SYSTEM FOR IONOGRAMS DIGITAL REGISTER.
1. Ionograms acquisition.

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I. ABSTRACT.

It was developed for an Analogical Ionospheric Sounder **AIS** (of the Russian language, **A**vtomaticheskaya **I**onosfernaya **S**tantsia) a "System for the Digital Registration of ionograms ", running as a background task in an IBM compatible PC with Windows OS. The system comprises:

1. "ION1", an interface card designed for the ISA bus of a PC;
2. "IONOSFER", an install and stay resident program that controls the interface card and saves the sounding information as a data file;
3. "IONES", an operation program with a sounding schedule that send commands to the interface card to turn on and off the station and acquire the data at the time programmed; besides, it allows to load the data files and display them as ionograms; and
4. A linking module, an electronic card designed to isolate and convert the signal levels between the AIS and the interface card "ION1" installed in the PC.

The system is working from August 2003.

II. INTRODUCTION

The Analogical Ionospheric Sounder, (**AIS**) it was made in the former USSR with a vacuum valve technology and registers the Ionograms in a photographic film which, is viewed via a slide projector to manually extract the information. In the **Fig.1** the ionosonde AIS is shown.

With the advent and development of digital signal processing and computers there has been designed new sounding digital stations, named Digisondes, based on IBM compatible PC. They store the ionograms as a file data in the hard disk of the PC, process them with automatic or semi automatic systems and visualize them in the monitor.

Fig.1 Ionosonde AIS

In some countries like Japan and New Zealand have been worked for modernization of ionograms record; for example, in Japan NOZAKI Kenrou et al., 1992 and e IGI Seiji et al., 1992, they developed these works for solid state and digital sweeping ionosondes that compose Japanese ionosphere monitoring network. In a same way in New Zealand were carried out similar works for an ionosonda IPS-IPS-42 Titheridge J.E., 1995

For the AIS, Borisov B. B. et al., 1989, propose an upgrading and recently, at the IZMIRAN, Moscow, it has been developed a more advance alternative.

In the case of the Habana Station, we intended to change the support of ionogram registration and to reach the following objectives:

- To Change the analogical ionogram registering system (costly 35 mm photographic film) and store the sounding data base in digital support (working data base in the hard disk of the PC, archive data base in CD or DVD);
- Increase the precision of the virtual height h´ and sweeping frequency calculation; and
- Improve the processing of the ionograms through a semi automatic but highly interactive system.

III. FUNDAMENTAL CHARACTERISTICS OF THE "AIS".

- Lineal frequency sweeping: two sub-bands, 1-10 and 1-18 MHz, with marks spaced 1 MHz apart;
- Duration of the sounding pulses: adjustable from 50 to 70 **µseg**, for Cuba it has been regulated to 60 seg;
- Period of repetition of the transmission and synchronism pulses: **T** = 16,66 mseg;
- The measured error of the sounding frequency **f** =± 0,1 MHz and virtual height **h'** =± 5 km;
- Marks of height each 50 km, in three ranges: 0-250, 0-750 and 0-1500; and
- Minimum power in the transmitted impulse in the high frequencies is not smaller than 2.5 **KW.**

IV. SYSTEM FOR THE DIGITAL REGISTRATION OF IONOGRAMS ("SYSTEM").

1. Interface Card "ION1":

- It performs the sampling and analogue to digital conversion of the video signal coming from the station.
- It writes each byte of data from the analogue to digital converter into the memory of the PC, by means of Direct Memory Access (DMA);
- It detects the termination of a sounding from the station;
- It detects the end of each block of 64 Kbytes of data transferred via DMA; and it generates the signals to turn on and off the station.

The Fig.2 shows the AIS with the linking module, the location of the card ION1 in the PC and the different signals that they are used.

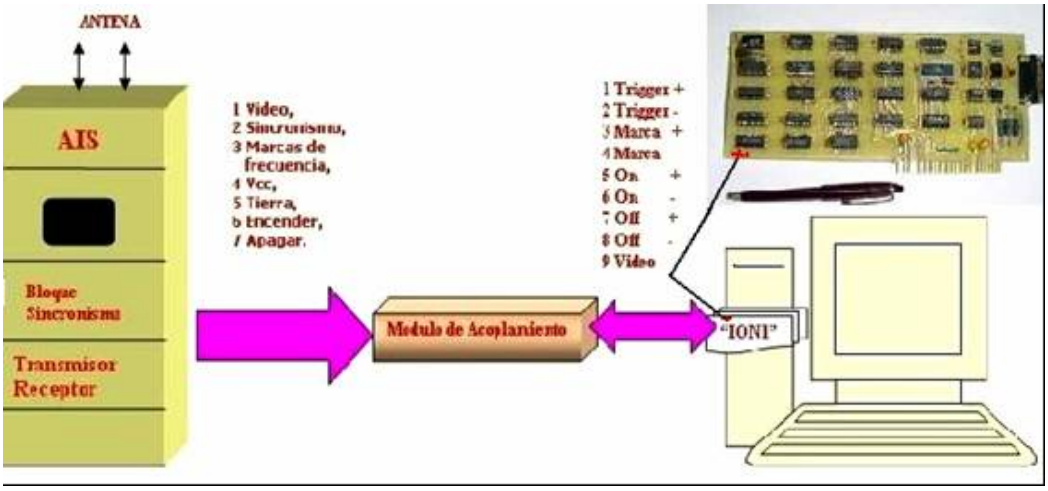


Fig.2

2. Software "IONOSFER" (Install and Stay Resident Program):

- It identifies the presence of the card in the computer;
- It installs the interruption IRQ5;
- It programs the selected DMA channel;
- It reserves the memory zone where the data will be written by the DMA service; and
- It saves automatically the data, as a file CAPAxxxx.dat, once concluded the sounding.

In the fig 3 the window IONOSFER is shown

Fig. 3 The window of IONOSFER allows to control the reception of the ionogram and to detect possible errors during the process.

3. Software "IONES":

- It controls the interface card;
- It builds up the schedule that turns on and out the station and sets the interval of registration between each ionogram; and
- It allows the visualization of the ionogram data files.

The Fig 4a, show us an ionogram in the window IONES and two menus: The first one Fig4b , Schedule that is where the sounding interval is programmed between each ionogram and second Fig 4c, Leer Datos (to "Read Data") that shows the localization of the ionograms to be loaded in the window IONES.

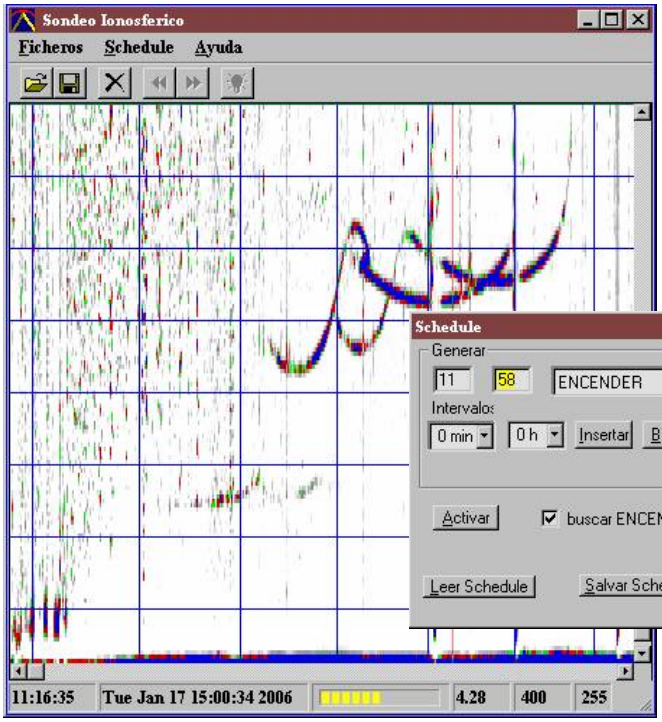


Fig 4a

Fig 4b

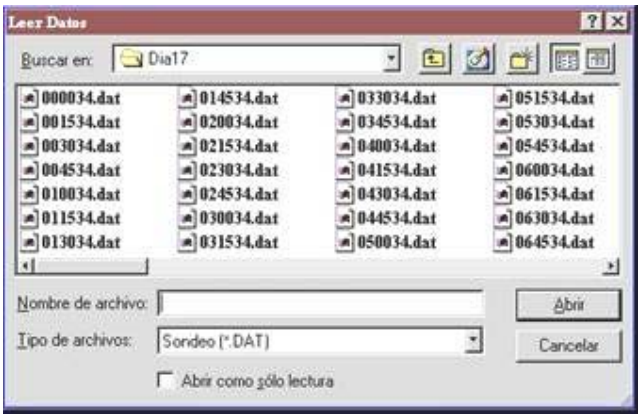


Fig4c

4. Linking Module:

- It filter, level convert and isolate the signals between the interface card "ION 1" (TTL levels) and the "AIS" (high voltage and very noisy levels)

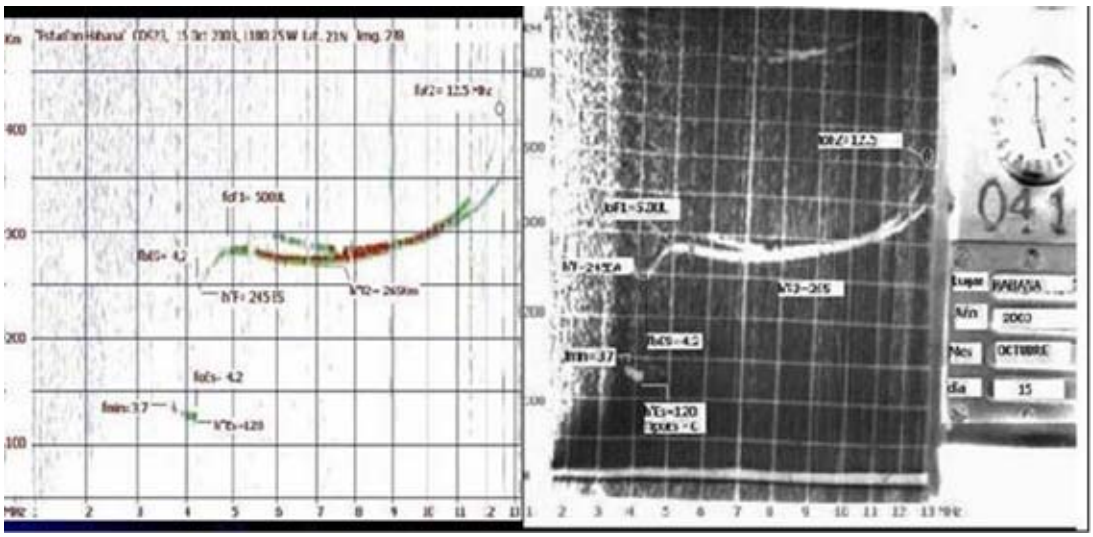
The fig5 show the Linking Module between the AIS and the PC with their input and output signals.

V. TREATMENT OF THE ANALOGUE VIDEO SIGNAL

Each τ = 60µseg a pulse, carrying the analogue video signal, with intervals, **T**=16.6mseg is received at the interface card where it's sampled with a resolution equivalent to 3 **km** eight. In total, there are taken 256 samples for each sounding pulse which correspond to an ionosphere height between 0 - 765 **km**.

VI. COMPARISON BETWEEN DIGITAL IONOGRAM IN PC AND ANALOGICAL IN FILM.

In the **fig.6**, they are shown for the 15/10/04 to the 1100 local time, ionograms registered in the same instant of time in two different registration supports. To the left an ionogram registered in the PC, and to the right registered in the 35mm film from CTR. of AIS.



The Fig 6

VI. - REACHED RESULTS:

- It is not longer necessary the purchase of 35 mm photographic film, at the cost of 3 000 US dollars a year (the total cost of the "SYSTEM", including the PC, doesn't overcome the sum of 2 000 US dollars);
- It decreases the space needed to store the ionograms (a month of film registration occupies the space of a roll of 300 m, while in digital form, without compacting, it takes less than a 750 Mbytes CD per month, with a cost of less than 1 US dollar);

- A better long term conservation (the preservation of celluloid film requires strict acclimatization and is a highly flammable material, while the CD is a media more economic and robust);
- There are plenty of facilities for the semi automatic and automatic extraction of the ionosphere parameters through a processing software;
- The error while calculating the virtual height h´ was reduced about 60% (3 to 5 km);
- The error while calculating the sweeping frequency f was reduced about 50% (0,05 to 0,1 MHz);
- It permits to estimate the pairs (h´, f) for the calculation of the N(h) profiles (the electronic concentration profiles with reference to the real height of the ionosphere) which are used in several researching projects at the Institute of Geophysical and Astronomy (IGA) and serve as useful data to enhance the International Reference Ionosphere (IRI);
- It makes possible to put on line in INTERNET the ionograms, with the primary processing, and the N(h) profiles calculated at the noteworthy hours of the day;
- It guarantees the continuity of the data base of ionosphere parameters, with about 40 years of existence; and
- It allows the real time transmission of the operative ionosphere parameters to the Defence as required.

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This work was presented in poster modality in the 1st Symposium of Astronomy and Space Geophysics, Third Cuban Congress of Geophysics GEOFÍSICA 2005, 1st CUBAN CONVENTION OF SCIENCES OF THE EARTH. April 5-8, 2005, International Convention Center, Havana, Cuba. http://www.scg.cu/geociencias.htm.