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Issue: A

Technical Bulletin

The Structure of Non-blocking HF Switching Matrix Systems for Radio Surveillance

1. Purpose

The purpose of this bulletin is to explain the structure of non-blocking HF signal switching matrix systems for radio surveillance, as they grow in size and complexity from a simple 16 x 32 signal exchange unit to a large matrix system with 512 receivers or more.

2. Definition of Systems

Radio surveillance is the monitoring of the radio frequency spectrum for technical, military or legal reasons. In the short-wave spectrum (3-30MHz) this is most usually done by connecting a relatively large number of receivers to a number of specialised antennas, usually antennas with directivity gain and/or restricted frequency coverage.

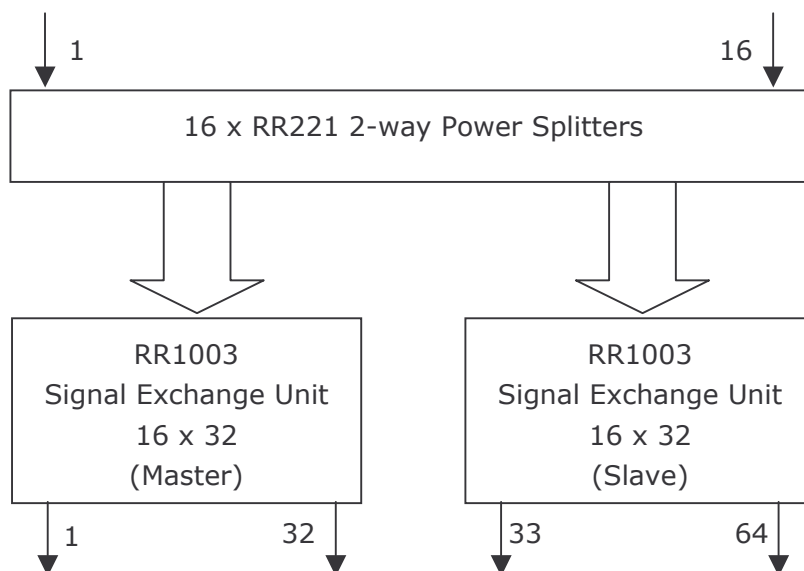


Figure 1 - 16 x 64 HF Matrix – Block Diagram

The simplest form of connection is through an RF multicoupler, a simple device for first pre-amplifying a signal and then splitting it a number of ways for connection to several different receivers, without loss of signal strength and with only minimal distortion. Where a number of

antennas are available it is desirable to make all of these antennas available to all of the receivers in the system and for this an antenna matrix switching system is required.

In this paper we are exclusively discussing low noise, high dynamic range front-end switching matrix systems. The inputs are directly connected to the antennas and the matrix routes these off-air signals directly to the appropriate RF receivers.

The matrix systems so formed are non-blocking in the forward direction. That is any number of outputs can be connected simultaneously to the same input.

3. Matrix Systems

16 x 32 Matrix Unit

The current standard for HF signal switching is the Raven Research RR1003. This is a 16 input x 32 output switching matrix, sometimes referred to as a signal exchange unit (SEU). It is a single 19" rack mounting unit, which is operated either under remote control or from the optional front panel.

16 x 64 Matrix Systems

As the matrix system is expanded to accommodate more receivers than 32, more of these SEUs are connected together with RF signal splitting devices, acting to distribute the signals to the available receivers.

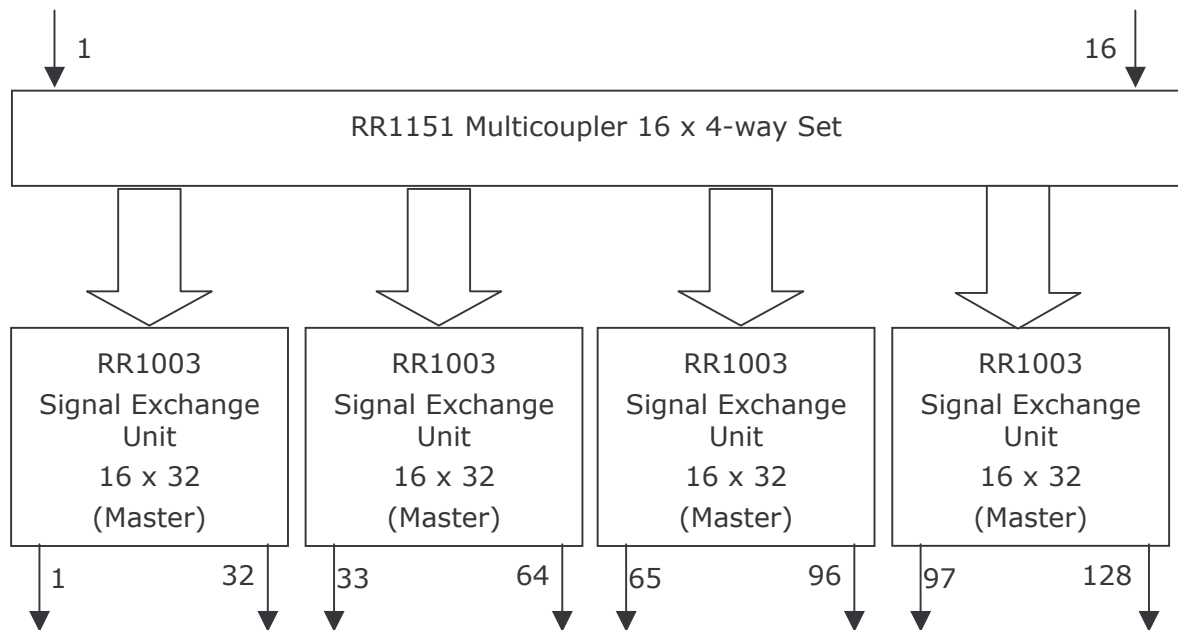


Figure 2 - 16 x 128 HF Matrix System – Block Diagram

The first expansion is to accommodate 64 receivers and this is usually achieved by a passive splitting of the signal at the front end and an increase in gain (+3dB) of the RR1003 unit, in order to compensate for the splitting loss. The system is illustrated in

Figure 1

For such a simple expansion, control will be by a master-slave set-up, with one SEU acting as the master, the other as a slave.

16 x 128 HF Matrix

The next expansion of the outputs will be 96/128. This will require the addition of an active multicoupler at the front end. This is needed to preserve the noise figure and dynamic range of the system, as a passive 4-way split is considered too lossy (>6dB) to allow in a surveillance system. Up to 128 outputs can be accommodated using the RR151 multicoupler unit. In this unit, up to 16 multicouplers are contained in a single rack-mounted unit, each multicoupler splitting the input signal 4 ways. The matrix system is illustrated in Figure 2.

Figure 2.

Control of the system is most effectively implemented by means of a system command processor, such as the RR1555. This is a single control unit, which features a front panel man-machine interface for local control and a remote control port. The function of the unit is to accept system commands (appropriate to the size of the total matrix system) and compute the individual commands to be sent to the individual equipment units. The unit has a number of local control ports for sending local unit commands.

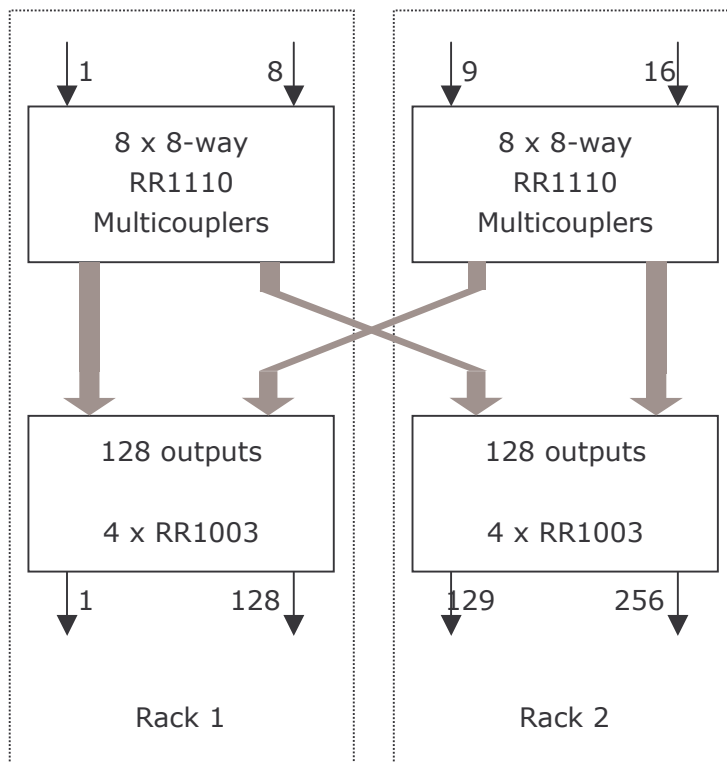


Figure 3 - 16 x 256 HF Matrix – Block Diagram

4. Further Expansion of the Number of Outputs

Expansion up to 512 receiver outputs is now a matter of adding more signal exchange units, with ever more front-end multicouplers. For 256 outputs and above, the RR1110-8/16 series of multicouplers are used. These are individual rack-mounting multicoupler units.

The current standard for the minimum spatial layout for a matrix with 128 outputs is a single 19" equipment rack, 37U high (1645mm). However, it is prudent to allow much more space than this for a new system, wherever possible, as radio receiving systems tend to grow in capacity with time to accommodate an ever increasing work load.

It can be convenient to design larger systems, with more than 128 outputs, as a series of 128 output subsystems, as this gives a rough guide to the size and cost at the outset. Thus a 16 x 256 system would comprise two racks of 128 outputs but the multicouplers would be changed to 8-way units with eight multicoupler units accommodated in each rack. This is illustrated in Figure 3. For 512 outputs four racks are used and the multicouplers need to be 16-way units, distributing signals over all four racks. For 1028 outputs, eight racks are needed and the multicouplers are 32-way units.

5. Expansion of Number of Inputs

When the number of input signals (antennas) rises above 16, there is a major impact on the architecture and cost of the RF matrix system. In principle, it requires the size and cost of the system to double, relative to the size of a similar matrix with the same number of outputs but less than 16 inputs.

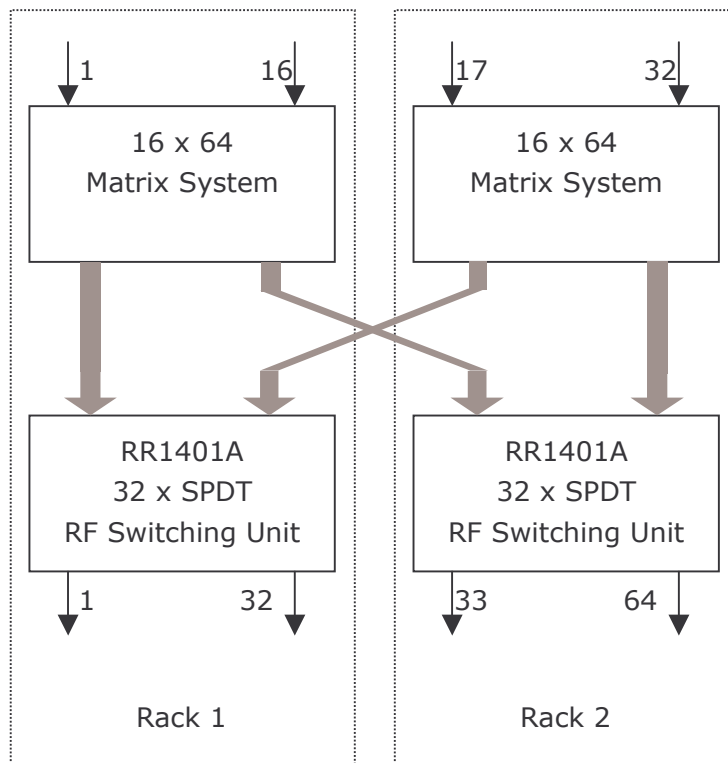


Figure 4 - 32 x 64 HF Matrix - Block Diagram

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Thus the 32 x 64 matrix system is illustrated in the block diagram of Figure 4. It is apparent that the really comprises two matrix systems, each with up to 16 inputs, with the outputs combined by a series of single pole double throw RF switches. These switches feature in the Raven Research inventory as the RR1401A series.

Again, the control of the system is usually done, using a system command processor.