Telecommunications Standards Advisory Committee (TSAC)

Technical Specification

Terminal Equipment connecting to the Network Terminating Equipment (NTE) or the Public Switched Telephone Network (PSTN) for access to voice band services

IMDA TS PSTN
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Content

Section	Title	Page
1.	Scope	2
2.	References	3
3.	General Requirements	4
4.	Method of Connection	6
5.	General Operating Requirements	6
6.	Electrical Characteristics	8
7.	Calling Function	9
8.	Automatic Answering	13
Annex		
A	Analogue Handset Function	14
B	2-Wire Analogue Leased Line Requirements	15
C	Call Detail Recording Facilities	17
D	Cordless Telephone Facility	18
E	Requirements for Coinafon	19
F	Requirements for Credit Card, Phonecard, ATM Card, Cashcard and Multi-Coin Payphone	20
G	Requirements for Caller Identity Equipment	23
H	Requirements for Call Switching Equipment	26
I	Requirements for Direct Inward Dialling	27
~~J~~	~~Input Procedure for Sending Alphanumeric Characters~~	Deleted
~~K~~	~~Requirements for Short Message Service (SMS)~~	Deleted
L	Requirements for POTS Splitter for use with ADSL Services	34
M	Addendum/Corrigendum	36
	Changes to IDA TS PSTN issue 2	
	Changes to IDA TS PSTN issue 1 Rev 2	
	Changes to IDA TS PSTN issue 1 Rev 1	
	Changes to IDA TS PSTN issue 1	
	Changes to IDA TS PSTN 1 Issue 4 Rev 2	

1 Scope

1.1 This Specification is applicable to all types of analogue terminal equipment (TE) that can be connected to the Public Switched Telephone Network (PSTN); or the network terminating equipment (NTE), which presents the PSTN functions for Internet Protocol (IP) or next generation networks to interwork with the TE.

1.2 It defines the telecommunications access interfaces or network termination points (NTP) available to end-users for connecting analogue TE in the scenarios as shown in Figure 1 below (Figure 3 of ETSI EG 201 730-1 [1]). For the purpose of this Specification, an NTP is a physical connection point to which an end-user is provided with access to voice band services via an analogue TE. Definition of the NTP in scenario 2 for wire-line and the different scenarios for wireless (air interfaces) which specify the radio paths between radio equipment and network equipment, is outside of the scope of this Specification.

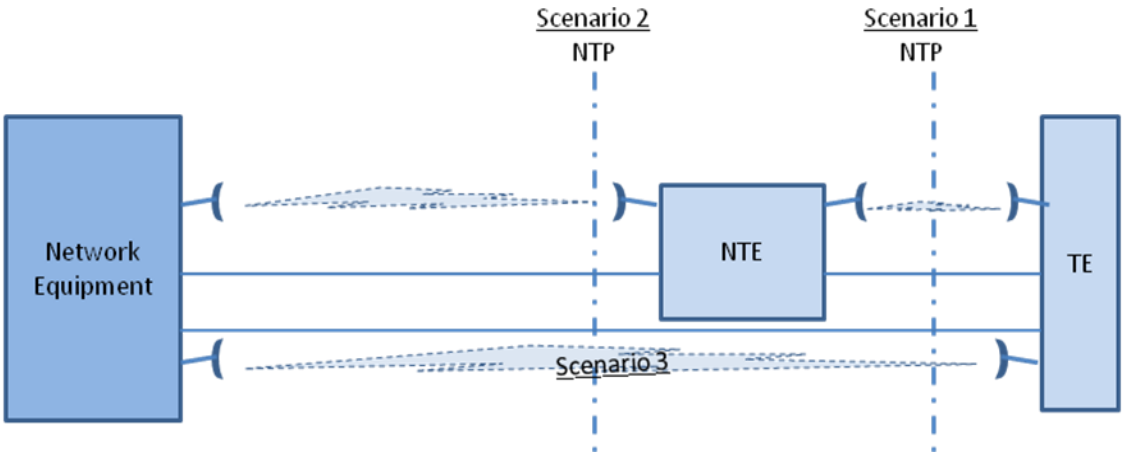


Figure 1 (Figure 3 of ETSI EG 201 730-1): Position of NTP

1.3 The technical requirements specified are intended to cover:

(a) Protection of users and personnel operating the network from hazards that may arise from the connection of TE to public telecommunication network (§ 3);
(b) Protection of public telecommunication network and service from interference and other adverse effects (§ 3, 5 to 8); and
(c) Assessment of compatibility of the TE with the network in scenario 3 and with the NTE in scenario 1 (§ 4 to 8).

1.4 This Specification is applicable for connection to NTPs where the analogue TE may be connected via a cable with a maximum loop resistance of 100 Ω (scenario 1) or via a cable with a maximum loop resistance of 1200 Ω (scenario 3).

1.5 Additional requirements are included as annexes to the Specification. They are applicable to the optional facilities supported by the different network operators.

2 References

For the technical requirements captured in this Specification, reference has been made to the following standards. Where versions are not indicated, implementation of this Specification shall be based on valid versions of these standards published by the respective Standards Development Organisations.

[1]	ETSI EG 201 730-1 V2.1.4 (2006-03)	Terminals' access to Public Telecommunications Networks; Application of the Directive 1999/5/EC (R&TTE), article 4.2; Guidelines for the publication of interface specifications; Part 1: General and common aspects
[2]	ETSI TBR 21 (1998-01) Note 1	Terminal Equipment (TE); Attachment Requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signaling
[3]	ETSI ES 201 970 V1.1.1 (2002-08)	Access and Terminals (AT);Public Switched Telephone Network (PSTN);Harmonized specification of physical and electrical characteristics at a 2-wire analogue presented Network Termination Point (NTP)
[4]	IEC CISPR 32	Electromagnetic compatibility of multimedia equipment – Emission requirements Note: Validity of the IEC CISPR 22, EMC standard for information technology equipment, will lapse by 31 March 2017, in sync with IEC's timeline for withdrawing this CISPR standard, and replacing it with the CISPR 32 standard.
	IEC CISPR 24	Information technology equipment – Immunity characteristics – Limits and methods of measurement
[5]	IEC 60950-1 or IEC 62368-1	Information Technology Equipment – Safety Audio/video, information and communication technology equipment – Part 1: Safety requirements
[6]	FCC 47, CFR 68	Connection of terminal equipment to the telephone network
[7]	ETS 300 001 (1997-01) Note 1	Attachments to Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface to PSTN
[8]	ETSI TBR 38 (1998-05) Note 1	Public Switched Telephone Network (PSTN); Attachment Requirements for a terminal equipment incorporating an analogue handset function capable of supporting the justified case service when connected to the analogue interface of the PSTN in Europe
[9]	ETSI ES 201 235-2 V1.2.1 (2002-05)	Access and Terminals (AT); Specification of Dual-Tone Multi-Frequency (DTMF) Transmitters and Receivers; Part 2: Transmitters
[10]	ITU-T Rec. E.161 (02/2001)	Arrangement of digits, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network
[11]	ITU-T Rec. G.712 (11/2001)	Transmission performance characteristics of pulse code modulation channels
[12]	ITU-T Rec. M.1040 (11/1988)	Characteristics of ordinary quality international leased circuits
[13]	ITU-T Rec. M.1025 (03/1993)	Characteristics of special quality international leased circuits with basic bandwidth conditioning
[14]	ITU-T Rec. M.1020 (03/1993)	Characteristics of special quality international leased circuits with special bandwidth conditioning
[15]	ITU-T Rec. E.164 (11/2010)	The international public telecommunication numbering plan
[16]	IMDA TS CT-CTS (Oct 2016)	Technical Specification for Cordless Telephone & Cordless Telecommunication System
[17]	IMDA TS SRD (Oct 2016)	Technical Specification for Short Ranges Devices
[18]	ITU-T Rec. G.711 (11/1998), Amd.1 (11/2009)	Pulse code modulation (PCM) of voice frequencies Annex A on lossless encoding of PCM frames
[19]	ITU-T Rec. Q.454 (11/1988)	The sending part of the multi-frequency signalling equipment

[20]	ITU-T Rec. Q.455 (11/1988)	The receiving part of the multi-frequency signalling equipment
[21]	ITU-T Rec. G.992.3 (04/2009)	Asymmetric digital subscriber line transceivers 2 (ADSL2)
[22]	ETSI TS 101 952-1 V1.1.1 (2009-06)	Access network xDSL splitters for European deployment; Part 1: Generic specification of xDSL over POTS splitters

ETSI – European Telecommunications Standards Institute
EG – ETSI Guide
ES – ETSI Standard
FCC - Federal Communications Commission
TBR - Technical Basis for Regulation

Note 1: Noted as a "Historical' standard in the ETSI website.

3 General Requirements

3.1 Power Supply

3.1.1 The TE may be AC powered or DC powered. For AC powered equipment, the technical requirements shall be complied with when operating from a AC mains supply of voltage 230V ± 10% and frequency 50 Hz ± 2%. Where external power supply is used, e.g. AC adaptor, it shall not affect the capability of the TE to meet the technical requirements.

3.1.2 Certain equipment may be allowed to be powered by DC from the exchange battery. In such cases, the current drawn by the equipment in the unlooped condition shall not be greater than 2 mA.

3.2 Polarity

The performance of the TE in scenario 3 shall be independent of the line polarity i.e. the TE shall conform to the requirements of this Specification for both polarities of the line feeding (ETSI TBR 21 [2], § 4.3.1). The polarity of the DC voltage presented at the NTP in scenario 1 is arbitrary with respect to the TE and the NTE (ETSI ES 201 970 [3], § 6.1).

3.3 Electromagnetic Compatibility & Safety Requirements

3.3.1	Electromagnetic Compatibility (EMC) Assessment
3.3.1.1	Electromagnetic Interference (EMI) or Emission Measurements
	The following emissions measurements shall be performed on the NTE/TE, where applicable: (a) Radiated emissions from the NTE/TE shall be measured to Class B requirements defined in §4 and Tables A.4 and A.5 of CISPR 32; (b) Conducted emission at the DC power port of the NTE/TE shall be measured to Class B requirements defined in §4 and Table A10 of CISPR 32; (c) Conducted emission at the AC mains port shall be measured for NTE/TE with dedicated AC/DC power converter to Class B requirements defined in §4 and Table A.10 of CISPR 32 (equipment with DC power port which is powered by a dedicated AC/DC power converter or adapter is defined as AC mains powered equipment [§3.1.1 of CISPR 32]); and (d) Conducted emission at the wired network port[1] of the ADSL modem shall be measured to Class B requirements defined in Table A.12 of CISPR 32.
3.3.1.2	Electromagnetic Susceptibility (EMS) or Immunity Testing
	The following immunity tests may be performed on the NTE/TE to requirements defined in CISPR 24, where applicable:

[1] Wired network port is used for voice, data and signaling transfers intended for connection to a communication network, e.g. CATV, PSTN, ISDN, ADSL and LAN (§3.1.32).

	(a) RF electromagnetic field (80 MHz to 1 GHz) at the enclosure of equipment; (b) Electrostatic discharge at the enclosure of equipment; (c) Fast transients (common mode) at DC power and AC main power ports that have cables longer than 3 m; (d) RF common mode 0.15 MHz to 80 MHz at DC power and AC mains power ports that have cables longer than 3 m; (e) Voltage dips and interruptions at AC mains power port of equipment with dedicated AC/DC power converter; and (f) Surges, common and differential mode at AC mains power port of equipment with dedicated AC/DC power converter.
3.3.2	Equipment Safety Testing
3.3.2.1	Equipment safety testing or assessment shall be performed to requirements defined in IEC 60950-1 or IEC 62368-1, based on the following assumptions: (a) NTE/TE is powered by a dedicated external power supply (AC/DC converter or power adapter/charger); and (b) NTE/TE operates with SELV in environments where overvoltage from telecommunication networks is not possible. SELV refers to voltages not exceeding 42.4 V peak or 60 V DC.
3.3.2.2	For NTE/TE safety assessment performed with the hazard-based approach, the processes defined in IEC 62368-1 shall be used: (a) Identify energy sources in the NTE/TE; (b) Classify energy sources (effect on the body or combustible material, e.g. possibility of injury or ignition); (c) Identify safeguards for protection against energy sources; and (d) Consider the effectiveness of safeguards with respect to compliance criteria or requirements defined in the IEC 62368-1 standard.

4 Method of Connection

4.1	Public Telecommunication Network Termination	Scenario 3 NTP TE connected to PSTN	Scenario 1 NTP TE connected to NTE
	Public telecommunication network termination for the connection of the TE is a miniature 6-position socket specified in FCC 47, CFR 68.500 [6], clause (a).	TE shall come with a miniature 6-position plug & socket as specified in FCC 47, CFR 68.500, clause (a). The connector is commonly referred to as RJ11/12.	TE shall come with a miniature 6-position plug & socket as specified in FCC 47, CFR 68.500, clause (a). The connector is commonly referred to as RJ11/12. NTE comes with a miniature 6-position socket.

5 General Operating Requirements

5.1	Ringing Signal and Service Tones
5.1.1	TE shall be able to work with the ringing signal from the public exchange as given in Table 1a and Table 1b of this Specification.
5.1.2	TE shall be able to work with the service tones from the public exchange as shown in Table 1a and Table 1b of this Specification.

5.2	Power-Fail Condition
5.2.1	In the event of failure of the power supply (back up supply included), the unattended TE shall immediately release the exchange line(s) and place it (them) in unlooped condition.
5.2.2	Upon the restoration of power, the TE shall remain in the unlooped condition when not in use.

Table 1a: Ringing Signal and Service Tones from the Public Switched Telephone Network (PSTN)

Tone No.	Ringing Signal and Service Tones	Frequency Note 1 (Hz)	Level at exchange MDF Note 3	Periodicity
	Ringing Current	24	75 V nominal	0.4 s on 0.2 s off 0.4 s on 2.0 s off
1	Dial Tone	425	-15 dBm	Continuous
2	Ringing Tone	425 x 24 (Note 2)	-10 dBm	0.4 s on 0.2 s off 0.4 s on 2.0 s off
3	Busy Tone	425	-10 dBm	0.75 s on 0.75 s off
4	NU Tone	425	-10 dBm	2.5 s on 0.5 s off
5	Congestion Tone	425	-10 dBm	0.25 s on 0.25 s off
6	Intrusion Tone	425	-20 dBm	0.25 s on 2.0 s off
7	Acceptance Tone	425	-15 dBm	0.125s on 0.125s off
8A	Holding Tone A followed by	425 x 24 (Note 2)	-15 dBm	0.5 s on 0.5 s off
8B	Holding Tone B	425	-15 dBm	0.5 s on 2.5 s off
9	Call Waiting Tone	425 x 24 (Note 2)	-15 dBm	0.3 s on 0.2 s off 0.3 s on 3.2 s off
10	Special Information Tone (not in use)	950 : 1400 : 1800 (Note 3)	-10 dBm	0.33 s : 0.33 s : 0.33 s on 1.0 s off
11	End of Period Tone (Warning Tone)	425	-20 dBm	0.624 s on 4.376 s off
~~12~~	~~Stutter Dial Tone~~	~~425~~	~~-15 dBm~~	~~0.2 on 0.2 off~~ ~~0.6 on 0.2 off~~ ~~4 cycles followed by continuous tone~~

Note 1: The maximum frequency deviation is as follows:
(a) 425 Hz ± 20 Hz
(b) 24 Hz ± 2 Hz
(c) Special Information Tone: ± 50 Hz

Note 2: f_1 x f_2 = f_1 modulated by f_2, depth of modulation is 100%
f_1 : f_2 = f_1 followed by f_2

Note 3: Nominal values are given. The actual values may deviate from these in working exchanges.

Table 1b: Ringing Signal and Service Tones from the Network Terminating Equipment (NTE) (§12&13 ES 201 970 [3])

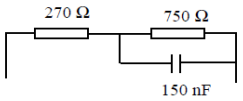
Tone No.	Ringing Signal and Service Tones	Frequency (Hz)	Level at NTE	Periodicity
	Ringing Current	25 ± 2 Hz	The open circuit AC voltage shall not exceed 100 Vrms at the NTP.	The nominal ringing cadence shall be 1 s on and 4 s off.
1	Dial Tone	425 ± 1.5 Hz	Note 4	Continuous
2	Ringing Tone	425 ± 1.5 Hz	Note 4	1 s on, 4 s off
3	Busy Tone	425 ± 1.5 Hz	Note 4	0.5 s on, 0.5 s off
4	Congestion Tone	425 ± 1.5 Hz	Note 4	0.25 s on 0.25 s off
5	Call Waiting Tone (Note 5)	425 ± 1.5 Hz	Note 4	0.2 s on, 0.2 s off, 0.2 s on, 9 s off

Note 4: The level of supervisory tones applied at the NTP into a reference impedance load Zr as shown in figure 3/ES 201 970, shall be within the range -18 dBV to ± 6 dBV.

Note 5: Whether tone is implemented in the NTE, is specific to the service provider, depending on whether the additional facility is supported.

6 Electrical Characteristics

6.1	Insulation Resistance	Scenario 3 NTP TE connected to PSTN	Scenario 1 NTP TE connected to NTE
	The insulation resistance between any one of the line terminals and the earth terminal shall be > 5 MΩ measured at 100 V DC.	ETS 300 001 [7], A.2.2.1 (GB)	–

6.2	Impedance Limits	Scenario 3 NTP TE connected to PSTN	Scenario 1 NTP TE connected to NTE
6.2.1	Unlooped Condition	Heading	Heading
6.2.1.1	TE shall present to the exchange line a DC resistance > 1 MΩ measured at 100 V DC.	ETS 300 001 [7], A.2.2.1 ETSI TBR 21 [2], A.4.4.1 The current drawn by the TE when connected to 100 VDC shall not exceed that which would be drawn by a 1 MΩ resistor replacing the TE. This requirement shall be applied for 30 seconds.	§ 5.2.2 ES 201 970 [3] DC resistance at quiescent state shall be > 1 MΩ. § 6.2 ES 201 970 Maximum open circuit DC voltage presented between A- and B- wires of the NTP shall not exceed 78 V. With 1 MΩ at A- and B- wires, DC voltage appearing at the NTP shall not be less than 38 V.
6.2.1.2	TE shall present to the exchange line impedance, Z > 6.66 kΩ in the frequency range of 300 to 3400 Hz, if no additional loading from parallel connections is intended. Z shall be > 20 kΩ in the frequency range of 300 to 3400 Hz if additional loading from parallel connections is intended.	ETS 300 001, A.4.1.1 (GB) 10 kΩ, 30 kΩ	–
6.2.1.3	TE shall present to the exchange line an impedance > 2 kΩ at 24 Hz.	ETS 300 001, A.4.4.2.1	§ 5.2.2 ES 201 970 Impedance at 25 Hz shall be > 4 kΩ.
6.2.1.4	TE shall be able to withstand sustained ringing voltages from the telephone line of 85 V rms at nominal frequency of 24 Hz.	TE shall withstand 85 Vrms at 24Hz.	§ 12.1.2 ES 201 970 The open circuit AC voltage shall not exceed 100 Vrms at the NTP.
6.2.2	Looped Condition	Heading	
6.2.2.1	A DC resistance of 80 Ω to 450 Ω for line currents between 20 mA to 110 mA.	ETSI TBR 21, A.4.7.1	§ 6.3.1 ES 201 970 DC current shall be ≥ 18 mA and < 70 mA when measured with a resistor in the range of 0 Ω to 500 Ω at the NTP. It is recommended that the DC current is in the range of 25 mA to 40 mA. § 9.1 ES 201 970 NTP impedance  **Figure 3: Reference impedance Z_r** **Table 3: Return loss requirements** Frequency [Hz] / Requirement [dB] 200 - 300 / 8 300 - 500 / 8 - 10 500 - 1 250 / 10 - 14 1 250 - 3 400 / 14 3 400 - 3 800 / 14 - 12 This requirement shall be met for any DC current that can be delivered at the NTP (i.e. between the 18 mA and the short circuit current).
6.2.2.2	For analogue TE supporting non-voice services only, the return loss calculated shall be > 8 dB with respect to 600Ω in the frequency range of 300 to 3400 Hz for line current up to 110 mA. See Note 1.	ETSI TBR 21, A.4.7.2	
6.2.2.3	For analogue TE supporting handset telephony, the return loss calculated shall be > 14 dB with respect to 600 Ω in the frequency range of 300 to 3400 Hz for line current up to 110 mA. See Note 2.	ETSI TBR 38 [8], A.2.8	
6.2.2.4	The equipment shall be capable of performing satisfactorily with continuous DC current between 20 mA and 110 mA from the public exchange.	ETSI TBR 21, A.4.7.1	

6.2.3	In the case where the connection of the equipment introduces a resistance in series with PSTN and other terminal equipment, the additional resistance introduced shall be less than 50 Ω.	ETS 300 001, A.2.5 (GB)	–
Note 1: Requirements are applicable only to non-voice TE (without handset function) such as modems and some facsimile machines. Note 2: Requirement is mandatory if TE incorporates analogue handset function.			

6.3	**Impedance Unbalance about Earth**	**Scenario 3 NTP TE connected to PSTN**	**Scenario 1 NTP TE connected to NTE**
	Impedance unbalance about earth expressed in Longitudinal Conversion Loss (LCL) shall be ≥ 40 dB in the frequency range of 300 to 600 Hz and ≥ 46 dB in the frequency range of 600 to 3400 Hz.	ETSI TBR 21 [2], A.4.7.4	§ 9.2 ES 201 970 [3] Balance about earth **Table 4: Balance about earth requirements** Frequency [Hz] / Requirement [dB] 50 / 40 200 - 600 / 40 600 - 3 800 / 46 See Note 1 and Note 2.
Note 1: It is recognised that this requirement may be difficult to measure at the NTP. It should be interpreted as a design target for the equipment delivering the NTP (where it can be more easily measured), and also in the choice of cable (the copper pairs of the cable should have a sufficiently high balance). Note 2: These values are taken from ITU-T Rec. Q.552, except that the frequency range has been extended to accommodate voice-band data applications.			

6.4	**Signal Frequencies and Sending Levels**	**Scenario 3 NTP TE connected to PSTN**	**Scenario 1 NTP TE connected to NTE**
6.4.1	All signals transmitted to public telecommunication network line shall be nominally confined to the frequency range of 300 to 3400 Hz and the power level during any 10 second period shall not exceed –6 dBm when measured with 600 Ω termination. These requirements do not apply to MFPB (DTMF) signals.	TBR 21 [2], A.4.7.3.1	§ 10.1 ES 201 970 [3] Relative level To enable full signal handling capacity, the nominal relative levels (at 1 020 Hz) at the NTP shall be: Input relative level Li = +4 ± 2 dBr; Output relative level Lo = -11 ± 2 dBr. See Note 1 and Note 2. The relative level is assumed to be 0 dBr on the digital side of the analogue/digital conversion point in the local network (Figure 4/§ 10.1 ES 201 970).
6.4.2	Any power transmitted above 3400 Hz shall be reduced progressively by at least 12 dB/octave.	TBR 21, A.4.7.3.4	–
6.4.3	Any individual spectral component of the transmitted signals into the public telecommunication network line shall not exceed –33 dBm at frequencies above 3.4 kHz and –70 dBm at 50 kHz and above.	TBR 21, A.4.7.3.4	–
Note 1: The concept of relative levels is described in ITU-T Rec. G.100.1. Note 2: These relative levels are chosen to obtain optimum performance for a speech telephony terminal in accordance with ETSI TBR 038 having nominal SLR = +3 dB and RLR = -8 dB.			

7 CALLING FUNCTION

TE that initiates calls to the public telephone exchange shall conform to the requirements of this section.

7.1	**Line Signalling**
	Each originating call shall begin with the establishment of looped condition. The TE shall be able to interwork with the DC loop start line signalling method of the public exchange as shown in Tables 2 and 3.

Table 2: Subscriber Line Conditions for Originating Call

Scenario 3 NTP TE connected to PSTN					Scenario 1 NTP TE connected to NTE (ES 201 970 [3])
Signal State	**Condition at the TE (Calling Subscriber)**		**Line Condition at exchange**	**Remarks**	
Idle	H		N		–
Seizure	H to L	Dial Tone	N	Loop via subscriber terminal equipment	§ 7 Seize signal Loop current > 3 mA DC for < 10 ms, shall not be recognised as a seize signal. Loop current > 10 mA DC for < 150 ms, shall be recognised as a seize signal. §14.5 Polarity reversal - Where polarity reversal is provided, its purpose shall be specified.
MFPB signalling	L		N		
Ringing	L	Ringing Tone	N		
Answer	L		N or N to R (Note 2)		
Conversation	L		N or R		
Register recall hooking (Note 1)	L to H to L		N or R	Loop break (Note 3)	–
Calling subscriber clears first (at any state)	L to H		N or R to N	Break in subscriber loop and return to idle state	§ 8.1 Clear signal generated by TE Clear signal threshold current shall be at least 0.5 mA lower than the seize signal threshold current. Loop current < threshold for < 250 ms, shall not be accepted as a clear signal. Loop current > threshold for > 500 ms, shall be accepted as a clear signal.
Called subscriber clears before calling subscriber clears (line lock-out)	L	Busy Tone	N or R	Line lock-out condition after time supervision	These time period values are valid for the calling party. For the called party, other values are possible (usually much longer times, e.g. to allow for the called party to change from one TE to another), and shall be stated by the operator). § 8.2 Clear indication from network A connection may be cleared by the calling party or the called party TE providing a clear signal to the network; or at the instigation of the network itself.
			Time supervision		
Calling subscriber subsequently clears	L to H		N or R to N	Return to idle condition	A PSTN end-of-call signal shall be applied at the NTP when the connection is cleared. This should be given as a release tone as specified in § 13.3. Polarity reversal can be used to indicate called party answer and end-of-call (§ 14.5).

Legend: H = High ohmic unlooped state + ve = 0 V and – ve = – 48 V ± 5 V
L = Low ohmic looped state
N = Battery feed with a lead – ve and b lead + ve
R = Battery feed with a lead + ve and b lead – ve

Note 1: Register recall is only applicable to subscriber line that has services such as 3 way calling, call waiting service or malicious call tracing.
Note 2: Line reversal may be sent as answer signal depending on the category of calling subscriber and type of call. For lines requiring a reversal of line potentials as an answer signal for proper working, such facility can be arranged.
Note 3: Loop break is at a value of 600 ± 300 ms.

Table 3: Subscriber Line Conditions for Terminating Call

Scenario 3 NTP TE connected to PSTN					Scenario 1 NTP TE connected to NTE (ES 201 970 [3])
Signal State	**Line Condition at Terminating Exchange**	**Condition at the TE (Called Subscriber)**		**Remarks**	
Idle	N		H		–
Ringing	N	Ringing Current	H	Ringing current on A lead	§ 12.1 Ringing TE shall interwork with NTE that delivers ringing voltage of not less than 35 Vrms across an AC load of 4 kΩ and ringing frequency of 25 Hz ± 2 Hz.
Answer	N		H to L		§ 12.3 Ring trip Any ringing signal presented at the NTP shall be removed within 200 ms of an answer signal consisting of: a) A DC condition as defined in § 7 being applied to the NTP; and b) For the case where the AC ringing signal is not superimposed on a DC voltage, an impedance not exceeding 700 Ω at 25 Hz applied at the NTP.
Conversation	N		L		–
Register recall hooking (Note 1)	N		L to H to L	Loop break (Note 2)	–
Called subscriber clears first	N		L to H	Return to idle after expiry of time supervision or after calling subscriber clears	As in Table 2
Calling subscriber clears before called subscriber clears (line lock-out)	N	Busy Tone	L		As in Table 2
Called subscriber subsequently clears	N		L to H	Return to idle condition	–

Legend: H = High ohmic unlooped state + ve = 0 V and – ve = – 48 V ± 5 V
L = Low ohmic looped state
N = Battery feed with a lead – ve and b lead + ve
R = Battery feed with a lead + ve and b lead – ve

Note1: Register recall is only applicable to subscriber line that has services such as 3 way calling, call waiting service or malicious call tracing.

Note 2: Loop break is at a value of 600 ± 300 ms.

<table>
<tr><th>7.2</th><th>Multi-frequency Push-Button (MFPB or DTMF) signalling</th><th>Scenario 3
NTP
TE connected to PSTN</th><th colspan="2">Scenario 1 NTP
TE connected to NTE</th></tr>
<tr><th></th><th></th><th></th><th>NTE (ES 201 970 [3])</th><th>TE (ES 201 235-2 [9])</th></tr>
<tr><td>7.2.1</td><td>The equipment shall send the call address information to the public exchange by means of MFPB signalling codes as specified below.

<table>
<tr><td colspan="2">Hz</td><td colspan="3">Digit Codes</td></tr>
<tr><td rowspan="4"></td><td>697</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>770</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>852</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td>941</td><td>*</td><td>0</td><td>#</td></tr>
<tr><td colspan="2">Hz</td><td>1209</td><td>1336</td><td>1477</td></tr>
</table></td><td>TBR 21 [2], A.4.8.2.1</td><td>§11 DTMF Dialling
Recognize the sixteen signals designated 0 to 9, *, #, A, B, C and D.</td><td>Additional Hi freq group of 1633 Hz

Depends on network transmission plan ITU-T Rec. Q23</td></tr>
<tr><td>7.2.2</td><td>Transmit signalling frequencies shall not deviate more than ± 1.5% from the nominal values.</td><td>TBR 21, A.4.8.2.2</td><td>± (1.5 % + 2 Hz) of the nominal value</td><td>± 1.5%
§ 4.2.1 or Annex A ITU-T Rec.Q.24</td></tr>
<tr><td>7.2.3</td><td>The sending level for low group frequencies into public telecommunication network line shall be −8 ± 2 dBm.</td><td>TBR 21, A.4.8.2.2</td><td rowspan="2">Level within the range -5 to -15 dBV

ES 201 235-3 specifies a reception range between -2 to -28 dBV as the line length to the terminal is very short (100 Ω).

Difference in level of two signalling frequencies is not more than 6 dB.</td><td rowspan="2"><u>Analogue</u>
Lo freq group:
-11 dBV +2.5/-2 dB
Hi freq group:
-9 dBV +2 /-2.5 dB

<u>Digital</u>
Lo freq group:
-6 dBm ± dB
Hi freq group:
-4 dBm ±1 dB</td></tr>
<tr><td>7.2.4</td><td>The sending level for high group frequencies into public telecommunication network line shall be −6 ± 2 dBm.</td><td>TBR 21, A.4.8.2.2</td></tr>
<tr><td></td><td>The total power of unwanted frequency components during signalling shall be at least 20 dB below the power level of signal frequency.</td><td>TBR 21, A.4.8.2.3</td><td>DTMF signalling valid even accompanied by freq components 20 dB below the level of the low group signalling frequency.</td><td>§ 4.2.3
At least 20 dB below</td></tr>
<tr><td>–</td><td>–</td><td>–</td><td>–</td><td>§ 4.3.1
Speech suppression by at least 50 dB</td></tr>
</table>

7.3	Keypad Dialling	ITU-T Rec. E.161 [10]
7.3.1	Keypads used in equipment for dialling shall be alphanumeric keypads and the relationships between the letters and the digits shall comply with ITU-T Rec. E.161 as shown in figure 2.	
7.3.2	The associated letters must not impair the legibility of the digit (§ 3.1.1, ITU-T Rec. E.161).	
7.3.3	The tactile identifier on the "5" button shall be provided (§ 3.6, ITU-T Rec. E.161)	

1	**2 ABC**	**3 DEF**
4 GHI	**5 JKL**	**6 MNO**
7 PQRS	**8 TUV**	**9 WXYZ**
*****	**0**	**#**

Figure 2/ITU-T Rec. E.161:
Alphanumeric Keypad Layout

7.4	Automatic Dialling	Scenario 3 NTP TE connected to PSTN	Scenario 1 NTP TE connected to NTE
	For equipment which carries out dialling automatically, (a) the sending length of the MFPB signal shall be at least 65 ms, and (b) the inter-digit pause between 2 MFPB signals shall not be less than 65 ms.	TBR 21 [2], A.4.8.2.4 & A.4.8.2.5	At least 65 ms < 75 ms for sup services § 4.2.4 ES 201 235-2 [9]

7.5	Repeat Call Attempts
	For TE with automatic repeat dialling facility, every automatic redial operation shall be limited to a maximum of 10 call re-attempts with intervals of minimum 60 seconds between re-attempts.

7.6	Automatic Calling
	Where automatic calling facility is provided in the equipment: (a) a dial tone detector shall be incorporated; (b) dialling digits shall be sent within 5 s of detecting the exchange dial tone.

8 Automatic Answering

8	Automatic Answering (Note 1)
8.1	TE shall have a ringing signal detector and answer an incoming call by looping the line within 9 seconds from the start of the ringing signal.
8.2	The maximum duration of looped condition for the automatic transmission of prerecorded message shall not exceed 2 minutes.
8.3	The maximum duration of looped condition for the automatic recording of incoming message shall not exceed 30 minutes.
8.4	TE shall restore the exchange line to unlooped condition: (a) after the detection of busy tone sent by the exchange to indicate that the calling party has cleared first; or (b) alternatively, for equipment with a timer, after the time pre-set for the automatic transmission or recording of message.
Note 1: Requirement is 'M' if TE incorporates features with telephone answering capability e.g. Direct Inward System Access (DISA), voice message system etc.	

Annex A: Analogue Handset Function

If TE supports handset telephony, then the following additional requirements are applicable.

A.1	Sending and Receiving Loudness Ratings (SLR and RLR)	Scenario 3 NTP TE connected to PSTN	Scenario 1 NTP TE connected to NTE
A.1.1	The SLR shall be +3 dB ± 4 dB when measured with the feed resistance R_f set to 2800 Ω and 1000 Ω and +3 dB +7/–4 dB when measured with the feed resistance R_f set to 500 Ω. For TE supporting handsfree or loudspeaking functions which is not powered from a separate power supply, the requirement to measure with R_f set to 2800 Ω shall be replaced by a requirement to measure with R_f set to 2300 Ω.	TBR 38 [8], A.2.2.1	Where applicable § 10.1 ES 201 970 [3]
A.1.2	The RLR shall be –8 dB ± 4 dB when measured with the feed resistance R_f set to 2800 Ω and 1000 Ω and –8 dB +7/–4 dB when measured with the feed resistance R_f set to 500 Ω. For TE supporting handsfree or loudspeaking functions which is not powered from a separate power supply, the requirement to measure with R_f set to 2800 Ω shall be replaced by a requirement to measure with R_f set to 2300 Ω.	TBR 38, A.2.2.2	Where applicable § 10.1 ES 201 970

A.2	Sidetone	Scenario 3 NTP TE connected to PSTN	Scenario 1 NTP TE connected to NTE
	Sidetone Masking Rating (STMR) shall not be less than +10 dB.	TBR 38, A.2.3	Where applicable

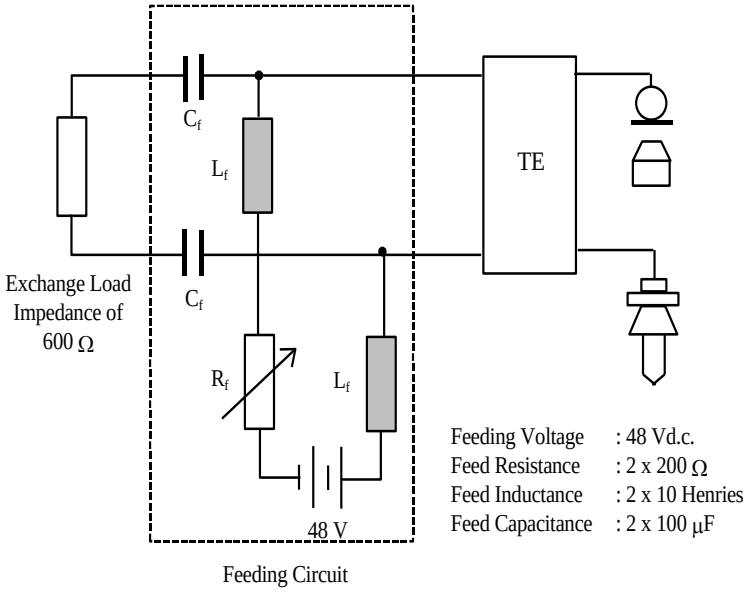


Figure A.1: Circuit for measurement of transmission characteristics
(Refer to Figure A.1/ETSI TBR 38)

Annex B: 2-Wire Analogue Leased Line Requirements

If TE is intended for use on 2-wire analogue leased lines, then the following additional requirements are applicable.

B.1	Longitudinal Conversion Loss (LCL)	Scenario 3 NTP TE connected to PSTN
	Longitudinal Conversion Loss (LCL) of the TE interface shall be ≥ 40 dB in the frequency range of 300 to 600 Hz and ≥ 46 dB in the frequency range of 600 to 3400 Hz.	TBR 21, A.4.7.4

B.2	Signal Frequencies and Sending Levels	Scenario 3 NTP TE connected to PSTN
B.2.1	All signals transmitted to public telecommunication network line shall be nominally confined to the frequency range of 300 to 3400 Hz and the power level during any 10 second period shall not exceed –6 dBm when measured with 600 Ω termination.	TBR 21, A.4.7.3.1
B.2.2	Any power transmitted above 3400 Hz shall be reduced progressively by at least 12 dB/octave.	TBR 21, A.4.7.3.4
B.2.3	Any individual spectral component of the transmitted signals into the public telecommunication network line shall not exceed –33 dBm at frequencies above 3.4 kHz and –70 dBm at 50 kHz and above.	TBR 21, A.4.7.3.4
B.2.4	The transmission of d.c. and low frequency ac signals may be allowed on local leased circuits provided over physical lines. Where allowed, the maximum level of such signals and ripple components transmitted by the equipment to line shall not exceed the values indicated in Table B.1 of this Specification.	Table B.1/TS PSTN (Note 1)
Note 1 Applicable only if TE is connected to the local leased circuits of SingTel's PSTN.		

Table B.1: Maximum level of DC and low frequency signals for private leased local circuits allowed over physical lines

Frequency Range (Hz)	Maximum Level	Remarks
D.C.	60 V 80 V	Maximum current to line must not exceed 50 mA DC. For telegraph signalling only
5	30 V peak	Maximum current to line must not exceed 10 mA AC.
6 - 100	7 V r.m.s. 30 V peak 85 V r.m.s.	Without a filter With 200 Hz LPF For 24 Hz (nominal) interrupted ringing only.
100 - 200	3.5 V r.m.s. 10 V r.m.s.	Without a filter With 200 Hz LPF
200 - 3400	– 6 dBm	Terminated 10 seconds mean total power in 600 Ω.

Technical Information on Singtel Private Leased Voice Grade Circuits

1. Local Leased Circuits

Local leased voice grade circuits are provided between destinations in Singapore over a combination of subscriber lines (between subscribers and local exchanges) and junction lines (between exchanges).

2. Subscriber Lines

Existing subscriber lines use unloaded distribution cables with conductor gauges of 0.32 mm, 0.4 mm, 0.5 mm, 0.63 mm and 0.9 mm. The planning of the subscriber-line network takes into account the criterion that the line attenuation should be limited to a maximum of 7.7 dB at 1 kHz or a d.c. loop resistance of 1200 Ω, whichever is exceeded first.

3. Junction Lines

The present network of exchanges is interconnected by mainly 0.63 mm and 0.9 mm loaded junction cables and PCM links of the 2.048 Mbit/s types. For the loaded cable pairs, the attenuation has a low pass characteristic with a well-defined cut-off frequency at around 3.7 kHz. PCM circuits, on the other hand, conform to ITU-T Rec G712 [11].

4. Characteristics of Local Leased Circuits

The characteristics of an ordinary local leased voice grade circuit are in accordance with ITU-T Rec M1040 [12]. The nominal overall loss of the circuit at the reference frequency between two arbitrary subscriber distribution points is not greater than 28 dB and the nominal psophometric noise power does not exceed -50 dBm. When used as the national section of an international leased voice grade circuit, the transmission loss of the local leased line is kept within 13 dB.

5. International Leased Voice Grade Circuits

These circuits are provided in accordance with ITU-T Rec M1040 [12], M1025 [13] or M1020 [14] to match the type of circuits specified by the subscriber.

6. Data Transmission Over Local Leased Circuits

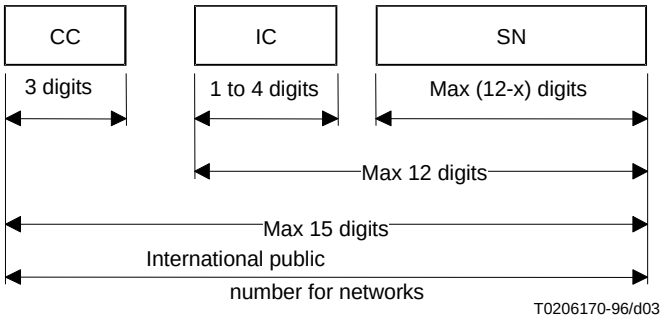
Singapore public telecommunication line distribution network is designed for voice transmission purpose. It is therefore not possible for the public telecommunication network to assure the quality of data transmission over the telephone lines. It is the supplier's responsibility to advise users of the line transmission characteristics that are required for the operation of their equipment and perform the necessary line conditioning.

The unconditioned voice grade leased circuit can generally support data transmission speeds up to 2400 bit/s at a bit error rate of 1×10^{-5}. For data transmission speeds of 4800 bit/s and above, line conditioning to ITU-T Rec. M1020 standard may be required.

Annex C: Call Detail Recording Facilities

If call detail recording facility is incorporated in the TE, then the following requirements shall apply to the TE connected to NTP in scenario 1 or 3.

C	Call Detail Recording Facilities
C.1	The start and stop of timing of the call duration are activated by permanent line reversal.
C.2	The structuring and programming of tariff tables for STD and IDD calls shall take into account the international public telecommunication number structure as shown in Figure C.1.
C.3	The structuring and programming of tariff tables for STD and IDD calls shall take into account the access codes (prefixes for discriminating between international network operators and/or the different network services they provide) and the tariff rates (the charge units) that are obtainable from network operators. Note: Tariff rates are subject to change.



CC Country Code for
IC Identification Code
SN Subscriber Number
x Number of digits in Identification Code

NOTE – National and international prefixes are not part of the international public telecommunication number for Networks.

Figure C.1: International Public Telecommunication Number Structure (Figure 3/E.164 [15])

Annex D: Cordless Telephone Facility

If the TE is a cordless telephone or telecommunication system which transmits within any of the authorised frequency bands and power limits indicated in the relevant IDA technical specifications for radio-communication equipment, then the following requirements shall apply to the TE connected to NTP in scenario 1 or 3.

D	**Cordless Telephone Facility**
	The TE shall also comply with the relevant requirements given in: (a) Technical Specification for Cordless Telephones and Cordless Telecommunication Systems (IMDA TS CT-CTS [16]); and/or (b) Technical Specification for Short Range Devices (IMDA TS SRD [17])

Annex E: Requirements for Coinafon

If the TE is a payphone designed to accept coins as the means of payment, then the following requirements shall apply to the TE connected to NTP in scenario 1 or 3.

E.1	**Call Charging**
E.1.1	TE shall commence call charging upon detecting the reversal of line voltage polarity from the exchange when the called party answers the call and effect the collection of the first coin.
E.1.2	If the equipment is unable to detect the reversal of line polarity, it shall be provided with a prominent notice with clear user instructions on the method of operation and the deposit of coins.
E.1.3	It shall be able to accept only Singapore coins.
E.1.4	It can be modified to accept the old Singapore coins, if required.
E.1.5	Call timing shall commence the moment the coin drops in by its own self-timing mechanism.
E.1.6	The timer shall be set to the charging rate of Y ¢ per X-minute block (Note 1), X shall be equal to or greater than 2, and can be changed to greater than 2, if required.
E.1.7	When the presence of a coin is not detected after the called party answers, forced release shall be activated immediately by the coinafon.
E.1.8	The equipment shall be able to accept 10 ¢, 20 ¢, 50 ¢ and $1.00 Singapore coins.
Note 1: To be set according to the prevailing tariff rate for local call.	

E.2	**Refund Facilities**
E.2.1	If the called party does not answer or if the line is busy, there shall be no coin collection.
E.2.2	All unused coins shall be refunded when the handset is replaced.
E.2.3	If unused coins other than the coin(s) that amount to Y ¢ are not refundable, the equipment shall be provided with a prominent notice to warn the user and advise him to insert Y ¢ coin(s), one (amount) at a time.

E.3	**Credit Expiry Warning**
E.3.1	A 400 Hz warning tone of 1 s on and 3 s off shall be sent from the TE 16 s before the call is terminated.
E.3.2	The level of the warning tone, at the receiver, shall be between 55 dB(A) and 74 dB(A).

E.4	**Emergency Free Call**
E.4.1	The equipment shall be able to recognise a coin free call when there is a detection of no reversal in line polarity.
E.4.2	If the equipment is unable to detect line polarity reversal, it shall be programmable to allow coin free calls, for example, to Emergency numbers (999 and 995) and 1800 toll-free numbers.

E.5	**Trunk Barring**
E.5.1	The equipment shall have a key mechanism such that when the key is not used: (a) local calls are payable; (b) called numbers beginning with digit ‘0’ and called levels such as ‘100’, ‘104’, ‘105’ and ‘1900’ shall be trunk-barred.
E.5.2	When the key is used, coin-free calls can be made and the equipment is not trunk-barred.

E.6	**Incoming-Call Barring**
	For protection against fraudulent usage, the TE should have the option to bar incoming calls to prevent unauthorised collect calls.

E.7	**Reliability**
E.7.1	When required, a test report on the reliability of the timing and coin collecting mechanism shall be made available. (The reliability tests should be based on a sample size of at least 8 units.)
E.7.2	The equipment housing should be of a sufficiently robust material such as the high resilience ABS plastic.

Annex F: Requirements for Credit Card, Phonecard, ATM Card, Cashcard and Multi-Coin Payphone

If TE is a Credit Card, Phonecard, ATM card, CashCard, Multi-Coin payphone or incorporates one or more of these means of payment collection facility, the following requirements shall apply to the TE connected to NTP in scenario 1 or 3.

F.1	**General**
F.1.1	If the equipment is capable of accepting Commercial Credit Cards as the means of payment, it shall be able to communicate with the Credit Card Companies' host computers through dial-up access.
F.1.2	If the equipment is capable of accepting ATM cards and CashCards or chip/smart cards issued by Banks and NETS[2] as the means of payment, it shall be able to communicate with the NETS' host computer through dial-up access.
F.1.3	If the equipment is capable of accepting phonecards issued by the public network operator as the means of payment, it shall have facilities for storage and retrieval of the transaction records.
F.1.4	If the equipment is a Multi-coin Payphone, (a) it shall be able to accept multiple Singapore coins of $1.00, 50¢, 20¢ and 10¢ denominations as a means of payment; (b) the equipment shall be equipped with a single coin entry slot where coins shall be channelled to an intelligent coin-validator for validation check before acceptance; (c) the equipment shall return unacceptable coins to the refund tray immediately; (d) when a coin is accepted by the equipment, the credit shall be updated and displayed.
F.1.5	The equipment shall have a display unit to: display the credit balance of the inserted phonecard and coins before dialling and during the conversation; display the digits of the number dialled; display the operating status, e.g. when the equipment is busy communicating with the NETS' host computer, or when it is in out-of-service condition; display guiding instructions on the call procedures.
F.1.6	The equipment shall comply with all the relevant technical requirements in other parts of the IDA TS PSTN.
F.1.7	The functioning of the equipment shall be independent of the exchange line polarity.

F.2	**Call Charging**
F.2.1	The equipment shall have a self-tariffing facility and be able to compute the conversation time based on the credit balance and tariff rate of the called number.
F.2.2	The equipment's self-tariffing tables shall be set to the prevailing STD and IDD rates and comply with clauses C.2 and C.3 of Annex C to the IDA TS PSTN.
F.2.3	The equipment shall have the means for remote updating of tariff data.
F.2.4	The equipment shall check the credit balance before sending the dialled digits to the public exchange. If the credit balance is less than the required minimum fee to make the call, the user shall not be allowed to continue with the call.
F.2.5	The equipment shall commence charging only upon detection of permanent line polarity reversal.
F.2.6	The equipment shall be able to force release the successful call when it detects that there is no more credit.
F.2.7	When permanent line polarity reversal is not detected in the case of a successful local call, the equipment shall treat the call as to a free number.
F.2.8	When permanent line polarity reversal is not detected in the case of a STD or IDD call, the transmitter of the equipment shall be muted and the equipment shall force release the call after a supervision period of 90s from the completion of the call set-up.
F.2.9	For local calls, the equipment shall allow only "n" number of digits dialled before the detection of permanent line polarity reversal, where "n" is programmable.
F.2.10	An initial fee (Y ¢ for local and STD calls and Z ¢ for IDD calls) (Note 1) shall be deducted from the credit when the call is answered. The debiting procedure shall be in accordance with Figure F.1.
F.2.11	The equipment shall be able to charge calls to special service numbers such as "1900-XXXXXXX" (Premium Information Service) at tariff rates different from local calls e.g. at a flat rate of X cents per call.
Note 1: To be set according to the prevailing tariff rates.	

F.3	**Refund Facilities**
F.3.1	If the called party does not answer or if the line is engaged, there shall be no debiting or collection of coins.
F.3.2	All unused coins shall be returned to the refund tray by the equipment when the user replaces the handset.

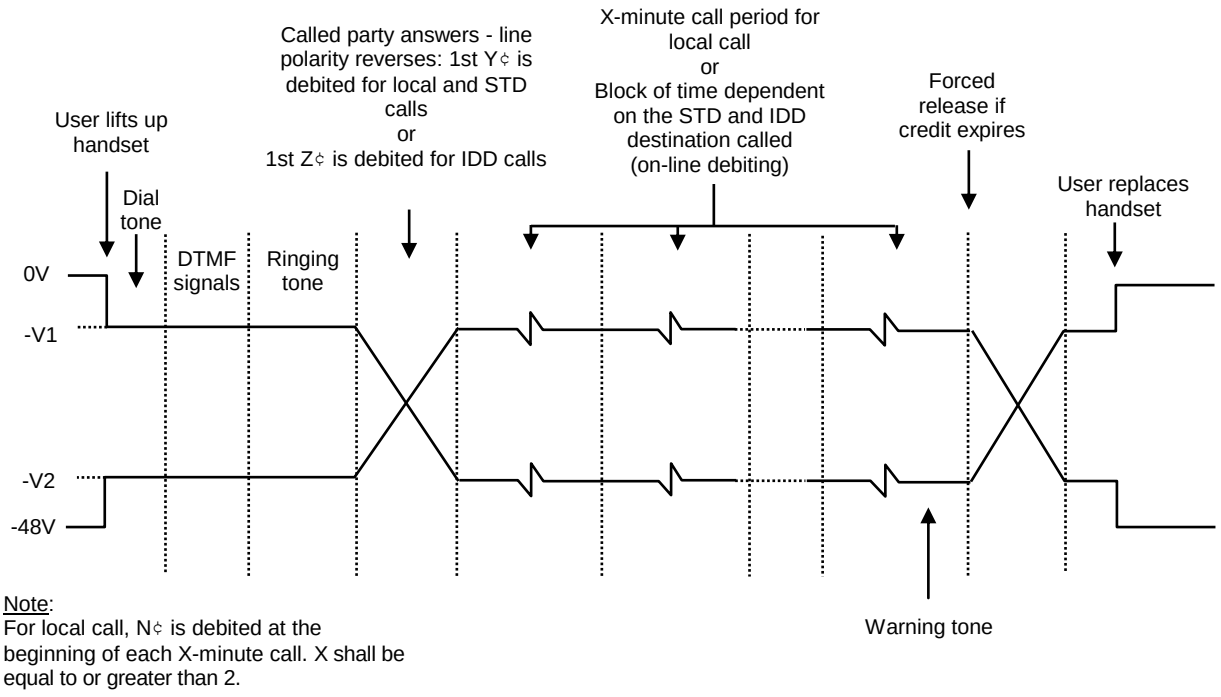
[2] Networks for Electronic Transfers (Singapore) Pte Ltd

F.4	Warning Facilities
F.4.1	The equipment should have a warning facility to remind user to collect the returned card after the handset is replaced at the end of the call.
F.4.2	The equipment shall have warning signals to inform the user that the credit balance is running low at an instant before the equipment terminates the call.
F.4.3	In the case of multi-coin payphone, if the user inserts more valid coins before the credit expires, the call shall be allowed to continue.
F.4.4	The warning signals shall comprise both tone on the receiver of the handset and a flashing message at the display. The warning tone shall be as follows: (a) for local calls, a 400 Hz tone of 1 second on and 3 seconds off shall be generated by the equipment; (b) for STD and IDD calls, only a one-pip 400 Hz tone shall be generated by the equipment; (c) level of the tone at the receiver shall be between 55 dB(A) and 74 dB(A).

F.5	Free Calls
F.5.1	The equipment shall allow the programming of free numbers such as emergency numbers (999 and 995), and calls to these numbers shall not require the slotting in of card or the insertion of coins.

F.6	Protection against fraudulent usage
F.6.1	The equipment should have security features e.g. preventing the tampering of tariff rates, functions for authentication of cards and intelligent coin-validator.
F.6.2	For protection against fraudulent usage, the equipment shall have an option to bar incoming calls to prevent unauthorised collect calls, and access to levels 104, 105 and 1635 (for operator assisted international calls and call bookings).

F.7	Reliability
F.7.1	The equipment should be capable of self-diagnosis and identification of any fault e.g. common faults related to the Credit Card.
F.7.2	There shall be accuracy in the charging. The difference in timing between the given conversation time and the computed conversation time shall not be more or less than 0.05%.
F.7.3	When required, a test report on the reliability and accuracy of the timing and coin collecting mechanism (where applicable) shall be made available (the tests conducted should be based on a sample size of at least 8 units).
F.7.4	The equipment housing should be of a sufficiently robust material such as the high resilience ABS plastic.



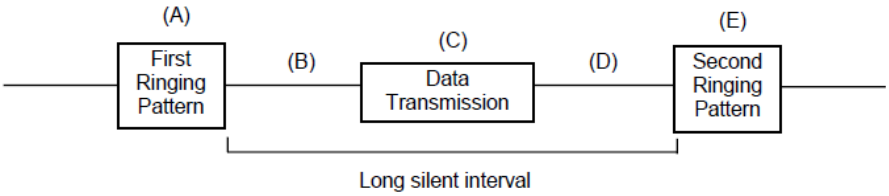
Note:
For local call, N¢ is debited at the beginning of each X-minute call. X shall be equal to or greater than 2.

Figure F.1: Debiting Procedure

Annex G: Requirements for Caller Identity Equipment

If the TE incorporates Analogue Calling Line Identity Presentation (A-CLIP) facility, then the following requirements[3] shall apply to the TE connected to NTP in scenario 3. The caller identity equipment shall be of Type 1, which supports on-hook data transmission with power ringing. Power ringing includes ringing of any distinctive pattern or a first burst.

G.1	**General**
G.1.1	The equipment shall be able to receive A-CLIP information while it is in on-hook condition (unlooped condition) and during the silent interval between the first and second ringing signal received as shown in Figure G.1).



Parameter	Value	Description
A	0.2 - 3.0 s	Power ringing includes ringing of any distinctive pattern or a first burst
B	0.5 - 1.5 s	Time between the end of first ringing pattern and the start of data transmission
C	variable	Time available for sending data, including Channel Seizure and Mark
D	≥ 200 ms	PSTN must stop data transmission at least 200 ms before the application of the second ringing pattern
E	0.8(Note) - 3.0 s	Power ringing includes ringing of any distinctive pattern
Note: To reflect local condition of 1.0 ± 10 % seconds of second ringing pattern.		

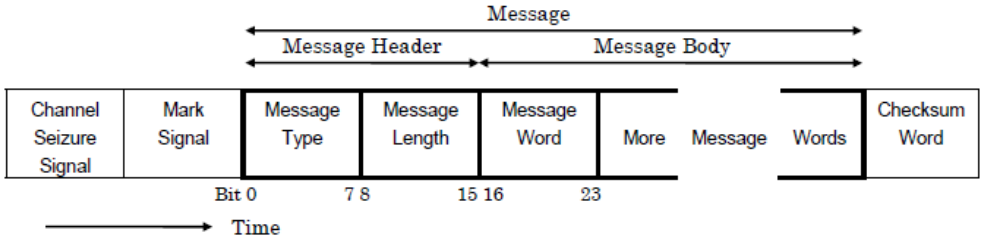
Figure G.1: Data transmission associated with Singapore PSTN power ringing

G.1.2	The equipment must conform with the ITU-T Rec. T.50 for the display of Calling Line Identification (CLI) and name of the calling party.
G.1.3	The equipment shall comply with all the relevant technical requirements in other parts of this Specification.

G.2	**PSTN-to-Terminal Equipment Information Signalling**
G.2.1	Data signalling interface for A-CLIP facility shall conform with the following parameters: (a) The equipment shall be connected to the PSTN by a two-wire simplex link. (b) The equipment shall be able to receive from an analogue, phase coherent frequency shift keying (FSK) transmission scheme. (c) The logical 1 (mark) is 1200 ± 12 Hz. (d) The logical 0 (space) is 2200 ± 22 Hz. (e) The transmission rate is 1200 bit/s. (f) The application of data is in serial, binary and asynchronous. (g) The bit error rate (BER) is ≤ 1 out of 100,000 bits. (h) Phase continuity is maintained from beginning of service to the end of the message. (i) The equipment's receiver sensitivity shall be -26 dBm ± 2 dBm. (j) The bit duration is 833 ± 50 µs (start and stop bits have the same duration as a standard bit).

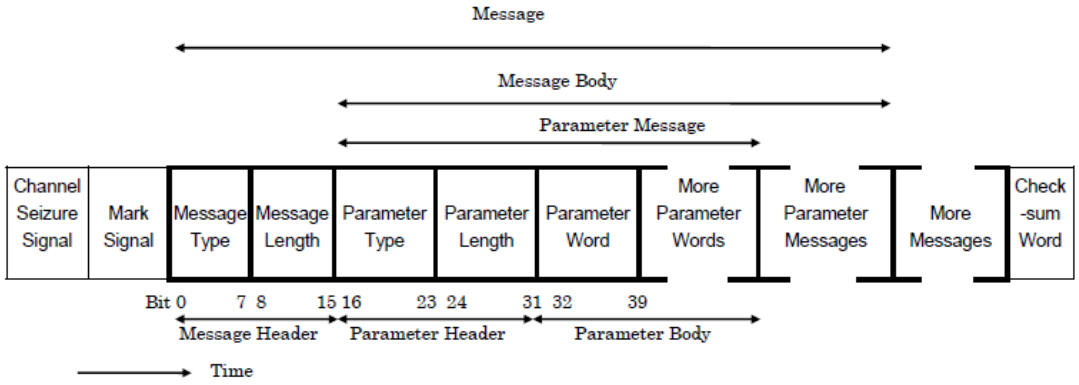
[3] The technical requirements are based on the on-hook data transmission associated with Power Ringing in the Bellcore Generic Requirements GR-30-CORE Issue 1, December 1994.

G.3	PSTN-to-Terminal Equipment Information Signalling
G.3.1	The equipment shall be able to receive data messages according to the following protocols:
G.3.1.1	The information is transmitted in a series of 8-bit data words each bounded by a start bit (space) and a stop bit (mark), and is segmented according to the Single Data Message Format (SDMF) or the Multiple Data Message Format (MDMF) as shown as in Figures G.2 and G.3.
G.3.1.2	The data shall be received in the order of the least significant bit first.
G.3.1.3	Data messages not recognised by the equipment shall be ignored.
G.3.1.4	If the equipment recognises the message type word of the multiple data message but does not recognise one or more of the parameter type words within the multiple data message, the equipment shall process all the recognised parameter type words and ignore all the unrecognised parameter type words.
G.3.1.5	On receiving each data message (single or multiple) the equipment shall be able to switch "on", provide the data to be displayed and then switched "off".



Note: The SDMF consists of a message type, a message length and one or more message words. Each word is an 8-bit byte.

Figure G.2: Single Data Message Format



Note: The MDMF consists of a message type, a message length, and one or more parameter messages. Each parameter message consists of a parameter type, a parameter length, and one or more parameter words. The message type, message length, parameter type, parameter length, and each parameter word are each an 8-bit byte.

Figure G.3: Multiple Data Message Format

G.3.2 Contents of data message

G.3.2.1 The equipment shall be able to support the 2 message type words and the 4 parameter type words as shown in Tables G.1, G.2 and G.3.

Table G.1: Message type word for Calling Number Delivery Service

Bit number	Value	Meaning	Type of data message
76543210	00000100	Calling Number Delivery Information	Single Data Message

Table G.2: Message type words for additional services

Bit number	Value	Meaning	Type of data message
76543210	10000000	Call Setup	Multiple Data Message

Table G.3: Parameter type words for Call Setup message type

Bit number	Value	Meaning
76543210	00000001	Date & Time
	00000010	Calling Line Identification
	00000100	Reason for Absence of DN
	00000111	Name

G.3.2.2 The equipment shall respond correctly to a Channel Seizure Signal consisting of a block of 300 continuous bits of alternating "0"s and "1"s (first bit to be "0") and a following Mark (logic 1) Signal consisting of 180 mark bits used to alert and condition the equipment for the reception of a message frame.

G.3.2.3 The equipment shall be able to support the data message formats used by Singapore PSTN to convey A-CLIP service information as shown in Table G.4.

Table G.4: Data Message Format for A-Clip Service

Calling Line Identification (CLI) (SDMF)	**Calling Line Identification (CLI) and Name (MDMF)**	**Calling Line Identification (CLI) Not Available (MDMF)**
Date	Date	Date
Time	Time	Time
CLI	CLI	Reason for absence of Directory Number (DN): "P" or "O"
	Name (caller's name if provided)	Name : For "P" - "PRIVATE" / "PAYPHONE" fixed characters may be sent For "O" - "OVERSEAS" / "OPERATOR" / "REMINDER" / "OUT" may be sent

G.3.3 Error Detection

The last word of the Single or Multiple Data Message is the checksum word and it shall be used for error detection. At the equipment the checksum shall be recomputed by the two's complement of the modulo 256 sum of each bit in all the other words in the message, and then compared with the checksum word received in the message. If both values are identical, the received message shall be considered as error free.

G.4 Terminal Equipment-To-PSTN Information Signalling

The equipment shall not initiate any data transmission to the PSTN.

G.5 If Caller ID facility is incorporated in a KTS, PABX or other call switching system, then the following requirements must be met:

G.5.1 The Caller ID receiver shall be directly connected to the PSTN at the exchange line interface of the call switching system.

G.5.2 The call switching system shall be able to transfer the Caller ID and/or other relevant information for display at the extension telephone for every call transfer.

G.5.3 The applicant shall submit a statement or test report confirming that the Caller ID facility has been field-tested to work correctly with the PSTN.

Annex H: Requirements for Call Switching Equipment

If TE is a Call Switching Equipment, then the following requirements shall apply to the TE connected to NTP in scenario 3.

H	Requirements for Call Switching Equipment
H.1	For an installation of call switching equipment, the connection point to the public telecommunication network shall be located at an IDF provided by the customer. The IDF shall also provide test and isolation access to each exchange circuit to the equipment (see Figure H.1).
H.2	Where the coding of voice-frequency signals for digital switching is by means of PCM, A-law companding as defined in ITU-T Rec G.711 [18] should be adopted.

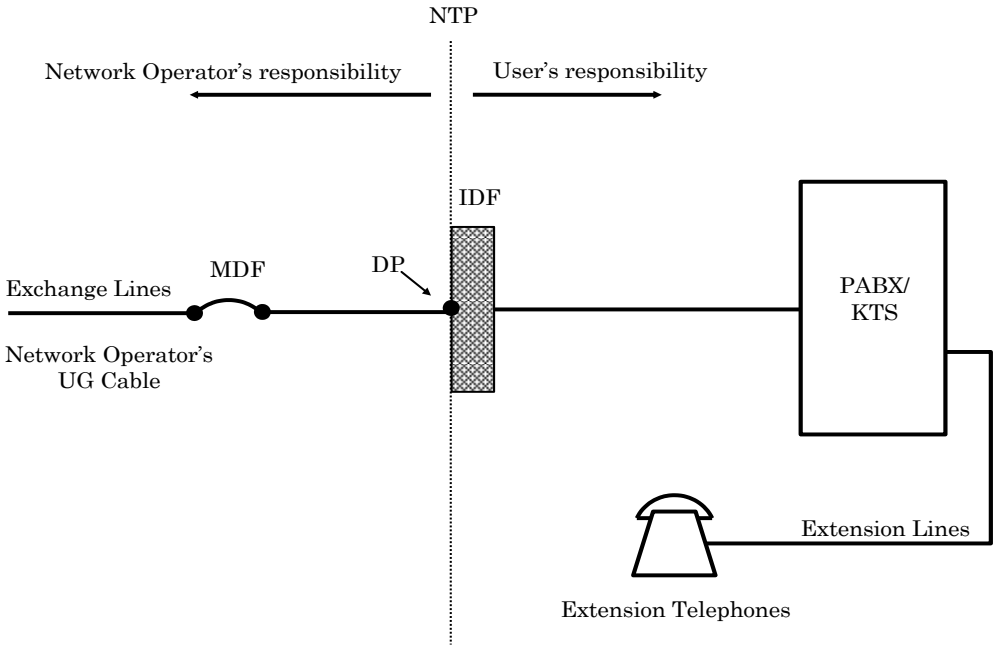


Figure H.1: **Method of connection for Call Switching Equipment**

Annex I: Requirements for Direct Inward Dialling Facility

If Direct Inward Dialling facility employing a variant of ITU-T R2 signalling system as adopted in Singapore PSTN is provided, then the following requirements shall apply to the TE connected to NTP in scenario 3.

I.1	**Line Signalling**
I.1.1	DID circuit is powered by –48 V ± 5 V d.c. supply from the PABX.
I.1.2	The maximum current drain during the idle line state shall not exceed 5 mA.
I.1.3	The minimum feed current during the line seizure state shall be at least 16 mA.
I.1.4	The d.c. line signalling between PABX and terminating exchange shall be in accordance with Table I.1.

I.2	**Register Signalling**
I.2.1	The MFC register shall be equipped to interwork with 2-out-of-6 forward signals and 2-out-of-5 backward signals (2-out-of-4 backward signals is acceptable conditionally, see clause I.3.5). The frequency combinations for the signal codes are as specified in Table I.2.
I.2.2	The forward and backward signal codes shall be used for indicating / controlling functions as specified in Table I.3.
I.2.3	The MFC signalling sequence for DID calls shall be according to Figure I.1.
I.2.4	The sending part of MFC signalling equipment shall conform to ITU-T Rec. Q.454 [19].
I.2.5	The receiving part of MFC signalling equipment shall conform to ITU-T Rec. Q.455 [20].
I.2.6	The equipment shall be capable of receiving signalling information from the exchange at a nominal rate of six digits per second.
I.2.7	The supervision of the PABX incoming register should be provided to ensure that the clear-back is sent when:
(a)	Interval between the seizure of the register and the receipt of the first forward MFC signal is > 5 s.
(b)	Interval between two successive forward MFC signals is > 5 s.
I.2.8	The PABX incoming register shall be disconnected within 30 ms after recognition of the end of transmission of the last backward signal.
I.2.9	The speech path at the PABX shall not be through connected until 75 ms after the end of transmission of the last backward signal.

I.3	**Switching of DID calls**
I.3.1	All DID circuits shall be 2-wire and unidirectional.
I.3.2	MFC signalling equipment shall be connected to circuit within 500 ms after circuit seizure.
I.3.3	If the called extension is free, the PABX shall return MFC B1 signal for the through connection to occur, and apply ringing current to the called extension and ringing tone to the calling party until the extension answers the call or a clear forward signal is received. The ringing tone shall be 425 Hz and having a periodicity of 0.4 s on, 0.2 s off, 0.4 s on and 2 s off.
I.3.4	If the called extension is engaged, the PABX shall return MFC B2 signal and await clear forward signal before restoring the DID circuit to idle state. The originating exchange on receipt of MFC B2 signal, will send busy tone to the calling party.
I.3.5	If the DID numbers received at the PABX are recognised as denied or unalloted numbers, the PABX shall take one of the following actions:
(a)	Return MFC B1 signal at call set-up and divert the call to operator for attention; or
(b)	Return MFC B1 signal at call set-up. Cause NU tone to be sent to the calling party. The PABX shall not give an answer signal; or
(c)	Return MFC B7 signal and await clear forward signal before restoring the DID circuit to idle state. The originating exchange will send Number Unobtainable (NU) tone to the calling party.
I.3.6	For a DID call from trunk offering operator, test operator (i.e. line test desk), interception operator or trunk / gateway exchange (based on forward II signals 1, 7, 8 or 9 received respectively), the PABX should divert the call to the PABX operator for attention and return MFC B1 signal.

Table I.1: DID Line Signalling

Line State	Interface Condition at		Remarks
	Terminating Exchange	PABX	
Idle	H	N	DID circuit ready for new call
Seizure	H → L	N	Signal from Terminating Exchange
Answer/Reanswer	L	N → R	Extension or operator has answered or reanswered call
Clearback	L	R → N	Called party has cleared
Clear Forward	L → H	N) R) → N	On receiving this signal, PABX clears connection and restores circuit to idle state
Back-busy	H	S/R	Circuit is blocked at the PABX end for maintenance purpose and not available for seizure

Legend:
H = High ohmic loop (greater than 20,000 ohms)
L = Low ohmic loop (400 to 900) ohms
N = Battery feed with a lead –ve and b lead +ve (0V)
R = Battery feed with a lead +ve and b lead –ve (–48V)
S = Battery removed from leads

Table I.2: Frequency Combination for MFC Signal Codes

Signal	Forward Signals for Gp I and Gp II (Hz)	1380	1500	1620	1740	1860	1980
	Backward Signals for Gp A and Gp B (Hz)	1140	1020	900	780	660	–
	Weight	0	1	2	4	7	11
1		X	X				
2		X		X			
3			X	X			
4		X			X		
5			X		X		
6				X	X		
7		X				X	
8			X			X	
9				X		X	
10					X	X	
11		X					X
12			X				X
13				X			X
14					X		X
15						X	X

Table I.3: Allocation of MFC Codes for DID

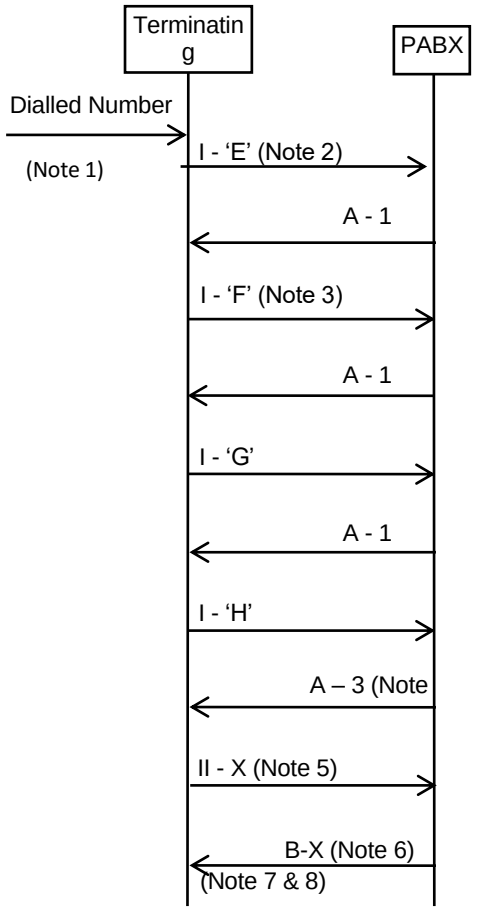
Signal	Forward Signals		Backward Signals	
	Group I	**Group II**	**A-Signals**	**B-Signals**
1	Digit 1	Operator with trunk offering	Send next digit of called number	Called party free
2	Digit 2	Ordinary subscriber or operator without trunk offering	*	Called party busy
3	Digit 3	Payphone	Send category of calling subscriber and prepare to receive B-signal	*
4	Digit 4	Subscriber with CLI non-display service	Congestion	Congestion
5	Digit 5	Coinafon	*	*
6	Digit 6	Test equipment	*	*
7	Digit 7	Line test desk	*	Unallocated/denied number
8	Digit 8	Interception operator	*	*
9	Digit 9	Call from transit exchange	*	*
10	Digit 0	Transferred call	*	*
11-15	#	Reserved for future use	#	#

Notes : 1. The DID PABX shall not send any of the signals marked *

2. Signals marked # would not be used for DID PABX

3. The DID PABX shall be able to receive and treat the call accordingly to the type of Group II signal (i.e. any one of the Group II/1 to Group II/15) received. Where a Group II signal is not defined (i.e. reserved), the DID PABX shall treat the call in the same way as for a Group II/2 signal received

4. For B7 signal, see also clause I.3.5



Note:

(1) The terminating exchange on receiving sufficient number of digits to determine the DID route will seize an idle DID circuit.
(2) Starting point of signalling to send last 4 digits to PABX.
(3) Starting point of signalling to send last 3 digits to PABX
(4) If A-4 is returned, the outgoing exchange will return congestion or busy tone to the calling subscriber and then perform line lock out.
(5) Can be any one of the Group II-1 to II-15 signals.
(6) Only one of the following B signals shall be returned: B1, B2, B4 or B7. On receipt of B-4, the outgoing exchange shall send busy tone to the calling subscriber.
(7) The B-X signal shall be returned within 2 seconds following the reception of the II-X signal.
(8) The overall MFC signalling shall, under normal conditions, take not more than 3 seconds.

Figure I.1: MFC Signalling Sequence for DID Call

Annex J: Input Procedure for Sending Alphanumeric Characters

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Annex K: Requirements for Short Message Service (SMS)

Deleted

Annex L: Requirements for POTS Splitter for use with ADSL Services

If the TE incorporates POTS splitter for xDSL system variants such as ADSL, ADSL2 and ADSL2plus, then the following requirements shall be applicable at the TE side near the NTP. Requirements are with reference to Annex E of ITU-T Rec. G.992.3 [21] § E.1, where the ADSL/POTS splitters shall comply with the ETSI TS 101 952-1 [22].

Table L.1: Testing Conditions & Methods

Testing Conditions & Methods		**ETSI TS 101 952-1 [22]**	**IDA TS PSTN**
DC Testing Conditions		**§ 5.1**	-
Polarity independence	The splitter shall conform to all the applicable requirements of this Annex for both polarities of the DC line-feeding voltage.	§ 5.1.1	§ 2.2
DC feeding conditions (on/off-hook)	On-hook requirements are tested with a DC load of several MΩ and a negligible current. Off-hook electrical requirements shall be met with a DC current of 13 mA to 80 mA.	§ 5.1.2	§ 6.2.1.1 § 6.2.2.1
AC terminating impedances Z_{AC}		**§ 5.2**	§ 6.2.1.2 § 6.2.1.3 § 6.2.2.2 § 6.2.2.3
High pass filter implementation		**§ 5.3**	-
General transmission test set-up (Insertion Loss & Return Loss)		**§ 5.3**	§ 6.2.2.3
Unbalance measurement		**§ 5.5**	§ 6.3
Noise measurement (Not required, only applicable for active/dynamic splitters)		**§ 5.6**	-
Common Mode Rejection Ratio measurement		**§ 5.7**	**-**

Table L.2: Splitter Requirements

Common requirements for passive POTS splitters	**Splitters over POTS for xDSL (§ A.2 of ETSI TS 101 952-1)**	**ETSI TS 101 952-1 [22]**	**IDA TS PSTN**
DC resistance to earth	> 20 MΩ	§ 6.2.1	-
DC insulation resistance between A-wire and B-wire	> 5 MΩ	§ 6.2.2	§ 6.1
DC series resistance	< 50 Ω	§ 6.2.3	§ 6.2.3
Ringing voltage drop at 25 Hz	< 2 V (source e.m.f. 35 V_{RMS})	§ 6.3.1	-
Z_{InRing} impedance in the presence of ringing at 25 Hz	> 40 kΩ / 36 kΩ	§ 6.3.2	§ 6.2.1.3
Total harmonic distortion at 25 Hz	< 10 %	§ 6.3.3	-
On-hook requirement for the case of high impedance termination (insertion loss)	± 4 dB in 200 Hz – 2.8 kHz	§ 6.4.1	-
Low impedance on-hook POTS pass band insertion loss	< 1 dB at 1 kHz	§ 6.4.2.1	-
Low impedance on-hook POTS pass band insertion loss distortion	< 1 dB relative to IL at 1 kHz	§ 6.4.2.2	-
Off-hook POTS pass band insertion loss	< 1 dB at 1 kHz	§ 6.5.1	-
Off-hook POTS pass band insertion loss distortion	< 1 dB relative to IL at 1 kHz	§ 6.5.2	-
POTS pass band return loss requirements, option A (Note: A value of 14 dB for the minimum Return Loss instead of 12 dB is desirable.)	< 12 dB in 300 Hz to 3.4 kHz < 8 dB in 3.4 kHz to 4 kHz	§ 6.6.1	§ 6.2.2.2 § 6.2.2.3
Unbalance of the low pass	> 40 dB in 50 Hz to 600 Hz > 46 dB in 600 Hz to 3.4 kHz > 40 dB in 3.4 kHz to 4 kHz	§ 6.8.1	§ 6.3
	> 40 dB in 4 kHz – f_L > 50 dB in f_L – 1.1 MHz		
	> 40 dB in 4 kHz – f_L > 50 dB in f_L – f_H > 30 dB in f_H – f_{Max}		
Unbalance of the high pass part for alternative B or C	> 45 dB in f_L – f_H > 30 dB in f_H – f_{Max}	§ 6.8.2	-
xDSL band on-hook isolation between LINE and POTS port	> 34 dB in f_L – f_{M2} > 51 dB in f_{M2} – f_H	§ 6.9.1	-
xDSL band off-hook isolation between LINE and POTS port	> 55 dB in f_L – f_H	§ 6.9.2 Option A	-
xDSL signal loss: IL LINE port to xDSL port	-0.5 dB < Att_{DB} < 3 dB in f_L – 50 kHz -0.5 dB < Att_{DB} < 1 dB in 50 kHz – f_H	§ 6.9.4	-
Group delay distortion	< 250 µs in 200 Hz – 600 Hz < 200 µs in 600 Hz – 3.2 kHz < 250 µs in 3.2 kHz – 4 kHz	§ 6.12	-

Annex M: Addendum/Corrigendum

Revised TS		Items Changed	Date of Issue
Page	**Section**		
Changes to IDA TS PSTN Issue 2, October 2013			
4	§3.3	The IMDA TS PSTN Issue 1 (October 2016) has replaced the IDA TS PSTN Issue 2 (October 2013). Changes are largely editorial to provide updates and clarity in the application of EMC and safety requirements, in line with standards development that has taken place in the Standards Development Organisation concerned.	1 Oct 16

Changes to IDA TS PSTN Issue 1 Rev 2, May 11			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
3 (Issue 2, page 2)	§ 1	Scope of the Specification has been enlarged to cover all types of analogue terminal equipment (TE) that can be connected to the Public Switched Telephone Network (PSTN); or the network terminating equipment (NTE), which presents the PSTN functions for IP or next generation networks to interwork with the analogue TE. It defines the telecommunications access interfaces or network termination points (NTP) available to end-users for connecting analogue TE with reference to Figure 1 (Figure 3 of ETSI EG 201 730-1). There are no changes to the basic requirements set out previously in the IDA Technical Specification for analogue TE for connecting to PSTN (IDA TS PSTN Issue 1 Rev 2, May 2011). It has been re-issued as the IDA Technical Specification for Terminal Equipment connected to Network Terminating Equipment (NTE) or the Public Switched Telephone Network (PSTN) for access to voice band services (IDA TS PSTN Issue 2).	29 Oct 13
3 (Issue 2, page 3)	§ 2.2	In addition to the requirement for TE to be independent of line polarity (scenario 3 for legacy PSTN connection given in Figure 1), it is made known that the polarity of the DC voltage presented at the NTP in scenario 1 is arbitrary with respect to the TE and the NTE (ETSI ES 201 970, § 6.1).	
4 – 11 (Issue 2, pages 4 – 12)	§ 4 – 7 and Annex A	Requirements for connection to NTP in scenario 1 with reference to Figure 1 (Figure 3 of ETSI EG 201 730-1) and the ETSI ES 201 970 have been added, in comparison with the existing requirements for connection to NTP in scenario 3 (the legacy PSTN connection). Table 1: Ringing Signal and Service Tones in the Public Switched Telephone Network (PSTN) has been changed to Table 1a: Ringing Signal and Service Tones from the Public Switched Telephone Network (PSTN) and Table 1b: Ringing Signal and Service Tones from the Network Terminating Equipment (NTE) (§12&13 ES 201 970 [3]).	
16 (Issue 2, page 17)	Annex E, § E.1.6 § E.2.3	Annex E has been updated for payphones connected to NTP in scenario 1 or 3 that are designed to accept Singapore coins as the means of payment, and can be set to the prevailing tariff rate for local call in Y ¢ per X-minute block. Unused coins other than the coin(s) that amount to Y ¢ shall be refunded if there is no warning to users for him to insert Y ¢ coin(s), one (amount) at a time.	
18 (Issue 2, page 18) 21 (Issue 2, page 20)	Annex F, § F.2.10 Figure F.1	Annex F has been updated for smart card or multi-coin payphones connected to NTP in scenario 1 or 3 in which an initial fee (Y ¢ for local and STD calls and Z ¢ for IDD calls) shall be deducted from the credit when the call is answered. The debiting procedure has been updated for 1st Y ¢ debited for STD calls or 1st Z ¢ debited for IDD calls when the called party answers. X-minute, Y and Z ¢ shall be set according to the prevailing tariff rates.	
22 (Issue 2, page 21)	Annex G	The IDA Technical Specification for Analogue Calling Line Identity Presentation Facility for connection to Public Switched Telephone Network (IDA TS ACLIP)	

Changes to IDA TS PSTN Issue 1 Rev 2, May 11			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
		has been withdrawn, as the technical requirements for receiving A-CLIP information have been incorporated in Annex G of this Specification.	
32 (Issue 2, page 30)	Annex J	Annex J for "Input Procedure for Sending Alphanumeric Characters" has been deleted as the facility is no longer supported.	
33 (Issue 2, page 31)	Annex K	Annex K on "Requirements for Short Message Service (SMS)" has been deleted as the facility is no longer supported.	
34 (Issue 2, page 32)	Annex L	Annex L has been updated for TE which incorporates POTS splitter for xDSL system variants such as ADSL, ADSL2 and ADSL2plus at the TE side near the NTP. Requirements are with reference to Annex E of ITU-T Rec. G.992.3 § E.1, where the ADSL/POTS splitters shall comply with the ETSI TS 101 952-1.	

Changes to IDA TS PSTN Issue 1 Rev 1, Mar 07			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
–	–	Change of IDA's address at cover page to Mapletree Business City.	1 May 11

Changes to IDA TS PSTN Issue 1			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
15	Annex D	Requirements for Cordless Telephone facility has been amended to include the provisions given in IDA TS SRD.	1 Mar 07
		Following the announcement on 'IDA Relaxes Its Policy on Uniform Local Payphone Rate' on 31 Jan 07, the following annexes have been amended:	1 Mar 07
16	Annex E, E.1.6 and E.1.7	The two clauses have been combined and revised. The timer charging rate has been changed from "10 ¢ per 3-minute block" to "10 ¢ per X-minute block. X shall be equal to or greater than 2, and can be changed to greater than 2, if required".	
21	Annex F, Figure F.1	The Figure F.1 on Debiting Procedure has been updated to reflect the change in the timer setting for local call.	

Changes to IDA TS PSTN 1 Issue 4 Rev 2			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
–	–	Title of Specification has been renamed as "Technical Specification for Terminal Equipment connecting to the Public Switched Telephone Network (PSTN)" (IDA TS PSTN Issue 1). The IDA Type Approval Specification for Terminal Equipment for connection to Public Switched Telephone Network (IDA TS PSTN 1 Issue 4 Rev2) has been superseded by this Technical Specification This Technical Specification has also incorporated the EMC requirements, previously published under the IDA TS EMC Issue 1 Rev 1. Changes are mainly editorial in nature, in which the essential technical requirements for compliance remain unchanged.	21 Jul 05