Aeroflex / Weinschel Subsystems

802.11 (WiFi)
Roaming System
Test Setup

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INTELLECTUAL PROPERTY NOTICE

1 Introduction

Aeroflex / Weinschel is pleased to present this technical paper describing an 802.11 wireless LAN attenuation matrix test set used to test the connectivity between a mobile (train) running along a line of 3 base stations.

Aeroflex / Weinschel develops and manufactures high-quality, high-reliability microwave and RF components and Subsystems. Aeroflex / Weinschel has over 25 years of product development experience in satellite and communications systems, test, measurement and simulation of wireless systems, including 3G, WCDMA, PCS, and GSM; cable modem test sets and precision microwave and RF instrumentation. Aeroflex / Weinschel is well positioned to deliver designs based upon this attenuation test subsystem.

1.1 Attenuation Matrix features

1.1.1 2 GHz - 6 GHz System

- Frequency Range 2 GHz - 6 GHz
- 3 inputs
- Programmable Attenuation 0-60 dB/ 1 dB steps (Please note that the attenuators are digitally controlled analog pin attenuators. This will ensure no loss of signal during changes in attenuation value.
- 1 output with a Programmable Attenuator, 0-60 dB/ 1 dB steps
- Universal Power supply
- Operator Set-Up parameters (Speed, Distance, Frequency for loss, Antenna factors, Loop Command)
- RS-232 control or optional Ethernet 10 Base T control
- Test Data Supplied at 2.44 GHz and 5.8 GHz
- Optional Calibration Tables at 2.44 GHz and 5.8 GHz

2 Scope

2.1 Test Set-up

The Attenuation Matrix test set is used to simulate the connectivity between a mobile (train) running along a line of 3 base stations spaced from 250 to 1000 meters apart. **(See Figure 1)** The test subsystem is able to simulate the variation of the RF signal from the base stations reaching the mobile (as well as the signal from the mobile reaching the base stations) when the mobile is moving at speeds of up to 250 km/h.

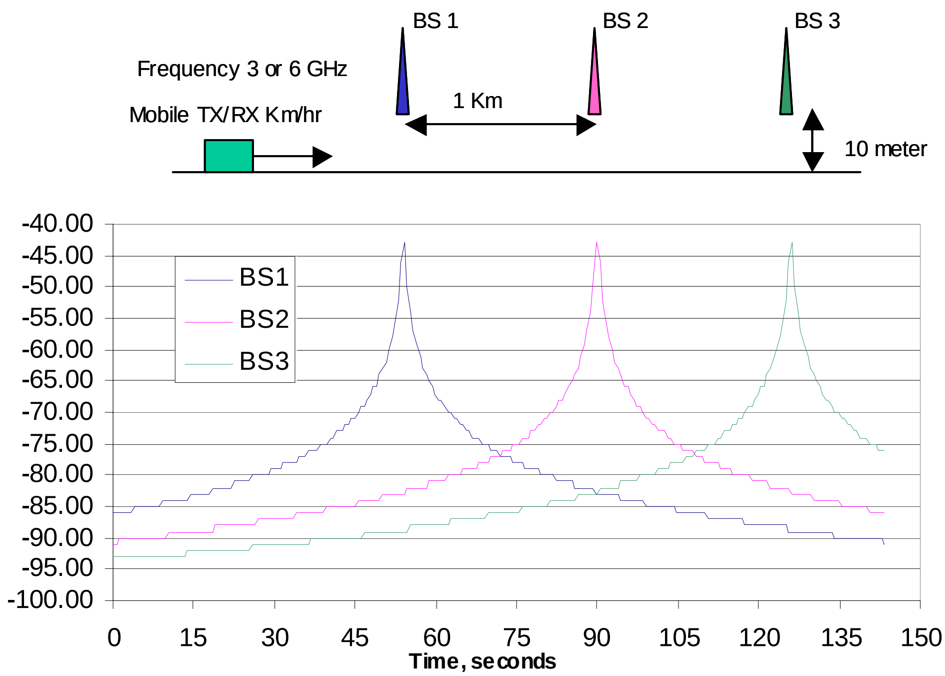

Figure 1. Calculated signal level from each Base Station. (Train moving at 100 km/hr)

The simulator will attenuate the Base Station signal through three independent attenuators**, (See Figures 1 and 2**) then combine the signals. Each attenuator will have a dynamic range of 60dB in 1 dB steps. The operation of the unit will be via a RS232 interface, ASCII commands can input parameters into the controller. Upon receiving a trigger the controller will execute the program to simulate the link loss to all three Base stations as seen from the mobile transceiver.

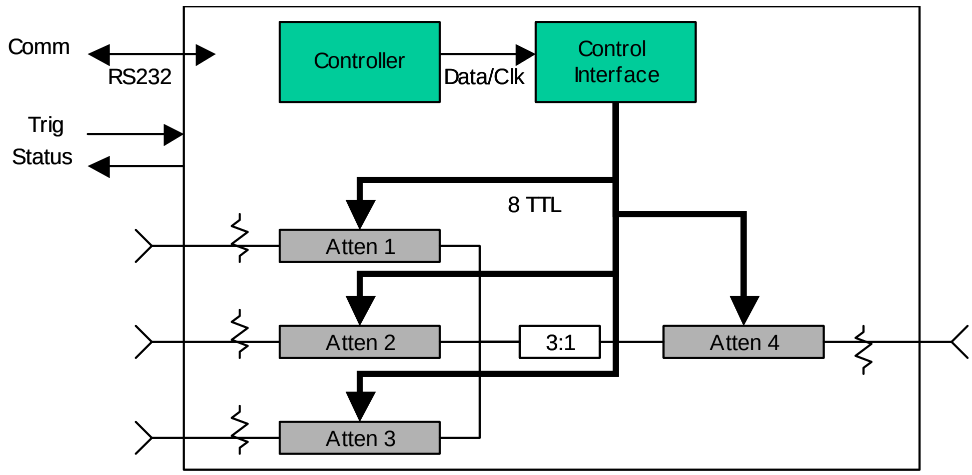

Figure 2. RF Attenuation Matrix

2.2 Quantization Error

The switching speed of the attenuators will limit the resolution of the simulator for extreme situations. The digital attenuators will also quantize the dB levels of attenuation. **Figure 3** shows the case of a mobile unit, at 250 km/hr, with the Base stations 250 meters apart and placed 10 meters from the path. The PIN attenuators will step 1dB increments and the controller will be able to switch the attenuator at a 1millisecond rate. The graph shows that for this scenario, the attenuators will need to be up dated as quick as 28 milliseconds, therefore the time resolution will not be noticeable.

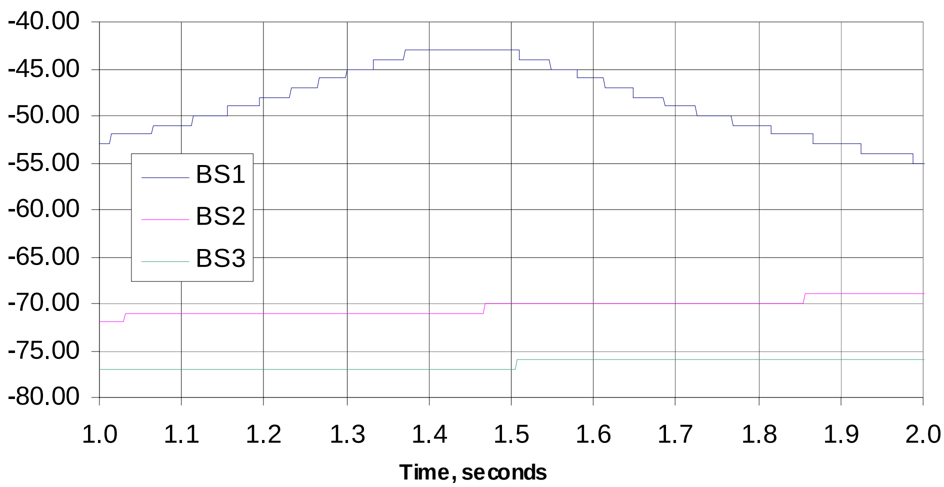

Figure 3. Speed 250 km/hr, Base Stations 250m spacing, 10 meter from track.

3 Hardware

The hardware being used for this matrix is standard production hardware from Aeroflex / Weinschel configured products.

Controller	Weinschel 193-5001
Attenuators	Weinschel pin (2-6 GHz Solid State pin)

4 General specifications

4.1 RF Specifications –Attenuation Matrix Design

Specifications:

4.1.1 2- 6 GHz System

Attenuator (Qty 4)	Pin diode design
Attenuation Range/Step Size	0-60 dB/ 1 dB step
Frequency:	2 GHz – 6 GHz
Configuration:	3 inputs, 1 output
Impedance:	50 ohm
Insertion Loss:	21 dB
RF Input Power (P1dB):	+22 dBm
RF connector:	N Female
Size:	3.5 h x 19 w x 13 d inches
VSWR:	1.75:1 Target
Control:	RS-232

4.1.2 Controller

The controller will be Weinschel P/N 8210A-1. The controller will control the four 0-60 dB programmable step attenuators in 1 dB steps.

The controller will use the operator supplied parameters (See 4.1.2.3) to pre-compute the attenuation vs time profiles for each of the attenuators, and store the results into internal data tables.

When a train run is triggered, the data from these tables will be used to update the attenuators at a programmable time period. The simulation could be re-triggered without re-computing the data table entries. This feature could be used with the loop command to simulate the train continuously running in a loop.

4.1.2.1 Software Control

HyperTerminal control is sufficient for operation of the controller, as there are a minimal number of required commands to set the operational parameters. Weinschel optionally can provide a small Visual BASIC application that allows the user to enter in the configuration parameters in a form, and send the information via RS232 to the controller. The form consists of approximately 15-16 (TBD) text boxes for entry of the configuration parameters, a RUN button to start the simulation, and a RESET button to reset the simulation to the initial conditions. This application can be made available in visual basic source code form for easy modification.

4.1.2.1.1 Trigger

The signal to begin a run can be either a hardware based trigger generated external from the controller, or via RS232 command. If it is desirable to synchronize the beginning of a train run with other external hardware/software, a hardware based trigger is recommended (electrical levels TBD, but TTL and/or RS232 voltage level compatibility would probably be desired). The controller would also output a status signal to indicate that the train is running. Once triggered, this signal would be active for the duration of the run (type TBD, possibly open-collector TTL)

4.1.2.2 Software Source Code

Weinschel will not supply the controller source code to our customers. However, the ability to load arbitrary attenuation profiles should make this unnecessary.

4.1.2.3 Operator controlled parameters

Using the RS-232 control interface the operator will have the ability to control the following parameters to set up a moving train simulation.

The Roaming System simulator operates by the customer inputting the parameters listed below. These values will generate data to control the attenuators to simulate the signaling link. Each of these parameters is interactive. The parameter ranges listed below must be evaluated interactively with all other parameters. If there are specific parameter combinations that the customer’s test situation requires, please indicate so we can optimize the firmware to accommodate.

Base Station Positions **(X meters, A station, B station, C station, + offset from the track)**

0-3000 meters for station positions and 10-100 meters for offset from the track.

Mobile Transceiver Start/Stop Position **(x , y meters)**

0-10, 000 meters.

Mobile Velocity **(Y km/hr)**

0-250 km/hr

Time Resolution

(1,10,100,1000 mS or auto to fill memory)

Frequency

2.44 GHz, 5.8 GHz

Ant Gain for Mobile and Base Station

Transmitter Antenna Gain –10 to +10 dB
Receiver Antenna Gain –10 to +10 dB

Loop Command

Used to simulate the train running in a continuos loop.

External parameter control

The parameters listed in paragraph 4.1.2.3 use a Friis Equation for calculation of link loss plus the correction factors associated with the antenna. The firmware computations are 2D and does not account for multi-bounce or environment. For more advanced link-loss profiles, the customer can externally compute the attenuation vs time profile and directly load this data via RS232 into the controller data tables for execution, effectively over-riding the built-in function. This allows arbitrary profiles to be generated.

$$LinkLoss = \left(\frac{\lambda}{4\pi R}\right)^2 + G_t + G_r$$: Friis Transmision Equation

where

$$R^2 = \left(y_{BS}^2 + x^2\right)$$

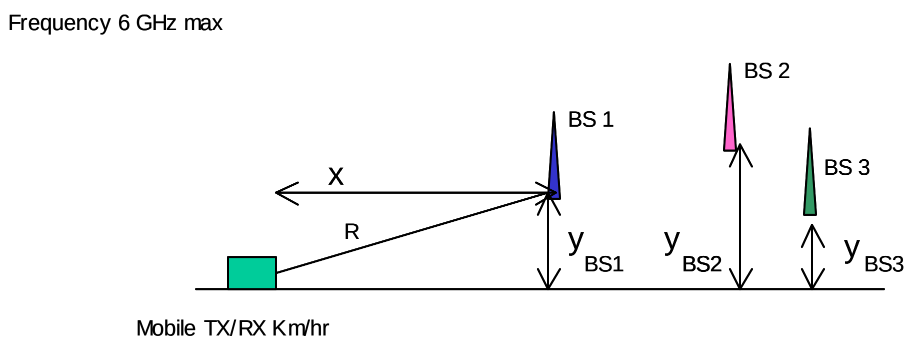

Figure 4. Geometry of the Link loss Calculation

4.1.3 Mechanical Construction

The attenuation matrix will be constructed in a 3.5 h x 19 w x 13 d (inches) chassis. There is a limited amount of unused space available in the chassis. If the customer is planning to add additional components it would be helpful to define these optional components before the design begins to allow sufficient space.

4 Quality Assurance

Aeroflex / Weinschel will implement its standard quality assurance program for development, fabrication, assembly, alignment and test of the deliverable items. This program supports compliance with the inspection requirements of ISO 9001.

5 Product Support

Aeroflex / Weinschel supplies a one-year warranty on all proprietary equipment. All fielded units that need repair can be repaired at the Aeroflex / Weinschel Frederick Maryland facility. Aeroflex / Weinschel typically supports equipment through hardware and software repair and updates for the usable life of the product. This period of time is typically in the 5 year period.