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SERIES V: DATA COMMUNICATION OVER THE TELEPHONE NETWORK

Interfaces and voiceband modems

List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)

ITU-T Recommendation V.24

(Formerly CCITT Recommendation)

ITU-T V-SERIES RECOMMENDATIONS

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ITU-T RECOMMENDATION V.24

LIST OF DEFINITIONS FOR INTERCHANGE CIRCUITS BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE)

Summary

This Recommendation applies to the interconnecting circuits being called interchange circuits at the interface between DTE and DCE for the transfer of binary data, control and timing signals as appropriate. This Recommendation also applies to both sides of separate intermediate equipment, which may be inserted between these two classes of equipment.

Source

ITU-T Recommendation V.24 was revised by ITU-T Study Group 16 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 17 February 2000.

FOREWORD

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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 expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, the ITU had not 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.

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Recommendation V.24

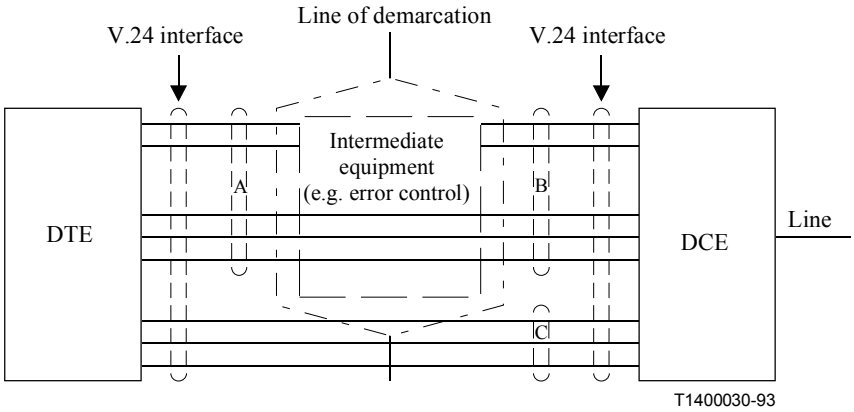
LIST OF DEFINITIONS FOR INTERCHANGE CIRCUITS BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE)

(Geneva, 1964, amended at Mar del Plata, 1968, Geneva, 1972, 1976 and 1980, Malaga-Torremolinos, 1984, Melbourne, 1988, Helsinki, 1993, Geneva, 1996 and 2000)

1 Scope

1.1 Range of application

This Recommendation applies to the interconnecting circuits being called interchange circuits at the interface between DTE and DCE for the transfer of binary data, control and timing signals as appropriate. This Recommendation also applies to both sides of separate intermediate equipment, which may be inserted between these two classes of equipment (see Figure 1).



NOTE – Without intermediate equipment, the selections A and B are identical. Selection C may be a selection specifically for automatic calling.

Figure 1/V24 – Illustration of general layout of equipment

The range of interchange circuits defined in this Recommendation is applicable, for example:

a) to synchronous and asynchronous data communications;

b) to data transmission on leased line service, either 2-wire or 4-wire, either point-to-point or multipoint operation;

c) to data transmission on switched network service, either 2-wire or 4-wire;

A DTE/DCE interface conforming to this Recommendation may also be used for attachment to a Public Data Network (PDN). For these cases, additional information on interchange circuit implementation and operational requirements may be found in Recommendations X.20 *bis* and X.21 *bis*.

In any type of practical equipment a selection will be made from the range of interchange circuits defined in this Recommendation, as appropriate.

The actual interchange circuits to be used in a particular DCE are those indicated in the appropriate Recommendation.

The required interchange circuits specified in the DCE Recommendations which make reference to this Recommendation apply only to the DCE side of the interface. Only those circuits necessary to assure satisfactory operation of the application the DTE is intending to support need be controlled or monitored by the DTE (see 4.5 for proper handling of unimplemented circuits).

The usage and operational requirements of certain interchange circuits and the interaction between them are specified in clause 4. For proper operation of the DCE it is important that the guidelines in clause 4 be observed.

1.2 Applicable electrical characteristics

Electrical characteristics for interchange circuits are specified in Recommendations V.10, V.11, V.12, V.28, V.31 and V.31 *bis*.

1.3 Applicable mechanical characteristics

For mechanical characteristics of the interface, refer to ISO/IEC 2110 (25-pole), ISO/IEC 11569 (26-pole), ISO/IEC 13575 (50-pole) or ISO/IEC 4902 (37-pole) as appropriate.

1.4 Allocation of functionalities

The DCE may include signal converters, timing generators, pulse regenerators, and control circuitry, together with equipment to provide functions such as error control, automatic calling and automatic answering. Some of these functions may be implemented in separate intermediate equipment or in the DTE.

2 Line of demarcation

The interface between DTE and DCE is located at a connector, which is the interchange point between these two classes of equipment.

The interface connector will not necessarily be physically attached to the DCE and may be mounted in a fixed position near the DTE.

An interconnecting cable or cables will normally be provided with the DTE. It is recommended to keep the cables as short as possible. Their lengths should be limited by the load capacitance and other electrical characteristics specified in the relevant Recommendation on electrical characteristics (see 1.2).

3 Definitions of interchange circuits

A list of these interchange circuits is presented in Table 1.

NOTE – Compared to earlier versions of this Recommendation, Table 1 and the definitions below summarize fewer interchange circuits, and some circuit numbers are void. Interchange circuits for which no practical application has become known or whose application has ceased have been removed, e.g. the 200-series of interchange circuits for parallel automatic calling in accordance with earlier versions of Recommendation V.25 and interchange circuits relevant for modems employing parallel data transmission in accordance with former Recommendation V.20.

Table 1/V.24 – Interchange circuits by category

Inter-change circuit number	Interchange circuit name	Ground	Data		Control		Timing	
			From DCE	To DCE	From DCE	To DCE	From DCE	To DCE
1	2	3	4	5	6	7	8	9
102	Signal ground or common return	X						
102a	DTE common return	X						
102b	DCE common return	X						
102c	Common return	X						
103	Transmitted data			X				
104	Received data		X					
105	Request to send					X		
106	Ready for sending				X			
107	Data set ready				X			
108/1	Connect data set to line					X		
108/2	Data terminal ready					X		
109	Data channel received line signal detector				X			
111	Data signal rate selector (DTE)					X		
112	Data signal rate selector (DCE)				X			
113	Transmitter signal element timing (DTE)							X
114	Transmitter signal element timing (DCE)						X	
115	Receiver signal element timing (DCE)						X	
116/1	Back-up switching in direct mode					X		
116/2	Back-up switching in authorized mode					X		
117	Standby indicator				X			
118	Transmitted backward channel data			X				
119	Received backward channel data		X					
120	Transmit backward channel line signal					X		
121	Backward channel ready				X			
122	Backward channel received line signal detector				X			
125	Calling indicator				X			
126	Select transmit frequency					X		
128	Receiver signal element timing (DTE)							X
131	Received character timing (DCE source)						X	
133	Ready for receiving					X		
134	Received data present				X			
135	Received energy present				X			
137	Transmitted character timing (DTE source)							X
138	Transmitted character timing (DCE source)						X	
140	Loopback/Maintenance test					X		
141	Local loopback					X		
142	Test indicator				X			

3.1 Circuit 102 – Signal ground or common return

This conductor establishes the signal common return for unbalanced interchange circuits with electrical characteristics according to Recommendation V.28 and the d.c. reference potential for interchange circuits according to Recommendations V.10 and V.11.

Within the DTE, this circuit should be brought to one point, and it should be possible to connect this point to protective ground or earth by means of a metallic strap within the equipment. This metallic strap can be connected or removed at installation, as may be required to meet applicable safety regulations or to minimize the introduction of noise into electronic circuitry. Caution should be exercised to prevent the establishment of ground loops carrying high currents.

3.2 Circuit 102a – DTE common return

This conductor is connected to the DTE circuit common return and is used as the reference potential for the unbalanced V.10-type interchange circuit receivers within the DCE.

3.3 Circuit 102b – DCE common return

This conductor is connected to the DCE circuit common return and is used as the reference potential for the unbalanced V.10-type interchange circuit receivers within the DTE.

NOTE – Two arrangements exist for the case where a mixture of V.10 and V.11 circuits is used in the same interface:

1) The DTE common return and the DCE common return are both connected to circuit 102. This arrangement is particularly useful where the need to conserve pole assignments is a requirement [10] and [12]. It should, however, be noted that only category 2 receivers as specified in clause 9/V.10 can be used in this case, and that the usable interface cable length may be shorter than specified in Appendix II/V.10.

2) Separate provision is made for the V.10 common return circuits 102a and 102b, and for a d.c. reference potential conductor circuit 102 [11].

3.4 Circuit 102c – Common return

This conductor establishes the signal common return for single-current interchange circuits controlled by contact closure with electrical characteristics according to Recommendation V.31, in cases where a common return is used.

Within the equipment containing the signal source of the interchange circuit, this conductor shall be isolated from signal ground and protective ground, irrespective of whether it is located within the DCE or within the DTE.

3.5 Circuit 103 – Transmitted data

Direction: To DCE

The data signals originated by the DTE:

1) to be transmitted via a data channel to one or more remote data stations;

2) to be passed to the DCE for maintenance test purposes under control of the DTE; or

3) for the programming or control of serial automatic calling DCEs,

are transferred on this circuit to the DCE.

3.6 Circuit 104 – Received data

Direction: From DCE

The data signals generated by the DCE:

1) in response to data channel line signals received from a remote data station;
2) in response to the DTE maintenance test signals; or
3) in response to (or as an echo of) programming or control signals from the DTE where a serial automatic calling facility is implemented in the DCE,

are transferred on this circuit to the DTE.

NOTE – The reception conditions for maintenance test signals are specified with circuit 107.

3.7 Circuit 105 – Request to send

Direction: To DCE

Signals on this circuit control the data channel transmit function of the DCE.

The ON condition causes the DCE to assume the data channel transmit mode.

The OFF condition causes the DCE to assume the data channel non-transmit mode, when all data transferred on circuit 103 have been transmitted.

3.8 Circuit 106 – Ready for sending

Direction: From DCE

Signals on this circuit indicate whether the DCE is prepared to accept data signals for transmission on the data channel or for maintenance test purposes under control of the DTE.

The ON condition indicates that the DCE is prepared to accept data signals from the DTE.

The OFF condition indicates that the DCE is not prepared to accept data signals from the DTE.

3.9 Circuit 107 – Data set ready

Direction: From DCE

Signals on this circuit indicate whether the DCE is ready to operate.

The ON condition, where circuit 142 is OFF or is not implemented, indicates that the signal converter or similar equipment is connected to the line and that the DCE is ready to exchange further control signals with the DTE to initiate transfer of data.

The ON condition, in conjunction with the ON condition of circuit 142, indicates that the DCE is prepared to exchange data signals with the DTE for maintenance test purposes.

The OFF condition, in conjunction with the ON condition on circuit 106, indicates that the DCE is ready to exchange data signals associated with the programming or control of serial automatic calling DCEs.

The OFF condition, in conjunction with the OFF condition on circuit 106, indicates:

1) that the DCE is not ready to operate in the data transfer phase;
2) that the DCE has detected a fault condition (which may be network or DCE dependent) which has lasted longer than some fixed period of time, such period of time being network dependent; or
3) in switched network operation, that the DCE has detected a disconnect indication from the remote station or from the network.

The OFF condition, in conjunction with the ON condition on circuit 142, indicates that the DCE is involved in tests from the network or remote station.

3.10 Circuit 108/1 – Connect data set to line

Direction: To DCE

Signals on this circuit control switching of the signal-converter or similar equipment to or from the line.

A transition from OFF to ON condition on this circuit causes the DCE to connect the signal-converter or similar equipment to the line.

A transition from OFF to ON condition of this circuit may also be used to initiate a direct call facility for automatic calling DCEs.

The ON condition on this circuit shall maintain the connection but shall not prevent the operation of disconnection functions optionally implemented in the DCE. Examples of such disconnection functions include, but are not limited to, the following:

– loss of line signal (on switched telephone network);

– implementation of callback facility;

– depression of a push button at the DCE.

The OFF condition on this circuit, except as noted below, causes the DCE to remove the signal-converter or similar equipment from the line, when the transmission of all data previously transferred on circuit 103 and/or circuit 118 has been completed. In the case where an intermediate function is implemented in the DCE, the DCE may delay the removal of the signal-converter from the line until the protocol requirements of the intermediate function have been satisfied (e.g. outstanding data has been acknowledged or a timeout has occurred).

The OFF condition on this circuit may also be used to direct the DCE to abort or to clear a direct call facility operation (see Recommendation V.25 *bis*).

3.11 Circuit 108/2 – Data terminal ready

Direction: To DCE

Signals on this circuit indicate the status of the DTE.

The ON condition, indicating that the DTE is ready to operate, prepares the DCE to connect the signal-converter or similar equipment to the line.

The DCE may be connected to the line by a supplementary condition. Examples of such supplementary conditions include, but are not restricted to, the following:

– depression of a push button at the DCE;

– an incoming call in the case of automatic answering;

– a call request command from the DTE in the case of automatic calling.

The DCE maintains the connection so long as the ON condition persists, except that the ON condition shall not prevent the operation of disconnection functions optionally implemented in the DCE. Examples of such disconnection functions are noted in the definition of circuit 108/1.

The DTE is permitted to present the ON condition on circuit 108/2 whenever it is ready to transmit or receive data.

The OFF condition on this circuit causes the DCE to remove the signal-converter or similar equipment from the line when the transmission to the line of all data previously transferred on circuit 103 and/or circuit 118 has been completed. In the case where an intermediate function is

implemented in the DCE, the DCE may delay the removal of the signal converter from the line until the protocol requirements of the intermediate function have been satisfied (e.g. outstanding data has been acknowledged or a timeout has occurred).

The OFF condition of this circuit may also be used to direct the DCE to abort or to clear a serial automatic calling operation (see Recommendation V.25 *bis*).

3.12 Circuit 109 – Data channel received line signal detector

Direction: From DCE

Signals on this circuit indicate whether the received data channel line signal is within appropriate limits, as specified in the relevant Recommendation for DCE.

The ON condition indicates that the received line signal is within appropriate limits.

Circuit 109 may also be in the ON condition during the exchange of data signals between the DCE and the DTE, associated with the programming or control of serial automatic calling DCEs.

The OFF condition indicates that the received signal is not within appropriate limits. In the case where an intermediate function is implemented in the DCE, the DCE may delay the assertion of an OFF condition on circuit 109, in response to the conditions stated above, until all of the data in its buffers has been transferred to its associated DTE on circuit 104 or a timeout has occurred.

3.13 Circuit 111 – Data signalling rate selector (DTE source)

Direction: To DCE

Signals on this circuit are used to select one of the two data signalling rates of a dual rate synchronous DCE, or to select one of the two ranges of data signalling rates of a dual range asynchronous DCE.

The ON condition selects the higher rate or range of rates.

The OFF condition selects the lower rate or range of rates.

3.14 Circuit 112 – Data signalling rate selector (DCE source)

Direction: From DCE

Signals on this circuit are used to select one of the two data signalling rates or ranges of rates in the DTE to coincide with the data signalling rate or range of rates in use in a dual rate synchronous or dual range asynchronous DCE.

The ON condition selects the higher rate or range of rates.

The OFF condition selects the lower rate or range of rates.

3.15 Circuit 113 – Transmitter signal element timing (DTE source)

Direction: To DCE

Signals on this circuit provide the DCE with signal element timing information.

The condition on this circuit shall be ON and OFF for nominally equal periods of time and the transition from ON to OFF condition shall nominally indicate the centre of each signal element on circuit 103.

3.16 Circuit 114 – Transmitter signal element timing (DCE source)

Direction: From DCE

Signals on this circuit provide the DTE with transmitter signal element timing information.

The condition on this circuit shall be ON and OFF for nominally equal periods of time. The DTE shall present a data signal on circuit 103 in which the transitions between signal elements nominally occur at the time of the transitions from OFF to ON condition of circuit 114.

Where variable transmitter signal element timing is required, the change to a different rate shall occur while this circuit is in the OFF condition. The new rate shall be an integer multiple or fraction of the old rate.

Where it is required to temporarily halt data transmission, this circuit may be held in the OFF condition for a limited period of time. The maximum permissible duration of this condition is for further study. The duration of the OFF condition shall be an integer multiple of the length of a signal element before halting the signal. Signalling on this circuit may then be resumed at the same rate or at a different rate, as specified above.

Where also character or 8-bit byte timing is provided using circuit 138 – *Transmitted character timing (DCE source)*, the change to a different rate on circuit 114 shall occur during the OFF condition that precedes the OFF-to-ON transition which indicates the first bit of a new character or 8-bit byte.

3.17 Circuit 115 – Receiver signal element timing (DCE source)

Direction: From DCE

Signals on this circuit provide the DTE with receiver signal element timing information.

The condition of this circuit shall be ON and OFF for nominally equal periods of time, and a transition from ON to OFF condition shall nominally indicate the centre of each signal element on circuit 104.

Where variable receiver signal element timing is required, the change to a different rate shall occur while this circuit is in the OFF condition. The new rate shall be an integer multiple or fraction of the old rate.

Where it is required to temporarily halt data reception, this circuit may be held in the OFF condition for a limited period of time. The maximum permissible duration of this condition is for further study. The duration of the OFF condition shall be an integer multiple of the length of a signal element before halting the signal. Signalling on this circuit may then be resumed at the same rate or at a different rate, as specified above.

Where also character or 8-bit byte timing is provided using circuit 131 – *Received character timing (DCE source)*, the change to a different rate on circuit 115 shall occur during the OFF condition that precedes the OFF-to-ON transition which indicates the first bit of a new character or 8-bit byte.

3.18 Circuit 116/1 – Back-up switching in direct mode

Direction: To the DCE

Signals on this circuit control switching of the DCE between normal and standby facilities.

The ON condition causes the DCE to connect to the standby facility.

The OFF condition causes the DCE to disconnect from the standby facility, when the transmission to line of all data previously transferred on circuit 103 has been completed, and the DCE then reconnects to the normal facility.

3.19 Circuit 116/2 – Back-up switching in authorized mode

Direction: To the DCE

Signals on this circuit control switching of the DCE between normal and standby facilities.

The ON condition indicates that the DTE is ready to switch from the normal to the standby facility and prepares the DCE to switch to the standby facility when necessary.

The OFF condition causes the DCE to disconnect from the standby facility, when the transmission to line of all data previously transferred on circuit 103 has been completed, and the DCE then reconnects to the normal facility.

3.20 Circuit 117 – Standby indicator

Direction: From DCE

Signals on this circuit indicate whether the DCE is conditioned to operate in its standby mode with the predetermined facilities replaced by their reserves.

The ON condition indicates that the DCE is conditioned to operate in its standby mode.

The OFF condition indicates that the DCE is conditioned to operate in its normal mode.

3.21 Circuit 118 – Transmitted backward channel data

Direction: To DCE

This circuit is equivalent to circuit 103, except that it is used to transmit data via the backward channel.

3.22 Circuit 119 – Received backward channel data

Direction: From DCE

This circuit is equivalent to circuit 104, except that it is used for data received on the backward channel.

3.23 Circuit 120 – Transmit backward channel line signal

Direction: To DCE

This circuit is equivalent to circuit 105, except that it is used to control the backward channel transmit function of the DCE.

The ON condition causes the DCE to assume the backward channel transmit mode.

The OFF condition causes the DCE to assume the backward channel non-transmit mode, when all data transferred on circuit 118 have been transmitted to line.

3.24 Circuit 121 – Backward channel ready

Direction: From DCE

This circuit is equivalent to circuit 106, except that it is used to indicate whether the DCE is conditioned to transmit data on the backward channel.

The ON condition indicates that the DCE is conditioned to transmit data on the backward channel.

The OFF condition indicates that the DCE is not conditioned to transmit data on the backward channel.

3.25 Circuit 122 – Backward channel received line signal detector

Direction: From DCE

This circuit is equivalent to circuit 109, except that it is used to indicate whether the received backward channel line signal is within appropriate limits, as specified in the relevant Recommendation for DCE.

3.26 Circuit 125 – Calling indicator

Direction: From DCE

Signals on this circuit indicate whether a calling signal is being received by the DCE.

The ON condition indicates that a calling signal is being received.

The OFF condition indicates that no calling signal is being received, and this condition may also appear during interruptions of a pulse-modulated calling signal.

3.27 Circuit 126 – Select transmit frequency

Direction: To DCE

Signals on this circuit are used to select the required transmit frequency of the DCE.

The ON condition selects the higher transmit frequency.

The OFF condition selects the lower transmit frequency.

3.28 Circuit 128 – Receiver signal element timing (DTE source)

Direction: To DCE

Signals on this circuit provide the DCE with signal element timing information.

The condition on this circuit shall be ON and OFF for nominally equal periods of time. The DCE shall present a data signal on circuit 104 in which the transitions between signal elements nominally occur at the time of the transitions from OFF to ON condition of the signal on circuit 128.

Where variable receiver signal element timing is required, the change to a different rate shall occur while this circuit is in the OFF condition. The new rate shall be an integer multiple or fraction of the old rate.

Where it is required to temporarily halt data reception, this circuit may be held in the OFF condition for a limited period of time. The maximum permissible duration of this condition is for further study. The duration of the OFF condition shall be an integer multiple of the length of a signal element before halting the signal. Signalling on this circuit may then be resumed at the same rate or at a different rate, as specified above.

3.29 Circuit 131 – Received character timing (DCE source)

Direction: From DCE

Signals on this circuit provide the DTE with received character or 8-bit byte timing information, as specified in the relevant Recommendation for DCE.

Unless otherwise specified in the relevant Recommendation for DCE, the condition of this circuit shall be OFF for nominally the period of the ON condition of circuit 115 – *Receiver signal element timing (DCE source)* which indicates the last bit of a character or an 8-bit byte, and shall be ON at all other times within the period of the character or 8-bit byte.

The centre of the last bit of each character or 8-bit byte will be presented by the DCE on circuit 104 – *Received data* nominally at the time of the OFF to ON transition of circuit 131.

The DCE shall transfer byte timing information on this circuit across the interface at all times that the timing source is capable of generating this information.

Where variable receiver signal element timing is required, also the received character timing will have to be accordingly changed. The change to a different rate shall occur during the ON condition of circuit 131 (see definition of circuit 115).

Where it is required to temporarily halt data reception, this circuit may be held in the ON condition for a limited period of time. The maximum permissible duration of this condition is for further study.

3.30 Circuit 133 – Ready for receiving

Direction: To DCE

Signals on this circuit control the transfer of data on circuit 104, indicating whether the DTE is capable of accepting a given amount of data (e.g. a block of data), specified in the appropriate Recommendation for an intermediate function, for example, error control.

The ON condition shall be maintained whenever the DTE is capable of accepting data, and causes the intermediate equipment or DCE to transfer the received data to the DTE.

The OFF condition indicates that the DTE is not able to accept data, and causes the intermediate equipment or DCE to retain the data.

3.31 Circuit 134 – Received data present

Direction: From DCE

Signals on this circuit are used to separate information messages from supervisory messages, transferred on circuit 104, as specified in the appropriate Recommendation for intermediate equipment, e.g. error control equipment.

The ON condition indicates the data which represents information messages.

The OFF condition shall be maintained at all other times.

3.32 Circuit 135 – Received energy present

Direction: From DCE

Signals on this circuit indicate the presence of energy on the line.

The ON condition on this circuit indicates the instantaneous presence of energy on the line.

The OFF condition on this circuit indicates the absence of energy on the line.

NOTE – For certain applications, this circuit may be used to transfer an indication of the changing instantaneous levels of the received energy in an analogue manner. Details may be found in the appropriate DCE Recommendation.

3.33 Circuit 137 – Transmitted character timing (DTE source)

Direction: From DTE

Signals on this circuit provide the DCE with transmitted character or 8-bit byte timing information, as specified in the relevant Recommendation for DCE.

Unless otherwise specified in the relevant Recommendation for DCE, the condition of this circuit shall be OFF for nominally the period of the ON condition of circuit 113 – *Transmitter signal element timing (DTE source)* which indicates the last bit of a character or an 8-bit byte, and shall be ON at all other times within the period of the character or 8-bit byte.

The DTE shall present the centre of the last bit of each character or 8-bit byte on circuit 103 – *Transmitted data* nominally at the time of the OFF to ON transition of circuit 137 and the beginning of the first bit of each character or 8-bit byte nominally at the time of the OFF to ON transition of circuit 113 which follows the OFF to ON transition of circuit 137.

The DTE shall transfer byte timing information on this circuit across the interface at all times that the timing source is capable of generating this information.

3.34 Circuit 138 – Transmitted character timing (DCE source)

Direction: From DCE

Signals on this circuit provide the DTE with transmitted character or 8-bit byte timing information, as specified in the relevant Recommendation for DCE.

Unless otherwise specified in the relevant Recommendation for DCE, the condition of this circuit shall be OFF for nominally the period of the ON condition of circuit 114 – *Transmitter signal element timing (DCE source)* which indicates the last bit of a character or an 8-bit byte, and shall be ON at all other times within the period of the character or 8-bit byte.

The DTE will present the centre of the last bit of each character or 8-bit byte on circuit 103 – *Transmitted data* nominally at the time of the OFF to ON transition of circuit 138 and the beginning of the first bit of each character or 8-bit byte nominally at the time of the OFF to ON transition of circuit 114 which follows the OFF to ON transition of circuit 138.

The DCE shall transfer byte timing information on this circuit across the interface at all times that the timing source is capable of generating this information.

Where variable transmitter signal element timing is required, also the transmitted character timing will have to be accordingly changed. The change to a different rate shall occur during the ON condition of circuit 138 (see definition of circuit 114).

Where it is required to temporarily halt data transmission, this circuit may be held in the ON condition for a limited period of time. The maximum permissible duration of this condition is for further study.

3.35 Circuit 140 – Loopback/Maintenance test

Direction: To DCE

Signals on this circuit are used to initiate and release loopback or other maintenance test conditions in DCEs.

The ON condition causes initiation of the maintenance test condition.

The OFF condition causes release of the maintenance test condition.

3.36 Circuit 141 – Local loopback

Direction: To DCE

Signals on this circuit are used to control the loop 3 test condition in the local DCE.

The ON condition of circuit 141 causes the establishment of the loop 3 test condition in the local DCE.

The OFF condition of circuit 141 causes the release of the loop 3 test condition in the local DCE.

3.37 Circuit 142 – Test indicator

Direction: From DCE

Signals on this circuit indicate whether a maintenance condition exists.

The ON condition indicates that a maintenance condition exists in the DCE, precluding reception or transmission of data signals from or to a remote DTE.

The OFF condition indicates that the DCE is not in a maintenance test condition.

4 Operational requirements

In the following, operational requirements are given for the usage of interchange circuits. It also explains in further detail the required correlation between interchange circuits, where implemented.

4.1 Data circuits and timing circuits

4.1.1 Data circuits

It is evident that proper data transmission may be impaired when the required condition is not present on an implemented control interchange circuit. Therefore, the DTE shall not transfer, on circuit 103, data which is for transmission to line or for maintenance purposes unless an ON condition is present on all of the following four circuits, where implemented: circuit 105, circuit 106, circuit 107 and circuit 108/1 or 108/2.

The DTE may transfer, on circuit 103, data which is for the programming or control of serial automatic calling DCEs when an ON condition is present on circuits 106 and 108/2, and an OFF condition is present on circuit 107. In this situation, the condition of circuit 105 need not be considered, and may be ON for DTE convenience.

All data transferred on circuit 103 during the time an ON condition is present on all of the above four circuits, where implemented, shall be transmitted by the DCE.

Refer also to 4.2.1 and 4.3.1 below for further explanation.

The DTE shall not transfer data on circuit 118 unless an ON condition is present on all of the following four circuits, where implemented: circuit 120, circuit 121, circuit 107 and circuit 108/1 or 108/2.

All data transferred on circuit 118 during the time an ON condition is present on all of the above four circuits, where implemented, shall be transmitted by the DCE.

4.1.2 Timing circuits

It is desirable that the transfer of timing information across the interface shall not be restricted to periods when actual transmission of data is in progress; however, during intervals when timing information is not transferred across the interface, the circuit involved should be held in the OFF condition.

Accuracy and stability of the signal on circuit 115 as defined in the DCE Recommendations are required only when circuit 109 is ON. Drift during the OFF condition of circuit 109 is acceptable; however, resynchronization of the signal on circuit 115 shall be accomplished as rapidly as possible following the turning ON of circuit 109 for the next transmission as indicated in the relevant DCE Recommendation.

4.2 Control and indication circuits

4.2.1 Operation of circuits 107, 108/1 and 108/2

4.2.1.1 In switched and leased line operations

Signals on circuit 107 are to be considered as responses to signals which initiate connection to line, e.g. circuit 108/1. However, the conditioning of a data channel, such as equalization and clamp removal, cannot be expected to have been completed when circuit 107 is turned ON.

A configuration option shall be provided within the DCE to select either circuit 108/1 or circuit 108/2 operation.

Under certain test conditions, both the DTE and the DCE may exercise some of the interchange circuits. Thus, when circuits 107, 108/1 or 108/2 are both OFF, the DTE is to ignore the conditions on all other interchange circuits from the DCE, except those on circuit 125 and the timing circuits, and the DCE is to ignore the conditions on all other interchange circuits from the DTE.

During the maintenance phases specified in Recommendation V.54, when the DTE is not involved in the test, circuit 142 is in the ON condition and circuit 107 is in the OFF condition. Circuit 107 shall not respond to circuits 108/1 or 108/2. When the DTE is involved in the test, circuit 142 is in the ON condition and circuit 107 shall respond to circuit 108/1 or 108/2.

4.2.1.2 In leased line operations

Where circuit 108 is not implemented in the DTE, the condition on this circuit is assumed to be permanently ON.

Where circuit 108 is implemented in the DTE, it shall be implemented as circuit 108/1.

4.2.1.3 In switched line operations

When the DCE is conditioned for automatic answering of calls, answering of incoming calls occurs only in response to a combination of the calling signal and an ON condition of circuit 108/1 or 108/2.

The OFF condition of circuit 108/1 or 108/2 shall not disable the operation of circuit 125.

When circuit 108/2 is in the ON condition and circuit 107 is in the OFF condition, the DTE may communicate with serial automatic calling DCEs on circuits 103 and 104. This state is recognized by an ON condition on circuit 106.

When circuit 108/1 or 108/2 is turned OFF, it shall not be turned ON again until circuit 107 is turned OFF.

In the case where the DCE turns circuit 107 OFF first, the DTE shall consider the call aborted and shall proceed as described below:

1) In the case of circuit 108/1, the DTE shall turn this circuit OFF with minimal delay and shall hold the circuit in the OFF condition for a minimum of 500 ms. After that period of time, the DTE may turn circuit 108/1 back ON either to initiate a new direct call or to respond to an incoming call signalled by circuit 125 coming ON.

   The DCE shall not answer an incoming call or initiate a new call until circuit 108/1 has first been turned OFF and then back ON again.

2) In the case of circuit 108/2, the DTE shall turn this circuit OFF with minimal delay and shall hold the circuit in the OFF condition for a minimum of 500 ms. After that period of time, the DTE may turn circuit 108/2 back ON either to initiate a new serial automatic calling procedure or to signal the DCE that it is prepared to accept an incoming call.

   The DCE shall answer an incoming call or initiate a new call until circuit 108/2 has been turned OFF and then back ON again or after a minimum delay (provisional value 2 s).

4.2.2 Circuit 125 – Calling indicator

The operation of circuit 125 shall not be impaired or disabled by any condition on any other interchange circuit.

4.2.3 Usage of circuit 126

Originally, this circuit was defined for operational control of a 2-wire, frequency-divided duplex DCE, such as the Recommendation V.21-type modem. Transmitter and receiver control were separated, so that local testing of both data channels might be performed as national Administrations required.

The modem according to Recommendation V.21 selects the transmit and receive frequencies according to the condition of circuit 125 in switched network operation.

However, the use of circuit 126 may become necessary in certain types of non-centralized multipoint operation, as specified in the relevant DCE Recommendation.

4.2.4 Circuit 140 – Loopback/Maintenance Test

4.2.4.1 Usage of circuit 140

Circuit 140 can be used in conjunction with coded commands on circuit 103 in accordance with the provisions of Recommendation V.54.

In systems not including the use of circuit 103, i.e. no coded commands, circuit 140 controls only the remote loopback (loop 2).

In systems that involve the use of circuit 103, additional maintenance applications of circuit 140 are possible. These additional applications remain for further study.

4.2.4.2 Interrelationship of circuits 105, 106 and 140

For automatic control of loop 2 test, circuit 106 is under the control of circuit 140 and circuit 105 is disregarded by the DCE.

4.3 Miscellaneous

4.3.1 Interrelationship of circuits 103, 105 and 106

The DTE signals its intent to transmit data by turning ON circuit 105. It is then the responsibility of the DCE to enter the transmit mode, i.e. be prepared to transmit data, and also to alert the remote DCE and condition it to receive data. The means by which a DCE enters the transmit mode and alerts and conditions the remote DCE are described in the appropriate DCE Recommendation.

When the transmitting DCE turns circuit 106 ON with circuit 107 in the ON condition, the DTE is permitted to transfer data across the interface on circuit 103. By turning ON circuit 106 with circuit 107 ON, it is implied that all data transferred across the interface prior to the time that any one of the four circuits (105, 106, 107 and 108/1 or 108/2) is again turned OFF, will be transferred to the line; however, the ON condition of circuit 106 is not necessarily a guarantee that the remote DCE is in the receive mode. (Depending on the complexity and sophistication of the transmitting signal converter, there may be a delay ranging from less than a millisecond up to several seconds between the time a bit is transferred across the interface until the time a signal element representing this bit is transmitted on the line.)

When the transmitting DCE turns circuit 106 ON, with circuit 107 in the OFF condition, the DTE is permitted to transfer programming or control signals to a serial automatic calling DCE across the interface on circuit 103.

During data transfer, the DTE shall not turn circuit 105 OFF before the end of the last bit (data bit or stop element) is transferred across the interface on circuit 103. Similarly, in certain duplex switched network applications where circuit 105 is not implemented (see the specific DCE Recommendations), this requirement applies equally when circuit 108/1 or 108/2 is turned OFF to terminate a switched network call.

Where circuit 105 is provided, the ON and OFF conditions on circuit 106 during the data transfer phase (i.e. circuit 107 ON) shall be responses to the ON and OFF conditions on circuit 105. Circuit 106 may, however, be turned OFF during the data transfer and test phases independent of the condition of circuit 105 to signal the DTE to interrupt the transfer of data on circuit 103 *transmitted data*, for a finite period of time (e.g. for DCE flow control purposes or DCE/DCE resynchronization). It should be noted that data presented on circuit 103 after circuit 106 turns OFF may be disregarded by the DCE. It should also be noted that circuit 106 may be turned back ON again at any time, provided that circuit 105 is ON at that time. For the appropriate response times of circuit 106, and for the operation of circuit 106 when circuit 105 is not provided, refer to the relevant Recommendation for the DCE.

For serial automatic calling DCEs, the ON and OFF conditions on circuit 106 outside the data transfer phase (i.e. circuit 107 OFF) shall be dependent on the interface state during the automatic call set-up and associated procedures. The transitions on circuit 106 for this application shall be as detailed in Recommendation V.25 *bis*.

When circuit 105 and circuit 106 are both OFF, the DTE shall maintain a binary 1 condition on circuit 103. When circuit 105 is turned OFF it shall not be turned ON again until circuit 106 is turned OFF by the DCE.

NOTE – These conditions also apply to the relationship between circuits 120, 121 and 118.

4.3.2 Idle periods

During intervals when circuit 105 and circuit 106 are in the ON condition and no data are available for transmission, the DTE may transmit binary 1 condition, reversals or other sequences to maintain timing synchronizing, e.g. SYN coded characters, idle characters according to the data link control procedure used, etc.

Specific requirements, where applicable, are stated in the appropriate DCE Recommendations.

4.3.3 Clamping

4.3.3.1 In all applications the DCE shall hold, where implemented:

a) circuit 104 in the binary 1 condition when circuit 109 is in the OFF condition; and

b) circuit 119 in the binary 1 condition when circuit 122 is in the OFF condition.

4.3.3.2 In addition, a DCE constrained to half-duplex operation on a 2-wire line shall also hold, where implemented:

a) circuit 104 in the binary 1 condition and circuit 109 in the OFF condition when circuit 105 is in the ON condition, and for a short time interval (to be specified in Recommendations for DCE) following the ON to OFF transition on circuit 105; and

b) circuit 119 in the binary 1 condition and circuit 122 in the OFF condition, when circuit 120 is in the ON condition, and for a short time interval (to be specified in Recommendations for DCE) following the ON to OFF transition on circuit 120.

4.4 Circuit failures (electrical)

A failure condition on one of the following interchange circuits, where implemented, shall be used to detect either a power-off condition in the equipment connected through the interface or the disconnection of the interconnecting cable:

Circuit 105 – Request to send

Circuit 107 – Data set ready

Circuit 108/1 – Connect data set to line

Circuit 108/2 – Data terminal ready

Circuit 120 – Transmit backward channel line signal

The criteria used to determine a failure condition shall be specified in the appropriate Recommendation for electrical characteristics.

The receivers for these circuits shall interpret the power-off condition or the disconnection of the interconnecting cable as an OFF condition on these circuits.

4.5 Provision of interchange circuits in DCEs and DTEs

In some DCE Recommendations optional facilities are defined which require control from the DTE via dedicated circuits. Where the DTE does not provide the respective circuits, these optional facilities cannot be used. The DCE should provide means to disable an option, when necessary, in case the DTE is not equipped with circuitry to control this option. On the other hand, in case the DCE does not provide an option, proper operation of the DTE should not rely on any specific response from the DCE when the DTE activates the control circuit related to that option.

Receiver circuits may be provided in a DTE or a DCE for which no generator is provided in the complementary equipment. Therefore, in cases where a receiver is not connected to a generator, it is suggested that means be provided in the equipment where the receiver is located to inhibit or disregard any possible false triggering of this receiver.

4.6 Data flow control

Some DTE and DCE functionalities rely on the presence of a data flow control mechanism between the DTE and the DCE. Methods for data flow control are described in detail in [9].

4.7 Power-up considerations

During a power-up condition of a DTE or a DCE, the behaviour at the interface towards the complementary equipment is unpredictable. For a short period of time conditions may be assumed that are illegal under normal operational conditions. DTEs and DCEs should therefore be tolerant to illegal conditions and return to normal operation when the illegal condition terminates.

5 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; all 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.

[1] ITU-T Recommendation V.10 (1993), *Electrical characteristics for unbalanced double-current interchange circuits operating at data signalling rates nominally up to 100 kbit/s*.

[2] ITU-T Recommendation V.11 (1996), Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s.

[3] ITU-T Recommendation V.12 (1995), *Electrical characteristics for balanced double-current interchange circuits for interfaces with data signalling rates up to 52 Mbit/s*.

[4] ITU-T Recommendation 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*.

[5] ITU-T Recommendation V.25 *bis* (1996), *Synchronous and asynchronous automatic dialling procedures on switched networks*.

[6] ITU-T Recommendation V.28 (1993), *Electrical characteristics for unbalanced double-current interchange circuits*.

[7] CCITT Recommendation V.31 (1972), *Electrical characteristics for single-current interchange circuits controlled by contact closure*.

[8] CCITT Recommendation V.31 *bis* (1984), *Electrical characteristics for single-current interchange circuits using optocouplers*.

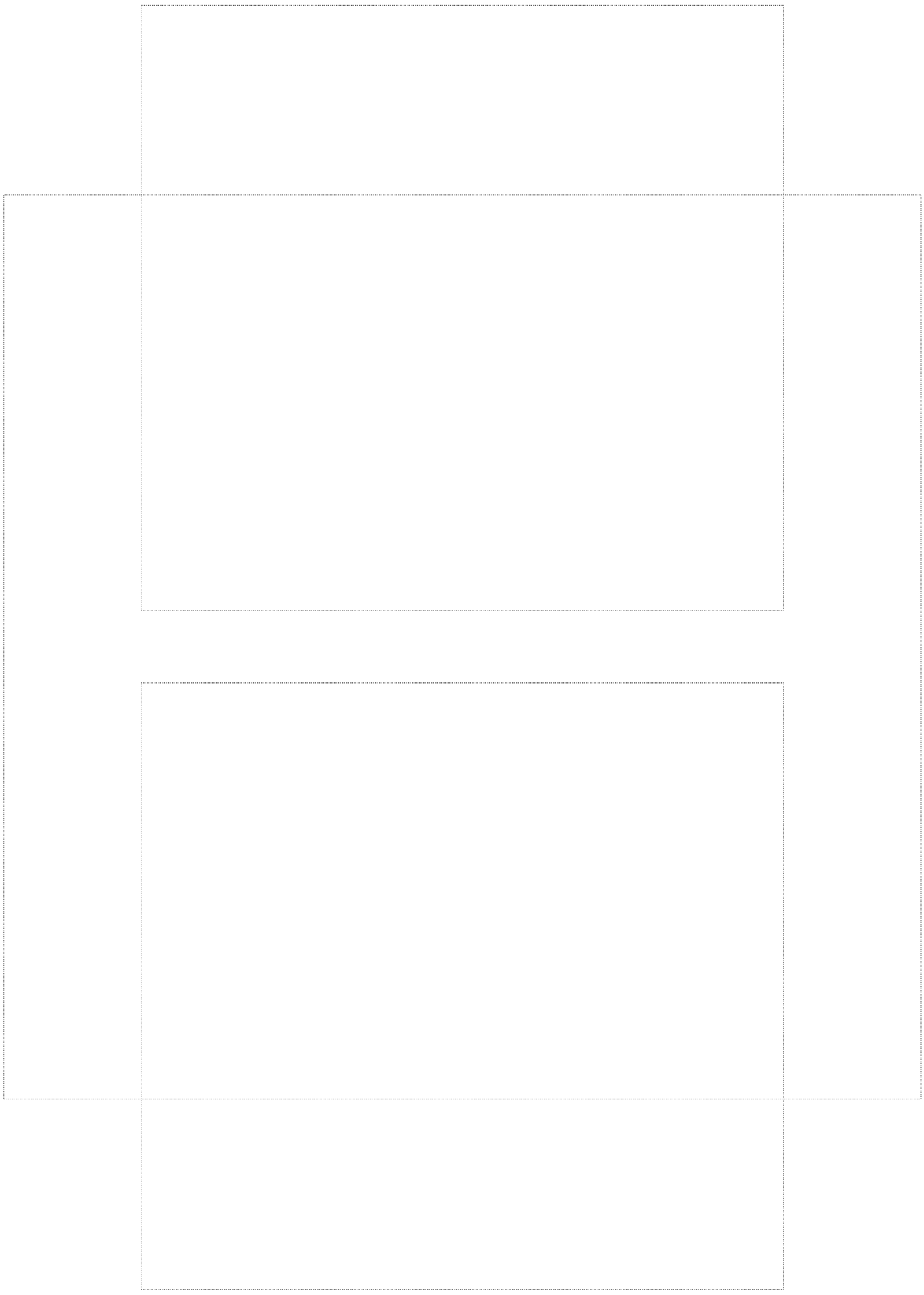
[9] ITU-T Recommendation V.43 (1998), *Data flow control.*

[10] ISO 2110:1989, *Information technology – Data communication – 25-pole DTE/DCE interface connector and contact number assignments*.

[11] ISO 4902:1989, *Information technology – Data communication – 37-pole DTE/DCE interface connector and contact number assignments*.

[12] ISO/IEC 11569:1993, *Information technology – Telecommunications and information exchange between systems – 26-pole interface connector mateability dimensions and contact number assignments*.

[13] ISO/IEC 13575:1995, *Information technology – Telecommunications and information exchange between systems – 50-pole interface connector mateability dimensions and contact number assignments*.



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