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PART I

Recommendations Q.310 to Q.331

SPECIFICATIONS OF SIGNALLING SYSTEM R1

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SIGNALLING SYSTEM R1

INTRODUCTION

PRINCIPLES OF SIGNALLING SYSTEM R1

General

The development of new exchanges, especially those utilizing stored programme control , has introduced new concepts in the division of functions between various components of signalling and switching systems. To allow the maximum freedom in incorporating new concepts which can contribute to the overall economy and efficiency of the system, the requirements as covered in this specification are for the combination of equipments necessary to

provide a function. For example, the requirements for line signal receiving equipment as given here may be met by various subdivisions of functions between signal receiver, trunk relay sets and stored programme control.

System R1 may be applied for automatic and semi-automatic operation of one-way and both-way circuits, within an international region (world numbering zone). When utilized in an integrated world numbering zone (e.g. Zone 1) the numbering and routing plans and operating facilities of that zone should apply.

The system is applicable to all types of circuits (except TASI derived circuits) meeting CCITT transmission standards, including satellite circuits.

The signalling equipment used in System R1 consists of two parts:

a) line signalling for line or supervisory signals; and

b) register signalling for address signals.

a) *Line signalling*

1) *2600 Hz signalling*

Continuous tone type in-band line-signalling is used for the link-by-link transmission of all supervisory signals except the ring-forward (forward-transfer) signal which is a spurt signal. A single frequency, 2600 Hz, is used in each direction of the 4-wire transmission path, the presence or absence of this frequency indicates a specific signal dependent upon when it occurs in the signalling sequence and in certain cases upon its duration. When the circuit is idle, a low level signalling tone is continuously present in both directions.

Register signalling can be made compatible with TASI by providing a TASI locking tone.

2) *PCM signalling*

The 2600 Hz line signalling described in 1) is not normally applied to the speech paths of circuits working on PCM systems unless the PCM channels are connected in cascade with analogue channels to form a circuit. The signalling on PCM systems in the North American region is channel associated, in-slot, providing two signalling channels per speech channel, and utilizing bit stealing of the eighth bit of each channel every sixth frame.

b) *Register signalling*

See in Fascicle VI.2, Recommendation Q.151, Note to § 3.1.1 for an explanation of these terms.
Link-by-link multifrequency (MF) in-band pulse signalling is used for the transmission of address information. The signalling frequencies are 700 Hz to 1700 Hz, in 200 Hz steps, and combinations of two, and two only, determine the signal. The address information is preceded by a KP signal

(start-of-pulsing) and terminated by an ST signal (end-of-pulsing). Either *en bloc* , or *en bloc* overlap , or overlap sending may apply. This register signalling arrangement is used extensively with other in-band and out-band line signalling systems.

Compandors may affect signalling, particularly short pulse compound register signals, due to pulse length distortion and the production of intermodulation frequencies. By virtue of the link-by-link signalling and the adopted duration of register and line signal pulses, System R1 functions correctly in the presence of compandors designed in accordance with CCITT recommendations.

SECTION 1

DEFINITION AND FUNCTION OF SIGNALS

Recommendation Q.310

1. DEFINITION AND FUNCTION OF SIGNALS

1.1 **connect (seizing) signal** (sent in the forward direction)

This line signal is transmitted at the beginning of a call to initiate circuit operation at the incoming end of the circuit to busy the circuit and to seize equipment for switching the call.

1.2 **delay-dialling signal** (sent in the backward direction)

This line signal is transmitted by the incoming exchange following the recognition of the connect (seizing) signal to verify receipt of the connect (seizing) signal and to indicate that the incoming register equipment is not yet attached or ready to receive address signals.

1.3 **start-dialling (proceed-to-send) signal** (sent in the backward direction)

This line signal is sent from the incoming exchange subsequent to the sending of a delay-dialling signal to indicate that the incoming register equipment has been connected and is ready to receive address signals.

1.4 **KP (start-of-pulsing) signal** (sent in the forward direction)

This register signal is sent subsequent to the recognition of a start-dialling signal and is used to prepare the incoming multifrequency register for the receipt of subsequent interregister signals.

1.5 **address signal** (sent in the forward direction)

This register signal is sent to indicate one decimal element of information (digit 1, 2, . | | , 9 or 0) about the called party's number. For each call a succession of address signals is sent.

1.6 **ST (end-of-pulsing) signal** (sent in the forward direction)

In this part the North American designation for line signals is used. The designation of the signal in System No. 5 which most nearly corresponds to a particular North American signal is shown in parentheses. There is not always exact correspondence in function, e.g. the ring-forward signal can only be effective when a connection has been established through an incoming operator.

This register signal is sent to indicate that there are no more address signals to follow. The signal is always sent in semi-automatic as well as automatic working.

Notes on the answer and hang-up (clear-back) signals. — See corresponding notes in Recommendation Q.120, § 1.8, Volume VI-2 of the *Green Book* .

1.7 **answer signal** (sent in the backward direction) ,

This line signal is sent to the outgoing exchange to indicate that the called party has answered.

In semi-automatic working, the signal has a supervisory function.

In automatic working, it is used:

— to start metering the charge to the calling subscriber;

— to start the measurement of call duration for international accounting purposes, if this is desired.

1.8 **hang-up (clear-back) signal** (sent in the backward direction)

This line signal is sent to the outgoing exchange to indicate that the called party has cleared. In the semi-automatic service it performs a supervisory function.

In automatic working, arrangements are made to clear the connection, stop the charging, and stop the measurement of call duration if within 10 to 120 seconds after recognition of the hang-up signal, the calling subscriber has not cleared. Clearing of the connection should preferably be controlled from the point where the charging is carried out.

1.9 **ring-forward (forward-transfer) signal** (sent in the forward direction)

This line signal is initiated by an operator to recall an operator at a point further ahead in the connection.

1.10 **disconnect (clear-forward) signal** (sent in the forward direction)

This line signal is sent in the forward direction at the end of a call when:

a) in semi-automatic working, the operator at the outgoing exchange withdraws the plug from the jack, or when an equivalent operation is performed;

b) in automatic working, the calling party hangs up, or when the time-out period of 10 to 120 seconds as discussed in § 1.8 above occurs.

1.11 *Diagrams showing signal sequence*

Typical sequences of signals in semi-automatic and automatic working are shown in Annex A to these Specifications of Signalling System R1.

See Recommendation Q.27 for the actions to be taken to assure that answer signals, both national and international, are transmitted as quickly as possible.

In word numbering Zone 1, 13 to 32 seconds is used.

SECTION 2

LINE SIGNALLING

Recommendation Q.311

2.1 2600 Hz LINE SIGNALLING

The line-signal coding arrangement is based on the application and removal of a single frequency tone (2600 Hz) as shown in Table 1/Q.311.

Table [1/Q.311], p.

By taking advantage of the fixed order of occurrence of specific signals, both tone-on and tone-off signals are used to indicate more than one signal condition. For example, in the backward direction tone-on is used to indicate start-dialling (proceed-to-send), and terminating end hang-up (clear-back) signals without conflict. The equipment must retain memory of the preceding signal states and the direction of signals in order to differentiate between tone-on and tone-off signals.

Recommendation Q.312

2.2 2600 Hz LINE SIGNAL SENDER (TRANSMITTER)

2.2.1 *Signal frequency*

2600 ± 5 Hz.

2.2.2 *Transmitted signal level of tone-on signals*

—8 ± 1 dBm0 for the duration of the signal or for a minimum of 300 ms (whichever is shorter) and for a maximum of 550 ms after which the level of the signal shall be reduced to —20 ± 1 dBm0.

2.2.3 *Transmitted signal durations*

The transmitted signal durations are shown in Table 1/Q.311.

2.2.4 *Signal frequency leak*

The level of signal frequency leak power transmitted to the line should not exceed —70 dBm0, during the tone-off condition.

2.2.5 *Extraneous frequency components*

The total power of extraneous frequency components accompanying a tone signal should be at least 35 dB below the fundamental signal power.

2.2.6 *Transmitting line split*

The following splitting arrangements are required when transmitting line signals to prevent incorrect operation of the receiving equipment due to transients caused by the opening or closing of direct current circuits in the exchange at the transmitting end:

See also Recommendation Q.112.

a) when a tone-on signal is to be transmitted, the speech path from the exchange shall be split (disconnected), if not already split, within an interval from 20 ms before, to 5 ms after tone is applied to the line, and remain split for a minimum of 350 ms and a maximum of 750 ms;

b) when a tone-off signal is to be transmitted, the speech path from the exchange shall be split (disconnected), if not already split, within an interval from 20 ms before to 5 ms after tone is removed from the line, and remain split for a minimum of 75 ms and a maximum of 160 ms after the tone is removed;

c) when the signalling equipment is receiving and sending tones simultaneously the split shall be maintained until:

i) the transmitted tone is terminated, in which case the split must be removed in the interval from 75 to 160 ms after tone is removed [as in *b)*]; or

ii) the incoming tone ceases, in which case the split must be removed in the interval from 350 to 750 ms after tone ceases;

d) when the signalling equipment is sending tone, a split shall be introduced, if not already split, within 250 ms of receipt of an incoming tone.

The above requirements given in *a)* , *b)* , *c)* and *d)* establish a transmitting path split at both ends of the circuit during the idle condition.

The 5 ms may be relaxed to 15 ms if tone is applied while tone is being received.

Recommendation Q.313

2.3 2600 Hz LINE SIGNAL RECEIVING EQUIPMENT

2.3.1 *Operate limits (tone-on signals)*

The receiving equipment shall operate on a received tone signal, in the presence of the maximum noise expected on an international circuit, —40 dBm0 uniform spectral energy over the range of 300 to 3400 Hz, that meets the conditions listed below:

a) 2600 ± 15 Hz;

b) to ensure proper operation in the presence of noise, the signal level of the initial portion of each tone-on signal shall be augmented by 12 dB (see § 2.2.2).

As a result, the following requirement reflects both the augmented and steady-state signal levels. The absolute power level N of each signal is within the limits (—27 + n N —1 + n) dBm where n is the relative power level at the input to the receiving equipment. The minimum absolute power level N = (—27 + n) gives a margin of 7 dB on the steady-state nominal absolute power level of the received signal at the input to the receiving equipment. With augmentation the effective margin is increased from 7 to 19 dB.

The maximum absolute power level N = (—1 + n) gives a margin of 7 dB on the augmented nominal absolute power level of the received signal at the input to the receiving equipment.

The above tolerances are to allow for variations at the sending end and variations in line transmission.

Note — Since higher steady noise as well as impulsive noise may be encountered on intra-regional circuits especially over certain compandored carrier systems, the maximum expected noise within a region must be taken into account in the design of equipment for that region.

2.3.2 *Non-operate limits*

1) The receiving equipment shall neither operate on signals originating from subscriber stations (or other sources) if the total power in the band from 800 Hz to 2450 Hz equals or exceeds the total power present at the same time in the band from 2450 Hz to 2750 Hz, as measured at the station, nor degrade these signals. Allowances shall be made in the receiving equipment design to accomodate expected deviations from these values due to attenuation distortion and carrier frequency shift on the total transmission path between the station and the receiving equipment.

2) The receiving equipment shall not operate on any tone or signal whose absolute power level at the point of connection of the receiving equipment is (—17 —20 + n) dBm or less, n being the relative power level at this point.

2.3.3 *Recognition of signals*

See also Recommendation Q.112.

1) System R1 must be protected against false signal recognition caused by:

a) signal simulation of tone-on or tone-off signals by speech or other signals;

b) signal simulation of tone-off signals by momentary interruptions of the transmission path.

The method of providing this protection is left to each Administration concerned to allow for maximum flexibility in the implementation of the signalling and switching system design. However, the overall system requirements given in 2) and 3) below shall be met.

2) The following requirements for signal recognition are specified in terms of signal duration at the input to the signal receiving equipment and further assumes that signal levels, frequency and accompanying noise are within the limits specified in § 2.3.1:

a) A tone-on signal lasting 30 ms or less must be rejected; that is, it must not be recognized as a signal.

b) A tone-off signal lasting 40 ms or less must be rejected if the previous tone-on signal is 350 ms or longer; that is, it must not be recognized as a signal.

c) Subsequent to establishing the cross office path, a tone-on ring-forward (forward-transfer) spurt signal lasting between 65 and 135 ms must be recognized as a valid signal.

d) A tone-on forward signal lasting 300 ms or longer must be recognized as a valid disconnect (clear-forward) signal. Prior to attaching a register, a forward tone-on signal lasting 30 ms or longer may be recognized as a valid disconnect (clear-forward) signal.

e) To protect against a momentary interruption in the transmission facility causing a continuous succession of false connect (seizing) and disconnect (clear-forward) signals,

the incoming equipment should be arranged to delay responding to the second of two closely spaced connect (seizing) signals. The timed delay introduced should be started at the end of initial connect (seizing) signal or on recognition of the disconnect (clear-forward) signal. The delay introduced should be a function of the round trip signalling time. For satellite circuits the recommended time is 1300 ± 100 ms. For terrestrial circuits the recommended time is 500 ± 100 ms. If the second connect (seizing) signal persists beyond this timed interval, the signal should be considered valid and a delay dialling signal returned.

f) Other tone-on and tone-off signals should be recognized as valid signals, subsequent to the minimum limits imposed by *a)* and *b)* above, as soon as possible.

Note — Delays introduced by line signalling equipment should be held to a minimum consistent with the requirements covered herein to minimize signal transfer times. Minimizing the delay is especially important in the case of the answer signal and in the case of satellite circuit operation. In this latter case, if a hang-up (clear-back) signal has not been sent prior to recognition of a disconnect (clear-forward) signal, it is necessary that the idle tone-on signal, sent by the incoming exchange in response to the disconnect signal, be recognized by the outgoing exchange prior to the elapse of the guard timing specified in Recommendation Q.317, § 2.7.1.

3) The following signal simulation rates shall not be exceeded.

In the case when no answer signal is transmitted (non-charged calls), the simulation rates specified in §§ 3 *a)* and 3 *b)* may, in some existing designs, be somewhat in excess of the values quoted.

a) On the average not more than one false recognition of a disconnect (clear-forward) signal shall occur per 1500 call hours of speech, at the *minimum* disconnect recognition time, as selected according to § 2.3.3, 2) *c)* and *d)* . (In some older designs, this requirement may not be met, but for these cases the call hours figure must not be less than 500 call hours.)

b) On the average, not more than one false ring-forward (forward-transfer) signal shall occur per 70 call hours of speech, at the *minimum* ring-forward recognition time.

c) Speech or other electrical signals as audible-tone signals, with levels up to +10 dBm0 shall not cause any false simulation of answer signals.

d) The number and characteristics of false splits of the speech path caused by speech or other signals shall not cause a noticeable reduction in the transmission quality of the circuit.

2.3.4 *Receiving line split*

To prevent line signals of the signalling system from causing disturbances to signalling systems on subsequent circuits, the receiving transmission path to the connected exchange should be split when the signal frequency is received to ensure that no portion of any signal exceeding 20 ms duration may pass out of the circuit. The use of a band-stop filter for splitting is necessary since in the case of non-charged calls a continuous signal tone persists in the return transmission path during conversation. The level of signal leak current transmitted to the subsequent circuit with the band-stop filter inserted should be at least 35 dB below the received signal level. In addition, the band-stop filter must not introduce more than 5 dB loss at frequencies 200 Hz or more above or below the midband frequency nor more than 0.5 dB loss at frequencies 400 Hz or more above or below the midband frequency.

The receiving line split must be maintained for the duration of the incoming tone signal, but must cease within 300 ms of tone removal.

Note — In some existing designs, the initial cut may be a physical line disconnection but the filter must be inserted within 100 ms of tone reception.

Recommendation Q.314

2.4 PCM LINE SIGNALLING

Individual channel line signalling is provided in the format of the CCITT primary multiplex operating at 1544 kbit/s (Recommendation G.733). Designated signalling bits are marked 0 or 1 corresponding to tone-on, tone-off in the single frequency in-band arrangement as shown in Table 1/Q.311. As in the in-band system, the same signalling state is used to indicate more than one signal by taking advantage of the fixed order of occurrence of specific signals. The equipment must retain memory of the preceding signal states and the direction of signals in order to differentiate between like state 0 and state 1 signals.

Recommendation Q.315

2.5 PCM LINE SIGNAL SENDER (TRANSMITTER)

2.5.1 *Signalling format*

The primary multiplex format is shown in Figure 1/Q.315. Per channel, in-slot signalling is accomplished by utilizing bit No. 8 in each time slot of the designated frames (6, 12, etc.) for signalling purposes. Bit No. 8 of each time slot in the intervening frames (1-5, 7-11, etc.) is used for encoding speech. Two signalling channels per speech channel are provided in the format. The multiframe alignment required for signalling purposes is obtained by subdividing the 8 kbit/s framing pulse stream into two 4 kbit/s streams, one for terminal framing and one for signalling framing (S-bits). The relationship of the framing and multiframing signals to the signalling bits is given in Table 2/Q.315. Since only one line signalling channel is required for System R1, the same signalling information is sent over both signalling channels A and B.

2.5.2 *Transmitted signal duration*

The transmitted signal durations are given in Table 1/Q.311 of Recommendation Q.311.

2.5.3 *Transmitting line split*

Since signalling is out-band, no transmitting line split is required.

FIGURE 1/Q.315 p.2

Tableau [2/Q.315] p.3

Recommendation Q.316

2.6 PCM LINE SIGNAL RECEIVER

2.6.1 *Recognition of signals*

System R1 must be protected against false signal recognition caused by signal simulation due to momentary loss of synchronization of the PCM system. The method of providing this protection is left to each Administration concerned to allow for maximum flexibility in the implementation of the signalling and switching system design. However, the overall system requirements given below must be met.

a) A state 0 signal lasting 30 ms or less must be rejected; that is, it must not be recognized as a signal.

b) A state 1 signal lasting 40 ms or less must be rejected if the previous state 0 signal is 350 ms or longer; that is, it must not be recognized as a signal.

c) Subsequent to establishing the speech path, a state 0 ring-forward (forward-transfer) signal lasting 65-135 ms must be recognized as a valid signal.

d) A state 0 forward signal lasting 300 ms or longer must be recognized as a valid disconnect (clear-forward) signal. Prior to attaching a register, a forward state 0 signal lasting 30 ms or longer may be recognized as a valid disconnect (clear-forward) signal.

e) To protect against a momentary fault causing a continuous succession of false connect (seizing) and disconnect (clear-forward) signals, the incoming equipment should be arranged to delay responding to the second of two closely spaced connect (seizing) signals. The time delay introduced

should be started at the end of the initial connect (seizing) signal or on recognition of the disconnect (clear-forward) signal. The delay introduced should be a function of the round trip signalling time. For satellite circuits the recommended time is 1300 ± 100 ms. For terrestrial circuits the recommended time is 500 ± 100 ms. If the second connect (seizing) signal persists beyond this timed interval, the signal should be considered valid and a delay dialling signal returned.

f) Other state 0 and state 1 signals should be recognized as valid signals subsequent to the minimum limits imposed by *a)* and *b)* above, as soon as possible.

Note — Delays introduced by line signalling equipment should be held to a minimum consistent with the requirements covered herein to minimize signal transfer times. Minimizing the delay is especially important in the case of the answer signal and in the case of satellite circuit operation. In this latter case, if a hang-up (clear-back) signal has not been sent prior to

recognition of a disconnect (clear-forward) signal, it is necessary that the idle state 0 signal, sent by the incoming exchange in response to the disconnect signal, be recognized by the outgoing exchange prior to the elapse of the guard timing specified in Recommendation Q.317, § 2.7.1.

2.6.2 *Receiving line split*

Since signalling is out-band, no receiving line split is required.

2.6.3 *Action on receipt of an alarm*

When the PCM primary multiplex has detected a fault and given an alarm (see Recommendation G.733, § 3.2) appropriate action shall be taken to remove automatically the affected circuits from service, and to terminate calls in progress, i.e. stop charging, release interconnected circuits, etc. When the alarm has been cleared the affected circuits should be automatically restored to service.

Recommendation Q.317

2.7 FURTHER SPECIFICATION CLAUSES RELATIVE TO LINE SIGNALLING

2.7.1 Access to the outgoing circuits shall be denied (guarded)

for 750 to 1250 ms (1050 ms to 1250 ms for satellite circuits) after initiation of the disconnect (clear-forward) signal to ensure sufficient time for the release of the equipment at the incoming exchange. [See also the Note to § 2.3.3, 2) of Recommendation Q.313 and to § 2.6.1 of Recommendation Q.316.]

2.7.2 The disconnect (clear-forward) signal may be sent at any time in the call sequence.

2.7.3 The release of the chain of circuits in an established connection is only initiated from the originating exchange or the charge-recording exchange.

2.7.4 The start of metering the charge should be delayed by an appropriate time after recording of the answer signal to prevent false charging resulting from possible false recognition of an invalid answer signal.

Recommendation Q.318

2.8 DOUBLE SEIZING WITH BOTH-WAY OPERATION

2.8.1 *General*

To minimize the probability of double seizing, the circuit selection at the two ends of both-way circuit groups should be such that, as far as possible, double seizing can occur only when a single circuit of the group remains free (e.g. by selection of circuits in opposite order at the two ends of the circuit group).

2.8.2 *Unguarded interval*

In general the unguarded interval is small, except in the case of satellite operation where the circuit propagation time is long. However, System R1 does provide a means of detecting double seizing.

2.8.3 *Detection of double seizing*

In the event of double seizing, the incoming connect (seizing) signal is recognized at each end as a delay-dialling signal. If a start-dialling (proceed-to-send) signal is not received within the time-out interval (e.g. 5 seconds) double seizing is assumed.

In this event, either of the following arrangements may apply:

a) an automatic repeat attempt to set up the call; or

b) a recorder indication is given to the operator or to the calling subscriber and no automatic repeat attempt is made.

With either method, means must be provided to ensure positive release of the double seized circuit. To achieve the release it is recommended that the office which first assumes (based on timing) that dual seizure has occurred transmits a tone-on (0 state) signal followed by a tone-off (1 state) signal before the final tone-on (0 state) signal (disconnect) is sent. The duration of initial tone-on (0 state) signal should be a minimum of 100 ms and a maximum of 200 ms. The tone-off (1 state) signal should be recognized as an unexpected tone-off (1 state) signal at the distant end, after which the action specified in § 3.6.2, 1) *c)* of Recommendation Q.325 applies.

Recommendation Q.319

2.9 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

2.9.1 It is recommended that the equipment in international exchanges shall have a high switching speed so that the switching time may be as short as possible.

2.9.2 At the outgoing, transit and incoming international exchanges,

the seizing of the circuit and the setting up of the connection should take place as soon as possible after receipt of the digits of the address that are necessary to determine the routing.

2.9.3 At international exchanges the delay-dialling signal should be returned as soon as possible after recognition of the connect (seizing) signal. The start-dialling (proceed-to-send) signal should be returned as soon as possible but in any case, the return should be before the time-out of the outgoing register. [See § 3.6.2, 1) *a)* and *b)* of Recommendation Q.325.]

SECTION 3

REGISTER SIGNALLING

Recommendation Q.320

3.1
SIGNAL CODE FOR REGISTER SIGNALLING

3.1.1 *General*

1) Either semi-automatic working (with automatic machine or direct operator access), or automatic working (with automatic machine access) may

be used for outgoing traffic. With automatic machine access the incoming address signals are stored in a register until sufficient address information is received to route the call properly, at which time a free circuit may be selected and a connect (seizing) line signal sent. Subsequent to the recognition of a delay-dialling line signal and a start-dialling (proceed-to-send) line signal a KP (start-of-pulsing) signal followed by the address and ST (end-of-pulsing) signals are transmitted. The KP signal, which is nominally 100 ms in duration, prepares the receiving equipment to accept subsequent register signals. The transmission of the KP signal should be delayed by a minimum of 140 ms, but not more than 300 ms, after recognition of the start-dialling line signal.

2) Link-by-link register signalling applies.

3) Register signalling is in a forward direction only and shall be in accordance with the two-out-of-six multifrequency code shown in Table 3/Q.320. Three of the 15 possible codes are unused in international service and are available for special purposes.

4) The receiving equipment must furnish a two-and-two only frequency check on each received signal to ensure its validity.

3.1.2 *Sending sequence of register signals*

1) The sending sequence of address signals conforms to the sequence indicated in Recommendation Q.107. However, for traffic within an integrated world numbering zone (e.g. Zone 1) the language or discriminating digit and country codes may have no application and may not be sent. In Zone 1, the sequence of signals sent from the operator or subscriber is as follows:

a) *Semi-automatic working for calls to a subscriber within Zone 1:*

As used in this Section the term register includes traditional registers in electromechanical exchanges and also the equivalent receiving device, memory and logic in stored program exchanges.

i) KP;

ii) national (significant) number of the called subscriber;

iii) ST.

b) *Semi-automatic working for calls to operators within Zone 1:*

i) KP;

ii) special decimal numbers;

iii) ST.

c) *Automatic working for calls to a subscriber within Zone 1:*

i) national (significant) number of the called subscriber.

2) The sending sequence of register signals shall conform to Table 3/Q.320, noting the following:

a) a KP (start-of-pulsing) signal shall precede the sequence of signals in all cases;

b) the ST (end-of-pulsing) signal shall follow the sequence of signals in all cases.

TABLE [3/Q.320], p.

Recommendation Q.321

3.2 END-OF-PULSING CONDITIONS — REGISTER ARRANGEMENTS CONCERNING ST SIGNAL

3.2.1 The register signalling arrangements shall provide for the sending of an ST signal for both semi-automatic and automatic operation; the arrangements in the outgoing international register for recognizing the ST (end-of-pulsing) signal condition may vary as follows:

a) *Semi-automatic operation*

The special numbers used to reach operators are by agreement between Administrations.

The ST condition is determined by the receipt of the end-of-pulsing signal initiated by the operator.

b) *Automatic operation*

i) Where the ST condition is determined by the originating national network, an ST signal is transmitted to the outgoing international register. No further arrangements are necessary in that register for this purpose.

ii) Where the ST condition is not received from the originating national network, the outgoing international register will be required to determine the ST condition. (See for example the requirements for System No. 5, Recommendation Q.152, *Green Book* .)

Recommendation Q.322

3.3 MULTIFREQUENCY SIGNAL SENDER

3.3.1 Signalling frequencies 700, 900, 1100, 1300, 1500 and 1700 Hz. A signal shall consist of a combination of any two of these six frequencies. The frequency variation shall not exceed ± | .5% of each nominal frequency.

3.3.2 Transmitted signal level —7 ± 1 dBm0 per frequency. The difference in transmitted level between the two frequencies comprising a signal shall not exceed 0.5 dB.

3.3.3 Signal frequency leak and modulation products level of the signal leak current transmitted to the line should be at least:

a) 50 dB below the single frequency level when a multifrequency signal is not being transmitted;

b) 30 dB below the transmitted signal level of either of the two frequencies when a multifrequency signal is being transmitted. The modulation products of a signal shall be at least 30 dB below the transmitted level of either of the two frequencies comprising the signal.

3.3.4 *Signal durations*

KP signal: 100 ± 10 ms.

All other signals: 68 ± 7 ms.

Interval between all signals: 68 ± 7 ms.

3.3.5 *Compound signal tolerance*

The interval of time between the moments when the two frequencies comprising a signal are sent must not exceed 1 ms. The interval of time between the moments when the two frequencies cease must not exceed 1 ms.

Recommendation Q.323

3.4 MULTIFREQUENCY SIGNAL RECEIVING EQUIPMENT

3.4.1 *Operate limits*

The signal receiving equipment must operate satisfactorily on any combination of two of the frequencies received as a single pulse or train of pulses in the presence of maximum expected noise on an international circuit, —40 dBm0 uniform spectral energy over the range of 300 to 3400 Hz, that meets the conditions listed below:

a) each frequency of the received signal is within ± | .5% of the nominal signalling frequency;

b) the absolute power level *N* of each received frequency is within the limits

$$(—14 + n \quad N \quad + 0 + n) \text{ dBm}$$

where *n* is the relative power level at the signal receiver input. Assuming a nominal circuit loss of 0 dB these limits give a margin of ± | dB on the nominal absolute level of each received signal. Considering that a single equipment may serve circuits whose designed loss (nominal loss) is greater than 0 dB (e.g., circuits that are not equipped with echo suppressors) account must be taken of the highest circuit loss in the design of the receiving equipment (e.g., by increasing must-operate sensitivity) to ensure that the minimum margin is 7 dB;

c) the difference in level between the frequencies comprising a received signal is less than 6 dB;

d) the signal receiving equipment must accept signals meeting the following conditions:

i) signals within the limits specified in *a)* , *b)* , and *c)* | bove in the presence of maximum expected noise and subject to the maximum expected delay distortion;

ii) the duration of each frequency comprising a signal is 30 ms or greater; and

iii) the silent interval preceding the signal is 20 ms or greater.

The tolerances given in *a)* , *b)* , and *c)* | re to allow for variations at the sending end and in line transmission.

The test values indicated in *d)* | re less than the working values. The difference between the test value and the working values will allow for pulse distortion, variations in registration devices, etc.

Note — Since higher steady noise as well as impulsive noise may be encountered on intraregional circuits, especially over certain compandored carrier systems, the maximum expected noise within a region must be taken into account in the design of equipment for that region.

3.4.2 *Non-operate limits*

1) The receiving equipment shall not operate on any signal whose absolute power level at the point of the receiving equipment is 9 dB or more below the must-operate sensitivity required to satisfy the conditions established in § 3.4.1 *b)* .

2) The receiving equipment shall release when the signal level falls 1 dB below the level established in § 1) above.

3) Operation of the receiving equipment shall be delayed for a minimum period necessary to guard against false operation due to spurious signals generated internally on reception of any signal.

4) The receiving equipment should not operate on a pulse signal of 10 ms or less. This signal may be of a single frequency or two frequencies received simultaneously. Likewise, after operation the equipment shall ignore short interruptions of the signal frequencies.

3.4.3 *Input impedance*

The value of the input impedance should be such that the return loss over a frequency range of 500 to 2700 Hz against a 600-ohm non-inductive resistor in series with a two-microfarad capacitor is greater than 27 dB.

Recommendation Q.324

3.5 ANALYSIS OF ADDRESS INFORMATION FOR ROUTING

In the application of System R1 to intraregional networks, the routing plan of that network shall apply. The routing plan is such that analysis is limited to a maximum of six digits.

Note — An ISC processing an incoming call on a circuit using System R1, if encountering a barred routing or unallocated number condition, should preferably send the special information tone toward the originating subscriber.

Recommendation Q.325

3.6 RELEASE OF REGISTERS

3.6.1 *Normal release conditions*

1) An outgoing register shall be released when it has transmitted the ST signal.

2) An incoming register shall be released on the forward transmission of the ST signal to the next exchange, or when all pertinent information has been transferred to an outgoing register.

3.6.2 *Abnormal release conditions*

1) An outgoing register shall release in any of the following situations:

a) on failure to recognize a delay-dialling signal within 5 seconds of circuit seizure unless a longer interval is preferred for particular traffic conditions;

b) on failure to recognize a start-dialling (proceed-to-send) signal within 5 seconds of recognition of the delay-dialling signal unless a longer interval is preferred for particular traffic conditions;

c) on recognition of an unexpected tone-off (0 state) line signal subsequent to the recognition of a start-dialling (proceed-to-send) signal, but prior to completion of outpulsing. This signal sequence will occur in the event of double seizing and therefore a repeat attempt may be invoked and as a result the register may not be released prior to completion of the second attempt. (See Recommendation Q.318.);

d) on exceeding overall register timing of 240 seconds.

2) An incoming register shall release in any of the following situations:

a) on failure to receive the KP signal within 10 to 20 seconds of register seizure;

b) on failure to receive the 1st through 3rd digits within 10 to 20 seconds of receipt of the KP signal;

c) on failure to receive the 4th through 6th digits within 10 to 20 seconds of the registration of the 3rd digit;

d) on failure to receive the remaining digits and ST signal within 10 to 20 seconds of registration of the 6th digit;

e) on error detection such as receipt of one or more than two frequencies in a pulse;

f) on failure to gain access to associated switching equipment within appropriate intervals of time.

The timing intervals given in 1) and 2) above are representative values but need not necessarily apply to all types of switching systems or all traffic loads.

An abnormal release of an outgoing register on failure to receive a delay-dialling signal as discussed in 1) *a)* above, shall result in the circuit being locked out which maintains the tone-off (1 state) condition toward the distant end. The maintenance personnel should be alerted.

Abnormal releases should result in the return of an audible re-order (congestion) tone toward the originating end. If this condition (re-order) persists for more than 1 to 2 minutes, maintenance personnel should be alerted.

Recommendation Q.326

3.7 SWITCHING TO THE SPEECH POSITION

At all exchanges, the circuit shall be switched to the speech position when the registers (incoming or outgoing) are released.

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