Crestron Programming

Design Guide

Crestron Electronics, Inc.

Original Instructions
The U.S. English version of this document is the original instructions.
All other languages are a translation of the original instructions.

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The product warranty can be found at www.crestron.com/warranty.

The specific patents that cover Crestron products are listed at www.crestron.com/legal/patents.

Certain Crestron products contain open source software. For specific information, visit www.crestron.com/opensource.

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Introduction

Crestron touch screens and keypads provide an intuitive way for users to interact with the systems in their homes, offices, schools, and other locations. From the user interface, individuals can create a comfortable environment, set a mood, or control different functions within a system. Crestron simplifies the development of user interfaces and the user experience with its Crestron Home® and .AV Framework™ software applications as well as its Crestron HTML5 User Interface design components.

Crestron Home® OS

Crestron Home unlocks the full potential of a smart home. It provides dealers with the ability to deliver a sleek user interface that includes fluid dynamic room controls and new features such as support for multiple homes, favorites, custom access, room image customizations, and more.

Refer to www.crestron.com/crestronhome for more information about Crestron Home and for a list of supported Crestron and third-party equipment.

.AV Framework™ Software

Crestron® .AV Framework™ software is a web-based management solution that is used to deploy scalable Crestron enterprise room solutions without requiring any programming. The .AV Framework configuration utility is accessible from most web browsers and provides the following functions:

- Select sources and displays.
- Configure device control for Blu-ray Disc® players, cable TV boxes, and video servers.
- Add a compatible touch screen to generate the GUI for single or multiple display systems.
- Add a compatible button panel to control single display systems.
- Connect to Crestron Fusion® software to monitor basic room data and to monitor and control system power, source selection, and room scheduling.
- Customize the .AV Framework user experience with additional components, custom functionality, and corporate logos.

Refer to www.crestron.com/avframework for more information about AV Framework and for a list of supported Crestron and third-party equipment.

Crestron HTML5 User Interface

Crestron HTML5 User Interface is a collection of design components used for creating a JavaScript® programming library that is compatible with HTML5. This library allows web application developers to create UI projects that communicate with Crestron control systems instead of normal HTTP servers.

Crestron HTML5 User Interface can be run on a touch screen, on a web browser using the HTML Web XPanel feature, or on an iOS® device (iPhone® and iPad® devices) using the Crestron ONE™ app.

For more information on downloading, installing, and using Crestron® HTML5 User Interface, refer to the Crestron HTML5 User Interface Developer Microsite at developer.crestron.com.

Crestron Go App

The Crestron Go App turns an Apple® iPhone® device into a mobile Crestron touch screen with Super Retina® display support, enabling complete control of AV systems, lighting, shades, climate control, security, and other systems from virtually anywhere. The Crestron Go App can be programmed with Smart Graphics® technology, making it easy to deliver a custom user experience that is both dynamic and intuitive. Additional capabilities include viewing video from IP-based security cameras, communicating with other Crestron touch screens using the Rava® SIP Intercom, and seamless integration with third-party apps.

Managing Expectations

To design a successful user interface, a programmer must have a clear vision of the project, space, subsystems, and the customer's desires and expectations—all of which dictate functionality. It is vital to know the functions to be controlled and to understand how the end user will control the system.

- Will the touch screen control subsystems such as lighting, HVAC, and security?
- How does the customer want the zones divided and controlled for lighting, audio, and video?
- Does the customer expect complex lighting, shades, and climate control events and scenarios, or do they just want to turn lights on and off?

It is equally important to evaluate the end user's level of technical sophistication. The programmer must work within the customer's abilities while striving to meet expectations. Clear, efficient design results in a system that will appeal to the client.

Managing expectations is critical to the success of any given project. If there are too many buttons on a page, reorganize or reprioritize the subcategories to reduce the number of buttons per page. The number of buttons that can be comfortably positioned on a screen is determined by the physical size of the touch screens. Therefore, a more attractive, more intuitive interface is achieved with a larger touch screen.

The ideal number of button presses required to effect an event from anywhere in the GUI is one to three. Reducing navigation, button presses, and subpages for the end user makes the interface more useful and attractive. When designing a custom interface, start by talking to the customer about the decor of the room, a corporate image, or their favorite colors. It is essential to understand how the interface is intended to complement or match the client's decor, environment, and needs.

UI Design Software

VisionTools™ Pro-e (or VT Pro-e®) software is Crestron's Windows® OS-based application for designing the page layouts and functionality of user interfaces. Controls are grouped together on "pages" and these control pages are organized and grouped together as a project. A typical page layout includes objects such as buttons and sliders that start actions and provide feedback to the end user. Pages can also include video windows, decorative graphics, background graphics, text, and a variety of other objects.

A "page flip" causes the screen to switch from one page to another when a button is pressed. Browser projects also support page flips to a URL, or even to a different section of the current (large) page. Subpages are similar in many ways to standard pages, in that they may contain buttons, text, graphics, etc. However, subpages ordinarily do not take up the entire display area. Instead, a subpage often defines a small area with buttons serving a specific function, such as video player control. A subpage can be designed to appear on top of a standard page at any time and then disappear when no longer needed.

VT Pro-e software enables layering of objects on top of each other, allowing for versatile design possibilities. Objects are layered in the order they are created. That is, a newly created object will be overlaid onto an existing one, and if one object is dragged over to another, the more recently created object is visible on top.

Sound

The VT Pro-e Sound Manager enables the user to add WAV files to projects for sound-enabled touch screens and keypads.

Background Images

VT Pro-e supports BMP, PCX, DIB, PNG, and JPEG formats. Images can be modified to fit the page. The **Tile** option fills the space on the page with multiple copies of the image. (This feature works best with smaller images.) The **Stretch to Fit** option stretches out the image to fill the entire page.

Bit Depth and File Size

Bit depth refers to the number of memory bits used to store color data for each pixel in a raster image. A touch screen's raster image consists of a rectangular grid of picture elements (pixels). Each pixel uses the same amount of memory to store its color data. The amount of memory is called the bit depth of the image.

Greater bit depths are required to represent finer gradations of color. Increasing bit depth increases file size. A black and white drawing requires only one bit per pixel to store all the available color information. Using a 32-bit per pixel bit depth for a black and white image increases the file size 32 times without adding anything to the image quality.

- In an 8-bit per pixel system, the associated 8 bits of video memory for every screen pixel contain a value referring to a location in an 8-bit color table. In this way, any one of the specific 256 color table locations is assigned to a pixel.
- A 16-bit highcolor system is considered sufficient to provide life-like colors. It is encoded using 5 bits to represent red, 5 bits to represent blue, and (since the human eye is more sensitive to the color green) 6 bits to represent 64 levels of green. These can therefore be combined to provide 65, 536 mixed colors (32 x 32 x 64 = 65, 536).
- In a 24-bit graphics display, 24 bits of video memory is allocated for each pixel on the screen enabling each pixel to take on any one of a possible 16.7 million colors. Each 24-bit value is composed of 8 bits for red, 8 bits for green, and 8 bits for blue. These triplets of 8-bit values are also referred to as the red, green, and blue color planes. A 24-bit image is actually composed of three component images, which combine to create the truecolor picture. The reason this is called truecolor is that this is near the maximum number of colors the human eye is able to detect.
- Truecolor images are sometimes represented by a 32-bit value. The extra 8 bits do not enhance the precision of the color representation but act as an alpha channel that represents pixel translucence. The 32-bit truecolor has become popular on computer desktops to provide effects such as translucent windows, fading menus, and shadows.

In graphics-intensive applications such as touch screens, raising or lowering the bit depth of the displayed graphics can achieve a balance of performance and quality. Lower bit depths do not require as much frame buffer memory or display bandwidth, allowing them to be generated and displayed more quickly. Increasing bit depth results in higher color quality at the expense of display speed and responsiveness. By using mostly 8-bit or 16-bit graphics and holding the 32-bit graphics to a minimum (for example, for a family photo, etc.), a sophisticated project can be created that fits in the memory space provided and allows the touch screen to remain very responsive.

Bits to Colors Relationship

Bits	Colors
1	Black and white
2	4 colors
4	16 colors
8	256 colors
16	65, 536 colors (highcolor)
24	16.7 million colors (truecolor)
32	16.7 million colors plus translucence

When creating a VT Pro-e project, compress and reduce the image size in the **Page Properties** window for the entire page, or perform the same function in the **Image Properties** window. A reduction in image size saves a considerable amount of memory space for the project.

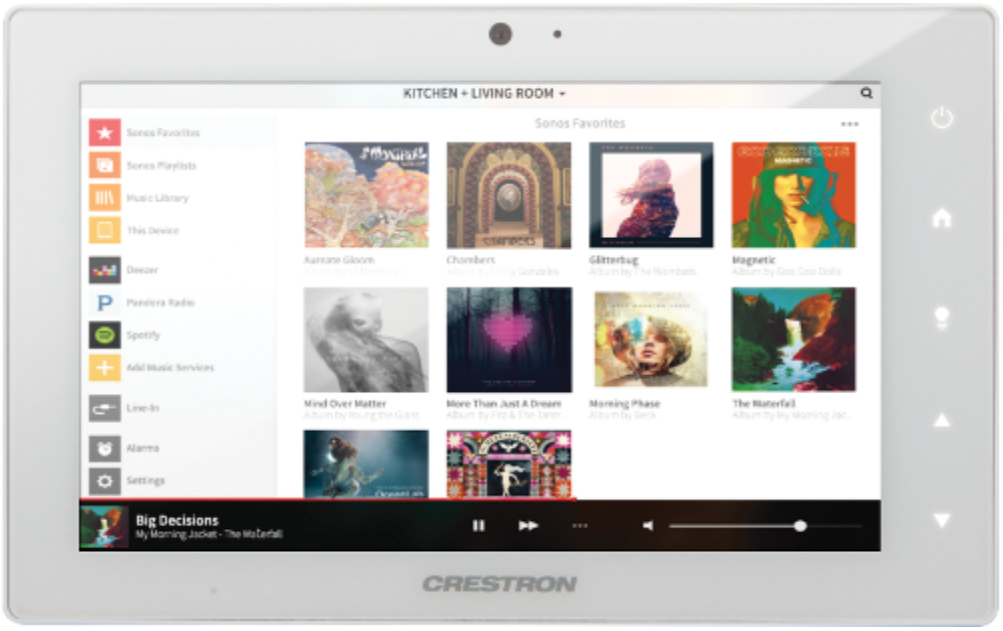
The conversion to a 16-bit image may cause the loss of some subtle shading. To compensate for this, use dithering to simulate the original shading. Various dithering types are available.

Touch Screens, Templates, and Themes

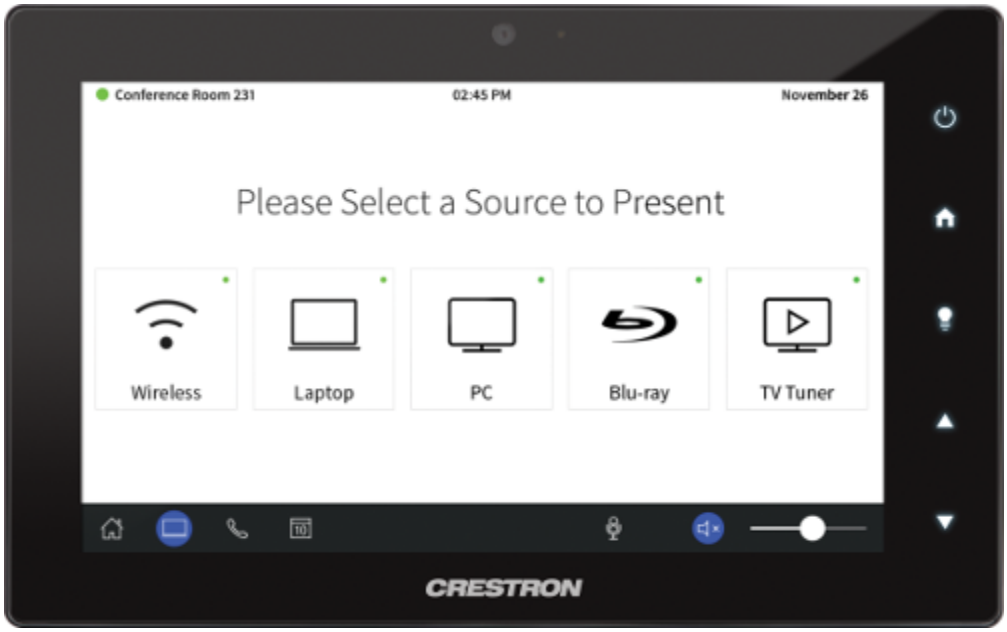
Crestron offers a variety of predesigned templates that may be customized to fit your project needs. The templates cover a wide variety of control requirements and provide the designer with a starting point for large or small projects.

The following are a few examples of the many possibilities that templates can provide.

Smart Graphics® for Home



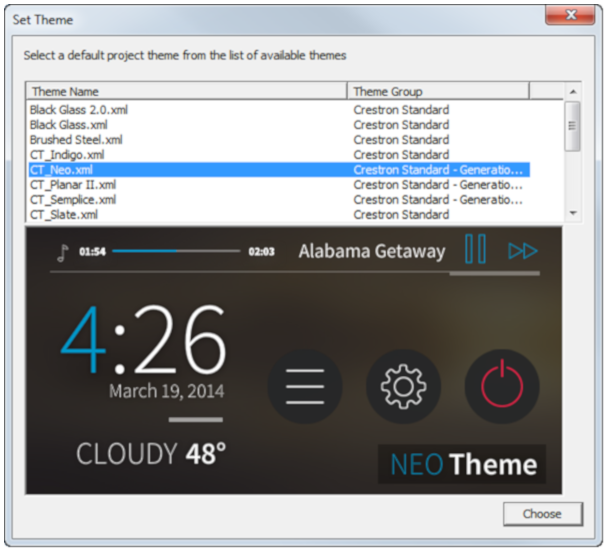
Smart Graphics for Conference Room



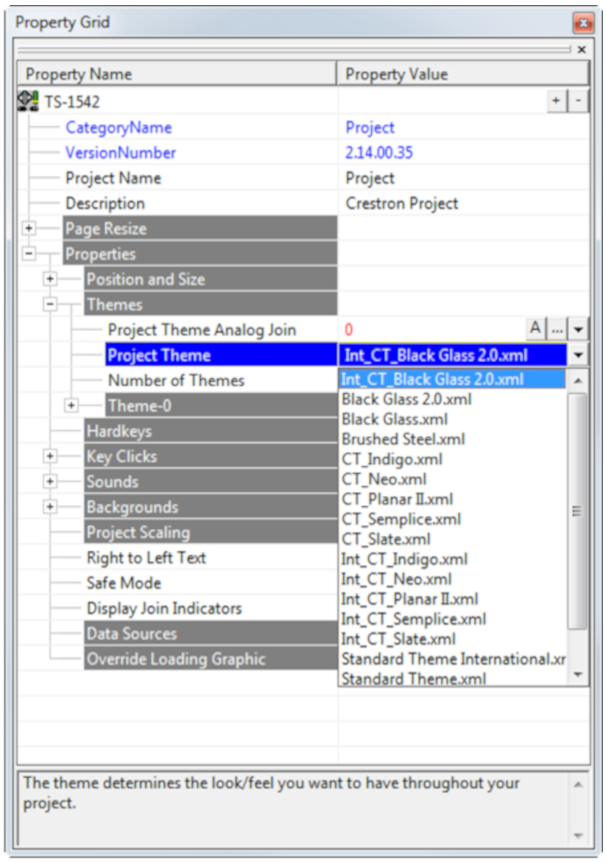
Smart Graphics for Room Scheduling

In VT Pro-e software, a theme is a set of unified design elements and color schemes for the objects and pages in the touch screen project. When a theme is applied to a project, VT Pro-e customizes attributes, such as colors, styles, fonts, and shapes for elements in the project. In this way a theme helps create a consistent and professional look.

Crestron provides several themes with VT Pro-e. The theme is chosen when a new project is created.



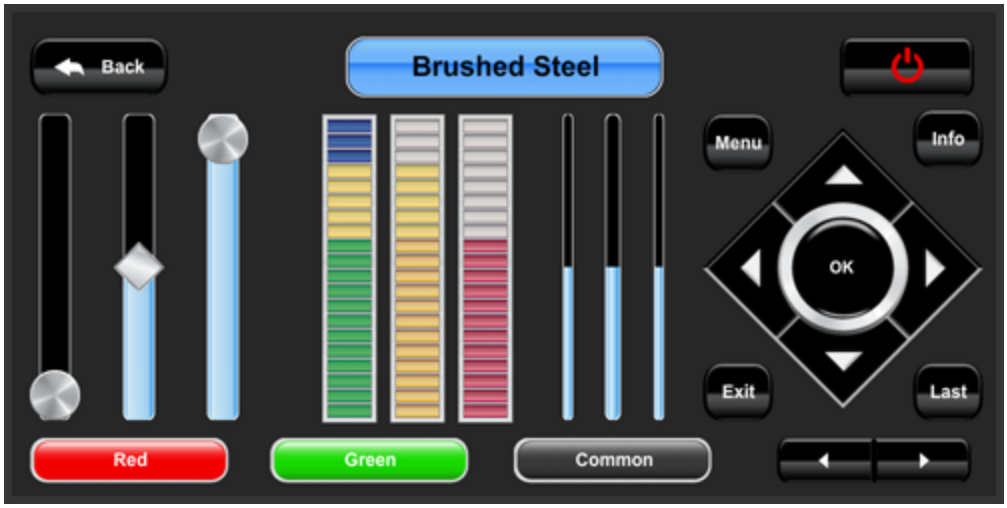
After the project has been created, the theme can be changed in the projects **Property Grid**.



All themes are available to any project of the same type, including projects created in earlier versions of VT Pro-e.

Black Glass Theme

Brushed Steel Theme



Project Planning

Planning your project carefully helps to produce a good result. The forms provided in the sections that follow can be used to ensure that all applicable information for a project has been recorded.

- Form A is a complete list of all equipment to be controlled.
- Form B defines the customer interface.
- Form C defines the routing of sources to destinations
- Form D provides a method to specify button panel operation and engraving.

> **NOTE:** Additional forms are provided for lighting control.

A successful design should include the following information:

- System block diagram
- Control diagrams
- Facility plans and/or other layout diagrams
- System description
- Applicable audio files
- Applicable graphic files

Form A - Device Data Instructions

Data collection is required before starting any programming project. Each controlled device must be listed by type, manufacturer, model number, and control method (for example, RS-232, IR, and so forth.).

For equipment that does not have discreet power on/off capability, specify additional video or current sensing equipment. Crestron maintains an extensive database of equipment control software, making it likely that there is data for all equipment in the project.

> **NOTE:** Custom control modules can be developed for any control system platform solution. This development should be performed by a knowledgeable Crestron developer.

Use as many copies of Form A as necessary to collect and record device data. Be sure to fill in the heading on every copy.

Form A - Device Data

Use the following form to record device data for the programming project.

Project Name	Date
Order/Quote #	Page of

Type of Device (Ex. Blu-ray Disc®, TV, CD)	Manufacturer (Ex. Sony®, Panasonic®)	Model Number (Ex. LIO-8)	Control Method (Ex. RS-232, IR, IP, RF)

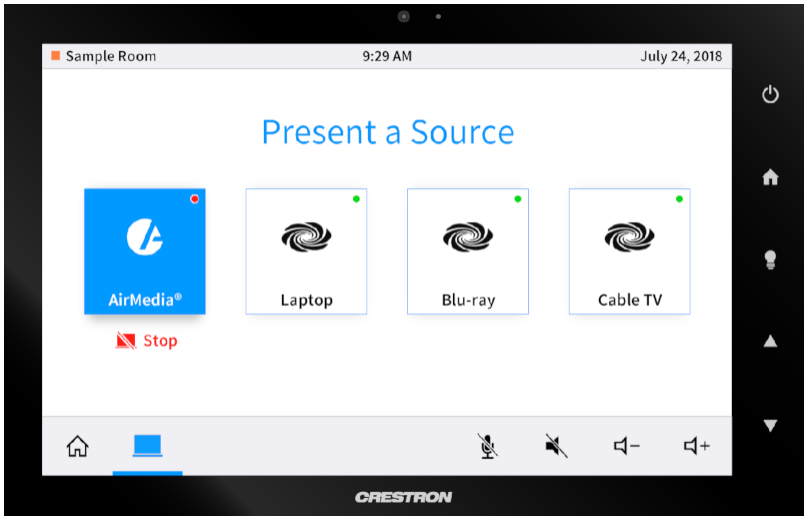
Form B - Interface Specification Instructions

Determine the number of pages required for the project, including at least one page for each device (such as projector, display, and video player), pages for systems (such as HVAC and security), and the main (home) page. Use at least an equal number of copies of Form B per page when planning the interface specification.

> **NOTE:** Pages and subpages are unique and should not share forms.

Fill in the project name, date, touch screen model (for example, TSW-770), the screen name (for example, Main page), location (for example, home theater room), order/quote number, and page number (for example, 1 of 7) on every page.

An example interface specification is provided in the section that follows. Using that example would result in a screen like the one shown below. Note that this screen is showing .AV Framework software and does not represent a custom user interface.



Form B - Interface Specification Sample

The following example form is provided to show how to record the interface specification for the programming project.

Project Name	Source Presentation for Conference Room	**Date**	7/11/21
Order/Quote #	BD5277	**Page**	1 of 1
Touch Screen Model #	TSW-770	**Screen Name and Location**	Presentation 1 - Room 2054

Object Type (Ex. Button, Gauge)	Object Label (Abbreviate as necessary)	Function/Device (Specify the function to control and the device to control)	Page Flip To... (Ex. Subpage name, Main Page)	Control Method (Ex. RS-232, IP, IR, RF)
Button	AirMedia®	Selects AirMedia source	Now Presenting AirMedia	
Button	Laptop	Selects HDMI source	Now Presenting Laptop	
Button	Blu-ray	Selects HDMI source	Now presenting Blu-ray	
Button	Cable TV	Selects HDMI source	Now presenting cable TV	
Button	Stop	Stop routing source to display		
Button	Home	Return to Main Page	Main Page	
Button	Present	Display source selection page	Present a Source	
Button	Mic mute	Toggles microphone on/off		IR
Button	Vol mute	Toggles device mute/unmute		IR
Button	Vol lower	Lowers volume		IR
Button	Vol raise	Raises volume		IR
Button	Back	Return to source selection	Present a Source	

Form B - Interface Specification

Use the following form to record the interface specification for the programming project.

Project Name		Date	
Order/Quote #		Page	of
Touch Screen Model	Screen Name and Location		

Object Type (Ex. Button, Gauge)	Object Label (Abbreviate as necessary)	Function/Device (Specify the function to control and the device to control)	Page Flip To... (Ex. Subpage name, Main Page)	Control Method (Ex. RS-232, IP, IR, RF)

Form C - System Routing Specification Instructions

Form C is used to describe the routing of each source output to each destination input. Specify the source (for example, DVD-1 or USB-C) and the particular source output (for example, HDMI-1 or DVI).

> **NOTE:** When an intermediate switcher is used, specify the device and the input/output ports (for example, Video 1 IN or Video 1 OUT).

The final destination device is noted in the second to last column. Include the device name and the input port. A Scenes Tag column is also provided to document any scenes (such as lighting, media, and so forth) that will need to be accounted for in the system route.

The bottom of the form has an area for additional notes that can be used to further define how the system can be programmed for specific needs.

Make as many copies of Form C as necessary.

Form C - System Routing Specification

Use the following form to record the system routing specification for the programming project.

Project Name	Date
Order/Quote #	Page of

Source Name	Source Output/Type	Switcher Device Name		Final Destination and Input Port	Scenes Tag
		Input Port	Output Port		

Touch Screen Resolution Specifications

The following tables provide resolution specifications for common Crestron touch screens.

Tabletop Touch Screens	Screen Size (inches)	Resolution	Color Depth	Aspect Ratio
TS-1542-TILT	15.6	1920 x 1080	24-bit, 16.7M colors	16:9 Full HD
TS-1070	10.1	1920 x 1200	24-bit, 16.7M colors	16:10 WUXGA
TS-770	7	1280 x 800	24-bit, 16.7M colors	16:10 WXGA
FT-TS600-B	5	800 x 480	24-bit, 16.7M colors	15:9 WVGA

Wall Mount Touch Screens	Screen Size (inches)	Resolution	Color Depth	Aspect Ratio
TS-1542	15.6	1920 x 1080	24-bit, 16.7M colors	16:9 Full HD
TSS/TSW-1070	10.1	1920 x 1200	24-bit, 16.7M colors	16:10 WUXGA
TSS/TSW-770	7	1280 x 800	24-bit, 16.7M colors	16:10 WXGA
TSW-570	5	1280 x 720	24-bit, 16.7M colors	16:9 HD 720
TSW-570P	5	720 x 1280	24-bit, 16.7M colors	16:9 HD 720*
TSD-2220**	21.5	1920 x 1080	24-bit, 16.7M colors	16:9 Full HD

* Portrait orientation

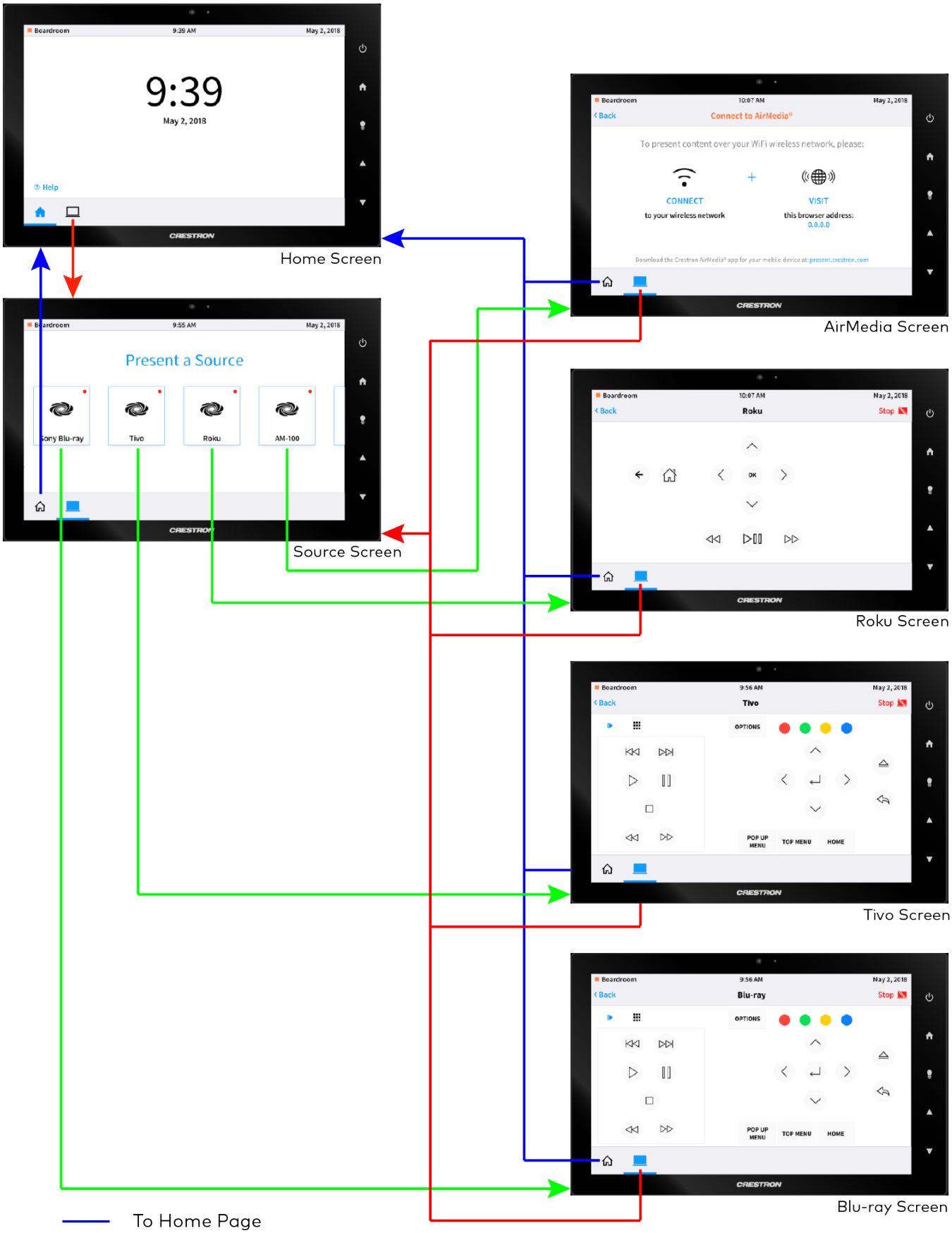
** When used as touch screen display along with a Crestron digital graphics engine.

Wireless Touch Screens	Screen Size (inches)	Resolution	Color Depth	Aspect Ratio
TSR-310	3	320 x 480	18-bit, 262k colors	3:2 HVGA*
TST-902	8.7	1008 x 588	24-bit, 16.7M colors	12:7
TST-1080	10.1	1920 x 1080	24 bit, 16.7M colors	16:10 WUXGA

* Portrait orientation

Touch Screen Control Flow

The following block diagram represents a simplified touch screen showing the relationship of pages. The arrows represent page flips. Creating a similar diagram when designing a system is highly recommended, as it allows the programmer to visualize the entire system. This process makes the task of specifying controls that appear on each screen much simpler.


Boardroom
9:39 AM
May 2, 2018
9:39
May 2, 2018
Help
CRESTRON
Home Screen
Boardroom
10:07 AM
May 2, 2018
Back
Connect to AirMedia®
To present content over your WiFi wireless network, please:
CONNECT
to your wireless network
VISIT
this browser address:
0.0.0.0
Download the Crestron AirMedia® app for your mobile device at: present.crestron.com
CRESTRON
AirMedia Screen
Boardroom
9:55 AM
May 2, 2018
Present a Source
Sony Blu-ray
Tivo
Roku
AM-100
CRESTRON
Source Screen
Boardroom
10:07 AM
May 2, 2018
Back
Roku
Stop
OK
CRESTRON
Roku Screen
Boardroom
9:56 AM
May 2, 2018
Back
Tivo
Stop
OPTIONS
POP UP MENU
TOP MENU
HOME
CRESTRON
Tivo Screen
Boardroom
9:56 AM
May 2, 2018
Back
Blu-ray
Stop
OPTIONS
POP UP MENU
TOP MENU
HOME
CRESTRON
Blu-ray Screen
To Home Page
To Source Menu Page
To Source Page

Impress Software

The Impress Custom Engraving Software provides custom engravings for the latest Crestron® engravable products, including remotes, keypads, signs, and more. The software is backwards compatible with Crestron Studio® software and engravings created with the Crestron Home® OS. Design options include engraving icons, mixing fonts on a single line, and styling text with emphasis, alignment, and font size. The software uses engraving technology to ensure what is designed on-screen matches the final product the customer receives.

For more information about using Impress software for programming projects, refer to the Impress Software Product Manual.

The latest version of Impress software can be downloaded from www.crestron.com/Support/Resource-Library.

Button Panel Specifications

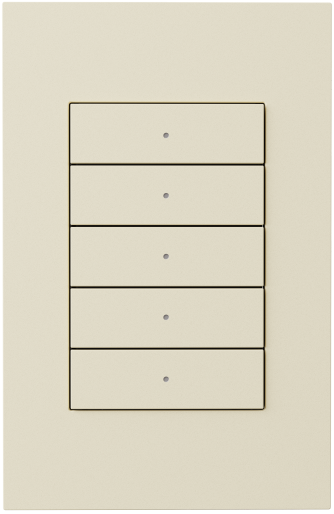
The following Crestron button panels are recommended for programming projects.

Horizon 2 Series Keypads

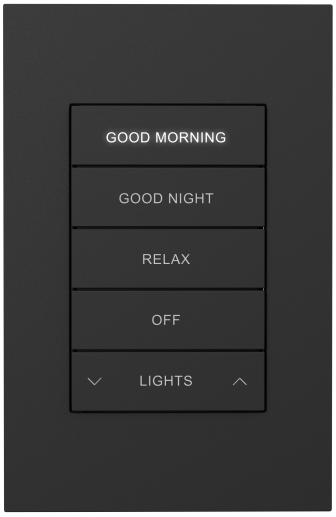
Each Horizon® 2 keypad has five button locations, each of which may be populated with a single push button or horizontal rocker. Larger vertical rockers are also available, one of which takes the place of three single buttons, and one that occupies all five locations.

Five single push buttons (without engraving) are included by default. Additional buttons are available separately (with or without custom backlit laser-etched engraving). Button backlight color is fully programmable. Up to four keypads can also be ganged side by side to easily configure a comprehensive keypad solution for any room control application.

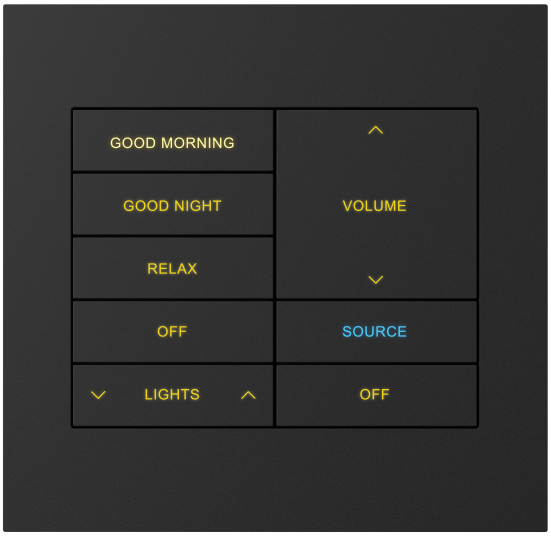
Single Push Buttons



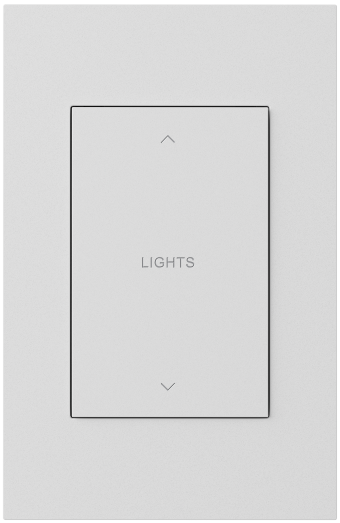
Single Side-to-Side Rocker Button



3-Button Vertical Rocker (in Ganged Keypads)



Full Button Vertical Rocker



C2N-CBD Series Cameo Keypads

C2N-CBD series Cameo® keypads can be configured to include two to eight buttons. Each keypad is furnished with an assortment of button caps in four different sizes to support a variety of physical layouts. Additional button caps may also be ordered with custom backlit laser engraving to clearly designate each button's function.

Through programming, each button can be configured to use "button events," allowing for up to three separate functions per button by tapping, double-tapping, or pressing and holding the button."Shift key" functionality, in which the user presses and holds one button while simultaneously tapping another, provides further customization for this versatile keypad.

Eight Push Buttons

Two Push Buttons

Six Push Buttons

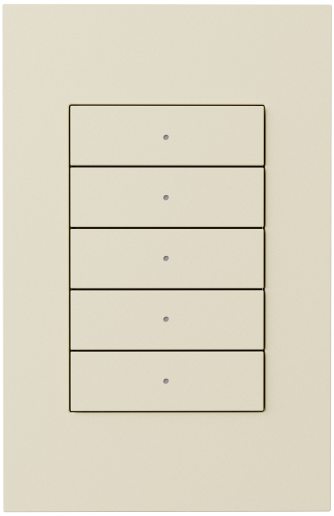
Six Push Buttons

The switch caps also offer white LED backlighting, with a programmable intensity of 0 to 100%. True backlighting is not practical in certain circumstances, such as when using black switch caps. Instead, the program can use the feedback LEDs to perform a backlighting function, turning them all on but at a fixed percentage of their active state intensity.

Form D - Horizon 2 Keypad Specifications

Use the following form to record Horizon 2 keypad specifications for the programming project.

Project Name	Date
Order/Quote #	Page of
Location	



Button Engraving
1
2
3
4
5

Button Label	Function	Color	Keypad Backlight %

Form E - Cameo Keypad Specifications

Use the following form to record Cameo keypad specifications for the programming project.

Project Name		Date	
Order/Quote #		Page	of
Location			

Button Engraving
1
2
3
4
5
6

Button Label	Function	Left	Right	Single Button	Keypad Backlight % *	Keypad Feedback % *

* Keypad backlight and keypad feedback levels are global for the entire keypad. These levels cannot be adjusted on individual buttons.

Cameo In-Wall Dimmers and Switches

Cameo buttons can be swapped in the field, making it easy to change engraving or color after installation. Buttons control in-room audio or lamps, in addition to any other light connected to the system. Cameo also functions as a keypad, sending commands to trigger whole-room lighting scenes or distributed audio functions. Supporting one, two, three, or four buttons, the in-wall dimmer serves as a great user interface in any Crestron system. Engraveable button caps are included.

Model	Description
CLW-DIMEX-P	Wireless In-Wall Dimmer
CLW-SWEX-P	Wireless In-Wall Switch
CLW-DIMSWEX-P	Wireless In-Wall Dimmer/Switch
CLC-FANDELVEX-W	Wireless Lighting and Fan Controller

Form F - Cameo Specifications

Use the following form to record Cameo in-wall dimmer and switch specifications for the programming project.

Project Name		**Date**	
Order/Quote #		**Page**	**of**
Location			

Button	Function	Engraving	Feedback / Bar Graph

C2N-CBF-P, C2N-CBD-P, and C2NI-CB Cameo Keypads

The following C2N series Cameo keypads are recommended for Crestron programming projects.

C2N-CBF-P and C2N-CBD-P Cameo Keypads

A single Cameo Keypad can be easily configured by the installer to provide two to eight distinct buttons. Each keypad comes with an assortment of engraveable button caps in four different sizes to support a variety of physical layouts.

Through programming, each button can be configured to use "button events," allowing for up to three separate functions per button by tapping, double-tapping, or pressing and holding the button. "Shift key" functionality, in which the user presses and holds one button while simultaneously tapping another, provides further customization for this versatile keypad. Split small buttons may be installed in the bottom two positions only.

Each keypad includes two large, three medium, six small, and four (two pairs) small split buttons. When a button cap covers two or three buttons the bottom button of the set is activated. For example, for a 2-button cap, if buttons 1 and 2 are covered, pressing the button shall activate button 2. For a 3-button cap, if buttons 4, 5, and 6 are covered, pressing the button shall activate button 6.

NOTES:

- For a single button cap, if button 7 is covered, pressing the button activates button 5.
- No LED feedback is provided for buttons 7 and 8.

C2NI-CB Cameo Keypad

Designed for installation in single-gang European or UK wall boxes, the Cameo International Keypads can be easily configured by the installer. Each keypad comes with two columns of engraveable button cap strips. Each strip is available in one of the following three button cap configurations:

- Set of two large buttons
- Set of three medium buttons
- Set of four small buttons and one medium button

Through programming, each button can be configured to use "button events," allowing for up to three separate functions per button by tapping, double-tapping, or pressing and holding the button. "Shift key" functionality, in which the user presses and holds one button while simultaneously tapping another, provides further customization for this versatile keypad.

Form G - C2N-CBF-P, C2N-CBD-P, and C2NI-CB Specifications

Use the following form to record C2N-CBF-P, C2N-CBD-P, or C2NI-CB specifications for the programming project.

Project Name		**Date**	
Order/Quote #		**Page**	**of**
Location			

Button	Function	Engraving	Tap	Double-Tap	Hold	"Shift"	Feedback / Bar Graph

HTT-B10EX Tabletop Keypads

The HTT-B10EX provides an elegant keypad for lighting, climate, and audio control. Ten tactile backlit engraveable buttons with white LED feedback, autodimmable backlighting and LED intensity, and dual bar graph capability. The HTT-B10EX ships with 10 blank buttons (two columns of five buttons each) offering the right amount of control for most applications. For more advanced applications, each button can be configured to enable up to three separate functions by tapping, double-tapping, or pressing and holding the button. "Shift key" functionality, in which the user presses and holds one button while simultaneously tapping another, provides further customization for this versatile keypad. Ten different blink patterns are built in, enabling all kinds of blinking LED feedback while simplifying programming and minimizing traffic on the infiNET EX® network. Additional bar graph capability uses the same LEDs to display actual level settings in the form of two vertical 5-segment bar graphs.

Available Accessories

Model	Description
B10-BTNB-T_5_BLANK	Blank buttons, black
B10-BTNB-T_5_ENGRAVED	Engraved buttons, black
B10-BTNW-T_5_BLANK	Blank buttons, white
B10-BTNW-T_5_ENGRAVED	Engraved buttons, white

Form H - HTT-B10EX Specifications

Use the following form to record HTT-B10EX specifications for the programming project.

Project Name		Date	
Order/Quote #		Page	of
Location			

Button	Function	Engraving	Tap	Double-Tap	Hold	"Shift"	Feedback / Bar Graph
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Lighting Control Interface

Crestron lighting and automation solutions provide excellent value and performance, comprising a comprehensive line of modular enclosures, wall-box dimmers, and climate control thermostats that are controlled by a powerful Crestron 4-Series™ Control System.

Crestron offers a complete selection of user interfaces. Keypads and touch screens provide convenient fingertip control access throughout any environment. Every installation is fully customizable to attain streamlined control and automation of complex system functions, as well as end-user comfort. Nearly limitless connectivity options are also available to support integration with non-Crestron components.

Crestron control can change the ambiance of a room at the press of a button, schedule landscape lighting to turn on automatically at dusk, or remotely adjust the air conditioning from a mobile device. Lighting, climate control, security, access control, irrigation, window treatments, pool and spa, A/V, and other systems all integrate seamlessly.

In order to properly design a lighting control system for a project, gather the following information.

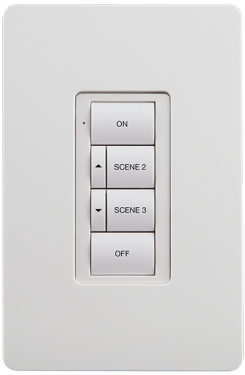
- Project name
- Project location
- Contact information for the project system designer
- Load schedule or panel schedule indicating controlled lighting load types (incandescent, magnetic or electronic low voltage, fluorescent, etc.) and the number of types assigned to each circuit
- Voltage for each load
- Ballast types specified for fluorescent dimming (2, 3, or 4-wire) or ELV if applicable
- Emergency power requirements—indicating which loads are connected to emergency power
- Spare circuits required
- External systems interface(s)
- Other special considerations, such as, specific panel locations, main or branch circuit breaker requirements. The touch screen Graphical User Interface (GUI) and the keypads are the only components that the end user sees or touches. These are the user's primary points of interaction with the integrated system. The quality of the GUI design and button layout largely determines the ultimate usefulness of the entire system.

Use as many copies of the following forms as necessary to specify the user interface.

Form I - Lighting Control Programming Request - Keypads

Use the following form to record lighting control information for keypads within the programming project.

Project Name	**Date**
Load Name	**Job #**
Location	**Start Date**
Contact Name	**Contact Phone**



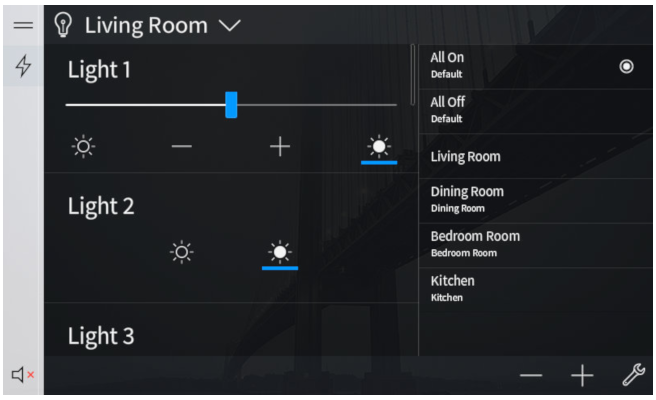
Button Number	Function	Keypad Backlight % *	Keypad Feedback % *

* Keypad backlight and keypad feedback levels are global for the entire keypad. These levels cannot be adjusted on individual buttons.

Form J - Lighting Control Programming Request - TSW-70 Series

Use the following form to record lighting control information for TSW-70 series touch screens within the programming project.

Project Name	Date
Load Name	Job #
Location	Start Date
Contact Name	Contact Phone



Load Number	Description

Form K - Lighting Control Programming Request - MPC3-302

Use the following form to record lighting control information for MPC3-302 button panels within the programming project.

Project Name	Date
Load Name	Job #
Location	Start Date
Contact Name	Contact Phone

Load Number	Description

Form L - Lighting Control Programming Request - MPC3-101/102/201

Use the following form to record lighting control information for MPC3-101, MPC3-102, or MPC3-201 button panels within the programming project.

Project Name	Date
Load Name	Job #
Location	Start Date
Contact Name	Contact Phone

Load Number	Description

Appendix A: Touch Screen Objects

This appendix describes objects that can exist on a touch screen. When designing a touch screen layout, keep the design simple and easy to use. Take into account the limited screen area of each page and avoid overcrowding.

> **NOTE:** Some touch screens do not support the entire list of objects described in this appendix.

Buttons

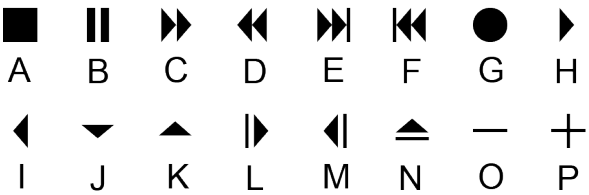
A button triggers most of the actions in a control system. Buttons are available in many styles and can be any size. However, the designer must take the user interface into account and ensure the buttons are large enough for descriptive text and touch control. For smaller touch screens, the minimum recommended size is 40 pixels wide by 40 pixels high. For larger touch screens, the minimum recommended size is 60 pixels wide by 60 pixels high.

For touch screens that support audio, a key click sound can be assigned to a button. A button press can also initiate a WAV file and provide audio feedback for a particular function.

Most Crestron touch screens support a variety of button styles, including shaded, three-dimensional, and two-dimensional.

The buttons provide visual feedback when pressed.

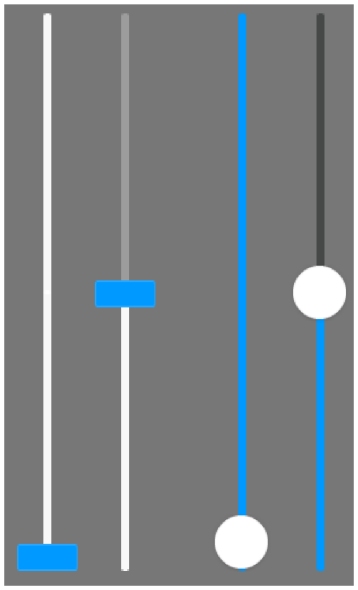
The amount of text that can fit on a button is governed by the button size, the font size, and font type. The Crestron Transport Font, available in VT Pro-e, consists of symbols that represent standard device functions such as fast forward, rewind, volume up, and volume down.



Some of the many possible button shapes and colors are shown below.

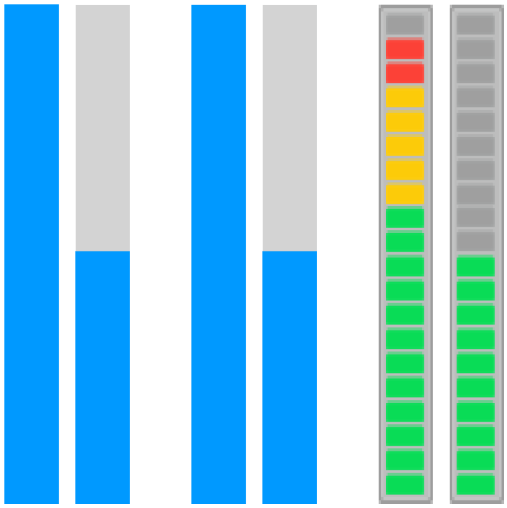
Sliders

A slider controls and displays an analog value, such as lighting level, temperature, volume, balance, bass, or treble. The color of the face, frame, text, and indicator bar may be chosen independently. Sliders may be drawn vertically or horizontally.



Gauges

A gauge displays analog levels such as lighting, temperature, or volume. Gauges may be drawn vertically or horizontally.



Clocks

A clock object displays the time of day in 12-or 24-hour format. Seconds and time periods (AM or PM) can also be displayed, if desired.

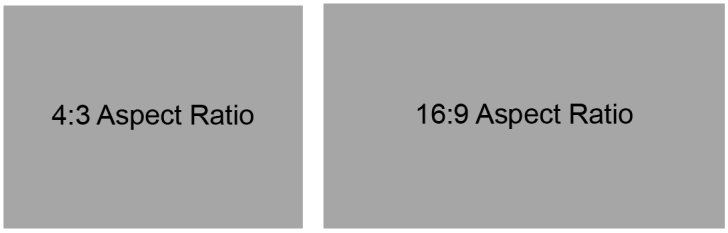
Video Objects

A video object (often referred to as a video window) displays real-time video on the screen. The recommended minimum video window size (4:3 aspect ratio) is 92 pixels by 69 pixels. The maximum video window size can be full screen. A full-screen transparent button can be placed on top of the video object to trigger return to the previous page. Video objects can have any aspect ratio or they can be set to the standard 4:3 or 16:9 aspect ratios.

NOTE: All video objects are scaled.

RGB Video Objects

An RGB object (often referred to as an RGB window) displays real-time RGB video on the screen. The recommended minimum RGB video window size (4:3 aspect ratio) is 92 pixels by 69 pixels. The maximum video window size can be full screen. A full-screen transparent button can be placed on top of the RGB video object to trigger return to the previous page. RGB video objects can have any aspect ratio or they can be set to the standard 4:3 or 16:9 aspect ratios.



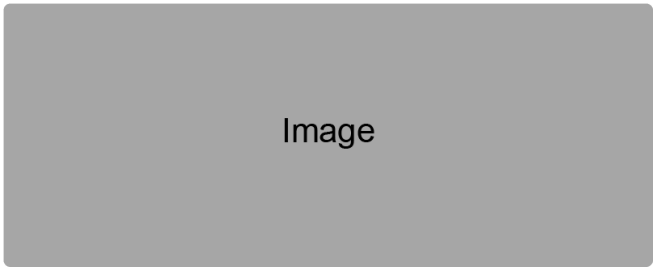
NOTE: All RGB objects are scaled.

Text Boxes

A text box enables the designer to add titles, headings, instructions, or other text to a page. Font size, color, type, and position are all selectable.

Images

An image object enables the designer to add a decorative image to a page. The image object can be any size and can contain a BMP, PCX, DIB, or JPG format image.



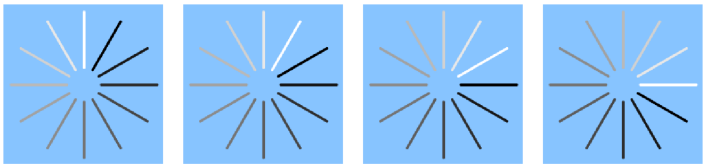
Legends

A legend is similar to a button in that it has two states. However, it cannot trigger a control system action. Instead, it is typically used to control the display of text via its digital feedback signal. Color, style, text, font, and font color are all selectable. Legends may also be displayed as round, elliptical, obround, or radius-selected objects.

Animation

An animation object creates the illusion of movement on the page by using a succession of static images that are displayed at a set speed. The designer can specify the transparency of an animation object from 0% (opaque) to 100% (completely transparent). If the resolution of any image is higher than 16 bits (65536 colors), VT Pro-e software automatically converts it to 16 bits when uploading. The resolution of every frame in the animation sequence is converted to the highest resolution of any frame in the sequence.

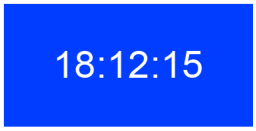
Animation frames can be in BMP, DIB, JPG, or PCX format. Images can be played forward or forward and backward. The associated logic permits the animation to run with many options, for example, animating only when a certain button is pressed.



> **NOTE:** There is no specific rule about how many animations to use or how large an animation can be on a page. However, too many animations or large animations can degrade performance. A good rule to keep in mind is to limit the animation size to one quarter of the total screen size.

Timers

A timer measures and displays time in two formats: hours, minutes, and seconds, or hours and minutes. The maximum range is 0 to 18H:12M:15S. Timers can be used to display values that are specific to the touch screen, such as timeouts.

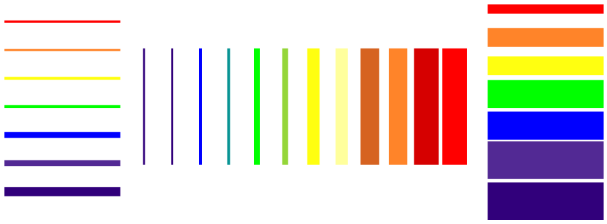


Borders

A border is a decorative element that serves to group together related objects and help visually clarify and organize the page. A border may contain text and it can be any color, two-dimensional, three-dimensional, shaded, or framed.

Lines

A line object enables the designer to add a line of any angle to a page. Lines can be any color and sized from 1 to 16 pixels wide.



Web Objects

The following web objects can also exist on a touch screen.

Web Map

A Web map is a graphic image in an HTML page that contains links to other targets. The clickable areas in the image are referred to as "hit points." When a hit point is selected, the Web browser displays the target, which can be another page or a different area within the same page.

Web Anchor

A Web anchor allows the Web browser to jump to a different section of the current HTML page (when a button or hit point is clicked) while giving the appearance of an entirely different page being displayed. In this way, a single HTML page can be designed that downloads once, rather than using a number of pages that each take time to download independently.

Web Marquee

A Web marquee displays scrolling text within a framed box.

Web Dial

A Web dial enables the mouse pointer to control and adjust analog values such as lighting levels, volume, and temperature.

Appendix B: Color Theory

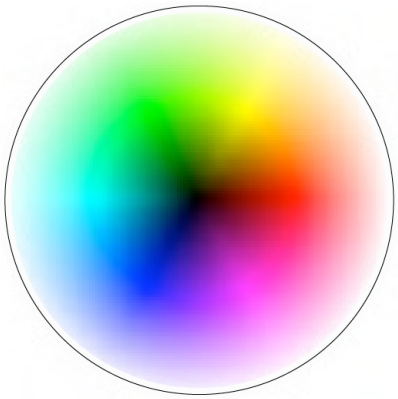
The following color definitions are useful when considering interface design.

- 8-bit color allocates 8 bits (1 byte) of memory to each pixel for up to 256 different colors.
- 16-bit color allocates 16 bits (2 bytes) of memory to each pixel for up to 65,536 different colors.
- 24-bit color allocates 24 bits (3 bytes) of memory to each pixel for up to 16,777,216 colors.
- True color is 32-bit color. The extra byte, called the alpha channel, is used for control and special effects information, such as transparency.

Colors can appear in nearly infinite variation, which can make selecting appropriate colors for the project difficult. This guide attempts to simplify the choices by presenting a few basic principles of color theory.

There are three basic (primary) video colors: red, green, and blue. All other colors are derived from these three.

Mixing two of the primary colors creates the secondary colors. For example, red plus green = yellow, blue plus red = magenta, and blue plus green = cyan.



Light versus Paint

Touch screens use red, green, and blue as their primary colors. The screen emits light from thousands of tiny red, green, and blue pixels that are so close together it is not easy to distinguish an individual light emitter. By turning these lights on and off, the illusion of mixed colors is produced. In touch screens, black is the absence of all light (all light emitters off) and white is the presence of all light (all red, green, and blue light emitters full on).

The painter's palette operates on a different principle. The white surface of a paper or canvas reflects all available light and appears white. Adding colors to the white background decreases the amount of light by absorbing specific frequencies of light. For example, red absorbs the green and blue light. What we see is the light reflected from the surface to our eyes. For paints, the absence of all paint is the white surface, and the presence of all colors is black, absorbing all light.

It is important to keep in mind that when designing a touch screen the surface is painted with light.

Color Properties

A color is described using three properties: color name, degree of saturation, and its value (luminance) or lightness. For example, pink, fire engine red, and brick are all in the red color family. They differ because of their saturation and intensity.

Hue, intensity, saturation, and luminance/value are interrelated terms and apply to the description of a color. Hue is the term for the pure spectrum colors that are usually referred to by name: red, orange, yellow, blue, green, and violet.

Value (or luminance) is the lightness or darkness of a color. The value is a function of shade and tint.

Shade is a hue produced by the addition of black.

Tint is a hue produced by the addition of white.

The saturation of a color describes color intensity or purity.
A pure hue has the highest saturation of color.

Color Perception

Warm colors (reds and yellows) appear to be in front of cool colors (blues and violets). The warm colors seem to advance or be on top of, or in front of, the receding cool colors. In addition, there are other psychological components to color. Red is the color of fire, so it is associated with energy, war, danger, strength, power, determination as well as passion, desire, and love.

Red is a very emotionally intense color. Red brings text and images to the foreground. Use it as an accent color to stimulate people to make quick decisions. Red is widely used to indicate danger.

Orange combines the energy of red and the happiness of yellow. It is associated with joy, sunshine, and the tropics. Orange represents enthusiasm, fascination, happiness, creativity, determination, attraction, success, and encouragement. To the human eye, orange is a very hot color so it gives the sensation of heat. Orange is not as aggressive as red. Orange has high visibility. Use it to catch attention and highlight the most important elements of the design.

Yellow is the color of sunshine. It is associated with happiness, intellect, and energy. Yellow produces a warming effect, encourages cheerfulness, stimulates mental activity, and generates muscle energy. Yellow is often associated with food. Bright, pure yellow is an attention getter, which is the reason taxicabs are painted this color. Yellow is seen before other colors when placed against black. This combination is often used to issue a warning. Yellow is very effective for attracting attention, so it is used to highlight the most important elements of the design. Light yellow tends to disappear into white, so it is best to use it with a dark color to highlight it. Shades of yellow are visually unappealing because they lose cheerfulness and become dingy.

Green is the color of nature. It symbolizes growth, harmony, freshness, and fertility. Green has strong emotional correspondence with safety. Dark green is also commonly associated with money. Green has great healing power. It is the most restful color for the human eye. Green suggests stability and endurance. Green, as opposed to red, means safety.

Blue is the color of the sky and sea. It is often associated with depth and stability. It symbolizes trust, loyalty, wisdom, confidence, intelligence, faith, truth, and heaven. Blue is considered beneficial to the mind and body. It slows human metabolism and produces a calming effect. Blue is strongly associated with tranquility and calmness, as opposed to emotionally warm colors like red, orange, and yellow. Blue is linked to consciousness and intellect. When used together with warm colors like yellow or red, blue can create high-impact, vibrant designs.

Purple (violet) combines the stability of blue and the energy of red. Purple is associated with royalty. It symbolizes power, nobility, luxury, and ambition. It conveys wealth and extravagance. Purple is associated with wisdom, dignity, independence, creativity, mystery, and magic.

White is associated with light, goodness, innocence, and purity. It is considered to be the color of perfection. White means safety, purity, and cleanliness. As opposed to black, white usually has a positive connotation.

Black is associated with power, elegance, formality, death, evil, and mystery. Black is a mysterious color associated with fear and the unknown. It usually has a negative connotation (such as blacklist or black humor). Black denotes strength and authority. It is considered to be a very formal, elegant, and prestigious color (such as black tie and a black Mercedes). Black gives the feeling of perspective and depth, but a black background diminishes readability. Black contrasts well with bright colors. Combined with red or orange—other very powerful colors—black gives a very aggressive color scheme.

Color Harmony

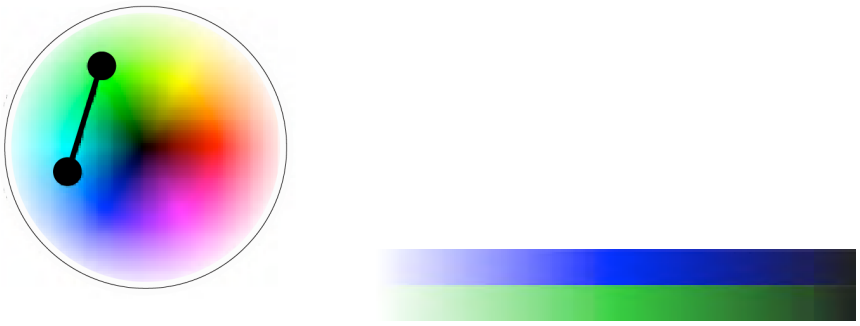
Color harmony refers to a set of colors that are pleasing to the eye, creating a sense of order and balance. The visual task of screen design requires a logical structure. Color harmony delivers visual interest, a sense of order, and creates a dynamic visual balance. Inharmonious color schemes are either dull or confused. At these extremes of bad design are bland, uninteresting display, or overdone, chaotic displays that repulse the viewer.

Monochromatic Harmony

Monochromatic harmony uses variations in lightness and saturation of a single color. This scheme looks clean and elegant. Monochromatic colors go well together, producing a soothing effect. The monochromatic scheme is very easy on the eyes, especially when using blue or green hues.

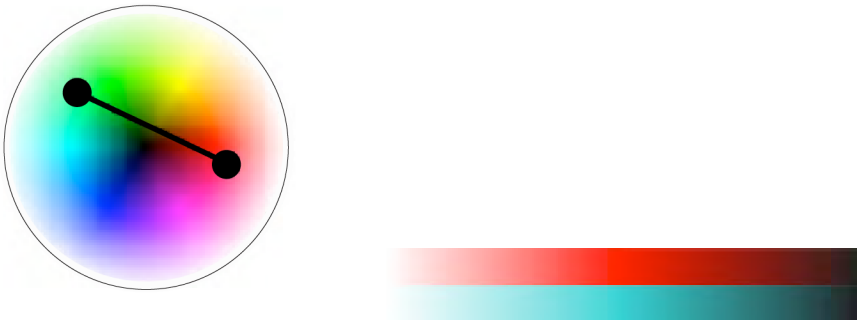
Analogous Harmony

Analogous harmony uses colors that are adjacent to each other on the color wheel. One color is used as a dominant color while others are used to enrich the scheme. The analogous scheme is similar to the monochromatic but offers more possibilities. Avoid using too many hues or combining warm and cool colors in this scheme.



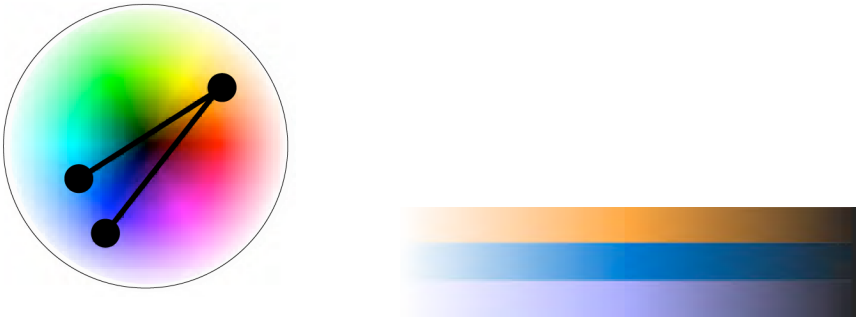
Complementary Harmony

Complementary harmony consists of two colors that are opposite each other on the color wheel. This scheme looks best when a warm color is placed against a cool color, for example, red against green-blue. This scheme is intrinsically high-contrast. For best results, place cool colors against warm ones, for example, blue against orange. If a warm color (red or yellow) is used as an accent, the saturation of the opposite cool colors can be reduced to put more emphasis on the warm colors. When choosing complementary colors, fully saturated colors will offer the highest level of contrast. Choosing from tints or shades within the hue family reduces the overall contrast of the composition. Avoid using browns or dull yellows.



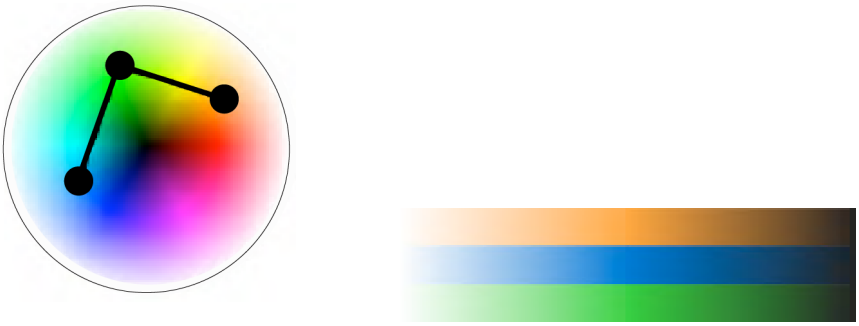
Split Complementary Harmony

Split complementary harmony is a variation of the standard complementary scheme. It uses a color and the two colors adjacent to its complement. This provides a high contrast without the strong tension of the complementary scheme. Use a single warm color against a range of cool colors to put an emphasis on the warm color (red against blue and blue-green, or orange against blue and blue-violet.



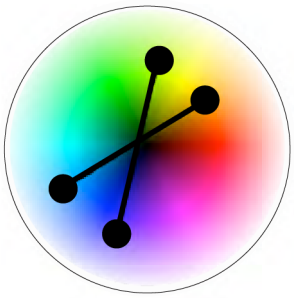
Equilateral Harmony

Equilateral harmony uses three colors equally spaced around the color wheel. This scheme offers strong visual contrast while retaining harmony and color richness. The triadic scheme is not as contrasting as the complementary scheme, but it often looks more balanced and harmonious. Choose one dominant color to be used in larger amounts than the others.



Double Complementary Harmony

Double complementary harmony is the most varied because it uses two complementary color pairs. This scheme can be difficult to harmonize if all four hues are used in equal amounts. If the scheme looks unbalanced, choose a color to be dominant and/or subdue (adjust the luminance) of the colors. Avoid using pure colors in equal amounts.

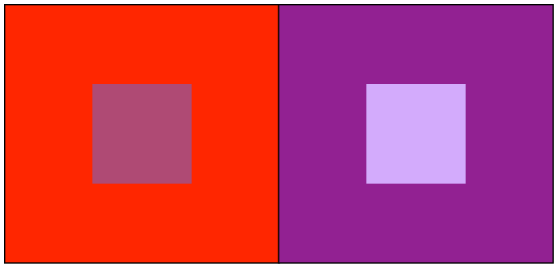


Specifying Colors

Color properties are specified by a set of associated number values.

Color Relativity and Readability

Observing the effects colors have on each other is the starting point for understanding the relativity of color. The relationship of value, saturation, and the warmth or coolness of respective hues can cause noticeable differences in our perception of color. The purple square on the left seems to recede, while the one on the right seems to advance. In addition, the one on the left appears larger, even though they are the same size.



NOTE: If large areas of a light hue are used, the whole screen appears light. Conversely, if large areas of dark values are used, the whole screen appears dark.

When fully saturated complements are brought together interesting effects are noticeable such as vibrating boundaries. This may be a desirable illusion but it can also be a problem if creating visuals that are to be read. When opposing colors are placed in close proximity to each other, the result is called simultaneous contrast (or chromostereopsis). Text may appear to vibrate or cast a shadow.

For visuals that are designed for reading, the viewer must have adequate contrast between the background and the text. Text presentations offer at least an 80% contrast between figure and ground (black text on a white background is ideal). When there is not enough contrast between figure and ground, the viewer must squint to read the text, causing eye fatigue. Yellow text on a white background or blue text on a black background are difficult to read due to the low level of contrast between figure and ground.

Appendix C: Touch Screen Typography

Typography is the arrangement, style, or general appearance of matter printed from type. There are two primary factors to consider when selecting and using typography: legibility and readability.

Legibility is the characteristic of an alphanumeric that enables the observer to quickly and positively identify it and differentiate it from all other letters and characters. Legibility depends on stroke width, form of characters, illumination, and the contrast between the characters and the background.

Readability is the quality of the text that allows for rapid recognition of a single word, word groups, abbreviations, and symbols. Readability depends on the spacing of individual characters, spacing of words, spacing of lines, and the ration between characters area to background area.

Typeface (Fonts)

Typefaces or fonts refer to the style of the alphanumeric. There are over 2,300 typefaces available. The two major groups of fonts are Roman and sans serif. Roman is well known since it is used in newspapers, journals, and books. Sans serif is a contemporary font style that does not include the small strokes (serifs) that project from the ends of a main stroke.

Several researchers have reported that when other typographical factors are controlled, sans serif fonts are more legible than Roman fonts. The premise behind this statement is that absence of serifs presents a simpler and cleaner typeface and, therefore, improves the legibility of the print. Serifs disrupt character discrimination and may add uneven appearance to the shape of strokes and characters. However, it is also evident that they somewhat aid the horizontal movement of the eye along the printed line—the serifs at the top and bottom of a character create a "track" for the eye to follow along the line of print. Therefore, when using a typeface without serifs, adequate spacing between the lines of print is required to prevent the eye from ridging (or slipping) to the adjoining line. The designer should safeguard against this as it may lead to skipping a line while reading a long list.

ARIAL

TIMES

PALATINO

FUTURA

MELIOR

OPTIMA

GARAMOND

There are many available sans serif fonts. A study compared the level of reading comprehension among subjects using five different fonts (three different sans serifs and two fonts with serifs). A significantly higher level of comprehension was found when subjects were using a sans serif font called Gill Medium. This font was also ranked first in its level of character discrimination. A careful examination of Gill Medium shows that the letters of other sans serif fonts are characterized by several "family resemblances." This results in similar appearance and may reduce legibility (for example, compare the "O" and "C"). Likewise, most of the modern sans serif fonts such as Futura, Avant Garde, and Helvetica also include characters that are too similar to one another and are therefore difficult to distinguish. The sources of similarity between the characters of modern sans serif fonts are:

- The standardized or modular appearance of the letters ("P," "R")
- The effect of mirror images between the upper and lower part of the character ("B," "D," "E")
- The use of equal radius for different letters ("C," "G," "O")

Gill Medium

ABCDEFGHIJKLMN

OPQRSTUVWXYZ

abcdefghijklmn

opqrstuvwxyz

Most Human Factors design handbooks advocate the use of modern sans serif fonts, emphasizing the characteristics of these as clean and simple.

Lowercase and Uppercase Characters

There is a near consensus among researchers that when other factors are controlled, lowercase characters are more legible than uppercase characters. An experiment was performed to determine the difference in readers' attention between uppercase and lowercase newspaper headings. Lowercase was read faster and ranked higher in pleasantness.

There are a few factors that contribute to the reduced legibility of uppercase words compared with lowercase:

- Most printed material that we read and use in everyday life is set in lowercase.
- Readability of lower case words is superior. Words set in lowercase are perceived at a greater distance, suggesting that the "total word form" and legibility of the elements is important while perceiving words set in lowercase.

Stopped STOPPED

Long chunks of text should be set in lowercase. If uppercase is required, the first letter of the word should be made larger in order to enhance the legibility of the word.

DURING READING OF UPPERCASE WORDS, PERCEPTION OCCURS IN A CHARACTER-BY-CHARACTER ORDER, THEREBY REDUCING READING SPEED AND READABILITY OF THE ENTIRE WORD.

The pattern or shape of a familiar word is stored in a person's memory. While reading text, a matching sequence occurs between the observed word and the memory patterns stored in the person's brain. The more unique the patterns of the word, the easier it is to perform the matching sequence.

Research suggests that successive lines of printed text, composing a pattern of "stripes," may induce discomfort and anomalous visual effects in the reader.

Lowercase words consist of characters that have ascenders (for example, the vertical stroke of a "d") and descenders (such as with "p" and "q"), which contribute to the unique shape and pattern of a word. This makes lowercase word form appear more "characteristic." Conversely, an uppercase word appears like a rectangular box with no distinguishable contour. Another explanation of the superior legibility of lowercase text is the combination of a capital letter and lowercase characters at the beginning of a sentence and proper names. Research has shown that visual emphasis given to the first letter of a word significantly improves the speed of a search. This finding is true for lowercase words as well as for uppercase words combined with a larger first character. This can be useful when a designer decides to make a distinction by using typographical features such as lowercase and uppercase words and still maintain discriminability and search speed.

Font Height (Type Size)

The following sections describe best practices for setting font height in a project.

Measurement

When specifying the height of a font and its spacing (both vertical and horizontal), the designer should be aware that there are several scales and methods of measurement. The traditional printer's "point" used for type height equals 1/100 of an inch. However, when it is used to measure distance between lines or words, a point is approximately equal to 1/72 of an inch.

Font Height and Viewing Condition

Most of the information in literature regarding font height is presented in graphs. These graphs usually indicate the relationship between character height, viewing distance, illumination level, stroke width, and visual acuity. While evaluating type size for optimum reading in a study, the results showed that a 0.11 inch type size was read significantly faster than 0.10-inch type. The majority of the readers judged the 0.11-inch type size as the most legible.

Stroke widths affect the ability of the eye to differentiate between the stroke of the character (such as with "I") and the space inside the character (such as with "E" and "F"). The width of a stroke is a function of the height of the character. Most Human Factors design books recommend the use of a height-to-width ratio of 5:3. This recommended ratio is applicable only when the document is in front of the observer (for example, a 90-degree angle between the light-of-sight and the document). In designing a display that is viewed from an unfavorable viewing angle (which may artificially reduce the apparent width of characters), a different height-to-width ratio should be considered in order to increase the actual width of the character (for example, 5:4) .

The vertical and horizontal spacing between characters affects the legibility and readability of text, especially when the font height is small. Increasing the vertical spacing between lines reduces the probability of adverse visual effects from the pattern of stripes. Research suggests that clarity of text is critically dependent on the spacing of the lines, more so than the overall density of lettering. Clarity of text can be improved by slightly increasing the separation between the lines and decreasing the mean horizontal spacing between the centers of letters. In addition, the "opening" of an appropriate vertical spacing between lines reduces the chance of optical bridging between adjacent lines—a critical factor for the design of any list type display. The recommended vertical space between lines is 25-33% of the overall size of the font. The horizontal space between characters should not be less than one stroke width. As for word spacing, the gap between characters should be large enough to allow grouping of words.

Line Length

Line length is an important factor because the designer will always try to minimize the size to fit in a button or small space.

Face, Italic, Bold, and Underline

Several experiments discuss the effects of different typefaces on legibility. In one experiment an italic face was read 2.7% slower than Roman lowercase (with an equal height). Furthermore, 96% of the 224 subjects who participated in this study judged the italic as less legible than a regular Roman font. Bold face was read at the same reading speed as lowercase text. However the majority of subjects (70%) commented about the unpleasantness of the text as compared to a plain Roman font. Results from another experiment suggested that bold and medium typefaces do not differ in readability, even under

low illumination suggesting that there is no apparent advantage in long chunks of text in bold face. Nevertheless, bold-face type can be safely and advantageously used for contrast and emphasis.

Although faces can highlight a specific term, overuse of this typographical technique can be inefficient. Employing too many faces for contrast, emphasis, and attention seeking may be confusing and can dramatically reduce legibility and readability.

Contrast

Crestron recommends the use of dark characters over a light background for normal illumination conditions. However, when the observer must maintain a dark adaptation condition (for example, in a darkened home theater environment), Crestron recommends a light character over a dark background.

Color Coding

A character and its background may differ in color and the amount of light they reflect. When viewed from a short distance, the visual difference between the character and background is better reinforced by using large luminance differences than by employing large chromatic (color) differences. In other words, contrast is more important than color differences in determining visibility of characters. For example, red and blue have considerable color contrast, yet can have a very small luminance contrast. Yellow characters over black and dark blue over white are probably the best choices for color contrast. In several experiments to determine the effect of color contrast on legibility to test the perception of different colored numerals at a glance, black characters over yellow background showed the best results.

Using Dark Characters Over Color Background

To maximize clarity and readability:

- The reflection percentage of the background should be at least 70%.
- The luminance ratio between the character and the background should be 1:8.
- The type size should be 0.10 inch or greater.

Human peripheral vision is limited in color sensitivity. Some colors are better recognized at a greater angle away from the line-of-sight than others. Colors have a psychological effect on human beings, mainly because we associate certain colors with past experiences. Some colors convey a feeling of warmth while others appear cold. The color red is usually associated with danger, green with normal, and amber with caution, and so are the colors of indicators. For example, black characters over a yellow background is associated with caution. Diagonal yellow and black stripes are used in many military cockpits to indicate caution conditions.

Typography Design Recommendations

The designer, based on the type, usage and criticality, should carefully evaluate each of the following recommendations.

- Sans serif fonts are usually more legible than fonts with serifs.
- Avoid using a font that has characters that are too similar to one another as this will reduce the legibility of the print.
- Long chunks of text should be set in lowercase.
- If uppercase is required, the first letter of the word should be made larger in order to enhance the legibility of the word. When specifying font height or accessing graphs to determine the size of a lowercase character, the distinction between "x" height and overall size should be made.
- As a general recommendation, the "x" height of a font used for important flight deck documentation should not be below 0.10 inch.
- The recommended height-to-width ratio of a font that is viewed in front of the observer is 5:3.
- The vertical spacing between lines should not be smaller than 25-33% of the overall size of the font.
- The horizontal spacing between characters should be 25% of the overall size and not less than one stroke width.
- Avoid using long strings of text set in italics.
- Use primarily one or two typefaces for emphasis.
- Avoid using black over dark red, green, or blue.

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Further Inquiries

If additional assistance is required after reviewing this guide, contact Crestron True Blue Support via email, chat, or phone as described at www.crestron.com/support.

Refer also to Crestron online help for common questions about Crestron products. First-time users must first create a Crestron.com user account prior to accessing online help.

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