Radiocommunications (Unacceptable Levels of Interference — 2 GHz Band) Determination 2016

Radiocommunications Act 1992

The AUSTRALIAN COMMUNICATIONS AND MEDIA AUTHORITY makes this Determination under subsection 145(4) of the *Radiocommunications Act 1992*.

Dated *31 October 2016*

Richard Bean
[signed]
Member

Brendan Byrne
[signed]
~~Member~~/General Manager

Australian Communications and Media Authority

1 Name of Determination

This Determination is the *Radiocommunications (Unacceptable Levels of Interference — 2 GHz Band) Determination 2016*.

2 Commencement

This Determination commences on 12 October 2017.

Note All legislative instruments and compilations are registered on the Federal Register of Legislation kept under the *Legislation Act 2003*. See http://www.legislation.gov.au.

3 Revocation

The *Radiocommunications (Unacceptable Levels of Interference — 2 GHz Band) Determination 2015* [F2015L00723] is revoked.

4 Purpose

This Determination is made for the purposes of section 145 of the Act and sets out what is an unacceptable level of interference caused by a radiocommunications transmitter operating under a spectrum licence issued in the 2 GHz band, so as to ensure that high levels of emission from radiocommunications transmitters operated under a spectrum licence are kept within the geographic area and frequency band of the spectrum licence.

Note 1 Under section 145 of the Act, the ACMA may refuse to register a radiocommunications transmitter if it is satisfied that the operation of the radiocommunications transmitter could cause an unacceptable level of interference to the operation of other radiocommunications devices under that or any other spectrum licence, or any other licence.

Note 2 The ACMA information paper, *Registration of radiocommunications devices under spectrum licences,* (available on the ACMA website: www.acma.gov.au), provides further information about the registration of radiocommunications transmitters under Part 3.5 of the Act.

Note 3 The ACMA has issued written advisory guidelines under section 262 of the Act about compatibility requirements in relation to the assignment of frequencies to radiocommunications transmitters operated under apparatus licences and the operation of radiocommunications transmitters under spectrum licences. The ACMA will take these guidelines into account during the settlement of interference disputes. Each case will be assessed on its merits. The guidelines do not prevent a licensee negotiating other compatibility requirements with another licensee. The guidelines are:

- *Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 2 GHz Band) 2016*; and
- *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 2 GHz Band) 2016.*

These instruments can be accessed on the Federal Register of Legislation website: www.legislation.gov.au.

5 Interpretation

(1) In this Determination, unless the contrary intention appears:

2 GHz band means the following frequency bands:

(a) 1920 MHz to 1980 MHz (2 GHz Lower Band); and
(b) 2110 MHz to 2170 MHz (2 GHz Upper Band).

Act means the *Radiocommunications Act 1992*.

ASMG 2012 means the *Australian Spectrum Map Grid 2012* published by the ACMA, as existing from time to time.

Note The ASMG 2012 can be accessed on the ACMA website: www.acma.gov.au.

centre frequency, in relation to a radiocommunications transmitter, means the frequency midway between the lower and upper frequency limits of the transmitter's occupied bandwidth.

DEM-9S means the '*GEODATA 9 Second Digital Elevation Model (DEM-9S) Version 3*' (Australia New Zealand Land Information Council unique identifier ANZCW0703011541) containing modelled terrain height information for Australia, published by Geoscience Australia, as existing from time to time.

Note The DEM-9S can be accesssed on the Geoscience Australia website: www.ga.gov.au.

DEM-9S cell means an individual height element of the DEM-9S.

device boundary, in relation to a radiocommunications transmitter or a group of radiocommunications transmitters operated under a spectrum licence, means the device boundary established in accordance with Part 1 of Schedule 2.

device boundary criterion means the value of the mathematical expression calculated in accordance with Part 2 of Schedule 2.

EIRP, in relation to a radiocommunications device, means the Effective Isotropic Radiated Power of the device.

emission designator means the designation of a radiocommunications transmitter's emission, determined in accordance with section 6.

fixed receiver means a radiocommunications receiver located at a fixed point on land or sea and not designed or intended for use while in motion.

fixed transmitter means a radiocommunications transmitter located at a fixed point on land or sea and not designed or intended for use while in motion.

GDA94 means the geodetic datum designated as the 'Geocentric Datum of Australia ' gazetted in the Commonwealth of Australia Gazette No. GN 35 on 6 September 1995.

Note The Geocentric Datum of Australia is a coordinate reference system. More information on the GDA94 can be obtained from the Geoscience Australia website: www.ga.gov.au.

geographic area, for a spectrum licence, means the area within which operation of a radiocommunications device is authorised under the spectrum licence.

horizontally radiated power, for a radiocommunications device, means the sum of:

(a) the maximum true mean power, in dBm per specified rectangular bandwidth at the antenna connector that is located within the frequency band of the spectrum licence authorising the operation of the radiocommunications device; and

(b) the antenna gain relative to an isotropic antenna in a specified direction in the horizontal plane containing the phase centre of the antenna used with the radiocommunications device, in dBi.

ITU means the International Telecommunication Union.

ITU-R means the International Telecommunication Union Radiocommunication Sector.

location, in relation to a radiocommunications transmitter or group of radiocommunications transmitters, means the location of the transmitter or group of transmitters, as the case may be, calculated in accordance with Schedule 1.

maximum true mean power means the true mean power measured in a specified rectangular bandwidth that is located within a specified frequency band such that the true mean power is the maximum of true mean powers produced.

Note The power within a specified bandwidth is normally established by taking measurements using either an adjacent channel power meter or a spectrum analyser. The accuracy of measuring equipment, measurement procedure and any corrections to measurements necessary to take account of practical filter shape factors would normally be in accordance with standard engineering practice.

mean power means the average power measured during an interval of time that is at least 10 times the period of the lowest modulation frequency.

occupied bandwidth, in relation to a radiocommunications transmitter, means the width of a frequency band having upper and lower limits that are necessary to contain 99% of the true mean power of the transmitter's emission at any time.

Radio Regulations means the 'Radio Regulations' published by the ITU, as in force from time to time.

Note The Radio Regulations can be obtained from the ITU website: www.itu.int.

true mean power means:

(a) if an unmodulated carrier is present — the mean power measured while the unmodulated carrier is present; and

(b) if an unmodulated carrier is not present — the mean power measured while transmitted information is present.

(2) In this Determination, unless otherwise specified, the range of numbers that identifies a frequency band includes the higher, but not the lower, number.

Note A number of terms, used in this Determination are defined in the Act and unless the contrary intention appears, have the meanings given to them by the Act. Those terms include:

- ACMA
- core condition
- frequency band
- interference
- radiocommunications device
- radiocommunications receiver
- radiocommunications transmitter
- radio emission
- Register
- spectrum licence.

(3) In this Determination, unless the contrary intention appears, a reference to another legislative instrument is a reference to that other legislative instrument as in force from time to time.

Note 1 For references to Commonwealth Acts, see section 10 of the *Acts Interpretation Act 1901*; and see also subsection 13(1) of the *Legislation Act 2003* for the application of the *Acts Interpretation Act 1901* to legislative instruments.

Note 2 All Commonwealth Acts and legislative instruments are registered on the Federal Register of Legislation.

6 Emission designator

(1) In this Determination, the designation of a radiocommunications transmitter's emission (***emission designator***) is determined using the methods specified in the Radio Regulations.

(2) For the purpose of determining the designation of a radiocommunications transmitter's emission using the methods specified in the Radio Regulations, the references to necessary bandwidth for a given class of emission are taken to be references to the occupied bandwidth of the transmitter.

Note At the date of the making of this Determination, Appendix 1 of the Radio Regulations made provision for determining the designation of a radiocommunications transmitter's emission.

7 Group of radiocommunications transmitters

(1) In this Determination, two or more fixed transmitters are a group of radiocommunications transmitters if:

(a) they have the same centre frequency and emission designator;

(b) they are operated for the purpose of communicating with the same radiocommunications receiver or group of radiocommunications receivers;

(c) each has an antenna of the same type, model and manufacturer;

(d) the antenna used with each fixed transmitter is located on the same structure and within 20 metres of the phase centre of all antennas within the group of radiocommunications transmitters; and

(e) the identification number assigned by the ACMA to the antenna used with each radiocommunications transmitter is the same.

(2) A radiocommunications transmitter must not belong to more than one group of radiocommunications transmitters.

(3) The location of a group of radiocommunications transmitters is worked out in accordance with Schedule 1.

8 Group of radiocommunications receivers

(1) In this Determination, two or more fixed receivers are a group of radiocommunications receivers if:

(a) the radiocommunications receivers are operated for the purpose of communicating with the same radiocommunications transmitter or group of radiocommunications transmitters;

(b) each has an antenna of the same type, model and manufacturer;

(c) the antenna used with each fixed receiver is located on the same structure and within 20 metres of the phase centre of all antennas within the group of radiocommunications receivers; and

(d) the identification number assigned by the ACMA to the antenna used with each radiocommunications receiver is the same.

(2) A radiocommunications receiver must not belong to more than one group of radiocommunications receivers.

(3) The location of a group of radiocommunications receivers is worked out as if it were a group of radiocommunications transmitters under Schedule 1.

9 Unacceptable levels of interference

(1) A level of interference caused by a radiocommunications transmitter operated under a spectrum licence issued for the 2 GHz band is unacceptable if:

(a) the operation of the transmitter in the 2 GHz band results in a breach of a core condition of the spectrum licence relating to the maximum permitted level of radio emission from the transmitter:

(i) outside the parts of the spectrum the use of which is authorised under the spectrum licence; or

(ii) outside the geographic area of the spectrum licence; or

(b) subject to subsections (2) and (3), any part of the device boundary of the transmitter lies outside of the geographic area of the spectrum licence; or

(c) the device boundary of the transmitter cannot be calculated in accordance with Part 1 of Schedule 2; or

(d) the transmitter:

(i) operates in the 2 GHz Lower Band; and

(ii) has an antenna with an effective antenna height for any radial n, he1(ϕn) greater than 20 metres.

(2) A level of interference mentioned in paragraph (1)(b) is not unacceptable in relation to a part of the device boundary of the transmitter that:

(a) lies outside the boundary of the ASMG 2012; and

(b) is connected to a radial that:

(i) is mentioned in Part 1 of Schedule 2; and

(ii) does not cross the geographic area of another spectrum licence in the 2 GHz band.

(3) A level of interference mentioned in paragraph (1)(b) is not unacceptable in relation to a part of the device boundary of the radiocommunications transmitter that lies outside the geographic area of the spectrum licence, if the radiocommunications transmitter has the same device details as a radiocommunications transmitter previously registered under Part 3.5 of the Act for a spectrum licence that expired on 11 October 2017.

(4) For the purpose of subsection (3), ***device details*** means the details for a radiocommunications transmitter set out in paragraphs 10(2)(h), 10(2)(j) and 10(2)(k) and in subsections 10(3) and 10(4) of the *Radiocommunications (Register of Radicommunications Licences) Determination 1997*.

Note Some radiocommunications transmitters are exempt from the requirement to be registered in the Register under their 2 GHz band spectrum licence – see subsection 69(2) of the Act. These radiocommunications transmitters are not required to meet the device boundary criteria specified in this Determination.

10 Accuracy

Unless otherwise specified, the value of a parameter in Schedules 2 and 3 must be estimated with a level of confidence not less than 95 percent that the true value of the parameter will always remain below the requirement specified in this Determination.

Schedule 1 Location of a transmitter

(subsections 5(1), 7(3) and 8(3), Schedule 3)

1. The location of a radiocommunications transmitter, (l_t, L_t) is the location (by latitude and longitude with reference to the GDA94) of the phase centre of the radiocommunications transmitter's antenna.

2. The location of a group of radiocommunications transmitters, (l_t, L_t) is the location (by latitude and longitude with reference to the GDA94) of the centre point between the phase centre of each radiocommunications transmitter antenna within the group.

3. In determining the location of a radiocommunications transmitter, or a group of radiocommunications transmitters, the measurement error should be less than 10 metres.

   Note 1 The ACMA issues site identifiers for established radiocommunications locations available in the Register.

   Note 2 The ACMA provides advice to assist licensees in determining the location and measurement error of a transmitter site in the document titled *Radiocommunications site data requirements* available on the ACMA website: www.acma.gov.au under Business Operating Procedures (BOP).

Schedule 2 Device boundaries and device boundary criteria

(subsections 5(1), 9(1), 9(2), 9(3) and section 10)

Part 1 Device boundary of a transmitter

1. The device boundary of a single radiocommunications transmitter is established as follows:

Step 1: Calculate the device boundary criterion at each m×500 metre increment along each of the n-degree radials, where:

(a) m is the values 1 through 92; and

(b) n is the values 0 (true north) through 359.

Step 2: For each radial, find the latitude and longitude of the first point (lowest value of m) where either:

(a) RP-MP is less than or equal to 0; or

(b) m is equal to 92.

Step 3: The end point of each radial is the device boundary of the radiocommunications transmitter.

Note RP-MP (device boundary criterion) is calculated under Part 2.

2. For a group of radiocommunications transmitters the device boundary is to be calculated as if for a single radiocommunications transmitter. The radiated power (RP) for groups of radiocommunications transmitters is taken:

(a) to be equal for each bearing σ_n; and

(b) to have a value that is the maximum horizontally radiated power, in any direction, of any radiocommunications transmitter in the group.

Part 2 Device boundary criterion

1. The device boundary criterion is the value of the mathematical expression:

RP – MP

where:

MP	is $PL(l_{mn},L_{mn}) + LOP - G_r$;
RP	is the horizontally radiated power, measured in dBm EIRP per 5 MHz, for each bearing, σ_n;
LOP	is the level of protection, set to –96 dBm per 5 MHz;
G_r	is the nominal radiocommunications receiver antenna gain including feeder loss

set to 0 dBi;

$PL(l_{mn},L_{mn})$ is the propagation loss (dB) set out in Part 3 of the m[th] increment on the n[th] radial.

Part 3 Calculation of propagation loss

1. In calculating $PL(l_{mn}, L_{nm})$:

f : is the nominal frequency of the radiocommunications transmitter, being 1950 MHz when operating in the 2 GHz Lower Band and 2140 MHz when operating in the 2 GHz Upper Band.

h_{gr} : is the nominal radiocommunications receiver antenna height above ground level, being 1.5 metres.

$h_{e_m(\sigma_n)}$: is the transmitter effective antenna height (in metres) as defined in Schedule 3, except:

if $h_{e_m(\sigma_n)} < 1.5$ metres, then $h_{e_m(\sigma_n)} = 1.5$ metres; or

if $h_{e_m(\sigma_n)} > 500$ metres then $h_{e_m(\sigma_n)} = 500$ metres.

$d(l_{mn}, L_{mn})$: is the distance in kilometres between the location of the radiocommunications transmitter, (l_t, L_t), and the m[th] increment on the n[th] radial (l_{mn}, L_{mn}).

2. The propagation loss for the m[th] increment on the n[th] radial is established as follows:

Step 1: Calculate the parameters required.

$$a(h_{gr}) = (1.1\log_{10}(f) - 0.7)\{\min(10, h_{gr})\} - (1.56\log_{10}(f) - 0.8) + \max\{0, 20\log_{10}(h_{gr}/10)\}$$

$$b(h_{e_m(\sigma_n)}) = \min\{0, 20\log_{10}(h_{e_m(\sigma_n)}/30)\}$$

$$\alpha = \begin{cases} 1 & d \le 20\,\text{km} \\ 1 + (0.14 + 0.000187 \times f + 0.00107 \times h_{e_m(\sigma_n)})(\log_{10}(d(l_{mn}, L_{mn})/20))^{0.8} & 20\,\text{km} < d \le 100\,\text{km} \end{cases}$$

Step 2: Calculate the propagation loss for the m[th] increment on the n[th] radial

For radiocommunications transmitters operating in the 2 GHz Lower Band:

$$PL(l_{mn}, L_{mn}) = 46.3 + 33.9\log_{10}(f) - 13.82\log_{10}(\max\{30, h_{e_m(\sigma_n)}\}) + \left[44.9 - 6.55\log_{10}(\max\{30, h_{e_m(\sigma_n)}\})\right](\log_{10}(d(l_{mn}, L_{mn})))^{\alpha} - a(h_{gr}) - b(h_{e_m(\sigma_n)}) - 2\left\{\log\left[f/28\right]\right\}^2 - 5.4$$

For radiocommunications transmitters operating in the 2 GHz Upper Band:

$$PL(l_{mn}, L_{mn}) = 46.3 + 33.9\log_{10}(2000) + 10\log(\frac{f}{2000}) - 13.82\log_{10}\left(\max\left\{30, h_{e_m(\sigma_n)}\right\}\right) +$$
$$\left[44.9 - 6.55\log_{10}\left(\max\left\{30, h_{e_m(\sigma_n)}\right\}\right)\right]\left(\log_{10}\left(d\left(l_{mn}, L_{mn}\right)\right)\right)^{\alpha} - a\left(h_{gr}\right) - b\left(h_{e_m(\sigma_n)}\right)$$
$$- 2\left\{\log\left(2000/28\right)\right\}^2 - 5.4$$

Note The formulae in Step 1 and Step 2 use the Modified Hata Suburban propagation model from ERC Report 068 published by the European Conference of Postal and Telecommunications Administrations (CEPT) in 2000 and revised in 2002.

Schedule 3 Antenna height and average ground height

(section 10, Schedule 2)

Part 1 Antenna height of a transmitter

1. If:

(a) h_{gt} is the vertical height in metres of the phase centre of the fixed transmitter's antenna measured with an error of less than 5 parts in 100 and relative to the point:

(i) located on the line of intersection between the external surface of the structure supporting the antenna and the surface of the ground or sea; and

(ii) having the lowest elevation on that line; and

(b) h_s is the sum of the DEM-9S cell height at the location of the radiocommunications transmitter as (defined in Schedule 1) and h_{gt}; and

(c) $h_{ag_m(\sigma_n)}$ is the average ground height at each m-increment on each n-radial as calculated in accordance with Part 2;

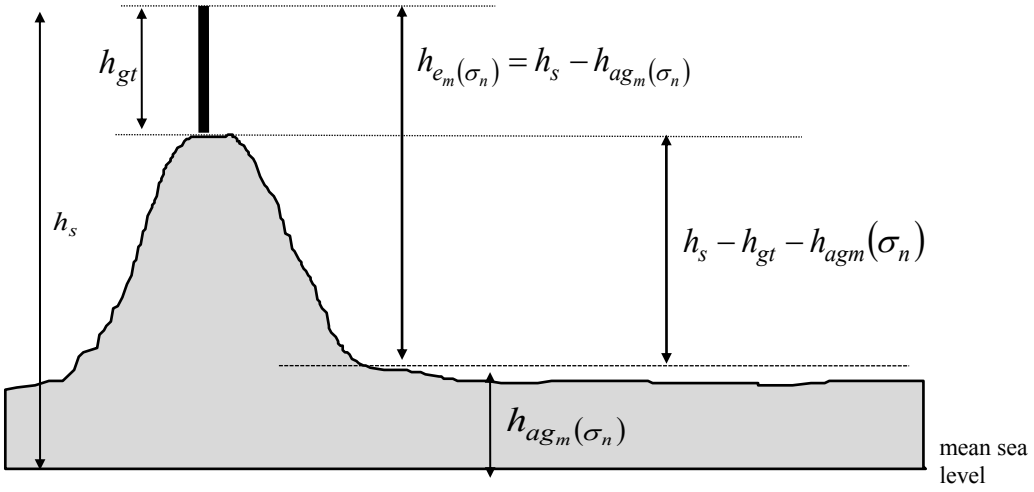
then the effective antenna height $h_{e_m(\sigma_n)}$ is $h_s - h_{ag_m(\sigma_n)}$ (as shown in Diagram 1) except when $h_s - h_{ag_m(\sigma_n)}$ is less than h_{gt}, in which case $h_{e_m(\sigma_n)}$ is h_{gt}.

2. For a group of radiocommunications transmitters, h_{gt} is the greatest of the h_{gt} for each individual transmitter in the group, calculated as in 1(a).

3. If the latitude or longitude of the radiocommunications transmitter as defined in Schedule 1 has a modulus of zero when divided by 0.0025, then h_s is the sum of h_{gt} and the maximum height of the adjacent DEM-9S cells.

Note Additional information for the purpose of calculating h_s where the latitude or longitude of the radiocommunications transmitter as defined in Schedule 1 corresponds to a DEM-9S cell boundary, is provided in the document titled '*Digital Elevation Model Interpretation*' available on the ACMA website: www.acma.gov.au.

Diagram 1 Calculating effective antenna height



Part 2 Average ground height

1. The average ground height for the m^{th} increment on the n^{th} radial is calculated as follows:

Step 1: Determine the associated latitude and longitude (l_{mn}, L_{mn}) of the m^{th} increment on the n^{th} radial as calculated in Part 3.

Step 2: Identify the DEM-9S cell represented by the latitude and longitude of the m^{th} increment on the n^{th} radial.

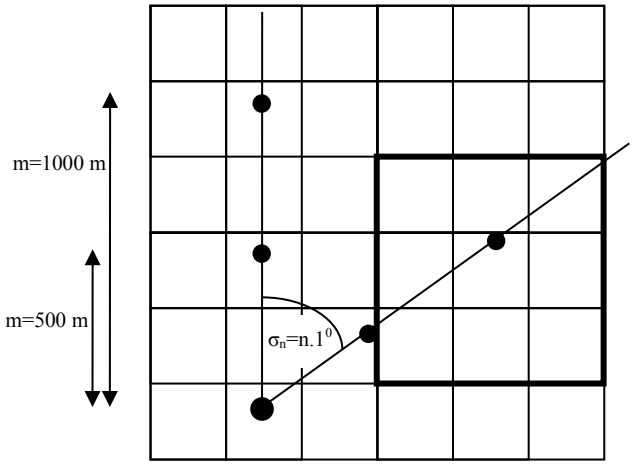
Step 3: Bound the identified DEM-9S cell with the 8 adjacent DEM-9S cells in a 3x3 matrix and obtain each DEM-9S cell height attribute (as shown in Diagram 2).

Step 4: Determine the average value of height from the 3x3 matrix.

2. If the latitude or longitude of the m^{th} increment on the n^{th} radial as calculated in Part 3 has a modulus of zero when divided by 0.0025, then the corresponding DEM-9S cell, as identified in Step 2 above, is the adjacent DEM-9S cell with the minimum height.

Note Additional information for the case where the associated latitude or longitude of the m^{th} increment on the n^{th} radial as calculated in Part 3 corresponds to a DEM-9S cell boundary is provided in the document titled '*Digital Elevation Model Interpretation*' available on the ACMA website: www.acma.gov.au.

Diagram 2 Calculating average ground height



Part 3 Vincenty's Formulae

Note This implementation of Vincenty's Direct Formulae uses the parameters $\{a, f_l, b\}$ from the Geodetic Reference System 1980 ellipsoid as referenced by the GDA94.

1. In calculating (l_{mn}, L_{mn}):

l_t : is the latitude of the fixed transmitter (decimal radians).

L_t : is the longitude of the fixed transmitter (decimal radians).

α : is the azimuth angle (decimal radians).

d : is the separation distance to required point (m×500 metres).

a : is the semi-major axis with value (6378137 metres).

f_l : is the flattening of the value (1/298.25722210).

b : is the semi-minor axis of ($a \times (1-f_l)$).

$$e^2 = \left(a^2 - b^2\right)/b^2$$
$$U_1 = \arctan\left((1 - f_1) \times \tan(l_1)\right)$$
$$\phi_1 = \arctan\left(\tan(U_1)/\cos(\alpha)\right)$$
$$\alpha_n = \arcsin\left(\cos(U_1) \times \sin(\alpha)\right)$$
$$u^2 = \cos^2(\alpha_n) \times e^2$$
$$A = 1 + \left(u^2/16384\right) \times \left(4096 + u^2 \times \left(-768 + u^2 \times \left(320 - 175 \times u^2\right)\right)\right)$$
$$B = \left(u^2/1024\right) \times \left(256 + u^2 \times \left(-128 + u^2 \times \left(74 - 47 \times u^2\right)\right)\right)$$

2. Using an initial value $\phi = d/(b \times A)$, iterate the following three equations until the change in ϕ is less than 10^{-12}.

$$\phi_m = \frac{2 \times \phi_1 + \phi}{2}$$

$$\Delta\phi = \mathrm{B}\sin(\phi) \times \left\{\cos(2\phi_m) + \frac{B}{4} \times \left[\cos(\phi) \times \left(-1 + 2\cos^2\left(2\phi_{\mathrm{m}}\right)\right) - \frac{B}{6}\cos(2\phi_m) \times \left(-3 + 4\sin^2(\phi)\right) \times \left(-3 + 4\cos^2\left(2\phi_m\right)\right)\right]\right\}$$

$$\phi = d/(b \times A) + \Delta\phi$$

3. Then:

$$l_{mn} = \arctan\left(\frac{\sin(U_1)\cos(\phi) + \cos(U_1)\sin(\phi)\cos(\alpha)}{(1 - f_l)\sqrt{\sin^2(\alpha_n) + \left(\sin(U_1)\sin(\phi) - \cos(U_1)\cos(\phi)\cos(\alpha)\right)^2}}\right)$$

Note Use the four-quadrant inverse tangent, *atan2*.

$$\lambda = \arctan\left(\frac{\sin(\phi)\sin(\alpha)}{\cos(U_1)\cos(\phi) - \sin(U_1)\sin(\phi)\cos(\alpha)}\right)$$

Note Use the four-quadrant inverse tangent, *atan2*.

$$C = \frac{f_l}{16}\cos^2(\alpha_n)\left[4 + f_l\left(4 - 3\cos^2(\alpha_n)\right)\right]$$

$$L = \lambda - (1 - C) f_l \sin(\alpha_n)\left\{\phi + C\sin(\phi)\left[\cos(2\phi_m) + C\cos\phi\left(-1 + 2\cos^2(2\phi_m)\right)\right]\right\}$$

$$L_{mn} = L_t + L$$