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SERIES V: DATA COMMUNICATION OVER THE
TELEPHONE NETWORK

Simultaneous transmission of data and other signals

Enhancements to Recommendation V.90

ITU-T Recommendation V.92

(Formerly CCITT Recommendation)

ITU-T V-SERIES RECOMMENDATIONS
DATA COMMUNICATION OVER THE TELEPHONE NETWORK

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Enhancements to Recommendation V.90

Summary

Digital and analogue modems for use on the Public Switched Telephone Network (PSTN) at data signalling rates up to 56 000 bit/s downstream and up to 48 000 bit/s upstream, with reduced start-up time on recognized connections, and procedures to support modem-on-hold in response to call-waiting events or outgoing call requests.

Source

ITU-T Recommendation V.92 was prepared by ITU-T Study Group 16 (2001-2004) and approved under the WTSA Resolution 1 procedure on 17 November 2000.

FOREWORD

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ITU-T Recommendation V.92

Enhancements to Recommendation V.90

1 Scope

This Recommendation specifies the operation between two different modems, one a digital modem and the other an analogue modem, both as defined in clause 3. The two modems are specified herein in terms of coding, start-up signals and sequences, operating procedures and DTE-DCE interface functionality. The network interface of the digital modem and the signalling rate that is used to connect the digital modem locally to a digital switched network are considered to be national matters and are hence not specified herein. The principal characteristics of these modems are as follows:

- a) duplex mode of operation on the PSTN;
- b) channel separation by echo cancellation techniques;
- c) PCM modulation in both directions at a symbol rate of 8000;
- d) synchronous channel data signalling rates in the downstream direction from 28 000 bit/s to 56 000 bit/s in increments of 8000/6 bit/s;
- e) synchronous channel data signalling rates in the upstream direction from 24 000 bit/s to 48 000 bit/s in increments of 8000/6 bit/s;
- f) adaptive techniques that enable the modems to achieve close to the maximum data signalling rates the channel can support on each connection;
- g) negotiate V.34 modulation upstream (downstream) if a connection will not support PCM modulation upstream (downstream);
- h) exchange of rate sequences during start-up to establish the data signalling rate;
- i) use of V.8, and optionally V.8 bis, procedures during modem start-up or selection;
- j) reduced start-up time on recognized connections; and
- k) support of modem-on-hold procedures in response to call-waiting events or outgoing call requests.

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 and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- ITU-T G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.
- ITU-T V.8 (2000), *Procedures for starting sessions of data transmission over the public switched telephone network*.
- ITU-T V.8 bis (2000), *Procedures for the identification and selection of common modes of operation between data circuit-terminating equipment (DCEs) and between data terminal equipment (DTEs) over the public switched telephone network and on leased point-to-point telephone-type circuits*.

- ITU-T V.14 (1993), *Transmission of start-stop characters over synchronous bearer channels.*
- ITU-T V.21 (1988), *300 bits per second duplex modem standardized for use in the general switched telephone network.*
- ITU-T V.24 (2000), *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE).*
- ITU-T V.25 (1996), *Automatic answering equipment and general procedures for automatic calling equipment on the general switched telephone network including procedures for disabling of echo control devices for both manually and automatically established calls.*
- ITU-T 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 V.42 (1996), *Error-correcting procedures for DCEs using asynchronous-to-synchronous conversion.*
- ITU-T V.43 (1998), *Data flow control.*
- ITU-T V.80 (1996), *In-band DCE control and synchronous data modes for asynchronous DTE.*
- ITU-T 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:

3.1 analogue modem: The analogue modem is the modem of the pair that, when in data mode, receives G.711 signals that have been passed through a G.711 decoder. The modem is typically connected to the PSTN.

3.2 digital modem: The digital modem is the modem of the pair that, when in data mode, generates G.711 signals. The modem is connected to a digital switched network through a digital interface, e.g. a Basic Rate Interface (BRI) or a Primary Rate Interface (PRI).

3.3 downstream: Transmission in the direction from the digital modem towards the analogue modem.

3.4 nominal transmit power: Reference transmit power that is configured by the user.

3.5 Qa.b format: Numbers denoted as signed Qa.b are represented in $(a + b + 1)$ -bit two's-complement format with b bits after the binary point, and assume values in the half-open interval $[-2^a, 2^a[$. Numbers denoted as unsigned Qa.b are represented in $(a + b)$ -bit format with b bits after the binary point, and assume values in the half-open interval $[0, 2^{a+1}[$.

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

3.7 upstream: Transmission in the direction from the analogue modem towards the digital modem.

3.8 L_U : The value of L_U is set such that TRN_{1U} is transmitted at the desired data mode transmit power.

4 Abbreviations

This Recommendation uses the following abbreviations:

BRI	Basic Rate Interface
DCE	Data Circuit-Terminating Equipment
DIL	Digital Impairment Learning sequence
DTE	Data Terminal Equipment
PRI	Primary Rate Interface
PSTN	Public Switched Telephone Network
RTDEd	Round-Trip Delay Estimate – digital modem

5 Digital modem

The data signalling rates, symbol rate, scrambler and encoder for the digital modem shall be the same as those given in clause 5/V.90.

6 Analogue modem

6.1 Data signalling rates

The modem shall transmit synchronously at data signalling rates of 24 000 bit/s to 48 000 bit/s in increments of 8000/6 bit/s. The data signalling rate shall be determined during Phase 4 of modem start-up according to the procedures described in 9.6.

6.2 Symbol rate

The upstream symbol rate shall be 8000 symbol/s derived from the digital network.

6.3 Scrambler

The analogue modem shall include a self-synchronizing scrambler as specified in clause 7/V.34, using the generating polynomial, GPA, in equation 7-2/V.34.

6.4 Transmitter

The framing of the transmitter shall be based upon Figure 1.

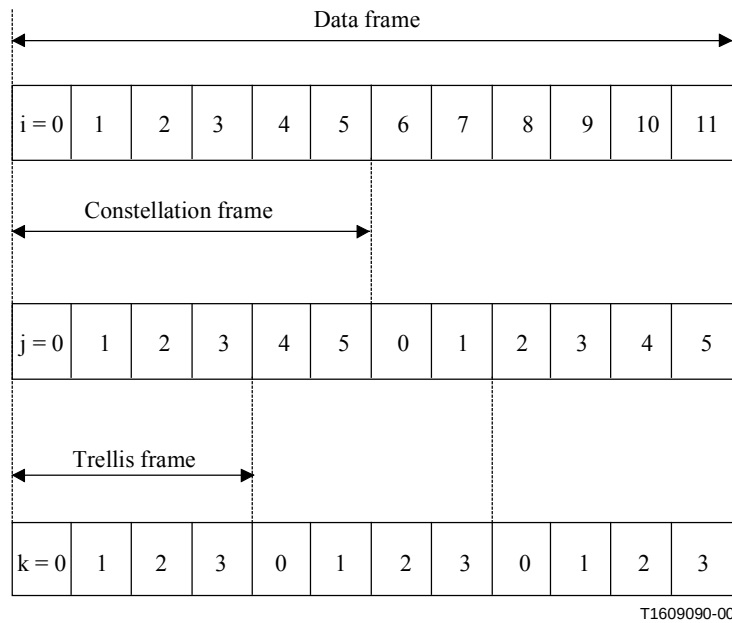


Figure 1/V.92 – Framing structure for the analogue modem

Figure 2 is a block diagram of the major elements of the analogue modem transmitter, which are described in detail in 6.4.1 to 6.4.4.

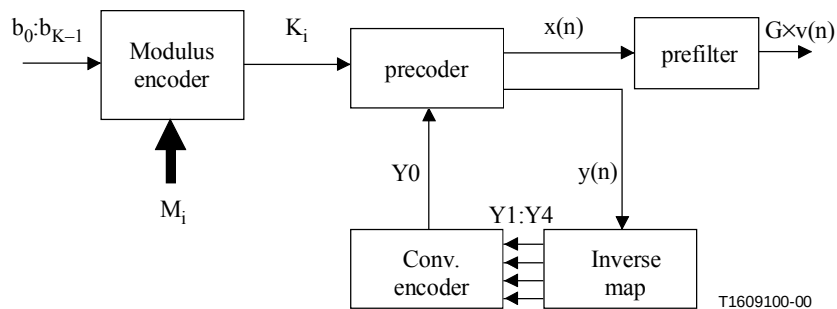


Figure 2/V.92 – Analogue modem transmitter block diagram

6.4.1 Modulus encoder

For each data frame, K scrambled bits, denoted by bits b_0 to b_{K-1} , where b_0 is first in time, enter the modulus encoder. Parameters M_0 to M_{11} also enter the modulus encoder.

The values of M_i and K shall satisfy the inequality $2^K \leq M = \prod_{i=0}^{11} M_i$

The modulus encoder converts the K bits into twelve numbers, K_0 to K_{11} , using the following algorithm.

NOTE – Other implementations are possible but the mapping function must be identical to that given in the algorithm described below.

- 1) Represent the incoming K bits as an integer, R :

$$R = b_0 + b_1 \times 2^1 + \dots + b_{K-1} \times 2^{K-1}$$

- 2) Determine the 'sign' of R:

$$s(f) = 0 \text{ if } R \leq (M-1)/2; s(f) = 1 \text{ if } R > (M-1)/2$$

- 3) Differentially encode the 'sign':

$$d(f) = s(f) \oplus d(f-1), \text{ where } \oplus \text{ represents modulo 2 addition}$$

- 4) Form R_0 :

$$R_0 = R \text{ if } d(f-1) = 0; R_0 = M-1-R \text{ if } d(f-1) = 1$$

- 5) Divide R_0 by M_0 . The remainder of this division gives K_0 , the quotient becomes R_1 for use in the calculation for the next data frame interval. Continue for the remaining eleven data frame intervals. This gives K_0 to K_{11} as:

$$K_i = R_i \text{ modulo } M_i, \text{ where } 0 \leq K_i < M_i; R_{i+1} = (R_i - K_i)/M_i$$

- 6) The numbers K_0 to K_{11} are the outputs of the modulus encoder, where K_0 corresponds to data frame interval 0 and K_{11} corresponds to data frame interval 11.

6.4.2 Precoder and prefilter

The precoder has inputs from the modulus encoder and the convolutional encoder. For each K_i received from the modulus encoder, the precoder identifies K_i with an equivalence class $E(K_i)$. The precoder selects a point $u(n)$ from the equivalence class $E(K_i)$. The index of the constellation point $u(n)$ is denoted by $y(n)$.

The equivalence classes are chosen as follows. Let the N constellation points be denoted by $a(\eta)$, $-N/2 \leq \eta < N/2$, where the indices are in the same order as the levels. (N is the appropriate constellation length taken from the CP_d sequence, i.e. one of $2*LC_1$ through $2*LC_6$ in Table 30). Thus negative points have negative indices, and positive points have non-negative indices. The modulus encoder output K_i has M_i possible values $0 \leq K_i < M_i$. The equivalence class $E(K_i)$ corresponding to K_i is then defined as:

$$E(K_i) = \{a(\eta_k) \mid \eta_k = K_i + z_k M_i, z_k \text{ an integer}\} \text{ for } k = 0, 1, 2;$$

$$\{a(\eta_k) \mid \eta_k = 2K_i + 2z_k M_i + (\eta_0 + \eta_1 + \eta_2 + Y_0) \bmod 2, z_k \text{ an integer}\} \text{ for } k = 3.$$

The precoder filter output is then:

$$x(n) = u(n) + \sum_{\kappa=1}^{LZ_1} u(n-\kappa)z_1(\kappa) + \sum_{\kappa=1}^{LP_1} x(n-\kappa)p_1(\kappa)$$

The prefilter takes the output of the precoder filter and produces $v(n)$, defined as:

$$v(n) = \sum_{\kappa=0}^{LZ_2-1} x(n-\kappa)z_2(\kappa) + \sum_{\kappa=1}^{LP_2} v(n-\kappa)p_2(\kappa)$$

Finally the output $v(n)$ is multiplied by a gain, G .

6.4.3 Inverse map

For each trellis frame the inverse map takes the two pairs $(y(0), y(1))$ and $(y(2), y(3))$ and produces Y_1, Y_2, Y_3 and Y_4 . It is identical to the symbol-to-bit converter described in 9.6.3.1/V.34. The odd-integer coordinates used in 9.6.3.1/V.34 are calculated as $2 \times y(k) + 1$.

6.4.4 Convolutional encoder

The convolutional encoders from ITU-T V.34 shall be used. The convolutional encoder takes the outputs Y1, Y2, Y3 and Y4 from the inverse map and produces Y0, as described in 9.6.3.2/V.34, except that the 2T delays are replaced by 4T delays.

7 Interchange circuits

The requirements of this clause apply to both modems.

7.1 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.92 – 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	
125	Calling indicator	1
133	Ready for receiving	
NOTE 1 – Thresholds and response times are not applicable because a line signal detector cannot be expected to distinguish received signals from talker echoes.		
NOTE 2 – Operation of circuit 133 shall be in accordance with 4.2.1.1/V.43.		

7.2 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 ITU-T V.14, ITU-T V.42 or ITU-T V.80. Data compression may also be employed.

8 Signals and sequences

All PCM codewords transferred in training sequences are described using the universal codes as specified in Table 1/V.90. In Tables 2 to 5, 11 to 24, 27 and 30 to 33, unless stated otherwise, values given as bit patterns are transmitted leftmost bit first in time and values given as integers are transmitted least-significant bit first in time.

8.1 Full Phase 1

All full Phase 1 signals and sequences are defined in ITU-T V.25, ITU-T V.80 or ITU-T V.8 bis.

8.2 Short Phase 1 signals and sequences for the analogue modem

Signals QC1a and QCA1a are intended for use when the connection is initiated according to ITU-T V.8. Signals QC2a and QCA2a are intended for use when the connection is initiated according to ITU-T V.8 *bis*.

Short Phase 1 information bits are transmitted at 300 bits/s modulating either V.21(L), the low-band channel defined in ITU-T V.21, or ITU-T V.21(H), the high-band channel defined in ITU-T V.21.

8.2.1 QC1a

Signal QC1a is a sequence of bits transmitted using V.21(L) modulation. The sequence consists of 10-bit frames using V.8-type formatting as defined in Table 2. QC1a is transmitted once, and is followed immediately by CM.

Table 2/V.92 – Definition of QC1a

Bit position	Content	Definition	
0:9	1111111111	Ten ONEs	
10:19	0101010101	Synchronization sequence	
20	0	Start bit	
21	0	Indication for analogue modem	
22	0	Indication for QC	
23	P	Set to 1 calls for LAPM protocol according to ITU-T V.42 (see 9.2.5)	
24:29	W0XYZ1	WXYZ	U _{QTS} : Ucode of the PCM codeword to be used for QTS
		0000	61
		0001	62
		0010	63
		0011	66
		0100	67
		0101	70
		0110	71
		0111	74
		1000	75
		1001	78
		1010	79
		1011	82
		1100	83
		1101	86
		1110	87
		1111	Cleardown from on-hold state
30:39	1111111111	Ten ONEs	
40:49	0101010101	Bits 10:19 repeated	
50:59	000PW0XYZ1	Bits 20:29 repeated	



8.2.2 QC2a

Signal QC2a is a sequence of bits transmitted using V.21(H) modulation. The bits are transmitted using the signal structure defined in clause 7/V.8 *bis* and the information field structure defined in clause 8/V.8 *bis*. The analogue modem shall encode the identification field as defined in Table 3.

Table 3/V.92 – Definition of identification field in QC2a

Bit position	Content	Definition
0:3	1011	Message type
4:7	VVVV	V.8 <i>bis</i> revision number (Note)
8:11	WXYZ	U _{QTS} from Table 2
12	0	Reserved for ITU
13	P	Set to 1 calls for LAPM protocol according to ITU-T V.42 (see 9.2.5)
14	0	QC identifier
15	0	Analogue modem
NOTE – At the time of publication the V.8 <i>bis</i> revision number is 0100. The receiving modem shall ignore this field.		

8.2.3 QCA1a

Signal QCA1a is a sequence of bits transmitted using V.21(H) modulation. The sequence consists of 10-bit frames using V.8-type formatting as defined in Table 4. QCA1a is transmitted once.

Table 4/V.92 – Definition of QCA1a

Bit position	Content	Definition
0:9	1111111111	Ten ONES
10:19	0101010101	Synchronization sequence
20	0	Start bit
21	0	Indication for analogue modem
22	1	Indication for QCA
23	P	Set to 1 calls for LAPM protocol according to ITU-T V.42 (see 9.2.5)
24:29	W0XYZ1	U _{QTS} : WXYZ from Table 2
30:39	1111111111	Ten ONES
40:49	0101010101	Bits 10:19 repeated
50:59	001PW0XYZ1	Bits 20:29 repeated
60:69	1111111111	Ten ONES

8.2.4 QCA2a

Signal QCA2a is a sequence of bits transmitted using V.21(L) modulation. The bits are transmitted using the signal structure defined in clause 7/V.8 *bis* and the information field structure defined in clause 8/V.8 *bis*. The analogue modem shall encode the identification field as defined in Table 5.

Table 5/V.92 – Definition of identification field in QCA2a

Bit position	Content	Definition
0:3	1011	Message type
4:7	VVVV	V.8 <i>bis</i> revision number (Note)
8:11	WXYZ	U _{QTS} from Table 2
12	0	Reserved for ITU
13	P	Set to 1 calls for LAPM protocol according to ITU-T V.42 (see 9.2.5)
14	1	QCA identifier
15	0	Analogue modem
NOTE – At the time of publication the V.8 <i>bis</i> revision number is 0100. The receiving modem shall ignore this field.		

8.2.5 TONEq

Signal TONEq is a 980 Hz tone.

8.3 Short Phase 1 signals and sequences for the digital modem

Signals QC1d and QCA1d are intended for use when the connection is initiated according to ITU-T V.8. Signals QC2d and QCA2d are intended for use when the connection is initiated according to ITU-T V.8 *bis*.

8.3.1 ANSpcm

Signal ANSpcm is a repetitive sequence of PCM codewords that produces a tone at approximately 2100 Hz. The sequence repeats every 301 symbols and has a phase reversal added to it every 3612 symbols. The codeword sequence may be used to verify that assumed channel characteristics are correct, and shall be transmitted at one of four transmit levels as defined in Table 6.

Table 6/V.92 – ANSpcm generation parameters

Transmit level	scl		ϑ
	μ -law	A-law	
−9.5 dBm0	1334	667	$0.25 \times \pi / 301$
−12 dBm0	1000	500	$0.25 \times \pi / 301$
−15 dBm0	708	354	$0.25 \times \pi / 301$
−18 dBm0	500	250	$0.25 \times \pi / 301$

The 301 symbol Ucode sequence may be generated using the following equation:

$$x = \lfloor scl \times \sqrt{2} \times \cos(2\pi k \times 79 / 301 + \vartheta) + 0.5 \rfloor \text{ for } k = 0, 1, 2, \dots, 300$$

and quantizing x to a linear PCM value according to ITU-T G.711 where scl and ϑ are defined in Table 6. The resulting output shall equal the output defined in Tables 7 to Table 10 depending on the value of scl .

NOTE – Some network equipment are known to alter the characteristics of the channel in response to ANSpcm.

Table 7/V.92 – –9.5 dBm0 ANSpcm sequence

	μ	A		μ	A		μ	A		μ	A		μ	A		μ	A		μ	A
0	A1	88	43	43	6F	86	24	0F	129	AD	87	172	AD	87	215	24	0F	258	43	6C
1	58	76	44	23	09	87	B1	98	130	A9	80	173	27	0D	216	39	10	259	A2	88
2	22	08	45	B8	93	88	A7	8D	131	29	00	174	31	18	217	A3	89	260	DC	CB
3	C2	EE	46	A5	8F	89	2C	07	132	2D	07	175	A4	8F	218	C5	ED	261	22	08
4	A3	89	47	30	1B	90	2A	00	133	A6	8D	176	BA	91	219	22	08	262	D6	F0
5	38	13	48	27	0D	91	A9	83	134	B2	99	177	23	09	220	5E	4F	263	A2	88
6	25	0F	49	AC	87	92	AD	84	135	24	0F	178	46	62	221	A2	88	264	40	69
7	B0	9B	50	AA	80	93	26	0D	136	3A	11	179	A2	88	222	53	7D	265	23	0E
8	A7	82	51	29	03	94	33	1E	137	A3	89	180	E2	C0	223	22	08	266	B7	92
9	2C	06	52	2D	04	95	A4	8F	138	C7	E3	181	22	08	224	BF	EB	267	A5	8F
10	2A	01	53	A6	8D	96	BB	96	139	22	08	182	D1	FF	225	A3	8E	268	2F	1A
11	A9	83	54	B3	9E	97	22	09	140	67	45	183	A2	89	226	37	12	269	27	02
12	AE	84	55	24	0E	98	48	60	141	A2	88	184	3F	6A	227	25	0C	270	AC	86
13	26	0C	56	3C	17	99	A2	88	142	4F	79	185	23	0E	228	AF	9A	271	AA	81
14	34	1F	57	A2	89	100	EC	DE	143	22	09	186	B6	9D	229	A8	82	272	28	03
15	A4	8E	58	CA	E6	101	22	08	144	BE	95	187	A5	8C	230	2B	06	273	2E	04
16	BC	97	59	22	08	102	CE	FA	145	A3	8E	188	2F	05	231	2B	01	274	A6	8C
17	22	09	60	72	53	103	A2	89	146	36	1D	189	28	02	232	A8	83	275	B4	9F
18	4B	67	61	A2	88	104	3E	15	147	25	0C	190	AB	86	233	AE	85	276	24	0E
19	A2	88	62	4D	65	105	23	0E	148	AF	85	191	AB	81	234	26	0C	277	3D	14
20	FC	D4	63	22	09	106	B5	9C	149	A8	82	192	28	02	235	35	1C	278	A2	89
21	22	08	64	BD	94	107	A5	8C	150	2B	01	193	2E	05	236	A4	8E	279	CC	E4
22	CB	E7	65	A4	8E	108	2E	05	151	2B	06	194	A5	8C	237	BD	94	280	22	08
23	A2	89	66	34	1F	109	28	03	152	A8	82	195	B5	9C	238	22	09	281	F7	D6
24	3C	17	67	26	0C	110	AB	81	153	AF	85	196	23	0E	239	4D	65	282	A2	88
25	24	0E	68	AE	85	111	AB	86	154	25	0C	197	3E	15	240	A2	88	283	4A	66
26	B4	9F	69	A8	83	112	28	02	155	36	1D	198	A2	89	241	6F	5D	284	22	09
27	A6	8C	70	2A	01	113	2F	05	156	A3	8E	199	CE	FB	242	22	08	285	BC	97
28	2E	04	71	2B	06	114	A5	8C	157	BF	EA	200	22	08	243	C9	E1	286	A4	8E
29	28	03	72	A7	82	115	B6	9D	158	22	09	201	EA	D8	244	A2	89	287	33	1E
30	AA	81	73	AF	9A	116	23	0E	159	50	7E	202	A2	88	245	3B	16	288	26	0C
31	AC	86	74	25	0F	117	3F	6B	160	A2	88	203	48	60	246	24	0E	289	AE	84
32	27	02	75	37	12	118	A2	89	161	65	47	204	23	09	247	B3	9E	290	A9	83
33	2F	1A	76	A3	8E	119	D2	FC	162	22	08	205	BB	96	248	A6	8D	291	2A	01
34	A5	8F	77	C0	E8	120	22	08	163	C6	E3	206	A4	8F	249	2D	04	292	2C	06
35	B8	93	78	22	08	121	E0	C2	164	A3	89	207	32	19	250	29	03	293	A7	82
36	23	0E	79	55	73	122	A2	88	165	3A	11	208	26	0D	251	AA	80	294	B0	9B
37	41	69	80	A2	88	123	45	6D	166	24	0F	209	AD	84	252	AC	87	295	25	0F
38	A2	88	81	5D	49	124	23	09	167	B2	99	210	A9	80	253	27	0D	296	38	13
39	D7	F1	82	22	8	125	BA	91	168	A6	8D	211	2A	00	254	30	1B	297	A3	89
40	21	08	83	C4	EC	126	A4	8F	169	2D	07	212	2C	07	255	A5	8F	298	C2	EE
41	DB	F5	84	A3	89	127	31	18	170	29	00	213	A7	8D	256	B9	90	299	22	08
42	A2	88	85	39	10	128	27	0D	171	A9	80	214	B1	98	257	23	09	300	59	74

Table 8/V.92 – –12 dBm0 ANSpcm sequence

	μ	A		μ	A		μ	A		μ	A		μ	A		μ	A		μ	A
0	A9	83	43	4A	66	86	2B	06	129	B3	9E	172	B3	9E	215	2B	06	258	4A	66
1	5D	49	44	2A	00	87	B8	93	130	AF	85	173	2D	07	216	3F	6A	259	A9	80
2	29	00	45	BE	95	88	AD	87	131	2F	05	174	39	10	217	AA	80	260	E0	C2
3	C9	E1	46	AB	86	89	32	19	132	33	1E	175	AB	81	218	CB	E7	261	29	03
4	AA	80	47	38	13	90	2F	1A	133	AD	87	176	BF	EB	219	29	00	262	DB	F5
5	3D	15	48	2D	07	91	AE	85	134	B9	90	177	2A	00	220	64	46	263	A9	80
6	2B	06	49	B2	99	92	B4	9F	135	2B	01	178	4C	64	221	A9	83	264	48	60
7	B7	92	50	AF	9A	93	2C	07	136	3F	6B	179	A9	80	222	59	77	265	2A	01
8	AD	84	51	2E	05	94	3A	11	137	AA	80	180	E7	DA	223	29	00	266	BD	94
9	32	19	52	34	1F	95	AB	81	138	CD	E5	181	29	03	224	C7	E3	267	AB	86
10	2F	1A	53	AC	87	96	C0	E8	139	29	00	182	D8	F6	225	AA	81	268	37	12
11	AE	85	54	BA	91	97	2A	00	140	6B	59	183	A9	80	226	3D	14	269	2D	04
12	B4	9F	55	2B	01	98	4E	7A	141	A9	83	184	46	62	227	2C	06	270	B1	98
13	2C	07	56	41	69	99	A9	80	142	56	70	185	2A	01	228	B7	92	271	B0	9B
14	3A	11	57	AA	80	100	EF	DD	143	29	00	186	BC	97	229	AD	84	272	2E	05
15	AB	81	58	CE	F8	101	29	03	144	C5	ED	187	AC	86	230	31	18	273	35	1C
16	C2	EE	59	29	03	102	D4	F2	145	AA	81	188	36	1D	231	30	1B	274	AC	87
17	29	00	60	76	51	103	A9	80	146	3C	17	189	2E	04	232	AE	84	275	BB	96
18	4F	79	61	A9	83	104	44	6C	147	2C	06	190	B1	98	233	B5	9C	276	2A	01
19	A9	83	62	52	7C	105	2A	01	148	B6	9D	191	B0	9B	234	2C	06	277	43	6F
20	FD	D4	63	29	00	106	BB	96	149	AE	84	192	2E	04	235	3B	16	278	A9	80
21	29	03	64	C3	EF	107	AC	86	150	30	1B	193	36	1D	236	AA	81	279	D1	FF
22	D0	FE	65	AA	81	108	35	1C	151	31	18	194	AC	86	237	C4	EC	280	29	03
23	A9	80	66	3B	16	109	2E	04	152	AE	84	195	BC	97	238	29	00	281	F9	D6
24	42	6E	67	2C	06	110	B0	9B	153	B6	9D	196	2A	01	239	53	7D	282	A9	83
25	2B	01	68	B5	9C	111	B1	98	154	2C	06	197	45	6D	240	A9	83	283	4F	78
26	BB	96	69	AE	84	112	2D	04	155	3C	17	198	A9	80	241	72	53	284	2A	00
27	AC	87	70	30	1B	113	36	1D	156	AA	81	199	D5	F3	242	29	03	285	C2	EE
28	35	1C	71	31	18	114	AC	86	157	C5	E2	200	29	03	243	CE	FB	286	AB	81
29	2E	05	72	AD	84	115	BC	97	158	29	00	201	ED	DF	244	AA	80	287	3A	11
30	AF	9A	73	B7	92	116	2A	01	159	57	71	202	A9	80	245	41	69	288	2C	07
31	B2	99	74	2B	06	117	46	62	160	A9	83	203	4D	65	246	2B	01	289	B4	9F
32	2D	04	75	3D	14	118	A9	80	161	69	5B	204	2A	00	247	BA	91	290	AE	85
33	37	12	76	AA	81	119	D8	F6	162	29	00	205	C0	E8	248	AC	87	291	2F	1A
34	AB	86	77	C7	E3	120	29	03	163	CC	E4	206	AB	81	249	34	1F	292	32	19
35	BD	94	78	29	00	121	E6	C4	164	AA	80	207	39	10	250	2E	05	293	AD	84
36	2A	01	79	5A	74	122	A9	80	165	3F	6B	208	2C	07	251	AF	9A	294	B8	93
37	48	60	80	A9	83	123	4B	67	166	2B	01	209	B4	9F	252	B2	99	295	2B	06
38	A9	80	81	62	40	124	2A	00	167	B9	90	210	AF	85	253	2D	07	296	3E	15
39	DC	CB	82	29	00	125	BF	EA	168	AD	87	211	2F	05	254	38	13	297	AA	80
40	29	03	83	CA	E6	126	AB	86	169	33	1E	212	33	1E	255	AB	86	298	C9	E1
41	DF	CC	84	AA	80	127	39	10	170	2F	05	213	AD	87	256	BE	95	299	29	00
42	A9	80	85	3E	15	128	2D	07	171	AF	85	214	B8	93	257	2A	00	300	5E	4F

Table 9/V.92 – –15 dBm0 ANSpcm sequence

	μ	A		μ	A		μ	A		μ	A		μ	A		μ	A		μ	A
0	AF	9A	43	4F	79	86	32	19	129	BB	96	172	BB	96	215	32	19	258	50	7E
1	63	41	44	31	18	87	BF	EA	130	B8	93	173	34	1C	216	47	63	259	AF	9B
2	30	1B	45	C6	E2	88	B5	9C	131	37	12	174	3F	6B	217	B0	9B	260	E7	C5
3	CF	F8	46	B2	99	89	3B	16	132	3B	16	175	B2	99	218	D1	FF	261	2F	1A
4	B1	98	47	3E	15	90	38	13	133	B4	9F	176	C8	E0	219	2F	1A	262	E0	C2
5	45	6D	48	35	1C	91	B7	92	134	BF	EB	177	30	1B	220	69	58	263	B0	9B
6	33	1E	49	BA	91	92	BC	97	135	32	19	178	52	7C	221	AF	9A	264	4E	7B
7	BE	95	50	B8	93	93	34	1F	136	48	60	179	AF	9A	222	5F	4C	265	31	18
8	B5	9C	51	37	12	94	40	68	137	B0	9B	180	EC	DE	223	30	1B	266	C5	ED
9	3A	11	52	3C	17	95	B2	99	138	D4	F2	181	2F	1A	224	CD	E5	267	B3	9E
10	38	13	53	B4	9F	96	C9	E1	139	2F	1A	182	DD	C9	225	B1	98	268	3E	15
11	B7	92	54	C0	E8	97	30	1B	140	6F	5D	183	B0	9B	226	44	6C	269	35	1C
12	BC	97	55	32	19	98	55	73	141	AF	9A	184	4D	65	227	33	1E	270	BA	91
13	34	1F	56	49	61	99	AF	9A	142	5C	4B	185	31	18	228	BE	95	271	B9	90
14	41	69	57	B0	9B	100	F3	D3	143	30	1B	186	C4	EC	229	B6	9D	272	36	1D
15	B2	99	58	D6	F0	101	2F	1A	144	CC	E4	187	B3	9E	230	3A	11	273	3C	17
16	CA	E6	59	2F	1A	102	DB	F5	145	B1	98	188	3D	14	231	39	10	274	B4	9F
17	30	1B	60	78	56	103	B0	9B	146	43	6F	189	36	1D	232	B6	9D	275	C2	EE
18	57	76	61	AF	9A	104	4C	64	147	33	1E	190	B9	90	233	BD	94	276	31	18
19	AF	9A	62	59	77	105	31	18	148	BD	94	191	B9	90	234	33	1E	277	4B	67
20	FD	D5	63	30	1B	106	C2	EE	149	B6	9D	192	36	1D	235	42	6E	278	B0	9B
21	2F	1A	64	CB	E7	107	B3	9E	150	39	10	193	3D	14	236	B1	98	279	D9	F7
22	D8	F6	65	B1	98	108	3D	14	151	39	10	194	B3	9E	237	CB	E7	280	2F	1A
23	B0	9B	66	42	6E	109	36	1D	152	B6	9D	195	C3	EF	238	30	1B	281	FB	D7
24	4A	66	67	34	1F	110	B9	90	153	BD	94	196	31	18	239	5A	74	282	AF	9A
25	31	19	68	BC	97	111	BA	91	154	33	1E	197	4C	64	240	AF	9A	283	57	71
26	C1	E9	69	B6	9D	112	36	1D	155	43	6F	198	B0	9B	241	76	51	284	30	1B
27	B4	9F	70	39	10	113	3D	14	156	B1	98	199	DB	F5	242	2F	1A	285	CA	E6
28	3C	17	71	3A	11	114	B3	9E	157	CC	E5	200	2F	1A	243	D6	F0	286	B2	99
29	37	12	72	B5	9C	115	C4	EC	158	30	1B	201	F0	D2	244	B0	9B	287	41	69
30	B8	93	73	BE	95	116	31	18	159	5D	48	202	AF	9A	245	49	61	288	34	1F
31	BA	91	74	33	1E	117	4D	65	160	AF	9A	203	54	72	246	32	19	289	BC	97
32	35	1C	75	44	6D	118	B0	9B	161	6D	5F	204	30	1B	247	C0	E8	290	B7	92
33	3E	15	76	B1	98	119	DE	CF	162	2F	1A	205	C8	E0	248	B4	9F	291	38	13
34	B3	9E	77	CE	FA	120	2F	1A	163	D3	FD	206	B2	99	249	3C	17	292	3A	11
35	C5	ED	78	30	1B	121	EB	D9	164	B0	9B	207	3F	68	250	37	12	293	B5	9C
36	31	18	79	5F	4D	122	AF	9A	165	48	60	208	34	1F	251	B8	93	294	BE	95
37	4E	7B	80	AF	9A	123	52	7C	166	32	19	209	BB	96	252	BB	96	295	33	1E
38	B0	9B	81	68	5A	124	30	1B	167	BF	EB	210	B7	92	253	35	1C	296	46	62
39	E2	C0	82	2F	1A	125	C7	E3	168	B4	9F	211	38	13	254	3F	6A	297	B1	98
40	2F	1A	83	D0	FE	126	B2	99	169	3B	16	212	3B	16	255	B2	99	298	CF	F9
41	E6	C4	84	B1	98	127	3F	6A	170	37	12	213	B5	9C	256	C6	E2	299	30	1B
42	B0	9B	85	47	63	128	35	1C	171	B8	93	214	BF	EA	257	31	18	300	64	46

Table 10/V.92 – –18 dBm0 ANSpcm sequence

	μ	A		μ	A		μ	A		μ	A		μ	A		μ	A		μ	A
0	B8	93	43	57	71	86	3B	16	129	C2	EE	172	C2	EE	215	3B	16	258	58	76
1	69	5B	44	39	10	87	C7	E3	130	BE	95	173	3C	17	216	4E	7A	259	B9	90
2	39	10	45	CD	E5	88	BC	97	131	3E	15	174	48	60	217	B9	90	260	EC	DE
3	D7	F1	46	BB	96	89	41	69	132	42	6E	175	BA	91	218	D9	F7	261	38	13
4	B9	90	47	47	63	90	3F	6A	133	BC	97	176	CE	FA	219	39	10	262	E7	C5
5	4C	64	48	3C	17	91	BE	95	134	C8	E0	177	39	10	220	6D	5C	263	B9	90
6	3B	16	49	C1	E9	92	C3	EF	135	3A	11	178	5A	74	221	B8	93	264	56	70
7	C6	E2	50	BF	EA	93	3C	17	136	4E	7B	179	B9	90	222	65	47	265	3A	11
8	BD	94	51	3E	15	94	48	61	137	B9	90	180	EF	DD	223	39	10	266	CC	E4
9	41	69	52	43	6F	95	BA	91	138	DB	F5	181	38	13	224	D5	F3	267	BB	96
10	3F	6A	53	BC	97	96	CF	F8	139	38	10	182	E3	C1	225	BA	91	268	46	62
11	BE	95	54	C9	E1	97	39	10	140	73	53	183	B9	90	226	4C	64	269	3D	14
12	C3	EF	55	3A	11	98	5B	4A	141	B8	93	184	54	72	227	3B	16	270	C0	E8
13	3C	17	56	4F	79	99	B8	93	142	61	40	185	3A	11	228	C6	E2	271	BF	EB
14	49	61	57	B9	90	100	F6	D1	143	39	10	186	CB	E7	229	BD	94	272	3E	15
15	BA	91	58	DC	CB	101	38	13	144	D3	FD	187	BB	96	230	40	68	273	44	6C
16	D0	FE	59	38	13	102	E0	C2	145	BA	91	188	45	6D	231	3F	6B	274	BC	97
17	39	10	60	7A	57	103	B9	90	146	4B	67	189	3D	14	232	BD	94	275	CA	E6
18	5D	49	61	B8	93	104	52	7C	147	3B	16	190	C0	E8	233	C4	EC	276	3A	11
19	B8	93	62	5F	4C	105	3A	11	148	C5	ED	191	BF	EB	234	3B	16	277	51	7F
20	FE	D5	63	39	10	106	CA	E6	149	BD	94	192	3D	14	235	4A	66	278	B9	90
21	38	13	64	D1	FF	107	BB	96	150	3F	6B	193	45	6D	236	BA	91	279	DE	CF
22	DE	CE	65	BA	91	108	44	6C	151	3F	68	194	BB	96	237	D2	FC	280	38	13
23	B9	90	66	4A	66	109	3D	14	152	BD	94	195	CB	E7	238	39	10	281	FC	D4
24	50	7E	67	3B	16	110	BF	EB	153	C5	ED	196	3A	11	239	5F	4D	282	B8	93
25	3A	11	68	C4	EC	111	C0	E8	154	3B	16	197	53	7D	240	B8	93	283	5D	48
26	CA	E6	69	BD	94	112	3D	14	155	4B	67	198	B9	90	241	78	56	284	39	10
27	BC	97	70	3F	6B	113	45	6D	156	BA	91	199	E1	C3	242	38	13	285	CF	F9
28	44	6C	71	40	68	114	BB	96	157	D3	FD	200	38	13	243	DC	CB	286	BA	91
29	3E	15	72	BD	94	115	CB	E7	158	39	10	201	F5	D0	244	B9	90	287	49	61
30	BF	EA	73	C6	E2	116	3A	11	159	62	41	202	B8	93	245	4F	79	288	3C	17
31	C1	E9	74	3B	16	117	54	72	160	B8	93	203	5B	75	246	3A	11	289	C3	EF
32	3D	14	75	4C	64	118	B9	90	161	71	52	204	39	10	247	C9	E1	290	BE	95
33	46	62	76	BA	91	119	E4	C6	162	39	10	205	CF	F8	248	BC	97	291	3F	6A
34	BB	96	77	D5	F3	120	38	13	163	DA	F4	206	BA	91	249	43	6F	292	41	69
35	CC	E4	78	39	10	121	EE	DC	164	B9	90	207	48	60	250	3E	15	293	BD	94
36	39	10	79	66	44	122	B9	90	165	4E	7B	208	3C	17	251	BF	EA	294	C6	E3
37	56	70	80	B8	93	123	59	77	166	3A	11	209	C2	EF	252	C1	E9	295	3B	16
38	B9	90	81	6D	5F	124	39	10	167	C8	E0	210	BE	95	253	3C	17	296	4D	65
39	E8	DA	82	39	10	125	CE	FA	168	BC	97	211	3E	15	254	47	63	297	B9	90
40	38	13	83	D8	F6	126	BA	91	169	42	6E	212	42	6E	255	BB	96	298	D7	F1
41	EB	D9	84	B9	90	127	47	60	170	3E	15	213	BC	97	256	CD	E5	299	39	10
42	B9	90	85	4D	65	128	3C	17	171	BE	95	214	C7	E3	257	39	10	300	6A	58

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8.3.2 QC1d

Signal QC1d is a sequence of bits transmitted using V.21(L) modulation. The sequence consists of 10-bit frames using V.8-type formatting as defined in Table 11. QC1d is transmitted once, and is followed immediately by CM.

Table 11/V.92 – Definition of QC1d

Bit position	Content	Definition	
0:9	1111111111	Ten ONES	
10:19	0101010101	Synchronization sequence	
20	0	Start bit	
21	1	Indication for digital modem	
22	0	Indication for QC	
23	P	Set to 1 calls for LAPM protocol according to ITU-T V.42 (see 9.2.5)	
24:29	000LM1	LM	Level of ANSpcm
		00	−9.5 dBm0
		01	−12 dBm0
		10	−15 dBm0
		11	−18 dBm0
30:39	1111111111	Ten ONES	
40:49	0101010101	Bits 10:19 repeated	
50:59	010P000LM1	Bits 20:29 repeated	

8.3.3 QC2d

Signal QC2d is a sequence of bits transmitted using V.21(H) modulation. The bits are transmitted using the signal structure defined in clause 7/V.8 *bis* and the information field structure defined in clause 8/V.8 *bis*. The digital modem shall encode the identification field as defined in Table 12.

Table 12/V.92 – Definition of identification field in QC2d

Bit position	Content	Definition
0:3	1011	Message type
4:7	VVVV	V.8 <i>bis</i> revision number (Note)
8:9	LM	Level of ANSpcm from Table 11
10:12	000	Reserved for the ITU
13	P	Set to 1 calls for LAPM protocol according to ITU-T V.42 (see 9.2.5)
14	0	QC identifier
15	1	Digital modem
NOTE – At the time of publication the V.8 <i>bis</i> revision number is 0100. The receiving modem shall ignore this field.		