



“Hands on – to **RADIO WAVES**”

## Introductory Demonstrations in Radio Technology

They are all around us. We can't see them, but we can generate them and detect them, we can determine their characteristics and we can measure them. Radio waves play a very great part in our daily lives, every member of the public uses this technology.

Radio provides the backbone technology for the information economy: radio and television broadcasting, cellphones, mobile communications, direction-finding, remote controls of many types, keyless car locks, remote door openers, wireless local area networks, satellite navigation, radio telescopes, environmental monitoring and so much more in our world. These all use the same “*electromagnetic waves*” so we should all have a working knowledge of them. Radio communication is so ubiquitous that it is almost taken for granted.

The widest public understanding of radio communication is important for our economy. There is a requirement for skilled radio communications engineers, technicians and scientists. Many of these innovations were developed by scientists and engineers who had their interest aroused by a hands-on demonstration, perhaps at school, perhaps at an exhibition, perhaps through a demonstration by a radio amateur.

Experiments with inexpensive home-made apparatus can open up our vision and reveal this unseen radio world to us. Outline suggestions and guidance for some radio experiments are presented here for the individual and for school-room class demonstrations. These unseen waves and many mysteries of radio can be revealed by your own “hands-on” investigations.

A special radio licence is not required for the demonstrations and experiments described here. The radio-frequency generator falls in the provisions of the “New Zealand Radiocommunications Regulations (General User Radio Licence for Short Range Devices)”. See: <http://www.rsm.govt.nz> and use the “search” facility. But it should be noted that voice and similar communications at the frequency used here are not permitted by this licence.

For voice communication at this and at many other frequencies and for many other privileges too, an amateur radio licence can be used. Becoming qualified as a radio amateur is highly recommended. It is an internationally-recognised qualification in radio with a certificate to hang on the wall. Each radio amateur has a listed unique and discrete personal radio callsign. Details about Amateur Radio and how to qualify can be found at: [www.nzart.org.nz](http://www.nzart.org.nz) The amateur radio qualification is a useful preliminary to a career in telecommunications. It is attainable by young and old, the youngest radio amateur in New Zealand was age 8.

### The NZART Radioscience Education Trust

This is a charitable trust, formed by the New Zealand Association of Radio Transmitters in 1998 to help and encourage young persons wishing to further their education in the science of radio whether by the payment of course fees for worthy candidates, the provision of prizes on a competitive basis for excellence in education activities, or as the trustees think fit. Young students could be Radioscience graduates in the years to come, the future generation of leaders in Science and Technology, a small start in this rapidly changing world. This is in keeping with the aims and objectives of NZART's Constitution. More details can be found at:

<http://www.nzart.org.nz/nzart/NZART/trustweb.html>

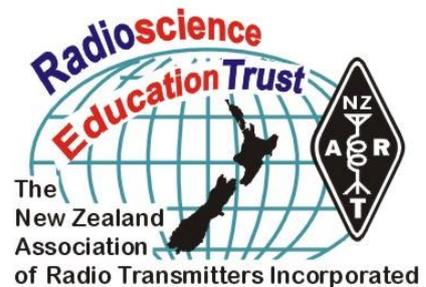
The Trust relies on volunteers from NZART Branches to provide judges to officiate at Science and Technology Fairs and for reports with photos of the prize winner's entry to be published in the Association's journal, “*Break-In*”. The main activity of the Trust has been the provision of prizes (currently worth \$100 each) at local Area Science & Technology Fairs. At a recent meeting the Trustees expressed their concern over the paucity of prize-worthy Science & Technology Fair projects. The Trustees have decided to offer limited sums of money to support student projects in the general areas of radio and electronics; these will be in addition to the existing Science & Technology Fair prizes. These grants would be targeted towards projects that could lead to exhibits in local area Science & Technology Fairs.

### An Electromagnetic Wave resource:

Details of the demonstrations and a series of booklets are in files that can be downloaded from:

<http://www.nzart.org.nz/nzart/waves/radiowaves.html>

*A summary of some of the demonstrations possible is on the next page ...*



The  
New Zealand  
Association  
of Radio Transmitters Incorporated

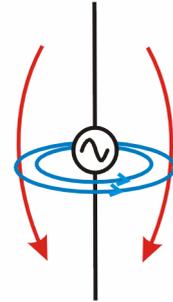
# “Hands on to *Radio Waves*”: Experiments and features to be explored

## General

The EM wave is not visible.  
The need for sensor/detector devices to “make the wave visible”.

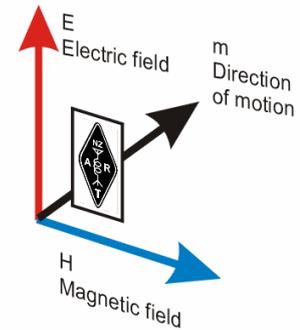
## Launching a wave

Consider the transmitter as a very high-speed switch.  
Electric and magnetic fields at the “near field”. Resonance.  
Polar radiation diagram of a dipole in the plane perpendicular to its axis.  
Polar radiation diagram of a dipole in the plane of its axis.



## The wave in space

Energy transfer from battery source to meter deflection.  
The wave in the “far field” – its vector model.  
Signal decrease with distance from a point source.  
Effects of various materials in the path.  
Polarisation.  
Reflection.  
The “boundary conditions”.  
Standing wave.  
Wavelength measurements and frequency calculations.  
Typical field-strengths and measurement in practice.



## Reception

Receiver principles – extraction of transmitted information.  
Positioning aerials in best signal path.  
Aerial polarisation.  
Power considerations, addition of reflectors and parasitic elements to increase useable distance.  
Aerial reciprocity.  
Typical aerial types: Yagi, square-corner, parabolic dishes, with FM and TV applications.



## Further considerations

Communication and information transfer from transmitter to receiver.  
Modulating and demodulating the signal.  
Practical transmitters and receivers.  
Noise, signals and screening.  
Feeder cables, aerial siting.  
Consideration of other test frequencies.  
The radio frequency spectrum.  
The “radio services”, sharing of spectrum, need for regulations and licensing.  
Applications of the wave: mobile communication, broadcasting, radar, satellites for communication and navigation, key-fob remote controls/locks.  
Amateur Radio for “self-training, intercommunication and technical investigation”.

## How do I get started?

The details of these demonstrations are in booklets that can be downloaded from the web.  
You can print your own copies and make your own demonstration apparatus from the instructions given at: <http://www.nzart.org.nz/nzart/waves/radiowaves.html>  
The apparatus is divided into three projects:  
building the *transmitter unit*, building the *receiver unit*, and building the “*hardware items*”.



**Further information:** *The New Zealand Association of Radio Transmitters Incorporated* is the New Zealand radio amateur’s society. **Enquiries are welcome.** Further assistance can be provided on radio topics. NZART has Branches in main centres with members able to assist with radio communications demonstrations of all kinds.

NZART provides radio training publications and training assistance for anyone who would like to proceed to the New Zealand Amateur Radio Examination, obtain an Amateur Operator Certificate of Competency and experience the **Wonderful World of Wireless**. Many of these items are free.

The Amateur Radio Examination syllabus and the full question-bank are in the public domain and can be downloaded from the NZART website. Examinations are computer-generated, 60 questions from the 600-question-bank and conducted by volunteer supervisors at mutually convenient times and places.

NZART Headquarters: PO Box 40 525 Upper Hutt, New Zealand, Phone: +64 4 528 2170.  
Fax: +64 4 528 2173. [nzart@nzart.org.nz](mailto:nzart@nzart.org.nz) [www.nzart.org.nz](http://www.nzart.org.nz) and [www.nzart.org.nz/nzart](http://www.nzart.org.nz/nzart)

(August 2007 version)