COMMENTS

Comments on the contents of this specification are invited. All comments will be considered, but it is not always practical to indicate to the originator whether the comment was accepted or not.

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Please note that comments should identify the number of the clause(s)/subclause(s) to which they refer. Suggestions for revision of the text should indicate the preferred wording.

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STANDARD SPECIFICATION FOR SWITCHING SYSTEMS FOR CONNECTION TO THE PUBLIC SWITCHED TELECOMMUNICATION NETWORK

1 DEFINITIONS

1.1 **Client** shall mean the registered subscriber of a telecommunications line provided by **Telkom,** or any person using such a telecommunications line in a manner that, in the opinion of the Director-General, renders such a person as a registered subscriber or causes him to be regarded as such a subscriber,

1.2 **Exchange line** shall mean the voice channel (physical or otherwise) that connects the **PABX** switching unit with the **PSTN**,

1.3 **Extension line** shall mean the voice channel (physical or otherwise) that connects the **PABX** switching unit with an extension terminal on premises under the **PABX user**'s control,

1.4 **Extension terminal** shall mean any **TLTE** connected to an **extension line** ,

1.5 **Junction** shall mean a voice channel for the direct interconnection of two **PABX nodes**,

1.6 **PABX supplier** shall mean the person or organisation to whom a licence has been issued, allowing him to supply, install and maintain a PABX system in accordance with the Director-General's requirements,

1.7 **PABX switching unit**, shall mean any automatic telephone switching unit intended for installation at a client's premises, which offers the following as a minimum:

1.7.1 An automatically controlled switching unit with interfaces for standard loop-disconnect, DTMF or digital type telephone instruments and public exchange lines,

1.7.2 The automatic establishment of extension to extension calls by means of dialling,

1.7.3 The automatic establishment of outgoing calls to the PSTN by means of dialling,

1.7.4 Interception of calls from the PSTN by the PABX attendant or, in the case of an unattended system, by an answering extension and transferring these calls to the required extension,

1.7.5 The transfer of exchange calls from one extension to another,

1.7.6 The capability of placing an exchange call to the "hold" condition,

1.8 **PABX system** shall mean the **PABX** switching unit and its associated exchange line terminations, extension reticulation and extension terminals, and may consist of a node or nodes,

1.9 **PABX type** shall mean a specific model and version of a specific make of PABX switching unit,

1.10 **PABX user** shall mean the person for whom and at whose request a **PABX system** will be installed and connected to the **PSTN** (a PABX user may own, lease or rent a PABX system),

1.11 **PBX** shall mean a private branch exchange, whether automatic or manual,

1.12 **Director-General** shall mean the Chief Executive of The Department of Communications, or any official within The Department suitably authorised to act on behalf of the **Director-General**,

1.13 **Private Automatic Branch Exchange** is any automatic telephone switching unit intended for installation at a **client's** premises,

1.14 **Public Switched Telephone Network** consists of the exchanges, inter-exchange connections (cable, microwave, optic fibre etc.) exchange lines and **TLTE** owned and operated by **Telkom SA Ltd**, for the provision of telephone service to the general public,

1.15 **Switching System** shall mean any system having one or more input ports capable of connecting to the **PSTN** and a number of extension ports to which TLTE may be connected and having the ability to interconnect incoming and extension ports together for the purpose of exchanging electronic information. This includes but is not limited to **PABXs.** A complete list of the various systems classified as **switching systems** may be found in Annexure A to this document.

1.16 **The Department** shall mean the **South African Department of Communications**, being the regulatory authority for telecommunication matters in the RSA,

1.17 **Tie-line** shall mean a line rented from **Telkom** for the purpose of directly interconnecting two **PABX**s,

1.18 **Telecommunication Line Terminal Equipment** is equipment connected to an exchange or an extension line to transmit and receive voice, data and video signals.

2 ABBREVIATIONS

A	Ampere
ac	alternating current
AGC	Automatic Gain Control
b/s	bits per second
°C	degree Celsius
C	Capacitor, Capacitance
CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications (European Conference of Posts and Telecommunications Administrations)
CCITT	Comité Consultatif International Télégraphique et Téléphonique (International Consultative Committee for Telegraphy and Telecommunications)
CH	Channel
dB	decibel
dBm	decibel relative to 1 mW
dBmp	decibel psophometrically weighted
dBV	decibel relative to 1 V
dc	direct current
DTMF	Dual Tone Multi-Frequency (Dialling)

SADC	South African Department of Communications
emf	electromotive force
ETSI	European Telecommunications Standards Institute
Hz	Hertz
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
log	logarithm to the base 10
LMO	Licensed Maintenance Organisation
kb/s	kilo-bits per second
kHz	kilo-Hertz
km	kilometer
kΩ	kilo-ohm
kPa	kilo-Pascal
m	metre
mA	milli-Ampere
mm	millimetre
ms	millisecond
mW	milli-Watt
MF	Multi-Frequency
MHz	Mega-Hertz
MΩ	Mega-ohm
NU	Number Unobtainable
Ω	ohm
pps	pulses per second
Pa	Pascal
PABX	Private Automatic Branch Exchange
PMBX	Private Manual Branch Exchange
PBX	Private Branch Exchange
PSTN	Public Switched Telephone Network
rms	root mean square
R	Resistor
s	second
SABS	South African Bureau of Standards
TCL	Telkom Certification Laboratories
Telkom	Telkom South Africa Limited
TLTE	Telecommunication-Line Terminal Equipment
µ**A**	micro-Ampere
µ**F**	micro-Farad
µ**s**	micro-second
µ**W**	micro-Watt
W	Watt
Z	Impedance

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CHAPTER 1
FACILITIES

1.1 GENERAL

1.1.1 Supplementary facilities

In addition to the "standard" facilities as defined in **Paragraph 2.1** of **Annexure A** to the Suppliers Guide (**DPT-SG-002**), PABX systems can usually provide a large number of supplementary facilities. No attempt will be made to list and describe all the permissible supplementary facilities in this specification, as such a list will be unnecessarily long and never quite complete. It must be stressed however, that all facilities, including the methods by which they are achieved, are subject to conditions of service negotiated with Telkom and The Department, as certain arrangements may be in contravention of Telecommunication regulations or may result in loss of revenue to Telkom or the degradation of service quality. For example:

1.1.1.1 The inter-connection of exchange line calls and conference calls will only be permitted if transmission levels and supervision are taken into account.

1.1.1.2 The routing of a public exchange line call from one PABX to another PABX via a tie line, if the PABXs are situated in different metering zones will only be permitted if special tariff arrangements have been arranged with Telkom.

1.1.2 Facilities permitted

As the prime purpose of a PABX is to provide connection between the various extension terminals and exchange lines, any facility that will assist with the establishment of such connections, will normally be permitted; subject to the provisions of **Chapter 2**.

1.1.3 Traffic recording

It is strongly recommended that, where possible, provision be made for the recording of traffic and equipment usage (time to answer etc.,) by the PABX as this is an important tool for the determination of quality of service.

1.2 PROHIBITED ARRANGEMENTS

1.2.1 The arrangements listed below could well be incorporated into PABX systems, but are prohibited for reasons given briefly at the end of each sub-paragraph. The list is not exhaustive and arrangements not listed are not necessarily acceptable.

1.2.1.1 The application of Right-of-way (priority, executive intrusion, executive override, etc.) by an extension; and Trunk Offering by an attendant on an existing call, without a suitable audible warning being provided to at least one of the conversing parties.

Reason: This prohibition is aimed at enhancing the privacy of telephone calls .

1.2.1.2 The automatic disconnection, or disconnection by a third party e.g. a PABX extension or the PABX attendant, of an established call via the PABX in order to seize that circuit for another purpose.

Reason: Calls must remain under the control of the originator of the call and his selected recipient at all times.

1.2.1.5 The injection of non-standard tones into the public network.

Reason: The possibility of creating confusion to users of the network.

1.2.1.6 The specific design of a system that will enable a third party to record the conversation of two other parties.

Reason: This prohibition is aimed at enhancing the privacy of telephone calls.

1.2.1.7 The linking of two or more PABX units (back to back working) to operate as one unit such that certain standard PABX facilities are lost.

Reason: Loss of facilities and call supervision and to prevent the use of multiple systems to achieve an ultimate capacity beyond the designed capacity of a system.

1.2.1.8 The connection of traffic concentrating equipment on the extension side of a PABX in a configuration that would cause traffic congestion.

1.3 MANDATORY ARRANGEMENTS

1.3.1 Secrecy

As a general rule, telephone conversations and data connections shall be private and secure against intrusion. Where intrusion into a speech connection is necessary, it shall not occur without a suitable audible warning being provided to at least one of the conversing parties.

1.3.2 Clears to the public exchange

Outgoing exchange calls established automatically by extensions or via the attendant, as well as incoming exchange calls extended by the attendant, shall be directly cleared by the extension going on-hook, except when the series call facility has been activated by the attendant. On DDI exchange lines the public exchange equipment employs "calling party" release principles.

1.3.3 Line lockout

Provision shall be made for an extension line that is faulty or permanently looped to be put in the line lock-out condition after the elapse of a pre-determined time interval, if common switching equipment is likely to be held unnecessarily.

1.3.4 Camp-on free, ringing or busy

All attendant's consoles shall be able to camp an exchange call on a free or busy extension to permit the attendant to attend to other calls. In the case of a camp-on busy or ringing, the extension shall be automatically rung when it becomes free. If the call is not answered within a pre-determined time, it shall revert back to the attendant. Other systems providing similar features to the attendant will also be considered.

1.3.5 Trunk offer

When an exchange call is extended to an busy extension, by an attendant or an answering extension, it shall be possible for the attendant or answering extension to enter the existing conversation and offer the call to the required extension. Adequate warning shall be provided to all parties for the duration of the intrusion.

1.3.6 Night service

Provision shall be made for the answering and extending of incoming exchange calls when the attendant's console is not attended.

1.3.7 Busying facilities

Provision shall be made for the busying out, or disabling, of all equipment and/or circuits that are selected automatically, should the equipment be faulty or unplugged from its mounting position. Automatic disabling is preferred.

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CHAPTER 2
STANDARD INTERFACE REQUIREMENTS

2.1 INTERFACE REQUIREMENTS

2.1.1 Standards

Switching Systems are required to interface with all public exchanges. The standard requirements for aspects such as Dialing, Ringing Current, Ring Current Detection Circuitry, Telkom Feed Bridges and Tones are given in this chapter and are applicable to equipment interfacing with the public exchange equipment.

2.1.2 Terminating resistance for signal level and frequency measurements

Unless stated otherwise, all measurements will be taken across a 900 Ω resistive load.

2.2 LOOP-DISCONNECT DIALING

2.2.1 DC conditions

This is accomplished by alternately disconnecting and looping the line. The make and break conditions are defined as follows:

2.2.1.1 Loop current

	Receiving	Generating
Break condition:	Less than 1 mA.	Less than 500 µA at 50 V.
Make condition:	At least 20 mA.	The DC characteristics shall meet the requirements in **Paragraph 2.8.1.3 (ii).**

2.2.2 Dial pulses

Dial pulses shall have the following characteristics:

2.2.2.1 Speed

Receiving: 10 pps ± 2
Generating: 10 pps ± 1

2.2.2.2 Ratio

i. **Receiving:** The PABX shall accept dial pulses with the ratio, break period to total make plus break period of 60% to 73%.

ii. **Generating:** The PABX shall generate dial pulses with the ratio, break period to total make plus break period of 63% to 72%, nominally 67%. (See 2.2.3)

2.2.2.3 Regeneration

PABXs regenerating pulses shall adhere to these parameters. The distortion introduced by PABXs not making use of regeneration shall not exceed ±2 ms.

2.2.2.4 Measurement

Pulse timings shall be measured between the start of the exponential fall and the start of the exponential rise of the loop current.

2.2.2.5 Inter-digit pause

i. For a PABX with an automatically controlled source of pulses, the pause duration between successive digits including one make period shall be between 720 ms and 1150 ms.

ii. The PABX shall recognise an inter-digit pause of 720 ms or greater.

2.2.3 Dial pulse distortion

2.2.3.1 The performance of the PABX and its spark quench shall be evaluated with the test setup shown in **Chapter 7 Section 7.17**.

2.2.3.2 Measurements are made by recording the duration of the ninth or tenth break pulse on digit '0'.

2.2.3.3 Measurements are made under four sets of conditions, in each case a 50 kΩ resistor is placed accross the detector input:

i. into a 3000-type relay dial-pulse receiver with a 0 Ω line,

ii. into a 3000-type relay dial-pulse receiver with 1500 Ω of artificial line (0,5 mm Cu cable),

iii. into a 200 Ω + 200 Ω resistive receiver with a 0 Ω line, and

iv. into a 200 Ω + 200 Ω resistive receiver with 1500 Ω of artificial line (0,5 mm Cu cable).

2.2.3.4 For each set of conditions, the limits are set by sending digit '0' at:

i. 11 pps with a 63% break, and

ii. 9 pps with a 72% break .

(The generator shall have metallic contacts and a spark quench of 100Ω + 1,8 μF)

2.2.3.5 The test pulse generator is then replaced by the PABX, and digit '0' is then dialed through the PABX from a standard telephone.

2.2.3.6 With each condition set in **Paragraph 2.2.3.3** the break duration shall be within the limits obtained from **Paragraph 2.2.3.4**.

2.2.3.7 The 3000-type relay (coil 200 Ω + 200 Ω, 3 NI or 200 Ω + 200 Ω + 570 Ω, 3 NI), fitted with a square-isthmus armature, must be mounted correctly (armature knife-edge vertical) and adjusted to the following:

i. **Residual** 0,3 mm

ii. **Travel** 0,64 mm

iii. **Operate** 14 mA

iv. **Release** 4,5 mA

2.2.3.8 The threshold voltage for the resistive detector shall be 2,5 V. (i.e. a line current of 12,5 mA)

2.3 DUAL TONE MULTI-FREQUENCY DIALING (DTMF)

2.3.1 Frequencies

Dual tone multi-frequency dialing (DTMF) uses the 2 (1/4) code as defined in ITU-T Recommendation Q.23 with a frequency tolerance of ± 1,5%. The frequencies to be used are as follows:

DIGITS					
1	2	3	A	697	686.545 - 707.455
4	5	6	B	770	758.45 - 781.55
7	8	9	C	852	839.22 - 864.78
*	0	#	D	941	926.885 - 955.115
1209	1336	1477	1633	**FREQ.**	± 1.5 %
1190.865 - 1227.135	1315.96 - 1356.04	1454.845 - 1499.155	1608.505 - 1657.495	± 1.5 %	**TOLERANCE**

2.3.2 DTMF transmission levels

(Refer **Paragraph 2.1.2**)

2.3.2.1 Receiving

DTMF receivers shall operate with signals as follows (for signals from within the PABX, limits ii and iv may be up to 10 dB higher):

i. **Maximum level:** -4 dBm (injected at the PABX line terminals).
ii. **Minimum level:** -30 dBm (injected at the PABX line terminals).
iii. **Relative levels between the high and low frequency groups:** not greater than 7 dB for a particular call.
iv. **Signal recognition.** A signal received at a level below -40 dBm (measured at the PABX line terminals) shall not be recognized.
v. **Minimum tone duration:** 40 ms.
vi. **Minimum inter-tone pause:** 40 ms.
vii. **Frequency tolerance**: ± 2%.

NOTE: The inter-digit time-out period for DTMF receivers in Telkom exchanges is 10 s prior to the outgoing circuit in the local exchange being seized and 4 s to 6 s for successive digits.

2.3.2.2 Transmitting

Sending levels, after correcting for any gain adjustment in terms of **Paragraph 2.11.1.4**, shall be:

i. **High frequency group:** -9,0 dBm ± 2 dBm (measured at the line terminals).
ii. **Low frequency group:** -11,0 dBm ± 2,0 dBm (measured at the line terminals).
iii. **Pre-emphasis of high frequencies:** +2,0 dB ± 1,0 dB.

iv. **Individual unwanted-frequency components shall not exceed the following limits** (points are joined with straight lines on a log-frequency/linear-dB graph):
(a) 0,3 kHz to 3,4 kHz: -33 dBm.
(b) 3,4 kHz to 5,1 kHz: -33 dBm to -40 dBm.
(c) 5,1 kHz to 8,9 kHz:-40 dBm.
(d) 8,9 kHz to 50 kHz: -40 dBm to -70 dBm.
(e) 50 kHz to 100 kHz: -70 dBm.

v. **Unwanted frequencies.** The total power level of all unwanted frequency components, measured at the line terminals, shall not exceed -30 dBm.

vi. **Inter-digit pause.** The total power level, measured at the line terminals during inter-digit pause or holdover shall not exceed -60 dBmp.

vii. **Transient voltages.** The peak transient voltage associated with the rise and fall of the tone burst shall not be greater than 5V.

viii. **Signal duration.** The DTMF signal duration shall not be less than 65 ms. The inter-digit pause shall not be less than 65 ms.

2.3.3 Timed break recall

Any recall signal transmitted to the PSTN shall be a break (Refer to **Paragraph 2.2.1**) for a duration of 50 ms to 130 ms.

2.4 RINGING CURRENT

2.4.1 Ringing current wave form

2.4.1.1 Ringing current shall have a frequency of 17 Hz ± 5% or 25 Hz ± 5%.

2.4.1.2 The output voltage waveshape shall approximate a sine-wave to such an extent that the output noise voltage under any load conditions does not exceed that produced by 1 V at 800 Hz.

2.4.1.3 The noise voltage shall be measured by means of a psophometer weighted in accordance with ITU-T Recommendation P.53, connected via a 6 dB/octave high pass filter having a corner frequency greater than 8 kHz.

2.4.2 Ringing generator

2.4.2.1 The ringing generator output voltage, measured at the output of the extension line circuit (except where otherwise stated), shall comply with the following:

i. Not exceed 100 V rms on no load,
ii. Not exceed 150 V peak (including voltage spikes),
iii. Not drop below 35 V rms (measured across the load) when ringing into a load of 4,4 μF in series with 1500 Ω, connected to the longest specified extension line.

2.4.2.2 Ringing generators supplied with PABXs shall be capable of supplying ringing current to at least 25% of the full extension capacity of the PABX simultaneously.

2.4.2.3 Ringing generators making use of staggered cadences (or other methods) to give a result similar to simultaneous ringing may also be acceptable.

2.4.3 Ring trip

2.4.3.1 Ring trip shall respond within 250 ms of the telephone going off-hook.

2.4.3.2 False ring trip shall not occur when a circuit consisting of a capacitor of N x 2,2 μF in series with a resistor of 3000/N Ω (where N is the specified number of parallel instruments that may be connected to any line) is connected in parallel with a 300 kΩ resistor across a 0 Ω extension line.

2.5 RING CURRENT DETECTION CIRCUITRY

2.5.1 Incoming ring current

Ring current incoming from the public exchange has the following characteristics:

Cadence:

On	Off	On	Off
400 ms	200 ms	400 ms	2000 ms

(± 50 ms per pulse, ± 100 ms per cycle).

Frequency: 17 Hz ± 5%.

2.5.2 Ring current detection circuitry

Ring current detection circuitry shall have the following characteristics measured across the A and B legs in the unanswered condition:

2.5.2.1 Present a series capacitance of 0,33 μF to 2,2 μF (± 10%).

2.5.2.2 Have a dc resistance of not less than 5 MΩ at 200 V.

2.5.2.3 The modulus of the impedance of the ringing detection circuit, including the capacitor, shall be between 6 kΩ and 60 kΩ when tested at 17 Hz and 25 Hz at 35 V and 75 V rms.

2.5.2.4 The detector shall respond reliably, after an initial delay of up to 600 ms, to ringing voltages of more than 35 V rms but shall not respond to ringing voltages of less than 10 V rms or to the reversal of the line potentials at 3 s intervals.

2.6 PSTN FEED BRIDGES

2.6.1 Automatic Public Telephone Exchanges

The main types of Automatic Public Telephone Exchanges which are currently used in the PSTN are listed below:

Type	Abbreviation
British motor-uniselector exchange	MU
British two-motion type exchange	TM
Siemens F8M type EMD exchange	F8M
Siemens S8M type FMD exchange	S8M
Siemens CP24 type exchange	CP24
Teltech SA128E electronic exchange	128E
Siemens EWSD electronic exchange	EWSD
Alcatel CIT	E10

2.6.2 Response time

A maximum response time of 6 s, from application of a loop until seized conditions applies, must be allowed for certain exchanges. For digital exchanges this is the time for the processor to acknowledge the seize condition.

2.6.3 Analogue Subscriber's Line Interface Circuit (SLIC)

Analogue SLICs with the following line feeding parameters are used in electronic public exchanges :

2.6.3.1 Line feed, conversation mode

Current limited at 40 mA ± 5 mA (20 mA minimum at a loop resistance of 1 800 Ω including the subscribers telephone instrument resistance).

2.6.3.2 Line feed, on hook state

At 5 mA or less, the output voltage between the feed bridge terminals will not fall below 30 V.

2.6.3.3 High resistance feeding during line lockout

During the line lockout state the SLIC will power down and provide a high resistance feed with a current feed of between 6 mA and 12 mA for a loop resistance of up to 1800 Ω including the subscribers telephone instrument resistance.

2.7 SUPERVISORY TONES

2.7.1 Dial tone

Indicates to the subscriber that the equipment is ready to receive dial signals. It is recommended that PABX dial tone should be a continuous tone with at least 50% of the power at 400 Hz to ensure compatibility with dial tone detection devices. (Refer to **Paragraph 2.7.12**)

2.7.2 Ring tone

Indicates to the caller that ring current has been applied to the called subscriber's telephone.

2.7.3 Busy tone

Indicates to the caller that the called subscriber's line is engaged.

2.7.4 Number unobtainable

Indicates that the caller has followed an incorrect operating procedure, e.g. has waited too long before dialing or has dialed a barred or invalid code.

2.7.5 Equipment busy tone

Indicates that the exchange equipment is engaged.

2.7.6 Warning tone

Indicates to the conversing parties that a third party has intruded on the call.

2.7.7 Hold Tone (or Music-on-hold)

Indicates to the calling party that the call has been placed on hold.

2.7.8 Call-waiting Tone

Indicates that an un-answered call is waiting.

2.7.9 Camp-on tone

Indicates that an answered call is waiting.

2.7.10 Special tones

These tones are used by a PABX for a particular function.

2.7.11 Frequencies and levels

Tones injected into the PSTN shall be in accordance with the following specifications:

TONE	FREQUENCY	CADENCE (ms)
Dialing	400 Hz modulated at 33 Hz (or 367 Hz + 400 Hz or 400 Hz + 433 Hz)	continuous
Ring	400 Hz modulated at 33 Hz (or 367 Hz + 400 Hz or 400 Hz + 433 Hz)	400:200:400:2 000 on: off: on: off
Busy tone	400 Hz	500:500 on: off
NU tone	400 Hz	2 500:500 on: off
Eqpt busy tone	400 Hz	250:250 on: off
Warning tone	400 Hz	150:250:150:1450 on: off: on: off
Hold tone	400 Hz	30:60:30:4 880 on: off: on: off
Music on hold	optional	optional
Special	optional	optional

NOTES:

(a) All tones are to be sinusoidal with a maximum distortion of 10% before modulation (where applicable).

(b) The frequency tolerance shall be ± 2%.

(c) The modulation depth for dial tone and ring tone shall be 80% to 100% (where applicable).

(d) Supervisory tone levels at the public exchange interface shall be in the range -6 dBm0 to -14 dBm0.

(e) The cadence timing shall be within 30 ms of the nominal value except in the case of NU tone where the timing shall be within 100 ms of the nominal value and Hold tone which shall be within ± 10% of the nominal values.

(f) No combination of DTMF tones shall be used except for dialing.

2.7.12 PABX dial tone

PABX dial tone shall sound noticeably different from public exchange dial tone.

2.7.13 Simulated exchange dial tone

Where simulated exchange dial tone is provided by the PABX to an extension that has dialed the public exchange access code, this simulated dial tone shall conform to the standard of this specification.

2.8 PABX INTERFACES

2.8.1 Automatic exchange working (Analogue lines. Non-DDI)

2.8.1.1 Direct Inward System Access (DISA)

PABXs with DISA facilities shall not inject any non-standard tones into the PSTN. (Refer **Specification DPT-SWS-010**)

2.8.1.2 Idle

i. **Public exchange to PABX:** PSTN feed bridge (Refer **Paragraph 2.6**).

ii. **PABX to Public exchange:** Ring current detection circuitry (Refer **Paragraph 2.5**).

NOTES: **(a)** Large PABXs: In cases where the exchange lines are routed off a group selector level in the public exchange instead of off a final selector, a method which is favoured by large non-DDI PABX users, no potentials will be standing out to line from the public exchange. Line monitoring shall be done under these conditions. (Suppliers should consult with Telkom as to whether this facility is available in a particular exchange unit.)

(b) The 3- to 2-wire terminating relay set in the public exchange can provide line monitoring facilities if a 6000 Ω battery potential and a 6000 Ω earth are applied to the line in the idle state. These shall be removed during speech conditions.

2.8.1.3 Line Seizure

i. **Public exchange to PABX (incoming call).** Ringing current is applied to the line. With some types of public exchange the line polarity is reversed until the call is answered.

ii **PABX to public exchange (outgoing call).** A loop is applied across the line. The dc characteristics of this loop shall fall within the mask shown in **Figure 2.2** for all possible line currents.

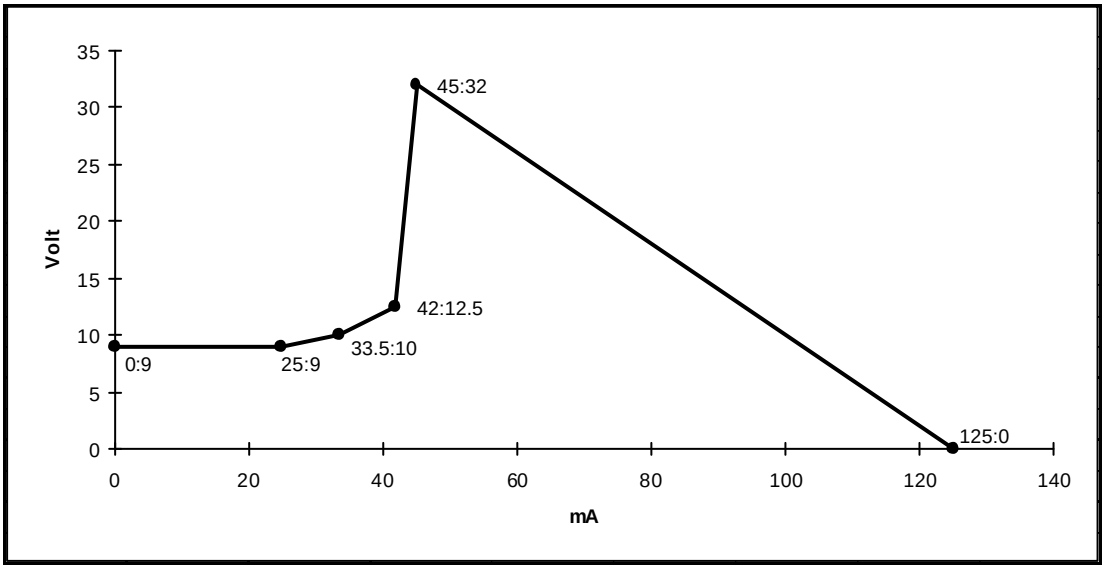

FIGURE 2.2

2.8.1.4 Dialing

i. **Public exchange to PABX:** N / A

ii. **PABX to public exchange:** Loop disconnect dialing or DTMF dialing (Refer **Paragraph 2.2** and **2.3**).

2.8.1.5 Answering

i. **Public exchange to PABX (incoming call).** Ring trip and connection of feed bridge.

ii. **PABX to public exchange (incoming call).** As for seizure.

iii. **Public exchange to PABX (outgoing call).** With some types of public exchanges the line polarity reverses. With some installations, Subscriber's Private Metering pulses may be applied at various times. (Refer **Paragraph 2.8.6**)

2.8.1.6 During speech

i. **Public exchange to PABX.** PSTN feed bridge (Refer **Paragraph 2.6.2**: seized condition)

ii. **PABX to public exchange.** Refer **Paragraph 2.8.1.3 (ii).**

2.8.1.7 Release

i. **Outgoing call from PABX**

(a) **Public exchange to PABX.** On public exchanges where the line polarity reverses on answer, the polarity will be restored when the called party releases.

(b) **PABX to public exchange.** A break in the loop from the PABX (Refer **Paragraph 2.2.1**) for more than 800 ms.

ii. **Incoming call to the PABX**

(a) **Public exchange to PABX.** On some exchanges, there may be a reversal of the line polarity. On most exchanges NU tone will be applied for a period, then the line feed will go into low-current lock-out if the PABX party has not yet released.

(b) **PABX to public exchange.** This shall be a break in the loop from the PABX (Refer **Paragraph 2.2.1**) for more than 800 ms and this condition will be signaled back to the originating exchange. Typically no action will be taken by any equipment for 30 s, and if the loop on the line is reapplied, the call can continue. After 30 s the exchange equipment may automatically release the call.

2.8.2 Automatic exchange working (Analogue lines, DDI)

(Electro-mechanical exchanges)

NOTE: All analogue DDI PABXs shall provide a DDI answering unit (Refer **Paragraph 2.8.8** for requirements).

2.8.2.1 Idle

i. **Public exchange to PABX:** The exchange presents not less than 19 kΩ to line. Line monitoring is provided by the exchange line interface.

ii. **PABX to Public exchange:** The PABX shall provide a minimum open circuit voltage of 44 V to line.

2.8.2.2 Ringing

N/A

2.8.2.3 Seizure and during speech

i. **Public exchange to PABX:** A current-limited looping device set for nominally 25 mA.

ii. **PABX to public exchange:** No circuitry limiting the current to less than 30 mA may be included in the PABX DDI line feed circuitry. The minimum PABX interface terminal voltage at 30 mA shall be 34 V.

2.8.2.4 Dialing

i. **Public exchange to PABX:** Loop disconnect dialing or DTMF dialing.

ii. **PABX to public exchange:** N/A

2.8.2.5 Answering

i. **Public exchange to PABX:** N/A

ii. **PABX to public exchange:** When the called extension goes off-hook, the PABX shall provide an answer signal in the form of a reversal of the line potentials standing out to the public exchange. This answer signal shall be maintained for the duration of the answered state.

2.8.2.6 Release

i. **Public exchange to PABX:** A disconnection of the loop of more than 300 ms. The PABX shall return Busy or NU tone to the extension on receipt of this signal.

ii. **PABX to public exchange:** The line polarities shall be restored to the normal (unanswered) state.

2.8.3 Automatic exchange working (Digital lines, DDI and DDO working)

2.8.3.1 Interfacing

The following ITU-T Recommendations shall be followed:

i. G.703 section 6 for the electrical characteristics of the interface at 2048 kb/s.
ii. G.704 for the frame structure.
iii. G.711 for the encoding of analogue signals. The A-law shall be used.
iv. G.732 for the format and structure of a PCM signal train.

2.8.3.2 Signaling

The signaling shall comply with the following ITU-T Recommendations:

i. Q411 Line signaling, analog version
ii. Q412 Clauses for exchange line signaling equipment
iii. Q414 Clauses for transmission line signaling equipment
iv. Q415 Signal receiver
v. Q416 Interruption control
vi. Q421 Line signaling digital version
vii. Q422 Clauses for exchange line signaling equipment
viii. Q424 Protection against the effects of faulty transmission
ix. Q440 Conversion between analogue and digital versions of R2 line signaling and interregister signaling .
x. Q441 Signaling code
xi. Q442 Pulse transmission of backward signals

2.8.3.3 Restrictions

i. In the case of DDO (i.e. call setup in the direction PABX to digital exchange), only the Group I and II Forward signals listed below may be sent by the PABX.
ii. In the case of DDI (i.e. call setup in the direction digital exchange to PABX), only the Group A and B Backward signals shown below may be sent by the PABX. The PABX shall accept all Group II forward signals, without prejudice to the completion of the call. Some of these signals are in use in the PSTN and others could be used in the future.

Group I Forward Signals

Combination	Designation	Meaning	Remarks
1	I-1	Digit 1	Numerical signals to indicate the address required to set up the call. These signals are sent either spontaneously and immediately after seizure of the link or in response to one of the backward signals A-1, A-2, A-7 or A-8.
2	I-2	Digit 2	
3	I-3	Digit 3	
4	I-4	Digit 4	
5	I-5	Digit 5	
6	I-6	Digit 6	
7	I-7	Digit 7	
8	I-8	Digit 8	
9	I-9	Digit 9	
10	I-10	Digit 10	
11	I-11	Reserved for Telkom use.	
12	I-12	i. Request not accepted ii. Calling party's unavailable number	Indicates that response to a Group A backward signal is not possible (A-2, A-7 or A-8). In the case of a repeated A-5, the calling party's number is not available.
13	I-13	Reserved for Telkom use	
14	I-14	Reserved for Telkom use	
15	I-15	End of pulsing	

Group II Forward Signals

Combination	Designation	Meaning	Remarks
1	II-1	Subscriber	Indicates the call is set up from a sub's line.
2	II-2	Priority call	Indicates the call is set up from a sub's line to which priority treatment has been accorded.
3	II-3	Reserved for Telkom use.	
4	II-4	Reserved for Telkom use.	
5	II-5	Reserved for Telkom use.	
6	II-6	Data transmission.	Indicates that the call will be used for data.
7	II-7	Reserved	
8	II-8	Reserved	
9	II-9	Reserved	
10	II-10	Reserved	
11	II-11	Reserved	
12	II-12	i. Calling party's category not available ii. Calling party's number unavailable.	Indicates that response to a Group A-5 or A-3 backward signal is not possible (calling party's category) In the case of a repeated A-5, the calling party's number is not available.
13	II-13	Reserved	
14	II-14	Reserved	
15	II-15	Reserved	

Group A Backward Signals

Combination	Designation	Meaning	Remarks
1	A-1	Send next digit (n+1)	After reception of digit n, request digit n+1.
2	A-2	Send last-but-one	After reception of digit n, request digit n-1.
3	A-3	Address complete, change to reception of Group B signals.	Incoming-end R2 register needs no more digits, is going over to transmission of Group B signal
4	A-4	Reserved for Telkom use	
5	A-5	i. Send calling party's category ii. Repeated sending of A-5 is reserved for Telkom use to request the number of the calling party.	Request Group II signal to indicate the calling party's category. The waiting for address complete (speech path through connection) timer in the PABX may be initiated after the transmission of the first digit from the PABX in which case it must not be shorter than 30 s or after the transmission of the last digit in which case it must not be shorter than 20 s.
6	A-6	Address complete, connect speech conditions and charge on answer.	Incoming-end R2 register needs no more digits, but will not send Group B signal. The call must be charged on answer.
7	A-7	Send last-but-two digit (n-2).	After reception of digit n, request digit n-2.
8	A-8	Send last-but-three digit (n-3).	After reception of digit n, request digit n-3.
9	A-9	Reserved	
10	A-10	Reserved	
11	A-11	Reserved	
12	A-12	Reserved	
13	A-13	Reserved	
14	A-14	Reserved	
15	A-15	Reserved	

Group B Backward Signals

Combination	Designation	Meaning	Remarks
1	B-1	Reserved for Telkom use.	
2	B-2	Reserved for Telkom use.	
3	B-3	Sub's line busy.	The line or lines are engaged.
4	B-4	Reserved for Telkom use.	
5	B-5	Unallocated national number.	The number received is not valid.
6	B-6	Sub's line free, charge on answer.	
7	B-7	Reserved for Telkom use	
8	B-8	Reserved for Telkom use	
9	B-9	Reserved for Telkom use	
10	B-10	Reserved	
11	B-11	Reserved	
12	B-12	Reserved	
13	B-13	Reserved	
14	B-14	Reserved	
15	B-15	Reserved	

2.8.3.4 Metering

DDO PABXs shall realise private metering through the use of meter pulses provided for MOJ working within the R2 signaling system as specified in CCITT Blue Book Volume VI Fascicle VI.4 Supplement No 6 Paragraph 3.

2.8.3.5 Choice of meter codes

Some line signaling systems (e.g. EWSD) indicate a meter pulse by a signal identical to a "pulsed clear-back", signal. Under these circumstances a meter pulse is represented by a_b=1, b_b=1. Other signaling schemes (e.g. E10) use a "pulsed answer" signal to indicate a meter pulse. Under these circumstances a meter pulse is represented by a_b=0, b_b=1.

2.8.3.6 Synchronization signal

The synchronization signal is to be extracted from the incoming bit stream.

NOTES: **(a)** No new systems with R2LDP will be approved. Concession is granted for new installations using R2LDP up to the year 2000.

(b) Support for the R2LDP signaling protocol will be withdrawn during the year 2004.

2.8.3.7 Electrical characteristics tested

i. System

(a) Wave shape: (ITU-T Recommendation G.703 Paragraph 6.2)
(b) Receive sensitivity: (ITU-T Recommendation G.703 Paragraph 6.3)
(c) Bit rate: (ITU-T Recommendation G.703 Paragraph 6.1)
(d) Return loss: (ITU-T Recommendation G.703 Paragraph 6.3.3) -- 75 Ω unbalanced and 120 Ω balanced working will be required, although the latter is normally used.
(e) Jitter: (ITU-T Recommendation G823 Table 2)
(f) Frame structure and format: (ITU-T Recommendations G.704 Paragraph 2.3, G.711 Paragraph 3.2, G.732 Paragraph 2 to 5)
(g) Synchronisation:

ii. Analogue extensions to digital port

(a) Insertion loss
(b) Gain versus frequency
(c) Distortion
(d) Gain versus input level (ITU-T Recommendation G.714 Paragraph 15.3)
(e) Group delay distortion (ITU-T Recommendation G.714 Paragraph 8.2)
(f) Out of band measurements (ITU-T Recommendation G.714 Paragraphs 11.1 & 12.1)
(g) Noise levels (ITU-T Recommendation G.714 Paragraph 9)

2.8.4 Magneto public exchange working

2.8.4.1 Idle

i. **Exchange to PABX:** Ring current detection circuitry consisting of an indicator having a minimum resistance of 1000 Ω, and high impedance to speech frequencies,
ii. **PABX to exchange:** A ring current detection circuit.

2.8.4.2 During speech

i. **Exchange to PABX:** As no direct current flows in a magneto exchange line, the conditions standing out to line are the same as when the circuit is idle.
ii. **PABX to exchange:** A dc holding loop is not required but the presence of such a loop is permissible.

2.8.4.3 Seizure and release

i. **Exchange to PABX:** Manually-controlled ringing,
ii. **PABX to exchange:** A burst of ring current of between one and two seconds duration. This ringing current shall have a frequency of 15 Hz to 27 Hz and an output voltage into a 1 kΩ load of 45 V rms minimum.

2.8.5 PABX interface with analogue extensions

2.8.5.1 General

i. The PABX supplier shall define the maximum rated extension line resistance of the system (at least 100 Ω), also the maximum number of telephones that may be connected to any extension:

ii. In the on-hook condition each standard telephone can be represented by a 1 MΩ resistor across the line.

iii. If repertory dialing and last-number-redial facilities are required from the telephone, a minimum of 20 V should be provided across the line terminals of each telephone in the idle state.

iv. The off-hook detector shall not respond to a leg-to-leg leakage of 20 kΩ or a leg-to-earth leakage of 20 kΩ, applied separately.

2.8.5.2 Seized and signaling states

i. **PABX to Extension:** Any type of feed circuit may be used but the following conditions shall be met:

(a) The nominal extension line current shall fall within the dc mask shown in **Figure 2.3** for extension lines between 0 Ω and the maximum specified for the PABX.

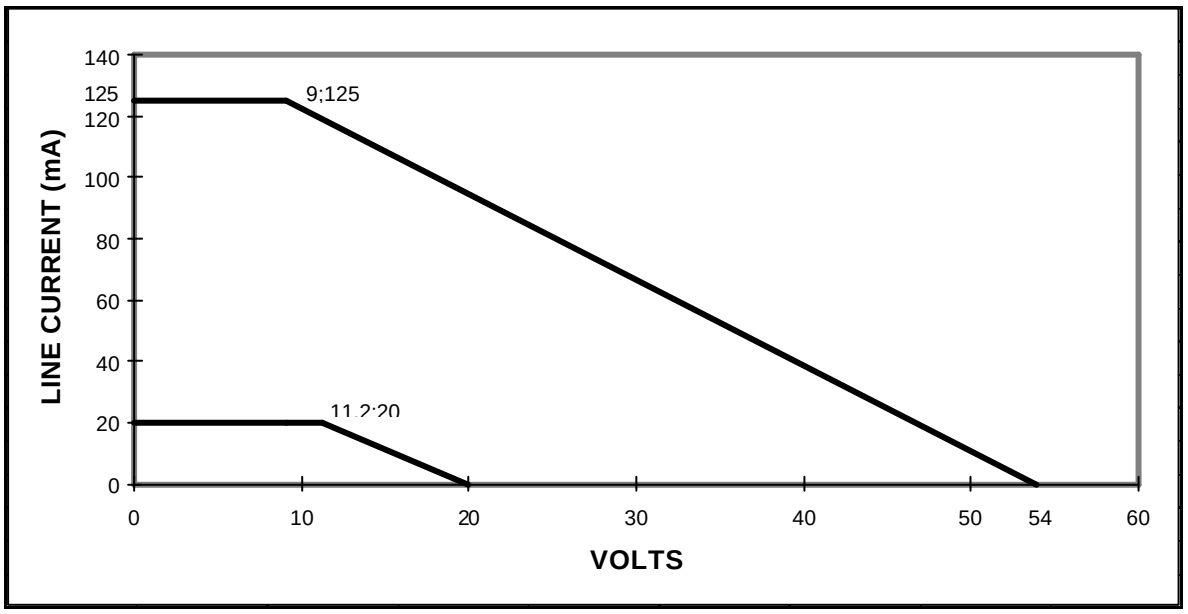

FIGURE 2.3

(b) The transmission requirements shall be complied with

(c) The current feed circuitry shall be self-protecting against a full short circuit on a 0 Ω loop and a full earth condition on the A and/or B legs.

ii. **Extension to PABX:** Ring current detection circuitry.

2.8.5.3 Seizure

i. **PABX to extension:** Ringing current is applied to the line.

ii **Extension to PABX (extension feed bridge idle):** Line seizure shall be accomplished when any device that meets the requirements of **Figure 2.2**, Refer **Paragraph 2.8.1.3**, is connected across the line terminals. Compliance will be checked as indicated in **Chapter 7 Section 7.14**.

2.8.5.4 Dialing

i **PABX to extension.** N/A

ii **Extension to PABX.** Loop disconnect dialing or DTMF dialing

2.8.5.5 Answering (incoming call)

i **PABX to extension.** Ring trip and connection of feed bridge.

ii **Extension to PABX.** Refer **Paragraph 2.8.1.3 (ii).**

2.8.5.6 During speech

i **PABX to extension.** Refer **Paragraph 2.8.5.2.**

ii **Extension to PABX.** Refer **Paragraph 2.8.1.3 (ii).**

2.8.5.7 Release

i **PABX to extension.** N/A

ii **Extension to PABX.** A disconnection of the loop (resistance greater than 20 kΩ) for more than 200 ms. A disconnection of less than 140 ms shall not be recognised as a release.

2.8.5.8 Recall

If earth and/or timed break recall signals are used, the PABX shall recognise the Telkom standard one(s) which are:

i **Loop-disconnect type telephones:** an earth potential with a maximum resistance of 100 Ω is applied at the telephone to one or both speech wires for longer than 60 ms.

ii **Dual-Tone Multi-Frequency type telephones:** a controlled break of 100 ms ± 10 ms will be generated by a standard telephone. Telephone attachments are allowed to generate a timed break recall signal in the range 50 ms to 130 ms.

NOTES:

(a) The use of a timed break on loop-disconnect telephones, e.g. dialing of the digit 1 (with a suitable time-out period after speech conditions have been established) has been used, but is not recommended due to the possibility of mis-operations.

(b) Access to plus facilities may be allowed on PABXs where the signaling used for the plus facilities does not interfere with the internal signaling used by the PABX.

2.8.5.9 2B + D Interfaces

See the separate specification.

2.8.6 Meter Pulse Receivers

Two signaling methods are employed by the PSTN. The detector specifications are as follows:

2.8.6.1 Longitudinal

Signal frequency:	50 Hz ± 2 Hz sinusoidal.
Line voltage (detect):	55 V ± 11 V.
Line voltage (non-detect):	20 V at 50 Hz (longitudinal). 100 V at 25 Hz or 16 $^2/_3$ Hz (applied to one leg with the other leg open-circuit).
Signal current to earth:	1,5 mA maximum at 66 V.
Signal duration:	(slow pulse train) 100 ms to over 1 s. (fast pulse train) 100 ms to 500 ms. (non-detect) 20 ms.
Pulse separation:	75 ms minimum.
Maximum rate:	1 per 575 ms (1,74 per s).

2.8.6.2 Transverse

Signal frequency:	16 kHz ± 0,5 % sinusoidal.
Signal source impedance:	200 Ω
Line voltage: (detect)	40 mV [1] to 6 V into 200 Ω.
Line voltage: (non-detect)	(16 kHz) 8 mV into 200 Ω. (white noise, 600 Ω source) +10 dBmOp$_{600}$
Signal duration:	(detect) 100 to 350 ms. (non-detect) 20 ms.
Pulse repetition rate:	1,74 per s maximum.
Insertion loss (line - phone):	0,5 dB maximum at 300 Hz to 3400 Hz; 20 dB minimum at 16 kHz ± 0,5 %.
Overload:	A 16 kHz signal of 8 V behind 200 Ω applied to the exchange line shall not produce distortion of more than 10% (-20 dB) in a signal.

[1] Provision shall be made to reduce the sensitivity by nominally 20 dB, i.e. approximately 300 mV minimum, for short-line working.

2.8.7 Polarity

2.8.7.1 Exchange lines on automatic exchanges have a DC potential between the conductors.

2.8.7.2 The operation of a PABX shall be independent of the polarity of this line voltage.

2.8.8 Requirements for DDI answering unit

2.8.8.1 A normal DDI extension number shall be dialed to access the answering unit interface.

2.8.8.2 Ring trip, preceded by ring tone to the public exchange, shall occur 3 s to 6 s after the receipt of ring current.

2.8.8.3 Ring trip shall be followed by line reversal to the public exchange and the transmission of a test tone of 400 Hz (± 2%) at a level between -6 dBmO and -14 dBmO for at least 3 s to indicate a successful call.

2.8.8.4 Answering units are mandatory on all new analogue DDI installations.

2.9 TIE LINES

Subject to the DPT regulations governing the use of tie lines, tie lines may be provided between (a) PABX and PABX and (b) PABX and PMBX. The various requirements for tie line working are as follows:

2.9.1 Magneto Tie Lines

Signaling as for Magneto working (Refer **Paragraph 2.8.4**) except that no ring-off signal is permitted.

2.9.2 Unidirectional-dial 2-wire tie lines

This is equivalent to the A-side being a telephone instrument connected to the B-side PABX. The A-side shall meet the electrical requirements for an analogue exchange-line interface, the B-side for an analogue extension interface.

NOTE: These operate with dialing in one direction (A-B) and ringing in the reverse direction.

2.9.3 Auto-auto (bothway dial) 2-wire tie lines (loop-disconnect or DTMF)

2.9.3.1 Idle

The line current feed circuit shall provide battery (-44 V to -56 V) and earth potentials to line. A balanced, constant resistance feed circuit is recommended. In the idle state the PABX auto to auto interface shall not allow longitudinal current flow when a difference in potential exists between the two ends of the tie line (e.g. earth and/or battery voltages).

2.9.3.2 Seized and during speech

A dc holding loop, refer **Paragraph 2.8.1.3 (ii)**, shall replace the potentials standing out to line on the calling side. The current feed circuitry shall be self protecting against a full short circuit on a 0 Ω loop and a full earth condition on the A and/or B legs.

2.9.3.3 Answer

The line reversal on answer facility, if provided, shall be disabled when working into a PABX which does not require line reversals.

2.9.3.4 Release

The idle conditions are restored to line. However, if an answer signal is being used, the line shall first be disconnected for 800 ms minimum.

NOTE: These tie lines may also make use of other types of signaling, such as ITU-T R2 MFC.

2.9.4 Auto-auto (bothway dialing) tie lines operating over the Telkom carrier network

Telkom offer a standard interface, with the following requirements.

2.9.4.1 General requirements

i. The nominal level at the 2-wire carrier interface shall not exceed 0 dBm.

ii. If tones are used to invoke special features, the levels shall not exceed -6 dBr for pulsed tones (on for less than 6 s per minute), -18 dBr for other tones.

NOTE: During loop-disconnect dialing of each digit, the interface isolates the 2-wire pair from the carrier speech path (and leaves it unterminated) until 130 ms ± 30 ms after the start of the last dial make.

2.9.4.2 Normal operating conditions

i. **Idle.** As per **Paragraph 2.9.3.1**. The carrier interface provides a 200 Ω + 200 Ω, 50 V feed bridge with a diode in each leg.

ii. **Seize**

(a) **Outgoing PABX.** Remove the feed bridge and loop the line as per **Paragraph 2.8.1.3 (ii).**

(b) **Incoming PABX.** The PABX shall recognise a loop of up to 1800 Ω.

iii. **Dialing.** Loop-disconnect dialing, if used, shall comply with **Paragraph 2.2**. DTMF dialing, if used, shall comply with **Paragraph 2.3**.

iv. **Answer.** The use of an answer signal (as follows) is optional, but if used then the carrier interface equipment must be strapped accordingly and certain operating conditions change [1, 2].

(a) **Incoming PABX.** When the called party answers, the polarity to line of the feed bridge shall be reversed for the duration of the answer state.

(b) **Outgoing PABX.** The initial polarity reversal will be echoed by the Telkom interface for use by the outgoing PABX.

[1] If the answer mode is disabled, reversals will not be repeated back to the caller. The call will be calling-party controlled.

[2] If the answer mode is enabled, the reversal will be extended but the call will be calling-party release if the incoming PABX restores the line polarity. In addition, the carrier interface equipment will time-out after 3 minutes if no reversal is received and drop the call.

v. **Clear Forward**

(a) **Outgoing PABX.** When the caller clears, the line shall be disconnected for a minimum of 300 ms. The idle-state feed bridge shall be re-applied to the line within 800 ms of the start of the disconnection, otherwise the carrier interface will assume a blocking state (Refer **Paragraph 2.9.4.3 (i)**). The tie-line interface shall then be prevented from being seized for outgoing calls, for a minimum period of 3 s.

(b) **Incoming PABX.** On receipt of the loop-disconnection, the call shall be dropped and the idle-state feed bridge shall be restored to line within 800 ms, and maintained until at least 1,5 s, measured from the start of the disconnection. (The carrier interface equipment will test for these potentials before applying its idle-state feed bridge.)

vi. **Clear Back.** (Only if answer mode is enabled - Refer **Paragraph 2.9.4.3 (iv)**). The incoming PABX shall restore the line polarity to normal. On detection of this restoration, the carrier interfaces will disconnect both 2-wire paths. After 900 ms they will test for idle potentials at each end -- if missing, the blocking state will be entered.

2.9.4.3 Abnormal Conditions

i. **Blocking.** The PABX shall provide a manual camp-on or busy facility by means of a disconnection of the feed bridge to put the carrier interface in its blocking mode. In this mode, the carrier interfaces disconnect both feed bridges and every 60 s initiates a re-test for idle potentials. When both ends are correct, the link reverts to normal idle conditions.

ii. **Fleeting seizure.** If an outgoing call is abandoned prematurely, the release procedure above shall still apply.

iii. **Dual seizure (call collision).** As with most both-way circuits, it can happen that both ends are seized simultaneously. The protocol under these conditions is not defined.

2.9.4.4 Electrical parameters

i. **2-wire equivalent.** The insertion loss of the Telkom carrier-plus-interface equipment between its 2-wire points will be 0 dB ± 0,5 dB.

ii. **2-wire impedance.** The impedance at the 2-wire points will be as per **Paragraph 2.11.3**.

iii. **Line resistance.** The Telkom equipment will function correctly with each 2-wire line loop being up to 1400 Ω but resultant speech levels may be unacceptable (dependent on the type of traffic carried).

iv. **Feed bridge.** Refer **Paragraph 2.6.2**.

2.9.5 E & M tie line signaling

The following E & M protocol specification is suggested to achieve inter-working of different manufacturers' PABXs over copper pairs or a PSTN carrier link. DTMF dialing may be used instead of loop-disconnect. The supplier shall state the protocol used.

2.9.5.1 Signaling system

i. **DC conditions**

SIGNAL	OUTGOING	INCOMING
Idle		
Seize	Earth M	
Digits (loop-dis)	Earth off M during each break pulse	
Answer		Earth E
Backward Clear		Earth off E (200 ms minimum)
Forward Clear	Earth off M	

ii. **E & M to tone, signal translation**

Whenever M is Earthed, the outgoing Tone is off; whenever the incoming tone is off, E is earthed.

2.10 CALL INFORMATION LOGGING

2.10.1 Line interface

The line interface of systems connected directly to the exchange and extension sides of the PABX will be tested according to the regulations applied to telephone attachments (Refer **DPT-TE-001**).

2.10.2 Data Circuit terminating Equipment (DCE)

Data Circuit terminating Equipment (DCE), such as modems, connected to ITU-T V.28/V.24/ISO 2110 ports (equivalent to EIA standard RS 232 C) have to be licensed by DPT if this equipment is connected directly or indirectly to the PSTN. Data Terminal Equipment (DTE) connecting to the PABX via a ITU V.28/V.24/ISO 2110 interface need not be subjected to any tests.

2.11 TRANSMISSION PARAMETERS

2.11.1 Loudness rating

2.11.1.1 The PABX shall be tested as an entirety with all types of terminals intended for use with the PABX.

2.11.1.2 The loudness rating shall be measured according to the test method described in ITU-T Recommendation P.76 using a 900 Ω termination.

2.11.1.3 The results shall be within the masks shown in **Figure 2.4 (a), (b)** and **(c)** for all combinations of exchange and extension line lengths allowed when using 0,5 mm Cu cable, except that the STMR may exceed the upper limit if it is 1,5 dB quieter (numerically 1,5 dB higher) than the SLR under the same conditions. The mask shows the sum of exchange and extension line length expressed in Ohms.

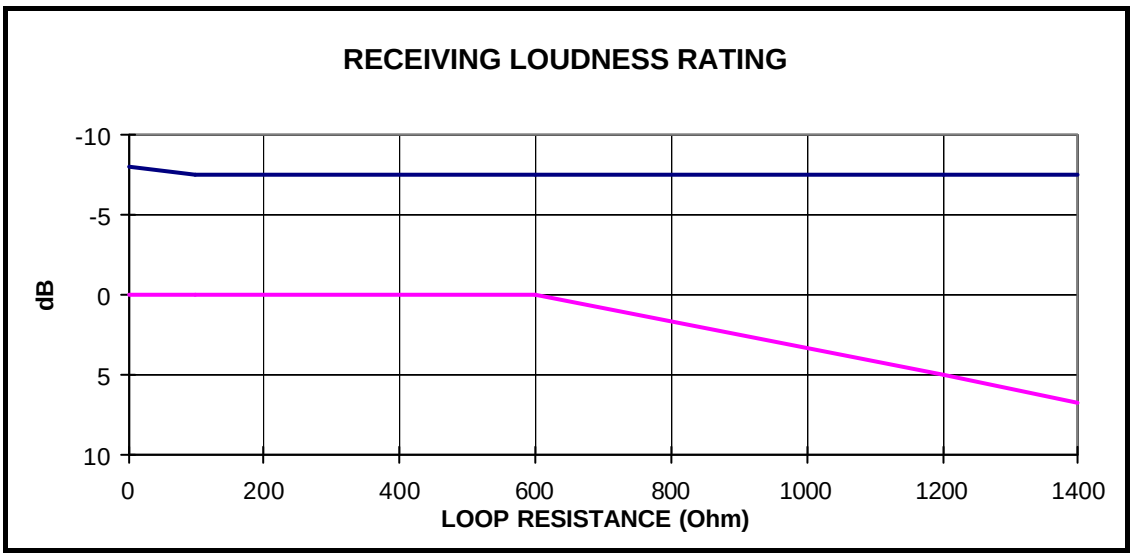

FIGURE 2.4 (a)

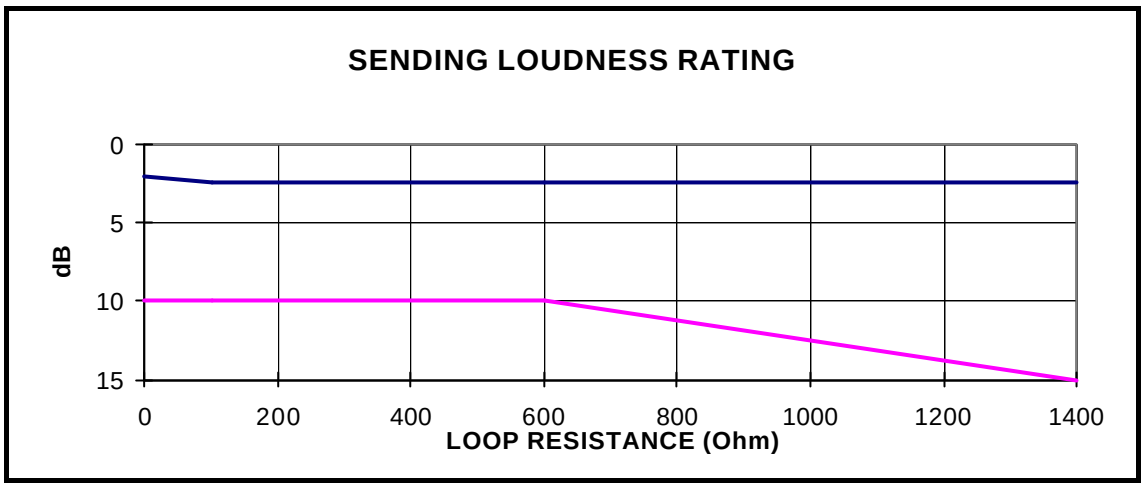

FIGURE 2.4 (b)

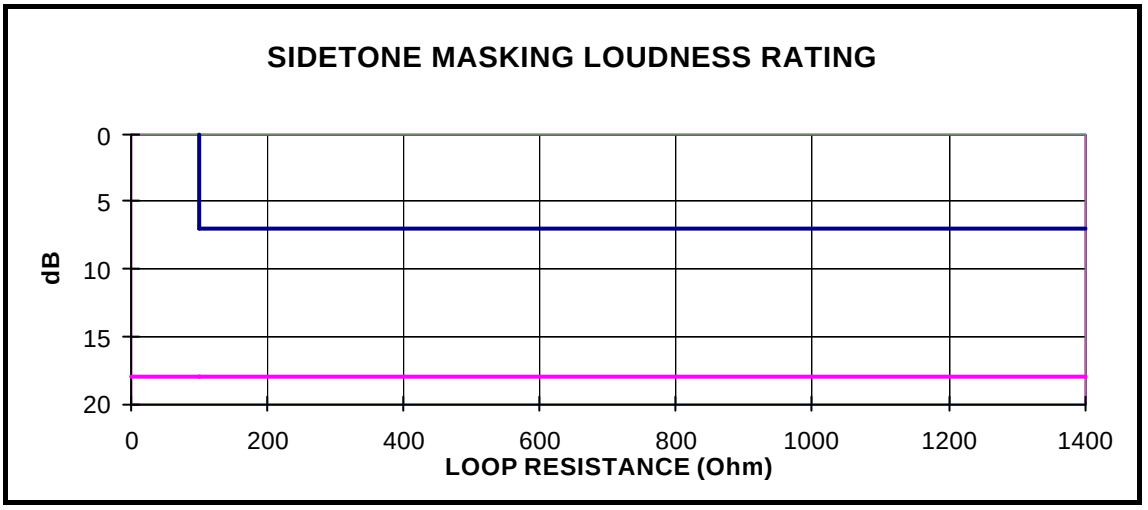

FIGURE 2.4 (c)

2.11.1.4 The exchange line attenuation at 1400 Hz may not exceed 5,5 dB and the sum of the exchange line attenuation, insertion loss and extension line attenuation at 1400 Hz may not exceed 9,0 dB.

NOTES:

(a) If current-limited feed bridges are used, it may be required to add the equivalent of 3 dB ± 1 dB insertion loss into each direction of transmission of the extension circuit at the 2-wire point to reduce the speech levels of the regulated terminals. (e.g. the relative encoding levels could be adjusted to +4 dBr for transmit and -9 dBr for receive in the case of PCM systems)

(b) For connections via analogue exchange lines to the public exchange the supplier may switch out the additional loss beyond a certain exchange line length on extension - exchange calls to extend the working range of the PABX (i.e. relative encoding levels of + 1 dBr for transmit and -6 dBr for receive in the case of PCM systems).

(c) These requirements will be determined during conformance testing. The requirements of **Paragraph 2.11.2.2 (ii)** are applicable.

2.11.1.5 PABXs shall meet all the requirements above when the extension line resistance is taken to be 100 Ω minimum.

2.11.1.6 Terminals shall be acoustically stable under all conditions.

2.11.1.7 No telephone terminals, attendant handsets or headsets shall be equipped with carbon granule transmitters.

2.11.2 Insertion loss

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for these measurements.

2.11.2.1 Definition

Insertion loss is defined as the difference in power level measured at 1000 Hz at the receiving port between two connections, the one connection consisting of a direct connect path between the transmit and receive ports, while the second connect path consists of a connect path via the PABX.

2.11.2.2 Types of connections

For the various types of connections via a PABX, the permissible insertion loss is as follows,

i. **Extension to extension**: at 1000 Hz, digital PABXs: 7 dB ± 2 dB, analogue PABXs: 10 dB maximum. Any additional loss requirement as a result of **Paragraph 2.11.1.4** is to be added to these figures. The maximum allowed variation of the loss (with variation in frequency) relative to the loss at 1000 Hz are shown in **Figure 2.5 (a)** and **(b)** for the various connections.

ii. **Extension to exchange line**: extension to tie line and tie line to tie line:

- **(a)** 4 dB maximum provided at least 1 dB can be switched out as would be required in the case of long exchange lines (Refer **Paragraph 2.11.1.4**), otherwise a maximum of 3 dB. Minimum loss shall be 0 dB.
- **(b)** The maximum allowed variation of the loss (with variation in frequency) relative to the loss at 1000 Hz is shown in **Figure 2.5 (a)** and **(b)**.
- **(c)** The difference in actual transmission loss between the two directions of transmission, at the reference frequency of 1000 Hz (1004 Hz to 1020 Hz), may not exceed 1 dB.

2.11.2.3 Tolerance of relative levels

(ITU-T Recommendation Q.517)In the case of PCM systems, the difference between the actual relative level and the nominal relative level (+1 dBr transmit, -6 dBr receive) shall be within the following limits (These terms are defined in ITU-T Recommendation G.101):

i. Input relative level: -0,3 dB to +0,7 dB

ii. Output relative level: -0,7 dB to +0,3 dB

2.11.2.4 Conference calls

Conference calls are permitted provided line supervisory is provided. The speech levels are however not guaranteed by Telkom.

i. Digital PABXs, exchange-to-extension: an additional loss, relative to **Paragraph 2.11.2.2**, of up to 4 dB for 3-party conferences and 6 dB for larger conferences is acceptable.

ii. Analogue PABXs shall comply with the following limits:

a) Between 3 extensions: 13 dB maximum.

b) Between 2 extensions and 1 exchange line: 7 dB maximum.

2.11.2.5 Frequency response

i. Analogue - Analogue

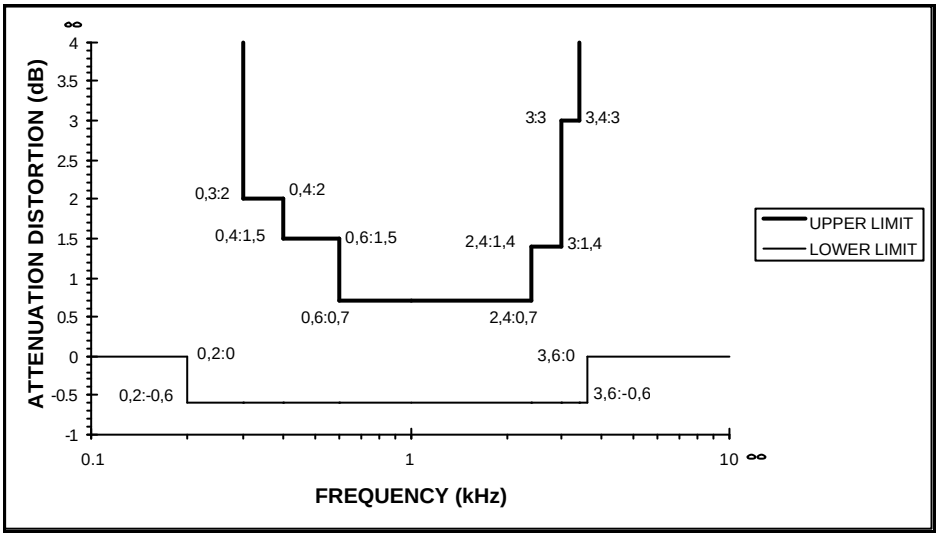

FIGURE 2.5 (a)

ii. Analogue - Digital and Digital - Analogue

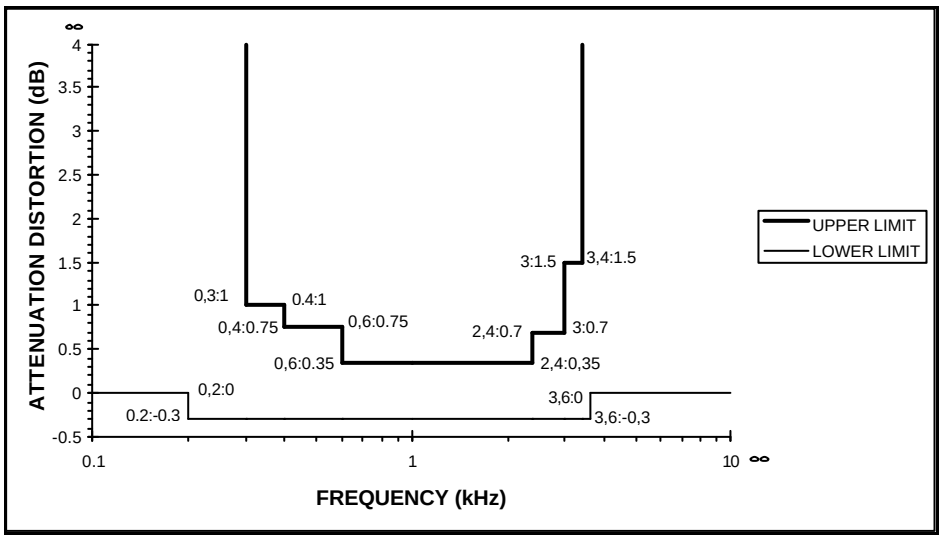

FIGURE 2.5 (b)

2.11.3 Return loss

2.11.3.1 During the transmission or reception of audio signals under call set-up and speech conditions, the line and extension interfaces shall provide correct terminations.

2.11.3.2 The input impedance of the termination shall be such that the return loss of any 2-wire port, when tested against the 3-element network shown in **Figure 2.6**, shall not be less than 12 dB for any frequency within the range 300 Hz to 3400 Hz.

2.11.3.3 The echo return loss shall not be less than 16 dB when calculated according to ITU-T Recommendation G.122 ANNEX B4.

2.11.3.4 This balance shall be maintained for all possible loop currents.

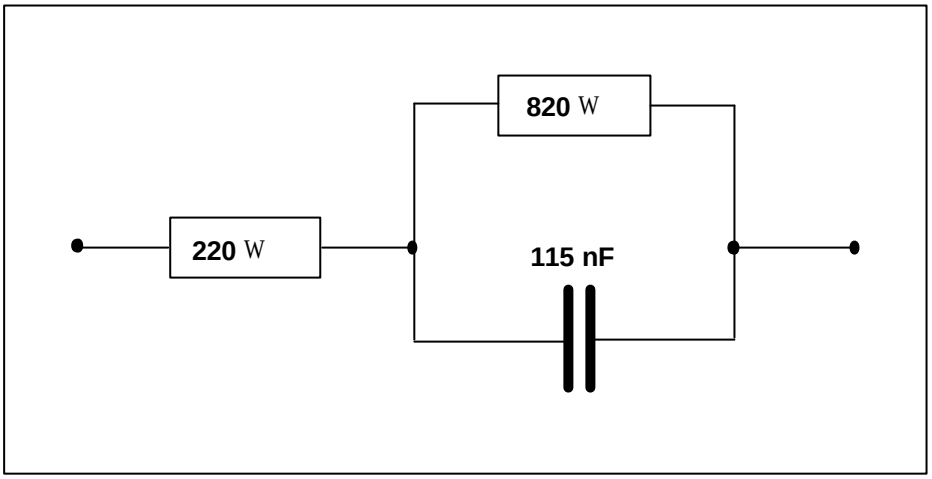

FIGURE 2.6

Nominal impedance at 1000 Hz: 900 Ω -23,5°

2.11.4 Unbalance about earth

The unbalance obout earth is expressed as the longitudinal conversion loss (impedance unbalance) when in receiving mode and transverce conversion loss (signal balance) when in transmitting mode.

2.11.4.1 Connection via the PABX

On any connection via the PABX, the speech path shall be balanced.

2.11.4.2 Maximum permissible unbalance

The maximum permissible unbalance is expressed by two parameters, L1 and L2.

(i) **Longitudinal conversion loss**, L1, of a one- or two-port network is a measure of the unwanted transverse signal produced at the terminals of the network due to the presence of a longitudinal signal on the connection leads.

$$L1 = 20 \log_{10} (V1/V2) \text{ dB}$$

where V1 and V2 are the voltages shown in **Chapter 7 Section 7.4**.

(ii) **Transverse conversion transfer loss**, L2, is a measure of an unwanted longitudinal signal produced at the output of a two port circuit due to the presence of a transverse signal at the input port.

$$L2 = 20 \log_{10} (V2/V1) \text{ dB}$$

where V1 and V2 are the voltages shown in **Chapter 7 Section 7.4.**

2.11.4.3 Values of L1 and L2

The values of L1 and L2 shall not be less than 40 dB in the frequency range 40 Hz to 600 Hz for exchange line interfaces, and not be less than 46 dB in the frequency range 600 Hz to 3400 Hz for extension and exchange line interfaces (ITU-T Recommendation G.713).

2.11.5 Crosstalk

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for this measurement.

2.11.5.1 Crosstalk is defined as signal spill-over during speech conditions from one connection via the PABX on to a second connection.

2.11.5.2 The signal to crosstalk ratio measured in accordance with ITU-T Recommendation Q.517 between any two connections established through the PABX shall be at least 67 dB at a frequency of 1100 Hz.

2.11.6 Noise

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for this measurement.

2.11.6.1 Weighted noise

i. When a connection is set up from a 2-wire analogue port through a PABX to any other 2-wire analogue port, the idle channel noise, measured at either of the ports with a psophometer weighted in accordance with ITU-T Recommendation P.53 shall not exceed -65 dBmOp. (ITU-T Recommendation G.712)

ii. The maximum permissible noise shall be the combined effect of all types of circuit and contact noise, crosstalk during dialing or switching from neighboring circuits, crosstalk coupling with speech and tone circuits, power supply hum etc.

2.11.6.2 Single frequency noise

The level of any single frequency (in particular the sampling frequency and its multiples), measured selectively, shall not exceed -50 dBmO in the frequency range 300 Hz to 20 kHz. (ITU-T Recommendation Q.517)

2.11.7 Discrimination against out-of-band signals

(Rec. Q.517)

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for this measurement.

2.11.7.1 Discrimination against out-of-band signals at an input port

With any sine-wave signal at test level of -25 dBmO between 4600 Hz and 100 kHz applied to the input port of the connection, the level of any image frequency produced at the output port of the connection shall be below -50 dBmO.

2.11.7.2 Spurious out-of-band signals at the output port

i. When any sine-wave signal in the range 300 Hz to 3400 Hz at a level of 0 dBmO is applied to an input port of a connection, the level of spurious out-of-band image signals, measured selectively in the frequency range 4600 Hz to 100 kHz at the output port, shall be lower than -25 dBmO.

2.11.8 Distortion

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for this measurement.

2.11.8.1 Total distortion, including quantizing distortion

The total distortion (including quantizing distortion) is measured with a sinusoidal signal between the analogue inputs and the test points or vice versa according to ITU-T Recommendation G.712, method 2. The applicable limits as shown in **Figures 2.7 (a)** and **(b)** may not be exceeded.

i. Analogue - Digital

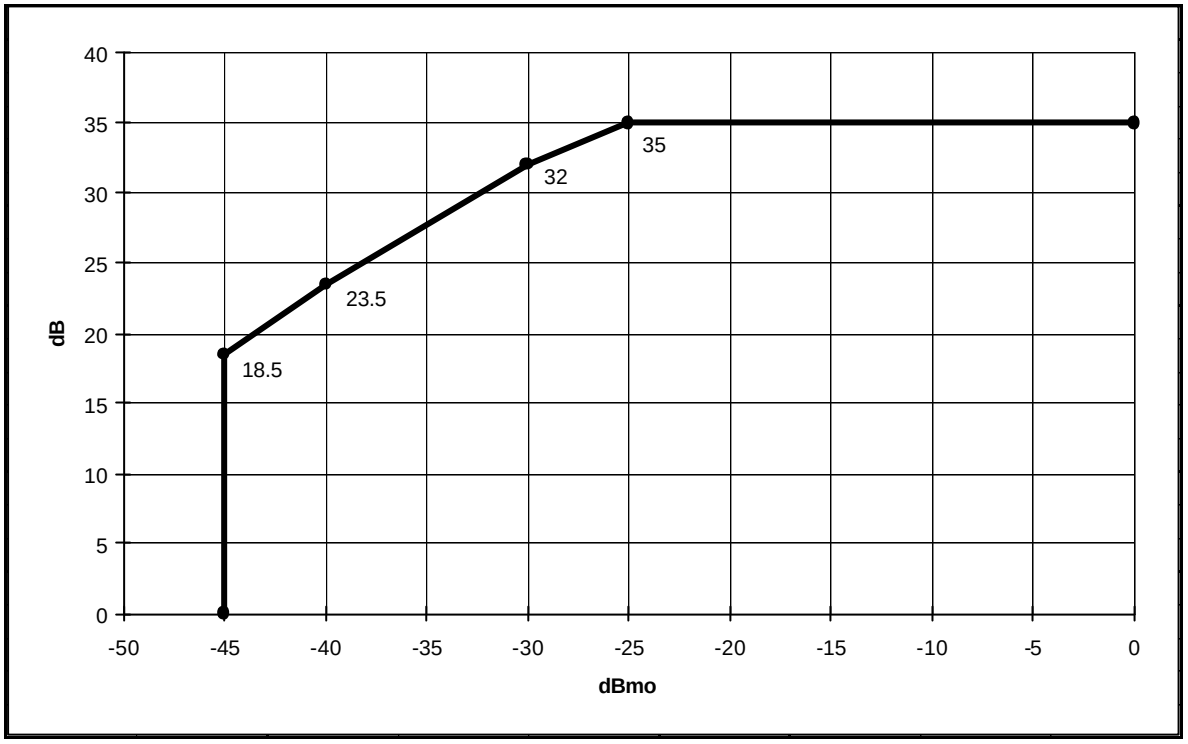

FIGURE 2.7 (a)

ii. Digital - Analogue

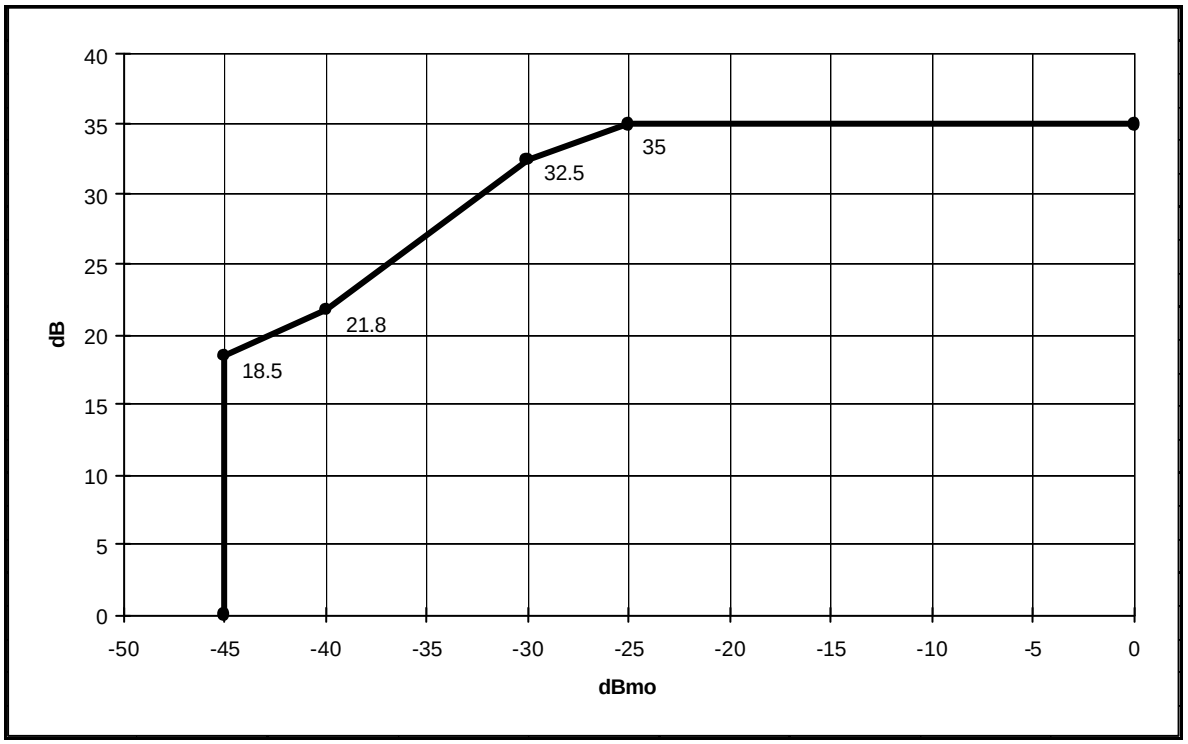

FIGURE 2.7 (b)

2.11.8.2 Spurious in-band signals at the output ports

When a sine-wave signal in the frequency range 700 Hz to 1 100 Hz (excluding sub-multiples of 8kHz) and a level of 0 dBm is applied to the input port of a connection, the output level at any frequency other than the applied signal, measured selectively in the frequency band 300 Hz to 3 400 Hz, shall not exceed -40 dBmO. (ITU-T Recommendation Q.517)

2.11.9 Variation of gain with input level

With a sine-wave signal in the frequency range 700 Hz to 1100 Hz (excluding sub-multiples of 8 kHz) applied to the input port of any channel at a level of between -55 dBmO and +3 dBmO, the gain variation of that channel relative to the gain at an input level of -10 dBmO, shall lie within the limits of the mask shown in **Figure 2.8**. The measurement shall be made selectively. (ITU-T Recommendation Q.517, method 2).

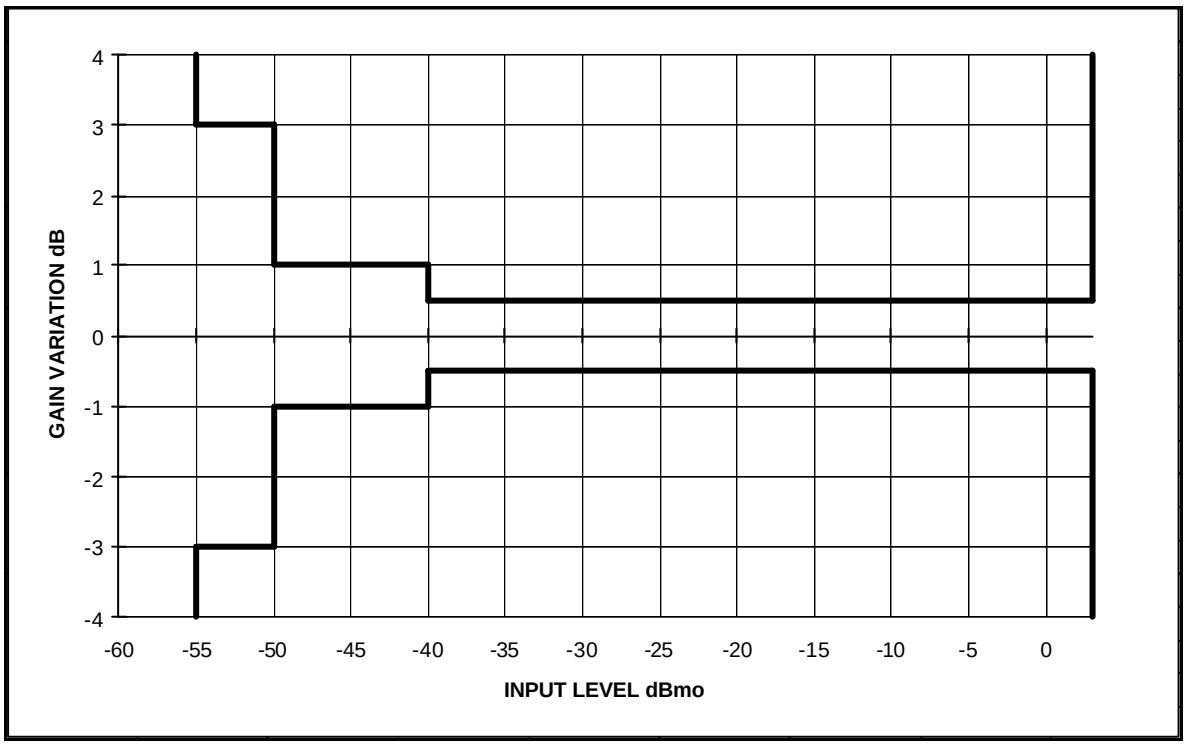

FIGURE 2.8

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for this measurement.

2.11.10 Group delay

2.11.10.1 Absolute group delay

Absolute group delay is the group delay at that frequency where it has its smallest value, in the frequency range 500 Hz to 2800 Hz. The sum of the separately measured absolute group delays for passing in each direction through a PABX shall meet the requirements given in the table below, where the mean value is understood as being the expected value in the statistical sense. The maximum value is the value that may not be exceeded.

Type of connection	2-way total	
	Mean value	Maximum value
Digital-digital	1 500 µs	2 250 µs
Analogue-digital	1 800 µs	2 550 µs
Digital-analogue	2 300 µs	3 050 µs
Analogue-analogue	3 000 µs	3 850 µs

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for this measurement.

2.11.10.2 Group delay distortion with frequency

The relative group delay distortion for a single direction of transmission (measured according to ITU-T Recommendation O.81) shall not exceed:

i. 1800 µs in the frequency band 500 Hz to 600 Hz,
ii. 900 µs in the frequency band 600 Hz to 1 000 Hz,
iii. 300 µs in the frequency band 1 000 Hz to 2 600 Hz, and
iv. 1800 µs in the frequency band 2600 Hz to 2800 Hz,

relative to the absolute group delay. (ITU-T Recommendation Q.517.)

NOTE: The complex impedance termination defined in **Paragraph 2.11.3** is used for this measurement.

2.12 DIAL TONE DETECTORS

2.12.1 Dial tone detectors shall respond to 400 Hz at -6 dBmO to -21 dBmO and not at any frequency at -35 dBmO.

2.13 PROTECTION

2.13.1 Protection on analogue ports

2.13.1.1 In accordance with standard practice, Telkom provides either 2- or 3-pole surge limiting devices for the lines connected to a PABX, for off-site connections, including overhead cable and open-wire routes.

2.13.1.2 The protection consists of 230 V rated striking-potential gas-discharge devices at the distribution point on the subscriber's premises.

2.13.1.3 For indoor connections, including underground cable, indoor cable and telephone instruments, no protection is normally provided.

2.13.1.4 The PABX equipment shall be able to withstand the following surge tests. Pulses shall be applied between the A and B wires and between each wire and earth. Pulses

shall be applied twice in each polarity for each test, in the idle and seized conditions on the extension and exchange lines.

i. Pulse 1:

Peak open circuit voltage:	4 kV
Open circuit voltage waveform:	1,2/50 µs
Short circuit current waveform:	640 ns/32 µs
Source impedance:	15 Ω

ii. Pulse 2:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the primary protection
Open circuit voltage waveform:	10 /700 µs
Short circuit current waveform:	1,5/25 µs
Source impedance:	15 Ω

.iii. Pulse 3:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the secondary protection
Open circuit voltage waveform:	10 /700 µs
Short circuit current waveform:	1,5/25 µs
Source impedance:	15 Ω

2.13.2 Protection on digital ports

2.13.2.1 Digital ports shall be able to withstand the following surge tests. Pulses shall be applied twice for each polarity.

i. Pulse 1:

Peak open circuit voltage:	4 kV
Open circuit voltage waveform:	1,2/50 µs
Short circuit current waveform:	640 ns/32 µs
Source Impedance:	15 Ω

ii. Pulse 2:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the primary protection
Open circuit voltage waveform:	10/700 µs
Short circuit current waveform:	1,5/25 µs
Source Impedance:	15 Ω

iii. Pulse 3:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the secondary protection
Open circuit voltage waveform:	10/700 µs
Short circuit current waveform:	1,5/25 µs
Source Impedance:	15 Ω

WARNING

Suppliers of Switching Systems must take note that very high voltages are associated with safety tests. Neither the DPT, TCL nor the SABS will accept any responsibility for damage to equipment which may occur due to the execution of such tests.

2.14 INSULATION REQUIREMENTS

2.14.1 The insulation resistance between the terminals of any PABX exchange connection ports with the line circuitry in the idle condition (free), shall exceed 5 MΩ when tested with 200 V dc for a period of not less than 5 s.

2.14.2 Similarly, the insulation resistance between any terminal and earth shall exceed 5 MΩ when tested with 200 V dc for a period of not less than 5 s.

2.15 POWER FAILURE

2.15.1 Adequate provision shall be made on the PABX for the retention of the main program and customer data base that is necessary for the functioning of the system in the event of power failure.

2.15.2 Irrespective of the type of memory used the PABX shall automatically restart on restoration of power after a power failure.

CHAPTER 3
SAFETY AND RFI REQUIREMENTS

3.1 ADDITIONAL SAFETY REQUIREMENTS

3.1.1 Standards
Switching systems that is intended for direct connection to the public network shall conform to the safety standards according to **SABS ARP 031**.

3.1.2 Certificate of compliance
A certificate of compliance shall be obtained from the SABS for all Switching systems and shall be submitted to the DPT together with the application for a license to connect Switching systems to the public network.

3.1.3 Protection
Adequate protection shall be provided in order to minimize fault conditions and to prevent the following:

3.1.3.1 hazardous voltages being encountered by operators and service personnel during normal operation and/or minor servicing of the equipment,

3.1.3.2 hazardous voltages originating in the equipment from reaching the telephone network,

3.1.3.3 hazardous voltages which may appear on the network during abnormal conditions, e.g. lightning etc., from reaching any user-accessible part of the Switching systems,

3.1.3.4 inadvertent contact with normal telephone network voltages by operators and service personnel, in order to minimize discomfort to the user and to safeguard the installation.

3.1.4 Adverse line voltages
Switching systems shall withstand the following line conditions without damage:

3.1.4.1 A voltage feed of 56 V via a 200 Ω resistor for a period of 20 s while in the seized condition.

3.1.4.2 A voltage of 100 V rms at 17 Hz with a cadence of 0,4 s on; 0,2 s off; 0,4 s on and 2 s off superimposed on 56 V dc while in the idle condition.

3.1.4.3 The back-emf generated by exchange pulsing relays.

3.2 RADIO FREQUENCY INTERFERENCE (RFI)

3.2.1 Interference
TLTE shall comply with the limits for **Class B** equipment, as stipulated in the latest issue of **CISPR 22**.

3.2.2 Electromagnetic compatibility
Equipment shall operate satisfactorily in the presence of electromagnetic fields in the frequency range 50 kHz - 200 MHz.

3.2.3 Certification

Compliance tests will be performed by the SABS and a certificate of compliance must be obtained and submitted to the Department as part of the application documentation. Should this certificate not be submitted the application will not be considered.

WARNING
Suppliers of Switching Systems must take note that very high voltages are associated with safety tests. Neither the DPT, TCL nor the SABS will accept any responsibility for damage to equipment which may occur due to the execution of such tests.

CHAPTER 4
DATA SWITCHING EQUIPMENT

4.1 LICENSING

4.1.1 Laboratory test
In cases where the hardware used is identical to that previously tested on the same family of voice switching PABXs, a full laboratory test will not be required and only the fees for licensing and functional testing will be applicable.

4.1.2 Telkom data division
PABXs submitted for approval of data facilities will also be scrutinized by Telkom data division.

4.1.3 Revised SOC
A revised SOC will be required to include the additional data facilities and equipment.

4.2 PABXs EMPLOYING MODEMS

4.2.1 Voice/data switching PABXs
PABXs making use of modems for data transmission will not be recognized as voice/data switching PABXs.

4.2.2 Leased line modems
Only approved 2/4 wire, stand-alone or built-in, dial-up or leased line modems are acceptable. These modems shall be licensed in accordance with Specifications **DPT-TE-001** and **DPT-TE-018**.

4.2.3 Dial-up modems
The operation of 2-wire, dial-up modems via a PABX is permitted but not guaranteed.

4.2.4 PMBXs
In the case of PMBXs it is recommended that direct exchange connections to the PSTN should be used for dial-up data transmission (i.e. data transmission should preferably not be routed via a PABX to the public exchange).

4.2.5 Approved data modems
Users should refer to Specification **DPT-TE-018** for details of standard speeds, Bit-error rates etc., available from approved data modems.

4.2.6 Ring current detection circuitry
The ring current detection circuitry of automatic answering dial-up modems is sharply tuned to either 16,67 Hz ± 2 Hz or 25 Hz ± 2 Hz. Successful operation in the automatic answering mode is dependent on the option selected in the modem, which will in turn depend on the ring current frequency of the PABX.

4.3 TELKOM ANALOGUE SERVICES

4.3.1 Leased line (analogue service)
The use of modems licensed by DPT are compulsory. The limits of line quality are specified in Specification **DPT-TE-018**.

4.4 TELKOM DIGINET SERVICES

4.4.1 Network Terminating Units (NTUs)

The Diginet service is provided via Network Terminating Units (NTUs) which are supplied by Telkom. These terminating unit provides the following interfaces, depending upon the speed of operation:

4.4.1.1 ITU-T Recommendation X.21-bis (V.24) interface for speeds of 600, 1200, 2400, 4800 and 9600 b/s. Electrically this interface conforms to ITU-T Recommendation V.28 and mechanically to ISO 2110, which uses a 25-pin sub-miniature D-type connector.

4.4.1.2 ITU-T Recommendation X.21 interface for speeds of 600, 1200, 2400, 4800, 9600, 48000 b/s and 64 to 1 820 kb/s in multiples of 64 kb/s. Electrically this interface conforms to ITU-T Recommendation V 11 and mechanically to ISO 4903, which uses a 15-pin sub miniature D-type connector.

4.4.1.3 ITU-T Recommendation X.21-bis (V 35 INTERFACE FOR SPEEDS OF 48 kbit/s). Electrically this interface conforms to ITU-T Recommendation V 28 and V 35 for the control circuits and clocks/data circuits respectively. Mechanically the interface conforms to ISO 2593 using a 34-pin MRAC connector with 1,5 mm pins.

4.4.1.4 ITU-T Recommendation X.21 Diginet-plus. The Diginet-plus offers data rates from 128 up to 1 920 kbit/s in 64kbit/s increments. The NTU installed at the client's premises is only available with this X.21 interface. The user's data is not structured as is the case with the standard NTU, but an additional 64 kbit/s time-slot is used to carry the control and management information. A total of N+1 time-slots are therefore required to carry the user data as well as the management and control information.

4.5 SAPONET

4.5.1 Connections to the SAPONET network via dial-up or leased-line modems or Diginet access circuits, shall conform to Specification **DPT-TE-018**.

4.6 GENERAL

4.6.1 Supporting traffic data

Where supporting traffic data is not available for data usage the traffic generated by the provision of data terminals as part of a PABX installation will be calculated on the basis of 0,41 erlang per terminal. This calculation will be taken into consideration when approving SOCs for PABX installations.

4.6.2 ISDN

With a view to ISDN the preferred method of operation for data switching is 2B + D signalling. The ITU-T U-interface for 2 wire working is preferred as existing cabling can be used.

4.6.3 Interface requirements

Where a PABX is directly interfaced with Telkom equipment it shall comply with the current DPT interface requirements.

4.6.4 Remote maintenance

If a ITU-T Recommendation V 24/V 28/ISO 2110 port (equivalent to EIA RS 232 C) is used for remote maintenance purposes, a modem licensed by DPT must be used.

CHAPTER 5
POWER SYSTEMS

5.1 GENERAL

5.1.1 The power system for a PABX typically consists of an AC - DC converter with or without standby batteries.

5.1.2 Where a power system is equipped with standby batteries, provision shall be made for float charging of the standby batteries.

5.1.3 The power system and wiring shall conform to the requirements of SABS 0142, Standard Regulations for Wiring of Premises.

5.1.4 The power system shall be adaptable to the nominal supply voltages referred to in SABS 1019 Specification for standard voltages, currents and insulation levels for electricity supply.

5.2 POWER SYSTEM PARAMETERS

5.2.1 The output of the converter shall not deviate from the operating range of the PABX under any combination of the following conditions:

5.2.1.1 Variations in PABX traffic from no load to full load.

5.2.1.2 Variation of ± 10 % from the nominal value of the ac supply voltage.

5.2.2 The converter shall have adequate short circuit current protection.

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CHAPTER 6
NATIONAL TRANSMISSION PLAN

6.1 GENERAL

6.1.1 This section is an extract of Telkom Technical Instruction A 2001, Transmission General, and refers, mainly to the transmission requirements in the local exchange and subscriber network.

6.2 REFERENCE EQUIVALENTS

6.2.1 In terms of the Transmission Plan, the maximum permissible reference equivalents in dB relative to Nosfer, are as follows:

	INTERIM STAGE		**PLANNED OBJECTIVE**	
	Subscriber and PMBXs	PABXs	Subscriber and PMBXs	PABXs
Subscriber's loop & instruments (S+R)/2	6.5	9.5	6.5	9.5
Switched network (Local and Trunk)	13.0	13.0	7. 0	7.0
Overall (Local and Trunk)	26.0	32.0	20.0	26.0

NOTES: **(a)** From the reference equivalents shown it is assumed that Protea/Lorea/Disa telephone instruments are used, which typically result in an improvement in the (S + R)/2 values of 1,5 dB per subscriber's loop in the case of PMBXs and direct subscriber's connections.

(b) The equivalents under interim stage refers to a mixed analogue/digital switching and transmission network, whereas the planned objective is an entirely digital switched network.

6.3 LINE LOSSES

6.3.1 From the above it follows that the maximum permissible equivalents in the subscriber's loop area:

6.3.1.1 Public exchange to PABX: 5,5 dB.

6.3.1.2 Public exchange to PABX extension: 9,5 dB.

6.4 TYPES OF CONNECTIONS

6.4.1 In order to achieve the objectives of the transmission plan, the following type of connection will be provided:

(The numbers and figures in the chart below refer to the notes below the chart).

TYPE OF PABX	TYPE OF EXCHANGE LINE (c)	
	ANALOGUE EXCHANGE	DIGITAL EXCHANGE
Analogue	A	A or B
Electronic	A	A or B
Digital(A law, without DDI)	A	A or B
Digital(A law, with DDI)	A	A(a) or B(a) or C(b) or E(b)

NOTES:
(a) For exchange lines PABX to public exchange.
(b) For exchange lines public exchange to PABX.
(c) Types of exchange line:
- **A:** Analogue link via physical wires (cable or open wire).
- **B:** PCM link with digital to analogue converters at the subscriber's premises and at the public exchange.
- **C:** PCM link working digitally into the PABX.
- **D:** PCM link with 144 Kbit ISDN connection.
- **E:** Analogue link via physical wires with a digital to analogue converter at the public exchange.

CHAPTER 7
PABX TEST METHODS

7.1 GENERAL

7.1.1 The following test methods are recommended by Telkom Laboratory but are not necessarily the only test methods for these particular parameters.

7.1.2 For the following tests a three element complex networks described earlier in the specification is used:

i. Return loss
ii. Insertion loss
iii. Gain versus frequency

7.1.3 For all other tests a single 900 Ω resistive load is sufficient.

7.1.4 Reference level at 0 dBm = 948 mV at 1 kHz into the complex impedance or 0 dBm = 948 mV into 900 Ω.

7.1.5 Frequency reference for relative measurements at 1 kHz.

7.1.6 Generator and meter circuit used in the measurement of Insertion loss and Gain versus Frequency is shown in **Figure 7.1**.

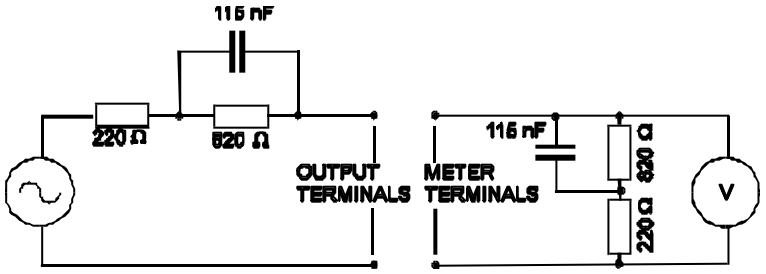

FIGURE 7.1

7.2 INSERTION LOSS

(Refer **Paragraph 2.11.2**)

7.2.1 Insertion loss is measured in both directions for extension to extension calls. The test set-up is shown in **Figure 7.2**.

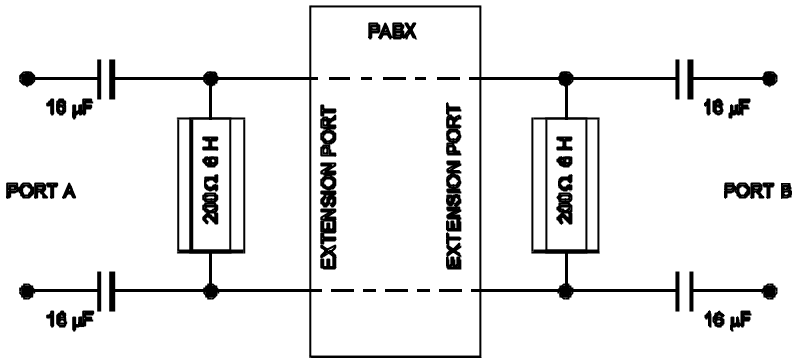

FIGURE 7.2

7.2.2 Insertion loss is measured in both directions for extension to exchange calls. The test set-up is shown in **Figure 7.3**.

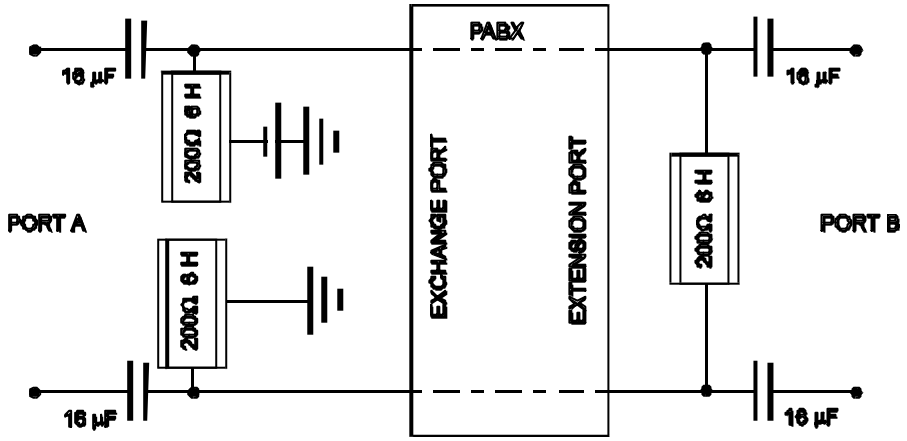

FIGURE 7.3

7.2.3 Insertion loss is measured in both directions for extension to DDI calls. The test set-up is shown in **Figure 7.4**.

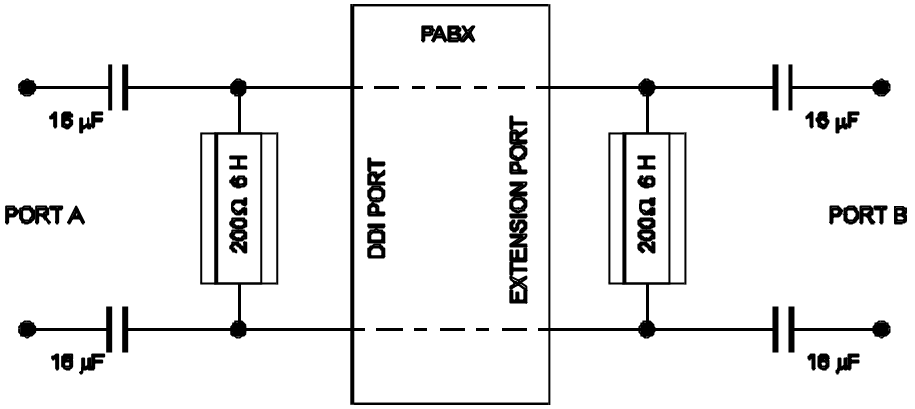

FIGURE 7.4

7.3 RETURN LOSS

(Refer **Paragraph 2.11.3**)

7.3.1 Return loss is measured on extension to exchange calls, as shown in **Figure 7.5**.

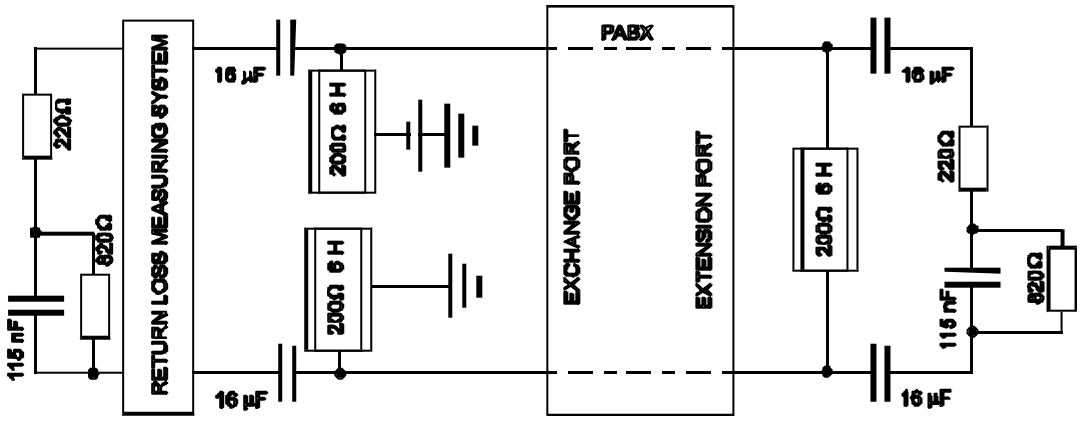

FIGURE 7.5

7.3.2 Echo return loss is measured on extension to extension calls, as shown in **Figure 7.6**.

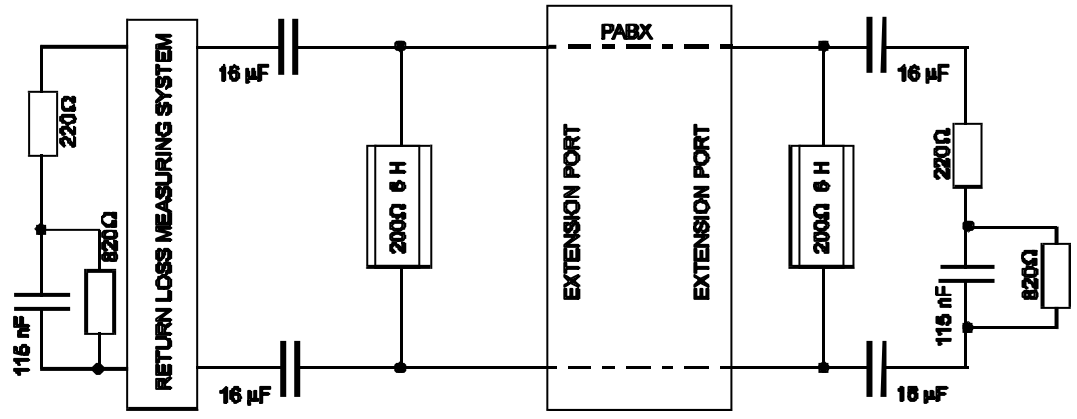

FIGURE 7.6

7.3.3 The return loss readings obtained by the return loss measuring system are used in the following formulas to calculate the weighted echo return loss:

7.3.3.1 If the loss/frequency characteristic of the echo-path is available in graphical form (or the data were suitably measured) the echo return loss may be calculated by using the trapezoidal rule as follows (ITU-T Recommendation G.122 Annex B):

(i) Divide the frequency band (300 Hz to 3 400 Hz) into N sub-bands of equal width on a log-frequency scale.

(ii) Read off the echo loss at each of the N + 1 frequencies at the edges of the N sub-bands, and express it as an output/input power ratio, A_i.

(iii) Calculate the echo loss using the formula:

$$L_e = -10 \log [\, 1/N(A_0/2 + A_1 + A_2 + ...+ A_{N-1} + A_N/2)]$$

7.3.3.2 When the loss/frequency data are only available at N + 1 discrete frequencies, which are non-uniformly spaced on a log-frequency scale, proceed as follows (ITU-T Recommendation G.122 Annex B):

$$L_e = 3.24 - 10 \log \sum_{i-1}^{N} (A_i + A_{i-1})(\log f_i - \log f_{i-1})$$

where:

A_0 is the output/input power ratio at frequency of f_0 = 300 Hz
A_i the ratio at frequency f_i, and
A_N the ratio at frequency f_N = 3 400 Hz.

NOTES: **(a)** The approximation involved is to assume that within the sub-band f_{i-1}, to f_i, the power ratio is constant and has the value $A(f) = (A_i + A_{i-1})/2$.

(b) The constant **3.24** in the approximate formula arises from a combination of the constant **3.85** in the definition and the other constants produced by the approximation.

7.4 UNBALANCE ABOUT EARTH

(Refer **Paragraph 2.11.4**)

7.4.1 Longitudinal Conversion Loss is measured on an extension to exchange call. The test set-up is shown in **Figure 7.7**.

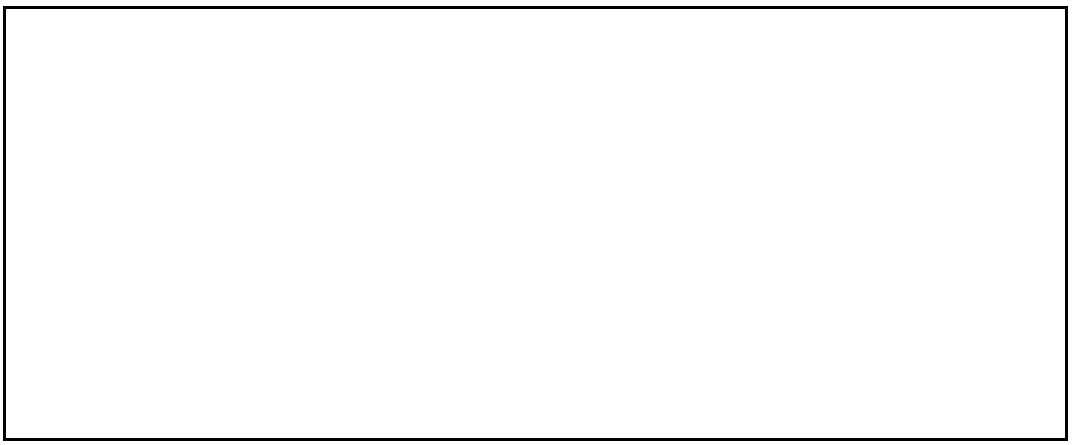

FIGURE 7.7

7.4.1 Transverse Conversion Transfer Loss is measured on an extension to exchange call. The test set-up is shown in **Figure 7.8**.

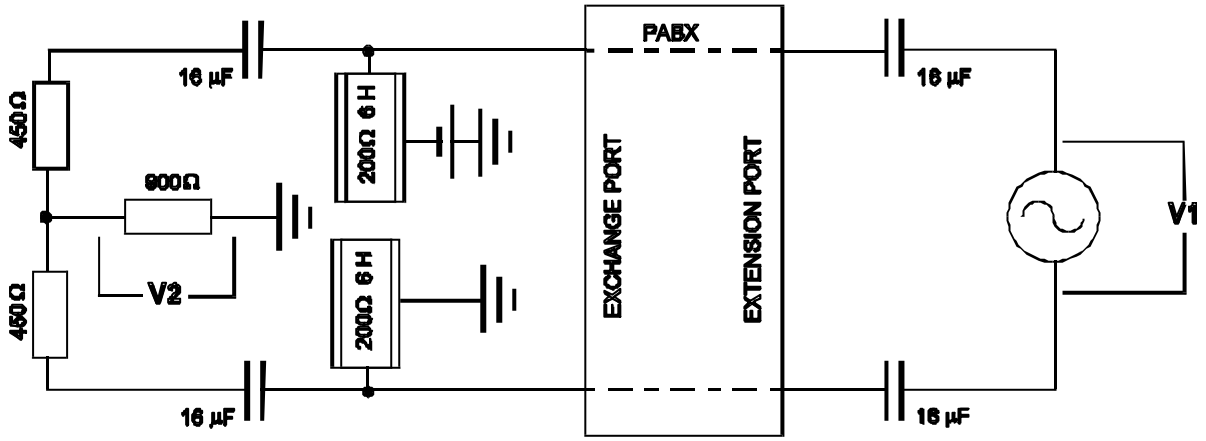

FIGURE 7.8

7.5 CROSSTALK

(Refer **Paragraph 2.11.5**)

7.5.1 Crosstalk is measured between two exchange to extension calls, with adjacent exchange and extension ports. The test set-up is shown in **Figure 7.9**.

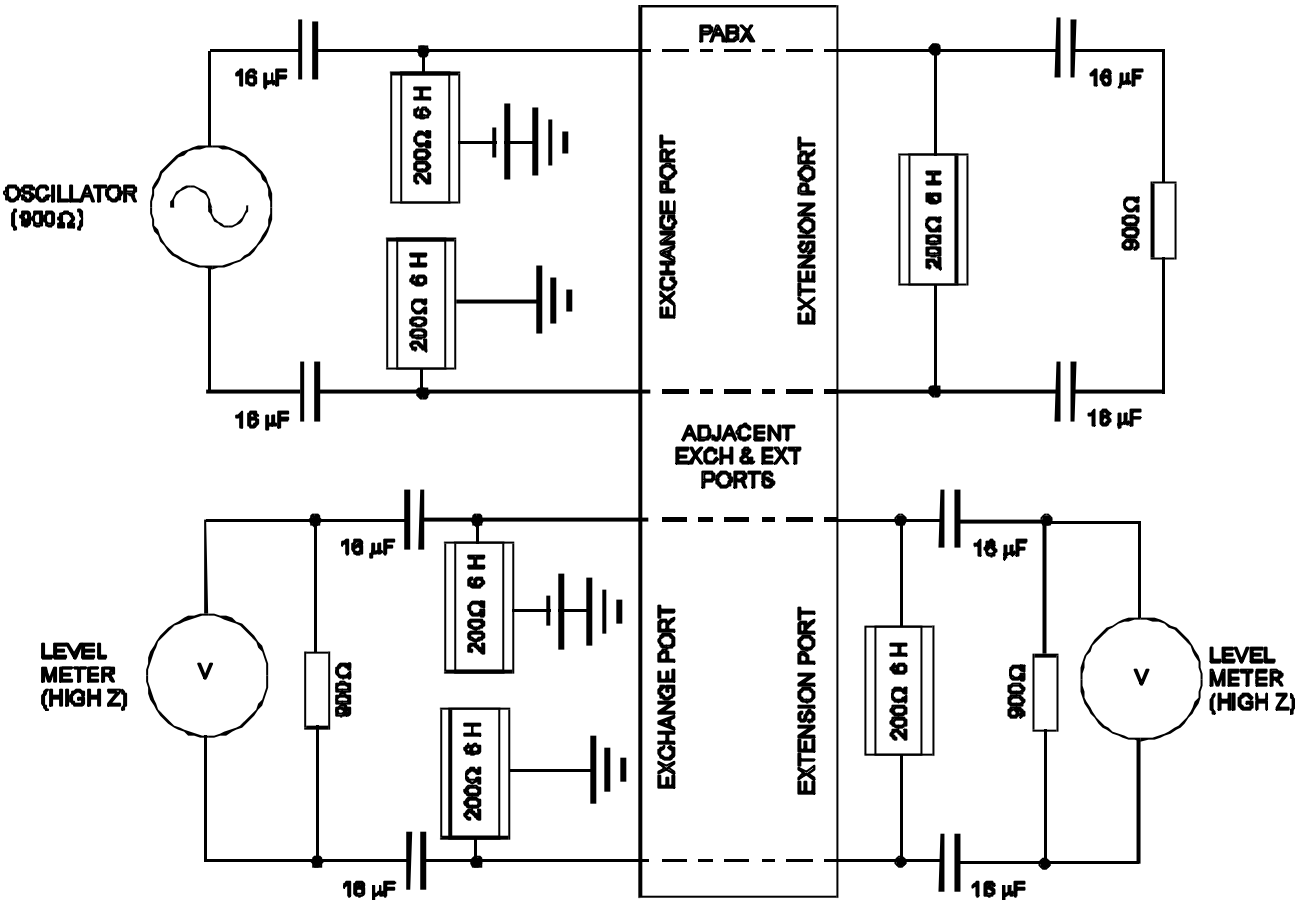

FIGURE 7.9

NOTE: In the case of a PABX with DID, the 50 V batteries are replaced by wire straps.

7.6 NOISE

(Refer **Paragraph 2.11.6**)

7.6.1 Noise is measured on an extension to extension call and on an exchange to extension call. The test set-up is shown in **Figure 7.10**.

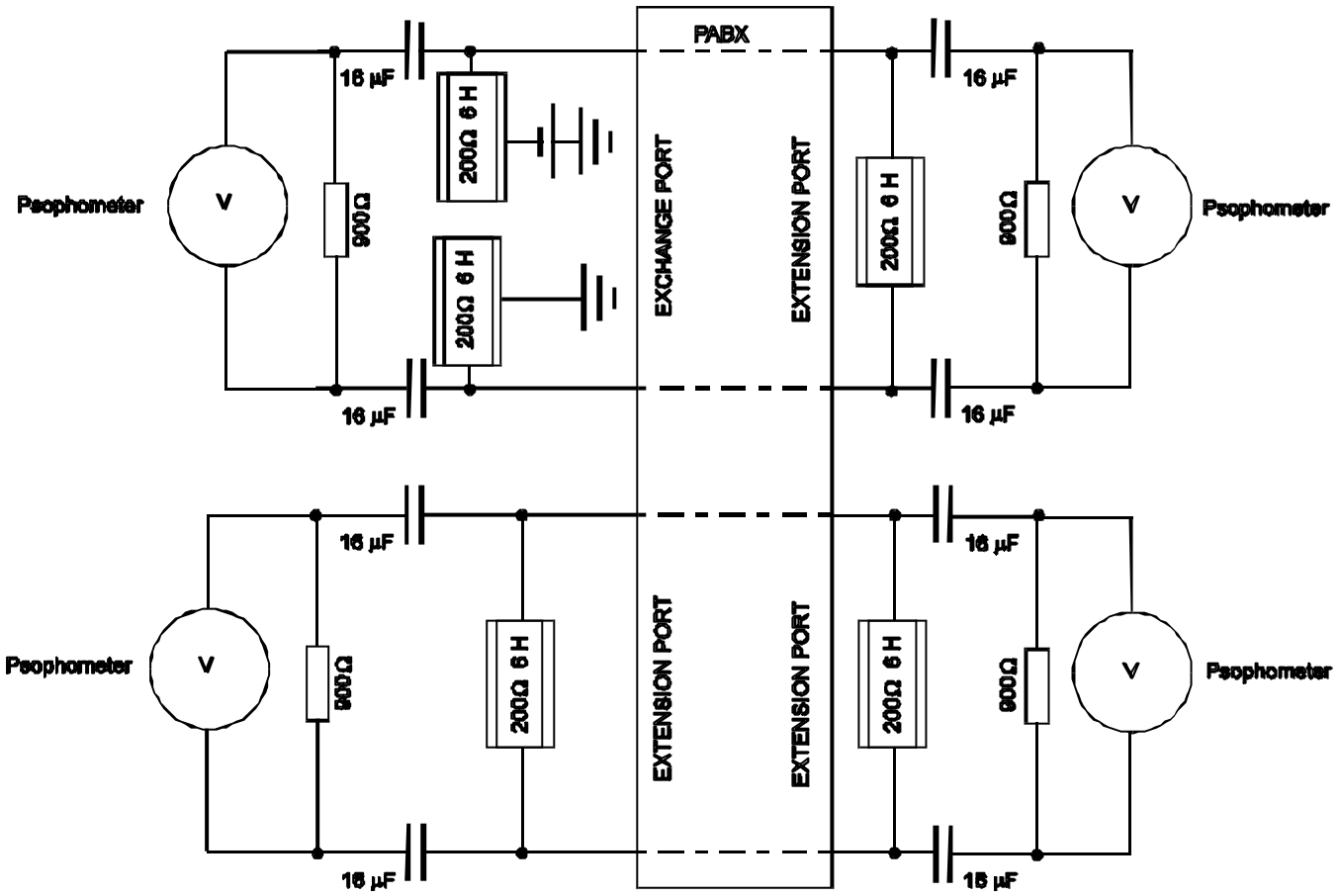

FIGURE 7.10

NOTE: In the case of a PABX with DID, the 50 V battery is replaced by a wire strap.

7.7 LOUDNESS RATING
(Refer **Paragraph 2.11.1**)

7.7.1 Transmission performance is a measure of the efficiency of the PABX in transmitting and receiving voice data through the system. The measuring method is Loudness Rating. **Figure 7.11** shows the test set-up.

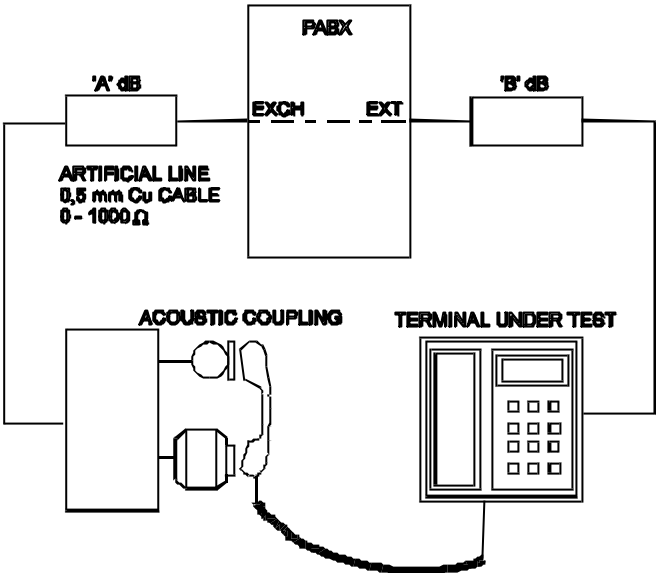

FIGURE 7.11

NOTE: The test equipment is coupled electrically to the exchange side of the PABX and acoustically to the terminal side when the transmission performance is measured.

7.8 LEVEL OF TONES
(Refer **Paragraph 2.7.11**)

7.8.1 The level of tones which are returned to the PSTN from the PABX are measured at the point on departure from the system, as shown in **Figure 7.12**.

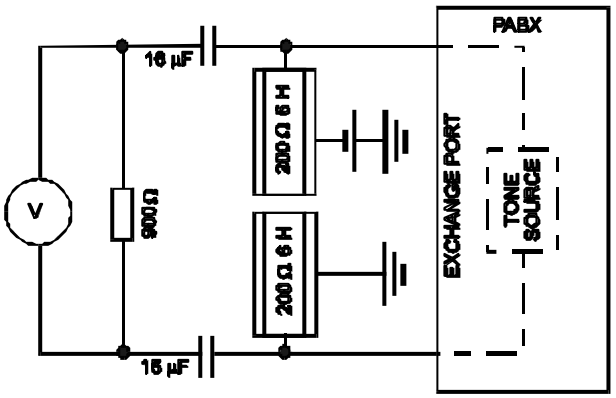

FIGURE 7.12

NOTE: In the case of a PABX with DDI the feedbridges are replaced by a dc holding circuit.

7.9 RINGING IMPEDANCE
(Refer **Paragraph 2.5.2.3**)

7.9.1 Ringing impedance is that impedance presented by the PABX exchange port to ringing current applied from the PSTN. The test set-up is shown in **Figure 7.13**.

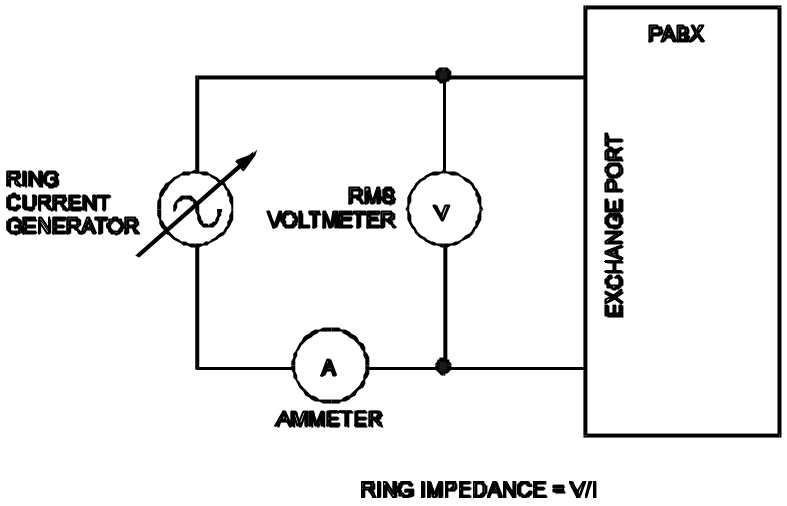

FIGURE 7.13

7.10 RINGING THRESHOLD
(Refer **Paragraph 2.5.2.4**)

7.10.1 The ringing threshold is the minimum ringing voltage that would be recognised by the PABX exchange port as a calling signal from the PSTN. The test set-up is shown in **Figure 7.14**.

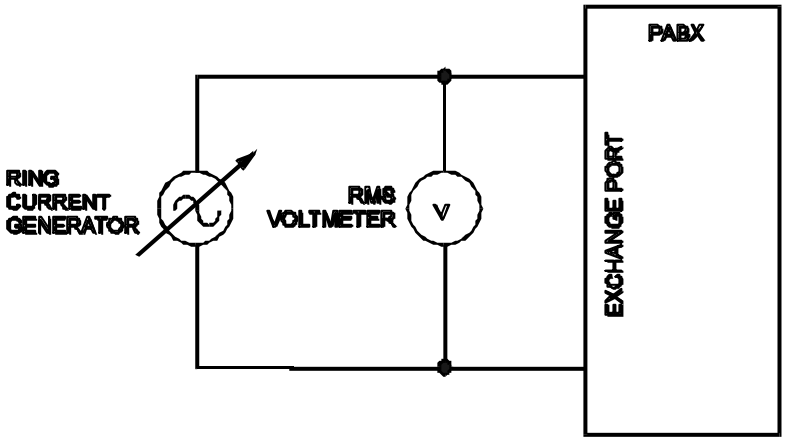

FIGURE 7.14

NOTE: The ringing threshold is obtained from the RMS voltmeter when the exchange port recognises and responds to the calling signal.

7.11 LOOPING RESISTANCE

7.11.1 The looping resistance is the calling and holding loop presented by the PABX exchange port to the PSTN. The test set-up is shown in **Figure 7.15**.

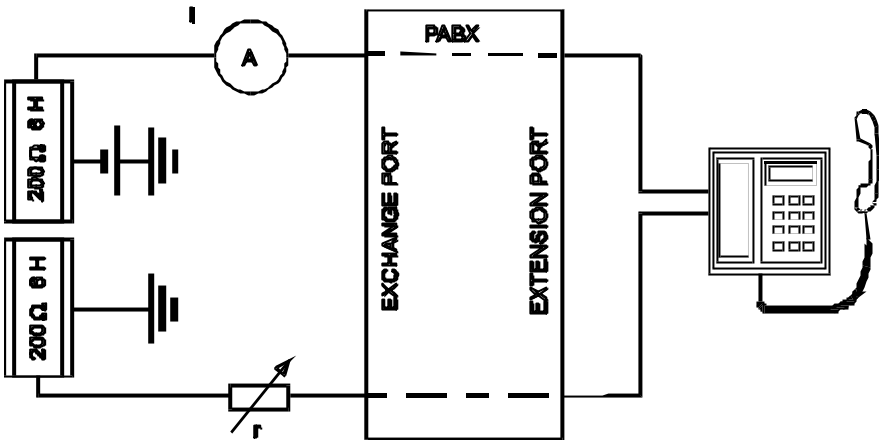

FIGURE 7.15

7.12 DIAL TONE DETECTOR SENSITIVITY

(Refer **Paragraph 2.12**)

7.12.1 Dial tone detector sensitivity is a measure of the response of the detector to PSTN dial tone at specified levels. The test set-up is shown in **Figure 7.16**.

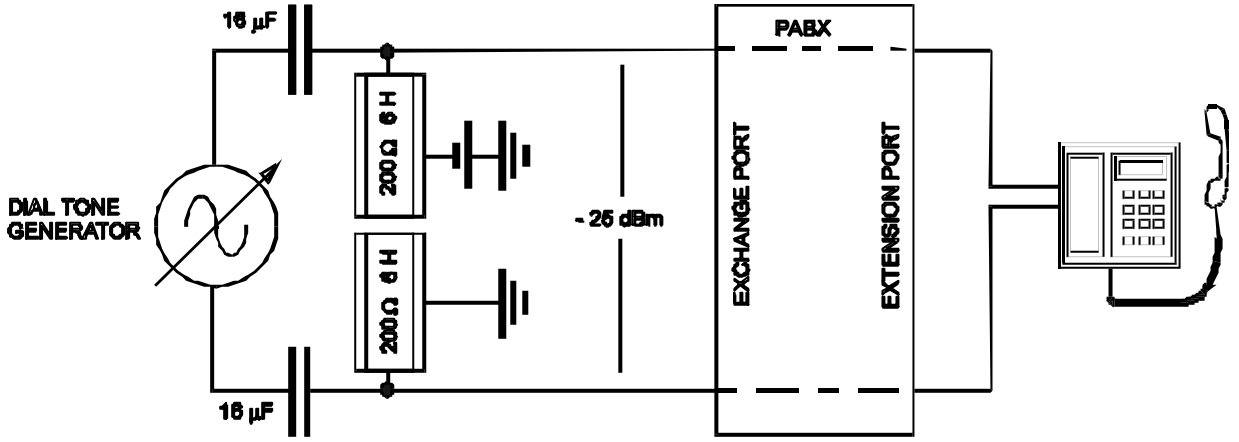

FIGURE 7.16

7.13 SUBSCRIBERS PRIVATE METERING (SPM) DETECTOR SENSITIVITY

7.13.1 Functional

Connect the IUT with a 2W analog exchange line.
Make an incoming call to the PABX.
Verify the exchange metering cycle.
Make an outgoing call to the exchange.
Verify the exchange metering cycle.

7.13.2 50 Hz Longitudinal metering signal test set-up is shown in **Figure 7.17**.(Refer **Paragraph 2.8.6.1**).

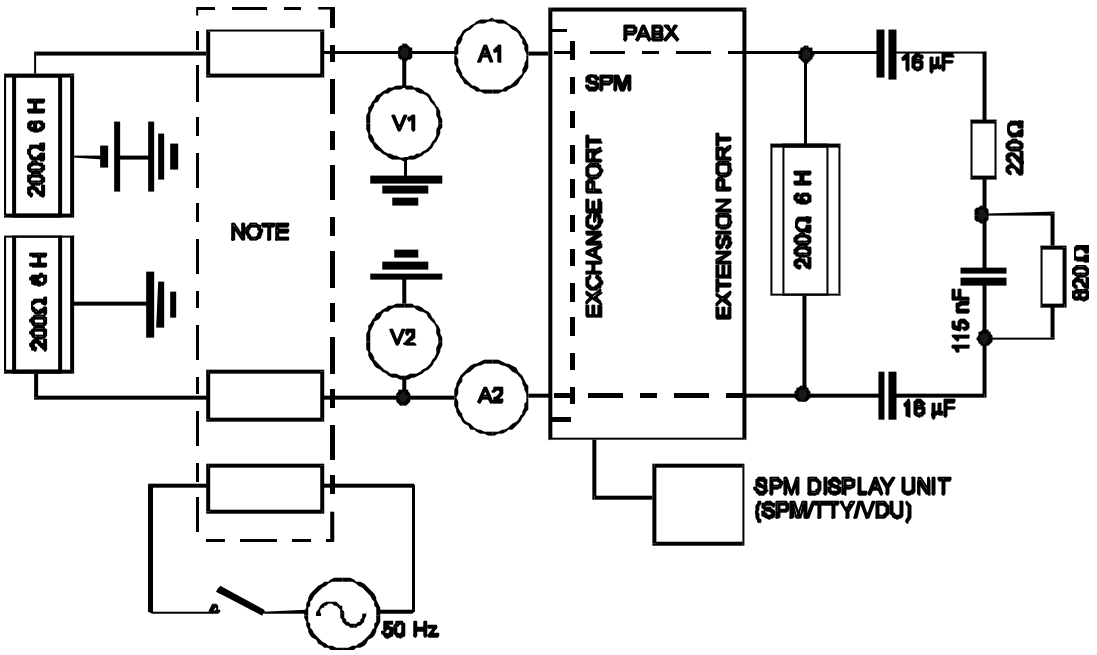

FIGURE 7.17

NOTES: **(a)** The oscillator output is set to 45 Vrms minimum and 65 Vrms maximum.
(b) The transformer is identical to that used in public exchange circuits ZW1000 60 (British exchanges) or S30030-E5142 (German exchanges S8M).

7.13.3 16 kHz Transverse metering signal test set-up is shown in **Figure 7.18**. (Refer **Paragraph 2.8.6.2**)

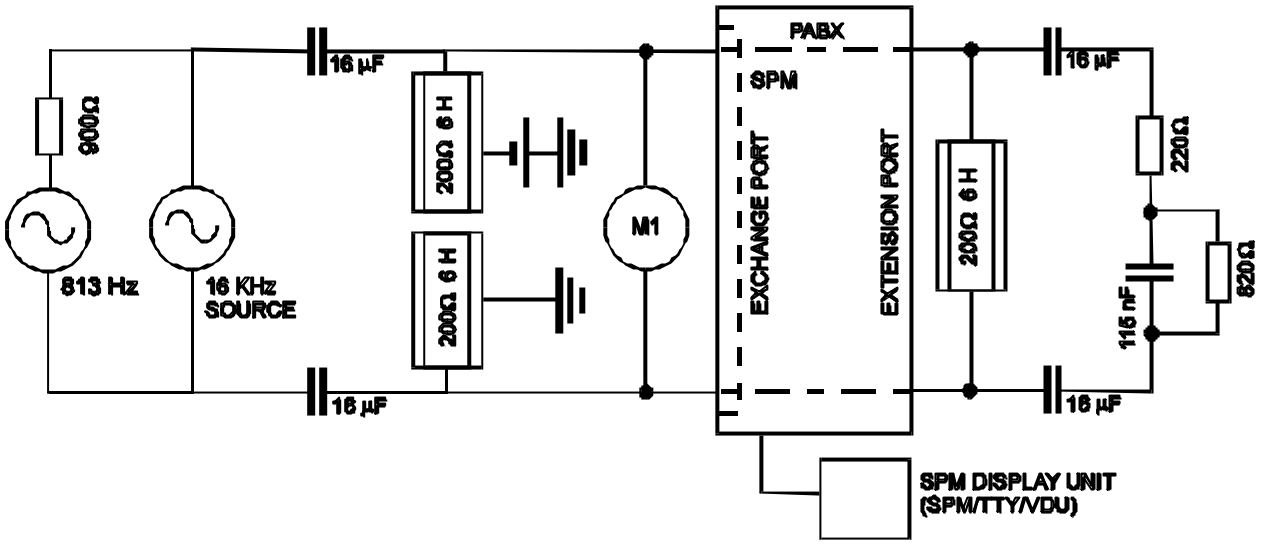

FIGURE 7.18

NOTE: The oscillator output level is adjusted to produce the correct level into 200 Ω before applying the output to the unit under test.

7.14 TELEPHONE FEED CURRENT

(Refer **Paragraph 2.8.5.3**)

7.14.1 The telephone feed current is made available from the PABX SLIC and the resistance in each leg of the current feed must be equal to within 2 %. The test set-up is shown in **Figure 9.19**.

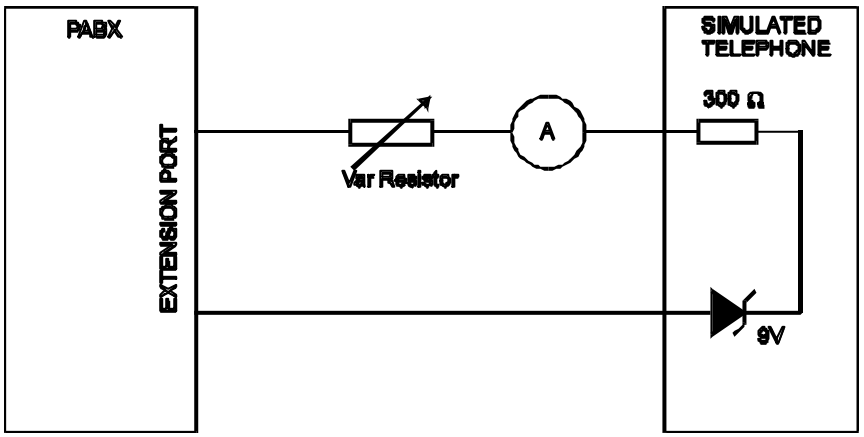

FIGURE 7.19

NOTE: The variable resistor is adjusted in 100 Ω steps from 0 Ω to the maximum extension loop resistance specified by the manufacturer or at that point where the line current measured, is 25 mA. The test is also done with the simulated telephone being a short circuit and a single 9V Zener Diode respectively.

7.15 HIGH VOLTAGE SURGE PROTECTION

(Refer **Paragraph 2.13**)

7.15.1 Protection on analogue ports

7.15.1.1 In accordance with standard practice, Telkom provides either 2- or 3-pole surge limiting devices for the lines connected to a PABX.

7.15.1.2 For off-site connections, including overhead cable and open wire routes, the protection consists of 230 V rated striking-potential gas-discharge devices at the distribution point on the subscribers premises.

7.15.1.3 For indoor connections, including underground cable, indoor cable and telephone instruments, no protection is normally provided.

7.15.1.4 The PABX equipment shall be able to withstand the following surge tests. Pulses shall be applied between the A and B wires and between each wire and the earth connection, twice of each polarity for each test, in the idle and seized conditions on the extension and exchange lines.

i. Pulse 1:

Peak open circuit voltage:	4 kV
Open circuit voltage waveform:	1,2/50 µs
Short circuit current waveform:	640 ns/32 µs
Source impedance:	15 Ω

ii. Pulse 2:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the primary protection
Open circuit voltage waveform:	10 /700 µs
Short circuit current waveform:	1,5/25 µs
Source impedance:	15 Ω

iii. Pulse 3:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the secondary protection
Open circuit voltage waveform:	10 /700 µs
Short circuit current waveform:	1,5/25 µs
Source impedance:	15 Ω

7.15.2 Protection on digital ports

7.15.2.1 Digital ports shall be able to withstand the following surge tests. Pulses shall be applied twice for each polarity.

i. Pulse 1:

Peak open circuit voltage:	4 kV
Open circuit voltage waveform:	1,2/50 µs
Short circuit current waveform:	640 ns/32 µs
Source Impedance:	15 Ω

ii. Pulse 2:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the primary protection
Open circuit voltage waveform:	10/700 µs
Short circuit current waveform:	1,5/25 µs
Source Impedance:	15 Ω

iii. Pulse 3:

Peak open circuit voltage:	adjusted to the highest voltage that does not turn on the secondary protection
Open circuit voltage waveform:	10/700 µs
Short circuit current waveform:	1,5/25 µs
Source Impedance:	15 Ω

WARNING

Suppliers of Switching Systems must take note that very high voltages are associated with safety tests. Neither the DPT, TCL nor the SABS will accept any responsibility for damage to equipment which may occur due to the execution of such tests.

7.16 DIRECT INWARD SYSTEM ACCESS (DISA)

7.16.1 Verify the outgoing message on an incoming call.

7.17 DIAL PULSE DISTORTION

(Refer **Paragraph 2.2.3**)

7.17.1 Equipment required

Power Supply.
Standard Feedbridge.
Artificial Line.
External Spark Quench.
Normally Closed Relay.
Dual trace Oscilloscope.
Pulse generator.
Relay Box.
Resistor, x-value.

7.17.2 Test method

Connect the equipment as shown in **Figure 7.19**.

Select the artificial line resistance at which the tests are to be done.
Select the lower limit of the specification on the pulse generator in the test position and measure the make/break period and note the result.
Select the upper limit of the specification in the test position and measure the make/break period and note the result.
Now place the telephone in the test position and measure the make/break period and note the result.
The result obtained should fall within the two other readings.

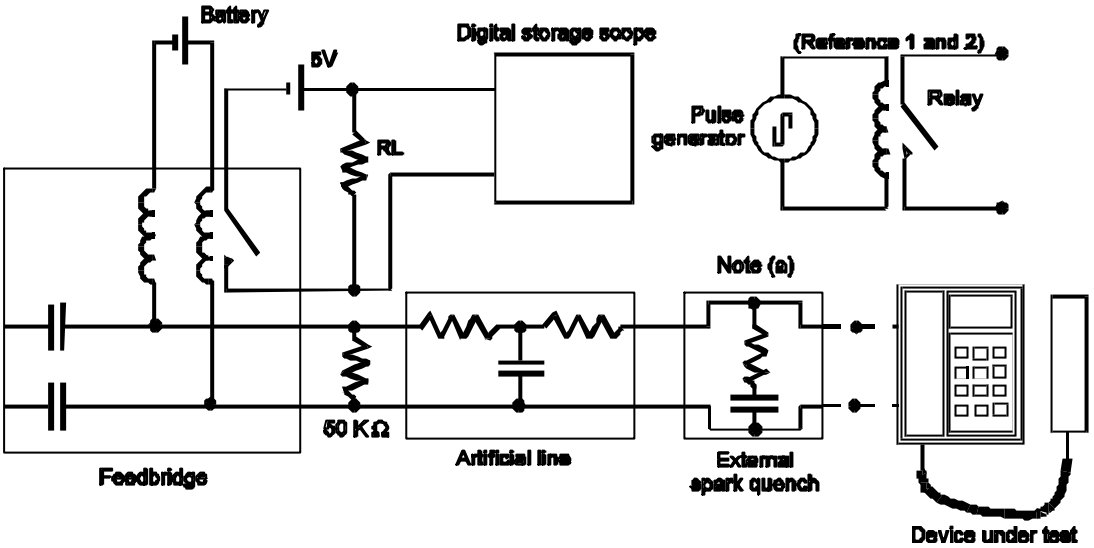

FIGURE 7.19

7.17.3 Additional Information

7.17.3.1 11 pps with a 63% break period

Make period : 33.6 ms
Break period : 57.3 ms

7.17.3.2 9 pps with a 72% break period

Make period : 31.1 ms
Break period : 80 ms

7.17.3.3 0 Ω line length

11 pps : break period = X1 (parameter)
9 pps : break period = X2 (parameter)

7.17.3.4 1500 Ω line length

11 pps : break period = Y1 (parameter)
9 pps : break period = Y2 (parameter)

7.17.3.5 Unit under test

0 Ω : break period = Z1 (X1 ≤ Z1 ≤ X2)
1500 Ω : break period = Z2 (Y1 ≤ Z2 ≤ Y2)

7.17.3.6 Results

- measure break period at 0 Ω line length for 9 pps and 11 pps using pulse generator (X1,X2).
- measure break period at 1500 Ω line length for 9 pps and 11 pps using pulse generator (Y1,Y2).
- measure break periods at 0 Ω and 1500 Ω (Z1,Z2) and see if they lie between the parameters.