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1 Introduction

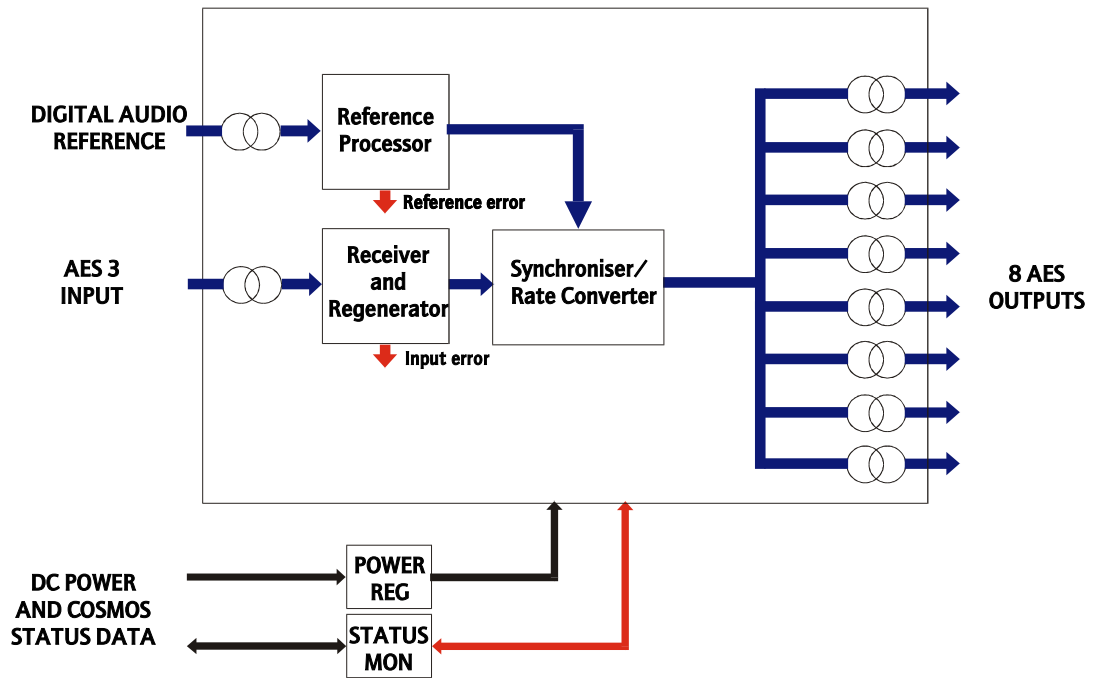
The 4407 is a eight output AES3 digital audio synchroniser/converter. It is designed to synchronise non-synchronous digital audio when locked to a AES11 reference. It will also sample rate convert from any valid digital audio signal in the range 32kHz to 54kHz to one of the available output sample clock rates; 32kHz, 44.1kHz and 48kHz.

The module features an on-board gain control, remote fader option and a programmable automatic fade facility is provided. Audio modify features include channel swap, either channel to both output channels and digital silence.

Remote control of gain and fader response is available through a dedicated RS484 serial port.

The module may be used in the 1050 3U and 1051 1U ICON modular product rackframes with a choice of balanced or unbalanced rear connectors. Characteristics of the 4407 are:

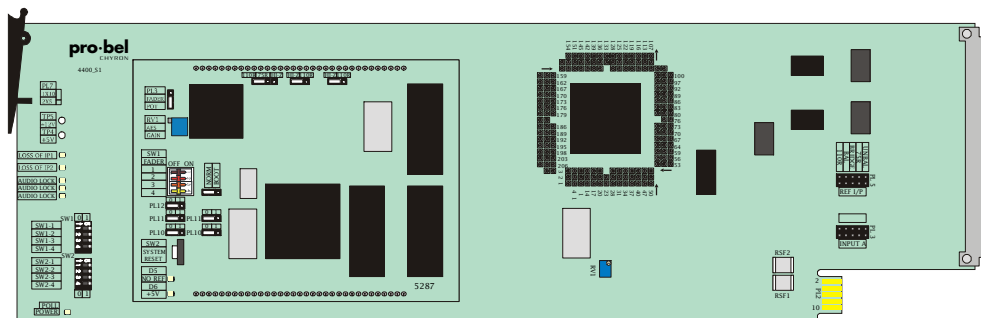
- eight outputs
- AES3 or SPDIF inputs
- sample rate synchronising for asynchronous 32kHz, 44.1kHz or 48kHz sources when module locked to AES11.
- sample rate conversion from 32 to 54kHz
- AES11 reference input
- gain control 0dB to -12dB
- jumper selectable audio modify facilities (A-both, B-both, A/B swap and digital silence)
- RS485 serial control (four wire and two wire) of gain and fader response
- automatic fade to or from silence in 0,1,2,4 or 8 seconds under serial control
- compatible with Pro-Bel COSMOS status monitoring.



The 4407 digital audio sample rate converter

2 Installation

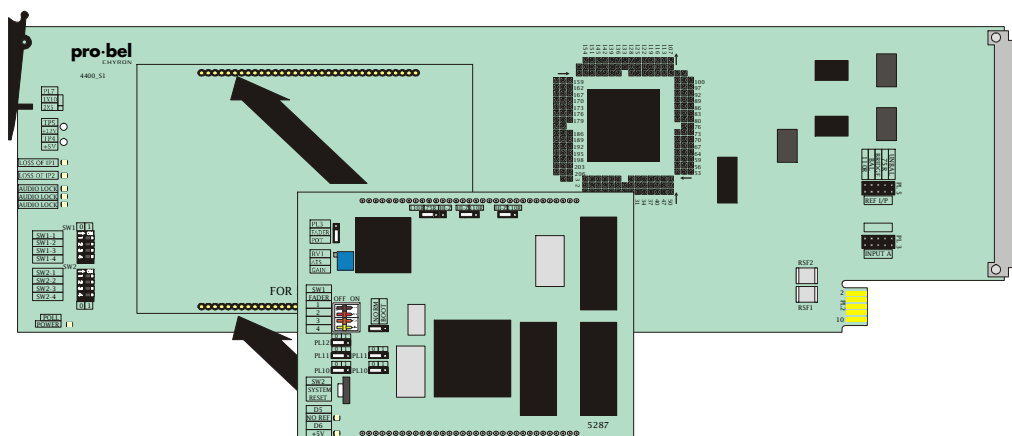
The 4407 eight output digital audio sample rate converter and synchroniser fits in the 1050 3U and 1051 1U ICON modular product rackframes. It is used with either the K4407.2B 30mm rear panel for balanced digital audio I/O or the K4407.3U 30mm rear panel for unbalanced digital audio I/O.



The 4407 digital audio reframer with the 5288 sub-module

The 4407 is supplied with the 5288 sub-module fitted at the factory. In the unlikely event that the sub-module needs to be removed and refitted proceed as follows:

- ease the sub-module out of its header sockets using gentle leverage under the top and bottom connectors
- refit by gently pushing the connectors into the PCB headers
- observe the correct sub-module orientation as shown

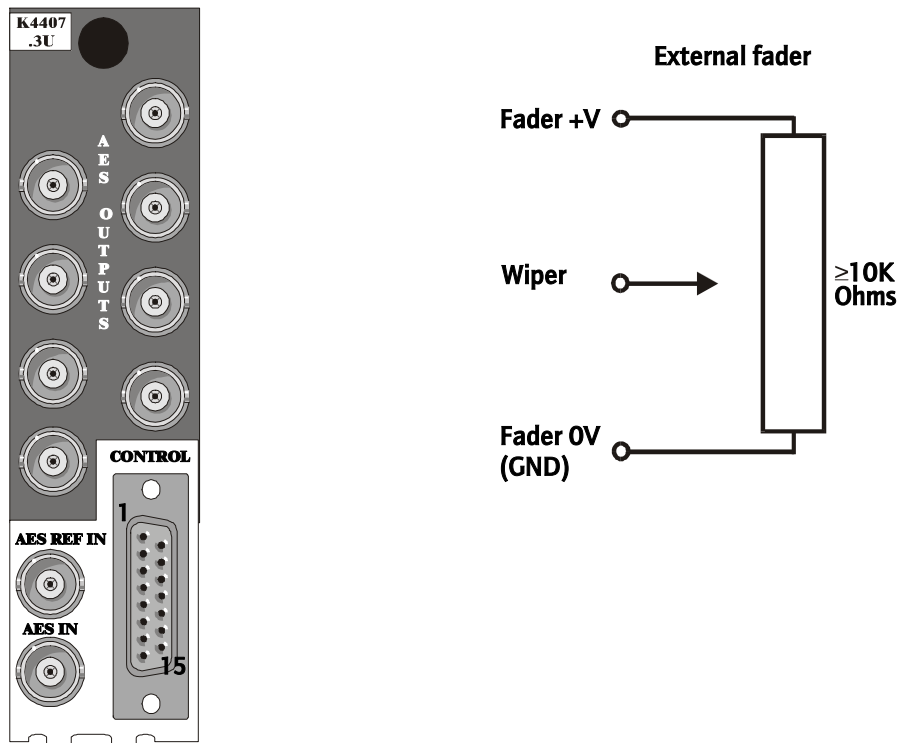


Re-fitting the 5288 sub-module

For module and rear connector installation please refer to the appropriate ICON rackframe section of the manual.

2.1 Signal I/O

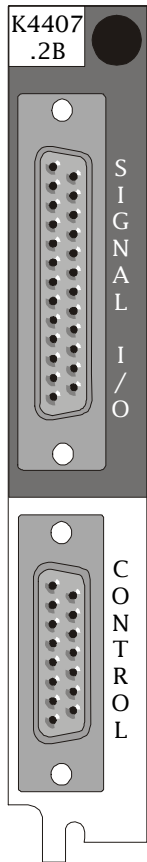
The K4407.3U panel is equipped with BNC connectors for unbalanced digital audio, whilst the K4407.2B panel is equipped with a 25 way 'D' type connector for balanced digital audio. Both panels have a 15 way 'D' connector for control and AES balanced input.



The K4407.3U rear panel for unbalanced I/O

Control Pin outs			
Pin	Function	Pin	Function
1	RS485 TX+	9	RS485 TX-
2	GND	10	RS485 RX+
3	RS485 RX-	11	GND
4	FADER +V	12	FADER WIPER
5	GND	13	*
6	*	14	GND
7	N/C	15	N/C
8	GND		

* INTERNAL CONNECTION – DO NOT USE



The K4407.2B rear panel for balanced I/O

Signal I/O (K4407.3B)			
Pin	Function	Pin	Function
1	O/P1-	14	O/P5-
2	O/P1+	15	O/P5+
3	GND	16	GND
4	O/P2-	17	O/P6-
5	O/P2+	18	O/P6+
6	AES REF IN-	19	N/C
7	AES REF IN+	20	N/C
8	GND	21	O/P7-
9	O/P3-	22	O/P+
10	O/P3+	23	GND
11	GND	24	O/P8-
12	O/P4-	25	O/P8+
13	O/P4+		

Control Pin outs			
Pin	Function	Pin	Function
1	RS485 TX+	9	RS485 TX-
2	GND	10	RS485 RX+
3	RS485 RX-	11	GND
4	FADER +V	12	FADER WIPER
5	GND	13	AES I/P+
6	AES I/P	14	GND
7	N/C	15	N/C
8	GND		

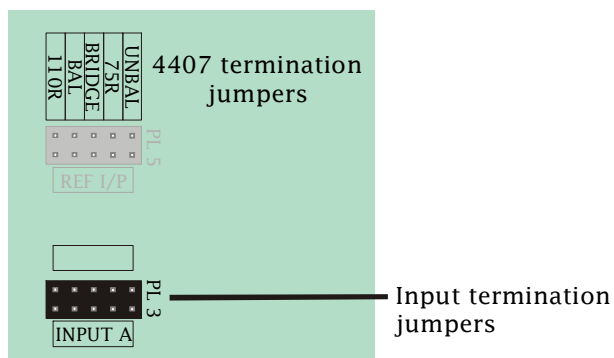
3 Configuration

The 4407 may be configured for different input and RS485 comms termination values and audio modify options. When placed under RS485 remote control, a unique multi-drop address may be selected.

3.1 Selecting reference termination options

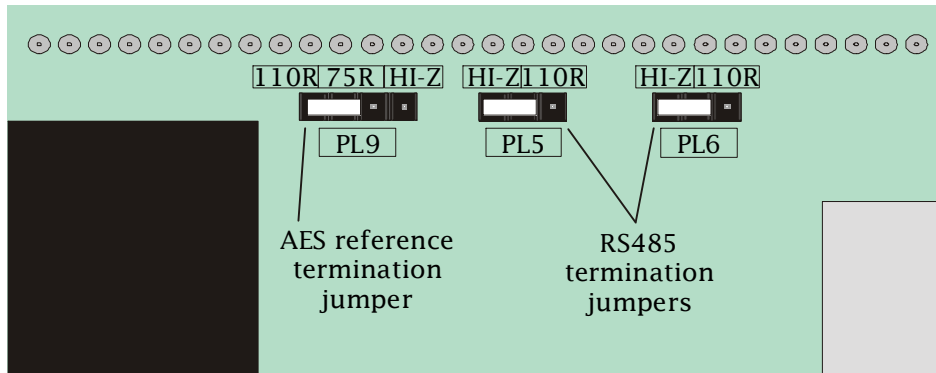
The jumpers to select AES input termination are located on the main 4407 module. The available options are explained in the following table:

AES input termination modes	
PL3 settings (4407)	Description
UNBAL	Use for unbalanced signal – requires K4407-3U rear panel
75R	Use with unbalanced input to terminate signal with 75Ω
BRIDGE	Selects high impedance termination (Hi-Z)
BAL	Use with balanced input – requires K4407-2B rear panel
110R	Use with balanced inputs to terminate signal with 110Ω



The jumper (PL9) to select the AES reference termination values is located on the 5288 sample rate converter sub-module itself. The available selections are as follows:

AES reference termination values	
PL9 settings (5288)	Description
75R	Use with unbalanced input to terminate signal with 75Ω
HI-Z	Selects high impedance termination (Bridging mode)
110R	Use with balanced inputs to terminate signal with 110Ω



5288 termination jumpers

The termination impedance for the RS485 communications ports are set by PL5 (transmitter) and PL6 (receiver) as described in the following table:

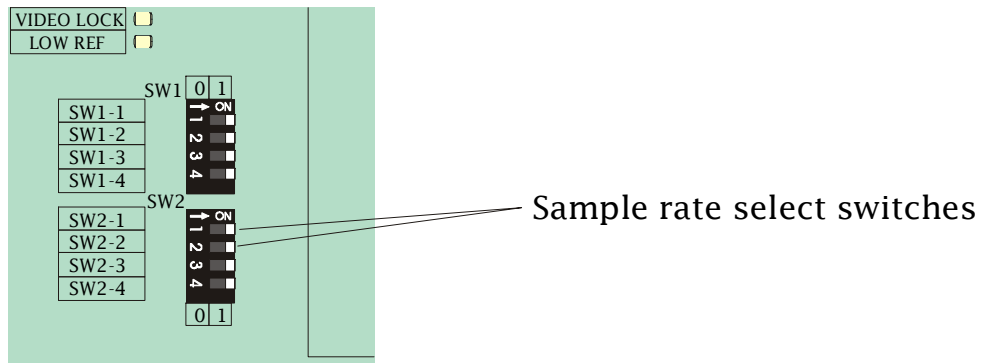
RS485 transmit and receive termination values	
PL5&6 settings (5288)	Description
HI-Z	Selects high impedance termination (Bridging mode)
110R	Use to terminate signal with 110Ω

Note: Do not leave the AES reference or RS485 inputs in high impedance with no signal connected to avoid spurious input.

3.2 Selecting the output sample rate

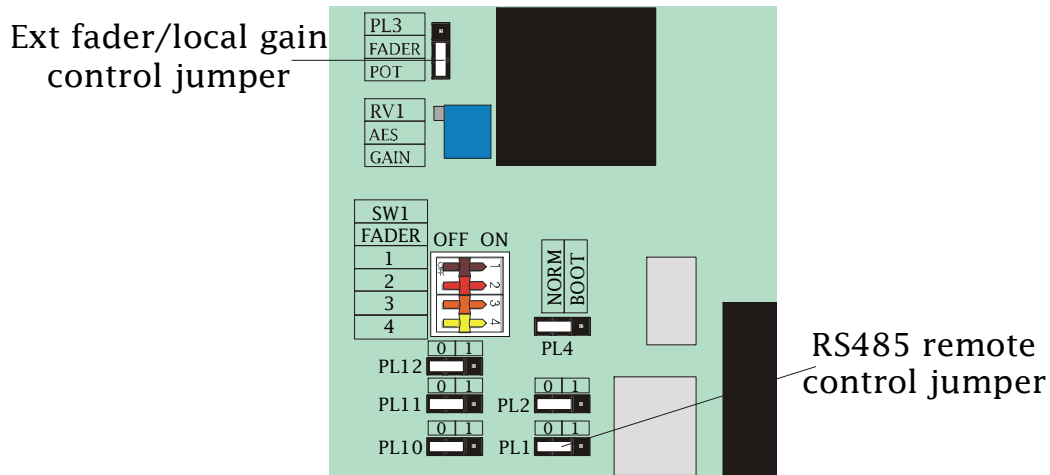
The output sample rate is selected with SW2-1 and SW2-2 as described in the following table:

4407 sample rate options		
SW2-2	SW2-1	Sample rate
0	0	44.1KHz
0	1	32KHz
1	0	48KHz
1	1	48KHz



3.3 Setting local/remote gain modes

The local or RS485 remote gain control is selected by 5288 jumper PL1. Setting PL1 to '0' enables PL3 to select either an external fader or the on-board potentiometer, RV1 to control AES gain.



Local/remote gain and fader control		
PL1	PL3	Mode
0	FADER	Control via external fader
0	POT	Control via on-board potentiometer, RV1
1	X	Control via RS485 comms

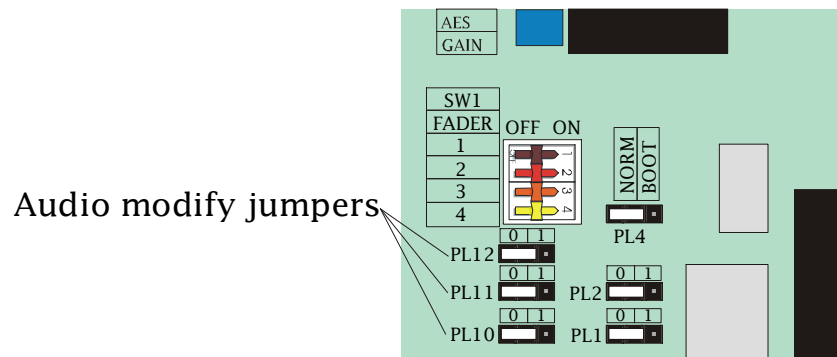
Notes:

- An external fader ($\approx 10\text{k}\Omega$), may be connected to the control port as described in the installation section.
- Setting PL1 to '1' assigns gain/fader control to the RS485 communication protocol.
- X = don't care
- PL4 must be left in the NORM position and PL2 is reserved for future use.

3.4 Setting audio modify options

The audio modify features of the module are set with 5288 jumpers PL10, 11 and 12 as described in the following table:

Audio modify options			
Function	PL10	PL11	PL12
Stereo (normal mode – no modify)	1	1	1
Input A - both	0	1	1
Input B - both	1	0	1
A/B swap	0	0	1
Digital silence	1	1	0
Reserved for future use	0	1	0
Reserved for future use	1	0	0
Reserved for future use	0	0	0

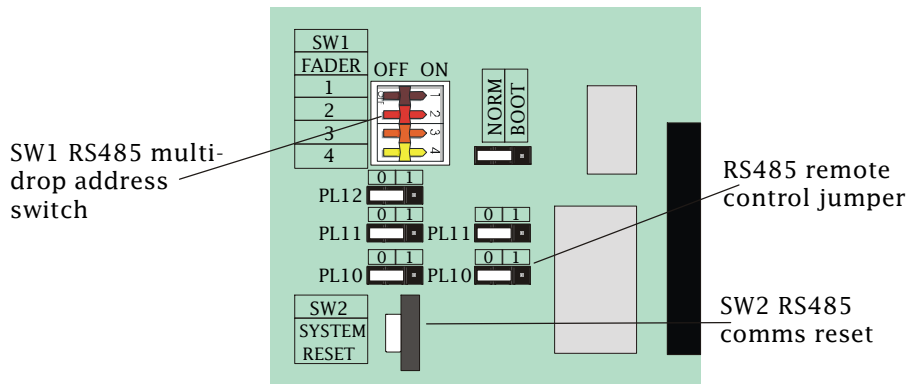


4 RS485 serial control

The RS485 comms control enables up to sixteen 4407 sample rate converter/synchroniser cards to be remotely controlled and monitored.

The RS485 controlling unit may set gain, automatic fades of various rates, reset and monitor the status of each card individually. Gain is automatically restored to 0dB after a power-on reset.

Assign a 4407 module to RS485control by placing PL1 on the 5288 sub-module to the '1' position:



4.1 Setting the multi-drop address

Each module may be assigned a unique multi-drop address using SW1 on the 5288 sub-module, to operate over the RS485 communication protocol as described in the following table

Multi-drop address, SW1				
Hex address	1	2	3	4
F(15)	0	1	1	1
E (14)	1	1	1	1
D (13)	0	0	1	1
C (12)	1	0	1	1
B (11)	0	1	0	1
A (10)	1	1	0	1
9	0	0	0	1
8	0	0	0	1
7	1	1	1	0
6	0	1	1	0
5	1	0	1	0
4	0	0	1	0
3	1	1	0	0
2	0	1	0	0
1	1	0	0	0
0	0	0	0	0

The reset switch, SW2, sets the RS485 comms to the initial state, fader at top, gain = 0dB and resets the AES Digital Signal Processor. The reset button must be pressed after changing the address switch, SW1 to update the multi-drop address memory.

4.2 Electrical parameters

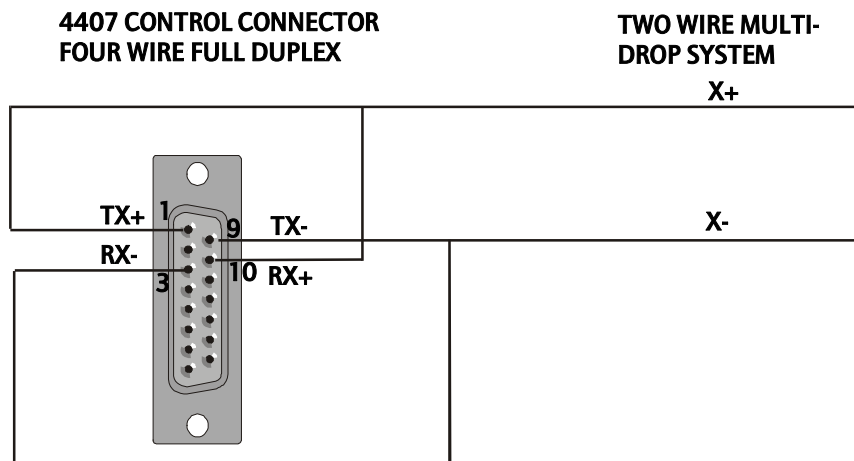
Normal electrical parameters are:

- RS485
- 8 bit data
- one stop
- even parity
- 38.4kbaud

Normal transmitters used must be capable of running in parallel i.e. more than one transmitter enabled, RS485 compatible. The group poll uses this feature.

4.3 Four wire and two wire operation

The 4407 is a full duplex four wire device. However due to the workings of the multi-drop communication protocol where the controller initiates data flows, the 4407 can be used as a two wire device with the following wiring modifications:



4.4 The link layer protocol

The general protocol format is:

MD header	Device address	Message
------------------	-----------------------	----------------

- all multi-drop (MD) headers have the top bit set
- the device address is a single byte in the range 0 to 16
- all undefined commands have no effect

Multi-drop headers

The following MD headers may be transmitted to the 4407 by a controller

F3 - Send device data

This is followed by a device address and any command message for the 4407.

F4 - Device data request

This is followed by a device address. The device must respond with a single byte of data. The null response may be sent if no data is ready.

F5 - Group poll

This causes any device with data to transmit a single null character. If more than one device replies the controller may receive an overrun, framing or parity error. The controller interprets any character received or any of the above error conditions as a request to send data by one of the devices.

The multi-drop link layer only packages outgoing messages as all incoming data is of one byte length.

4.5 Message layer

After the controller has issued a send device data byte (F3) followed by a device address (hex 01-10), the next byte sent will be a command to that device.

The controller can send the following commands to the 4407:

set output level gain - byte 1 : 0001HHHH
 - byte 2 : 0000LLLL

This command sets the audio input, output gain, HHHH are the high gain bits, while LLLL are the lower gain bits. Step size is 0.09375 dB per bit.

HHHHLLLL = 00 = -12db minimum gain setting
 HHHHLLLL = 80 = 0db unity gain (if greater than 80 gain is set to 0db)

set fade - byte 1 : 00I0000D
 - byte 2 : 0SSSSSS

To start an audio fade this command is sent with the parameters D for up (1) or down (0) and SSSSSS for fade rate.

SSSSSS	00	=	fade in 0 seconds	} Notes: These are approximate times
	05	=	fade in 1 second	
	0A	=	fade in 2 seconds	
	14	=	fade in 4 seconds	
	28	=	fade in 8 seconds	

Other values have no effect.

status request - byte 1 : 00110000

On receiving this command the 4407 will respond by sending 6 bytes of status data as detailed in the following section.

reset - byte 1 : hex FD

Causes the 4407 card to reset to the power up condition which is fader at the top and unity gain.

Bytes transmitted

The following data bytes are transmitted by the 4407 after a panel poll from the link layer has been issued by the controller.

fader gain high - 0001HHHH

fader gain low - 00I0LLLL

Reports the fader gain status. This is not the audio gain setting but a value corresponding to the fade position at that particular point. These bytes are issued in response to a status request command given from the controller.

HHHHLLLL 00 = fade has reached bottom position
 80 = fade active
 FF = fade has reached top position

Note: These bytes are included for compatibility with the CBC 5015 fader protocol.

transition status - 00 11ABCD

These are status bits indicating the current fade action. All bits are active when they are high.

- A = fading down
- B = fading up
- C = fade at bottom
- D = fade at top

No two bits should be on at any time. This byte is issued in response to a status request command and when the fade transition status changes.

AES data status - 01000N00

The AES bit stream input signal has various status bits which are active when high.

Data error (no input)

Typically, with no audio signal, BIT N will be set high. This byte is issued in response to a status request command and when the AES input status changes.

4.6 Protocol examples

Status request		
Controller	Description	Device response
F5	Group poll	
F3 0A 30	Status request card 10	
F5	Group poll	00
F4 0A	Request data from card 10	1F
F4 0A		2F
F4 0A		31
F4 0A		44
F4 0A		58
F4 0A		60
F5	Group poll	

Device response 1F, 2F says that the fader gain is fully up. Byte 31 indicates that the fader is at the top position and byte 44 says that no valid AES bit stream data is present at the card inputs. Byte 58 and 60 form together to report the output level gain of 0db (unity gain).

Note: This is the status of the 4407 card after a reset command, on power-up and when the comms reset button is pushed.

Set output level gain		
Controller	Description	Device response
F5	Group poll	
F3 07 18 00	Set unity gain on card 7	
F3 0B 10 00	Set - 12dB gain on card 11	
F5	Group poll	

No response is issued from the 4407 card when the gain is changed.

Set fade		
Controller	Description	Device response
F4 09	Request data from panel 9	FF
F3 09 20 00	Fast fade down for panel 9	
F4 09	Request data from panel 9	32
F3 09 21 05	Fade up in one second	
F4 09	Request data from panel 9	34
F4 09	Request data from panel 9	31

Device response 32 indicates fade at bottom. Byte 34 says that the fader is currently fading up but has not reached the top yet and finally, byte 31 tells the controller that the fade is finished and at the top

5 Status monitoring

The status monitoring circuit, will provide the following information to the status monitoring controller:

- module present
- I/P 1 present
- audio locked
- SW 2 status
- audio locked

In addition, the module is programmed with the following information, which can be read by the status monitoring controller:

- Module type
- Module bar code
- Module issue no

For further details of the Pro-Bel status monitoring system please refer to the COSMOS status monitoring manual.

6 Trouble shooting

The green card edge POWER LED is not lit

- check the PSU indicator to confirm that there is power to the frame
- check the resettable fuses protecting the card - do this by removing the power to the card for about 30 seconds then restoring the power
- if necessary, refer to the power supply trouble shooting guide in the appropriate ICON rackframe manual section

There is no output signal

- ensure that the green power LED on the front of the main card is lit
- check that the green +5V LED is lit on the 5288 sub-module
- check that a valid input is connected to the rear panel
- check that the red LOSS OF INPUT LED is not lit

The output signal is corrupted

- check the quality of the input signal(s)
- Check Red "No Ref" led on 5288 is off
- Check Red "Loss of Input 1" is off
- check that the red LOW REF LED on the main card is not lit
- check that the appropriate termination has been set
- check that the appropriate sample rate has been selected

The manual gain control does not work

The incorrect mode may have been selected

- check that jumper PL1 on the sub-module is set to '0'
- press the reset button on the sub-module to change mode if necessary
- ensure that jumper PL4 on the sub-module is set to 'NORM'

The RS485 comms do not work

The incorrect mode or address may have been selected

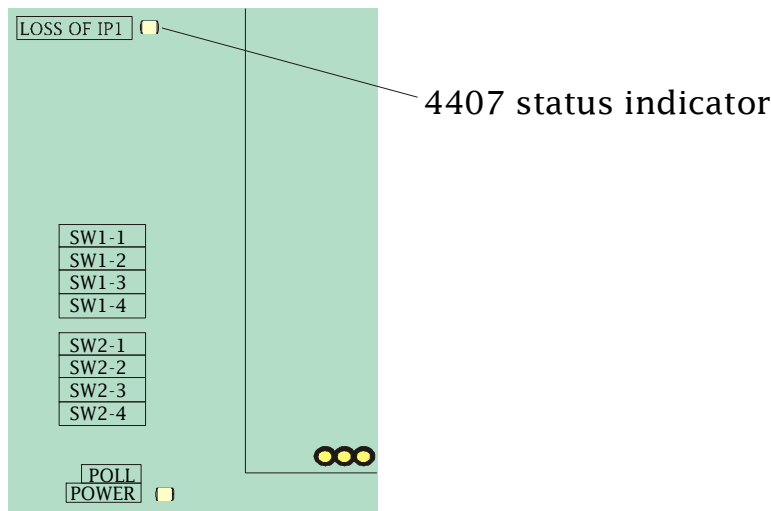
- check that jumper PL1 on the sub-module is set to '1'
- press the reset button on the sub-module to change mode if necessary
- check that the multi-drop address is set correctly
- if the multidrop address needs to be changed, push the reset button afterwards to store the new address

The output signal causes pops and clicks in downstream equipment

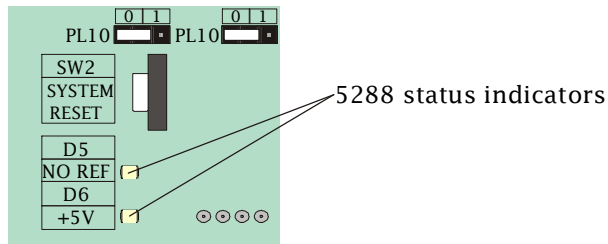
- check that the reference used has the same phase and frequency as all other digital audio equipment used in the system

Note: It is recommended to employ a common AES11 reference for all digital audio equipment if accurate phasing to station signals is required throughout a facility. The 4407 should meet the timing requirements of AES11 under these conditions.

4407 Status indicators	
LED label	Meaning when lit
LOSS OF I/P	Lights red when I/P 1 is not present or when channel 1 error flag (ERF) is set
POWER	Lights green if all voltage rails present



5288 status indicators	
LED label	Meaning when lit
NO REF	Lights red when I/P 1 is not present or when channel 1 error flag (ERF) is set
+5V	Lights green if +5V rail is present



7 Specification

Inputs (signal)

Number and type: 1, balanced, transformer coupled to AES3-1992 or unbalanced to AES3-id including SPDIF

Termination: High, 75 Ω or 110 Ω

Inputs (reference)

Number and type: 1, balanced, transformer coupled to AES11-1997 or unbalanced to AES3-id

Termination: High, 75 Ω or 110 Ω

Outputs

Number and type: 8, transformer coupled, balanced to AES3-1992 or unbalanced to AES3-id

Performance

Sample rate: 32, 44.1 or 48kHz

Word length: 20 bits

Audio modify

Attenuation from 0 to -12dB

Channel A to both

Channel B to both

Channel A swapped with channel B

Digital silence

Fader law

Logarithmic, i.e. linear dBs with time

Time specified is from full gain to -60dB

Automatic fades

Fades to or from silence in 0,1,2,4 or 8 seconds to or from current gain level (0 to -12dB)

Remote control

Number and type:

RS485 @38.4kBaud, 4 or 2 wire duplex multi-drop bus for gain control, automatic fading and remote status monitoring, 8 data bits, 1 stop bit, even parity

Impedance:

Selectable for 110 Ω or bridge

Temperature range

Operating:

0° to +40°C

Storage:

-10°C to +70°C

8 Ordering Information

ICO-4407-2B00	Digital Audio Sample Rate Synchroniser, balanced I/O, 20 mm
ICO-4407-3U00	Digital Audio Sample Rate Synchroniser, unbalanced I/O, 30 mm