SAM64

SDI to AES/MADI interface

Installation and User Guide

Reference To Statement Of Conformity

This document confirms that products bearing the CE label meet all the requirements in the EMC directive 2004/108/E and LV directive 2006/95/EC laid down by the Member States Council for adjustment of legal requirements. Furthermore the products comply with the rules and regulations from 30 August 1995 referring to the electromagnetic compatibility of devices. 4HM SAM64 units bearing the CE label comply with the following harmonised or national standards:

EMC:

EN 55103-1 :1997

EN 55103-2 :1997

Safety:

IEC 60065 :2002

Mains Harmonics:

EN 61000-3-2 Class A :2001

Insulation:

Class1

For U.S.A.:

TO THE USER:

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference. And 2) This device must accept any interference received including interference that may cause undesired operation.

CAUTION:

This product satisfies FCC regulations when shielded cables and connectors are used to connect the unit to other equipment. To prevent electromagnetic interference with electric appliances such as radios and televisions, use shielded cables and connectors for connections.

4HM Ltd.

Milton Keynes, United Kingdom, April 2010.

CE

User's Notice and disclaimer:

The information contained in this manual has been carefully checked for accuracy; however no guarantee is given with respect to its correctness. 4HM Ltd. accepts no responsibility or liability for any errors or inaccuracies that may appear in this manual or the products and software described in it.

Specifications and information contained in this manual are subject to change at any time without notice.

This appliance has a serial number located on the rear panel. Please record the model number and serial number here for your records.

Model Number.....SAM64

Serial Number.....

Contents

1. Read these instructions
2. Keep these instructions
3. Heed all warnings
4. Follow all instructions
5. Do not use this apparatus near water
6. Clean only with a dry cloth
7. Do not block any ventilation openings. Install with accordance with the manufacturer's instructions.
8. Do not install near any heat sources such as radiators, heat registers, stoves or other apparatus (including amplifiers) that produce heat.
9. Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding-type plug has two blades and a third grounding prong. The wide blade or the third prong are provided for your safety. If the provided plug does not fit into your outlet, consult an electrician for replacement of the obsolete outlet.
10. Protect the power cord from being walked on or pinched, particularly at plugs, convenience receptacles, and the point where they exit from the apparatus.
11. Only use attachments/accessories specified by the manufacturer.
12. Only use with the cart, stand, tripod, bracket or table specified by the manufacturer, or sold with the apparatus.

13. Unplug this apparatus during lightning storms or when unused for long periods of time.
14. Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, such as power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally or has been dropped.

WARNING: To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.

- Do not expose this apparatus to drips or splashes.
- Do not place any objects filled with liquids, such as vases on the apparatus.
- Do not install this apparatus in a confined space such as a bookcase or similar unit.
- Slots and openings in the cabinet are provided for ventilation and to ensure reliable operation of the product and to protect it from overheating. Please ensure adequate space around the apparatus for sufficient ventilation. Ventilation should not be impeded by covering the ventilation openings with items such as newspapers, tablecloths, curtains, etc.
- The apparatus should be located close enough to an AC outlet so that you can easily grasp the power cord plug at any time.
- An apparatus with Class 1 construction shall be connected to an AC outlet with a protective grounding connection.
- No naked flames, such as lighted candles, should be placed on the apparatus.

Important Safety Precautions

CAUTION: TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT REMOVE COVER (OR BACK). NO USER-SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL

The lightning flash with arrowhead symbol, within equilateral triangle, is intended to alert the user to the presence of uninsulated “dangerous voltage” within the product’s enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating instructions and maintenance (servicing) instructions in the literature accompanying the appliance.

Caution: To prevent fire or shock hazard, do not expose this appliance to rain or moisture.

Important Safety Information

This apparatus has no mains switch or other user-operated control for disconnecting the AC mains power. The mains plugs or the appliance couplers (IEC sockets) are used as the disconnect devices. Either device must remain readily operable and accessible when the apparatus is installed for use.

This unit includes thermally resettable fuses that are integral to the power supply circuitry, but the unit must always be powered from a supply fitted with an HRC type (High In-Rush Current) fuse with a rating of 1 A.

Thank you for buying this 4HM product. The SAM64 SDI to AES+MADI interface is designed to resolve and simplify a common audio infrastructure problem encountered in many broadcast facilities - de-embedding the audio data from up to four SDI (Serial Digital Interface) video signals and making it available to the user in AES3 and MADI formats. The SAM64 is a very high quality product, engineered for maximum reliability in professional broadcast environments. It is intended to be "installed and forgotten", and left in permanent operation. It requires virtually no configuration on installation, or adjustment in normal use.

This manual covers the SAM64's connections and indications, including its various options for synchronisation and external control. Please keep the manual in a safe place once you have installed the SAM64.

Important – Please register your SAM64 with 4HM Ltd. on-line at www.4hmbroadcast.com. Registering your unit will help us in providing you with after-sales service should the need arise, and may also be of assistance in the event of the unit being stolen.

Environment – The SAM64's range of operating temperature and relative humidity (RH) are as follows:

Temperature: 0°C to 40°C

RH: 70% maximum (non-condensing)

What's In The Box

Unpacking

Unpack the SAM64 with care. It is always a good idea to store all packaging (if practical), in case you ever need to return the unit to 4HM for any reason.

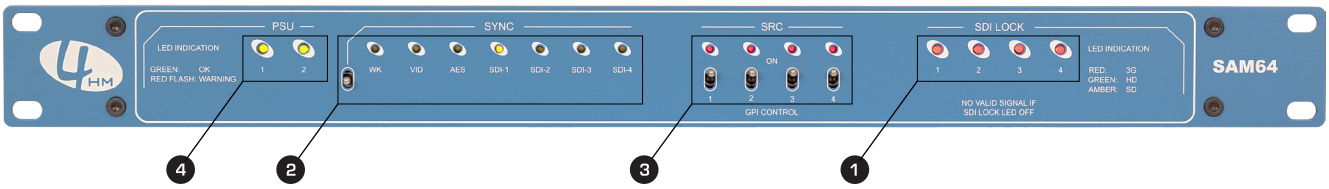
The shipping carton should contain the items listed below. Please contact your distributor immediately if any of them are missing or damaged.

- SAM64 SDI-to-AES/MADI audio interface
- Instruction manual
- 2 x IEC AC cables fitted with moulded UK 13 A plugs (UK), or 2 x mating IEC plugs (all other territories)

SAM64 Main Features

- De-embeds all 16 channels of audio from each of 4 SDI bitstreams
- Auto-sensing of SDI format on each input
- Compatible with all current SDI specifications, including SD, HD and 2.9 Gbps 3G (up to 1080p60)
- Audio outputs available in 32 x AES3 and 64ch. MADI formats at 48 kHz
- MADI bitstream available at both copper (BNC) and optical (ST) outputs
- MADI output conforms to AES10id-2008; AES3 output to AES3-1992
- Active loop-through SDI outputs
- Loop-through outputs transparent to Dolby D/E
- Switchable sample rate conversion (SRC) on all inputs
- Audio sync to external wordclock, SDI clocks, external AES3 or video black-and-burst
- Sync reference outputs in wordclock and AES3 formats
- External SRC enable/disable via GPI
- RS-422 and Ethernet ports for planned future enhancements
- GPO tally outputs indicating SRC status
- Two independent PSUs with separate IEC inputs

Front Panel Description



1 **SDI Lock LEDs** – four tri-colour LEDs, for SDI inputs 1 to 4. Each illuminates when a valid SDI video signal is detected at its input, and the colour indicates the interface standard in use, as below:

COLOUR	SDI FORMAT
YELLOW	SD-SDI
GREEN	HD-SDI
RED	3G-SDI
OFF	NO VALID SDI SIGNAL DETECTED

2 **Sync source selection** – a 3-position toggle switch for selecting the audio sync source.

The switch's 'down' position is latching, while its 'up' position is momentary. Repeated 'upward' presses on the switch scroll through the possible external sync sources. The adjacent amber LEDs indicate the currently-selected source. When the LED for the desired source is on, the switch may be placed in the latching 'down' position to prevent inadvertent further changes of sync source.

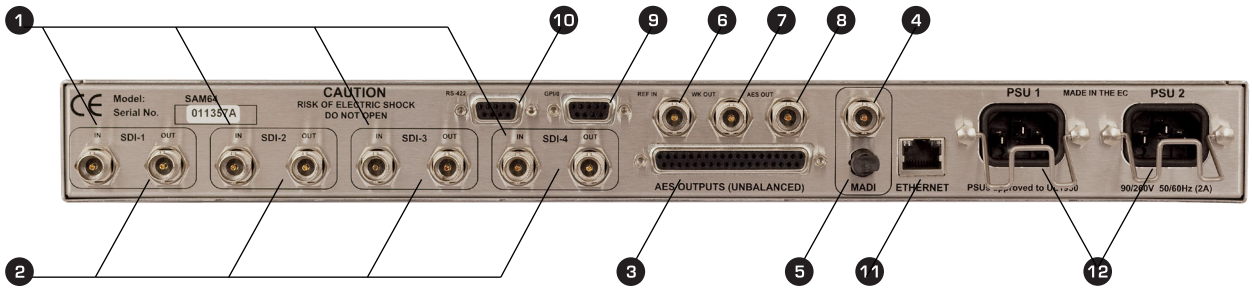
SWITCH POSITION	FUNCTION
CENTRE	NO ACTION
UP (MOMENTARY)	INCREMENTS SYNC SOURCE SELECTION
DOWN (LATCHES)	LOCKS SYNC TO CHOSEN SOURCE

3 **SRC control** – four 2-position toggle switches controlling the four 16-channel output SRCs. The switch also enables external GPI control of each SRC.

SWITCH POSITION	FUNCTION
UP	SRC ON
DOWN	SRC OFF, BUT UNDER EXTERNAL GPI CONTROL

4 **PSU status** – two bi-colour LEDs confirming the current status of each PSU. The LEDs are green in normal operation and flash red if a PSU fault condition is detected.

Rear Panel Description



1. **SDI video inputs 1 to 4 (4 x BNCs)** – internally illuminated green
2. **SDI video active loopthrough outputs 1 to 4 (4 x BNCs)** - internally illuminated red
3. **AES3 outputs (37-way female Dsub)**
4. **Co-axial MADI output (BNC)**
5. **Optical MADI output (ST)**
6. **Ext. Sync input (BNC)**
7. **Wordclock out (BNC)**
8. **AES3 sync out (BNC)**
9. **GPI/O port (9-pin female Dsub)**
10. **RS-422 port (9-pin female Dsub)**
11. **Ethernet port (RJ45)**
12. **AC inputs – 2 x IEC sockets**

Hardware Considerations

The SAM64 is built in a 1U 19" enclosure. It is intended to be permanently installed in a standard 19" equipment rack. The unit has no internal fans and is cooled by natural convection. There are ventilation grilles in the top, bottom and both sides of the enclosure, and care must be taken to ensure that these are not blocked by cables or other equipment when the unit is installed. Do not install any other items of equipment immediately above or below to the SAM64; the use of 1U blanking panels is recommended.

Power Supply Considerations

The SAM64 is fitted with two separate, auto-ranging switch-mode power supplies (PSUs). The operating voltage range is 90 to 264 V AC, 50/60 Hz. The internal power rails are diode-paralleled to the two supplies, and the unit will operate normally if only one PSU is powered or functional. For maximum protection when using both PSUs, the two AC inlet cables should be connected to mains circuits which are as independent of each other as possible.

If redundant operation is not required, only one AC supply cable need be connected; either AC inlet may be used.

Fuses And Ratings

Each of the SAM64's PSUs has an internal resettable fuse for PSU protection. These fuses are not accessible to the user. The unit should be powered from a mains supply (supplies) fitted with an external HRC-type fuse (High Inrush Current) rated at 1 A.

Unit Connections

SDI Inputs

The SAM64 can simultaneously de-embed the 16 audio channels in each of four separate SDI video signals. Four BNC sockets are provided at the rear panel for connecting the SDI inputs. The characteristic impedance is 75 Ω . The SAM64 is compatible with all SDI formats up to 3G (2.9 Gbps) and auto-detects between them. See the *Technical Specifications* on page 14 for full list of compatible formats.

Each SDI input has an active "loopthrough" output, to simplify the connection of further equipment. The outputs are fully buffered from the inputs and are re-clocked. The SDI bitstream is otherwise unaltered.

AES3 Outputs

The 64 audio channels de-embedded from the four SDI inputs are available as 32 AES3 digital audio outputs on the rear panel 37-way female Dsub connector. The outputs are unbalanced, but are compliant with AES3-1992 in all other respects. The table below gives the pinout:

PIN	OUTPUT	SDI SOURCE	AUDIO CHANNELS
1	AES 1	SDI 1	Chs 1 & 2
2	AES 2		Chs 3 & 4
3	AES 5		Chs 9 & 10
4	AES 6		Chs 11 & 12
5	AES 9	SDI 2	Chs 1 & 2
6	AES10		Chs 3 & 4
7	AES 13		Chs 9 & 10
8	AES 14		Chs 11 & 12
9	AES 17	SDI 3	Chs 1 & 2
10	AES 18		Chs 3 & 4
11	AES 21		Chs 9 & 10
12	AES 22		Chs 11 & 12
13	AES 25	SDI 4	Chs 1 & 2
14	AES 26		Chs 3 & 4
15	AES 29		Chs 9 & 10
16	AES 30		Chs 11 & 12
17	n/c		
18	n/c		
19	GND		
20	AES 3	SDI 1	Chs 5 & 6
21	AES 4		Chs 7 & 8
22	AES 7		Chs 13 & 14
23	AES 8		Chs 15 & 16
24	AES 11	SDI 2	Chs 5 & 6
25	AES 12		Chs 7 & 8
26	AES 15		Chs 13 & 14
27	AES 16		Chs 15 & 16
28	AES 19	SDI 3	Chs 5 & 6
29	AES 20		Chs 7 & 8
30	AES 23		Chs 13 & 14
31	AES 24		Chs 15 & 16
32	AES 27	SDI 4	Chs 5 & 6
33	AES 28		Chs 7 & 8
34	AES 31		Chs 13 & 14
35	AES 32		Chs 15 & 16
36	n/c		
37	GND		

Note that each AES3 output carries 2 audio channels, thus the 16 audio channels embedded in each SDI input generate 8 AES3 outputs.

To aid installation, an optional AES Signal Break Out accessory (ASB0) is available from 4HM. This consists of a 1U 19" panel with 32 BNC sockets, prewired to a 37-way Dsub plug. This may be mounted at the front or rear of the rack and greatly simplifies wiring.

MADI Outputs

The 64 de-embedded audio channels are also available as MADI (Multichannel Audio Digital Interface), in both co-axial and optical formats.

The MADI bitstream contains all 16 channels from all four SDI inputs. The channel numbering within the MADI bitstream is one-to-one, i.e., Channel 1 of SDI 1 becomes MADI Channel 1, Channel 2 of SDI 1 becomes MADI Channel 2, and so on for the remainder of SDI 1's audio channels. Then Channel 1 of SDI 2 becomes MADI Channel 17, and the cycle repeats. If less than four SDI inputs are in use, the MADI bitstream time slots corresponding to the unused inputs will simply contain all zeroes.

SDI INPUT	MADI CHANNELS
SDI 1	1 to 16
SDI 2	17 to 32
SDI 3	33 to 48
SDI 4	49 to 64

The co-axial MADI output is on a BNC socket, and is compliant with AES10id-2008. The characteristic impedance is 75 Ω, at a nominal data rate of 125Mbps. Transmission distances up to 50 m are generally achievable.

The same bitstream is available in optical format on an ST type connector, allowing the MADI output signal to be transmitted by fibre if preferred. Recommended fibre types are 62.5/125 µm or 50/125 µm, multimode. Transmission distances of at least 1000 m are achievable.

RS-422 Port

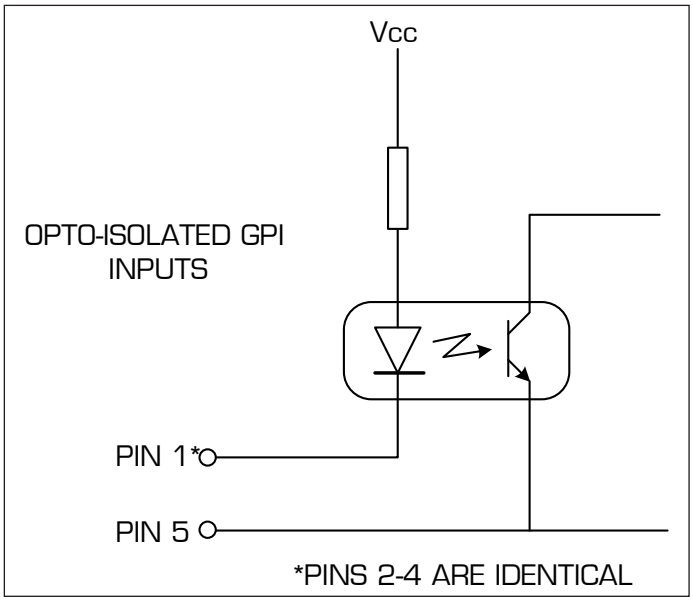
The SAM64's rear panel includes an RS-422 port on a 9-pin female Dsub connector. This is included to allow the future possibility of bi-directional external control of various unit functions. This functionality is not currently implemented.

GPIO Port

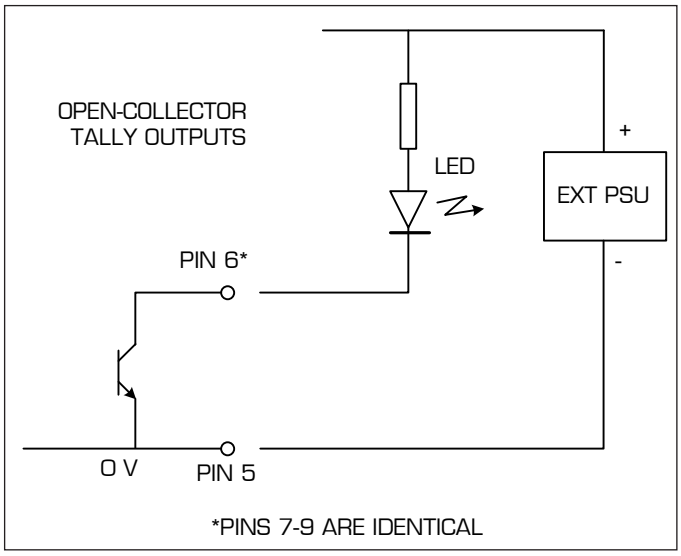
A GPIO (General-Purpose Input-Output) port is available at the rear panel in the form of a 9-pin female Dsub connector. This has four inputs and four outputs, and allows the SAM64's four output SRCs (Sample Rate Converters) to be enabled from external control equipment by contact closure. Tallies confirming the SRC status are also available on this connector. Pinout is as follows:

PIN	FUNCTION
1	GPI 1
2	GPI 2
3	GPI 3
4	GPI 4
5	GND
6	TALLY 1
7	TALLY 2
8	TALLY 3
9	TALLY 4

The GPI inputs are opto-isolated internally, and activate when the pin is connected to 0 V. (i.e. connect pins 1-4 to pin 5 to activate).



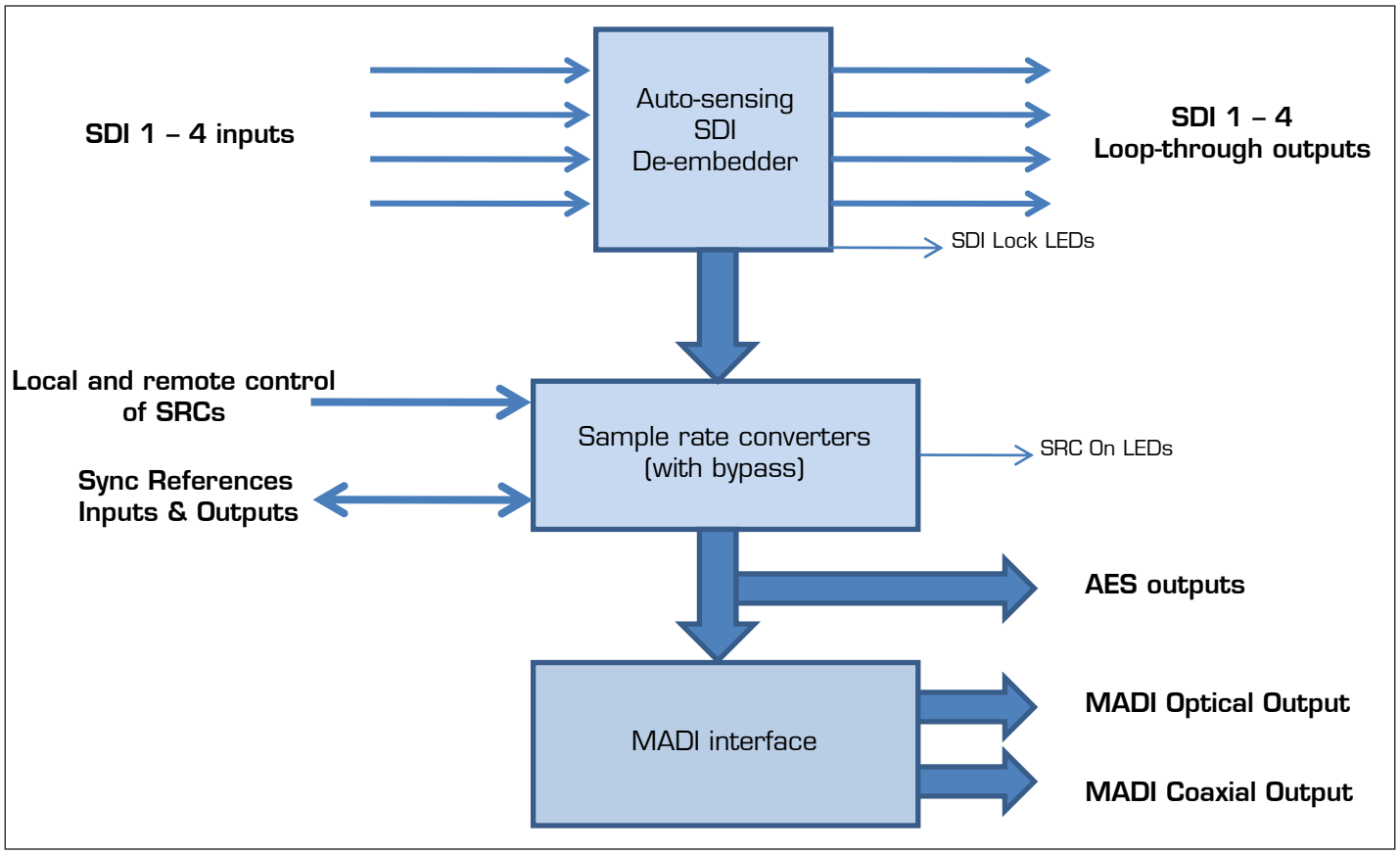
The tally outputs are open-collector type, with transistors rated at 24 V. The tallies will typically be used to drive LEDs; connect the cathode of the LED to the tally output and the anode, via a suitable resistor, to an external DC voltage of not more than +24 V. The 0 V reference of the external DC voltage should be connected to pin 5.



ETHERNET Port

The SAM64 includes a standard Ethernet port (an RJ45 socket). This allows the future possibility of various unit control and monitoring functions. This functionality is not currently implemented.

Block Diagram



Sample Rate Converters

The sampling frequency of the audio data embedded in SDI video signals is 48 kHz. This is invariant, and is enshrined in the defining standards for all SDI formats. As with all operations involving digital audio, it will generally be desirable for the audio outputs of the SAM64 to be synchronised (in frequency and/or phase) with a master reference clock, which will also synchronise all other digital audio processing in the facility.

To achieve this, the SAM64 includes four 16-channel Sample Rate Converters (SRCs), one for each SDI input (see *Rear Panel Description* on page 8). Each SRC may be switched in or out by a front panel switch ❸ (see *Front Panel Description on page 7*) or by external control via the GPIO port. When each SRC is active, a red LED illuminates, and a tally output voltage is also available at the rear GPIO port.

When enabled, the SRCs re-clock the audio data against a new reference, thereby changing the sampling frequency of the data to that of the reference. They also ensure that the word blocks in the data are phase-locked exactly to the reference clock. The SAM64 allows the user to select a reference clock source to suit the infrastructure of the facility and the nature of the transfer process. See following section on "*Synchronisation*".

GPIO Control

As the SAM64 could be installed in a central control room or outside broadcast vehicle using automated system software applications, external control of the SRCs can be achieved via the GPIO port. Simple contact closure (grounding the GPI) enables any or all the SRCs, allowing them to be switched in or out from a remote point. Maximum recommended operating distance is 5 m (though this may be increased by the use of external relays or similar).

Refer to the pinout on page 10 for wiring details.

Synchronisation

The SAM64 offers a choice of wordclock synchronisation sources. The selection is made from the front panel, and the array of LEDs confirms the currently-selected source. The selected source is used as reference for all four output SRCs, thus ALL audio outputs, both in AES3 and MADI formats, will be locked to the selected reference.

The various clock sources are discussed on the following page.

Sync To Wordclock

SRC sync to an external wordclock is indicated by illumination of the 'WK' front panel LED. The clock source should be connected to the SYNC IN connector (a BNC socket) on the rear panel. Nominal frequency is 48 kHz 50ppm, and clock pulses should be of 5 V amplitude, positive-going.

Sync To Video Black-And-Burst

The SAM64 can also synchronise to a standard (SD) 1 V black-and-burst video signal. The video signal should be connected to the SYNC IN connector on the rear panel. The sync input auto-detects NTSC or PAL standard video.

Sync To AES3

An AES3-compliant digital audio source may be used as the clock reference source. The internal 48 kHz wordclock source is phase-locked to the incoming AES3 signal. Any audio data contained in the AES3 word will be ignored. The audio source should be compliant with AES3-id for 75 Ω coaxial transmission and connected to the SYNC IN connector on the rear panel.

Sync To The SDI Inputs

Any of the four SDI inputs may be used to reference the audio outputs. Each two channels of embedded audio in an SDI stream is essentially compatible with an AES3 word format at a sample frequency of 48 kHz and thus this frequency may be extracted and used as the SRC wordclock in the same way as an AES3 sync source. If one or more pairs of audio channels in an SDI signal is carrying Dolby-encoded material, the SRC for that input should be set OFF, and that input should be the sync referenced source.

Use the derived wordclock output as the master sync reference for downstream equipment.

Note: If using this method, it is important to consider how the remaining three SDI sources synchronise in relation to the sync source. If the inputs are asynchronous then they should have their SRCs set to ON. This ensures that the audio content will synchronise to the referenced SDI input.

Note: Passing Dolby-encoded material through sample rate converters will corrupt the Dolby bitstream.

Clock Outputs

A reference clock output is available at the rear panel WK OUT connector in the form of a 48 kHz clock signal, of 5 V amplitude, positive-going, or at the AES OUT connector in the form of an AES3 digital audio signal ("digital silence"). These are derived from whichever synchronisation source is selected.

VIDEO INPUTS	
Connector/input impedance	4 x BNC sockets, 75 Ω
Compatible formats	SDI, SD/HD/3G, compliant with SMPTE 259M, 296M, 274M, 292M, 424M or 425M
VIDEO OUTPUTS	
Connector/output impedance	4 x BNC sockets, 75 Ω
Format	Active, re-clocked loop-through of SDI inputs
AUDIO INPUTS	
Format	Extracted from SDI video inputs
AES3 AUDIO OUTPUTS	
Connector/output impedance	37-way female Dsub, 32 x 75 Ω unbalanced
Format	Compliant to AES3-1992
Sampling frequency	48 kHz nominal
MADI AUDIO OUTPUT	
Connector/output impedance (coaxial)	BNC socket, 75 Ω
Connector (optical)	ST Multimode
Format	64-channel, compliant with AES10id-2008
Data rate	125 Mbps ±25ppm
SYNCHRONISATION	
Sample Rate Conversion	SRC available on all inputs, switchable in banks of 16
Sources	(External): SDI1 to 4, AES3, Video black-and-burst, Wordclock
Video sync input	PAL/NTSC 50/60 Hz (SD)
Wordclock input	48 kHz ±50ppm, DC coupled, positive going pulses
AES3 input	AES3 input at f_s=48 kHz
Wordclock output	48 kHz nominal
AES3 output	Digital audio signal compliant with AES3-1992
GPIO PORT	
GPIO port – connector	9-pin female Dsub
Input functions	4 x SRC select (short-to-ground)
Output functions	4 x SRC status (open-collector)
OTHER CONTROL	
RS-422	9-pin female Dsub – for possible future use
Ethernet	For possible future use
POWER SUPPLY	
Type	2 x independent switch-mode regulated, auto-ranging
Inputs	2 x 90 to 264 V AC, 50/60 Hz
Power consumption	16 W
Connectors	2 x IEC with retaining clips
Fuse data	Internal fixed resettable (non-user-accessible). Use a 1 A HRC externally-fused supply
PHYSICAL	
Dimensions (w x d x h)	483 x 200 x 44.5 mm (1U) 19 x 7.87 x 1.75 inches (1U)
Weight	4 kg / 8.8 lbs
Operating temperature range	0°C to +40°C
Relative humidity range	70% max, (non-condensing)

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