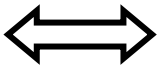
Bluebell OPTICOM LIMITED

OPERATIONS & TECHNICAL MANUAL

For

BC450T
BC450R

Analogue Audio

SDI/HD/3G  **Optical**

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Safety Warning – Important Precautions

To reduce the risk of fire or electric shock, do not expose this equipment to rain, moisture, or wet conditions.

General Safety Guidelines

- Always **disconnect the entire system from the AC mains** before cleaning or servicing.
- The following product frames – **BC100, BC100i, BC101, BC102, BC120, BC160i** – must be connected using a **three-conductor AC mains power cord with an earth ground**. All three conductors must be used at all times to prevent electric shock.
- Do **not** bypass or disable any fuse.
- Only replace fuses with those of the **specified type and rating**.
- Do **not** use flammable or combustible chemicals for cleaning.
- Do **not** pour or spill liquids directly onto the unit.
- Do **not** allow any liquid to enter the unit or wet the internal components.
- Do **not** operate the unit with any cover or panel removed.
- Do **not** obstruct the ventilation slots—**adequate airflow must be maintained**.
- Do **not** operate the unit in environments with **extreme temperatures**.
- Do **not** use or store the unit in **explosive atmospheres**.
- Do **not** attempt to repair the unit yourself. If servicing is required, please contact your local **Bluebell Opticom** distributor.
- **Product Warranty**
- **Bluebell Opticom Ltd** provides warranty coverage as detailed in our general terms and conditions.
  Please note that warranty support is only valid **if product serial numbers remain intact and legible**. Tampering with or removing serial numbers may void your warranty.

CE	EN60950	Safety
	EN55103-1: 1996	Emission
	EN55103-2: 1996	Immunity

Bluebell Opticom Ltd FC Tested To Comply With FCC Standards FOR HOME OR OFFICE USE	This device complies with part 15 of the FCC Rules Operation is subject to the following two condition: (1) This device may cause harmful interference, and (2) This device must accept any interference received, including, Interference that may cause undesired operation

Contents	**BC450T/BC450R**

BC450T

The BC450T (Optical transmitter) module accepts SDI/HD/3G video and analogue audio inputs and after processing, outputs SDI/HD/3G video with embedded audio onto optical fibre.

The BC450T module assembly comprises a BC450T audio processor sub-board coupled to a BC440T transmitter base-board.
The BC440T receives and processes the digital video and also embeds audio from the attached BC450T sub-board.
On the BC450T, eight channels of analogue audio are converted to four stereo channels of I2S digital audio.
Digital audio input to the BC440T is via intercard connectors between the BC440T and the BC450T.

The analogue audio inputs enter via a 26 way high density D type connector.

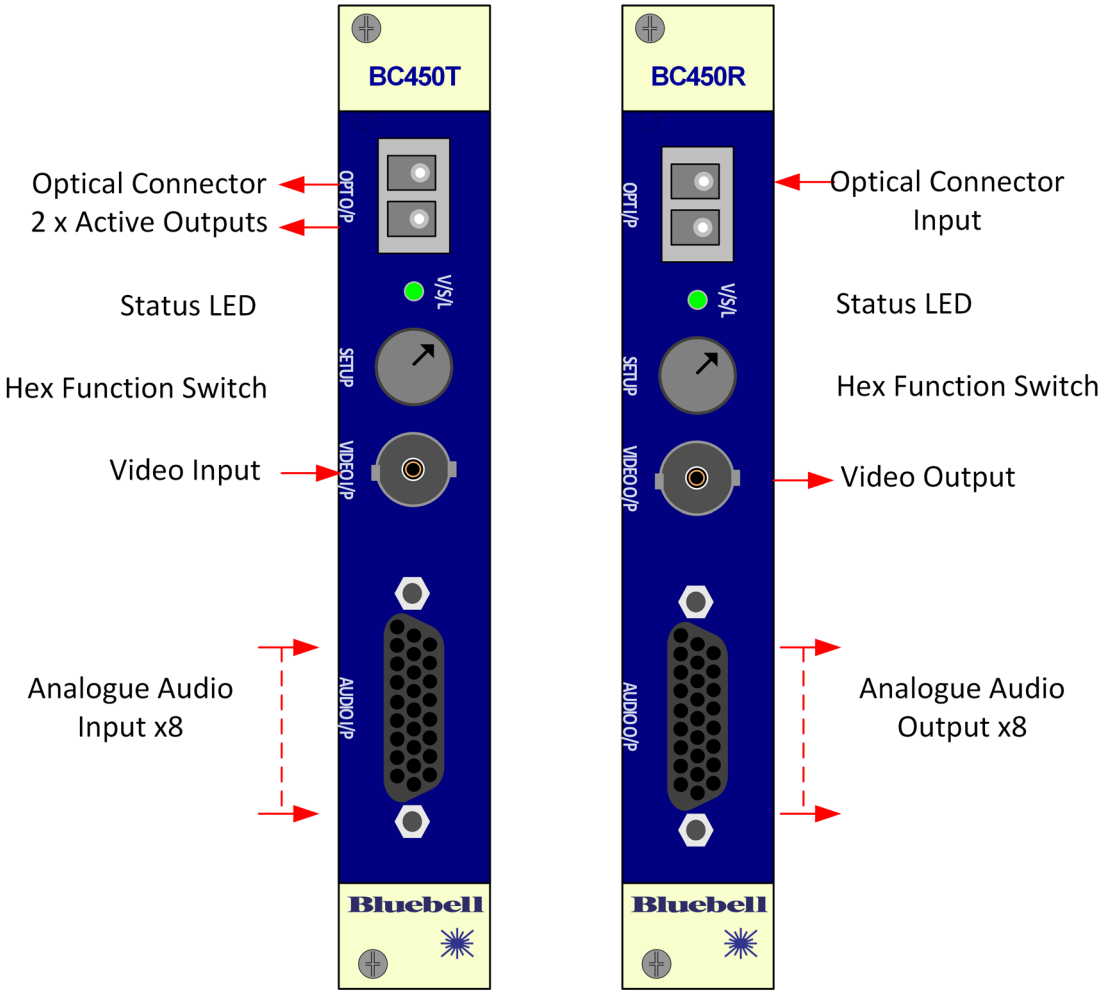
BC450R

The BC450R (Optical receiver) module receives a fibre optic input carrying SDI/HD/3G video with embedded audio and processes the audio to produce analogue audio outputs.

The BC450R module assembly comprises a BC450R audio processor sub-board coupled to a BC440R receiver base-board.
The BC440R base-board receives the optical signal and de-embeds the audio for processing by the attached BC450R sub-board.
On the BC450R, four stereo channels of I2S digital audio from the BC440R are converted to eight channels of analogue audio.
Digital audio connection between the BC440R and the BC450R is via intercard connectors.

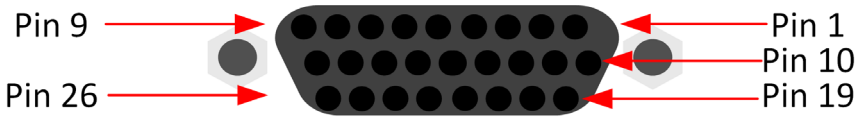
The analogue audio outputs come out on a 26 way high density D type connector.

Product photos	BC450T/BC450R



BC450T Optical transmitter

BC450R Optical receiver



Specification	BC450T/BC450R

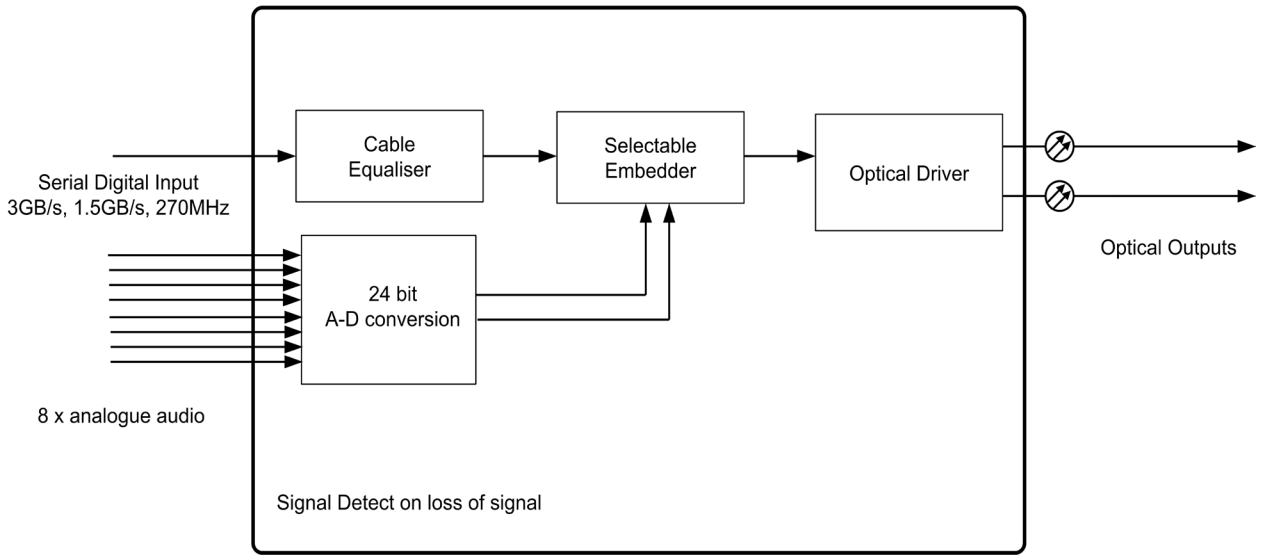
BC450T

Depth	60mm
Width	20mm (4TE)
Height	100mm (3RU)
Weight	100g
Power Supply	6V DC
Power consumption	6W
Current consumption	1000mA
Optical output	LC type connector.
Analogue audio input	4 stereo pairs
Audio connector	26 way female, high density “D” type
Audio levels	Link selectable for:- 0dBu i/p to -18dBFS o/p (Europe) 0dBu i/p to -24dBFS o/p (USA) (=+4dBu i/p to -20dBFS) Variable potentiometer: -0.5 to +3.5dB
Embedding	Onto groups 1 & 2 or 3 & 4 - selectable
Video input	75 Ω BNC
Standards supported	SDI, HD (1080i, 720p @ 50 or 59.94), 3G

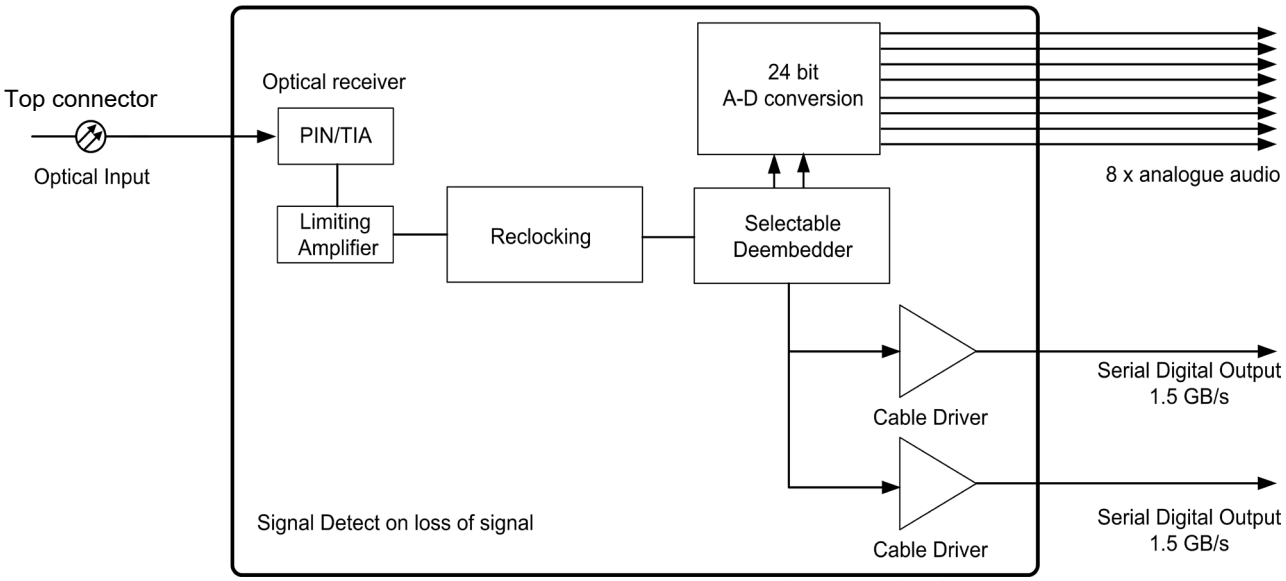
BC450R

Depth	60mm
Width	20mm (4TE)
Height	100mm (3RU)
Weight	100g
Power Supply	6V DC
Power consumption	6W
Current consumption	950mA
Optical input	LC type connector.
Analogue audio output	4 stereo pairs
Audio connector	26 way female high density “D” type
Audio levels	Link selectable for:- -18dBFS i/p to 0dBu o/p (Europe) -24dBFS i/p to 0dBu o/p (USA) (=-20dBFS i/p to +4dBu) -20dBFS i/p to 0dBu o/p Variable potentiometer: -3.5 to +0.5dB
De-embedding	Groups 1 & 2 or 3 & 4 - selectable
Video output	75 Ω BNC

BC450T



BC450R



BC450T - Analogue Audio Input Connections:

The 26 way high density D type electrical connections are as follows:-

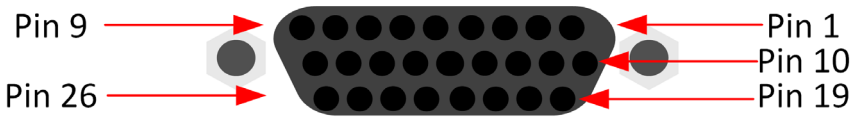
(NOTE; Channel B L & R are reversed compared to other channels)*

1	chan A Left +	10	chan A Left screen	19	chan A Left -
2	chan A Right +	11	chan A Right screen	20	chan A Right -
3*	chan B Right +	12	chan B Right screen	21	chan B Right -
4*	chan B Left +	13	chan B Left screen	22	chan B Left -
5	chan C Left +	14	chan C Left screen	23	chan C Left -
6	chan C Right +	15	chan C Right screen	24	chan C Right -
7	chan D Left +	16	chan D Left screen	25	chan D Left -
8	chan D Right +	17	chan D Right screen	26	chan D Right -
9	Ground	18	Ground		

BC450R - Analogue Audio Output Connections:

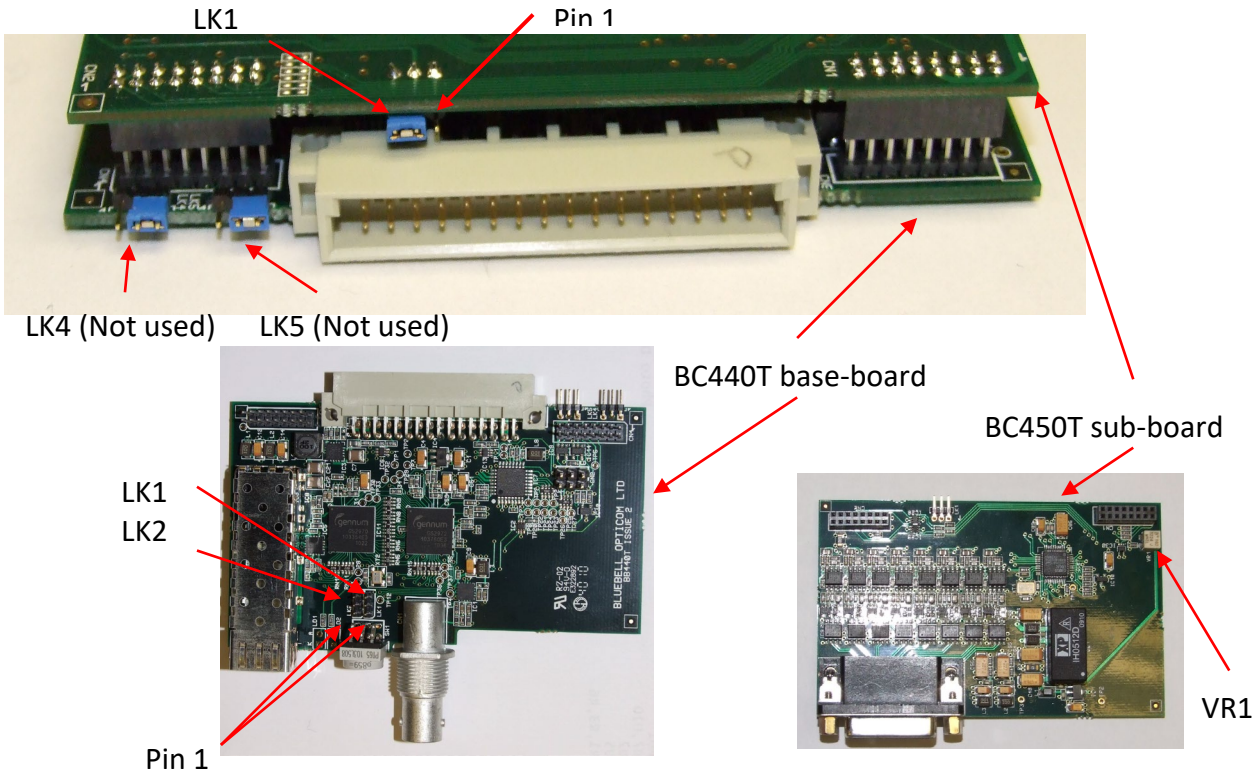
The 26 way high density D type electrical connections are as follows:-

1	chan A Left +	10	chan A Left screen	19	chan A Left -
2	chan A Right +	11	chan A Right screen	20	chan A Right -
3	chan B Left +	12	chan B Left screen	21	chan B Left -
4	chan B Right +	13	chan B Right screen	22	chan B Right -
5	chan C Left +	14	chan C Left screen	23	chan C Left -
6	chan C Right +	15	chan C Right screen	24	chan C Right -
7	chan D Left +	16	chan D Left screen	25	chan D Left -
8	chan D Right +	17	chan D Right screen	26	chan D Right -
9	Ground	18	Ground		



BC450T - Link Settings

	Link	To Link	
On BC450T Analogue Audio Input sub-board			
LK1	Pin 1	Pin 2	0dBu input gives -24dBFS output (Factory default)
	Pin 2	Pin 3	0dBu input gives -18dBFS output
On BC440T base-board			
LK1	Pin 1	Pin 2	Not used
	Pin 2	Pin 3	LD1 indicates SDI input lock (Must be fitted)
LK2	Pin 1	Pin 2	(or no link) Enable embedded audio to fibre output
	Pin 2	Pin 3	Not used (Disable embedded audio to fibre out)
LK4			Not used (Link fitted for possible future use)
LK5			Not used (Link fitted for possible future use)



Variable Resistor Settings: On BC450T sub-board

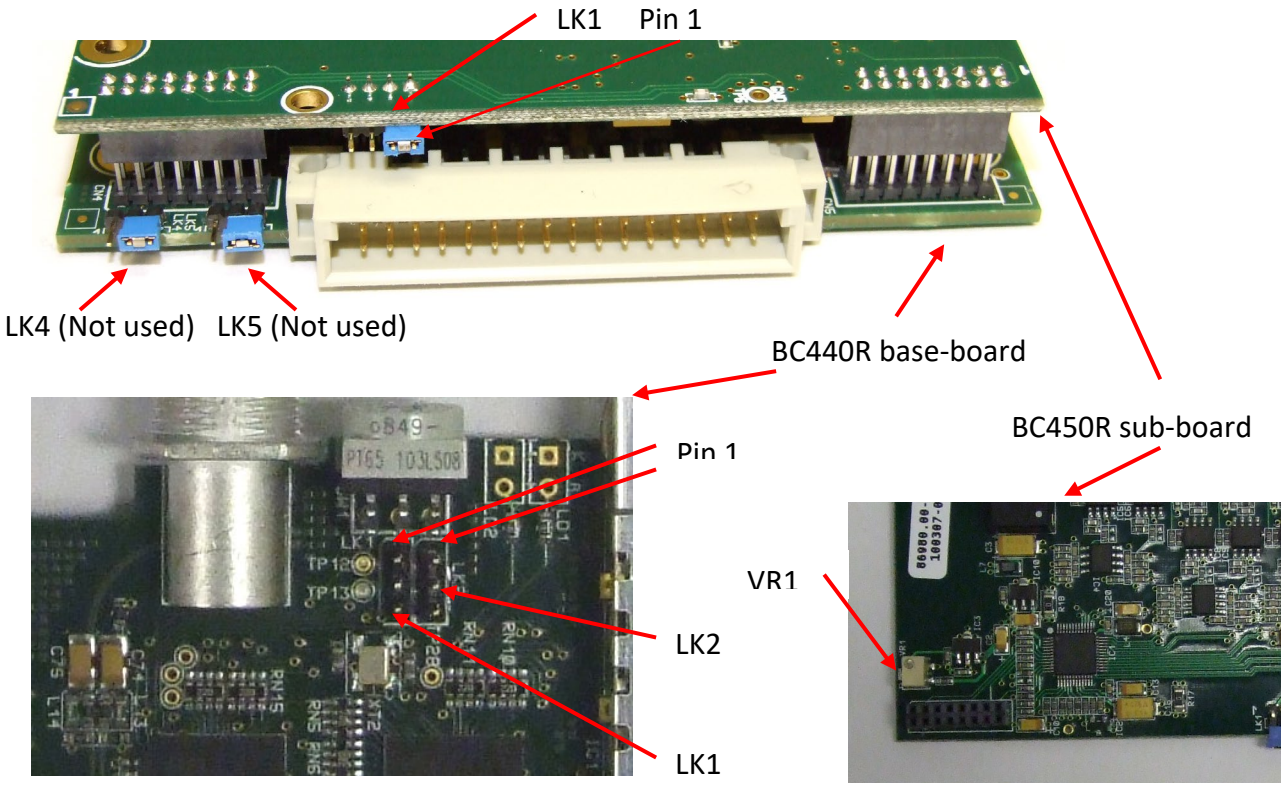
VR1	Gain adjustment for all analogue audio channels: -0.5 to +3.5 dB e.g. (LK1, p2-p3) 0dBu i/p => -18.5 to -14.5dBFS (Factory setting: -18dBFS)

Indicator LEDs

Indicator	Function
LED LD1	"VS/L" SDI/HD/3G input lock
LED LD2 (if fitted)	"AS/L" (Not normally fitted)

BC450R - Link Settings

	Link	To Link	
On BC450R Analogue Audio Output sub-board			
LK1	Pin 1	Pin 2	-18dBFS input gives 0dBu output
	Pin 2	Pin 3	-24dBFS input gives 0dBu output (Factory default)
	Pin 3	Pin 4	-20dBFS input gives 0dBu output
On BC440R base-board			**(Note: LK1, LK2 removed on iss 3 PCBs)**
LK1	Pin 1	Pin 2	Not used
	Pin 2	Pin 3	LD1 indicates i/p optical signal lock (Must be fitted)
LK2	Pin 1	Pin 2	(or no link) Enable embedded audio out
	Pin 2	Pin 3	Not used (Disable embedded audio out)
LK4			Not used (Link fitted for possible future use)
LK5			Not used (Link fitted for possible future use)



Variable Resistor Settings: On BC450R sub-board

VR1	Gain adjustment for all analogue audio channels: -3.5 to +0.5dB e.g. (LK1, p1-p2) -14.5 to -18.5dBFS i/p => 0dBu (Factory setting: -18dBFS)

Indicator LEDs

Indicator	Function
LED LD1	"VS/L" Optical input lock (LK1 pins 2/3 linked)
LED LD2 (if fitted)	"AS/L" (Not normally fitted)

BC450T - Hex Switch Setting summary:

Hex switch	Function
4	Embed Analogue AB, CD on grps 1, 2; Blank audio on grps 3, 4.
5	Embed Analogue AB, CD on grps 3, 4; Blank audio on grps 1, 2.
6	Embed Analogue AB, CD on grps 1, 2; Pass SDI audio on grps 3, 4.
7	Embed Analogue AB, CD on grps 3, 4; Pass SDI audio on grps 1, 2.
A *	Embed Analogue AB, CD on grps 1, 4. Pass SDI audio on grps 2, 3.
other	Not used

See tables below and "Audio Group Selection" page for more details on hex switch.

Audio inputs

Analogue stereo pairs			
A L /R	B L/R	C L/R	D L/R

SDI input embedded audio			
i/p group 1 L1/R1 & L2/R2	i/p group 2 L1/R1 & L2/R2	i/p group 3 L1/R1 & L2/R2	i/p group 4 L1/R1 & L2/R2

Output is fibre carrying SDI with embedded audio

Hex switch	Group 1	Group 2	Group 3	Group 4
0	Not used			
1	Not used			
2	Not used			
3	Not used			
4 (default)	Stereo pairs A & B	Stereo pairs C & D	Blanked	Blanked
5	Blanked	Blanked	Stereo pairs A & B	Stereo pairs C & D
6	Stereo pairs A & B	Stereo pairs C & D	Input group 3 L1/R1 & L2/R2	Input group 4 L1/R1 & L2/R2
7	Input group 1 L1/R1 & L2/R2	Input group 2 L1/R1 & L2/R2	Stereo pairs A & B	Stereo pairs C & D
8	Not used			
9	Not used			
A *	Stereo pairs A & B	Input group 2 L1/R1 & L2/R2	Input group 3 L1/R1 & L2/R2	Stereo pairs C & D
B	Not used			
C	Not used			
D	Not used			
E	Not used			
F	Not used			

* The “hex switch = A” function was added in June 2012 (firmware version 1.04).

BC450R - Hex Switch Setting summary:

Hex switch	Function
0	De-embed groups 1, 2 to analogue. Pass SDI embedded audio.
1	De-embed groups 3, 4 to analogue. Pass SDI embedded audio.
2	De-embed groups 1, 2 to analogue. Blank SDI embedded audio.
3	De-embed groups 3, 4 to analogue. Blank SDI embedded audio.
4 - F	Not used

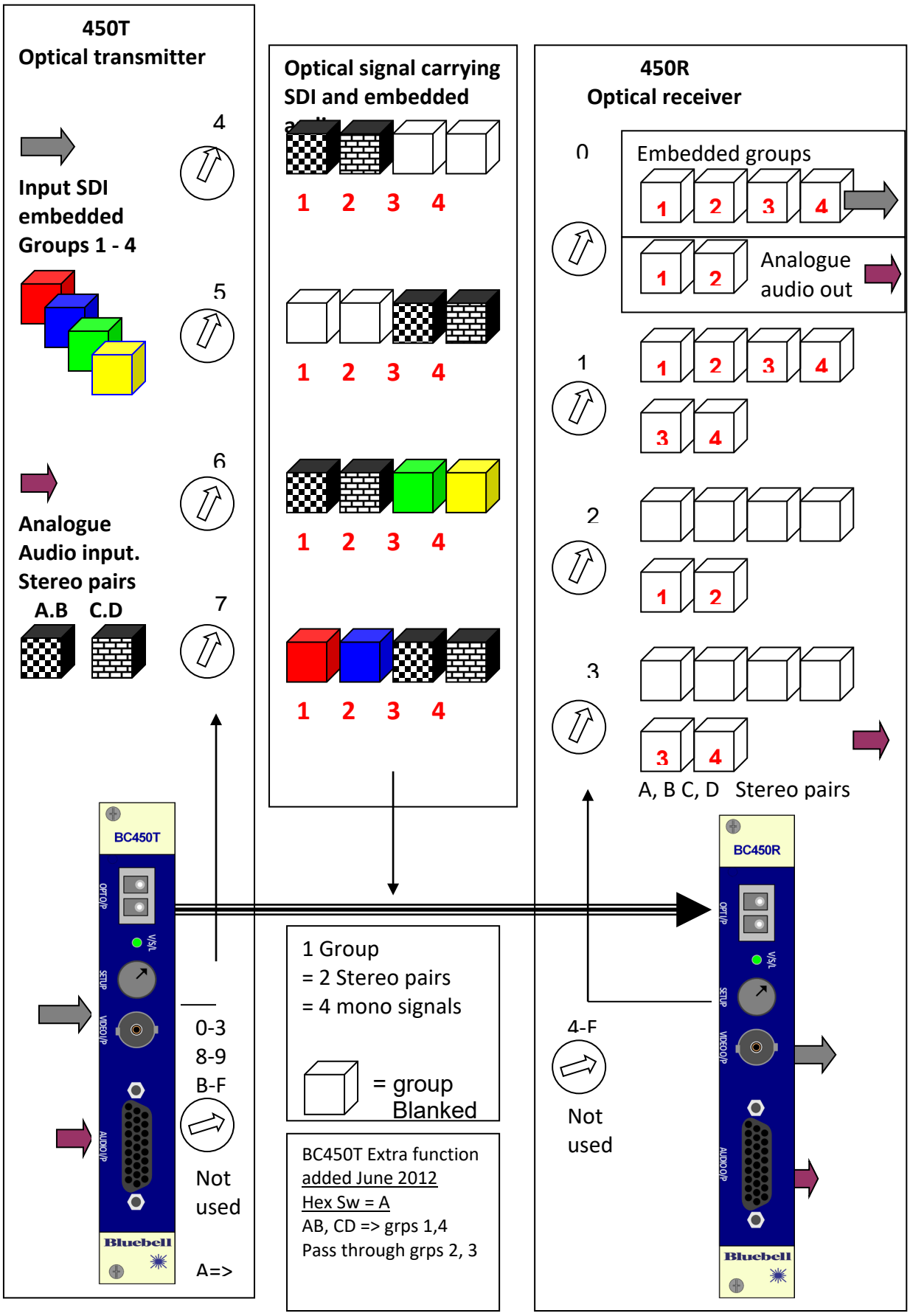
See tables below and "Audio Group Selection" page for more details on hex switch.

Audio inputs

Input is fibre carrying SDI with embedded audio **As configured by BC450T Hex switch**			
i/p group 1 L1/R1 & L2/R2	i/p group 2 L1/R1 & L2/R2	i/p group 3 L1/R1 & L2/R2	i/p group 4 L1/R1 & L2/R2

Outputs are SDI with embedded audio, and analogue audio

Hex switch	SDI output				Analogue audio output A	B	C	D
0 (default)	i/p grp 1	i/p grp 2	i/p grp 3	i/p grp 4	i/p grp 1 L1 / R1	i/p grp 1 L2 / R2	i/p grp 2 L1 / R1	i/p grp 2 L2 / R2
1	i/p grp 1	i/p grp 2	i/p grp 3	i/p grp 4	i/p grp 3 L1 / R1	i/p grp 3 L2 / R2	i/p grp 4 L1 / R1	i/p grp 4 L2 / R2
2	Blanked	Blanked	Blanked	Blanked	i/p grp 1 L1 / R1	i/p grp 1 L2 / R2	i/p grp 2 L1 / R1	i/p grp 2 L2 / R2
3	Blanked	Blanked	Blanked	Blanked	i/p grp 3 L1 / R1	i/p grp 3 L2 / R2	i/p grp 4 L1 / R1	i/p grp 4 L2 / R2
4	Not used							
5	Not used							
6	Not used							
7	Not used							
8	Not used							
9	Not used							
A	Not used							
B	Not used							
C	Not used							
D	Not used							
E	Not used							
F	Not used							


450T
Optical transmitter
4
Input SDI
embedded
Groups 1 - 4
5
6
Analogue
Audio input.
Stereo pairs
A.B C.D
7
Optical signal carrying
SDI and embedded
1 2 3 4
1 2 3 4
1 2 3 4
1 2 3 4
450R
Optical receiver
0
Embedded groups
1 2 3 4
1 2
Analogue
audio out
1
1 2 3 4
3 4
2
1 2
3
3 4
A, B C, D Stereo pairs
BC450T
0-3
8-9
B-F
Not
used
A=>
1 Group
= 2 Stereo pairs
= 4 mono signals
= group
Blanked
BC450T Extra function
added June 2012
Hex Sw = A
AB, CD => grps 1,4
Pass through grps 2, 3
4-F
Not
used
BC450R
Bluebell

BC450T

The BC450T sub-board receives +6V and +3.3V DC supplies from the BC440T base-board. The +6V DC input is filtered by C47, L1 and C49 and fed to DC to DC converter DC1 pin 6. DC1 converts the +6V to +12 Volts and -12 Volts for the analogue audio output stage. The +6V DC is also regulated by IC1 to +5V which goes to the I2S A to D converter stage, IC27. The +3.3V input from the BC440T base-board is decoupled by C68, C2, and C3 and supplies the internal logic of IC27. Power test points are TP2 (GND) and TP3 (+5V). IC10 provides a fixed delay to the reset line of IC27 on power up and holds the reset line low if the +3.3V supply drops lower than 3.0 V.

The differential analogue audio inputs from J1 D type connector are buffered by IC2, IC3, IC4, IC5, IC6, IC7, IC8, and IC9 and are low pass filtered by IC11, IC13, IC15, IC17, IC19, IC21, IC23, and IC25 for differential input to the A to D converter IC27. LK1 originally allowed an adjustment of 0dB and -2dB so that 0dBu input would be represented by either -20dBFS or -18dBFS digital output signal levels, but a modification was introduced around December 2010 so that 0dBu input gives either -24dBFS or -18dBFS digital output. VR1 provides an analog gain adjustment of -0.5 to +3.5dB so that, for example, a scaling of 0dBu to -15dBFS can be achieved. The I2S data outputs to the BC440T are on CN2 pins 5, 6, 7, and 8. Audio clock inputs are on CN1 pins 1, 2, and 3

BC440T

The BC440T base-board is an audio embedder with a BNC input and fibre optic output. It is intended for operation with a BC450T sub-board to embed eight channels of analogue audio into the digital video data stream.
The digital video input is on a BNC connector.
The audio inputs are via a 26 way HD D-type socket on the BC450T sub-board.
The digital video fibre optic output is via an LC type connector.

The +6V DC input is filtered by C6, L5, and C7 and fed to regulator IC3 pin 3. The regulated +3.3V output is on L6, and C21 and C22 decouple this to ground.
The +3.3V DC goes to pin 2 of IC4, the +1.2V regulator. C4 decouples this +1.2V rail to ground.
Power supply test points are TP1 (GND), TP2 (+3.3V), and TP3 (+1.2V).

The serial data input from the BNC CN1 is fed to IC1, which equalises the serial data cable input. IC1's output is then fed to IC11 which provides indication of correct data rate lock via TP31. Either this or a lock detection signal from IC7 is selected by LK1 to drive, via buffer IC6, local LED indicator LD1 and the lock status output to drive the system 'ch A' status lines. An AudioErr- signal from IC7 is buffered by IC13 to drive local LED LD2 (not normally fitted) and the system 'ch B' status lines.

The re-clocked serial digital video signal is de-serialised by IC11 which also provides the data and reference clock signal to IC12. IC11 allows the extraction of the existing embedded audio data and audio clocks from the digital video data stream. LK2 provides

an option to disable audio extraction, but this has no use on the BC450T and a link may be omitted. On issue 3 PCBs, LK2 is omitted anyway.

The BC450T sub-board is fitted on CN4 and CN5 to insert audio into the data stream. IC7 is a single chip microcontroller which is used to access the functions and operation modes on the registers in IC11 and IC12 and on the BC450T sub-board. Hex switch SW1 allows operation mode setting. The digital audio data from groups 1 and 2 (AES 1, 2, 3, and 4) or from groups 3 and 4 (AES 5, 6, 7, and 8) of the input video data stream can be extracted (not used on BC450T) or embedded. SW1 should be set according to the operation mode required. See the 'Settings' section for details.

Note that in firmware update v1.04 (released in June 2012) an extra embedding option was added for the "A" setting on the hex switch. This option embeds the input analogue audio stereo pairs A, B and C, D onto groups 1 and 4 respectively, leaving groups 2 and 3 with their incoming embedded groups 2 and 3.

The parallel video data output from IC11 goes to IC12 to be converted to a serial data stream. This serial data is fed to the dual driver IC5, which outputs to IC8, the SFP fibre output module. Digital audio to be embedded is fed from the sub-board via CN4 to IC12 which can insert the audio data into groups 1 and 2 (AES 1, 2, 3, and 4) or groups 3 and 4 (AES 5, 6, 7, and 8) of the video data stream according to the table in the 'Settings' section. In overwrite mode any existing audio already in the data stream will be overwritten and in cascade mode (not used on BC450T) new data to be inserted is appended to any existing data.

Links LK4 and LK5 currently have no use, but a link may be fitted to them so that a customer may use it if a future software upgrade introduces a use for the links.

BC450R

The BC450R sub-board receives +6V and +3.3V DC supplies from the BC440R base-board. The +6V DC input is filtered by C1, L7 and C3 and fed to DC to DC converter DC1 pin 6. DC1 converts the +6V to +12 Volts and -12 Volts for the analogue audio output stage. The +6V DC is also regulated to 5V by IC3 and goes to the I2S D to A converter stage IC1. IC10 provides a regulated 2.5V for the internal logic of IC1. The +3.3V input is decoupled by C6, C7 and C14 at logic interface of IC1. Power test points are: TP1 (+5V) and TP6 (GND). IC2 provides a fixed delay to the reset line of IC1 on power up and holds the reset line low if the +3.3V supply drops lower than 3.0 V.

The I2S data inputs from the BC440 are on CN2 pins 13, 14, 15, and 16. The differential analogue audio outputs from IC1 are low pass filtered by IC4, IC7, IC11, and IC14 and buffered by IC5, IC6, IC8, IC9, IC12, IC13, IC15, and IC16 to drive the differential analogue outputs at the 26-way high density D-type connector J2. VR1 allows fine adjustment of output signal level for all channels. LK1 originally allowed scaling of -20dBFS, -18dBFS and -16dBFS input digital signal levels for 0dBu output to be selected, but a modification was introduced around December 2010, allowing scaling of -24dBFS, -20dBFS, and -18dBFS for 0dBu output to be selected. VR1 provides an analog gain adjustment of -3.5 to +0.5dB for all channels so that, for example, a scaling of -15dBFS to 0dBu can be achieved..

Analogue audio outputs are on the 26-way high density D-type socket, J2.

BC440R

The BC440R base-board is an audio de-embedder with a fibre optic input and BNC output. It is used with the BC450R audio sub-board and will de-embed eight channels of analogue audio from the optical video data stream.
The digital video fibre optic input is via an LC type connector.
The digital video output is on a BNC connector.
The audio outputs are via a 26-way HD D-type socket on the BC450R sub-board.

The +6V DC input is filtered by C8 and fed to regulator IC3 pin 3. The regulated +3.3V output is on IC3 pin 4. C6 and C7 decouple this to ground.
The +3.3V DC goes to pin 2 of IC4, the +1.2V regulator, and C4 decouples its output at pin 1 to ground.
Power supply test points are: TP1 (GND), TP2 (+3.3V), and TP3 (+1.2V).

The optical data output from the SFP module IC1 is fed to IC11, which re-clocks the serial data stream and provides indication of correct data rate lock on TP31. Either this TP31 signal or an alternative lock detection signal from IC7 can be selected by LK1 and buffered by IC6 to drive local LED indicator LD1 and the system status lines for ‘ch A’. Note that LK1 has been removed from issue 3 PCBs.

The re-clocked serial digital video signal is de-serialised by IC11 which provides the data and reference clock signal to IC12. IC11 allows the removal of the embedded audio data from the digital video data stream and generates audio clock signals which are locked to

digital video. The BC450R sub-board is fitted on CN4 and CN5 to extract audio from the data stream. IC7 is a single chip microcontroller which is used to access the functions and operation modes on the registers in IC11 and IC12, and on the BC450R sub-board. SW1 allows operation mode setting according to the table in the 'Settings' section. The digital audio data from groups 1 and 2 (AES 1, 2, 3, and 4) or from groups 3 and 4 (AES 5, 6, 7, and 8) of the video data stream can be extracted. The microcontroller IC7 also derives an AudioErr- signal which is buffered by IC13 to drive LD2 (not normally fitted) and the system status lines for 'ch B'.

The parallel video data output from IC11 goes to IC12 to be converted to a serial data stream. This serial data is fed to output CN1, the BNC connector. The ability of IC12 to embed external digital audio from CN4 onto SDI is not used on the BC450R, where it simply passes the already embedded audio or not.

Links LK4 and LK5 currently have no use, but a link may be fitted to them so that a customer may use it if a future software upgrade introduces a use for the links.