INTERNATIONAL TELECOMMUNICATION UNION

ITU-T V.91

(05/99)

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SERIES V: DATA COMMUNICATION OVER THE TELEPHONE NETWORK

Simultaneous transmission of data and other signals

A digital modem operating at data signalling rates of up to 64 000 bit/s for use on a 4-wire circuit switched connection and on leased point-to-point 4-wire digital circuits

ITU-T Recommendation V.91

(Previously CCITT Recommendation)

ITU-T V-SERIES RECOMMENDATIONS

DATA COMMUNICATION OVER THE TELEPHONE NETWORK

General	V.1–V.9
Interfaces and voiceband modems	V.10–V.34
Wideband modems	V.35–V.39
Error control	V.40–V.49
Transmission quality and maintenance	V.50–V.59
Simultaneous transmission of data and other signals	**V.60–V.99**
Interworking with other networks	V.100–V.199
Interface layer specifications for data communication	V.200–V.249
Control procedures	V.250–V.299
Modems on digital circuits	V.300–V.399

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION V.91

A DIGITAL MODEM OPERATING AT DATA SIGNALLING RATES OF UP TO 64 000 bit/s FOR USE ON A 4-WIRE CIRCUIT SWITCHED CONNECTION AND ON LEASED POINT-TO-POINT 4-WIRE DIGITAL CIRCUITS

Summary

This Recommendation specifies the operation of a duplex digital modem for use on a 4-wire circuit switched connection and on leased point-to-point 4-wire digital circuits at data signalling rates of up to 64 000 bit/s. The modem is specified in terms of coding, start-up sequences, operating procedures and DTE-DCE interface functionalities. The modem includes an optional control channel and support for transparent mode on unrestricted 64 000 bit/s channels. The network interface of the modem and the signalling rate that is used to connect the modem locally to a 4-wire connection are considered to be national matters and are hence not specified.

Source

ITU-T Recommendation V.91 was prepared by ITU-T Study Group 16 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 27 May 1999.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. 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, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 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 term *recognized operating agency (ROA)* includes any individual, company, corporation or governmental organization that operates a public correspondence service. The terms *Administration, ROA* and *public correspondence* are defined in the *Constitution of the ITU (Geneva, 1992)*.

INTELLECTUAL PROPERTY RIGHTS

The ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. The ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, the ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation V.91

A DIGITAL MODEM OPERATING AT DATA SIGNALLING RATES OF UP TO 64 000 bit/s FOR USE ON A 4-WIRE CIRCUIT SWITCHED CONNECTION AND ON LEASED POINT-TO-POINT 4-WIRE DIGITAL CIRCUITS

(Geneva, 1999)

1 Scope

This modem is specified herein in terms of coding, start-up signals and sequences, operating procedures and DTE-DCE interface functionalities. The network interface of the modem and the signalling rate that is used to connect the modem locally to a 4-wire connection are considered to be national matters and are hence not specified herein. The principal characteristics of the modem are as follows:

a) duplex mode of operation on a 4-wire digital connection;

b) channel separation by 4-wire connection;

c) PCM modulation at a rate of 8000 symbols per second;

d) synchronous channel data signalling rates from 28 000 bit/s to 64 000 bit/s in increments of 8000/6 bit/s;

e) an optional control channel that uses 125 bit/s of the primary channel data signalling rate and allows for a 67.5 bit/s secondary channel data signalling rate;

f) adaptive techniques that enable the modem to achieve close to the maximum data signalling rate that the channel can support on each connection;

g) support of transparent mode on unrestricted 64 000 bit/s channels;

h) exchange of rate sequences during start-up to establish the data signalling rate; and

i) automoding to devices supporting V.8, and optionally V.8 *bis*, procedures.

2 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 are subject to revision; all users of this Recommendation and other references 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.

– CCITT Recommendation G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.

– ITU-T Recommendation V.8 (1998), *Procedures for starting sessions of data transmission over the public switched telephone network*.

– ITU-T Recommendation V.8 *bis* (1998), *Procedures for the identification and selection of common modes of operation between Data Circuit-terminating Equipments (DCEs) and between Data Terminal Equipments (DTEs) over the public switched telephone network and on leased point-to-point telephone-type circuits*.

– ITU-T Recommendation V.14 (1993), *Transmission of start-stop characters over synchronous bearer channels*.

– ITU-T Recommendation V.24 (1996), *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)*.

– ITU-T Recommendation V.34 (1998), *A modem operating at data signalling rates of up to 33 600 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits*.

– ITU-T Recommendation V.42 (1996), *Error-correcting procedures for DCEs using asynchronous-to-synchronous conversion*.

– ITU-T Recommendation V.43 (1998), *Data flow control*.

– CCITT Recommendation V.54 (1988), *Loop test devices for modems*.

– ITU-T Recommendation V.80 (1996), *In-band DCE control and synchronous data modes for asynchronous DTE*.

– ITU-T Recommendation V.90 (1998), *A digital modem and analogue modem pair for use on the public switched telephone network (PSTN) at data signalling rates of up to 56 000 bit/s downstream and up to 33 600 bit/s upstream*.

3 Definitions

This Recommendation defines the following terms:

Nominal transmit power: As defined in clause 3/V.90.

Uchord: As defined in clause 3/V.90.

Ucode: As defined in clause 3/V.90.

4 Abbreviations

This Recommendation uses the following abbreviations:

DCE Data Circuit-Terminating Equipment

DIL Digital Impairment Learning sequence

DTE Data Terminal Equipment

5 Interchange circuits

5.1 List of interchange circuits

References in this Recommendation to V.24 interchange circuit numbers are intended to refer to the functional equivalent of such circuits and are not intended to imply the physical implementation of such circuits. For example, references to circuit 103 should be understood to refer to the functional equivalent of circuit 103 (see Table 1).

Table 1/V.91 – Interchange circuits

Interchange circuit		Notes
No.	Description	
102	Signal ground or common return	
103	Transmitted data	
104	Received data	
105	Request to send	
106	Ready for sending	
107	Data set ready	
108/1 or	Connect data set to line	
108/2	Data terminal ready	
109	Data channel received line signal detector	1
125	Calling indicator	
133	Ready for receiving	2
141	Local loopback	
142	Test indicator	
NOTE 1 – Thresholds and response times are not applicable in this Recommendation.		
NOTE 2 – Operation of circuit 133 shall be in accordance with 4.2.1.1/V.43.		

5.2 Asynchronous character-mode interfacing

The modem may include an asynchronous-to-synchronous converter interfacing to the DTE in an asynchronous (or start-stop character) mode. The protocol for the conversion shall be in accordance with Recommendation(s) V.14, V.42 or V.80. Data compression may also be employed.

6 Line signals

6.1 Data signalling rates

Synchronous channel data signalling rates from 28 000 bits/s to 64 000 bit/s in increments of 8000/6 bit/s shall be supported. The data signalling rate shall be determined during modem start-up according to the procedures described in 8.2.

6.2 Symbol rate

The symbol rate shall be 8000 established by timing from the digital network interface.

6.3 Encoder for non-transparent mode

As defined in 5.4/V.90 and Figure 1/V.90.

6.3.1 Scrambler

The modem shall include a self-synchronizing scrambler as specified in Recommendation V.34, Equation 7-1/V.34, GPC.

6.3.2 Mapping parameters

As defined in 5.4.1/V.90 with $S_r = 0$, S = 6 and K ranging from 15 to 42.

Table 2 shows the data signalling rates achieved by the valid values of K and S.

Table 2/V.91 – Data signalling rates for different K and for S

K, bits entering modulus encoder	S, sign bits used for user data	Data signalling rate, kbit/s
15	6	28
16	6	29 1/3
17	6	30 2/3
18	6	32
19	6	33 1/3
20	6	34 2/3
21	6	36
22	6	37 1/3
23	6	38 2/3
24	6	40
25	6	41 1/3
26	6	42 2/3
27	6	44
28	6	45 1/3
29	6	46 2/3
30	6	48
31	6	49 1/3
32	6	50 2/3
33	6	52
34	6	53 1/3
35	6	54 2/3
36	6	56
37	6	57 1/3
38	6	58 2/3
39	6	60
40	6	61 1/3
41	6	62 2/3
42	6	64

6.3.3 Input bit parsing

As defined in 5.4.2/V.90.

6.3.4 Modulus encoder

As defined in 5.4.3/V.90.

6.3.5 Mapper

As defined in 5.4.4/V.90.

6.3.6 Differential encoding

The differential encoding is as defined in 5.4.5.1/V.90 ($S_r = 0$, $S = 6$). The differential encoding is applied continuously to all sign bits irrespective of their allocation to the primary channel or the control channel.

6.3.7 Sign assignment

As defined in 5.4.6/V.90.

6.3.8 Mux

As defined in 5.4.7/V.90.

6.3.9 Control channel bit assignment

When provided, the control channel uses all 6 sign bits of every 64th data frame. The control channel bits are differentially encoded but not scrambled. The first data frame used for the control channel is the first data mode frame. Frame synchronization is maintained from this point on. The control channel is only available in non-transparent mode.

6.4 Control channel

A control channel may be requested by the receiving modem by setting bit 27 of INFO. The peer modem shall supply a control channel if and only if it is requested to do so. The control channel can be used to detect digital slips, to cleardown the call and to request a retrain. Secondary channel data may also be carried in the control channel. The control channel uses 125 bit/s of the primary channel data signalling rate.

The control channel consists of repetitions of the 96-bit sequence defined in Table 3. Bit 0 is transmitted first.

The CRC generator used is described in 10.1.2.3.2/V.34.

Table 3/V.91 – Definition of bits in a control channel sequence

Control channel bits LSB:MSB	Definition
0:15	Digital slip detection pattern: 0111011111111010
16	Set to 1 indicates cleardown (see 8.6)
17	Set to 1 indicates retrain (see 8.4.1)
18:23	Reserved for ITU-T: These bits are set to 0 by the transmitter and are not interpreted by the receiver
24:77	Secondary channel data
78:93	CRC
94:95	Fill bits: 00

6.5 Encoder for transparent mode

When the modem is operating in transparent mode, data bits are passed from the scrambler input to the network interface transparently. The order of the bits in time is preserved.

Subclauses 8.4, 8.5 and 8.6 do not apply to transparent mode.

NOTE – There are no provisions in transparent mode for altering the data bits. This means that even a channel that is merely polarity inverted cannot be considered an unrestricted 64 000 bit/s channel suitable for using transparent mode.

7 Start-up sequences

All PCM codewords transferred in training sequences are described using the universal codes as specified in Table 1/V.90.

7.1 B1

B1 consists of 12 PCM codewords transmitted at the end of start-up. The PCM codewords are the result of mapping binary ones using the selected data mode.

7.2 CP

CP is used to pass constellation parameters for use in the transmitter of the peer modem. A CP sequence with the acknowledge bit set to 1 is denoted by CP'.

CP sequences are mapped in the same manner as SCR (see 7.11). The scrambler and differential encoder are initialized to zero prior to the transmission of the first CP sequence unless it is preceded by SCR. In this case they are initialized with the final symbol of the transmitted SCR. Bit fields for CP sequences are defined in Table 4. Bit 0 is transmitted first.

The CRC generator used is described in 10.1.2.3.2/V.34.

CP sequences are defined to be of variable length. A constellation mask consists of 128 bits where a bit set to 1 indicates that the constellation includes the PCM code represented by the corresponding Ucode. Only the number of different constellations need to be sent. The constellations that are sent are indexed from 0 (in bits 136:271) to a maximum of 5 (in bits 816:951). Due to the variability in the number of constellations, a parameter γ is defined to be 136* (multiplexed by the maximum constellation index given in bits 103:127).

Table 4/V.91 – Definition of bits in CP

CP bits LSB:MSB	Definition
0:16	Frame Sync: 1111111111111111
17	Start bit: 0
18	Set to 1 indicates transparent mode granted
19	Set to 1 to maintain V.90 compatibility
20:24	Selected digital modem to analogue modem data signalling rate, an integer, drn, between 0 and 28. drn = 0 indicates cleardown. Data signalling rate = (drn + 20)*8000/6
25:29	Reserved for ITU-T: These bits are set to 0 by the transmitter and are not interpreted by receiver
30:32	Set to 0 to maintain V.90 compatibility
33	Acknowledge bit: 0 = modem has not received CP from far end, 1 = received CP from far end
34	Start bit: 0
35:50	Reserved for ITU-T: These bits are set to 0 by the transmitter and are not interpreted by receiver
51	Start bit: 0
52:67	Reserved for ITU-T: These bits are set to 0 by the transmitter and are not interpreted by receiver
68	Start bit: 0

Table 4/V.91 – Definition of bits in CP *(continued)*

CP bits LSB:MSB	Definition
69:84	Reserved for ITU-T: These bits are set to 0 by the transmitter and are not interpreted by receiver
85	Start bit: 0
86:101	Reserved for ITU-T: These bits are set to 0 by the transmitter and are not interpreted by receiver
102	Start bit: 0
103:106	An integer between 0 and 5 denoting the index of the constellation to be used in data frame interval 0
107:110	An integer between 0 and 5 denoting the index of the constellation to be used in data frame interval 1
111:114	An integer between 0 and 5 denoting the index of the constellation to be used in data frame interval 2
115:118	An integer between 0 and 5 denoting the index of the constellation to be used in data frame interval 3
119	Start bit: 0
120:123	An integer between 0 and 5 denoting the index of the constellation to be used in data frame interval 4
124:127	An integer between 0 and 5 denoting the index of the constellation to be used in data frame interval 5
128	Set to 0 to maintain V.90 compatibility
129:135	Reserved for ITU-T: These bits are set to 0 by the transmitter and are not interpreted by receiver
136	Start bit: 0
137:152	Constellation mask for $Uchord_1$ (Bit 137 corresponds to Ucode 0)
153	Start bit: 0
154:169	Constellation mask for $Uchord_2$ (Bit 154 corresponds to Ucode 16)
170	Start bit: 0
171:186	Constellation mask for $Uchord_3$ (Bit 171 corresponds to Ucode 32)
187	Start bit: 0
188:203	Constellation mask for $Uchord_4$ (Bit 188 corresponds to Ucode 48)
204	Start bit: 0
205:220	Constellation mask for $Uchord_5$ (Bit 205 corresponds to Ucode 64)
221	Start bit: 0
222:237	Constellation mask for $Uchord_6$ (Bit 222 corresponds to Ucode 80)
238	Start bit: 0
239:254	Constellation mask for $Uchord_7$ (Bit 239 corresponds to Ucode 96)
255	Start bit: 0
256:271	Constellation mask for $Uchord_8$ (Bit 256 corresponds to Ucode 112)
272:271γ	Possibly more constellations in same format as bits 136:271

Table 4/V.91 – Definition of bits in CP *(concluded)*

CP bits LSB:MSB	Definition
272+γ	Start bit: 0
273+γ:288+γ	CRC
289+γ	Fill bit: 0
290+γ:…	Fill bits: 0s to extend the CP sequence length to the next multiple of 6 bits

7.3 DIL

The DIL is as defined in 8.4.1/V.90. Only one instance of the DIL is transmitted.

If a modem requests the default DIL by setting bit 26 of INFO, then the DIL sent to that modem shall have the parameters given in Table 5. The training symbol for the first DIL-segment is represented by Ucode 124, the training symbol for the 2nd DIL-segment is represented by Ucode 0, etc.

Table 5/V.91 – Default DIL parameters

N	125															
L_{SP}	12															
L_{TP}	12															
SP	0FC0 hex															
TP	0FFF hex															
H_1, …, H_8	1															
REF_1, …, REF_8	0															
Training symbols	124	0	123	1	122	2	121	3	120	4	119	5	118	6	117	7
	116	8	115	9	114	10	113	11	112	12	111	13	110	14	109	15
	108	16	107	17	106	18	105	19	104	20	103	21	102	22	101	23
	100	24	99	25	98	26	97	27	96	28	95	29	94	30	93	31
	92	32	91	33	90	34	89	35	88	36	87	37	86	38	85	39
	84	40	83	41	82	42	81	43	80	44	79	45	78	46	77	47
	76	48	75	49	74	50	73	51	72	52	71	53	70	54	69	55
	68	56	67	57	66	58	65	59	64	60	63	61	62			

NOTE – It is highly desirable that a modem requests a DIL that does not allow echo control devices in the network to re-enable. The default DIL has this property.

7.4 E_u

E_u is used to signal the beginning of DIL when both modems have requested the default DIL. It consists of 12T of binary zeroes mapped as the bits of INFO. The differential encoder shall be initialized with the final bit transmitted before E_u.

The first symbol transmitted after E_u is defined to be transmitted in data frame interval 0. The modem shall keep frame alignment from this point on.

7.5 E_s

E_s is used to signal the end of CP. It consists of 12T of binary zeroes mapped as the bits of SCR. The differential encoder and scrambler shall be initialized with the final bit of the transmitted CP.

7.6 E_z

E_z is used to transition from the end of the silence following Phase 1 to the beginning of the INFO sequences. It consists of 24T of binary zeroes mapped as the sign bit of Ucode 66.

7.7 E_m

E_m is used to terminate PHIL. E_m is also used to terminate J unless J is followed by PHIL. It consists of 12T of differential encoded and scrambled binary zeroes mapped as the bits of INFO. The scrambler shall not be initialized at the start of E_m. The differential encoder shall be initialized with the final bit transmitted before E_m.

The first symbol transmitted after E_m is defined to be transmitted in data frame interval 0. The modem shall keep frame alignment from this point on.

7.8 INFO

The INFO sequence is differentially encoded and mapped as the sign bit of Ucode 66. The differential encoder shall be initialized to zero prior to the transmission of the first bit of INFO. The definition of the bits in the INFO sequence is given in Table 6. Bit 0 is transmitted first in time. The CRC generator is described in 10.1.2.3.2/V.34.

Table 6/V.91 – Definition of bits in INFO

INFO bits LSB:MSB	Definition
0:3	Fill bits: 1111
4:11	Frame sync: 01110010, where the left-most bit is first in time
12:25	Reserved for ITU-T: Set to 0 by the transmitter and not interpreted by the receiver
26	Set to 0 to request default DIL
27	Set to 1 to request the control channel
28	Set to 1 to acknowledge correct reception of an INFO frame
29:32	Reserved for ITU-T: Set to 0 by the transmitter and not interpreted by the receiver
33:37	Maximum transmit power. 0 denotes unspecified maximum transmit power. Integers 1 to 31 represent the maximum transmit power in –0.5 dBm0 steps where 1 denotes –1 dBm0 and 31 denotes –16 dBm0

Table 6/V.91 – Definition of bits in INFO *(concluded)*

INFO bits LSB:MSB	Definition
38	Set to 1 indicates the modem's transmit power shall be measured after digital impairments (i.e. at the receiver). Otherwise the modem's power shall be measured at its terminals
39	PCM coding used by the transmitter: 0 = μ-law, 1 = A-law
40	Set to 1 to request transparent data mode
41	Set to 1 to indicate the desire to cleardown if the request for transparent data mode is not granted. This bit may only be set to 1 if bit 40 is set to 1
42:57	CRC
58:61	Fill bits: 1111

7.9 J

J consists of a series of differentially encoded scrambled bits mapped as the bits in INFO. The differential encoder is initialized with the final bit of the transmitted INFO. The definition of the bits in J is given in Table 12/V.90. The scrambler shall be initiated to zero prior to the first symbol of J. The bits are sent only once and are not repeated. Bit 0 is transmitted first in time.

7.10 PHIL

PHIL consists of a series of differentially encoded scrambled binary ones mapped as the bits in INFO. The scrambler and the differential encoder shall be initialized to zero prior to the first symbol of PHIL unless PHIL is preceded by J.

7.11 SCR

Signal SCR is defined as differentially encoded scrambled binary ones mapped as the sign bit of Ucode 66. The scrambler and the differential encoder shall be initialized to zero prior to the first symbol of SCR. When generating SCR, the modem shall use the polynomial, GPC, in Equation 7-1/V.34. SCR shall be an integer multiple of 6 symbols long.

8 Operating procedures

8.1 Phase 1

V.8, and optionally V.8 *bis*, is used in Phase 1. All signals in Phase 1 shall be transmitted at the nominal transmit power level. If V.91 capability is indicated by both modems during the Phase 1 negotiation, the modem shall generate silence for 75 ± 5 ms by sending PCM codewords with magnitudes represented by Ucode 0. The modem shall then proceed with the V.91 start-up.

8.2 V.91 start-up

The modem may initiate a retrain at any time during start-up or data mode according to 8.4.1. Examples of V.91 start-up procedures are shown in Figures 1, 2, and 3.

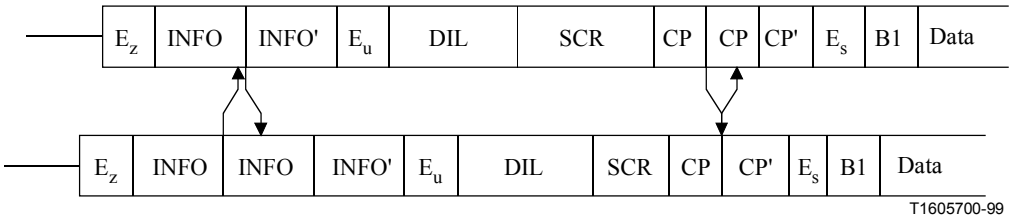


Figure 1/V.91 – Start-up with both modems requesting the default DIL

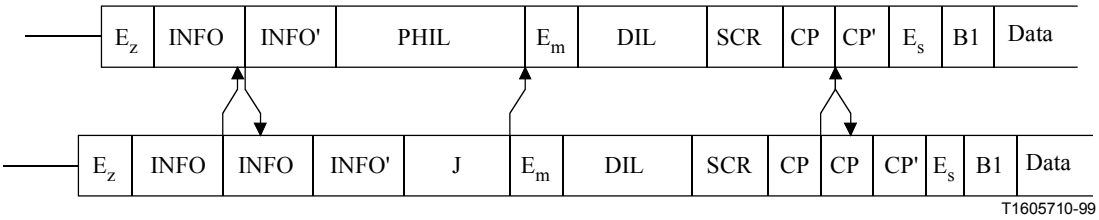


Figure 2/V.91 – Start-up with one modem requesting the default DIL and the other specifying a DIL

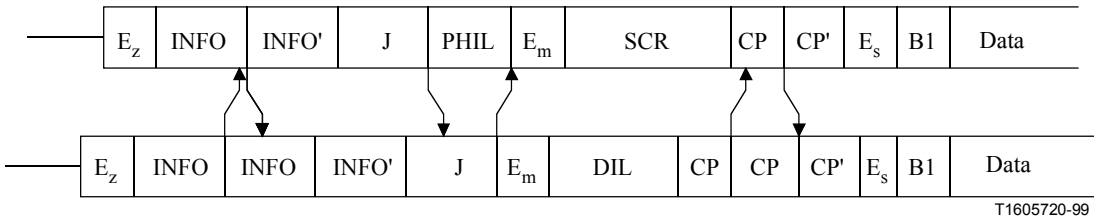


Figure 3/V.91 – Start-up with both modems specifying a DIL and in one case the DIL has length 0

8.2.1 Call and answer modem

8.2.1.1 The modem shall transmit E_z.

8.2.1.2 The modem shall transmit INFO sequences with bit 28 set to 0 and condition its receiver to receive an INFO sequence.

8.2.1.3 Upon receiving an INFO sequence, the modem shall complete sending the current INFO sequence and then send an INFO sequence with bit 28 set to 1.

8.2.1.4 If both modems have requested the default DIL, they shall both transmit E_u followed by the default DIL. After transmitting E_u the modems shall turn ON circuit 107. The modems shall then transmit an optional amount of SCR and proceed to 8.2.1.8.

8.2.1.5 If the modem has not requested the default DIL, it shall send sequence J.

8.2.1.6 The modem shall then send PHIL until it has the information necessary to provide the DIL requested by the peer modem. If it already has the information necessary to provide the DIL requested by the peer modem, it shall proceed to 8.2.1.7; otherwise the modem shall transmit E_u followed by the DIL requested by the peer modem. The modem shall then transmit an optional amount of SCR without transmitting PHIL.

8.2.1.7 The modem shall transmit E_m followed by the DIL requested by the peer modem. After transmitting E_m the modem shall turn ON circuit 107. The modem shall then transmit an optional amount of SCR.

8.2.1.8 The modem shall transmit CP sequences within 1.5 seconds of receiving E_u or E_m and condition its receiver to receive a CP sequence.

8.2.1.9 After receiving a CP sequence, the modem shall complete sending the current CP sequence and send a CP' sequence.

8.2.1.10 The modem shall continue to send CP sequences until it has sent a CP' sequence and received a CP' sequence or E_s. The modem shall then complete the current CP' sequence and send a single E_s.

8.2.1.11 After sending E_s, the modem shall send B1. The modem shall then enable circuit 106 to respond to the condition of circuit 105 and begin data transmission.

8.2.1.12 After receiving E_s, the modem shall condition its receiver to receive B1. After receiving B1, the modem shall unclamp circuit 104, turn on circuit 109, and begin receiving data.

8.3 Escape to V.34

The modem may escape to V.34 at any time during start-up. The modem shall escape to V.34 if it does not receive an INFO' sequence within 1.5 seconds of beginning the procedure in 8.2.1.2. The modem shall escape to V.34 if it does not receive B1 within 10 seconds of beginning the procedure in 8.2.1.2. The signals and sequences referred to in this subclause are defined in Recommendation V.34.

8.3.1 Call modem

To escape to V.34 or if it receives repeated $INFO_{0a}$ sequences, the call modem shall repeatedly send $INFO_{0c}$.

If the call modem receives $INFO_{0a}$ with bit 28 set to 1, it shall condition its receiver to detect Tone A and the subsequent Tone A phase reversal, complete sending the current $INFO_{0c}$ sequence, and then transmit Tone B. Alternatively, if the call modem detects Tone A and has received $INFO_{0a}$, it shall condition its receiver to detect a Tone A phase reversal, complete sending the current $INFO_{0c}$ sequence, and transmit Tone B. In both cases, the call modem shall then proceed according to 11.2.1.1.3/V.34.

8.3.2 Answer modem

To escape to V.34 or if it receives repeated $INFO_{0c}$ sequences, the answer modem shall repeatedly send $INFO_{0a}$.

If the answer modem receives $INFO_{0c}$ with bit 28 set to 1, it shall condition its receiver to detect Tone B, complete the current $INFO_{0a}$, and then transmit Tone A. Alternatively, if the answer modem detects Tone B and has received $INFO_{0c}$, it shall complete the current $INFO_{0a}$, and transmit Tone A. In both cases, the answer modem shall then proceed according to 11.2.1.2.3/V.34.

8.4 Retrains

The modem shall start a 10-second timer after clamping circuit 104. The timer shall be disabled upon successfully completing a retrain. On expiry of the timer the modem shall turn OFF circuits 106, 107 and 109 and terminate the connection.

8.4.1 Initiating retrain

To initiate a retrain, a modem shall turn OFF circuit 106, clamp circuit 104 to binary one, hold circuits 107 and 109 in the ON condition and continue in accordance with 8.2.1.2. If a modem is transmitting the control channel, then it may warn the peer modem that it is about to initiate a retrain by setting bit 17 of the control channel sequence. In this case, the modem shall initiate the retrain after completing the current control channel sequence.

8.4.2 Responding to retrain

After detecting the onset of INFO, the modem shall turn OFF circuit 106, clamp circuit 104 to binary one, hold circuits 107 and 109 in the ON condition and continue in accordance with 8.2.1.2.

8.5 Loss of frame synchronization

If a loss of frame synchronization is detected, the modem shall clamp circuit 104 and start a 10-second timer. The modem may either initiate a retrain according to 8.4.1 or attempt to reacquire frame synchronization by another means. Upon successful reacquisition of frame synchronization the timer shall be disabled, circuit 104 shall be unclamped and the modem begins receiving data. On expiry of the timer the modem shall turn OFF circuits 106, 107 and 109 and terminate the connection.

8.6 Cleardown

The cleardown procedure shall be used to terminate a connection. Cleardown is indicated by setting drn to 0 in CP. This may be signalled at any time that a modem sends a CP sequence. To cleardown from data mode, a modem shall either initiate retrain according to 8.4.1 in order to send a CP sequence with drn = 0 or signal cleardown by setting bit 16 of the control channel sequence. If a modem signals cleardown through the control channel, it shall complete the current control channel sequence before cleardown.

8.7 Transparent mode

If a transparent data mode was requested by either modem using bit 40 of INFO, then bit 18 of CP signals whether that request has been granted or not. In order to enter transparent data mode, both modems must grant the request by setting bit 18. If the requesting modem set bit 41 of INFO to 1, then the modems shall cleardown if either fails to grant the request. Otherwise, if either modem fails to grant the request, the modem shall proceed with a non-transparent data mode using the parameters sent in the CP sequences. A modem granting a request to enter transparent data mode shall set drn to 28.

A modem issuing or receiving a request for transparent mode shall grant transparent mode after verifying that an unrestricted 64 000 bit/s channel is present.

8.8 Four-wire leased line operation

For four-wire leased line operation, the modems shall proceed according to 8.2.1.2.

9 Testing facilities

Test loop 3 as defined in Recommendation V.54 shall be provided.

10 Glossary

γ Variable used to define bit positions in CP

drn A parameter used in determining the data signalling rate

K The number of modulus encoder input data bits per data frame

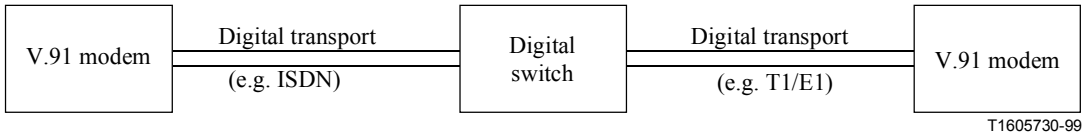
S The number of differential encoder input data bits per data frame

S_r The number of PCM code sign bits per data frame used as redundancy for spectral shaping

APPENDIX I

Typical network configuration

V.91 can only be used when two V.91 capable modems that have digital interfaces are connected by a 4-wire circuit switched connection. An example network configuration is shown below.



ITU-T RECOMMENDATIONS SERIES

Series A	Organization of the work of the ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	**Data communication over the telephone network**
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	Languages and general software aspects for telecommunication systems