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Original

OR

Maintenance of the international data transmission network for use by the railways

Maintenance du réseau international de transmission de données à l'usage des chemins de fer
Wartung und Instandhaltung des internationalen Datenübertragungsnetzes für die Eisenbahnen

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

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Contents

Summary

The purpose of this leaflet is to provide limits for the commissioning and maintenance of international data transmission within railway data-transmission networks. The preventive maintenance of international data transmission is based on the in-service measurement of erroneous data blocks.

1 - General

1.1 - International data transmission network

1.1.1 - The International Railway Data Transmission Network (IRDN) consists of a set of International Data Nodes (IDN) forming the network and link layer of the OSI model, a set of International Telecommunication Lines (ITL), together forming the physical layer (generally transport layer), and a Network Management Centre (NMC). The IRDN is a packet-switched network with a variable length of packets (blocks).

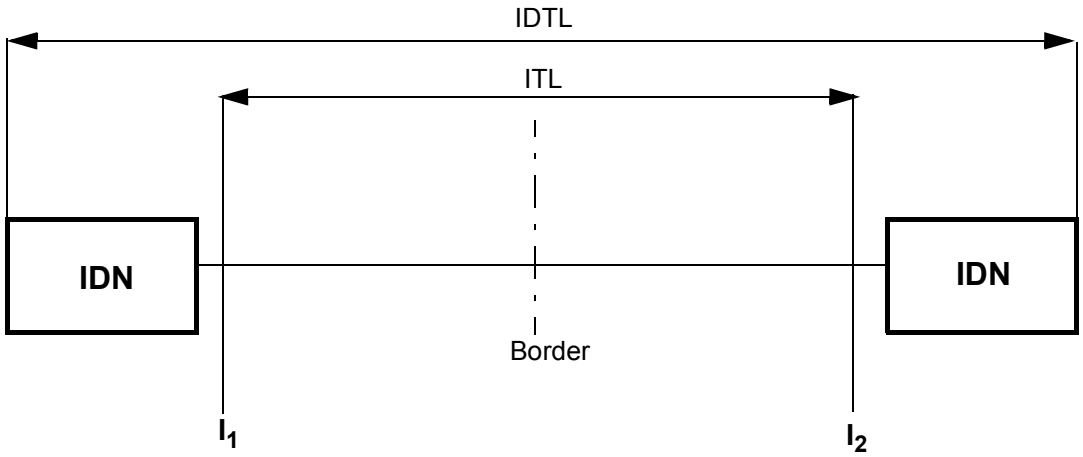
1.1.2 - An international data node is described in *UIC Leaflet 917-1* (see Bibliography - page 16). The IDN need not be dedicated to international data transmission.

1.1.3 - The ITL with two adjacent IDNs establishes an International Data Transmission Line (IDTL).

1.1.4 - An ITL must comply with *UIC Leaflet 753-1*; an IDTL with *UIC Leaflet 917-4* (see Bibliography - page 16).

1.1.5 - The NMC can be subordinated to, or replaced fully with, a National Telecommunication Centre (NTC), if such NTC exists. The distribution of tasks between NMC and/or NTC is a national matter.

1.1.6 - The figure below gives a possible example of an IRDN.



Key: I_1, I_2: Interface of the data circuit termination equipment (V.24, X.21, G.703, etc.)

1.2 - Operation of the ITL

1.2.1 - An ITL used for connection between international data nodes crosses one or more borders. Points of lines are defined in *UIC Leaflet 917-4*.

1.2.2 - An ITL can consist of several analogue or digital circuits. These circuits can be built from two or four wire analogue telephone circuits (using modems) or digital paths in transmission equipment of different types (PDH, SDH, ATM, PCM, xDSL) or even as semi-permanent circuits in ISDN (see List of abbreviations - page 15). The definition of the data circuit termination interface is beyond the scope of this leaflet.

1.2.3 - Data transmission is controlled by the IDN and when a failure causes an interruption in data transmission, the data flow is re-routed over a diversion line and the information is given from the IDNs to the NMCs concerned.

1.3 - Purpose of maintenance

1.3.1 - Maintenance includes all operations necessary to keep the international data transmission network operational with the quality of service parameters laid down in this leaflet. A distinction is made between:

- settings for commissioning (bringing-in-service) according to the values defined in this leaflet;
- preventive (in-service) maintenance based on information of block errors supplied by the IDN and collected in NMC;
- corrective maintenance for finding a defect and for adjustments that must be made after a failure has occurred.

1.3.2 - The organisational procedures for international communication between railway staff engaged in maintenance of IRDN are defined in *UIC Leaflet 917-4*.

2 - Definitions

2.1 - Block (packet)

A block is a set of consecutive bits, each bit belonging to one (and only one) block. A block can be of variable length, the maximum acceptable length is usually defined on a multilateral or bilateral basis. Block length definition is beyond the scope of this leaflet.

2.2 - Bit error

A bit error is the misinterpretation of a single bit by the receiver. It can be caused by the distortion on an ITL or by problems with the processing equipment (IDN).

2.3 - Errored block

A block influenced by at least one bit error that cannot be repaired by the equipment in the transport layer (ITL).

2.4 - Bit error ratio (BER)

Bit Error Ratio is defined as the ratio of the number of errored bits related to the total number of bits transmitted in a given time interval.

2.5 - Block error ratio (BBER)

Block Error Ratio is defined as the ratio of the number of errored blocks related to the total number of blocks transmitted in a given time interval.

3 - Organisation of maintenance

3.1 - General rules

o **3.1.1 -** Before connecting an IDN to the IRDN, a primary adjustment of the ITL quality parameters must be performed (commissioning measurement).

o **3.1.2 -** The commissioning measurement and in-service measurement must be performed in the first IDN adjacent to an ITL (e.g. in IDTL).

3.1.3 - Out-of-service measurements shall also be block-based. It is expected that the out-of-service error detection capability will be superior to the in-service capability.

3.1.4 - The measurement of Errored Seconds (ES) and Severely Errored Seconds (SES) according to *ITU-T G.821* and *M.2100* (see Bibliography - page 16) must be applied to packet-switched services with care because bit errors can influence one or more packets (e.g. blocks) and even single bit errors at regular intervals that are not assessed, as the cause of unavailability can degrade the packet flow significantly. The in-service measurement of ES and SES is not usually supported by the IDN. Therefore the methodology described below will be used for the evaluation of data transmission quality.

NB : The terms ES and SES correspond to the terminology of ITU-T G.821,G.826 and M.2100.

3.2 - Technical documentation of IDTL

o **3.2.1 -** For each IDTL, the railways concerned will prepare and exchange a document with the results of the commissioning measurement. The document will contain information on the testing period and the measured number of erroneous blocks.

o **3.2.2 -** The ITL number must comply with *UIC Leaflet 917-4*.

o **3.2.3 -** The results of preventive maintenance measurements on an IDTL must be archived.

3.2.4 - The manner of archiving is a national matter.

o 3.3 - Preventive maintenance

3.3.1 - As preventive maintenance, at least one in-service measurement per month must be performed over a period of 24 hours. The in-service measurement can be performed on an IDTL of the railway concerned in arbitrary time.

3.3.2 - The NMC must advise an adjacent railway of the intended out-of-service measurements on an IDTL at least 72 hours before starting the work. The message must contain the ITL number and the time at which the work begins and ends. If there is no other IDTL available to the adjacent railway, all the railways listed in Appendix C - page 14 must be advised.

3.4 - Corrective maintenance

3.4.1 - The NMC who discovers a defect or finds that it is not possible to transmit data must check that the IDN for which the NMC is responsible is functioning correctly. At the same time the NMC announces the breakdown to the corresponding NMC responsible for the adjacent part of the IDTL. The procedure for exchange and identification of messages must comply with *UIC Leaflet 917-4*.

3.4.2 - The adjacent NMC must carry out the same checking operation.

3.4.3 - If both IDNs are functioning correctly, the NMC will contact the staff responsible for the ITL required to take all the necessary steps to remedy the breakdown.

3.4.4 - The railways must acquaint their operators with the procedures to be followed in order to minimise the failure period.

3.4.5 - Any failure affecting an IDTL, detected by the IDN and consequently by the NMC, must be announced to an adjacent railway. If there is no other IDTL available to the adjacent railway, all the railways listed in Appendix C - page 14 must be advised.

3.4.6 - With breakdowns that require a long time to be remedied, are very difficult to locate, or if the same kind of breakdown occurs frequently in a particular section and there are no back-up lines enabling data transmission to be maintained between the railways concerned, the NMC must inform all users of the failure.

3.4.7 - The NMC must archive the information on the IDTL by entering all details regarding breakdowns, in particular the date and time they occurred, when they were remedied, the type of breakdown involved, the remedial steps taken, etc.

4 - IDTL on analogue ITL

4.1 - General rules

o **4.1.1 -** The BER of an analogue ITL must be better than $1 \cdot 10^{-6}$.

4.1.2 - Using analogue ITL, the transmission speed is restricted to 28,8 kbit/s.

NB : Base-band modems are considered to be digital transmission equipment and the relevant paragraphs of point 5 - page 9 are to be applied to them.

4.2 - Commissioning

o **4.2.1 -** The diagrams of commissioning measurements of line quality performed on an analogue ITL must comply with *UIC Leaflet 753-1, point 5*.

o **4.2.2 -** After performing the measurements according to point 4.2.1, the measurements of block error performance according to point 4.4.1 - page 8 must be performed.

o **4.2.3 -** No line quality parameter requirements are defined for recent ITU-T Recommendations for modems (such as *V.34*). In this case the commissioning measurement will be performed at block level only.

o **4.2.4 -** Block error performance must be measured during at least 24 hours. The resulting number of erroneous blocks must be lower than that defined in Appendix A, tables 1 and 2 - page 12.

o **4.2.5 -** The railways concerned will exchange the diagrams of ITL used for data transmission and block error performance values, and keep them archived.

4.2.6 - The modems based on the *ITU-T V.34 Recommendation* need the 250 Hz to 4 000 Hz frequency range. Therefore, the use of multi-channel systems is not recommended.

o 4.3 - In-service measurements on ITL

Using analogue ITL, in-service measurements are restricted to signal level on the high-resistance point of connection. This value must comply with the level diagram (hypsogram) from the commissioning measurement.

4.4 - In-service measurement on IDTL

4.4.1 - The evaluation of error performance depends on the block size and transmission speed. The maximum permitted number of erroneous blocks is calculated as follows:

$$NEB \leq (1 - (1 - BER)^{BS}) \cdot \frac{PRBS}{BS}$$

where:

NEB	Number of Erroneous Blocks
BER	Bit Error Ratio
PRBS	transmission speed in bit/s
BS	block size in bits

The performance limits for NEB applying the methodology described above are given in Appendix A, tables 1 and 2 - page 12.

4.4.2 - If the NEB exceeds the limits defined in Appendix A, it is necessary to repeat the commissioning measurements on the analogue ITL concerned.

5 - IDTL on digital ITL

5.1 - General rules

The BER of a digital ITL must be better than $1 \cdot 10^{-9}$ (if no other value is specified).

5.2 - Commissioning

5.2.1 - Before commissioning, measurement of the ITL parameters according to *ITU-T M.2100, Clause 6.2*, must be performed. The test period must be at least 24 hours (recommended period: 3 days).

5.2.2 - Having regard to the *ITU-T M.2100*, the simplified approach in the following table shall be applied:

	Distance between IDN and frontier (d)	**% of end-to-end RPOs**
Country A (terminating)	d ≤ 500 km	2
	500 km < d ≤ 1 000 km	3
Transit country	d ≤ 500 km	2
	500 km < d ≤ 1 000 km	3
Country B (terminating)	d ≤ 500 km	2
	500 km < d ≤ 1 000 km	3

The length of the allocation path can be calculated by simple addition.

Example: The IDN in Country A is connected to the IDN in Country B. Both countries are adjacent (i.e. no transit country). The distance between IDN and the frontier is less than 500 km in country A and more than 500 km, though less than 1 000 km, in country B. The total RPO is 5 %.

The resulting figure (in %) is to be entered as path allocation into *ITU-T Recommendation M.2100, Annexe B, Table C.11* (for transmission speeds < 2 Mbit/s) and *Table C.21* (transmission speed 2 Mbit/s).

For successful commissioning, the error performance must be better than S1.

5.3 - In-service measurement

5.3.1 - For transmission speeds below 2 Mbit/s, the formula according to point 3.4 - page 6 is to be applied. As the number of erroneous blocks does not vary significantly according to the block size, the influence of this factor is omitted. The performance limits for NEB are given in Appendix B, table 3 - page 13.

5.3.2 - For a transmission speed above 2 Mbit/s, the maximum permitted number of erroneous blocks is calculated as follows:

$$NEB \leq BBER \cdot \frac{PRBS}{BS}$$

where:

NEB	number of erroneous blocks
BBER	block error ratio
PRBS	transmission speed in bit/s
BS	block size in bits

The recommended value of BBER $= 2 \cdot 10^{-4}$ complies with *ITU-T G.826, Table 1*. However, the meaning of BBER is different to that from *ITU-T G.826*.

The performance limits for NEB applying the methodology described above are given in Appendix B, table 4 - page 13.

5.3.3 - If the NEB exceeds the limits defined in Appendix B, table 4, it is necessary to repeat the commissioning measurements.

6 - Combined analogue and digital ITL

O **6.1 -** The quality of parameters must comply with those specified for the analogue ITL.

6.2 - The digital part of the ITL is not expected to produce higher error performance than the analogue part.

O **6.3 -** The number of digital/analogue conversions must be less than 3.

Appendix A - The erroneous block limits for analogue IDTL

Table 1 : Transmission speed 19,2 kbit/s, BER = 1 . 10^{-8}

Block size in bytes	NEB per 1 second	NEB per 15 minutes	NEB per 60 minutes	NEB per 24 hours
128	$1{,}9 \cdot 10^{-4}$	0,17	0,69	16
256	$1{,}9 \cdot 10^{-4}$	0,17	0,69	16
512	$1{,}9 \cdot 10^{-4}$	0,17	0,69	16
1 024	$1{,}9 \cdot 10^{-4}$	0,17	0,69	16
2 048	$1{,}9 \cdot 10^{-4}$	0,17	0,69	16
4 096	$1{,}9 \cdot 10^{-4}$	0,17	0,69	16

Table 2 : Transmission speed 28,8 kbit/s, BER = 1 . 10^{-8}

Block size in bytes	NEB per 1 second	NEB per 15 minutes	NEB per 60 minutes	NEB per 24 hours
128	$2{,}9 \cdot 10^{-4}$	0,26	1	24
256	$2{,}9 \cdot 10^{-4}$	0,26	1	24
512	$2{,}9 \cdot 10^{-4}$	0,26	1	24
1 024	$2{,}9 \cdot 10^{-4}$	0,26	1	24
2 048	$2{,}9 \cdot 10^{-4}$	0,26	1	24
4 096	$2{,}9 \cdot 10^{-4}$	0,26	1	24

NB : All values are rounded off.

Appendix B - The erroneous block limits for digital IDTL

Table 3 : Transmission speed < 2 Mbit/s, BER = 1 . 10^{-9}

Block size in bytes	NEB per 1 second	NEB per 15 minutes	NEB per 60 minutes	NEB per 24 hours
64	$6,4 \cdot 10^{-5}$	0	0	5
128	$1,2 \cdot 10^{-4}$	0	0	11
256	$2,5 \cdot 10^{-4}$	0	0	22
512	$5,1 \cdot 10^{-4}$	0	1	44
1 024	$1 \cdot 10^{-3}$	0	3	88

NB : The block size of 1 024 bytes is calculated. All values are rounded off.

Table 4 : Transmission speed 2 Mbit/s, BBER = 2 . 10^{-4}

Block size in bytes	NEB per 1 second	NEB per 15 minutes	NEB per 60 minutes
128	0,4	360	1 440
256	0,2	180	720
512	0,1	90	360
1 024	0,05	45	180
2 048	0,025	22,5	90
4 096	0,0125	11,25	45

NB : Values in bold frame are not defined in the *ITU-T G.826* (block size in bits is larger).

Appendix C - The NMC of the railways concerned that must be advised

according to points 3.3.2 - page 5 and 3.4.5 - page 6 (work on an IDTL or failure of an IDTL)

IDL between		NMC in
Austria	Czech Republic	Germany, Hungary, Italy, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Ukraine
Austria	Germany	Czech Republic, Hungary, Italy, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Ukraine
Austria	Hungary	Czech Republic, Germany, Italy, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Ukraine
Austria	Italy	Czech Republic, Germany, Hungary, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Ukraine
Austria	Slovenia	Czech Republic, Germany, Hungary, Italy, Poland, Romania, Slovak Republic, Switzerland, Ukraine
Austria	Switzerland	Czech Republic, Germany, Hungary, Italy, Poland, Romania, Slovak Republic, Slovenia, Ukraine
Czech Republic	Germany	Austria, Hungary, Italy, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Ukraine
Czech Republic	Slovak Republic	Austria, Germany, Hungary, Italy, Poland, Romania, Slovenia, Switzerland, Ukraine
Germany	Poland	Austria, Czech Republic, Hungary, Italy, Romania, Slovak Republic, Slovenia, Switzerland, Ukraine
Germany	Switzerland	Austria, Czech Republic, Hungary, Italy, Poland, Romania, Slovak Republic, Slovenia, Ukraine
Hungary	Romania	Austria, Czech Republic, Germany, Italy, Poland, Slovak Republic, Slovenia, Switzerland, Ukraine
Hungary	Slovak Republic	Austria, Czech Republic, Germany, Italy, Poland, Romania, Slovenia, Switzerland, Ukraine
Italy	Switzerland	Austria, Czech Republic, Germany, Hungary, Poland, Romania, Slovak Republic, Slovenia, Ukraine
Poland	Ukraine	Austria, Czech Republic, Germany, Hungary, Italy, Romania, Slovak Republic, Slovenia, Switzerland
Slovak Republic	Ukraine	Austria, Czech Republic, Germany, Hungary, Italy, Poland, Romania, Slovenia, Switzerland

List of abbreviations

ATM	Asynchronous Transfer Mode
BER	Bit Error Ratio
BBER	Block Error Ratio
IDN	International Data Node
IDTL	International Data Transmission Line
IRDN	International Railway Data Transmission Network
ISDN	Integrated Services Digital Network
ITL	International Telecommunication Lines
ITU	International Telecommunication Union
NEB	Number of Erroneous Blocks
NMC	Network Management Centre
NTC	National Telecommunication Centre
PCM	Pulse Coded Modulation
PDH	Plesiochronous Digital Hierarchy
SDH	Synchronous Digital Hierarchy

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UIC Leaflet 753-1: Technical regulations concerning international railway telephone circuits, (5th edition under preparation)

UIC Leaflet 917-1: Technical provisions for the international interconnected Railway data transmission network, 3rd edition, August 2003

UIC Leaflet 917-4: Information and instructions for the maintenance of the telecommunication lines used by the Railways for the interconnection of data transmission networks, (3rd edition under preparation)

2. Miscellaneous

International Telecommunication Union (ITU)
G.821: Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network,

G.826: Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate,

M.2100: Performance limits for bringing-into-service and maintenance of international PDH paths, sections and transmission systems,

Warning

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