SECTION 6

TESTING AND MAINTENANCE

Recommendation Q.490

TESTING AND MAINTENANCE

6.1 *General*

In international working the guiding principles and testing arrangements for maintenance as defined in Recommendations M.700 to M.728 and Q.134 also apply to Signalling System R2. The organization of routine maintenance, tests and measurements of signalling and switching should comply with Recommendations M.716, M.718, M.719, M.728 and M.732.

The analogue line signalling of System R2 differs from other CCITT signalling systems in two significant respects:

— line signals are sent over out-band signalling channels;

— an ‘‘interruption control’’ protects the line signalling from the consequences of interruptions of the transmission path.

These two features of System R2 require special attention from a maintenance point of view.

6.2 *Automatic procedures for transmission measurements and signalling tests*

Circuits operated with System R2 require elaborate transmission measurements and signalling tests and also rapid and simple testing of transmission and signalling. Both needs are preferably met by means of automatic devices.

The specification for ATME-2 as adopted by CCITT makes it applicable to the testing of international circuits using System R2. The necessary information for its use on such circuits is contained in Recommendation O.22.

A description of a simplified programme for rapid testing of signalling and checking the transmission quality of a circuit is given in § 6.3. Generally speaking, the arrangements for automatic testing consist of outgoing test equipment connected at the outgoing end of the circuit and incoming test equipment connected at the incoming end.

6.3 *Automatic test procedures for test equipments*

Automatic test procedures provides a means for rapid testing of signalling and also checking the transmission quality of circuits operated with Signalling System R2.

6.3.1 *Numbering of access to test equipment*

In international working, to set up a call to maintenance equipment via circuits operated with System R2, the following multifrequency signals must be sent:

— I-13 (replacing the language digit, in accordance with Recommendation Q.133),

— I-13,

— two digits ‘‘XY’’ which will be associated with the type of test equipment and the procedure for testing to be employed (see Recommendation Q.107, Table 7),

— I-15 (if requested by the incoming equipment).

Provision is made for repetition of signal I-13 to avoid complications in the incoming R2 register in the country of destination. The second signal I-13 is stored in the place where the first digit of the routing information is normally recorded. In this way, access to the test equipment requires no analysis, for routing purpose, of the signal which takes the place of the language digit.

When calls are set up to the test equipment, it is desirable to avoid repetition of the request for the access code or for any other digit. This is because the calls may come from equipment which is not normally designed to interpret signals A-2, A-7 or A-8.

The address complete signal to be sent on calls to test equipment must be one of the following:

— A-6 or A-3 followed by B-6 when incoming test equipment is free,

— A-4 or A-3 followed by B-3 or B-4 when incoming test equipment is busy.

Precautions should be taken that signal A-6 is only sent when it is sure that the incoming test equipment is available for that call. When receiving signal A-3, the outgoing test equipment sends signal II-7 in response.

Note — In national working, or in international working where the language digit is omitted by bilateral agreement, the following multifrequency signals must be sent:

— I-13.

— Two digits ‘‘XY’’.

— I-15 (if necessary).

6.3.2 *Test sequence for simplified test*

The test sequence is as follows:

a) seizing of the automatic incoming test equipment;

b) transition to answer state;

c) sending backward of a composite identification signal 1020 + 1140 Hz; this signal will be acknow ledged in a compelled manner by the signal mentioned under d);

d) recognition of a composite acknowledgement signal 1380 + 1980 Hz, sent in the forward direction;

e) on the disappearance of the acknowledgement signal the incoming test equipment passes to the clear-back state;

f) on recognition of the clear-back signal, the outgoing equipment will send in a normal manner the clear-forward signal which will clear the connection and release incoming test equipment. After release of the incoming line circuit the release-guard signal will be sent in the normal way.

Detection of failure is made by timing out at the outgoing equipment.

The frequencies mentioned under c) and d) are those for System R2 interregister signalling; transmission and reception of these frequencies in the incoming test equipment must be in accordance with Section 4.

Attenuation pads may be inserted in the send and receive paths of the outgoing test equipment to shift the receive level at the input of the multifrequency receivers of the outgoing and incoming test equipment toward the lower operational limit. This makes it possible to diagnose abnormal loss on the circuit under test from defective multifrequency signal exchange between outgoing and incoming test equipment. For testing international System R2 circuits, the additional attenuation produced by the pads should be 10 ± 1 dB.

6.3.3 *Good/no good transmission test equipment*

In addition to the tests described in §§ 6.3.1 and 6.3.2 a good/no good transmission test may be provided as a simple means for fast error localization. Such a test is described in Recommendation Q.137 for System No. 4 (i.e. and the frequency of the test signal, the tolerances and the deviation from the nominal value, the test signal generators and receivers would all be the same) but the sending level being —10 dBm.

It is to be noted that loop transmission measurements of the kind specified in Recommendation Q.136 cannot be made on System R2 circuits.

6.4 *Testing of analogue line signalling equipment under abnormal conditions*

The specification of the analogue line signalling equipment contains clauses concerning operation under abnormal conditions, including the action to be taken in case of interruption control alarm. The testing equipment described in § 6.2 is not applicable to such conditions and therefore the functioning of the analogue line signalling equipment under abnormal conditions should be tested internally at each end of a circuit either manually or automatically with special equipment.

The detailed programme for this testing will be specified by each Administration.

The design and construction of the line signalling equipment should be such as to permit both operational and limit testing in normal and abnormal conditions.

6.5 *Alarms for the technical staff*

Certain abnormal conditions in the signalling equipment should cause alarms to be set off for the technical staff (see also Recommendation Q.117). The relevant requirements are found in Section 2 (line signalling equipment) and in Section 5 (time-out in multifrequency registers).

As indicated in § 2.2.3, a fault occurring during release of a circuit

may result in an abnormal blocking condition. In this case there is a ‘‘tone-on’’ condition in both signalling directions, yet the circuit is not in the idle condition since the release-guard signal has not been received. If no special action is taken, a temporary fault may therefore result in the circuit’s being out of service until it is manually restored by the maintenance staff, after receipt of an alarm (see § 2.2.4).

It may accordingly be desirable to arrange for automatic restoration of abnormally blocked circuits. For Administrations wishing to introduce this function, the recommended arrangement is described below.

6.6 *Recommended method for automatic restoration of an abnormally blocked circuit*

When an outgoing link is abnormally blocked, periodic sending on the outgoing link of the seizing signal, followed shortly afterwards by the clear-forward signal, is initiated.

Clearance of the fault which caused the abnormal blocked condition will initiate a release-guard signal at the incoming end whereupon the outgoing end restores the link to the idle condition.

The intervals, at which the periodic sequence described above is repeated, should be between 30 seconds and 2 minutes.

The first operation of the automatic device should be performed as soon as possible, but not before 2-3 seconds have elapsed, after recognition of the abnormally blocked condition at T1 (see § 2.2).

After a period of three to six minutes a delayed alarm should be given in accordance with Recommendation Q.412, § 2.2.4.

In the event of a backward tone-off condition being detected, other than in response to a periodic clear-forward signal, the periodic sequence is suspended until the backward tone is again recognized whereupon the periodic sending sequence is restarted.

If interruption control at the outgoing end occurs during the abnormally blocked condition, the periodic sending sequence is suspended until the interruption control reverts to normal, whereupon the periodic sending sequence is restarted.

6.7 *Instructions for the maintenance of channels and circuits using System R2 line signalling system at 3825 Hz*

The analogue line signalling equipment specified in Section 2 is closely associated with the channel translating equipment and its operation may be a function of the group and supergroup translating and through-connection equipments. Maintenance of the circuits and groups which support them is governed by the principles and Recommendations of Volume IV. However, the introduction of out-band signalling calls for a few complements to these Recommendations, as described below.

6.7.1 *Bringing into service of group, supergroup, mastergroup or supermastergroup links*

a) *§§ 2.1 and 7.6 of Recommendation M.460*

It should be noted that group and supergroup pilots placed at 140 Hz from a virtual carrier frequency are incompatible with signalling at 3825 Hz. Hence, the pilot on 84.140 kHz should not be applied to groups in which channel 6 is to be operated with this out-band signalling. Similarly, the pilot on 411.860 kHz should not be applied to supergroups in which channel 1 of the group in the group 3 position is to be operated with signalling at 3825 Hz.

If the channels of a group are to be operated with System R2, each extremity of the group should be equipped, at the receiving end, with a device to give protection against faulty signalling conditions which may result from an interruption in the transmission channels (interruption control). This equipment, which is based on pilot level detection; must comply with the conditions specified in § 2.4.3 of Recommendation Q.416.

Note — If the channels of a supergroup which are operated with System R2 have the same extremities as the supergroup, a device based on monitoring of the supergroup pilot can be used instead of one based on monitoring of the group pilot. It will have to meet the same specifications.

b) *§ 7.2 of Recommendation M.460*

The group-translating and through-connection equipments are specified with a passband extending from 60.600 kHz to 107.700 kHz. If it is wished to use channels 12 with signalling at 3825 Hz, it is necessary to ensure when the group is set up, that the corresponding frequency (60.175 kHz) is transmitted satisfactorily from end to end of the group link.

Provisionally, in view of the operating margin of the receiving part of the signalling equipment, it is desirable to check that attenuation at this frequency does not exceed the attenuation at the group pilot frequency by more than 3 dB.

A similar precaution should be taken on setting up group links when signalling is to be used at 3825 Hz on channel 12 of the group transmitted in position 5 on the supergroup.

6.7.2 *Setting-up and lining-up the channels of an international group*

6.7.2.1 *Setting up the out-band signalling channel for the System R2*

Testing of the sending equipment:

— The sending level of the signalling frequency corresponding to 3825 Hz if the carrier is taken as the frequency of origin must be lined up at —20 ± 1 dBm0. When this frequency is not to be sent, its leak transmitted to line should not exceed —45 dBm0.

Testing of the receiving equipment:

— The signalling receiver must operate in the conditions described in §§ 2.3.2.1 and 2.3.2.2. It must not function when a signal, of which the characteristics (level and frequency) are such that the representative point is below the graph in Figure 8/Q.415, is applied to the same point.

This test may be replaced by the following one to check the protection against unwanted signals (impulsive noise):

— The sending part of the group terminal equipment is connected to its receiving part by a closed-circuit loop at the group distribution frame, this loop introducing a slight gain (e.g. 3 dB)

if possible. The standardized click generator (see Figure 7/Q.414) is applied to each speech channel successively at the point where this channel is connected to the switching equipment, and a check is made to ensure that no wrong signals are retransmitted at the receiving end to the switching equipment by the channel signalling equipment concerned or by those of the other channels in the group.

6.7.2.2 *Closed-circuit loop tests: response time*

When the transmission-reception loop of the terminal equipment is effected at the group distribution frame or at an equivalent point, a check is made to ensure that less than 30 ms elapse between the moment when the change of condition is applied to the transmitter associated with each channel and the moment when it appears at the output of the corresponding receiver.

6.7.2.3 *End-to-end tests*

When the terminal channel-translating equipments are normally connected to the extremities of the link, an end-to-end operating test is carried out. The level of the line-signalling frequencies transmitted and

received for each channel are likewise measured, to provide a reference, at the group terminal distribution frames or at equivalent points.

ANNEX A
(to Signalling System R2 Specifications)

(see Recommendations Q.400 and Q.441)

Provision of a forward-transfer signalling facility

A.1 *General*

The System R2 does not provide a forward-transfer line signal. However for certain relations it may be decided by bilateral or multilateral agreement to introduce the forward-transfer signalling facility into System R2.

One possible procedure that has been adopted for use within Europe, is to use the PYY in-band signal of System No. 4. This solution is only economical in regions where the facility is needed for a small proportion of the calls.

For international working the method as described below may be followed.

Note — The method given in this Annex may also be adopted in national networks where the forward-transfer facility is considered necessary for trunk offering and recalling operators. However, care must be taken to see that the transmission limits applying to the forward-transfer signal specified are observed.

A.2 *Method recommended for introducing the forward-transfer signalling facility into System R2*

Forward-transfer signalling will be provided by means of special equipment which uses in-band signalling and which is switched only on to those connections which may require this facility. The amount of special equipment necessary can, accordingly, be reduced to a minimum and adapted, in a flexible manner, to actual needs. The in-band signal constituting the forward-transfer signal is sent end-to-end between the outgoing and incoming international exchanges. When the special equipment receives the

forward-transfer signal, it performs the necessary operations at the incoming exchange.

A.2.1 *Access to the special equipment in an incoming international exchange*

In an incoming international exchange access to the special equipment for forward-transfer signalling can be determined by the use of the following indicators:

1) Special marking of incoming routes on which forward-transfer signalling is used.

2) Language digit indicating semi-automatic traffic.

3) Calls for code 11 or code 12 operator.

4) Special interregister signalling sequence in which the incoming exchange sends signal A-5, *send calling party's category* the forward-transfer signalling facility is required the outgoing R2 register will respond to this by sending the signal II-10. This signal indicates an operator-initiated call on which special equipment for forward-transfer signalling is needed.

The use of these indicators will depend on the amount of traffic for which forward-transfer signalling is employed. In some cases one or two of the indicators will be utilized. In others, combinations of all will be used to reduce to a minimum the amount of special equipment required.

A.2.2 *In-band forward-transfer signalling*

In System R2 the in-band forward-transfer signal is the same as that used in System No. 4. For the definition of this signal see Recommendation Q.120, § 1.12. The signal is the signal PYY defined in Recommendation Q.121, § 2.3.

The forward-transfer signal is sent in accordance with Recommendations Q.122 and Q.124.

The signal receiver and the splitting arrangements to be incorporated in the special equipment at the incoming international exchange are in accordance with Recommendations Q.123 and Q.124.

Provided it creates no difficulty for incoming national network signalling, no splitting need be effected at the receiving end and the caller will then hear the entire signal PYY.

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PART IV

SUPPLEMENTS TO THE SERIES Q RECOMMENDATIONS

CONCERNING SIGNALLING SYSTEMS R1 AND R2

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Supplement No. 1

LINE SIGNALLING FOR DC LINES WITH SYSTEM R2 INTERREGISTER SIGNALLING

1 Introduction

In the following specification a line signalling system is defined for 2-wire, DC-lines with or without metering facility during speech.

The signalling polarity is provided by the incoming exchange and a loop is provided in the outgoing exchange, so that in case of cable fracture the outgoing exchange is informed automatically that the line(s) concerned is(are) no longer available.

The line signal repertoire is based on the presence of System R2 interregister signalling.

Apart from the metering pulses, the line signalling is continuous, which means that a certain state of a connection is characterized by a

special signalling condition which is maintained as long as the indicated condition continues to exist.

The following states are provided:

Forward direction:

1) idle

2) seized

3) clear-forward

Backward direction:

1) available

2) seized before answer

only without metering
only with metering

3) answered

4) metering

5) clear-back

6) forced release

7) not available (blocking)

2 Principles of the signalling and speech circuit

2.1 *Signalling circuit*

An example of a signalling circuit is shown in Figure 1. Feeding of the loop occurs at the incoming exchange; the direction of the current can be reversed by contacts X and the feeding current can be switched off by contacts Tu. Contacts Bl are also used to switch off the feeding current and consequently, to block the circuit. This can only take place if the line circuit in the outgoing exchange is detected as being in the open or high resistance state.

When the contacts are in the position shown in the figure, normal loop current flows and when the contacts X are switched over reversed loop current flows.

In the outgoing exchange the state can be changed, by means of contact W, from the high resistance condition with the current-direction sensitive detector H switched in, to a state with two low resistance current-direction sensitive detectors L and R.

In addition to contact W a contact K is provided to open the loop; the open loop state is used to expedite the recognition of clear-forward.

In the line circuit in the incoming exchange a filter is needed to provide sufficient attenuation in the audible components arising in case of polarity reversing. This is necessary, in particular, when metering pulses are sent during conversation.

In the line circuit in the outgoing exchange a filter may be needed to provide sufficient attenuation in the audible components arising when detectors L and R are operated and/or released. This filter, if required at all, can normally be much simpler than the one used in the incoming exchange.

2.2 *Speech circuit*

An example of a speech circuit is also shown in Figure 1. A circuit equipped with the loop signalling system concerned has to be electrically separated, from the preceding or following parts of the connection. This prevents interference by longitudinal voltages in other parts of the connection.

The detectors shall be of high impedance for speech.

Figure 1 p.

3 Meaning of the signalling states

In the Tables 1, 2 and 3 the meaning of the various signalling states are shown.

Outgoing exchange:

— high resistance = idle

— low resistance = seized

— open = clear-forward.

Incoming exchange (*without* | etering):

— normal loop polarity = available, seized or clear-back

— reversed loop polarity = unavailable or answer

— no voltage = unavailable (blocking).

Incoming exchange (*with* | etering):

— normal loop polarity = available or seized

— reversed loop polarity = unavailable or metering pulse

— no voltage = unavailable (blocking) or forced release.

4 Discrimination between the various signalling states

It is not necessary to be able to discriminate between each state of one end and all states of the other end. However, the capabilities shown in Tables 1, 2 and 3 should be provided.

Table 1 p.

Table 2 p.30

Table 3 p.

5 **Operation** (see Figures 2a-2f)

5.1 In the idle state the line circuit in the outgoing exchange continuously checks whether or not the line is blocked by the high resistance detector H. This detector operates when the line is intact and the normal loop polarity is present in the incoming exchange indicating the state ‘‘available’’.

Detector V in the incoming exchange is marginal and does not operate in this state.

5.2 If the circuit in the outgoing exchange is seized for a call the

exchange switches in the low resistance state and the low resistance detector L operates.

In the line circuit in the incoming exchange the detector V operates and the incoming equipment assumes the seized state.

5.3 *The B-subscriber answers*

a) *Without metering*

When the B-subscriber answers this is indicated by the line circuit in the incoming exchange by reversing the loop feeding polarity to reversed loop polarity. In the circuit in the outgoing exchange the low resistance detector R operates and L releases.

b) *With metering*

When the B-subscriber answers this is indicated by the incoming exchange (except in the case of a call that is free of charge) by sending a metering pulse. The incoming exchange sends a metering pulse by reversing the loop feeding polarity to reversed loop polarity during the metering pulse.

In the line circuit in the outgoing exchange the low resistance detector R operates and L releases.

5.4 The equipment must allow the following rules to be applied with respect to the sending of metering pulses.

— A metering pulse must be completed by the incoming exchange before sending forced release.

— After sending a metering pulse there is no minimum period with normal loop polarity before forced release is sent.

— During the receipt of a metering pulse the outgoing exchange is allowed to start sending clear-forward.

5.5 *Backward release*

a) *Without metering*

The incoming exchange can inform the outgoing exchange that the B-subscriber has cleared by sending clear-back. This signal consists in reversing the loop feeding polarity to normal loop polarity. In the line circuit of the outgoing exchange the low resistance detector L operates and R releases.

The incoming exchange remains in this state (clear-back) until the outgoing exchange sends clear-forward or the B-subscriber reanswers.

b) *With metering*

The incoming exchange can inform the outgoing exchange that the connection can be released by sending forced release. This signal, which consists in switching off the loop feeding potential, must persist for a minimum time T3. After receiving forced release the line circuit of the outgoing exchange must transmit clear-forward within a time T4 which is less than time T3.

Time T3 finishes when the line circuit in the incoming exchange is again available; normal loop polarity is then sent.

The above mentioned cleard-forward in the line circuit in the outgoing exchange is followed (just as in the case of the release without forced release described in § 5.6 by the idle state).

5.6 In order to release the circuit the outgoing exchange opens the loop (clear-forward) during a time T1, before switching in the high ohmic detector.

The incoming exchange must switch to one of the unavailable states within a time T2 which is less than T1, unless the circuit in this exchange is available before the time T2 has elapsed.

5.7 The incoming exchange can signal in two ways that it is not available for a new call, namely by reversing the loop or by switching off the feeding potentials.

In so far as the unavailability of the line circuit in the incoming exchange forms part of normal operation, this state should be indicated by reversed loop polarity.

Unavailability of the line circuit in the incoming exchange for other reasons should be indicated by switching off the feeding potentials.

5.8 If during the seized state of the line circuit in the outgoing exchange, the circuit is interrupted by disturbances or by the feeding potential being switched off, the outgoing exchange has to react to it in the same way as it does to clear-back (without metering) or forced release (with metering), possibly followed by blocking.

5.9 At the incoming exchange during the unavailable state and for a subsequent period of 100 ms during the available state, operation of detector V should be ineffective.

FIGURES 2 a)/b) p.5

FIGURES 2 c)/d) p.6

FIGURE 2 e) p.7

FIGURE 2 f) p.8

6 Time requirements

6.1 *Recognition times*

a) When the outgoing exchanges is in the idle state but blocked the recognition time of the unblocking condition (normal loop polarity) must be 100-300 ms.

b) In order to make a clear distinction between the reversal of the polarity and no voltage the recognition time of forced release must be 60-180 ms.

c) The recognition time of all remaining conditions must be 10-40 ms.

6.2 *Release times*

a) The time T2 depends on the recognition time of detector V and the reaction time of the incoming exchange which can be assumed 30 ms; consequently the time T2 is defined 10-70 ms.

b) *Without metering*

The worst case when releasing a circuit occurs if the B-subscriber releases just after the A-subscriber releases, causing clear-back to be sent before the recognition time of clear-forward has elapsed. In order to safeguard the operation in that particular situation the time T1 is defined 300-600 ms.

c) *With metering*

The worst case when releasing a circuit occurs if within the recognition time of clear-forward a metering pulse starts and that within the length of this pulse clear-forward cannot be recognized. In order to safeguard the operation in that particular situation the time T1 is defined 500-1000 ms.

The time T3 depends on the discharge time of the involved circuit and the time T4. For the discharge time, a time 80 ms can be assumed. The time T4 depends on the recognition time of forced release [see § 6.1 |)] and the reaction time of the outgoing exchange which can be assumed 30 ms; consequently the time T4 is defined 60-210 ms. Addition of these times leads to a time T3 ≥" 300 ms.

6.3 *Sending times*

The length of the metering pulse to be sent shall be 120-180 ms.

7 Miscellaneous

This supplement does not describe values for the impedance of the detectors and the cable and does not indicate operate/nonoperate limits for the detectors, because these parameter are rather dependent on the capabilities of the related network. Therefore these requirements must be provided by each Administration.

Supplement No. 2

BOTH-WAY WORKING OF THE ANALOGUE LINE

SIGNALLING VERSION OF SIGNALLING SYSTEM R2

1 Both-way working

In principle the Signalling System R2 is specified for one-way working. The following additional clauses therefore apply only to cases where Administrations have undertaken by bilateral agreement to use both-way working.

Equipment which must be equally usable in both-way and in one-way operation should be so designed that it can be easily adapted to the requirements of either mode of operation.

A peculiarity of both-way working with the system under consideration is that a blocking signal cannot be distinguished from a seizing signal at either end of a circuit, since the transition of the signalling condition corresponding to these signals is the same, namely from *tone-on* to *tone-off* .

When a both-way circuit is seized simultaneously at both ends, the signalling tone is disconnected in both directions of transmission; this is the criterion for detecting the double-seizure situation.

The special arrangements required for both-way working relate to the two cases mentioned above. For all other signalling phases the specifications for one-way working remain valid without modification.

1.1 *Normal conditions*

1.1.1 *Double-seizure*

When the signalling equipment at one end of a both-way circuit seizes that circuit by disconnecting the signalling tone, it must verify that cessation of the signalling tone in the opposite direction does not occur within 250 ± 50 ms of the disconnection of the signalling tone in the forward direction. If the signalling equipment detects the removal of the signalling tone within that interval then a double-seizure situation is recognized. Each end must return to the idle state after sending the clear-forward signal and recognizing *tone-on* condition on the signalling channel.

However, each end must, even if immediately seized for an outgoing call, maintain *tone-on* condition for at least 100 ms on the outgoing signalling channel to ensure that the end of the double seizure situation is recognized at the other end.

Although a double seizure has been recognized, the *tone-off*
| ondition in the backward direction is passed on backwards. This will be regarded as an erroneous answer signal and lead to the release of the connection in accordance with § 2.2.3 in the Specifications. However, as

specified in § 1.2.1 below the clear-forward signal (*tone-on*
| ondition) must not be sent until the *tone-off* condition has been maintained for at least 1250 ± 250 ms. Each end after sending of the clear-forward signal returns to the idle condition when the time interval 250 ± 50 ms (see § 2.2.2.6 in the Specifications) has elapsed, and the sending of the *tone-on* condition from the other end has been recognized.

In the sense of preventive action it is recommended that an opposite order of circuit selection is used by each exchange of a both-way circuit group to minimize double seizure.

1.1.2 *Minimum duration of idle state after release-guard*

When a both-way circuit is released, the end which acted as the incoming end must, even if immediately seized for a call in the opposite traffic direction, maintain the *tone-on* condition for at least 100 ms to ensure that the release-guard sequence is recognized at the other end.

1.1.3 *Blocking*

When a both-way circuit is blocked manually in its idle state at one end (A), the blocking signal, must be transmitted to the other end (B), where it will nevertheless be interpreted as a seizing signal. This will mean that an incoming R2 register is seized, but is not receiving any interregister signal. After the lapse of this register's time-out delay the circuit must be kept blocked locally (at end B) against all calls in the B-A direction so long as the *tone-off* condition persists in A-B direction.

To avoid certain difficulties (see §§ 1.2.1 and 1.2.2 below) and in contrast to § 2.2.3.5 in the Specifications the *tone-off* condition is not applied in the opposite direction (B-A) to the blocking direction (A-B).

When the blocking is removed at end A the signalling tone is again transmitted in direction A-B and the B-end interprets the onset of the signalling tone as a clear-forward signal, thereby initiating the release-guard sequence in the

B-A direction.

1.2 *Abnormal conditions*

The cases described below relate to interruption of the individual signalling channels or to faults in the individual line-signalling equipment. Interruption control does not function in these cases.

In any circuit the interruption of one or both signalling channels can bring about signalling sequences different from those described in § 2.2.3 in the Specifications for one-way working.

1.2.1 When an interruption of the signalling channel in one of the two directions brings about a signalling state corresponding to blocking, the release-guard sequence will be initiated the moment the interruption ends (see § 1.1.3).

The release-guard sequence implies that the signalling tone in the backward direction be disconnected for an interval 450 ± 90 ms. In both-way working this *tone-off* condition must not be interpreted as seizing. To avoid a repetition of the exchange of release-guard sequences certain precautions must be taken.

The following additional requirements should then be met:

— when the *tone-off* | ondition has lasted for an interval of less than 750 ± 150 ms the return to *tone-on* condition must not initiate a release-guard sequence;

— once the signalling condition corresponding to seizing has been established, it must be maintained for at least 1250 ± 250 ms (this is a deviation to the requirement in § 2.2.2.1 in the Specifications).

When the interruption of one of the signalling channels has brought about blocking of the circuit at one end (B), as described above, that circuit can be seized at the other end (A). The end A will not have received the blocking signal from end B (see § 1.1.3) because that would cause permanent blocking of the circuit, which would then no longer be able to restore itself to normal functioning. Should a seizing now occur, this will lead to loss of a call; but subsequently, since the clear-forward signal cannot be transmitted, the circuit will remain blocked at end A. The whole further signalling sequence for reverting the circuit under consideration to idle follows the specification for one-way circuits.

1.2.2 An interruption of both signalling channels on any circuit will be interpreted by the equipment at each end of the line as seizing and the equipments will be blocked after the lapse of the time-out delay of the incoming R2 registers.

If, after an interruption, only one signalling channel is restored, the equipment at the incoming end in relation to that signalling channel will interpret the *tone-on* condition as a clear-forward signal and therefore bring into operation the release-guard sequence. The terminal equipment at that end will revert to the idle state, while the terminal equipment at the other end remains blocked. This is the situation envisaged in § 1.2.1 above.

When both signalling channels are simultaneously restored, the terminal equipment at both ends will interpret the onset of the signalling tone as a clear-forward signal and this will bring the release-guard sequence into operation. The result will be that the terminal equipment at both ends will again recognize the *tone-off* condition for a brief interval.

The following additional clause must be observed, to avoid permanent blocking of the circuit in this condition:

— When, after blocking, the line-signalling equipment at one end (A) of a both-way circuit has recognized the clear-forward signal, it must complete the release-guard sequence and restore the signalling tone after 450 ± 90 ms in the direction A-B, even if the tone in direction B-A is interrupted. If such interruption (in direction B-A) lasts for less than 750 ± 150 ms, the circuit returns to the idle state when the signalling tone is restored in both directions. If the interruption is longer than 750 ± 150 ms, restoration of the signalling tone in direction B-A will initiate a new release-guard sequence in direction A-B (see § 1.2.1 above).

1.2.3 If an abnormal condition according to § 2.2.3.3 in the Specifications occurs at one end of a both-way circuit, this end is blocked for outgoing traffic. Such blocking should, however, not prevent the circuit being used in the other traffic direction.

2 Special conditions regarding the interruption control for both-way working

2.1 As soon as an operating condition has been established on a both-way circuit and the outgoing and incoming ends of the circuit have been determined with certainty, the interruption control specifications for one-way working become equally applicable to both-way circuits.

2.2 When a both-way circuit is in the idle state, transition to alarm of the interruption control of one direction of transmission must bring about operations to ensure that the signalling condition existing at that moment on the signalling channel of the opposite direction is maintained — in contrast to specification 2.4.2.1 |) |) in the Specifications for one-way

working. This precaution obviates a permanent blocking of a both-way circuit when interruption of the signalling channels occurs simultaneously in both directions. It does not ensure immediate blocking of the circuit; this will not occur until the circuit has been seized by the next call.

2.3 In all operating conditions intermediate between the *idle*
| tate and the condition at the moment when the direction of seizure of the both-way circuit is determined (see above), the line-signalling equipment at both ends will be locked by interruption control in the condition in which it was before interruption control passed to alarm.

Supplement No. 3

USE OF THE ANALOGUE LINE SIGNALLING VERSION

ON 2048 kbit/s PCM TRANSMISSION SYSTEMS

(refer to Recommendation G.732)

This solution is restricted for use within national networks or internationally subject to bilateral agreements because it requires some conventions which otherwise would have to be agreed upon in CCITT. However, cost aspects may be a more decisive factor than the required conventions.

The analogue version of the line signalling is used on both the analogue and the digital transmission systems.

Two examples of the use of the analogue line signalling on digital transmission systems are shown in Figure 1.

Apart from the interruption control handling, the transmultiplexer or other conversion equipment is transparent to the line signalling.

The out-slot signalling is carried in time slot 16 of 2048 kbit/s systems (refer to Recommendation G.732, Table 3). Bit *a* of time slot 16 is used to transmit the line signalling state of the corresponding analogue channel. Bit *b* is used to indicate that the analogue transmission system is in the alarm condition with the following convention. For all the digital circuits connected to the circuits of this analogue group bit $b = 1$ means alarm condition on the analogue group.

1 In order to ensure the correct working of the line signalling under fault conditions when employing T MUX some time requirements must be fulfilled.

1.1 *The fault occurs on a PCM multiplex* | see Figure 2)

If the fault occurs on PCM multiplex No. 1, the transmission of the alarm indication will take place in the following time conditions:

— the fault occurs at T ;

— the fault is detected by the transmultiplexer at $T + t_1$;

— the transmultiplexer stops sending the pilot on GP_1, GP_2 and GP_3 at $T + t_1 + t_2$;

— the alarm indication is detected at the analogue distant end at $T + t_1 + t_2 + t_3 + t_p$,

where:

— t_1 is the time needed for recognition of the faulty transmission on a PCM 2048 kbit/s multiplex;

— t_2 is a processing time needed by the transmultiplexer after detection of alarm on the PCM multiplex;

— t_3 is the response time for the pilot receiver when the pilot level falls; it is the time $t\downarrow$ specified in Recommendation Q.416 ($t\downarrow < t_{r\backslash ds}$ | dm\di\dn + 13 ms), applicable only for the recognition time $t = 20 \pm 7$ ms;

— t_p is the propagation delay on the analogue section.

FIGURE 1 p.9

Figure 2, p.10

In the same situation, if the transmission fault disturbs signalling information, erroneous signals will be transmitted in the following time conditions:

— the fault occurs at T ;

— the erroneous signalling condition appears at the input of the analogue channel at $T + t_4$;

— the erroneous signalling condition appears at the input of the distant signalling equipment at $T + t_4 + t_5 + t_p$,

where:

— t_4 is the time needed for transferring a line signal from digital access to analogue access;

— t_5 is the response time of the line signals receiver at the distant analogue end ($t_{r\backslash ds}$ in Signalling System R2 Specifications);

— t_p is the propagation delay on the analogue section.

If t_r is the recognition time of line signals specified in Recommendation Q.412, correct working can be ensured if:

$$t_1 + t_2 + t_3 + t_p \quad t_4 + t_5 + t_p + t_r$$

or

$$t_1 + t_2 + t_3 \, t_4 + \; t_5 + t_r$$

or

$$t_1 + t_2 + t \downarrow t_4 + \; t_{r\backslash ds} + t_r.$$

Recommendation Q.416 specifies that $t \downarrow t_{rs}$ | in. $+ \, t\, r$ | in. (where $t\, r$ | in. = 13 ms). Thus, if $t_1 + t_2 t_4$, correct working of line signalling can be ensured.

This inequality indicates simply that the time needed for detection of a faulty transmission on a PCM multiplex plus the time needed for stopping pilot sending when the alarm is detected must be less than the transfer time of a line signal across the transmultiplexer. This time requirement can be fulfilled, if necessary, by introducing in the transmultiplexer a small delay in line signals transmission.

1.2 *The fault occurs on an analogue group*

If, for example, the fault occurs on the analogue group GP_1, the transmission of the alarm indication will take place in accordance with the following time conditions:

— the fault occurs at T ;

— the fault is detected by the transmultiplexer at $T + t_1$;

— bit *b* is set to 1 on the digital channels concerned at $T + t_1 + t_2$;

— the alarm indication appears at the distant digital end at $T + t_1 + t_2 + t_3 + t_p$,

where:

— t_1 is the time needed for detection of loss of pilot;

— t_2 is the time needed for transferring alarm information to the digital output;

— t_3 is the response time of the signalling equipment of the digital multiplex;

— t_p is propagation delay.

If the same fault disturbs signalling information, erroneous signals will be transmitted in the following time conditions:

— the fault occurs at T ;

— the erroneous signalling condition is detected by the transmultiplexer at $T + t_4$;

— bit *a* is changed at the sending end of the digital section by the transmultiplexer at $T + t_4 + t_5$;

— the erroneous signalling condition appears at the input of the distant signalling equipment at $T + t_4 + t_5 + t_6 + t_p$,

where:

— t_4 is the response time of the signalling tone receiver in the transmultiplexer;

— t_5 is the time needed for transferring a line signal from the output of the signalling tone receiver to the digital output (change of bit *a*);

— t_6 is the response time of the signalling equipment of the PCM 2048 kbit/s multiplex ($t_3 = t_6$).

Correct working of line signalling is ensured if:

$$t_1 + t_2 + t_3 + t_p \; t_4 + t_5 + t_6 + t_p + t_r$$

or

$$t_1 + t_2 \; t_4 + t_5 + t_r$$

and if t_r has its minimum value $t_1 + t_2 \; t_4 + t_5 + 13\ ms$.

This inequality indicates that the time for detecting loss of pilot plus the time needed for setting bit *b* to 1 after loss of pilot detection by the transmultiplexer must be less than the response time of the signalling tone receiver in the transmultiplexer plus the transfer time of line signal plus 13 ms.

Supplement No. 4

IN-BAND LINE SIGNALLING FOR 3 kHz SPACED CHANNELS

1 Line signalling code

1.1 *General*

For 3 kHz spaced carrier circuits, an in-band line signalling system is necessary. For this purpose the line signalling of Signalling System No. 4 (Recommendations Q.121, §§ 2.1, 2.2, 2.3 and Q.122) must be used.

1.2 *Line signals*

The following line signals of Signalling System No. 4 are necessary in combination with Signalling System R2 interregister signalling.

1.2.1 *Forward signals*

— Terminal seizing: in case of transit this is indicated by the interregister signalling;

— Forward-transfer: although the forward-transfer facility is not provided in Signalling System R2, it can be used when Recommendation Q.400, § 1.1.3 is implemented;

— Clear-forward.

1.2.2 *Backward signals*

— Answer,

— Clear-back,

— Release-guard,

— Blocking,

— Unblocking: this signal is not separately defined in the Specifications of Signalling System R2, but it is similar to restoring the tone (see Recommendation Q.412, § 2.2.2.5).

Supplement No. 5

LINE SIGNALLING (ANALOGUE VERSION) WITH METERING

1 General

Signalling System R2 may be used as an integrated signalling system for national and international traffic in a national network. Under certain conditions it is desirable to have additional line signals available, and in particular a metering signal in order to permit the charging of national calls and international calls generated in the national network concerned.

This supplement to the specifications of Signalling System R2 deals only with the clauses for exchange line signalling equipment which has been changed in order to take care of the addition of new operating conditions created by the additional metering signals and related only to the requirements of a national network. The conditions of the interruption control have been adapted accordingly.

The transmission of the metering signal can be extended over a maximum of three links between the subscriber exchange and the exchange where the charging equipment has been installed.

2 Line conditions

Taking into account the time sequence, the circuit will have the seven characteristic operating conditions shown in Table 1.

TABLE 1 p.

3 Clauses for exchange line signalling equipment

3.1 *Recognition time for transition of signalling condition*

The recognition time for a changed condition (transition from tone-on to tone-off or vice versa) is 40 ± 10 ms according to the decisions taken by Study Group XI of the CCITT. The definition of the recognition time is indicated in Recommendation Q.412, § 2.2.1.

3.2 *Normal operating conditions*

3.2.1 *General*

Except for the states, metering and forced release, the other states (seizure, answered, release, blocking and release-guard) follow the same states as those indicated in Recommendation Q.412, § 2.2.2. Instead of the situation ‘‘release in clear-back state’’ a situation ‘‘release in forced release state’’ is possible.

3.2.2 *Metering*

The metering signals are pulse-type signals transmitted backwards during the conversation on a link-by-link basis. They are the only signals for which a repetition of the actual signal in a link-by-link basis is necessary in order to avoid an inacceptable distortion of the metering signals.

For the meter pulses the following limits have to be respected:

— sending: 120-180 ms;

— recognition time between the recognized transitions at the receiving side: 60-90 ms.

For the interval between metering signals, the following sending limit has to be observed: minimum 300 ms.

The time at the sending end between the answer signal and the start of the first metering signal and between the end of the last metering signal and the start of the forced release signal shall be more than 300 ms.

3.2.3 *Forced release* | see Figures 1 and 2)

When the called subscriber clears at the end of a call, the exchange which controls the connection will receive the clear-back signal from the called subscriber's end. If the calling subscriber does not clear within a period defined by the Administration concerned for national traffic, and according to Recommendation Q.118 for international traffic, the controlling exchange stops metering, transmits forced release to the preceding exchange and clears forward the succeeding part of the connection. In the preceding exchange, the forced released signal will only be recognized after 300 ms or more in order to avoid confusion with a metering signal.

After recognition of the forced release signal in the originating exchange, the tone-on condition will be transmitted forwards and the part of the connection to the controlling exchange will be released.

The release procedure is identical to the one specified for the analogue version of the line signalling.

There is no forced release in case of no reception of the answer signal in the controlling exchange following an address-complete signal. After a period defined by the Administration concerned for national traffic, and according to Recommendation Q.118 for international traffic the controlling exchange sends busy tone to the calling subscriber and sends clear-forward to release the succeeding part of the connection.

Figure 1 p.

Figure 2 p.

4 Mode of operation of interruption control

4.1 *General*

Generally speaking, it can be said that the mode of operation of the interruption control complies with the specifications of Signalling System R2, and in particular with Recommendation Q.416. However, it is necessary to define the work of operation of the interruption control for the following conditions:

a) circuit in answered state (metering in the backward direction);

b) circuit in forced release state.

4.2 *Mode of operation of interruption control at the incoming end (transmission interrupted in the forward direction)*

a) *Circuit in answered state*

Transition of interruption control to alarm brings about:

i) locking of the sending unit in its position, i.e. in the tone-off condition; if, at the moment of operation of interruption control the tone-on condition existed on the backward direction (metering signal), it will be locked in the tone-off condition;

ii) locking of the receiving unit in its position, i.e. in the tone-off condition.

The other conditions are also in agreement with the specifications described in Recommendation Q.416, § 2.4.2.1 |).

b) *Circuit in forced release state (transmission of forced release signal in backward direction)*

Transition of interruption control to alarm brings about:

i) locking of the sending unit in its position, i.e. in the tone-on condition;

ii) locking of the receiving unit in its position, i.e. in the tone-off condition;

iii) immediate release of the part of the connection beyond faulty circuit (including the called subscriber’s line).

The conditions are similar to the specifications described in Recommendation Q.416, § 2.4.2.1 |), ‘‘clear-back state’’.

4.3 *Mode of operation of the interruption control at the outgoing end (transmission in the backward direction interrupted)*

a) *Circuit in answered state*

In this case, transition of the interruption control to alarm does not cause immediate action. A clear-forward signal sent on the part of the connection preceding the faulty circuit must be repeated forward to ensure that, if the forward signalling channel is left intact, the part beyond the faulty circuit is cleared.

Once the interruption control reverts to normal, the connection is maintainted provided the caller and the called subscriber are still holding. On the other hand, by the time the interruption control reverts to normal, the clear-forward signal may already have been sent and the situation will be the one described under circuit seized but not in answered state.

b) *Circuit in forced release state (transmission forced release signal in backward direction)*

Transition of interruption control to alarm causes locking of the receiving unit in its position, i.e. the tone-on condition. The procedures are similar to those in the position ‘‘clear-back state’’ in the specifications of the analogue version of the line signalling, Recommendation Q.416, § 2.4.2.2 b).

LINE SIGNALLING (DIGITAL VERSION) WITH METERING

1 Introduction

Signalling System R2 line signalling, digital version, is a line signalling system for use over digital line transmission equipment conforming to Recommendation G.732.

For many national applications it is desirable that the digital version has additional line signals available to enable the charging of calls.

This supplement proposes possible solutions to provide for charging of calls, namely the provision of a meter signal and a forced release signal.

2 Signal codes

The signalling codes are given in the Table 1 below.

H.T. [A/T1]
TABLE 1

State of the circuit	Signalling Code			
	Forward		Backward	a f
Idle/released	1	0	or 1	or 0
Seized	0	0	or 1	or 0
Seizure acknowledged	0	0	or 1	or 1
Answered/meter	0	0	or 0	or 1
Meter/seizure acknowledged	0	0	or 1	or 1
Clear-forward	1	0	or 0	or 1
			or 1	or 1
			or 0	or 0
Forced release	0	0	or 0	or 0
Blocked	1	0	or 1	or 1

Table [A/T1], p.

3 Choice of meter codes

Some line signalling systems indicate a meter pulse by a signal identical to a ‘‘pulsed clear-back’’, signal. In this circumstance for ease of signal conversion $a_b = 1$, $b_b = 1$, which normally indicates clear-back, may be used to represent a meter pulse. Other signalling schemes however use a ‘‘pulsed answer’’ signal to indicate a meter pulse. In this circumstance $a_b = 0$, $b_b = 1$ may be used to represent a meter pulse.

4 Clauses for exchange line signalling equipment

4.1 *Normal operating conditions*

The following operating conditions apply in addition to those described in Recommendation Q.422.

4.1.1 *Meter:* | etering signals are pulse type signals transmitted backwards during the conversation from the call charging point to the subscriber's call meter in the originating exchange.

In the case of ‘‘pulsed clear-back’’ meter pulses, a pulse is indicated by a change from the answer ($a_b = 0$, $b_b = 1$) signal to an $a_b = 1$, $b_b = 1$ signal and then a change back to $a_b = 0$, $b_b = 1$. To avoid confusion between meter pulses and clear-back the use of clear-back is not allowed.

In the case of ‘‘pulsed answer’’ meter pulses, a pulse is indicated by a change of $a_b = 1$, $b_b = 1$ to $a_b = 0$, $b_b = 1$ and back to $a_b = 1$, $b_b = 1$. The first pulse indicates answer, it may also indicate a meter pulse. A clear-back signal is not provided.

Meter pulses must be longer than 30 ms to ensure recognition at the outgoing end.

4.1.2 *Forced release:* | rior to answer and after a period defined by the Administration concerned for national traffic and according to Recommendation Q.118 for international traffic, the charge controlling exchange transmits the forced release signal to the preceding exchange and clears forward the succeeding part of the connection. When the called subscriber clears at the end of a call, the exchange which controls call charging will receive the clear-back signal from the called subscriber’s end. If the calling subscriber does not clear within a period defined for national traffic by the Administration concerned and for international traffic according to Recommendation Q.118, the charge controlling exchange stops metering, transmits the forced release signal to the preceding exchange and clears forward the succeeding part of the connection. A forced release signal is indicated by a change to $a_b = 0$, $b_b = 0$.

On recognition of forced release in a preceding exchange the connection is released, the forced release signal repeated to any other preceding exchanges, and a clear forward signal sent on the link. The succeeding exchange, on receipt of the clear forward, returns an idle signal and returns the link to the idle state.

Figure 1 shows line signals for a sequence of meter pulses followed by forced release in the case of ‘‘pulsed clear-back’’ meter pulses.

4.2 *Actions appropriate to various signalling conditions*

Tables 2 and 3 indicate the states appropriate to each signalling code recognized and the actions to be taken at the outgoing and incoming ends respectively.

Figure 1, p.15

H.T. [A/T2]
TABLE 2
Outgoing end

{		Received code a b = 0, b b = 0	a b = 0, b b = 1	a b = 1, b b = 0	a b =
Idle/released	a f = 1, b f = 0	Abnormal, see Note 1	Abnormal, see Note 1	Idle	E
Seized	a f = 0, b f = 0	Abnormal, see Note 2	Abnormal, see Note 2	Seized, see Note 2	Seizure
Seizure acknowledged	a f = 0, b f = 0	Forced release	Answered/ meter	Abnormal, see Note 3	Seizure
{ Answered[a]/meter[b] }	a f = 0, b f = 0	Forced release	Answered/ meter	Abnormal, see Note 4	Meter/seizu
{ Meter[a]/seizure acknowledged[b] }	a f = 0, b f = 0	Forced release	Answered/ meter	Abnormal, see Note 4	Meter/seizu
Forced release	a f = 0, b f = 0	Forced release, see Note 5	Abnormal, see Note 5	Abnormal, see Note 5	Abnorm
Clear-forward	a f = 1, b f = 0	Clear-forward	Clear-forward	Released = Idle	Clea
Blocked	a f = 1, b f = 0	Abnormal, see Note 1	Abnormal, see Note 1	Idle	E

[a] Used for ‘‘pulsed clear-back’’ meter pulses.

[b] Used for ‘‘pulsed answer’’ meter pulses.

Note 1 — In these conditions the outgoing end must prevent a new seizure of the circuit. A delayed alarm should also be given.

Note 2 — Non-recognition of the seizing acknowledgement signal 100-200 ms after sending the seizing signal on a terrestrial link or 1-2 seconds after sending the seizing signal on a satellite link results in an alarm and either congestion information being sent backward or a repeat attempt being made to set up the call. The outgoing end must prevent a new seizure of the circuit. When the seizure acknowledgement signal is recognized after the time-out period has elapsed, the clear-forward signal must be sent.

Note 3 — Receipt of a b = 1, b b = 0 by the outgoing switching equipment for 1-2 seconds after recognition of the seizing acknowledgement signal and prior to recognition of the answer signal, results in an alarm and either congestion information being sent backward or a repeat attempt being made to set up the call. The outgoing end must prevent new seizures of the circuit. When b b reverts to 1 after the 1-2 seconds time-out period has elapsed, the clear-forward signal must be sent.

Note 4 — In the case of recognition of a b = 1, b b = 0 whilst in the answered state, immediate action is not necessary. On receipt of clearing from the preceding link, the clear-forward signal (a f = 1, b f = 0) must not be sent until b b is restored to 1. A delayed alarm should also be given.

Note 5 — After forced release is recognized, the outgoing switching equipment must be released and then the idle signal (a f = 1, b f = 0) sent on the link. The outgoing end must prevent a new seizure on the circuit until the link returns to the idle state upon reception of a b = 1, b b = 0. The forced release signal must be sent on the preceding link (if any).

Tableau [A/T2], p.16

Blanc

H.T. [A/T3]

TABLE 3

Incoming end

{		Received code a f = 0, b f = 0	a f = 0, b f = 1	a f = 1, b f =
Idle/released	a b = 1, b b = 0	Seized	Fault, see Note 1	Idle
Seizure acknowledged	a b = 1, b b = 1	Seizure acknowledged	Fault, see Note 2	Clear-forwa

{
Answered | ua)/meter | ub)
}
	a b = 0, b b = 1	Answered/ meter	Fault, see Note 3	Clear-forwa

{
Meter | ua)/seizure acknowledged | ub)
}
	a b = 1, b b = 1	Meter/seizure acknowledged	Fault, see Note 3	Clear-forwa

Forced release	a b = 0, b b = 0	Forced release	Fault, see Note 8	Clear-forward se
Clear-forward a b = 0, b b = 1 or a b = 1, b b = 1 }	{ Abnormal seized see Note 7	Fault, see Note 7	Clear-forward see Note 7	Fault, see No
Blocked	a b = 1, b b = 1	Abnormal seized see Note 5	Fault, see Note 6	Blocked

a) Used for ‘‘pulsed clear-back’’ meter pulses.

b) Used for ‘‘pulsed answer’’ meter pulses.

Note 1 — When in the idle/released state b f changes to 1, b b must be changed to 1.

Note 2 — In these cases a timeout device is started which after a certain interval clears the connection beyond the faulty circuit: this timing arrangement may be the one specified in Recommendation Q.118, § 4.3.3. If the answer signal is recognized during the timeout delay, the timer is stopped but the answer signal is not sent on the preceding link until recognition of a f = 0, b f = 0. If the clear-back signal is recognized while the fault persists, the connection beyond the faulty circuit must be released immediately. Additionally, when the incoming register has not started to send the last backward signal, the rapid release procedure described in Note 5 may be used.

Note 3 — In these cases no action is taken until the forced release signal or the clear-back signal (if the exchange is the call metering control point) is recognized, at which stage the connection beyond the faulty circuit is immediately released and the forced release signal sent to the preceding exchange.

Note 4 — After a f = 1, b f = 0 is recognized, the circuit is returned to the idle state by sending a b = 1, b b = 0.

Note 5 — In this case, immediate action is not necessary. However, rapid release of the circuit should occur if the incoming end simulates answer by sending a b = 0, b b = 1.

Note 6 — Under these conditions no action is taken.

Note 7 — After clear-forward signal is recognized and until the code a b = 1, b b = 0 is sent, all transitions in the forward direction shall be ignored.

Note 8 — The circuit is kept in the forced release state until a f = 1, b f = 0 is recognized.

Tableau [A/T3], p.17

Blanc

5 Protection against the effects of faulty transmission

5.1 *Introduction*

When faulty transmission conditions in PCM systems are detected both PCM terminals apply the state corresponding to state 1 on the PCM line on each ‘‘receive’’ signalling channel at the interface with the switching equipment, as indicated in Table 4 of Recommendation G.732. In this way the incoming switching equipment receives the equivalent $a_f = 1$, $b_f = 1$ on the PCM line and the outgoing switching equipment receives the equivalent of $a_b = 1$, $b_b = 1$.

5.2 *Incoming switching equipment*

At the incoming end a PCM fault results in $a_f = 1$, $b_f = 1$: so this fault can be identified and appropriate actions according to Table 3 can be taken.

5.3 *Outgoing switching equipment*

At the outgoing end a PCM fault results in $a_b = 1$, $b_b = 1$.

Two cases are to be considered:

a) Meter pulses are indicated by $a_b = 0$, $b_b = 1$

A fault results, as it is stated in Table 2, in a blocked state or seizure acknowledged state. This means that all circuits in the idle state of a faulty PCM multiplex will be blocked and that seized circuits will go to or remain in the seizure acknowledged state.

b) Meter pulses are indicated by $a_b = 1$, $b_b = 1$

A PCM fault will result in the recognition of a meter pulse each time a failure appears. To avoid this recognition, the outgoing switching equipment must handle the service alarm information given by the PCM terminal equipment in a separate way.

When the outgoing switching equipment detects a service alarm information it must block the detection of signalling transitions to avoid recognition of erroneous signalling codes caused by the failure.

The reception of a clear-forward signal on the preceding link or the detection of the calling subscriber’s release will cause, after the end of the PCM failure, the sending of a clear-forward signal on the succeeding part of the connection.

6 Bothway working

The additions described in this contribution do not affect the suitability of the digital version for bothway use.

Supplement No. 7

SEMI-COMPELLED AND NON-COMPELLED MULTIFREQUENCY INTERREGISTER SIGNALLING FOR NATIONAL SATELLITE APPLICATIONS BASED ON SYSTEM R2

INTERREGISTER SIGNALLING

1 Introduction

1.1 The Semi-Compelled and Non-Compelled Multifrequency Signallings, herein specified and based on Signalling System R2 (Fully-Compelled Signalling), make use of a pulse signal sending procedure and are supposed to increase signalling speed on national satellite circuits. Their application is restricted to those cases in which the consequences of increased propagation times over Fully-Compelled Signalling may bring about insolvable technical problems for the national network, may make impossible the retention of the information capabilities and facilities provided by that signalling or may make rather expensive the operation of circuits.

This may occur in national networks which have a large number of satellite circuits, e.g. when national satellites are used.

1.2 Parameters related to operation of national networks may be affected by great increase in satellite propagation time, compared with the terrestrial value, such as:

— increase in the holding times of the telecommunications network;

— increase post-dialling delay;

— increased amount of equipment to handle the same traffic and consequently larger space taken up by equipment;

— the maximum capacity of exchanges is reached at lower traffic values.

The negative effect over those parameters implies a loss in service quality and an increase in investments made in national networks.

Better performances may be obtained through the Semi-Compelled Multifrequency Signalling, which speeds up the process of interchange of signals via satellite.

1.3 In some cases, the characteristics of national networks where the features of the Signalling System R2 are fully used may require that the process of interchange of signals via satellite must be still more accelerated so that delays may be kept within certain limits, otherwise those characteristics should be changed. Some of the said characteristics are the following:

— time-out requirements;

— routing plan;

— charging method;

— sending of complete calling subscriber number (total identification of calling subscriber);

— information about called subscriber condition by means of Group B signals, instead of simple Address-Complete signal (signal A-6);

— traffic restriction through analysis of calling subscriber category in destination (Group II signal in acknowledgement to signal A-3).

Relative to the above-mentioned cases, the choice falls on the Non-Compelled Multifrequency Signalling which allows a substantial increase in speed as regards signal interchange.

1.4 Unlike the Fully-Compelled Multifrequency Signalling, the Semi-Compelled and Non-Compelled Signal lings here described permit that, within certain particular limitations, the characteristics, facilities and mode of operation (including network management) already existing in the national networks which use Signalling System R2 may be maintained, making possible the operation of satellite circuits with an information interchange rate similar to that of Signalling System R2 which operates on the terrestrial links.

2 Line signalling

The line signalling to be used together with the Non-Compelled Interregister Signalling must include a Proceed-to-Send signal.

All remaining signals may be used in the original form.

As for digital circuits, line signalling-digital version of Signalling System R2 may be fully used. The seizing acknowledgement signal in this application is used as Proceed-to-Send indication.

A pulsed line signalling which presents an excellent performance over terrestrial or satellite links and can be used with Non-Compelled Signallings is specified in § 4.

3 Interregister signalling

3.1 *General*

The Semi-Compelled and Non-Compelled Multifrequency Signallings here specified basically show the same characteristics and facilities existing in the Fully-Compelled Multifrequency Signalling used with Signalling System R2, except, obviously, the way of sending and receiving MF signals.

This Supplement specifies only the characteristics and facilities which differ from those foreseen in Specifications of Signalling System R2 and the meanings of some signals which are used in a different way from that system.

3.2 *Semi-Compelled Signalling*

3.2.1 *Introduction*

The Semi-Compelled Signalling over satellite links can be usually used in the end-to-end method, between the signalling equipment of the origin of the call and the signalling equipment at the incoming end of the satellite link, as recommended in Specifications of Signalling System R2 except when, for charging or management reasons, the signalling equipment at the outgoing end of the satellite link is not released until the complete setting-up of the call.

The pulsed form of sending backward signals (Groups A and B) is the only difference that such signalling presents in relation to Specifications of Signalling System R2.

3.2.2 *Pulse duration*

As regards backward signals, pulse duration corresponds to 100 ± 20 ms.

3.2.3 *Composition of the Groups of Signals I and II (forward) and A and B (backward) and Meaning of the Signals*

The composition of the Groups of Signals and their respective meanings are thoroughly identical with those foreseen in Signalling System R2, as well as combinations of frequencies which form the various signals.

3.2.4 *Build-up and Time Specifications of a Complete Forward Semi-Compelled Signalling Cycle*

Figure 1 shows in detail the build-up and time sequence of a semi-compelled signalling cycle.

If the values of $T_{int|}$ and $T_{int|}$ lie within certain limits, they do not contribute to the total duration of the semi-compelled signalling cycle, as can be seen from Figure 1. Then, the total duration $T_{S\backslash dC}$ of a complete semi-compelled signalling cycle is given by the formula:

$$T_{SC} = T_{PF} + T_{PB} + \left\{ \begin{matrix} T_{IT\,dRD} + T_{OA} \\ T'_{RD} + T'_{OA} \end{matrix} \right\} + T_{int|} + T_{S1D} + T_{S1A} + T_{P} \text{ or}$$

The subscripts D and A apply respectively to the outgoing and the incoming registers.

Considering the values established in Recommendation Q.457, § 4.5.2 and assuming that:

$$T_{S1D} + T_{S1A} = T_{S1} + T_{S2} \text{ and } T_P = 100 \pm 20 \text{ ms,}$$

the probable extreme values of the semi-compelled signalling cycle $T_{S\backslash dC}$ would be:

$$620 \text{ ms} \;\; T_{\mathrm{S\backslash dC}} \; 840 \text{ ms}$$

3.2.5 *Call routing procedures*

Whenever technically feasible, the overlap method may be used for call routing.

The Semi-Compelled Signalling is applied just like the Fully-Compelled Signalling (System R2), though there are minor restrictions towards its use on satellite channels.

3.2.6 *Other characteristics of the Semi-Compelled Signalling*

As concerns other characteristics related with the signalling (Multi-frequency Signalling Equipment, Time and Transmission Requirements, etc.), Specifications of Signalling System R2 are applicable.

3.3 *Non-Compelled Signalling*

3.3.1 *Introduction*

The Non-Compelled Signalling over satellite links is used in the link-by-link method between signalling equipment correspondent to the outgoing and incoming ends of the satellite link.

The basic differences that such signalling shows in relation to Specifications of Signalling System R2 are the way of sending signals in both directions (those forward and backward signals are sent in the form of pulses) and the non-existence of Group A of Signalling System R2.

3.3.2 *Pulse duration and minimum pulse interval*

Pulse duration corresponds to 100 ± 20 ms for both forward and backward signals.

The minimum interval between two consecutive forward pulses is 100 ± 20 ms.

3.3.3 *Composition of the Groups of Signals (I, II and B) and Meaning of the Signals*

3.3.3.1 *General*

The Non-Compelled Signalling is composed of the Groups of Signals I and II (forward signals) and B (backward signals) correspondent to the same Groups as those of Signalling System R2.

The Group A of backward signals of Signalling System R2 is unnecessary by the following reasons:

— The signalling equipment at the incoming end of the satellite link operates as storage point for information coming from the origin and operates without sending via satellite the signals A-1, A-2, A-3, A-5, A-7, A-8, A-11, A-12, A-13 and A-14.

— The meaning of signal A-4 is transferred to Signal B-9 (spare for national use in the Fully-Compelled Signalling System R2).

— The use of signal A-6 is not required. Signals of Group B can be used. In case it is necessary to use the meaning of A-6, it can be allocated to Signal B-10 (spare for national use in the Fully-Compelled Signalling System R2).

— Signals A-9 and A-10 are spare for national use in the Fully-Compelled Signalling System R2.

The Groups of Signals I, II and B maintain the same structure (including the same frequency combinations) as that used in the Fully-Compelled Signalling System R2, using the same signalling senders and receivers.

Some modifications, exclusions or inclusions in the meaning of some signals in relation to the Fully-Compelled Signalling System R2 allow the Non-Compelled Signalling the following facilities:

— Sending of category and number of calling subscriber, through positioning of Signals I-12 and I-15 respectively before and after the sending of this complete information. Category information can be transmitted only through that same procedure. Such a method for sending the calling subscriber category and number by means of Signals I-12 and I-15 is carried out in a predetermined sequence between two successive digits of the transmission of the called subscriber number.

3.3.3.2 *Meaning of the signals for national use*

Only the signals which have shown some variation in relation to their usual meanings in the Fully-Compelled Signalling System R2 are presented next.

3.3.3.2.1 *Group I forward signals*

I-12 It indicates that only the category or the category and the number of the calling subscriber will follow.

I-13 a) Test call indicator.

b) Access to test equipment (code 13).

Both a) and b) have the same meanings as those of the Fully-Compelled Signalling System R2. The meaning ‘‘Satellite Link not Included’’ was deleted.

3.3.3.2.2 *Group B backward signals*

B-9 Congestion in the national network (before changeover from Group A signals to Group B signals in the Fully-Compelled Signalling System R2) or if time-out in the signalling equipment at the destination end of the satellite link has occurred.

B-10 Address-complete, charge, set-up speech conditions (only if destination equipment of the national network cannot send the usual end-of-selection signals).

3.3.4 *Configurations of the signalling network*

The Non-Compelled Signalling may be basically used:

a) Between the Signalling Equipment of two Switching Exchanges (Translation Points coincide with Switching Points).

Signalling equipment of switching exchanges located at both ends of the satellite links must be able to send and receive Non-Compelled Signalling, as illustrated in Figure 2.

For that configuration, adequate functional changes are required in the signalling equipment of those switching exchanges.

b) Between Signalling Translation Equipment separated from the Switching Exchanges (Translation Points do not coincide with Switching Points).

Signalling Translation Equipment is independent of signalling equipment of switching exchanges. It may be installed near those exchanges or in separate places, as illustrated in Figure 3.

For that configuration, there is not any change in any equipment of the national network, and the introduction of signalling translators may be carried out just through the simple interconnection with distribution frames.

Note — A combined solution is also possible.

3.3.5 *Call routing procedures*

3.3.5.1 *Relative to the starting point*

There are no restrictions for applying the overlap method when using the Non-Compelled Signalling.

There are two main kinds of calls:

a) Calls for subscribers from a national (or international) numbering area different from that of the calling subscriber.

The national (or international) prefix and code are to be dialled.

b) Calls for subscribers from the same numbering area as that of the calling subscriber.

The national (or international) prefix and code are not to be dialled, but only the subscriber number.

In both cases a) and b), the starting point at the Signalling Translation Point at the outgoing end of the satellite link occurs after reception of the sufficient number of digits to route the call.

If configuration presented in § 3.3.4 b) (Signalling Translation Equipment separated from the Switching Exchanges) is adopted, signals may be sent forward as soon as they are received by the Signalling Translation Equipment at the Signalling Translation Point.

3.3.5.2 *Relative to the sending sequence of Group I and II forward signals*

The main cases concerning the sending sequence of non-compelled signals are the following:

a) Calls with complete identification of the calling subscriber number (i.e. for centralized toll ticketing).

After reception of a sufficient number of digits of the called subscriber number to route the call, they may be sent *en bloc* . Then, there is the sending of category and number of calling subscriber, which are preceded and followed by signals I-12 and I-15, respectively. Such signals can also be sent *en bloc* if it does not contribute to delay routing procedures. After reception of signal I-15, the digits of the called subscriber number continue to be sent so far as they are dialled and available for sending (overlap method).

A scheme corresponding to national calls is shown in Figure 4.

b) Calls without complete identification of the calling subscriber number.

After reception of a sufficient number of digits of the called subscriber number to route the call, they may be sent *en bloc* . Then, there is the sending of the calling subscriber category, which is preceded and followed by Signals I-12 and I-15, respectively. Such signals can also be sent *en bloc* . After reception of Signal I-15, the digits of the called subscriber number continue to be sent so far as they are dialled and available for sending (overlap method).

The scheme corresponding to that kind of call is identical with that shown in Figure 4, however, without the signals corresponding to the calling subscriber number (ID N_j).

Note — As for international calls, the sending sequence begins with the international prefix, which is followed by the sufficient number of digits of the international number of the called subscriber to route the call. The remaining sequence is also similar to that used for national calls in Items a) and b) above.

When configuration presented in § 3.3.4 b) (Signalling Translation Equipment separated from the Switching Exchanges) is adopted, signals may be sent forward as soon as they are received by the Signalling Translation Equipment at the Signalling Translation Point, although the relative position for sending the calling subscriber identification (between two determined digits of called subscriber number) may be at any fixed point.

If the procedures for sending forward signals are defined for each different type of call, a check towards reception of forward signals may be made by the Signalling Equipment at the destination end of the satellite link by simply counting the signals received. Signals I-12 and I-15 serve as reference points.

3.3.5.3 *Relative to the sending of Group B backward signals*

A Group B backward signal may be sent at any time during the period for sending of Group I and II forward signals provided that there is a condition which must require interruption of the call setting-up process, such as time-out or congestion at any point of the national or international network and non-existent national or international code or non-existent exchange prefix.

3.3.6 *Operational procedures of the system*

3.3.6.1 *Introduction*

The Non-Compelled Signalling, based on the Signalling System R2, is conceived for the purpose of making possible retention of the mode of operation, facilities and other characteristics of a national network, which uses the Signalling System R2, after introduction of telephone satellite communications on a large scale. Modifications necessary for operation on satellite links must be restricted only to equipment connected with the involved links so as to avoid any undesirable effect on the remaining system.

The use of the Non-Compelled Signalling requires modifications only in the equipment connected with satellite links [§ 3.3.4 a)]. Besides, a solution which will not interfere at all in the existing equipment may be also adopted [§ 3.3.4 b)].

3.3.6.2 *Interface procedures at the signalling translation points*

Figure 5 shows the most general case concerning setting-up of a call via satellite by means of the Non-Compelled Signalling in a national network which operates with the Signalling System R2 and using configuration of § 3.3.4 a).

The signalling equipment which precedes the Signalling Translation Point at the outgoing end of the satellite link will operate with the end-to-end method up to this point, at which the Fully-Compelled Signalling will be converted into the Non-Compelled Signalling.

The inverse conversion, that is, from the Non-Compelled Signalling to the Fully-Compelled Signalling, will be performed at the Signalling Translation Point at the incoming end of the satellite link, from which signalling will become fully-Compelled using the end-to-end method.

The procedures carried out towards call setting-up by using the Non-Compelled Signalling are basically the following for national calls:

The Signalling Translation Point at the outgoing end of the satellite link receives the sufficient number of digits to route the call ($ON_1 \ldots N_i$) and then starts (starting point) the procedures for sending those digits forward in the form of pulses (it sends the Seizure signal and receives the Proceed-to-Send signal) and it sends digits from 0 to N_i. The sending sequence continues through the sending of Signal I-12, which determines the beginning of transmission of the category (CAT) and number (ID N_j) of the calling subscriber. Signal I-15 follows after the sending of the last digit of that subscriber number. Then, the sending of the digits of the called subscriber number ($\ldots N_K \ldots$) succeeds up to the last digit (N_L).

The Signalling Translation Point at the outgoing end of the satellite link starts call routing immediately after receiving the sufficient number of digits, thus establishing a process of signalling with subsequent signalling equipment in the end-to-end method up to reception of Signal A-3 and an End-of-Selection signal (Group B Signal). At that moment, that last signal is repeated backward in the form of pulse up to the Signalling Translation Point at the outgoing end of the satellite link. The final signal interchange is carried out between that point and the preceding signalling equipment (A-3, CAT, B) and then the speech path is set up.

If there is no need to send the calling subscriber number, only the category is sent forward and Signals I-12 and I-15 are maintainted before and after the sending of that calling subscriber category, which is used by the Signalling Translation Point at the destination end in acknowledgement to Signal A-3 at the end of the call setting-up procedure.

The signalling process may be interrupted at any time by a Group B signal, as explained in § 3.3.5.3.

Note — As for international calls, procedures include receiving of international prefix and international code, but they are similar to those used for national calls.

If configuration presented in § 3.3.4 b) (Signalling Translation Equipment separated from the Switching Exchanges) is adopted, signals in both outgoing and incoming Signalling Translation Equipment at the Signalling Translation Points may be sent forward as soon as they are received by Signalling Translation Equipment.

3.3.7 *Multifrequency signalling equipment*

Recommendations for Signalling System R2 other than for exclusive use in Fully-Compelled Signalling are applicable to Non-Compelled Signalling. Thus, the requirements related to transmission and to the sending and receiving parts of the multifrequency equipment may be applied to that signalling. The same signal senders and receivers specified for Signalling System R2 may be used.

The use of such signal senders and receivers avoids the development of new equipment, and they will operate easily in relation to their sending and receiving characteristics, taking into consideration that they have been dimensioned for end-to-end operation, but with Non-Compelled Signalling they operate link-by-link.

3.3.8 *Time requirements*

3.3.8.1 *General*

As Non-Compelled Signalling is performed to operate between two signalling points inserted in a multi-point signalling network using Signalling System R2, time requirements should be compatible with the specifications for this system.

3.3.8.2 *Time-out conditions*

a) In the signalling equipment at the outgoing end of the satellite link, the time-out delay between the Seizing signal and the sending of the first forward interregister signal and between the sending of each two subsequent forward interregister signals until the reception of the Group B signal should not be less than 24 s.

b) In the signalling equipment at the incoming end of the satellite link, the time-out delay between the sending of the Proceed-to-Send signal and the reception of the first forward interregister signal and between the reception of each two subsequent forward interregister signals until the sending of the Group B signal should not be less than 24 s.

4 Pulsed line signalling

4.1 *Introduction*

The line signalling herein presented and foreseen to be used in FDM carrier circuits is a pulsed, high level, out-of-band signalling which operates link-by-link. It may also be used on PCM systems (with channel-associated signalling).

4.2 *Description of the signals*

4.2.1 *Seizure Signal* — It is a signal which is sent forward, from the outgoing junctor, in order to drive the associate incoming junctor to the seizure condition.

4.2.2 *Proceed-to-Send Signal* — It is a signal which is sent backward, from the incoming junctor to the associate outgoing junctor, in order to indicate that a destination interregister signalling equipment has been already seized and that interregister signalling may start.

4.2.3 *Answer Signal* — It is a signal which is sent backward, from the incoming junctor to the associate outgoing junctor, so as to indicate that the called subscriber has answered.

4.2.4 *Clear Back Signal* — It is a signal which is sent backward, from the incoming junctor to the associate outgoing junctor, so as to indicate that the called subscriber has hung up or that a similar operation has occurred.

4.2.5 *Clear Forward Signal* — It is a signal which is sent forward, from the outgoing junctor to the associate incoming junctor, in order to release the equipment involved in the connection.

4.2.6 *Release Guard Signal* — It is a signal which is sent backward, from the incoming junctor to the associate outgoing junctor, in response to a Clear Forward signal, so as to indicate that the release of equipment associated to the incoming junctor has occurred.

4.2.7 *Forced Release Signal* — It is a signal which substitutes, after time-out, the Clear Back signal at a charging point. With reception of Forced Release signal, the speech path is immediately opened.

4.2.8 *Multimetering Signal* — It is a signal which is sent backward, from the incoming junctor to the associate outgoing junctor, according to the cadence corresponding to the charging rate, as from the multimetering charging point.

4.2.9 *Call-Back Signal* — It is a signal which is sent forward, from the outgoing junctor to the associate incoming junctor, when an operator wants to call back the called subscriber (or another operator) after he has hung up.

4.2.10 *Blocking Signal* — It is a signal which is sent backward, from the incoming junctor to the associate outgoing junctor, by means of a manual or automatic procedure, in order to indicate that the circuit or a group of circuits is blocked.

Taking into consideration the transmission level, the duration of the signal and the conventional load in satellite circuits, its use must be avoided when the number of telephone circuits is large in relation to the total number of circuits of the route. In this case, when there is blocking, the line signalling system itself already foresees procedures that can prevent successive losses of calls, as described in § 4.6.1.

4.3 *Characteristics of the signals*

4.3.1 *Duration of the signals*

Line signals show the following durations:

H.T. [B/T1]
TABLE 1
Pulsed Line Signals
Sending Times and Tolerances

Signal	{ Sending tolerances (ms) Forward	Backward	
Seizure	150		± 30
Proceed-to-send		150	± 30
Answer or re-answer		150	± 30
Multimetering		150	± 30
Call-back	150		± 30
Clear-forward	600		±120
Clear-back		600	±120
Release guard		600	±120
Forced release		600	±120
Blocking		continuous	{
— a) Short signal: 150 ms Long signal: 600 ms }			

Table [B/T1], p.

4.3.2 *Recognition times of the signals*

Recognition times of the signals are presented in Table 2 and they take into account time distortions introduced by transmission equipment and tolerances of switching equipment which adopts the conventional electromechanical technology.

H.T. [B/T2]

TABLE 2

Pulsed Line Signals

Recognition Times and Tolerances

Signal	Nominal recognition time (ms)	Receiving tolerances (ms)
Short	80	± 20
Long	375	± 75

Table [B/T2], p.

a) The recognition time of short signals ranges from 80 ± 20 ms to 375 ± 75 ms. Any received signal with duration between 100 ms and 300 ms will be necessarily recognized as a short signal.

b) The recognition time of long signals corresponds to 375 ± 75 ms. Any received signal with duration superior to 450 ms will be necessarily recognized as a long signal.

c) The received signals with duration between 300 ms and 450 ms may be recognized as long or short signals, depending on the adjustment characteristics of the equipment.

d) The receiver ignores interruptions up to 20 ms.

4.3.3 *Minimum interval between signals*

The minimum interval between two consecutive signals must be 240 ms at the transmission end. Distortion may reduce this interval at the receiving end.

4.3.4 *Transmission of signals*

The transmission of signals between the switching equipment and the transmission equipment and vice versa is made by sending a polarity which corresponds to the battery voltage.

4.4 *Transmission characteristics of the line signalling in FDM equipment*

4.4.1 *Signal sender*

The signalling frequency measured at the sending point has a value of 3825 ± 4 Hz.

The send level of the signalling frequency measured at the group distribution frame or an equivalent point must be —5 ± 1 dBm0.

4.4.2 *Signal receiver*

The receiver must recognize as valid signals which lie between 3825 ± 6 Hz.

The receiving levels are determined in accordance with the relative levels of the transmission plans adopted by each Administration.

4.5 *Operational procedure of the system*

4.5.1 When the circuit is idle, there is no signal on the line. The seizure of the outgoing junctor causes the forward sending of a short signal (Seizure signal). This signal causes the seizure of the associate incoming junctor and the seizure of equipment capable of receiving interregister signals.

4.5.2 Immediately after the seizure of equipment for interregister signalling interchange, the incoming junctor sends back a short signal (Proceed-to-Send signal).

4.5.3 When called subscriber answers, a short signal (Answer signal) is sent back, thus causing the start of call charging.

4.5.4 When calling subscriber hangs up, a long signal (Clear Forward signal) is sent forward, thus causing equipment release. After such release, a Release Guard signal is sent back and the circuit comes back to idle condition.

4.5.5 If the called subscriber hangs up first, a Clear Back signal will be sent and then, after time-out at a determined point of the network, there will be the sending of a Clear Forward signal, thus completing the process, as described in § 4.5.4. If another Answer signal appears during the time supervision period, timing will be interrupted and the equipment involved will return to the speech condition. If the calling subscriber hangs up during the time supervision period, the same procedure as that described in § 4.5.4 will occur.

After time-out, the Clear Back signal is replaced by the Forced Release signal between the charging point and the preceding exchange.

Note — When there is coincidence of two signals, the forward signal will always prevail.

4.6 *Behaviour of the system during interruption in transmission*

4.6.1 *Interruption during the Seizure signal*

The Seizure signal does not get to the incoming junctor and therefore there is not its seizure. After time-out, the outgoing junctor sends the Clear Forward signal. As the incoming junctor has not been seized, the Release Guard signal will not be sent. So, time-out in the outgoing junctor occurs and then a maintenance alarm is activated and another Seizure signal is sent, being followed by the Clear Forward signal. Such sequence is repeated at intervals identical with those of the time supervision period of the junctor. After the reset up of the transmission system and the next reception in sequence of the Seizure and Clear Forward signals, the incoming junctor sends the Release Guard signal, thus releasing the outgoing junctor.

4.6.2 *Interruption during the Proceed-to-Send signal*

The Proceed-to-Send signal does not get to the outgoing junctor and therefore interregister signalling does not start. Two cases are possible:

a) After time-out in the signalling equipment at the incoming end of the link, the specific interregister backward signal is sent back. The signalling equipment at the incoming end of the link releases and the outgoing junctor sends forward the Clear Forward signal.

b) After time-out, the signalling equipment at the outgoing end of the link releases and the outgoing junctor sends forward the Clear Forward signal.

4.6.3 *Interruption during the Answer signal*

The Answer signal does not get to the outgoing junctor and the call may be completed even if charging has not started. After time-out in the origin, the Clear Forward signal is sent. The incoming junctor sends the Release Guard signal, thus releasing the outgoing junctor.

4.6.4 *Interruption during the Clear Forward signal*

The Clear Forward signal does not get to the incoming junctor and therefore it cannot send the Release Guard signal. After time-out, a maintenance alarm is activated and the Seizure signal is sent, being followed by the Clear Forward signal. Such sequence is repeated at intervals identical with those of the time supervision period of the outgoing junctor until the Release Guard signal is received.

If there is a short interruption in the transmission system, thus preventing reception of the Clear Forward signal at the incoming junctor and in case the called subscriber will hang up during the time supervision period of the outgoing junctor, the Clear Back signal will be taken as a Release Guard signal and therefore there will be the release in the origin. However, the equipment which has not received the Clear Foward signal will remain set up until it has been requested again and released by another call, which will not be successful.

4.6.5 *Interruption during the Clear Back signal*

The Clear Back signal does not get to the outgoing junctor and the release of the equipment will be dependent on the calling subscriber hang-up.

4.6.6 *Interruption during the Release Guard signal*

The Release Guard signal does not get to the outgoing junctor and, after time-out, the procedure used is the same as that established in § 4.6.4.

4.6.7 *Interruption during the Forced Release signal*

The Forced Release signal does not get to the outgoing junctor and the release of the equipment will be dependent on the calling subscriber hang-up.

Figure 1, p.20

Figure 2, p.21

Figure 3, p.22

Figure 4, p.23

Figure 5, p.24