International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.173
(11/2005)

SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

IPCablecom

IPCablecom embedded MTA primary line support

ITU-T Recommendation J.173

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Summary

This Recommendation defines the embedded MTA (E-MTA) requirements for the analogue interface and for powering of the E-MTA. An embedded MTA is a Cable Modem (CM) integrated with an IPCablecom Media Terminal Adapter (MTA).

The purpose of this Recommendation is to define a set of requirements that will enable a service that is sufficiently reliable to meet a consumer expectation of essentially constant availability, including, availability during power failure at the customer's premises, and (assuming the service is used to connect to the PSTN), access to emergency services.

Source

ITU-T Recommendation J.173 was approved on 29 November 2005 by ITU-T Study Group 9 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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CONTENTS

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1 Scope

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The purpose of this Recommendation is to define a set of requirements that will enable a service that is sufficiently reliable to meet a consumer expectation of essentially constant availability, including, availability during power failure at the customer's premises, and (assuming the service is used to connect to the PSTN), access to emergency services.

2 References

2.1 Normative references

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- ITU-T Recommendation J.161 (2001), *Audio codec requirements for the provision of bidirectional audio service over cable television networks using cable modems*.
- ITU-T Recommendation J.162 (2005), *Network call signalling protocol for the delivery of time-critical services over cable television networks using cable modems*.
- ITU-T Recommendation J.172 (2005), *IPCablecom management event mechanism*.

2.2 Informative references

- ITU-T Recommendation J.160 (2005), *Architectural framework for the delivery of time-critical services over cable television networks using cable modems*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 E-MTA: Term used in this Recommendation generically representing the CM and MTA combination. This could be an embedded MTA or a stand-alone MTA.

3.2 Media Terminal Adapter (MTA): An MTA is an IPCablecom client that can be attached to a CM (stand-alone) or integrated with a CM (embedded) that supports POTS.

4 Abbreviations, acronyms and conventions

4.1 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

A/D	Analog to Digital converter
AN	Access Node
CM	Cable Modem
CMS	Call Management Server
CPE	Customer Premises Equipment
E-MTA	Embedded MTA
HFC	Hybrid Fibre Coax
MTA	Media Terminal Adapter
NCS	Network Call Signalling (the IPCablecom MGCP profile used for controlling calls)
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
SNMP	Simple Network Management Protocol
UPS	Uninterruptible Power Supply

4.2 Conventions

If this Recommendation is implemented, the key words "MUST" and "SHALL" as well as "REQUIRED" are to be interpreted as indicating a mandatory aspect of this Recommendation.

The key words indicating a certain level of significance of a particular requirement that are used throughout this Recommendation are summarized as follows:

"MUST"	This word or the adjective "REQUIRED" means that the item is an absolute requirement of this Recommendation.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this Recommendation.
"SHOULD"	This word or the adjective "RECOMMENDED" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label.
"MAY"	This word or the adjective "OPTIONAL" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

5 Introduction

This Recommendation covers requirements for the E-MTA necessary to support primary line service. It is the intention of this Recommendation to address requirements only for the E-MTA.

The *E-MTA* is defined as an IPCablecom MTA integrated with a cable modem. See 5.1 for a complete description of the E-MTA.

The service referred to in this Recommendation is voice-grade communications, including communications with stations on the public switched telephone network (PSTN). "Primary line service" refers to service sufficiently reliable to meet a consumer expectation of essentially constant availability, including, specifically, availability during power failure at the customer's premises, and (assuming the service is used to connect to the PSTN), access to emergency services.

To enable support for reliable service, three E-MTA interfaces have been identified:

1) powering the E-MTA;
2) telemetry support; and
3) the analog POTS interface.

Powering the E-MTA is critical for the service to function during periods when utility power fails. Consequently, the power consumption characteristics of the E-MTA will enable service providers to offer alternate powering techniques.

Telemetry support enables the service provider to remotely monitor the status of the E-MTA. The first application of telemetry enables remote monitoring of the E-MTA power source.

The analog POTS interface requirements ensure that CPE that meets telephone industry interoperability requirements (normal telephones, answering machines, etc.) will also operate in the IPCablecom environment. Note that the voice-grade analog transmission requirements are dependent on the compression algorithm utilized to transport the packetized voice signal in the IPCablecom architecture. These requirements are derived from existing PSTN requirements that are based on a full 64 kbit/s voice channel. Therefore, the requirements specified are relevant only for the G.711 audio codec. Other audio codec compression algorithms specified by ITU-T Rec. J.161 are not currently addressed in this Recommendation.

Note also that the telemetry interface specified in this Recommendation is between the E-MTA and an external local uninterruptible power supply (UPS). The UPS itself is not within the scope of this Recommendation, so specific requirements for the UPS are not included here. Nonetheless, requirements for the E-MTA telemetry interface may have certain design implications on the UPS.

5.1 Media Terminal Adapter (MTA)

An MTA is an IPCablecom client device that contains a subscriber-side interface to the subscriber's CPE (e.g., telephone) and a network-side signalling interface to call control elements in the network (e.g., Call Management Server (CMS)). An MTA provides codecs and all signalling and encapsulation functions required for media transport and call signalling.

MTAs reside at the customer site and are connected to other IPCablecom network elements via the HFC access network (ITU-T Recs J.112 or J.122). IPCablecom MTAs are required to support the Network Call Signalling (NCS) protocol.

IPCablecom only defines support for an embedded MTA. An embedded MTA (E-MTA) is a single hardware device that incorporates a J.112/J.122 cable modem as well as an IPCablecom MTA component. Figure 1 shows a representative functional diagram of an embedded MTA. Additional MTA functionality and requirements are further defined in ITU-T Rec. J.160.

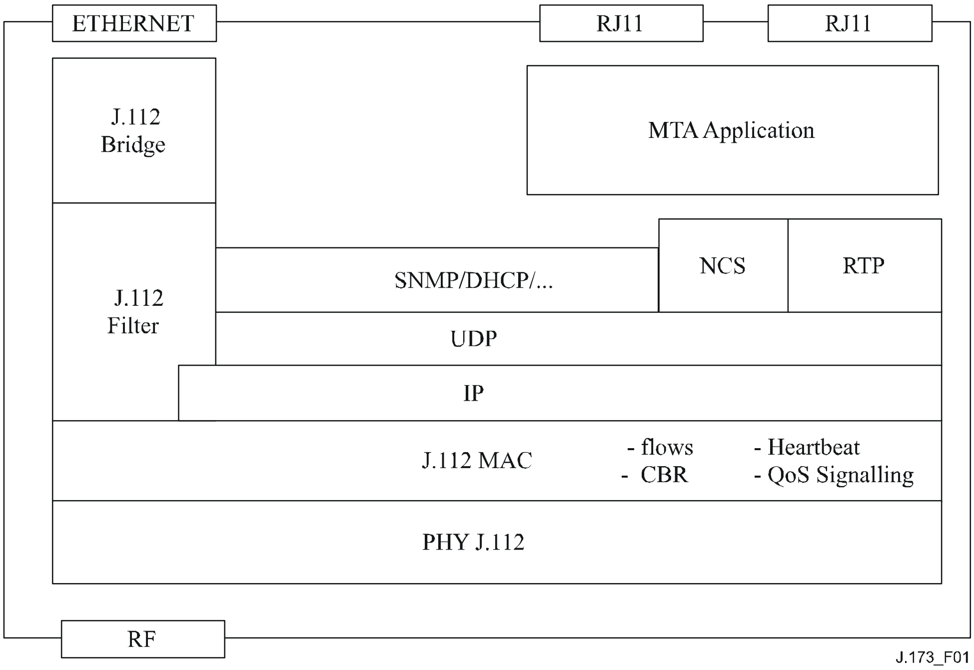

Figure 1/J.173 – Embedded MTA

6 E-MTA monitoring requirements

The E-MTA is a critical element in the IPCablecom architecture. It provides the customer's interface to the service provider's network and is located outside the service provider's "headend". As such, it is critical that the operational status of the E-MTA be monitored in order to provide the quickest information to the service provider. This clause details the critical monitoring requirements of the E-MTA.

6.1 E-MTA alarms

The E-MTA functions as the customer premises *network interface* to the IPCablecom network and thus enables service to the customer. If the E-MTA fails and is not capable of providing the intended service, the service provider will need to know about this condition quickly (and preferably before the customer).

The minimum goal of fault management should be to isolate failures to a *field replaceable unit.* This enables the service provider to confidently dispatch service personnel with the appropriate equipment necessary to repair the problem in the least amount of time (i.e., minimize MTTR). Since the MTA is embedded, or integrated with the CM, the E-MTA can be considered a field replaceable unit.

6.1.1 CM failures

The CM provides the critical connection between the MTA and the IPCablecom/J.112 network. A CM failure will affect the availability of the service.

IPCablecom service will rely on the CM failure detection mechanisms. In this Recommendation, ITU-T Recs J.112/J.122 refer to events that the CM must detect as well as events the CMTS must detect.

6.1.2 MTA failures

The minimum MTA monitoring MUST utilize the CM failure detection mechanisms since the CM and MTA are integrated together.

Additional MTA monitoring mechanisms **MAY** be developed but are not defined in this Recommendation. For example, the E-MTA may include internal on-line diagnostics utilized to detect vendor-specific events.

6.2 E-MTA telemetry

The telemetry feature provides the ability for the E-MTA to transmit alarm information to the headend. The alarm information could reflect status of the E-MTA itself or of a supporting device connected to the E-MTA.

One powering option of the E-MTA is local power with uninterruptible power supply (UPS) battery backup. Maintaining constant power at the E-MTA is important to providing service. For example, an operator may want the service to continue to function when the commercial utility power fails at the subscriber's home. Thus, an alternate power source is required to bridge the gap when utility power is not available.

The telemetry feature specified here is initially intended for UPS battery alarms. However, the UPS powering option of the E-MTA may not always be used. As such, the design allows enough flexibility for the telemetry feature to be utilized for other purposes. This clause will define the specific UPS battery alarm usage. Other usage of telemetry is not defined and is outside the scope of this Recommendation.

The UPS may be a separate, external device connected to the E-MTA or an internal device, integrated with the E-MTA. The physical telemetry interface defined in this Recommendation is for the external UPS device. An internal UPS is not required to support the same physical interface.

6.2.1 Telemetry signals (External interface)

The E-MTA alarm telemetry input signals MUST determine the input state by sensing the presence of a short circuit to ground (low) or an open circuit condition (float high) on the input connection (open drain compatible). The alarm *active* state is defined as the open circuit condition (float high). The alarm *inactive* state is defined as the short circuit to ground (low).

A telemetry common signal separate from the 48V DC return signal MUST be provided. Since the E-MTA power supply input is required to support AC network power, both of the power supply input pins will be floating with respect to ground. Therefore, a separate telemetry common signal is required to establish a common ground reference between the E-MTA and UPS.

Note that this interface forces the external device to "actively" control the signal states. In other words, the device must actively short-circuit the signal to ground to signal an inactive alarm state, and must actively open the circuit to float high to signal an active alarm state. This provides a fail-safe mechanism such that if any or all of the signals become disconnected from the E-MTA, they will float high and thus indicate an active alarm condition. For example, it is not valid for all 4 UPS alarms to be active at the same time (cannot operate off battery if a battery is not present). Therefore, if such a condition is detected, it is possible to deduce that the UPS has become disconnected from the E-MTA.

6.2.2 Telemetry Signal 1 – AC fail

The active alarm state of this signal indicates an "AC Fail" condition, which means the UPS has detected a failure of the utility AC power and is operating off its battery.

The inactive alarm state of this signal indicates an "AC Restored" condition which means the UPS has detected the presence of utility AC power and is no longer operating off its battery.

6.2.3 Telemetry Signal 2 – Replace battery

The active alarm state of this signal indicates a "Replace Battery" condition which means the UPS, via internal test mechanisms outside the scope of this Recommendation, has determined that the battery can no longer maintain a charge sufficient enough to provide the designed amount of battery backup (e.g., 8 hours of battery backup) and thus is failing and should be replaced with a new battery.

The inactive alarm state of this signal indicates a "Battery Good" condition.

6.2.4 Telemetry Signal 3 – Battery missing

The active alarm state of this signal indicates a "Battery Missing" condition, which means the UPS, has detected that a battery is not present and a battery should be installed in the UPS.

The inactive alarm state of this signal indicates a "Battery Present" condition.

6.2.5 Telemetry Signal 4 – Battery low

The active alarm state of this signal indicates a "Battery Low" condition which means the battery has sufficiently discharged (e.g., 75% discharged) to the point where a power source can only be maintained for a short while longer.

The inactive alarm state of this signal indicates a "Battery Not Low" condition which means the battery has charged above the "battery low" threshold (e.g., at least 25% charged).

6.2.6 OSS event reporting

The MTA MUST support the event and alarm reporting mechanism as defined in ITU-T Rec. J.172. Furthermore, the MTA MUST support the Powering events as defined in ITU-T Rec. J.172.

7 E-MTA power requirements

This clause defines the power requirements of the E-MTA. Since national power safety regulations vary, several items in this clause provide general guidelines that must be adapted to the local or national environment.

7.1 Power considerations

E-MTA powering is an important element in providing reliable telephone service through HFC cable networks. There are two basic methods to power the E-MTA:

1) local with battery backup; and
2) network powering.

Local power refers to utilizing the subscriber's home AC utility power as the supply for the E-MTA. A battery backup is utilized when the utility power fails. Network power refers to utilizing power supplied by the service provider via their HFC cable network.

A key consideration in HFC power system design is maintaining power to the E-MTA even when local AC power has failed. In general, the power system should provide an E-MTA with sufficient backup power (to accommodate typical power outages) for a typical E-MTA traffic model. This creates constraints on power consumption for locally powered systems that provide battery backup. An E-MTAs average power consumption directly affects the size and cost of the backup batteries.

Although network power centralizes backup power reserves, E-MTA power consumption nevertheless directly affects the cost and size of a power node. In addition, in network powered systems, other conditions exist that limit the amount of power that can be delivered to an E-MTA (e.g., a coaxial power passing tap).

7.2 Typical E-MTA traffic model

In order to properly dimension the power equipment, it is necessary to calculate long-term average power usage. Since these are likely to vary considerably from location to location, it is impossible to have a single answer. One method to estimate the average long-term power requirements is contained in Appendix I.

7.3 Power passing tap limitations

Power passing taps typically have a maximum continuous current rating that specifies limits on the amount of current that can be supplied to a particular "drop" off of the network (the drop is the section of coax connecting the operator network to the subscriber's home). Power passing taps contain a self-resetting protection device that is rated at some value (typically 350 mA) of continuous current. Since the network power voltage can vary at the subscriber interface it is necessary to consider the worst case, typically 40 V AC. Therefore, for the worst case, the maximum continuous power that can be supplied to a network device on the drop is about 14 VA rms (VA = watts − power factor) before the self-resetting protection device of the power passing tap activates.

IPCablecom network powered E-MTAs SHOULD **NOT** exceed 14 VA rms power consumption in any continuous mode of operation. Furthermore, network powered E-MTAs MUST limit input current to less than the trip value of the power passing tap as specified in national standards in any continuous mode of operation for input voltages in the range permitted by national practice. Continuous mode of operation refers to any sustained mode that would draw more than 14 VA rms and thus potentially cause the power passing tap protection device to activate. For example, all lines off-hook with data traffic running at maximum average throughput for the device under consideration would be considered a sustained, continuous mode of operation while cadence ringing would not. In general, higher ringing currents can be tolerated due to the slow reacting nature of the self-resetting protection device.

7.4 Average power calculations

For network powered systems, E-MTA power is also limited by the total power available from the power node and the required number of E-MTAs to be supported from each node. Because a common power source is being utilized to power a large number of E-MTAs, long-term average E-MTA power can be utilized for power node calculations instead of maximum E-MTA power. Since E-MTAs will operate in various modes (on-hook, off-hook, ringing, etc.), a statistical traffic model can be used to characterize long-term average E-MTA power and furthermore the number of E-MTAs that can be supported in a particular power node domain can be calculated.

For local powered systems with battery backup, long-term average E-MTA power can be utilized to determine the typical battery backup time for a particular E-MTA and UPS combination. By dividing the battery's effective watt-hour rating by the E-MTAs average power rating, and taking into account power conversion and wire I-R loss effects, the typical battery-backed operation time can be determined.

7.5 Power factor considerations

Since network power utilizes alternating current (AC), the power factor of a device also affects a node's power calculation. Power factor specifies the ratio of watts to volt-amps.

The IPCablecom power factor of an E-MTA device SHOULD be 0.85 or greater to ensure efficient utilization of the available network power.

To stress that power factor must be accounted for in E-MTAs, power figures MUST be specified in terms of Volt-Ampere (VA) rather than Watts (W).

7.6 E-MTA average power requirements

Since many different HFC power node domain architectures exist, it is not possible to calculate an E-MTA average power requirement that relates to all architectures. Nonetheless, several common power consumption objectives have been specified to enable efficient powering capabilities.

For example, the average E-MTA power consumption SHOULD be less than or equal to 5 VA when applying the traffic model in Appendix I. The average power consumption refers to the typical long-term average consumption of the device and is intended to provide a reference for designing the power node architecture.

7.7 Service requirements under AC fail conditions

For local power with battery backup, the E-MTA device is aware of AC power failure via the UPS telemetry inputs or via internal means with an embedded UPS. Since data traffic is not required for IPCablecom service, data service **MAY** be de-activated immediately under local AC power fail conditions. However, all lines provided by an E-MTA MUST remain operational (operational means capable of originating calls, ringing, and terminating calls, if provisioned as in-service).

7.8 Power source compatibility

To provide flexibility to make powering decisions on a node-by-node basis and to allow local power-to-network power migration, outdoor primary line E-MTAs MUST support both network power and local power with battery backup (as defined below). Since network powering is removed from the coax drop before entering the home, indoor primary line E-MTAs MUST support local powering with battery backup and are not required to support network power.

7.9 Network powering

Network power is supplied from a power node controlled by the service provider and is distributed through the HFC plant via the network cable. It is common practice for Network power to be delivered from the "tap" to the E-MTA either through centre conductor powering (centre coax conductor) or through composite pair (siamese pair) powering.

7.9.1 Centre conductor delivery

Centre conductor network power delivers power on the centre conductor of the coaxial cable drop. Outdoor E-MTAs MUST be capable of extracting power from the centre conductor of the coaxial cable. If an E-MTA provides a subscriber side coaxial drop, network power MUST be removed from the subscriber drop such that network power does not enter the customer's premises. If an E-MTA provides a subscriber side coaxial drop, greater than 60 dB of Isolation MUST be provided between the network side coaxial drop and the subscriber side coaxial drop at frequencies that relate to the commercial AC power used in the location. That is 50 Hz, 100 Hz, 150 Hz and 200 Hz when 50 Hz AC power is used and 60 Hz, 120 Hz, 180 Hz, and 240 Hz when 60 Hz AC power is used. To prevent the introduction of "AC HUM" into the coexisting RF signals, for an E-MTA that provides a subscriber side coaxial drop, the E-MTA MUST **NOT** degrade Hum Modulation more than 3% toward the subscriber side drop.

In centre conductor network power mode, the composite pair power terminals MUST **NOT** present a shock hazard.

7.9.2 Composite pair delivery

Composite pair network power delivers power on a separate pair of wires that are bundled with the coaxial cable drop (siamese) from the tap. E-MTAs MUST be capable of accepting power through a separate pair of input terminals. The power-input terminals MUST be compatible with telephone house wire. The power-input terminals **MAY** also be compatible with any other gauge wire.

7.9.3 Network power characteristics

At the input of the device, E-MTAs supporting network power MUST be compatible with and properly operate from the voltage range and wave characteristics specified in national practice.

7.10 Local powering with battery backup

Local powering is accomplished utilizing an uninterruptible power supply (UPS) that converts household AC power to DC power for the E-MTA. The UPS also provides battery backup to bridge E-MTA operation through typical local power outages. In addition, telemetry signals provide remote monitoring capability for local AC power and battery conditions. Outdoor E-MTA devices will typically utilize a separate UPS such that batteries can be placed inside the customer's facility. The indoor climate controlled environment is typically desired for battery placement to maximize battery life. E-MTAs utilizing an external UPS will require metallic connections between the two units for transmission of power and telemetry information. E-MTA implementations **MAY** include an embedded UPS or utilize an external UPS depending on the vendor implementation.

7.10.1 E-MTA to UPS interface

A standardized interface is defined between the E-MTA and an external UPS to allow vendor interoperability between the two devices. This interface is comprised of seven (7) conductors including two (2) for DC power, four (4) for telemetry signals, and one (1) for telemetry ground reference. The external E-MTA-UPS interface MUST be included on E-MTA implementations that do not provide embedded UPS functionality. For E-MTAs with embedded UPS functionality, there is no requirement to provide the physical E-MTA-UPS interface signals externally; however, the embedded telemetry information MUST still be made available to upstream network management systems as defined in clause 6.

7.10.1.1 Physical connection

Since the interface cable between the E-MTA and UPS will typically be cut to length, the E-MTA SHOULD provide individual connections for each conductor but **MAY** utilize a standard multi-pin connector. The specific type of connection device will not be specified; however, the connection device MUST support typical telephone building wire. The connection device **MAY** also support any other gauge wire.

7.10.1.2 Power signals (External UPS)

The power interface is designed to provide 20 watts of peak power to the E-MTA which provides ample power for E-MTA implementations supporting a high-speed data link and up to 4 telephony lines with a total ringing load of 10 REN. To enable the use of typical telephone house wire for the interface, 48 V DC nominal power is being required.

The E-MTA without embedded UPS functionality, MUST support the following input voltage range:

Signal	Value
Power	+48 V DC nominal, +42 V DC min, +51 V DC max
Power return	48 V DC Return

8 MTA analog port requirements

The MTA analog port represents an interface between the IPCablecom/Cable Modem/IP (Internet protocol) network and devices designed to function when connected to the PSTN using standard PSTN interfaces. The subscriber side of this interface is an analog interface consistent with the PSTN and the network side of this interface is a digital interface to the IP-based IPCablecom network, which rides on top of the J.112 transport. It is expected that many cable operators will choose to use the IPCablecom architecture to offer service to customers in residential dwellings. In such applications, the MTA will reside at the subscriber premises, either inside or outside. The MTA will, in the context of the IPCablecom network, be analogous to the NIU (network interface unit) or NID (network interface device) as those terms are used in connection with the PSTN. Finally, because the network side of the port interface is digital, and the device resides close to the subscriber, the analog subscriber side of the port interface will only be required to support relatively short metallic (copper twisted pair) drops (i.e., 150 metres).

For basic IPCablecom service, the interface requirements can be divided into four categories:

- Loop Start Signalling;
- General Supervision;
- General Ringing;
- Voice Grade Analog Transmission.

Most MTA analog 2-wire interface parameters are listed below. Since the actual values used vary from country to country, it will be necessary to conform to the national practice of each country or region. One example is contained in Appendix II.

8.1 Loop start signalling

Loop Start Signalling should consider the following parameters:

- DC Supervisory Range;
- Idle State voltage;
- Loop Closure Detection;
- Loop Open Detection;
- Off Hook Delay;
- On hook Delay;
- Ringsplash;
- Distinctive Ringing;
- Transmission Path.

8.2 General supervision

General Supervision should consider the following parameters:

- Off-Hook Loop Current;
- Immunity to Line Crosses;
- System Generated Open Intervals;
- Open Switched Interval Distortion;
- Dial Pulsing;
- DTMF Signalling;
- Dialtone Removal.

8.3 General ringing

General Ringing should consider the following parameters:

- Alerting Signals;
- Ringing Delay;
- Ringing Source;
- Ringing Capability;

- Ringing Capacity;
- Ring Trip;
- Ring Trip Reporting Delay;
- Ring Trip Immunity.

8.4 Voice grade analog transmission

The IPCablecom system utilizes digital transmission of voice signals to and from the MTA. The MTA converts between the digital voice signal on the IP network and the analog voice signal on the tip and ring loop. System impairments in the digital network, such as packet loss, can affect the voice signal but are outside the control of the MTA. Therefore, this clause defines the analog voiceband requirements of the MTA and assumes an error-free digital network.

These requirements are derived from the PSTN which, in some cases, utilizes analog transmission from a headend central office switch to a customer. Typically, the reference point by which these requirements are measured is the middle of the switch (digital-to-analog). This reference point is referred to as the 0 Transmission Level Point (TLP) and could be thought of as any point in the digital portion of the network. Note that these are not end-to-end analog requirements since they apply to a single digital-to-analog conversion point (a typical voice call will be analog at each end with a digital network connecting the two ends).

The 0 TLP of the IPCablecom system is any point in the digital IP network. The digital IP network, for voice signal transmission purposes, extends all the way to the MTA where the digital-to-analog conversion occurs.

These requirements only apply to the G.711 audio codec as specified in ITU-T Rec. J.161. Transmission requirements for the other compression algorithms specified in ITU-T Rec. J.161 are not yet defined.

Specific parameters to be considered include:

- Input Impedance;
- Hybrid Balance;
- Longitudinal Balance;
- MTA Loss;
- MTA Loss Tolerance;
- Frequency Response;
- 50 or 60 Hz Loss;
- Amplitude Tracking;
- Overload Compression;
- Idle Channel Noise;
- Signal to Distortion;
- Impulse Noise;
- Intermodulation Distortion;
- Single Frequency Distortion;
- Generated Tones;
- Peak-to-Average Ratio;
- Channel Crosstalk.

Appendix I

Typical E-MTA traffic model

A projected "typical" E-MTA traffic model has been developed and is in Table I.1 below. As the IPCablecom architecture is actually deployed in the field, and as consumer demand for services using that architecture continues to evolve, individual cable operators with actual IPCablecom implementations may experience significantly different traffic characteristics. Thus, it will be necessary, over time, to update this "typical" traffic model based on actual experience in the field. With those qualifications, this model may be used to calculate long-term average power.

Table I.1/J.173 – E-MTA traffic model

Line number	MTA Line 1	MTA Line 2	MTA Line 3	MTA Line 4	Cable modem data
Assumed Use	Voice	Modem/ Voice	Voice/ Fax	Voice	High Speed Data
Erlang/CCS	.11/4	.11/4	.06/2	.06/2	.11/4
Line Penetration (Normalized by Penetration)	100%	80%	50%	25%	25%
Average Ringing Period	14 s	14 s	14 s	14 s	n/a
Average call length					
E-MTA w/o Data Service	5 min	26 min	5 min	5 min	n/a
E-MTA with Data Service	5 min	5 min	5 min	5 min	n/a
Average Data Rate to Subscriber	n/a	n/a	n/a	n/a	100 kbit/s
Average Data Rate From Subscriber	n/a	n/a	n/a	n/a	10 kbit/s

The average cable modem data rates shown in column 5 assume that when a user is active on the system (i.e., .11 Erlang or 4 CCS), the user is interpreting or typing information during 90% of the active session, and no significant data is flowing through the data interface. Data interface rates of 1 Mbit/s to the subscriber and 100 kbit/s from the subscriber are assumed during the remaining 10% of the session. The averages are assumed to be long-term and are considered over the entire domain of a power node (i.e., 100's of E-MTAs).

Appendix II

Analog interface values for North America

Terminology

For the purpose of this clause, the subscriber twisted pair copper wiring (typically the wiring inside the subscriber's premises) that is connected to the E-MTA analog port will be referred to as the "loop". Note that this usage is different from the way these terms may be used in the context of the PSTN, in which the "loop" is defined as the transmission path between a telephone company central office and a customer's premises. The "loop" referred to in this clause, in PSTN terms, would typically be referred to as "premises wire" or "inside wire". References here to "loops" and "transmission paths" should not be confused with links from customer premises to either a telephone company office or to a cable operator's headend.

II.1 Loop start signalling

The DC supervisory range MUST meet: $R_{DC} \geq 450$ ohms. R_{DC} is the DC supervisory range. The actual value of R_{DC} depends on the resistance of the loop wire from the E-MTA (the subscriber's inside wiring). That is, $R_{DC} = 430 + R_{loop}$.

II.1.1 Idle state voltage

The idle state is when the loop is open or on-hook. In this state the idle voltage satisfies:

MUST be 21 V DC $\leq V_{IDLE} \leq$ 80 V DC.

SHOULD be 42.75 V DC $\leq V_{IDLE} \leq$ 80 V DC.

Ring is negative with respect to tip.

Ring-to-ground and tip-to-ground voltages are < 0.

NOTE – The V_{IDLE} minimum recommendation has been added for IPCablecom. In some cases, 21 V DC causes interoperability problems with certain CPE devices.

II.1.2 Loop closure detection

Loop closure is off-hook. Detection of loop closure MUST meet:

Resistance $\leq R_{DC}$ between tip and ring is loop closure.

Resistance ≥ 10 kohm between tip and ring is not loop closure.

When loop closure is detected, appropriate actions as defined by the CMS will be taken.

II.1.3 Loop open detection

Loop open is on-hook. Detection of loop open MUST meet:

Resistance ≥ 10 kohm is loop open.

Resistance $\leq R_{DC} + 380$ ohms is not loop open.

The MTA MUST be able to distinguish between a hit, dial pulse, flash, or disconnect and signal appropriately to the CMS as defined in ITU-T Rec. J.162.

II.1.4 Off-hook delay

The MTA MUST be able to detect a subscriber origination request (off-hook) and attempt to transmit the notification to the CMS within 50 ms.

2-way voice signal transmission capability on the loop MUST be established within 50 ms of detecting the origination request (off-hook).

II.1.5 On-hook delay

The MTA MUST be able to detect a subscriber termination request (on-hook) and attempt to transmit the notification to the CMS within 50 ms.

II.1.6 Ringsplash

When the CMS indicates one 500 ms ringsplash, the MTA MUST apply one 500 ± 50 ms ring burst to the line.

Note that the ringsplash requirement stated here is within the bounds of the ringsplash requirement stated in ITU-T Rec. J.162. Thus, by meeting this requirement, the NCS requirement is also met.

II.1.7 Distinctive ringing

Defined ring cadences **MUST** be applied to the drop within ±50 ms resolution.

The MTA shall be able to apply any of the distinctive alerting patterns described in ITU-T Rec. J.162 to the line when signalled by the CMS.

Note that the ringing requirement stated here is within the bounds of the ringing requirement stated in ITU-T Rec. J.162. Thus, by meeting this requirement, the NCS requirement is also met.

II.1.8 Transmission path

The MTA MUST support part-time on-hook transmission capabilities: part-time = within 400 ms after a ringsplash. On-hook transmission provides the capability of transmitting a voiceband signal in both directions on the loop when the loop is open (on-hook).

II.2 General supervision

II.2.1 Off-hook loop current

The MTA MUST provide at least 20 mA of loop current in the off-hook state.

Loop voltage is such that the ring conductor is negative with respect to the tip conductor.

II.2.2 Immunity to line crosses

Shorts between tip-to-tip, tip-to-ring, or ring-to-ring involving two or more lines MUST **NOT** damage the MTA.

Shorts between tip-to-ground or ring-to-ground involving one or more lines MUST **NOT** damage the MTA.

II.2.3 System generated open intervals

When in the loop closure state (off-hook), interruptions to loop current feed MUST **NOT** exceed 100 ms unless instructed by the CMS.

II.2.4 Open switching interval distortion

When in the loop closure state and providing loop current feed, loop current feed open commands of duration T MUST have resolution to ±25 ms for $50 \leq T \leq 1000$ ms.

When in the above state, the MTA MUST continue to maintain loop closure (towards the CMS) with no interruptions > 1 ms.

Loop current feed open MUST **NOT** exceed 5 s in duration.

Loop current feed open is an interruption of the loop current sourced on the drop.

This MUST be satisfied for both on-hook and off-hook.

II.2.5 Dial pulsing

Dial pulses **MAY** be collected at the MTA. Depending on CMS instructions, the digits can either be individually sent or gathered according to the digit map and all digits sent in a single message.

If the MTA supports dial pulsing, the MTA MUST support 8-12 pps with 58-64% break.

Note that IPCablecom does not require support for pulse dialling. Therefore, this is an optional MTA requirement.

II.2.6 DTMF signalling

DTMF (Dual Tone Multi-Frequency) signalling will be collected at the MTA. Depending on CMS instructions, the digits can either be individually sent or gathered according to the digit map and all digits sent in a single message.

The MTA MUST **NOT** amplitude overload at the maximum expected DTMF signal level. Amplitude overload is any output frequency between 0-12 kHz greater than –28 dBm0 when the input frequency is between 600-1500 Hz at a power level equal to the maximum expected DTMF signal level.

II.2.7 Dialtone removal

The MTA MUST remove dialtone within 250 ms of detecting the first dialled digit unless otherwise instructed by the CMS.

NOTE – The NCS protocol defined in ITU-T Rec. J.162 provides the ability to request the MTA to play signals (in this case dialtone) in response to events (in this case off-hook). The protocol also provides the ability to instruct the MTA to "keep the signals active" after an event has been detected (in this case keep dialtone active even if a digit has been detected). Thus, it is not the intention of this Recommendation to override the NCS protocol Recommendation and as such, the CMS has the ability to override this requirement.

II.3 General ringing

II.3.1 Alerting signals

The MTA MUST support unbalanced or balanced ringing.

The applied cadence MUST be within ±50 ms of the defined cadence.

Nominal cadence has a 6 s period with 1.7-2.1 s ringing and 3.1-5.5 s of silence.

For Unbalanced Ringing:

- Alerting cadence is applied to ring with tip grounded.
- The dc component during ringing is such that the ring conductor is negative with respect to tip.

For Balanced Ringing:

- Alerting cadence is applied to both tip and ring, typically 180° out of phase.
- With or without a dc component.

II.3.2 Ringing delay

Ringing MUST be applied within 200 ms of being signalled by the CMS. The cadence **MAY** be entered at any point (i.e., the cadence may start with the silent period).

II.3.3 Ringing source

MUST meet the duration-limiting source safety requirements of local or national practice (GR-1089 in the US).

Ringing frequency MUST be 20 ± 1 Hz.

The dc component (offset) MUST be ≤ 75 V DC.

MUST meet $1.2 \leq$ peak-to-rms voltage ratio ≤ 1.6.

The bridged C-weighted noise ≤ 90 dBrnC when referenced to 900 ohms during ringing (i.e., the 20 Hz component < 0 dBm) and the analog voiceband lead conducted emissions criteria of TR1089 MUST be met.

II.3.4 Ringing capability

The minimum ringing voltage MUST meet 40 V rms across a five REN load on a drop with resistance $\leq R_{DC} - 400$ ohms.

II.3.5 Ringing capacity

The MTA MUST support five REN per line.

The MTA **MUST** support at least 10 REN per device for MTAs that support two or more lines.

NOTE – It is anticipated that many MTAs will support more than two lines (i.e., four POTS lines) but it is also unreasonable to require the MTA with more than two lines to support five REN for each line for power consumption reasons. Therefore, the minimum REN requirement of 10 REN per device, across all lines, is established.

II.3.6 Ring trip

Ringing MUST be removed within 200 ms of detecting loop closure.

II.3.7 Ring trip reporting delay

The MTA MUST be able to detect a ring trip and attempt to transmit the notification to the CMS within 300 ms.

II.3.8 Ring trip immunity

Ringing MUST **NOT** be tripped when a termination of 10 kohm in parallel with 6 µF is applied to tip and ring.

Ringing MUST **NOT** be tripped when a termination of 200 ohms is applied to tip and ring for ≤ 12 ms.

II.4 Voice grade analog transmission

These requirements only apply to the G.711 audio codec as specified in ITU-T Rec. J.161. Transmission requirements for the other compression algorithms specified in ITU-T Rec. J.161 are not yet defined.

General: All these requirements **MUST** be satisfied for both on-hook and off-hook.

II.4.1 Input impedance

600 ohms nominal.

ERL (echo return loss) > 26 dB (29 dB objective).

SRL (singing return loss) > 21 dB (24 dB objective).

II.4.2 Hybrid balance

ERL > 21 dB (26 dB objective).

SRL > 16 dB (21 dB objective).

$ERL = 15 + L_{T1} + L_{R1}$.

$SRL = 10 + L_{T1} + L_{R1}$.

Where L_{T1} is transmit loss and L_{R1} is receive loss at 1004 Hz.

II.4.3 Longitudinal balance

200 Hz: min > 45 dB, ave > 50 dB (ave > 61 dB objective).

500 Hz: min > 45 dB, ave > 50 dB (ave > 58 dB objective).

1000 Hz: min > 45 dB, ave > 50 dB (ave > 52 dB objective).

3000 Hz: min > 40 dB, ave > 45 dB.

II.4.4 MTA loss

4 dB in the D/A direction (towards the subscriber).

2 dB in the A/D direction (from the subscriber).

This is the loss within the MTA.

II.4.5 MTA loss tolerance

Within ±1 dB of the MTA loss.

II.4.6 Frequency response

Off-hook transmission loss between 400-2800 Hz MUST be within –0.5 to +1 dB of the loss at 1004 Hz using a 0 dBm0 signal.

On-hook transmission loss between 400-2800 Hz MUST be within –1 to +2 dB of the loss at 1004 Hz using a 0 dBm0 signal.

(+ means more loss, – means less loss).

II.4.7 60 Hz loss

The transmission path loss at 60 Hz MUST be at least 20 dB greater than the off-hook transmission path loss at 1004 Hz. The intention is to limit the encoding of 60 Hz induction in the A/D direction.

II.4.8 Amplitude tracking

The deviation of a 1004 Hz off-hook transmission path loss relative to the loss of a 0 dBm0 input signal.

–37 to –3 dBm0 input: ±0.5 dB max (±0.25 dB ave).

–50 to –37 dBm0 input: ±1.0 dB max (±0.5 dB ave).

–55 to –50 dBm0 input: ±3.0 dB max (±1.5 dB ave).

The deviation of a 1004 Hz on-hook transmission path loss relative to the loss of a 0 dBm0 input signal.

–37 to 0 dBm0: ±0.5 dB max.

II.4.9 Overload compression

The increase in the off-hook transmission path loss at 1004 Hz relative to the loss of a 0 dBm0 input signal.

+3 dBm0 input: ≤ 0.5 dB increased loss.

+6 dBm0 input: ≤ 1.8 dB increased loss.

+9 dBm0 input: ≤ 4.5 dB increased loss.

This is to ensure the receiver off-hook signal can be transmitted.

II.4.10 Idle channel noise

Not to exceed 20 dBrnC at the output of the MTA (18 dBrnC objective).

II.4.11 Signal to distortion

The ratio of the output signal to output C-notched noise with a 1004 Hz input signal while providing an on-hook and off-hook transmission path.

0 to –30 dBm0 input: > 33 dB ratio.

–30 to –40 dBm0 input: > 27 dB ratio.

–40 to –45 dBm0 input: > 22 dB ratio.

II.4.12 Impulse noise

≤ 15 impulses in 15 minutes with no holding tone applied at a threshold of 47 dBrnC0.

≤ 15 impulses in 15 minutes with a –13 dBm0 tone at 1004 Hz at a threshold of 65 dBrnC0.

These SHOULD be met for both the on-hook and off-hook transmission path. For a line under test, other lines on the MTA SHOULD be active (off-hook, dialling, ringing, etc.).

II.4.13 Intermodulation distortion

R_2 > 43 dB using a –13 dBm0 input signal.

R_3 > 44 dB using a –13 dBm0 input signal.

R_2 and R_3 are the 2nd and 3rd order intermodulation products measured using the IEEE 743-1995 4-tone method.

II.4.14 Single frequency distortion

Using a 0 dBm0 input signal between 0-12 kHz, the output between 0-12 kHz < –28 dBm0.

Using a 0 dBm0 input signal between 1004-1020 Hz, the output between 0-4 kHz < –40 dBm0.

II.4.15 Generated tones

< –50 dBm0 between 0-16 kHz.

II.4.16 Peak-to-average ratio

P/AR > 90 with a –13 dBm0 input level. On-hook and off-hook transmission paths.

II.4.17 Channel crosstalk

With a 0-dBm0 signal between 200-3400 Hz applied to a line, other lines on the MTA < –65 dBm0 C message weighted output between 200-3400 Hz.

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Printed in Switzerland
Geneva, 2006