1   Test Sample Description:

Product Name: Deadman Transmitter

Functional Description: This device is a rechargeable battery-powered RF transceiver that transmits the state of an operator's Deadman switch to a paired transceiver. Pairing ensures the Deadman Transmitter commands are processed only by its designated receiver.

Power supply: Internal Battery

LoRa:

Frequency Range: 903 – 927 MHz

Mode of operation: DTS

Antenna Description: ISM 868/915MHz Flexible, Peak Gain (dBi) =1 dBi

Transmitter Category: Portable (A transmitting device designed to be used in other than fixed locations and to generally be used in such a way that the RF source's radiating structure(s) is/are within 20 centimeters of the body of the user.)

Reference Standards

§ 1.1310: Radiofrequency radiation exposure limits.

§ 2.1093: Radiofrequency radiation exposure evaluation: portable devices.

§ 1.1307(b)(3)(i)(b): For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section)

KDB 447498 D01 General RF Exposure Guidance v06

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2   Determination of exemption.

(i) For single RF sources (*i.e.,* any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B)

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20\,cm}(d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ \\ ERP_{20\,cm} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\,cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\,cm} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Table 1 to § 1.1307(b)(3)(i)(C)- Single RF Sources Subject to Routine Environmental Evaluation				
RF Source frequency (MHz)		Minimum Distance		Threshold ERP (watts)
FL	FH	$\lambda L/2\pi$	$\lambda H/2\pi$	
0.3	1.34	159 m	35.6m	1,920 R².
1.34	30	35.6 m	1.6m	3,450 R²/f².
30	300	1.6 m	0.159 m	3.83 R².
300	1,500	0.159 m	0.0318 m	0.0128 R² f.
1,500	100,000	0.0318 m	0.0005 m	19.2R².

R= minimum separation distance in meter
f= frequency in MHz

As per KDB 447498 D01 General RF Exposure Guidance v06 Appendix A

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

MHz	5	10	15	20	25	30	35	40	45	50	mm
900	16	32	47	63	79	95	111	126	142	158	SAR Test Exclusion Threshold (mW)
1500	12	24	37	49	61	73	86	98	110	122	

3   Calculation:

Using equation i(B) as per determination of exemption, minimum antenna separation distance of 0.5 cm from the human body, and maximum Tx frequency is 903 MHz.

ERP_{20cm} (mW) = 2040 x f (Frequencies = 0.3GHz ≤ f ≤ 1.5 GHz)

ERP_{20cm} (mW) = 2040 x 0.927 (GHz)

ERP_{20cm} = 1891.08 mW)

$x = -\log_{10} (60 / ERP_{20\,cm}\sqrt{f})$ (f in GHz)

$x = -\log_{10} (60 / 1891.08\sqrt{0.927})$

$x = 1.482098518$

Calculation for **24mm separation distance**

P_{th} (mW) = $ERP_{20\,cm}$ (d / 20 cm)^×

P_{th} (mW) = 1891.08 (2.4cm / 20 cm)^ 1.482098518

P_{th} = 81.65180524 (mW)

P_{th} = 81.652 (mW)

P_{th} = 19.1197 (dBm)

The Deadman Transmitter, antenna peak gain is 1.0 dBi, and therefore,

Antenna Gain dBd = dBi – 2.15

dBd = 1.0 – 2.15

dBd (Gain) = -1.15

ERP = Antenna port conducted Power + (-1.15)dBd

So

ERP ≤ P_{th}

ERP ≤ 19.12 dBm

Table 1 to § 1.1307(b)(3)(i)(C)- Single RF Sources Subject to Routine Environmental Evaluation				
RF Source frequency (MHz)		Minimum Distance		Threshold ERP (watts)
FL	FH	λL/2π	λH/2π	
300	1,500	0.159 m	0.0318 m	0.0128 R² f.
Deadman Transmitter Low and High Frequencies				
903	927	0.05287 m	0.05151 m	0.323W (25.092 dBm	0.315W (24.98 dBm)

TX (Mode)	Frequency (MHz)	Max Conducted RF Output 100% Duty Cycle (dBm)	Max. antenna gain (dBi)	Max. antenna gain (dBd)	ERP 100% Duty Cycle (dBm)	ERP 100% Duty Cycle (mW)	ERP Exemption limit ≥ 24mmSepration distance
LoRa 500 KHz DTS	903.0	19.58	1	-1.15	18.43	69.7	
	915.0	19.20	1	-1.15	18.05	63.8	
	927.0	19.51	1	-1.15	18.36	68.55	81.652 mW = 19.12 dBm
Maximum output power		20	1	-1.15	18.85	77.0	

4   Conclusion:

Deadman Transmitter is for professional use in industrial locations, and the general public is not exposed to the radio. As per the manufacturer, the closest separation distance from the transmitter at its final installation is ≥ 27mm (2.7cm) from any human body part.

EUT meet SAR exemption limit