes
PSU Emergency Revert	Yes (after activation)	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes	Yes
PSU Remote VR Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	N/A	N/A	N/A
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	Yes	Yes
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock /Unlock	N/A	NA	N/A
PSU Phone Interconnect	N/A	N/A	N/A
PSU Adaptive Power Control	No	Yes	Yes
Audio Buffering	No	Yes	Yes
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	Yes	Yes
PSU Status / Message	No	Yes	Yes
PSU PTT ID	No	Yes	Yes

Table 17 Digital Channel Type-DVR/DVR-LX w P25 Conventional Mode Selected on MSU

Digital Channel Type-VRX1000 (P25 Operation) w P25 Conventional Mode Selected

When only **P25 Operation** option is enabled on VRX1000.

FEATURE	VRX1000 **OFF** Mode	VRX1000 **SYSTEM** Mode	VRX1000 **LOCAL** Mode
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying / Translation	No	Yes	Yes
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	Keys up MSU only	As programmed [12]
Inbound Group Call	No	Yes	Yes
PSU PTT ID Pass Through	No	Yes	Yes
Inbound Private Call	No	No	No
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes	Yes
PSU Remote VRX1000 Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	N/A	N/A	N/A
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VRX1000 Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock /Unlock	N/A	N/A	N/A
PSU Phone Interconnect	N/A	N/A	N/A
PSU Adaptive Power Control	No	Yes	Yes
Audio Buffering	No	Yes	N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
PSU P25 Encryption	No	Yes	Yes
PSU Status / Message	No	Yes	Yes

Table 18 Digital Channel Type-VRX1000 (*P25 Operation*) w P25 Conventional Mode Selected on MSU

[12] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.

Digital Channel Type-VRX1000 (P25 Enhanced Trunking Features) w P25 Conventional Mode Selected

When **P25 Enhanced Trunking Features** option is enabled on VRX1000 with **'DVRS Enabled'** PSUs.

FEATURE	VRX1000 **OFF** Mode	VRX1000 **SYSTEM** Mode	VRX1000 **LOCAL** Mode
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying / Translation	No	Yes	Yes
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	Keys up MSU only	As programmed [13]
Inbound Group Call	No	Yes	Yes
PSU PTT ID Pass Through	No	Yes	Yes
Inbound Private Call	No	No	No
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm	Yes-after activation	Yes	Yes
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	Yes-after activation	Yes	Yes
PSU Remote VR Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	N/A	N/A	N/A
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	Yes	Yes
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock /Unlock	N/A	N/A	N/A
PSU Phone Interconnect	N/A	N/A	N/A
PSU Adaptive Power Control	No	Yes	Yes
Audio Buffering	No	Yes	N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
PSU P25 Encryption	No	Yes	Yes
PSU Status / Message	No	Yes	Yes

Table 19 Digital Channel Type-VRX1000 (*P25 Enhanced Trunking Features*) w P25 Conventional Mode Selected on MSU

[13] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.

Forced Analog Channel Type

PREREQUISITE: Forced Analog/Forced Analog All channel types are only available to Local PSUs which are **'DVRS ENABLED'**.

Forced Analog is a hybrid channel type where the signalling between the VR and the PSU is P25 digital, however, depending on the MSU channel selected, voice communications may be Analog or Digital. Based on the MSU channel, the following rules apply:

- when MSU is on an Analog Conventional or Type II Trunking voice channel
    - whether the call is analog or digital, the VR 'forces' the PSU to transmit analog voice
- when MSU is on a P25 voice channel, Conventional or Trunking
    - the VR and PSU operate in P25 digital mode for voice

Forced Analog All is similar to the Forced Analog channel type except that voice communications between the VR and PSU are always analog regardless of what channel type the MSU is on.

At all times, the signalling between the PSUs and the VR is P25 digital.
e.g.: Signalling
Emergency
Remote Activation

VR Channel Type	System Type	VR ↔ PSU Signalling	VR ↔ PSU Voice
Forced Analog	Analog Conv. or Type II Trunking (MSU Ch: Analog/Digital)	P25 Digital	Analog
	P25 Conv. or P25 Trunking	P25 Digital	P25 Digital
Forced Analog All	All	P25 Digital	Analog

Table 20: Summary of System Type vs Signalling and Voice Communications

For a list of supported PSU features, refer to the **Forced Analog Channel Type-Summary of Supported Features** tables.

Forced Analog Channel Type – Summary of Supported Features

NOTE: VRX1000 support is based on the Tier 3 offering which includes P25 Enhanced Trunking Features.

MSU/System Type: Conventional Analog

FEATURE	VR MODE: OFF	VR MODE: SYSTEM	VR MODE : LOCAL
PSU Affiliation	No	No	No
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	**DVR-LX:** As programmed **VRX1000:** Keys up MSU only	As programmed [14]
Inbound Group Call	No	Yes	**DVR-LX:** Yes-Local Side **VRX1000:** Yes
Inbound Private Call	No	No	No
Inbound Call Alert	No	No	**DVR-LX**: Yes-Local Side **VRX1000**: No
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Revert via DVRS	No	Yes	Yes
PSU Emerg. ID Pass Through	No	Yes	Yes
PSU Remote VR Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	N/A	N/A	N/A
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	Yes	Yes
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock / Unlock	N/A	N/A	N/A
PSU Phone Interconnect	N/A	N/A	N/A
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	**DVR-LX**: Yes **VRX1000**: N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	Programmable	Programmable
PSU Status / Message	No	Yes	Yes
PSU PTT ID	No	Locally only	**DVR-LX:** Locally only **VRX1000**: No

Table 21 Forced Analog VR Channel Type with Conventional Analog MSU/System Type

[14] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.

MSU/System Type: Type II Trunked

FEATURE	VR MODE: OFF	VR MODE: SYSTEM	VR MODE : LOCAL
PSU Affiliation	No	No	No
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	As programmed	As programmed[15]
Inbound Group Call	No	Yes	Yes-Local Side
Inbound Private Call	No	No	No
Inbound Call Alert	No	No	**DVR-LX**: Yes-Local Side **VRX1000**: No
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Call	No	Yes (group call)	Yes (group call)
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes (with Emergency Alarm)	Yes (with Emergency Alarm)
PSU Remote VR Activation & Steering	Yes – Call Alert	Yes – Call Alert	Yes – Call Alert
Failsoft / Out of Range / Site Trunking Indication on PSU	No	**DVR-LX**: No **VRX1000**: Yes	**DVR-LX**: No **VRX1000**: Yes
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check /Inhibit	No	No	No
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	No	No	No
PSU Dynamic Regrouping	No	No	No
PSU Selector Lock / Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	**DVR-LX**: Yes **VRX1000**: N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	No	**DVR-LX**: Programmable **VRX1000**: Yes[16]
PSU Status / Message	No	No	No
PSU PTT ID	**DVR-LX:** No **VRX1000:** N/A	**DVR-LX:** Locally only **VRX1000:** N/A	**DVR-LX:** Locally only **VRX1000:** N/A

Table 22 Forced Analog Channel Type with Type II Trunked MSU/System Type

[15] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both
[16] P25 Encryption supported in direct mode i.e. local PSU to local PSU; no ICM support

MSU/System Type: P25 Trunking TDMA

FEATURE	VR MODE: OFF	VR MODE: SYSTEM	VR MODE : LOCAL
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying/Translation	No	Yes	Yes
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	Yes	Yes
MSU Microphone PTT	Keys up MSU only	As programmed	As programmed[17]
Inbound Group Call	No	Yes	Yes (Local Side)
Inbound Private Call	No	Yes	Yes
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Call	No	Yes (group call)	Yes (group call)
PSU Emergency Revert	No	Yes	Yes
PSU Emergency ID Pass Through	Yes (after activation)	Yes	Yes
PSU Remote VR Activation	Yes (Call Alert)	N/A	Yes (Call Alert)
MSU Mode Steering	No	Yes (Call Alert)	Yes (Call Alert)
Failsoft / Out of Range / Site Trunking Indication on PSU	No	Yes	Yes
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	Yes	Yes
PSU P25 Trunking OTAR	N/A	Yes	Yes
PSU Patch	No	Yes	Yes
PSU Dynamic Regrouping	No	Yes	Yes
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	**DVR-LX**: Yes **VRX1000**: No	**DVR-LX**: Yes **VRX1000**: No
PSU Adaptive Power Control	No	Yes	Yes
Audio Buffering	No	Yes	**DVR-LX:** Yes **VRX1000:** N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	Yes	Yes[18]
PSU Status / Message	No	**DVR-LX:** Yes **VRX1000:** Status only	**DVR-LX:** Yes **VRX1000:** Status only
PSU PTT ID*	No	Yes	Yes
PSU Authentication	No	Yes	Yes
***PSU PTT ID is displayed on the FNE side (on system radios) but not on other local PSUs. (FA-All)**			

Table 23 Forced Analog Channel Type with P25 Trunking MSU/System Type

[17] VRX1000 can be programmed so MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.
[18] P25 Encryption supported in direct mode i.e. local PSU to local PSU; no ICM support.

MSU System Type: P25 Trunking

FEATURE	VR MODE: OFF	VR MODE: SYSTEM	VR MODE : LOCAL
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying/Translation	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	As programmed	As programmed[19]
Inbound Group Call	No	Yes	Yes (Local Side)
Inbound Private Call	No	No	No
Inbound Call Alert	No	Yes	Yes
PSU Talk Permit Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Call	No	Yes (group call)	Yes (group call)
PSU Emergency Revert	No	Yes	Yes
PSU Emergency ID Pass Through	Yes (after activation)	Yes	Yes
PSU Remote VR Activation	Yes (Call Alert)	N/A	Yes (Call Alert)
MSU Mode Steering	No	Yes (Call Alert)	Yes (Call Alert)
Failsoft / Out of Range / Site Trunking Indication on PSU	No	Yes	Yes
PSU Local Mode Indication	No	No	Yes
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	Yes	Yes
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	N/A	**DVR-LX**: Yes **VRX1000:** N/A	**DVR-LX**: Yes **VRX1000**: N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	Yes	Yes
Audio Buffering	No	Yes	**DVR-LX:** Yes **VRX1000:** N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	As Programmed	Yes[20]
PSU Status / Message	No	**DVR-LX:** Yes **VRX1000:** Status only	**DVR-LX:** Yes **VRX1000:** Status only
PSU PTT ID[21]	No	Yes	No
PSU Authentication	No	Yes	Yes

Table 24: Forced Analog All Channel Type with P25 Trunking MSU System Type

[19] VRX1000 can be programmed so MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.
[20] P25 Encryption supported in direct mode i.e. local PSU to local PSU; no ICM support.
[21] PSU PTT ID is displayed on the FNE side (on system radios) but not on other local PSUs.

Analog Mode Operation

This chapter provides details on the DVRS Analog mode of operation.

The Analog mode assumes the following:

- APX MSU Programmed for DVRS Operation.
- PSU programmed for DVRS operation using a Conventional, Analog, non-ASTRO Personality.
- VR channel used is programmed for Analog (or Mixed) mode of operation.

VR Channel Setup for Analog Mode

To enable Analog VR operation on a specific VR channel the Channel Type (in the Repeater Channel Setup Menu) must be set to **Analog**.
The VR Tx / Rx Frequencies as well as the Tx / Rx PL or DPL must be programmed to match the corresponding PSU settings.

NOTE:
Mixed VR mode allows analog VR operation by switching between default digital and temporary analog modes as described in the Mixed VR Mode section. The use of mixed mode for analog VR communications is not recommended since it requires special user training due to the switching from digital to analog mode dynamics. Mixed VR mode should only be used when both analog and digital PSUs are required to operate on the same VR channel.

Group Calls

Inbound PSU calls will be repeated on the MSU side over the currently selected MSU TG / Channel. Outbound calls received by the MSU are repeated to the local analog PSUs.

DVR / DVR-LX	VRX1000
An analog local PSU in VR mode can communicate with other analog local PSUs via an active Primary VR if all units are using the same radio channel (full duplex only) and using matching PL / DPLs.	An analog local PSU in VR mode can communicate with other analog local PSUs in Talk Around mode if all units are using the same simplex radio channel and matching PL / DPLs.

Emergency in Analog Mode

The Emergency operation in analog mode is based on the type of signaling as selected in the Emergency Mode Setup Menu. The recommended analog mode signaling type is MDC1200. Note that in addition to the VR programming, MDC1200 signaling must also be enabled in the local PSU personality. If MDC 1200 signaling is used, the Local PSU Emergency Alarm MDC ID will be passed through to the system provided the MDC ID is enabled (valid) on the system side.

NOTE:
MDC PTT ID pass-through is not supported by VR on Type 2 Trunking MSU modes. Only MDC Emergency ID (with Emergency Alarm) pass-through is supported by the VR on Type 2 Trunking MSU modes.

NOTE:
MDC ID offset. The VR will add a user programmable value/offset to the PSU MDC ID while proxying a call to a P25 Trunking system.

Emergency Alarm

When an affiliated local PSU issues an Emergency Alarm, the active Primary VR will process the emergency to the system as follows:

- If the **'Portable ID Display'** box (in the VR **Emergency Mode Setup**) is checked, the Local PSU Unit ID will be displayed on the MSU control head of the current Primary VR.
- The PSU Unit ID will also appear on the display of the other local PSUs if they are programmed accordingly.
- The local PSU ID during Emergency may also be displayed on the dispatcher console.
- The VR sends back an Emergency ACK to prevent the PSU from re-sending the Emergency either right after the VR decodes the Emergency request (if the **'System Acknowledge Type'** on the **Mobile Radio Channel Settings** menu is set to **"VR Ack"**) or after FNE ACK has been received (if the **'System Acknowledge Type'** on the **Mobile Radio Channel Settings** menu is set to **'Site Ack'** or **'Console Ack'**).
- All Secondary VRs in the area are monitoring the number of emergencies issued by local PSUs according to the **'Attempts Timeout'** and **'Attempts Counter'** settings programmed in the VRs **Emergency Mode Setup**. If the number of detected not serviced Emergency Attempts exceeds the counter, the Secondary VRs will go through Primary / Secondary voting to select a new Primary to pass the emergency to the system.
- If a VR is in the OFF mode when it receives an Emergency from a local PSU, the VR will switch to SYSTEM mode after the **'Attempts Counter'** is exceeded, affiliate the PSU and pass the Emergency to the system.

The PSU Emergency attempts counter must be programmed to be equal to the VR **'Attempts Counter'** plus 3.

Emergency Call

Emergency Call operation provides the user with access to a voice resource on a priority basis. The user's Emergency Call has priority over all other types of call traffic. Upon receipt of an Emergency Call from a local PSU, the VR will process the call locally as well as proxy the call to the FNE. On Type II Trunking systems, the PSU Emergency Call will be proxied with the **MSU Emergency ID**, NOT the PSU MDC ID. The VR also updates its display to indicate the PSUs Emergency Call condition.

Emergency Revert through VR

The VR can be configured to revert the local PSUs that have entered emergency by mode steering the MSU to a preconfigured zone/channel. When the VR is programmed for emergency revert and the MSU is not already in Emergency, the VR steers the MSU to the preprogrammed zone/channel upon receiving and Emergency Alarm / Call from the PSU. The emergency revert condition can be configured as permanent or timed. If configured as timed then the VR will revert the MSU back to the original channel after the emergency inactivity timer expires without inbound or outbound activity.

Analog Audio Buffering

Audio buffering is supported by the VR to eliminate loss of messages / parts of messages due to the inherent delays associated with acquiring system access. The analog buffer is programmable in the VR (up to 1300ms).

Fireground (FG) Signaling

The Fireground deployment consists of a fleet of subscribers communicating with an incident commander position using digital signaling and either analog or digital voice. Fireground (FG) Emergency signaling received from the local PSU can be either repeated locally, sent to the system, or both (as programmed in the VR).

NOTE:
For DVR/DVR-LX: If FG signaling is enabled in the local PSUs and on the selected full duplex VR channel, the DVR/DVR-LX repeats locally the FG messages received from the local PSUs to the FG terminal.

NOTE:
Only Generic P25 PSUs support Fireground operation.

Remote VR Activation via DTMF

The local PSU may be programmed to remotely activate the VR by switching it from OFF or LOCAL to SYSTEM mode by sending a pre-programmed DTMF sequence (refer to **Analog Setup** screen in Futurecom Repeater Configurator for VR programming instructions related to this feature).

The remote activation only works if the local PSU and the VR are set to operate on the same radio channel and there is no other Primary / Permanent Primary VR in the area operating on the same channel.

NOTE:
The VR cannot be switched OFF remotely via DTMF.

P25 Encryption in Analog Mode

If the MSU is receiving a P25 Encrypted call while the VR is operating on an analog channel, the VR can be programmed to do one of the following:

- Forward encrypted audio to the local PSUs
- Forward Clear audio to the local PSUs
- Send Warning Tones to the local PSUs and no audio

P25 Encrypted audio received by the MSU is processed by the VR as described below:

Call from FNE received by MSU	VR Programming for Outbound Encrypted Calls	VR Transmits to receiving Local PSUs
P25 Encrypted (FDMA)	Transmit Encrypted	P25 Encrypted [22]
P25 Encrypted	Transmit Clear	Clear Analog
P25 Encrypted	Send Warning Tones	Warning Tones

IMPORTANT!
If the MSU is operating in TDMA mode, the VR cannot transmit outbound Encrypted Audio to the PSUs and inbound PSU encrypted calls are not proxied to the system.

[22] Local PSUs must be configured for Mixed receive.

Leading & Trailing Tones

The VR can be programmed to send over-the-air Leading or Trailing tones to the local PSUs to indicate successful MSU key up / system access.
If Leading Tones are enabled, the local PSU operation involves the following:

1. User does a quick PTT of local PSU so that MSU can request channel grant
2. User releases the PTT for a moment and waits to hear the Leading tones.
3. If the Leading tones indicate successful system access (channel grant), the local PSU user PTTs again and talks.
4. If the Leading tones indicate lack of channel grant, the LPSU user can try the call again.

Trailing tones are sent at the end of local PSU transmission and therefore do not require double PTT.
Both Leading and Trailing Tones are sent over-the-air (i.e. not generated in the PSU that initiates the call) therefore all local PSUs that are within the VR range and switch to the VR channel will hear the tones.

Mobile Mode Steering via PL/DPL

Each VR Channel may be configured to allow Local PSUs to direct the MSU to change its current channel/mode settings. The target Mobile Radio channel is based on the PL/DPL received in the PSU transmission. The MSU typically stays on the new channel/mode temporarily, until PSU traffic resumes on the original channel or a timeout occurs.

The VR typically operates in a mode in which it processes PSU calls which match the VR channel's Selected Rx PL/DPL configuration. Calls matching this Selected PL/DPL are repeated and/or passed through the DVRS, with behavior dependent on the current (Selected) VR mode (OFF/LOCAL/SYSTEM).

The ability to remotely steer the Mobile Radio channel, DVRS mode, and VR Tx PL/DPL is configured in the VR's **Repeater Channel Setup** window by setting **Steering** = "Yes", and configuring the VR channel's **Steering Table**, indicating which Mobile Radio channel and VR Tx PL/DPL the DVRS should be steered to when a given Steering PL/DPL is received from a PSU. (The Steering Table for each VR channel allows up to 14 different received PL/DPLs to be identified to steer the Mobile Radio channel, DVRS Mode, and VR Tx PL/DPL.)

Steering is only done if the DVRS is in LOCAL or SYSTEM mode. (DVRS cannot be steered if in OFF mode or DISABLED.)

Each analog transmission received by the VR is checked for presence of PL/DPL. If PL/DPL is detected, then the VR channel's **Steering Table** → **Rx PL/DPL** is checked for a match. If a match is found, then a transition occurs to the MSU Channel, and VR Tx PL/DPL found in the table; DVRS mode also changes to SYSTEM.
The duration of time that the DVRS remains on this new channel/mode depends on additional configuration parameters and received traffic.

- If VR's Repeater Channel is set for **Steering Revert** = No, then DVRS remains on the new channel/mode indefinitely.

- If VR's Repeater Channel is set for **Steering Revert** = Yes, then DVRS returns to its Selected Mobile Radio Channel, Selected DVRS mode, and original Tx PL/DPL after a period of radio inactivity configured in **Analog Setup → MSU Mode Steering Hang Time** parameter. Some amount of Steering Hang Time is usually configured so that other radio users can respond to the steered call before DVRS times out and returns to its previously selected Mobile Radio Channel, selected VR mode, and Tx PL/DPL.
- If VR receives a PSU-initiated call on the VR channel's (original) Selected Rx PL/DPL, this causes the DVRS to go back to its original Selected MSU channel, Selected VR Mode, and Tx PL/DPL. (This may happen during VR hangtime or for a VR channel configured for Steering Revert = No.)
- Note: If VR is configured with **Analog Setup → MSU Mode Steering Hang Time = 0**, this essentially disables Steering Revert for all VR channels. (Programming **Analog Setup → MSU Mode Steering Hang Time = 0,** disallows any Repeater Channel from being programmed with **Steering Revert = Yes.**)
- DVRS mode transitions to SYSTEM when steering occurs.

Steering and Emergency

- If steering is disabled on the current VR channel, local PSU emergency is declared on the currently selected MSU channel (no steering).
- If steering is enabled on the current VR channel, the local PSU emergency is declared on the new (steered) MSU mode.
- When MSU is in emergency call state ('**Put DVR in Emergency Call State**' is enabled), the local PSU calls handling is defined by the **'Steering in Emergency'** programming for the specific VR channel. If **'Steering in Emergency'** is Disabled, the VR repeats any local PSU calls on the emergency channel (no steering occurs).
- If '**Steering in Emergency'** is enabled, the VR will steer and then key up the MSU. In this case the MSU will re-declare Emergency call on the new (steered to) channel.
- If '**Put DVR in Emergency Call State'** is Disabled (local PSU and MSU programmed for Emergency Alarm only), an inbound local PSU call initiated while the MSU is waiting for emergency ACK, should terminate MSU emergency and steer the MSU to the corresponding MSU mode/channel without re-declaring the emergency alarm on the new MSU channel.

MSU Operating on TDMA (P25, Phase 2)

When the MSU is switched to a TDMA capable mode, the VR can operate in either Analog, Forced Analog, Forced Analog All or Digital mode.
For Forced Analog & Forced Analog All mode operation, please refer to the **Forced Analog & Forced Analog All Mode** section of this document.
When operating on TDMA system, any TDMA specific feature that can cause the MSU to interrupt an ongoing transmission will also affect the proxying of Local PSU transmissions to the system. The Local PSU will not receive an indication that its proxy transmission from the MSU to the system may have gotten interrupted.

Analog Mode – Summary of Features

Analog VR Mode with P25 Trunking Mode Selected on MSU

Analog Channel Type-DVR/DVR-LX with P25 Trunking Mode Selected

The operation described below assumes a VR Analog Mode channel and P25 Talkgroup are selected on the DVR/DVR-LX and MSU respectively.

FEATURE	DVR/DVR-LX OFF Mode	DVR/DVR-LX SYSTEM Mode	DVR/DVR-LX LOCAL Mode
PSU Affiliation	No	MDC	MDC
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	As programmed	As programmed
Inbound Group Call	No	Yes	Yes (Local Side)
Inbound Private Call	No	No	No
Inbound Call Alert	No	No	No
PSU Leading/Trailing Tones	No	As Programmed	As Programmed
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Call	No	Yes (group call)	Yes (group call)
PSU Emergency Revert	Yes (after activation)	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes – MDC1200 with Emerg. Alarm	Yes – MDC1200 with Emerg. Alarm
PSU Remote VR Activation	Yes – DTMF	N/A	Yes – DTMF
MSU Mode Steering	No	Yes (PL/DPL)	Yes (PL/DPL)
Failsoft / Out of Range / Site Trunking Indication on PSU	No	No	No
PSU Local Mode Indication	No	No	No
DVR Primary / Secondary Voting	No	Yes	Yes
DVR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	No	No	No
PSU Patch	No	No	No
PSU Dynamic Regrouping	No	No	No
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	Yes
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	Programmable	Programmable
PSU Status / Message	No	Yes Status only	Yes Status only
PSU PTT ID	No	Yes	Yes

Table 25 Analog Channel Type-DVR/DVR-LX with P25 Trunking Mode Selected on MSU

Analog Channel Type-VRX1000 with P25 Trunking Mode Selected

FEATURE	VRX1000 OFF Mode	VRX1000 SYSTEM Mode	VRX1000 LOCAL Mode
PSU Affiliation	No	Yes	Yes
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU	Keys up MSU only	As programmed [23]
Inbound Group Call	No	Yes	No
PSU PTT ID Pass Through	No	Yes	Yes
Inbound Private Call	No	No	No
Inbound Call Alert	No	No	No
PSU Leading/Trailing Tones	No	As Programmed	As Programmed
PSU Emergency Alarm	Yes (after	Yes	Yes
PSU Emergency Call	No	Yes (group call)	Yes (group call)
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after activation)	Yes – MDC1200 with Emerg. Alarm	Yes – MDC1200 with Emerg. Alarm
PSU Remote VR Activation	Yes – DTMF	N/A	Yes – DTMF
MSU Mode Steering	No	Yes (PL/DPL)	Yes (PL/DPL)
Failsoft / Out of Range / Site Trunking Indication on PSU	No	No	No
PSU Local Mode Indication	No	No	No
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	No	No	No
PSU Patch	No	No	No
PSU Dynamic Regrouping	No	No	No
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
PSU P25 Encryption	No	Yes (except Tier 1)	Yes (except Tier 1)
PSU Status / Message	No	Yes Status only	Yes Status only

Table 26 Analog Channel Type-VRX1000 with P25 Trunking Mode Selected on MSU

[23] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.

Analog VR Mode with P25 Conventional Mode Selected on MSU

Analog Channel Type on DVR/DVR-LX and VRX with P25 Conventional Mode Selected

The operation described below assumes a VR Analog Mode channel and Conventional P25 Channel are selected on the DVR/DVR-LX and MSU respectively.

FEATURE	OFF Mode	SYSTEM Mode	LOCAL Mode
PSU Affiliation	No	No	No
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	DVR: As programmed VRX: Keys up MSU only	As programmed
Inbound Group Call	No	Yes	DVR: Yes (Local Side) VRX: No
Inbound Private Call	No	No	No
Inbound Call Alert	No	No	No
PSU Leading / Trailing Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	DVR: Yes (after activation) VRX: Yes (after MDC1200 activation)	Yes – MDC1200 with Emerg. Alarm	Yes – MDC1200 with Emerg. Alarm
PSU Remote VR Activation	DVR: N/A VRX: Yes – DTMF	N/A	DVR: N/A VRX: Yes - DTMF
MSU Mode Steering	No	Yes (PL/DPL)	Yes (PL/DPL)
Failsoft / Out of Range / Site Trunking Indication on PSU	N/A	N/A	N/A
PSU Local Mode Indication	No	No	No
Primary / Secondary Voting	No	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock /Unlock	N/A	N/A	N/A
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	DVR: Yes VRX: N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	DVR: Programmable VRX: Yes (Not Tier 1)	DVR: Programmable VRX: Yes (Not Tier 1)
PSU Status / Message	No	Yes	Yes
PSU PTT ID	No	Yes	Yes

Table 27 Analog Channel Type on DVR/DVR-LX and VRX with P25 Conventional Mode Selected on MSU

Analog VR Mode with Conventional Analog Mode Selected on MSU

Analog Channel Type on DVR/DVR-LX and VRX with Conventional Analog Mode Selected

The operation described below assumes a VR Analog Mode channel and Conventional Analog Channel are selected on the DVR/DVR-LX / VRX and MSU respectively.

FEATURE	OFF Mode	SYSTEM Mode	LOCAL Mode
PSU Affiliation	No	No	No
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	DVR: As programmed VRX: Keys up MSU only	As programmed
Inbound Group Call	No	Yes	DVR: Yes (Local Side) VRX: NO
Inbound Private Call	N/A	N/A	N/A
Inbound Call Alert	No	No	No
PSU Leading / Trailing Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	DVR: Yes (after activation) VRX: Yes (after MDC1200 activation)	DVR: Yes VRX: Yes – MDC1200 with Emerg. Alarm	DVR: Yes VRX: Yes – MDC1200 with Emerg. Alarm
PSU Remote VR Activation	Yes – DTMF	N/A	Yes – DTMF
MSU Mode Steering	No	Yes (PL/DPL)	Yes (PL/DPL)
Failsoft / Out of Range / Site Trunking Indication on PSU	N/A	N/A	N/A
Local Mode Indication on PSU	No	No	No
Primary / Secondary Voting	Yes	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	No	No
P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock / Unlock	N/A	N/A	N/A
PSU Phone Interconnect	N/A	N/A	N/A
PSU Adaptive Power Control	N/A	N/A	N/A
Audio Buffering	No	Yes	DVR: Yes VRX: N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	DVR: No VRX: Yes (not Tier 1)	DVR: Programmable VRX: Yes (not Tier 1)
PSU Status / Message	No	Yes	Yes
PSU PTT ID	No	Yes	Yes

Table 28 Analog Channel Type on DVR/DVR-LX and VRX with Conventional Analog Mode Selected on MSU

Analog Channel Type on VRX1000 with Conventional Analog Mode Selected

FEATURE	VRX OFF Mode	VRX SYSTEM Mode	VRX LOCAL Mode
PSU Affiliation	No	No	No
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	Keys up MSU only	As programmed [24]
Inbound Group Call	No	Yes	No
PSU PTT ID Pass Through	No	Yes	Yes
Inbound Private Call	N/A	N/A	N/A
Inbound Call Alert	No	No	No
PSU Leading / Trailing Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	Yes (after MDC1200 activation)	Yes – MDC1200 with Emerg. Alarm	Yes – MDC1200 with Emerg. Alarm
PSU Remote VR Activation	Yes – DTMF	N/A	Yes – DTMF
MSU Mode Steering	No	Yes (PL/DPL)	Yes (PL/DPL)
Failsoft / Out of Range / Site Trunking Indication on PSU	N/A	N/A	N/A
Local Mode Indication on PSU	No	No	No
Primary / Secondary Voting	Yes	Yes	Yes
VR Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	No	No
P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	N/A	N/A	N/A
PSU Dynamic Regrouping	N/A	N/A	N/A
PSU Selector Lock / Unlock	N/A	N/A	N/A
PSU Phone Interconnect	N/A	N/A	N/A
PSU Adaptive Power Control	N/A	N/A	N/A
Audio Buffering	No	Yes	N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
PSU P25 Encryption	No	Yes (except Tier 1)	Yes (except Tier 1)[25]
PSU Status / Message	No	Yes	Yes

Table 29 Analog Channel Type on VRX1000 with Conventional Analog Mode Selected on MSU

[24] VRX1000 can be programmed so that MSU MIC PTT keys up either VRX1000 OR MSU side, but not both.
[25] VRX1000 Tier 1 means P25 Option and P25 Enhanced Trunking Features options are not enabled

Analog VR Mode with 3600 Baud Analog or Digital Trunking Mode Selected on MSU

Analog Channel Type on DVR/DVR-LX and VRX with 3600 Baud Analog or Digital Trunking Mode Selected

The operation described below assumes a VR Analog Mode channel and 3600 Baud Analog or Digital Trunking Mode are selected on the DVR/DVR-LX and MSU respectively.

FEATURE	OFF Mode	SYSTEM Mode	LOCAL Mode
PSU Affiliation	No	No	No
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	DVR: As programmed VRX: MSU Only	As programmed
Inbound Group Call	No	Yes	DVR: Yes-Local Side VRX: Yes
Inbound Private Call	No	No	No
Inbound Call Alert	No	No	No
PSU Leading / Trailing Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Call	No	Yes (group call, uses MSU ID and TG)	Yes (group call, uses MSU ID and TG)
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	DVR: Yes (after activation) VRX: Yes-after MDC1200 activation	Yes – MDC1200 with Emerg. Alarm	Yes – MDC1200 with Emerg. Alarm
PSU Remote VR Activation	Yes – DTMF	N/A	Yes – DTMF
MSU Mode Steering	No	Yes (PL/DPL)	Yes (PL/DPL)
Failsoft / Out of Range / Site Trunking Indication on PSU	No	No	No
PSU Local Mode Indication	No	No	No
Primary / Secondary Voting	No	Yes	Yes
DVR/VR Tones–MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	No	No	No
PSU Dynamic Regrouping	No	No	No
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	DVR: Yes VRX: N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	No	DVR: Programmable VRX: Yes
PSU Status / Message	No	No	No
PSU PTT ID	No	No	No

Table 30 Analog Channel Type on DVR/DVR-LX and VRX with 3600 Baud Analog or Digital Trunking Mode Selected on MSU

Analog VR Mode with P25 Phase II (TDMA) Trunking Mode Selected on MSU

Analog Channel on DVR/DVR-LX and VRX1000 with P25 Phase II (TDMA) Trunking Mode Selected

The operation described below assumes a VR Analog Mode channel and Phase II TDMA 9600 Baud Trunking Mode are selected on the DVR/DVR-LX / VRX1000 and MSU respectively.

FEATURE	OFF Mode	SYSTEM Mode	LOCAL Mode
PSU Affiliation	No	DVR: No VRX: Yes	DVR: No VRX: Yes
Talkgroup Proxying	No	No	No
Outbound Group Call	No	Yes	Programmable
Outbound Private Call	No	No	No
MSU Microphone PTT	Keys up MSU only	DVR: As programmed VRX: MSU Only	As programmed
Inbound Group Call	No	Yes	DVR: Yes (Local Side) VRX: Yes
Inbound Private Call	No	No	No
Inbound Call Alert	No	No	No
PSU Leading / Trailing Tones	No	Yes	Yes
PSU Emergency Alarm	Yes (after activation)	Yes	Yes
PSU Emergency Call	No	Yes (group call)	Yes (group call)
PSU Emergency Revert	No	Yes	Yes
PSU Emerg. ID Pass Through	DVR: Yes (after activation) VRX: Yes-after MDC1200 activation	Yes – MDC1200 with Emerg. Alarm	Yes – MDC1200 with Emerg. Alarm
PSU Remote VR Activation	Yes – DTMF	N/A	Yes – DTMF
MSU Mode Steering	No	Yes (PL/DPL)	Yes (PL/DPL)
Failsoft / Out of Range / Site Trunking Indication on PSU	No	No	No
PSU Local Mode Indication	No	No	No
DVR Primary / Secondary Voting	No	Yes	Yes
Tones – MSU Speaker	No	Yes	Yes
PSU Radio Check / Inhibit	No	No	No
PSU LOCATION	No	No	No
PSU P25 Trunking OTAR	N/A	N/A	N/A
PSU Patch	No	No	No
PSU Dynamic Regrouping	No	No	No
PSU Selector Lock /Unlock	No	No	No
PSU Phone Interconnect	No	No	No
PSU Adaptive Power Control	No	No	No
Audio Buffering	No	Yes	DVR: Yes VRX: N/A
PSU Scan	Yes	Yes	Yes
PSU Announcement Group	No	No	No
P25 Encryption	No	No	DVR: Programmable VRX: Yes
PSU Status / Message	No	Status only	Status only
PSU PTT ID	No	Yes (MDC1200)	Yes (MDC1200)

Table 31 Analog Channel on DVR/DVR-LX / VRX1000 with P25 Phase II (TDMA) Trunking Mode Selected on MSU

Mixed VR Mode

Mixed VR mode allows Analog VR operation by switching between Digital and Analog modes as described below. The use of Mixed mode for Analog DVRS communications is not recommended since it requires special User Training to be able to handle the VR switching between analog and digital mode as described below.

Mixed VR mode should only be used when both analog and digital PSUs are required to operate on the same VR channel. Mixed VR Mode requires the MSU to be switched to a P25 Digital channel. When a VR Channel is programmed to operate in Mixed Mode, the VR can handle calls from both P25 and Analog Local PSUs while the same VR channel is selected on the MSU.

When Mixed Mode is selected, the VR can be toggled between Digital and Analog Mode as follows:

- The default VR mode is Digital i.e. the P25 modem is enabled by default.
- If a Call from a Local PSU is detected and the VR does not decode a P25 frame sync within the preprogrammed **'P25 Frame Sync Detection Timer'**, the VR switches to Analog Mode and starts decoding Analog Mode signaling (such as DTMF, MDC1200). The VR repeats analog signals to the local analog PSUs and system MSUs / PSUs on the selected System channel / TG.
- After the local PSU keys off, the VR stays in the Analog Mode for the duration of the preprogrammed **'VR Ch Mixed Mode Hold Timer'.** Any outbound calls which are received by the MSU prior to the above timer's expiration will be repeated by the VR as Analog Conventional.
- Once the **'VR Ch Mixed Mode Hold Timer'** expires, the VR returns back to digital mode and any outbound calls are repeated as digital. Inbound analog calls received by the VR in Mixed Mode are repeated to the system by the MSU on the selected TG / Channel.
- If TG Proxying is enabled, digital inbound calls received by the VR are transmitted by the MSU on the TG selected on the local PSU (not on the TG selected on the MSU).

Special Features Support

TPS Signaling

The Tactical Public Safety (TPS) feature allows TPS enabled subscribers to send digital PTT ID information on TPS channel with analog voice. It is an alternative to using MDC IDs and has the advantage of being slightly quieter (eliminates the audible noise when decoding MDC IDs) and has a larger range of IDs available for use.

TPS is fully supported on Conventional P25 mobile radio channels.

Compatible with generic P25 PSU only.

Data Sheets

Futurecom website → Products → DVR-LX → Supporting Documents → DVR-LX Datasheet

Futurecom website → Products → VRX1000 → Supporting Documents → Product Datasheet – VRX1000

Contact Information

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Glossary

Keyword	Description
ACK	Acknowledgement of communications.
AVRA	Automated VR Activation. Programmable feature which permits automated activation of the VR by either using a VIP input on the MSU CH / DEK or a pin on the VR Auxiliary cable. Requires external logic / switch not supplied with the VR hardware.
Authentication	To prevent unauthorized access for Conventional **DVRS Enabled** PSU, Authentication key can be loaded on the authentication capable **DVRS Enabled** PSU.
Band Lock	When enabled, causes the MSU to block usage of the same frequency band as the VR while the VR is active. Enabled by default when no in-band filter is present.
BL	Busy Lockout – dynamic voting phase (follows the static Primary / Secondary phase) of the VR simulcast prevention algorithm.
Channel	A group of characteristics, such as transmit / receive frequency pairs, radio parameters, encryption encoding etc.
Coded Squelch	Tone Private-Line (PL) or Digital Private-Line (DPL). Used on conventional channels for signal validation.
Conventional	Refers to radio-to-radio communications, sometimes through a base station repeater or vehicular repeater.
Dispatcher	An individual who has radio system management duties.
DPL Coded Squelch	A continuous sub-audible data signal transmitted with the carrier. See Coded Squelch.
VR	Futurecom Vehicular Repeater.
VR Mode	Determines the communication exchange capabilities between System Users and Local Portable Users; Can be set to OFF, LOCAL or SYSTEM.
DVRS	Vehicular Repeater interfaced to a Remote Mount APX Mobile radio with or without Control Head.
'DVRS Enabled' PSU	P25 XTS1500, XTS2500, XTS5000, APX4000, APX6000 or APX7000 Portable Radio with enabled DVRS operation.
FCC	Federal Communications Commission.
FNE	Fixed Network Equipment – Trunking or Conventional System Infrastructure

Keyword	Description
Forced Analog Mode	Hybrid VR Mode of operation where communications between the VR and the P25 **'DVRS Enabled'** PSUs are digital while the voice communications are forced to be analog whenever a non-P25 channel / TG is selected on the MSU.
FRC	Futurecom Repeater Configurator
Heart Beat	P25 Message periodically sent by a Primary VR to other VRs during Primary / Secondary processing.
HUB	Hang Up Box – refers to the MSU Microphone being on hook or off hook.
ICM	In Car Monitor – when enabled in the MSU, allows the MSU user to monitor voice traffic to and from the local PSU
Inbound Call	A Call transmitted by Local PSU and received by the VR.
Local Mode	VR Mode which provides extended portable-to-portable voice and data range by repeating Local PSU (optionally MSU) communications without keying up the mobile radio interfaced to the VR.
Local PSU	PSU switched to the VR channel and used for communication with the VR
Local Tx Fallback	When enabled, the MSU reverts to local call if the MSU fails to access the system.
Mode	**MSU / PSU** - A programmed combination of operating parameters. **VR** – OFF, SYSTEM or LOCAL (see **VR Mode**)
MSU	Mobile Subscriber Unit
NAC	Network Access Code – used in P25 mode for validation of P25 radio communications, similar to the use of PL/DPL in analog mode. Also used for VR Steering.
NID	Network ID - see Network Access Code (NAC)
Outbound Call	System Call received by the MSU
PSU	Portable Subscriber Unit
PSU Scan	This feature allows a scan list to be attached to PSU that is configured with DVRS as its system type. This enables an Enhanced PSU to support conventional scan feature.
PTT	Push to talk. The PTT engages the transmitter (of the Portable or Mobile radio and / or VR) when pressed.

Keyword	Description
RF	Radio Frequency. Part of the general frequency spectrum 10kHz - 10,000,000 MHz
RSSI	Received Signal Strength Indicator
System Mode	VR mode which provides extended voice and signaling communications between System Users and Local Portable users over the selected VR channel / Mobile Radio Mode.
Talkgroup	A group of radio users who communicate with each other by using the same communication path.
Talkgroup Matching	Requires that the local PSU and MSU have the same selected talkgroup for successful PSU communications
Talkgroup Proxying	Ensures that local PSU calls are sent to the system via the DVRS on the PSU talkgroup, regardless of the MSU selected talkgroup.
Talkgroup Translation	PSU talkgroup is translated by the VR to match the currently selected MSU talkgroup.
Trunking	The automatic sharing of radio frequencies by large number of users based on communication path sharing for the length of a conversation.
UID Translation	The local PSU's ID and TG are replaced with the MSU's ID and TG.

References

Compatibility Chart

DVRS: VR Compatible APX Mobile Radios and

DVRS: VR Compatible XTS/APX Portable Radios list

Futurecom Website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Compatibility Charts

Vehicular Repeater (VR) User's Guide Template

Futurecom Website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Vehicular Repeater (VR) User's Guide Template

Over the Air Programming Via Radio Manager User Guide

Futurecom Website → Support → Documentation and Software → DVR-LX/DVR/VRX1000 → Over the Air Programming Via Radio Manager User Guide

VR Ordering Guides

Futurecom Website → Products → DVR LX - Digital Vehicular Repeater → DVR-LX Ordering Guide

Futurecom Website → Products → DVR - Digital Vehicular Repeater → DVR Ordering Guide

Futurecom Website → Products → VRX1000 - Digital Vehicular Repeater → VRX1000 Ordering Guide

Data Sheets

DVR-LX®
Futurecom Website → Products → DVR-LX → Supporting Documents → DVR-LX Data Sheet

VRX
Futurecom Website → Products → VRX1000 → Supporting Documents → Product Datasheet VRX1000