# RFID Installation Guidelines

# for up to

# 4 W EIRP RFID (UHF)

# Operation in Australia

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## Scope

This document is a recommended installation procedure for Radio Frequency Identification (RFID) readers in Australia, operating at a power greater that 1 W Effective Isotropic Radiated Power (EIRP). Whilst a power setting of 4W EIRP, in relation to RFID systems, is currently permitted in Australia, under a Scientific Licence, many applications and RFID reading scenarios do not need the full 4W in order to provide a satisfactory solution. This document outlines a procedure that can be used to deploy RFID systems between 1W and 4W EIRP.

## Objective

The objective of this document is to provide a set of installation guidelines that can be used for the deployment, installation and commissioning of RFID readers operating up to 4 W EIRP, in Australia, to reduce as far as possible interference to Global System for Mobile Communications (GSM) cellular mobile phone networks.

This document has been prepared by GS1 in conjunction with Australian Industry representative RFID Vendors, Users and Industry Associations.

## Disclaimer

Every reasonable effort has been taken in identifying and understanding the processes, components and constraints in the drafting of this document. However, should the steps outlined in this document still result in interference to GSM equipment, the authors (and their employers and related organisations) accept no responsibility for any loss, damage or claims resulting thereby.

It is stressed that the procedures outlined in this document will not guarantee that no interference will be caused. As of the date of publication, this document represents what a number of professionals in the RFID industry consider to be the most appropriate way to minimise interference.

The RFID installer at all times has full responsibility to ensure RFID systems and their components are installed correctly and comply with all necessary regulatory and operational requirements.

The authors (and their employers and related organisations) expressly disclaim all liability for any claims, damages, expenses, losses or costs (howsoever incurred) by any party as a result of information in this document being inaccurate, incomplete or incorrect in any way for any reason.

## History

For many years RFID industry representatives have been lobbying the Australian Communications and Media Authority (ACMA) to increase the permitted power for Ultra High Frequency (UHF) RFID applications in the Low Interference Potential Devices (LIPD) Class licence 2000 (ref 1) from the existing 1W EIRP to 4W EIRP. Most of Australia's trading partners in other countries are permitted to use either 4W EIRP or 2W Effective Radiated Power (ERP), which is equivalent to 3.2W EIRP for RFID applications.

In Australia, the spectrum around UHF RFID operation is surrounded by GSM operators. The 1W RFID UHF band spans from 918 MHz to 926 MHz. The nearest GSM operator is Vodafone, with their receiver baseband operating from 910 MHz to 915 MHz. ACMA has determined that a 3 MHz guard band between the GSM band and the RFID band would be sufficient for 1W EIRP.

However, as the power of RFID transmitters is increased to 4W EIRP, this guard band may not be sufficient, and ACMA has proposed a reduced band of operation for RFID devices operating up to 4W EIRP of 920 to 926 MHz. In July 2005, ACMA issued a Scientific Apparatus Licence to GS1 to allow the operation of 4W EIRP for RFID applications on a trial basis, using the reduced band of 920 to 926 MHz. While statistics have been gathered since that initial scientific licence, they have not been sufficient for ACMA to implement a permanent change to the LIPD regulations.

In order to boost the number of statistical data points for the scientific investigation, a major scientific trial of approximately 60 RFID readers operating at 4W EIRP, pointing to and within 100m of a Vodafone base station receiver was undertaken, in Q3, 2007. That trial indicated that no significant interference to the Vodafone network is likely to be expected from a reader that is correctly set up, in accordance with the requirements of the Australian 4W Scientific Apparatus Licence, and hence an amendment to the LIPD licence could be proposed. To support that amendment process, ACMA requested the development of this installation guideline, to limit the number of RFID readers operating at full 4W EIRP.

## Installation Procedures

The principle of using the minimum power necessary to achieve satisfactory operation applies. This means that standard 1 Watt EIRP devices are to be used unless the circumstances of the particular situation justify 4 Watt devices.

The legislative instrument that authorises RFID devices is the ACMA Radiocommunications Low Interference Potential Devices Class Licence (LIPD), [Ref1].

A condition of operation is that interference is not to be caused to other radiocommunications devices and that interference must be accepted if it occurs. An additional requirement for 4 Watt RF ID devices is that if they cause interference to other devices operating in accordance with the LIPD then the 4 Watt RF ID devices must reduce their EIRP to that necessary to avoid interference noting that this additional obligation ceases to apply if the EIRP is reduced to 1 Watt.

The LIPD class licence is granted to RFID equipment which operates in the correct frequency band, on a “no interference” basis. If interference is detected on an established GSM installation the offending RFID readers must be shut down immediately, and will not be allowed to transmit until the interference has been eliminated or reduced to an acceptable level.

The proposed amendments to the LIPD licence that will allow operation of RFID equipment up to 4W EIRP are based on the RFID equipment using the transmission (Tx) characteristics outlined in Table 1 below.

It is expected that provided that RFID vendors follow these installation procedures, then minimal interference should occur. The procedures outlined in this document will NOT guarantee that NO interference will be caused. At the date of publication this document represents the RFID Industry’s view of the most appropriate way to minimise interference to the Vodafone base station receiver.

| Item Number | Item Description | Value | Units |
|---|---|---|---|
| 1 | Frequency of Operation | 920 to 926 | MHz |
| 2 | Power into Antenna | 1 | W |
| 3 | Maximum Antenna Gain | 6 (linear)<br>9 (circular) | dBi (linear)<br>dBiC (circular) |
| 4 | | Frequency Hopping Spread Spectrum (FHSS) | |
| 5 | Number of Tx Channels | 12 | |
| 6 | Bandwidth per channel | 500 | kHz |
| 7 | Maximum time per channel | 0.4 | s |
| 8 | Selection of next channel | Pseudo random selection | |

**Table 1 - RFID 4W EIRP Transmission Characteristics**

Please Note: Currently, rail applications FHSS is not used, and hence items 4 to 8 are not mandatory. Rail RFID applications use a variety of transmission methods. Historically CW readers are used running at a single frequency in the 918MHz band. Many installations will turn the reader on only when a train is present. Sometimes the reader is left on permanently, especially when reading high speed trains passing. New readers are now beginning to use frequency hopping techniques.

## Recommended Installation Procedures

### Site Survey

A site survey should be undertaken by physically attending the proposed site. Apart from the usual site survey activities, the surveyor MUST review the site (including the areas surrounding the proposed site) for the presence of a GSM base station. If there is a base station within 100 m of the proposed location, then the alternative installation procedures outlined below should be followed. If there is no base station within 100 m of the proposed location, the installation of the UHF equipment can proceed as per the vendor's usual implementation procedures.

It should be noted that the obligation to avoid interference to mobile phone base stations (currently GSM base stations) is an ongoing obligation. Licensees of mobile phone services are entitled to establish additional base stations at any time and they must be protected from interference from RF ID devices.

### Installation where GSM Base Station is within 100m

This procedure MUST be followed when a proposed UHF antenna site is within 100m of a GSM base station, a flow chart is provided as Figure 1 .

- Review the proposed installation location and determine if the RFID Antennas can be orientated so that they do not point to the base station. If the RFID Antennas can be pointed away from the base station then that orientation should be used.
- If and only if the RFID antennas must point to the base station, then determine if the RFID antennas can be pointed away from the GSM base station's antennas. Usually the GSM antennas are elevated, and it is unlikely that an RFID antenna would be pointing in an upward direction. If the RFID antennas can be orientated away from the base station antennas, then that orientation should be used.
- Install the RFID reader equipment, ensuring that the system is configured to deliver 1W EIRP, and to operate in the 920 to 926 MHz band.
- Start the commissioning process by setting the RF Power level to 250mW or less [1W EIRP, assumes that each antenna has a gain of 6 dBi (for linear antennas) or 9 dBiC (for circularly polarised antennas)]. If antenna gains greater than this are employed, then the formula below should be used to determine the maximum allowable RF power setting.
- If the antenna gain of a circularly polarised antenna is quoted as dBiC, the installer will first need to calculate the antenna gain in dBi by using the following formula:
    - $G = 0.5 * 10^{(G(dBiC)/10)}$ (Comes from Gt = 10 log (Gv+Gh), where Gt is the total gain and Gv and Gh are the vertical and horizontal polarisation gains). To calculate the gain in dBi, use the formula G(dBi) = 10*log(G).
- To calculate the EIRP power P(EIRP) from the antenna gain G(dBi) and power P(W) supplied to antenna), ignoring cable loss, the installer would need to use the following formula
    - $P[EIRP] = 10^{(P[dBW]+ G[dBi])/10}$ or simply P[EIRP W] = G * P[W]
    - The Table 2 below gives some examples

| Antenna Gain G(dBi) | Antenna Gain Factor $G = 10^{G[dBi]/10}$ | Input RF Power to Antenna P(W) | Equivalent Isotropic Radiated Power (W EIRP) = G*P(W) |
|---|---|---|---|
| 6 dBi | 4 (rounded) | 1W | 4 W EIRP |
| 8.7 dBiC => 5.69 dBi | 3.7 | 1W | 3.7 W EIRP |
| 9 dBi | 7.9 | 0.5 W | 3.97 W EIRP |
| 20 dBi | 100 | 0.01W | 1 W EIRP |

**Table 2 - Examples Conversions**

- If the RFID system operates satisfactorily at 1W EIRP, then the power setting should not be altered. If and only if the power is lower than 1W EIRP, the frequency band of operation can be increased to be between 918 to 926 MHz.
- If the RFID system is not operating satisfactory at the 1W EIRP level, the power should be increased in convenient small steps, and RFID system performance should then rechecked at each step. Once satisfactory RFID system performance is achieved, the power should not be increased any further. Record the power setting, including a conversion to EIRP (multiply the power at the connector by the antenna gain), for example a 6 dBi gain antenna has a gain factor (G) of $10^{(G[dBi]/10)} = 3.98$ (rounded to 4).
- Record in the Technical Construction File [Ref2] of the RFID installation, the following information
    - Date of installation/commissioning
    - Manufacturer, Type, Model and Serial numbers of RFID reading equipment, reader and antenna
    - Final commissioned power setting, and equivalent EIRP
    - Photographs of installation, showing antenna orientations.
    - Plan drawing of installation site and location of GSM baseband station.
    - RFID Engineering, signing off on the commissioning process
- If the RFID antennas point to the base station antennas, and if the power is greater than 1W EIRP, then if feasible a screen should be erected between the RFID antenna installation and the GSM base station. This can take the form of a metallic wall of a warehouse, or building.

If at any time interference is recorded by Vodafone, the offending equipment must immediately be shut down. Correction to the installation should then be undertaken to reduce the interference before the RFID system is brought back online. Suggested corrective actions may include:

- reducing the output power, to 1W EIRP or less (although with the reduction of power, more 1W EIRP RFID readers may need to be employed);
- moving the RFID system installation further away from the GSM base station;
- pointing the RFID system antennas away from the GSM base station antennas;
- installing screens to minimise the interference; or
- a combination of all of the above.

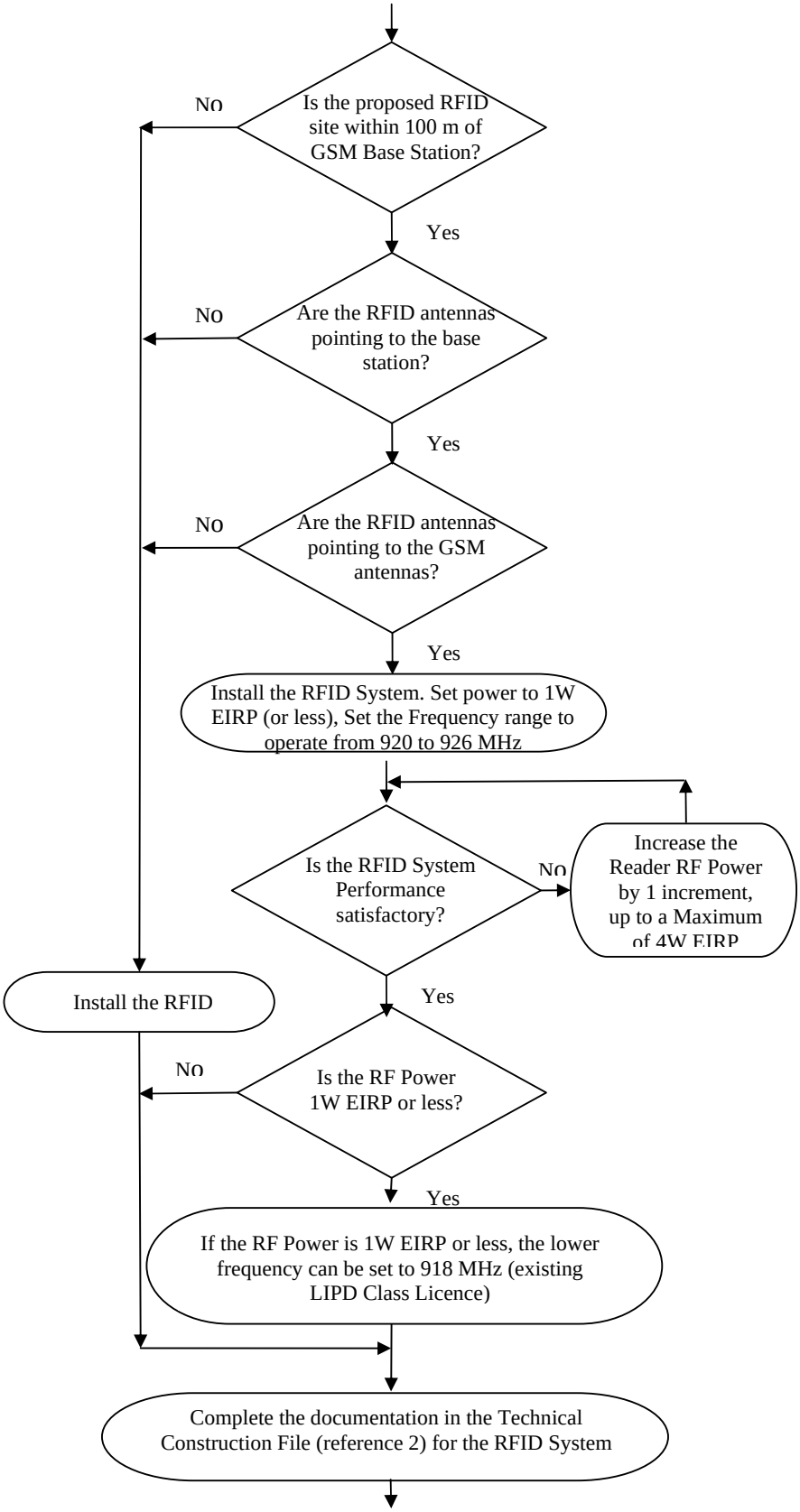


**Figure 1 - Flow Chart**

## References


[Ref1] ACMA Radiocommunications Low Interference Potential Devices Class Licence (LIPD)
http://www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrumentCompilation1.nsf/0/71D36E0C17A40CB3CA2571B80018AF7A/$file/RadcomLIPDClassLic2000.pdf
or
www.acma.gov.au/WEB/STANDARD/pc=PC_297

[Ref2] Compliance Marks C-Tick
http://internet.aca.gov.au/WEB/STANDARD//pc=PC_2796
and
http://www.acma.gov.au/webwr/aca_home/publications/reports/forms/rf10.pdf

[Ref3] Class 1 Generation 2 UHF Air Interface Protocol Standard "Gen 2"
http://www.epcglobalinc.org/standards/uhfc1g2/uhfc1g2_1_1_0-standard-20071017.pdf

[Ref4] ISO/ IEC 18000 Part 6 Type C
http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=34117