PhaseSpace Impulse: LED System

FCC Compliance Statements

WARNING: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: The PhaseSpace Impulse system is delivered with shielded Ethernet cables. Shielded Ethernet cables are required to comply with emissions limits. It is the responsibility of the user to use the supplied cables.

Note: This equipment has been tested and found to comply within the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

Industry Canada Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

CE Compliance Statement

WARNING: This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

WARNING: DO NOT connect or disconnect devices to the HUB while the server computer is on. The LED Base Station is considered a device and should only be connected or disconnected while the server computer is off.

WARNING: Only use standard shielded Ethernet cables with the PhaseSpace system. DO NOT use crossover cables.

WARNING: The six-pin port on the LED Base Station is only to be used to connect to LED Driver Units. DO NOT use this port to connect to any other device.

Document Purpose

This purpose of this document is to describe the LED component of the PhaseSpace Impulse system. The items covered are:

- LED Base Station description
- LED Driver Unit description
- LED String description
- LED Module description
- LED String creation
- LED system setup procedure

Table of Contents

1: LED System Description

The PhaseSpace LED (Light Emitting Diode) system can be classified as the data-generating side of the PhaseSpace Impulse system. The individual components of the system are described in this section.

1.1 LED Base Station

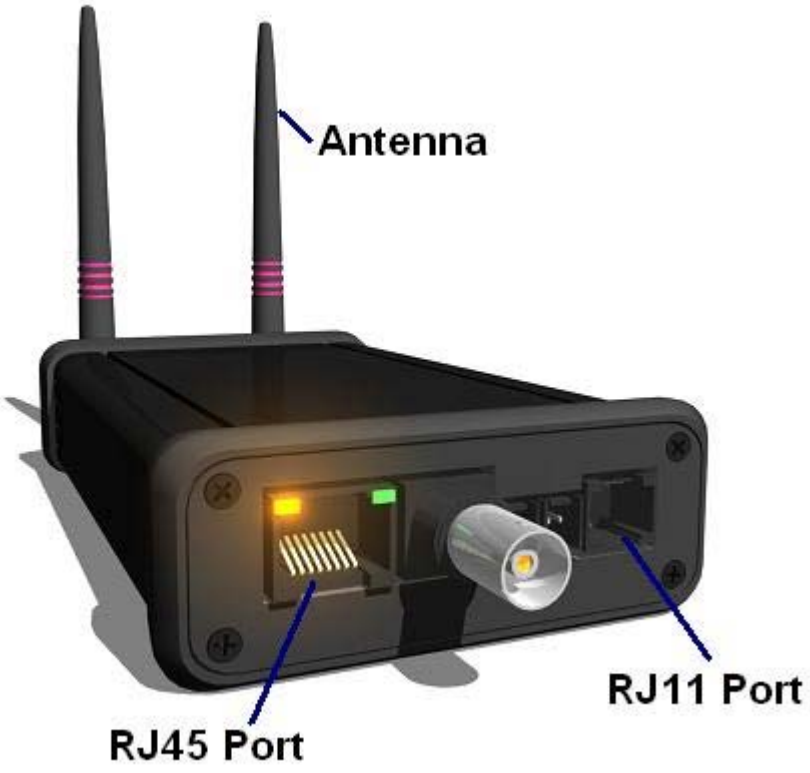

Figure 1.1.1: LED Base Station

The LED Base Station functions as the primary link between the PhaseSpace HUB and the LED system. The base station is connected to the HUB by connecting one end of an ethernet cable to a port on the HUB and connecting the other end of the cable into the ethernet (RJ45) port on the base station.

The LED Base Station has these functions:

- Transmission of timing signal to the LED Driver Unit(s)
- LED programming

The base station also has the capability to drive LED strings independently.

The interfaces on the LED Base Station are:

- One 6-pin (RJ11) port
- One 8-pin ethernet (RJ45) port
- LED string ports
- External RF antennae

The LED Base Station transmits a timing signal via the RF antennae (or directly through a 6-pin connection) to the LED Driver Unit. This signal is sent once per frame.

1.2 LED Driver Unit

The LED Driver Unit is the driver of the LED modules. The unit consists of a battery pack as well as an RF receiver, which receives a timing signal from the LED Base Station. The interfaces on the upper edge of the driver unit are (refer to Figure 1.2.2):

- A power/reset button
- A 6-pin (RJ11) port
- A 14-pin LED string port

In tetherless mode the LED driver unit is turned on by quickly depressing the power/reset button. In tethered mode, the unit automatically turns on when connected to the base station. To turn off the unit, the button should be held down for at least a second.

IMPORTANT NOTE: ***If the power button is held down too long when turning the unit on, the unit will not power up and it will be necessary to wait a few seconds before the unit can be turned on.***

Figure 1.2.1: LED Driver Unit

The battery pack is charged by connecting the driver unit to the LED driver charger. From a completely discharged state the battery pack should take two to three hours to fully charge.

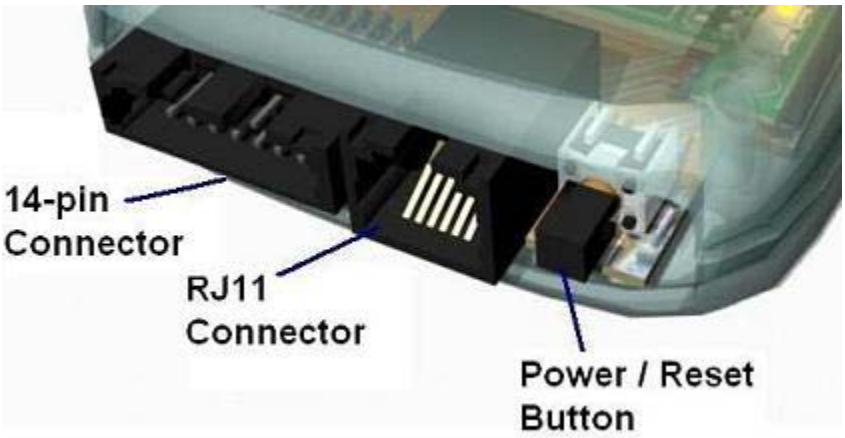

Figure 1.2.2: LED Driver Unit connector view

A total of six LED strings can be connected to the 14-pin connector using a six-wire breakout adaptor or a six-port breakout box.

The face of the LED driver unit has a set of function indicator lights (Figure 1.2.3).

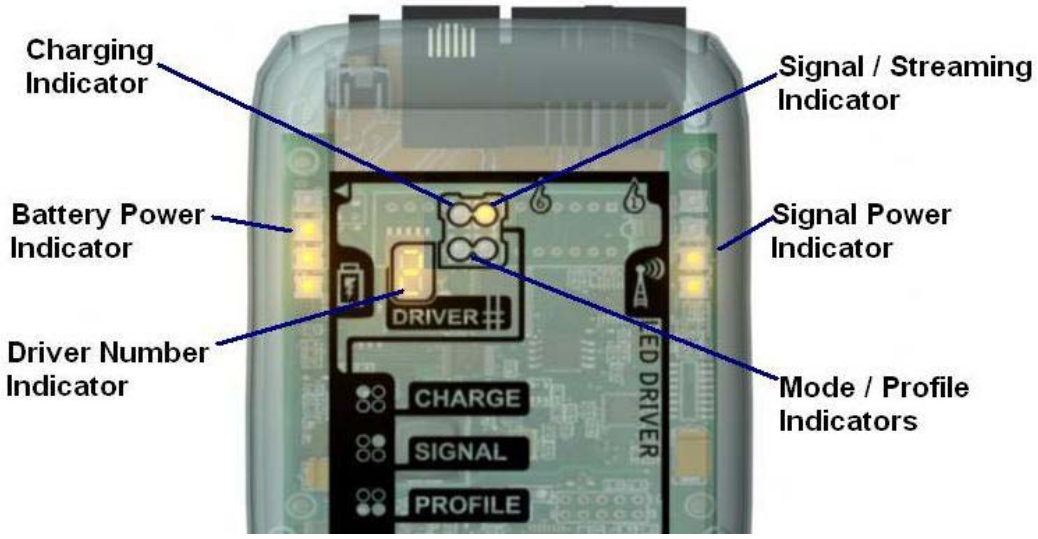

Figure 1.2.3: LED Driver Unit indicators

The indicators give the following information:

- Battery Power - The leftmost column of four lights indicates battery power
- Signal Power - The rightmost column of four lights indicates signal power (tetherless mode)
- Driver Number – The numeric indicator shows the driver number assigned to the unit. During calibration this indicator will display the letter “C”.
- Mode / Profile – The bottom two lights of the group of four lights near the center of the face of the unit show the mode / profile that the system is using (refer to Figure 1.2.4).
- Signal / Streaming – The upper right light of the group of four lights is on when the system is streaming data and a signal is being sent to the unit.
- Charging – The upper left light of the group of four lights is on when the unit is charging.

Figure 1.2.4: Mode indicator states

The LED driver unit is encoded by connecting it to the LED base station. Within five seconds of connecting to the base station all the driver unit indicator lights will turn on (refer to Figure 1.2.5). This is an indication that the unit is ready to be encoded. For more information about encoding refer to the ***PhaseSpace Impulse: Configuration Manager*** document.

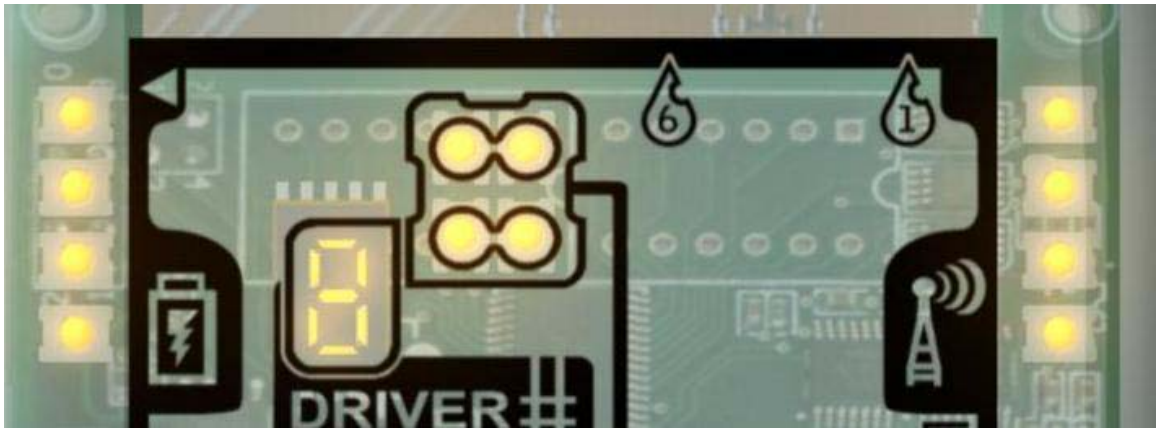

Figure 1.2.5: LED Driver Unit is ready to be encoded

1.3 LED Strings

An LED String consists of:

- The LED cable
- The LED cable connectors

The LED cable consists of two wires, one of which is colored. The connector has two sockets, one for each wire of the LED cable.

A total of six LED strings can be attached to a single 14-pin connector, which connects to the 14-pin LED string port on the LED Driver Unit. Each LED string is capable of having up to 12 LED modules attached to it using the proper LED connectors. Each LED module on a particular LED string must have a unique LED designation, i.e. two LEDs with the same designation should not be connected to the same string.

1.4 LED Modules

The LED modules contain the actual light sources that are tracked by the PhaseSpace cameras. Along with the light source is a microprocessor that controls the modulation of the LED's pulse duration and amplitude.

Each LED has one of 12 LED designations (labeled A through L). This designation along with the identifier of the LED driver gives each LED a unique identifier.

Connecting an LED module to an LED string is illustrated in Figure 1.4.1. The prongs of the LED module should be pushed completely into the connector on the string. There is only one way to push the module into the connector, so care should be taken not to force the connection.

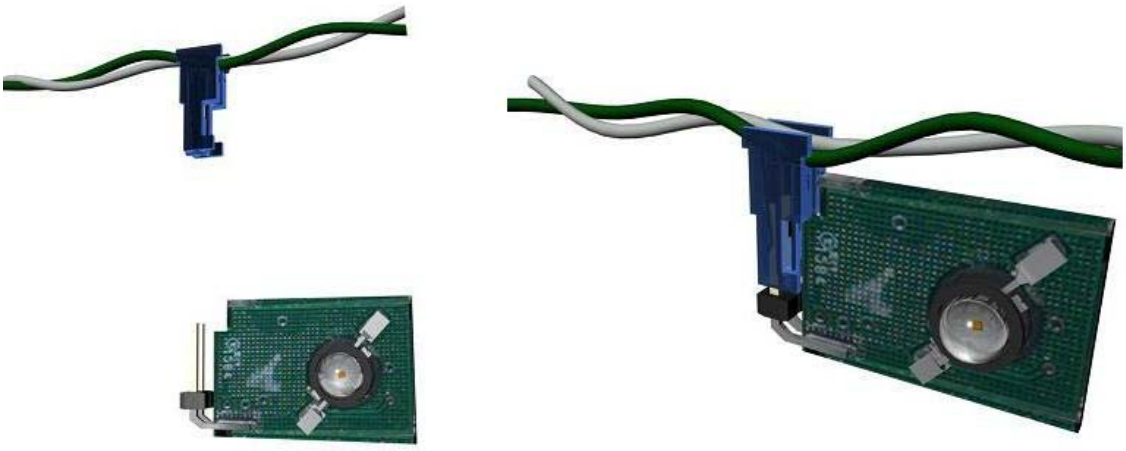

Figure 1.4.1: Connecting LED Module to LED String

IMPORTANT NOTE: ***A maximum of 12 LED modules can be connected to a single LED string and there cannot be any repeat of LED designation on a single string.***

2: LED String Creation

In general, the LED Strings are delivered “unpopulated”, meaning that connectors are not attached to the LED cable. This is due to the fact that the placement of connectors on the cable is dependent on the particular motion capture application. Leaving the LED strings unpopulated allows the user to customize the position of the connectors on the LED cables.

2.1 Attaching Connectors to the LED Cable

Populating the strings requires attaching connectors to the LED cable using the provided crimp tool. The figures below illustrate this procedure.

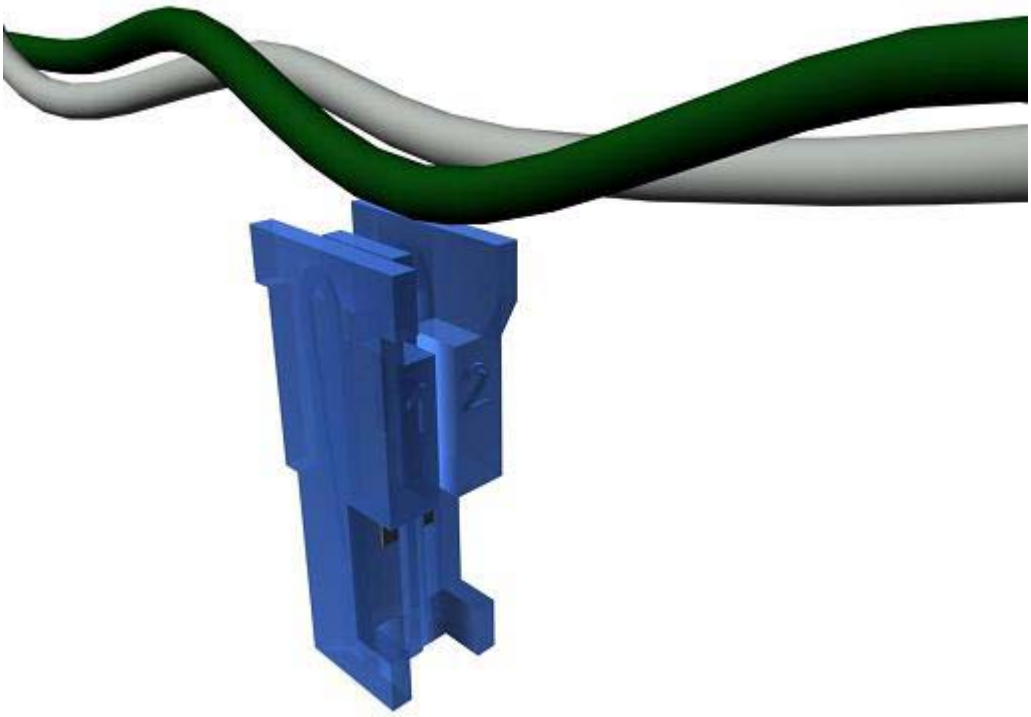

Figure 2.1.1: LED cable and LED connector

The first step in attaching a connector to the LED cable is to line up the cable so that the colored wire on the cable is positioned over the socket

labeled with the number “1”. The uncolored wire should be positioned over the socket labeled with the number “2” (refer to Figures 2.1.1 and 2.1.2).

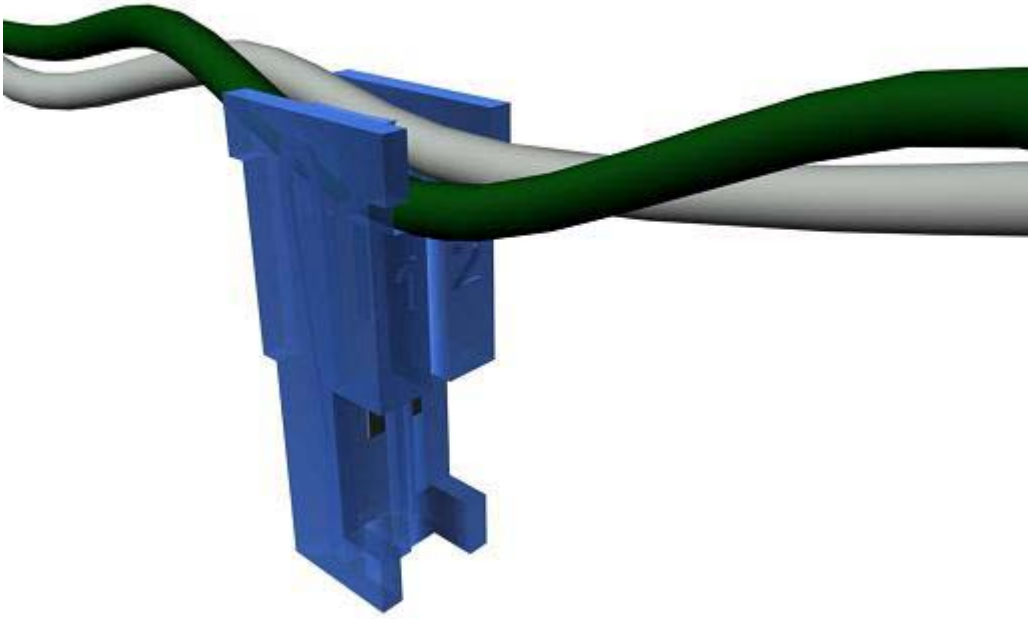

Figure 2.1.2: LED cable positioned in LED connector

Each of the cable wires should then be pushed into the sockets on the connector using the crimp tool (refer to Figures 2.1.3 and 2.1.4). To do this it is best to place the connector on a solid surface in the orientation shown. The connector should be held with one hand (or held using pliers), and the crimp tool should be held and pushed down with the other hand.

Figure 2.1.3: Attaching of connector to LED cable using crimp tool

It is important that the wires be pushed fully into the teeth of the connector sockets. This may require more than one push using the crimp tool.

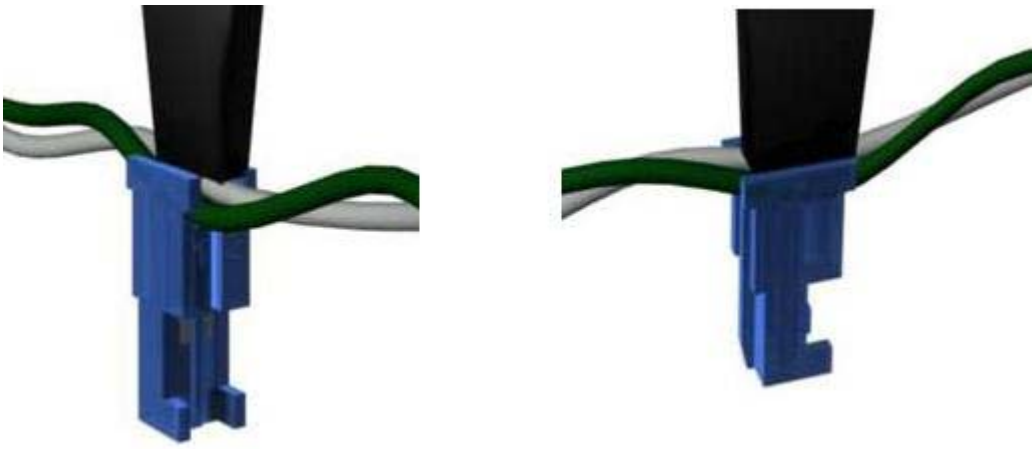

Figure 2.1.4: Close-up of crimp tool and connector

The number of connectors necessary for a cable equal the number of LED modules to be attached to the cable plus one connector that is required to connect to the LED driver. Splitter connectors may be needed if string branching is desired.

3: LED System Setup

The placement and number of LEDs used will depend on the nature of the target that is to be tracked. For example, full body motion is tracked best by placing LEDs along the legs, arms, head, and torso. Full body motion requires the attaching of numerous LEDs (PhaseSpace recommends at least 30 for full body motion) to be properly tracked. Other targets such as the end of a bat or golf club may require only one LED.

3.1 LED Hardware Setup

The components of the LED system that are described in section 1 are connected as follows:

- The **LED Base Station** is connected to the HUB/Server by connecting one end of an ethernet cable to a port on the HUB and the other end of the cable to the ethernet port on the LED Base Station.

  IMPORTANT NOTE: ***Never connect the LED Base Station to the HUB while the HUB / server computer is on. Always make sure that the HUB / server computer is off before connecting the LED Base Station to the HUB.***

- The **LED Modules** are attached to the **LED Strings** using the string's connectors. Each LED Module has a label that indicates the LED's designation. The labels are: A, B, C, D, E, F, G, H, I, J, K, L.

  IMPORTANT NOTE: ***Two or more LEDs with the same designation cannot be on one string. For example, two or more LEDs labeled "A" must not be on the same string.***

- The LED Strings connect to the 14-pin connector on the **LED Driver Unit** (using the six-pin wire breakout or the six-port breakout box). In the case of un-tethered operation, the driver unit should be positioned for optimal signal reception. For example, for full body motion capture placing the unit upside down on the shoulder blade is better than placing the unit in the middle of the back.

- In un-tethered (RF) mode there is no physical connection between the driver unit and base station In tethered mode, the LED Driver Unit is connected to the LED Base Station using a 6-pin cable between the 6-pin connectors on the driver unit and base station.

3.2 LED String File Setup

Customizing the LED string file is optional, but is recommended especially when using more than one LED driver. The default file setup assumes that each LED string has 8 LEDs. Thus, in a setup that contains six LED strings to be tracked, the number of markers that would have to be entered in a client such as the Master Control Client would have to be 48.

In order to optimize CPU usage, the LED string file can be setup so that the number of markers that need to be tracked equals the actual number of LEDs on the strings. The content of the strings file is accessed from the LED configuration page of the ***PhaseSpace Configuration Manager*** (refer to the ***PhaseSpace Impulse: Configuration Manager*** document).

```
6:ABCDEFGH
7:ABCDEFGH
8:ABCDEFGH
9:ABCDEFGH
10:ABCDEFGH
11:ABCDEFGH

12:ABCDEFGH
13:ABCDEFGH
14:ABCDEFGH
15:ABCDEFGH
16:ABCDEFGH
17:ABCDEFGH
```

The number on the left side of the colon is the port number while the letters represent LED designations. The entries for the first six ports (0-5) are reserved for the LED Base Station and are not included in this file. Ports 6 through 11 represent the information for the first driver unit, while ports 12 through 17 represent the information for a second driver unit. Additional entries would be necessary in the case of more driver units.

It is best to look at an example to illustrate how to customize the LED string file. Take, for instance, a single LED driver unit setup with six LED strings connected to the driver unit. The first string has LEDs labeled A, B, C, D. The second string has LEDs labeled E, F, G, H, A. The third string has LEDs labeled B, C, D, E, F, G, H. The fourth string has LEDs labeled I, J, K, L. The fifth string has LEDs labeled A, B, C, D, E, and the sixth string has

LEDs labeled F, G, H, I, J. In such a case, the strings file can be modified (edited and saved) to look like:

```
6:ABCD
7:EFGHA
8:BCDEFGH
9:IJKL
10:ABCDE
11:FGHIJ

12:ABCDEFGH
13:ABCDEFGH
14:ABCDEFGH
15:ABCDEFGH
16:ABCDEFGH
17:ABCDEFGH
```

Notice that the entries representing ports 6 through 11 match the manner in which the strings on the driver unit are populated. After modification the file should be saved and the LED encoding command must be run (this is done by clicking on the "**encode**" button on the LED configuration page of the ***PhaseSpace Configuration Manager***). The advantage of this particular setup over the default is that the software has specific information about the LED setup and the number of markers that need to be specified will be equal to the actual number of LEDs on the strings (in this case 30).

If there subsequent changes to the physical LED configuration, then it would be necessary to again modify the strings file accordingly.

Technical Support

For any questions regarding hardware, software, or documentation use the contact details given below to contact PhaseSpace.

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