

Proposed program of experimental propagation studies in the frequency range 504-509 kHz

Purpose

To conduct experiments with transmission and reception in the frequency range of approximately 504 – 509 kHz over land paths to northern, eastern, central and western Canada, to provide supporting data for technical studies for World Radiocommunication Conference (WRC) 2012, Agenda Item 1.23.

The objective is to better understand:

- i) The characteristics of propagation in the MF portion of the spectrum over land and its potential for emergency use by Canadian radio amateurs;
- ii) How to develop communication systems for high reliability amateur radio ground wave communications in the vicinity of 500 kHz;
- iii) The design and optimization of electrically small MF transmitting and receiving aerials and associated measuring apparatus;
- iv) The range in kilometres over which such a system can be expected to operate.

Background

For almost a century, radio amateurs have been required to constrain their transmissions below 200 metres. Following extensive Low Frequency (LF) experimentation at 135 kHz in many countries including Canada, a world-wide LF band at 135.7 – 137.8 kHz was approved at WRC-07, with consideration for a band in the vicinity of 500 kHz being placed on the agenda for WRC-2012. A report outlining the LF experimental results was prepared jointly by several prominent individual Canadian amateurs and the Marconi Radio Club of Newfoundland. This was submitted to Industry Canada at a recent CARAB meeting in support of a Canadian Secondary allocation at 135.7 to 137.8 kHz. We now wish to gather experimental information for a similar report for an allocation to the amateur service at 500 kHz.

While the band 135.7 – 137.8 kHz was an excellent platform for development of advanced radio techniques, it demanded a high degree of technical competence and specialized apparatus that was beyond the resources of many of today's radio amateurs. These demands are somewhat less at 500 kHz, and coupled with the propensity for 500 kHz emergency communications makes it a better band for this purpose as more amateurs will be able to receive the experimental transmissions and contribute to the experiments by reporting on their quality. There remains much to be discovered about transmission, propagation over land and apparatus design on this band in support of emergency communications by radio amateurs.

This experiment will augment the findings of the previous investigators and provide an opportunity to promote to the technical aspects of amateur radio and interest in medium frequency experimentation. It is anticipated that the experiment will yield information in support of a future Canadian allocation to the amateur service near 500 kHz, as well as

being used to support the technical studies being conducted by Working Party 5A of the ITU-R, in preparation for WRC-2012.

Technical and Operating Information

The transmitter, Figure 1, will be used to work CW (A1A) and FSK (F1B) within a band of frequencies between 504 and 509 kHz. Emissions outside the band will be suppressed by at least 30 dB. The bandwidth of the emissions will be 100 Hz or less. The transmitter power will be adjusted from 0 to 250 watts so that a maximum ERP of 20 watts is not exceeded.

The transmitting antenna will be an existing 100 metre wire at an average height of 10 metres, Figure 2. A proposed monopole with height up to 25 metres may also be used, with and without top-loading, Figure 3. A variety of tuning and grounding systems will be tried to optimise the efficiency of the aeriels. Calculated antenna gain and radiation patterns as required as part of the application for the Developmental Licence by Industry Canada's Form IC2365BB are not expected to differ significantly from the representative simulations by D. Conn, viz.: omnidirectional in the azimuth with a predominately high vertical angle of radiation and a low efficiency indicated by effective gains of -14 to -12 dBi. Because the ground conductivity at the proposed site is less than 1 mS/m and is less than average (<1 mS/m) these gains may be taken as upper limits. In any case, the transmitter power will be limited to constrain the ERP to less than 20 watts.

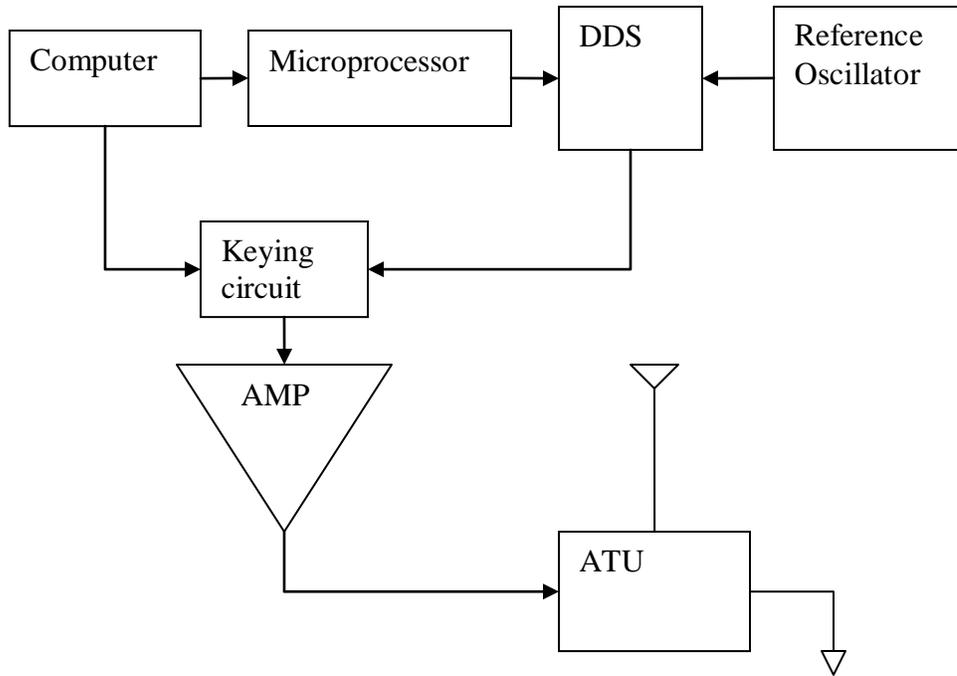


Figure 1. Experimental 504-509 kHz transmitter system block diagram.

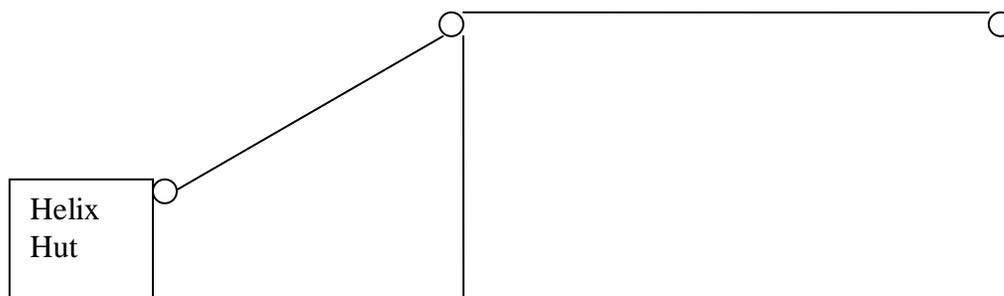


Figure 2. 100m wire aerial at 10 metres average height. The wire slopes up over a length of 30 metres. The horizontal portion is suspended from insulators from 10 metre masts

and is 70 metres long. The earth connection is made to 6 radials 10 metres long around the helix hut.

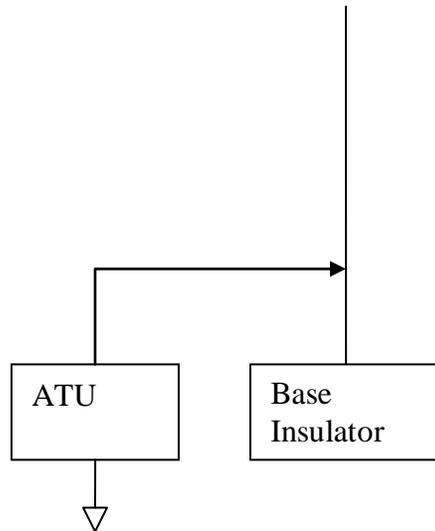


Figure 3. Proposed monopole aerial comprising a guyed steel tower up to 25 metres high resting on a ceramic base insulator. The earth connection will be via 12 equally spaced radials 30 metres long on the ground surface. The ATU is fed with 50 Ohm coaxial cable from the transmitter.

Conduct of Operations:

Morse code, conventional and slow speed (QRSS, DFCW/FSK) and digital emissions such as PSK and FSK using a variety of encoding schemes will be used to transmit beacon signals and communications with amateur and experimental stations authorized to transmit in 504 – 509 kHz. Two-way communications will be attempted with other licensed Experimental Developmental Stations in British Columbia, western, central, eastern and northern Canada over north - south and east - west propagation paths, and with stations in the United States and other countries that have been authorized to conduct similar experiments in this frequency range. Messages will be received on other bands from stations not so authorized for the purpose of exchanging signal reports and comparing propagation at 500 kHz, in particular when conditions on other bands are not favourable.

The transmit frequencies will be monitored when the transmitter is off the air. The transmitter will be operated with care so as not to interfere with Primary authorized users. Insofar as the authorization for the experimental transmissions will be on a Secondary user basis; any requests from the Department or Primary users to cease transmission or change frequency will be complied with immediately.

Transmissions will be identified at regular intervals by transmitting the assigned call sign in accordance with the requirements of RIC-15.

The operation will be publicized world-wide by Radio Amateurs of Canada bulletins and by the Marconi Radio Club of Newfoundland. Periodic updates will be posted to the MRCN (VO1MRC) web page. Reports of the experiments conducted will be provided through Radio Amateurs of Canada (RAC) providing information of two-way contacts including the signal strengths, station locations and propagation conditions experienced. Reports will also be solicited from Short Wave Listeners (SWLs) and and/or reception reports from amateurs co-ordinated on amateur frequencies.

Results

Details of the experimental transmitter, antenna and tuner along with reception reports will be will be submitted to the Editor of TCA, the RAC Journal, for publication. Copyright for the experimental results will be retained by the authors.

Developmental Licence

A Developmental Licence is requested for the period 1 October, 2009 to 31 March, 2010. It is anticipated that renewal of the licence on 1 April 2010 will be required to gather sufficient data for the purposes of the experiments.