Appendix L: Antenna Power & Cable Selection

Overview

This section provides formulas and data that are necessary inputs for determining the right cable to be measured, cut, and installed. There are 3 types of cables that are part of the Base Station installation: antenna cables, calibration (cal) cable, and data/power cable.

The antenna cables are the eight cables that carry amplified RF signals. They run between the RF/PA cards and the 8 antenna elements. The calibration (cal) cable is a single RF coaxial cable that provides an RF feedback path for calibrating the system. It runs between the backplane of the digital shelf and the RFS. The data/power cable may or may not be a separate cable from the cal cable. It is possible to use different types of cable with different loss factors for the antenna cables and cal cable. The formulas presented in this section call for either an antenna cable loss or a cal cable loss. Most applications deploy the same cable type for both the antenna and cal cables.

To determine the type of cable and acceptable loss of that cable for a site, the operating transmit and receive range must be known. This is commonly referred to as the maximum transmit output power and the receiver sensitivity range. The operating transmit power and receive range should have been identified during the site survey, or they may be based on regulatory compliance.

Determining the cable type and acceptable loss for a site are typically driven by two goals: (1) Which is the least expensive cable; and (2) Which has the higher (normally) loss. Whether or not the goals are achieved is determined by the output power. For example, the maximum transmit output power for a 2.6 Base Station might be given as +30dBm, or 1 Watt, to the antenna. An example of receiver sensitivity for a 2.6 system would be given as – 80 to –90 dBm.

In addition to cable power loss, other types of loss have to be factored - for example, the calibration board. The calibration board is part of the RFS that samples the energy being transmitted from or received by the 8 antenna elements and combines that energy which is used when performing a calibration on the Base Station. This loss, plus cable loss and other types of loss in the equipment are called out in the following procedure.

Procedure

Read and follow the 7 steps/formulas below, in the order shown, to determine the resulting PA/RFS output power and desired transmit and receive calibration range for the type of Base Station you will be installing. Refer to Tables L1 and L2 to complete the steps. Table L1 provides Base Station operating parameters based on system type (2.3, 2.4, etc.), as well as other variables. Table L2 provides cable attenuation data. Before you begin, read through the steps/formulas, notes, and Table L1 in detail. Refer to the column letters at the top of Table L1 to locate the appropriate values requested in some of the formulas. Note that step/formula 1 contains a sub-procedure for determining antenna cable loss using Table L2.

Step/Formula 1 **Determine the maximum capable BTS output power to the antenna.**

= [(PA Output to Meet FCC) or (to Meet SNR)] – BTS Loss – RFS Loss – BTS Antenna Cable Loss*
[Column A or B][1] – [Column E][2] – [Column F or G] – [Calculated* or Measured]

- BTS Antenna Cable loss < 18 dB for ACTIVE RFS configurations
- BTS Antenna Cable loss < 8 dB for PASSIVE RFS configurations

Change the EMS settings accordingly.

Antenna Cable Selection

***Sub-procedure**: **Calculate BTS antenna cable loss, referring to Table 8.**

= [[Distance (length in ft) ÷ 100 ft] x Attenuation value/cable type] + 0.6 for 6 connectors/3 cables

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Step/Formula 2 **Determine the maximum BTS output power that can be calibrated.**

= Max Synth Input + Cal Cable Loss + Min Cal Board Loss[3] + Backplane Loss[4]
[Column K] + [Calculated or Measured] + [Note [3]] + [Default of 5.0 in EMS or Measured]

Step/Formula 3 **Determine the actual** max BTS output power available to the antenna.**

= The lesser of the two values of Step/Formula 1 and Step/Formula 2 (*aka*, the "floor")

** Actual is what you can calibrate the BTS at.

Step/Formula 4 **Determine the minimum BTS output power that can be calibrated .**

= Min Synth Input + Cal Cable Loss + Max Cal Board Loss[3] + Backplane Loss[4]
[Column J] + [Calculated or Measured] + [Note [3]] + [Default of 5.0 in EMS or Measured]

Step/Formula 5 **Determine the actual** maximum EIRP.**

= Step/Formula 3 + Antenna Gain. The antenna gain is affected by the type of antenna (omni, panel, 2.3, 2.4, etc.) and refers to the values in the RFS Configuration Script that accompanied the antenna from Manufacturing.

**Actual is what you can calibrate the BTS at.

Cal Cable Selection

Step/Formula 6 **Determine the minimum BTS RX input power that can be calibrated.**

= Min Synth Output - Cal Cable Loss - Min Cal Board Loss[3] - Backplane Loss[4]
[Column H] - [Calculated or Measured] - [Note [3]] - [Default of 5.0 in EMS or Measured]

Step/Formula 7 **Determine the maximum BTS RX input power that can be calibrated.**

= Max Synth Output - Cal Cable Loss -Max Cal Board Loss[3] - Backplane Loss[4]
[Column I] - [Calculated or Measured] - [Note [3]] - [Default of 5.0 in EMS or Measured]

NOTES

[1]This note pertains to Step/Formula 1: For **PA_Output_Power**, if in the U.S. use Column A. If outside the U.S., as a precaution contact Navini Technical Support (Engineering) for sign-off. The value input cannot be more than the value shown in Column B.

[2]This note pertains to Step/Formula 1: **BTS_Loss** is either (a) loss with a filter - i.e., if operating in the U.S. or other market that requires a filter, or (b) loss with a bypass cable. The first number (+1) is the correct value if a standard filter is used. The second number (0.4) is the correct value if a bypass cable is used. In Column D, for a 2.3 GHz system the values are the same for both the 8-carrier and the 10-carrier systems.

[3]Min loss in Cal Board is 27 dB. Max loss in Cal Board is 31 dB.

[4]In the EMS the backplane loss will show 5.0 as default. Actual measured loss will be indicated on the back of the chassis.

Table 7: Transmitter Operating Parameters

	A	B	C	D	E	F	G	H	I	J	K
	PA Max Output Power to Meet FCC Limits (dBm)	PA Max Output Power (dBm)	PA Min Output Power Before Damage Level or Auto Shutdown* (dBm)	Max Antenna Terminal Power to Meet FCC Limits (dBm)	BTS Loss With Standard Filter / Bypass Cable** (dB)	Active RFS Loss Type (dB)	Passive RFS Loss Type** * (dB)	Synth Min Output (dBm)	Synth Max Output (dBm)	Synth Min Input (dBm)	Synth Max Input (dBm)
2.3 (6 carrier)	+38	+40	+42	+30	1 / 0.4 Block Filter has 1.0 dB max insertion loss	3.2	1.7	-60	-32	-23	+0
2.3 (8 carrier)	+38	+40	+42	+30	1 / 0.4 Block Filter has 1.0 dB max insertion loss	3.2	1.7	-60	-32	-23	+0
2.3 (10 carrier)	+37	+40	+42	+30	1 / 0.4 Block Filter has 1.0 dB max insertion loss	3.2	1.7	-60	-32	-23	+0
2.4 (combo)	+37	+37	+42	+17.5	0.4 Bypass	3.2	1.7	-50	-20	-35	-10
2.5	+39	+41	+42	Limited by Cable Loss	1.0 / 0.4 Channel Filter has 1.0 +/- 0.2 dB insertion loss	3.2	1.7	-60	-32	-23	+0
2.6 (EFGH Split)	+39	+41	+42	Limited by Cable Loss	1.0 / 0.4 Channel Filter has 1.0 +/- 0.2 dB insertion loss	3.2	1.7	-60	-32	-23	+0
2.6 (EF Combo)	+37	+41	+42	Limited by Cable Loss	1.8 / 0.4 Channel Filter has 1.8 +/- 0.2 dB including cable to backplane	3.2	1.7	-60	-30	-20	+0

* The lowest value at which 2.3, 2.5, and 2.6 EFGH PA's will shut down automatically. There is no auto shutdown for 2.4 and 2.6 EF combo systems.
** The value at which the bypass does not meet FCC limits.
***Passive configurations of BTS affect system Noise figure. For passive systems other than 2.4, consult SYSTEMS ENGINEERING.

Table L2: Cable Attenuation in dB per 100 Feet

Cable Type	2 ¼″ LDF 12-50	1 5/8″ LDF 7-50A	**LMR 1700**	1 ¼″ LDF 6-50A	**LMR 1200**	7/8″ LDF 5-50A	**LMR 900**	5/8″ LDF 4.5-50A	½ ″ LDF 4-50A	**LMR 600**	½ ″ Super flex FSJ 4-50B	**LMR 500**	3/8″ LDF 2-50A	**LMR 400**
Frequency/Size	2.350	1.980	**1.670**	1.550	**1.200**	1.090	**0.870**	0.865	0.630	**0.590**	0.520	**0.500**	0.440	**0.405**
2000 MHz	0.994	1.11	**1.5**	1.42	**1.99**	1.82	**2.64**	2.27	3.25	**3.9**	5.09	**4.84**	5.17	**6**
2400 MHz	N/A	1.24	**1.7**	1.5	**2.2**	2.02	**2.9**	2.52	3.63	**4.3**	5.67	**5.4**	5.67	**6.6**
2500 MHz	N/A	1.27	**1.71**	1.53	**2.26**	2.07	**3**	2.58	3.70	**4.42**	5.8	**5.48**	**5.79**	**6.8**
2600 MHz	N/A	1.3	**1.8**	1.57	**2.3**	2.12	**3.1**	2.64	3.78	**4.5**	5.94	**5.6**	5.91	**6.9**
Weight lbs/ft	1.22	0.82	**0.74**	0.63	**0.45**	0.33	**0.27**	0.15	0.15	**0.13**	0.14	**0.1**	0.08	**0.07**
Bend Radius (inches)	24	20	**13.5**	15	**6.5**	10	**3**	8	5	**1.5**	3	**1.25**	3.75	**1**