Safire HD

High Definition chroma keyer

USER MANUAL

Crystal Vision

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Revision 1. Note on page 6 amended to indicate that all ancillary data will be passed on the channel selected as the timing input. 12/01/2012

1 Introduction

Safire HD is a 10-bit High Definition chroma keyer with additional features including linear keying, mixing and wipes. Safire HD can also be used with Standard Definition sources, making it suitable for multi-standard environments.

The linear keyer allows captions, graphics and logos to be added to a video source, whilst the chroma keyer is particularly suited to placing newsroom or virtual studio output into a new background or ‘set’.

Self key over background using linear keyer

Chroma key foreground, suppressed foreground, and final chroma key onto new background

A chroma key auto-configure facility allows for very quick and simple set-up using a cursor to select a representative area of the chroma-key background colour.

Alternatively, Safire HD can be placed into self-key mode, where the luminance of the foreground input is used as the key to cut part of the foreground into the background.

Both chroma keying and self-keying can be supported with an external key to cater for sources with a dedicated key channel. The external key can also be used independently for foreground sources that are already keyed into a black background.

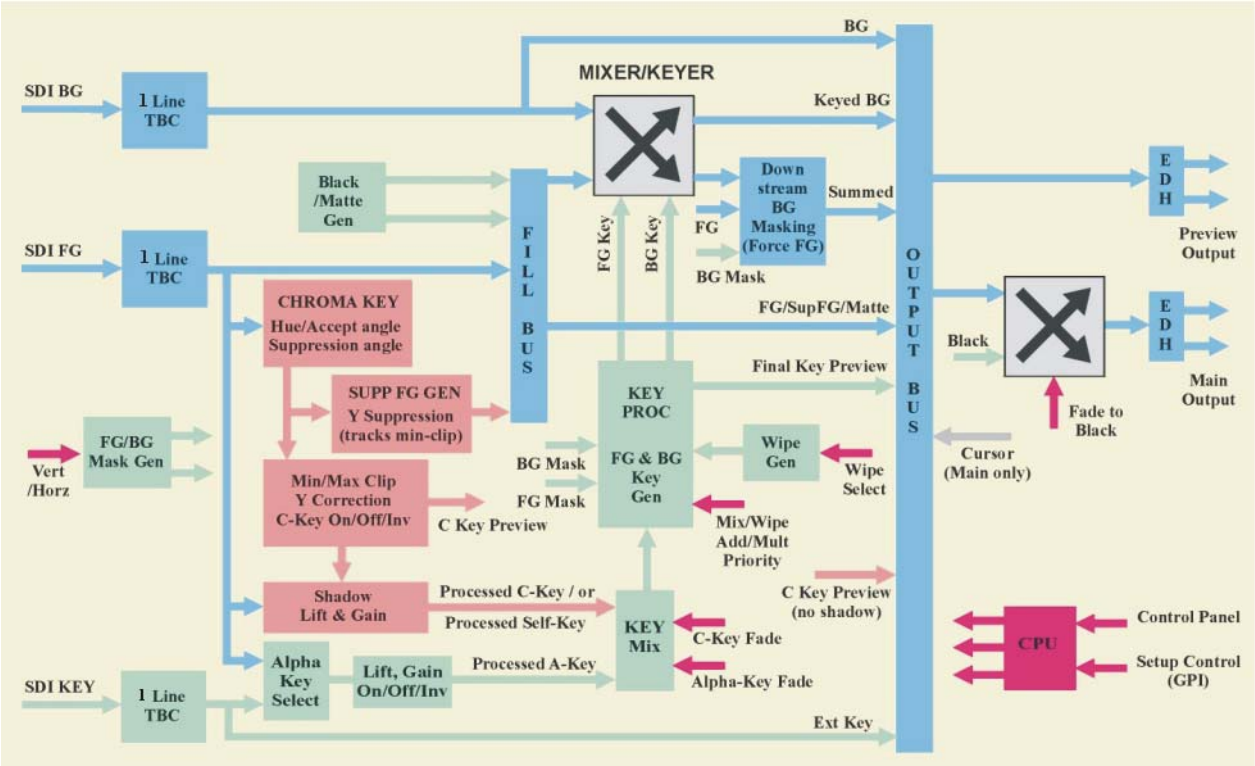
In addition a variable background and a variable foreground mask have been provided. The masks may be used independently or combined with priority control to select which mask has precedence in areas of overlap.

The background mask can be used to modify keys or clean up imperfect keys such as those produced by poor chroma key backgrounds. The foreground mask has been specially designed to allow down stream masking to force selected areas of the foreground irrespective of the main keyer, but prior to the fade to black of the main output.

The external input may be used to generate custom or moving mask shapes instead of or in addition to the internal masks.

A comprehensive range of fine tuning controls allows the efficiency of the chroma keying process to be optimised to produce very realistic edges and shadows with a minimum of residual colour spill.

A flexible output bus allows both main and preview outputs to monitor each stage of the keying process such as the keyed background, final key, chroma key or the suppressed foreground (with backdrop key colour removed).



The Safire HD chroma keyer

The fill video may be selected from any one of three video sources: foreground input, suppressed foreground from chroma key or a single colour from a matte generator.

The keyed signal may be amplified, offset, inverted and faded in and out either manually or as a timed transition. The fade direction may be selected from fade to background and fade to foreground.

Safire HD provides both additive and multiplicative keying. Although linear multiplicative keying achieves good results even with transparent and reflective objects, additive keying is recommended for shadows, smoke and transparent objects.

However, additive keying benefits from careful attention to the lighting of both backdrops and foreground objects.

Safire accepts all common HD formats as well as either 625 or 525-line input and configures itself automatically for the incoming video standard. It should be noted that all inputs must be of the same format.

The unit may also be placed in mix or wipe mode and a range of simple wipe patterns are available.

The main features are as follows:

- Additive and multiplicative keying
- Linear key from external key and/or self-key from foreground
- Linear key from external key and/or chroma-key from foreground
- Auto-configure chroma key
- Special self-key 'grey' mode for restricted luma range keying – ideal for winter sports
- Comprehensive chroma key fine-tune adjustments
- Dual force mask generation - special downstream foreground force mask
- Force background mode for virtual studio applications
- Selective chroma key and force foreground/background mode for sports graphics
- Mix
- Wipe with 10 simple wipe patterns
- Fade to black on main output
- Manual and automatic transitions
- Key offset, gain and inversion
- Main and preview outputs with EDH insertion
- Dedicated direct access Safire Controller panel
- Passes ancillary data and embedded audio on input assigned as the timing source
- HD/SD operation
- Transfer settings to another Safire HD for real preview keyer
- Dedicated frame GPI inputs for remote preset memory recall
- Dedicated panel GPI inputs for remote Safire controller assignment to Safire modules
- Unreserved panel GPI outputs for flexible system integration

Safire is controlled using a dedicated Safire Controller panel with its T-Bar, direct entry function keys, assignable 'soft' buttons/rotary controls and clear matrix display.

The Safire Controller Panel - one panel controls up to 15 linear chroma keyers

2 Key concepts

This chapter explains some of the concepts and terminology used in self-keying, chroma keying, mixing and wiping.

2.1 Additive and multiplicative keying

Keying works by superimposing fill (usually foreground) video over the top of background video. To prevent 'double images' where the fill and background are added, the background video is usually prepared by being 'faded to black' or ‘cut out’ wherever the fill video is to appear.

The signal that controls the ‘hole cutting’ or 'fade to black’ is known as the key signal and the device that performs the operation is a multiplier. The rise and fall time of the key signal must be bandwidth controlled in the same way as normal video.

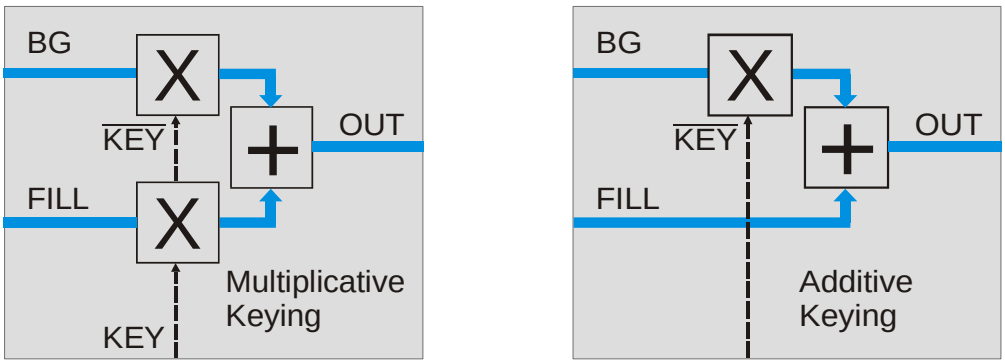
Such high quality keys are sometimes described as possessing ‘shaped edges’ and should never be larger than any foreground graphic elements.

Where a foreground signal consists of graphic elements with properly shaped edges against a black background, it may be selected as fill and simply added to the prepared background.

This is known as ‘Additive keying' and is typically used with devices such as logo or character generators that provide a high quality key output which is also used to key their graphic output against a black background.

Additive keying is usually preferred in this case since it often ensures the best image quality at the boundary between foreground graphic edges and background video.

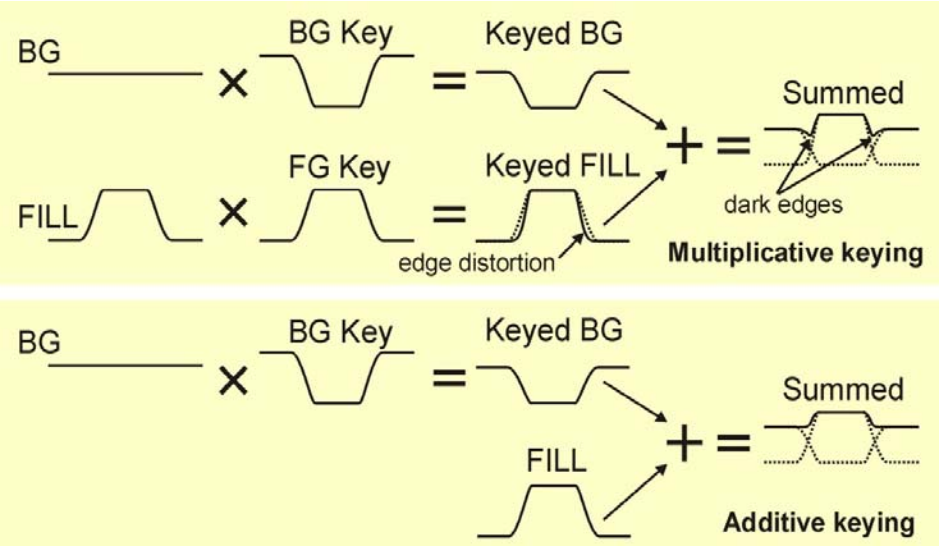
If the fill video has graphics elements without 'shaped edges' or if it is full frame video and only the key signal defines the required foreground subject(s) the fill must also be multiplied by the key signal prior to being added to the background. This process is commonly (but inaccurately) referred to as Multiplicative keying.



Multiplicative versus additive keying

Note: Note that the key is inverted when used to prepare the background video before the fill video is added but is not inverted when defining required areas of the fill in ‘Multiplicative’ keying.

Additive keying avoids 'double shaping' graphic or text image outlines, which might otherwise appear to have a black outline when the key signal provided has already been used to prepare the edges of graphic elements of the selected fill video.



Additive keying may avoid edge distortion caused by an unnecessary multiplier stage

A typical application for additive keying is for character generators that supply a high quality key and also use this key to prepare their own video text output against a black background.

Additive keying can also be used in chroma keying to improve performance with edges, shadows and transparent objects.

Summed output – using multiplicative keying

Summed output – using additive keying

Note: Although additive keying enables superior handling of shadows, transparency and reflections, to obtain the best results careful lighting and optimisation of Safire HD's settings may be required.

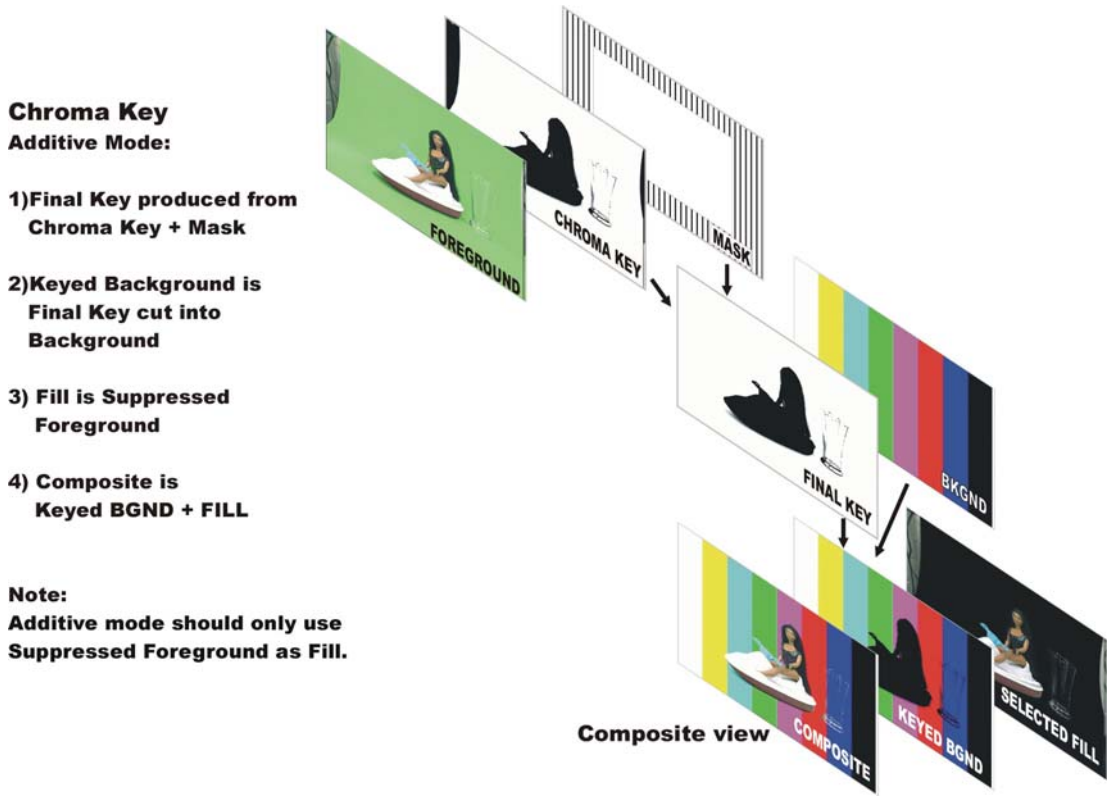
Although additive keying produces better shadows and improved rendering of transparent objects, any residual luminance in the suppressed foreground will simply add to the output. This may cause an overall increase in luminance without careful adjustment of Safire HD's many fine-tuning controls. The subject of chroma keying and the use of suppressed foreground are covered in the next section.

2.2 Understanding chroma keying

Electronic chroma keying uses signal processing to replace uniformly coloured areas in an image with a different image. A foreground image is often captured against a blue backdrop so that the uniform blue areas can be replaced with a different backdrop.

The stages involved in producing a typical chroma keyed composite image are as follows:

- Shoot the foreground subject against a uniformly coloured backdrop
- Ensure that the subject is well lit from the front and that the backdrop colour is evenly illuminated
- Produce a suppressed foreground signal in which the backdrop colour is removed
- Create a key or 'hole cutter' from this signal to remove an area of the background video that is identical in size to the foreground subject
- If necessary, add variable masks to remove unwanted foreground (or force backdrop)
- Replace or key the suppressed foreground into the 'hole' cut into the backdrop in an additive or multiplicative keyer – select key mode and view summed output
- Adjust fine shading, luminance suppression and chroma selectivity if necessary



Stages involved in making a chroma key

Although Safire HD will work with any backdrop colour, it helps if the backdrop colour has low luminance to limit reflected light and that it does not occur in the foreground subject.

Blue backdrops tend to produce better results than green, since it is easier to produce and light a blue chroma screen with low luminance.

However, Safire HD does have flexible masking, shadow and chroma key selectivity controls to compensate for some defects in chroma key backdrops, colour spill and subject areas that include the chroma key colour.

Both the foreground subject and backdrop should be well lit. It is also advisable to use a camera with excellent noise properties, bandwidth and black performance.

The keyed foreground may be faded out to leave the background signal or the entire composite may be faded to black at any time either manually or as a timed transition.

In practice chroma key setup is handled automatically, with the exception of masks and fine-tuning, by the auto-configure function accessed from Statesman or the AUTO button on the Safire Controller panel.

2.3 Using the auto chroma key function

The auto chroma key function allows a representative area of a blue or green chroma key background to be sampled and establishes a working chroma keyed composite using the existing foreground and background images. A movable grab cursor is available, if required, that can be superimposed on the main output to allow the sample area to be manually selected.

Foreground against a green background

Grab cursor positioned on green background

Suppressed foreground – chroma key green removed and associated luminance set to black

Composite output - suppressed foreground cut into new background

The 'auto' function performs the following functions:

- Sets chroma key hue to the average value contained at the cursor sample
- Sets Max Clip so that chroma key value in cursor sample is 110% of Max Clip value - all amplitudes above max clip are forced to maximum key
- Sets Min Clip to 2 - all key amplitudes below 'Min Clip' are forced to zero
- Sets acceptance angle to 71 degrees – defines the range of hues centred on the grab sample that will be suppressed
- Sets Y suppression so that foreground luminance in cursor area is suppressed to black

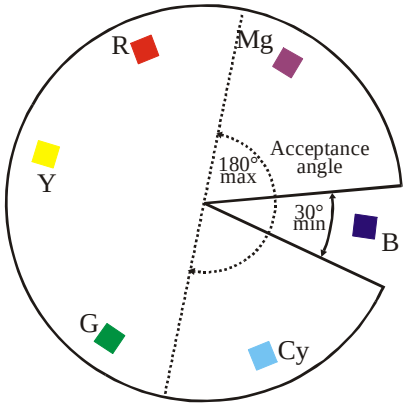
The cursor is turned off by default and only appears when turned on in the AUTO menu. It is not possible to view the cursor on the AUX output.

When the cursor is on, the main output selection is switched automatically to the foreground input to assist with positioning the cursor to a representative area of the chroma key background.

2.4 Chroma key selectivity

The range of colours that Safire can suppress in the foreground is adjustable in a number of ways:

- Hue: the suppression range centre, expressed in degrees (0° to 360°)
- Acceptance angle: the width of the suppression range, expressed in degrees (30° to 180°)
- Suppression angle: the degree to which colours just within the acceptance angle, tend to grey



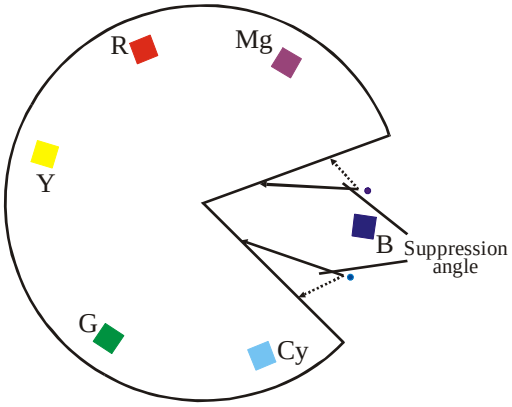
Chroma key hue and Acceptance angle

Hue incorrect – blue background not fully suppressed

Acceptance angle too high – blue handle bar also suppressed

It is recommended to start with a narrow Acceptance Angle when fine-tuning hue to increase the sensitivity of the adjustment. It also helps to avoid suppressing required foreground colours that are similar to the suppressed chroma key background.

The use of the Suppression Angle control is subtle and requires a high resolution RGB monitor to observe the effects. Colours close to the Acceptance Angle edges, which are not entirely suppressed, can be deliberately de-saturated by increasing the Suppression Angle control in the chroma key manual menu. This is one method of reducing chroma bleed on foreground edges.



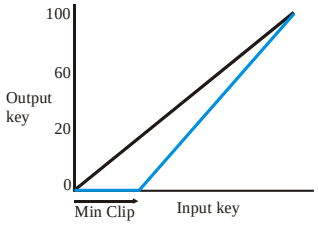
Suppression Angle

Excessive chroma bleed at boat hull edge

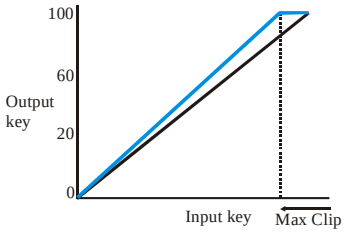
Suppression angle adjusted to remove chroma bleed

2.5 Highlights, shadows and transparency

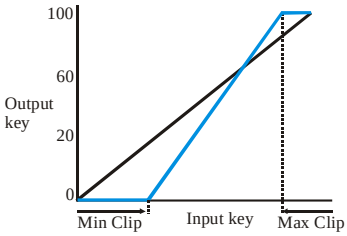
The basic controls for adjusting the amount of the chroma key used in the output key are Min Clip and Max Clip. All key amplitudes below 'Min Clip' are forced to zero. All amplitudes above 'Max Clip' are forced to maximum key.



Adjusting Min Clip



Adjusting Max Clip



Adjusting Min and Max Clip

The effect of adjusting Min Clip is to increase gain and to raise the lower clip level at the same time, whilst the upper clip level and maximum gain are unaffected. This allows only low level areas of the key to be manipulated.

The effect of adjusting Max Clip is to increase gain and to lower the upper clip level at the same time, whilst the lower clip level and minimum gain are unaffected. This allows only high level areas of the key to be manipulated.

The range of values between Min Clip and Max Clip is always linearly mapped onto the full output key range. The minimum difference between Min Clip and Max Clip is 12.

Min Clip and Max Clip incorrectly adjusted

Final key showing the effect of the incorrectly adjusted clipping

Note: It may help to view the Final key output when optimising Safire HD's keying controls - there should not normally be any gaps or holes in the Final Key.

In some cases reducing the chroma key in areas of high foreground luminance with 'Y Correction' may reduce spill in white areas of the picture and help 'fill-in' wanted foreground areas which appear as holes in the Final Key. However, excessive use of this control may affect the overall key level.

Safire HD also offers controls to enhance shadows by reducing the chroma key in areas of the final image where the foreground luminance is below a certain cut-off value.

Shadow Minimum alters the cut-off value and Shadow Enhancement determines the amount of shadow correction for a given luminance difference. A value of zero turns off shadow enhancement.

No shadow enhancement

Enhanced shadows

Note: Additive mode is recommended when shadows and/or transparency are important.

The controls discussed for manually adjusting chroma keys can be accessed from the Chroma Key Manual menu obtained by pressing the MANUAL key on the Safire Controller. The use of the Safire Controller to create chroma keys is discussed in section 3.3 of the Safire Controller chapter.

2.6 Key shrink

When a chroma key is active, the combined or final key is derived from the colour component of a foreground image. The combined key is a full bandwidth signal and the chroma information extracted from the foreground has to be up-converted. The interpolation used in the up-conversion does not however increase the rise time of the key edges.

One effect of the slower rise times of chroma derived keys is that they can tend to ‘spread out’ slightly compared to the desired foreground image when the min and max clip controls are used to produce a useable key. This often results in a thin dark line around the subject, where unsuppressed foreground video bleeds through. The effect occurs in both multiplicative and additive key modes.

Key shrink is a Safire mode that reduces the size of the combined key, when derived from a chroma key.

Although the effect is subtle it is known to improve most chroma keys and can safely be left active. Key shrink has no effect on external or self-key modes.

2.7 Using a self-key

Safire HD can be used as a standard Digital Linear Keyer mode to add captions, graphics or logos to a HD/SD video source. The key may be derived from an external key input or a self-key can be produced using the luminance or black and white information of the foreground video. Foreground and background masks may also be used in conjunction with the key signal.

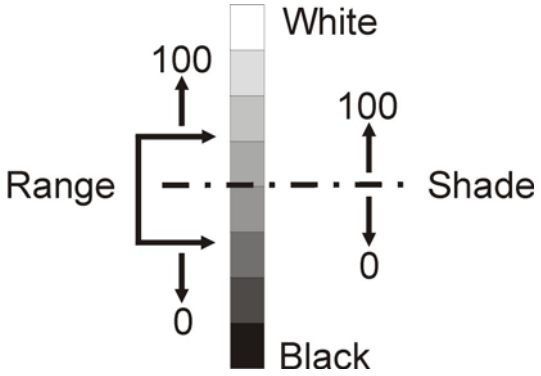
Foreground input to be used as self-key

Composite output – foreground input used as Fill

The self-key can be optionally used with a special restricted range or 'grey' luminance key mode which enables only defined range of luminance values or 'range- window' to produce a key.

The grey mode provides a very selective self-key that only places the foreground subject in front of the background when the foreground subject has a specific luminance value. If the final key is inverted, then only those objects with a specific luminance value in the foreground allow the background to appear.

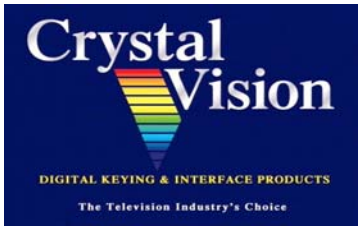
When 'grey' is selected two new options will appear in addition to Min and Max Clip:



'Grey' self-key controls

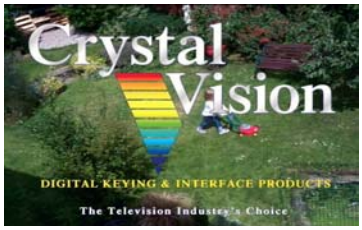
The ranges of luminance values that produce a key are defined by the range control, which is centred on the Shade luminance value. Shade may be placed anywhere between black (0) and white (100).

The self-key grey mode can also be used to force the keyer to ignore near-black and/or near-white objects. A self-key can be used with both external keys and masks.



Foreground - Logo against blue

Final Key – 'Grey' Self-Key



Composite – 'Grey' Self-Key

In the above example, a 'grey' self-key is used in Multiplicative mode as an alternative to a chroma-key to overlay Crystal Vision logo graphics over a garden scene. The blue was removed by excluding its luminance value with the Shade and Range controls.

2.8 Using an external key

The external key may be used where external graphics are available with a separate key signal. An example would be a character generator output where only the key signal itself has accurate and correctly formed edges. In this case the external key signal is normally preferred to a self-key, to avoid the edge distortion discussed in Section 2.1.

The external key input to the Safire HD can also be used to force areas of a chroma keyed output to be either background or fill, dynamically over-riding the chroma key. A typical application for this is the simulation of a desk or pillar in a virtual studio. By forcing the area to background under control of a key from the graphics system, the presenter can be put behind a graphics object.

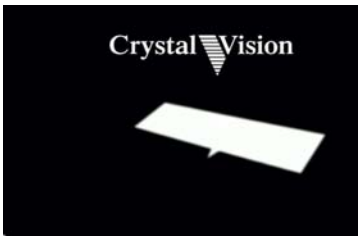
The external key can also be used to force areas of the image to be the unsuppressed foreground fill video signal. This is of use in sports graphics where players are chroma keyed off the grass to allow them to appear in front of a graphics or logo apparently painted on the grass. Outside of the graphic area the foreground is forced to allow the grass back in to the composite output.

There is a range of Force foreground/background setups that establish the correct key states in the Ext Key menu.

- Force background setups with both chroma key and external key (Force Bg)
- Force foreground setups with both chroma key and external key (Force Fg)
- Force background and foreground mode with both chroma key and external key (Force FB)

Foreground over background

This is the setup for a standard keyer, where there is no requirement for a chroma key and simple graphics such as text can be faded over a background. It can be achieved by turning the Chroma Key Off, turning the External Key on, inverting the key and selecting the foreground as the fill using Mult mode.



External key

Foreground graphics

Composite showing foreground over background

Note: A positive key such as the one shown above will require the key to be inverted in the external key menu.

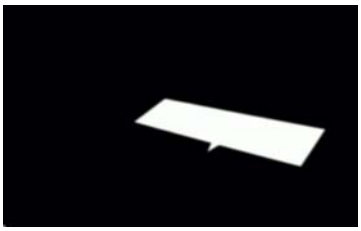
Using the Chroma key with combinations of forced foreground and background can create more complicated and realistic effects.

The simplest is Force background.

Force background

Force background allows an external key to override a chroma key and force part of the background in front of the chroma key subject in the area of the supplied external key.

A suitable external key can be toggled on and off to effectively place the chroma key subject behind or in front of part of the background graphics as required.



External key

Subject chroma keyed into background graphics

Chroma key overridden by external key

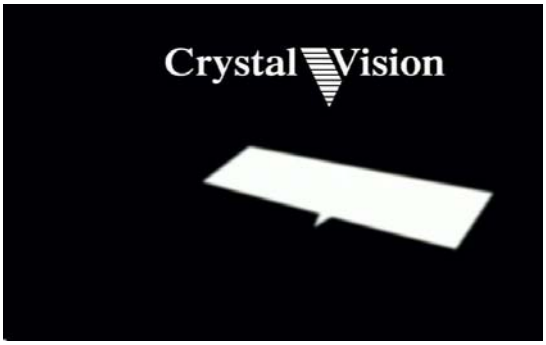
A typical application for force background is in the context of a virtual set where the talent is to be seen sitting in front of or sometimes behind a computer-generated desk.

Force foreground

Force foreground restricts the chroma key to the area of the background graphic. This allows the chroma key hue itself to be retained as in the example below where the grass is an integral part of the effect desired.

Background

Foreground



External key

Composite Output – Fill:Foreground

A typical application might be sports where players on grass are keyed over a sponsor's logo, which is made to appear as if painted on the grass.

In the above example, a chroma key is created with the girl on the grass as foreground and the logo graphics as the background. The grab cursor is placed on the green grass. The resulting chroma key removes green and replaces it with the background.

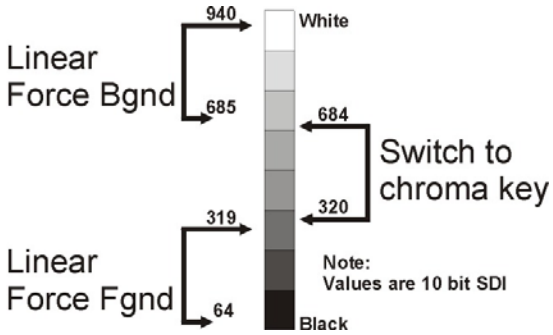
This would leave all the green in the foreground replaced by background. The external key is used to over-ride this, restricting the use of the chroma key to the area occupied by the graphic. Both the final key and the external key are automatically inverted to allow the graphic to be controlled by fade operations. The fill is taken from the non-suppressed foreground.

The Crystal Vision graphic at the top of the Force foreground example could be a computer generated score board, but a source of colour for the chroma key cannot be guaranteed. This is where Force FB can help.

Force background and foreground whilst doing a chroma key

Force FB is an ingenious arrangement that allows a chroma keyed subject to move in front of a selected background object, whilst maintaining a graphics keyed over the background. This is made possible by using a composite external key.

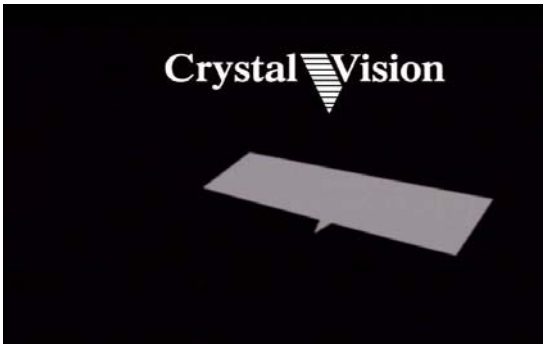
There are three luminance levels in the external key and each level applies a different effect.



Force FB fixed key levels

Background

Foreground



External key

Black = Fgnd, White = Bgnd, Grey = chroma key

A chroma key is created with the girl on the grass as before, but only where the external key is grey. The fill is taken from the non-suppressed foreground.

The black in the External Key is then used to force the foreground back. This restricts the action of the chroma key to the grey area in the external key - in this case the logo on the grass. Finally the white key forces the top logo. The external key normally has a higher priority than the chroma key, but was turned off whilst grey was present in the external key.

If the top graphic were (say) a score board, it would appear cleanly in front of any background.

Masks have the next highest priority but were not used in the above example.

Force Bg/Fg/FB defaults

Button	External Key	Final Key	**Fill**	Chroma Key
Force Bg	Normal	Normal	Supp Fgnd	On
Force Fg	Invert - On	Invert	Foreground	On
Force FB	Normal - On	Normal	Foreground	On

2.9 Using masks

Sometimes the chroma key background may contain imperfections such as uneven lighting or wires or cables running across the set. These unwanted areas of the foreground can usually easily be removed by 'forcing' the background with a foreground mask. Similarly wanted areas of the foreground can be forced with a background mask. A special downstream background mask ensures that the unsuppressed foreground can always be forced over the final keyer output.

Foreground with cables at left

Final Key including mask (shown shaded)

The effect of adjusting the mask can be seen by viewing any signal on the Output Bus that is downstream of the keyer and the Final Key itself.

The following mask facilities are provided:

- Background, Foreground and External Key masks may be used together or independently
- Masks may be turned on or off and inverted and adjusted in position and size

In the following example, the Force FB chroma key is improved by masking out everything except the girl.

Chroma key modified by inverted foreground mask

Composite – with cleaner background logo on lawn

Although the cleaner logo is to be preferred, the use of masks may not always be suitable since the mask would be required to track the chroma-keyed subject. It may be preferable to shoot the scene with a more uniform coloured grass.

2.10 Mixing and wiping

In these modes the unit will perform a mix or wipe between the foreground and background video sources. The mix or wipe can be controlled manually with the T-Bar, or by setting an auto-transition triggered from the EFFECT button on the control panel, or from remote control.

The internal wipe pattern generator has eight wipe patterns available as shown in the following table:

	Vertical		Left Corner
	Horizontal		Right Corner
	Vertical Blind		Box
	Horizontal Blind		Cross

Safire Wipe Patterns

3 The Safire Controller

The Safire Controller panel provides convenient access to keyer and mixer functions with a combination of direct access keys and assignable or 'soft' controls. A bright seven line dot-matrix display ensures high visibility and both manual and timed transitions have dedicated controls.

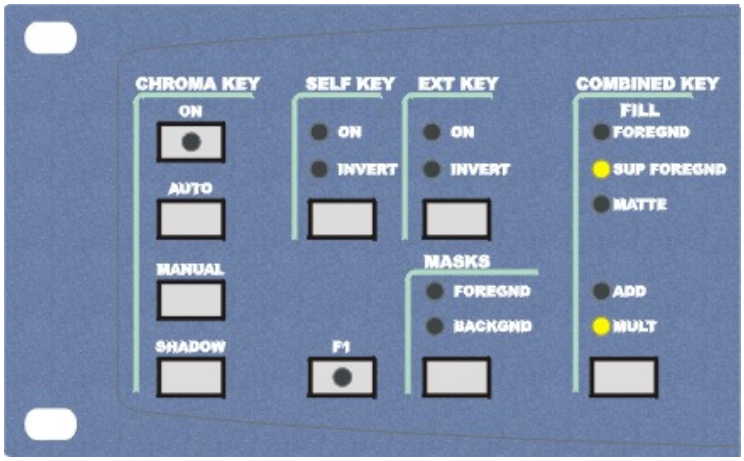
3.1 Using the controller panel

Besides a T-Bar to perform transitions, direct access keys include dedicated buttons for chroma key on/off, menu entry keys, and timed functions such as chroma/black fades and effects. Four soft rotary controls allow numeric data to be easily assigned to variables.

Use of the Safire Controller panel requires setting the board edge DIL switch levers 1 and 4 both DOWN. Specific jumper settings may also be required as explained in sections 6.5.

Safire Controller panel showing rack mount ears

The left-most group of buttons provides quick access keys to five main functions; Chroma Key, Self Key, Ext Key, Combined Key and Masks. The F1 button provides access to the panel-lock/unlock menu.



Keying, Masks, Fill Source and panel lock/unlock controls

The available functions are summarised in the following tables:

Chroma Key

Button	Function	Notes
ON	Direct action - turns Chroma Key on/off – and enters status menu	Chroma key button LED illuminates when chroma key is on
AUTO	Enters Auto Chroma Key menu	Select blue or green chroma screen and/or activate manual cursor
Manual	Enters manual Chroma Key menu	Optimise the Chroma Key
Shadow	Enters Chroma Key shadow menu	Set and adjust Chroma Key shadows

Self Key

Button	Function	Notes
Self Key	Enters Self Key menu	Self Key LED illuminates when self key is on Invert LED illuminates when self key is inverted

Ext Key

Button	Function	Notes
Ext Key	Enters Ext Key menu	Ext Key LED illuminates when external key is on Invert LED illuminates when external key is inverted

Combined Key

Button	Function	Notes
Com Key	Enters Combined Key menu	
	Select Fill Source	Foregnd, Sup Foregnd or Matte fill source LED illuminates when selected
	Select Add/Mult keyer type	Add or Mult key type LED illuminates when selected
	Shrink [Key]	Shrink is only active in chroma key mode
	Invert Final Key	Invert the final or combined key

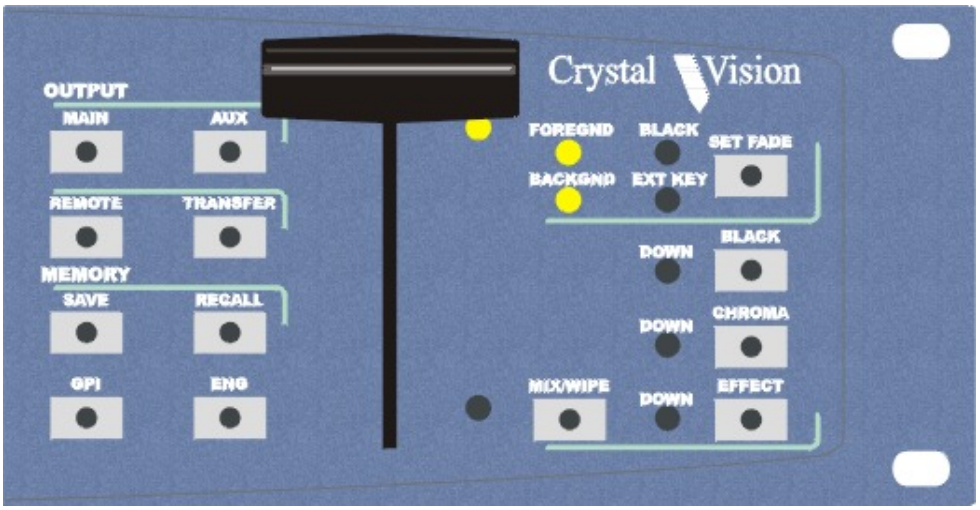
Masks

Button	Function	Notes
Masks	Enters Masks menu	Foregnd Mask LED illuminates when foreground mask is on Backgnd LED illuminates when background mask is on

Panel Lock/Unlock

Button	Function	Notes
F1	Enters panel/lock/unlock menu	Password is stored in NVRAM and is displayed on first entering menu after power up

The button groups to the right of the T-Bar are; the Set Fade enter-menu button and the Black, Chroma, Effect and Mix/Wipe direct action transition buttons. The groups to the immediate left of the T-Bar comprise the Output, Remote, Transfer, GPI, ENG and Memory enter-menu buttons.



Live controls, fader/output assignments and engineering menus

The available functions are summarised in the following tables:

Output

Button	Function	Notes
Main	Enters Main Output source select menu	Choose from FG, BG, Ext Key, Sup FG, Composite, Final Key, Chroma Key, Keyed BG
Aux	Enters Auxiliary Output menu	As Main
Remote	Enters Remote menu	Assign Safire Controller to Safire module
Transfer	Enters Transfer menu	Copy Setup between Safires

Memory

Button	Function	Notes
Save	Enters Save Configuration menu	Ten named presets available
Recall	Enters Recall Memory menu	As Save
GPI	Enters GPI Configure menu	Recall and Select On/Off and Output Configure
ENG	Enters Engineering menu	Input status, Ref Select, H Phase and Display brightness

Set Fade

Button	Function	Notes
Set Fade	Enters Set Fade menu	Assign signal T-Bar/Chroma button fades to – FG, BG, Black or Ext Key. Select transition time for transition buttons. LED confirms fade-to source selected.

Transition buttons

Button	Function	Notes
Black	Initiates a Fade to Black	Transition time set in Set Fade menu
Chroma	Initiates a chroma or self-key fade – type depends on which keys are active.	Transition time and fade-to source set in Set Fade menu. Down LED illuminates when transition is fully active.
Mix/Wipe	Enters Mix/Wipe mode and Mix/Wipe menu	Transition time set in Set Fade menu Mix or Wipe and wipe effect selected in Mix/Wipe menu. Down LED illuminates when transition is fully active.
Effect	Initiates a Mix or a Wipe when in Mix/Wipe mode Initiates external key fade in any other mode	Transition time set in Set Fade menu Mix or Wipe and wipe effect selected in Mix/Wipe menu. Down LED illuminates when transition is fully active.

If a transition button is pressed during a timed transition, its effect will be reversed.

T-Bar

Control	Function	Notes
T-Bar	Manually controls Mix/Wipe/Key/Fade	Fade up or Fade down LED illuminates at end stops.

Selecting one of the CHROMA ON, BLACK, MIX or WIPE buttons initialises Safire and sets some default values.

The T-bar ‘end-stop’ LEDs always show the electronic state of the assigned fade function. If an end-stop LED shows that the T-bar is ‘at the wrong end’, it can be moved to the lit position, *without affecting the program output*.

The video faded in or out by the T-bar/CHROMA transition button is dependent on which keys are currently active. It is possible to have two keys active at any one time; the following table summarises the possible combinations:

Key combinations

Key	Chroma Key ON	Self Key On	**Ext Key On**
Chroma Key	Y	N	Y
Self Key	N	Y	Y

Note: It is not possible to have a Chroma Key and a Self-Key active at the same time. An external key can be used with either.
The ‘Chroma’ fade button is used to control chroma keys and self-keys.

3.2 Using the display and soft controls

The display is used together with eight soft buttons and four soft rotary controls. The function assigned to each is entirely dependent on the currently active menu.

Safire Controller assignable controls

An LED within the soft buttons or just to the left of the rotary controls always indicates the active controls.

Button LEDs on right show rotary control assignment

Button LEDs on left show rotary control assignment

If there are more than four variables to be controlled, buttons will be used (any of the lower three in above example) to assign displayed variables to rotary controls. Rotate the appropriate rotary control to change the variable, it will be active immediately and the effect in most menus can be seen immediately on the affected output. If there are more variables than can be displayed on one menu, a MORE button is used to access additional menu(s).

The next section will show how to assign a Safire Controller to a Safire HD module and then perform a simple auto-configured chroma key. Some of the manual controls used to 'fine-tune' a chroma key are also introduced. A full discussion of available Safire HD menus and controls follows. Further examples of Safire HD's ability to handle a variety of keying tasks are discussed in the Advanced-keying chapter with off-screen illustrations.

3.3 Getting started

Ensure that the Safire Controller is connected to the appropriate remote connector of a Crystal Vision rack containing one or more Safire units and apply power to both controller and rack. Refer to sections 6.2 and 6.3 of the Installation chapter for cable connection details.

For these examples at least two synchronous video inputs will be needed. A background image connected to the BG IN connector and a suitable subject set against an isochromatic background such as a blue or green chroma screen at the FG IN connector. A third synchronous SDI input may be connected to the external key input if desired. Connect a suitable monitor to the Main output.

Tip: An external key will be mandatory if the Ext Ref is set to use the Ext Key input as a reference (refer to the ENG menu).

Controller Polling for Safire module (power on default)

At power-up all LEDs illuminate for a few seconds whilst the Safire controller polls for available Safire modules. If one or more Safire module(s) respond during this time it (they) will be listed.

Safire module found in slot 5 (numbered from 0)

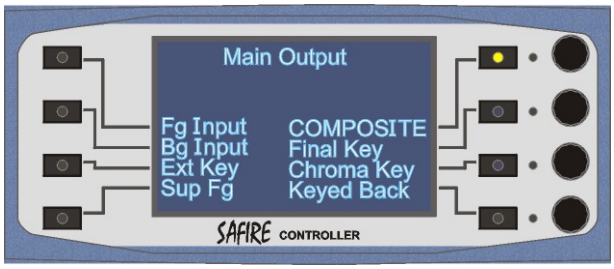
If necessary press Poll All to search for Safire modules in connected frames.

Tip: The Safire module may take longer to initialise from power up than the panel's polling time-out.

Select the desired Safire module to control. The Poll All command can be found by pressing the REMOTE button at any time.

Assigning the Main output

The output assignment function allows a number of internal video signals to be monitored in addition to the COMPOSITE output. For example, inspection of the FINAL KEY is a good way to spot imperfections within the chroma key.



Main output assignment

Enter the Main Output select source menu by pressing the MAIN OUTPUT button. Select the desired signal from the eight available with the appropriate soft button. The chosen signals will be highlighted in CAPITAL letters and the soft-button LED will illuminate.

Assigning the Fade-To source

The type and duration of timed fades can be selected using the SET FADE button.

Fader assignment menu

Select one of Foreground, Background or Black as the input to be FADED TO by the T-Bar.

The T-bar mixes between the keyed signal and the signal selected in the SET FADE menu. This mix has a lower priority than foreground and background masks.

Tip: Selecting Ext Key in this menu will allow the external key to be faded down using the T-bar or timed transition.

Performing an auto-configured Chroma key

The in-built auto-configure Chroma key function will quickly produce a usable Chroma key from both green and blue Chroma screen backed subjects. (Refer to the Key concept chapter for more information on Chroma keying.)

Auto-configure Chroma key

Press the AUTO button and select the appropriate Chroma screen colour, blue or green, as in FOREGROUND background screen colour. This will set up the Chroma keyer with typical values for use with this colour backdrop.

The Main and Aux outputs will automatically show the COMPOSITE output with the foreground keyed into the background.

If this fails to change the Safire module output check that the Safire panel has been assigned to the correct Safire module – i.e. the one whose output you are monitoring.

The default configurations have the following settings:

- A Chroma key is always attempted with the FOREGROUND image present at the FG input and a BACKGROUND image present at the BG input
- MULT mode is selected
- EXT KEY is Off
- SHADOW is Off
- SELF KEY is Off
- SUPP FG is used as FILL
- MASKS are Off
- Fader (T-BAR) and Chroma key button are set to ‘Fade [Chroma Key] to BACKGROUND’

Making adjustments

If the default Chroma key setup function fails, the backdrop colour or luminance might be different from the typical values used.

Auto-configure Chroma key with manual cursor control

Use the soft button (top right) to turn the cursor on and sample the Chroma colour. Then use the indicated soft rotary controls to vary H Pos and V Pos to change the cursor position to sample the Chroma key background colour at the desired position within the FOREGROUND.

Press the lower right soft button to perform a Grab and complete the automatic Chroma key setup.

Fine tuning the Chroma key

There are six manual controls that can further improve Chroma key luminance:

- **Max/Min Clip** – Chroma key amplitude range
- **Y suppression** –luminance subtracted from suppressed foreground in areas of key colour
- **Y correction** – reduces Chroma key in areas of high foreground luminance
- **Shad Min** – reduces Chroma key in areas of the final image where foreground luminance is below a certain value
- **Shad Enh** – determines shadow enhancement for a given luminance difference

There are three manual controls that can further improve the colour sensitivity of the Chroma key:

- **Hue** – Chroma key ‘null’ colour in degrees
- **Acceptance angle** – range of colours, centred on the selected suppression hue, on which keying occurs
- **Suppression angle** - range of colours, centred on the selected suppression hue, which are completely suppressed

Tip: Turn Shrink On in the Combined key menu to help remove residual unsuppressed foreground around the foreground subject when a Chroma key is active.

To start optimising the Chroma key enter the Manual Chroma key menu with the MANUAL button in the Chroma Key group.

Manual Chroma key configuration

Although, the required correction is entirely dependent on the precise FOREGROUND and/or BACKGROUND signals in use, it is recommended to try adjusting the Y Correction first to reduce Chroma-spill in predominantly white areas of the foreground to produce a more solid key.

Tip: Switch the monitored output to FINAL KEY whilst making Y Correction changes.

In multiplicative mode, the Y Suppression control can then be used to reduce the effect of a small (pixel wide) border of unwanted suppressed foreground around the wanted foreground image. Use the COMPOSITE output to monitor Y Supp changes, they cannot be seen looking at the FINAL KEY. The effect can be subtle (in MULTIPLICATIVE mode) and tends to affect shadows and translucent objects.

Tip: Switch the monitored output to COMPOSITE and/or Suppressed Foreground whilst making Y Suppression changes.

Manual Chroma key configuration

The Chroma key Acceptance angle and Suppression angle should be carefully adjusted whilst looking at undesirable Chroma spillage at the wanted foreground subject edges.

Warning: Excessive use of the Acceptance angle control could widen the hues suppressed to the point where coloured components of the foreground subject are suppressed to grey.

It may be necessary to misadjust one or more of these controls to better judge the effect of other controls. (For example, if necessary back off Y Supp to optimise Suppression angle)

Tip: Switch the monitored output to COMPOSITE and/or Suppressed Foreground whilst making Acceptance angle changes.

It is recommended to avoid large changes in Max Clip or Min Clip to improve shadows at this time, since dedicated shadow processing has been provided.

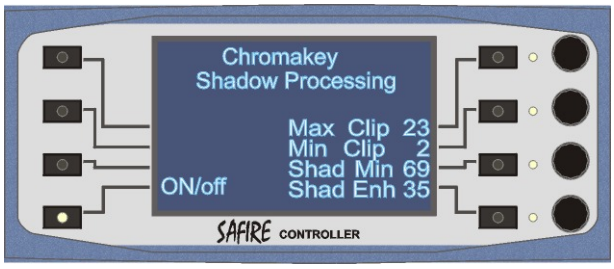
If the Chroma key setup still fails, it may be necessary to alter the Hue setting slightly and repeat the manual adjustment procedure.

Note: It will be hard to Chroma key if the wanted subject contains the same or similar colour to the Chroma screen background. Adjusting Acceptance angle and Hue may help.

There are two shadow controls to improve low-level luminance keying performance:

- Shad Min – Chroma key is reduced in areas of the final image where foreground luminance is below the Shad Min value
- Shad Enh – determines shadow enhancement for a given luminance difference

Press the lower left soft button in the SHADOW menu to switch shadow processing on.



Chroma key shadow configuration

Use the lower right soft rotary controls Shad Min and Shad Enh to optimise shadows.

Start out by adjusting the Shadow Enhancement control to a low value (say 10 or 20) and then adjust Shadow Minimum control until shadows in the final COMPOSITE output appear close to the desired effect. If necessary readjust both shadow controls until the optimum effect has been achieved.

Max Clip or Min Clip can be varied if the Shad Min/Shad Enh controls do not provide the desired effect. Large changes to Max Clip or Min Clip should not be necessary.

Manual Chroma key adjustment summary

- Y Correction to make key as solid as possible in bright areas of foreground.
- Max/Min clip to achieve desired solid key.
- Y Suppression to reduce unwanted foreground silhouette around suppressed foreground in multiplicative mode or force key colour areas to black in additive mode
- Acceptance angle to remove Chroma spill around and even within wanted subject image
- Suppression angle to narrow or widen the range of colours suppressed to grey - particularly at the subject/Chroma key boundary
- Hue (and repeat above adjustments) if good Chroma key cannot be achieved
- Try setting Shrink key to On in the Combined key menu
- Finally adjust shadows and low-level Chroma key performance

The effect of all these controls is necessarily interactive, and the best compromise should be sought.

3.4 Safire menus

This chapter describes Safire HD's operational, engineering and status menus.

Output source

The MAIN and AUX (Preview) output assignment functions allows a number of internal video signals to be monitored in addition to the COMPOSITE output.

Main output assignment – composite output selected

Aux output assignment – final (combined) key selected

Enter the Main Output source-select menu with the OUTPUT button, or the Aux Output source-select menu with the AUX button.

Select the desired signal from the eight available with the appropriate soft button. The chosen signals will be highlighted in CAPITAL letters and the appropriate soft-button LED will illuminate.

Function	Notes
Fg Input	Selects the foreground input.
Bg Input	Selects the background input
Ext Key	Selects the external key input
SupFg	Selects the suppressed foreground. The Chroma will be modified according to the hue, acceptance angle and suppression angle controls. The luminance in the key area will be modified according to the Y suppression control.
Composite	Selects the combined video image.
Final Key	Selects the combined key. This will be a combination of some or all of external key input, Chroma key, foreground mask and background mask.
Chroma Key	Selects the Chroma key after scaling due to the clip and shadow controls
Keyed Back	Selects the background multiplied by the combined key

The Main output is identical to the Aux output, apart from the fact that the Aux output has no FTB function or cursor overlay.

Assigning fade controls

The Set Fade menu allows the fade-to source to be selected

The type and duration of timed fades can be selected using the SET FADE button.

Fader assignment menu

Select one of Foreground, Background or Black as the input to be FADED TO by the T-Bar.

The T-bar mixes between the keyed signal and the signal selected in the SET FADE menu. This mix has a lower priority than foreground and background masks.

Tip: Selecting Ext Key in this menu will allow the external key to be faded down using the T-bar or timed transition.

If a Chroma key is the active key, the fade-to source is normally background, but this may be overridden by selecting foreground as the fade-to source.

Alternatively, the fade-to source may be changed by inverting the final key. If the active key is also inverted, the effect is the same as selecting fade to foreground.

Note: The foreground fade-to source selection only works when a Chroma key is active. Invert the final key and active key to achieve this effect with a self-key or external key.

The ‘Down’ indicator is lit when the effect of a key is not contributing to the output.

The fade may be initiated by using the Manual fade slider or by pressing the Start Auto button when the fade will occur at a rate set by the Fade Time control.

Note: The Chroma Fade Time control affects both Chroma keys and self-keys.
The Ext Key selection is not faded to. Selecting Ext Key in this menu will allow the external key to be faded down using the T-bar or timed transition.

Mix/Wipe mode

The Mix/Wipe mode, entered by pressing the MIX/WIPE key, enables mixing or wiping from foreground to background or background to foreground with the following controls:

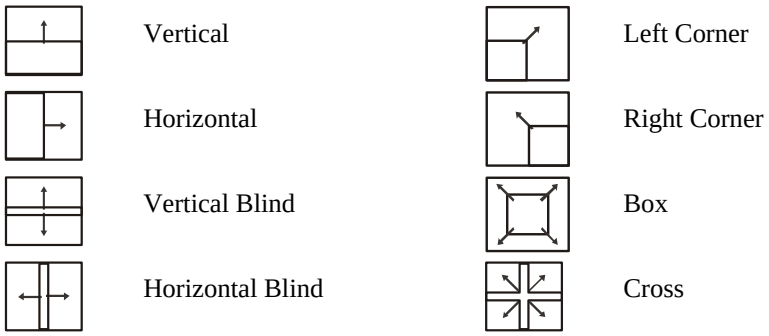
- Manual with the T-bar
- Automatic or 'timed' with the EFFECTS key

Select MIX or WIPE transition

Select pattern for wipe

Function	Notes
Mix	Select mix transition
Wipe	Select wipe transition
Mix/Wipe on	Mix/Wipe status
Select wipe pattern	Use next menu to select wipe pattern

The available wipe patterns are as shown in the following table:



Safire Wipe Patterns

Pressing the EFFECTS key again during a transition reverses the direction of the transition.

MIX/WIPE mode will prevent any keys or masks that may have been set from contributing to the output, but will not erase any settings.

Note: To exit MIX/WIPE mode select Chroma key mode.

Selecting the transition time

The time for the transition in fields is set using the SET FADE menu in Mix or Wipe mode.

Set the Mix or FTB transition times

Set the Wipe or FTB transition times

Assign either Mix/Wipe or Black (for Fade To Black) to the T-Bar.

Note: Mix will be available when mix is active and Wipe if wipe is active.

Use the appropriate soft rotary control to set the transition time in fields (1 to 100) for the Fade to Black or the Mix/Wipe transition.

Using Chroma keys

Press the CHROMA KEY button on to bring up the Chroma Key Mode menu and change the Chroma key state (on/off). If Suppressed Foreground has not been selected as the Fill Source the Combined Key menu will then appear. If necessary select ‘supp fg’ as the Fill Source and then return to the Chroma Key Mode menu.

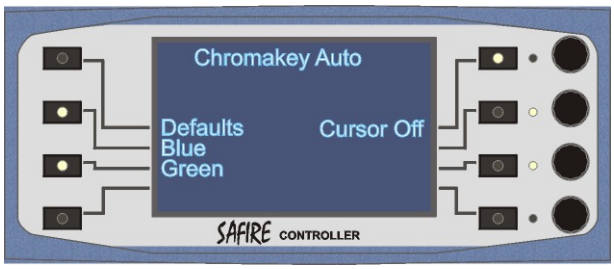
Chroma Key status

Function	Notes
Loc	Frame and slot position used
Ckey on/off	Chroma Key status
ExtKey On/off	Ext Key status
Mult/Add	Keyer mode: Multiplicative (default) or Additive
Force	Force Fgnd/Bgnd and Force FB status
Masks on/off	Fgnd and Bgnd Mask status

Note: This status only menu is displayed when the Chroma key mode is entered. If displayed, the next selection of the Chroma key on button will toggle the Chroma key state.

Auto-configure Chroma key

Press the AUTO button to auto-configure a Chroma key.



Auto-configure Chroma key with manual cursor control

Press the AUTO button and select the appropriate Chroma screen colour, blue or green, as in FOREGROUND background screen colour.

The Main and Preview outputs should show the COMPOSITE output with the foreground keyed into the background.

The auto-configure function has the following defaults:

- A Chroma Key is always attempted with the FOREGROUND image present at the FG input and a BACKGROUND image present at the BG input.
- MULT mode is selected.
- EXT KEY is Off
- SHADOW is Off
- SELF KEY is Off
- SUPP FG is used as FILL
- MASKS are Off
- Fader (T-BAR) and Chroma key button are set to ‘Fade [Chroma Key] to BACKGROUND’

Auto-configure Chroma key – cursor on

Turn the manual colour sample cursor on with the top right soft-select button.

Auto-configure Chroma key with manual cursor control

Use the H Pos and V Pos soft rotary controls to change the cursor position to sample the Chroma key background colour at the desired position within the FOREGROUND.

Press the lower right soft button to perform a Grab Hue and complete the automatic Chroma key setup.

Configuring the Chroma key manually

To setup up or optimise the Chroma key enter the Chroma key manual menu with the MANUAL button in the Chroma Key group.

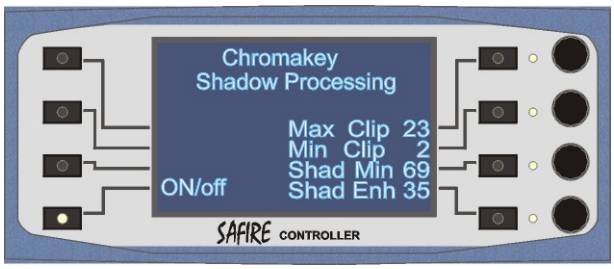
Manual Chroma key configuration

Function	Notes
Min/Max Clip.	These set the range of Chroma key amplitudes used in the output key. All key amplitudes below 'Min Clip' are forced to zero. All amplitudes above 'Max Clip' are forced to maximum key or 100%. The range of values between the two is linearly mapped onto the full output key range. The minimum difference between Min Clip and Max Clip is 12%.
Y correction	Y correction reduces the Chroma key in areas of high foreground luminance, for instance in white areas of foreground subject to Chroma spill. This control determines the amount of reduction. A set value of zero turns off Y correction.
Suppression angle	Determines the range of colours, centred on the selected hue, which are completely suppressed. The value is in percent. 100% corresponds to roughly 1/3 of the acceptance angle
Acceptance Angle	Determines the range of colours, centred on the selected hue, on which keying occurs. The value is in degrees, by analogy with a vector scope.
Hue	Selects the Chroma key colour. The value is in degrees.
Y suppression	Determines the amount of luminance subtracted from the suppressed foreground in areas of key colour.

There is a link in software between Min Clip and Y suppression that allows luminance to be subtracted from the foreground in areas of key colour in relation to the amount of Min Clip used. This is intended to simplify the Y Suppression control and eliminate the need for Y Suppression lift and gain.

Adjusting Chroma key shadows

Press the lower left soft-select button in the SHADOW menu to switch shadow processing on.



Chroma key shadow configuration

Use the lower right soft rotary controls Shad Min and Shad Enh to optimise shadows.

Function	
Min/Max Clip.	These set the range of Chroma key amplitudes used in the output key. All key amplitudes below 'Min Clip' are forced to zero. All amplitudes above 'Max Clip' are forced to maximum key or 100%. The range of values between the two is linearly mapped onto the full output key range. The minimum difference between Min Clip and Max Clip is 12%.
Shadow min	Shadow processing reduces the Chroma key in areas of the final image where the foreground luminance is below a certain value. This control determines that luminance value. Typical values for this control are in the range 50 to 150, depending on the foreground content. A set value of zero turns off shadow enhancement.
Shadow enh	This control determines the amount of shadow enhancement for a given luminance difference. A set value of zero turns off shadow enhancement.

None of the shadow parameters are affected by the Grab-Hue facility.

Chroma keys can be combined with an external key and foreground and background masks.

Tip: Turn Shrink On in the Combined key menu to help remove residual unsuppressed foreground around the foreground subject.
Chroma keys are discussed in depth in the Key Concepts chapter.

Self-key

A self-key is produced using the luminance or black and white information of the foreground video. This mode is often used with the output from a character generator that does not supply a key output.

Self-key Off/On

Self-key GREY

Self-key has three options:

- Off - inactive
- On - active
- Grey – create a range of mid-level luminance values prior to producing the key

Function	Notes
Min/Max Clip.	Max Clip defines a Luma level above which the key will be full amplitude. Min Clip defines a Luma level below which the key will be zero. The minimum difference between Min Clip and Max Clip is 6%.
Shade – GREY only	Used to set the centre of a range of grey levels upon which the Min/Max Clip key processor works
Range – GREY only	The 'Range' control varies the range of luminance values around the Shade value that produces a linear key.

Luminance self-keys can be combined with an external key and foreground and background masks.

See section 2.6 for further description of self-key operation.

Note: When the selection is ‘GREY’ the min/Max Clip controls operate on the key produced by the Shade and Range settings.

Ext key

The external key is produced using the luminance or black and white information of the external video. External keys can be combined with foreground and background masks and either self-keys or Chroma keys.

External Key and Force Fg/Bg/FB defaults

Function	Notes
On/Off	Enable or disable the external key
Min/Max Clip	Max Clip defines a Luma level above which the key will be full amplitude or 100%. Min Clip defines a Luma level below which the key will be zero. The minimum difference between Min Clip and Max Clip is 12%.
Invert	Invert the external key signal
Force Bg	External key forces background
Force Fg	External key forces foreground
Force FB	Set mode for Force Foreground and Background with a single external key

Force Fg and Force Bg

The external key can be used to force areas of a Chroma-keyed output to be either background or fill, dynamically over-riding the Chroma key. A typical application for this is the simulation of a desk or pillar in a virtual studio. By forcing the area to background under control of a key from the graphics system, the presenter can be put behind a graphics object.

The external key can also be used to override the Chroma key and force areas of the image to be the unsuppressed foreground fill video. The final key and Chroma key must be inverted. Note that that the final key inversion also affects the key fade and force controls.

The Force Bg and Force Fg buttons establish the appropriate defaults to produce the desired effects as follows:

Button	External Key	Final Key	**Fill**	Chroma Key
Force Bg	Normal	Normal	Supp Fgn	On
Force Fg	Invert - On	Invert	Foreground	On
Force FB	Normal - On	Normal	Foreground	On

Force FB

This customer requested mode is intended for use where Chroma keying is only needed in a very limited area of a foreground input, and a greater degree of control is required than can be accomplished using masks. The main application is in sports graphics.

Force FB applies the following defaults:

Function	Force FB
Chroma Keyer	Turned on unless Self Key is already on
Invert Chroma Key	No
Invert Ext Key	No
Invert Final Key	No
Fill Source	Foreground
Mult/Add	MULT
Low luminance in Ext Key	SDI black/grey (10 bit 64 to 319) linearly forces foreground
Mid luminance in Ext Key	SDI grey (10 bit 320 to 684) switches to Chroma key mode
High luminance in Ext Key	SDI white (10 bit 685 to 940) linearly forces background (Chroma key off)

Black (10-bit value 64) forces foreground. The next 255 levels act as a linear 'force foreground' key, until at an input of 320 there is no force foreground, and the Safire acts as a Chroma keyer. The 'Chroma key' range extends to 684. Then between 685 and 940 (white) there are 255 levels of linear 'force background' key, with full background at white. See section 2.7 for further description of 'Force FB' operation.

Note: The three ‘Force’ setups in the EXT KEY menu do not turn any masks on, this must be done via the MASKS menu.

Mask setup

Both foreground and background masks are provided which can be used with any of the valid key combinations to force or censor elements of both the background and foreground. The priority of each mask can be changed.

Foreground Mask Setup

Background Mask Setup

Masks	
Fg Off/On/Invert	Enables, disables invert foreground mask. When the mask is on, the area it occupies is forced to background
Bg Off/On/Invert	Enables, disables invert background mask. When the mask is on, the area it occupies is forced to unsuppressed foreground.
Priority F/B	Selects which mask window that has control in areas where they overlap. A selection of 'F' results in unsuppressed foreground in the area of overlap. A selection of 'B' results in background in the area of overlap.
Adjust Fg/Bg	Mask controls alter Fgnd or Bgnd
Hpos	Adjusts the position of the left-hand edge of the window. Value is the digital pixel number of the edge.
Vpos	Adjusts the position of the top edge of the window. The displayed value is in lines.
Width	Adjusts the mask width in pixels.
Height	Adjusts the mask height in lines.

It may help to slightly misadjust Max Clip (multiplicative mode) or Y Suppression (additive mode) to make a mask window more visible during mask adjustment.

If an external key and force masks are enabled they are combined with a non-additive mix. This means that if a mask and the external key are both forcing background, where they overlap the signal that forces background most strongly will take priority.

The priority setting determines whether the background or foreground force mask takes precedence when they overlap. When the priority is set to 'F' the foreground mask remains unmodified by the background mask (if the masks overlap the foreground mask will control the area of overlap). When the priority is set to 'B' then the background mask remains unmodified by the foreground mask.

When external and Chroma keys are turned off internal masks can be used as the only keying source. When turned on the external key and/or the Chroma key and the internal masks can be used.

Combined key

This menu provides access to Fill Source selection, Set Matte, Add/Mult mode change and invert/normal Final Key.

Combined Key

Function	Notes
Foreground	Select foreground as Fill Source. Capitalised when selected.
SUPP FG	Select suppressed foreground as Fill Source. Capitalised when selected.
Matte	Select matte as Fill Source. Capitalised when selected.
MULT/Add	Select additive or multiplicative keying. Chosen mode capitalised when selected.
Invert	Invert the Final Key signal
Shrink	Sub-pixel reduction in combined key size to remove residual suppressed backdrop around foreground subject when Chroma keying. Capitalised when selected. Key shrink has no effect on external or self-key modes.
Set Matte	Select Matte colour – see next menu

Set matte

The matte colour can be viewed by selecting it as the fill with a key active whilst monitoring the Main or Aux output.

Combined Key – Set Matte

Function	Notes
Hue	Select Hue 0 to 360degrees
Luminance	Select luminance value 0 to 100
Saturation	Select saturation 0 to 100

Matte processing limits the matte output based on RGB values to generate only legal colours in the YCrCb colour space.

Note: One effect of the built in colour-space legaliser is that luminance and chrominance values are cross-linked. For example, luminance is reduced as saturation is increased and saturation has to be manually reduced if a higher luminance value is required.
The displayed numerical values reflect the limited range of values legal in broadcast television colour-space.

Remote

This menu is entered with the REMOTE button and upon initial panel power-up.

Controller Polling for Safire module (power on default)

Safire found at frame slot 5 (numbered from 0)

At power-up, or when the Poll All soft button is pressed, the Safire controller polls for available Safire modules. If one or more Safire module(s) respond during this time it (they) will be listed. Select the required Safire module with the appropriate soft button. Pressing the soft button will then capitalise to show the selection has been actioned.

The card-edge RxA LED on each Safire connected to a control panel will illuminate when menu access is attempted. The TxA LED will only illuminate on the Safire assigned using the remote menu.

Engineering

This menu is entered with the ENG button.

Polled Safire HD status

Function	Notes
Eng Vers	Displays software version
Fgnd	Shows presence or absence of foreground input
Bgnd	Shows presence or absence of background input
Ext Key	Shows presence or absence of selected output timing reference or external key input
Ref	Toggles through the inputs to select the output timing reference
1920x1080i/625/525	Shows input standard
Bright	Adjust brightness over 0 (half) to 7 (full) range
Defaults	Recall factory defaults
H Phase	Adjusts output delay relative to selected reference over a 124 microsecond (µs) range from about 5µs (5) to 128µs (128). Acceptable range depends on relative timing of input signals.

On power up Safire restores all the settings, including H Phase, to the value they were when a set-up was last stored. If the value of H Phase is subsequently adjusted the new value will not be overwritten when a set-up is recalled unless the recalled set-up was the last one to be saved. This allows the user to recover a previous H Phase value if required and to recall set-ups without overwriting an H Phase adjustment that has changed to cope with different input signal timing. If the H Phase value is changed to accommodate external timing then storing a set-up after the adjustment will prevent an unexpected reversion to the old value.

Note: Output timing is selectable with 0-1 lines delay from the assigned reference input. The other inputs must be 0-1 lines earlier than the output. Inputs outside the timing range will be horizontally aligned but vertically offset.

Configuring GPIs

There are two types of GPI interfaces available with Safire HD. Frame GPIs are available for each Safire and accessible at the frame rear connectors. Panel GPIs are accessible at the rear of an assigned Safire Controller.

The first four Frame GPIs are serial communication lines that are reserved for serial control for Safire Controller panels. The next two Frame GPIs are reserved for remote preset memory recall.

There are currently five Panel GPI inputs reserved for remote Safire Controller assignment to Safire modules and four unreserved Panel GPI outputs whose states are stored in each Safire, but only output from an assigned panel.

The unreserved Panel GPI outputs are available for any use for which they may be suitable – such as indicating which Safire is assigned to a panel on a dedicated status display.

The GPI menu, accessed with the GPI button, provides access to the following functions:

- Memory recall on/off - enable or disable preset recall from frame GPIs
- Safire select on/off – remote assignment of panel to Safire module from panel GPIs
- Output configure – set panel GPI output states for each GPI and/or Safire
- Panel GPI monitoring – see panel GPI I/O status at a glance

Configure GPI response for selected Safire

Mem recall /On/Off

It is recommended to disable frame GPI memory recall when storing or recalling setups via the MEMORY menu.

Frame GPI lines ‘e’ and ‘f’ (refer to Installation section for pinout) form a binary number, in which ‘e’ has the weight ‘1’ and ‘f’ has the weight ‘2’. The following table illustrates the Frame GPI states required:

Set-up recalled	Frame GPI ‘e’	Frame GPI ‘f’
1	Open	Open
2	Low	Open
3	Open	Low
4	Low	Low

When GPI control is on (MEMORY RECALL) the memory indicated by the above table will be recalled automatically when the GPI lines change state.

Adjustment of system parameters is possible when the GPI lines are stable, but storage of changes is not automatic.

If there is more than one Safire module controlled from the control panel, the set-ups of each one must be saved separately. Select the module from the REMOTE menu and then save its set-up.

Safire HD select

The Safire controller may be assigned to any one of 7 Safire HD modules directly via the REMOTE menu, or remotely using the first five Panel GPI inputs available at the GPI 1 9-way ‘D’ type at the rear of the control panel.

To activate the remote Safire HD select function press the Safire Off soft-select button until SAFIRE HD SEL is shown. The panel GPI inputs will now assign the Safire controller to a Safire HD according to its node address as follows:

Safire node (slot address)	GPI ‘1’	GPI ‘2’	GPI ‘3’	GPI ‘4’	GPI ‘5’
1.02	Low	Open	Open	Open	Open
1.04	Low	Low	Open	Open	Open
1.06	Low	Open	Low	Open	Open
1.08	Low	Low	Low	Open	Open
1.10	Low	Open	Open	Low	Open
1.12	Low	Low	Open	Low	Open
2.02	Low	Open	Open	Open	Low
2.04	Low	Low	Open	Open	Low
2.06	Low	Open	Low	Open	Low
2.08	Low	Low	Low	Open	Low
2.10	Low	Open	Open	Low	Low
2.12	Low	Low	Open	Low	Low

Configuring Panel GPI outputs

The Panel GPI output configure sub-menu allows GPI action for each GPI output to be configured for the currently assigned Safire module.

Three actions are available:

- Open – high impedance, may be pulled high by external resistor connected to 5V
- Stet – when recalled as part of a preset output remains in the same state prior to recall
- Gnd – output sinks up to 16ma of current to drive an external pull-up low

Configure GPI action

The ‘Stet’ action type is useful since it allows each of the four GPI outputs to be assigned to a different function. For example, suppose in a transmission suite one Safire Controller is used to control four separate graphic suites, each with a dedicated Safire module.

A hardware selection panel could be built which assigns the panel and turns on a preset channel logo or graphic. Panel GPI 1 is associated with the logo for suite 1; Panel GPI 2 is associated with the logo for suite 2 and so on. When configuring Panel GPIs for suite 1, GPIs 2, 3 and 4 would be set to ‘Stet’ to ensure that they remain in the same state as previously set.

Note: Panel GPI outputs are output from the panel although their state is stored with Safire presets.

Panel GPI monitoring

The ‘gpi in’ and ‘gpi op’ data are hexadecimal representation of the status of the Panel GPI inputs and the Panel GPI outputs respectively. This status information may be useful when selecting the appropriate action type for Panel GPI s.

Memory - save

The SAVE key allows access to the Save Configuration menu for storing and naming of setups within Safire HD's non-volatile memory.

Select named setup

Select named setup continued

Function	Notes
(1-10) name	Select preset memory to save current configuration
more	Select presets 8 to 10

Saving and naming presets

Pressing any of the presets in the SAVE menu will enter this menu.

Set name and confirm

To save the current Safire HD configuration in the named memory location or setup press the Confirm soft button at the bottom right of the display.

To re-name a setup proceed as follows:

- Use the Left and Right soft-select buttons to choose a character
- Rotate the top right rotary control to change the character
- Press the Confirm soft-select button when ready

Setup names may consist of up to ten alphanumeric characters. Cancel returns to the previous menu.

Note: Save and recall may fail unless GPI memory recall is disabled.
Although presets are stored in Safire, preset names are stored in the panel and each panel may use different names for the same presets.

Memory - recall

The RECALL key allows access to the Recall Memory menu for loading set-ups stored in Safire HD's non-volatile memory.

Select named setup

Select named setup continued

Function	Notes
(1-10) name	Select preset memory to recall current configuration.
more	Select presets 8 to 10

To recall a setup simply select the desired setup with the appropriate soft-select button and the settings stored for that preset will be instantly recalled.

Note: Save and recall may fail unless GPI memory recall is disabled.
Although presets are stored in Safire, preset names are stored in the panel and each panel may use different names for the same presets.

Transfer

The TRANSFER key allows access to the Copy Setup menu for copying configuration from one Safire to another.

Select the FROM Safire

Select the TO Safire

Function	Notes
Poll All	If necessary allow the panel to poll for Safire modules
From	Select the source Safire
To	Select the target Safire
Copy Now	Transfer configuration between Safires

It is recommended to disable GPI memory recall when transferring setup.

Panel lock/unlock

This menu is entered by pressing the F1 key.

Lock or unlock the panel

To lock the panel to prevent unauthorised use, proceed as follows:

- Enter the password (if not displayed)
- Press Confirm
- Press UNLOCKED to change state to LOCKED

To unlock the panel, proceed as follows:

- Enter the password
- Press Confirm
- Press LOCKED to change state to UNLOCKED

To change the password proceed as follows:

- Enter the password
- Press Confirm
- Press the Set New soft-select button
- Rotate the top right rotary control to change the character selected by the Left and Right soft-select buttons
- Press the Confirm soft-select button when ready

Passwords may consist of up to ten alphanumeric characters. Cancel returns to the previous menu.

The power-up default is always Unlocked (and the password will be displayed until Confirm is pressed)

Note: Lock and Set New are left enabled by the Confirm action until the panel lock menu is exited.

4 Using Statesman

The Crystal Vision Statesman PC control software is designed to control a range of Crystal Vision modules via serial control from a PC.

Statesman provides a user friendly means of configuring and operating Crystal Vision modules with the benefit of see-at-a-glance status monitoring.

The main Statesman application communicates with each module in a frame through an active control panel. An active panel must be fitted to allow for Statesman control.

4.1 Installation

Minimum pre-requisites:

- Windows 98, NT4 with SP 5 or higher, Windows 2000, or Windows XP
- A parallel port dongle supplied with the Statesman software package
- An RS422 serial connection from the host PC to the Remote 2 connector of an FR2AV Crystal Vision frame and at least one Statesman module and/or other Statesman compatible module
- An active control panel MUST be fitted to the frame with version 1.5 or above firmware
- An optional RS422 to RS232 converter if the PC has no RS422 ports

Installing Statesman

- To view all application windows, set graphics resolution to at least 1024 x 768
- Remove any previous version of the Statesman software using the Add/Remove Programs application in the Windows Control Panel
- Ensure that the Statesman dongle is fitted to the parallel port of the host PC
- Insert the Statesman CD and the installation should start immediately – if it does not, run the setup.exe file on the CD
- Obey any installation program prompts and restart the PC when prompted

Running Statesman for the first time

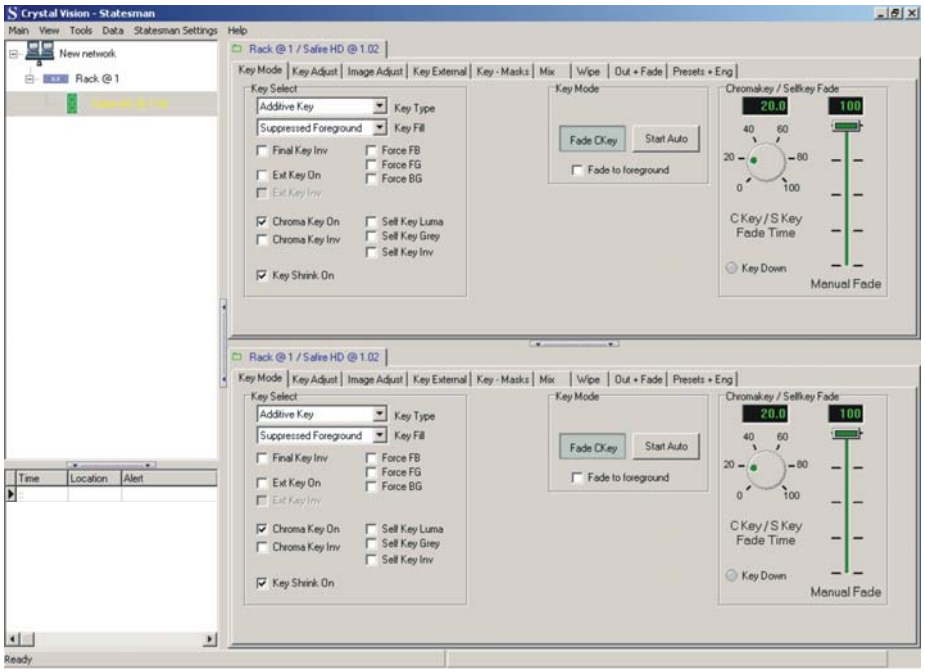
Statesman may be run from the Crystal Vision programs folder via the Start menu or by double clicking on the Statesman.exe file in the installed program directory (default is C:\Program Files\Crystal Vision).

When the program runs it should automatically detect any Statesman compatible modules in the connected frame or frames and display them in the main application left hand explorer-style window.

4.2 Statesman operation

The initial view will show an explorer style view of the connected frames and modules. Open any frame by clicking on the '+' sign or by double clicking on a frame. Installed modules should be shown with module icons. Frame and module icons can be named as desired by right-clicking or using the edit menu.

Double clicking on a module will enable the display of the main application menus.



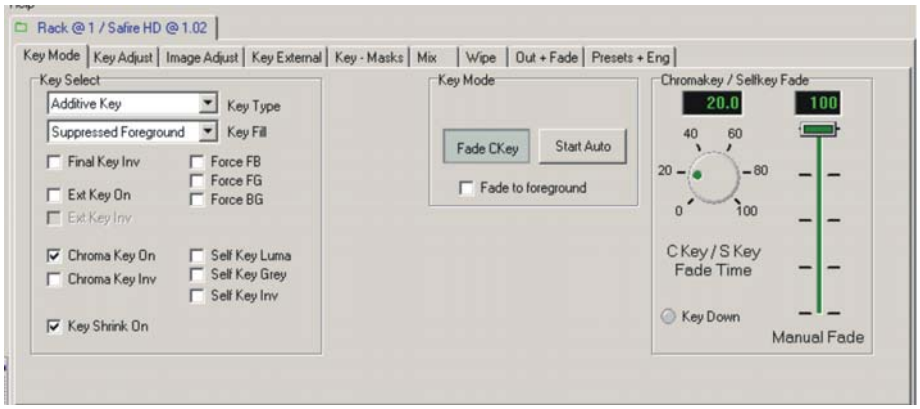
The Statesman (upper pane) main application window

The menu display is repeated for convenience to allow dual-module display, dual-control display of modules with duplicate signal paths or to allow two functions to be viewed at the same time.

Note: Features and controls that are inappropriate in certain modes or mutually exclusive with other controls are usually 'greyed out' to indicate that they are currently unavailable.

Selecting key mode options

Use the Key Mode menu to select the type of keying operation required.



SafireHD Key Mode menu

The following keying options are available with all keying modes:

Function	Key options
Key type	Multiplicative or Additive
Key fill	Black, Foreground, Suppressed Foreground or Matte
Final key	Invert/normal

Note: Key type is discussed in section 2.1
'KEY MODE OFF' will be shown if a Mix or Wipe is selected

The available keying operations are described in the following table:

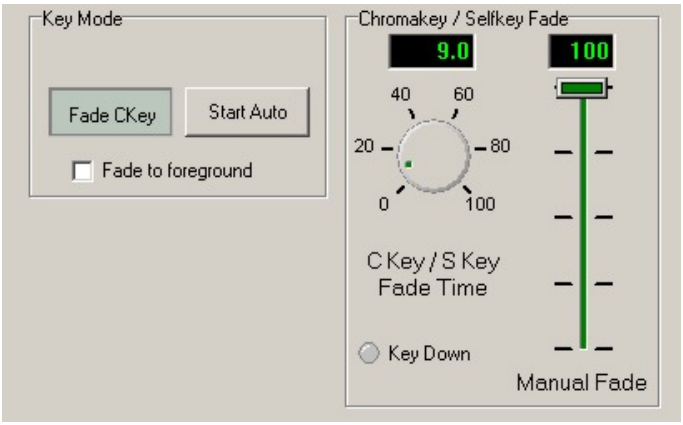
Key mode	Key options	Use with
Chroma Key	On/Invert/Off	External key
Self Key	Luma/Grey/Invert/Off	External key
Key Shrink	On/Off	Chroma key
Ext (External) Key	On/Invert/Off	Chroma key or Self key (but not both)
Force BG	Force background	
Force FG	Force Foreground	
Force FB	Force Background + Foreground + Chroma Key	

Notes: Key Shrink provides a sub-pixel reduction in combined key size to remove residual suppressed backdrop around foreground subject when Chroma keying.
Key shrink has no effect on external or self-key modes.
Chroma keying is discussed in section 2.2, self-keying is discussed in section 2.7 and external keying and force options are discussed in section 2.8.

Using fade controls

The fade controls consist of an on-screen-manual fade slider that acts like a ‘T-bar’, a Fade Disable/Enable button, a Start Auto button and Fade Time control to set the automatic fade duration.

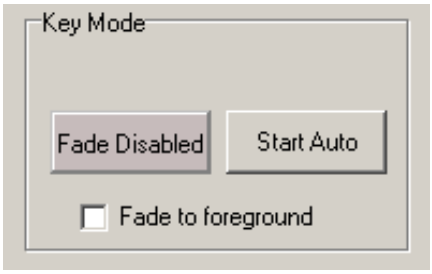
These controls are duplicated for each menu that requires them, and are normally enabled according to the type of key mode that has been selected in the main Key Mode menu.



Safire HD Key Mode menu – fade options

The manual and automatic fade controls in the Key Mode menu are for Chroma keys and self-keys only.

Enabling an external key fade, enabling a fade to black or clicking on the Fade Ckey button will disable the fade function in this menu.



Safire HD Key Mode menu – CKey/Self-key disabled

To enable the Ckey/Self-key fade function directly click on the Fade Disabled button in the Key Mode menu.

When disabled, the button will have a faint purple background, when enabled the background will turn green.

The Chroma key / Self-key Fade box shows the setting for the automatic fade time (0 to 100 fields) and the position of the manual on-screen ‘T-bar’ fader.

Safire Key Mode menu – Chromakey / Self-key Fade settings

The Key Down indicator always shows the fully off state of the assigned fade function (i.e. Chroma key or self-key).

The fade may be initiated by using the Manual fade slider or by pressing the Start Auto button, when the fade will occur at a rate set by the Fade Time control. If the Auto button is pressed during a timed transition, its effect will be reversed.

The default effect of the fade function (manual or automatic fade down) is to fade the active keyed video off the screen leaving the background signal. If a Chroma key is the active key, the ‘fade-to’ source is normally background, but this may be overridden by checking the ‘fade to foreground’ box in the Key Mode menu.

The ‘fade to foreground’ check box only works for an active Chroma key. However, inverting the active key and the final key will change the fade-to source of any key.

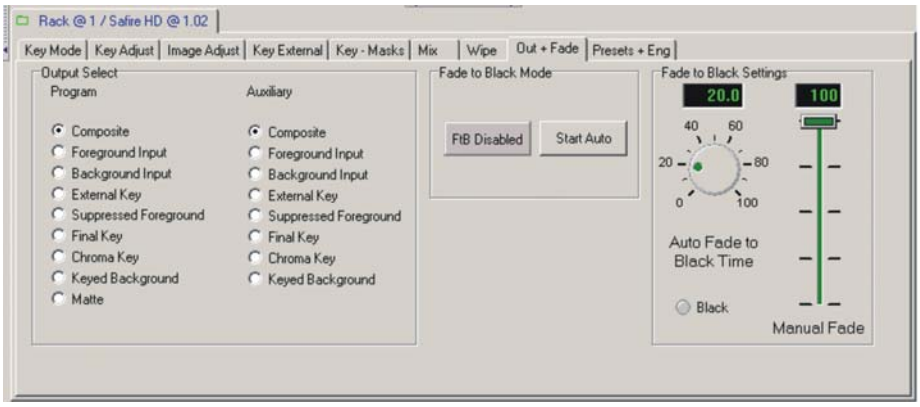
Tip: Invert the final key and active key for external keys and self-keys to change between foreground and background fade-to sources.

Fade controls in other menus work in a similar fashion, but the ‘Fade to foreground’ check box is only found in the Key Mode menu and only works for Chroma keys.

Selecting the main and aux output source

There are a number of sources that may be assigned to the Main and Aux outputs to assist with the construction and operation of keying, mix/wipe operations.

Use the Out + Fade menu to select the source for the Main and Aux outputs.



Safire HD Out + Fade menu

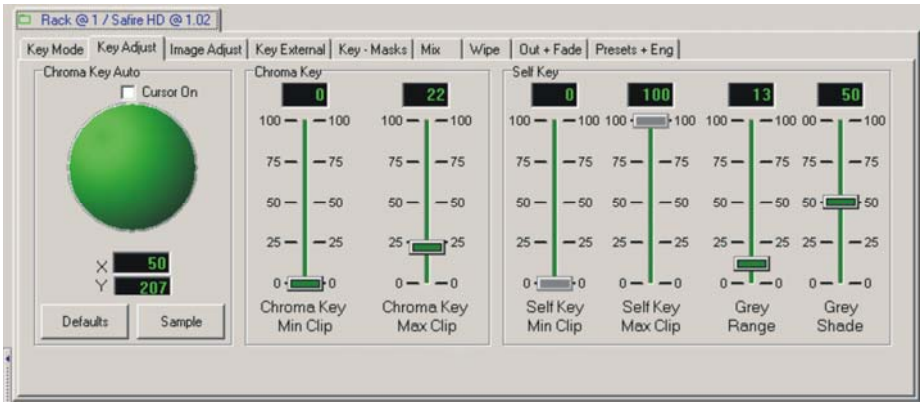
The Main and Auxiliary outputs may be assigned to sources as follows:

Function	Notes
Fg Input	Selects the foreground input.
Bg Input	Selects the background input
Ext Key	Selects the external key input
SupFg	Selects the suppressed foreground. The chroma will be modified according to the hue, acceptance angle and suppression angle controls. The luminance in the key area will be modified according to the Y suppression control.
Composite	Selects the final combined video image.
Final Key	Selects the combined key. This will be a combination of some or all of external key input, chroma key, foreground mask and background mask.
Chroma Key	Selects the chroma key after scaling due to the clip and shadow controls
Keyed Background	Selects the background multiplied by the combined key
Matte	Selects the output of the Matte generator (Main output only)

Tip: The matte colour may be observed whilst selecting its colour on the Main output by selecting Matte as the output source or by using it as the fill in an active key, and viewing the composite output.

Performing an auto-configured chroma key

The provided Auto Chroma Key function in the Key Adjust menu will quickly produce a usable chroma key.



Safire HD Key Adjust menu

There are two auto-configure chroma key options:

- Press the Defaults button to set up for a chroma key with a typical blue backdrop
- Check the Cursor On box to manually sample a colour from the foreground input

If the manual colour sample method is used, the main output will switch automatically to the foreground input. Click in the coloured circle to change the position of the sample cursor. When the Sample button is pressed, the main output will revert to the previously selected source. The Default auto-chroma key always selects the output source as Composite.

The Default setup function has the following defaults:

- A chroma key is always attempted with the FOREGROUND image present at the FG input and a BACKGROUND image present at the BG input.
- Hue is 0 degrees
- Multiplicative mode is selected.
- EXT KEY is Off
- SHADOW is Off
- SELF KEY is Off
- SUPP FG is used as FILL
- MASKS are Off
- Key Mode Fade is set to Ckey Fade and the Fade-to source is Background
- Main output source when the auto-configure chroma key is finished is Composite

Making adjustments

There are six manual controls that can further improve chroma key luminance:

- **Chroma Key Min Clip/Chroma Key Max Clip**– chroma key amplitude range
- **Y suppression** –luminance subtracted from suppressed foreground in areas of key colour
- **Y correct (correction)** – reduces chroma key in areas of high foreground luminance
- **Shad Min** – reduces chroma key in areas of the final image where foreground luminance is below a certain value
- **Shad Enh** – determines shadow enhancement for a given luminance difference

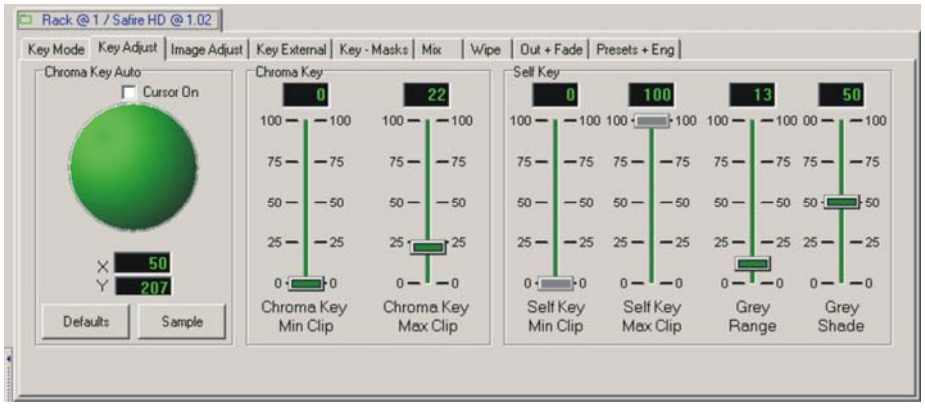
There are three manual controls that can further improve the colour sensitivity of the chroma key:

- **Hue** – chroma key 'null' colour in degrees
- **Accept (Acceptance) angle** – range of colours, centred on the selected suppression hue, on which keying occurs
- **Supp (Suppression) angle** - range of colours, centred on the selected suppression hue, which are completely suppressed

Note: Terms in brackets are equivalent Safire Controller terms.

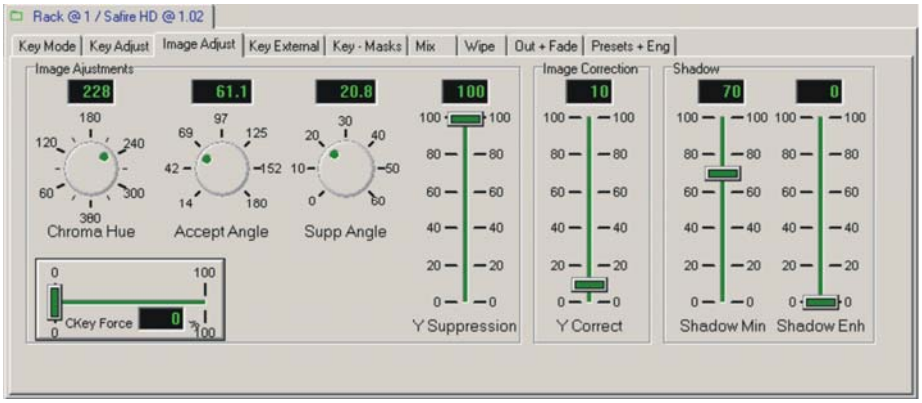
The required controls are to be found on the Key Adjust and Image Adjust menus.

Adjusting chroma keys



Safire HD Key Adjust menu

Function	Notes
Chroma Key Min/Chroma Key Max	Sets the range of chroma key amplitudes used in the output key. All key amplitudes below 'Min' are forced to zero. All amplitudes above 'Max' are forced to maximum key or 100%. The range of values between the two is linearly mapped onto the full output key range. The minimum difference between Min and Max is 12%.



Safire HD Image Adjust menu

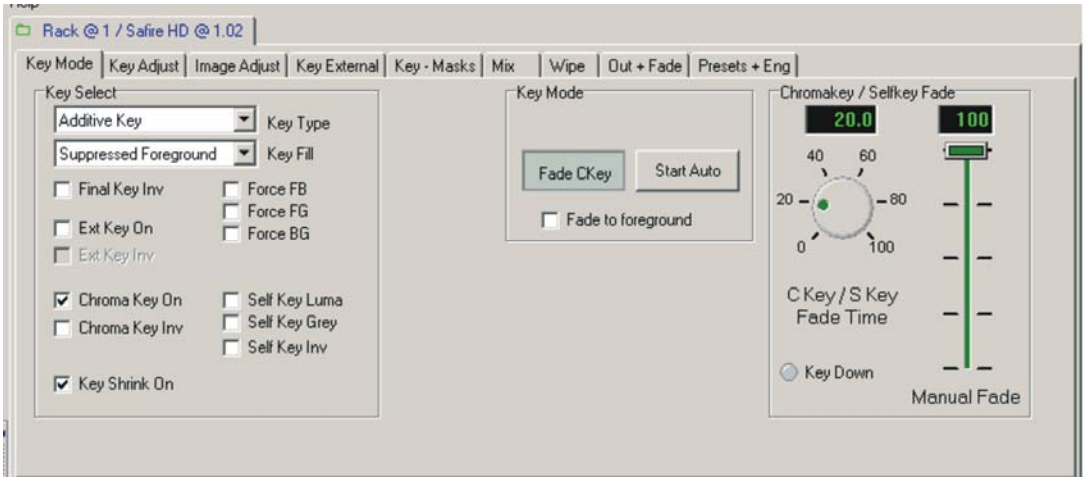
Function	Notes
Y Correct	Luma correction reduces the chroma key in areas of high foreground luminance, for instance in white areas of foreground subject to chroma spill. This control determines the amount of reduction. A set value of zero turns off Luma correction.
Y Suppression	Determines the amount of luminance subtracted from the suppressed foreground in areas of key colour.
Supp angle	Determines the range of colours, centred on the selected hue, which are completely suppressed. The value is in percent. 100% corresponds to roughly 1/3 of the acceptance angle
Accept Angle	Determines the range of colours, centred on the selected hue, on which keying occurs. The value is in degrees, by analogy with a vector scope.
Chroma Hue	Selects the chroma key colour. The value is in degrees.
Shadow Min	Shadow processing reduces the chroma key in areas of the final image where the foreground luminance is below a certain value. This control determines that luminance value. Typical values are in the range 50 to 150, depending on the foreground content. A set value of zero turns off shadow processing.
Shadow Enh	This control determines the amount of shadow enhancement for a given luminance difference. A set value of zero turns off shadow enhancement.

Tip: Check Key Shrink On in the Key Mode tab to help remove residual unsuppressed foreground around the foreground subject.

Chroma keys are discussed in depth in the Key Concepts chapter and a step by step procedure for manually creating a chroma key is given (using the Safire Controller panel) in section 3.3.

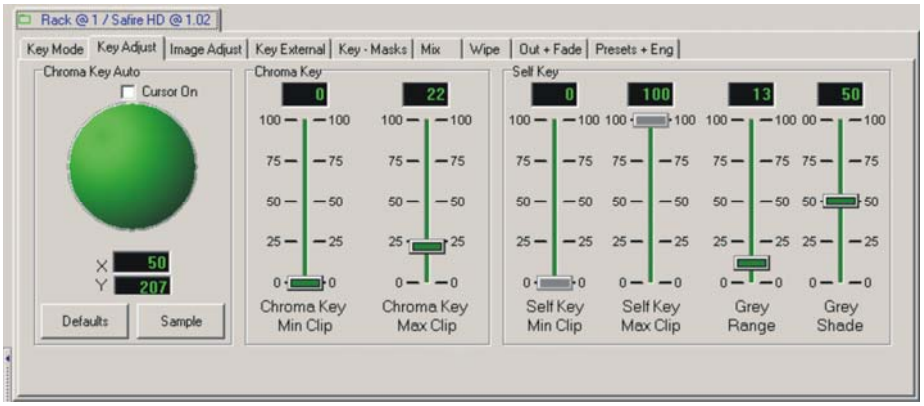
Adjusting self-keys

A self-key is enabled in the Key Mode menu and adjusted in the Key External menu.



Safire HD Key Mode menu – Self-Key On

Function	Notes
Self-Key Luma	Enable or disable the self-key
Self-Key Grey	Enable or disable the self-key grey mode
Self-Key Invert	Invert the self-key



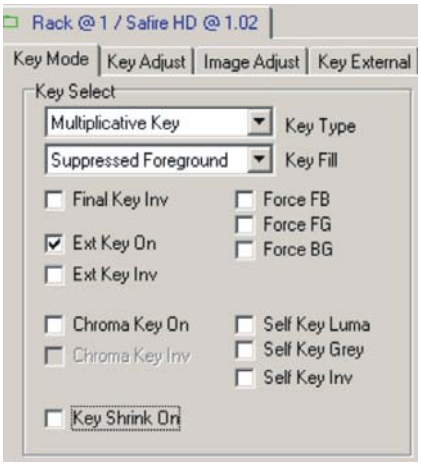
Safire HD Key Adjust menu

Function	Notes
Self Key Min Clip/Max Clip.	Max Clip defines a Luma level above which the key will be full amplitude. Min Clip defines a Luma level below which the key will be zero. The minimum difference between Min Clip and Max Clip is 6.
Grey Shade	Used to set the centre of a range of grey levels upon which the Min/Max Clip key processor works
Grey Range	The 'Range' control varies the range of luminance values around the Shade value that produces a linear key.

Note: When the selection is 'GREY' the min/max controls operate on the key produced by the 'Shade' and 'Range' settings. Further description of self-keying is given in section 2.6.

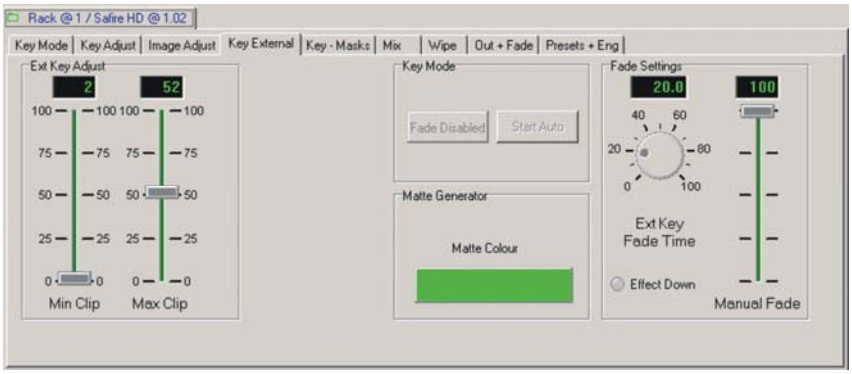
Adjusting external keys

An external key is enabled in the Key Mode menu and adjusted in the Key External menu.



Safire HD Key Mode menu – Ext Key On

Function	Notes
Ext Key Inv	Invert the external key signal
Force Bg	External key forces background
Force Fg	External key forces foreground
Force FB	Set defaults for Force Foreground and Background with a single external key



Safire HD Key External menu

Function	Notes
Key Min Clip/Max Clip	Min Clip defines a Luma level below which the key will be zero. The minimum difference between Min Clip and Max Clip is 12%. Max Clip defines a Luma level above which the key will be full amplitude or 100%.
Fade Ext Key	Enable/disable external key fade button/indicator
Start Auto	Initiate timed transition
Fade settings	Set external key fade time / perform manual fade of external key

Pressing the Start Auto key during a transition reverses the direction of the transition.

Force Fg and Force Bg

The external key can be used to force areas of a chroma-keyed output to be either background or fill, dynamically over-riding the chroma key. A typical application for this is the simulation of a desk or pillar in a virtual studio. By forcing the area to background under control of a key from the graphics system, the presenter can be put behind a graphics object.

The external key can also be used to override the chroma key and force areas of the image to be the unsuppressed foreground fill video. The final key and chroma key must be inverted. Note that that the final key inversion also affects the key fade and force controls.

The Force Bg and Force Fg options in the Key Menu establish the appropriate defaults to produce the desired effects as follows:

Key mode	External Key	Final Key	**Fill**	Chroma Key
Force Bg	Normal	Normal	Supp Fgn	On
Force Fg	Invert - On	Invert	Foreground	On
Force FB	Normal - On	Normal	Foreground	On

Force FB

This customer requested mode is intended for use where chroma keying is only needed in a very limited area of a foreground input, and a greater degree of control is required than can be accomplished using masks. The main application is in sports graphics.

Force FB applies the following defaults:

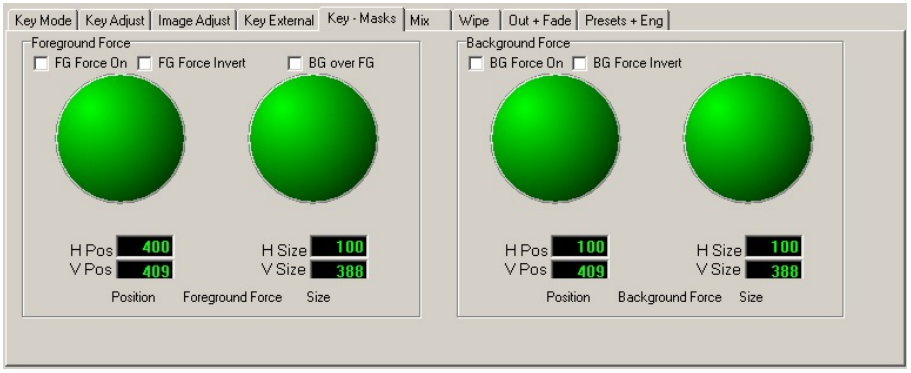
Function	Force FB
Chroma Keyer	Turned on unless Self Key is already on
Invert Chroma Key	No
Invert Ext Key	No
Invert Final Key	No
Fill Source	Foreground
Mult/Add	MULT
Low luminance in Ext Key	SDI black/grey (10 bit 64 to 319) linearly forces foreground
Mid luminance in Ext Key	SDI grey (10 bit 320 to 684) switches to chroma key mode
High luminance in Ext Key	SDI white (10 bit 685 to 940) linearly forces background (chroma key off)

Black (10-bit value 64) forces foreground. The next 255 levels act as a linear 'force foreground' key, until at an input of 320 there is no force foreground, and the Safire acts as a chroma keyer. The 'chroma key' range extends to 684. Then between 685 and 940 (white) there are 255 levels of linear 'force background' key, with full background at white. See section 2.7 for further description of Force FB operation.

Note: The three ‘Force’ setups in the Key Mode menu do not turn any masks on, this must be done via the Key - Masks menu.

Using Masks

Both foreground and background masks are provided which can be used with any of the valid key combinations to force or censor elements of both the background and foreground. The priority of each mask can be changed.



Safire HD Key Masks menu

Masks	
FG Force On	Enables foreground mask. When the mask is on, the area it occupies is forced to background
FG Force Invert	Inverts foreground mask
BG Force On	Enables background mask. When the mask is on, the area it occupies is forced to unsuppressed foreground.
BG Force Invert	Inverts background mask
BG over FG	Selects, which mask window, have control in areas where they overlap. Leaving BG over FG unchecked results in unsuppressed foreground in the area of overlap. Checking BG over FG results in background in the area of overlap.
Hpos Fgnd/Bgnd Force	Adjusts the position of the left-hand edge of the window. Value is the digital pixel number of the edge.
Vpos Fgnd/Bgnd Force	Adjusts the position of the top edge of the window. The displayed value is in lines.
H Size Fgnd/Bgnd Force	Adjusts the mask width in pixels.
V Size Fgnd/Bgnd Force	Adjusts the mask height in lines.

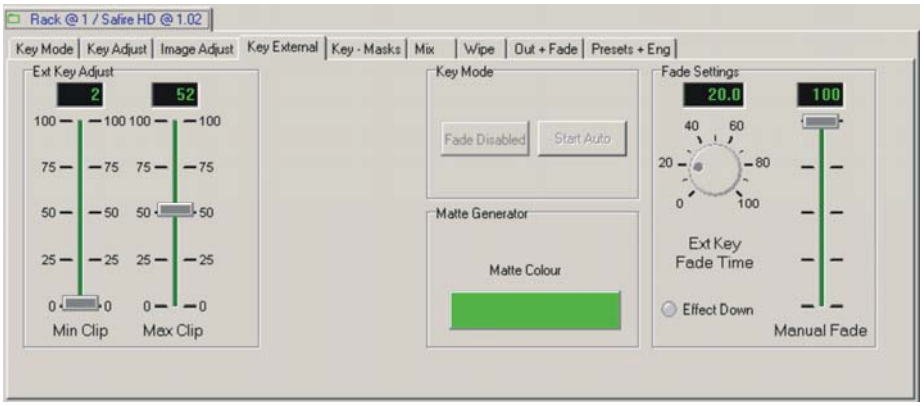
It may help to slightly misadjust Key Max (multiplicative mode) or Y Suppression (additive mode) to make a mask window more visible during mask adjustment.

If an external key and force masks are enabled they are combined with a non-additive mix. This means that if a mask and the external key are both forcing background, where they overlap the signal that forces background most strongly will take priority.

When external and chroma keys are turned off internal masks can be used as the only keying source. When turned on the external key and/or the chroma key and the internal masks can be used.

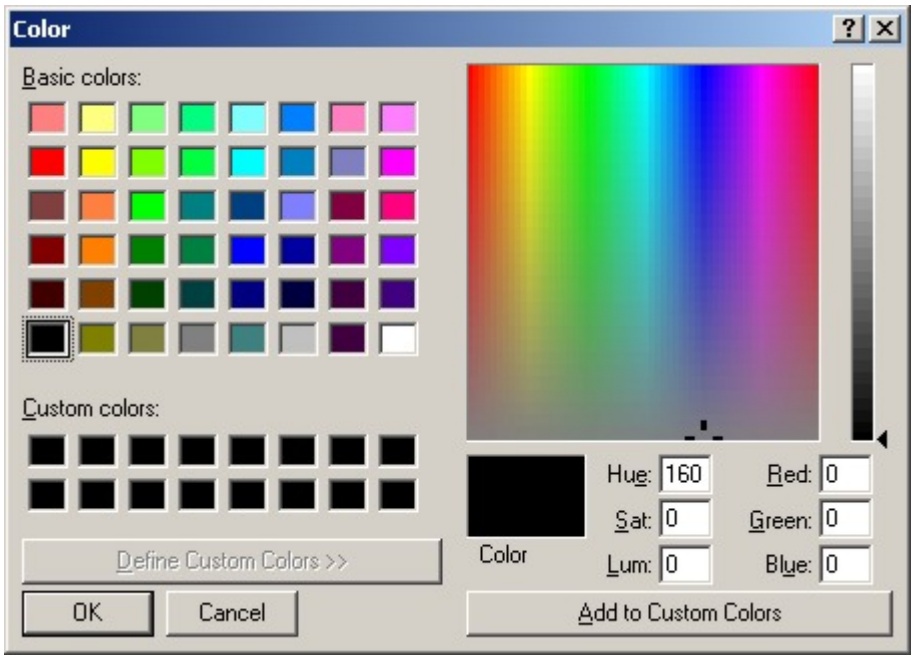
Selecting the matte colour

The select Matte colour menu is located within the Key External menu.



Safire HD Key External menu

Click on the Matte Colour button to bring up the Matte Colour selector.



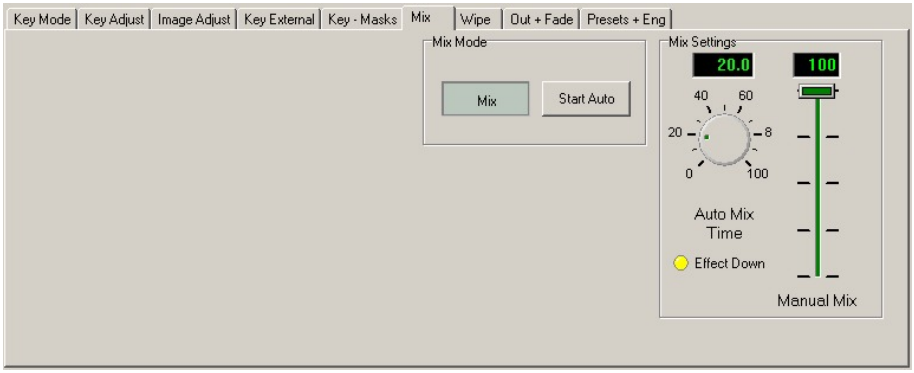
Safire HD Matte colour select sub-menu

Matte processing limits the matte output based on RGB or HLS values to generate only legal colours in the YCrCb colour space.

Note: One effect of the built in colour-space legaliser (matte processing) is that luminance and chrominance values are cross-linked. For example, displayed luminance is reduced as saturation is increased and saturation is reduced to if a higher luminance value is required.
The displayed numerical values of the standard windows colour selector may not reflect the limited range of values legal in broadcast television colour-space.
However, Safire HD's matte processor will NOT output illegal colours.

Using mixes

To enable Mix mode, enter the Mix menu and click on the Mix Disabled button to toggle it to Mix. When disabled, the button will have a faint purple background, when enabled the background will turn green.



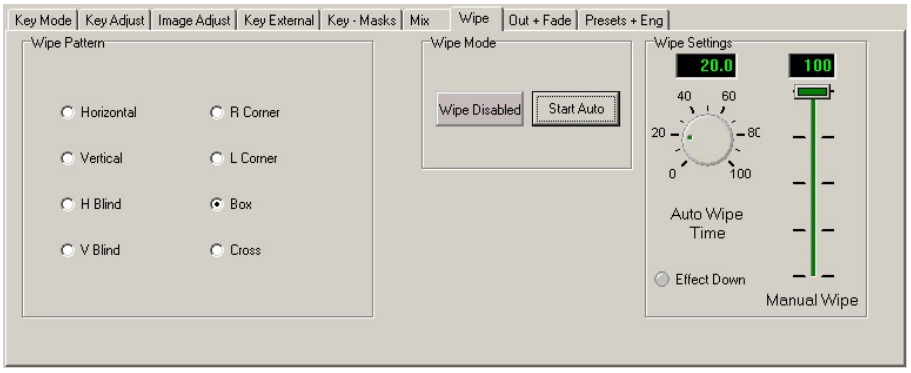
Safire HD Mix menu

The mix Settings box shows the setting for the automatic fade times (0 to 100 fields) and the position of the manual on-screen ‘T-bar’ fader.

The Effect Down indicator always shows the fully off state of the mix. Pressing the start auto key during a transition reverses the direction of the transition.

Using wipes

To enable Wipe mode, enter the Wipe menu and click on the Wipe Disabled button to toggle it to Wipe. When disabled, the button will have a faint purple background, when enabled the background will turn green.



Safire HD Wipe menu

The Wipe Settings box shows the setting for the automatic fade times (0 to 100 fields) and the position of the manual on-screen ‘T-bar’ fader.

The Effect Down indicator always shows the fully off state of the assigned wipe function.

Pressing the Start Auto key during a transition reverses the direction of the transition.

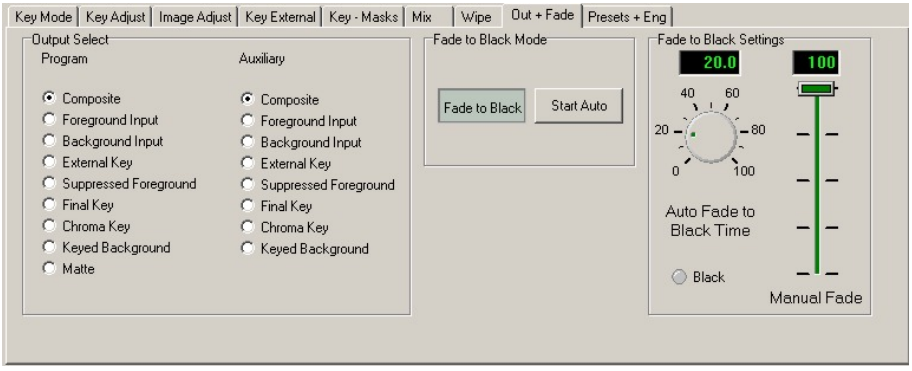
The available wipe patterns are as shown in the following table:

	Vertical		Left Corner
	Horizontal		Right Corner
	Vertical Blind		Box
	Horizontal Blind		Cross

Safire Wipe Patterns

Performing a fade to black

To enable the Fade to black function, enter the Out + Fade menu and click on the FtB Disabled button to toggle it to Fade to Black. When disabled, the button will have a faint purple background, when enabled the background will turn green.



Safire HD Out + Fade menu

The Fade to Black Settings box shows the setting for the automatic fade times (0 to 100 fields) and the position of the manual on-screen ‘T-bar’ fader.

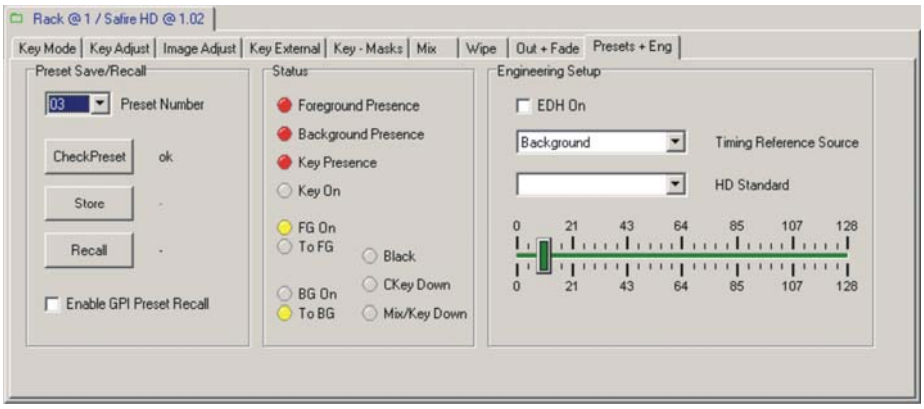
The Black indicator shows the fully off state of the Main output i.e. black

Pressing the Start Auto key during a Fade to Black transition reverses the direction of the transition.

Note: Fade to Black is only available on the main output.

Using presets

Up to ten setups may be stored and recalled from Statesman, the Safire Controller or by external GPIs.



Safire HD Presets + Eng menu

Presets store Safire configuration data, but not names, which may have been set via the Safire controller panel. Statesman presets are numbered 1-10.

To store a preset proceed as follows:

- Ensure ‘Enable GPI Preset Recall’ is unchecked
- Select appropriate preset with the Preset Number drop-down menu
- Click on ‘CheckPreset’ to find an empty preset
- Click on ‘Store’ to save setup data into the selected preset

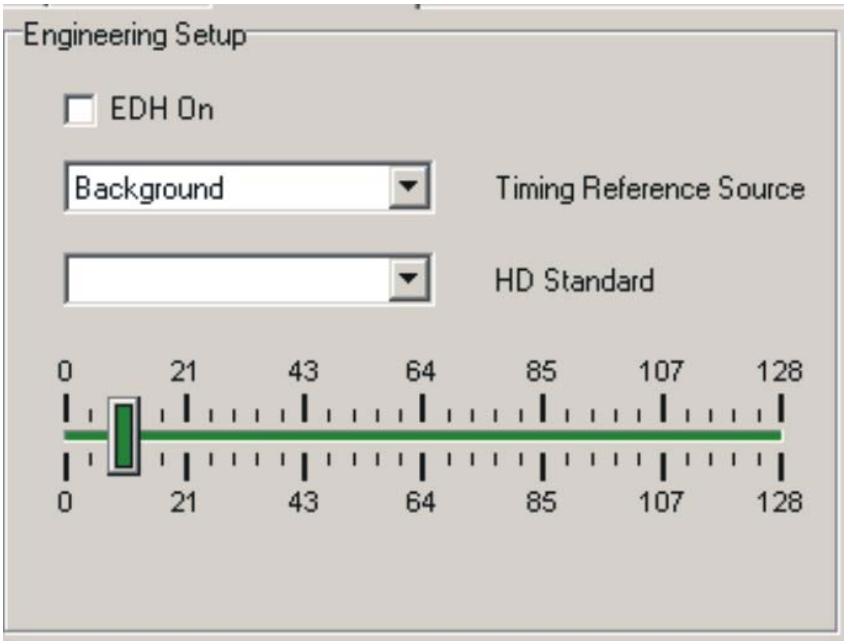
To recall a preset proceed as follows

- Ensure ‘Enable GPI Preset Recall’ is unchecked
- Select appropriate preset with the Preset Number drop-down menu
- Click on ‘Recall’ to recall setup data from the selected preset

‘Enable GPI Preset Recall’ should not be checked whilst presets are being created or recalled by this menu, to prevent inadvertent GPI operation. Enable ‘GPI Preset Recall’ when finished if required.

Configuring engineering setup

The ENG menu, which is co-located with the Presets menu, provides access to, Horizontal Delay, EDH on/off and Timing Reference Source select.



Safire HD ENG menu

Function	Notes
Timing reference source	Click on the pull-down list to select the output timing reference from Foreground, Background or External Key.
EDH	Turn EDH checking on/off
HD Standard	Indicates the line standard of the current input
H Phase	Adjusts output delay relative to selected reference over a range of approximately 40µs in HD or in SD a 124µs range from about 5µs to 128µs. Acceptable range depends on relative timing of input signals and standard.

On power up Safire HD restores all the settings, including H Phase, to the value they were when a set-up was last stored. If the value of H Phase is subsequently adjusted the new value will not be overwritten when a set-up is recalled unless the recalled set-up was the last one to be saved.

This allows the user to recover a previous H Phase value if required and to recall set-ups without overwriting an H Phase adjustment that has changed to cope with different input signal timing.

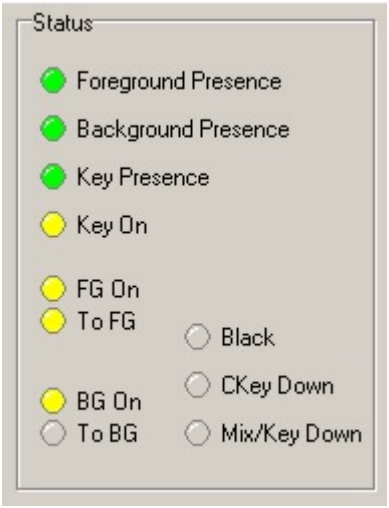
If the H Phase value is changed to accommodate external timing then storing a set-up after the adjustment will prevent an unexpected reversion to the old value.

Note: Output timing is selectable with 0-2-line delay from the assigned reference input. The other inputs must be 0-2 lines earlier than the output. Inputs outside the timing range will

be horizontally aligned but vertically offset.

Safire status

Statesman provides basic status information within the Presets + ENG menu



Safire HD status display

Function	Colour On/present	Colour Off/absent	State when on/present/active
Foreground Presence	Green	Red	Foreground input present
Background Presence	Green	Red	Background input present
Key Presence	Green	Red	External key input present
Key On	Yellow	Greyed out	External key in use
FG On	Yellow	Greyed out	Foreground contributing to output
BG On	Yellow	Greyed out	Background contributing to output
To FG	Yellow	Greyed out	Fade to source is foreground
To BG	Yellow	Greyed out	Fade to source is background
Black	Yellow	Greyed out	Output is faded to black – FTB active and faded down
Ckey Down	Yellow	Greyed out	Chroma Key is active but faded down
Mix/Key Down	Yellow	Greyed out	Mix or Key is active and faded down

5 Default parameter settings.

CHROMA parameters

Chroma key on, not inverted
Min Clip = 2
Max Clip = 24
Hue = 0 (Blue) or (230) green
Acceptance angle = 77.6 degrees
Y suppression = 30%
Y correction = 0
Fade direction set to Background
Shadow off (Shadow Min = 70, Shadow Enh = 0)
Suppression angle = 31.4 degrees
Grab cursor set to off, cursor position in centre of video image

EXT KEY parameters

Ext key off, not inverted
Max Clip 52
Min Clip 2
Force BG off
Force FG off
Force FB off

SELF KEY parameters

Max Clip 100
Min Clip 0
Self Key off

COMBINED KEY

Final combined key not inverted
Fill = suppressed foreground
Mode = multiplicative
Key shrink = On
Matte hue set to 0 (blue)
Matte luminance set 0%
Matte saturation set 0%

MASKS

Mask priority set to Back
Foreground mask set off
Background mask set off
Foreground mask set to a box (invert off) of size 25X50 at Hpos = 25, Vpos = 50
Background mask set to a box (invert off) of size 25X50 at position Hpos = 25, Vpos = 50

MIX parameters

Mix time set to 20 fields

WIPE parameters

Wipe pattern set to cross
Wipe time set to 20 fields

SET FADE parameters

Wipe time set to 20 fields
Mix time set to 20 fields
Foreground time set to 20 fields
Background time set to 20 fields
Black time set to 20 fields
Ext Key time set to 20 fields

OUTPUT parameters

Main output set to composite video image
Aux output set to composite video image
Key fade time set to 20 fields
All signals faded up to maximum

ENG parameters

EDH insertion on
Hphase not affected
Bright = 0
Ref = Key

GPI parameters

Recall off
Select off

F1 parameters

Password = password
Unlocked

6 Installation

Safire HD is a dual height module, used with the Safire Controller panel. The module will fit into all Crystal Vision rack frames. The Indigo 4 frame will accommodate up to 12 Safire HD cards. The Indigo 2 frame will accommodate up to six and three cards will fit in the Indigo 1U frame. A single card will fit into the Indigo DT desktop box.

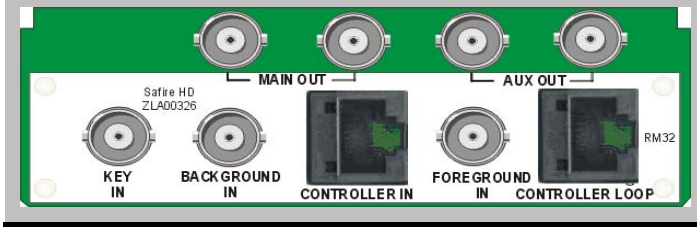
6.1 Rear modules and signal I/O

Indigo frame rear connectors

There is a single dual height rear connector available. All modules can be plugged in and removed while the frame is powered without damage.

The available rear connector is as follows:

RM32

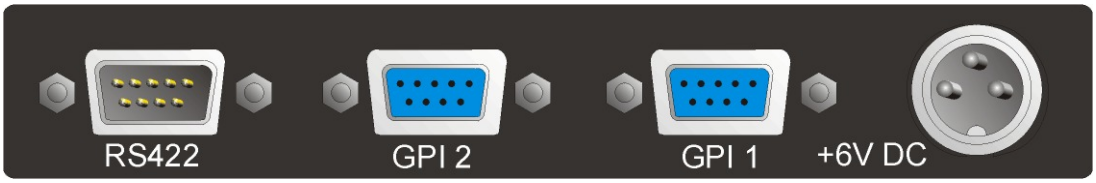
FR2AV RM01 rear connectors	Description
	**RM32** • 12 Safire modules per 4U frame • All frame slots can be used

Special Label Name (ZLA00326)	Description
MAIN OUT(1)	Serial Digital Main output 1
MAIN OUT(2)	Serial Digital Main output 2
AUX OUT (1)	Serial Digital Preview/Auxiliary output
AUX OUT (2)	Serial Digital Preview/Auxiliary output
KEY IN	Serial Digital External Key input
BACKGROUND IN	Serial Digital Background input
CONTROLLER IN	RJ45 connection for Safire controller remote panel
FOREGROUND IN	Serial Digital Foreground input
CONTROLLER LOOP	RJ45 Loop-through connection for Safire controller remote panel. To daisy-change further Safire HD modules

6.2 Control panel connectors

The control panel requires a cable from the “RS422” connector on the panel to one or more of the “Remote” connectors on the rear of the frame or dedicated RJ45 connector on the RM32 rear module.

Rear of Safire Controller panel showing connector side view



Safire Controller panel connectors

A dedicated external power supply supplied with the control panel, screws into the three-pin power socket.

The RS422 connector is used to connect the control panel to frames containing Safire HD modules. If more than one Safire HD is to be controlled, a daisy-chain configuration will be required.

The GPI 1 connector s used to allow remote assignment of the Safire panel to a particular Safire module according to its node address in connected frames.

The GPI 2 connector provides access to unassigned Panel GPI outputs whose state is stored in Safire HD module preset memory but output from an assigned Safire controller panel.

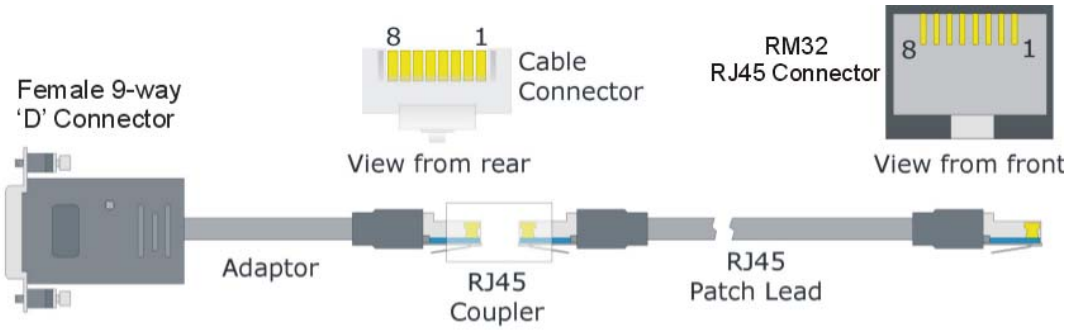
Safire Controller panel to frame wiring details is provided in the Frame-panel interconnect wiring section

Frame and Panel GPI I/O pin out is given in the GPI section.

6.3 Frame-panel interconnect wiring

The connection from the control panel to the appropriate frame remote connector has a cable with a D-type plug at one end and an RJ45 connector at the other.

It is suggested that a short adaptor cable be made with a standard RJ45 patch lead and an in-line coupler used. The required cable length can then be added to connect between the controller and frame containing the Safire HD. Further Safire HD modules may then be daisy-chained from the RM32 loop-thought.



Controller panel to RM32 adaptor and CAT5 patch lead

CAT5 Colour	RJ45 plug		9-way 'D' connector
Brown	**8**	Twisted Pair	**8**
W/Brown	**7**		**3**
Blue	**4**	Twisted Pair	**7**
W/Blue	**5**		**2**

Note. For reliable communications both the Safire controller and all frames containing Safire HD cards must share a common ground return.

Existing Safire/Lkey wiring

It is possible to use existing SD Safire and Lkey wiring to control a Safire HD as the comms connections via the GPI ports has been retained.

Note, link selection of comms via GPI lines is no longer necessary as the Safire HD reserves these connections solely for control via the GPIs. Also note, as the Safire HD is a dual height (2 slot) card the GPI control wiring must only be connected to the lower of the two slots occupied by the Safire HD.

6.4 GPI connections

There are two types of GPI interfaces, Frame GPIs available for each Safire HD and accessible at the frame rear connectors and Panel GPIs, which are accessible at the rear of an assigned Safire Controller.

There are 12 GPIs available from the Safire HD. The first four Frame lower-slot GPIs ‘a’ to ‘d’ are serial communication lines, which are reserved for serial control for Safire Controller panels. The next two Frame lower-slot GPIs are reserved as outputs and have no function at present. Of the six Frame upper-slot GPIs, four are assigned to mix and fade functions. The final two are assigned for remote preset memory recall.

There are currently five Panel GPI inputs reserved for remote Safire Controller assignment to Safire modules and four unreserved Panel GPI outputs whose states are stored in each Safire, but only output from an assigned panel.

Frame GPI pinout

Each slot has an associated set of connections on the frame rear-panel remote connectors. For convenience, GPI lines are associated with reference codes ‘a’ to ‘f’ in the connector pin-out tables for each frame.

Lower Slot GPI	
‘a’	Tx-
‘b’	Tx+
‘c’	Rx+
‘d’	Rx-
‘e’	Not used
‘f’	Not used
Upper Slot GPI	
‘a’	Auto fade to black
‘b’	Auto fade external key
‘c’	auto fade chromakey
‘d’	auto mix
‘e’	preset recall
‘f'	preset recall

Preset	‘e’	‘f’
0	closed	closed
1	closed	open
2	open	closed
3	open	open

4U frame GPI connections

GPI lines ‘a’ to ‘f’ of each card connect to one of eight rear remote connectors as follows:

Slot no. Upper Frame	‘a’ pin	‘b’ pin	‘c’ pin	‘d’ pin	‘e’ pin	‘f’ pin
1	8 (1)	9 (1)	18 (1)	26 (1)	19 (2)	20 (2)
2 }	7 (1)	16 (1)	17 (1)	25 (1)	10 (2)	11 (2)
3	8 (3)	9 (3)	18 (3)	26 (3)	19 (4)	20 (4)
4 }	7 (3)	16 (3)	17 (3)	25 (3)	10 (4)	11 (4)
5	5 (1)	6 (1)	15 (1)	24 (1)	1 (2)	2 (2)
6 }	4 (1)	14 (1)	13 (1)	23 (1)	3 (2)	4 (2)
7	5 (3)	6 (3)	15 (3)	24 (3)	1 (4)	2 (4)
8 }	4 (3)	14 (3)	13 (3)	23 (3)	3 (4)	4 (4)
9	3 (1)	12 (1)	22 (1)	21 (1)	12 (2)	13 (2)
10 }	10 (1)	11 (1)	19 (1)	20 (1)	21 (2)	22 (2)
11	3 (3)	12 (3)	22 (3)	21 (3)	12 (4)	13 (4)
12 }	10 (3)	11 (3)	19 (3)	20 (3)	21 (4)	22 (4)
Slot no. Lower Frame	**‘a’ pin**	**‘b’ pin**	**‘c’ pin**	**‘d’ pin**	**‘e’ pin**	**‘f’ pin**
1	8 (5)	9 (5)	18 (5)	26 (5)	19 (6)	20 (6)
2 }	7 (5)	16 (5)	17 (5)	25 (5)	10 (6)	11 (6)
3	8 (7)	9 (7)	18 (7)	26 (7)	19 (8)	20 (8)
4 }	7 (7)	16 (7)	17 (7)	25 (7)	10 (8)	11 (8)
5	5 (5)	6 (5)	15 (5)	24 (5)	1 (6)	2 (6)
6 }	4 (5)	14 (5)	13 (5)	23 (5)	3 (6)	4 (6)
7	5 (7)	6 (7)	15 (7)	24 (7)	1 (8)	2 (8)
8 }	4 (7)	14 (7)	13 (7)	23 (7)	3 (8)	4 (8)
9	3 (5)	12 (5)	22 (5)	21 (5)	12 (6)	13 (6)
10 }	10 (5)	11 (5)	19 (5)	20 (5)	21 (6)	22 (6)
11	3 (7)	12 (7)	22 (7)	21 (7)	12 (8)	13 (8)
12 }	10 (7)	11 (7)	19 (7)	20 (7)	21 (8)	22 (8)

Table shows pin number (Remote number)

Note: Remote 1, Remote 3, Remote 5 and Remote 7 are 26 way high-density D-Type female sockets and frame ground is pin 2 and +5V @500mA is pin 1 in each case.

Remote 2 and Remote 4 are 26 way high-density D-Type male plugs and frame ground is pin 6 and +5V @500mA is pin 15 in each case.

2U frame GPI connections

GPI lines ‘a’ to ‘f’ of each card connect to one of four rear remote connectors as follows:

Slot no.		‘a’ pin	‘b’ pin	‘c’ pin	‘d’ pin	‘e’ pin	‘f’ pin
1		8 (1)	9 (1)	18 (1)	26 (1)	19 (2)	20 (2)
2	}	7 (1)	16 (1)	17 (1)	25 (1)	10 (2)	11 (2)
3		8 (3)	9 (3)	18 (3)	26 (3)	19 (4)	20 (4)
4	}	7 (3)	16 (3)	17 (3)	25 (3)	10 (4)	11 (4)
5		5 (1)	6 (1)	15 (1)	24 (1)	1 (2)	2 (2)
6	}	4 (1)	14 (1)	13 (1)	23 (1)	3 (2)	4 (2)
7		5 (3)	6 (3)	15 (3)	24 (3)	1 (4)	2 (4)
8	}	4 (3)	14 (3)	13 (3)	23 (3)	3 (4)	4 (4)
9		3 (1)	12 (1)	22 (1)	21 (1)	12 (2)	13 (2)
10	}	10 (1)	11 (1)	19 (1)	20 (1)	21 (2)	22 (2)
11		3 (3)	12 (3)	22 (3)	21 (3)	12 (4)	13 (4)
12	}	10 (3)	11 (3)	19 (3)	20 (3)	21 (4)	22 (4)

Table shows pin number (remote number)

Note: Remote 1 and Remote 3 are 26 way high-density D-Type female sockets and frame ground is pin 2 and +5V @500mA is pin 1 in each case.

Remote 2 and Remote 4 are 26 way high-density D-Type male plugs and frame ground is pin 6 and +5V @500mA is pin 15 in each case.

1U frame GPI connections

GPI lines ‘a’ to ‘f’ of each card connect to one of two rear remote connectors as follows:

Slot no.		‘a’ pin	‘b’ pin	‘c’ pin	‘d’ pin	‘e’ pin	‘f’ pin
1		8 (1)	9 (1)	18 (1)	26 (1)	19 (2)	20 (2)
2	}	7 (1)	16 (1)	17 (1)	25 (1)	10 (2)	11 (2)
3		5 (1)	6 (1)	15 (1)	24 (1)	1 (2)	2 (2)
4	}	4 (1)	14 (1)	13 (1)	23 (1)	3 (2)	4 (2)
5		3 (1)	12 (1)	22 (1)	21 (1)	12 (2)	13 (2)
6	}	10 (1)	11 (1)	19 (1)	20 (1)	21 (2)	22 (2)

Table shows pin number (remote number)

Note: Remote 1: 26 way high-density D-type socket. Frame ground is pin 2 and +5V @500mA is pin 1.

Remote 2: 26 way high-density D-Type plug. Frame ground is pin 6 and +5V @500mA is pin 15.

DTB-AV desk top box GPI connections

GPI lines ‘a’ to ‘f’ of each card connect to the rear remote connector as follows:

Slot no.	‘a’ pin	‘b’ pin	‘c’ pin	‘d’ pin	‘e’ pin	‘f’ pin
1 }	1	2	3	4	5	6
2 }	9	10	11	12	13	14

Note: Remote connector is 15 way normal density D-Type socket. Frame ground is pin 15.

Indigo DT desk top box GPI connections

GPI lines ‘a’ to ‘f’ of each card connect to the rear remote connector as follows:

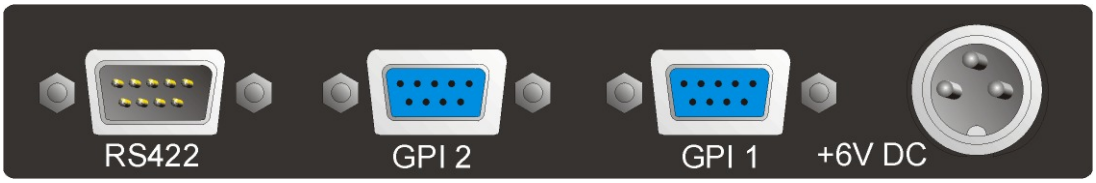
Slot no.	‘a’ pin	‘b’ pin	‘c’ pin	‘d’ pin	‘e’ pin	‘f’ pin
1 }	8 (1)	9 (1)	18 (1)	26 (1)	19 (2)	20 (2)
2 }	7 (1)	16 (1)	17 (1)	25 (1)	10 (2)	11 (2)

Table shows pin number (remote number)

Note: Remote 1: 26 way high-density D-Type socket. Frame ground is pin 2 and +5V @500mA is pin 1.
Remote 2: 26 way high-density D-Type plug. Frame ground is pin 6 and +5V @500mA is pin 15.

Safire controller panel GPI pinout

There are currently five Panel GPI inputs reserved for remote Safire Controller assignment to Safire modules and four unreserved Panel GPI outputs whose states are stored in each Safire, but only output from an assigned panel.



Safire Controller panel connectors

GPI 1 pinout is as follows:

Pin No	Panel GPI IN
1	GPI in 1
2	GPI in 2
3	GPI in 3
4	GPI in 4
5	GPI in 5
6	GPI - not used
7	GPI - not used
8	GPI - not used
9	GND

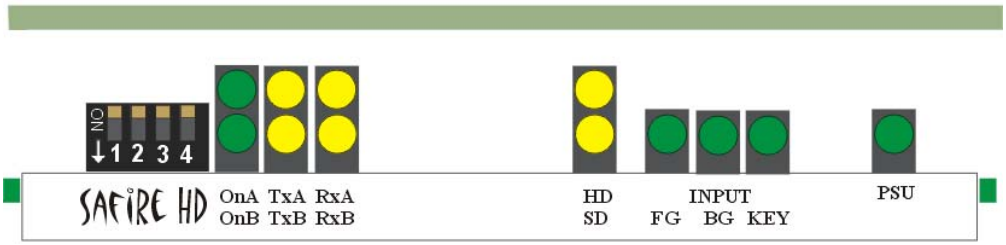
GPI 2 pinout is as follows:

Pin No	Panel GPI OUT
1	GPI 5 – not used
2	GPI 6 – not used
3	GPI 7 – not used
4	GPI 8 – not used
5	GPI op 1
6	GPI op 2
7	GPI op 3
8	GPI op 4
9	GND

Refer to section 3.4/Configuring GPI for details of remote Safire assignment and using Panel GPI outputs.

6.5 Safire board level controls

Safire can only be controlled from the Safire Controller panel. Ensure that DIL1 and DIL4 are set for 'Control Panel'.



Safire HD front view

Control	DIL 1	DIL 4
Not assigned	UP	UP
Not assigned	UP	DOWN
Not assigned	DOWN	UP
Control panel	DOWN	DOWN

Selecting default user memories

Overwrite the ten non-volatile user memories with default values as follows:

	DIL 3	Notes
Normal	UP	No Effect
Overwrite	DOWN	Leave in this position during power up to overwrite user memories

Note: DIL 2 has no function.

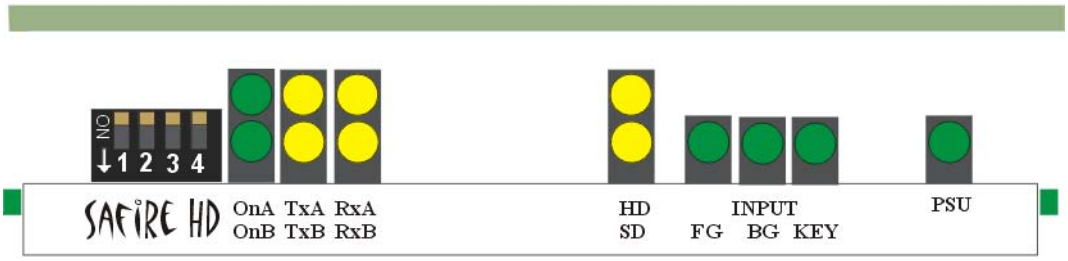
Software and firmware upgrades

The software for the Safire HD module is contained in a single EPROM U32. The firmware is contained in the pluggable module adjacent to the EPROM. To change either of these, remove the board from the frame and carefully remove the EPROM or firmware module taking great care not to bend any of their pins. When refitting the EPROM and firmware module take great care that all pins are located correctly and that they have been orientated correctly. Note. Incorrect orientation will result in permanent damage to the device.

7 Problem solving

Card edge status LEDs

Board edge LEDs provide status reporting and may be useful when fault finding.



Safire status LEDs

The following table summarises the card edge LED functions and colours:

LED label	Colour	Status when on
OnA	Green (top)	Front panel to Safire transmission
OnB	Green (bottom)	Control panel to Safire transmission
TxA	Amber (top)	Safire to front panel transmission
TxB	Amber (bottom)	Safire to control panel transmission
RxA	Amber (top)	Front panel to Safire comms request
RxB	Amber (bottom)	Control panel to Safire comms request
HD	Amber (top)	High Definition input detected.
SD	Amber (bottom)	Standard Definition 625/525 lines input detected.
FG	Green	Valid Foreground input detected.
BG	Green	Valid Background input detected.
Key	Green	Valid External Key input detected.
PSU	Green	All PSU rails are within tolerance

Card Status from Safire control panel

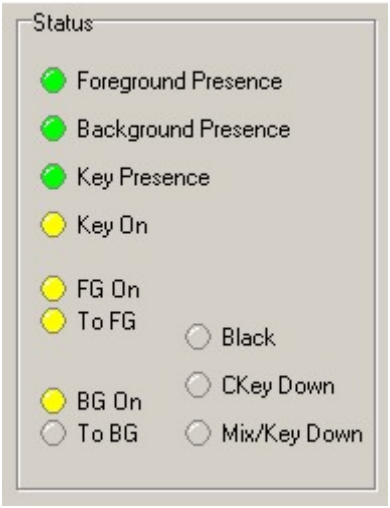
This menu is entered with the ENG button and gives a brief overview of the card status- Inputs present, input standard etc.

Poled Safire HD module status

Function	Notes
Eng Vers	Displays software version
Fgnd	Shows presence or absence of foreground input
Bgnd	Shows presence or absence of background input
Ext Key	Shows presence or absence of selected output timing reference or external key input
Ref	Toggles through the inputs to select the output timing reference
1920x1080i/625/525	Shows input standard
Bright	Adjust brightness over 0 (half) to 7 (full) range
Defaults	Recall factory defaults
H Phase	Adjusts output delay relative to selected reference over a 124 microsecond (µs) range from about 5µs (5) to 128µs (128). Acceptable range depends on relative timing of input signals.

Card status from Statesman status

Statesman provides basic status information within the Presets + ENG menu



Safire status display

LED indication of signal presence and configuration is given. This information may be of use when problem solving.

Function	Colour On/present	Colour Off/absent	State when on/present/active
Foreground Presence	Green	Red	Foreground input present
Background Presence	Green	Red	Background input present
Key Presence	Green	Red	External key input present
Key On	Yellow	Greyed out	External key present
FG On	Yellow	Greyed out	Foreground contributing to output
BG On	Yellow	Greyed out	Background contributing to output
To FG	Yellow	Greyed out	Fade to source is foreground
To BG	Yellow	Greyed out	Fade to source is background
Black	Yellow	Greyed out	Output is faded to black – FTB active and faded down
Ckey Down	Yellow	Greyed out	Chroma Key is active but faded down
Mix/Key Down	Yellow	Greyed out	Mix or Key is active and faded down

Basic fault finding guide

The Power OK LEDs are not illuminated

Check that the unit is correctly powered and that any fuses are intact
Check that the frame PSU is functioning
Refer to the appropriate frame manual for detailed information

There is no video output

Check that valid HD/SD inputs are present and of the same standard, also that any cabling is intact

The video output is corrupted or shows digital noise

Check that the required signal inputs are present for the current effect

The video output is not synchronous with other sources

Check that inputs are co-timed within two lines of each other and are synchronous with downstream equipment and that the correct video standard is selected

Check that horizontal delay is set correctly. Output timing is selectable up to approximately 40 us in HD or in SD 0-2-line delay from the assigned reference input. The other inputs must be 0-1 lines earlier than the output. Inputs outside the timing range will be horizontally aligned but vertically offset.

The Safire Controller panel does not work as expected

Check that a unique node address is being used in the frame the module is fitted into
Check that the card edge DIL switch is set for panel control (1 and 4 down).

To check Safire HD card and Safire Controller communications proceed as follows:

1) Attempt to adjust a parameter while viewing the card edge LED's:-

The RxB LED does not illuminate – the board is not receiving any signals. Check the serial cabling. Check that the card is in the correct slot for the cable being used. Check that PL& jumpers are set for serial control (default)

Only the RxB LED illuminates – the board is receiving instructions but not responding. Check that the correct remote is selected on the control panel. If the node select switch is not set to zero when the board is in an AV frame the node address will not correspond to the slot number.

2) If necessary try re-setting the Safire card and/or Safire Controller.

Some Statesman features or controls are greyed out

Features and controls are automatically 'greyed out' if they are rendered inappropriate or invalid due to the selection of other controls.
For example, if Ext Key On is deselected then the Ext Key Inv control and its Min Clip/Max Clip sliders are greyed out, as they have useful function.
If Chroma Key On is selected when Self Key Luma was previously selected Self Key Luma is deselected automatically, since Chroma Key and Self Key re mutually exclusive and cannot be on at the same time.

The foreground subject has a thin border of unsuppressed foreground

Check the chroma key fine adjustment controls and that Key Shrink is On in the Statesman Key Mode tab or the Combined Key Safire menu to help remove residual unsuppressed foreground around the foreground subject.

Re-setting the card

If required, the card may be reset by simply removing the rack power if safe to do so, and re-applying power after a few seconds or by removing the card from the rack re-inserting the card

It is safe to reinsert the card whilst the rack is powered

8 Specification

General

Dimensions	100mm x 266 mm dual height module with DIN 41612 connectors
Weight	250g
Power consumption	14.5W

Inputs

Foreground, Background and Key Video SDI	HD or SD SDI 270Mb/s to 1.485Gb/s serial digital compliant to SMPTE-259M and SMPTE-292M
	Cable equalisation >250m Belden 8281 or equivalent
	HD (1.485Gb/s) – 100 meters
	SD (270Mb/s) >250 meters 270Mb/s serial digital to EBU Tech 3267-E and SMPTE-259M
	(Auto selection)

Outputs

Main Video SDI	2 reclocked SDI outputs 270Mb/s - 1.485Gb/s to SMPTE-259M and SMPTE-292M
	Belden 8281 or equivalent
	HD (1.485Gb/s) – 100 meters
	SD (270Mb/s) >250 meters 2 x 270Mb/s serial digital to EBU Tech 3267-E and SMPTE-259M.
Preview Video SDI	2 reclocked SDI outputs 270Mb/s - 1.485Gb/s to SMPTE-259M and SMPTE-292M
	Belden 8281 or equivalent
	HD (1.485Gb/s) – 100 meters
	SD (270Mb/s) >250 meters 2 x 270Mb/s serial digital to EBU Tech 3267-E and SMPTE-259M.
Blanking (selected reference channel)	All data in the vertical and horizontal blanking interval is passed through unprocessed with full 10-bits. Therefore, the unit will pass through embedded audio and any ancillary data with a delay as set by the horizontal phase adjustment.

Timing

Timebase range	Maximum input buffer length 1 line plus up to 3000 pixels
Minimum input to output delay	approximately 5µs
Reference timing	Selectable from foreground, background or key