INTERNATIONAL TELECOMMUNICATION UNION

# ITU-T

**V.24**

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(03/93)

## DATA COMMUNICATION OVER THE TELEPHONE NETWORK

---

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

## ITU-T Recommendation V.24

(Previously "CCITT Recommendation")

---

## FOREWORD

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

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

ITU-T Recommendation V.24 was revised by the ITU-T Study Group XVII (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

---

NOTES

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 Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

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

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

© ITU 1993

All rights reserved. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the ITU.

## CONTENTS

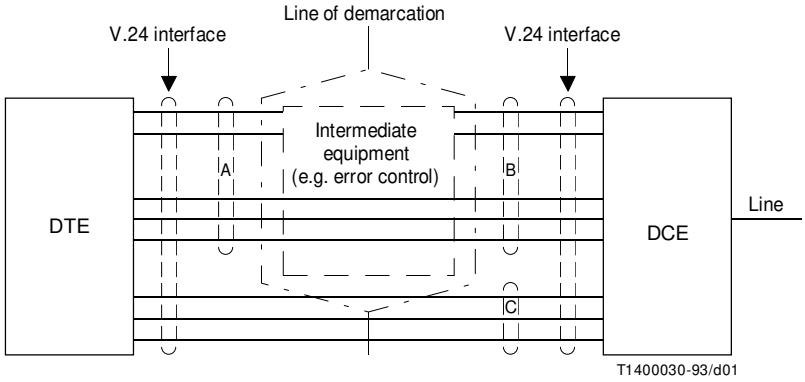

| | | | *Page* |
|---|---|---|---|
| 1 | Scope | | 1 |
| 2 | Line of demarcation | | 2 |
| 3 | Definitions of interchange circuits | | 2 |
| | 3.1 | 100-Series – General application | 2 |
| | 3.2 | 200-Series – Specifically for parallel automatic calling | 12 |
| | 3.3 | Circuit failures (electrical) | 14 |
| | 3.4 | Optional circuits | 15 |
| 4 | Operational requirements | | 15 |
| | 4.1 | Data circuits | 15 |
| | 4.2 | Idle periods | 15 |
| | 4.3 | Clamping | 16 |
| | 4.4 | Operation of circuits 107, 108/1 and 108/2 | 16 |
| | 4.5 | Interrelationship of circuits 103, 105 and 106 | 17 |
| | 4.6 | Timing circuits | 18 |
| | 4.7 | Circuit 125 – Calling indicator | 18 |
| | 4.8 | Usage of circuits 126 and 127 | 18 |
| | 4.9 | Circuit 140 – Loopback/Maintenance Test | 18 |
| | 4.10 | Interrelationship of circuits 202 to 211 | 18 |
| Reference | | | 19 |

# 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, and Helsinki, 1993)*

## 1 Scope

**1.1** 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 and analogue 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/V.24

**Illustration of general layout of equipment**

Electrical characteristics for interchange circuits are detailed in appropriate Recommendations for electrical characteristics, or in certain special cases, in Recommendations for DCE.

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 Note to 3.4 for proper handling of unimplemented circuits).

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

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

**1.3** 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;

d) where short interconnecting cables are used between DTE and DCE. An explanation of short cables is given in 2 below.

**1.4** A DTE 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 recorded in Series X Recommendations.

## 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. Separate connectors may be provided for the interchange circuits associated with the signal-conversion or similar equipment and those associated with the parallel automatic calling equipment. For mechanical characteristics of the interface refer to ISO 2110 or ISO 4902 as appropriate.

The connector(s) 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. The use of short cables is recommended. Their length should be limited solely by the load capacitance and other electrical characteristics specified in the relevant Recommendation on electrical characteristics.

## 3 Definitions of interchange circuits

### 3.1 100-Series – General application

A list of these interchange circuits is presented in tabular form in Table 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, V.11 and V.35.

Within the DCE, this circuit shall be brought to one point, and it shall 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.

*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 Recommendation V.10-type interchange circuit receivers within the DCE.

TABLE 1/V.24

**100-series interchange circuits by category**

| Interchange 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 | | | |
| 110 | Data signal quality 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 | | | |

TABLE 1/V.24 *(end)*

**100-series interchange circuits by category**

| Interchange 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 |
| 122 | Backward channel received line signal detector | | | | X | | | |
| 123 | Backward channel signal quality detector | | | | X | | | |
| 124 | Select frequency groups | | | | | X | | |
| 125 | Calling indicator | | | | X | | | |
| 126 | Select transmit frequency | | | | | X | | |
| 127 | Select receive frequency | | | | | X | | |
| 128 | Receiver signal element timing (DTE) | | | | | | | X |
| 129 | Request to receive | | | | | X | | |
| 130 | Transmit backward tone | | | | | X | | |
| 131 | Received character timing | | | | | | X | |
| 132 | Return to non-data mode | | | | | X | | |
| 133 | Ready for receiving | | | | | X | | |
| 134 | Received data present | | | | X | | | |
| 136 | New signal | | | | | X | | |
| 140 | Loopback/Maintenance test | | | | | X | | |
| 141 | Local loopback | | | | | X | | |
| 142 | Test indicator | | | | X | | | |
| 191 | Transmitted voice answer | | | | | X | | |
| 192 | Received voice answer | | | | X | | | |

*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 Recommendation V.10-type interchange circuit receivers within the DTE.

NOTE – Where a mixture of Recommendations V.10 and V.11 circuits is used in the same interface, separate provision must be made for the Recommendation V.10 common return circuits 102a and 102b, and for a d.c. reference potential conductor circuit 102.

*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 must be isolated from signal ground and protective ground, irrespective of whether it is located within the DCE or within the DTE.

*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.

*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.

*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.

*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.

*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.

*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 connect 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*).

*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 requiremens 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*).

*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.

*Circuit 110 – Data signal quality detector*

Direction: From DCE

Signals on this circuit indicate whether there is a reasonable probability of an error in the data received on the data channel. The signal quality indicated conforms to the relevant DCE Recommendation.

The ON condition indicates that there is no reason to believe that an error has occurred.

The OFF condition indicates that there is a reasonable probability of an error.

*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.

*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.

*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.

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

Direction: From DCE

Signals on this circuit provide the DTE with 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.

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

Direction: From DCE

Signals on this circuit provide the DTE with 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.

*Circuit 116/1 - Back-up swtiching 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.

*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.

*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.

*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.

*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.

*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.

*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.

*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.

*Circuit 123 – Backward channel signal quality detector*

Direction: From DCE

This circuit is equivalent to circuit 110, except that it is used to indicate the signal quality of the received backward channel line signal.

*Circuit 124 – Select frequency groups*

Direction: To DCE

Signals on this circuit are used to select the desired frequency groups available in the DCE.

The ON condition causes the DCE to use all frequency groups to represent data signals.

The OFF condition causes the DCE to use a specified reduced number of frequency groups to represent data signals.

*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.

*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.

*Circuit 127 – Select receive frequency*

Direction: To DCE

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

The ON condition selects the lower receive frequency.

The OFF condition selects the higher receive frequency.

*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.

*Circuit 129 – Request to receive*

Direction: To DCE

Signals on this circuit are used to control the receive function of the DCE.

The ON condition causes the DCE to assume the receive mode.

The OFF condition causes the DCE to assume the non-receive mode.

*Circuit 130 – Transmit backward tone*

Direction: To DCE

Signals on this circuit control the transmission of a backward channel tone.

The ON condition causes the DCE to transmit a backward channel tone.

The OFF condition causes the DCE to stop the transmission of a backward channel tone.

*Circuit 131 – Received character timing*

Direction: From DCE

Signals on this circuit provide the DTE with character timing information, as specified in the relevant Recommendation for DCE.

*Circuit 132 – Return to non-data mode*

Direction: To DCE

Signals on this circuit are used to restore the non-data mode provided with the DCE, without releasing the line connection to the remote station.

The ON condition causes the DCE to restore the non-data mode. When the non-data mode has been established, this circuit must be turned OFF.

*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 must 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.

*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 represent information messages.

The OFF condition shall be maintained at all other times.

*Circuit 136 – New signal*

Direction: To DCE

Signals on this circuit are used to control the response times of the DCE receiver.

The ON condition of circuit 136 instructs the DCE receiver to prepare itself to detect rapidly the disappearance of the line signal (e.g., by disabling the response time circuitry associated with circuit 109). After the received line signal falls below the threshold of the received line signal detector, the DCE will:

1) turn OFF circuit 109; and

2) prepare itself to detect rapidly the appearance of a new line signal (e.g., by resetting the receiver timing recovery circuitry).

Once turned ON, circuit 136 may be turned OFF after one unit interval and must be turned OFF after circuit 109 is turned OFF. Circuit 136 shall be OFF at all other times.

*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.

*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.

*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.

*Circuit 191 – Transmitted voice answer*

Direction: To DCE

Signals generated by a voice answer unit in the DTE are transferred on this circuit to the DCE.

The electrical characteristics of this analogue interchange circuit are part of the appropriate DCE Recommendation.

*Circuit 192 – Received voice answer*

Direction: From DCE

Received voice signals, generated by a voice answering unit at the remote DTE, are transferred on this circuit to the DTE.

The electrical characteristics of this analogue interchange circuit are part of the appropriate DCE Recommendation.

## 3.2 200-Series – Specifically for parallel automatic calling

A list of these interchange circuits is presented in tabular form in Table 2.

For parallel automatic calling procedures, refer to Recommendation V.25 for the general switched telephone network and Recommendation S.16 [1] for the telex network.

TABLE 2/V.24

**200-series interchange circuits specifically for automatic calling**

| Interchange circuit number | Interchange circuit name | From DCE | To DCE |
|---|---|---|---|
| 201 | Signal ground or common return | X | X |
| 202 | Call request | | X |
| 203 | Data line occupied | X | |
| 204 | Distant station connected | X | |
| 205 | Abandon call | X | |
| 206 | Digit signal ($2^0$) | | X |
| 207 | Digit signal ($2^1$) | | X |
| 208 | Digit signal ($2^2$) | | X |
| 209 | Digit signal ($2^3$) | | X |
| 210 | Present next digit | X | |
| 211 | Digit present | | X |
| 213 | Power indication | X | |

*Circuit 201 – Signal ground or common return*

This conductor establishes the signal common reference potential for all 200-series interchange circuits. Within the parallel automatic calling equipment this circuit shall be brought to one point, and it shall 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 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.

*Circuit 202 – Call request*

Direction: To DCE

Signals on this circuit are used to condition the parallel automatic calling equipment to originate a call and to switch the automatic calling equipment to or from the line.

The ON condition causes the DCE to condition the parallel automatic calling equipment to originate a call and to connect this equipment to the line.

The OFF condition causes the automatic calling equipment to be removed from the line and indicates that the DTE has released the automatic calling equipment.

*Circuit 203 – Data line occupied*

Direction: From DCE

Signals on this circuit indicate whether or not the associated line is in use (e.g. for automatic calling, data transmission or voice communication, test procedures).

The ON condition indicates that the line is in use.

The OFF condition indicates that the line is not in use, and that the DTE may originate a call.

*Circuit 204 – Distant station connected*

Direction: From DCE

Signals on this circuit indicate whether a connection has been established to a remote data station (or telex station).

The ON condition indicates the receipt of a signal from a remote DCE signalling that a connection to that equipment has been established.

The OFF condition shall be maintained at all other times.

*Circuit 205 – Abandon call*

Direction: From DCE

Signals on this circuit indicate whether a preset time has elapsed between successive events in the calling procedure.

The ON condition indicates that the call should be abandoned.

The OFF condition indicates that call origination can proceed.

*Digit signal circuits:*

Circuit 206 – Digit signal ($2^0$)

Circuit 207 – Digit signal ($2^1$)

Circuit 208 – Digit signal ($2^2$)

Circuit 209 – Digit signal ($2^3$)

Direction: To DCE

On these circuits the DTE presents the code combinations shown in Table 3, being the digits of the data station (or telex station) to be called and the delimiting control characters.

The control character EON (end of number) causes the DCE to take appropriate action to await an answer from the called data station.

The control character SEP (separation) indicates the need for a pause between successive digits or in front of the digit series, and causes the parallel automatic calling equipment to insert the appropriate time interval.

The code combinations listed above are intended to apply only to equipment using Recommendations V.25 and S.16 [1].

*Circuit 210 – Present next digit*

Direction: From DCE

Signals on this circuit indicate whether the parallel automatic calling equipment is ready to accept the next code combination.

The ON condition indicates that the automatic calling equipment is ready to accept the next code combination.

The OFF condition indicates that the automatic calling equipment is not ready to accept signals on the digit signal circuits.

TABLE 3/V.24

| Information | Binary states | | | |
|---|---|---|---|---|
| | 209 | 208 | 207 | 206 |
| Digit 1 | 0 | 0 | 0 | 1 |
| Digit 2 | 0 | 0 | 1 | 0 |
| Digit 3 | 0 | 0 | 1 | 1 |
| Digit 4 | 0 | 1 | 0 | 0 |
| Digit 5 | 0 | 1 | 0 | 1 |
| Digit 6 | 0 | 1 | 1 | 0 |
| Digit 7 | 0 | 1 | 1 | 1 |
| Digit 8 | 1 | 0 | 0 | 0 |
| Digit 9 | 1 | 0 | 0 | 1 |
| Digit 0 | 0 | 0 | 0 | 0 |
| Control character EON | 1 | 1 | 0 | 0 |
| Control character SEP | 1 | 1 | 0 | 1 |

*Circuit 211 – Digit present*

Direction: To DCE

Signals on this circuit control the reading of the code combination presented on the digit signal circuits.

The ON condition causes the automatic calling equipment to read the code combination presented on the digit signal circuits.

The OFF condition on this circuit prevents the automatic calling equipment from reading a code combination on the digit signal circuits.

*Circuit 213 – Power indication*

Direction: From DCE

Signals on this circuit indicate whether power is available within the parallel automatic calling equipment.

The ON condition indicates that power is available within the automatic calling equipment.

The OFF condition indicates that power is not available within the automatic calling equipment.

## 3.3 Circuit failures (electrical)

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

Circuit 202 – Call request

Circuit 213 – Power indication

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

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

### 3.4 Optional circuits

In some modem Recommendations optional facilities are defined which require control from the DTE via optional (non-essential) circuits. Additional optional facilities may exist in DCEs also requiring control via interchange circuits defined in this Recommendation.

The DCE should provide means to disable an option, when necessary, in case the DTE is not equipped with circuitry to control this option.

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.

NOTE – DTEs may be in existence which do not comply with the above requirements. Therefore, for an interim period, DCEs not providing a certain option may provide means to respond to the DTE invocation of that option in the proper way. Especially, this may be the case for simplex or duplex DCEs not providing a carrier switch option (continuous carrier operation) but still responding with circuit 106 to circuit 105.

For an interim period of time, 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 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

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 4.4 and 4.5 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.

### 4.2 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 Clamping

**4.3.1** 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.

**4.3.2** 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 Operation of circuits 107, 108/1 and 108/2

### 4.4.1 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 wiring 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.

### 4.4.2 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.

### 4.4.3 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).

## 4.5 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.

## 4.6 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 must be accomplished as rapidly as possible following the turning ON of circuit 109 for the next transmission as indicated in the relevant DCE Recommendation.

## 4.7 Circuit 125 – Calling indicator

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

## 4.8 Usage of circuits 126 and 127

Originally, these circuits were 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 does not require separate operational control by the DTE of circuits 126 and 127 since it selects the transmit and receive frequencies according to the condition of circuit 125 in switched network operation.

However, the use of circuits 126 and 127 may become necessary in certain types of non-centralized multipoint operation.

## 4.9 Circuit 140 – Loopback/Maintenance Test

### 4.9.1 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.

### 4.9.2 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.

## 4.10 Interrelationship of circuits 202 to 211

*Circuit 202*

Circuit 202 must be turned OFF between calls or call attempts and shall not be turned ON before circuit 203 is turned OFF.

*Circuit 204*

The ON condition of this circuit must be maintained until the DTE has released the automatic calling equipment, i.e. until circuit 202 is turned OFF.

*Circuit 205*

The OFF condition shall be maintained on this circuit after circuit 204 comes ON.

The initial time interval starts when circuit 202 comes ON. Subsequent time intervals start each time circuit 210 is turned OFF.

*Circuits 206, 207, 208 and 209*

The conditions on these four circuits shall not change whilst circuit 211 is ON.

*Circuit 210*

When circuit 210 is turned OFF, it shall not be turned ON again before circuit 211 is turned OFF.

*Circuit 211*

Circuit 211 shall neither be turned ON when circuit 210 is in the OFF condition, nor until after the DTE has presented the required code combination on the digit signal circuits.

Circuit 211 shall not be turned OFF before circuit 210 is turned OFF.

## Reference

[1] CCITT Recommendation *Connection to the telex network of an automatic terminal using a V.24 DCE/DTE interface*, Vol. VII, Rec. S.16.