

## Use of Voter Comparators to Improve Railroad Radio Communications

### Purpose

This Application Note will describe the use of the Raytheon SNV-12 Voter Comparator to expand radio coverage in railroad applications.

### Introduction

Railroad communications sometimes suffer from unique communications issues. Many factors impact railroad communications as a train moves along its journey. The long distances trains sometimes travel, high rise buildings in urban environments, tunnels, and mountainous terrain pose different challenges. The utility of railroad radio systems can be greatly enhanced by the use of multiple transceivers or receivers connected through a voter comparator.

The following diagrams demonstrate some of the challenges. In Figure 1, the train can't communicate with the station in the city due to the high mountain between the train and the station. In Figure 2, the train is simply beyond the normal range of the radio system. Both of these issues can be solved by using the SNV-12.

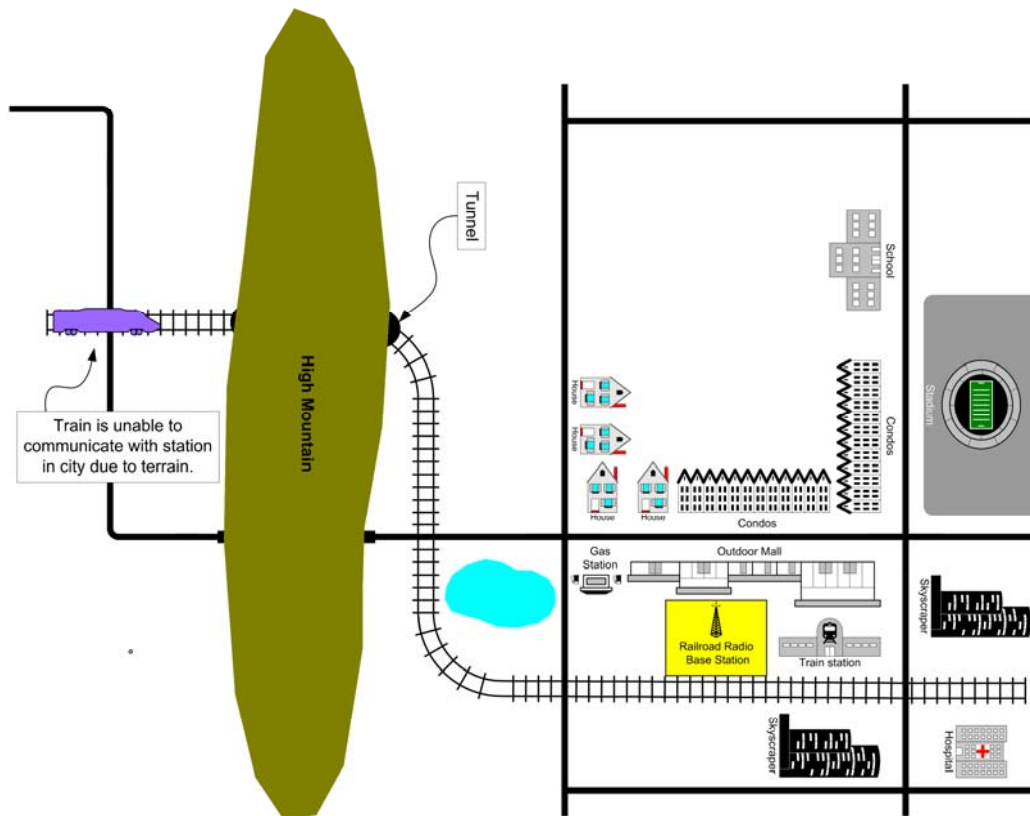
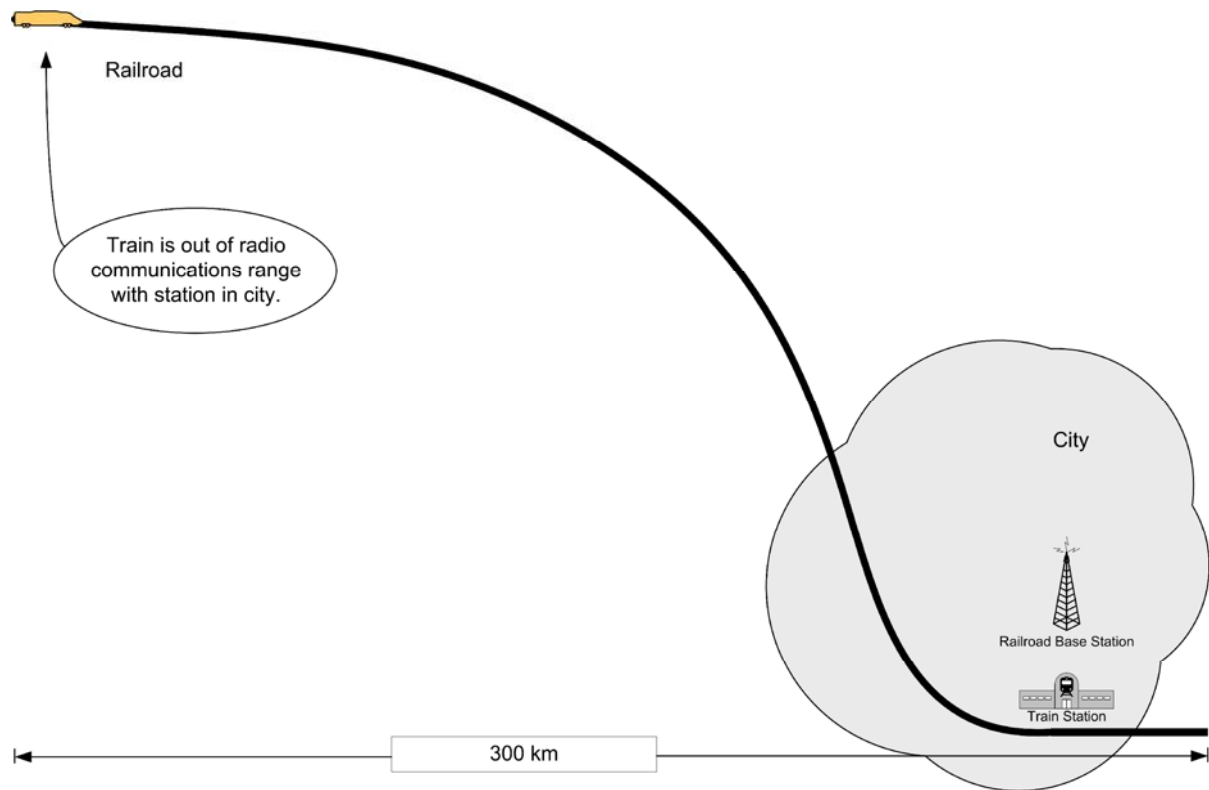


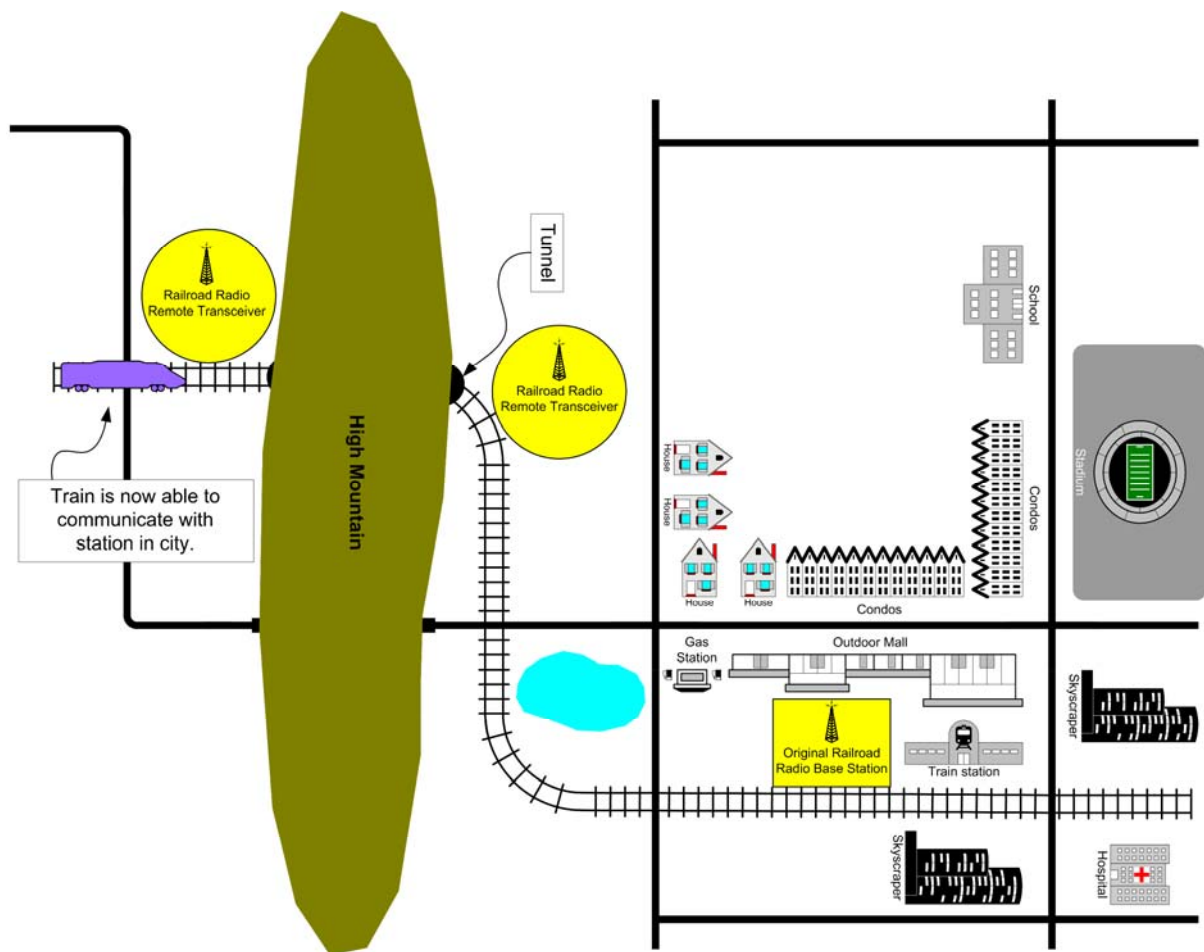
Figure 1 Communications Issue Due to Terrain



**Figure 2 Communications Issue Due to Distance**

## Requirement

Expansion of existing railroad radio communications into poorly covered areas in a cost effective manner. The SNV-12 Voter Comparator can be used to compare the signals from remote transceivers. The voter comparator in turn routes the best signal back to the dispatch console and/or repeater. The voter comparator also has the ability to automatically route the console reply transmissions back to the site closest to the train.



**Figure 3 Terrain Issue Solved Using Remote Transceivers**

## Solutions

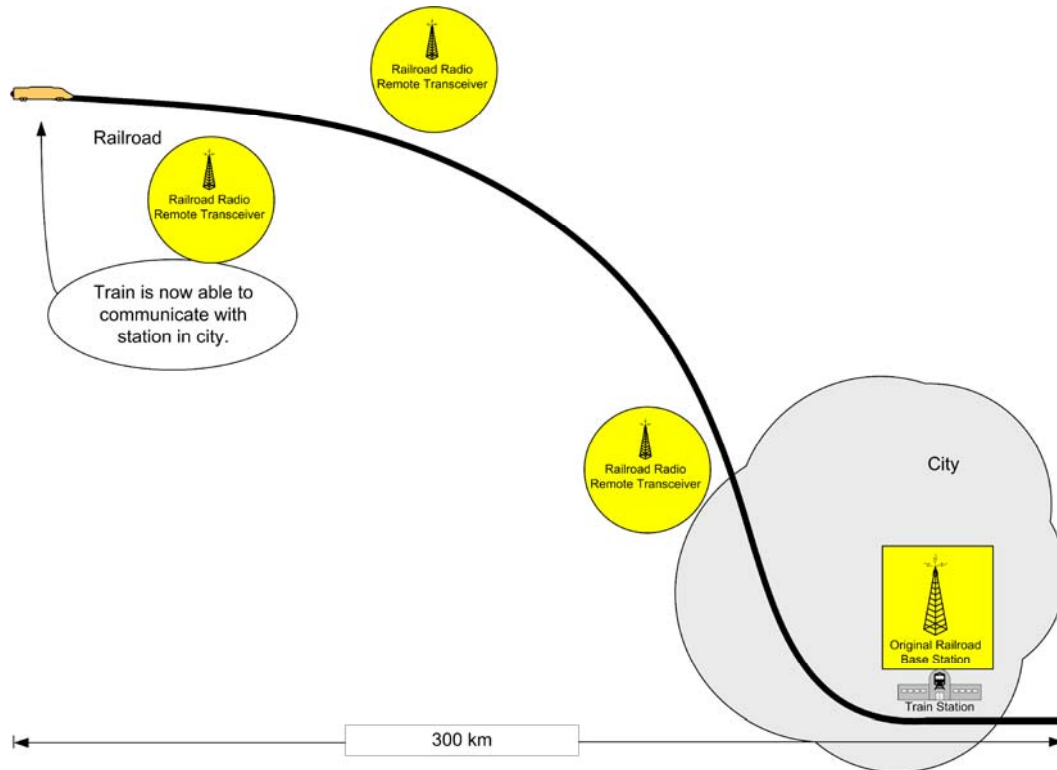
In Figures 3 and 4, possible solutions to the issues faced in Figures 1 and 2 are shown. In Figure 3, additional sites are employed to enhance the radio communications range beyond the mountain. Up to 36 sites can be employed to solve these “dead spots” in the railroad communication area.

In Figure 4, multiple sites are added along the route of the train to solve terrain and distance issues. As sites are placed along the route, they essentially track the progress of the train on its journey so two-way communications with the station are possible at all times.

A simplified block diagram showing this is shown in Figure 5. In this diagram, there are 5 different sites employed to communicate with the train. The signals from these sites are routed back and forth through the voter comparator to the dispatch console at the station.

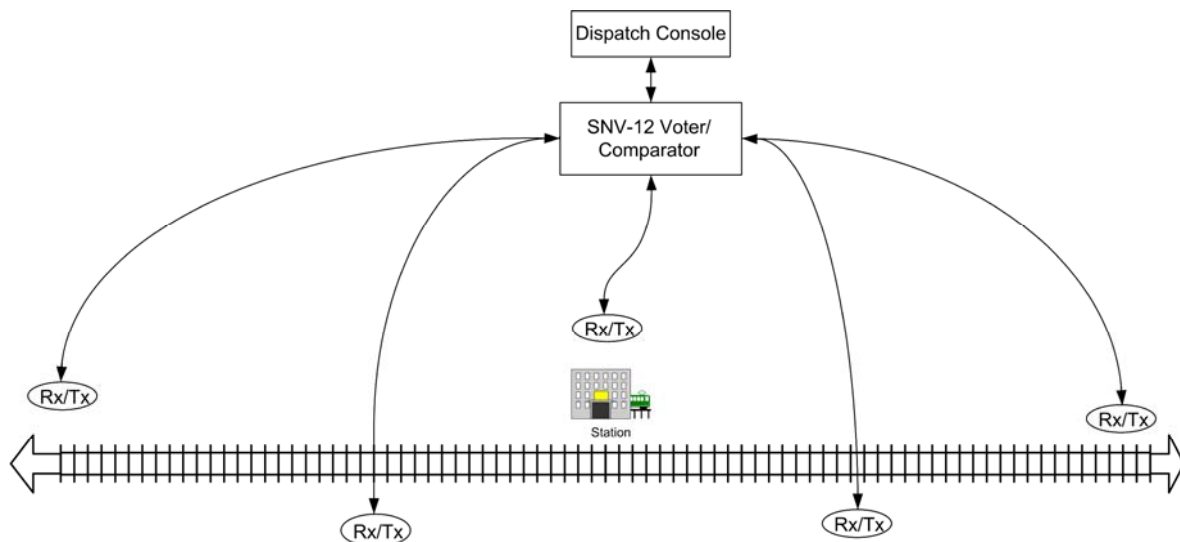
In an application with multiple receivers or transceivers, the signals from up to 36 receivers at different sites can be brought into the voter comparator. The voter comparator selects the site with the best quality signal, and forwards it to a dispatch console, and/or retransmits it through a repeater. The reply transmissions can be sent back through the voter comparator to one or more transmitter sites.

The SNV-12 Voter Comparator has many built in options, including the ability to automatically direct the console reply transmissions back to the transceiver sites closest to the train.

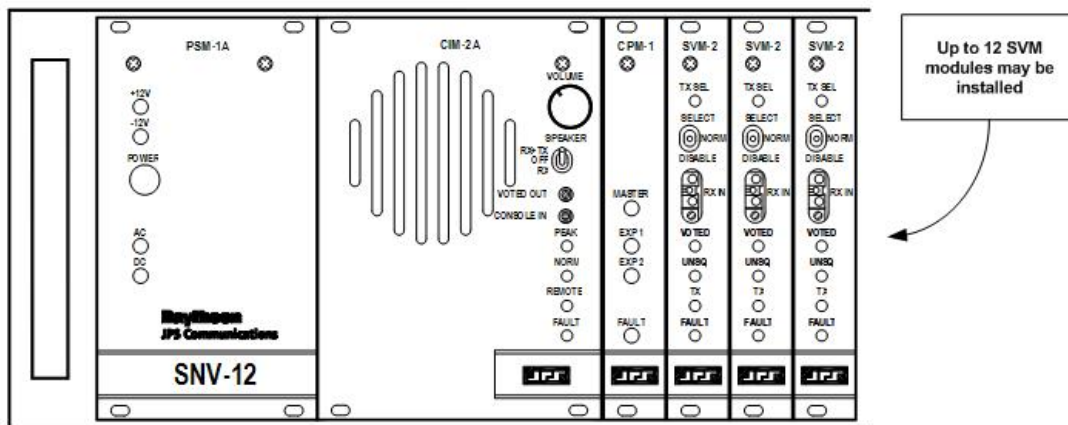


**Figure 4 Terrain Issue Solved Using Remote Transceivers**

The SNV-12 Voter Comparator can be used to sort the incoming radio signals and pick the best quality signal from up to 36 sites. Once the best quality signal is determined (usually from the site closest to the train), it forwards this signal to a dispatch console and/or repeater. Console reply transmissions can be routed in a number of ways. The voter comparator has the ability to send the reply to a single wide area coverage site, or multicast to several sites. In addition, the voter comparator also can automatically route the reply back to the transceiver closest to the train.



**Figure 5 Typical Radio System Using 5 Transceivers**



**Figure 6 SNV-12 Chassis**

The SNV-12 Voter Comparator can utilize virtually any manufacturer's receivers or transceivers for the remote sites. The remote receivers generally route their signals to the Site Voter Modules (SVM) in the voter comparator using telephone lines, microwave links, or RF links. If the receiver is local to the voter comparator, the audio may be wired directly from the receiver to the voter comparator.

The voter comparator can use different methods to determine active receivers. It can use pilot tones, either 1950 Hz or 2175 Hz, hardwired COR, or E&M signaling. There is also an audio activated (VOX) method available.

Once the voter comparator has determined the best quality signal, it routes the "voted" audio to a dispatch console and/or a repeater. The console reply transmissions are routed to a single transmitter or multiple transmitters. The voter comparator has the ability to automatically route the console reply to the site where the original signal came from.

The voter comparator has many built in options that are enabled via dipswitch. These include:

- Automatic Transmit Steering (STARS)
- Sites can be transmit and receive, or receive only
- Generation of transmit keying tones
- Ability to accept keying tones from the console
- Multiple methods to qualify remote signals
- AM or FM compatibility
- Audio delay for incoming and outgoing signals
- Repeat or console only operation
- Console or repeat priority
- Line fault detection
- Latched or manual transmit steering
- Duplex or simplex operation
- Voting transition control
- RS-232 operation
- Operation from a AC or DC power source

### SNV-12 External Input/Output

The SNV-12 has five primary connections:

- TB1-TB12 – 20 position screw terminal block with connections for Rx/Tx audio, and optional console functions
- TB13 – 18 position screw terminal block with connections for console
- P1 – System expansion port
- P2 – Alternate port for console connections
- P3 – System expansion port

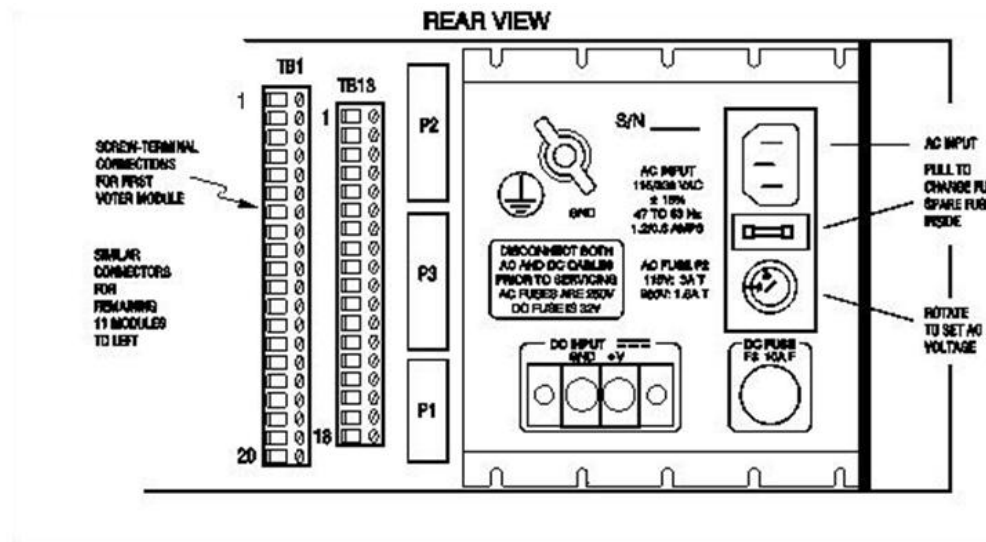


Figure 7 SNV-12 Rear View

<b>TB1 – TB12 Wiring Connections</b>		
<b>PIN</b>	<b>Signal</b>	<b>Description</b>
1	Site Audio In A	Balanced audio input from the site receiver.
2	Site Audio In B	Balanced audio input from the site receiver.
3	Ground	Ground connection.
4	TX Audio Out A	Balanced audio output to the site transmitter.
5	TX Audio Out B	Balanced audio output to the site transmitter.
6	Line Audio	Module's throughput audio for monitoring (600 ohm, single-ended).
7	Ground	Ground connection.
8	TX Sel In	Low to select SVM for transmission of console audio. Site remains selected until input goes back high.
9	Pilot Tone AGC	Low to enable Pilot Tone AGC function.
10	Pilot Tone Notch Disable	Low to disable pilot tone notch filter except when pilot tone is detected.
11	Select In	Low to select (force-vote) this site.
12	Disable In	Low to disable this site (remove from voting).
13	COR In	Hardwired COR Input from receiver.
14	MOM TX Sel In	Momentary low to select SVM for transmit. Reverts to default site when holdover timer expires.
15	Voted Out	Low when this site is voted (Or Selected by front panel SELECT switch or by pin 11).
16	Unsquench Out -OR- TX SEL OUT	Configurable output. Normally indicates positive COR (Unsquenced) when low. When SVM COR type is pilot tone or hardwired COR, the function of this output determined by SVM SW2-5. When OFF, output goes low when positive COR detected. When ON, output goes low when this site is selected for Console TX.
17	Fault Out	Low while fault detected on this site.
18	Site PTT Out	Active low PTT output to associated transmitter.
19	TX Inhibit	When low, disables SVM transmit output (with 700 msec hangtime).
20	Ground	Ground connection.



<b>TB-13 Wiring Connections</b>		
<b>PIN</b>	<b>Signal</b>	<b>Description</b>
1	Console TX In B	Balanced transmit audio input from the console.
2	Console TX In A	Balanced transmit audio input from the console.
3	Audio Ground	Ground connection for audio cable shields.
4	Voted Out B	Balanced voted receive audio output to the console.
5	Voted Out A	Balanced voted receive audio output to the console.
6	Speaker Out	Output to external monitor speaker.
7	Console PTT In	PTT input from the console; active low.
8	PTT Out - COR Out - Directed COR Out	Indicates if any site is keyed or when any SVM is unsquelched. (Internally configurable- active high or low, or with delay).
9	Voted Line Out	Line Level Voted Audio (not muted by pin 17).
10	System Voted Out	Logic low if any SVM is voted.
11	System Fault Out	Logic low if any SVM is faulted.
12	COR Input	Low input activates Directed (Active High) COR Output.
13	Relay N.C.	Follows configuration of PTT – COR – Directed COR Output.
14	Relay N.O.	Follows configuration of PTT – COR – Directed COR Output.
15	Relay Common	Relay common for pins 13, 14.
16	Relay-Ground	Follows configuration of PTT – COR – Directed COR Output.
17	VA Mute In	Mutes Voted Audio Output when active. Jumper selectable (JP7) for either Active Low or Active High.
18	Ground	Ground connection.

**Notes:**  
 For unbalanced audio, ground the “B” pin of audio pair connections; connect single-ended audio input to the “A” pin.  
 COR Input (pin 12) and active high and delayed COR output features not available with older CIM-2s (not available if no JP8 on the module).  
 Voted Line Out (pin 9) only operational when SVM-2 modules used; signal not available with SVM-1s.

### Configuration of SNV-12:

Technical Service is available to assist installers in configuration of their systems. They may be contacted by email at voter.sales@raytheon.com or (919) 790-1011.

### Conclusions

In a radio system where coverage problems exist, the SNV-12 Voter Comparator can be used to expand coverage into these problem areas. Poor receiver coverage and/or poor transmitter coverage can both be addressed by the SNV-12. Many different sites can be added to the system to solve issues due to terrain, distance and urban environments.

### Glossary

**COR:** Carrier Operated Relay - A signal from a receiver that gives a positive indication that a carrier or signal is being received and that the receiver is unsquelched. It has the same function as Carrier Operated Squelch (COS).

**Dipswitch:** Dual In-Line Package Switch - A multi-unit switch that fits into a standard DIP integrated circuit footprint. It usually contains eight or ten individual switches.



**Pilot Tone:** A tone sent from a remote receiver site to indicate a squelched receiver condition. The pilot tone is notched out of the RX audio. Also called “line proving tones”

**Repeat Mode:** Voted audio is retransmitted through all sites or through all sites in a group. Also called *Voted Site Talk-through*.

**RX:** Receiver or Receiving.

**STARS:** Smart Transmit and Receive Steering – the transmit steering algorithm, based on the history of which receiver site was voted best during the end of the voting sequence, rather than simply on which receiver was voted last.

**SVM:** Site Voter Module - The SNV-12 module that interfaces with the voting receivers.

**TX:** Transmit or Transmitter.

### References

SNV-12 Installation and Operation Manual, P/N 5951-800200, Revision 6.2.