Internal Report No. 43

IMP-H Experiment Tape Data Format

by

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1) General Observations

Data pertaining to the Caltech experiment on IMP-H (Explorer 47) is stripped from the spacecraft data stream and supplied to Caltech in the form of "experiment tapes." Additional data, such as spacecraft position, etc., is supplied on attitude-orbit tapes. The experiment tapes (EXT's) are 7 track magnetic tapes, written at 800 BPI with odd parity. Each EXT contains from 1 to 50 files of data and is terminated by a double end-of-file. This maximum quantity (50 files) corresponds to about 4 days of data at the high bit rate (1600 BPS). Each file corresponds to filling a 10" reel (occasionally 14") of mag tape with the analog telemetry stream from the spacecraft. A file normally contains up to about 2 hours of data and up to about 90 records. Data within a file are generally time ordered. The files themselves are generally time ordered, but with gaps and overlaps.

2) Data Organization and Notation

A) Records Et Cetera

The spacecraft data stream is organized as shown in Table 1. The "bits" in that table are information bits, as opposed to telemetry bits. The telemetry is 50% redundant, with 16 transmitted bits per channel. The high bit rate is 1600 information bits per second or 3200 BPS total.

On the experiment tapes the data is organized into files and records as previously mentioned. Each file begins with a header record which contains data such as the satellite identification, orbit number, etc. All succeeding records in the file are data records. Each data record consists of 4 sub-records. Each sub-record corresponds to one page from the spacecraft data. There is no correspondence between records and albums since pages may be missing and no attempt is made to maintain synchronism.

It should be noted that the last record of a file may not have four pages of data available; in this case, the record is filled out with zeroes including

TABLE 1: Spacecraft Data Stream Organization

Unit		Next Smaller Unit	Period of Unit at High Bit Rate
album	=	4 pages	81.92 sec
page	=	4 snapshots	20.48 sec
snapshot	=	4 sequences	5.12
sequence	=	16 frames	1.28
frames	=	16 channels	0.08
channel	=	8 bits	0.005

the data quality flags. In all other cases the data quality flags would be set to 1 to indicate the presence of fill.

B) Bits, Characters, Et Cetera

The spacecraft data stream is organized into 8-bit channels. The Caltech PDP-11 data processing unit is organized into 8-bit bytes. Unfortunately the intermediate step, the EXT, is a 7 track tape with 6 bits of data per character. The contortions involved in coding and decoding the EXT's may be visualized as in Figures 1-3. Figure 1 schematically illustrates the arrangement of data on the 6 data channels of the tape. The 0th channel contains the least significant bits (LSB's) of characters A thru G. The 5th channel has the most significant bits (MSB's). Character A will be read first, then B, and so on. The data will be stored in the PDP-11 core as illustrated in Figure 2. The bytes are swapped and the zeroes squeezed out by the computer program, yielding the arrangement illustrated in Figure 3. When this process has been completed, an 8-bit channel will normally be represented by the 8 bits in the low-order byte of a word, e.g., $A^1A^0B^5$---B^0 of byte 0 of word 0 or $C^1C^0D^5$---D^0 of byte 2 of word 2. In this case, the bits in the high order byte will normally be zeroes, e.g., $A^5A^4A^3A^2$ might all be zeroes. Some data is organized into 36-bit words. These words are written on the tape as 6 6-bit characters. In this case all 12 of the data bits in a PDP-11 word, e.g., E^5E^4--F^1F^0 of word 4 in Figure 3 represent valid data. Three of these 12-bit groups are required to reconstruct the original word.

Data in the header records is all coded in a modified BCD scheme. Each tape character represents one decimal digit. The coding is BCD, except that 0 is represented by the binary number 001010, which would normally be interpreted as a decimal 10. The binary number 000000 should never occur in the header records. When the data has been rearranged as shown in Figure 3, two adjacent digits will be mixed. For example, we might have one digit represented by $B^3B^2B^1B^0$ with B^5 and $B^4 = 0$, and another digit represented by $A^3A^2A^1A^0$ with A^5 and $A^4 = 0$.

In the following tables and discussions of the EXT data records, the description given applies to the data as it appears in PDP-11 core, after having been rearranged into the form illustrated in Figure 3. The description does not apply to the data as it appears on the tape itself.

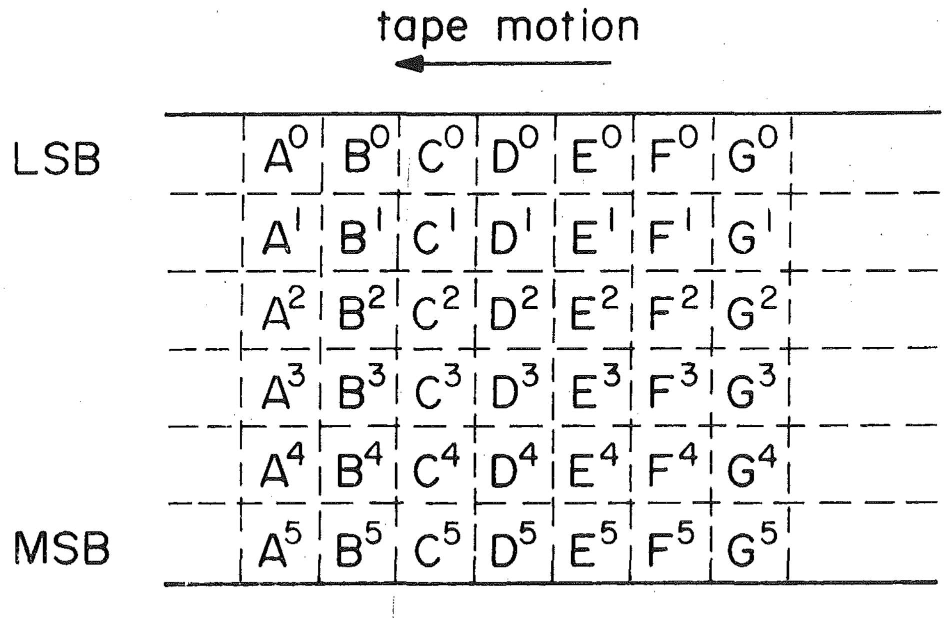

Figure 1

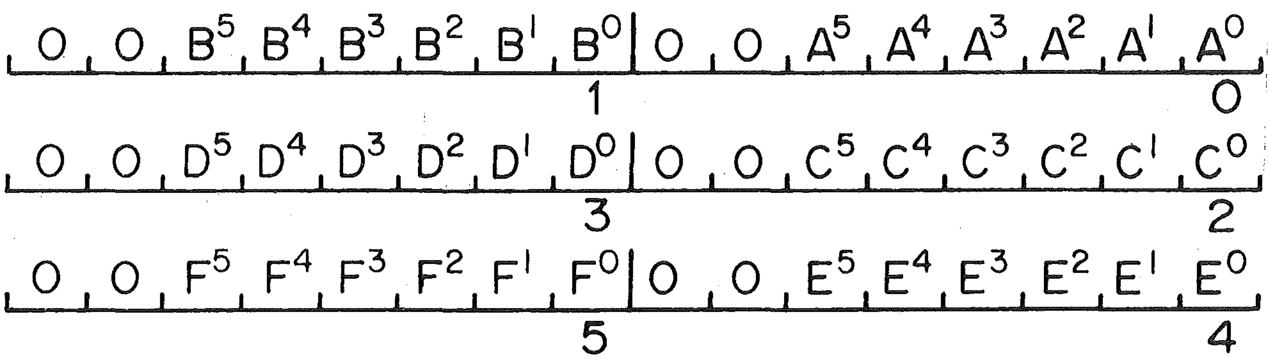

Figure 2

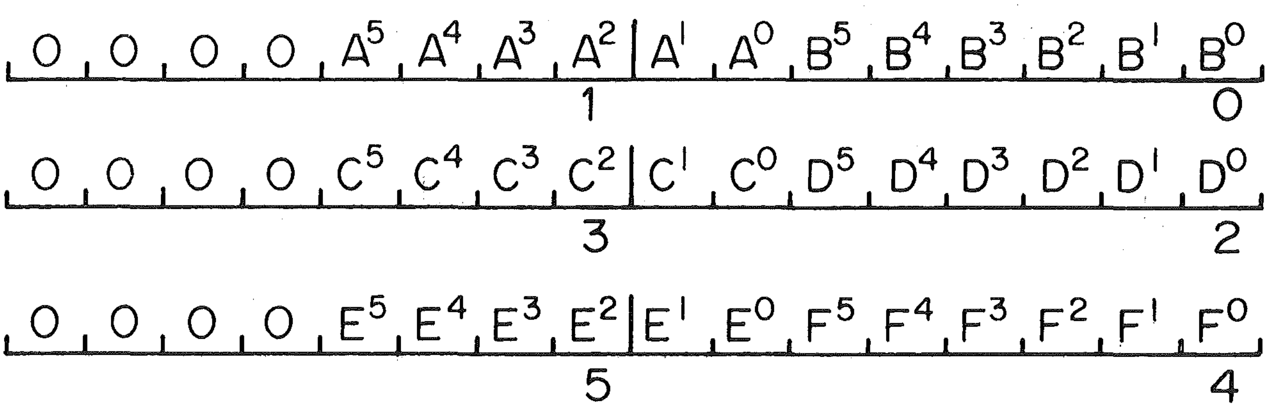

Figure 3

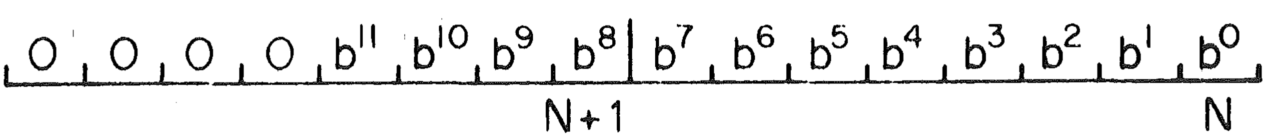

Figure 4

The following notation will be used to describe the data records: The bits in a 12-bit group in a word will be numbered from 0 to 11 and represented by the letter b with a superscript to indicate position, as in Figure 4. For example, b^0 is the LSB of byte N in word N, b^8 is the LSB of byte N+1 in word N, and b^7 is the MSB of byte N in word N. If it is not clear which word is referenced it will be indicated as follows: $b^0(N),\ldots,b^7(N)$, $b^8(N)\ldots$. Two types of numbers are defined here for convenience. The number indicated by $\beta(N)$ is the number whose binary representation is given by the bits $b^{11}(N)$ through $b^0(N)$, with b^{11} as the MSB. The number indicated by $\gamma(N)$ is that number whose binary representation is given by the bits $b^0(N)$ through $b^7(N)$ with b^0 as the MSB and b^7 as the LSB.

The EXT header records are described in decimal notation with each digit derived from a character on the EXT tape itself.

3) Data Format

The format and content of the EXT's is described in the following tables, Table 2 for the header records and Table 3 for the data records. Notes for these tables follow immediately after the tables.

TABLE 2: EXT Header Records

First word of this item	No. of bytes in this item	Contents and Description
0	6	satellite identification (decimal 207310)
6	3	station identification
10	3	zero
12	4	analog tape numbers
16	2	zero
18	2	analog file number
20	4	zero
24	5	date of recording at station (YMMDD)
29	7	zero
36	4	analog start time (HHMM)
40	2	zero
42	6	average sequence time (sec) x 10^5
48	4	analog stop time (HHMM)
52	8	GSFC internal use
60	4	data type 0000 normal 0001 encoder bypass 0002 encoder failure 0003 uncoded
64	2	experimenter number (decimal 21)
66	1	data rate 0 ⇒ low bit rate 1 ⇒ high bit rate
67	3	orbit number (perigee count)
70	4	day of next perigee crossing
74	4	time of next perigee crossing (HHMM)
78	4	Master Edit Tape number
82	2	Master Edit File number
84	3108	Fill

TABLE 3: EXT Data Records

First word of this item	No. of bytes in this item	Contents and Description
0	2	continuity flags b^0=1 if no fill data in page b^1=1 if no time discontinuity follows All other bits are zero.
2	2	bit rate flag 1 => High rate (1600 BPS) 0 => Low rate (400 BPS)
4	2	day of the year of the first non-filled sequence in the page Jan 1 = 1,....
6	6	MilliSeCond of the day of the first non-filled sequence in the page $MSC = 2^{24} \cdot \beta(6) + 2^{12} \cdot \beta(8) + \beta(10)$
12	2	time quality flags for seq 12-15 seq 3 flag = $b^0 + 2 \cdot b^1$ seq 2 flag = $b^2 + 2 \cdot b^3$ seq 1 flag = $b^4 + 2 \cdot b^5$ seq 0 flag = $b^6 + 2 \cdot b^7$ All other bits are zero. Flag Values: 0 => analog time unverified 1 => analog time verified by S/C clock 2 => analog time in error, S/C clock used 3 => time put with fill data, computed
14	2	time quality flags for seq 8-11
16	2	time quality flags for seq 4-7
18	2	time quality flags for seq 0-3

TABLE 3 (cont.)

20	2	data quality flags for seq 0 Frames 12-15 flag = $b^0 + 2\cdot b^1$ Frames 8-11 flag = $b^2 + 2\cdot b^3$ Frames 4-7 flag = $b^4 + 2\cdot b^5$ Frames 0-3 flag = $b^6 + 2\cdot b^7$ All other bits are zero. Flag Values: 0 => excellent (error rate $< 10^{-6}$) 1 => good (error rate $< 10^{-4}$) 2 => fill 3 => undetermined
22	2	data quality flags for seq 1
:		
:		
:		
50	2	data quality flags for seq 15
52	2	zeroes
54	6	Pseudo-Sequence Counter for the first non-filled sequence in the page (See note 1.) $PSC = 2^{24}\cdot\beta(54) + 2^{12}\cdot\beta(56) + \beta(58)$
60	38	irrelevant analog parameters
98	2	Temperature Counter (See note 2.) If $b^4(218) = 1$, $TC = \gamma(98)$, otherwise irrelevant
100	24	irrelevant analog parameters
124	2	zero
126	2	analog transmitter flag for seq 1 b^4 and $b^0 = \begin{cases} 1 \text{ if ATX is ON} \\ 0 \text{ if ATX is OFF} \end{cases}$
128	2	analog transmitter flag for seq 5
130	2	analog transmitter flag for seq 9
132	2	analog transmitter flag for seq 13
134	56	irrelevant digital parameters

TABLE 3 (cont.)

190	2	PCM transmitter flag for seq 0
		b^6 and $b^2 = \begin{cases} 1 \text{ if PTX is ON} \\ 0 \text{ if PTX is OFF} \end{cases}$
192	2	PCM transmitter flag for seq 8
194	4	irrelevant digital parameters
198	2	experiment power flag for seq 4
		b^7 and $b^3 = \begin{cases} 1 \text{ if power is ON} \\ 0 \text{ if power is OFF} \end{cases}$
200	2	experiment power flag for seq 12
202	4	irrelevant digital parameters
206	2	OA/TM slave mode flag for seq 5 (See Note 3)
		b^5 and $b^1 = \begin{cases} 1 \text{ if TM} \\ 0 \text{ if OA} \end{cases}$
208	2	OA/TM slave mode flag for seq 13
210	4	irrelevant digital parameters
214	6	spacecraft clock for first non-filled sequence in page
		page number = $b^4(218) + 2 \cdot b^5(218)$
220	12	irrelevant OA parameters
232	4	Spin Period at seq 4
		$SP(msec) = 5/32\ (\gamma(232) + \gamma(234) \cdot 2^8)$
236	20	irrelevant OA parameters
256	4	Spin Period at seq 12
260	8	irrelevant OA parameters
268	10	A rates for sectors 0-3 (See note 4.)
278	10	A rates for sectors 4-7
288	20	B rates for sectors 0-7
308	20	C rates for sectors 0-7
328	20	E rates for sectors 0-7
348	4	F1 rate in snapshot 0 (See note 5.)

TABLE 3 (cont.)

352	4	F1 rate in snapshot 2 (See note 5.)
356	4	F2 rate in snapshot 1 (See note 6.)
360	4	F2 rate in snapshot 3 (See note 6.)
364	4	F3 rate in snapshot 0 (See note 6.)
368	4	F3 rate in snapshot 1 (See note 6.)
372	4	F3 rate in snapshot 2 (See note 6.)
376	4	F3 rate in snapshot 3 (See note 5.)
380	4	F4 rate in snapshot 0 (See note 5.)
⋮		
392	4	F4 rate in snapshot 3 (See note 5.)
396	4	F5 rate in snapshot 0 (See note 5.)
⋮		
408	4	F5 rate in snapshot 4 (See note 5.)
412	12	event 0 (See note 7.) first event in page
424	12	event 1
436	12	event 2
⋮		
784	12	event 31 last event in page
796	2	zero
798	2394	next 3 sub-records

Note 1 The PSC counts sequences from the beginning of the mission, just as the spacecraft clock does. The PSC, however, is calculated by the ground station computer rather than counted by an actual counter in the spacecraft. It is therefore, less subject to occasional glitches, etc. which may affect the accuracy of the spacecraft clock. The PSC also has 36 bits rather than the 24 available to the spacecraft clock. In spite of these disadvantages, the spacecraft clock must be used for determining page numbers, etc. since all commutation counters on the spacecraft are controlled by the spacecraft clock.

Note 2 The TC is converted to a temperature by use of the calibration table (Table 4) which is calculated from the circuit illustrated in Figure 5. The TC is a linear digital representation of the voltage V_0, given by

$$TC = 230 - 40 \cdot V_0 \quad .$$

The voltage V_0 is derived from the thermistor resistance R_T:

$$\frac{V_0}{V_S} = \frac{\dfrac{R_T R_2}{R_T + R_2}}{\dfrac{R_T R_2}{R_T + R_2} + R_1}$$

The thermistor resistance is given by the table in Figure 6. Using the values

$$V_0 = 7.75 \text{ volts}$$
$$R_1 = 39{,}200 \text{ ohms}$$
$$R_2 = 100{,}000 \text{ ohms}$$

the entries in Table 4 may be derived.

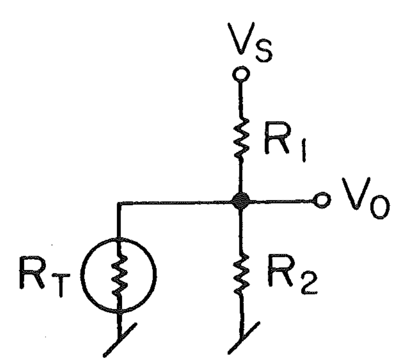

Figure 5

TABLE 4: Temperature Counter Calibration

TC	temp (°C)	TC	temp (°C)	TC	temp (°C)
31	-40.1	63	-21.3	95	-8.12
32	-39.0	64	-20.8	96	-7.73
33	-38.2	65	-20.4	97	-7.35
34	-37.5	66	-20.0	98	-6.96
35	-36.8	67	-19.5	99	-6.58
36	-36.1	68	-19.0	100	-6.19
37	-35.4	69	-18.6	101	-5.81
38	-34.7	70	-18.2	102	-5.42
39	-34.1	71	-17.8	103	-5.04
40	-33.4	72	-17.3	104	-4.65
41	-32.8	73	-16.9	105	-4.27
42	-32.2	74	-16.5	106	-3 88
43	-31.6	75	-16.1	107	-3.50
44	-30.9	76	-15.7	108	-3.12
45	-30.4	77	-15.3	109	-2.73
46	-29.8	78	-14.8	110	-2.35
47	-29.3	79	-14.4	111	-1.96
48	-28.7	80	-14.0	112	-1.58
49	-28.2	81	-13.6	113	-1.19
50	-27.6	82	-13.2	114	- .81
51	-27.1	83	-12.8	115	- .42
52	-26.6	84	-12.4	116	- .04
53	-26.1	85	-12.0	117	+ .35
54	-25.6	86	-11.6	118	+ .73
55	-25.1	87	-11.2	119	+1.12
56	-24.6	88	-10.8	120	+1.50
57	-24.1	89	-10.4	121	1.88
58	-23.6	90	-10.0	122	2.31
59	-23.1	91	- 9.65	123	2.69
60	-22.7	92	- 9.27	124	3.08
61	-22.2	93	- 8.88	125	3.48
62	-21.7	94	- 8.50	126	3.88

TABLE 4 (cont.)

TC	temp (°C)	TC	temp (°C)	TC	temp (°C)
127	4.28	160	18.8	193	39.9
128	4.68	161	19.3	194	40.8
129	5.08	162	19.8	195	41.7
130	5.48	163	20.3	196	42.6
131	5.88	164	20.8	197	43.6
132	6.29	165	21.3	198	44.6
133	6.71	166	21.8	199	45.6
134	7.12	167	22.3	200	46.6
135	7.54	168	22.9		
136	7.96	169	23.5		
137	8.38	170	24.1		
138	8.79	171	24.6		
139	9.21	172	25.2		
140	9.63	173	25.8		
141	10.0	174	26.4		
142	10.5	175	27.0		
143	10.9	176	27.6		
144	11.3	177	28.2		
145	11.8	178	28.8		
146	12.2	179	29.5		
147	12.7	180	30.1		
148	13.1	181	30.8		
149	13.5	182	31.5		
150	14.0	183	32.1		
151	14.5	184	32.9		
152	14.9	185	33.6		
153	15.4	186	34.4		
154	15.9	187	35.1		
155	16.3	188	35.8		
156	16.8	189	36.6		
157	17.3	190	37.4		
158	17.8	191	38.2		
159	18.3	192	39.0		

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Uni-Curve

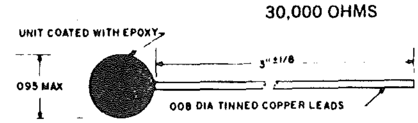
INTERCHANGEABLE CURVE-MATCHED THERMISTOR

UNI-CURVE PART NUMBER
UUT 43J1
Color Code: BROWN

• 30,000 OHMS AT 25 C • ± 0.2 C • 0-70 C •

Temp. °C	Resist.	Temp. °C	Resist.	Temp. °C	Resist.
−40	1,204,600	37	17,441	114	1,085.9
−39	1,125,000	38	16,697	115	1,054.1
−38	1,051,100	39	15,989	116	1,023.3
−37	982,390	40	15,314	117	993.53
−36	918,590	41	14,672	118	964.74
−35	859,280	42	14,059	119	936.91
−34	804,130	43	13,475	120	909.99
−33	752,820	44	12,919	121	883.95
−32	705,070	45	12,388	122	858.76
31	660,620	46	11,881	123	834.39
30	619,200	47	11,398	124	810.81
29	580,620	48	10,937	125	787.98
28	544,650	49	10,497	126	765.89
27	511,100	50	10,077	127	744.50
26	479,810	51	9,676.0	128	723.78
25	450,610	52	9,292.8	129	703.73
24	423,340	53	8,926.7	130	684.31
23	397,870	54	8,576.9	131	665.49
22	374,070	55	8,242.5	132	647.27
21	351,830	56	7,922.7	133	629.60
20	331,030	57	7,617.0	134	612.50
19	311,580	58	7,324.6	135	595.91
18	293,370	59	7,044.8	136	579.83
17	276,330	60	6,777.1	137	564.26
16	260,370	61	6,520.9	138	549.15
15	245,420	62	6,275.6	139	534.50
14	231,410	63	6,040.8	140	520.30
13	218,280	64	5,815.9	141	506.52
12	205,960	65	6,600.4	142	493.16
11	194,410	66	5,394.0	143	480.19
10	183,560	67	5,196.2	144	467.61
9	173,380	68	5,006.6	145	455.41
8	163,820	69	4,824.8	146	443.57
7	154,840	70	4,650.5	147	432.07
6	146,400	71	4,483.4	148	420.91
5	138,470	72	4,323.0	149	410.08
4	131,000	73	4,169.1	150	399.56
3	123,990	74	4,021.4		
2	117,380	75	3,879.7		
1	111,160	76	3,743.7		
0	105,310	77	3,613.0		
1	99,792	78	3,487.5		
2	94,596	79	3,367.0		
3	89,698	80	3,251.2		
4	85,080	81	3,140.0		
5	80,725	82	3,033.0		
6	76,616	83	2,930.2		
7	72,738	84	2,831.3		
8	69,077	85	2,736.2		
9	65,620	86	2,644.8		
10	62,354	87	2,556.8		
11	59,268	88	2,472.2		
12	56,352	89	2,390.7		
13	53,594	90	2,312.3		
14	50,986	91	2,236.8		
15	48,519	92	2,164.2		
16	46,184	93	2,094.2		
17	43,974	94	2,026.8		
18	41,882	95	1,961.8		
19	39,900	96	1,899.3		
20	38,022	97	1,839.0		
21	36,242	98	1,780.8		
22	34,556	99	1,724.8		
23	32,956	100	1,670.8		
24	31,439	101	1,618.7		
25	30,000	102	1,568.4		
26	28,634	103	1,520.0		
27	27,338	104	1,473.2		
28	26,107	105	1,428.1		
29	24,937	106	1,384.5		
30	23,827	107	1,342.5		
31	22,771	108	1,301.9		
32	21,768	109	1,262.7		
33	20,814	110	1,224.9		
34	19,907	111	1,188.3		
35	19,044	112	1,153.0		
36	18,223	113	1,118.9		

30,000 OHMS



UNI-CURVE INTERCHANGEABLE THERMISTOR:

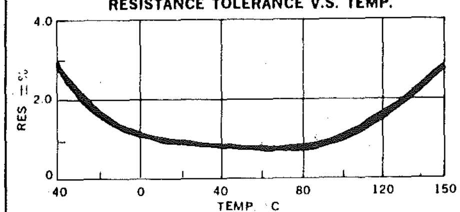
Epoxy encapsulated, precision matched to standardized resistance temperature curve, providing predicted temperature accuracy based on resistance values and tolerance over the entire temperature range.

NOTE: May be operated to 150°C — however, use or cycling above 90°C may change resistance to exceed the specified tolerance.

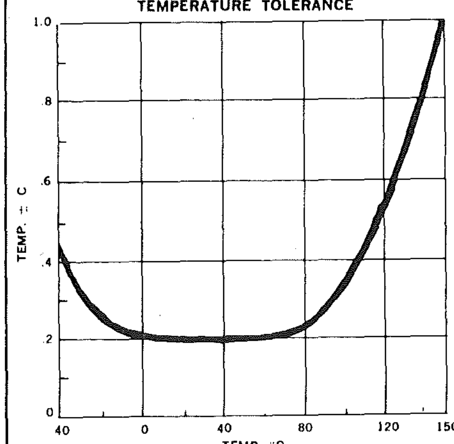
Condition	Dissipation Constant	Time Constant
Still Air	1mw/°C	10 sec. max.
Stirred Oil Bath	8 mw/°C	1 sec. max.

*D.C. — Power in milliwatts required to raise thermistor temperature 1°C.
**T.C. — Time required for thermistor to indicate 63% of a new impressed temperature

RESISTANCE TOLERANCE V.S. TEMP.



TEMPERATURE TOLERANCE



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L6-D4

Figure 6

<u>NOTE 3</u> The OA (optical aspect) system utilizes a sun sensor to determine a fixed direction in space. This system supplies signals to the spacecraft and experiment which are used to define which spin octant the experiment is in at any given time. When in the OA mode the sectored rates are accumulated as follows:

1) The spacecraft waits for a new page to begin.

2) The spacecraft waits for the octant number to change.

3) After these two events, the spacecraft begins accumulating rates at the beginning of the next <u>quadrant</u> (octant 0, 2, 4, and 6).

4) Rates are accumulated in separate scalers for each octant for a 14-revolution period (a nominal 18.26 sec compared to a 20.48 sec page).

5) The scalers' gates are closed at the end of this 14-revolution period and the accumulated rates are read out before the next sequence begins.

If the OA system fails, the TM mode will be used. In this case the sun sensor signal is replaced by a signal synchronized to the telemetry system and the accumulators have 100% live time. The sectoring is meaningless in this case.

Figure 7 and Table 5 specify the average direction corresponding to each sector. Table 5 also relates the S1, S2, and S3 bits in the event data on the EXT to the sector numbering. The unusual order is due to grey coding.

TABLE 5: Sectors

Sector	S1	S2	S3	Direction
0	0	1	0	76°
1	0	1	1	31°
2	0	0	1	346°
3	0	0	0	301°
4	1	0	0	256°
5	1	0	1	211°
6	1	1	1	166°
7	1	1	0	121°

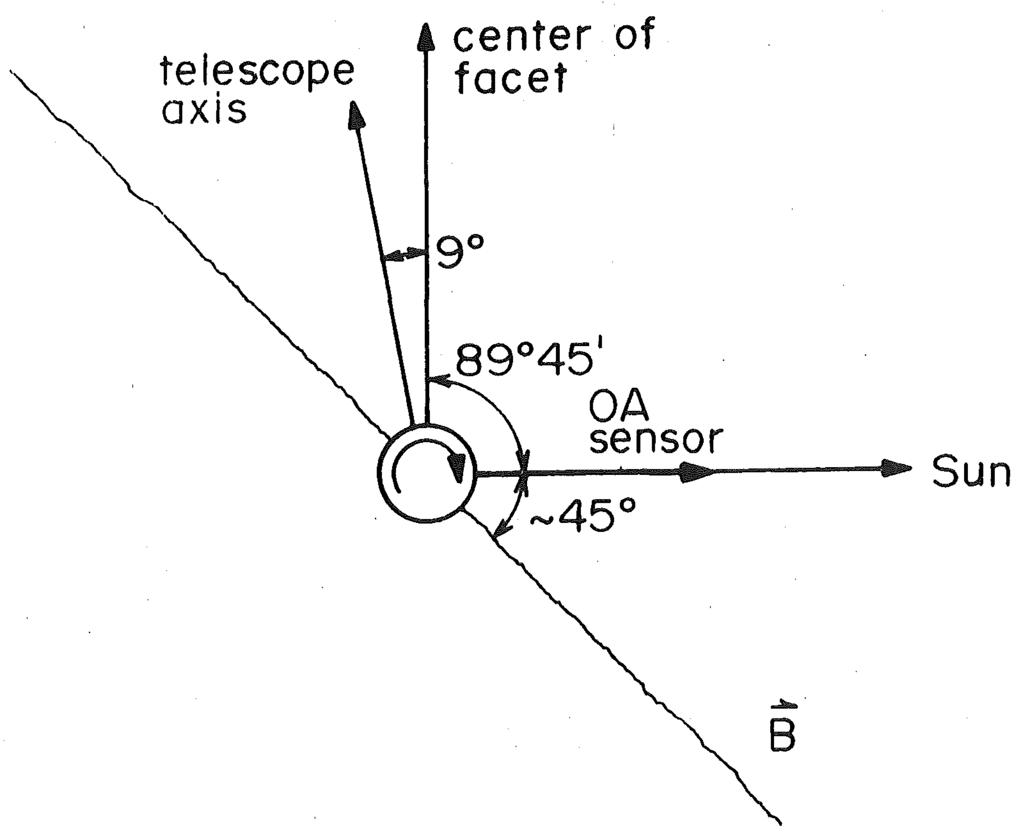

Figure 7

NOTE 4 The meanings of these rates are discussed in the digital data processor writeup. The rates are accumulated in 24 bit scalers, but compressed by means of a floating-point compression scheme. The sectored rates are compressed to 10 bits. A group of 4 sectors will be found in 5 contiguous PDP-11 words, as illustrated in Figure 8. The X's represent a "mantissa"; the C's represent a "characteristic." A complete description of the decoding is given in the following excerpt from the encoding system specifications.

FLOATING POINT COMPRESSION

A. GENERAL

The development of AMI's MOS Thick Oxide Process has been so rapid that it now takes less components (3 chips and 2 resistors) to do 24 to 12 bit floating point compression than to do the usual compression by S-T accumulators. Two basic types of compression will be done as follows:

1. 16 or 24 or 32 bits compressed to 12 bits telemetered as $X_1X_2X_3X_4X_5X_6X_7C_1C_2C_3C_4C_5$ where the 5 each C bits are the number of shifts to the right required to find the first 1 and the 7 each X bits are the value of the seven bits preceding the first 1.

Thus the first 255 counts will be telemetered with no error and the maximum counting error will be $1/2^7$ = 1/128 or $\pm 1/256$ or less than $\pm 1/2\%$.

24 bits was chosen because it will take about 16 seconds to fill at 1 megacycle. Many readouts will be about 10 seconds and the accumulator will be reset. If larger times are required, 32 bits would fill in about 4000 seconds at a MC, and for low counting rates 16 bits can be used.

2. 16 or 24 or 32 bits compressed to 10 bits telemetered as $X_3X_4X_5X_6X_7C_1C_2C_3C_4C_5$. It will be noted that this is the same as the 12 bit compression except that the X_1 and X_2 bits are not read out.

Thus the first 63 counts will be telemetered with no error and the maximum error will be $1/2^5 = 1/32$ or $\pm 1/64$ or less than $\pm 1.6\%$.

The compressed answer will be held in temporary storage and nondestructively read out at the telemetry rate. It is strongly recommended that the experimenter use the floating point instead of the S-T accumulator in IMP Eye.

B. EQUATIONS FOR 24 TO 12 BIT COMPRESSION:

The bit compressor formats the word:

$X_1X_2X_3X_4X_5X_6X_7C_1C_2C_3C_4C_5$.

For 12 bit compression all 12 of the bits are telemetered while for the 10 bit compression the X_1 and X_2 bits are not telemetered. The compression of the 24 bit accumulator word, Ac, will be expressed by:

$$Ac = X_1 2^{(16-N)} + X_2 2^{(17-N)} + X_3 2^{(18-N)} + X_4 2^{(19-N)}$$

$$+ X_5 2^{(20-N)} + X_6 2^{(21-N)} + X_7 2^{(22-N)} + 2^{(23-N)} + \triangle \pm \triangle$$

where $\triangle = \frac{1}{2}\left(2^{(16-N)}-1\right)$ for 12 bit compression

or $\triangle = \frac{1}{2}\left(2^{(18-N)}-1\right)$ for 10 bit compression

and $N = C_1 2^0 + C_2 2^1 + C_3 2^2 + C_4 2^3 + C_5 2^4$

SOME SPECIAL CASES:

1. If N = 31, the contents of the accumulator was zero which means the accumulator received 1 pulse.

2. If N = 0 and all the X's = 1 then the accumulator reads all 1's which means it received no pulses since the last time it was reset.

3. Anytime $N > 16$ (for the 24 bit accumulators) negative exponents will result. Disregard only the negative exponents because less than 256 counts were received for the 12 bits, or less than 64 counts were received for the 10 bit accumulator so Ac will accurately represent the contents of the accumulator.

4. Since the accumulator is set to all 1's instead of reset to all zeros, the contents of the accumulator will be one less than the number of pulses counted, therefore, Ac + 1 = number of pulses counted.

The accumulator is set instead of reset for checkout purposes and to avoid any race problems.

5. If compression of 32 bits is used, the same answer will result for 1 or 2 counts. This problem will not occur in 16 bit or 24 bit accumulators.

C. BRIEF DESCRIPTION OF OPERATION OF 24 TO 12 BIT COMPRESSOR:

The 24 bit accumulator counts at a maximum rate of 640 KC. Upon a transfer command, the 24 bit accumulator is frozen (will accept no more pulses) and the contents of the accumulator is transferred in parallel to a 24 bit shift register. At the end of the transfer command, the accumulator is set to all 1's and is unfrozen. Thus the accumulator is again ready to count while its old contents reside in a shift register. This entire operation takes less than a MS.

If the last bit in the shift register is not "1" the shift register is shifted right one place and the C register receives a count. The shift register will shift until the last bit is a 1 advancing the C register by 1 on each count or will shift until the C register reads 31.

Thus the C register gives the number of shifts to find the first 1. The last bit of the shift register will be a 1 (therefore, is not telemetered) and the next 7 leftmost bits X_1 thru X_7 are telemetered for a 12 bit compression.

The 7 each X bits and 5 each C bits are held in temporary storage and are nondestructively read out synchronously with the telemetry. When the next transfer pulse (usually a spin pulse) occurs the C register is reset to zero and the process repeats.

D. SOME EXAMPLES (See Chart #1)

Assuming 12 bit compression

1. For example #1, N = 12 and the 12 telemetered bits will be: $X_1X_2X_3X_4X_5X_6X_7C_1C_2C_3C_4C_5$

0 0 0 0 0 0 0 0 0 1 1 0

and $Ac = 0+0+0+0+0+0+0+2^{11}+\frac{1}{2}(2^4-1) = 2048 + \frac{1}{2}(15)$

$= 2055.5 \pm 7.5$

2. For example #2, N = 0 and the 12 telemetered bits will be: $X_1X_2X_3X_4X_5X_6X_7C_1C_2C_3C_4C_5$

1 1 1 1 1 1 1 0 0 0 0 0

and Ac = "All 1's" = no pulses in.

3. For example #3, N = 31 and the 12 telemetered bits will be: $X_1X_2X_3X_4X_5X_6X_7C_1C_2C_3C_4C_5$

0 0 0 0 0 0 0 1 1 1 1 1

and Ac = "all zeros" = 1 pulse in.

4. For example #4, N = 20 and the 12 telemetered bits will be: $X_1X_2X_3X_4X_5X_6X_7C_1C_2C_3C_4C_5$

? ? ? ? 1 1 0 0 0 1 0 1

and $Ac = X_1 2^{-4} + X_2 2^{-3} + X_3 2^{-2} + X_4 2^{-1} + 1X2^0 + 1X2^1 + 0X2^2$

$+ 2^3 + \frac{1}{2}\ 2^{-4}-1$

Disregarding all negative exponents we get

$Ac = 2^0 + 2^1 + 2^3 = 1 + 2 + 8 = 11$

(e.g., 12 pulses in) and there is no error.

	2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}	2^{11}	2^{12}	2^{13}	2^{14}	2^{15}	2^{16}	2^{17}	2^{18}	2^{19}	2^{20}	2^{21}	2^{22}	2^{23}
Ex.#	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}	A_{17}	A_{18}	A_{19}	A_{20}	A_{21}	A_{22}	A_{23}	A_{24}
1.	?	?	?	?	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
2.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CHART #1

24 BIT ACCUMULATOR BEFORE COMPRESSION

NOTE 5 Non-sectored rates are compressed into 12 bits in the same manner as described in Note 4. Two different bit arrangements are used; all rates which are referred to this note use the arrangement illustrated in Figure 9. The F rates are sub-commutated in phase with the telemetry pages, with a cycle of four. The sub-com state is used as a subscript in the digital data processor writeup to identify the rates. The correspondence between page number and sub-com states is:

page no.	sub-com state
0	4
1	3
2	2
3	1

Note that readout of the non-sectored rates is done during the accumulation period following their actual accumulation. As an example, the F1 rate in bytes 348-351 is accumulated during snapshots 2, 3 of one page and is read out in snapshot 0 of the following page. The accumulation periods are the same as the interval between readouts, i.e., 2 snapshots for F1 and F2, 1 snapshot for F3, F4, and F5.

NOTE 6 As in Note 5, but with the bit arrangement of Figure 10.

NOTE 7 Event data includes 42 information bits and 6 parity bits, arranged as shown in Figure 11. The meaning of the bits is described in the digital data processor writeup. See note 3 for a description of the S bits.

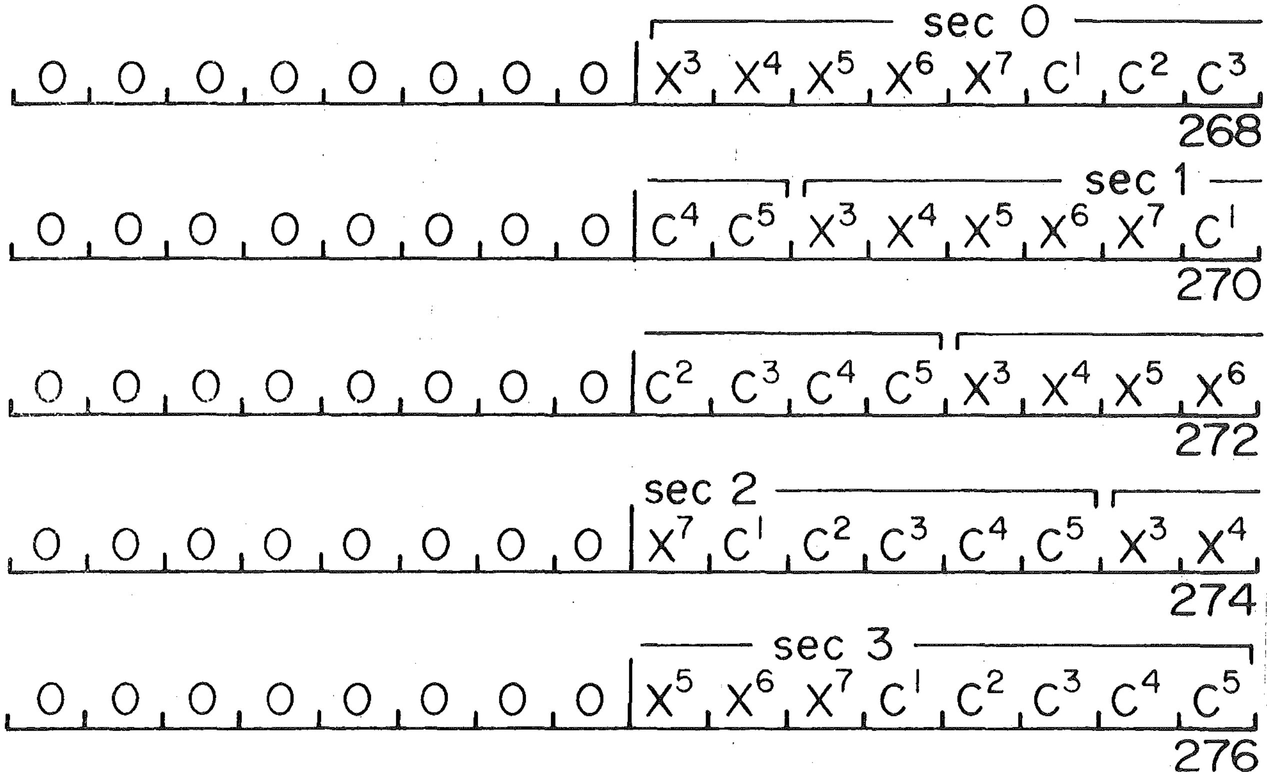

Figure 8

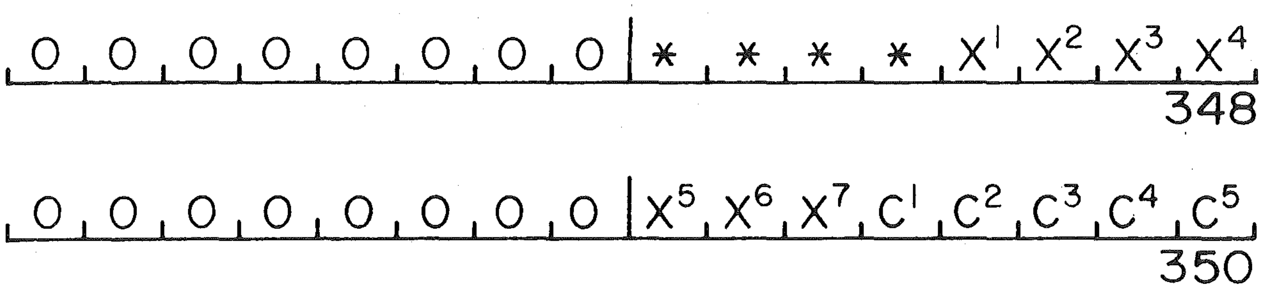

Figure 9

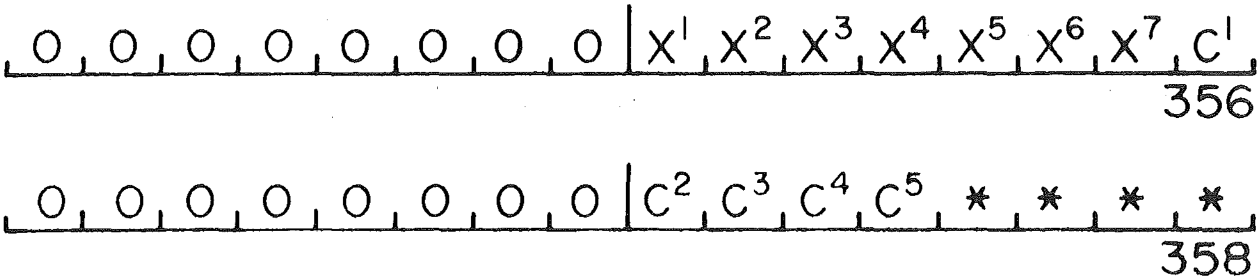

Figure 10

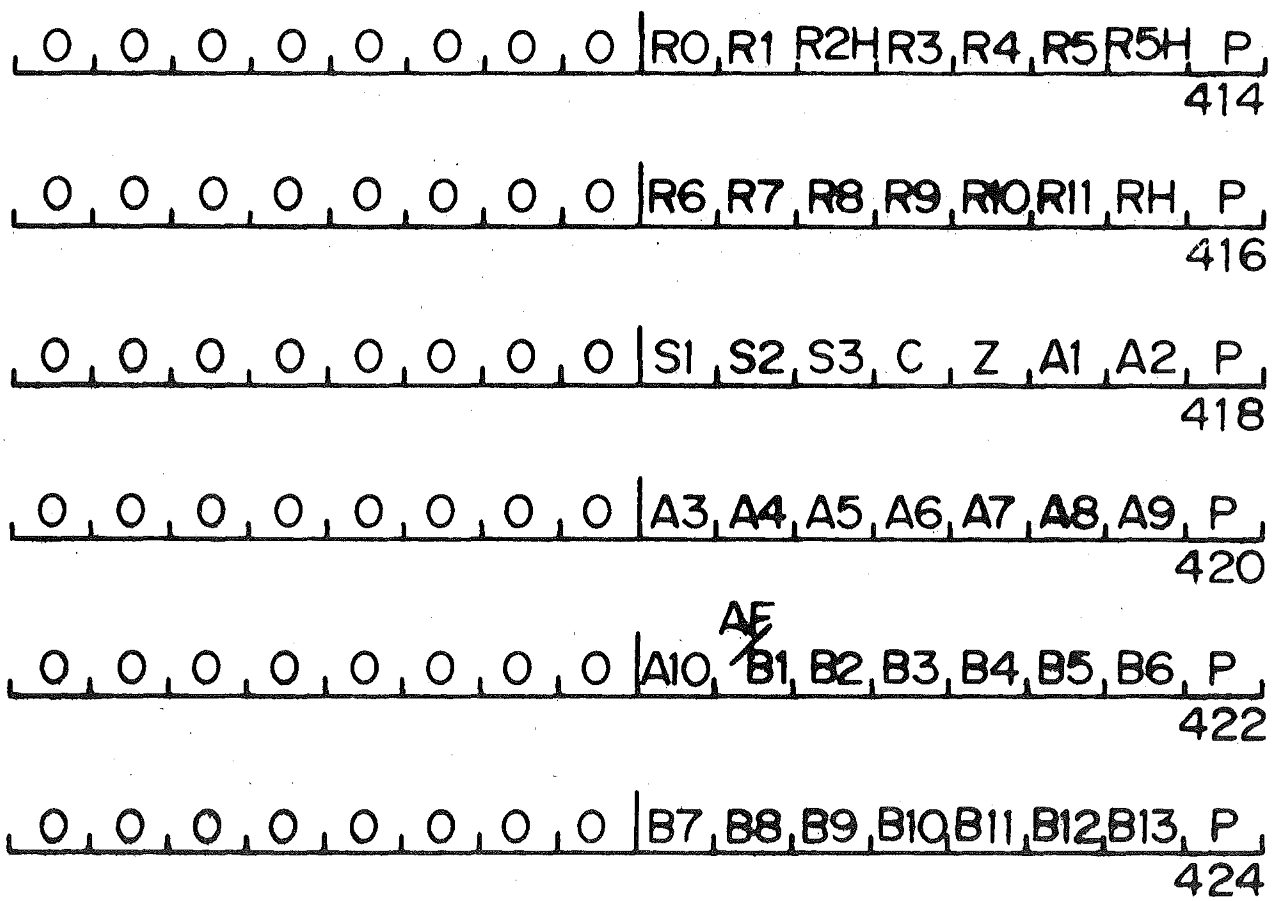
0 0 0 0 0 0 0 0 R0 R1 R2H R3 R4 R5 R5H P
414
0 0 0 0 0 0 0 0 R6 R7 R8 R9 R10 R11 RH P
416
0 0 0 0 0 0 0 0 S1 S2 S3 C Z A1 A2 P
418
0 0 0 0 0 0 0 0 A3 A4 A5 A6 A7 A8 A9 P
420
0 0 0 0 0 0 0 0 A10 AE/B1 B2 B3 B4 B5 B6 P
422
0 0 0 0 0 0 0 0 B7 B8 B9 B10 B11 B12 B13 P
424

Figure 11