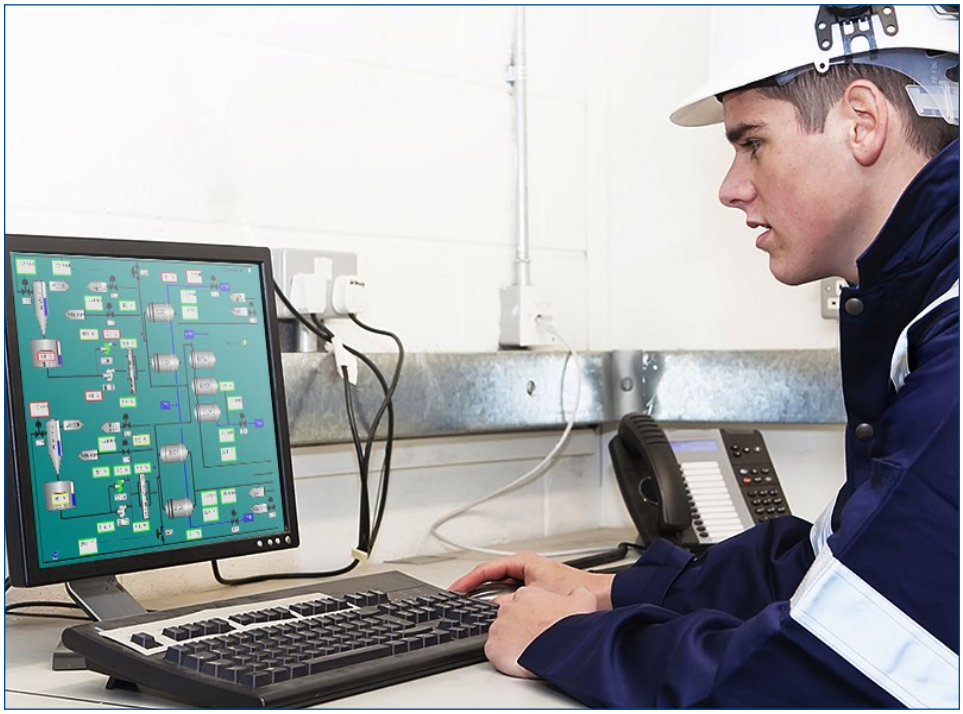
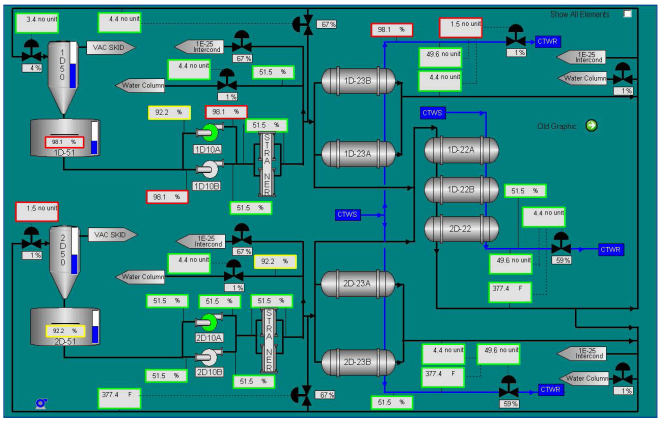
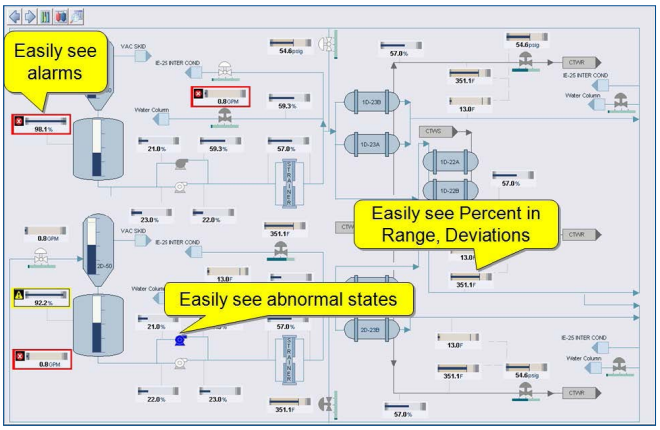
DeltaV Operate Themes

This document provides background on the use of colors, shapes and pattern recognition approaches included in DeltaV Operate Theme displays using the FRSModule_Theme dynamos.





Example original display.



Display with DeltaV Operate Silver Theme.

Introduction

Developing a strategy for your operator displays involves a lot more than defining a picture type and window size. A recent report by the Chemical Manufacturers' Association on the Causes of Incidents attributed 26% of the incidents to Operator Error. Some individual facilities have informally stated that they attribute a much higher percentage – even up to 66% of incidents on Operator Error. Regardless of the actual percentage, there is an increasing awareness of the role that operators have in the incident-free operation of a plant.

There is a wide range of university led research on human capabilities that is very relevant to operations. This includes what attracts visual attention (what do people notice, or not notice), impact of different colors and shapes on visual perception (the ability to quickly find or notice an important object amongst others) and the use of patterns in displays to improve the speed with which a person can scan a large amount of information. Many of these discoveries are creating a better understanding of how we recognize and process information and can be applied to improve plant operation.

Human Centered Design is the application of research for specific users and tasks, as It is not always clear which general research results apply to a particular user, and which do not. The Center for Operator Performance (http://www.operatorperformance.org/) is an industry/university consortium that performs operations specific research, evaluating and measuring the impact on operations.

There have also been several process control specific publications that describe many good practices and practical gudelines for display design. These include:

- EEMUA 201 - Process Plant Control Desks Utilising Human-Computer Interfaces - A Guide to Design, Operational and Human Interface Issues – Edition 2
- ASM Consortium Guidelines – Effective Operator Display Design – 2008
- High Performance Operator Graphics - 2008

This paper presents display concepts based on this current research and publications for operators. However, new discoveries, and questions, are still being uncovered. So while this paper presents Human Centered Design display concepts that apply this current research for operators, this is just a step towards creating an operating environment truly optimized for operators – as human beings.

It is also important to note that there is not 'one answer' to the creation of good operator displays. Deciding what display colors, shapes and styles work well together is more of an artistic decision than a scientific one. In other words, there is no mathematical equation that you can use to select colors that are effective and 'look good' together. The same RGB color can be look differently on different types of monitors, different room lighting, etc.

DeltaV Operate Themes were developed to improve operator visual attention and recognition of important information in operator displays, based on current DeltaV monitors and office lighting. Colors, shapes and patterns were created with the help of a graphics artist.

DeltaV Operate includes new default global color tables, color sets and dynamos that are coordinated into DeltaV Themes.

General

Key to picture design is deciding what information should be shown together and how best to present that information to the operator so that the relative importance of the information is clear.

General human factors literature recommends careful use of color coding. Color coding is the practice of using a color to indicate specific information. For example a red DeltaV alarm is by default a critical alarm. With color coding, a single color to indicate a single piece of information. This means that red should not also be used both to indicate a critical alarm and to indicate a pump is off. Similarly if yellow is an alarm color, it should not be used as a pipe or PV color.

In addition, the use of color coding should be kept to around 7 colors. While you may find the need to exceed the recommendation of 7 colors, you should strive to limit the excessive use of color coding. If you have displays with a large amount of color coding, or displays with unique color coding, it may be helpful to create a color key and add it to the operator graphics where the colors are used. That way, the operator has a quick reference for each color. You can change the default colors used in the DeltaV standard faceplates by changing the color set used in the Named_Colors table.

As more items are color coded or when the same color is used to represent multiple process conditions, it becomes more difficult for operators to visually scan for information and to remember what the different colors mean.

While it is recommended that the coded colors (where the color is significant) should be limited, additional colors can be used in your graphic. For example, you might want to make information more visually distinctive or pictures more appealing through the use of colors. These colors should be soft (non-saturated) and blend with the display background and static tank colors such that they do not visually distract the operator. These additional colors do not count towards the ideal 7 coded colors. Using the DeltaV Operate Themed color sets assist in keeping the colors on the screen in the same color palette.

The first step in picture design should be to determine the colors you will deploy throughout your pictures. Alarm colors are typically the most important colors to define; and therefore, drive your other color selections. The default DeltaV alarm colors are red, yellow and purple. You can change the default alarm colors by changing the colors in the Alarm_Color_Table. The colors selected as alarm colors should only be used for alarms.

Alarm colors are defaulted to bright, saturated colors because these colors draw attention. The use of these saturated colors, as well cyan, bright blue, and bright green, should be limited to items requiring operator attention. For example, a pipe that should not be empty or a relief valve that is open can be shown in bright blue to make the unusual condition more obvious to the operator. Be careful to minimize your use of saturated colors on a display so that the items that are most important visually stand out.

These saturated alarm colors are also classified as hot colors. To create a display that allows alarms to be distinctive, less saturated cool colors (for example, grays, blues, and greens) should be used.

Any status indication shown in a picture should also be distinctive, although typically less important than alarms. DeltaV Operate Themed color sets use a single, saturated color to indicate status.

Selection of the picture background color is your next step. Select the background color so that the alarm and status colors are distinctive. With DeltaV Operate Themed color sets, four different background selections are provided to pick from.

Text and numbers must be distinctive on your selected background for optimum readability in the operator's environment. If you select a grey background color, text on that background should be a very dark grey to be readable. The section Calculating Color Contrast for Readability provides a calculation we found useful to determine when there is enough contrast between colors to be easy to read.

The tanks, pipes, and so on, on your picture provide a focal point for operators and help operators quickly recognize and verify that they are on the correct picture. Take care to make these items distinctive but not distracting.

The colors used, or color theme used, along with what is animated (that is, changes color, visibility and movement) can be effectively used to draw the operators' attention.

Theme Dynamo Colors

It is important to define the relative importance of the information shown to the operator. This can vary from plant to plant – or – even process to process and affects the color selections used.

The colors used in the DeltaV Operate Themes were selected based on the following relative importance (e.g. impact in attracting operator attention):

1. Alarms

2. Abnormal Status

- Abnormal equipment states - such as when a relief valve is open.
- Abnormal pipe process color(s) – shows something is/is not in the pipe.

3. Process values/information

- ON/OFF equipment states
- Process values - Easily readable
- Some Pipe process color(s) – Option to show what is in the pipe, whether pipe is empty

4. Display information

- Tag name / value label color
- Large/background equipment color and label color – want to visually ground the user
- Pipe fixed color - just shows where pipes are in the process, optionally different types

Using the same themed color set for all objects on the picture, as well as for the picture background color assures you that the colors will work well together without one color obscuring another.

Note: Theme pipe colors were defined for use with line width of 1. For pipes that are thicker, less distinct colors may be needed, unless there is a particular reason to draw attention to that pipe.

Theme Color Sets

The themed color sets are named with the word Theme and the base color for that set (for example, Shades of Tan Theme).

Each themed color set contains the complimentary and contrasting colors defined for many possible values. Colors are used to draw attention to important items using contrasts and are used to create a focal point for operators. Colors are also used to keep the supporting information subtle by using complimentary colors. Keeping the colors to one palette or tone helps to create a pleasing visual; especially considering the operators must look at one display for many hours and if the display is discordant, then operator eye strain and mental fatigue can result.

Each themed color set has contrasting colors that can be used when animating objects. Since a contrasting color draws attention to an object, it should be used only when an object is out of range or in alarm. Using a contrasting color too frequently (or for too frequent of a change) reduces the effect and will tend to be ignored over time. Using too many contrasting colors can make remembering what the colors signify difficult.

Item name	Description
Shades of Silver Theme.ftb	Colors based on a silver display background (default display background color)
Shades of Light Blue Theme.ftb	Colors based on a light blue display background
Shades of Dark Blue Theme.ftb	Colors based on a dark blue display background
Shades of Tan Theme.ftb	Colors based on a tan display background
Shades of Dark Grey Theme.ftb	Colors based on a dark gray display background

Default Dynamo Theme Colors (Silver Theme)

Theme_Colors Color Table

General			
Picture Background color (224, 226, 235) iFIX 15459040		Dynamo background color (235, 236, 241)	
Display Dynamo			
PV loop background color, light tan (223, 215, 204) iFIX color 13424607		SP Work color, dark tan (205,194,182)	
PV AI/ALM background color, light grey (219, 219, 224)		PV level background color, light blue (203, 217, 226)	
PV foreground dark blue (60, 98, 145)		Status Border outline for dynamos (0, 0, 198) blue	
Alarm 1 grey-blue (155, 173, 198)		Alarm 2 dark grey-blue (123, 146, 173)	
OUT bargraph foreground blue green (20, 105, 106) iFIX 8284436		OUT bargraph background color, light green (131, 180, 172) iFIX 12174233	
SP, PV, Number values on background (0, 0, 0) black		Informational text -Tag names, EU (14, 50, 96) iFIX 6304270	
Pipe and Tank			
Main pipe color (107, 141, 175) 11505003		Main Big Equipment Color, (178, 199, 213)	

Border EdgeColor Table

Module select (157,79,0) pumpkin	

Alternate Colors (not in global color tables)

Arrows and Display Links			
Off display reference foreground color (206, 223, 239)		Arrow 1 grey-blue (107, 142, 173)	
Off display reference edge and arrow color (140,170,198)		Arrow 2 (107, 195, 107) grey	
Other Demo Colors			
Display Title color (203, 217, 226)		Display Title outline (178, 199, 213)	
Big Equipment outline (25, 47, 61)		Alternate Title outline (178, 199, 213) – main tank color	
Alternate Title color (203, 212, 217) 14275787- matches level		Alternate main pipe color grey (106, 106, 106)	
Control Information Lines light grey (198, 198, 198) iFIX 13027014		Big Equipment Dark 3 (89, 129, 150)	
Big Equipment Dark 1 and Highlight color (139, 171, 192)		Text on tanks (36, 60, 89) (same as all informational text)	
Big Equipment Dark 2 (119, 151, 172)			

Light Blue Dynamo Theme Colors

Theme_Colors_Light_Blue Color Table

General			
Picture Background color (222,227,239) iFIX 15721438		Dynamo background color (227, 232, 242)	
Display Dynamo			
PV loop background color steel blue (185, 198, 215)		SP Work color light blue(145, 173, 213)	
PV AI/ALM background color (219, 219, 224)		PV level background color (185, 198, 215)	
PV foreground color dark blue (43, 71, 106) iFIX color 6965035		Status Border outline for dynamos blue (33, 33, 165)	
Alarm 1 alarm grey blue (155, 173, 198)		Alarm 2 dark blue grey blue (123, 146, 173)	
OUT bargraph foreground blue green (20, 105, 126)		OUT bargraph background color light green (131, 180, 172)	
SP, PV, Number values on background black (0, 0, 0)		Informational text -Tag names, EU (14, 50, 96) 6304270	

Pipe and Tank			
Main pipe color (107, 141, 175) 11505003		Main Big Equipment Color, (178, 199, 213)	

BorderEdgeColor_Light_Blue Table

Module select pumpkin (157,79,0)		Equipment abnormal blue (0, 0, 255) 16711680	

Alternate Colors (not in global color tables)

Arrows and Display Links			
Off display reference foreground color (206, 223, 239)		Arrow 1 grey-blue (107, 142, 173)	
Off display reference edge and arrow color (139, 171, 192)		Arrow 2 grey (107, 195, 107)	
Other Demo Colors			
Display Title color (203, 217, 226)		Title outline (178, 199, 213)	
Big Equipment outline (25, 47, 61)		Alternate main pipe color grey (106, 106, 106)	
Control Information Lines light grey (198, 198, 198) iFIX 13027014		Big Equipment Dark 3 (89, 129, 150)	
Big Equipment Dark 1 and Highlight (139, 171, 192)		Text on tanks (36, 60, 89) (same as all informational text)	
Big Equipment Dark 2 (119, 151, 172)			

Dark Blue Dynamo Theme Colors

Theme_Colors_Dark_Blue Color Table

General			
Picture background color (41,65, 99) iFIX 650474		Dynamo background color (55, 78, 112)	
Slate Blue Display Dynamo			
PV loop background color blueish-grey (98,124,157)		SP Work color (148, 182, 214)	
PV AI/ALM background color blueish-grey (98,124,157)		PV level background color blueish-grey (98,124,157)	
PV foreground color light tan (223,215,204)		Bad status outline for dynamos cyan (0, 202, 202)	
Alarm 1 grey-blue (132,157,183)		Alarm 2 lighter grey-blue (165,181,203)	
OUT bar graph foreground blue green (48,160,167)		OUT bar graph background color light green (153,202,187)	

SP, PV, Number values on background really light blue (222, 231 239)		Informational text -Tag names, EU's light blue (173, 211, 255)	
Pipe and Tank			
Main pipe color (107, 141, 175) 11505003		Main Big Equipment Color (123, 146, 173)	

BorderEdgeColor_Dark_Blue Table

Module select light orange (255,213,174)		Equipment abnormal cyan (0, 236, 236)	

Alternate Colors (not in global color tables)

Arrows and Display Links			
Off display reference foreground color (156, 174, 198)		Arrow 1 blue (107, 141, 175)	
Off display reference edge and arrow color (123, 146, 173)		Arrow 2 (206, 219, 231) light blue iFix # 15195086	
Other Demo Colors			
Display Title color (204, 214, 225)		Title outline (123, 146, 173)	
Big Equipment outline (25, 47, 61)		Text on tanks (41,65, 99)-same as background	
Control Information Lines dark grey (106, 106, 106) iFIX 6974058		Alternate main pipe color dark tan (160, 155, 139)	
Big Equipment, Dark 1 and Highlight color (156, 174, 198)		Big Equipment Dark 3 (98, 124,157)	

Tan Dynamo Theme Colors

Theme_Colors_Light_Tan Table

General			
Display Background (222,219,214) iFIX		Dynamo background light tan (228,224,218)	
Display Dynamo			
PV background color light blue (191,198,208)		SP Work color (222,231,235)	
PV AI/ALM background color light blue (191,198,208)		PV level background color light blue (191,198,208)	
PV foreground color dark blue (41, 69, 106) iFIX color 6965035		Status Border outline for dynamos blue blue (33, 33, 165)	
Alarm 1 (155,173,198)		Alarm 2 (123,146,173)	
OUT bargraph foreground blue green (20, 105, 126) iFIX color 8284436		OUT bargraph background color, light green (135,182,174) iFIX color	

SP, PV, Number values on background (6,31,49) darkest grey		Informational text -Tag names, EU's dark blue (33,65,118)	
Pipe and Tank			
Main pipe color (107, 141, 175) 11505003		Main Big Equipment Color tan (206, 199, 189)	

BorderEdgeColor_Tan Table

Abnormal Status			
Module select cyan (3, 187, 207)		Equipment abnormal blue (0, 0, 255)	

Alternate Colors (not in global color tables)

Arrows and Display Links			
Off display reference foreground color (214,211,206)		Arrow 1 grey-blue (107, 142, 173)	
Off display reference edge and arrow color (148,142,148)		Arrow 2 (148,142,148) grey	
Other Demo Colors			
Big Equipment outline (25, 47, 61)		Text on tanks (36, 60, 89) (same as all informational text)	
Alternate main pipe color (90, 145, 170)		Alternate main pipe color greyish (148, 143,148)	
Control Information Lines light grey (198, 198, 198) iFIX 13027014		Big Equipment, Dark 1 and Highlight color (182, 171, 156)	

Dark Gray Dynamo Theme Colors

Theme_Colors_Dark_Gray Color Table

Alarm 1 bar foreground (109, 138, 167)		PV background (48, 82, 122)	
Alarm 2 bar foreground (165, 181, 203)		PV background AI/ALM (85, 108, 136)	
Data value (222, 231, 239)		PV background level (85, 108, 136)	
Dynamo background (53, 53, 53)		PV foreground (22, 37, 56)	
OUT background (32, 113, 117)		SPWRK bar foreground (176, 158, 134)	
OUT foreground (140, 186, 181)		Status border (0, 202, 202)	
Picture background (45, 45, 45)		Tag EU (119, 151, 172)	
Pipe (107, 141, 175)		Vessel (77, 82, 88)	

BORDEREDGECOLOR_DARK_GRAY

Module select (45, 45, 45)		Equipment abnormal (0, 202, 202)	

Discrete and Analog Devices

All DeltaV Operate Themes use the same device global color tables.

Equipment ON/OFF OPEN/CLOSE colors:

Dynamic Equipment	
Equipment (pump/valve) outline (117,132,155)	
Discrete/Analog On color (238,242,249) off-white	
Discrete/Analog off color (180,185,200) silver-grey	

Discrete device global color tables:

DeviceControl_Color_Grey	Color table for On/Off colors for Normally Closed/Off
DeviceControl2_Color_Grey	Color table for On/Off colors for Normally Open/On

Along with the ON/OFF colors, discrete devices can also have one of the positions highlighted as abnormal. The abnormal discrete position is configured in the dynamo edit form. For example, a relief valve dynamo can be configured such that the OPEN position is abnormal. When the valve is open, the valve outline is wider and the color is changed to the ABNORMAL Color.

thrDCEdgeColor	Sets the value to 1 if the current DC State is the abnormal state
thrDCEdgeWidth	Sets the edge width when DC state is abnormal
Named_Colors	Abnormal color defined in this table

The analog valve dynamo indicates if the valve is open or closed, similar to a discrete valve. The percent that the valve must be open to indicate that it is open is user definable.

GN_AVLV_Open	OUT value above which the analog valve will show as open

Patterns Used in Theme Dynamos

The theme dynamos provide a few different graphical approaches in data presentation to aid in operator pattern recognition. Each incorporates spatial orientation and color usage to reduce the operators need to review the numeric data values and focus on the important information within the dynamo. Typical operator displays and dynamos rely on operators reading and comparing the process values. For example, operators are commonly shown the SP and PV values for loops. From these values, operators are tasked with determining whether the SP and PV are properly tracking, whether there is a deviation worth addressing and how close to an alarm limit is the PV.

Human factors research shows that reading requires users to focus on each value individually. Operators read the values and calculate the difference in those values one at a time (that is, serially). While focusing on one value, the other values on the screen are ignored. Thus, with only numeric displays, operators must periodically focus on each value and determine whether action is required.

The combination and normalized bar graphs were inspired from Bullet Graphs, described in the publication Information Dashboard Design – The Effective Visual Communication of Data by Stephen Few.

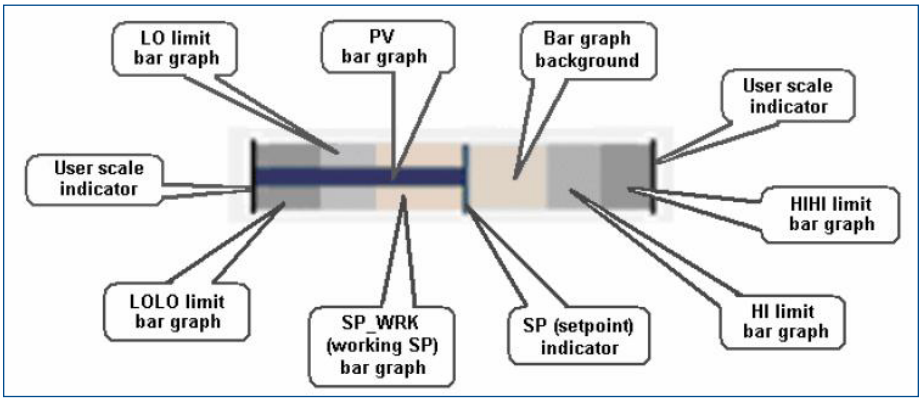
Spatial orientation is also a concept applied to these dynamos. Each dynamo is made up of individual elements. These elements are placed in the same location across all the dynamos where used. For example, alarm indication is in the upper left corner for all of the dynamos and mode indication is always to the left of the status indication. Consistency of element location creates a fixed spatial location within the dynamo for this related information. This is important because when operators can rely on looking to the same place, the display is less confusing and they can more quickly scan a display to understand what tags are affected.

Combination Bar Graph

The combination bar graph presents PID, AI or ALM information graphically, relative to the defined high and low scale defined in the dynamo. This allows operators to scan a display and understand their approximate values and position in range without needing to read the corresponding numerical values. The combination bar graph indicates the relative values of PV, SP, SP_WRK, and alarm limits (when the corresponding alarm is enabled), based on the defined range. By default, the range used is PV_SCALE (OUT_SCALE for AI blocks). The SP and SP_WRK indicators are hidden when the function block definition is the AI block.

Optionally, a user-defined scale can be configured. The user-defined scale can be defined as values, such as low range = 20 and high range = 80 or can be defined by paths, such as LO_LIM and HI_LIM. When paths are configured for the range, the range will dynamically adjust in runtime based on the current value of those paths.

Operators are provided indication that the dynamo is based on user-defined scales. When user-defined scales have been configured for the dynamo, it is indicated with perpendicular lines shown at the ends of the combination bar graph. Perpendicular lines are shown at both ends of the bar graph to indicate that a partial range is defined.



Combination Bar Graph.

The combination bar graph graphically shows the following key information:

- Comparison of PV and SP - Shape recognition is used to aid detection. When PV is equal to SP, the PV bar touches the perpendicular SP bar, forming a 'T'. If the PV is above SP, a 't' is shown. Knowing these shapes allows the operator scan a display and quickly know how PV and SP compare.
- Comparison of PV and SP, when operation is limited to a small portion of the full range - the user defined scaling can be defined such that even a small differences between PV and SP is very visible within the range defined. For example, a temperature bar graph may only show the range of 740 – 755, because this is the range the temperature is normally operated within. The full PV_SCALE may be 0 to 800.

- Comparison of PV and SP to SP_WRK - When SP_WRK is different from SP, it is shown on the bar graph. This allows operators to recognize the situation where PV is not equal to SP because SP_WRK is active and the currently displayed SP value is not being used by the module.
- PV and SP relative range - Operators are shown PV and SP are at the appropriate place in range. By default, the full 0 – 100% PV_Scale (OUT_SCALE for AI) range is shown in the graph. For process values such as temperature or pH where operation is required within a small percentage of the overall range, the bar graph can be defined with a partial range.
- PV and SP value relative to alarm limits - HI, HIHI, LO and LOLO Alarm limits are shown on the bar graph. If the PV or SP is near an alarm limit, the operator can determine this from the combination bar graph. The indication of these alarm locations is shown subtly (such as in grays), providing alarm limit information without being distracting or creating excessive visual clutter.

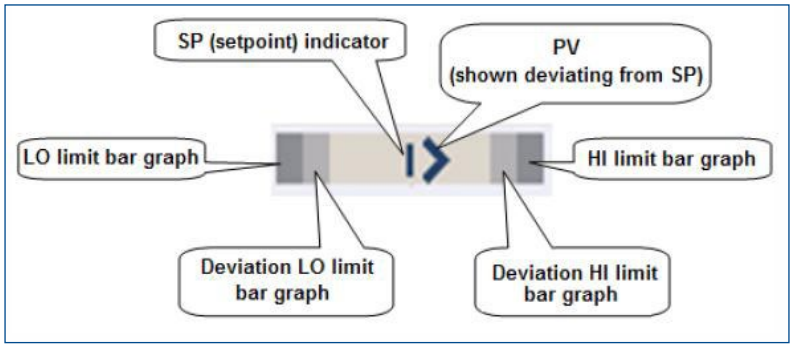
PV – SP Deviation (comparison) Bar Graph

The deviation bar graph presents PID or ALM information graphically relative to the current SP. This allows operators to scan a display and determine which modules have significant deviations between PV and SP, without needing to read the corresponding numerical values. The deviation bar graph compares the value of PV and the value of SP and displays the deviation. The perpendicular line representing SP does not move and is always in the center of the bar graph. The greater the deviation, the more visible the PV diamond becomes.

The distance between PV and SP on a bar graph always represents the same amount of deviation from that SP, whether PV is above or below SP. Thus a 2% deviation between PV and SP places PV at the same location on the bar graph, whether PV is above, or below SP. Since SP is fixed in the middle of the bar graph, it is the current SP value that defines the current range of PV shown in the bar graph.

By default, the maximum configured bar graph range uses PV_SCALE. In runtime, the bar graph always uses this maximum. Since the SP value is always in the middle of the graph, when SP is set at 50% of range, the PV diamond at the end of the bar would indicate that PV was at 0 or 100% of PV_SCALE. If SP is then set to 25% of PV_SCALE, the PV diamond at the end of the bar graph would indicate that PV was at -25% or 75% of PV_SCALE. Note that, in this case, PV would be limited to 0 and the diamond would never reach the bottom of the bar graph range of -25%, because the PV value cannot be outside of the PV_SCALE range.

Optionally, you can have a user-defined maximum configured bar graph range. The user-defined percent of scale can be defined as either a number or a path that resolves to percent . If the value is set to 10, it equates to +/- 5% of EU range. So the maximum bar graph range would have zero scale at SP minus 5% of EU range and full scale on the bar graph is SP plus 5% of EU range for a total of 10%. When using a path, limit the value to between 0 and 100. When a path is configured for the range, the range will dynamically adjust in runtime based on the current value of that path.



PV-SP Deviation Bar Graph.

The deviation bar graph graphically shows the following key information:

- Comparison of PV and SP - Shape recognition is used to aid detection of PV deviations. When PV equals SP, only the perpendicular SP line is visible. The greater the deviation, the more visible the PV diamond becomes, starting as an arrow and growing into the diamond shape. Knowing these shapes allows the operator to scan a display and quickly know how PV and SP compare.
- Pattern recognition to detect the the significance of any PV deviations from SP is possible, when multiple deviation bar graphs are viewed together, since the SP indication is fixed.
- Comparison of PV and SP, when small deviations are important - the user-defined scaling can be defined such that even a small deviation between PV and SP is very visible and provide this information for any SP value.
- Operators are shown PV and SP at the appropriate place in range. By default, the full 0 – 100% PV_Scale range is shown in the graph. For process values such as temperature or pH where operation is required within a small ercentage of the overall range, the bar graph can be defined with a partial range.
- PV and SP value relative to alarm limits - HI, DV_HI, LO and DV_LO Alarm limits are shown on the bar graph. If the PV or SP is near an alarm limit, the operator can determine this from the combination bar graph. The indication of these alarm locations is shown subtly (such as in grays), providing alarm limit information without being distracting or creating excessive visual clutter.

Normalized Bar Graph

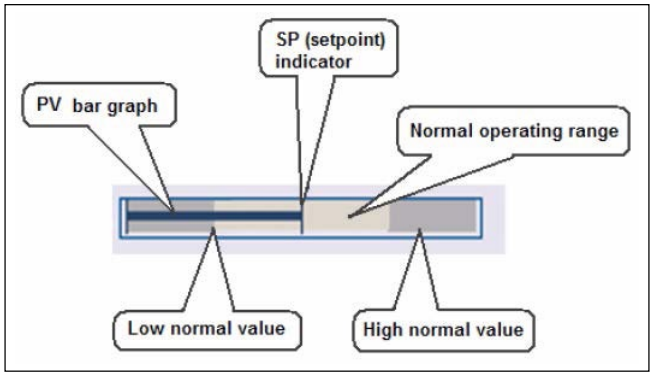
The normalized bar graph is a horizontal bar that presents PID, AI or ALM information graphically relative to defined normal ranges of PV_SCALE (OUT_SCALE for AI). This graph is useful when it is important whether values are in the defined normal range. The normalized bar graph divides PV_SCALE (OUT_SCALE for AI) into three sections. The three sections are always shown the same size, regardless of the percentage of the scale they represent. Thus, if several normalized bar graphs are stacked vertically, the normal sections line up, facilitating pattern recognition for value comparisons based on the defined normal ranges.

By default, the low normal value is defined by the block LO_LIM parameter and the high normal value is defined by the block HI_LIM parameter. Changing the alarm limit parameters adjusts the percentage of the scale in the three sections during run time. Optionally, user-defined parameters can be configured for the low and high normal values.

The normalized bar graph divides PV_SCALE (OUT_SCALE for AI) into three sections as defined by the High and Low Normal Values. For example, if the full scale is defined as 0 to 100, with LO_LIM equal to 10 and HI_LIM equal to 70, the three sections would be defined as 0 – 10, 10 – 70 and 70 – 100. PV and SP are positioned linearly within each section. Therefore, if PV was equal to 5, it would be shown at the midpoint of the low normal value section. If PV changed to 11, it would be shown on the left side of the normal value section. If PV changed to 40, it would be positioned at the midpoint of the normal section.

The SP indicator is hidden when the function block definition is the AI block.

Note: If the Low Limit Value is equal to EU0 then the left bar graph will not display. If the High Limit Value is equal to EU100 then the right bar graph will not display. We recommend that you do not set the LO or HI limits equal to EU0 or EU100, respectively.



Normalized Bargraph.

The normalized bar graph graphically shows the following key information:

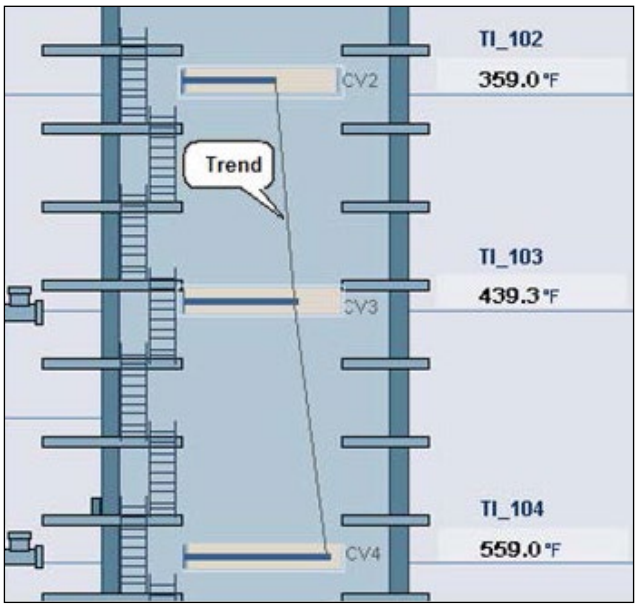
- Comparison of PV and SP - Shape recognition is used to aid detection. When PV is equal to SP, the PV bar touches the perpendicular SP bar, forming a 'T'. If the PV is above SP, a 't' is shown. Knowing these shapes allows the operator scan a display and quickly know how PV and SP compare.
- Comparison of PV and SP - based on current defined operating ranges. This graph can be particularly useful when the portion of the range defined as normal often changes for a value and so it is less likely that the operator will know where the values should be relative to percent in range. Operators can scan the graph knowing that the values outside the normal operating range are consistently represented (that is, not in the fixed, normal section).
- Monitoring of PV and SP when the normal operating range is a small percentage of the overall range – Since the normalized operating section is always shown the same size, the normalized bar graph can be used to show a small normal operating region as a large portion of the graph. For process values such as temperature or pH where operation is required within a small percentage of the overall range, the bar graph Normal Operating Region can be defined such that the operator has improved visibility to PV and SP movement within this region.

MultiPoint Trend Dynamo

The MultiPoint Profile dynamo allows you to trend up to 15 different data values (for example, the PV from 15 different modules) on one chart. The points are connected on the chart with a trend line. This allows operators to scan the trend line and view how the data points compare to each other. Each data point can be a single parameter's current value, or can be a complete expression (where the result of the expression is the data point). The trend line can be either horizontal or vertical.

The MultiPoint Trend Dynamo is useful when there are several related values that together form a pattern, such as multiple temperature values on a column. The trend line shows the comparison of these measurements, so that the operator can graphically view the pattern and also notice differences in the pattern, without needing to read and mathematically compare the corresponding numerical values.

Once added to the operator graphic, you can resize the dynamo to better fit on the picture and the type of profile. In the column example above, you can make the width and height to fit in the column shape on your picture. Also, the data points do not need to be evenly spaced; instead, the space between them can be adjusted to match the process.



Multipoint Vertical Trend Dynamo Example.

Alarm Indication

The dynamo is surrounded by a colored rectangle at run time when a module alarm is active or unacknowledged. The color corresponds to the highest priority alarm color. When a module's picture is open and selected, a visible alarm outline is surrounded by a slightly larger rectangle to indicate it is the selected module on the picture.

Default Alarm colors:

- Critical: Red (255, 0, 0)
- Warning: Yellow (255, 255, 0)
- Advisory: Purple (111, 49, 152)

Defined in Alarm_Color_Table. The alarm text colors are defined in AlarmTextColor

The alarm icon is also displayed representing the highest priority alarm for that module. The suppressed alarm icon is visible if there is a suppressed alarm (that would otherwise be active) and there are no other active or unacknowledged alarms.

Alarm Icon	Description
	Critical alarm (active or unacknowledged). Cross-hatching is visible behind the icon when the alarm is unacknowledged and inactive.
	Warning alarm (active or unacknowledged). Cross-hatching is visible behind the icon when the alarm is unacknowledged and inactive.
	Advisory alarm (active or unacknowledged). Cross-hatching is visible behind the icon when the alarm is unacknowledged and active.
	Suppressed alarm (otherwise active). Visible only if there are no other active or unacknowledged alarms. When the suppressed alarm icon is visible, the status outline surrounding the dynamo is shown instead of the alarm outline.

Status Indication

The dynamo shows a status icon and is surrounded by a colored rectangular outline at run time to indicate that a condition needing attention exists. The status outline is shown when there are no active alarms. The color of the status outline is based on the named Status border color in the Theme_Colors table. When there are active alarms, the alarm outline is shown instead.

The visibility of the status outline can be disabled for the following specific types of status.

ShowBorderBadIO	Determines the visibility of the status border when the Bad I/O is present in the module (default=Show)
ShowBorderDCWrongMode	Determines the visibility of the DC module dynamos' status border when the actual mode of the DC block is not the same as the normal mode or not the same as the target mode (default=Show) Note: Permissive Not Present condition causes LO mode
ShowBorderNoRunning	Determines the visibility of the status border when the module is not running (default=Show)
ShowBorderSim	Determines the visibility of the status border when Simulate is Active (default=Show)
ShowBorderWrongMode	Determines the visibility of the analog module dynamos' status border when the actual mode is not the same as the normal mode or not the same as the target mode (default=Show)

There are global variables for each of these indications. To turn off the visibility in DeltaV v11, uncomment the variable in User Settings and change the value to not show the outline. For custom dynamos in DeltaV v10, the variables can be changed in either the User or SIGlobals section (depending on which section has the variables).

The following describes the status icons used in the theme dynamos. These icons include: Mode, module running state, I/O state, simulate condition, permissive option, and interlock states.

Status Icon	Description
	Mode icon - Provides indication when Mode is not as expected. It is visible whenever either of the following is true: ■ The Actual mode of the PID block is not equal to the Normal mode ■ The Actual mode of the PID block is not equal to the Target mode **Note**: For DC modules, the mode icon is visible when Mode <> normal OR Permissive Active (Permissive Active also causes mode = LO). Shown in dynamo's lower left corner.
	Not Running icon - Visible if the module has any of the following conditions in the module MSTATUS parameter: ■ Out of Service ■ Breakpoint Set ■ Not Running Shown in dynamo's lower left corner, to the right of the Mode icon.
	Bad IO icon is visible if the module has any of the following conditions in the BLOCK_ERR parameter: ■ Out of Service ■ Readback Failed ■ Output Failure ■ Input Failure ■ Other Error The Bad IO icon is never visible when the Not Running icon is visible. Shown in the dynamo's lower left corner, to the right of the Mode icon.
	Simulate Active icon is visible per the Simulation Active condition in the module's BLOCK_ERR parameter. The Simulation Active icon is never visible if either the Not Running or Bad IO icon is visible. Shown in the dynamo's lower left corner, to the right of the Mode icon.
	No Permit icon - Visible if the following three things are true in the DC block: ■ DEVICE_OPTS parameter is set to Permissive ■ DC_STATE is set to Confirmed Passive ■ There is no permit. Shown in the dynamo's upper right corner.
	Interlock Bypassed icon - Visible if the module level BYPASSED parameter is True. Used only in modules containing a DC block. Shown in the middle of the dynamo's right side.
	Interlocked icon - Visible if DC_STATE of the DC block is Shutdown/Interlock. Shown in the dynamo's lower right corner.

Calculating Color Contrast for Readability

Although it is not possible to calculate what colors look well together, the following calculation can be used to verify if the there is enough contrast between the text and background colors for readability. This is particularly important for numbers, tag names, etc. on the display.

Brightness = sqrt(.241 R2 + .691 G2 + .068 B2)

The difference between the background and text brightness should be > 130. For example,
The brightness of the silver background is 226 (R=224, G=226, B=235)
The brightness of light grey text is 125 (R=124, G=124, B=137)
The brightness of dark blue text is 49 (R=14, G=50, B=96)

For light grey text, the difference is 101 (226 – 125). Since this is less than 130, there is not enough contrast to recommend using this color for items that must be read (although it may be OK as an accent color).

However, for dark blue text the difference is 177 (226 – 49), and therefore should offer enough contrast to be used as a text color.

This calculation was defined at the following web site: **http://alienryderflex.com/hsp.html**

Creating Your Own Theme Colors and Color Sets

Global Color Tables

It is easy to override the color settings defined in any of the global color tables. This should be done in your own copy of the color table, in either SIGlobals or User directory locations. Do Not change the colors in the tables in FRSVariables. Whenever you upgrade DeltaV, the FRSVariables file will be replaced during the product upgrade to the newer DeltaV version. This means that any changes users made to the FRSVariables file will be lost.

To modify a color setting from a global color table:

1. If the table is in FRSVariables, copy desired color table to User or SIGlobals (using the Copy Global Table toolbar button)

2. In User or SIGlobals

   a. Rename color table to match system default name (if necessary) to Theme_Colors, BorderEdgeColor, etc.

   b. Modify the colors in table as desired

3. In run mode, your color table will be used instead of the default system theme colors.

You can easily modify the default DeltaV Theme Colors table to better match your operating requirements. The Theme_Colors threshold table defaults to the Theme_Color_Silver threshold table.

To change the theme color table used,

1. Rename Theme_Colors to Theme_Colors_SIlver

2. Rename the desired table to Theme_Colors (e.g. from Theme_Colors_Tan to Theme_Colors)

Custom Color Sets

Although less common, you can also create your own color set, such that your favorite colors are included in a single palette. When you create a new color set, it is automatically added to the list of color set tables on that workstation. However, you need to edit the list of color tables to ensure that all workstations properly show your selected colors.

Tables.lst	List of color palettes available to DeltaV Operate (file in PIC directory)

The Tables.lst file is used by DeltaV Operate as the master list of what color sets to use. The order of the color sets in this list is very important for the proper display of color in displays. Do not rearrange or delete the color set names in this list. This means that the Shades of Silver Theme color set must always be the 21st entry in this list.

There are a number of blank locations (called Custom Color Set Placeholders) in the table.lst file. For upgrading systems, it is very important that if you have created custom color sets, that they are included in this file, in the exact same distance from the top. Replace one of the placeholder locations with the name of your color set.

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