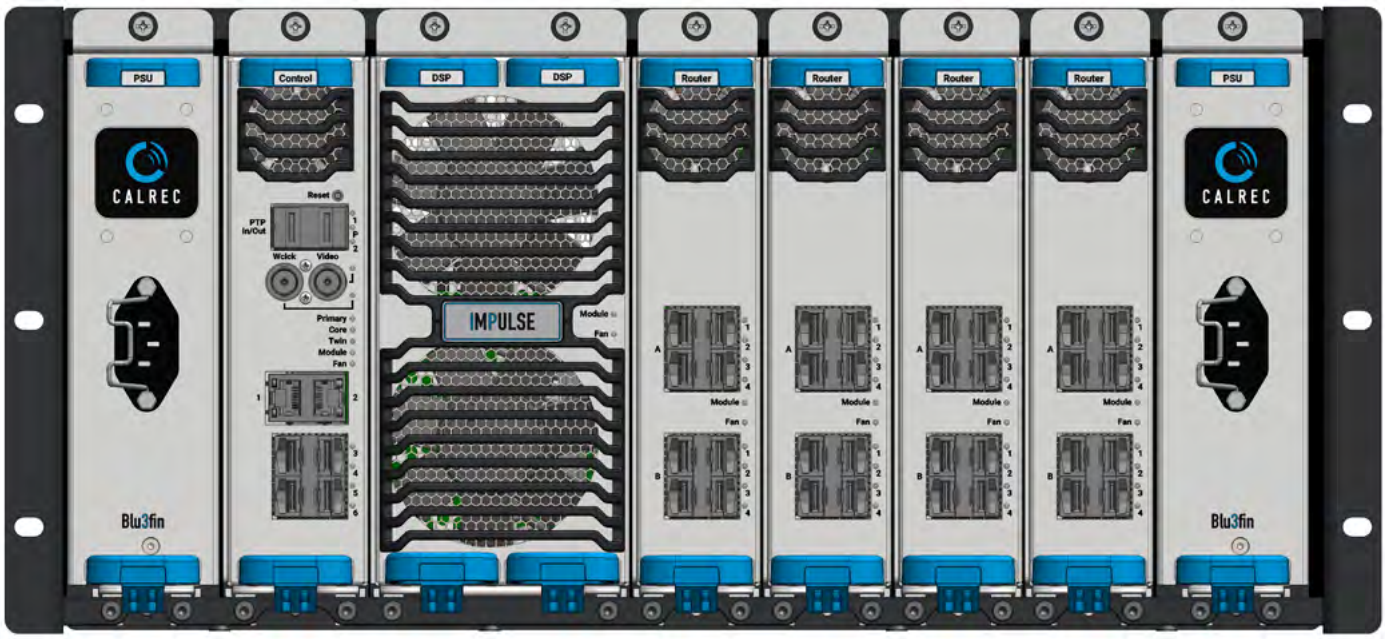
IMPULSE INSTALLATION MANUAL



IP Audio Routing & Mixing System

calrec.com

CALREC

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INFORMATION

Should you require any technical assistance with your Calrec product please contact your regional Calrec distributor. Customers within the UK or Ireland should contact Calrec directly.

For a complete list of worldwide distributors by region, go to www.calrec.com or contact us for more information.

Our UK customer support team works closely with our global distributor network to provide the highest level of after sales support. Your distributor should be your first point of contact and will often be able to provide an instant solution, be it technical advice, spares or a site visit by an engineer.

Product Warranty

A full list of our conditions and warranties relating to goods services is contained in Calrec's standard terms and conditions. A copy of this is available on request.

Repairs

If you need to return goods to Calrec for whatever reason, please contact your regional distributor, or Calrec customer support beforehand for guidance, as well as to log the details of the problem and receive a reference number.

For customers outside the UK and Ireland, shipping via the distributor saves customers from dealing with exportation paperwork. If there is a need to send direct to Calrec, contact us beforehand to log the incoming repair and for assistance with exportation documents.

Standard of Service

Ensuring the highest standards is a priority, if you have any comments on the level of service, product quality or documentation offered to you by Calrec, please contact the Calrec Customer Support team in the UK who will endeavour to address your issues. Calrec welcomes all customer feedback.

For feedback specific to this document, please contact enquiries@calrec.com.

Whenever you contact Calrec Customer Support please have the following information to hand:

- Name.
- Company.
- Email Address.
- Full details of enquiry (e.g. fault report).
- Serial number of faulty hardware (if applicable).

Once this information has been provided, a service ticket will be created to log your enquiry. The service ticket reference number will be given via email.

Serial Numbers

All units produced by Calrec are given a serial number and are booked into a central record system at the time of manufacture. These records are updated whenever a piece of hardware is dispatched to or received from a customer.

When contacting Calrec Customer Support with a hardware inquiry it is important that the correct Calrec serial number is provided to enable the customer support team to provide a high level of service. Serial numbers can be found on the label on each unit.

After Sales Modifications

Please be aware that any modifications other than those made or approved by Calrec Audio Limited or their agents, may invalidate the console's warranty. This includes changes to cabling provided by Calrec and variations to the recommended installation as detailed in Calrec documentation.

Modifications to this equipment by any party other than Calrec Audio Limited may invalidate EMC and safety features designed into the equipment. Calrec Audio Limited can not be liable for any legal proceedings or problems that may arise relating to such modifications.

If in doubt, please contact Calrec Audio Limited for guidance prior to commencing any modification work.

Telephone: (9:00am-5.30pm)	+44 (0) 1422 842159
Email - Technical:	support@calrec.com
Email - General:	enquiries@calrec.com
Postal Address:	Calrec Audio Ltd. Nutclough Mill, Hebden Bridge, West Yorkshire, HX7 8EZ, UK
Fax:	+44 (0) 1422 842159
Website:	www.calrec.com

Installation
In many installations the AC power connectors will not be readily accessible, effectively making the equipment permanently connected. The installation should be carried out in accordance with all applicable installation rules and regulations.

Service Personnel
The AC power disconnect devices are the 2 x IEC (IEC60320-1 C13/C14) couplers located at the rear of each unit. WARNING: The apparatus has a dual power system. It is essential that BOTH AC power IEC couplers are disconnected to prevent exposure to hazardous voltage within the unit.

Third Party Equipment
Integrating third party equipment into a Calrec system may compromise the product's ability to comply with the radiated emission limits set in the latest EMC (Electro Magnetic Compatibility) standard.

Calrec Audio Limited can not be responsible for any non-conformities due to use of third party equipment. If in doubt, please contact Calrec Audio Limited for guidance prior to integrating any third party equipment.

ESD (Static) Handling Procedures
In its completed form, this equipment has been designed to have a high level of immunity to static discharges. However, when handling individual boards and modules, many highly static sensitive parts are exposed. In order to protect these devices from damage and to protect your warranty, please observe static handling procedures, for example, use an appropriately grounded anti-static wrist band.

All modules and modules should be returned to Calrec Audio Limited in anti-static wrapping. Calrec Audio Limited can supply anti-static wrapping upon request.

This applies particularly to digital products due to the types of devices and very small geometries used in their fabrication, analogue parts can, however, still be affected.

RoHS Legislation
In order to comply with European RoHS (Reduction of Hazardous Substances) legislation, Calrec PCB and cable assemblies are produced with lead-free (tin/copper/silver) solder instead of tin/lead solder.

In the unlikely event of a customer having to carry out any re-soldering on any Apollo, Artemis, Summa, Brio, RP1, TypeR, Hydra2 or ImPulse Core hardware, it is imperative that lead-free solder is used; contaminating lead-free solder with leaded solder is likely to have an adverse effect on the long-term reliability of the product. Circuit boards assembled with lead-free solder can be identified (in accordance with IPC/JEDEC standards) by a small oval logo (see below) on the top-side of the circuit board near the PCB reference number (8xx-xxx). The same logo is used on the connector hoods of soldered cable assemblies.

If in doubt, please check with a Calrec customer support engineer before carrying out any form of re-soldering.

ISO 9001 and RAB Registered
Calrec Audio Ltd has been issued the ISO9001: 2008 standard by the Governing Board of ISOQAR.

The award, for both UKAS and RAB registration (see below), is the most comprehensive of the ISO9000 international standards. Granted in recognition of excellence across design, development, manufacture and after-sales support, the certification follows a rigorous and thorough review of Calrec's internal and external communication and business procedures.

UKAS AND ANAB REGISTRATION

LEAD FREE

LEAD FREE STICKER

HEALTH AND SAFETY

Important Safety Instructions:

- Read these instructions.
- Keep these instructions.
- Heed all warnings.
- Follow all instructions.
- Do not use this apparatus near water.
- Do not block any ventilation openings.
- Install in accordance with the manufacturer's instructions.
- Do not install near any heat sources such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat.
- Protect the power cord from being walked on or pinched particularly at the plugs, convenience receptacles, and the point where they exit from the apparatus.
- Use only with the cart, stand, tripod, bracket, or table specified by the manufacturer, or sold with the apparatus. When a cart is used, use caution when moving the cart/ apparatus combination to avoid injury from tip-over.
- Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, such as power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.
- Warning: To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.
- Not intended for outdoor use.
- This equipment must be EARTHED.
- Caution - Shock Hazard
- Disconnect all power sources before starting any servicing operation, equipment must be isolated from the AC power supply. The disconnect devices are the 2 x IEC connectors (IEC 60320-1 C13/C14 couplers).
- Do not leave the equipment powered up with the dust cover fitted.

Cleaning

For cleaning the front panels of the equipment we recommend using a soft anti-static cloth, lightly dampened with water if required.

Explanation of Warning Symbols

Triangular warning symbols contain a black symbol on a yellow background, surrounded by a black border.

The lightning flash with arrow head symbol within an equilateral triangle, as shown on this page, is intended to alert the user to the presence of dangerous voltages and energy levels within the product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock or injury.

The exclamation mark within an equilateral triangle, as shown on this page, is intended to prompt the user to refer to important operating or maintenance instructions in the documentation supplied with the product.

The altitude warning symbol indicates that the equipment is to be used at an altitude not exceeding 2000m.

The multiple power sources symbol indicates that more than 1 power source is connected and that all power sources should be disconnected before servicing.

Earthing

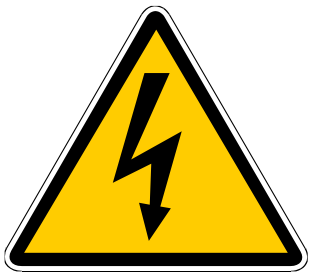
This is a Class I product. An Earth connection MUST be provided in each AC power cord.

The Earth Bolt connection at the rear of the core is provided for those users who wish to have a separate ground/ earth connection using Earth cable at least 6 mm^2 in cross section (10 AWG), this connection is optional and is NOT a requirement to comply with safety standards.

Lithium Battery Replacement

Caution: Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type. Batteries must not be exposed to excessive heat such as sunshine, fire or the like.

DANGEROUS VOLTAGES



IMPORTANT INSTRUCTIONS

ALTITUDE WARNING SYMBOL

MULTIPLE POWER SOURCES SYMBOL

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

IMPULSE ELEMENTS

There are a number of options when ordering ImPulse Systems: for User Interfaces and I/O options.

The ImPulse System consists of a 5U ED6534 Rack Assembly with a HN6412 Backplane. Into this backplane are plugged the following modules:- 2 x ZN6430 Impulse PSU Modules, 1 x UN6426 Impulse Control Processor & Sync Module, 1 x UD6415 Impulse DSP Carrier Module which can contain up to 4 x SD6416 DSP Mezzanine modules and up to 4 x RY6427 Impulse AoIP Router modules. Note if fewer router modules are fitted then the remaining gaps are fitted with a NN6527 Blank panel

	Surface, Applications and Impulse Core
Surfaces and Applications	Impulse Cores can be connected to a number of Calrec Control Surfaces and/or be controlled via the various Calrec GUI applications such as Assist, Configure & Connect which are provided to run on a configuration computer optionally supplied by Calrec or provided by the customer, providing it meets the minimum specification.
Impulse Core	Power, Routers, Control Processor, and DSP are all self contained within the 5U Core unit which has two power supply units each with their own IEC connector to provide PSU redundancy. The core operates at 44.1, 48, & 96 kHz. A number of DSP packages are available for different configurations running on a core. These are listed in the Core DSP Pack Options section of this document.
Cabling	IEC mains cables are required for supplying power to the Impulse Core and each of the Optional I/O units. The Power cabling for any attached console surface is supplied separately with the surface.
	AoIP I/O packs
Impulse compatible I/O	The AoIP router interfaces all conform to AES67 and SMPTE ST2110-30 along with SMPTE ST2022-7 packet merging for seamless cable/network redundancy.
Calrec Optional I/O	There are a number of optional I/O units taken from the Hydra2 I/O range that are adapted for use with AoIP systems like the Impulse Core System by replacing the Hydra2 interface with an AoIP interface equivalent. For all Fixed Format I/O Boxes, the existing controller module SU6411 is replaced with an AoIP controller module SU6529, this allows the continued use of the AD5782, AD5781, AD5780, AE5743, AE5991, AE5992 Fixed Format Analogue I/O boxes and the JB5606, JB5783, JB5962 Fixed Format AES-3 Digital I/O boxes. For the Modular I/O Box, the Hydra2 UJ5836 controller module is replaced with an AoIP controller module UJ6429, this allows the continued use of all the existing Modular I/O module options. For further information on the available I/O for the existing console range, the Hydra2 Installation manual continues to provide full details of configuration and performance for each type. In addition to the above, there are 3 optional 1U high I/O box types that can be added to a system via the built in US6525 AoIP interface (with redundant Primary and Secondary connections) which are on the back of each I/O box: ▪ AD6501 Combo I/O unit which provides 4 AES Input ports with SRC indication, 4 AES Output ports, 8 channels of analogue mic/line input with 48v phantom power indication, 8 channels of analogue line level output, 6 GPI and 6 GPO ports and 2 Stereo headphone outputs. ▪ AD6502 Analogue I/O unit which provides 16 channels of analogue mic/line input with 48v phantom power indication, 16 channels of analogue line level output, 6 GPI and 6 GPO ports ▪ JD6503 AES I/O unit which provides 8 AES Input ports with SRC indication, 8 AES Output ports, 6 GPI and 6 GPO ports

IMPULSE
OVERVIEW

CALREC

OVERVIEW

The Impulse system is a next generation IP audio mixing processing and routing platform that can be controlled by Apollo and Artemis surfaces and/or via Web UI. Existing Apollo and Artemis surfaces will require a software upgrade to work with Impulse.

Features

- Modular and hugely scaleable DSP and Routing.
- Dual redundant power supplies to protect against internal and external power failure.
- Full hardware redundancy, provided by a complete secondary unit that can take over in the event of a critical failure.
- ST-2022-7 packet merging redundancy to protect against AoIP cable or network failure.
- PTP Slave and Master capability on dedicated redundant SFP interfaces for synchronising AoIP audio transport.
- Ability to use Legacy sync formats.
- Multiple SFP and RJ45 interfaces for Console, Calrec and third party control, redundancy link, debugging and system management.
- High bandwidth point to point backplane connectivity between all DSP and Router modules for very high channel count.
- High bandwidth control interfaces for low latency DSP and Router control.
- High bandwidth storage for fast memory recall.
- Flexible and engineer friendly low level hardware management system for controlling modules and subsystems.
- Robust thermal management system.
- Expandability.

IMPULSE
SYSTEM ELEMENTS

CALREC

SYSTEM INTERCONNECTS

External Interconnects
The external interconnects to the Impulse Core are as follows.

- Mains Power – The Impulse Core has two Mains PSU modules that plug into and supply DC power to the backplane and all the other core modules. One AC Mains IEC inlet is present on the face of each PSU module below. The Mains input is converted within the module to 12V and 5V DC power rails that are distributed via the backplane. A single PSU module is sufficient to power a fully populated system. The second power supply module is provisioned for redundancy. The PSU modules are plugged in at either end of the Impulse core unit, as shown below in slots 1 & 8.

- AoIP Ethernet Connections – Router modules provide up to 8 SFP Ethernet ports for connections to network infrastructure for audio transport. Each router module can be set to operate with 4 x ST-2022-7 pairs for 1Gbps interfaces or 1 pair for 10Gbps interfaces. It is intended that each pair of interfaces connects to two separate networks such that if any critical link in one network fails or an Ethernet packet is dropped, then packets will be received over the redundant network link, which allows uninterrupted or "hit-less" operation under fault conditions.

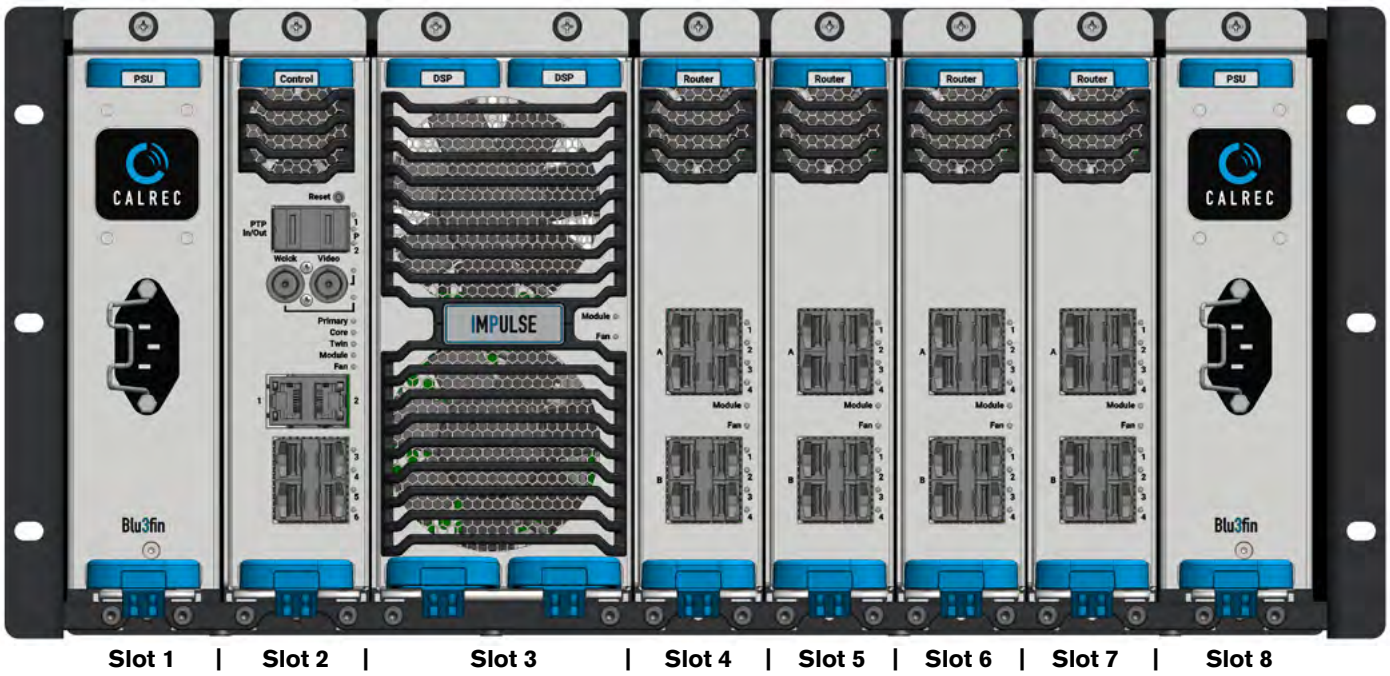
Up to four Router modules can be plugged into an Impulse Core allowing 4 pairs x 10Gbps redundant AoIP links or 16 pairs x 1Gbps redundant AoIP links or a combination thereof in total. The router modules are fitted between the Impulse DSP module and the right hand PSU module as shown below in slots 4-7.

- PTP Ethernet Connections – The Control Processor module provides two dedicated connections for PTP sync. At least one of these needs to be connected to the media network regardless of whether the core is acting as a PTP master or slave. In AoIP systems, the primary means of synchronisation is through Precision Time Protocol (PTP) synchronisation to a master clock source over the audio Ethernet network. A pair of 1Gbps SFP interfaces are provided on the module for redundant connection to two AoIP networks, either of which can be the source for PTP synchronisation.

- Legacy Sync Connections – In addition to the pair of Ethernet ports for PTP synchronisation, the Control processor Sync Subsystem provides a pair of BNC inputs for synchronisation to legacy Video and Wordclock sources. When an Impulse core is configured to act as a PTP master, it can free run or it can be made synchronous with one of these legacy sync inputs.

- Control Processor Ethernet Connections – The Control Processor modules also provide two RJ45 and four SFP interfaces. This provides Ethernet connectivity to control and management networks. These interfaces can assume different configurations for connectivity to different networks or for dedicated purposes. They provide connectivity to surfaces and also provide redundancy links to other Impulse cores. They may be configured to support third party control and monitoring protocols and will serve Assist, Connect and other Calrec control Web UIs over COTS network infrastructures. The Control Processor module is plugged into the Impulse core between the Impulse DSP module and the left hand PSU module as shown below in slot 2.

ED6534 IMPULSE CORE - FRONT VIEW



SYSTEM MODULES

System Module Overview
The major system modules of the Impulse Core are as follows:

▪ Control Processor Module – This carries the main host CPU, a powerful Intel processor for coordinating all of the functions of the Impulse system. It provides all processing for the Core and Console local and network control systems as well as control of the DSP and Router modules in the core. The Control Processor processor provides fast storage and network interfaces for rapid state changes and low latency control. The Control Processor module also provides the Impulse Core Sync Subsystem, which uses a dedicated network interface for PTP synchronisation (or BNCs for legacy inputs) to generate a timebase for synchronising audio transfer on the backplane. The Control Processor module contains 2 small fans:- one on the front and one on the base. The PTP, Legacy and Ethernet connections are all described in the system interconnects section.

Above the PTP connections in the Core Control Processor Module is a recessed reset button on the front panel (see right), which allows a two-level Core system reset. A short press and release of the reset button using a pointed object such as a paperclip will trigger the first level, “Short” reset, this acts as a reset of the Control Processor module only. If the button is held in the depressed position for at least 4 seconds, the second level, “Long” reset is triggered, which provides a system level reset signal is asserted as well. This signal is routed to the backplane connector striped across the Core backplane to provide a system level reset. This signal generally resets all Management Controllers and Power Sequencers in the core, thus causing a system-wide power re-sequence and system reset and initialisation.

UN6426 IMPULSE CONTROL PROCESSOR MODULE - FRONT VIEW

The Control Processor module also controls two fans, the first is mounted on the front of the module and the other is mounted in the base of the module. The ‘Fan’ LED shows the ‘Fan’ status, if the Fan LED lights solid Green this indicates that the Fans are OK, but if it lights Red this indicates a Fan failure. This status LED along with the other status LEDs are shown in the image on the left. The LED status function table on the next page describes the usage and behaviour of these LEDs. Note: this or any other failure within the core is also reported in the UI.

LED Status Table Reference Numbers

<-1 PTP port 1 active status
<-2 PTP sync status
<-3 PTP port 2 active status

<-4 Video Sync Status

<-5 Wordclock Sync Status

<-6 Acting as Primary Core
<-7 Core Status
<-8 Twinned Status
<-9 Module OK
<-10 Fan Ok

Standard RJ45 LEDs Not Controlled
RJ45-1 Active and Connected
RJ45-2 Active and Connected

<-11 SFP port 3 (left) activity

<-12 SFP port 4 (right) activity

<-13 SFP port 5 (left) activity

<-14 SFP port 6 (right) activity

The above numbers are referenced in the LED status table on the next page.

UN6426 IMPULSE CONTROL PROCESSOR MODULE - LED FUNCTION TABLE (FROM TOP TO BOTTOM)

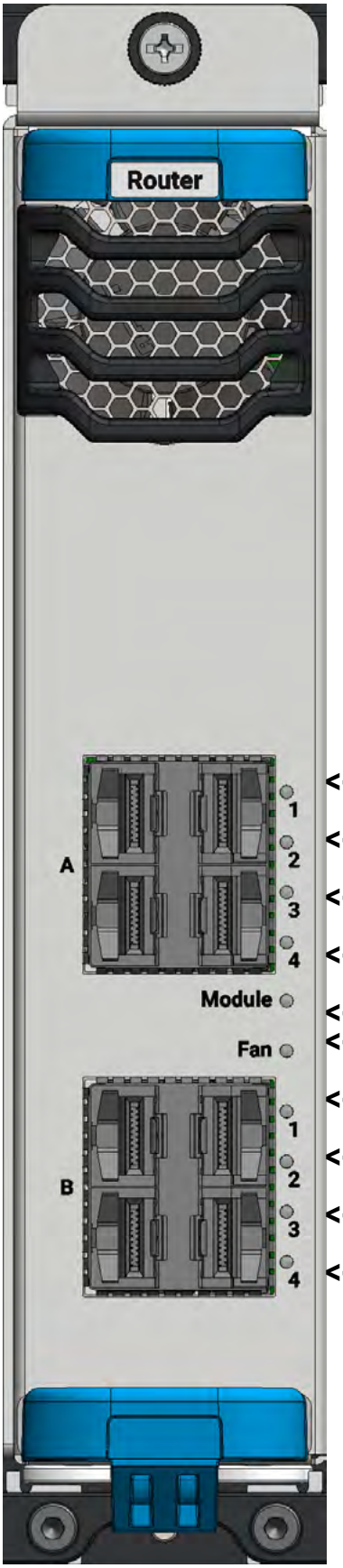
LED No	LED Label	LED Type	LED Function	LED Behaviour
1	1	Red / Green	PTP port 1 Active Status	Solid Green - Core locked to external PTP into port 2 Solid Red - No PTP activity on port 2 Solid Yellow - No ext PTP but PTP output from port 2 to external devices
2	P	Red / Green	PTP Sync Status	Solid Green - Core locked to external PTP Flashes Green - Core is in the process of locking to external PTP Solid Red - PTP system failure (no external or Internal PTP signal) Solid Yellow - If Core is PTP Master outputs PTP from both ports. If Core is PTP Slave it's failed to lock to an external PTP
3	2	Red / Green	PTP port 2 Active Status	Solid Green - Core locked to external PTP into port 2 Solid Red - No PTP activity on port 2 Solid Yellow - No ext PTP but PTP output from port 2 to external devices
4	Video	Red / Green	Video Sync Status	Solid Green - Core locked to this sync Solid Yellow - Core NOT locked to this sync which is in priority list Solid Red - Sync in priority list but not being received
5	Wclck	Red / Green	Wordclock Sync Status	Solid Green - Core locked to this sync Solid Yellow - Core NOT locked to this sync which is in priority list Solid Red - Sync in priority list but not being received
6	Primary	Green	Core acts as Primary Core	Solid Green - Core is configured to act as Primary Core
7	Core	Red / Green / Blue	Core Status	Flashes Green - Core OK and Active Flashes Yellow - Core OK and in Standby/Backup mode Solid Red - Core NOT OK
8	Twin	Red / Green / Blue	Twinned Status	Flashes Green - Twinned Core OK and Active Flashes Yellow - Twinned Core OK and in Standby/Backup mode Solid Red - Twinned Core NOT OK
9	Module	Red / Green / Blue	Module OK	Solid Green - Module OK Solid Red - Module NOT OK
10	Fan	Red / Green	Fan OK	Solid Green - All Fans on Module are OK Solid Red - Fan Failure on the module
RJ45-1	1	Green & Yellow	RJ45-1 Activity & Connected	Standard RJ45 LEDs (Not controlled from Core)
RJ45-2	2	Green & Yellow	RJ45-2 Activity & Connected	Standard RJ45 LEDs (Not controlled from Core)
11	3	Red / Green	SFP Port 3 (left) Activity	Flashes Green - Activity
12	4	Red / Green	SFP Port 4 (right) Activity	Flashes Green - Activity
13	5	Red / Green	SFP Port 5 (left) Activity	Flashes Green - Activity
14	6	Red / Green	SFP Port 6 (right) Activity	Flashes Green - Activity

▪ AoIP Router Module – This module can provide up to Eight 1Gbps Ethernet connections (Four redundant connections) or Two 10Gbps (One redundant) Ethernet connection via SFP modules for networked audio transport with other AoIP endpoints. The Router buffers and synchronises the audio data between these Ethernet interfaces and the backplane interface for transport to the DSP or another Router module.

The Router module also controls two fans the first is mounted on the front of the module and the other is mounted in the base of the module. Two LED indicators appear on the front of the module , one to show the 'Module OK' status. If the Module LED lights solid Green this indicates that the Module is OK, but if it lights solid Red this indicates that the Module is not OK.

The other LED shows the 'Fan' status, if the Fan LED lights solid Green this indicates that the Fans are OK, but if it lights Red this indicates a Fan failure.

RY6427 IMPULSE ROUTER MODULE - FRONT VIEW



Router LED Status Indicators

<-1 SFP port A1 (left) activity

<-2 SFP port A2 (right) activity

<-3 SFP port A3 (left) activity

<-4 SFP port A4 (right) activity

<-5 Module OK
<-6 Fan Ok

<-7 SFP port B1 (left) activity

<-8 SFP port B2 (right) activity

<-9 SFP port B3 (left) activity

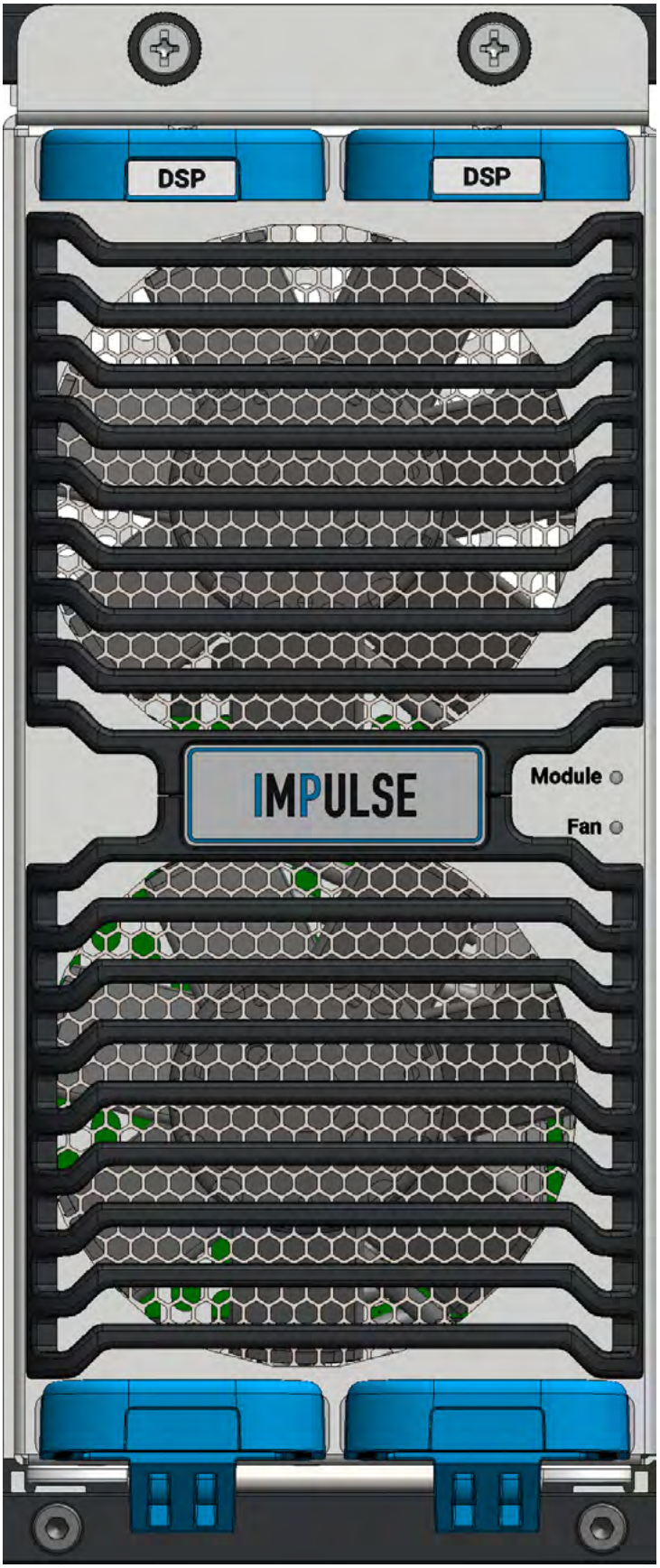
<-10 SFP port B4 (right) activity

▪ DSP Carrier Module – This module carries up to four DSP Mezzanine modules, which provide scalable DSP processing capacity. The carrier also provides high bandwidth interconnect between the Mezzanine modules as well as lower level management and power distribution. The module also controls the 2 large fans mounted on the front of the module. Two LED indicators appear on the front of the module , one to show the 'Module OK' status. If the Module LED lights solid Green this indicates that the Module is OK, but if it lights solid Red this indicates that the Module is not OK.

The other LED shows the 'Fan' status, if the Fan LED lights solid Green this indicates that the Fans are OK, but if it lights Red this indicates a Fan failure.

▪ Mezzanine DSP – The Mezzanine DSP module provides a hugely scalable DSP processing resource.

UD6415 IMPULSE DSP MODULE - FRONT VIEW



DSP LED Status Indicators

<-1 Module OK
<-2 Fan Ok

▪ PSU Module – The PSU module carries a 600W mains power converter and a small PSU module for producing a management sub-rail, control and status interfacing and backplane connectivity.

It is powered via an IEC Mains connector on the front of the module and operates and the Calrec Logo above it illuminates to show that the module has detected no faults and is providing the correct DC power rails required for operation.

Note the ZN6430 does not contain fans it uses the modules heatsink.

▪ Backplane – The Backplane module (not shown) provides interconnectivity between the above listed modules.
In particular, it provides high current power distribution, management and fan power distribution from up to two PSU modules. It provides low level, USB, 1Gbps Ethernet and PCIe control connectivity and also high bandwidth audio transport connectivity between the DSP Carrier or Router modules.

ZN6430 IMPULSE PSU MODULE - FRONT VIEW

PSU LED Status Indicator

<-1 Module OK (Logo Illuminates)

IMPULSE
CORE DSP PACK OPTIONS

CALREC

DSP PACK OPTIONS

The digital signal processing element of the Impulse core allows a combination of different 'Console Pack' sizes. It is designed to be flexible and provide sufficient processing for different consoles connected to an Impulse core.

DSP Pack Sizes
The Impulse Core has 5 DSP Packs available which can be installed on a DSP Mezzanine module available in the DSP Module.

These are roughly in line with the existing console range with additional channels/buses to cater for extra width and height options. See the next page in which the Console type determines the Mixer DSP pack size.

Note: The DSP packs no longer relate to physical surface size, the user can run a Light pack from an Apollo mixer for example, or an Apollo pack from an Artemis mixer. Apollo surfaces are still 160 fader max, Artemis are still 72 faders max, but you can use either with any DSP pack. DSP packs are shown on the next page as Input Channel counts.

CONSOLE COMPARISON

	Apollo+	Artemis Shine+	Artemis Ray+	Artemis Beam+	Artemis Light+
Physical Faders	Up to 160 (single or dual)	Up to 72	Up to 72	Up to 64	Up to 56
Input Channels	1122	768	512	384	256
Main Output Buses	Up to 16 from Main/ Group pool of 192 mono legs	Up to 16 from Main/ Group pool of 192 mono legs	Up to 16 from Main/ Group pool of 192 mono legs	Up to 16 from Main/ Group pool of 192 mono legs	Up to 16 from Main/ Group pool of 96 mono legs
Audio Group Buses	Up to 48 from Main/ Group pool of 192 mono legs	Up to 48 from Main/ Group pool of 128 mono legs	Up to 48 from Main/ Group pool of 128 mono legs	Up to 48 from Main/ Group pool of 128 mono legs	Up to 48 from Main/ Group pool of 72 mono legs
Track/IFB Output Buses	Up to 96 from a pool of 96 mono legs	Up to 64 from a pool of 64 mono legs	Up to 64 from a pool of 64 mono legs	Up to 64 from a pool of 64 mono legs	Up to 48 from a pool of 48 mono legs
Track/IFB Sends per Path	4	4	4	4	4
Aux Output Buses	Up to 48 from pool of 48 mono legs	Up to 32 from pool of 32 mono legs	Up to 32 from pool of 32 mono legs	Up to 32 from pool of 32 mono legs	Up to 32 from pool of 32 mono legs
Direct/ Mix-Minus Outputs per Channel/ Group	Up to 4 outputs from pool of 512 mono legs	Up to 4 outputs from pool of 512 mono legs	Up to 4 outputs from pool of 512 mono legs	Up to 4 outputs from pool of 512 mono legs	Up to 4 outputs from pool of 256 mono legs
Insert Send & Returns	Pool of 256 mono legs	Pool of 256 mono legs	Pool of 256 mono legs	Pool of 256 mono legs	Pool of 128 mono legs
EQ on Channels, Groups and Mains	6 full bands of parametric EQ/filters	6 full bands of parametric EQ/filters	6 full bands of parametric EQ/filters	6 full bands of parametric EQ/filters	6 full bands of parametric EQ/filters
Dynamics	2 x compressor/ limiters +1 x expander/gate per Channel, Group & Main	2 x compressor/ limiters +1 x expander/gate per Channel, Group & Main	2 x compressor/ limiters +1 x expander/gate per Channel, Group & Main	2 x compressor/ limiters +1 x expander/gate per Channel, Group & Main	2 x compressor/ limiters +1 x expander/gate per Channel, Group & Main
Input Delay	Up to 2.73s per input from pool of 256 mono legs	Up to 2.73s per input from pool of 256 mono legs	Up to 2.73s per input from pool of 128 mono legs	Up to 2.73s per input from pool of 128 mono legs	Up to 2.73s per input from pool of 128 mono legs
Path Delay	Up to 2.73s per path	Up to 2.73s per path	Up to 2.73s per path	Up to 2.73s per path	Up to 2.73s per path
Output Delay	Up to 2.73s per output from pool of 256 mono legs	Up to 2.73s per output from pool of 256 mono legs	Up to 2.73s per output from pool of 128 mono legs	Up to 2.73s per output from pool of 128 mono legs	Up to 2.73s per output from pool of 128 mono legs

IMPULSE
SFP CONNECTIVITY

CALREC

SFP - OVERVIEW

The connections between control surface and processing core, as well as all AoIP network connections, the connections between I/O boxes and routers, and router to router connections between different cores, are made via SFP modules (Small Form-factor Pluggable Gigabit Interface Converters).

SFPs can be provided for RJ45 copper connections, as well as for singlemode or multimode fibre on duplex LC connectors. This allows for each port's connection type to be chosen depending on the distance of the run or to match the infrastructure present. SFPs can easily be changed on a port by port basis as and when required.

The correct quantity of SFPs are supplied pre-fitted. The type of each connection - copper, singlemode fibre or multimode fibre, should be specified at the time of order to ensure the correct SFP types are supplied. Additional SFP modules can be ordered if required. If a system is to be connected to an existing Hydra2 network, please discuss this with your Calrec project leader, sales person or local distributor to ensure that SFPs are provided and ports provisioned for the additional router to router connections.

SFP MODULES

- Both SFP types above have a handle latching mechanism, shown in the locked position. The unit on the left is a singlemode duplex LC fibre module. The unit on the right is a copper RJ45 module.

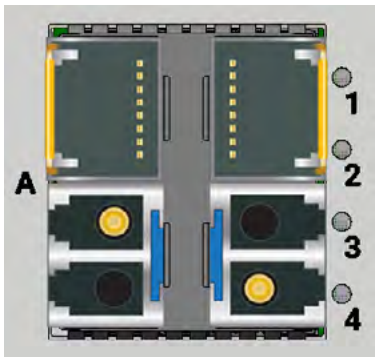
SFP slot orientation

SFP modules plug into front panel slots on control & router modules in the Impulse core and modular I/O controller modules, and rear panel slots on fixed format I/O boxes. The modules can be fitted or removed whilst the system is powered and without removing or opening any module or box cases.

Note the orientation of the SFP modules, as shown in the illustrations on this page - modules fitted in even numbered router ports 2 & 4 (right hand column) are fitted the opposite way around to those in the odd numbered router ports 1 & 3 (left hand column). Likewise for fixed format I/O boxes, the primary SFP module is the opposite way around to the secondary SFP module. The modules are orientated so that the release catch for the RJ45 / LC connector plugs once inserted into the SFP are on the outside edge.

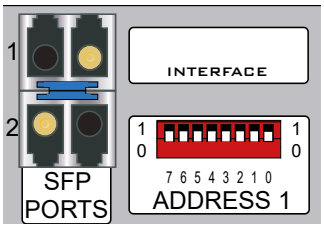
For modular I/O box controller modules, both SFP slots are orientated so that the release catch on the cable / fibre connector are on the same side.

ROUTER MODULE SFP ORIENTATION



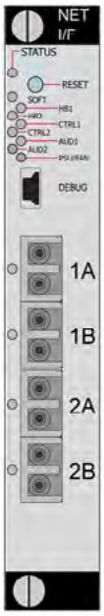
- Impulse Router module shown with copper SFPs fitted in ports A1 & A2 and singlemode fibre SFPs (button release type) fitted in ports A3 & A4.

FIXED FORMAT I/O BOX SFPS



- I/O box shown with singlemode fibre SFPs (button release) fitted.

MODULAR I/O BOX SFPS



- Modular I/O controller module SFPs are all orientated the same way around (Button release singlemode fibre SFPs shown).

SFP latching and extraction

Calrec source SFP modules from various manufacturers. All types used conform to the same specification, however the latching mechanism on them can vary slightly.

The standard copper SFPs and some fibre SFPs as shown in the photograph on the previous page have latch / extraction handles. On insertion, the handles should be set against the outer edge (the same side as the release catch on the RJ45 / LC connector plug that fits into the SFP) to lock it into place and prevent accidental removal if cables are pulled.

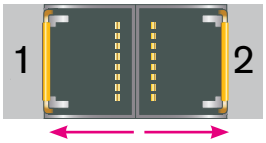
To remove this style of SFP, remove the cable / fibre and slide the handle (copper) or lift the handle out (fibre) to the inside edge position as shown in the diagram below. The module can then be removed by pulling on the handle.

Other SFPs automatically latch into place when they are inserted fully and have a release button on their inside edge. The fibre SFPs shown in the orientation diagrams and below are of this type and have blue release buttons. To remove, depress the button using a small flat blade screwdriver or similar tool. The SFP module will then be free to be removed.

SFP slot covers

Dust covers should be fitted to all SFP slots that do not have SFP modules fitted in them in order to maintain plug-in connection reliability.

SFP WITH HANDLES - LATCHED



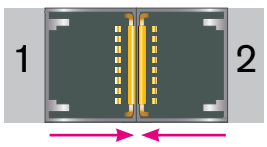
- Both SFPs shown are locked in place - Latch / extraction handles in outer position (or 'down' position for fibre).

Loose SFP storage

SFP modules are small, yet reasonably expensive devices. When removing or changing SFPs, take care to keep track of them and store loose modules in a clean, dry, and anti-static environment. Fibre SFPs should always have a dust cover fitted into their optical transceiver end when no fibre is connected to them.

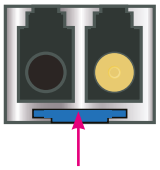
Calrec will not be liable for lost or missing SFP modules, or damage due to poor storage.

SFP WITH HANDLES - UNLATCHED



- Both SFPs free to remove - Latch / extraction handles in inner (or 'Lifted' for fibre) position.

AUTO-LATCHING SFP



- Depress the release button to remove.

SFP design varies depending on the manufacturer, please ensure that SFPs are correctly latched in place after fitting them. In the event that a connection is not automatically established after hot-plugging an SFP, please reset the unit the SFP is plugged in to.

COPPER SFP CONNECTIVITY

Network connections and control surface to processing core connections made via copper SFP modules require shielded F/UTP Category 5e or Category 6 cables with shielded RJ45 mating connectors.

Calrec do not supply these cables as it is often preferable to terminate them after they have been run through cable ducting to avoid damaging the terminations, and to be able to cut them to the precise length required.

Shielded cables and connectors

Shielded cabling and connectors are required in order to meet EMC (Electro-magnetic compatibility) standards to comply with the radiated emission limits set in the standard EN55022, as well as to guarantee performance in electrically noisy environments.

F/UTP Cat5e/Cat6 cable has an overall foil shield around the conductor cores. Shielded RJ45 connector plugs have a metallic shield around them which should be clamped / bonded to the shield within the cable. The shield on the connector mates with the chassis of the RJ45 socket that it is plugged into, providing an earth to the cable shield.

The method of attaching the connector shield to the cable shield can vary. Please refer to the connector manufacturer's information for further guidance.

SHIELDED RJ45 CONNECTOR

Conductive connector mating screen clamped / bonded to cable shield

Maximum cable length

The maximum length of Cat5e/Cat6 cables is 90m / 295ft. This is the absolute maximum and needs to include any patch points and cables that may be in the path. Hydra2 cable runs can NOT be extended using Ethernet switches, hubs or repeaters. If a run between Hydra2 hardware exceeds the maximum recommended distance for copper cabling, fibre and optical SFPs should be used instead.

Cable routing considerations

The layout and twist rate of the data cores within Cat5e/Cat6 cables are integral to their performance at high speed over distance. Poor installation practise can seriously impact upon this. The following are general good rules of practise, please refer to the cable manufacturer's information for comprehensive installation rules.

When running Cat5e / Cat6 network cabling, it is important to avoid kinking the cable. Kinks can seriously impair performance. Cable manufacturers advise that kinked cables should be dismoduleed and replaced as the damage caused cannot be addressed simply by straightening the outer appearance.

Cables should not be bent in tight angles, this too can seriously impair performance. Please refer to the cable manufacturer's specification on minimum bend radii.

Excessive pulling force when routing cables can deform the twist rate of the cable cores, causing irreparable damage. Cable manufacturers specify a maximum pulling tension.

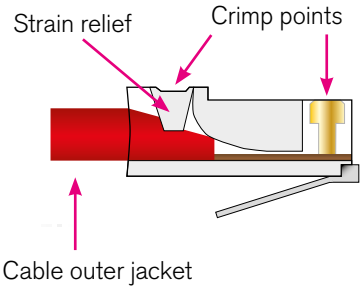
Cable-ties should not be over-tightened as this also deforms the internal structure of the cable. Cable ties should be tight enough only to support the cable weight but not so tight as to cause any visible deformation to the cable's outer jacket. Large, heavy bundles of cables can be difficult to support using cable-ties without causing damage. 'Velcro' style hook-and-loop cable straps can be a good alternative to plastic cable-ties.

Whilst neatly bundled parallel cable runs are tidy and aesthetically pleasing, they decrease cross-talk immunity which can impact on performance. Avoid neat bundling of network cables over any kind of distance - the majority of a cables length is normally unseen, running under floor or through ducting where they should be loosely laid rather than neatly bundled.

Termination - strain relief

Poor termination and lack of strain relief is one of the most common causes of high speed network cable problems. To properly strain relief the data cores, the outer jacket of the cable should be inserted into the RJ45 housing and held in place once crimped by the strain-relief point, as shown in the following diagram. This also maintains the integrity of the twist rate and shield into the termination,

STRAIN RELIEVED RJ45 TERMINATION



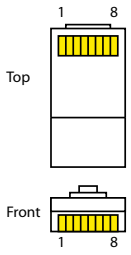
- Note, this is a simplified diagram that does not include the shield.

and therefore the full length of the cable conforms to its' intended specification. Slide on outer boots offer additional strain-relief protection but are not sufficient on their own. In order to be able to crimp the cable jacket inside the RJ45 and land the data cores on the terminals, the amount that the jacket is stripped back in relation to the cores needs to be quite accurate. Cables with exposed data cores should not be used as they will be unreliable.

Termination - pin-out

Network cables use the standard gigabit Ethernet pin-out. Performance relies on the positive and negative leg of each signal pair using cores that are twisted together. Calrec recommends that 'straight-through' or 'pin-for-pin' cables are used. 'Cross-over' style cables can be used, however they must be gigabit standard cross-over. Older pin-outs, designed for use with slower Ethernet standards only use two of the four pairs, even though all four pairs are terminated. Cross-over variants of this style only cross the pairs that are used (A & B). Gigabit cross-over cables require that the blue (C) pair is crossed with the brown (D) pair as well as the orange (A) pair being crossed with the blue (B) pair.

STANDARD RJ45 PIN-OUT



RJ45 PIN NUMBERING

Pin	Colour	Signal
1	Orange-White	A+
2	Orange	A -
3	Green-White	B+
4	Blue	C+
5	Blue-White	C -
6	Green	B -
7	Brown-White	D+
8	Brown	D -

- For standard wiring, both ends of the cable should be terminated as above

Testing / certification

Calrec strongly recommend that all network cabling is properly tested or certified prior to on-site commissioning of the system. Simple test devices that only check the pin-out of the terminations are not sufficient to prove the performance and reliability of high speed data cabling. Certification level test equipment can give a simple pass / fail response but in doing so will test various important factors as well as pin-out. Certification type tests include determining cable length, measuring skew (timing differences between pairings due to variations in length caused by intentional differences in twist rate), measuring for loss, signal to noise ratio and BERT error checking on data.

Cables that fail certification tests or fail to perform, may appear to function fine in other applications, such as a PC LAN connection where errors leading to retries and therefore delays are acceptable and often unnoticed.

Temporary / reusable cables

Cabling that is not part of a permanent infrastructure, such as temporary runs used for outside broadcasts should be carefully coiled and uncoiled to avoid kinking and they should be regularly tested. Cables showing any sign of damage should be replaced.

FIBRE SFP CONNECTIVITY

Optical SFP modules for fibre connectivity can be used for console to processing core, router to router, and router to I/O connections.

Fibre connectivity is required when the cable run between units exceeds the maximum permissible length for Cat5e/ Cat6 copper cabling. Fibre can also be used for shorter runs if it is simply the preferred medium.

Note that this section only concerns fibre connections made via SFPs. Like all I/O boxes, MADI units have pluggable SFPs for their connections to routers, but they also have fibre connectors that pass the actual MADI audio format in and out of the system. The MADI I/O format fibre connectors are of a fixed type which has no relation to SFP choice. Different build types of MADI I/O box are available to provide various types of MADI fibre interface. Please refer to the Hydra2 installation manual for more details on MADI I/O options.

Singlemode vs multimode SFP's

The core within multimode fibre is relatively thick when compared to singlemode. Light travels through multimode fibre at multiple angles, 'bouncing' of the sides of the core as it travels through it, taking multiple paths, or 'modes' of varying length from one end to the other, resulting in pulses being lengthened as they travel. Singlemode fibre has a very fine core and light travels in a single, direct path from one end to the other without affecting pulse length.

The result is that singlemode fibre has a higher bandwidth capacity and lower signal loss allowing much greater distances to be achieved. Light can be transmitted into multimode fibre using LED's or low powered lasers whilst singlemode uses a higher powered laser.

Bi-Directional SFP's

These SFP's use a simplex LC connector and operate by transmitting and receiving at 2 different frequencies down the same fibre in opposite directions. These have to be used in a Type A /Type B pair. Type A has a TX frequency of 1310nm and a RX frequency of 1550nm whilst its opposite uses a TX frequency of 1550nm and a RX frequency of 1310nm. Calrec recommend the use of singlemode fibre whenever possible in order to maximise the flexibility in the location of hardware and maintain uniformity across the system by using a single type. If a multimode infrastructure is in place, fibre length, the number of inter-connects and equipment location becomes important. SFP modules are available in bi-directional, singlemode and multimode fibre types. It is important to select the correct SFP for the type of fibre being used in the installation. If using a mixture of singlemode and multimode fibre, it is important to ensure the correct SFPs are matched to the correct fibre type.

Identification

The release button / handles of fibre SFPs are colour coded - Blue (TypeA) /Purple or Green (TypeB) for bi-directional, Blue for singlemode and Black for multimode.
Blue LC connectors, as shown below should be used to terminate singlemode fibre, and beige connectors for multimode.

Connectors / terminations

Calrec fibre bi-directional SFPs use simplex LC connectors whilst multimode and singlemode use duplex LC connectors. The duplex termination requires two fibres per connection, one is a send path, the other is a receive path. When terminating the fibre, the send from one end should connect to the receive of the other and therefore they are 'cross-over', terminated A to B & B to A.

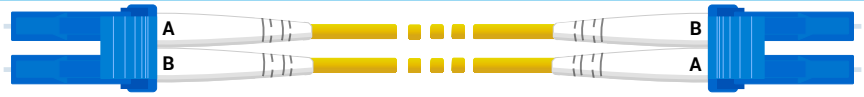
SFP / fibre specifications

Specifications are shown in the table below. The maximum distances shown assume a single point to point connection with no intermediary interconnections. Losses should be measured across the total signal path including interconnects - between points of transceiver connection. Losses need to be less than the optical power budget of the SFP transceivers.

FDDI SFP 491-254 (see table below)

This is a Bi-Directional SFP used for FDDI interfacing to the JM6199 MADI module.

DUPLEX LC FIBRES CORRECTLY TERMINATED A TO B & B TO A



BI-DIRECTIONAL LC FIBRE CORRECTLY TERMINATED TYPE A TO TYPE B

SFP COPPER/FIBRE SPECIFICATION TABLE

Part Number	Description /Cable Type	Type	TX Freq	RX Freq	Bale Colour	Max Dist	Connector Type	GBIC Type	Power Budget
491-194	SFP Module Copper CAT5/6	N/A	N/A	N/A	N/A	90m	RJ45	N/A	N/A
491-087	SFP Module Fibre Multimode 62.5/125um	N/A	850nm	850nm	Black	275m	LC Duplex	SX	7.5dB
As above	SFP Module Fibre Multimode 50/125um	N/A	850nm	850nm	Black	550m	LC Duplex	SX	7.5dB
491-072	SFP Module Fibre Singlemode 8/125um	N/A	1310nm	1310nm	Blue	10km	LC Duplex	LX	8.0dB
491-060	SFP Module Fibre Singlemode 8/125um	N/A	1310nm	1310nm	Blue	70km	LC Duplex	LH	23.0dB
491-195	SFP Module Fibre Bi-Directional 9/125um	A	1310nm	1550nm	Blue	10km	LC Simplex	LX	11.5dB
491-196	SFP Module Fibre Bi-Directional 9/125um	B	1550nm	1310nm	Purple	10km	LC Simplex	LX	11.5dB
491-201	SFP Module Fibre Bi-Directional 9/125um	A	1310nm	1550nm	Blue	40km	LC Simplex	LH	23.0dB
491-200	SFP Module Fibre Bi-Directional 9/125um	B	1550nm	1310nm	Green	40km	LC Simplex	LH	23.0dB
491-254	SFP Module Fibre FDDI Multimode 62.5/125um	FDDI	1310nm	1310nm	Black	2km	LC Duplex	SX	11.9dB

FIBRE – GENERAL RULES

Testing / certification
Calrec strongly recommends that all fibres are properly tested or certified prior to onsite commissioning of the system. A certain amount of signal loss occurs over the length of a fibre path. If the total loss of a path exceeds the optical power budget of the SFPs in use, the system will be unreliable.

Areas of loss
Signal loss occurs in various areas. Splice loss occurs in terminations - at the point where the fibre meets the connector. Typically splice loss should be <0.3dB per termination. Poor termination results in higher loss.

Connector loss occurs at the point where the connector meets the SFP / optical transceiver, or another connector, such as extension interconnects or patch-points. Connector loss should typically be <0.5dB per interconnect. Dust or other contamination between interconnects and scratches on the end surface contact point of the fibre will substantially increase the amount of loss. As such, dust covers should always be fitted to optical transceivers such as SFPs when no fibre is connected and to fibre connectors that are not landed.

As well as splice and connector loss, the fibre itself has inherent loss over distance, typically fibre loss will vary from 3.5dB per Km for multimode down to 0.4dB per Km for singlemode. Poor installation practise and lack of care can damage the fibre and result in substantially increased losses.

Fibre handling practise
It is important to follow the fibre manufacturer's guidelines when handling fibre and installing fibre runs. Some of the main points of concern are:

- Minimum bend radii - fibre should not be bent through too tight an angle. Tight angles can cause significant losses and permanent damage to the fibre. Fibres may pass initial installation testing but can fail at a later date due to stresses on the core of the fibre caused by tight bends.
- Twists, snags and kinks - Twists in fibre runs add stresses to the core which can cause damage over time. Avoid snagging on other cables or conduit which will cause excessive tensions when pulling and can cause kinks and excessive bends in the fibre. When routing through angled conduit, provide enough clearance around corners to avoid the fibres being pulled sharply around the inside of the angle.
- Pulling - observe the manufacturers maximum pulling tension specification. Use pulling tools and lubrication where appropriate. Never pull on the connector.
- Strain relief - fibres should be adequately strain relieved to prevent tension on terminations, however use of plastic cable ties can crush the internal construction of the cable. Hook-and-loop 'Velcro' straps are harder to over-tighten, offer more gentle support and a greater surface area to dissipate the pressure.
- Crushing - never place heavy items on top of unprotected fibre.

Ruggedised fibre
For temporary / re-usable fibre runs , or runs unprotected by conduit, fibre that is likely to be exposed to the elements, snagging or to being stood on, should always be of a ruggedised / armoured type to protect the internal construction of the core.

WARNING

Never look into the end of an optical transceiver or fibre when in use. Laser radiation can be harmful to the human eye and should be avoided.

Remember that when disconnecting a fibre, the transmitting device at the other end may still be active.

Cleaning and preventative maintenance

Contamination of transceiver and fibre mating contact points causes signal loss and can cause permanent damage by scratching.

Dust covers should be fitted to all fibre connectors and SFP optical transceivers when they are not mated. It is also important to ensure that dust covers themselves are kept clean.

When handling fibres without dust covers, do not allow the ends to come into contact with any surface, including fingers.

Specialist materials should be used for the cleaning of mating contact points to avoid further contamination or scratching. The following items are low cost and readily available from camera shops and laboratory suppliers:

- Canned compressed air - it is important to use specialist filtered, clean, dry air, free of contaminants and moisture.
- Isopropyl alcohol. Use with cotton swabs or lint-free wipes to ensure no residue is left.
- Lint free wipes / long fibre, low ash lens paper - needs to be free from chemical additives. Ensure wipes and swabs are stored in a clean environment and are not reused.

Cleaning fibre optic cables and connectors

There are multiple ways to clean fibre-optic cables and connectors.

Included below are some helpful tips to properly clean fibre optic cables.

- Do not allow the end of the fibre optic cable to make contact with any surface including fingers.
- Do not excessively bend the fibre cable. Bending the cable may cause internal breaks along the fibre resulting in poor performance or instability.
- Optics and optic coatings are easily chipped and/or scratched. Use of finger cots or powder free surgical gloves while handling fibre optic cables, will help ensure cleanliness.
- Only fresh (dry) spectroscopic grade Isopropyl Alcohol should be used as a cleaning solvent.
- Ensure that the module power is off and that other light sources are disabled.

Cleaning procedure

1. Blow the fibre surface with a stream of Clean Dry Air, this will dislodge larger loose particles.
2. Place 1-3 drops of spectroscopic grade Isopropyl Alcohol in the centre of a lens tissue.
3. Hold the fibre by the connector or cable, place the wet portion of the lens tissue on the optical surface and slowly drag it across.
4. Examine the surface of the fibre end under high intensity light using a direct magnifying inspection microscope or an indirect video inspection tool if available. If streaks or contaminants still remain, repeat the process using a fresh lens tissue.
5. Immediately install a protective cover over the end of the cable to avoid re-contamination or insert the fibre back into the previously cleaned receptacle for immediate use.

Additional notes

Do not tip the can of Clean Dry Air whilst aerosol spraying as liquid may be released contaminating the surface of the fibre.

Do not use lens paper dry as dry lens paper is extremely abrasive.

Do not use Acetone as a cleaning solvent on the fibre optical surfaces.

To ensure the purity of the Isopropyl Alcohol, do not insert the lens tissue, swabs, etc into the liquid, instead, drip the liquid on to the material.

Cleaning optical transceivers

The best way to clean a transceiver port is to remove particles using a stream of Clean Dry Air.

Included below are some helpful tips to properly clean fibre optic modules.

- Always handle optical SFP modules in an ESD safe manner using the proper safety precautions.
- Ensure that the module power is off and handle the modules with care.
- Always use Clean Dry Air or an approved canned compressed air supply.
- Always hold the can of compressed air upright. Tipping may release liquids into the air stream.
- Do not touch the inner surfaces of the module including the Optical Sub-Assemblies (OSA), or insert any foreign objects into the ports.
- Use of finger cots or powder free surgical gloves are not required but may be used for cleanliness.

Cleaning procedure

1. With the clean dry air, blow the inner barrel of the Transmitter and Receiver Optical Sub-Assemblies (OSA). This will dislodge loose particles.
2. Examine the surface of the OSA lens under high intensity light using the inspection microscope. If contaminants still remain, repeat the process.

Following these guidelines should provide a successful installation and ensure optimum reliability and system performance.

For further information or advice please feel free to contact Calrec.

IMPULSE
SYNCHRONISATION CONNECTIONS

CALREC

SYNCHRONISATION

Impulse Synchronisation sources.
The UN6426 Control Processor module provides the Impulse Core Sync Subsystem, which uses a dedicated network interface for PTP synchronisation (or BNCs for legacy inputs) to generate a timebase for synchronising audio transfer on the backplane. The sync system obtains an audio synchronisation source from the external AoIP network's PTPv2 clock via the 2 SFP connections on the front of the Control Processor module as shown right.
It also has two BNC connectors on its front panel for incoming legacy system synchronisation sources:

- 1 x TTL word clock input
- 1 x Video clock input

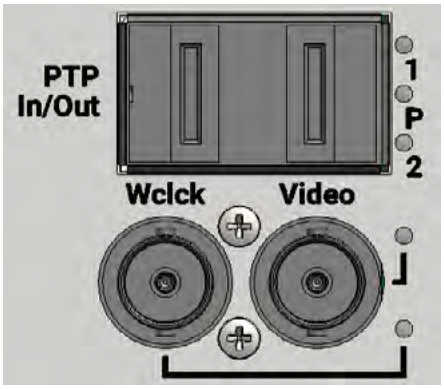
Impulse being an AoIP device requires PTPv2 sync. The core can act as a PTP master, or it can slave to an external PTP master, either way, at least one of the PTP connections on the Control Processor needs to be connected to the media network to exchange PTP data.

If the core is acting as master, it can either free run or use the Wordclock or video inputs to be synchronous with a legacy sync system

The firmware multiplexes these sources based on a prioritisation list and failover arrangement to select and lock-on to an active reference clock or switch to an alternative source if synchronisation is lost. The board also includes an on-board reference clock for use when neither the external AoIP clock or the legacy sync inputs are selected.

AoIP Clock
The IEEE 1588-2008 (PTPv2) standard for Precision Time Protocol (PTP) specifies a mechanism for synchronising multiple endpoints over an Ethernet IP network. With high end commercial off-the-shelf network switches & a well-managed network, sub-microsecond synchronisation between endpoints can be achieved.

SYNC INPUTS



PTP specifies that the network has a Grand Master Clock source, which is generally synchronised to a high precision real-time clock source such as GPS. The grand master clock transmits Ethernet packets to switches and endpoints across the network, which are returned to the clock source in order to measure round-trip delay.
An algorithm is used to calibrate the delay and synchronise the endpoint to the clock source.
If the grand master clock on a network fails, another algorithm is used to determine the next best clock source on the network, which is automatically nominated as the new grand master.

To synchronise all audio data transfers within the Impulse Core and audio transmission across the external network, a centralised PTP Synchronisation Subsystem is implemented on the Core Control Processor module.

This subsystem synchronises the Core to the PTP grand master clock through a pair of SFP connectors providing dedicated connections to primary and secondary AoIP networks. These SFP interfaces can only operate at 1Gbps, which is more than enough for the sparse PTP synchronisation traffic.

If the grand master clocks on the AoIP networks were to fail, it is possible for the Impulse Core to become grand master, synchronising AoIP network endpoints to an internal or legacy input clock source.

This is unlikely in practice as most networks will have backup grand master clocks that are ranked "better" in the best master clock decision algorithm.

The Control Processor Sync Subsystem generates a backplane clock signal with encoded sequence numbers in order to synchronise the Core Routers and DSP and to determine offset between IP packets to achieve coherence between samples transported on different Routers in the Core.

Legacy Sync Connections
The Sync Subsystem on the Control Processor module provides two BNC input connectors on the module front panel in addition to the SFP cages.

These BNC connectors are dedicated to legacy Video and Wordclock inputs for synchronisation. If a network grand master clock source is unavailable, it is possible to synchronise the Impulse Core to a legacy clock source transmitted as a video or wordclock signal.

In such a case, it may be possible for the Impulse Core Sync Subsystem to be promoted to grand master and generate PTP Ethernet packets to synchronise the AoIP network via the SFP interfaces described above.

The BNC inputs have an input impedance of 75 Ohms. The signals are buffered on the Control Processor module and the video input is passed through a sync-separator device to extract timing information. The logic level video clock and wordclock signals are processed within the Sync Subsystem to synthesise the local timebase.

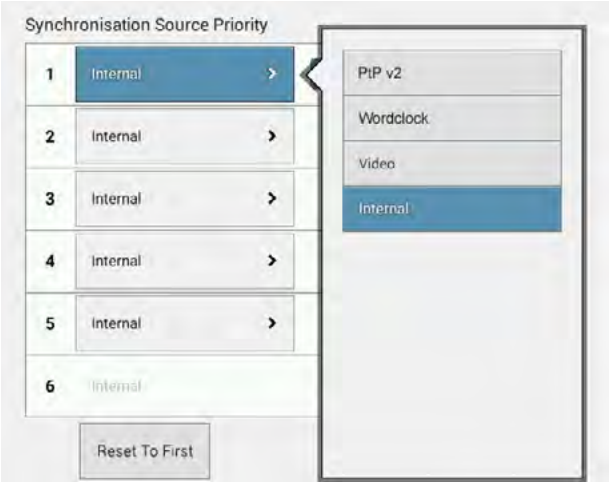
See the External sources table right and below for information on how to set up synchronisation priority.

The console will always attempt to boot to the highest priority sync selected, and move down the priority list until it finds a valid sync.

If a valid sync later fails, it will move down the list. If no valid sync is present, the system will always default to internal as this is fixed as the last source in the list. The priority will never automatically move back up the list even if a higher priority sync becomes available. Press the 'Reset To First' button to move back up to the top of the list.

It is important that the required sync source is available before the console boots up otherwise it won't be locked to the correct sync. If this occurs press the 'Reset to first' button after the sync generator is running.

EXTERNAL SOURCES TABLE



IMPULSE
SURFACE CONNECTIONS

CALREC

SURFACE TO CORE CONNECTION-APOLLO+/ARTEMIS+

A connection is required between the Control processor in the Impulse processing core and the Surface Switches inside the control surface.

These connections are via SFPs, the SFP type will be either fibre or copper, as requested at order depending on the distances and infrastructure involved.

Calrec do not provide these interconnecting fibres / cables as the length, type and quality will vary depending on the specific requirements of each installation.

Copper connections should be made using screened Cat5e or Cat6 cable. For more information on copper connections, SFPs and fibres, please see the Connection Types and Cat5e Cables sections.

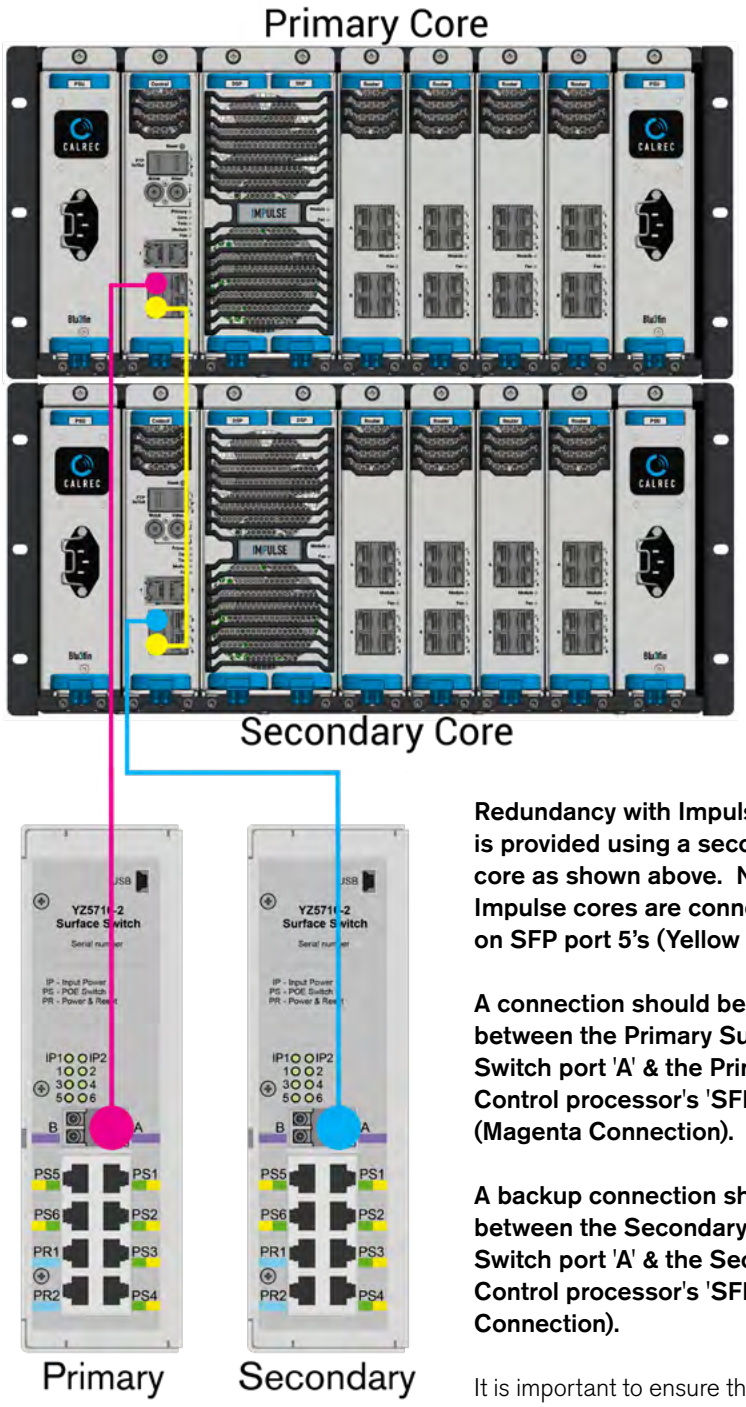
The illustration to the right shows the location of the connection on the impulse core and surface switches.

The two surface switches are located inside the control surface, mounted to the rear cover of the section containing the IEC mains power inlets. These can be accessed by removing the control surface panels and upstand meter panels in that area of the console.

The two surface switches should be easily identifiable on the rear cover. The left hand unit, when viewed from the front is the primary Surface Switch, the right hand unit is the secondary Surface Switch.

In the Impulse processing core, the Control Processor module has 6 connections on its front, 2 x RJ45 and 4 x SFP connectors. Typically the connection would be made to SFP port 3 for the Main Console and if a secondary surface or 'Sidecar' exists that would be on SFP port 4.

IMPULSE CORE TO CONSOLE SWITCH CONNECTIONS



Redundancy with Impulse Systems is provided using a second Impulse core as shown above. Note that the 2 Impulse cores are connected together on SFP port 5's (Yellow Connection).

A connection should be fitted between the Primary Surface Switch port 'A' & the Primary Core Control processor's 'SFP port 3' (Magenta Connection).

A backup connection should be fitted between the Secondary Surface Switch port 'A' & the Secondary Core Control processor's 'SFP port 3' (Cyan Connection).

It is important to ensure that these connections are made correctly - primary to primary and secondary to secondary, as well as using the correct ports.

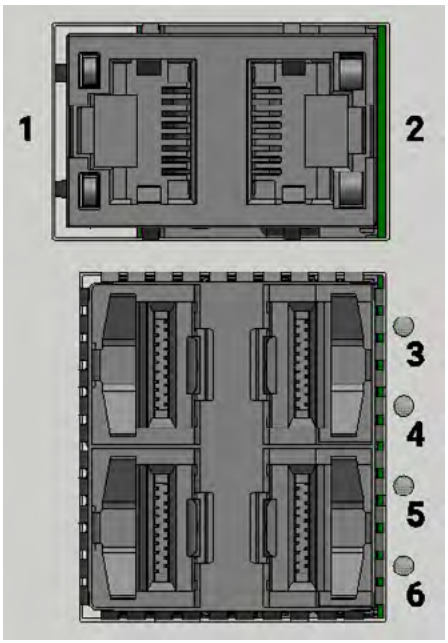
Note:- For Redundancy purposes, two Impulse cores are used, typically with SFP port 3 on the Control Processor module in the Primary Core being the main connection and SFP port 3 on the Control Processor module in the Secondary Core being the backup connection for the main console. If a 'sidecar' or secondary console is required this is connected in the same way as the main console via the Primary & Secondary SFP port 4's.

Control Port Connectivity

- "Misc control data" includes:- CSCP/SW-P-08/EMBER - 3rd party control such as Mosart.
- Misc control data can also include client PC Access to Calrec UI such as Configure, Connect and Assist apps.
- All misc control data can be aggregated (and/or extended) by connecting to IP switches, or it can instead be spread across the available connections on the Impulse controller modules if diversity is required.
- The connect server connections are made to the IP network for stream control. Note these can also be aggregated over the same ports on the Impulse core (but would need routing to the media networks).
- The link between the primary and backup Impulse cores can also be aggregated (and consoldated over the same misc control connections) if required.
- The Routing of data through the six connections on the front of the Control Processor module of the Impulse core provides very flexible interfacing.
- **The only limitation is that each Apollo+ or Artemis+ control surface requires its own dedicated connection to the impulse core.**

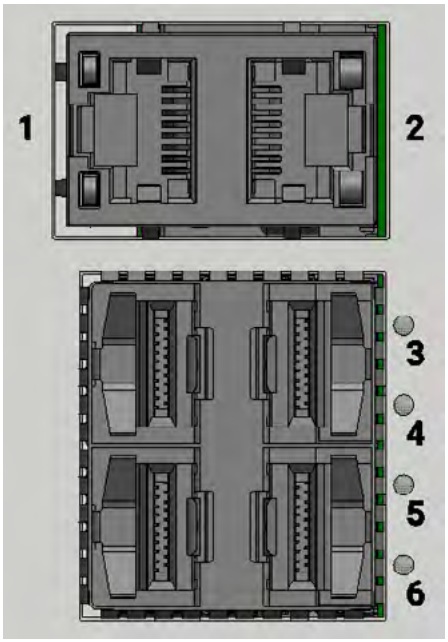
OTHER IMPULSE CORE CONNECTIVITY

Primary Impulse Core Control Processor module



Port 1	**RJ45**	**Misc Control Data**
Port2	**RJ45**	**Connect Server**
Port 3	**SFP**	**Surface #1 Primary Link**
Port 4	**SFP**	**Surface #2 Primary Link**
Port 5	**SFP**	**To Secondary Impulse Core**
Port 6	**SFP**	**Available for Other Connections**

Secondary Impulse Core Control Processor module



Port 1	**RJ45**	**Misc Control Data**
Port2	**RJ45**	**Connect Server**
Port 3	**SFP**	**Surface #1 Secondary Link**
Port 4	**SFP**	**Surface #2 Secondary Link**
Port 5	**SFP**	**To Primary Impulse Core**
Port 6	**SFP**	**Available for Other Connections**

IMPULSE
AOIP NETWORK CONNECTIONS

CALREC

DESIGNING AN AOIP/AES67 NETWORK

AoIP/AES67 network examples
The design of an AoIP/AES67 network will depend on the number of console Cores and IO Boxes the user wishes to connect to the network.

The following examples are provided to show the recommended connectivity for Impulse networked systems from a single Core system to larger multiple Core systems with Core redundancy.

These network example show the AoIP/AES67 audio connectivity.

Recommended third party equipment.
The following examples are based upon the use of the following third-party switches and clock;

1. Artel Quarra "1G" - 10 port (8+2), PTPv2/AES67 switch (Calrec part number 491-270)
   - 8 x 1Gbps RJ45.
   - 2 x SFP slots that can accept 1Gbps or 2.5Gbps modules.

   Note that the use of the 2 x SFP slots will require additional SFP modules which are not supplied with the switch.

2. Sonifex AVN-GMCS IEEE1588 PTP Grandmaster Clock with GPS Receiver (Calrec part number 491-268)

3. Cabling of networks can either be via copper RJ45 Cat5e shielded twisted pair (STP) cables, or for longer run lengths, using the SFP interfaces of the Quarra switches singlemode fibre may be used.

Switch and Network Configuration for AoIP / AES67 Networks
Below are shown some useful links for AoIP / AES67 network configuration

- Using ARG/Artel Quarra, PTPv2 aware switches (our recommendation for AoIP networks):

ARG Quarra PTP switch range

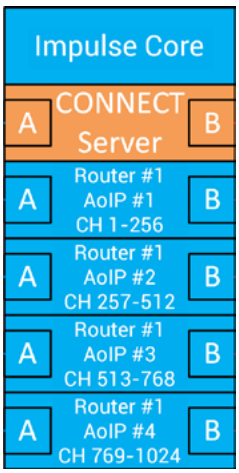
http://www.artel.com/media-transport-products/quarra

ARG Quarra Configuration Guide for AES67

http://www.artel.com/-/media/products-related/configguides/quarra-configuration-guides/quarra-configuration-guide-for-aes67.ashx?la=en

Key for example diagrams.

1. Impulse Core with Calrec **Connect** stream management server installed, 1 AoIP/AES67 Router Module fitted.



Connect stream manager connected to network via the network Core Control Processor connections.

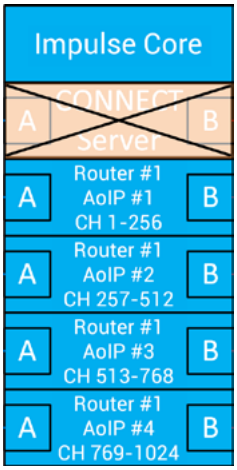
1st AoIP/AES67 Router Port on 1st Router Module

2nd AoIP/AES67 Router Port on 1st Router Module

3rd AoIP/AES67 Router Port on 1st Router Module

4th AoIP/AES67 Router Port on 1st Router Module

2. Impulse Core without Calrec **Connect** stream management server installed, 1 AoIP/AES67 Router module fitted.



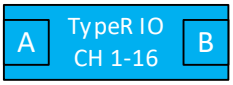
1st AoIP/AES67 Router Port on 1st Router Module

2nd AoIP/AES67 Router Port on 1st Router Module

3rd AoIP/AES67 Router Port on 1st Router Module

4th AoIP/AES67 Router Port on 1st Router Module

3.. IO Box (Example of AoIP IO box)



4. Connect stream manager installed on standalone Windows PC.

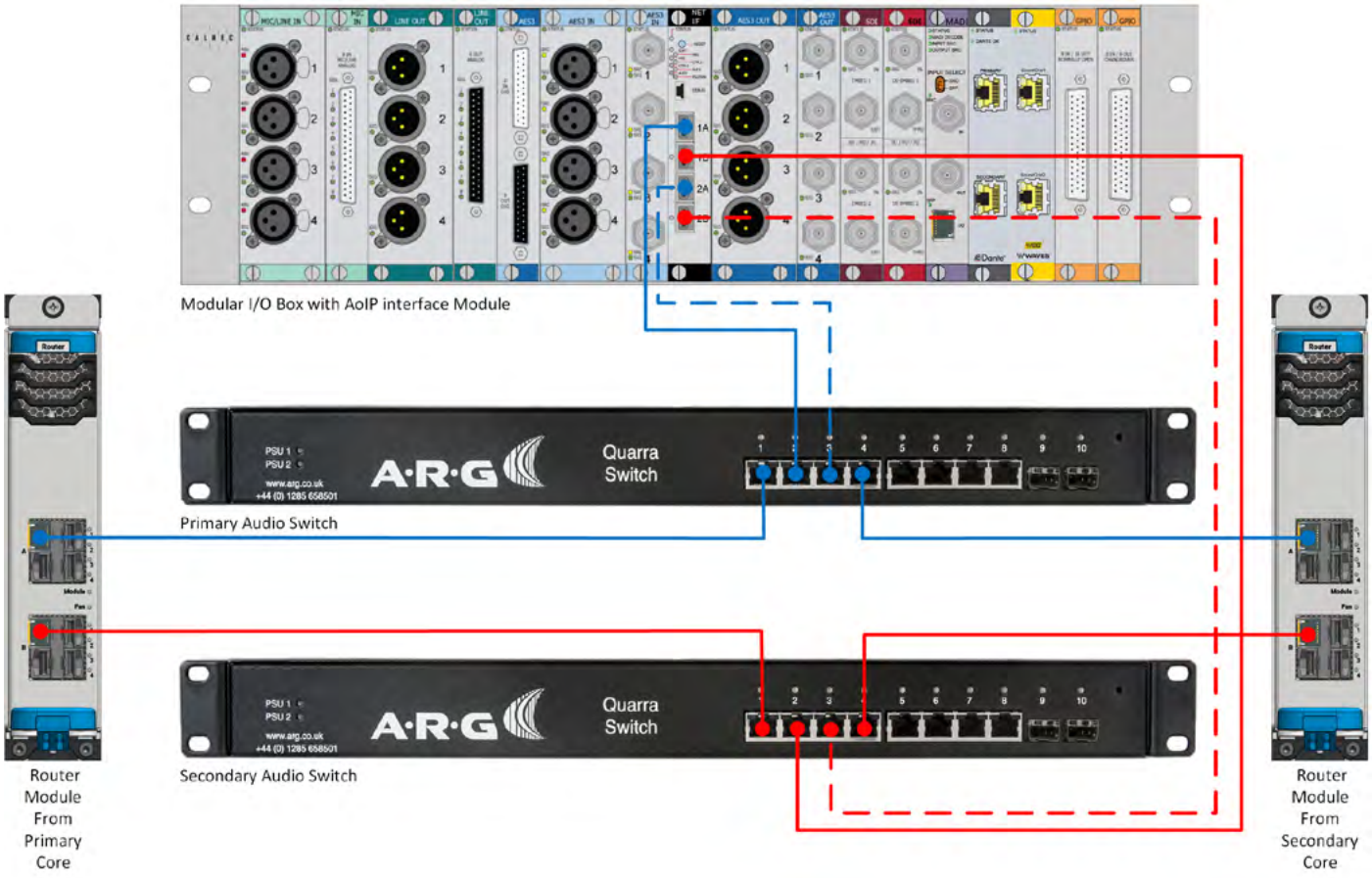
5. Connection reserved for network system administration and diagnostics.

Redundancy

Calrec AoIP products support network redundancy, meaning that each device has a pair of A and B AoIP network connections. It is not essential to have both connected, however it is recommended in order to provide resilience for network traffic. Both A and B connections can be passed over the same physical switching hardware, but to provide the best redundancy, it is recommended that A and B are passed over physically separate networks.

With AoIP redundancy based on ST2022-7, there is no real "primary" and "secondary" - devices are free to receive audio from either A or B networks seamlessly on a packet by packet basis. Impulse Core redundancy has a complete failover system, only one core of a redundant pair is truly active at a given time. For complete redundancy, both primary and secondary cores should each connect to both A and B audio networks. For a fully redundant connection to an AoIP I/O box the following topology should be implemented.

IMPULSE CORE TO MOD IO WITH AOIP INTERFACE MODULE



The Router module (above left) provides an A and B connection to the separate Quarra audio switches which allows seamless packet switching for up to 256 channels. The router on the left, is one of the four possible Routers in the Primary Impulse core. In order to provide full redundancy this connectivity is replicated on the Router on the right, which is one of the four possible routers in the Secondary Impulse core. The example above shows a connection from the Primary Quarra audio switch to the A or 1st connection of an AoIP I/O box and another connection from the Secondary Audio switch to the B or 2nd connection of the same AoIP I/O box. If for example the I/O box connected has 64 I/O channels, then the user can simply connect more I/O boxes to the audio switches until the chosen capacity limit on the router port is reached, at which point further connections to that router's other ports to the switches may be added to increase the available channel count/network bandwidth to meet the demand.

Switch Port Quantities
AoIP I/O boxes have an A/B pair of 1Gbps AoIP connections.

In addition to providing switch ports for each devices' Audio over IP connections, at least one switch port needs to be available on each AoIP network as a whole for a Connect server to communicate with devices on that network..

Typically, Connect will be served by an Impulse core via the Control Processor RJ45 port 2 connection. For redundancy, a backup Connect server should also be considered via the secondary Impulse core though having an active Connect server will not be an on-air critical requirement for many users who will have a fairly static network configuration. Impulse cores can be configured to act as Connect servers, but only one server is needed per network.

At least one spare additional AoIP network switch port should normally also be available on each network for System Administration, to allow engineers access to network and 3rd party device configuration and diagnostics.

Bandwidth, Inter-Switch Links and Larger Networks

Network topology and bandwidth management are impacted not just by the quantity, but also by the physical location of devices. Each copper Ethernet cable should be less than 100m total length (factoring in cable routing and looming, so often 90m is quoted). Fibre SFP ports or additional switch hops need to be used to extend the range beyond 100m.

Where switches are connected together, one should be mindful of the bandwidth available on the inter-switch links.
Multiple links can be fitted between switches as trunks to increase bandwidth (switches need to be appropriately configured to support such connections using LACP link aggregation), and many switches have a pair or more of SFP slots that are capable of higher bandwidth, intended to be used to connect to other switches.

On the 10 (8+2) port Quarra switches that Calrec currently use, 2 of the ports are SFP slots that can be fitted with either 1Gbps or 2.5Gbps SFP modules. Note that switches are not supplied with the SFP modules.

As a general rule of thumb for AoIP, audio traffic should not exceed roughly 60% of the capacity on a link.
This broadly equates to 256 channels of audio over a 1Gbps link. This is a somewhat conservative guideline, but it is a safe recommendation for critical live audio application such as broadcast.

Audio is not the only data being passed, even on a dedicated audio network there is still additional traffic. Higher channel counts can be achieved, but deterministic network conditions are required to successfully exceed the safe working recommendations.

Impulse Cores can pass up to 256 audio channels in either direction over each AoIP Router Interface connection.
Using 32 x 8 channel streams (at 32 bit / 48k / 125us packet time), the bandwidth consumption of audio for each port would be 554Mbps. If a further 32 x 8 channel streams are required, the overall audio consumption can potentially be more than 1Gbps. Under these conditions, adding a further connection from the Router Module to the PTP Switch increases the available bandwidth by a further 1Gbps by aggregating the links.

If large amounts of audio/data have to pass over a given network segment such as an inter-switch link, then higher bandwidth SFPs should be used for those segments (or multiple aggregated links can be employed). As an example of bandwidth usage Calrec's 1U AoIP I/O boxes have a single redundant pair of AoIP ports, capable of passing up to 64 channels of audio. As the largest 1U I/O boxes only have 16 channels of physical audio I/O ports, typical actual usage would be only 35Mbps. If required, audio bandwidth can be reduced by using a 1ms packet time (at the cost of increased latency), or by using 24 bit audio (sacrificing the additional headroom we provide for our mic inputs).

For larger networks with lots of switches, instead of daisy-chaining them together, they should connect via an additional switch, in order to limit the number of switches that data has to pass through to get from point A to point B, providing more uniform latency, and making bandwidth simpler to manage.

AoIP capacity in 1Gbps mode:

- Each router card provides 4 pairs of 2022-7 packet merging media NICs.
- Each NIC can send and receive up to 64 streams in each direction.
- Each stream can be configured to have up to 80 channels.
- In 1G mode, the limitation is on the bandwidth of the 4 x 1G NICs.
- General good practise with AoIP says media streams should not exceed around 60% of the bandwidth of the link:
  This generally equates to 256 channels per 1G, assuming a baseline config of 32 x 8 channel streams @ 125us packet time using an L24 codec @ 48k audio sample rate.
  Using higher channel count streams you can get more channels, e.g. . 6 x 80 channel streams + 1 x 32 channel streams = 512 channels in 625Mbps per NIC
  The rough 60% bandwidth utilisation figure can be pushed higher if you have a well-managed and deterministic network.

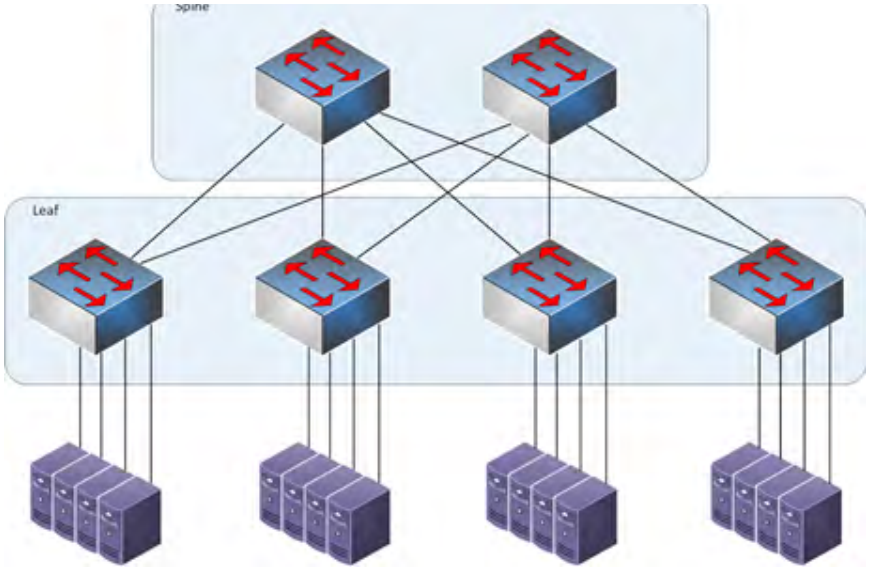
AoIP capacity in 10Gbps mode (available in a later release):

- Only one media NIC pair per router card is active.
- Each 10G NIC support up to 512 streams in each direction
- Again each stream can be up to 80 channels.
- In this mode of operation you can fully utilise the router with IP streams, e.g. 512 streams of 8 channels = 4096 = 7,270Mbps

Leaf and Spline Architecture

When scaling up, additional spine switches can be added. “Leaf and spine” topology is common for large scale media networks. “Leaf” switches provide connections to end-points and are interconnected by spine switches. Each leaf needs a connection to each spine.

The following diagram shows the architecture of a Leaf and Spline network.



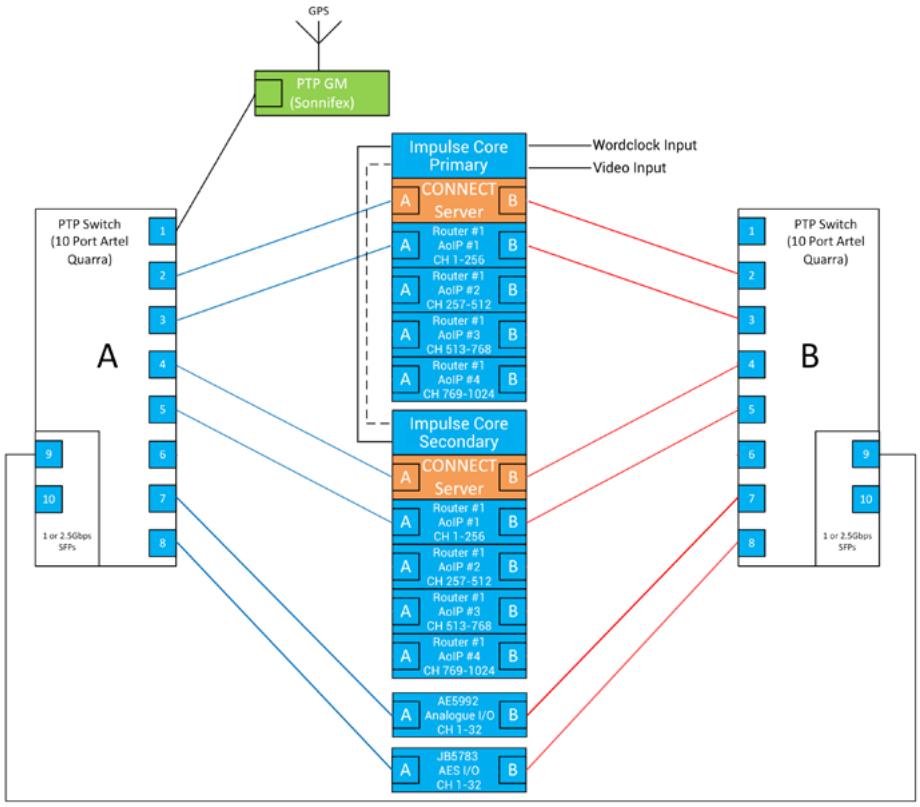
Switch Choice

Small AoIP dedicated networks with very low audio channel counts can use low cost switches, but almost all AES67 broadcast networks should use PTPv2 (IEEE1588-2008) aware switches such as the Quarra to guarantee timing.

In the following pages there are a number of topology examples showing the interconnection of the AoIP networks.

EXAMPLE 1: REDUNDANT IMPULSE CORE WITH 2 AOIP BOXES ON 2 REDUNDANT PTP SWITCHES

Redundant AoIP Connections	✓
Redundant AoIP Switch/es	✓
Redundant Core	✓
Connect server in Core	✓
Wordclock Input	✗
PTP Grand Master Clock	✓
Redundant PTP Grand Master Clock	✗

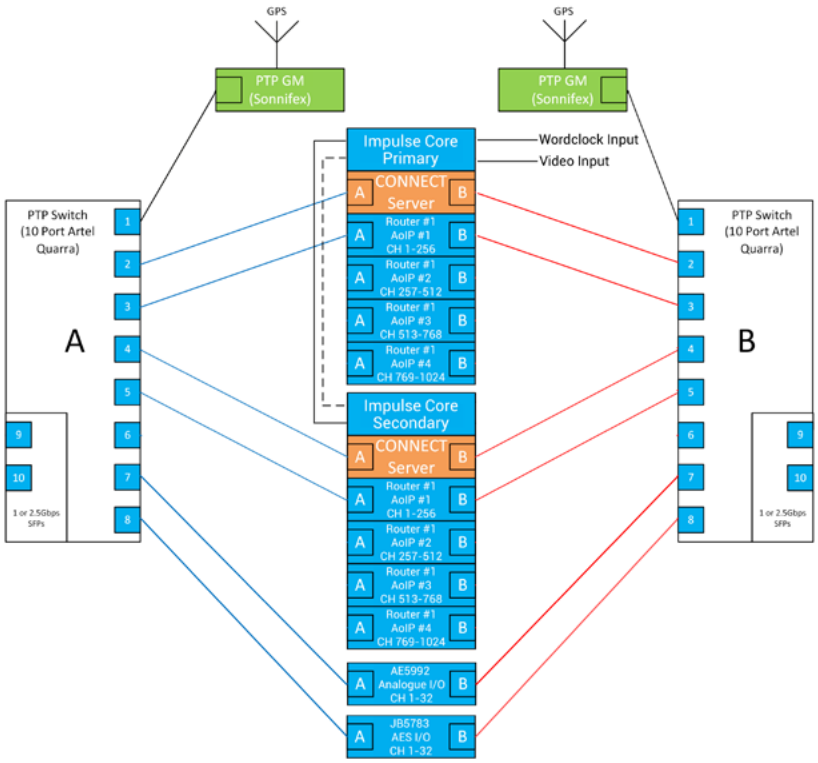


I/O Note:
For I/O signals where redundancy is required we recommend the use of fully A/B networked AoIP I/O Boxes.

Connection Notes:
a) The direct link between the Primary and Secondary Impulse Cores is typically via the Control Processor RJ45 port 5 connection which keeps the Secondary Core in step with the Primary Core. The link may be wired with a single cable or two for cable redundancy.
b) The direct link between the A and B switches is to provide PTP sync.
This will require specific setup of the switch ports so that Switch A, Port 9 is seen as a master boundary clock.

EXAMPLE 2: REDUNDANT IMPULSE CORE WITH 2 AOIP BOXES ON 2 REDUNDANT PTP SWITCHES + REDUNDANT PTP CLOCK

Redundant AoIP Connections	✓
Redundant AoIP Switch/es	✓
Redundant Core	✓
Connect server in Core	✓
Wordclock Input	✗
PTP Grand Master Clock	✓
Redundant PTP Grand Master Clock	✓

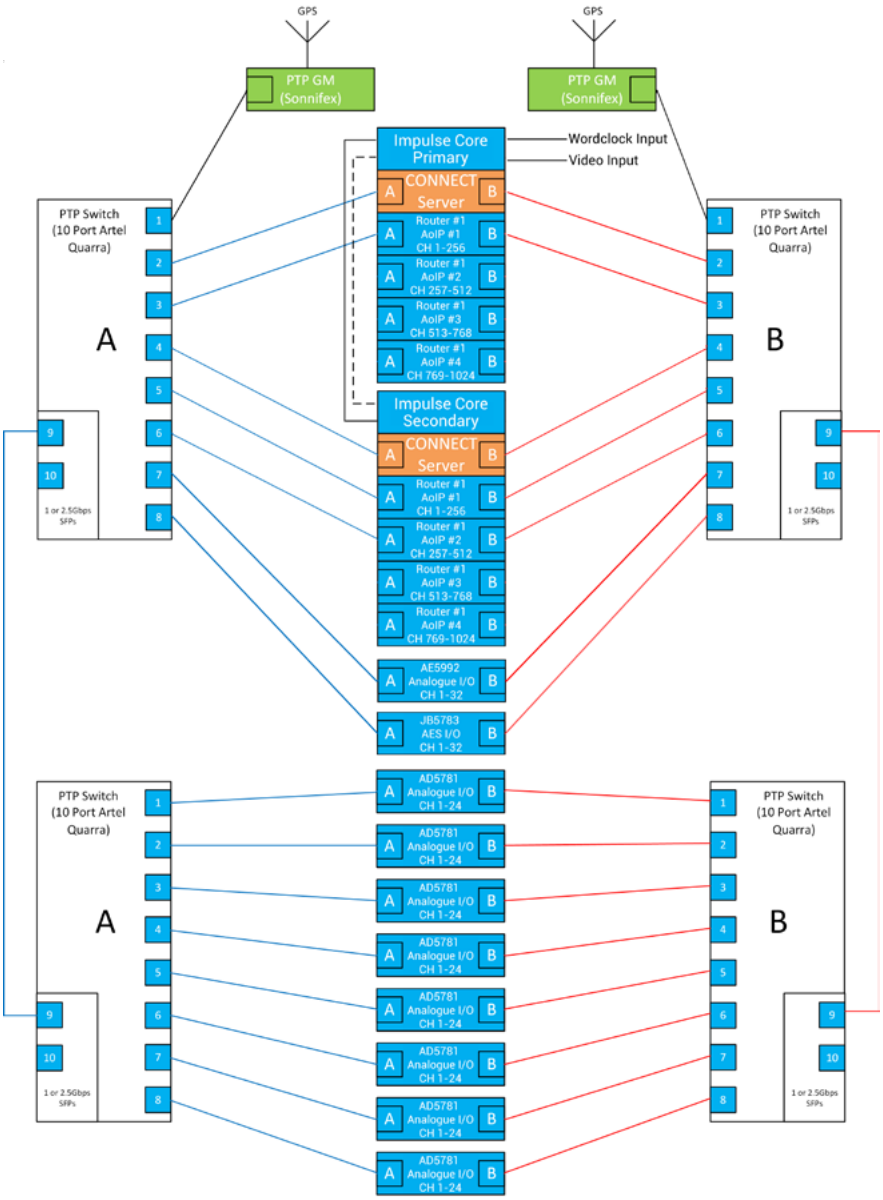


I/O Note:
For I/O signals where redundancy is required we recommend the use of fully A/B networked AoIP I/O Boxes.

Connection Notes:
The direct link between the Primary and Secondary Impulse Cores is via the Control Processor RJ45 port 5 connection which keeps the Secondary Core in step with the Primary Core. The link may be wired with a single cable or two for cable redundancy.

EXAMPLE 3: REDUNDANT IMPULSE CORE WITH 10 AOIP BOXES ON 4 REDUNDANT PTP SWITCHES

Redundant AoIP Connections	✓
Redundant AoIP Switch/es	✓
Redundant Core	✓
Connect server in Core	✓
Wordclock Input	✗
PTP Grand Master Clock	✓
Redundant PTP Grand Master Clock	✓



I/O Note:
For I/O signals where redundancy is required we recommend the use of fully A/B networked AoIP I/O Boxes.

Connection Notes:
The direct link between the Primary and Secondary Impulse Cores is via the Control Processor RJ45 port 5 connection which keeps the Secondary Core in step with the Primary Core. The link may be wired with a single cable or two for cable redundancy.

The Router #1, Port #2 has been amalgamated into the Primary and Secondary AoIP networks to provide additional bandwidth. In addition the extra I/O boxes have been added to the networks via a second pair of Quarra PTP switches which is connected to the first pair of Quarra PTP switches via the SFP port 9 connections on the switches

IMPULSE
EXTERNAL CONTROL CONNECTIONS

CALREC

SW-P-08 REMOTE CONTROL

The router allows for cross-point matrix routing of AoIP inputs direct to AoIP outputs via Virtual PatchBays without using console DSP or control surface space. Control over input to output cross-point routing can be controlled from the Connect application on a browser or via 3rd party controllers supporting the SW-P-08 protocol.

As well as physical I/O ports, the SW-P-08 controllers also have access to Virtual Patchbays, enabling them to change sources on console DSP inputs and access to console DSP outputs.

The following 3rd party SW-P-08 systems have been proven with, and are supported by Calrec:

- L-S-B VSM
- Colledia BNCS
- Grass Valley Jupiter
- Evertz
- NVision
- Axon Cortex
- Harris Edge

Please refer to the relevant manufacturer's guidance for specific information relating to their products.

Connection

The 3rd party SW-P-08 controller is typically connected to the '**Misc control data**' 'port on RJ45 port 1 on the front of the Control Processor module in the Primary Impulse core.

A secondary, backup connection can be made to the '**Misc control data**' 'port on RJ45 port 1 on the front of the Control Processor module in the Secondary Impulse core.

Systems requiring both SW-P-08 and Ember control can use the same Ethernet port and therefore an Ethernet switch is required. The various control systems are separated by using different TCP socket port settings.

The Ethernet ports on the Control Processor Module have a 1000MHz or Gigabit connection which uses standard Ethernet straight-through or cross-over pin-outs and pairings. Screened Cat5e cable should be used to guarantee performance.

Configuration of the ports to setup and use SW-P-08 control to follow:-.

EMBER REMOTE CONTROL

The EMBER protocol is a sophisticated data exchange mechanism that has potential for controlling many functions across varied equipment types.

EMBER control has been incorporated into Calrec's Apollo & Artemis range to allow various remote control functionality, both over consoles and the wider network.

Currently, Calrec support the use of the following EMBER controllers:

- L-S-B VSM
- Colledia BNCS

Please refer to the relevant manufacturer's guidance for specific information relating to their products.

Currently, EMBER has the ability to control the following features when connected to a Calrec Apollo / Artemis network:

- Loading of shows and user memories onto control surfaces.
- Loading / removing alias files used by consoles, instructing them to use different pre-defined sets of I/O ports.
- Please refer to the console operator manual for more information on the use of alias files.
- Input port settings - mic input gain, mic input phantom power switching and SRC switching on digital inputs.
- EMBER controllers can view and edit the I/O box and port labels.
- The information below in GREY is subject to change.
- Inserting SMPTE2020 metadata into SDI embedder outputs - Metadata sets can be uploaded and edited.
- EMBER controllers can select any of the available metadata sets for insertion to, or removal from any of the SDI embedder outputs on the network.
- EMBER controllers can selectively mute any of the audio channels within the SDI output of Hydra2 embedders.

Connection

The 3rd party EMBER client controller is typically connected to the '**Misc control data**' 'port on RJ45 port 1 on the front of the Control Processor module in the Primary Impulse core.

A secondary, backup connection can be made to the '**Misc control data**' 'port on RJ45 port 1 on the front of the Control Processor module in the Secondary Impulse core.

Systems requiring both SW-P-08 and Ember control can use the same Ethernet port and therefore an Ethernet switch is required. The various control systems are separated by using different TCP socket port settings.

The Ethernet ports on the Control Processor Module have a 1 Gbps connection which uses standard Ethernet straight-through or cross-over pin-outs and pairings. Screened Cat5e cable should be used to guarantee performance.

Configuration of the ports to setup and use EMBER control to follow:-.

CALREC SERIAL CONTROL PROTOCOL

The Calrec Serial Control Protocol, CSCP, allows for remote control over mixing console operational functions by 3rd party systems such as video switchers and production automation systems.

Several broadcast equipment manufacturers provide serial control protocols that are compatible with CSCP. The following systems are currently in use around the world, actively controlling Calrec audio mixing consoles for live on-air applications:

- Ross Overdrive (Automated Production Control system) & Ross video switchers.
- Sony ELC.
- Snell Kahuna.
- Mosart.
- Grass Valley Ignite.
- L-S-B VSM

Please refer to the manufacturer's guidance for specific information relating to their products.

CSCP versions

Additional controls have been made accessible via CSCP since it was first introduced, requiring new commands be added to the protocol, and new versions released. If 3rd party equipment receives CSCP data it does not understand, it should simply ignore it, however Calrec cannot guarantee the operation of third parties, and as such makes all CSCP versions available for use on Apollo and Artemis consoles.

Faders controlled by CSCP

Third party systems with a CSCP connection to an Apollo or Artemis console have access to control and read back the status of 192 path faders. Starting with the lowest numbered fader (usually #1) on layer 1A, up to the highest consecutively numbered fader, followed by the same fader numbers on layer 1B, then layer 2A, 2B, 3A, 3B etc. up to a total of 192 faders.

If required, the faders exposed to CSCP control can be zoned, preventing remote control over the entire surface width by intentionally inserting gaps in fader numbering. The 8 faders within a panel are always consecutively numbered, but they do not need to be so between panels. Under technician level access to the console's Main Application, the surface layout page allows a number to be chosen for the first fader on each panel. If for example, the first panel is numbered 1-8, but the second panel, instead of starting with fader 9, is actually set to start at 10 (or any higher number), CSCP would only have access to faders on the first panel, ensuring faders in the remaining surface area cannot be remotely controlled by third parties. Using this example of exposing only one fader panel to CSCP control, all layers of that panel can be accessed by the protocol (12 layers x 2 A/B sub-layers x 8 faders on a single panel = 192 faders total). It is also worth noting, that the lowest numbered faders in a control surface do not have to physically be at the left hand side.

Controls available via CSCP

CSCP V1.0 allows third party controllers:

- Control over and read back of the position of 192 path faders.
- Read back of the 192 faders' path / port labels.
- Control over and read back of the Cut / On status for the same 192 faders.
- Control over and read back of the PFL status for the same 192 faders.
- Control over and read back of Main output bus levels and PFL status.
- Read back of the console's name / ID.

CSCP V2.0 provides the same functionality as V1.0 with the following additional features being made available:

- Control over and status read back of the same 192 faders' routing to the first 20 Auxiliary output buses.
- Control over and read back of the first 20 Aux bus output levels.
- Read back of the path types allocated to the 192 faders.

CSCP V2.1 provides all the functionality of V1.0 & V2.0 along with the following additional features:

- Control and status read back over the 192 faders' routing to Main output buses.
- Control and status read back over Left to Both & Right to Both input controls for stereo paths on the same 192 faders.

Connection
Although the protocol is based on and passes serial data, the Calrec connection is made via TCP/IP. If interfacing to third party systems who only support point to point RS232/422 serial connections, TCP/IP conversion will be required. For this purpose, Calrec support the use of, and can supply Perle IOLAN units.

The CSCP connection should typically be connected to the '**Misc control data**' 'port on RJ45 port 1 on the front of the Control Processor module in the Primary Impulse core.

A secondary, backup connection can be made to the '**Misc control data**' 'port on RJ45 port 1 on the front of the Control Processor module in the Secondary Impulse core.

Systems requiring SW-P-08, Ember and/or CSCP control can use the same Ethernet port and therefore an Ethernet switch is required.
The various control systems are separated by using different TCP socket port settings.

The Ethernet ports on the Control Processor Module have a 1000MHz or Gigabit connection which uses standard Ethernet straight-through or cross-over pin-outs and pairings. Screened Cat5e cable should be used to guarantee performance.

Configuration of the ports to setup and use CSCP control to follow:-.

Secondary connections
Third party CSCP controllers that support redundant secondary connections can be connected to the '**Misc control data**' 'port on RJ45 port 1 on the front of the Control Processor module in the Secondary Impulse core.

This provides complete redundancy, protecting against cable / port failure and module removal. If required, this connection can be via an Ethernet switch, e.g. to allow a single RJ45 port on a 3rd party controller to connect to both primary and secondary Calrec ports as described.

Connecting via corporate LAN
DHCP servers run on the Control Processor modules in the Impulse core to allow easy connection. If a CSCP or other connection is to be made to these ports via a corporate LAN, it is important that the Calrec DHCP servers are disabled and the connections are manually configured as appropriate.

Configuration
Please discuss your installation requirements with your Calrec sales representative or distributor prior to delivery. CSCP connections should be configured and tested by, or under the guidance of a Calrec approved engineer.

User & boot up enable / disable
Once configured, CSCP can be enabled or disabled from the console's Main Application, **>System Settings>Ext Control** screen. Being part of the System Settings, the enabled / disabled selection is automatically saved for recall after a reset or power cycle. System Settings settings are not saved as part of the show or user memory and will therefore not change when different shows / memories are loaded onto the control surface.

IMPULSE
SPECIFICATIONS

CALREC

GENERAL SPECIFICATIONS

SIGNAL PROCESSING PER CONSOLE

	Impulse Core facilities per Console
Input Channel Paths	From 240 to 1120
Main Buses	Up to 16 (mono, stereo or surround) from a pool of 192 paths*.
Group Buses	Up to 48 (mono, stereo or surround) from a pool of 192 paths*
Aux Buses	Up to 48 (mono or stereo) from a pool of 48 paths*
Track Buses	4 track sends per Channel/Group up to 96 from a pool of 96 legs
Direct/Mix Minus Outputs	4 assignable per Channel/Group from a pool of 512 legs**
Insert Sends & Returns	1 per Channel/Group/Aux/Main (mono, stereo or surround) from a pool of 256 legs
Monitor Inserts	Dedicated Insert available to Mon1 LS and Mon2 LS
Mix Minus Buses	1 Mono
VCA Groups	Unlimited
EQ	6 band full Parametric EQ or+ LF & HF filters on every Channel, Group & Main
Dynamics Processing (from v1.0 onwards)	2 x compressor/limiters + 1 x expander/gate with sidechain EQ per Channel, Group & Main
Input Delay	2.73 s per Input from a pool of 256 delay blocks
Path Delay	2.73 s per path
Output Delay	2.73 s per Output including Direct Outputs from a pool of 256 delay blocks

* Pool of Paths available for each DSP Pack is summarised under DSP Options see “DSP Pack Options” on page 22
** Pool of 512 legs shared between Direct & Mix Minus Outputs/console with a maximum of 512 legs available in the core

CORE ROUTER

	Impulse Core
Router Module (1 of 4)	4096^2
AoIP Connections	1 + 1 redundant connection for connecting I/O boxes
Audio Channels Per AoIP Port	Up to 256 in either direction

POWER/ENVIRONMENTAL SPECIFICATIONS

Both the core and external I/O racks have two IEC AC power inlets feeding two sets of internal power distribution. Although both the core and external I/O rack will operate with one inlet supply we recommend both inlets are powered. This will ensure continued operation should a PSU or AC source fail. The operating AC supply voltage is 100 V - 240 V +/-10%.

The peak inrush current per inlet: = 25A

5U IMPULSE CORE BOX (WHEN FULLY LOADED)

UR6500 Impulse Core	240V Operation	115V Operation	100V Operation
Supply Current	1.62 A	3.23 A	3.72 A
Power Factor	0.94	0.99	0.99
Power Dissipation (Heat)	365 W	368 W	368 W
Cooling	The Impulse Core Unit is 5U and is cooled under control with fan assistance. The PSU's are cooled by heatsink only, however the Control Processor, Router and DSP modules are cooled by a variety of fans. Fan speed is monitored and system status warnings are generated if fans fail. The front & rear panels of the unit should be unobstructed to allow airflow. No clearance is required above or below the unit.		
Operating Ambient Air Temperature	0°C - 40°C		
Weight	25 kG		
Dimensions	444mm Width x 223mm Height x 500mm Depth (483mm Wide Front Panel)		

OPTIONAL 1U I/O BOXES

AD6501 Combo I/O	240V Operation	115V Operation	100V Operation
Supply Current	0.22 A	0.37 A	0.41 A
Power Factor	0.60	0.79	0.84
Power Dissipation (Heat)	31 W	34 W	34 W
Cooling	This 1U Rack is cooled by natural ventilation and does not require fan assistance, having sufficient surface area to radiate heat adequately. The side panels of the I/O unit should be unobstructed with at least 50mm (2') clearance to allow airflow. No clearance is required above or below the unit.		
Operating Ambient Air Temperature	0°C - 40°C		
Weight	4.6 kG (Includes US6525 AoIP Board weighing 0.04kG)		
Dimensions	430mm Width x 44mm Height x 363mm Depth (483mm Wide Front Panel)		

AD6502 Analogue I/O	240V Operation	115V Operation	100V Operation
Supply Current	0.29 A	0.50 A	0.57 A
Power Factor	0.60	0.77	0.77
Power Dissipation (Heat)	41 W	44 W	44 W
Cooling	This 1U Rack is cooled by natural ventilation and does not require fan assistance, having sufficient surface area to radiate heat adequately. The side panels of the I/O unit should be unobstructed with at least 50mm (2') clearance to allow airflow. No clearance is required above or below the unit.		
Operating Ambient Air Temperature	0°C - 40°C		
Weight	4.7 kG (Includes US6525 AoIP Board weighing 0.04kG)		
Dimensions	430mm Width x 44mm Height x 363mm Depth (483mm Wide Front Panel)		

JD6503 AES I/O	240V Operation	115V Operation	100V Operation
Supply Current	0.13 A	0.13 A	0.14 A
Power Factor	0.36	0.88	0.85
Power Dissipation (Heat)	11 W	13 W	12 W
Cooling	This 1U Rack is cooled by natural ventilation and does not require fan assistance, having sufficient surface area to radiate heat adequately. The side panels of the I/O unit should be unobstructed with at least 50mm (2') clearance to allow airflow. No clearance is required above or below the unit.		
Operating Ambient Air Temperature	0°C - 40°C		
Weight	3.3 kG (Includes US6525 AoIP Board weighing 0.04kG)		
Dimensions	430mm Width x 44mm Height x 239mm Depth (483mm Wide Front Panel)		

ALL CORE AND I/O BOXES

	Core and All Optional I/O boxes
Power	The Impulse Core and all I/O units have two IEC AC power inlets and are fitted with dual power supplies. Units will be fully functional on one PSU, however both should be fed where possible from separate sources to provide redundancy against both PSU failure and external power loss. The operating AC supply voltage is 100 V - 240 V +/-10%. The peak inrush current is limited (cold start). This reduces the chance of a nuisance trip or fuse blow from power up. The RMS quiescent current figures are specified on the rating label for all types of I/O box and are shown in this manual for each I/O box type.
Power Factor	All I/O units require less than 75W of input power. The internal power supplies fitted have passive filtering (as opposed to active power factor correction) to reduce the harmonics to within the limits of the standard EN61000-3-2. At the time of writing the standard does not apply to equipment <75W. If the lower limit is ever reduced the units will be compliant and as such are future proof.
Heat Output and Efficiency	The heat output from I/O units depends on the supply voltage and loading. Typically it is 0.55 times the RMS VA (Volts x Amperes) at 230V and 0.7 times the RMS VA at 115V. Heat output figures are available for all I/O boxes. The low power PSU efficiency is again dependant on supply voltage and loading, generally >70%.
Cooling	The Impulse Core Unit is 5U and is cooled under control with fan assistance. The PSU modules are cooled by Heat Sink Only, however the Control Processor, Router and DSP modules are cooled by a variety of Fans. Fan speed is monitored and system status warnings are generated if fan failure occurs. The Optional 2U, 3U & 4U I/O boxes keep their operating temperature under control with fan assistance. Operation is not dependant on the fans; they are there to extend the operating life of the unit. There is an 80mm low power, low speed and low noise fan mounted in the right side of the boxes viewed from the front. The fan is speed monitored so if it slows down or stops a warning is given. The air intake is at the left side of the boxes viewed from the front and the air outtake on the right. The Optional 1U I/O boxes do not require fan assistance having sufficient surface area to radiate heat adequately. The side panels of all I/O units should be unobstructed with at least 50mm (2') clearance to allow airflow. No clearance is required above or below the unit. I/O units may be mounted in an open bay providing the ambient air temperature is within limits (see below). The units may also be housed in any air conditioned bay.
Acoustic Noise Core	<43 dB SPL (A-weighted, 1m from front).
Operating Ambient Air Temperature	0°C - 40°C
Relative Humidity	5% - 80% Non-Condensing

AUDIO PERFORMANCE SPECIFICATIONS

AES3 BALANCED DIGITAL INPUTS (ON UR6500, AD6501 AND JD6503)

Format	AES/EBU (AES3) 24-bit.
Interface, Input Sensitivity	110 Ohm balanced (D-Type), 0.2V-7.0V Pk-Pk
Sample Rate Conversion	24-Bit switchable on all AES inputs, SRC Range 30kHz-100kHz
SRC THD+N	-117dB @ 1kHz, 0.00014%

AES3 BALANCED DIGITAL OUTPUTS (ON UR6500, AD6501 AND JD6503)

Format	AES/EBU (AES3) 24-bit
Interface	110 Ohm balanced (D-Type)
Jitter	<0.015UI (2.5ns) peak

ANALOGUE INPUT SPECS (ON UR6500, AD6501 AND AD6502)

Analogue - Digital Conversion	24 Bit
Input	Electronically Balanced
Input Impedance	5.4k Ohms at mic/line level gain settings
Sensitivity	+18 / -78dB for Mic/Line Inputs
Maximum Input Level	24dBu
Frequency Response	20Hz to 20kHz +/- 0.25dB on Mic/Line Inputs
Distortion	-1dBFS @ 1kHz - Better than 0.005% (-86dB) -20dBFS @ 1kHz - Better than 0.003% (-90dB) -40 dBFS @ 1kHz - Better than 0.03% (-70dB)
Dynamic Range(CCIR-RMS)	-116dB
Idle Channel Noise	-116dBFS (88dBu)
Equivalent Input Noise	-126dB (150 Ohm source)
Input CMR (Common Mode Rejection)	>90dB at a 52dB gain setting >75dB at a 4dB gain setting
Crosstalk	-115dB or better on adjacent inputs with 0dBFS tone at 1kHZ on Source
Phantom power current limit	9.5mA / channel

ANALOGUE OUTPUT SPECS (ON UR6500, AD6501 AND AD6502)

Digital - Analogue Conversion	24 Bit
Output Balance	Electronically Balanced
Output Impedance	31 Ohms
Maximum Output Level	24dBu
Frequency Response	20Hz to 20kHz +/- 0.25dB
Distortion	-1dBFS @ 1kHz - Better than 0.002%(-93dB) -20dBFS @ 1kHz - Better than 0.003% (-90dB) -40 dBFS @ 1kHz - Better than 0.03% (-70dB)
Dynamic Range (CCIR-RMS)	-113dB
Idle Channel Noise	-113dBFS (85dBu)
Crosstalk	-105dB or better on adjacent outputs with 0dBFS tone at 1kHZ on Source

AUDIO PERFORMANCE DATA

Digital to Digital (AES3) Distortion	-1dBFS, 20Hz to 20kHz - Better than 0.0001%
Digital to Digital (AES3 with SRC) Distortion	-1dBFS, 20Hz to 20kHz - Better than 0.0002%
Frequency Response (Analogue Input to Output)	20Hz to 20kHz +/- 0.25dB

SYNCHRONISATION INPUTS

48KHz Synchronisation	PTPv2 Grand Master Clock TTL Wordclock (48kHz) Video Internal Crystal Reference

LATENCY @ 48KHZ / 96KHZ SAMPLE RATE *

From	To	Via	Samples	@48kHz	@96kHz
AES3 inputs (SRC off)	AES3 Outputs	Port to port	18	0.376ms	0.188ms
	AES3 Outputs	channel, group, and aux or main output	30	0.626ms	0.313ms
	Analogue Outputs	Port to port	65	1.354ms	0.677ms
	Analogue Outputs	channel, group, and aux or main output	77	1.604ms	0.802ms
		Turning SRC on adds to the above:	+ 39	+ 0.814ms	+ 0.407ms
Mic/Line inputs	AES3 Outputs	Port to port	43	0.896ms	0.448ms
	AES3 Outputs	channel, group, and aux or main output	55	1.146ms	0.573ms
	Analogue Outputs	Port to port	90	1.876ms	0.938ms
	Analogue Outputs	channel, group, and aux or main output	102	2.126ms	1.063ms

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