RECEIVER MULTICOUPLERS 101- THE BASICS ON THE USE OF MULTICOUPLERS IN THE RECEPTION OF RADIO SIGNALS

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Introduction

This paper is an introduction to receiver multicouplers that are used in the reception of radio signals. It discusses their application to various situations and explains how they operate. There are two different types of receiver multicouplers. One type of receiver multicoupler is referred to as a channelized receiver multicoupler. In this type of multicoupler, there are separate filters and amplifiers for each receive frequency. This is often used in VHF systems where there is no band plan for frequency use. The type discussed here uses power dividers to provide received signals to more than one receiver. The channelized receiver multicoupler using C-Series or Pass-Thru technology will not be discussed in this paper and is the topic for a future white paper.

A diagram of a four channel receiver multicoupler is shown in Figure 1. The principal elements of the device are: preselector, amplifier, and power divider. The power supply is needed for the amplifier.

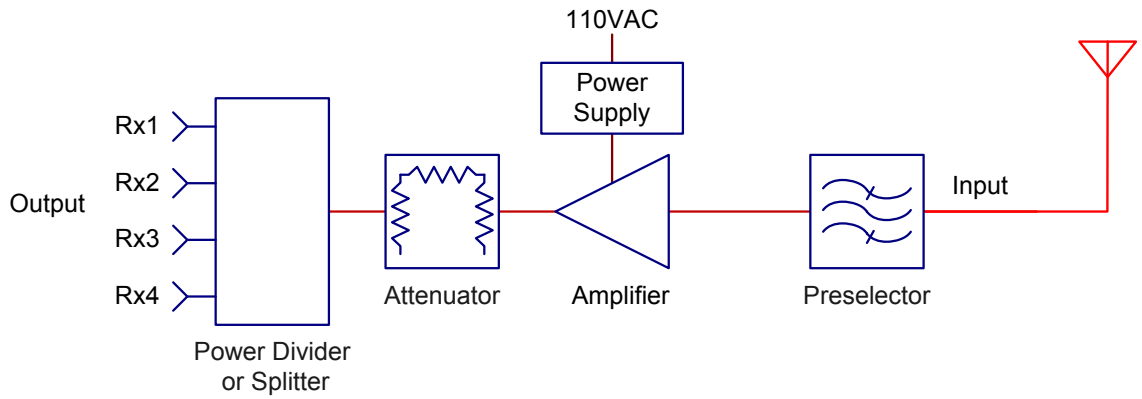

Figure 1: A block diagram of a typical receiver multicoupler is illustrated

Preselector

The preselector as shown in Figure 2, is the first component the received signal encounters. Its purpose is to filter out any undesired signals and prevent them from reaching the amplifier. The preselector functions as a bandpass filter. A typical response curve for a UHF unit is shown in Figure 3. Typically these units have a very sharp cutoff yet a reasonably wide passband. From the curve in Figure 3, one can see that the bandwidth is approximately 5 MHz passing frequencies 507.0 to 512.0 MHz, but signals 7.5 MHz from the center frequency are attenuated by 23 dB. The received signal input to the filter encounters some signal loss, typically between 1.0 to 3.0 dB, depending on the bandwidth of the preselector, and the frequency of operation.

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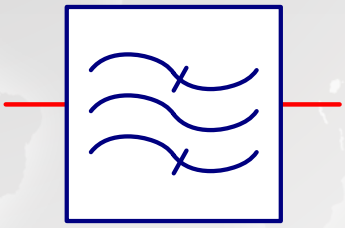
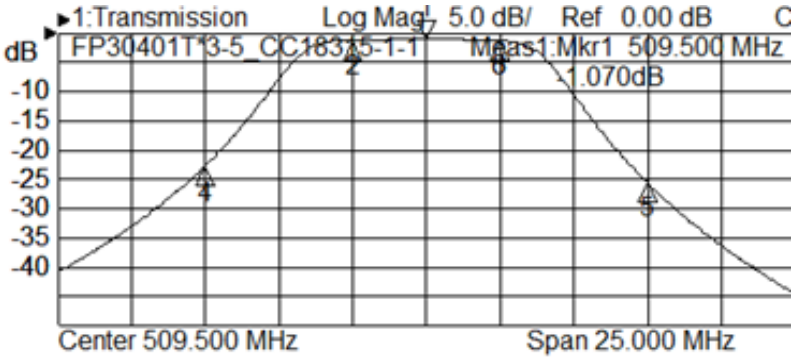


Preselector

Figure 2: A FP20401 VHF bandpass preselector and schematic symbol illustrated.

As would be expected, all received signals must be within the 5 MHz passband of the chosen preselector if they are to reach the receiver. Conversely, no on-site transmitter can be within this range or it will pass through the preselector. If this situation were to occur, the high level signal from the on-site transmitter would drive the amplifier into saturation. The overloaded amplifier would not adequately amplify any desired distant signals so reception would be impaired.



1:Mkr (MHz)	dB	2:Mkr (MHz)	dB
1> 509.5000	-1.070	1> 509.5000	-26.693
2: 507.0000	-1.227	2: 507.0000	-20.243
3: 512.0000	-1.281	3: 512.0000	-24.755
4: 502.0000	-22.727	4: 502.0000	-0.486
5: 517.0000	-25.521	5: 517.0000	-0.273
6: 512.0000	-1.281	6: 512.0000	-24.755

Figure 3: A Response curve of a FP-30401 UHF preselector

The preselector is a filter for the amplifier. It prevents local signals from overloading the amplifier into a situation which distorts the desired signal. A transmitter producing wideband transmit noise inside the passband of the filter will still be a problem, but this problem cannot be remedied from the receive side of the system. Filters would be required on the transmitter to eliminate the wideband noise within the receive passband.

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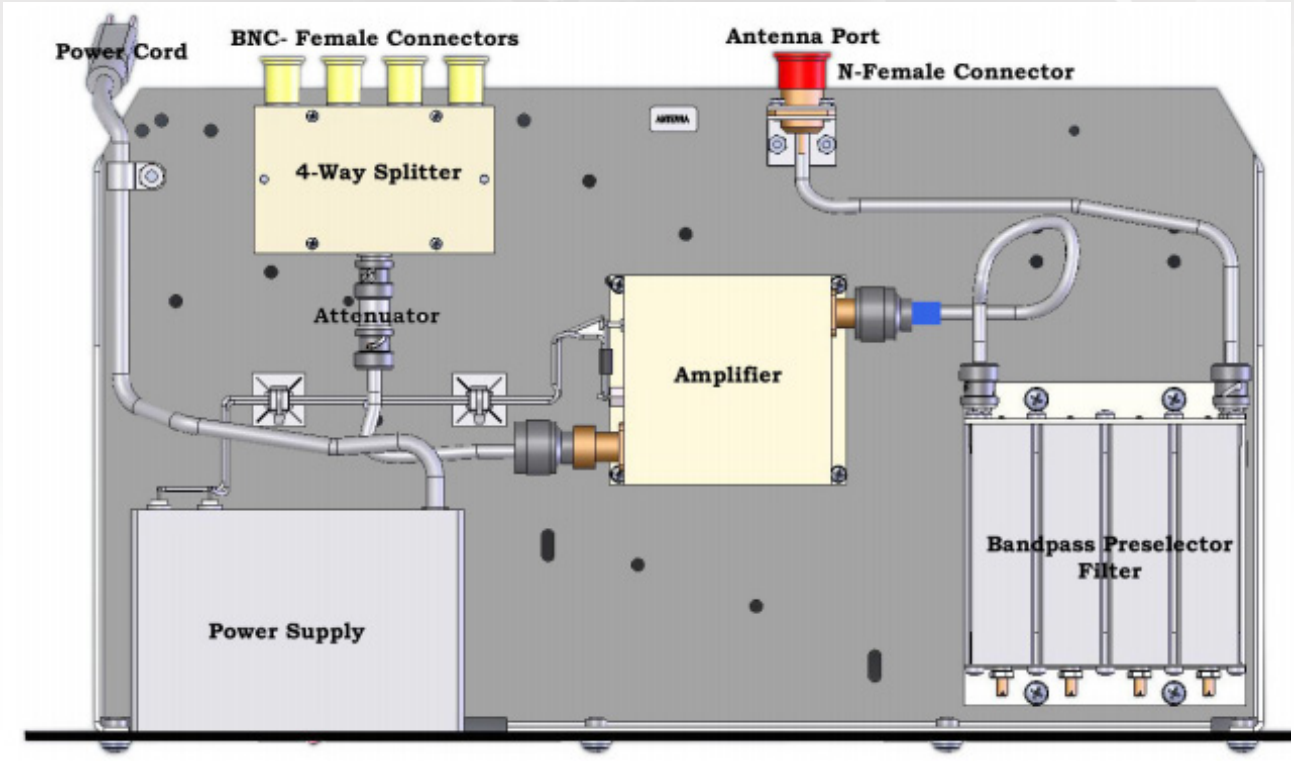

Figure 4: A receiver multicoupler showing physical component connections

Low Noise Amplifier (LNA)

The low noise amplifier increases the signal strength before it enters the divider. The amplifier is illustrated in the center of Figure 4. Since each division of the power divider weakens the individual signals by 3 dB, the amplifier is inserted as compensation for the signal loss encountered passing through both the preselector and power divider. In some situations the amplifier gain is also used to make up for antenna feed line losses. Attenuators are required after the amplifier, to reduce the amount of amplification. This will in turn keep the amplified signal from overloading the input stage of the receiver.

Power Divider

The power divider is often called a signal splitter. Each binary split of the power weakens the power fed into the divider by 3 dB. A 50% reduction in the input signal strength represents a 3 dB loss. In a 2-way power divider as shown in Figure 4, the signals are split once to provide two outputs. In the 4-way power divider shown in Figure 4, the signals are split twice to provide the four outputs. The signal arriving into a 2-way splitter is reduced by at least 3 dB before it arrives at any of the two output ports. Similarly, the signal arriving into the 4-way splitter is reduced by at least 6 dB before it arrives at any of the four output ports. In a receiver multicoupler system, the amplifier is used to increases the signal strength before the 4-way divider as shown in Figure 1. In order to produce more outputs, more power dividers, or as they are often called, signal splitters are used. Outputs are often configured to provide eight or 16 outputs.

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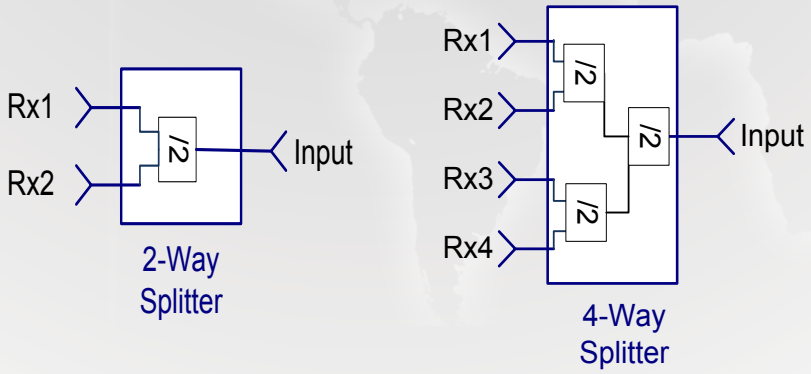

Figure 5: A diagram representing a 2-way, and 4-way power divider

It is recommended that all unused output ports be terminated with a 50 ohm load. If an unused port is not terminated, the signal will be reflected back to the point of division. At this point the reflected signal will interfere with other signals on other ports with detrimental results. The required load is a very low power device. Sinclair produces a load which has a BNC termination called a model T50-01.

The power supply provides a regulated and filtered direct current (DC) voltage to the amplifier. The power supply can be chosen to accommodate several different power sources. The power source can either be an alternating current source (AC) or a direct current power source (DC). The AC power source accommodates 115 to 220 volts AC with 50 to 60 Hz frequency. The DC power supply options include 12, 24, and 48 volts. An advanced receiver multicoupler option includes a DC power backup failover if the AC power is lost. The power supply is connected to the amplifier as shown in Figure 4.

A Typical Application

A typical application is shown in Figure 6. The UHF receiver multicoupler is coupled through a duplexer to the antenna. When selecting a duplexer, the pass and reject bandwidth of the duplexer must accommodate all the desired transmit and receive frequencies.

If the preselector bandwidth is wider than the duplexer, the preselector will have a minimal effect and can often be eliminated. The narrowest bandwidth in the system determines which signals are passed through the system. For example, a 5 MHz bandwidth preselector and a 1 MHz passband duplexer will only receive or transmit signals within the 1 MHz bandwidth. Any signals outside of the 1 MHz bandwidth will be attenuated by the duplexer.

The outputs of the receiver multicoupler with a bandpass preselector are not frequency sensitive. An identical signal appears at each output. Multiple receivers tuned to the same frequency can be connected to the receiver multicoupler.

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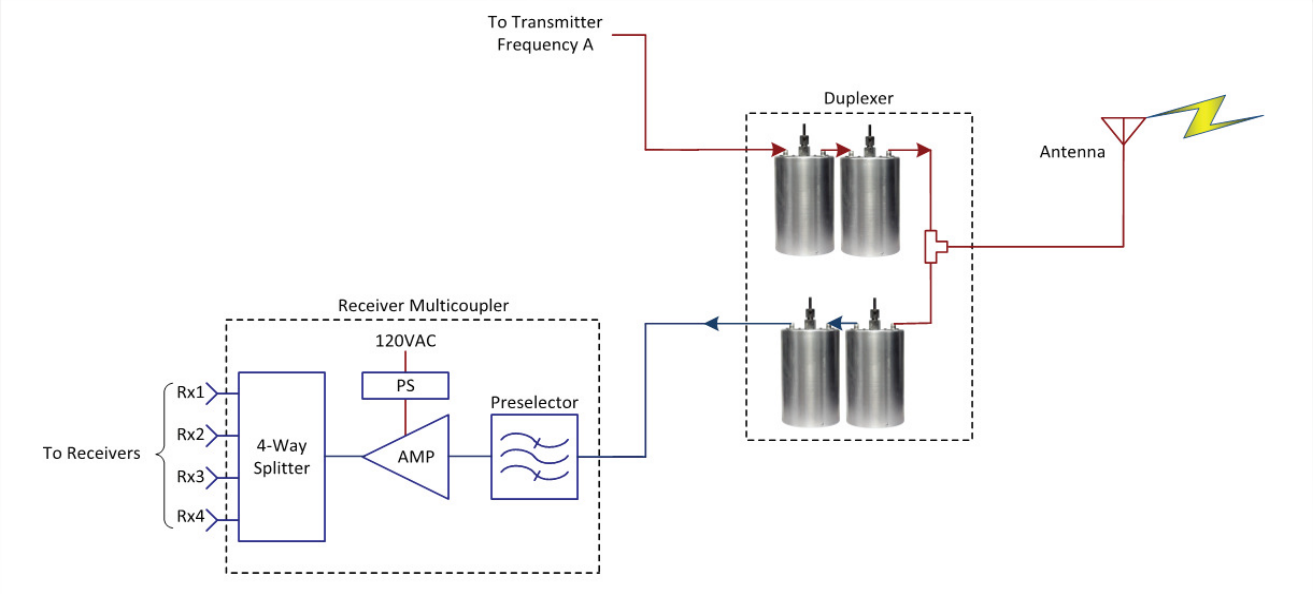

Figure 6: Example use of a receiver multicoupler to provide multiple receiver output ports

The example in Figure 7 is provided to familiarize you with the specifications Sinclair typically provides for each receiver multicoupler model that we produce.

Example Specifications

Electrical Specifications		
Frequency Range	MHz	350 to 512
Number of channels		2
Bandwidth	MHz	1
System gain (min)	dB	2
Input Connectors		N-Female
Output Connectors		BNC-Female or N-Female
Input VSWR (max)		1.5:1
Output VSWR		1.5:1
Impedance	Ω	50
1 dB Compression point	dBm	24
Isolation Rx to Rx	dB	20
Noise figure (amplifier (typ))	dB	0.8
Noise figure (system (typ))	dB	4.1
Third order intercept - amplifier	dBm	40
Supply voltage		115-220 VAC

Figure 7: Example UHF Electrical Specifications

Frequency Range This value is the frequency range of all the receiver multicoupler components not including the preselector filter.

Number of Channels This unit is a two- channel device meaning two receivers can be connected to one antenna. Other versions of the receiver multicoupler support four, eight, and 16 or more receivers.

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Bandwidth: Once you have chosen a preselector filter, it narrows the range to the frequency range needed for a particular application to a desired frequency range.

System Gain (Min.): The multicoupler will provide a minimum of 2dB of gain for the system receivers.

Connectors: The antenna input connector is a Type N Female connector. The outputs to the radio receivers are either BNC type Female or optionally, N Type Female connectors.

VSWR Input and Output: The VSWR of 1.5:1 dB corresponds to a return loss of 14 dB shows that approximately four percent of an input signal is reflected.

Impedance: The antenna input port, and the receiver output ports all have an impedance of 50 Ohms. This is to match the impedance of the antenna, and receivers you are connecting to the receiver multicoupler.

1 dB Compression Point: The 1 dB compression point is the power level that causes the amplifier gain to drop by 1 dB from its small signal value.

Isolation Rx to Rx: The isolation between receiver ports is shown as 20 dB. Since each signal output is identical, this number does not need to be large. 20 dB is easily enough to compensate for any variation in receiver loading.

Noise Figure (amplifier): The noise performance of the low noise amplifier is indicated.

Noise Figure (system): This value indicates the noise performance of the entire receiver multicoupler system.

Third Order Intercept Point (amplifier): This number indicates how linear the amplifier is. The higher the number is, indicates a greater degree of linearity. An exact explanation of this term is beyond the scope of this white paper.

Supply Voltage: The supply voltage can be an AC voltage or a DC voltage depending on which power supply is chosen. The specification in Figure 6 above indicates that an AC power supply was chosen for this particular receiver multicoupler.

Sinclair can offer a wide range of multicouplers as described in this paper and the professional services to complete an RF system design that meets a customer's specific needs.

Please refer to the Sinclair's website (www.sinctech.com) for more information related to duplexer, preselector, combiner and cavity filter products.

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