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GENERAL CHARACTERISTICS OF INTERNATIONAL TELEPHONE CONNECTIONS AND INTERNATIONAL TELEPHONE CIRCUITS

CHARACTERISTICS OF N + M TYPE DIRECT TRANSMISSION RESTORATION SYSTEMS FOR USE ON DIGITAL AND ANALOGUE SECTIONS, LINKS OR EQUIPMENT

ITU-T Recommendation G.180

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation G.180 was revised by the ITU-T Study Group XV (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 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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CHARACTERISTICS OF N + M TYPE DIRECT TRANSMISSION RESTORATION SYSTEMS FOR USE ON DIGITAL AND ANALOGUE SECTIONS, LINKS OR EQUIPMENT

(Melbourne, 1988; amended at Helsinki, 1993)

1 General

Transmission restoration functions are often implemented in the modern telecommunication networks to improve the availability and quality of service, by minimizing the effects or potential effects of a transmission failure, and to make the maintenance operations easier.

The terminology and general principles of transmission restoration are described in Recommendation M.495. The functional organization for automatic transmission restoration is described in Recommendation M.496.

2 Object of Recommendation

This Recommendation specifies the characteristics of equipment for N + M type direct transmission restoration systems (protection link switching) for digital and analogue sections, links and equipment (see Recommendations G.701 and G.211). The general arrangement of a system for N + M direct transmission restoration is shown in Figure 1. This Recommendation refers to the equipment labelled as RSE (restoration switching equipment) and RSCE (restoration switching control equipment).

This Recommendation is intended also to cover the case where the signals at the interfaces T belong to different hierarchical levels. In this case, each access at one side can be a group of accesses as indicated in the example of Figure 2. The left part of this figure refers to the particular case where the restored path is not on a complete link but just through a multiplex equipment.

NOTE – The equipment specified in this Recommendation can possibly be used also for N + M automatic or semi-automatic transmission rerouting (protection network switching) but generally this type of restoration function is implemented by different equipment, often incorporating also other functions (such as, for example, automatic digital distribution frames).

Three types of direct transmission restoration systems are considered by this Recommendation:

The first one should permit routing of any one of N normal links on to any one of M restoration links.

The second type should permit the interconnection of any of the N accesses to any one of the N + M links.

The third one should permit routing of any one of N normal links to a single restoration link (in many cases this type can be considered just a special case of the first type).

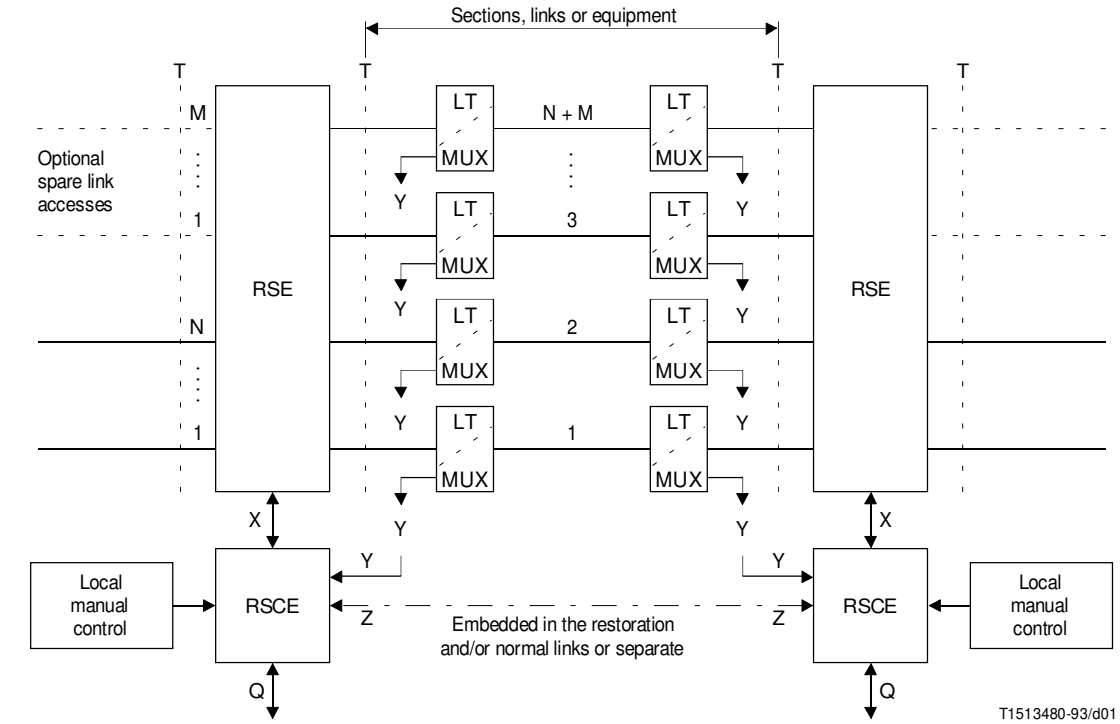
For all the types two options exist:

a) to switch the two directions of transmission independently; and

b) to switch the two directions of transmission simultaneously.

This Recommendation does not cover the restoration systems fully embedded in transmission systems and the 1 + 1 systems where the switching occurs at the receive end only (see Recommendation G.181).

The hierarchical levels at interfaces T are those specified in Recommendation G.702 (hierarchy levels 1 and up). For RSE to be used on analogue transmission systems the frequency bands at interface T are those specified in Recommendation G.211.



RSE Restoration switching equipment

RSCE Restoration switching control equipment

LT MUX Line terminal, digital multiplexing or analogue translating equipment

This link can be replaced by connection in the TMN

X Non-standardized (or standard Q) interface. If RSE and RSCE are combined interface X does not exist

Y Interface to be standardized in the future (possibly standard Q)

Z Interface possibly to be standardized

Q Optional standard Q interface to the TMN (telecommunication management network) or to a control centre

T Transmission path interfaces

NOTES

1 The failing of a section or link can possibly be detected in the RSE and the information transferred to the RSCE. In this case interface Y may not exist.

2 The interworking with the TMN via interface Q is at present beyond the scope of the Recommendation.

3 The N + M links or sections can be in the same cable or follow different routes.

4 Spare link accesses may be used to convey low priority traffic.

5 The interface between the RSCE and local manual control is not standardized and it is not covered by this Recommendation.

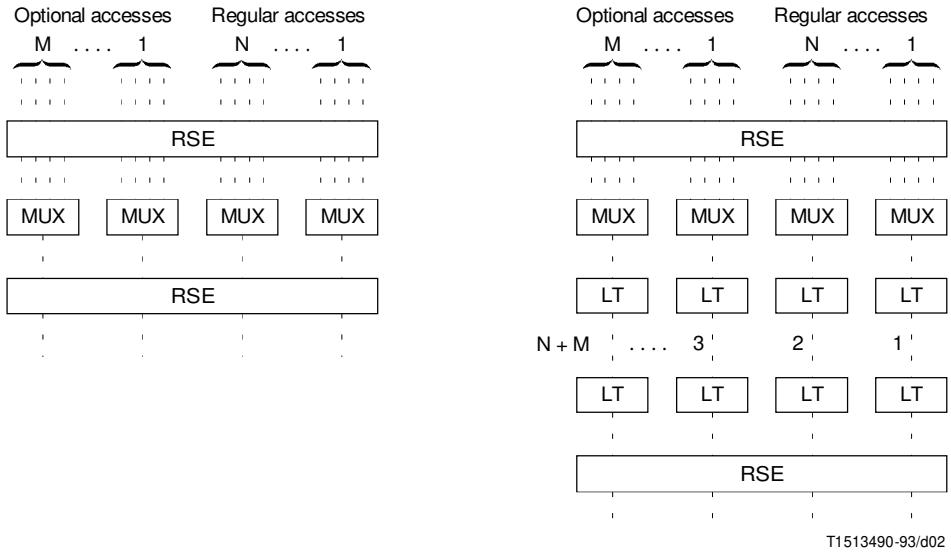
FIGURE 1/G.180

N + M direct transmission restoration system

3 RSE specifications

Two types of RSE are considered by this Recommendation: “regenerative” and “non-regenerative”.

The first type, where the digital signal undergoes a complete process of retiming and reshaping, is for digital systems only. It makes the RSE a digital equipment, and it is sometimes considered to be advantageous, e.g. from the station cabling point of view.



RSE Restoration switching equipment
MUX Digital multiplexing or analogue translating equipment
LT Line terminal equipment

FIGURE 2/G.180

Examples of restoration systems where the hierarchical levels at the two ends are different

The second type, where the output signal is proportional to the input signal (except for minor distortion) is considered to be useful for digital systems under some circumstances, e.g. from a reliability and cost point of view, and it is the only one usable for analogue systems.

3.1 Interfaces

3.1.1 Transmission path interfaces (T)

The relevant parameters and the recommended values are listed in the uppermost part of Table 1 for the non-regenerative RSE, to be used for digital systems. The uppermost part of Table 2 covers the regenerative RSE. The uppermost part of Table 3 is for the non-regenerative RSE to be used for analogue systems.

3.1.2 Control interfaces

The only control interface of the RSE is X. This interface is not at present specified by the CCITT. However in the future, it may be specified as a Q interface (see Recommendation G.773).

If the interface X is not standardized, the separation between the RSE and RSCE (and consequently between clauses 3 and 4) will be somewhat arbitrary.

3.2 Operational aspects

3.2.1 Transfer of the switched signals

The relevant parameters and the recommended values are listed in the lower part of Table 1 for the non-regenerative RSE to be used for digital systems. The lower part of Table 2 covers the regenerative RSE. The lower part of Table 3 is for the non-regenerative RSE to be used for analogue systems.

TABLE 1/G.180

Recommended values for the interface and transfer characteristics of non-regenerative RSE for use on digital systems

Interface	Nominal impedance	As stated in Rec. G.703
	Return loss at the input port (with the output port terminated on the nominal impedance)	6 dB above the values stated in Rec.G.703
	Accepted levels	The output levels considered in Rec. G.703
Transfer	Transfer function between the input and the output of the RSE (terminated on the nominal impedances) (see Note 2 of Table 2)	< 10% of the interconnecting pair loss and phase distortion allowed in Rec. G.703 for the relevant hierarchical level, or the complement thereof, plus or minus 0.5 dB flat loss. It is assumed that the loss vs frequency distortion approximates to the $\sqrt{f}$ law
	Crosstalk attenuation	≥ 40 dB from any channel ≥ 30 dB multi-channel interference evaluated on a voltage-sum basis. These values apply up to a frequency value equal to the nominal bit-rate

TABLE 2/G.180

Recommended values for the interface and transfer characteristics of regenerative RSE

Interface (Note 2)	Connecting pairs Test impedance and return loss at the input ports Pulse shape and levels Tolerable input jitter	As stated in Rec. G.703
	Intrinsic output jitter	As stated in Annex A
Transfer (Note 2)	Jitter transfer	As stated in Annex B
	Error performance	99.99% error-free seconds (Note 1)
	Others	The paths across each switch shall maintain bit sequence independence and integrity

NOTES

1 Evaluated under maximum loading condition and excluding any external source of interference.

2 The nominal bit rate and tolerance are as stated in Recommendation G.703.

TABLE 3/G.180

Recommended values for the interface and transfer characteristics of non-regenerative RSE for use on analogue systems

Interface	Nominal relative levels in switching points	As stated in Recommendation G.233
	Nominal impedance at the input/output ports	
	Return loss at the input/output ports	
	Longitudinal balance conversion loss	(Note) ≥ 46 dB
Transfer	Insertion loss	≤ 0.3 dB
	Frequency response as stated in Recommendation G.211	± 0.2 dB
	Noise referred to the voice-frequency channel bandwith	≤ 20 pW0 for a pair of RSEs loaded by the signal of maximum power averaged over one minute interval
	Intelligible crosstalk ratio between ports within the same RSE	≥ 90 dB
NOTE – For groups only.		

3.2.2 Response

For RSE providing M restoration paths to N normal paths (M = 1 included) it is recommended that in response to a RSCE command the RSE should apply the incoming interface signal belonging to a given normal link to the input port of a given restoration link. The signal should not be removed from the input port of the concerned normal link, except that it may be replaced by a test signal.

For RSE providing N + M link to N accesses it is recommended that in response to a RSCE command, the RSE should apply the incoming interface signal belonging to a given access from 1 to N to a given link from 1 to N + M.

The time required for the above response is the restoration transfer time, as defined in Recommendation M.495.

3.2.3 Other operational aspects

A recognized failure of the RSCE or its disconnection from the RSE at interface X (when applicable) should either:

a) Cause the RSE to route all the signals on the N normal links. After the failure of the RSCE is cleared or the RSCE is reconnected to the RSE, normal restoration operations will resume.

b) Not alter the state of the RSE. The cross-connection pattern of the RSE should be available by interrogation from the RSCE to enable it to update, when the failure is cleared or it is reconnected to the RSE, its own record on the cross-connection pattern.

For the restoration systems of the second type (as defined alternative in b) only holds. For the systems of the first and third types both alternatives are applicable.

4 RSCE specifications

4.1 Interfaces

Interfaces Y, Z of the RSCE (see Figure 1) are at present non standardized. However they may be standardized in the future.

4.2 Operational aspects

4.2.1 Responses

A switching to a restoration link should be initiated under a request coming from interfaces Y, Z, Q (and X where the faults are detected within the RSE) or on command from the local manual control.

When decided in the RSCE the allocation of a restoration link can optionally take place according to defined priority rules based on:

- defined priority for each normal link;
- request type (low or high priority request).

Otherwise the allocation should be specified by the information coming from interfaces Z, Q or local manual control.

For the restoration systems providing M restoration links (M = 1 included) on N normal links, when a successful restoration request clears, traffic should be returned to the pertinent normal link and the pertinent restoration link should be released.

It should be possible from interfaces Z, Q and under local manual control to lock in a working link (e.g. during system maintenance).

The time required for the above response is the sum of the waiting time and the restoration procedure time, as defined in Recommendation M.495.

4.2.2 Alarm and status criteria

The alarm and status criteria provided by the RSCE are not standardized. Examples are reported in Appendix I.

4.2.3 Monitoring and self-test procedures

The monitoring and self-test procedures of the RSCE are not standardized. Examples are reported in Appendix II.

Annex A

(This annex provides information which is supplementary to Table 2 and does not form an integral part of this Recommendation)

A.1 Maximum permissible intrinsic jitter at output ports of regenerative restoration switching equipment

NOTE – Values for bit rates of the 1544 kbit/s digital hierarchy are not covered by this Recommendation.

A.1.1 For asynchronous space matrix RSE

Digital rate (kbit/s)	Parameter value		
	Maximum value Unit interval peak-peak	Measurement filter bandwith	
		Bandpass filter having a lower cut-off frequency f_1 and an upper cut-off frequency f_4	
		f_1	f_4
2 048	0.1	20 Hz	100 kHz
8 448	0.1	20 Hz	400 kHz
34 368	0.075	100 Hz	800 kHz
139 264	0.05	200 Hz	3500 kHz

A.1.2 For synchronous RSE using central timing

Digital rate (kbit/s)	Parameter value				
	Maximum value Unit interval peak-peak		Measurement filter bandwidth		
			Bandpass filter having a lower cut-off frequency f_1 or f_3 and an upper cut-off frequency f_4		
	B_1 (f_1 ÷ f_4 filter)	B_2 (f_3 ÷ f_4 filter)	f_1	f_3	f_4
2 048	0.25	0.05	20 Hz	18 kHz (700 Hz)	100 kHz
8 448	0.25	0.05	20 Hz	3 kHz (80 kHz)	400 kHz
34 368	0.35	0.05	100 Hz	10 kHz	800 kHz
139 264	0.35	0.05	200 Hz	10 kHz	3500 kHz

NOTES

1 UI Unit interval

for 2 048 kbit/s 1 UI 488 ns

for 8 448 kbit/s 1 UI 118 ns

for 34 368 kbit/s 1 UI 29.1 ns

for 139 264 kbit/s 1 UI 7.18 ns.

2 These figures shall be met for any valid signal in the absence of input jitter. The measurement shall be implemented using equipment designed in accordance with Recommendation O.171.

3 Clause 2/G.823 indicates the measurement method.

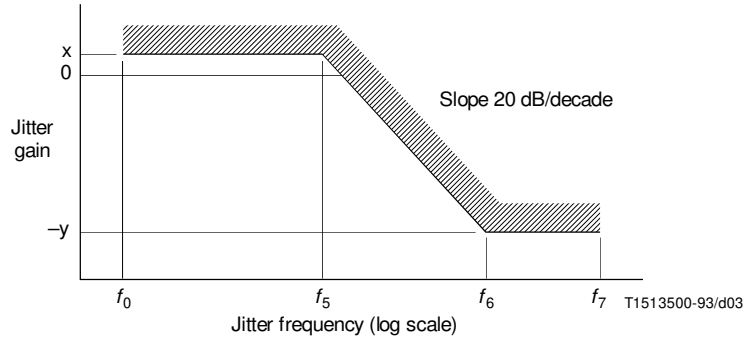
4 The frequency values in parentheses only apply to certain national interfaces.

Annex B

(This annex provides information which is supplementary to Table 2 and
does not form an integral part of this Recommendation)

B.1 Jitter transfer characteristics recommended for regenerative restoration switching equipment

NOTE – Values for bit rates of the 1544 kbit/s digital hierarchy are not covered by this Recommendation.



B.1.1 For asynchronous space matrix RSE

Digital rate (kbit/s)	Parameter value						
	x (dB) (Note 5)	$-y$ (dB)	f_0 (Hz)	f_5 (kHz)	f_6 (kHz)	f_7 (kHz)	Test signal (pseudorandom as Rec. O.151)
2 048	0.5	–8.4 (–9.5)	(Note 1)	36 (1.4)	100 (4.4)	100	$2^{15} - 1$
8 448	0.5	–9.5 (–7.5)	(Note 1)	6 (160)	19 (400)	400	$2^{15} - 1$
34 368	0.5	–9.5	(Note 1)	20	64	800	$2^{23} - 1$
139 264	0.5	–9.5	(Note 1)	20	64	3500	$2^{23} - 1$

NOTES

1 The frequency f_0 should be as low as possible (e.g. 10 Hz) taking into account the limitations of measuring equipment.

2 The measuring method should be selective with a bandwith sufficiently small referred to the relevant measuring frequency, but not wider than 40 Hz.

3 In the f_6 to f_7 frequency range the jitter gain should be less than –y dB, with the exception of spurious responses, which should be suppressed below –6 dB.

4 The frequency values shown in parentheses only apply to certain national interfaces.

5 A value of 0.2 dB has been suggested as technically possible for this type of equipment. This may be useful where large numbers of RSE are employed in the network.

B.1.2 For synchronous RSE using central timing

Digital rate (kbit/s)	Parameter value						
	x (dB)	$-y$ (dB)	f_0 (Hz)	f_5 (Hz)	f_6 (Hz)	f_7 (kHz)	Test signal (pseudorandom as Rec. O.151)
2 048	0.5	19.5	(Note 1)	40	400	100	$2^{15} - 1$
8 448	0.5	19.5	(Note 1)	100	1000	400	$2^{15} - 1$
34 368	0.5	19.5	(Note 1)	300	3000	800	$2^{23} - 1$
139 264	0.5	19.5	(Note 1)	900	9000	3500	$2^{23} - 1$

NOTES

1 The frequency f_0 should be as low as possible (e.g. 10 Hz) taking into account the limitations of measuring equipment.

2 The measuring method should be selective with a bandwidth sufficiently small referred to the relevant measuring frequency, but not wider than 40 Hz.

Appendix I

Examples of alarms and status criteria for digital systems

(Both refer to a N + 1 system)

(This appendix does not form an integral part of this Recommendation)

Provided by STC PLC	Provided by AT&T Network Systems International
Alarms The system should include: a) System fail. b) Protection failure. c) Manual switch in operation d) System software self check in operation. e) Control system failure. f) System software failure. g) Communication failure. h) Stand-by channel failure. i) Power supply failure. j) Card removal.	Separate alarm criteria shall be issued at the occurrence of the following faulty conditions: a) Loss of signal at the traffic input port, transmit side. b) Loss of signal at the traffic output port, receive side. c) Automatic lock-in (see Note). d) Switch failure. e) Protection failure. f) Control system failure. g) Communication failure. h) Stand-by channel failure. i) Power supply unit failure. j) Loss of power supply. k) Switch exerciser failure.
	Separate status criteria shall be issued, on the occurrence of the following situations: a) Switch operated. b) Switch locked. c) Switch request pending. d) Switch in manual mode. The protective switching control equipment shall make available to the remote control and maintenance centre alarm and status information corresponding to the criteria shown above.
NOTE – This system is required to automatically lock in the normal or the protection channel if an excesive number of switching operations are made in a given period.	

Appendix II

Examples for monitoring and self-test procedures for digital system

(Both refer to a N + 1 system)

(This appendix does not form an integral part of this Recommendation)

Provided by STC PLC	*Standby channel monitoring* The system should include means of monitoring the standby channel continuously for proper operation. *Self-check* The system should include self-check facilities as follows: a) Communication channel. b) Background-checking of the memory, coaxial relay drive buffer and other hardware. c) Correct programme execution.
Provided by AT&T Network Systems International	*Standby channel monitoring* The standby channel shall be monitored continuously for proper operation. *Switch exerciser* The protective switching system shall provide a switch exerciser meeting the following requirements: The exerciser shall test the complete switch-over procedure up to but excluding the last transfer switch in the direction of transmission. The switching system shall drop the exerciser routine and serve switch requests from failed or deteriorated channels. A facility for including the last switch in the exercise routine may be provided. This feature shall have the capability of being disabled.