May 20, 2002

Cabling of the ATLAS Liquid Argon Receiver System

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1 Introduction

In this document, we describe the cabling of the inputs to the liquid argon Receiver system, which is located in USA15. The technical specifications for this system are found in a separate working document[1].

Trigger cables are driven from the front end electronics by either the Tower Builder Board (TBB) or the Tower Driver Board (TDB). The nomenclature and content of the cables from the em calorimeter, which are driven by the TBBs, are described in [2], and the corresponding information for the TDBs are described in [3].

2 Mapping Requirements

The signals arriving from the front end electronics are ordered according to the channel assignment of the TBBs[2] and TDBs[3]. For convenience, the TBB table is reproduced below in Table 4. The corresponding table for the TDBs for the HEC is given in Table 6 and the table for the FCAL is given in Table 8. In the barrel, a single cable contains signals of at a single ϕ value; the 15 signals are for trigger towers at different η values. In the endcap, the ordering is more complicated. Some cables contain signals at only one value of η, whereas others contain, for example, an array of $N_\phi \times N_\eta = 2 \times 8$.

The Level 1 trigger requires that the trigger sum signals be available on connectors which represent a array of size $\Delta\eta \times \Delta\phi$=0.4 × 0.4 for $0 \leq |\eta| \leq 2.4$. For $2.4 > |\eta| \leq 3.2$ the array size is 0.8 × 0.8, and for $|\eta$ ¿ 3.2 it is 1.6 × 1.6. The pinout for each connector (*i.e.*, the pin number - geometrical position of the trigger tower in the global ATLAS coordinate system) should be invariant as one moves across the detector. Given this requirement and the ordering of signals at the input, it is clear that a remapping of signals in the receiver is desirable.

The cables which are driven by the Tower Builder or Tower Driver module are numbered according to the module number plus a letter (A or B for the TBB, A through F for the TDR) indicating which connector is used on the module. These modules are numbered consecutively, as described for the EM calorimeters in Ref. [2] and for the HEC and FCAL in Ref. [3]. These cables are brought to USA 15, where they are plugged into the back of the receiver crates.

There are two types of output connectors on the receiver modules. Connectors A, B, C, and D contain 16 signals which go to the FADC inputs. Connector E contains 4 signals which are used for analog summing. Each output connector receives a unique name using a convention which gives the location of the 0.4×0.4 "patch" on the detector. For the em calorimeters, there are 16 steps (of 0.4) in η and 16 steps (also of 0.4) in ϕ. The names of the output connectors A, B, C, and D may have up to four characters $\alpha MN\beta$. The first character α identifies the type of section (E for EM, H for Hadronic); the characters M and N are (extended) hexadecimal numerals which depend on the position in (η, ϕ) space: M is the ϕ index, which denotes the minimum value of ϕ for the sector in units of 0.4. The quantity N is an η index, whose relationship to η is given in Tables 2, 5, and 7 for each of the calorimeters. The fourth character β (absent in most cases) is reserved for special cases. It can have one of 6 values e, b, x, y, s, o, used in one of the following three situations:

- *Connectors at the EM barrel-endcap transition.* The values (e, b) are used in the case where a connector is only partially used, where the trigger sums for a given "patch" are split across two receiver modules. The value of β indicates which portion of the elements in the connector are present: e is for the connector containing only endcap signals and b is for the connector containing only barrel signals. For the Connector E, which handles the case of trigger sums which are partially formed in the em barrel front end crate (FEC) and partially in the em FEC the same convention is followed as for the other connectors, only in this case the value of β is s, which identifies it as a "summation" connector. This connector contains the part of the trigger tower formed in the barrel FEC.

- *FCAL hadronic sums.* A pairwise lateral summation of the signals from FCAL2 and FCAL3 is made in the receiver (to reduce the granularity in η), resulting in output connectors which are only 50% occupied. The FCAL2+FCAL3 sum is made in the L1 preprocessor, using a cable formed from two receiver output connectors. In this case, $\beta = x$ or y is used to designate the sums from FCAL2 or FCAL3, respectively.

- Octant sums. For values of $|\eta| > 2.4$, the output connector of the receiver represents a "patch" of $\Delta\eta \times \Delta\phi = 0.8 \times 0.8$. These receive special treatment in that the cables must be split going into the Level 1 preprocessor. For this reason, the connectors are given the designation $\beta = o$.

An overview of the receiver system is shown in Table 1. In the following sections, we give the details of the receiver system for each of the calorimeters.

3 Receiver Mapping of the EM Trigger Sums

There are four receiver crates which service the signals from the em calorimeters: two for the barrel ($+z$ and $-z$), and one for each endcap. There are 16 receiver modules in each

Table 1: Overview of the receiver system, showing the number of modules in each of the crates.

Crate No.	Modules	Calorimeter
1	16	Barrel($+z$)
2	16	Barrel(-z)
3	16	EM Endcap $A(+z)$
4	16	EM Endcap C(-z)
5	13 3	Hadronic Endcap A FCAL A
6	13 3	Hadronic Endcap C FCAL C

of these crates. The input cables and the names of the output connectors associated with each of the receiver modules is shown in Fig. 1 for the barrel and Fig. 2 for the endcaps.

Drawings which show the relationship, in (η, ϕ) space, between the receiver input cables and output connectors as well as the trigger sums are shown in Fig. 3 for the barrel, Fig. 4 for endcap C, and Fig. 5 for endcap A.

The signals from the barrel which are to be summed with signals from the endcaps are collected together in summing boxes (labelled Sn, with n running from 1 to 8), and the output cable from this box plugs into the back of the receiver module in Slot 1 of each of the endcap receiver crates. The cabling of the summing boxes is given in Table 3.

4 Receivers for the HEC and FCAL Trigger Sums

One major difference between the electronic chains for the HEC and FCAL trigger sums and that for the em calorimeters is that instead of using tower builder modules for summation of signals from different layers, tower driver modules are used, where no summation is performed. Each tower driver module contains 96 channels, which are carried to USA15 over cables identical to those used in the em calorimeters. Thus the tower driver module has 6 connectors on it front panel, which we designate A through F. As in the em calorimeters, the cables are numbered with the module number followed by the letter of the connector. In order to have unique cable numbers in USA15, we begin the number of the tower driver modules where the numbering of the tower builder modules leaves off. In Table 6 we give the numbering of the tower driver modules for the HEC[3].

There are two receiver crates (one for each endcap) which contain modules for both the hadronic and forward calorimeters. The diagrams for the input cables and output connectors for each of these crates are given in Fig. 6. In Figs. 7 and 8 are given the

Table 2: Values of the η index used in the em calorimeters to identify the receiver connectors, along with the corresponding values of η.

N	$\eta_{\min}$	$\eta_{\max}$	$\Delta\eta$	$\Delta\phi$
0	-3.2	-2.7	0.5	0.8
1	-2.7	-2.4	0.3	0.8
2	-2.4	-2.0	0.4	0.4
3	-2.0	-1.6	0.4	0.4
4	-1.6	-1.2	0.4	0.4
5	-1.2	-0.8	0.4	0.4
6	-0.8	-0.4	0.4	0.4
7	-0.4	0.0	0.4	0.4
8	0.0	0.4	0.4	0.4
9	0.4	0.8	0.4	0.4
A	0.8	1.2	0.4	0.4
B	1.2	1.6	0.4	0.4
C	1.6	2.0	0.4	0.4
D	2.0	2.4	0.4	0.4
E	2.4	2.7	0.3	0.8
F	2.7	3.2	0.5	0.8

Table 3: Cabling of the summing boxes. The inputs to this box are the summing connectors on the barrel receiver modules, and the output goes to the receiver module in slot 1 of the em endcap receiver crates.

Input	Output	Input	Output
E04s	1S	E0Bs	4S
E14s		E1Bs	
E24s		E2Bs	
E34s		E3Bs	
E44s	2S	E4Bs	5S
E54s		E5Bs	
E64s		E6Bs	
E74s		E7Bs	
E84s	3S	E8Bs	6S
E94s		E9Bs	
EA4s		EABs	
EB4s		EBBs	
EC4s	4S	ECBs	8S
ED4s		EDBs	
EE4s		EEBs	
EF4s		EFBs	

Table 4: Numbering of TBBs, specifying the trigger sums formed and the quadrant in the calorimeter. The quadrants are numbered Q1, Q2, Q3, and Q4, in order of increasing ϕ The letters "B" and "E" stand for barrel and endcap, respectively; +/- refers to the sign of the z coordinate, and A and C refer to the endcaps at $+z$ and $-z$, respectively.

TBB Number	Quadrant No.	Trigger sums
1	Q1B-	1A–15A, 1B–15B
2	Q1B-	1C–15C, 1D–15D
3	Q1B-	1E–15E, 1F–15F
4	Q1B-	1G–15G, 1H–15H
5	Q1B-	1I–15I, 1J–15J
6	Q1B-	1K–15K, 1L–15L
7	Q1B-	1M–15M, 1N–15N
8	Q1B-	1O–15O, 1P–15P
9–16	Q2B-	1A-15P (distributed as Nos. 1–8)
17–24	Q3B-	1A-15P (distributed as Nos. 1–8)
25–32	Q4B-	1A-15P (distributed as Nos. 1–8)
33–40	Q1B+	1A-15P (distributed as Nos. 1–8)
41–48	Q2B+	1A-15P (distributed as Nos. 1–8)
49–56	Q3B+	1A-15P (distributed as Nos. 1–8)
56–64	Q4B+	1A-15P (distributed as Nos. 1–8)
65	Q1EC	3A–10A, 3B–10B, 3C–10C, 3D–10D (Outer Wheel)
66	Q1EC	3E–10E, 3F–10F, 3G–10G, 3H–10H (Outer Wheel)
67	Q1EC	3I–10I, 3J–10J, 3K–10K, 3L–10L (Outer Wheel)
68	Q1EC	3M–10M, 3N–10N, 3O–10O, 3P–10P (Outer Wheel)
69	Q1EC	1A–1P, 2A–2P (Outer Wheel)
70	Q1EC	11A–11P, 12A-12H (Outer Wheel)
71	Q1EC	13A–15H (Inner Wheel)
72–78	Q2EC	1A–15H (distributed as Nos. 65–71)
79–85	Q3EC	1A–15H (distributed as Nos. 65–71)
86–92	Q4EC	1A–15H (distributed as Nos. 65–71)
93–99	Q1EA	1A–15H (distributed as Nos. 65–71)
100–106	Q2EA	1A–15H (distributed as Nos. 65–71)
107–113	Q3EA	1A–15H (distributed as Nos. 65–71)
114–120	Q4EA	1A–15H (distributed as Nos. 65–71)

EMB (+z)

Crate 1

Input Cable	Slot Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	33A	35A	37A	39A	41A	43A	45A	47A	49A	51A	53A	55A	57A	59A	61A	63A
2	33B	35B	37B	39B	41B	43B	45B	47B	49B	51B	53B	55B	57B	59B	61B	63B
3	34A	36A	38A	40A	42A	44A	46A	48A	50A	52A	54A	56A	58A	60A	62A	64A
4	34B	36B	38B	40B	42B	44B	46B	48B	50B	52B	54B	56B	58B	60B	62B	64B
Conn	Quadrant 1				Quadrant 2				Quadrant 3				Quadrant 4			
A	E08	E18	E28	E38	E48	E58	E68	E78	E88	E98	EA8	EB8	EC8	ED8	EE8	EF8
B	E09	E19	E29	E39	E49	E59	E69	E79	E89	E99	EA9	EB9	EC9	ED9	EE9	EF9
C	E0A	E1A	E2A	E3A	E4A	E5A	E6A	E7A	E8A	E9A	EAA	EBA	ECA	EDA	EEA	EFA
D	E0Bb	E1Bb	E2Bb	E3Bb	E4Bb	E5Bb	E6Bb	E7Bb	E8Bb	E9Bb	EABb	EBBb	ECBb	EDBb	EEBb	EFBb
E	E0Bs	E1Bs	E2Bs	E3Bs	E4Bs	E5Bs	E6Bs	E7Bs	E8Bs	E9Bs	EABs	EBBs	ECBs	EDBs	EEBs	EFBs

EMB (-z)

Crate 2

Input Cable	Slot Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1A	3A	5A	7A	9A	11A	13A	15A	17A	19A	21A	23A	25A	27A	29A	31A
2	1B	3B	5B	7B	9B	11B	13B	15B	17B	19B	21B	23B	25B	27B	29B	31B
3	2A	4A	6A	8A	10A	12A	14A	16A	A8A	20A	22A	24A	26A	28A	30A	32A
4	2B	4B	6B	8B	10B	12B	14B	16B	B8B	20B	22B	24B	26B	28B	30B	32B
Conn	Quadrant 1				Quadrant 2				Quadrant 3				Quadrant 4			
A	E04b	E14b	E24b	E34b	E44b	E54b	E64b	E74b	E84b	E94b	EA4b	EB4b	EC4b	ED4b	EE4b	EF4b
B	E05	E15	E25	E35	E45	E55	E65	E75	E85	E95	EA5	EB5	EC5	ED5	EE5	EF5
C	E06	E16	E26	E36	E46	E56	E66	E76	E86	E96	EA6	EB6	EC6	ED6	EE6	EF6
D	E07	E17	E27	E37	E47	E57	E67	E77	E87	E97	EA7	EB7	EC7	ED7	EE7	EF7
E	E04s	E14s	E24s	E34s	E44s	E54s	E64s	E74s	E84s	E94s	EA4s	EB4s	EC4s	ED4s	EE4s	EF4s

Figure 1: Diagram of the receiver crates for the barrel, showing the input cables and the output connectors for each receiver module. The upper diagram is for the barrel at $+z$ and the lower diagram is for the $-z$ end. In each diagram the upper part (Cables 1-4) shows the input cables from the TBB, whereas the lower part (Connectors A-E) shows the names of the five output connectors on the module.

correspondence between in input cables, output connectors and the trigger sums for the HEC. In Fig. 9 is shown the corresponding information for the FCAL.

EMEC A

Crate 3

Input Cable	Slot Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	97A	93A	95A	98A	104A	100A	102A	105A	111A	107A	109A	112A	118A	114A	116A	119A
2	97B	93B	95B	98B	104B	100B	102B	105B	111B	107B	109B	112B	118B	114B	116B	119B
3	5S	94A	96A	99A	6S	101A	103A	106A	7S	108A	110A	113A	8S	115A	117A	120A
4		94B	96B	99B		101B	103B	106B		108B	110B	113B		115B	117B	120B
Conn	Quadrant 1				Quadrant 2				Quadrant 3				Quadrant 4			
A	E0Be	E0C	E2C	E0Eo	E4Be	E4C	E6C	E4Eo	E8Be	E8C	EAC	E8Eo	ECBe	ECC	EEC	ECEo
B	E1Be	E0D	E2D	E0Fo	E5Be	E4D	E6D	E4Fo	E9Be	E8D	EAD	E8Fo	EDBe	ECD	EED	ECFo
C	E2Be	E1C	E3C	E2Eo	E6Be	E5C	E7C	E6Eo	EABe	E9C	EBC	EAEo	EEBe	EDC	EFC	EEEo
D	E3Be	E1D	E3D	E2Fo	E7Be	E5D	E7D	E6Fo	EBBe	E9D	EBD	EAFo	EFBe	EDD	EFD	EEFo
E																

EMEC C

Crate 4

Input Cable	Slot Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	69A	65A	67A	70A	76A	72A	74A	77A	83A	79A	81A	84A	90A	86A	88A	91A
2	69B	65B	67B	70B	76B	72B	74B	77B	83B	79B	81B	84B	90B	86B	88B	91B
3	1S	66A	68A	71A	2S	73A	75A	78A	3S	80A	82A	85A	4S	87A	89A	92A
4		66B	68B	71B		73B	75B	78B		80B	82B	85B		87B	89B	92B
Conn	Quadrant 1				Quadrant 2				Quadrant 3				Quadrant 4			
A	E04e	E02	E22	E00o	E44e	E42	E62	E40o	E84e	E82	EA2	E80o	EC4e	EC2	EE2	EC0o
B	E14e	E03	E23	E01o	E54e	E43	E63	E41o	E94e	E83	EA3	E81o	ED4e	EC3	EE3	EC1o
C	E24e	E12	E32	E20o	E64e	E52	E72	E60o	EA4e	E92	EB2	EA0o	EE4e	ED2	EF2	EE0o
D	E34e	E13	E33	E21o	E74e	E53	E73	E61o	EB4e	E93	EB3	EA1o	EF4e	ED3	EF3	EE1o
E																

Figure 2: Diagram of the receiver crates for the two em endcaps, showing the input cables and the output connectors for each receiver module. The upper diagram is for Endcap A (at $+z$) and the lower diagram is for Endcap C. In each diagram the upper part (Cables 1-4) shows the input cables from the TBB, whereas the lower part (Connectors A-D) shows the names of the five output connectors on the module. Connector E is not used in the endcap receiver modules. The cables labelled 1S...8S are the summing interconnect cables described in Table 3.

Table 5: Values of the η index N used in the hadronic endcap receivers to identify the receiver connectors, along with the corresponding values of η.

N	$\eta_{\min}$	$\eta_{\max}$	$\Delta\eta$	$\Delta\phi$
0	-3.2	-2.7	0.5	0.8
1	-2.7	-2.4	0.3	0.8
2	-2.4	-2.0	0.4	0.8
3	-2.0	-1.6	0.4	0.4
4	-1.6	-1.5	0.4	0.4
B	1.5	1.6	0.4	0.4
C	1.6	2.0	0.4	0.4
D	2.0	2.4	0.4	0.4
E	2.4	2.7	0.3	0.8
F	2.7	3.2	0.5	0.8

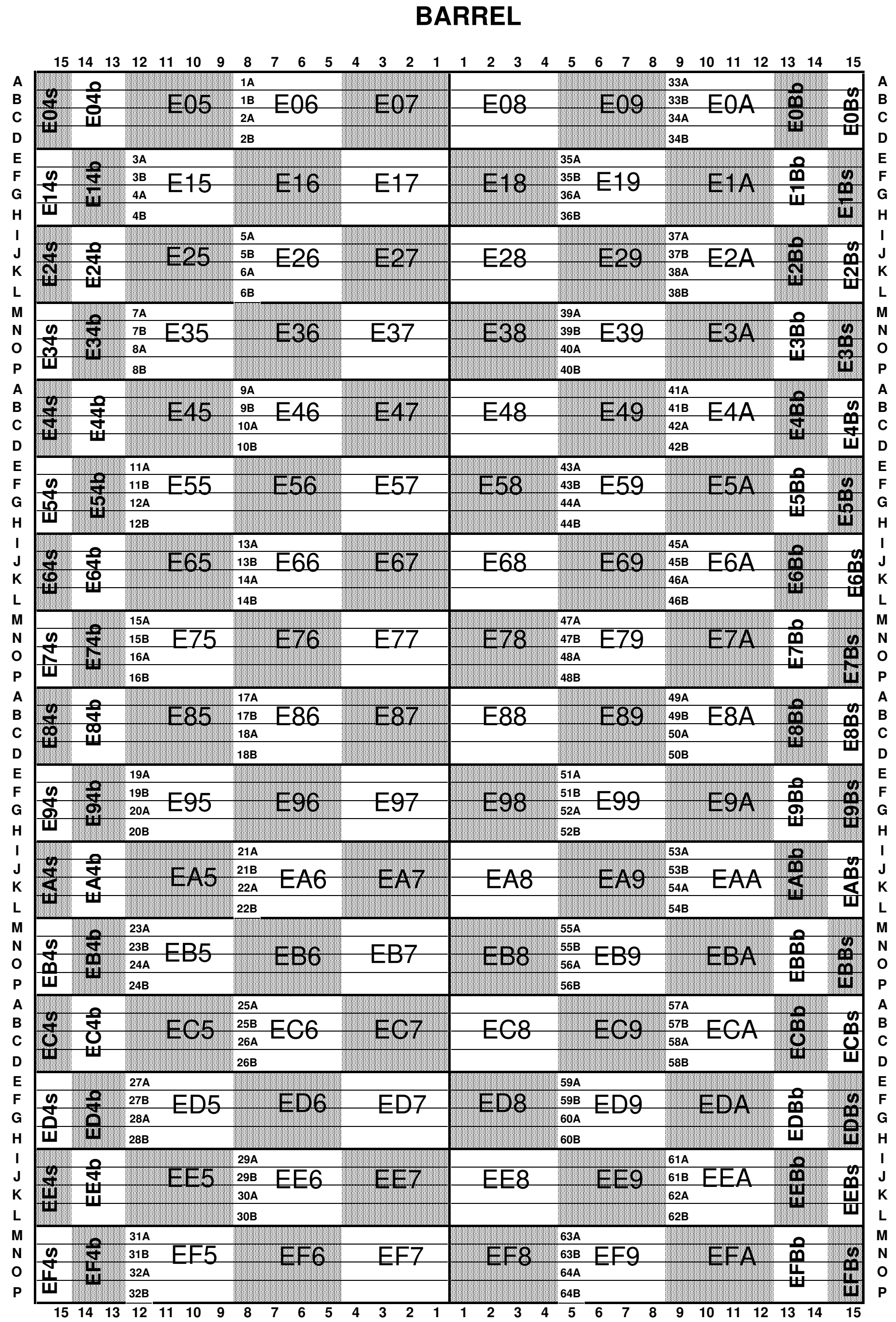

Figure 3: Receiver output connectors for the EM barrel calorimeter. Contiguous shaded regions represent the trigger sums which are contained in a connector, whose name is shown in large type within the same area. Light solid lines represent the cable boundaries, and the cable number is given within each boundary. Heavy solid lines represent the boundaries of the receiver modules. The granularity of the trigger sums is everywhere $\Delta\eta \times \Delta\phi$=0.1×0.1. The trigger sums are indicated by the numbers and letters at the periphery of the drawing.

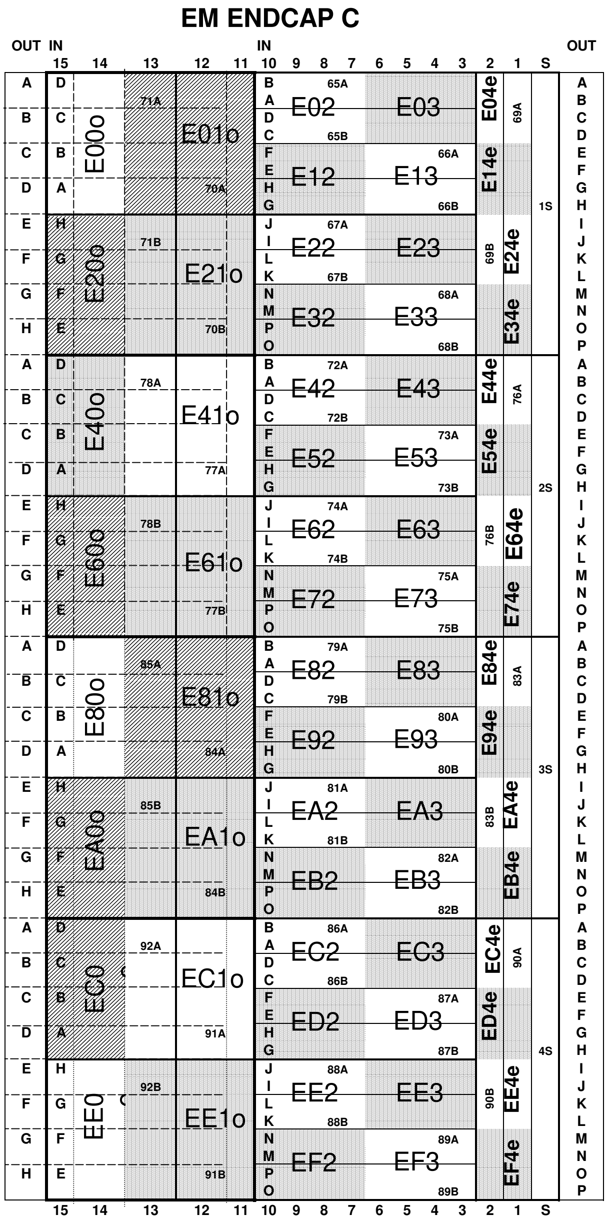

Figure 4: Receiver output connectors for the EM endcap calorimeter C. Contiguous shaded regions represent the trigger sums which are contained in a connector, whose name is shown in large type within the same area. Light solid lines represent the cable boundaries, and the cable number is given within each boundary. Heavy solid lines represent the boundaries of the receiver modules. The granularity of the trigger sums is normally $\Delta\eta \times \Delta\phi$=0.1×0.1; areas where the granularity is coarser is indicated by the dotted lines. The trigger sums are indicated by the numbers and letters at the periphery of the drawing. The ordering in ϕ is reversed by the receiver module, as indicated by the columns labelled "IN" and "OUT".

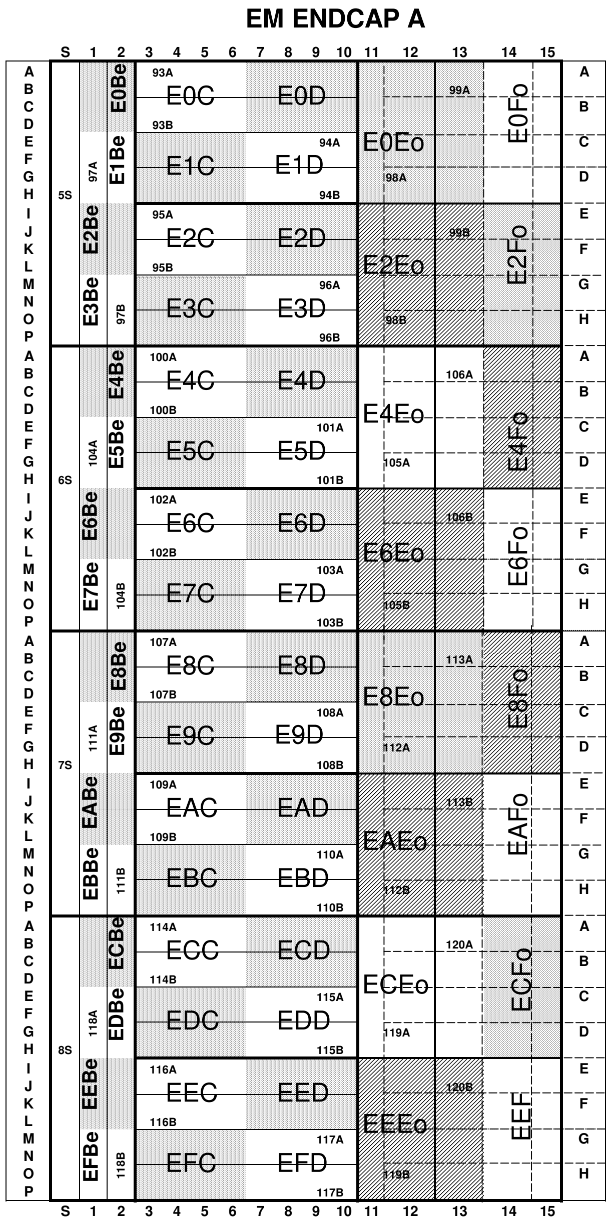

Figure 5: Receiver output connectors for the EM endcap calorimeter A. Contiguous shaded regions represent the trigger sums which are contained in a connector, whose name is shown within the same area. Light solid lines represent the cable boundaries, and the cable number is given within each boundary. Heavy solid lines represent the boundaries of the receiver modules. The granularity of the trigger sums is normally $\Delta\eta \times \Delta\phi$=0.1×0.1; areas where the granularity is coarser is indicated by the dotted lines. The trigger sums are indicated by the numbers and letters at the periphery of the drawing.

HEC/FCAL A

Crate 5

CAL:	HEC													FCAL1	FCAL2	FCAL3
Input	Slot Number															
Cable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	129A	129B	129F	130D	131B	131F	132D	133B	133F	134D	135B	135F	136D	139A	139E	140C
2	131A	129C	130A	130E	131C	132A	132E	133C	134A	134E	135C	136A	136E	139B	139F	140D
3	133A	129D	130B	130F	131D	132B	132F	133D	134B	134F	135D	136B	136F	139C	140A	140E
4	135A	129E	130C		131E	132C		133E	134C		135E	136C		139D	140B	140F
Conn	Q1234	Quadrant 1			Quadrant 2			Quadrant 3			Quadrant 4			Q1234	Q12	Q34
A	H0B	H0C	H0D	H0Eo	H4C	H4D	H4Eo	H8C	H8D	H8Eo	HCC	HCD	HCEo	E0Z	H0Zx	H0Zy
B	H4B	H1C	H1D	H0Fo	H5C	H5D	H4Fo	H9C	H9D	H8Fo	HDC	HDD	HCFo	E4Z	H4Zx	H4Zy
C	H8B	H2C	H2D	H2Eo	H6C	H6D	H6Eo	HAC	HAD	HAEo	HEC	HED	HEEo	E8Z	H8Zx	H8Zy
D	HCB	H3C	H3D	H2Fo	H7C	H7D	H6Fo	HBC	HBD	HAFo	HFC	HFD	HEFo	ECZ	HCZx	HCZy
E																

HEC/FCAL C

Crate 6

CAL:	HEC													FCAL1	FCAL2+FCAL3	
Input	Slot Number															
Cable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	121A	122D	121F	121B	124D	123F	123B	126D	125F	125B	128D	127F	127B	137A	137E	138C
2	123A	122E	122A	121C	124E	124A	123C	126E	126A	125C	128E	128A	127C	137B	137F	138D
3	125A	122F	122B	121D	124F	124B	123D	126F	126B	125D	128F	126B	127D	137C	138A	138E
4	127A		122C	121E		124C	123E		126C	125E		128C	127E	137D	138B	138F
Conn	Q1234	Quadrant 1			Quadrant 2			Quadrant 3			Quadrant 4			Q1234	Q12	Q34
A	H04	H00o	H02	H03	H40o	H42	H43	H80o	H82	H83	HC0o	HC2	HC3	E0G	H0Gx	H0Gy
B	H44	H01o	H12	H13	H41o	H52	H53	H81o	H92	H93	HC1o	HD2	HD3	E4G	H4Gx	H4Gy
C	H84	H20o	H22	H23	H60o	H62	H63	HA0o	HA2	HA3	HE0o	HE2	HE3	E8G	H8Gx	H8Gy
D	HC4	H21o	H32	H33	H61o	H72	H73	HA1o	HB2	HB3	HE1o	HF2	HF3	ECG	HCGx	HCGy
E																

Figure 6: Diagram of the receiver crates for the hadronic endcaps and forward calorimeters, showing the input cables and the output connectors for each receiver module. The upper diagram is for the endcap A (at $+z$) and the lower diagram is for endcap C (at $-z$). In diagram the upper box (Cables 1-4) shows the input cables from the TBB, whereas the lower box (Connectors A-D) shows the names of the five output connectors on the module. Connector E is not used in the endcap receiver modules.

Table 6: Numbering of Tower Drivers for the HEC, specifying the trigger sums formed and the quadrant in the calorimeter. The quadrants are numbered Q1, Q2, Q3, and Q4, in order of increasing ϕ The symbols A and C refer to the endcaps at $+z$ and $-z$, respectively.

TDB Number	Quadrant No.	Trigger sums
121	Q1C	2A-2P, 3A-3P, 4A-4P, 5A-5P, 6A-6P, 7A-7P
122	Q1C	8A-8P, 9A-9P, 10A-10P, 11A-11P, 12A-13H, 14A-15H
123,124	Q2C	2A-15H (distributed as 121-122)
125,126	Q3C	2A-15H (distributed as 121-122)
127,128	Q4C	2A-15H (distributed as 121-122)
129,130	Q1A	2A-15H (distributed as 121-122)
131,132	Q2A	2A-15H (distributed as 121-122)
133,134	Q3A	2A-15H (distributed as 121-122)
135,136	Q4A	2A-15H (distributed as 121-122)

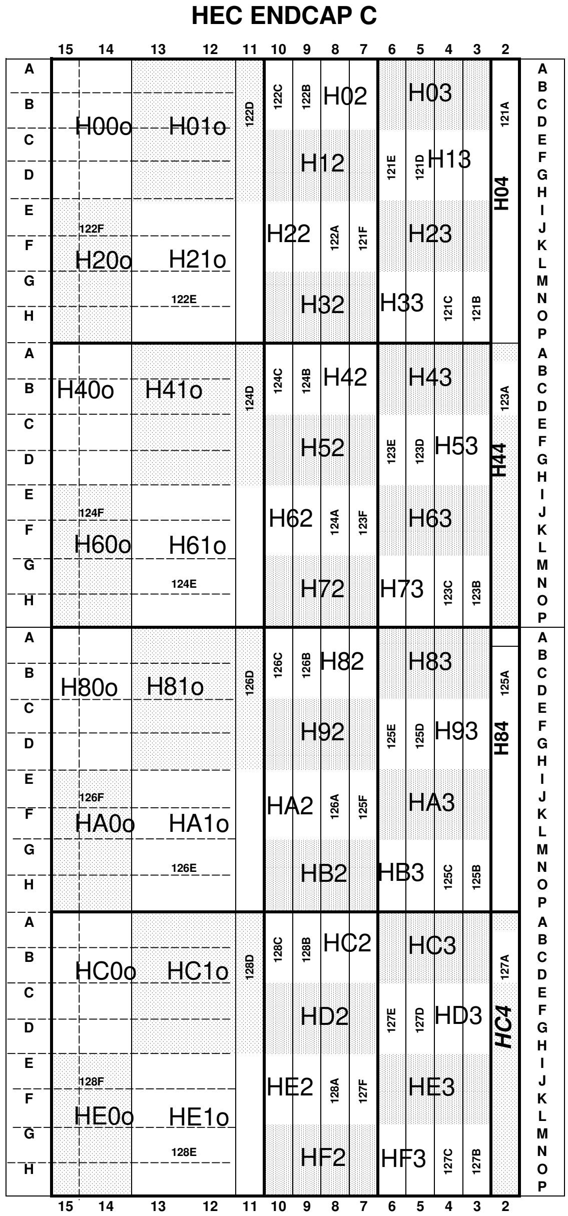

Figure 7: Receiver output connectors for the hadronic endcap calorimeter C. Contiguous shaded regions represent the trigger sums which are contained in a connector, whose name is shown within the same area. Light solid lines represent the cable boundaries, and the number of the cable is given within each boundary. Heavy solid lines represent the boundaries of the receiver modules. The granularity of the trigger sums is normally 0.1×0.1; areas where the granularity is coarser is indicated by the dotted lines.

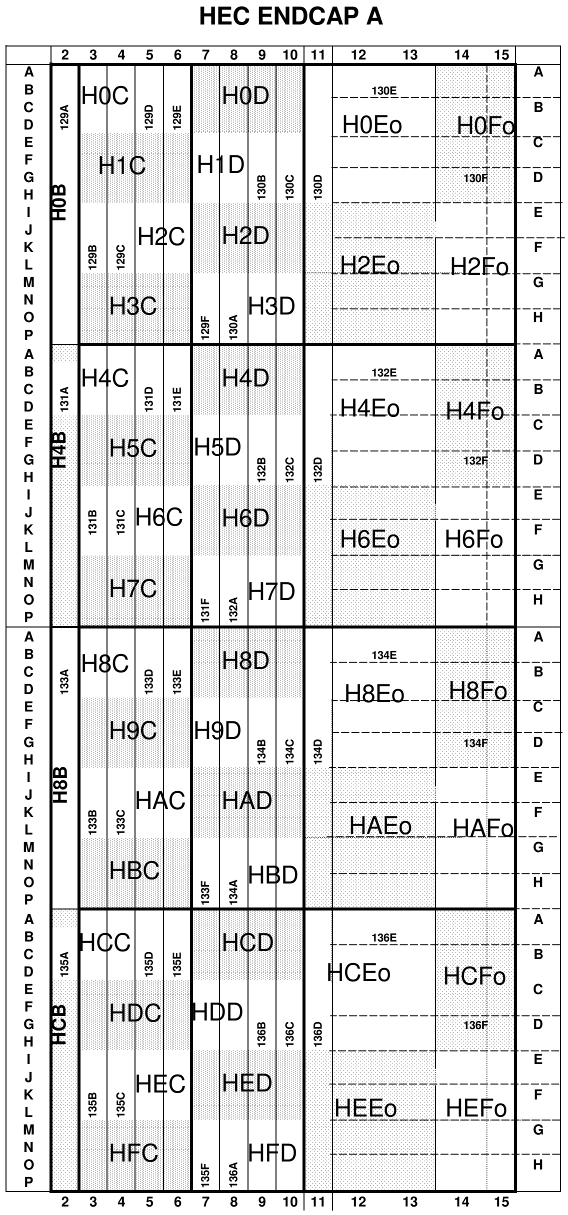

Figure 8: Receiver output connectors for the hadronic endcap calorimeter A. Contiguous shaded regions represent the trigger sums which are contained in a connector, whose name is shown within the same area. Light solid lines represent the cable boundaries, and the number of the cable is given within each boundary. Heavy solid lines represent the boundaries of the receiver modules. The granularity of the trigger sums is normally 0.1×0.1; areas where the granularity is coarser is indicated by the dotted lines.

Table 7: Values of the η index used in the FCAL receivers to identify the receiver connectors, along with the corresponding values of η.

N	$\eta_{\min}$	$\eta_{\max}$	$\Delta\eta$	$\Delta\phi$
Z	-4.9	-3.2	1.7	0.8
G	3.2	4.9	1.7	0.8

Table 8: Numbering of Tower Drivers for the FCAL, specifying the trigger sums formed in each calorimeter. The symbols A and C refer to the endcaps at $+z$ and $-z$, respectively. Since the trigger sums in FCAL2 and FCAL3 are summed pairwise in the receiver module, there are half as many output sums as input sums.

TDr Cables	Calorimeter	Endcap	Trigger sums (in)	Trigger sums (out)
137A-137D	FCAL1	C	1A-4P	E0G - ECG
137E-137F	FCAL2	C	1A-4H	H0Gx, H4Gx
138C-138D	FCAL3	C	1A-4H	H0Gy, H4Gy
138A-138B	FCAL2	C	1I-4P	H8Gx, HCGx
138E-138F	FCAL3	C	1I-4P	H8Gy, H8Gy
139A-139D	FCAL1	A	1A-4P	E0Z-ECZ
139E-139F	FCAL2	A	1A-4H	H0Zx, H4Zx
140C-140D	FCAL3	A	1A-4H	H0Zy, H4Zy
140A-140B	FCAL2	A	1I-4P	H8Zx, HCZx
140E-140F	FCAL3	A	1I-4P	H8Zy, HCZy

FCAL1, FCAL2, FCAL3

1A	2A	3A	4A
1B	2B	3B	4B
1C	2C	3C	4C
1D	2D	3D	4D
1E	2E	3E	4E
1F	2F	3F	4F
1G	2G	3G	4G
1H	2H	3H	4H
1I	2I	3I	4I
1J	2J	3J	4J
1K	2K	3K	4K
1L	2L	3L	4L
1M	2M	3M	4M
1N	2N	3N	4N
1O	2O	3O	4O
1P	2P	3P	4P

FCAL1

E0Z	1A	2A	3A	4A
	1B	2B	3B	4B
	1C	2C	3C	4C
	1D	2D	3D	4D
E4Z	1E	2E	3E	4E
	1F	2F	3F	4F
	1G	2G	3G	4G
	1H	2H	3H	4H
E8Z	1I	2I	3I	4I
	1J	2J	3J	4J
	1K	2K	3K	4K
	1L	2L	3L	4L
ECZ	1M	2M	3M	4M
	1N	2N	3N	4N
	1O	2O	3O	4O
	1P	2P	3P	4P

FCAL2

H0Zx	1A	2A
	1B	2B
	1C	2C
	1D	2D
H4Zx	1E	2E
	1F	2F
	1G	2G
	1H	2H
H8Zx	1I	2I
	1J	2J
	1K	2K
	1L	2L
HCZx	1M	2M
	1N	2N
	1O	2O
	1P	2P

FCAL3

H0Zy	1A	2A
	1B	2B
	1C	2C
	1D	2D
H4Zy	1E	2E
	1F	2F
	1G	2G
	1H	2H
H8Zy	1I	2I
	1J	2J
	1K	2K
	1L	2L
HCZy	1M	2M
	1N	2N
	1O	2O
	1P	2P

Figure 9: (Upper diagram) FCAL trigger sums as they arrive at the receiver input. The η coordinate is horizontal (running from 3.2 to 4.9 in four steps), and the ϕ coordinate is vertical, with each step = 0.4. The granularity of all three calorimeters at the receiver input is the same. (Lower diagrams) FCAL trigger sums as they exit the receiver system. Pairwise analog sums (in η) are formed in the receiver for FCAL2 and FCAL3, so the number of sums is halved. The receiver output connectors for Endcap A is shown at the left of each diagram. For Endcap C the fourth character "Z" is replaced with "G". These represent an extention of the hexadecimal digits "0" through "F", used as η indices for the other calorimeters.

References

[1] W. E. Cleland, The ATLAS Receiver/Monitor System

[2] W. E. Cleland, Cabling of the Barrel and EMEC Level 1 Trigger Sums, v. 1 Dec 1999

[3] W. E. Cleland, Cabling of the HEC and FCAL Level 1 Trigger Sums v. 1 May 2002