EPIC DPU SOFTWARE

Users Guide

Prepared by
Andreas Hestermeyer

6. June 1991

Contributors :

A. Galvin, UMD/SPG

B. Gerlach TUB/IDA

A. Hestermeyer, TUB/IDA

B. Lundgren, UMD/SPG

R.W. McEntire, JHU/APL

C. Schlemm JHU/APL

W. Wiewesieck, TUB/IDA

List of figures

Fig. 1 : STICS event word 9

Fig. 2 : STICS massbins 17

Fig 3 : STICS PHA event word format 17

Fig. 4 : Table structure for STICS event classification 18

Fig. 5 : ICS event word 21

Fig. 6 : Table structure for ICS event classification 28

Fig. 7 : General EDB layout 34

Fig. 8 : DPU common area 1 35

Fig. 9 : DPU common area 2 35

Fig. 10 : STICS data area (lines 24 -44) in dual sensor mode 49

Fig. 11 : STICS data area (lines 45 - 59) in dual sensor mode 50

Fig. 12 : ICS data area (odd EDB) in dual sensor mode 51

Fig. 13 : ICS data area (even EDB) in dual sensor mode 52

Fig. 14 : STICS single sensor mode EDB (lines 0 - 18) 58

Fig. 15 : STICS single sensor mode EDB (lines 19 - 35) 59

Fig. 16 : STICS single sensor mode EDB (lines 36 - 59) 60

Fig. 17 : ICS single sensor mode EDB (lines 0 - 22) 61

Fig. 18 : ICS single sensor mode EDB (lines 23 - 41) 62

Fig. 19 : ICS single sensor mode EDB (lines 42 - 59) 63

List of tables

Table 1 : STICS over/underflow mass classes 11

Table 2 : STICS mass class parameters 12

Table 3 : STICS mass/charge classification parameters 13

Table 4 : STICS science rate bins in M vs. M/Q space 14

Table 4: STICS PHA & basic rate ranges in M vs. M/Q space 17

Table 6 : ICS mass ranges 22

Table 7 : ICS Proton bins 23

Table 8 : ICS Helium bins 23

Table 9 : ICS Medium bins 23

Table 10 : ICS Heavies bins 23

Table 11 : ICS over/underflow bins 24

Table 12 : ICS mass classification parameters 24

Table 13 : ICS time of flight bins 25

Table 14 : ICS energy bins 26

Table 15 : Telemetry format modes 29

Table 16 : EPIC format dependent telemetry allocation 30

Table 17 : EPIC format independent telemetry allocation 31

Table 18 : EPIC status area contents 33

Table 19 : ICS formatting schemes 53

Table 20 : ICS rates dual sensor mode (sorted by formatting scheme) 56

Table 21 : ICS rates dual sensor mode (sorted by rate type) 57

Table 22 : ICS rates single sensor mode (sorted by format scheme) 65

Table 23 : ICS rates single sensor mode (sorted by format scheme) 66

Table 24 : STICS time of flight calibration levels 107

Table 25 : ICS time of flight calibration levels 120

Table 26 : ICS PHA Energy level bins 124

Table 26 : ICS PHA Species level bins 125

6.8 Classification Command Register (C_COM) 141

7. DPU Internal Timing 142

7.1 Sectorization timing 142

8. Known problems 143

Contents

1. INTRODUCTION 7

2. PARTICLE CLASSIFICATION 8

2.1 STICS Iinstrument 9

2.1.1 Mass classification 9

2.1.2 Mass per Charge classification 12

2.1.3 Species classification 13

2.1.4 PHA data collection 17

2.1.5 Classification implementation in the DPU 18

2.2 ICS Instrument 21

2.2.1 Mass classification 21

2.2.2 TOF classification 25

2.2.3 Energy classification 25

2.2.4 PHA data collection 26

2.2.5 Classification implementation in the DPU 27

3. TELEMETRY 29

3.1 The GEOTAIL telemetry system 29

3.2 EPIC data contained in telemetry stream 29

3.3 Experiment status areas 31

3.4 EDB 33

3.5 Subcommutated housekeeping 66

4. DPU COMMANDS 67

5. Upload parameters accepted by the D_PARLDA command 131

6. DPU special function registers 136

6.1 LU-Test Register (LUTEST) 137

6.2 DPU Command Register (COMREG) 138

6.3 Message Register 1 (MREG1) 138

6.4 SCI-Control Register (SCICMD) 139

6.5 Power Control Register (PREG1) 139

6.6 Message Register 2 (MREG2) 140

6.7 Classification Status Register (C_STAT) 141

1. INTRODUCTION

2. PARTICLE CLASSIFICATION

Once initialized by the DPU, the STICS and ICS instrument's electronics send event words to the DPU which include information about the energy, the time-of-flight and the (polar) flight direction of measured ions.

The way the DPU processes the data of both instruments is basically the same : the event words are classified by time, energy and (polar & equatorial) direction The equatorial direction is derived from the S/C revolution, which each revolution (spin) is subdivided into 16 sectors. Each class (often referred to as a bin) is assigned a counter (the bin counter) which increments each time an event of that class is received. The bin counters are read and reset by the DPU on a cyclic basis, different bins can have different cycles. The counter values (rates) are logarithmically compressed and the resulting values are placed in the telemetry data stream.

Additionally, some event words are selected and placed into the telemetry data stream as they are. This is the direct event data, the singe events are referred to as PHA words (PHA means pulse hight analysis).

The classification process for STICS and ICS mainly differ in the fact that STICS has a deflection plate system and therefore is able to measure the charge state of each particle, which ICS is not able to do.

STICS classifies the particle mass into mass classes as a function of energy and time-of-flight. It also classifies the particle mass-per-charge into mass-per-charge classes as a function of time-of-flight and present deflection voltage. The mass classes and the mass-per-charge classes define a two-dimensional space in which the STICS bins are defined. Two types of bins are used : the science bins and the basic bins (the values of the assigned counters are the science rates and the basic rates). The science bins are defined such that every bin represents a particle species with a defined charge state.
The basic bins represent the areas in the mass vs. mass-per-charge class space from which the PHA words are selected. Due to the limited telemetry data rate, not every event word which falls into one of these areas can be transmitted as a PHA word. To get information about the absolute number of events in the basic bins, the DPU also counts basic rates.
Most rates for STICS are summed over all directions and get reported once per spin. Some rates are transmitted with the highest directional resolution possible (16 sectors * 6 polar directions) and some other with half the possible directional resolution.

ICS classifies each particle by mass, energy and time-of-flight. The mass bins (areas in the energy vs. time-of-flight plane) are also used for PHA word selection. A priorization scheme is used where the DPU always tries to select PHA words from high priority bins. The priority is rotated between the bins every 2nd spin by means of energy level and mass.

The ICS rates are summed in a number of formats. Some rates are transmitted with a high directional resolution and a low time resolution by summing rates from the same sectors and polar directions over a couple of spins. The maximum number of spins over which the rates are summed is 32. Therefore, 32 spins were defined to be the EPIC science record.

2.1 STICS Iinstrument

The event data transmitted by the STICS instrument to the DPU has the following format. One event word is transmitted for each particle to be classified. The maximum data rate is 100,000 events/second.

9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	0	1	0	3	2	1	0	1	0
TOF (T_d)										Energy (E_d)										SSD		START				STOP	

Fig. 1 : STICS event word

With its knowledge about the current deflection voltage level step S, the DPU classifies each received particle into a mass class (N) and a mass per charge class (NQ) using the transmitted T_d and E_d. The mass and mass-per-charge class is then used to classify the event into its science and basic bin.

The SSD-, START- and STOP-identifiers are used to differentiate between 6 polar directions (PD_0 - PD_5). The START-Id has priority over the STOP id and the STOP id has priority over the SSD id. Thus, if no START id is given, the STOP id is used to determine the direction and if also no STOP id is given, the SSD id is used to determine from which direction the particle came into the telescope. Since the STOP- and SSD-Id's only have a resolution of 3 Directions, the events are assigned to directions PD_0, PD_2 and PD_4. If an invalid id information is provided, the event is classified in direction PD_6, which is an artificial "direction" defined for debugging purposes.

The next sections will give an overview about the math equations used to classify events, one other subsection will deal about how the DPU implements this.

2.1.1 Mass classification

The mass classification uses the equation

$$\ln(m) = A_1 + A_2 \cdot x + A_3 \cdot y + A_4 \cdot x \cdot y + A_5 \cdot x^2 + A_6 \cdot y^3 \quad (1)$$

$$x = \ln(E_m) \quad (2)$$

$$y = \ln(T_m) \quad (3)$$

$$E_m = (E_d - EOC) / EADC \quad (4)$$

$$T_m = (T_d - TOC) / TADC \quad (5)$$

where :

- m is the mass in [amu]
- E_m is the measured energy in [keV]
- T_m is the measured time-of-flight in [ns]
- E_d is the digital energy contained in the event word in [channel] (0..1023)
- T_d is the digital time-of-flight contained in the event word in [channel] (0..1023)
- EOC is the conversion offset of the energy analog-to-digital (ADC) converter of the instrument analog electronics (AE) in [channel] (default 0)
- EADC is the energy A/D conversion factor of the AE ADC in [channel / keV] (default 0.33333 channel/keV)
- TOC is the conversion offset of the time-of-flight ADC of the instrument analog electronics in [channel] (default 0)
- TADC is the time-of-flightA/D conversion factor of the AE ADC in [channel / ns] (default 2.5 channel/ns)
- A_1 - A_6 are the polynomial coefficients with the following default values :
  - A_1 = 2.69575
  - A_2 = -0.843766
  - A_3 = -2.38009
  - A_4 = 0.385641
  - A_5 = 0.0513127
  - A_6 = 0.0690096

The mass m is mapped onto a logarithmically space mass-class axis by the relation

$$m = m_{min} \cdot k_4^{(NM-1)} \quad (6)$$

$$k_4 = (m_{max}/m_{min})^{1/NMAX} \quad (7)$$

1,094684214

where

- m is the mass in [amu]
- NM is the mass class [1..NMAX]
- NMAX is the highest mass class (58)
- m_{min} lower bound of mass in [amu] (0.5 amu)
- m_{max} upper bound of mass in [amu] (95.0 amu)

Equations (1) and (6) can be combined to

$$NM = B_1 + B_2 \cdot x + B_3 \cdot y + B_4 \cdot x \cdot y + B_5 \cdot x^2 + B_6 \cdot y^3 \qquad (8)$$

where

$B_1 = 1 + (A_1 - \ln(m_{min})) / \ln(k_4) = 38.462073$

$B_2 = A_2 / \ln(k_4) = -9.327289$

$B_3 = A_3 / \ln(k_4) = -26.31096$

$B_4 = A_4 / \ln(k_4) = 4.263013$

$B_5 = A_5 / \ln(k_4) = 0.567229$

$B_6 = A_6 / \ln(k_4) = 0.762857$

NM is the mass class between and including 1 and NMAX

All events are checked for mass-, time-of-flight- and energy over/underflow. For these, special 'mass classes' are reserved :

Mass class	Event
59	mass overflow : $m \geq m_{max}$
60	mass underflow : $m \leq m_{min}$
61	energy overflow : $E_m \geq E_{max}$, default 3030 keV
0	energy underflow (i.e. MASS ZERO) : $E_m \leq E_{min}$, default 0.0 keV
62	time-of-flight underflow : $T_m \leq T_{min}$, default ??
63	time-of-flight overflow : $T_m \geq T_{max}$, default ??

Table 1 : STICS over/underflow mass classes

So, whenever an event falls into the window given by E_{max}, E_{min}, T_{max} and T_{min} it will be classified as given by equation 8. If this results in a massclass above 58 or below 1, the event will be classified as mass overflow (mass class 59) or mass underflow (mass class 60)

The following table gives the relations between the coefficients of the mass equations and the variables and their format in which the values are actually stored in the DPU. Also given is the parameter number for the **D_PARLDA** command to load the variables.

Coefficient	Default	Variable	Format
Parmeter #			
B_1 - B_6	rB1 - rB6	signed 16.16 fix point	11
EADC	rSEADK	signed 16.16 fix point	12

ln(EADC)	rLnEADK	signed 16.16 fix point	12
TADC	rSTADK	signed 16.16 fix point	12
ln(TADC)	rLnTADK	signed 16.16 fix point	12
EOC	iSNMEOC	signed 16 bit integer	13
TOC	iSNMTOC	signed 16 bit integer	13
E_{min}	rSEMin	signed 16.16 fix point	24
E_{max}	rSEMax	signed 16.16 fix point	24
T_{min}	rSTMin	signed 16.16 fix point	24
T_{max}	rSTMax	signed 16.16 fix point	24

Table 2 : STICS mass class parameters

2.1.2 Mass per Charge classification

The mass per charge classification uses the equation

$$\ln(mq) = \ln(C_1) + \ln(D_1 \bullet D_2^S - C_2) + 2 \bullet \ln(T_m) \qquad (9)$$

where

mq	is the mass/charge in [amu/e]
$\ln(C_1)$	is -10.86274
C_2	1.5 if mq < 11 amu/e, else 4.0
T_m	as defined for equation 1
S	the deflection voltage step number (0 ... 31)
D_1	is 7.97
D_2	is 1.116

The mass per charge (m/q) is mapped onto a logarithmically spaced mass-per-charge-class axis by the equation

$$mq = mq_{min} \bullet k_2^{(NQ-1)} \qquad (10)$$

$$k_2 = (mq_{max}/mq_{min})^{1/NQMAX} \quad = 1,038727043 \qquad (11)$$

mq	is the mass per charge in [amu/e]
NQ	is the mass per charge class (1 .. NQMAX)
NQMAX	is the hightst mass-per-charge class (126)
mq_{min}	lower bound of mass-per-charge in [amu/e] (0.5 amu/e)
mq_{max}	upper bound of mass-per-charge in [amu/e] (60 amu/e)

Equations (9) and (10) can be combined to

$$NQ = E_1 + E_2 \cdot \ln(D_1 \cdot D_2{}^S - C_2) + E_3 \cdot \ln(T_m) \qquad (12)$$

where

$E_1 = 1 + (\ln(C_1) - \ln(mq_{min})) / \ln(k_2) = -266.649566$

$E_2 = 1 / \ln(k_2) = 26.318612$

$E_3 = 2 / \ln(k_2) = 52.637224$

The following table gives the relations between the coefficients of the mass equations and the variables and the format in which the values are actaully stored in the DPU.. Also given is the parameter number for the **D_PARLDA** command to load the variables.

Coefficient	Variable	Format	Parmeter #
E1 - E3	dwE1 - dwE3	signed 16.16 fix point	16
D_1 - D_2	dwD1 - dwD2	signed 16.16 fix point	16
C_2	dwC2_1	signed 16.16 fix point	15
	dwC2_2	signed 16.16 fix point	15

Table 3 : STICS mass/charge classification parameters

Note that for the mass-per-charge classification there is no special over/underflow check.

2.1.3 Species classification

Table 4 gives the default definition list of the (rectangular) areas defined in the mass vs. mass-per-charge class plane for the science bins. Because the areas are rectangular, they are often also referred as boxes. The definition table can be changed by setting up an appropiate box definition with the **D_PARLDA 30** command and copying that definition to the list using the **D_DIGCMD 42** . Finally the new definition list can be used to overwrite the old classification scheme by the **D_DIGCMD 17** command.

Bin No.	Species	Logic	mass range	mass class range		m/q range	m/q class range	
112	D1			3	60		0	127
113	D2			0	2		0	127
114	D3			1	18		11	26
115	D4			18	30		31	61
116	D5			32	57		32	66
117	D6			31	57		67	80
118	D7			24	58		84	99

					y	NM		x	NQ	
119	D8				28	56			105	119
22	MOVER				59	59			0	127
23	MUNDER				60	60			0	127
24	EUNDER				61	61			0	127
25	TUNDER				62	62			0	127
26	TOVER				63	63			0	127
16	HR0	H +	0.60	2.20	3	16	0.80	1.25	13	24
17	HR1	O +	5.00	80.00	26	56	14.95	20.30	90	97
18	SMR0	He +	2.70	6.50	20	28	3.55	4.65	53	59
19	SMR1	He + 2	2.70	6.50	20	28	1.70	2.30	33	40
20	SMR2	O + 2	9.00	30.00	33	45	7.70	9.20	73	77
32	MR0	C + 3	9.70	13.60	34	37	3.80	4.40	54	57
33	MR1	C + 4	9.50	13.60	34	37	2.85	3.20	47	49
34	MR2	C + 5	9.50	13.60	34	37	2.25	2.55	41	43
35	MR3	C + 6	9.50	13.60	34	37	1.85	2.15	35	38
36	MR4	N +	5.00	50.00	26	51	12.50	14.95	86	89
37	MR5	N +	0.00	0.00	MASS ZERO		11.50	14.95	84	89
38	MR6	N + 2	9.00	23.00	33	42	6.60	7.70	69	72
39	MR7	N + 2	0.00	0.00	MASS ZERO		6.60	7.70	69	72
40	MR8	H +	0.00	0.00	MASS ZERO		0.80	1.25	13	24
41	MR9	O +	0.00	0.00	MASS ZERO		14.95	20.30	90	97
42	MR10	He +	0.00	0.00	MASS ZERO		3.55	4.65	53	59
43	MR11	O + 2	0.00	0.00	MASS ZERO		7.70	9.70	73	78
44	MR12	O + 3	12.70	20.00	37	41	4.95	5.95	61	65
45	MR13	O + 4	13.60	20.00	38	41	3.70	4.40	54	57
46	MR14	O + 5	13.60	20.00	38	41	3.00	3.40	48	50
47	MR15	O + 6	11.00	20.00	35	41	2.55	2.85	44	46
48	MR16	O + 7	13.90	20.00	38	41	2.15	2.45	39	42
49	MR17	O + 8	13.90	20.00	38	41	1.80	2.10	35	38
50	MR18	Ne + 8	17.80	22.10	40	42	2.30	2.55	41	43
51	MR19	MgSi1	22.10	39.00	43	48	2.15	3.29	39	50
52	MR20	MgSi1	22.10	39.00	43	48	3.29	5.95	51	65
53	MR21	Fe6,7	39.00	75.00	49	55	7.40	9.80	72	78
54	MR22	Fe8,9	39.00	75.00	49	55	5.83	7.40	66	71
55	MR23	Fe10,11	39.00	75.00	49	55	4.82	5.83	61	65
56	MR24	Fe12,13	39.00	75.00	49	55	4.10	4.82	56	60
57	MR25	Fe14,15	39.00	75.00	49	55	3.57	4.10	53	55
58	MR26	Fe16,17	39.00	75.00	49	55	3.06	3.57	49	52
59	MR27	NO + O2 +	7.00	72.00	30	55	28.00	42.00	107	117
60	MR28	NO + O2 +	0.00	0.00	MASS ZERO		28.00	60.00	107	126
61	MR29	He + 2	0.00	0.00	MASS ZERO		1.60	2.30	32	40
						NM			NQ	

Table 4 : STICS science rate bins in M vs. M/Q space

Matrix Rates: uploaded to S/C GEOTAIL/STICS 17-SEP-92

bin	entry	NMlr	NQlr	NMul	NQul	bin	name	species
16	42	0	24	16	13	16	HR0	H+
17	21	0	97	56	91	17	HR1	O+1
18	44	0	59	30	53	18	SMR0	He+1
19	46	0	40	30	33	19	SMR1	He+2
20	23	33	77	45	73	20	SMR2	O+2
32	13	34	57	37	54	32	MR0	C+3
33	14	34	49	37	47	33	MR1	C+4
34	15	34	43	37	41	34	MR2	C+5
35	16	34	38	37	35	35	MR3	C+6
36	17	0	90	56	86	36	MR4	N+1
37	18	36	53	40	51	37	MR5	N+4
38	19	33	72	42	69	38	MR6	N+2
39	20	0	69	0	72	39	MR7	N+2zero
40	43	31	38	33	35	40	MR8	BHE2
41	22	31	57	33	54	41	MR9	BHE1
42	45	0	32	0	25	42	MR10	BH+zero
43	24	0	78	0	73	43	MR11	O+2zero
61	19	37	65	41	61	61	MR12	O+3
45	26	38	57	41	54	45	MR13	O+4
46	27	38	50	41	48	46	MR14	O+5
47	28	35	46	41	44	47	MR15	O+6
48	29	38	42	41	39	48	MR16	O+7
49	30	38	38	41	35	49	MR17	O+8
50	31	40	43	42	41	50	MR18	Ne+8
51	32	43	50	48	39	51	MR19	MgSi +10:14
52	33	43	65	48	51	52	MR20	MgSi +5:~~10~~ 9
53	34	49	78	55	72	53	MR21	Fe +6,7
54	35	49	71	55	66	54	MR22	Fe +8,9
55	36	49	65	55	61	55	MR23	Fe +10,11
56	37	49	60	55	56	56	MR24	Fe +12,13
57	38	49	55	55	53	57	MR25	Fe +14,15
58	39	49	52	55	49	58	MR26	Fe +16,17
59	40	0	117	56	107	59	MR27	NO+1 & O2+1
60	41	1	32	16	25	60	MR28	BH+triples
44	25	34	68	37	65	44	MR29	C+2

* changed in 1993 to 90 and 89

Basic Rates: uploaded to S/C GEOTAIL/STICS 17-SEP-92

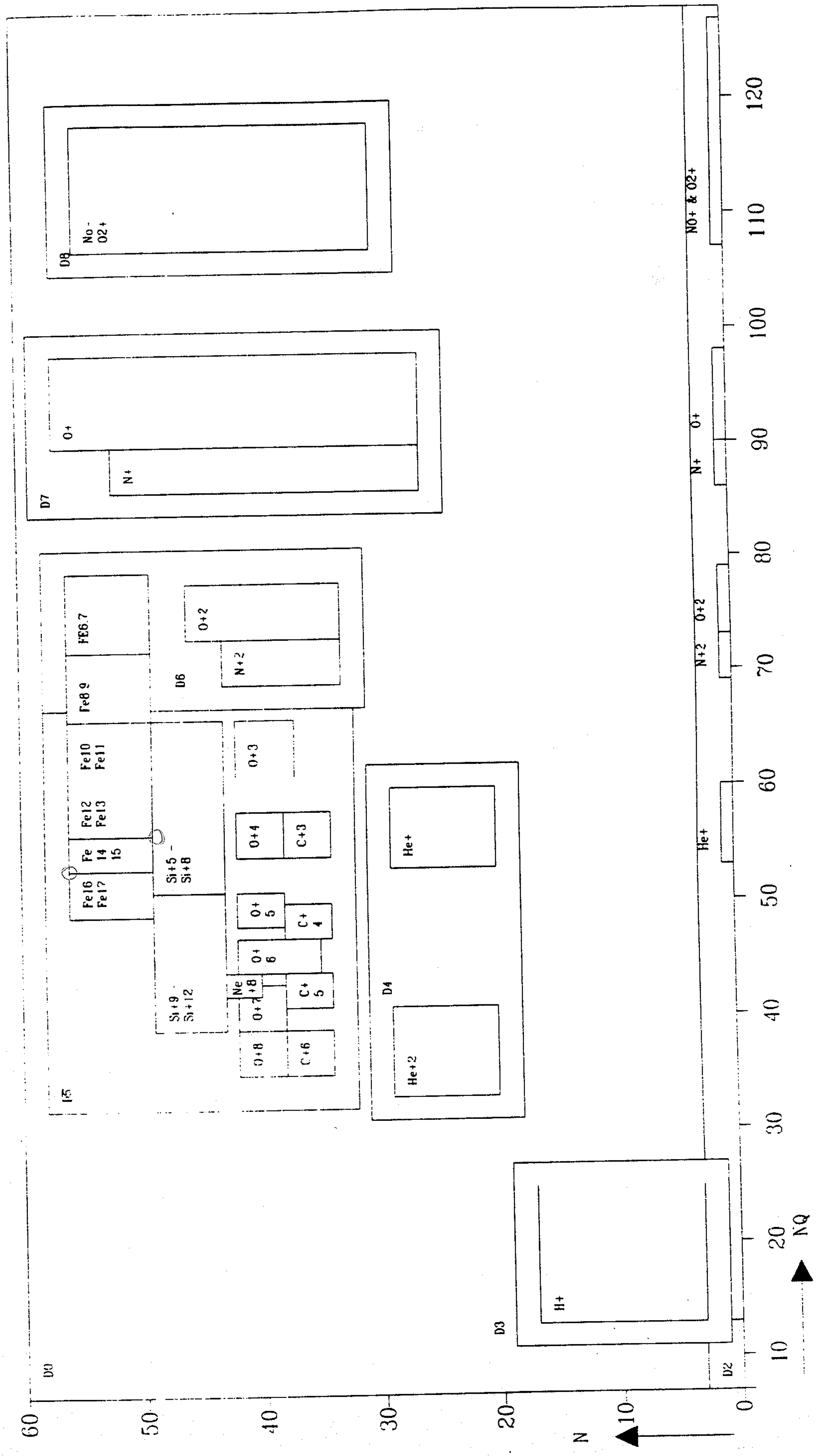
bin	entry	NMlr	NQlr	NMul	NQul	bin	name	species
0	0	31	81	58	0	0	BR0	CNONE
1	1	0	126	58	82	1	BR1	O & NO
1	2	0	126	0	82	1	BR1	O & NO
2	3	0	81	30	0	2	BR2	H & He
2	4	0	81	0	0	2	BR2	H & He
3	5	0	81	30	31	3	BR3	H
3	6	0	81	0	31	3	BR3	H

22.1
39.0
(30.50)

	M/Q	2.15	3.29	5.95
24 28 32	30.50 / M/Q	14.19	9.27	6.13
		* 14.0 30.10		* 5.0 =29.75
	30 / M/Q	13.95	9.12	5.04

The D1 to D8 "species" surround the physical species and were implemented for debugging purposes. This is the same for the MOVER, MUNDER, EOVER, TUNDER and TOVER bins which represent counting rates for mass over/underflow, energy overflow and time-of-flight over/underflow. These "diagnostic rates" are accumulated over one science record in the DPU and spilled out once per science record.

Figure 2 on page 16 shows the species boxes defined in this table in the N vs NQ space.


D8
No-
O2+
D7
O+
N+
D6
FE6.7
Fe8.9
O+2
N+2
Fe10
Fe11
O+3
Fe12
Fe13
Fe
14
15
Fe16
Fe17
Si+5 -
Si+8
O+4
C+3
O+
5
C+
4
O+
6
Ne
+8
Si+9 -
Si+12
C+
5
O+8
C+6
D5
D4
He+
He+2
D3
H+
D0
D2
NO+ & O2+
O+
N+
O+2
N+2
He+
120
110
100
90
80
70
60
50
40
30
20
10
0
NQ
60
50
40
30
20
10
N

2.1.4 PHA data collection

The DPU transmits 47 event word samples in each EDB. These event words are selected from three of four possible basic bins defined in the mass vs. mass-per-charge class plane. Each of these four bins (called "PHA ranges") is a union of one or more rectangular areas. They are defined in a list similar to the box definition list for the science rate bins.

Since the DPU can't transmit **every** event which falls into one of the defined PHA ranges, the total number of events which fall into each range are accumulated in the basic bins.

The following is the content of the default basic bin box definition table.

Range	Species	mass range [amu]		mass class range		m/q range [amu/e]		m/q class range	
0	P001	8.16	95.00	32	58	1.47	10.85	29	81
	P002	0.00	0.00	0	0	5.48	10.85	64	81
1	P101	1.78	8.16	15	31	1.45	10.85	29	81
	P102	0.00	0.00	0	0	1.45	5.48	29	63
2	P201	0.00	95.00	0	58	10.85	60.00	82	126
3	P301	0.00	95.00	0	58	0.50	1.45	1	28
	P302	0.50	1.78	1	14	1.45	10.85	29	81

Table 4: STICS PHA & basic rate ranges in M vs. M/Q space

Due to limited data rate, only three of the four defined bins can be active at a given time. By default, the PHA ranges 0 - 2 are active and associated with the basic bins 0 - 2, respectively. This assignation can be changed with the S_RANGE command.

The DPU will try to transmit one PHA event word from every sector and every active PHA range in a spin, leaving out the last range in sector 15, which sums up to 47 PHA event words per spin as mentioned above. If not enough PHA event words for some sector/range combination were received from the sensor, the rest is filled with event words from other sectors or ranges. Each PHA event word is 32 bits long and is coded as follows :

MSB					LSB
1 0	4 3 2 1 0	8 7 6 5 4 3 2 1 0	3 2 1 0	1 0	9 8 7 6 5 4 3 2 1 0
STP	ID	Energy (E_{dc})	sector	SSD	TOF (T_d)

Fig 3 : STICS PHA event word format

Here,

ID = START * 3 + RANGE

where START is the START ID (0..9) and RANGE (0..2) is the basic rate bin number of the area in M vs. M/Q the event fell into.

E_{dc} is obtained by compressing the 10-bit value E_d to 9 bits according to the following algorithm :

if $E_d < 256$
  $E_{dc} = E_d$
else
  $E_{dc} = E_d / (\text{int}(\text{ld}(E_d))-6)$

2.1.5 Classification implementation in the DPU

The EPIC DPU does not calculate the given formulas above each time it receives a valid event word. Instead it uses a look-up technique based on linear tables to classify the incoming events. Figure 4 shows the basic table structure implemented in the DPU.

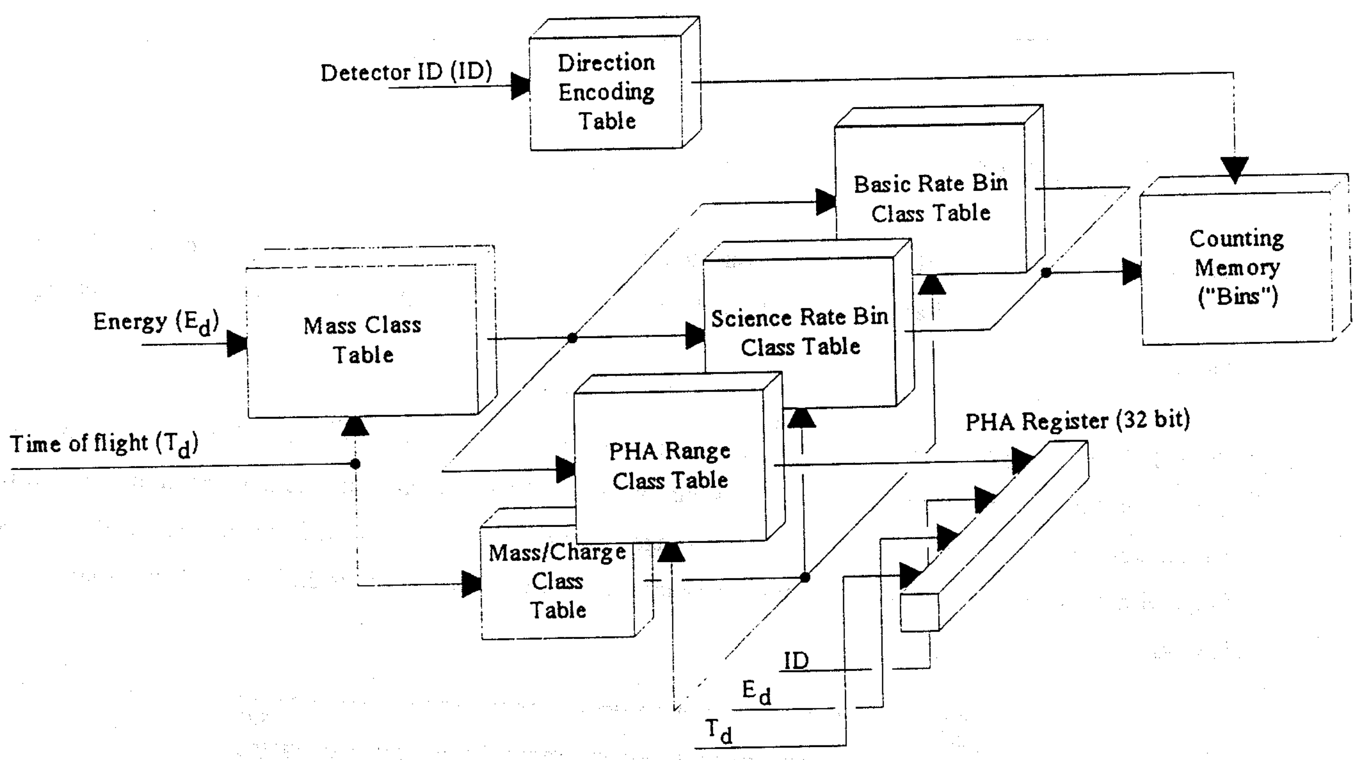


Fig. 4 : Table structure for STICS event classification

The digital energy and time-of-flight values address a two-dimensional mass classification table, which delivers a mass class N at its output. This table is built during DPU initialization and by command (see D_DIGCMD) using equations (2 - 6).

The time-of-flight value also addresses a one-dimensional mass-per-charge table, which delivers a mass-per-charge class NQ at its output. This table is built during DPU initialization using equations (12,5) and is updated once per spin depending on the current deflection voltage step S.

The mass class and the mass-per-charge class values address two two-dimensional tables (i.e. the mass vs. mass-per-charge space), the science bin and the basic rate bin classification table to look-up the bin numbers. A table with contents similar to the basic bin table is used to decide wether the event falls into one of the basic bins and is worth being classified as a PHA word.

These three tables are painted with rectangular areas of bin numbers which address the respective bin counters in the counting memory. Whereas the science bin table has its own defined boxes, the boxes drawn in the basic bin table are the same as in the PHA bin table.

The boxes are painted according to two box definitions lists starting with the first and ending with the last entry. Therefore, choosing a special ordering scheme in the definition lists, boxes can overlap each other. Table 4 showed the default definition list for the science bin table, Table 4 showed the definition list for the PHA ranges and basic bins.

The detector ID (containing START-, STOP- and SSD-Id, see figure 1 on page 9 addresses a one dimensional table which encodes the given informations into six possible directions and one "invalid ID direction".

Using two consecutive classification cycles, the bin numbers gained from the science bin classification table and from the basic bin classification table are used, together with the direction code, to address and increment the appropriate bin counters in the counting memory. The rates from the counting memory are read, reset and processed by the DPU processor on a cyclic basis.

It must be noted that figure 4 does not present every detail of the classification process. Especially, the energy compression table is not displayed. This one-dimensional table is used to compress the received 10 bit value for E_d to an 8 bit value. This lowers the needed size for the mass classification table to 256 kB instead of 1 MB of memory.

The logarithmic compression scheme is defined below.

$$
\begin{aligned}
&\text{if } E_d < 96 \\
&\quad E_c = E_d \\
&\text{else} \\
&\quad E_c = \mathrm{int}(\, E_d/2^L\,) + 48 \cdot L \\
&\quad \text{where } L = \mathrm{int}(\, \mathrm{ld}(Ed/48)\,)
\end{aligned}
\tag{13}
$$

2.2 ICS Instrument

The event data transmitted by the ICS instrument to the DPU has the following format :

9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	0	0	6	5	4	3	2	1	0
TOF (T_d)										Energy (E_d)										H							

Fig. 5 : ICS event word

The DPU classifies the time-of-flight, the energy and the mass of the received events into different bins. The H identifier is used to differentiate between the north (H = 0) and the south (H = 1) telescope ("head") of the ICS instrument. H is also often referred to as the ICS "head id".

2.2.1 Mass classification

The mass classification uses the equation

$$\ln(m) = A_1 + A_2 \cdot x + A_3 \cdot y + A_4 \cdot x \cdot y + A_5 \cdot x^2 + A_6 \cdot y^3 \quad (14)$$

$$x = \ln(E_m) \quad (15)$$

$$y = \ln(T_m) \quad (16)$$

$$E_m = (E_d - EOC) / EADC \quad (17)$$

$$T_m = (T_d - TOC) / TADC \quad (18)$$

where :

- m is the mass in [amu]
- E_m is the measured Energy in [keV]
- T_m is the measured time-of-flight in [ns]
- E_d is the digital energy contained in the event word in [channel] (0..1023)
- T_d is the digital time-of-flight contained in the event word in [channel] (0..1023)
- EOC is the conversion offset of the energy analog-to-digital (ADC) converter of the instrument analog electronics (AE) in [channel] (default 0)
- EADC is the energy A/D conversion factor of the AE ADC in [channel / keV] (default 0.333333 channel/keV)
- TOC is the conversion offset of the time-of-flight ADC of the instrument analog electronics in [channel] (default 0)
- TADC is the time-of-flightA/D conversion factor of the AE ADC in [channel / ns] (default 9.0909090909 channel/ns)

A_1 - A_6 are the polynomial coefficients with the following default values :

A_1 = -5.70969

A_2 = -0.188562

A_3 = 0.634870

A_4 = 0.134778

A_5 = 0.0394281

A_6 = 0.0381063

The mass is classified into 4 ranges and the mass under/overflow ranges. Each of the 4 mass ranges itself is divided into several subranges (the ICS mass bins) with respect to the energy.

The mass ranges are defined as follows

mass [amu] ≥	<	range name
0	0.5	mass underflow
0.5	2.5	Protons
2.5	8	Helium
8	21	Medium
21	100	Heavies (Na - Fe)
100	∞	mass overflow

Table 6 : ICS mass ranges

The Protons (P_i), Heliums (HE_i), Mediums (M_i) and Heavies (H_i) are subdivided into mass bins according to the following tables.

Energy [keV] ≥	<	range name	bin no
20.	31.70	P_1	0
31.70	50.30	P_2	1
50.30	79.80	P_3	2
79.80	126.50	P_4	3
126.50	200.60	P_5	4
200.60	318.10	P_6	5
318.10	504.50	P_7	6
504.50	800.00	P_8	7
800.00	1550.00	P_9	8
1550.00	3000.00	P_{10}	9

Table 7 : ICS Proton bins

Energy [keV] ≥	<	range name	bin no
21.	31.70	HE_1	10
31.70	50.30	HE_2	11
50.30	79.80	HE_3	12
79.80	126.50	HE_4	13
126.50	200.60	HE_5	14
200.60	318.10	HE_6	15
318.10	504.50	HE_7	16
504.50	800.00	HE_8	17
800.00	1550.00	HE_9	18
1550.00	3000.00	HE_{10}	19

Table 8 : ICS Helium bins

Energy [keV] ≥	<	range name	bin no
22.	33.00	M1	20
33.00	55.00	M2	21
55.00	90.00	M3	22
90.00	118.00	M4	23
118.00	245.00	M5	24
245.00	404.00	M6	25
404.00	667.00	M7	26
667.00	1100.00	M8	27
1100.00	1820.00	M9	28
1820.00	3000.00	M10	29

Table 9 : ICS Medium bins

Energy [keV] ≥	<	range name	
23.	120.00	H_1	30
120.00	228.00	H_2	31
228.00	435.00	H_3	32
435.00	880.00	H_4	33
880.00	1575.00	H_5	34
1575.00	3000.00	H_6	35

Table 10 : ICS Heavies bins

All events are checked for mass-, time-of-flight- and energy over/underflow. For this, special "mass" bins are reserved :

bin no	condition
36	mass underflow
37	mass overflow
42	Energy underflow ($E_d < E_{dmin}$)
43	Energy overflow ($E_d \geq E_{dmax}$)
44	Time-of-flight underflow ($T_d < T_{dmin}$)
45	Time-of-flight overflow ($T_d \geq T_{dmax}$)

Table 11 : ICS over/underflow bins

The following table gives the relations between the coefficients of the mass equations and the variables and their format in which the values are stored. Also given is the parameter number for the **D_PARLDA** command to load the variables.

Coefficient	Variable	Format	Parmeter #
A_1 - A_6	rA1 - rA6	signed 16.16 fix point	0
EADC	rEADC	signed 16.16 fix point	1
ln(EADC)	rEADCLN	signed 16.16 fix point	1
TADC	rTADC	signed 16.16 fix point	2
ln(TADC)	rTADCLN	signed 16.16 fix point	2
EOC	iEOC	signed 16 bit integer	3
TOC	iTOC	signed 16 bit integer	3
E_{dmin}	iECmin	signed 16 bit integer	use D_PARLDB to load
E_{dmax}	iECmax	signed 16 bit integer	use D_PARLDB to load
T_{dmin}	iTCmin	signed 16 bit integer	use D_PARLDB to load
T_{dmax}	iTCmax	signed 16 bit integer	use D_PARLDB to load

Table 12 : ICS mass classification parameters

2.2.2 TOF classification

The time-of-flight is classified into 16 bins plus two over/underflow bins according to the following table.

Time-of-flight [ns] ≥	<	range name	bin no
24.1.1.1.1	T_{min}	T_0	39
T_{min}	3.5	T_1	62
3.5	6.0	T_2	63
6.0	7.2	T_3	64
7.2	8.8	T_4	65
8.8	10.7	T_5	66
10.7	12.9	T_6	67
12.9	15.7	T_7	68
15.7	19.0	T_8	69
19.0	23.0	T_9	70
23.0	27.8	T_{10}	71
27.8	33.7	T_{11}	72
33.7	40.9	T_{12}	73
40.9	49.5	T_{13}	74
49.5	60	T_{14}	75
60	77	T_{15}	76
77	T_{max}	T_{16}	77
T_{max}	∞	T_{17}	41

Table 13 : ICS time of flight bins

T_{min} and T_{max} can be calculated from Tdmin and Tdmax using equation 18.

2.2.3 Energy classification

The energy is classified into 16 bins plus two over/underflow bins according to the following table.

Energy [keV] ≥	<	range name	bin no
0	E_{min}	E_0	38
E_{min}	26.5	E_1	62
26.5	35.0	E_2	63
35.0	46.5	E_3	64
46.5	62.0	E_4	65
62.0	82.5	E_5	66
82.5	109.5	E_6	67
109.5	145.4	E_7	68
145.4	193.0	E_8	69
193.0	256.0	E_9	70
256.0	340.0	E_{10}	71
340.0	452.0	E_{11}	72
452.0	600.0	E_{12}	73
600.0	900.0	E_{13}	74
900.0	1340.0	E_{14}	75
1340.0	2006.0	E_{15}	76
2006.0	E_{max}	E_{16}	77
E_{max}	∞	E_{17}	40

Table 14 : ICS energy bins

E_{min} and E_{max} can be calculated from Edmin and Edmax using equation 17.

2.2.4 PHA data collection

The EPIC DPU can collect ICS PHA data in two different modes : a (rotating) priority mode and a fifo mode. Each of these modes will be explained in detail now. The DPU can be switched between these two modes using the **I_DIGCMD 10** command.

2.2.4.1 Priority mode

In priority mode, the mass bins of of received particles are subdivided into 4 different energy levels and four different mass levels (the P, HE, M and H ranges). There are 16 possible combinations of energy and mass levels, which are the ICS PHA ranges.

For each 2 spin period, the DPU tries to collect up to 3 event words from each PHA range and each sector, so a maximum of 3*16*16 = 768 PHA words are collected. To get an equal distribution over heads, the DPU will not accept more than 2 event words from either head for each sector and PHA range. The collected PHA words are stored in internal buffers.

Since only 48 PHA words can be transmitted every 2nd spin, the 4 different energy levels and the 4 mass levels are assigned different priorities in every 2nd spin and the DPU will always try to transmit high priority PHA words before others. The mass level priority rotates every 2nd spin and wraps around after 2 spins * 4 priorities = 8 spins. Therefore, the energy level rotates every 8th spin such that all possible combinations are looped through within 8 spins * 4 priorities = 32 spins, which is called a science record.

In every 2nd spin, the DPU tries to transmit 48 PHA words, 3 of each sector, from the presently highest priority PHA range. If there wer not enough events collected in that range, events are taken from the range with the next-to-the-highest priority and so on.

Using the **I_PR_OVR** command, it is possible to stop priority rotation for mass and/or energy levels, so that high visibility can be given to any of the defined mass and/or energy levels.

The documentation for the **I_PR_OVR** command will give some additional information on this topic and shows which mass bins are assigned to the different PHA ranges.

2.2.4.2 Fifo mode

During fifo mode, there is no differentiation between PHA ranges. The DPU will store the first 48 event words it receives each sector, so a maximum of 48*16 = 768 PHA words are received during 2 spins.

Every 2nd EDB, the DPU chooses the events to place in the telemetry stream by looping through the 16 sector buffers as often as it needs to fill the available telemetry space of 48 PHA words. The first loop would choose the first event received in every sector (if one was received), the second loop the second event and so on. So, if during every sector at least 3 events were received, the events would be equally distributed over sectors.

2.2.5 Classification implementation in the DPU

To classify an event by species, the EPIC DPU does not calculate equations (14-18) each time it receives a valid event word. Instead, a table-based look-up technique is used to classify the incoming events. Figure 6 shows the basic table structure implemented in the DPU.

The digital energy and time-of-flight values address a two dimensional mass classification table, which delivers a species bin number at its output. This table is built during initialization using equations (14-18) and the definitions given by tables 6 through 11.

Energy and time-of-flight each address a separate table to classify the energy and time-of-flight into 16 bins each. The contents of these classification tables are defined by tables 13 and 14.

Using three consecutive classification cycles, the bin numbers gained from the three classification tables, together with the head ID H, address and increment the counting memory bins. These are are read, reset and processed by the DPU processor on a cyclic basis.

An additional table is used to decide wether a received event is worth being classifed as PHA word which would be a candidate for the set of 48 PHA words placed in every 2nd EDB (experiment data block, see next

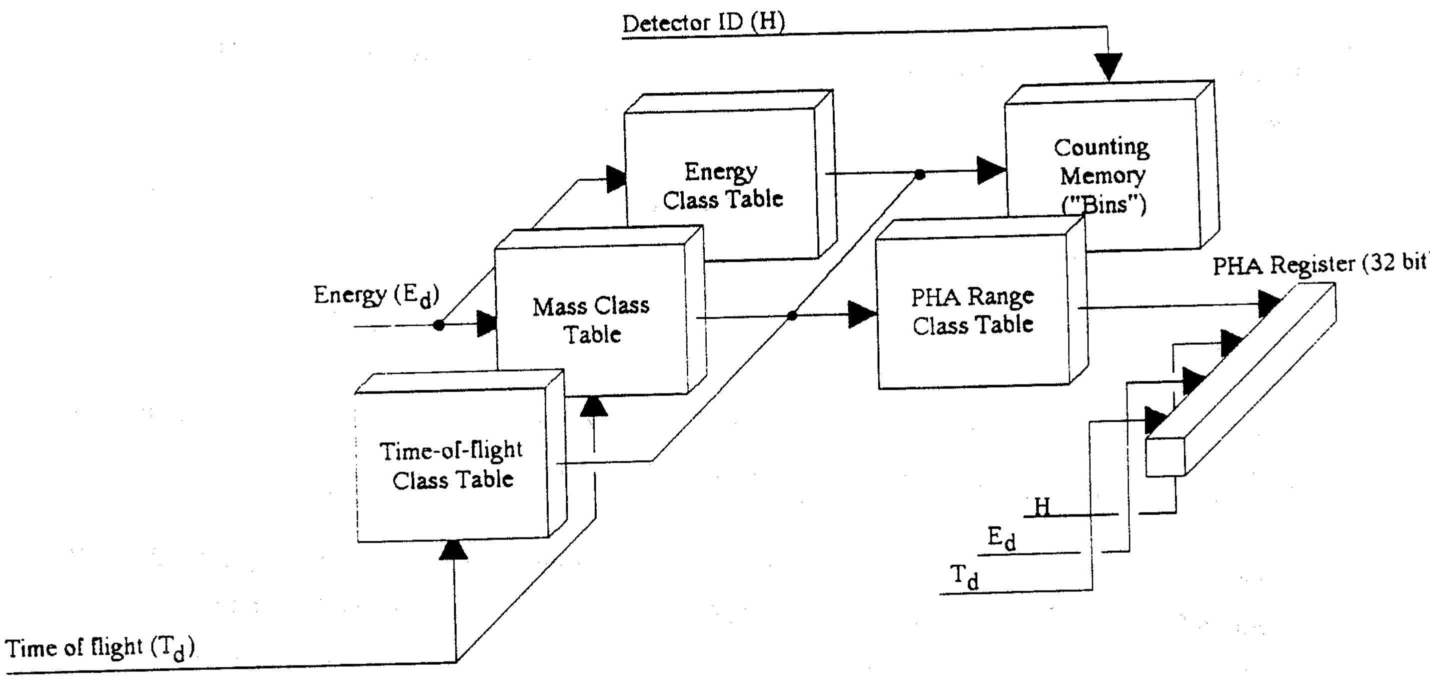


Fig. 6 : Table structure for ICS event classification

chapter). Basically, every event which falls into one of the defined mass classes is a valuable candidate.

3. TELEMETRY

3.1 The GEOTAIL telemetry system

The GEOTAIL S/C provides two telemetry channels. They are called Editor A and Editor B. Editor A is the real time telemetry data link and transmits data with 64 kBit/sec. Editor B is the recorded telemetry and transmits data with 16 kBit/sec. The telemetry data is subdivided into *frames* of 128 data words (bytes) which are numbered from 0 to 255 and wrap around to 0 after 255. GEOTAIL assigns different format modes to each editor depending on the S/C Operational Mode. GEOTAIL knows 13 possible format modes for each telemetry.

The following table shows the different editor format mode used during the various S/C operational mode.

Operational Mode	Editor A	Editor B
Nominal mode	Format 2, 65 kbps	Format 1, 16 kbps
AOCS mode	Format 2, 65 kbps	Format 0, 16/65 kbps
RAM CHK mode	Format 4 ..13	Format 1, 16 kbps or Format 0, 16/65 kbps
Contingency mode	Format 2/3 65 kbps	off
Emergency mode	off	Format 0, 256 bps

Table 15 : Telemetry format modes

The allocated amount of data words for each experiment in every frame depends on the S/C operational mode, to speak exactly : it depends on the format mode of each telemetry. However, there are some additional data bytes which are allocated to each experiment independent of telemetry format mode. These data words reflect the coarse status of the experiments.

3.2 EPIC data contained in telemetry stream

The following tables shows how much space for scientific data was allocated for EPIC. Then the next table shows which format mode independent data words EPIC has allocated.

Format Mode	Editor A	Editor B
0	-	-
1	-	20 bytes/frame
2	-	-
3	5 bytes/frame	-
4 - 11	-	-

12	3 bytes/frame address data + 64 bytes/frame RAM CHECK data	-
13	-	-

Table 16 : EPIC format dependent telemetry allocation

The science data transmitted in format 1 and 3 must be concatenated by the ground software to blocks of 960 bytes. Such a block is called an experiment data block (EDB). The start of an EDB can be identified by two header bytes which contain the values 14H and 6FH.

The next table shows which format-mode-independent data bytes EPIC has allocated.

Frame #	Word #	description
32*n+27	8,9,10	experiment status area 1 (S/W generated), details see next subsection
32*n+28	8,9,10	experiment status area 2 (S/W generated), details see next subsection
32*n+12	10	BC answer (H/W generated), this bytes reflects the last block command code sent to the DPU.
167	8,9	program address (S/W generated), this 16 bit word reflects the lower 16 bits of the current program address (set by the D_PRDADR command). The high byte is sent in word # 8, the low byte is sent in word # 9
128*n+33	11	EPIC-D Temp (H/W generated), DPU temperature sensor, digitized by S/C. At the preparation time of this document the conversion factor from the digital value to Farenheid degrees was unknown to TUB (ISAS/NEC supplied the temperature sensors).

128*n+34	11	EPIC-S Temp (H/W generated), STICS temperature sensor, digitized by S/C. At the preparation time of this document the conversion factor from the digital value to Farenheid degrees was unknown to TUB (ISAS/NEC supplied the temperature sensors).
128*n+35	11	EPIC-I Temp (H/W generated), ICS temperature sensor, digitized by S/C. At the preparation time of this document the conversion factor from the digital value to Farenheid degrees was unknown to TUB (ISAS/NEC supplied the temperature sensors).
24	11	+5V Current (H/W generated), +5V DPU logic supply current, digitized by S/C. The conversion to [mA] is as I[mA] = 3.92 mA * VALUE (0..255)
152	11	+29V Current (H/W generated), DPU-gated +29V instrument supply current, digitized by S/C.The conversion to [mA] is as I[mA] = 3.92 mA * VALUE (0..255)

Table 17 : EPIC format independent telemetry allocation

3.3 Experiment status areas

The experiment status areas (together 6 bytes every 32 frames) are used to transmit the power status data, the subcommutated housekeeping data and the DC (discrete command) answer.

How EPIC uses these 6 bytes can be seen from the table 18.

	Bit	ITEM	Source
BYTE1	7	EPIC DPU POWER	MREG2(7)
	6	EPIC BAKE HEATERS	MREG2(6)
	5	STICS SUPL HEATERS	MREG2(5)
	4	ICS SUPL HEATERS	MREG2(4)
	3	ICS MCP POWER	MREG2(3)
	2	STICS MCP POWER	MREG2(2)
	1	STICS DPPS POWER	MREG2(1)
	0	INSTRUMENT POWER	MREG2(0)

	Bit	ITEM	Source
BYTE2	7	STICS HVPS 6	adwSTICSAnsw[0](5)
	6	STICS HVPS 5	adwSTICSAnsw[0](4)
	5	STICS HVPS 4	adwSTICSAnsw[0](3)
	4	STICS HVPS 3	adwSTICSAnsw[0](2)
	3	STICS HVPS 2	adwSTICSAnsw[0](1)
	2	STICS HVPS 1	adwSTICSAnsw[0](0)
	1	ICS ANALOG POWER	MREG2(9)
	0	STICS ANALOG POWER	MREG2(8)

	Bit	ITEM	Source
BYTE3	7	STICS HVPS 7	adwSTICSAnsw[0](6)
	6	STICS + DPPS	adwSTICSAnsw[2](1)
	5	STICS - DPPS	adwSTICSAnsw[2](0)
	4	ICS HVPS 5	adwICSAnsw[0](4)
	3	ICS HVPS 4	adwICSAnsw[0](3)
	2	ICS HVPS 3	adwICSAnsw[0](2)
	1	ICS HVPS 2	adwICSAnsw[0](1)
	0	ICS HVPS 1	adwICSAnsw[0](0)

	Bit	ITEM	Source
BYTE4	7 - 0	Subcom Index	bySubcomIdxA,bySubcomIdxB

	Bit	ITEM	Source
BYTE5	7 - 0	subcommutated housekeeping data	abyHKA[],abyHKB[]

	Bit	ITEM	Source
BYTE6	7 - 0	(BYTE4 & 07h) = 0 : DC code, HVIS Answer, contains ABh if no DC is available 1 : not used 2 : not used 3 : not used. 4 : not used 5 : not used 6 : not used 7 : not used	DC command buffer

Table 18 : EPIC status area contents

3.4 EDB

The science data are grouped into *experiment data blocks* (EDB) of 960 bytes each. This block length was choosen such that one EDB gets transmitted withing 3 seconds, which is the nominal spin duration. An EPIC *science record* is defined as 32 EDBs (or spins). Within one science record all data and most of the housekeeping data gets transmitted once, therefore after 32 spins the data is consistent (except for some parameter downloads, which are sub-subcommutated)
The EDB is divided up into 60 lines of 16 bytes each. The contents vary with the instrument mode. Three different modes are implemented :

- dual sensor mode (default)
- ICS single sensor mode
- STICS single sensor mode

However, the basic structure of each EDB is the same for all modes as depicted in figure 7. This figure shows the EDB structure for the dual sensor mode. If EPIC operates in one of the single sensor modes, the science data area of the idle instrument is assigned to the active instrument. The DPU Common Areas, however, don't change their position in the different modes.

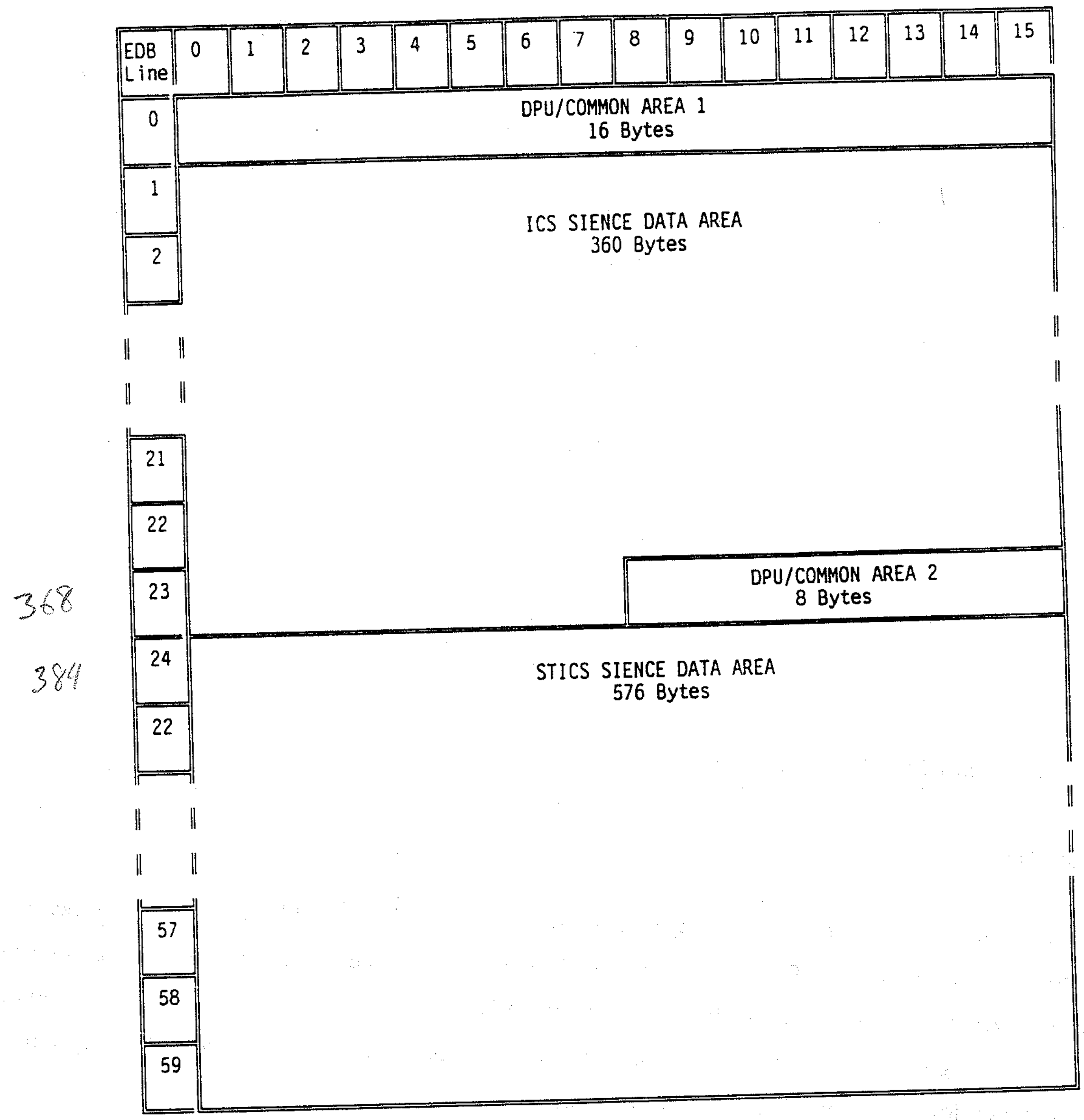


Fig. 7 : General EDB layout

The following sections will document the contents of the mode independent and the mode dependend sections of the EDB in deatil.

3.4.1 DPU common areas for all modes

368

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	14H	6FH	EDB CNTR	SPIN CNTR	SPIN /EDB, INSTR LVPS	MCP STP, HV ENBL,	HK 7	HK Ø	HK 1	HK 2	HK 3	HK 4	HK 5	CMD STATS, SENSOR MODE DUAL SNGL	ST/SP MCP ENBL -DPPS ENBL	+DPPS ENBL

Fig. 8 : DPU common area 1

The DPU common area 1 contains the EDB identifer words, spin & EDB counters, subcommutated housekeeping data and the main powerstatus. Some other userful items are also contained in here.

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
23									TIME TAG	STICS TBL ON	STICS [illegible] OVR					
									FRM CNTR	DPPS STEP	CRNT					

Fig. 9 : DPU common area 2

The DPU common area 2 is positioned between the data area for ICS & STICS in the dual sensor mode.

The next pages will give detailed information about the contentof the DPU common areas

DPU common area 1 Bytes 0 and 1

Byte #	Bit #	Comment	
0	0	0	
	1	0	
	2	1	
	3	0	14 Identifier
	4	1	
	5	0	
	6	0	
	7	0	Source: Rom constant
1	0	1	
	1	1	
	2	1	
	3	1	6FH identifier
	4	0	
	5	1	
	6	1	
	7	0	Source: ROM constant

DPU common area 1 Bytes 2 and 3

Byte #	Bit #	Comment
2	0	LSB EDB Counter This byte increments for every EDB which was formatted in the DPU. It wraps around to 00H after FFH
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: byEDBCount
3	0	LSB Spin Counter This byte increments for every spin. It wraps around to 00H after FFH.
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: wSpinNo.

DPU common area 1 Bytes 4 and 5

Byte #	Bit #	Comment
4	0	LSB Measured Spin Counter
	1	This 5 bit item counts the measured spins of a science record.
	2	If it wraps around to 00H, a a new science record starts.
	3	
	4	MSB Source: byMeasureSpinNo.
	5	EPIC INSTUMENT POWER "1" = ON "0" = OFF Source: MREG2 bit 0
	6	STICS LVPS "1" = ON "0" = OFF Source: MREG2 bit 8
	7	ICS LVPS "1" = ON "0" = OFF Source: MREG2 bit 9
5	0	STICS STEP "1": STICS MCPPS stepping active Source: or'ed abySHVStepFlag [0..6],bit 5
	1	ICS STEP "1": ICS MCPPS stepping active Source: or'ed abyIHVStepFlag [0..4],bit 5
	2	HV ENABLE "1": HV is enabled "0": HV disabled Source: MREG2, bit 11
	3	CMD VAL "1" successfull command execution Source: change of byValCmdCnt
	4	CMD ERR "1" error during command execution Source: change of byInvCmdCnt
	5	INVALID CMD "1" COI detected a command as invalid Source: change of byCOIInvCmdCnt
	6	Bit Value Bits 7,6,5 ... 0 are transmitted in this order
	7	BYTE START Marks bit 7 of a long sequence data byte Source:ROM

DPU common area 1 Bytes 6 and 7

Byte #	Bit #	Comment
6	0	LSB subcom index for subcommutated HK data in EDB. This byte contains the index of the HK data byte in byte 7 of the DPU common areal.
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: byEDBHKIdx
7	0	LSB HK data byte 0
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: abyHKTelemBuf[byEDBHKIdx+0]

DPU common area 1 Bytes 8 and 9

Byte #	Bit #	Comment
8	0	LSB HK data byte 1
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: abyHKTelemBuf[byEDBHKIdx+1]
9	0	LSB HK data byte 2
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: abyHKTelemBuf[byEDBHKIdx+2]

DPU common area 1 Bytes 10 and 11

Byte #	Bit #	Comment
10	0	LSB HK data byte 3
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: abyHKTelemBuf[byEDBHKIdx+3]
11	0	LSB HK data byte 4
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: abyHKTelemBuf[byEDBHKIdx+4]

DPU common area 1 Bytes 12 and 13

Byte #	Bit #	Comment
12	0	LSB HK data byte 5
	1	
	2	
	3	
	4	
	5	
	6	
	7	MSB Source: abyHKTelemBuf[byEDBHKIDX+5]
13	0	STICS CMD STAT "0": no errors "1": command rejected in last spin Source: change of bySTICSCmdErr
	1	ICS CMD STAT "0": no errors "1": commands rejected in last spin Source: change of byICSCmdErr
	2	STICS Actuator power 0 : off 1 : on
	3	Memory image 0 : disabled 1 : enabled
	4	LSB bySensorMode 0 dual sensor mode
	5	MSB 1 STICS single sensor mode 2 ICS single sensor mode
	6	ICS Aperture motor moving 0 : still standing 1 : moving
	7	HK sync 1 : synchronized 0 : unsynchronized

DPU common area 1 Bytes 14 and 15

Byte #	Bit #	Comment
14	0	STICS north start MCP enable HVPS1 Source: adwSTICSAnsw[1] bit 8
	1	STICS equatorial start MCP enable HVPS2 Source: adwSTICSAnsw[1] bit 9
	2	STICS south start MCP enable HVPS3 Source: adwSTICSAnsw[1] bit 10
	3	STICS north stop MCP enable HVPS4 Source: adwSTICSAnsw[1] bit 11
	4	STICS equatorial stop MCP enable HVPS5 Source: adwSTICSAnsw[1] bit 12
	5	STICS south stop MCP enable HVPS6 Source: adwSTICSAnsw[1] bit 13
	6	STICS time of flight PS disable HVPS7 Source: adwSTICSAnsw[1] bit 14
	7	STICS negative DPPS enable Source: adwSTICSAnsw[2] bit 0
15	0	STICS positive DPPS enable Source: adwSTICSAnsw[2] bit 1
	1	STICS classification H/W Status 0 --> disabled Source: C_STAT Bit 0 1 --> running
	2	ICS classification H/W Status 0 --> disabled Source: C_STAT Bit 1 1 --> running
	3	ICS north stop MCP enable HVPS1 Source: adwICSAnsw[1] bit 0
	4	ICS north start MCP enable HVPS2 Source: adwICSAnsw[1] bit 1
	5	ICS south stop MCP enable HVPS3 Source: adwICSAnsw[1] bit 2
	6	ICS south start MCP enable HVPS4 Source: adwICSAnsw[1] bit 3
	7	ICS time of flight enable HVPS5 Source: adwICSAnsw[1] bit 4

DPU common area 2 Bytes 0 and 1

Byte #	Bit #	Comment
0	0	LSB Time Tag Source : byFrameCntB Time in # of frames (telemetry B) since last frame 0 on telemetry B when this EDB was started to be formatted.
	1	
	2	
	3	
	4	
	5	
	6	
	7	
1	0	STICS table calculation active 0 : not acitve 1 : active
	1	ICS table calculation active 0 : not active 1 : active
	2	LSB DPPS Step # of present spin (remember that the instrument data contained in this EDB is from the previous spin)
	3	
	4	
	5	
	6	MSB
	7	

DPU common area 2 Bytes 2 and 3

Byte #	Bit #	Comment	
2	0	ICS A/E over current	0 : no over current 1 : over current during last spin
	1	STICS A/E over current	0 : no over current 1 : over current during last spin
	2		
	3		
	4		
	5		
	6		
	7		
3	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		

DPU common area 2 Bytes 4 and 5

Byte #	Bit #	Comment
4	0	
	1	
	2	
	3	
	4	
	5	
	6	
	7	
5	0	
	1	
	2	
	3	
	4	
	5	
	6	
	7	

DPU common area 2 Bytes 6 and 7

Byte #	Bit #	Comment
6	0	
	1	
	2	
	3	
	4	
	5	
	6	
	7	
7	0	
	1	
	2	
	3	
	4	
	5	
	6	
	7	

3.4.2 Dual sensor mode

In the dual sensor mode, the DPU common area 1 is followed by the ICS data area. The DPU common area 2 precedes the STICS data area.

3.4.2.1 STICS data area

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
24	HR0 0/0															HR0 0/15
25	HR0 1/0															HR0 1/15
26	HR0 2/0															HR0 2/15
27	HR0 3/0															HR0 3/15
28	HR0 4/0															HR0 4/15
29	HR0 5/0															HR0 5/15
30	HR1 0/0															HR1 0/15
31	HR1 1/0															HR1 1/15
32	HR1 2/0															HR1 2/15
33	HR1 3/0															HR1 3/15
34	HR1 4/0															HR1 4/15
35	HR1 5/0															HR1 5/15
36	SMR0 0/0							SMR0 0/7	SMR0 1/0							SMR0 1/7
37	SMR0 2/0							SMR0 2/7	SMR1 0/0							SMR1 0/7
38	SMR1 1/0							SMR1 1/7	SMR1 2/0							SMR1 2/7
39	SMR2 0/0							SMR2 0/7	SMR2 1/0							SMR2 1/7
40	SMR2 2/0							SMR2 2/7	BR0 0/0							BR0 0/7
41	BR0 1/0							BR0 1/7	BR0 2/0							BR0 2/7
42	BR1 0/0							BR1 0/7	BR1 1/0							BR1 1/7
43	BR1 2/0							BR1 2/7	BR2 0/0							BR2 0/7
44	BR2 1/0							BR2 1/7	BR2 2/0							BR2 2/7

Fig. 10 : STICS data area (lines 24 -44) in dual sensor mode

In the Figure above the HR, SMR and BR are tagged with the respective polar direction id (0..5) and the sector number (0..15). Keep in mind that the SMR and BR only differentiate between 3 polar directions and 8 sectors.

	EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
720	45	MR0	MR1	MR2	MR3	MR4	MR5	MR6	MR7	MR8	MR9	MR10	MR11	MR12	MR13	MR14	MR15
736	46	MR16	MR17	MR18	MR19	MR20	MR21	MR22	MR23	MR24	MR25	MR26	MR27	MR28	MR29	FSR0	FSR1
752	47	FSR2	UFSR	URSR	RSR0	RSR1	RSR2	DCR0	DCR1	DCR2	TCR0	TCR1	TCR2	SSD0	SSD1	SSD2	MFSR
768	48	MDCR	MPF	MPR	DIAG	PHA00				PHA01				PHA02			
	49	PHA03				PHA04				PHA05				PHA06			
	50	PHA07				PHA08				PHA09				PHA10			
	51	PHA11				PHA12				PHA13				PHA14			
	52	PHA15				PHA16				PHA17				PHA18			
	53	PHA19				PHA20				PHA21				PHA22			
	54	PHA23				PHA24				PHA25				PHA26			
	55	PHA27				PHA28				PHA29				PHA30			
	56	PHA31				PHA32				PHA33				PHA34			
	57	PHA35				PHA36				PHA37				PHA38			
	58	PHA39				PHA40				PHA41				PHA42			
	59	PHA43				PHA44				PHA45				PHA46			

Fig. 11 : STICS data area (lines 45 - 59) in dual sensor mode

3.4.2.2 ICS data area

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	A0-0 0/0															A0-0 0/15
2	A0-1 0/0															A0-1 0/15
3	A1-0 0/0															A1-0 0/15
4	A1-1 0/0															A1-1 0/15
5	B0-0 0/0							B0-0 0/7	B0-1 0/0							B0-1 0/7
6	B1-0 0/0							B1-0 0/7	B1-1 0/0							B1-1 0/7
7	C0 0/0															C0 0/15
8	C0 1/0															C0 1/15
9	C1 0/0															C1 0/15
10	C1 1/0															C1 1/15
11	C2 0/0															C2 0/15
12	C2 1/0															C2 1/15
13	C3 0/0															C3 0/15
14	C3 1/0															C3 1/15
15	C4 0/0															C4 0/15
16	C4 1/0															C4 1/15
17	C5 0/0															C5 0/15
18	C5 1/0															C5 1/15
19	C6 0/0															C6 0/15
20	C6 1/0															C6 1/15
21	C7 0/0															C7 0/15
22	C7 1/0															C7 1/15
23	"F" - Rates, "FA"- Rates, subcommutated with Measure Spin Number															

Fig. 12 : ICS data area (odd EDB) in dual sensor mode

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	PHA 0			PHA 1			PHA 2			PHA 3			PHA 4			PHA 5
2	PHA 5		PHA 6			PHA 7			PHA 8			PHA 9			PHA 10	
3	PHA 10	PHA 11			PHA 12			PHA 13			PHA 14			PHA 15		
4	PHA 16			PHA 17			PHA 18			PHA 19			PHA 20			PHA 21
5	PHA 21		PHA 22			PHA 23			PHA 24			PHA 25			PHA 26	
6	PHA 26	PHA 27			PHA 28			PHA 29			PHA 30			PHA 31		
7	PHA 32			PHA 33			PHA 34			PHA 35			PHA 36			PHA 37
8	PHA 37		PHA 38			PHA 39			PHA 40			PHA 41			PHA 42	
9	PHA 42	PHA 43			PHA 44			PHA 45			PHA 46			PHA 47		
10	"D" - Rates, some "F"-Rates, some "FA" - Rates, subcommutated with Measure Spin Number															
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																
21																
22	"F" - Rates, "FA" - Rates, subcommutated with Measure Spin Number															
23																

Fig. 13 : ICS data area (even EDB) in dual sensor mode

3.4.2.3 ICS formatting schemes

The counting rates from the ICS bins are accumulated in different ways. Six different **formatting schemes** (Scheme A,B,C,D,F and FA) are used in the dual sensor mode. For different schemes (schemes C,D,G,H) are used in the ICS single sensor mode. The schemes differ in time & directional resolution. Each scheme accumulates the data over one or more spins (time resolution), over one or more sectors (equatorial directional resolution) and over one or two heads (polar directional resolution).

The following table describes how the different schemes work :

Scheme	# of cycles collected	time resolution (spins)	polar dir. resolution (sectors)	equator. dir. resolution (heads)
A	2	1	1	2
B	2	1	2	2
C	1	2	1	1
	2	1	1	2
	2	1	2	1
D	1	16	1	1
	2	8	2	1
	2	8	1	2
	4	4	2	2
F	1	32	1	1
	2	16	2	1
	2	16	1	2
	4	8	2	2
FA	1	32	2	1
G	1	1	1	1
H	8	1	1	1

Table 19 : ICS formatting schemes

For formatting schemes C,D and F, the time resolution can be increased to the disadvantage of directional resolution (see **I_DIGCMD**).

Example : The "C" rates would normally be accumulated over two spins, and have full sector and head resolution. They would only be formatted into every 2nd EDB, so one EDB would contain data of 1 accumulation cycles.

If "head summation" would be turned on, the data of the two heads would be accumulated into the same bins. The time resolution would increase, i.e. the data would no longer be accumulated over two spins and the measurement cycle period would be one spin instead of two before. Still, "C" data is only transmitted in every 2nd EDB, so each 2nd EDB will contain data of 2 measurement cycles.

The following table shows how the bins are assigned to the formatting schemes in the dual sensor mode and at which positions the data of the respective bins can be found in the EDB.

Scheme	**Rate Bin**	**EDB**	**Line**	**Pos**
A0	E2	odd	1,2	0..15
A1	E5	odd	3,4	0..15
B0	T14	odd	5	0..15
B1	ED1	odd	6	0..15
C0	E1	odd	7,8	0..15
C1	E3	odd	9,10	0..15
C2	E4	odd	11,12	0..15
C3	T11	odd	13,14	0..15
C4	P2	odd	15,16	0..15
C5	HE2	odd	17,18	0..15
C6	M2	odd	19,20	0..15
C7	FSR0,1	odd	21,22	0..15
D0	E2	0,16	10,11	0..15
D1	E5	0,16	12,13	0..15
D2	E6	0,16	14,15	0..15
D3	E7	0,16	16,17	0..15
D4	E8	0,16	18,19	0..15
D5	E9	0,16	20,21	0..15
D6	E10	2,18	10,11	0..15
D7	E11	2,18	12,13	0..15
D8	E12	2,18	14,15	0..15
D9	E13	2,18	16,17	0..15
D10	T6	2,18	18,19	0..15
D11	T8	2,18	20,21	0..15
D12	T9	4,20	10,11	0..15
D13	T10	4,20	12,13	0..15
D14	T12	4,20	14,15	0..15
D15	T13	4,20	16,17	0..15
D16	T15	4,20	18,19	0..15
D17	P1	4,20	20,21	0..15
D18	P3	6,22	10,11	0..15
D19	P4	6,22	12,13	0..15
D20	P5	6,22	14,15	0..15
D21	P6	6,22	16,17	0..15
D22	P7	6,22	18,19	0..15
D23	P8	6,22	20,21	0..15
D24	HE1	8,24	10,11	0..15
D25	HE3	8,24	12,13	0..15
D26	HE4	8,24	14,15	0..15
D27	HE5	8,24	16,17	0..15
D28	HE6	8,24	18,19	0..15
D29	HE7	8,24	20,21	0..15
D30	HE8	10,26	10,11	0..15
D31	M1	10,26	12,13	0..15
D32	M3	10,26	14,15	0..15
D33	M4	10,26	16,17	0..15

D34	M5	10,26	18,19	0..15
D35	M6	10,26	20,21	0..15s
D36	RSR0,1	12,28	10,11	0..15
D37	DCR0,1	12,28	12,13	0..15
D38	TCR0,1	12,28	14,15	0..15
D39	SSD0,1	12,28	16,17	0..15
D40	UFSR	12,28	18	0..15
D41	URSR	12,28	19	0..15
D42	MFSR	12,28	20	0..15
D43	ED2	12,28	21	0..15
F0	E14	0	22	0..15
		0	23	0..7
		1	23	0..7
F1	E15	2	22	0..15
		2	23	0..7
		3	23	0..7
F2	E16	4	22	0..15
		4	23	0..7
		5	23	0..7
F3	T1	6	22	0..15
		6	23	0..7
		7	23	0..7
F4	T2	8	22	0..15
		8	23	0..7
		9	23	0..7
F5	T3	10	22	0..15
		10	23	0..7
		11	23	0..7
F6	T4	12	22	0..15
		12	23	0..7
		13	23	0..7
F7	T5	14	10,11	0..15
F8	T7	14	12,13	0..15
F9	T14	14	14,15	0..15
F10	T16	14	16,17	0..15
F11	P9	14	18,19	0..15
F12	P10	14	20,21	0..15

F13	HE9	14	22	0..15
		14	23	0..7
		15	23	0..7
F14	HE10	16	22	0..15
		16	23	0..7
		17	23	0..7
F15	M7	18	22	0..15
		18	23	0..7
		19	23	0..7
F16	M8	20	22	0..15
		20	23	0..7
		21	23	0..7
F17	M9	22	22	0..15
		22	23	0..7
		23	23	0..7
F18	M10	24	22	0..15
		24	23	0..7
		25	23	0..7
F19	H1	26	22	0..15
		26	23	0..7
		27	23	0..7
F20	H2	28	22	0..15
		28	23	0..7
		29	23	0..7
F21	H3	30	10,11	0..15
F22	H4	30	12,13	0..15
F23	H5	30	14,15	0..15
F24	H6	30	16,17	0..15
F25	MDCR	30	18	0..15
FA0	ZM	30	19	0..7
FA1	SM	30	19	8..15
FA2	E0	30	20	0..7
FA3	E17	30	20	8..15
FA4	T0	30	21	0..7
FA5	T17	30	21	8..15

Table 20 : ICS rates dual sensor mode (sorted by formatting scheme)

Scheme	Rate Bin	EDB	Line	Pos
D37	**DCR0,1**	12,28	12,13	0..15
C7	**FSR0,1**	odd	21,22	0..15
D36	**RSR0,1**	12,28	10,11	0..15
D39	**SSD0,1**	12,28	16,17	0..15
D38	**TCR0,1**	12,28	14,15	0..15
F25	**MDCR**	30	18	0..15
D42	**MFSR**	12,28	20	0..15
D40	**UFSR**	12,28	18	0..15
B1	**ED1**	odd	6	0..15
D43	**ED2**	**12,28**	**21**	**0..15**
D41	**URSR**	12,28	19	0..15
FA2	**E0**	30	21	0..15
C0	**E1**	odd	7,8	0..15
A0	**E2**	odd	1,2	0..15
D0	**E2**	0,16	10,11	0..15
C1	**E3**	odd	9,10	0..15
C2	**E4**	odd	11,12	0..15
A1	**E5**	odd	3,4	0..15
D1	**E5**	0,16	12,13	0..15
D2	**E6**	0,16	14,15	0..15
D3	**E7**	0,16	16,17	0..15
D4	**E8**	0,16	18,19	0..15
D5	**E9**	0,16	20,21	0..15
D6	**E10**	2,18	10,11	0..15
D7	**E11**	2,18	12,13	0..15
D8	**E12**	2,18	14,15	0..15
D9	**E13**	2,18	16,17	0..15
F0	**E14**	0	22	0..15
		0	23	0..7
		1	23	0..7
F1	**E15**	2	22	0..15
		2	23	0..7
		3	23	0..7
F2	**E16**	4	22	0..15
		4	23	0..7
		5	23	0..7
FA3	**E17**	30	22	0..15
FA4	**T0**	30	23	0..7
		31	23	0..7
F3	**T1**	6	22	0..15
		6	23	0..7
		7	23	0..7
F4	**T2**	8	22	0..15
		8	23	0..7
		9	23	0..7
F5	**T3**	10	22	0..15
		10	23	0..7
		11	23	0..7
F6	**T4**	12	22	0..15
		12	23	0..7
		13	23	0..7
F7	**T5**	14	10,11	0..15
D10	**T6**	2,18	18,19	0..15
F8	**T7**	14	12,13	0..15
D11	**T8**	2,18	20,21	0..15
D12	**T9**	4,20	10,11	0..15
D13	**T10**	4,20	12,13	0..15
C3	**T11**	odd	13,14	0..15
D14	**T12**	4,20	14,15	0..15
D15	**T13**	4,20	16,17	0..15
B0	**T14**	odd	5	0..15
F9	**T14**	14	14,15	0..15
D16	**T15**	4,20	18,19	0..15
F10	**T16**	14	16,17	0..15
FA5	**T17**	12	21	7..15
		28	21	7..15
F19	**H1**	26	22	0..15

		26	23	0..7
		27	23	0..7
F20	**H2**	28	22	0..15
		28	23	0..7
		29	23	0..7
F21	**H3**	30	10,11	0..15
F22	**H4**	30	12,13	0..15
F23	**H5**	30	14,15	0..15
F24	**H6**	30	16,17	0..15
D24	**HE1**	8,24	10,11	0..15
C5	**HE2**	odd	17,18	0..15
D25	**HE3**	8,24	12,13	0..15
D26	**HE4**	8,24	14,15	0..15
D27	**HE5**	8,24	16,17	0..15
D28	**HE6**	8,24	18,19	0..15
D29	**HE7**	8,24	20,21	0..15
D30	**HE8**	10,26	10,11	0..15
F13	**HE9**	14	22	0..15
		14	23	0..7
		15	23	0..7
F14	**HE10**	16	22	0..15
		16	23	0..7
		17	23	0..7
D31	**M1**	10,26	12,13	0..150
C6	**M2**	odd	19,20	0..15
D32	**M3**	10,26	14,15	0..152
D33	**M4**	10,26	16,17	0..153
D34	**M5**	10,26	18,19	0..154
D35	**M6**	10,26	20,21	0..155
F15	**M7**	18	22	0..15
		18	23	0..7
		19	23	0..7
F16	**M8**	20	22	0..15
		20	23	0..7
		21	23	0..7
F17	**M9**	22	22	0..15
		22	23	0..7
		23	23	0..7
F18	**M10**	24	22	0..15
		24	23	0..7
		25	23	0..7
D17	**P1**	4,20	20,21	0..15
C4	**P2**	odd	15,16	0..15
D18	**P3**	6,22	10,11	0..15
D19	**P4**	6,22	12,13	0..15
D20	**P5**	6,22	14,15	0..15
D21	**P6**	6,22	16,17	0..15
D22	**P7**	6,22	18,19	0..15
D23	**P8**	6,22	20,21	0..15
F11	**P9**	14	18,19	0..15
F12	**P10**	14	20,21	0..15
FA1	**SM**	30	20	0..15
FA0	**ZM**	30	19	0..15

Table 21 : ICS rates dual sensor mode (sorted by rate type)

3.4.3 STICS single sensor mode

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	DPU / COMMON AREA 1															
1	HR0 0/0															HR0 0/15
2	HR0 1/0															HR0 0/15
3	HR0 2/0															HR0 0/15
4	HR0 3/0															HR0 3/15
5	HR0 4/0															HR0 4/15
6	HR0 5/0															HR0 5/15
7	HR1 0/0															HR1 0/15
8	HR1 1/0															HR1 1/15
9	HR1 2/0															HR1 2/15
10	HR1 3/0															HR1 3/15
11	HR1 4/0															HR1 4/15
12	HR1 5/0															HR1 5/15
13	HR2 0/0															HR2 0/15
14	HR2 1/0															HR2 1/15
15	HR2 2/0															HR2 2/15
16	HR2 3/0															HR2 3/15
17	HR2 4/0															HR2 4/15
18	HR2 5/0															HR2 5/15

Fig. 14 : STICS single sensor mode EDB (lines 0 - 18)

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	BR0 0/0							BR0 0/7	BR0 1/0							BR0 1/7
20	BR0 2/0							BR0 2/7	BR1 0/0							BR1 0/7
21	BR1 1/0							BR1 1/7	BR1 2/0							BR1 2/7
22	BR2 0/0							BR2 0/7	BR2 1/0							BR2 1/7
23	BR2 2/0							BR2 2/7	DPU / COMMON AREA 2							
24	HR3 0/0															HR3 0/15
25	HR3 1/0															HR3 1/15
26	HR3 2/0															HR3 2/15
27	HR3 3/0															HR3 3/15
28	HR3 4/0															HR3 4/15
29	HR3 5/0															HR3 5/15
30	HR4 0/0															HR4 0/15
31	HR4 1/0															HR4 1/15
32	HR4 2/0															HR4 2/15
33	HR4 3/0															HR4 3/15
34	HR4 4/0															HR4 4/15
35	HR4 5/0															HR4 5/15
36	MR0							MR7	MR8							MR15

Fig. 15 : STICS single sensor mode EDB (lines 19 - 35)

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
37	MR16							MR23	MR24							MR31
38	MR32	MR33	FSR0	FSR1	FSR2	UFSR	URSR	RSR0	RSR1	RSR2	DCR0	DCR1	DCR2	TCR0	TCR1	TCR2
39	SSD0	SSD1	SSD2	MFSR	MDCR	MPF	MPR	DIAG	PHA00				PHA01			
40	PHA02				PHA03				PHA04				PHA05			
41	PHA06				PHA07				PHA08				PHA09			
42	PHA10				PHA11				PHA12				PHA13			
43	PHA14				PHA15				PHA16				PHA17			
44	PHA18				PHA19				PHA20				PHA21			
45	PHA22				PHA23				PHA24				PHA25			
46	PHA26				PHA27				PHA28				PHA29			
47	PHA30				PHA31				PHA32				PHA33			
48	PHA34				PHA35				PHA36				PHA37			
49	PHA38				PHA39				PHA40				PHA41			
50	PHA42				PHA43				PHA44				PHA45			
51	PHA46				PHA47				PHA48				PHA49			
52	PHA50				PHA51				PHA52				PHA53			
53	PHA54				PHA55				PHA56				PHA57			
54	PHA58				PHA59				PHA60				PHA61			
55	PHA62				PHA63				PHA64				PHA65			
56	PHA66				PHA67				PHA68				PHA69			
57	PHA70				PHA71				PHA72				PHA73			
58	PHA74				PHA75				PHA76				PHA77			
59	PHA78				PHA79				PHA80				PHA81			

Fig. 16 : STICS single sensor mode EDB (lines 36 - 59)

3.4.4 ICS single sensor mode

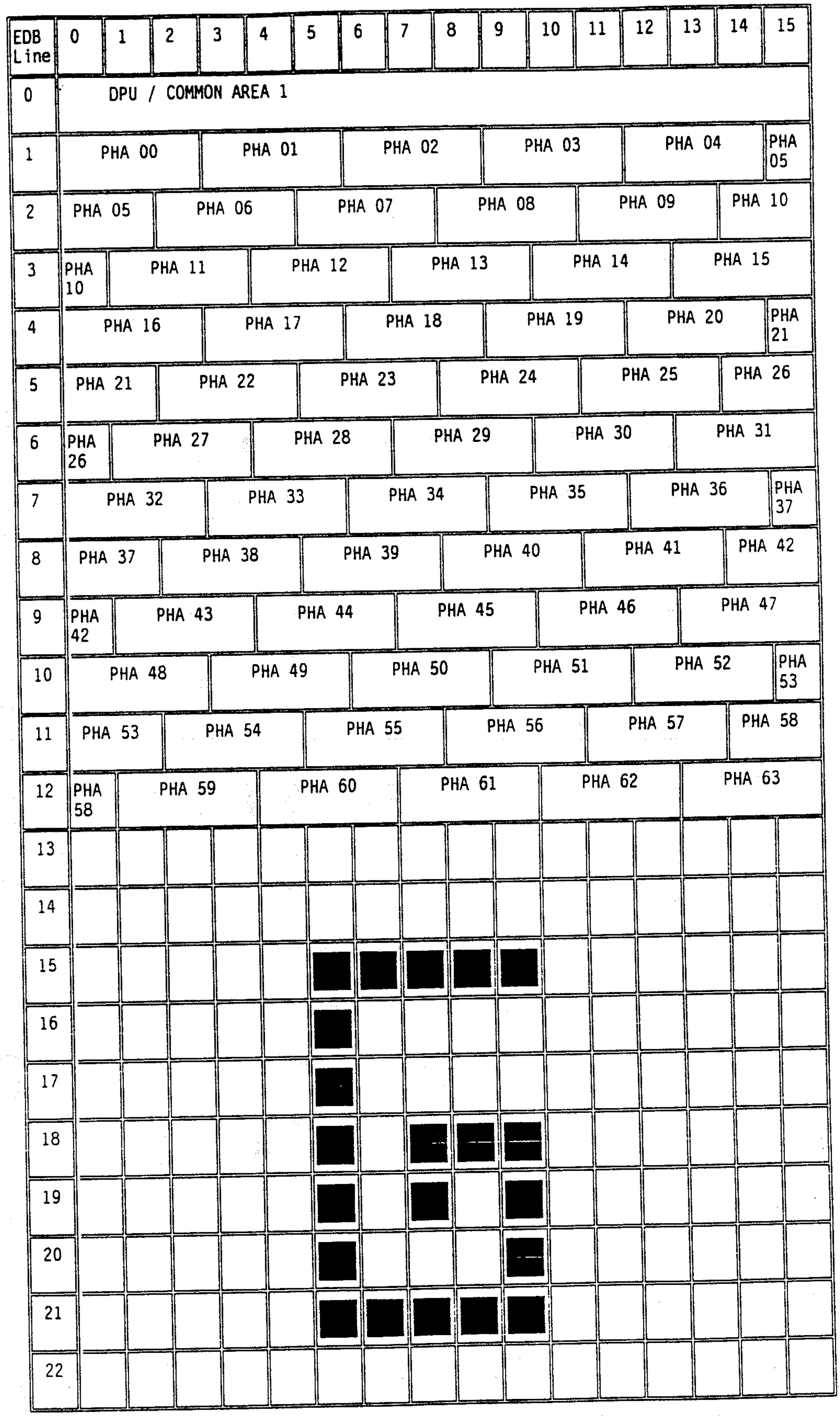


Fig. 17 : ICS single sensor mode EDB (lines 0 - 22)

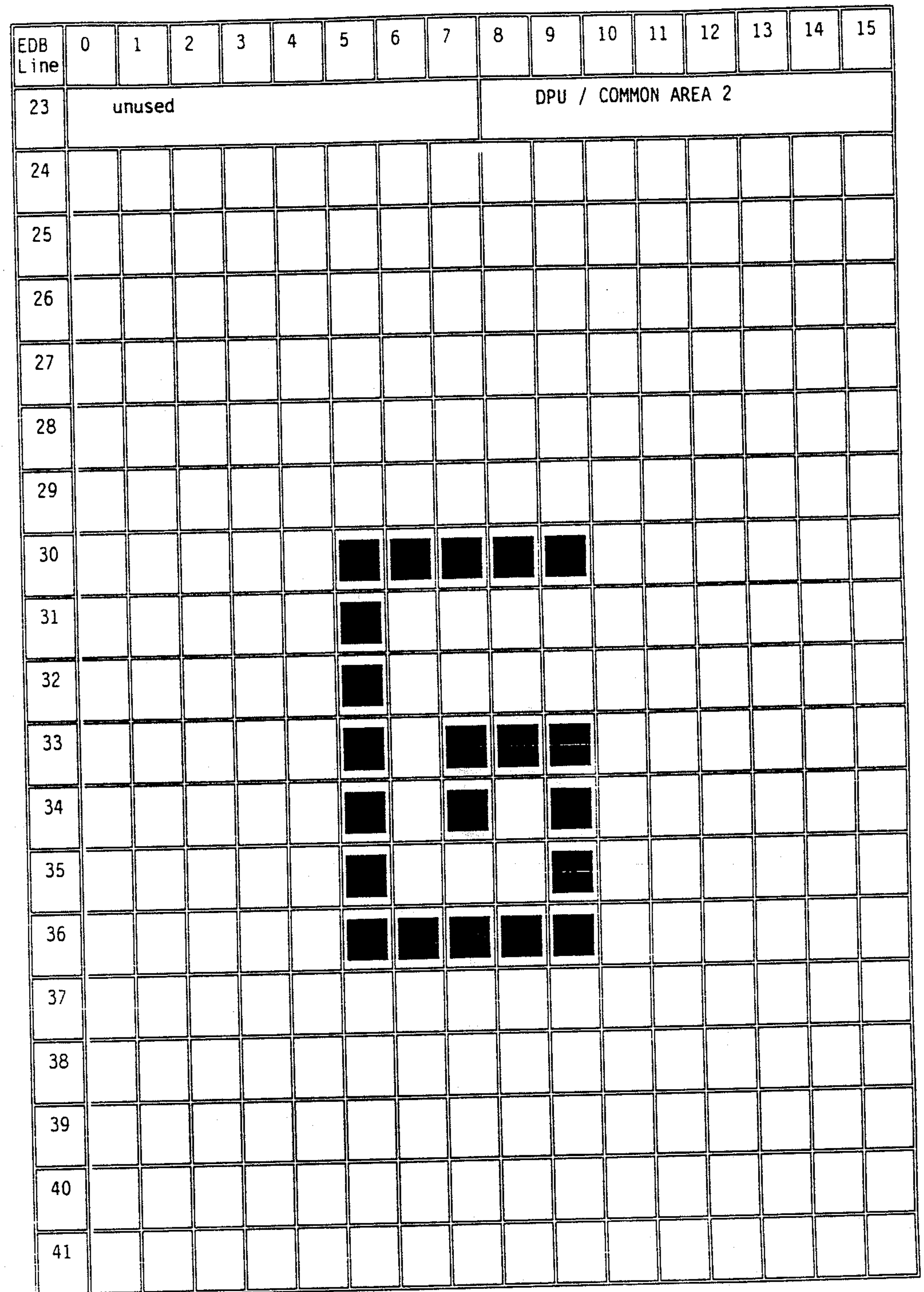


Fig. 18 : ICS single sensor mode EDB (lines 23 - 41)

EDB Line	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
42						■	■	■	■	■						
43						■										
44						■										
45						■										
46						■										
47						■	■	■	■	■						
48																
49						■				■						
50						■				■						
51						■	■	■	■	■						
52						■				■						
53						■				■						
54						■				■						
55																
56						■	■	■								
57						■			■							
58						■			■							
59						■	■	■								

Fig. 19 : ICS single sensor mode EDB (lines 42 - 59)

Scheme	Rate Bin	EDB	Line	Pos
C0	E1	even	42,43	0..15
C1	E3	even	44,45	0..15
C2	E4	even	46,47	0..15
C3	T8	odd	42,43	0..15
C4	P1	odd	44,45	0..15
C5	P3	odd	46,47	0..15
D0	E15	0,16	56,57	0..15
D1	E16	0,16	58,59	0..15
D2	T1	1,17	56,57	0..15
D3	T2	1,17	58,59	0..15
D4	T3	2,18	56,57	0..15
D5	T15	2,18	58,59	0..15
D6	T16	3,19	56,57	0..15
D7	P9	3,19	58,59	0..15
D8	P10	4,20	56,57	0..15
D9	He7	4,20	58,59	0..15
D10	He8	5,21	56,57	0..15
D11	He9	5,21	58,59	0..15
D12	He10	6,22	56,57	0..15
D13	M1	6,22	58,59	0..15
D14	M8	7,23	56,57	0..15
D15	M9	7,23	58,59	0..15
D16	M10	8,24	56,57	0..15
D17	H1	8,24	58,59	0..15
D18	H2	9,25	56,57	0..15
D19	H3	9,25	58,59	0..15
D20	H4	10,26	56,57	0..15
D21	H5	10,26	58,59	0..15
D22	H6	11,27	56,57	0..15
D23	E0	11,27	58,59	0..15
D24	E17	12,28	56,57	0..15
D25	T0	12,28	58,59	0..15
D26	T17	13,29	56,57	0..15
D27	MS	13,29	58,59	0..15
D28	MZ	14,30	56,57	0..15
D29	MFSR	14,30	58	0..15
D30	MDCR	14,30	59	0..15
G0	E2	every	13,14	0..15
G1	E5	every	15,16	0..15
G2	E8	every	17,18	0..15
G3	E11	every	19,20	0..15
G4	T6	every	21,22	0..15
G5	T11	every	24,25	0..15
G6	T14	every	26,27	0..15
G7	P2	every	28,29	0..15
G8	P4	every	30,31	0..15
G9	He2	every	32,33	0..15
G10	He4	every	34,35	0..15
G11	FSR	every	36,37	0..15
G12	SSD	every	38,39	0..15
G13	ED1	every	40	0..15
G14	ED2	every	41	0..15
H0	E6	0,8,16,24	48,49	0..15
H1	E7	0,8,16,24	50,51	0..15
H2	E9	0,8,16,24	52,53	0..15
H3	E10	0,8,16,24	54,55	0..15
H4	E12	1,9,17,25	48,49	0..15
H5	E13	1,9,17,25	50,51	0..15
H6	E14	1,9,17,25	52,53	0..15
H7	T4	1,9,17,25	54,55	0..15
H8	T5	2,10,18,26	48,49	0..15
H9	T7	2,10,18,26	50,51	0..15
H10	T9	2,10,18,26	52,53	0..15
H11	T10	2,10,18,26	54,55	0..15
H12	T12	3,11,19,27	48,49	0..15
H13	T13	3,11,19,27	50,51	0..15
H14	P5	3,11,19,27	52,53	0..15
H15	P6	3,11,19,27	54,55	0..15
H16	P7	4,12,20,28	48,49	0..15

H17	P8	4,12,20,28	50,51	0..15
H18	He1	4,12,20,28	52,53	0..15
H19	He3	4,12,20,28	54,55	0..15
H20	He5	5,13,21,29	48,49	0..15
H21	He6	5,13,21,29	50,51	0..15
H22	M2	5,13,21,29	52,53	0..15
H23	M3	5,13,21,29	54,55	0..15
H24	M4	6,14,22,30	48,49	0..15
H25	M5	6,14,22,30	50,51	0..15
H26	M6	6,14,22,30	52,53	0..15
H27	M7	6,14,22,30	54,55	0..15
H28	RSR	7,15,23,31	48,49	0..15
H29	DCR	7,15,23,31	50,51	0..15
H30	TCR	7,15,23,31	52,53	0..15
H31	UFSR	7,15,23,31	54	0..15
H32	URSR	7,15,23,31	55	0..15

Table 22 : ICS rates single sensor mode (sorted by format scheme)

Rate Bin	Scheme	EDB	Line	Pos
DCR	H29	7,15,23,31	50,51	0..15
FSR	G11	every	36,37	0..15
RSR	H28	7,15,23,31	48,49	0..15
SSD	G12	every	38,39	0..15
TCR	H30	7,15,23,31	52,53	0..15
MDCR	D30	14,30	59	0..15
MFSR	D29	14,30	58	0..15
UFSR	H31	7,15,23,31	54	0..15
URSR	H32	7,15,23,31	55	0..15
ED1	G13	every	40	0..15
ED2	G14	every	41	0..15
P1	C4	odd	44,45	0..15
P2	G7	every	28,29	0..15
P3	C5	odd	46,47	0..15
P4	G8	every	30,31	0..15
P5	H14	3,11,19,27	52,53	0..15
P6	H15	3,11,19,27	54,55	0..15
P7	H16	4,12,20,28	48,49	0..15
P8	H17	4,12,20,28	50,51	0..15
P9	D7	3,19	58,59	0..15
P10	D8	4,20	56,57	0..15
He1	H18	4,12,20,28	52,53	0..15
He2	G9	every	32,33	0..15
He3	H19	4,12,20,28	54,55	0..15
He4	G10	every	34,35	0..15
He5	H20	5,13,21,29	48,49	0..15
He6	H21	5,13,21,29	50,51	0..15
He7	D9	4,20	58,59	0..15
He8	D10	5,21	56,57	0..15
He9	D11	5,21	58,59	0..15
He10	D12	6,22	56,57	0..15
M1	D13	6,22	58,59	0..15
M2	H22	5,13,21,29	52,53	0..15
M3	H23	5,13,21,29	54,55	0..15
M4	H24	6,14,22,30	48,49	0..15
M5	H25	6,14,22,30	50,51	0..15
M6	H26	6,14,22,30	52,53	0..15
M7	H27	6,14,22,30	54,55	0..15
M8	D14	7,23	56,57	0..15
M9	D15	7,23	58,59	0..15
M10	D16	8,24	56,57	0..15
H1	D17	8,24	58,59	0..15
H2	D18	9,25	56,57	0..15
H3	D19	9,25	58,59	0..15
H4	D20	10,26	56,57	0..15
H5	D21	10,26	58,59	0..15

H6	D22	11,27	56,57	0..15
T0	D25	12,28	58,59	0..15
T1	D2	1,17	56,57	0..15
T2	D3	1,17	58,59	0..15
T3	D4	2,18	56,57	0..15
T4	H7	1,9,17,25	54,55	0..15
T5	H8	2,10,18,26	48,49	0..15
T6	G4	every	21,22	0..15
T7	H9	2,10,18,26	50,51	0..15
T8	C3	odd	42,43	0..15
T9	H10	2,10,18,26	52,53	0..15
T10	H11	2,10,18,26	54,55	0..15
T11	G5	every	24,25	0..15
T12	H12	3,11,19,27	48,49	0..15
T13	H13	3,11,19,27	50,51	0..15
T14	G6	every	26,27	0..15
T15	D5	2,18	58,59	0..15
T16	D6	3,19	56,57	0..15
T17	D26	13,29	56,57	0..15
E0	D23	11,27	58,59	0..15
E1	C0	even	42,43	0..15
E2	G0	every	13,14	0..15
E3	C1	even	44,45	0..15
E4	C2	even	46,47	0..15
E5	G1	every	15,16	0..15
E6	H0	0,8,16,24	48,49	0..15
E7	H1	0,8,16,24	50,51	0..15
E8	G2	every	17,18	0..15
E9	H2	0,8,16,24	52,53	0..15
E10	H3	0,8,16,24	54,55	0..15
E11	G3	every	19,20	0..15
E12	H4	1,9,17,25	48,49	0..15
E13	H5	1,9,17,25	50,51	0..15
E14	H6	1,9,17,25	52,53	0..15
E15	D0	0,16	56,57	0..15
E16	D1	0,16	58,59	0..15
E17	D24	12,28	56,57	0..15
MS	D27	13,29	58,59	0..15
MZ	D28	14,30	56,57	0..15

Table 23 : ICS rates single sensor mode (sorted by format scheme)

3.5 Subcommutated housekeeping

There are 192 subcommutated housekeeping channels defined, each of which gets transmitted once during one science record on editor A and during four science records on editor B. However, the subcommutated HK data is also redundently transmitted in the EDBs (each EDB contains 6 HK data bytes, 6*32 = 192).

The content of the 191 subcommutated housekeeping bytes

A sector can roughly be subdivided into a time of measurement and a time of data readout where the measurement is disabled. The data readout is executed by the **sector interrupt** routine. This interrupt routine also handles the synchronization of measurement modes (e.g. ICS head summation) to science records. It therefore has more work to do as after 'normal' sectors if it reaches a spin boundary and even more if it reaches a science record boundary. The following three tables describes the timing for the three possible cases.

x. ms	start of sector interrupt routine
x. ms	disable STICS PHA & event classification hardware
x. ms	disable ICS PHA & event classification hardware
x. ms	increment sector counter
x. ms	end of sector interrupt routine
x. ms	enable STICS PHA & event classification hardware
x. ms	enable ICS PHA & event classification hardware
x. ms	start of next sector interrupt routine

x. ms	start of sector interrupt routine
x. ms	disable STICS PHA & event classification hardware
x. ms	disable ICS PHA & event classification hardware
x. ms	start to transmit DPPS step command
x. ms	increment sector counter
x. ms	increment spin counter

One S/C spin is subdivided into 16 sectors.

6. MISCELLANEAOUS

6.1 Upload parameters accepted by the D_PARLDA command

With the D_PARLDA command a number of parameters for the EPIC DPU operation are set. Note that parameter setting just writes new values to the parameter variables and does not activate any procedures like classification table recalculation.

The variables which the D_PARLDA command writes to are of the following basic types :

Type	Variable	# bytes	Explanation
char	cXXX	1	signed byte value (-128 .. +127)
BYTE	byXXX	1	unsigned byte value (0 .. 255)
int	iXXX	2	signed int value, 16 bit, (-32768 .. 32767)
WORD	wXXX	2	unsigned int value (0 .. 65535)
long	lXXX	4	signed long value (-2^{32} .. $2^{32}-1$)
DWORD	dwXXX	4	unsigned long value (0 .. 2^{32})
fix point	rXXX	4	signed 16.16 value (-32768.0 .. 32767.99998)
array of bytes	abyXXX	dimension	array of bytes

For types which occupy more than 1 byte, the lowest significant byte is always loaded first and the most significant byte is loaded last.

Example : For parameter 0, the first transmitted byte in the data area of the D_PARLDA command is the lowest significant byte of rA1, the last transmitted byte is the most significant byte of rA6.

Each parameter loads one or a number of variables. The following lists the loaded variables for every parameter and gives some explanations for every parameter.

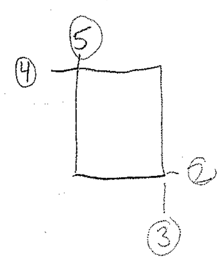
Parm #	Variables loaded	# of bytes	Explanation

0 1	rA1 rA2 rA3 rA4 rA5 rA6	24	The variables rA1 - rA6 hold the polynom coefficients for the ICS mass classification polynom.
1 25	rEADC rEADCLN	8	rEADC contains the ICS Energy conversion factor, rEADCLN contains its natural logarithm.
2 33	rTADC rTADCLN	8	rTADC contains the time-of-flight conversion factor, rTADCLN contains its natural logarithm.
3 41	iEOC iTOC	4	iEOC contains the ICS energy correction offset, iTOC contains the ICS TOF correction offset
4 45	abyMotCurLimit[2]	2	abyMotCurLimit[0] contains the north motor current limit (motor 0), abyMotCurLimit[1] contains the south motor current limit.
5 47	abyMotCurLevel[2]	2	abyMotCurLevel[0] contains the north motor current level, abyMotCurLimit[1] contains the south motor current level. These settings are used in all motor movements.
6 49	abyDPSTab3_0[8]	8	abyDPPSTab3_0 contains the STICS DPPS levels for spin 0 to spin 7 of DPPS stepping sequence 3, the alterable stepping sequence.
7 57	abyDPSTab3_1[8]	8	abyDPPSTab3_1 contains the STICS DPPS levels for spin 8 to spin 15 of DPPS stepping sequence 3, the alterable stepping sequence.
8 65	abyDPSTab3_2[8]	8	abyDPPSTab3_2 contains the STICS DPPS levels for spin 16 to spin 23 of DPPS stepping sequence 3, the alterable stepping sequence.

9 73	abyDPSTab3_3[8]	8	abyDPPSTab3_3 contains the STICS DPPS levels for spin 24 to spin 31 of DPPS stepping sequence 3, the alterable stepping sequence.
10 81	wPreStepWait wStepWait	4	wPreStepWait contains the duration of a wait loop which is executed prior to each ICS aperture motor step. wStepWait contains the duration of a wait loop which is executed prior to each motor phase switching.
11 85	rB1 rB2 rB3 rB4 rB5 rB6	24	rB1 - rB6 contain the STICS mass classification polynom coefficients.
12 109	rSEADK rSTADK rLnEADK rLnTADK	16	rSEADK contains the STICS energy conversion factor, rLnEADK its natural logarithm. rSTADK contains the STICS time-of-flight conversion factor, rLnTADK its natural logarithm.
13 125	iSNMEOC iSNMTOC	4	iSNMEOC contains the STICS energy offset correction, iSNMTOC contains the STICS time-of-flight offset correction.
14 129	iSNMMaxClas	2	Additional STICS mass class parameter. iSNMMaxClas contains the number of the hight mass class to be contained in the STICS mass classification table.
15 131	rC2_1 rC2_2 wSNQ_C2Bound	10	rC2_1 and rC2_2 are the two possible values for C2, wSNQ_C2Bound contains the NQ value (mass-per-charge-class) at which the value of C_2 is switched from rC2_1 to rC2_2.

16 141	rD1 rD2 rE1 rE2 rE3	20	STICS NQ table parameters.
17 161	byHKStartSpin	1	Contains spin number in which HK data is taken.
18 162	byLUMask	1	Value for low level latch-up detector port
19 163	wSTICSErrLim1 wSTICSErrLim2 wSTICSErrLim3 wSTICSErrLim4 wSTICSErrLim5 wSTICSErrLim6 wSTICSErrLim7 wSTICSErrLim8	16	parity errors/sectors before switching off error checker parity errors/sector in direction table before recalculating parity errors/sector in energy comp. table before recalculating parity errors/sector in mass table before recalculating parity errors/sector in M/Q table before recalculating parity errors/sector PHA range table before recalculating parity errors/sector basic rate table before recalculating parity errors/sector science rate table before recalculating
20 179	wICSErrLim1 wICSErrLim2 wICSErrLim3 wICSErrLim4 wICSErrLim5 wICSErrLim6 wICSErrLim7	14	parity errors/sectors before switching off error checker parity errors/sector in direction table before recalculating parity errors/sector in energy table before recalculating parity errors/sector in energy comp. table before recalculating parity errors/sector in mass table before recalculating parity errors/sector time-of-flight table before recalculating parity errors/sector PHA range table before recalculating
21 193	rSEMin rSEMax rSTMin rSTMax	16	STICS energy and time-of-flight boundaries
22 209	byFixedDPPSValue	1	STICS fix DPPS level (see **D_DIGCMD** 15) command

23 210	dwRAMChkLowerBound	4	lower bound for RAM check (default : 10000h)
24 214	dwRAMChkUpperBound	4	upper bound for RAM check (default 1FFFFh)
25 218	abyICalELevel[16]	16	ICS energy calibration levels for the **I_CAL** & **I_BIGCAL** commands
26 234	abyICalTOFLevel[16]	16	ICS time-of-flight calibration levels for the **I_CAL** & **I_BIGCAL** commands
27 250	abySCalELevel[32]	32	STICS energy calibration levels for the **S_CAL** command.
28 282	abySCalTOFLevel[32]	32	STICS time-of-flight calibration levels for the **S_CAL** command.
29 314	acArtSecClkOffset[16]	16	artificial clock sector corrections for each sector, contain # of frames (signed values).
30 330	abySLoadCorner	8	specify box in STICS N vs. NQ space. The bytes are used as follows : 0 : Select science rates (0) or basic rates & PHA (FFh) 1 : entry # in table 2,3 : N,NQ of lower right corner 4,5 : N,NQ of upper left corner 6 : bin number 7 : not used (but has to be supplied)
31 338	wICSDoubleErrLim	2	Number of double errors in ICS classification control memory before reloading the control memory
32 340	wSTICSDoubleErrLim	2	Number of double erros in STICS classification control memory before reloading the control memory.



33 342	byHKFixIdxStart byHKFixIdxEnd	2	Subcom HK boundaries in 'fixed' mode (see **D_DIGCMD 13**)
34 344	byPrgAdrSegment wPrgAdrOffset	3	Segment and offset of the load address for the **D_PARLDB** command
35 347	byStepSeq	1	Number of STICS DPPS stepping sequence to active at the next science record boundary. See also the description of the former **S_DF_SEQ** command.
36 348	awSCRPriorTab[3]	6	Each entry into this array contains the number of the PHA class (0 - 3) the appropriate Basic Rate is assigned to. See also the description of the former **S_RANGE** command.

6.2 DPU special function registers

This chapter describes special DPU I/O ports which are no 8086 system standard. The following table gives a brief overview of all system I/O ports.

Address	Port Name	Access	Description
0000h,0002h	PIC	R/W	Base address of interrupt controller 82C59.
4000h,4001h, ...,400Fh	DMA	R/W	82C37 DMA controller
1000h,1002h, ...,1006h	TIM	R/W	82C54 16 bit timer
1E00h	SEGREG	WR	DMA page register
1600H	COA	WR	command interrupt acknowledge
1C00H	SIA	WR	sector interrupt acknowledge
3800h	FBAA	WR	telemetry A frame begin interrupt acknowledge
3A00h	VOA	WR	under voltage control interrupt acknowledge
3C00	FBAB	WR	telemetry B frame begin interrupt acknowledge
3000h	MREG1	RD	S/C signals, RAM single error counter
3200h	MREG2	RD	power status
		WR	reset RAM single error counters
3000h	SCICMD	WR	S/C interface control
3400h	COMREG	RD	S/C command interface
3600h	SUNREG	WR	Subsector offset of sunpulse
D000h	PREG1	WR	power switch register
2800H	WATCHDOG	WR	watchdog reset register
6000h	ICS_COM	WR	ICS command register
	ICS_DATA_L	RD	ICS command answer low word
6002h	ICS_RESET	WR	ICS command I/F reset
	ICS_DATA_H	RD	ICS command answer high word
6004h	ICS_STATUS	RD	ICS command I/F status
6800h	STICS_COM	WR	STICS command register
	STICS_DATA_L	RD	STICS command answer low word
6802h	STICS_RESET	WR	STICS command I/F reset
	STICS_DATA_H	RD	STICS command answer high word
6804h	STICS_STATUS	RD	STICS command I/F status
1200h	C_COM	R/W	classification control register
1280h	C_STAT	RD	classification status register
	S_CL_PAR	WR	reset STICS parity error
12C0h	S_CL_DEF	WR	reset STICS double error
12D0h	S_CL_INIT	WR	reset STICS classification (event generation)

1400h	S_PE_TOF	RD	STICS PHA event, TOF word
	S_PS_0	WR	STICS prior switches 0 - 15
1480h	S_PE_E	RD	STICS PHA event, energy word
	S_PS_1	WR	STICS prior switches 16 - 31
12A0h	I_CL_PAR	WR	reset ICS parity error
12E0h	I_CL_DEF	WR	reset TICS double error
12F0h	I_CL_INIT	WR	reset ICS classification (event generation)
1500h	I_PE_TOF	RD	ICS PHA event, TOF word
	I_PS_0	WR	ICS prior switches 0 - 15
1580h	I_PE_E	RD	ICS PHA event, energy word
	I_PS_1	WR	ICS prior switches 16 - 31
1800h	S_CL_PE	WR	clear STICS PHA interrupt
1A00h	I_CL_PE	WR	clear ICS PHA interrupt

Table 28 : DPU I/O ports

6.2.1 LU-Test Register (LUTEST)

Address : 0F000H

Access : 8 Bit, W/O

Purpose : To activate the low level Latch Up current sensors

Layout :

7	6	5	4	3	2	1	0
TIME				SPM	IPM	UPM	UPC

UPC	μP - Test, active "0"
UPM	μP - Memory Test, active "0"
IPM	ICS Memory Test, active "0"
SPM	STICS Memory Test, active "0"
TIME	Testtime (= TIME * 2 μs)

A low level latch up test is performed after a write operation to this register. However, if the 4 least significatn bits were all set to 1, no latchup test is performed.

6.2.2 DPU Command Register (COMREG)

Address : 3400H

Access : 16 Bit, R/O

Purpose : supplies S/C commands to the DPU

Layout :

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x	x	x	x	ERR	DC	BC	ECS	MSB			COMMAND				LSB

COMMAND	command byte from S/C
ECS	Status of Error Checker 0 : Error Checker is enabled 1 : Error Checker is disabled
BC	"1" if the received command was a BC
DC	"1" if the received command was a DC
ERR	"0" if an command transmission error occured, i.E. the command was not transmitted with 8 bits but with less or more

6.2.3 Message Register 1 (MREG1)

Address : 3000H

Access : 16 Bit, R/O

Purpose : Reports the telemetry status

Layout :

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ROM single err				RAM single err				TBS	TAS	SUN	FTC	FBB	FWB	FBA	FWA

ROM single err	Number of single errors in ROM
RAM single err	Number of single erros in RAM
FWA	F_0W_0 - Pulse of telemetry A, active high
FBA	Frame Begin Pulse of telemetry A, active high. This signal also causes a frame begin interrupt to the processor.
FWB	F_0W_0 - Pulse of telemetry B, active high
FBB	Frame Begin Pulse of telemetry B, active high. This signal also causes a frame begin interrupt to the processor.
FTC	"Format C" signal for telemetry A, active high
SUN	Sun Pulse Signal, active high. If this bit is set, the sun pulse occured during the last sector. (The sunpulse is latched with every sector interrupt signal).

TAS Telemetry A status, "1" means telemetry A is enabled.

TBS Telemetry B status, "1" means telemetry B is enabled.

6.2.4 SCI-Control Register (SCICMD)

Address : 03000H

Access : 8 Bit, W/O

Purpose : To control the S/C interface

Layout :

7	6	5	4	3	2	1	0
x	x	x	x	x	TBO	TAO	ECO

ECO enables ("1") or disables ("0") the error checker for the DPU command channel

TAO enables ("1") ord disables ("0") telemetry A

TBO enables ("1") ord disables ("0") telemetry B

6.2.5 Power Control Register (PREG1)

Address : 0D000H

Access : 8 Bit, W/O

Purpose : to switch the various software controlled power switches inside the DPU

Layout :

7	6	5	4	3	2	1	0
SWADR			0	x	x	x	SWB

SWB Switch Bit, switches the selected power supply on ("1") or off ("0")

SWADR Switch Address, selects the power supply to be switched :

0 : unused
1 : ICS LVPS
2 : ICS MCPPS
3 : STICS ACTUATOR PS
4 : STICS LVPS
5 : STICS DPPS
6 : STICS MCPPS
7 : Instrument PS (main switch for all above)

6.2.6 Message Register 2 (MREG2)

Address	:	3200H
Access	:	16 bit, R/O
Purpose	:	mirrors the status of the power switches to the DPU
Layout	:	

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LUR	PRS	SWS	HWS	HVE	SAP	ILP	SLP	EDP	BHP	SHP	IHP	IMP	SMP	SDP	EIP

EIP	Epic Instrument Power		
SDP	STICS Deflection Plate Power		
SMP	STICS Microchannel Plate Power		
IMP	ICS Microchannel Plate Power		
IHP	ICS Supplement Heater Power		
SHP	STICS Supplement Heater Power		
BHP	Bakeout Heater Power		
EDP	EPIC DPU Power		
SLP	STICS Low Voltage Power		
ILP	ICS Low Voltage Power		
SAP	STICS Actuator Power		
HVE	HV - Enable		
	"1" : HV is enabled		
	"0" : HV is disabled		
HWS	"1"	:	DC timing circuit is active, hardware controlled relay may be currently switching
	"0"	:	DC timing circuit is inactive.
SWS	"1"	:	software timing circuit is active, software controlled relay is currently switching
	"0"	:	all software controlled relays are inactive
PRS	"0"	:	PROM1a is selected
	"1"	:	PROM1b is selected
LUR	0	:	Last power on was by command
	1	:	Last power on was after a latch up detection

Note : The "Power" - Bits in this register have the following meanings :

"0" : respective power is switched off

"1" : respective power is switched on

6.2.7 Classification Status Register (C_STAT)

Address : 1280H

Access : 16 Bit, R/O

Purpose : mirrors the status of the classifications units to the DPU

Layout :

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x	x	x	x	x	x	x	VIP	DEI	DES	PEI	PES	PI	PS	ICR	SCR

SCR	STICS classification is running
ICR	ICS classification is running
PS	STICS PHA word received
PI	ICS PHA word received
PES	Parity error in STICS table memory
PEI	Parity error in ICS table memory
DES	Double error in STICS control memory
DEI	Double error in ICS control memory
VIP	Under voltage condition

Note : all Bits are active high

6.2.8 Classification Command Register (C_COM)

Address : 1200H

Access : 16 bit, W/O

Purpose : to control the classification units

Layout :

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
PAGE					VIE	EDI	EDS	EPI	EPS	HCI	HCS	PEI	CEI	PES	CES

CES	"0" : Disable STICS classification
	"1" : Enable STICS classification
PES	"0" : Disable STICS PHA events
	"1" : Enable STICS PHA events
CEI	"0" : Disable ICS classification
	"1" : Enable ICS classification
PEI	"0" : Disable ICS PHA events
	"1" : Enable ICS PHA events

HCS	"0" : Allow STICS classification operation "1" : Halt STICS classfication immediately This bit has priority over the CES bit !
HCI	"0" : Allow ICS classification operation "1" : Halt ICS classfication immediately This bit has priority over the CEI bit !
EPS	"0" : Disable STICS parity error interrupts "1" : Enable STICS parity errors interrupts
EPI	"0" : Disable ICS parity errors interrupts "1" : Enable ICS parity errors interrupts
EDS	"0" : Disable STICS double errors interrupts "1" : Enable STICS double errors interrupts
EDI	"0" : Disable ICS Double errors interrupts "1" : Enable ICS double errors
VIE	"0" : Disable UVC interrupt "1" : Enable UVC interrupt
PAGE	selects page 0..31 of the classfication control memories

7. KNOWN PROBLEMS

13.Mar.91 — The ICS motor movement will be interrupted during the first sectors of a spin, where the EDB is formatted.

6.June.91 — Due to a bug in the job manager, it might happen that if a job deletes itself or other jobs which preceed this job in the job table, the job next to the current job is not executed in that cycle where the deletion occurs.

This can happen for example while stepping a couple of HV in parallel. If one HV reached its maximum and deletes the stepping job, another HV might not be stepped up in that spin.

Since the ROM in segment E0000h was not buildt into the DPU, the DPU will report up to 5 ROM errors in each spin, since the software accesses this ROM up to 5 times per spin (guess why...)

DPU Commands **59**
D_ALARM_MON 74
D_ALRLIM 77
D_BAKE_HTR 61
D_CMPRSS 82
D_DIGCMD 84, 126
12, 79, 102, 127
D_HSKPG 79
84
D_JOB 89
D_LUDET 67
D_PARLDA 86
10, 11, 12, 21, 103, 123
D_PARLDB 88
12, 86, 87, 103, 127
D_PATCH 71
D_PLDBAD 87
88
D_POWER 60
D_PRGADR 72
73, 87
D_PRGLD 73
12, 86, 103
D_PROM_MODE 65
D_PROM_SEL 66
D_PWRCMD 75
90, 93, 104, 106
D_RESCONF 69
68
D_SAVCONF 68
69
D_SUNSET 80
D_WATCHDOG 70
HV 64
75, 90, 93, 104, 106
I_BIGCAL 122, 126
I_CAL 121, 126
I_DIGCMD 114
45, 119, 120
I_DIRMOT 120
I_ECAL 111
I_EN_THS 109
I_HV_LEV 106
105, 138
I_HV_LIM 105
106, 138
I_HVCMD 104
106, 138
I_MTRCMD 119
I_PHACMD 118
I_PR_OVR 116
118
I_PWRCMD 107
I_SUP_HTR 63
I_TCAL 112
I_VALID 110
S_CAL 127

S_DF_SEQ 103
127
S_DIGCMD 101
S_ECAL 98
S_EN_THS 96
S_HV_LEV 93
92
S_HV_LIM 92
93
S_HVCMD 90
93
S_PWRCMD 94
S_RANGE 102
127
S_SUP_HTR 62
S_TCAL 99
S_VALID 97

Ports

C_COM 133
C_STAT 133
COMREG 130
LUTEST 129
MREG1 130
MREG2 132
PREG1 131
SCICMD 131

Revision notes

4.2.91	First document release
28.2.91	Command execution synchronization notes added Changed HV PS names for ICS due to misswireing in ICS A/E flight model (I_HVCMD, I_HV_LIM, I_HV_LEV) Table 17,18 updated due to new formatting scheme of ED2 (D instead of DA) and new addressing scheme of FA rates (sum over 4 sectors instead of 2)
13.3.91	Commands D_RANGE, D_HSKPG, D_PLDBAD, S_DF_SEQ, S_RANGE, I_PHACMD marked with warnings since they were replaced by parameter load commands.
5.4.91	Some editorial changes. Classification equations for STICS updated. Limits for mass & mass-per-charge classes updated Energy slope default value updated. Energy compression formula updated. Correlations between STICS bins and HR/MR/SMR described. STICS Deflection Voltage stepping sequence 2 updated. Switches in D_WATCHDOG command corrected. D_DIGCMD option 42 (load STICS box definition) documented. D_JOB command code corrected. S_HVCMD DPPS switches corrected (options 7,8) S_PWRCMD options 8 and 11 updated (Main bias power is not inverted) Byte numbers for parameter updated. Structure of parameter 30 (STICS box definition) updated.
6.6.91	Editorial changes Classification explained in more detail ICS PHA processing documented