International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.996.2

Amendment 3
(03/2013)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Access networks

Single-ended line testing for digital subscriber lines (DSL)

Amendment 3: Definition of accuracy values for MELT-PMD and MELT-P in Annex E

Recommendation ITU-T G.996.2 (2009) – Amendment 3

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Recommendation ITU-T G.996.2

Single-ended line testing for digital subscriber lines (DSL)

Amendment 3

Definition of accuracy values for MELT-PMD and MELT-P in Annex E

Summary

Amendment 3 to Recommendation ITU-T G.996.2 (2009) updates Annex E defining accuracy values for MELT-PMD and MELT-P (new functionality).

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.996.2	2009-05-22	15
1.1	ITU-T G.996.2 (2009) Amd. 1	2009-10-09	15
1.2	ITU-T G.996.2 (2009) Amd. 2	2012-04-06	15
1.3	ITU-T G.996.2 (2009) Amd. 3	2013-03-16	15

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Recommendation ITU-T G.996.2

Single-ended line testing for digital subscriber lines (DSL)

Amendment 3

Definition of accuracy values for MELT-PMD and MELT-P in Annex E

1 Updates to Annex E – Specific requirements for a MELT-PMD

Update Annex E as follows:

Annex E

Specific requirements for a MELT-PMD

(This annex forms an integral part of this Recommendation.)

E.1 MELT-PMD functions

MELT-PMD functions are applicable at the η_C reference point only.

Various implementations of the MELT-PMD feature are possible, including the use of a common functional block shared among multiple lines and capable of executing the procedures described herein on the basis of one line at a time.

It is assumed that the MELT-PMD measurements are performed when there is no transmission in the frequency band up to 4 kHz on the loop under test. The method of ensuring this is beyond the scope of this Recommendation.

E.1.1 MELT-PMD measurement functions

The maximum allowed time for single or combined measurement (see clause E.2.1.1), excluding the processing time in the MELT-P, shall not exceed 20 seconds for a test sequence made of foreign DC and AC voltage, 4-element resistance with a controlled metallic voltage, and 3-element capacitance with a controlled metallic voltage. <u>This requirement applies to a test executed on a typical loop without obtaining the optional measurement results (see Table E.12) and does not include an allowance for system or network delays.</u>

E.1.1.1 Measurement of the 4-element DC resistance with a controlled metallic voltage

E.1.1.1.1 4-element DC resistance

This parameter defines a measurement, or a series of measurements, to measure the relevant resistance values from an equivalent DC resistance network located between tip, ring and GND as shown in Figure E.1.

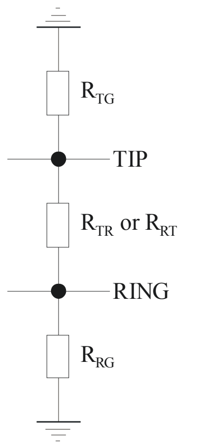

Figure E.1 – DC resistance between tip, ring and GND

Four resistance values R_{XY} shall be reported:

1) R_{TR} – DC resistance between tip and ring
2) R_{RT} – DC resistance between ring and tip
3) R_{TG} – DC resistance between tip and GND
4) R_{RG} – DC resistance between ring and GND.

R_{TR} is measured with a voltage applied between tip and ring such that tip is positive with respect to ring. A reversed voltage is applied between the tip and ring leads for the measurement of R_{RT}.

In the case where the metallic branch elements, R_{TR} or R_{RT}, may be in parallel with a signature network containing a non-linear element such as a zener diode, it will be required to limit the metallic test voltage such as to remain below the conduction threshold when measuring the cable leakage resistances. To this effect, the metallic voltage used by this procedure shall be lower than the minimum far-end signature conduction voltage configuration parameter (see clause E.2.1.6).

The accuracy numbers apply to a measurement performed with only one resistance component at a time connected to one of tip and ring, ring and tip, tip and GND, or ring and GND.

The accuracy for each element of this parameter is defined in Table E.1.

Table E.1 – 4-element DC resistor accuracy

R_{XY} Range	Accuracy
0 Ω – 250 Ω	±10 Ω
250 Ω – 1 kΩ	±4%
1 kΩ – 100 kΩ	±4%
100 kΩ – 1 MΩ	±8%
1 MΩ – 5 MΩ	±15%
5 MΩ – 10 MΩ	±25%

E.1.1.1.2 Test voltages for the measurement of the 4-element DC resistance with a controlled metallic voltage

This parameter reports the voltages present on the tip and ring wires while executing the measurement with a controlled metallic voltage and which are used to calculate the resistance results. Four values are reported in relation with the tip-to-ground, ring-to-ground, tip-to-ring, and ring-to-tip branches. If a branch is measured by comparing the load current at two different source voltages, the voltage delta is reported instead of each individual voltage.

NOTE – The voltage values can be based on a calculation, using the source voltage, the load current, and the output impedance, or can be a direct measurement.

Four voltage values VDC_{XY} shall be reported:

1) VDC_{TR} – DC voltage between tip and ring
2) VDC_{RT} – DC voltage between ring and tip
3) VDC_{TG} – DC voltage between tip and GND
4) VDC_{RG} – DC voltage between ring and GND.

The accuracy for each element of this parameter is ~~for further study~~given in Table E.1.1, while the range of valid values and granularity are defined in clause E.2.3.2.

Table E.1.1 – Measurement test voltages (VDC_{TR}, VDC_{RT}, VDC_{TG} and VDC_{RG}) accuracy

Voltage range (V)	Accuracy	Granularity
$-20 \le VDC_{XY} \le 20$	±1 V	100 mV
$-100 < VDC_{XY} < -20$ $20 < VDC_{XY} < 100$	±5%	100 mV

E.1.1.1.3 Test currents for the 4-element DC resistance with a controlled metallic voltage

This parameter reports the DC currents measured during the test execution. Those currents are useful to identify the possible presence of a foreign voltage source. To this effect, the current contribution resulting from the application of the test voltage to the measured external resistance shall be removed from the reported currents.

Four current values IDC_{XY} shall be reported:

1) IDC_{TR} – DC current between tip and ring
2) IDC_{RT} – DC current between ring and tip
3) IDC_{TG} – DC current between tip and GND
4) IDC_{RG} – DC current between ring and GND.

The accuracy for each element of this parameter is ~~for further study~~given in Table E.1.2, while the range of valid values and granularity are defined in clause E.2.3.3.

Table E.1.2 – Measurement test currents (IDC_{TR}, IDC_{RT}, IDC_{TG} and IDC_{RG}) accuracy

Current range (mA)	Accuracy	Granularity
$-20 \le IDC_{XY} \le 20$	±2 mA	1 µA
$-100 < IDC_{XY} < -20$ $20 < IDC_{XY} < 100$	±10%	1 µA

NOTE – Removing the current contribution resulting from the application of the test voltage only leaves the current due to a foreign potential, if any is present. To this effect, the IDC_{TR} and IDC_{RT} results are equivalent to the results that would be obtained when connecting a current meter between tip and ring. Similarly, the IDC_{TG} and IDC_{RG} results are equivalent to the results that would be obtained when connecting two current meters, one between tip and ground and one between ring and ground.

E.1.1.2 Measurement of the 3-element capacitance with a controlled metallic voltage

This parameter defines a measurement, or a series of measurements, to measure the capacitance of the cable plus line equipment, if present, from an equivalent AC network located between tip, ring and GND as shown in Figure E.2.

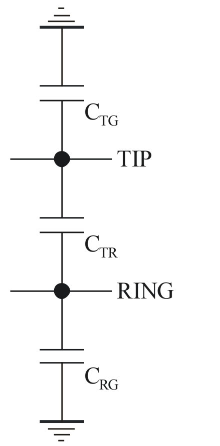

Figure E.2 – Capacitance between tip, ring and GND

The capacitance C_{XY} is defined as the measured capacitance between nodes *X* and *Y*. The measuring method for C_{XY} is vendor discretionary.

Three capacitance values C_{XY} shall be reported:

1) C_{TR} – Capacitance between tip and ring
2) C_{TG} – Capacitance between tip and GND
3) C_{RG} – Capacitance between ring and GND.

In the case where the metallic branch element, C_{TR}, may be in parallel with a signature network containing a non-linear element such as a zener diode, it will be required to limit the metallic test voltage such as to remain below the conduction threshold when measuring the cable capacitances. To this effect, the metallic voltage used by this procedure shall be lower than the minimum far-end signature conduction voltage configuration parameter (see clause E.2.1.6).

The accuracy of each element of this parameter is defined in Tables E.2 and E.3.

The accuracy of each element of this parameter in cases of MELT measurements on SHDSL equipment according to [ITU-T G.991.2] is defined in Tables E.4 and E.5.

The accuracy numbers apply to a measurement performed with only one capacitance component at a time connected to one of tip and ring, tip and GND, or ring and GND.

NOTE – In cases of MELT measurements on loops connected to SHDSL equipment according to [ITU-T G.991.2], the accuracy requirements have to be relaxed. This accounts for the typically high input capacitance of SHDSL equipment ports.

Table E.2 – Capacitance accuracy C_{TR}

Capacitance range	Accuracy
0 nF – 60 nF	±3 nF
60 nF – 1 μF	±5%
1 μF – 5 μF	±10%

Table E.3 – Capacitance accuracy C_{TG}, C_{RG}

Capacitance range	Accuracy
0 nF – 20 nF	±1 nF
20 nF – 1 μF	±5%
1 μF – 5 μF	±10%

Table E.4 – Capacitance accuracy C_{TR} for MELT-measurements on SHDSL equipment according to [ITU-T G.991.2]

Capacitance range	Accuracy
0 nF – 1 μF	±50 nF
1 μF – 5 μF	±10%

Table E.5 – Capacitance accuracy C_{TG}, C_{RG} for MELT-measurements on SHDSL equipment according to [ITU-T G.991.2]

Capacitance range	Accuracy
0 nF – 100 nF	±5 nF
100 nF – 1 μF	±5%
1 μF – 5 μF	±10%

E.1.1.3 Measurement of foreign voltages

Foreign voltages may occur differentially between tip and ring, in common mode between tip/ring and GND, or be single-ended, between tip and GND or between ring and GND. Therefore, three types of V_{XY} measurements are defined:

1) V_{TR} – Foreign voltage between tip and ring
2) V_{TG} – Foreign voltage between tip and GND
3) V_{RG} – Foreign voltage between ring and GND.

The measurement parameter foreign voltage (see clause E.2.3.5) shall be reported for each of the three types, including the following information:

- Foreign DC voltage level ($V_{XY,DC}$)
- Foreign AC rms voltage level ($V_{XY,AC}$)
- Foreign AC voltage frequency ($F_{XY,AC}$) estimated on the basis that the foreign AC voltage is sine-shaped with a constant frequency.

When measuring the foreign voltages, the input impedance of the measuring instrument can affect the measurement and should be reported in addition to the results.

The accuracies for each of these parameters are defined in Tables E.6 to E.8.

The accuracy requirements apply when only one foreign voltage source at a time is connected to one of tip and ring, ring and tip, tip and GND, or ring and GND.

The frequency accuracy numbers only apply to Foreign AC Voltages V_{XY} higher than 5 Vrms.

NOTE – Typically the maximum capacitance connected between tip and ring does not exceed 5 µF. The maximum foreign DC voltages error due to the residual charge at this maximum capacitance is not expected ~~not~~ to be higher than 1 V.

Table E.6 – Foreign DC voltages accuracy

Foreign DC voltages V_{XY} range	Accuracy
0 V – 20 V	±1 V
20 V – 250 V	±5%

Table E.7 – Foreign AC voltages accuracy

Foreign AC voltages V_{XY} range	Accuracy
0 V – 20 V rms	±1 V rms
20 V – 250 V rms	±5%

Table E.8 – Foreign AC frequency accuracy

Foreign AC frequency V_{XY} range	Accuracy
10 Hz – 60 Hz	±3 Hz
60 Hz – 90 Hz	±10%

E.1.1.4 Measurement of the loop capacitance with a high metallic voltage

The loop capacitance $C_{TR,HV}$ is defined as the measured capacitance between tip and ring, using a high voltage to conduct current through the zener diode located in the far-end signature (see clause E.2.1.5). To this effect, the metallic voltage used by this procedure shall be higher than the maximum far-end signature conduction voltage configuration parameter (see clause E.2.1.5).

The measuring method is vendor discretionary.

The accuracy of this parameter is defined in Table E.9.

The accuracy of this parameter in cases of MELT measurements on loops connected to SHDSL equipment according to [ITU-T G.991.2] is defined in Table E.10.

The accuracy numbers apply to a measurement performed with only one capacitance component connected to tip and ring.

NOTE – When MELT measurements on loops are connected to SHDSL equipment according to [ITU-T G.991.2] the accuracy requirements have to be relaxed. This accounts for the typically high input capacitance of SHDSL equipment ports.

Table E.9 – Capacitance accuracy $C_{TR, HV}$

Capacitance range	Accuracy
0 nF – 60 nF	±3 nF
60 nF – 1 μF	±5%
1 μF – 5 μF	±10%

Table E.10 – Capacitance accuracy $C_{TR, HV}$ for loops connected to SHDSL equipment according to [ITU-T G.991.2]

Capacitance range	Accuracy
0 nF – 1 μF	±50 nF
1 μF – 5 μF	±10%

E.1.1.5 Measurement of the loop resistance with a high metallic voltage

E.1.1.5.1 Measurement of the loop resistance

The loop resistances $R_{TR,HV}$ and $R_{RT,HV}$ are defined as the measured resistance between tip and ring and between ring and tip, respectively, using a high voltage to conduct current through the zener diode located in the far-end signature (see clause E.2.1.5). To this effect, the metallic voltage used by this procedure shall be higher than the maximum far-end signature conduction voltage configuration parameter (see clause E.2.1.5).

In order to identify the loop resistance, a dynamic resistance measurement using at least two voltages levels may be performed. However, the measuring method is at the vendor's discretion.

The accuracy for each element of this parameter is defined in Table E.11.

The accuracy numbers apply to a measurement performed with only one resistance connected between tip and ring.

Table E.11 – Loop resistance accuracy

$R_{XY,HV}$ range	Accuracy
0 Ω – 250 Ω	±10 Ω
250 Ω – 1 kΩ	±4%
1 kΩ – 100 kΩ	±4%
100 kΩ – 500 kΩ	±8%

E.1.1.5.2 Test voltage for the measurement of the loop resistance with a high metallic voltage

This parameter reports the voltage present on the tip and ring wires while executing the measurement with a high metallic voltage and which are used to calculate the resistance results. Two values are reported in relation with the tip-to-ring and ring-to-tip branches. If a branch is measured by comparing the load current at two different source voltages, the voltage delta is reported instead of each individual voltage.

NOTE – The voltage values can be based on a calculation, using the source voltage, the load current, and the output impedance, or can be a direct measurement.

Two voltage values $VDCH_{XY}$ shall be reported:

1) $VDCH_{TR}$ – DC voltage between tip and ring

2) $VDCH_{RT}$ – DC voltage between ring and tip.

The accuracy for each element of this parameter is ~~for further study~~defined in Table E.11.1, while the range of valid values and granularity are defined in clause E.2.3.8.

Table E.11.1 – Measurement test voltages ($VDCH_{TR}$ and $VDCH_{RT}$) accuracy

Voltage range (V)	Accuracy	Granularity
$-20 \leq VDCH_{XY} \leq 20$	±1 V	100 mV
$-100 < VDCH_{XY} < -20$ $20 < VDCH_{XY} < 100$	±5%	100 mV

E.1.1.6 Measurement of the 3-element complex admittances with a controlled metallic voltage

When measuring a signature network made of a resistor in series with a capacitor, a simple 3-element capacitance measurement may not produce the correct component values depending on the load network topology. Better visibility is obtained by performing a test that takes the phase of the load impedance into consideration and reports its real and imaginary parts.

Three different types of admittance are defined using the following relationship:

$$Y_{XY} = G_{XY} + j \cdot B_{XY}$$

1) G_{TR}, B_{TR} – Conductance and susceptance between tip and ring

2) G_{TG}, B_{TG} – Conductance and susceptance between tip and GND

3) G_{RG}, B_{RG} – Conductance and susceptance between ring and GND.

The measuring method is vendor discretionary.

In the case where the metallic branch element, G_{TR} and B_{TR}, may be in parallel with a signature network containing a non-linear element such as a zener diode, it will be required to limit the metallic test voltage such as to remain below the conduction threshold when measuring the cable admittances. To this effect, the metallic voltage used by this procedure shall be lower than the minimum far-end signature conduction voltage configuration parameter (see clause E.2.1.6).

The accuracy of this parameter is for further study.

E.1.1.7 Measurement of the loop complex admittance with a high metallic voltage

The loop branch elements $G_{TR,HV}$ and $B_{TR,HV}$ are defined as the measured conductance and susceptance between tip and ring, using a high voltage to conduct current through the zener diode located in the far-end signature (see clause E.2.1.5). To this effect, the metallic voltage used by this procedure shall be higher than the maximum far-end signature conduction voltage configuration parameter (see clause E.2.1.5).

The measurement is performed on the basis of a linear load and does not modify the result to compensate for the cross-over distortion introduced by the zener diode. To this effect, the metallic voltage applied between tip and ring should be set to a value well above the conduction threshold of the zener diode.

The measuring method is vendor discretionary.

NOTE – If the tip-to-ground and ring-to-ground impedances are large in comparison to the tip-to-ring impedance, the testing time can be reduced by only measuring the impedance in the metallic branch instead of executing the 3-element resistance and capacitance measurements.

The accuracy of this parameter is for further study.

E.1.1.8 Measurement voltages for the 3-element capacitance test with a controlled metallic voltage

This parameter reports the AC voltages present on the tip and ring wires while executing a 3-element capacitance test with a controlled metallic voltage as defined in clause E.1.1.2, if performed with a sine wave signal. Three values are reported in relation with the tip-to-ground, ring-to-ground and tip-to-ring branches.

Three values VAC_{XY} shall be reported:

1) $VAC_{TR\text{-}CC}$ – AC voltage between tip and ring
2) $VAC_{TG\text{-}CC}$ – AC voltage between tip and GND
3) $VAC_{RG\text{-}CC}$ – AC voltage between ring and GND.

The accuracy for each element of this parameter is ~~for further study~~defined in Table E.11.2, while the range of valid values and granularity are defined in clause E.2.3.11.

Table E.11.2 – Measurement test voltages ($VAC_{TR\text{-}CC}$, $VAC_{TG\text{-}CC}$ and $VAC_{RG\text{-}CC}$) accuracy

Voltage range (Vrms)	Accuracy	Granularity
$0 \le VAC_{XY\text{-}CC} \le 10$	±0.5 Vrms	100 mV
$10 < VAC_{XY\text{-}CC} \le 100$	±5%	100 mV

E.1.1.9 Measurement voltage for the loop capacitance test with a high metallic voltage

This parameter reports the AC voltage present on the tip and ring wires while executing a loop capacitance test with a high metallic voltage as defined in clause E.1.1.4, if performed with a sine wave signal. One value is reported in relation with the tip-to-ring branch.

One value VAC_{XY} shall be reported:

1) $VAC_{TR\text{-}HC}$ – AC voltage between tip and ring

The accuracy for this parameter is ~~for further study~~defined in Table E.11.3, while the range of valid values and granularity are defined in clause E.2.3.12.

Table E.11.3 – Measurement test voltage ($VAC_{TR\text{-}HC}$) accuracy

Voltage range (Vrms)	Accuracy	Granularity
$0 \le VAC_{TR\text{-}HC} \le 10$	±0.5 Vrms	100 mV
$10 < VAC_{TR\text{-}HC} \le 100$	±5%	100 mV

E.1.1.10 Measurement voltages for the 3-element complex admittance test with a controlled metallic voltage

This parameter reports the AC voltages present on the tip and ring wires while executing a 3-element complex admittance test with a controlled metallic voltage as defined in clause E.1.1.6, if performed with a sine wave signal. Three values are reported in relation with the tip-to-ground, ring-to-ground and tip-to-ring branches.

Three values VAC_{XY} shall be reported:

1) $VAC_{TR\text{-}CA}$ – AC voltage between tip and ring
2) $VAC_{TG\text{-}CA}$ – AC voltage between tip and GND
3) $VAC_{RG\text{-}CA}$ – AC voltage between ring and GND.

The accuracy for each element of this parameter is ~~for further study~~defined in Table E.11.4, while the range of valid values and granularity are defined in clause E.2.3.13.

Table E.11.4 – Measurement test voltages ($VAC_{TR\text{-}CA}$, $VAC_{TG\text{-}CA}$ and $VAC_{RG\text{-}CA}$) accuracy

Voltage range (Vrms)	Accuracy	Granularity
$0 \leq VAC_{XY\text{-}CA} \leq 10$	±0.5 Vrms	100 mV
$10 < VAC_{XY\text{-}CA} < 100$	±5%	100 mV

E.1.1.11 Measurement voltage for the loop complex admittance test with a high metallic voltage

This parameter reports the AC voltage present on the tip and ring wires while executing a loop complex admittance test with a high metallic voltage as defined in clause E.1.1.7, if performed with a sine wave signal. One value is reported in relation with the tip-to-ring branch.

One value VAC_{XY} shall be reported:

1) $VAC_{TR\text{-}HA}$ – AC voltage between tip and ring

The accuracy for this parameter is ~~for further study~~defined in Table E.11.5, while the range of valid values and granularity are defined in clause E.2.3.14.

Table E.11.5 – Measurement test voltage ($VAC_{TR\text{-}HA}$) accuracy

Voltage range (Vrms)	Accuracy	Granularity
$0 \leq VAC_{TR\text{-}HA} \leq 10$	±0.5 Vrms	100 mV
$10 < VAC_{TR\text{-}HA} < 100$	±5%	100 mV

E.1.2 MELT-PMD non-measurement functions

E.1.2.1 Pair identification tone generation

This function shall be used to generate a tone in the frequency range defined in clause E.2.1.4 at a signal level of at least 120 mVrms but not higher than 330 mVrms on 600 ohms between tip and ring of the MELT-PMD unit. The actual level is vendor discretionary. This function does not report any measurement result to the MELT-ME-PMD. In order to identify the individual wires (tip or ring), a DC voltage of 10 V ±2 V shall be superimposed on the pair identification tone between tip and ring such that the tip wire is positive with respect to the ring wire.

NOTE – The generated tone may be listened to or detected by a field technician.

E.2 MELT-PMD management entity

E.2.1 MELT-PMD configuration parameters

E.2.1.1 Measurement class

This parameter defines the list of measurements to be executed. It shall support a single measurement or a set of MELT measurements in a consecutive manner. The measurements of interest are selected via a flag register, or equivalent.

E.2.1.2 Peak metallic voltage between tip and ring

This parameter defines the peak metallic voltage which must not be exceeded in any active measurement applying a metallic voltage between tip and ring in order not to conduct current in a non-linear termination located at the far-end during the measurement. The range of valid values is from 0 to 100 V with a granularity of 1 V. In the case of a test performed with a sinewave signal, it applies to the peak of the sinewave, not to its rms value.

E.2.1.3 Signal frequency for active AC tests

This parameter controls the frequency used during the 3-element capacitance test, if performed with a sinewave signal, and during the 3-element complex admittance test. This parameter shall be represented in linear format with values from 10 to 1000 Hz with a granularity of 1 Hz.

The supported set of frequencies is at the vendor's discretion with an option to operate in automatic mode for which the testing routine will select the frequency on its own.

E.2.1.4 Pair identification tone frequency

This parameter sets up the frequency of the pair identification tone as defined in clause E.1.2.1. The range of frequencies is from 300 to 3400 Hz in granularity of 1 Hz.

The supported set of frequencies is at the vendor's discretion.

E.2.1.5 Maximum far-end signature conduction voltage

This parameter specifies the maximum conduction voltage level of an expected far-end signature. It defines the minimum metallic voltage required for all measurements with a high metallic voltage between tip and ring in order to conduct current in a far-end signature during the measurement. The range of valid values is from 0 to 50 V with a granularity of 0.1 V.

E.2.1.6 Minimum far-end signature conduction voltage

This parameter specifies the minimum conduction voltage level of an expected far-end signature. It defines the maximum metallic voltage allowed for all measurements with a controlled metallic voltage between tip and ring in order not to conduct current in a far-end signature during the measurement. The range of valid values is from 0 to 50 V with a granularity of 0.1 V. In the case of a measurement performed with a sinewave signal, it applies to the peak of the sinewave, not to its rms value.

E.2.2 MELT-PMD reporting parameters

E.2.2.1 Measurement frequency for active AC tests

This parameter is the measurement frequency for a 3-element capacitance measurement, if performed with a sinewave signal, or a for 3-element complex admittance measurement. The range of valid values is from 10 to 1000 Hz with a granularity of 1 Hz.

E.2.2.2 Input impedance for foreign voltage measurements

This parameter reports the nominal input impedance of the measuring instrument during foreign voltage tests. The range of valid values is from 0 to 10 MΩ with a granularity of 1 Ω.

E.2.2.3 Test voltage for measurement of the loop complex admittance with a high metallic voltage

This parameter is the peak amplitude of the differential sinewave used by the measurement of the loop complex admittance with a high voltage metallic test (see clause E.1.1.7). The range of valid values is from 0 to 100 V and it shall be represented in linear format with a granularity of 0.1 V.

E.2.3 MELT-PMD measurement parameters

E.2.3.1 4-element DC resistance with controlled metallic voltage

The 4-element DC resistances R_{TR}, R_{RT}, R_{TG} and R_{RG}, shall be represented in linear format. The range of valid values is from 0 to 10 MΩ with a granularity of 1Ω.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.2 DC test voltages for the measurement of the 4-element DC resistance with a controlled metallic voltage

The test voltages for the measurement of the 4-element DC resistance VDC_{TR}, VDC_{RT}, VDC_{TG} and VDC_{RG}, shall be represented in linear format. The range of valid values is from –100 V to +100 V with a granularity of 0.1 V.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.3 Test currents for the 4-element DC resistance with a controlled metallic voltage

The test currents for the measurement of the 4-element DC resistance IDC_{TR}, IDC_{RT}, IDC_{TG} and IDC_{RG}, shall be represented in linear format. The range of valid values is from –1 A to +1 A with a granularity of 1 µA.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.4 3-element capacitance with controlled metallic voltage

The 3-element capacitances C_{TR}, C_{TG} and C_{RG}, shall be represented in linear format. The range of valid values is from 0 to 5 µF with a granularity of 0.1 nF.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.5 Foreign voltage

The range of valid values for the foreign DC voltages $V_{TR,DC}$, $V_{TG,DC}$ and $V_{RG,DC}$ is from –350 to 350 V. The range of valid values for the foreign AC voltages $V_{TR,AC}$, $V_{TG,AC}$ and $V_{RG,AC}$ is from 0 to 250 Vrms. The foreign AC and DC voltages shall be represented in linear format with a granularity of 100 mV. The range of valid values for the foreign AC voltage frequencies $F_{TR,AC}$, $F_{TG,AC}$ and $F_{RG,AC}$ is from 10 to 90 Hz with a granularity of 0.1 Hz.

NOTE – The voltage actually present on the tip and ring leads may be limited by the presence of protection components.

The reported DC voltage polarity is defined with respect to ground for the $V_{TG,DC}$ and $V_{RG,DC}$ measurements and returns a positive result for the $V_{TR,DC}$ measurement if the tip wire is more positive than the ring wire.

E.2.3.6 Loop capacitance with high metallic voltage

The loop capacitance $C_{TR,HV}$ shall be represented in linear format. The range of valid values is from 0 to 5 µF with a granularity of 0.1 nF. The $C_{TR,HV}$ value of the loop capacitance with high metallic voltage test is the total capacitance measured. The C_{TR} value obtained from the 3-element capacitance with controlled metallic voltage test is not subtracted from the results.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.7 Loop resistance with high metallic voltage

The loop resistances $R_{TR,HV}$ and $R_{RT,HV}$ shall be represented in linear format. The range of valid values is from 0 to 10 MΩ with a granularity of 1 Ω. The $R_{TR,HV}$ and $R_{RT,HV}$ values of the loop resistance with high metallic voltage test are the total resistances measured. The R_{TR} and R_{RT} values obtained from the 3-element resistance with controlled metallic voltage test are not subtracted from the results.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.8 Test voltage for the measurement of the loop resistance with a high metallic voltage

The test voltages for the measurement of the loop resistance with a high metallic voltage $VDCH_{TR}$ and $VDCH_{RT}$ shall be represented in linear format. The range of valid values is from –100 V to +100 V with a granularity of 0.1 V.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.9 3-element complex admittance with controlled metallic voltage

The range of valid values for the 3-element complex conductances and susceptances G_{TR}, B_{TR}, G_{TG}, B_{TG}, G_{RG} and B_{RG} is from 0.1 µSiemens to 0.1 Siemens. The values shall be represented in linear format with a granularity of 0.1 µSiemens.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.10 Loop complex admittance with high metallic voltage

The range of valid values for the 3-element complex conductance and susceptance $G_{TR,HV}$, and $B_{TR,HV}$ is from 0.1 µSiemens to 0.1 Siemens. The values shall be represented in linear format with a granularity of 0.1 µSiemens. The $G_{TR,HV}$ and $B_{TR,HV}$ values of the loop complex admittance with high metallic voltage test are the total conductance and susceptance measured. The G_{TR} and B_{TR} values obtained from the 3-element complex admittance with controlled metallic voltage test are not subtracted from the results.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.11 Measurement voltages for the 3-element capacitance test with a controlled metallic voltage

The range of valid values for the AC voltages $VAC_{TR\text{-}CC}$, $VAC_{TG\text{-}CC}$, and $VAC_{RG\text{-}CC}$ for the 3-element capacitance test with a controlled metallic voltage is from 0 V rms to 100 V rms. The values shall be represented in linear format with a granularity of 0.1 V.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.12 Measurement voltage for the loop capacitance test with a high metallic voltage

The range of valid values for the AC voltage $VAC_{TR\text{-}HC}$ for the loop capacitance test with a high metallic voltage is from 0 V rms to 100 V rms. The values shall be represented in linear format with a granularity of 0.1 V.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.13 Measurement voltages for the 3-element complex admittance test with a controlled metallic voltage

The range of valid values for the AC voltages $VAC_{TR\text{-}CA}$, $VAC_{TG\text{-}CA}$, and $VAC_{RG\text{-}CA}$ for the 3-element complex admittance test with a controlled metallic voltage is from 0 V rms to 100 V rms. The values shall be represented in linear format with a granularity of 0.1 V.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.3.14 Measurement voltage for the loop complex admittance test with a high metallic voltage

The range of valid values for the AC voltage $VAC_{TR\text{-}HA}$ for the loop complex admittance test with a high metallic voltage is from 0 V rms to 100 V rms. The values shall be represented in linear format with a granularity of 0.1 V.

NOTE – The linear format is chosen for simplicity reason and does not imply any future accuracy requirements.

E.2.4 MELT-PMD parameter partitioning

This clause defines the parameters which correspond to the η_C reference point.

The parameters at the η_C reference point are described by Table E.12 indicating the status of the parameter as:

– R are read only.
– W are write only.
– R/W are read and write.
– (M) are mandatory.
– (O) are optional.

R and W are defined as:

– W: parameter written by the MELT-ME-P-C to the MELT-ME-PMD-C.
– R: parameter provided by the MELT-ME-PMD-C to be read by the MELT-ME-P-C.

Table E.12 – Partitioning of MELT-ME-PMD parameters

Category/element	Defined in clause	η_C – reference point
MELT-PMD configuration parameters		
Measurement class (MELT-MCLASS)	E.2.1.1	R/W (O)
Peak metallic voltage between tip and ring (MELT-PV)	E.2.1.2	R/W (M)
Signal frequency for active AC tests (MELT-AC-F)	E.2.1.3	R/W (O)
Pair identification tone frequency (MELT-PIT-F)	E.2.1.4	R/W (M)
Maximum far-end signature conduction voltage (MELT-MAXFE-SCV)	E.2.1.5	R/W (M)

Table E.12 – Partitioning of MELT-ME-PMD parameters

Category/element	Defined in clause	η_C – reference point
Minimum far-end signature conduction voltage (MELT-MINFE-SCV)	E.2.1.6	R/W (M)
MELT-PMD reporting parameters		
Measurement frequency for active AC tests (MELT-MFREQ)	E.2.2.1	R (O)
Input impedance for foreign voltage measurements (MELT-IMP-V)	E.2.2.2	R (O)
Measurement voltage for loop complex admittance with a high voltage test (MELT-HCA-V)	E.2.2.3	R (O)
MELT-PMD measurement parameters		
4-element DC resistance with controlled metallic voltage R_{TR} (MELT-CDCR-TR)	E.2.3.1	R (M)
4-element DC resistance with controlled metallic voltage R_{RT} (MELT-CDCR-RT)	E.2.3.1	R (M)
4-element DC resistance with controlled metallic voltage R_{TG} (MELT-CDCR-TG)	E.2.3.1	R (M)
4-element DC resistance with controlled metallic voltage R_{RG} (MELT-CDCR-RG)	E.2.3.1	R (M)
DC test voltage for the measurement of the 4-element DC resistance with a controlled metallic voltage VDC_{TR} (MELT-CDCV-TR)	E.2.3.2	R (O)
DC test voltage for the measurement of the 4-element DC resistance with a controlled metallic voltage VDC_{RT} (MELT-CDCV-RT)	E.2.3.2	R (O)
DC test voltage for the measurement of the 4-element DC resistance with a controlled metallic voltage VDC_{TG} (MELT-CDCV-TG)	E.2.3.2	R (O)
DC test voltage for the measurement of the 4-element DC resistance with a controlled metallic voltage VDC_{RG} (MELT-CDCV-RG)	E.2.3.2	R (O)
Test current for the 4-element DC resistance with a controlled metallic voltage IDC_{TR} (MELT-CDCI-TR)	E.2.3.3	R (O)
Test current for the 4-element DC resistance with a controlled metallic voltage IDC_{RT} (MELT-CDCI-RT)	E.2.3.3	R (O)
Test current for the 4-element DC resistance with a controlled metallic voltage IDC_{TG} (MELT-CDCI-TG)	E.2.3.3	R (O)
Test current for the 4-element DC resistance with a controlled metallic voltage IDC_{RG} (MELT-CDCI-RG)	E.2.3.3	R (O)
3-element capacitance with controlled metallic voltage C_{TR} (MELT-CC-TR)	E.2.3.4	R (M)
3-element capacitance with controlled metallic voltage C_{TG} (MELT-CC-TG)	E.2.3.4	R (M)
3-element capacitance with controlled metallic voltage C_{RG} (MELT-CC-RG)	E.2.3.4	R (M)
Foreign DC voltage $V_{TR,DC}$ (MELT-FVDC-TR)	E.2.3.5	R (M)
Foreign DC voltage $V_{TG,DC}$ (MELT-FVDC-TG)	E.2.3.5	R (M)
Foreign DC voltage $V_{RG,DC}$ (MELT-FVDC-RG)	E.2.3.5	R (M)
Foreign AC voltage $V_{TR,AC}$ (MELT-FVAC-TR)	E.2.3.5	R (M)
Foreign AC voltage $V_{TG,AC}$ (MELT-FVAC-TG)	E.2.3.5	R (M)
Foreign AC voltage $V_{RG,AC}$ (MELT-FVAC-RG)	E.2.3.5	R (M)
Foreign AC voltage frequency $F_{TR,AC}$ (MELT-FVACF-TR)	E.2.3.5	R (M)
Foreign AC voltage frequency $F_{TG,AC}$ (MELT-FVACF-TG)	E.2.3.5	R (M)

Table E.12 – Partitioning of MELT-ME-PMD parameters

Category/element	Defined in clause	η_C – reference point
Foreign AC voltage frequency $F_{RG,AC}$ (MELT-FVACF-RG)	E.2.3.5	R (M)
Loop capacitance with high metallic voltage $C_{TR,HV}$ (MELT-HC-TR)	E.2.3.6	R (M)
Loop resistance with high metallic voltage $R_{TR,HV}$ (MELT-HDCR-TR)	E.2.3.7	R (M)
Loop resistance with high metallic voltage $R_{RT,HV}$ (MELT-HDCR-RT)	E.2.3.7	R (M)
Test voltage for the measurement of the loop resistance with a high metallic voltage $VDCH_{TR}$ (MELT-HDCV-TR)	E.2.3.8	R (O)
Test voltage for the measurement of the loop resistance with a high metallic voltage $VDCH_{RT}$ (MELT-HDCV-RT)	E.2.3.8	R (O)
3-element complex admittance with controlled metallic voltage real part G_{TR} (MELT-CAG-TR)	E.2.3.9	R (O)
3-element complex admittance with controlled metallic voltage imaginary part B_{TR} (MELT-CAB-TR)	E.2.3.9	R (O)
3-element complex admittance with controlled metallic voltage real part G_{TG} (MELT-CAG-TG)	E.2.3.9	R (O)
3-element complex admittance with controlled metallic voltage imaginary part B_{TG} (MELT-CAB-TG)	E.2.3.9	R (O)
3-element complex admittance with controlled metallic voltage real part G_{RG} (MELT-CAG-RG)	E.2.3.9	R (O)
3-element complex admittance with controlled metallic voltage imaginary part B_{RG} (MELT-CAB-RG)	E.2.3.9	R (O)
Loop complex admittance with high metallic voltage real part $G_{TR,HV}$ (MELT-HAG-TR)	E.2.3.10	R (O)
Loop complex admittance with high metallic voltage imaginary part $B_{TR,HV}$ (MELT-HAB-TR)	E.2.3.10	R (O)
Measurement voltage VAC_{TR-CC} (MELT-ACV-CC-TR)	E.2.3.11	R (O)
Measurement voltage VAC_{TG-CC} (MELT-ACV-CC-TG)	E.2.3.11	R (O)
Measurement voltage VAC_{RG-CC} (MELT-ACV-CC-RG)	E.2.3.11	R (O)
Measurement voltage VAC_{TR-HC} (MELT-ACV-HC-TR)	E.2.3.12	R (O)
Measurement voltage VAC_{TR-CA} (MELT-ACV-CA-TR)	E.2.3.13	R (O)
Measurement voltage VAC_{TG-CA} (MELT-ACV-CA-TG)	E.2.3.13	R (O)
Measurement voltage VAC_{RG-CA} (MELT-ACV-CA-RG)	E.2.3.13	R (O)
Measurement voltage VAC_{TR-HA} (MELT-ACV-HA-TR)	E.2.3.14	R (O)

E.3 Test management

For further study.

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Printed in Switzerland
Geneva, 2013