Ministry of Railways, Research, Design & Standards & Organisation (RDSO), Lucknow is interested in developing specifications for the development of **Full Duplex Radio Modem for UHF Communication based Railway Signalling projects involving communication among Base & mobile Locomotives.** Firms who have enough experience and capabilities in the field and ISO certificate and are interested in developing and supply of said item are requested to see the details on the RDSO websitehttp://www.rdso.gov.in or contact L.K.Mansukhani, Director, Signal, RDSO in Lucknow on any working day for further details.

The firms are requested to submit details in the prescribed format by **15th Jan 2015** to L.K.Mansukhani, Director, Signal, RDSO.

FORMAT FOR LETTER OF RESPONSE

Respondents Ref No.:
Date:

L.K. Mansukhani
Director, Signal,
2nd Floor
Building: Annexe -1
Research Designs & Standards Organization
Ministry of Railways
Manak Nagar
Lucknow,
INDIA 226011

Dear Sir,

Subject: RESPONSE TO – EOI FOR PARTICIPATION _____

1. We, the undersigned, offer the following information in response to the Expression of Interest sought by you vide your Notification No.- **NOTICE No**. **STS /E / FULL DUPLEX RADIO MODEM/Vol.1** dated **17/11/2014**.
2. We are duly authorized to represent and act on behalf of _____ (hereinafter the "respondent")
3. We have examined and have no reservations to the EOI Document including additional details (point no. 8) .
4. We are attaching with this letter, the copies of original documents defining: -
   4.1. the Respondent's legal status;
   4.2. its principal place of business;
   4.3. its place of incorporation (if respondents are corporations); or its place of registration (if respondents are cooperative institutions, partnerships or individually owned firms);
   4.4. Self-certified financial statements of Last three years, clearly indicating the financial turnover and net worth.
   4.5. Copies of any market research, business studies, feasibility reports and the like sponsored by the respondent, relevant to the project under consideration
5. We shall assist MoR and/or its authorized representatives to obtain further clarification from us, if needed.
   5.1. RDSO and/or its authorized representatives may contact the following nodal persons for further information on any aspects of the Response:

6. This application is made in the full understanding that:

S. No.	**Contact Name**	**Address**	**Telephone**	**E Mail**
1				
2				

6.1. Information furnished in response to EOI shall be used confidentially by RDSO for the purpose of development of the project.

6.2. RDSO reserves the right to reject or accept any or all applications, cancel the EOI and subsequent bidding process without any obligation to inform the respondent about the grounds of same.

6.3. We confirm that we are interested in participating in development of the project.

7. We certify that our turnover and net worth in the last three years is as under:

Financial Year	**Turn over**	**Net worth**

8. In response to the EOI we hereby submit the following additional details annexed to this application.

8.1. Details of supplies made in the field of item along with experience / expertise under EoI as per format given in Table C(i) of Annexure-C.

8.2. Details of man-power with their qualification and experience as per format given in Table C(ii) of Annexure-C.

8.3. Details of Intellectual Property Rights (IPR) held, patent filed/held and MoU/agreement signed as per format given in Table C(iii) of Annexure-C.

8.4. Detailed proposal for items proposed in EOI including alternative proposal, if any.

8.5. Details of ISO certification

8.6. Letter of agreement from OEM Associate with OEM's view whether they would consider manufacturing of the product in India meeting the RDSO Specification so developed.

8.7. Marks calculated as per Annexure-B for "head 2 under Criteria for Shortlisting".

8.8. Undertaking as per Annexure-A:

9. The undersigned declare that the statements made and the information provided in the duly completed application are complete, true, and correct in every detail. We also understand that in the event of any information furnished by us being found later on to be incorrect or any material information having been suppressed, RDSO may delete our name from the list of qualified Respondents. We further understand that RDSO will give first preference to the applicants considered relevant for the purpose

10. Our response is valid till (date in figures and words):

_____

Yours sincerely,

(Sign)
NAME
In the Capacity of
(Duly authorized to sign the response for and on behalf of …….)
Date

Annexure-A

*(*To be taken on non-judicial stamp paper of appropriate value as applicable in the respective state and dully notarised & witnessed)

UNDERTAKING

I, son of …… aged about …..... Years resident of …….. do hereby solemnly affirm as under

1. That the deponent is the Authorised signatory of *(Name of the Sole Proprietorship Concern/Partnership Firm/ Registered Company/ Joint Venture).*

2. That the deponent declares on behalf of *(Name of the Sole Proprietorship Concern/ Partnership Firm/ Registered Company/Joint Venture)* that:

a) In regard to matters relating to the security and integrity of the country, no charge sheet has been filed by an agency of the Government / conviction by a Court of Law for an offence committed by the ----------(name of the entity)or by any sister concern of the ----------(name of the entity) would result in disqualification.

b) In regard to matters other than the security and integrity of the country, ----------(name of the entity) has not been convicted by a Court of Law or indicted / passed any adverse order by a regulatory authority against it or it's any sister concern which relates to a grave offence, or would constitute disqualification. Grave offence is defined to be of such a nature that it outrages the moral sense of the community.

DEPONENT

VERIFICATION

I declare that the contents of para 1 to 2 above are true as per my knowledge and nothing has been hidden.

DEPONENT

CRITERIA FOR SHORTLISTING: Table A

SN	Item	Marks	Remarks
1.	Turnover of the firm during last 3 years. Firm needs to substantiate through documents.	20	Firm having maximum be given full marks and other as percentile.
2.	Details of supplies made in the field of item under EoI along with weightage to experience / expertise	60	See Annexure B Table B(i) & Table B(ii)
3.	Manpower & their qualification	10	See Annexure B Table B (iii)
4.	Number of patents held by firm in the field of Radio Communication	10	Firm having maximum be given full marks and other as percentile.

Annexure-B

Details of supplies made in the field of item under EoI : Table B(i) :

Item	Whether supply of item has been made either by the participating agency or by OEM under agreement with the participating agency for the item	Whether substan-tiated by Supporting document for item in previous column	Marks as below If the entries in previous two columns are "Yes". Otherwise, it is " 0 (zero)"	Experience / Expertise Factor (B) (Please see table below for calculation)
UHF Radio Modem	Yes / No	Yes / No	A1 = 30	B1 = 1.0/0.8/0.6/0.4/0.2/0.0
Deployment of Radio Modem in mobile Railway Applications	Yes / No	Yes / No	A2 = 8	B2 = 1.0/0.8/0.6/0.4/0.2/0.0
Deployment of Radio Modem in multi OEM Over-The-Air Interoperable Systems	Yes / No	Yes / No	A3 = 8	B3 = 1.0/0.8/0.6/0.4/0.2/0.0
Active Radio Components such as Power Amplifier, Low Noise Amplifier, Frequency Synthesizer, etc. other than as built-in part of radio	Yes / No	Yes / No	A4 = 6	B4 = 1.0/0.8/0.6/0.4/0.2/0.0
Base Station UHF Antenna	Yes / No	Yes / No	A5 = 2	B5 = 1.0/0.8/0.6/0.4/0.2/0.0
Mobile Vehicle UHF Antenna	Yes / No	Yes / No	A6 = 2	B6 = 1.0/0.8/0.6/0.4/0.2/0.0
Transmission Line components such as UHF cable, connectors, Passive Duplexers, Splitter, etc	Yes / No	Yes / No	A7 = 2	B7 = 1.0/0.8/0.6/0.4/0.2/0.0
UHF Radio Measuring Instruments	Yes / No	Yes / No	A8 = 2	B8 = 1.0/0.8/0.6/0.4/0.2/0.0

Calculation of Experience / expertise factor (B) (to be calculated individually for each item) : Table B(ii) :

More than 5 years	1.0
4 to 5 years	0.8
3 to 4 years	0.6
2 to 3 years	0.4
1 to 2 years	0.2
Less than 1 year	0.0
Notes: (i) Number of completed years since first supply shall be counted (ii) Experience/ Expertise factor will be calculated for individual items of Table A	

Marks under Head 2 of Criteria for Shortlisting

Marks = (A1 x B1) + (A2 x B2) + (A3 x B3) + (A4 x B4) + (A5 x B5) + (A6 x B6) + (A7 x B7) + (A8 x B8)

Manpower and their Expertise : Table B(iii) :

Criteria	Maximum Marks	Remarks
Number of Graduates or above Engineers including B.Sc. (Engg) & M.Sc. (Engg)	7	Firm having maximum be given full marks and other as percentile.
Number of other Engineers /Technicians / Scientists	3	Firm having maximum be given full marks and other as percentile.

Note:
Only those engineers / technicians / scientists who are involved in the radio communication related fields with participating firm or its OEM associate under agreement and possessing indicated qualification are only to be considered for aforesaid evaluation.

Annexure - C

Following details are required to be provided by the participating agency:

Table C(i):

Item	Whether supply of item has been made either by the participating agency or by OEM under agreement with the participating agency for the item (Yes / No)	Reference of document in the offer to support the claim made for item in previous column (Yes / No)	Experience / Expertise (Number of completed years since first supply of the item)
UHF Radio Modem	Yes / No	Yes / No	
Deployment of Radio Modem in mobile Railway Applications	Yes / No	Yes / No	
Deployment of Radio Modem in multi OEM Over-The-Air Interoperable Systems	Yes / No	Yes / No	
Active Radio Components such as Power Amplifier, Low Noise Amplifier, Frequency Synthesizer, etc. other than as built-in part of radio	Yes / No	Yes / No	
Base Station UHF Antenna	Yes / No	Yes / No	
Mobile Vehicle UHF Antenna	Yes / No	Yes / No	
Transmission Line components such as UHF cable, connectors, Passive Duplexers, Splitter, etc	Yes / No	Yes / No	
UHF Radio Measuring Instruments	Yes / No	Yes / No	

Table C(ii):

Staff category	Number of staff
Engineers associated with participating firm or its OEM Associate under agreement continuously for more than one year and possessing qualification during such involvements as Graduates or above Engineers including B.Sc. (Engg) & M.Sc. (Engg)	
Engineers associated with participating firm or its OEM Associate under agreement continuously for more than one year and possessing qualification during such involvements as other Engineers /Technicians / Scientists	

Note:
Only those engineers / technicians / scientists who are involved in the radio communication related fields with participating firm or its OEM associate under agreement and possessing indicated qualification are only to be considered.

Table C (iii):

SN	Brief description of patent	Whether patent is owned (partially or fully) by participating agency or its OEM Associate under agreement or both	Patent ID / Patent Number	Whether the patent is filed or held
Total ……. Number of patents filed / held				

RESEARCH DESIGNS & STANDARDS ORGANIZATION

Manak Nagar,Lucknow-226011

FUNCTIONAL REQUIREMENT SPECIFICATION FOR FULL DUPLEX RADIO MODEM FOR 400 MHz BAND UHF COMMUNICATION BASED RAILWAY SIGNALLING

Version 0.1

1.0 INTRODUCTION

1.1 This document sets forth general, operational, system, technical, functional and performance requirements of Radio Modem.

1.2 This Radio Modem is intended to be used in Railway applications for providing full duplex UHF communication among onboardequipments such as fast moving Locomotive and Base Stations in various types of terrains & topography with open protocol without any proprietary fields Over –The-Air so as to enable multi-supplier interoperability.

2.0 Abbreviations and Definitions

CTS	Clear to Send
CWID	Continuous Wave Identification
DOX	Data Operated Transmit
DTE	Data Terminal Equipment
FCC	Federal Communications Commission
FSK	Frequency Shift Keying
HS	Handshake
MTBF	Mean Time between Failures
OTA	Over-The-Air
RI	Ring Indicator
RSSI	Received Signal Strength Indication
RTS	Request to Send
Rx	Receive
TNC	Threaded Neill-Councelman Connector
Tx	Transmit
VDC	Voltage, Direct Current
Acceptance Tests	Test carried out on the equipment / system for the purpose of acceptance of equipment / system.
Routine Tests	Tests carried out on the equipment / system by the manufacturer before offering for inspection.
Type Tests	Tests carried out to prove conformity with the specification. These are intended to prove general qualities and design of equipment / system.

3.0 General Requirements

3.1 Radio modem shall form the interface between data terminal equipment and antenna.

3.2 Radio modem shall be able to communicate on full duplex mode.

3.3 Radio modem shall be able to work as a standalone device as well as with suitable duplexer.

3.4 The antennas used shall have DC grounded active elements.

3.5 There shall not be any proprietary field over the air.

3.6 The output power of the transmitting antenna shall be user adjustable.

3.7 The CWID parameters like CWID type, CWID duration, CWID repeat interval, 'Enable' CWID shall be configurable.

3.8 The channel bandwidth shall be user adjustable.

3.9 There shall be a facility to select between "RTS/CTS handshaking mode" and "DOX mode".

3.10 There shall be facility to use any of RS 232, RS422 or RS485 serial communication.

3.11 The radio modem shall support following operation modes:

Mode	Description
Sync/ESC with no HS	Sends data using Sync/ESC byte stuffing protocol without handshaking
Buffered with no HS	Sends buffered data without handshaking
Sync/ESC with RTS/CTS HS	Sends data using the Sync/ESC byte stuffing protocol with RTS/CTS hardware handshaking
Buffered with RTC/CTS HS	Sends buffered data with RTS/CTS hardware handshaking
Sync/ESC with flow control HS	Sends data using Sync/ESC byte stuffing protocol with flow control handshaking
Buffered with flow control HS	Sends buffered data with flow control handshaking

3.12 There shall be provisions for configuring Baud rate, Data bits, parity and stop bits.

3.13 It shall be possible to disable/enable check for traffic on the RF channel before beginning a transmission.

3.14 It should support 8 configurable different link configurations which would include frequency channel pairs. It shall be possible to dynamically control frequency channel, power output.

3.15 It shall be possible to tune to altered Tx and Rx frequencies within end to end delay of 15ms between command and effective OTA communication.

3.16 It shall include antenna, mounting bracket, surge protector, grounding kit, cable ties, 18" TNC male to N-male jumper cable and weather kit.

4.0 Operational Requirements

4.1 General

Frequency Range	Typical 400MHz/406MHz – 512 MHz
Channel Bandwidth	12.5 kHz, 25 kHz
Modes of Operation	Simplex, Half-Duplex, Full Duplex
Modulation	2FSK
Certification	FCC, IC

4.2 **Receiver**

Bit Error Rate @ 1 x 10^{-6}	12.5 kHz	-107dBm @ 9.6 kbps
		-110 dBm @ 4.8 kbps
	25 kHz	-100 dBm @ 19.2 kbps
		-107 dBm @ 9.6 kbps
		-110 dBm @ 4.8 kbps
Adjacent Channel Rejection	12.5 kHz	60 dB
	25 kHz	70 dB

4.3 **Transmitter**

Carrier Output Power	1-10 W
Frequency Stability	1 ppm
Duty Cycle	100 %
Output Impedance	50 Ω

4.4 **Electrical**

Tx Current	1.2-3.6A @ 10V
	0.6-1.8A @ 20V
	0.4-1.2A @ 30V
Rx Current	360mA @ 10V
	200mA @ 20V
	150mA @ 30V
Primary Power	10 – 30 VDC

4.5 **Connectivity**

4.5.1 Radio modem shall have user interface block connector for Audio IN, Audio OUT, RSSI OUT and configuration select

4.5.2 Radio modem shall have 50Ω TNC female antenna connector

4.5.3 Radio modem shall have 50Ω SMA female receive antenna connector

4.5.4 Radio Modem shall have Right angle power connector

4.5.5 Radio modem shall have 2 DE-9F RS-232 ports

4.5.6 Radio modem shall have RS 232, RS 422 and RS 485 connectivity

4.6 The dimensions of radio modem shall not exceed 14 x 6 x 11 cm^3

4.7 Radio modem shall be able to work continuously in the temperature range :"-30^0C to +60^0C" for 100% duty cycle and "-30^0C to +70^0C" for duty cycle below 50% at 10W output power

5.0 Technical Requirements

5.1 Modulation

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

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

5.1.3 The nominal deviation shall be 4.3kHz +/- 0.1kHz

5.2 **Transmission**

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

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

5.2.3 RTS shall be raised before commencement of preamble transmission.

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

DTR	**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

5.3 **Encoding**

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

5.3.2 The radio modem shall complete transmission by suffixing post amble (5 bytes of 0x7E) to the modified data, as per clause 6.3.2.

5.3.3 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	01111111011111110	01010101010101010	00000011111100000011

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

0x7C - 01111100 is sent OTA as 011111 0 00
0xF8 - 11111000 is sent OTA as 11111 0 000

5.4 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
    Scarmbler_State = Scrambler_State OR (Output_Bit SHIFT LEFT 6)
    Scrambler_State = Scrambler_State AND 0x7F
```

5.5 Receiving

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

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

5.5.3 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.

5.5.4 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.

5.6 Diagnostics

5.6.1 The radio modem shall have diagnostics facility for easy and early localizations of faults

5.6.2 The diagnostics for radio modem include both online and offline diagnostics

5.6.2.1 There shall be facility for online diagnosis so that remote monitoring can be achieved. The parameters for online diagnosis shall include

5.6.2.1.1 Short ID
5.6.2.1.2 RSSI
5.6.2.1.3 Temperature

5.6.2.1.4 Battery Voltage
5.6.2.1.5 Forward Power
5.6.2.1.6 Reverse Power
5.6.2.1.7 Time

5.6.2.2 There shall be facility to monitor following parameters through diagnostic port

5.6.2.2.1 RSSI
5.6.2.2.2 Temperature
5.6.2.2.3 Battery Voltage
5.6.2.2.4 Forward Power
5.6.2.2.5 Reverse Power
5.6.2.2.6 AnalogVcc
5.6.2.2.7 Preamble Good
5.6.2.2.8 Preamble Total
5.6.2.2.9 Preamble DCD

6.0 The MTBF of radio modem shall be minimum 1,00,000 Hrs.

7.0 <u>Quality Assurance</u>

7.1 All materials and workmanship shall be of good quality. Since the quality of the equipment bears a direct relationship to the manufacturing process and the environment under which it is manufactured, the manufacturer shall ensure Quality Assurance Program of adequate standard.

7.2 All test instruments shall be available with the manufacturer.

7.3 The manufacturer shall have detailed Quality Assurance Plan to ensure quality of the product. The manufacturer shall also possess ISO certification of the product.

8.0 The manufacturer shall, as a minimum, submit following hardware and software design documentation:

8.1 System requirement specification
8.2 Failure mode effect analysis
8.3 Operating manual
8.4 Maintenance manual

9.0 <u>Tests and Verification</u>

9.1 The test procedure shall be based on the product design and is required to be provided by the manufacturer. The methodologies to be adopted for various tests shall be decided taking into account the design / configuration of the product and shall be approved by RDSO.

9.2 The formats for conducting following tests shall be designed and provided by the manufacturer and approved by RDSO

9.2.1 Type Tests
9.2.2 Acceptance Tests
9.2.3 Routine Tests
9.2.4 Integration Tests

10.0 Other Specifications to be followed

10.1 Variation and interruption of voltage supply to equipment tests as per clause 3.1.1.1 and 3.1.1.2 of IEC 60571 – 1998 or relevant clause of latest amendment / issue.

10.2 Supply over voltage, surges and electrostatic discharge tests as per clause 10.2.6 of IEC 60571 – 1998 or relevant clause of latest amendment / issue.

10.3 Transient burst and susceptibility test as per clause 10.2.7 of IEC 60751 – 1998 or relevant clause of latest amendment / issue.

10.4 Radio interface test as per clause 10.2.8 of IEC 60751 – 1998 or relevant clause of latest amendment / issue.

10.5 Insulation test as per clause 10.2.9 of IEC 60751 – 1998 or relevant clause of latest amendment / issue.