

## PHABRIX Qx Operation Manual

Software Release 1.0.3

Manual Revision 4



# About this Manual

## Notice

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## Revision

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This manual is a revision controlled document. Any changes to any page content will be reflected in the overall revision status of the whole manual.

Release	Date	Software Version	Comment
1	23 Jan 2017	1.0.0.196	First release of manual
2	21 Mar 2017	1.0.1.227	Addition of Waveform, Vectorscope, HDMI audio and new video standards
3	20 Jun 2017	1.0.2	Reference locking support with Output offset adjustment. Input timing against reference with Input Measurement Offset.
4	21 Aug 2017	1.0.3	HDR Heat-map, CIE 1931 x y Chart, HDR/WCG additions for Waveform and Vectorscope, and new PQ video standards. REST API for remote control and automation. CRC Analysis frame change detection added.

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# Getting Started

## Package Contents

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The shipping box should contain the following

PHABRIX Qx unit: PHQX-01 or PHQX-01 E (with Physical Layer Analysis)

Power Supply Unit

Mains lead

## General Safety

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### Avoiding Personal Injury



*This instrument is designed for use by qualified personnel only.*

*No user serviceable parts are provided. Units should be returned to your local PHABRIX agent for servicing.*

*The Operator should NOT remove the case from the unit.*

*Do not spill any liquid onto the unit or its power adaptor.*

### Power Supply

Make sure that the unit is connected to the correct power supply voltage. A power supply adaptor is supplied with the unit which may be connected to any AC power supply between 100 and 240VAC at 50-60Hz. Only the supplied power adaptor should be used with the unit. Do not use a damaged AC cable with the unit as it may cause a shock or fire hazard. Replacement AC cables are available from your local PHABRIX agent.

## How to upgrade software

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New software releases will be made available regularly as the product develops.

Software downloads are approximately 100 MB and can be found in the Support area of the PHABRIX website currently located at [www.phabrix.com/support.asp](http://www.phabrix.com/support.asp)

Download the file to any FAT32 formatted USB stick.

Make sure the unit is turned OFF before upgrading.

Insert the USB into the front panel USB port.

Press the start button TWICE in succession. The start button will glow pink when the upgrade procedure begins. If the button doesn't glow pink then repeat the procedure.

The start button will flash several colours and the fans will be on full throughout the upgrade process. Please wait approximately 4 minutes as the unit upgrades. It will automatically show the menu screen when complete.



## Installation Environment

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### Operating Temperature



*The unit should only be operated between 0 and 40 °Celsius. If the unit is operated at a higher temperature there is a possibility of a fire hazard. If the temperature is changed rapidly from a cold environment to a hot environment, moisture can be created internally which can cause malfunction or damage the unit. Allow the unit to sit for 30 minutes without power applied to reduce any possibility of condensation. If the internal temperature rises above 65 °Celsius the unit will turn OFF automatically.*

### Input/Output Terminals

Do not connect the input or output BNC connectors to external power as this can damage the internal circuitry and cause the unit to work incorrectly.

The BNC connectors fitted on this unit are 75Ω type which are not compatible with 50Ω plugs.



*The use of 50Ω plugs will permanently damage the connectors on the unit. The use of 50Ω plugs is considered to be misuse of the equipment and will therefore invalidate the unit's warranty.*

### When Not In Use

Disconnect the unit from the power supply and AC power source when not in use.

### Maintenance

Wipe the case gently with a soft cloth, lightly dampened with a neutral cleaning agent.



*Remove the power supply from the unit and turn OFF before cleaning. Do not allow any water or other liquid to enter the unit while cleaning.*

## RoHS Compliance

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PHABRIX products are designed and manufactured using only RoHS compliant components and materials. Therefore based on information provided by our suppliers, PHABRIX certifies that ALL products that it manufactures are “RoHS-5” compliant and that they do not exceed the designated levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether flame retardants (PBDE) legislated under the provisions of the “European Parliament and Council Directive” on the “Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (2011/65/EC)” and associated regulations collective known as the “RoHS Regulations”.

## Disposal of Equipment

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This product is subject to the European WEEE (Waste Electrical and Electronic Equipment) directive and should be disposed of according to the regulations of each country.

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## Icon display and meaning

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Eye - SDI In A



Jitter - SDI In A



System IO (SDI)



Stats - SDI In A



Stats - SDI In B



Stats - SDI In C



Stats - SDI In D



Timing and System Reference



Analyser - Configuration



Analyser - Ancillary Status



Analyser - Audio Meters



Analyser - CIE Chart



Analyser - CRC Errors



Analyser - Dataview



Analyser - Picture



Analyser - Vectorscope



Analyser - Waveform



Generator - Configuration



Generator - Status



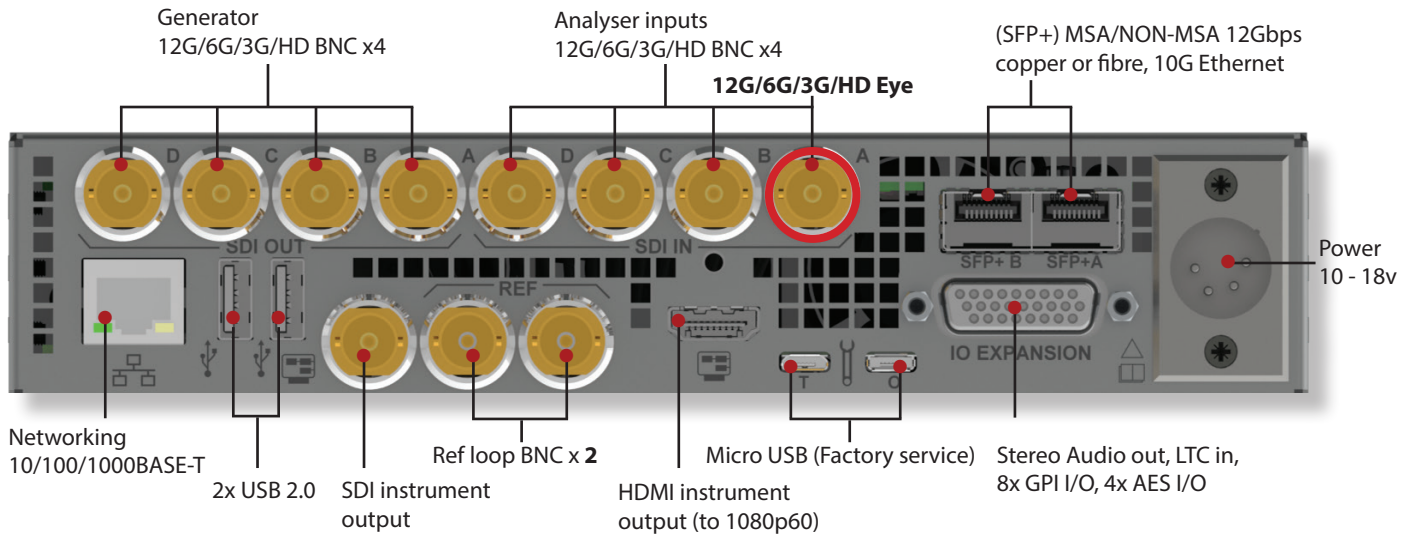
Event Logging



Network Status

# Overview

## Start up



## Installation

The rear of the unit shown above describes the connections and interfaces of the Qx.

Before turning on the Qx, make sure the following connections are in place:

The XLR power cable is inserted.

For instrument display connect a suitable 1920 x 1080 capable monitor to either the HDMI instrument output or the SDI instrument output. The monitor output can be configured for 1080p60, 1080p59.94 or 1080p50 frame rates using 'Display Options' submenu of the 'Instrument Launch Menu'.

For mouse and keyboard control, the two USB ports at the rear of the unit should be used.

*Note: The following interfaces are temporarily unavailable in this release of software:*

- SFP A and SFP B
- LTC In
- GPI I/O
- AES I/O

## Analyser SDI connections

Analyser

The Physical Layer connection for eye and jitter outlined in red is the furthest right BNC with a red nut. This provides the multi rate eye and jitter connection from HD-SDI to 12G-SDI.

There are four 12G-SDI capable input BNC's for the analyser SDI IN A, B, C, D.

Up to four SDI inputs may be connected at any one time however the system will automatically determine the signal set to analyse be it single link, dual link or quad link based on the SMPTE ST 352 packets present. The algorithm looks to 'SDI IN A' first and then determines the overall standard.

If the SMPTE ST 352 packets are known to be incorrect then the user has the option to select 'Ignore payload identifier packets (ST 352)' in the 'Analyser Configuration' window.



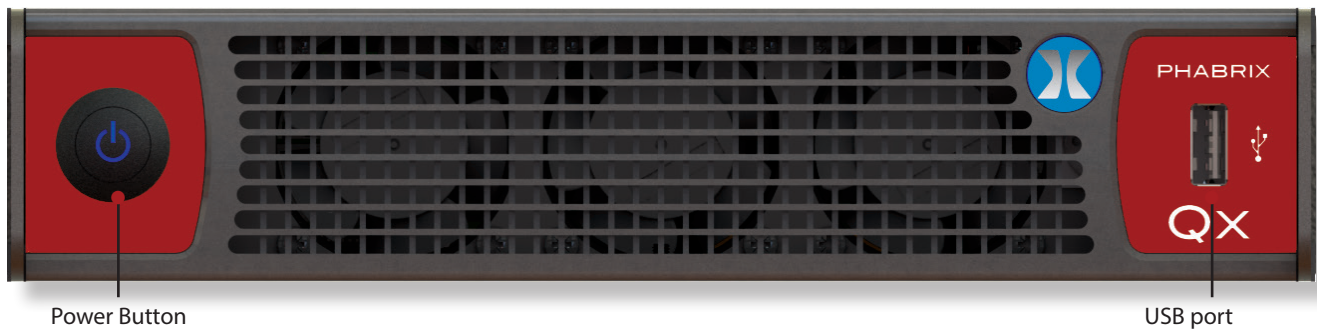
## Generator SDI connections

The generator provides up to four SDI output signals which must form part of the same video signal set e.g. 12G payload using four 3G-SDI outputs or 12G payload using two 6G-SDI signals.

'SDI OUT A' is always present and carries the first signal in the group. 'SDI OUT B' is active for dual link standards and 'SDI OUT C' and 'SDI OUT D' are active for quad link standards.

## Powering up the Qx

When the 'Power Button' on the Qx is first pressed, the unit fans will cycle for 20-30 seconds at high speed as the system boots then settle to their normal operating speed.



## Menu selection

The following menu screen will be displayed after power up:



To activate the 'Instrument Launch Menu' left click the PHABRIX symbol on the 'Instrument Bar'

To hide the 'Instrument Bar' left click within its blank area

Bringing the cursor to the bottom of screen re-enables the 'Instrument Bar'

## Instrument Launch Menu





- Display Options ▶
- Eye - SDI In A
- Jitter - SDI In A
- System IO (SDI)
- Stats - SDI In A
- Stats - SDI In B
- Stats - SDI In C
- Stats - SDI In D
- Timing and System Reference
- Analyser - Configuration
- Analyser - Ancillary Status
- Analyser - Audio Meters
- Analyser - CIE Chart
- Analyser - CRC Errors
- Analyser - Dataview
- Analyser - Picture
- Analyser - Vectorscope
- Analyser - Waveform
- Generator - Configuration
- Generator - Status
- Event Logging
- Network Status
- System Settings ▶
- About..



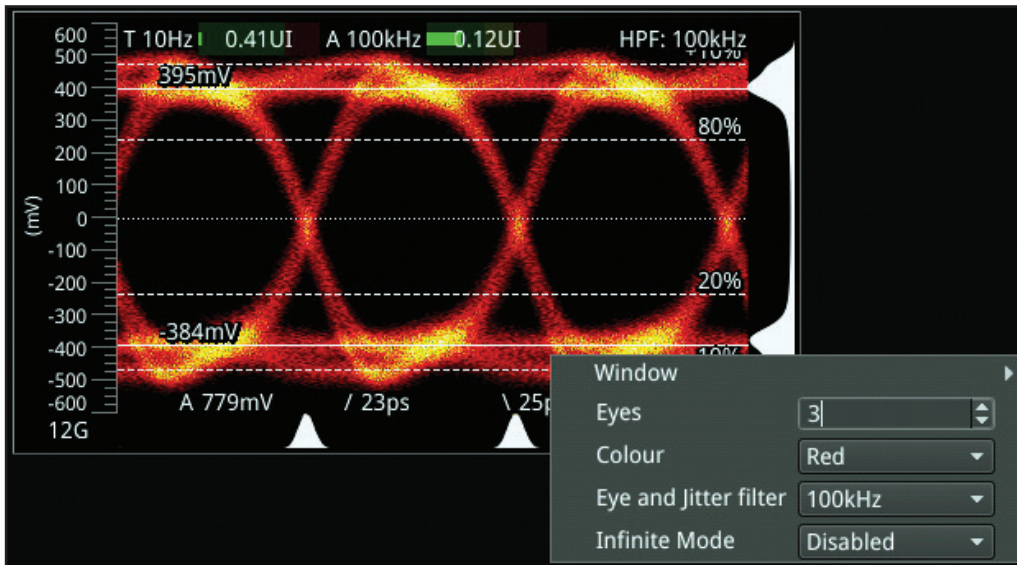
As each instrument is selected, an icon will be placed on the 'Instrument Bar'. The instrument and icon will be assigned a colour. Each icon will glow in the assigned colour to indicate if it is part of a 'group' of instruments related to analyser, generator, or system.

Instruments automatically group by colour. If one instrument is placed next to another then the border will outline all instruments of a common group in contact with each other to aid group recognition.

Each instrument also has a sub menu. The sub menu is activated by right clicking the mouse in the window enabling a drop down configuration menu. Click and drag on the grey bar at the top of the sub menu to move it. In addition to window specific commands, the option to 'Close' the instrument is provided in its sub menu.

Double clicking within a window will cycle through a set of standard instrument sizes. In many cases the size of a window can be further adjusted to suit requirements. Click and drag on an instrument's surface to reposition the instrument.

Example of drop down menu on right mouse click:

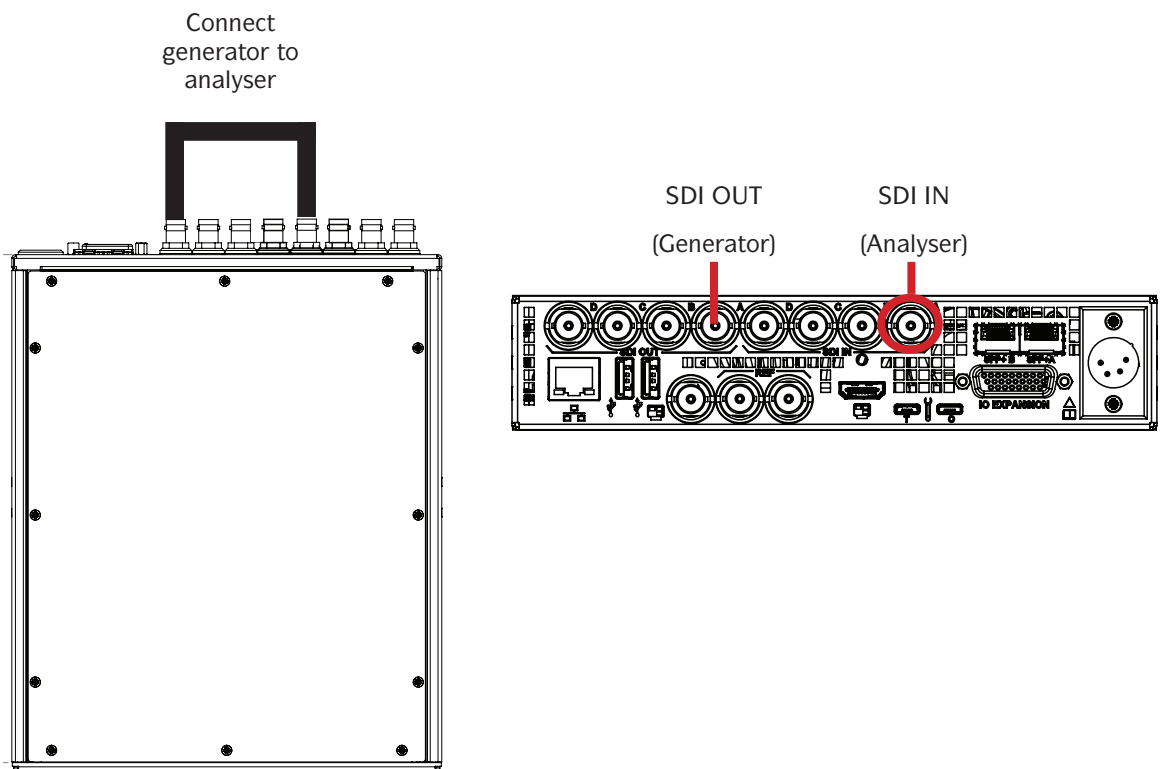


right click mouse for additional drop down menus

## Instrument Description

The guide that follows is intended as an introduction to the menu selection and the tool-set. The Qx has the advantage of being a generator and an analyser so this tour of the product will be using both tool-sets simultaneously.

For this guide we will assume that you have connected the unit to itself as shown in the following diagram.



# Generation

## Generator - Configuration



The 'Generator Configuration' window is used to select the generator video standard and test pattern. Once selected the new test signal is loaded by pressing the '**Generate**' pane.

*Note: In this software revision the generator takes approximately 8 seconds to load after which the eye and jitter toolset will be enabled. During this period all other analyser functions are disabled.*

Right clicking anywhere within the generator window brings up a configuration menu.

To simplify selection the generator standards list may be filtered using the following settings:

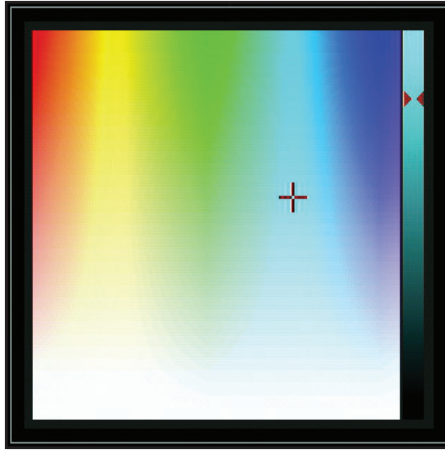
- *Filter video standard list > Frame Rate > [No filter, 23.98, 24, 25, 29.97, 30, 47.95, 48, 50, 59.94, 60]*
- *Filter video standard list > Colour Format > [No filter, YCbCr:422, YCbCrA:4444, RGBA:4444, YCbCr:444, RGB:444, YCbCrA:4224]*
- *Filter video standard list > Bit depth > [No filter, 10, 12]*
- *Filter video standard list > Active Lines > [No filter, 720, 1080, 2160]*
- *Filter video standard list > Sub Image Format > [No filter, Single Image, square division, 2 Sampl...erleave]*
- *Filter video standard list > Level > [No filter, A, B]*
- *Filter video standard list > Combined SDI rate > [No filter, 1.5G, 3G, 6G, 12G]*
- *Filter video standard list > Source image width > [No filter, 1280, 1920, 2048, 3840, 4096]*
- *Filter video standard list > Interlace > [No filter, progressive, interlaced, segmented]*
- *Filter video standard list > Link Count > [No filter, 1, 2, 4]*
- *Filter video standard list > Transfer Curve > [No filter, SDR-TV, PQ]*

Filters are removed by selecting in menu:

- *Filter video standard list > Clear filters*

Generator toolset border colour selection is provided for clear identification:

- *Generator tools colour select, [colour]*



Colour selection is via the HSV tool shown above using two cursors. The left hand colour rectangle allows selection of hue (horizontal) and saturation (vertical). The right hand vertical bar selects luminance.

### Pathological signal insertion

Pathological Signal Insertion is a powerful feature.

In addition to selecting a background test pattern a pathological pattern may be added as an overlay.

- *Pathological insertion, [Enabled, Disabled]*

Three types of pattern are supported:

- *Pathological insertion, Pattern to overlay, [EQ, PLL, CheckField]*

The amount of pathological pattern may be configured to enable the user to verify how sensitive the SDI link is to pathological conditions on the interface:

- *Pathological insertion, Pairs to insert, [0 to 16384]*

This control limits at the selected formats line length.

*Note: Pathological signals are approved by SMPTE for use with HD and 3G level A standards only. For 3G level B, 6G and 12G-SDI interface formats pathological signals can still be used but are not approved by SMPTE (as of February 2017). It is believed that inserting a full line of pathological signal in these non-approved standards is too stressful a test for the SDI interface. No physical damage will occur but the interface may exhibit reduced operating performance in the form of bit errors.*

### Output offset adjustment

A signal can be generated with a fixed offset relative to the system reference.

Offsets can be entered in temporal or spatial terms:

- *Output offset adjustment > Offset Type > [Time, Lines And Pixels]*

Selecting 'Time' reveals a drop down field where the timing offset can be set in microseconds:

- *Output offset adjustment > Offset Type > Time > Output Time Offset > [0.00, +/- 0.01, etc...]*

Selecting 'Lines And Pixels' reveals drop down fields where the offset can be set in these terms:

- *Output offset adjustment > Offset Type > Lines And Pixels > Output Line Offset > [0 to +/- (Total no. of Lines for current standard - 1)]*
- *Output offset adjustment > Offset Type > Lines And Pixels > Output Pixel Offset > [0 to +/- (Total no. of Pixels per Line for current standard - 1)]*

Generator offset is removed by selecting in menu:

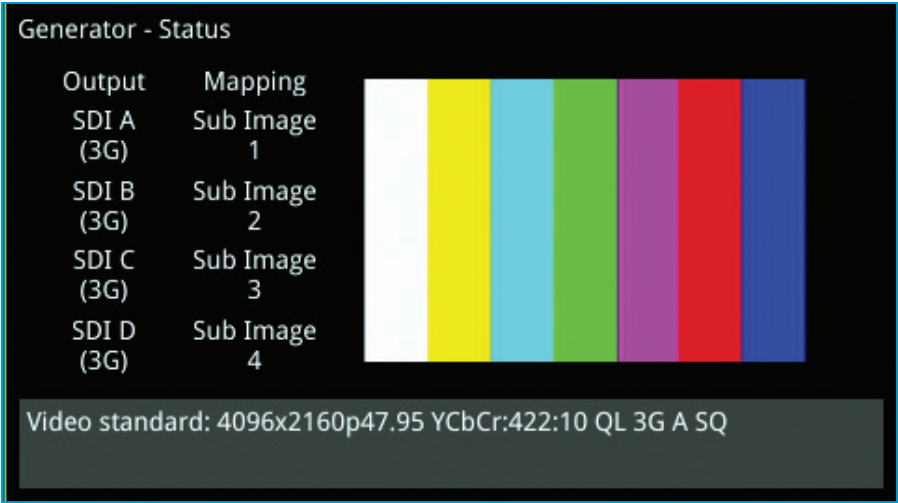
- *Output offset adjustment > Clear offsets*



# Generation

## Generator - Status

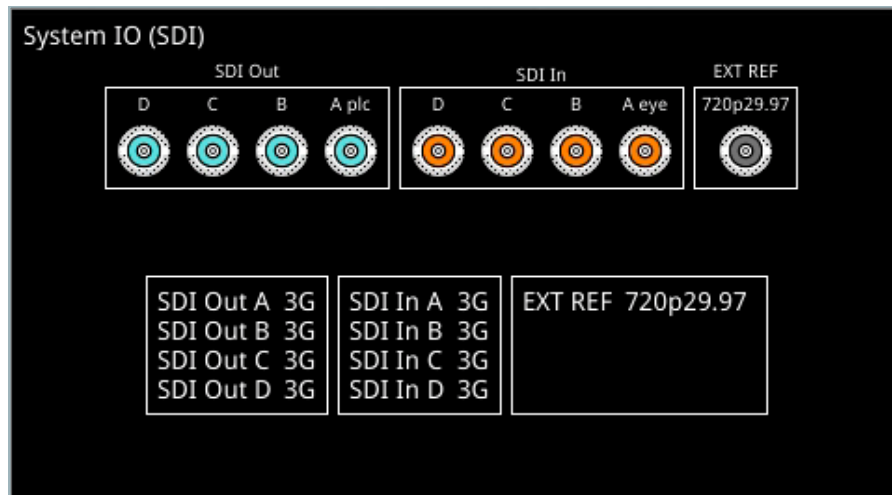
---



The 'Generator - Status' menu shows the generator pattern selected and confirms the SDI OUT A, B, C or D presence and Sub Image mapping information. This window is status only, there are no user configurations.

# System

## System IO (SDI)



Due to the complexity of the UHDTV standards, PHABRIX has introduced innovative ways of displaying status. This however does involve the information being displayed across several instruments. The 'System IO (SDI)' window has been designed as a quick view of the signal inputs and outputs attached to the Qx.

Active SDI inputs and outputs are indicated by the coloured connectors. Greyed out connectors indicate signals not present. The colour of the connectors corresponds to the colour of the instrument borders and instrument icons to aid recognition.

The presence of external reference and its standard is also displayed graphically with a coloured connector. If the system is set to lock to the external reference and a stable lock has been achieved, then the inner ring of the EXT REF BNC pictured will be highlighted in Grey.

- **BNC image:** [Grey (reference connected), Red (error with reference), Black (no reference connected)]

*Note: The EXT REF BNC shows the status of external reference only; which is not necessarily the system reference. System reference is selectable in the 'Timing and System Reference' instrument.*

Below the graphical connector display is a table showing SDI input and output status, and external reference standard and status. The external reference field displays the following states:

- **EXT REF:** [No Signal, Unstable, 525/59.94, 625/50, etc...]

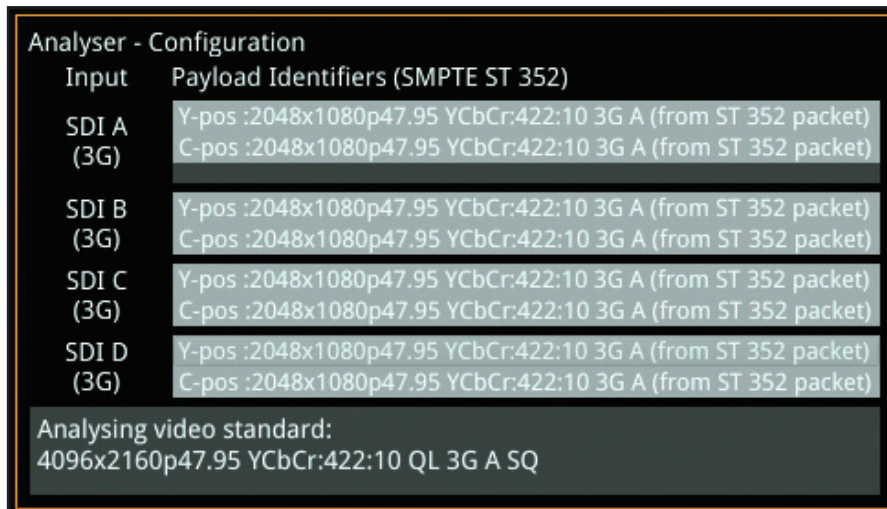
If external reference is not currently being used as system reference, its field text will display in yellow. When external reference is the system reference, this table field text will be white.



# Analysis

## Analyser - Configuration

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The 'Analyser - Configuration' window controls the video standard being analysed. It lists the payloads on the SDI input signals and highlights the ones used by the video standard being analysed.

The Payloads are identified primarily by ST-352 packets, if these are missing the signal stats will be analysed and a best guess payload identifier will be listed.

Incorrect ST 352 packets are indicated in red within the 'Analyser - Configuration' window.

- *Ignore Payload Identifier Packets (ST 352) > Checkbox [tick = ignore]*

ST-352 packets can be ignored such that a best guess payload identifier is always used. Select the "Ignore Payload Identifier Packets (ST-352)" option from the window's menu.

- *Analyser tools colour select > [colour]*

*Colour selection is via a HSV tool providing two cursors. The left hand colour rectangle allows selection of hue (horizontal) and saturation (vertical). The right hand vertical bar selects luminance.*

# Analysis

## Stats - SDI In A, B, C, D

'Stats - SDI In A', B, C and D provide information to verify the format of the signals being analysed. A video signal may be comprised of up to four separate SDI signals hence four separate windows.

Stats - SDI In A		12G Signal - Clock Divisor 1.000			
	Sub Image 1	Sub Image 2	Sub Image 3	Sub Image 4	
Counters Stable	true	true	true	true	
Active Samples Per Line	1920	1920	1920	1920	
Active Lines Per Field	1080	1080	1080	1080	
Total Samples Per Line	2640	2640	2640	2640	
Total Lines Frame/Field1	1125	1125	1125	1125	
Total Lines Field2	progressive	progressive	progressive	progressive	
Payload ID Y-Pos	CE C9 80 01	CE C9 80 01	CE C9 80 01	CE C9 80 01	
Payload ID C-Pos	CE C9 80 01	CE C9 80 01	CE C9 80 01	CE C9 80 01	

Example 1 shows the display of data from a single 12G input on input A

Stats - SDI In A		3G Signal - Clock Divisor 1.001		Stats - SDI In B		3G Signal - Clock Divisor 1.001	
	Sub Image 1				Sub Image 1		
Counters Stable	true			Counters Stable	true		
Active Samples Per Line	2048			Active Samples Per Line	2048		
Active Lines Per Field	1080			Active Lines Per Field	1080		
Total Samples Per Line	2750			Total Samples Per Line	2750		
Total Lines Frame/Field1	1125			Total Lines Frame/Field1	1125		
Total Lines Field2	progressive			Total Lines Field2	progressive		
Payload ID Y-Pos	89 C4 40 01			Payload ID Y-Pos	89 C4 40 01		
Payload ID C-Pos	89 C4 40 01			Payload ID C-Pos	89 C4 40 01		

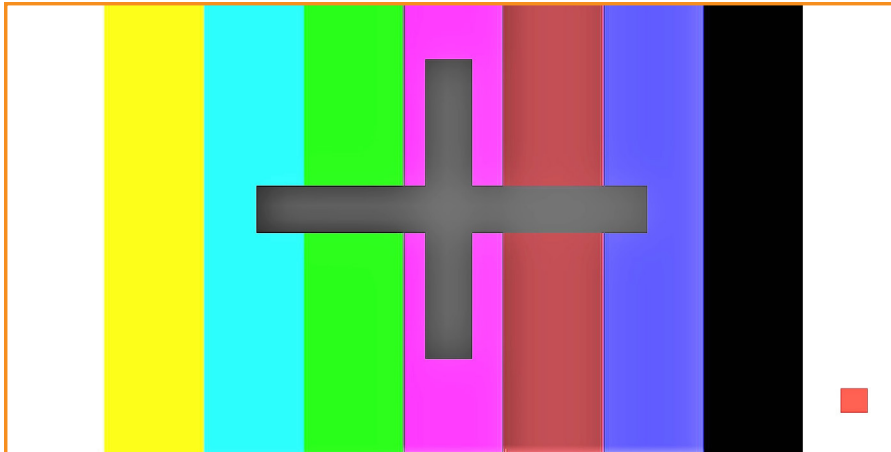
Stats - SDI In C		3G Signal - Clock Divisor 1.001		Stats - SDI In D		3G Signal - Clock Divisor 1.001	
	Sub Image 1				Sub Image 1		
Counters Stable	true			Counters Stable	true		
Active Samples Per Line	2048			Active Samples Per Line	2048		
Active Lines Per Field	1080			Active Lines Per Field	1080		
Total Samples Per Line	2750			Total Samples Per Line	2750		
Total Lines Frame/Field1	1125			Total Lines Frame/Field1	1125		
Total Lines Field2	progressive			Total Lines Field2	progressive		
Payload ID Y-Pos	89 C4 40 01			Payload ID Y-Pos	89 C4 40 01		
Payload ID C-Pos	89 C4 40 01			Payload ID C-Pos	89 C4 40 01		

Example 2 shows the display of data from a quad 3G input hence 4 separate video status windows

# Analysis

## Analyser - Picture

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The picture view shows the generator pattern currently being analysed by the Qx. The picture window may default to full screen - simply right click to change the picture to SMALL or MEDIUM. Right click the mouse to select MOVE to reposition the picture anywhere on the display.

The instrument's right click submenu provides various settings, including the ability to confidence monitor multi-sub-image video signals:

- *Per Sub-Image Decimation* > [Disabled, Enabled]

With this setting enabled, sub-images are decimated individually and recombined, allowing detection of significant errors in individual sub-images (2SI only).

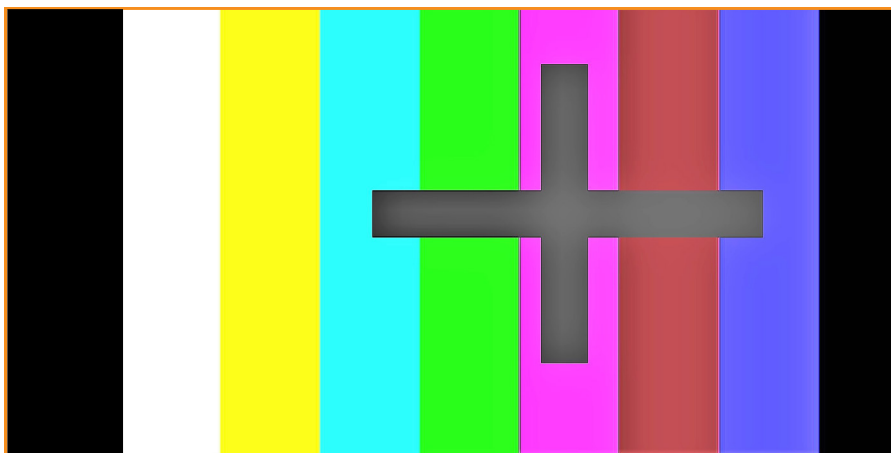
*Note: The above setting will be available soon in a future software release.*

### Blanking Area

By right clicking with the mouse the operator can also enable 'Show Blanking'. This will offset the picture to the right revealing the blanking area.

- *Show Blanking* > [Disabled, Enabled]

*Note: 'Show Blanking' is not available for multiple sub-image video standards as the active picture is separated from the blanking regions during active picture reconstruction.*





### *HDR Heat-map (False Colour Overlay)*

A false colour overlay can be applied to the picture view, to highlight areas of the image that are of particular luminance.

The picture can be displayed in greyscale. If enabled at the same time as 'False colour highlighting', all image elements outside of the enabled false colour overlay luminance range(s) will be displayed in greyscale mode; leaving the false colour highlight elements to stand out more:

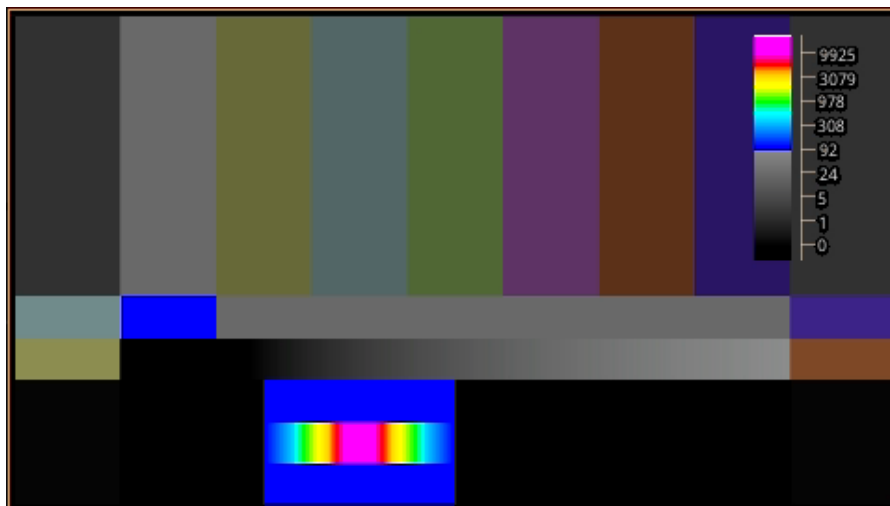
- *Greyscale mode* > [Enabled, Disabled]

A scale with numeric and graphic display of the luminance range(s) of the overlay in use, is available:

- *False Colour Overlay Scale* > [Enabled, Disabled]

The required luminance units for the scale can be selected:

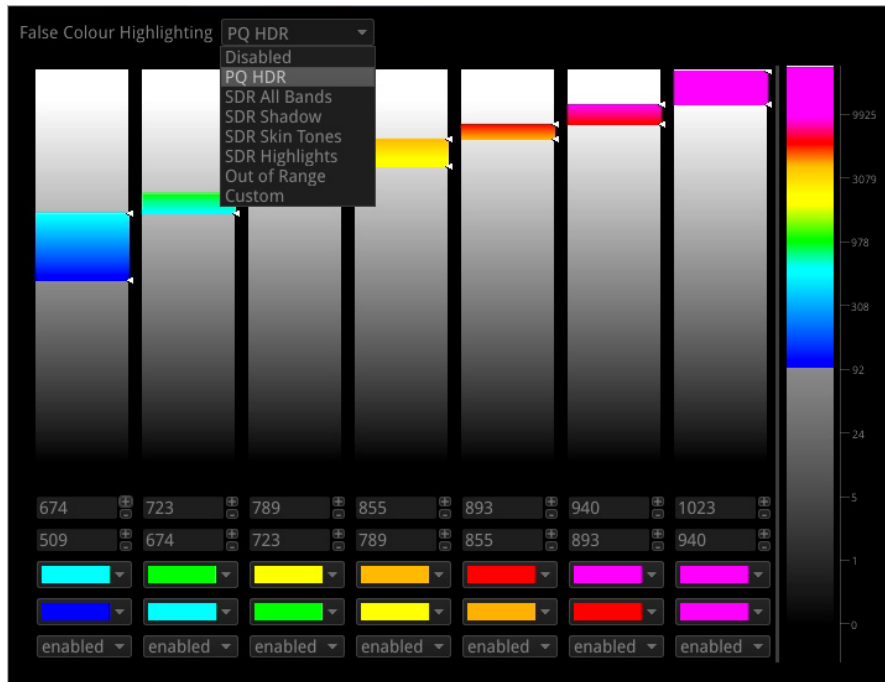
- *Luminance Measurement* > [Decimal Level, PQ Nits]



Different types of false colour overlay may be applied to clearly visualise different image details, and a custom mode is provided to allow the creation of a modified or bespoke overlay:

- *False colour ranges* > *False Colour Highlighting* > [Disabled, PQ HDR, SDR All Bands, SDR Shadow, SDR Skin Tones, SDR Highlights, Out of Range, Custom]

The range(s) and colours of a selected false colour overlay can be modified by adjusting the 7 overlay bands. Up to 7 distinct ranges can be simultaneously enabled in a single overlay. If adjusted, the new or modified overlay will be designated as the 'Custom' overlay type.



### Transfer Curve and Colourimetry Overrides

There is currently no ratified SMPTE standard for HDR payload ID. As a consequence, much HDR content today will contain the SMPTE payload ID for SDR and Rec. 709 colour space (as 'standard').

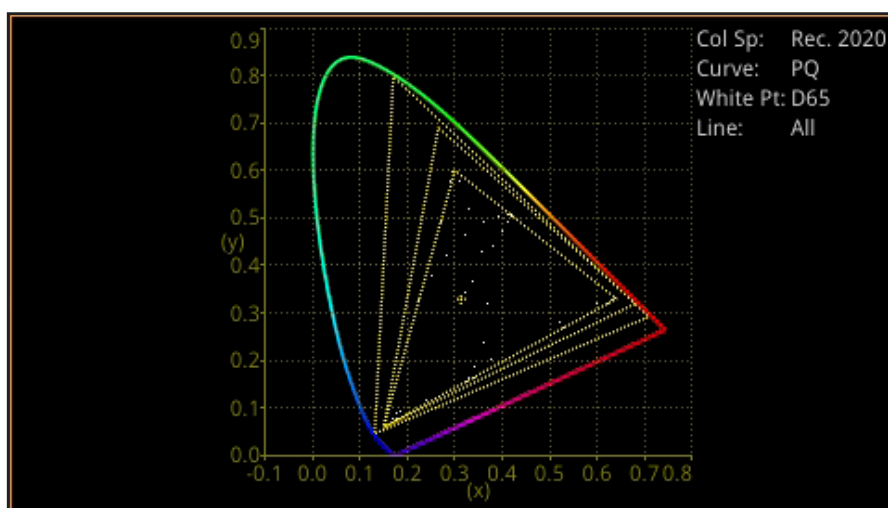
Therefore, for accuracy, when analysing most known HDR and WCG content, overrides should be enabled for the appropriate HDR transfer curve, and for WCG colour space:

- *Enable Transfer Curve Override* > [Enabled, Disabled]
- *Transfer curve Override* > [SDR-TV, PQ]
- *Enable Colourimetry Override* > [Enabled, Disabled]
- *Colourimetry Override* > [ColRec709, ColUHDTV]

All Qx HDR test signals contain the HDR payload ID and therefore do not require overrides for analysis.

## Analysis

### Analyser - CIE Chart





The CIE 1931 x y chart provides signal colourimetry analysis - complete with WCG and DCI-P3 colour gamut overlays, and Illuminant D65 white point reference.

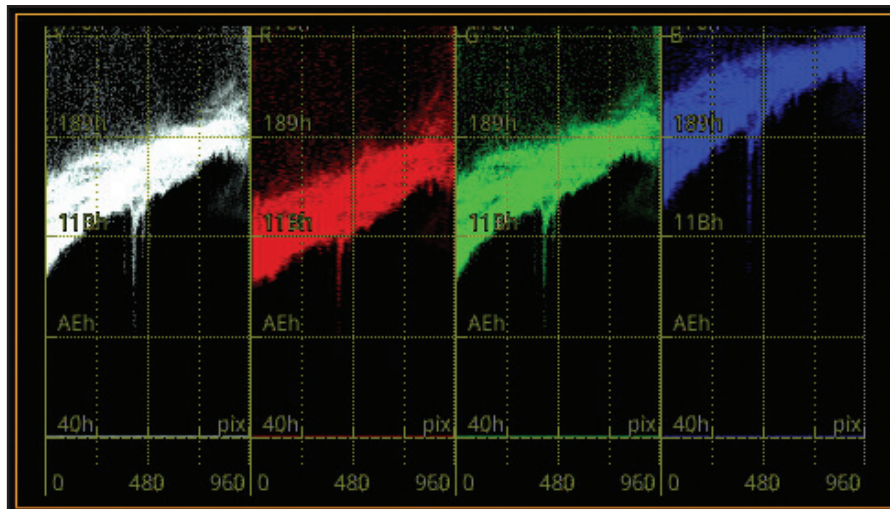
CIE Chart setup is accessed by right clicking within the chart area:

- *Rec. 709 Triangle* > [Enabled, Disabled]
- *Rec. 2020 Triangle* > [Enabled, Disabled]
- *P3 Triangle* > [Enabled, Disabled]
- *D65 White Point* > [Enabled, Disabled]
- *Single Line Mode* > [Enabled, Disabled]
- *Brightness* > [slider 1..31]
- *Gamma* > [slider 1..255]
- *Persistence* [1..255]

## Analysis

### Analyser - Waveform

---

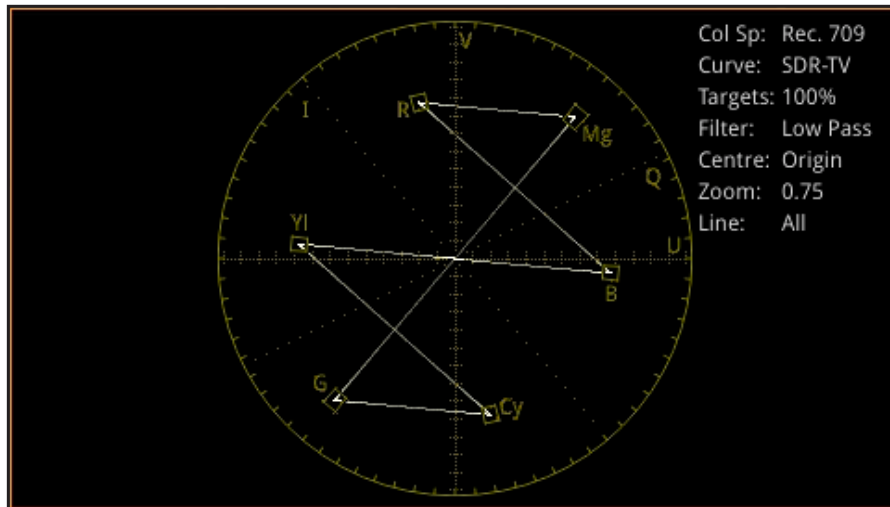


Waveform setup is accessed by right clicking within the waveform area:

- *Parade Mode* > [YCbCr, Y, Cb, Cr, RGB, GBR, YRGB, YGBR, Red, Green, Blue]
- *V Scale* > [% IRE, Hex Value, Decimal Value, Millivolts, PQ Nits]
- *H Scale* > [Pixels, % Line]
- *Filter* > [Flat, Low Pass, Raw]
- *Single Line Mode* > [Enabled, Disabled]
- *H Magnification* > [x1, x2, x4]
- *H Position* > [slider]
- *V Magnification* > [x1, x2, x4]
- *V Position* > [slider]
- *Brightness* > [slider 1..31]
- *Gamma* > [slider 1..255]
- *Persistence* [1..255]
- *Monochrome mode* [Enabled, Disabled]

# Analysis

## Analyser - Vectorscope



Vectorscope setup is accessed by right clicking within the vectorscope area:

- *Targets* > [Off, 75%, 100%]
- *I/Q Axes* > [Off, I Only, Q Only, Both]
- *Filter* > [Flat, Low Pass, Raw]
- *Centre* > [Origin, Red, Green, Blue, Magenta, Cyan, Yellow]
- *Single Line Mode* > [Enabled, Disabled]
- *Zoom* > [slider 0.5..4.0]
- *Brightness* > [slider 1..31]
- *Gamma* > [slider 1..255]
- *Persistence* [1..255]

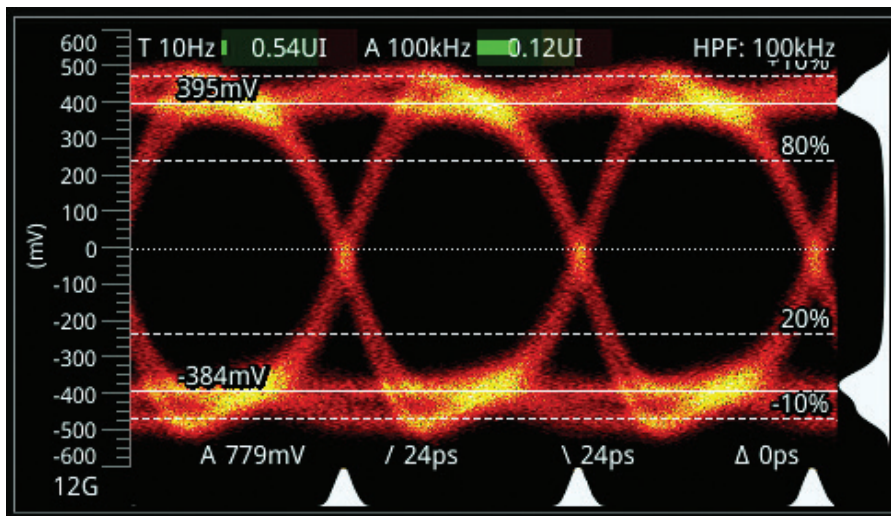
# Analysis

## Eye - SDI in A (PHQX-01E only)

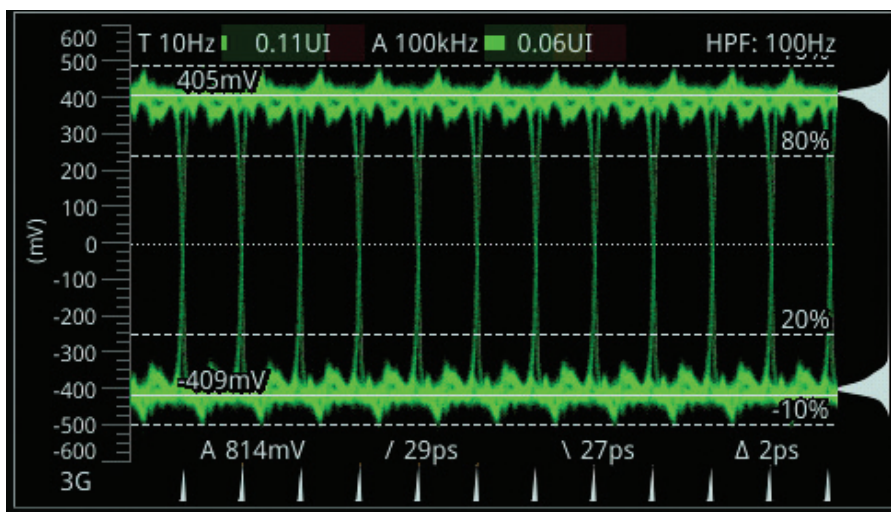
One of the unique features of the Qx is the PHYSICAL layer analysis tool-set. The PHABRIX Qx contains fundamental technology developed and patented by PHABRIX which makes it unique where physical layer compliance measurements are required up to 12 Gbps.

The Qx employs an analogue front end providing in excess of 30 GHz bandwidth (5th harmonic of the 6GHz fundamental for 12G-SDI). Featuring PHABRIX RTE™ (Real Time Eye) technology the Qx is in a league of its own. More akin to expensive high end oscilloscopes, the Qx provides broadcast engineers with a reliable, instantaneous physical layer display with automatic measurements to SMPTE standards.

The PHABRIX Qx enables measurement of both overshoot and undershoot along with amplitude, rise time, fall time and delta - compulsory when testing against SMPTE standards and a key differentiator when comparing Qx technology. Accurate measurements are obtained with seconds of connecting an SDI signal making for very fast system testing solution. Out of specification measurements are indicated in red.



Example 1: 12G-SDI Eye pattern display with 100 kHz jitter filter

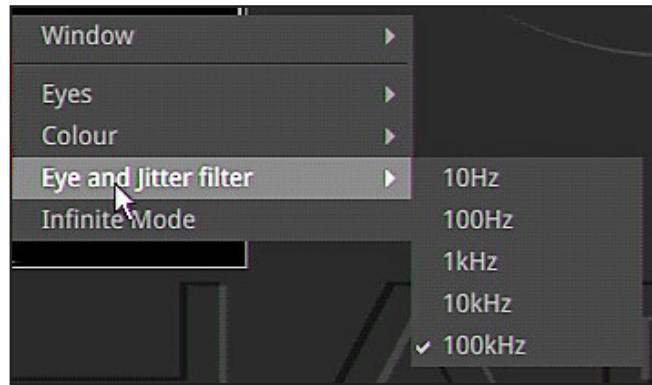


Example 2: 3G-SDI Eye pattern display with 100 kHz jitter filter

Note: 'SDI In A' has a red nut to indicate it is the SDI BNC that has the eye and jitter circuitry behind it



The Physical Layer tool-set has several drop down menus selected by a right click of the mouse. (A table showing the SMPTE tolerances for each standard is available at the end of this manual.)



Selections include:

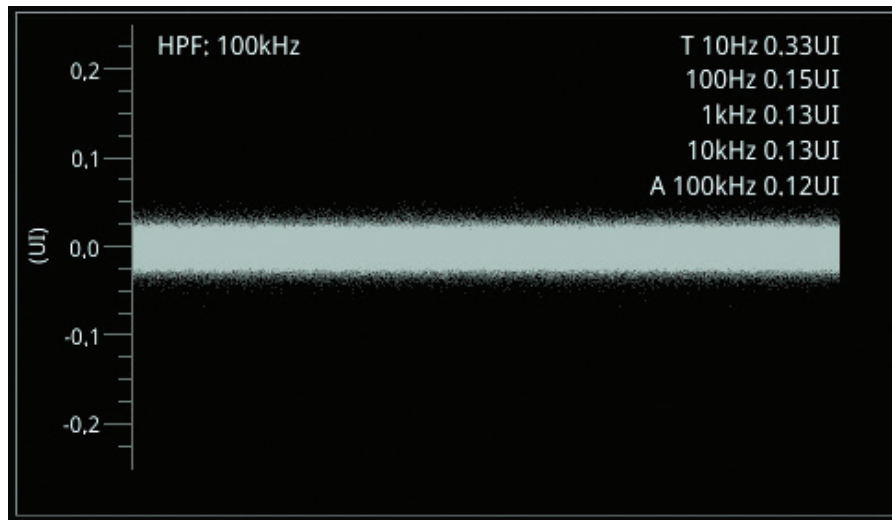
- *Eyes > [1, 2, 3...20]*
- *Colour > [Green, Heat, Red, Ferrara, Green-red, Blacklight]*
- *Eye and jitter filter > [10Hz, 100Hz, 1kHz, 10kHz, 100kHz]*
- *Infinite mode > [Enabled, Disabled]*

The display also provides:

- Timing jitter thermometer colour coded according to analysed SDI standard
- Alignment jitter thermometer colour coded according to analysed SDI standard
- On screen indication of 20% and 80% levels for rise and fall time measurement
- On screen indication of +10% and -10% levels for overshoot and undershoot analysis
- Positive and negative amplitude values providing DC offset information
- Horizontal histogram of eye crossing point (0mV threshold)
- Vertical histogram providing indication of energy distribution over all samples

# Analysis

## Jitter - SDI In A (PHQX-01E only)



The jitter tool-set is available on the 'SDI In A' BNC (the one with the red nut)

The jitter instrument shows automated measurements to SMPTE standards.

Readings for each of the filters are shown displayed as an overlay on the right hand side of the instrument.

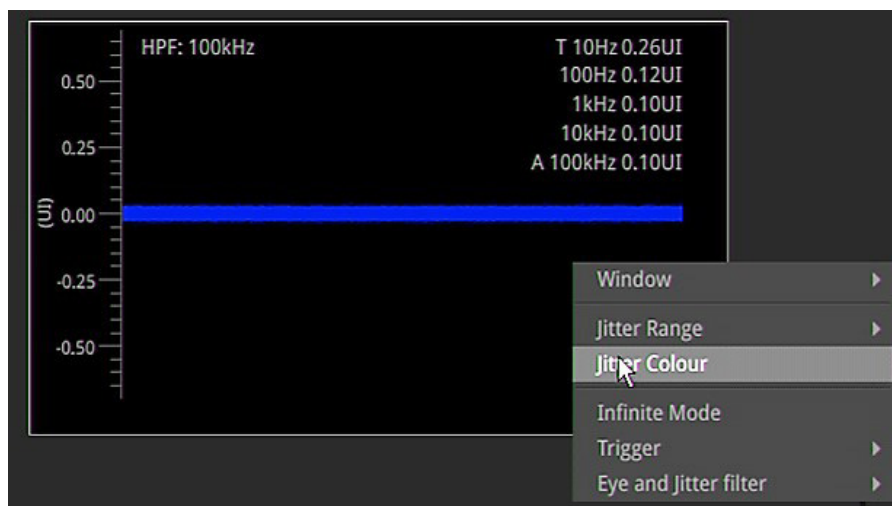
Any red text displayed indicates an out of specification reading.

As with the Eye instrument, further drop down menus are available using the right click on the mouse control:

- *Scale* > [sliding scale: Y graticule adjustment from +/- 0.2 UI to +/-8UI]
- *Trigger* > [None, Single Line, Two Lines, Single Field, Two Fields, Frame]
- *Eye and jitter filter* > [10Hz, 100Hz, 1kHz, 10kHz, 100kHz]
- *Infinite Mode* > [Enabled, Disabled]
- *Jitter Colour* > Waveform colour selection

Colour selection is via a HSV tool providing two cursors. The left hand colour rectangle allows selection of hue (horizontal) and saturation (vertical). The right hand vertical bar selects luminance.

Trigger modes are useful for correlating jitter content to line and frame rate frequencies



# Analysis

## Analyser - Dataview



This instrument presents the raw data present in the signal be it HD-SDI, 3G-SDI, 6G-SDI or 12G-SDI. The data can be observed in hexadecimal, decimal or binary formats and the data is navigated by pixel and line selection. The instrument displays the entire video frame complete with active video, TRS words and blanking information.

By right clicking using the mouse on this instrument, the following drop down menus are presented:

- *Sample* > [slider 0 to max\_pix\_count]
- *Line* > [slider 0..max\_line\_count]
- *Navigate* > [calls up navigation pane - see below]
- *Base* > [hex, decimal, binary]
- *Field* > [Field 1, Field 2] (standard dependant)
- *Sub-Image* > [Sub Image 1, Sub Image 2, Sub Image 3, Sub Image 4] (standard dependant)

Data is presented with a colour coding for both text and background:

- Foreground colour indicates video sample type: Y (white), Cb (blue), Cr (red)
- Background colour indicates data type: TRS words (blue), Blanking (black), Active picture (green)

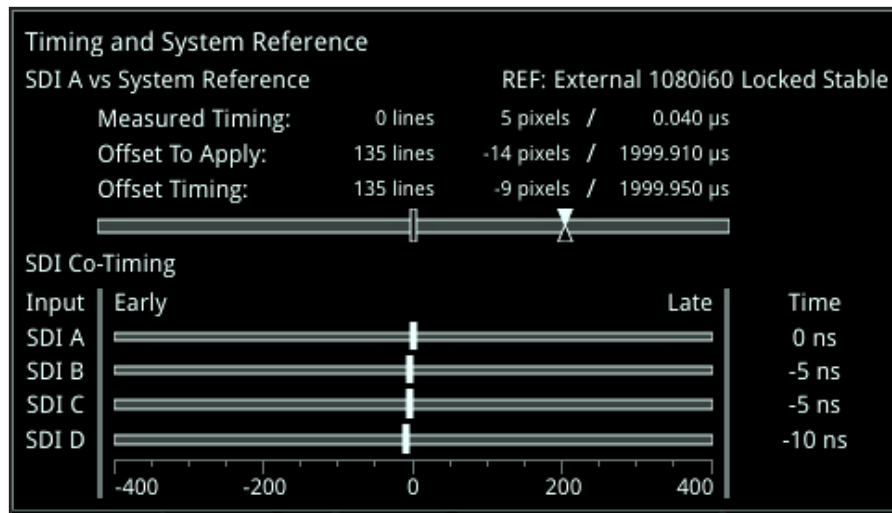
Changing the window size changes the amount of data displayed.

A navigation keypad activated by selecting 'Navigate' on the top bar of the instrument allows the user to quickly navigate the dataview window.



# Analysis

## Timing and System Reference



The upper part of the instrument view is devoted to SDI A vs System Reference timing comparison; and system reference is set in the instrument sub menu.

The lower part displays SDI Co-timing information for elements of a quad or dual link signal.

### System Reference Lock

The sub menu accessed by right clicking within the 'Timing and System Reference' window calls up system reference locking controls; defining the reference that the Qx system and any signal it generates will be locked to:

- *System Reference* > [Free Run, External Reference, SDI]
- *Default To Freerun* > [Enabled, Disabled]

System reference status information is displayed in the upper right hand corner of the instrument, and any reference health state error will be displayed in red.

### SDI A vs System Reference

This section of the instrument displays the timing difference between the SDI A input signal and the system reference the Qx is locked to. Both graphic and numeric (spatial and temporal) values are presented by the instrument for this measurement. A relative timing bar tool dynamically measures the timing of 'SDI In A' (white triangle) against the system reference (centrally fixed black vertical crosshair).

The tool can be adjusted to display readings at frame scale, or zoom in all the way to a fraction of a line:

- *Reference Timing Meter Range* > [+/- 0.1 line, +/- 0.5 line, +/- 0.5 frame]

### Input Measurement Offset

In addition to measurement of 'SDI In A' against absolute system reference, a system reference offset can also be applied in the tool to measure against. The offset position is indicated on the relative timing bar tool with a black triangle.

Offsets can be entered in temporal or spatial terms:

- *Input Measurement Offset Type* > [Time, Lines And Pixels]

Selecting 'Time' reveals a drop down field where the timing offset can be set in microseconds:

- *Input Measurement Offset Type* > Time > *Input Measurement Time Offset* > [0.00, +/- 0.01, etc...]

Selecting 'Lines And Pixels' reveals drop down fields where the offset can be set in these terms:

- *Input Measurement Offset Type > Lines And Pixels > Input Measurement Line Offset > [0 to +/- (Total no. of Lines for current standard - 1)]*
- *Input Measurement Offset Type > Lines And Pixels > Input Measurement Pixel Offset > [0 to +/- (Total no. of Pixels per Line for current standard - 1)]*

The input measurement offset can be set to the same position as the current 'SDI In A' signal:

- *Set Input Measurement Offset to current*

The input measurement offset is removed by selecting in menu:

- *Clear Input Measurement Offset*

### SDI Co-Timing

Many of the standards associated with UHD TV are a combination of signals to form the image plane. Relative timing tools indicate that the quad or dual elements creating the single picture are correctly aligned and compared with reference. Both graphic and numeric values are presented by the instrument for this critical measurement. Any red text displayed indicates an out of specification measurement.

*Note: The Timing instrument in this software release is locked to Input A.*

## Analysis

### Analyser - Ancillary Status

S353 MPEG Recode	S305 SDTI	S348 HD-SDTI	S427 Link Encryption
S352 Payload ID	S2016-3 AFD	S2016-4 PAN	S2010 ANSI/SCTE
S2031 DVB/SCTE	S2056 MPEG TS	S2068 3D Packing	S2064 Lip Sync
ITU-R BT.1685	OP47 Caption	OP47 VBI/WST	ARIB-TR-B29
RDD18 Metadata	RP214 KLV Metadata	RP223 UMID/ID	S2020 Audio
S2051 Two Frame	RDD8 WSS	RP215 Film Codes	S12M-2 V-TCODE
EIA-708 Caption	EIA-608 Caption	RP207 Program	S334-1 Data
RP208 VBI Data	Mark Deleted	S299-2 3G Audio	S299-1 HD Audio
S272 SD Audio	S315 Camera Pos	RP165 EDH	

The Qx has a sophisticated display to analyse ancillary data in the signal. UHD TV has a new set of rules for carrying this data. The clear graphical representation of this is required to establish compliance. Colour coded signal conditions - present, lost, and error are all available. Additional data is displayed as the instrument is resized.

- White - Indicates ANC packets present and correct
- Red - Indicates ANC packets present but in error
- Yellow - indicates ANC packets present and correct but there has been a previous error

Status is reset by selecting in menu:

- *Reset*



# Analysis

## Analyser - Audio Meters



The 'Analyser - Audio Meters' instrument displays 16 x audio meters along with peak level indication and audio pair phase indication. In addition dBFS values are indicated at the base of each meter.

Dolby E, D and D+ streams are detected by the system with Dolby stream indication in blue.

The HDMI instrument output carries a stereo pair of audio, the same signal is made available on the 26-way D-type at the rear of the Qx chassis.

Stereo pair monitoring selection is provided by selecting the speaker icon above each set of audio meters. Mono channel selection is provided by selecting the appropriate solo bus located between the audio meters and the speaker icons.

Menu options provided:

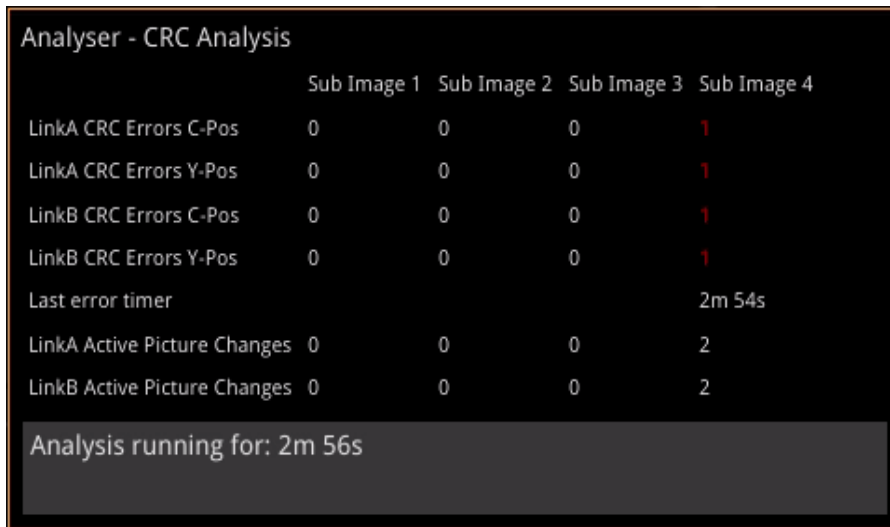
- *Input Select > [Image/Sub-Image 1 Group 1-4, Image/Sub Image 1 Group 5-8, Sub-Image 2 Group 1-4, Sub-Image 2 Group 5-8, Sub-Image 3 Group 1-4, Sub-Image 3 Group 5-8, Sub-Image 4 Group 1-4, Sub-Image 4 Group 5-8]*
- *Ballistics > [PPM Type I, PPM Type II, Vu, VuFr]*
- *PPM Scale Type > [dBFS, dBu -18dBFS, dBu-20dBFS, BBC, DIN45406, NordicN9]*
- *Hat Hold Time > [0.00...10.00, infinity]*
- *Monitor Buttons > [Enabled, Disabled]*
- *Solo Buttons > [Enabled, Disabled]*

Up to two audio meter instrument windows can be enabled providing 32 simultaneous channels of audio metering. Each window is assignable to monitor groups 1 to 4 (defined in SMPTE ST 299-1) or groups 5 to 8 (defined in SMPTE ST 299-2) in any of up to 4 potential sub-image ANC areas as defined in SMPTE ST 2082-10.

Each audio window is scalable from 1/32 to 1/4 of screen area.

# Analysis

## Analyser - CRC Analysis



	Sub Image 1	Sub Image 2	Sub Image 3	Sub Image 4
LinkA CRC Errors C-Pos	0	0	0	1
LinkA CRC Errors Y-Pos	0	0	0	1
LinkB CRC Errors C-Pos	0	0	0	1
LinkB CRC Errors Y-Pos	0	0	0	1
Last error timer				2m 54s
LinkA Active Picture Changes	0	0	0	2
LinkB Active Picture Changes	0	0	0	2

Analysis running for: 2m 56s

The 'Analyser - CRC Analysis' window checks for CRC errors in the signal. Dependant on the input required for the standard under test, i.e. 4 inputs or single, the Sub Image columns will show any errors in each of the inputs attached.

The 'Last error timer' event shows in seconds the last CRC error event in each input.

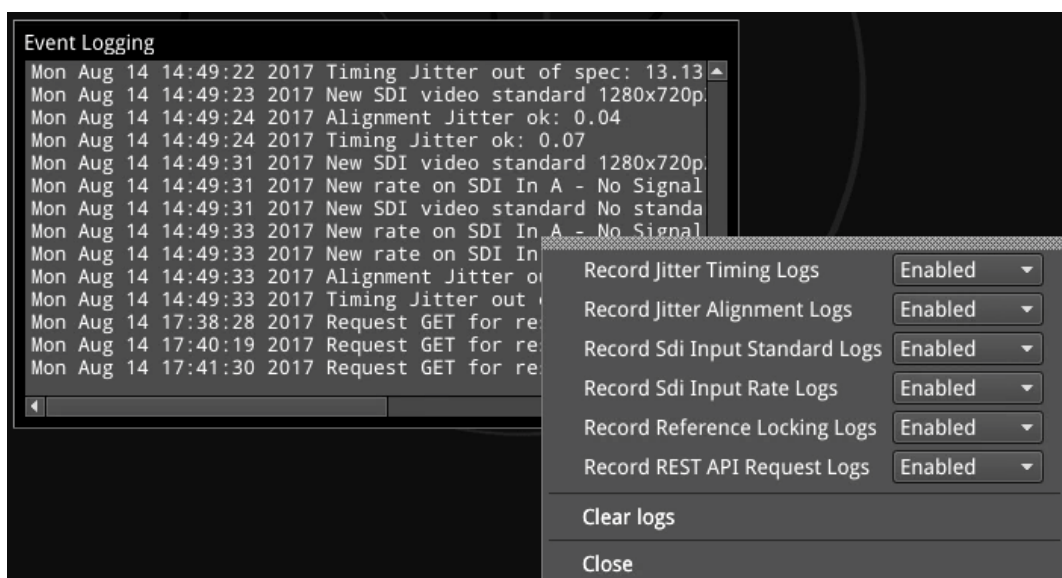
In addition, a separate timer indicates the time since error checking began.

The instrument also analyses the CRC of the overall active picture to detect changes.

- *Reset errors and running time*

# System

## Event Logging



Event Logging

```
Mon Aug 14 14:49:22 2017 Timing Jitter out of spec: 13.13
Mon Aug 14 14:49:23 2017 New SDI video standard 1280x720p
Mon Aug 14 14:49:24 2017 Alignment Jitter ok: 0.04
Mon Aug 14 14:49:24 2017 Timing Jitter ok: 0.07
Mon Aug 14 14:49:31 2017 New SDI video standard 1280x720p
Mon Aug 14 14:49:31 2017 New rate on SDI In A - No Signal
Mon Aug 14 14:49:31 2017 New SDI video standard No standa
Mon Aug 14 14:49:33 2017 New rate on SDI In A - No Signal
Mon Aug 14 14:49:33 2017 New rate on SDI In
Mon Aug 14 14:49:33 2017 Alignment Jitter ok: 0.04
Mon Aug 14 14:49:33 2017 Timing Jitter out of spec: 13.13
Mon Aug 14 17:38:28 2017 Request GET for re
Mon Aug 14 17:40:19 2017 Request GET for re
Mon Aug 14 17:41:30 2017 Request GET for re
```

- Record Jitter Timing Logs
- Record Jitter Alignment Logs
- Record Sdi Input Standard Logs
- Record Sdi Input Rate Logs
- Record Reference Locking Logs
- Record REST API Request Logs
- Clear logs
- Close

Logging is provided on the Qx, and logs can be viewed in 'Event Logging'. The Qx allocates 500 lines for logging detail before over writing this data. It will also recall the log data last captured if the unit is started from cold. The setting for logging data will need to be re-entered from a cold start using the right click selection. Logs can also be accessed and saved via the REST API.

By right clicking the mouse on this instrument the following drop down menus are presented:

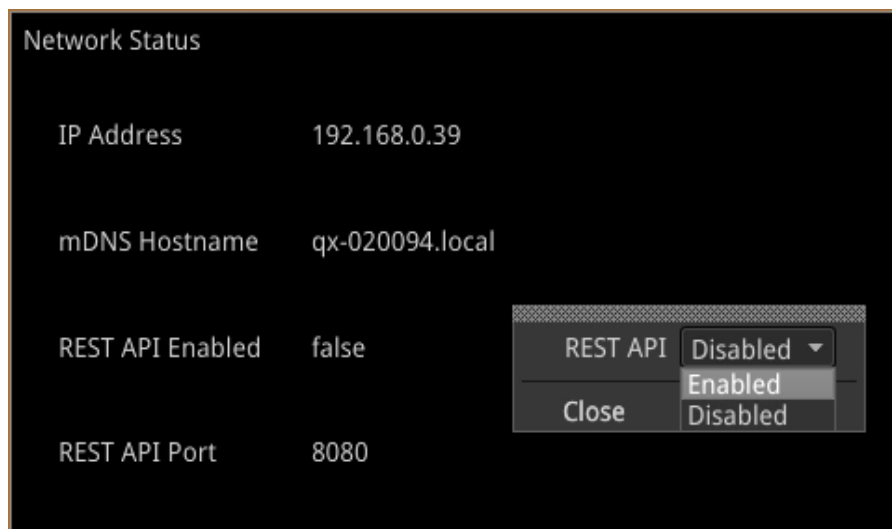
- *Record jitter Timing Logs > [Enabled, Disabled]*
- *Record jitter Alignment Logs > [Enabled, Disabled]*
- *Record SDI Input Standard Logs > [Enabled, Disabled]*
- *Record SDI Input Rate Logs > [Enabled, Disabled]*
- *Record Reference Locking Logs > [Enabled, Disabled]*
- *Record REST API Request Logs > [Enabled, Disabled]*
- *Clear logs*

Event logging will be significantly improved in subsequent software releases.

## System

### Network Status

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The Qx can be controlled remotely via REST API, which can be used for automated testing. The network will need to be DHCP enabled, as the IP address of the Qx will be automatically assigned.

From the 'Network Status' window a remote connection can be established by enabling 'REST API' in the submenu:

- *REST API > [Disabled, Enabled]*

The 'Network Status' window contains all the information on the Qx that is needed in order to send it a REST request. 'IP Address' (or 'mDNS Hostname' if your client's host supports it) should be used as the recipient of the request, and 'REST API Port' is the port that requests will need to be directed towards.

The REST API supports two HTTP methods; GET and PUT.

GET requests can be used to retrieve Qx information and navigate the submenus. PUT requests can be used to modify and control Qx behaviour and actions.

A web browser can be used to retrieve Information from the Qx with GET requests.

Any HTTP/1.1 compliant application can be used to control the Qx with both GET and PUT requests.

PUT and GET requests can be scripted for automated testing.



## REST API Requests

For the following REST API request examples, an example IP address (192.168.0.39) and default REST API Port (8080) are used. The base resource to aim requests at is "/api". The base URL for requests (GET) will be in the format: *http://192.168.0.39:8080/api* or *http://qx-020094.local:8080/api*

REST API requests can be used to:

- Report the current analysed standard (GET): *http://192.168.0.39:8080/api/v1/analyser/status*
- Report the currently generated standard (GET): *http://192.168.0.39:8080/api/v1/generator/status*
- Navigate through list of available generator standards (GET): *http://192.168.0.39:8080/api/v1/generator/standards*. Select from tree and GET again to drill down to appropriate colour format, bit depth, level, SDR or HDR format, and test pattern.
- Generate a standard (PUT): *http://192.168.0.39:8080/api/v1/generator/standards/1920x1080p60/YCbCr%3A422%3A10/3G\_A/100%25%20Bars*. A pathological overlay, its type and number of pairs can be added by including a raw payload of, for example, `{ "action": "start", "pathological": { "type": "CheckField", "pairs": 100 } }`
- View instantaneous Eye readings (GET): *http://192.168.0.39:8080/api/v1/eye/status*
- View instantaneous Jitter readings (GET): *http://192.168.0.39:8080/api/v1/jitter/status*
- Retrieve the event logs (GET): *http://192.168.0.39:8080/api/v1/eventlog/logs*
- Manage the event logs (PUT): *http://192.168.0.39:8080/api/v1/eventlog/config/restAPI* with a raw payload of `{ "action": "enable" }` in this example, to enable REST API event logging.

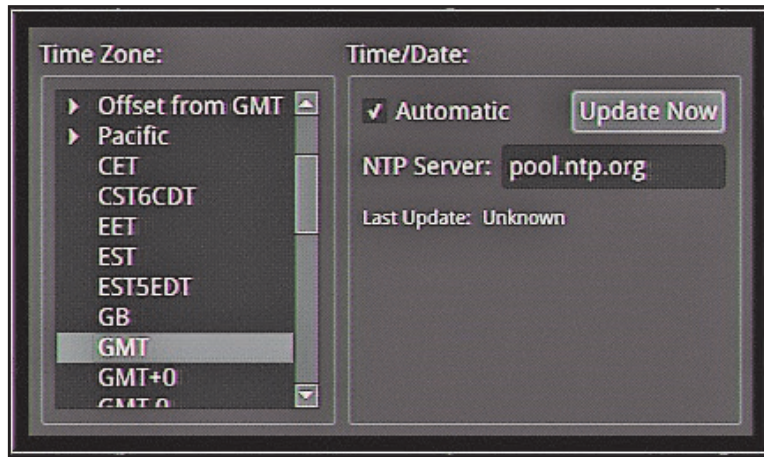
# System

## Time and NTP

---



By 'right clicking' the time displayed on the right hand side of the menu bar, a separate window will be displayed. Use the slider control to select the required time zone:



NTP can be turned off which will then provide manual control of time setting. To return to NTP use the mouse to select the 'Automatic' feature.

- *Time Zone* > [select zone]
- *Set Time & Date* > *Automatic* [check box]
- *Set Time & Date* > *Update Now* [press to update]
- *NTP Server:* > [eg. pool.ntp.org]

## Specifications

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### Power

Connector	4-pin XLR, Male
Voltage	10-18V, 12V DC nominal DC Power adapter provided Overvoltage, undervoltage and reverse voltage protection

### External Locking Reference

Label	REF
Input Signal	Tri-level or Bi-Level (black burst) syncs 50/59.94/60Hz
Connector	2x BNC
Input Impedance	> 10k $\Omega$
Input Return Loss	> 40dB to 6MHz (typical)
Maximum Input voltage	+/- 2V
Specification	Tri-level syncs (SMPTE 274M and SMPTE 296M) 600 mV pk-pk PAL Black Burst (ITU 624-4/SMPTE 318) 1V pk-pk, Composite NTSC (SMPTE 170M) 1V pk-pk

### SDI Instrument Output

Label	SDI OUT
Connector	BNC
Output Impedance	75 $\Omega$
Output Level	800mV p-p +/-10%
Purpose	3Gbps SDI instrument output

### HDMI Instrument Output

Label	HDMI
Connector	Type A
Video Format	1920 x 1080 RGB 4:4:4
Audio Format	4 x PCM stereo audio at 48 KHz
Purpose	Monitor output that allows up to 16 individual instrument panels (or windows) to be displayed.

### USB

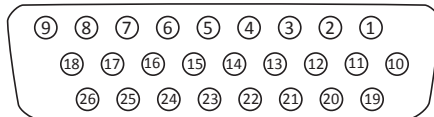
USB	USB 2
USB Connector	Type A
Quantity	3 (1 x front mounted, 2 x rear mounted)
Purpose	Keyboard and mouse control of the HDMI <sup>®</sup> monitor output of instrument and software installation.

## Networking

Ethernet IEEE 802.3 10/100/1000Mb/s (10/100/1000 base-T)  
 Ethernet Connector RJ-45

## Rear panel D26

Label: I/O Expansion  
 Connector: 26-way D-type  
 Purpose: 8x GPI I/O, 4x AES I/O, LTC input, stereo analogue audio out  
 Pin out:



Pin Number	Pin Name	Description
1	AES_IO0	Bidirectional AES I/O - 75Ohm unbalanced
2	AES_IO1	Bidirectional AES I/O - 75Ohm unbalanced
3	AES_IO2	Bidirectional AES I/O - 75Ohm unbalanced
4	AES_IO3	Bidirectional AES I/O - 75Ohm unbalanced
5	LTC_RX_P	LTC Receive (RX) P (RS-422 compatible)
6	LTC_RX_N	LTC Receive (RX) N (RS-422 compatible)
7	AUDIO_R	Audio Line Out - right
8	AUDIO_L	Audio Line Out - left
9	5V0_GPIO	5V current limited GPIO supply (500mA)
10, 11, 12, 13, 14, 15, 16, 17, 18	GND	0V
19	GPIO-0	Open drain, 10k pull-up to +5V
20	GPIO-1	Open drain, 10k pull-up to +5V
21	GPIO-2	Open drain, 10k pull-up to +5V
22	GPIO-3	Open drain, 10k pull-up to +5V
23	GPIO-4	Open drain, 10k pull-up to +5V
24	GPIO-5	Open drain, 10k pull-up to +5V
25	GPIO-6	Open drain, 10k pull-up to +5V
26	GPIO-7	Open drain, 10k pull-up to +5V

## AES I/O

Connector 26-way D-type  
 Pins 1 (AES I/O 1), 2 (AES I/O 2), 3 (AES I/O 3), 4 (AES I/O 4)  
 Input Impedance 75 Ω terminated  
 Maximum Input Voltage +/- 2V  
 Input Sample Rate 48kHz synchronous audio  
 Input Bit Depth 20bit or 24bit  
 Output Sample Rate 48kHz synchronous to system reference  
 Output Bit Depth 24bit  
 Specification Conforming to AES3-2003 and SMPTE-276M  
 Purpose Not currently supported in software

### Longitudinal Timecode (LTC)

Connector	26-way D-type
Pins	5 (RX - P), 6 (RX-N)
Format	RS-422 Compatible
Purpose	Not currently supported in software

### Analogue Audio Output

Connector	26-way D-type
Pins	7 (Audio Line Out - Right), 8 (Audio Line Out - Left)
Type	Stereo Pair
Level	(1V peak-to-peak analogue audio, full scale 0dBFS)
Purpose	Audio Monitoring output

### GPIO

Connector	26-way D-type
Pins	19 (GPIO - 0), 20 (GPIO - 1), 21 (GPIO - 2), 22 (GPIO - 3), 23 (GPIO - 4), 24 (GPIO - 5), 25 (GPIO - 6), 26 (GPIO - 7)
Format	open drain with 10k $\Omega$ pull-up to +5 Volts
Power	5 Volt (pin 9), current-limited GPIO supply for 'open drain' input/outputs. 0 Volt/ signal ground (pins 10 to 18)
Purpose	Not currently supported in software

## On-going Development

PHABRIX is committed to developing the tool-sets on the Qx to meet the very high expectations of its customers. There will be frequent upgrades which will include improvements to existing instruments and the addition of new ones.

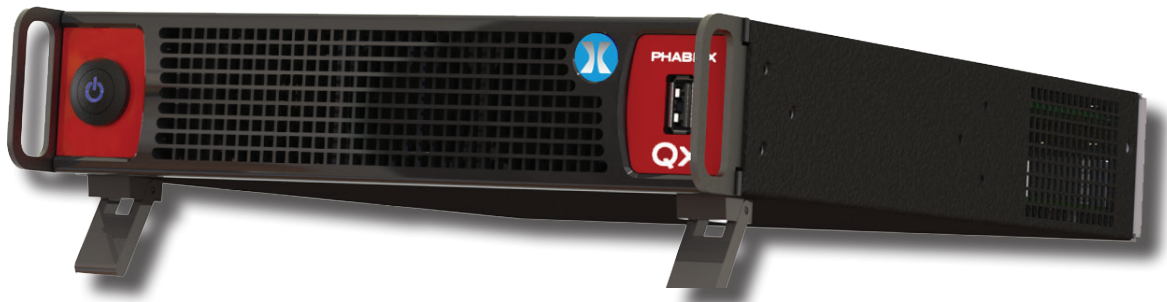
Please do not hesitate to contact PHABRIX at any time to discuss your requirements for the product or to discuss the current product time-line.

## SMPTE UHD TV: SDI PHYSICAL LAYER

Coding	Scrambled NRZI	Scrambled NRZI	Scrambled NRZI	Scrambled NRZI
Amplitude	800 mV +/- 10%	800 mV +/- 10%	800 mV +/- 10%	800 mV +/- 10%
DC Offset	0.0 V +/- 0.5 V	0.0 V +/- 0.5 V	0.0 V +/- 0.5 V	0.0 V +/- 0.5 V
Rise/Fall time:	< 270 ps	< 135 ps	< 80 ps	< 45 ps
Rise/Fall time difference:	< 100 ps	< 50 ps	< 35 ps	< 18 ps
Over/Under-shoot:	<10% of the amplitude	<10% of the amplitude	<10% of the amplitude	<10% of the amplitude
Timing Jitter	< 1 UI (10 Hz to 148.5 MHz)	< 2 UI (10 Hz to 297 MHz)	< 4 UI (10 Hz to 594 MHz)	< 8 UI (10 Hz to 1188 MHz)
Alignment Jitter	< 0.2 UI (100 kHz to 148.5 MHz)	< 0.3 UI (100 kHz to 297 MHz)	< 0.3 UI (100 kHz to 594 MHz)	< 0.3 UI (100 kHz to 1188 MHz)
Qx 75 Ohm Coaxial cable length (Belden 1694A)	200 m	200 m	100 m	70 m
Qx 75 Ohm Coaxial cable length (Canare L-5.5CUHD)				100 m (colour bars)

Automatic measurement provided by Qx

The complexity of both analysing and generating signals for UHD TV is exemplified above. The data bandwidth testing from HD through to UHD TV at 12Gbps, standard on the Qx, is immense and the parameters set by SMPTE require that the instruments measure these critical values for compliance.



## Supported SDI standards

This version of software supports the following standards:

Please contact PHABRIX if you required support for any standards not listed here.

SMPTE Standards Link (Content)	Interface	Resolution	Sampling Structure	Pixel Depth	Frame/Field Rate	PQ HDR Available?
ST 292 (ST 296)	HD	1280 x 720	4:2:2 (YCbCr)	10	60p, 59.94p, 50p, 30p, 29.97p, 25p, 24p, 23.98p	Yes
ST 292 (ST 274)	HD	1920 x 1080	4:2:2 (YCbCr)	10	60i, 59.94i, 50i	Yes
ST 292 (ST 274)	HD	1920 x 1080	4:2:2 (YCbCr)	10	30p, 29.97p, 25p, 24p, 23.98p	Yes
ST 292 (ST 2048-2)	HD	2048 x 1080	4:2:2 (YCbCr)	10	30p, 29.97p, 25p, 24p, 23.98p	Yes
ST 425-1 (ST 274)	3G Level A,B (1)	1920 x 1080	4:2:2 (YCbCr)	10	60p, 59.94p, 50p	Yes
ST 425-1 (ST 2048-2)	3G Level A,B (1)	2048 x 1080	4:2:2 (YCbCr)	10	60p, 59.94p, 50p, 48p, 47.95p	Yes
ST 425-1 (ST 296)	3G Level A (2)	1280 x 720	4:4:4 (YCbCr/RGB) 4:4:4:4 (YCbCrA/RGBA)	10	60p, 59.94p, 50p, 30p, 29.97p	–
ST 425-1 (ST 274)	3G Level A (2)	1920 x 1080	4:4:4 (YCbCr/RGB) 4:4:4:4 (YCbCrA/RGBA)	10	60i, 59.94i, 50i 30p, 29.97p, 25p, 24p, 23.98p	–
ST 425-1 (ST 2048-2)	3G Level A (2)	2048 x 1080	4:4:4 (YCbCr/RGB) 4:4:4:4 (YCbCrA/RGBA)	10	30p, 29.97p, 25p, 24p, 23.98p	–
ST 425-1 (ST 274)	3G Level A (3)	1920 x 1080	4:4:4 (YCbCr/RGB)	12	60i, 59.94i, 50i 30p, 29.97p, 25p, 24p, 23.98p	–
ST 425-1 (ST 2048-2)	3G Level A (3)	2048 x 1080	4:4:4 (YCbCr/RGB)	12	30p, 29.97p, 25p, 24p, 23.98p	–
ST 425-1 (ST 274)	3G Level A (4)	1920 x 1080	4:2:2 (YCbCr)	12	60i, 59.94i, 50i 30p, 29.97p, 25p, 24p, 23.98p	–
ST 425-1 (ST 2048-2)	3G Level A (4)	2048 x 1080	4:2:2 (YCbCr) 4:2:2:4 (YCbCrA)	12	30p, 29.97p, 25p, 24p, 23.98p	–
ST 2081-10 M1, (ST 2036-1)	6G-2SI	3840 x 2160	4:2:2 (YCbCr)	10	30p, 29.97p, 25p, 24p, 23.98p	Yes
ST 2081-10 M1, (ST 2048-1)	6G-2SI	4096 x 2160	4:2:2 (YCbCr)	10	30p, 29.97p, 25p, 24p, 23.98p	Yes
ST 425-5 (ST 2036-1)	Quad-link 3G-A (1) 2SI,SQ	3840 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p	Yes
ST 425-5 (ST 2048-1)	Quad-link 3G-A (1) 2SI,SQ	4096 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p, 48p, 47.95p	Yes
ST 425-5 (ST 2036-1)	Quad-link 3G-B (1) 2SI,SQ	3840 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p	Yes
ST 425-5 (ST 2048-1)	Quad-link 3G-B (1) 2SI,SQ	4096 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p, 48p, 47.95p	Yes
ST 2081-11 M1, ST 425-5 (ST 2036-1)	Dual-link 6G-2SI (I)	3840 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p	Yes
ST 2081-11 M1, ST 425-5 (ST 2048-1)	Dual-link 6G-2SI (I)	4096 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p, 48p, 47.95p	Yes
ST 2082-10 M1, ST 425-5 (ST 2036-1)	12G-2SI (I)	3840 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p	Yes
ST 2082-10 M1, ST 425-5 (ST 2048-1)	12G-2SI (I)	4096 x 2160	4:2:2 (YCbCr)	10	60p, 59.94p, 50p, 48p, 47.95p	Yes