

Return loss comparisons

Ground based system vs. short remote radio head jumper

Rob Cameron, applications engineer
January 2014

Contents

Typical system return loss	3
Typical system reflection vs. worst system reflection	5

Typical system return loss

A system return loss test measures multiple devices at once in a wireless network.

The manner in which devices are connected impacts system return loss test results. Generally, devices that are farthest from the test point have their return loss masked by the insertion loss of intermediate devices.

Figure 1 shows a typical cell site sector for a ground-mounted base station radio that utilizes a coaxial feeder line to connect the radio to the antenna. The system return loss is a composite for the devices. The typical value for this type of configuration is presented in sheet 1.

The antenna's 14 dB return loss is masked by the insertion loss of the components located between it and the point of measurement. This insertion loss affects the measurement by twice the total additive value: once as the incident signal travels in the direction of the antenna and a second time as the reflected signal travels in the direction of the test equipment. As a result, system return loss measurements usually exceed the return loss of any single component (in this example, the typical system return loss measures 16.5 dB).

This example incorporates average return loss values; actual return loss values will be higher. Other components contribute to the system return loss value, but their return loss values are much higher than the antenna return loss values, reducing their overall contributions to the total.

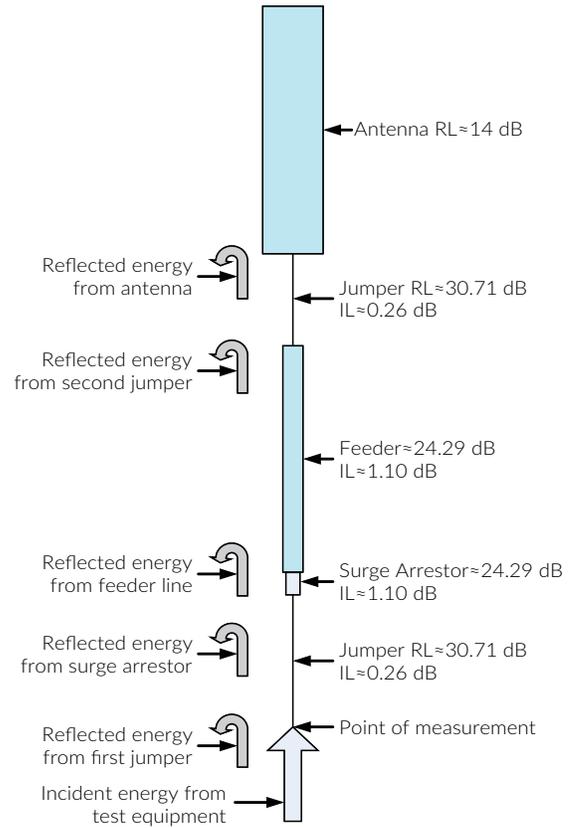


Figure 1: The diagram shows a traditional ground-mounted radio configuration

VSWR System Calculator - Global									
Frequency (MHz): 850.00		Version 8.6		COMMSCOPE®					
		25-Jan-12							
Component Used?	System Component	Max. VSWR	Return Loss (dB)	Cable Type / Component Loss (dB)	Cable Length (m)	Cable Length (ft)	Ins Loss w/2 Conn (dB)	% of Est. System Reflection	Reflections at input
Yes	Antenna or Load	1.50	13.98					76.7%	0.1308
Yes	Jumper	1.06	30.71	LDF4-50A	3.048	10.00	0.26	1.8%	0.0202
No	Tower Mounted Amp	1.29	17.95	0.50			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Top Diplexer or Bias Tee	1.13	24.29	0.20			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
Yes	Main Feed Line	1.13	24.29	AVAS-50	30.480	100.00	1.10	13.4%	0.0546
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Bias Tee	1.17	22.12	0.10			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
Yes	Surge Suppressor	1.07	29.42	0.10			0.10	4.3%	0.0310
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Bottom Diplexer or Duplexer	1.13	24.29	0.20			0.00	0.0%	0.0000
Yes	Jumper	1.06	30.71	FSJ4-50B	3.048	10.00	0.38	3.8%	0.0291
100.0%									
Legacy Jumper / TL Cables		Andrew	CommScope	Field Install VSWR	SureFlex VSWR	Typical Conn Loss (2per cable) 0.028			
1/2 inch Superflexible Copper		FSJ4-50B		1.13	1.06				
1/2 inch Foam Copper		LDF4-50A		1.13	1.06				
1/2 inch Superflexible Aluminum			SFX 500	1.10					
1/2 inch Foam Aluminum			FXL 540	1.10					
Legacy Transmission Lines		Andrew	CommScope			Typical System Reflection: 0.1493			
7/8 inch Copper		LDF5-50A		1.13		Typical System VSWR: 1.35			
1 1/4 inch Copper		LDF6-50		1.13		Typical System Return Loss (dB): 16.5			
1 5/8 inch Copper		LDF7-50A		1.13					
7/8 inch Virtual Air Copper		AVAS-50		1.13					
7/8 inch Virtual Air Copper		AVAS-50FX		1.13					
1 5/8 inch Virtual Air Copper		AVAT-50		1.13					
7/8 inch Aluminum		AL5-50	FXL 780	1.13	1.10	Worst System Reflection: 0.2656			
1 1/4 inch Aluminum			FXL 1480	1.10		Worst System VSWR: 1.72			
1 5/8 inch Aluminum		AL7-50	FXL 1873	1.13	1.10	Worst System Return Loss (dB): 11.5			
						Total Insertion Loss (dB): 1.85			
						RL to VSWR converter			
						Return Loss (dB)			
						VSWR			
						Feet			
						meters			
						17.00 1.33 3.00 0.914			

Sheet 1: This spreadsheet shows the system return loss calculation for figure 1

In figure 2, the base station radio is mounted next to the antenna and connected with a short jumper. As a result, there is little insertion loss to mask the return loss of the antenna. The system return loss measurement will essentially equal the return loss of the antenna plus some small loss associated with the jumper insertion loss. See sheet 2 for the typical system return loss (14.4 dB) for this type of configuration.

Both antennas used in these examples offer the same return loss values, yet each configuration yields a markedly different result.

System return loss limits have been set based on legacy configurations and not updated to reflect current installation trends. With the increased reliability of radio components, RRUs are being deployed at the tops of towers next to the antennas, as illustrated in figure 2. However, system return loss limits are still being enforced based upon values determined for figure 1. Without the additional insertion loss of the feeder line, the system return loss more closely reflects the antenna return loss.

Additionally, even though figure 2 represents a configuration that returns a lower system return loss measurement, its system performance is actually improved due to the removal of the feeder line loss. Without feeder loss, equivalent isotropic radiated power (EIRP) is higher in the downlink, while the noise figure is better in the uplink.

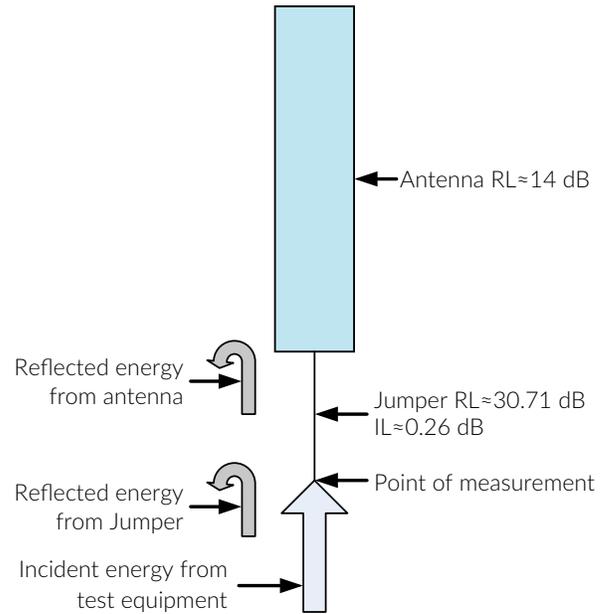


Figure 2: This diagram shows a typical tower-mounted radio (RRU) configuration

VSWR System Calculator - Global									
		Version 8.6		COMMSCOPE®					
		25-Jan-12							
		Frequency (MHz): 850.00							
Component Used?	System Component	Max. VSWR	Return Loss (dB)	Cable Type / Component Loss (dB)	Cable Length (m)	Cable Length (ft)	Ins Loss w/2 Conn (dB)	% of Est. System Reflection	Reflections at input
	Antenna or Load	1.50	13.98					97.7%	0.1884
Yes	Jumper	1.06	30.71	LDF4-50A	3.048	10.00	0.26	2.3%	0.0291
No	Tower Mounted Amp	1.29	17.95	0.50			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Top Diplexer or Bias Tee	1.13	24.29	0.20			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Main Feed Line	1.13	24.29		30.480	100.00	0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Bias Tee	1.17	22.12	0.10			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Surge Suppressor	1.07	29.42	0.10			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		0.914	3.00	0.00	0.0%	0.0000
No	Bottom Diplexer or Duplexer	1.13	24.29	0.20			0.00	0.0%	0.0000
No	Jumper	1.06	30.71		3.048	10.00	0.00	0.0%	0.0000
100.0%									
Legacy Jumper / TL Cables		Andrew	CommScope	Field Install VSWR	SureFlex VSWR		Typical Conn Loss (2per cable) 0.026		
1/2 inch Superflexible Copper		FSJ4-50B		1.13	1.06		Typical System Reflection: 0.1907		
1/2 inch Foam Copper		LDF4-50A		1.13	1.06		Typical System VSWR: 1.47		
1/2 inch Superflexible Aluminum			SFX 500	1.10			Typical System Return Loss (dB): 14.4		
1/2 inch Foam Aluminum			FXL 540	1.10			Worst System Reflection: 0.2176		
Legacy Transmission Lines		Andrew	CommScope				Worst System VSWR: 1.58		
7/8 inch Copper		LDF5-50A		1.13			Worst System Return Loss (dB): 13.2		
1 1/4 inch Copper		LDF6-50		1.13			Total insertion Loss (dB): 0.26		
1 5/8 inch Copper		LDF7-50A		1.13					
7/8 inch Virtual Air Copper		AVA5-50		1.13					
7/8 inch Virtual Air Copper		AVA5-50FX		1.13					
1 5/8 inch Virtual Air Copper		AVA7-50		1.13					
7/8 inch Aluminum		AL5-50	FXL 780	1.13 1.10					
1 1/4 inch Aluminum			FXL 1480	1.10					
1 5/8 inch Aluminum		AL7-50	FXL 1873	1.13 1.10					
		RL to VSWR converter		Feet to meters converter					
	Return Loss (dB)	VSWR	Feet	meters					
	14.00	1.50	3.00	0.914					

Sheet 2: This spreadsheet shows the system return loss calculation for figure 2

Typical system reflection vs. worst system reflection

To this point, we have addressed reflected signals in the typical fashion, when the vectors add randomly at the measurement point. However, in certain instances, the reflected signals' vectors add constructively at the measurement point. In such cases, the system return loss measurement is far worse than typical, a phenomenon unattributed to any single component. Rather, it is the measurement of the components taken in their configuration that result in this vector alignment.

Sheets 1 and 2 illustrate what this value would be for the configurations in figures 1 and 2, respectively.

One method of scrambling the vectors randomly is changing the length of the bottom jumper or feeder line by 90 degrees of phase shift. This is usually done by removing the connector, trimming the cable length, and re-installing the connector on the shortened cable.

Everyone communicates. It's the essence of the human experience. *How we communicate* is evolving. Technology is reshaping the way we live, learn and thrive. The epicenter of this transformation is the network—our passion. Our experts are rethinking the purpose, role and usage of networks to help our customers increase bandwidth, expand capacity, enhance efficiency, speed deployment and simplify migration. From remote cell sites to massive sports arenas, from busy airports to state-of-the-art data centers—we provide the essential expertise and vital infrastructure your business needs to succeed. The world's most advanced networks rely on CommScope connectivity.

COMMScope®

commscope.com

Visit our website or contact your local CommScope representative for more information.

© 2017 CommScope, Inc. All rights reserved.

All trademarks identified by ® or ™ are registered trademarks or trademarks, respectively, of CommScope, Inc. This document is for planning purposes only and is not intended to modify or supplement any specifications or warranties relating to CommScope products or services. CommScope is committed to the highest standards of business integrity and environmental sustainability, with a number of CommScope's facilities across the globe certified in accordance with international standards, including ISO 9001, TL 9000, and ISO 14001. Further information regarding CommScope's commitment can be found at www.commscope.com/About-Us/Corporate-Responsibility-and-Sustainability.

WP-107598.1-EN (05/17)