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<?php require_once "lib.php"; title("LANforge WiFi RF Attenuator User Guide");
require_once("javascript_hdr.php"); ?>
    <meta charset="UTF8" />
</head>
<body>
<?php require_once("header.php"); ?>
<?php require_once("menu.php"); ?>

<div id="contentDiv">

<h1 class="big_heading">LANforge WiFi RF Attenuator User Guide</h1>

<P>
<a href="#overview">Overview</a>
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<a name="overview"></a>
<h2 class="big_heading">Overview</h2>
<P>

The LANforge-Attenuator is designed to add RF attenuation on 2.4Ghz and 5Ghz WiFi
connections. It supports 3 attenuator modules, each capable of adding attenuation
to one connection. The attenuation range is 0 to 95.5 dB (see notes on signal strength below).
The attenuation may
be controlled by knobs on the front of the system, and may also be adjusted programmatically
over a USB-serial port. Currently, the serial-port option is only available on Linux.
Each attenuaton module may be configured independently of the others.
<P>
The LANforge software suite can also control the attenuator through its GUI
and/or CLI for integrated testing scenarios. This includes built-in scripting
to automatically adjust attenuation over time.
<P>
<center><?php printScaledImage("images/systems/atten-front.jpg", "LANforge Attenuator Front"); ?></center>
<P>

<ol class="med">
    <a name="features"></a>
    <li>
<span class="big_heading">Features</span>
<span class="default">
<P>
The LANforge-Attenuator uses the <a href="specs/Data_ATS0760-95.pdf">ATS0760-95</a>
modules from EUBUS. A summary of the technical specifications is below:
<P>
<table align="center" class="system2">
    <tr><td>Type:</td><td>ATS0760-95</td></tr>
    <tr><td>Impedance:</td><td>50 Î©</td></tr>
    <tr><td>Frequency Range:</td><td>0.7 GHz â€” 6.0 GHz</td></tr>
    <tr><td>Attenuation Range:</td><td>0 â€” 95.5dB</td></tr>
    <tr><td>Attenuation Steps:</td><td>0.5 dB increments</td></tr>
    <tr><td>Attenuation Accuracy:</td><td>1-15db: Â±1dB, 16-95.5 dB: Â±1.5dB or 4% ref. to Ins. Loss</td></tr>
    <tr><td>Insertion Loss:</td><td>8dB nominal, 10dB max</td></tr>
    <tr><td>max. VSWR:</td><td>2:1</td></tr>
    <tr><td>Maximum Input Power:</td><td>+ 20 dBm</td></tr>
    <tr><td>Operating Temperature:</td><td>0Â°C to +70Â°C</td></tr>
</table>

<P>
The LANforge-Attenuator contains 3 of these modules, for a total of 6 RP-SMA connectors on
the front panel. Each pair of connectors provides one attenuation path. A micro-controller
provides a control interface over a USB plug that appears as a USB-Serial adapter to the operating
system. The attenuator does not require an external computer to function: It can be manually adjusted
with two knobs, and has a small LCD screen to provide information to the user.
<P>
The top knob adjusts the LCD menu items. The first menu shows information. The second is to adjust
all attenuator modules in lock-step. The next three or four menus (depending on if it is a three or
four module attenuator) are for adjusting individual attenuator modules. The Debug and Test Cables
menus can be ignored as they are specifically for Candela engineers. The Color menu is for changing
the display color (using the bottom knob).
<P>
The bottom knob adjusts the attenuation when the selected menu is All or individual attenuator

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modules. Pressing the knob down activates a button that toggles between each click adjusting by 5dBm or by 0.5dBm. Enabling the x5 mode enables quick adjustments over larger ranges, and the 0.5 mode allows fine tuning. When the selected menu is Color, the bottom knob changes the display color. Pressing the knob down saves the selected color and current attenuation values as the default setting.

<P>
The system may be powered off of a 500ma USB plug, but many computers only provide 100ma USB plugs, so it is suggested that the external DC power-brick (9v 1-Amp) be used at all times.

<P>
The LANforge software can manage the attenuator over the USB-Serial interface. It can be scripted in the 2544 and Hunt scripts in the LANforgeGUI. The LANforge CLI can also control one or more attenuators. Here is a screen-shot of the Attenuator control screen in the LANforge-GUI:

<P>

<p>Users may also prefer to directly interface with the attenuator over the USB-Serial interface using minicom or some other serial-console application. The serial port will be named something like: <tt>/dev/ttyACM0</tt>, and the settings are: <tt>115200 8N1</tt>. The LANforge-Attenuator provides a text-based interface, and supports these commands:</p>

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<dl>
  <dt><b>info</b></dt>
  <dd>Display information and current settings.</dd>

  <dt><b>eeprom read</b></dt>
  <dd>Display EEPROM information and current settings.</dd>

  <dt><b>atten get [index]</b></dt>
  <dd>Display attenuator configuration for specified module.</dd>

  <dt><b>atten set [index] [dBm tenths]</b></dt>
  <dd>Set attenuator configuration for specified module. The attenuation is in tenth's of a dB, but the modules support 0.5dB steps, so you could use '55' to set 5.5dBm, but setting it to '51' would round down to 5.0dBm.</dd>

  <dt><b>atten eeprom set [key] [val]</b></dt>
  <dd>Set attenuator eeprom configuration. This should normally not be done except by Candela engineers.
  <ul>
    <li><tt>acount [attenuator-count]</tt>: Set number of attenuator modules available in attenuator.</li>
    <li><tt>test [0 | 1]</tt>: Enable (1) or Disable (0) test mode. Test mode is only useful when the attenuator connector cables have been connected to attenuator-4 and one of the other attenuator connectors on the adapter board. The test is to verify the cables and shield were manufactured properly.<P>When testing, first connect attenuator 1 header to attenuator 4, press the bottom button to start the test. Each time you click it, a different header will be tested. So, when testing attenuator 3 header, expect 1 and 2 to fail, but 3 should pass. Attenuator 4 header is tested indirectly when testing any of the others.</li>
    <li><tt>serno [serial-number]</tt>: Set the serial number.</li>
    <li><tt>color [0 - 6]</tt>: Set the display text color.
      <br>0: Red
      <br>1: Green
      <br>2: Yellow
      <br>3: Blue
      <br>4: Violet
      <br>5: Teal
      <br>6: White
    </li>
  </ul>
</dd>
</dl>
```

<p>The micro-controller in the LANforge Attenuator is configured to reset itself each time a new serial connection is made to the Attenuator. It only takes a second or two to boot, but this could cause interruption of testing if your application often opens and closes the serial connection. If you are controlling the attenuator over the serial connection, it is suggested that you program it in such a way that the serial connection remains up for the duration of the test. Please contact support if you have any questions on this.</p>

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</span>
</li>

  <a name="accuracy"></a>
<li>
  <span class="big_heading">Accuracy and RF Isolation</span>
  <span class="default">
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<p>The LANforge Attenuator has been designed with RF Isolation and accuracy in mind,

but in testing with the LANforge CT520 WiFire traffic generator systems, we still see a bit of signal leakage even when attenuation is set to 95.5. We suspect that the CT520 systems leak a bit of signal out of their NICs and communicate directly, bypassing the attenuator.</p>

<p>The internal attenuator modules are tested by their vendor and should have excellent isolation. The SMA cables connecting the attenuator to the face plate are double-shielded KSR-100 with > 90 dB isolation.</p>

<p>The LANforge attenuator comes with 6 cables to connect the attenuator to systems under test. These cables use LMR-195 cable which also has isolation of > 90 dB. If you use your own cables, be sure they are of high quality for optimal performance. Our testing indicates that even these double-shielded LMR-195 cables may be leaking more than we hoped, so we will continue to investigate different cable types.</p>

<p>Our primary test setup is one 3-antenna AP connected to another 3-antenna Station system (3x3 MIMO Atheros/Qualcom radio). The AP and Station system are about 3 feet apart, and the attenuator system sits between them. The maximum attenuation gives a signal level of about -84 dB, and noise floor of about -92. This is right at the cut-off point for the AP and Station to communicate and they may lose association from time to time. Here is a graph of signal level v/s attenuation settings for this configuration. In this case, the signal went to about -86 and then lost connection (and so reported signal as 0).</p>

<P><center><?php printScaledImage("images/systems/atten-vs-sig.png", "LANforge Attenuation v/s Signal"); ?></center></P>

The graph below shows the attenuation v/s rx-rate. The connection was lost at max attenuation and reported a zero signal. That makes the right-hand side of the graph a bit weird.

<P><center><?php printScaledImage("images/systems/atten-vs-rate.png", "LANforge Attenuation v/s Rate"); ?></center></P>

Upgrade Attenuator Firmware<p>

The LANforge-Attenuator uses an Arduino-Mega as the controller. The firmware is stored on flash in the controller and may be updated using the 'avrdude' program on a Linux machine. The firmware can be downloaded from the Downloads page. It will be named something like: <tt>attenuator-1.0.hex</tt>.

<p>To upgrade, do the following steps. Do the console commands as the root user.

<p>Stop LANforge
<pre>cd /home/lanforge; ./serverctl.bash stop</pre>Un-plug the USB cable, then the power cable, and plug power and USB back in again.

```
<pre>[root@lec2010-ath9k-1 lanforge]# <b>tail -10 /var/log/messages</b>
Oct 19 11:25:17 localhost dhclient[25360]: DHCPRELEASE on rddvR15 to 99.88.77.2 port 67
Oct 19 11:25:34 localhost kernel: [1276937.250169] usb 2-2: &gt;USB disconnect, device number 23
Oct 19 11:25:39 localhost kernel: [1276941.370134] usb 2-2: &gt;new full-speed USB device number 24 using uhci_hcd
Oct 19 11:25:39 localhost kernel: [1276941.571176] usb 2-2: &gt;New USB device found, idVendor=2341, idProduct=0042
Oct 19 11:25:39 localhost kernel: [1276941.584803] usb 2-2: &gt;New USB device strings: Mfr=1, Product=2, SerialNumber=220
Oct 19 11:25:39 localhost kernel: [1276941.599345] usb 2-2: &gt;Manufacturer: Arduino (www.arduino.cc)
Oct 19 11:25:39 localhost kernel: [1276941.608628] usb 2-2: &gt;SerialNumber: 74934303030351118071
Oct 19 11:25:39 localhost kernel: [1276941.620586] cdc_acm 2-2:1.0: &gt;ttyACM0: USB ACM device
Oct 19 11:25:39 localhost mtp-probe: checking bus 2, device 24: "/sys/devices/pci0000:00/0000:00:1d.0/usb2/2-2"
Oct 19 11:25:39 localhost mtp-probe: bus: 2, device: 24 was not an MTP device
</pre>
```

In this case, it is using <tt>/dev/ttyACM0</tt>

Upload the new image using avrdude (use the serial device that matches your system)
<pre>avrdude -patmega2560 -cstk500v2 -P/dev/ttyACM0 -b115200 -D -Uflash:w:attenuator-1.0.hex:i</pre>You may now restart LANforge, or use some other means of accessing the serial port to control the Attenuator.


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<a name="drivers"></a><h2 class="big_heading">Install Drivers (Windows Only)</h2>
<li>When using the LANforge-Attenuator on Windows, a driver must be installed
  before the attenuator can be accessed over the USB-Serial port. There is
  no need to install any drivers on Linux.</p>

<p>The Latest drivers for arduino boards exist in the Arduino IDE package available
at the <a href="https://www.arduino.cc/en/Main/Software">Arduino Software</a> page.

<em>We suggest downloading the ZIP file</em>. Expand it into your Desktop folder. Then go to
the Control Panel and use the Device Manager to update the driver.
</p>

<ol>
  <li><a href="cookbook.php?vol=misc&book=Install+Arduino+Mega+Driver+on+Windows+XP">Install Arduino Mega Driver on Windows
XP</li>
  <li><a href="cookbook.php?vol=misc&book=Install+Arduino+Mega+Driver+on+Windows">Install Arduino Mega Driver on Windows 7</a>
</li>
  <li><a href="cookbook.php?vol=misc&book=Install+Arduino+Mega+Driver+on+Windows+10">Install Arduino Mega Driver on Windows
10</a></li>
</ol>
</li>

<a name="opensource"></a><h2 class="big_heading">Open Source code and Hardware Files</h2>
<li>The LANforge Attenuator control logic is based on the
  <a href="http://www.arduino.cc/en/Main/arduinoBoardMega">Arduino Mega</a> micro controller.
  Candela Technologies releases the Arduino source code used to program the Arduino Mega
  as well as the Eagle PCB layout and routing files. The source code is released under
  the GPL (GNU Public License), and the Eagle hardware files are released under the
  Creative Commons Attribution-ShareAlike license. You may download the code and Eagle
  files on the <a href="downloads.php">Downloads</a> page after creating an account on
  our web site.
</li>
</ol>

<?php require_once("footer.php"); ?>
</div>
</body>
</html>
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