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Mega_Link

APPLICATION NOTE AN004

Introduction to Radio Communications for Telemetry

Summary

Radio presents an ideal communications media for many telemetry applications. However, the user must understand the implications, restrictions and benefits of various radio options before deciding if it is right for their applications.

This Application Note outlines the details in a format which should be clear to the average engineer.

Outline

Most countries in the world control usage of the radio spectrum to prevent interference between users. In the UK the controlling authority is the Radiocommunications Agency (RA), which acts on behalf of the European Telecommunications Standards Institute (ETSI).

Every band within the usable spectrum range is designated for a particular application, and several bands have been allocated for telemetry use in each country. In each band the controlling authority dictates the transmitter characteristics such as bandwidth and power, to ensure the range is limited so the spectrum can be shared with other users separated by distance or frequency.

De-regulated bands can be used at will, provided the transmitter and its installation complies with the relevant specifications of the RA.

The most useful band in the UK for telemetry use is designated MPT1329, and is a de-regulated band in the range 458.50…458.95MHz. It allows up to 32 channels to co-exist by frequency multiplexing, and limits the Effective Radiated Power (ERP) to 500mW, which restricts the range to a maximum of around 40Km (25 miles) so each channel can be shared with others.

Other bands allocated for telemetry include MPT1411 and MPT1328. MPT1411 is a regulated band in the range 457.5…458.5MHz and 463.0…464.0MHz, which can allow transmit powers up to 10W, subject to a survey by the RA. It is intended for long-range scanning systems. MPT1328 is a de-regulated VHF band in the range 173.2MHz…173.35MHz, limited to 10mW. Its range is thus restricted, and it is more susceptible to electrical interference. This Application Note therefore concentrates on MPT1329.

Range Considerations

a) Topography
At UHF frequencies, radio signals travel in almost straight lines, so the transmitter and receiver should ideally be within line of sight. Although there could be diffraction around some objects and reflection from others, a solid mass such as a hill or a large building may block transmission.

This can be partially alleviated by raising the aerial on a mast, so a good first test of the viability of radio communications over a given path is to examine an Ordnance Survey map of the area to determine the mast height necessary to clear topographical features.

b) Transmitter Output Power
The range is obviously influenced by the transmitter output power. However, national regulations will inevitably dictate the maximum power which can be transmitted, with the precise intention of limiting the range. For example, MPT1329 limits the power to 500mW ERP.

c) Propagation Loss
As the signal disperses from the transmitter it diminishes in theory inversely proportional to the square of the distance. This is a physical constraint which cannot be overcome and in practice the fall off in signal is always greater than the theory.

d) Receiver Sensitivity
Improving the receiver sensitivity will also increase range. However, there are theoretical limits on the maximum sensitivity achievable, coupled with economic considerations. However, recent technological advances have improved the sensitivity over older designs.

e) Aerial efficiency
A half-wave dipole aerial is omni-directional, and has unity gain. A directional aerial such as a Yagi focuses the signal in one direction, giving effective gain in that direction at the expense of loss in other directions.

A Yagi on a receiver therefore effectively increases its sensitivity, provided it is only receiving signals from one direction.

A Yagi on a transmitter increases its Effective Radiated Power (ERP) in one direction while reducing it in other directions. However, the transmitter power output must be reduced by a corresponding amount to keep the ERP within the regulations, so there is no functional benefit in using a Yagi on a transmitter. It is, however, recommended if there is only one receiver, because it reduces pollution of the airways.

f) Aerial Location
The location of the aerial can have a dramatic effect on the range achievable. In some cases, moving the aerial from one end of a building to the other can make major improvements. These changes are usually due to local obstacles such as steel frameworks.

g) Feeder Loss
If the aerial is located remotely away from the radio, or linked via multiple connectors, then feeder loss can be significant. Increasing transmitter power, within the statutory ERP limits, can compensate for this.

However, feeder loss on a receiver cannot be compensated, and effectively reduces the range achievable. It is therefore advantageous to minimise feeder loss by locating the aerial close to the radio. The physical location of the equipment should be considered from the outset.

Theoretical Calculations

The signal margin can be estimated as follows:

Transmitter o/p power (500mW) (in dB relative to 1mW)	+27dBm
Free space loss (where d is distance in km)	-(86 + 20log(d))dB
Receiver sensitivity (typical)	119dB
Aerial gain per end (8 element Yagi)	+10dB
Typical feeder loss (per 6m cable)	-1dB

Churchill Controls recommend a signal margin of at least 10dB to ensure reliable communications under adverse conditions.

Radio Surveys

If theory indicates that radio communication is achievable, a radio survey is recommended before installing a new system. As well as determining the actual signal margin, the survey will also identify other radio users in the area to ensure the new system will not interfere with them, or be affected by them.

The survey will define the optimum location and type of aerials, mast requirements and recommended channel frequency and power.

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