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MANUAL FOR ADJUSTMENT AND HANDLING OF PLATFORMS FOR DATA COLLECTION VIA SATELLITE (CDCP)

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MANUAL FOR ADJUSTMENT AND HANDLING OF PLATFORMS FOR DATA COLLECTION VIA SATELLITE (CDCP)

OSCAR BAKIR HANDAL

ERTS PROGRAM FOR BOLIVIA

LA PAZ - FEBRUARY 1977

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1. INTRODUCTION /1

The documentation selected for preparing this manual was obtained from the Seminar for the Collection of Satellite Transmitted Data held in La Paz, Bolivia during January 1977 by an assembly of experts consisting of representatives of the United States Geological Survey (USGS), the National Aeronautics and Space Administration (NASA) and La Barge, Inc of Tulsa, Oklahoma.

The data collection system is based on the capability of transmitting signals through space and receiving those from other locations.

Radio signals are transmitted from the CDCP (Convertible Data Collection Platform) to the satellite in a suitable form. Upon arrival of these signals at the satellite, the latter detects the message and returns the information to earth. This information is retained by the data acquisition centers for subsequent distribution to the users.

2. OBJECTIVES

This manual contains detailed documentation so as to supply the users with appropriate information and to enable them to obtain adequate data collection from the platforms.

The manual also contains examples and exercises which are fully explained so as to be easily understood in addition to a general glossary of technical terms that are important in performing the work. There is also an operational notebook which is designed specifically for enabling adjustments to be made to the platforms.

More detailed information will be included in future training /2 courses to be organized within the scope of the ERTS -Bolivia program.

3. DATA COLLECTION SYSTEM

3.1. LANDSAT system

This system is based on the LANDSAT satellite which orbits over the North and South poles with a period of 102 minutes. Rotation of the earth permits LANDSAT to pass over different segments of the earth during each pass, there being a differential of 18 degrees from one pass to the next one. For example, the satellite passes over the U.S.A. three times during daylight and three times at night. The LANDSAT (ERTS) satellite orbits the earth at a distance of 920 kilometers from its surface.

3.2. The GOES System

There are three satellites of the GOES system that are located at longitudes of 70, 105 and 135 degrees and a longitude [Translator's note: Error in original. This should read "latitude" instead of "longitude"] of 0°. These satellites rotate at the same velocity as does the earth, i.e., the three satellites are located at a constant geographical position with respect to the country of Ecuador. The GOES satellites orbit the earth at an approximate distance of 36,000 kilometers from its surface.

3.3. Data Acquisition Center

Each of the aforementioned systems has a different data acquisition system. The LANDSAT (ERTS) system requires regional centers due to the fact that the satellite is continuously moving.

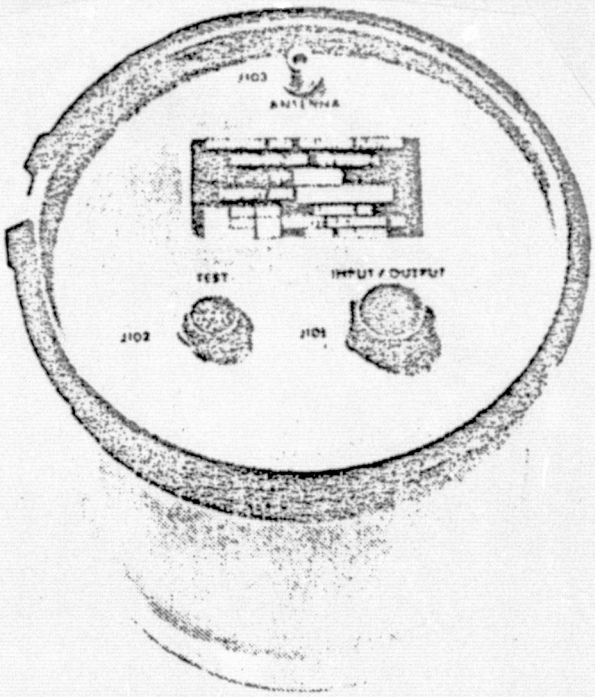


Figure 1-1. Convertible Data Collection Platform

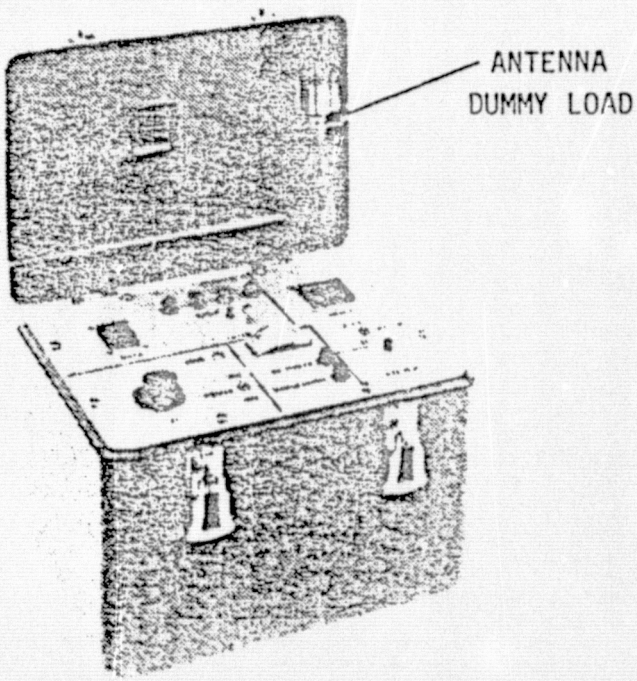


Figure 1-2. CDCP Test Set

The South American Center is located in Santiago, Chile and receives data in real time. This center sends data to the various users via telex each day.

In the GOES system, the data acquisition system for the three satellites is located near Washington, D.C. from where the processed data are distributed to all of the users under the supervision of the NOAA (National Oceanic and Atmospheric Administration).

3.4. Platform Components

In order to study the platforms for collection of satellite transmitted data, it is necessary to be familiar with each and every one of their components. As can be seen from Figure 1-3, the platforms are compatible with the GOES and ERTS systems with their respective antennas. Furthermore, this figure shows the basic components which are required to constitute a complete platform. A description of the most important units within a typical ERTS/GOES data collection installation is given.

3.4.1. Convertible Data Collection Platforms (CDCP) (Figure 1-1)

The CDCP is a control microprocessor. All of the controlled parameters enter the microprocessor due to information that is introduced by the Test Set (Figure 1-2) and the data are furnished to the satellite in real time.

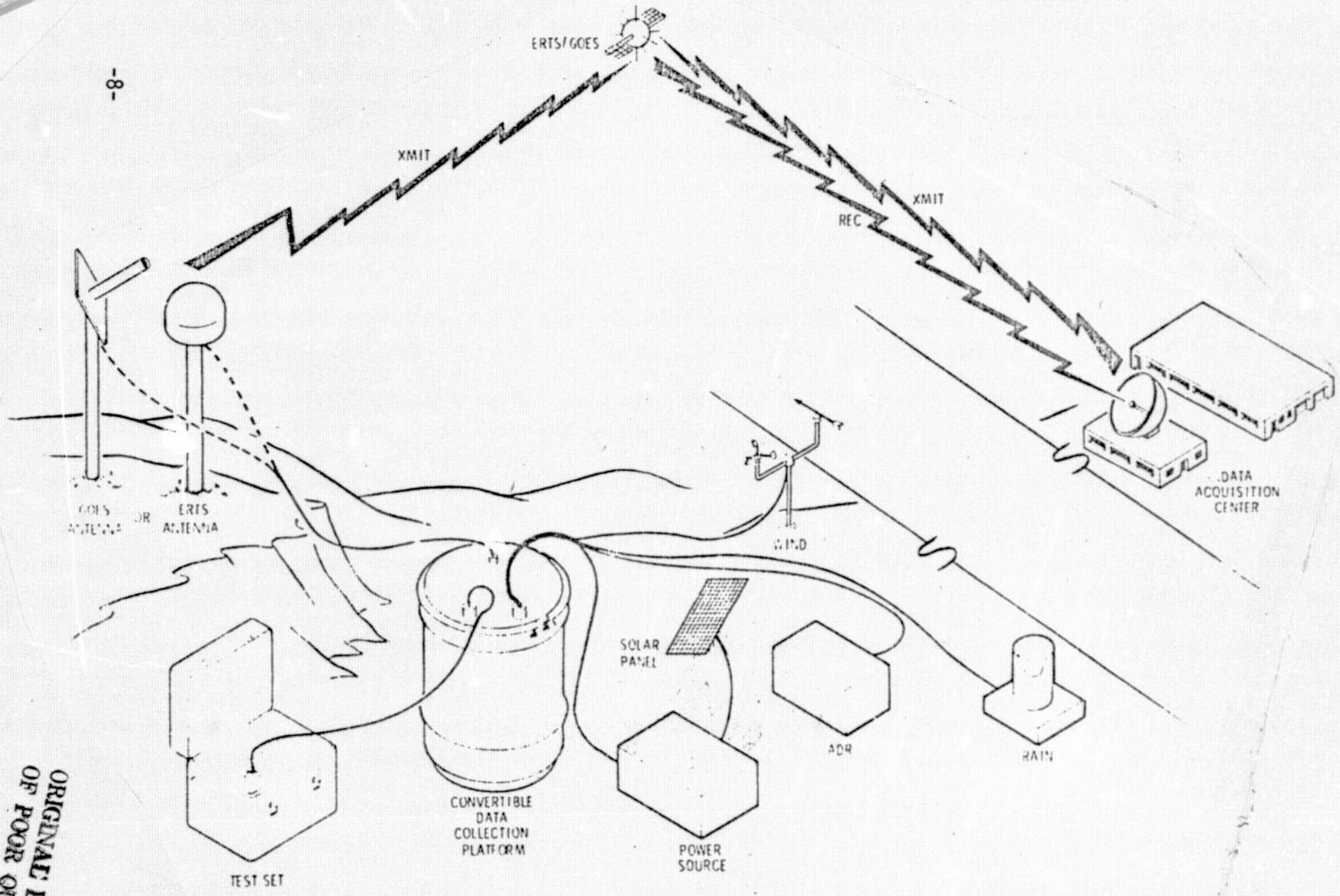


Figure 1-3. Typical ERTS/GOES Convertible/Data Collection Platform Installation

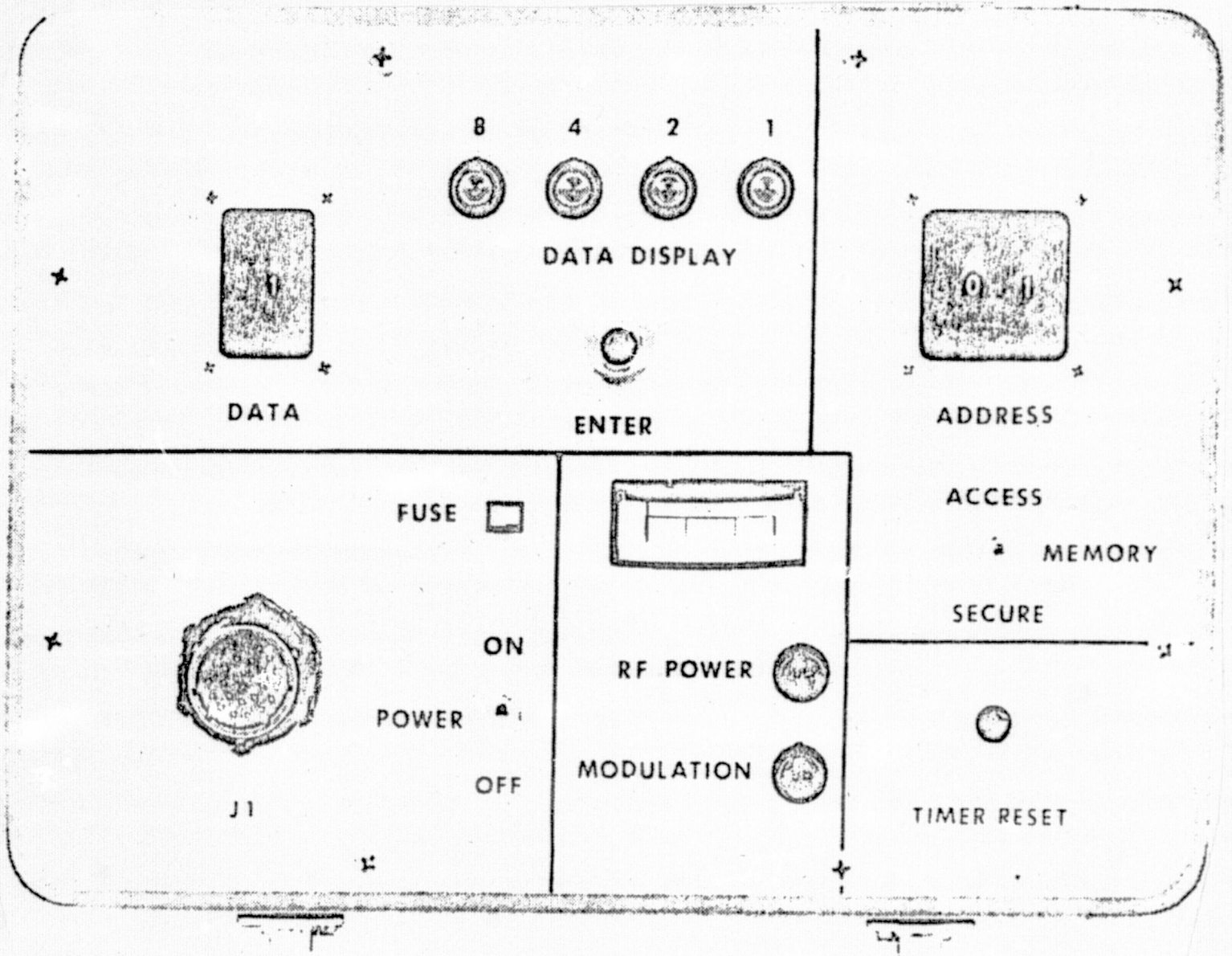
Depending on the operational mode of the CDCP, the data may be inserted in series or in parallel. /6

If the processing configuration is for data in parallel, the input to the appropriate unit is achieved by means of 16 lines where the input bus is processed with more than 4 words, each consisting of 16 bits (a total of 64 bits), at the same time in approximately 14 seconds for each group of 16 bits, i.e., one word is transmitted in 56 seconds. When the instantaneous configuration is installed to accept data in parallel, the CDCP can immediately accept more than 8 channels of analog data. Parallel digital input occurs when all of the platform's units are located in one place.

If the processing configuration of the CDCP is for serial input of data, this implies that not all of the platform units are located in one place. Therefore, a special new configuration unit is required to connect all of the scattered units. The series and parallel operational modes can be employed with both of the ERTS and GOES systems.

MEMORY CAPACITY

The maximum memory capacity of the GOES system is 832 bits, i.e., 13 groups of 64 bits each. The maximum memory capacity of the ERTS system is 768 bits, consisting of 12 groups of 64 bits each. /8



CDCP Test Set

NOTE: The ERTS system can handle from 6 to 8 groups for a period of 90 seconds and from 3 to 4 groups for a period of 180 seconds.

3.4.2. CDCP Test Set

The CDCP Test Set is a vitally important unit for a minimum configuration for a data collection station (Figure 1-4). This unit makes it possible to control all of the platforms's operations, i.e., to program and adjust the system and all of the various sensors. The Test Set is the only method available to the user for obtaining a direct effective interface between the satellite and the platform.

The changes to the station and the data sent to the satellite are to be recorded by the Test Set, automatically cancelling the data introduced during the previous adjustment of the platform. As can be seen in Figure 1-4, the Test Set includes a data recorder (DATA) and a data verifier in the binary mode (DATA DISPLAY) in addition to a data classifier (ADDRESS). These three components of the Test Set enable adjustment and control of the information which is to be processed.

3.4.3. Antenna for the ERTS system /9

The antenna for the ERTS system consists of crossed dipoles on a reflecting surface having a nominal frequency of 401 MHz. The transmission type consists of transmitting circularly polarized energy, employing the right hand rule, and is mounted on a tube having a diameter of 2 inches.

3.4.4. Antenna for the GOES system

The antenna for the GOES system consists of a two-wire helix

on a reflecting surface having a nominal frequency of 402 MHz. The transmission type consists of transmitting circularly polarized energy, employing the right hand rule, and is mounted on a tube having a diameter of 2 inches.

3.4.5. Analog-Digital Recorder (ADR)

This unit, which belongs to a basic configuration of a data collection platform, consists of a paper tape recorder of information between platform and satellite using previously determined formats comprising 3 fields as is depicted in drawing A below.

			G							G				
80	40	20	A	8	4	2	1	.8	.4	.2	.1	A	.08	.04	.02	.01
			P									P				

Drawing A: Format of paper tape of ADR

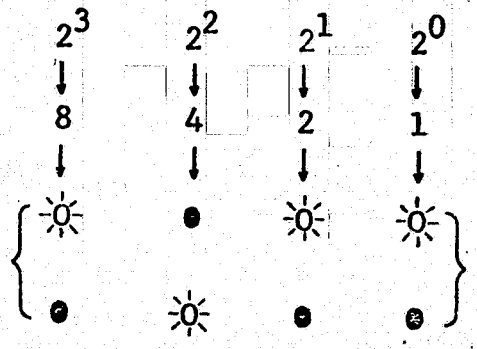
More information is furnished in Figures 1.5, 1.6 and 1.7 and additional details regarding this information is analyzed further on. /10

This unit operates with groups of 16 bits. The information is recorded on the ADR by means of perforations of the paper tape in accordance with the values corresponding to the transmission made. These perforations correspond to the lights of the CDCP Test Set which are illuminated. The perforations are read from left to right.

3.4.6. Analog to Digital Converter and Multiplexer (A/D)

This unit, which also forms part of a basic configuration for a data collection platform, operates with groups of 8 bits using table 1-2 for hexadecimal conversion to volts. The A/D may also be shown in the following form in the CDCP Test Set.

1 A/D: group of 8 bits



More detailed information dealing with operation of the A/D will be found in Figure 1-8. /16

4. METHODOLOGY FOR CODING AND DECODING PLATFORM DATA

4.1. Numerical Conversion Systems

It is of utmost importance that the user be familiar with and work properly with the three conversion methods shown in Figure 1-5 and with the Test Set indicators depicted in Figure 1-9 to utilize all of the information transmitted and received by the platforms for data collection via satellite.

4.2. Application of numerical systems

Figures 1-6, 1-7 and 1-8 illustrate the data display of the CDCP Test Set consisting of 4 lamps. These indicate the presence of information by means of an illuminated lamp (☼) and its absence by an unilluminated lamp (●).

BINARY - BASE 2

1	0	1	1	1
2^4	2^3	2^2	2^1	2^0

$1 \times 2^4 = 1 \times 16 = 16$

$+0 \times 2^3 = 0 \times 8 = 0$

$+1 \times 2^2 = 1 \times 4 = 4$

$+1 \times 2^1 = 1 \times 2 = 2$

$+1 \times 2^0 = 1 \times 1 = 1$

23 DECIMAL

DECIMAL - BASE 10

2	3
10^1	10^0

$2 \times 10^1 = 2 \times 10 = 20$

$+3 \times 10^0 = 3 \times 1 = 3$

23 DECIMAL

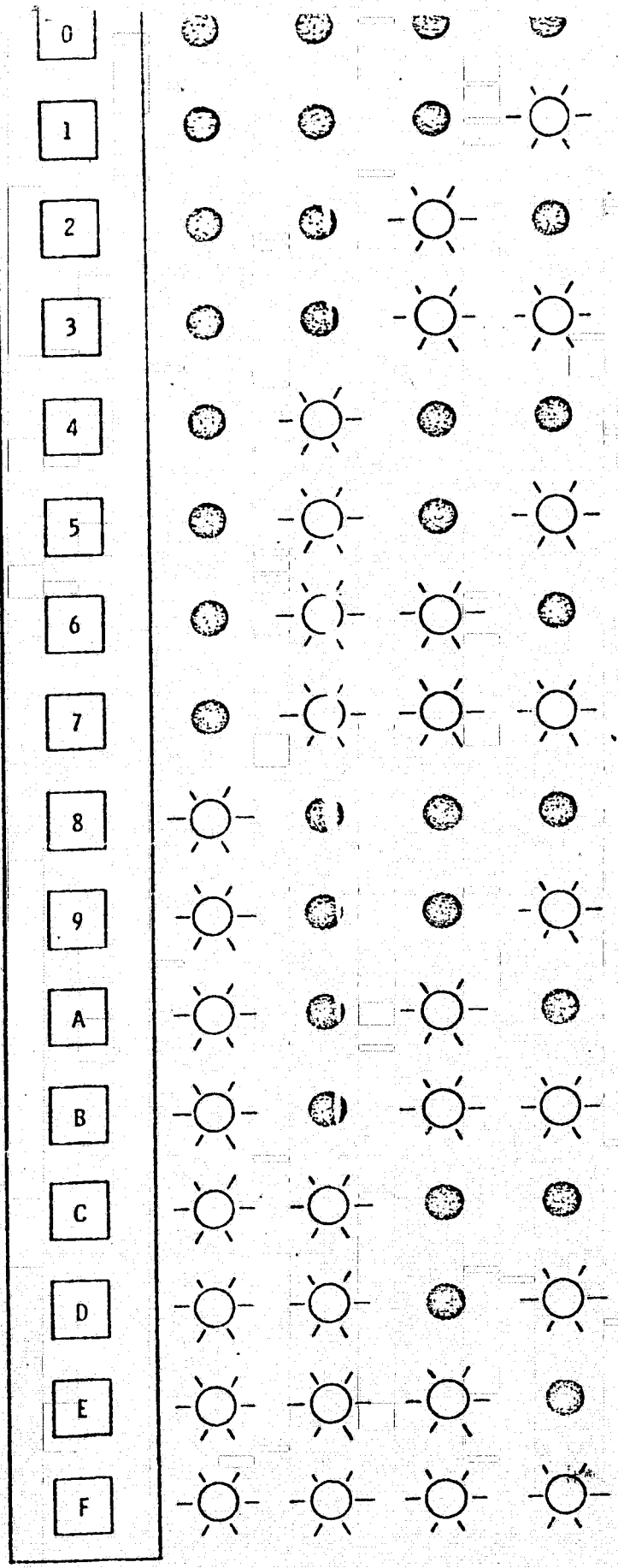
HEXADECIMAL - BASE 16

1	7
16^1	16^0

$1 \times 16^1 = 1 \times 16 = 16$

$+7 \times 16^0 = 7 \times 1 = 7$

23 DECIMAL



TEST SET, VISUAL REPRESENTATION OF HEXADECIMAL NUMBERS

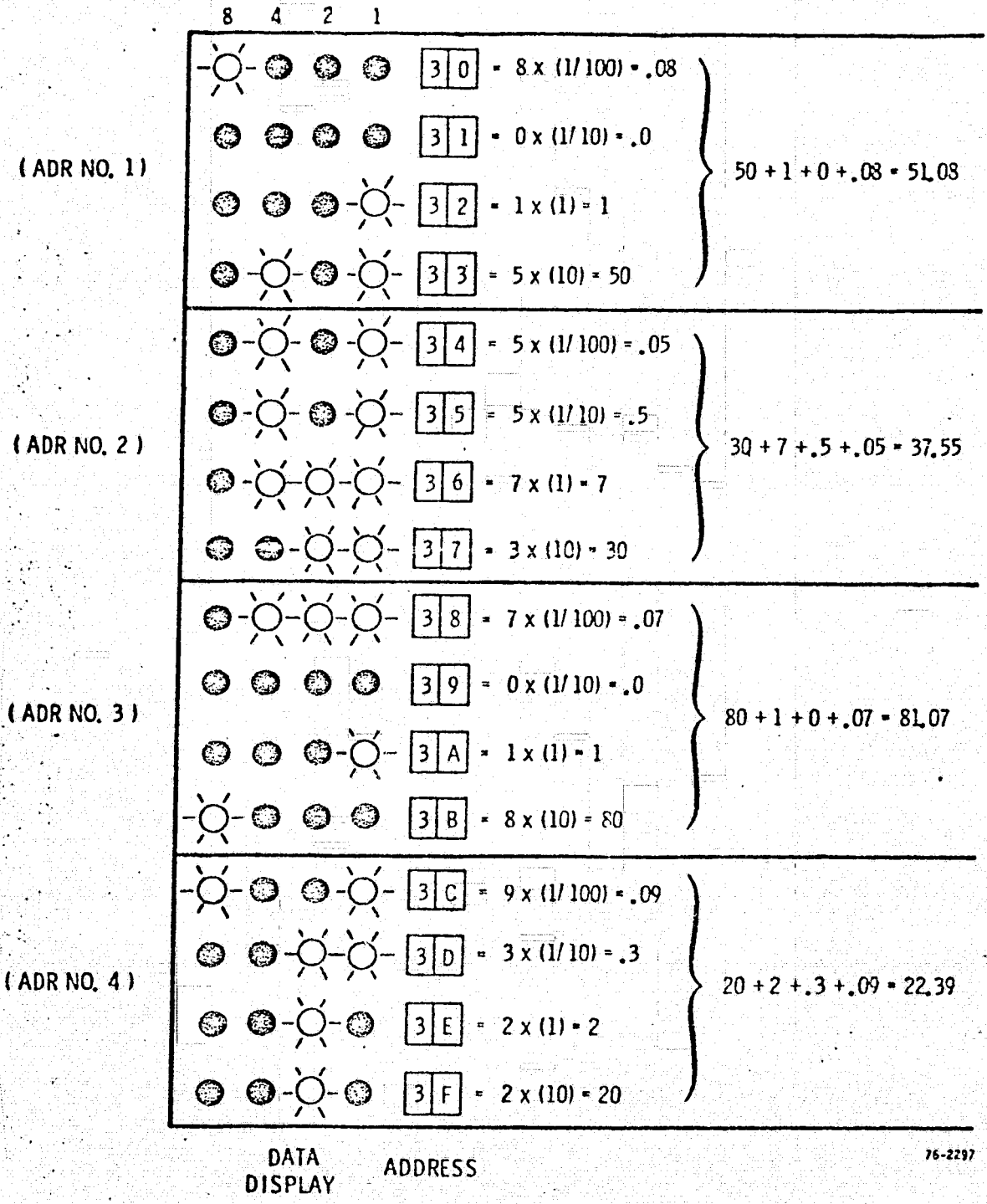
/13

ASSUME:

(1) 4 ADR'S USED

(2) ADR NO. 1 READS 51.08 FT.
ADR NO. 2 READS 37.55 FT.
ADR NO. 3 READS 81.07 FT.
ADR NO. 4 READS 22.39 FT.

THE TEST DET DATA DISPLAY/ADDRESS FOR THE ABOVE WILL BE AS FOLLOWS:

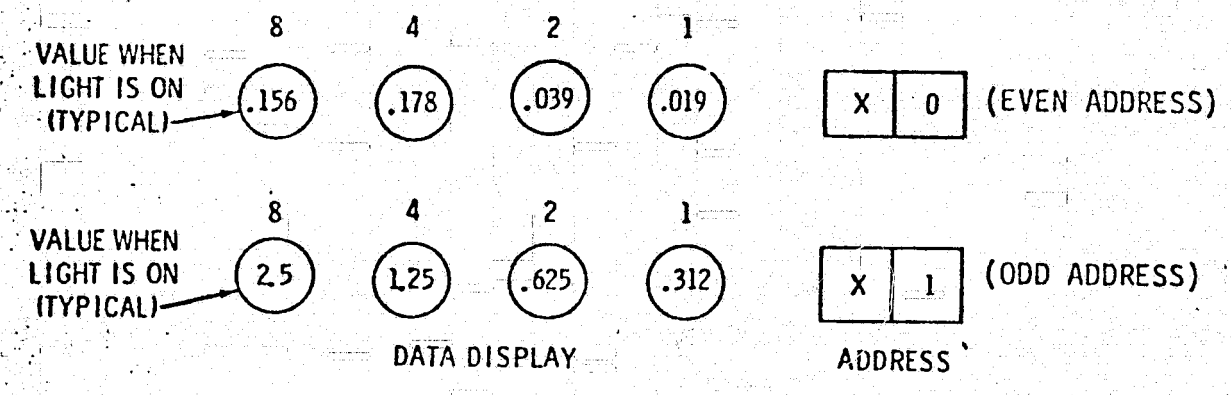


How To Read And Interpret ADR Readings From The Test Set

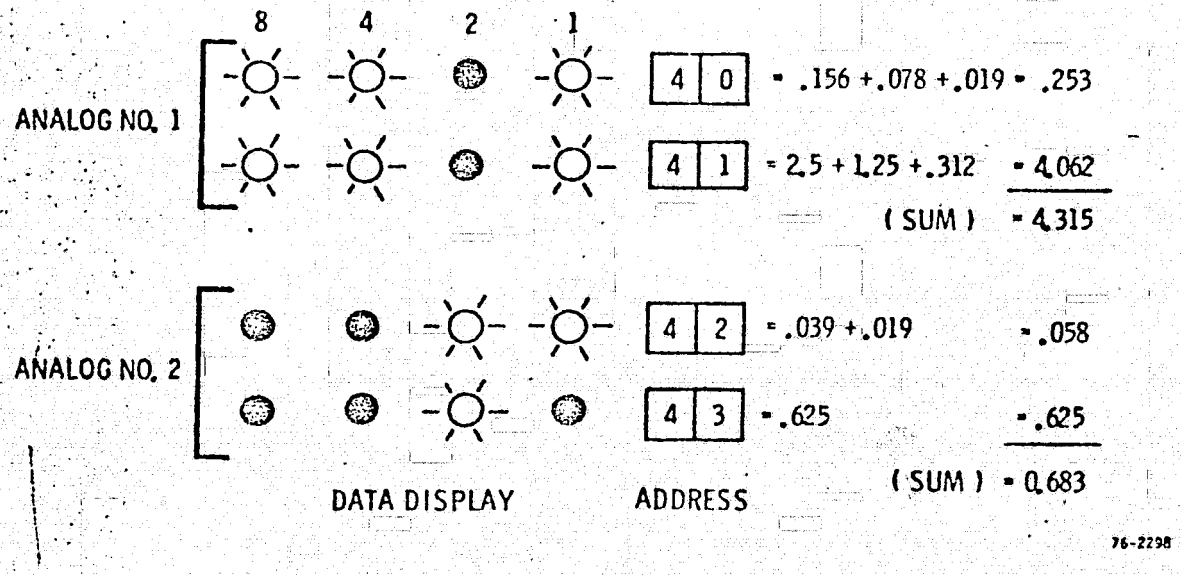
ASSUME:

(1) 4 ADR'S ARE USED (ADRESSES 30H THROUGH 3FH)
(2) 2 ANALOG DEVICES USED (OF EIGHT POSSIBLE)
(3) ANALOG DEVICE NO. 1 READS: 4.321 Vdc
ANALOG DEVICE NO. 2 READS: 0.685 Vdc

WHEN READING ANALOG CONVERTED DATA THE TEST SET INDICATORS TAKE ON A NEW SIGNIFICANCE AS SHOWN BELOW:



THEREFORE THE TEST SET DATA DISPLAY/ADDRESS FOR THE ABOVE EXAMPLES (4.321 Vdc AND 0.685 Vdc) ARE AS FOLLOWS:



76-2298

-17-

Refer to Table 1.2 for Complete List of All Possible Voltage Readings.

How To Read And Interpret Analog Reading From The Test Set After The A to D Conversion

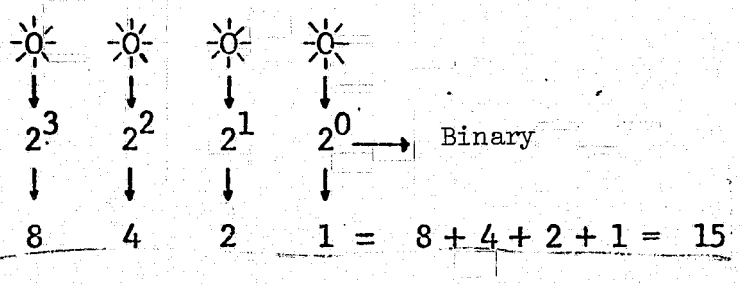
Binary to Hexadecimal Conversion Chart

Test Set INDICATOR No.				Equivalent Hexadecimal Number
8	4	2	1	
0	0	0	0	0
0	0	0	X	1
0	0	X	0	2
0	0	X	X	3
0	X	0	0	4
0	X	0	X	5
0	X	X	0	6
0	X	X	X	7
X	0	0	0	8
X	0	0	X	9
X	0	X	0	A
X	0	X	X	B
X	X	0	0	C
X	X	0	X	D
X	X	X	0	E
X	X	X	X	F

* In this chart, the symbol "0" means light is off and the symbol "X" means light is on.

EXAMPLES

A



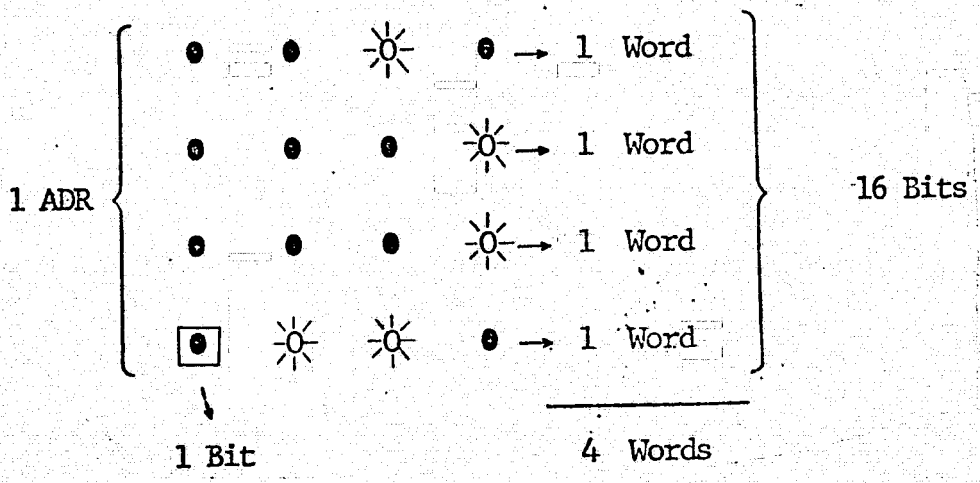
(decimal). According to table 1.1, this corresponds to F (hexadecimal) and is also shown in Figure 1-6.

B: 1 ADR = 16 bits

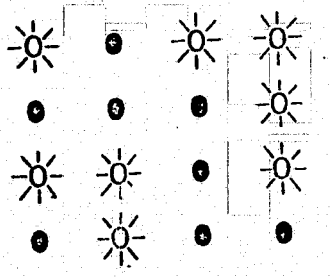
4 bits = 1 word

/17

Consequently, 1 ADR = 16 bits = 4 words. This is shown in Figure 1-7 as follows:



The way to decode the Test Set lights is the following:



8+0+2+1 = 11 x (1/100) = 0.11

0+0+0+1 = 1 x (1/10) = 0.1

8+4+0+1 = 13 x (1) = 13

0+4+0+0 = 4 x (10) = 40

0.11 is least significant number

0.1

13

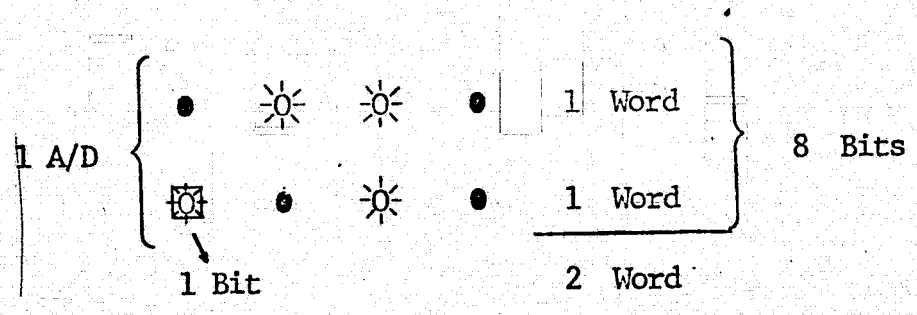
40 is most significant number

40 + 13 + 0.1 + 0.11 = 53.21

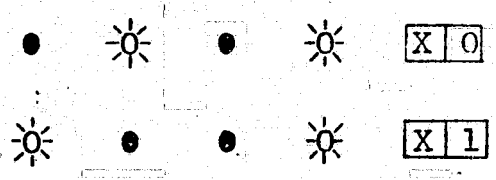
C: 1 A/D = 8 bits /18

4 bits = 1 word

Consequently, 1 A/D = 8 bits = 2 words. This is shown in Figure 1-8 as follows:



The way to decode the Test Set lights is the following:



0.546 volts = 1 C (hexadecimal) = 28 (decimal)

+ 2.5 volts = 80 (hexadecimal) = 128 (decimal)

3.046 volts = 9 C (hexadecimal) = 156 (decimal)

This means that the values in volts are added. This value is converted to hexadecimal by means of table 1.2. The resulting value is converted to decimal by table 1.1.

It is easy to see from Figure 1-6 that the maximum usable number of ADR is 4 and that the maximum usable number of AD is 8. /19

5. DESCRIPTION AND ADJUSTMENT OF PLATFORMS

5.1. Requirements for and adjustment of input data

DESCRIPTION	CHARACTERISTICS
FOR SERIES DIGITAL INPUT	
Maximum longitude	LANDSAT (ERTS) mode, 64 bits GOES mode, ASCII coding, 2000 bits GOES mode, no ASCII coding, 828 bits
Logic level	+ 3.5 to 5.0 volts = 1 logic 0.0 to 1.5 volts = 0 logic
Impedance	50 kilohms (typical)
FOR PARALLEL DIGITAL INPUT	
Maximum longitude	LANDSAT (ERTS) mode, 12 groups of 64 bits = 768 bits
Logic level	+ 3.5 to 5.0 volts = 1 logic 0.0 to 1.5 volts = 0 logic
Impedance	50 kilohms (typical)
FOR ANALOG INPUT	
Usable channels	8 channels maximum
Logic level	0.0 to 5.0 volts, analog data convertible to digital
Impedance	100 kilohms (typical)
Resolution	8 bits (2^8 binary)
Precision	plus or minus 1 bit

NOTEBOOK FOR OPERATION OF LANDSAT (ERTS) SYSTEM /20

ERTS BOLIVIA PROGRAM

NOTEBOOK FOR OPERATION OF CDCP

STATION INFORMATION

O.A Name ..... La Paz

O.B Institution .....

O.C Station number .....

O.D S/N .....

O.E Address ..... La Paz

O.F Location: Latitude 16° 28' south

Longitude 64° 18' west

O.G Operator

Name .....

Adress .....

Telephone .....

NOTE: Original for operator; copy for verification

CONSTANTS FOR DATA COLLECTION (ERTS AND/OR GOES)	REGISTER (ADDRESS)	INPUT VALUE
1.A DATA UPDATING INTERVAL		
least significant number	14	8
most significant number	15	0
1.B UPDATING TIME CONTROL		
(0 = 15 minutes; 1 = 6 minutes)	16	0
1.C NUMBER OF DIGITAL SENSORS (ADR)		
(maximum 4) (4 words x 4 bits = 1 ADR)	0D	2
PARAMETERS		
1. water level 2. precipitation		
3. ..... 4.		
1.D NUMBER OF ANALOG SENSORS (A/D)		
(maximum 8) (2words x 4 bits = 1 A/D)	0E	3
PARAMETERS		
1. Ground temperature 2. Water temp.		
3 Air temperature ..... 4.		
5. ..... 6.....		
7. ..... 8		

CONSTANTS FOR DATA COLLECTION (ERTS AND/OR GOES)	REGISTER (ADDRESS)	INPUT VALUE	/22
1.E MEMORY CAPACITY TO BE USED (no. of 4-bit words)			
least significant number	18	0	8
most significant number	19	6	1 (case 2)

MAXIMUM UTILIZABLE

GOES: 13 groups of 16 words = 832 bits

ERTS: (for 90 seconds) 6 groups of 16 words = 384 bits

1.F DATA INPUT 0 = series; 1 = parallel	0A	1

1.G DATA COLLECTION INTERVAL

Hours _____

1.H STARTING TIME _____

1.I TRANSMISSION TIME OF FIRST DATA GROUP

Time _____

CONSTANTS EXCLUSIVELY FOR GOES DCS	REGISTER (ADDRESS)	INPUT VALUE	/23
2.A ERTS/GOES SELECTION 0 = ERTS; 1 = GOES	09	1	
2.B CODING CONTROL 0 = GOES; 1 = ERTS	0F	0	

2.C WORD PARITY FOR DATA IN ASCII MODE

0 = Even; 1 = Odd (only in GOES) 0C 1

2.D SERIES INPUT DATA FORMAT

0 = binary; 1 = ASCII (only in GOES) 0B

2.E TRANSMISSION INTERVAL

Number of 15-minute periods

least significant number 12

most significant number 13

2.F INITIAL TRANSMISSION TIME

Number of 15-minute periods; maximum

63 hours 45 minutes = 255 periods

least significant number 10

most significant number 11

2.G PLATFORM IDENTIFICATION CODE /24

(8 hexadecimal characters)

most significant number 01

02

03

04

05

06

07

least significant number 08

2.H TIME ASSIGNED TO INITIAL TRANSMISSION Working hours

GMT _____

Local _____

2.I INTERVAL ASSIGNED TO TRANSMISSIONS

Hours _____

2.J CHANNEL ASSIGNED TO STATION

Number _____

2.K ANTENNA

Elevation _____ Azimuth_____

CONSTANTS EXCLUSIVELY FOR ERTS DCS	REGISTER (ADDRESS)	INPUT VALUE
3.A ERTS/GOES SELECTION		
0 = ERTS: 1 = GOES	09	0
3.B CODING CONTROL		
0 = GOES: 1 = ERTS	0F	1
3.C Transmission Period		
0 = 180 seconds; 1 = 90 seconds	17	1
3.D PLATFORM IDENTIFICATION CODE		
(3 hexadecimal characters)		
most significant number	01	A
	02	B
least significant number	03	C

/25

6. OPERATIONAL METHOD FOR ERTS/GOES SYSTEMS /26

6.1 Detailed procedure for LANDSAT (ERTS) system

ID $5274_{(8)}$ = Number assigned to platform in octal base

Collection of data: 2 hours; data updated every 2 hours

Transmission every 90 seconds

2 ADR = 2 digital addresses, one for water level and the second for precipitation

3 A/D = 3 analog registers that measure ground, water and air temperatures.

QUESTIONS

1. What should be the memory capacity assuming 12 hours of data storage?

2. What should be the memory capacity assuming that 12 hours of data are stored, using only 1 ADR and updating the data every 2 hours?

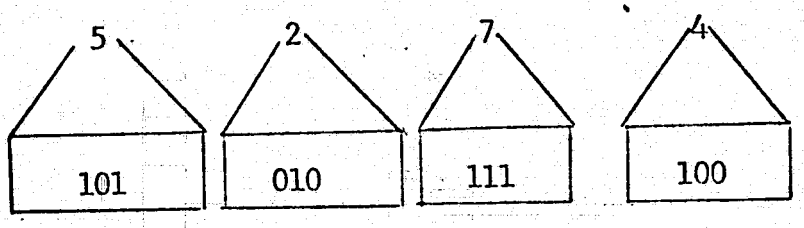
NOTE: It should be kept in mind that in working in the ERTS mode the data are introduced in groups of 64 bits. When the data updating cycle is begun, the microprocessor checks to see whether it can store all of the new data in the remaining positions of the 64-bit group. If all of the data do not fit into this space, the microprocessor then seeks another 64-bit group for storing the new data. The answer should be an integral multiple of 64 (decimal).

RESOLUTION /27

a. Platform Identification Number

This number is given in octal base terms and needs to be converted to the hexadecimal base using the following procedure:

5274 ——→ X
(8) (H)



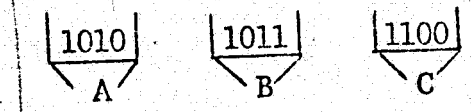
Octal base

Binary base

We obtain the equivalent values for each digit in the binary base and we write down these values in series as a single binary number, for example:

101010111100

We then divide the digits in groups of 4 from left to right. The binary numbers obtained are then converted into the hexadecimal base by means of table 1.9:



Binary base

hexadecimal base

We thus obtain ABC the platform identification in the hexadecimal base. This result is written down in the operational notebook under position 3D. /28

01	A
02	B
03	C

b. Updating of data every 2 hours means that data are obtained during 8 intervals of 15 minutes each. In the operational notebook,

under position 1 A, we write the number of intervals in hexadecimal units (08_H) in registers 14 and 15, i.e., 8 (the least significant digit) is placed in register 14 while zero (the most significant digit) is placed in register 15.

Under position 1B, register 16, of the operational notebook, we write a zero to indicate that we are working in 15-minute intervals and in position 1F, register 0A, we write the corresponding type of input. In our exercise, we write the digit 1.

c. Transmission Interval

In the position 3C, register 17, we write the digit 1 which corresponds to the transmission interval of 90 seconds.

d. Memory capacity (question 1)

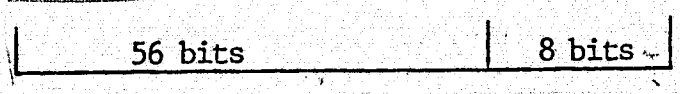
d.1.

1 ADR = 4 Words of 4 Bits = 16 bits
2 ADR = 8 Words of 4 Bits = 32 bits

1 A/D = 2 Words of 4 Bits = 8 bits
3 A/D = 6 Words of 4 Bits = 24 bits

TOTAL 32 + 24 = 56 Bits

The first data group takes up 56 bits of the first group of 64 / 29 bits, leaving 8 bits unused. During the second recording of data (2 hours later), the microprocessor will try to admit the new group of 56 bits into the remainder of the first group of 56 bits.



Since this is impossible, the microprocessor will seek a new group for storing the succeeding 56 bits.

NOTE: The CDCP sends groups of 64 bits every time that it transmits. The satellite receives the message from a single platform each time, the other signals being cut off during this interval. Furthermore, the satellite may receive messages from all of the platforms which are in its line-of-sight and, in the case of reception of a 64-bit data group and identification of a platform, it may happen that the same information is received from another platform followed by repeating of the information from the first platform. After a period of 90 seconds or during another transmission period, the satellite may receive the data groups which have not yet been admitted, i.e., the data may arrive in an interrupted fashion. Consequently, the unused positions (8 bits in this case) are not employed to complete the groups of 64 bits.

Every 2 hours, a new group of 64 bits will be admitted so that 6 groups of 64 bits will be stored during a 12-hour period. A total of 384 bits (6 x 64) is the maximum capacity that can be used. This corresponds to 96 words.

In the position 1C, register 0D, of the operational notebook, we write a 2 for the 2 ADR's employed and in position 1D, register 0E, we write a 3 for the 3 A/D's used in addition to noting their descriptions. In position 1E is written number 96 (decimal) converted to hexadecimal (table 1.1) which is 60_H. In register 18 is written a zero /30

(least significant digit) and in register 19 is written a 6 (most significant digit).

d. Memory capacity (question 2)

d.2. In this case alone, we rely on an ADR sensor. Therefore, 1 ADR = 4 words of 4 bits each = 16 bits. During 8 hours, we complete a 64-bit group, updating the data every 2 hours. After 12 hours, we have 96 bits which are equivalent to 24 words.

Using table 1.1, we convert 24 (decimal) into 18 (hexadecimal) which is written in position 1E of the operational notebook. An 8 (least significant digit) is written in register 18 and a 1 (most significant digit) is written in register 19. A 1 is written in position 1C, register 0D since there is only one ADR sensor and a zero is written in register 0E.

NOTEBOOK FOR OPERATION OF GOES SYSTEM /31

ERTS BOLIVIA PROGRAM

NOTEBOOK FOR OPERATION OF CDSP

STATION INFORMATION

O.A. Name _____La Paz_____

O.B. Institution _____

O.C. Station number_____

O.D. S/N _____

O.E. Address_____La Paz_____

O.F. Location: Latitude 16° 28' south

Longitude 64° 18' west

O.G Operator

Name _____

Address _____

Telephone _____

NOTE: Original for operator; copy for verification

CONSTANTS FOR DATA COLLECTION (ERTS AND/OR GOES)	REGISTER (ADDRESS)	INPUT VALUE	/32
1.A DATA UPDATING INTERVAL			
least significant number	14	8	
most significant number	15	0	
1.B UPDATING TIME CONTROL (0 = 15 minutes; 1 = 6 minutes)	16	0	
1.C NUMBER OF DIGITAL SENSORS (ADR) (maximum 4) (4 words x 4 bits)= 1 ADR	0D	2	
PARAMETERS			
1._____ 2_____			
3_____ 4_____			
1.D NUMBER OF ANALOG SENSORS (S/D)	0E	3	
PARAMETERS			
1 _____ 2_____			
3_____ 4_____			
5_____ 6_____			
7_____ 8_____			

CONSTANTS FOR DATA COLLECTION (ERTS AND/OR GOES)	REGISTER (ADDRESS)	INPUT VALUE	/33
1.E MEMORY CAPACITY TO BE USED (no. of 4-bit words)			
least significant number	18		
most significant number	19		
MAXIMUM UTLIZABLE			
GOES: 13 groups of 16 words = 832 bits			
ERTS: (for 90 seconds) 6 groups of 16 words = 384 bits			
1.F DATA INPUT			
0 = series; 1 = parallel	0A	1	
1.G DATA COLLECTION INTERVAL			
Hours _____			
1.H STARTING TIME _____			
1.I TRANSMISSION TIME OF FIRST DATA GROUP			
Time _____			

CONSTANTS EXCLUSIVELY FOR GOES DCS	REGISTER (ADDRESS)	INPUT VALUE	/34
2.A ERTS /GOES SELECTION			
0 = ERTS; 1 = GOES	09	1	
2.B CODING CONTROL			
0 = GOES; 1 = ERTS	0F	0	

2.C WORD PARITY FOR DATA IN ASCII MODE		
0 = Even; 1 = Odd (only in GOES)	0C	1
2.D SERIES INPUT DATA FORMAT		
0 = binary; 1 = ASCII (only in GOES)	0B	
2.E TRANSMISSION INTERVAL		
Number of 15-minute periods		
least significant number	12	C
most significant number	13	0
2.F INITIAL TRANSMISSION TIME		
Number of 15-minute periods; maximum		
63 hours 45 minutes = 255 periods		
least significant number	10	9
most significant number	11	3
2.G PLATFORM IDENTIFICATION CODE		
(8 hexadecimal characters)		
most significant number	01	1
	02	6
	03	C
	04	6
	05	5
	06	6
	07	9
least significant number	08	E

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2.H TIME ASSIGNED TO INITIAL TRANSMISSION — WORKING HOURS

GMT 0031 — 2031

Local 2031 — 2331

2.I INTERVAL ASSIGNED TO TRANSMISSIONS — 0231

Hours 3 — 0531

2.J CHANNEL ASSIGNED TO STATION — 0831

Number _____ — 1131

2.K ANTENNA — 1431

Elevation 45.47° Azimuth 296.66° — 1731

1931

CONSTANTS EXCLUSIVELY FOR ERTS DCS	REGISTER (ADDRESS)	INPUT VALUE
3.A ERTS/GOES SELECTION		
0 = ERTS; 1 = GOES	09	0
3.B CODING CONTROL		
0 = GOES; 1 = ERTS	0F	1
3.C Transmission period		
0 = 180 seconds; 1 = 90 seconds	17	
3.D PLATFORM IDENTIFICATION CODE		
(3 hexadecimal characters)		
most significant number	01	
	02	
least significant number	03	

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6.2 Detailed procedure for GOES system

a. The procedure for this case will be the same as that used in the case of the LANDSAT (ERTS) system except for the following changes:

a.1. Time assigned for initial transmission: 0031 GMT.

a.2. Interval between transmissions: 3 hours.

a.3. Geographical position of station: 16° 28' south latitude; 68° 18' west longitude.

a.4. Platform identification code: 16C6569E.

b. In this procedure, we shall not repeat the explanation for positions 1A through 1F of the operational notebook since this is the same as that for the previous case.

RESOLUTION OF DATA

The appropriate format is given under position 2D, register 0B of the operational notebook.

The transmission period is 3 hours, which is equivalent to 12 periods of 15 minutes each. This number when converted to a hexadecimal base (Table 1.1) corresponds to the value $0C_H$ which is written in position 2E. C (least significant value) belongs to register 12 and zero (most significant number) corresponds to B.

From position 2H, we shall now calculate local time which is 4 hours less than GMT, i.e., 2031 hours. Starting with this time and adding the proper time interval (3 hours), we obtain all of the transmission times written in the operational notebook under the heading of working

hours, namely: 2031, 2331, 0231, 0531, 0831, 1131, 1431, 1731 and 1931.

In order to select the initial transmission time, position 2F, a calculation is made of the number of 15-minute periods counting from the moment that the platform is ready to begin transmitting to the moment that we want it to start transmitting, the maximum number of periods being 255, i.e., 63 hours and 45 minutes. /38

For example, let us assume that it is 1502 hours on the tenth day and we want the first transmission to take place at 0531 hours on the eleventh day. Therefore, the number of 15-minute intervals from 1516 hours of the tenth day to 0531 hours of the eleventh day is 57. When this number is converted to the hexadecimal base by means of Table 1.1, we obtain the number 39. The digit 9 (least significant digit) is recorded in register 10 and the digit 3 (most significant digit) is recorded in register 11. Once these data are recorded, we wait until 1516 hours at which time we press the TIMER RESET button of the Test Set (Figure 1-4).

In position 2G, we write the hexadecimal number 16C6569E, which is the platform identification number. We record the digit 1 (most significant number) in register 01 and the value E (least significant value) in register 08.

In position 2K, we write the angles of elevation and azimuth of the GOES antenna as calculated from Tables 1.3.1 to 1.3.6.

In our exercise, we are going to work with the GOES satellite, which is located at a longitude of 105 degrees west, from which we subtract the longitude of the La Paz Station.

theta = 105° - 68°

theta = 37°

We round out the value of theta to the nearest 5 degrees (in this case to 35 degrees) and we consult Tables 1.1.3 to 1.1.6. We search for the value of latitude that is closest to that of the station, which is 17°, and in the same row, we read the following: azimuth = 67.34°, elevation = 45.47°.

Consequently, the angle of azimuth for the Southern Hemisphere /39 will be 360° - 67.34° = 296.66°. [Translator's note: It appears that this may be an error and that the correct value should be "292.66" and not "296.66"]

In the operational notebook, we write 45.47° or 45° 28' 12" under Elevation and 296.66° [Translator's note: Same comment] or 296° 39' 36" under Azimuth.

Appendix D: Hexadecimal To Decimal Conversion 1.

HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC
00	0	20	32	40	64	60	96
01	1	21	33	41	65	61	97
02	2	22	34	42	66	62	98
03	3	23	35	43	67	63	99
04	4	24	36	44	68	64	100
05	5	25	37	45	69	65	101
06	6	26	38	46	70	66	102
07	7	27	39	47	71	67	103
08	8	28	40	48	72	68	104
09	9	29	41	49	73	69	105
0A	10	2A	42	4A	74	6A	106
0B	11	2B	43	4B	75	6B	107
0C	12	2C	44	4C	76	6C	108
0D	13	2D	45	4D	77	6D	109
0E	14	2E	46	4E	78	6E	110
0F	15	2F	47	4F	79	6F	111
10	16	30	48	50	80	70	112
11	17	31	49	51	81	71	113
12	18	32	50	52	82	72	114
13	19	33	51	53	83	73	115
14	20	34	52	54	84	74	116
15	21	35	53	55	85	75	117
16	22	36	54	56	86	76	118
17	23	37	55	57	87	77	119
18	24	38	56	58	88	78	120
19	25	39	57	59	89	79	121
1A	26	3A	58	5A	90	7A	122
1B	27	3B	59	5B	91	7B	123
1C	28	3C	60	5C	92	7C	124
1D	29	3D	61	5D	93	7D	125
1E	30	3E	62	5E	94	7E	126
1F	31	3F	63	5F	95	7F	127

Appendix D: (Cont.) Hexadecimal To Decimal Conversion 1.

HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC
80	128	A0	160	C0	192	E0	224
81	129	A1	161	C1	193	E1	225
82	130	A2	162	C2	194	E2	226
83	131	A3	163	C3	195	E3	227
84	132	A4	164	C4	196	E4	228
85	133	A5	165	C5	197	E5	229
86	134	A6	166	C6	198	E6	230
87	135	A7	167	C7	199	E7	231
88	136	A8	168	C8	200	E8	232
89	137	A9	169	C9	201	E9	233
8A	138	AA	170	CA	202	EA	234
8B	139	AB	171	CB	203	EB	235
8C	140	AC	172	CC	204	EC	236
8D	141	AD	173	CD	205	ED	237
8E	142	AE	174	CE	206	EE	238
8F	143	AF	175	CF	207	EF	239
90	144	B0	176	D0	208	F0	240
91	145	B1	177	D1	209	F1	241
92	146	B2	178	D2	210	F2	242
93	147	B3	179	D3	211	F3	243
94	148	B4	180	D4	212	F4	244
95	149	B5	181	D5	213	F5	245
96	150	B6	182	D6	214	F6	246
97	151	B7	183	D7	215	F7	247
98	152	B8	184	D8	216	F8	248
99	153	B9	185	D9	217	F9	249
9A	154	BA	186	DA	218	FA	250
9B	155	BB	187	DB	219	FB	251
9C	156	BC	188	DC	220	FC	252
9D	157	BD	189	DD	221	FD	253
9E	158	BE	190	DE	222	FE	254
9F	159	BF	191	DF	223	FF	255

TABLE 1.1

Appendix E: Direct Conversion of Hexadecimal to Equivalent Voltages.

HEX	VDC	HEX	VDC	HEX	VDC	HEX	VDC
00	0.000	20	0.625	40	1.250	60	1.875
01	0.019	21	0.645	41	1.270	61	1.895
02	0.039	22	0.664	42	1.289	62	1.914
03	0.059	23	0.684	43	1.309	63	1.934
04	0.068	24	0.703	44	1.328	64	1.953
05	0.088	25	0.723	45	1.348	65	1.973
06	0.117	26	0.742	46	1.367	66	1.992
07	0.137	27	0.762	47	1.387	67	2.012
08	0.156	28	0.781	48	1.406	68	2.031
09	0.176	29	0.801	49	1.426	69	2.051
0A	0.195	2A	0.820	4A	1.445	6A	2.070
0B	0.215	2B	0.840	4B	1.465	6B	2.090
0C	0.234	2C	0.859	4C	1.484	6C	2.109
0D	0.254	2D	0.879	4D	1.504	6D	2.129
0E	0.273	2E	0.898	4E	1.523	6E	2.148
0F	0.293	2F	0.918	4F	1.543	6F	2.168
10	0.313	30	0.938	50	1.563	70	2.188
11	0.332	31	0.957	51	1.582	71	2.207
12	0.352	32	0.977	52	1.602	72	2.227
13	0.371	33	0.996	53	1.621	73	2.246
14	0.391	34	0.016	54	1.641	74	2.266
15	0.410	35	0.035	55	1.660	75	2.285
16	0.430	36	0.055	56	1.680	76	2.305
17	0.449	37	0.074	57	1.699	77	2.324
18	0.469	38	0.094	58	1.719	78	2.344
19	0.488	39	0.113	59	1.738	79	2.363
1A	0.508	3A	0.133	5A	1.758	7A	2.383
1B	0.527	3B	0.152	5B	1.777	7B	2.402
1C	0.546	3C	0.172	5C	1.797	7C	2.422
1D	0.566	3D	0.191	5D	1.816	7D	2.441
1E	0.586	3E	0.211	5E	1.836	7E	2.461
1F	0.605	3F	0.230	5F	1.855	7F	2.480

Appendix E: (Cont.) Direct Conversion of Hexadecimal to Equivalent Voltages

HEX	VDC	HEX	VDC	HEX	VDC	HEX	VDC
80	2.500	A0	3.125	C0	3.750	E0	4.375
81	2.520	A1	3.145	C1	3.770	E1	4.395
82	2.539	A2	3.164	C2	3.789	E2	4.414
83	2.559	A3	3.184	C3	3.809	E3	4.434
84	2.578	A4	3.203	C4	3.828	E4	4.453
85	2.598	A5	3.223	C5	3.848	E5	4.473
86	2.617	A6	3.242	C6	3.867	E6	4.492
87	2.637	A7	3.262	C7	3.887	E7	4.512
88	2.656	A8	3.281	C8	3.906	E8	4.531
89	2.676	A9	3.301	C9	3.926	E9	4.551
8A	2.695	AA	3.320	CA	3.945	EA	4.570
8B	2.715	AB	3.340	CB	3.965	EB	4.590
8C	2.734	AC	3.359	CC	3.984	EC	4.609
8D	2.754	AD	3.379	CD	4.004	ED	4.629
8E	2.773	AE	3.398	CE	4.023	EE	4.648
8F	2.793	AF	3.418	CF	4.043	EF	4.668
90	2.813	B0	3.438	D0	4.063	F0	4.688
91	2.832	B1	3.457	D1	4.082	F1	4.707
92	2.852	B2	3.477	D2	4.102	F2	4.727
93	2.871	B3	3.496	D3	4.121	F3	4.746
94	2.891	B4	3.516	D4	4.141	F4	4.766
95	2.910	B5	3.535	D5	4.160	F5	4.785
96	2.930	B6	3.555	D6	4.180	F6	4.805
97	2.949	B7	3.574	D7	4.199	F7	4.824
98	2.969	B8	3.594	D8	4.219	F8	4.844
99	2.988	B9	3.613	D9	4.238	F9	4.863
9A	3.008	BA	3.633	DA	4.258	FA	4.883
9B	3.027	BB	3.652	DB	4.277	FB	4.902
9C	3.047	BC	3.672	DC	4.297	FC	4.922
9D	3.066	BD	3.691	DD	4.316	FD	4.941
9E	3.086	BE	3.711	DE	4.336	FE	4.961
9F	3.105	BF	3.730	DF	4.355	FF	4.980

TABLE 1.2

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TABLE 1.3.1
GOES ANTENNA AZIMUTH/ELEVATION ANGLES

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
0.00	1.00	0.00	88.82
0.00	3.00	0.00	86.47
0.00	5.00	0.00	84.11
0.00	7.00	0.00	81.76
0.00	9.00	0.00	79.40
0.00	11.00	0.00	77.06
0.00	13.00	0.00	74.71
0.00	15.00	0.00	72.37
0.00	17.00	0.00	70.04
0.00	19.00	0.00	67.71
0.00	21.00	0.00	65.38
0.00	23.00	0.00	63.07
0.00	25.00	0.00	60.76
0.00	27.00	0.00	58.46
0.00	29.00	0.00	56.16
0.00	31.00	0.00	53.88
0.00	33.00	0.00	51.60
0.00	35.00	0.00	49.34
0.00	37.00	0.00	47.08
0.00	39.00	0.00	44.84
0.00	41.00	0.00	42.60
0.00	43.00	0.00	40.38
0.00	45.00	0.00	38.16
0.00	47.00	0.00	35.96
0.00	49.00	0.00	33.77
0.00	51.00	0.00	31.59
0.00	53.00	0.00	29.42
0.00	55.00	0.00	27.27
0.00	57.00	0.00	25.12
0.00	59.00	0.00	22.99
0.00	61.00	0.00	20.87
0.00	63.00	0.00	18.76
0.00	65.00	0.00	16.66
0.00	67.00	0.00	14.57
0.00	69.00	0.00	12.50
0.00	71.00	0.00	10.44
0.00	73.00	0.00	8.39
0.00	75.00	0.00	6.35
0.00	77.00	0.00	4.32
0.00	79.00	0.00	2.30
0.00	81.00	0.00	.29
0.00	83.00	0.00	-1.70
5.00	1.00	78.72	83.99
5.00	3.00	59.11	83.13
5.00	5.00	45.11	81.68
5.00	7.00	35.67	79.88
5.00	9.00	29.22	77.89
5.00	11.00	24.63	75.80
5.00	13.00	21.25	73.64
5.00	15.00	18.68	71.45
5.00	17.00	16.66	69.22
5.00	19.00	15.04	66.98
5.00	21.00	13.72	64.73
5.00	23.00	12.62	62.48
5.00	25.00	11.70	60.22
5.00	27.00	10.91	57.97
5.00	29.00	10.23	55.72
5.00	31.00	9.64	53.47
5.00	33.00	9.13	51.22
5.00	35.00	8.67	48.99
5.00	37.00	8.27	46.76
5.00	39.00	7.91	44.54
5.00	41.00	7.60	42.32
5.00	43.00	7.31	40.12
5.00	45.00	7.05	37.92
5.00	47.00	6.82	35.74
5.00	49.00	6.61	33.56
5.00	51.00	6.42	31.40
5.00	53.00	6.25	29.24
5.00	55.00	6.10	27.10
5.00	57.00	5.96	24.97
5.00	59.00	5.83	22.85
5.00	61.00	5.71	20.74
5.00	63.00	5.61	18.64
5.00	65.00	5.51	16.55
5.00	67.00	5.43	14.48
5.00	69.00	5.35	12.41
5.00	71.00	5.29	10.36
5.00	73.00	5.23	8.32
5.00	75.00	5.18	6.29
5.00	77.00	5.13	4.27
5.00	79.00	5.09	2.26
5.00	81.00	5.06	.26
5.00	83.00	5.04	-1.73
10.00	1.00	84.35	78.17
10.00	3.00	73.47	77.72
10.00	5.00	63.70	76.86
10.00	7.00	55.35	75.67
10.00	9.00	48.42	74.22
10.00	11.00	42.74	72.58
10.00	13.00	38.09	70.80
10.00	15.00	34.27	68.91
10.00	17.00	31.09	66.95
10.00	19.00	28.44	64.94
10.00	21.00	26.20	62.88
10.00	23.00	24.29	60.79
10.00	25.00	22.65	58.68
10.00	27.00	21.23	56.55

TABLE 1.3.2

GOES ANTENNA AZIMUTH/ELEVATION ANGLES

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
10.00	29.00	19.99	54.41
10.00	31.00	18.90	52.26
10.00	33.00	17.94	50.11
10.00	35.00	17.09	47.96
10.00	37.00	16.33	45.80
10.00	39.00	15.65	43.65
10.00	41.00	15.04	41.50
10.00	43.00	14.50	39.35
10.00	45.00	14.00	37.21
10.00	47.00	13.56	35.08
10.00	49.00	13.15	32.95
10.00	51.00	12.78	30.83
10.00	53.00	12.45	28.72
10.00	55.00	12.15	26.61
10.00	57.00	11.87	24.52
10.00	59.00	11.62	22.43
10.00	61.00	11.40	20.36
10.00	63.00	11.19	18.29
10.00	65.00	11.01	16.24
10.00	67.00	10.84	14.18
10.00	69.00	10.70	12.15
10.00	71.00	10.56	10.13
10.00	73.00	10.45	8.11
10.00	75.00	10.35	6.11
10.00	77.00	10.26	4.11
10.00	79.00	10.18	2.13
10.00	81.00	10.12	.15
10.00	83.00	10.07	-1.81
15.00	1.00	86.27	72.33
15.00	3.00	78.95	72.03
15.00	5.00	71.98	71.45
15.00	7.00	65.54	70.60
15.00	9.00	59.72	69.52
15.00	11.00	54.54	68.26
15.00	13.00	49.99	66.83
15.00	15.00	45.99	65.28
15.00	17.00	42.50	63.62
15.00	19.00	39.46	61.87
15.00	21.00	36.79	60.06
15.00	23.00	34.44	58.19
15.00	25.00	32.38	56.27
15.00	27.00	30.55	54.32
15.00	29.00	28.93	52.35
15.00	31.00	27.49	50.34
15.00	33.00	26.20	48.33
15.00	35.00	25.04	46.30
15.00	37.00	24.00	44.26
15.00	39.00	23.06	42.21
15.00	41.00	22.22	40.16
15.00	43.00	21.45	38.10
15.00	45.00	20.75	36.05
15.00	47.00	20.12	33.99
15.00	49.00	19.55	31.94
15.00	51.00	19.02	29.89
15.00	53.00	18.55	27.85
15.00	55.00	18.11	25.81
15.00	57.00	17.72	23.78
15.00	59.00	17.36	21.75
15.00	61.00	17.03	19.78
15.00	63.00	16.74	17.72
15.00	65.00	16.47	15.71
15.00	67.00	16.23	13.72
15.00	69.00	16.01	11.73
15.00	71.00	15.82	9.75
15.00	73.00	15.65	7.78
15.00	75.00	15.50	5.81
15.00	77.00	15.38	3.86
15.00	79.00	15.27	1.92
15.00	81.00	15.18	- .02
20.00	1.00	87.25	66.52
20.00	3.00	81.82	66.30
20.00	5.00	76.53	65.86
20.00	7.00	71.49	65.22
20.00	9.00	66.74	64.39
20.00	11.00	62.33	63.40
20.00	13.00	58.28	62.25
20.00	15.00	54.58	60.97
20.00	17.00	51.23	59.58
20.00	19.00	48.19	58.10
20.00	21.00	45.44	56.53
20.00	23.00	42.97	54.89
20.00	25.00	40.74	53.19
20.00	27.00	38.72	51.44
20.00	29.00	36.90	49.65
20.00	31.00	35.25	47.82
20.00	33.00	33.75	45.97
20.00	35.00	32.40	44.09
20.00	37.00	31.17	42.19
20.00	39.00	30.04	40.28
20.00	41.00	29.02	38.35
20.00	43.00	28.09	36.41
20.00	45.00	27.24	34.47
20.00	47.00	26.46	32.52
20.00	49.00	25.75	30.57
20.00	51.00	25.10	28.62
20.00	53.00	24.50	26.66
20.00	55.00	23.96	24.71
20.00	57.00	23.46	22.76
20.00	59.00	23.01	20.81
20.00	61.00	22.59	18.86

TABLE 1.3.3

GOES ANTENNA AZIMUTH/ELEVATION ANGLES

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
20.00	63.00	22.22	16.92
20.00	65.00	21.88	14.99
20.00	67.00	21.57	13.06
20.00	69.00	21.30	11.14
20.00	71.00	21.05	9.22
20.00	73.00	20.84	7.31
20.00	75.00	20.65	5.41
20.00	77.00	20.48	3.51
20.00	79.00	20.34	1.62
20.00	81.00	20.23	-.26
25.00	1.00	87.86	60.74
25.00	3.00	83.60	60.56
25.00	5.00	79.41	60.22
25.00	7.00	75.35	59.72
25.00	9.00	71.45	59.06
25.00	11.00	67.75	58.26
25.00	13.00	64.25	57.33
25.00	15.00	60.97	56.27
25.00	17.00	57.91	55.11
25.00	19.00	55.08	53.85
25.00	21.00	52.46	52.50
25.00	23.00	50.04	51.08
25.00	25.00	47.81	49.59
25.00	27.00	45.77	48.05
25.00	29.00	43.89	46.45
25.00	31.00	42.16	44.81
25.00	33.00	40.57	43.13
25.00	35.00	39.11	41.42
25.00	37.00	37.77	39.68
25.00	39.00	36.54	37.92
25.00	41.00	35.40	36.13
25.00	43.00	34.36	34.33
25.00	45.00	33.40	32.52
25.00	47.00	32.52	30.70
25.00	49.00	31.71	28.86
25.00	51.00	30.86	27.02
25.00	53.00	30.28	25.18
25.00	55.00	29.65	23.33
25.00	57.00	29.07	21.48
25.00	59.00	28.55	19.63
25.00	61.00	28.06	17.77
25.00	63.00	27.63	15.92
25.00	65.00	27.23	14.08
25.00	67.00	26.87	12.23
25.00	69.00	26.54	10.39
25.00	71.00	26.25	8.55
25.00	73.00	25.99	6.72
25.00	75.00	25.77	4.89
25.00	77.00	25.57	3.07
25.00	79.00	25.41	1.25
25.00	81.00	25.27	-.56
30.00	1.00	88.27	55.00
30.00	3.00	84.82	54.87
30.00	5.00	81.42	54.59
30.00	7.00	78.08	54.19
30.00	9.00	74.84	53.65
30.00	11.00	71.71	53.00
30.00	13.00	68.71	52.23
30.00	15.00	65.85	51.35
30.00	17.00	63.14	50.37
30.00	19.00	60.58	49.30
30.00	21.00	58.17	48.15
30.00	23.00	55.91	46.93
30.00	25.00	53.80	45.63
30.00	27.00	51.82	44.28
30.00	29.00	49.98	42.87
30.00	31.00	48.26	41.41
30.00	33.00	46.67	39.91
30.00	35.00	45.19	38.37
30.00	37.00	43.81	36.80
30.00	39.00	42.53	35.19
30.00	41.00	41.35	33.57
30.00	43.00	40.25	31.92
30.00	45.00	39.23	30.25
30.00	47.00	38.29	28.56
30.00	49.00	37.42	26.86
30.00	51.00	36.61	25.15
30.00	53.00	35.86	23.43
30.00	55.00	35.18	21.70
30.00	57.00	34.54	19.96
30.00	59.00	33.96	18.22
30.00	61.00	33.43	16.48
30.00	63.00	32.94	14.73
30.00	65.00	32.50	12.98
30.00	67.00	32.10	11.24
30.00	69.00	31.73	9.49
30.00	71.00	31.41	7.75
30.00	73.00	31.12	6.01
30.00	75.00	30.87	4.27
30.00	77.00	30.65	2.53
30.00	79.00	30.46	.80
30.00	81.00	30.31	-.92
35.00	1.00	88.57	49.32
35.00	3.00	85.73	49.21
35.00	5.00	82.90	48.99
35.00	7.00	80.13	48.65
35.00	9.00	77.41	48.21
35.00	11.00	74.76	47.67

TABLE 1.3.4

GOES ANTENNA AZIMUTH/ELEVATION ANGLES

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
35.00	13.00	72.19	47.03
35.00	15.00	69.71	46.30
35.00	17.00	67.34	45.47
35.00	19.00	65.06	44.57
35.00	21.00	62.90	43.59
35.00	23.00	60.84	42.54
35.00	25.00	58.89	41.42
35.00	27.00	57.04	40.24
35.00	29.00	55.30	39.00
35.00	31.00	53.66	37.72
35.00	33.00	52.12	36.39
35.00	35.00	50.68	35.02
35.00	37.00	49.32	33.62
35.00	39.00	48.05	32.18
35.00	41.00	46.86	30.71
35.00	43.00	45.75	29.21
35.00	45.00	44.72	27.69
35.00	47.00	43.75	26.15
35.00	49.00	42.85	24.59
35.00	51.00	42.02	23.02
35.00	53.00	41.24	21.43
35.00	55.00	40.52	19.84
35.00	57.00	39.86	18.23
35.00	59.00	39.24	16.61
35.00	61.00	38.68	14.99
35.00	63.00	38.16	13.36
35.00	65.00	37.69	11.73
35.00	67.00	37.26	10.09
35.00	69.00	36.87	8.46
35.00	71.00	36.52	6.82
35.00	73.00	36.21	5.18
35.00	75.00	35.94	3.55
35.00	77.00	35.70	1.91
35.00	79.00	35.50	.28
35.00	81.00	35.33	-1.34
40.00	1.00	88.81	43.71
40.00	3.00	86.43	43.61
40.00	5.00	84.07	43.43
40.00	7.00	81.74	43.15
40.00	9.00	79.44	42.79
40.00	11.00	77.19	42.34
40.00	13.00	74.99	41.80
40.00	15.00	72.86	41.18
40.00	17.00	70.79	40.49
40.00	19.00	68.79	39.72
40.00	21.00	66.87	38.89
40.00	23.00	65.03	37.99
40.00	25.00	63.27	37.03
40.00	27.00	61.58	36.01
40.00	29.00	59.98	34.94

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
40.00	31.00	58.46	33.82
40.00	33.00	57.01	32.65
40.00	35.00	55.64	31.44
40.00	37.00	54.35	30.20
40.00	39.00	53.13	28.92
40.00	41.00	51.98	27.61
40.00	43.00	50.90	26.27
40.00	45.00	49.88	24.90
40.00	47.00	48.92	23.52
40.00	49.00	48.03	22.11
40.00	51.00	47.20	20.68
40.00	53.00	46.42	19.23
40.00	55.00	45.69	17.77
40.00	57.00	45.01	16.30
40.00	59.00	44.39	14.82
40.00	61.00	43.81	13.33
40.00	63.00	43.28	11.83
40.00	65.00	42.79	10.32
40.00	67.00	42.35	8.81
40.00	69.00	41.95	7.30
40.00	71.00	41.59	5.78
40.00	73.00	41.26	4.26
40.00	75.00	40.96	2.74
40.00	77.00	40.73	1.22
40.00	79.00	40.52	-.30
45.00	1.00	89.00	38.15
45.00	3.00	87.00	38.08
45.00	5.00	85.02	37.92
45.00	7.00	83.05	37.69
45.00	9.00	81.11	37.39
45.00	11.00	79.20	37.01
45.00	13.00	77.32	36.56
45.00	15.00	75.49	36.05
45.00	17.00	73.70	35.46
45.00	19.00	71.97	34.82
45.00	21.00	70.28	34.11
45.00	23.00	68.66	33.34
45.00	35.00	67.09	32.52
45.00	27.00	65.58	31.65
45.00	29.00	64.14	30.72
45.00	31.00	62.75	29.76
45.00	33.00	61.43	28.74
45.00	35.00	60.16	27.69
45.00	37.00	58.96	26.60
45.00	39.00	57.82	25.48
45.00	41.00	56.73	24.32
45.00	43.00	55.71	23.14
45.00	45.00	54.74	21.93
45.00	47.00	53.82	20.69
45.00	49.00	52.96	19.43

TABLE 1 3.5.

GOES ANTENNA AZIMUTH/ELEVATION ANGLES

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
45.00	51.00	52.15	18.15
45.00	53.00	51.39	16.85
45.00	55.00	50.68	15.54
45.00	57.00	50.01	14.21
45.00	59.00	49.40	12.87
45.00	61.00	48.83	11.52
45.00	63.00	48.30	10.15
45.00	65.00	47.81	8.78
45.00	67.00	47.37	7.40
45.00	69.00	46.97	6.02
45.00	71.00	46.60	4.63
45.00	73.00	46.28	3.24
45.00	75.00	45.99	1.84
45.00	77.00	45.74	.44
45.00	79.00	45.53	-.95
50.00	1.00	89.16	32.67
50.00	3.00	87.49	32.61
50.00	5.00	85.82	32.48
50.00	7.00	84.16	32.29
50.00	9.00	82.52	32.04
50.00	11.00	80.90	31.72
50.00	13.00	79.31	31.35
50.00	15.00	77.75	30.92
50.00	17.00	76.22	30.43
50.00	19.00	74.72	29.88
50.00	21.00	73.26	29.29
50.00	23.00	71.85	28.64
50.00	25.00	70.47	27.94
50.00	27.00	69.15	27.20
50.00	29.00	67.86	26.41
50.00	31.00	66.63	25.59
50.00	33.00	65.44	24.72
50.00	35.00	64.30	23.81
50.00	37.00	63.21	22.87
50.00	39.00	62.16	21.89
50.00	41.00	61.17	20.89
50.00	43.00	60.22	19.85
50.00	45.00	59.32	18.79
50.00	47.00	58.46	17.71
50.00	49.00	57.65	16.60
50.00	51.00	56.89	15.47
50.00	53.00	56.17	14.32
50.00	55.00	55.50	13.16
50.00	57.00	54.86	11.97
50.00	59.00	54.27	10.78
50.00	61.00	53.73	9.57
50.00	63.00	53.22	8.35
50.00	65.00	52.75	7.12
50.00	67.00	52.32	5.88
50.00	69.00	51.93	4.64
50.00	71.00	51.57	3.39
50.00	73.00	51.26	2.13
50.00	75.00	50.97	.87
50.00	77.00	50.73	-.39
60.00	1.00	89.42	21.92
60.00	3.00	88.27	21.88
60.00	5.00	87.12	21.79
60.00	7.00	85.98	21.66
60.00	9.00	84.84	21.49
60.00	11.00	83.71	21.28
60.00	13.00	82.60	21.03
60.00	15.00	81.50	20.74
60.00	17.00	80.42	20.41
60.00	19.00	79.35	20.04
60.00	21.00	78.31	19.63
60.00	23.00	77.29	19.18
60.00	25.00	76.29	18.70
60.00	27.00	75.31	18.19
60.00	29.00	74.36	17.64
60.00	31.00	73.44	17.05
60.00	33.00	72.54	16.44
60.00	35.00	71.68	15.80
60.00	37.00	70.84	15.13
60.00	39.00	70.03	14.43
60.00	41.00	69.25	13.71
60.00	43.00	68.51	12.96
60.00	45.00	67.79	12.19
60.00	47.00	67.11	11.40
60.00	49.00	66.46	10.59
60.00	51.00	65.83	9.76
60.00	53.00	65.25	8.91
60.00	55.00	64.69	8.04
60.00	57.00	64.16	7.16
60.00	59.00	63.67	6.27
60.00	61.00	63.21	5.36
60.00	63.00	62.78	4.44
60.00	65.00	62.38	3.51
60.00	67.00	62.01	2.57
60.00	69.00	61.68	1.62
60.00	71.00	61.37	.66
60.00	73.00	61.10	-.30
70.00	1.00	89.64	11.46
70.00	3.00	88.91	11.44
70.00	5.00	88.18	11.38
70.00	7.00	87.46	11.31
70.00	9.00	86.74	11.20
70.00	11.00	86.03	11.07
70.00	13.00	85.32	10.92

TABLE 1.3.6
GOES ANTENNA AZIMUTH/ELEVATION ANGLES

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
70.00	15.00	84.62	10.74
70.00	17.00	83.93	10.53
70.00	19.00	83.24	10.30
70.00	21.00	82.57	10.05
70.00	23.00	81.91	9.77
70.00	25.00	81.26	9.47
70.00	27.00	80.62	9.15
70.00	29.00	79.99	8.80
70.00	31.00	79.38	8.43
70.00	33.00	78.79	8.05
70.00	35.00	78.21	7.64
70.00	37.00	77.64	7.21
70.00	39.00	77.10	6.77
70.00	41.00	76.57	6.30
70.00	43.00	76.06	5.82
70.00	45.00	75.57	5.32
70.00	47.00	75.09	4.81
70.00	49.00	74.64	4.28
70.00	51.00	74.21	3.74
70.00	53.00	73.79	3.18
70.00	55.00	73.40	2.61
70.00	57.00	73.03	2.03
70.00	59.00	72.67	1.44
70.00	61.00	72.34	.84
70.00	63.00	72.03	.22
70.00	65.00	71.74	-.40
80.00	1.00	89.82	1.29
80.00	3.00	89.47	1.28
80.00	5.00	89.12	1.26
80.00	7.00	88.77	1.22
80.00	9.00	88.42	1.17
80.00	11.00	88.07	1.11
80.00	13.00	87.73	1.03
80.00	15.00	87.39	.95
80.00	17.00	87.05	.85
80.00	19.00	86.71	.74
80.00	21.00	86.38	.62
80.00	23.00	86.06	.49
80.00	25.00	85.74	.35
80.00	27.00	85.42	.19
80.00	29.00	85.11	.03
80.00	31.00	84.81	-.15
81.00	1.00	89.84	.29
81.00	3.00	89.53	.28
81.00	5.00	89.21	.26
81.00	7.00	88.89	.22
81.00	9.00	88.58	.18
81.00	11.00	88.27	.12

θ	LATITUDE	AZIMUTH ANGLE	ELEVATION ANGLE
81.00	13.00	87.96	.06
81.00	15.00	87.65	-.02

7. APPENDIX

7.1 GENERAL GLOSSARY OF TECHNICAL TERMS

ADDRESS = Register

A/D = Analog to digital converter

ADR = Analog to digital register

ASCII = American Standard Code for Information Interchange

BIT = Elementary binary information unit

BINARY = Numerical system or mode to the base 2

CDCP = Convertible Data Collection Platform

DATA = Data used for coding and decoding of the platforms

DATA DISPLAY = Panel for data recording in the CDCP test set

DECIMAL = Numerical system or mode to the base 10

ERTS = Earth Resources Technology Satellite

GMT = Greenwich Mean Time

GAP = Register separator

GOES = Geostationary Operational Environment Satellite

HEXADECIMAL = Numerical system or mode to the base 16

INPUT = Data input

INPUT/OUTPUT BUS = Collective inputs and outputs

LANDSAT = Same satellite as ERTS

OUTPUT = Data output

TEST SET = Testing equipment which is a vital unit of a platform

WORD = Group of bits (in our case a group of 4 bits)

XMT = Transmission

7.2 BIBLIOGRAPHY

PRELIMINARY INSTRUCTION MANUAL FOR THE CONVERTIBLE DATA COLLECTION PLATFORM (CDCP) AND RELATED EQUIPMENT

Manufacturer: LABARGE, INC.
ELECTRONICS DIVISION
TULSA, OKLAHOMA
U.S.A.

ERTS BOLIVIA PROGRAM /SHEET 1

CDCP OPERATIONAL DATA NOTEBOOK

STATION INFORMATION

O.A Name _____

O.B Institution _____

O.C Station Number _____

O.D S/N _____

O.E Address _____

O.F Location: Latitude _____South
Longitude _____West

O.G Operator

Name _____

Address _____

Telephone _____

NOTE: Origin for operator
Copy for verification

CONSTANTS FOR DATA COLLECTION (ERTS AND/OR GOES)	REGISTER (ADDRESS)	INPUT VALUE /SHEET 2
1.A DATA UPDATING INTERVAL		
LEAST SIGNIFICANT NUMBER	14	
MOST SIGNIFICANT NUMBER	15	
1.B UPDATING CONTROL TIME (0 = 15 minutes; 1 = 6 minutes)	16	

CONSTANTS FOR DATA COLLECTION REGISTER INPUT VALUE /SHEET 3

(ERTS AND/OR GOES) (ADDRESS)

1.C NUMBER OF DIGITAL SENSORS (ADR)

(Maximum 4) (4 words x 4 bits)= 1 ADR) OD

PARAMETERS

1_____2_____

3_____4_____

1.D NUMBER OF ANALOG SENSORS (A/D)

PARAMETERS

(Maximum 8) (2 words x 4 bits = 1 A/D) OE

1_____2_____

3_____4_____

5_____6_____

7_____8_____

CONSTANTS FOR DATA COLLECTION REGISTER INPUT VALUE /SHEET 4

(ERTS AND/OR GOES) (ADDRESS)

1.E MEMORY CAPACITY TO BE USED

(Number of 4-bit words)

least significant number 18

most significant number 19

MAXIMUM UTILIZABLE

GOES: 13 groups of 16 words = 832 bits

ERTS: (For 90 seconds) 6 groups of

16 words = 384 bits

(For 180 seconds) 4 groups of 16 words = 256 bits

CONSTANTS FOR DATA COLLECTION (ERTS AND/OR GOES)	REGISTER (ADDRESS)	INPUT VALUE	/SHEET 5
1.F DATA INPUT			
0 = series; 1 = parallel	0A		
1.G DATA COLLECTION INTERVAL			
Hours_____			
1.H INITIAL TIME			
Time_____			
1.I TRANSMISSION TIME OF FIRST DATA GROUP			
Time_____			

CONSTANTS EXCLUSIVELY FOR GOES DCS	REGISTER	INPUT VALUE	/SHEET 6
2.A ERTS/GOES SELECTION			
0 = ERTS, 1 = GOES	09	1	
2.B CODING CONTROL			
0 = GOES; 1 = ERTS	0F	0	
2.C WORD PARITY OF DATA IN ASCII mode			
0 = even; 1 = odd (only in GOES)	0C	1	
2.D SERIES INPUT DATA FORMAT			
0 = binary; 1 = ASCII (only in GOES)	0B		

CONSTANTS EXCLUSIVELY FOR GOES DCS	REGISTER (ADDRESS)	INPUT VALUE	/SHEET 7
2.E TRANSMISSION INTERVAL			
Number of 15-minute periods			
least significant number	12		
most significant number	13		
2.F INITIAL TRANSMISSION TIME			
Number of 15-minute periods			
(maximum 63 hours 45 minutes = 255 periods)			
least significant number	10		
most significant number	11		

CONSTANTS EXCLUSIVELY FOR GOES DCS	REGISTER (ADDRESS)	INPUT VALUE	/SHEET 8
2.G PLATFORM IDENTIFICATION CODE			
(8 hexadecimal characters)			
most significant number	01		
	02		
	03		
	04		
	05		
	06		
	07		
least significant number	08		

CONSTANTS EXCLUSIVELY FOR GOES DCS WORKING HOURS /SHEET 9

2.H TIME ASSIGNED FOR INITIAL TRANSMISSION

GMT _____

Local _____

2.I INTERVAL ASSIGNED TO TRANSMISSIONS

Hours _____

2.J CHANNEL ASSIGNED TO STATION

Number _____

2.K ANTENNA

Elevation _____ Azimuth _____

CONSTANTS EXCLUSIVELY FOR ERTS DCS

	REGISTER (ADDRESS)	INPUT VALUE
3.A ERTS/GOES SELECTION		
0 = ERTS, 1 = GOES	09	0
3.B CODING CONTROL		
0 = GOES; 1 = ERTS	0F	1

/SHEET 10

CONSTANTS EXCLUSIVELY FOR ERTS DCS	REGISTER (ADDRESS)	INPUT VALUE	/SHEET 11
3.C TRANSMISSION INTERVAL			
0 = 180 seconds; 1 = 90 seconds	17		
3.D PLATFORM IDENTIFICATION CODE			
(3 hexadecimal characters)			
most significant number	01		
	02		
least significant number	03		