

1 Test Sample Description:

Product Name: Torque Monitoring Sub

Functional Description: The Volant TMS torque sub is a wireless, battery powered connection monitoring sub installed on the drilling rig below the top-drive. The sub measures torque, turns, rotational speed, and hook load during the make-up of a drilling string or connection using a Casing Running Tool (CRT). This device is typically setup on the top of a casing rig.

Category: Mobile

Power supply: Internal Battery

BLE:

Frequency Range: 2402 – 2480 MHz

Mode of operation: BLE (DTS)

Antenna Description (2): Ceramic Patch Antenna Max Gain: 7 dBi

Directional Gain of 2 Antennas: 10 dBi

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2 Determination of exemption.

2.1 Limits for General Population/Uncontrolled Exposure: 47 CFR 1.1310 Table 1 (B)

The maximum exposure level to the public from the RF power of the EUT shall not exceed a power density, S as per the respective limits in Table 1 below, at a distance, d, of 20 cm (Mobile condition) from the EUT.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	*180/f ²	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30
Where f is in MHz		*Plane-wave equivalent power density		

3 Calculation:

Using equation i(B) as per determination of exemption, minimum antenna separation distance of 20 cm from the human body using the directional gain of two antenna.

Mode of operation	Data Rate	Channel	Freq. (MHz)	Measured Average Power ANT Port 1 (dBm)	Measured Average Power ANT Port 2 (dBm)	Duty Cycle correction Factor (dB)	Total Average Power Sum (dBm)	Antenna D.G. Gain (dBi)	EIRP (dBm)	EIRP (mW)	Limit Power density (mW/cm ²)
BLE	125Kbps	Low	2402	1.75	1.61	0.7	5.39	10	15.39	34.6	1
		Mid	2440	1.57	2.04		5.52		15.52	35.6	
		High	2480	1.15	0.87		4.72		14.72	29.6	
	500Kbps	Low	2402	2.13	2.26	0.4	5.61		15.61	36.4	
		Mid	2440	2.20	2.04		5.53		15.53	35.7	
		High	2480	1.38	1.20		4.70		14.70	29.5	
As per KDB 662911 D01 Multiple Transmitter Output v02r01, If any transmit signals are correlated with each other, Directional gain = GANT + 10 log(NANT) dBi = 7 + 10 log (2) = 10 dBi											

Using worst case scenario, the highest EIRP or [P*G(numeric gain)] value for the transmitter was rounded up to 37.0 mW.

Using the highest transmitted power at a distance of 20 cm in the equation below:

$$S = EIRP / (4\pi R^2)$$

Where: S, power density in 'mW/cm²'

EIRP, Effective Isotropic Radiated Power in 'mW'

R, distance to the center of the radiation of the antenna in 'cm'

The RF exposure from the radio is less than the limit specified as shown below and meets the exemption criteria.

$$S \text{ (mW/cm}^2\text{)} = (37 \text{ mW}) / (4 \times \pi \times 20^2)$$

S = 0.007360916 mW/cm2 <<< 1 mW/cm2 (max limit)

Rounded up $S = 0.0074 \text{ mW/cm}^2$ <<<<<< 1 mW/cm² (max limit)

To determine the minimum safe distance

$$R = \sqrt{[EIRP / (4\pi S)]}$$

$$R = \sqrt{[37 / (4\pi \times 1)]}$$

$$R = 1.715915629 \text{ cm}$$

Rounded up $R = 1.7 \text{ cm}$

4 Conclusion:

The manufacturer manual specified a minimum safe distance of 20 cm.

EUT meet SAR exemption limit