HELIOS

COMPUTATION NOTE BOOK

NATIONAL | 43-648
Made in U. S. A.

Course HELIOS

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PHA DATA BLOCK (Bit 48 = Ø)

12 bit data words

PHA data block is 48 bits (with 3 PHA data words and a series of TAG bits)

TAG BIT	HET (bit 47 = Ø)	LET (bit 47 = 1)
T3 (Bit 46)	Sector ID (2^2)	Sector ID (2^2)
T4 (Bit 45)	Sector ID (2^1)	Sector ID (2^1)
T5 (Bit 44)	Sector ID (2^0)	Sector ID (2^0)
T6 (Bit 43)	Event Type Code (2^1)	Event Type Code
T7 (Bit 42)	Event Type Code (2^0)	Priority Rank
T8 (Bit 41)	CII Range	
T9 (Bit 40)	Priority Rank Bit S1	
T10 (Bit 39)	Priority Rank Bit S2	
T11 (Bit 38)		
T12 (Bit 37)		

PHA Event Types: A, B, CI + CII, DI, DII and E

PHA Data word	HET	LET
1	A when T6 = Ø	
2	CIII when T6 = 1	DI
3	B	DII
3	CI + CII	E

PHA Channel range: $2^0 - 1 \rightarrow 2^{12} - 1$ / Ø → 4095

The HET/LET rates is always 1:1 and they alternate. However, since there is always an odd number of PHA blocks between rates blocks it is never previously known what type of PHA block will follow any random rate block

RATE DATA BLOCK (Bit 48 = 1)

S-XR : sectored x-ray counters

R1, R2, etc. : unsectored rate counters

SR1-(1), etc. : sectored rate counters and the number in parenthesis specifies the 45° increment during which counting is allowed in each counter relative to the roll index pulse SPØ.

There are 56 unsectored rates including R2Ø, the unsectored x-ray rate (USXR); R1 is used for only one rate, R2-R9 and R11-R13 are each used for 2 rates, R15, R16, R18 and R19 are each used for 4 rates, and R1Ø, R14, R17 are each used for 8 rates.

Special attention must be given to the unsectored rates R1, R9, R14 and R17 which are not readout in a single line. Each requires 3 consecutive rate blocks to complete its readout since each rate block contains only 4 of the 12 necessary bits.

UNSECTORED RATES (64)

tector	RATE INPUT	RATE	DS2 A|B	DS3 SEQ1	DS4 SEQ2
HET	R1	$(A_2 K_1 + A_1 CI)\, B\, \overline{C\,III}$			
	R2	$A_1 \overline{A_2}\, BC\, III$	∅		
		$A_1 B K_2 \overline{C\,III}$	1		
	R3	$A_2 BC\, III$	∅		
		$A_2 B K_2 \overline{CI}$	1		
	R4	$A_2 B K_2 C\, I\, \overline{C\,II}$	∅		
		A_1	1		
	R5	$A_2 B K_2 C\, I\, C\, II\, \overline{C\,III}$	∅		
		A_2	1		
	R6	$A_1 \overline{A_2}\, B\, \overline{CI}$	∅		
		$A_1 \overline{A_2}\, BCI\, \overline{C\,II}$	1		
	R7	$A_1 \overline{A_2}\, B\, CI\, C\,II\, \overline{C\,III}$	∅		
		$A_2 B K_1\, \overline{CI}$	1		
	R8	$A_2 B K_1 CI\, \overline{C\,II}$	∅		
		$A_2 B K_1 CI\, C\,II\, \overline{C\,III}$	1		
LET 1	R9	$SI\, S\,II\, S\,II_a\, S\,III$	∅		
LET 2		$SI\, S\,II\, S\,II_a\, S\,III$	1		
LET	R10	DI_1	∅	∅	∅
		DI_2	1	∅	∅
		DI_3	∅	1	∅
		DI_4	1	1	∅
		DI_5	∅	∅	1
		DI_6	1	∅	∅
		DI_7	∅	1	1
		DI_8	1	1	1
	R11	$DI\, D\,II\, \bar{F}$	∅		
		$DI\, D\,II\, \Sigma D \bar{F}$	1		
	R12	$DI\, D\,II\, E_1 \bar{F}$	∅		
		$DI\, D\,II\, \Sigma D E_3 \bar{F}$	1		
	R13	$DI\, D\,II\, E_2 \bar{F}$	∅		
		$DI\, D\,II\, \Sigma D E_4 \bar{F}$	1		
	R14	DI	∅	∅	
		$D\,II$	1	∅	
		E_1	∅	1	
		F	1	1	
HET		B	∅	∅	1
		CI	1	∅	1
		$C\,II$	∅	1	1
		$C\,III$	1	1	1

UNSECTORED RATES (CONT.)

tector	RATE INPUT	RATE	DS2 A/B	DS3 SEQ1	DS4 SEQ2
VLET1	R15	$SI_1\ \overline{SII}\ \overline{SII_a}\ \overline{SIII}$	Φ	Φ	
		$SI_2\ \overline{SII}\ \overline{SII_a}\ SIII$	1	Φ	
		$SI_3\ SII\ \overline{SII_a}\ \overline{SIII}$	Φ	1	
		$SI_4\ SII\ SII_a\ SIII$	1	1	
	R16	$SI\ SII_1\ \overline{SII_a}\ \overline{SIII}$	Φ	Φ	
		$SI\ SII_2\ \overline{SII_a}\ SIII$	1	Φ	
		$SI\ SII_3\ SII_a\ \overline{SIII}$	Φ	1	
		$SI\ SII_4\ SII_a\ SIII$	1	1	
	R17	SI	Φ	Φ	Φ
		SII	1	Φ	Φ
		SII_a	Φ	1	Φ
		SIII	1	1	Φ
LET2		SI	Φ	Φ	1
		SII	1	Φ	1
		SII_a	Φ	1	1
		SIII	1	1	1
	R18	$SI_1\ \overline{SII}\ \overline{SII_a}\ \overline{SIII}$	Φ	Φ	
		$SI_2\ SII\ \overline{SII_a}\ \overline{SIII}$	1	Φ	
		$SI_3\ \overline{SII}\ SII_a\ \overline{SIII}$	Φ	1	
		$SI_4\ SII\ SII_a\ \overline{SIII}$	Φ	1	
	R19	$SI\ SII_1\ \overline{SII_a}\ \overline{SIII}$	Φ	Φ	
		$SI\ SII_2\ SII_a\ \overline{SIII}$	1	Φ	
		$SI\ SII_3\ \overline{SII_a}\ SIII$	Φ	1	
		$SI\ SII_4\ SII_a\ SIII$	1	1	
-RAY	R2Φ	USXR			

SECTORED RATES (2Φ)

Detector	Rate Input	Rate	DS2 SSEQ1	DS3 SSEQ2	DS4 SSEQ3
HET	SR1	$A1\,\overline{A2}\,B\,C1\,\overline{C\text{III}}$	Φ	Φ	Φ
		$A2\,B\,K1\,\overline{C\text{III}}$	1	Φ	Φ
LET		$D1\,D\text{II}\,\overline{F}$	Φ	1	Φ
		$D1\,D\text{II}\,E1\,\overline{F}$	1	1	Φ
VLET1	SR2	$S1_5\,\overline{S\text{II}}\,\overline{S\text{IIa}}\,\overline{S\text{III}}$	Φ	Φ	Φ
		$S1_6\,\overline{S\text{II}}\,\overline{S\text{IIa}}\,S\text{III}$	1	Φ	Φ
		$S1_7\,\overline{S\text{II}}\,S\text{IIa}\,\overline{S\text{III}}$	Φ	1	Φ
		$S1_8\,\overline{S\text{II}}\,S\text{IIa}\,S\text{III}$	1	1	Φ
		$\overline{S1}\,S\text{II}_5\,\overline{S\text{IIa}}\,\overline{S\text{III}}$	Φ	Φ	1
		$\overline{S1}\,S\text{II}_6\,\overline{S\text{IIa}}\,S\text{III}$	1	Φ	1
		$\overline{S1}\,S\text{II}_7\,S\text{IIa}\,\overline{S\text{III}}$	Φ	1	1
		$\overline{S1}\,S\text{II}_8\,S\text{IIa}\,S\text{III}$	1	1	1
VLET2	SR3	$S1_5\,\overline{S\text{II}}\,\overline{S\text{IIa}}\,\overline{S\text{III}}$	Φ	Φ	Φ
		$S1_6\,\overline{S\text{II}}\,\overline{S\text{IIa}}\,S\text{III}$	1	Φ	Φ
		$S1_7\,\overline{S\text{II}}\,S\text{IIa}\,\overline{S\text{III}}$	Φ	1	Φ
		$S1_8\,\overline{S\text{II}}\,S\text{IIa}\,S\text{III}$	1	1	Φ
		$\overline{S1}\,S\text{II}_5\,\overline{S\text{IIa}}\,\overline{S\text{III}}$	Φ	Φ	1
		$\overline{S1}\,S\text{II}_6\,\overline{S\text{IIa}}\,S\text{III}$	1	Φ	1
		$\overline{S1}\,S\text{II}_7\,S\text{IIa}\,\overline{S\text{III}}$	Φ	1	1
		$\overline{S1}\,S\text{II}_8\,S\text{IIa}\,S\text{III}$	1	1	1
	SECTORED XRAY (S-XR)				

12-BIT RATE DECOMPRESSION

C C C C C M M M M M M M

characteristic 5 bits — mantissa 7 bits

1. Shift right double to separate the mantissa from the characteristic. Mantissa is left justified in register.
2. Shift the mantissa right once, entering a "1" from the left.
3. Shift right the number of times indicated in the characteristic. Entering zeroes from the left.
4. Shift right 8 bits to right justify the 24 bit reconstructed field in the computer word (32 bits).

EVENT TYPE RATES

Detector	Rate Input	Rate		
HET	R1	$(A2K_1 + A_1 C_I)\, B\, \overline{C_{III}}$	●	
	R2A	$A_1 \overline{A_2}\, B\, C_{III}$		ϕ
	R2B	$A_1 B K_2\, \overline{C_{III}}$	●	3
	R3A	$A_2 B C_{III}$	●	2
LET	R11A	$D_I D_{II} \bar{F}$	●	
	R11B	$D_I D_{II} \Sigma D \bar{F}$	●	

R1 readout twice / page

R2A, R2B, R3A, R11A, R11B readout once / page

128 RATE Blocks

Bit Rate	FORMAT	DM	PHA Readouts RATE Readouts	#48 Bit Blocks Per Cycle	CYCLE TIME sec.	CYCLE TIME MIN.	# Rolls for Sectored RATES CNTRS	Expected # of COUNTS IN SR Read. @ 60 RPM
4096	5	—	5:1	768	432	7.2	53	26624
2048	5	—	5:1	768	864	14.4	53	
2048	1	—	5:1	768	432	7.2	53	13312
1024	1	—	3:1	512	576	9.6	69	8832
512	1	—	1:1	256	576	9.6	69	4416
512	2	—	3:1	512	576	9.6	69	4416
256	2	—	1:1	256	576	9.6	69	2208
128	2	—	1:1	256	1152	19.2	138	2208
64	2/3	—	1:1	256	2304	38.4	276	2208
32	3	—	1:1	256	4608	76.8	552	2208
16	3	—	1:1	256	9216	153.6	1104	2208
8	3	—	1:1	256	18432	307.2	2208	2208
8	3	B/O	0:1	128	9216	153.6	1104	1104

HELIOS - EXPERIMENT 7

ENGINEERING DATA

ENGR FRAME	ENGR WORD	DESCRIPTION
Ø	11	Power Status (E-ØØ4Ø) 1 = ON, Ø = OFF
Ø	16-17	Spin Rate (in RPM) (D-ØØØ/Ø-7 → D-ØØ1/Ø-3)

Z	
DØØØ/Ø =	2^{11}
1 =	2^{10}
2 =	2^{9}
3 =	2^{8}
4 =	2^{7}
5 =	2^{6}
6 =	2^{5}
7 =	2^{4}
DØØ1/Ø =	2^{3}
1 =	2^{2}
2 =	2^{1}
3 =	2^{0}

$$RPM = \frac{1024 * 60}{Z}$$

1	11			
1	28	Ø	X-RAY Window Clock (E-187)	Ø = 1, 1 = Ø
		1	X-RAY Window Data (E-188)	Ø = ON, 1 = OFF
		2	Internal calibrator A (E-189)	Ø = ON, 1 = OFF
		3	Internal calibrator B (E-19Ø)	Ø = ON, 1 = OFF
		4	X-RAY High voltage (E-191)	Ø = ON, 1 = OFF
		5	Sector synchronyzer (E-192)	Ø = ON, 1 = OFF
		6	Force blackout mode (E-193)	Ø = OFF, 1 = ON
		7	X-RAY sector data mode (E-194)	Ø = ON, 1 = OFF
1	4Ø		HET (E7A) temperature (D-Ø42)	
1	41		VLET3 (E7B2) temperature (D-Ø43)	
1	42		Detector mounting plate temp. (D-Ø44)	
1	43		X-RAY detector temperature (D-Ø45)	
1	44		Thermal Blanket support plate 1 temp. (D-Ø46)	
1	45		Thermal Blanket support plate 2 temp. (D-Ø47)	
1	64		Electronics temperature (D-Ø48)	
1	65		Base plate temperature (D-Ø49)	
1	66		+12 volts monitor (D-Ø5Ø)	
1	67		+6 volts digital monitor (D-Ø51)	
1	68		+6 volts analog monitor (D-Ø52)	
1	69		+7.75 volts monitor (D-Ø53)	
1	88		+4.7 volts monitor (D-Ø54)	
1	89		Base plate temp. (front) (D-Ø55)	

Engineering Data (Cont.)

ENGR. FRAME	ENGR. WORD	DESCRIPTION
2	11	
2	40	YLET1 (E7B1) temperature (D-078)
2	41	LET (E7C) temperature (D-079)
3	11	
3	28	

READOUT Times at Each Bit Rate

1 FRAME = 144 8-bit WORDS = 1152 bits

1 EDR RECORD = 72 FRAMES = 82944 bits

1 ALBUM = 128 RATES BLOCKS

AT 0:1 Ratio (Blackout Mode) -- 128 FRAMES/ALBUM = 147456 bits/ALB.

AT 1:1 RATIO -- 256 FRAMES/ALBUM = 294912 bits/ALBUM

AT 3:1 Ratio -- 512 FRAMES/ALBUM = 589824 bits/album

AT 5:1 RATIO -- 768 FRAMES/ALBUM = 884736 bits/ALBUM

PHA Data Statistics

Possible combinations:

FORMAT	RATIO	Number of PHA blocks / Page
1	1:1	32
2	1:1	64
3	1:1	64
1	3:1	96
2	3:1	192
5	5:1	80

Maximum occurs at format 2, 512 BPS

192 PHA blocks / page

96 Het-let entries / page

3 fullwords / Het-let entry

∴ 288 fullwords / page

Calculating variable Dimensioning for PHA record

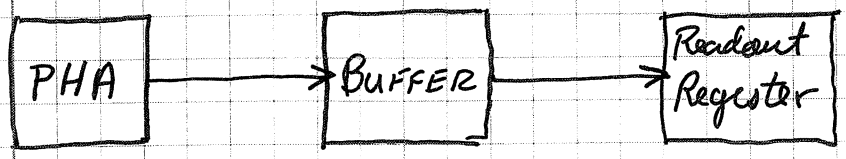
N = No. of 3-halfword PHA entries / page

N/2 = No. of HET-CET entries / page

(N/2)*3 = # of fullwords / page

Bit Rate	FORMAT	N	N/2	(N/2)*3
4096	5	160	80	240
2048	1	160	80	240
1024	1	96	48	144
512	1	32	16	48
512	2	96	48	144
256	2	32	16	48
128	2	32	16	48
64	2/3	32	16	48
32	3	32	16	48
16	3	32	16	48
8	3	32	16	48
8	3 (B/O)	32	16	48

Helios PHA DATA TRANSFER



- Buffer always reset to 1's
- transfer is always from buffer to readout register even when a non event occurs
- the readout register is not reset

a 12-bit PHA readout of all one bits is the reset condition. eg the reset condition occurs simultaneously on all three PHA amplitudes it is to considered a NULL event.

PHA Summary Program Bit Rate Normalization

Normalize all bit rates to their corresponding bit rate is data had been transmitted in format 1

data transmission rates:

formats 2/3 → 2X format 1

format 5 → 1/2 format 1

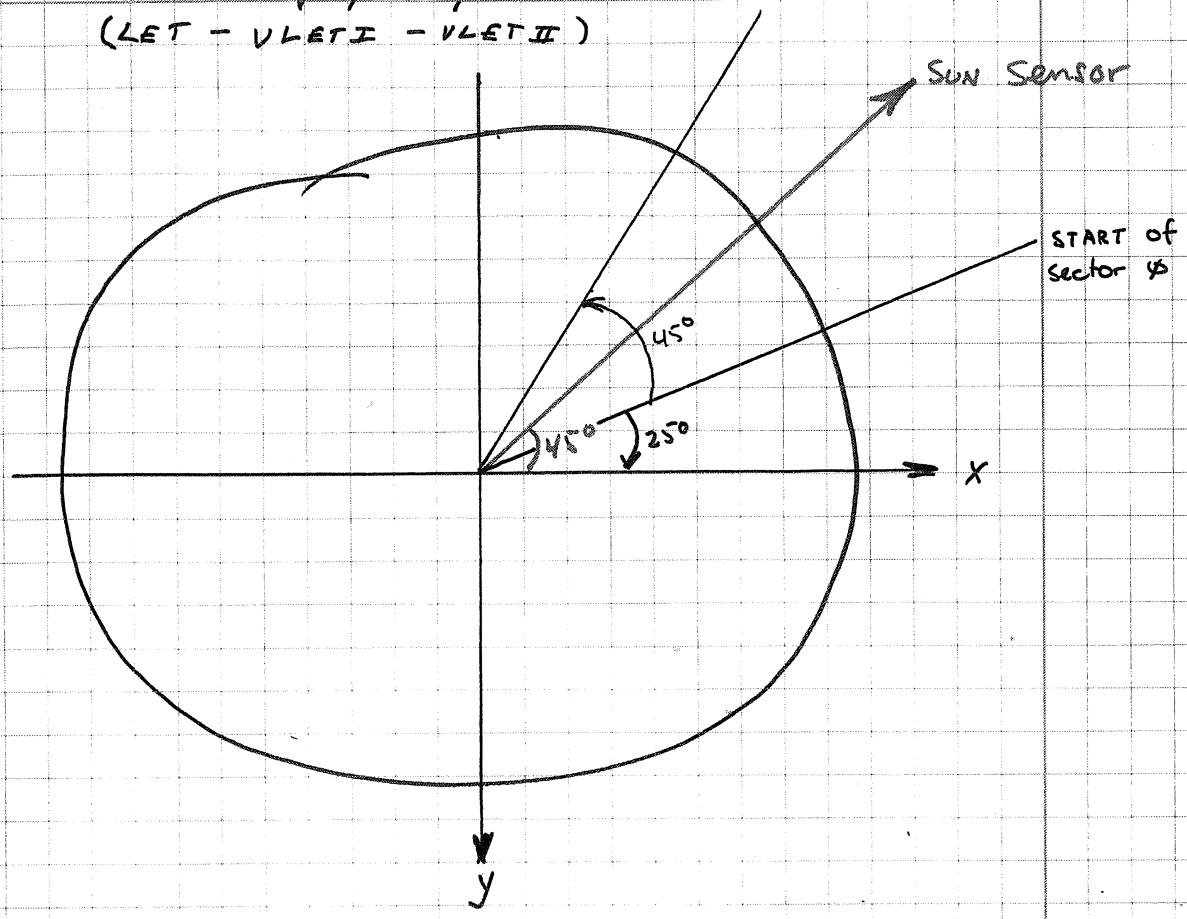
the following table indicates the normalized bit rates:

FORMAT	BIT RATE	Normalized Bit Rate
1	2048	2048
1	1024	1024
1	512	512
2	512	1024
2	256	512
2	128	256
2	64	128
3	64	128
3	32	64
3	16	32
3	8	16
5	4096	2048
5	2048	1024

the following logic is in the routine HXDATA to accomplish this bit rate normalization:

```
IB = HBIT
IF(HFMTP. Eq. 5)  IB=IB-1
IF(HFMTP. Eq. 2)  IB=IB+1
IF(HFMTP. Eq. 3)  IB=IB+1
```

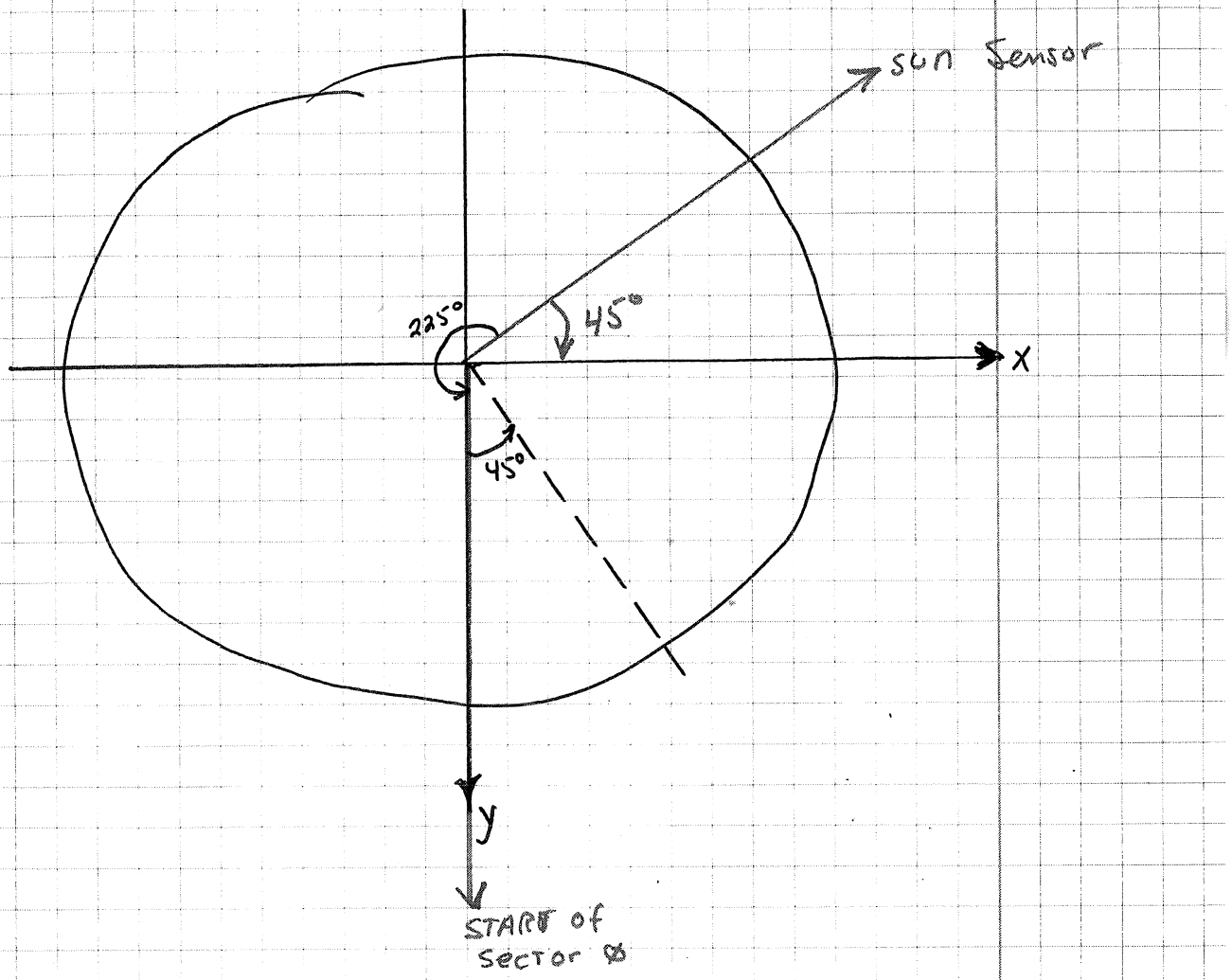
Sector Display Program
(LET - VLET I - VLET II)



bisector of sector ∅ at 47.5° from x-axis
sun sensor at +45° from x-axis
∴ sector ∅ bisector +2.5° from sun sensor

Sector	Degrees	Radians
∅	2.5°	0.04363
1	47.5°	0.829031
2	92.5°	1.614429
3	137.5°	2.399827
4	182.5°	3.185225
5	227.5°	3.970624
6	272.5°	4.756022
7	317.5°	5.541420

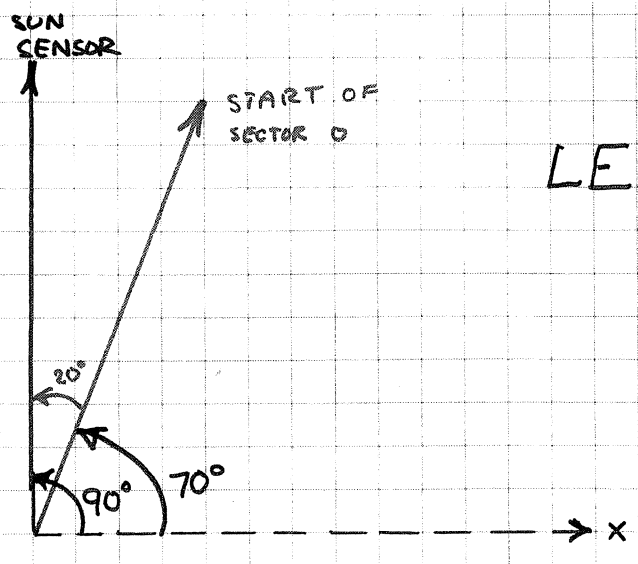
Sector Display Program (cont.)
(HET)



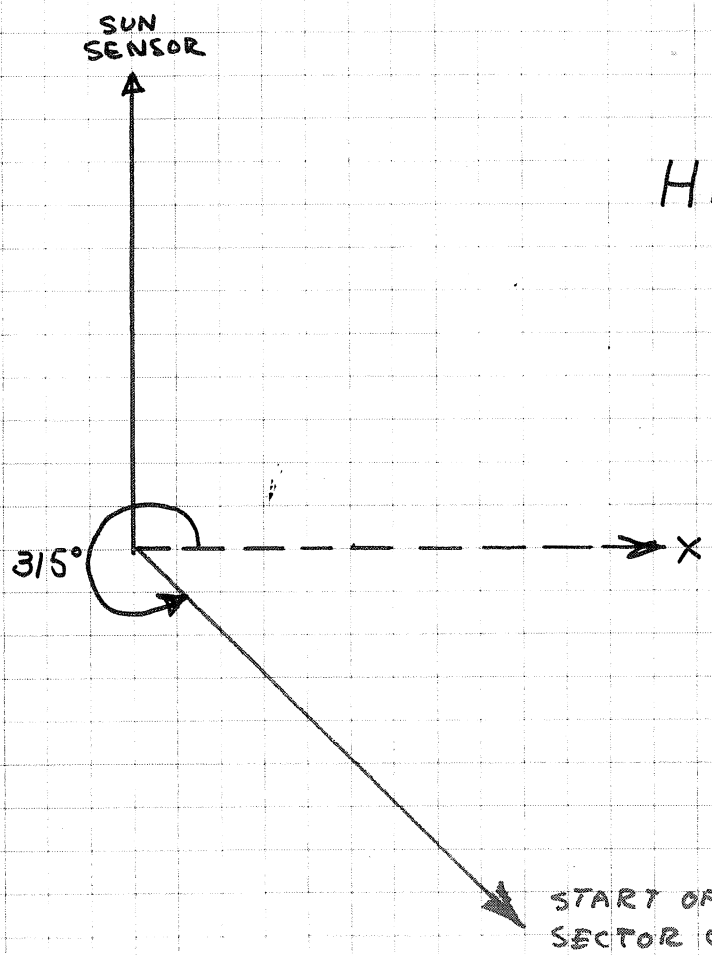
bisector of sector ∅ at +292.5°
sun sensor at +45°
∴ sector ∅ bisector +247.5 from sun sensor

Sector	Degrees	Radians
∅	247.5	4.319689
1	292.5	5.105088
2	337.5	5.890486
3	22.5	.392699
4	67.5	1.178097
5	112.5	1.963495
6	157.5	2.748893
7	202.5	3.534291

HELIOS SECTORED RATES PLOT PROGRAM



LET/VLET



HET