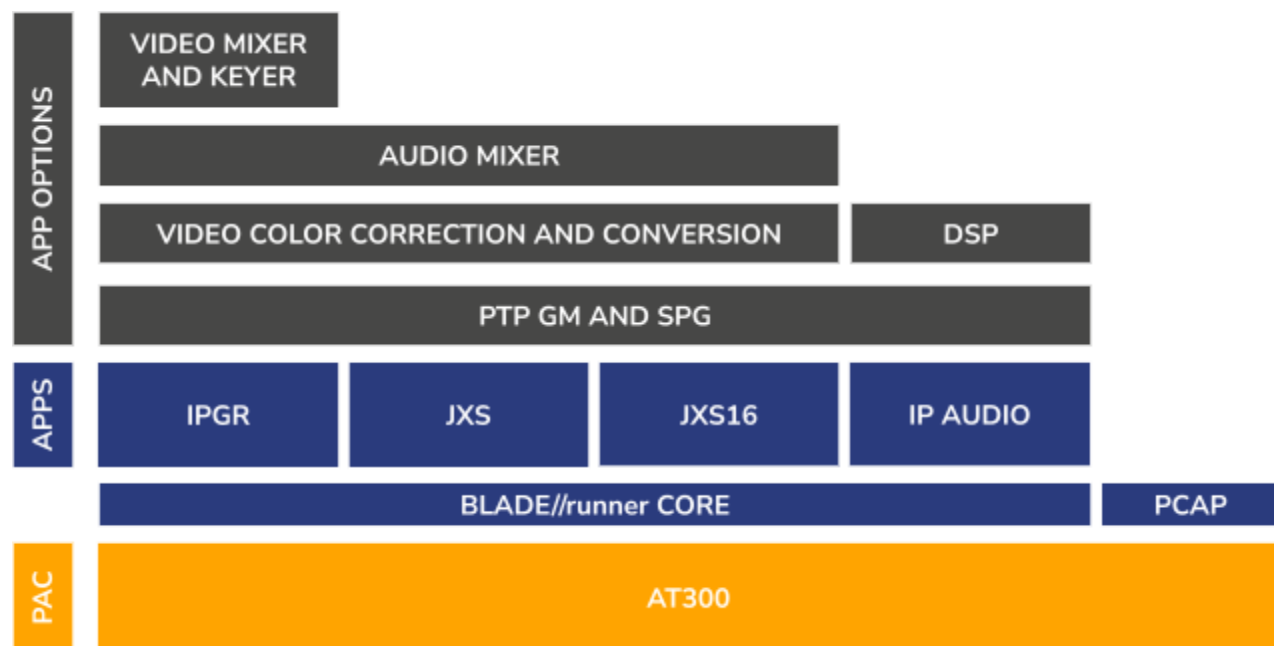


BLADE//runner SOFTWARE

BLADE//runner is arkona's product line of software applications and programmable acceleration cards which provide core infrastructure solutions for Tier-1 live broadcast productions.

BLADE//runner is a software defined ecosystem that offers multiple APPs that are tailored for different functionality. Each APP sits on top of a highly flexible and modular **CORE** framework that allows for the creation, control and deletion of all processing functions on-the-fly through an open API as well as through NMOS IS-04/-05. Some APPs have additional optional features.

The block diagram below shows the available APPs and associated options in the BLADE//runner ecosystem. An AT300 Programmable Acceleration Card (PAC) can run one APP at a time but APPs can be changed by rebooting the PAC. Each APP has one or more licensable options which are listed above each APP. For example the IPGR APP has four different software licensable options. Each option can run concurrently with any other options for that APP.



BLADE//runner architecture showing APPs available for the AT300 in blue and APP options in gray

BLADE//runner APPs

IP GATEWAY AND ROUTER APP (IPGR)

IPGR is a software APP for the AT300 PAC that provides a comprehensive audio, video and metadata framework for encapsulation/de-encapsulation, routing and delay/sync of IP and SDI. In addition to the AT300's native dual 100GE IP network interfaces, SDI and MADI I/O are available when using one of the micro-BNC rear-modules thereby providing direct access to legacy baseband infrastructures. IPGR also features test-signal and LTC insertion functionality.

JPEG-XS ENCODE / DECODE APPS (JXS & JXS16)

JXS and JXS16 are software applications for the AT300 PAC that provide 8 (JXS) or 16 (JXS16) instances of ST2110-22 JPEG-XS codecs. The JXS APP can be configured as either 8 encode OR 8 decode, while the JXS16 APP can be configured as 16 encode OR 16 decode OR 8 encode + 8 decode. This configuration can be changed upon reboot. Each codec instance supports one UHD/FHD/HD signal for a max of 16 x UHD.

In addition the JXS app provides uncompressed gateway capabilities with 2110-20, -30/31 and -40 encapsulation/de-encapsulation as well as routing/shuffling and delay/sync capabilities.

IP AUDIO (IPA)

IPA is a software application for the AT300 PAC that provides a dedicated audio mixing, DSP and routing engine with over 16 thousand inputs. When combined with an appropriate rear-module it offers coax MADI I/O and/or WordClock reference outputs.

PACKET CAPTURE (PCAP)

PCAP is a software application for the AT300 PAC that permits PTP-timestamped packet capturing at wire speed (with a total capacity of 4GiB per 100G port), packet retransmission with configurable delay, jitter and packet loss, and timed replay of nanosecond-precision pcap files. PCAP is ideal for troubleshooting purposes and provided as a free APP for all BLADE//runner customers.

BLADE//runner **CORE** framework

BLADE//runner is built upon a **CORE** framework consisting of I/O, Routing, Processing, Delay and Sync features that are common across all APPs. Note that the IP Audio (IPA) APP does not support Video or Metadata sources.

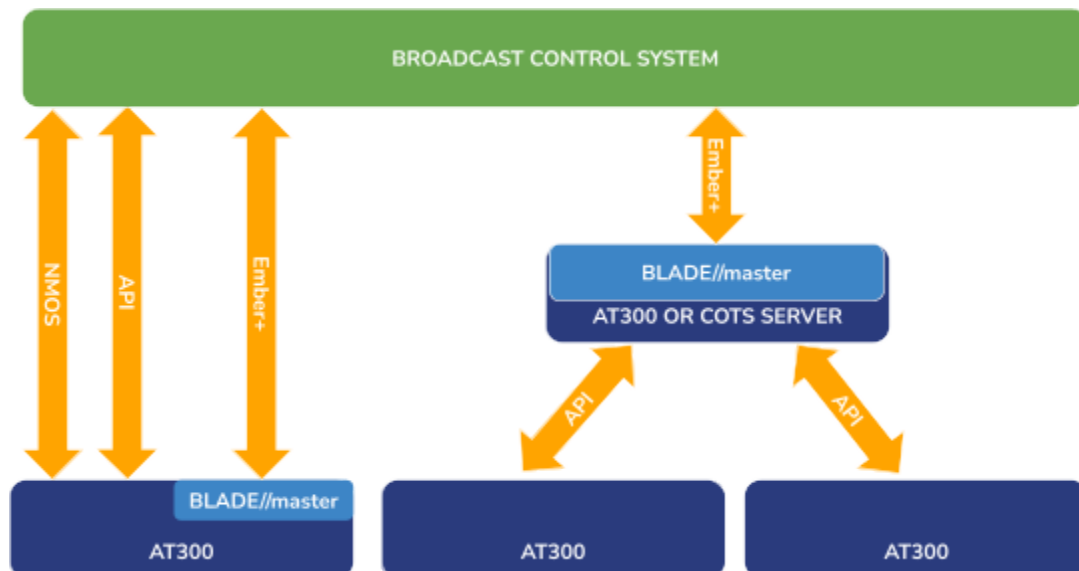
CORE CONTROL:

All BLADE//runner APPs are controlled by a modern and extensive JSON based API with which all parameters can be controlled and monitored. The API can be natively accessed with both WebSocket and REST. In addition all APPs support NMOS IS-04 and IS-05 for discovery and connection management.

BLADE//master

BLADE//master is a software service that runs on either a COTS server or on the AT300 PAC. With BLADE//master it is possible to expose a customizable subset of the feature set of any BLADE//runner software APP as an Ember+ parameter tree.

BLADE//master can be configured to expose the control of a single AT300 or a defined cluster of AT300s as a single instance. For example it is possible to present a group of AT300s to look like one homogenous video router that can perform clean & quiet switching. Multiple instances of BLADE//master can run concurrently to provide redundancy.



BLADE//master also comes with a crossbar GUI to easily route your sources and destinations plus a live view function to quickly inspect video streams.

CORE: I/O

The BLADE//runner **CORE** framework provides input/output functionality with instantiable ST2110 and ST2022 transmitters and receivers as well as interfacing to legacy infrastructure through modular rear-modules. All IP senders and receivers support ST2022-7 seamless protection switching with at least class C (150ms) path differential.

IP I/O:

VIDEO

ST-2110-20 (HD and UHD), ST2022-6 (SD and HD with embedded audio and ANC)
Encap/Decap latency: Less than 1 line

JPEG-XS

ST2110-22 (HD and UHD).
Available with the JXS and JXS16 APPs.
Compression configurable between 5:1 and 40:1.
Total Encoding-Decoding latency: Approximately 2 ms¹.

AUDIO

ST2110-30/31 Level CX (64 channel max per stream), ST2022-6 (with embedded video and ANC), AES67, RAVENNA (80 channel max per stream)
Payload: L16, L24, AM824
Encap/Decap latency: Synchronous operation < 2msec; bypass option

METADATA

ST2110-40, ST2022-6 (with embedded video and audio)

¹ Measured as a sum total of one encode plus one decode latency, not including path delay.

The following table shows the amount of IP senders and receivers per APP:

TX/RX INSTANCES PER APP	IPGR	JXS (8 x Encode Mode)	JXS (8 x Decode Mode)	JXS16 (16 x Encode Mode)	JXS16 (16 x Decode Mode)	JXS16 (8+8 mode)	IPA
2110-20/2022-6 - Uncompressed (UHD uses 2 instances)	36/32	30/32	30/32	16/32	30/32	24/32	0/0
2110-22 - JPEG-XS Encoders (UHD)	0	8	0	16	0	8	0
2110-22 - JPEG-XS Decoders (UHD)	0	0	8	0	16	8	0
2042 - VC2 (UHD uses 4 instances)	20/32	0/32	0/16	0/0	0/0	0/0	0/0
2110-30/31 - Audio	511/256	511/256	511/256	511/256	511/256	511/256	1022/1024
2110-40 - Metadata (UHD uses 2 instances)	32/32	30/32	30/32	16/32	30/32	24/32	0/0

Note:

An active 2110-22 encoder instance replaces one uncompressed 2110-20 TX instance.

An active 2110-22 decoder instance replaces one uncompressed 2110-20 RX instance, two if decoding JPEG-XS UHD streams.

SDI I/O:

16 x UHD inputs, 16 x UHD outputs. Limit dependent on rear-module configuration.

16/32 audio channels de-embedded from each input.

16/32 audio channels selectively embedded to each output from the audio matrix.

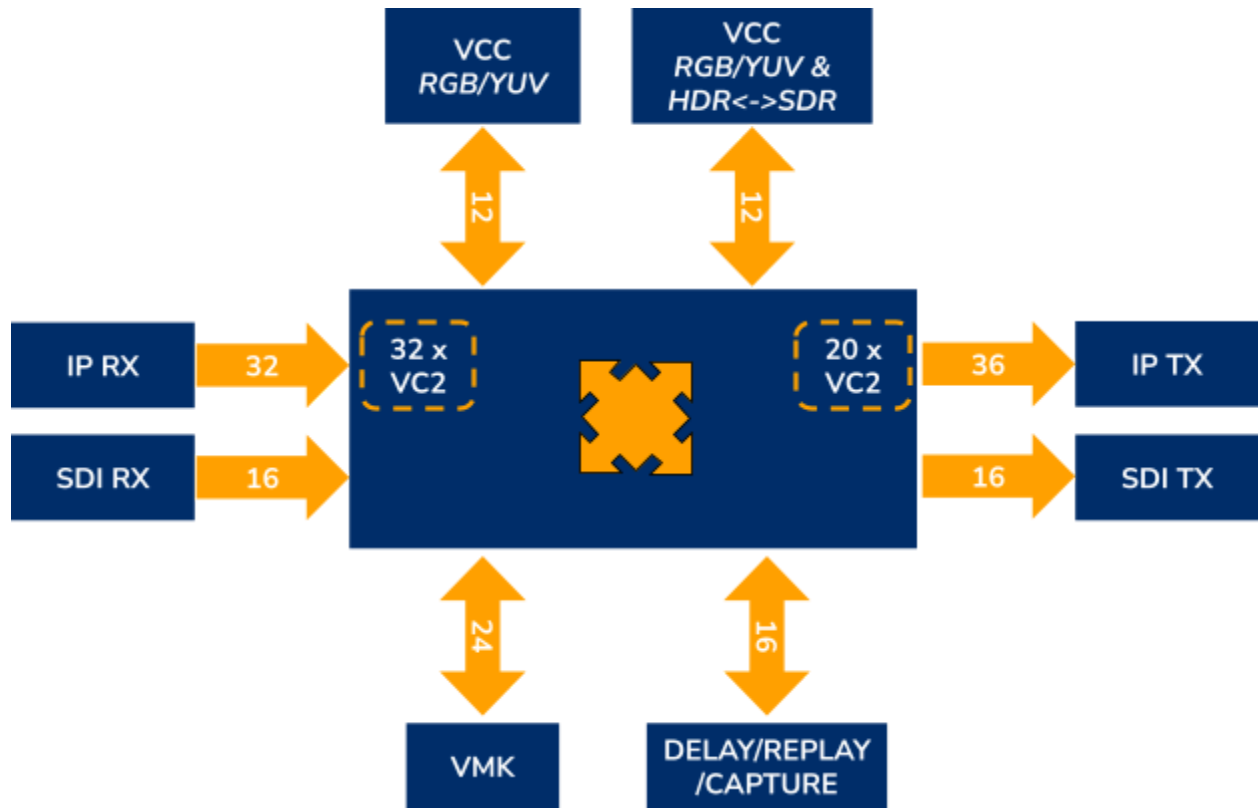
ATC (LTC, VITC1, VITC2), Binary group data, AFD, Audio Meta Data, Closed-Caption, VBI data services /DTV descr., DVB/SCTE VBI data, ANSI/SCTE104, OP47, OBS source-id

MADI I/O:

16 x inputs, 16 x outputs. Limit dependent on rear-module configuration.

CORE: ROUTING & PROCESSING

Routing & Processing is an inherent layer of all BLADE//runner apps that provide any-to-any routing of Video, Audio and Metadata between processing functions, such as color correction and video mixing, and I/O.



Any-to-any Video Routing of IGPR APP

All routing is “clean and quiet” with make-before-break (MBB) or break-before-make (BBM) configurable per video receiver. Audio routing and shuffling within the audio router is always done with crossfade while V-fade is used when an audio IP receiver changes source.

DELAY & SYNC

Delay and Sync is part of all BLADE//runner apps and provide Audio, Video and Metadata delay through routable instances using a shared memory pool. SDI frame sync and UHD single-link to quad-link conversion is available on all input interfaces when outfitted with an appropriate rear-module.

- Configurable audio and video delay instances using a shared memory pool with multiple outputs (readers) per delay instance allowing for playout at different times from the buffer. *(Example: A single delay instance with a 2 second total delay buffer utilizes 4 readers to play out the same content at a delay of 2s, 1.8s, 0.75s and 0.2s.)*
- Auto-alignment feature using ST2110 RTP information for audio/video/metadata alignment.
- Frame Sync for up to 16x SDI inputs when an optional rear-module is attached.
- UHD Single-link/Quad-link splitter (2SI) and merger (2SI/SQD) with automatic re-ordering based on identifiers.

VIDEO DELAY

16 instances of video delay using an 8GB shared memory pool (upgradeable to 16GB). Total delay is dependent on format/bitrate. Each video delay instance provides up to 10 outputs (readers) allowing for playout at different times.

Example max delay with the standard 8GB memory:

At 3G 1080p50 = 32 sec.

At 3G 1080p60 = 27 sec.

12G UHD would use 4 x the memory of 3G, while HD and SD use less.

AUDIO DELAY

256 instances of 16-channel audio delay each using up to 256MB from a 1GB shared memory pool. Each audio delay instance provides up to 16 outputs (readers) allowing for playout at different times.

Dolby-E alignment functionality is available for every audio delay instance.

Example max delay@ 48kHz for one instance = 42 sec, max 8 instances with max delay.

DELAY AND SYNC FEATURES PER APP	IPGR	JXS	JXS16 16 x Encode	JXS16 8+8 & 16 Decode	IPA
Video delay instances	16	16	0	16	0
Video delay memory pool. Standard (Optional)	8GB (16GB)	8GB (16GB)	8GB (16GB)		N/A
Video delay readers per instance	10	10	0	10	0
Audio delay instances	256	256	256	256	256
Audio delay memory pool	1GB	1GB	1GB	1GB	1GB
Audio delay readers per instance	16	16	16	16	16
Automatic A/V/M alignment based on RTP timestamps	YES	YES	YES	YES	N/A
DolbyE alignment	YES	YES	YES	YES	NO
SDI frame syncs	16	16			N/A

VIDEO STILL STORE PLAYER/GRABBER AND CLIP PLAYER

The BLADE//runner IPGR, JXS and JXS16 (16 x Decode and 8 Encode + 8 Decode) APPs provide the ability to do frame grabbing, still store playing and clip playing. In total there are 16 video writers and 24 video readers using a shared memory pool of 8GB (upgradeable to 16GB).

NOTE - Currently the JXS16 APP when configured in 16 x Encode mode does not have video player/grabber functionality.

A frame grabber instance requires 1 writer and 1 reader while a still store or clip player requires 1 reader. The frame grabber can have up to 10 outputs with different delays.

It is possible to mix and match players and grabbers.

FEATURE	WRITERS	READERS
Video clip/still store player requirement per instance	0	1 (UHD needs 2)
Video frame grabber requirement per instance	1 (UHD needs 2)	1 (UHD needs 2)
Total amount available per app	16	24

TEST-SIGNAL & LTC GENERATOR

The BLADE//runner IPGR and JXS APPs include 2 instances of test signal generators routable to any I/O as well as LTC time code generation.

OUTPUTS

Video: 100% color bar, counters, RP198.

Audio: Silence/1kHz/440Hz/400Hz (-6dB, -18dB,-20dB)

Time code generator/insert: Free run, SDI, PTP, LTC (dig. Audio) output.

CORE: AUDIO

BLADE//runner CORE audio provides mono routing and audio processing such as mixing, gain and sample rate conversion. The functionality differs between the IP AUDIO and the IPGR/JXS APPs as per below.

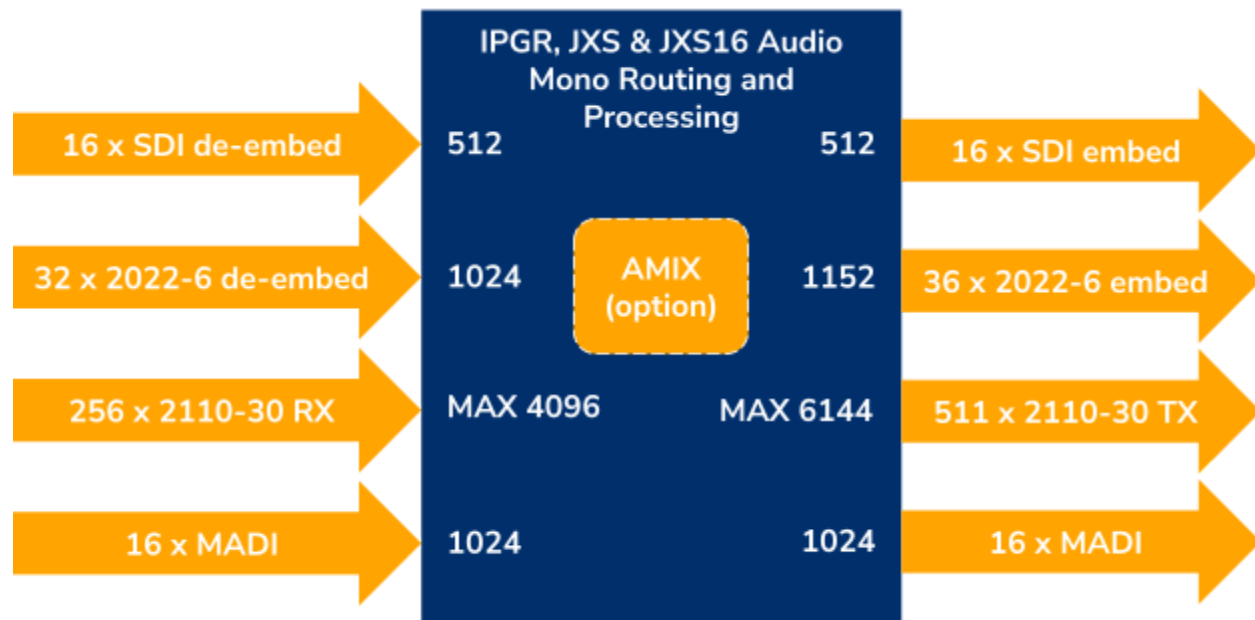
SAMPLE RATE CONVERTERS:

All BLADE//runner APPs provide routable instances of audio sample-rate converters. Each instance processes up to 16 mono channels of audio.

SRC INSTANCES PER APP	IPGR	JXS	JXS16	IPA
Sample-rate converters (16 channel)	72	48	48	240

AUDIO ROUTING AND PROCESSING FOR IPGR & JXS

The IPGR, JXS and JXS16 APPs provide a non-blocking audio router of about 6K x 8K mono channels, all individually routable. Furthermore, the optional AMIX feature adds additional mixing capabilities and is further described in the [APP OPTIONS](#) section below.



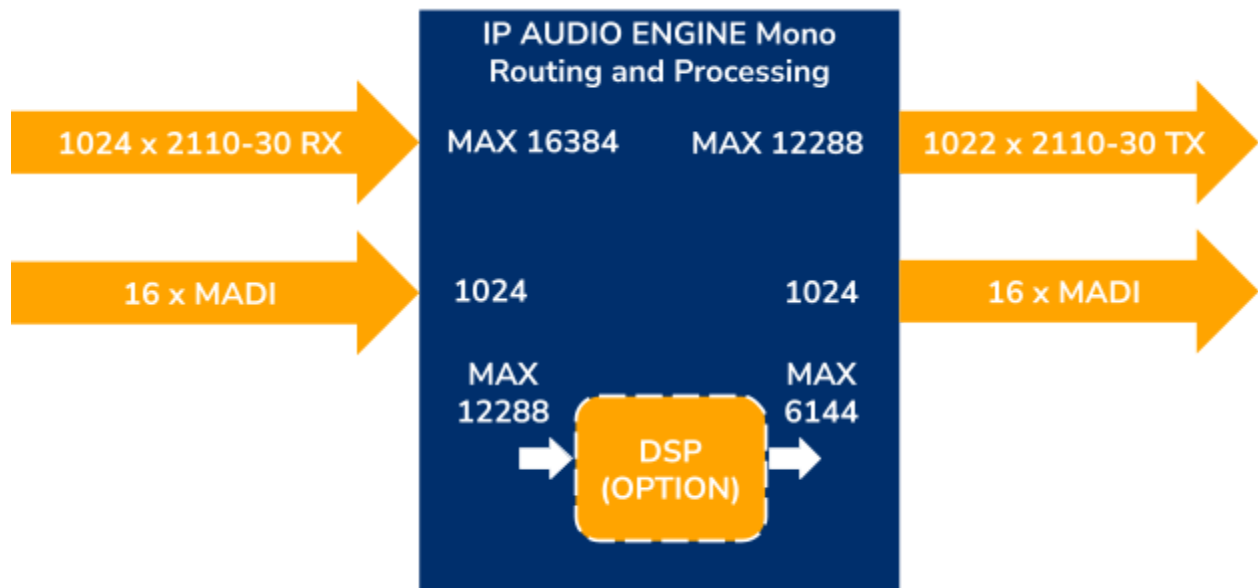
Mono routing capacity of the IPGR and JXS APPs

AUDIO ROUTING AND PROCESSING FOR THE IPA APP

The dedicated IP AUDIO (IPA) APP provides a massive 16k x 12k router with 12k channels of audio mixing and DSP functionality. IPA provides mono, stereo and mix-minus (N-1) mixing instances. In combination with the optional DSP software license it also provides dynamic compressors, equalizers and true peak and loudness metering.

All mixing and DSP instances can be cascaded/combined in any order without adding delay. Max delay from input to output is no more than 2 samples.

When combined with one of the optional micro-BNC rear-modules the IPA APP also supports MADI I/O.



Mono routing and processing capacity of the IPA APP

The following table describes the features and functionality of the IPA APP.

IP AUDIO APP FUNCTIONALITY	MAX INSTANCES	MAX INPUTS	FEATURE SET
Mix Minus (N-1)	32	256	Gain, Phase Invert, Mute, Solo, Post fader peak meters
Mono Mix	256	64	Gain, Phase Invert, Mute, Solo, Optional output Master Fader, Post fader peak meters
Stereo Mix	256	64 (mono or stereo)	Gain Phase invert (left/right output separate), Mute, Solo Pan/Balance with different laws selectable per fader, Optional output Master Fader Post fader peak meters
DSP OPTION FEATURES			
Dynamic Compression	1024	16	Side chain support for control from either true peak or Loudness (RMS) meters. Optional output gain adjust Attack/Release with hold option in either samples or time based Presets (soft knee, hard knee, ducking, gate or 8 point custom curve with linear or quadratic segments)
Effect Delay	1024	16	128K sample delay (2.7s @ 48KHz) per mono channel up to 16 delay taps (the product of channel taps must not exceed 80)
Multi-band Equalizer	2048	16	1 - 31 bands Total of 8192 IIR (biquad) stages (e.g. a 4-stage EQ needs 4)
True Peak Meter	512	16	Can be used as control input for compressor
Loudness Meter	1024	16	Configurable amount of front/surround channels Momentary (400ms), short term (3s) and gated loudness measurement (with active enable & reset button) Can be used as control input for a compressor. Option to disable K-weighting

APP OPTIONS

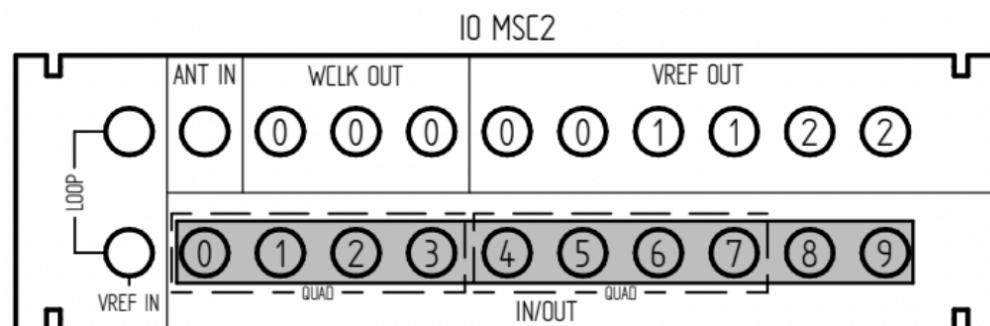
The following section describes the BLADE//runner options. Not all options are available for all APPs. See the infographic at the top of this datasheet.

PTP GRANDMASTER CLOCK & SYNC PULSE GENERATOR (GMC)

GMC is an option for all APPs that provide IEEE1588 PTPv2 GrandMaster functionality with support for the SMPTE 2059-2 and AES67 profiles allowing it to be the PTP GM for ST2110 networks.

Synchronization can either be derived from internal clock, GPS input, or external video reference (BB or Tri-Level). GMC supports up to 256 simultaneous PTP agents.

With the optional IO_MSC2 rear-module it also adds support for GPS/GLONASS antenna input as well as legacy reference outputs for Word Clock (3 outputs) and Black and Burst and Tri-Level video reference outputs (6 outputs in total which can have up to three different timing domains). In addition the IO_MSC2 provides 10 BNC connectors for UHD/3G/HD/SD or MADI which are configurable as IN or OUT.



The IO_MSC2 rear-module

IPGR - VIDEO MIXER & KEYER (VMK)

VMK is an option for the IPGR app that adds 24 routable instances of Mixer/Keyer functionality.

MIXER & KEYER

A/B mix or Luminance Key/Fill with configurable transitions. UHD uses 2 instances.

IPGR/JXS/JXS16 - VIDEO COLOR CORRECTION & CONVERSION (VCC)

VCC is an option for the IPGR and JXS APPs that provide additional routable instances of RGB/YUV color correction and SDR-HDR color space conversion.

COLOR CORRECTION

RGB color and ProcAmp (YUV) controls. UHD uses 2 instances.

Processing latency: < 100 pixels.

COLORSPACE CONVERSION SDR<->HDR

Broadcast quality colorspace conversion: SDR (BT609/709) to/from HDR (BT2020/2100) using tetrahedral interpolation with user loadable 3D LUTs.

FEATURE AND INSTANCES	IPGR	JXS & JXS16 (except 16 x encode)	JXS16 (16 x Encode)
Proc Amp	12	0	0
Colorspace conversion and Proc Amp	12	8	0

IPGR/JXS/JXS16 - AUDIO MIXER (AMIX)

AMIX is an option for the IPGR, JXS and JXS16 APPs that provide high quality floating point mono and stereo mixing as well as mix minus (N-1) functionality. The AMIX functionality supports up to 4096 inputs, 1024 outputs and 4096 faders. Any amount of mixers can be cascaded together in any order without incurring additional delay.

AMIX FUNCTIONALITY	MAX INSTANCES	MAX INPUTS PER INSTANCE	FEATURE SET
Mix Minus (N-1)	16	256 mono	Gain, Phase Invert, Mute, Solo
Mono Mix	64	64 mono	Gain, Phase Invert, Mute, Solo, Optional output Master Fader
Stereo Mix	64	64 stereo/mono	Gain, Phase invert (left/right output separate), Mute, Solo Pan/Balance with different laws selectable per fader, Optional output Master Fader

IPA - DIGITAL SIGNAL PROCESSING (DSP)

DSP is an option for the IPA app that adds dynamic compressors, equalizers and true peak and loudness metering. Please refer to the IPA APP description for details.

SUPPORTED VIDEO STANDARDS

UHD FORMATS

2160p 50;59.94;60Hz SMPTE ST-2082
2160p 30;29.97;25;24;23.98Hz SMPTE
ST-2081

HD FORMATS

1080p 60Hz SMPTE-424M, 425M Level A
1080p 59.94Hz SMPTE-424M,425M Level A
1080p 50Hz SMPTE-424M, 425M Level A
1080i 60Hz SMPTE-274M(4),-292M(D)
1080i 59.94Hz SMPTE-274M(5),-292M(E)
1080i 50Hz SMPTE-274M(6),-292M(F)
1080p 30Hz SMPTE-274M(7)-292M(G)
1080p 29.97Hz SMPTE-274M(8)-292M(H)
1080p 25Hz SMPTE-274M(9)-292M(I)
1080p 24Hz SMPTE-274M(10)-292M(J)
1080p 23.98Hz SMPTE-274M(11)-292M(K)
720p 60Hz SMPTE-296M(1),-292M(L)
720p 59.94Hz SMPTE-296M(2),-292M(M)
720p 50Hz SMPTE-296M(2),-292M(M)
720p 30Hz;29.97Hz;25Hz SMPTE-296M(2),
-292M(M)

SD FORMATS

576i 16:9 and 4:3 SMPTE-259M(C)
480i 16:9 and 4:3 SMPTE-259M(C)

DCI FORMATS

2048x1080 DCI p24 and sF25

COLORSPACE

REC 601, REC 709, REC 2020 / 2100