ATL-AL-PITT-ES-10.0
August 30, 2002

Cabling of the Barrel and EMEC Level 1 Trigger Sums

W. E. Cleland
University of Pittsburgh

1 Introduction

This note describes the topological connections that are made to form the trigger sums for the barrel and EM endcap calorimeters. The trigger sums are made in four stages: the linear mixer, the Layer Sum Board (LSB), the Tower Builder Board (TBB), and the Receiver/ Monitor Board. The topology of the trigger sums is determined by (1) the cabling of the calorimeter into the FEB, (2) the traces on the FEB, (3) the design of the LSBs, (4) the interconnects between the FEBs and the TBB via the baseplane in the Front End Crate (FEC), and (5) the design of the TBB.

The designation $I_\eta L_\phi$ (a number folled by a letter) of the trigger sums in the barrel is described in Figure 10-11 of the TDR[1]. The number (1-15) corresponds to the η coordinate in units of 0.1, increasing with $|\eta|$, and the letter (A-P) corresponds to the phi coordinate within a quadrant, in units of $\pi/32$. In the endcap, a similar convention is used, with the eta index (1-15) starting at the outer rim The phi index (A-P) defined as in the barrel for the Outer Wheel ($|\eta| < 2.5$). For the Inner Wheel, this index runs from A to H, with each segment equal to $\pi/16$. Table 1 is given the correspondence between the trigger sum indices and the angular variables.

The cabling of the calorimeters is discussed elsewhere[2]. Signals arrive from the calorimeter on the FEB in a prescribed order and pass through the preamplifier and shaper circuits. The 4-channel shaper chip contains a linear mixer which forms an unweighted sum of the four channels on the chip. The output of this mixer is the input to the LSB, the next level of analog summing. The required interconnects between the linear mixer output and the LSB inputs are given in Section 2, along with the required connections between the LSB outputs and the FEB middle connector J2 (a 96-pin DIN connector). The topology of the various LSBs is also described in Section 2. The TBB board[3] has four inputs per trigger sum, one for each depth layer in the calorimeter. The connections between the various FEBs in a crate and the TBB(s) in the crate are made via the baseplane, which is discussed in Section 3.

Table 1: Correspondence between the indices used for the trigger sums and the angular coordinates within a quadrant.

η Intervals

I_η	Barrel	EMEC
1	0.0-0.1	1.4-1.5
2	0.1-0.2	1.5-1.6
3	0.2-0.3	1.6-1.7
4	0.3-0.4	1.7-1.8
5	0.4-0.5	1.8-1.9
6	0.5-0.6	1.9-2.0
7	0.6-0.7	2.0-2.1
8	0.7-0.8	2.1-2.2
9	0.8-0.9	2.2-2.3
10	0.9-1.0	2.3-2.4
11	1.0-1.1	2.4-2.5
12	1.1-1.2	2.5-2.7
13	1.2-1.3	2.7-2.9
14	1.3-1.4	2.9-3.1
15	1.4-1.5	3.1-3.2

ϕ Intervals (within a quadrant)

L_ϕ	Barrel and EMEC($I_\eta < 12$)	EMEC ($I_\eta \geq 12$)
A	0.000-0.098	0.000-0.196
B	0.098-0.196	0.196-0.393
C	0.196-0.295	0.393-0.589
D	0.295-0.393	0.589-0.785
E	0.393-0.491	0.785-0.982
F	0.491-0.589	0.982-1.178
G	0.589-0.687	1.178-1.374
H	0.687-0.785	1.374-1.570
I	0.785-0.884	
J	0.884-0.982	
K	0.982-1.080	
L	1.080-1.178	
M	1.178-1.276	
N	1.276-1.374	
O	1.374-1.473	
P	1.473-1.570	

Table 2: Types of Layer Sum Boards

Type	Width of sum	No. of circuits per board
1×16	1	16
$2 \times 8^*$	2	8
4×4	4	4
8×2	8	2
*with 4-fold sum option		

2 Layer Sum Boards

The Layer Sum Boards (sometimes called “Personality Cards”) exist in 4 different topologies, which are described in Table 2. The board types are labelled by the notation $n \times m$, where m is the number of summing circuits on the card, each of which performs an n-fold sum. As shown in Table 2, there are three “pure” configurations and one card (the $2{\times}8$) which, through the use of jumpers on the board, can be configured with some channels as four-fold sums. This is required to accomodate an anomaly in the cabling of the barrel calorimeter.

The first stage of summing is carried out in the linear mixer circuit located on the shaper chip, which sums the signals found in the four channels on the chip. The output of the linear mixer is routed to the input pins of the layer sum boards, as shown in Table 3. The shapers are numbered following the ordering of the input channels (Shaper 0 handles channels 0–3, Shaper 1 handles channels 4–7, etc..). Examples of how the LSB boards are employed in the Barrel Calorimeter are shown in Table 4. The same boards are employed in the end-cap FEBs, but they are distributed diffeently. The complete specification of how the LSBs are deployed in the three types of crates needed for the EM calorimeters (barrel crate, end-cap standard crate, and end-cap special crate) are shown in Figs 1–6. The ”utilization” tables (Figures 1, 3, and 5) are are Excel spreadsheet tables which have one column for each relevant slot (slots containing the calibration, control, or monitor boards are not shown). Each row corresponds to the output of one of the linear mixers, which becomes an input to the Layer Sum Board on the board. The entries are labels of the types shown in Table 4, giving the trigger sum number, along with a subscript which numbers the element in the analog sum. The colums labelled ”J2 OUT” give the pin number on the middle connector where the output of the sums shown in the right-hand adjacent column(s) can be found. The ”trigger sum maps” (Figures 2, 4, and 6) are tables that show the same information, but organized by trigger sum number, *i.e.*, they show where the contribution to each of the trigger sums can be found in the crate.

Table 3: Connections between the shaper outputs, layer sum board inputs, layer sum board outputs, and output connector pins on the FEB.

Shaper No.	LSB IN Pin No.	LSB OUT Pin No.	FEB OUT J2 Pin No.	Shaper No.	LSB IN Pin No.	LSB OUT Pin No.	FEB OUT J2 Pin No.
0	2	49	1	16	2	49	17
1	4	47	3	17	4	47	19
2	5	46	5	18	5	46	21
3	7	44	7	19	7	44	23
4	8	43	9	20	8	43	25
5	10	41	11	21	10	41	27
6	11	40	13	22	11	40	29
7	13	38	15	23	13	38	31
8	14	37	66	24	14	37	82
9	16	35	68	25	16	35	84
10	17	34	70	26	17	34	86
11	19	32	72	27	19	32	88
12	20	31	74	28	20	31	90
13	22	29	76	29	22	29	92
14	23	28	78	30	23	28	94
15	25	26	80	31	25	26	96

Table 4: Examples of usage of each of the LSB card types in the FEBs for the Barrel Calorimeter.The 1×16 card is located in the presampler FEB, the 2×8 cards (some of which are configured as $2 \times 6 + 4 \times 1$) are located in FEBs for the back section, and the 8×2 and 4×4 cards are located in the front and middle section FEBs, respectively.

1×16

J2 OUT	Trigger Sum
1	1A
3	1B
5	2A
7	2B
9	3A
11	3B
13	4A
15	4B
66	5A
68	5B
70	6A
72	6B
74	7A
76	7B
78	8A
80	8B

2×8

J2 OUT	Trigger Sum
1	$1A_0$
	$1A_1$
5	$2A_0$
	$2A_1$
9	$3A_0$
	$3A_1$
13	$4A_0$
	$4A_1$
66	$5A_0$
	$5A_1$
70	$6A_0$
	$6A_1$
74	$7A_0$
	$7A_1$
78	$8A_0$
	$8A_1$

4×4

J2 OUT	Trigger Sum
1	$1A_0$
	$1A_1$
	$1A_2$
	$1A_3$
9	$2A_0$
	$2A_1$
	$2A_2$
	$2A_3$
66	$3A_0$
	$3A_1$
	$3A_2$
	$3A_3$
74	$4A_0$
	$4A_1$
	$4A_2$
	$4A_3$

8×2

J2 OUT	Trigger Sum
1	$1A_0$
	$1A_1$
	$1A_2$
	$1A_3$
	$1A_4$
	$1A_5$
	$1A_6$
	$1A_7$
66	$2A_0$
	$2A_1$
	$2A_2$
	$2A_3$
	$2A_4$
	$2A_5$
	$2A_6$
	$2A_7$

	FT		1		2	3	4	5	6	7	8		9		10		11	12	13	14
	SLOT		1		2	3	4	5	6	7	8		11		12		13	14	15	16
	LSB TYPE		1X16		8X2	8X2	8X2	8X2	8X2	8X2	8X2		2X8		2X6-4X1		4X4	4X4	4X4	4X4
	CONN.		J20		J21	J22	J23	J24	J25	J26	J27		J30		J31		J32	J33	J34	J35
	SHAPER LOCATION	J2 OUT	PS	J2 OUT	FRONT 0	FRONT 1	FRONT 2	FRONT 3	FRONT 4	FRONT 5	FRONT 6	J2 OUT	BACK 0	J2 OUT	BACK 1	J2 OUT	MID 0	MID 1	MID 2	MID 3
	0	1	1A	1	1A_0	3A_0	5A_0	7A_0	9A_0	11A_0	13A_0	1	1A_0	1	9A_0	1	1A_0	5A_0	9A_0	13A_0
	1	3	1B		1A_1	3A_1	5A_1	7A_1	9A_1	11A_1	13A_1		1A_1		9A_1		1A_1	5A_1	9A_1	13A_1
	2	5	2A		1A_2	3A_2	5A_2	7A_2	9A_2	11A_2	13A_2	5	2A_0	5	10A_0		1A_2	5A_2	9A_2	13A_2
	3	7	2B		1A_3	3A_3	5A_3	7A_3	9A_3	11A_3	13A_3		2A_1		10A_1		1A_3	5A_3	9A_3	13A_3
	4	9	3A		1A_4	3A_4	5A_4	7A_4	9A_4	11A_4	13A_4	9	3A_0	9	11A_0	9	2A_0	6A_0	10A_0	13B_0
	5	11	3B		1A_5	3A_5	5A_5	7A_5	9A_5	11A_5	13A_5		3A_1		11A_1		2A_1	6A_1	10A_1	13B_1
	6	13	4A		1A_6	3A_6	5A_6	7A_6	9A_6	11A_6	13A_6	13	4A_0	13	12A_0		2A_2	6A_2	10A_2	13B_2
A	7	15	4B		1A_7	3A_7	5A_7	7A_7	9A_7	11A_7	13A_7		4A_1		12A_1		2A_3	6A_3	10A_3	13B_3
	8	66	5A	66	2A_0	4A_0	6A_0	8A_0	10A_0	12A_0	14A_0	66	5A_0	66	13A_0	66	3A_0	7A_0	11A_0	14A_0
	9	68	5B		2A_1	4A_1	6A_1	8A_1	10A_1	12A_1	14A_1		5A_1		13A_1		3A_1	7A_1	11A_1	14A_1
	10	70	6A		2A_2	4A_2	6A_2	8A_2	10A_2	12A_2	14A_2	70	6A_0	70	14A_0		3A_2	7A_2	11A_2	14A_2
	11	72	6B		2A_3	4A_3	6A_3	8A_3	10A_3	12A_3	14A_3		6A_1				3A_3	7A_3	11A_3	14A_3
	12	74	7A		2A_4	4A_4	6A_4	8A_4	10A_4	12A_4	14A_4	74	7A_0	74	15A_0	74	4A_0	8A_0	12A_0	14B_0
	13	76	7B		2A_5	4A_5	6A_5	8A_5	10A_5	12A_5	14A_5		7A_1		15A_1		4A_1	8A_1	12A_1	14B_1
	14	78	8A		2A_6	4A_6	6A_6	8A_6	10A_6	12A_6	14A_6	78	8A_0		15A_2		4A_2	8A_2	12A_2	14B_2
	15	80	8B		2A_7	4A_7	6A_7	8A_7	10A_7	12A_7	14A_7		8A_1		15A_3		4A_3	8A_3	12A_3	14B_3
	16	17	9A	17	1B_0	3B_0	5B_0	7B_0	9B_0	11B_0	13B_0	17	1B_0	17	9B_0	17	1B_0	5B_0	9B_0	
	17	19	9B		1B_1	3B_1	5B_1	7B_1	9B_1	11B_1	13B_1		1B_1		9B_1		1B_1	5B_1	9B_1	
	18	21	10A		1B_2	3B_2	5B_2	7B_2	9B_2	11B_2	13B_2	21	2B_0	21	10B_0		1B_2	5B_2	9B_2	
	19	23	10B		1B_3	3B_3	5B_3	7B_3	9B_3	11B_3	13B_3		2B_1		10B_1		1B_3	5B_3	9B_3	
	20	25	11A		1B_4	3B_4	5B_4	7B_4	9B_4	11B_4	13B_4	25	3B_0	25	11B_0	25	2B_0	6B_0	10B_0	
	21	27	11B		1B_5	3B_5	5B_5	7B_5	9B_5	11B_5	13B_5		3B_1		11B_1		2B_1	6B_1	10B_1	
	22	29	12A		1B_6	3B_6	5B_6	7B_6	9B_6	11B_6	13B_6	29	4B_0	29	12B_0		2B_2	6B_2	10B_2	
B	23	31	12B		1B_7	3B_7	5B_7	7B_7	9B_7	11B_7	13B_7		4B_1		12B_1		2B_3	6B_3	10B_3	
	24	82	13A	82	2B_0	4B_0	6B_0	8B_0	10B_0	12B_0	14B_0	82	5B_0	82	13B_0	82	3B_0	7B_0	11B_0	
	25	84	13B		2B_1	4B_1	6B_1	8B_1	10B_1	12B_1	14B_1		5B_1		13B_1		3B_1	7B_1	11B_1	
	26	86	14A		2B_2	4B_2	6B_2	8B_2	10B_2	12B_2	14B_2	86	6B_0	86	14B_0		3B_2	7B_2	11B_2	
	27	88	14B		2B_3	4B_3	6B_3	8B_3	10B_3	12B_3	14B_3		6B_1				3B_3	7B_3	11B_3	
	28	90	15A		2B_4	4B_4	6B_4	8B_4	10B_4	12B_4	14B_4	90	7B_0	90	15B_0	90	4B_0	8B_0	12B_0	
	29	92	15B		2B_5	4B_5	6B_5	8B_5	10B_5	12B_5	14B_5		7B_1		15B_1		4B_1	8B_1	12B_1	
	30				2B_6	4B_6	6B_6	8B_6	10B_6	12B_6	14B_6	94	8B_0		15B_2		4B_2	8B_2	12B_2	
	31				2B_7	4B_7	6B_7	8B_7	10B_7	12B_7	14B_7		8B_1		15B_3		4B_3	8B_3	12B_3	

Figure 1: Utilization of LSBs in barrel FEC.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1		PRESAMPLER					FRONT					BACK					MIDDLE				
2			FEB		TBB			FEB		TBB			FEB		TBB			FEB		TBB	
3	TRIG SUM	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#
4																					
5	1A	1A_P	J20	1	J9	2	1A_F	J21	1	J9	65	1A_B	J30	1	J9	66	1A_M	J32	1	J9	1
6	1B	1B_P	J20	3	J28	20	1B_F	J21	17	J28	83	1B_B	J30	17	J28	84	1B_M	J32	17	J28	19
7	2A	2A_P	J20	5	J9	5	2A_F	J21	66	J9	68	2A_B	J30	5	J9	69	2A_M	J32	9	J9	4
8	2B	2B_P	J20	7	J28	23	2B_F	J21	82	J28	86	2B_B	J30	21	J28	87	2B_M	J32	25	J28	22
9	3A	3A_P	J20	9	J9	8	3A_F	J22	1	J9	71	3A_B	J30	9	J9	72	3A_M	J32	66	J9	7
10	3B	3B_P	J20	11	J28	26	3B_F	J22	17	J28	89	3B_B	J30	25	J28	90	3B_M	J32	82	J28	25
11	4A	4A_P	J20	13	J9	11	4A_F	J22	66	J9	74	4A_B	J30	13	J9	75	4A_M	J32	74	J9	10
12	4B	4B_P	J20	15	J28	29	4B_F	J22	82	J28	92	4B_B	J30	29	J28	93	4B_M	J32	90	J28	28
13	5A	5A_P	J20	66	J9	14	5A_F	J23	1	J9	77	5A_B	J30	66	J9	78	5A_M	J33	1	J9	13
14	5B	5B_P	J20	68	J28	32	5B_F	J23	17	J28	95	5B_B	J30	82	J28	96	5B_M	J33	17	J28	31
15	6A	6A_P	J20	70	J9	17	6A_F	J23	66	J9	80	6A_B	J30	70	J9	81	6A_M	J33	9	J9	16
16	6B	6B_P	J20	72	J47	2	6B_F	J23	82	J47	65	6B_B	J30	86	J47	66	6B_M	J33	25	J47	1
17	7A	7A_P	J20	74	J9	20	7A_F	J24	1	J9	83	7A_B	J30	74	J9	84	7A_M	J33	66	J9	19
18	7B	7B_P	J20	76	J47	5	7B_F	J24	17	J47	68	7B_B	J30	90	J47	69	7B_M	J33	82	J47	4
19	8A	8A_P	J20	78	J9	23	8A_F	J24	66	J9	86	8A_B	J30	78	J9	87	8A_M	J33	74	J9	22
20	8B	8B_P	J20	80	J47	8	8B_F	J24	82	J47	71	8B_B	J30	94	J47	72	8B_M	J33	90	J47	7
21																					
22	9A	9A_P	J20	17	J9	26	9A_F	J25	1	J9	89	9A_B	J31	1	J9	90	9A_M	J34	1	J9	25
23	9B	9B_P	J20	19	J47	11	9B_F	J25	17	J47	74	9B_B	J31	17	J47	75	9B_M	J34	17	J47	10
24	10A	10A_P	J20	21	J9	29	10A_F	J25	66	J9	92	10A_B	J31	5	J9	93	10A_M	J34	9	J9	28
25	10B	10B_P	J20	23	J47	14	10B_F	J25	82	J47	77	10B_B	J31	21	J47	78	10B_M	J34	25	J47	13
26	11A	11A_P	J20	25	J9	32	11A_F	J26	1	J9	95	11A_B	J31	9	J9	96	11A_M	J34	66	J9	31
27	11B	11B_P	J20	27	J47	17	11B_F	J26	17	J47	80	11B_B	J31	25	J47	81	11B_M	J34	82	J47	16
28	12A	12A_P	J20	29	J28	2	12A_F	J26	66	J28	65	12A_B	J31	13	J28	66	12A_M	J34	74	J28	1
29	12B	12B_P	J20	31	J47	20	12B_F	J26	82	J47	83	12B_B	J31	29	J47	84	12B_M	J34	90	J47	19
30	13A	13A_P	J20	82	J28	5	13A_F	J27	1	J28	68	13A_B	J31	66	J28	69	13A_M	J35	1	J28	4
31	13B	13B_P	J20	84	J47	23	13B_F	J27	17	J47	86	13B_B	J31	82	J47	87	13B_M	J35	9	J47	22
32	14A	14A_P	J20	86	J28	8	14A_F	J27	66	J28	71	14A_B	J31	70	J28	72	14A_M	J35	66	J28	7
33	14B	14B_P	J20	88	J47	26	14B_F	J27	82	J47	89	14B_B	J31	86	J47	90	14B_M	J35	74	J47	25
34	15A	15A_P	J20	90	J28	11	15A_F					15A_B	J31	74	J28	75	15A_M				
35	15B	15B_P	J20	92	J47	29	15B_F					15B_B	J31	90	J47	93	15B_M				
36																					

Figure 2: Map of the trigger sum components in barrel FEC.

	FT		1		2	3	4	5		6	7		8	9		10	11	12	13
	SLOT		2		3	4	5	6		7	8		11	12		13	14	15	16
	LSB TYPE		1x16		8X2	8X2	8X2	8X2		4X4	4X4		2X8	2X8		4X4	4X4	4X4	4X4
	CONN		J20		J21	J22	J23	J24		J25	J26		J29	J30		J31	J32	J33	J34
		J2		J2					J2			J2			J2				
	SHAPER	OUT	PS	OUT	FRONT 0	FRONT 1	FRONT 2	FRONT 3	OUT	FRONT 4	FRONT 5	OUT	BACK 0	BACK 1	OUT	MID 0	MID 1	MID 2	MID 3
	LOCATION																		
	0	1	3A	1	3A_0	4A_0	5A_0	6A_0	1	7A_0	9A_0	1	3A_0	7A_0	1	3A_0	5A_0	7A_0	9A_0
	1	3	3B		3A_1	4A_1	5A_1	6A_1		7A_1	9A_1		3A_1	7A_1		3A_1	5A_1	7A_1	9A_1
	2	5	3C		3A_2	4A_2	5A_2	6A_2		7A_2	9A_2	5	3B_0	7B_0		3A_2	5A_2	7A_2	9A_2
	3	7	3D		3A_3	4A_3	5A_3	6A_3		7A_3	9A_3		3B_1	7B_1		3A_3	5A_3	7A_3	9A_3
	4	9	4A		3A_4	4A_4	5A_4	6A_4	9	7B_0	9B_0	9	3C_0	7C_0	9	3B_0	5B_0	7B_0	9B_0
	5	11	4B		3A_5	4A_5	5A_5	6A_5		7B_1	9B_1		3C_1	7C_1		3B_1	5B_1	7B_1	9B_1
	6	13	4C		3A_6	4A_6	5A_6	6A_6		7B_2	9B_2	13	3D_0	7D_0		3B_2	5B_2	7B_2	9B_2
A	7	15	4D		3A_7	4A_7	5A_7	6A_7		7B_3	9B_3		3D_1	7D_1		3B_3	5B_3	7B_3	9B_3
	8			66	3B_0	4B_0	5B_0	6B_0	66	8A_0	10A_0	66	4A_0	8A_0	66	3C_0	5C_0	7C_0	9C_0
	9				3B_1	4B_1	5B_1	6B_1		8A_1	10A_1		4A_1	8A_1		3C_1	5C_1	7C_1	9C_1
	10				3B_2	4B_2	5B_2	6B_2		8A_2	10A_2	70	4B_0	8B_0		3C_2	5C_2	7C_2	9C_2
	11				3B_3	4B_3	5B_3	6B_3		8A_3	10A_3		4B_1	8B_1		3C_3	5C_3	7C_3	9C_3
	12				3B_4	4B_4	5B_4	6B_4	74	8B_0	10B_0	74	4C_0	8C_0	74	3D_0	5D_0	7D_0	9D_0
	13				3B_5	4B_5	5B_5	6B_5		8B_1	10B_1		4C_1	8C_1		3D_1	5D_1	7D_1	9D_1
	14				3B_6	4B_6	5B_6	6B_6		8B_2	10B_2	78	4D_0	8D_0		3D_2	5D_2	7D_2	9D_2
	15				3B_7	4B_7	5B_7	6B_7		8B_3	10B_3		4D_1	8D_1		3D_3	5D_3	7D_3	9D_3
	16			17	3C_0	4C_0	5C_0	6C_0	17	7C_0	9C_0	17	5A_0	9A_0	17	4A_0	6A_0	8A_0	10A_0
	17				3C_1	4C_1	5C_1	6C_1		7C_1	9C_1		5A_1	9A_1		4A_1	6A_1	8A_1	10A_1
	18				3C_2	4C_2	5C_2	6C_2		7C_2	9C_2	21	5B_0	9B_0		4A_2	6A_2	8A_2	10A_2
	19				3C_3	4C_3	5C_3	6C_3		7C_3	9C_3		5B_1	9B_1		4A_3	6A_3	8A_3	10A_3
	20				3C_4	4C_4	5C_4	6C_4	25	7D_0	9D_0	25	5C_0	9C_0	25	4B_0	6B_0	8B_0	10B_0
	21				3C_5	4C_5	5C_5	6C_5		7D_1	9D_1		5C_1	9C_1		4B_1	6B_1	8B_1	10B_1
	22				3C_6	4C_6	5C_6	6C_6		7D_2	9D_2	29	5D_0	9D_0		4B_2	6B_2	8B_2	10B_2
B	23				3C -7	4C_7	5C_7	6C_7		7D_3	9D_3		5D_1	9D_1		4B_3	6B_3	8B_3	10B_3
	24			82	3D_0	4D_0	5D_0	6D_0	82	8C_0	10C_0	82	6A_0	10A_0	82	4C_0	6C_0	8C_0	10C_0
	25				3D_1	4D_1	5D_1	6D_1		8C_1	10C_1		6A_1	10A_1		4C_1	6C_1	8C_1	10C_1
	26				3D_2	4D_2	5D_2	6D_2		8C_2	10C_2	86	6B_0	10B_0		4C_2	6C_2	8C_2	10C_2
	27				3D_3	4D_3	5D_3	6D_3		8C_3	10C_3		6B_1	10B_1		4C_3	6C_3	8C_3	10C_3
	28				3D_4	4D_4	5D_4	6D_4	90	8D_0	10D_0	90	6C_0	10C_0	90	4D_0	6D_0	8D_0	10D_0
	29				3D_5	4D_5	5D_5	6D_5		8D_1	10D_1		6C_1	10C_1		4D_1	6D_1	8D_1	10D_1
	30				3D_6	4D_6	5D_6	6D_6		8D_2	10D_2	94	6D_0	10D_0		4D_2	6D_2	8D_2	10D_2
	31				3D_7	4D_7	5D_7	6D_7		8D_3	10D_3		6D_1	10D_1		4D_3	6D_3	8D_3	10D_3

Figure 3: Utilization of LSBs in endcap standard FEC.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1		PRESAMPLER					FRONT					BACK					MIDDLE				
2			FEB		TBB			FEB		TBB			FEB		TBB			FEB		TBB	
3	TRIG SUM	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#
4																					
5	3A	3A_P	J20	1	J8	2	3A_F	J21	1	J8	65	3A_B	J29	1	J8	66	3A_M	J31	1	J8	1
6	3B	3B_P	J20	3	J8	5	3B_F	J21	66	J8	68	3B_B	J29	5	J8	69	3B_M	J31	9	J8	4
7	3C	3C_P	J20	5	J27	20	3C_F	J21	17	J27	83	3C_B	J29	9	J27	84	3C_M	J31	66	J27	19
8	3D	3D_P	J20	7	J27	23	3D_F	J21	82	J27	86	3D_B	J29	13	J27	87	3D_M	J31	74	J27	22
9	4A	4A_P	J20	9	J8	8	4A_F	J22	1	J8	71	4A_B	J29	66	J8	72	4A_M	J31	17	J8	7
10	4B	4B_P	J20	11	J8	11	4B_F	J22	66	J8	74	4B_B	J29	70	J8	75	4B_M	J31	25	J8	10
11	4C	4C_P	J20	13	J27	26	4C_F	J22	17	J27	89	4C_B	J29	74	J27	90	4C_M	J31	82	J27	25
12	4D	4D_P	J20	15	J27	29	4D_F	J22	82	J27	92	4D_B	J29	78	J27	93	4D_M	J31	90	J27	28
13	5A						5A_F	J23	1	J8	77	5A_B	J29	17	J8	78	5A_M	J32	1	J8	13
14	5B						5B_F	J23	66	J8	80	5B_B	J29	21	J8	81	5B_M	J32	9	J8	16
15	5C						5C_F	J23	17	J27	95	5C_B	J29	25	J27	96	5C_M	J32	66	J27	31
16	5D						5D_F	J23	82	J46	65	5D_B	J29	29	J46	66	5D_M	J32	74	J46	1
17	6A						6A_F	J24	1	J8	83	6A_B	J29	82	J8	84	6A_M	J32	17	J8	19
18	6B						6B_F	J24	66	J8	86	6B_B	J29	86	J8	87	6B_M	J32	25	J8	22
19	6C						6C_F	J24	17	J46	68	6C_B	J29	90	J46	69	6C_M	J32	82	J46	4
20	6D						6D_F	J24	82	J46	71	6D_B	J29	94	J46	72	6D_M	J32	90	J46	7
21	7A						7A_F	J25	1	J8	89	7A_B	J30	1	J8	90	7A_M	J33	1	J8	25
22	7B						7B_F	J25	9	J8	92	7B_B	J30	5	J8	93	7B_M	J33	9	J8	28
23	7C						7C_F	J25	17	J46	74	7C_B	J30	9	J46	75	7C_M	J33	66	J46	10
24	7D						7D_F	J25	25	J46	77	7D_B	J30	13	J46	78	7D_M	J33	74	J46	13
25	8A						8A_F	J25	66	J8	95	8A_B	J30	66	J8	96	8A_M	J33	17	J8	31
26	8B						8B_F	J25	74	J27	65	8B_B	J30	70	J27	66	8B_M	J33	25	J27	1
27	8C						8C_F	J25	82	J46	80	8C_B	J30	74	J46	81	8C_M	J33	82	J46	16
28	8D						8D_F	J25	90	J46	83	8D_B	J30	78	J46	84	8D_M	J33	90	J46	19
29	9A						9A_F	J26	1	J27	68	9A_B	J30	17	J27	69	9A_M	J34	1	J27	4
30	9B						9B_F	J26	9	J27	71	9B_B	J30	21	J27	72	9B_M	J34	9	J27	7
31	9C						9C_F	J26	17	J46	86	9C_B	J30	25	J46	87	9C_M	J34	66	J46	22
32	9D						9D_F	J26	25	J46	89	9D_B	J30	29	J46	90	9D_M	J34	74	J46	25
33	10A						10A_F	J26	66	J27	74	10A_B	J30	82	J27	75	10A_M	J34	17	J27	10
34	10B						10B_F	J26	74	J27	77	10B_B	J30	86	J27	78	10B_M	J34	25	J27	13
35	10C						10C_F	J26	82	J46	92	10C_B	J30	90	J46	93	10C_M	J34	82	J46	28
36	10D						10D_F	J26	90	J46	95	10D_B	J30	94	J46	96	10D_M	J34	90	J46	31

Figure 4: Map of the trigger sum components in endcap standard FEC.

	FT		1		2		3	4		5	6	7	8		9		10	11		12		13		14	15		HEC-1	HEC-2
	SLOT		1		2		3	4		5	6	7	8		11		12	13		14		15		17	18		19	21
	LSB TYPE		1X16		1x16		4X4	4X4		8X2	8X2	8X2	8X2		2X8		4X4	4X4		1X16		2x8		4X4	4X4		1X16	1X16
	CONN		J20		J21		J22	J23		J24	J25	J26	J27		J30		J31	J32		J33		J34		J36	J37		JX20	JX22
		J2		J2		J2			J2					J2					J2				J2			J2		
	SHAPER	OUT	PS	OUT	FRONT 0	OUT	MID 0	MID 1	OUT	FRONT 1	FRONT 2	FRONT 3	FRONT 4	OUT	BACK 0	OUT	MID 2	MID 3	OUT	FRONT 5	OUT	BACK 1	OUT	MID 4	MID 5	OUT	FRONT	MID
	LOCATION																											
	0	1	2A	1	1A	1	1A_0	1I_0	1	2A_0	2E_0	2I_0	2M_0	1	2A_0	1	2A_0	2I_0	1	11A	1	11A-0	1	11A_0	11I_0	1	12A	12A
	1	3	2B	3	1B		1A_1	1I_1		2A_1	2E_1	2I_1	2M_1		2A_1		2A_1	2I_1	3	11B		11A_1		11A_1	11I_1	3	12B	12B
	2	5	2C	5	1C		1A_2	1I_2		2A_2	2E_2	2I_2	2M_2	5	2B_0		2A_2	2I_2	5	11C	5	11B_0		11A_2	11I_2	5	12C	12C
	3	7	2D	7	1D		1A_3	1I_3		2A_3	2E_3	2I_3	2M_3		2B_1		2A_3	2I_3	7	11D		11B_1		11A_3	11I_3	7	12D	12D
	4	9	2E	9	1E	9	1B_0	1J_0		2A_4	2E_4	2I_4	2M_4	9	2C_0	9	2B_0	2J_0	9	11E	9	11C_0	9	11B_0	11J_0	9	13A	13A
	5	11	2F	11	1F		1B_1	1J_1		2A_5	2E_5	2I_5	2M_5		2C_1		2B_1	2J_1	11	11F		11C_1		11B_1	11J_1	11	13B	13B
	6	13	2G	13	1G		1B_2	1J_2		2A_6	2E_6	2I_6	2M_6	13	2D_0		2B_2	2J_2	13	11G	13	11D_0		11B_2	11J_2	13	13C	13C
A	7	15	2H	15	1H		1B-3	1J_3		2A_7	2E_7	2I_7	2M_7		2D_1		2B_3	2J_3	15	11H		11D_1		11B_3	11J_3	15	13D	13D
	8	66	2I			66	1C_0	1K_0	66	2B_0	2F_0	2J_0	2N_0	66	2E_0	66	2C_0	2K_0			66	11E_0	66	11C_0	11K_0	66	14A	14A
	9	68	2J				1C_1	1K_1		2B_1	2F_1	2J_1	2N_1		2E_1		2C_1	2K_1				11E_1		11C_1	11K_1	68	14B	14B
	10	70	2K				1C_2	1K_2		2B_2	2F_2	2J_2	2N_2	70	2F_0		2C_2	2K_2			70	11F_0		11C_2	11K_2	70	14C	14C
	11	72	2L				1C_3	1K_3		2B_3	2F_3	2J_3	2N_3		2F_1		2C_3	2K_3				11F_1		11C_3	11K_3	72	14D	14D
	12	74	2M			74	1D_0	1L_0		2B_4	2F_4	2J_4	2N_4	74	2G_0	74	2D_0	2L_0			74	11G_0	74	11D_0	11L_0	74	15A	15A
	13	76	2N				1D_1	1L_1		2B_5	2F_5	2J_5	2N_5		2G_1		2D_1	2L_1				11G_1		11D_1	11L_1	76	15B	15B
	14	78	2O				1D_2	1L_2		2B_6	2F_6	2J_6	2N_6	78	2H_0		2D_2	2L_2			78	11H_0		11D_2	11L_2	78	15C	15C
	15	80	2P				1D_3	1L_3		2B_7	2F_7	2J_7	2N_7		2H_1		2D_3	2L_3				11H_1		11D_3	11L_3	80	15D	15D
	16			17	1I	17	1E_0	1M_0	17	2C_0	2G_0	2K_0	2O_0	17	2I_0	17	2E_0	2M_0	17	11I	17	11I_0	17	11E_0	11M_0	17	12E	12E
	17			19	1J		1E_1	1M_1		2C_1	2G_1	2K_1	2O_1		2I_1		2E_1	2M_1	19	11J		11I_1		11E_1	11M_1	19	12F	12F
	18			21	1K		1E_2	1M_2		2C_2	2G_2	2K_2	2O_2	21	2J_0		2E_2	2M_2	21	11K	21	11J_0		11E_2	11M_2	21	12G	12G
	19			23	1L		1E_3	1M_3		2C_3	2G_3	2K_3	2O_3		2J_1		2E_3	2M_3	23	11L		11J_1		11E_3	11M_3	23	12H	12H
	20			25	1M	25	1F_0	1N_0		2C_4	2G_4	2K_4	2O_4	25	2K_0	25	2F_0	2N_0	25	11M	25	11K_0	25	11F_0	11N_0	25	13E	13E
	21			27	1N		1F_1	1N_1		2C_5	2G_5	2K_5	2O_5		2K_1		2F_1	2N_1	27	11N		11K_1		11F_1	11N_1	27	13F	13F
	22			29	1O		1F_2	1N_2		2C_6	2G_6	2K_6	2O_6	29	2L_0		2F_2	2N_2	29	11O	29	11L_0		11F_2	11N_2	29	13G	13G
B	23			31	1P		1F_3	1N_3		2C_7	2G_7	2K_7	2O_7		2L_1		2F_3	2N_3	31	11P		11L_1		11F_3	11N_3	31	13H	13H
	24					82	1G_0	1O_0	82	2D_0	2H_0	2L_0	2P_0	82	2M_0	82	2G_0	2O_0			82	11M_0	82	11G_0	11O_0	82	14E	14E
	25						1G_1	1O_1		2D_1	2H_1	2L_1	2P_1		2M_1		2G_1	2O_1				11M_1		11G_1	11O_1	84	14F	14F
	26						1G_2	1O_2		2D_2	2H_2	2L_2	2P_2	86	2N_0		2G_2	2O_2			86	11N_0		11G_2	11O_2	86	14G	14G
	27						1G_3	1O_3		2D_3	2H_3	2L_3	2P_3		2N_1		2G_3	2O_3				11N_1		11G_3	11O_3	88	14H	14H
	28					90	1H_0	1P_0		2D_4	2H_4	2L_4	2P_4	90	2O_0	90	2H_0	2P_0			90	11O_0	90	11H_0	11P_0	90	15E	15E
	29						1H_1	1P_1		2D_5	2H_5	2L_5	2P_5		2O_1		2H_1	2P_1				11O_1		11H_1	11P_1	92	15F	15F
	30						1H_2	1P_2		2D_6	2H_6	2L_6	2P_6	94	2P_0		2H_2	2P_2			94	11P_0		11H_2	11P_2	94	15G	15G
	31						1H_3	1P_3		2D_7	2H_7	2L_7	2P_7		2P_1		2H_3	2P_3				11P_1		11H_3	11P_3	96	15H	15H

Figure 5: Utilization of LSBs in endcap special FEC.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1		PRESAMPLER					FRONT					BACK					MIDDLE				
2			FEB		TBB			FEB		TBB			FEB		TBB			FEB		TBB	
3	TRIG SUM	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#	SIGNAL	CONN	PIN#	CONN	PIN#
4																					
5	1A						1A_F	J21	1	J9	65						1A_M	J22	1	J9	1
6	1B						1B_F	J21	3	J9	68						1B_M	J22	9	J9	4
7	1C						1C_F	J21	5	J9	71						1C_M	J22	66	J9	7
8	1D						1D_F	J21	7	J9	74						1D_M	J22	74	J9	10
9	1E						1E_F	J21	9	J9	77						1E_M	J22	17	J9	13
10	1F						1F_F	J21	11	J9	80						1F_M	J22	25	J9	16
11	1G						1G_F	J21	13	J9	83						1G_M	J22	82	J9	19
12	1H						1H_F	J21	15	J9	86						1H_M	J22	90	J9	22
13	1 I						1I_F	J21	17	J9	89						1I_M	J23	1	J9	25
14	1J						1J_F	J21	19	J9	92						1J_M	J23	9	J9	28
15	1K						1K_F	J21	21	J9	95						1K_M	J23	66	J9	31
16	1L						1L_F	J21	23	J28	65						1L_M	J23	74	J28	1
17	1M						1M_F	J21	25	J28	68						1M_M	J23	17	J28	4
18	1N						1N_F	J21	27	J28	71						1N_M	J23	25	J28	7
19	1O						1O_F	J21	29	J28	74						1O_M	J23	82	J28	10
20	1P						1P_F	J21	31	J28	77						1P_M	J23	90	J28	13
21	2A	2A_P	J20	1	J28	20	2A_F	J24	1	J28	83	2A_B	J30	1	J28	84	2A_M	J31	1	J28	19
22	2B	2B_P	J20	3	J28	23	2B_F	J24	66	J28	86	2B_B	J30	5	J28	87	2B_M	J31	9	J28	22
23	2C	2C_P	J20	5	J28	26	2C_F	J24	17	J28	89	2C_B	J30	9	J28	90	2C_M	J31	66	J28	25
24	2D	2D_P	J20	7	J28	29	2D_F	J24	82	J28	92	2D_B	J30	13	J28	93	2D_M	J31	74	J28	28
25	2E	2E_P	J20	9	J28	32	2E_F	J25	1	J28	95	2E_B	J30	66	J28	96	2E_M	J31	17	J28	31
26	2F	2F_P	J20	11	J47	2	2F_F	J25	66	J47	65	2F_B	J30	70	J47	66	2F_M	J31	25	J47	1
27	2G	2G_P	J20	13	J47	5	2G_F	J25	17	J47	68	2G_B	J30	74	J47	69	2G_M	J31	82	J47	4
28	2H	2H_P	J20	15	J47	8	2H_F	J25	82	J47	71	2H_B	J30	78	J47	72	2H_M	J31	90	J47	7
29	2 I	2I_P	J20	66	J47	11	2I_F	J26	1	J47	74	2I_B	J30	17	J47	75	2I_M	J32	1	J47	10
30	2J	2J_P	J20	68	J47	14	2J_F	J26	66	J47	77	2J_B	J30	21	J47	78	2J_M	J32	9	J47	13
31	2K	2K_P	J20	70	J47	17	2K_F	J26	17	J47	80	2K_B	J30	25	J47	81	2K_M	J32	66	J47	16
32	2L	2L_P	J20	72	J47	20	2L_F	J26	82	J47	83	2L_B	J30	29	J47	84	2L_M	J32	74	J47	19
33	2M	2M_P	J20	74	J47	23	2M_F	J27	1	J47	86	2M_B	J30	82	J47	87	2M_M	J32	17	J47	22
34	2N	2N_P	J20	76	J47	26	2N_F	J27	66	J47	89	2N_B	J30	86	J47	90	2N_M	J32	25	J47	25
35	2O	2O_P	J20	78	J47	29	2O_F	J27	17	J47	92	2O_B	J30	90	J47	93	2O_M	J32	82	J47	28
36	2P	2P_P	J20	80	J47	32	2P_F	J27	82	J47	95	2P_B	J30	94	J47	96	2P_M	J32	90	J47	31
37	11A						11A_F	J33	1	J16	89	11A_B	J34	1	J16	90	11A_M	J36	1	J16	25
38	11B						11B_F	J33	3	J16	92	11B_B	J34	5	J16	93	11B_M	J36	9	J16	28
39	11C						11C_F	J33	5	J16	95	11C_B	J34	9	J16	96	11C_M	J36	66	J16	31
40	11D						11D_F	J33	7	J35	65	11D_B	J34	13	J35	66	11D_M	J36	74	J35	1
41	11E						11E_F	J33	9	J35	68	11E_B	J34	66	J35	69	11E_M	J36	17	J35	4
42	11F						11F_F	J33	11	J35	71	11F_B	J34	70	J35	72	11F_M	J36	25	J35	7
43	11G						11G_F	J33	13	J35	74	11G_B	J34	74	J35	75	11G_M	J36	82	J35	10
44	11H						11H_F	J33	15	J35	77	11H_B	J34	78	J35	78	11H_M	J36	90	J35	13
45	11 I						11I_F I	J33	17	J35	83	11I_B I	J34	17	J35	84	11I_M I	J37	1	J35	19
46	11J						11J_F	J33	19	J35	86	11J_B	J34	21	J35	87	11J_M	J37	9	J35	22
47	11K						11K_F	J33	21	J35	89	11K_B	J34	25	J35	90	11K_M	J37	66	J35	25
48	11L						11L_F	J33	23	J35	92	11L_B	J34	29	J35	93	11L_M	J37	74	J35	28
49	11M						11M_F	J33	25	J35	95	11M_B	J34	82	J35	96	11M_M	J37	17	J35	31
50	11N						11N_F	J33	27	J54	65	11N_B	J34	86	J54	66	11N_M	J37	25	J54	1
51	11O						11O_F	J33	29	J54	68	11O_B	J34	90	J54	69	11O_M	J37	82	J54	4
52	11P						11P_F	J33	31	J54	71	11P_B	J34	94	J54	72	11P_M	J37	90	J54	7
53	12A						12A_F	J20X	1	J16	77						12A_M	JX22	1	J16	13
54	12B						12B_F	J20X	3	J16	80						12B_M	JX22	3	J16	16
55	12C						12C_F	J20X	5	J16	83						12C_M	JX22	5	J16	19
56	12D						12D_F	J20X	7	J16	86						12D_M	JX22	7	J16	22
57	12E						12E_F	J20X	17	J54	77						12E_M	JX22	17	J54	13
58	12F						12F_F	J20X	19	J54	80						12F_M	JX22	19	J54	16
59	12G						12G_F	J20X	21	J54	83						12G_M	JX22	21	J54	19
60	12H						12H_F	J20X	23	J54	86						12H_M	JX22	23	J54	22
61	13A						13A_F	J20X	9	JX2	77						13A_M	JX22	9	JX2	13
62	13B						13B_F	J20X	11	JX2	80						13B_M	JX22	11	JX2	16
63	13C						13C_F	J20X	13	JX2	83						13C_M	JX22	13	JX2	19
64	13D						13D_F	J20X	15	JX2	86						13D_M	JX22	15	JX2	22
65	13E						13E_F	J20X	25	JX21	95						13E_M	JX22	25	JX21	31
66	13F						13F_F	J20X	27	JX40	65						13F_M	JX22	27	JX40	1
67	13G						13G_F	J20X	29	JX40	68						13G_M	JX22	29	JX40	4
68	13H						13H_F	J20X	31	JX40	71						13H_M	JX22	31	JX40	7
69	14A						14A_F	J20X	66	JX2	89						14A_M	JX22	66	JX2	25
70	14B						14B_F	J20X	68	JX2	92						14B_M	JX22	68	JX2	28
71	14C						14C_F	J20X	70	JX2	95						14C_M	JX22	70	JX2	31
72	14D						14D_F	J20X	72	JX21	65						14D_M	JX22	72	JX21	1
73	14E						14E_F	J20X	82	JX40	74						14E_M	JX22	82	JX40	10
74	14F						14F_F	J20X	84	JX40	77						14F_M	JX22	84	JX40	13
75	14G						14G_F	J20X	86	JX40	80						14G_M	JX22	86	JX40	16
76	14H						14H_F	J20X	88	JX40	83						14H_M	JX22	88	JX40	19
77	15A						15A_F	J20X	74	JX21	68						15A_M	JX22	74	JX21	4
78	15B						15B_F	J20X	76	JX21	71						15B_M	JX22	76	JX21	7
79	15C						15C_F	J20X	78	JX21	74						15C_M	JX22	78	JX21	10
80	15D						15D_F	J20X	80	JX21	77						15D_M	JX22	80	JX21	13
81	15E						15E_F	J20X	90	JX40	86						15E_M	JX22	90	JX40	22
82	15F						15F_F	J20X	92	JX40	89						15F_M	JX22	92	JX40	25
83	15G						15G_F	J20X	94	JX40	92						15G_M	JX22	94	JX40	28
84	15H						15H_F	J20X	96	JX40	95						15H_M	JX22	96	JX40	31

Figure 6: Map of the trigger sum components in endcap special FEC.

3 Baseplanes

The Front End Crate contains FEBs for each of the different depth segments of the calorimeter, and the LSB form the appropriate sums on each of the FEBs for the trigger. It is the function of the The Tower Builder Board (TBB) to form the sums of the signals from the different depth layers. There are 32 sums formed on one TBB, and each sum contains four inputs: (1) presampler, (2) front section, (3) middle section, and (4) back section. The baseplane is a printed circuit board mounted at the base of the FEC, which supports the input connectors to the FEBs but also acts as a conduit for the LSB outputs from each FEB to the input pins of the TBB. In Table 5 is given the ordering of trigger sums in the channels of the TBB (and hence the ordering of channels in the output cable) for the barrel. Table 6 gives the corresponding information for the endcap standard crate. For the endcap special crate, there are three TBBs and hence six output cables. The ordering of the trigger sums in these cables is given in Table 7.

4 Cables

There are two cables connected to each TBB card. The ordering of channels within the cables are given in the tables in Section 3. Here we describe the cable plant which transport these signals from the front end crate to the L1 Cavern.

Since the notation for the trigger sums given in Section 1 are repeated within each quadrant, we introduce a label for each of the eight quadrants. We call the quadrants I, II, III, and IV, in increasing ϕ, and the two halves are labelled - and +, according to the sign of the z coordinate in the standard coordinate system. We also note whether the quadrant is in the barrel (B) or endcap (E). Thus the quandrant with ϕ between 0 and $90°$ at negative z in the barrel is labelled IB-. Each TBB card in the experiment is then assigned a number, and in Table 8 is given the correspondence between the trigger sums carried on a cable and the quadrant of the calorimeter. We suggest that the cable numbering also follow this convention, using the TBB number followed by A and B suffixes.

Table 5: Tower Builder channel utilization in the barrel calorimeter. The Tower Builder Board has 32 channels which drive two output cables through connectors on the front panel (labelled Connector A and B below). The traces on the baseplane define the inputs to the TBB, which in turn determines the ordering of the trigger sums on the output cables.

Connector A

TBB	Trigger Sum	
Channel	$\eta > 0$	$\eta < 0$
1	1A	1B
2	2A	2B
3	3A	3B
4	4A	4B
5	5A	5B
6	6A	6B
7	7A	7B
8	8A	8B
9	9A	9B
10	10A	10B
11	11A	11B
12	12A	12B
13	13A	13B
14	14A	14B
15	15A	15B
16	–	–

Connector B

TBB	Trigger Sum	
Channel	$\eta > 0$	$\eta < 0$
17	1B	1A
18	2B	2A
19	3B	3A
20	4B	4A
21	5B	5A
22	6B	6A
23	7B	7A
24	8B	8A
25	9B	9A
26	10B	10A
27	11B	11A
28	12B	12A
29	13B	13A
30	14B	14A
31	15B	15 A
32	–	–

Table 6: Tower Builder channel utilization in the endcap calorimeter, standard crate. See Table 5 for details.

Connector A

TBB Channel	Trigger Sum $\eta > 0$	Trigger Sum $\eta < 0$
1	3A	3D
2	3B	3C
3	4A	4D
4	4B	4C
5	5A	5D
6	5B	5C
7	6A	6D
8	6B	6C
9	7A	7D
10	7B	7C
11	8A	8D
12	8B	8C
13	9A	9D
14	9B	9C
15	10A	10D
16	10B	10C

Connector B

TBB Channel	Trigger Sum ($\eta > 0$)	Trigger Sum ($\eta < 0$)
17	3C	3B
18	3D	3A
19	4C	4B
20	4D	4A
21	5C	5B
22	5D	5A
23	6C	6B
24	6D	6A
25	7C	7B
26	7D	7A
27	8C	8B
28	8D	8A
29	9C	9B
30	9D	9A
31	10C	10B
32	10D	10A

Table 7: Tower Builder channel utilization in the endcap calorimeter, special crate. In this crate there are three TBB boards and hence 6 output cables.

TBB0 Connector A

TBB Channel	Trigger Sum $\eta > 0$	Trigger Sum $\eta < 0$
1	1A	1P
2	1B	1O
3	1C	1N
4	1D	1M
5	1E	1L
6	1F	1K
7	1G	1J
8	1H	1I
9	1I	1H
10	1J	1G
11	1K	1F
12	1L	1E
13	1M	1D
14	1N	1C
15	1O	1B
16	1P	1C

TBB0 Connector B

TBB Channel	Trigger Sum $\eta > 0$	Trigger Sum $\eta < 0$
17	2A	2P
18	2B	2O
19	2C	2N
20	2D	2M
21	2E	2L
22	2F	2K
23	2G	2J
24	2H	2I
25	2I	2H
26	2J	2G
27	2K	2F
28	2L	2E
29	2M	2D
30	2N	2C
31	2O	2B
32	2P	2A

TBB1 Connector A

TBB Channel	Trigger Sum $\eta > 0$	Trigger Sum $\eta < 0$
1	–	–
2	–	–
3	–	–
4	–	–
5	12A	12H
6	12B	12G
7	12C	12F
8	12D	12E
9	11A	11P
10	11B	11O
11	11C	11N
12	11D	11M
13	11E	11L
14	11F	11K
15	11G	11J
16	11H	11I

TBB1 Connector B

TBB Channel	Trigger Sum $\eta > 0$	Trigger Sum $\eta < 0$
17	11I	11H
18	11J	11G
19	11K	11F
20	11L	11E
21	11M	11D
22	11N	11C
23	11O	11B
24	11P	11A
25	–	–
26	12E	12D
27	12F	12C
28	12G	12B
29	12H	12A
30	–	–
31	–	–
32	–	–

TBB2 Connector A

TBB Channel	Trigger Sum $\eta > 0$	Trigger Sum $\eta < 0$
1	–	–
2	–	–
3	–	–
4	–	–
5	13A	13H
6	13B	13G
7	13C	13F
8	13D	13E
9	14A	14H
10	14B	14G
11	14C	14F
12	14D	14E
13	15A	15G
14	15B	15H
15	15C	15F
16	15D	15E

TBB2 Connector B

TBB Channel	Trigger Sum $\eta > 0$	Trigger Sum $\eta < 0$
17	–	–
18	–	–
19	–	–
20	–	–
21	13E	13D
22	13F	13C
23	13G	13B
24	13H	13A
25	14E	14D
26	14F	14C
27	14G	14B
28	14H	14A
29	15E	15D
30	15F	15C
31	15G	15B
32	15H	15A

Table 8: Numbering of TBBs, specifying the trigger sums formed and the quandrant in the calorimeter. The quandrants are numbered I, II, III, and IV, in order of increasing ϕ The letters "B" and "E" stand for barrel and endcap, respectively; and +/- refers to the sign of the z coordinate.

TBB Number	Quadrant No.	Trigger sums
1	IB-	1A–15A, 1B–15B
2	IB-	1C–15C, 1D–15D
3	IB-	1E–15E, 1F–15F
4	IB-	1G–15G, 1H–15H
5	IB-	1I–15I, 1J–15J
6	IB-	1K–15K, 1L–15L
7	IB-	1M–15M, 1N–15N
8	IB-	1O–15O, 1P–15P
9–16	IIB-	1A-15P (distributed as Nos. 1–8)
17–24	IIIB-	1A-15P (distributed as Nos. 1–8)
25–32	IVB-	1A-15P (distributed as Nos. 1–8)
33–40	IB+	1A-15P (distributed as Nos. 1–8)
41–48	IIB+	1A-15P (distributed as Nos. 1–8)
49–56	IIIB+	1A-15P (distributed as Nos. 1–8)
56–64	IVB+	1A-15P (distributed as Nos. 1–8)
65	IE-	3A–10A, 3B–10B, 3C–10C, 3D–10D (Outer Wheel)
66	IE-	3E–10E, 3F–10F, 3G–10G, 3H–10H (Outer Wheel)
67	IE-	3I–10I, 3J–10J, 3K–10K, 3L–10L (Outer Wheel)
68	IE-	3M–10M, 3N–10N, 3O–10O, 3P–10P (Outer Wheel)
69	IE-	1A–1P, 2A–2P (Outer Wheel)
70	IE-	11A–11P, 12A-12H (Outer Wheel)
71	IE-	13A–15H (Inner Wheel)
72–78	IIE-	1A–15H (distributed as Nos. 65–71)
79–85	IIIE-	1A–15H (distributed as Nos. 65–71)
86–92	IVE-	1A–15H (distributed as Nos. 65–71)
93–99	IE+	1A–15H (distributed as Nos. 65–71)
100–106	IIE+	1A–15H (distributed as Nos. 65–71)
107–113	IIIE+	1A–15H (distributed as Nos. 65–71)
114–120	IVE+	1A–15H (distributed as Nos. 65–71)

References

[1] Liquid Argon Technical Design Report

[2] J. Colas,it et al., Cabling of Liquid Argon Calorimeters, ATL-AL-LAPP-ES-7.0, 30 June 1997

[3] Notes describing Tower Builder Board