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Using Virtual Levels to control the ESP Audio sub-router in Series 2 Systems

This document discusses some of the methods for controlling the TDM audio router that can be configured to reside inside the UT400 Series 2 routing switcher system. It will discuss the architecture of the TDM router, its input and output ports and their crosspoint numbering, the types of IO cards that can be part of this audio router, and how the Utah Scientific UCON configuration utility can be used to make effective use of the TDM matrix.

Background

The TDM audio router is an optional matrix that can be added to any Series 2 router. It provides a high speed bus that carries up to 256 channels of Audio to and from the first 12 input and output slots in that router. Those signals can then be switched at will from any control point in the system.

IO Port Numbering

Only cards within the first 12 slots of the router have a physical connection to the TDM matrix. The table below shows the physical input and output numbers that each card slot corresponds to.

TDM Crosspoint Port to System IO number lookup.

TDM Input Port	First Input	Last Input	TDM Output Port	First Output	Last Output
1	0	191	1	0	191
2	256	447	2	256	447
3	512	703	3	512	703
4	768	959	4	768	959
5	1024	1215	5	1024	1215
6	1280	1471	6	1280	1471
7	1536	1727	7	1536	1727
8	1792	1983	8	1792	1983
9	2048	2239	9	2048	2239
10	2304	2495	10	2304	2495
11	2560	2751	11	2560	2751
12	2816	3007	12	2816	3007

Supported Card Types

IO cards that send and receive TDM audio fall into 3 categories –

1. Video Embedder and Disembedder products.
   These cards support twelve video signals each and 16 channels of embedded audio within each signal, for a total capacity of 16x12 or 192 audio channels. The way that the audio from these cards is presented to or taken off the TDM bus is linear, grouped by the video signal. In other words, the audio associated with first video input arrive at the TDM crosspoint on inputs 0-15. The audio associated with the second video channel arrives at the TDM matrix on inputs 16-31, and so on. The table below associates video and audio crosspoints for the first slot. Remember that if the card you are encoding is in a slot other than 0, you must apply the offset for the slot number from the 'TDM Crosspoint Port to System IO number lookup' table above.

   Video to Audio crosspoint association

Video Crosspoint	First Audio Crosspoint	Last Audio Crosspoint
0	0	15
1	16	31
2	32	47
3	48	63
4	64	79
5	80	95
6	96	111
7	112	127
8	128	143
9	144	159
10	160	175
11	176	191

2. Triple MADI IO cards.
   These boards act as a gateway for three unique MADI (AES-10) 64 channel signals into or out of the TDM matrix. They have a capacity of 3x64 or 192 audio signals. These three signals are presented linearly to the TDM matrix, with the first channel of the first MADI stream feeding TDM crosspoint 0, the first channel of the second stream feeding TDM crosspoint 64, etc. The table below illustrates this mapping.

   MADI to Audio crosspoint association

MADI Channel	First Audio Crosspoint	Last Audio Crosspoint
1	0	63
2	64	127
3	128	191

3. AES and Analog IO cards.
   These boards manage 12 AES or analog stereo pairs of audio and present them to the TDM crosspoint. Because they only deal with 24 unique audio signals, they do not fully use the TDM bus. Crosspoints located on this bus that are not serviced by these cards become inaccessible to the rest of the system. The table below illustrates their mapping.

   AES or Analog IO card crosspoint association

AES or Stereo IO	First Audio Crosspoint	Last Audio Crosspoint
0	0	1
1	2	3
2	4	5
3	6	7
4	8	9
5	10	11
6	12	13

7	14	15
8	16	17
9	18	19
10	20	21
11	22	23

System Configuration

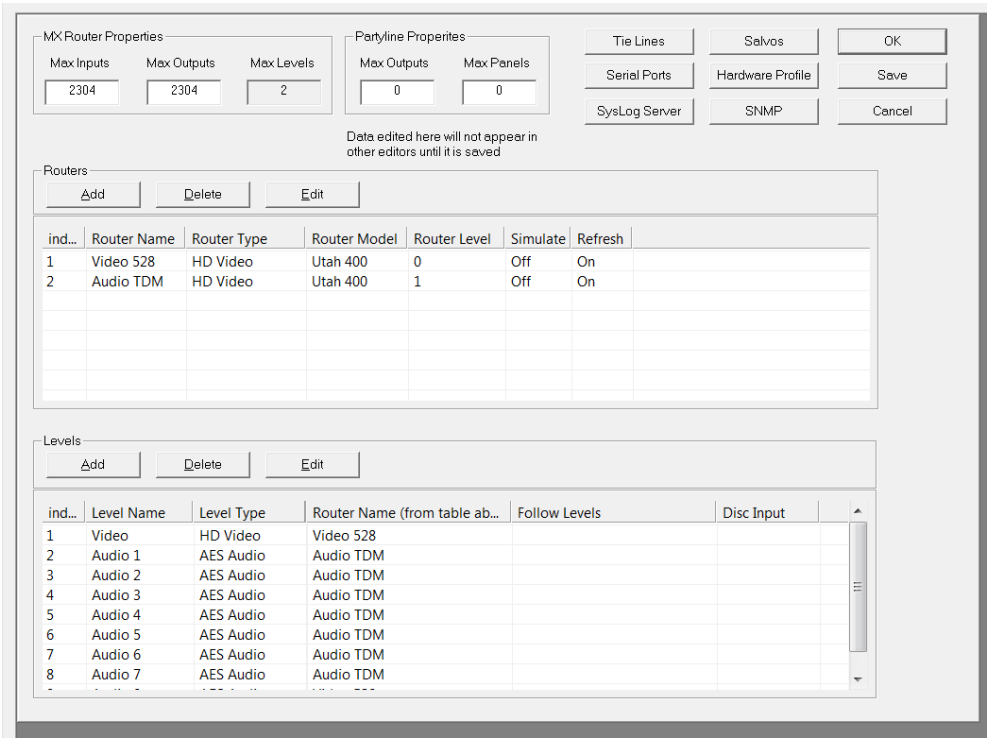
The UCON configuration utility is used to map physical routing matrices into virtual levels to provide ease of control. While a TDM matrix like the one described above can be configured as a single flat level that is 2304x2304, multiple switches would be need to connect any more than one audio crosspoint at a time. This is where defining and using virtual levels can ease overall system operation.

The examples below are based upon a system with a mixture of embedded audio, MADI, and discrete AES routing being combined in a system where the requirement is to manage the first two audio groups in the video signals within the matrix (4 stereo pairs, or 8 mono channels). The example can be scaled from two audio channels to 14 audio channels simply by adding or removing virtual levels.

SC4 Configuration

Within the SC4 editor of UCON is where the physical routers are mapped to virtual levels. As seen in the screen capture below, only two physical routers exist. They are a 528x528 Series 2 video router, and the TDM sub-router within it.

In the virtual level section, one level for the video router is created. Because this system requires the management of 8 channels of audio within the embedded video portion of the router, 8 virtual levels for the TDM matrix are created.

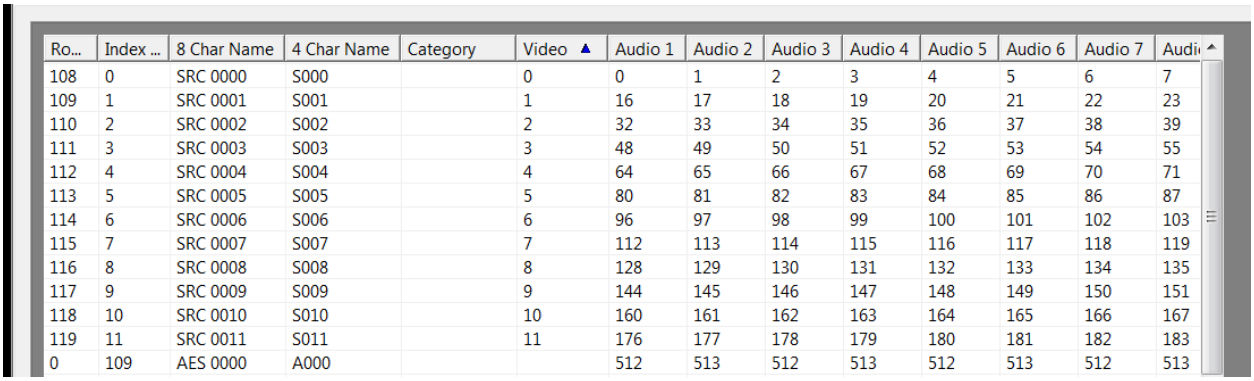


This example system has an SDI Disembedder card installed in input slot 0, a 3x MADI Input card installed in input slot 1 and an AES input card in input slot 2. It also had an SDI embedder installed in output slot 0, a 3x MADI Output card installed in output slot 1, and an AES output card in output slot 2. The MADI signals are configured as 32 stereo pairs each instead of 64 monaural signals.

Input List Creation

Once the levels are defined, we can move on to creating sources that manage the signals coming into the TDM matrix

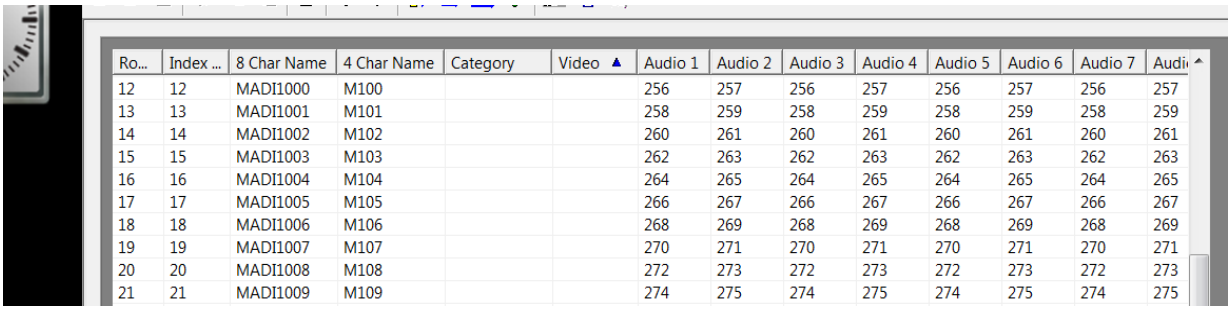
For the sources associated with SDI disembedder card in slot 0, we use the information from the 'Video to Audio crosspoint association' table above to assign the proper crosspoint for the video level, and the first 8 audio channels disembedded from that video signal. As you can see from the table below, for the first video source (SRC 0000) The video is input 0 and the audio begins at 0 and continues to 7. Inputs 8-15 are not encoded, only because in this system the last 8 audio signals disembedded from the video are not used by design. For the next source, the video crosspoint is 1 and the audio crosspoints begin at 16 and go to 23. This pattern continues until there are no more disembedded sources to encode. Remember that this example is for an SDI disembedder in input slot 0, where the base offset for the TDM matrix is 0. Were it in another slot, that base offset would need to be taken into account.



Ro...	Index ...	8 Char Name	4 Char Name	Category	Video ▲	Audio 1	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audi
108	0	SRC 0000	S000		0	0	1	2	3	4	5	6	7
109	1	SRC 0001	S001		1	16	17	18	19	20	21	22	23
110	2	SRC 0002	S002		2	32	33	34	35	36	37	38	39
111	3	SRC 0003	S003		3	48	49	50	51	52	53	54	55
112	4	SRC 0004	S004		4	64	65	66	67	68	69	70	71
113	5	SRC 0005	S005		5	80	81	82	83	84	85	86	87
114	6	SRC 0006	S006		6	96	97	98	99	100	101	102	103
115	7	SRC 0007	S007		7	112	113	114	115	116	117	118	119
116	8	SRC 0008	S008		8	128	129	130	131	132	133	134	135
117	9	SRC 0009	S009		9	144	145	146	147	148	149	150	151
118	10	SRC 0010	S010		10	160	161	162	163	164	165	166	167
119	11	SRC 0011	S011		11	176	177	178	179	180	181	182	183
0	109	AES 0000	A000			512	513	512	513	512	513	512	513

For the sources associated with the 3x MADI Input card in slot 1, the encoding maps out as is shown below. There are several things different about this encoding –

- There is no video crosspoint associated with these sources. The 3X MADI cards connect only to the TDM audio matrix, they have no connection to the video router section.
- The sources begin at number 256. This is the base offset for this slot within the TDM matrix, so everything has an offset of +256.
- The sources are arranged as stereo pairs. Two contiguous input numbers are located in the Audio 1 and Audio 2 levels. This allows the routing of a pair at one time, instead of selecting first the left, then the right audio channel. This method is used because in the system definition, the MADI signals are defined as carrying stereo pairs.
- Lastly, the two inputs associated with a channel (256, 257 for source MADI 1000, for example) are *repeated* on Audio 3-4, Audio 5-6, and Audio 7-8 levels. Why is that? The reason is that it allows you to selectively decide which pairs in an embedded output signal the incoming MADI pair can be sent to. With the encoding set this way, you are able to send any MADI input signal pair to the output 1-2 pair, 3-4 pair, 5-6 pair or 7-8 pair, or all of them at once.



Ro...	Index ...	8 Char Name	4 Char Name	Category	Video ▲	Audio 1	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audi
12	12	MADI1000	M100			256	257	256	257	256	257	256	257
13	13	MADI1001	M101			258	259	258	259	258	259	258	259
14	14	MADI1002	M102			260	261	260	261	260	261	260	261
15	15	MADI1003	M103			262	263	262	263	262	263	262	263
16	16	MADI1004	M104			264	265	264	265	264	265	264	265
17	17	MADI1005	M105			266	267	266	267	266	267	266	267
18	18	MADI1006	M106			268	269	268	269	268	269	268	269
19	19	MADI1007	M107			270	271	270	271	270	271	270	271
20	20	MADI1008	M108			272	273	272	273	272	273	272	273
21	21	MADI1009	M109			274	275	274	275	274	275	274	275

Lastly, encoding of the AES Input card in slot 2 is described. You can see that it has the same characteristics as the MADI encoding, except that it is much smaller. AES Input cards only provide 24 unique audio channels to the TDM matrix. This encoding still gives you the flexibility to put any AES source onto any channel of an outgoing embedded system. Note that since the AES output card is in slot 2, its base offset is 512.

Ro...	Index ...	8 Char Name	4 Char Name	Category	Video ▲	Audio 1	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audi
0	109	AES 0000	A000			512	513	512	513	512	513	512	513
1	110	AES 0001	A001			514	515	514	515	514	515	514	515
2	111	AES 0002	A002			516	517	516	517	516	517	516	517
3	112	AES 0003	A003			518	519	518	519	518	519	518	519
4	113	AES 0004	A004			520	521	520	521	520	521	520	521
5	114	AES 0005	A005			522	523	522	523	522	523	522	523
6	115	AES 0006	A006			524	525	524	525	524	525	524	525
7	116	AES 0007	A007			526	527	526	527	526	527	526	527
8	117	AES 0008	A008			528	529	528	529	528	529	528	529
9	118	AES 0009	A009			530	531	530	531	530	531	530	531
10	119	AES 0010	A010			532	533	532	533	532	533	532	533
11	120	AES 0011	A011			534	535	534	535	534	535	534	535
12	12	MADI1000	M100			256	257	256	257	256	257	256	257

Destination List Creation

The destination encoding is very similar to the input encoding, and follows all of the same rules as far as Video to Audio association and offsets. No repeated entries are required or allowed in the destination section of the encoding.

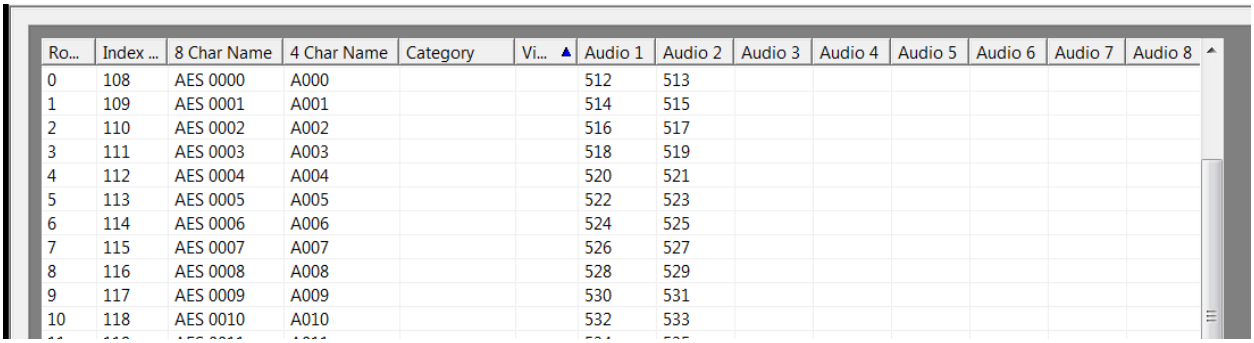
SDI Embedder card encoding.

Ro...	Index ...	8 Char Name	4 Char Name	Category	Vi... ▲	Audio 1	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audio 8
12	0	DST 0000	D000		0	0	1	2	3	4	5	6	7
13	1	DST 0001	D001		1	16	17	18	19	20	21	22	23
14	2	DST 0002	D002		2	32	33	34	35	36	37	38	39
15	3	DST 0003	D003		3	48	49	50	51	52	53	54	55
16	4	DST 0004	D004		4	64	65	66	67	68	69	70	71
17	5	DST 0005	D005		5	80	81	82	83	84	85	86	87
18	6	DST 0006	D006		6	96	97	98	99	100	101	102	103
19	7	DST 0007	D007		7	112	113	114	115	116	117	118	119
20	8	DST 0008	D008		8	128	129	130	131	132	133	134	135
21	9	DST 0009	D009		9	144	145	146	147	148	149	150	151
22	10	DST 0010	D010		10	160	161	162	163	164	165	166	167
23	11	DST 0011	D011		11	176	177	178	179	180	181	182	183
0	108	AES 0000	A000			512	513						

3x MADI Output card encoding.

Ro...	Index ...	8 Char Name	4 Char Name	Category	Vi... ▲	Audio 1	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audio 8
24	12	MADI1000	M100			256	257						
25	13	MADI1001	M101			258	259						
26	14	MADI1002	M102			260	261						
27	15	MADI1003	M103			262	263						
28	16	MADI1004	M104			264	265						
29	17	MADI1005	M105			266	267						
30	18	MADI1006	M106			268	269						
31	19	MADI1007	M107			270	271						
32	20	MADI1008	M108			272	273						
33	21	MADI1009	M109			274	275						

AES Output card encoding.



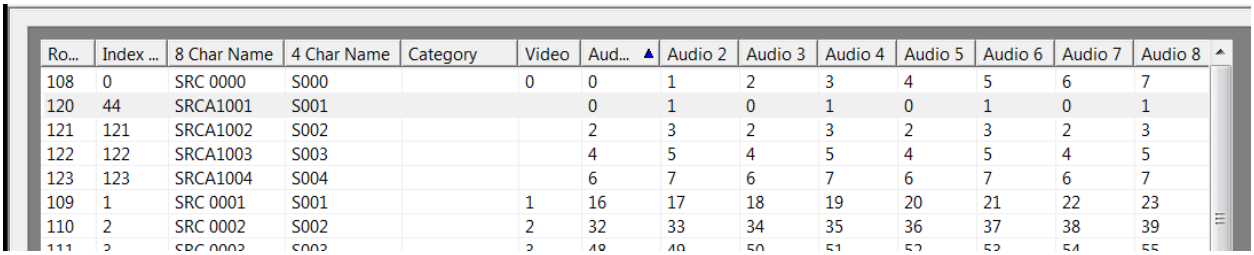
Ro...	Index ...	8 Char Name	4 Char Name	Category	Vi...	Audio 1	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audio 8
0	108	AES 0000	A000			512	513						
1	109	AES 0001	A001			514	515						
2	110	AES 0002	A002			516	517						
3	111	AES 0003	A003			518	519						
4	112	AES 0004	A004			520	521						
5	113	AES 0005	A005			522	523						
6	114	AES 0006	A006			524	525						
7	115	AES 0007	A007			526	527						
8	116	AES 0008	A008			528	529						
9	117	AES 0009	A009			530	531						
10	118	AES 0010	A010			532	533						

Special Requirements

Other requirements may drive more variation in the source and destination encoding foir a system of this type.

Audio Shuffling.

Audio shuffling is the act of moving audio from one location in the embedded SDI signal to another. Some of the previous examples have shown how you can replace audio in an embedded output signal with audio from a MADI, AES, or another disembedded audio source, but what if the goal is to move channel 7-8 to channel 1-2 and move channel 1-2 to channel 7-8, all within the same video stream? This can easily be accomplished with the same type of source duplication across levels as was described for the MADI cards earlier. Below is a encoding section that allows any input pair arriving on video SRC 0000 to be placed on any other pair within that or any other video signal on an embedded output.

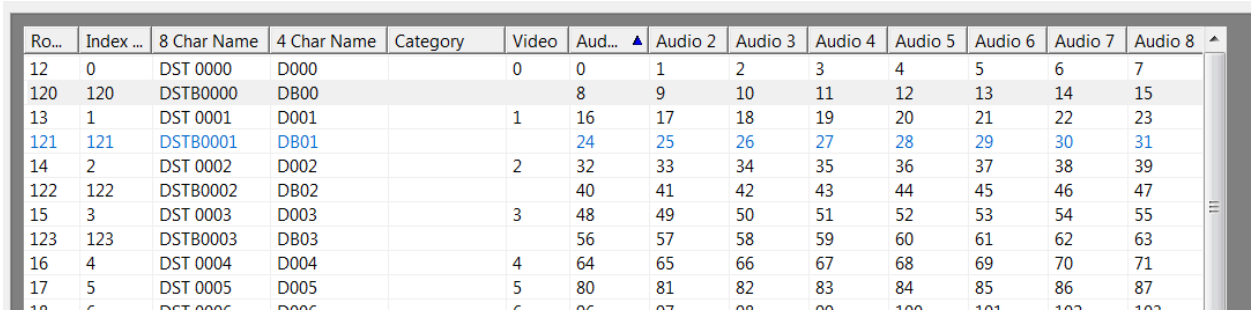


Ro...	Index ...	8 Char Name	4 Char Name	Category	Video	Aud... ▲	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audio 8
108	0	SRC 0000	S000		0	0	1	2	3	4	5	6	7
120	44	SRCA1001	S001			0	1	0	1	0	1	0	1
121	121	SRCA1002	S002			2	3	2	3	2	3	2	3
122	122	SRCA1003	S003			4	5	4	5	4	5	4	5
123	123	SRCA1004	S004			6	7	6	7	6	7	6	7
109	1	SRC 0001	S001		1	16	17	18	19	20	21	22	23
110	2	SRC 0002	S002		2	32	33	34	35	36	37	38	39

As you can see, by adding the SRCA 100x entries, each audio pair on the incoming video signal has been made available to any audio pair on an outgoing video signal. This allows for the placement of any audio in any location, at the penalty of having more entries in the input list.

16 Channel Audio Support

Some applications require that all 16 channels of an embedded audio output of the router be fed with some audio signal. The SC4 system supports only 16 virtual levels, so this is not possible to do using a standard approach. One approach that is very workable involves having two separate names for a destination of this type, one that covers the video level and the first 8 audio channels, and another that covers the last 8 audio channels.



Ro...	Index ...	8 Char Name	4 Char Name	Category	Video	Aud... ▲	Audio 2	Audio 3	Audio 4	Audio 5	Audio 6	Audio 7	Audio 8
12	0	DST 0000	D000		0	0	1	2	3	4	5	6	7
120	120	DSTB0000	DB00			8	9	10	11	12	13	14	15
13	1	DST 0001	D001		1	16	17	18	19	20	21	22	23
121	121	DSTB0001	DB01			24	25	26	27	28	29	30	31
14	2	DST 0002	D002		2	32	33	34	35	36	37	38	39
122	122	DSTB0002	DB02			40	41	42	43	44	45	46	47
15	3	DST 0003	D003		3	48	49	50	51	52	53	54	55
123	123	DSTB0003	DB03			56	57	58	59	60	61	62	63
16	4	DST 0004	D004		4	64	65	66	67	68	69	70	71
17	5	DST 0005	D005		5	80	81	82	83	84	85	86	87

Adding the DSTB 000x entries allows access to the last two audio groups for the respective destination. In this way, by switching both destinations, all 16 audio channels in the outgoing video signal can be fed.