

GeoCue Group Support

6/2/2016

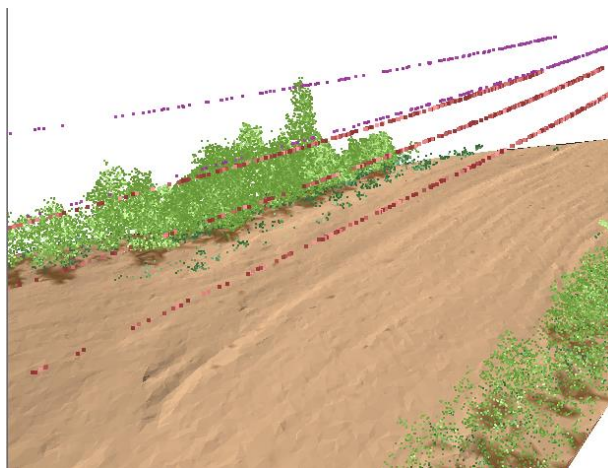
Revision 1.0

LP360 introduced Live View in LP360 2015.1. Live View is a new point filter for defining how points are visualized in real-time within the program. The purpose of this article is to provide users with a more in-depth look into Live View and how it can be integrated into the LIDAR workflow.

## Display Properties within LP360

Display properties are the various combinations of display options that are supported within LP360. The properties are divided into two different categories: Attribute Filters and Symbology. Attribute Filters include classification, intensity, elevation, flags, scan angle and point source ID. Symbology represents the color and size of the LIDAR points. The ability to define display properties exists in all LP360 views: Map View, 3D View, Profile View and the Preview View.

In addition to Attribute and Symbology Filters, LP360 also gives users different rendering options. Users can display the data as either points or as a surface model, which is generated using a Triangulated Irregular Network (TIN). Surface models can be viewed either as a wireframe model or with triangle facets colored in. In addition, there is a hybrid (merged) option which exists to allow users to combine the two different display options. In this instance a user would be able to view points on a surface. Figure 1 is an example of points displayed on a ground surface.



*Figure 1 - Points on TIN Surface*

## Live View

The Live View dialog is invoked by pressing the Live View tool (Figure 2) on any of the four views (Map, 3D, Profile, Preview). Live View will act on the view from which it was invoked. If a user invokes Live View from one view (say the Map View) and then presses the Live View tool on a different view, Live View will immediately switch to the new view. A user can always tell the current view to which Live View is connected by looking at the Live View title bar (Figure 3).



Figure 2 - Live View Button

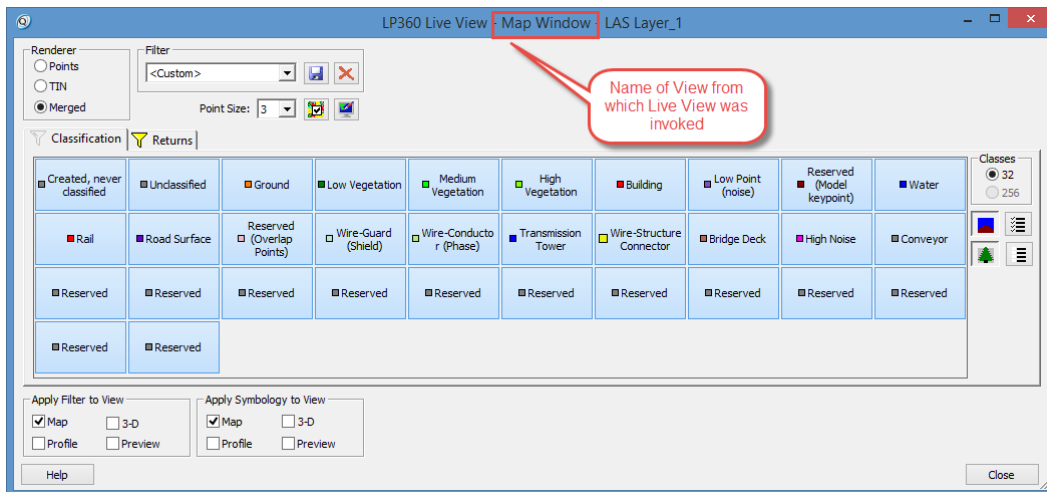
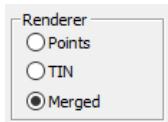


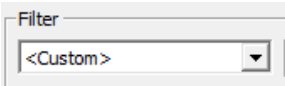
Figure 3 - Specified View



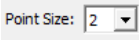


Live View is what Microsoft cryptically calls a “modeless” dialog. What this means is that Live View can remain up while you perform any other function in LP360. Unlike the LIDAR Properties Dialog which must be closed in order to continue in the program, Live View can remain open while a user continues to work.

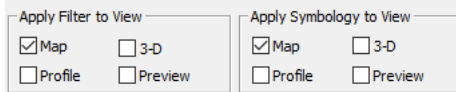
## Live View Tools/Parameters

- **Renderer:** This indicates to which *renderer* your filter applies – Points, TIN or Merged (both).



- **Filter** : Is the current named filter being applied to the Applied Views. If you are in the midst of modifying a filter, this drop-down will read “<Custom>.”

- New/Rename/Update 
  - New: command lets you create a new name for the current filter on which you are working.
  - Rename: If the current filter is anything but <Custom> when you open the dialog, you can select Rename and key in a new name for the filter on which you are working.
  - Update: Update allows you to replace an existing filter with the filter on which you are working.
- Delete : Allows you to Delete the current named filter. The delete tool is disabled if the current filter is <Custom> since Custom is a dynamic filter that cannot be deleted. Be careful in deleting a named filter since this action cannot be undone.
- Point Size  the tool allows you to:
  - Specify that the point size is to be determined by the Symbology (this is with the dropdown set to “L Use Legends”
  - Explicitly set the point size by selecting a number from 1 to 10 in the dropdown. Note that the selected size applies to all points and overrides the individual symbology.
- Auto Select Classes/Returns :
  - This tool invokes a probe of the point cloud data. If the tab is set to Classification, the data are probed and all classes found in the data set are enabled in the filter. If the tab is set to Returns, then all return combinations found in the data set are enabled in the Returns filter.
  - Note that the probe is of a subsampled data set. It is possible for a class or return to be missed if it occurs at very low density in the data set.
- Set Theme : this tool allows you to change the look of the classification/returns selection grid.
- Apply Filter and Symbology
  - The Apply Filter to View and Apply Symbology to View options at the lower left of the dialog direct the changes that you have made (or named filter you have selected) to one or more of the four views. Note the “Map” selection applies only to the current Active



LAS Layer.

- As with all actions in Live View, changes are made to the selected views as soon as you make a change on the dialog.
- The default checked view will be the view from which Live View is linked. This synchronization is maintained if you change associated views.

## Tools

# LP360 Live View



- Filter on Indicators
  - Each tab of the Live View dialog contains a filter icon to the left of the tab name. If this tab is greyed out, nothing on this tab is currently filtering data. If the icon is enabled (not greyed out), at least one filter criteria is being applied by the tab. This provides you with a quick way of determining if filter criteria are being applied.

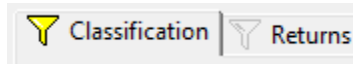


Figure 4 - View is filtered by Classification, but not returns

## Classification Tab

The first tab (left-most) of the Live View setting dialog is for setting classification codes and flags. The Live View dialog is resizable and will change its appearance when made larger or smaller.

If you enlarge the dialog, the assigned class names will be spelled out with a symbology icon showing the color of the class as well as the relative size of points for the point channel. If you shrink the dialog, the buttons will reduce to simply the symbology icon. In all cases, if you hover the mouse pointer over a button, a tool tip with details on that class (or Return if you are on the Returns tab) will appear.

### **Renderer**

As mentioned earlier, LP360 supports two drawing channels, one for the TIN renderer and one for the Points renderer. The Renderer is selected via the Renderer section of the dialog. It is important to note that while LP360 supports separate renderers for Points and TIN, symbology is a single color for both renderers.

### **Classes**

LAS versions 1.0 and 1.4<sup>1</sup> support 256 different classes (numbered from 0 to 255) whereas LAS 1.1, 1.2 and 1.3 support 32 different classes. The Classes option on the right of the Classes tab allows you to reduce the number of displayed classes in the class tab grid from 256 to 32 (simply to reduce the size and complexity of the tab). The default selection is set to 32 and disabled for formats that support only 32 classes.

Classes are turned off and on by pressing the corresponding button in the Classification tab of the Live View dialog. Note that if you have difficulty discerning the off/on state of buttons, use the Theme tool to modify the look.

As soon as you turn a class off or on, the filter name will change to:

- <Custom> if no filter in your saved filters collection matches your current configuration
- *Name* where name is a stored filter that matches your current configuration

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<sup>1</sup> Point Data Record Format (PDRF) 6 and above

## Tools

### LP360 Live View



Choices are immediately applied to the Views that are checked in the “Apply Filter to Views” section of the dialog (hence the “Live” in Live View). If you have Renderer set to Merged, the setting will apply to both the TIN and the Points channels. If you separate these channels by selecting Points or TIN in the Renderer selection, the now separate TIN and Points filters will be initialized with the values of the merged filter. If you have separate Renderers for a filter and then set the Renderer selector to “Merged”, the filter will initialize to the values of the Points filter.

#### **Quick Set/Reset Tools**

The Classification tab has several tools to speed common filter settings. These tools are to the right of the Classification filter buttons (see Figure 5). Starting at the upper right and moving clockwise through the buttons, their functions are:

- Turn On all Classes
- Turn Off all Classes
- Turn On/Off the vegetation classes (3, 4 and 5)
- Turn On/Off the ground classes (classes 2 and 8)

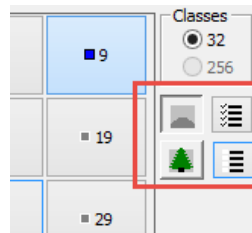


Figure 5 - Quick Set/Reset Tools

#### **Troubleshooting Class Display**

If you turn a class off or on and nothing seems to happen in the view, check the following:

- Ensure that the toggled class exists in the data set (you can use the Auto Select function to scan the data set)
- Ensure that the View selection at the lower left of the Live View dialog has the view that you expect to be modified checked
- Ensure that some other filter criteria is not suppressing the display. All tabs of the dialog apply to the view so, for example, if you have Returns set to show only “first of many” returns and none of these returns are in the ground class, then you will not see a change in the display as you toggle the ground class off and on.
- Ensure that you have not set the Flags filter (see the Flags section of this document) such that it is suppressing the display of points. For example, if you have Key Points set on the ground class but no Model Key point flags have been set in the data, then you will see no points if you select the ground class filter.
- Ensure that the Renderer you are modifying is currently displayed. For example, if you have Renderer set to TIN but you have the display mode set to Points (on the view toolbar), you will not see your changes until you switch the display mode to one that uses the TIN Renderer (TIN, Points on TIN, Wireframe).

## Returns

Return combinations are selected on the Returns tab of the Live View dialog. Just like the Classification tab, the Returns filter can be separately applied to the Points and TIN channel.

LAS versions 1.0 through 1.3 support 5 returns if the data are ASPRS LAS compliant. However, these versions of LAS reserved 3 bits for return information and hence can support up to 7 returns (the value 0 is reserved for other uses). Some software applications support using the non-standard return 6 and 7 in these lower LAS formats (note that return number must be deduced by sensor hardware or post-processing software that has knowledge of the sensor returns). Due to the prevalence of the non-standard use of returns 6 and 7, LP360 allows you to see this in the Live View filter, the Returns tab shows 7 returns for LAS 1.0 through LAS 1.3.

LAS 1.4 supports up to 15 returns<sup>2</sup>. If the current Active LAS Layer contains LAS 1.4 format data, the Returns tab will show 15 returns.

### ***Setting/Clearing Returns***

The returns are turned off and on by simply pressing the associated button in the Returns tab. Rows represent pulses with a certain number of returns (e.g. the third row represents outgoing pulses for which three returns were detected). Columns represent the particular return number. Just like the Classification tab, a tool tip will list the return if you hover the mouse pointer over a particular return button.

You can set/clear an entire row or column by pressing the button at the side of the row or bottom of a column.

### ***Quick Settings***

Several Quick settings are available using tools in the upper right of the Returns tab. A drop-down list allows you to select common combinations of returns (e.g. Last Returns, First Returns, etc.). Similar to the Classification tab, there are tools to select all returns or to clear all returns.

If you manually set a named return set by pressing return buttons in the dialog, the name will appear in the drop-down list. For example, if you enable only the right-most return of every row, you have selected Last Returns. The drop down selector will change to read "Last Returns."

### ***Unknown Returns***

Unfortunately, LAS supports the value zero for both the number of returns and the return number. This gives rise to a large collection of non-standard return encodings. For example, Return 0 of 4, Return 0 of 0, Return 3 of 0 and so forth. It is disappointingly common for these combinations to appear for some points in a LIDAR data set. The encoding of Return 0 of 0 is very typical of point data derived from dense image matching (such as sUAS point clouds).

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<sup>2</sup> Point Data Record Format (PDRF) 6 and higher

## Tools

# LP360 Live View



It is also not uncommon to find incorrectly numbered standard returns. For example, a return labeled “3 of 1” is clearly an error. You can enable and disable display for erroneously recorded returns using the Unknown button at the lower left of the Returns tab. In fact, this can make a nice QC tool for finding incorrectly labeled returns.

### **Troubleshooting Returns**

- Recall that, like Classification, Live View supports separate Point and TIN channels. Thus you might have a combination such as All Returns for the point channel and No Returns for the TIN channel. If a view display mode is set to TIN, you will not see anything in that window.
- Returns are often not correctly encoded in LAS. For example, 0, 6 and 7 are never supposed to be used in a LAS 1.0 to 1.3 compliant file whereas the value 0 should never be used in a LAS 1.4 file. If points encoded with these values and you do not have the Unknown button enabled, these points will not display.
- There may be so few points of a particular return combination that you simply are not seeing them in the display. For example, return 5 of 5 would typically represent a low fraction of the total points. Due to the way LP360 creates fast display pyramids, these points may not be represented at all in the zoomed out views unless the Force 100% Resolution is used.

## Symbology

Symbology for Live View is the color and size of a point. Symbology can be uniquely assigned for Classification and Returns on a view by view basis. That is, the Ground class (class 2), could have a different color and/or size in the Map View and the 3D View.

Symbology cannot be separately assigned for the Points and TIN channel. That is, a particular class or return will show with the same color regardless of the channel through which that point is rendered.

Symbology can be set using one of two methods:

- Double click Class/Return Button
- Right-click Class/Return Button

### **Double Click Class/Return Button**

Double click the Class or Return button. You can set the size and color of the point (Figure 6). Note that the class or return for which symbology is being modified is displayed in the title bar of the Symbology dialog.

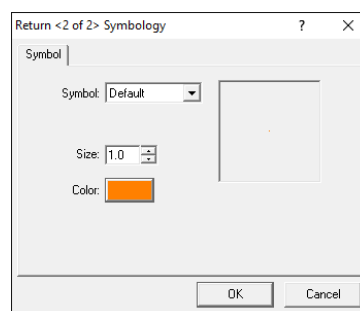


Figure 6 - Change Size and Color

**Right-click Class/Return Button**

Right-clicking a Class or Return button will invoke the dialogs of Figure 7 or Figure 8 respectively. From this dialog, you can choose to operate on the selected class/return, all On Classes>Returns or all Off Classes>Returns. Navigating one of these options will allow you to select the symbology option (Figure 9). This will invoke the symbology dialog (Figure 9).

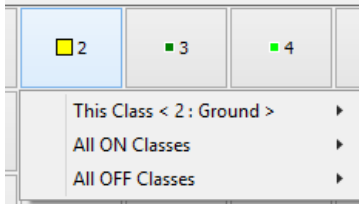


Figure 7 – Right-click Dialog to change class symbology

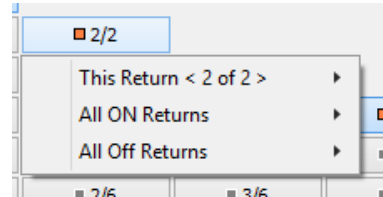


Figure 8 – Right-click Dialog to change return symbology

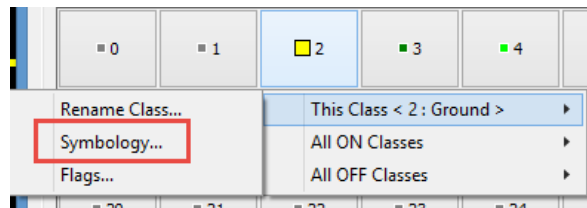


Figure 9 - Selecting the Symbology Option

**Color Grouping**

Using the right-click function for multiple Classes>Returns can be very handy for color grouping. For example, to color all last returns red, select Last Returns in the drop down list on the Returns tab. Now right-click on one of the return buttons and select All On Returns. Navigate to Symbology and set the color to Red. Now all last returns will display in red (Figure 10).

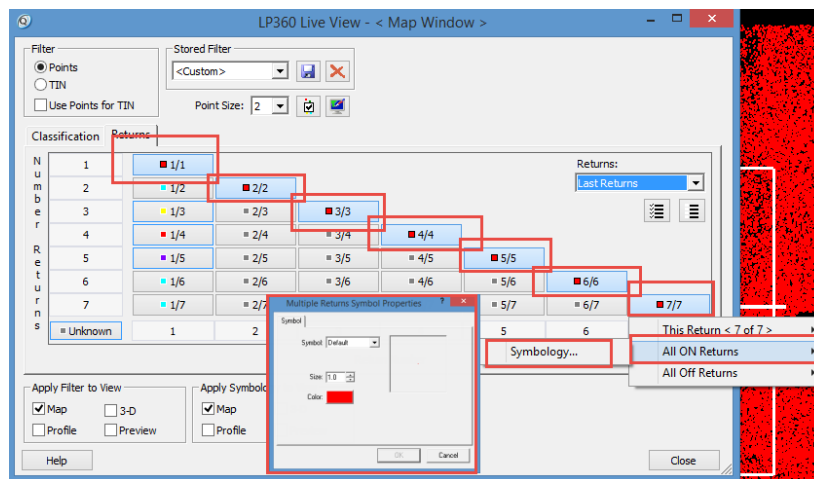


Figure 10 - Example of Group Coloring



## Tools

# LP360 Live View



### **Point Size**

Point size can be set on an attribute (elevation, classification, intensity, Point Source ID, etc.) by attribute basis or globally for all points. Point size is set on a class/return by class/return basis using the Symbology dialog. This is referred to as the Legend setting.

Point size is adjusted for a view using the Point Size selector in Live View (Figure 11). The first option in the drop down list sets the size to use the settings in the Legend. The numeric options override the legend and set all points, regardless of the legend, to the selected size. Even though point size is technically a Symbology attribute, the Size override function (that is, selecting a numeric value in the drop down) function is applied to the same views selected for Filter application (lower left checkboxes in the main Live View dialog). This prevents colors from being reassigned in the other views when all you wanted to do was a temporary size change.

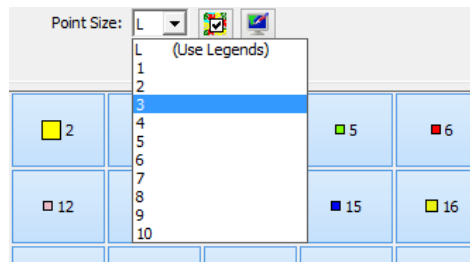


Figure 11 - Setting Point Size

### **Symbology is Filter Independent**

Symbology settings are independent of the filters. Thus, if you recolor the ground class for the Map View while working on a filter that you might have labeled “Stockpile”, that same symbology will apply to the ground class in the Map View for all other filters.

### **Setting the Applied Views**

LP360 allows each view to have independent symbology. That is, you might set Ground to be orange in the Map View with a point size of 1 but red in the 3D View with a point size of 3.

Filter and Symbology is applied to the view or views that you have checked in the lower left of the Live View dialog. This setting defaults to the View from which you most recently pressed the Live View activation button. If you want the current filter or symbology to apply to other views, simply check those in the Apply Symbology to View section of the Live View dialog (Figure 12).

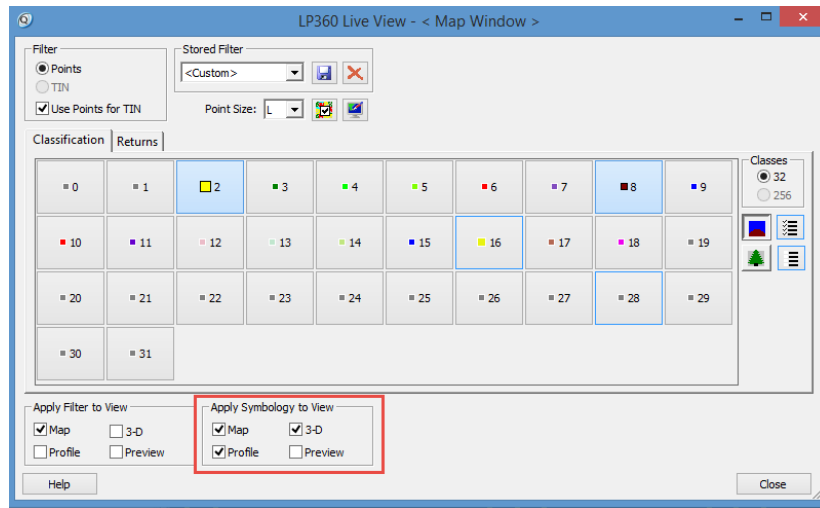


Figure 12 - Apply Symbology to Views

## Naming/Renaming Classes

Classes can be renamed by right clicking on a Class button and selecting the “This Class” path. One of the three options is Rename. Renaming is global to an LP360 project. Thus, regardless of the view selected in Live View, the renamed class will be updated for all views and all filters. For example, if you rename class 19 from Reserved to Conveyor, class 19 will show up everywhere in the project as Conveyor.

## (Attribute) Flags

Starting with LAS version 1.1, per-point Classification Attribute Flags were introduced. For LAS 1.1 to 1.3 there are three flags. A fourth flag was added with LAS version 1.4 (Point Data Record Format 6 and above). Each flag is a single bit and hence has states of Set (the bit is a 1) or Clear (the bit is a zero). The states can be thought of as True (1) and False (0). The meanings of the flags are listed in Table 1.

Table 1: The Attribute Flags

Flag	LAS Version	Meaning
Synthetic	LAS 1.1 – LAS 1.4	If set then this point was created by a technique other than LIDAR collection such as digitized from a photogrammetric stereo model or by traversing a waveform.
(Model) Key Point	LAS 1.1 – LAS 1.4	If set, this point is considered to be a model key-point and thus generally should not be withheld in a thinning algorithm.
Withheld	LAS 1.1 – LAS 1.4	If set, this point should not be included in processing (synonymous with Deleted).
Overlap	LAS 1.4 (PDRF 6 and above)	If set, this point is within the overlap region of two or more swaths or takes. Setting this bit is not mandatory (unless, of course, it is mandated by a particular delivery specification) but allows Classification of overlap points to be preserved.

In versions of LP360 prior to the introduction of Live View, you could filter on Attribute Flags (“Flags”) but only as a total filter. For example, if you set the Model Key Point (MKP) flag to True in the Flags filter, then only points with the MKP flag set to True, regardless of classification or any other attribute, would pass through the filter. You could not do filtering such as “show only Ground points with the MKP flag set but allow all building points to show.”

The ability to *filter* points using flags has been extended to a per-class system starting with Live View. Now you can set the flags on a class by class basis. We have also retained the ability to quickly set the flags on all classes (e.g. show all points with the MKP flag set, regardless of class).

Flags are set as part of the Classification process. LP360 allows you to add flags to the destination class in all of its classification routines. It also allows you to modify only flags as a result of classification.

**Setting a Flag Filter**

Flag filters are set using the Classification tab of Live View. Right-click on a class button and select the category for which you would like to apply the flag setting (the currently selected class, all On classes or all Off classes). Next select the Flags... option. Set the state of the flags that you wish to apply to the filter (Figure 13). If the logic selector is set to AND (the default) then all of the states that you select must be true. If the logic is OR, then at least one of the states you have set must be true.

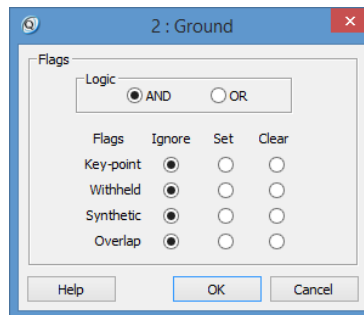


Figure 13 - Flags Filter Dialog

The meanings of the settings are listed in Table 2.

Table 2: Flag Setting Meanings

<b>Setting</b>	<b>Meaning</b>
Ignore	The flag state is not used in the filter nor in the AND, OR testing of the filter combinations
Set	Only points with this flag set will pass the filter
Clear	Only points with this flag clear will pass the filter

# Tools

## LP360 Live View



### Live View Flag Indicator

If you have set a flag condition on a class or multiple classes, the class name or number (depending on what is being displayed in Live View) will be underlined (Figure 14).

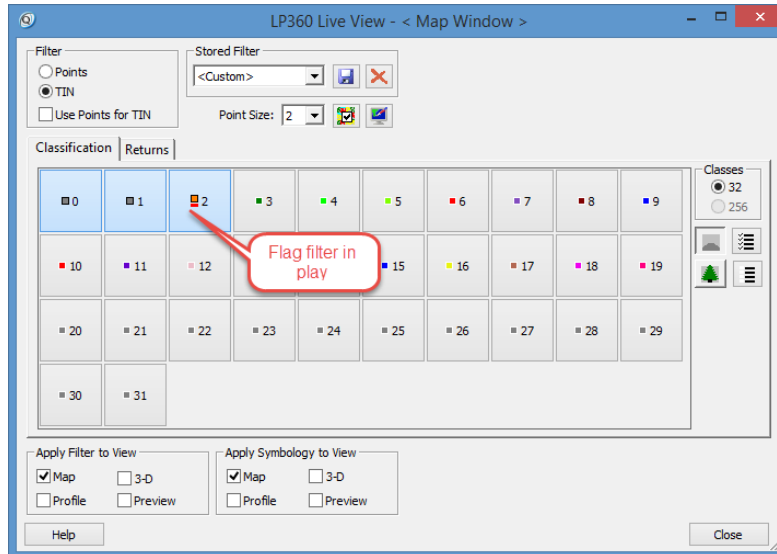


Figure 14 - Underscore represents flag filter is active

## Summary

Live View provides a powerful new way to explore your point cloud data. The new interactive nature and available shortcuts will allow for more productive uses of the viewing filters. The Live View dialog replaces some of the Layer Properties' Display and Symbology tab functions, but can be used in concert with them for the time being. The additional tabs from Layer Properties will be added to Live View in future versions of LP360. Let us know what you think of this new visualization tool.