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AUTORIZADA POR/AUTHORIZED BY

Clóvis Solano Pereira
Space Tec. Eng. Dir.

AUTOR RESPONSAVEL / RESPONSIBLE AUTHOR

Luiz C. Pacola Sobrinho

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TÍTULO/TITLE

GROUND STATION DATA COLLECTING SUBSYSTEM

AUTORES/AUTHORSHIP

Luiz Carlos Pacola Sobrinho
Auro Tikami

RESUMO - NOTAS / ABSTRACT - NOTES

The main characteristics of the Ground Station Data Collecting Subsysytem of the first satellite of the Brazilian Complete Space Mission (MECB), a short description of the system conception and specification are presented. A brief description of each equipment of the subsystem as well as some practical results are also presented.

OBSERVAÇÕES / REMARKS

RESUMO

As principais características do Processador de Coleta de Dados do 1º satélite da Missão Espacial Completa Brasileira (MECB), uma descrição sucinta da concepção e especificação a nível de sistemas são apresentadas. Cada equipamento do sub-sistema é brevemente descrito, apresentando-se alguns resultados práticos obtidos.

CONTENTS

1 - GROUND STATION DATA COLLECTING SUBSYSTEM (DCS)

The first satellite Data Collecting System of the Brazilian Complete Space Mission (MECB) receives, in a Ground Station, signals from the Data Collecting Platforms (DCPs) spread over the Brazilian territory. The DCP signals are transmited in a UHF band to a satellite (altitude of about 700 km) which relays them to the ground in a PM carrier in the S-Band. There will be no on-board demodulation or processing of any individual DCP signal. This function will be performed in the Ground Station at Cuiabá.

The acquisition probability of a data packet after two consecutive emissions of the same data by any given DCP during a satellite pass with mutual visibility of Cuiabá, receiving station, shall exceed 85%.

The system shall be capable of operation with up to 500 DCPs uniformly spread over the Brazilian territory.

The Ground Station Data Collecting functions are to receive the Data Collecting Platform (DCP) transmissions, to search and process the DCP signals and to send the recovered data to the Mission Center which is responsible for delivering the data to the users. The DCS is also able to perform frequency measurement which allows the DCP location.

The DCS is composed of:

- RF Receiver Equipment (RRE);
- Data Collecting Processor Equipment (DCPE);
- Serial Communication Equipment (SCE);
- DCPE check-out Equipment (CE);
- Monitoring and Control Unit (MCU).

Figure 1 shows the subsystem block diagram.

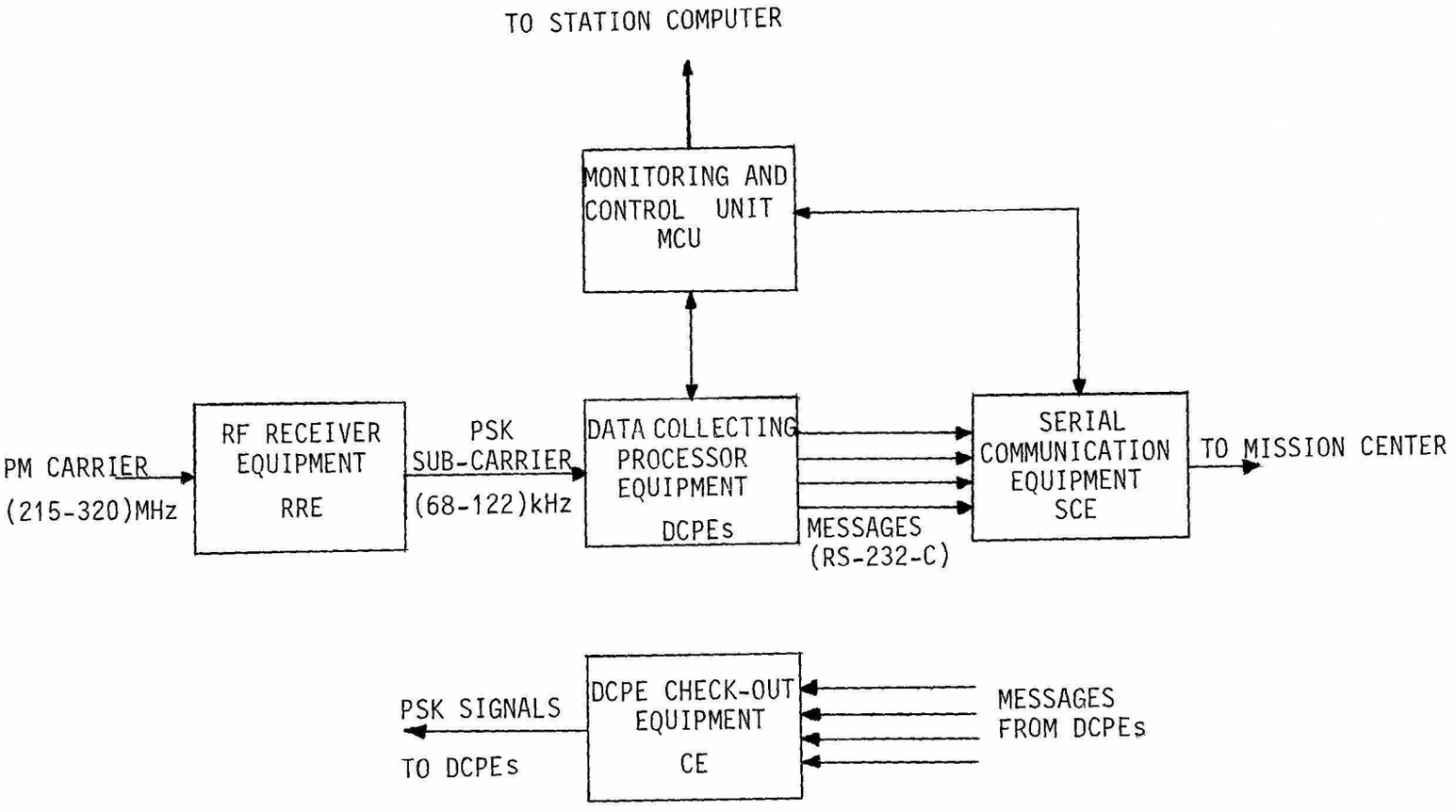

Fig. 1 - Ground Station Data Collecting Subsystem block diagram.

1.1 - THE RF RECEIVER EQUIPMENT (RRE)

The PM signal in the S-Band from satellite, received in the Ground Station, is down converted to the UHF band. The PM demodulation is performed by the RF Receiver Equipment which has the following main characteristics.

- Input frequency range: (215-320) MHz;
- Input impedance: 50 Ω;
- Maximum Noise Figure: < 12 dB;
- Input Dynamic Range: 110 dB;
- AGC Dynamic Range: 110 dB;
- PM demodulation;
  - . Maximum deviation: ± 135 ;
  - . Output video level stability: ± 3 dB;
  - . Video bandwidth: ≧ 150 kHz.

Nowadays the RRE is purchased from Scientific Atlanta. It is obvious that the subsystem can work with a few changes in the Front-End in a UHF Ground Station.

1.2 - DATA COLLECTING PROCESSOR EQUIPMENT (DCPE)

General Description

The DCP transmissions are random both in time and frequency, so the DCP must:

- search for incoming signals at DCP signal band;
- control the processing channel assignments;
- process the signal for data recovery;
- measure signal and equipment parameters;
- store the reception occurence time;
- format a message with data information, time and parameters;
- send the formatted message to the Mission Center.

The Data Collecting Processor Equipment is composed of two units: the Control and Search Unit (CSU) and the Signal Processing Unit (SPU). The block diagram of DCPE is presented in Figure 2.

There are two DCPEs, one receives the INPE DCP transmissions and the other receives the ARGOS DCP transmissions. The characteristics of the INPE DCP transmissions are identical to those from ARGOS DCPs.

Specifications

. Input:

- Band: INPE DCPE 68 - 92 kHz;
  ARGOS DCPE 98 - 122 kHz;
- Modulation: PSK/Biphase-L (±60Ω);
- Signal-to-noise density ratio: S/N ≧ 40.0 dBHz;
- Bit error rate: BER $< 10^{-4}$;
- Message: ARGOS standard (see Table 1).

. Output

- RS 232-C Interface
- Message: PROCOD standard.

. Characteristics:

- Number of data processing channels: 2;
- Capability of operation with up to 1000 DCPs uniformly spread over the Brazilian territory (500 DCPs per channel);
- Detection probability: Pd ≧95%;

- Success probability*: > 90%;
- False alarm rate: 1 fa/s;
- Acquisition Probability (in less than 60 ms): ≧ 99%;
- Frequency measurement capability: precision of about $\pm$ 0.5 Hz.

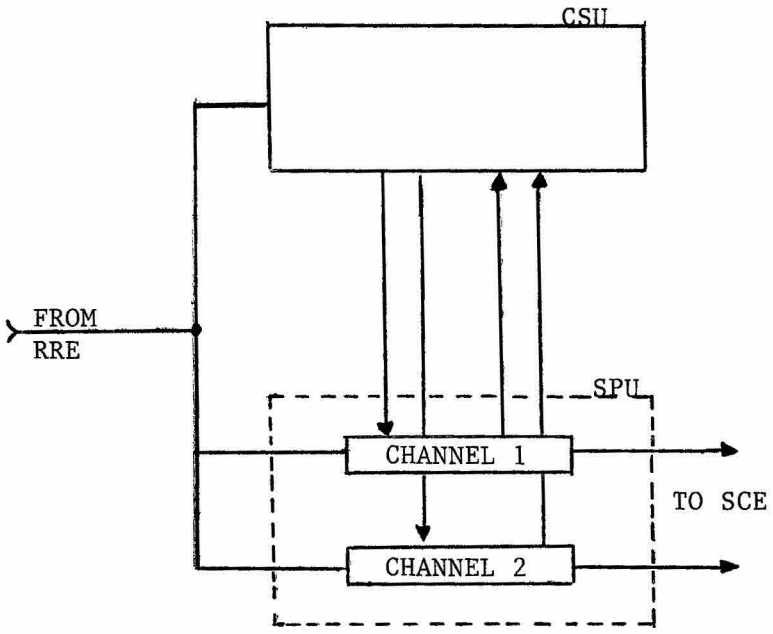

Fig. 2 -Data Collecting Processor Equipment block Diagram.

. Operation Mode

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* Probability of a DCP signal with S/No ≧ 40 dBHz be detected and correctly processed by the DCPE.

The Control and Search Unit acts as a spectrum analyzer. It searchs for a DCP transmission in a band of 24 kHz (68-92 kHz or 98-122 kHz). When a DCP signal is detected, a SPU data processing channel is allocated by the CSU which sends an auxiliary signal (related to the signal location in the 24 kHz band) to one of the PSK demodulators of the SPU to perform a quick signal acquisition.

Using the auxiliary signal from the CSU, the PSK demodulator performs the signal demodulation, the data is recovered and sent to the Mission Center. If the processing channel is not able to achieve these functions, the CSU controller releases the channel for another DCP transmission. Each DCPE can process up to 2 simultaneous messages.

A DCP transmission is composed of 160 msec of unmodulated carrier followed by 360 to 920 ms 60° PSK modulated carrier.

The search and signal detection and the carrier acquisition have to be performed in less than 160 msec (unmodulated carrier period).

Table 1 shows the characteristics of a DCP transmission.

TABLE 1

CHARACTERISTICS OF A DCP TRANSMISSION.

UNMODULATED CARRIER	MODULATED CARRIER					
	a	b	c	d	e	f

- unmodulated carrier duration	160 ± 2.5 ms
- modulation	PSK
index	60º ± 6º
- data rate	400±5 bps
codification	biphase-L
- message structure	
a - bit synchronism	15 bits "1"
b - frame synchronism	8 bits:00010111
c - initialization	1 bit "1"
d - identification	24 bits
e - number of sensors ($1 \leqq n \leqq 8$)	4 bits
f - sensor data	32 n bits
- message length n = 1	360 ± 5 ms
n = 8	920 ± 12 ms
- carrier frequency INPE	401.62 MHz±1.2kHz
ARGOS	401.65 MHz±1.2kHz
- frequency stability	
short term (during a message)	$\pm 1 \times 10^{-9}$
medium term (during a message)	$\pm 2 \times 10^{-7}$
long term (between 2 consecutive passes)	$\pm 1 \times 10^{-6}$
ageing	2 kHz/year
- transmitter power	33 dBm± 0.5 dB

1.3 - SERIAL COMMUNICATION EQUIPMENT (SCE)

The SCE receives up to 4 simultaneous messages from the DCPEs (ARGOS/INPE). The messages are serialized, stored in 2 floppy disk units and sent to MC according to a predefined schedule.

The SCE is composed of 2 units: Serial Communication Unit (SCU) and Storage Unit (SU). The first is responsible for the reception and serialization of DCPE messages and the second stores the received messages. The messages are sent using RS 232C standard.

1.4 - MONITORING AND CONTROL UNIT (MCU)

The MCU performs the monitoring of the Data Collecting Processor Equipment and the Serial Communication Equipment, which allows a quick check-out of these equipment. The MCU is also responsible for the remote control of the DCPE and of the SCE.

1.5 - DCPE CHECK-OUT EQUIPMENT (CE)

The CE simulates up to 4 simultaneous DCP signals to test and qualify the Data Collecting Processsor Equipment. After the processing of the signals by the DCPE, the recovered data are sent to the CE wich compares the received and the transmitted data. This procedure permits to check and qualify the DCPE performance.

The main DCP signal parameters simulated by the CE are:

- signal-to-noise density ratio: 40 dBHz to 55 dBHz in steps of 1 dB;
- Doppler rate: 25, 50, 100, 150 and 200 Hz/s (up or down);
- Number of simultaneous signals: up to 4;
- Time of occurence;
- message contents;
- message duration.

2 - CONCLUSION

All the equipment, except the RF Receiver, was developed at INPE. The results show a good design philosophy and exceed the design specifications. Let's take, for instance, the acquisition probability of a data packet after two consecutive emissions of the same data by any given DCP which is greater than or equal to 99%. The Data Collecting Subsystem (DCS) can operate with up to 1000 platforms of each type (INPE or ARGOS) uniformly distributed over the Brazilian territory.

The frequency measurement capacity is not a design specification and was added in order to make possible preliminary DCP location experiments. The frequency measurement specifications must be revised according to location experiment specifications.

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