Why Combiners?

You use a combiner when you want to add another service without adding another system. Perhaps you need to add a second data channel to your VSAT, so you bought a top quality modem and now you just need to hook it up. You know that you cannot just splice the coax cables together, so why not just use an L band splitter in reverse to combine the signals? It works for an LNB, right?

"No, it works for a DRO or PLL LNB, but not for an external reference LNB or BUC. These synchronized low noise devices need a pristine 10 MHz signal, a clean and filtered set of L band signals, and a noise free high current source of DC, all on the same cable. When adding one or more modems, a specialized assembly called a combiner is necessary. This combiner must:

1. lose as little of the signal from each modem as possible as it goes through, "insertion loss"

2. prevent each modem from interfering with the other, "isolation value"

3. lose as little signal as possible from summing the modem signals into one line "combining loss"

4. provide optimum impedance match to all devices to assure maximum transfer of energy "return loss or VSWR"

Now we can go into exotic math and esoteric theory to define this magical combiner, but lets pare this down to what you need to know and what you really need."

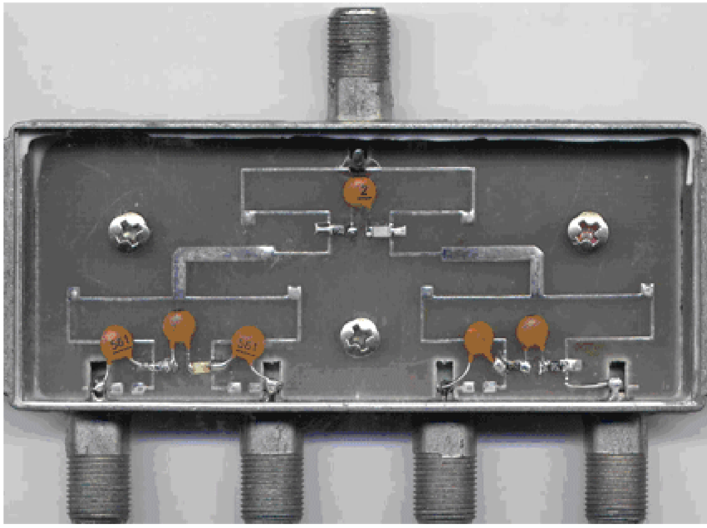
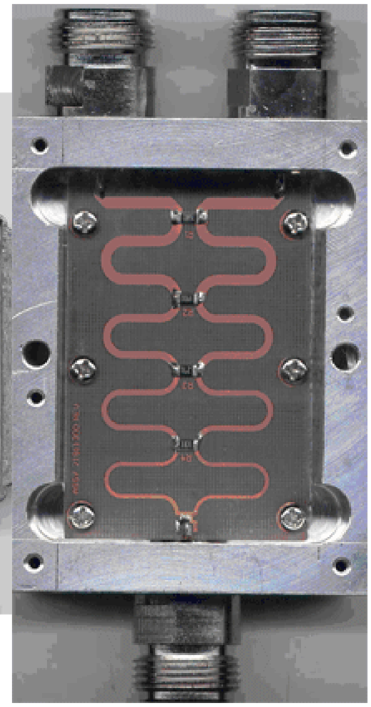
1. You need DC for the BUC from one modem only. The simple solution would be to turn off the DC on the other modem - problem solved. Of course, if you need more power for your BUC than the modem gives, or you want your BUC power to be independent of your modems, you might think you could use a Bias Tee, but what about the 10 MHz? An ordinary Bias Tee was never designed to pass 10 MHz, you need one of our Orbital Mux Tees to insert power properly onto the L band cable without affecting the 10 MHz signal, but more on that later.

2. You need 10 MHz at a level of 0 dBm at the BUC. This can come from either modem, but NOT both. The simple solution seems to be 'turn off the 10 MHz in the other modem', or turn off both modems and use a separate 10 MHz oscillator that would be inserted by a Diplexer, which you can if you have an external DC port on your BUC, but then what about the DC? It brings you back to needing a Mux Tee. Even then, you still need to remove the 10 MHz out of the Combiner, so that the Combiner is only dealing with L-band. And that means you need a high quality Mux Tee like the Orbital MT25/40 with its low insertion loss, great VSWR, high isolation, and low loss impedance transforms.

3. So far, so good, but now you need to combine the L band signals from each modem onto one cable to the BUC under some fairly strict criteria. Since some good quality L band divider/combiners are readily available, again this seems like a simple solution, so why not buy a cheap L band divider with one port passing DC, attach the cables, and away we go. After all, if it passes DC, so it must pass 10 MHz, right?

Not so fast. What will happen is a fluctuating BER, poor phase noise, intermittent BUC lock, cycle slip, and a really angry customer. Worse yet, you might make several service calls trying to catch the problem and that will cost you a lot of money . You might substitute the BUC and the Modems, causing your suppliers to be angry when they spend a lot of time trying to find a fault in their returned products that doesn't exist. Your client may lose confidence in your abilities, not to mention that your client's customers will be losing thousands of dollars from loss of data. All this from a divider? What is happening? Lets take a look:

"El Cheapo" *"El Grande"*

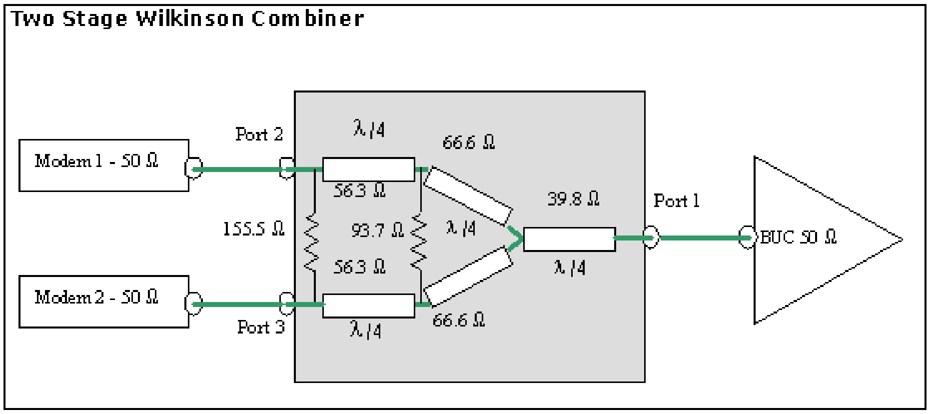
 

What you are looking at is a carefully engineered microwave circuit built with precision manufacture and tight tolerance components. Okay, so the one on the left is an el cheapo 75 ohm F connector four way divider/combiner, but on the right is a high quality 'el grande' 50 ohm N connector two way divider/combiner. Both use the same theory created in 1960 by Ernest J Wilkinson, hence the name 'Wilkinson Combiner'. (Make sure you are using this type of combiner, as there are resistive designs that are not optimum for this application. When you hook up DC to a bunch of resistors that go between ports and to ground, the smoke is quite noxious, not to mention the fact that it only works for 2 seconds.)

Also, take a look at the width of the traces, they are about the size of a 3 amp fuse core. The el cheapo was meant to run a 150 ma LNB, not a 2 to 4 amp BUC. Even the 'el grande' 50 ohm pro combiner was never meant to pass DC. And one other tip; when you first apply power to a BUC, the power supply takes a huge dump. Let me rephrase that: there is a large inrush of current before regulation and stabilization takes place. If that goes through a combiner, the smell of molten copper tells you that you have just blown the world's most expensive 4 amp fuse.

OK, so we cannot pass DC through the combiner; but why can't the 10 MHz go through the combiner? Well it can, but you will lose 4.3 dB in the 50 ohm version, and 6.6 dB in the 75 ohm version. That may not seem like much when the combining loss is 3.5 dB for a two port at L band, but take a close look at the dynamic range spec on your BUC. Bet you it says "0 to −8 dBm", and we just lost 6.6 dB in the coupler without even considering cable losses to the BUC. You have also degraded your signal to noise ratio, and if you think you have problems now, wait till you try and deal with phase noise hits in your BUC lock and cycle slip from transients. Your best insurance is to make sure a pristine 10 MHz signal gets to your BUC at 0 dBm. Don't even think about trying to use a regular bias tee, it will eat your 10 meg. Just to rub it in a bit, an Orbital Mux Tee only loses 0.25 dB at 10 MHz, and we will show you how to use that exceptional spec later.

But I digress. There is another problem with the 10 MHz that you need to know about - here is the schematic of a two stage 50 ohm Wilkinson combiner. The El Grande shown above is a four stage combiner, flat from 900 to 2400 MHz., and the el cheapo is a 2 stage four port design, (don't ask how flat, you get what you pay for and hey, it's 'F' connectors).

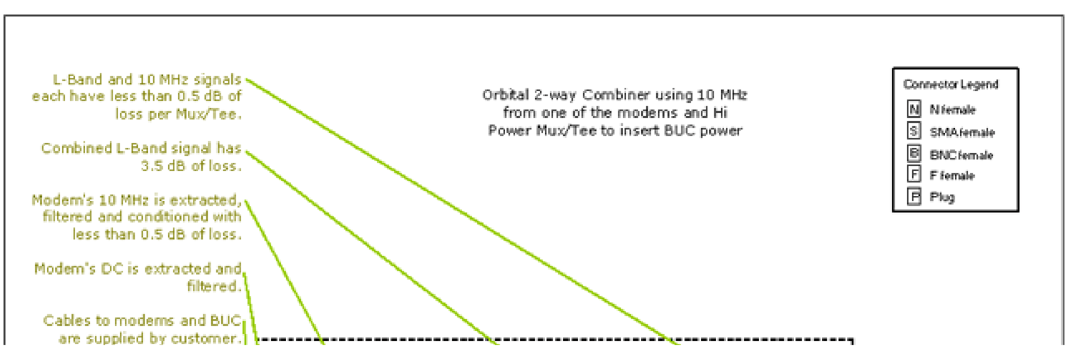


The combiner works at L band because of the length of the pieces shown in the diagram above. These are strips of copper that are a quarter wavelength long, and the right width to give the impedance values shown in the diagram. These values form a network so that each port appears to have a 50 ohm impedance. This is not trivial as it provides a good match for each device connected to the combiner. This means maximum transfer of energy and minimum loss. But there is another piece of magic.

Say we have a 1 GHz signal from modem 1 going into the combiner at Port 2. It takes two paths, one thru the 155.5 ohm resistor to Port 3 and one through the quarter wavelengths circuits and back to Port 3. The signals arriving at Port 3 will be 180 degrees out of phase, AND THEY WILL CANCEL. In the real world, this measures out at about 30 dB of isolation loss, so the 1 GHZ signal at – 10 dBm from Modem 1 will be -40 dBm at Modem 2, and a 1.1 GHz signal from Modem 2 will likewise be suppressed by 30 dB at Modem 1. But the signal going through from Modem 1 or Modem 2 to the BUC will only lose about 3.5 dB. Now the modems will not interact, and the BUC will get a good signal from each.

Why can't we do the same with 10 MHz signal and have it cancel at the other modem port? Well, you can, but a quarter wavelength at 1 GHz is about 7.5 mm so a 180 degree phase shift needs about 15mm of stripline on the printed circuit board. A quarter wavelenth at 10 MHz is 100 times longer, so the same 180 degree phase shift would need nearly 1.5 meters of stripline to achieve cancellation. Hard to justify another rack just to hold the combiner. Oh and by the way, it no longer works at 1 GHz, and just to add insult to injury, remember that the 10 MHz must be 0 dBm, and the L band signals are often much lower amplitude. Some modems react adversely to so much non-L band signal going back into them.

So what do you do? You pass the DC and 10 MHz around the combiner, with minimal loss, and you combine only the L band signals with minimal loss and good isolation. Here's how. Use two Orbital Mux Tees, back to back, with the Wilkinson in between to combine just the L band. It looks like this:

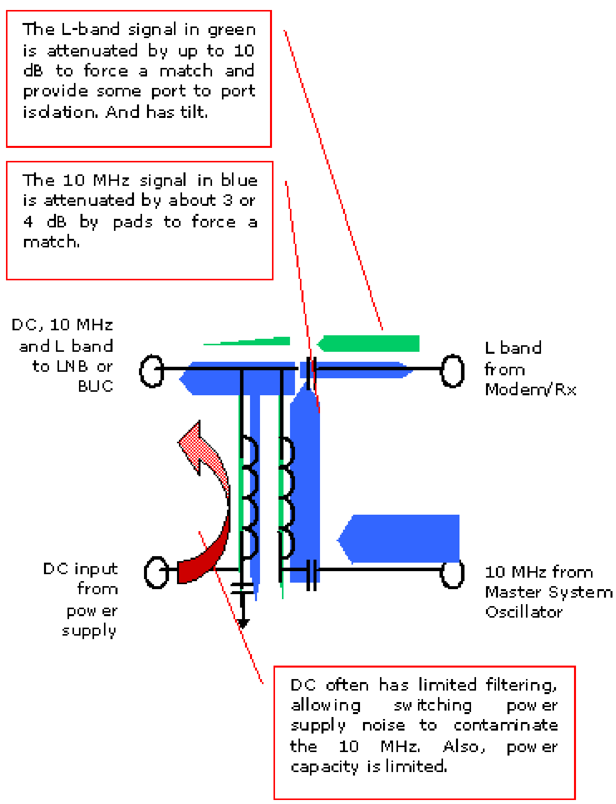


So what do you end up with? Well, a filtered and combined L band signal to your BUC with only 3.5 dB insertion loss, flat from 900 to 2400 MHz, ± 0.5 dB, virtually no tilt. Since the Orbital Mux Tee has over 92 dB of isolation at 10 MHz back to the L band port, the modems cannot talk to each other, and there is no way that the 10 MHz will be contaminated in the combining process. Likewise, the isolation at the insertion MuxTee assures filtered L band, clean 10 MHz with only 0.5 dB loss, and DC that is filtered and conditioned to keep transients out of the BUC.

As well, you do not have to use the bypass mode. Since Orbital products are modular with standard BNC and SMA connectors, you can insert a separate standalone power supply for your BUC, and a separate 10 MHz signal from a master oscillator if you wish. One more neat feature from Orbital is the ability to mix and match your modems. Since our mux tees are available in both 75 and 50 ohm versions with built in stripline (non-resistive) impedance transforms, you can combine both 50 and 75 ohm modems and BUCs. (By the way, do not try and use minimum loss pads to match 50 and 75 ohm equipment, they use resistors to force a match, so you lose 4.5 dB at L-band and 10 MHz, and if there is DC on the line, the term 'smokin system' is not a compliment).

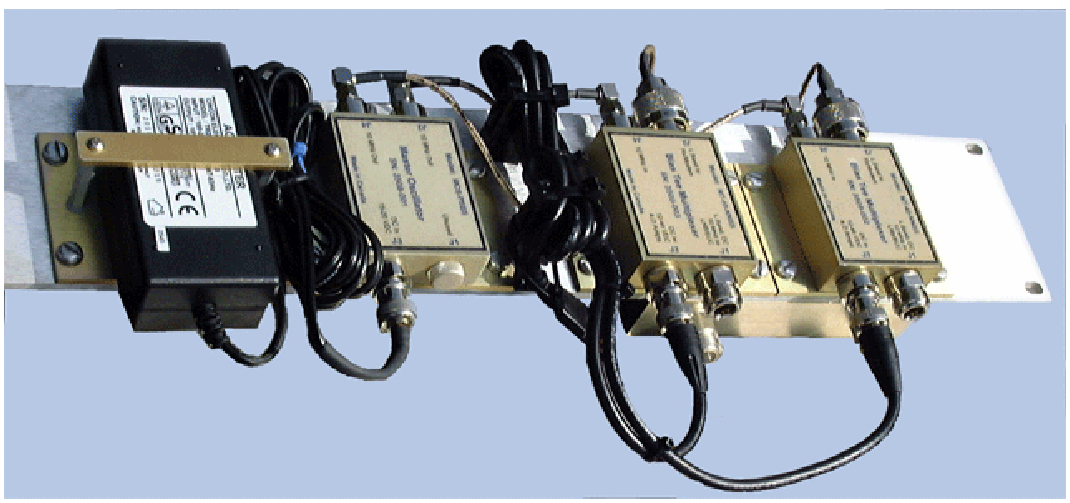
The cornerstone of the Orbital Combiner is the Orbital MT25/40 Mux/Tee. Why is it so good when compared to a conventional model?

Conventional Mux Tee



Orbital Mux Tee

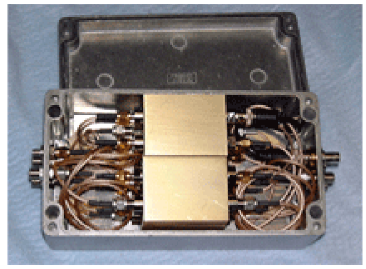
Check out our web site to see examples of Combiner designs, or give us a call to see if we can help your system designs with the Orbital modular architecture. Ask about our four port combiners, combiners that incorporate our 10 MHz master oscillators, 10 MHz splitters, dividers, TTL switches, and our new Orbital 433 Mux Tee, with the new 433 MHz M&C channel. Our Combiners are available in a stack, on a plate, in an enclosure, or in a rack mount chassis.



Orbital Combiner on a plate - this one with an Oscillator

The beauty of the Orbital Modular system is that the same components can be re-assembled in an enormous number of ways, to solve a vast array of problems.

Orbital Redundancy Control System



Orbital Combiner in an enclosure

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In addition to Combiners, Orbital Manufactures a wide array of:

Dividers, 10 MHz Splitters, Mux Tees, Bias Tees, Diplexers, Dual Power Tees, 10 MHz Pass Thru Tees, TTL Switches, Master Oscillators, Precision Oscillators, Precision LNBs, BDC modules, Rack-Mount BDCs, Redundancy Systems, ODU and IDU control systems.

If you have any engineering problem or issue between the Dish and the Demod, contact our engineers at:

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Most Orbital solutions are simply a re-arrangement of existing modules, so that design and delivery can be swift and costs can be kept low while quality is kept high due to the re-purposing of proven components.