Annexure – E1

Kavach

UHF Radio Modem Requirements

1. Introduction

This document describes the UHF Radio modem requirements to be used for the purpose of Kavach System.

2. Radio Modem Requirements

Radio Unit shall be as per following specifications:

2.1 Shall be FCC or IC or CE certified shall possess RTS/CTS and/or DOX modes

2.2 Shall be capable of RF Data Transfer in "Bitwise" / streaming Mode

2.3 RF frequency range: 406-470MHz

2.4 RF Channel Bandwidth : 25kHz

2.5 Modes of operation Full Duplex

2.6 Modulation : 2FSK at 19200 bps with linear 8th order low pass filter (raised – cosine alpha.1 approximation).

2.7 Deviation : 4.3 kHz +/- 0.1kHz. Occupied Bandwidth :16.35 kHz +/- 0.15 kHz

2.8 Operating frequencies : Ranging from 406 MHz to 470 MHz

i. Transmission by Station / Interlocked LC Gate / IBS : fs1, fs2, ...

ii. Regular Transmission by Loco: fm1, fm2, ...

iii. Additional Transmission by Loco dedicatedly for emergency/access request : f0

2.9 It shall be possible to set other frequencies in the range specified above, if so required at later stage.

2.10 Emission : according to 16K0F2D

2.11 Transmitter freq. stability : 1 ppm

2.12 Transmitter Turn-on time (Tx. Freq. stable)/ Channel Switching time: not more than 15msec

2.13 Carrier Output Power: 1-10 w adjustable through software.

2.14 Receiver Adjacent Channel Rejection 70dB at 25kHz

2.15 Receiver Sensitivity: 35 micro-volts for 12 dB SINAD /

2.16 1 x 10 -6 BER at -100 dBm Level for 19.2kbps and 25kHz Bandwidth

2.17 Interfaces: RS232/RS 485

2.18 RF Impedance : 50 ohm

2.19 Power Supply : 10V-30V DC

2.20 Set-up and Diagnostic features to be available through separate port RS232/RS485 and real time non-intrusive online diagnostics.

3. Functional Requirements

3.1 Modulation

3.1.1 The modulation used shall be 2FSK with 19,200 baud rate with linear 8th order low pass filter (raised cosine alpha 1 approximation).

3.1.2 Occupied bandwidth shall be 16.35kHz +/- 0.15kHz

3.1.3 The nominal deviation shall be 4.3kHz +/- 0.1kHz.

3.2 Transmission

3.2.1 During bit stream over the air transmission, LSB shall be transmitted first.

3.2.2 Transmission shall start within 3ms +/- 1ms after data terminal equipment causes the signal on RTS line to be high.

3.2.3 RTS shall be raised before commencement of preamble transmission.

3.2.4 Radio modem shall transmit based on the DTR, RTS and RI signals according to the table shown below:

DTS	RTS	Ring Indicator Status	Radio Modem
Low	*	Low	Won't transmit
High	Low	Low	Receiving or buffering Tx data
High	↑	↑	Transmit all buffered data and incoming data
High	High	High	Send all data in Tx buffer and continue transmitting even when Tx buffer is empty
High	↓	↓	Continue transmitting remaining data in Tx buffer, then unkey
↓	High	↓	Abort transmission, discard data in Tx buffer and unkey immediately

* : Don't Care
↑ : Transition from low to high
↓ : Transition from high to low

3.3 Encoding

3.3.1 The radio modem shall commence transmission by prefixing preamble (12 bytes of 0x7E) to the data received from DTE.

3.3.2 The radio modem shall complete transmission by suffixing post amble (5 bytes of 0x7E) to the modified data.

3.3.3 The data to be sent shall be encoded as shown in following Pseudo code. Encoder state shall be updated throughout the transmission.

Input _Bit = Input_bit XOR 1

Encoder State = Encoder State XOR Input_Bit

Output_Bit = Encoder State

Examples:

Case	**Consecutive Flag Characters**	**Two bytes of User Data (having all '0's)**	**Two bytes of User Data having all '1's with '0' stuffing**
Input bit stream	0111111001111110	0000000000000000	1111101111101111101
Output bit stream	011111101111111110	01010101010101010	00000011111100000011

3.3.4 Radio modem shall insert additional '0' after five consecutive '1's of data during transmission. For example,

0x7C - 01111100 is sent OTA as 011111000
0xF8 - 11111000 is sent OTA as 111110000
0x7E – 01111110 is sent OTA as 011111010
0xFE – 11111110 is sent OTA as 111110110

3.4 Scrambling

The encoded data shall be scrambled before stuffing of '0' bit as shown in following Pseudo code. Scrambler state shall be updated throughout the transmission.

Initialization

Scrambler_State= 0

When the bit is input:

Mask_Val = Scrambler_State AND 0x06

Feedback_Bit = 0

For (i = 0 to 6)

{ Feedback_Bit = Feedback_Bit XOR (Mask_Val AND 0x01)

Mask_Val = Mask_Val SHIFT RIGHT 1

i = i + 1 }

Output_Bit = Feedback_bit XOR Input_Bit

Scrambler_State = Scrambler_State SHIFT RIGHT 1

Scrambler_State = Scrambler_State OR (Output_Bit SHIFT LEFT 6)

Scrambler_State = Scrambler_State AND 0x7F

3.5 Receiving

3.5.1 The received data shall contain application data as well as preamble and post amble.

3.5.2 Reception of complete post amble (5 bytes of 0x7E) shall act as delimiter between two successive "Receive" bursts.

3.5.3 At the end of transfer of received data from radio modem to DTE, the radio modem shall additionally append "0xA5 – 0xC9 – 0xA5 – 0xC9" after the data.

3.5.4 After the data transfer to DTE, the EIA 232F function shall be switched to high from low, shall remain high for 2 ms and shall be switched to low again.

3.5.5 Refer the below timing diagram, for data transfer between Kavach sub-system and radio modem.