Chapter 6

Setting Up a Radio Astronomy Station

Selecting a Site for the Receiving Station

For most observers site selection will be an easy choice – your home. Although you may not have any choice of alternate locations, some consideration has go into the practicalities of constructing a receiving station. You need to have space for the antennae you intend to use. Some aerials need lots of room, others can be quite compact, so depending on the space you have available this may determine what kind of radio astronomy is possible.

Very low frequency propagation studies as a way of monitoring solar flares should be possible anywhere. The small loop antenna even works well indoors and does not take up a lot of room. However, setting up an interferometer to work at 80 MHz using an array of four dipoles may well require more space than is available in your garden. In general aerials get smaller with increasing frequency, so working at higher frequencies is better suited to small spaces, although above 1 GHz a dish reflector is usually needed to increase the collecting area and improve the efficiency for detecting weak signals. Although the antenna is very small, the dish needs to be large to increase its collecting area.

The alternative to your garden is to find a suitable large site nearby. This may be easier said than done, and it may involve having to pay rental of some kind. Astronomical societies working as a team could construct a radio observatory in a more remote place. Being away from built up areas also helps to isolate the receivers from some types of radio noise. However, be aware of radio towers nearby used for things like pagers or mobile phones. These will cause problems in some frequency bands. Mobile phone masts in the UK operate at around 872–960, 1,710–1,876, 1,920–2,169 MHz. Although these are not the only strong signals to avoid, the masts tend to be spread all over the place and could be right on your doorstep.

When evaluating a site try to survey it with a scanning receiver. It will tell you what sorts of signals, or noise, is present in the region. Sources of noise can come from strong transmissions at frequencies adjacent to the chosen one. Choice of radio channel for forward scatter meteor astronomy requires that no local

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station is present, yet a distant transmitter in the range of 500–1,500 km should be available on that channel. Ideally the neighboring channels higher and lower should also be clear locally. When relying on the broadcast FM band this could be challenging at best, or maybe impossible.

Other sources of interference could be computers, including the one you will use to log the data. Metal-cased computers may be better for radio astronomy. The casing will be grounded, reducing the chance of stray noise in the locality. Clearly the covers should always remain in place. If interference is tracked to the PC, then keeping it as far from the radio receiver as possible should help.

Radio equipment needs to be grounded with a purpose made grounding rod. It is preferable to place the grounding rod into the earth outside. Damp ground is better than very dry soil. Clearly this is not possible for apartment dwellers. A substitute could be a water pipe or similar device where these are metal.

Electrical noise can be a problem, especially near industrial sites where large electrical machines are operated. Many residential properties are isolated from such industrial locations, but be aware of them. Cars, too, were traditionally quite noisy, generating spiky noise from their ignition systems, but they are much better now than they used to be. Other forms of radio interference can be found from amateur radio bands, CB, and television. Of course, you need to operate away from these channels, but adjacent channel interference can still be a problem and does not necessarily enter the system through the aerial device. Direct pick up into various parts of the receiver is possible, but a receiver well shielded in a grounded metal box will help stop this. Interference can even enter the radio via the power connection. However, well made modern stabilized power supplies should filter that out. Even house lighting can cause problems. Modern fluorescent low energy lamps do generate some RF noise. Some lights are clearly visible in the spectrum of the VLF receiver. Old style CRT television is also strong at VLF frequencies, particularly 15,625 kHz.

Atmospheric Noise and Other Environmental Considerations

The strongest noise from the atmosphere is caused by electrical storms. Some areas of the world suffer worse than others in this respect. It is wise to shut down receivers during local electrical storms and isolate the antenna feeders, ensuring that they are grounded. Although a direct hit of lightning will be disastrous, induced currents by nearby strikes are more likely and could still be strong enough to destroy sensitive radio equipment.

Electronic equipment is designed to work best at room temperature. Strong swings in temperature can seriously affect system performance. Also large swings in system temperature can significantly change the noise performance of radio systems. Colder temperatures will reduce system noise somewhat but may make comparison of observations from different seasons a problem. The main receivers and computing equipment should ideally be kept as close to a constant temperature as possible. This means working in a garden shed environment a bit more challenging. At least evaluate what different temperatures do to the performance of the system. It's not that you can't work in a garden shed, but just be aware of temperature effects.

Antenna Mounting

A number of considerations must be given to mounting aerials. Wind loading is one. A large solid dish antenna clearly presents a hazard in strong winds. Mesh dishes are only slightly better in this respect. The pole on which a dish is mounted needs to be strong enough to withstand up to 100 mile/h winds. This author once had a dish only 1 m across, mounted on a 2-in. steel pole that admittedly was a thin wall type, but it was provided with the dish mount. In a strong windstorm the pole was bent over 90°! A thick-walled steel or aluminum pipe such as a scaffold pole would have survived that storm.

Even open-wire dipoles may be susceptible to wind damage if the wire it is made from is too thin. Strong rope supports are needed at the tips of the aerial, and dog bone insulators used between the wire and the rope. Choose porcelain insulators over plastic ones (Fig. 6.1).

The center point of dipoles should be strengthened with a insulating material. If the antenna is kept reasonably taut but not over tight, it will reduce its flapping

Fig. 6.1. Porcelain "dog bone" insulators.

tendency in winds, which lead to fatigue in the wire and potential breakage. If the aerial is over tightened in summer, then thermal contraction in winter may be enough to snap the wire.

Certain antennae need to be kept up in the air a minimum distance from the ground to avoid their impedance properties being affected by Earth.

If a mast is required to support antennae, it will need a good footing, usually concrete, in the ground. The stability of the location should be considered. If it is too sandy, or too wet and soft, it is not a good location for mounting a tall mast.

Power Considerations

If you are working from a fixed location with the availability of mains power there should be no problem with power stability. The receivers described in this book all work from low voltage and should be powered from commercially purchased regulated DC power supplies. There is no need to construct your own power supplies from scratch, and this should certainly be avoided if you have no experience in this area. What you need to be aware of is that not all of the little black box power supplies are in fact regulated. An unregulated 12-V power supply is often used in battery chargers, and the output voltage will be more than the face value at 14 or even 15 V. Unregulated supplies will not be stable under variable load conditions either. Always use a power supply that is marked as regulated for radio use. In fact many radio projects use internal regulator chips to guarantee a stable power source. It is wise to do the same in your projects. However it means that if you require a 12-V supply, and you use a 12-V regulator in your design, then you will need to connect a power supply of a slightly higher voltage, say 14–16 V. Most regulator ICs have a wide tolerance for input voltage, but it must be higher than the voltage it is expected to output. Check its data sheet for information.

If you are working at a remote site without power or in a mobile situation then you can't beat a good battery as a power source. For example a car battery will provide many hours of power for low-power receivers, or for extended use between charges a leisure battery as used in caravans is best, but more expensive. However, computers used for data logging can be a big drain on battery power. This is where the dedicated microcontroller data logger is a useful tool. Refer to Chap. 13 in this book for details of such devices. If long-term remote monitoring stations were contemplated, then consider installing a solar battery charger.