ADI-648

Multichannel Audio Digital Interface

Application Notes

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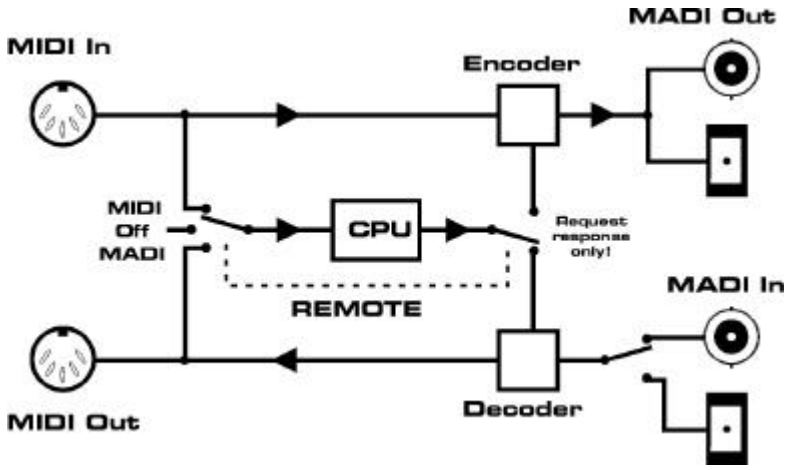
1. MIDI

1.1 MIDI Transmission

MADI allows for a transmission of 64 audio channels over long distances with a single line – perfect. But what about MIDI? Be it remote control commands or sequencer data, in practice only a single MADI line will not suffice. Therefore the ADI-648 also has a MIDI I/O port. The data at the MIDI input are being included into the MADI signal invisibly, and can be collected at the MIDI output of another ADI-648, or a Hammerfall DSP MADI, at the other end of the MADI line.

Technically every single MADI channel includes several additional bits, containing various information (Channel Status). RME use the usually unused *User Bit* of channel 56 (channel 28 in 96k Frame mode), to transmit MIDI data invisibly within MADI, ensuring full compatibility.

The block diagram shows the basic MIDI operation. The MIDI input signal is added to the MADI output signal. The MIDI data found in the MADI input signal will be available at the MIDI output. This functionality, a bi-directional MIDI/MADI converter, is always available, and not affected by the REMOTE key.



The MIDI input signal will never be transferred directly from MADI to MADI, no matter how the matrix router is set up. A MIDI cable connecting MIDI output and MIDI input of the ADI-648, will realize a direct pass-through of MIDI, from MADI input to MADI output.

1.2 Remote Control via MIDI

The ADI-648 can be completely remote controlled via MIDI. The CPU shown above reacts on specific commands. Furthermore, upon request the CPU will report the complete device status. This includes all controls and LEDs on the front plate. Each ADI-648 can be programmed with its own ID, providing a separated remote control of multiple devices via a single MIDI channel.

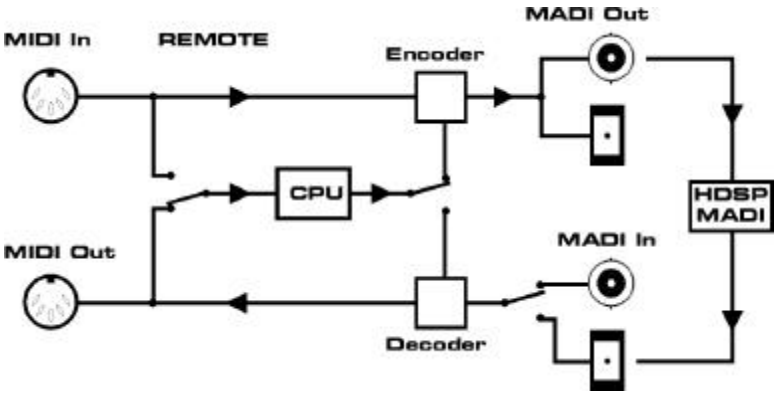
The key REMOTE is used to select the source of the MIDI commands, and also the destination for the ADI-648's request replies. A push on REMOTE toggles between MIDI port, MADI port and Off. The latter is a safety function to prevent any setup-change by any MIDI signal. In the picture above, the MIDI commands reach the CPU via the MIDI input, and the CPU's feedback on commands is only available at the MIDI output.

To remote control an ADI-648 from a Hammerfall DSP via MADI, REMOTE has to be set to MADI. As can be seen in the block diagram on the next page, this setup provides a complete data path for MIDI in both directions.

1.3 Software MIDI Remote

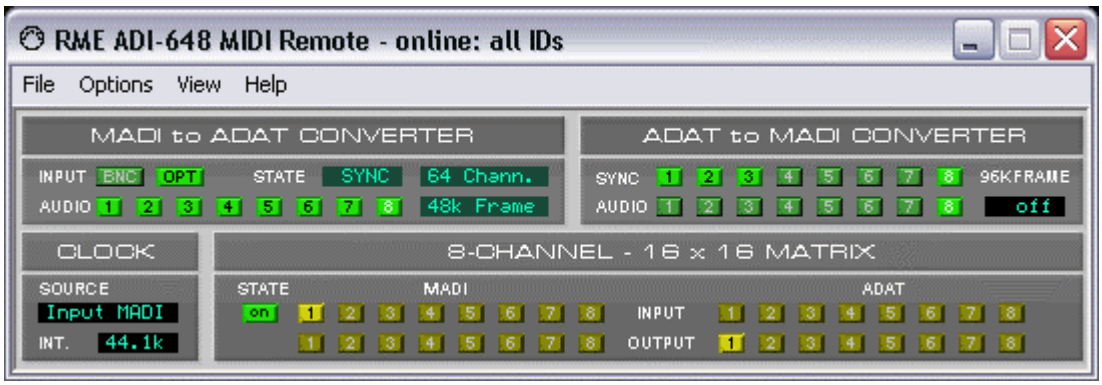
The Windows software **MIDI Remote** can be downloaded for free from the RME website. It uses any existing MIDI port within the system to perform remote control and status requests of all ADI-648 via a simple mouse click. Most appealing is the combination with a HDSP MADI (PCI card), offering a direct control of the ADI-648 via MADI. The remote control software then uses a virtual MIDI port of the card (port 3), which directly sends and receives MIDI data via MADI.

The block diagram shows the signal flow in a MADI remote controlled system. MIDI commands from a software on PC or Mac travel via MADI to the MIDI Out of the ADI-648. At the same time they reach the 648's CPU. The MIDI signals of external devices travel via MIDI In and MADI Out back to the software, together with the request responses of the CPU.

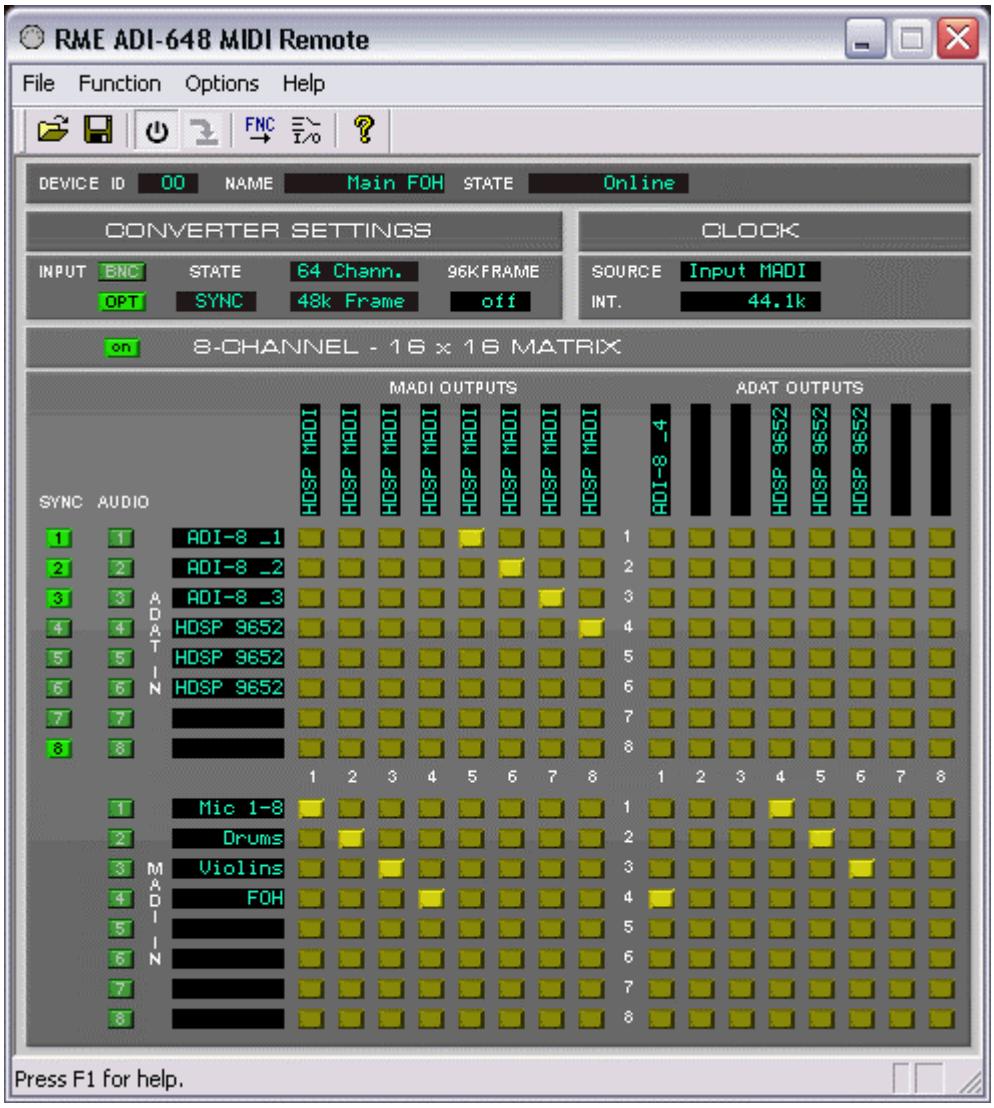


Software download adress: http://www.rme-audio.com/download/midiremote.zip

MIDI Remote's user interface offers lots of advanced features for an easy and intuitive everyday usage. Two views are available: a front-panel style surface, and a full matrix display. The following screenshot shows the software in operation and in both views.



Software MIDI Remote in front panel view mode



Software MIDI Remote in matrix view mode

2. Application Examples

2.1 MADI to MADI Converter

MADI has been used for quite some time now and therefore not all interfaces from different manufacturers are compatible with each other. An AMS Neve Logic DFC e. g. only accepts the 56 channel input format and when a 64 channel signal is applied, the whole input is muted. There exist lots of other but similar examples.

The ADI-648 can serve here as a perfect link, because its MADI input can read any input format. The ADI-648's MADI output can be set to 56 channel or 64 channel output mode by applying an ADAT signal to ADAT input 8 (see manual). After selecting 96K FRAME there are also 28 or 32 channels in a 96k Frame mode. With this option, the ADI-648 can translate a double wire MADI signal (2 single speed channels contain one double speed channel's data) into a single wire double speed signal (1 channel contains 1 channel's data at double sample rate), or vice-versa.

Thanks to an integrated matrix router, no further cabling has to be arranged for (except for activating or deactivating of the 64 channel mode), since all MADI input signals can be sent to the MADI output directly via the router.

In short: the ADI-648 makes all MADI interfaces existing at the moment compatible to each other in the easiest way.

2.2 ADAT Patchbay and Splitter

The integrated Matrix Router makes the ADI-648 also an interesting 8 port ADAT patchbay. No matter if different devices are to be connected with each other, or one ADAT signal has to be sent to multiple ADAT receivers, the ADI-648 can achieve this by simply pushing a button.

When the MADI input and output are connected directly (loopback), the user can easily switch between a 1:1 connection and a freely defined router/splitter setting.

2.3 MADI Coaxial / Optical Converter

The integrated Matrix Router allows to send the MADI signals from the MADI input directly to the MADI output. As the ADI-648 supports both coaxial and optical format, it can be used as either coaxial to optical or optical to coaxial format converter. Thanks to a completely newly generated signal, jitter suppression by SteadyClock, and a reclocking of the MADI output signal, the ADI-648 truly represents a hi-end format converter.

For such a simple application, the ADI-648 seems to be highly over-qualified. But seeing the very high prices (but not better quality) of dedicated format converters, we could not resist to add an explicite note on this ADI-648's capability.

2.4 MADI Merger

Another very interesting application, else only possible by using very special and expensive devices, becomes reality when using more than one ADI-648: combining the audio channels of multiple MADI sources into one single MADI wire. The need for this application arises quite often, because many devices don't make use of the full channel count. Often only 32 or 40 channels are used. A HDSP MADI card allows to record 64 channels simultaneously into a computer. To also use the remaining channels, further channels have to be added to the original MADI signal. Two examples will show how the ADI-648 can handle this task with ease.

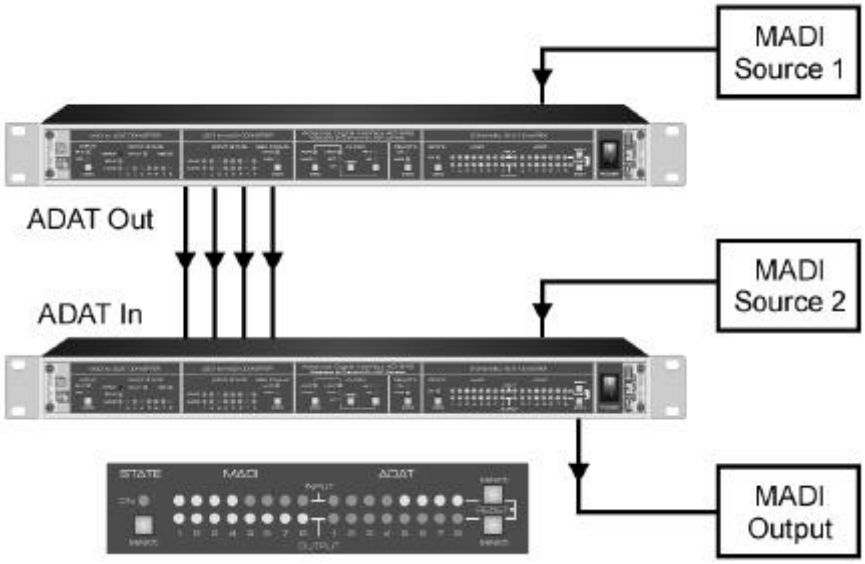
Example 1: A mixing desk sends 48 channels via MADI. 16 more channels from two RME OctaMic-D (8-channel microphone preamps with ADAT output) shall be recorded by a HDSP MADI into a computer. This application requires only one ADI-648, which has to be inserted into the MADI line. The Routing Matrix is used to loop channels 1 to 48 from MADI input to MADI output (groups 1 to 6). The two OctaMic-D will be connected to the ADAT inputs 7 and 8, which not only guarantee best overview, but also automatically activate the 64-channel mode. The Routing Matrix is now set up to send the ADAT input channels 49 to 64 (group 7 and 8) to channels 49 to 64 (group 7 and 8) of the MADI output. Now the ADI-648's MADI output signal includes both the original MADI input channels 1 to 48, and the audio signals of both OctaMics (on channels 49 to 64).

Example 2: The signals of two MADI devices shall be united to a single MADI stream. This can be handy, because it requires only one MADI cable for transmission. It can also be a requirement, because the receiving device may have only one input…

The number of ADI-648s necessary is identical to the number of MADI signal sources, so it's two for this example. The first ADI-648 serves as MADI to ADAT converter. Its ADAT outputs are connected with the ADAT inputs of the second ADI-648. The second ADI-648 is used as described in example 1, sending the MADI input signal directly to the MADI output. At the same time, the unit fills the unused MADI channels at its MADI output with the audio signals from the ADAT inputs.

The block diagram shows cabling and signal flow of such an application.

At the bottom, the setting of the second unit's Matrix Router is shown.



2.5 MADInet

MADI is much more flexible and powerful as commonly known. To better make clear what MADI realy is – a kind of audio network – we introduced the term ***MADInet***. The main point to know is that the MADI input signal is completely rebuild before it is sent to the MADI output. A clock with active jitter suppression (like SteadyClock) provided, numerous ADI-648 can be daisy chained. The input signal can be passed on in different ways using the matrix router. And when build as as ring loop, audio can even be sent back from all ADI-648 to the first device. The specified length of BNC cable connections is multiplied by the number of used ADI-648, as each device resends the MADI signal as a newly generated original.

A real world example: Imagine a theme park, where different audio is needed at 20 places far away from each other. The audio material is send from a computer, playing back 20 different stereo tracks via a HDSP MADI. The card is connected via BNC to the first ADI-648. This one (like all others) is set up to pass all incoming audio 1:1 to its MADI output, so that the audio is sent directly to the next ADI-648. At the same time the audio is available at each unit using the ADAT optical outputs. The distance between the units is more than 50 meters. The last ADI-648 is connected with the HDSP MADI again, as each ADI-648 can also be used to insert signals into the loop (for example surveillance microphones). MIDI transmission also included. Fascinating...

3. Technical Background

3.1 MADI Basics

MADI, the serial **M**ultichannel **A**udio **D**igital **I**nterface, has been defined already in 1989 as an extension of the existing AES3 standard following several manufacturers' wish. The format also known as AES/EBU, a balanced bi-phase signal, is limited to two channels. Simply put, MADI contains 28 of those AES/EBU signals in serial, i. e. after one another, and the sample rate can still even vary by +/-12.5%. The limit which cannot be exceeded is a data rate of 100Mbit/s.

Because an exact sampling frequency is used in most cases, the 64 channel mode was introduced officially in 2001. It allows for a maximum sample rate of 48 kHz + ca. 1%, corresponding to 32 channels at 96 kHz, without exceeding the maximum data rate of 100 Mbit/s. The effective data rate of the port is 125 Mbit/s due to additional coding.

Older devices understand and generate only the 56 channel format. Newer devices often work in the 64 channel format, but offer still no more than 56 audio channels. The rest is being eaten up by control commands for mixer settings etc.. The ADI-648 and the HDSP MADI show that this can be done in a much better way, with an invisible transmission of 16 MIDI channels and the MADI signal still being 100% compatible.

For the transmission of the MADI signal, proved methods known from network technology were applied. Most people know unbalanced (coaxial) cables with 75 Ohms BNC plugs, they are not expensive and easy to get. The optical interface is much more interesting due to its complete galvanic separation, but for many users it is a mystery, because very few have ever dealt with huge cabinets full of professional network technology. Therefore here are some explanations regarding 'MADI optical'.

- The cables used are standard in computer network technology. They are thus not at all expensive, but unfortunately not available in every computer store.

- The cables have an internal fibre of only 50 or 62.5 µm diameter and a coating of 125 µm. They are called network cables 62.5/125 or 50/125, the former mostly being blue and the latter mostly being orange. Although in many cases not clearly labeled, these are always (!) glass fibre cables. Plastic fibre cables (POF, plastic optical fibre) can not be manufactured in such small diameters.

- The plugs used are also an industry standard and called SC. Please don't mix them up with ST connectors, which look similar to BNC connectors and are being screwed. Plugs used in the past (MIC/R) were unnecessarily big and are not being used any longer.

- The cables are available as a duplex variant (2 cables being glued together) or as a simplex variant (1 cable). The ADI-648's opto module supports both variants.

- The transmission uses the multimode technique which supports cable lengths of up to almost 2 km. Single mode allows for much longer distances, but it uses a completely different fibre (8 µm). By the way, due to the wave-length of the light being used (1300 nm), the optical signal is invisible to the human eye.

4. Appendix

RME news and further information can be found on our website:

http://www.rme-audio.com

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