The MROD data format and the tower partitioning of the MDT chambers

Abstract

This note describes the data format for the MROD (MDT Read Out Driver) that reads out the Muon Precision MDT (Monitored Drift Tubes) Chambers in the ATLAS detector. The note also contains the tables that show how the MDT chambers are to be partitioned into read out towers and to which MROD each of the MDT chambers is connected.

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Document Change Record

Revision	Date	Reason for change
1.00	22-May-2003	First version
1.01	28-Aug-2003	As of DAQ Format Version number 2.2.0.0 at least one status word must be present in the trailer of the event.
1.02	01-May-2005	As of DAQ Format Version number 3.0 a Run Number must be added to the ROD header of the event. Furthermore the format of the source identifier word has been changed to contain a 12 bit Module ID (in stead of 8 bit). Some MROD specific error flags have been defined in the status word.
1.10	01-Sep-2005	The production version of the MROD has a maximum of 8 input channels which avoids the use of any "extension boards". Each MROD can now handle a full tower with a maximum of 8 MDT chambers. The tables in chapter 5 also state the slot numbers for the MROD modules. The LWC word has been changed to contain a 16 bit word count (in stead of 20 bit). In the LWC word, a 4 bit L1ID has been added for debugging purposes. The EOB word has also been changed to contain a 16 bit word count (in stead of 24 bit).
1.20	14-Dec-2005	Some chambers have their readout combined into one CSM and all of the produced MROD modules will have only 6 inputs. Therefore some extra towers have been defined that also solve possible bandwidth problems in MDT chambers with a high background rate. An optional trailer suppression mode has been built into the FPGA to further reduce the total number of data words per event.
1.21	13-Jan-2006	As of DAQ Format Version number 3.0.0.0 the source identifier word in the ROD header has been changed to contain an 8 bit Sub-detector ID and a 16 bit Module Identifier (not 12 bit).
1.22	26-Jul-2006	Slot 21 in the readout crate (VME-9U) has insufficient cooling for an MROD module. For that reason the RCAT (Remote Configuration And Test) module is placed in slot 21 and the MROD modules are moved to the left. Slot 13 must be used for the TIM (TTC Interface Module). The special chambers BOG0 in sectors 12 and 14 have been connected to the side A (in stead of side C) of the TTC system and thus their readout links are also moved to the other partition (0x61): BOG0A12 in tower 13 and BOG0A14 in tower 14.
1.23	07-Jul-2007	The End Cap chambers EIL2 and EIL3 share their readout link. In the tables in the towers 16 thru 23, EIL2 is now called EIL23 and EIL3 has been removed. In the tables the Channel inputs (CSM/chamber inputs) of the MROD are numbered, from left to right, from 0 thru 5.
1.24	01-Jun-2008	The End Cap chambers EEL1 in sectors A05 and C05 do not exist. They are removed from the tower tables (EEL2A/C05 has 12 mezzanines, other EEL2 chambers have 10).
1.25	01-Aug-2008	In the MROD Status Element (MSE) bits 08 thru 15 have been added to indicate that the assembly of event fragments on MROD input link(s) has been stopped.
1.26	27-Nov-2009	The TDC error word (TES) contains 14 bits for errors flag (see TDC manual).

1 MROD Data format

The description below gives a summary of the data format of the MROD modules in the ATLAS detector. The MDT chambers are read out via the ATLAS Muon TDC (AMT), the Chamber Service Module (CSM) and the Muon Read Out Driver (MROD). One should note that not all of the described header and trailer words will always be present in the data. However, the format is chosen such that every type of header or data word may uniquely be distinguished without sending a notification to the ROB handler. The MROD may optionally strip off TDC header and trailer words (after checking), to reduce the total data volume that is sent to the ROB.

The MROD accepts a maximum of 8 CSM Links, which will be implemented as Gigabit Optical Links (GOL). Each CSM Link connects to a CSM (Chamber Service Module) that is mounted on the Front End Faraday cage of one of the Muon Precision Chambers. The CSM multiplexes a maximum of 18 TDC Links into a single output link (Read Out Link). The multiplexer operates as a simple rotating multiplexer that is continuously checking each input TDC link for data present. When a TDC link has delivered a word, it is transmitted to the output CSM Link. When no data was delivered inside the time frame, a Filler ("zero") word is transmitted. A special Separator word is sent at the beginning of the rotating scan sequence to insure the synchronization at the receiving end of the CSM link. The bandwidth of the CSM Link is such that it will sustain a throughput of a maximum of 18 TDC Links operating at full bandwidth (40 Mbit/s, data/clock signals). The MROD receives data, strips off the Separator and Filler words and demultiplexes the TDC data such that data belonging to each TDC is stored in a separate buffer. The logic in the MROD now assembles an event based on the notion that all TDC event fragments are terminated by an "End of TDC" word. Fragments that have the same event number (L1ID) will be packed together into one event going out of the MROD.

1.1 Data transmission and error handling

The electrical links between the TDCs and the CSM and the optical link between the CSM and the MROD are unidirectional. This implies than in case of transmission errors, the receiving end can flag errors but never ask for a re-transmit. Fortunately there is some redundancy in the format of the datawords as they are transmitted by the TDC and the CSM and we have chosen to use two bits in the 32 bit word to serve as parity or error bit during the transmission of data from the CSM to the MROD. In all the data words coming from the TDC, bits 27 thru 24 carry a 4 bit TDC number. This number is assigned to each TDC via a parameter in the JTAG setup and therefore it is not reliable since all TDCs may be set with equal numbers. To determine the TDC number, the CSM has to rely on the connector or port number where a certain TDC link enters the CSM.

So, in stead of the 4 bits, we now use two bits (27 and 26) for error and parity, and the remaining two bits (25 and 24) are still copied from the TDC. The TDC sends data serially to the CSM and adds a parity bit to the 32 bit word. The CSM checks the incoming parity and inserts a error flag ("1") into bit 27 when the received parity is wrong. When the CSM is sending data to the MROD, it inserts a parity bit into bit 26 to indicate that the data word has "odd" parity. The parity bit is set on all data words leaving the CSM, including the separator word which is thus defined as 0xD000 0000 and the filler word

that is now defined as 0x0400 0000.

On the receiving end, the MROD checks the error and parity bit and in order to clearly mark and preserve the word with an error it assigns the 4 most significant bits (31-28) to either one of two special identifiers. These error words (labelled as "TTER" or "CTER") are stored in the buffers and they are always sent out with the current event data. This will ensure that any word that had transmission errors is uniquely identified in the data stream. One has to realise that also TDC header/trailer IDs may be overwritten, but the logic of the MROD will take appropriate action and try to build events in a consistent manner.

1.2 CSM Separator word and Filler word †

The CSM will be working in a "transparent" multiplexing mode. This means that the data from all TDCs will be time-multiplexed to the optical output link of the CSM. The bandwidth of the optical link is such that it will sustain a throughput of a maximum of 18 TDC Links operating at full 40 MHz bandwidth. The CSM will continuously send data in a cycle of 21 words: one Separator word, followed by 18 TDC words and two IDLE words. The IDLE words (4 "idle" characters in the GOL chip) are required for re-synchronisation of the optical Link and they are invisible to the MROD user. When no data is available from one TDC Link, a Filler word (all zeroes) will be sent to the MROD, where it will simply be dropped by the receiver. Note however that the CSM will set bit26 to make the total parity for this word odd and thus the Filler word is defined as 0x0400 0000.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

P: 1 bit parity; "1" because bits 25...0 will be zero

The Separator word is required to reset the multiplexer such that the next word will be assigned to TDC #0, #1 and so on until the last (#17). This will insure "TDC word" synchronization. The Separator word is *not* put into the data stream. It is checked and dropped, but may contain error info that can be sent to DCS. The formatting is:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	P	0	0	CSMI				0	0	Reserved for TDC Link Info																	

P: 1 bit parity; "0" when bits 25...0 are zero

CSMI: 4 bits reserved for CSM information

TDC Info: 18 bits, flags, one for each link between TDC and CSM

In the current version of the CSM, no special bits are defined and thus the Separator word will be formatted as 0xD000 0000. Any flags that are transmitted are treated as "static" information; these bits may be monitored by the MROD but are never inserted into the datastream!

† *Note: both words will never be passed to the output of the MROD !*

2 Types of data words from MROD and TDC

The upper four (most significant) bits of a 32 bit word are used as a type identifier. In this way one can easily determine that a word originates from the TDC or the MROD. The following paragraphs describe the header and data types as the may appear in the data coming out of the MROD.

2.1 Header types

The header type is denoted by a one in bit 31 and the eight possible header types, defined by bits 30-28, are shared by the MROD, CSM and the TDC:

31	30	29	28			
1	0	0	0	Begin Of Block		(for MROD)
1	0	0	1	Begin Of Group		(reserved for TDC/MROD) †
1	0	1	0	Begin Of TDC	(for TDC #00-15)	(used by TDC/MROD)
1	0	1	1	Begin Of TDC	(for TDC #16-17)	(formerly used by TDC as EOG) ††
1	1	0	0	End of TDC		(used by TDC/MROD)
1	1	0	1	CSM Transmission Error		(for MROD)
1	1	1	0	Status flags		(for MROD)
1	1	1	1	End Of Block		(for MROD)

2.2 Data types

The upper four bits of a 32 bit word are used as a type identifier. The data type is denoted by a zero in bit 31 and the eight possible data types, defined by bits 30-28, are shared by the MROD and the TDC:

31	30	29	28		
0	0	0	0	General MROD Reserved words	
0	0	0	1	MROD Leader information words	
0	0	1	0	TDC Masked channels flags	
0	0	1	1	TDC Single measurement	
0	1	0	0	TDC Combined measurement, trailing edge	
0	1	0	1	TDC Transmission Error	(No TDC Charge measurement †)
0	1	1	0	TDC Error flags	
0	1	1	1	TDC Debug and Reserved information words	

† *Note: these type identifiers are not implemented in the AMT-2/-3 chip. They are now reserved for use by the MROD !*

†† *Note: this type is now also used as "Begin of TDC" since the End of TDC Group identifier is no longer implemented in the AMT-2/-3 chip !*

2.3 MROD header types

There are 3 header types defined for the MROD and there is one that is used only during the transfer from CSM to MROD.

2.3.1 BOB (MROD Begin Of Block) word

The BOB word (defined as 0x80nn nnnn) marks the first data word of an event block coming out of the MROD. It is formatted as:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	0	0	0	0	L1ID																							

The lower 24 bits of this header word are used for a copy of the L1ID (L1 trigger identification).

2.3.2 LWC (MROD Link Word Count) word

The LWC word (defined as 0x81nn nnnn) marks the first word of an event fragment coming from one CSM. It is formatted as:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	0	0	0	1	FTYP = 0				ECNT				CLWC															

FTYP:	4 bits Flag Type: defined to be 0
ECNT:	4 bits L1ID (least significant bits), for debugging purposes.
CLWC:	16 bits word count for the number of words from this CSM link, i.e. all words including the LWC itself, upto and including the TWC word.

The LWC word will always be followed by the BOL word which contains the CSM Link number.

2.3.3 TLP (MROD TDC Link Present) flag word

The MROD TLP word (defined as 0x89nn nnnn) gives status information about the TDC links being processed on this CSM Link. It marks the first word for this CSM event fragment and it is always present, even if this CSM had no data at all or if that data was zero-suppressed.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	1	0	0	1	FTYP = 0				0	0	Flags																	

FTYP:	4 bits Flag Type: defined to be 0
Flags:	18 bits of flags, one bit for each TDC link that is present in this event: a TDC trailer (with or without TDC data) with the correct event number has been received via the CSM Link in the MROD.

2.3.4 TWC (MROD Trailer Word Count) word

The TWC word (defined as 0x8Ann nnnn) marks the last word of an event fragment coming from one CSM Link. It is formatted as:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	1	0	1	0	ECNT												CTWC											

ECNT:	12 bits event counter. It should match with the lower 12 bits of 24 bit L1ID stored in the MROD.
CTWC:	12 bits word count for the number of words from this CSM link.

This word counter is implemented in the MROD-In part of the MROD and for each of the CSM input Links, it counts all words starting from (and including) the TLP word and all TDC words up to and including the TWC word itself.

2.3.5 EOB (MROD End Of Block) word

The EOB word (defined as 0xF0nn nnnn) marks the last data word of an event block coming out of the MROD. It is formatted as:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	1	EOBF				0	0	0	0	0	0	0	0	MROD Block WCNT (or MROD info)															

EOBF:	4 bits to specify the type of information from the MROD as follows:
0000:	WCNT: 16 bits word count for this MROD event block, counting from and including the BOB word, onto and including the EOB word
others:	info: 24 bits of info to be specified when the need arises ...

2.3.6 MROD Status word

The MROD Status word (defined as 0xE0nn nnnn) is inserted into the event block (it may be present after the BOB word and/or it may be present before the EOB word) when the MROD has warnings or errors to report to a higher level of the readout system. It is formatted as:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	0	STYP				FLAGS																				CSM Link			

STYP:	4 bits to specify the type of information from the MROD as follows:
0000:	FLAGS: 20 bits MROD status flags
	CSM Link: 4 bits CSM Link number
others:	24 bits to be specified when the need arises ...

2.4 MROD Data type

The MROD will add data words to the output stream that give information about e.g. the CSM Link number from which the next string of words is coming. Some error flags or optional debug words may be added to forward information about the internal status to the next level in the readout system.

The MROD information words (defined as 0x1tnn nnnn, t=0...f) are inserted when needed to give information about the data that follows from a CSM Link.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	DTYP				data / flags																							

DTYP:	4 bits Data Type specifier
data:	24 bits of data whose meaning depends on DTYP

The DTYP specifier allows these words to be defined in the range of 0x10nn nnnn up to and including 0x1Fnn nnnn. So far only two types (0x18nn nnnn and 0x19nn nnnn) have been specified. That leaves a range of MROD reserved words that may be defined if they are needed. These words have a header type that is defined to be in the range of 0x10nn nnnn ... 0x17nn nnnn and 0x1Ann nnnn ... 0x1Fnn nnnn. The two types of MROD information words ared defined in the following sections.

2.4.1 BOL (MROD Begin Of Link) word

The MROD BOL word (defined as 0x18nn nnnn) signals which CSM Link is now giving its data.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	0	0	0	E	0	0	T	Z	MROD												CSM Link			

CSM Link:	4 bits CSM Link number
MROD:	12 bits MROD module serial number
Z:	1 status bit, 1 when the TDC data will be zero-suppressed
T:	1 status bit, 1 when the TDC trailer words (EOT) may be suppressed
E:	1 status bit, 1 when error flags (ERS words) are coming next

The MROD number is the unique serial number of this MROD module. Normally there will be no ERS words included in the data. The E bit serves as warning that the data decoder should expect ERS words after this BOL word and preceeding the TLP word.

2.4.2 ERS (MROD Error/Status) flag word

The MROD ERS word (defined as 0x19nn nnnn) gives status or error information about the CSM Link or the data that is being processed.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	1	FTYP				Flags																			

FTYP: 4 bits Flag Type, the number is in the range 0x1 ... 0xF.

Flags: 20 bits of status information, where FTYP determines its meaning. Details will be filled in during the progress of the MROD design.

2.5 TDC Header types

For the full description of the TDC header and data type of words, one should read the description in the AMT chip specification by Y. Arai. A compressed list is given here to complete the overview. Note however that the original 2 bit contents of bits 27-26 is overwritten with "00" and the remainder (bits 25-24) is still a copy of the TDC number as programmed via the JTAG setup register bits 42:39. This is done in all words (header or data) that arrive from the TDCs except for the Begin of TDC header word and in case there was a transmission error between TDC and CSM or CSM and MROD (see below). There are 4 header types defined for the TDC:

2.5.1 BOT (Begin Of TDC) header word

The TDC BOT word (defined as 0xAtnn nnnn or 0xBtnn nnnn) signals the begin of TDC data words for this event. By using one bit of the identifier we are able to encode a 5 bit TDC number into the output stream. As mentioned earlier, the TDC number is taken from the multiplexer position (in stead of from bits 27-24 in the header or data word). So, the identifier appears to be 0xA for BOT words from TDC 0-15 and 0xB for BOT words from TDC 16-17 since one bit of the original identifier is overwritten with the highest bit of the TDC number!

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	TDC					ECNT												BCID											

TDC: The 5 bits TDC number that is taken from the CSM muliplexer timeslot and uniquely determines the real TDC number (0-17).

Note that this number **must** be used for all TDC data words that follow until the next EOT or BOT word !

ECNT: 12 bits event counter, counted by the TDC. It should match with the lower 12 bits of 24 bit L1ID stored in the MROD.

BCID: 12 bits bunch crossing identifier of the trigger (L1A) signal, counted by the TDC. It should match with the BCID stored in the MROD.

2.5.2 EOT (End Of TDC) trailer word

The TDC EOT word (defined as 0xCtnn nnnn, t=0,1,2,3) signals the end of TDC data words for this event. This word may be removed from the data when the "trailer suppression" mode is turned on. The EOT word may be suppressed when its ECNT and TDC WCNT are found to be correct.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	0	JT		ECNT												TDC WCNT											

JT: remaining 2 bits TDC number from the TDC register that is programmable via the JTAG setup register bits 42:39.

ECNT: 12 bits event counter, counted by the TDC. It should match with the lower 12 bits of 24 bit L1ID stored in the MROD.

WCNT: 12 bits number of words in this TDC data block (including itself), counted by the TDC.

2.6 TDC Data types

There are 6 different data types defined for the TDC.

2.6.1 TMC (TDC Masked Channels) flag word

The TDC Masked channels flags (defined as 0x2tnn nnnn, t=0,1,2,3) signals that there are hits masked within the mask window in this event.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	0	JT		Masked channels flags																							

JT: remaining 2 bits TDC number from the TDC register that is programmable via the JTAG setup register bits 42:39.

Mask flags: 24 bits, each bit specifies one of the 24 channels that had a hit within the mask window.

2.6.2 TSM (TDC Single Measurement) word

The TDC Single measurement (defined as 0x3tnn nnnn, t=0,1,2,3) gives the leading edge information about a TDC hit in this event.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	0	0	JT		Channel					T	E	Coarse												Fine				

JT:	remaining 2 bits TDC number from the TDC register that is programmable via the JTAG setup register bits 42:39.
Channel:	5 bits TDC channel number
T:	1 bit specifies the edge of the hit signal: 1 = Leading, 0 = Trailing
E:	1 bit hit error, specifies that an error was detected in the time measurement
Coarse:	12 bits coarse counter time stamp, in 25 ns units relative to the BCID of the trigger signal
Fine:	5 bits fine counter time stamp, in 0.78125 ns units relative to the BCID of the trigger signal

2.6.3 TCM (TDC Combined Measurement) word (leading edge & pulse width)

The TDC Combined measurement (defined as 0x4tnn nnnn, t=0,1,2,3) gives the leading edge and pulse width information, as encoded by the Wilkinson ADC in the ASD chip, about a TDC hit in this event.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	0	JT		Channel					Width								Coarse						Fine				

JT:	remaining 2 bits TDC number from the TDC register that is programmable via the JTAG setup register bits 42:39.
Channel:	5 bits TDC channel number
Width:	8 bits width measurement of the hit pulse, measured in the programmed time resolution (see JTAG setup register bits 141:139)
Coarse:	6 bits leading edge coarse counter time stamp, in 25 ns units relative to the BCID of the trigger signal
Fine:	5 bits fine counter time stamp, in 0.78125 ns units relative to the BCID of the trigger signal

2.6.4 TES (TDC Error/Status) flag word

The TDC Error flag word (defined as 0x6tnn nnnn, t=0,1,2,3) gives the error information about this event.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	0	0	0	JT		Unused										EFLG													

JT:	remaining 2 bits TDC number from the TDC register that is programmable via the JTAG setup register bits 42:39.
Unused:	10 bits that are unused
EFLG:	14 bits for error flags

Note: the AMT-2/-3 specification describes the meaning of each flag bit. The error flags are generated by the individual TDCs.

2.6.5 TDD (TDC Debug Data) word

The TDC Debug data word (defined as 0x7tnn nnnn, t=0,1,2,3) gives the debugging information about this event.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	1	0	0	JT		Subtype				Debug information																			

JT:	remaining 2 bits TDC number from the TDC register that is programmable via the JTAG setup register bits 42:39.
Subtype:	4 bits that specify the type of information
Info:	20 bits that give debugging information for this TDC

Note: the AMT-2/-3 specification describes the debugging subtypes and their data.

2.6.6 TTER (TDC Transmission Error) and CTER (CSM Transmission Error) words

Each word with this identifier is a word that was distorted during its transmission from the TDC to the CSM or the transmission from the CSM to the MROD. The CSM checks the parity coming from the TDC and flags a violation. The MROD checks the parity coming from the CSM. When one or both transfers have errors, the identifier (bits 31-28) are overwritten with:

0x5 in the case of a parity error in the TDC to CSM transmission: **TTER** ;
0xD in the case of a parity error in the CSM to MROD transmission: **CTER** .

When both errors have occurred on the same word, the CSM-MROD error flag will be given priority and the identifier will be set to 0xD. The original header bits (31-28) will be copied into bits 27-24, thus providing knowledge about the rest of the bits inside that word. The TTER of the CTER word will remain in the datastream and may provide debugging information via the readout chain.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	OHID				Debug information (copy of TDC word)																							

or

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	OHID				Debug information (copy of TDC word)																							

OHID:	4 bits copy of the Original Header ID bits (31-28) of this word after transfer from CSM to MROD
Debug:	24 bits debug information which are copied from the incoming TDC word. The original ID can be used to determine its meaning.

2.7 TDC Unused / Reserved types

The AMT-1 allowed grouping of the TDCs in chains such that the readout could be combined and sent over one TDC Link to the CSM. Another option of the AMT-1 was the ability to encode a charge measurement in the signal coming from the ASD. Both options have been removed from the implementation of the AMT-2/-3 chip. Therefor the following header and data type are no longer in use by the TDC. All three are now reserved for internal use by the MROD and they are mentioned here for completeness sake.

2.7.1 BOG (Begin Of TDC Group) header word †

The TDC BOG word (defined as 0x9nnn nnnn) signalled the begin of a group of TDCs giving data words for this event. This ID is now unused and remains reserved for use by the MROD!

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	1	GTYP				ECNT												BCID											

2.7.2 EOG (End Of TDC Group) trailer word †

The TDC EOG word (defined as 0xBnnn nnnn) signalled the end of a group of TDCs giving data words for this event. This ID is now used to encode the BOT word for TDCs 16 and 17.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	1	GTYP				ECNT												TDC WCNT											

2.7.3 TCCM (TDC Combined Charge Measurement) data word †

The TDC Combined Measurement data word (defined as 0x5nnn nnnn) gave the leading edge and charge information about a TDC hit in this event. This ID is now used for indicating the TTER (TDC Transmission Error) word.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	GTYP				Channel					Charge								Coarse						Fine				

† *Note: these modes of operation are not implemented in the AMT-2/-3 chip.*

2.8 Sequence of MROD and TDC words and "zero"/"trailer" suppression

In "normal running" conditions one may expect the presence of the following words in each event for each MROD: the BOB word, followed by a maximum of 8 "CSM blocks", each consisting of the LWC, BOL and TLP words, a number of TDC words and a terminating TWC word. The last "CSM block" is terminated by the EOB word. Also, in "normal running" conditions one may expect the presence of the following words in each event for each TDC: BOT, TDC-Mask, TDC-measurement(s), EOT. If no hits were present inside the TDC window, no data words will be present. If no hits were masked inside the mask window, the TDC-Mask may be absent. The TDC-Debug words may be inserted before the EOT.

The MROD will optionally perform "zero-suppression". To allow consistency checks at the input of all six CSM Links, each TDC will always send both header and trailer words (BOT and EOT), even if there is no real measurement data present. The MROD can check for each TDC whether it only received a BOT and EOT word with the correct event ID encoded in both words. If that is the case, both words may be skipped ("zero-suppressed") when sending data to the MROD output link. In the case where there is real data (track hits or error information) coming from a TDC, the BOT cannot be suppressed because it is the only word with the full 5 bit TDC number.

When "trailer-suppression" is turned on in the MROD, the TDC trailer (EOT) words may also be skipped even if that TDC contained real data. The EOT word will only be removed if it contained a correct event number and a correct word count; if one of them is incorrect, the EOT will still be placed in the data stream. The BOL word will show whether either one or both suppression modes have been turned on. Both suppression modes will be overridden on the very first event and on every n-th event (default n=1024) in each DAQ run. When all TDCs have no data, only the LWC, BOL, TLP and TWC words of a CSM Link will be present in the output. These signal that all TDC links on this CSM are working correctly.

3 General MROD Reserved words

3.1 ROD Headers and Trailers

The data transfer from a Read Out Driver to a Read Out Buffer should have both a Header and a Trailer for fast and easy recognition of the event fragment characteristics. Here are the special words that are required as the header and trailer of a MROD event fragment, as proposed in the ATLAS note ATL-DAQ-98-129 (Ref. 1). The following words are to be sent as the very first words in the Read Out Driver event fragment:

1. Start of ROD Header marker. This marker indicates the start of a ROD fragment header, which is defined to be 0xEE12 34EE for all RODs. The asymmetry in the value of the header marker allows for the byte ordering in this fragment (big or little endian) to be determined.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	0	1	1	1	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	1	1	1	0	1	1	1	0

2. ROD Header size. This word indicates the size of the header including the header marker. For version 3.0.0.0 the header containes 9 words.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	ROD Header size (= 9)																							

3. Format version number. This word gives the integer value for the format version of this ROD fragment. The upper two byte state the Major and the lower two byte state the Minor version number, e.g. the current implementation is named 3.0.0.0: (0x0300 0000), i.e. Major version 3.0 and Minor version 0.0.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Format Version Major # (= 0x0300)																Format Version Minor # (= 0x0000)															

4. Source identifier. This word identifies the origin of the ROD fragment. The word consists of a module type, a sub-detector ID and a module ID. The sub-detector IDs (or TTC partition number) for the MDT detector are in the range 0x61 thru 0x64. The module type of all RODs is defined to be 0x0. In total there are 192 MRODs (12 in each of the 16 sectors) and they are equally partitioned into 4 TTC partitions. Some extra towers have been defined and thus the module ID is in the range 0 thru 51 (0 thru 0x33).

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved (=0x00)								Sub-det. ID (0x61...64)								Module ID (0x0...0x0033)															

5. Run Number. This word contains the Run number; the highest 8 bits are defined by the type of the Run (physics, calibration, etc.). The low order 24 bits represent the ordered sequence of Runs within a type. It will be loaded into the MROD by the crate controller. To date the defined Run types are “Physics” (0x00), “Calibration” (0x01), “Cosmics” (0x02) and “Test” (0x0F).

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Run type								Run sequence number																							

6. Level 1 ID. This word contains the event identifier (24 bit) generated by the Level-1 trigger system and the 8-bit ECRID (event-counter-reset identifier) implemented in the MROD.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ECRID from MROD								Level1 Identifier from TTC																							

7. Bunch Crossing ID. This word contains the bunch crossing identifier (12 bit) generated by the Level-1 trigger system.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bunch Crossing Identifier											

8. Level 1 Trigger type. This word contains the event trigger type (8 bit) transmitted by the Level-1 trigger system.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Trigger Type Identifier							

9. Detector event type. This word identifies an event which may have been generated by a sub-detector, independent of other sub-detectors and the ATLAS trigger systems. For a normal, global trigger the event type is 0.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Detector Event Type																															

The order of the words in the header is fixed for all RODs in the ATLAS detector. The MROD event header can thus be depicted as:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ROD Start of Header marker (=0xEE1234EE)																															
ROD Header size (=0x00000009)																															
Format Version Number (Major.Minor)																															
Reserved (=0x00)								Sub-det. ID (0x61...64)								Source ID (0x0...0x0033)															
Run type								Run sequence number																							
ECRID from MROD								Level1 Identifier from TTC																							
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bunch Crossing Identifier											
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Trigger Type Identifier							
Detector Event Type (= 0)																															

After the header one may expect the data elements as described in the previous chapters. The block of data coming from the TDC, CSM and MROD begins with the BOB word and ends with the EOB word. These data elements are then followed by (at least) one status element (as of DAQ format version 2.2.0.0) and three more words giving the word counts and the position of the status block. So, the MROD data fragment is terminated by:

1) One MROD status element (MSE). When zero it shows that no known errors are associated with this event fragment. It is divided in a DAQ generic part (bit 15...0) and a MROD specific part (bit 31...16).

2) Number of status elements (NSE). This is the total number of words that were inserted in the status block. As of DAQ Format Version number 2.2.0.0 at least one status word must be present in the event. Only one status word is implemented.

3) Number of data elements (NDE). This is the total number of words that are contained in the data block, excluding the 9 words in the MROD header. The NDE word is equal to the word count in the EOB word.

4) Status block position (SBP). This word defines the relative order of the data and status elements. A value of zero indicates that the status block precedes the data block and a value of one indicates that the status block follows the data block.

The currently defined bit values in the MROD Status Element are:

bit 0: the check of the BCID from the TTC versus the BCNT of the TDCs has failed.

bit 1: the check of the L1ID from the TTC versus the ECNT of the TDCs has failed.

bit 3: the MROD found parity errors on the input channel (CSM), see bit 16,17.

bit 8: the MROD stopped the assembly of event fragments from CSM input link #0 because the dataflow from it has stopped or was corrupt

bit 9: the MROD stopped the assembly of event fragments from CSM input link #1 because the dataflow from it has stopped or was corrupt

bit 10: the MROD stopped the assembly of event fragments from CSM input link #2 because the dataflow from it has stopped or was corrupt

bit 11: the MROD stopped the assembly of event fragments from CSM input link #3 because the dataflow from it has stopped or was corrupt

bit 12: the MROD stopped the assembly of event fragments from CSM input link #4 because the dataflow from it has stopped or was corrupt

bit 13: the MROD stopped the assembly of event fragments from CSM input link #5 because the dataflow from it has stopped or was corrupt

bit 14: the MROD stopped the assembly of event fragments from CSM input link #6 because the dataflow from it has stopped or was corrupt

bit 15: the MROD stopped the assembly of event fragments from CSM input link #7 because the dataflow from it has stopped or was corrupt

(Note that links #6 and #7 do not exist on the MROD modules installed in Atlas.)

bit 16: the CSM found parity errors in the data transfer from the TDC to the CSM

bit 17: the MROD found parity errors in the data transfer from the CSM to the MROD

bit 20: the MROD is running while ignoring the TTC information (testmode)

The MROD event data block and the trailer can thus be depicted as:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	0	0	0	0	MROD Begin of Block																							
								MROD data																							
								...																							
								MROD data																							
1	1	1	1	0	0	0	0	MROD End of Block																							

MROD Status word
Number of Status Elements (= 0x00000001)
Number of Data Elements (WCNT from EOB word)
Status Block Position (= 0x00000001: status at end)

Note that the ROB may optionally add a checksum word after the SBP word. The checksum word is not part of the data that the MROD produces.

3.2 Framing on the Read Out Link

When the event fragment is transmitted from the Read Out Driver to the Read Out Buffer via the Read Out Link (ROL), the fragment must be framed by technology specific information. This framing is not part of the event format and it will be removed by the receiving part of the link. For the S-LINK implementation of the ROL, each ROD fragment must be preceded by a single S-LINK control word (Begin of Frame: 0xB0F0 rrrr) and terminated by a S-LINK control word (End of Frame: 0xE0F0 rrrr). The lower 16 bits are used by the S-LINK to report transmission errors (see Ref. 1).

4 Example of an event

The table below shows an example of an event with different types of data in the blocks for each CSM Link section to demonstrate the "zero-suppressing" features of the MROD. Note that the framing words (BOF and EOF) are not shown, since these link control words will not appear in the data buffers.

Example of an event in the MROD

In the table below words marked as follows:

H1-H9, NSE, NDE, SBP :	DAQ specific header/trailer words
`MSE1-MSEn` :	MROD specific Status words
BOB and **EOB** :	MROD specific header/trailer words
LWC and *BOL, TLP, TWC* :	CSM-Link specific header/trailer words
BOT, TD, **EOT** :	TDC header, data and trailer words
words labelled as **BOT**, **EOT** :	may be "zero-suppressed" (no TDC data).
words labelled as *EOT* :	may be "trailer-suppressed" (superfluous EOT).

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
H1	1	1	1	0	1	1	1	0	ROD Start of Header marker (= 0xEE1234EE)																							
H2	0	0	0	0	0	0	0	0	ROD Header size (= 0x00000009)																							
H3	Format Version Number (Major = 0x0300)																Format Version Number (Minor =0x0000)															
H4	0	0	0	0	0	0	0	0	Sub-detector ID								MROD Module ID															
H5	Run Type								Run Sequence number																							
H6	ECR Identifier								Level1 Identifier																							
H7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bunch Crossing Identifier											
H8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Trigger Type ID							
H9	0	0	0	0	0	0	0	0	Detector Event Type (= 0)																							
BOB	1	0	0	0	0	0	0	0	L1ID																							
LWC	1	0	0	0	0	0	0	1	0	0	0	0	ECNT				Link Word Count															
BOL	0	0	0	1	1	0	0	0	BOL flags								MROD number												CSM Link 0			
TLP	1	0	0	0	1	0	0	1	0	0	0	0	TDC Link Present flags																			
BOT	1	0	1	TDC 0					ECNT												BCID											
TD	0	0	1	0	0	0	JT	Masked channels flags																								
TD	0	0	1	1	0	0	JT	Channel 0				T	E	Coarse															Fine			
TD	...				0	0	JT	... TDC data ... (n words)																								
TD	0	0	1	1	0	0	JT	Channel 1				T	E	Coarse															Fine			
EOT	1	1	0	0	0	0	JT	ECNT													TDC WCNT (=5+n)											
...	...				...			... more TDC data (BOT+hits+EOT) ...																										
BOT	1	0	1	TDC 1					ECNT												BCID											
EOT	1	1	0	0	0	0	JT	ECNT													TDC WCNT (=2)											
BOT	1	0	1	TDC 2					ECNT												BCID											
TD	0	0	1	0	0	0	JT	Masked channels flags																								
TD	0	0	1	1	0	0	JT	Channel 0				T	E	Coarse															Fine			
TD	0	0	1	1	0	0	JT	Channel 1				T	E	Coarse															Fine			
EOT	1	1	0	0	0	0	JT	ECNT													TDC WCNT (=5)											
TWC	1	0	0	0	1	0	1	0	ECNT												Trailer Word Count											

Example of an event (continued)

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LWC	1	0	0	0	0	0	0	1	0	0	0	0	ECNT				Link Word Count															
BOL	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	MROD number												CSM Link 1			
TLP	1	0	0	0	1	0	0	1	0	0	0	0	TDC Link Present flags																			
BOT	1	0	1	TDC 3					ECNT												BCID											
TD	0	0	1	0	0	0	JT		Masked channels flags																							
TD	0	0	1	1	0	0	JT		Channel 0				T	E	Coarse													Fine				
TD	...				...				... more TDC data ...																							
TD	0	0	1	1	0	0	JT		Channel 1				T	E	Coarse													Fine				
EOT	1	1	0	0	0	0	JT		ECNT												TDC WCNT											
TWC	1	0	0	0	1	0	1	0	ECNT												Trailer Word Count											

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LWC	1	0	0	0	0	0	0	1	0	0	0	0	ECNT				Link Word Count															
BOL	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	MROD number												CSM Link 3			
TLP	1	0	0	0	1	0	0	1	0	0	0	0	TDC Link Present flags (=0)																			
TWC	1	0	0	0	1	0	1	0	ECNT												Trailer Word Count (=2)											

no TDC data at all !

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	...				...				... more CSM data (header + TDC data + trailer) ...																							

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LWC	1	0	0	0	0	0	0	1	0	0	0	0	ECNT				Link Word Count															
BOL	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	MROD number												CSM Link 5			
TLP	1	0	0	0	1	0	0	1	0	0	0	0	TDC Link Present flags (=0x00080)																			
BOT	1	0	1	TDC 2					ECNT												BCID											
TD	0	0	1	1	0	0	JT		Channel 6				T	E	Coarse													Fine				
BOT	1	0	1	TDC 7					ECNT												BCID											
TD	0	0	1	1	0	0	JT		Channel 14				T	E	Coarse													Fine				
EOT	1	1	0	0	0	0	JT		ECNT												TDC WCNT (=3)											
TWC	1	0	0	0	1	0	1	0	ECNT												Trailer Word Count (=7)											

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
EOB	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	MROD Block WCNT															

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSE1	MROD Status word																															

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
NSE	Number of Status Elements (= 0x00000001)																															
NDE	Number of Data Elements (= WCNT from EOB word)																															
SBP	Status Block Position (= 0x00000001: status at end)																															

5 MROD Module Identifiers / Tower numbers

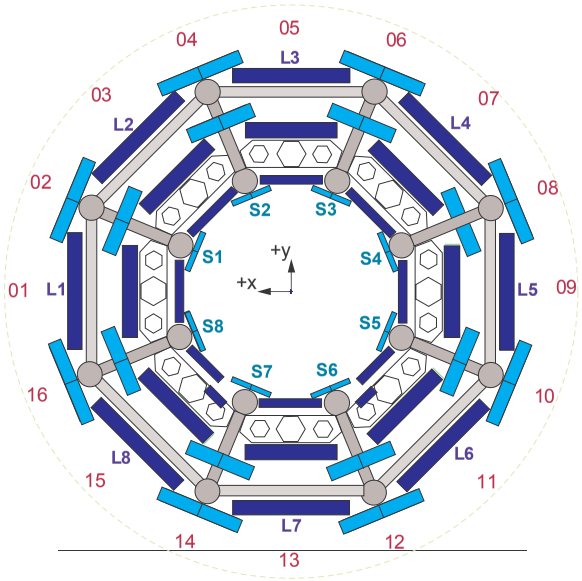
These are the tables showing MROD numbers and connected MDT Chambers.
All the MROD modules will send an unique number in the event header to identify the source of this MROD event fragment. This number is composed of two bytes, the Sub-detector Identifier and the Module Identifier. The read out of the MDT detector is divided into four TTC partitions and each partition has been given an unique Sub-detector Identifier.

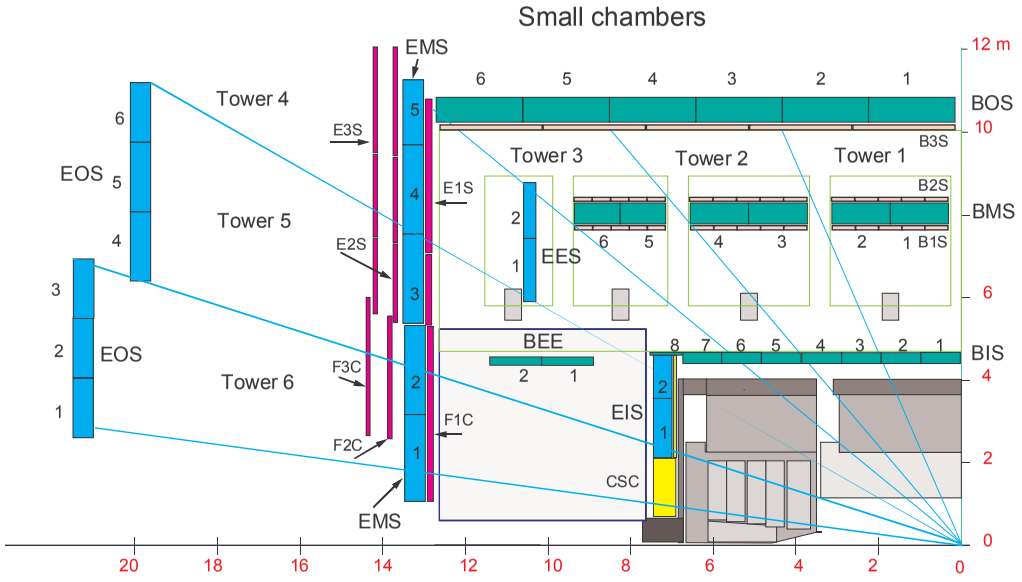
In each partition there are nominally 48 read out towers, which are built from nominally 6 chambers in one segment/sector or one eta/phi-slice. Due to the fact that some chambers had to be split up, e.g. in the "feet" regions, some read out towers consist of 7 or 8 chambers and some towers on the A-side are different from their opposite ones on the C-side. In total there are 1172 MDT chambers: 656 MDT chambers in the barrel towers and 516 MDT chambers in the endcap towers.

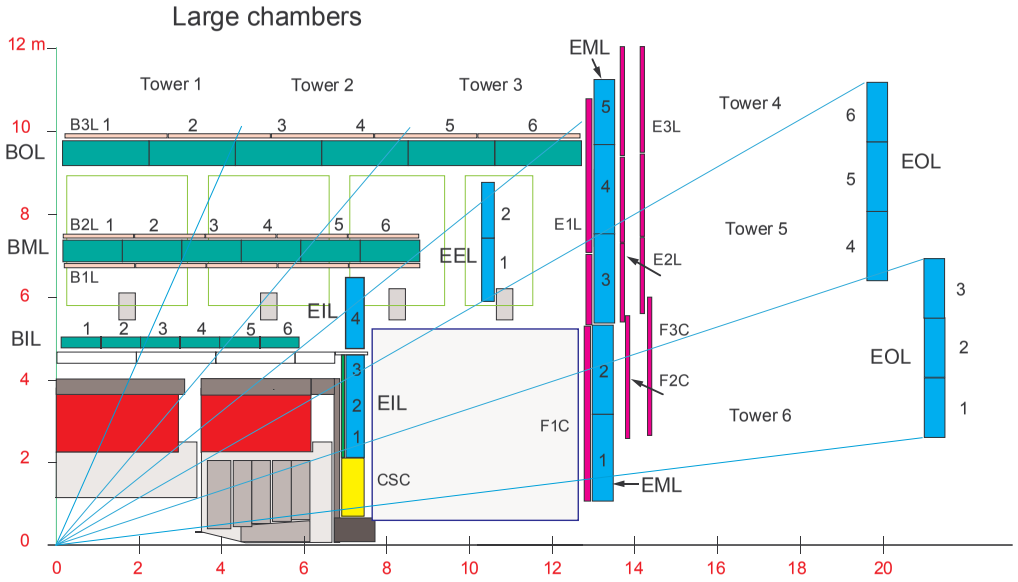
Some chambers have their readout combined into one CSM and all of the produced MROD modules will have only 6 inputs. Therefore some extra towers have been defined that also solve possible bandwidth problems in chambers with a high backgroud rate. The table below shows how the 204 (192+12) MROD modules are divided over the 16 MROD crates.

Subdetector Identifier	Partition name	Sectors	ROD crate	# of MRODs 6-channel
0x61	MDT Barrel A-side	1... 4	1	12
		5... 8	2	12
		9...12	3	13
		13...16	4	13
0x62	MDT Barrel C-side	1... 4	5	12
		5... 8	6	12
		9...12	7	13
		13...16	8	13
0x63	MDT EndCap A-side	1... 4	9	13
		5... 8	10	13
		9...12	11	13
		13...16	12	13
0x64	MDT EndCap C-side	1... 4	13	13
		5... 8	14	13
		9...12	15	13
		13...16	16	13
			total	204

The following tables show the tower numbers which are equally encoded as the Module Source Identifiers and the MROD crate in which the respective MROD modules are located. The tower configuration is based on the MDT Parameter (EXCEL) file, version Q-013 (d.d. 14-Jan-2003). The MDT chamber names used here follow the convention of the Parameter Book. The name is shown in red in places where a discrepancy exists with the Off-Line Identifiers.


01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
L1
L2
L3
L4
L5
L6
L7
L8
S1
S2
S3
S4
S5
S6
S7
S8
+y
+x


Small chambers
EMS
12 m
BOS
B3S
BMS
B2S
BIS
B1S
Tower 1
Tower 2
Tower 3
Tower 4
Tower 5
Tower 6
E3S
E2S
E1S
EES
BEE
EIS
F3C
F2C
F1C
CSC
EOS
20
18
16
14
12
10
8
6
4
2
0


Large chambers
12 m
EML
Tower 1
Tower 2
Tower 3
Tower 4
Tower 5
Tower 6
BOL
BML
BIL
B3L
B2L
B1L
E3L
E2L
E1L
EEL
EIL
F3C
F2C
F1C
CSC
EOL
0
2
4
6
8
10
12
14
16
18
20

5.1 Towers 0-15 in "eta 1" MDT Barrel A-side (Sub-detector ID = 0x61)

tower #	module ID.	MDT Chambers / CSM Links 0	1	2	3	4	5		MROD crate	slot
A-side - "eta 1" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
0	0x00	BIL1A01	BIL2A01	BML1A01	BML2A01	BOL1A01	BOL2A01		1	8
1	0x01	BIL1A03	BIL2A03	BML1A03	BML2A03	BOL1A03	BOL2A03		1	9
2	0x02	BIL1A05	BIL2A05	BML1A05	BML2A05	BOL1A05	BOL2A05		2	8
3	0x03	BIL1A07	BIL2A07	BML1A07	BML2A07	BOL1A07	BOL2A07		2	9
4	0x04	BIL1A09	BIL2A09	BML1A09	BML2A09	BOL1A09	BOL2A09		3	8
5	0x05	BIR1A11	BIR2A11	BML1A11	BML2A11	BOL1A11	BOL2A11		3	9
6	0x06	BIL1A13	BIL2A13	BML1A13	BML2A13	BOL1A13	BOL2A13		4	8
7	0x07	BIR1A15	BIR2A15	BML1A15	BML2A15	BOL1A15	BOL2A15		4	9
A-side - "eta 1" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
8	0x08	BIS1A02	BIS2A02	BMS1A02	BMS2A02	BOS1A02	BOS2A02		1	10
9	0x09	BIS1A04	BIS2A04	BMS1A04	BMS2A04	BOS1A04	BOS2A04		1	11
10	0x0A	BIS1A06	BIS2A06	BMS1A06	BMS2A06	BOS1A06	BOS2A06		2	10
11	0x0B	BIS1A08	BIS2A08	BMS1A08	BMS2A08	BOS1A08	BOS2A08		2	11
12	0x0C	BIS1A10	BIS2A10	BMS1A10	BMS2A10	BOS1A10	BOS2A10		3	10
13	0x0D	BIS1A12	BIS2A12	BMF1A12	BOF1A12	BOG0A12	BOG2A12		3	11
14	0x0E	BIS1A14	BIS2A14	BMF1A14	BOF1A14	BOG0A14	BOG2A14		4	10
15	0x0F	BIS1A16	BIS2A16	BMS1A16	BMS2A16	BOS1A16	BOS2A16		4	11

5.2 Towers 16-31 in "eta 2" MDT Barrel A-side (Sub-detector ID = 0x61)

tower #	module ID.	MDT Chambers / CSM Links 0	1	2	3	4	5		MROD crate	slot
A-side - "eta 2" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
16	0x10	BIL3A01	BIL4A01	BML3A01	BML4A01	BOL3A01	BOL4A01		1	12
17	0x11	BIL3A03	BIL4A03	BML3A03	BML4A03	BOL3A03	BOL4A03		1	14
18	0x12	BIL3A05	BIL4A05	BML3A05	BML4A05	BOL3A05	BOL4A05		2	12
19	0x13	BIL3A07	BIL4A07	BML3A07	BML4A07	BOL3A07	BOL4A07		2	14
20	0x14	BIL3A09	BIL4A09	BML3A09	BML4A09	BOL3A09	BOL4A09		3	12
21	0x15	BIR3A11	BIR4A11	BML3A11	BML4A11	BOL3A11	BOL4A11		3	14
22	0x16	BIL3A13	BIL4A13	BML3A13	.	BOL3A13	BOL4A13		4	12
23	0x17	BIR3A15	BIR4A15	BML3A15	BML4A15	BOL3A15	BOL4A15		4	14
A-side - "eta 2" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
24	0x18	BIS3A02	BIS4A02	BMS3A02	BMS4A02	BOS3A02	BOS4A02		1	15
25	0x19	BIS3A04	BIS4A04	BMS3A04	BMS4A04	BOS3A04	BOS4A04		1	16
26	0x1A	BIS3A06	BIS4A06	BMS3A06	BMS4A06	BOS3A06	BOS4A06		2	15
27	0x1B	BIS3A08	BIS4A08	BMS3A08	BMS4A08	BOS3A08	BOS4A08		2	16
28	0x1C	BIS3A10	BIS4A10	BMS3A10	BMS4A10	BOS3A10	BOS4A10		3	15
29	0x1D	BIS3A12	BIS4A12	BMF2A12	BOF3A12	BOF5A12	BOG4A12		3	16
30	0x1E	BIS3A14	BIS4A14	BMF2A14	BOF3A14	BOF5A14	BOG4A14		4	15
31	0x1F	BIS3A16	BIS4A16	BMS3A16	BMS4A16	BOS3A16	BOS4A16		4	16

5.3 Towers 32-49 in "eta 3" MDT Barrel A-side (Sub-detector ID = 0x61)

tower	module	MDT Chambers / CSM Links						MROD	
#	ID.	0	1	2	3	4	5	crate	slot
		A-side - "eta 3" - Long chambers in sectors 1,3,5,7,9,11,13,15 :							
32	0x20	BIL5A01	BIL6A01	BML5A01	BML6A01	BOL5A01	BOL6A01	1	17
33	0x21	BIL5A03	BIL6A03	BML5A03	BML6A03	BOL5A03	BOL6A03	1	18
34	0x22	BIL5A05	BIL6A05	BML5A05	BML6A05	BOL5A05	BOL6A05	2	17
35	0x23	BIL5A07	BIL6A07	BML5A07	BML6A07	BOL5A07	BOL6A07	2	18
36	0x24	BIL5A09	BIL6A09	BML5A09	BML6A09	BOL5A09	BOL6A09	3	17
37	0x25	BIR5A11	BIR6A11	BML5A11	BML6A11	BOL5A11	BOL6A11	3	18
38	0x26	BIL5A13	BIL6A13	BML5A13	BML6A13	BOL5A13	BOL6A13	4	17
39	0x27	BIR5A15	BIR6A15	BML5A15	BML6A15	BOL5A15	BOL6A15	4	18
		A-side - "eta 3" - Short chambers in sectors 2,4,6,8,10,12,14,16 :							
40	0x28	BIS5A02	BIS6A02	BMS5A02	BMS6A02	BOS5A02	BOS6A02	1	19
41	0x29	BIS5A04	BIS6A04	BMS5A04	BMS6A04	BOS5A04	BOS6A04	1	20
42	0x2A	BIS5A06	BIS6A06	BMS5A06	BMS6A06	BOS5A06	BOS6A06	2	19
43	0x2B	BIS5A08	BIS6A08	BMS5A08	BMS6A08	BOS5A08	BOS6A08	2	20
44	0x2C	BIS5A10	BIS6A10	BMS5A10	BMS6A10	BOS5A10	BOS6A10	3	19
45	0x2D	BIS5A12	BIS6A12	BMF3A12	BOF7A12	BOG6A12	BOG8A12	3	20
46	0x2E	BIS5A14	BIS6A14	BMF3A14	BOF7A14	BOG6A14	BOG8A14	4	19
47	0x2F	BIS5A16	BIS6A16	BMS5A16	BMS6A16	BOS5A16	BOS6A16	4	20
		A-side - extra towers for sector 11 and 15 :							
48	0x30	BIM1A11	BIM2A11	BIM3A11	BIM4A11	BIM5A11		3	7
49	0x31	BIM1A15	BIM2A15	BIM3A15	BIM4A15	BIM5A15		4	7

Notes:

1. Due to the choice of cabling (TTC fibres) from the TTC fanouts to the chambers, the readout of the BOG0C12 and BOG0C14 chambers has been moved from the C-side to the A-side, tower 13 and 14. The chambers are now called BOG0A12 and BOG0A14.

5.4 Towers 0-15 in "eta 1" MDT Barrel C-side (Sub-detector ID = 0x62)

tower	module	MDT Chambers / CSM Links							MROD	
#	ID.	0	1	2	3	4	5		crate	slot
C-side - "eta 1" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
0	0x00	BIL1C01	BIL2C01	BML1C01.	BML2C01	BOL1C01	BOL2C01		5	8
1	0x01	BIL1C03	BIL2C03	BML1C03.	BML2C03	BOL1C03	BOL2C03		5	9
2	0x02	BIL1C05	BIL2C05	BML1C05	BML2C05	BOL1C05	BOL2C05		6	8
3	0x03	BIL1C07	BIL2C07	BML1C07	BML2C07	BOL1C07	BOL2C07		6	9
4	0x04	BIL1C09	BIL2C09	BML1C09.	BML2C09	BOL1C09	BOL2C09		7	8
5	0x05	BIR1C11	BIR2C11	BML1C11	BML2C11	BOL1C11	BOL2C11		7	9
6	0x06	BIL1C13.	BIL2C13	BML1C13.	BML2C13	BOL1C13	BOL2C13		8	8
7	0x07	BIR1C15	BIR2C15	BML1C15	BML2C15	BOL1C15	BOL2C15		8	9
C-side - "eta 1" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
8	0x08	BIS1C02	BIS2C02	BMS1C02	BMS2C02	BOS1C02	BOS2C02		5	10
9	0x09	BIS1C04	BIS2C04	BMS1C04	BMS2C04	BOS1C04	BOS2C04		5	11
10	0x0A	BIS1C06	BIS2C06	BMS1C06	BMS2C06	BOS1C06	BOS2C06		6	10
11	0x0B	BIS1C08	BIS2C08	BMS1C08	BMS2C08	BOS1C08	BOS2C08		6	11
12	0x0C	BIS1C10	BIS2C10	BMS1C10	BMS2C10	BOS1C10	BOS2C10		7	10
13	0x0D	BIS1C12	BIS2C12	BMF1C12	BOF1C12	.	BOG2C12		7	11
14	0x0E	BIS1C14	BIS2C14	BMF1C14	BOF1C14	.	BOG2C14		8	10
15	0x0F	BIS1C16	BIS2C16	BMS1C16	BMS2C16	BOS1C16	BOS2C16		8	11

5.5 Towers 16-31 in "eta 2" MDT Barrel C-side (Sub-detector ID = 0x62)

tower	module	MDT Chambers / CSM Links							MROD	
#	ID.	0	1	2	3	4	5		crate	slot
C-side - "eta 2" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
16	0x10	BIL3C01	BIL4C01	BML3C01	BML4C01	BOL3C01	BOL4C01		5	12
17	0x11	BIL3C03	BIL4C03	BML3C03	BML4C03	BOL3C03	BOL4C03		5	14
18	0x12	BIL3C05	BIL4C05	BML3C05	BML4C05	BOL3C05	BOL4C05		6	12
19	0x13	BIL3C07	BIL4C07	BML3C07	BML4C07	BOL3C07	BOL4C07		6	14
20	0x14	BIL3C09	BIL4C09	BML3C09	BML4C09	BOL3C09	BOL4C09		7	12
21	0x15	BIR3C11	BIR4C11	BML3C11	BML4C11	BOL3C11	BOL4C11		7	14
22	0x16	BIL3C13	BIL4C13	BML3C13	.	BOL3C13	BOL4C13		8	12
23	0x17	BIR3C15	BIR4C15	BML3C15	BML4C15	BOL3C15	BOL4C15		8	14
C-side - "eta 2" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
24	0x18	BIS3C02	BIS4C02	BMS3C02	BMS4C02	BOS3C02	BOS4C02		5	15
25	0x19	BIS3C04	BIS4C04	BMS3C04	BMS4C04	BOS3C04	BOS4C04		5	16
26	0x1A	BIS3C06	BIS4C06	BMS3C06	BMS4C06	BOS3C06	BOS4C06		6	15
27	0x1B	BIS3C08	BIS4C08	BMS3C08	BMS4C08	BOS3C08	BOS4C08		6	16
28	0x1C	BIS3C10	BIS4C10	BMS3C10	BMS4C10	BOS3C10	BOS4C10		7	15
29	0x1D	BIS3C12	BIS4C12	BMF2C12	BOF3C12	BOF5C12	BOG4C12		7	16
30	0x1E	BIS3C14	BIS4C14	BMF2C14	BOF3C14	BOF5C14	BOG4C14		8	15
31	0x1F	BIS3C16	BIS4C16	BMS3C16	BMS4C16	BOS3C16	BOS4C16		8	16

5.6 Towers 32-49 in "eta 3" MDT Barrel C-side (Sub-detector ID = 0x62)

tower	module	MDT Chambers / CSM Links						MROD	
#	ID.	0	1	2	3	4	5	crate	slot
	C-side - "eta 3" - Long chambers in sectors 1,3,5,7,9,11,13,15 :								
32	0x20	BIL5C01	BIL6C01	BML5C01	BML6C01	BOL5C01	BOL6C01	5	17
33	0x21	BIL5C03	BIL6C03	BML5C03	BML6C03	BOL5C03	BOL6C03	5	18
34	0x22	BIL5C05	BIL6C05	BML5C05	BML6C05	BOL5C05	BOL6C05	6	17
35	0x23	BIL5C07	BIL6C07	BML5C07	BML6C07	BOL5C07	BOL6C07	6	18
36	0x24	BIL5C09	BIL6C09	BML5C09	BML6C09	BOL5C09	BOL6C09	7	17
37	0x25	BIR5C11	BIR6C11	BML5C11	BML6C11	BOL5C11	BOL6C11	7	18
38	0x26	BIL5C13	BIL6C13	BML5C13	BML6C13	BOL5C13	BOL6C13	8	17
39	0x27	BIR5C15	BIR6C15	BML5C15	BML6C15	BOL5C15	BOL6C15	8	18
	C-side - "eta 3" - Short chambers in sectors 2,4,6,8,10,12,14,16 :								
40	0x28	BIS5C02	BIS6C02	BMS5C02	BMS6C02	BOS5C02	BOS6C02	5	19
41	0x29	BIS5C04	BIS6C04	BMS5C04	BMS6C04	BOS5C04	BOS6C04	5	20
42	0x2A	BIS5C06	BIS6C06	BMS5C06	BMS6C06	BOS5C06	BOS6C06	6	19
43	0x2B	BIS5C08	BIS6C08	BMS5C08	BMS6C08	BOS5C08	BOS6C08	6	20
44	0x2C	BIS5C10	BIS6C10	BMS5C10	BMS6C10	BOS5C10	BOS6C10	7	19
45	0x2D	BIS5C12	BIS6C12	BMF3C12	BOF7C12	BOG6C12	BOG8C12	7	20
46	0x2E	BIS5C14	BIS6C14	BMF3C14	BOF7C14	BOG6C14	BOG8C14	8	19
47	0x2F	BIS5C16	BIS6C16	BMS5C16	BMS6C16	BOS5C16	BOS6C16	8	20
	C-side - extra towers for sector 11 and 15 :								
48	0x30	BIM1C11	BIM2C11	BIM3C11	BIM4C11	BIM5C11		7	7
49	0x31	BIM1C15	BIM2C15	BIM3C15	BIM4C15	BIM5C15		8	7

Notes:

1. The TTC fibres from the TTC fanouts to the BOG0C12 and BOG0C14 chambers are now connected to the A-side (not the C-side) of the detector. The chambers have been renamed to BOG0A12 and BOG0A14 and their readout is placed in tower 13 and 14 of the Barrel A-side partition (0x61).

5.7 Towers 0-15 in "eta 4" MDT EndCap A-side (Sub-detector ID = 0x63)

tower	module	MDT Chambers / CSM Links							MROD	
#	ID.	0	1	2	3	4	5		crate	slot
A-side - "eta 4" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
0	0x00	EILM4A01	EEL1A01	EEL2A01	EML4A01	EML5A01			9	8
1	0x01	EIL4A03	EEL1A03	EEL2A03	EML4A03	EML5A03			9	9
2	0x02	EIL4A05		EEL2A05	EML4A05	EML5A05			10	8
3	0x03	EIL4A07	EEL1A07	EEL2A07	EML4A07	EML5A07			10	9
4	0x04	EILM4A09	EEL1A09	EEL2A09	EML4A09	EML5A09			11	8
5	0x05	EIL4A11	EEL1A11	EEL2A11	EML4A11	EML5A11			11	9
6	0x06	EIL4A13	EEL1A13	EEL2A13	EML4A13	EML5A13			12	8
7	0x07	EIL4A15	EEL1A15	EEL2A15	EML4A15	EML5A15			12	9
A-side - "eta 4" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
8	0x08	BIS78A02	EES1A02	EES2A02	EMS4A02	EMS5A02			9	10
9	0x09	BIS78A04	EES1A04	EES2A04	EMS4A04	EMS5A04			9	11
10	0x0A	BIS78A06	EES1A06	EES2A06	EMS4A06	EMS5A06			10	10
11	0x0B	BIS78A08	EES1A08	EES2A08	EMS4A08	EMS5A08			10	11
12	0x0C	BIS78A10	EES1A10	EES2A10	EMS4A10	EMS5A10			11	10
13	0x0D	BIS78A12	EES1A12	EES2A12	EMS4A12	EMS5A12			11	11
14	0x0E	BIS78A14	EES1A14	EES2A14	EMS4A14	EMS5A14			12	10
15	0x0F	BIS78A16	EES1A16	EES2A16	EMS4A16	EMS5A16			12	11

5.8 Towers 16-31 in "eta 5" MDT EndCap A-side (Sub-detector ID = 0x63)

tower	module	MDT Chambers / CSM Links							MROD	
#	ID.	0	1	2	3	4	5		crate	slot
A-side - "eta 5" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
16	0x10	EIL23A01		EML3A01	EOL4A01	EOL5A01	EOL6A01		9	12
17	0x11	EIL23A03		EML3A03	EOL4A03	EOL5A03	EOL6A03		9	14
18	0x12	EIL23A05		EML3A05	EOL4A05	EOL5A05	EOL6A05		10	12
19	0x13	EIL23A07		EML3A07	EOL4A07	EOL5A07	EOL6A07		10	14
20	0x14	EIL23A09		EML3A09	EOL4A09	EOL5A09	EOL6A09		11	12
21	0x15	EIL23A11		EML3A11	EOL4A11	EOL5A11	EOL6A11		11	14
22	0x16	EIL23A13		EML3A13	EOL4A13	EOL5A13	EOL6A13		12	12
23	0x17	EIL23A15		EML3A15	EOL4A15	EOL5A15	EOL6A15		12	14
A-side - "eta 5" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
24	0x18	EIS1A02	EIS2A02	EMS3A02	EOS4A02	EOS5A02	EOS6A02		9	15
25	0x19	EIS1A04	EIS2A04	EMS3A04	EOS4A04	EOS5A04	EOS6A04		9	16
26	0x1A	EIS1A06	EIS2A06	EMS3A06	EOS4A06	EOS5A06	EOS6A06		10	15
27	0x1B	EIS1A08	EIS2A08	EMS3A08	EOS4A08	EOS5A08	EOS6A08		10	16
28	0x1C	EIS1A10	EIS2A10	EMS3A10	EOS4A10	EOS5A10	EOS6A10		11	15
29	0x1D	EIS1A12	EIS2A12	EMS3A12	EOS4A12	EOS5A12	EOS6A12		11	16
30	0x1E	EIS1A14	EIS2A14	EMS3A14	EOS4A14	EOS5A14	EOS6A14		12	15
31	0x1F	EIS1A16	EIS2A16	EMS3A16	EOS4A16	EOS5A16	EOS6A16		12	16

5.9 Towers 32-47 in "eta 6" MDT EndCap A-side (Sub-detector ID = 0x63)

tower	module	MDT Chambers / CSM Links							MROD	
#	ID.	0	1	2	3	4	5		crate	slot
	A-side - "eta 6" - Long chambers in sectors 1,3,5,7,9,11,13,15 :									
32	0x20		EML1A01	EML2A01	EOL1A01	EOL2A01	EOL3A01		9	17
33	0x21		EML1A03	EML2A03	EOL1A03	EOL2A03	EOL3A03		9	18
34	0x22		EML1A05	EML2A05	EOL1A05	EOL2A05	EOL3A05		10	17
35	0x23		EML1A07	EML2A07	EOL1A07	EOL2A07	EOL3A07		10	18
36	0x24		EML1A09	EML2A09	EOL1A09	EOL2A09	EOL3A09		11	17
37	0x25		EML1A11	EML2A11	EOL1A11	EOL2A11	EOL3A11		11	18
38	0x26		EML1A13	EML2A13	EOL1A13	EOL2A13	EOL3A13		12	17
39	0x27		EML1A15	EML2A15	EOL1A15	EOL2A15	EOL3A15		12	18
	A-side - "eta 6" - Short chambers in sectors 2,4,6,8,10,12,14,16 :									
40	0x28		EMS1A02	EMS2A02	EOS1A02	EOS2A02	EOS3A02		9	19
41	0x29		EMS1A04	EMS2A04	EOS1A04	EOS2A04	EOS3A04		9	20
42	0x2A		EMS1A06	EMS2A06	EOS1A06	EOS2A06	EOS3A06		10	19
43	0x2B		EMS1A08	EMS2A08	EOS1A08	EOS2A08	EOS3A08		10	20
44	0x2C		EMS1A10	EMS2A10	EOS1A10	EOS2A10	EOS3A10		11	19
45	0x2D		EMS1A12	EMS2A12	EOS1A12	EOS2A12	EOS3A12		11	20
46	0x2E		EMS1A14	EMS2A14	EOS1A14	EOS2A14	EOS3A14		12	19
47	0x2F		EMS1A16	EMS2A16	EOS1A16	EOS2A16	EOS3A16		12	20
	A-side - extra towers for sector 1 ... 16 :									
48	0x30	BEE12A02	BEE12A04	EIL1A01	EIL1A03				9	7
49	0x31	BEE12A06	BEE12A08	EIL1A05	EIL1A07				10	7
50	0x32	BEE12A10	BEE12A12	EIL1A09	EIL1A11				11	7
51	0x33	BEE12A14	BEE12A16	EIL1A13	EIL1A15				12	7

Notes:

1. All the BIS7 and BIS8 chambers have their read out combined through BIS78.

2. In the sectors 1 and 9, the chambers EIL4 and EIM4 have their read out combined through EILM4.

3. All the BEE1 and BEE2 chambers have their read out combined through BEE12.

4. All the EIL2 and EIL3 chambers have their readout combined through EIL23.

5. The EEL1 chamber in sector A05 (crate 10) does not exist.

5.10 Towers 0-15 in "eta 4" MDT EndCap C-side (Sub-detector ID = 0x64)

tower #	module ID.	MDT Chambers / CSM Links 0	1	2	3	4	5		MROD crate	slot
C-side - "eta 4" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
0	0x00	EILM4C01	EEL1C01	EEL2C01	EML4C01	EML5C01			13	8
1	0x01	EIL4C03	EEL1C03	EEL2C03	EML4C03	EML5C03			13	9
2	0x02	EIL4C05		EEL2C05	EML4C05	EML5C05			14	8
3	0x03	EIL4C07	EEL1C07	EEL2C07	EML4C07	EML5C07			14	9
4	0x04	EILM4C09	EEL1C09	EEL2C09	EML4C09	EML5C09			15	8
5	0x05	EIL4C11	EEL2C11	EEL2C11	EML4C11	EML5C11			15	9
6	0x06	EIL4C13	EEL1C13	EEL2C13	EML4C13	EML5C13			16	8
7	0x07	EIL4C15	EEL1C15	EEL2C15	EML4C15	EML5C15			16	9
C-side - "eta 4" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
8	0x08	BIS78C02	EES1C02	EES2C02	EMS4C02	EMS5C02			13	10
9	0x09	BIS78C04	EES1C04	EES2C04	EMS4C04	EMS5C04			13	11
10	0x0A	BIS78C06	EES1C06	EES2C06	EMS4C06	EMS5C06			14	10
11	0x0B	BIS78C08	EES1C08	EES2C08	EMS4C08	EMS5C08			14	11
12	0x0C	BIS78C10	EES1C10	EES2C10	EMS4C10	EMS5C10			15	10
13	0x0D	BIS78C12	EES1C12	EES2C12	EMS4C12	EMS5C12			15	11
14	0x0E	BIS78C14	EES1C14	EES2C14	EMS4C14	EMS5C14			16	10
15	0x0F	BIS78C16	EES1C16	EES2C16	EMS4C16	EMS5C16			16	11

5.11 Towers 16-31 in "eta 5" MDT EndCap C-side (Sub-detector ID = 0x64)

tower #	module ID.	MDT Chambers / CSM Links 0	1	2	3	4	5		MROD crate	slot
C-side - "eta 5" - Long chambers in sectors 1,3,5,7,9,11,13,15 :										
16	0x10	EIL23C01		EML3C01	EOL4C01	EOL5C01	EOL6C01		13	12
17	0x11	EIL23C03		EML3C03	EOL4C03	EOL5C03	EOL6C03		13	14
18	0x12	EIL23C05		EML3C05	EOL4C05	EOL5C05	EOL6C05		14	12
19	0x13	EIL23C07		EML3C07	EOL4C07	EOL5C07	EOL6C07		14	14
20	0x14	EIL23C09		EML3C09	EOL4C09	EOL5C09	EOL6C09		15	12
21	0x15	EIL23C11		EML3C11	EOL4C11	EOL5C11	EOL6C11		15	14
22	0x16	EIL23C13		EML3C13	EOL4C13	EOL5C13	EOL6C13		16	12
23	0x17	EIL23C15		EML3C15	EOL4C15	EOL5C15	EOL6C15		16	14
C-side - "eta 5" - Short chambers in sectors 2,4,6,8,10,12,14,16 :										
24	0x18	EIS1C02	EIS2C02	EMS3C02	EOS4C02	EOS5C02	EOS6C02		13	15
25	0x19	EIS1C04	EIS2C04	EMS3C04	EOS4C04	EOS5C04	EOS6C04		13	16
26	0x1A	EIS1C06	EIS2C06	EMS3C06	EOS4C06	EOS5C06	EOS6C06		14	15
27	0x1B	EIS1C08	EIS2C08	EMS3C08	EOS4C08	EOS5C08	EOS6C08		14	16
28	0x1C	EIS1C10	EIS2C10	EMS3C10	EOS4C10	EOS5C10	EOS6C10		15	15
29	0x1D	EIS1C12	EIS2C12	EMS3C12	EOS4C12	EOS5C12	EOS6C12		15	16
30	0x1E	EIS1C14	EIS2C14	EMS3C14	EOS4C14	EOS5C14	EOS6C14		16	15
31	0x1F	EIS1C16	EIS2C16	EMS3C16	EOS4C16	EOS5C16	EOS6C16		16	16

5.12 Towers 32-47 in "eta 6" MDT EndCap C-side (Sub-detector ID = 0x64)

tower	module	MDT Chambers / CSM Links							MROD	
#	ID.	0	1	2	3	4	5		crate	slot
		C-side - "eta 6" - Long chambers in sectors 1,3,5,7,9,11,13,15 :								
32	0x20		EML1C01	EML2C01	EOL1C01	EOL2C01	EOL3C01		13	17
33	0x21		EML1C03	EML2C03	EOL1C03	EOL2C03	EOL3C03		13	18
34	0x22		EML1C05	EML2C05	EOL1C05	EOL2C05	EOL3C05		14	17
35	0x23		EML1C07	EML2C07	EOL1C07	EOL2C07	EOL3C07		14	18
36	0x24		EML1C09	EML2C09	EOL1C09	EOL2C09	EOL3C09		15	17
37	0x25		EML1C11	EML2C11	EOL1C11	EOL2C11	EOL3C11		15	18
38	0x26		EML1C13	EML2C13	EOL1C13	EOL2C13	EOL3C13		16	17
39	0x27		EML1C15	EML2C15	EOL1C15	EOL2C15	EOL3C15		16	18
		C-side - "eta 6" - Short chambers in sectors 2,4,6,8,10,12,14,16 :								
40	0x28		EMS1C02	EMS2C02	EOS1C02	EOS2C02	EOS3C02		13	19
41	0x29		EMS1C04	EMS2C04	EOS1C04	EOS2C04	EOS3C04		13	20
42	0x2A		EMS1C06	EMS2C06	EOS1C06	EOS2C06	EOS3C06		14	19
43	0x2B		EMS1C08	EMS2C08	EOS1C08	EOS2C08	EOS3C08		14	20
44	0x2C		EMS1C10	EMS2C10	EOS1C10	EOS2C10	EOS3C10		15	19
45	0x2D		EMS1C12	EMS2C12	EOS1C12	EOS2C12	EOS3C12		15	20
46	0x2E		EMS1C14	EMS2C14	EOS1C14	EOS2C14	EOS3C14		16	19
47	0x2F		EMS1C16	EMS2C16	EOS1C16	EOS2C16	EOS3C16		16	20
		C-side - extra towers for sector 1 ... 16 :								
48	0x30	BEE12C02	BEE12C04	EIL1C01	EIL1C03				13	7
49	0x31	BEE12C06	BEE12C08	EIL1C05	EIL1C07				14	7
50	0x32	BEE12C10	BEE12C12	EIL1C09	EIL1C11				15	7
51	0x33	BEE12C14	BEE12C16	EIL1C13	EIL1C15				16	7

Notes:

1. All the BIS7 and BIS8 chambers have their read out combined through BIS78.

2. In the sectors 1 and 9, the chambers EIL4 and EIM4 have their read out combined through EILM4.

3. All the BEE1 and BEE2 chambers have their readout combined through BEE12.

4. All the EIL2 and EIL3 chambers have their readout combined through EIL23.

5. The EEL1 chamber in sector C05 (crate 14) does not exist.

5.13 Towers in MDT Barrel and Endcap with naming discrepancies

There appears to be a difference between the naming convention in the Parameter Book and the Off-Line Identifiers for the MDT Chambers. A summary of the discrepancies is listed in the table below. Here the names are listed according to the Off-Line Identifiers. The name is shown in red in places where a discrepancy exists with the Parameter Book.

tower	module	MDT Chambers / CSM Links						MROD	
#	ID.	0	1	2	3	4	5	crate	slot
		A-side - "eta 1" - Long & Short chambers in sectors 1 ... 16 :							
13	0x0D	BIS1A12	BIS2A12	BMF1A12	BOF1A12	BOG0A12	BOG2A12	3	11
14	0x0E	BIS1A14	BIS2A14	BMF1A14	BOF1A14	BOG0A14	BOG2A14	4	10
		A-side - "eta 2" - Long & Short chambers in sectors 1 ... 16 :							
29	0x1D	BIS3A12	BIS4A12	BMF2A12	BOF2A12	BOF3A12	BOG2A12	3	16
30	0x1E	BIS3A14	BIS4A14	BMF2A14	BOF2A14	BOF3A14	BOG2A14	4	15
		A-side - "eta 3" - Long & Short chambers in sectors 1 ... 16 :							
38	0x26	BIL5A13	BIL6A13	BML4A13	BML5A13	BOL5A13	BOL6A13	4	17
45	0x2D	BIS5A12	BIS6A12	BMF3A12	BOF4A12	BOG3A12	BOG4A12	3	20
46	0x2E	BIS5A14	BIS6A14	BMF3A14	BOF4A14	BOG3A14	BOG4A14	4	19
		A-side - extra towers for sector 11 and 15 :							
48	0x30	BIL1A11	BIL2A11	BIL3A11	BIL4A11	BIL5A11		3	7
49	0x31	BIL1A15	BIL2A15	BIL3A15	BIL4A15	BIL5A15		4	7
		C-side - "eta 1" - Long & Short chambers in sectors 1 ... 16 :							
13	0x0D	BIS1C12	BIS2C12	BMF1C12	BOF1C12	.	BOG2C12	7	11
14	0x0E	BIS1C14	BIS2C14	BMF1C14	BOF1C14	.	BOG2C14	8	10
		C-side - "eta 2" - Long & Short chambers in sectors 1 ... 16 :							
29	0x1D	BIS3C12	BIS4C12	BMF2C12	BOF2C12	BOF3C12	BOG2C12	7	16
30	0x1E	BIS3C14	BIS4C14	BMF2C14	BOF2C14	BOF3C14	BOG2C14	8	15
		C-side - "eta 3" - Long & Short chambers in sectors 1 ... 16 :							
38	0x26	BIL5C13	BIL6C13	BML4C13	BML5C13	BOL5C13	BOL6C13	8	17
45	0x2D	BIS5C12	BIS6C12	BMF3C12	BOF4C12	BOG3C12	BOG4C12	7	20
46	0x2E	BIS5C14	BIS6C14	BMF3C14	BOF4C14	BOG3C14	BOG4C14	8	19
		C-side - extra towers for sector 11 and 15 :							
48	0x30	BIL1C11	BIL2C11	BIL3C11	BIL4C11	BIL5C11		3	7
49	0x31	BIL1C15	BIL2C15	BIL3C15	BIL4C15	BIL5C15		4	7
		A-side - "eta 4" - Long & Short chambers in sectors 1 ... 16 :							
0	0x00	EILM4A01	EEL1A01	EEL2A01	EML4A01	EML5A01		9	8
4	0x04	EILM4A09	EEL1A09	EEL2A09	EML4A09	EML5A09		11	8
		C-side - "eta 4" - Long & Short chambers in sectors 1 ... 16 :							
0	0x00	EILM4C01	EEL1C01	EEL2C01	EML4C01	EML5C01		13	8
4	0x04	EILM4C09	EEL1C09	EEL2C09	EML4C09	EML5C09		15	8

5.14 Towers and Crates in Rack 1

Rack 1 = Y.22-19.A1 | total # of chan's in rack: **221** | … in Barrel: **592** | … in Barrel + EC: **1118**

Partition: x61 — Tower 1 A | Tower 2 A | Tower 3 A

Tower number: 0 1 8 9 | 16 17 24 25 | 32 33 40 41

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1								BIL1 A01	BIL1 A03	BIS1 A02	BIS1 A04	BIL3 A01		BIL3 A03	BIS3 A02	BIS3 A04	BIL5 A01	BIL5 A03	BIS5 A02	BIS5 A04	
								BIL2 A01	BIL2 A03	BIS2 A02	BIS2 A04	BIL4 A01		BIL4 A03	BIS4 A02	BIS4 A04	BIL6 A01	BIL6 A03	BIS6 A02	BIS6 A04	
U39								BML1 A01	BML1 A03	BMS1 A02	BMS1 A04	BML3 A01		BML3 A03	BMS3 A02	BMS3 A04	BML5 A01	BML5 A03	BMS5 A02	BMS5 A04	
Barrel, side A, Q. 1								BML2 A01	BML2 A03	BMS2 A02	BMS2 A04	BML4 A01		BML4 A03	BMS4 A02	BMS4 A04	BML6 A01	BML6 A03	BMS6 A02	BMS6 A04	
# chan's in crate: 72								BOL1 A01	BOL1 A03	BOS1 A02	BOS1 A04	BOL3 A01		BOL3 A03	BOS3 A02	BOS3 A04	BOL5 A01	BOL5 A03	BOS5 A02	BOS5 A04	
								BOL2 A01	BOL2 A03	BOS2 A02	BOS2 A04	BOL4 A01	TIM	BOL4 A03	BOS4 A02	BOS4 A04	BOL6 A01	BOL6 A03	BOS6 A02	BOS6 A04	RCAT
								ROL BA00	ROL BA01	ROL BA08	ROL BA09	ROL BA16	TTC BA01	ROL BA17	ROL BA24	ROL BA25	ROL BA32	ROL BA33	ROL BA40	ROL BA41	

Partition: x61 — Tower 1 A | Tower 2 A | Tower 3 A

Tower number: 2 3 10 11 | 18 19 26 27 | 34 35 42 43

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
2								BIL1 A05	BIL1 A07	BIS1 A06	BIS1 A08	BIL3 A05		BIL3 A07	BIS3 A06	BIS3 A08	BIL5 A05	BIL5 A07	BIS5 A06	BIS5 A08	
								BIL2 A05	BIL2 A07	BIS2 A06	BIS2 A08	BIL4 A05		BIL4 A07	BIS4 A06	BIS4 A08	BIL6 A05	BIL6 A07	BIS6 A06	BIS6 A08	
U27								BML1 A05	BML1 A07	BMS1 A06	BMS1 A08	BML3 A05		BML3 A07	BMS3 A06	BMS3 A08	BML5 A05	BML5 A07	BMS5 A06	BMS5 A08	
Barrel, side A, Q. 2								BML2 A05	BML2 A07	BMS2 A06	BMS2 A08	BML4 A05		BML4 A07	BMS4 A06	BMS4 A08	BML6 A05	BML6 A07	BMS6 A06	BMS6 A08	
# chan's in crate: 72								BOL1 A05	BOL1 A07	BOS1 A06	BOS1 A08	BOL3 A05		BOL3 A07	BOS3 A06	BOS3 A08	BOL5 A05	BOL5 A07	BOS5 A06	BOS5 A08	
								BOL2 A05	BOL2 A07	BOS2 A06	BOS2 A08	BOL4 A05	TIM	BOL4 A07	BOS4 A06	BOS4 A08	BOL6 A05	BOL6 A07	BOS6 A06	BOS6 A08	RCAT
								ROL BA02	ROL BA03	ROL BA10	ROL BA11	ROL BA18	TTC BA02	ROL BA19	ROL BA26	ROL BA27	ROL BA34	ROL BA35	ROL BA42	ROL BA43	

Partition: x61 — Tower 1 A | Tower 2 A | Tower 3 A

Tower number: 48 | 4 5 12 13 | 20 21 28 29 | 36 37 44 45

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
3							BIM1 A11	BIL1 A09	BIR1 A11	BIS1 A10	BIS1 A12	BIL3 A09		BIR3 A11	BIS3 A10	BIS3 A12	BIL5 A09	BIR5 A11	BIS5 A10	BIS5 A12	
							BIM2 A11	BIL2 A09	BIR2 A11	BIS2 A10	BIS2 A12	BIL4 A09		BIR4 A11	BIS4 A10	BIS4 A12	BIL6 A09	BIR6 A11	BIS6 A10	BIS6 A12	
U15							BIM3 A11	BML1 A09	BML1 A11	BMS1 A10	BMF1 A12	BML3 A09		BML3 A11	BMS3 A10	BMF2 A12	BML5 A09	BML5 A11	BMS5 A10	BMF3 A12	
Barrel, side A, Q. 3							BIM4 A11	BML2 A09	BML2 A11	BMS2 A10	BOF1 A12	BML4 A09		BML4 A11	BMS4 A10	BOF3 A12	BML6 A09	BML6 A11	BMS6 A10	BOF7 A12	
# chan's in crate: 77							BIM5 A11	BOL1 A09	BOL1 A11	BOS1 A10	BOG0 A12	BOL3 A09		BOL3 A11	BOS3 A10	BOF5 A12	BOL5 A09	BOL5 A11	BOS5 A10	BOG6 A12	
								BOL2 A09	BOL2 A11	BOS2 A10	BOG2 A12	BOL4 A09	TIM	BOL4 A11	BOS4 A10	BOG4 A12	BOL6 A09	BOL6 A11	BOS6 A10	BOG8 A12	RCAT
							ROL BA48	ROL BA04	ROL BA05	ROL BA12	ROL BA13	ROL BA20	TTC BA03	ROL BA21	ROL BA28	ROL BA29	ROL BA36	ROL BA37	ROL BA44	ROL BA45	

5.15 Towers and Crates in Rack 2

Rack 2 = Y.23-19.A1 | total # of chan's in rack: **151** … in Barrel: **592** … in Barrel + EC: **1118**

Partition: x61

		Tower 1 A					Tower 2 A						Tower 3 A					
Tower number	49	6	7	14	15	22		23	30	31	38	39	46	47				
Hex Tower number																		
crt	BIM1 A15	BIL1 A13	BIR1 A15	BIS1 A14	BIS1 A16	BIL3 A13		BIR3 A15	BIS3 A14	BIS3 A16	BIL5 A13	BIR5 A15	BIS5 A14	BIS5 A16				
4	BIM2 A15	BIL2 A13	BIR2 A15	BIS2 A14	BIS2 A16	BIL4 A13		BIR4 A15	BIS4 A14	BIS4 A16	BIL6 A13	BIR6 A15	BIS6 A14	BIS6 A16				
U39	BIM3 A15	BML1 A13	BML1 A15	BMF1 A14	BMS1 A16	BML3 A13		BML3 A15	BMF2 A14	BMS3 A16	BML5 A13	BML5 A15	BMF3 A14	BMS5 A16				
Barrel, side A, Q. 4	BIM4 A15	BML2 A13	BML2 A15	BOF1 A14	BMS2 A16			BML4 A15	BOF3 A14	BMS4 A16	BML6 A13	BML6 A15	BOF7 A14	BMS6 A16				
# chan's in crate: 76	BIM5 A15	BOL1 A13	BOL1 A15	BOG0 A14	BOS1 A16	BOL3 A13		BOL3 A15	BOF5 A14	BOS3 A16	BOL5 A13	BOL5 A15	BOG6 A14	BOS5 A16				
		BOL2 A13	BOL2 A15	BOG2 A14	BOS2 A16	BOL4 A13	TIM	BOL4 A15	BOG4 A14	BOS4 A16	BOL6 A13	BOL6 A15	BOG8 A14	BOS6 A16	RCAT			
	ROL BA49	ROL BA06	ROL BA07	ROL BA14	ROL BA15	ROL BA22	TTC BA04	ROL BA23	ROL BA30	ROL BA31	ROL BA38	ROL BA39	ROL BA46	ROL BA47				
slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	

Partition: x62

		Tower 1 C					Tower 2 C						Tower 3 C					
Tower number	49	6	7	14	15	22		23	30	31	38	39	46	47				
Hex Tower number																		
crt	BIM1 C15	BIL1 C13	BIR1 C15	BIS1 C14	BIS1 C16	BIL3 C13		BIR3 C15	BIS3 C14	BIS3 C16	BIL5 C13	BIR5 C15	BIS5 C14	BIS5 C16				
8	BIM2 C15	BIL2 C13	BIR2 C15	BIS2 C14	BIS2 C16	BIL4 C13		BIR4 C15	BIS4 C14	BIS4 C16	BIL6 C13	BIR6 C15	BIS6 C14	BIS6 C16				
U27	BIM3 C15	BML1 C13	BML1 C15	BMF1 C14	BMS1 C16	BML3 C13		BML3 C15	BMF2 C14	BMS3 C16	BML5 C13	BML5 C15	BMF3 C14	BMS5 C16				
Barrel, side C, Q. 4	BIM4 C15	BML2 C13	BML2 C15	BOF1 C14	BMS2 C16			BML4 C15	BOF3 C14	BMS4 C16	BML6 C13	BML6 C15	BOF7 C14	BMS6 C16				
# chan's in crate: 75	BIM5 C15	BOL1 C13	BOL1 C15		BOS1 C16	BOL3 C13		BOL3 C15	BOF5 C14	BOS3 C16	BOL5 C13	BOL5 C15	BOG6 C14	BOS5 C16				
		BOL2 C13	BOL2 C15	BOG2 C14	BOS2 C16	BOL4 C13	TIM	BOL4 C15	BOG4 C14	BOS4 C16	BOL6 C13	BOL6 C15	BOG8 C14	BOS6 C16	RCAT			
	ROL BC49	ROL BC06	ROL BC07	ROL BC14	ROL BC15	ROL BC22	TTC BC04	ROL BC23	ROL BC30	ROL BC31	ROL BC38	ROL BC39	ROL BC46	ROL BC47				
slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	

crt																						
17																						
U15																						
Test Crate for MROD																						
													TIM								RCAT	
slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	

5.16 Towers and Crates in Rack 3

Rack 3 = Y.24-19.A1 | total # of chan's in rack: **220** | … in Barrel: **592** | … in Barrel + EC: **1118**

Partition: x62 | Tower 1 C | Tower 2 C | Tower 3 C

Tower number: 0 1 8 9 16 17 24 25 32 33 40 41

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
5								BIL1 C01	BIL1 C03	BIS1 C02	BIS1 C04	BIL3 C01		BIL3 C03	BIS3 C02	BIS3 C04	BIL5 C01	BIL5 C03	BIS5 C02	BIS5 C04	
								BIL2 C01	BIL2 C03	BIS2 C02	BIS2 C04	BIL4 C01		BIL4 C03	BIS4 C02	BIS4 C04	BIL6 C01	BIL6 C03	BIS6 C02	BIS6 C04	
U39								BML1 C01	BML1 C03	BMS1 C02	BMS1 C04	BML3 C01		BML3 C03	BMS3 C02	BMS3 C04	BML5 C01	BML5 C03	BMS5 C02	BMS5 C04	
Barrel, side C, Q. 1								BML2 C01	BML2 C03	BMS2 C02	BMS2 C04	BML4 C01		BML4 C03	BMS4 C02	BMS4 C04	BML6 C01	BML6 C03	BMS6 C02	BMS6 C04	
# chan's in crate: 72								BOL1 C01	BOL1 C03	BOS1 C02	BOS1 C04	BOL3 C01		BOL3 C03	BOS3 C02	BOS3 C04	BOL5 C01	BOL5 C03	BOS5 C02	BOS5 C04	
								BOL2 C01	BOL2 C03	BOS2 C02	BOS2 C04	BOL4 C01	TIM	BOL4 C03	BOS4 C02	BOS4 C04	BOL6 C01	BOL6 C03	BOS6 C02	BOS6 C04	RCAT
								ROL BC00	ROL BC01	ROL BC08	ROL BC09	ROL BC16	TTC BC05	ROL BC17	ROL BC24	ROL BC25	ROL BC32	ROL BC33	ROL BC40	ROL BC41	

Partition: x62 | Tower 1 C | Tower 2 C | Tower 3 C

Tower number: 2 3 10 11 18 19 26 27 34 35 42 43

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
6								BIL1 C05	BIL1 C07	BIS1 C06	BIS1 C08	BIL3 C05		BIL3 C07	BIS3 C06	BIS3 C08	BIL5 C05	BIL5 C07	BIS5 C06	BIS5 C08	
								BIL2 C05	BIL2 C07	BIS2 C06	BIS2 C08	BIL4 C05		BIL4 C07	BIS4 C06	BIS4 C08	BIL6 C05	BIL6 C07	BIS6 C06	BIS6 C08	
U27								BML1 C05	BML1 C07	BMS1 C06	BMS1 C08	BML3 C05		BML3 C07	BMS3 C06	BMS3 C08	BML5 C05	BML5 C07	BMS5 C06	BMS5 C08	
Barrel, side C, Q. 2								BML2 C05	BML2 C07	BMS2 C06	BMS2 C08	BML4 C05		BML4 C07	BMS4 C06	BMS4 C08	BML6 C05	BML6 C07	BMS6 C06	BMS6 C08	
# chan's in crate: 72								BOL1 C05	BOL1 C07	BOS1 C06	BOS1 C08	BOL3 C05		BOL3 C07	BOS3 C06	BOS3 C08	BOL5 C05	BOL5 C07	BOS5 C06	BOS5 C08	
								BOL2 C05	BOL2 C07	BOS2 C06	BOS2 C08	BOL4 C05	TIM	BOL4 C07	BOS4 C06	BOS4 C08	BOL6 C05	BOL6 C07	BOS6 C06	BOS6 C08	RCAT
								ROL BC02	ROL BC03	ROL BC10	ROL BC11	ROL BC18	TTC BC06	ROL BC19	ROL BC26	ROL BC27	ROL BC34	ROL BC35	ROL BC42	ROL BC43	

Partition: x62 | Tower 1 C | Tower 2 C | Tower 3 C

Tower number: 48 4 5 12 13 20 21 28 29 36 37 44 45

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
7							BIM1 C11	BIL1 C09	BIR1 C11	BIS1 C10	BIS1 C12	BIL3 C09		BIR3 C11	BIS3 C10	BIS3 C12	BIL5 C09	BIR5 C11	BIS5 C10	BIS5 C12	
							BIM2 C11	BIL2 C09	BIR2 C11	BIS2 C10	BIS2 C12	BIL4 C09		BIR4 C11	BIS4 C10	BIS4 C12	BIL6 C09	BIR6 C11	BIS6 C10	BIS6 C12	
U15							BIM3 C11	BML1 C09	BML1 C11	BMS1 C10	BMF1 C12	BML3 C09		BML3 C11	BMS3 C10	BMF2 C12	BML5 C09	BML5 C11	BMS5 C10	BMF3 C12	
Barrel, side C, Q. 3							BIM4 C11	BML2 C09	BML2 C11	BMS2 C10	BOF1 C12	BML4 C09		BML4 C11	BMS4 C10	BOF3 C12	BML6 C09	BML6 C11	BMS6 C10	BOF7 C12	
# chan's in crate: 76							BIM5 C11	BOL1 C09	BOL1 C11	BOS1 C10		BOL3 C09		BOL3 C11	BOS3 C10	BOF5 C12	BOL5 C09	BOL5 C11	BOS5 C10	BOG6 C12	
								BOL2 C09	BOL2 C11	BOS2 C10	BOG2 C12	BOL4 C09	TIM	BOL4 C11	BOS4 C10	BOG4 C12	BOL6 C09	BOL6 C11	BOS6 C10	BOG8 C12	RCAT
							ROL BC49	ROL BC04	ROL BC05	ROL BC12	ROL BC13	ROL BC20	TTC BC07	ROL BC21	ROL BC28	ROL BC29	ROL BC36	ROL BC37	ROL BC44	ROL BC45	

5.17 Towers and Crates in Rack 4

Rack 4 = Y.25-19.A1 | total # of chan's in rack: **197** … in EndCap: **526** … in Barrel + EC: **1118**

Partition: x63 | Tower 4 A | Tower 5 A | Tower 6 A

Tower number 48 0 1 8 9 16 17 24 25 32 33 40 41

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
							BEE12 A02	EILM4 A01	EIL4 A03	BIS78 A02	BIS78 A04	EIL23 A01		EIL23 A03	EIS1 A02	EIS1 A04					
9							BEE12 A04	EEL1 A01	EEL1 A03	EES1 A02	EES1 A04				EIS2 A02	EIS2 A04	EML1 A01	EML1 A03	EMS1 A02	EMS1 A04	
U39							EIL1 A01	EEL2 A01	EEL2 A03	EES2 A02	EES2 A04	EML3 A01		EML3 A03	EMS3 A02	EMS3 A04	EML2 A01	EML2 A03	EMS2 A02	EMS2 A04	
EndCap, side A, Q. 1							EIL1 A03	EML4 A01	EML4 A03	EMS4 A02	EMS4 A04	EOL4 A01		EOL4 A03	EOS4 A02	EOS4 A04	EOL1 A01	EOL1 A03	EOS1 A02	EOS1 A04	
# chan's in crate: 66								EML5 A01	EML5 A03	EMS5 A02	EMS5 A04	EOL5 A01		EOL5 A03	EOS5 A02	EOS5 A04	EOL2 A01	EOL2 A03	EOS2 A02	EOS2 A04	
												EOL6 A01	TIM	EOL6 A03	EOS6 A02	EOS6 A04	EOL3 A01	EOL3 A03	EOS3 A02	EOS3 A04	RCAT
							ROL EA48	ROL EA00	ROL EA01	ROL EA08	ROL EA09	ROL EA16	TTC EA09	ROL EA17	ROL EA24	ROL EA25	ROL EA32	ROL EA33	ROL EA40	ROL EA41	

Partition: x63 | Tower 4 A | Tower 5 A | Tower 6 A

Tower number 49 2 3 10 11 18 19 26 27 34 35 42 43

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
							BEE12 A06	EIL4 A05	EIL4 A07	BIS78 A06	BIS78 A08	EIL23 A05		EIL23 A07	EIS1 A06	EIS1 A08					
10							BEE12 A08		EEL1 A07	EES1 A06	EES1 A08				EIS2 A06	EIS2 A08	EML1 A05	EML1 A07	EMS1 A06	EMS1 A08	
U27							EIL1 A05	EEL2 A05	EEL2 A07	EES2 A06	EES2 A08	EML3 A05		EML3 A07	EMS3 A06	EMS3 A08	EML2 A05	EML2 A07	EMS2 A06	EMS2 A08	
EndCap, side A, Q. 2							EIL1 A07	EML4 A05	EML4 A07	EMS4 A06	EMS4 A08	EOL4 A05		EOL4 A07	EOS4 A06	EOS4 A08	EOL1 A05	EOL1 A07	EOS1 A06	EOS1 A08	
# chan's in crate: 65								EML5 A05	EML5 A07	EMS5 A06	EMS5 A08	EOL5 A05		EOL5 A07	EOS5 A06	EOS5 A08	EOL2 A05	EOL2 A07	EOS2 A06	EOS2 A08	
												EOL6 A05	TIM	EOL6 A07	EOS6 A06	EOS6 A08	EOL3 A05	EOL3 A07	EOS3 A06	EOS3 A08	RCAT
							ROL EA49	ROL EA02	ROL EA03	ROL EA10	ROL EA11	ROL EA18	TTC EA10	ROL EA19	ROL EA26	ROL EA27	ROL EA34	ROL EA35	ROL EA42	ROL EA43	

Partition: x63 | Tower 4 A | Tower 5 A | Tower 6 A

Tower number 50 4 5 12 13 20 21 28 29 36 37 44 45

Hex Tower number

crt	slot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
							BEE12 A10	EILM4 A09	EIL4 A11	BIS78 A10	BIS78 A12	EIL23 A09		EIL23 A11	EIS1 A10	EIS1 A12					
11							BEE12 A12	EEL1 A09	EEL1 A11	EES1 A10	EES1 A12				EIS2 A10	EIS2 A12	EML1 A09	EML1 A11	EMS1 A10	EMS1 A12	
U15							EIL1 A09	EEL2 A09	EEL2 A11	EES2 A10	EES2 A12	EML3 A09		EML3 A11	EMS3 A10	EMS3 A12	EML2 A09	EML2 A11	EMS2 A10	EMS2 A12	
EndCap, side A, Q. 3							EIL1 A11	EML4 A09	EML4 A11	EMS4 A10	EMS4 A12	EOL4 A09		EOL4 A11	EOS4 A10	EOS4 A12	EOL1 A09	EOL1 A11	EOS1 A10	EOS1 A12	
# chan's in crate: 66								EML5 A09	EML5 A11	EMS5 A10	EMS5 A12	EOL5 A09		EOL5 A11	EOS5 A10	EOS5 A12	EOL2 A09	EOL2 A11	EOS2 A10	EOS2 A12	
												EOL6 A09	TIM	EOL6 A11	EOS6 A10	EOS6 A12	EOL3 A09	EOL3 A11	EOS3 A10	EOS3 A12	RCAT
							ROL EA50	ROL EC04	ROL EC05	ROL EA12	ROL EA13	ROL EA20	TTC EA11	ROL EA21	ROL EA28	ROL EA29	ROL EA36	ROL EA37	ROL EA44	ROL EA45	

5.18 Towers and Crates in Rack 5

Rack 5 = Y.26-19.A1 | total # of chan's in rack: **132** | … in EndCap: **526** | … in Barrel + EC: **1118**

Partition: x63

		Tower 4 A					Tower 5 A						Tower 6 A				
Tower number	51	6	7	14	15	22		23	30	31	38	39	46	47			
Hex Tower number																	
crt		BEE12 A14	EIL4 A13	EIL4 A15	BIS78 A14	BIS78 A16	EIL23 A13		EIL23 A15	EIS1 A14	EIS1 A16						
12		BEE12 A16	EEL1 A13	EEL1 A15	EES1 A14	EES1 A16				EIS2 A14	EIS2 A16	EML1 A13	EML1 A15	EMS1 A14	EMS1 A16		
U39		EIL1 A13	EEL2 A13	EEL2 A15	EES2 A14	EES2 A16	EML3 A13		EML3 A15	EMS3 A14	EMS3 A16	EML2 A13	EML2 A15	EMS2 A14	EMS2 A16		
EndCap, side A, Q. 4		EIL1 A15	EML4 A13	EML4 A15	EMS4 A14	EMS4 A16	EOL4 A13		EOL4 A15	EOS4 A14	EOS4 A16	EOL1 A13	EOL1 A15	EOS1 A14	EOS1 A16		
# chan's in crate: 66			EML5 A13	EML5 A15	EMS5 A14	EMS5 A16	EOL5 A13		EOL5 A15	EOS5 A14	EOS5 A16	EOL2 A13	EOL2 A15	EOS2 A14	EOS2 A16		
							EOL6 A13	TIM	EOL6 A15	EOS6 A14	EOS6 A16	EOL3 A13	EOL3 A15	EOS3 A14	EOS3 A16	RCAT	
		ROL EA51	ROL EA06	ROL EA07	ROL EA14	ROL EA15	ROL EA22	TTC EA12	ROL EA23	ROL EA30	ROL EA31	ROL EA38	ROL EA39	ROL EA46	ROL EA47		
slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Partition: x64

		Tower 4 C					Tower 5 C						Tower 6 C				
Tower number	51	6	7	14	15	22		23	30	31	38	39	46	47			
Hex Tower number																	
crt		BEE12 C14	EIL4 C13	EIL4 C15	BIS78 C14	BIS78 C16	EIL23 C13		EIL23 C15	EIS1 C14	EIS1 C16						
16		BEE12 C16	EEL1 C13	EEL1 C15	EES1 C14	EES1 C16				EIS2 C14	EIS2 C16	EML1 C13	EML1 C15	EMS1 C14	EMS1 C16		
U27		EIL1 C13	EEL2 C13	EEL2 C15	EES2 C14	EES2 C16	EML3 C13		EML3 C15	EMS3 C14	EMS3 C16	EML2 C13	EML2 C15	EMS2 C14	EMS2 C16		
EndCap, side C, Q. 4		EIL1 C15	EML4 C13	EML4 C15	EMS4 C14	EMS4 C16	EOL4 C13		EOL4 C15	EOS4 C14	EOS4 C16	EOL1 C13	EOL1 C15	EOS1 C14	EOS1 C16		
# chan's in crate: 66			EML5 C13	EML5 C15	EMS5 C14	EMS5 C16	EOL5 C13		EOL5 C15	EOS5 C14	EOS5 C16	EOL2 C13	EOL2 C15	EOS2 C14	EOS2 C16		
							EOL6 C13	TIM	EOL6 C15	EOS6 C14	EOS6 C16	EOL3 C13	EOL3 C15	EOS3 C14	EOS3 C16	RCAT	
		ROL EC51	ROL EC06	ROL EC07	ROL EC14	ROL EC15	ROL EC22	TTC EC16	ROL EC23	ROL EC30	ROL EC31	ROL EC38	ROL EC39	ROL EC46	ROL EC47		
slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

crt																					
18																					
U15																					
Spare																					
slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

5.19 Towers and Crates in Rack 6

Rack 6 = Y.27-19.A1 | total # of chan's in rack: **197** | … in EndCap: **526** | … in Barrel + EC: **1118**

Partition: x64

		Tower 4 C					Tower 5 C					Tower 6 C				
Tower number		48	0	1	8	9	16		17	24	25	32	33	40	41	
Hex Tower number		x30	x00	x01	x08	x09	x10		x11	x18	x19	x20	x21	x28	x29	
crt		BEE12 C02	EILM4 C01	EIL4 C03	BIS78 C02	BIS78 C04	EIL23 C01		EIL23 C03	EIS1 C02	EIS1 C04					
13		BEE12 C04	EEL1 C01	EEL1 C03	EES1 C02	EES1 C04				EIS2 C02	EIS2 C04	EML1 C01	EML1 C03	EMS1 C02	EMS1 C04	
U39		EIL1 C01	EEL2 C01	EEL2 C03	EES2 C02	EES2 C04	EML3 C01		EML3 C03	EMS3 C02	EMS3 C04	EML2 C01	EML2 C03	EMS2 C02	EMS2 C04	
EndCap, side C, Q. 1		EIL1 C03	EML4 C01	EML4 C03	EMS4 C02	EMS4 C04	EOL4 C01		EOL4 C03	EOS4 C02	EOS4 C04	EOL1 C01	EOL1 C03	EOS1 C02	EOS1 C04	
# chan's in crate: 66			EML5 C01	EML5 C03	EMS5 C02	EMS5 C04	EOL5 C01		EOL5 C03	EOS5 C02	EOS5 C04	EOL2 C01	EOL2 C03	EOS2 C02	EOS2 C04	
							EOL6 C01	TIM	EOL6 C03	EOS6 C02	EOS6 C04	EOL3 C01	EOL3 C03	EOS3 C02	EOS3 C04	RCAT
		ROL EC48	ROL EC00	ROL EC01	ROL EC08	ROL EC09	ROL EC16	TTC EC13	ROL EC17	ROL EC24	ROL EC25	ROL EC32	ROL EC33	ROL EC40	ROL EC41	
slot	1 2 3 4 5 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Partition: x64

		Tower 4 C					Tower 5 C					Tower 6 C				
Tower number		49	2	3	10	11	18		19	26	27	34	35	42	43	
Hex Tower number		x31	x02	x03	x0a	x0b	x12		x13	x1a	x1b	x22	x23	x2a	x2b	
crt		BEE12 C06	EIL4 C05	EIL4 C07	BIS78 C06	BIS78 C08	EIL23 C05		EIL23 C07	EIS1 C06	EIS1 C08					
14		BEE12 C08		EEL1 C07	EES1 C06	EES1 C08				EIS2 C06	EIS2 C08	EML1 C05	EML1 C07	EMS1 C06	EMS1 C08	
U27		EIL1 C05	EEL2 C05	EEL2 C07	EES2 C06	EES2 C08	EML3 C05		EML3 C07	EMS3 C06	EMS3 C08	EML2 C05	EML2 C07	EMS2 C06	EMS2 C08	
EndCap, side C, Q. 2		EIL1 C07	EML4 C05	EML4 C07	EMS4 C06	EMS4 C08	EOL4 C05		EOL4 C07	EOS4 C06	EOS4 C08	EOL1 C05	EOL1 C07	EOS1 C06	EOS1 C08	
# chan's in crate: 65			EML5 C05	EML5 C07	EMS5 C06	EMS5 C08	EOL5 C05		EOL5 C07	EOS5 C06	EOS5 C08	EOL2 C05	EOL2 C07	EOS2 C06	EOS2 C08	
							EOL6 C05	TIM	EOL6 C07	EOS6 C06	EOS6 C08	EOL3 C05	EOL3 C07	EOS3 C06	EOS3 C08	RCAT
		ROL EC49	ROL EC02	ROL EC03	ROL EC10	ROL EC11	ROL EC18	TTC EC14	ROL EC19	ROL EC26	ROL EC27	ROL EC34	ROL EC35	ROL EC42	ROL EC43	
slot	1 2 3 4 5 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Partition: x64

		Tower 4 C					Tower 5 C					Tower 6 C				
Tower number		50	4	5	12	13	20		21	28	29	36	37	44	45	
Hex Tower number		x32	x04	x05	x0c	x0d	x14		x15	x1c	x1d	x24	x25	x2c	x2d	
crt		BEE12 C10	EILM4 C09	EIL4 C11	BIS78 C10	BIS78 C12	EIL23 C09		EIL23 C11	EIS1 C10	EIS1 C12					
15		BEE12 C12	EEL1 C09	EEL1 C11	EES1 C10	EES1 C12				EIS2 C10	EIS2 C12	EML1 C09	EML1 C11	EMS1 C10	EMS1 C12	
U15		EIL1 C09	EEL2 C09	EEL2 C11	EES2 C10	EES2 C12	EML3 C09		EML3 C11	EMS3 C10	EMS3 C12	EML2 C09	EML2 C11	EMS2 C10	EMS2 C12	
EndCap, side C, Q. 3		EIL1 C11	EML4 C09	EML4 C11	EMS4 C10	EMS4 C12	EOL4 C09		EOL4 C11	EOS4 C10	EOS4 C12	EOL1 C09	EOL1 C11	EOS1 C10	EOS1 C12	
# chan's in crate: 66			EML5 C09	EML5 C11	EMS5 C10	EMS5 C12	EOL5 C09		EOL5 C11	EOS5 C10	EOS5 C12	EOL2 C09	EOL2 C11	EOS2 C10	EOS2 C12	
							EOL6 C09	TIM	EOL6 C11	EOS6 C10	EOS6 C12	EOL3 C09	EOL3 C11	EOS3 C10	EOS3 C12	RCAT
		ROL EC50	ROL EC04	ROL EC05	ROL EC12	ROL EC13	ROL EC20	TTC EC15	ROL EC21	ROL EC28	ROL EC29	ROL EC36	ROL EC37	ROL EC44	ROL EC45	
slot	1 2 3 4 5 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

6 References

The raw event format in the ATLAS Trigger & DAQ
C. Bee et all. CERN, Atlas note ATL-DAQ-98-129 (ATL-COM-DAQ-98-018).
URL: http://cdsweb.cern.ch/?c=ATLAS
Version 4.0 of this document is available on EDMS as ATL-D-ES-0019.
URL: https://edms.cern.ch/document/445840/4.0/event-format-40.pdf

AMT. The ATLAS Muon TDC
Y. Arai. KEK, Japan.
URL: http:///atlas.kek.jp/tdc/

The Chamber Service Module
J. Chapman et all. University of Michigan.
URL: http://atlas.physics.lsa.umich.edu/docushare/ (ATLAS Electronics)

ASD. The ATLAS Amplifier Shaper Discriminator
J. Oliver (Harvard University), E. Hazen and C. Posch (Boston University).
URL: http://bmc.bu.edu/bmc/asd/asd_chip.html