PRODUCT INFORMATION

CANADIAN ADVANCED DIGITAL IONOSONDE (CADI)

NOVEMBER 2003

The Canadian Advanced Digital Ionosonde (CADI) is a low cost, state of the art, flexible, full-featured ionosonde ideal for both routine ionospheric monitoring and research.

Extensive Features :

- Height Range Up to 1020 km

  Resolution of 6 km.

- High Flexibility

  Multiple operating modes available.

- Frequency Range From 1 to 20 MHz Digitally Synthesized

  User definable frequency steps allowing for almost unlimited number of frequencies and types of frequency sweeps.

- Noise Suppression

  Pulse shaping to avoid spurious emissions.

  Coherent pulse averaging and FFT techniques used to improve signal to noise ratio.

- Oblique Sounding Option
- Operational Check

  Internal calibration signal available for an operational "quick check".

- PC Based System

  PC controlled system provides highly versatile setup with storage and analysis capabilities.

- Field Programmable Firmware

Applications :

- Atmospheric Research

  The combination of portability, low cost, and ease of installation make CADI ideal for both permanent installations and campaign-type research programs of shorter duration.

- Polar Cap Studies

  Studies including Morphology and behaviour of patches and arcs.

- Auroral Zone Studies

  Measurement in stand-alone and in conjunction with optical and VHF/HF radar measurements.

- Equatorial and High Latitude Electrojet Studies.

Ionospheric Monitoring :

- CADI provides the full complement of basic information on state of the ionosphere required for routine monitoring:
  - Scaling of standard URSI parameters
  - Data storage format suitable for World Data Centre archives.

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The Canadian Advanced Digital Ionosonde (CADI) is a low cost, state of the art, flexible, full featured ionosonde ideal for both routine ionospheric monitoring and research.

CADI provides sounding capability using high power radio frequency pulses at vertical incidence. The system integrates phase coding techniques, solid state electronics and PC technology to make CADI a significantly smaller and less expensive ionosonde. The system may be operated with single or multiple receivers. Observables include: echo delay (height) versus frequency; the phase and amplitude of the echo; angle of arrival; and polarization of the echo. Drifts can also be measured using the spaced-antenna method. This information is used in radio propagation forecasts of the most effective operating frequency for point to point radio communication. The data is also used in scientific research relating to the ionosphere.

Features:

- Height range up to 1024 km with 1 km resolution, variation resolution <1 km.
- The digital control system provides high flexibility. Multiple operating modes are available.
    - Frequency range from 1 to 20 MHz. The number of frequency steps is controlled by a table read in from a text file for each mode of operation. This provides for an almost unlimited user choice of numbers of frequencies and types of frequencies sweep.
    - System is PC-based with the major units of the ionosonde mounted on plug-in boards. A basic one-receiver system uses two plug-in boards. Add one board for each additional receiver.
- Pulse shaping to avoid spurious emissions.
- Internal calibration signal for an operational "quick check".
- Oblique sounding option.

Transmitter - The transmitter power required is only 600 W. Amplifier units are all solid state and include monitors for forward and reverse power. The use of pulse coding techniques gives an 11 dB signal to noise (S/N) ratio improvement, equivalent to having approximately thirteen times the transmitter power.

Receiver - The system is modular in design. Additional receivers may be added simply by including an additional receiver card in the PC.
The receiver outputs are sampled simultaneously using two microprocessors per channel. The increased data rate over a time-shared antenna system allows further improvements to the S/N ratio using post-detection processing.

Frequency Synthesizer - Frequency generation is provided by a frequency synthesizer based on direct digital synthesis (DDS). The synthesizer produces two output frequencies that may be changed almost instantaneously in frequency or phase. The DDS synthesizer provides the transmitter frequency and the receiver local oscillator frequency.

Noise Suppression - Coherent pulse averaging can be used to improve the signal to noise (S/N) ratio when the ionosphere is not moving too quickly. At midlatitudes light pulse coherent averages can be used and will give a 9 dB improvement in the S/N. Where fast ionospheric variations prohibit coherent pulse averaging, comparable improvements of S/N can be obtained by using FFT techniques.
Post-detection processing with Fast Fourier Transforms (FFTs) has been incorporated. The use of FFTs on a modern PC offers tremendous benefits without a large delay (a few seconds per ionogram) or expensive special processors.

Operation - Routine operation is controlled by text files that can easily be edited to change the mode types and the time when each mode runs. The system is very flexible and allows users to construct operating sequences that are tailored to their own requirements. A complete ionogram requires from a few seconds (at low frequency resolution and averaging two pulses) to several minutes (at high resolution averaging 16 pulses). A

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medium resolution ionogram with four pulse averaging requires about 45 seconds. Data is stored to the computer's hard disk. The data is periodically backed up to tape cartridges or DVD. Remote control and communication is possible using standard PC communication packages or Ethernet with the Linux system.

SPECIFICATIONS

Pulse Power:	600 W (25 W average)
Frequency Range:	1 to 20 MHz
Frequency Sweeps:	Variable, controlled by frequency tables. Can have one to several hundred frequencies and linear, logarithmic or any user defined frequency spacings.
Frequency Generation:	DDS-based synthesizer: 50 mHz reference frequency
Height Range:	90 to 1024 km
Height Resolution:	1 km (40 usec pulse length)
Pulse Coding:	13 bit Barker, 7 bit Barker single pulse, complementary
Storage:	CD
Power Requirements:	PC plug-in boards run off standard bus power Power amplifier units require 110/220V, 50/60Hz, 100VA
Dimensions:	Power amplifier cabinet 3.5" x 17" x 15" (89 x 432 x 381 mm)
Computer:	IBM compatible PC with at least two free 8 bit slots (5 slots for a four-receiver system) Ethernet connection

FEATURES

1. Conventional Ionogram in the 1 – 20 mHz range
2. Oblique Ionograms (pulsed mode)
3. Phase Measurement
4. Doppler Shift Measurement
5. Angle and Direction of Arrival
6. Drift Velocity Measurement
7. Remote Access via Ethernet Connection
8. HF Surveillance and Background Noise Monitoring
9. Manual and Autoscaling Ionograms
10. Auto Scheduling (User Programmable)
11. Real Time Display of Ionograms

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