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***Application Note for
Matrix Switches***

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Matrix Switches: Blocking vs. Non-blocking

In the RF & Wireless Industries, system performance requirements seem to expand almost daily. These systems continue to encompass more and more of today's broad-reaching technologies. Engineers working in this environment are often tasked with designs that must combine and distribute RF signals from multiple input devices. While at the same time, making those signals available via multiple outputs. In many cases, an RF Matrix Switch can be the solution to this problem. In this article, we will explore the three most basic types of Matrix Switches. We will also touch upon the inherent advantages and disadvantages of each of these configurations.

Blocking Matrix Switch

A blocking matrix switch is built with switches on both the inputs and the outputs. Each input signal can be switched to only one output port at a time. If an application requires an input to be available to more than one output simultaneously, then a non-blocking matrix becomes necessary. Figure 1 illustrates the connectivity of a 3 X 3 blocking matrix switch. Figures 2 and 3 depict some of the possible connection states with this type of switch.

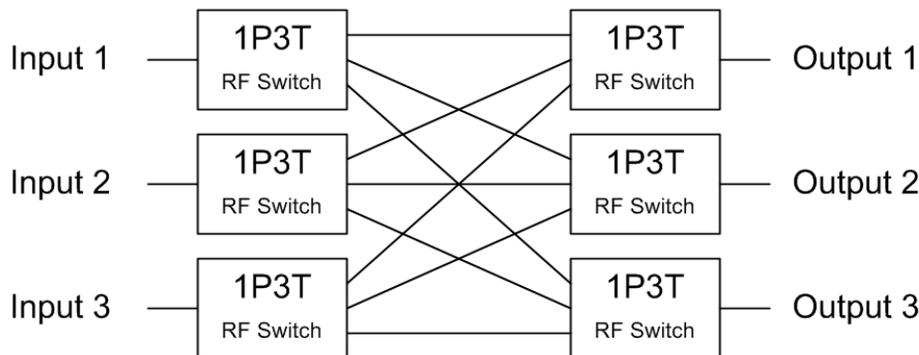


Figure 1. 3 x 3 Blocking Matrix Switch

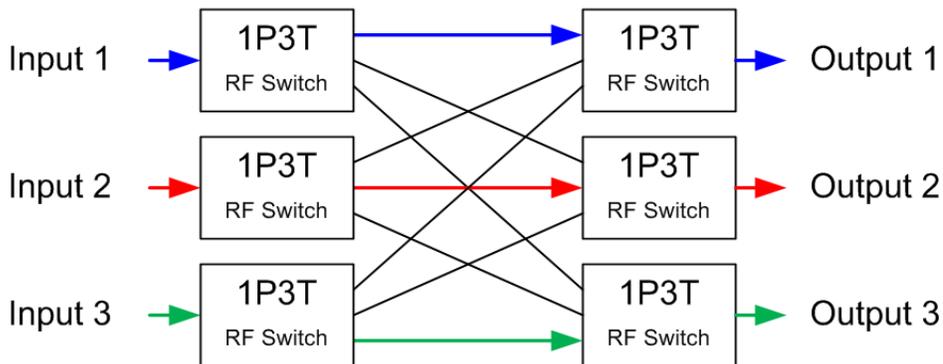


Figure 2. Example RF Paths for 3 x 3 Blocking Matrix

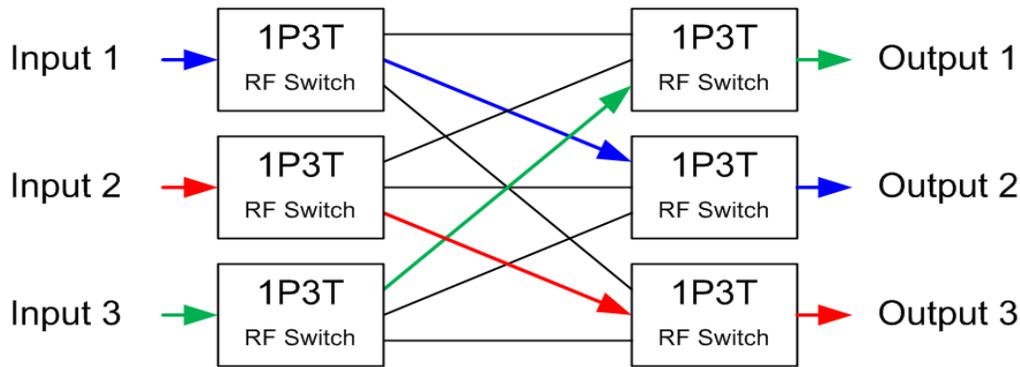


Figure 3. Example RF Paths for 3 x 3 Blocking Matrix

The two most notable advantages of a blocking matrix switch are insertion loss and isolation. Because the design uses only switches and no power dividers, the insertion loss will be lower than any other matrix configurations. Using only switches also makes it possible to maintain very high isolation from input to output because RF switches have better isolation characteristics than power divider/combiners. The one disadvantage is that each input is only available to a single output. To have an input port available to multiple outputs simultaneously, you have to use a Non-blocking matrix switch.

Non-Blocking Matrix Switch

A typical Non-blocking matrix switch is one that is built with power dividers on the inputs and switches on the outputs. Each input signal is thereby split to all output switches. This means that, in a 4 X 20 non-blocking matrix switch for example, the four input signals could be split to all twenty outputs. This would allow an engineer to select the signal to be seen on each output. A user could even have a single input connected to all twenty outputs without using the other inputs. Figure 4 shows the layout of a typical 3 X 3 Non-blocking matrix. Figures 5 and 6 depict some of the possible connection states with this type of switch.

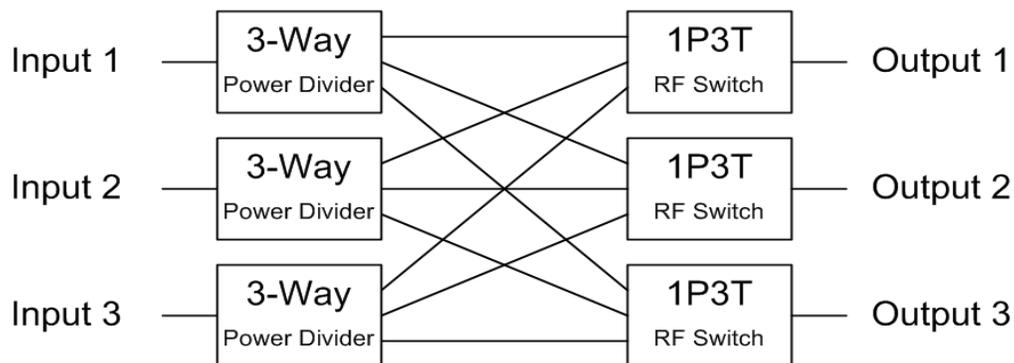


Figure 4. 3 x 3 Non-Blocking Matrix Switch

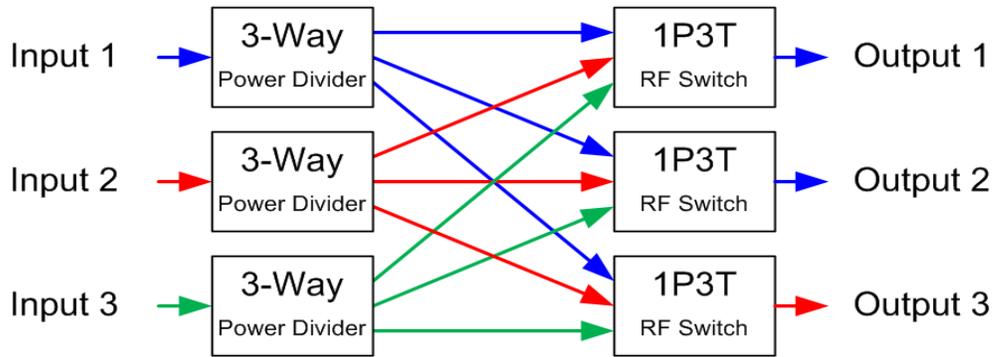


Figure 5. Example RF Paths for 3 x 3 Non-Blocking Matrix

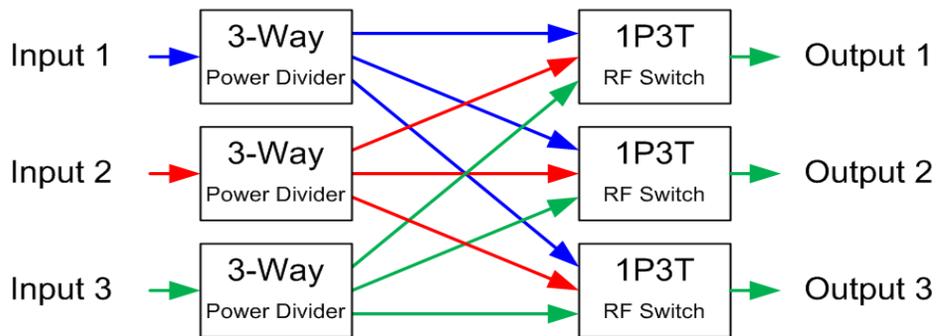


Figure 6. Example RF Paths for 3 x 3 Non-Blocking Matrix

The obvious upside to a non-blocking matrix switch is its greater flexibility. On a 3x3 non-blocking matrix, input 1 can be connected to all three outputs simultaneously. However, certain compromises have to be made in order to achieve that increased flexibility. Because it uses power dividers, a matrix like this will have higher insertion loss than a blocking matrix switch. Having a power divider at each input can also have a negative effect on the isolation between channels. In the event that two outputs are switched to receive the same input signal, the isolation between output ports is determined by the isolation of the power divider. Typical wide-band power dividers have 20dB of isolation.

Super Non-Blocking Matrix Switch

A super non-blocking matrix switch is one that is built with power dividers on the inputs and on the outputs and 1P1T switches in between. This configuration allows multiple inputs to be connected to multiple outputs simultaneously. This is the most flexible matrix switch type.

See Figure 7 below for a 3 X 3 Super Non-blocking Matrix. Figure 8 shows some of the connection states that are possible with this type of matrix switch.

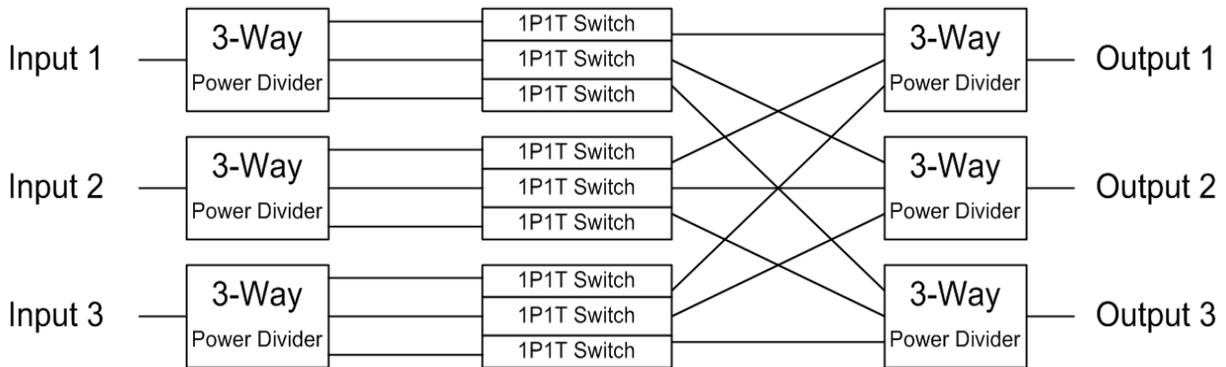


Figure 7. 3 x 3 Super Non-Blocking Matrix Switch

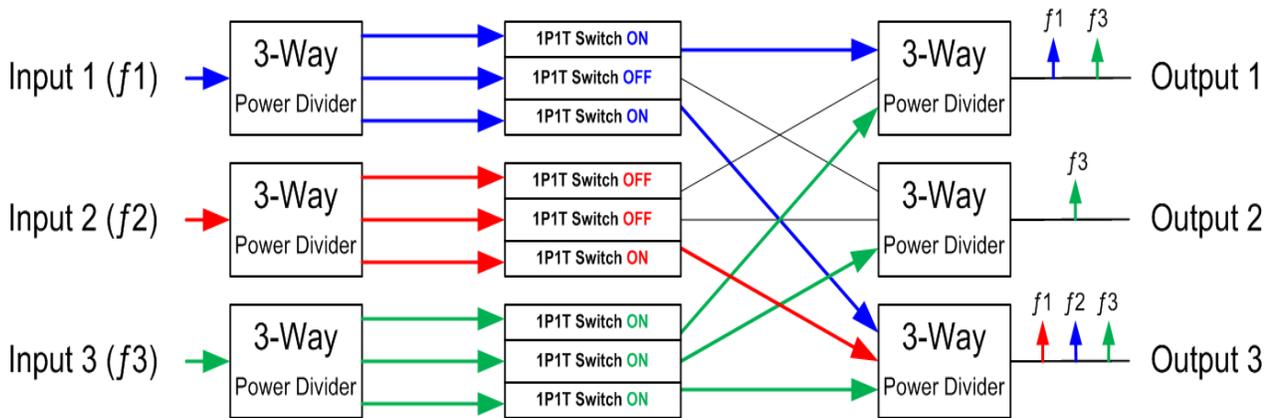


Figure 8. Example RF Paths for 3 x 3 Super Non-Blocking Matrix

This configuration offers even greater switching flexibility than a standard Non-Blocking Matrix Switch and can be used bi-directionally. The insertion loss of a super non-blocking matrix is greater than a non-blocking matrix because it uses power dividers on the inputs and the outputs.

Handover Test Systems

The handover test system construction is very similar to a super non-blocking matrix. The difference is that instead of using 1P1T switches in between the power dividers, the handover system uses programmable attenuators. The programmable attenuators allow the user to individually adjust the amplitude of each signal being received by an output.

Both handover systems and super non-blocking matrix configurations allow multiple inputs to be connected to multiple outputs simultaneously. The handover test system design adds to the flexibility by allowing the user to attenuate each RF path independently.

See Figure 9 below for a 3 X 3 handover test system. Figure 10 shows some of the connection states that are possible with this type of design.

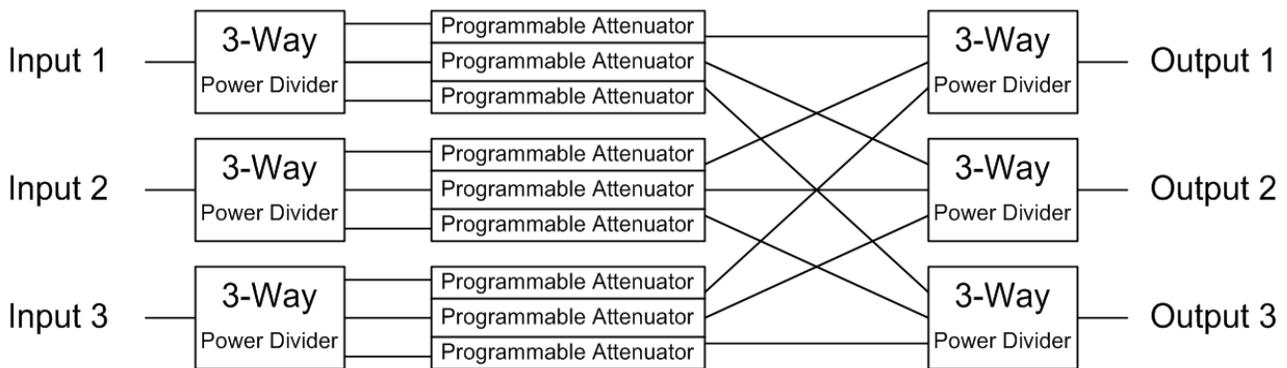


Figure 9. 3 x 3 Handover System

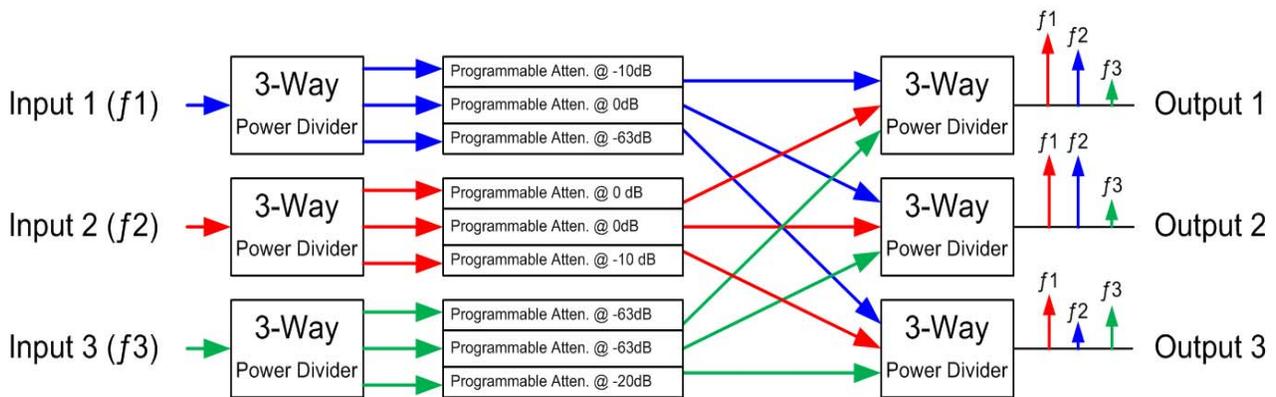


Figure 10. Example RF Paths for 3 x 3 Handover System

Conclusions

When choosing the right matrix switch design, it is important to have a thorough understanding of the application. Many different variables must also be taken into account, along with the matters of connectivity that were addressed in this application note. Everything from RF performance and reliability to control interfaces and remote command formats should be considered before making a decision.

If you have any questions, please contact our engineering department at jfwengr@jfwindustries.com.

If you would like to see specific matrix switch models, please see our [Test Systems section](#) of the website. We list multiple models for each type of test system including specification sheets, outline drawings, and block diagrams.

If you have a block diagram or description of a matrix switch you would like JFW to quote, then please email your requirement to sales@jfwindustries.com. We will respond with ROM (rough order of magnitude) pricing in 1-2 days.

Regards,

JFW Engineering Dept.