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RF Exposure Technical Brief

Tait Unify Vehicle

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Equipment: TMBM1A

FCC identification CASTMBM1A

Rated transmit power: 16.5dBm

Frequency range: 2412 → 2484 MHz

Test standards: USA – 47CFR 1.1310

Reference Standard: IEEE C95.3 -2002

Contents

Introduction

The Tait TMBM1A UnifyVehicle mobile radio control head contains a module to provide both wifi and Bluetooth connectivity. These functions utilise a single antenna, and cannot operate simultaneously. The antenna may be an internally mounted ceramic chip or an assembly mounted outside the vehicle.

Limits: Safe Distance calculations – Uncontrolled environment

USA – 47CFR 1.1310
RF Field Strength limit for uncontrolled environments (47CFR 1310 Table1) 300MHz to 1500MHz
Limit = 1 mW/c m^2
= 10 W/m^2

Result Summary

Antenna	Antenna Gain (dBi)	Average output power (W)	System losses (dB)	Recommended minimum distance (m)	Power density at recommended distance (mW/cm^2)	Limit (mW/cm^2)	Result
Internal	3.2	0.05	-1.5	0.2	0.013	1	Pass
External	4.0	0.05	-2.5	0.2	0.012	1	Pass

MPE Calculation Method

Near field Calculation

Equation 39 of IEEE C95.3-2002

$$S_{near} = \frac{P}{(2\ \pi\ d\ h)}$$

Fresnel region and far field calculation

Equation 37 of IEEE C95.3-2002

$$S_{far} = \frac{P\ G}{4\ \pi\ d^2}$$

Far Field boundary calculation

The near field equation may be applied close to the antenna, but may over predict the power density at longer distances. To determine which result should be used, the crossover point where the predicted field strengths are the same is calculated.

$$S_{near} = S_{far}$$

$$\frac{P}{(2\ \pi\ d\ h)} = \frac{P\ G}{4\ \pi\ d^2}$$

Rearranged to find d

$$d = \frac{Gh}{2}$$

Where: S=power density in W/m^2
P= net power output to the antenna (W)
d = radius of a cylinder around the antenna (m)
h = aperture height of antenna (m)
G = Effective linear gain of antenna relative to an isotropic radiator
F = frequency (MHz)

Internal Antenna:

Highest Transmitter Power:	16.5dbm = 0.045W
Antenna Type:	On board ceramic chip
Antenna Make:	Pulse
Specified Antenna Gain:	3.2dbi = 2.1
Antenna Length:	11.6mm
Antenna Coupling Loss:	1.5dB
Antenna Height:	0.011m
Calculation Frequency:	2400MHz

Effective Transmit Power

P = net power output to the antenna (W)
= Specified transmitter power - Antenna Coupling Loss
= 16.5 – 1.5
= 15 dBm
= 32mW

Far Field boundary calculation

$$d = \frac{Gh}{2}$$

$$d = \frac{2.09 \times 0.011}{2}$$

$$= 0.01m$$

For a 0.11m antenna at 2400MHz, the crossover point is 0.01m. This is less than the 0.2m safe distance stated in the manual, therefore the far-field calculation is appropriate.

Minimum distance requirement stated in the user manual

The minimum safe distance stated in the manual is 0.2m. This is outside the near/far field boundary so the far field occasion is appropriate to calculate the power density.

$$S_{far} = \frac{P\ G}{4\ \pi\ d^2}$$

$$= \frac{0.032 * 2.09}{4\ \pi \times 0.2^2}$$

$$= 0.13\ W/m^2$$

$$= 0.013\ mW/cm^2$$

External Antenna:

Two types of external antennae are specified for the TMBM1A: the GPSD “Sharkee”, produced by Panorama antennas which has a gain of 4dBi, and the WLP2458NGP-T, produce by PCTEL which has a gain of 3.2dBi. The higher gain of 4dBi is used for calculation.

Highest Transmitter Power :	16.5dbm = 0.05W
Antenna Type:	Roof mount multi band
Antenna Make:	Panorama Antennas
Specified Antenna Gain:	4dBi = 2.5
Antenna Length:	50mm
Antenna Coupling Loss:	2.5dB (Connector + 3m vehicle cable)
Antenna Height:	0.05m
Calculation Frequency:	2400MHz

Effective Transmit Power

P = net power output to the antenna (W)
= Specified transmitter power - Antenna Coupling Loss
= 16.5 – 2.5
= 14 dBm
= 25mW

Far Field boundary calculation

$$d = \frac{Gh}{2}$$

$$d = \frac{2.5 \times 0.05}{2}$$

$$= 0.06m$$

For a 0.05m antenna at 2400MHz, the crossover point is 0.06m. Therefore the far-field calculation is appropriate.

Minimum distance requirement stated in the user manual

The minimum safe distance stated in the manual is 0.2m. This is outside the near/far field boundary so the far field occasion is appropriate to calculate the power density.

$$S_{far} = \frac{P\ G}{4\ \pi\ d^2}$$

$$= \frac{0.025\ \times 2.5}{4\ \pi \times\ 0.2^2}$$

$$= 0.12\ W/m^2$$

$$= 0.12\ mW/cm^2$$

References:

1. 47CFR 1.1310 Radiofrequency radiation exposure limits
2. IEEE Std C95.3-2002 IEEE Recommended Practice for Measurements and Computations of Radio Frequency

End