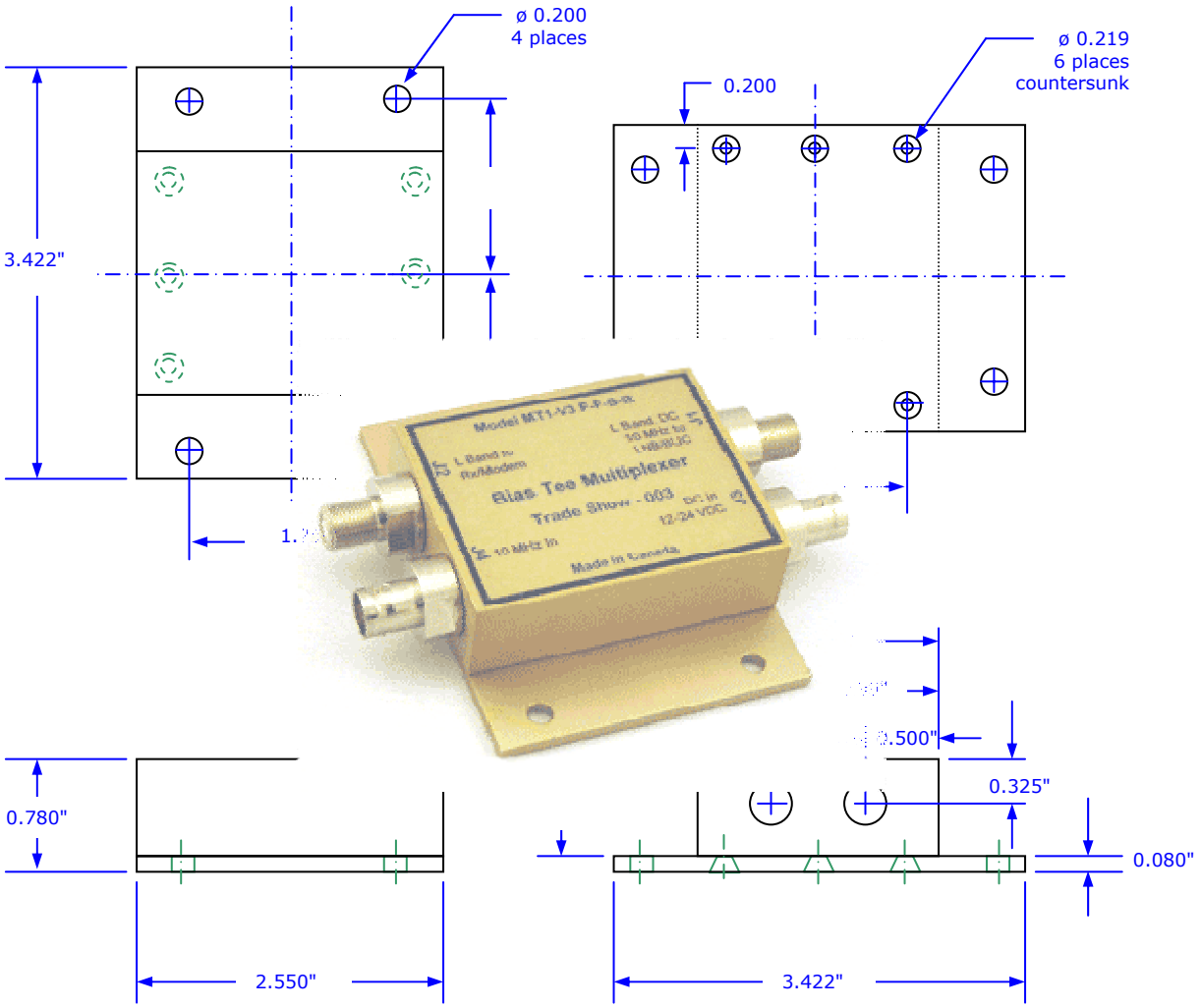
Orbital Research Ltd
Bias Tee Multiplexer (Mux/Tee)
Manual



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1 Product Description

1.1 Overview

The Orbital Research Bias Tee Multiplexer is commonly called a Mux/Tee. It is the building block for most of the Orbital System Interface Product Line (SIP). Incorporated inside are many functions and best-in-the-world specifications.

1.2 Design Functions

The Orbital Research Mux Tee inserts or extracts up to 3 separate signals onto or off of one cable. Those signals are: DC (to power devices), 10 MHz (to phase lock all devices connected to the cable) and L-Band signal (to pass with minimum loss).

Some of the design criteria are:

General

1. Margins designed in to assure consistent performance up to maximum specifications.
2. Design optimizes impedance matching (VSWR) on all ports resulting in minimum insertion loss and maximum transfer of energy.

DC

1. To insert or extract DC up to 4 amps and 48 Volts to power active devices (BUCs or LNBs) without affecting the 10 MHz or L-Band.
2. To condition the DC to protect devices from transients, spurs, and harmonics.
3. To block DC between L-Band input and output ports to allow dividing or combining of L-Band signals.

10 MHz

1. Insert or extract the 10 MHz reference signal without impairing phase noise and maximizing immunity from transients.
2. To couple the 10 MHz reference with less than 0.5 dB of insertion loss to the BUC or LNB and maximum isolation (over 90 dB) to the modem or receiver.

L-Band

1. Preserve the integrity of an L-Band signal of over 1 GHz of bandwidth in the presence of a 10 MHz signal that can be a million times stronger.
2. L-Band high pass filter to filter out any unwanted noise and signal in the 0 to 900 MHz band.

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The result of using a conventional Mux Tee is the compromise or tradeoff of performance and reliability to reduce cost. Without filtering and conditioning of signals, without careful impedance matching designs, without tuning and optimization of circuitry, conventional Mux Tees can function, but not optimally. Poor port to port isolation means multiple 10 MHz signals may interfere with each other to induce cycle slip and intermittent phase noise performance. Poor filtering may result in inferior frequency response and band flatness, resulting in slope and group delay anomalies. Poor impedance matching can result in performance anomalies and signal losses that impair performance. Since every single dollar of your clients' cash flow passes through a Mux Tee, is it prudent to compromise on quality and performance?

The result of using an Orbital Mux Tee is the optimal passage of L band and 10 MHz signal to the BUC or LNB, with no interference between the signals or the ports. The benefits are no loss of lock, preservation of phase noise, and no cycle slip. As well, the DC current carrying capacity of the inductor is designed to power BUCs and LNBs reliably with no compromise in 10 MHz performance. What is not apparent from the diagram is the exceptionally good impedance matching of the Orbital design. With greater than 20 dB return loss on the L band ports, maximal transfer of energy is assured, with minimal reflections or disruptions in the response from 950 - 2100 MHz.

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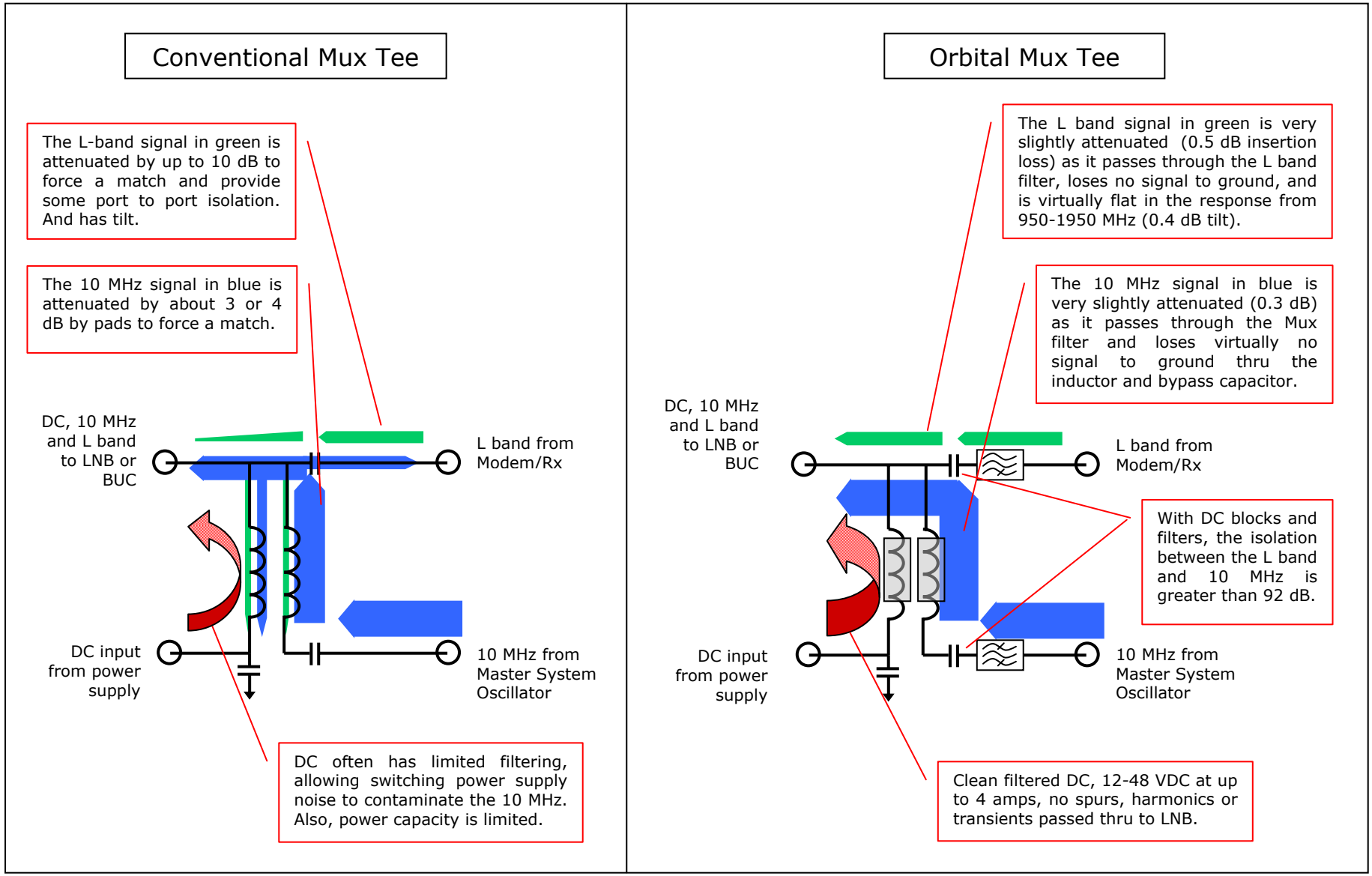

Figure 1: Comparison of Conventional MuxTee to Orbital Research MuxTee

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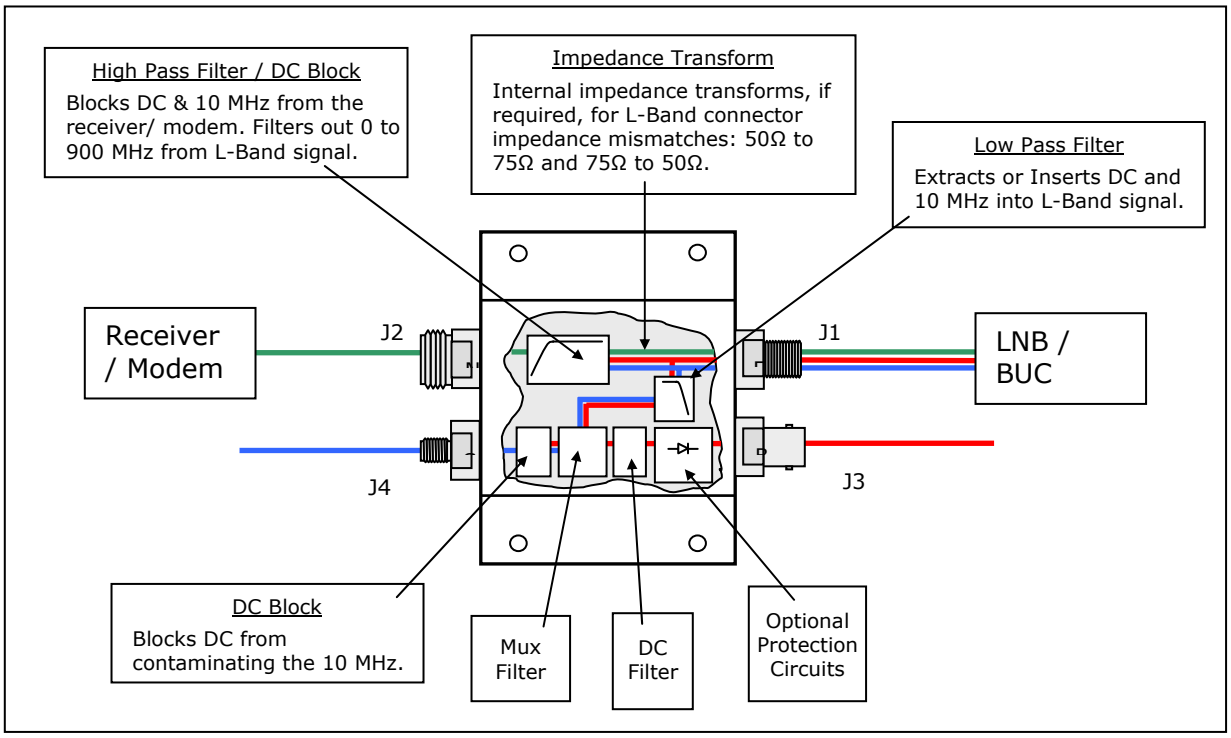

Figure 2: Connector explanation

J1: This is the combined signal going out the LNB or BUC.

- Signals going out to the BUC (DC, 10 MHz, L-Band): The Mux/Tee takes signals coming from J2, J3 and J4, and combines and sends them out J1.
- Signals coming in from an LNB (L-Band). The Mux/Tee lets the L-Band signal from the LNB straight through but filters out 1 to 900 MHz. It does this with less than 0.5 dB of Thru Loss, less than ±0.3 dB of Ripple and less than 1.3:1 input and output VSWR.

J2: There is a high pass filter between J1 and J2. L-Band from 900 to 2100 MHz passes. DC and **10 MHz signals are blocked from the modem or receiver**. (If 10 MHz is needed to pass along with the L-Band signal, see Orbital Research's TT-Thru Tee.) Any transient or unwanted signals collected by the IFL cable acting as an antenna (picking up local radio stations, etc) are also filtered out leaving a clean L-Band signal to the receiver (or BUC if the Mux/Tee is used outdoors in the Outdoor Unit).

J3: DC coming in is filtered so any noise is blocked. If the Mux/Tee is in reverse mode, the DC would be extracted (from L-Band at J1) and come out of this connector.

J4: 10 MHz going in is filtered to block DC and noise. If the Mux/Tee is in reverse mode, the 10 MHz would be extracted (from L-Band at J1) and come out of this connector.

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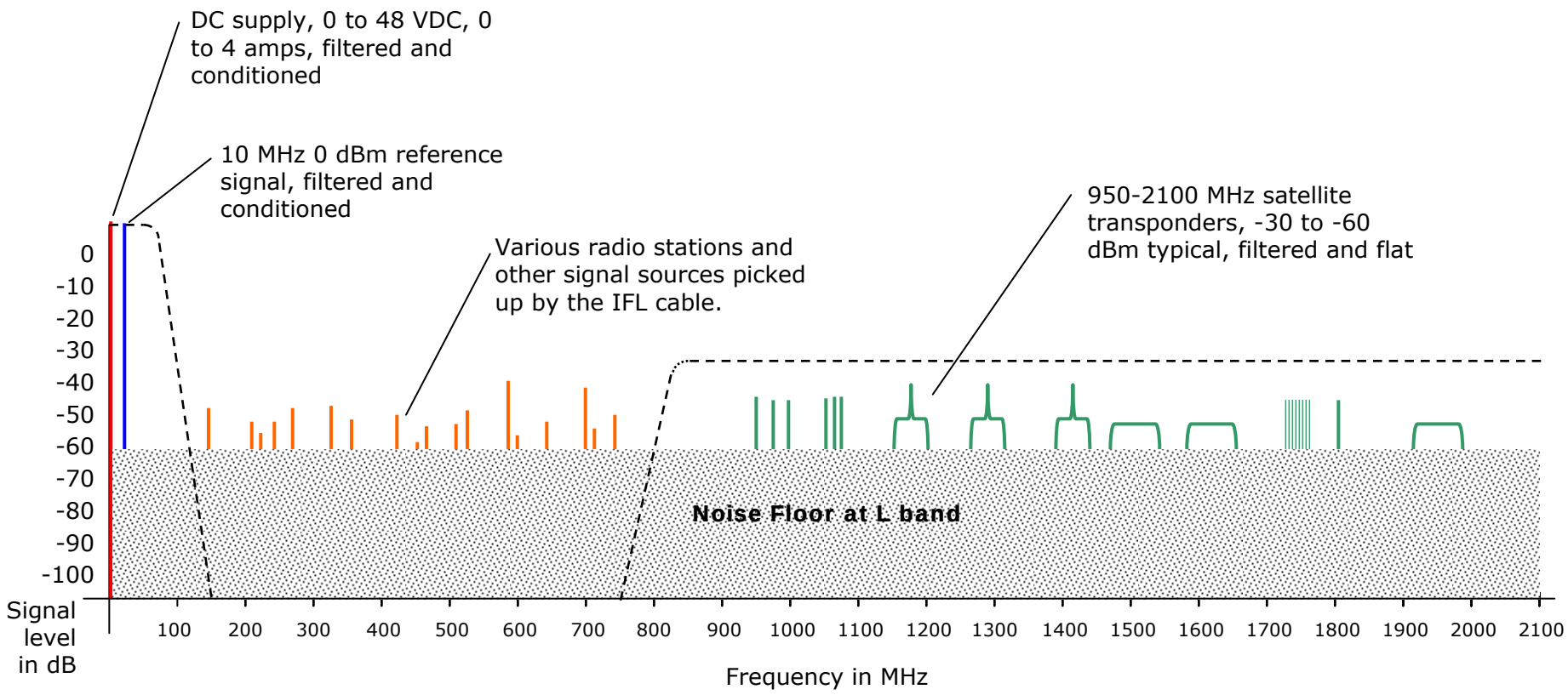

All three signals, DC, 10MHz and L band must coexist on the same cable with absolutely no interaction between any of them. Signals must be inserted and extracted with nearly no loss or alteration of any of their characteristics. The most sensitive to any perturbation is the 10 MHz reference signal, and great care is taken to assure its purity as it is multiplexed and demultiplexed on the IFL cable.

Figure 3: Frequency spectrum of Mux/Tee response range

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2 Installation Tips

Some tips when installing an Orbital Research Mux/Tee:

1. Do not connect or disconnect equipment with power applied. Transients and surges can damage your equipment and can be hazardous.
2. Double-check J1 connector (combined signal) to make sure it is NOT connected to any DC sensitive device such as attenuators, pads, minimum loss pads, spectrum analyzers, combiners, dividers, splitters, or fingers. Remember that the combined signal may have up to almost 200 watts of DC power.
3. While we take every measure to ensure proper sealing of our product, proper sealing of the cable and connector to the device is your responsibility – please ensure that butyl tape or its equivalent is used on all outdoor connectors, or if you are operating in a very humid environment.
4. Depending on your environment, install all necessary lightning arrestors, grounding protection, etc.
5. Ensure sound and stable mechanical integrity of all cable connectors. Ensure proper lead dress to minimize vibration, and avoid crimping of cables.
6. When attaching connectors, (especially 'N' type connectors) be careful not to under/over tighten. Proper torque is just a bit more than finger tight – 6-9 inch pounds of torque.
7. Insure that connectors are installed dry. Use of dielectrics is good practice but not mandatory.
8. To help ensure good connections, use Q tips and Isopropyl alcohol to prepare connections. An artist's foam or bristle brush can be used to clean female connectors – remember that we are dealing in very weak signals in the satellite industry – good connections are essential.
9. The 10 MHz signal is extremely sensitive to any low level anomalies or perturbations. It is imperative that all grounds and shielding be of as good a quality as possible. Poor quality cables and connectors, poorly crimped connections and bad grounds can all contribute to transient or impulse noise. In the presence of vibration, wind, fluctuating temperature or moisture, poor quality cables can cause cycle slip or loss of lock in the LNB or BUC.

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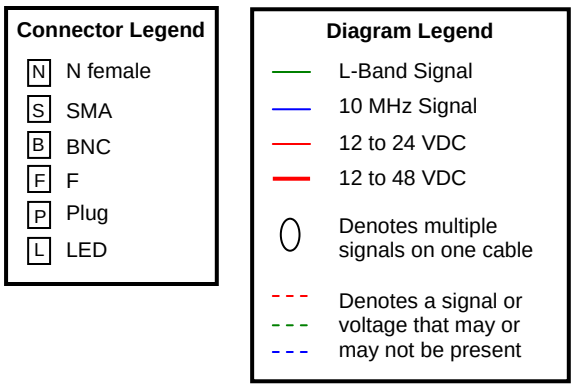
3 Applications

Diagram Legends



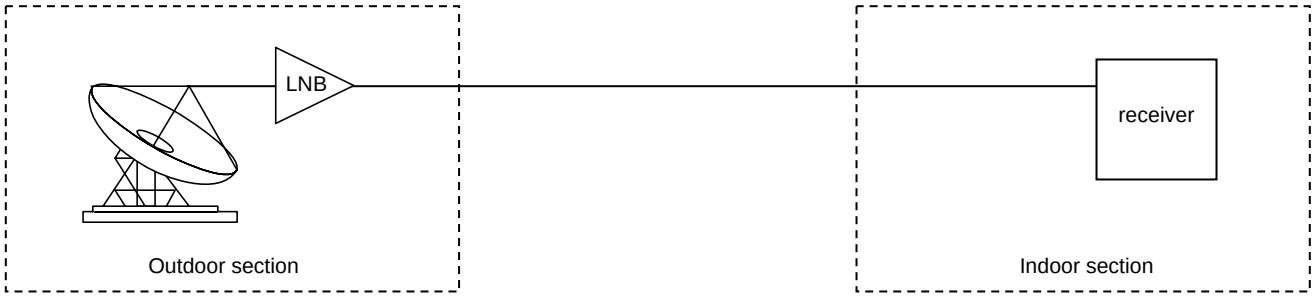


Figure 4: Simplified system diagram of a LNB receive system.

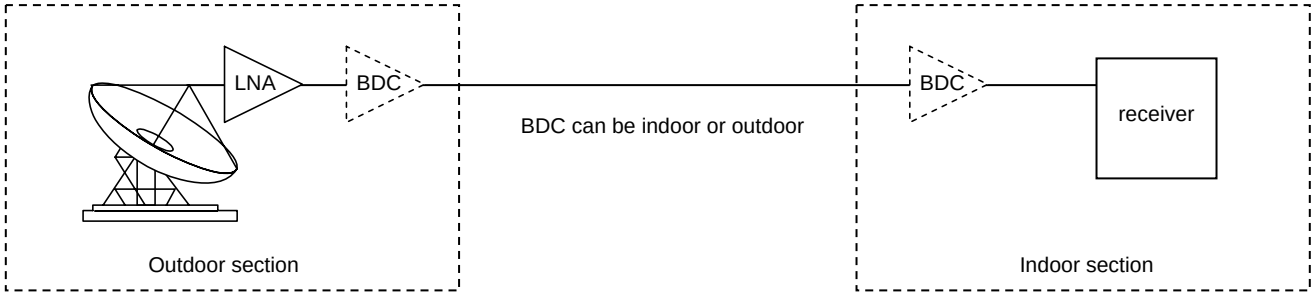


Figure 5: Simplified system diagram of an LNA/BDC receive system.

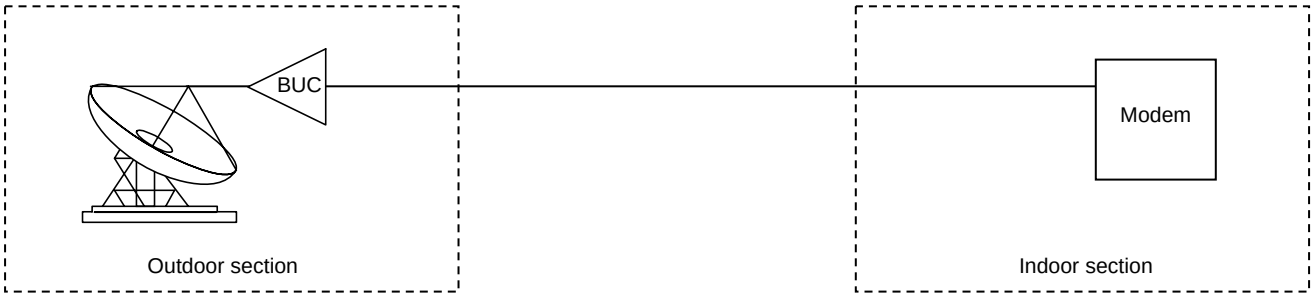


Figure 6: Simplified system diagram of a BUC transmit system.

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3.1 Application 1: Standard Mux/Tee for a BUC (or external reference LNB)

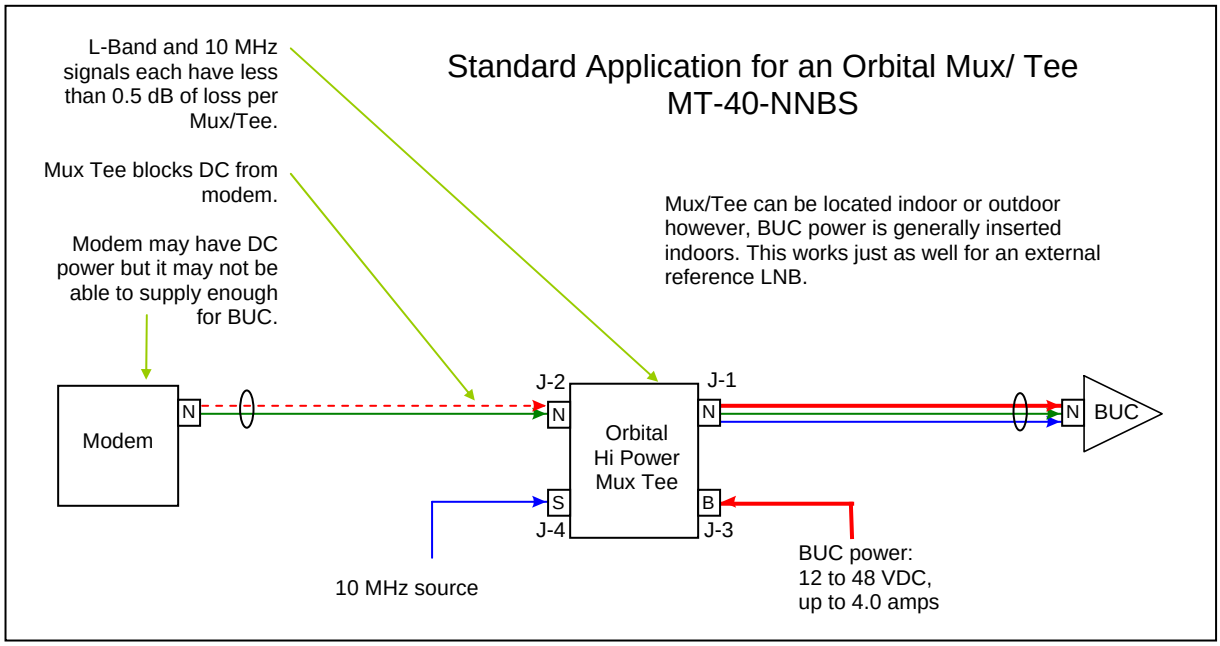

Figure 7: Diagram of Mux/Tee in standard application.

3.2 Application 2: Mux/Tee used as a Bias Tee

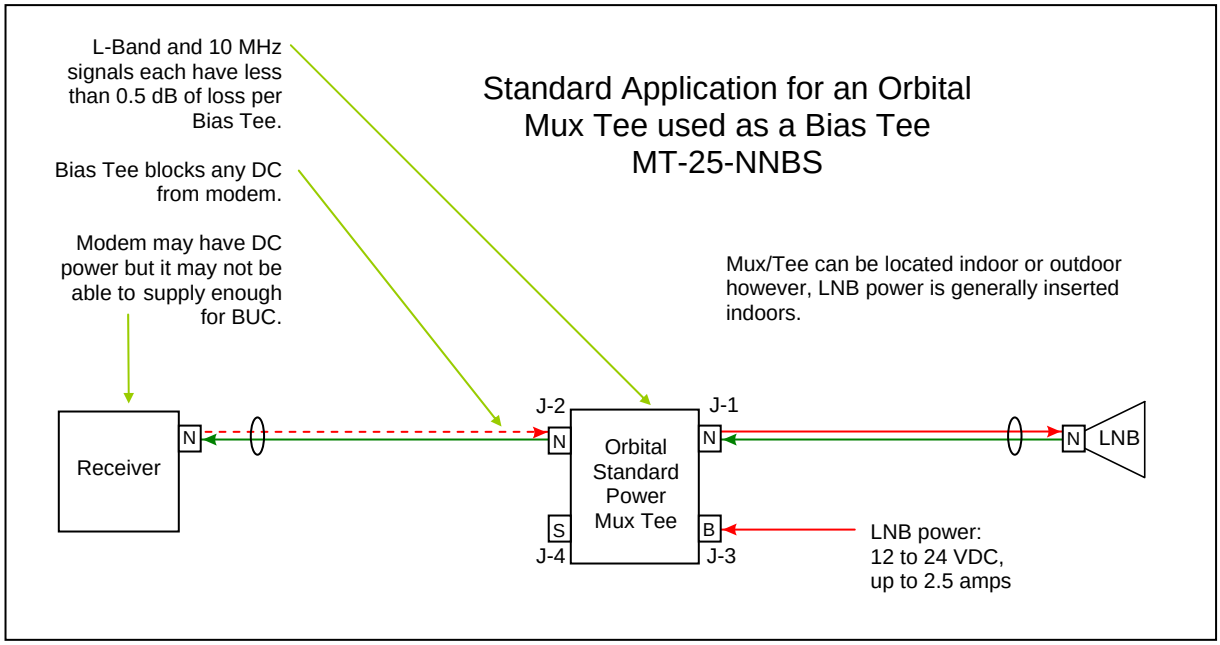

Figure 8: Diagram of Mux/Tee in a Bias Tee application

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3.3 Application 3: Mux/Tee used as a Diplexer

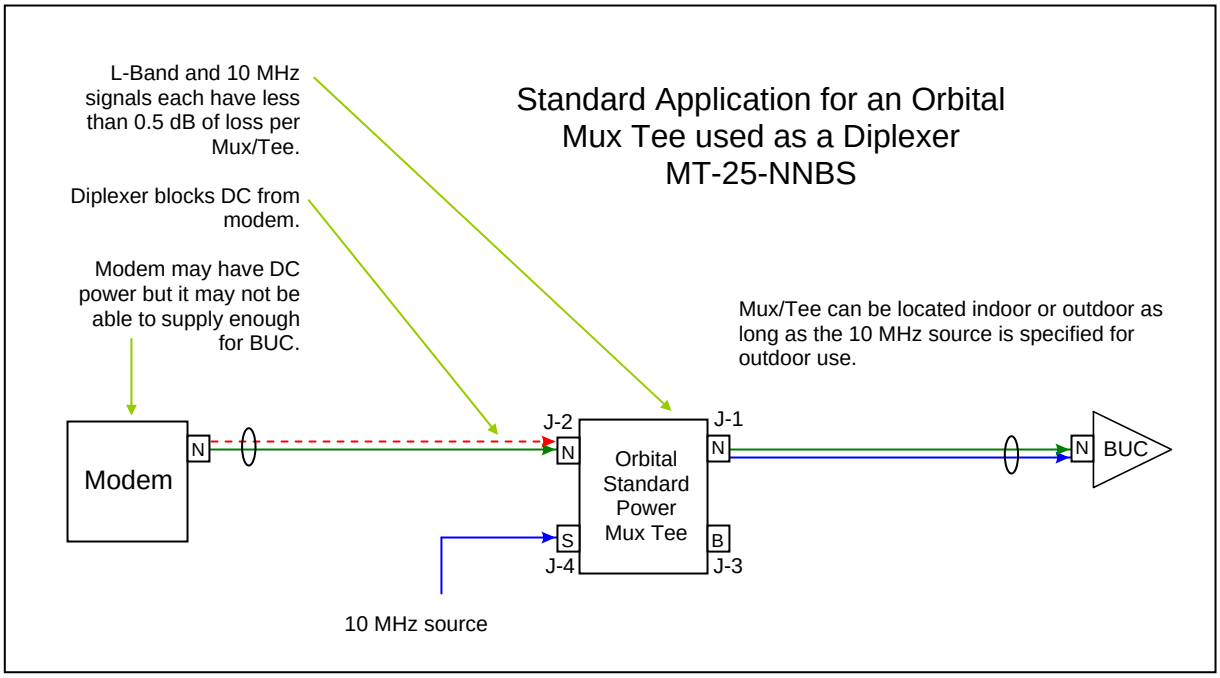

Figure 9: Diagram of Mux/Tee in a Diplexer application

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3.4 Application 4: Diagnostics - Indoors: Voltage/Current measurement

Use two Mux/Tees (one in reverse to extract the DC and 10 MHz and one to insert) to check the voltage at the modem under load. This value combined with the same voltage measurement out at the dish, will give you your cable droop measurement.

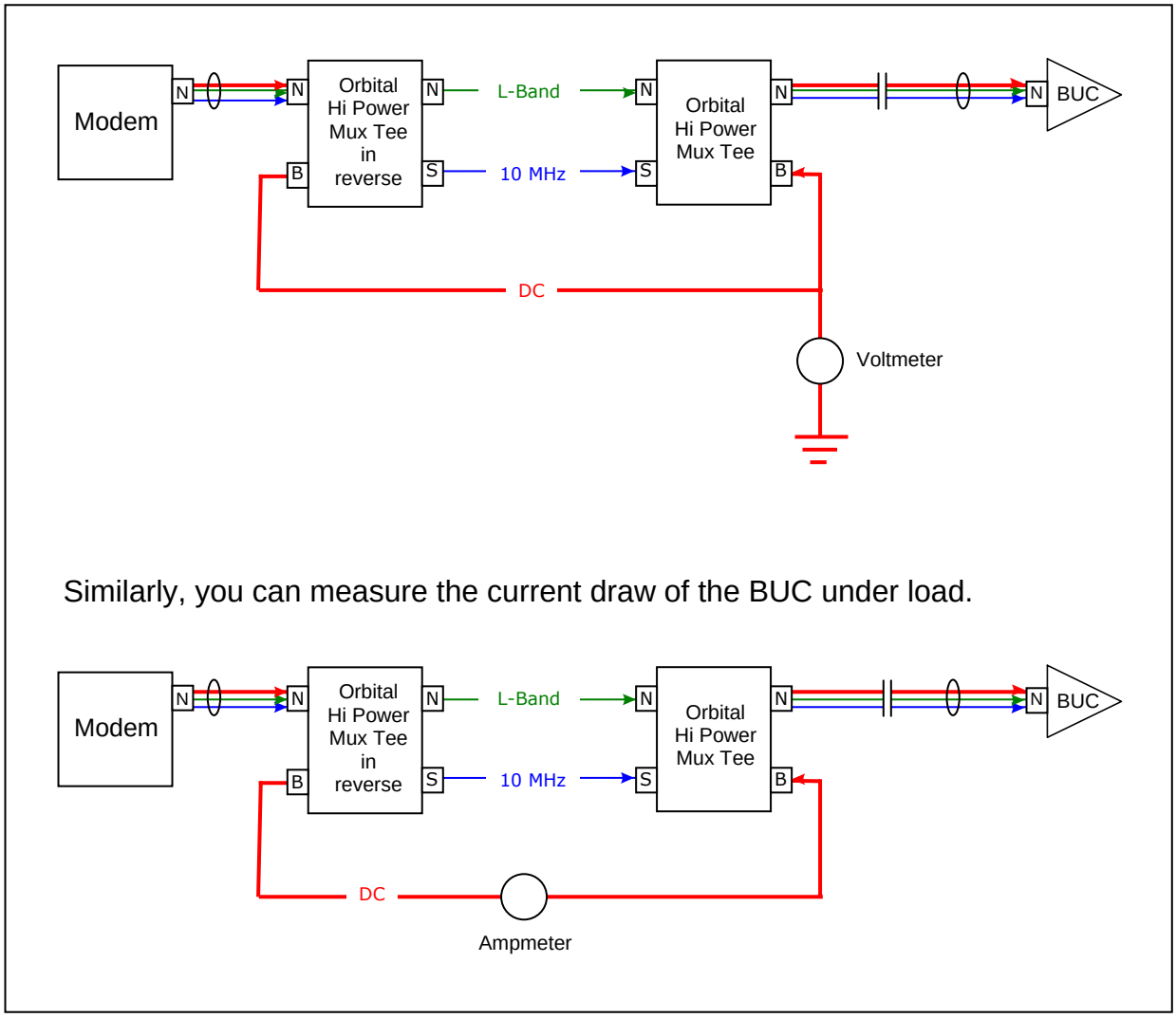

Figure 10: Measuring current and voltage indoors, at the modem.

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3.5 Application 5: Diagnostics - Indoors: Inspect signal

As a DC block, the Mux/Tee can be used in between the modem and a Spectrum Analyzer. It blocks (and extracts) the DC and 10 MHz signal, but lets the L-Band through, protecting the Spectrum Analyzer.

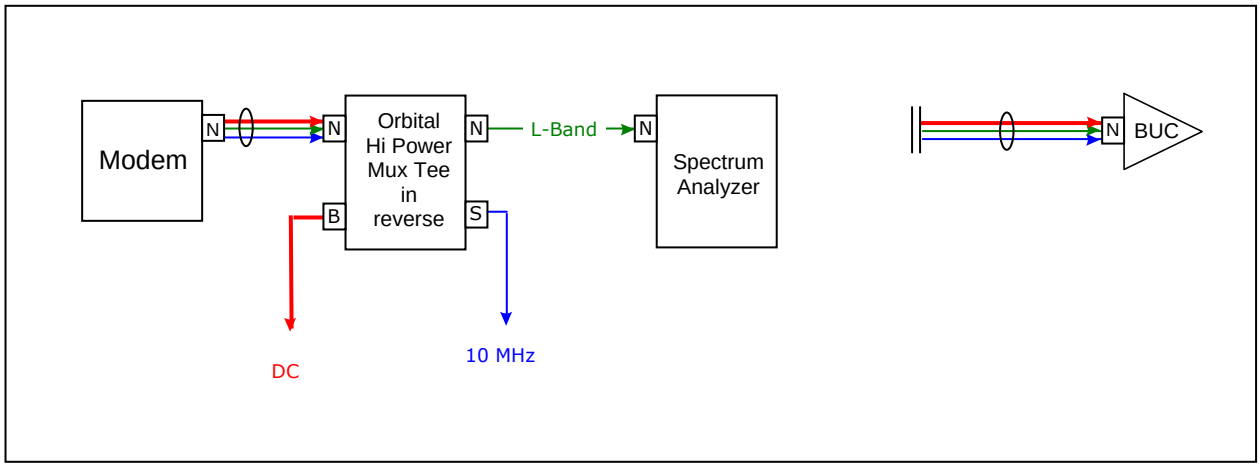

Figure 11: Testing the L-Band signal(s) indoors, at the modem.

3.6 Application 6: Diagnostics - Outdoors: Inspect 10 MHz signal to BUC

Out at the dish, the Mux/Tee can be used to block the DC and extract the 10 MHz signal. A Spectrum Analyzer can be connected to the 10 MHz output. This is a great way to test for any break in the cable shield, which can show up as interference on the 10 MHz signal.

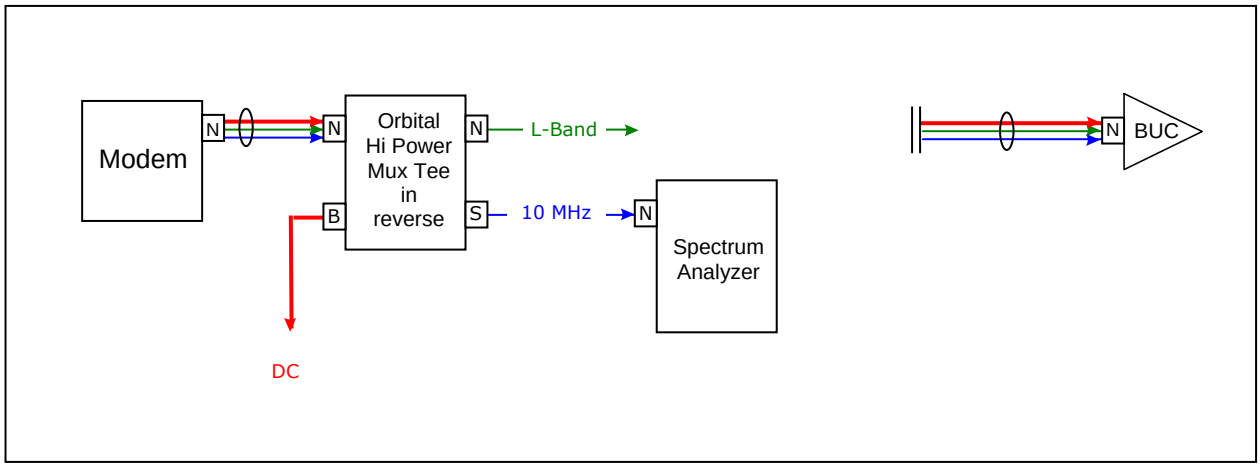

Figure 12: Testing the 10 MHz signal outdoors, at the dish.

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3.7 Application 7: Diagnostics - Outdoors: Inspect 10 MHz signal to BUC

Measure voltage out at the BUC under load to compare with the voltage measured by the modem to determine your cable droop.

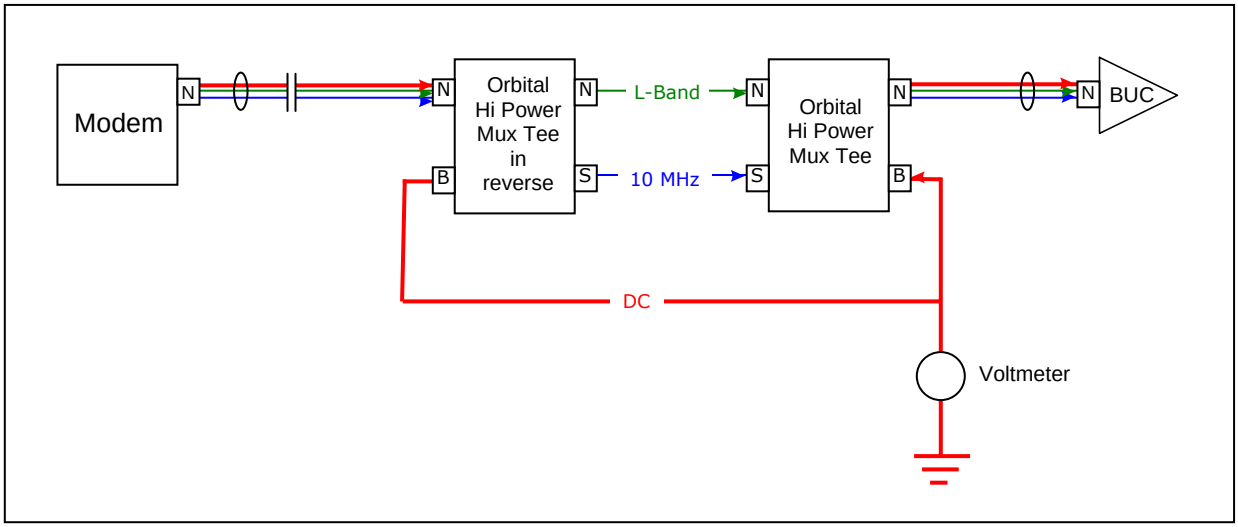

Figure 13: Measuring voltage outdoors, at the dish.

3.8 Application 8: Diagnostics - Outdoors: Inspect signal from LNB

The Mux/Tee can be used to insert DC (and 10 MHz if required) to an LNB, but blocking any DC to a Spectrum Analyzer. The Spec An can now test the signal coming directly from the LNB.

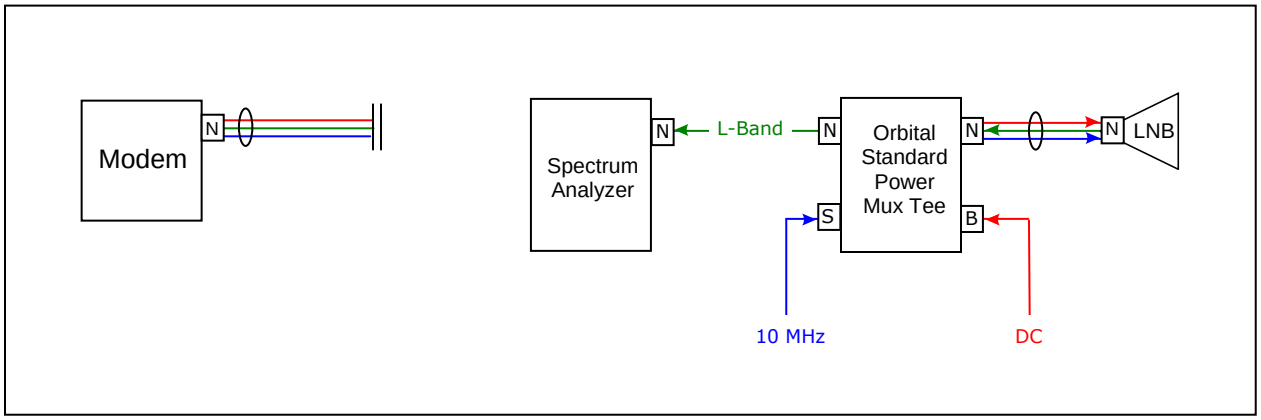

Figure 14: Testing the L-Band signal(s) outdoors, from the LNB or outdoor BDC.

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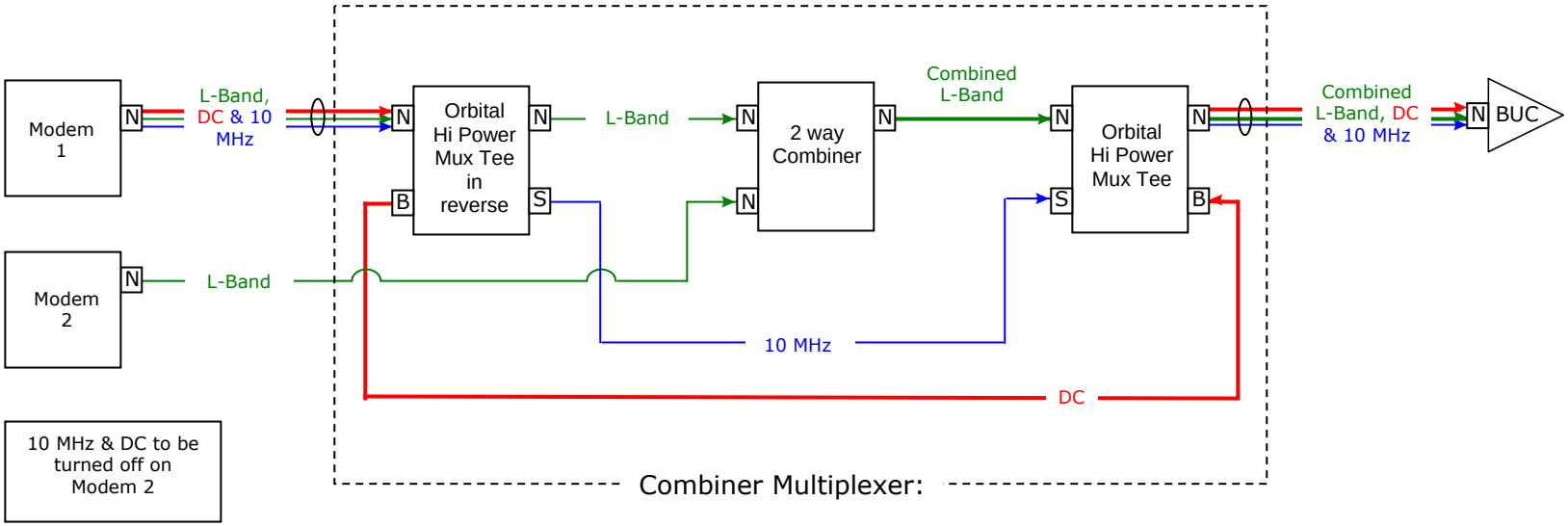
3.9 Combiner System



Model number: LB2CX-40NN, L-Band Combiner that extracts and re-inserts DC and 10 MHz from Modem 1 - in a 3-high stack.

This configuration can be supplied in a 3-high stack, on a 19" plate, in an outdoor enclosure or rackmountable chassis. Part number, pricing and lead time depend on assembly type. Check Figure 4: Samples of Mux Tee applications for type of assemblies.

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4 Mechanical

4.1 Diagram

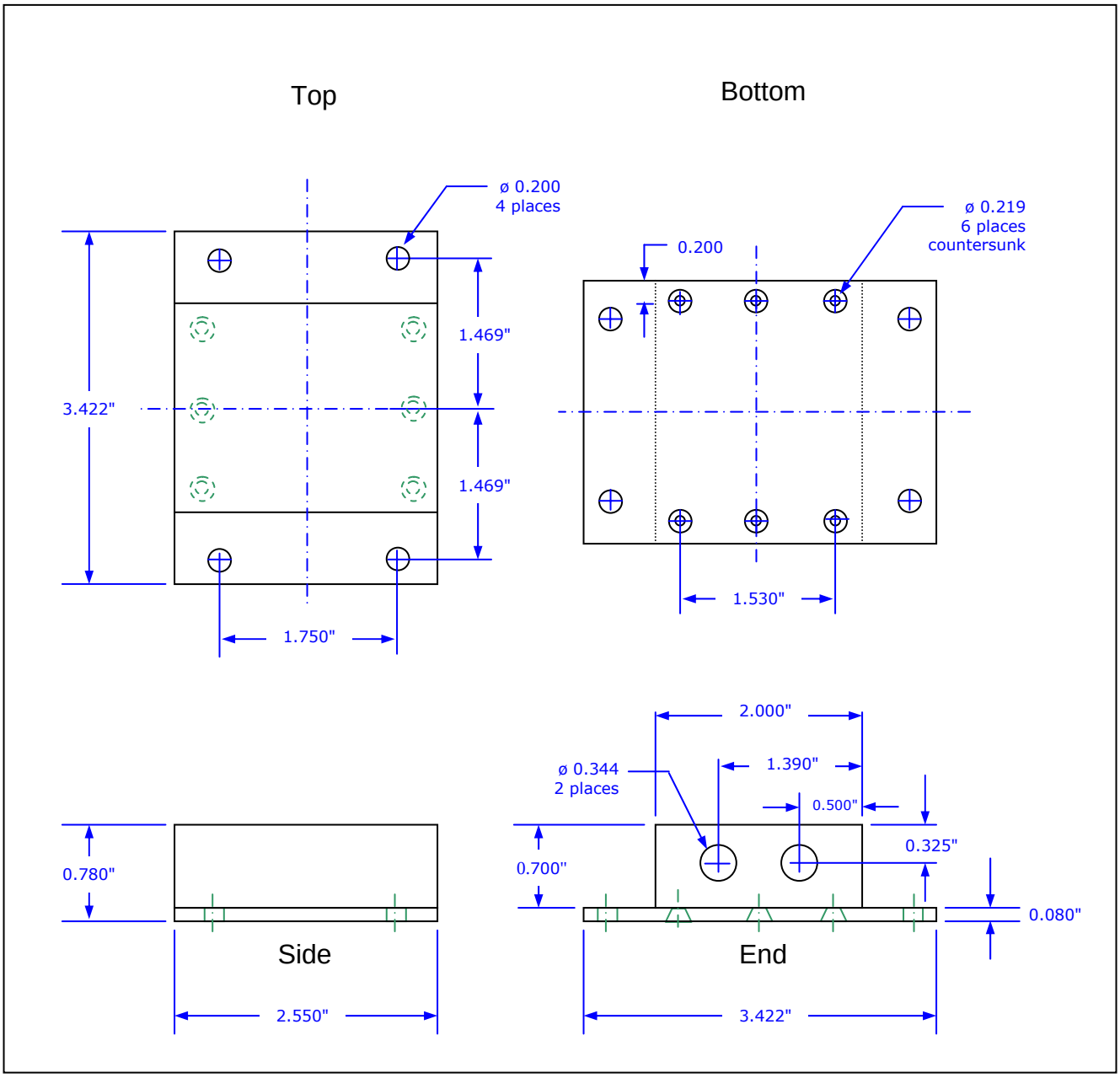

Figure 15: Mux/Tee chassis and mounting plate without connectors

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4.2 Samples of Uses

Figure 16: Samples of Mux Tee applications

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Warnings

1. Do not exceed 4 amps or 48 VDC.
2. Do not connect or disconnect equipment with power applied. Transients and surges can damage your equipment and can be hazardous.
3. Double-check J1 connector (combined signal) to make sure it is NOT connected to any DC sensitive device such as attenuators, pads, minimum loss pads, Spectrum analyzers, combiners, dividers, splitters, or fingers. Remember that the combined signal may have up to almost 200 watts of DC power.
4. We use an Allodyne finish because of its good grounding qualities, and its resistance to corrosion – it can be easily scratched, so for cosmetic reasons and to retain your corrosion resistance, careful handling is required.
5. The 10 MHz signal is extremely sensitive to any low level anomalies, therefore the best possible grounding and shielding is imperative. Poor quality cables and connectors, poorly crimped connections and bad grounds can all contribute to transient or impulse noise. In the presence of vibration, wind, temperature or moisture, poor quality cables can cause cycle slip or loss of lock in the LNB or BUC.

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5 Warranty

All products are warranteed for 2 years. Any product that becomes defective within the warranty period will be repaired or replaced. If product was damaged because of natural disaster or using the product out of specification, it can be returned for repair at the customer's expense.

To confirm that you have a defective product (if it's not obvious), look through the Orbital Research Troubleshooting guide or contact us for assistance.

To return defective or damaged product for repair or replacement, please do the following:

1) Contact Orbital Research for an RMA number
2) Give as detailed as possible, a description of the problem found and any related information.
3) Send the defective product back with the description of the problems encountered (address below).
   Product is returned at the customer's expense.
   If it is a warranty issue, Orbit Research will return the product at its expense.
4) Make sure to inform Orbital Research of the return using the Contact Information below.

Return address:

US
Orbital Research Ltd
1160 Yew Street
Blaine, WA, USA
98230

Attn: Lynn Tripp
604-317-5227
lynntripp@orbitalresearch.net
www.orbitalresearch.net

Canada and International
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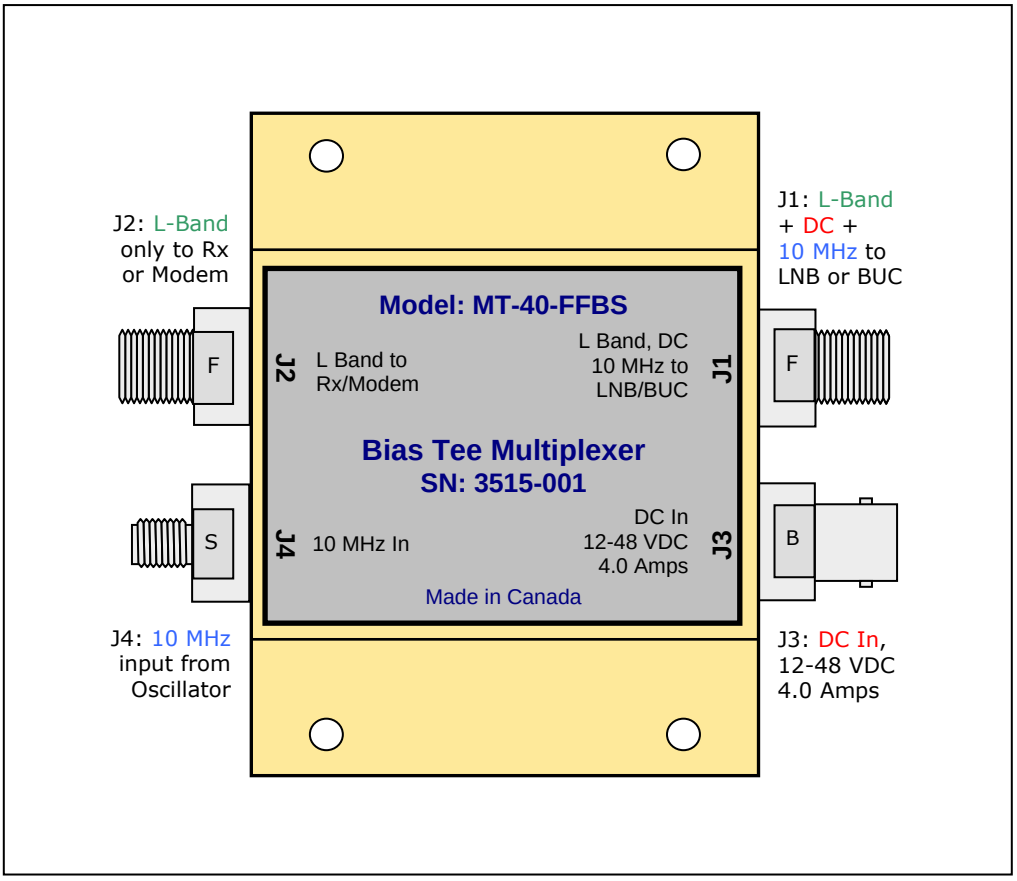

Figure 17: Diagram of Mux/Tee label

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6 Troubleshooting

1. My Mux Tee doesn't work

   Solution: If you have an extra Orbital Mux Tee, swap Mux Tees. If this solves the problem then the original Mux Tee was defective. Send back Mux Tee for repair or replacement. If this does not solve the problem, confirm that the connectors are connected to the proper connections. To confirm that the Mux Tee is labeled correctly look at the connectors on the Mux Tee from the side. J-3 is slightly offset (closer to the plate then the other connectors). The connector next to it is always J-1. If the connectors are all correct and you are still having problems, with the Mux Tee disconnected, use a multi-meter and check continuity between J-1 and J-3. If it is continuous, DC insertion should be working. If there is still a problem, contact Orbital Research for assistance.

   Just make sure that J-1 is the port going to the device being powered.

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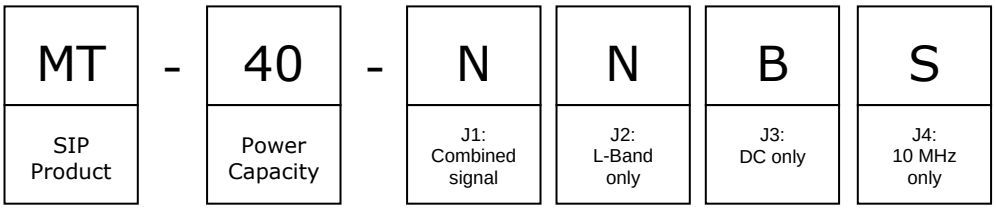
7 Model Number Description



SIP Product:

MT: Mux Tee (Bias Tee Multiplexer
TT: Thru Tee (Bias Tee Throughplexer)
RPT: Redundant Power Bias Tee

Power Capacity

25: 2.5 Amps, 12 to 24 VDC
40: 4.0 Amps, 12 to 48 VDC

J1: Combined Signals to LNB/BUC

N: N connector (f)
F: F connector (f)
S: SMA connector (f)

J2: L-Band Only Signal to Receiver/Modem

N: N connector (f)
F: F connector (f)
S: SMA connector (f)

J3: DC Only

B: BNC connector (f)
N: N connector (f)
ft: Feedthrough connector
F: F connector (f), Not available for 4.0 amp version

J3: 10 MHz Only

S: SMA connector (f)
B: BNC connector (f)
N: N connector (f)

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8 Specifications and Test Data

Electrical Specifications

L Band

Bandpass:	900 to 2100 MHz
Thru Loss:	0.5 dB maximum
Ripple:	±0.3 dB maximum
Input VSWR:	1.3 : 1 maximum
Output VSWR:	1.3 : 1 maximum

10 MHz

Thru Loss:	0.3 dB 10 MHz to combined (LNB/BUC) port maximum
Isolation:	>90 dB 10 MHz to L-Band only (Rx/Modem) port

DC

Filtering:	Hash filter, low pass filter

Environmental Specifications

Operating Temp:	-40 to +60° Celsius
Relative Humidity:	Up to 100% condensation and frost

Power Specifications

Input DC Voltage:	Passive Device. No power required
Power Capacity:	12 to 24 VDC - 2.5A, 12 to 48 VDC - 4.0A optional

Mechanical Specifications

Size:	2.55 x 3.43 x 0.875 in.
Weight:	5 oz
Paint / Colour:	Gold Allodyne finish
Mounting holes:	3/16" (4.75mm) Accepts standard rackmounting screws: 10-32 or 10-24

Switching Power Supply (optional)

Input Voltage:	90 to 240 VAC
Power Out:	Options from 12 to 48 VDC, 1700 mA to 2.08A
Output Conn:	BNC (preferred), F, or N

See PS1 or PS2 brochure for ordering information

Test Data

Test	Unit	Spec	Measured
Insertion Loss	dB	0.5 maximum	
VSWR (return loss)	dB	18 maximum	
10 MHz insertion loss	dB	0.3 maximum	
10 MHz isolation	dB	>90 10 MHz to Rx port	
VDC limit - test	VDC	24	
Current limit - test	Amps	4.0	
Band flatness (L-Band)	dB	± 0.3 maximum	
		Test Engineer	
		Test Date	

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