Vaunix Technology Corporation

Lab Brick® Family of Digital Attenuators

Operation Manual
and
Programming Guide

Revision A

Certification

Vaunix Technology Corporation certifies that this product met its published specifications at the time of shipment from the factory.

Warranty

Lab Brick Signal Generators are warranted against defects in material and workmanship for a period of one year from the date of shipment.

LIMITATION OF WARRANTY

The foregoing warranty does not apply to connectors that have failed due to normal wear. Also, the warranty does not apply to defects resulting from improper or inadequate maintenance by the Buyer, unauthorized modification or misuse, or operation outside of the environmental specifications of the product. No other warranty is expressed or implied, and the remedies provided herein are the Buyer's sole and exclusive remedies. Vaunix Technology Corporation shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

NOTICE

This ISM apparatus meets all requirements of the Canadian Interference-Causing Equipment regulations.

Ce generateur de fequence radio ISM respecte toutes les exigences du Reglement sur le materiel brouilleur du Canada.

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This instruction complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical/ electronic product in domestic household waste.

To return an unwanted instrument, contact Vaunix Technology Corporation.

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Table of Contents

1.0 GENERAL INFORMATION

This guide contains information on the installation , operation and specifications of the Lab Brick® Family of Digital Attenuators.

1.1 General Safety Information

To prevent the risk of personal injury and loss related to equipment malfunction, Vaunix Technology Corporation provides the following safety information. For you own safety please read this section before operating the equipment.

Warning

Before connecting your Lab Brick Digital Attenuator to other instruments ensure that all instruments are connected to earth ground. Any interruption of the earth grounding may cause a potential shock hazard.

Caution

- The Lab Brick Digital Attenuator contains components which are sensitive to Electro Static Discharge (ESD). Proper ESD precautions must be maintained at all times while using this equipment.
- This equipment has no serviceable parts.
- To prevent the risk of electrical shock or damage to precision components, ***do not*** remove the equipment covers.
- Unauthorized entry into the unit voids all warranties.

2.0 GETTING STARTED

Prior to installing your Lab Brick Digital Attenuator, verify the contents of the package. The package should contain:

Quantity 1 Lab Brick Digital Attenuator

Quantity 1 Cable - USB Type A male/ Mini-B male

Quantity 1 Flash Drive containing the manual and the Graphical User Interface program

2.1 System Requirements

The Lab Brick Digital Attenuator runs from a standard PC or lap top computer with the following minimum requirements:

- Operating System - Windows® 2000, Windows® XP or Windows® Vista
- RAM - 256 MB
- Processor Speed - 512 MHz
- A minimum of one USB port

No other AC or DC supply is required as the power for this unit is delivered from a USB port on the computer or a self powered USB hub.

2.2 Installation of the Graphical User Interface (GUI)

The Lab Brick is controlled through the GUI program supplied on the provided USB flash drive. To install the GUI proceed with the following steps:

- Insert the supplied USB flash drive into an available USB port on the computer
- Run the program “Setup.exe”
- Follow the instructions on the screen
- After Installation is complete, remove the USB flash drive

2.3 Using the Lab Brick Digital Attenuator

Start the Lab Brick program by selecting the Lab Brick Icon or selecting the Lab Brick program from the Start Menu on the computer. Attach the supplied USB cable to the Lab Brick Digital Attenuator and the USB port on the computer. The green LED on the Lab Brick will illuminate as communication with the computer is automatically established. The GUI program will recognize the device and display the model number and serial number in the title bar and lower left corners respectively. The Lab Brick is now ready for operation.

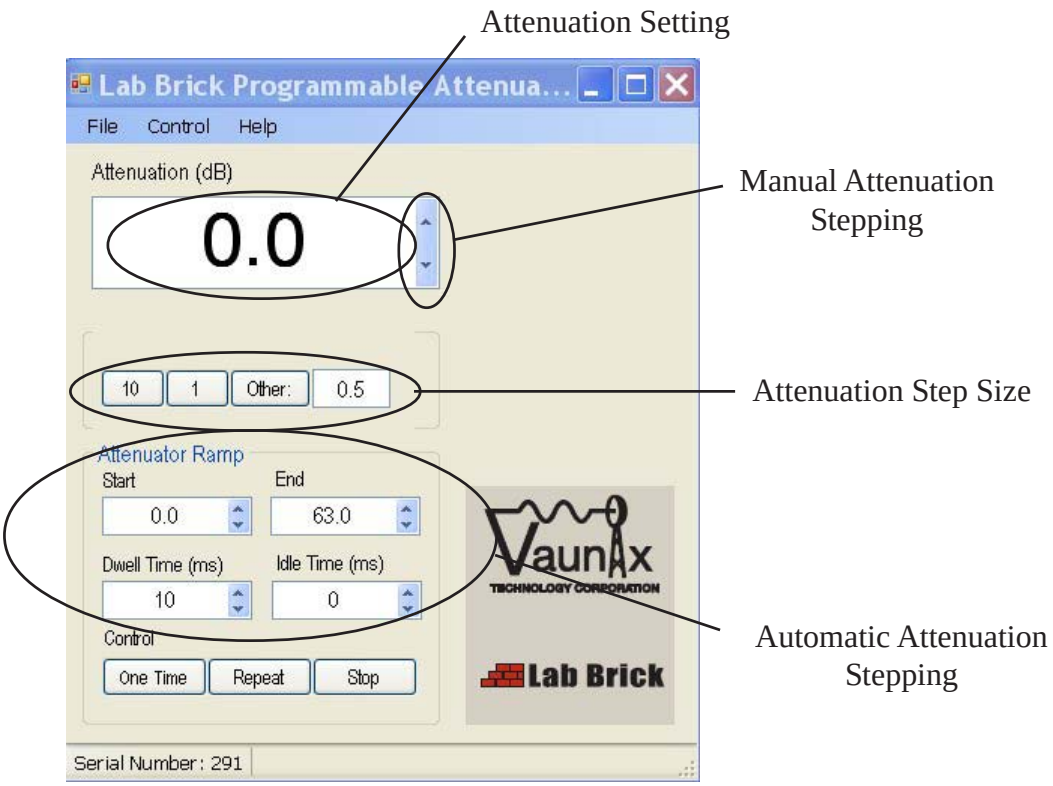
2.4 Using Multiple Lab Brick Digital Attenuators

Users may operate and control multiple Lab Bricks from a single computer. Start the Lab Brick GUI as described in section 2.3 for each Lab Brick Digital Attenuator that you will control from the computer. Connect each Lab Brick either directly to the USB port or through a self powered USB hub to the USB port of the computer. The green LED on each Lab Brick will illuminate as communication with the computer is automatically established. Each GUI application will automatically connect to one Lab Brick. The GUI will display the model number and serial number of the connected device in the title bar and lower left corners respectively.

3.0 OPERATING FEATURES AND CONTROLS

The general operation of the Lab Brick Digital Attenuator is designed by the Vaunix engineers to be intuitive and easy to use. This section describes the available features of the Lab Brick Digital Attenuator.

3.1 Attenuation



3.1.1 Manual Attenuation

The output power is set using the Attenuation field found on the top of the GUI. Simply type the desired attenuation level into the window and hit the “Enter” key on your computer keyboard. The attenuation level will immediately be set.

3.1.2 Configuring the Manual Attenuation Step Size

The attenuation may also be controlled by using the up and down arrows adjacent to the Power field. Use the controls directly below the Attenuation field to set the desired step size. Quick select buttons are available for fixed step sizes of 10 dB and 1 dB. Custom step sizes may also be used by selecting “Other” and entering the desired step size between 0.5 dB and 63 dB in 0.5 dB increments.

3.1.3 Configuring the Automated Attenuation Step Function

The Lab Brick can be configured to automatically step through a range of attenuation. The user must specify the starting attenuation level, final attenuation level, step size, dwell time and time between repeating sweeps. The starting and ending attenuation levels can be configured between 0 dB of attenuation and 63 dB of attenuation. The dwell time may be configured from 10 milliseconds to 20000 milliseconds per step. The step size is configured as described in section 3.1.2. The attenuation level may increase of decrease during the sweep depending if the starting attenuation is higher or lower than the ending attenuation setting.

By selecting the “One Time” control button, the Lab Brick attenuatorwill sweep from the start to the end attenuation level. Upon completing the sweep, the Lab Brick output will stay at the end attenuation setting. The user may stop the sweep at any time by selecting the “Stop” button.

By selecting the “Repeat” control button, the Lab Brick will repeatedly sweep from the start to the end attenuation level. The user may stop the sweep at any time by selecting the “Stop” button.

3.3 Setting the Initial Operating State

After configuring the attenuation parameters, the user may select to save the current settings. From the File menu select Save Current Settings.

These settings will be stored within the Lab Brick device. The Lab Brick will now power on in this predefined state when plugged into a USB port on any computer or USB self powered hub. The user may change the saved state at any time by repeating the process.

4.0 SPECIFICATIONS

Electrical	**LDA-102**	**LDA-602**
Operating Frequency	0.1 to 1000 MHz	6 to 6000 MHz
Insertion Loss	0.1 to 100 MHz : 6 dB max. 100 to 1000 MHz: 7 dB max.	6 to 1000 MHz: 7 dB max. 1000 to 2000 MHz: 8 dB max. 2000 to 4000 MHz: 9 dB max. 4000 to 6000 MHz: 10 dB max.
Attenuation Range	0 to 63 dB	0 to 63 dB
Attenuation Step Size	Programmable: 0.5 dB min. 63 dB max.	Programmable: 0.5 dB min. 63 dB max.
Programmable Step Size Resolution	0.5 dB	0.5 dB
Attenuation Accuracy[2]	± 0.3 + 5% of Atten. Setting, dB max.	± 0.3 + 5% of Atten. Setting, dB max.
Input / Output VSWR	0 dB Atten. Setting: 2.0:1 max. 0.5 dB Atten. Setting: 1.7:1 max. All Other Settings: 1.5:1 max.	0 dB Atten. Setting: 2.0:1 max. 0.5 dB Atten. Setting: 1.8:1 max. All Other Settings: 1.5:1 max.
Input Power for 0.1 dB Compression	+22 dBm typ.	+22 dBm typ.
Input 3rd Order Intercept Point	0 dB Atten. Setting: +46 dBm typ. All Other Settings: +32 dBm typ.	0 dB Atten. Setting: +46 dBm typ. All Other Settings: +32 dBm typ.
Operating Modes	Fixed Attenuation Automatic Stepping	Fixed Attenuation Automatic Stepping
DC Power	via USB	via USB
GUI Compatibility[3]	Windows™2000/XP/Vista	Windows™2000/XP/Vista
Mechanical		
Length	3.86" (98mm)	3.86" (98mm)
Width	2.52" (64mm)	2.52" (64mm)
Height	1.35" (34mm)	1.35" (34mm)
Weight	< 0.5 lbs (0.23 Kg)	< 0.5 lbs (0.23 Kg)
RF Connectors	SMA-F	SMA-F
USB Cable[4]	USB 2.0 A to Mini B	USB 2.0 A to Mini B

Notes

1. These specifications are subject to change without notice.
2. Customized models are available tailored to specific performance requirements.
3. The GUI software is included with the purchase of each Lab Brick Digital Attenuator.
4. A 6’ USB cable is included with the purchase of each Lab Brick Digital Attenuator.

5.0 OPTIONAL ACCESSORIES

Vaunix offers the following optional accessories for the Lab Brick Digital Attenuator family. Please consult your sales representative or visit LabBrick.com for up to date pricing and availability.

4 Port USB Hub with external power adapter

USB Hub with LAN interface

USB cable TypeA male/Mini-B male - 3 feet

USB cable TypeA male/Mini-B male - 6 feet

USB cable TypeA male/Mini-B male - 9 feet

USB cable TypeA male/Mini-B male - 15 feet

6.0 PROGRAMMING GUIDE

The Lab Brick Digital Attenuators are designed to be easily controlled from either their included control software or from applications programs that directly access the digital attenuators. The Lab Bricks use the USB HID class so that applications software can send commands and receive responses and status messages without the need to install any drivers or other special software components.

As with any USB HID device, there are two phases to working with the Lab Bricks. The first phase is the process of identifying the device you want to work with, and then opening the device to send and receive commands and status messages from it. The second phase is communicating with the device, using its commands to control it and reading its responses and status messages to determine the state of the Lab Brick.

This documentation includes examples from the Microsoft Windows™ environment. Similar strategies are used to communicate with USB HID devices under other operating systems, and this documentation will provide you with a general understanding of how to control the Lab Bricks under any operating system which supports USB HID class devices.

6.1 Identifying the Lab Brick Digital Attenuators

The Lab Brick Digital Attenuators are identified by their Vendor ID (“VID”) and Product ID (“PID”). Each Lab Brick also has a unique serial number, so that individual digital attenuators can be identified and selected in situations where multiple, otherwise identical Lab Bricks are connected to one computer.

Model Name	Description	VID	PID
LDA-102	.1 MHz – 1 GHz	0x041F	0x1207
LDA-602	6 MHz – 6 GHz	0x041F	0x1208

Normally, in the Microsoft Windows environment, USB devices are identified by repeatedly calling the SetupDiEnumDeviceInterfaces function and then getting the symbolic link name for the HID device’s interface with the SetupDiGetDeviceInterfaceDetail function. There are a number of publications that explain this technique, Writing Windows WDM Device Drivers by Chris Cant is a good starting point. Also, the Wiimote library by Brian Peek, (http://

www.codeplex.com/WiimoteLib) is a good example of code for identifying and communicating with a USB HID device in a Microsoft Windows environment.

Use the SetupDiGetDeviceInterfaceDetail function to get the symbolic link name for the interface, which the operating system uses to encode its enumeration information describing the device. The string contains the VID and PID of the device found by the operating system. Test each string to find the one (or more if you have multiple Lab Bricks attached) that contains the VID and PID values in it. For the Microsoft Windows environment, the portion of the device strings containing the VID and PID are in the format:

```
sDevSubstring1 = “vid_041f&pid_1207”;        // VID and PID for LDA-102
sDevSubstring2 = “vid_041f&pid_1208”;        // VID and PID for LDA-602
```

Once you have identified a Lab Brick, open it by using the DevicePath from the Interface Device Detail Data structure, using the normal CreateFile function. Once you have opened the device[1] you can read the Lab Brick’s serial number using the HidD_GetSerialNumberString function.

```
WCHAR *pBuffer = new WCHAR [32]; // this buffer must be large enough to hold
                                 // any serial number
HidD_GetSerialNumberString(hDevice, pBuffer, 32);
```

If you are using multiple Lab Bricks you will need to identify the Lab Bricks, open them all, and then use the serial numbers returned by each of the devices to map the device handles to the specific Lab Bricks.

6.2 Controlling the Lab Brick Digital Attenuators

6.2.1 Commands

The Lab Brick Digital Attenuators use a simplified HID based set of commands. The commands, and the responses from the Lab Brick, are designed so that they can be easily created or parsed directly by your applications software. It is not necessary to use the normal HID API parsing functions.

Each Lab Brick command consists of an eight byte packet with the following format:

```
typedef struct
{
  BYTE command;
  BYTE count;
  BYTE byteblock[6];
} HID_REPORT_OUT;
```

(Note that in the Microsoft Windows environment, the HID driver stack requires a pre-pended 0 byte on packets written, and pre-pends a 0 byte to packets received, so your applications software needs to use a structure which has an additional BYTE before the command, and is therefore 9 bytes long.)

The command byte determines the meaning of the bytes within the byteblock. The count byte contains a count of the number of valid bytes in the byteblock. The values and the meaning of the bytes in the byteblock are set forth in the table below. For most commands the byteblock contains a 32bit DWORD quantity, several instances use a single byte quantity.

The most significant bit of the command byte determines whether the command gets or sets the parameter. To set the parameter, set the most significant bit. For example, to set the Lab Brick LDA-102 to an attenuation of 10 dB you would send the following command:

Command Byte	Count	Byteblock Contents
0x8D	4	0x28, 00, 00, 00, 00, 00

The command to get the current attenuation setting is:

Command Byte	Count	Byteblock Contents
0x0D	0	xx, xx, xx, xx, xx, xx

The Lab Brick responds with a report that contains the command byte in its status field, along with a count of 1 byte and a byte representing the current attenuation setting in the byteblock of the response. Attenuation is represented as a byte quantity where the least significant bit is 0.25 dB of attenuatin. The attenuator operates in steps of 0.5 dB, so the least significant bit is ignored. As an example, an attenuation of 0.5 dB is represented by 0x02, 63 dB is represented by 0xFC, and 0x00 represents 0 dB of attenuation.

Note that the attenuation value is passed in a DWORD quantity for the commantds that define the start, step, and stop attenuation levels for attenuation ramps. This is to simplify the development of software which controls ramps and/or sweeps, since frequency sweeps require DWORD quantities to represent the frequencies.

The format of certain responses will be described in more detail in the next section.

[1] Actually, due to the architecture of USB HID devices, Interfaces on the device are opened and closed. A single HID device can have multiple Interfaces, and it is the Interfaces that are exposed by the HID Class driver for user level processes to interact with.

Command Set

Command	Command Byte	Count	Byteblock Contents
Set/Get Attenuation	0x8D/0x0D	1	Byte = attenuation in .25db steps. 00 is maximum power, 02 is .5db less than full power. Note that the resolution of the power output setting is only .5db, the least significant bit of the value is ignored
Set/Get Attenuator Ramp Dwell Time	0xB3/0x33	4	DWORD = Time to dwell at each attenuation level during a ramp in 1 millisecond intervals.
Set/Get Ramp Start Attenuation Level	0xB0/0x30	4	DWORD = Start level of the ramp in .25 db units
Set/Get Ramp Stop Attenuation Level	0xB1/0x31	4	DWORD = End level of the ramp in .25 db units
Set/Get Ramp Step Size	0xB2/0x32	4	DWORD = Ramp step size in .25 db units.
Start/Stop Ramp	0x89/0x09	1	Byte = 01 for a single ramp, 00 to stop a ramp, and 02 for continuous ramps.
Set/Get Ramp Wait Time	0xB6/0x36	1	DWORD = Time to wait before starting a new ramp in 1 millisecond intervals, when continuous ramps are in operation.
Restore Defaults	0x8F	1	Resets all of the parameters to their factory default settings.
Get Maximum Attenuation	0x35	0	This is a read only value, only the "Get" command is supported. Minimum attenuation is always 0 db.
Save User Parameters	0x8C	3	The first three bytes of the byteblock must be set to 0x42, 0x55, 0x31 as a key to enable the save operation. Save User Parameters records the attenuation and ramp settings into non-volatile memory in the Lab Brick. The Lab Brick will reload these parameters when it is powered on.

As an example, this C code function sets the starting attenuation level of a ramp to 32 dB

```
static long AtnStart = 4 * 32;       // the attenuation ramp starts at 32 db

void SetRampStart(HANDLE hDevice)
{
        unsigned char *ptr = (unsigned char *) &AtnStart;
        if (SendReport(hDevice, VNX_ASTART | VNX_SET, ptr, 4)){
                printf(" sending the ramp start attenuation value\n");
        }

}

SetRampStart(hDevice);
```

Applications programs should ensure that commands are sent with a minimum delay of 30ms between commands, in order that the Lab Brick can generate and send its responses.

6.2.2 Responses

The Lab Brick Digital Attenuators send status reports to the host computer periodically while they are operating, and in response to some commands. Applications programs should normally set up and maintain a read thread to capture responses and status reports from the device. The status reports are designed to be easily parsed directly by the applications program.

Each Lab Brick response consists of an eight byte packet with the following format:

```
typedef struct
{
  BYTE status;
  BYTE count;
  BYTE byteblock[6];
} HID_REPORT1;
```

The status byte contains a value indicating the type of status report, like the commands the contents of the byteblock varies depending on the value in the status byte. For command responses, the value of the status byte is equal to the command. So for example, the response to the Get Attenuation command shown above would have a status byte of 0x04, a count of 1 corresponding to the 1 byte used by the attenuation value in the byteblock, and a value of 0x37DC, or .5 db.

Status Byte	Count	Byteblock
0x04	1	0x02, 00, 00, 00, 00, 00

The Lab Bricks report their status periodically, at an interval equal to the dwell time set for attenuation ramps, whether or not a ramp is active. During a ramp, the status report occurs when the attenuation level changes[2]. This allows an applications program to track the attenuation level of the Lab Brick during the ramp. This allows an applications program to track the attenuation level of the Lab Brick during the ramp. The format for the periodic status report is:

```
typedef struct
{
  BYTE pkt_status;          // = 0x0E
  BYTE count;               // = 6
  DWORD frequency;
  BYTE dev_status;
  signed char power;
} VNX_STATUS_REPORT;
```

Status Byte	Count	Byteblock
0x0E	6	reserved, dev_status, power

The dev_status byte contains a set of flags which describe the current state of the

Lab Brick:

```
#define STATUS_PLL_LOCK 0x80        // MASK: PLL lock status bit, unused by
#define STATUS_NEW_PARAM 0x40       // MASK: A parameter was set since the last
                                    // “Save Settings” command
#define STATUS_OK 0x20              // MASK: A command completed
#define STATUS_ON 0x08              // MASK: The RF HW is on

// Bit masks and equates for the Ramp command byte (stored in Ramp_mode, and
reported also in Status)
#define SWP_DIRECTION       0x04    // MASK: bit = 0 for sweep up, 1 for
sweep down
#define SWP_CONTINUOUS 0x02         // MASK: bit = 1 for continuous
sweeping
#define SWP_ONCE 0x01               // MASK: bit = 1 for single sweep
```

Power is the current value of the attenuation level as set by the Power Level command.

Since Lab Brick status reports occur asynchronously with respect to command responses, the applications code handling reports from the Lab Brick should be able to accept either a command response report or a status report.

Command Response Report Formats

Command Response	Status Byte	Count	Byteblock Contents
Attenuation Level	0x04	4	DWORD = Frequency in 100KHz units
Dwell Time	0x33	4	DWORD = Time to dwell at each attenuation level during a ramp in 1 millisecond intervals.
Ramp Start Attenuation Level	0x30	4	DWORD = Lower level of the ramp in .25 db units
Ramp Stop Attenuation Level	0x31	4	DWORD = Upper limit of the ramp in .25 db units
Ramp Attenuation Step Size	0x32	4	DWORD = Attenuation step size in .25 db units.
Ramp Wait Time	0x36	4	DWORD = Time to wait at the end of each attenuation ramp before beginning another attenuation ramp when the ramp is in continuous operation mode. The time is in 1 millisecond intervals.
Ramp Mode	0x09	1	Byte = 01 for a single ramp, and 02 for continuous ramps
Attenuation Level	0x0D	1	Byte = attenuation level in .25db steps. 0x00 is maximum power, 0x02 is .5db of attenuation. Note that the resolution of the power output setting is only .5db, the least significant bit of the value is ignored.
Maximum Attenuation	0x35	0	Byte = The maximum attenuation level provided by the attenuator.

[2] The timing of the status reports will vary somewhat depending on the timing of the USB bus transactions, and software processes within the operating system, particularly for dwell times less than 100 milliseconds.

6.3 Tips and Suggestions

Remember to handle the error cases for device removal, and close the device handles when you are done interacting with the device.

Remember that in the Microsoft Windows environment, the operating system pads the reports with a byte at the beginning of the report. Make sure to adjust your structures accordingly.

If you are programming in C or C++ you can create a set of unions to allow for convenient access to and conversion of the fields of the reports. For other languages, ensure that the byte order of a 32 bit unsigned integer is the same as the byte order used in the reports, which has the least significant byte stored in the lowest address.

7.0 MECHANICAL OUTLINE