

RADIOCOMMUNICATIONS EQUIPMENT
COMPLIANCE ASSESSMENT
FOR
FCC 47 CFR 1.1310
RADIOFREQUENCY RADIATION EXPOSURE LIMITS
MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Client:	Circuitlink Pty Ltd
Address:	7/30 Foundry Road, Seven Hills, NSW 2147 Australia
Report Number:	0206CIR_TACHO5_FCC(MPE) <i>[This report supersedes report 0121CIR_TACHO5_FCC(MPE)]</i>
Date of Assessment	23 Dec 2014
File Number:	CIR130403

Equipment Name:	Tacholink 5
Equipment Model No:	TACHO5A, TACHO5B, TACHO5C
Equipment Description:	Vehicle Data Recorder with 2.4GHz WiFi Function

Result:	COMPLIES (General Population/Uncontrolled Exposure)
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Assessed by:	Colin Gan
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Approved by:	Phillip Kane
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Date of Issue:	06 Feb 2015
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Results appearing herein relate only to the sample(s) assessed through the submitted test report(s).

This report is issued errors and omissions exempt and is subject to withdrawal at Austest Laboratories discretion.

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EQUIPMENT DETAILS	
MANUFACTURER:	Circuitlink Pty Ltd
MODELS:	1. TACHO5A (2G + WiFi modes) 2. TACHO5B (WiFi mode) 3. TACHO5C (3G + WiFi modes)
OPERATING FREQUENCY:	2G mode: 850MHz and 1900MHz ^{Notes 1 & 4} 3G mode: 850MHz, 1700MHz and 1900MHz ^{Notes 2 & 4} WiFi mode: 2412MHz to 2462MHz ^{Note 3}
TRANSMITTER POWER INTO ANTENNA:	2G mode: 1.683W (850MHz) ^{Notes 1 & 4} 0.927W (1900MHz) ^{Notes 1 & 4} 3G mode: 1.995W (850MHz worst-case) ^{Notes 2 & 4} 0.226W (1700MHz) ^{Notes 2 & 4} 0.993W (1900MHz worst-case) ^{Notes 2 & 4} WiFi mode: 0.229W ^{Note 3}
TYPE OF ANTENNAS:	1. Linx ANT-2.4-CW-RH 2. Taoglas MA.206 GPS/2.4~2.54GHz Combination Antenna 3. Taoglas MA600 Screw-mount 3in1 Combination Antenna
ANTENNA GAINS:	<u>Linx ANT-2.4-CW-RH</u> ^{Note 5} -0.9dBi (WiFi 2.4GHz) <u>Taoglas MA.206 Combination Antenna</u> ^{Note 6} 3.4dBi (WiFi 2.4GHz) <u>Taoglas MA600 Combination Antenna</u> 2.1dBi (850MHz) ^{Notes 7 & 8} 2.9dBi (1700MHz) ^{Notes 7 & 8} 3.0dBi (1900MHz) ^{Notes 7 & 8} 2.1dBi (WiFi 2.4GHz) ^{Note 7}

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Notes:

1. Data taken from TCB Grant of Equipment Authorization (FCC ID: R17GE910) for integrated cellular module GE910, dated 17 Jul 2012.
2. Data taken from TCB Grant of Equipment Authorization (FCC ID: R17HE910) for integrated cellular module HE910, dated 13 Mar 2012.
3. Actual measured transmit power measured at the antenna port was 23.6dBm (0.229W).
4. Client has stated that the equipment will operate on all cellular frequencies, but not at the same time. Hence, the MPE calculations consider only one cellular frequency transmission at a time.
5. Data taken from ANT-2.4-CW-RH datasheet (Revised 12/19/13) provided by client.
6. Obtained from the maximum Gain figure indicated in the Radiation Patterns WiFi Antenna plots in the MA.206.A.A301111.B301151 datasheet (SPE-11-8-111/A/SS) provided by client.
7. Data taken from MA600.A.ABC.006 datasheet (SPE-12-8-048/E/ZL) provided by client.
8. The antenna gain is less than the antenna gain stated in the TCB Grant of Equipment Authorization.

FCC § 15.247(b) RF Exposure Criteria for Intentional Radiators**RF Exposure Requirements: FCC §1.1307(b)(1), §1.1307(b)(2) and §1.1307(b)(3):**

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: FCC §1.1310:

As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

Maximum Permissible Exposure

(As specified in Table 1B of 47 CFR 1.1310 – Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure)

<i>Frequency range (MHz)</i>	<i>Power density (mW/cm²)</i>
300 – 1500	f/1500
1,500 – 100000	1.0

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MPE Calculations

The possible EUT models versus transmitter antenna configurations for reasonable MPE considerations are as follows:

1. TACHO5A (2G + WiFi modes) – MA600 Combination Antenna.
2. TACHO5B (WiFi mode) –
 - a. Linx ANT-2.4-CW-RH Antenna.
 - b. Taoglas MA.206 Combination Antenna.
 - c. MA600 Combination Antenna.
3. TACHO5C (3G + WiFi modes) – MA600 Combination Antenna.

The WiFi and cellular antennas are considered co-located as they are less than 20cm apart for the purpose of the MPE calculations.

The following radio modules will be used in the Tacholink 5 (Models: TACHO5A & TACHO5C) that will result in co-location of the antennas for the modules:

1. Telit 2G Cellular module GE910, FCC ID: RI7GE910 (in TACHO5A)
2. Telit 3G Cellular module HE910, FCC ID: RI7HE910 (in TACHO5C)
3. Qualcomm Atheros, Inc. WiFi Module AR4100 (in both models)

Results of MPE calculations for the EUT in both WiFi alone and WiFi co-located with the cellular antenna configurations are included below.

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MPE Calculation for WiFi Only Operation with Linx ANT-2.4-CW-RH Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	-0.90

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²): Tx1 = **1**

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = **20**

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	-0.90	100	0.0370	3.70%
Total Cumulative Exposure						3.70%

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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MPE Calculation for WiFi Only Operation with Taoglas MA.206 Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	3.40

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²): Tx1 = **1**

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = **20**

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	3.40	100	0.0997	9.97%
Total Cumulative Exposure						9.97%

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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MPE Calculation for WiFi Only Operation with Taoglas MA600 Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	2.10

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²): Tx1 = **1**

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = **20**

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	2.10	100	0.0739	7.39%

Total Cumulative Exposure **7.39%**

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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MPE Calculation for Multiple Co-located Tx Sources (WiFi & 2G 850MHz) with Taoglas MA600 Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	2.10
2	GE910	RI7GE910	850	32.26	2.10

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
300 to 1500	NA	NA	f/1500	30
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²): Tx1 = **1** Tx2 = **0.567**

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = **20.4**

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20.4 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	2.10	100	0.0710	7.10%
2	850	32.26	2.10	100	0.5218	92.03%
Total Cumulative Exposure						99.14%

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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MPE Calculation for Multiple Co-located Tx Sources (WiFi & 2G 1900MHz) with Taoglas MA600 Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	2.10
2	GE910	RI7GE910	1900	29.70	3.00

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²):

Tx1 =

1

Tx2 =

1

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) =

20

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	2.10	100	0.0739	7.39%
2	1900	29.70	3.00	100	0.3705	37.05%
Total Cumulative Exposure						44.44%

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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MPE Calculation for Multiple Co-located Tx Sources (WiFi & 3G 850MHz) with Taoglas MA600 Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	2.10
2	HE910	RI7HE910	850	33.00	2.10

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
300 to 1500	NA	NA	f/1500	30
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²):

Tx1 =

1

Tx2 =

0.567

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) =

22

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 22 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	2.10	100	0.0611	6.11%
2	850	33.00	2.10	100	0.5320	93.83%

Total Cumulative Exposure 99.94%

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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MPE Calculation for Multiple Co-located Tx Sources (WiFi & 3G 1700MHz) with Taoglas MA600 Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	2.10
2	HE910	RI7HE910	1700	23.54	2.90

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²):

Tx1 =

1

Tx2 =

1

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) =

20

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	2.10	100	0.0739	7.39%
2	1700	23.54	2.90	100	0.0876	8.76%
Total Cumulative Exposure						16.16%

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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MPE Calculation for Multiple Co-located Tx Sources (WiFi & 3G 1900MHz) with Taoglas MA600 Antenna

Product Details

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	AR4100		2400	23.60	2.10
2	HE910	RI7HE910	1900	29.97	3.00

Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

* = Plane-wave equivalent power density.

Power Density Limits (mW/cm²):

Tx1 =

1

Tx2 =

1

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) =

20

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm ²)	Cumulative Exposure (%)
1	2400	23.60	2.10	100	0.0739	7.39%
2	1900	29.97	3.00	100	0.3942	39.42%
Total Cumulative Exposure						46.81%

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

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Based on worst-case MPE calculations, the minimum separation distance for the Tacholink 5 product with co-located radios is 22cm between the transmission point (generally referring to the transmit antennas or structure) and the human body, which is to be clearly and prominently stated in the product manuals for the above listed combination of radios and maximum antenna gains.

The above minimum safety distances are not valid for transmit antennas with higher antenna gains.

Austest Summary and Recommendations

The equipment complies with FCC 47 CFR 1.1310: Limits for Maximum Permissible Exposure (MPE), Limits for General Population / Uncontrolled Exposure, when the indicated minimum separation distance is adhered to.

If compliance is sought for model numbers other than those listed in the test report, then the compliance folder must hold additional documentation, demonstrating the equivalence of the products between the different model numbers.

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