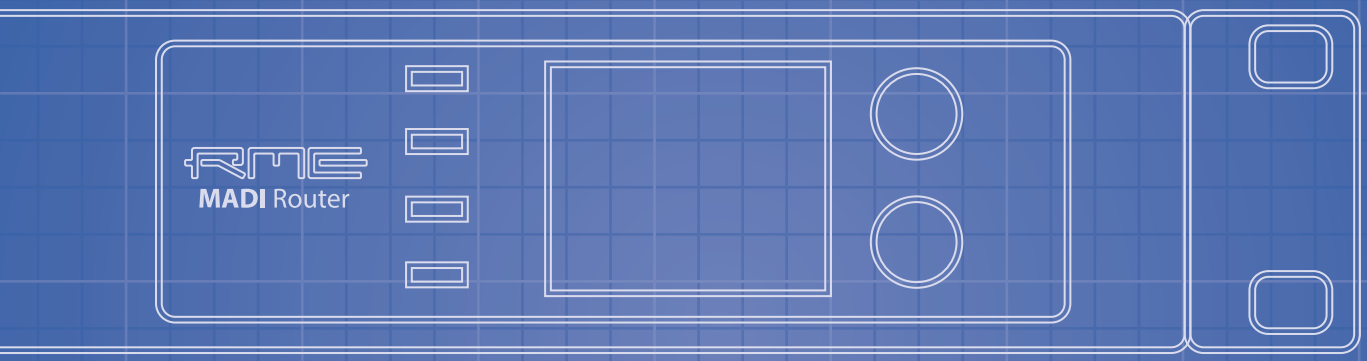
INTELLIGENT AUDIO SOLUTIONS

Usage and Applications



MADI

MADI Router
12 Port MADI Digital Patch Bay & Format Converter

RME - the industry standard

RME products are known for their reliability and their unique feature sets. Acknowledged by professional users and hobbyists alike, their digital interfaces and analog converters capture, transport and play back audio with exceptional quality - for which they have received numerous awards. After having also been included in many scientific and industrial applications, RME has set a standard much talked about whenever the focus is on uncompressed, high quality audio.

This brochure is focuses on MADI - a protocol that has evolved alongside RME to be the most widely accepted multi channel digital audio protocol on the market. It has been written for anyone who is new to the technology or who feels the need to know a bit more about how MADI may be used to create or extend audio systems for their specific requirements.

RME - the development team

RME consists of a German team of developers with a robust vision for creating innovative, user friendly, and sophisticated digital audio solutions that will meet any professional budget. Founded in 1996, RME quickly earned their stripes as a premier industry provider, expanding rapidly into mainstream international markets.

Each developer in the RME team is either a musician or sound engineer, as well as being a specialist in hardware and software development. In addition to their proven skills, they also regularly network with specialists within other industries to exchange knowledge and know-how - aiming to gain a competitive advantage in the audio industy.

RME is absolutely commited to sell, update and maintain each of their products for many years - exceeding the average lifetime of most other products in their league. Nevertheless, a consistent string of new and innovative products throughout RME's history, has earned frequent awards and accolades from the press and the public.

Why MADI?

With its architecture directly related to the AES3 (AES/EBU) audio protocol and its widely available consumer equivalent S/PDIF, MADI is a format that provides sim-plicity, extremely low latencies and ease of use across short and long distances.

MADI is designed to send up to 64 audio channels at 48kHz sampling frequency (32 channels at 96kHz, 16 channels at 192kHz) from one device to another device in a unidirectional data stream. This distinguishes MADI signals from so-called "network audio protocols" that require user interaction to send audio signals between several audio devices once they have detected each other in a local area network.

The fact that MADI is a point-to-point protocol simplifies the design of digital audio devices, and brings several benefits for the user:

- Audio devices with MADI such as A/D or digital format converters, computer audio interfaces and others have incredibly low boot up times of usually less than 5 seconds from power on to full operability and signal processing

- An audio signal of up to 64 channels, 24 bit, 48kHz is detected by the receiving device in the blink of an eye

- The latency between two MADI equipped digital devices is extremely low compared to network audio formats (commonly less than three samples - equivalent to 62.5 µs)

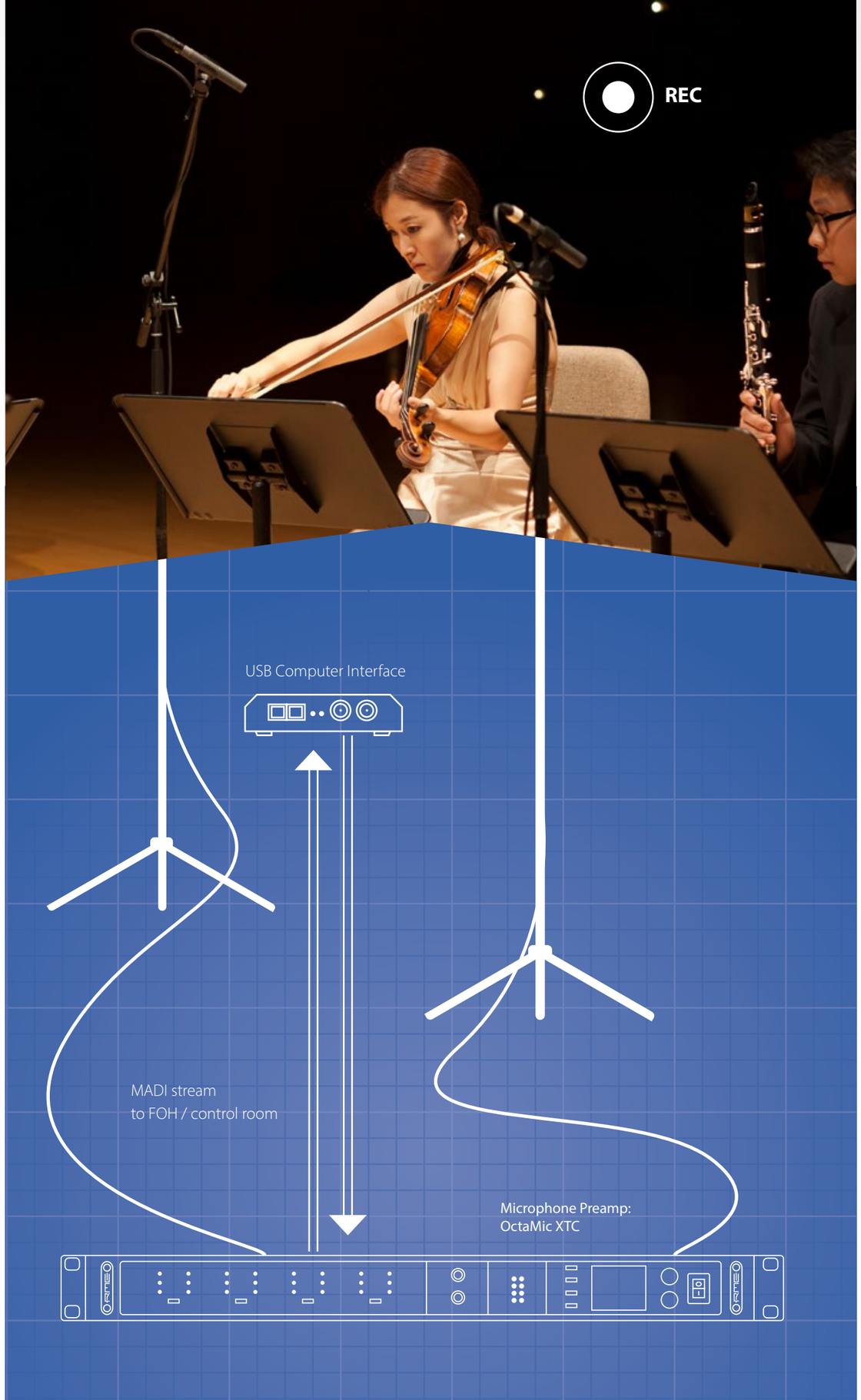
- A minimum amount of configuration is required, after that, it's all plug and play

- Devices can be configured stand-alone, all routings and channel assignments are static and independent of an existing connection to another device

- MADI devices perform consistently, regardless of how many devices are connected

- Malfunctions can quickly be traced and resolved, for example by using RME's free DIGIcheck application.

The Multichannel Audio Digital Interface was created as an open standard (AES-10) and has, since its creation, been implemented in the audio devices of countless manufacturers worldwide. Its wide acceptance through-out the industry makes it a safe investment wherever a large number of audio channels need to be transmitted.



MADI - cable basics

In its current revision, the MADI standard suggests two types of cables, optical and coaxial. Both have been supported by RME since 2003, when RME released its first MADI computer interface card HDSP MADI, and its first ADAT-MADI converter ADI-648.

A third type of cable, known from common computer networks, is called "twisted pair" (CAT5e or higher) and has the advantage of providing additional capacity for the transport of DC voltage. At the time of writing, this cable type is not part of the MADI standard and is therefore implemented by manufacturers in different ways.

All cables carry the same information and achieve the same signal quality, the type of cable is therefore a question of convenience, budget and compatibility. Optical cables have the advantage of being galvanically isolated, extremely lightweight and available in lengths of up to 2000m. 75 ohms coaxial cables are robust, feature a locking mechanism and are widely in use for word clock and video cabling.

They normally bridge distances of up to 100m. Twisted pair cables are very affordable and often already integrated into the existing building infrastructure. Depending on the classification of the cable, lengths of more than 150m can be used.

While the optical and coaxial ports provide independent input and output connectors, the RJ45 connector for twisted pair cables integrates both input and output in one plug. For this reason there are two ports on devices where several units might be connected in a chain.

In a MADI system, each device detects the complete 64 channel stream at its input, and creates a new stream at its output to send it to the next device. If some channels should be passed on through a device, they are simply copied from input to output without any alteration by the device.

On the following pages, you are guided through some common MADI systems - please keep in mind that each product may be used in a variety of different ways. Contact your local RME dealer for a tailor-made setup to fit your needs!

Computer Interfaces

MADI shows its real advantages when computers are involved in the playback and recording process. Due to its simple format, it excels over other multichannel protocols in both latency and channel count. This advantage also reduces the system load of the workstation and leads to extremely low latencies. Newer computer chipsets even provide the same performance on any peripheral standard - therefore the question if one should use USB 2.0, 3.0, PCI, PCIe or bridged PCIe is rather a question of channel count and availability than a question of latency.

The first MADI setup example is built around the MADIface XT. It is in many ways a perfect fit for small and large audio setups, as it provides connections for monitor speakers, talk back microphones, a pair of headphones and even line level inputs.

MADI to DAW

As an alternative to the existing RME MADI interfaces for PCI, PCIe and ExpressCard, RME chose the USB 3.0 connection standard to transport 3x MADI in and out of the computer for a simple reason: USB 3.0 is an open standard that allows RME to build the complete driver architecture, without relying on third party controllers. USB 3.0 brings along many advantages for users, such as USB 2.0 downward compatibility, affordable cables and availability across Windows and Mac.

As an alternative the MADIface XT also features the ePCIe connector - providing a lockable PCIe solution that can easily be adapted to external Thunderbolt™ converters or internal ePCIe cards.

The RME drivers, legendary for their performance and stability, integrate perfectly with various recording applications.

Built-in mixing

The RME computer interfaces feature TotalMix, which is a 192kHz capable mixing engine that can be controlled from an attached computer or even a hardware controller. The MADIface XT boasts an additional DSP processor which lets you add reverb, equalizers or compressors within a few samples, avoiding the time-consuming detour to software plugins and other effects processors via USB or PCIe.

Of course, you can also create submixes on every single output channel of the device - the headphones, the speakers, the AES3 output and the 192 audio channels that are sent on the three MADI connectors.

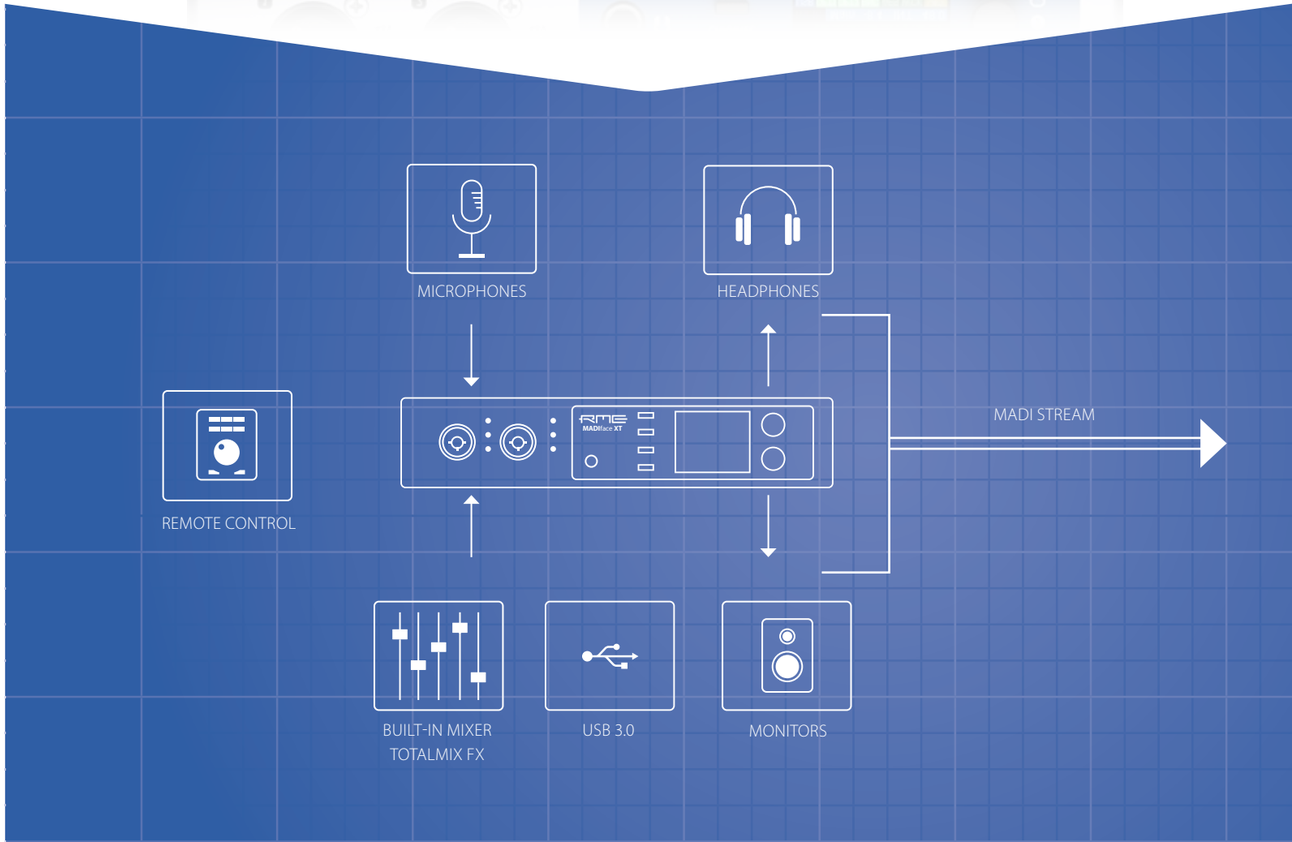
Stand alone operation

Imagine that someone pulls the plug on your computer while you were using a MADIface XT in a critical situation. While you reboot the system, the MADIface XT keeps running as if nothing happened - even internal routing and mixing across its input and output channels stay active without a glitch.

Choice of formats

If your mixing desk makes use of coaxial instead of optical MADI cables - no problem! Next to the two optical connectors, the third MADI connector makes it possible to send your signals on coaxial cables. Between RME devices, you can even connect both cable types for extra safety if someone accidentally unplugs one of the two cables.

Meet tomorrow's control room:



MADI - from a microphone's point of view

RME offers two microphone preamplifiers with MADI - the flagship model **Micstasy** and the **OctaMic XTC**. Its eight microphone and line inputs, four switchable to Hi-Z mode, meet an unrivaled variety of digital connection options - from common ADAT and AES/EBU to sophisticated 64-channel MADI optical. This device fits virtually anywhere into your existing setup and is the perfect entry point to larger MADI systems.

iPad®

The Octamic XTC is the first MADI device compatible to Class Compliant USB Audio. That means that you can connect it to your Apple iPad® Camera Connection Kit and integrate your favorite audio apps - such as synthesizers and multitrack recorders. You can record and play back up to 24 channels of audio - from and to any signal source that's connected to the XTC - analog, AES/EBU, ADAT or MADI.

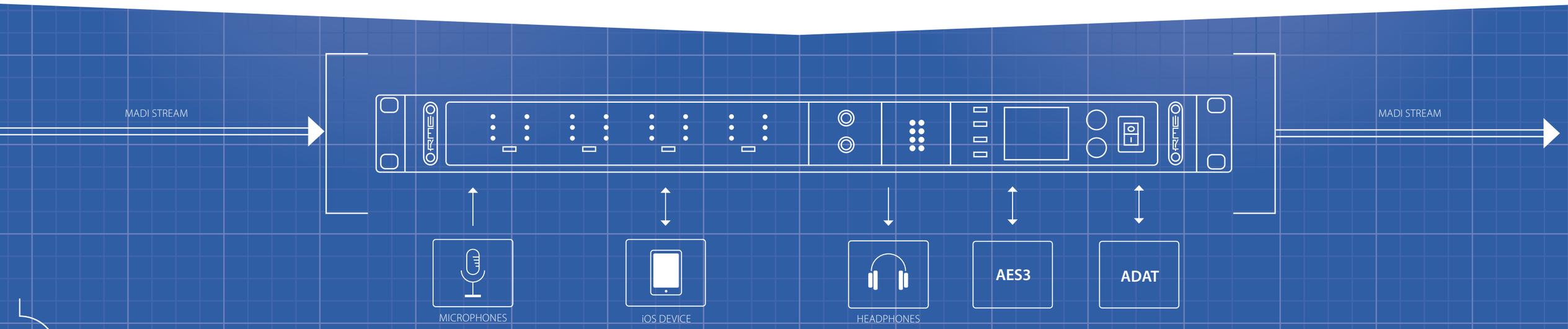
Compared to the new XTC the **Micstasy** excels with +30 dBu universal inputs, 85 dB Gain range - in steps of 0.5 dB, separated instrument inputs, faster AutoSet gain reduction, analog high-pass filters, additional coaxial MADI connectors, MADI redundancy, one-look-see-it-all front design and eight pure analog preamp outputs.

Connect - to insert, merge and extend.

Connecting the XTC to other MADI devices is simple: in our example, connect the output of the MADIface XT to the input of the OctaMic XTC in order to send remote control and clocking information. Then, connect the output of the OctaMic XTC to the input of the MADIface XT to receive audio. You're all set! The MADIface XT can now receive the signals of the OctaMic XTC, including its microphone preamps, ADAT and AES3 inputs and even up to 24 audio channels from an attached iOS device. Got an older ADAT or AES3 preamp? You can attach that to the OctaMic XTC too.

Headphones

Headphone outputs are rare on microphone preamps, but they are useful. Remember TotalMix FX on the previous page? A microphone signal going from the OctaMic microphone input via MADI to the MADIface XT, adding some reverb and returning to the headphone outputs takes about the same amount of time that sound needs to travel in air over a distance of 25 cm, even if you're running 2000m of MADI cable in between. Your musicians will love it - they play better with less delay in their monitoring. Each pair of headphones can monitor any pair of audio channels that the OctaMic XTC receives.



Daisy chains and signal embedding

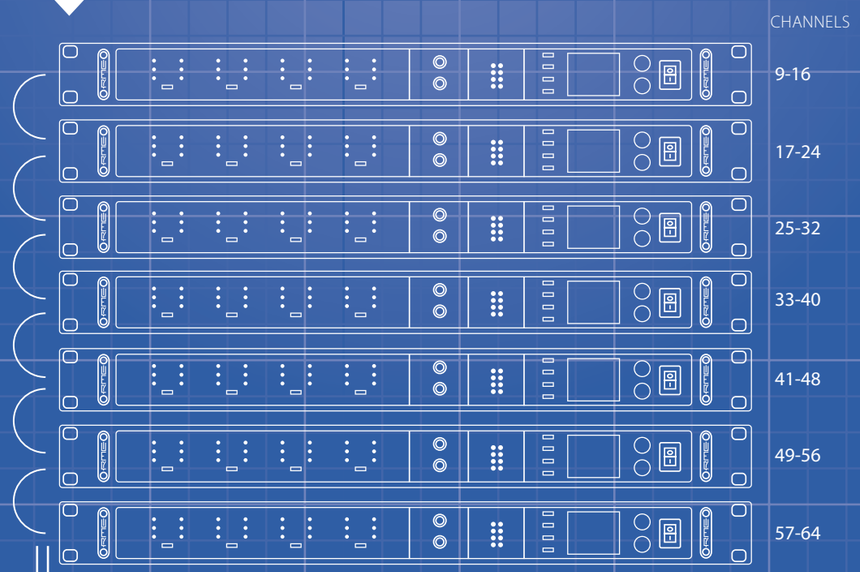
Many MADI devices, such as the OctaMic XTC, have one MADI input and one MADI output. But this does not mean that each device has to have its own connection to the computer interface. In fact, MADI devices pass through any audio channels that they receive - except for the ones that they insert themselves.

If you require, for example, 24 microphone inputs, all you need to do is create a daisy-chain of three devices: the first writes into channel 1-8 and passes this signal to the second. The second device passes channel 1-8 directly to the output but additionally embeds its own signal into channel 9-16. The third device passes on channel 1-16 and embeds its own signals into channel 17-24.

The 3 sample offset between each pair of devices can be automatically compensated with **delay compensation.**

MADI STREAM

The signal that leads to your chain of devices can be used to send remote control and clock information to them. Also, the audio that is received at each OctaMic XTC can be routed to the available outputs of the devices below, which are 2 ADAT ports, 4 stereo AES3 outs, two headphone outs and a 24 channel USB class compliant output - on each device.



A perfect companion

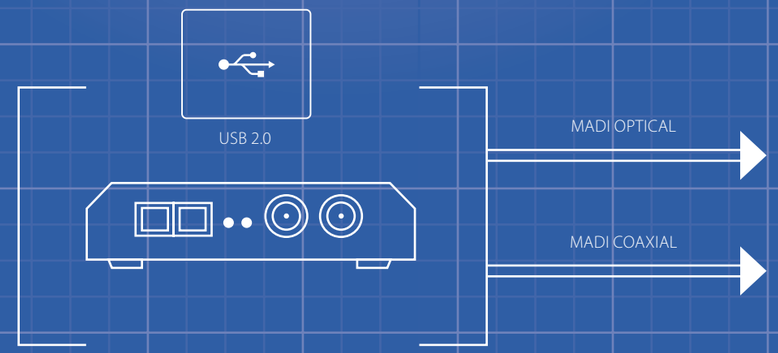
Mixer, router, format converter, stream splitter, signal repeater - the MADIface USB is a perfect addition to any MADI system.

You can use it to create redundancy, for automatic failover, and even for creating mixes with extremely low latency between the optical, coaxial and USB 2.0 audio inputs altogether! The MADIface USB can be easily integrated into a broad range of applications.

In the example below, the MADIface USB is used as a splitter to create redundancy for the signals that are received from the stage box.

It doesn't matter if the USB port is connected to a simple USB charger or battery pack and the MADIface used in stand-alone mode, or if it is connected to a computer which can additionally record all 64 microphone signals that are received from the attached set of preamps.

When attached to a computer, it is even possible to access TotalMix FX, the built-in mixer, to create patches and mixes before the signal is passed on to the next device.



MADI distribution

As MADI systems grow, they may require a central router to distribute and merge streams and individual channels. The MADI Router is a device that can be used to split MADI signals into several outputs, or combine audio channels from several inputs into one signal.

The MADI Router has a variety of different MADI connectors - four optical, four coaxial and four twisted pair (TP) - which may all be used independently with their complete channel counts, even running at different clocks.

If you require more optical or more coaxial connectors, you can simply add one or two more MADI Routers or a MADI Converter to the system - which does not increase the system latency by a single sample.

Four internal matrices can access all 768 input channels and create a new 64 channel output signal from them. This can then be sent to any number of MADI outputs required. This means that these four internal matrices act like four additional, internal inputs - resulting in 16 possible sources for each physical MADI output port on the device.

Introducing MADI TP

Technical background

RME's MADI TP implementation uses standard Layer 1 Ethernet technology. That means that the signal itself remains stable and is encoded for maximum stability over long distances, just like on a computer network.

Common network switches cannot be used with MADI as they require more complex Layer 2 or Layer 3 network audio protocols, which in turn increase latency and complexity.

While TP cables are not part of the official MADI standard, RME decided to add them as a third option since they are cheap and widely available. And they come with another benefit. Apart from containing two MADI streams (one in each direction), they can also provide power to attached devices. That means attached devices do not require an extra power supply, but instead make use of the redundant PSU of the MADI Router.

MAIN and EXT ports

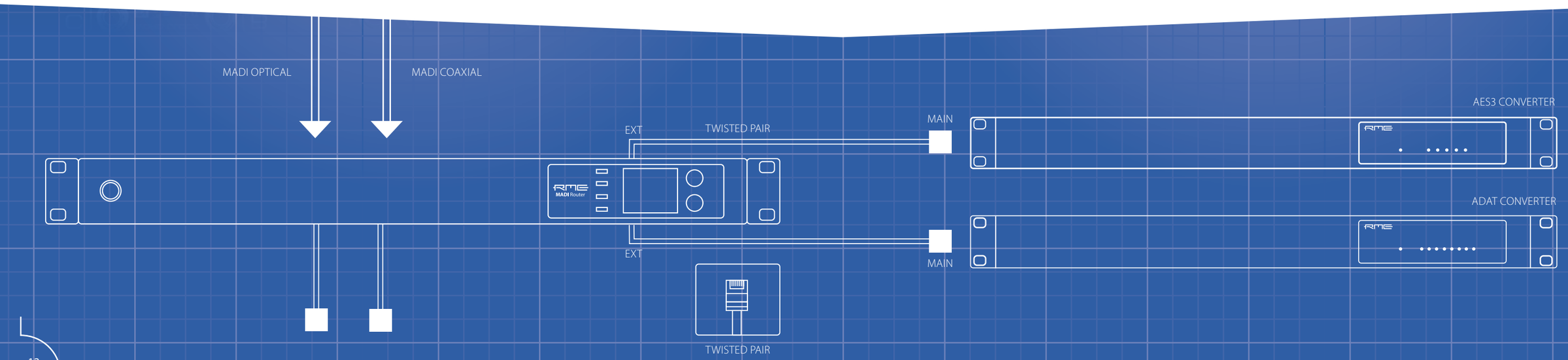
Each RJ45 port features a complete 64 channel sender and receiver. On the ADAT and AES Router and Converter products, there are two RJ45 ports labelled MAIN and EXT. Why? The difference is simple: their pinout is crossed. So the MAIN port could be explained as an IN/OUT port, while the EXT port is an OUT/IN port. Therefore, it is necessary to connect the EXT port of one device with the MAIN port of another device. If two EXT-ports were to be connected, an ethernet crossover cable must be used.

Including TP into your existing setup

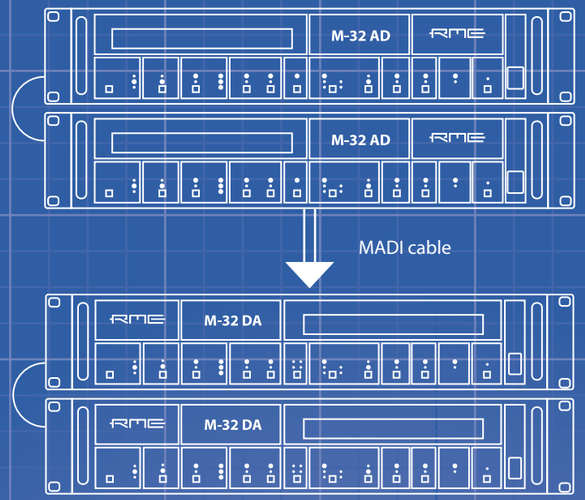
The twisted pair cables offer a convenient way to extend your MADI system with a new range of digital routers and converters.

The ADAT Converter in our example below extends the MADI Router by 8 ADAT light pipe I/O. The MADI Router can access each of the 64 inputs and outputs individually with its internal routing matrix.

The AES3 Converter shows another great extension as it can be configured to be either sending or receiving 64 audio channels, or sending and receiving 32 audio channels at the same time.



Example: analog multicore. 64 channels of analog inputs are converterd to MADI using two M-32 AD analog to digital converters at the source, and two M-32 DA converters at the destination.



Safe recording

In every recording situation, backups and redundancy are crucial. Many RME devices therefore feature the capability to split their output signal to two or more connectors.

Seamless MADI redundancy

On the receiver side, the identical signals are then compared: the MADIface USB, MADIface XT and the HDSPe MADI FX offer RME's new seamless redundancy which immediately switches the active input in case the current input signal is lost.

Power supply safety and redundancy

The MADIface XT has an external power supply with a locking connector to the device.

The new MADI Router, AES3 Router and ADAT Router each feature two independent internal power supply units that can be used with optional locking connector AC cables.

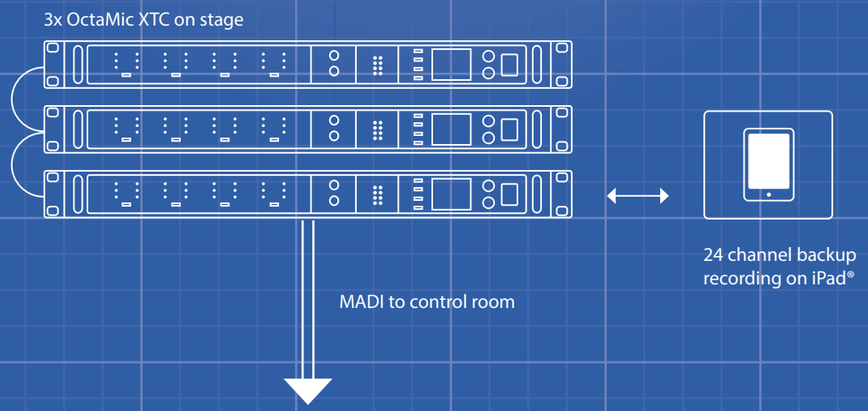
Backup recording

Thanks to the Class Compliant USB Audio connection of the OctaMic XTC, a 24 channel backup recording can easily be created close to the stagebox as a modern alternative to an additional Windows/Mac OS DAW.

Offline configuration

Since each MADI device saves the routing assignments for the outgoing MADI signal at its core, it can of course also be configured without any input signal present.

In addition, devices such as the MADI Router, the MADIface XT and the OctaMic XTC also have preset storage on board - so all routings and settings can be saved and recalled for different situations.

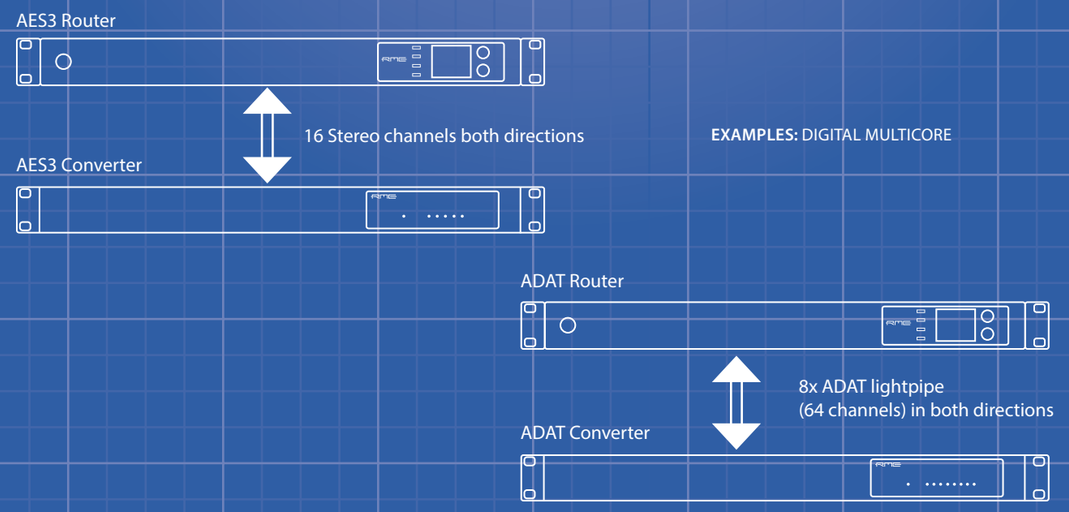


Simple digital multicores

The examples on the previous pages showed how to connect computer audio interfaces and microphone preamplifiers via MADI - but of course, it is also possible to connect two MADI devices together directly, without any computer interface involved.

This is very useful for multicores. A single MADI cable can replace 64 balanced analog cables, eight ADAT lightpipe cables or 32 balanced 110 ohms AES3 cables, reducing weight and complexity while at the same time increasing the signal quality.

The AES3 and ADAT Routers and Converters make this type of setup simple and convenient - the twisted pair cable not only carries a bidirectional MADI signal, but also DC power on the same cable. Therefore, only the Routers have to be connected to a power source - the Converters receive their power via MADI TP.



Stage Box 1
32 Microphone Inputs

OctaMic XTC

Micstasy-M

FOH/Control Room Mixing Console

Stage Box 2
32 Microphone Inputs + 32 Line Level Inputs, 32 Line Level Outputs + 8 Stereo Headphone Outputs

OctaMic XTC

ADAT

ADI-8 DS MK-III

MADI Router

Control Room / Mixing
196 Input / 198 Output channels

MADIface XT

Talkback Mic

Stereo Monitors

Digital SRC Extension
32 Ch. ADAT/AES3/TDIF I/O with SRC

AES3 Router

ADI-192DD

AES3 Extension
32 stereo digital I/O powered by MADI TP

AES3 Converter

AES3 Converter

Surround Monitoring Room
192kHz 24 bit 7.1 Setup
(ext. up to 22.2 at 96kHz)

MADIface USB

ADI-8QS-M

SACD / DVD-A Player

Active Monitor Speakers

Analog Extension
48 Ch. Analog I/O

M-32 DA / M-16 DA

M-32 AD / M-16 AD

Analog Mixing Desk
48 Ch. I/O

ADAT Extension
8 ADAT Lightpipe I/O (64 audio channels)

ADAT Converter

Alesis® Digital Audio recorder with ADAT interface

OctaMic II or Fireface audio interfaces

KEY

MADI Optical

MADI Coaxial

MADI TP

ADAT Optical

Analog

Selected RME products for your MADI system

			Digital Audio												Audio Interface			Analog Audio		Features		
			MADI Optical		MADI Coaxial		MADI TP				ADAT		AES-3		USB CC	USB 2.0	USB 3.0/ PCIe	Analog				
		Connector Type																				
			IN	OUT	IN	OUT	EXT		MAIN		IN	OUT	IN	OUT	iOS	Win/Mac	Win/Mac	IN	OUT			
Audio channels per connector:							IN	OUT	IN	OUT	IN	OUT	IN		IN/OUT	IN/OUT	IN/OUT			Router	TotalMix FX	DSP Effects
at 32-48kHz			64/56	64/56	64/56	64/56	64	64	64	64	8	8	2	2	24	64	~200	1	1			
at 88.2, 96kHz			32/28	32/28	32/28	32/28	32	32	32	32	4	4	2	2	24	32	~100	1	1			
at 176.4, 192kHz			16/14	16/14	16/14	16/14	16	16	16	16	2	2	2	2	8	16	~50	1	1			
Number of connectors (for number of audio channels, multiply according to list above)																						
Computer Interfaces																						
MADIface XT			2	2	1	1							1	1		1	1	2 (2MIC)	4 (1 HP)	•	•	•
MADIface USB			1	1	1	1										1				•	•	
HDSPe MADI FX			2	2	1	1							1	1			1 (PCIe)		2 (1 HP)	•	•	•
Digital Converters																						
MADI Router			4	4	4	4	4													•		
AES3 Router	Mode	Normal	1	1	1	1	1		1				16	16						•		
		All In											32	0								
		All Out											0	32								
AES3 Converter	Mode	Normal					1		1				16	16								
		All In											32	0								
		All Out											0	32								
ADAT Router			1	1	1	1	1		1		8	8								•		
ADAT Converter							1		1		8	8										
DMC-842			1 (R)	1 (S)	1 (R)	1 (S)						2	4 SRC	4						•		
ADI-192 DD (no MADI)											1 SRC	2	4 SRC	4						•		
MADI Converter			6	6	6	6																
Analog Converters																						
M-32 AD			1 (R)	1 (S)	1 (R)	1 (S)												32				
M-16 AD			1 (R)	1 (S)	1 (R)	1 (S)												16				
M-32 DA			1 (R)	1 (S)	1 (R)	1 (S)													32			
M-16 DA			1 (R)	1 (S)	1 (R)	1 (S)													16			
ADI-8 QS-M			1 (R)	1 (S)	1 (R)	1 (S)						2	4	4				8	8			
ADI-8 DS MKIII (no MADI)											2	2	4	4				8	8	•		
Micstasy-M			1 (R)	1 (S)	1 (R)	1 (S)						2		4						•		
Octamic XTC			1	1							1	2	4	4	1			8 (8MIC/4INST)	4 (2 HP)	•		

1) At the time of writing, MADI TP is implemented with a maximum channel count of 64 Ch. At 44.1kHz, or 56 Ch. At 48kHz sampling frequency.
2) (R) means that even though the device has two MADI inputs, only one input is used at a time and the other used for redundancy.
3) (S) means that even though the device has two MADI outputs, both outputs always send an identical signal (split output).
4) The AES3 Router and Converter can operate in either mode (can be set at the unit).
For a complete list of products and their specifications, please refer to the MADI Solutions brochure.

Sketch your own MADI system. Questions? Take a picture and mail it to: support@rme-audio.de

INTELLIGENT AUDIO SOLUTIONS

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