

TFR, a division of

TRANSNET SOC LTD

Registration Number 1990/000900/30

[hereinafter referred to as **Transnet**]

REQUEST FOR QUOTATION [RFQ] No SAZ /53148

FOR THE SUPPLY AND DELIVERY OF PORTABLE RADIOS

FOR DELIVERY TO: TELECOMS DEPOT OREX BUILDING SALDANHA

ISSUE DATE: 28.08.2014

CLOSING DATE: 09.09.2014

CLOSING TIME: 10.00

"PREVIEW COPY ONLY"

Respondent's Signature

Date & Company Stamp

Section 1
NOTICE TO BIDDERS

Quotations which must be completed as indicated in Section 2 of this RFQ are to be submitted as follows:

METHOD: Courier or hand delivered
CLOSING VENUE: SEE BELOW FOR CLOSING VENUE

1 Responses to RFQ

Responses to this RFQ [**Quotations**] must not include documents or reference relating to any other quotation or proposal. Any additional conditions must be embodied in an accompanying letter. Proposals must reach the Secretariat, Acquisition Council before the closing hour on the date shown below, and must be enclosed in a sealed envelope which must have inscribed on the outside:

RFQ No: SAZ / 53148
Description SUPPLY AND DELIVERY OF PORTABLE RADIOS FOR SALDANHA

Closing date and time: 09 September 2014 AT 10:00 Sharp

Closing address [Refer to options in Delivery Instructions for RFQ below]

All envelopes must reflect the return address of the Respondent on the reverse side.

1 DELIVERY INSTRUCTIONS FOR RFQ

1.1 Delivery by hand

If delivered by hand, the envelope is to be deposited in the Transnet Freight Rail Tender box which is located at the main entrance of Transnet Park, ROBERT SOBUKWE Road, Bellville, and should be addressed as follows:

THE SECRETARIAT
ACQUISITION COUNCIL
TRANSNET PARK
TENDER BOX
ROBERT SOBUKWE ROAD
BELLVILLE 7535

The measurements of the "tender slot" are 400mm wide x 100mm high, and Respondents must please ensure that response documents or files are no larger than the above dimensions. Responses which are too bulky [i.e. more than 100mm thick] must be split into two or more files, and placed in separate envelopes, each such envelope to be addressed as above.

Respondent's Signature

Date & Company Stamp

1.2 Dispatch by courier

If dispatched by courier, the envelope must be addressed as follows and delivered to the Office of The Secretariat, Acquisition Council and a signature obtained from that Office:

THE SECRETARIAT
TRANSNET ACQUISITION COUNCIL
6TH FLOOR
TRANSNET PARK
ROBERT SOBUKWE ROAD
BELLVILLE 7535

Please note that this RFQ closes punctually at **10.00 on Tuesday 09 September 2014**

1. If responses are not delivered as stipulated herein, such responses will not be considered and will be treated as "NON-RESPONSIVE" and will be disqualified.
2. No email or facsimile responses will be considered, unless otherwise stated herein.
3. The responses to this RFQ will be opened as soon as practicable after the expiry of the time advertised for receiving them.
4. Transnet shall not, at the opening of responses, disclose to any other company any confidential details pertaining to the Proposals / information received, i.e. pricing, delivery, etc. The names and locations of the Respondents will be divulged to other Respondents upon request.
5. Envelopes must not contain documents relating to any RFQ other than that shown on the envelope.

2 Broad-Based Black Economic Empowerment [B-BBEE]

Transnet fully endorses and supports the Government's Broad-Based Black Economic Empowerment Programme and it would therefore prefer to do business with local business enterprises who share these same values. Transnet will accordingly allow a "preference" to companies who provide a valid B-BBEE Verification Certificate. All procurement transactions will be evaluated accordingly.

2.1 B-BBEE Scorecard and Rating

As prescribed in terms of the Preferential Procurement Policy Framework Act (PPPFA), Act 5 of 2000 and its Regulations, Respondents are to note that the following preference point system is applicable to all bids:

- the 80/20 system for requirements with a Rand value of up to R1 000 000 (all applicable taxes included)
- Bidders are to note that if the 80/20 preference point system is stipulated in this RFQ and all Bids received exceed R1 000 000.00, the RFQ must be cancelled.

The value of this bid is estimated to be below R1000 000 (all applicable taxes included) and therefore the **80/20** system shall be applicable.

5 VAT Registration

The valid VAT registration number must be stated here: _____ [if applicable].

6 Legal Compliance

The successful Respondent shall be in full and complete compliance with any and all applicable national and local laws and regulations.

7 Changes to Quotations

Changes by the Respondent to its submission will not be considered after the closing date and time.

8 Pricing

All prices must be quoted in South African Rand on a fixed price basis, excluding VAT.

9 Prices Subject to Confirmation

Prices quoted which are subject to confirmation will not be considered.

10 Negotiations

Transnet reserves the right to undertake post-tender negotiations with selected Respondents or any number of short-listed Respondents.

11 Binding Offer

Any Quotation furnished pursuant to this Request shall be deemed to be an offer. Any exceptions to this statement must be clearly and specifically indicated.

12 Disclaimers

Transnet is not committed to any course of action as a result of its issuance of this RFQ and/or its receipt of a Quotation in response to it. Please note that Transnet reserves the right to:

- modify the RFQ's goods / service(s) and request Respondents to re-bid on any changes;
- reject any Quotation which does not conform to instructions and specifications which are detailed herein;
- disqualify Quotations submitted after the stated submission deadline;
- not necessarily accept the lowest priced Quotation;
- reject all Quotations, if it so decides;
- place an order in connection with this Quotation at any time after the RFQ's closing date;
- award only a portion of the proposed goods / service/s which are reflected in the scope of this RFQ;
- split the award of the order/s between more than one Supplier/Service Provider; or
- make no award at all.

Transnet reserves the right to award business to the highest scoring bidder/s unless objective criteria justify the award to another bidder.

13 Transnet's supplier integrity pact

Transnet's Integrity Pact requires a commitment from suppliers and Transnet that they will not engage in any corrupt and fraudulent practices, anti-competitive practices; and act in bad faith towards each other. The Integrity Pact also serves to communicate Transnet's Gift Policy as well as the remedies available to Transnet where a Respondent contravenes any provision of the Integrity Pact.

Respondents are required to familiarise themselves with the contents of the Integrity Pact which is available on the Transnet Internet site [www.transnet.net/Tenders/Pages/default.aspx] or on request. Furthermore, Respondents are required to certify that they have acquainted themselves with all the documentation comprising the Transnet Integrity Pact and that they fully comply with all the terms and conditions stipulated in the Transnet Supplier Integrity Pact as follows:

| | | | |
|------------|--------------------------|-----------|--------------------------|
| YES | <input type="checkbox"/> | NO | <input type="checkbox"/> |
|------------|--------------------------|-----------|--------------------------|

Should a Respondent need to declare previous transgressions or a serious breach of law in the preceding 5 years as required by Annexure A to the Integrity Pact, such declaration must accompany the Respondent's bid submission.

"PREVIEW COPY ONLY"

14 Evaluation Criteria

Transnet will utilise the following criteria [not necessarily in this order] in choosing a Supplier/Service Provider, if so required:

| Criterion/Criteria | Explanation |
|---|--|
| Administrative responsiveness | Completeness of response and returnable documents |
| Substantive responsiveness | Prequalification criteria, if any, must be met and whether the Bid materially complies with the scope and/or specification given. <ul style="list-style-type: none"> • Submit certificate to proof radios is ICASA approved |
| Functionality Threshold | As prescribed in terms of the Preferential Procurement Policy Framework Act (PPPFA), Act 5 of 2000 and its Regulations, Respondents are to note that functionality is included as threshold with a prescribed percentage threshold of 80%. The minimum threshold of 80% must be met or exceeded for a Bidders proposal to progress to the next stage of evaluation. |
| Final weighted evaluation based on 80/20 preference point system as indicated in paragraph 2 | <ul style="list-style-type: none"> • Pricing and price basis [firm] - whilst not the sole factor for consideration, competitive pricing and overall level of unconditional discounts¹ will be critical • B-BBEE status of company - Preference points will be awarded to a bidder for attaining the B-BBEE status level of contribution in accordance with the table indicated below. |

Preference points will be awarded to a bidder for attaining the B-BBEE status level of contribution in accordance with the table below:

| B-BBEE Status Level of Contributor | Number of points (80/20 system) |
|------------------------------------|---------------------------------|
| 1 | 20 |
| 2 | 18 |
| 3 | 16 |
| 4 | 12 |
| 5 | 8 |
| 6 | 6 |
| 7 | 4 |
| 8 | 2 |
| Non-compliant contributor | 0 |

¹ Only unconditional discounts will be taken into account during evaluation. A discount which has been offered conditionally will, despite not being taken into account for evaluation purposes, be implemented when payment is effected.

Technical Evaluation Criteria

The Technical criteria and maximum score in respect of each of the criteria are as follows:

| Technical criteria | Sub-criteria Maximum number of Points | Checklist for submission Yes / No |
|---|---|---|
| Compliance To Specifications | 60% | |
| Number of Projects with Reference | 20% | |
| Delivery Lead Time | 20% | |
| Maximum possible score for quality (Ms) | 100 | |

The minimum Threshold for technical criteria is 80%

The minimum threshold of 80% must be met or exceeded for a Bidder's proposal to progress to the next stage of evaluation.

NB: Kindly ensure that you submit with your proposal all the required documentation for the technical criteria mentioned above.

15 Validity Period

Transnet desires a validity period of 30 [thirty] days from the closing date of this RFQ.

This RFQ is valid until _____.

Banking Details

BANK: _____

BRANCH NAME / CODE: _____

ACCOUNT HOLDER: _____

ACCOUNT NUMBER: _____

16 Company Registration

Respondent's Signature

Date & Company Stamp

Registration number of company / C.C _____

Registered name of company / C.C _____

17 Disclosure of Prices Quoted

Respondents must indicate here whether Transnet may disclose their quoted prices and conditions to other

Respondents:

YES NO

18 Returnable Documents

Returnable Documents means all the documents, Sections and Annexures, as listed in the tables below.

- a) Respondents are required to submit with their Quotations the **mandatory Returnable Documents**, as detailed below.

Failure to provide all these Returnable Documents at the Closing Date and time of this RFQ may result in a Respondent's disqualification. Respondents are therefore urged to ensure that all these Documents are returned with their Quotations.

All Sections, as indicated in the footer of each page, must be signed, stamped and dated by the Respondent. Please confirm submission of these Returnable Documents by so indicating [Yes or No] in the table below:

| Mandatory Returnable Documents |
|---|
| SECTION 2 : Quotation Form |
| APPENDIX A: Schedule of Requirements |
| APPENDIX B & C: Bill of Quantities and Cost Schedule |
| APPENDIX D & E: Delivery Schedule for Equipment |
| APPENDIX F: Number of Projects with References |
| ANNEXURE A: Specification document BBD 8635 Version 8 dated May 2014 |
| ANNEXURE B : Specification document BBF 2516 Version 3.00 dated 6 June 2014 |
| Submit Current Icasa Radio Certificate |

- b) In addition to the requirements of paragraph a) above, Respondents are further requested to submit with their Quotations the following **essential returnable documents** as detailed below.

Failure to provide all these Returnable Documents may result in a Respondent's disqualification. Respondents are therefore urged to ensure that all these documents are returned with their Quotations.

All Sections, as indicated in the footer of each page, must be signed, stamped and dated by the Respondent. Please confirm submission of these Returnable Documents by so indicating [Yes or No] in the table below:

Respondent's Signature

Date & Company Stamp

| Essential Returnable Documents | Submitted [Yes or No] |
|---|-----------------------------|
| SECTION 1 : Notice to Bidders | |
| <ul style="list-style-type: none"> - Valid and original B-BBEE Verification Certificate or certified copy thereof [Large Enterprises and QSEs] Note: failure to provide a valid B-BBEE Verification Certificate at the closing date and time of the RFQ will result in an automatic score of zero for preference | |
| <ul style="list-style-type: none"> - Valid and original B-BBEE certificate/sworn affidavit or certified copy thereof from auditor, accounting officer or SANAS accredited Verification Agency [EMEs] Note: failure to provide a valid B-BBEE Verification Certificate at the closing date and time of the RFQ will result in an automatic score of zero being allocated for preference | |
| <ul style="list-style-type: none"> - In the case of Joint Ventures, a copy of the Joint Venture Agreement or written confirmation of the intention to enter into a Joint Venture Agreement | |
| <ul style="list-style-type: none"> - Original valid Tax Clearance Certificate [Consortia / Joint Ventures must submit a separate Tax Clearance Certificate for each party] | |
| SECTION 3: Vendor Application Form | |
| <ul style="list-style-type: none"> • Original cancelled cheque or bank verification of banking details | |
| <ul style="list-style-type: none"> • Certified copies of IDs of shareholder/directors/members [as applicable] | |
| <ul style="list-style-type: none"> • Certified copies of the relevant company registration documents from Companies and Intellectual Property Commission (CIPC) | |
| <ul style="list-style-type: none"> • Certified copies of the company's shareholding/director's portfolio | |
| <ul style="list-style-type: none"> • Entity's letterhead | |
| <ul style="list-style-type: none"> • Certified copy of VAT Registration Certificate [RSA entities only] | |
| <ul style="list-style-type: none"> • Certified copy of valid Company Registration Certificate [if applicable] | |

Respondent's Signature

Date & Company Stamp

Section 2 QUOTATION FORM

I/We _____
hereby offer to supply the goods/services at the prices quoted in the Price Schedule below, in accordance with the conditions related thereto.

I/We agree to be bound by those terms and conditions in:

- the Standard Terms and Conditions for the Supply of Goods or Services to Transnet [available on request]; and
- any other standard or special conditions mentioned and/or embodied in this Request for Quotation.

I/We accept that unless Transnet should otherwise decide and so inform me/us, this Quotation [and, if any, its covering letter and any subsequent exchange of correspondence], together with Transnet's acceptance thereof shall constitute a binding contract between Transnet and me/us.

I/We further agree that if, after I/we have been notified of the acceptance of my/our Quotation, I/we fail to deliver the said goods/service/s within the delivery lead-time quoted, Transnet may, without prejudice to any other legal remedy which it may have, cancel the order and recover from me/us any expenses incurred by Transnet in calling for Quotations afresh and/or having to accept any less favourable offer.

Price Schedule

I/We quote as follows for the goods required, to be delivered at Telecoms Depot Orex Building Saldanha excluding Vat: **PROJECT SPECIFICATION REFER TO ANNEXURE A and B**

| Item No | Description of Goods /Services | Unit of Measure | Quantity | Unit Price (ZAR) | Total Price (ZAR) |
|---------|--------------------------------|-----------------|----------|------------------|-------------------|
| 1 | SEE APPENDIX A,B,C,D | | | | |

Delivery Lead-Time from date of purchase order : _____ [days/weeks]

Notes to Pricing:

All Prices must be quoted in South African Rand, exclusive of VAT

To facilitate like-for-like comparison bidders must submit pricing strictly in accordance with this price schedule and not utilise a different format. Deviation from this pricing schedule could result in a bid being disqualified.

Please note that should you have offered a discounted price(s), Transnet will only consider such price discount(s) in the final evaluation stage if offered on an unconditional basis.

Respondent's Signature

Date & Company Stamp

Section 3

STANDARD TERMS AND CONDITIONS FOR THE SUPPLY OF GOODS OR SERVICES TO TRANSNET

A Supplier/Service Provider shall be obliged to adhere to the Standard Terms and Conditions for the Supply of Goods and Services to Transnet as expressed hereunder. Should the Respondent find any condition(s) unacceptable, it should indicate which condition(s) is/are unacceptable and offer an alternative(s). A Quotation submitted by a Respondent will be subjected to review and acceptance or rejection of its proposed contractual terms and conditions by Transnet's Legal Counsel, prior to consideration for an award of business.

1 SOLE AGREEMENT

Unless otherwise agreed in writing, these terms [**Terms** and each **Term**] and Transnet's purchase order(s) [**Order** or **Orders**] represent the only conditions upon which Transnet SOC Ltd [**Transnet**] procures goods [**the Goods**] or services [**the Services**] specified in the Order from the person to whom the Order is addressed [**the Supplier/Service Provider**]. Transnet does not accept any other conditions which the Supplier/Service Provider may specify, unless otherwise agreed to by Transnet in writing. In the event of any inconsistency between these Terms and any Order, these Terms shall take precedence.

2 CONFORMITY WITH ORDER

Goods/Services shall conform strictly with the Order. The Supplier/Service Provider shall not vary the quantities specified and/or the specification, if any, stipulated in the Order, without the prior written consent of Transnet. The Supplier/Service Provider warrants that the Goods/Services shall be fit for their purpose and of satisfactory quality.

3 DELIVERY AND TITLE

- 3.1 The delivery dates and addresses are those in the Order. Time shall be of the essence in respect of the Supplier's/Service Provider's obligations under the Order.
- 3.2 The Supplier/Service Provider will not be excused for delay in delivery or performance except due to circumstances outside its control and then only subject to the Supplier/Service Provider having notified Transnet in writing on becoming aware of such circumstances. Transnet may terminate an Order, in whole or in part, without incurring any liability to the Supplier/Service Provider if such a delay becomes, in Transnet's absolute opinion, significant.
- 3.3 Risk of loss or damage to Goods shall pass to Transnet on delivery and acceptance, and title shall pass to Transnet when payment to the Supplier for the Goods has been effected.
- 3.4 If on delivery, the Goods/Services do not conform to the Order, Transnet may reject the Goods/Services and the Supplier/Service Provider shall promptly rectify any defects or in Transnet's opinion, supply appropriate replacement Goods/Services at the Supplier's/Service Provider's expense within the specified delivery times, without any liability due by Transnet. Goods shall be subject to such testing and/or inspection as Transnet may consider necessary.

4 PRICE AND PAYMENT

- 4.1 Prices specified in an Order cannot be increased. Payment for the Goods/Services shall be made by Transnet against an original undisputed invoice(s) [a Tax Invoice], supporting documentation and month-end statement from the Supplier/Service Provider. Tax Invoices plus supporting documentation shall be posted to the address shown in the Order.
- 4.2 Payment of the Supplier's/Service Provider's valid Tax Invoice(s) will be made by Transnet in the South African currency and on the terms stated in the Order, the standard payment terms being 30 [thirty] days from date of receipt by Transnet of a month-end statement, unless otherwise agreed to in writing. Transnet shall arrange for payment of such Tax Invoices and any pre-authorised additional expenses incurred, provided that the authorised expenses are supported by acceptable documentary proof of expenditure incurred [where this is available]. Any amounts due in terms of these Terms shall be paid to the Supplier/Service Provider, taking into account any deduction or set-off and bank charges.

5 PROPRIETARY RIGHTS LIABILITY

If any allegations should be made or any claim asserted against Transnet that ownership of, or any act or omission by Transnet in relation to Goods/Services or any written material provided to Transnet relating to any Goods/Services or pursuant to an Order being a violation or infringement of any third party's contractual, industrial, commercial or intellectual property rights including but not limited to any patent, registered design, design right, trade mark, copyright or service mark on any application thereof, the Supplier/Service Provider hereby indemnifies Transnet against and hold it harmless from any and all losses, liabilities, costs, claims, damages and expenses [including any legal fees] arising directly or indirectly from such allegation or claim provided that this indemnity shall not apply where the allegation or claim arises solely as a result of the Supplier/Service Provider following a design or process originated and furnished by Transnet. The Supplier/Service Provider shall either

- a) procure for Transnet the right to continue using the infringing Goods; or
- b) modify or replace the Goods/Services so that they become non-infringing,

provided that in both cases the Goods/Services shall continue to meet Transnet's requirements and any specifications stipulated in the Order. Should neither option be possible, the Supplier/Service Provider may remove, with Transnet's prior written consent, such Goods/Services and will pay to Transnet a sum equivalent to the purchase price. If Transnet refuses to give such consent, the Supplier/Service Provider shall have no liability in respect of any continued use of the infringing Goods/Services after Supplier's/Service Provider's prior written request to remove the same.

6 PROPRIETARY INFORMATION

All information which Transnet has divulged or may divulge to the Supplier/Service Provider and any information relating to Transnet's business which may have come into the Supplier's/Service Provider's possession whilst carrying out an Order, and the existence of the Order, shall be treated by the Supplier/Service Provider as confidential information and shall not, without Transnet's prior written consent, be disclosed to any third party, or be used or copied for any purposes other than to perform the Order. This clause does not apply to information which is public knowledge or available from other sources other than by breach of this Term. Upon request by Transnet, the Supplier/Service Provider shall return all

materials issued pursuant to the Order and, pending this, shall protect Transnet's rights in any such materials. Such confidential information shall at all material times be the property of Transnet.

7 PUBLICITY

The Supplier/Service Provider shall not name Transnet or use its trademarks, service marks [whether registered or not] or Goods in connection with any publicity without Transnet's prior written consent.

8 AFTER SALES SERVICE

The Supplier shall provide replacement parts necessary to ensure the uninterrupted operation of the Goods supplied for the duration of the warranty period, from delivery of any particular item of the Goods and if requested by Transnet shall make these parts available to a third party maintainer of Transnet's choice at the same price as if the parts had been supplied to Transnet. The Supplier undertakes to provide a maintenance service for Goods, should Transnet so request, on terms to be agreed. If the Order so indicates, the Supplier will provide a warranty service for the Goods at a level to be agreed with Transnet.

9 TERMINATION OF ORDER

- 9.1 Transnet may cancel an Order in whole or in part at any time upon at least 7 [seven] days' written notice to the Supplier/Service Provider, or when there is a change in control of the Supplier/Service Provider or the Supplier/Service Provider commits any serious breach or any repeated or continued material breach of its obligations under these Terms and/or Order or shall have been guilty of conduct tending to bring itself into disrepute, on written notice to the Supplier/Service Provider when such work on the Order shall stop.
- 9.2 Transnet shall pay the Supplier/Service Provider a fair and reasonable price for justified work in progress, where such price reflects only those costs not otherwise recoverable by the Supplier/Service Provider, at the time of termination, and the Supplier/Service Provider shall give Transnet full assistance to check the extent of such work in progress. Payment of such price shall be in full and final satisfaction of any claims arising out of such termination and upon such payment the Supplier/Service Provider shall deliver to Transnet all work, including any materials, completed or in progress. The sum payable to the Supplier/Service Provider under this clause will not in any event exceed the total amount that would have been payable to the Supplier/Service Provider had the Order not been terminated.
- 9.3 In the event of termination the Supplier/Service Provider must submit all claims within 2 [two] months of termination after which time claims will only be met in what Transnet considers exceptional circumstances.
- 9.4 If the Goods or Services are not provided in accordance with an Order, the Order shall be deemed terminated and the Supplier/Service Provider shall compensate Transnet for any costs incurred in obtaining substitute Goods or any damage caused due to the failure or delay in the delivery.

10 ACCESS

The Supplier/Service Provider shall be liable for the acts, omissions and defaults of its personnel or agents who, for the purposes of the Order, shall be treated as if they are the Supplier's/Service Provider's employees. The Supplier/Service Provider shall ensure that any such personnel or agents, whilst on Transnet's premises, shall comply with Transnet's health and safety, security and system security rules and procedures as and where required.

11 WARRANTY

The Supplier/Service Provider warrants that it is competent to supply the Goods/Services in accordance with these Terms to the reasonable satisfaction of Transnet and that all Goods/Services delivered under the Order: (a) conform and comply in all relevant legislation, standards, directives and orders related to *[inter alia]* the supply, manufacture and use of the Goods/Services in force at the time of delivery, and to any specifications referred to in the Order; (b) will not cause any deterioration in the functionality of any Transnet equipment; and (c) do not infringe any third party rights of any kind. The Supplier/Service Provider hereby indemnifies Transnet against all losses, liabilities, costs, claims, damages, expenses and awards of any kinds incurred or made against Transnet in connection with any breach of this warranty.

12 INSOLVENCY

If the Supplier/Service Provider shall have a receiver, manager, administrator, liquidator or like person appointed over all or any part of its assets or if the Supplier/Service Provider compounds with its creditors or passes a resolution for the writing up or administration of the Supplier/Service Provider, Transnet is at liberty to terminate the Order or Orders forthwith, or at its option, to seek performance by any such appointed person.

13 ASSIGNMENT

The Supplier/Service Provider shall not assign its obligations under an Order without Transnet's prior written consent, which consent shall not be unreasonably withheld or delayed.

14 NOTICES

Notices under these Terms shall be delivered by hand to the relevant addresses of the parties in the Order or may be served by facsimile or by email, in which event notice shall be deemed served on acknowledgement of receipt by the recipient.

15 LAW

Orders shall be governed by and interpreted in accordance with South African law and any disputes arising herein shall be subject to South African arbitration under the rules of the Arbitration Foundation of South Africa, which rules are deemed incorporated by reference in this clause. The reference to arbitration shall not prevent Transnet referring the matter to any South African courts, having jurisdiction, to which the Supplier/Service Provider hereby irrevocably submits but without prejudice to Transnet's right to take proceedings against the Supplier/Service Provider in other jurisdictions and/or obtaining interim relief on an urgent basis from a court of competent jurisdiction pending the decision in other courts or from instituting in any court of competent jurisdiction any proceedings for an interdict or any other injunctive relief. If the Supplier/Service Provider does not have a registered office in the South Africa it will at all times maintain

an agent for service of process in South Africa and shall give Transnet the name and address of such agent as such may be amended, in writing, from time to time.

16 GENERAL

Completion or termination of an Order shall be without prejudice to any Term herein which by its nature would be deemed to continue after completion or termination, including but not limited to clauses. Headings are included herein for convenience only. If any Term herein be held illegal or unenforceable, the validity or enforceability of the remaining Terms shall not be affected. No failure or delay by Transnet to enforce any rights under these Terms will operate as a waiver thereof by Transnet. All rights and remedies available to either party under these Terms shall be in addition to, not to the exclusion of, rights otherwise available at law.

17 COUNTERPARTS

These Terms and conditions may be signed in any number of counterparts, all of which taken together shall constitute one and the same instrument. Any party may enter into this agreement by signing any such counterpart.

"PREVIEW COPY ONLY"

Respondent's Signature

Date & Company Stamp

By signing this RFQ document, the Respondent is deemed to acknowledge that he/she has made himself/herself thoroughly familiar with all the conditions governing this RFQ, including those contained in any printed form stated to form part hereof and Transnet SOC Ltd will recognise no claim for relief based on an allegation that the Respondent overlooked any such condition or failed to properly take it into account for the purpose of calculating quoted prices or otherwise.

SIGNED at _____ on this _____ day of _____ 20____

.....
SIGNATURE OF RESPONDENT'S AUTHORISED REPRESENTATIVE

NAME: _____

DESIGNATION: _____

REGISTERED NAME OF COMPANY: _____

PHYSICAL ADDRESS:

Respondent's contact person: *[Please complete]*

| | |
|-------------|---|
| Name | : |
| Designation | : |
| Telephone | : |
| Cell Phone | : |
| Facsimile | : |
| Email | : |
| Website | : |

**Transnet urges its clients, suppliers and the general public
to report any fraud or corruption to
TIP-OFFS ANONYMOUS : 0800 003 056**

Respondent's Signature

Date & Company Stamp

Section 3
VENDOR APPLICATION FORM

Respondents are to furnish the following documentation and complete the Vendor Application Form below:

1. **Original** cancelled cheque **OR** letter from the Respondent's bank verifying banking details **[with bank stamp]**
2. **Certified** copy of Identity Document(s) of Shareholders/Directors/Members [where applicable]
3. **Certified copies** of the relevant company registration documents from Companies and Intellectual Property Commission (CIPC)
4. **Certified copies** of the company's shareholding/director's portfolio
5. A letter on the company's letterhead confirm physical and postal addresses
6. **Original** valid SARS Tax Clearance Certificate
7. **Certified copy** of VAT Registration Certificate
8. **A valid and original** B-BBEE Verification Certificate / sworn affidavit **or certified copy** thereof meeting the requirements for B-BBEE compliance as per the B-BBEE Codes of Good Practice
9. **Certified copy** of valid Company Registration Certificate [if applicable]

Vendor Application Form

| | | | | | | |
|---|----|-------|----------------------|---------|-------------|-----------------|
| Company trading name | | | | | | |
| Company registered name | | | | | | |
| Company Registration Number or ID Number if a Sole Proprietor | | | | | | |
| Form of entity [✓] | CC | Trust | Pty Ltd | Limited | Partnership | Sole Proprietor |
| VAT number [if registered] | | | | | | |
| Company telephone number | | | | | | |
| Company fax number | | | | | | |
| Company email address | | | | | | |
| Company website address | | | | | | |
| Bank name | | | Branch & Branch code | | | |
| Account holder | | | Bank account number | | | |
| Postal address | | | | | | |

Respondent's Signature

Date & Company Stamp

Code

Physical Address Code

Contact person

Designation

Telephone

Email

Annual turnover range [last financial year] < R5 m R5 - 35 m > R35 m

Does your company provide Products Services Both

Area of delivery National Provincial Local

Is your company a public or private entity Public Private

Does your company have a Tax Directive or IRP30 Certificate Yes No

Main product or services [e.g. Stationery/Consulting]

Complete B-BBEE Ownership Details:

% Black ownership % Black women ownership % Disabled Black ownership % Youth ownership

Does your entity have a B-BBEE certificate Yes No

What is your B-BBEE status [Level 1 to 9 / Unknown]

How many personnel does the entity employ Permanent Part time

If you are an existing Vendor with Transnet please complete the following:

Transnet contact person

Contact number

Transnet Operating Division

Duly authorised to sign for and on behalf of Company / Organisation:

| | | | |
|-----------|--|-------------|--|
| Name | | Designation | |
| Signature | | Date | |

APPENDIX F

1. NUMBER OF PROJECTS WITH REFERENCE

Note to tenderers:

Tenderers are required to demonstrate their experience in the supply and delivery of similar goods and to this end shall supply a sufficiently detailed reference list (minimum 5) with contact details of existing customers.

| List of References | | | |
|--------------------|----------------|-----------------|---|
| Name of Company | Contact Person | Contact Details | Number of Projects Completed and Duration |
| | | | |
| | | | |
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Signed _____ Date _____

Name _____ Position _____

Tenderer _____

RAIL NETWORK TELECOMS

SCHEDULE OF REQUIREMENTS FOR THE SUPPLY HANDHELD TRUNKED AND CONVENTIONAL RADIO EQUIPMENT TO TRANSNET ENGINEERING WAGONS - SALDANHA

APPENDIX A: SCHEDULE OF COMPLIANCE FOR THE ABOVE:

- Tenders are invited in respect of the following Schedule of Requirements.
- Tenderers must indicate compliance with each item and indicate make and model being offered.
- Alternate offers must be **indicated on separate documents**.

| ITEM | DESCRIPTION | COMPLY YES/ NO | MAKE & MODEL | COMMENT |
|------|--|-------------------|-----------------|---------|
| 1 | HANDHELD REQUIREMENTS | | | |
| 1.1 | UHF, (400 – 470 MHz band) IP54, Handheld Trunked and Conventional radio, with a minimum of 32 conventional 12.5 kHz channels. (Can specify alternative number of channels). Excluding - Antenna, Battery and Charger Must comply with attached Specifications BBD 8635 version 8 dated 21 May 2014 and BBF 2516 version 3.00, dated 24 June 2014. | | | |
| 1.2 | Quarter wave flexible whip antenna for item 1.1, to cover the 455 to 467 MHz band. | | | |
| 1.3 | High capacity Battery to fit item 1.1, capable of sustaining a 20 - 20 - 60 duty cycle for an 8 hour shift. (Tx, Rx, Standby). | | | |
| 1.4 | Single bay rapid rate Charger for item 1.1 Provision must be made for a standard 3 pin 15 amp mains plug. | | | |
| 1.5 | 6 Bay wall mount rapid rate Charger for item 1. Provision must be made for a standard 3 pin 15 amp mains plug. | | OPTIONAL | |
| 1.6 | Leather carry bag for item 1 with shoulder strap. | | | |
| 1.7 | Programming software, Leads, Adaptors and technical manuals on CD. | | | |

SCHEDULE OF REQUIREMENTS
FOR THE SUPPLY OF RADIO EQUIPMENT

APPENDIX B & C: BILL OF QUANTITIES AND COST SCHEDULE

Indicate the cost per unit for the quantities indicated in the respective columns

| ITEM | DESCRIPTION | QTY | UNIT PRICE | TOTAL |
|------|---|-----|-----------------|-------|
| 2 | HANDHELD REQUIREMENTS | | | |
| 2.1 | UHF, (400 – 470 MHz band) IP54, Handheld Trunked and Conventional radio, with a minimum of 16 conventional 12.5 kHz channels. (Can specify alternative number of channels). Excluding - Antenna, Battery and Charger Must comply with attached Specifications BBD 8635 version 8 dated 21 May 2014 and BBF 2516 version 3.00, dated 24 June 2014. | 10 | | |
| 2.2 | Quarter wave flexible whip antenna for item 1.1, to cover the 455 to 467 MHz band. | 10 | | |
| 2.3 | High capacity Battery to fit item 1.1, capable of sustaining a 20 - 20 - 60 duty cycle for an 8 hour shift. (Tx, Rx, Standby). | 20 | | |
| 2.4 | Single bay rapid rate Charger for item 1.1 Provision must be made for a standard 3 pin 15 amp mains plug. | 10 | | |
| 2.5 | 6 Bay wall mount rapid rate Charger for item 1.1 Provision must be made for a standard 3 pin 15 amp mains plug. | | OPTIONAL | |
| 2.6 | Leather carry bag for item 1 with shoulder strap. | 10 | | |
| 2.7 | Programming software, Leads & Adaptors, technical manuals. | 1 | | |

APPENDIX D: DELIVERY PERIOD

SCHEDULE OF REQUIREMENTS
FOR THE SUPPLY OF RADIO EQUIPMENT

Indicate the delivery period, in weeks, for the quantities as indicated in the bill of quantities above:

| ITEM | DESCRIPTION | QTY | DELIVERY DATE | COMMENT |
|------|---|-----|-----------------|---------|
| 3 | HANDHELD REQUIREMENTS | | | |
| 3.1 | UHF, (400 – 470 MHz band) IP54, Handheld Trunked and Conventional radio, with a minimum of 16 conventional 12.5 kHz channels. (Can specify alternative number of channels). Excluding - Antenna, Battery and Charger Must comply with attached Specifications BBD 8635 version 8 dated 21 May 2014 and BBF 2516 version 3.00, dated 24 June 2014. | | | |
| 3.2 | Quarter wave flexible whip antenna for item 1.1, to cover the 455 to 467 MHz band. | | | |
| 3.3 | High capacity Battery to fit item 1.1, capable of sustaining a 20 - 20 - 60 duty cycle for an 8 hour shift. (Tx, Rx, Standby). | | | |
| 3.4 | Single bay rapid rate Charger for item 1.1 Provision must be made for a standard 3 pin 15 amp mains plug. | | | |
| 3.5 | 6 Bay wall mount rapid rate Charger for item 1. Provision must be made for a standard 3 pin 15 amp mains plug. | | OPTIONAL | |
| 3.6 | Leather carry bag for item 1 with shoulder strap. | | | |
| 3.7 | Programming software, Leads & Adaptors, technical manuals. | | | |

APPENDIX E: DELIVERY SCHEDULE

The supplied equipment must be delivered to the following location.

TRANSNET FREIGHT RAIL
RAIL NETWORKS TELECOMS
SALKOR
NORTH WEST CROSSING
SALDANHA

Box to be labelled - Transnet Freight Rail – Rail network Telecoms

CONTACT: Prior to delivery

Henri Ferreira
022 703 2241
071 855 4411

TECHNICAL QUERIES

Henri Ferreira
022 703 2241
071 855 4411



TRANSNET

freight rail

A Division of Transnet Limited

INFRASTRUCTURE TELECOMS

STANDARD

TECHNICAL SPECIFICATION AND METHODS OF MEASUREMENT FOR ANGLE MODULATED RADIO EQUIPMENT

Author: Senior Engineering Technician
Quality Assurance, National
Test Centre

C J Muller

Approved: Principal Engineer
Transmission Engineering

M L Nuttall

PP
MUTHUMBUTO
MIMBENGWA

Date:

21 May 2014

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Transnet and Relevant Third Parties

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I Distribution

Once updated, a copy of the latest revision will be published in the document management system in use. An e-mail to this effect will be sent to the relevant personnel or heads of department.

II Document Change History

| ISSUE NO. | DATE ISSUED | ISSUED BY | HISTORY DESCRIPTION |
|------------------|--------------------|-----------------------------------|--|
| 2.00 | January 2004 | Quality Assurance, Infrastructure | Revision |
| 3.0 | June 2006 | QA | Convert to ISO Standard |
| 3.1 | June 2007 | QA | Revision |
| 4.0 | July 2008 | QA | Revision |
| 5.0 | February 2010 | QA | New format & revision |
| 6.0 | August 2010 | QA | New format & revision |
| 6.1 | November 2010 | QA | Add measurement |
| 6.2 | August 2011 | QA | Add information, definitions, supply standards & DC-DC Converter |
| 7.0 | January 2012 | QA | Revision & add Trunking functional tests |
| 8.0 | May 2014 | QA | Omit the difference between General and Shunt portables, revise the Loudspeaker sound pressure level & Transmitter microphone sensitivity. |

III Changes Since Last Revision

| CLAUSES | DESCRIPTION |
|----------------|--|
| IV | Add abbreviations |
| 1.3.3.5 | Change specification |
| 1.11 | Add trunking |
| 2.4.2.3 | Change graph |
| 2.5 | Add trunking functional tests |
| 1.12 | Omit the difference between General and Shunt portables, revise the Loudspeaker sound pressure level & Transmitter microphone sensitivity. |

IV List of Abbreviations and Definitions

| ABBREVIATIONS | DESCRIPTION |
|----------------------|--|
| AC | Alternating Current |
| AF | Audio Frequency |
| BS | Base Station |
| CCITT | Consultative Committee for International Telephone and Telegraph (ITU-T) |
| CTCSS | Continuous Tone Coded Squelch System |
| dB | Decibel |
| dB(A) | Sound pressure A-weighted |
| dBc | Decibel relative to the carrier power |
| dBd | Decibel relative to a Dipole antenna |
| dBm | Decibel relative to 1 mW, impedance 50 Ω (power) |
| dBm | Decibel relative to 0.775 V _{pd} , impedance 600 Ω (audio frequency) |
| dB _{MUOP} | Decibel relative to the Maximum Useful Output Power |
| dB _{SOP} | Decibel relative to the Standard Output Power |
| DC | Direct Current |
| EMF | Electromotive Force |
| ERP | Effective Radiated Power |
| FFSK | Fast Frequency Shift Keying |

| | |
|-------|--|
| FM | Frequency Modulation |
| GSM | Global System for Mobile communication |
| Hz | Hertz |
| ITU-T | International Telecommunication Union – Telecommunication Standardization Sector |
| kHz | Kilohertz |
| LBU | Line Branching Unit |
| LS | Loudspeaker |
| m | Metre |
| mA | Milliampere |
| MHz | Megahertz |
| mm | Millimetre |
| ms | Millisecond |
| mVp-p | Millivolt peak-to-peak |
| mW | Milliwatt |
| MUOP | Maximum Useful Output Power |
| pd | Potential Difference |
| PM | Phase Modulation |
| PSTN | Private Switching Telephone Network |
| RF | Radio Frequency |
| Rx | Radio receiver |
| SANS | South African National Standards |
| SINAD | Signal, Noise & Distortion to Noise & Distortion ratio |
| SOP | Standard Output Power |
| SPL | Sound Pressure Level |
| THD | Total Harmonic Distortion |
| TSC | Trunk Site Controller |
| Tx | Radio transmitter |
| V | Voltage |
| Vp-p | Voltage peak-to-peak |
| VSWR | Voltage Standing Wave Ratio |
| W | Wattage |
| WiFi | Wireless Fidelity |
| μV | Microvolt |
| % | Percentage |

| <u>DEFINITIONS</u> | <u>DESCRIPTION</u> |
|-----------------------------------|--|
| GENERAL | |
| Angle Modulation | A term used to encompass both frequency modulation and phase modulation. |
| Decibel | The decibel is 1/10 of a Bel. Decibel is the logarithm of the ratio between a measured quantity and an agreed reference level. |
| dBc | The absolute power in decibel with reference to the carrier power. |
| dBm | The absolute power in decibel with reference to 1 mW. |
| Land Mobile Radio Services | Radio communication from fixed radio stations to mobile radio stations carried in surface vehicles or portable radio stations, and between mobile and portable radio stations. |

| DEFINITIONS | DESCRIPTION |
|-------------------------------|--|
| Portable Radio Station | A radio station designed to be carried by or on a person. |
| Mobile Radio Station | A radio station designed for installation in a surface vehicle and capable of operating while the vehicle is in motion and while it is stationary. |
| Fixed Radio Station | It is a fixed radio station installed in an office or control room, fitted with an external antenna. |
| Base Station | A radio station designed to be installed in a fixed location and performing the function of a repeater/enhancer. |

RADIO RECEIVER

| | |
|---|--|
| Adjacent Channel Selectivity and Desensitization Ratio | A measure of the ability of a radio receiver to receive the modulated standard input signal in the presence of modulated signals that differ in frequency from the standard input signal frequency by the spacing of one channel. |
| Amplitude Characteristics | The relationship between the radio frequency input level of a specified modulated signal and the audio frequency level at a radio receiver output. |
| Attack Time | The time required to produce an audio output level of $-0.5 \text{ dB}_{\text{SOP}}$ after application of a RF signal level, 12 dB above usable sensitivity, modulated with standard test modulation. |
| Audio Frequency Response | The relationship between the modulation factor of a received signal and the audio output level of the demodulated signal at various audio frequencies. |
| Audio Frequency Total Harmonic Distortion | The change in harmonic content of an audio signal as a result of its passing through the audio frequency and radio frequency circuits of a radio. |
| Blocking or Desensitisation | A reduction in the wanted audio output power of a radio receiver, or a reduction in the SINAD ratio, owing to an unwanted signal on another frequency. |
| Co-channel Rejection Ratio | A measure of the capability of a radio receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver. |
| Conducted Spurious Radiation | It is radiation components at any frequency generated by a radio receiver and radiated by the radio's antenna. |
| Desensitisation | Is a condition where off-channel transmitting energy passes through the front-end of the radio receiver, causing a reduction in receiver gain. |
| High RF Signal Level Interference | A measure of the ability of a radio receiver to oppose high RF signal levels at frequencies other than the normal frequency of the receiver. |
| Intermodulation Spurious Response Attenuation/ Rejection | The ability of a radio receiver to receive a modulated standard input signal, in the presence of two interfering signals of which the carrier frequencies are so separated from the standard input signal frequency and from each other that n'th order mixing of the two undesired signals can occur in the non-linear elements of the receiver, producing a third signal whose frequency is equal to that of the standard input signal frequency, or intermediate frequency. |
| Maximum Useful Output Power | The greatest average audio output power supplied to the rated load, which power does not exceed 10 % of the total harmonic distortion. |
| Modulation Acceptance Bandwidth | The selectivity characteristic of an angle modulated radio receiver that limits the maximum permissible modulation deviation of the radio frequency input signal that a receiver can accept, without degradation of the 12 dB SINAD ratio, when the radio frequency input signal is 6 dB greater than the usable sensitivity level. |
| Modulation Factor | The ratio of the maximum positive or negative peak variation of the modulating variable, to the maximum rated system-modulating variable, expressed as a |

| DEFINITIONS | DESCRIPTION |
|---|--|
| | percentage. |
| Signal, Noise & Distortion to Noise & Distortion Ratio | The ratio, expressed in decibels of the signal power, plus noise power, plus distortion power, to noise power plus distortion power produced at the output of a radio receiver resulting from a modulated signal input. |
| Signal to Hum and Noise Ratio | The ratio of residual receiver audio output power to standard output power. |
| Spurious Response Attenuation/ Rejection | A measure of the ability of a radio receiver to discriminate between the standard input signal frequency and an undesired signal at any other frequency to which it is also responsive, excluding the two adjacent channels. |
| Squelch Closing Time | The period of time between the removal of the RF signal and the squelch closure. |
| Squelch Operating Threshold | The RF signal input level, modulated with standard test modulation, at which the squelch opens and closes. |
| Standard Output Power | An audio output level 3 dB below maximum useful output power used to define a reference level for test purposes. |
| Usable Sensitivity | The minimum radio frequency input signal level modulated with standard test modulation that will produce, at a radio receiver, a SINAD ratio of at least 12 dB and an audio output signal power of at least $-3 \text{ dB}_{\text{SOP}}$. |
| RADIO TRANSMITTER | |
| Adjacent Channel Power | The part of the total power output of a radio transmitter that, under defined conditions of modulation, falls within a specified bandwidth centred on the normal frequency of either of the adjacent channels. |
| Amplitude Modulation Hum & Noise Level | A measure of the unwanted amplitude modulation of a carrier resulting from hum and noise. |
| Angle Modulation Hum & Noise Ratio | The ratio of residual angle modulation to standard test modulation. |
| Audio Frequency Response | The relationship between the modulation factor of a transmitted signal and the input level of the modulating signal at various audio frequencies. |
| Audio Frequency Total Harmonic Distortion | The change in harmonic content of an audio signal as a result of its passing through the audio frequency and radio frequency circuits of a radio. |
| Carrier Attack Time | The time required, changing the state of a radio transmitter from standby to a state where the unmodulated carrier voltage level reaches a value 6 dB below the steady state. |
| Carrier Frequency Error | Is the difference between the measured unmodulated carrier frequency from the assigned frequency. |
| Carrier Power | The mean power available at the output terminal of a radio transmitter in the absence of modulation. |
| Conducted Spurious Emissions | Emissions at the antenna terminal of a radio transmitter on a frequency or frequencies that are outside the channel on which the transmitter is operating. |
| Extreme Transmitter Loads | Conditions under which the radio transmitter operates into an open circuit or short circuit. |
| Intermodulation Attenuation | The ability of a radio transmitter to attenuate signals generated in its non-linear elements by the presence of the carrier and a parasitic signal arriving at the transmitter through its antenna. |
| Microphone sensitivity | It is the amount of modulation that the radio transmitter produces when a specified audio signal level is present at the microphone. |

| <u>DEFINITIONS</u> | <u>DESCRIPTION</u> |
|--|---|
| Mismatch between Transmitter and Antenna System | A condition in which the impedance as presented to the radio transmitter by the transmission line and antenna is not the same as the designed system impedance. |
| Modulation Limiting (Tx deviation) | A measure of the ability of radio transmitter circuits to prevent a transmitter from producing modulation such that the modulation factor exceeds the maximum rated system modulation factor. |

| <u>TALK THROUGH SIGNAL</u> | |
|--|--|
| Modulation Factor Linearity | The relationship between the modulation factor of a received signal and the transmitted modulation factor. |
| <u>FILTERS</u> | |
| Duplexer/Combiner | Is a filter system providing RF isolation to allow the sharing of a single antenna for both transmission and reception. |
| Insertion Loss | It is the amount of loss to a signal passing through a filter at a designated frequency. |
| Receiver Isolation at Transmitter Frequencies | It is the ability of the duplexer/combiner to suppress the transmitter carrier power at the receiver port. It is also called the selectivity of the duplexer/combiner. |
| <u>ANTENNAS</u> | |
| Effective Radiated Power | It is the mean power radiated by the antenna in the direction of maximum radiation. |
| dBd | The power gain of an antenna in decibel with reference to a Dipole antenna. |
| <u>TRUNK CONTROL SIGNAL</u> | |
| Fast Frequency Shift Keying | Bit 0 = 1.8 kHz Bit 1 = 1.2 kHz |

| <u>AUDIO LINE BRANCHING UNIT</u> | |
|---|---|
| Common-mode Rejection Ratio | Is the ratio of the differential gain over the common-mode gain. |
| <u>POWER SUPPLY UNIT, DC-DC CONVERTER AND BATTERY CHARGER</u> | |
| Noise Voltage | Is irregular amplitude voltages superimposed on the output DC voltage line. |
| Output Voltage Regulation | It is the ability of a power supply device to keep the output voltage constant over a range of applied loads. |
| Ripple Voltage | Is AC voltage superimposed on the output DC voltage line. |
| Variac | A device that supply a variable AC voltage from 0 V to 260 V. |
| <u>ACOUSTIC</u> | |
| A-weighted | It is a network that weights an audio signal in a manner, which approximates to an inverted equal loudness contour (it approximates the human ear's response to sound). |

| <u>DEFINITIONS</u> | <u>DESCRIPTION</u> |
|-----------------------|--|
| Sound Pressure | It is the force (N) of sound on a surface area (m ²) perpendicular to the direction of the sound. SPL is express as N/m ² or Pascal (Pa). |

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1. TECHNICAL SPECIFICATION

Where not specifically indicated, this specification only applies for open channel and Trunked radio systems.

1.1 Radio Receiver: 12.5 kHz channel spacing; operating frequency band 450 MHz to 470 MHz.

1.1.1 Normal condition (see clause 2.1.1)

| Characteristics | Portable | Mobile & Fixed Radio Station | Base Station (Repeater) |
|---|--|---|-------------------------|
| 1.1.1.1 Maximum Useful Audio Output Power | Maximum power not exceeding 10 % THD. | | |
| 1.1.1.2 Audio Frequency THD at Low Output Power Level 500 Hz & 1.0 kHz | ≤ 5 % | ≤ 2 % | ≤ 2 % |
| 1.1.1.3 Usable Sensitivity | ≤ -115 dBm | | |
| 1.1.1.4 Squelch Operating Threshold | Open - 115 dBm minimum Close ≤ 3 dB lower than the opening threshold | See clause 1.3.1.1 ≤ 3 dB lower than the opening threshold | |
| 1.1.1.5 Attack Time | ≤ 150 ms | | |
| 1.1.1.6 Squelch Closing Time | ≤ 250 ms | | |
| 1.1.1.7 Modulation Acceptance Bandwidth | ≥ 3.75 kHz | | |
| 1.1.1.8 Adjacent Channel Selectivity and Desensitization Ratio | ≥ 60 dB | ≥ 65 dB | ≥ 70 dB |
| 1.1.1.9 Spurious Response Attenuation/Rejection | ≥ 70 dB | ≥ 75 dB | ≥ 75 dB |
| 1.1.1.10 Intermodulation Spurious Response Attenuation/Rejection | ≥ 65 dB | ≥ 65 dB | ≥ 70 dB |
| 1.1.1.11 Co-channel Rejection Ratio | ≤ 12 dB | | |
| 1.1.1.12 Blocking | ≥ 84 dB | | |
| 1.1.1.13 Conducted Spurious Radiation | ≤ - 57 dBm | | |
| 1.1.1.14 Audio Frequency Response (6 dB/octave) | + 1 dB to - 3 dB 300 to 900 Hz + 1 dB to - 3 dB 1.1 to 2.5 kHz + 1 dB to - 4.5 dB 3.0 kHz | | |
| 1.1.1.15 Signal to Hum and Noise Ratio | Squelched ≥ 60 dB Unsquelched ≥ 39 dB | | |
| 1.1.1.16 Amplitude Characteristics | ≤ 3 dB | | |

1.1.2 Extreme conditions (see clause 2.1.2)

| Characteristics | Portable | Mobile & Fixed Radio Station | Base Station (Repeater) |
|--|---------------------|------------------------------|-------------------------|
| 1.1.2.1 Power Supply | | | |
| 1.1.2.1.1 Usable Sensitivity variation | $\leq \pm 3$ dB | | |
| 1.1.2.1.2 Adjacent Channel Selectivity and Desensitisation Ratio | ≥ 60 dB | ≥ 65 dB | ≥ 70 dB |
| 1.1.2.2 Temperature | | | |
| 1.1.2.2.1 Usable Sensitivity variation | $\leq \pm 3$ dB | | |
| 1.1.2.2.2 Adjacent Channel Selectivity and Desensitisation Ratio | ≥ 60 dB | ≥ 65 dB | ≥ 70 dB |
| 1.1.2.3 Selectivity at High RF Signal Level | | | |
| 1.1.2.3.1 Input signal level | - 47 dBm to - 7 dBm | | |

1.2 **Radio Transmitter:** 12.5 kHz channel spacing; operating frequency band 450 MHz to 470 MHz.

1.2.1 Normal condition (see clause 2.1.1)

| Characteristics | Portable | Mobile & Fixed Radio Station | Base Station (Repeater) |
|--|--|------------------------------|-------------------------|
| 1.2.1.1 Carrier Power (conducted) | $\leq \pm 1$ dB from manufacturer's claim | | |
| 1.2.1.2 Conducted Spurious Emissions Operating Standby | $\leq - 36$ dBm $\leq - 57$ dBm | | |
| 1.2.1.3 Carrier Frequency Error | ≤ 1.5 kHz | ≤ 1.5 kHz | ≤ 1.0 kHz |
| 1.2.1.4 Carrier Attack Time | ≤ 100 ms | | |
| 1.2.1.5 Adjacent Channel Power | $\leq - 60$ dBc | $\leq - 70$ dBc | $\leq - 70$ dBc |
| | Or - 37 dBm maximum. | | |
| 1.2.1.6 Intermodulation Attenuation | n.a. | n.a. | ≥ 40 dB |
| 1.2.1.7 Modulation Limiting (Tx Deviation) Modulating freq. 0.3 to 2.55 kHz 3 to 6 kHz 6 to 12.5 kHz | 2.5 kHz maximum 0.75 kHz maximum at 6 kHz - 14 dB/octave | | |
| 1.2.1.8 CTCSS Deviation | 250 Hz | | |
| 1.2.1.9 Audio Frequency THD 500 Hz 1.0 kHz | ≤ 5 % | ≤ 2 % | ≤ 2 % |

| | Characteristics | Portable | Mobile & Fixed Radio Station | Base Station (Repeater) |
|----------|---|--|------------------------------|-------------------------|
| 1.2.1.10 | Audio Frequency Response (6 dB/octave) 300 to 900 Hz 1.1 to 2.5 kHz 3.0 kHz | + 3 dB to – 1 dB + 3 dB to – 1 dB + 4.5 dB to – 1 dB | | |
| 1.2.1.11 | Angle Modulation Hum & Noise Ratio | ≥ 34 dB | | |
| 1.2.1.12 | Amplitude Modulation Hum & Noise Level | ≤ – 34 dB | | |

1.2.2 Extreme conditions (see clause 2.1.2)

| | Characteristics | Portable | Mobile & Fixed Radio Station | Base Station (Repeater) |
|-----------|---|--------------------------|------------------------------|-------------------------|
| 1.2.2.1 | Power Supply | | | |
| 1.2.2.1.1 | Carrier Power Variation | ≤ ± 2 dB | | |
| 1.2.2.1.2 | Conducted Spurious Emissions Operating Standby | ≤ – 36 dBm ≤ – 57 dBm | | |
| 1.2.2.1.3 | Carrier Frequency Error | ≤ 1.5 kHz | ≤ 1.5 kHz | ≤ 1.0 kHz |
| 1.2.2.2 | Temperature | | | |
| 1.2.2.2.1 | Carrier Power Variation | ≤ ± 2 dB | | |
| 1.2.2.2.2 | Conducted Spurious Emissions Operating Standby | ≤ – 36 dBm ≤ – 57 dBm | | |
| 1.2.2.2.3 | Carrier Frequency Error | ≤ 1.5 kHz | ≤ 1.5 kHz | ≤ 1.0 kHz |
| 1.2.2.3 | Antenna Terminal Loads | | | |
| 1.2.2.3.1 | Short Circuit and Open Circuit Carrier Power Variation | ≤ ± 1 dB | | |

1.3 **Radio Base Station (Repeater):** 12.5 kHz channel spacing; operating frequency band 450 MHz to 470 MHz.

The receiver and transmitter specifications are referred to in clauses 1.1 and 1.2 respectively.

1.3.1 Receiver

| | Characteristics | Base Station (Repeater) |
|---------|--|---|
| 1.3.1.1 | Squelch operating threshold calculation Open Close | - 115 dBm minus coaxial cable loss minus duplexer loss plus antenna gain. ≤ 3 dB lower than the opening threshold |

1.3.2 Receiver and transmitter

| | Characteristics | Base Station (Repeater) |
|---------|-----------------|-------------------------|
| 1.3.2.1 | Response time | ≤ 300 ms |

1.3.3 Talk Through Signal

| | Characteristics | Base Station (Repeater) |
|-----------------------------------|---|---|
| 1.3.3.1 1.3.3.1.1 1.3.3.1.2 | Audio input and output terminals Impedance Return Loss | 600 Ω balanced ≤ -25 dB |
| 1.3.3.2 1.3.3.2.1 1.3.3.2.2 | Audio Levels RTO & Trunking (local & intersite) Old Trunking Teletra system | - 10 dBm ± 0.5 dBm - 4 dBm ± 0.7 dBm |
| 1.3.3.3 | Audio Frequency Response (With de-emphasis and pre-emphasis) Modulating frequency 300 to 900 Hz 1.1 to 3.0 kHz | ± 3.0 dB ± 3.0 dB |
| 1.3.3.4 | Audio Frequency Response (Without de-emphasis and pre-emphasis) Modulating frequency 300 to 900 Hz 1.1 to 3.0 kHz | ± 2.0 dB ± 2.0 dB |
| 1.3.3.5 | Modulation Factor Linearity Modulation 0.5 kHz 1.0 kHz 1.5 kHz 2.0 kHz 2.5 kHz | 0.5 kHz ± 100 Hz 1.0 kHz ± 100 Hz 1.5 kHz ± 100 Hz 2.0 kHz ± 100 Hz 2.5 kHz - 250 Hz (not to exceed 2.5 kHz) |
| 1.3.3.6 | Audio Frequency THD | ≤ 5 % |

1.4 **Filters**

1.4.1 Duplexer (Radio Train Order)

| Characteristics | Base Station (Repeater) |
|--|---|
| 1.4.1.1 Insertion Loss (Tx & Rx) | ≤ 1.2 dB |
| 1.4.1.2 Rx Isolation at Tx Frequencies | ≥ 65 dB (operating band) ≥ 80 dB (single channel) |
| 1.4.1.3 Impedance Matching, 50 Ω (all ports) | VSWR ≤ 1.5:1 Return Loss ≤ - 14 dB |
| 1.4.1.4 * Operating Frequency Band | Receiver Transmitter 465.0500 MHz to 465.9875 MHz 455.0500 MHz to 455.9875 MHz |

* Duplexer for link operation is channelized.

1.4.2 Combiner (Trunked)

| Characteristics | Base Station (Repeater) |
|--|---|
| 1.4.2.1 Insertion Loss - Receiver path | 0 dB ± 0.5 dB |
| 1.4.2.2 Insertion Loss - Transmit path | ≤ 10 dB |
| 1.4.2.3 Rx Isolation at Tx Frequencies | ≥ 85 dB |
| 1.4.2.4 Isolation between Rx ports | ≥ 20 dB |
| 1.4.2.5 Isolation between Tx ports | ≥ 60 dB |
| 1.4.2.6 Impedance Matching, 50 Ω (all ports) | VSWR ≤ 1.5:1 Return Loss ≤ - 14 dB |
| 1.4.2.7 Operating Frequency Band | Receiver Transmitter 465.0000 MHz to 466.6375 MHz 455.0000 MHz to 456.6375 MHz |

1.5 **Coaxial Cable**

| Characteristics | Mobile & Fixed Radio Station | Base Station (Repeater) |
|--------------------------|---------------------------------------|-------------------------|
| 1.5.1 Impedance | 50 Ω | |
| 1.5.2 Impedance matching | VSWR ≤ 1.5:1 Return Loss ≤ - 14 dB | |
| 1.5.3 Insertion loss | ≤ 1 dB | ≤ 5 dB |

1.6 **Antenna**

| Characteristics | Various |
|--------------------------|---|
| 1.6.1 Impedance | 50 Ω |
| 1.6.2 Impedance matching | VHF & UHF GSM & WiFi VSWR ≤ 1.5:1 Return Loss ≤ - 14 dB VSWR ≤ 2.0:1 Return Loss ≤ - 9.54 dB |

| Characteristics | Various |
|-----------------|---------|
|-----------------|---------|

| | | |
|-------|--|---|
| 1.6.3 | * Antenna gain Mobile Fixed station Radio link: Point to point Point to multipoint Base station | 0 dBd ≤ 12 dBd 9 dBd minimum Not specified ≤ 12 dBd |
| 1.6.4 | # Antenna vertical separation | ≥ 4 λ |
| 1.6.5 | * Antenna height above ground level Mobile & Fixed station Radio link: Point to point Point to multipoint Base station | 10 m maximum 20 m maximum 20 m maximum 20 m maximum |

Based on 20 W ERP and antennae having a Dipole as a live element. Distance measured from centre to centre of dipoles.

* Licence conditions

1.7 Transmitting Power

| | Characteristics | Various |
|-------|---|--|
| 1.7.1 | * Conducted power at transmitter terminal Radio link: Point to point Point to multipoint | 1 W maximum 1 W maximum |
| 1.7.2 | * Effective Radiated Power (ERP) Mobile & Fixed station Radio link: Point to point Point to multipoint Base station | 20 W maximum 8.2 W maximum 8.2 W maximum 20 W maximum |

* Licence conditions

1.8 Receiver Desensing

| | Characteristics | Various |
|-------|---|---------|
| 1.8.1 | Desensing | ≤ 1 dB |
| 1.8.2 | Desensing at high receiving signal level (radio links only) ≥ - 100 dBm | ≤ 20 dB |

1.9 Audio Line Branching Unit

| | Characteristics | Base Station (Repeater) |
|-------|--|--------------------------------------|
| 1.9.1 | Audio input and output terminals Impedance Return Loss | 600 Ω balanced ≤ - 25 dB |
| 1.9.2 | Input and output audio signal level | - 10 dBm ± 0.5 dB |
| 1.9.3 | Audio frequency response 300 Hz to 3 kHz | ± 0.5 dB |
| 1.9.4 | Audio total harmonic distortion (THD) | ≤ 0.5 % |
| 1.9.5 | Audio signal to hum and noise ratio | ≥ 70 dB |
| 1.9.6 | Channel cross talk | ≥ 60 dB |
| 1.9.7 | Common-mode rejection ratio | ≥ 60 dB at 1 kHz |
| 1.9.8 | E-signal | Up to 50 V DC, 10 mA Opto coupler |

| | Characteristics | Base Station (Repeater) |
|-------|-----------------|--|
| 1.9.9 | | Bi-directional polarity |
| | M-signal | Up to 50 V DC, 10 mA Voltage free contact |

1.10 Power Supply Unit, DC-DC Converter and Battery Charger

| | Characteristics | Various |
|--------|--|--|
| 1.10.1 | Operating conditions Temperature range Relative humidity | - 10 °C to 60 °C Up to 85 % |
| 1.10.2 | Input power AC Voltage Frequency DC Voltage | 220 V AC \pm 10 % 50 Hz \pm 2 % Nominal \pm 10 % |
| 1.10.3 | Output voltage regulation (Intermittent & continuous) | 13.8 V \pm 5 % (12 V system) 27.6 V \pm 5 % (24 V system) 55.2 V \pm 5 % (48 V system) |
| 1.10.4 | Efficiency | \geq 70 % |
| 1.10.5 | Output voltage ripple & noise | \leq 200 mVp-p (12 V system) \leq 400 mVp-p (24 V system) \leq 800 mVp-p (48 V system) |
| 1.10.6 | Radiation of spurious frequencies | \leq - 119 dBm in radio operating band |
| 1.10.7 | Desensing of receiver | \leq 1 dB |
| 1.10.8 | Load shedding (when required) Shed Restore | 11.0 V (12 V system) 22.0 V (24 V system) 44.0 V (48 V system) 13.0 V (12 V system) 26.0 V (24 V system) 52.0 V (48 V system) |

1.11 Trunking

1.11.1 Functional Tests

| | Characteristics | Various |
|----------|--|---|
| 1.11.1.1 | Registration | Register on instrument Register on trunk system |
| 1.11.1.2 | Local call to radio with the same prefix number | Establish call to instrument Establish call through the trunk system |
| 1.11.1.3 | Local call to radio with an interprefix number | Establish call to instrument Establish call through the trunk system |
| 1.11.1.4 | Local call to radio with the same prefix number using short form dialling | Establish call to instrument Establish call through the trunk system |
| 1.11.1.5 | Intersite call to radio with the same prefix number | Establish call through the trunk system |
| 1.11.1.6 | Intersite call to radio with an interprefix number | Establish call through the trunk system |
| 1.11.1.7 | Intersite call to radio with the same prefix number using short form dialling | Establish call through the trunk system |

| | | |
|-----------|---------------------------|--|
| 1.11.1.8 | PSTN call | Establish call to instrument Establish call through the trunk system |
| 1.11.1.9 | Call the radio under test | Establish call from instrument Establish call through the trunk system |
| 1.11.1.10 | Handoff | Reregister on new control channel with instrument Reregister on new control channel on the trunk system |

1.11.2 Control Signal - Trunk Site Controller

| | Characteristics | Base Station (Repeater) |
|----------|--|--|
| 1.11.2.1 | FFSK level from TSC | 1 Vp-p \pm 0.2 Vp-p |
| 1.11.2.2 | FFSK frequency from TSC | 1.2 kHz \pm 100 Hz 1.8 kHz \pm 100 Hz |
| 1.11.2.3 | Tx deviation at FFSK level For channel dragging problem | 1.5 kHz \pm 100 Hz 800 Hz \pm 100 Hz |
| 1.11.2.4 | FFSK level from Rx measured at TSC (Modulation 1.5 kHz) (Modulating frequency 1.2 kHz) | 1 Vp-p \pm 0.2 Vp-p |

1.12 Acoustical measurements

| | Characteristics | Portable |
|--------|----------------------------------|---|
| 1.12.1 | Receiver | |
| | Loudspeaker sound pressure level | \geq 84 dB(A) at 300 mm |
| 1.12.2 | Transmitter | |
| | Transmitter deviation | Between 300 and 500 Hz from a SPL of 80 dB(A) at the microphone |

1.13 Co-channel Interference

| | Characteristics | Various |
|--------|----------------------------------|--------------|
| 1.13.1 | Speech | |
| | Level difference between signals | \geq 15 dB |
| 1.13.2 | Data (FFSK) | |
| | Level difference between signals | \geq 20 dB |

2. METHODS OF MEASUREMENT

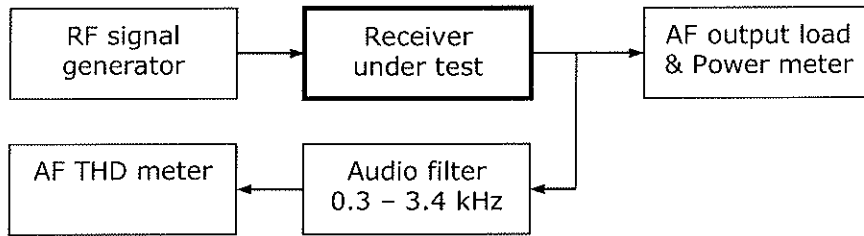
Applied Standard

- 2.1 Normal condition
- | | | |
|------------------------------|---|----------------|
| Temperature | : | 23 °C ± 3 °C |
| Relative Humidity | : | 45 to 85 % |
| Lead acid battery | : | 2.3 V per cell |
| Lithium-ion battery | : | 3.6 V per cell |
| Nickel cadmium | : | 1.2 V per cell |
| Nickel Metal Hydrate battery | : | 1.2 V per cell |
| Mains | : | 220 V AC 50 Hz |
- 2.2 Extreme conditions
- | | | |
|------------------------------|---|--|
| Temperature | : | – 10 °C and 60 °C |
| Relative humidity | : | 45 to 95 % |
| Lead acid battery | : | 1.8 V minimum & 2.6 V maximum per cell |
| Lithium-ion battery | : | 3.0 V minimum & 4.2 V maximum per cell |
| Nickel Cadmium battery | : | 1.0 V minimum & 1.5 V maximum per cell |
| Nickel Metal Hydrate battery | : | 1.0 V minimum & 1.5 V maximum per cell |
| Mains | : | 220 V AC ± 10 % 50 Hz ± 2 % |
- Power Supply Systems
- | | | | | |
|-------------|---|----------------|----------------|----------------|
| 12 V system | : | Minimum 11.0 V | Nominal 13.8 V | Maximum 15.6 V |
| 24 V system | : | Minimum 22.0 V | Nominal 27.6 V | Maximum 31.2 V |
| 48 V system | : | Minimum 44.0 V | Nominal 55.2 V | Maximum 62.4 V |
- 2.3 Warm up time
As specified by the manufacturer.
- 2.4 Temperature stabilising period
One hour minimum.
- 2.5 Power source tolerance
≤ ± 3 %.
- 2.6 Standard RF Test Signal
- 2.6.1 Standard test modulation
- | | | |
|----------------------|---|---|
| Modulating frequency | : | 1.0 kHz. |
| Modulation | : | 1.5 kHz (60 % of maximum rated system deviation). |
- 2.6.2 Standard RF Signal Input Level
– 60 dBm (223.6 μ V_{pd} or 447.2 μ V_{EMF}).
- 2.7 Audio Output Level
SOP = – 3 dB_{MUOP}.

2.2 Radio Receiver

2.2.1 Maximum Useful Output Power

Connect the equipment as shown below.



2.2.1.1 Inject a standard RF test signal from the RF signal generator.

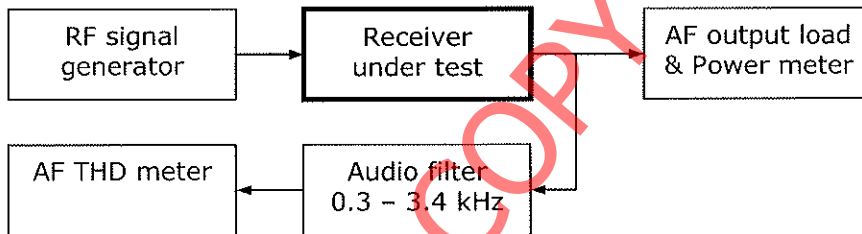
2.2.1.2 Adjust the volume control of the radio until the THD is 10 % or the volume control reaches its maximum travel, whichever occurs first.

2.2.1.3 Measure the audio output power (MUOP).

Note: The impedance of the AF output load must be the same value as the load (loudspeaker) with which the receiver normally operates.

2.2.2 Audio frequency total harmonic distortion

Connect the equipment as shown below.



2.2.2.1 Standard measurement

2.2.2.1.1 Test 1.

2.2.2.1.1.1 Inject a standard RF test signal from the RF signal generator into the receiver.

2.2.2.1.1.2 Adjust the volume control of the radio to obtain SOP.

2.2.2.1.1.3 Measure the THD.

2.2.2.1.2 Test 2.

2.2.2.1.2.1 Change the modulating frequency to 500 Hz using the same modulation factor as in test 1, except that in the case of PM receivers, the modulation factor should be reduced by 50 %.

2.2.2.1.2.2 Repeat the procedure given in test 1.

2.2.2.1.2.3 Measure the THD.

2.2.2.2 600 Ω balanced line

Where a 600 Ω balanced line is provided, the THD must be measured on this line.

2.2.2.2.1 Inject a standard RF test signal from the RF signal generator into the receiver.

2.2.2.2.2 Load the line with a 600 Ω resistive load or equivalent impedance, provided by the measuring instrument.

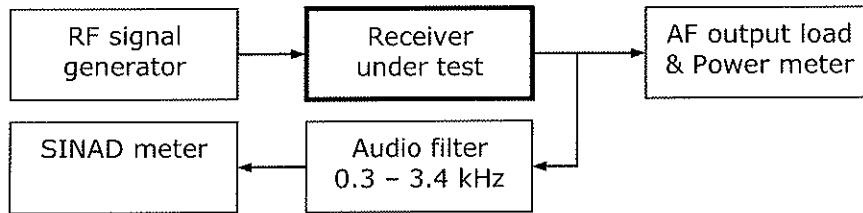
2.2.2.2.3 Adjust the audio signal level to measure -10 dBm on the line.

2.2.2.2.4 Measure the THD.

2.2.2.2.5 Repeat the THD measurement when applying test 2.

2.2.3 Usable sensitivity

Connect the equipment as shown below.

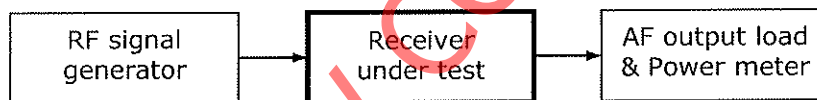


- 2.2.3.1 Adjust the RF signal generator to produce a standard RF input signal level.
- 2.2.3.2 Adjust the volume control of the radio to obtain SOP.
- 2.2.3.3 Reduce the RF signal level until the SINAD ratio is 12 dB.
- 2.2.3.4 Without readjustment of the volume control check whether the audio output level is less than $-3 \text{ dB}_{\text{SOP}}$.
- 2.2.3.5 If the audio output is less than $-3 \text{ dB}_{\text{SOP}}$, increase the RF signal level until $-3 \text{ dB}_{\text{SOP}}$ is obtained.
- 2.2.3.6 Take the RF signal output level from the signal generator at this setting as the usable sensitivity.
- 2.2.3.7 The measurement shall be made under the extreme test conditions as well. Under the extreme test conditions, the receiver audio output power shall be within $\pm 3 \text{ dB}$ of the value obtained under normal test condition.

Note: The impedance of the AF output load must be the same value as the load (loudspeaker) with which the receiver normally operates.

2.2.4 Squelch operating threshold

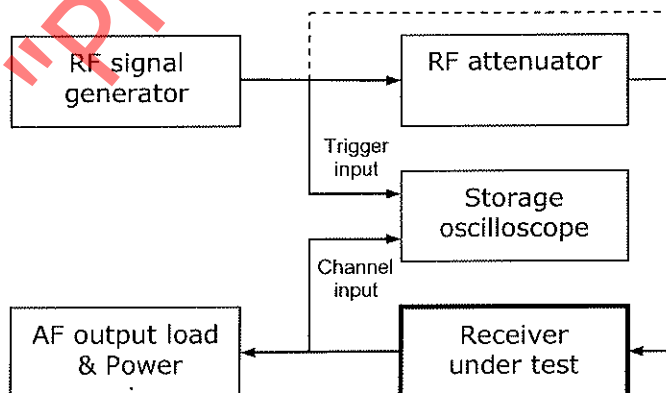
Connect the equipment as shown below.



- 2.2.4.1 Apply a standard RF test signal to the receiver under test and adjust the volume control of the radio to obtain SOP.
- 2.2.4.2 Reduce the RF signal level **slowly** until the squelch closes and record this RF signal level as the squelch closing level in dBm.
- 2.2.4.3 Increase the RF signal level **slowly** until the squelch opens and record this RF signal level as the squelch opening level in dBm.

2.2.5 Attack time

Connect the equipment as shown below.

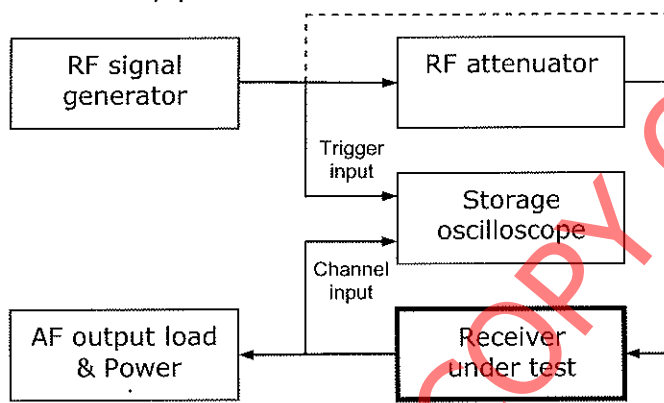


- 2.2.5.1 Apply a standard RF test signal to the receiver under test.

- 2.2.5.2 Adjust the volume control of the radio to obtain SOP.
- 2.2.5.3 Determine the usable sensitivity as described in clause 2.2.3.
- 2.2.5.4 Adjust the squelch to open at a RF signal level of -115 dBm, measured at the antenna terminal.
- 2.2.5.5 Set the RF signal level from the signal generator to 0 dBm.
- 2.2.5.6 Set the value of the RF attenuator to decrease the signal level to 12 dB above the usable sensitivity level, measured at the antenna terminal and switch the output of the signal generator off.
- 2.2.5.7 Set the storage oscilloscope to single sweep operation.
- 2.2.5.8 Switch the RF output on and measure the time required for the audio output to reach -0.5 dB_{SOP}.
- 2.2.5.9 Repeat the measurement three times and take the average of the three measurements as the receiver attack time.

2.2.6 Squelch Closing Time

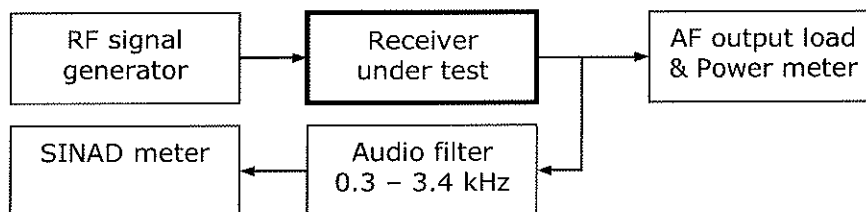
Connect the equipment as shown below.



- 2.2.6.1 Apply a standard RF test signal to the receiver under test.
- 2.2.6.2 Adjust the volume control of the radio to obtain SOP.
- 2.2.6.3 Determine the usable sensitivity as described in clause 2.2.3.
- 2.2.6.4 Adjust the squelch to open at a RF signal level of -115 dBm, measured at the antenna terminal.
- 2.2.6.5 Set the RF signal level from the signal generator to 0 dBm.
- 2.2.6.6 Set the value of the RF attenuator to decrease the signal level to 12 dB above the usable sensitivity level, measured at the antenna terminal.
- 2.2.6.7 Set the storage oscilloscope to single sweep operation.
- 2.2.6.8 Switch the output of the signal generator off and measure the time required for the audio output to be reduced by 10 dB from the SOP value.
- 2.2.6.9 Repeat the measurement three times and take the average of the three measurements as the squelch closing time.

2.2.7 Modulation acceptance bandwidth

Connect the equipment as shown below.

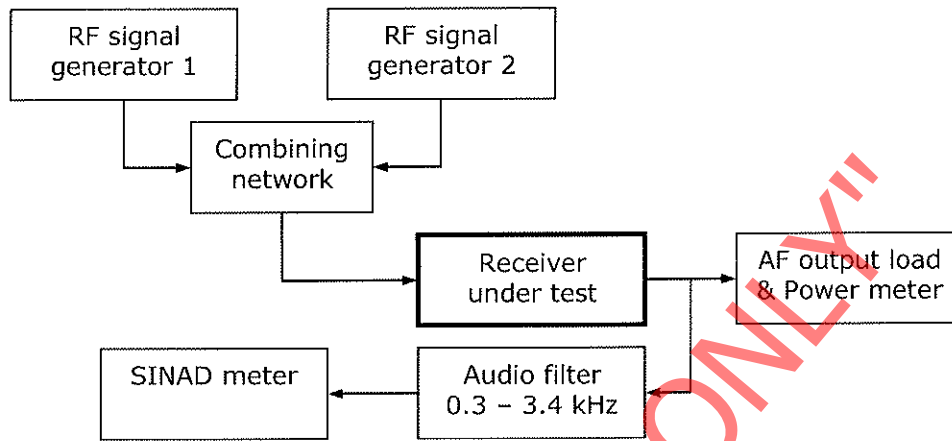


- 2.2.7.1 Apply a standard RF test signal to the receiver under test.
- 2.2.7.2 Adjust the receiver volume control to obtain SOP.

- 2.2.7.3 Reduce the RF signal level until the SINAD ratio is 12 dB.
- 2.2.7.4 Increase the RF signal level by 6 dB.
- 2.2.7.5 Increase the modulation factor until the SINAD ratio is again 12 dB.
- 2.2.7.6 Record this value of the modulation factor as the modulation acceptance bandwidth.

2.2.8 Adjacent channel selectivity and desensitization ratio

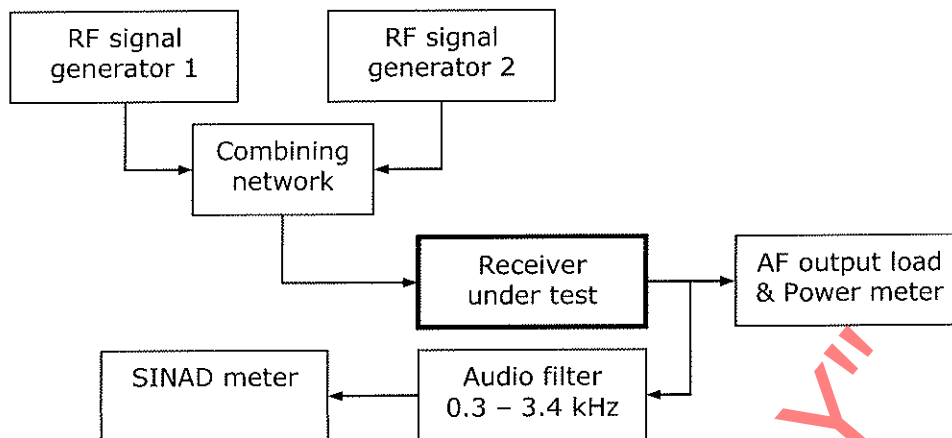
Connect the equipment as shown below.



- 2.2.8.1 Switch the RF signal output of signal generator 2 off.
- 2.2.8.2 RF signal generator 1:
 - 2.2.8.2.1 Apply a standard RF test signal to the receiver under test.
 - 2.2.8.2.2 Adjust the volume control of the radio to obtain SOP.
 - 2.2.8.2.3 Reduce the RF signal until the SINAD ratio is 12 dB (wanted signal).
 - 2.2.8.2.4 Note this RF signal level.
- 2.2.8.3 RF signal generator 2:
 - 2.2.8.3.1 Switch the RF signal output on (unwanted signal).
 - 2.2.8.3.2 Modulate the RF signal with 400 Hz at the standard modulation factor.
 - 2.2.8.3.3 Set the frequency (unwanted signal) to a frequency one-channel width above the assigned frequency (wanted signal).
 - 2.2.8.3.4 Adjust the RF signal level such that the SINAD ratio is degraded to 6 dB.
 - 2.2.8.3.5 Note this RF signal level.
 - 2.2.8.3.6 Repeat for the unwanted signal set to a frequency one-channel width below the assigned frequency.
- 2.2.8.4 Calculate the difference between the unwanted and wanted signal levels in dB, as the adjacent channel selectivity and desensitization ratio.
- 2.2.8.5 Take the worst case of the two measurements as the result.
- 2.2.8.6 The measurements shall be made under the extreme test conditions as well.

2.2.9 Spurious response attenuation/rejection

Connect the equipment as shown below.

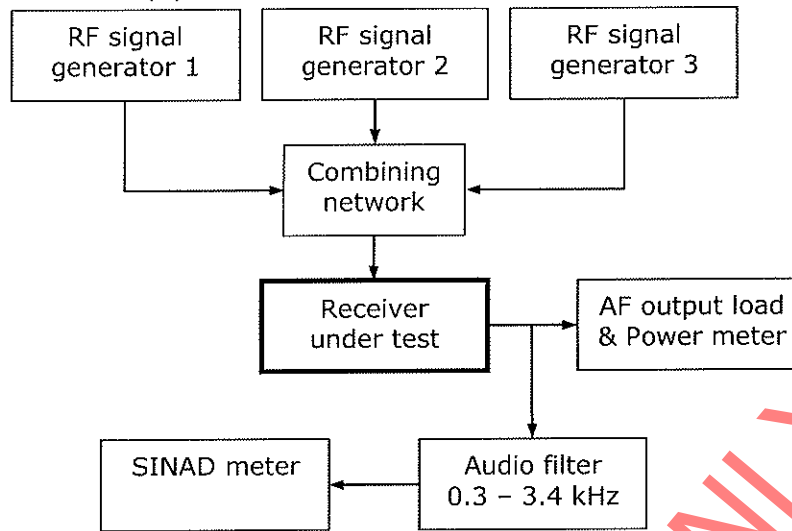


- 2.2.9.1 Switch the RF signal output of signal generator 2 off.
- 2.2.9.2 RF signal generator 1:
- 2.2.9.2.1 Adjust the RF signal generator to produce a standard RF test signal.
 - 2.2.9.2.2 Adjust the volume control of the radio to obtain SOP.
 - 2.2.9.2.3 Reduce the RF signal to the receiver until the SINAD ratio is 12 dB.
- 2.2.9.3 RF signal generator 2:
- 2.2.9.3.1 Switch the RF signal output on and adjust the signal level to 80 dB (portable) or 85 dB (mobile and base) higher than that of signal generator 1.
 - 2.2.9.3.2 Modulate the RF signal with 400 Hz at standard modulation factor.
 - 2.2.9.3.3 Slowly sweep the carrier frequency over the range 100 kHz to 1 GHz in 12.5 kHz steps (channels) excluding the assigned channel and the two adjacent channels.
 - 2.2.9.3.4 When the receiver is responsive to a spurious signal, adjust the RF signal level until the SINAD ratio is 6 dB.
- 2.2.9.4 Note the frequency and the RF signal levels of the two signal generators and take the difference between the two levels expressed in dB as the measure of the spurious response attenuation at that frequency.

Note: Ensure that the measured response is not caused by spurious signals from the RF signal generators or intermodulation products between the two signals.

2.2.10 **Intermodulation spurious response attenuation/rejection**

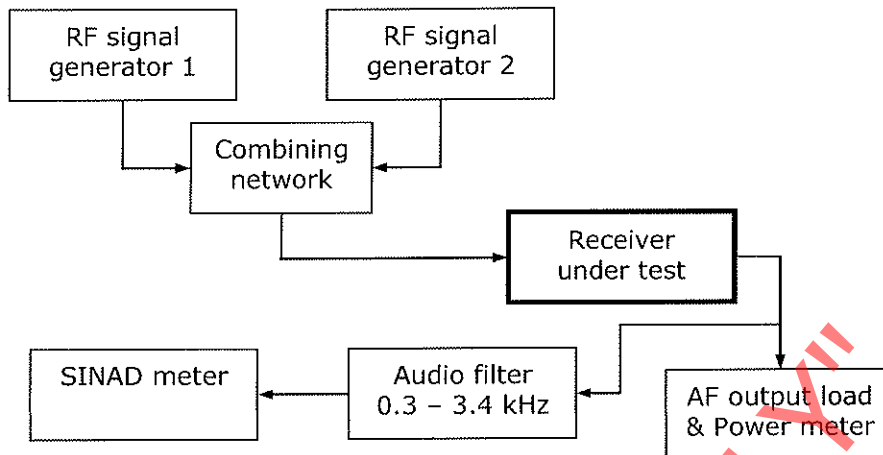
Connect the equipment as shown below.



- 2.2.10.1 Switch the RF signal output of signal generators 2 & 3 off.
- 2.2.10.2 RF signal generator 1:
- 2.2.10.2.1 Adjust the RF signal generator to produce a standard RF test signal.
- 2.2.10.2.2 Adjust the volume control of the radio to obtain SOP.
- 2.2.10.2.3 Reduce the RF signal to the receiver until the SINAD ratio is 12 dB.
- A. 2.2.10.3 RF signal generator 2:
- 2.2.10.3.1 Adjust the unmodulated frequency of the RF signal generator to the second adjacent channel above the nominal carrier frequency.
- 2.2.10.4 RF signal generator 3:
- 2.2.10.4.1 Modulate the RF signal with 400 Hz at standard modulation factor.
- 2.2.10.4.2 Adjust the frequency of the RF signal generator to the fourth adjacent channel above the nominal carrier frequency.
- 2.2.10.5 Switch the RF signal output of signal generators 2 & 3 on.
- 2.2.10.6 Maintain the outputs of RF signal generators 2 & 3 at equal levels.
- 2.2.10.7 Adjust the RF signal levels to reduce the SINAD ratio to 6 dB.
- 2.2.10.8 Adjust the frequency of RF signal generator 3 slightly to produce the maximum interfering signal.
- 2.2.10.9 Note the difference in dB between the RF signal output level from RF signal generator 1 and the RF signal output level from RF signal generators 2 & 3.
- B. 2.2.10.10 Repeat these measurements with RF signal generators 2 & 3 adjusted to the fourth adjacent and eighth adjacent channels above the nominal carrier frequency.
- C. 2.2.10.11 The measurements described in A & B shall be repeated with RF signal generators 2 & 3 set to the appropriate channels below the nominal frequency of the receiver.
- 2.2.10.12 Record the worst ratio in dB as the measure of the intermodulation spurious response attenuation.

2.2.11 Co-channel rejection ratio

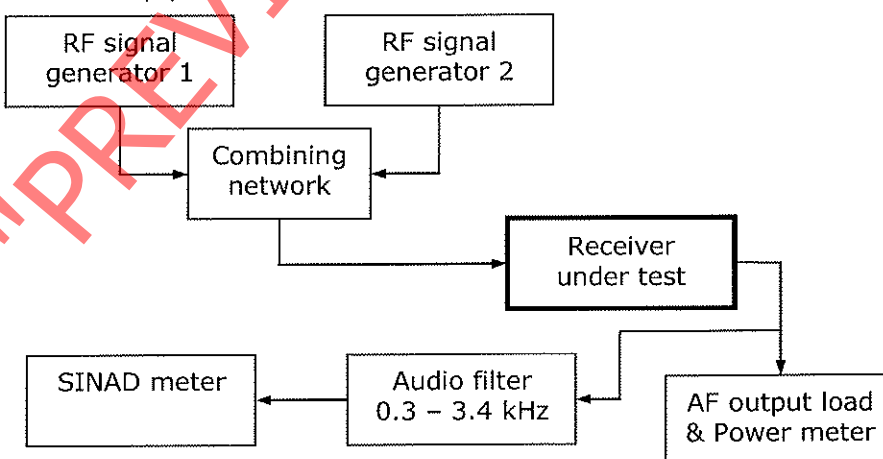
Connect the equipment as shown below.



- 2.2.11.1 Switch the RF signal output of signal generator 2 off.
- 2.2.11.2 RF signal generator 1:
- 2.2.11.2.1 Adjust the RF signal generator to produce a standard RF test signal.
- 2.2.11.2.2 Adjust the volume control of the radio to obtain SOP.
- 2.2.11.2.3 Reduce the RF signal until the SINAD ratio is 12 dB (wanted signal).
- 2.2.11.3 RF signal generator 2:
- 2.2.11.3.1 Switch the RF signal output on (unwanted signal).
- 2.2.11.3.2 Set the frequency to the assigned receiver frequency.
- 2.2.11.3.3 Modulate the RF signal with 400 Hz at standard modulation factor.
- 2.2.11.3.4 Adjust the RF signal level such that the SINAD ratio is reduced to 6 dB.
- 2.2.11.4 Record the co-channel rejection ratio as the difference in dB, between the wanted and unwanted signal levels.
- 2.2.11.5 Repeat the measurement with signal generator 2 set to frequencies 1.5 kHz and 3.0 kHz above and below the assigned frequency.
- 2.2.11.6 The highest value of the five measurements shall be recorded as the co-channel rejection ratio.

2.2.12 Blocking or Desensitisation

Connect the equipment as shown below.



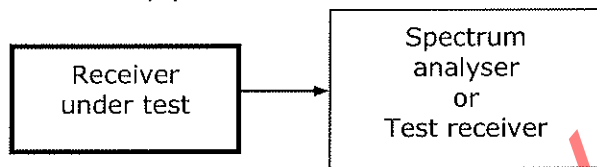
- 2.2.12.1 Switch the RF signal output of signal generator 2 off.

- 2.2.12.2 RF signal generator 1:

- 2.2.12.2.1 Adjust the RF signal generator to produce a standard RF test signal.
- 2.2.12.2.2 Adjust the volume control of the radio to obtain SOP.
- 2.2.12.2.3 Reduce the RF signal until the SINAD ratio is 12 dB (wanted signal).
- 2.2.12.3 RF signal generator 2:
- 2.2.12.3.1 Switch the unmodulated RF signal output on (unwanted signal).
- 2.2.12.3.2 Set the RF signal to a level 84 dB higher than signal generator 1.
- 2.2.12.3.3 Vary the frequency from 1 MHz to 10 MHz on either side of the assigned carrier frequency.
- 2.2.12.4 Monitor the variation in the audio output level and the SINAD ratio.
- 2.2.12.5 Record the difference in dB between the signal output levels from the two RF signal generators at which the audio output power decreased with 3 dB or the SINAD ratio decreases to 6 dB, whichever occurs first.
- Note: Ensure that the measured response is not caused by spurious signals from the RF signal generators.

2.2.13 Conducted Spurious radiation

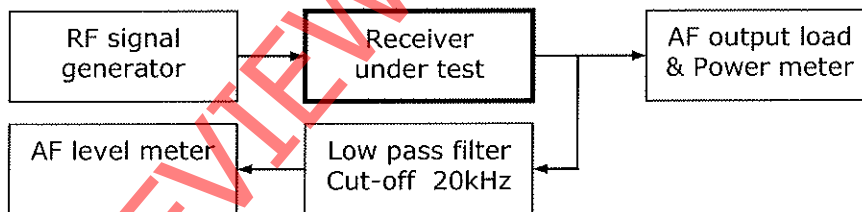
Connect the equipment as shown below.



- 2.2.13.1 Switch the receiver on.
- 2.2.13.2 The receiver must be in standby mode.
- 2.2.13.3 Slowly sweep the measuring instrument over the range 9 kHz to 4 GHz.
- 2.2.13.4 Record the frequencies and measure the absolute levels of the conducted spurious radiation.

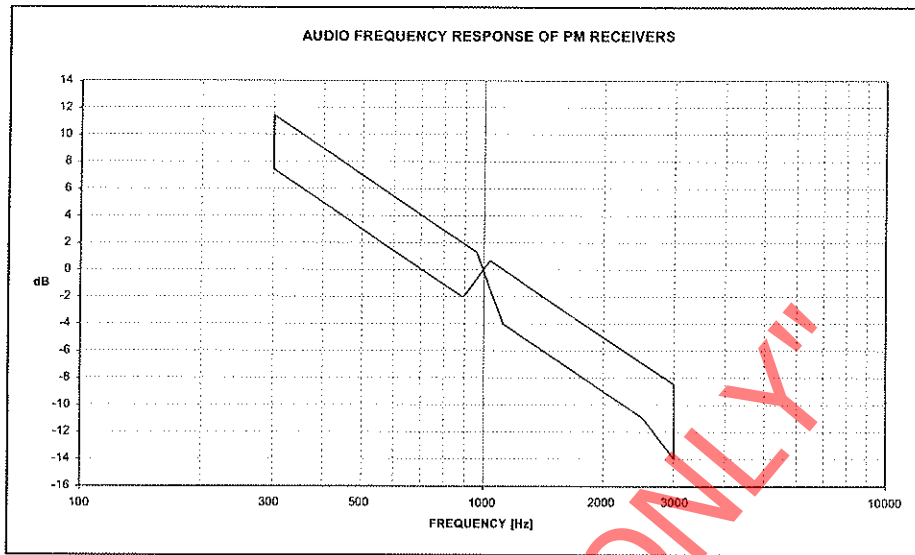
2.2.14 Audio frequency response

Connect the equipment as shown below.

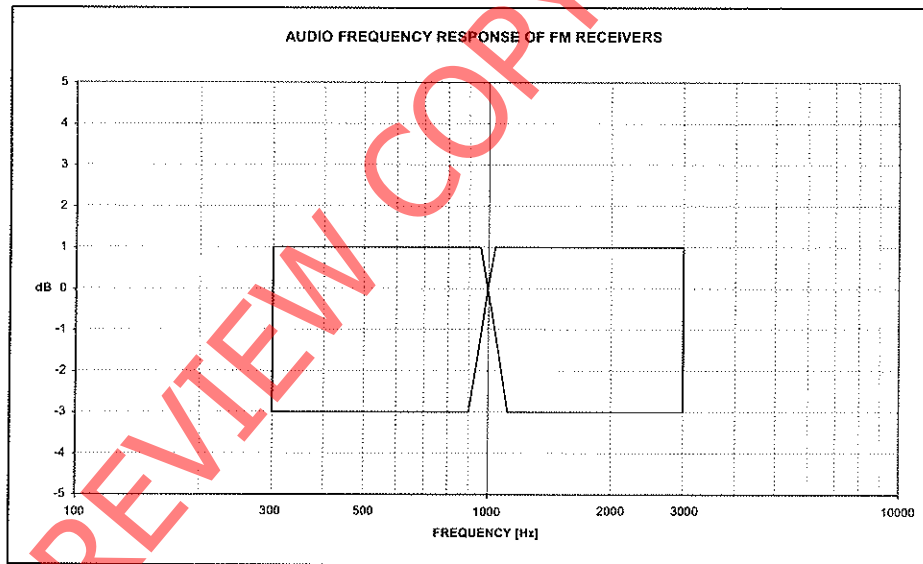


- 2.2.14.1 Standard measurement
- 2.2.14.1.1 Adjust the RF signal generator to produce a standard RF test signal and inject it into the receiver.
- 2.2.14.1.2 Adjust the volume control of the radio to obtain SOP.
- 2.2.14.1.3 Adjust the modulation of the RF signal generator to 20 % of the maximum system deviation.
- 2.2.14.1.4 While keeping the modulation factor constant vary the modulating frequency over the range 300 Hz to 3 kHz.
- 2.2.14.1.5 Record the variation of the audio output power over this range in dB with reference to the corresponding level at 1 kHz.
- 2.2.14.1 600 Ω balanced line
- Where a 600 Ω balanced line is provided, the audio frequency response must be measured on this line.
- 2.2.14.2.1 Inject a standard RF test signal from the RF signal generator into the receiver.
- 2.2.14.2.2 Load the line with a 600 Ω resistive load or equivalent impedance, provided by the measuring instrument.

- 2.2.14.2.3 Adjust the audio signal level to measure – 10 dBm on the line.
- 2.2.14.2.4 Proceed with clauses 2.2.14.1.3 and 2.2.14.1.5.

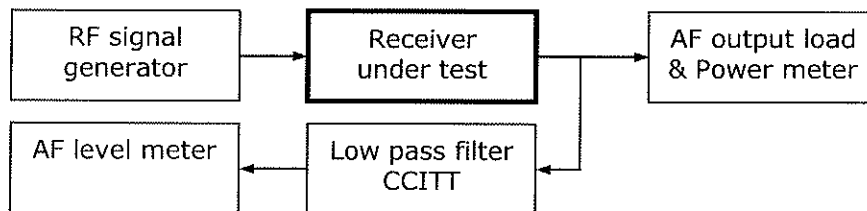


6dB/octave slope



2.2.15 **Signal to hum and noise ratio**

Connect the equipment as shown below.

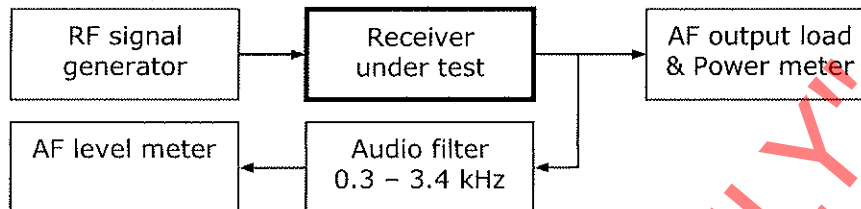


- 2.2.15.1 Select the CCITT filter (low pass filter).
- 2.2.15.2 Adjust the RF signal generator to produce a standard RF test signal.
- 2.2.15.3 Adjust the volume control of the radio to obtain SOP.

- 2.2.15.4 Adjust the squelch to its minimum (unsquelched).
- 2.2.15.5 Remove the modulation and measure the audio output power.
- 2.2.15.6 Adjust the squelch to its maximum (squelched).
- 2.2.15.7 If the receiver remains unsquelched remove the RF signal.
- 2.2.15.8 Measure the audio output power.
- 2.2.15.9 Record the ratio in dB between the audio output powers without modulation, and the SOP level as the signal to hum and noise ratio.

2.2.16 **Amplitude characteristics**

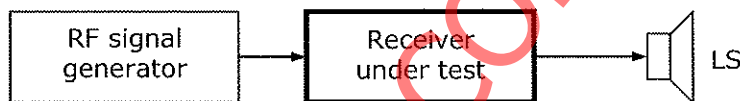
Connect the equipment as shown below.



- 2.2.16.1 Adjust the RF signal generator to produce a standard RF test signal.
- 2.2.16.2 Increase the RF output signal level to -13 dBm.
- 2.2.16.3 Adjust the volume control of the radio to obtain SOP.
- 2.2.16.4 Decrease the RF signal output level from -13 dBm to -107 dBm and measure the change in the audio output level in dB.

2.2.17 **High RF signal level interference**

Connect the equipment as shown below.



- 2.2.17.1 Set the radio to operate on the lowest channel.
- 2.2.17.2 Adjust the RF signal generator to produce a standard RF test signal.
- 2.2.17.3 Adjust the squelch to open at a RF signal level of -115 dBm.
- 2.2.17.4 Increase the RF signal level to -7 dBm.
- 2.2.17.5 Scan the frequencies of 132 channels above the receiving channel, excluding the assigned channel and the adjacent channels.
- 2.2.17.6 Record the channel and the RF signal level, at which the squelch opens in the window of -47 dBm to -7 dBm.
- 2.2.17.7 Set the radio to operate on the highest channel.
- 2.2.17.8 Scan the frequencies of 132 channels below the receiving channel, excluding the assigned channel and the adjacent channels.
- 2.2.17.9 Record the channel and the RF signal level, at which the squelch opens in the window of -47 dBm to -7 dBm.

Note: Where the interfering channels correspond with the intermodulation free channel groups, interference could occur.

Intermodulation free channel groups**High site channels**Duplex, 5th order, 132 channels

| | | | | | | | | | | | | | | | |
|---------|---|---|---|---|----|----|----|----|----|----|----|----|-----|-----|-----|
| Group A | 1 | 2 | 6 | 8 | 22 | 37 | 54 | 61 | 79 | 80 | 88 | 91 | 101 | 124 | 129 |
|---------|---|---|---|---|----|----|----|----|----|----|----|----|-----|-----|-----|

Duplex, 5th order, 132 channels

| | | | | | | | | | | | | |
|---------|---|---|---|----|----|----|----|----|----|-----|-----|-----|
| Group B | 3 | 4 | 7 | 23 | 45 | 73 | 75 | 85 | 96 | 102 | 120 | 128 |
|---------|---|---|---|----|----|----|----|----|----|-----|-----|-----|

Duplex, 5th order, 132 channels

| | | | | | | | | | | | |
|---------|----|----|----|----|----|----|----|-----|-----|-----|-----|
| Group C | 16 | 41 | 57 | 59 | 74 | 78 | 83 | 110 | 122 | 123 | 130 |
|---------|----|----|----|----|----|----|----|-----|-----|-----|-----|

Duplex, 5th order, first 52 channels

| | | | | | | | |
|---------|----|----|----|----|----|----|----|
| Group D | 17 | 18 | 21 | 31 | 40 | 46 | 48 |
|---------|----|----|----|----|----|----|----|

Duplex, 5th order, first 52 channels

| | | | | | | | |
|---------|----|----|----|----|----|----|----|
| Group E | 19 | 28 | 32 | 43 | 44 | 49 | 51 |
|---------|----|----|----|----|----|----|----|

Duplex, 5th order, first 52 channels

| | | | | | | |
|---------|----|----|----|----|----|----|
| Group F | 29 | 30 | 35 | 42 | 50 | 52 |
|---------|----|----|----|----|----|----|

Duplex, 5th order, first 52 channels

| | | | | |
|---------|----|----|----|----|
| Group G | 11 | 14 | 24 | 26 |
|---------|----|----|----|----|

Duplex, 5th order, first 52 channels

| | | | |
|---------|----|----|----|
| Group H | 34 | 36 | 47 |
|---------|----|----|----|

Shunting channelsSimplex, 5th order, last 80 channels

| | | | | | | | | | | | |
|---------|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| Group A | 53 | 56 | 60 | 71 | 97 | 99 | 109 | 118 | 126 | 131 | 132 |
| Group B | 55 | 58 | 62 | 63 | 72 | 84 | 112 | 125 | | | |
| Group C | 64 | 67 | 69 | 76 | 95 | 103 | 116 | 127 | | | |
| Group D | 68 | 77 | 82 | 90 | 107 | 113 | 114 | 117 | | | |
| Group E | 65 | 66 | 70 | 94 | 100 | 121 | | | | | |
| Group F | 81 | 87 | 89 | 92 | 104 | 108 | | | | | |

2.3 Radio Transmitter

2.3.1 Carrier power (conducted)

Connect the equipment as shown below.

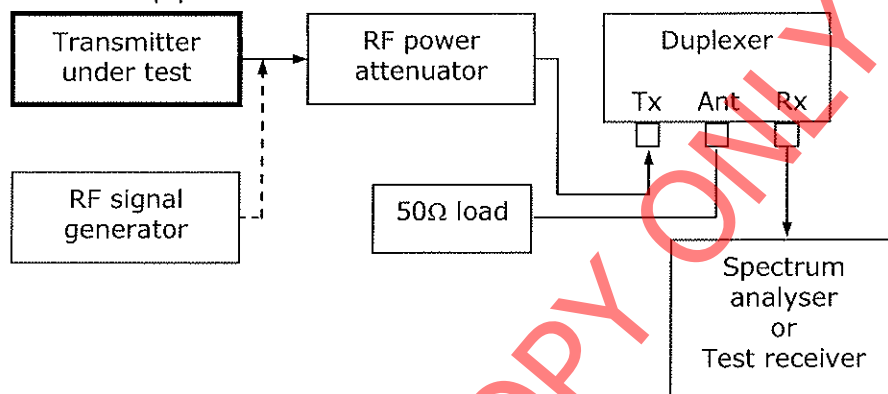


2.3.1.1 Measure the carrier power in the absence of modulation.

2.3.1.2 The measurement shall be made under the extreme test conditions as well.

2.3.2 Conducted spurious emissions

Connect the equipment as shown below.



2.3.2.1 The duplexer must be tuned to the operating band. See specifications in clause 1.4.1.

2.3.2.2 The value of the RF attenuator (including the duplexer) must be such to limit the carrier level at the spectrum analyser/test receiver to approximately – 60 dBm.

2.3.2.3 With the transmitter transmitting an unmodulated carrier, measure and record the frequencies and absolute levels of the conducted spurious up to the 5th harmonic.

2.3.2.4 Replace the transmitter with the RF signal generator.

2.3.2.5 Tune the RF signal generator to the recorded frequency and adjust the output level to obtain the recorded level on the spectrum analyser/test receiver.

2.3.2.6 Record the output level of the RF signal generator as the conducted spurious emission at that specific frequency.

2.3.2.7 Repeat 2.3.2.5 & 2.3.2.6 for all the other spurious emissions detected.

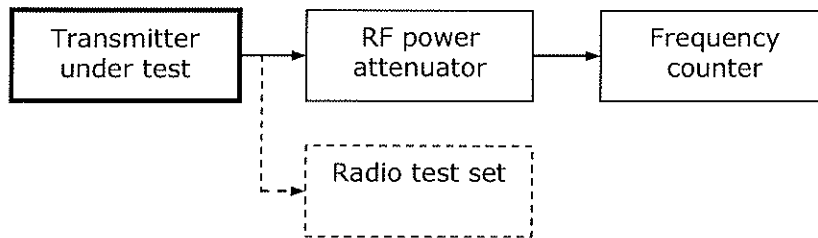
2.3.2.8 Remove the RF attenuator and duplexer and repeat the measurements when the transmitter is in the standby mode.

2.3.2.9 The measurements shall be made under the extreme test conditions as well.

2.3.1.10 With the above circuit the reverse channels can also be tested.

2.3.3 Carrier frequency error

Connect the equipment as shown below.



2.3.3.1 Measure the carrier frequency in the absence of modulation.

2.3.3.2 Repeat the measurement on each channel on which the transmitter is equipped to operate.

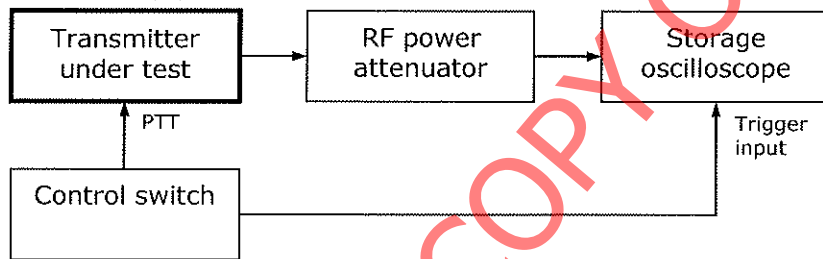
2.3.3.3 Calculate the carrier frequency error as the difference between the assigned frequency and the measured frequency. (Some test instruments can be set to measure the frequency error directly).

2.3.3.4 Record the worst case as the result.

2.3.3.5 The measurement shall be made under the extreme test conditions as well.

2.3.4 Carrier attack time

Connect the equipment as shown below.

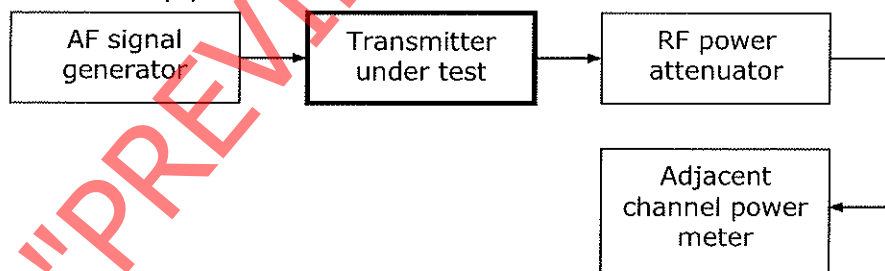


2.3.4.1 Set the storage oscilloscope to single sweep operation.

2.3.4.2 Operate the control switch and measure the time interval for the unmodulated carrier voltage level to reach a value 6 dB (50 %) below the steady state level.

2.3.5 Adjacent channel power

Connect the equipment as shown below.



2.3.5.1 Ensure that the modulation limiting (Tx deviation) is set correctly (see clause 2.3.7).

2.3.5.2 Measure the unmodulated carrier power level.

2.3.5.3 Modulate the transmitter with a 1 250 Hz signal at a level 20 dB greater than that required to produce the standard test modulation factor.

2.3.5.4 Measure the mean power produced by the modulation, hum and noise of the transmitter in the adjacent channels.

2.3.5.5 Express the adjacent channel power in dB with reference to the measured carrier power.

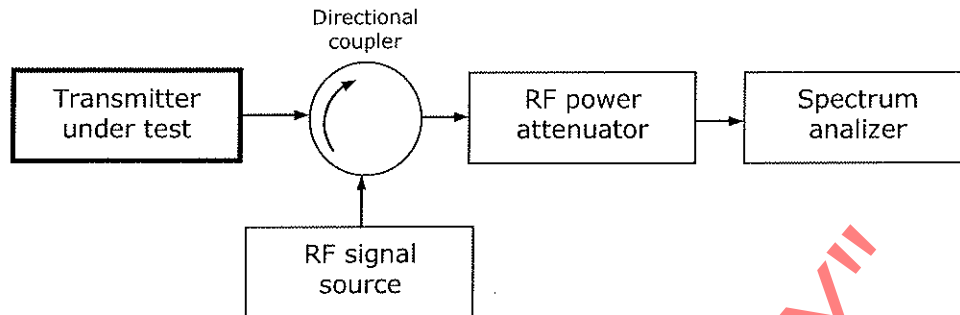
2.3.5.6 Record the worst ratio as the measure of the adjacent channel power.

Or: When the measured level does not comply with the specification:

The adjacent channel power not to exceed a level of -37 dBm irrespective of the carrier power level.

2.3.6 Intermodulation attenuation (fixed radio stations only)

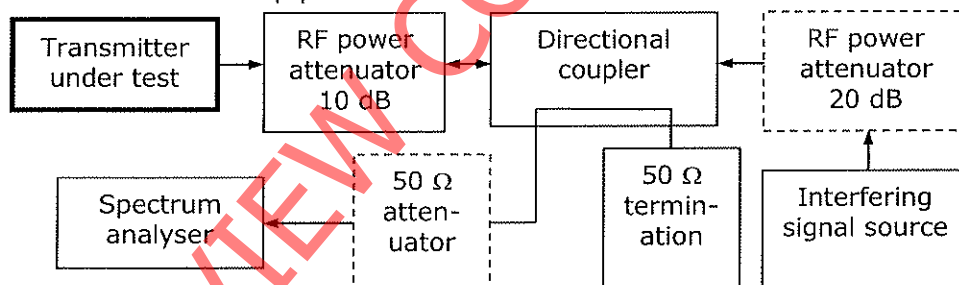
Method A: Connect the equipment as shown below.



- 2.3.6.1 Set the unmodulated signal level from the RF signal source to give a level, measured at the transmitter output terminal, 30 dB below the output carrier level.
- 2.3.6.2 With the transmitter transmitting an unmodulated carrier, vary the frequency of the RF signal source between 50 kHz and 100 kHz, above and below the carrier frequency.
- 2.3.6.3 Measure the levels of the Intermodulation components.
- 2.3.6.4 The Intermodulation attenuation is expressed as the ratio of the carrier level to the level of the largest Intermodulation product (third order) observed.
- 2.3.6.5 Record the worst case as the result.

Note: Ensure that the measured response is not caused by spurious signals from the RF signal source.

Method B: Connect the equipment as shown below.



- 2.3.6.6 The coupling between the transmitter under test and the 10 dB RF power attenuator must be as short as possible to minimize mismatching.
- 2.3.6.7 The directional coupler must have an insertion loss of ≤ 1 dB, directivity of ≥ 20 dB and sufficient bandwidth.
- 2.3.6.8 The transmitter under test and the interfering signal source must have sufficient physical separation to prevent the measurement being influenced by direct radiation.
- 2.3.6.9 The RF signal level from the interfering signal source must have the same level as that of the transmitter. Alternatively, the RF signal level from the interfering signal source must be 20 dB lower than that of the transmitter – omit the 20 dB RF power attenuator.
- 2.3.6.10 The transmitter under test shall be unmodulated.
- 2.3.6.11 The spectrum analyser must be adjusted to give a maximum indication (amplitude) with a frequency scan of 500 kHz.
- 2.3.6.12 The interfering signal source must be unmodulated and the frequency must be varied between 50 kHz to 100 kHz above and below the frequency of the transmitter under test.

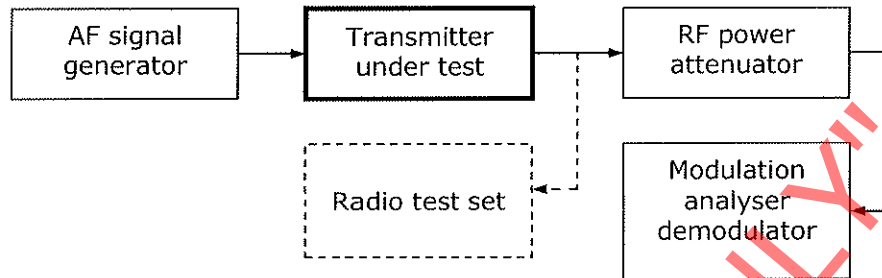
2.3.6.13 Measure the levels of the Intermodulation components on the spectrum analyser and determine the ratio of the carrier level to the level of the largest Intermodulation product (third order) observed, in dB.

2.3.6.14 Record the worst case as the result.

Note: Ensure that the measured response is not caused by spurious signals from the RF signal source.

2.3.7 **Modulation limiting** (Tx deviation)

Connect the equipment as shown below.



2.3.7.1 Ensure that the maximum deviation is set correctly and according to the manufacturer's procedure.

2.3.7.2 Apply electrically a 1 kHz audio test signal to the microphone input of the transmitter at a level sufficient to produce the standard test modulation factor.
(When an electrical input signal cannot be applied this may be replaced by an acoustical signal.)

2.3.7.3 Set the audio filter of the modulation analyser to Low Pass cut-off 15 kHz or 20 kHz.

2.3.7.4 Note the level of the audio test signal (reference).

2.3.7.5 Modulating frequency 0.3 kHz to 2.55 kHz:

2.3.7.5.1 Increase the audio test signal with 20 dB. Ensure that the measured deviation equals the maximum system deviation.

2.3.7.5.2 Without changing the audio input signal level vary the modulating frequency between 300 Hz and 2.55 kHz.

2.3.7.5.3 Record the largest positive or negative peak deviation obtained, as the modulation limit.

2.3.7.6 Modulating frequency 2.55 kHz to 6.0 kHz:

2.3.7.6.1 Decrease the audio test signal to obtain the standard test modulation factor (reference).

2.3.7.6.2 Without changing the audio input signal level vary the modulating frequency between 2.55 kHz and 6.0 kHz.

2.3.7.6.3 Record the largest positive or negative peak deviation obtained, as the modulation limit for the specific modulating frequency band.

Note: The deviation produced by the modulating frequencies between 2.55 kHz and 6.0 kHz must not exceed that of the deviation produced by the modulating frequency 2.55 kHz.

2.3.7.7 Modulating frequency 6.0 kHz to 12.5 kHz:

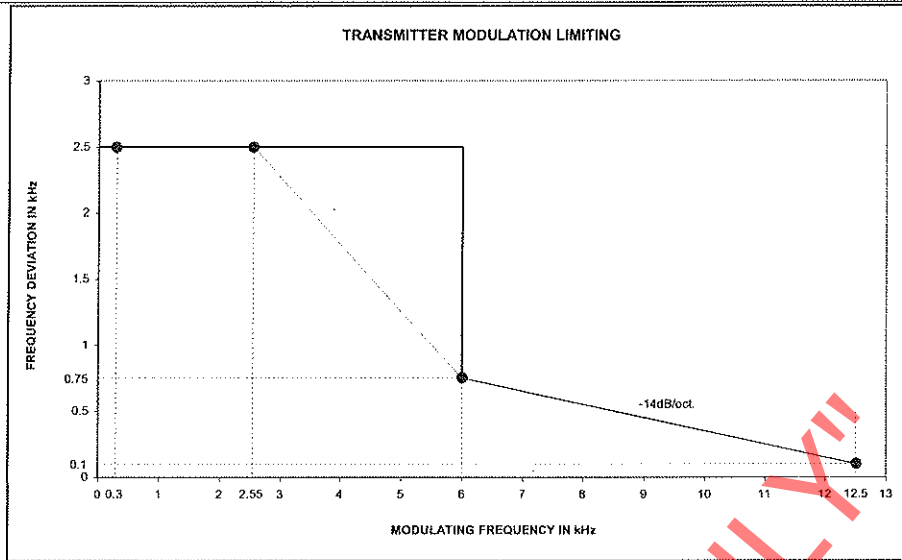
2.3.7.7.1 Obtain the standard test modulation factor (reference).

2.3.7.7.2 Without changing the audio input signal level vary the modulating frequency between 6.0 kHz and 12.5 kHz.

2.3.7.7.3 Record the decrease in the positive or negative peak deviation, as the modulation limit for the specific modulating frequency band.

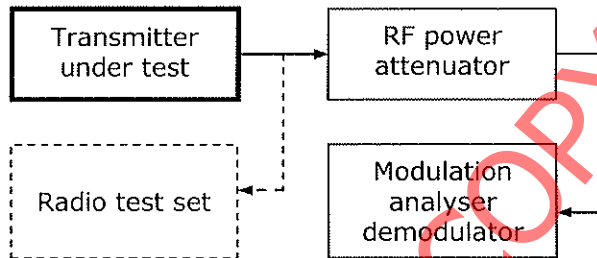
Note: Care must be taken not to generate hum when the audio signal is connected electrically.

It must be ensured that the acoustical audio source has a flat response throughout the bandwidth.



2.3.8 CTCSS deviation

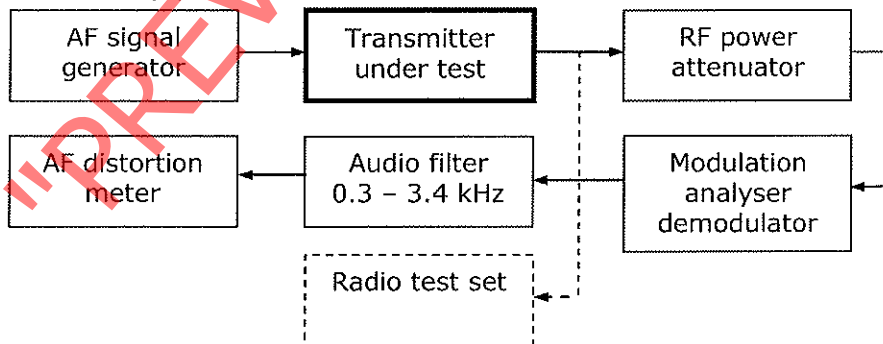
Connect the equipment as shown below.



- 2.3.8.1 Select the CTCSS frequency and activate the function.
- 2.3.8.2 Set the audio filter of the modulation analyser to Low Pass cut-off 15 kHz or 20 kHz.
- 2.3.8.3 In the absence of an audio input signal (modulating signal) transmit a carrier.
- 2.3.8.4 Measure and record the deviation of the sub-audible tone.

2.3.9 Audio frequency total harmonic distortion (THD)

Connect the equipment as shown below.



- 2.3.9.1 Standard measurement
 - 2.3.9.1.1 Apply electrically a 1 kHz audio test signal to the microphone input of the transmitter at a level sufficient to produce the standard test modulation factor.
 - 2.3.9.1.2 Record the distortion obtained.
 - 2.3.9.1.3 Adjust the audio signal generator frequency to 500 Hz.

2.3.9.1.4 Set the audio output signal at a level sufficient to produce the standard test modulation factor.

2.3.9.1.5 Record the distortion obtained.

Note: Care must be taken not to generate hum when the audio signal is connected electrically.

2.3.9.2 600 Ω balanced line input

Where a 600 Ω balanced line is provided, the THD must be measured on this line.

2.3.9.2.1 Load the line with a 600 Ω resistive load or equivalent impedance, provided by the test instrument.

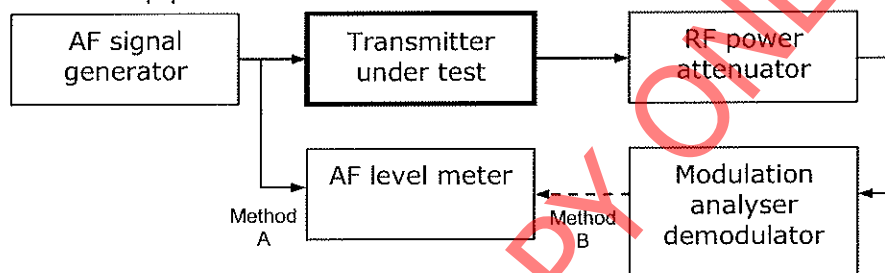
2.3.9.2.2 Inject a 1 kHz audio test signal into the line at a level of -10 dBm.

2.3.9.2.3 Ensure that the transmitting signal deviation comply with the standard test modulation factor.

2.3.9.2.4 Measure and record the THD.

2.3.10 Audio frequency response

Connect the equipment as shown below.



2.3.10.1 Standard measurement

Method A.

2.3.10.1.1 Apply electrically a 1 kHz audio test signal to the microphone input of the transmitter at a level sufficient to obtain 20 % of the maximum system deviation.

2.3.10.1.2 Select the low pass filter (cut-off 20 kHz) at the modulation analyser.

2.3.10.1.3 Vary the modulating frequency (audio signal) from 300 Hz to 3 kHz.

2.3.10.1.4 Adjust the modulating frequency level (audio signal) to maintain the modulation factor constant.

2.3.10.1.5 Record the variation in the audio output level of the AF signal generator in dB with reference to the corresponding level at 1 kHz.

Method B.

2.3.10.1.6 Apply electrically a 1 kHz audio test signal to the microphone input of the transmitter at a level sufficient to obtain 20 % of the maximum system deviation.

2.3.10.1.7 Select the low pass filter (cut-off 20 kHz) at the modulation analyser.

2.3.10.1.8 Keeping the audio signal level constant, vary the frequency from 300 Hz to 3 kHz.

2.3.10.1.9 Record the variation in the audio output level from the demodulator in dB with reference to the corresponding level at 1 kHz.

Note: The + and – signs must be inverted to be able to apply the graph.

2.3.10.2 600 Ω balanced line input

Where a 600 Ω balanced line is provided, the audio frequency response must be measured on this line.

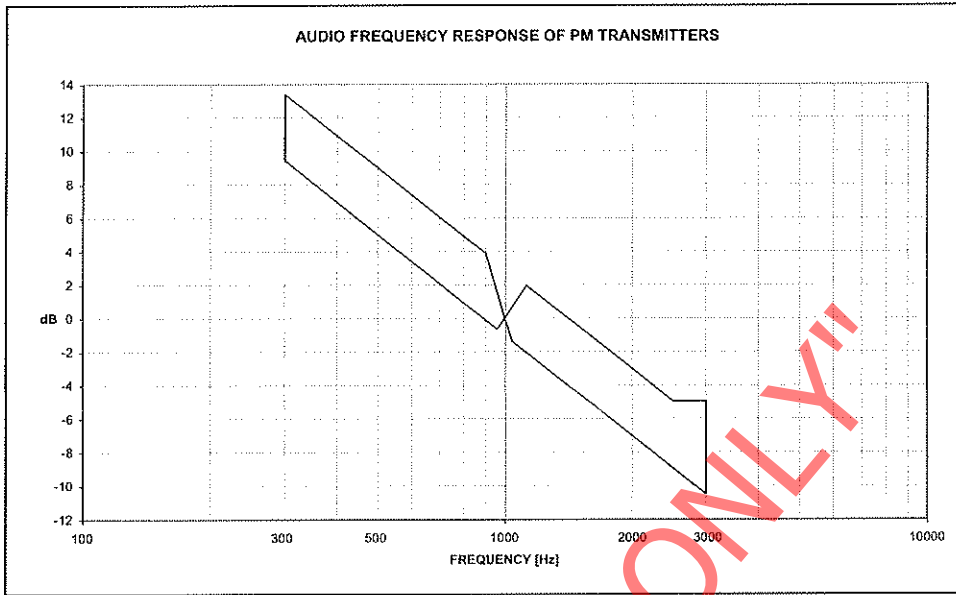
2.3.10.2.1 Load the line with a 600 Ω resistive load or equivalent impedance, provided by the test instrument.

2.3.10.2.2 Inject a 1 kHz audio test signal into the line at a level of -10 dBm.

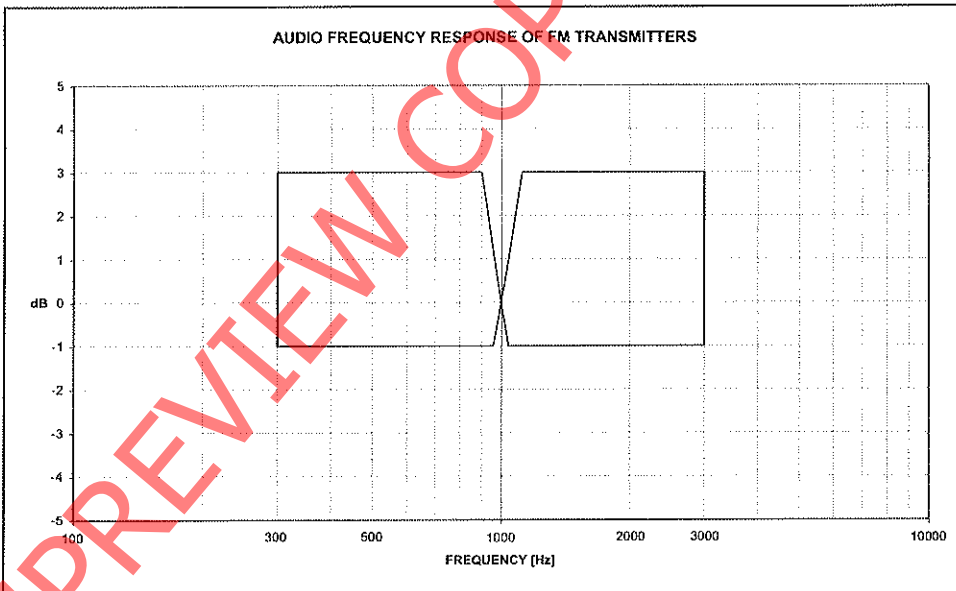
2.3.10.2.3 Ensure that the transmitting signal deviation comply with the standard test modulation factor.

2.3.10.2.4 Reduce the audio signal level to obtain 20 % of the maximum system deviation.

2.3.10.2.5 Proceed with test method A (2.3.10.1.2 to 2.3.10.1.5) or test method B (2.3.10.1.7 to 2.3.10.1.9)

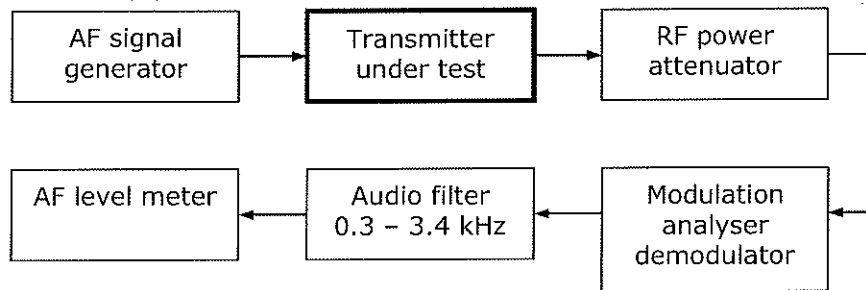


6dB/octave slope



2.3.11 Angle modulation hum and noise ratio

Connect the equipment as shown below.



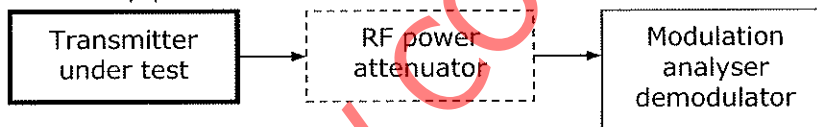
- 2.3.11.1 Apply electrically a 1 kHz audio test signal to the microphone input of the transmitter at a level sufficient to produce the standard test modulation factor.
- 2.3.11.2 Record the audio output level from the modulation analyser demodulator.
- 2.3.11.3 Remove the modulation from the transmitter.
- 2.3.11.4 Again record the audio output level from the modulation analyser demodulator.
- 2.3.11.5 Calculate the angle modulation hum and noise ratio by determining the difference between the two measurements in dB.

Note: Care must be taken not to generate hum when the audio signal is connected electrically.

Short circuit the audio input connections of the radio transmitter when the audio signal is removed.

2.3.12 Amplitude modulation hum and noise level

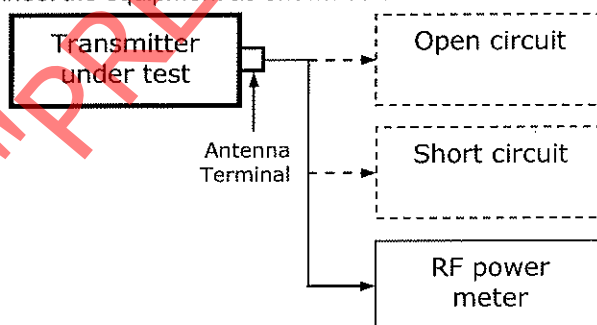
Connect the equipment as shown below.



- 2.3.12.1 Set the modulation analyser to measure the RMS AM modulation factor (m %).
- 2.3.12.2 In the absence of an audio input signal (modulating signal) measure the modulation factor.
- 2.3.12.3 Calculate the AM hum and noise level as follow:
AM hum and noise level (dB) = $20\text{Log}(2 m/100)$

2.3.13 Extreme transmitter loads

Connect the equipment as shown below.



- 2.3.13.1 Measure the carrier power in the absence of modulation.
- 2.3.13.2 Operate the transmitter under open and short circuit load conditions for a period of:
 - 2.3.13.2.1 One minute each in the case of a transmitter rated for intermittent duty cycle.
 - 2.3.13.2.2 Five minutes each in the case of a transmitter rated for continuous operation.

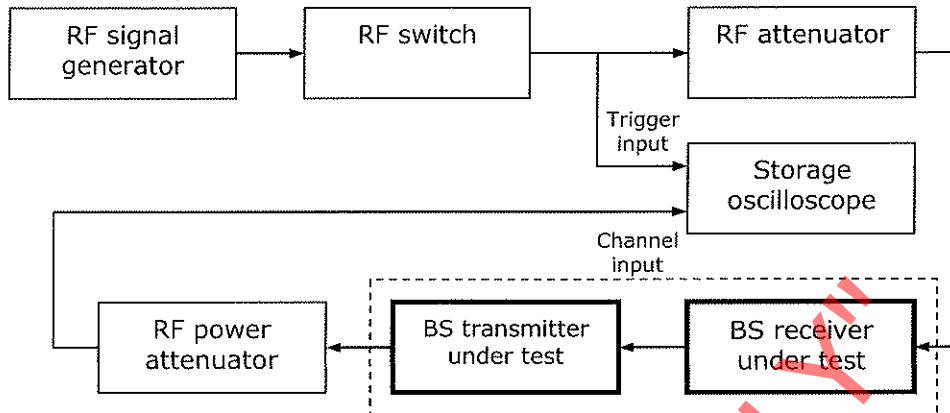
-
- 2.3.13.3 After each exposure to the extreme load measure the carrier power in the absence of modulation.
 - 2.3.13.4 Calculate the variation of the carrier power in dB with reference to clause 2.3.13.1.

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2.4 High Site Equipment

2.4.1 Radio Base Station Response Time

Connect the equipment as shown below.

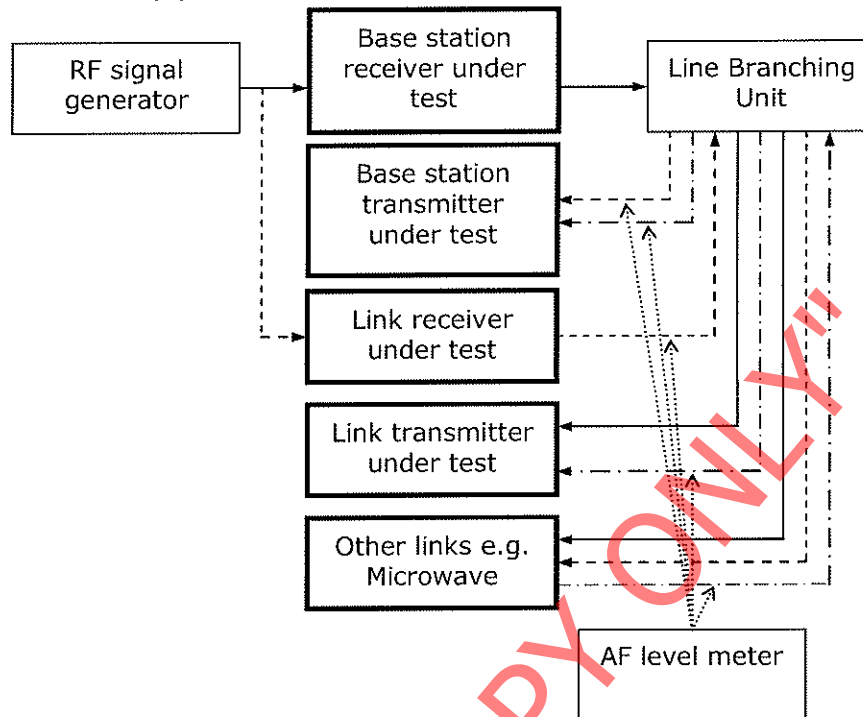


- 2.4.1.1 Apply a standard RF test signal to the receiver under test.
- 2.4.1.2 Determine the usable sensitivity as described in clause 2.2.3.
- 2.4.1.3 Adjust the squelch to open at a RF signal level of -115 dBm, measured at the antenna terminal.
- 2.4.1.4 Set the RF signal level 12 dB above the usable sensitivity level.
- 2.4.1.5 Set the storage oscilloscope to single sweep operation.
- 2.4.1.6 Enable the RF switch and measure the time required for the unmodulated transmit carrier voltage level to reach a value 6 dB (50 %) below the steady state level.
- 2.4.1.7 Repeat the measurement three times and take the average of the three measurements as the repeater attack time.

"PREVIEW COPY ONLY"

2.4.2 Talk Through Signal2.4.2.1 Audio levels

Connect the equipment as shown below.

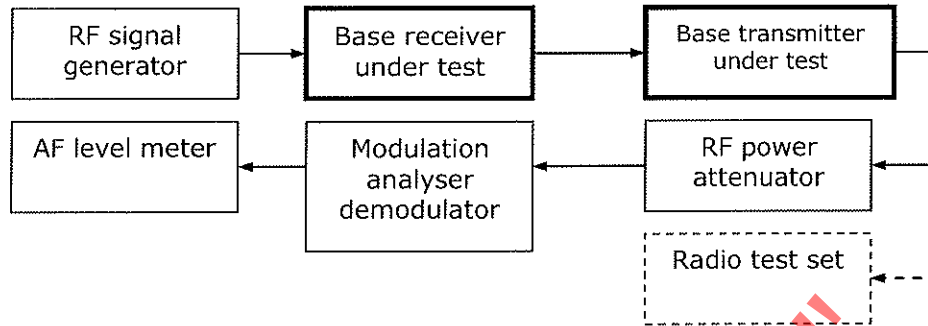


- 2.4.2.1.1 Adjust the RF signal generator to produce the standard RF test signal.
- 2.4.2.1.2 Connect the audio lines to the units as it would be connected when in operation. This is to ensure that the lines are correctly loaded.
- 2.4.2.1.3 Set the audio frequency level meter to high impedance/bridge mode. This is to ensure that the level meter does not load the lines.
- 2.4.2.1.4 Measure the audio level from the source (Rx) first. Adjust the level if necessary.
- 2.4.2.1.5 Measure all the outgoing lines from the LBU and adjust the levels if necessary.
- 2.4.2.1.6 Use the method described in clauses 2.4.2.1.1 to 2.4.2.1.4 to measure and adjust the audio level from the link receiver.
- 2.4.2.1.7 Measure the audio level from the microwave and adjust if necessary.

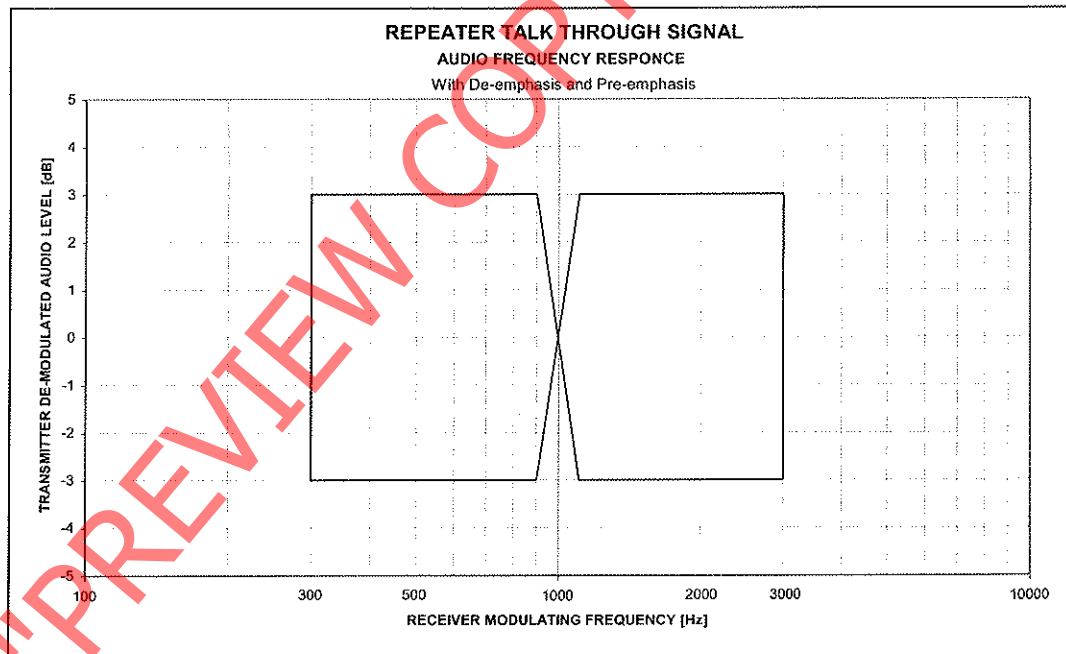
Note: The same measuring method is used on the Trunked radio equipment.

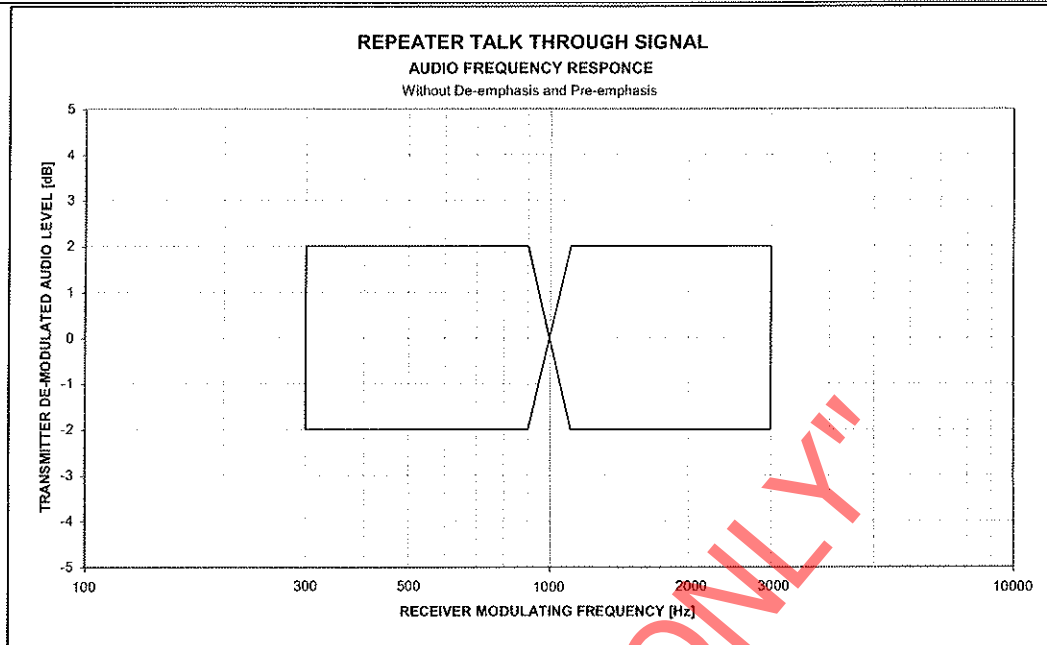
2.4.2.2 **Audio Frequency Response**

Connect the equipment as shown below.



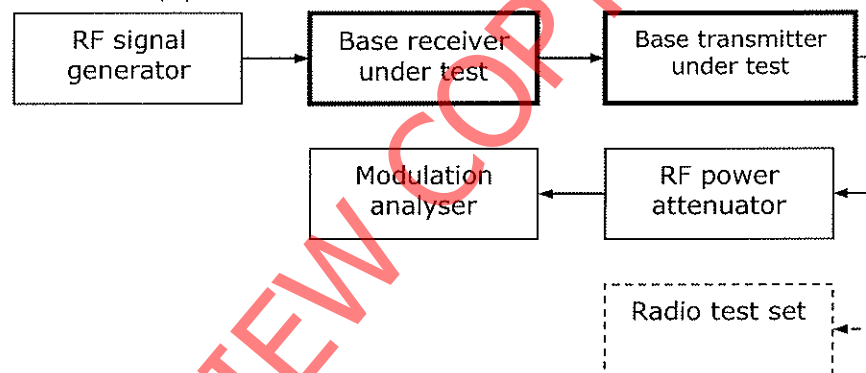
- 2.4.2.2.1 Ensure that all the audio level settings have been set correctly.
- 2.4.2.2.2 Adjust the RF signal generator to produce the standard RF test signal.
- 2.4.2.2.3 Select the low pass filter (cut-off 20 kHz) at the modulation analyser.
- 2.4.2.2.4 While keeping the modulation factor constant vary the modulating frequency over the range 300 Hz to 3 kHz.
- 2.4.2.2.5 Record the variation in the audio output power from the demodulator over this range in dB with reference to the corresponding level at 1 kHz.
- 2.4.2.2.6 Branches to the link radio and other links must also be measured.



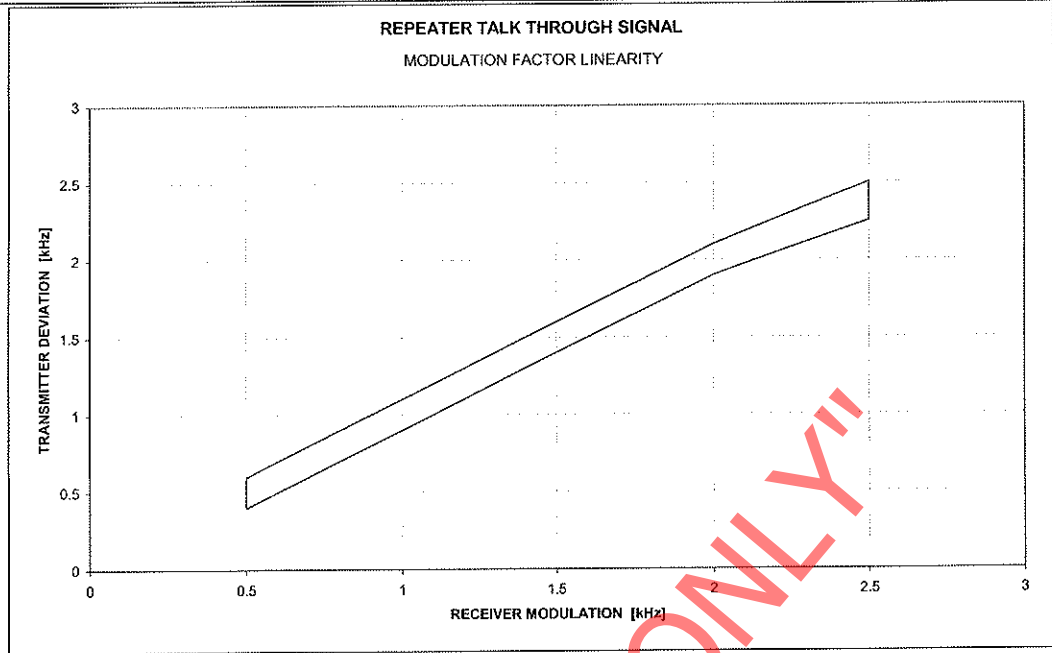


2.4.2.3 Modulation factor linearity

Connect the equipment as shown below.

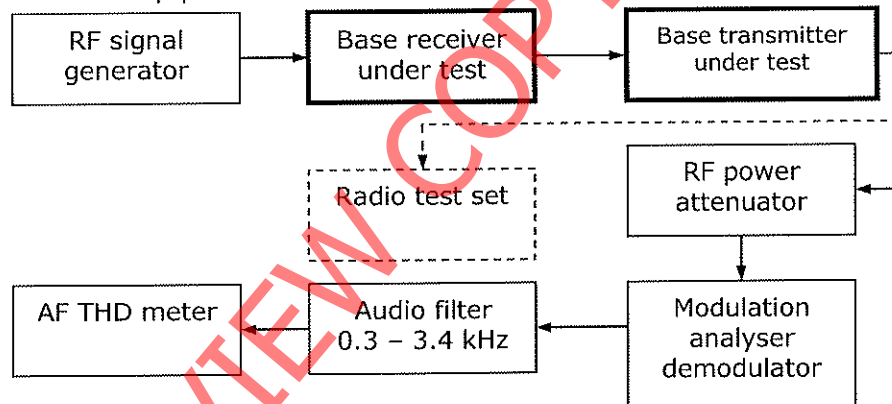


- 2.4.2.3.1 Ensure that the transmitter modulation limiting (deviation) has been set correctly (see clause 2.3.7).
- 2.4.2.3.2 Ensure that all the audio levels have been set correctly (see clause 2.4.2.1).
- 2.4.2.3.3 Apply a standard RF test signal from the RF signal generator to the receiver.
- 2.4.2.3.4 Vary the modulation of the RF input signal between 0.5 kHz and 2.5 kHz and measure the transmitter deviation.
- 2.4.2.3.5 Branches to the link radio and other links must also be measured.



2.4.2.4 **Audio frequency THD**

Connect the equipment as shown below.



- 2.4.2.4.1 Ensure that all the audio levels are set correctly.
- 2.4.2.4.2 Apply a standard RF test signal to the receiver under test.
- 2.4.2.4.3 Record the audio total harmonic distortion from the transmitter.
- 2.4.2.4.4 Branches to the link radio and other links must also be measured.

2.4.3 Filters

2.4.3.1 Duplexer

The best method to check or tune a duplexer is to use a Transmission Line Analyser. This measuring method will not be covered in this document.

If any problem is detected the duplexer/combiner must be send to a facility with the proper equipment and competency. Do not attempt the tune the unit.

A RF signal generator and a test receiver/spectrum analyser could be used to make measurements.

2.4.3.1.1 Calibration

2.4.3.1.1.1 Connect the RF signal generator with the two connecting cables to the test receiver or spectrum analyser.

2.4.3.1.1.2 Tune the RF signal generator and the test receiver/spectrum analyser to the in-band receiving/transmitting frequency to be measured.

2.4.3.1.1.3 Set the output level of the RF signal generator as required:

e.g. Low-level : ≤ -60 dBm

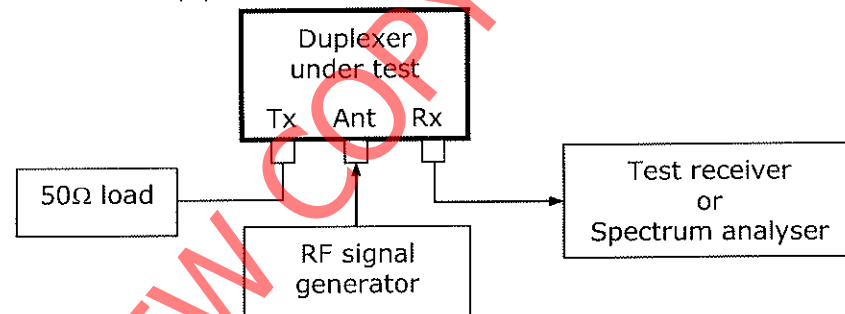
High-level : 0 dBm.

2.4.3.1.1.4 Record the difference between the applied and measured signal level. The difference must be included in the calculations.

Note: This method compensates for differences and the connecting cable losses.

2.4.3.1.2 Insertion loss - Rx

Connect the equipment as shown below.



2.4.3.1.2.1 Tune the RF signal generator and the test receiver/spectrum analyser to the in-band receiving frequency to be measured.

2.4.3.1.2.2 Inject the signal at the antenna port (low level) and measure the level at the receiving port.

2.4.3.1.2.3 Calculate the insertion loss by determining the difference between the injected signal level and the measured level in dB.

2.4.3.1.2.4 The insertion loss must comply throughout the operating band.

At the high site this measurement can be made in the following way:

2.4.3.1.2.5 Connect the RF signal generator directly to the receiver.

2.4.3.1.2.6 Adjust the RF signal generator to produce a standard RF test signal.

2.4.3.1.2.7 Decrease the RF signal level till the squelch closes.

2.4.3.1.2.8 Increase the RF signal level **slowly** and note the level when the squelch open.

2.4.3.1.2.9 Connect the RF signal generator to the receiver via the duplexer (Ant port).

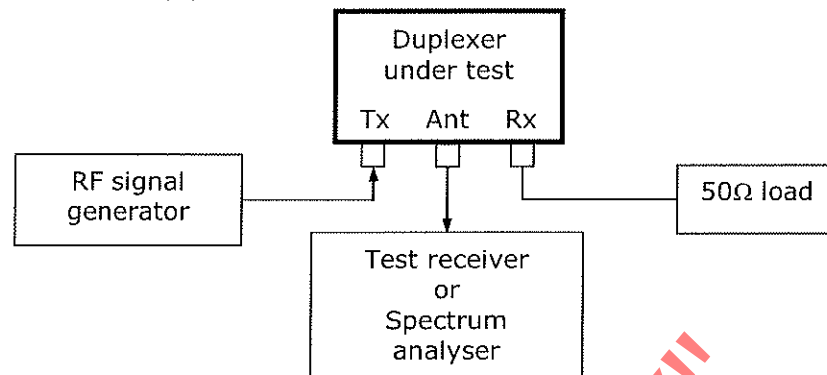
2.4.3.1.2.10 Repeat the procedure from clause 2.4.3.1.2.6 to 2.4.3.1.2.8.

2.4.3.1.2.11 Calculate the insertion loss by determining the difference between the two recorded signal levels in dB.

Note: When the result is within specification, the insertion loss through the coaxial cable between the receiver and duplexer can be ignored.

2.4.3.1.3 Insertion loss - Tx

Connect the equipment as shown below.

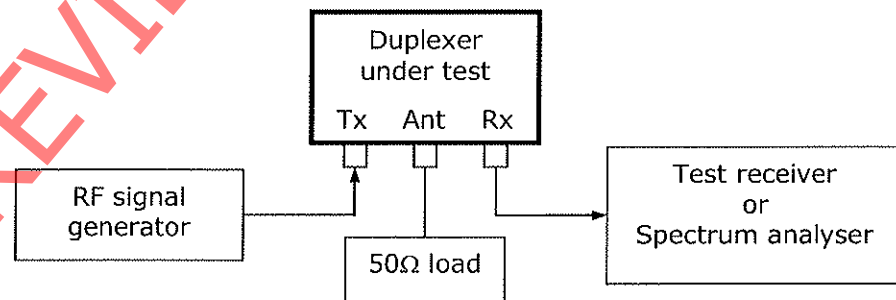


- 2.4.3.1.3.1 Tune the RF signal generator and the test receiver/spectrum analyser to the in-band transmitting frequency to be measured.
- 2.4.3.1.3.2 Inject the signal at the transmitting port (high level) and measure the level at the antenna port.
- 2.4.3.1.3.3 Calculate the insertion loss by determining the difference between the injected signal level and the measured level in dB.
- 2.4.3.1.3.4 The insertion loss must comply throughout the operating band.
- At the high site this measurement can be made in the following way:
- 2.4.3.1.3.5 Connect a terminated wattmeter directly to the transmitter.
- 2.4.3.1.3.6 Measure the un-modulated carrier power from the transmitter.
- 2.4.3.1.3.7 Connect the same terminated wattmeter to the transmitter via the duplexer (Antenna port).
- 2.4.3.1.3.8 Measure the un-modulated carrier power from the transmitter.
- 2.4.3.1.3.9 Calculate the insertion loss by determining the difference between the two measured power levels in dB.

Note: When the result is within specification, the insertion loss through the coaxial cable between the transmitter and duplexer can be ignored.

2.4.3.1.4 Isolation between the transmitting and receiving paths

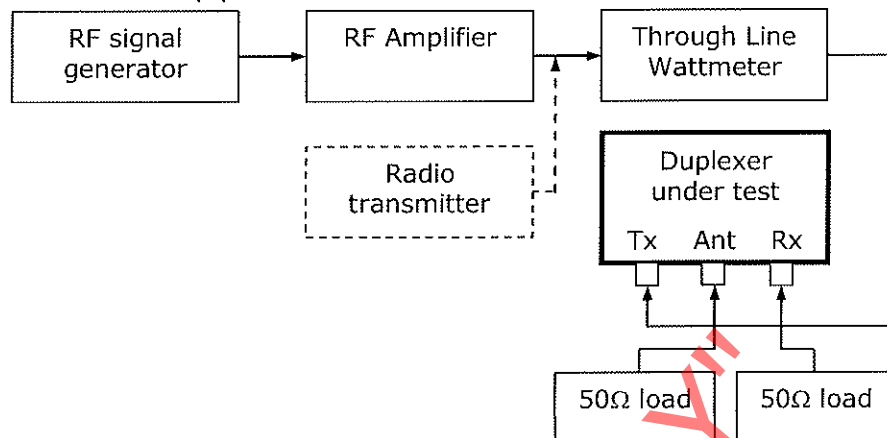
Connect the equipment as shown below.



- 2.4.3.1.4.1 Tune the RF signal generator and the test receiver/spectrum analyser to the in-band transmitting frequency to be measured.
- 2.4.3.1.4.2 Inject the signal at the transmitting port (high level) and measure the level at the receiving port.
- 2.4.3.1.4.3 Calculate the isolation by determining the difference between the injected signal level and the measured level in dB.
- 2.4.3.1.4.4 The isolation must comply throughout the operating band.

2.4.3.1.5 **Impedance matching**

Connect the equipment as shown below.



- 2.4.3.1.5.1 Tune the RF signal generator to the in-band transmitting frequency to be measured.
- 2.4.3.1.5.2 Measure the Voltage Standing Wave Ratio (VSWR) with a through line wattmeter.
- 2.4.3.1.5.3 If the wattmeter does not indicate the VSWR, note the forward and reflected power and calculate the VSWR.

$$(1 + \sqrt{\text{Power reflected/Power forward}}) / (1 - \sqrt{\text{Power reflected/Power forward}})$$

- 2.4.3.1.5.4 The impedance matching must comply throughout the operating band.
- 2.4.3.1.5.5 Use the same method to measure the impedance at the receiver and antenna terminals.

2.4.3.2 **Combiner**2.4.3.2.1 **Insertion loss - Rx**

- 2.4.3.2.1.1 The insertion loss can be measured as explained in clause 2.4.3.1.2.
- 2.4.3.2.1.2 Fifty-ohm loads must be connected to all open transmitting and receiving ports.
- 2.4.3.2.1.3 The injected signal level at the antenna port must be low (≤ -80 dBm) to prevent the RF amplifier in the receiving path being saturated.
- 2.4.3.2.1.4 All the receiving ports must be measured.
- 2.4.3.2.1.5 The insertion loss must comply throughout the operating band.

2.4.3.2.2 **Insertion loss - Tx**

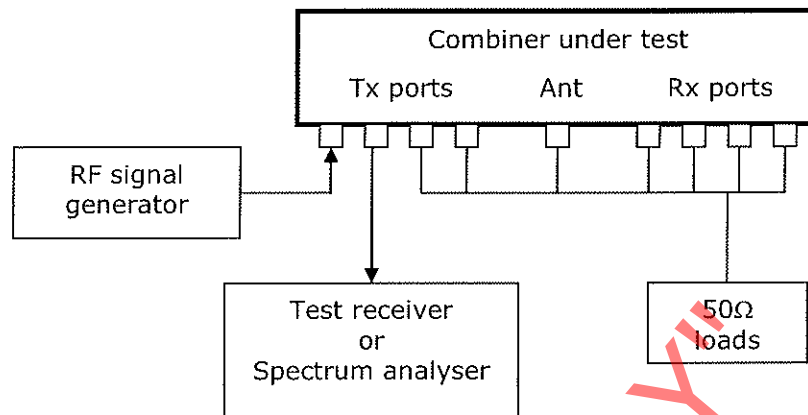
- 2.4.3.2.2.1 The insertion loss can be measured as explained in clause 2.4.3.1.3.
- 2.4.3.2.2.2 Fifty-ohm loads must be connected to all open transmitting and receiving ports.
- 2.4.3.2.2.3 All the transmitting ports must be measured.
- 2.4.3.2.2.4 The insertion loss must comply throughout the operating band.

2.4.3.2.3 **Isolation between the transmitting and receiving paths**

- 2.4.3.2.3.1 The isolation between the transmitting and receiving paths can be measured as explained in clause 2.4.3.1.4.
- 2.4.3.2.3.2 Fifty-ohm loads must be connected to all open transmitting and receiving ports.
- 2.4.3.2.3.3 All the ports must be measured.
- 2.4.3.2.3.4 The isolation must comply throughout the operating band.

2.4.3.2.4 **Isolation between the transmitting ports**

Connect the equipment as shown below



- 2.4.3.2.4.1 Tune the RF signal generator and the test receiver/spectrum analyser to the in-band transmitting frequency to be measured.
- 2.4.3.2.4.2 Fifty-ohm loads must be connected to the antenna- and all open transmitting and receiving ports.
- 2.4.3.2.4.3 Inject the signal at the first transmitting port (high level) and measure the level at the other transmitting ports.
- 2.4.3.2.4.4 Repeat step 2.4.3.2.4.3 when injecting the signal at ports 2 to 4.
- 2.4.3.2.4.5 Calculate the isolation by determining the difference between the injected signal level and the measured level in dB.
- 2.4.3.2.4.6 The isolation must comply throughout the operating band.

2.4.3.2.5 **Impedance matching**

- 2.4.3.2.5.1 The impedance matching can be determined as explained in clause 2.4.3.1.5.
- 2.4.3.2.5.2 Fifty-ohm loads must be connected to all open transmitting and receiving ports.
- 2.4.3.2.5.3 All the transmitting ports must be measured.

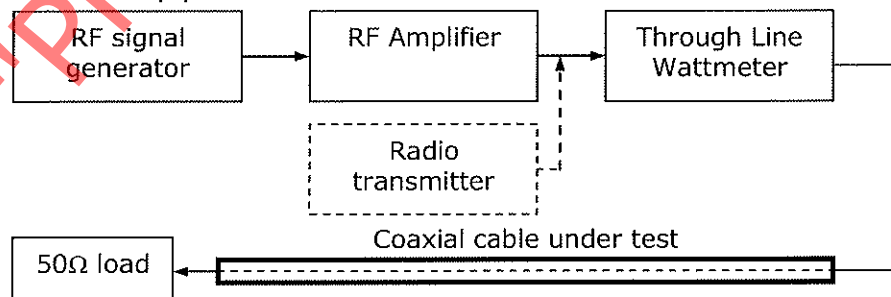
Note: **Do not** use this method to determine the impedance matching at the receiver and antenna terminals. If a problem is suspected, the combiner must be send to a facility with the proper equipment and competency.

2.4.4 **Coaxial Cable**

2.4.4.1 **Impedance matching**

The best method to measure the impedance and insertion loss of the coaxial cable is to use a Transmission Line Analyser. This measuring method will not be covered in this document.

Connect the equipment as shown below.

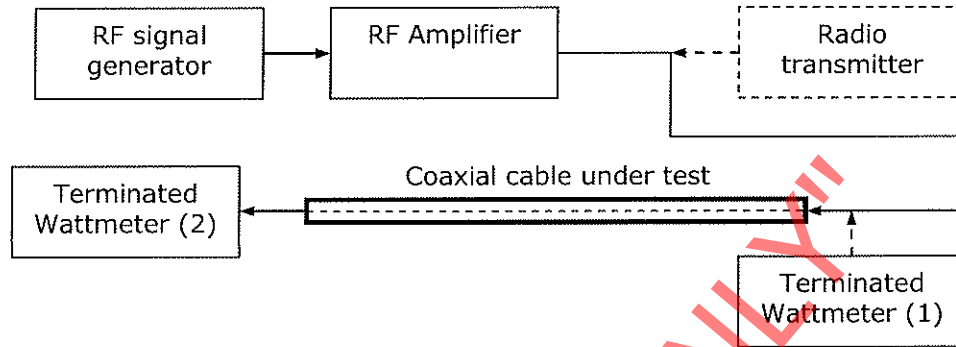


- 2.4.4.1.1 Tune the RF signal generator to the in-band transmitting frequency.
- 2.4.4.1.2 Measure the Voltage Standing Wave Ratio (VSWR) with a through line wattmeter.
- 2.4.4.1.3 If the wattmeter does not indicate the VSWR, note the forward and reflected power and calculate the VSWR (see clause 2.4.3.1.5.3).

- 2.4.4.1.4 Tune the RF signal generator to the in-band receiving frequency.
- 2.4.4.1.5 Measure the Voltage Standing Wave Ratio as above.
- 2.4.4.1.6 The impedance matching must comply throughout the operating band.
- 2.4.4.1.7 Record the worst case as the impedance matching.

2.4.4.2 Insertion loss

Connect the equipment as shown below.



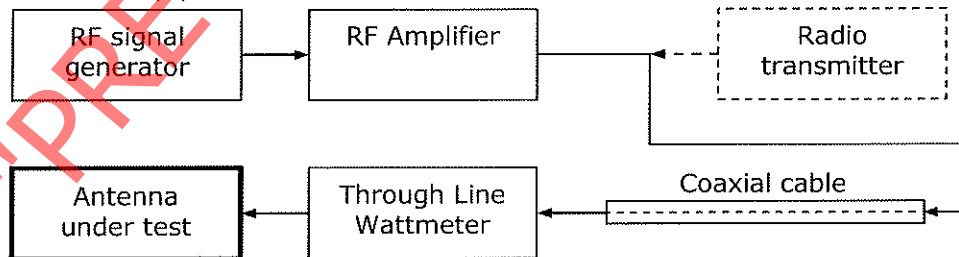
- 2.4.4.2.1 Tune the RF signal generator to the in-band transmitting frequency.
- 2.4.4.2.2 Measure the power at the near end of the coaxial cable using the terminated wattmeter (1).
- 2.4.4.2.3 Measure the power at the far end of the coaxial cable using the same terminated wattmeter (2).
- 2.4.4.2.4 Calculate the insertion loss by determining the difference between the power levels measured in dB.
- 2.4.4.2.5 Tune the RF signal generator to the in-band receiving frequency.
- 2.4.4.2.6 Repeat the measurements as above.
- 2.4.4.2.7 The insertion loss must comply throughout the operating band.
- 2.4.4.2.8 Record the highest loss measured, as the insertion loss.

2.4.5 Antenna

2.4.5.1 Impedance matching

The best method to measure the impedance of the antenna is to use a Transmission Line Analyser. This measuring method will not be covered in this document.

Connect the equipment as shown below.



- 2.4.5.1.1 The impedance matching of the coaxial cable (clause 2.4.4.1) must be measured first.
- 2.4.5.1.2 Tune the RF signal generator to the in-band transmitting frequency.
- 2.4.5.1.3 Measure the Voltage Standing Wave Ratio (VSWR) with a through line wattmeter.
- 2.4.5.1.4 If the wattmeter does not indicate the VSWR, note the forward and reflected power and calculate the VSWR (see clause 2.4.3.1.5.3).
- 2.4.5.1.5 Tune the RF signal generator to the in-band receiving frequency.
- 2.4.5.1.6 Measure the Voltage Standing Wave Ratio as above.

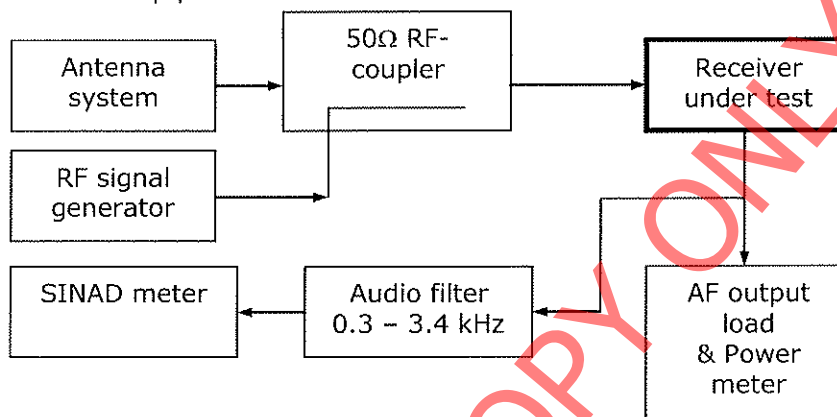
- 2.4.5.1.7 The impedance matching must comply throughout the operating band.
 2.4.5.1.8 Record the worst case as the impedance matching.

2.4.5.2 **Effective Radiated Power (ERP)**

- 2.4.5.2.1 The effective radiated power is calculated as follows:
 The RF power measured into a 50 Ω load that replaces the antenna, times the gain of the antenna with reference to a Dipole antenna (dBd).
 2.4.5.2.2 The following calculation could also be used:
 Antenna gain (dBd) - Duplexer/combiner insertion loss (dB) - Coaxial cable insertion loss (dB) + Transmitting power at transmitter (dBm). Convert the result to Watts ($0.001 \times \text{Antilog}(\text{dB}/10)$).

2.4.6 **Receiver Desensitisation (Desensing)**

Connect the equipment as shown below.

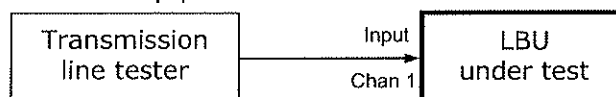


- 2.4.6.1 The transmitting power of all the transmitters must be set correctly.
 2.4.6.2 The insertion loss of the RF-coupler must be ≤ 1 dB.
 2.4.6.3 Adjust the RF signal generator to produce the standard test signal and apply it to the receiver via the RF-coupler.
 2.4.6.4 Reduce the RF signal output level until the SINAD ratio is 12 dB.
 2.4.6.5 Note the RF signal level at which the 12 dB SINAD is obtained.
 2.4.6.6 Transmit from the other transmitters situated on the site.
 2.4.6.7 Note if the SINAD ratio is degrading.
 2.4.6.8 If so, while transmitting increase the RF signal output from the generator to obtain a SINAD ratio of 12 dB.
 2.4.6.9 Note the RF signal level.
 2.4.6.10 Calculate the desensing level by determining the difference between the two measurements in dB.

2.4.7 **Audio Line Branching Unit (LBU)**

2.4.7.1 **Impedance matching**

Connect the equipment as shown below.

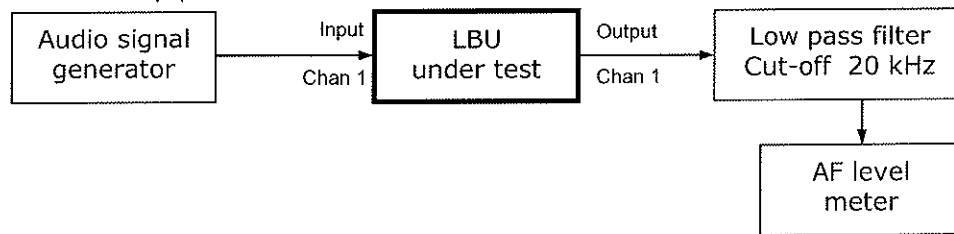


- 2.4.7.1.1 Switch the power of the LBU on.
 2.4.7.1.2 Measure the return loss of the input transformer to determine the impedance matching.

- 2.4.7.1.3 Repeat the measurement to determine the impedance matching of the other input and output terminals.

2.4.7.2 **Audio levels**

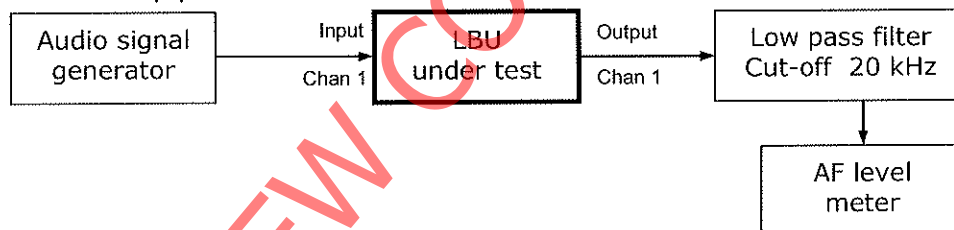
Connect the equipment as shown below.



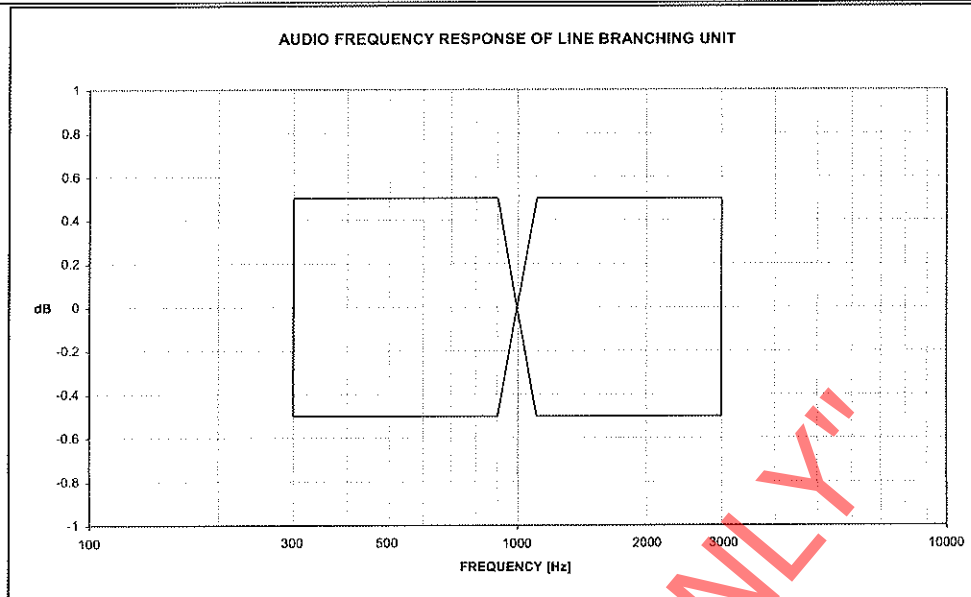
- 2.4.7.2.1 Ensure that the audio signal generator and audio level meter are set to the correct impedance.
- 2.4.7.2.2 Route all the input terminals to all the output terminals. This is required for the tests that follow.
- 2.4.7.2.3 Apply a 1 kHz signal at a level of -10 dBm into channel 1 of the LBU.
- 2.4.7.2.4 Measure the signal level at the output terminals of the LBU.
- 2.4.7.2.5 Adjust the output levels to obtain -10 dBm if necessary.
- 2.4.7.2.6 Repeat the measurements with the audio signal applied to the other input terminals.
- 2.4.7.2.7 All output levels should be -10 dBm without readjustment.

2.4.7.3 **Audio frequency response**

Connect the equipment as shown below

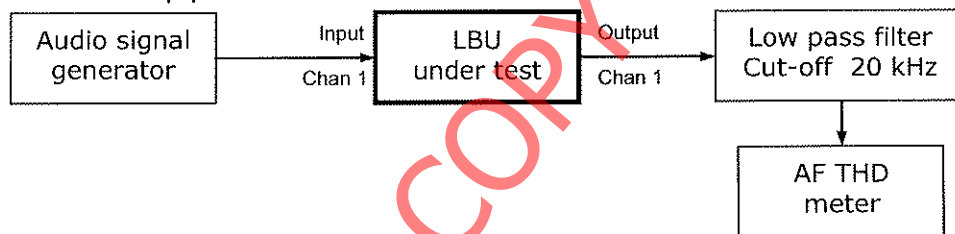


- 2.4.7.3.1 Ensure that all the audio levels are set correctly.
- 2.4.7.3.2 Apply a 1 kHz signal at a level of -10 dBm into channel 1 of the LBU.
- 2.4.7.3.3 Measure the signal level at the output terminal of channel 1.
- 2.4.7.3.4 While keeping the audio signal level constant vary the frequency from 300 Hz to 3 kHz.
- 2.4.7.3.5 Record the variation of the audio output level in dB with reference to the corresponding level at 1 kHz.
- 2.4.7.3.6 Repeat the measurements with the audio signal applied to the other input terminals.



2.4.7.4 Audio total harmonic distortion (THD)

Connect the equipment as shown below.



2.4.7.4.1 Ensure that all the audio levels are set correctly.

2.4.7.4.2 Route all the input terminals to all the output terminals.

2.4.7.4.3 Ensure that the audio signal generator and THD meter are set to the correct impedance.

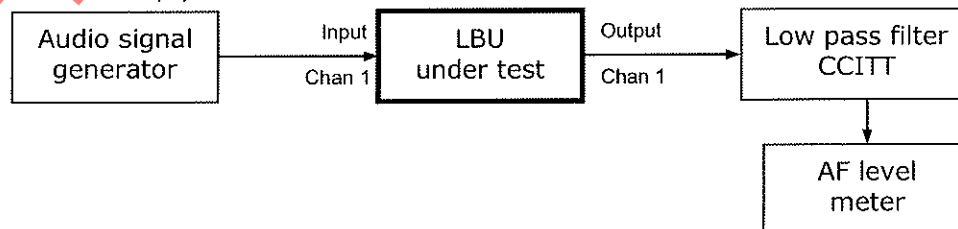
2.4.7.4.4 Apply a 1 kHz signal at a level of - 10 dBm into channel 1 of the LBU.

2.4.7.4.5 Record the audio total harmonic distortion obtained at the output terminals.

2.4.7.4.6 Repeat the measurements with the audio signal applied to the other input terminals.

2.4.7.5 Audio signal to hum and noise ratio

Connect the equipment as shown below.



2.4.7.5.1 Ensure that all the audio levels are set correctly.

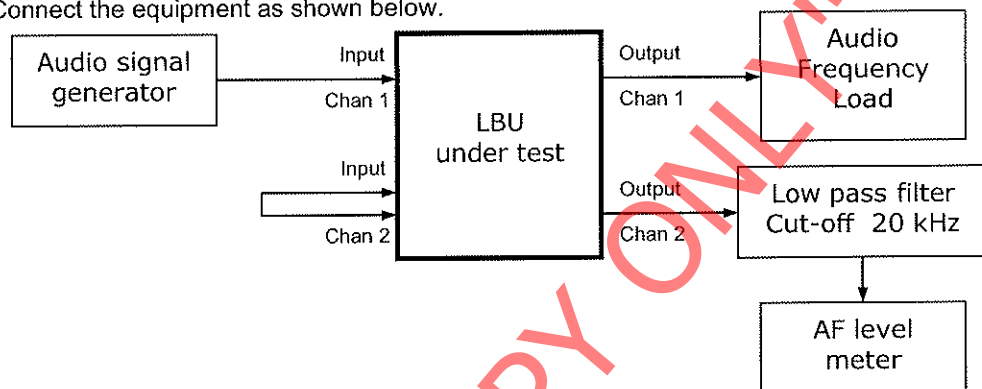
2.4.7.5.2 Route all the input terminals to all the output terminals.

2.4.7.5.3 Apply a 1 kHz signal at a level of - 10 dBm into channel 1 of the LBU.

- 2.4.7.5.4 Short-circuit all the other input terminals.
- 2.4.7.5.5 Measure the signal level at the output terminals of the LBU.
- 2.4.7.5.6 Remove the audio signal generator and short circuit the input terminal (1) of the LBU.
- 2.4.7.5.7 Measure the signal level at the output terminals of the LBU.
- 2.4.7.5.8 Calculate the ratio in dB between the audio output levels obtained with and without the applied audio signal, as the signal to hum and noise ratio.
- 2.4.7.5.9 Repeat the measurements with the audio signal applied to the other input terminals.
- 2.4.7.5.10 Record the lowest ratio as the result.

2.4.7.6 **Channel cross talk**

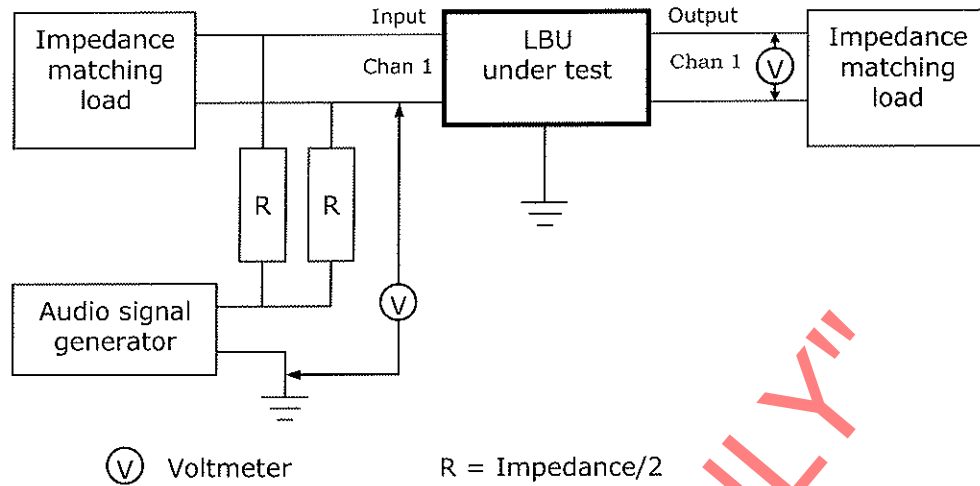
Connect the equipment as shown below.



- 2.4.7.6.1 Route all the channels to operate separately e.g. Channel 1 input terminal to channel 1 output terminal; channel 2 input terminal to channel 2 output terminal; etc.
- 2.4.7.6.2 Ensure that all the level settings are correct for each channel.
- 2.4.7.6.3 Inject a 1 kHz signal at a level of – 10 dBm into channel 1 of the LBU.
- 2.4.7.6.4 Short-circuit all the other input terminals.
- 2.4.7.6.5 Calculate the ratio in dB between the audio input signal level and that measured at the other output terminals, except that of channel 1.
- 2.4.7.6.6 Repeat the measurements with the audio signal injected into the other input terminals.
- 2.4.7.6.7 Record the worst case as the result.

2.4.7.7 **Common-mode rejection ratio**

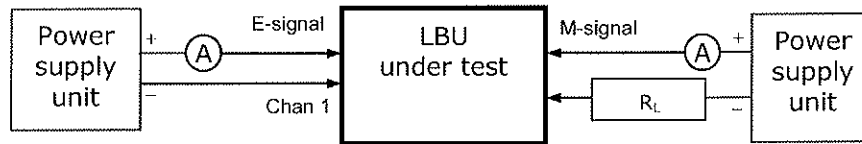
Connect the equipment as shown below.



- 2.4.7.7.1 Adjust the amplification of the LBU to unity gain.
If the gain cannot be adjusted, measure the input and output voltage levels and calculate the gain.
- 2.4.7.7.2 Set the audio signal generator frequency to 1 kHz and set the output impedance to HIGH.
- 2.4.7.7.3 Increase the signal output level of the audio generator till the level measured on the output line of the LBU, also increases.
- 2.4.7.7.4 Record the input and output signal voltage levels.
- 2.4.7.7.5 If the LBU is set for unity gain, calculate the ratio in dB between the audio input signal level and that measured on the output line of the LBU.
OR
- 2.4.7.7.6 If the LBU has a gain, calculate the ratio by dividing the input voltage level by the output voltage level.
Multiply the calculated ratio with the gain of the LBU under tests and express the ratio in dB.
e.g. Input voltage/Output voltage = R:1
 $R \times \text{Gain} = T:1$
 $\text{dB} = 20\text{Log}_{10}(T/1)$
- 2.4.7.7.7 Repeat the measurement on the other channels.
- 2.4.7.7.8 Record the worst case as the result.

2.4.7.8 E & M-signalling

Connect the equipment as shown below.



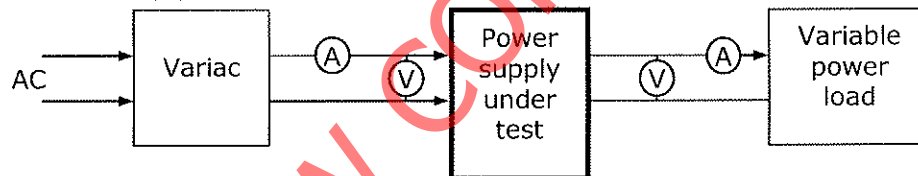
(A) Ammeter

- 2.4.7.8.1 Route the E-signal of channel 1 to activate the M-signal of all the channels.
- 2.4.7.8.2 The value of the load resistor R_L must be such to permit a current flow of 8 mA to 10 mA.
- 2.4.7.8.3 Apply a DC voltage at the appropriate level to the M signal terminal.
- 2.4.7.8.4 Apply a DC voltage at the appropriate level to the E signal terminal and measure the current.
- 2.4.7.8.5 Measure the current flow at all the M-signal terminals.
- 2.4.7.8.6 Reverse the voltage polarity at the E & M-signal terminals and repeat the test.
- 2.4.7.8.7 Repeat the above tests with other routing combinations.
- 2.4.7.8.8 Measure the resistance between the E & M-signal terminals and the LBU earth. The resistance must be infinity.

2.4.8 Power Supply & Battery Charger Unit

2.4.8.1 Output voltage regulation

Connect the equipment as shown below.

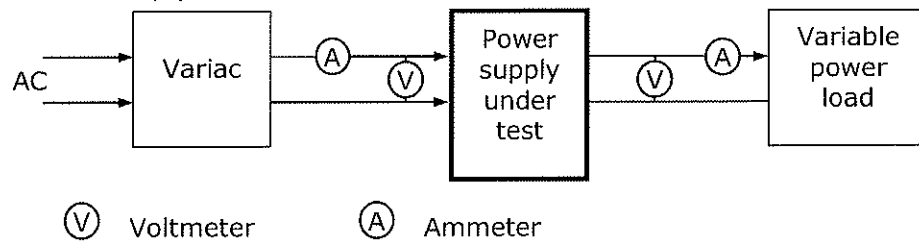


(V) Voltmeter (A) Ammeter

- 2.4.8.1.1 Intermittent:
 - 2.4.8.1.1.1 Adjust the Variac to obtain the nominal input voltage to the power supply/battery charger.
 - 2.4.8.1.1.2 Vary the power load to obtain a current drain from 0 ampere to maximum current while recording the output voltage.
 - 2.4.8.1.1.3 The measurement shall be made under the extreme test conditions as well.
- 2.4.8.1.2 Continuous:
 - 2.4.8.1.2.1 Adjust the Variac to obtain the nominal input voltage to the power supply/battery charger.
 - 2.4.8.1.2.2 Set the power load to obtain the maximum current drain and record the output voltage level for a period of four hours.

2.4.8.2 **Efficiency**

Connect the equipment as shown below.

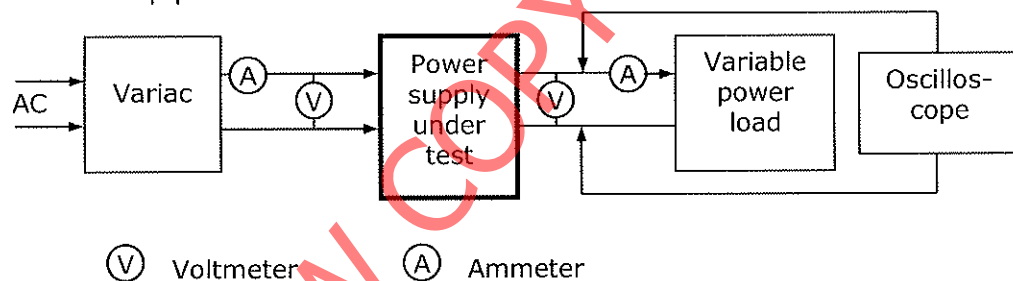


- 2.4.8.2.1 Adjust the Variac to obtain the nominal input voltage to the power supply/battery charger.
- 2.4.8.2.2 Vary the power load to obtain a current drain from 0 ampere to maximum current while recording the input and output voltages and currents.
- 2.4.8.2.3 Calculate the efficiency in percentage.

$$\text{Efficiency} = (\text{Power out} / \text{Power in}) \times 100 \%$$
- 2.4.8.2.4 Repeat the test with the specified minimum and then the maximum input voltage to the power supply/battery charger.
- 2.4.8.2.5 Record the worst case as the result.

2.4.8.3 **Output voltage ripple**

Connect the equipment as shown below.

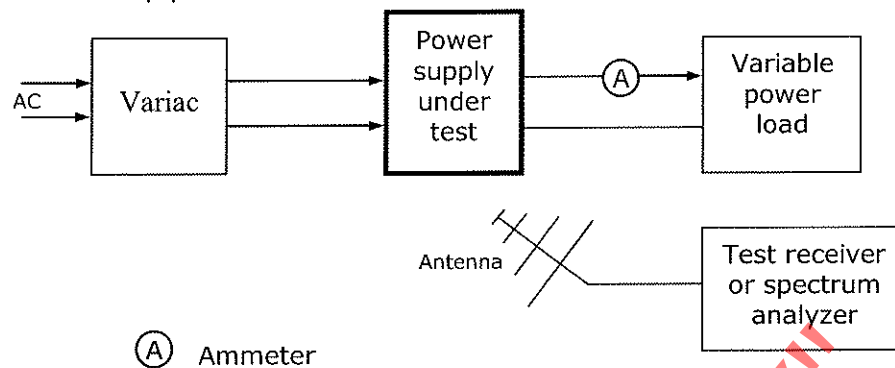


- 2.4.8.3.1 Adjust the Variac to obtain the nominal input voltage to the power supply/battery charger.
- 2.4.8.3.2 Vary the power load to obtain a current drain from 0 ampere to maximum current while recording the output voltage ripple with the oscilloscope.
- 2.4.8.3.3 The measurement shall be made under the extreme test conditions as well.
- 2.4.8.3.4 Record the worst case as the result.

Note: Some battery chargers apply high instantaneous pulses of short duration. In a Lead-acid battery, this breaks down lead-sulphate crystals, thus extending the battery service life. This function must be noted.

2.4.8.4 Radiation of spurious frequencies

Connect the equipment as shown below.



2.4.8.4.1 This test has to be performed inside a Faraday cage (RF shielding).

2.4.8.4.2 All the instruments and electrical equipment inside the cage not used for the test have to be switched off to prevent interference with the frequencies to be scanned. Ideally, all the equipment except the power supply under test and the antenna should be on the outside of the cage.

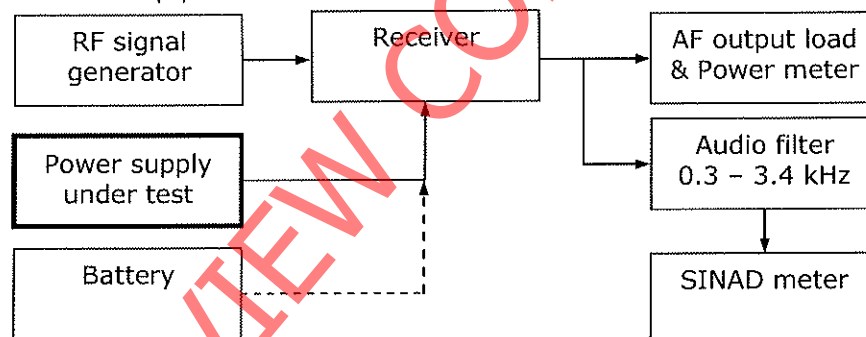
2.4.8.4.3 The measuring antenna to be placed 1 m from the power supply/battery charger.

2.4.8.4.4 Vary the power load to obtain a current drain from 0 ampere to maximum current while scanning the radio-operating band (455.0000 MHz to 467.0000 MHz).

2.4.8.4.5 Record the frequencies and levels of all the detected signals.

2.4.8.5 Desensing of receiver (conductive)

Connect the equipment as shown below.



2.4.8.5.1 Use a battery to power the receiver.

2.4.8.5.2 Adjust the RF signal generator to produce a standard RF test signal.

2.4.8.5.3 Adjust the volume control of the radio to give SOP.

2.4.8.5.4 Reduce and record the RF signal input level at which 12 dB SINAD ratio is obtained.

2.4.8.5.5 Replace the battery with the power supply under test.

2.4.8.5.6 The length of the power leads to the radio must be 1.0 m.

2.4.8.5.7 Place the power supply as far as possible from the radio.

2.4.8.5.8 Readjust and record the RF signal output level at which 12 dB SINAD ratio is obtained.

2.4.8.5.9 Record the difference in dB between the recorded RF signal levels as the receiver desensing.

2.5 Trunking functional tests

Programme the radio under test with the correct trunking parameters and with a validated number on the trunk network.

1.5.1 On instrument

Connect the radio under test to the trunk enabled instrument.

1.5.1.1 Registration

Switch the radio on and ensure that it register on the instrument. The radio will display a registered indication and the instrument will display the radio's trunking number.

1.5.1.2 Make a call with the same prefix number (e.g. 2052001203 to 2052001204).

The instrument will display the called radio's prefix and the *derived* identification number.

1.5.1.3 Make a call with the interprefix number (e.g. interfleet call: 2052001203 to 2142001301).

The instrument will display the called radio's prefix and the *derived* identification number.

1.5.1.4 Short form dialling (e.g. 204)

Repeat 1.5.1.2 using the short form dialling.

1.5.1.5 PSTN call (e.g. 0117748227)

The dialled number must be presided with 0 (e.g. 00117748227). The instrument will display the called number.

1.5.1.6 Call the radio under test

Make a call to the radio from the instrument.

1.5.1.7 Handoff

Change the control channel on the instrument and ensure that the radio re-register on the new channel.

1.5.2 On trunk system

Two trunk radios and a PSTN telephone must be available and dedicated to the tests.

One trunk radio must be programmed with the same prefix number as the radio under test and the second radio with an interprefix number.

1.5.2.1 Registration

Switch the radio under test on and ensure that it register on the trunk system. The radio will display a registered indication.

1.5.2.2 Local call

Ensure that all the trunk radios are registered on the same local site.

1.5.2.2.1 Call a radio with the same prefix number

Call the radio having the same prefix number. Have a conversation with the second party.

1.5.2.2.2 Call a radio with an interprefix number

Call the radio having the interprefix number. Have a conversation with the second party.

1.5.2.2.3 Short form dialling

Repeat 1.5.2.2.1 using the short form dialling. Have a conversation with the second party.

1.5.2.2.4 Call the radio under test

Make a call to the radio under test from the other radios.

1.5.2.3 Intersite call

Move the radio under test to a distant site.

Ensure that the radio is registered on that site.

1.5.2.3.1 Call a radio with the same prefix number

Call the radio having the same prefix number. Have a conversation with the second party.

1.5.2.3.2 Call a radio with an interprefix number

Call the radio having the interprefix number. Have a conversation with the second party.

1.5.2.3.3 Short form dialling

Repeat 1.5.2.3.1 using the short form dialling. Have a conversation with the second party.

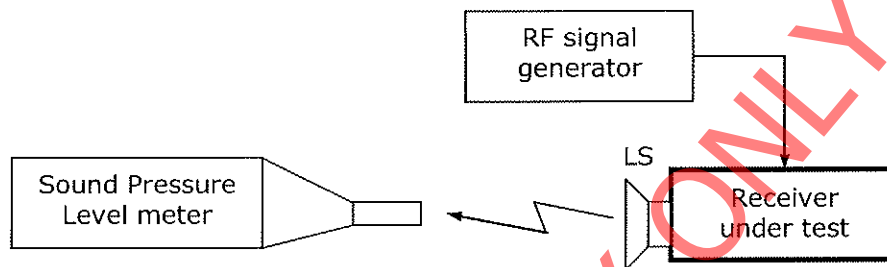
- 1.5.2.3.4 PSTN call
Call the PSTN telephone. Have a conversation with the second party.
- 1.5.2.3.5 Call the radio under test
Call the radio under test from the other radios. Have a conversation with the second party.
- 1.5.2.3.6 Handoff
Travel between sites and ensure that the radio under test re-register on the different sites.

Note: Call failures must be confirmed through different trunk sites.

2.6 Acoustical Measurements

2.5.1 Receiver loudspeaker sound pressure level

Connect the equipment as shown below.

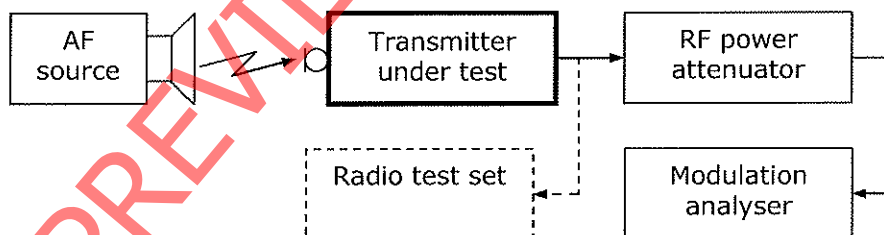


- 2.5.1.1 Adjust the RF signal generator to produce a standard RF test signal.
- 2.5.1.2 Increase the modulation to 2.5 kHz (maximum system modulation).
- 2.5.1.3 Adjust the volume control of the radio to obtain MUOP.
- 2.5.1.4 Place the Sound Pressure Level (SPL) meter at a distance of 300 mm in front of the radio loudspeaker.
- 2.5.1.5 Record the SPL in dB(A).

Note: Sound wave reflections should be kept to a minimum by measuring in an open area.

2.5.2 Transmitter modulation (deviation)

Connect the equipment as shown below.



- 2.5.2.1 Ensure that the transmitter modulation limiting has been set correctly (see clauses 2.3.7).
- 2.5.2.2 Generate a 1 kHz tone with the AF source at a level of 80 dB(A), measured at the radio microphone.
- 2.5.2.3 Transmit and record the measured deviation.

Note: Sound wave reflections should be kept to a minimum by measuring in an open area.

3. RELEVANT DOCUMENTATION
APPLICABLE

| DOCUMENT NO. | DESCRIPTION | LOCATION |
|--------------------|---|----------|
| SANS 300086-1:2005 | Electromagnetic compatibility and Radio Spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech Part 1: Technical characteristics and methods of measurement. | External |
| | | |
| | | |

RELEVANT

| DOCUMENT NO. | DESCRIPTION | LOCATION |
|--------------|-------------|----------|
| | | |
| | | |

END OF DOCUMENT

"PREVIEW COPY ONLY"

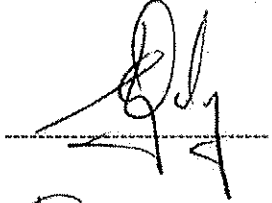
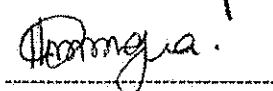
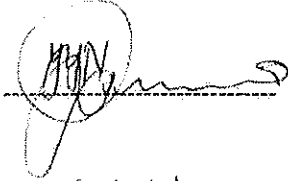
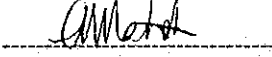


TRANSNET
freight rail

RAIL NETWORK TELECOMMUNICATION

SPECIFICATION BBF 2516 VERSION 3.00

SPECIFICATION FOR UHF HANDHELD TRUNKED AND CONVENTIONAL RADIO

| | | | |
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Date 24 June 2014

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"PREVIEW COPY ONLY"

I. Document Authorisation

| FUNCTION | NAME | TITLE & DIVISION | | DATE |
|--------------|----------------|--------------------------------------|------------------|--------------|
| Reviewed By: | Freddie Visser | Frequency Management Rail Network | <i>F. Visser</i> | 26 June 2014 |
| Reviewed By: | Chris Muller | Quality Assurance Rail Network | <i>C. Muller</i> | 26 June 2014 |

II. Distribution

Once updated, a copy of the latest revision will be published on the document management system, "Project Wise".

III. Document Change History

| ISSUE NO. | DATE ISSUED | ISSUED BY | HISTORY DESCRIPTION |
|-----------|---------------|--------------|--------------------------|
| 1.00 | October 2011 | Robert Yates | New Document |
| 2.00 | November 2012 | Graeme Daly | New Document |
| 2.01 | December 2012 | Graeme Daly | Revised 5.17 & 5.18 |
| 2.02 | May 2013 | Graeme Daly | Signatory & Revision 4.1 |
| 3.00 | June 2014 | Graeme Daly | Revised Document |

IV. Changes since Last Revision

| CLAUSES | DESCRIPTION |
|--------------------------------|----------------------|
| 5.17 & 5.18 | Channel Availability |
| 5.2, 5.3 & Revised all clauses | Revised Document |

V. List of Abbreviations and Acronyms

| ABBREVIATIONS AND ACRONYMS | DESCRIPTION |
|----------------------------|--|
| AC | Alternating Current |
| Ah | Ampere hour |
| EC Amendment Act | Electronic Communications Amendment Act No.1 2014 |
| BS | British Department of Trade and Industry Specification |
| dBm | Decibel relative to 1 milli watt |
| LED | Light Emitting Diode |
| m | Metre |
| mm | Millimetre |
| MPT | Minister of Post and Telecommunication |
| PTT | Press – To - Talk |
| RBU | Radio Base Unit |
| RCU | Remote Control Unit |
| RF | Radio Frequency |
| RTO | Radio Train Order |
| Rx | Receive |
| TFR | Transnet Freight Rail |
| THD | Total Harmonic Distortion |
| Tx | Transmit |
| UHF | Ultra High Frequency |
| V | Volt |
| W | Watt |
| Char | Character |
| CTC | Central Train Control |
| CTCSS | Continuous Tone Code Squeich System |
| dB(A) | Sound pressure A-weighted |
| DC | Direct Current |
| GPS | Global Positioning System |
| ICASA | Independent Communication Authority of South Africa |
| ID | Identification |
| IP | International Protection |
| mW | Milli watt |
| RF | Radio Frequency |
| TCO | Train Controlling Officer |
| UHF | Ultra High Frequency |
| VCO | Voltage Control Oscillator |
| VSWR | Voltage Standing Wave Ratio |
| NTC | National Test Centre |
| RFQ | Request for quotation |

VI. Relevant Documentation Applicable

Where there is a conflict between the SPECIFICATION and SCHEDULE OF REQUIREMENT DOCUMENT, the SCHEDULE OF REQUIREMENT DOCUMENT takes precedence.

The equipment must comply with the latest issue of the following applicable specifications:

| DOCUMENT NO. | DESCRIPTION | LOCATION |
|-----------------------------------|---|----------|
| ISO 9000 | Quality Management Systems. | External |
| ETSI EN 300 086 | European Telecommunication Standards for Radios. | External |
| GG 3736 | Electronic Communications Amendment Act No.1 2014 | External |
| BS 3939 | British Department of Trade and Industry Specification: | External |
| MPT 1317 | Code of Practice for Transmission of Digital Information over Land Mobile Radio Systems. | External |
| MPT 1327 | A signalling Standard for Trunked Private Mobile Radio Systems | External |
| MPT 1343 | System Interface Specification for Radio Units to be used with Commercial Trunked Networks. | External |
| BBD 8635 Version 8 22 May 2014 | Technical specifications and methods of measurement for angle modulated equipment. | Internal |
| IP 54 | Dust protected. Protected against splashing of water. | External |
| IP 55 | Dust protected. Protected against water jets. | External |
| IP 57 | Dust protected. Protected against the effect of immersion between 15 cm and 1 m. | External |
| IP 67 | Totally protected against dust. Protected against the effect of immersion between 15 cm and 1 m. | External |

1. INTRODUCTION

Transnet utilise UHF Handheld - Trunked and Conventional radio equipment, to control train shunting movements, communicate with train control officers, flagmen, shipping and harbours operations, etc.

2. SCOPE

2.1. This specification is for the supply of the above radio equipment and accessories as per attached Schedule of Requirements. **(Appendix A)**.

2.2. This specification will provide Bill of Quantities and Cost Schedule, as per attached. **(Appendix B & C)**

2.3. It is envisaged that equipment for this enquiry will be ordered and supplied to Transnet Freight Rail's nominated address. **(Appendix D & E)**.

3. COMPLIANCE

| Item | Description | Comply Y/N | Remarks |
|------|---|---------------|---------|
| 3.1. | Tenderers shall submit a clause-by-clause statement of compliance for this Technical Specification BBF 2516 version 3.00, dated 6 June 2014, in the columns provided. *Failure to comply will exclude Tenderers from consideration. | | |
| 3.2. | Alternative offers, will be considered at Transnet Freight Rail's discretion, provided that such offers provide equivalent functionality to what has been specified in this document. Separate compliance documents must be completed for each alternative offer. (Appendix A- B & C – D & E) *Failure to comply will exclude Tenderers from consideration. | | |
| 3.3. | The successful bidder is obligated as per the Act to ensure Transnet is in possession of a valid frequency spectrum licence, for the Radio's to be supplied. A reference must be obtained from Transnet Frequency Spectrum Manager Mr Freddie Visser, at Freddie.Visser@Transnet.net or at 011 583 0125 prior to the delivery. *Failing to adhere to the above will result in the cancelation of this transaction and the matter will be reported to ICASA. | | |
| 3.4. | Radio's that comply with Technical Specifications BBD 8635 version 8, dated 21 May 2014 and this specification BBF 2516 version 3.00, dated 6 June 2014, but have not yet been submitted to Transnet for evaluation, must be submitted to the Transnet National Test Centre (NTC) to 2 Foley St. Ffactoria, Krugersdorp, Gauteng, attention Mr Chris Muller 011 774 8229 prior to, or, within 5 (Five) working days after the tender has closed. Approval letter from Transnet NTC must be included in the Tender/RFQ for each product offered. *Failure to comply will exclude Tenderers from consideration. | | |

| Item | Description | Comply Y/N | Remarks |
|------|---|------------|---------|
| 3.5. | All programming software, accessories, test interface box / cables, service manuals, ICASA certificate, etc. must be submitted with the radio when being delivered to the NTC for evaluation. Refer to document BBD 8635, for requirements. *Failure to comply will exclude Tenderers from consideration | | |
| 3.6. | This Specification BBF 2516 must be read in conjunction with Technical Specification and Method of Measurement for Angle Modulated Radio Equipment BBD 8635 Version 8, dated 21 May 2014. *Failure to comply will exclude Tenderers from consideration | | |
| 3.7. | The equipment offered must be ICASA equipment type approved and a certificate per model offered must be submitted. *Failure to comply will exclude Tenderers from consideration. | | |
| 3.8. | Tenderers must provide a copy of their current ICASA Radio Dealers certificate. *Failure to comply will exclude Tenderers from consideration. | | |
| 3.9. | Radio's will be required to be batch tested by Transnet NTC prior to delivery or shipment. *Failure to comply will result in the termination of the order when radio equipment is delivered. | | |

4. TENDER REQUIREMENTS

| Item | Description | Comply Y/N | Remarks |
|------|--|------------|---------|
| 4.1. | Tenderers shall submit a clause-by-clause statement of compliance for equipment / items offered on the attached Schedule of Requirements (Appendix A) in the columns provided. *Failure to comply will exclude Tenderers from consideration. | | |
| 4.2. | Tenderers shall complete the attached Cost Schedule (Appendix B & C) for equipment. *Tenderers will be excluded from supplying any items not priced. | | |
| 4.3. | Tenderers shall complete the attached Delivery Schedule (Appendix D & E) for equipment. *Tenderers will be excluded from supplying if delivery dates are not included, as this will be a deciding factor. | | |

5. TECHNICAL REQUIREMENT

| Item | Description | Comply Y/N | Remarks |
|-------|--|------------|---------|
| 5.1. | Technical specifications for items offered must be submitted. *Failure to comply will exclude Tenderers from consideration. | | |
| 5.2. | The Receiver loudspeaker must comply with a sound pressure level equal to or better than ≤ 84 dB (A) at 300 mm. Refer to document BBD 8635 version 8, dated 21 May 2014 for test method. | | |
| 5.3. | The Transmitter deviation must be between 300 - 500 Hz from sound pressure level of 80 dB (A) at the microphone. Refer to document BBD 8635 version 8, dated 21 May 2014 for test method. | | |
| 5.4. | Radios must be capable of handling a frequency switching bandwidth of 15 MHz on both transmit and receive between channels with no degradation. | | |
| 5.5. | Radios must be programmable in the 400 – 470 MHz band without signal degradation nor component or board changes - to be specified. | | |
| 5.6. | Radio's must operate with 12, 5 kHz channel spacing. | | |
| 5.7. | The handheld radio RF output power must be software selectable between 1 and 4 watts, or to be specified. | | |
| 5.8. | In conventional mode, the handheld radio must have a minimum of 16 channels. (Can specify alternative number of channels) | | |
| 5.9. | The display on the radio must have a minimum of twelve alpha numeric characters. | | |
| 5.10. | It must be possible to assign an alpha – numeric label to each conventional channel. | | |
| 5.11. | Radios must be IP54 compliant or better. | | |
| 5.12. | Battery capacity must be capable of sustaining an 8 hour shift, with a duty cycle of 20, 20, 60. (Transmit, Receive, Standby) | | |
| 5.13. | Battery capacity to be declared in mAh. | | |

| Item | Description | Comply Y/N | Remarks |
|-------|---|------------|---------|
| 5.14. | Battery chemical composition to be provided. | | |
| 5.15. | Battery Model number must be provided. | | |
| 5.16. | Radio key pad must have a lock - out facility after a channel has been selected. | | |
| 5.17. | Rotary channel selector switch must be able to be disabled with software. | | |
| 5.18. | Birth date of radio. (when was it released into the market) | | |
| 5.19. | Date expected to be withdrawn, superseded or replaced from the market. (Manufacture official letter to be provided) | | |
| 5.20. | Warranty period, exceptions, terms and conditions to be indicated. | | |
| 5.21. | Warranty period of radio to be indicated. | | |
| 5.22. | Warranty turn – around time for repairs to be specified in working days. | | |
| 5.23. | Supplier must prove that warranty repairs and technical support can be carried out on its own premises. | | |
| 5.24. | Spares and technical support must be readily available locally for a period of at least seven years from date of purchase. | | |
| 5.25. | All equipment returned from repairs must be fully aligned to meet the specification of compliance. Certification must be issued and random batch testing will be performed. | | |
| 5.26. | Service manuals must be in English and available on CD-ROM. | | |
| 5.27. | Programming software must be on CD-ROM. | | |
| 5.28. | Programming software must be Microsoft Windows 7 compatible. | | |
| 5.29. | The selection between Trunked and Conventional modes must be easily selectable. | | |

| Item | Description | Comply Y/N | Remarks |
|-------|---|------------|---------|
| 5.30. | Trunked handheld radio must operate in accordance with MPT 1327 and MPT 1343 standards. | | |
| 5.31. | Trunked radio handheld must have a User Selectable inclusive and exclusive Group call facility catering for 100 Groups. | | |

6. TRAINING

| Item | Description | Comply Y/N | Remarks |
|------|--|------------|---------|
| 6.1. | Tenderers must be in a position to provide training on all products offered, country wide. | | |
| 6.2. | Training required on products will be indicated in the schedule of requirements. | | |

END OF DOCUMENT