

MANUAL

# PAS-8

DIGITAL AUDIO-ROUTER



FUNK TONSTUDIOTECHNIK

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# PLEASE NOTE

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This user manual only applies to the **PAS-8** digital router with 8 digital inputs.

## CAUTION:

Always connect this device to a 230 VAC /50..60 Hz (115 VAC /50—60 Hz) earthed power supply.

Never connect the device to any outlet without a protective earth contact!

Never expose the device to rain or moisture, as this creates a hazard of fire and electrical shock. Do not connect the device to a power supply if it has been damaged mechanically, or if fluids or objects have entered into it. Immediately disconnect the power supply in the event of mechanical damage or contact with fluids. Only qualified service personnel following all applicable rules and regulations may open the device or perform repairs.

## ENVIRONMENTAL REQUIREMENTS:

Never place the device near heat sources like radiators or hot-air vents. Do not expose the device to dust, vibration, or mechanical shocks.

## CONDENSATION:

When the device is brought from a cold into a warm environment, water may condense in the interior, and there is a risk of malfunction. Do not turn on the device for thirty minutes after such a temperature change in order to allow the PAS-8 to assume the temperature of the environment.

## CLEANING:

Use a soft cloth slightly moistened with a mild soap solution for cleaning the casing, the front panel, and the controls. Do not use abrasive pads or powders or alcohol or petroleum-based solvents to clean the device, as this may damage the casing surface and the controls.

## WARRANTY:

This device has a three-year warranty. Any manufacturing or material defects will be repaired free of charge during this period. Unauthorised opening will void the warranty!

# PAS - 8 INTRODUCTION

## PAS-8

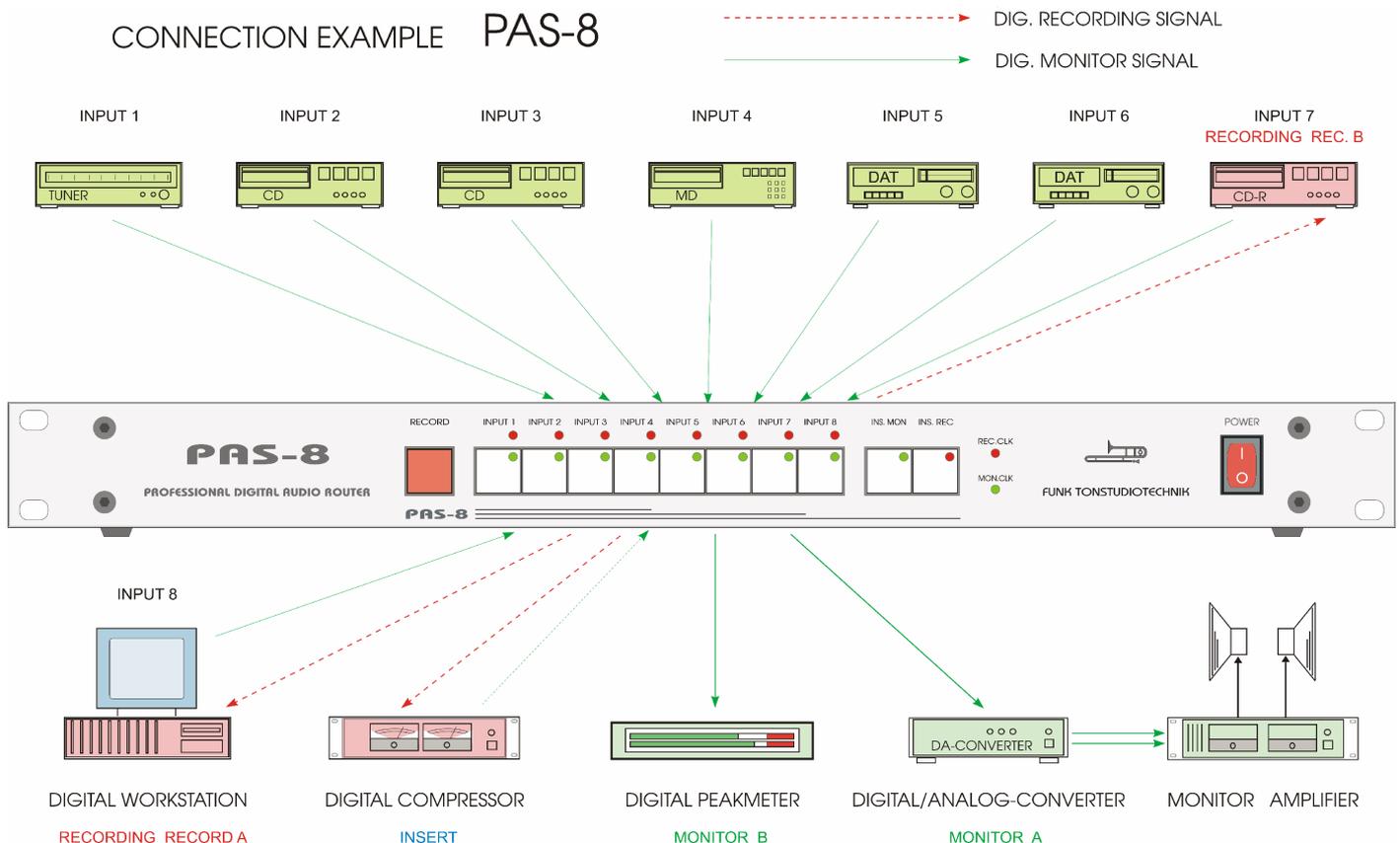
## DIGITAL MONITOR ROUTER

The **PAS-8 DIGITAL AUDIO SIGNAL SWITCH** is a professional monitor router for AES/EBU signals. It is used to play back, record, and monitor digital signals in recording and video studios. The **PAS-8** is ideal for connecting digital audio devices to AES/EBU interfaces and various peripheral devices. All inputs and outputs have XLR jacks with gold-plated contacts.

The PAS-8 is not a format converter. However, it accepts the commonly used SPDIF signal levels. The signal output is at the usual AES/EBU level of 4 V<sub>ss</sub> (peak to peak).

The device is controlled using buttons on the front panel. However, it can also be remote controlled via **AMS-2** or **MTX-MONITOR** monitor systems.

As a special feature, the PAS-8 offers a switchable **INSERT** function. This permits a processing unit connected to the rear XLR jacks to be looped into the signal chain. This function can be selected for the monitor or the recording channel. This for instance allows (as shown in the example below) a digital compressor to be routed into the monitor channel for adjustment, then switched to the recording channel after optimisation. Afterwards the monitor channel will be free for monitoring again.



At this configuration example it is possible to make a copy from every source to the CD-Recorder or to the digital workstation. At the same time it is possible to monitor another source independent from the recording signal and to measure the level of this signal. The digital compressor is switchable into the copy signal path or to the monitor signal for testing.

# PAS - 8 INTRODUCTION

## CIRCUITRY:

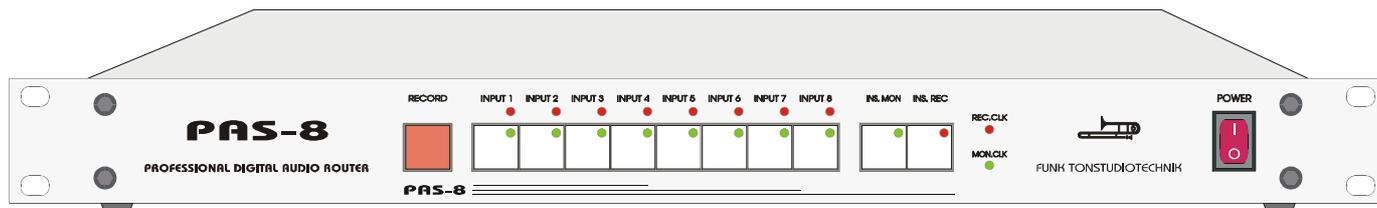
The router's active circuitry ensures low jitter, which makes the device suitable for use before a D/A converter in the signal chain. In order to improve the operation of a subsequent converter, the output amplifiers of the PAS-8 come with DUTY CYCLE correction. This ensures a DC-free output signal irrespective of the signal level and duty cycle (mean time ratio of positive and negative bits) of the selected source, in addition to reducing potential jitter caused by the low-pass effect of a connected line.

## SYNCHRONISATION:

The PAS-8 does not require external synchronisation. If the router is operated as a signal switch in a synchronised periphery environment, then signal switch-over is noise-free for two identically modulated signal sources, as well as for digital = 0. The same is true for switchover between two signals derived from a single source by splitting between two matrix inputs.

Switching between two differently modulated signals however produces a cracking noise due to the level difference at the moment of switchover. This type of switchover noise is inherent to the design of fast switching analogue and digital matrices.

The delay between switching off the first signal and switching on the new signal is in the nanosecond range ( $10^{-8} \dots 10^{-9}$  s).



## FRONT PANEL

### MONITOR SELECT:

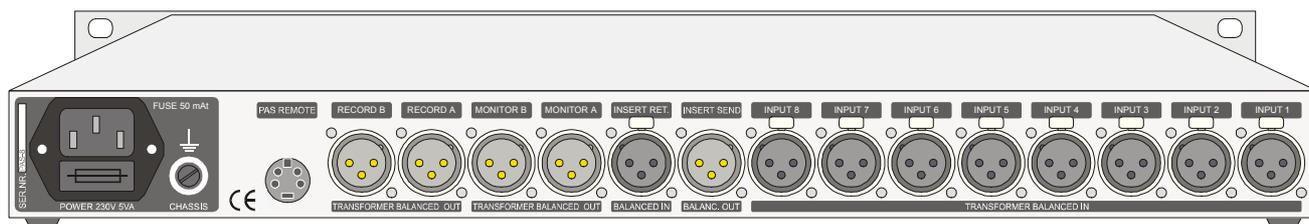
Two symmetrical stereo routers (monitor and recording router) form the core of the PAS-8. The **MONITOR ROUTER** is used to select the desired monitor signal.

### RECORD SELECT:

Selecting the **RECORD ROUTER** allows a signal to be selected as the recording source independent of the signal source.

### DIGITAL INSERT:

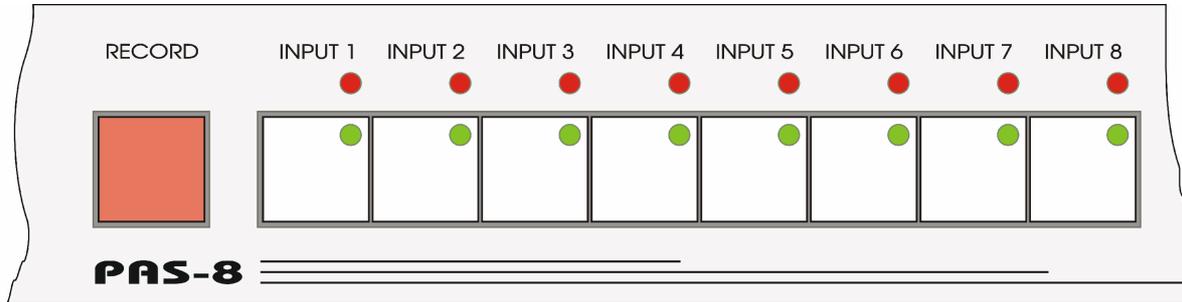
This button is used to insert an external digital processing unit into the monitor or recording channel.



## BACK PANEL

# PAS - 8 OPERATION

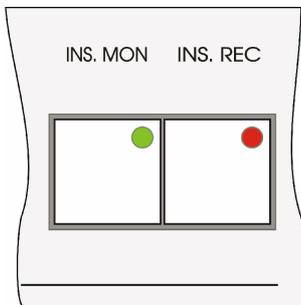
## OPERATION:



## DIGITAL INPUT SWITCHOVER:

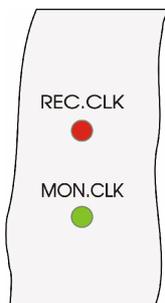
The digital **monitor signal** is selected by pushing the corresponding **INPUT 1..8** button. Selecting a new input turns off the previously selected channel. In addition to the digital monitor matrix, the router also features a second digital matrix for recording. This allows a user to select a signal from inputs 1..8 and use it as the source for a connected digital recorder. This is independent from the signal that is currently being monitored. Pressing **SHIFT** and simultaneously selecting a digital source (1..8) activates the digital **RECORDING MATRIX** and routes the selected signal to the **recording output**.

## DIGITAL INSERT:



The **INS.MON** and **INS.REC** are used to patch the point of insertion either into the **monitor** or the **recording** signal channel. The monitor and recording channels are interlocked in order to prevent the insert function to be routed into both channels simultaneously. This means that before the insert can be patched into the monitor channel, any active recording insert needs to be switched off and vice versa.

## CLOCK DISPLAY:



These two LEDs indicate the presence of a digital signal with a valid input level at the selected PAS-8 input. For instance, if an input with a valid digital signal is selected for the monitor matrix, the relevant **MON.CLK** LED (green) lights up. This also happens for non-modulated signals (digital level = 0), as long as the sample rate is present.

The **REC.CLK** LED (red) works similarly for the selected recording signal.

# PAS - 8 AUDIO FORMAT and CONFIGURATIONS

## DIGITAL FORMAT:

The 8 inputs of the router's two active digital matrices are designed for **AES/EBU** and **AES-3** formats. The inputs also accept SPDIF signals, as long as the usual level (400...500 mV) is maintained. A selected signal is patched through to the output (e.g. for an external D/A converter) and provided (buffered) to a second output (e.g. for a digital peak meter). This applies both to the recording matrix and the monitor matrix.

The output format is the same as the input format; the digital signal is not processed in any way. (Further processing steps like format conversion, signal distribution or sample rate conversion in **AES/EBU** or **SPDIF** format are available using the **DAS-SRC** or the **DDA-12**).

The PAS-8 is fully transparent for all data in the serial data stream. All usual sample rates can be processed (including 96 kHz and 24 bit signals).

## INPUT IMPEDANCE:

All inputs and outputs of the digital router are symmetrical and equipped with transformers. The input impedance can also be set later, separately for each input, by using jumpers. Input impedance is  $>1\text{ k}\Omega$  with the jumper open and  $110\ \Omega$  with the jumper closed. This makes it easier to distribute the signal to additional recipients.

## INPUT SIGNAL SPLITTING:

In order to send a signal not only to the digital switch but also to a second digital recipient, the jumper for the relevant input is opened in the router. The signal line is routed from the source to the PAS-8 first, then to the second recipient.

The router is delivered with a 110 Ohm input terminator. For more information on configuring the PAS-8's input resistors, please see the "INPUT IMPEDANCE" section.

## BACKUP:

In the event of a power failure or when the device is turned off, the current input selection is automatically backed up in non-volatile memory. As soon as the power supply is back online, the router automatically restores the stored configuration. This also allows the **PAS-8** to be operated with a time switch.

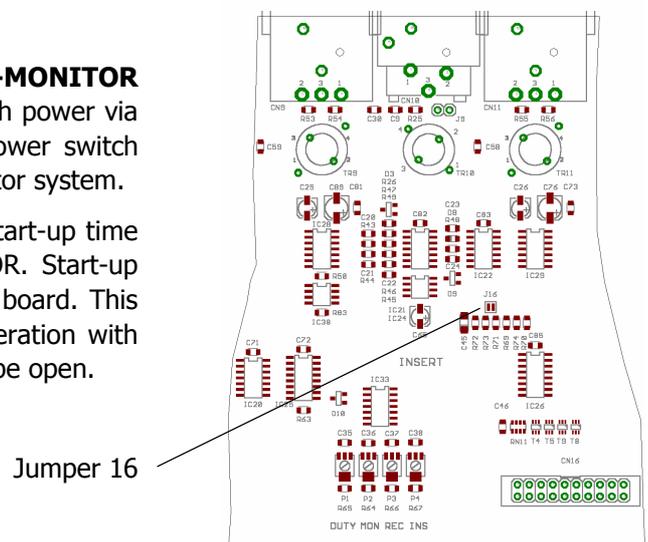
## INPUT SIGNAL MONITORING:

The digital router indicates the presence of a **clock** for the currently selected input at the front panel, which facilitates quick signal tracking when required. There are separate indicators for the monitor and recording channel.

## PAS-8 combined with AMS-2 or MTX-MONITOR:

If the PAS-8 is used in combination with an **AMS-2** or **MTX-MONITOR** analogue monitor system, the PAS-8 should be supplied with power via these monitor systems. In this configuration the PAS-8 power switch should be left off in order to ensure a central reset by the monitor system.

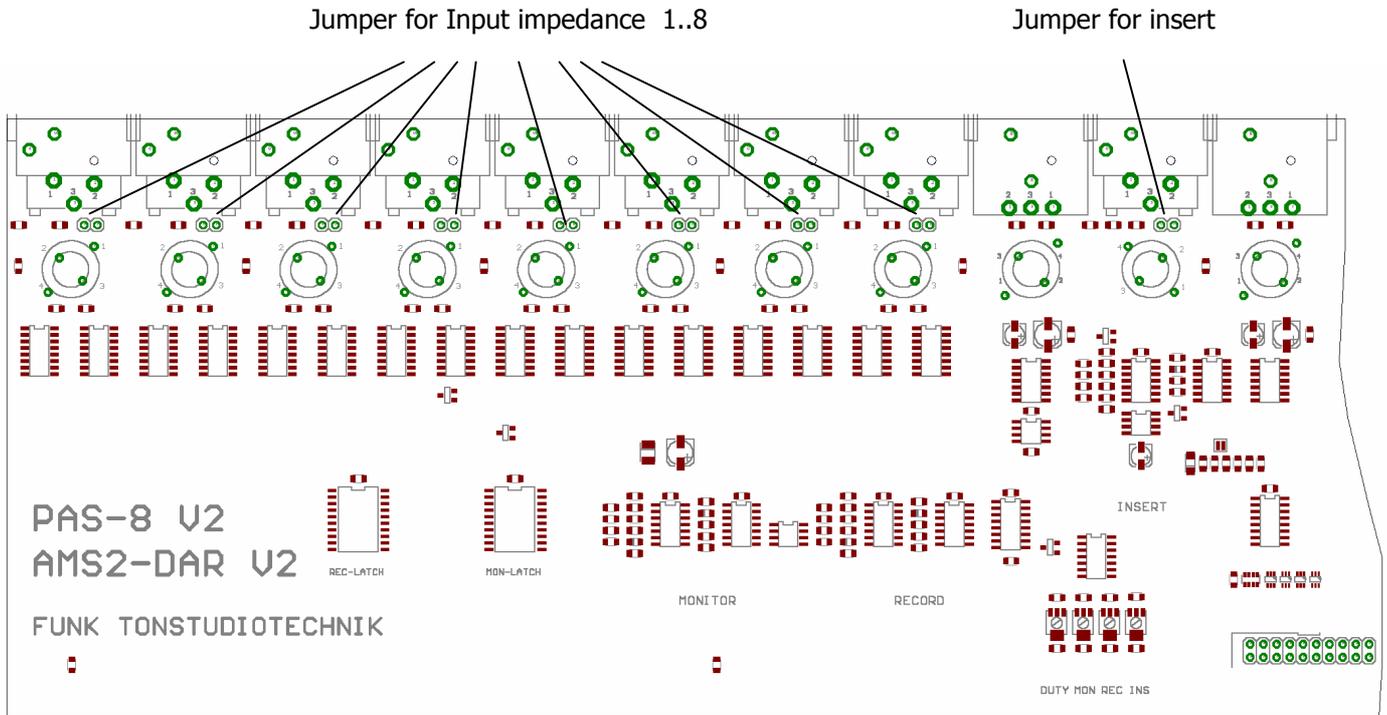
The PAS-8 has an internal switching feature to adapt the start-up time to the different requirements of AMS-2 and MTX-MONITOR. Start-up time is controlled by Jumper 16 in the centre of the main board. This jumper is normally closed (for standalone operation or operation with MTX-MONITOR). For use with the AMS-2, jumper 16 has to be open.



# PAS-8 INPUT CONFIGURATION

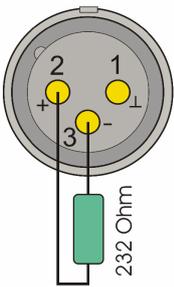
## CHANGING THE INPUT IMPEDANCE:

The jumpers for input impedance selection can be reached by opening the device cover. If the jumper is on both contacts, input impedance is 110  $\Omega$ . If the jumper is on only one contact, the input impedance is  $>1$  k $\Omega$ . The PAS-8 has 8 jumpers for its 8 inputs and an additional jumper for the digital insert input.



## SPDIF SIGNALS TO BALANCED AES/EBU INPUTS:

### XLR-CONNECTOR



If an SPDIF signal is fed in through the XLR inputs, the impedance at the connected XLR plug should be adjusted by wiring a 232  $\Omega$  resistor in parallel between pins 2 and 3. This sets the input to a characteristic impedance of 75  $\Omega$ , which is common for SPDIF signals. The "hot" wire of the incoming line is connected to pin 2, while the shielding is connected to pins 3 and 1 of the XLR plug.

Pin 1 on the XLR plug is left open if the sending device and the PAS-8 need to be galvanically separated. The shielding is only connected to pin 3 in this case.

The figure shows the solder side of the XLR plug.

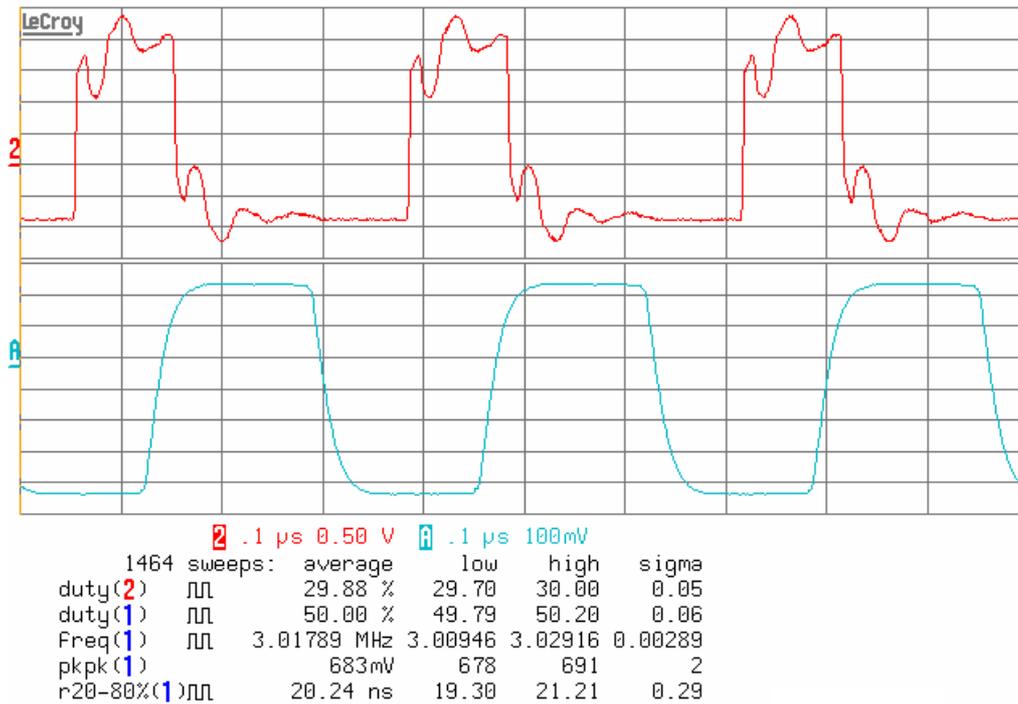
Pre-assembled adapter cables for this purpose are available under the name **CASA**.

The **CASA-T** cable has similar functions, but works using an integrated fast pulse transformer, which allows it to be used with non-standard balanced inputs (without an input transformer).

# AUDIO SIGNAL QUALITY

## INPUT AND OUTPUT AMPLIFIERS

The **PAS-8** is designed not only as a recording signal switch, but primarily as a high-quality **monitor matrix** for use with an external D/A converter. In order to guarantee the required high signal quality, all the outputs of these routers are equipped with automatic duty cycle post-correction (positive and negative pulse widths are balanced). This keeps the bit width (duty cycle) more or less constant even for highly different input levels and varying rise and fall times of the signal at the input. The same applies to the PAS-8's insert channel.

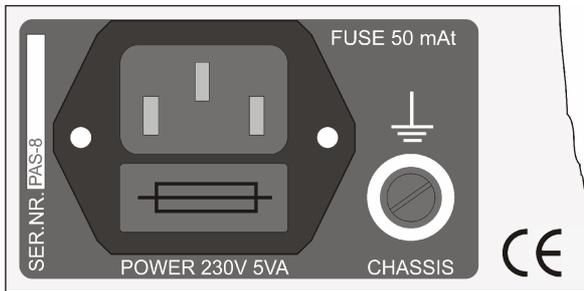


The above diagram illustrates the operating principle of the duty cycle correction. The upper, red curve shows a highly misaligned input signal with an additional offset in the duty cycle of 30/70 (uppermost line of the readings). The signal level is approx. 3.5 Vss. The lower, blue curve shows the PAS-8's corrected, clean output signal with a symmetrical duty cycle of typically 50 % (lines 2 to 5 of the readings). The diagram also shows the accurately defined, overshoot-free rise and fall times as well as the delay between input and output.

All amplifier stages are optimised for minimum jitter. The latency between input and output is approx. 60 ns (nanoseconds) for the monitor channel and 70 ns for the recording channel. An active insert in the PAS-8 adds 30 ns. These extremely short latencies allow the device to be used even in highly complex, synchronous studio systems.

# PAS-8 POWER SUPPLY OPTIONAL VERSIONS

## POWER SUPPLY



Protective earth and technical earth are separate in the **PAS-8**. This isolates the audio circuits from parasitic currents in the 19-inch rack or the protective earth conductor.

Technical earth and chassis are connected internally via several parallel 0.047  $\mu\text{F}$  capacitors. This creates a low-resistance connection that serves as a HF shield, while simultaneously preventing the formation of a ground loop for the mains frequency and its harmonics. Thanks to these features, the matrix is suitable for use with various earthing strategies in the studio.

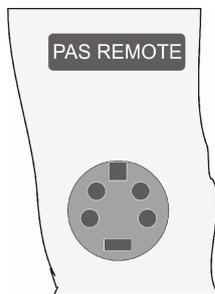
The router works flawlessly even when exposed to mains voltage fluctuations between 180 and 245 VAC. The PAS-8's stabilised supply voltages are short-proof and can be monitored by means of an LED in the front panel.

The mains fuse is in the power cable socket below the cable gland. The duct can be pulled out using a small screwdriver. The duct also contains a spare fuse. If a new fuse is required, only uses fuses of the type 5 x 20 mm, 50 mA/250 V, anti-surge.

## OPTIONAL VERSIONS and ACCESSORIES

The **PAS-8** is available in two versions for different supply voltages: 230 V/50 Hz, or 115 V/50..60 Hz. Only the manufacturer may convert the device for a different power supply.

## ACCESSORIES – INTERFACE



In the pack panel of the digital audio router there is a 4-pole mini DIN socket labelled **PAS REMOTE**. It is used for connecting a serial remote controller. The remote controller has feedback LEDs for all functions.

This remote jack also allows for the PAS-8 inputs to be switched via the **AMS-2 audio monitor system** or the **MTX monitor**. In this case the PAS-8 is supplied with power via the MTX monitor or the AMS-2 and can be controlled simultaneously both at the PAS-8 itself and from the analogue monitor systems. The PAS-8's power supply should be turned off (power switch) in order to ensure a centralised reset at start-up.

## AES/EBU $\Rightarrow$ SPDIF ADAPTER CABLE (UAS)



This cable is used to adapt the level, impedance and balance of digital XLR outputs, allowing the PAS-8 outputs to be connected to unbalanced coaxial inputs. Levels, balancing and impedance are converted to standard SPDIF values without any format conversion taking place. Please note that the receiving device needs to be able to process the transmitted format. The cable is usable for sample rates up to 192 kHz. Available lengths: 0.5 m, 1.0 m, 2.0 m and 3.5 m.

## SPDIF $\Rightarrow$ AES/EBU ADAPTER CABLE (CASA-T)



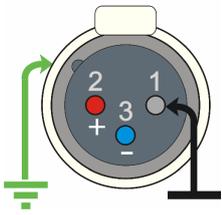
This cable is used to adapt the impedance and unbalance of digital SPDIF outputs to balanced 110  $\Omega$  AES/EBU Inputs, allowing the PAS-8 inputs to be connected to unbalanced coaxial inputs. Balancing and impedance are converted to standard AES/EBU values without any format conversion taking place. Please note that the receiving device needs to be able to process the transmitted format. The cable is usable for sample rates up to 192 kHz. Available lengths: 0.5, 1.0, 2.0 and 3.5 m.

# PAS - 8 WIRING

## CONNECTIONS

### BALANCED INPUTS:

XLR-FEMALE

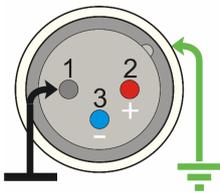


All balanced inputs are equipped with NEUTRIK **XLR FEMALE** jacks with gold-plated contacts. The pin assignment is according to professional industry standards (see figure).

Protective earth and technical earth are separate in the PAS-8. To prevent ground loops via the input cables (XLR pin 1), pin 1 is not wired to technical earth internally, but to the chassis via an intermediate capacitor. This is to prevent interference currents via pin 1 from creating a voltage drop over the ground wire's internal resistance, which could potentially interfere with the signal. This capacitor acts as an isolator for the mains voltage for all practical purposes, while also functioning as a low-resistance dissipater for high frequencies.

### BALANCED OUTPUTS:

XLR-MALE

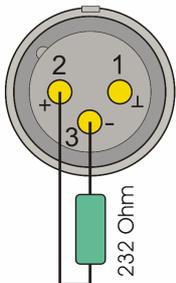


All balanced outputs are equipped with NEUTRIK **XLR MALE** jacks with gold-plated contacts. The pin assignment is according to professional industry standards (see figure).

Protective earth and technical earth are separate in the PAS-8. To prevent ground loops via the outputs (pin 1), pin 1 is not wired to technical earth internally but to the chassis via an intermediate capacitor. This is to prevent interference currents via pin 1 from creating a voltage drop over the ground wire's internal resistance, which could potentially interfere with the signal. This capacitor acts as an isolator for the mains voltage for all practical purposes, while also functioning as a low-resistance dissipater for high frequencies.

### SPDIF SIGNALS TO BALANCED INPUTS:

XLR-CONNECTOR

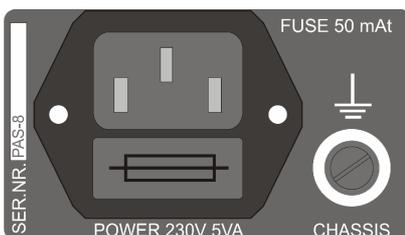


If an SPDIF signal is fed in through the XLR inputs, the impedance at the connected XLR plug should be adjusted from 110  $\Omega$  to 75  $\Omega$  by wiring a 232  $\Omega$  resistor in parallel between pins 2 and 3. The "hot" wire of the incoming line is connected to pin 2, the shielding is connected to pins 3 and 1 of the XLR plug.

If there is a risk of a ground loop forming between the sending device and PAS-8, then pin 1 should not be connected. The shield of the unbalanced signal source will be terminated on pin 3 of the XLR input in this case.

We offer pre-made adapter cables of various lengths as accessories, including impedance adaptation from RCA to XLR for digital audio applications. In these cables, the transmitter's and the recipient's earths are galvanically separated (UAS-cable and CASA-T-cable). This prevents the formation of a ground loop through this connection. The shielding is terminated on the RCA plug casing.

### MAINS CONNECTOR IN THE BACK PANEL:



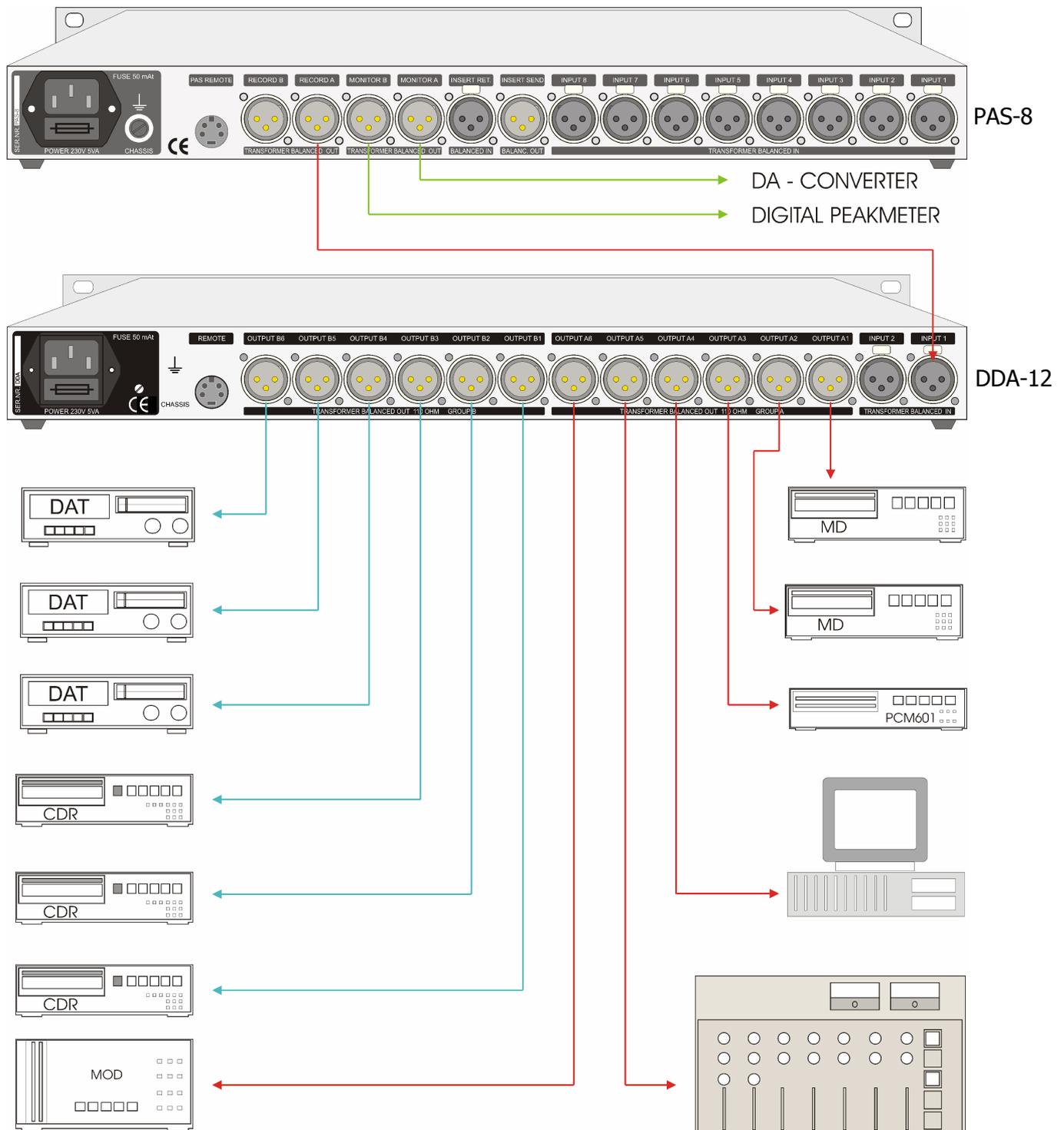
Always use a power cable with a protective earth conductor and a Schuko plug (included) to connect this device to mains power. A chassis screw next to the power jack can be used to create a low-ohm connection to the rack. If the device is used with the **AMS-2** audio monitor system, this contact should be connected to the chassis jack of the AMS-2.

# DIGITAL ROUTER PAS-8 CONNECTIONS

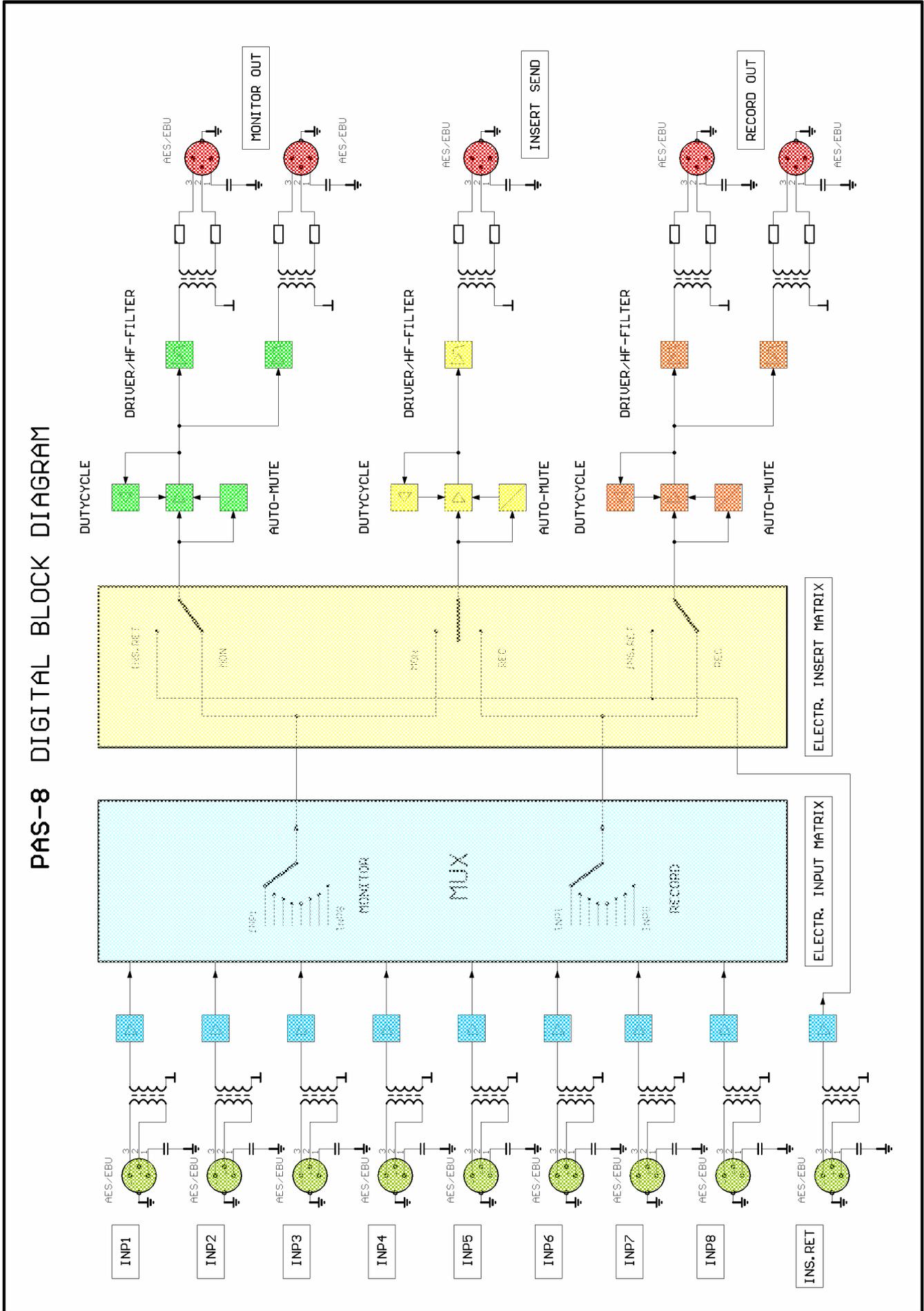
## EXAMPLE CONNECTIONS FOR DIGITAL RECORDING CHANNELS

The drawing below shows an example connection for recording signals (**recording matrix**). Since AES/EBU signals cannot simply be distributed to several recipients in parallel, the use of an AES/EBU distribution amplifier is recommended for more than 4 digital recipients. As an example, the following figure illustrates the use of a DDA-12 distribution amplifier in conjunction with the PAS-8.

This configuration allows any recipient to record signals from any source. The switching options of the DDA-12 permit the signal to be routed to input 2 of the DDA-12 instead of the D/A converter or the digital peakmeter. Either the monitor or the recording signal can be used as the source. Moreover, it is possible to send both the monitor and recording signals simultaneously to different recipients for recording.



# PAS-8 BLOCK DIAGRAM



## JITTER ANALYSES:

Small time offsets (jitter) of individual flanks are the main cause of quality degradation in digital audio signal transmission. High-quality transmission therefore requires a reduction of the jitter to a minimum.

The router's active circuitry ensures low jitter, which makes the device highly suitable for use before a D/A converter in the signal chain. The additional DUTY CYCLE correction ensures a DC-free output signal irrespective of signal levels and duty cycle (mean time ratio of positive and negative bits) of the selected source, in addition to reducing potential jitter caused by the low-pass effect of a connected cable. The figures below show jitter measurements for the PAS-8 and the AMS-2 DAR and illustrate the extremely low jitter in the signal processing.

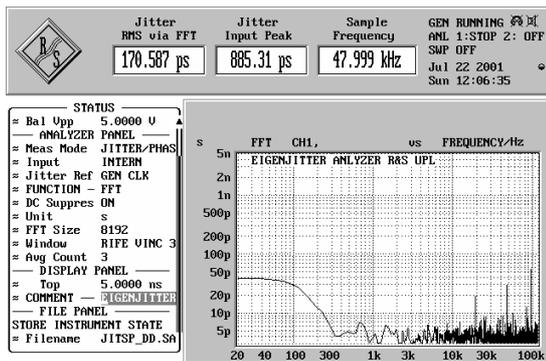


Fig. 1: The measurement record on the left shows the jitter spectrum of the testing device (Rhode & Schwarz UPL). All measurement records are scaled identically. The evaluated measurement range is from a few Hz up to 120 kHz.

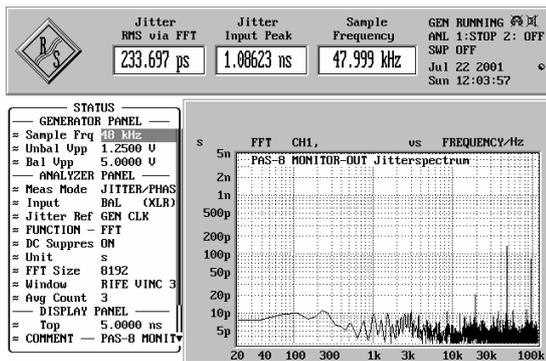


Fig. 2: Measurement at the PAS-8 monitor output. Despite the measuring device's extremely high resolution, it shows that there is hardly any increase of jitter across the entire spectrum. All readings are very close to the sensitivity limit of the measuring device. The highest recorded jitter is at approx. 1 nanosecond, and effective jitter is below 300 ps ( $10^{-12}$  seconds!). Signal input was at input 1.

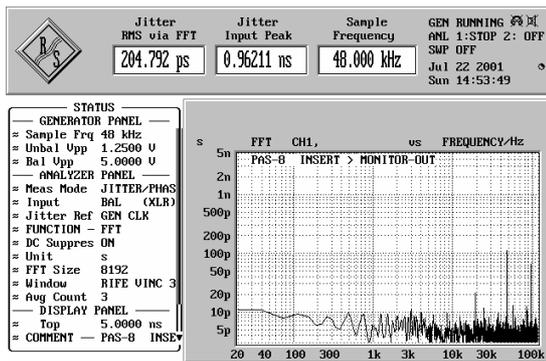


Fig. 3: Measurement at the PAS-8 monitor output, signal input at insert return. Despite the measuring device's extremely high resolution, it hardly shows any increase of jitter across the whole spectrum compared with fig. 1. Again, rms jitter is below 300 ps. The highest recorded peak jitter is at approx. 1 nanosecond ( $10^{-12}$  seconds!).

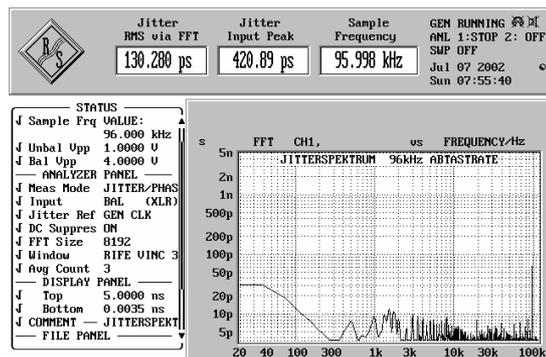


Fig. 4: Measurement at the monitor output of the PAS-8. Audio signal input was via input 1 at a sample rate of 96 kHz and a level of approx. 4 Vss. All AES/EBU cables have lengths of approx. 2 m. Rms jitter is below 150 ps. The highest recorded peak jitter is at approx. 420 ps.

# TECHNICAL SPECIFICATIONS PAS-8

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<b>Number of inputs :</b> .....	8 Inputs	1 Insert return	
<b>Number of outputs :</b> .....	2 Monitor	2 Record	1 Insert send
<b>Connector inputs:</b> .....	XLR female	gold-plated contacts	
<b>Connector outputs:</b> .....	XLR male	gold-plated contacts	
<b>Digital format :</b> .....	AES/EBU / AES-3 [also SPDIF with adapter plug] (transparent for all formats)		
<b>Sampling frequency :</b> .....	depends from input signal (25...105 kHz)		
<b>Input voltage range :</b> .....	300 mV...5V pp		
<b>Input impedance:</b> .....	110 $\Omega$ (1 k $\Omega$ without internal jumpers) transformer balanced, free of ground		
<b>Common mode input voltage, max. :</b> .....	$\pm 60V$		
<b>Output voltage:</b> .....	4,0 V pp at 110 $\Omega$		
<b>Output impedance:</b> .....	110 $\Omega$ transformer balanced, free of earth		
<b>Common mode output voltage, max. :</b> .....	$\pm 60V$		
<b>Rise time :</b> .....	20 ns		
<b>Delay time input-output :</b> .....	60...80 ns		
<b>Synchronisation :</b> .....	external synchronisation is not required		
<b>Remote control format :</b> .....	seriell balanced, likewise RS422		
<b>Power supply :</b> .....	230 V / 50...60 Hz (115 V / 60 Hz optional)		
<b>Power consumption :</b> .....	3 VA		
<b>Fuse :</b> .....	50 mA/250V 5 x 20 mm		
<b>Protection class :</b> .....	1		
<b>Case:</b> .....	steel, light grey Front panel: aluminium, light grey (RAL 7035)		
<b>Dimensions :</b> .....	483 mm x 250 mm x 44 mm (width x depth x height)		
<b>Warranty :</b> .....	3 years		

Do not connect signals with levels above 10 Vpp to the inputs, as they may damage the device.

# ELECTROMAGNETIC INTERFERENCE

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## **ELECTROMAGNETIC INTERFERENCE and EMC**

This device complies with the EMC requirements as defined in the directives 89/336/EEC and FCC part 15:

The device's electromagnetic emissions are sufficiently low to not interfere with the intended use of other devices and systems.

The device is sufficiently resistant to electromagnetic interference for its intended use.

The device has been tested and fulfils the requirements below:

Safety: Protection acc. to EN60950; 1992 + A1/A2; 1993 (UL1950)

EMC: Audio, video, audio-visual and  
entertainment lighting control apparatus for professional use.

Interference: EN55103-1

Immunity: EN55103-2

Compliance with these standards ensures protection of the environment and immunity of the device at reasonable levels. However, it cannot be guaranteed absolutely that no negative effects due to electromagnetic interference occur during the operation of the device.

The following measures should be taken to reduce the likelihood of electromagnetic interference as much as possible:

Observe the information in this user manual when installing the device.

Use shielded cables for all audio channels (XLR connectors). Ensure proper, corrosion-resistant connections with a large surface between the shielding and the connector casing. Cable shielding terminated on only one end may act as a transmitter or receiver antenna.

In your system and in the operating environment, use only components (equipment, devices) that are themselves compliant with the above standards.

Provide an earthing strategy that accounts for both safety requirements and EMC aspects. Carefully weigh the benefits and disadvantages of using a star ground, a ground plane or a combined strategy.

Be careful to prevent the formation of current loops and reduce their unwanted effects by keeping their area as small as possible (avoid unnecessarily long cables) and reducing any currents by adding a common mode choke.

# MAINTENANCE AND REPAIR

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## **SAFETY**

Only qualified service personnel following all applicable rules and regulations may perform any work inside the device.

Turn off the device and disconnect the power supply before removing any part of the housing.

When performing maintenance work on an open device under mains voltage, be careful not to contact any bare parts of the circuit or metal semiconductor housings either directly or with a non-insulated tool.

Only use spare parts approved by the manufacturer for the maintenance and repair of safety-relevant parts of the device.

## **ELECTROSTATIC DISCHARGE (ESD)**

Integrated circuits and other semiconductors are sensitive to electrostatic discharge (ESD). Improper handling of assemblies containing such components during maintenance and repair may degrade the functional characteristics and service life of such parts or cause failure.

Always observe the following rules when handling components sensitive to ESD:

Components sensitive to ESD may only be stored or shipped in dedicated, designated packaging.

Any handling of ESD-sensitive components outside of their packaging has to take place in electrostatic-protected areas (EPA, e.g. area for field service or a repair and service workshop). Persons handling such components must be connected to the EPA's ground potential. The device to be serviced or repaired, as well as any tools, aids and EPA-compliant (semi-conducting) table mats or floor mats must also be connected to metallic surfaces in order to prevent ESD.

To prevent any exposure of the components to transients and damage by excessive voltage or equalisation currents, always turn off the device and dissipate any capacitor charges before making or breaking electrical connections.

# PLEASE NOTE

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## CE DECLARATION OF CONFORMITY

FUNK TONSTUDIOTECHNIK 10997 BERLIN

hereby declares and warrants that the product

### **PAS-8**

is compliant with the following standards according to EU Directives and their amendments:

Safety:

Protection acc. to EN60950; 1992 + A1/A2; 1993 (UL1950)

EMC:

EN55103-1 EN55103-2

Evaluation criterion B, electromagnetic environment E4

Berlin, 12 Jan 2011



Th. Funk, owner

