User's Guide

![RME - Intelligent Audio Solutions logo]

ADI-8 DD

SyncAlign[R]

SyncCheck[R]

Intelligent Clock Control[TM]

Hi-Precision 24 Bit / 96 kHz
8 Channel Dual Universal Format Converter
8 Channel Sample Rate Converter
ADAT[R] optical / TDIF[R]-1 / AES/EBU Interface

adat[R]
OPTICAL   TDIF-1

24 Bit Interface

Contents

1. Introduction

With the ADI-8 DD you have an incredibly versatile digital interface to your supply. What at first looks like a simple AES/TDIF/ADAT format converter, turns out to be *the* universal problem solver at a closer look. From small project studios to broadcast and television, the *Universal Format Converter* is the perfect link between the formats mostly used today.

As a consequent continuation of RME's world-wide successful ADI-8 series, the DD also contains elaborate technology and the latest integrated circuits, delivering 8 full channels in 24 bit and 96 kHz. The ADI-8 DD is a uniquely powerful and high-quality device, which will excite you even after many years of operation.

2. Package Contents

Please check that your ADI-8 DD package contains each of the following:

- ADI-8 DD
- Manual
- Power chord
- 2 x 2 m optical cable (TOSLINK)

3. Brief Description and Characteristics

The ADI-8 DD consists of two 8-channel digital format converters in reference quality, in a standard 19" box with 1 unit height. The compact device has numerous extraordinary features like Intelligent Clock Control (ICC), SyncCheck®, SyncAlign®, Bitclock PLL, patchbay functionality and active jitter suppression per SD-PLL. Switchable high-end sample rate converters (SRC) allow for both sample rate conversion in best possible quality, as well as clock-decoupling of all AES/EBU inputs.

All of the ADI-8 DD's I/Os support 96 kHz/24 bit. As ADAT optical and TDIF are restricted to 48kHz, in DS mode (Double Speed) two channels are being used for the transmission of one channel's data. The *Sample Split* algorithm used is also implemented in RME's Hammerfall and Hammerfall DSP. Thus the ADI-8 DD also serves as an ideal AES/EBU frontend for these interface cards, on both Mac and PC.

The format conversion between AES/EBU and ADAT/TDIF operates in both directions at the same time, both completely independent or intelligently coupled. LEDs of different colours show the present state of incoming and outgoing signals and of the internal processing in a clear way.

The unique Intelligent Clock Control (ICC) allows for a flexible use with internal clock (44.1, 48, 88.2 and 96 kHz), external word clock or the digital input signals. These options being available for both directions are intelligently coupled in a way typical for RME and easy to apply thanks to a clear and easily understandable display of the Lock and Sync states. Besides, the unique *Copy Mode* allows for operation as digital patchbay and signal distributor. Up to 16 channels can be distributed and converted at the same time. In few words: The ADI-8 DD is a true *Intelligent Audio Solution*.

4. Technical Specifications

- Power supply: Internal, 100-240 V AC, 15 Watts
- Dimensions: 483 x 44 x 205 mm
- Weight: 2 kg

4.1 Inputs

AES/EBU

- 4 x XLR, transformer balanced, ground-free, according to AES3-1992
- High-sensitivity input stage (< 0.3 Vss)
- SPDIF compatible (IEC 60958)
- Accepts Consumer and Professional format, copy protection will be ignored
- Single Wire: 4 x 2 channels 24 bit, up to 96 kHz
- Double Wire: 4 x 2 channels 24 bit 48 kHz, equalling 4 channels 96 kHz
- Lock range: 27 kHz – 103 kHz
- Jitter when synced to input signal: < 3 ns

ADAT Optical

- 2 x TOSLINK, according to Alesis specification
- Standard: 8 channels 24 bit, up to 48 kHz
- Copy Mode: up to 2 x 8 channels 24 bit / 48 kHz
- Sample Split (S/MUX): 2 x 8 channels 24 bit / 48 kHz, equalling 8 channels 24 bit 96 kHz
- Bitclock PLL ensures perfect synchronisation even in varispeed operation
- Lock range: 33 kHz – 56 kHz
- Jitter when synced to input signal: < 2 ns

TDIF

- 2 x D-sub 25 pol., according to TDIF-1
- Standard: 8 channels 24 bit, up to 48 kHz
- Copy Mode: up to 2 x 8 channels 24 bit / 48 kHz
- Sample Split (Dual Line): 2 x 8 channels 24 bit / 48 kHz, equalling 8 channels 24 bit 96 kHz
- SD-PLL for low jitter synchronisation even in varispeed operation
- Lock range: 27 kHz – 56 kHz
- Jitter when synced to input signal: < 3 ns

Word Clock

- BNC, not terminated (10 kOhm)
- Automatic Double Speed detection and internal conversion to Single Speed
- SD-PLL for low jitter synchronisation even in varispeed operation
- AC-coupling, not effected by DC-offsets within the network
- Signal Adaptation Circuit: signal refresh through auto-center and hysteresis
- Overvoltage protection
- Level range: 1.0 Vss – 5.6 Vss
- Lock range: 27 kHz – 112 kHz
- Jitter when synced to input signal: < 3 ns

4.2 Outputs

AES/EBU

- 4 x XLR, transformer balanced, ground-free, according to AES3-1992
- Output voltage Professional 4.5 Vss, Consumer 2.1 Vss
- Format Professional according to AES3-1992 Amendment 4
- Format Consumer (SPDIF) according to IEC 60958
- Single Wire: 4 x 2 channels 24 bit, up to 96 kHz
- Double Wire: 4 x 2 channels 24 bit 48 kHz, equalling 4 channels 96 kHz

ADAT Optical

- 2 x TOSLINK
- Standard: 8 channels 24 bit, up to 48 kHz
- Copy Mode: up to 2 x 8 channels 24 bit / 48 kHz
- Sample Split (S/MUX): 2 x 8 channels 24 bit / 48 kHz, equalling 8 channels 24 bit 96 kHz

TDIF

- 2 x D-sub 25 pin, according to TDIF-1
- Standard: 8 channels 24 bit, up to 48 kHz
- Copy Mode: up to 2 x 8 channels 24 bit / 48 kHz
- Sample Split (Dual Line): 2 x 8 channels 24 bit / 48 kHz, equalling 8 channels 24 bit 96 kHz

Word Clock

- BNC
- Max. output voltage: 5 Vss
- Output voltage @ 75 Ohm: 4.0 Vss
- Impedance: 10 Ohm
- Frequency range: 27 kHz – 56 kHz

4.3 Digital

- Low Jitter Design: < 1 ns internal
- Internal sample rates: 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz
- Internal resolution: 24 bit

4.4 Sample Rate Converter

- Self adjusting, high order aliasing filter (-110 dB)
- Resolution: 24 bit
- Dynamic range: 128 dBA
- Distortion (THD+N): -117 dB (0.00014%)
- Input / Output sample rate range: 27 kHz - 103 kHz
- Supports varispeed operation through fast tracking

5. First Usage

5.1 Quick Start

The user interface of the ADI-8 DD is characterized by a clearly structured architecture and an unambiguous labelling of the front and rear sides. The device can thus be used easily without a manual, because numerous LEDs show the state of the device and of all incoming and outgoing signals in a strictly logical way.

However, we have to question this statement a little, because we couldn't stop ourselves and integrated everything in the ADI-8 DD that we could think of and that was in any way possible. As a consequence, you will find some application examples in chapter 10 that break up the logical structure of the front board. Those are however very special applications for professionals, where we anticipate both the understanding of those modes and the ability to read a manual.

When being switched on for the first time, the ADI-8 DD comes up in a default mode, which should be appropriate for most applications. Both converters are set to their typical format conversion modes, and synchronize to the input signals.

AES to ADAT/TDIF:

- SOURCE: AES
- SRC not active
- Slave mode (CLOCK AES / INPUT)

ADAT/TDIF to AES:

- SOURCE: ADAT
- Slave mode (CLOCK ADAT / INPUT)
- AES STATE PRO

If the device is being used with TDIF, simply select SOURCE TDIF instead of ADAT in the right part.

The ADI-8 DD remembers all settings before switching off and sets them automatically when switching on the next time.

A quick guide for operation and functionality of the ADI-8 DD can be found on the next pages.

For transmission of the digital signals into a computer with PCI-bus, we recommend RME's interface cards of the DIGI96® and Hammerfall® series. These high quality digital audio cards are available with drivers for all common operating systems, and have the highest reputation world-wide.

5.2 The DD plain and simple

With a device as powerful as the ADI-8 DD, it is for sure sometimes difficult to find out what's going on, or can be done with it. The device is capable of 34 different format conversions – which nobody can remember. And how are they set up? What can the user do at all?

The key to understanding the ADI-8 DD is the block diagram below. Reduced to the core functionality, it shows clearly and easily to be understood, which inputs and outputs work together where and when.
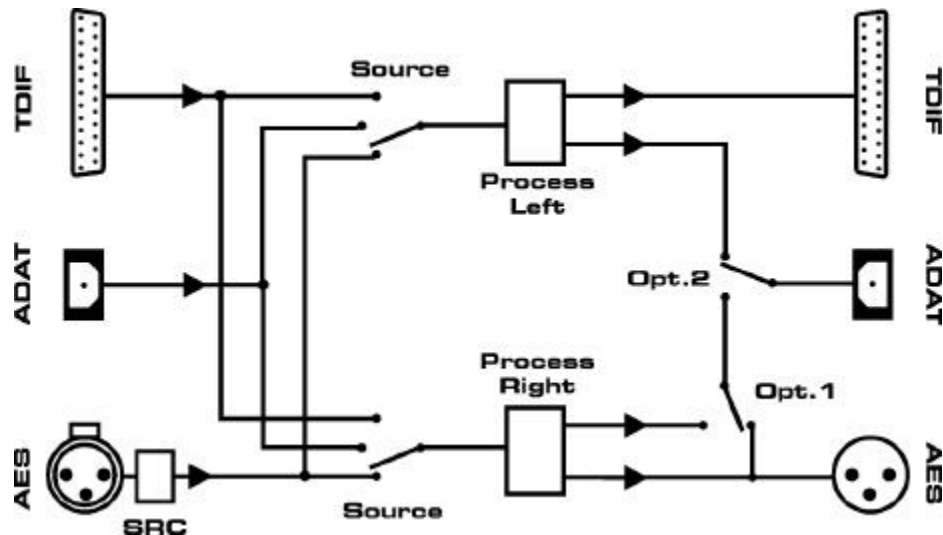
The three inputs AES, ADAT and TDIF are shown on the left side. Using one source switch each, both the left and the right part can access the inputs independently. The output of the left part is connected to TDIF, and basically also to the ADAT output. The output of the right part is connected to the AES output. This is the obvious design and functionality of the device, as can be learned from the front panel and the rear (connectors). The two converter units of the ADI-8 DD operate independently from each other, no matter which of the three inputs they use, sending a signal to their hard-wired outputs.

But there are two special cases, in which the optical ADAT outputs work for the right part instead of the left part. Using the AES STATE key, the AES signal can also be routed to the optical output*. This functionality is activated by switch Opt.2 in the diagram. It is very useful when a device shall be connected which has only an optical SPDIF input (e.g. Mini-Disc).

The second special function enables an 'ADAT to TDIF and vice versa' converter, i.e. ADAT/TDIF in both directions simultaneously. So far, the ADI-8 DD can be used bi-directional as AES to TDIF and AES to ADAT converter. But ADAT to TDIF, as well as TDIF to ADAT, are both a function of the left part, therefore require to change the input and are thus not available at the same time. As can be seen in the block diagram the ADAT output can also be fed from the right part, activated by switch Opt.1 in the diagram. The conversion TDIF to ADAT now takes place in the right part, and the ADI-8 DD can convert ADAT/TDIF in both directions at the same time.

*The AES output 1/2 is sent to the second ADAT output AUX.

5.3 Operating the ADI-8 DD

Join us for a small 'tour de ADI', starting on the left side at the *AES to ADAT/TDIF* converter. Configuration starts with choosing the input signal (AES, ADAT or TDIF). The state of the input signal is displayed by 16 LEDs. Shown are Lock (per XLR jack, including SyncCheck), Emphasis and the level of the audio signal.

SRC activates a Hi-End 8-channel Sample Rate Converter. It is especially useful when sources cannot be synced, or the output signal shall have another sampling frequency.

RME's intelligent clock control (ICC) offers extensive and professional means that are not easily met. To start with, the clock source can be set to Internal (crystal), External (BNC word clock) and Input, while Input lets you select between AES, ADAT or TDIF. The INT(ernal) clock rates are 44.1 and 48kHz, which turn to 88.2 and 96kHz after activating the DS mode. After activating SRC, any AES signal from 32 to 96kHz can be converted to 44.1, 48, 88.2 or 96kHz. Lock state and clock synchronicity are being displayed by the state of each LED (flashing or constantly lit).

The *ADAT/TDIF to AES* section is layed out in a similar way. After choosing the input signal (AES, ADAT or TDIF), the clock source and the sampling rate, there is a field with 16 LEDs for displaying the current status. An Emphasis bit at the TDIF input will be automatically set and indicated for the AES out. The Lock state of the input signals is being displayed at the SOURCE selector by flashing LED. The Sync LEDs show the synchronicity between both ADAT or TDIF inputs (or the four XLR inputs), as in double speed mode (DS) 2 I/Os are active (4 channels each).

The AES output signal can be set to Consumer or Professional subcode. The first output (channel 1/2) can optionally be output optically (via TOSLINK) using the second ADAT output. The AES STATE key also allows to connect both ADAT outputs to the AES outputs (OPT. blinking; useful for TDIF to ADAT conversion).

The unit always sends its output signal to ADAT and TDIF simultaneously. Additionally when operating at no higher than 48kHz, both ADAT outputs and TDIF interfaces get the same signal. Thus the distribution capability is doubled to 2 x ADAT and 2 x TDIF. Thanks to the freely available inputs all attached devices can send signals to each other without the need to rearrange the cabling between them.

6. The AES to ADAT/TDIF Converter

6.1 General

This ADI-8 DD's functional unit, which will be called 'left part' further on, is an 8-channel format converter from AES, TDIF or ADAT to ADAT/TDIF, with the output signal being transmitted both at the ADAT and TDIF ports in parallel. As long as the device is not working in DS mode (Double Speed), the output signal is even present at both ADAT and TDIF ports (MAIN/AUX). Therefore the ADI-8 DD can pass on a 4 x 2 channel AES/EBU input signal to up to two ADAT and TDIF devices at the same time (splitter 1 to 4). If AES is chosen as source in the right part, the signal will additionally be passed on to the four AES/EBU outputs as well.

The four AES/EBU inputs process Double Speed (up to 96 kHz) and Double Wire (up to 48 kHz) automatically. Excessive status displays (Lock, SyncCheck, Emphasis, Level) help to avoid wrong configuration and wrong clock setup.

A switchable high-end 8-channel sample rate converter can both convert the sample rate and decouple the AES/EBU inputs.

6.2 Inputs

At the rear side of the ADI-8 DD there are four XLR sockets for the AES/EBU inputs. Every input is transformer-balanced and ground-free. Channel status and copy protection are being ignored. Thanks to a highly sensitive input stage, also SPDIF signals can be processed by using a simple cable adapter (Phono/XLR).

To achieve this, pins 2 and 3 of an XLR plug are being connected to the two contacts of a Phono plug. The ground shield of the cable is only connected to pin 1 of the XLR plug.
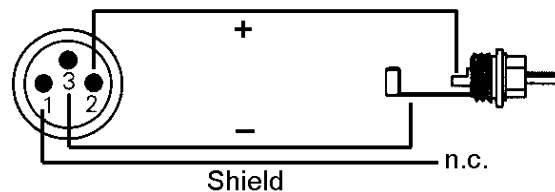
The inputs can be used in any combination, e. g. it is sufficient to connect an input signal only to input 3. In slave mode, this input is automatically being used as clock source. If more than one signal is present, the one furthest left is being used as clock source, i. e. the active input with the lowest number.

The inputs are being copied to the 8 channel ADAT/TDIF formats in logical order:

AES/EBU Input	1	2	3	4
ADAT/TDIF MAIN+AUX	1/2	3/4	5/6	7/8

If an input sample rate higher than 56 kHz is detected at the AES/EBU input, the DS LED lights up and the left part automatically switches to DS mode, using the following channel distribution:

AES/EBU	1L	1R	2L	2R	3L	3R	4L	4R
ADAT/TDIF	1/2 MAIN	3/4 MAIN	5/6 MAIN	7/8 MAIN	1/2 AUX	3/4 AUX	5/6 AUX	7/8 AUX

If a signal in Double Wire format is present at the input, technically no special processing is activated, because the output signals will be in Sample Split format (S/MUX, Double Line) right away.

6.3 Input State Display

The input state is displayed by 16 LEDs. Every input has its own SYNC LED. However a missing or invalid input signal is indicated by slow flashing of the SOURCE LED. As soon as a valid input signal is present the four SYNC LEDs will react per input. If ADAT or TDIF are chosen as input source, all four SYNC and Emphasis LEDs show the same information. In DS mode, both two and two LEDs show the state of the MAIN (1/2) and the AUX (3/4) inputs.

If a valid input signal is applied, SyncCheck is active automatically. When more than one input signal is present, the input with the lowest number serves as reference. If the AES input is not chosen as clock source, SyncCheck takes the chosen clock as reference and compares it with the input clocks. Inputs which are not synchronous will be signalled by quick flashing of the corresponding SYNC LED.

AES/EBU, SPDIF and TDIF can contain an Emphasis information. Audio signals with Emphasis have a strong high frequency boost and thus require a high frequency attenuation on playback. If one of the inputs detects Emphasis, this information is being set at the TDIF output (and being transmitted correctly to a DTRS machine). Note that the alerting red colour of the Emphasis LEDs has a reason:

Emphasis is not available within the ADAT standard! This information is thus neither passed on to the ADAT output, nor taken into account later on for acoustic transmission!

Each channel's audio level is shown by a LEVEL LED. The green LED becomes active from -90 dBFS and above, a higher level yields brighter light. Thus only one LED is necessary to see if there is an audio signal or digital zero, only noise floor or a meaningful signal.

6.4 Sample Rate Conversion

Each AES/EBU input has its own sample rate converter (SRC). An SRC allows for a conversion of the sampling rate in real-time. The 24 bit SRCs used in the ADI-8 DD work virtually without loss, i. e. there are no audible artefacts or noise signals. The SRC works so well that we could recommend to leave it switched on all the time, and thus eliminate any clock problem in the first place.

The ADI-8 DD's SRC yields a maximum conversion ratio of 3:1 or 1:3. 96 kHz can be converted to any sample rate down to 32 kHz, 32 kHz to any rate up to 96 kHz.

If the internal clock is being used, the SRC works as a perfect jitter killer. But the ADI-8 DD allows for any source as clock reference (except AES/EBU). With other settings than INT, the device is slave as usual, and the jitter of the output signal thus is depending on the jitter of the clock source.

An SRC is not only being used for conversion of sample rates and jitter suppression, it is especially useful for the so-called clock decoupling. By means of an SRC, any device which can't be synchronized (CD-Player, consumer DAT etc.) can be used within a digital audio network as if it was synchronizable. The SRC decouples any input clocks and sets the output clock to the common reference (no matter which one), thus allows for bringing together various clock sources without any clicks or drop-outs.

Further information on sample rate conversion can be found in chapter 11, Technical Background.

6.5 Outputs ADAT Optical/TDIF

The ADI-8 DD provides two digital outputs, both in ADAT optical and TDIF-1 format. In normal operation only the MAIN outputs are used. When using more than the first 4 channels at activated DS (Double Speed), the AUX outputs also have to be used.

TDIF and ADAT optical outputs always operate simultaneously and carry the same audio data. As long as DS isn't activated MAIN and AUX also operate simultaneously and carry the same audio data. With this it is possible to distribute the output signal to two devices of the same format. When using all connectors the ADI-8 DD can feed up to 4 devices (2 x ADAT, 2 x TDIF).

The ADAT optical outputs of the ADI-8 DD are fully compatible to all ADAT optical inputs. A usual TOSLINK cable is sufficient for connection.

ADAT Main
Interface for the first or only device receiving an ADAT signal from the ADI-8 DD. Carries the channels 1 to 8. When sending a Double Speed signal, this port carries the channels 1 to 4.

ADAT AUX
Copy of the data at the MAIN output. When sending a Double Speed signal, this port carries the channels 5 to 8. When AES STATE OPT is selected, ADAT AUX is used from the right part of the ADI-8 DD to send channels 1/2 in SPDIF format

The TDIF-1 connectors of the ADI-8 DD are fully compatible to all devices with such an interface, for example DA-38 and DA-88. The connection is done through a special TDIF cable, available at your local dealer (Tascam part number PW-88D).

TDIF Main
Interface for the first or only device with a TDIF-1 interface. Carries the channels 1 to 8. When transmitting a Double Speed signal, this port carries the channels 1 to 4.

TDIF AUX
Copy of the data at the MAIN interface. Carries the channels 5 to 8 in Bit Split or Double Speed mode.

General hints on TDIF operation

TDIF and word clock
When the ADI-8 DD is slave no additional word clock connection is necessary. In case DA88 and/or DA38 are slave the word clock output of the ADI-8 DD has to be connected to the word clock input of the first (master) recorder. When using more than one recorder a special sync cable (Tascam part number PW-88S) is needed.

Emphasis
The AES/EBU and TDIF interface of the ADI-8 DD support Emphasis. Please note that an Emphasis indication will not be stored or processed on the sound when doing digital transfers between AES/EBU or TDIF and ADAT, because the ADAT standard does not include Emphasis.

6.6 Input ADAT/TDIF (Copy Mode)

By means of the SOURCE button, ADAT and TDIF are available as signal sources in the left part as well. The ADI-8 DD thus turns into a unique ADAT to TDIF and TDIF to ADAT converter, a digital patch bay and signal distributor. These two source formats are notified with a yellow LED, because they are the main inputs for the right part (the ADAT/TDIF to AES/EBU converter), for which they are still available as inputs.

In this operating mode, which is called *Copy Mode* due to its identical source and destination format, the input signal can be forwarded to a same format without having to change cables externally. The mathematical equation is

(2 x ADAT In or 2 x TDIF In) to (2 x ADAT Out plus 2 x TDIF Out)

In other terms: The ADAT or TDIF input signal appears in parallel at the ADAT and TDIF outputs. And the MAIN and AUX ports can be used to pass through / distribute up to 16 channels at the same time.

In addition to the already described feature of signal distribution, the ADI-8 DD thus also works as a patch bay, because the ADAT and TDIF devices connected to the ADI-8 DD can exchange data directly among each other without re-connecting cables. An ADAT optical or TDIF input signal is being output at two ADAT optical and two TDIF ports at the same time.

Please take a look at the block diagrams on page 7 and 30. They show the whole signal routing inside the ADI-8 DD in a clear way, also for this *Copy Mode*.

> *The sample rate converter is a part of the AES/EBU inputs, so when selecting ADAT/TDIF it is still only available to the AES inputs. The AES inputs (including the SRC) can also be used by the right part of the ADI-8 DD if necessary.*

If the Copy Mode is active, the DS mode can be activated manually with the button for the sampling frequency. There is a reason for this: normally, the 8 channel input signal of the ADAT or TDIF MAIN input is copied to both outputs MAIN/AUX (splitter). But if a Sample Split, S/MUX or Double Wire signal is present at the ADAT or TDIF input, also the data of the AUX input has to be passed on to the AUX output for full transmission of 8 channels. In other terms: 16 channels are being forwarded 1:1.

> *In order to make use of all 16 TDIF and ADAT channels in Copy Mode, DS has to be activated, even if the source carries only Single Speed signals.*

The level display then works like in Sample Split operation. Two channels are being displayed on one LED (1+2, 3+4 etc.).

Note: For a bi-directional format conversion ADAT/TDIF set up the left part as ADAT to TDIF, the right part as TDIF to ADAT converter. See notes on page 15, and remarks on operation modes 10.7/10.8 on page 22.

Emphasis
The AES/EBU and TDIF interface of the ADI-8 DD support Emphasis. Please note that an Emphasis indication will not be stored or processed on the sound when doing digital transfers between AES/EBU or TDIF and ADAT, because the ADAT standard does not include Emphasis.

7. The ADAT/TDIF to AES/EBU Converter

7.1 General

This ADI-8 DD's functional unit, called 'right part' further on, is an 8-channel format converter from ADAT/TDIF or AES to AES/EBU.

Because the *Double Wire* and *Sample Split* (S/MUX) formats don't contain a coding, the ADI-8 DD cannot distinguish them from normal (44.1/48 kHz) material. Whether the AES/EBU outputs are supposed to work in Single (44.1/48 kHz) or Double Speed (88.2/96 kHz) has to be set explicitly by the user. This happens in the clock section with the sample frequency button, activating DS.

Complete status displays (Lock, SyncCheck, Emphasis, Level) help to avoid wrong configuration and wrong clock setup.

7.2 Inputs

The ADI-8 DD provides two digital inputs, both in ADAT optical and TDIF-1 format. The key SOURCE sets the desired input active.

In normal operation only the MAIN inputs are used. When using more than the first 4 channels at activated DS (Double Speed), the AUX inputs also have to be used.

The input data is passed on to the four AES/EBU outputs in logical order:

ADAT/TDIF	1	2	3	4	5	6	7	8
AES/EBU	1L	1R	2L	2R	3L	3R	4L	4R

If the input data is encoded with Sample Split, S/MUX or Double Line, the AES output has to be set to DS mode manually. Every input contains the information of only 4 channels, for full 8 channels MAIN *and* AUX have to be used. 16 input channels 44.1/48 kHz are being converted to 8 output channels 88.2/96 kHz. The channels are being distributed in the following manner:

ADAT/TDIF MAIN+AUX	1/2 MAIN	3/4 MAIN	5/6 MAIN	7/8 MAIN	1/2 AUX	3/4 AUX	5/6 AUX	7/8 AUX
AES/EBU	1L	1R	2L	2R	3L	3R	4L	4R

The ADAT optical inputs of the ADI-8 DD are fully compatible with all ADAT optical outputs. RME's unsurpassed Bitclock PLL prevents clicks and drop outs even in extreme varipitch operation, and guarantees a fast and low jitter lock to the digital input signal. A usual TOSLINK cable is sufficient for connection.

ADAT Main
Interface for the first or only device sending an ADAT signal to the ADI-8 DD. Carries the channels 1 to 8. When receiving a Double Speed signal, this input carries the channels 1 to 4.

ADAT AUX
Interface for the second device sending a Double Speed signal to the ADI-8 DD. Carries the channels 5 to 8. Receives channels 9-16 in Copy Mode.

The TDIF-1 connectors of the ADI-8 DD are fully compatible with all devices offering such an interface, for example DA-38 and DA-88. A SD-PLL ensures best playback sound quality and reliable operation. RME's exclusive SyncCheck verifies synchronous operation when using both TDIF ports. The connection is done through a special TDIF cable, available at your local dealer (Tascam part number PW-88D).

TDIF Main
Interface for the first or only device with a TDIF-1 interface. Carries the channels 1 to 8. When transmitting a Double Speed signal, this port carries the channels 1 to 4.

TDIF AUX
Carries the channels 5 to 8 in Double Speed mode. Transmission of channels 9-16 in Copy Mode.

General hints on TDIF operation

TDIF and word clock
When the ADI-8 DD is slave no additional word clock connection is necessary. In case DA88 and/or DA38 are slave the word clock output of the ADI-8 DD has to be connected to the word clock input of the first (master) recorder. When using more than one recorder a special sync cable (Tascam part number PW-88S) is needed.

7.3 Input State Display

The input state is being displayed by means of 16 LEDs. A missing or invalid input signal is indicated by slow flashing of the SOURCE LED. In case ADAT or TDIF are selected all four SYNC and Emphasis LEDs are showing the same information. In DS mode both two and two LEDs show the state of the MAIN (1/2) and the AUX (3/4) inputs.

If MAIN and AUX are not synchronous to each other, the corresponding input's SYNC LEDs will be quickly flashing. If the input is not chosen as clock reference, SyncCheck takes the chosen clock (internal, external etc.) as reference and compares it to the clocks of the inputs. Non synchronous inputs will be indicated by quick flashing of the corresponding SYNC LEDs.

If the TDIF input signal contains emphasis information, all four EMPHASIS LEDs in the INPUT STATE area will light up. The AES/EBU output channel status will then be changed from 'no emphasis' to '50/15 µs' (emphasis). Because this coding cannot be changed manually, and unfortunately does not necessarily have to be correct in the source, we chose red LEDs to give both a note and warning.

Each channel's audio level is shown by a LEVEL LED. The green LED becomes active from -90 dBFS and above, a higher level yields brighter light. Thus only one LED is necessary to see if there is an audio signal or digital zero, only noise floor or a meaningful signal.

7.4 Outputs AES/EBU

At the rear side of the ADI-8 DD there are four XLR sockets for the AES/EBU outputs. Every output is transformer-balanced, ground-free and compatible to all devices with AES/EBU port. Connection is accomplished using balanced cables with XLR plugs.

If AES STATE PRO (Professional) is chosen, the output level is almost 5V. If CON (Consumer) is chosen, the output signal will have a channel status compatible to SPDIF. As far as we know, every SPDIF device should be capable of handling an input signal of up to 5V instead of the usual 0.5V. Nevertheless the output level will be reduced to 2V when CON is selected.

Connecting devices with coaxial SPDIF ports to the ADI-8 DD is accomplished by simple cable adapters (XLR/Phono).

To achieve this, pins 2 and 3 of an XLR plug are being connected to the two contacts of a Phono plug. The ground shield of the cable is only connected to pin 1 of the XLR plug.
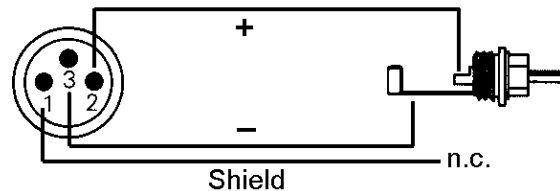
Besides the audio data, digital signals in SPDIF or AES/EBU format contain a channel status coding, which is being used for transmitting further information. The output signal coding of the ADI-8 DD has been implemented according to AES3-1992 Amendment 4.

- 32 kHz, 44.1 kHz, 48 kHz, 64, kHz, 88.2 kHz, 96 kHz according to sample rate
- Audio use
- No Copyright, Copy permitted
- Format Consumer oder Professional
- Category General, Generation not indicated
- 2-Channel, No Emphasis oder 50/15 µs
- Aux bits Audio use, 24 Bit
- Origin: ADI8

Note that most consumer-orientated equipment (with optical or phono SPDIF inputs) will only accept signals in 'Consumer' format!

The status 'Professional' should always be active when sending data to a device with AES/EBU input (when the XLR connectors are used).

Notes on special functions

Using the AES STATE key the second ADAT output can be configured to act as optical SPDIF output. When choosing AES STATE OPT., the red LED is lit constantly, and the channels 1/2 will also be transmitted via ADAT AUX.

When stepping through all AES STATE options the red LED OPT. begins to blink. The blinking informs the user, that both ADAT outputs no longer operate with the left part, but with the right part, and therefore in parallel to the AES/EBU outputs. This mode provides a bi-directional ADAT/TDIF converter.

7.5 Input AES/EBU (Copy Mode)

With the SOURCE button, AES/EBU can be chosen as the source for the right part, in addition to ADAT or TDIF. The ADI-8 DD then turns into a unique 8 channel AES/EBU to AES/EBU sample rate converter, line buffer, signal refresher and signal distributor. This input format is indicated by a yellow LED, because it is the main input for the left part (the AES/EBU to ADAT/TDIF converter), for which it is still available as input.

In addition to the already described feature of signal distribution, the ADI-8 DD thus works as a patch bay, because the AES/EBU devices connected to the ADI-8 DD can exchange data directly among each other without re-connecting cables.

Please take a look at the block diagrams on page 7 and 30. They show the whole signal routing inside the ADI-8 DD in a clear way, also for this *Copy Mode*.

Notes on special functions

In the operating mode AES to AES, which is only available in the right part, the ADI-8 DD has several special features. The right INPUT STATE display then works like the left one, and displays LOCK/SYNC and EMPHASIS per AES input.

☞ *If AES is chosen as source and only one AES input is supplied with a valid signal, the ADI-8 DD switches to a distribution mode. The input signal will then be copied to all outputs (splitter 1 to 4). Therefore all level LEDs (instead of only two) will light up.*

While in the left part an AES Double Speed signal (sample rate > 56 kHz) is being indicated automatically by the DS LED, this is not the case in the right part. If you are not sure about the input sampling frequency, you can still check it in the left part (by switching to AES source for a moment).

☞ *The reason for the missing automatism is the ability to convert Double Wire to Single Wire and Single Wire to Double Wire. This is steared by manual activation of the DS function.*

• If an AES signal in Double Wire format is present (carrier 32 to 48 kHz) and DS is activated, the data split into up to 8 channels is being converted into the original up to 4 channels Single Wire (64 to 96 kHz, output in Double Speed). As outputs 5 to 8 can't be adressed in this specific mode, the channels 1-4 are copied onto the outputs 5-8 (AES sockets 3/4). They can be used to send the converted signal simultaneously to another destination (splitter 1 to 2).

• The formats ADAT (S/MUX) and TDIF (Double Line) can also be converted to single wire double speed AES/EBU in the right part.

• If a single wire Double Speed AES signal (64 to 96 kHz) is present, the first 4 channels will be converted to 8 channels Double Wire (32 to 48 kHz) with DS deactivated.

All those conversions are loss-less, the available samples will only be put together or distributed between the channels.

In AES to AES mode the SRC is also available. Although placed on the left side of the front panel, it then works for the right part of the device. This is indicated by a quick alternating flashing of the SRC LED and the right AES SOURCE LED. If the SRC is active, the conversion between Single Wire and Double Wire as described above is not available. The DS function only sets the output sample rate.

8. Clock Section

8.1 Clock Configuration

The ADI-8 DD has an almost identical clock section in the left and right part, with professional capabilities that are hard to meet. The unique ICC technology (Intelligent Clock Control) allows for a flexible use of both functional units with internal clock (44.1 and 48 kHz, 88.2 and 96 kHz in DS mode), external word clock or the digital input signals. All options are intelligently coupled and easily applicable and understandable, thanks to a clear display of the corresponding lock state.

As clock source, INTERNAL (crystal), EXTERNAL (BNC word clock) and INPUT (the digital input signal AES/TDIF/ADAT) can be chosen. If the clock signal is present, the corresponding LED will light constantly. If not present, the LED will flash.

If the SRC is active and AES is chosen as signal source in both parts, the right part's clock LEDs will be inactive, because two different clock settings for one signal are not possible.

If AES is chosen as signal source in both parts, and the SRC is not active, both clock sections remain active. By this it is avoided that the present clock setting is lost for a short moment when stepping through the inputs on one side. Note that the clock settings on left and right part should be identical. The clock setting still remains understandable, because SyncCheck indicates reliably if wrong or unequal settings are chosen.

INPUT
As displayed on the front panel, the CLOCK SOURCE for the INPUT setting can be the AES, TDIF or ADAT input. This selection is independant from the signal source. If the signal source is set to AES, the clock source can still be ADAT, given that a valid ADAT signal is available. A missing or invalid clock source signal is indicated by slow flashing of the corresponding LED.

EXT.
With EXTERNAL, the ADI-8 DD's word clock input is used as clock reference. The LED will flash slowly, if the word clock is missing or unusable.

INT
For INTERNAL, 44.1 kHz or 48 kHz sampling rate is available. If DS is active in the left part, the data will be transmitted in Sample Split format (S/MUX, Double Line). If DS is active in the right part, the output sample rate doubles to 88.2 kHz or 96 kHz.

For the INTERNAL clock setting it is mandatory that the clock rate of the sources is synchronous to the ADI-8 DD. Therefore the external device has to be synchronized to the ADI-8 DD's word clock out or AES/TDIF/ADAT out.

The ADI-8 DD thus has to be master, all devices connected to it slave (exception: SRC mode). In order to avoid clicks and drop outs due to faulty or missing synchronicity, a special process called *SyncCheck* compares the incoming data and the ADI-8 DD's internal clock. Like LOCK, SYNC is indicated by flashing (error) or constantly lit (OK) LED. While LOCK is also indicated with the source LEDs, SyncCheck steers the four SYNC LEDs. Besides, the flashing frequency is twice as high.

8.2 Lock, SyncCheck and SyncAlign

Digital signals consist of a carrier and the data. If a digital signal is applied to an input, the receiver has to synchronize to the carrier clock in order to read the data correctly. To achieve this, the receiver uses a PLL (Phase Locked Loop). As soon as the receiver meets the exact frequency of the incoming signal, it is locked. This **Lock** state remains even with small changes of the frequency, because the PLL tracks the receiver's frequency.

If an AES, TDIF or ADAT signal is applied to the ADI-8 DD, the corresponding input LED stops flashing. The ADI-8 DD indicates LOCK, i. e. a valid input signal.

Unfortunately, LOCK does not necessarily mean that the received signal is correct with respect to the clock which processes the read out of the embedded data. Example [1]: The ADI-8 DD is set to 44.1 kHz INT(ernal), and a CD-Player is connected to input AES1. The INPUT LED will show LOCK immediately, but the CD-Player's sample rate is generated internally, and thus slightly higher or lower than the ADI-8 DD's internal sample rate. Result: When reading out the data, there will frequently be read errors that cause clicks and drop outs.

Also when using multiple inputs, a simple LOCK is not sufficient. The above described problem can be solved elegantly by setting the ADI-8 DD from INT to INPUT (its internal clock will then be the clock delivered by the CD-Player). But in case a DAT recorder is connected as a second source, there will again be a slight difference in the sample rate, and therefore clicks and drop outs [2]. Another example could be connecting to ADAT machines which are not synchronous to each other due to wrong clock setup [3].

In order to display those problems optically at the device, the ADI-8 DD contains **SyncCheck**®. It checks all clocks used for synchronicity. If they are not synchronous to each other (i. e. absolutely identical), the SYNC LED of the asynchronous input flashes. In example 1 it would have been obvious at once that the SOURCE AES LED was constantly lit when connecting the CD-Player, but that the SYNC LED was flashing. In example 2, all LEDs would be constantly lit except the SYNC LED of the input used by the DAT. In example 3, two LEDs are constantly lit, while two others are flashing.

In practice, SyncCheck allows for a quick overview of the correct configuration of all digital devices. So one of the most difficult and error-prone topics of the digital studio world finally becomes easy to handle.

A special problem occurs with devices offering several AES or SPDIF inputs. While with ADAT and TDIF all 8 channels share the same clock base, with AES there are several completely independant receivers with their own PLLs and data buffers. Therefore there can be a random error of ± 1 sample difference between the stereo pairs. The ADI-8 DD's exclusive **SyncAlign**® technology avoids this effect and guarantees sample synchronicity among all 4 stereo channels.

Unfortunately this method does not work automatically with activated SRC. After connection of all AES sources and stable LOCK switch off the SRC and on again. The SRCs are now sample-aligned (note that this is only of interest when processing a multitrack signal from *a single source*, for example a mixing desk or a tape machine).

8.3 Word Clock Input and Output

Input

The ADI-8 DD's word clock input is available to both the left and the right part. It is active, when EXT is chosen in the clock section. The signal at the BNC input can be single or double speed, the ADI-8 DD automatically adapts to it. As soon as a valid signal is detected, the EXT LED is constantly lit, otherwise it is flashing slowly.

Thanks to RME's *Signal Adaptation Circuit*, the word clock input still works correctly even with heavily mis-shaped, dc-prone, too small or overshoot-prone signals. Thanks to automatic signal centering, 300 mV (0.3V) input level are sufficient in principle. An additional hysteresis reduces sensitivity to 1.0 V, so that over- and undershoots and high frequency disturbances don't cause a wrong trigger.

The ADI-8 DD's word clock input is shipped as high impedance type (not terminated). A push switch allows to activate internal termination (75 Ohms). The switch is found on the back between the ADAT ports. Use a small pencil or similar and carefully push the blue switch so that it snaps into its lock position. Another push will release it again and de-activate the termination.
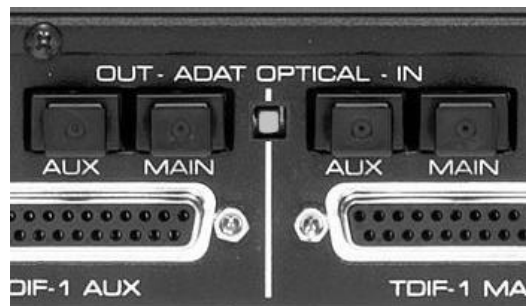
Output

The word clock output is constantly active and basically delivers the sample rate of the left part as word clock signal. As long as it is working with internal clock, the output word clock is extremely stable and jitter-free (< 1 ns). The device can even be used as a central word clock generator (except for the limitation of having only one output). In slave mode (EXT/INPUT), the amount of jitter is depending on the input signal.

A word clock signal fed to the ADI-8 DD can even be passed through via the word clock output, because the output signal is phase locked to the input signal (0°). Thus the usual T-adaptor at the input is not needed, and the ADI-8 DD can be used as a signal refresher. This application is even more interesting, because the exceptional input of the ADI-8 DD (1 Vss sensitivity instead of the usual 2.5 Vss, dc cut, Signal Adaptation Circuit) guarantees a secure function also with critical word clock signals.

☞ *The ADI-8 DD's word clock output is derived from the left part, because the TDIF ports need a fixed word clock reference.*

For this reason, the word clock signal derived from AES, TDIF and ADAT has a phase shift of 90° at the output. This has no effect when being used with AES or ADAT, because these formats don't require a certain relation to the word clock signal.

☞ *The wordclock output as well as all ADAT and TDIF ports always operates in Single Speed mode only. At 96 kHz, the word clock output will therefore be a 48 kHz signal.*

Thanks to a low impedance, but short circuit proof output, the ADI-8 DD delivers 4 Vss to 75 Ohms. For wrong termination with 2 x 75 Ohms (37.5 Ohms), there are still 3.3 Vss at the output.

9. Word Clock

9.1 Operation and Technical Background

In the analogue domain one can connect any device to another device, a synchronization is not necessary. Digital audio is different. Correct interpretation of digital audio data is dependent upon a definite sample frequency. Signals can only be correctly processed or transferred between devices if these all share the same clock. Otherwise digital signals are misinterpreted, causing distortion, clicks/crackle and even dropouts.

AES/EBU, SPDIF and ADAT optical are self-clocking (seen from a non-technical view TDIF too, as word clock is embedded inside the TDIF cable), so an additional line for word clock could be considered redundant. In practice however, using several devices at the same time can cause problems. For example, if devices are connected in a loop without there being a defined 'master' device, self-clocking may break down. Besides, the clocks of all devices must be synchronized from a single source. Devices without SPDIF inputs (typically playback devices such as CD- players) cannot be synchronized via self-clocking. Finally there are 'problematic' devices, which are nearly un-usable without a word clock attached anyway.

In digital studios, synchronization requirements can be met by connecting all devices to a central sync source. For instance, the master device could be a mixing desk, sending a reference signal - word clock - to all other devices. However, this will only work if all the other devices have word clock or sync inputs (e.g. some professional CD-players), allowing them to run as slaves. This being the case, all devices will receive the same clock signal, so there is no fundamental reason for sync problems when they are connected together.

But word clock is not only the 'great problem solver', it also has some disadvantages. The word clock is based on a fraction of the really needed clock. For example SPDIF: 44.1 kHz word clock (a simple square wave signal) has to be multiplied by 128 or 256. This signal then replaces the one from the internal quartz crystal. Because of the high multiplication factor the reconstructed clock will have great deviations called jitter. The jitter caused by word clock is typically 15 times higher as when using a quartz based clock*.

The end of these problems should have been the so called Superclock, which uses 256 times the word clock frequency. The PLL for multiplying is no longer needed, and the clock can be used directly. But in practise Superclock proved to be much more critical than word clock. A square wave signal of 11 MHz distributed to several devices - this simply means to fight with high frequency technology. Reflections, cable quality, capacitive loads - at 44.1 kHz these factors may be ignored, at 11 MHz they are the end of the clock network. After all, Superclock never became popular - and we didn't make up our minds to add this not standardized technique to the ADI-8 DD.

The usage of word clock with ADAT optical is critical too. The ADI-8 DD always uses a Bitclock PLL, no matter if the clock reference is word clock or ADAT. Thanks to its very fine resolution this exceptional circuit is able to follow the complete vari-speed range of the ADAT recorder without losing a sample. Many other devices use a much coarser word clock PLL to track the ADAT input. When changing the sample rate (speed) fast, some bits are already sampled invalidly before the frequency is corrected. Drop outs and crackling will be the audible result. So as long as you are working with the ADI-8 DD - no problem. Working with devices of other manufacturers you may experience drop outs when the sample rate changes only slightly.

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* As long as it does not cause functional problems, jitter is only affecting AD- and DA-conversion. For completely digital devices like the ADI-8 DD jitter is virtually meaningless, because the data remains unaltered even with high jitter.

The TDIF format is especially critical with respect to word clock. We have mentioned this in different places of this manual:

When the ADI-8 DD is slave no additional word clock connection is necessary. In case DA88 and/or DA38 are slave the word clock output of the ADI-8 DD has to be connected to the word clock input of the first (master) recorder. When using more than one recorder a special sync cable (Tascam part number PW-88S) is needed.

What you do not need to know: the ADI-8 DD takes care of the first DTRS machine's properties, the DA-88, and it can be used together with this device without further settings.

9.2 Cabling and Termination

Word clock signals are usually distributed in the form of a network, split with BNC T-adapters and terminated with resistors. We recommend using off-the-shelf BNC cables to connect all devices, as this type of cable is used for most computer networks. You will find all the necessary components (T-adapters, terminators, cables) in most electronics and/or computer stores.

Ideally, the word clock signal is a 5 Volt square wave with the frequency of the sample rate, of which the harmonics go up to far above 500 kHz.

To avoid voltage loss and reflections, both the cable itself and the terminating resistor at the end of the chain should have an impedance of 75 Ohm. If the voltage is too low, synchronization will fail. High frequency reflection effects can cause both jitter and sync failure.

Unfortunately there are still many devices on the market, even newer digital mixing consoles, which are supplied with a word clock output that can only be called unsatisfactory. If the output breaks down to 3 Volts when terminating with 75 Ohms, you have to take into account that a device, of which the input only works from 2.8 Volts and above, does not function correctly already after 3 meter cable length. So it is not astonishing that because of the higher voltage, word clock networks are in some cases more stable and reliable if cables are not terminated at all.

Ideally all outputs of word clock delivering devices are designed with very low impedance, but all word clock inputs with high impedance, in order to not weaken the signal on the chain. But there are also negative examples, when the 75 Ohms are built into the device and cannot be switched off. In this case the network load is often 2 x 75 Ohms, and the user is forced to buy a special word clock distributor. Note that such a device is generally recommended for larger studios.

Also, 75 Ohm cable is almost impossible to find these days. 50 Ohm cable is standard - this will also work as long as the termination resistors are 75 Ohm.

The ADI-8 DD's word clock input can be high-impedance or terminated internally, ensuring maximum flexibility. If termination is necessary (e.g. because ADI-8 DD is the last device in the chain), push the switch at the back (see chapter 8.3).

In case the ADI-8 DD resides within a chain of devices receiving word clock, plug a T-adapter into its BNC input jack, and the cable supplying the word clock signal to one end of the adapter. Connect the free end to the next device in the chain via a further BNC cable. The last device in the chain should be terminated using another T-adapter and a 75 Ohm resistor (available as short BNC plug). Of course devices with internal termination do not need T-adaptor and terminator plug.

10. Conversion Modes and Notes

In this chapter the ADI-8 DD's conversion modes are listed functionally and separated for left and right part. At first the functions of the left part are described. From chapter 10.7 on the right part follows. Chapter 10.12 describes a special case where both parts are being operated together.

'ADAT || TDIF' means that the output signal is present at the ADAT and TDIF outputs in parallel, i. e. at the same time. 'ADAT / TDIF' means that either ADAT *or* TDIF can be used as input signal.

Left Part

10.1 8-channel AES to ADAT || TDIF Converter (96 kHz)

SOURCE: AES

Remark: For sample rates higher than 56 kHz the DS LED lights up, and the outputs automatically work in Sample Split/Double Line mode. Each output port (MAIN/AUX) then carries 4 channels.

10.2 8-channel AES to 2 x ADAT || 2 x TDIF Splitter (48 kHz)

SOURCE: AES

Remark: For sample rates below 56 kHz the MAIN and AUX outputs will carry the same data. Thus two outputs each can be used for ADAT and TDIF (splitter).

10.3 2-channel AES to 8-hannel TDIF || ADAT Splitter (96 kHz)

SOURCE: AES

Remark: If only one AES input is being fed, the ADI-8 DD automatically switches to a distribution mode. The input signal will then be copied to all stereo output channels (splitter 1 to 4). Because MAIN and AUX carry the same data, the input signal is split to eight stereo pairs for ADAT and eight stereo pairs for TDIF. If AES is selected in the right part, the stereo input signal will also appear at all four AES outputs.

For sample rates above 56 kHz the DS LED lights up, and the outputs operate in Sample Split/Double Line mode. Every output (MAIN/AUX) then carries 4 channels.

10.4 8-channel ADAT/TDIF to 2 x ADAT || 2 x TDIF Splitter (48 kHz)

SOURCE: ADAT or TDIF

Remark: For sample rates below 56 kHz the MAIN and AUX outputs will carry the same data. Thus two outputs each for ADAT and TDIF can be used (splitter).

10.5 16-channel ADAT/TDIF to ADAT || TDIF Converter (48 kHz)

SOURCE: ADAT or TDIF

Remark: If DS is activated manually at sample rates below 56 kHz, the MAIN and AUX outputs will not carry the same data any longer. Instead the data from the MAIN and AUX inputs will be passed 1:1 to the MAIN/AUX outputs. It is then possible to transmit and convert 16 channels at the same time.

10.6 8-channel ADAT/TDIF to ADAT || TDIF Converter (96 kHz)

Remark: Identical to 10.5

Signals in Sample Split (S/MUX) or Double Line format require 16 channels for the transmission of 8 channels in Double Speed. Therefore the data has to be passed on 1:1.

Right Part

10.7 8-channel TDIF/ADAT to ADAT || AES Converter (96 kHz)

SOURCE: ADAT or TDIF

Remark: If the input data is encoded in Sample Split (S/MUX) or Double Line format, the DS function has to be activated manually in order to have the AES outputs transmit 8 channels in Double Speed Single Wire.

Note: When the red AES STATE OPT. LED is blinking the ADAT outputs are fed from the right part. Conversion mode 10.6 and 10.7 then realize a bi-directional ADAT/TDIF converter.

10.8 16-channel TDIF/ADAT to ADAT (|| AES) Converter (48 kHz)

SOURCE: ADAT or TDIF

Remark: identical to 10.7. When operating at sample rates below 56kHz, up to 16 channels can be processed. But as the unit is limited to 4 AES outputs, only the first 8 channels will be available in parallel at the AES outputs.

Note: When the red AES STATE OPT. LED is blinking the ADAT outputs are fed from the right part. Conversion mode 10.5 and 10.8 then realize a bi-directional ADAT/TDIF converter.

10.9 8-channel AES to AES Sample Rate Converter (96 kHz)

SOURCE: AES

Remark: After activating the sample rate converter (SRC) and using the internal clock (INT), the desired output sample rate can be chosen with the clock button.

10.10 2-channel AES to 8-channel AES Splitter (96 kHz)

SOURCE: AES

Remark: If only one AES input is being fed with a valid signal, the ADI-8 DD automatically switches to a distribution mode. The input signal will be copied to all stereo output channels (splitter 1 to 4), i. e. it will appear at all four AES outputs. If AES is selected as input source for the left part, this also holds true for the ADAT/TDIF outputs (see 10.3).

10.11 4-channel AES Double Wire to AES Single Wire Converter (96 kHz)

SOURCE: AES

Remark: If the input signal is present in Double Wire format, DS has to be activated manually in order to have the AES outputs transmit 4 channels of Double Speed Single Wire data.

10.12 4-channel AES Single Wire to AES Double Wire Converter (96 kHz)

SOURCE: AES

Remark: When DS is not active and the input signal is in Single Wire Double Speed format, the data will be converted to Double Wire Single Speed. Because only 8 physical output channels are available, there will only be 4 audio channels effectively. The inputs 5 - 8 cannot be transmitted via AES.

10.13 8-channel ADAT/TDIF to ADAT || TDIF Sample Rate Converter (96 kHz)

The ADI-8 DD's sample rate conversion is a fixed component of the AES inputs. However, because the device contains two independant format converters, also 8 channels ADAT or TDIF can be both changed in sample rate *and* clock-decoupled!

To achieve this, connect the four AES outputs with the four AES inputs (loop-back cabling), i. e. 1 with 1, 2 with 2, 3 with 3 and 4 with 4.

Right part
SOURCE: ADAT or TDIF

Left part
SOURCE: AES
SRC: Active

At first ADAT/TDIF is converted to AES in the right part. The ADI-8 DD's AES outputs are connected to the AES inputs with XLR cables and are being converted back to ADAT||TDIF in the left part. Now the SRC can also be activated.

11. Technical Background

11.1 DS - Double Speed

When activating the *Double Speed* mode the ADI-8 DD operates at double sample rate. The internal clock 44.1 kHz turns to 88.2 kHz, 48 kHz to 96 kHz. The internal resolution is still 24 bit.

Sample rates above 48 kHz were not always taken for granted, and are still not widely used because of the CD format (44.1 kHz) dominating everything. Before 1998 there were no receiver/transmitter circuits available that could receive or transmit more than 48 kHz. Therefore a work-around was used: instead of two channels, one AES line only carries one channel, of which the odd and even samples are being distributed to the former left and right channels. By this, you get the double amount of data, i. e. also double sample rate. Of course in order to transmit a stereo signal two AES/EBU ports are necessary then.

This transmission mode is being called *Double Wire* in the professional studio world, and is also known as *S/MUX* in connection with the ADAT format. The DTRS recorder DA-98HR by Tascam also uses this technique, which is called *Dual Line* here.

Not before February 1998, Crystal shipped the first 'single wire' receiver/transmitters that could also work with double sample rate. It was then possible to transmit two channels of 96 kHz data via one AES/EBU port.

But *Double Wire* is still far from being dead. On one hand, there are still many devices which can't handle more than 48 kHz, e. g. digital tape recorders. But also other common interfaces like ADAT or TDIF are still using this technique.

Because the ADAT interface does not allow for sampling frequencies above 48 kHz (a limitation of the interface hardware), the ADI-8 DD automatically uses the described *Sample Split* method in DS mode. One channel's data is distributed to two channels according to the following table:

Original	1	2	3	4	5	6	7	8
DS Signal Port	1/2 MAIN	3/4 MAIN	5/6 MAIN	7/8 MAIN	1/2 AUX	3/4 AUX	5/6 AUX	7/8 AUX

As the transmission of double rate signals is done at standard sample rate (Single Speed) the word clock output still delivers 44.1 kHz or 48 kHz.

☞ *The wordclock output as well as all ADAT and TDIF ports always operates in Single Speed mode only. At 96 kHz, the word clock output will therefore be a 48 kHz signal.*

The TDIF interface of the ADI-8 DD also supports the 'Double Wire' technique. This allows a recording with up to 96 kHz at halfed track numbers with every (!) DTRS device.

Note: The ideal combination is an ADI-8 DD together with the digital I/O card **RME Hammerfall Light** (DIGI9636), which has Sample Split implemented in hardware. This combination offers 4 AES/EBU I/Os, with 2 channels 24 bit/96 kHz each, using PC or Mac.

11.2 AES/EBU - SPDIF

The most important electrical properties of 'AES' and 'SPDIF' can be seen in the below table. AES/EBU is the professional balanced connection using XLR plugs. The standard is being set by the *Audio Engineering Society* based on the AES3-1992. For the 'home user', SONY and Philips have omitted the balanced connection and use either Phono plugs or optical cables (TOSLINK). The format called S/P-DIF (SONY/Philips Digital Interface) is described by IEC 60958.

Type	AES3-1992	IEC 60958
Connection	XLR	RCA / Optical
Mode	Balanced	Un-balanced
Impedance	110 Ohm	75 Ohm
Level	0.2 V up to 5 Vss	0.2 V up to 0.5 Vss
Clock accuracy	not specified	I: ± 50ppm
		II: 0,1%
		III: Variable Pitch
Jitter	< 0.025 UI (4.4 ns @ 44.1 kHz)	not specified

Besides the electrical differences, both formats also have a slightly different setup. The two formats are principally compatible, because the audio information is stored in the same place in the data stream. However, there are blocks of additional information, which are different for both standards. In the table, the meaning of the first byte (#0) is shown for both formats. Already in the first bit there is the decision, whether the following bits should be read as Professional or Consumer information.

Byte	Mode	Bit 0	1	2	3	4	5	6	7
0	Pro	P/C	Audio?	Emphasis			Locked	Sample Freq.	
0	Con	P/C	Audio?	Copy	Emphasis			Mode	

As can be seen, the meaning of the following bits differs quite substantially in both formats. If a device like a common DAT recorder only has an SPDIF input, it usually understands only this format. In most cases, it will switch off when being fed Professional-coded data. The table shows that a Professional-coded signal would lead to malfunctions for copy prohibition and emphasis, if being read as Consumer-coded data. This actually happened in former times, but if found today then it was implemented to force the costumer to buy a more expensive device.

Nowadays many devices with SPDIF input can handle Professional subcode. Devices with AES3 input almost always accept Consumer SPDIF (passive cable adapter necessary).

11.3 Clock De-coupling using the SRC

Master-slave problems occur at the latest with the use of a digital mixer. For 'normal' use of CD-player, DAT and harddisk recording, the tasks are clearly defined. The device playing back is the master in each case, the recording device the slave. The CD-player delivers the clock and the DAT synchronizes to it.

When working with a digital mixer, the CD-player would be the master and the mixer the slave. This model breaks down with a single stroke, if a DAT is also being connected, which is not recording, but also playing back. Every digital device can only synchronize to one source, the audio data of the other sources is processed with errors due to missing synchronization. Clicks and drop outs are the consequence.

Normally, the mixing console works as master and delivers a reference signal (word clock) to all other devices. But this is only possile, if the other devices have a sync input, i. e. are capable of being slaved. In a studio with digital tape machine, digital effects and harddisk recording, common CD-players and DATs cannot be connected to the mix section of the console, simply because they cannot be synchronized.

This is no problem, if a sample rate converter is being used. It synchronizes any input signal to the desired sampling rate, re. the desired clock reference.

By this, any device can be connected via the ADI-8 DD to any other device in a studio with a central clock, independant from its original capabilities. Instead of the CD-player or the DAT, the ADI-8 DD is the slave now.

11.4 The SRC as Signal Conditioner

DAT tapes often show little formatting errors between the various recorded takes. There can also be tiny snippets with other sample rates between the recordings. An SRC converts this patch-work reliably into a continuous permanently valid data stream with a fixed sample rate. Even if there are unformatted spots on the tape, or the DAT is being stopped or switched off, the ADI-8 DD delivers a constant signal (which does of course not contain audio information in this case).

The use as supplier of an uninterrupted data stream is also helpful for applications, that would otherwise suffer from functional errors or automatic switch-off of devices. Thanks to the SRC, the ADI-8 DD always delivers a constant output clock, no matter if the inputs are not being used at the moment, are just being connected or have been used all the time.

12. Controls and Connectors

Front Left Part

Clock Section

Signal source	Status display	Sample	Clock source	Clock source	Internal clock
AES	Lock of inputs	Rate	AES	Input	44.1 / 48 kHz
TDIF	Emphasis	Converter	TDIF	External	DS active:
ADAT	Level indication		ADAT	(Word clock)	88.2 / 96 kHz
				Internal	

Front Right Part

Clock Section

Signal source	Clock source	Clock source	Internal clock	Status display	Status AES output
AES	AES	Input	44.1 / 48 kHz	Lock of inputs	Professional
TDIF	TDIF	External	DS active:	Emphasis	Consumer
ADAT	ADAT	(Wordclock)	88.2 / 96 kHz	Level indication	Optical output
		Internal			

Rear

Power   Outputs   Inputs

13. Connector Pinouts

D-Sub TDIF-1

The 25 pin D-sub connectors are wired according to TDIF-1, version 1.1:

Signal	Out 1/2	Out 3/4	Out 5/6	Out 7/8	Out LRCK	Out EMPH	Out FS0	Out FS1
D-sub	1	2	3	4	5	18	6	19

Signal	In FS1	In FS0	In EMPH	In LRCK	In 7/8	In 5/6	In 3/4	In 1/2
D-sub	20	8	21	9	10	11	12	13

GND is connected to pins 7, 14, 15, 16, 17, 22, 23, 24, 25.

### AES/EBU

The XLR connectors are wired according to AES3-1992:

1 = GND (shield)
2 = Signal
3 = Signal

AES/EBU and SPDIF are biphase modulated signals, therefore polarity doesn't matter. Pins 2 and 3 are neither hot nor cold, they carry the same signal. But as AES3 uses a balanced transmission they are inverted in polarity.

14. Block Diagram

On the following page, there is a block diagram of the ADI-8 DD. It shows a functional overview of the device in order to help with questions regarding functions and routing. It has been made simpler in some points and does not show all possible functions in order to remain understand-able and overseeable. So, for instance the function of the optical SPDIF output is missing.

14. Block Diagram
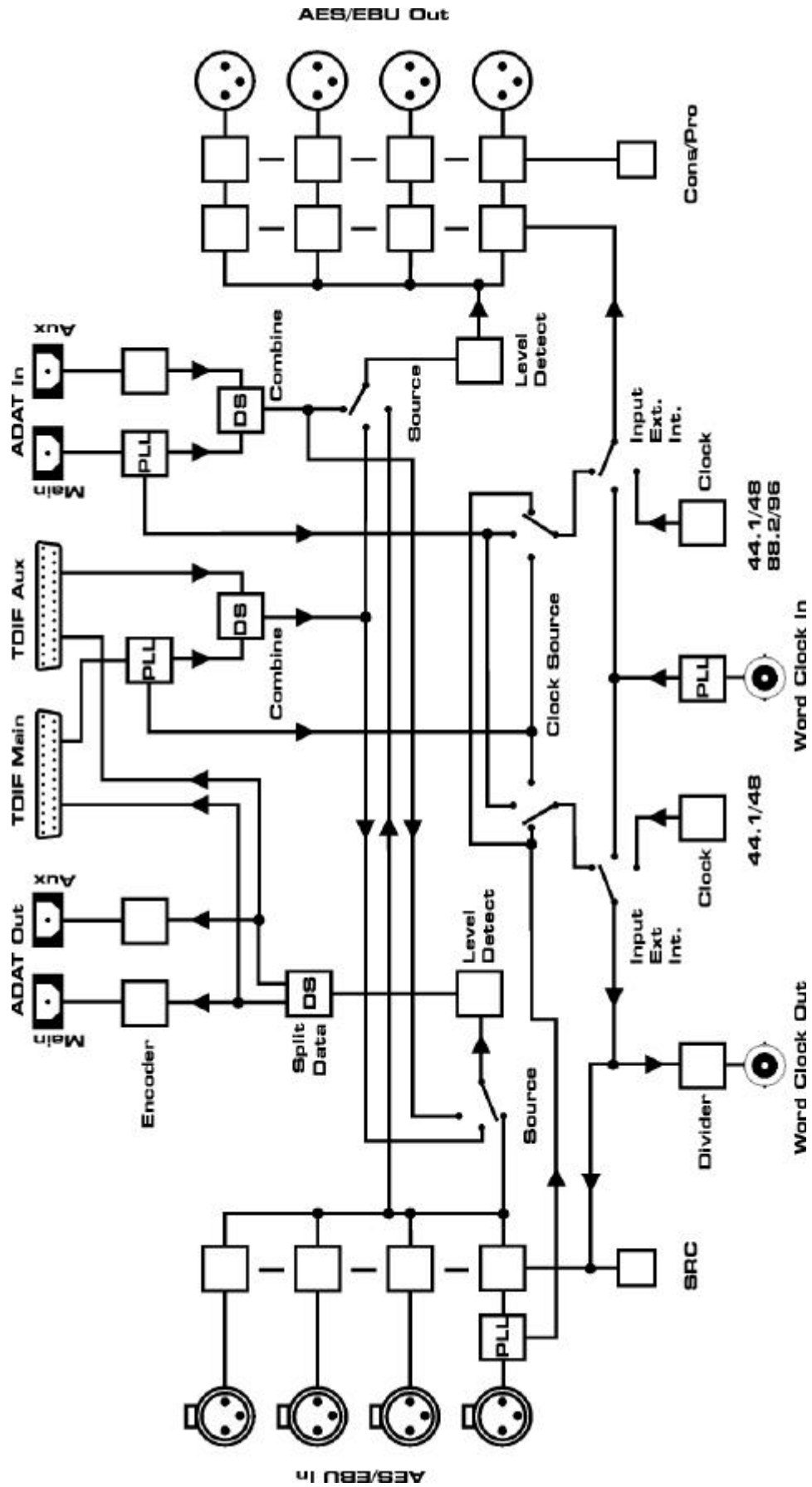
15. Warranty

Before shipping each ADI-8 DD is tested by RME in a complete test sequence. Using only the best hi-grade components allows us to offer two years of warranty. The copy of the sales receipt or the Bill of Sale is your warranty legitimation.

In case of any error or defect please contact your local dealer. The warranty does not cover damage due to abuse, incorrect installation or incorrect handling.

RME's liability is limited to the repair or the replacement of the product, and does in no way include the liability for incidental or consequential damages resulting from using the ADI-8 DD.

16. Appendix

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

http://www.rme-audio.com

Distributor:
Synthax, Am Pfanderling 62, D-85778 Haimhausen, Tel.: (49) 08133 / 91810

Manufacturer:
IMM Elektronik GmbH, Leipziger Str. 27, D-09648 Mittweida

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CE

This device has been tested and found to comply with the limits of the European Council Directive on the approximation of the laws of the member states relating to electromagnetic compatibility (EMVG) according to EN 55022 class B and EN50082-1.

FCC Compliance Statement

Certified to comply with the limits for a Class B computing device according to subpart J or part 15 of FCC rules. See instructions if interference to radio reception is suspected.

FCC Warning

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This device complies with part 15 of 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.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

• Reorient or relocate the receiving antenna
• Increase the seperation between the equipment and receiver
• Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
• Consult the dealer or an experienced radio/TV technician for help.

In order for an installation of this product to maintain compliance with the limits for a Class B device, shielded cables must be used for the connection of any devices external to this product.