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YELLOW BOOK

VOLUME VI – FASCICLE VI.5

DIGITAL TRANSIT EXCHANGES FOR NATIONAL AND INTERNATIONAL APPLICATIONS

RECOMMENDATIONS Q.501-Q.507

INTERWORKING OF SIGNALLING SYSTEMS

RECOMMENDATIONS Q.601-Q.685

VIITH PLENARY ASSEMBLY
GENEVA, 10–21 NOVEMBER 1980

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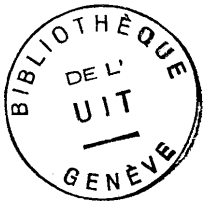

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1) "Telematic services" is used provisionally.

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Interworking of signalling systems

REMARKS

1 The strict observance of the specifications for standardized international signalling and switching equipment is of the utmost importance in the manufacture and operation of the equipment. Hence these specifications are obligatory except where it is explicitly stipulated to the contrary.

The values given in Fascicles VI.1 to VI.6 are imperative and must be met under normal service conditions.

2 The Questions entrusted to each Study Group for the Study Period 1981-1984 can be found in Contribution No. 1 to that Study Group.

CCITT NOTE

In this Fascicle, the expression "Administration" is used for shortness to indicate both a telecommunication Administration and a recognized private operating agency.

PART I

Recommendations Q.501 to Q.507

DIGITAL TRANSIT EXCHANGES FOR NATIONAL AND INTERNATIONAL APPLICATIONS

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INTRODUCTION

1 Application

The Q.500 Series of Recommendations applies to digital transit exchanges for international and national applications.

In cases where there are differences between international and national applications, these are clearly distinguished.

These exchanges may exist in several network configurations. Initially exchanges may not be connected digitally to any other digital exchanges and will exist as digital islands in an analogue environment. As exchanges are commissioned and linked by digital transmission facilities, there will be a merging of islands to form synchronous regions until the mixed analogue/digital network evolves into an Integrated Digital Network (IDN). The IDN is expected to evolve into an Integrated Services Digital Network (ISDN).

Telephony is the main consideration of the Recommendations. However, additional capabilities are considered which will allow the exchange to function as part of the IDN and ISDN as they are currently conceived.

Circuit-to-circuit switched connections and corresponding semi-permanent connections are considered.

2 General objectives

The general objectives of the exchange are:

- to set up and release connections controlled by a signalling system or under man/machine control;
- to perform as specified in Recommendations Q.503 and Q.507;
- to work in harmony as a network element with other exchanges conforming to this Recommendation (international and national transit), digital local and existing analogue exchanges;
- to provide at least a specified minimum of maintenance, and operations and diagnostic information (Recommendations Q.504, 505, 506);
- to be a component of the IDN and to put minimal constraints on the development of the ISDN;
- to act as a node in the timing/synchronization system;
- to work with the CCITT international and other signalling system(s) required by its position in the international or national networks.

Certain other objectives may be optional:

- to control ancillary equipment;
- to provide additional maintenance, operations and diagnostic information for efficient operation of the exchange and associated transmission, signalling, timing and ancillary equipment;
- to provide accounting and/or charging information;
- to provide operator services;
- to act as a timing/synchronization source.

3 Relation of design objectives to recommended performance

Recommendations Q.503 and Q.504 specify the exchange performance to be met and are interpreted as design objectives.

The design objective for a measurable impairment (e.g. tolerance to jitter and wander, bit error ratio, slip rates) in an exchange is its value when the exchange is operating under stated conditions, such as presence or absence of failures, or in stated electrical/physical environments. These environments might be defined by such parameters as power supply voltage, traffic load, temperature, humidity, etc. Some of these parameters may be subject to CCITT Recommendations. For others, Administrations are expected to assign values as required.

BASIC FUNCTIONS

1 General

This Recommendation applies to digital transit exchanges for telephony in Integrated Digital Networks (IDNs) and mixed (analogue/digital) networks. It will form the basis for digital switching in Integrated Services Digital Networks (ISDNs) when other services are integrated with telephony. The field of application of this Recommendation is found in Recommendation Q.501.

The fundamental purpose of a digital transit exchange is circuit switching.

The functions which may be required to fulfil this purpose are described in this Recommendation. There is no intent to describe hardware, software or firmware implementations and no constraint on the design of the functions, either individually or collectively, is implied.

2 Functional arrangements

The functional block diagram, Figure 1/Q.502, is intended only as an aid to comprehension. It is not intentionally a representation of any specific exchange architecture.

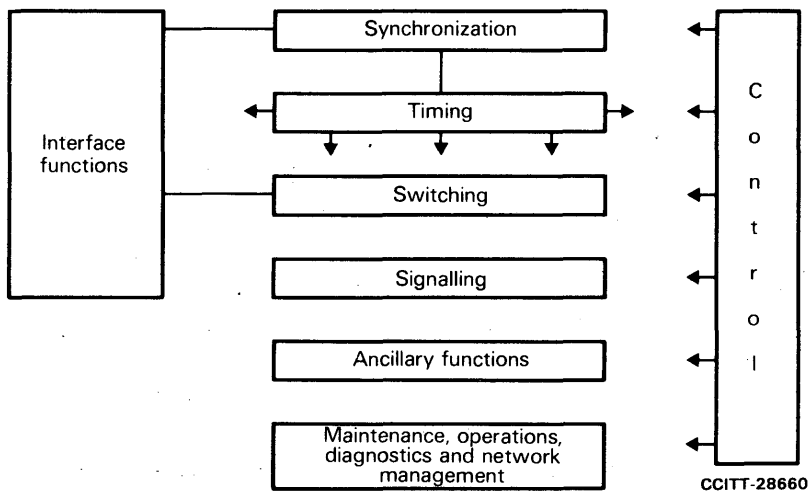


FIGURE 1/Q.502

Functional block diagram of digital transit exchange

3 Interface functions

Interface functions include all functions necessary for interworking with digital and analogue transmission [including Exchange Terminal (ET) functions in Recommendations Q.503 and Q.504].

4 Synchronization

The synchronization function will depend on the international and national synchronization plans and exchange timing arrangements.

Exchanges will usually extract synchronizing information from the incoming bit streams or a separate synchronization network and use this to adjust the timing signals generated and distributed within the exchange.

The exchange at the head of the synchronization hierarchy may contain the national timing source or may be directly slaved from it.

5 Timing

The timing function comprises the generation and distribution of timing signals and includes timing of outgoing signals. It enables the synchronous operation of those parts of the exchange which form the switched path of a connection.

6 Switching

The switching function may involve one or more stages of time and/or space switching, providing a "path" for transmission through the exchange on command of the control function.

For telephony, a "path" will have the external appearance of a bidirectional connection.

7 Signalling

The signalling function includes reception of call related and other information, its translation into information for control and other functions and transfer of information to previous and subsequent exchanges, as required.

The signalling function may involve common channel and/or channel associated signalling.

8 Control

The control function includes initiation, supervision and termination of most actions in the exchange.

Information from all functions is accepted and processed.

Commands are initiated and/or information is passed to the other functions, as required.

Control functions include generation of charging information, running diagnostic routines on its own and other functions and generating traffic and maintenance statistics, if required.

For simplicity, the control function is shown as a single block. The functions may be distributed throughout the exchange.

9 Ancillary functions

The location of these functions is dependent on the function and the exchange configuration. Examples of such functions are:

- echo control,
- application of recorded announcements,
- tone generation,
- access to operator services,
- conferencing.

10 Maintenance, operations, diagnostics and network management

This function involves interfacing between exchanges and operating agencies.

Included may be fault recording and diagnosis, provision of man/machine communication, collection of information concerning the exchange and network operation, accounting, etc.

TECHNICAL PARAMETERS

1 General

This Recommendation applies to digital transit exchanges for telephony in Integrated Digital Networks (IDNs) and mixed (analogue/digital) networks. It will form the basis for digital switching in Integrated Services Digital Networks (ISDNs) when other services are integrated with telephony. The field of application of this Recommendation is found in Recommendation Q.501.

2 Interfaces

Interfaces associated with a digital exchange are shown in Figure 1/Q.503. The transmission/switching boundary in the figure is for specification purposes and does not imply any particular arrangement.

2.1 *Digital environment*

Interfaces A and B are digital interfaces described in Recommendations G.703 [1], G.734 [2], G.735 [3] and G.746 [4]. For 2048-kbit/s systems the preferred solutions are coaxial pairs and symmetrical pairs as described in Table 6/G.703 [5]. For 8448-kbit/s systems the preferred solution is coaxial pairs, as described in Table 8/G.703 [6]. For 1544-kbit/s systems only one solution is described.

2.2 *Analogue environment*

2.2.1 Interfaces C and D are analogue interfaces. Their performance characteristics at audio frequencies are defined in Recommendation G.712 [7]. The muldex is connected to interface A or B as appropriate.

2.2.2 Interface E is a voice-frequency interface. This implies that a PCM codec, connected to this interface, is incorporated in the digital exchange. Voice-frequency connections over the interface E should conform to Recommendation Q.507. The equipment to the right of interface E may include a muldex within the exchange terminal functions.

2.2.3 At interfaces C, D and E both 2-wire and 4-wire interfaces are considered.

2.3 *Other interfaces*

Specifications for other interfaces will be defined when they are identified. For the time being the need for other interfaces has not been identified.

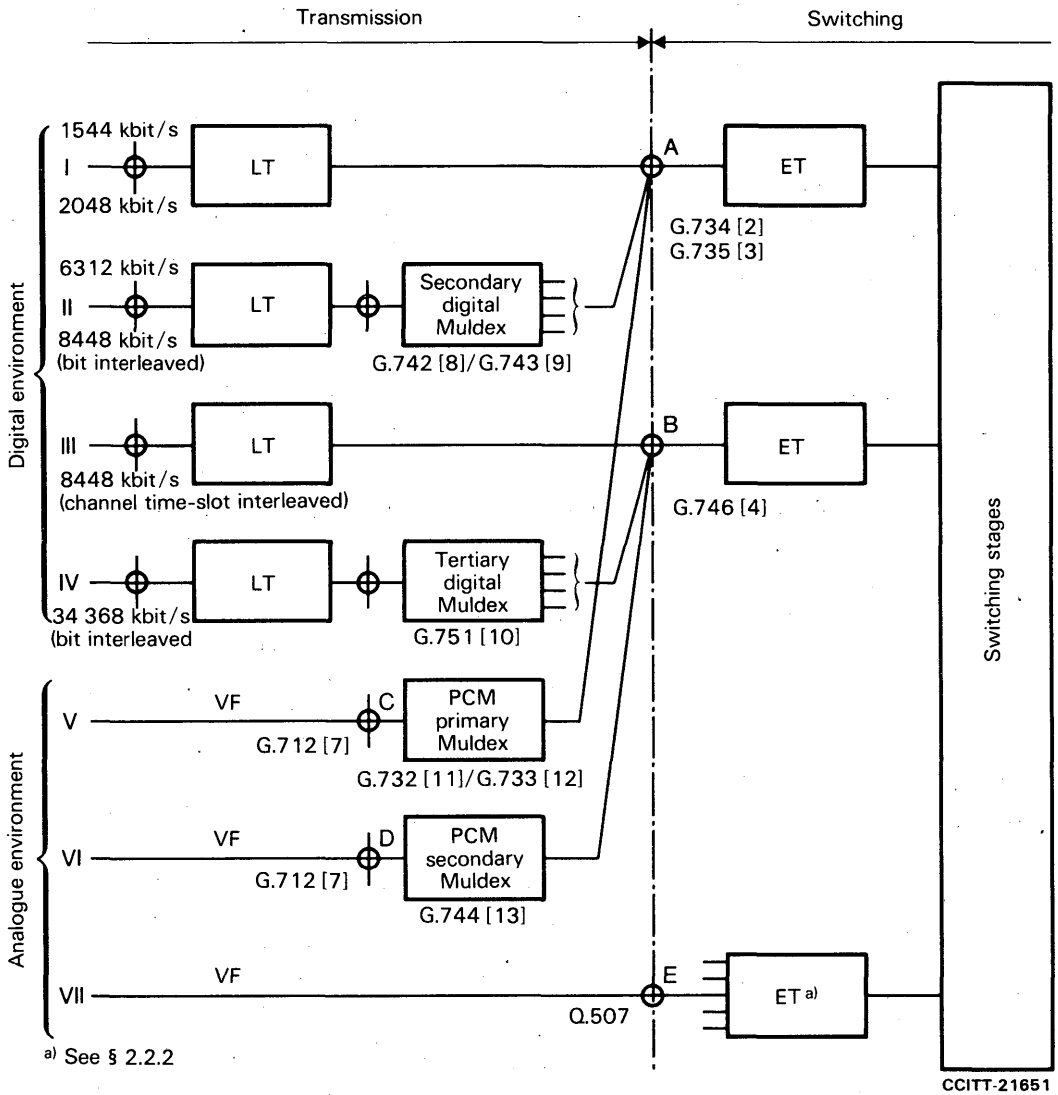
2.4 *Interface characteristics*

2.4.1 *Interface characteristics at interface A*

The characteristics of the multiplex structure and frame structure at interface A are given in Recommendations G.732 [11], G.733 [12], G.734 [2] and G.735 [3].

The main characteristics (taken from these Recommendations) are:

- Nominal bit rate: 2048/1544 kbit/s;
- Number of bits per channel time slot: 8, numbered 1 to 8;
- Number of channel time slots per frame: 32/24, numbered 0-31/1-24;
- Channel time slot assignment (2048 kbit/s systems): channel time slot 0 is used for frame alignment, alarm indication and other purposes.



Note 1 – Other configurations, such as series connection of secondary, tertiary or higher order muldex, may be used.

Note 2 – Examples of functions of Exchange Terminal (ET) – interfaces A & B:
- Signalling insertion and extraction
- Code conversion
- Frame alignment
- Alarms and fault indication

Note 3 – Examples of functions of Exchange Terminal (ET) – interface E:
- A/D conversion
- Signalling insertion and extraction
- Multiplexing
- 2-wire/4-wire conversion

Note 4 – Examples of functions of Line Terminal (LT):
- Power feed
- Fault location
- Regeneration
- Code conversion

FIGURE 1/Q.503

Interfaces associated with a digital exchange

The following extensions to these characteristics are made by this Recommendation:

– In 2048-kbit/s systems, channel time slot 16 is primarily intended for signalling but should be switchable. On systems between exchanges (not involving PCM primary muldex), when channel 16 is not assigned to carry signalling it may be allocated to speech or other services. Time slot 0 is reserved for frame alignment, alarms and network synchronization information.

– In 2048-kbit/s systems, although no specific application is at present foreseen for switching time slot 0, it is recommended that the possibility of read and write access to this time slot should be retained as a safeguard for future requirements. Such access would allow processing of some or all of the information contained in this time slot, in particular those bits reserved for national and international use. The need to switch channel time slot 0 as a normal channel, without special access, requires further study. In any case the incoming frame alignment signal will not be passed through the exchange to an outgoing system.

– Additional signalling capacity. Where more signalling capacity is required between exchanges, additional channel time slots may be utilized for common channel signalling. They should be selected from the channel time slots allocated for data purposes in PCM multiplex equipment according to Recommendation G.737 [14]. When no such channel time slots are allocated or available, additional channel time slots may be selected from channel time slots allocated for voice channels.

– Timing in the transmitting direction will be derived within the digital exchange.

2.4.2 *Interface characteristics at interface B (8448-kbit/s systems)*

The characteristics of the multiplex structure and frame structure at interface B are given in Recommendations G.744 [13] and G.746 [4].

The main characteristics (taken from these Recommendations) are:

– Nominal bit-rate: 8448 kbit/s.

– Frame structure – The frame structure, frame alignment procedures and standard channel time slot assignment will be as defined in G.744 [13]. Where signalling capacity is required between exchanges, time slots 67, 68, 69 and 70 can be utilized for signalling in this order of descending priority. Those channels not used for signalling can be used for speech or other purposes. If a channel time slot is reserved for service purposes within the switch, it shall be channel time slot 1.

– It is left for mutual agreement whether or not channel time slot 1 will carry traffic.

The following extensions to these characteristics are made by this Recommendation:

– Fundamental characteristics – The multiplex structure contains 132 channel time slots, each of 64 kbit/s, of which 128 may carry traffic through the exchange.

– Timing in the transmitting direction will be derived within the exchange.

2.4.3 *Jitter and wander at the exchange input*

Jitter and wander tolerance is the ability of the exchange to accept phase deviations on incoming facilities without introducing slips or errors.

The jitter and wander tolerance mask of Figure 2/Q.503 shall be used to specify jitter and wander at digital interface inputs A and B in Figure 1/Q.503.

Jitter and wander are similar phenomena. At frequencies above f_1 in Figure 2/Q.503 the term "jitter" is used. At frequencies below f_1 the term "wander" is used.

The recommended values for the mask of tolerable sinusoidal peak-to-peak jitter and wander are given in Table 1/Q.503. The values of A_0 and f_0 for 2048-kbit/s and 8448-kbit/s systems and all values for 1544-kbit/s systems are provisional. A_0 approaches the worst case and is recognized as being higher than necessary for some applications.

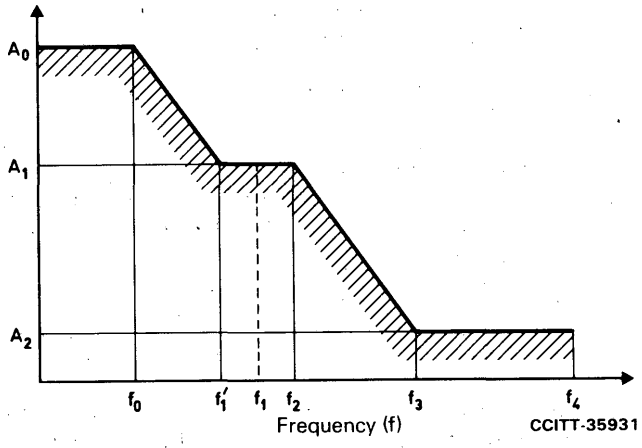


FIGURE 2/Q.503

Mask of tolerable sinusoidal jitter and wander

TABLE 1/Q.503

Values for the mask of tolerable peak-to-peak sinusoidal jitter and wander at the exchange input interfaces

	2048 kbit/s	8448 kbit/s	1544 kbit/s
A_0 (μs)	18	18	18
A_1 (UI)	1.5	1.5	2
A_2 (UI)	0.2	0.2	0.05
f_0 (Hz)	12×10^{-6}	12×10^{-6}	12×10^{-6}
f'_1 (Hz)	see Note 3	see Note 3	see Note 3
f_1 (Hz)	20	20	10
f_2 (Hz)	2.4×10^3	400	200
f_3 (Hz)	18×10^3	3×10^3	8×10^3
f_4 (Hz)	100×10^3	400×10^3	40×10^3

Note 1 – See Figure 2/Q.503.

Note 2 – UI = Unit Interval
For 1544 kbit/s systems 1 UI = 648 ns
For 2048 kbit/s systems 1 UI = 488 ns
For 8448 kbit/s systems 1 UI = 118 ns

Note 3 – The value of f'_1 needs further study.

Note 4 – For interfaces within national networks only, values of f_2 = 93 Hz and f_3 = 700 Hz for 2048 kbit/s interface, and f_2 = 10.7 kHz and f_3 = 80 kHz for 8448 kbit/s interface may be used.

2.4.4 *Time interval error (TIE) at the exchange output*

Time Interval Error (TIE) at the exchange output is defined as the difference in time delay of a given timing signal when compared to a reference timing signal for a given measurement period.

The TIE over any period of time at the output of the standardized digital interfaces should not exceed the limits shown in Figure 3/Q.503 and Table 2/Q.503.

In the case of synchronous operation the limits are specified on the assumption of an ideal synchronizing signal (no jitter, no wander and no frequency deviation) on the line delivering timing information. In the case of asynchronous operation the limits are specified assuming no frequency deviation of the exchange clock (this is equivalent to taking the output of the exchange clock as the reference timing signal for the TIE measurements).

It is recognized that the approach of using TIE to specify the performance of an exchange in the case of synchronous operation in some implementations (e.g. when mutual synchronization methods are used) requires further study.

Any internal operation or rearrangement within the synchronization and timing unit or any other cause should not result in a phase discontinuity greater than 1/8 of a Unit Interval (UI) on the outgoing digital signal from the exchange.

The limits given in Figure 3/Q.503 and in Table 2/Q.503 may be exceeded in cases of infrequent internal testing or rearrangement operations within the exchange. In such cases, the following conditions should be met. The TIE over any period up to 2^{11} UI should not exceed 1/8 of a UI. For periods greater than 2^{11} UI the phase variation for each interval of 2^{11} UI should not exceed 1/8 UI up to a total maximum TIE recommended in Recommendation G.811 [15] for long periods.

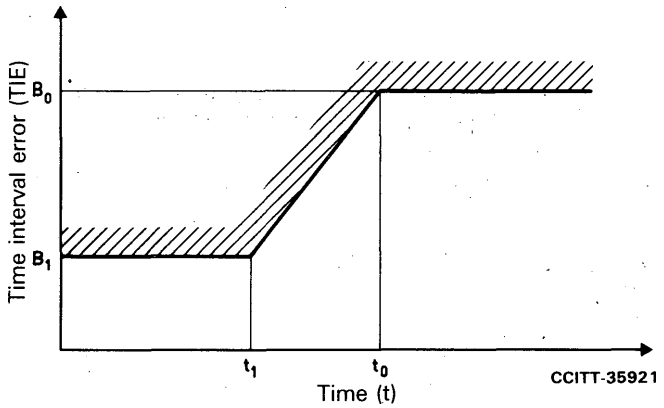


FIGURE 3/Q.503

Limits of peak-to-peak TIE at the exchange output

TABLE 2/Q.503

Values for the mask of peak-to-peak TIE limits at the exchange output interfaces

	2048 kbit/s	8448 kbit/s	1544 kbit/s
B_0 (μs) B_1 (UI) t_1 (s) t_0 (s)	1.0 0.05 100 4000	1.0 0.05 25 4000	see Note

Note – The specification and limits in terms of either jitter and wander or TIE for 1544-kbit/s systems have yet to be established.

2.4.5 *Exchange transfer function - jitter and wander*

The exchange transfer function defines the limits of wander at the output of the exchange relative to wander in the timing information at the input.

It is recognized that the approach of using the exchange transfer function to specify the performance of an exchange is not applicable to all implementations (e.g. when mutual synchronization methods are used).

The exchange transfer mask is similar to that of a lowpass filter with a maximum gain of 0.2 dB, a break point at 0.1 Hz and a slope of 6 dB/octave, as shown in Figure 4/Q.503.

The higher frequency (jitter) portion of the exchange transfer mask is undefined, but must provide significant attenuation above 100 Hz.

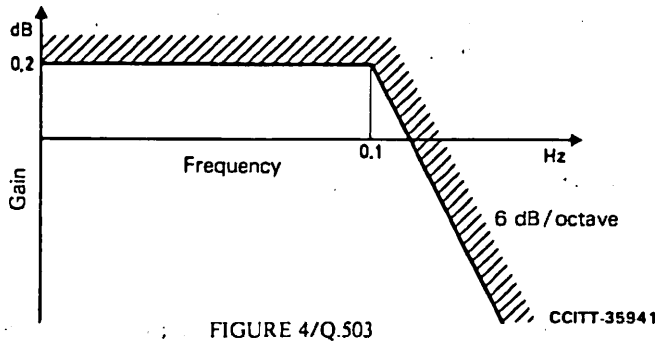


FIGURE 4/Q.503

Exchange transfer mask

2.4.6 *Bit patterns generated by the exchange in idle channel time slots*

At interfaces A and B, the following patterns are recommended for the idle condition where the leftmost digit is the polarity digit.

01111111 for 1544 kbit/s systems

01010100 for 2048 and 8448 kbit/s systems

The patterns should not be used as an indication of the idle or barred condition of a channel since this information should be derived from the control or signalling functions.

3 Timing and synchronization

3.1 *Exchange timing distribution*

The timing distribution system of an exchange will be derived from a highly reliable exchange clock system. The distribution of timing within the exchange must be designed so that the exchange will maintain synchronism on 64-kbit/s channel time slots in a connection through the exchange.

3.2 *Network synchronization*

Within a synchronized IDN, means of synchronizing the exchange clock with other exchange clocks must be provided.

3.2.1 *International interworking*

Plesiochronous operation of international digital links is covered in Recommendation G.811 [15].

3.2.2 *National interworking*

For synchronous or plesiochronous interworking in national networks, different methods of providing timing between exchanges may be used. Synchronized national networks may be provided with exchange clocks not having the frequency accuracy required for international interworking. However when these synchronized networks within national boundaries are required to interwork internationally as part of the international IDN, it will be necessary to provide means to operate these national networks to the internationally recommended value of frequency accuracy in Recommendation G.811 [15]. This corresponds to slip rates in § 3.2.3 below.

3.2.3 *Slip*

The design objective controlled slip rate at a digital exchange within a synchronized region should be zero, provided that jitter and wander remain within the limits given in this Recommendation.

The design objective controlled slip rate at a digital exchange in plesiochronous operation (or operating to another synchronized region) shall be not more than one slip in 70 days in any 64-kbit/s channel, provided that jitter and wander remain within the limits given in this Recommendation.

The requirements for slip rates that occur as a result of temporary loss of timing control and in the case of abnormal conditions are covered in Recommendation Q.504.

The occurrence of a controlled slip should not cause loss of frame alignment.

Note – A synchronized region is defined as a geographic entity normally synchronized to a single source and operating plesiochronously with other synchronized regions. It may be a continent, country, part of a country or countries.

4 Connections through an exchange

4.1 *General*

The characteristics of the connections detailed in § 4 refer to an established connection when it is made available to the users.

An exchange must be able to provide bidirectional connections between input and output interfaces for telephony and other services as required.

A bidirectional connection is a connection in which both directions of transmission are established.

No other types of connection have as yet been agreed.

4.2 *Bit rate of a connection through an exchange*

4.2.1 *Basic bit rate*

The exchange should be able to make connections between channel time slots with the basic bit rate of 64 kbit/s. The channel time slots to be connected are contained in primary or secondary order frame structures appearing at the digital interfaces of the exchange or derived from analogue channels appearing at the analogue interfaces. The coding and performance of these analogue channels is covered in § 2.2.

4.2.2 *Services offered at bit rates less than 64 kbit/s*

Services requiring less than 64 kbit/s for a connection should be switched as 64-kbit/s connections. They should be presented to the exchange as 64-kbit/s channels by digitally filling or by being multiplexed to a 64-kbit/s channel before entering the exchange via a primary or secondary frame structure at the transmission/switching interface. The process by which this is performed is not the subject of this Recommendation. Lower bit rate channels multiplexed into a 64-kbit/s bit stream will be switched as a 64-kbit/s entity.

4.2.3 *Services offered at bit rates requiring more than 64 kbit/s*

Services requiring more than 64 kbit/s for a connection are offered as a multiple of 64-kbit/s connections. They are called multislot connections and referred to as $n \times 64$ kbit/s connections.

It should be noted that an $n \times 64$ kbit/s connection can seriously affect the blocking probability of an exchange and the network, particularly if all n slots are routed in a defined order in the same multiplex. The ability to handle multislot traffic will be influenced by the traffic loading of the exchange at any instant and the number of circuits available on the required route.

All aspects of the provision of a multislot service, both switched and semipermanent, are therefore the subject of further study.

The interim requirements for a multislot service should be satisfied by the establishment of a number of separate semipermanent connections, each of which would be set up to preserve the sequence with the other slots forming the multislot connection. A restriction on the value of n_{max} or on the percentage of multislot connections carried by an exchange is not appropriate until further studies are complete. The n slots forming a semipermanent multislot connection shall all appear in the same multiplex (defined in interface A or B) incoming to the exchange and shall be switched all on the same outgoing multiplex. The channel timeslots received at the output of the exchange may occur in the same frame or the individual timeslots may occur in successive frames.

Note – As this paragraph refers to possible allocation of functions in the IDN, further study is needed.

4.3 *Mode of establishment*

4.3.1 *Switched connections*

Switched connections are set up at any time on demand.

4.3.2 *Semipermanent connections*

The exchange should have the capability of establishing semipermanent connections. Explanation of semipermanent connections:

- Semipermanent connections are carried within PCM multiplexes together with other connections.
- They are normally not set up by subscriber control procedures.
- They are normally not set up during the exchange busy hours.
- They pass through the exchange switching network.
- The grade of service for semipermanent connections may differ from that of switched connections and requires further study.

§ 4.2 also applies to semipermanent connections.

Note – The supervision and re-establishment (if provided) of semipermanent connections in the event of a failure require special arrangements in the exchange.

4.4 *Bit sequence independence*

A limitation should not be imposed by the exchange on the number of consecutive binary ones or zeros or any other binary pattern within the 64-kbit/s path through the exchange.

4.5 *Transmission delay through the exchange*

Recommendation Q.507, § 3 applies except in the case of multislot connections.

4.6 *Error performance*

The design objective long-term mean Bit Error Ratio (BER) for a single pass of a 64-kbit/s connection through an exchange between the digital transmission/switching interfaces should be 1 in 10^9 or better. This corresponds to 99.5% error free minutes assuming that the occurrence of errors has a Poisson distribution.

Note – The operational error performance is specified in Recommendation Q.504, § 2.6.

4.7 *Transmission loss*

For telephony connections, Recommendation Q.507, § 4 applies.

In the case of digital-to-digital 64-kbit/s connections carrying service other than telephony, e.g. data, the requirement of bit integrity being maintained (§ 4.9) is equivalent to a 0 dB loss. For such connections requiring bit integrity, digital loss pads must be disconnected when they are implemented in the exchange.

4.8 *In-call rearrangement*

When in-call rearrangement is provided, it is essential that the recommendations for error performance, quality of service, sequence integrity of multislot connection, etc., be met.

4.9 *Bit integrity*

Bit integrity is said to be maintained when the binary values of bits in an octet at the input of an exchange are exactly reproduced at the output.

Bit integrity will be maintained for nontelephony calls if required.

Note 1 – It is understood that to meet this requirement, digital processing devices such as μ/A law converters, echo suppressors and digital pads must be disabled for nontelephony calls requiring bit integrity. The means of disabling these devices has yet to be determined.

Note 2 – It is understood that bit integrity in an exchange does not preclude the use of bit stealing channel associated signalling systems such as the system used nationally in some 1544-kbit/s networks.

5 Signalling

The exchange should be able to interwork with other exchanges as required using the signalling systems indicated in Recommendations Q.7 [16] and Q.110 [17].

5.1 *Through-connection of signalling channels*

64-kbit/s signalling channels entering the exchange via a multiplex structure may be connected through the exchange as semipermanent channels.

6 Control

The requirements for the control function are implicit in the requirements recommended for the other functions of the exchange.

7 Ancillary functions

7.1 *Connection of ancillary equipment*

Ancillary equipment may be connected in the following ways:

a) Serially. This may require more than one connection through the exchange. Examples of serially connected equipment include:

- encoding law converters,
- echo suppressors,
- manual board access equipment (for operator controlled traffic).

b) As terminal connected equipment usually requiring one connection through the exchange. Examples of such equipment include:

- recorded announcements,
- manual board terminations,
- speech codecs,
- data terminal facilities,
- test equipment (such as test call sender),
- tone generators,
- signalling receivers.

The interface between the exchange and the items of equipment listed above may be left to the national designers. However, the use of internationally standardized interfaces is preferred.

Note – In some cases it may be necessary to establish more than one connection to one timeslot at the same time.

7.2 *Digitally generated tones and frequencies*

When tones and frequencies are digitally generated the following minimum requirements apply on a provisional basis.

7.2.1 *Service tones*

Digitally generated tones should meet the recommended limits specified in Recommendation Q.35 [18] when decoded.

7.2.2 *Signalling frequencies*

Digitally generated signalling frequencies should be such that they can be detected after decoding by any analogue receivers designed to CCITT recommendations.

References

[1] CCITT Recommendation *General aspects of interfaces*, Vol. III, Fascicle III.3, Rec. G.703.

[2] CCITT Recommendation *Characteristics of 2048 kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. G.734.

[3] CCITT Recommendation *Characteristics required to terminate 1544 kbit/s digital paths on a digital exchange*, Vol. III, Fascicle III.3, Rec. G.735.

[4] CCITT Recommendation *Characteristics of 8448 kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. G.746.

[5] CCITT Recommendation *General aspects of interfaces*, Vol. III, Fascicle III.3, Rec. G.703, Table 6/G.703.

[6] *Ibid.*, Table 8/G.703.

[7] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712.

[8] CCITT Recommendation *Second order digital multiplex equipment operating at 8448 kbit/s and using positive justification*, Vol. III, Fascicle III.3, Rec. G.742.

[9] CCITT Recommendation *Second order digital multiplex equipment operating at 6312 kbit/s and using positive justification*, Vol. III, Fascicle III.3, Rec. G.743.

[10] CCITT Recommendation *Digital multiplex equipment operating at the third order bit rate of 34 368 kbit/s and the fourth order bit rate of 139 264 kbit/s and using positive justification*, Vol. III, Fascicle III.3, Rec. G.751.

[11] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732.

[12] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.733.

[13] CCITT Recommendation *Second order PCM multiplex equipment operating at 8448 kbit/s*, Vol. III, Fascicle III.3, Rec. G.744.

[14] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s and offering synchronous 64-kbit/s digital access options*, Vol. III, Fascicle III.3, Rec. G.737.

[15] CCITT Recommendation *Performance of clocks suitable for plesichronous operation of international digital links*, Vol. III, Fascicle III.3, Rec. G.811.

[16] CCITT Recommendation *Signalling systems to be used for international automatic and semi-automatic telephone working*, Vol. VI, Fascicle VI.1, Rec. Q.7.

[17] CCITT Recommendation *General aspects of the utilization of standardized CCITT signalling systems on PCM links*, Vol. VI, Fascicle VI.1, Rec. Q.110.

[18] CCITT Recommendation *Characteristics of the ringing tone, the busy tone, the congestion tone, the special information tone and the warning tone*, Vol. VI, Fascicle VI.1, Rec. Q.35.

PERFORMANCE REQUIREMENTS

1 General

This Recommendation applies to digital transit exchanges for telephony in Integrated Digital Networks (IDNs) and mixed (analogue/digital) networks. It will form the basis for digital switching in Integrated Services Digital Networks (ISDNs) when other services are integrated with telephony. The field of application of this Recommendation is found in Recommendation Q.501.

The parameters specified in this Recommendation are to be applied as design objectives and are not expected to be actual values encountered in different networks. They may be used by Administrations in providing a method for verifying the performance of switching systems under defined conditions. They are also intended to ensure that an exchange will be able to meet international network grade of service requirements when normal engineering and implementation procedures are used.

2 Service performance

2.1 *Reference load conditions*

Reference load conditions used for specifying the service performance design objectives of the exchange are given below. However, further study is required for a more detailed definition of the reference load conditions.

a) *Reference load A*

- 0.7 Erlang average occupancy on all incoming circuits;

$$\text{Call attempts/h} = \frac{0.7 \times \text{Number of incoming circuits}}{\text{Average holding time in hours}}$$

Note – Ineffective call attempts must be included in computing average holding time or added as a separate factor in determining the reference call attempts.

b) *Reference load B*

- 0.8 Erlang average occupancy on all incoming circuits;
- 1.2 times Reference load A call attempts/hr.

The above reference loads are specific load points and are assumed to be applied to exchanges that have been engineered and provisioned to provide the grade of service specified in the E.500 Series of Recommendations. Where signalling system recommendations state requirements for the parameters in this Recommendation, they shall be applied.

2.2 *Blocking probability (within the whole exchange)*

The design objective under "no failure" conditions for internal point-to-point blocking probability (from any inlet to any outlet) including possible limitations in any kind of processing and equipment should not exceed the values in Table 1/Q.504.

The requirements for multislot connections require further study.

The definition of the objectives under failure conditions requires further study.

TABLE 1/Q.504

	Reference load A	Reference load B
Probability	1×10^{-3}	1×10^{-2}

2.3 *Delay probability*

The objectives in § 2.3 are recommended to be met under "no failure" conditions. The definition of the objectives under failure conditions requires further study.

In the following the term "mean value" is understood as the expected value in the statistical sense.

2.3.1 *Incoming response delay*

The incoming response delay of an exchange is a characteristic that is applicable where channel associated signalling is used. It is defined as the interval from the instant an incoming circuit seizure signal is recognized until a proceed-to-send signal is sent backwards by the exchange.

The parameters in Table 2/Q.504 are recommended.

Note – Different call set-up procedures are used with common channel signalling operation and a requirement covering incoming response delay as defined above is not relevant.

TABLE 2/Q.504

	Reference load A	Reference load B
Mean value	⩽ 300 ms	⩽ 400 ms
0.95 probability of not exceeding	400 ms	500 ms

2.3.2 *Exchange call set-up delay*

Call set-up delay of an exchange is defined as the interval from the instant when the digits required for setting up a call are available in the exchange or the address information is received at the incoming signalling data transmission control of the exchange to the instant when the seizing signal is sent to the subsequent exchange or the corresponding address information is sent from the outgoing signalling data transmission control.

The parameters in Table 3/Q.504 are recommended.

Note – Since the exchange will provide connections between circuits that may use either channel associated or common channel signalling system in various combinations, the above requirement applies to all possible combinations. For connections involving the same common channel signalling system the requirement of that signalling system specification should apply.

TABLE 3/Q.504

	Reference load A	Reference load B
Mean value	⩽ 250 ms	⩽ 400 ms
0.95 probability of not exceeding	300 ms	600 ms

2.3.3 *Through-connection delay*

Through-connection delay is the interval from the instant at which the information required for setting up a through-connection in an exchange is available for processing in the exchange to the instant that the switching network through-connection is established and available for carrying traffic between the incoming and outgoing 64-kbit/s circuits.

The exchange through-connection delay does not include an interoffice continuity check if provided but does include a cross office check if one occurs during the defined interval.

When the through-connection in an exchange is not established during the exchange call set-up interval, the through-connection delay may then contribute to the network call set-up delay.

The parameters in Table 4/Q.504 are recommended.

When the through-connection is established as soon as the last digit of the address information required for through-connection is received, then the requirements for call set-up delay apply.

The requirements for multislot connections require further study.

TABLE 4/Q.504

	Reference load A		Reference load B	
	Without ancillary equipment	With ancillary equipment	Without ancillary equipment	With ancillary equipment
Mean value	$\leqslant$ 250 ms	$\leqslant$ 350 ms	$\leqslant$ 300 ms	$\leqslant$ 500 ms
0.95 probability of not exceeding	300 ms	500 ms	400 ms	600 ms

2.3.4 *Exchange call-release delay*

Exchange call-release delay is the interval from the instant at which the last information required for releasing a call in an exchange is available for processing in the exchange to the instant that the switching network through-connection is no longer available between the incoming and outgoing 64-kbit/s circuits and the disconnection signal is sent to the subsequent exchange. This interval does not include the time taken to detect the release signal, which might become significant during certain failure conditions e.g. transmission system failures.

The parameters in Table 5/Q.504 are recommended.

For common channel signalling the relevant signalling system specification should apply.

TABLE 5/Q.504

	Reference load A	Reference load B
Mean value	$\leqslant$ 250 ms	$\leqslant$ 400 ms
0.95 probability of not exceeding	300 ms	600 ms

2.3.5 *Exchange signal-transfer delay*

The exchange shall conform to the appropriate signalling system recommendation as required.

2.4 *Call processing performance*

2.4.1 *64-kbit/s switched connections*

2.4.1.1 *Premature release*

The probability that an exchange malfunction will result in the premature release of an established connection in any one-minute interval should be:

$$P \leqslant 2 \times 10^{-5}.$$

2.4.1.2 *Release failure*

The probability that an exchange malfunction will prevent the required release of a connection should be:

$$P \leqslant 2 \times 10^{-5}.$$

2.4.1.3 *Incorrect charging or accounting*

The probability of a call attempt receiving incorrect charging or accounting treatment due to an exchange malfunction should be:

$$P \leqslant 10^{-4}.$$

2.4.1.4 *Misrouting*

The probability of a call attempt being misrouted following receipt by the exchange of a valid code should be:

$$P \leqslant 10^{-4}.$$

2.4.1.5 *No tone*

The probability of a call attempt encountering no tone following receipt of a valid code by the exchange should be:

$$P \leqslant 10^{-4}.$$

2.4.1.6 *Other failures*

The probability of the exchange causing a call failure for any other reason not identified specifically above should be:

$$P \leqslant 10^{-4}.$$

Note – Some performance objectives such as those for premature release, charging errors etc., probably cannot be measured by the exchange itself and may have to be verified or measured by external means.

2.4.2 *64-kbit/s semipermanent connections*

To be studied, taking into consideration:

- the need to recognize an interruption;
- the probability of an interruption;
- the requirements for re-establishment of interrupted connection;
- any other unique requirements.

2.4.3 *n × 64 kbit/s switched connections*

To be recommended if/when specific services are defined.

2.4.4 *n × 64 kbit/s semipermanent connections*

To be recommended if/when specific services are defined.

2.5 *Transmission performance*

2.5.1 *64-kbit/s switched connections*

The probability of a connection being established with an unacceptable speech path transmission quality across the exchange should be:

$$P(\text{Unacceptable transmission}) \leqslant 10^{-5}.$$

The speech path transmission quality across the exchange is said to be unacceptable when the bit error ratio is above alarm condition.

Note – The alarm condition has yet to be defined.

2.5.2 *64-kbit/s semipermanent connections*

To be recommended.

2.5.3 *n × 64 kbit/s switched connections*

To be recommended if/when specific services are defined.

2.5.4 *n × 64 kbit/s semipermanent connections*

To be recommended if/when specific services are defined.

2.6 *Operational error performance*

The operational bit error ratio should be better than 10^{-6} (provisional value).

Tests should yield a 95% confidence level that this objective is met. The number of measurements in which the measured BER exceeds the objective should not be more than x% over a long-term period, say one month.

Note – The actual percentage will be determined in accordance with Recommendation G.821 [1].

2.7 *Slip rate*

2.7.1 *Normal conditions*

The slip rate under normal conditions is covered in Recommendation Q.503.

2.7.2 *Temporary loss of timing control*

The slip rate resulting from temporary loss of timing control is the subject of further study taking into account the requirements of Recommendation G.822 [2].

2.7.3 *Abnormal conditions at the exchange input*

The slip rate in case of abnormal conditions (wide phase deviations, etc.) at the exchange input is the subject of further study taking into account the requirements of Recommendation G.822 [2].

3 Availability

3.1 *System and subsystem availability*

System and subsystem availability categories and parameters have yet to be determined.

3.2 *Exchange synchronization system*

The operation of the exchange at an acceptable slip rate may be assured by different design approaches. Examples are:

i) provision of a reliable synchronization system with a highly accurate exchange clock; or

ii) provision of a more reliable synchronization system with a less accurate exchange clock relative to i) above.

The relationship between the probability of slip rate occurring, the duration of the occurrence and the corresponding slip rate needs further study. The long-term overall performance should be the same for all design approaches.

4 Service quality assurance functions

4.1 *Fault and alarm detection and consequent actions – exchange terminal function at interfaces A and B*

4.1.1 *Fault detection*

The following fault conditions should be detected:

- failure of local power supply (if practicable),
- loss of incoming signal

  Note – The detection of this fault condition is required only when the fault does not result in an indication of loss of frame alignment.
- loss of frame alignment (see the Recommendations cited in [3], [4] and [5]),
- excessive error rate.

The criteria for activating and deactivating the indication of the fault conditions are given in the Recommendations cited in [6] and [7].

4.1.2 *Alarm detection*

The following alarm indications should be detected:

- alarm indication (remote alarm) received from the remote end,
- Alarm Indication Signal (AIS) for 2048 and 8448-kbit/s systems. The equivalent binary content of the AIS is a continuous stream of binary 1s at 2048 or 8448 kbit/s.

The strategy for detecting the presence of the AIS should be such that the AIS is detectable even in the presence of an error of 1 in 10^3. However, a signal with all bits except the frame alignment in the 1s state should not be mistaken as an AIS.

4.1.3 *Consequent actions*

4.1.3.1 *Generation of alarms*

4.1.3.1.1 *Alarm signals generated for action within the exchange*

- The service alarm indication should be generated to signify that the service is no longer available (see Table 6/Q.504).
- The prompt maintenance alarm indication should be generated to signify that performance is below acceptable standards and that immediate maintenance attention is required locally (see Table 6/Q.504).

4.1.3.1.2 *Alarms transmitted by the exchange*

- Alarm signals sent "upstream" towards the transmission/switching interface. The relevant alarm bits for the remote alarm indication, as recommended in Recommendations G.732 [8], G.733 [9] and G.744 [10], should be effected as soon as possible (see Table 6/Q.504).
- Alarm signals sent "downstream" towards the switching function. The Alarm Indication Signal applied in all received timeslots containing speech, data and/or signalling should be applied as soon as possible and not later than 2 ms after the detection of the fault condition (see Table 6/Q.504).

Note – The terms "upstream" and "downstream" are defined in Recommendation G.704 [11].

4.1.3.2 *Removal of alarm indications*

When all fault conditions have been cleared and the Alarm Indication Signal is no longer received, the Alarm Indication Signal and remote alarm indication should be removed within the same respective time limits as specified under § 4.1.3.1 after the conditions have cleared.

TABLE 6/Q.504

Fault conditions and alarms detected by exchange terminal functions and consequent actions

Fault conditions and alarms detected (see §§ 4.1.1 and 4.1.2)	Consequent actions (see § 4.1.3)			
	Service alarm indication generated	Prompt maintenance alarm indication generated	Alarm indication to remote end generated	AIS towards the switching stages
Failure of power supply	Yes	Yes	Yes, if practicable	Yes, if practicable
Loss of incoming signal	Yes	Yes	Yes	Yes
Loss of frame alignment	Yes	Yes	Yes	Yes
Excessive error ratio	Yes	Yes	Yes	Yes
Alarm indication received from remote end	Yes G. 733 [9]: optional	G. 733 [9]: Yes		
AIS received	Yes		Yes	Yes

Note – A *Yes* in the table signifies that an action should be taken as a consequence of the relevant fault condition or alarm detected. An *open space* in the table signifies that the relevant action should *not* be taken as a consequence of the relevant fault condition or alarm, if this condition is the only one present. If more than one fault condition or alarm is simultaneously present, the relevant action should be taken if, for at least one of the conditions, a *Yes* is defined in relation to this action, except in the case of AIS received for which § 4.1.4. applies.

4.1.4 *Alarm processing*

The following items are required to ensure that equipment is not removed from service because of short breaks in transmission (e.g. due to noise or transient fault) and to ensure that maintenance action does not result where no direct maintenance action is required.

- The persistence of service alarm and of prompt maintenance alarm indications may be checked for 100 ms (provisionally) before action is taken.
- When the AIS is detected, the prompt maintenace alarm indication, associated with loss of frame alignment and excessive error ratio in the frame alignment pattern, should be inhibited.
- When the fault conditions cease, the service alarm and prompt maintenance alarm indications, if given, should be removed. Again, the persistence of this change in condition may be checked for 100 ms (provisionally) before action is taken.
- It is possible that some line systems could suffer from frequent transient faults resulting in an unacceptable quality of service. For this reason, if a persistence check is provided, fault rate monitoring should also be provided for each digital link. This monitoring will result in permanent removal from service of digital links which are frequently removed from service or frequently produce transient alarm conditions. The threshold for removal from service needs study. When this action is taken the service alarm indication and the prompt maintenance alarm indication shall be given.

Note to § 4.1 – The utilization of these indications will depend upon the switching and signalling arrangements provided nationally. Separate indications for some of the fault conditions listed may be provided nationally if required.

4.2 *Fault and alarm detection – transmission systems*

Faults and alarms which cannot be directly detected by the exchange terminal function but which are detected by transmission equipment should be accepted by the exchange as a need to take appropriate action (such as group pilot indication of failure which may be necessary for service and/or maintenance actions).

4.3 *Fault and alarm detection and consequent actions – signalling function*

4.3.1 *Channel associated signalling (2048 and 8448-kbit/s systems)*

4.3.1.1 *Fault detection*

The exchange signalling function should detect the following fault conditions for each 64-kbit/s signalling multiplex:

- failure of local power supply (if practicable),
- loss of 64-kbit/s incoming signal.

  Note – The detection of this fault condition is required only when the fault does not result in an indication of loss of multiframe alignment.
- loss of multiframe alignment.

The criteria for activating and deactivating the indication of the fault condition are given in the Recommendations cited in [12] and [13].

4.3.1.2 *Alarm detection*

The exchange signalling function should detect the alarm indication (remote alarm) received from the remote end.

4.3.1.3 *Consequent actions*

4.3.1.3.1 *Generation of alarms*

4.3.1.3.1.1 *Alarm signals generated for action within the exchange*

- The service alarm indication should be generated by the exchange signalling function to signify that the service is no longer available (see Table 7/Q.504).
- The prompt maintenance alarm indication should be generated to signify that performance is below acceptable standards and that immediate maintenance attention is required locally (see Table 7/Q.504).

4.3.1.3.1.2 *Alarm transmitted by the exchange*

An alarm indication (remote alarm) should be applied "upstream" towards the transmission/switching interface as soon as possible (see Table 7/Q.504). The relevant alarm bit for the remote alarm indication is given in the Recommendation cited in [14].

4.3.1.3.2 *Removal of alarm indication*

When all fault conditions have been cleared and AIS is no longer received, the remote alarm indication should be removed as soon as possible.

4.3.1.3.3 *Alarm processing*

The same applies as in § 4.1.4.

4.3.2 *Channel associated signalling (1544 kbit/s)*

Requires further study.

4.3.3 *Common channel signalling*

Requirements specified in relevant Recommendations apply.

TABLE 7/Q.504

Fault conditions and alarms detected by the exchange signalling function and consequent actions

Fault conditions and alarms detected (see §§ 4.3.1.1 and 4.3.1.2)	Consequent actions (see § 4.3.1.3)		
	Service alarm indication generated	Prompt maintenance alarm indication generated	Alarm indication to remote end generated
Failure of power supply	Yes	Yes	Yes, if practicable
Loss of 64 kbit/s incoming signal	Yes	Yes	Yes
Loss of multiframe alignment	Yes	Yes	Yes
Alarm indication received from remote end	Yes		

Note – A *Yes* in the table signifies that an action should be taken as a consequence of the relevant fault condition or alarm detected. An *open space* in the table signifies that the relevant action should *not* be taken as a consequence of the relevant fault condition or alarm, if this condition is the only one present. If more than one fault condition or alarm is simultaneously present, the relevant action should be taken if, for at least one of the conditions, a *Yes* is defined in relation to this action.

4.4 *Fault and alarm detection and consequent actions – other functions of the exchange*

4.4.1 *Faulty circuits*

The exchange should not switch any new calls to a faulty circuit.

The exchange should remove from service all circuits found to be permanently faulty as detailed in §§ 4.1.4, 4.2 and 4.3.1.3.3.

4.4.2 *Master clock distribution*

The absence of timing information distributed from a master clock located at the exchange or received from an external master clock shall be recognized and a prompt maintenance alarm shall be given.

Changeover to an alternate timing source shall be made so as to fulfil the requirements of § 2.7 and § 3.2 above and § 2.4.4 of Recommendation Q.503.

4.4.3 *Internal timing distribution*

The distribution of timing information to the major elements of the exchange shall be supervised as required. A service alarm shall be given when a failure is detected. A maintenance alarm shall be given if it is appropriate.

4.4.4 *Supervision or testing of interface function*

The exchange shall have the capability of verifying the proper operation of the interface functions, including the fault detection and supervision functions.

Routine tests, statistical tests, manual activities and/or other means may be used to verify proper operation of these functions.

Information shall be given to the far-end exchange when new calls cannot be established on the circuits on which routine tests are being initiated. Established calls, including semipermanent connections, must not be interrupted. During the tests, the generation of alarms at the far-end exchange due to the removal of circuits from service should be avoided, if possible.

4.4.4.1 *Supervision or testing of ET functions - interfaces A and B*

The verification of the proper operation of the exchange terminal function can be performed by means of statistical observations or by testing. Testing may be manual or automatic.

4.4.4.2 *Supervision or testing of ET functions - interface E*

i) Failures of codecs [except those covered in ii) below] should be recognized by the exchange using the criteria defined in the Recommendation cited in [15].

ii) Supervision or testing of codecs of one or a small number of channels may be accomplished according to i) above or by interoffice transmission measurement and testing on circuits between exchanges or by statistical measurements.

4.4.5 *Through-connection supervision*

The exchange should provide adequate supervision of the cross office path continuity.

4.4.5.1 *Switched connections*

The requirements of § 2.5.1 are considered to be sufficient in order to guarantee the cross office path continuity.

The method by which this is performed may be on per call basis, continuously, statistically or by other means.

4.4.5.2 *Semipermanent connections*

Semipermanent connections may require special supervision procedures.

4.4.5.3 *$n \times$ 64-kbit/s connections*

This item requires further study for both switched and semipermanent connections.

4.4.6 *Supervision or testing of signalling functions*

In addition to fault detection required in § 4.3, the following applies.

4.4.6.1 *Channel associated signalling*

The exchange should be able to verify the proper operation of the signalling functions by generating and responding to test calls or by a statistical observation.

4.4.6.2 *Common channel signalling*

The exchange should be able to verify the proper operation of the signalling functions as required by the common channel signalling Recommendations.

4.4.7 *Supervision or testing of exchange error performance*

A means of determining that the operational bit error ratio requirements is being met should be provided (see § 2.6).

4.5 *Supervision or testing of digital facilities performance*

The exchange shall have the capability of monitoring digital link performance to detect when bit error ratio, slip rate and loss of framing thresholds exceed operational objectives. The exchange will then take subsequent action to give appropriate trouble indications or alarms and perform other appropriate actions, such as removing circuits from service.

4.6 *Supervision or testing of analogue facilities performance*

4.6.1 *Interoffice speech path continuity check*

The exchange should be capable of performing speech path continuity checks in accordance with the appropriate signalling system Recommendations. Circuits failing the speech path continuity checks should be removed from service and repair procedures initiated as required.

4.6.2 *Interoffice transmission measurement and testing on circuits between exchanges*

The exchange may also be equipped internally or give access to external equipment to perform other transmission test on circuits. Faulty circuits should be removed from service and repair procedures initiated as required.

5 Exchange performance measurements

5.1 *Call processing delays*

To be determined.

5.2 *Ineffective call attempts*

Ineffective call attempts are bids for service that do not result in successful processing of the answer signal by the exchange. These may occur for many reasons. Examples are:

- faulty dialling;
- abondonments prior to completion of dialling or address complete;
- busy or no answer terminating line conditions;
- equipment malfunctions;
- inability of the network to handle offered traffic due to capacity limits or application of special network controls.

The exchange is required to recognize ineffective call attempts. Summary information of various categories should be available on request for service monitoring, service protection and repair activities.

Further study is required on determining specific requirements including categories of ineffective call attempts.

5.3 *Call processing and transmission performance*

The exchange will be required to collect data that can be used to measure its performance. In some cases external means of making measurements will also be necessary. Further study is required.

5.4 *Other measurements*

To be determined.

Note – § 5.4 is intended to include measurements of exchange performance that would be of use to operating personnel. Such indications could be used to verify the performance of the exchange.

References

[1] CCITT Recommendation *Error performance on an international digital connection forming part of an integrated services digital network*, Vol. III, Fascicle III.3, Rec. G.821.

[2] CCITT Recommendation *Controlled slip rate objectives on an international digital connection*, Vol. III, Fascicle III.3, Rec. G.822.

[3] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732, § 2.5.

[4] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.733, § 2.5.

[5] CCITT Recommendation *Second order PCM multiplex equipment operating at 8448 kbit/s*, Vol. III, Fascicle III.3, Rec. G.744, § 2.6.

[6] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732, § 3.1.6.

[7] CCITT Recommendation *Second order PCM multiplex equipment operating at 8448 kbit/s*, Vol. III, Fascicle III.3, Rec. G.744, § 3.2.6.

[8] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732.

[9] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.733.

[10] CCITT Recommendation *Second order PCM multiplex equipment operating at 8448 kbit/s*, Vol. III, Fascicle III.3, Rec. G.744.

[11] CCITT Recommendation *Maintenance of digital networks*, Vol. III, Fascicle III.3, Rec. G.704.

[12] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732, § 4.2.3.

[13] CCITT Recommendation *Second order PCM multiplex equipment operating at 8448 kbit/s*, Vol. III, Fascicle III.3, Rec. G.744, § 4.2.3.

[14] CCITT Recommendation *Characteristicsor primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732, § 4.2.4.2.3.

[15] *Ibid.*,§ 3.1.2.

Recommendation Q.505

TRAFFIC MEASUREMENTS

The digital transit exchange may be required to collect traffic data in order to facilitate engineering of the exchange, connecting circuit groups and the national and international network. Specific requirements need further study.

Recommendation Q.506

NETWORK MANAGEMENT FUNCTIONS

The ditigal transit exchange shall have the capability of collecting data, and detecting or indicating both normal and unusual traffic conditions in the telephone network. It may send information to allow network control systems or centres to analyze the data and be able to invoke controls or reroutes, either automatically or as directed, to help alleviate problems in the network. Specific requirements need further study.

Examples of data that may be required to be reported are:

a) For each outgoing circuit group, the number of bids offered and the number of seizures that result, determined by quarter-hour intervals. (Unsuccessful bids can be measured as an alternative to seizures).

b) The number of answer signals received for each outgoing circuit group determined by quarter-hour intervals.

c) The length of queue waiting for access to common control equipment.

d) The equipment occupancy or number of call arrivals per unit time.

e) Periodic observation of efficiency rates to destination countries with summaries of failures by categories.

The exchange should have the capability to respond as required to network management controls.

TRANSMISSION CHARACTERISTICS FOR TELEPHONY OF DIGITAL TRANSIT EXCHANGES

1 General

This Recommendation applies to digital transit exchanges for telephony in Integrated Digital Networks (IDNs) and mixed (analogue/digital) networks. The field of application of this Recommendation is found in Recommendation Q.501.

The signals taken into consideration are passed through the following interfaces as described in Recommendation Q.503 and in Figure 1/Q.507:

- interface A, for primary PCM multiplex signals at 2048 kbit/s or 1544 kbit/s;
- interface B, for secondary PCM multiplex signals at 8448 kbit/s;
- interface E, comprising both 4-wire and 2-wire interfaces. Interfaces E1 and E2 are analogue interfaces and represent possible applications of interface E in Figure 1/Q.503.

Specifically this Recommendation applies to the transmission characteristics of digital transit exchanges for signals passed between analogue interfaces, namely interfaces E1 and E2.

In addition, for parameters such as transmission delay or transmission loss, values for signals passing from interface E to interfaces A or B ("analogue-to-digital") are given. Corresponding values are also given for signals of the same type, e.g. related to telephony or similar services, when passing from interface A or B to interface A or B ("digital-to-digital").

For signals of other types, for example, 64-kbit/s data signals, which are never passed through an analogue interface, this Recommendation should be considered in conjunction with the other transmission characteristics recommended in Recommendation Q.503.

Some of the transmission characteristics for connections between an analogue interface and a 64-kbit/s channel timeslot at the recommended digital interfaces are still under study and therefore are not yet included in this Recommendation.

The transmission characteristics of voice-frequency (VF) connections through a digital transit exchange should in principle provide performance in accordance with Recommendations G.712 [1] and, where applicable, Recommendation Q.45 [2] (see also Recommendation G.142 [3]).

2 Definition of switching points

2.1 *Virtual analogue switching point*

The virtual analogue switching points are defined in Recommendation G.101 [4].

2.2 *Switching input and output*

The transmission/switching boundaries shown in Figure 1/Q.507) should be used considering as:

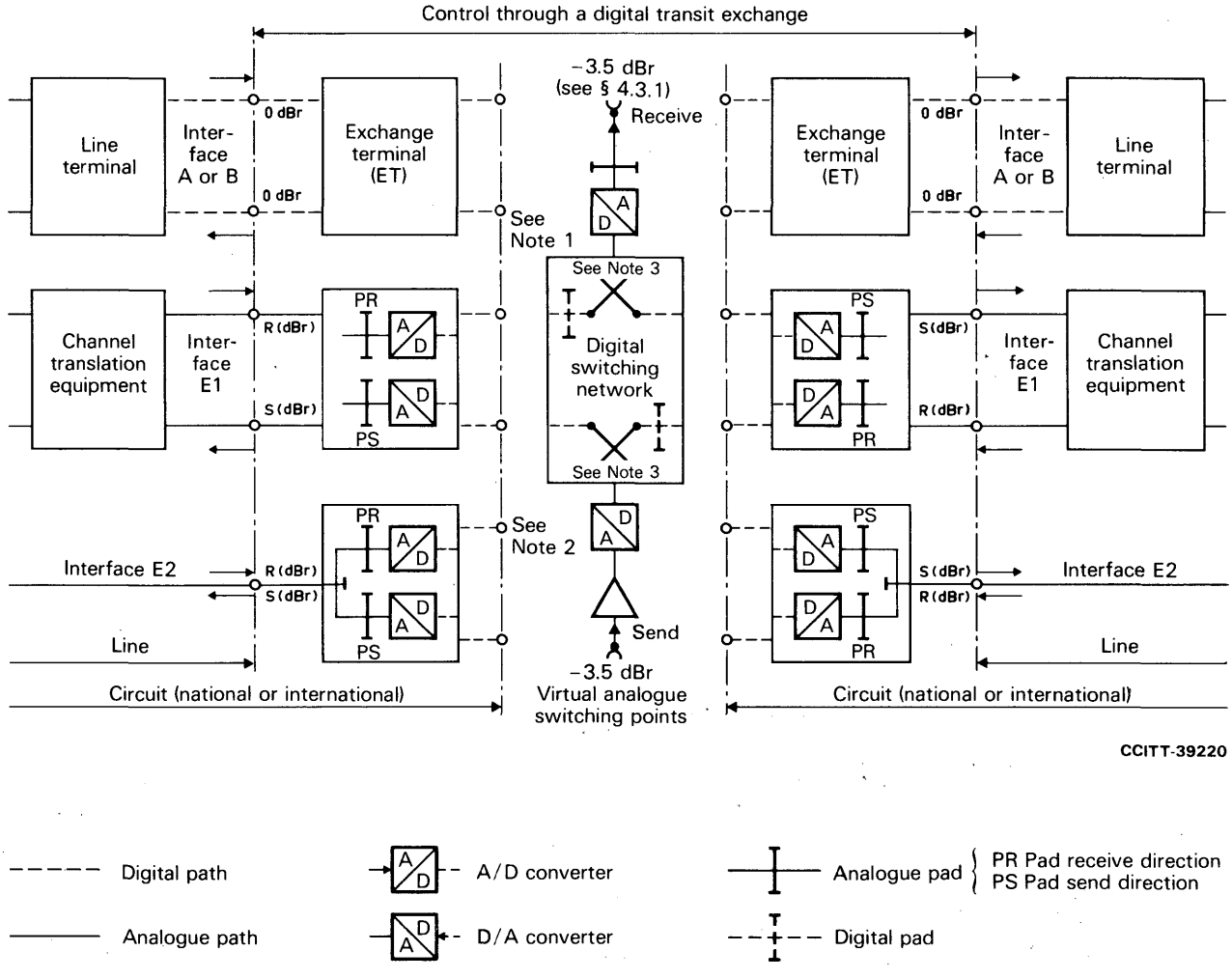
a) switching equipment input: the point for the receive channel,

b) switching equipment output: the point for the transmit channel.

The exact position of each of these points depends on national practice and it is unnecessary for the CCITT to define it. Only the national authority responsible for each digital transit exchange can fix the position of these points in each case.

3 Transmission delay through an exchange

The transmission delay through an exchange is the sum of the times necessary to pass in both directions on a connection through the exchange. It includes delay due to alignment of the frame but does not include delays due to ancillary functions, such as echo suppression or echo cancellation. The transmission delay for passing in both directions through any exchange should meet the requirements given in Table 1/Q.507, where the term mean value is understood as the expected value in the statistical sense. The minimum delay point of the delay/frequency curve will be selected when analogue interfaces are involved.



Note 1 – Ideal digital to analogue converter (see § 4.1.2.2).
Note 2 – Ideal analogue to digital converter (see § 4.1.2.2).
Note 3 – Possible digital loss pad (see § 4.2.1).
Note 4 – The values of R and S for 2-wire interfaces may not necessarily be equal to those of 4-wire interfaces.

FIGURE 1/Q.507

Transmission levels and virtual analogue switching points at a digital transit exchange

TABLE 1/Q.507

Transmission delays through an exchange

Interconnection	Mean value	0.95 probability of not exceeding
Digital-digital	≤ 900 µs	1500 µs
Digital-analogue	≤ 1500 µs	2100 µs
Analogue-analogue	≤ 2100 µs	2700 µs

Note – These values for the transmission delays are applicable under reference load A conditions as defined in Recommendation Q.504, § 2.1.

4 Transmission relative levels and transmission loss

4.1 *Definitions*

4.1.1 *Relative levels*

4.1.1.1 *Analogue interfaces*

Let the nominal relative level at the switching equipment input point associated with a receive channel be *R*.

Let the nominal relative level at the switching equipment output point associated with a transmit channel be *S*.

4.1.1.2 *Digital interfaces*

In any case, the relative level at the switching equipment input and output points will be said to be 0 dBr. Since relative level has no real meaning when applied to digital signals, it is necessary to assume virtual ideal analogue/digital conversion as specified in 4.1.2.2 (see also [5]).

4.1.2 *Transmission loss*

4.1.2.1 *Nominal transmission loss*

When a transit connection is established through an exchange by connecting the receive and transmit channels of one circuit to the transmit and receive channels respectively of another circuit and the transmission loss to be attributed to the incoming channel of a circuit is *T*, the nominal transmission loss (NL) for each way of the connection, is defined as

$$NL = R - S + T.$$

Note 1 – In some cases the loss corresponding to *T* may be implemented external to the switching equipment. In those cases the nominal transmission loss of the exchange becomes:

$$NL = R - S.$$

Note 2 – If the circuits are operated at different losses, the nominal transmission loss of the exchange will be correspondingly different in the two directions.

4.1.2.2 *Actual transmission loss*

For each direction of a transit connection the actual transmission loss (AL) is the change in level caused to a test signal of appropriate level at the reference frequency recommended in Recommendation G.712 [1] injected at the switching equipment input and detected at the switching equipment output.

For definition purposes, in the case of telephony, a digital termination must be considered to be connected to an ideal decoder (which conforms exactly to [6]) and to an ideal encoder (which conforms exactly to [7]).

For measurement purposes the ideal decoder and encoder will be replaced by real ones with appropriate accuracy.

Note – In the case of digital-to-digital connections, an equivalent measurement could also be performed in a pure digital way.

4.1.2.3 *Net switching loss*

The net switching loss (SL) is defined as the difference between the actual transmission loss and the nominal transmission loss:

$$SL = AL - NL.$$

4.2 *Transmission loss requirements*

In practice, different connections established by the switching equipment will introduce different values of net switching loss so that a distribution of net switching losses will arise.

4.2.1 *Mean value of net switching loss*

The mean value of the net switching loss should be 0 dB.

As a general principle the use of digital loss pads should be avoided since apparatus needed to preserve or control the transmission plan defined for the analogue network should wherever possible be incorporated in analogue portions of the network. Adherence to this principle will ensure that the evolving digital network will not become encumbered with superfluous apparatus needed only for the interim mixed analogue/digital period. However, it is recognized that during the transition stage to a completely digital network, existing national transmission plans may require digital pads to be inserted for digital exchange connections terminating in the country in question.

4.2.2 *Loss dispersion of net switching loss*

The standard deviation of loss measured with a test signal of appropriate level at the reference frequency recommended in Recommendation G.712 [1] injected at all possible ports between any switching equipment input and any switching equipment output should not be greater than x dB.

Note – The value for x requires further study.

4.3 *Relative levels requirements*

4.3.1 *Relative levels at the virtual analogue switching points*

With respect to international telephone connections, the nominal send and receive relative levels at the virtual analogue switching points of an international digital exchange should in general be −3.5 dBr, but some exceptions can be found in [8].

The nominal send and receive relative level at the virtual analogue switching points at intermediate national exchanges should comply with the national transmission plans.

4.3.2 *Relative levels at the analogue interfaces of the exchange*

The minimum and maximum relative levels at the analogue input and output ports of the exchange need to be specified. This item is still under study.

Some explanations concerning the concept of relative levels can be found in [5].

5 Requirements for echo and stability control

This applies to exchanges to which 2-wire circuits are connected. The recommendation cited in [9] (with respect to stability) and [10] (with respect to echo) have to be observed. This Recommendation gives values of the necessary loss of the path "a-t-b" which is determined by relative levels and by the balance return loss.

Note – A wide variety of values of pads PR and PS (see legends to Figure 1/Q.507) as well as of balance networks can be encountered because of the differences among national practices. The choice of pad and balance values is governed not only by the transmission requirements of the individual national networks but also by the need to comply with CCITT Recommendations (Volume III) concerning echo, stability, system loading, crosstalk, etc., on international connections.

6 Attenuation distortion

6.1 *Between 4-wire interfaces*

See the Recommendation cited in [11] adopting where required the more stringent limits shown dotted in Figure 1/G.712 [12].

6.2 *Between 2-wire interfaces or 2-wire and 4-wire interfaces*

Under study.

Note – In case of 2-wire and 4-wire interfaces the influence of line-signalling equipment using the speech wires is not included in Recommendation G.712 [1].

7 Delay distortion

See the Recommendation cited in [13].

8 Impedance of VF ports

8.1 *4-wire interfaces*

See the Recommendation cited in [14].

8.2 *2-wire interfaces*

Nominal impedance to be defined depending on national conditions (e.g. for loaded and unloaded cables).

9 Return loss

The return loss has to be measured against the nominal impedance given in § 8.

9.1 *At 4-wire interfaces*

In accordance with the Recommendation cited in [15].

9.2 *At 2-wire interfaces*

Under study.

10 Impedance unbalance to earth

Measurements and values defined in the Recommendation cited in [16] apply, namely:

at 300 - 600 Hz > 40 dB

at 600 - 3400 Hz > 46 dB

Note – These values are suggested as a provisional basis. An improvement of these values is desirable and seems possible. Further study is required, especially for values needed at lower frequencies (e.g. 50 or 60 Hz).

11 Idle channel noise

11.1 *At 4-wire interfaces*

In accordance with the Recommendations cited in [17] or [18].

11.2 *At 2-wire interfaces*

Under study.

Note – Noise caused by analogue sources in cases of 4-wire and 2-wire analogue interfaces has also to be taken into account.

12 Crosstalk

12.1 *Analogue 4-wire interfaces*

12.1.1 *Crosstalk requirements*

See the Recommendations cited in [19] and [20].

12.1.2 *Crosstalk measurements (for sine-wave measurements)*

For measurement, an auxiliary signal (a low level activating signal) should be injected into the disturbed channel; a pseudo-noise signal as specified in Recommendation O.131 [21] at a level of −65 to −51 dBm0 is suitable. It is necessary to use a frequency selective detector when performing this measurement.

12.2 *Analogue 2-wire interfaces*

Under study.

Note – Crosstalk caused by analogue sources in case of 4-wire and 2-wire analogue interfaces has also to be taken into account.

13 Intermodulation products

The Recommendation cited in [22] applies. For measurement purposes a simplified method as defined in the Recommendation cited in [23] is preferred.

The Recommendation cited in [24] also applies.

14 Total distortion, including quantizing distortion

The Recommendation cited in [25] applies.

For additional information concerning the concept of the "quantizing distortion unit", used for transmission planning purposes, see [4] and [26].

15 Unwanted in-band signals at the channel output interface

See the Recommendation cited in [27].

16 Variation of gain with input level

See the Recommendation cited in [28].

17 Discrimination against out-of-band input signals

See the Recommendation cited in [29].

Note – An additional requirement for 2-wire interfaces may be needed in order to suppress frequencies at 16 2/3 Hz and 50 or 60 Hz (e.g. fundamental waves of interference from power lines and electrical railways).

18 Spurious out-of-band signals at the channel output

See the Recommendation cited in [30].

19 Short-term and long-term variation of loss

See the Recommendation cited in [31].

20 Adjustment of relationship between VF level and encoding law

See the Recommendation cited in [7].

Note – Some modification or addition may be required for 2-wire interfaces.

References

[1] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712.

[2] CCITT Recommendation *Transmission characteristics of an international exchange*, Vol. VI, Fascicle VI.1, Rec. Q.45.

[3] CCITT Recommendation *Transmission characteristics of exchanges*, Vol. III, Fascicle III.1, Rec. G.142.

[4] CCITT Recommendation *The transmission plan*, Vol. III, Fascicle III.1, Rec. G.101.

[5] *Ibid.*, § 5.

[6] CCITT Recommendation *Pulse code modulation (PCM) of voice frequencies*, Vol. III, Fascicle III.3, Rec. G.711, § 4.

[7] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712, § 17.

[8] CCITT Recommendation *The transmission plan*, Vol. III, Fascicle III.1, Rec. G.101, § 4.

[9] CCITT Recommendation *Influence of national networks on stability and echo losses in national systems*, Vol. III, Fascicle III.1, Rec. G.122, § 1.

[10] *Ibid.*, § 2.

[11] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712, § 2.

[12] *Ibid.*, Figure 1/G.712.

[13] *Ibid.*, § 3.

[14] *Ibid.*, § 4.1.

[15] *Ibid.*, § 4.2.

[16] CCITT Recommendation *Transmission characteristics of an international exchange*, Vol. VI, Fascicle VI.1, Rec. Q.45, § 6.4.

[17] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712, § 5.1.

[18] *Ibid.*, § 5.2.

[19] *Ibid.*, § 12.

[20] *Ibid.*, § 13.

[21] CCITT Recommendation *Specification for a quantizing distortion measuring apparatus using a pseudo-random noise stimulus*, Vol. IV, Fascicle IV.4, Rec. O.131.

[22] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712, § 8.1.

[23] CCITT Recommendation *Transmission characteristics of an international exchange*, Vol. VI, Fascicle VI.1, Rec. Q.45, § 6.1.

[24] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712, § 8.2.

[25] *Ibid.*, § 9.

[26] CCITT Recommendation *Transmission impairments*, Vol. III, Fascicle III.1, Rec. G.113.

[27] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712, § 10.

[28] *Ibid.*, § 11.

[29] *Ibid.*, § 6.

[30] *Ibid.*, § 7.

[31] *Ibid.*, § 16.

PART II

Recommendations Q.601 to Q.685

INTERWORKING OF SIGNALLING SYSTEMS

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1 GENERAL

1.1 *Change from narrative to SDL presentation*

These Recommendations provide a set of interworking specifications for CCITT signalling systems. The specifications are based on the CCITT Specification and Description Language (SDL) described in Recommendations Z.101 to Z.104. In these Recommendations on interworking the SDL is used as a specification language.

Existing specifications in narrative form have not completely and unambiguously specified interworking of CCITT Signalling Systems. In addition, the introduction of digital switching, transmission and signalling systems creates new interworking demands.

Previous interworking specifications have been analyzed and reconsidered in preparation of the present Recommendations. Where discrepancies exist between the previously printed interworking specifications and the interworking specifications of the present Recommendations, the latter shall be binding.

The new SDL interworking specifications will not replace the existing (narrative) specifications of the signalling systems concerned. They will only cover that part of the signalling system procedures which is of importance to interworking. The detailed procedures of the signalling systems are to be found in the existing Recommendations (Yellow Book, Fascicles VI.2, VI.3 and VI.6). Furthermore, only those switching procedures are shown that are relevant to interworking.

SDL provides an implementation independent and comprehensive method of presentation. It encompasses the previous interworking Recommendations and ensures that the interworking conditions are included in a regular and formalized manner. The chosen method facilitates the specification of interworking with future signalling systems. The use of well defined events with a graphical presentation reduces readers' language problems.

1.2 *Compatibility between signalling systems*

During the development of CCITT Signalling Systems, the signalling capacity has constantly been increased. In this way it has been possible to incorporate new features. However, it is not always possible to transfer these features when interworking with older systems.

In the case of signalling systems with large signalling capacity, it is possible to transmit distinct statements on certain conditions, e.g. "busy", "type of connection", etc. On the other hand, however, signalling systems with small signalling capacity require more general meanings to be assigned to the signals. Figure 1/Q.601 illustrates this by an example.

1.3 *Interworking combinations*

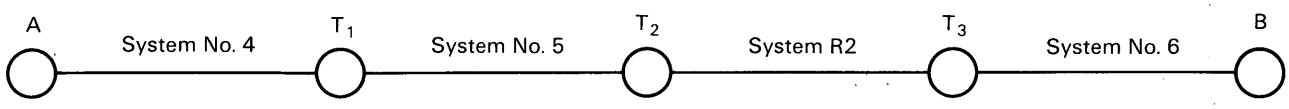
Since the CCITT Signalling Systems are to be used for international telephone communication, interworking between the different signalling systems must be ensured. Interworking takes place in a transit exchange which must possess suitable equipment for processing the signals of both signalling systems involved. Interworking of the signalling systems can take place on all levels of the telephone network:

- national
- regional
- international.

With a number of s different signalling systems the maximum number of interworking combinations will be:

$$i = s \cdot (s - 1)$$

If the present standardized Signalling Systems No. 4, No. 5, No. 6, No. 7, R1 and R2 only are taken into account, a total of 30 different interworking combinations is obtained with $s = 6$.



Busy-flash signal	Busy-flash signal	A-4 : Congestion in the national network	NNC : National-network-congestion signal
		B-4 : Congestion (encountered after changeover from A signals to B signals)	CFL : Call-failure signal ADI : Address-incomplete signal
		A-15 : Congestion in an international exchange or its output	SEC : Switching-equipment-congestion signal CGC : Circuit-group-congestion signal
		B-3 : Subscriber line busy	SSB : Subscriber-busy signal (electrical)

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FIGURE 1/Q.601

Hypothetical transit connection; interworking of some backward signals

The number of possible combinations becomes even greater if the national signalling systems are taken into account.

The method for interworking of standardized CCITT Signalling Systems described in these Recommendations may also be advantageous for interworking with other signalling systems.

Recommendation Q.602

2 INTRODUCTION

Interworking is defined to be

- the controlled transfer of signalling information across the interface between different signalling systems where the significance of the transferred information is identical or where the significance is translated in a defined number, and
- the performance of appropriate switching procedures in association with the transfer.

The duration of interworking commences with the instant when an outgoing signalling system is successfully selected and the interworking continues throughout the call until the connection is released. Interworking ceases with the release of the connection whether the release is initiated by reception of a clear-forward signal or in response to some other condition.

2.1 *Functional partitioning*

When interworking is specified in SDL, three separate functional blocks with distinct procedures [1] are used (see Figure 2/Q.602), namely

- the incoming signalling system logic procedures,
- the interworking logic procedures,
- the outgoing signalling system logic procedures.

It is understood that interworking logic procedures are dealt with in the second functional block. This functional subdivision allows only those events which can be processed within the individual incoming and outgoing signalling system logic procedures part to be sent to or from the interworking logic procedures part.

Both the incoming and outgoing signalling system logic procedures cause actions such as the sending of an acknowledgement signal, the starting of time supervision, and the generation of an interworking event that includes additional information, e.g. the use of satellite circuits and echo suppressors.

The action following the reception of an interworking event may be the generation of one or more signals as well as the operation of internal signalling and switching procedures.

The interworking logic procedures are used to specify the action to be taken in all cases, especially when there is no direct translation from an interworking event to a signal.

2.2 *Descriptive tools*

A general approach to specifying interworking – known as events approach – is used.

To prepare SDL diagrams three sets of events are used [see Recommendation Q.603], namely

- Forward Interworking Telephone Events (FITEs)
- Backward Interworking Telephone Events (BITEs) and
- Switching Processing Interface Telephone Events (SPITEs).

FITEs perform information transfer in the forward direction from an incoming signalling system to an outgoing signalling system.

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[1] In the Recommendations on interworking of signalling systems the term "procedure" is used in the same way as the term "process" in Recommendation Z.101, § 1.3.9.

BITEs perform information transfer in the backward direction from an outgoing signalling system to an incoming signalling system.

SPITEs describe the information flow at the functional interface between signalling and switching. These events are considered to be internal to the signalling procedures.

In the events approach, all information transfer between any incoming and outgoing signalling system occurs at a standard interface by means of interworking telephone events. This is illustrated in Figure 2/Q.602. The concept of an interworking event is generally valid and applies to all interworking combinations.

To provide a tool for the interworking specifications, *information analysis tables* [see Recommendation Q.604] are prepared. They identify the information elements of all forward and backward signals (which are relevant to interworking) for each signalling system. They also identify the possible information loss, addition or change which occurs in the case of interworking of signalling systems.

2.3 *Symbols*

The symbols and rules of SDL used for interworking specifications are presented in Recommendation Z.102.

2.4 *Rules for interworking diagrams*

The general objective is to present all the interworking specifications by means of SDL.

The following rules apply to interworking specifications.

2.4.1 The interworking specifications shall be implementation independent.

2.4.2 They shall facilitate the specification of interworking with other signalling systems.

2.4.3 They shall be unambiguous and as complete as possible, this means specifically that

a) only those switching procedures shall be represented which directly influence the interworking of signalling systems;

b) only those procedures of the outgoing and the incoming signalling system logic are specified which are relevant to interworking, i.e. procedures which are signalling system dependent and others which have no influence on the interworking procedures are not represented in the functional parts of the outgoing and incoming signalling system logic procedures;

c) detailed information, such as the exact description of the compelled signalling cycle, recognition times of signals, encoding, frequencies used, is not described in the outgoing or incoming functional parts. Such details can be found in the specifications of the signalling system;

d) conditions resulting from malfunctions of equipment which have no relevance to interworking, shall not be taken into account.

2.4.4 SDL connector symbols are used to cover some detailed procedures that need not be represented when their descriptions are not important for the interworking procedures.

2.4.5 Equipment terminology, e.g. "register" mentioned in the logic procedures is understood to be functional.

2.4.6 The information analysis tables include only signals relevant to interworking. Any internal signals with a meaning specific to a single signalling system are not listed.

2.4.7 In drawing the SDL diagrams for the interworking specifications, it was assumed that no time elapses between consecutive states; i.e. state transitions are instantaneous. Time elapses only within a state.

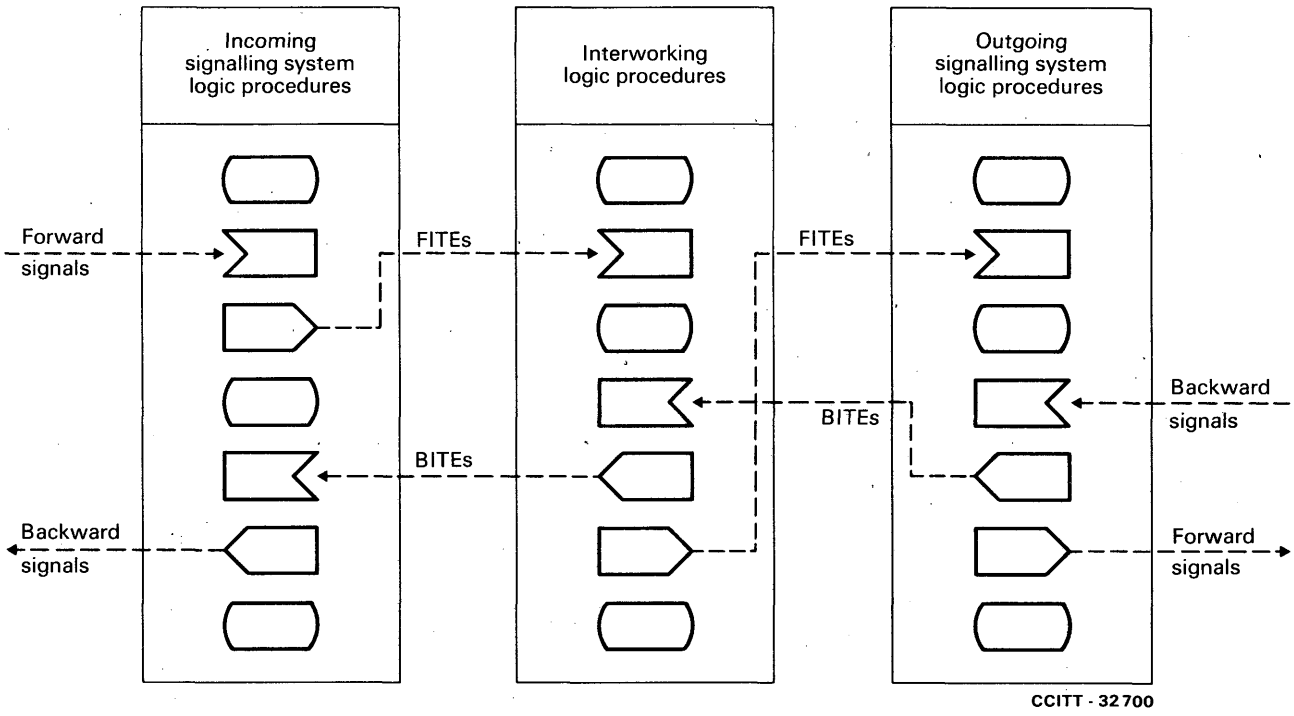

FIGURE 2/Q.602

Partitioning of interworking procedures in functional blocks (SPITEs are not presented in this figure)

3 EVENTS

All information transfer between incoming and outgoing signalling systems logic procedures occurs as events. These events are represented as FITEs, BITEs and activation signals. In addition, SPITEs are used internally.

The translation of the information content of a signal into its corresponding interworking telephone event must not lead to a change of its information content, i.e. the information content must be translated only into one single interworking telephone event.

Tables A-1 to A-3[1] list all of the forward interworking telephone events (FITEs), backward interworking telephone events (BITEs) and switching processing interface telephone events (SPITEs).

There are some events which are the direct result of signals received in some particular call phase. These events perform the transfer of signalling information. However not all signals directly generate interworking events.

There are some events which are the result of signals in a particular call phase and internal logic procedures. This applies particularly to routing, country code indications and echo-suppressor control.

There are some events (e.g. due to time-outs) which are purely the result of internal interworking logic procedures. In addition, it may be useful to consider the internal procedures of the various signalling systems, which do not generate interworking events.

In using the events approach the following rules are observed:

a) In generating events all the circumstances under which the event may arise are examined so that the event description is exact.

b) All events which have been identified by considering the response of a signalling system to events are included in Tables A-1 to A-3.

4 INFORMATION ANALYSIS TABLES

Information analysis tables are provided for each signalling system. These tables list the information elements of the forward and backward signals for CCITT signalling systems.

Tables A-4 to A-8 [1] show the forward signals relevant to interworking of Signalling Systems No. 4, No. 5, No. 6, R1 and R2, split up into their individual information elements. In these tables, comparisons are made between the contents of the signals used by the different systems.

Tables A-9 to A-13 [1] show the backward signals relevant to interworking of Signalling Systems No. 4, No. 5, No. 6, R1 and R2, split up into their individual information elements. In the rows headed "corresponds to signal No. ... of Signalling System ..." the signals are entered together with their corresponding signal, if any, in the different systems.

The tables include an indication to the other signalling systems where

- equivalent signals have the same information content,
- equivalent signals are not provided,
- equivalent signals contain less or substitute information,
- equivalent signals contain additional or changed information.

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[1] See Annex A to Recommendations Q.601-Q.608.

4.1 *Information content of the signals*

The individual signals are assigned specific information so as to enable messages to be transmitted. The meaning of these signals can be seen from the specifications of CCITT Signalling Systems.

With regard to their information content, a basic distinction can be made between:

– signals containing a single information element, and

– signals containing several information elements.

An information element is understood to be the smallest indivisible component of information (within a signal) considered in this Recommendation.

For the interworking of different signalling systems, the information content of the signals to be translated is of great importance. In the case where two signalling systems interwork, it is possible to assign all signals used in the CCITT Signalling Systems to one of the following categories:

a) signals coinciding in all information elements,

b) signals coinciding at least in one, but not in all information elements,

c) signals coinciding in no information element at all.

4.2 *Consequences*

If signals with identical information content are present in the signalling systems, the interworking condition is fulfilled. No modification of information occurs [refer to a) of § 4.1 above].

If the signal meanings do not agree in all information elements, those signals must be allocated to one another where maximum agreement is to be achieved, so as to minimize the loss or addition of information [refer to b) of § 4.1 above].

If a signal possesses information elements which are not present in the signals of the other signalling system with which interworking should take place, the information concerned cannot be transmitted and the appropriate performance feature cannot be utilized [refer to c) of § 4.1 above].

In a few cases special procedures have to be laid down if the status of the connection does not permit transmission of the intended interworking signal. If conversion is not possible with certain backward signals, it may be necessary to apply a corresponding tone (see Recommendation Q.35).

In addition, there are cases in which the information content of several signals of one of the signalling systems has to be converted so as to obtain one signal of the other signalling system and vice versa.

Recommendation Q.605

5 DRAWING CONVENTIONS

In addition to Recommendations Z.101 to Z.104, the following rules apply to the logic procedures of the interworking specifications.

5.1 *Inputs and outputs*

In accordance with the basic concepts of SDL, *internal* inputs and outputs are used for logic procedures that do not go beyond the functional block involved. In addition, some SPITEs are used as *internal* inputs to describe the information flow at the interface between the signalling and switching procedures.

All other inputs and outputs, including FITEs and BITEs as well as signals, which pass from one functional block to another are considered as being *external.*

The *external* inputs and outputs point in the direction of the data flow between the three functional blocks as shown in Figure 2/Q.602.

A multiple input (i.e. a group of signals) which leads to one and the same procedure can be represented by one standard symbol including that group of signals, if possible.

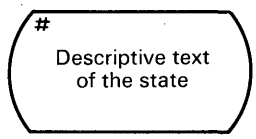
5.2 *States*

State symbols shall contain

- the state number, and
- the descriptive text of the state.

Most frequently the state indicates the input being waited for.

The layout of the state symbol to be used for the interworking specifications is given in Figure 3/Q.605.



State number

FIGURE 3/Q.605

State symbol

5.3 *Connectors*

Connectors are represented by a circle. The in-connector labels (within the connector symbol) shall be unique within the same interworking diagram.

The designations used within the connector symbols are as follows (see Figure 4/Q.605):

a) arabic numbers, where the vertical line of flow of the procedure is to be interrupted. Subscripts outside the connector indicate the sheet numbers on which the associated connectors appear;

b) capital letters, where the horizontal line of a multiple branching of the process is to be interrupted. Subscripts outside the connectors indicate the sheet numbers, on which the associated connectors appear;

c) "P_i" to indicate that the procedures are not completed (e.g. a subroutine or another detailed procedure). The connector symbol will then be non-subscripted with sheet numbers but be provided with the comment "to be completed" associated with a reference to the Recommendation concerned, if any.

The connector reference is always shown in the left-hand column of each sheet of the interworking diagrams.

5.4 *Procedures not presented*

In general, possible signals which are not shown as inputs in a given state are to be considered as consumed but discarded, i.e. ignored. A special treatment may be required in the following cases:

a) electrical conditions not recognized as regular signals (e.g. 1 out of 6 frequencies in the case of MFC signalling),

b) regular signals, but not relevant to interworking (e.g. blocking, identification),

c) any other regular signal recognized as an abnormality (e.g. out of sequence).

In the cases a) and c), the appropriate actions to be taken are not specified in the existing Recommendations. Further study is required.

The reactions in case of signals out of sequence can be shown by means of a state/signal matrix as auxiliary documentation. The interpretation of the diagrams will then be unambiguous.

5.5 *Presentation of time supervision*

The method of time supervision presentation to be used is shown in Figure 5/Q.605.

If two timers are running in a state such that the longer timer can never mature, the input "time release" should nevertheless be shown for both timers in order that no misunderstanding can result. The meaning of start t_1 also includes the possibility of restart t_1, $\bar{t}_1$ means the expiry of t_1.

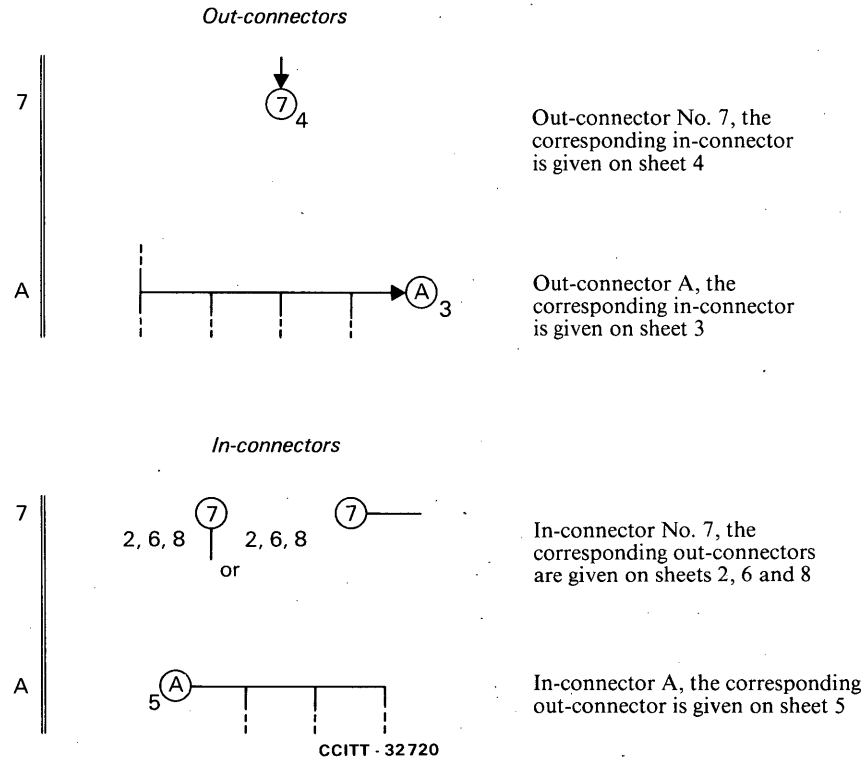


FIGURE 4/Q.605

Examples of how to use connectors

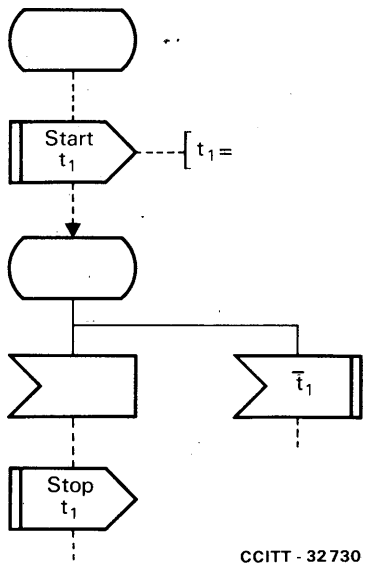


FIGURE 5/Q.605

Method of time supervision presentation

5.6 *Storage of inputs*

During the method of register function activation, all inputs are implicitly stored and the sequence of FITEs is also recorded. When the register function is not activated, inputs must explicitly be stored if required in a later state transition.

5.7 *Method of changing the order of signals*

In several interworking situations, the order in which signals are received is not necessarily the order of their utilization. Therefore, a rearrangement of the order is necessary. To change the signalling sequence in the interworking diagrams, the method indicated in Figure 6/Q.605 should be applied. Figure 6/Q.605 shows how such a situation can be coped with by SDL.

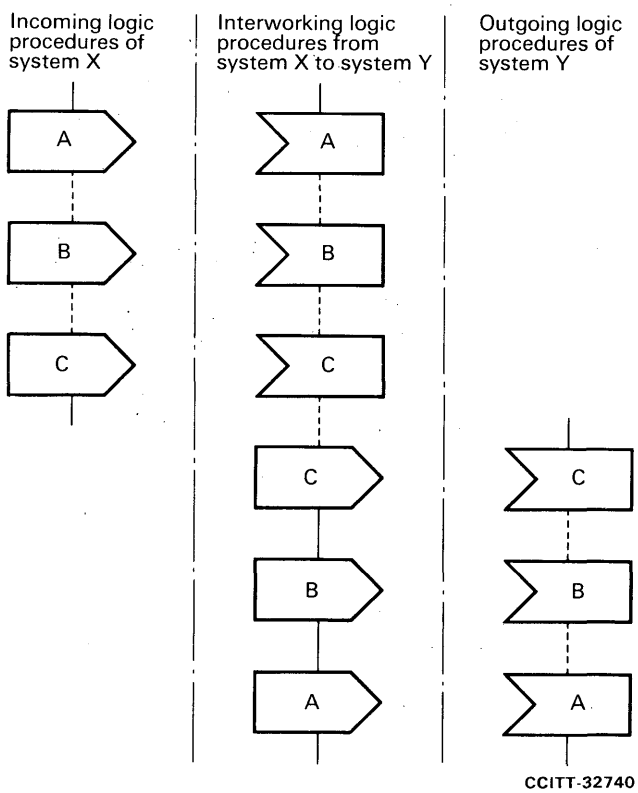
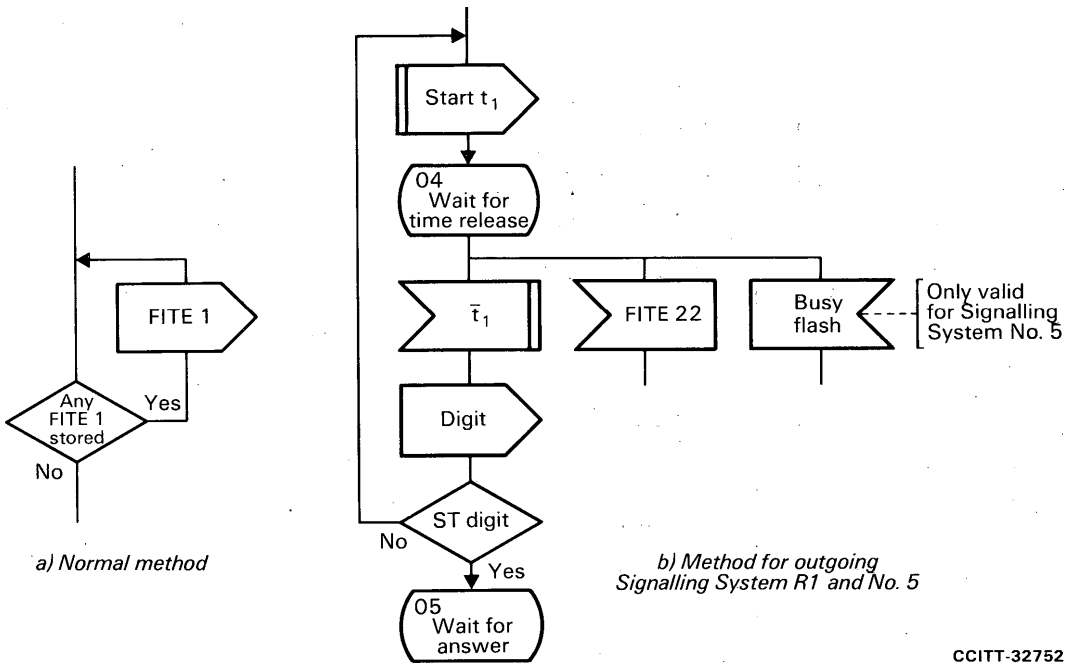


FIGURE 6/Q.605

Method of changing the order of signals

5.8 *Multiple sending of FITEs 1 or digits*

The case of multiple sending of FITEs 1 or digits often occurs in the logic procedures: in the former case in the incoming or interworking procedures, and in the latter case in the outgoing procedures of the en-bloc Signalling Systems No. 5 and R1. The presentation of Figure 7/Q.605 should be used. *a)* of Figure 7/Q.605 is used for multiple FITEs 1, while *b)* of Figure 7/Q.605 is used for outgoing Signalling Systems No. 5 or R1. In *b)* of Figure 7/Q.605 the outgoing logic has already received all the FITEs 1 and has established the "ST condition" prior to the logic sequence shown.



a) Normal method

b) Method for outgoing Signalling System R1 and No. 5

FIGURE 7/Q.605

Presentation method for multiple use of FITE 1

5.9 *Different signalling speeds*

In interworking cases where the signalling system at the outgoing end uses the overlap signalling mode with acknowledgements (Signalling Systems No. 4 and R2) or where the signalling speed of the system at the outgoing end is lower than that at the incoming end, the presentation method indicated in Figure 8/Q.605 should be used.

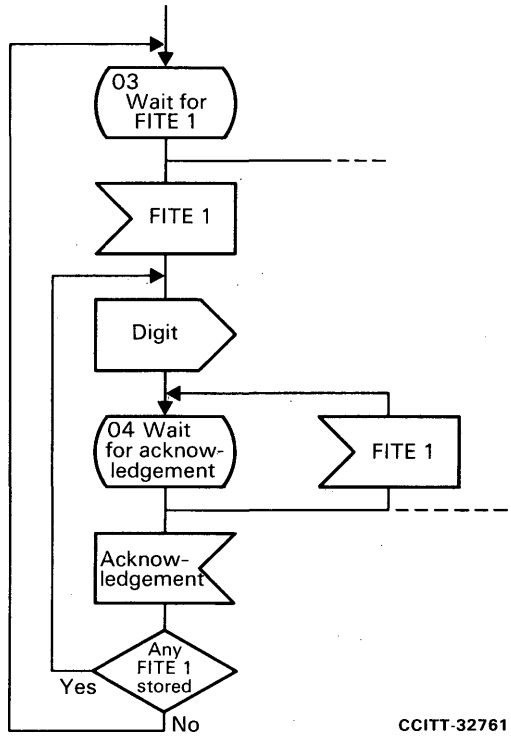


FIGURE 8/Q.605

Presentation method for cases where the signalling system at the outgoing end uses the overlap signalling method

6 LOGIC PROCEDURES

The logic procedures are prepared as:

a) logic procedures for incoming signalling systems,

b) interworking logic procedures,

c) logic procedures for outgoing signalling systems.

A state overview diagram is provided with each procedure. The state overview diagram:

- lists the states for the logic,
- provides a sheet reference for each state, and
- shows permitted transitions between states.

In addition, notes and timers are provided.

6.1 *Incoming signalling system logic procedures*

In specifying the logic procedures the following elements are used:

a) inputs in the form of forward signals,

b) outputs in the form of FITEs,

c) inputs in the form of BITEs,

d) outputs in the form of backward signals,

e) time supervision arrangements,

f) routing and switching aspects that are needed for interworking (SPITEs).

Incoming signalling system logic procedures are provided for:

- Signalling System No. 4 in Recommendation Q.611,
- Signalling System No. 5 in Recommendation Q.612,
- Signalling System No. 6 in Recommendation Q.613,
- Signalling System R1 in Recommendation Q.615,
- Signalling System R2 in Recommendation Q.616.

Signalling System No. 7 procedures are to be provided after the Signalling System No. 7 Specifications become available.

6.2 *Interworking logic procedures*

In specifying the logic procedures the following elements are used:

a) inputs in the form of FITEs from the incoming signalling system,

b) outputs in the form of FITEs to the outgoing signalling system,

c) inputs in the form of BITEs from the outgoing signalling system,

d) outputs in the form of BITEs to the incoming signalling system,

e) routing and switching aspects that are needed for interworking (SPITEs).

Interworking logic procedures can be provided for every possible combination of CCITT Signalling Systems.

The following interworking combinations are provided:

- Signalling System No. 4 to R2 in Recommendation Q.634,
- Signalling System No. 5 to No. 6 in Recommendation Q.642,
- Signalling System No. 5 to R1 in Recommendation Q.644,
- Signalling System No. 5 to R2 in Recommendation Q.645,

– Signalling System No. 6 to No. 5 in Recommendation Q.652,

– Signalling System No. 6 to R1 in Recommendation Q.654,

– Signalling System No. 6 to R2 in Recommendation Q.655,

– Signalling System R1 to No. 5 in Recommendation Q.671,

– Signalling System R1 to No. 6 in Recommendation Q.672,

– Signalling System R1 to R2 in Recommendation Q.674,

– Signalling System R2 to No. 4 in Recommendation Q.681,

– Signalling System R2 to No. 5 in Recommendation Q.682,

– Signalling System R2 to No. 6 in Recommendation Q.683,

– Signalling System R2 to R1 in Recommendation Q.685.

Note – The combination of Signalling System No. 4 to R1 and vice versa are not specified. These combinations are neither in use nor is it, at present, intended to apply them in future.

6.3 *Outgoing signalling system logic procedures*

In specifying the logic procedures, the following elements are used:

a) inputs in the form of FITEs,

b) outputs in the form of forward signals,

c) inputs in the form of backward signals,

d) outputs in the form of BITEs,

e) time supervision arrangements,

f) routing and switching aspects that are needed for interworking (SPITEs).

Outgoing logic procedures are provided for:

– Signalling System No. 4 in Recommendation Q.621,

– Signalling System No. 5 in Recommendation Q.622,

– Signalling System No. 6 in Recommendation Q.623,

– Signalling System R1 in Recommendation Q.625,

– Signalling System R2 in Recommendation Q.626.

Signalling System No. 7 procedures are to be provided after Signalling System No. 7 specifications become available.

Recommendation Q.607

7 INTERWORKING REQUIREMENTS FOR NEW SIGNALLING SYSTEMS

7.1 *Treatment of new signals in another signalling system*

In order to facilitate the interworking between new signalling systems and existing ones, it is desirable to elaborate rules to be taken into account when specifying the new signalling system(s). Since compatibility between all CCITT Signalling Systems must be ensured, any newly developed system has to meet the following requirements with regard to interworking.

a) New signalling systems should be capable of processing all interworking events specified for the existing signalling systems without losing or adding information elements.

This is best achieved by the concept of transparency, whereby the signals of all existing systems have a unique translation into the new system and back again. In this way a tandem connection via an interposed link employing the new signalling system will neither add nor subtract from the information transfer that would otherwise have occurred had the new signalling system not been present.

b) Newly developed systems should not lead to any modification to the specifications covering the present signalling systems except that the translation of new interworking events arising from the meanings of new signals in the new system will need to be defined for the existing signalling systems.

In order that the new signals should cause the minimum loss or gain of information when interworking with existing signalling systems, any new signals should, if possible, not contain any information elements already existing. Hence it is better that these new signals convey only a single meaning rather than a multiple meaning as occurs in some existing systems (e.g. Signalling System R2 signal I-14 corresponds to FITE 8 which combines the elements of FITE 3 and FITE 5). Therefore, only one new information element will be associated with the new signal and only one new FITE or BITE will be needed.

In some cases the new signal will be translated into a presently defined signal of an existing system and hence will cause the addition or, more often, the loss of information. In some cases, no electrical signal being available, all the information may be lost or a tone may need to be used. In the case of Signalling Systems R2 and No. 6, some reserved signals exist within the capacity of these systems and such signals may be introduced to enhance the signalling system and provide an interworking capability.

However it should be borne in mind that with such existing systems, it may not be easy or desirable to modify existing equipment, and even if such modification were possible, in the transitional period the interworking of existing and enhanced signalling equipment of the same system must also be considered.

In view of the difficulties of interworking with existing signalling systems, new features of signals should only be introduced in a new system if there are good operational reasons for doing so.

7.2 *Reserve for national use*

In practice, provision of appropriate spare signalling capacity in a new system reserved for national/regional use cannot be avoided. In such a case, precautions must be taken to prevent signals with an individual national meaning from entering the international network.

One general objective of a new signalling system should be to meet also the national requirements in order to avoid national versions of a given signalling system as far as possible.

7.3 *Unambiguous specifications*

After a clear specification of a new feature to be included in a signalling system, the related signalling procedures should be specified in a unique and standard form. The same applies to the signals involved.

The designation of signals of different signalling systems, which carry the same information, should be the same.

7.4 *Escape codes*

It is obvious that appropriate spare capacity should be provided in order to cope with future demands. One way of doing so is the provision of escape codes.

Recommendation Q.608

8 MISCELLANEOUS INTERWORKING ASPECTS

In producing the interworking specifications in the present form some interworking aspects were found, which are not covered by the specifications of the signalling systems themselves and need to be taken into account when using the SDL diagrams for interworking specification.

8.1 *Transfer of no charge information*

Difficulties related to the use of charge or no charge information were recognized by CCITT for the following reasons:

In the case of interworking with systems not able to provide the no charge information together with the answer signal, a *no charge* call is only possible by withholding the answer signal. In the international network, the

absence of the answer signal results in a time-out within a delay period of 2 to 4 minutes as described in Recommendation Q.118, which considers this situation to be abnormal. Thus for certain cases of interworking, intentional withholding of the answer signal would be identical with the abnormal condition. Thus discrimination is impossible.

It is recommended that:

a) withholding the answer signal cannot be a satisfactory solution since

- the connection may remain in the abnormal transmission condition (e.g. failure to enable the echo suppressor in Signalling System R2 and retention of band-stop filter in Signalling System R1),
- the time supervision will interrupt the connection after 2 or 4 minutes,

and the answer signal should thus be retained (be used) even in the case of a *no charge* condition over the international network;

b) there is no necessity to modify existing equipment to provide *charge/no charge* information transfer capabilities.

From a technical viewpoint, international *no charge* calls are possible without restrictions only when the Signalling Systems No. 6 or R2 are used exclusively throughout the entire international network (assuming that *no charge* information is received from the national network).

In the case of interworking with systems not able to transfer the *no charge* information, a *no charge* call can at present only be provided by withholding the answer signal. Consequently the transfer of *no charge* information must not be performed in these cases.

In the case of Signalling System No. 6, the information *no charge* should be sent together with the *address-complete, no charge.* If this information is contradicted by the subsequent *answer, charge* signal the call should nevertheless not be charged (§ 4.1.9, Signalling System No. 6 specification).

The transfer of *no charge* information is possible when interworking:

from Signalling System:	No. 6	R2	No. 6 [1]	R2
to Signalling System	No. 6	R2	R2	No. 6

8.2 *Time-out guidelines* (need further study).

8.2.1 *Time-outs connected with subscribers' behaviour*

The specified register time-out of 4 to 6 seconds (after each digit is received which is resorted to when address complete cannot be identified in another way) has proved to give satisfactory technical functioning at least in those cases where the exception described in Recommendation Q.261, § 4.1.5, e) does not apply.

Insufficient information is obtained to motivate a change at this stage of the duration of the 4 to 6 seconds time-out specified in the outgoing register in cases where no address-complete indication is available.

It is recommended that the 4 to 6 seconds interdigital time-out procedure should be used where needed only. It is furthermore recommended that Administrations make their network numbering known to their respondents so that maximum use of number length analysis can be made whenever address-complete information cannot be given.

8.2.2 *General time-out guidelines* (need further study).

[1] When interworking from Signalling System No. 6 to Signalling System R2 the comments of § 8.1 have to be taken into account.

ANNEX A

(to Recommendations Q.601-Q.680)

TABLE A-1

List of forward interworking telephone events (FITEs)

No.	Forward interworking telephone events	Equivalent with signal of Signalling System				
		No. 4	No. 5	No. 6	R2	R1
1	Digit 1, 2, ... 9 or 0, code 11 or 12, end-of-pulsing (ST) signal	1	1	1	1	1
2	Country-code indicator, country code not included	8	8	2	18	
3	Country-code indicator, country code included	9	9	3		
4	Echo-suppressor indicator, outgoing half-echo suppressor not included, incoming half-echo suppressor not required			6	19	
5	Echo-suppressor indicator, outgoing half-echo suppressor included, incoming half-echo suppressor required	10		7	11	
6	Country-code indicator, country code included ; echo-suppressor indicator, outgoing half-echo suppressor not included, outgoing half echo suppressor required				8	
7	Country-code indicator, country code included ; echo-suppressor indicator, outgoing half-echo suppressor not included, no echo suppressor required				9	
8	Country-code indicator, country code included ; echo-suppressor indicator, outgoing half-echo suppressor included, incoming half-echo suppressor required				10	
9	Calling-party's-category indicator, operator, language French	2	2	8	2	
10	Calling-party's-category indicator, operator, language English	3	3	9	3	
11	Calling-party's-category indicator, operator, language German	4	4	10	4	
12	Calling-party's-category indicator, operator, language Russian	5	5	11	5	
13	Calling-party's-category indicator, operator, language Spanish	6	6	12	6	
14	Calling-party's-category indicator, operator with forward-transfer facility				15	
15	Calling-party's-category indicator, subscriber				7	
16	Calling-party's-category indicator, subscriber or operator without forward-transfer facility				12	
17	Calling-party's-category indicator, subscriber, ordinary call	7	7	13		
18	Calling-party's-category indicator, subscriber, call with priority			14	14	
19	Calling-party's-category indicator, data call			15	13	
20	Nature-of-circuit indicator, no satellite circuit in the connection			4		
21	Nature-of-circuit indicator, one satellite circuit in the connection			5		
22	Clear-forward	11	10	16	16	3
23	Forward-transfer	12	11	17		2
24	Continuity			18		

A.1 *Explanatory notes on the meanings and uses of FITEs* (see Table A-1)

These are Forward Interworking Telephone Events sent from an incoming procedure to an interworking procedure, or from an interworking procedure to an outgoing procedure.

A.1.1 FITE 1 means one of the digits 1-9, 0, code 11, code 12 and code 15 (ST), when used as an *address signal* (i.e. not including their use for other information, e.g. language digits). Each FITE 1 represents one digit only and that digits value is implicit in the signal.

A.1.2 FITEs 2, 3, 6, 7 and 8 are events representing *country code indicators.* These signals are not sent from the incoming procedure to the interworking procedure, since the country code indicator is a link dependent signal and is used by the incoming procedure as part of the input information to the digit analysis. These FITEs are generated in the interworking procedure by the use of SPITE 22 (see Table A-3).

A.1.3 FITEs 4-8 are events representing *echo-suppressor indicators.* These signals are not sent from the incoming procedure to the interworking procedure, since the echo-suppressor indicator is a link dependent signal and is used by the incoming procedure as part of the input information to the digit analysis. These FITEs are generated in the interworking procedure by the use of SPITE 21 (see Table A – 3).

A.1.4 FITEs 9-19 are events representing *calling-party's category indicators* and include telephone events derived from language digits, discriminating digits and calling-party's-category signals.

A.1.5 FITEs 20 and 21 are events representing *nature-of-circuit indicators.* These signals are not sent from the incoming procedure to the interworking procedure, but the nature-of-circuit indicator is used by the incoming procedure as part of the input information to the digit analysis. These FITEs are generated in the interworking procedure by the use of SPITE 20 (see Table A-3). These signals are not completely link dependent, since if the nature-of-circuit indicator on the incoming circuit implies one satellite in the connection, the same signal (FITE 21) will be sent to the outgoing procedure.

A.1.6 FITE 22 is an event representing the *clear-forward signal* and overrides all other procedures. It should therefore be shown as an input in all call states except idle, even though the waiting state might not appear to be capable of receiving FITE 22.

A.1.7 FITE 23 is an event representing the *forward-transfer signal* and is assumed to be capable of reception after the state *Address-complete* when the register function is deactivated and the speech condition is set up.

A.1.8 FITE 24 is an event representing the *continuity signal* in common channel signalling systems. When interworking from a channel associated signalling system to a common channel signalling system, FITE 24 must be generated by the interworking procedure.

TABLE A-2

List of backward interworking telephone events (BITEs)

No.	Backward interworking telephone events	Equivalent with signal of Signalling System				
		No. 4	No. 5	No. 6	R2	R1
1	Spare					
2	Address-complete, charge	1		1	2	
3	Address-complete, no charge			2		
4	Address-complete, coin box			3		
5	Address-complete, subscriber free, charge			4	8 and 13	
6	Address-complete, subscriber free, no charge			5	9	
7	Address-complete, subscriber free, coin box			6		
8	Call unsuccessful	2	1			
9	Call unsuccessful, switching-equipment congestion			7		
10	Call unsuccessful, circuit-group congestion			8		
11	Call unsuccessful, switching-equipment congestion or circuit group congestion				3	
12	Call unsuccessful, national-network congestion			9	1	
13	Call unsuccessful, address-complete, national network congestion				6 and 15	
14	Call unsuccessful, address incomplete			10		
15	Call unsuccessful, (address-complete), unallocated number			11	7 and 14	
16	Call unsuccessful, address-complete, subscriber busy (elec.)			12	5	
17	Call unsuccessful, address-complete, line out of service			13	10	
18	Spare					
19	Call unsuccessful, call-failure			15		
20	Call unsuccessful, send special information tone			14	4 and 14	
21	Answer, subscriber free				11	
22	Answer, subscriber free, charge	3	2	16		1
23	Answer, subscriber free, no charge			17		
24	Answer, re-answer			18		
25	Clear-back	4	3	19	12	2
26	Artificial address complete may be sent		4			3
27	Sending-finished ; set up speech condition		(5) [a]			(4) [a]
28	Deactivate register function					

[a] To be clarified in the Study Period 1981-1984.

A.2 *Explanatory notes on the meanings and uses of BITEs* (see Table A-2)

These are Backward Interworking Telephone Events sent from an outgoing procedure to an interworking procedure, or from an interworking procedure to an incoming procedure.

A.2.1 BITE 2 is an *address-complete event* which may be originated either by the receipt of an address complete signal or by the simulation of the address complete condition from a signalling system not employing address complete signals. This latter event is designated BITE 26, when signalling from the outgoing procedure to the interworking procedure. Since in most cases the forward signalling continues beyond the time that the address-complete is simulated, BITE 2 does not cause register deactivation in the incoming logic in the way that BITEs 3-7 do. The incoming procedure must wait for the subsequent reception of BITE 27 or BITE 28 (see §§ A.2.7 and A.2.8).

A.2.2 BITEs 3-7 are *address-complete events* which cause the speech condition to be set up and the register function to be deactivated.

A.2.3 BITEs 8-17, 19, 20 are *call unsuccessful events* which cause the return of a corresponding event to the incoming procedure where the register function will be deactivated. They are separated according to the reasons of an unsuccessful call.

A.2.4 BITEs 21-24 are *answer events*, differentiated where possible.

A.2.5 BITE 25 is the event representing the *clear-back signal.*

A.2.6 BITE 26 is an event signalling the *simulation of address-complete* condition by an outgoing signalling system which does not employ address-complete signals (e.g. No. 5 or R1). If the incoming signalling system uses address-complete signals, BITE 26 is translated to BITE 2 in the interworking procedures, in other cases it is discarded.

A.2.7 BITE 27 means that an outgoing signalling system which does not employ address-complete signals has *completed forward signalling* (e.g. ST has been sent) and the *speech condition should be set up.* When used, it will follow after BITE 26.

For incoming signalling systems employing address-complete signals, BITE 27 will always be expected after BITE 2. Therefore when both interworking systems employ address-complete signals, the interworking procedure must translate BITE 2 to BITE 2 + BITE 27.

A.2.8 BITE 28 is used only from an interworking procedure to an incoming procedure in the case where a BITE is received from the outgoing procedure which has no corresponding BITE in the incoming procedure. A tone will be returned by the use of SPITE 6 in the interworking procedure, and BITE 28 is used solely to deactivate the register function in the incoming procedure.

TABLE A-3

List of switching processing interface telephone events (SPITEs)

No.	Designation	Symbol
1	Activate register function (physical register or equivalent function)	Task
2	Register function activated	Internal input
3	Deactivate register function	Task
4	Set up speech condition	Task
5	Release speech condition (of the speech path in the exchange)	Task
6	Return appropriate tone	Task
7	Spare	
8	Release all equipment (covers also stop of tones ; exclusively used at the incoming procedures)	Task
9	Spare	
10	Spare	
11	Shall digit analysis be started ?	Decision
12	Perform digit analysis	Task
13	Digit analysis cannot be completed (covers insufficient information, waiting for enough digits for routing etc.)	Internal input
14	Routing information	Internal input
15	Unallocated number	Internal input
16	Unprovided routing (e.g. transit connection received at an exchange handling terminating traffic only)	Internal input
17	Barred routing	Internal input
18	Switching equipment congestion	Internal input
19	Circuit group congestion	Internal input
20	Satellite link included?	Decision
21	Incoming half-echo suppressor to be included at distant end?	Decision
22	Transit connection following? (otherwise a terminal connection is following)	Decision
23	Has Z-digit been received?	Decision
24	Is this the Z-digit?	Decision
25 to 30	Spare	
31	Perform continuity check at the outgoing end (covers all necessary switching procedures : — connecting of the transceiver — disabling of echo suppressors — sending check tone — automatic reattempts, where applicable)	Task
32	Insert check loop at the incoming end (including disabling of echo suppressors)	Task
33	Continuity check O.K. (covers also receiving of checktone and removal of the transceiver)	Internal input
34	Remove check loop at the incoming end (including enabling of echo suppressors)	Task
35	Ignore further register signals	Task
36 to 40	Spare	

A.3 *Explanatory notes on the meanings and uses of SPITEs* (see Table A-3)

SPITEs are Switching Processing Interface Telephone Events used in all three procedures. For convenience the three signalling procedures are considered to be processes within a larger switching process and all SPITEs are considered to be *internal to the signalling procedures* but having, where necessary, full access to any switching information provided by other signalling procedures. For example digit analysis is initiated by the incoming procedure, but the results are available to both the interworking and outgoing procedures, where necessary. By contrast all FITEs, BITEs and telephone signals are external signals. The SPITEs are grouped into three categories:

a) SPITEs 1-10 are allocated or reserved for *switching SPITEs*;

b) SPITEs 11-30 are allocated or reserved for *digit analysis SPITEs*;

c) SPITEs 31-40 are allocated or reserved for SPITEs used by a *restricted number of signalling systems.*

A.3.1 SPITE 1 *activate register function* is used in the incoming procedure to activate the register function following the receipt of the seizing signal or the initial address message. The register function keeps a memory of all received signals.

A.3.2 SPITE 2 *register function activated* is used following SPITE 1 where a proceed to send signal must be sent.

A.3.3 SPITE 3 *deactivate register function* is used in the incoming procedure to deactivate the register function. It is used after one of the following events:

- clear-forward,
- register timeout,
- SPITEs 15-19 (reasons of unsuccessful calls)
- BITEs 3-17, 19, 20, 27, 28 or any other error condition indicating an unsuccessful call.

A.3.4 SPITE 4 *set-up speech condition* is used in the incoming procedure to set-up the speech condition at the end of the register phase. It is therefore used in conjunction with SPITE 3 after reception of BITEs 3-7 and 27.

A.3.5 SPITE 5 *release speech condition* is used in the incoming or interworking procedure where a call unsuccessful BITE is received after SPITE 4. If the BITE is returned to the incoming procedure, SPITE 5 is used there but if the BITE is translated to a tone in the interworking procedure using SPITE 6, then SPITE 5 is used in the interworking procedure.

A.3.6 SPITE 6 *return appropriate tone* is used in the incoming procedure where no electrical signal corresponds to SPITEs 15-19, and also in the interworking procedure when a BITE is received for which no corresponding BITE exists in the incoming procedure.

A.3.7 SPITE 8 *release all equipment* is used in the incoming procedure when a clear-forward signal is received after the register phase.

A.3.8 SPITE 11 *shall digit analysis be started?* is used in the incoming procedure to determine, when sufficient digits have been received, that digit analysis may begin.

A.3.9 SPITE 12 *perform digit analysis* is used in the incoming procedure to perform digit analysis. The analysis takes into account the following information, where available:

- address information
- Z-digit (L- or D-digit)
- country-code indicator
- echo-suppressor indicator
- nature-of-circuit indicator
- calling-party's-category.

SPITE 12 will be followed by one of the SPITEs 13-19 which indicate the result of the analysis, and are only used in the incoming procedure.

A.3.10 SPITE 13 *digit analysis cannot be completed* indicates that insufficient address information is available to complete the digit analysis.

A.3.11 SPITE 14 *routing information* indicates that digit analysis has been completed and the following information determined:

- type of outgoing signalling system
- transit or terminal connection
- echo-suppressor indicator
- nature-of-circuit indicator
- position of Z-digit.

SPITEs 15-19 are results of digit analysis.

A.3.12 SPITE 15 *unallocated number* indicates that the received address digits represent an unallocated number (country code, area code, etc.).

A.3.13 SPITE 16 *unprovided routing* indicates that the received address digits represent a valid code but that the required destination cannot be reached via this exchange.

A.3.14 SPITE 17 *barred routing* indicates that the received address digits represent a valid code but that access to it is barred by reason of, for example:

- wrong calling party's category
- prohibited route-route combination.

A.3.15 SPITE 18 *switching equipment congestion* indicates that the switching attempt to the outgoing circuit met switching equipment congestion.

A.3.16 SPITE 19 *circuit group congestion* indicates that all circuit groups to the required destination were congested.

SPITEs 20-24 ask for information from the results of digit analysis.

A.3.17 SPITE 20 *satellite link included?* is used in the interworking procedure to determine the required nature of circuit indicator that should be transmitted. This information is available from the results of digit analysis.

A.3.18 SPITE 21 *incoming half-echo-suppressor to be included at distant end?* is used in the interworking procedure to determine the required echo suppressor indicator that should be transmitted. This information is available from the results of digit analysis.

A.3.19 SPITE 22 *transit connection following?* is used in the interworking procedure to determine the required country code indicator that should be transmitted. This information is available from the results of digit analysis.

A.3.20 SPITE 23 *has Z-digit been received?* is used in the incoming procedure following digit analysis to decide whether the Z-digit has already been received. The position of the Z-digit is determined as part of the digit analysis.

A.3.21 SPITE 24 *is this the Z-digit?* is used in the incoming procedure to decide whether a received register signal is the Z-digit or an address digit. This can be determined, since the position of the Z-digit is known after digit analysis.

A.3.22 SPITE 31 *perform continuity check* is used in the outgoing procedure of common channel signalling systems to perform the continuity check including all necessary switching procedures.

A.3.23 SPITE 32 *insert check loop* is used in the incoming procedure of common channel signalling systems to insert the continuity check loop.

A.3.24 SPITE 33 *continuity check O.K.* is used in the outgoing procedure of common channel signalling systems to indicate a successful continuity check.

A.3.25 SPITE 34 *remove check loop* is used in the incoming procedure of common channel signalling systems to remove the continuity check loop.

A.3.26 SPITE 35 *ignore further register signals* is used in the incoming procedure of Signalling System No. 5 and R1 following the receipt of the ST signal to indicate that all further register signals should be ignored.

TABLE A-4

Representation of the information contents – Forward signals of Signalling System No. 4

Signals of Signalling System No. 4 / Information elements / Signal No.		1 Address signals	2 Language digit 1: French	3 Language digit 2: English	4 Language digit 3: German	5 Language digit 4: Russian	6 Language digit 5: Spanish	7 Discriminating digit 0	8 Terminal-seizing signal	9 Transit-seizing signal	10 Incoming half-echo suppressor required [a]	11 Clear-forward signal	12 Forward-transfer signal
Digit 1, 2 ... 9 or 0, code 11 or 12,		×											
end-of-pulsing (ST) signal		×											
Country-code indicator									×	×			
Country-code not included									×				
Country-code included										×			
Nature-of-circuit indicator													
No satellite circuit in the connection													
One satellite circuit in the connection													
Echo-suppressor indicator											×		
Outgoing half-echo suppressor not included													
Outgoing half-echo suppressor included											×		
Outgoing half-echo suppressor required													
No echo-suppressor required													
Incoming half-echo suppressor required											×		
Calling-party's-category indicator			×	×	×	×	×	×					
Operator			×	×	×	×	×						
Subscriber								×					
Ordinary call								×					
Call with priority													
Forward-transfer facility													
No forward-transfer facility													
Language French			×										
Language English				×									
Language German					×								
Language Russian						×							
Language Spanish							×						
Clear-forward												×	
Forward-transfer													×
Corresponds to signal No. ... of Signalling System	No. 5	1	2	3	4	5	6	7	8	9	⊗	10	11
	No. 6	1	8	9	10	11	12	13	2	3	7	16	17
	R2	1	2	3	4	5	6	(7)	18	[8, 9 or 10]	11	16	17

[a] Signal code 14 is available for use upon multi-lateral or bilateral agreement for echo-suppressor control.

⊗ No equivalent signal

(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20522

TABLE A-5

Representation of the information contents – Forward signals of Signalling System No. 5

Information elements / Signals of Signalling System No. 5	Signal No.	1	2	3	4	5	6	7	8	9	10	11
		Address signals	Language digit 1: French	Language digit 2: English	Language digit 3: German	Language digit 4: Russian	Language digit 5: Spanish	Discriminating digit 0	Start-of-pulsing signal KP1	Start-of-pulsing signal KP2	Clear-forward signal	Forward-transfer signal
Digit 1, 2 ... 9 or 0, code 11 or 12,		×										
end-of-pulsing (ST) signal		×										
Country-code indicator									×	×		
Country-code not included									×			
Country-code included										×		
Nature-of-circuit indicator												
No satellite circuit in the connection												
One satellite circuit in the connection												
Echo-suppressor indicator												
Outgoing half-echo suppressor not included												
Outgoing half-echo suppressor included												
Outgoing half-echo suppressor required												
No echo-suppressor required												
Incoming half-echo suppressor required												
Calling party's-category indicator			×	×	×	×	×	×				
Operator			×	×	×	×	×					
Subscriber								×				
Data call												
Ordinary call								×				
Call with priority												
Forward-transfer facility												
No forward-transfer facility												
Language: French			×									
Language: English				×								
Language: German					×							
Language: Russian						×						
Language: Spanish							×					
Clear-forward											×	
Forward-transfer												×
Corresponds to signal No. ... of Signalling System	No. 4	1	2	3	4	5	6	7	8	9	11	12
	No. 6	1	8	9	10	11	12	13	2	3	16	17
	R2	1	2	3	4	5	6	(7)	18	[8, 9 or 10]	16	17
	R1	1	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	3	2

⊗ No equivalent signal

(No.) Loss of information

[No.] Additional information of change of information

No. Identical meaning of signals

CCITT - 20531

TABLE A-6

Representation of the information contents – Forward signals of Signalling System No. 6

Signals of Signalling System No. 6 / Information elements / Signal No.		1 Address signals	2 Country-code indicator, country-code not included	3 Country-code indicator, country-code included	4 Nature of circuit indicator, no satellite circuit in the connection	5 Nature of circuit indicator, one satellite circuit in the connection	6 Echo-suppressor indicator, outgoing half-echo suppressor not included	7 Echo-suppressor indicator, outgoing half-echo suppressor included	8 Calling-party's-category indicator, operator, language French	9 Calling-party's-category indicator, operator, language English	10 Calling-party's-category indicator, operator, language German	11 Calling-party's-category indicator, operator, language Russian	12 Calling-party's-category indicator, operator, language Spanish	13 Calling-party's-category indicator, ordinary calling subscriber	14 Calling-party's-category indicator, calling subscriber with priority	15 Calling-party's-category indicator, data call	16 Clear-forward signal	17 Forward-transfer signal	18 Continuity signal		
Digit 1, 2 ... 9 or 0, code 11 or 12,		×																			
end-of-pulsing (ST) signal		×																			
Country-code indicator			×	×																	
Country-code not included			×																		
Country-code included				×																	
Nature-of-circuit indicator					×	×															
No satellite circuit in the connection					×																
One satellite circuit in the connection						×															
Echo-suppressor indicator							×	×													
Outgoing half-echo suppressor not included							×														
Outgoing half-echo suppressor included								×													
Outgoing half-echo suppressor required																					
No echo-suppressor required																					
Incoming half-echo suppressor required								×													
Calling-party's-category indicator									×	×	×	×	×	×	×	×					
Operator									×	×	×	×	×								
Subscriber														×	×						
Data call																×					
Ordinary call														×							
Call with priority															×						
Forward-transfer facility																					
No forward-transfer facility																					
Language: French									×												
Language: English										×											
Language: German											×										
Language: Russian												×									
Language: Spanish													×								
Clear-forward																	×				
Forward-transfer																		×			
Continuity																			×		
Corresponds to signal No. ... of Signalling System	No. 4	1	8	9	Ⓧ	Ⓧ	Ⓧ	10[a]	2	3	4	5	6	7	Ⓧ	Ⓧ	11	12	Ⓧ		
	No. 5	1	8	9	Ⓧ	Ⓧ	Ⓧ	Ⓧ	2	3	4	5	6	7	Ⓧ	Ⓧ	10	11	Ⓧ		
	R2	1	18	[8,9 or 10]	Ⓧ	Ⓧ	19	11	2	3	4	5	6	[12]	14	13	16	17	Ⓧ		
	R1	1	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	Ⓧ	3	2	Ⓧ		

[a] Signal code 14 is available for use upon multi-lateral or bilateral agreement for echo-suppressor control.

Ⓧ No equivalent signal

(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20353

TABLE A-7

Representation of the information contents – Forward signals of Signalling System R1

Information elements / Signals of Signalling System R1		Address signals	Ring-forward (forward-transfer)	Clear-forward																	
Signal No.		1	2	3																	
Digit 1, 2 ..., 9 or 0, ST signal		×																			
Country-code indicator																					
Country-code not included																					
Country-code included																					
Nature-of-circuit indicator																					
No satellite circuit in connection																					
One satellite circuit in connection																					
Echo-suppressor indicator																					
Outgoing half-echo suppressor not included																					
Outgoing half-echo suppressor included																					
Outgoing half-echo suppressor required																					
No echo suppressor required																					
Incoming half-echo suppressor required																					
Calling-party's-category indicator																					
Operator																					
Subscriber																					
Data call																					
Ordinary call																					
Call with priority																					
Forward-transfer facility																					
No forward-transfer facility																					
Language: French																					
Language: English																					
Language: German																					
Language: Russian																					
Language: Spanish																					
Clear-forward				×																	
Forward-transfer			×																		
Corresponds to signal No. ... of Signalling System	No. 5	1	11	10																	
	No. 6	1	17	16																	
	R2	1	17	16																	

CCITT - 20250

TABLE A-8

Representation of information contents – Forward signals of Signalling System R2

Information elements / Signals of Signalling System R2	Signal No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		Address signals	I-1: Language digit: French	I-2: Language digit: English	I-3: Language digit: German	I-4: Language digit: Russian	I-5: Language digit: Spanish	I-10: Discriminating digit	I-11: Country-code indicator, outgoing half-echo suppressor required	I-12: Country-code indicator, no echo-suppressor required	I-14: Country-code indicator, incoming half-echo suppressor required	I-14: Incoming half-echo suppressor required [e]	II-7: Calling-party's-category, subscriber or operator without forward-transfer facility	II-8: Calling-party's-category, data transmission control	II-9: Calling-party's-category, subscriber with priority	II-10: Calling-party's-category operator with forward-transfer facility	Clear-forward signal	Forward-transfer signal [a]	First digit I-1, I-2, ... I-10	Reply to A-14, I-1, ... I-10 [e]
Digit 1, 2 ... 9 or 0, code 11 or 12,		×																		×
end-of-pulsing (ST) signal		×																		
Country-code indicator									×	×	×								×	
Country-code not included																			×	
Country-code included									×	×	×									
Nature-of-circuit indicator																				
No satellite circuit in the connection																				
One satellite circuit in the connection																				
Echo-suppressor indicator									×	×	×	×								
Outgoing half-echo suppressor not included									×	×										
Outgoing half-echo suppressor included											×	×								
Outgoing half-echo suppressor required									×											
No echo-suppressor required										×										×
Incoming half-echo suppressor required											×	×								
Calling party's-category indicator			×	×	×	×	×	×					× or	×	×	×				
Operator			×	×	×	×	×						×			×				
Subscriber								×					×		×					
Data call														×						
Ordinary call													×							
Call with priority															×					
Forward-transfer facility																×				
No forward-transfer facility													×							
Language: French			×																	
Language: English				×																
Language: German					×															
Language: Russian						×														
Language: Spanish							×													
Clear-forward																	×			
Forward-transfer																		×		
Corresponds to signal No. ... of Signalling System	No. 4	1	2	3	4	5	6	7	10 [c] +9 [d]	(9)	10 [d] +9	10	7	⊗	⊗	7 [f]	11	12	8	⊗
	No. 5	1	2	3	4	5	6	7	⊗	(9)	⊗	⊗	7	⊗	⊗	7 [f]	10	11	8	⊗
	No. 6	1	8	9	10	11	12	b)	3 7 [c]	3 +6	3 +7	7	13	15	14	13 [f]	16	17	2	6
	R1	1	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	3	2	⊗	⊗

a) See Rec. Q. 400, § 1.1.3. A forward-transfer signal does not normally form part of Signalling System R2.

b) See signals II-7, II-8 and II-9.

c) Translation of signal I-11, succeeding circuit must be equipped with outgoing half-echo suppressor.

d) Signal code 14 is available for use upon multi-lateral or bilateral agreement for echo-suppressor control.

e) In reply to signal A-14.

f) The I/0 logic treates the signal II-10 as II-7, as long as no treatment of the *forward-transfer signal* is considered.

⊗ No equivalent signal

(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20542

TABLE A-9

Representation of the information contents – Backward signals of Signalling System No. 4

Information elements \ Signals of Signalling System No. 4		Number-received signal	Busy-flash signal	Answer signal	Clear-back signal																
Signal No.		1	2	3	4																
Address-complete		×																			
Subscriber free		·		×																	
Coin box																					
Charge		×		×																	
No charge																					
Call unsuccessful			×																		
Switching-equipment congestion																					
Circuit-group congestion																					
National-network congestion																					
Address-incomplete																					
Unallocated number																					
Subscriber busy (elec.)																					
Line out of service																					
Send special information tone																					
Call failure																					
Clear-back					×																
Answer				×																	
Re-answer																					
Corresponds to signal No. ... of Signalling System	No. 5	⊗	1	2	3																
	No. 6	1	8	16 or 18	19																
	R2	2	a)	11	12																

a) 2, 4 or busy tone after sending of signal A-6.

⊗ No equivalent signal

(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20552

TABLE A-10

Representation of the information contents – Backward signals of Signalling System No. 5

Information elements / Signals of Signalling System No. 5	Signal No.	1 Busy-flash signal	2 Answer signal	3 Clear-back signal	4 Proceed-to-send signal	5 Inform that ST has been sent
Address-complete						
Subscriber free			×			
Coin box						
Charge			×			
No charge						
Call unsuccessful		×				
Switching-equipment congestion						
Circuit-group congestion						
National-network congestion						
Address-incomplete						
Unallocated number						
Subscriber busy (elec.)						
Line-out-of-service						
Send special-information tone						
Call failure						
Answer			×			
Re-answer						
Clear-back				×		
Artificial address-complete					×	
Sending-finished						×
Corresponds to signal No. ... of Signalling System	No. 4	2	3	4	⊗	⊗
	No. 6	8	16 or 18	19	⊗	⊗
	R2	a)	11	12	⊗	⊗
	R1	b)	1	2	3	4

a) Busy tone.

b) Appropriate or tone announcement.

⊗ No equivalent signal

(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20323

TABLE A-11

Representation of the information contents – Backward signals of Signalling System No. 6

Information elements \ Signals of Signalling System No. 6		ADC: Address complete, charge	ADN: Address complete, no charge	ADX: Address complete, coin box	AFC: Address-complete, subscriber free, charge	AFN: Address-complete, subscriber free, no charge	AFX: Address-complete, subscriber free, coin box	SEC: Switching-equipment congestion	CGC: Circuit-group congestion	NNC: National-network congestion	ADI: Address-incomplete	UNN: Unallocated number	SSB: Subscriber busy (elec.)	LOS: Line-out-of-service	SST: Send special information tone	CFL: Call failure	ANC: Answer, charge	ANN: Answer, no charge	RA1-3: Re-answer No. 1-No. 3	CBI-3: Clear-back No. 1-No. 3
	Signal No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Address-complete		×	×	×	×	×	×					×	×	×	×		(×)	(×)		
Subscriber free					×	×	×										×	×		
Coin box				×			×													
Charge		×			×												×			
No charge			×			×												×		
Call unsuccessful								×	×	×	×	×	×	×	×	×				
Switching-equipment congestion								×												
Circuit-group congestion									×											
National-network congestion										×										
Address-incomplete											×									
Unallocated number												×								
Subscriber busy (elec.)													×							
Line-out-of-service														×						
Send special-information tone															×					
Call failure																×				
Answer																	×	×	×	
Re-answer																			×	
Clear-back																				×
Corresponds to signal No. ... of Signalling System	No. 4	1	(1)	(1)	(1)	(1)	(1)	(2)	(2)	(2)	(b)	(b)	(2)	(b)	(b)	(2)	3	(3)	(3)	4
	No. 5	⊗	⊗	⊗	⊗	⊗	⊗	(1)	(1)	(1)	(b)	(b)	(1)	(b)	(b)	(1)	2	(2)	(2)	3
	R2	2	9	2	8	9	(8)	(3)	(3[a])	1[a]	(1)	7	5	10	4	(2[a])	(11)	(11)	(11)	12
	R1	⊗	⊗	⊗	⊗	⊗	⊗	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	1	(1)	1	2

a) Before an address-complete signal is sent ; otherwise audible tone.

b) Appropriate tone and possibly announcement.

⊗ No equivalent signal

(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20333

TABLE A-12

Representation of the information contents – Backward signals of Signalling System R1

Signals of Signalling System R1 / Information elements	Signal No.	1 Answer signal	2 Clear-back (hang-up)	3 Circuit seized	4 Inform that ST has been sent
Address-complete					
Subscriber free		×			
Coin box					
Charge		×			
No charge					
Call unsuccessful					
Switching-equipment congestion					
Circuit-group congestion					
National-network congestion					
Address-incomplete					
Unallocated number					
Subscriber busy (elec.)					
Line-out-of-service					
Send special-information tone					
Call failure					
Answer		×			
Re-answer					
Clear-back			×		
Artificial-address-complete				×	
Sending-finished					×
Corresponds to signal No. ... of Signalling System	No. 5	2	3	4	5
	No. 6	16 or 18	19	⊗	⊗
	R2	(11)	12	⊗	⊗

⊗ No equivalent

(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20242

TABLE A-13

Representation of the information contents – Backward signals of Signalling System R2

Signals of Signalling System R2 / Information elements / Signal No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	A-4: Congestion on the national network	A-6: Address-complete, charge, set-up speech conditions	A-15: Congestion in an international exchange or at its output	B-2: Send special-information tone	B-3: Subscriber line busy	B-4: Congestion (encountered after change-over from A-signals to B-signals)	B-5: Unallocated number	B-6: Subscriber line free, charge	B-7: Subscriber line free, no charge	B-8: Subscriber line out of order	Answer signal	Clear back signal	B-1-B-6: International, subscriber line free, charge	B-9, B-10: International send special information tone	B-11-B-15 = B-4				
Address-complete		×		(x)	×	×	(x)	×	×	×			×	(x)	×				
Subscriber free								×	×		×		×						
Coin box																			
Charge		×						×					×						
No charge									×										
Call unsuccessful	×		×	×	×	×	×			×				×	×				
Switching-equipment congestion			×																
Circuit-group congestion			or ×																
National-network congestion	×					×									×				
Address-incomplete																			
Unallocated number							×												
Subscriber busy (elec.)					×														
Line-out-of-service										×									
Send special-information tone				×										×					
Call failure																			
Answer											×								
Re-answer																			
Clear-back												×							
Corresponds to signals No. ... of Signalling System – No. 4	(2)	1	(2)	a)	(2)	(2)	a)	⊗	⊗	a)	(3)	4	⊗	a)	(2)				
No. 5	(1)	⊗	(1)	a)	(1)	(1)	a)	⊗	⊗	a)	(2)	3	⊗	a)	(1)				
No. 6	9	1	(8)	14	12	9	11	4	5	13	[16, 17 or 18]	19	4	14	9				
R1	b)	⊗	b)	b)	b)	b)	b)	⊗	⊗	b)	1	2	⊗	b)	b)				

a) Special information tone.

b) Appropriate tone or announcement.

⊗ No equivalent signal

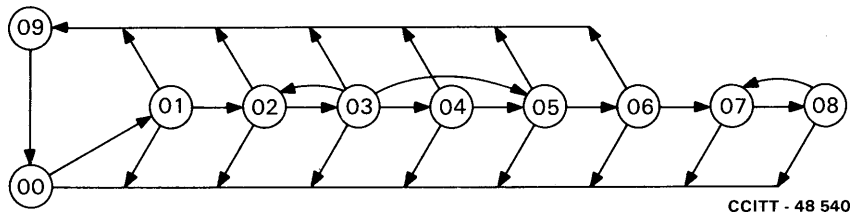
(No.) Loss of information

[No.] Additional information or change of information

No. Identical meaning of signals

CCITT - 20343

LOGIC PROCEDURES FOR INCOMING SIGNALLING SYSTEM NO. 4



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1, 3	
01	Wait for register activation	1	t_1
02	Wait for (next) forward reg. signal	1	t_2, (t_4)
03	Wait for digit analysis	2	t_3
04	Wait for address-complete	2	t_4
05	Wait for register deactivation	3	
06	Wait for answer	3	
07	Answered	3	
08	Clear-back	3	

FIGURE 1/Q.611

State overview diagram for incoming Signalling System No. 4

Supervisory timers

$t_1 \leqslant 5$ s	Q.125, § 4.2.4
$t_2 = 5$-10 s	Q.127, § 4.4.3 (2, b)
$t_3 \leqslant 10$ s	Q.125, § 4.2.4
$t_4 = 30$-60 s	Q.127, § 4.4.3 (2, a)

Procedures not shown

The following procedures, not directly relevant to interworking are not shown in the logic procedures.

FIGURE 2/Q.611

Notes to incoming Signalling System No. 4

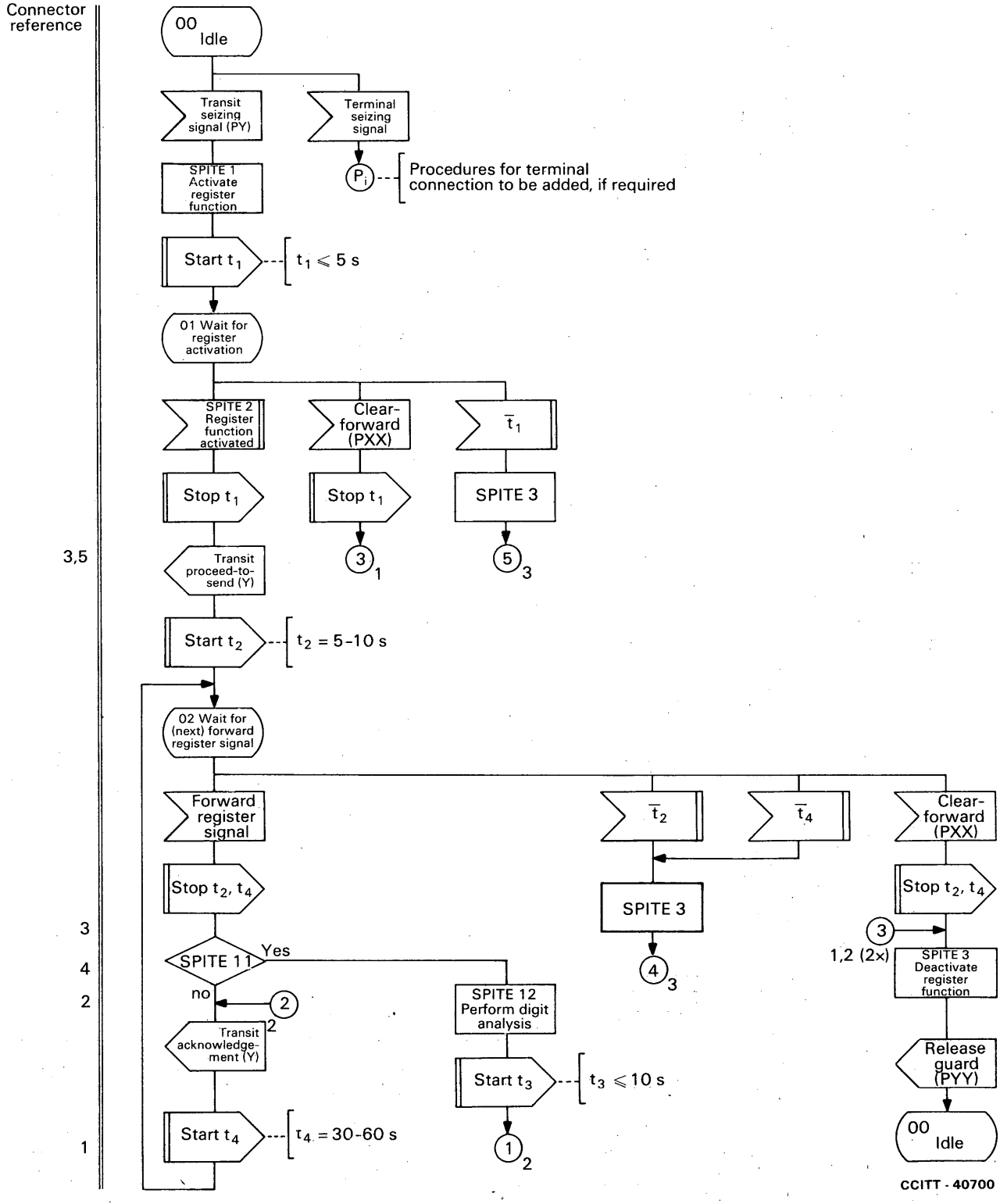


FIGURE 3/Q.611 (Sheet 1 of 3)

Incoming Signalling System No. 4

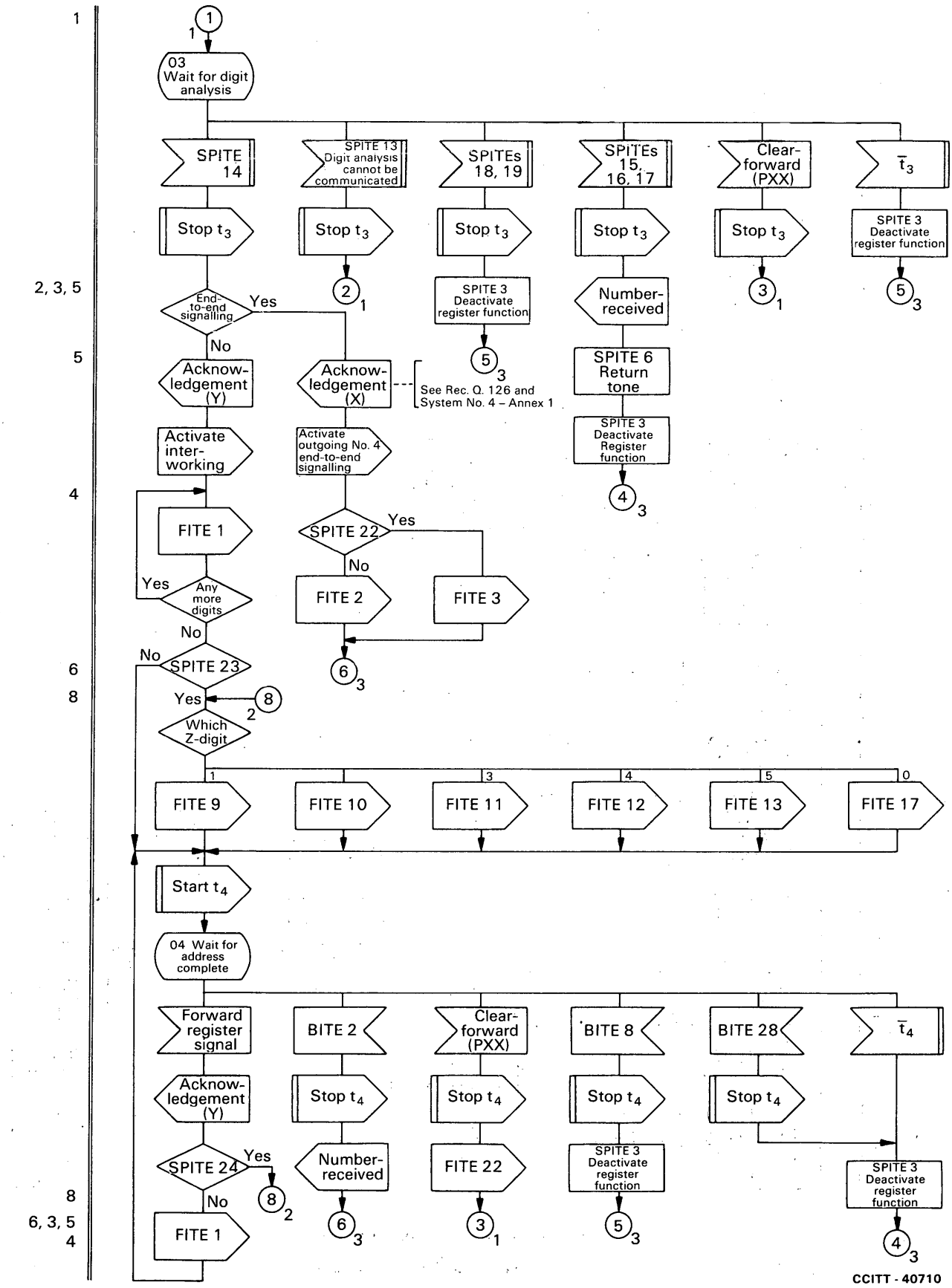


FIGURE 3/Q.611 (sheet 2 of 3)

Incoming Signalling System No. 4

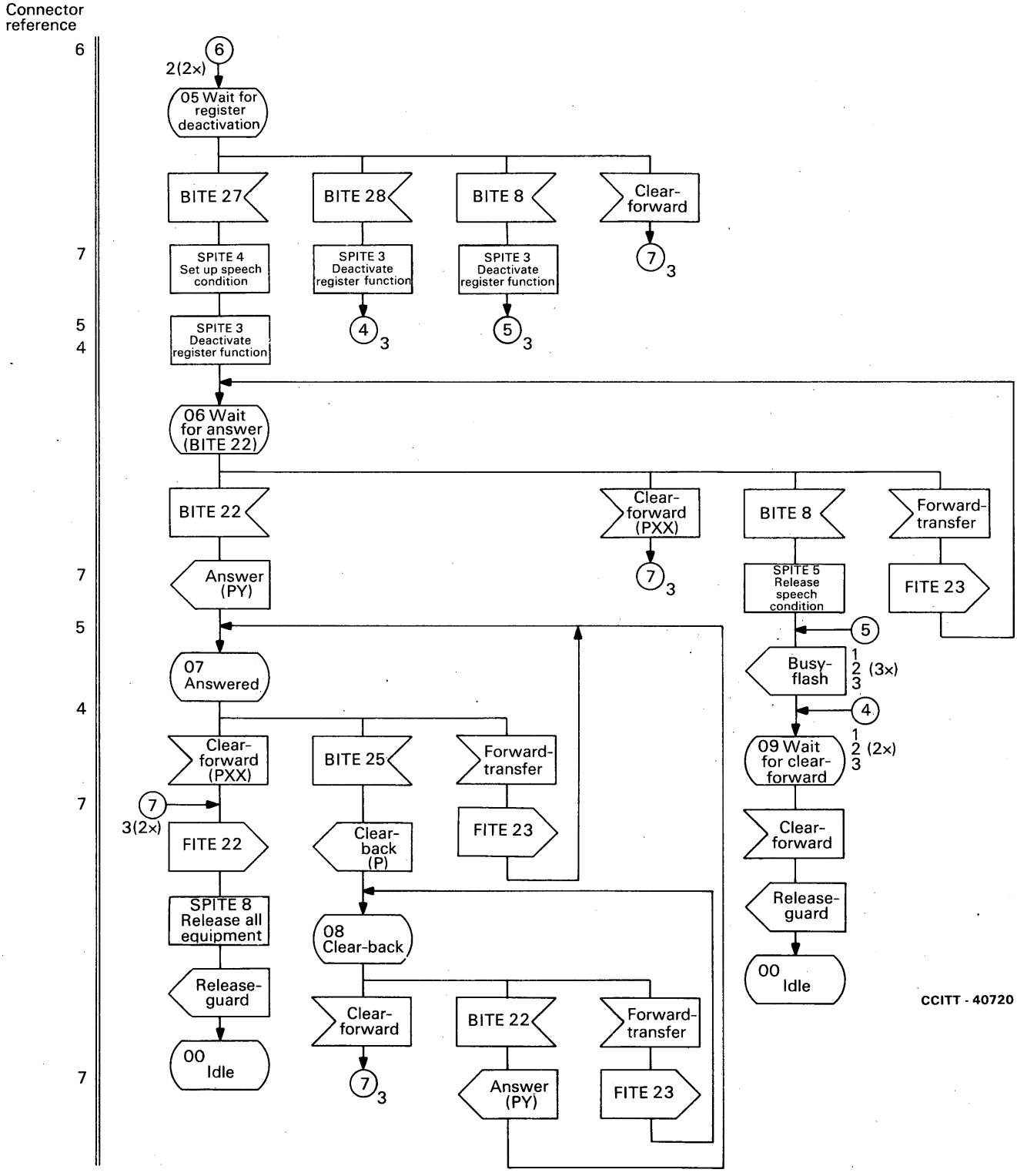
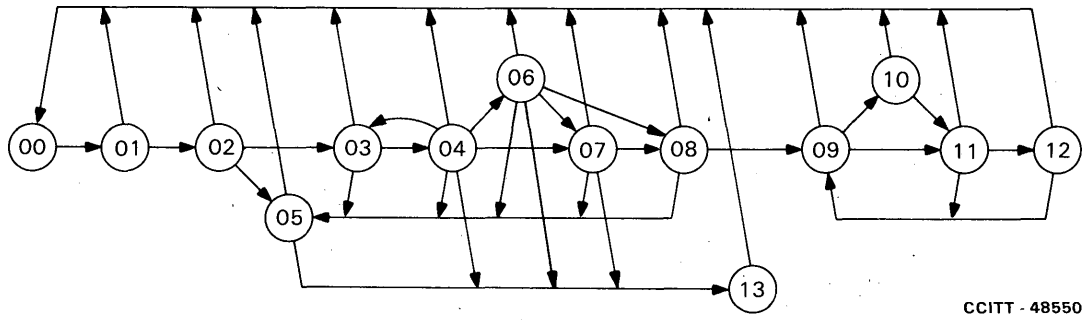


FIGURE 3/Q.611 (Sheet 3 of 3)

Incoming Signalling System No. 4

LOGIC PROCEDURES FOR INCOMING SIGNALLING SYSTEM NO. 5



State number	*State description*	*Sheet reference*	*Running timers*
00	Idle	1, 4	
01	Wait for register activation	1	
02	Wait for register signal	1	t_1, t_2
03	Wait for next register signal	1	t_2
04	Wait for digit analysis	2	t_2
05	Wait for acknowledgement	2	t_3
06	Wait for next register signal	3	t_2
07	Wait for register deactivation	3	
08	Wait for answer	3	
09	Wait for acknowledgement	4	t_3
10	Answered	4	
11	Wait for acknowledgement	4	t_3
12	Clear-back	4	
13	Wait for clear-forward	2	

FIGURE 1/Q.612

State overview diagram for incoming Signalling System No. 5

Supervisory timers

t_1 = 4-9 s	Q.141, § 2.1.3.1 e); Q.141, § 2.1.6 d)
t_2 = 20-40 s	Q.156, § 3.6.2 b)
t_3 = 10-20 s	Q.141, § 2.1.3.1 e)

Procedures not shown

The following procedures, not directly relevant to interworking, are not shown in the logic procedures.

Procedures for timeout routine.

FIGURE 2/Q.612

Notes to incoming Signalling System No. 5

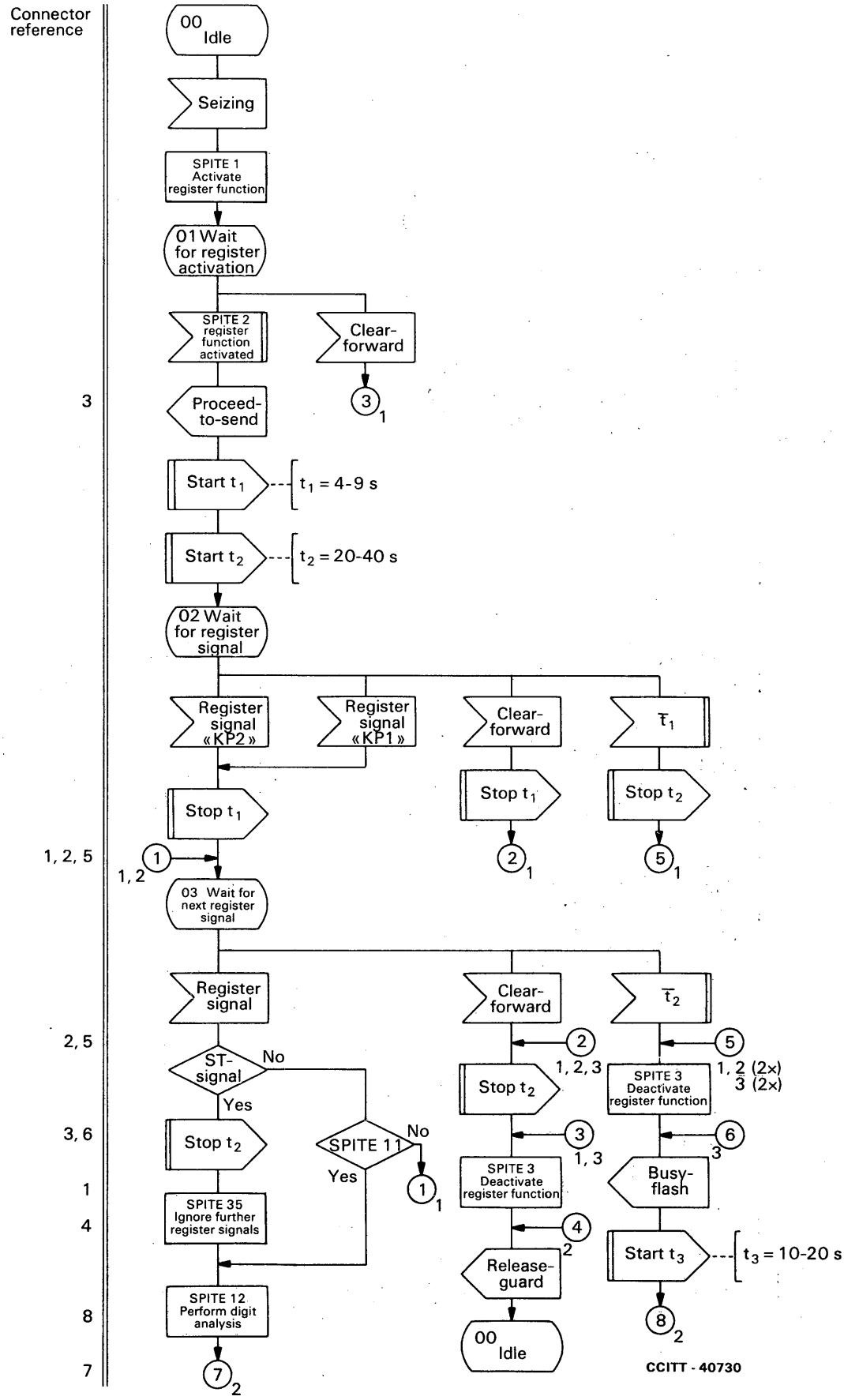


FIGURE 3/Q.612 (Sheet 1 of 4)

Incoming Signalling System No. 5

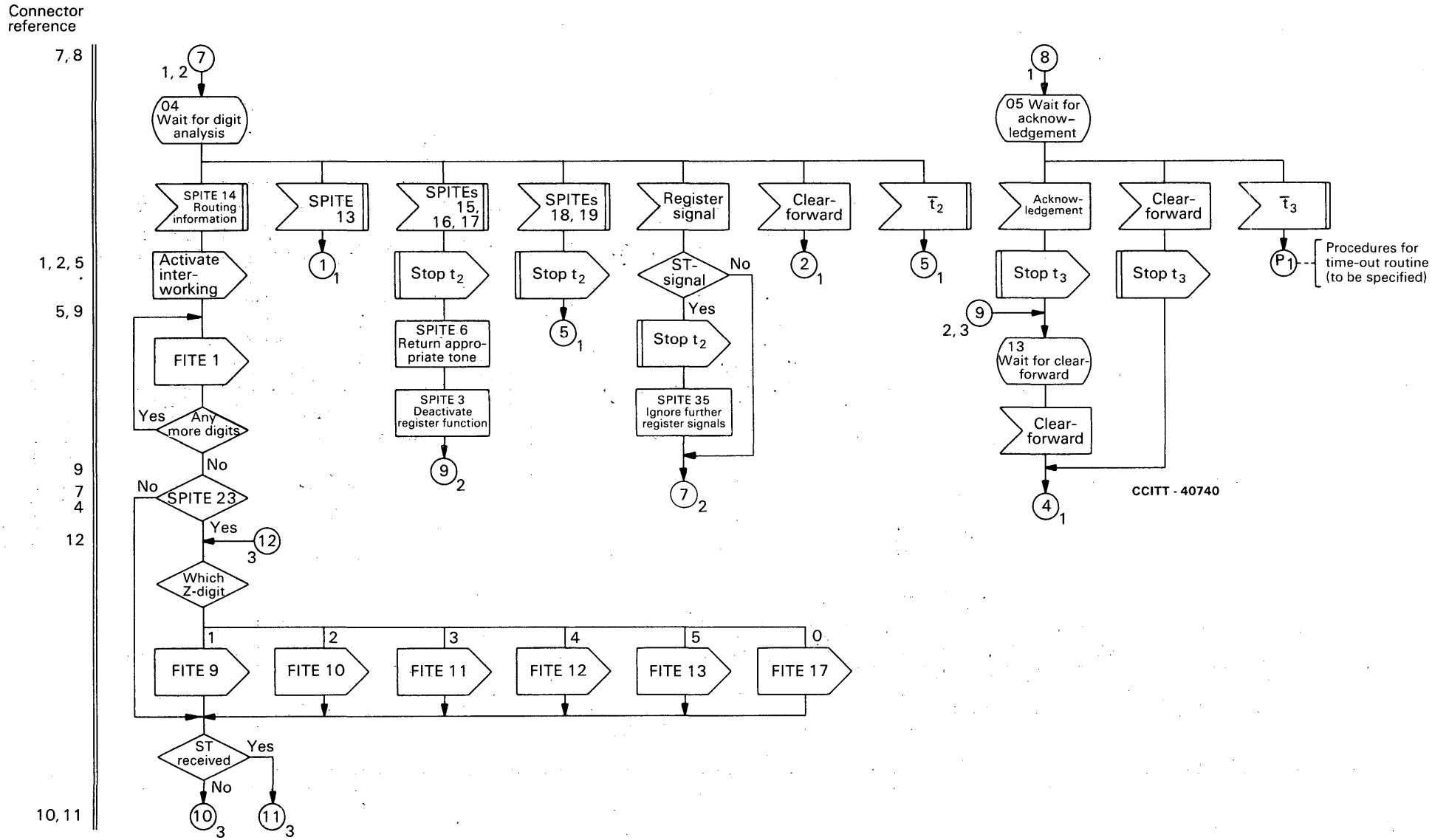


FIGURE 3/Q.612 (Sheet 2 of 4)

Incoming Signalling System No. 5

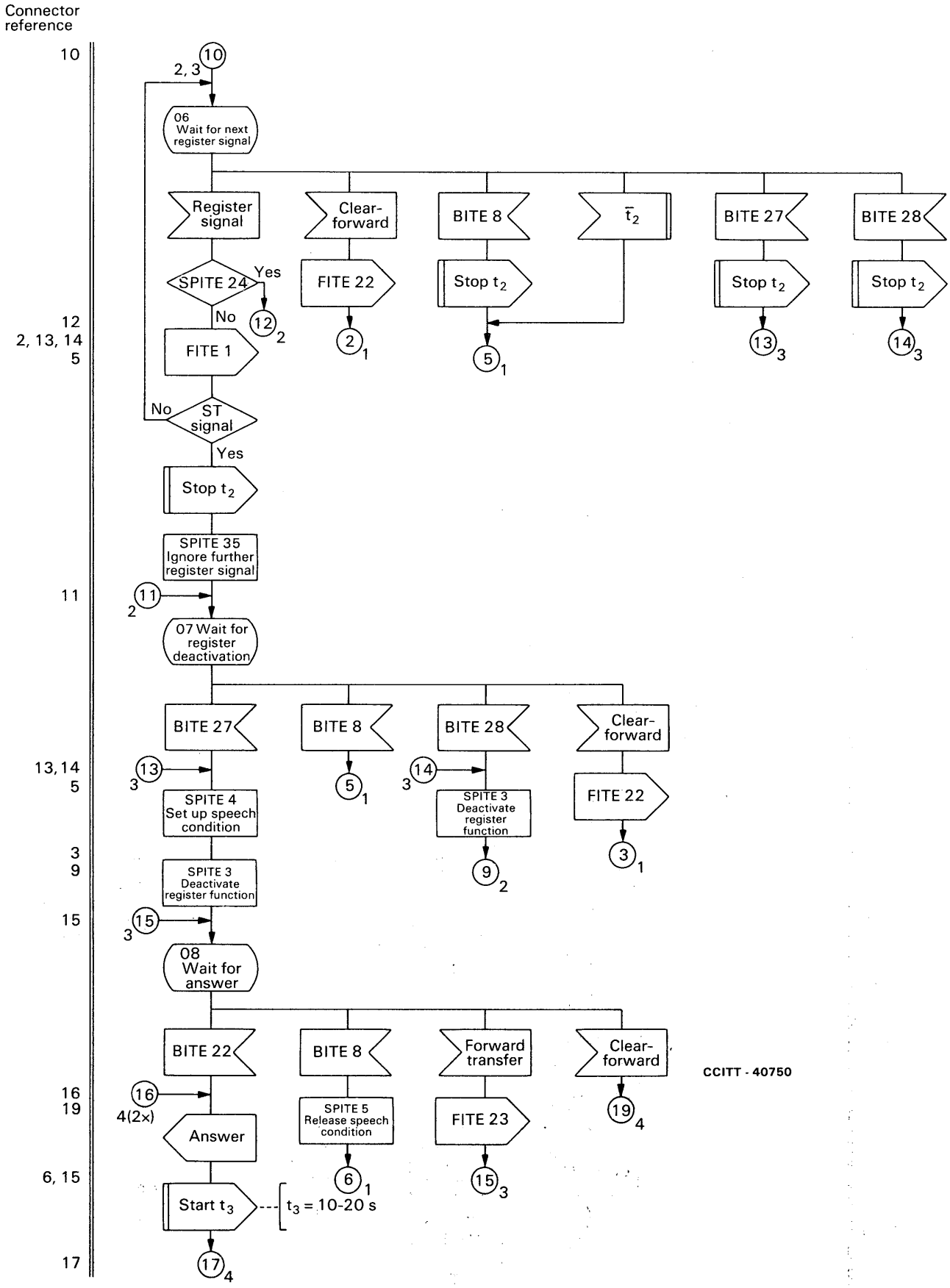


FIGURE 3/Q.612 (Sheet 3 of 4)

Incoming Signalling System No. 5

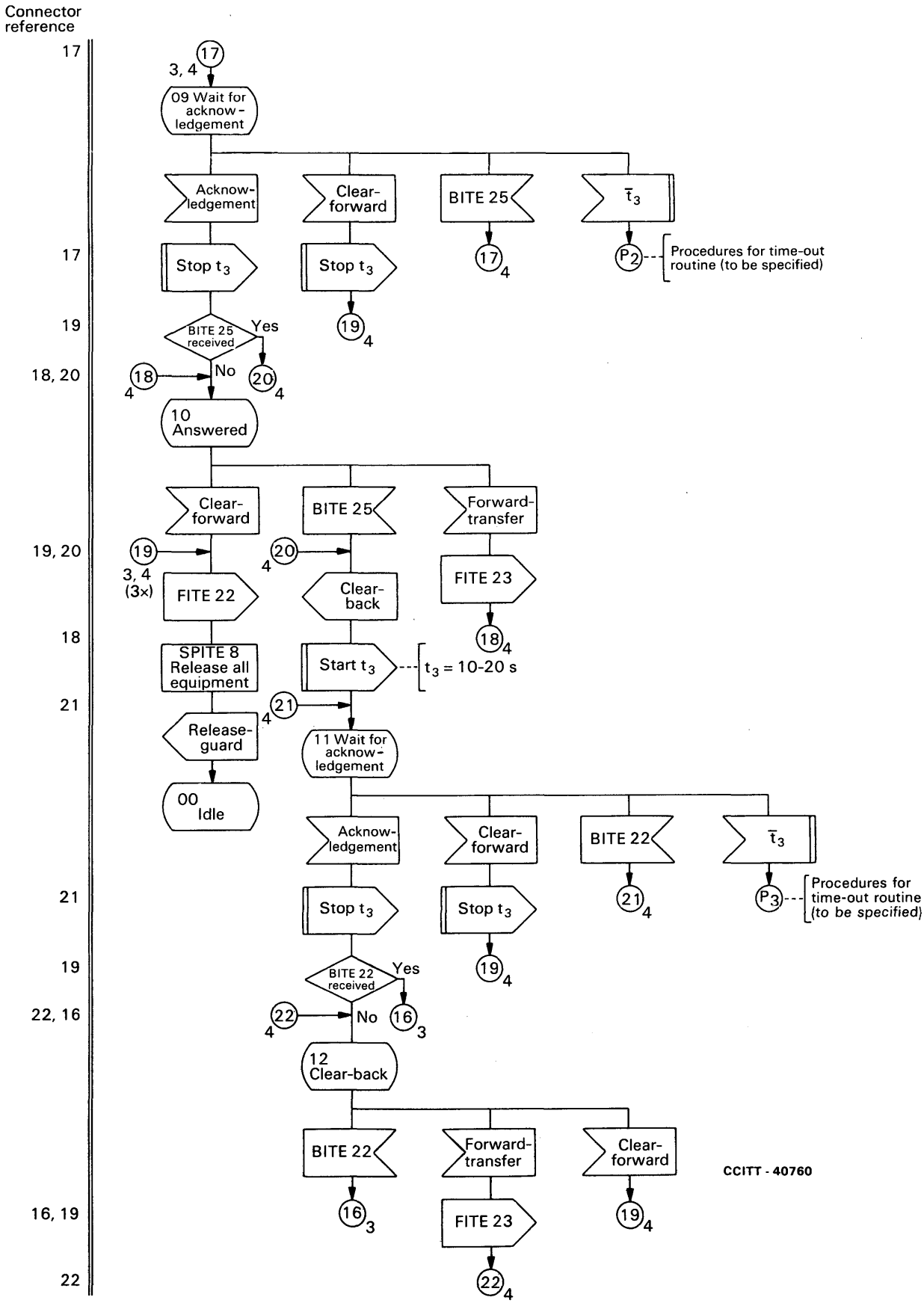
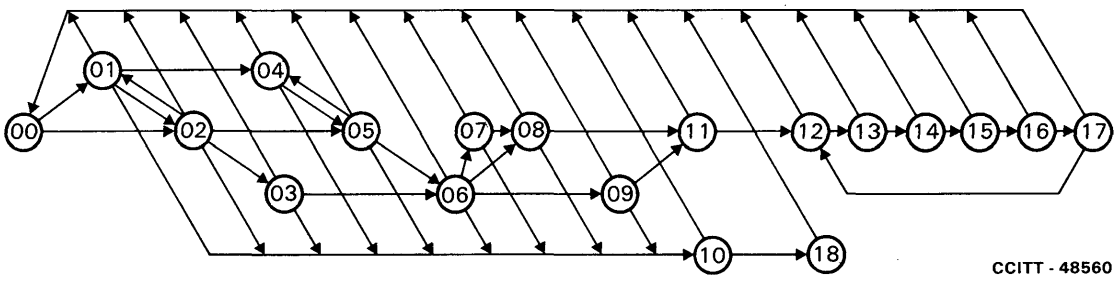


FIGURE 3/Q.612 (Sheet 4 of 4)

Incoming Signalling System No. 5

LOGIC PROCEDURES FOR INCOMING SIGNALLING SYSTEM N0. 6



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1, 8	
01	Wait for further digits	1	t_1, t_2
02	Wait for digit analysis	3	t_1, t_2 or t_3
03	Wait for continuity check (COT)	4	t_1, t_2 or t_3
04	Wait for further digits (COT received)	2	t_2
05	Wait for digit analysis (COT received)	2	t_2 or t_3
06	Wait for address complete (COT received)	5	t_2 or t_3
07	Wait for register deactivation	5	
08	Address complete – Wait for answer	7	
09	Address complete, subscriber free – Wait for answer	7	
10	Call unsuccessful – wait for clear-forward	6	t_4
11	Answered	7	
12	Clear-back 1	7	
13	Reanswer 1	7	
14	Clear-back 2	8	
15	Reanswer 2	8	
16	Clear-back 3	8	
17	Reanswer 3	8	
18	Call failure – wait for clear-forward	6	t_4, t_5

FIGURE 1/Q.613

State overview diagram for incoming Signalling System No. 6

Supervisory timers for incoming Signalling System No. 6

t_1 = 10-15 s	Recommendation Q.268, § 4.8.5.3, a)
t_2 = 15-20 s	Recommendation Q.261, § 4.1.6
t_3 = 20-30 s	Recommendation Q.268, § 4.8.5.3, a)
t_4 = 4-15 s	Recommendation Q.268, § 4.8.5.3, b)
t_5 = 1 min	Recommendation Q.268, § 4.8.5.3, b)

Procedures not shown

The following procedures, not directly relevant to interworking, are not shown in the logic procedures :

— Dual seizure,
— Blocking and unblocking sequences,
— Unreasonable sequences,
— Confusion and message refusal signals,
— Reset circuit/band procedures,
— Test call procedures,
— Out of service.

Signal abbreviations used

The signal abbreviations used correspond to those of the Signalling System No. 6 specifications unless otherwise indicated on the same sheet.

FIGURE 2/Q.613

Notes to incoming Signalling System No. 6

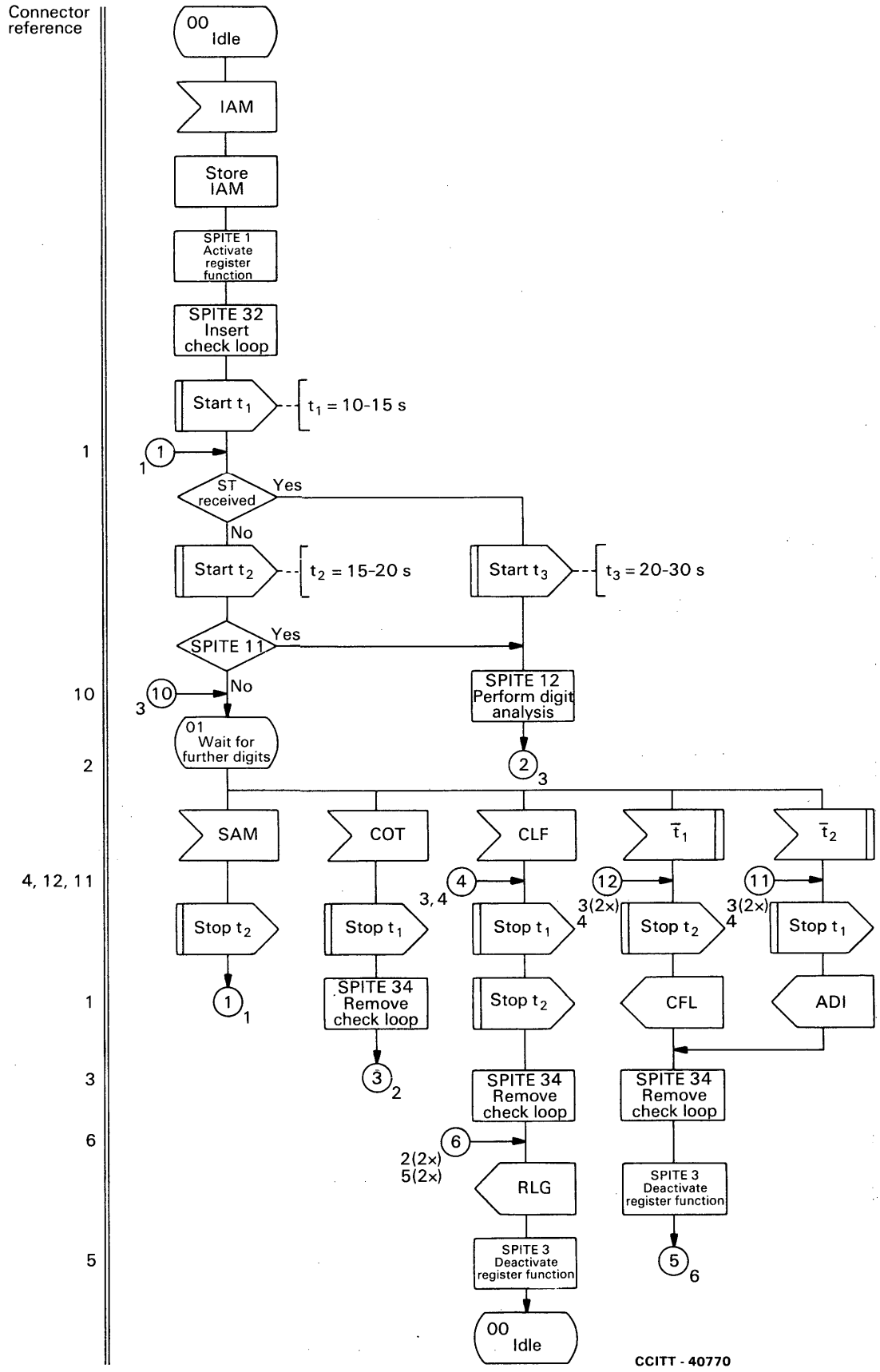


FIGURE 3/Q.613 (Sheet 1 of 8)

Incoming Signalling System No. 6

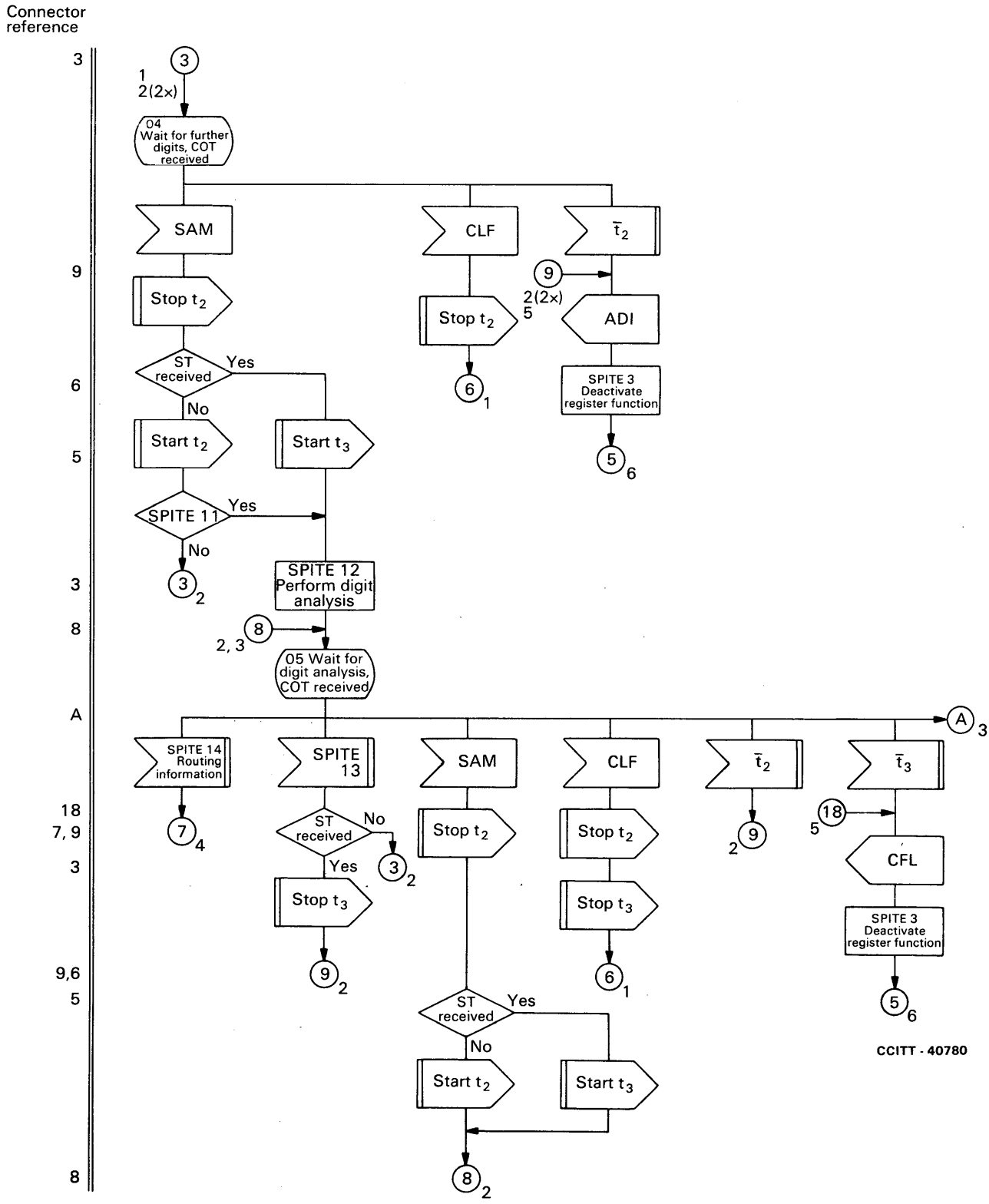


FIGURE 3/Q.613 (Sheet 2 of 8)

Incoming Signalling System No. 6

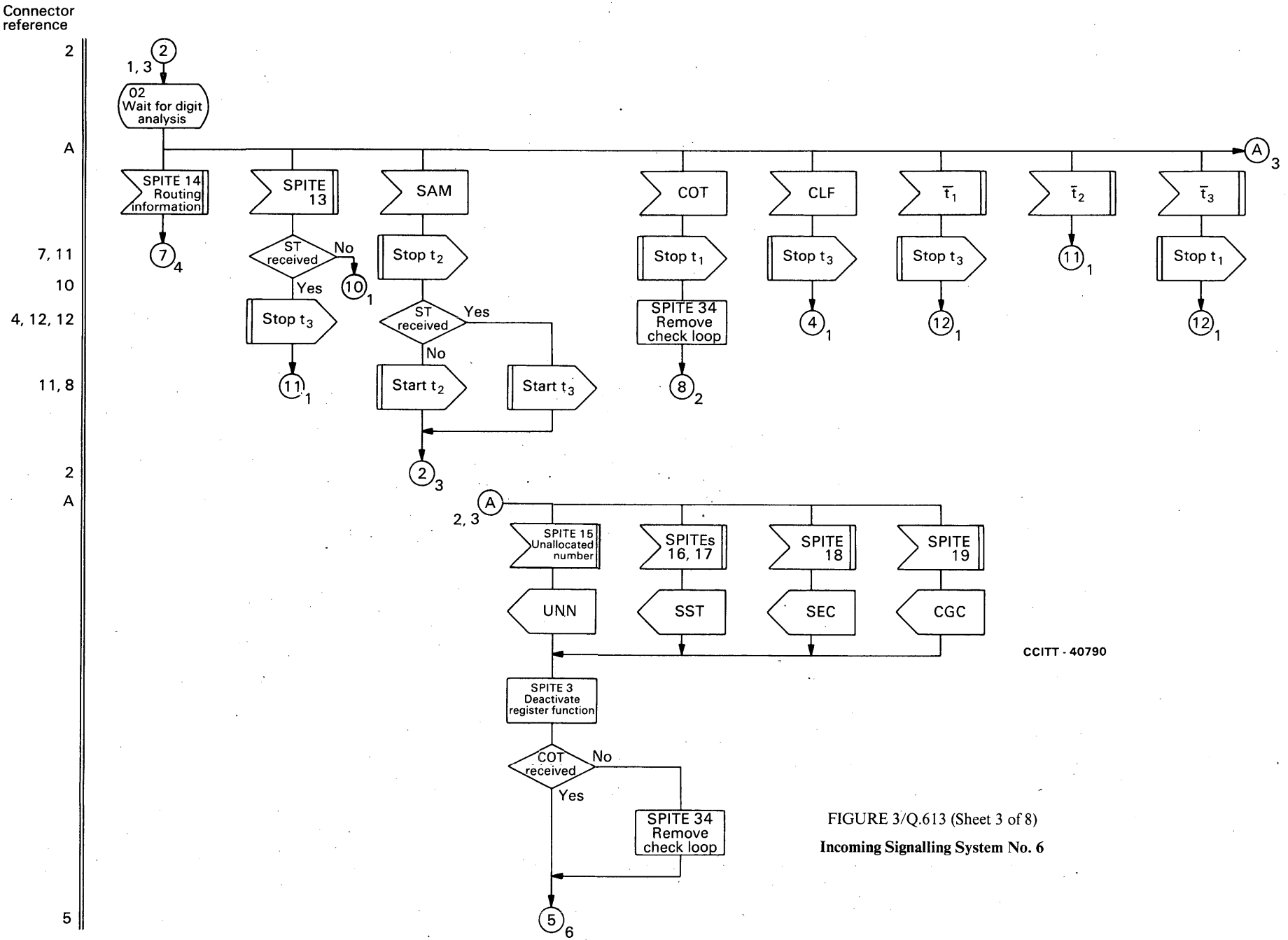


FIGURE 3/Q.613 (Sheet 3 of 8)

Incoming Signalling System No. 6

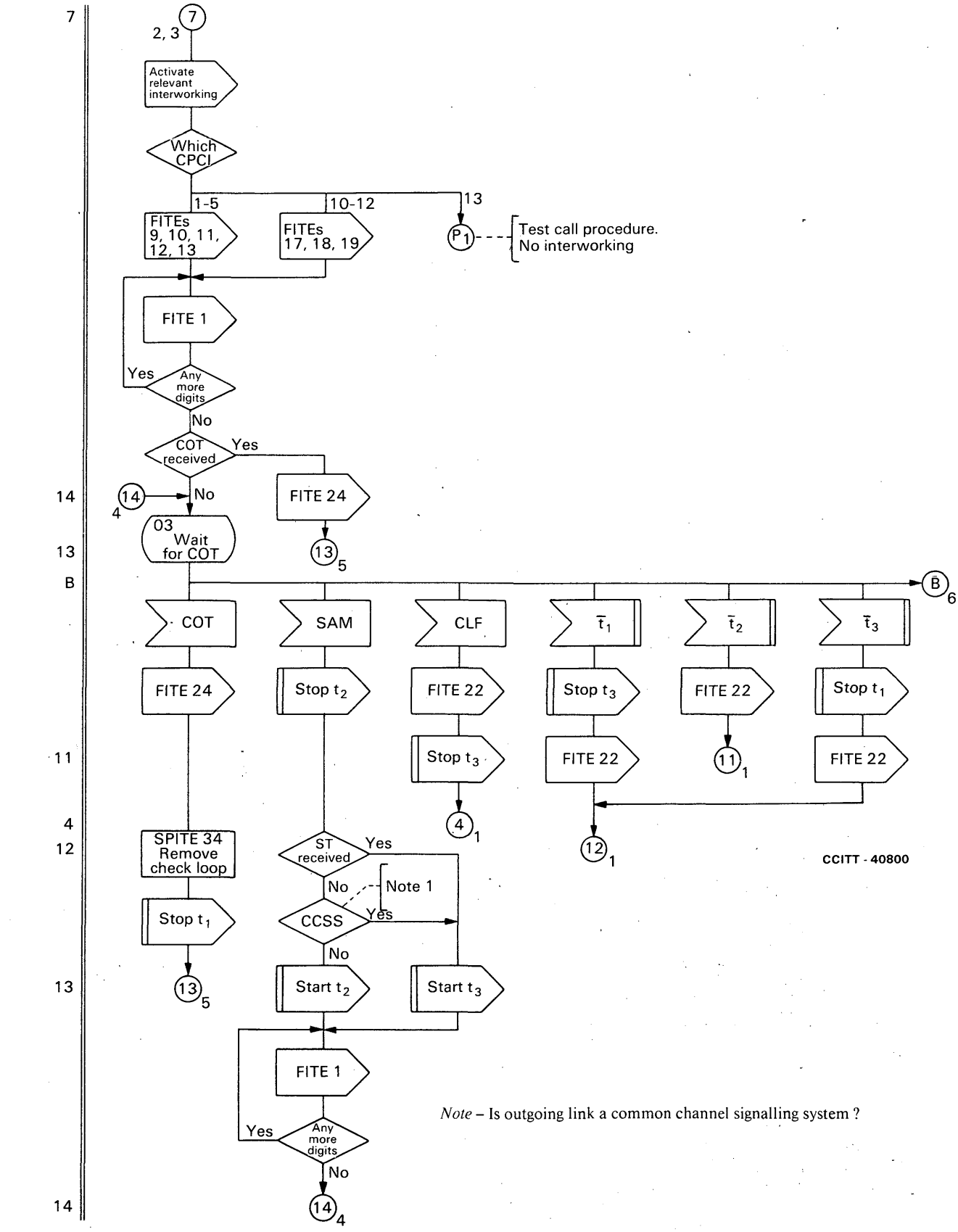


FIGURE 3/Q.613 (Sheet 4 of 8)

Incoming Signalling System No. 6

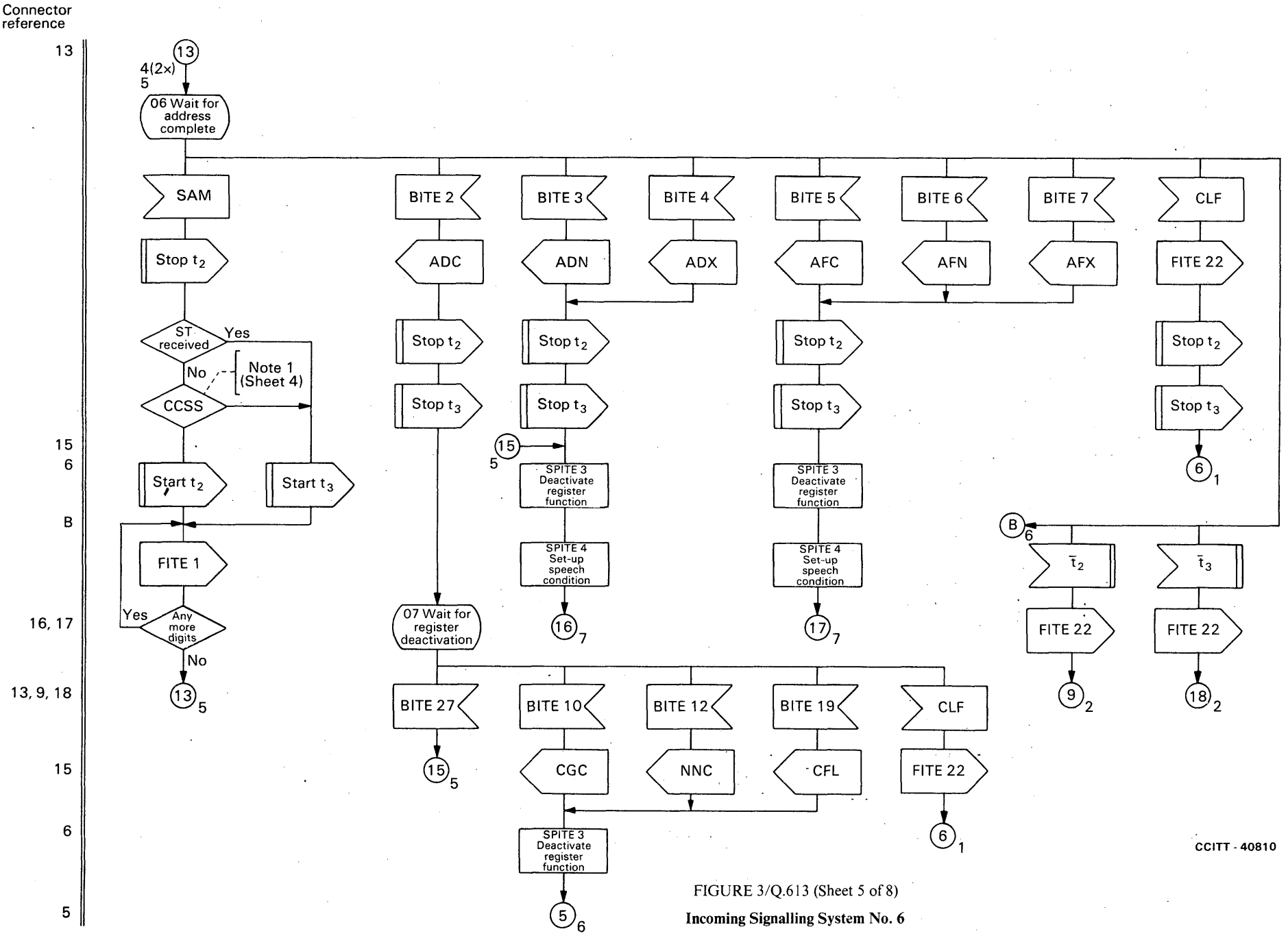


FIGURE 3/Q.613 (Sheet 5 of 8)

Incoming Signalling System No. 6

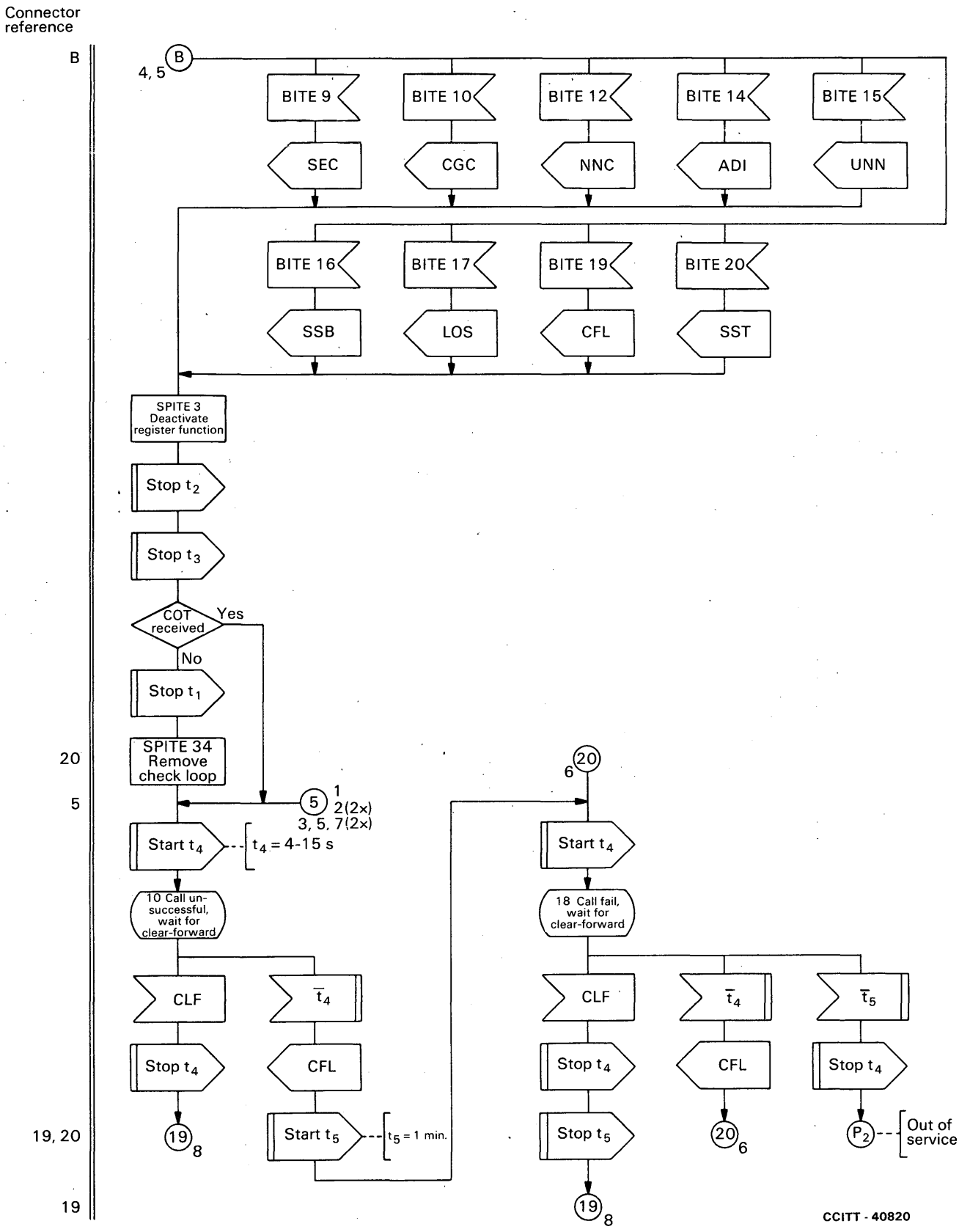


FIGURE 3/Q.613 (Sheet 6 of 8)

Incoming Signalling System No. 6

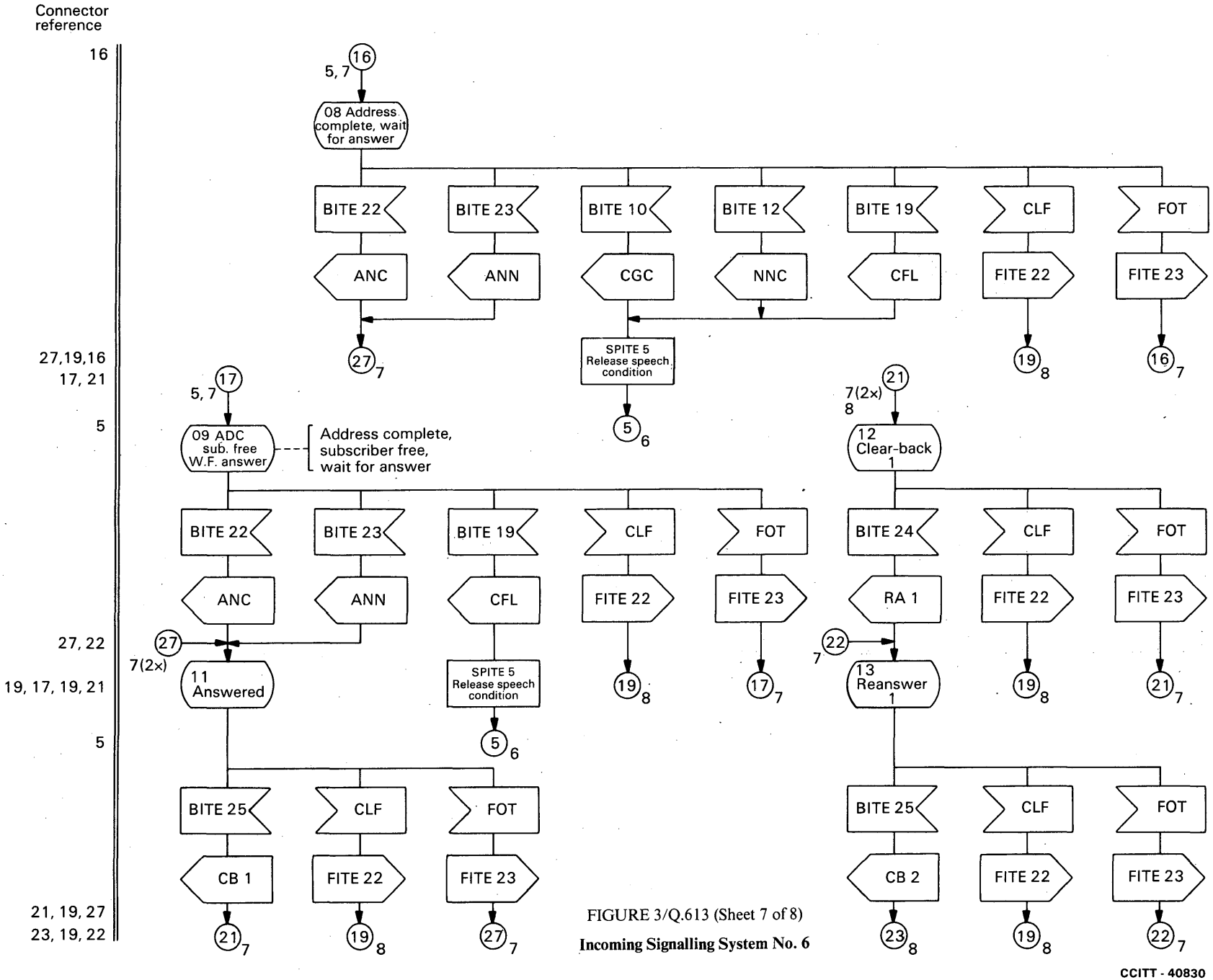


FIGURE 3/Q.613 (Sheet 7 of 8)

Incoming Signalling System No. 6

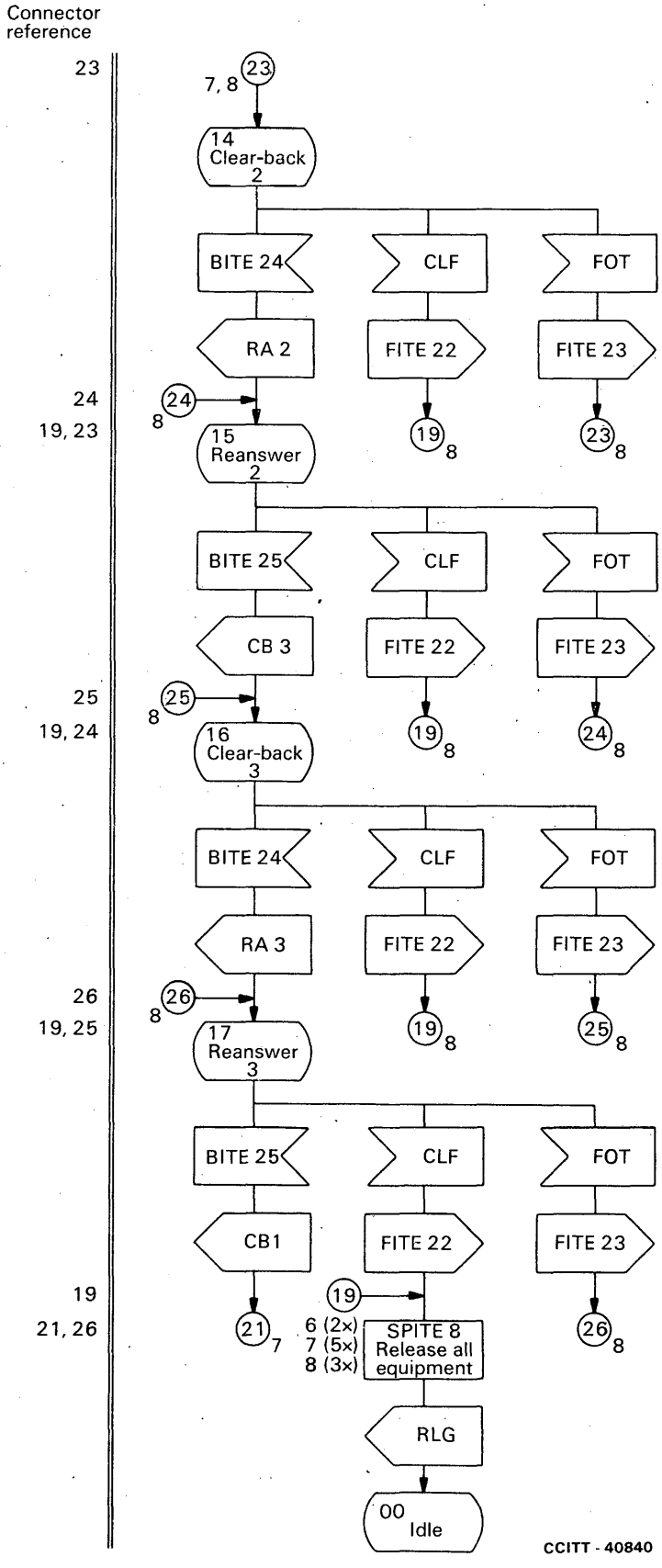
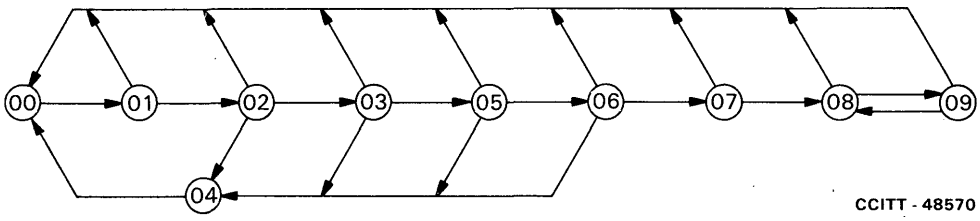


FIGURE 3/Q.613 (Sheet 8 of 8)

Incoming Signalling System No. 6

LOGIC PROCEDURES FOR INCOMING SIGNALLING SYSTEM R1



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1, 2	
01	Wait for register activation	1	
02	Wait for first register signal (KP)	1	t_1
03	Wait for next register signal	1	t_1
04	Wait for clear-forward	1	
05	Wait for digit analysis	2	
06	Wait for register deactivation	2	
07	Wait for answer	2	
08	Answered	2	
09	Clear-back	2	

FIGURE 1/Q.615

State overview diagram for incoming Signalling System R1

Supervisory timers for incoming Signalling System R1

t_1 = 10-20 s Recommendation Q.325

Remarks to facilitate reading and understanding the SDL flow chart

a) The procedure P1 is not described because no procedure is specified at present in the Signalling System R1 specifications.

b) The procedure described in Recommendation Q.313, § 2.3.3.2, e) is not shown because this has no impact on the interworking.

c) This incoming Signalling System R1 procedure assumes the inclusion of country code digits in the case where Signalling System R1 is used to access the outgoing international exchange.

FIGURE 2/Q.615

Notes to incoming Signalling System R1

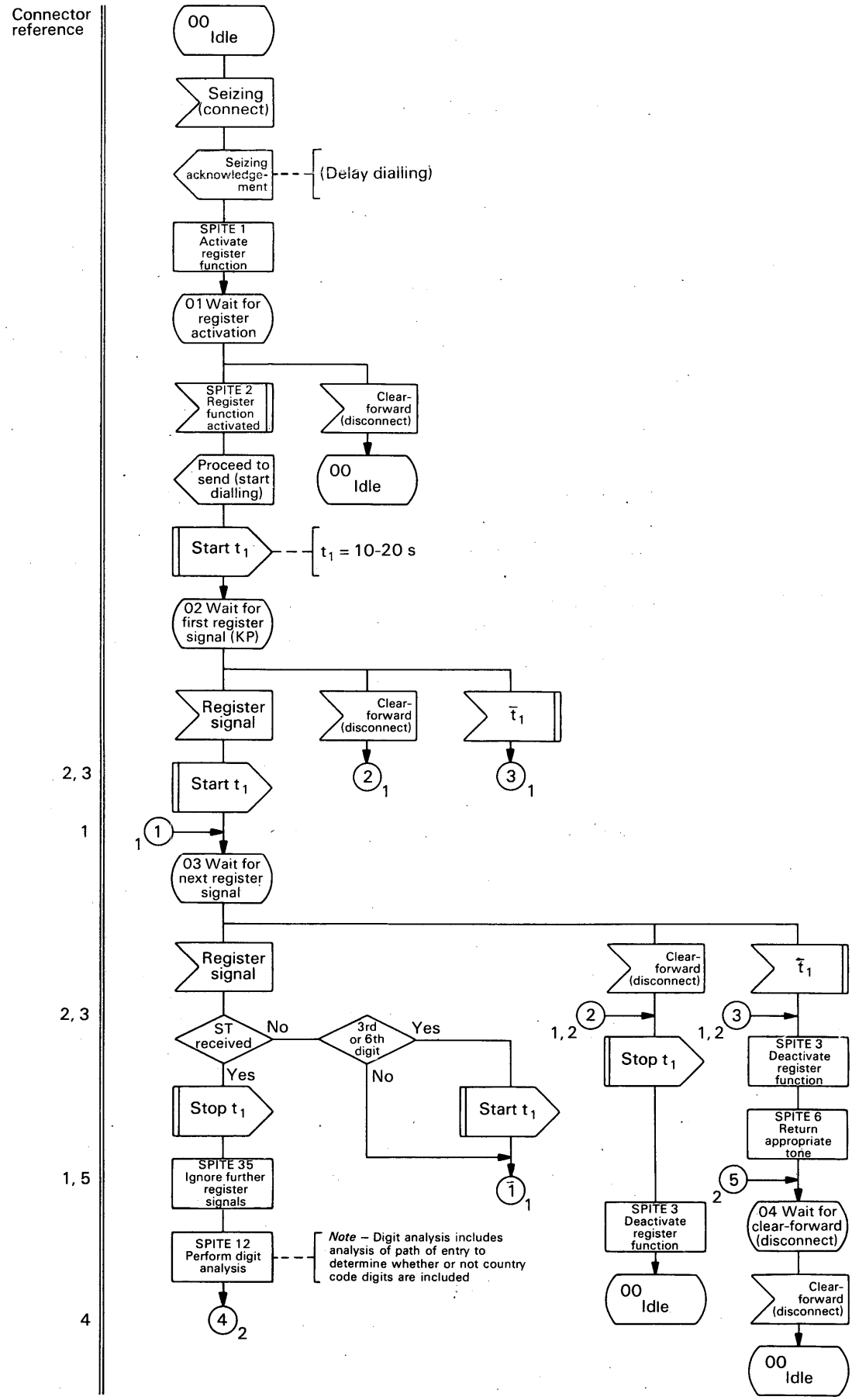


FIGURE 3/Q.615 (Sheet 1 of 2)

Incoming Signalling System R1

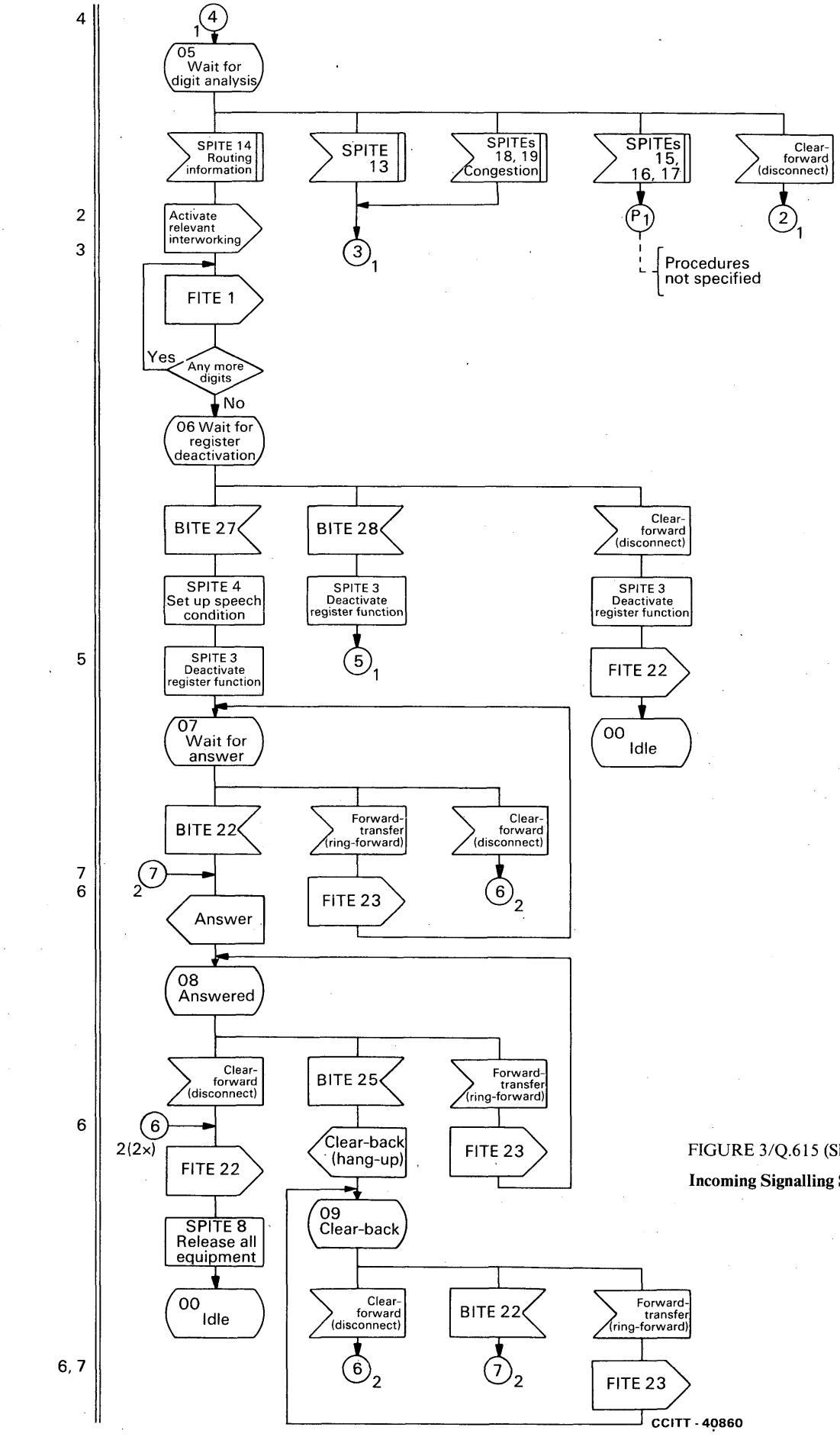
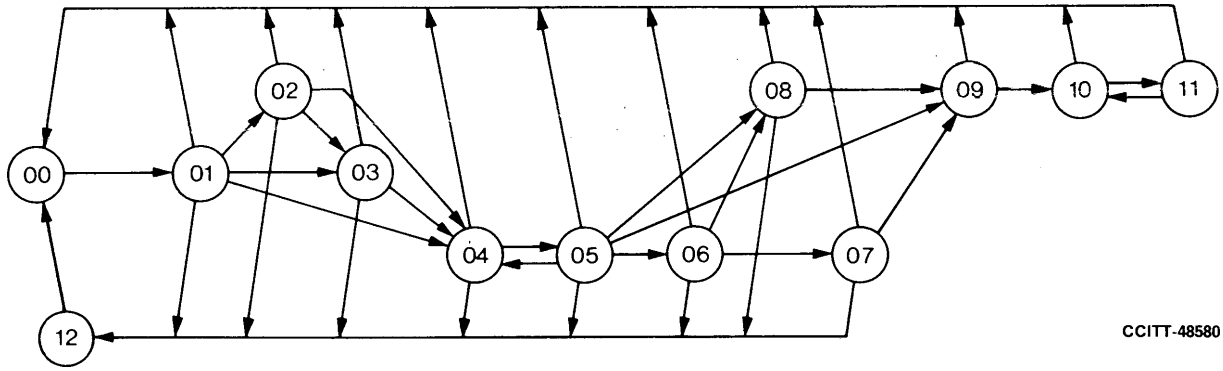


FIGURE 3/Q.615 (Sheet 2 of 2)

Incoming Signalling System R1

LOGIC PROCEDURES FOR INCOMING SIGNALLING SYSTEM R2



State number	*State description*	*Sheet number*	*Running timers*
00	Idle	1	
01	Wait for first forward signal	1	t_1
02	Wait for reply to A-14	2	t_1
03	Wait for calling party's category	1	t_1
04	Wait for forward register signal	2	t_1
05	Wait for digit analysis	2	t_1
06	Wait for address-complete	3	t_1
07	Wait for register deactivation	4	
08	Wait for group II signal	4	t_1
09	Wait for answer	4	
10	Answered	4	
11	Clear-back	4	
12	Wait for clear-forward	1	

FIGURE 1/Q.616
State overview diagram for Incoming Signalling System R2

Supervisory timers

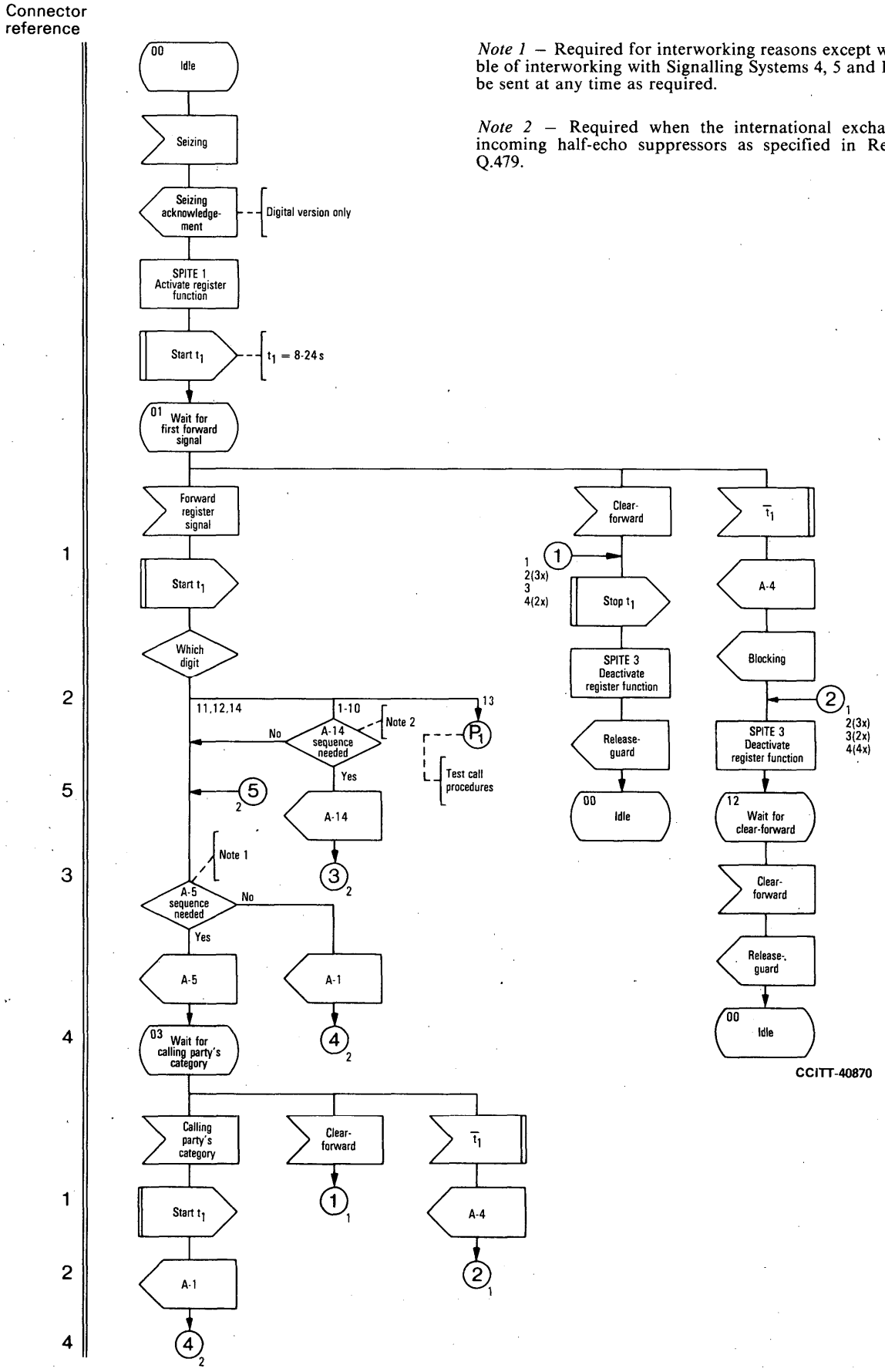
t_1 = 8-24 s Recommendation Q.476, § 5.5.2.1

Procedures not shown

The following procedures, not directly relevant to interworking, are not shown in the logic procedures:

- Interrupt control procedures (analogue version).
- Transmission fault procedures (digital version).
- Test call procedures.
- Analogue T_2 release guard timing.
- Optional forward transfer procedure.
- Blocking and unblocking sequences.

FIGURE 2/Q.616
Notes to incoming Signalling System R2



Note 1 – Required for interworking reasons except when only capable of interworking with Signalling Systems 4, 5 and R1, but A5 may be sent at any time as required.

Note 2 – Required when the international exchange can insert incoming half-echo suppressors as specified in Recommendation Q.479.

FIGURE 3/Q.616 (Sheet 1 of 4)
Incoming Signalling System R2

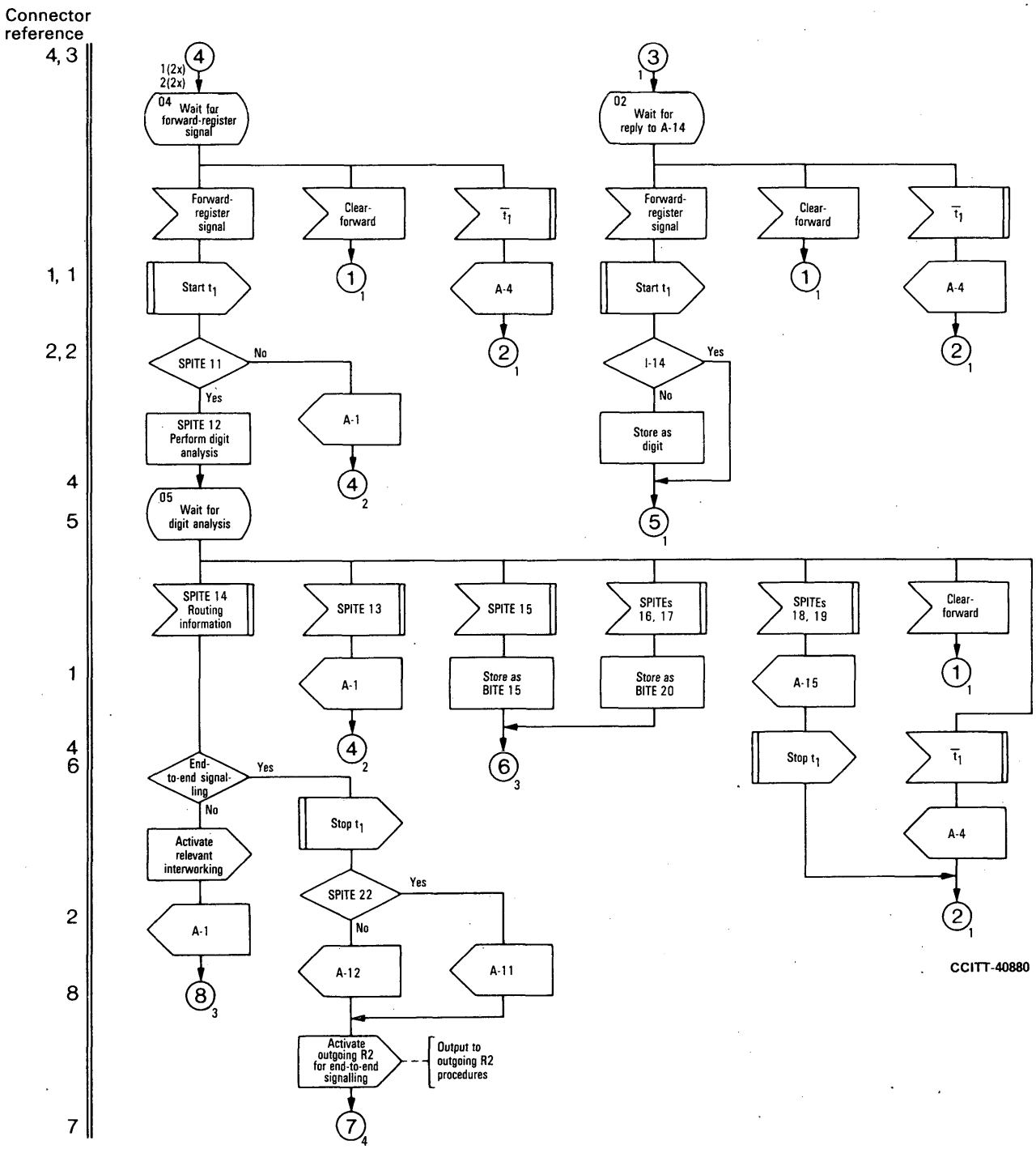


FIGURE 3/Q.616 (Sheet 2 of 4)
Incoming Signalling System R2

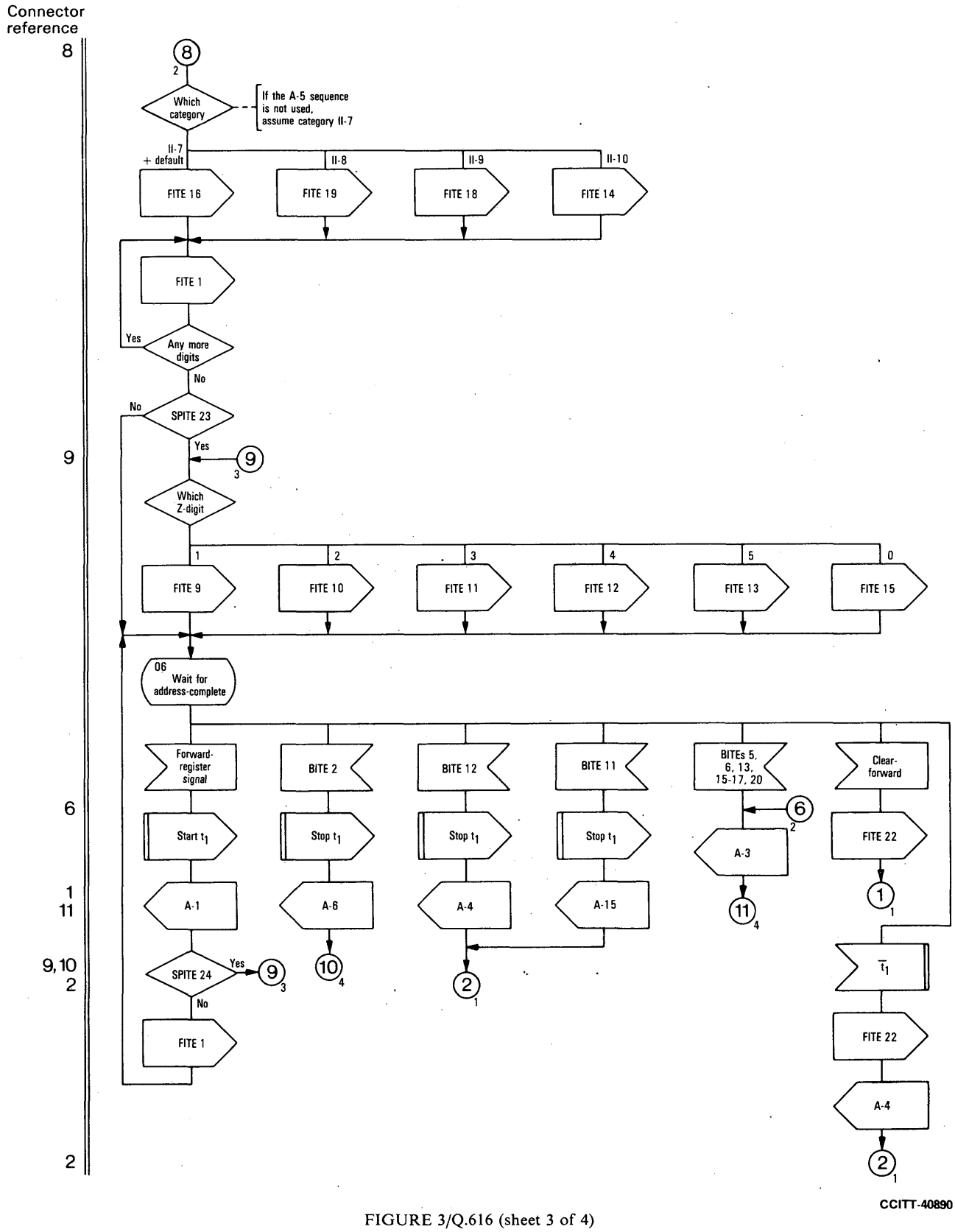


FIGURE 3/Q.616 (sheet 3 of 4)

Incoming Signalling System R2

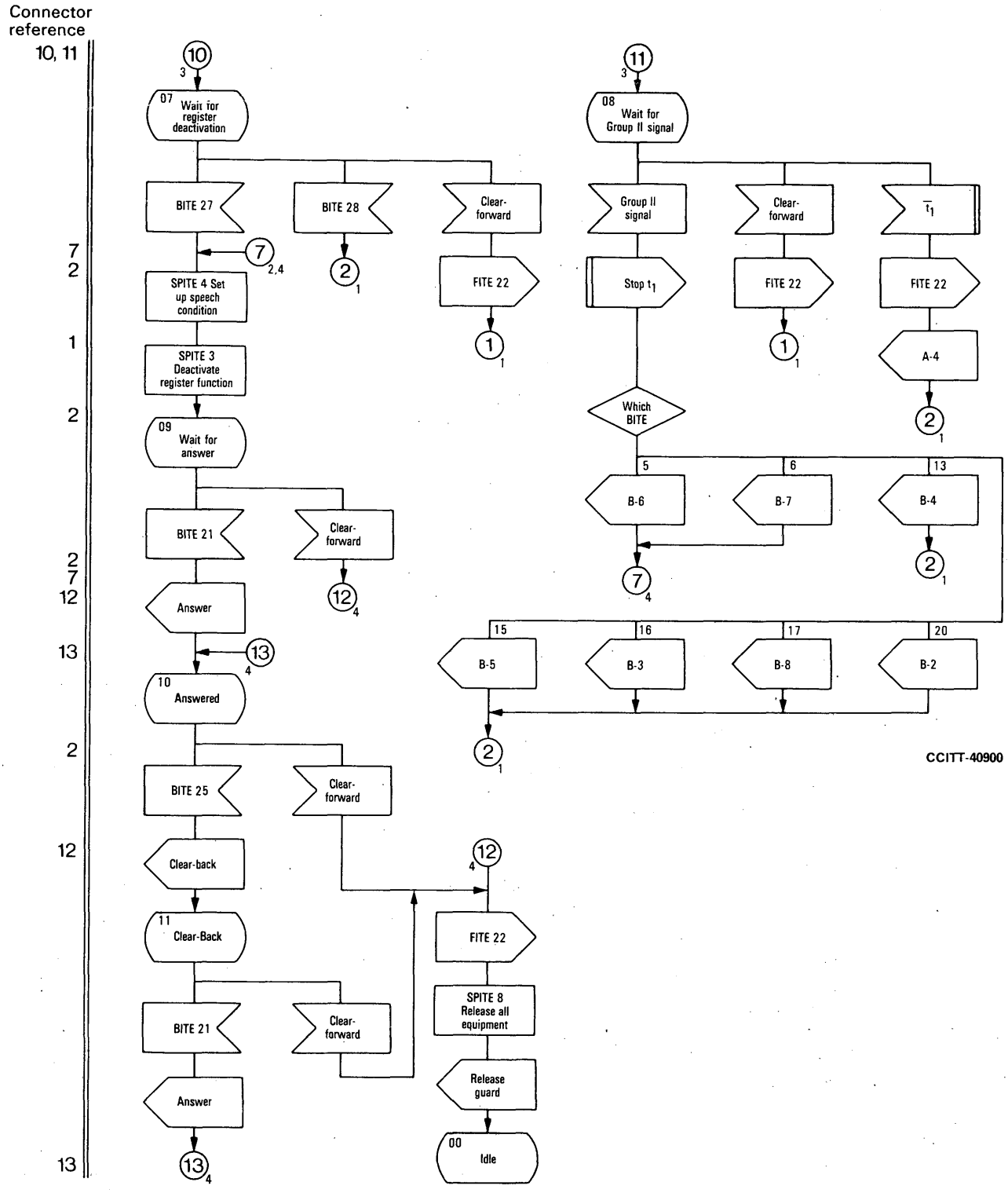
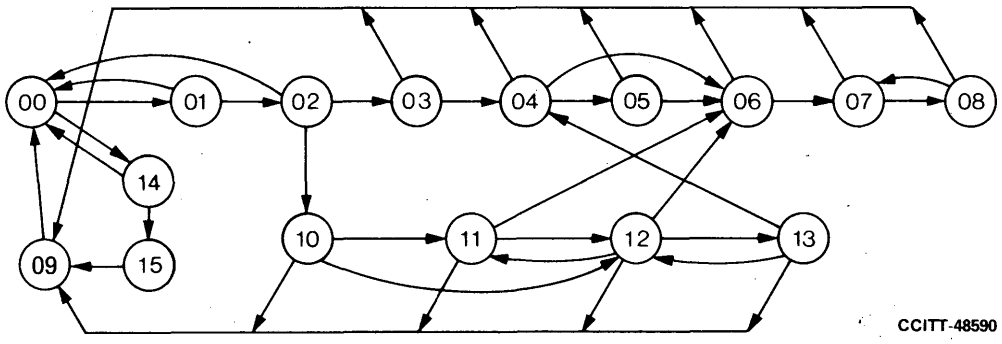


FIGURE 3/Q.616 (Sheet 4 of 4)
Incoming Signalling System R2

LOGIC PROCEDURES FOR OUTGOING SIGNALLING SYSTEM No. 4



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1, 2	
01	Wait for CPCI-FITE	1	
02	Wait for FITE 2 or 3	1	
03	Wait for terminal proceed-to-send	1	t_1
04	Wait for acknowledgement	1	t_2
05	Wait for number-received	2	t_3
06	Wait for answer	2	
07	Answered	2	
08	Clear-back	2	
09	Wait for release-guard	2	t_4
10	Wait for proceed-to-send	3	t_1
11	Wait for number-received	3	t_3
12	Wait for acknowledgement signal	3	t_2
13	Wait for proceed-to-send	4	t_3
14	Wait for FITE 2 or 3 (end-to-end)	1	
15	Wait for clear-forward	1	

FIGURE 1/Q.621
State overview diagram for outgoing Signalling System No. 4

Supervisory timers

t_1 = 10-30 s Recommendation Q.127, § 4.4.1, (2), c)
t_2 = 5-10 s Recommendation Q.127, § 4.4.1, (2), d)
t_3 = 15-30 s Recommendation Q.127, § 4.4.1, (2), a)
t_4 = 5-10 s Recommendation Q.130, § 4.7.1

Procedures not shown

The following procedure, not directly relevant to interworking, are not shown in the logic procedures:

– Time-out procedure.

FIGURE 2/Q.621
Notes to outgoing Signalling System No. 4

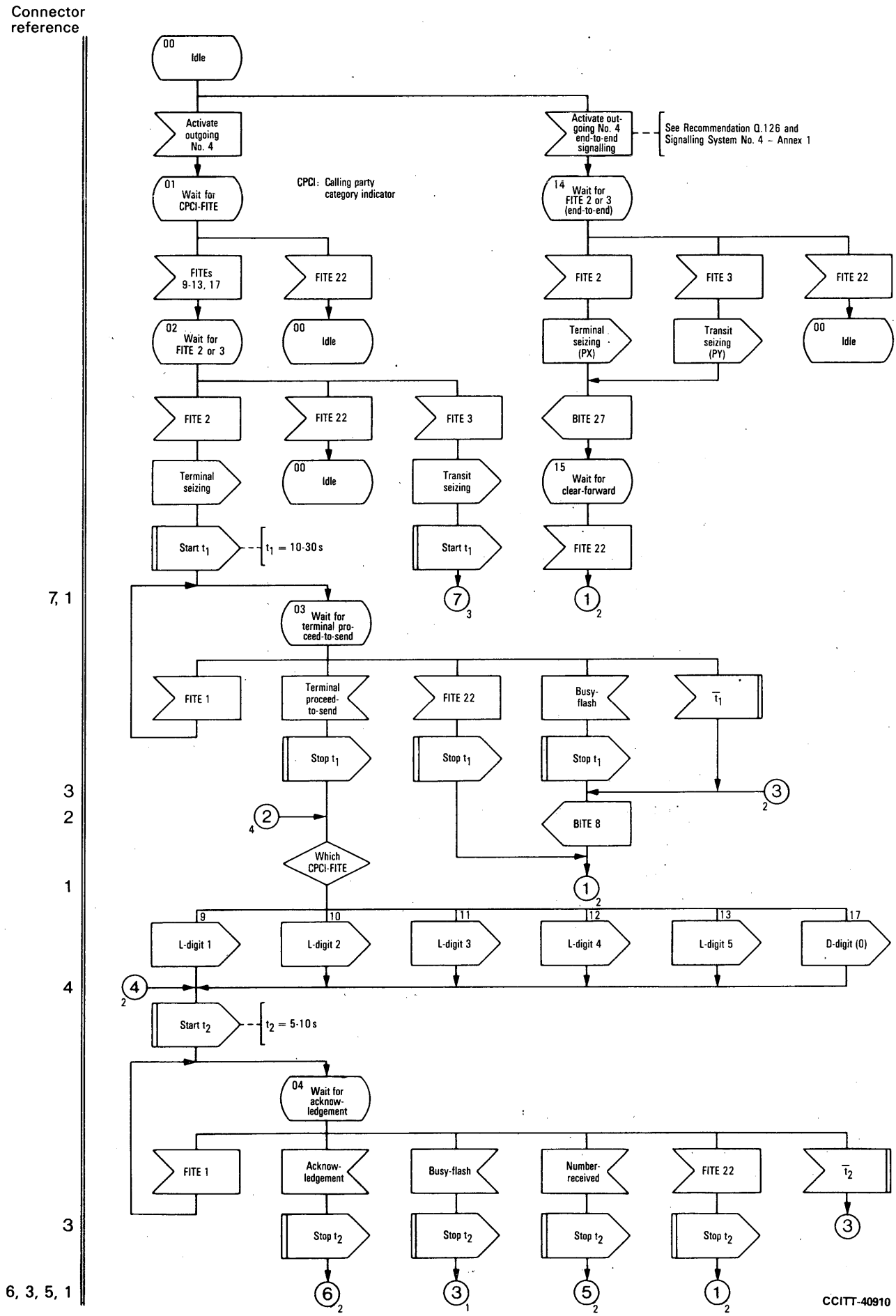


FIGURE 3/Q.621 (Sheet 1 of 4)

Outgoing Signalling System No. 4

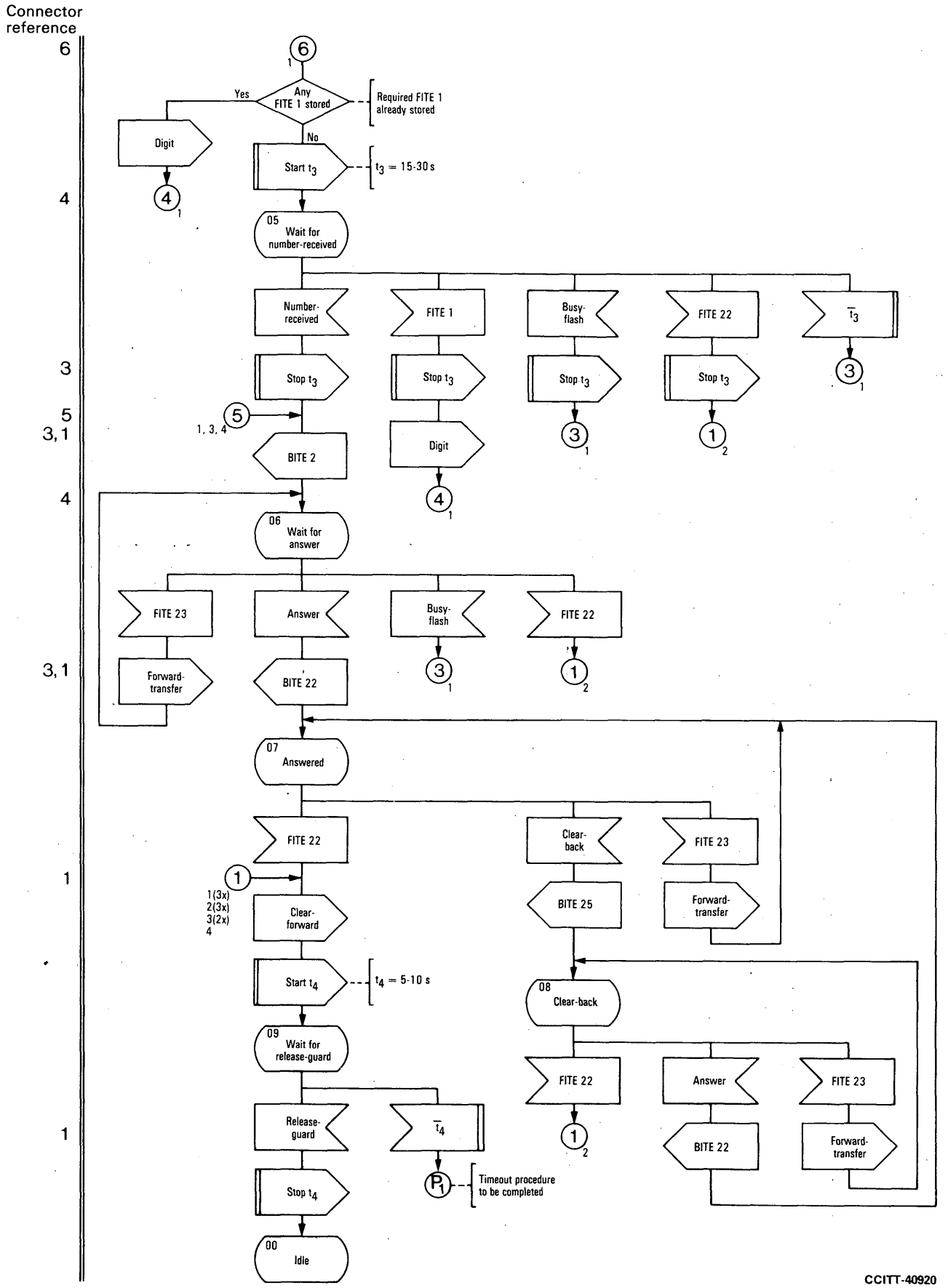


FIGURE 3/Q.621 (Sheet 2 of 4)

Outgoing Signalling System No. 4

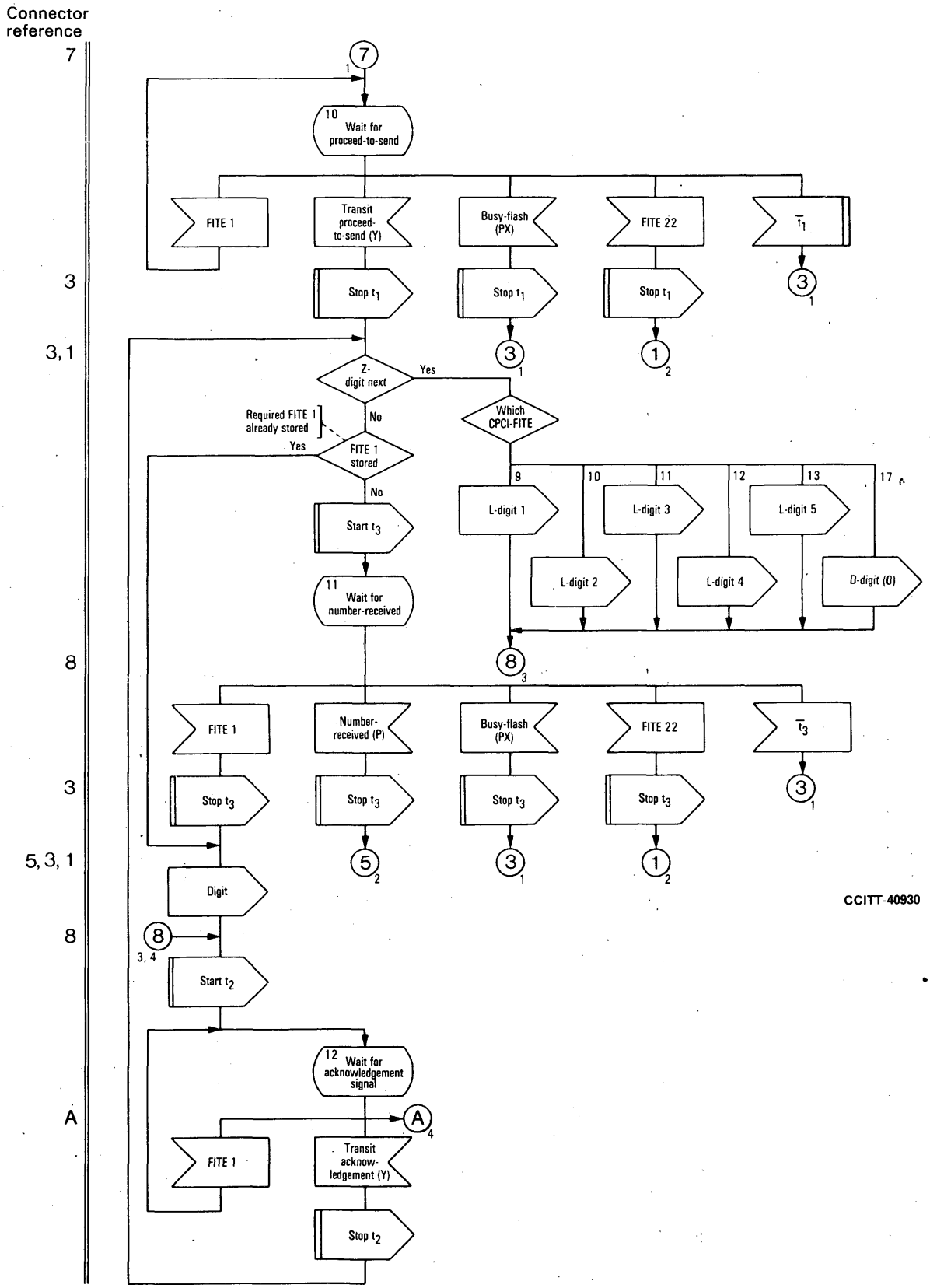


FIGURE 3/Q.621 (Sheet 3 of 4)
Outgoing Signalling System No. 4

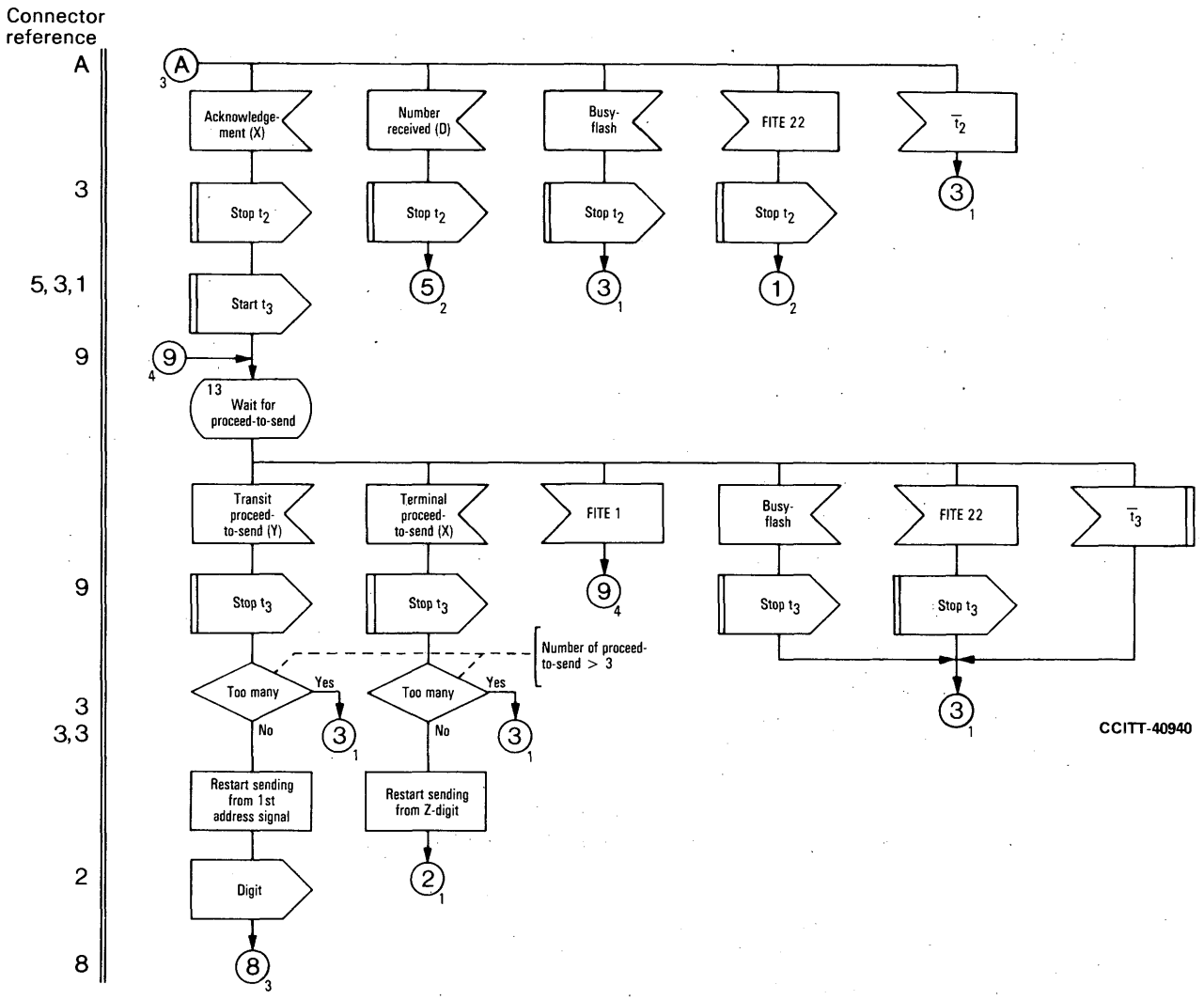
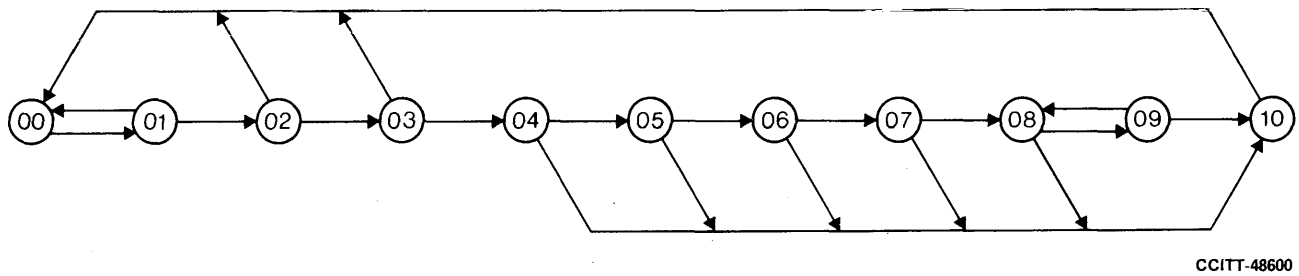


FIGURE 3/Q.621 (Sheet 4 of 4)

Outgoing Signalling System No. 4

LOGIC PROCEDURES FOR OUTGOING SIGNALLING SYSTEM No. 5



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1	
01	Wait for calling party's category (CPCI)	1	
02	Wait for country code indicator (CCI)	1	
03	Wait for ST	1	t_1
04	Wait for proceed-to-send	1	t_2
05	Wait for time release t_3	2	t_3
06	Wait for time release t_4	2	t_4
07	Wait for answer	3	
08	Answered	3	
09	Clear-back	3	
10	Wait for release-guard	3	t_2

FIGURE 1/Q.622
State overview diagram for outgoing Signalling System No. 5

Supervisory timers for outgoing Signalling System No. 5

t_1 = 4-6 s	Recommendation Q.152, § 3.2.1, b)
t_2 = 10-20 s	Recommendation Q.141, § 2.1.3.1, e), i)
t_3 = (100 ± 10) + (55 ± 5) ms	Recommendation Q.153, § 3.3.3
t_4 = 2 (55 ± 5) ms	Recommendation Q.153, § 3.3.3

Procedures not shown

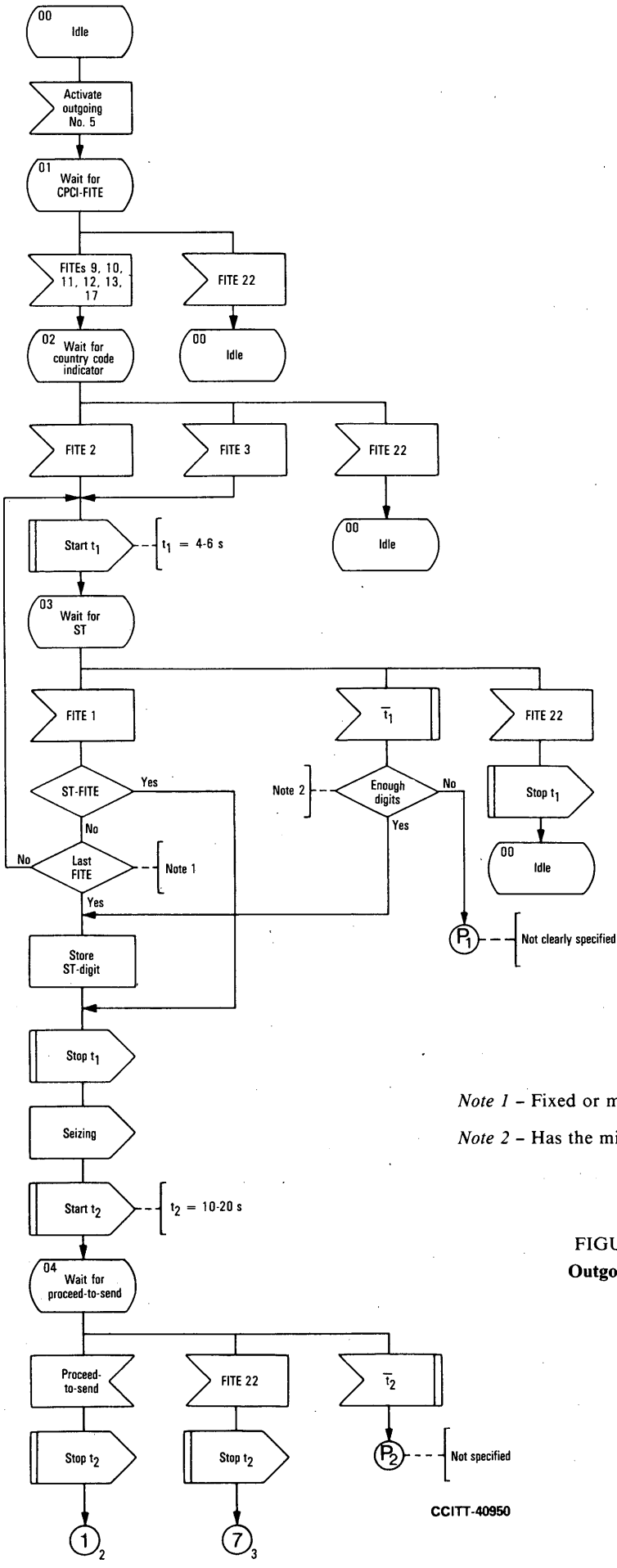
The following procedures, not directly relevant to interworking, are not shown in the logic procedures:

P_1 = Recognition of ST-condition by timing after receipt of insufficient number of digits.

P_2 = Delayed proceed-to-send.

P_3 = Delayed release-guard.

FIGURE 2/Q.622
Notes to outgoing Signalling System No. 5



Note 1 – Fixed or maximum number length reached?

Note 2 – Has the minimum number of digits been received?

FIGURE 3/Q.622 (Sheet 1 of 3)
Outgoing Signalling System No. 5

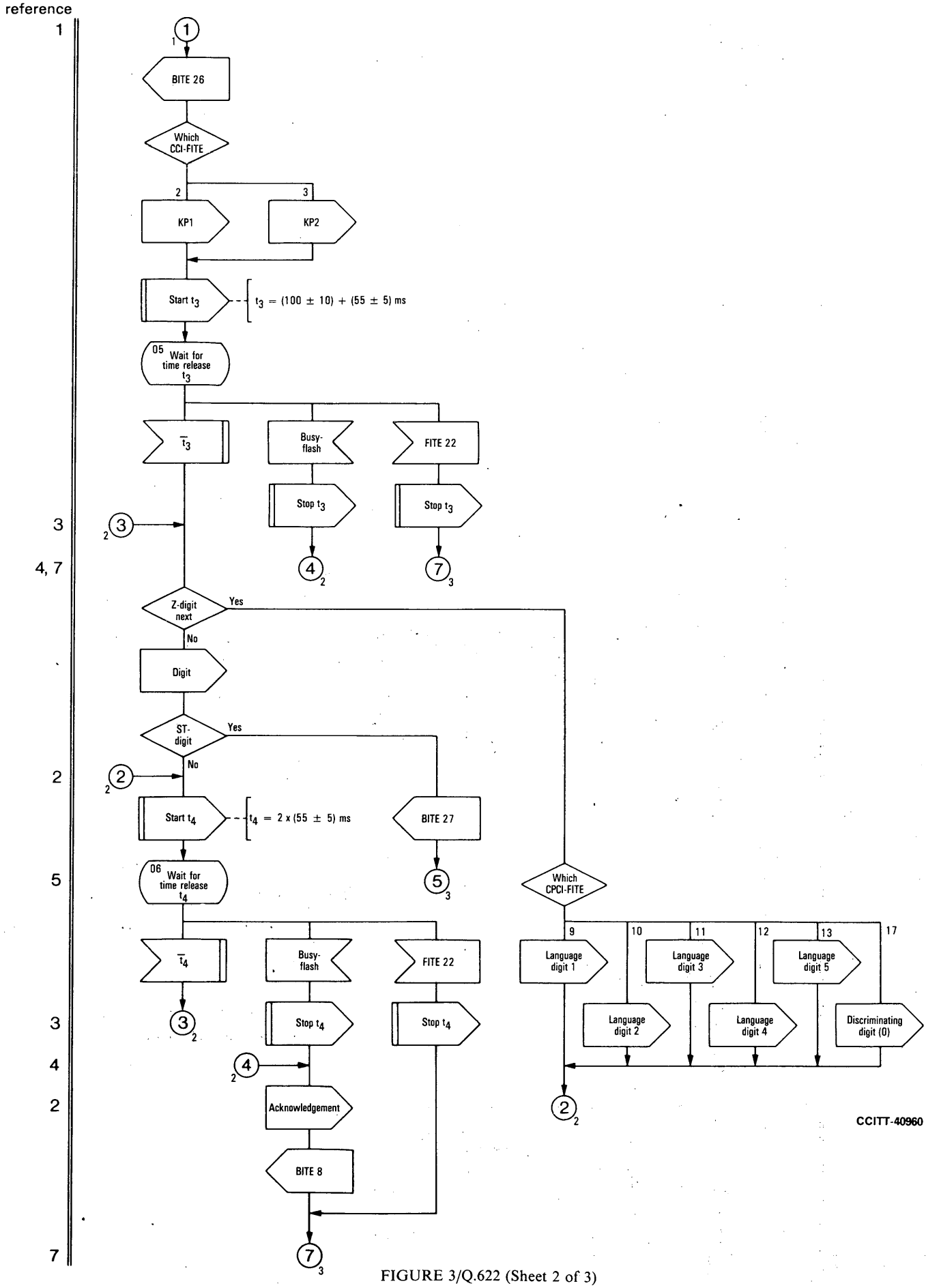


FIGURE 3/Q.622 (Sheet 2 of 3)
Outgoing Signalling System No. 5

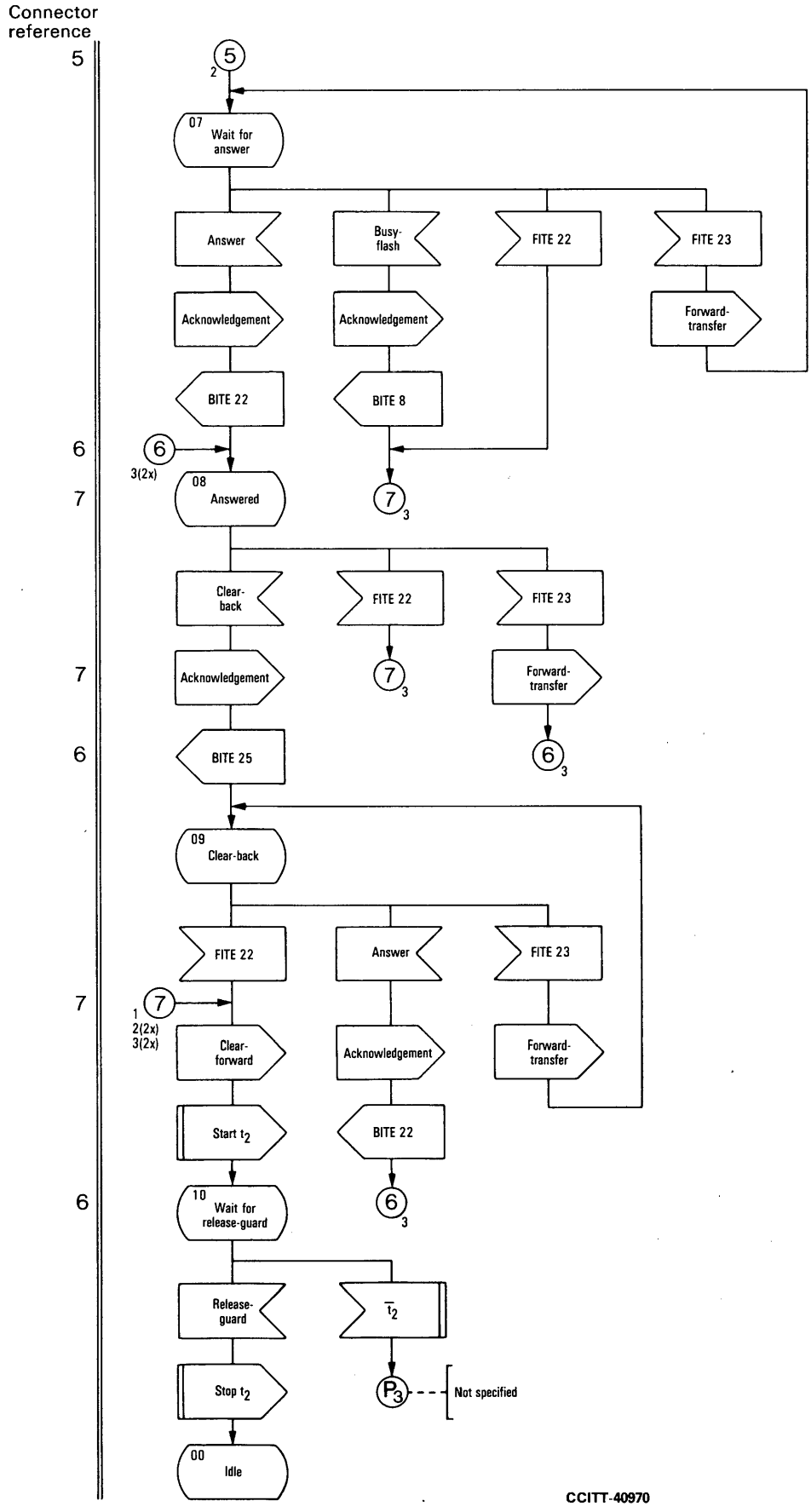
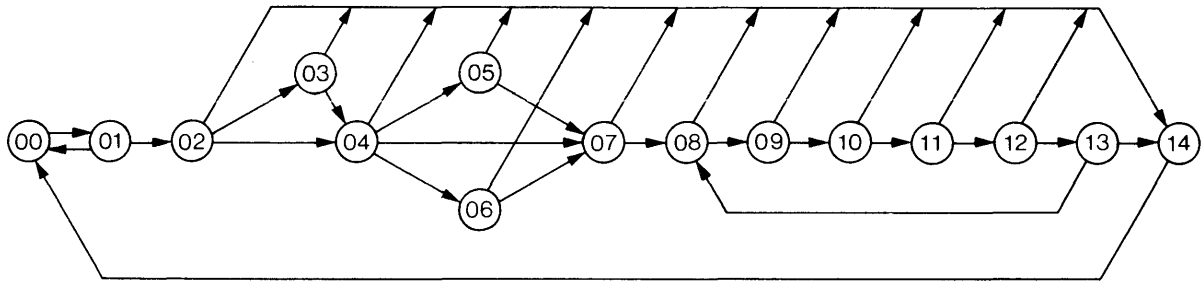


Figure 3/Q.622 (Sheet 3 of 3)
Outgoing Signalling System No. 5

LOGIC PROCEDURES FOR OUTGOING SIGNALLING SYSTEM No. 6



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1, 5	
01	Wait for FITEs OF IAM	1	
02	Wait for continuity check	2	t_1, t_2
03	Wait for continuity indicator	2	t_2
04	Wait for address-complete	3	t_2
05	Wait for answer	3	
06	Wait for answer (subscriber free)	4	
07	Answered	4	
08	Clear-back 1	4	
09	Reanswer 1	4	
10	Clear-back 2	4	
11	Reanswer 2	5	
12	Clear-back 3	5	
13	Reanswer 3	5	
14	Wait for release-guard	5	t_3, t_4

FIGURE 1/Q.623
State overview diagram for outgoing Signalling System No. 6

Supervisory timers for outgoing Signalling System No. 6

t_1 = 2 s Recommendation Q.271, § 5.7.1
t_2 = 20-30 s Recommendation Q.268, § 4.8.5.1, a)
t_3 = 4-15 s Recommendation Q.268, § 4.8.2.3
t_4 = 1 min. Recommendation Q.268, § 4.8.2.3, a)

Procedures not shown

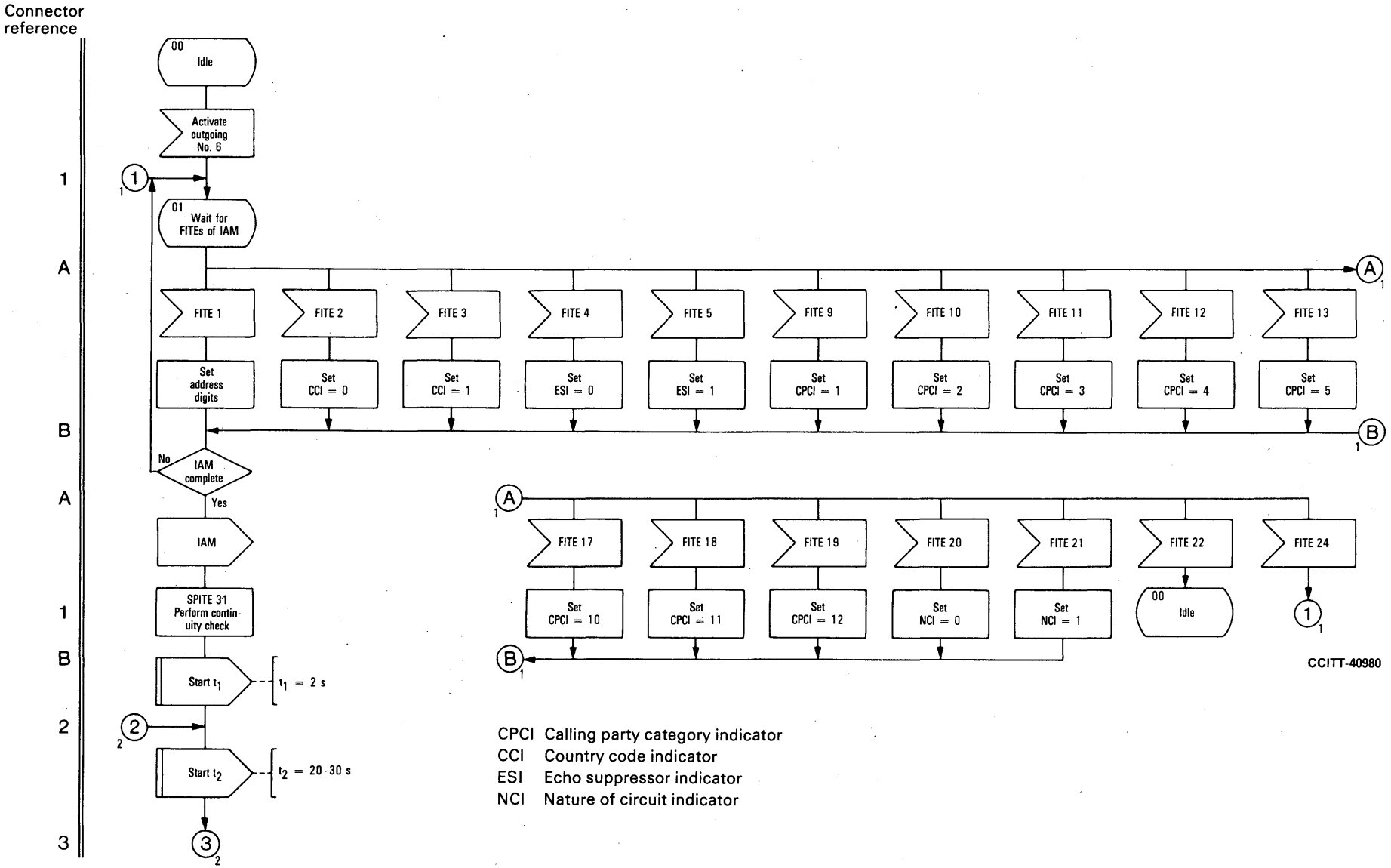
The following procedures, not directly relevant to interworking, are not shown in the logic procedures:

- Dual seizure.
- Blocking and unblocking sequences.
- Unreasonable sequences.
- Confusion and message refusal signals.
- Reset circuit/band procedures.
- Test call procedures.
- Out of service.

Signal abbreviations used

The signal abbreviations used correspond to those of the Signalling System No. 6 specifications unless otherwise indicated on the same sheet.

FIGURE 2/Q.623
Notes to outgoing Signalling System No. 6



CPCI Calling party category indicator
CCI Country code indicator
ESI Echo suppressor indicator
NCI Nature of circuit indicator

FIGURE 3/Q.623 (Sheet 1 of 5)
Outgoing Signalling System No. 6

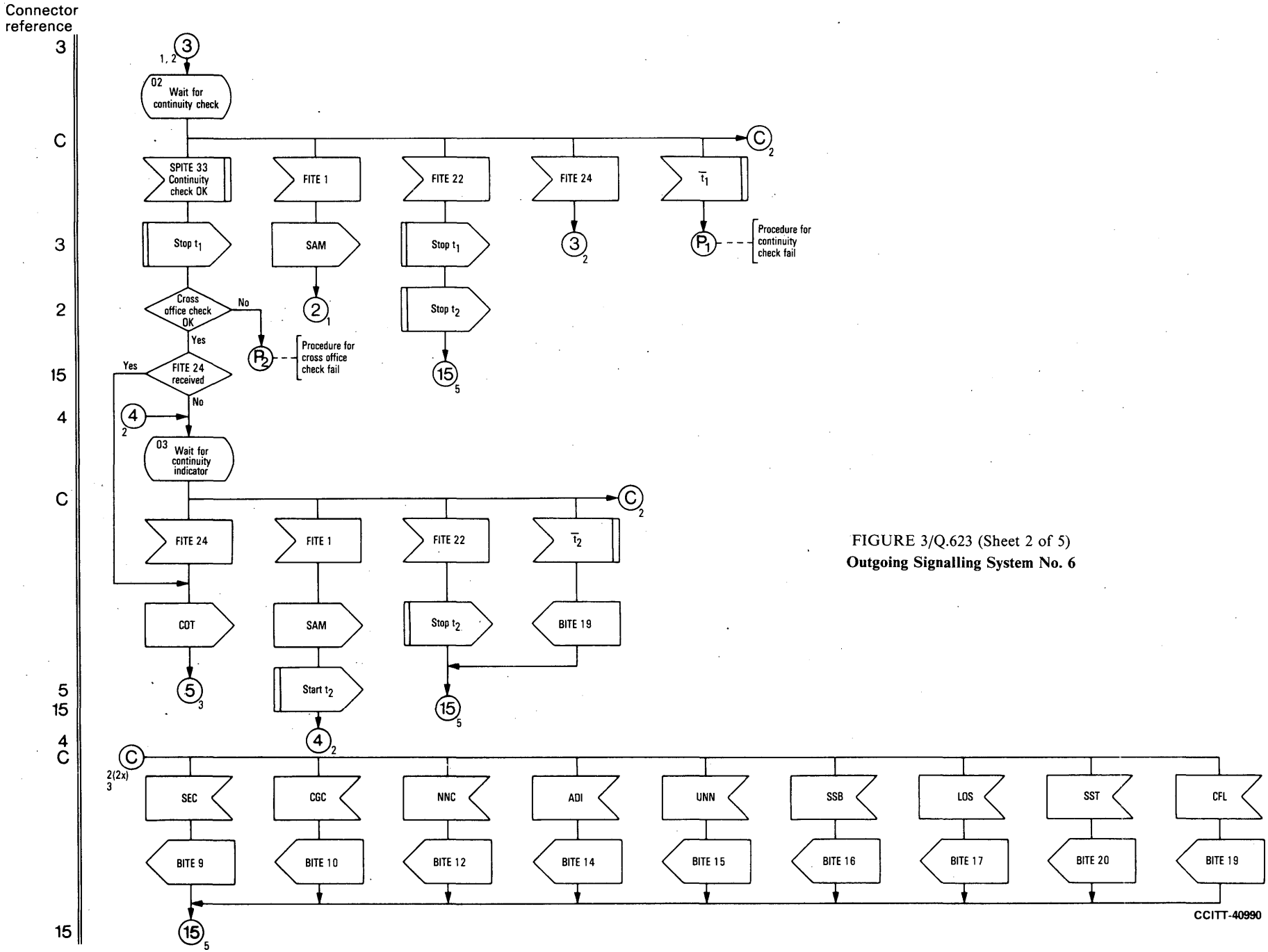


FIGURE 3/Q.623 (Sheet 2 of 5)
Outgoing Signalling System No. 6

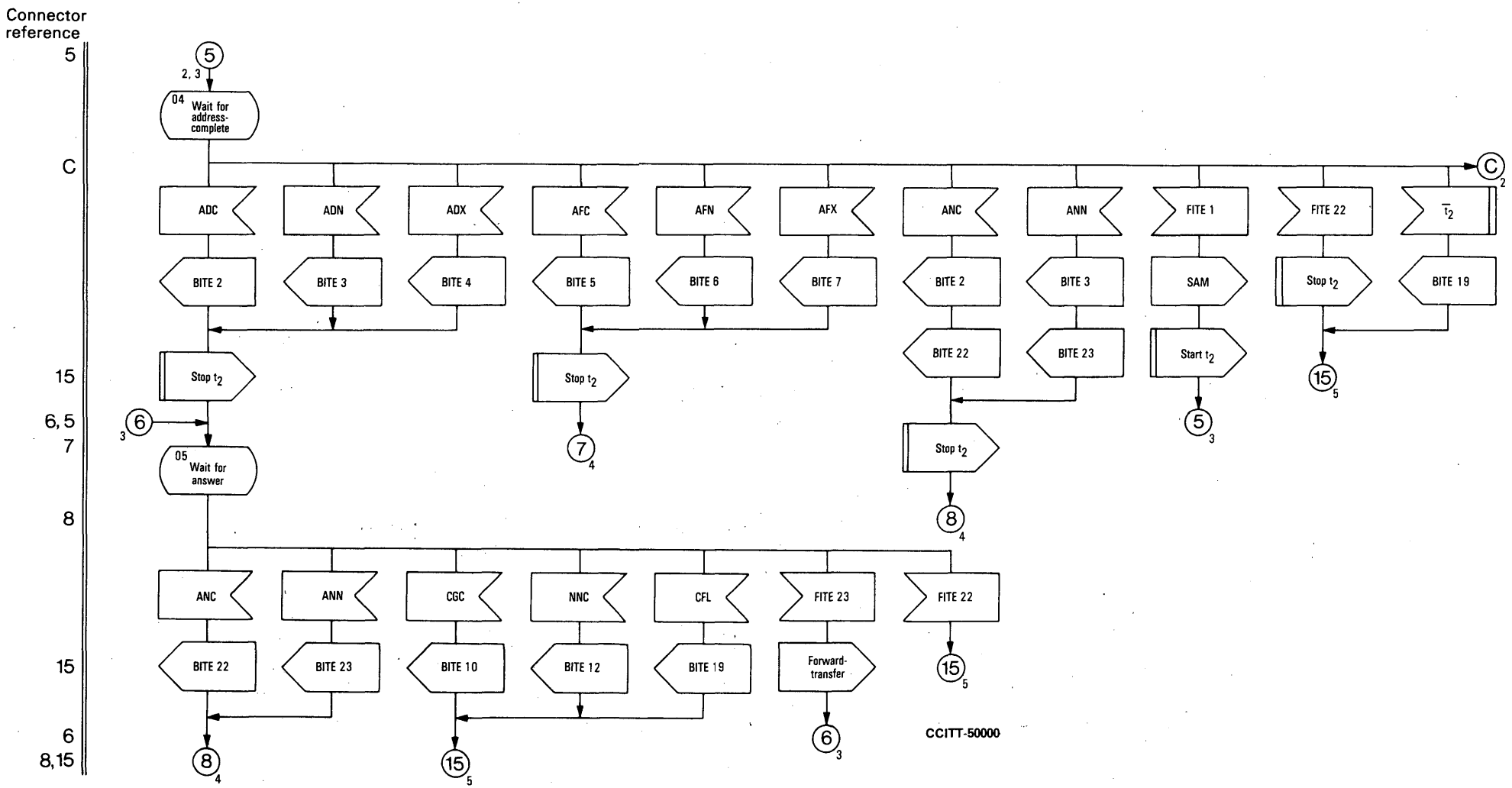


FIGURE 3/Q.623 (Sheet 3 of 5)

Outgoing Signalling System No. 6

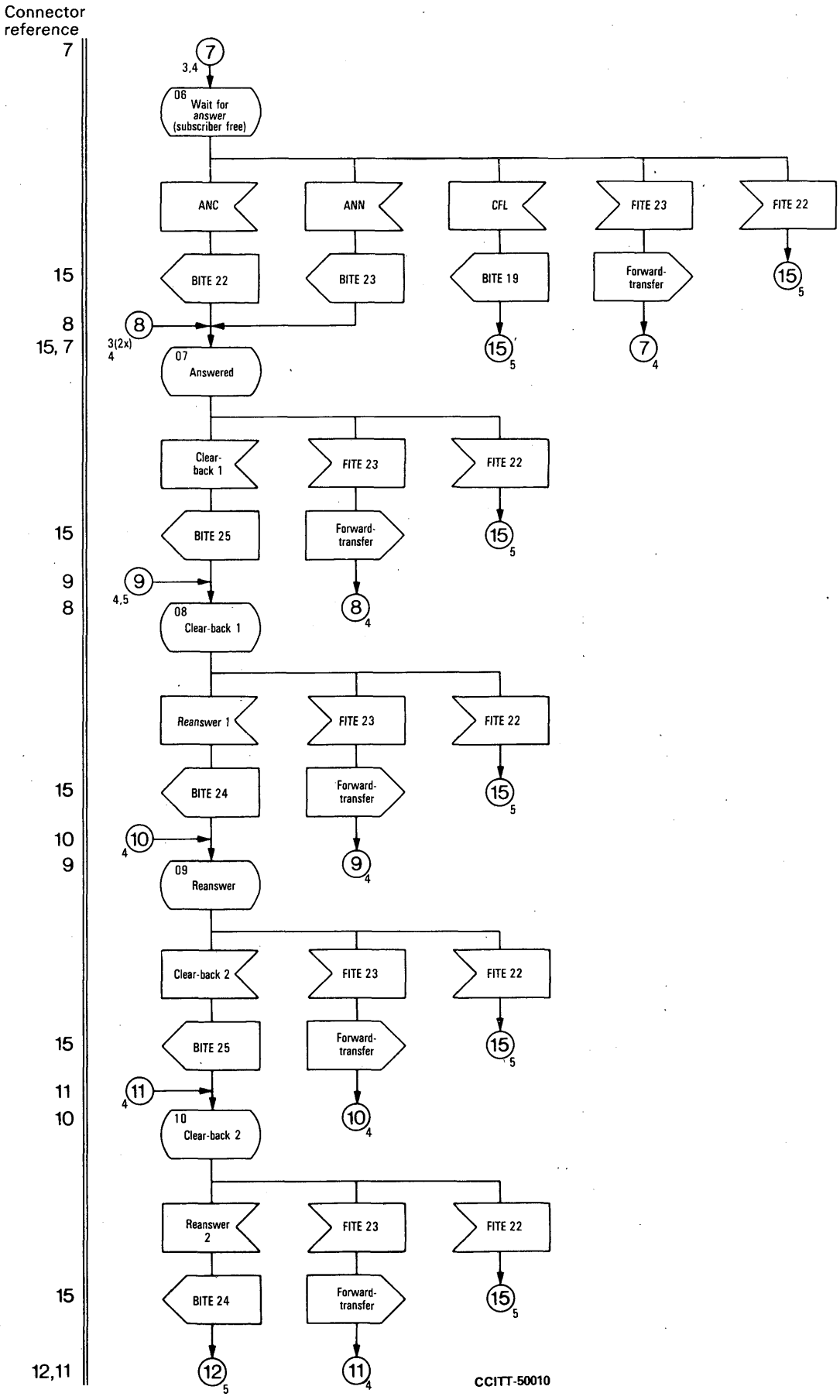


FIGURE 3/Q.623 (Sheet 4 of 5)
Outgoing Signalling System No. 6

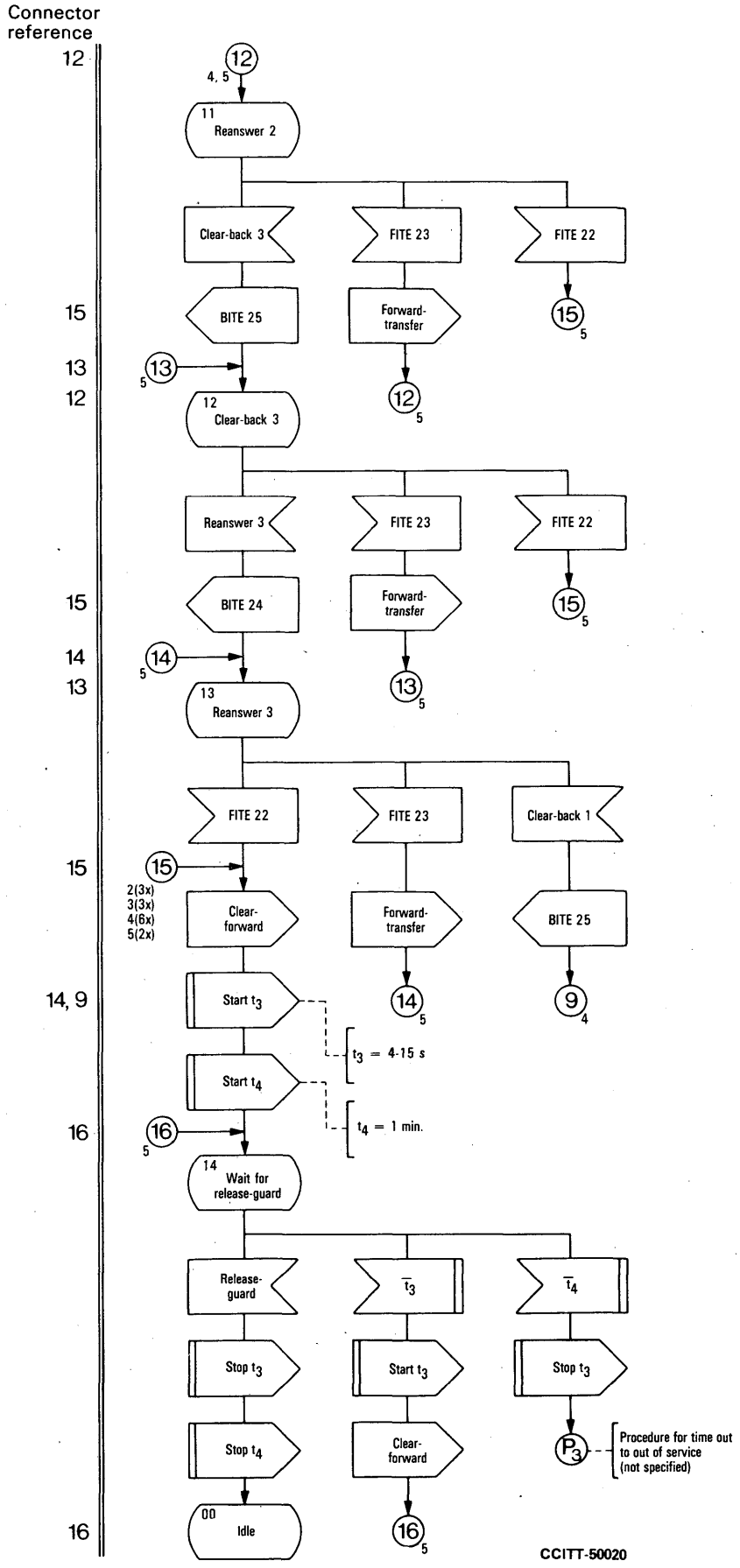
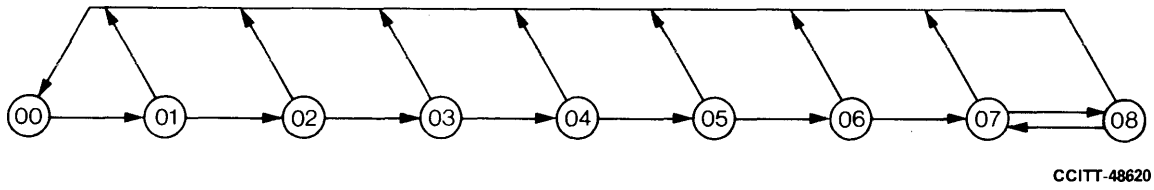


FIGURE 3/Q.623 (Sheet 5 of 5)
Outgoing Signalling System No. 6

LOGIC PROCEDURES FOR OUTGOING SIGNALLING SYSTEM R1



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1	
01	Wait for ST-FITE	1	t_1
02	Wait for seizing acknowledgement	1	t_2
03	Wait for proceed-to-send	1	t_3
04	Wait for time release t_4 (KP pulse + pause)	2	t_4
05	Wait for time release t_5 (pulsed digit + pause)	2	t_5
06	Wait for answer	2	
07	Answered	2	
08	Clear-back	2	

FIGURE 1/Q.625
State overview diagram for outgoing Signalling System R1

Supervisory timers for outgoing Signalling System R1

$t_1 = 5 \pm 1$ s	Recommendation Q.321, § 3.2.1, b), ii)
$t_2 = 5$ s	Recommendation Q.325, § 3.6.2, l), a)
$t_3 = 5$ s	Recommendation Q.325, § 3.6.2, l), b)
$t_4 = 100 + 68$ ms	Recommendation Q.322, § 3.3.4
$t_5 = 2 \times 68$ ms	Recommendation Q.322, § 3.3.4

Remarks to facilitate reading and understanding the SDL flow chart

a) The procedure P_1 is not clearly specified.

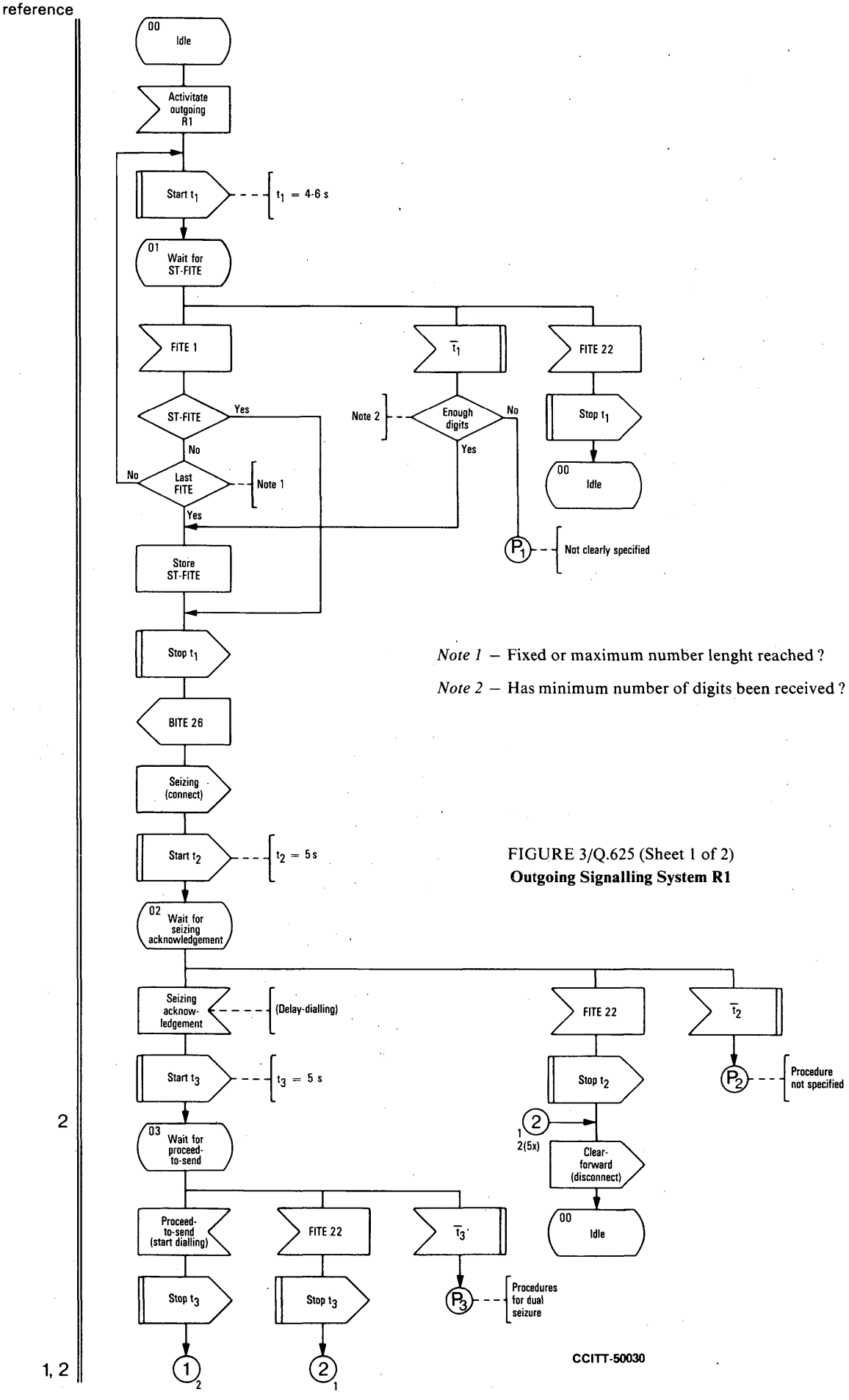
b) The procedure P_2 is not described because no procedure is specified at present in the Signalling System R1 specification.

c) The procedure P_3, related to dual seizure with both-way operation, is not described because no procedure is specified with consequences to interworking.

d) The time supervisions t_4 and t_5 are introduced to ensure the possibility of handling a clear-forward signal during outpulsing.

d) It is asumed that no country code digits are sent in the outgoing Signalling System R1 procedures.

FIGURE 2/Q.625
Notes to outgoing Signalling System R1



Note 1 – Fixed or maximum number lenght reached ?

Note 2 – Has minimum number of digits been received ?

FIGURE 3/Q.625 (Sheet 1 of 2)
Outgoing Signalling System R1

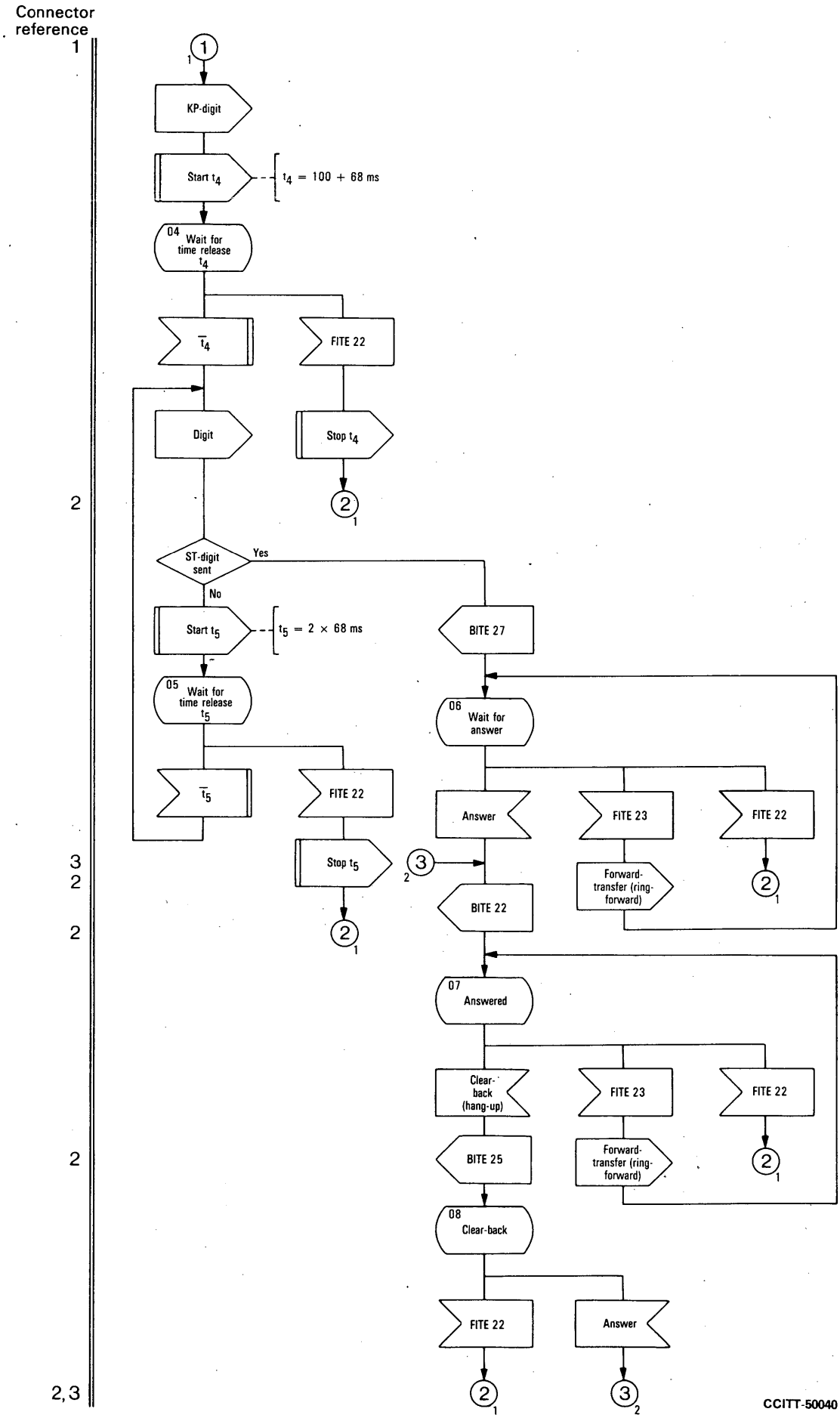
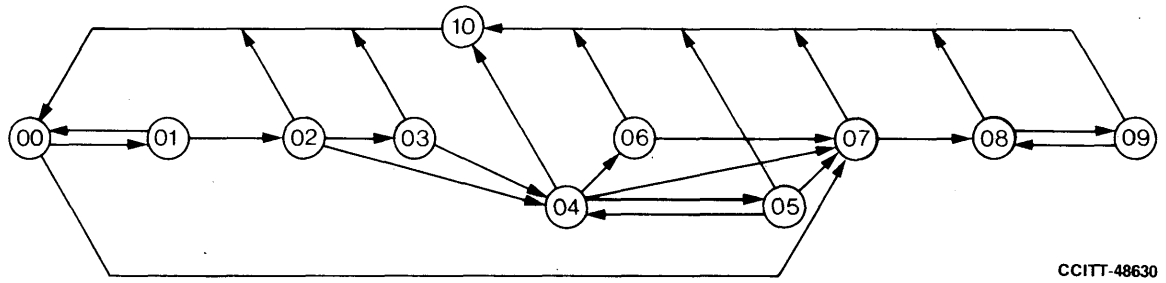


FIGURE 3/Q.625 (Sheet 2 of 2)
Outgoing Signalling System R1

LOGIC PROCEDURES FOR OUTGOING SIGNALLING SYSTEM R2



State number	*State description*	*Sheet reference*	*Timers running*
00	Idle	1, 4	
01	Wait for calling party's category (CPCI)	1	
02	Wait for country code indicator (CCI)	1	
03	Wait for echo suppressor indicator (ECI)	1	
04	Wait for backward signal	2	t_1
05	Wait for address information	3	t_2
06	Wait for Type B signal	3	t_1
07	Wait for answer	4	
08	Answered	4	
09	Clear-back	4	
10	Clear-forward	4	

FIGURE 1/Q.626
State overview diagram for outgoing Signalling System R2

Supervisory timers for outgoing Signalling System R2

t_1 = 12-18 s Recommendation Q.476, § 5.5.1.1

t_2 > 24 s Recommendation Q.476, § 5.5.1.2

Procedures not shown

The following procedures, not directly relevant to interworking, are not shown in the logic procedures:

- Interrupt control procedures (analogue version).
- Seizing acknowledgement (digital version).
- Transmission fault procedures (digital version).
- T_1 time-out and abnormal release sequence (analogue version).
- Optional forward transfer.
- Blocking and unblocking sequences.

FIGURE 2/Q.626
Notes to outgoing Signalling System R2

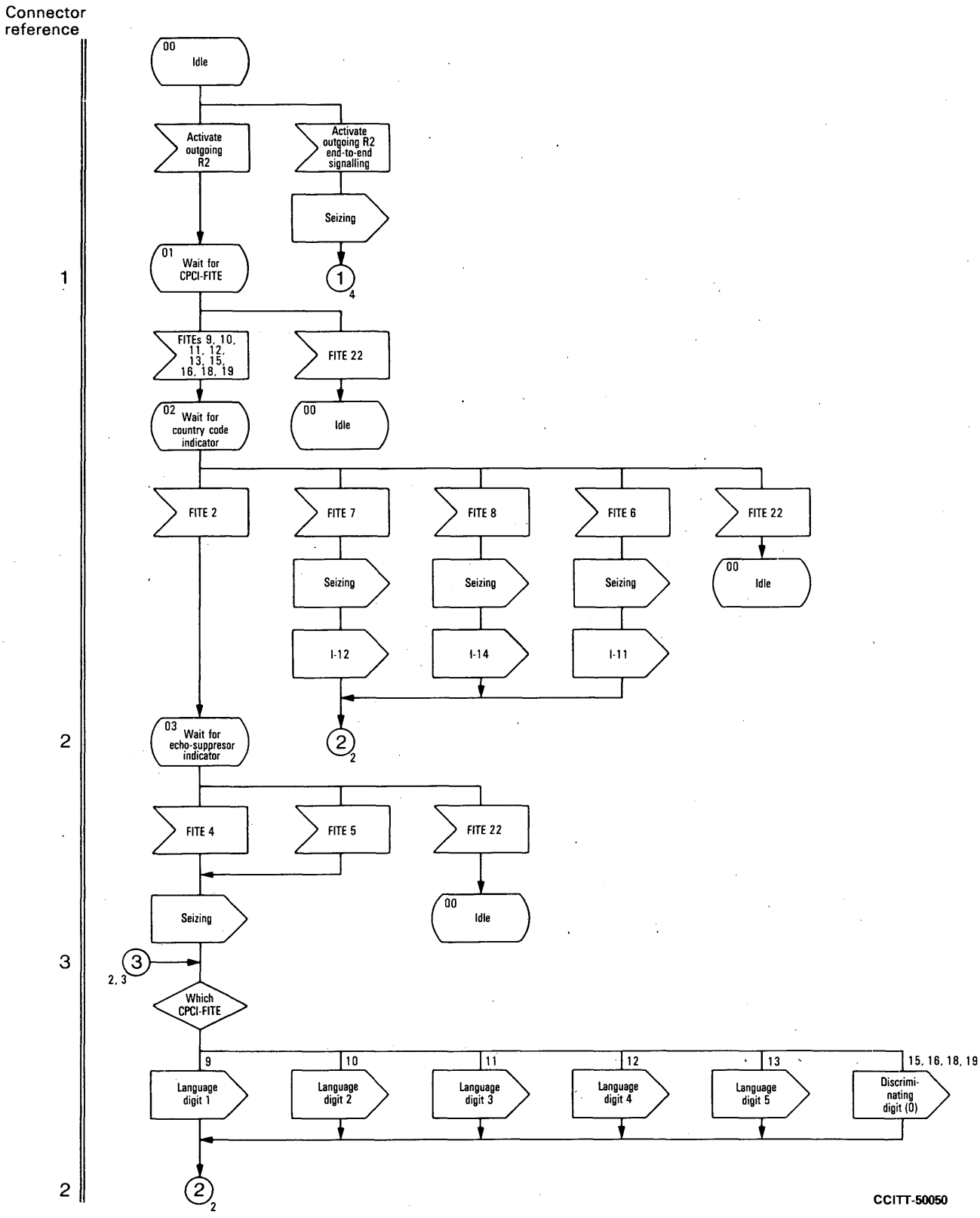


FIGURE 3/Q.626 (Sheet 1 of 4)
Outgoing Signalling System R2

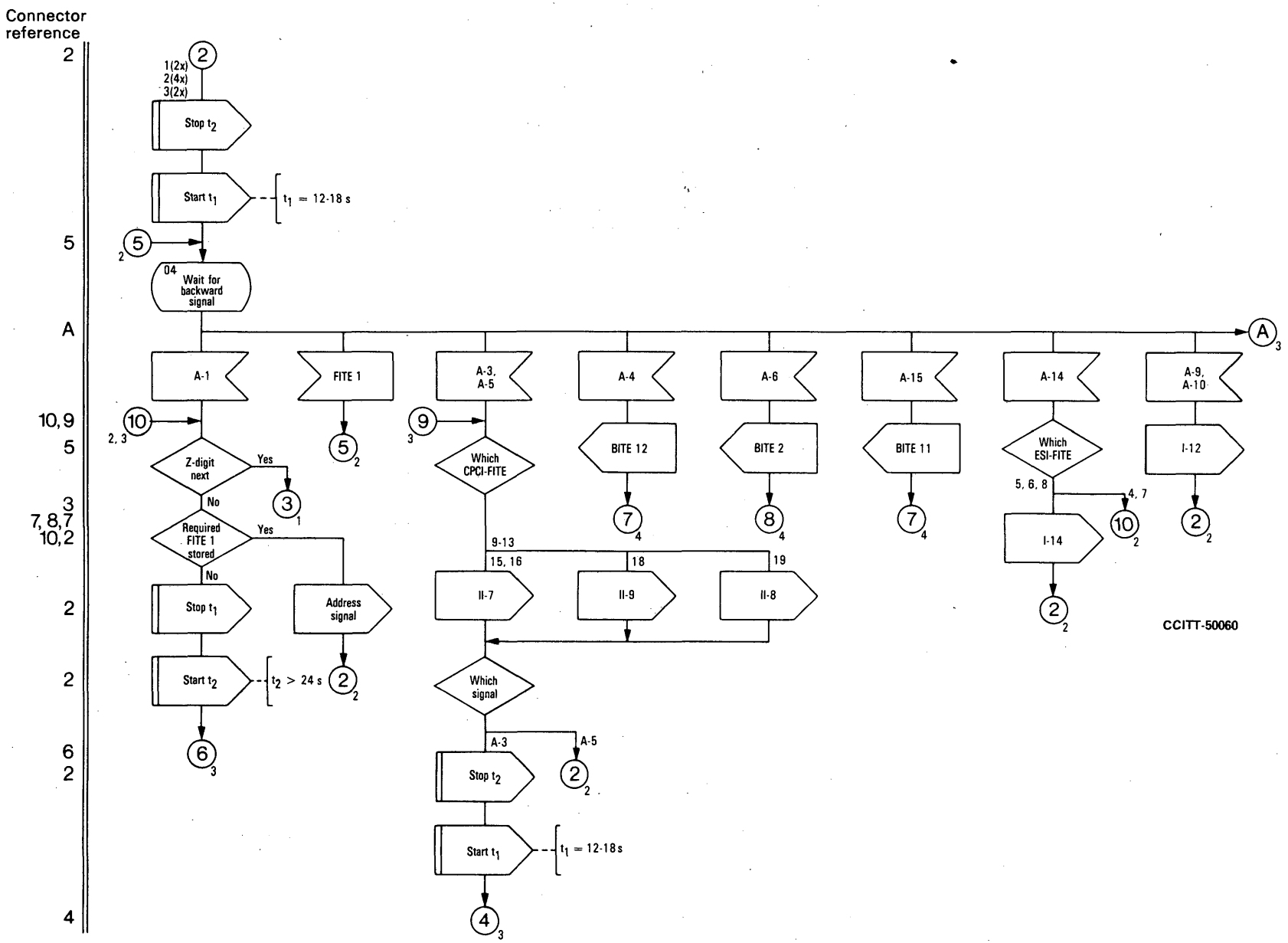


FIGURE 3/Q.626 (Sheet 2 of 4)

Outgoing Signalling System R2

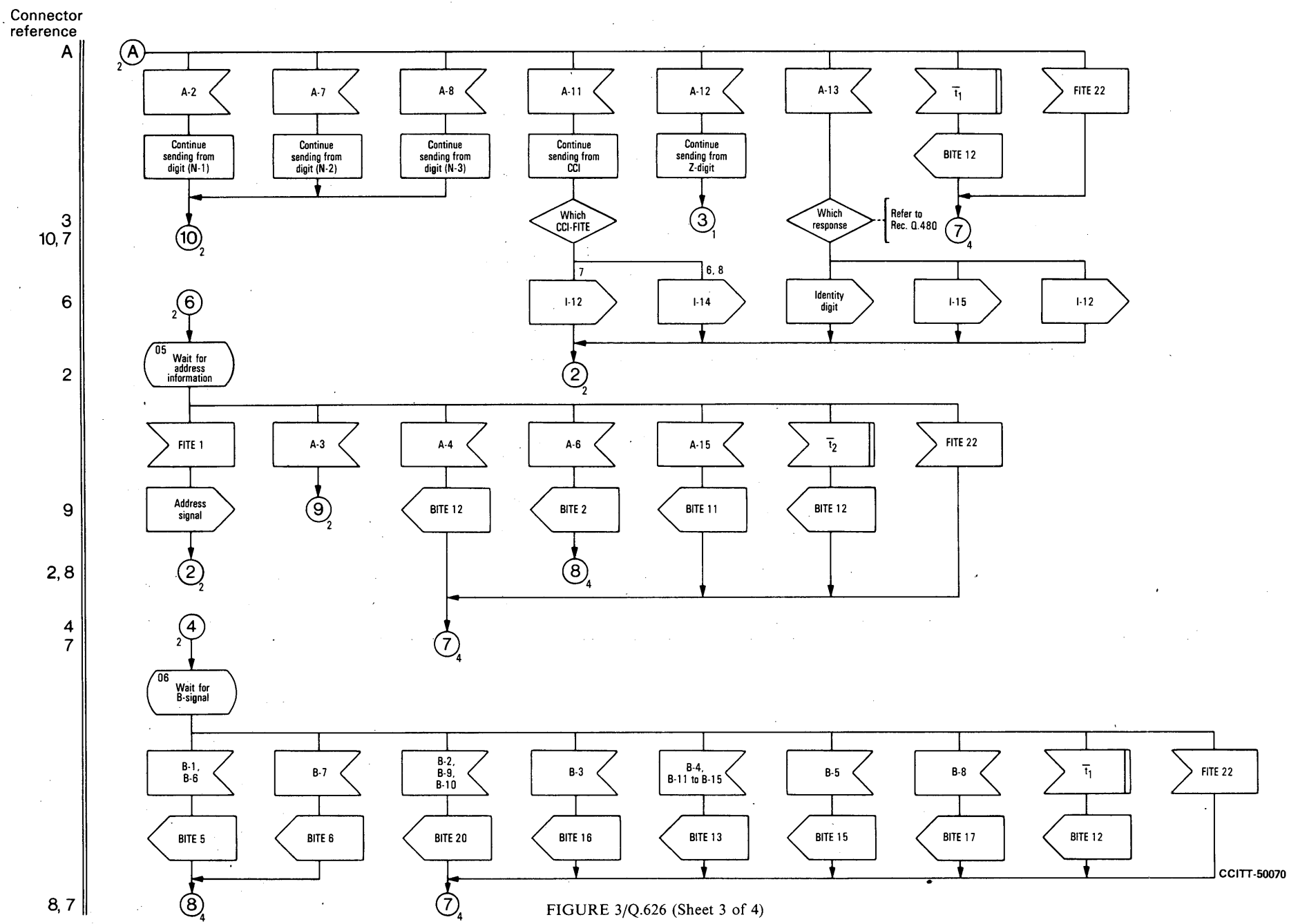


FIGURE 3/Q.626 (Sheet 3 of 4)
Outgoing Signalling System R2

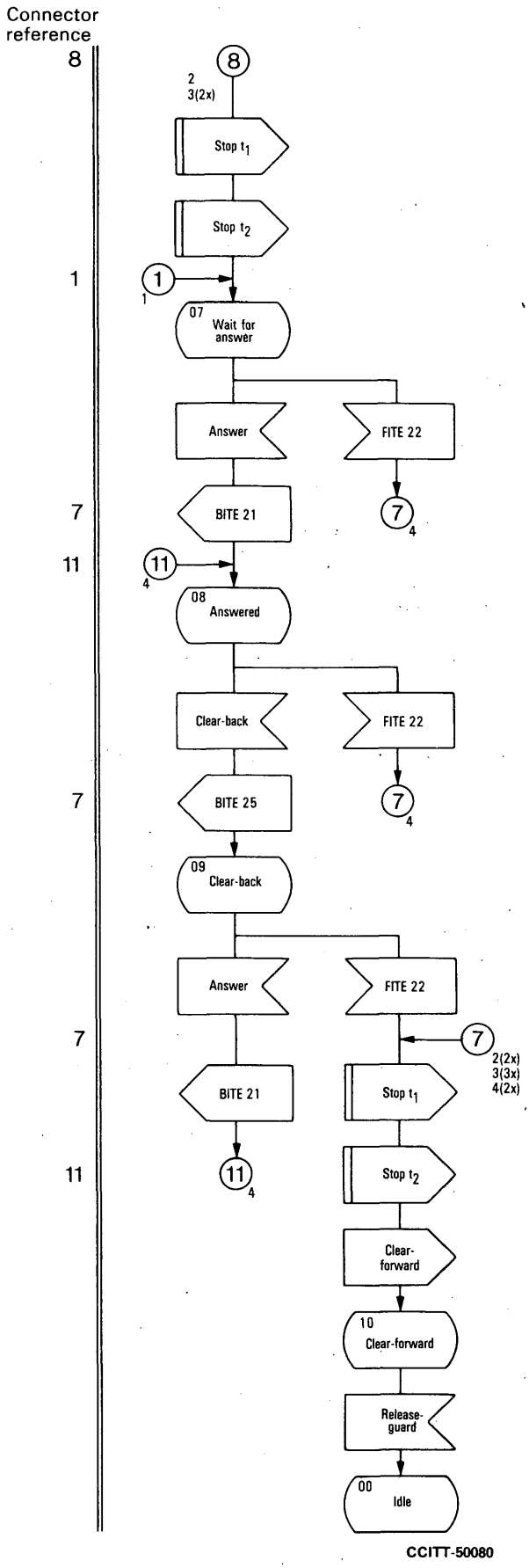
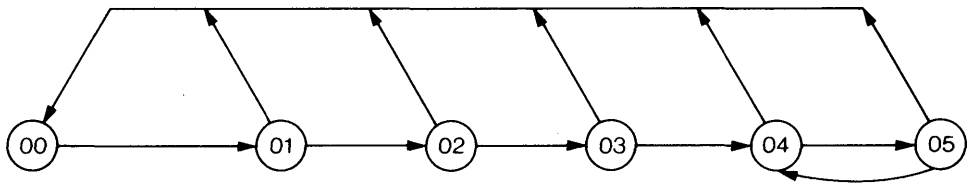


FIGURE 3/Q.626 (Sheet 4 of 4)
Outgoing Signalling System R2

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM No. 4 TO R2



State number	*State description*	*Sheet reference*
00	Idle	1
01	Wait for CPCI-FITE	1
02	Wait for address-complete	1
03	Wait for answer	2
04	Answered	2
05	Clear-back	2

FIGURE 1/Q.634
State overview diagram for interworking of Signalling System No. 4 to R2

Procedures not shown

The following procedures, not directly relevant to interworking, are not shown in the logic procedures:

– Repeat attempt.

FIGURE 2/Q.634
Notes to interworking of Signalling System No. 4 to R2

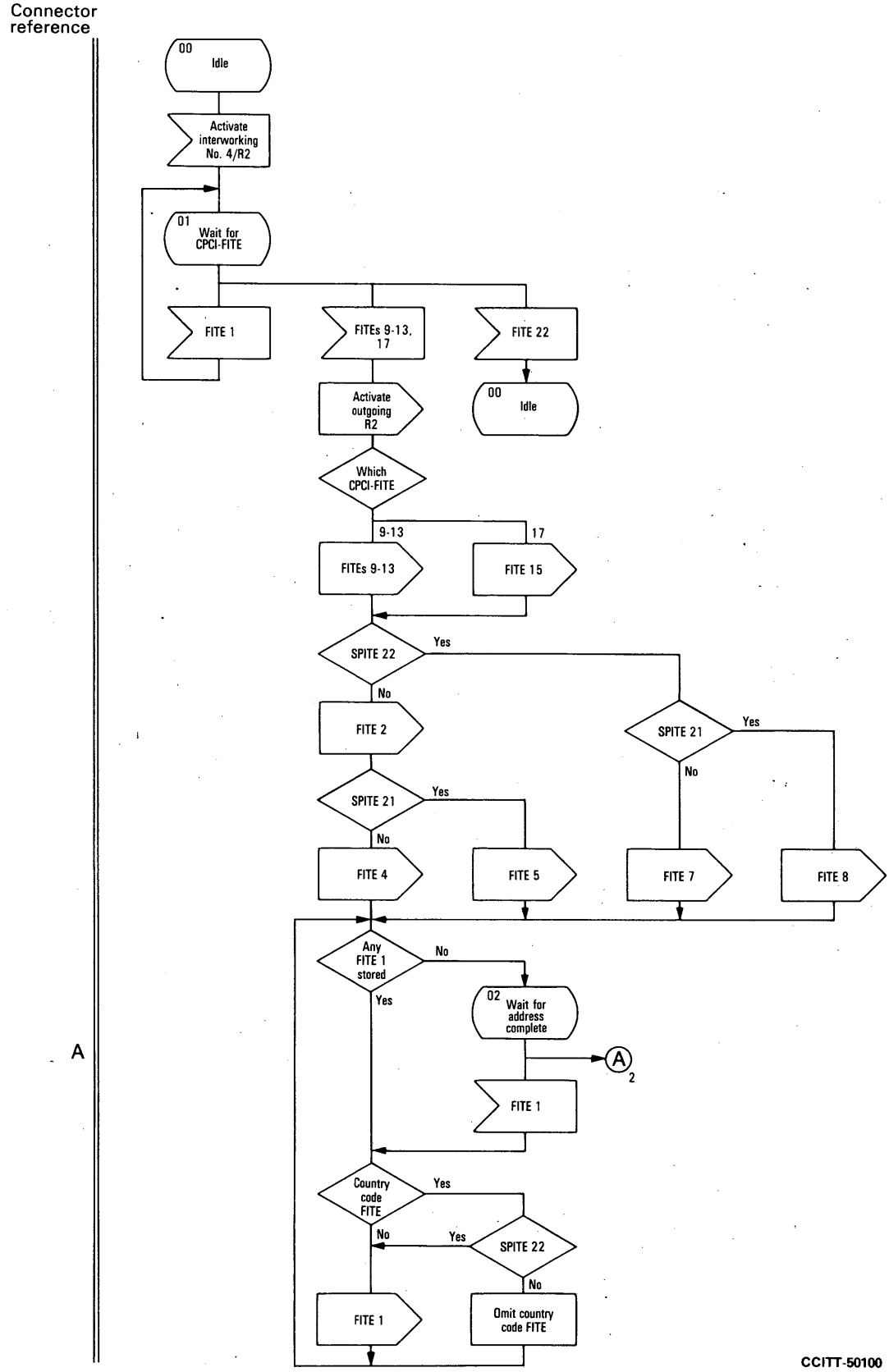


FIGURE 3/Q.634 (Sheet 1 of 2)

Interworking of Signalling System No. 4 to R2

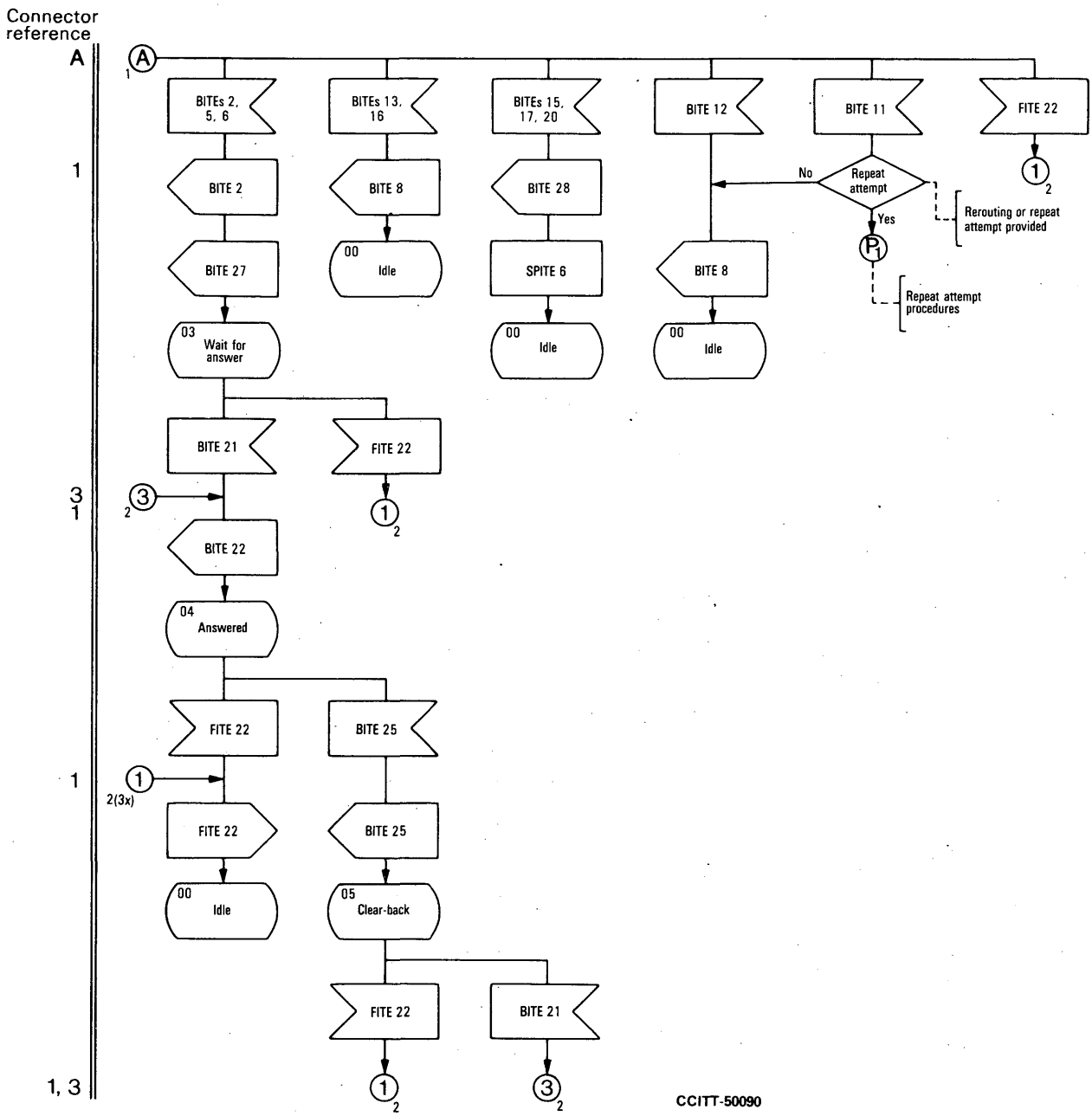
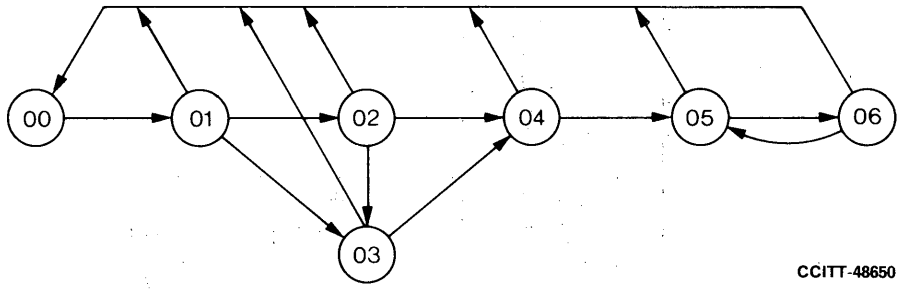


FIGURE 3/Q.634 (Sheet 2 of 2)

Interworking of Signalling System No. 4 to R2

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM No. 5 TO No. 6



State number	*State description*	*Sheet reference*
00	Idle	1, 2, 3
01	Wait for CPCI-FITE	1
02	Wait for ST	2
03	Wait for address-complete	2
04	Wait for answer	3
05	Answered	3
06	Clear-back	3

FIGURE 1/Q.642
State overview diagram for interworking of Signalling System No. 5 to No. 6

FIGURE 2/Q.642
(Reserved for future notes)

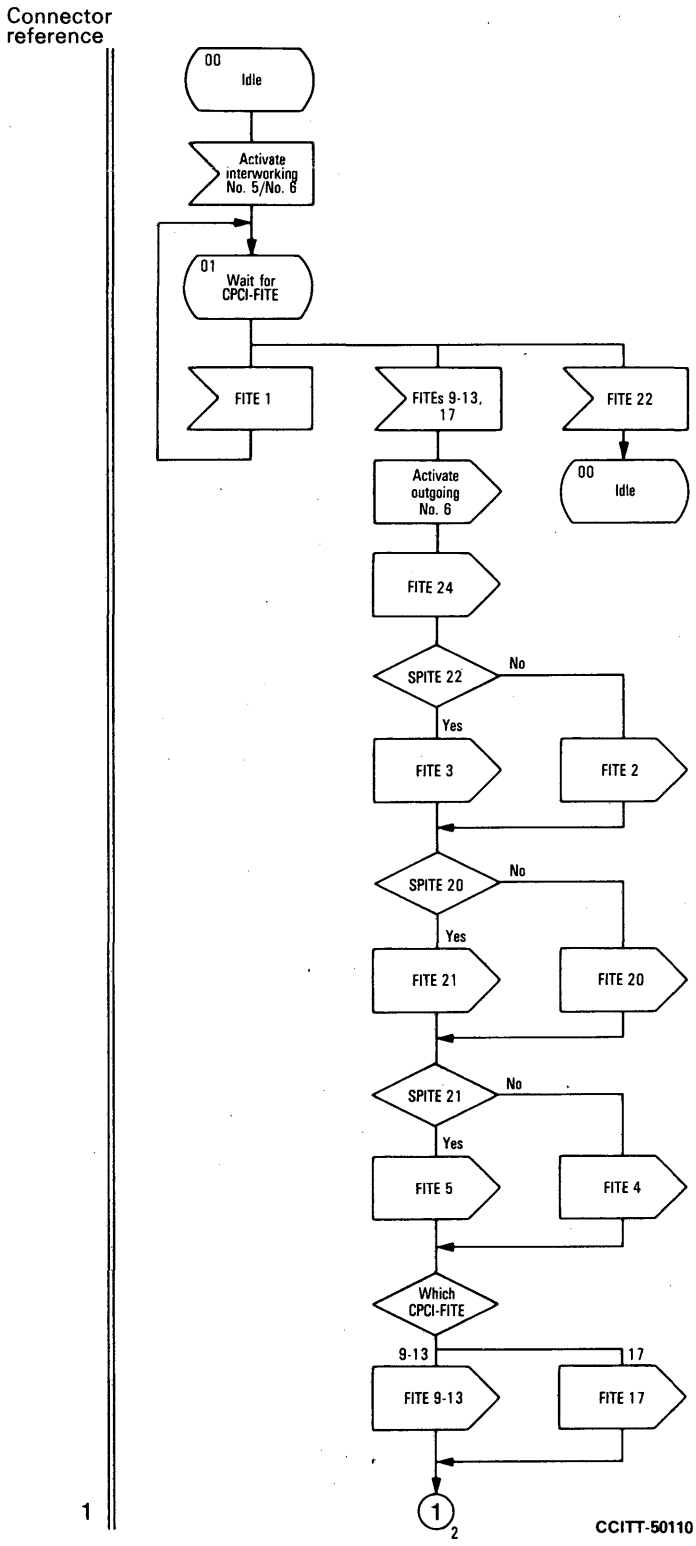


FIGURE 3/Q.642 (Sheet 1 of 3)

Interworking of Signalling System No. 5 to No. 6

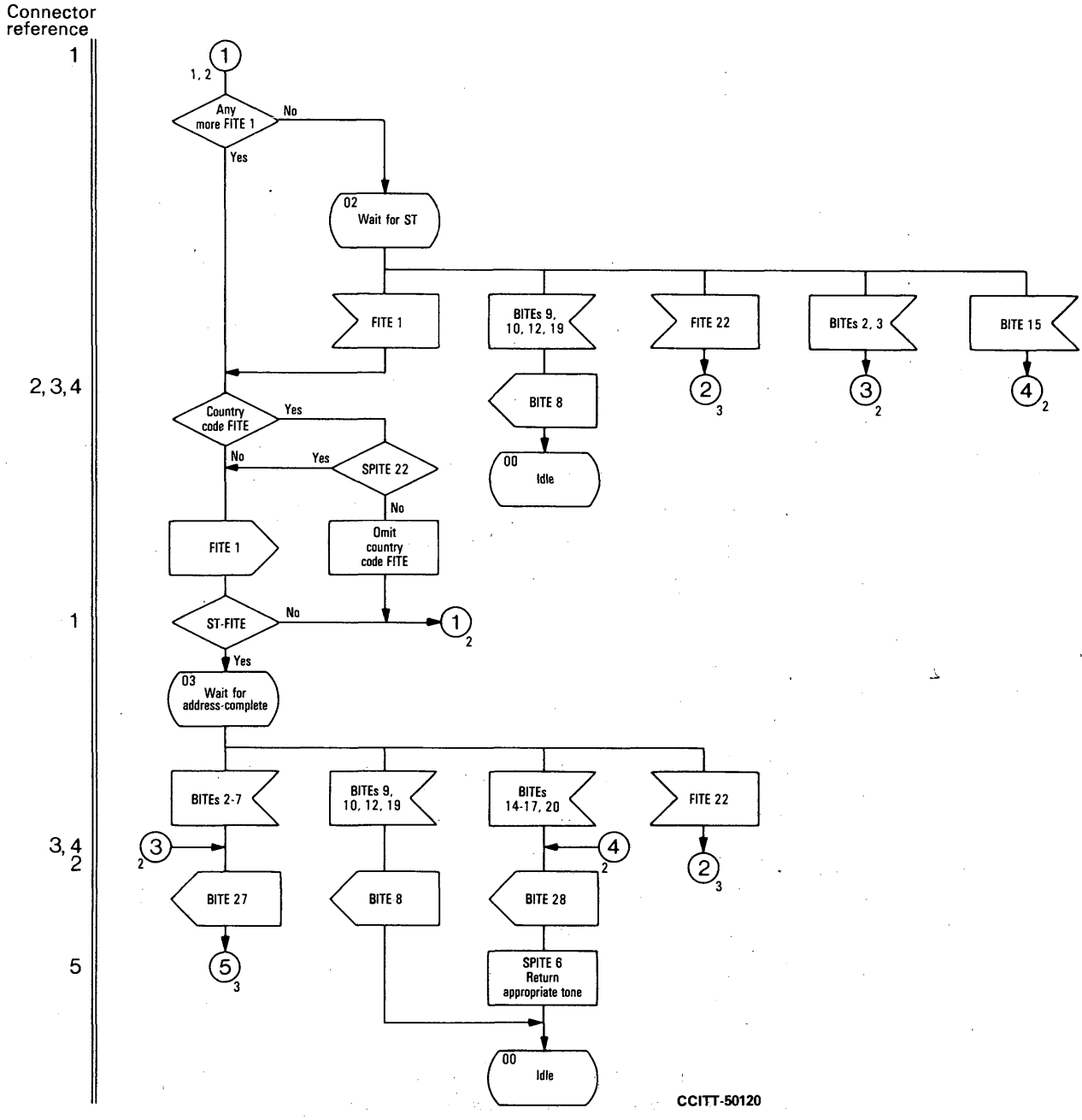


FIGURE 3/Q.642 (Sheet 2 of 3)

Interworking of Signalling System No. 5 to No. 6

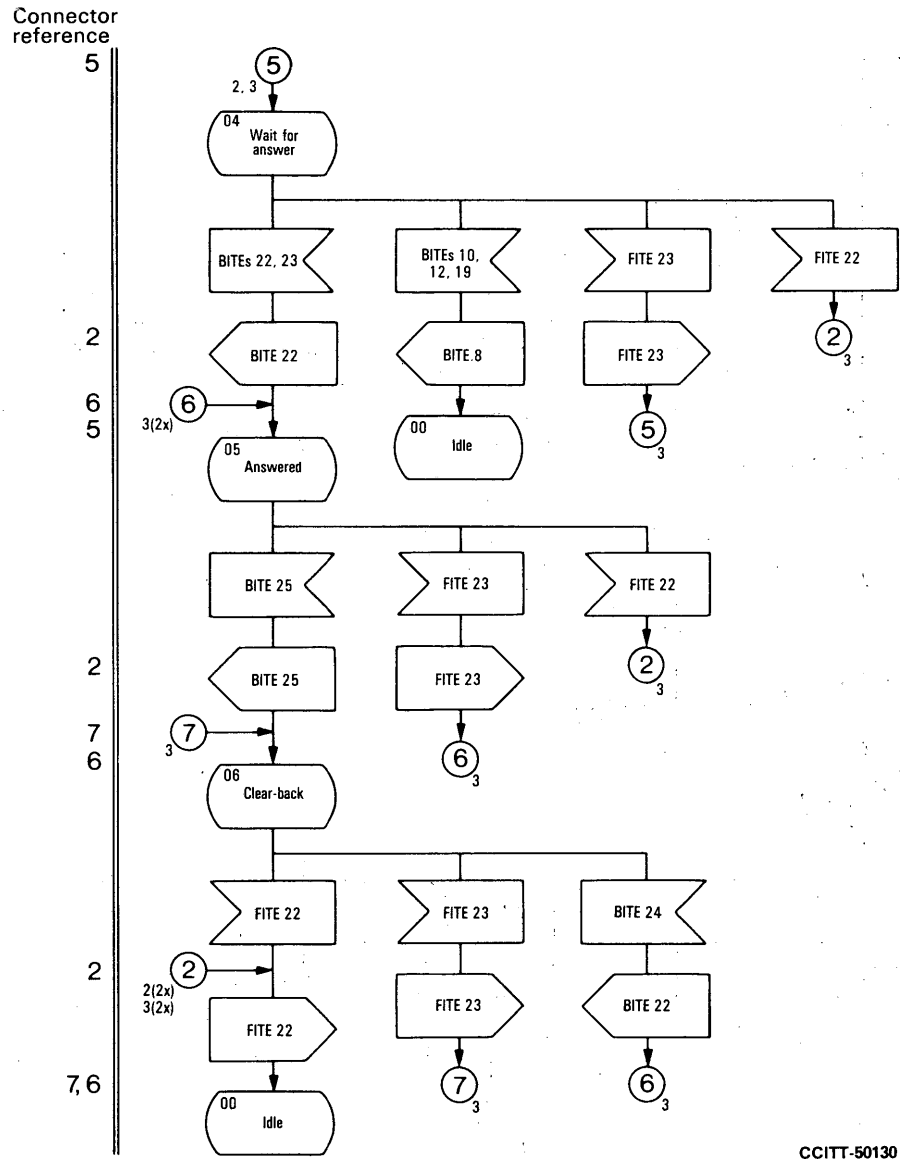
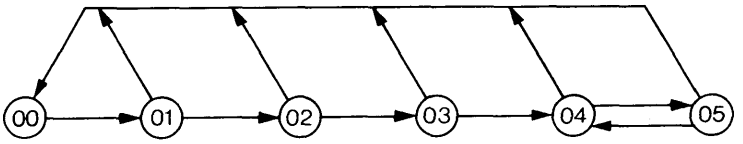


FIGURE 3/Q.642 (Sheet 3 of 3)

Interworking of Signalling System No. 5 to No. 6

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM No. 5 TO R1



State number	*State description*
00	Idle
01	Wait for ST
02	Wait for register deactivation
03	Wait for answer
04	Answered
05	Clear-back

FIGURE 1/Q.644
State overview diagram for interworking of Signalling System No. 5 to R1

Procedures not shown

Procedure P_1 is not described because the procedure has not been specified in the Signalling System R1 specifications.

FIGURE 2/Q.644
Notes to interworking of Signalling System No. 5 to R1

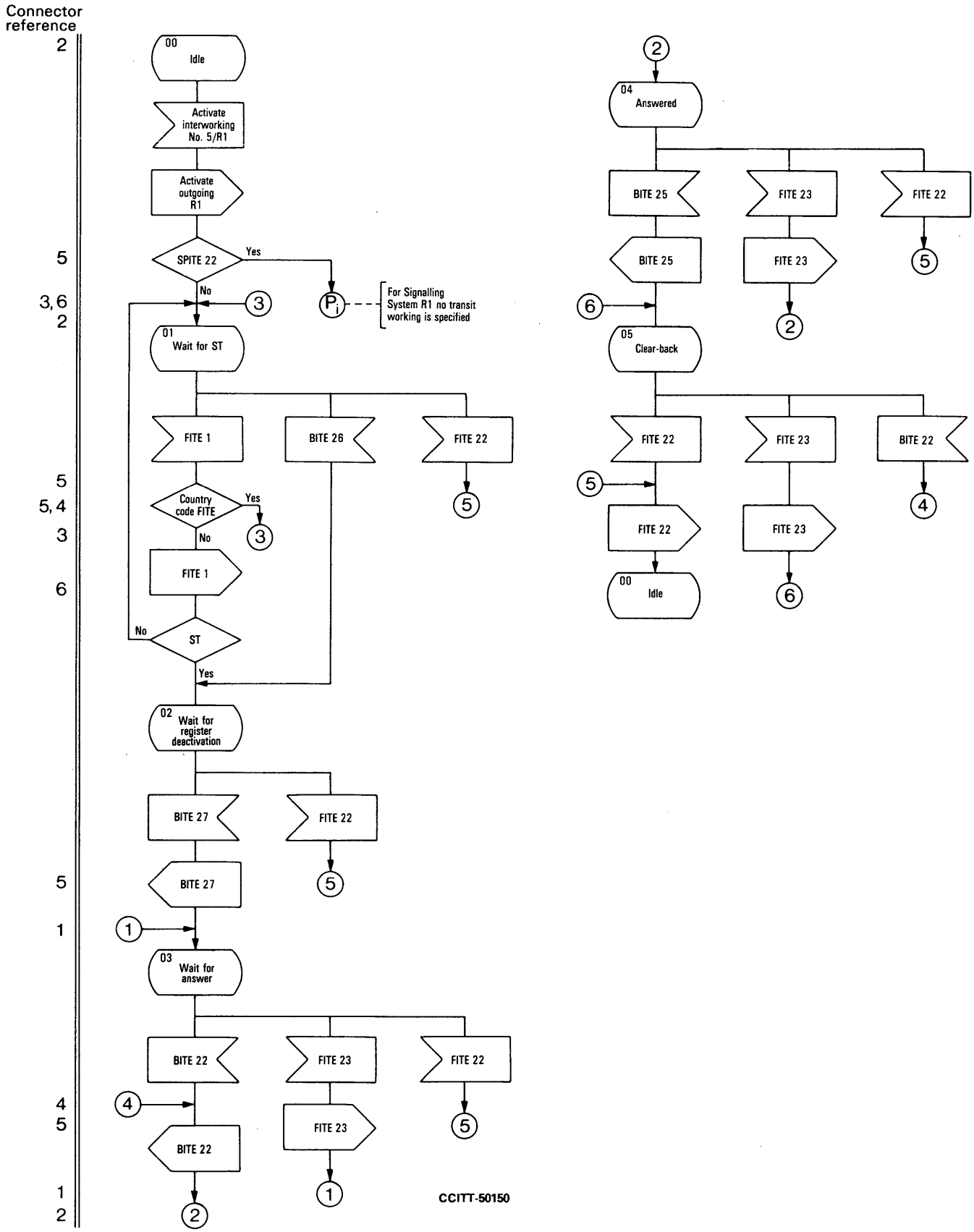
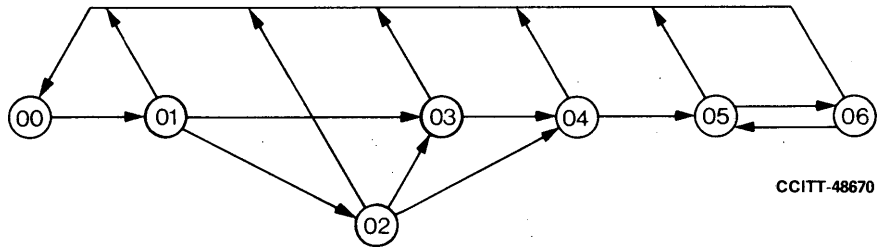


FIGURE 3/Q.644

Interworking of Signalling System No. 5 to R1

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM No. 5 TO R2



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for calling party's category (CPCI)	1
02	Wait for ST	1
03	Wait for address-complete	2
04	Wait for answer	2
05	Answered	2
06	Clear-back	2

FIGURE 1/Q.645
State overview diagram for interworking of Signalling System No. 5 to R2

FIGURE 2/Q.645
(Reserved for future notes)

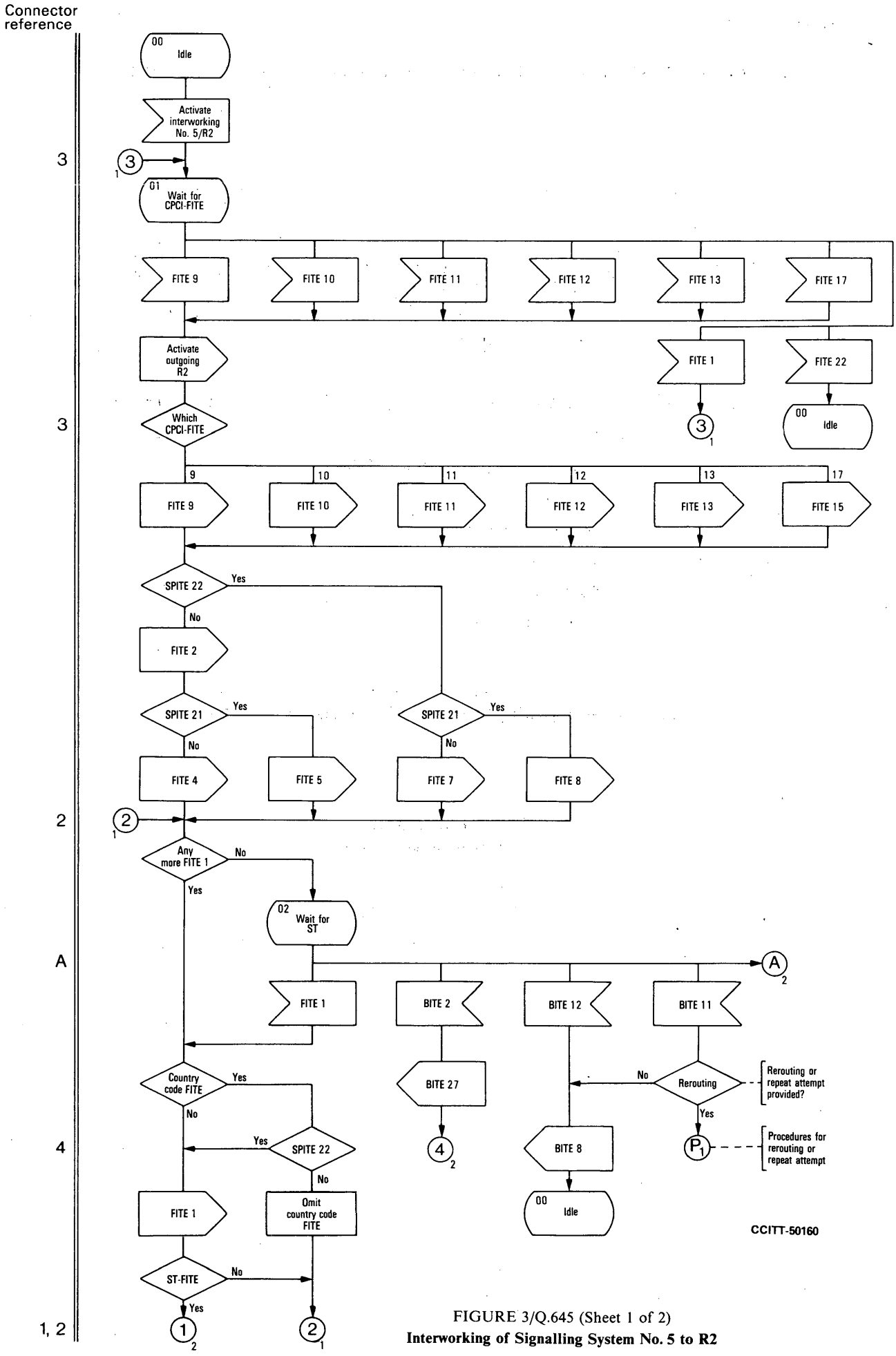
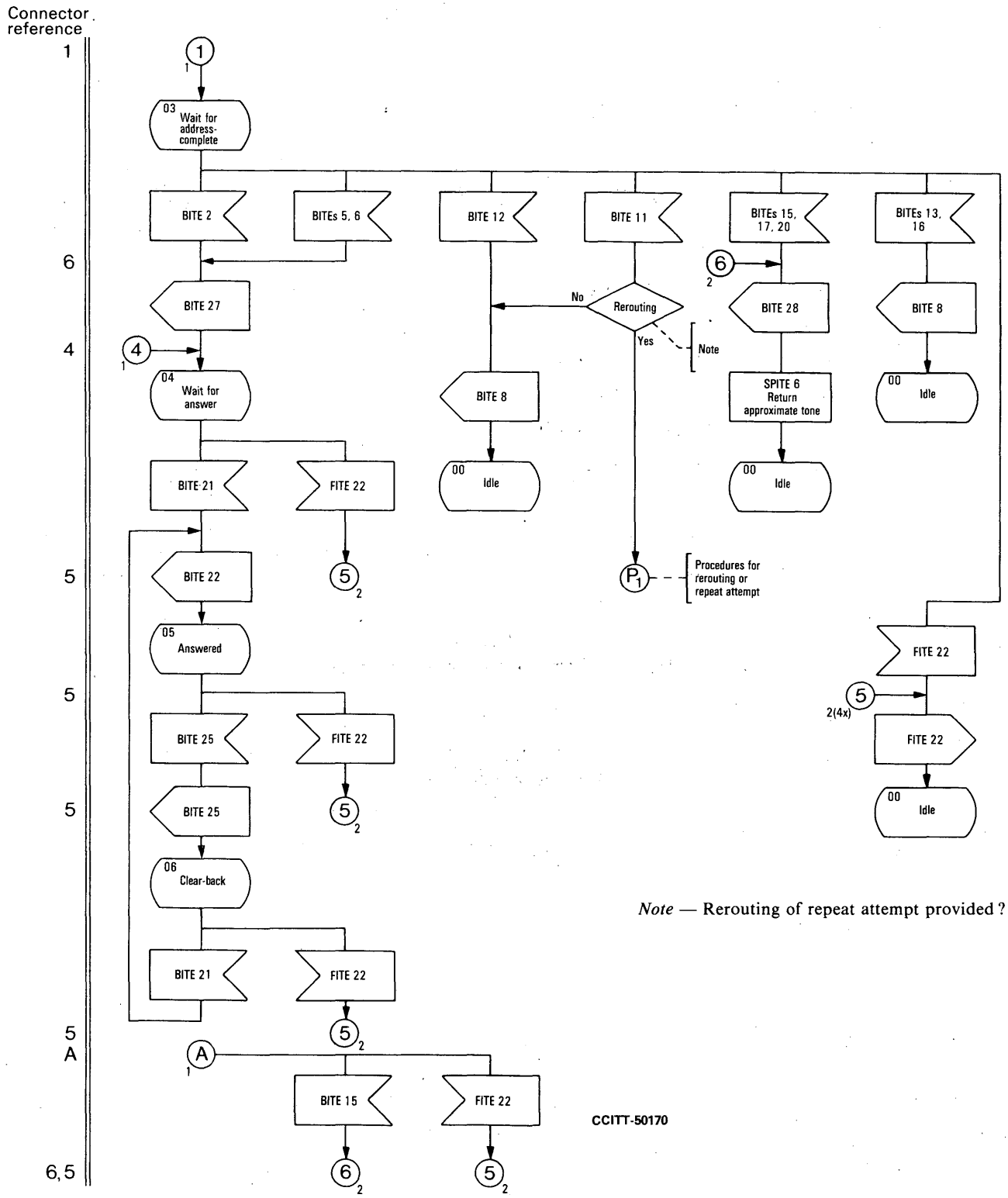


FIGURE 3/Q.645 (Sheet 1 of 2)
Interworking of Signalling System No. 5 to R2

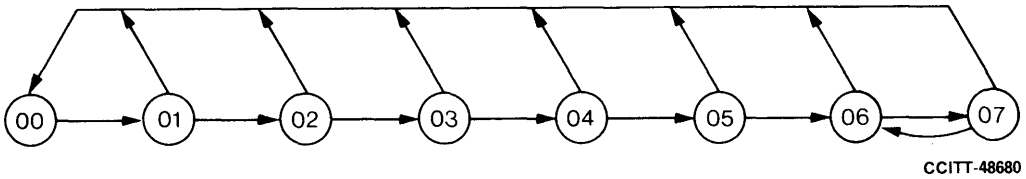


Note — Rerouting of repeat attempt provided?

FIGURE 3/Q.645 (Sheet 2 of 2)

Interworking of Signalling System No. 5 to R2

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM No. 6 TO No. 5



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for CPCI-FITE	1
02	Wait for COT	1
03	Wait for address-complete	1
04	Wait for register deactivation	2
05	Wait for answer	2
06	Answered	2
07	Clear-back	2

FIGURE 1/Q.652
State overview diagram for interworking of Signalling System No. 6 to No. 5

FIGURE 2/Q.652
(Reserved for future notes)

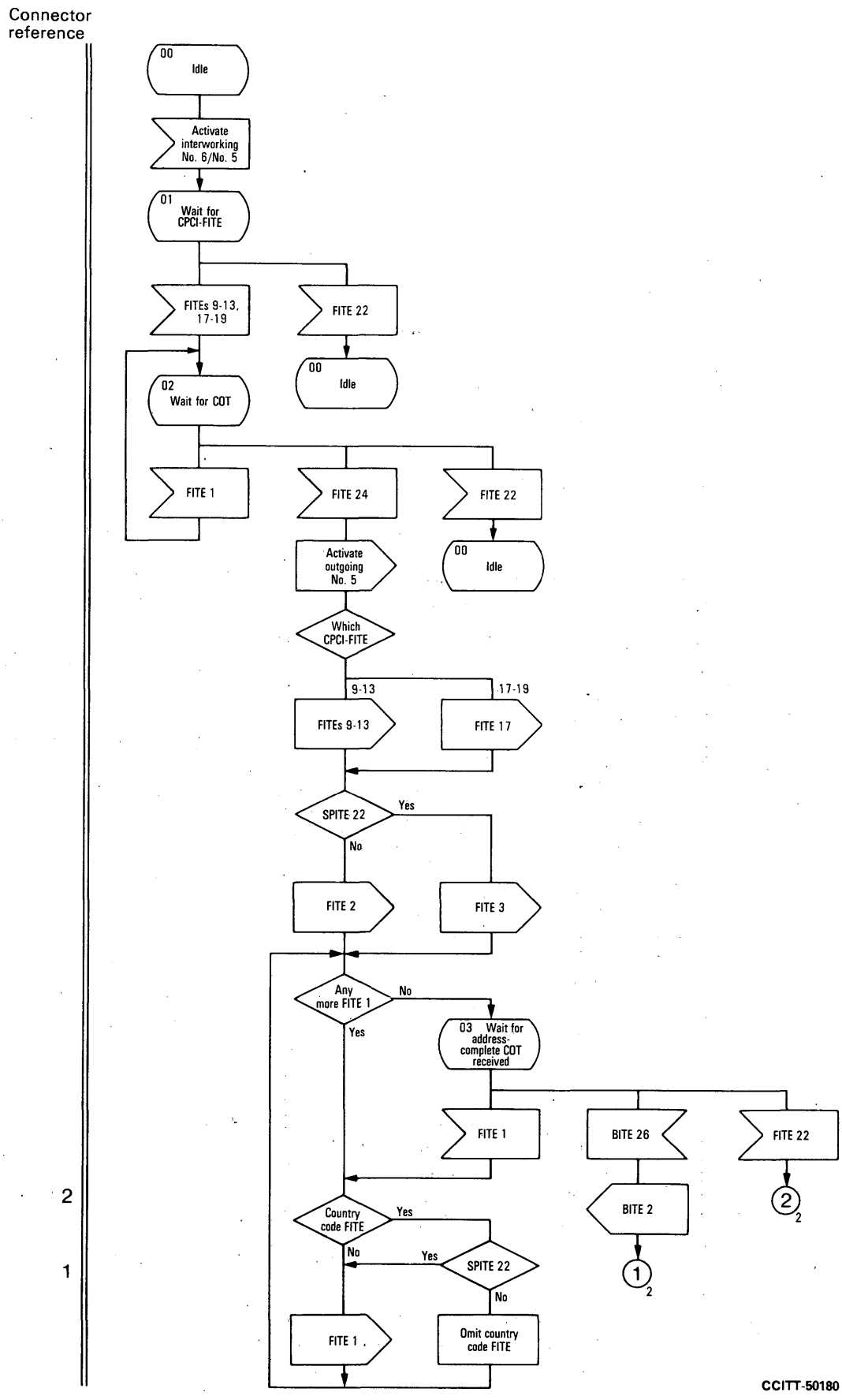


FIGURE 3/Q.652 (Sheet 1 of 2)

Interworking of Signalling System No. 6 to No. 5

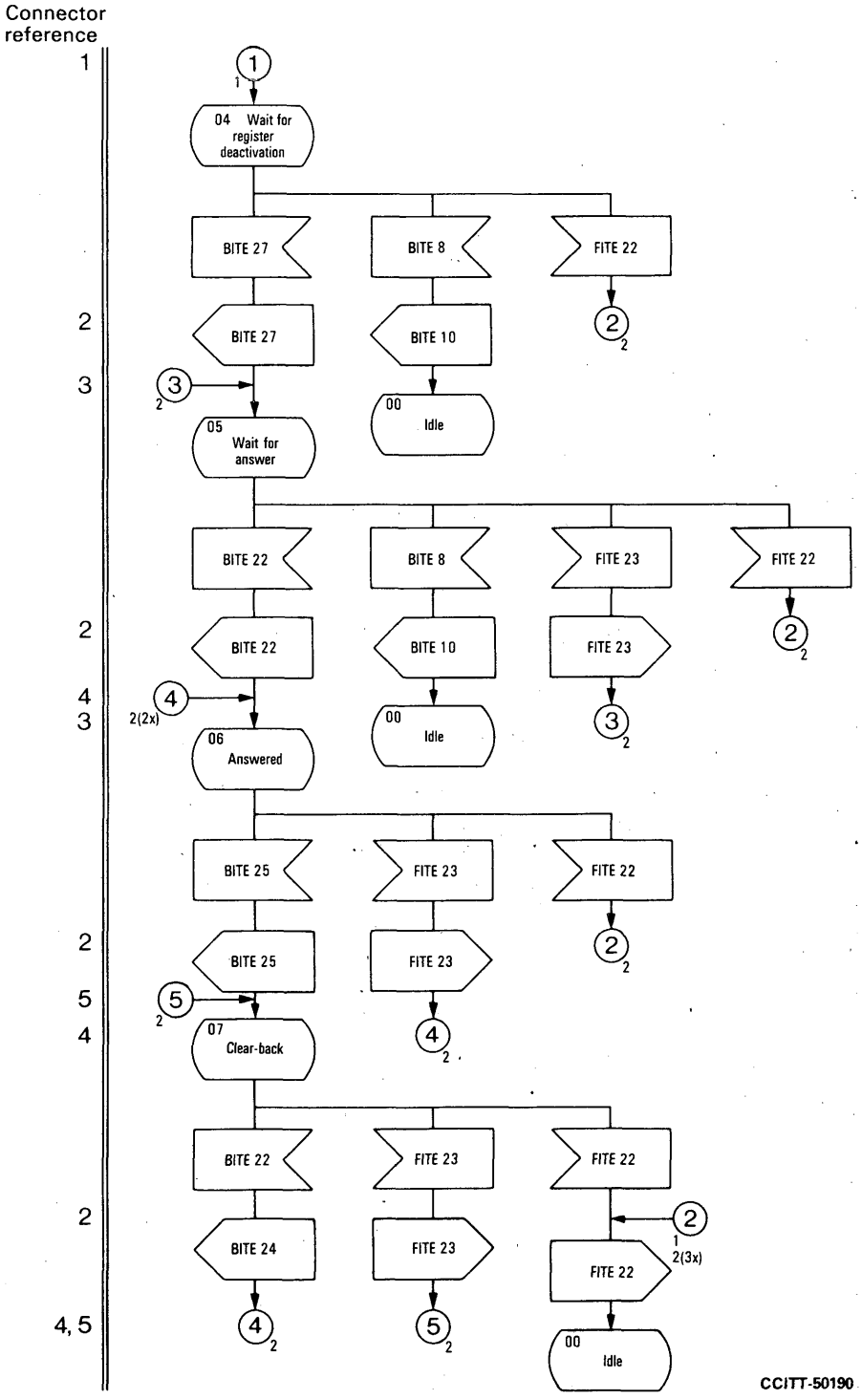
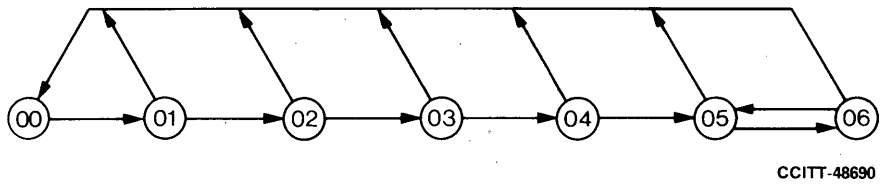


FIGURE 3/Q.652 (Sheet 2 of 2)

Interworking of Signalling System No. 6 to No. 5

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM No. 6 TO R1



State number	*State description*
00	Idle
01	Wait for continuity check
02	Wait for address-complete
03	Wait for register deactivation
04	Wait for answer
05	Answered
06	Clear-back

FIGURE 1/Q.654
State overview diagram for interworking of Signalling System No. 6 to R1

Procedures not shown

Procedure P_1 is not described because no procedure is specified in the Signalling System R1 specifications.

FIGURE 2/Q.654
Notes to interworking of Signalling System No. 6 to R1

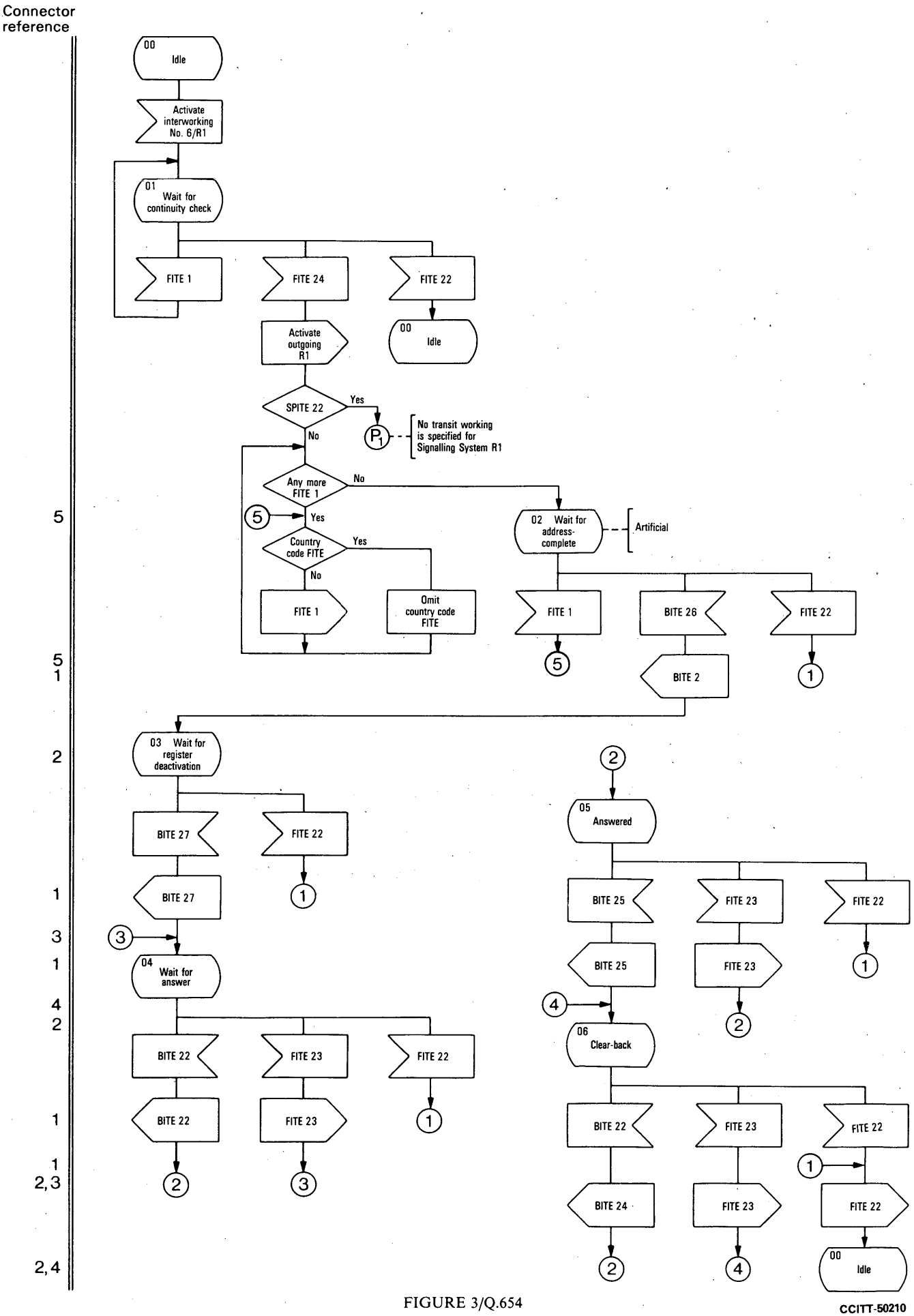
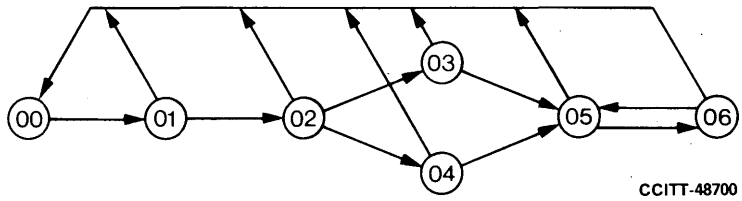


FIGURE 3/Q.654

Interworking of Signalling System No. 6 to R1

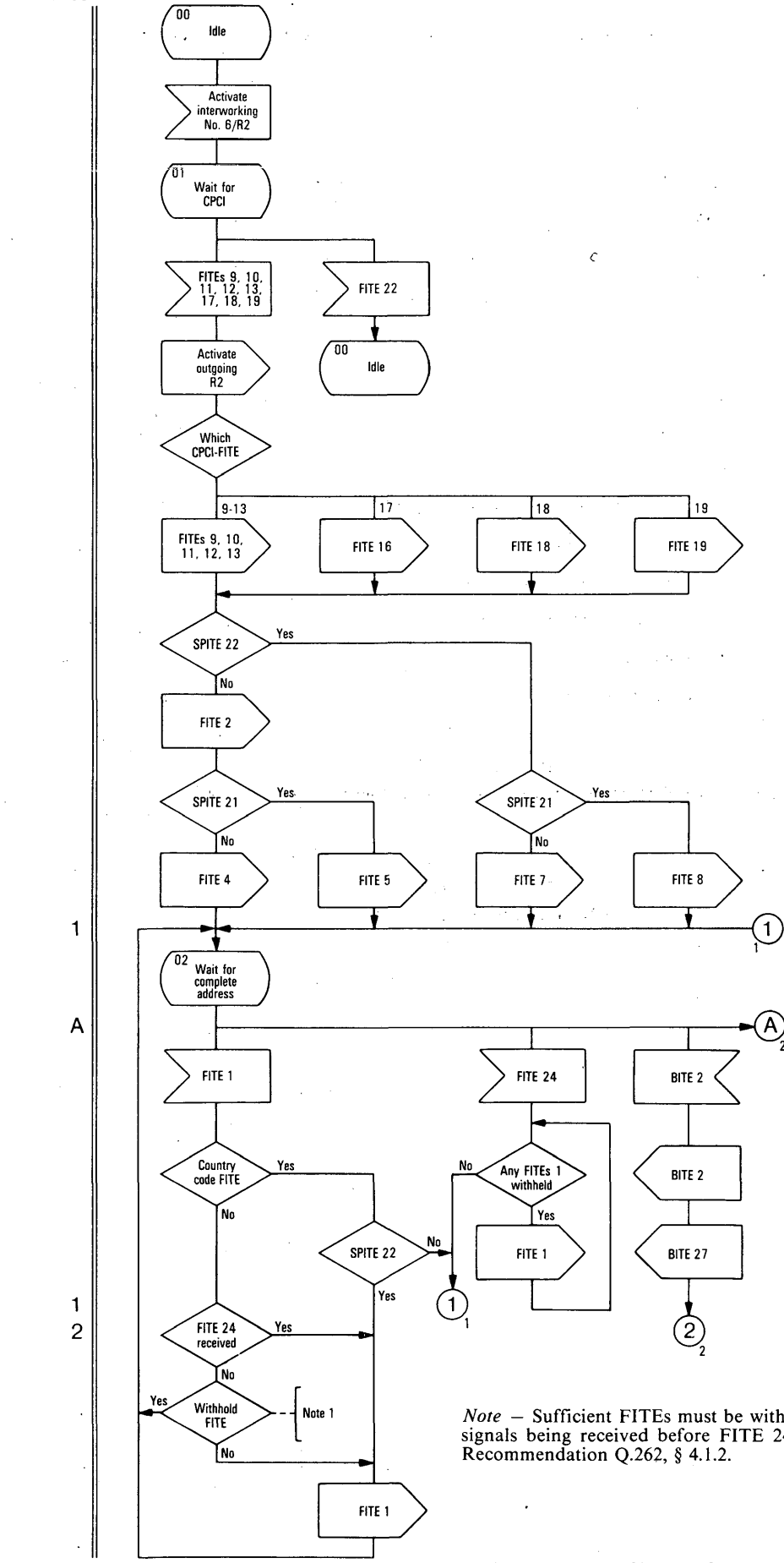
LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM No. 6 TO R2



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for calling party's category (CPCI)	1
02	Wait for address-complete	1
03	Wait for answer, charge	2
04	Wait for answer, no charge	2
05	Answered	2
06	Clear-back	2

FIGURE 1/Q.655
State overview diagram for interworking of Signalling System No. 6 to R2

FIGURE 2/Q.655
(Reserved for futures notes)



Note – Sufficient FITEs must be withheld to prevent address-complete signals being received before FITE 24 (continuity) has been received. Recommendation Q.262, § 4.1.2.

FIGURE 3/Q.655 (Sheet 1 of 2)

Interworking of Signalling System No. 6 to R2

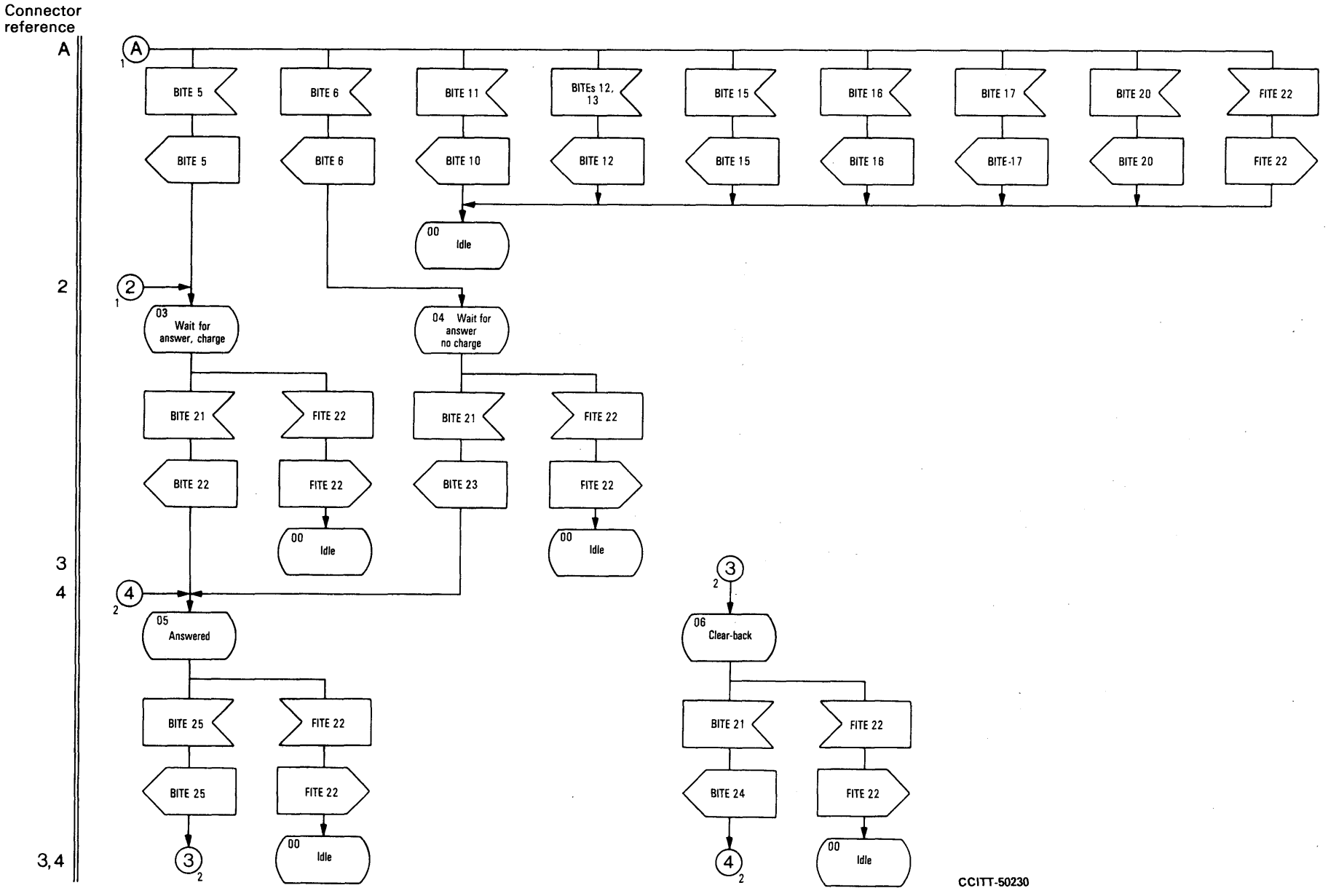
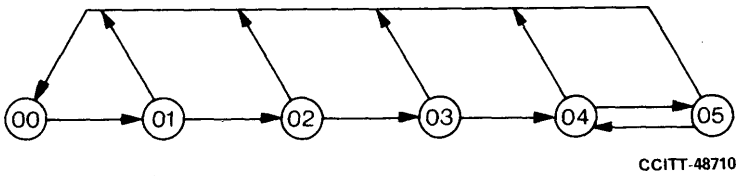


FIGURE 3/Q.655 (Sheet 2 of 2)

Interworking of Signalling System No. 6 to R2

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM R1 TO No. 5



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for ST	1
02	Wait for register deactivation	1
03	Wait for answer	2
04	Answered	2
05	Clear-back	2

FIGURE 1/Q.671
State overview diagram for interworking of Signalling System R1 to No. 5

FIGURE 2/Q.671
(Reserved for future notes)

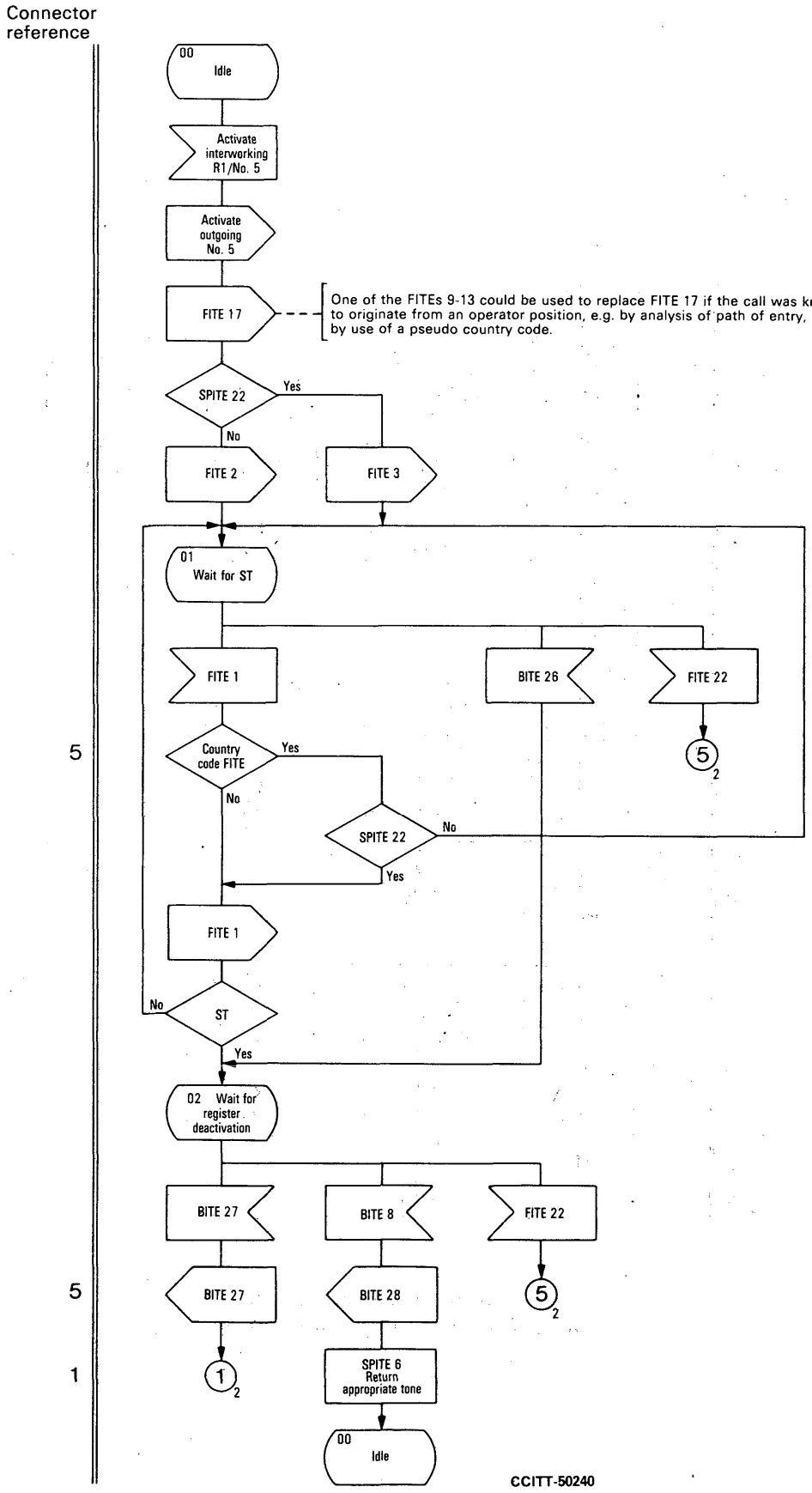


FIGURE 3/Q.671 (Sheet 1 of 2)

Interworking of Signalling System R1 to No. 5

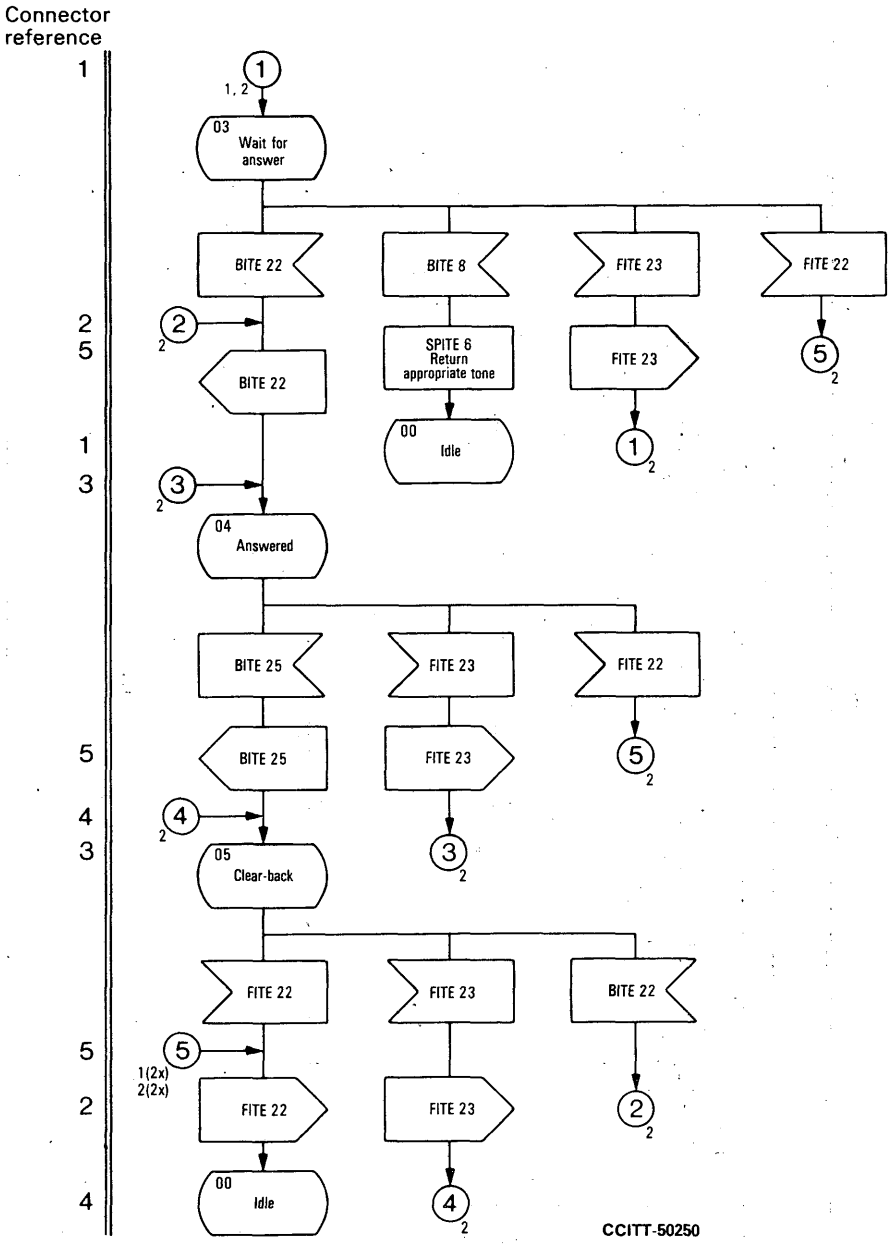
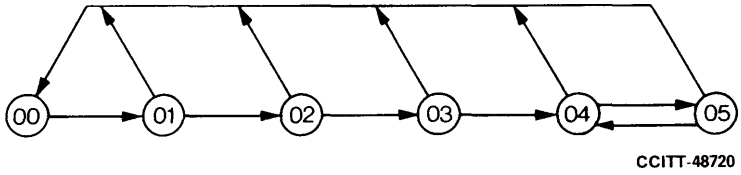


FIGURE 3/Q.671 (Sheet 2 of 2)

Interworking of Signalling System R1 to No. 5

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM R1 TO No. 6



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for ST	1
02	Wait for address-complete	2
03	Wait for answer	2
04	Answered	2
05	Clear-back	2

FIGURE 1/Q.672
State overview diagram for interworking of Signalling System R1 to No. 6

FIGURE 2/Q.672
(Reserved for futures notes)

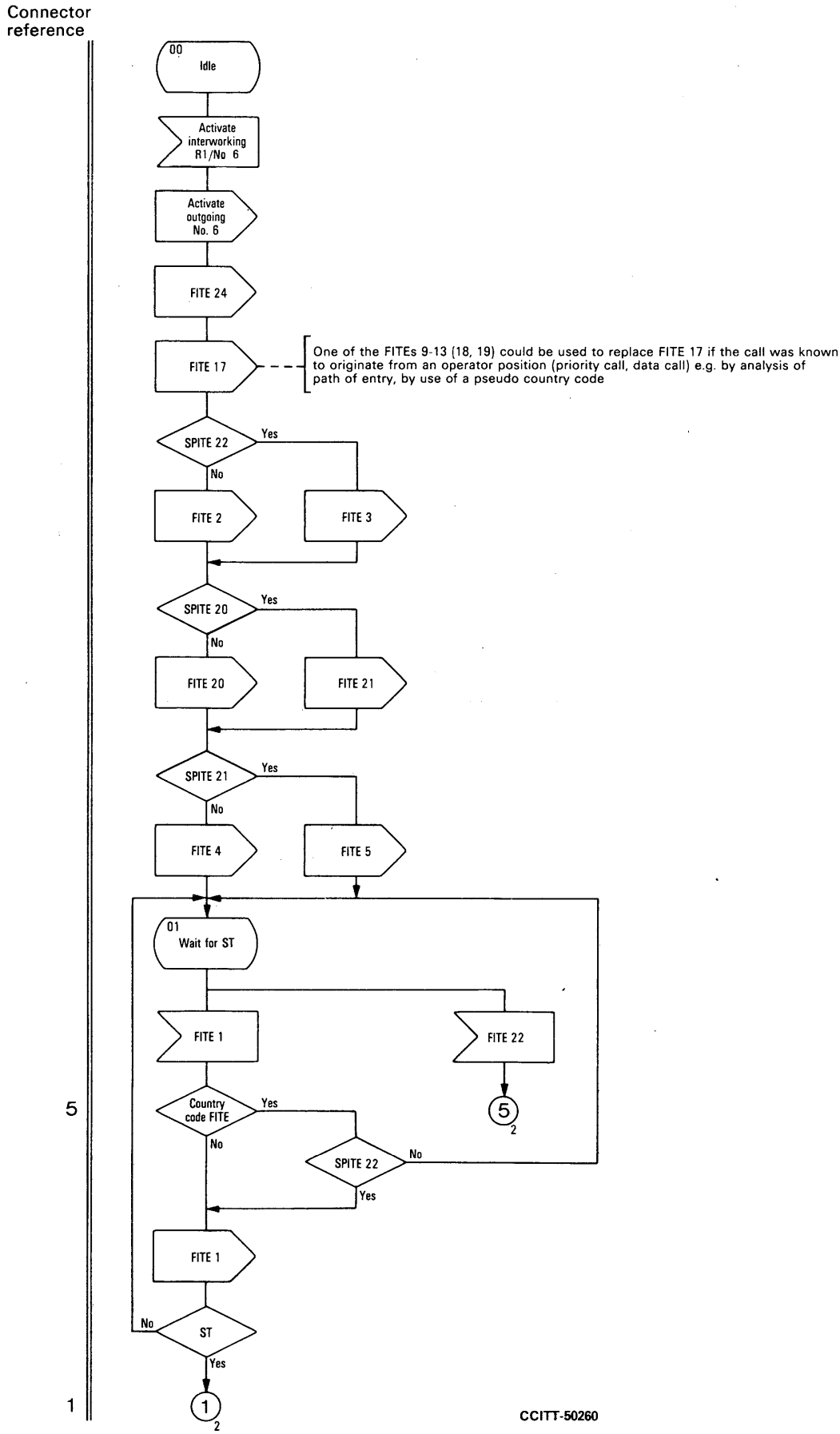


FIGURE 3/Q.672 (Sheet 1 of 2)

Interworking of Signalling System R1 to No. 6

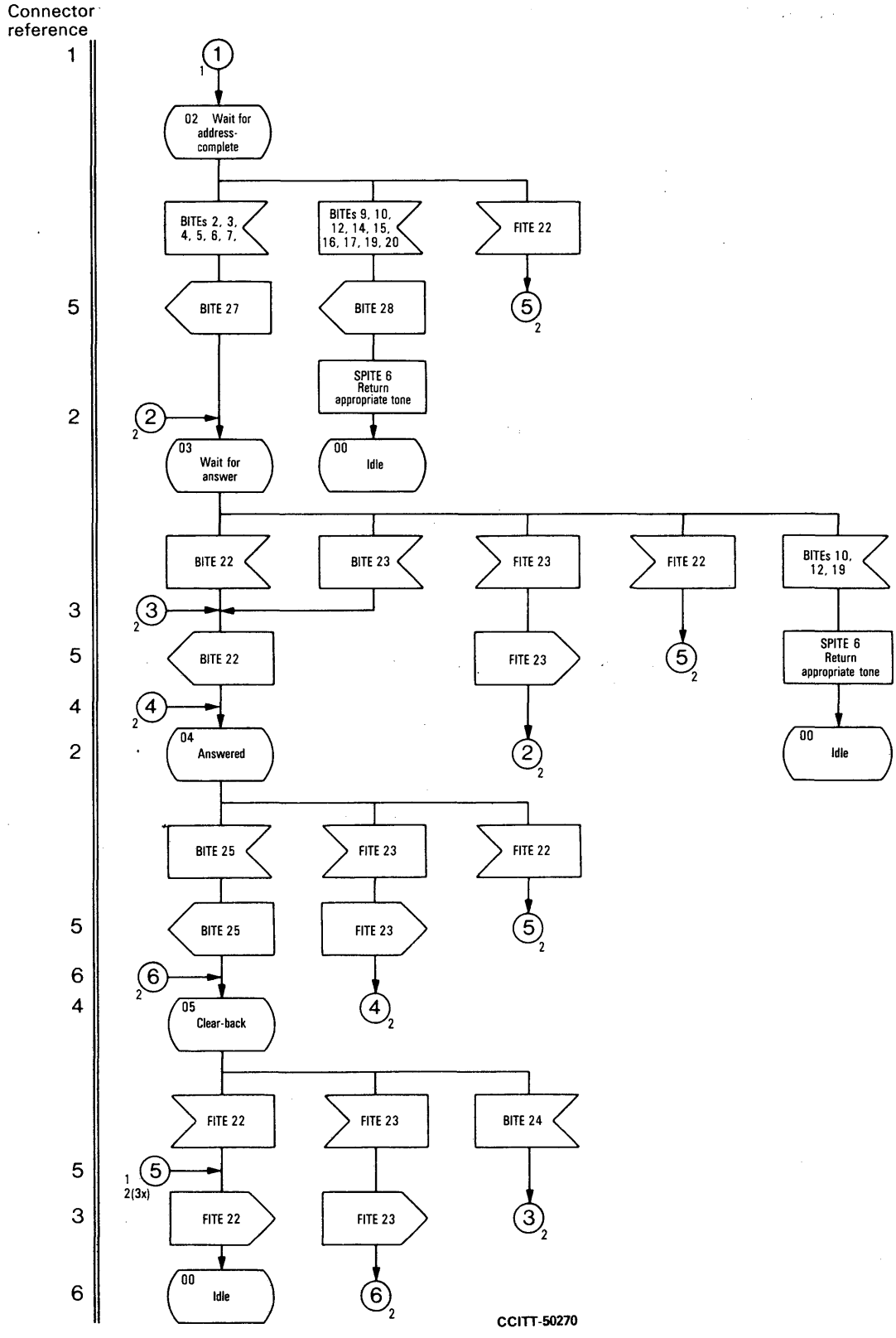
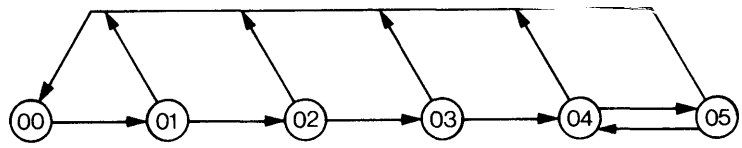


FIGURE 3/Q.672 (Sheet 2 of 2)

Interworking of Signalling Sytem R1 to No. 6

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM R1 TO R2



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for ST-FITE	1
02	Wait for address-complete	1
03	Wait for answer	2
04	Answered	2
05	Clear-back	2

FIGURE 1/Q.674
State overview diagram for interworking of Signalling System R1 to R2

FIGURE 2/Q.674
(Reserved for futures notes)

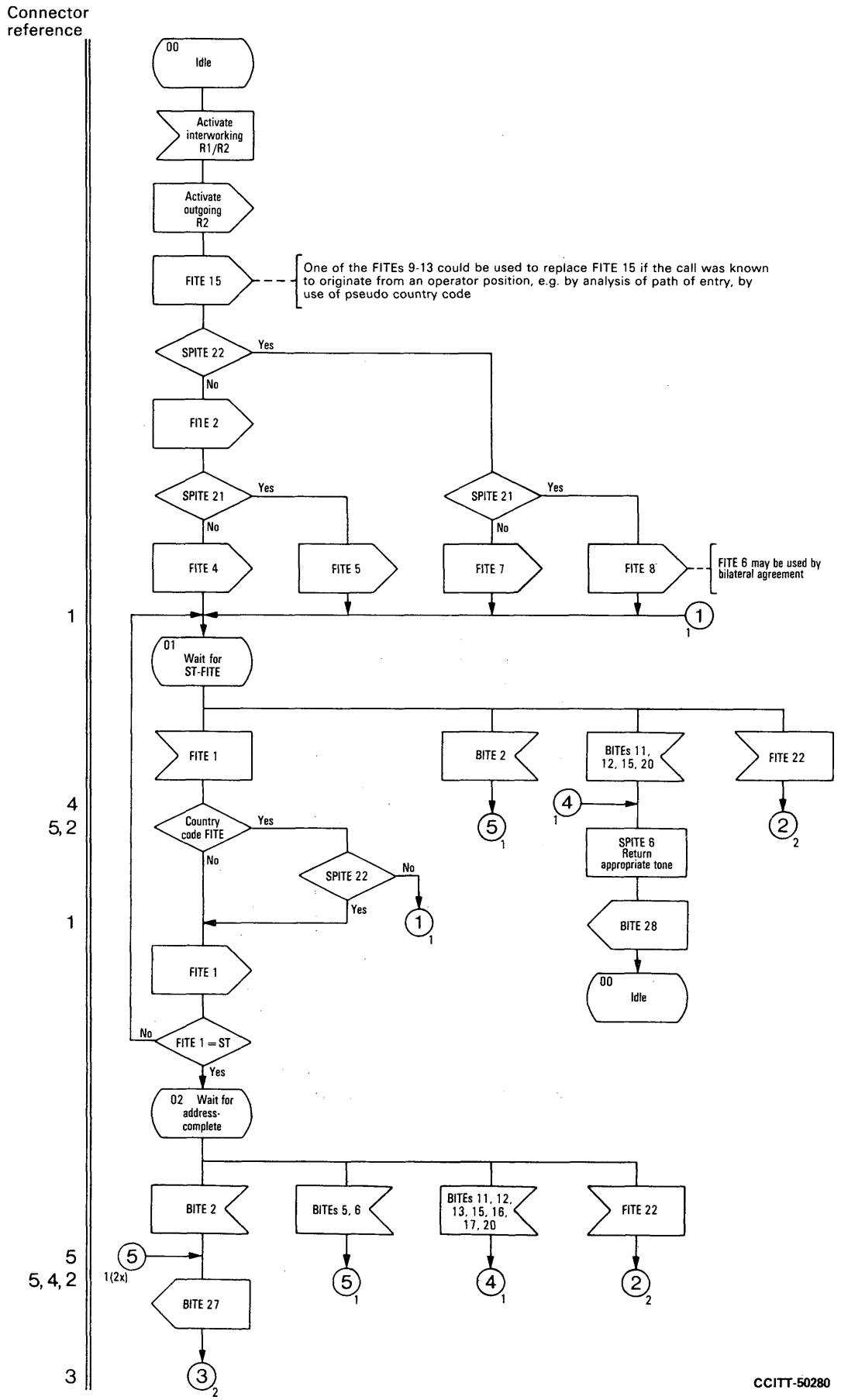


FIGURE 3/Q.674 (Sheet 1 of 2)

Interworking of Signalling System R1 to R2

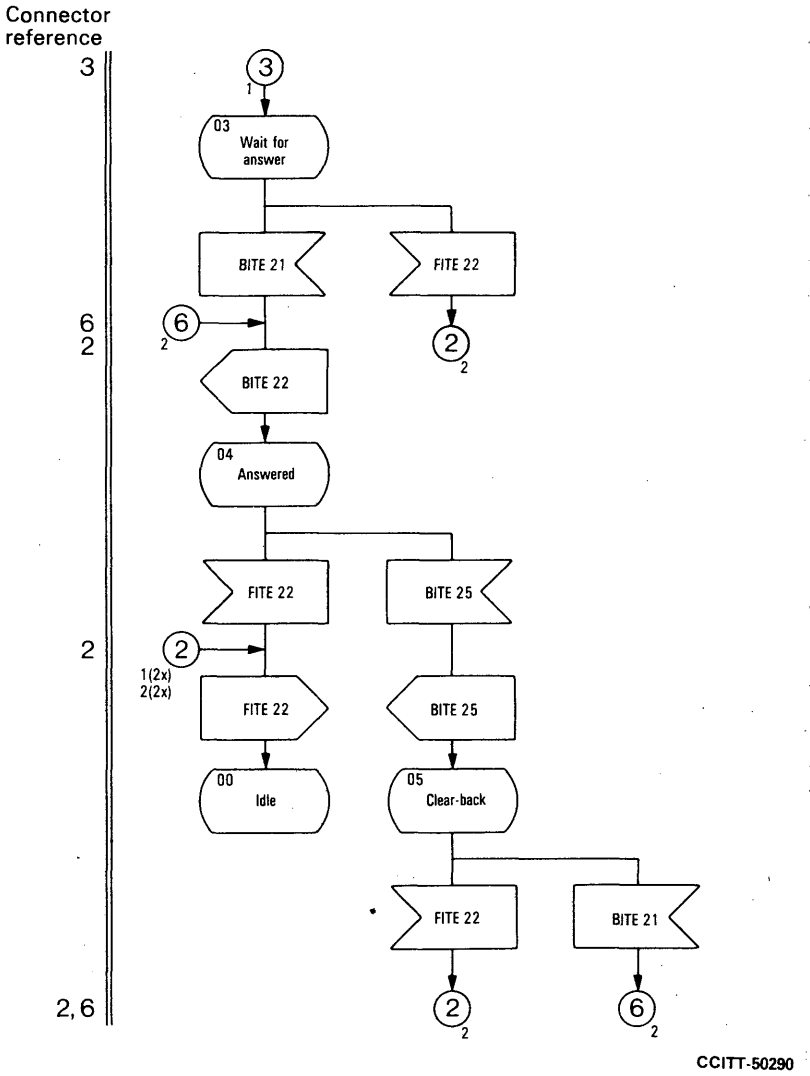
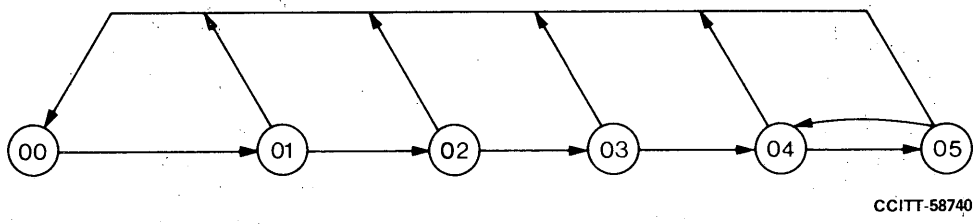


FIGURE 3/Q.674 (Sheet 2 of 2)

Interworking of Signalling System R1 to R2

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM R2 TO No. 4



State number	*State description*
00	Idle
01	Wait for CPCI-FITE
02	Wait for address-complete
03	Wait for answer
04	Answered
05	Clear-back

FIGURE 1/Q.681
State overview diagram for interworking of Signalling System R2 to No. 4

FIGURE 2/Q.681
(Reserved for future notes)

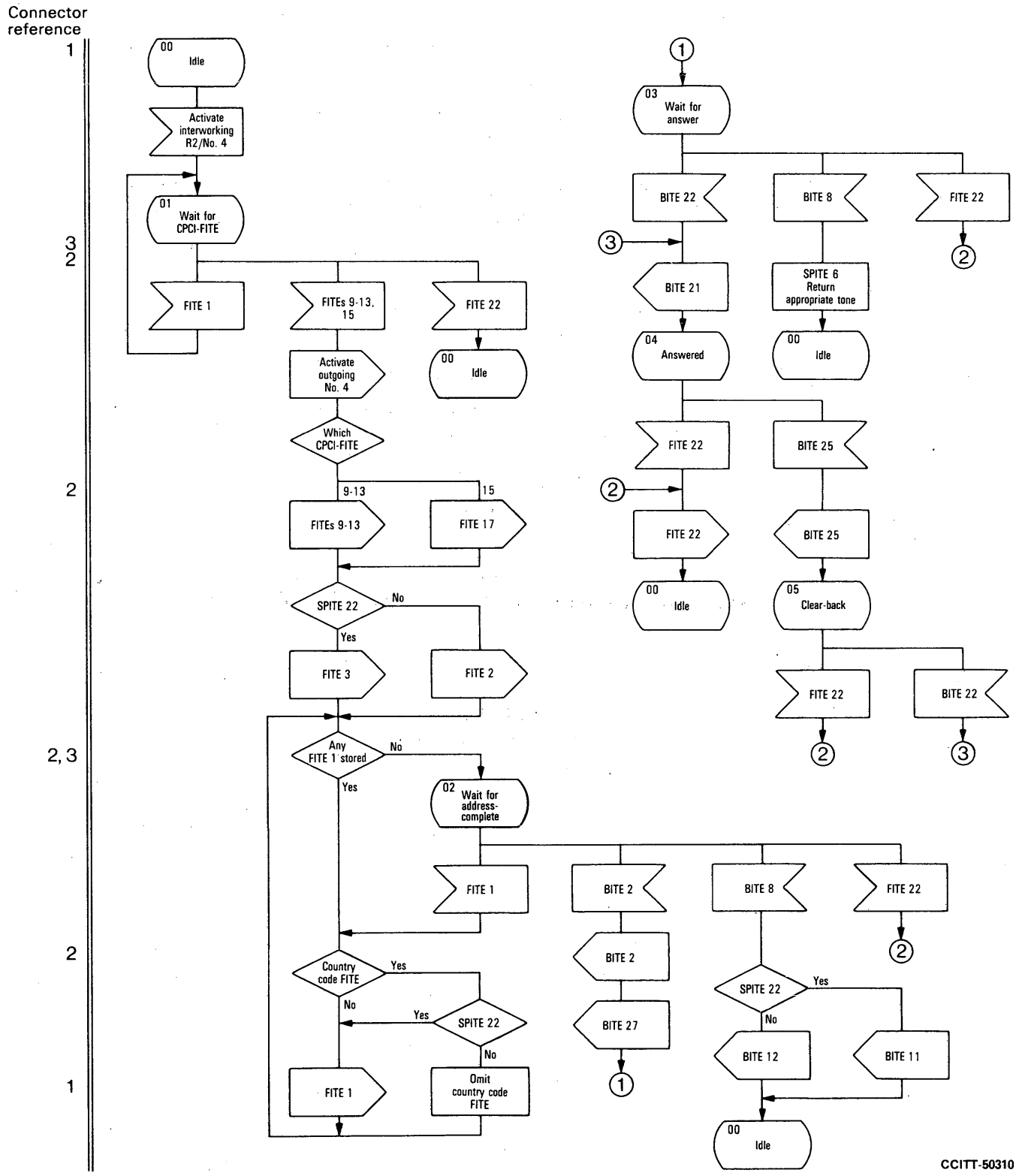
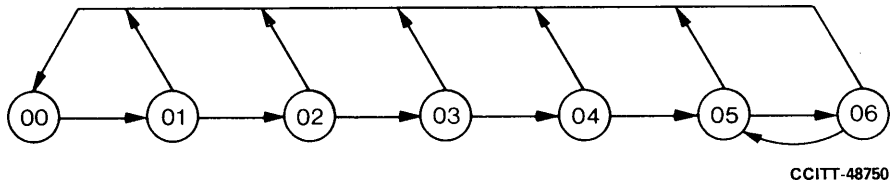


FIGURE 3/Q.681
Interworking of Signalling System R2 to No. 4

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM R2 TO No. 5



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for CPCI-FITE	1
02	Wait for address-complete	1
03	Wait for register deactivation	2
04	Wait for answer	2
05	Answered	2
06	Clear-back	2

FIGURE 1/Q.682
State overview for interworking of Signalling System R2 to No. 5

FIGURE 2/Q.682
(Reserved for futures notes)

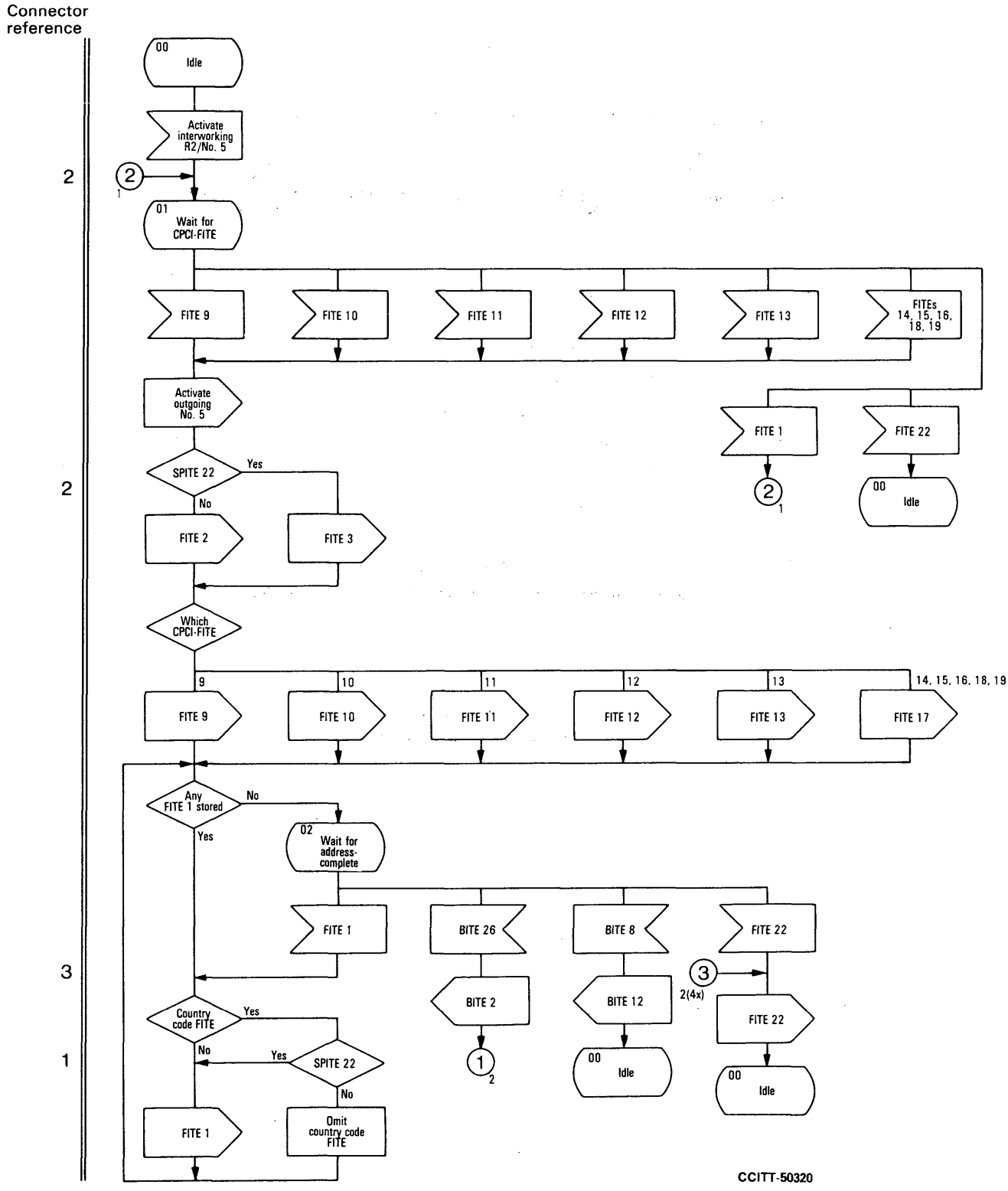


FIGURE 3/Q.682 (Sheet 1 of 2)
Interworking of Signalling System R2 to No. 5

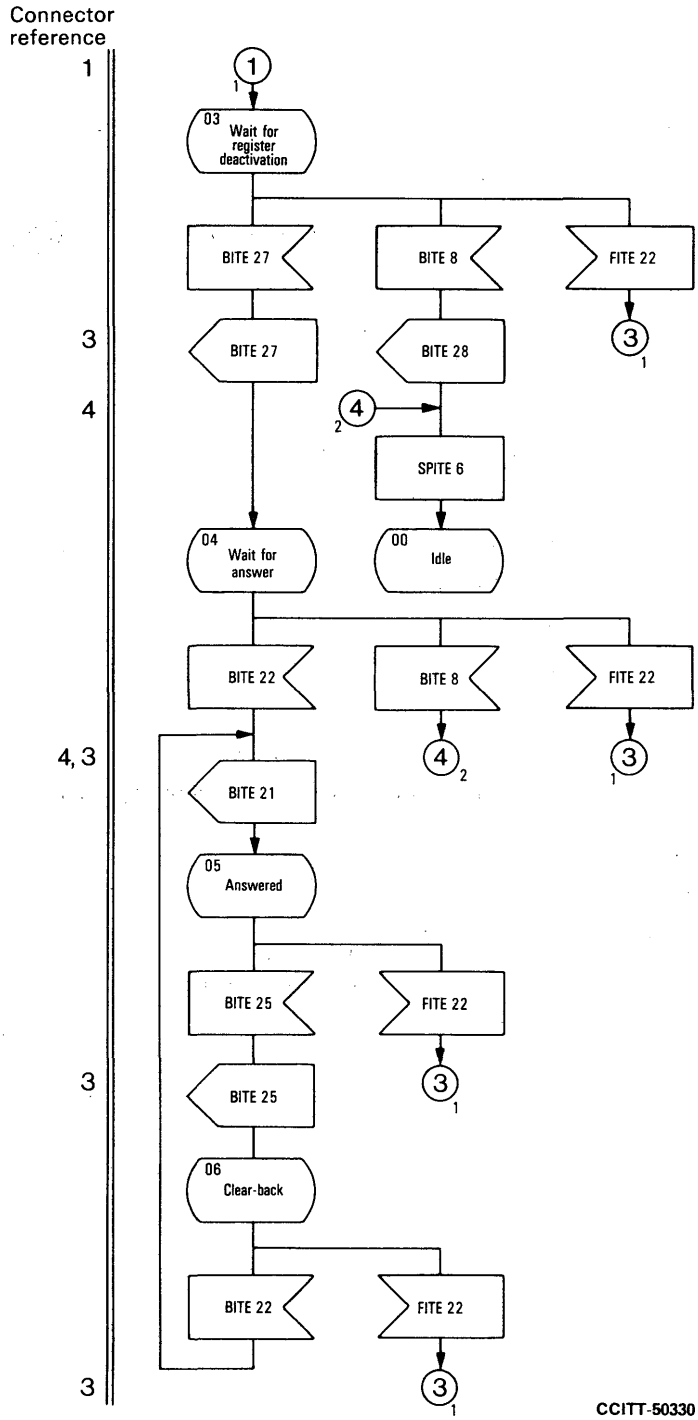
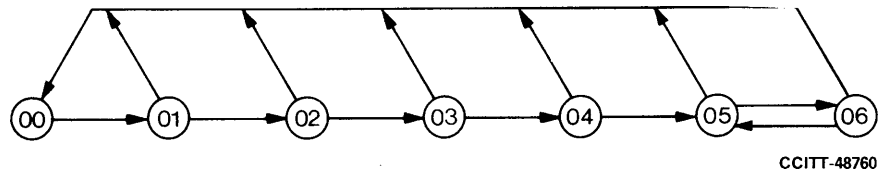


FIGURE 3/Q.682 (Sheet 2 of 2)
Interworking of Signalling System R2 to No. 5

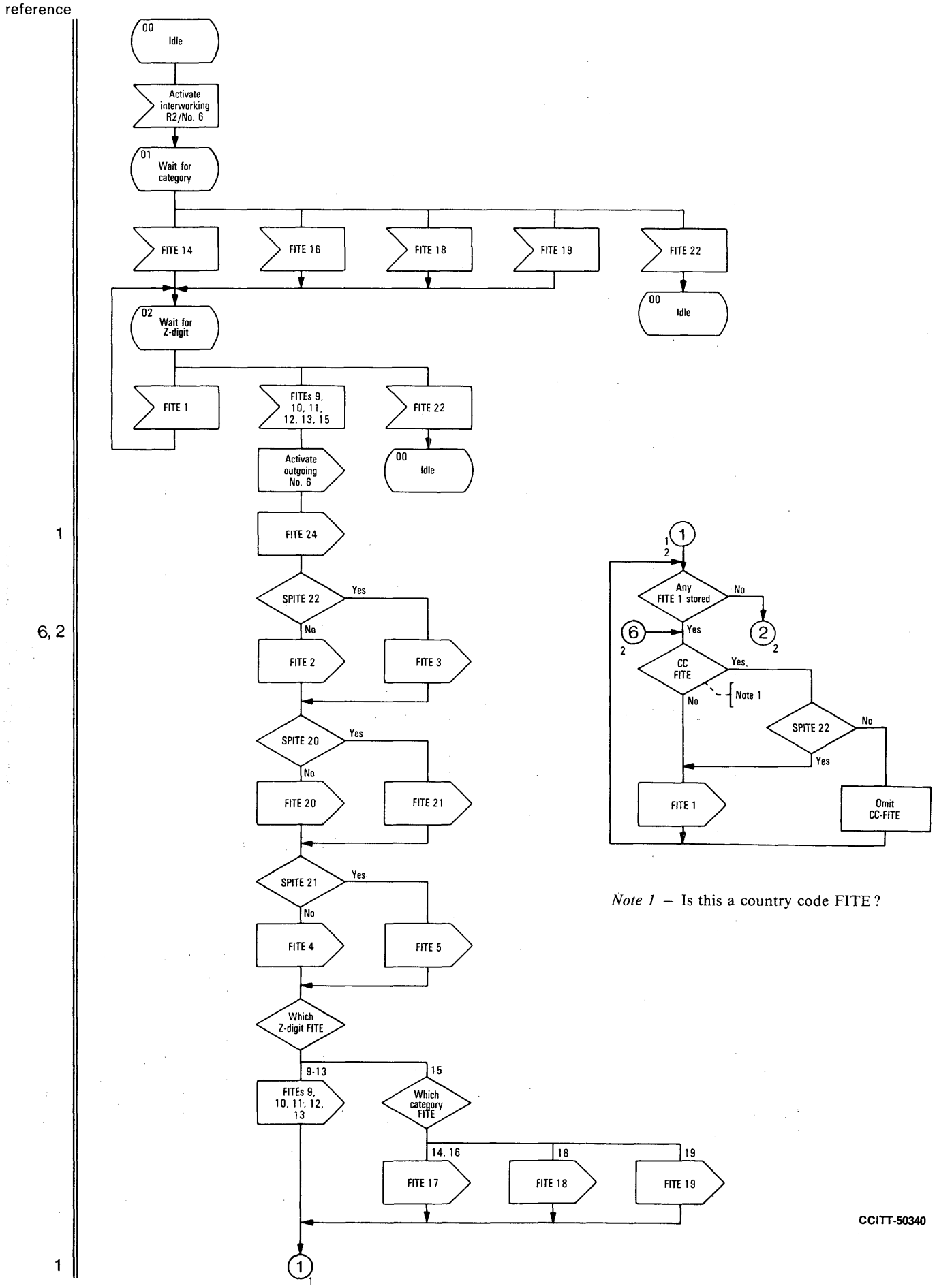
LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM R2 TO No. 6



State number	*State description*	*Sheet reference*
00	Idle	1, 2
01	Wait for calling party's category	1
02	Wait for Z-digit	1
03	Wait for address-complete	2
04	Wait for answer	2
05	Answered	2
06	Clear-back	2

FIGURE 1/Q.683
State overview diagram for interworking of Signalling System R2 to No. 6

FIGURE 2/Q.683
(Reserved for future notes)



Note 1 – Is this a country code FITE?

FIGURE 3/Q.683 (Sheet 1 of 2)

Interworking of Signalling System R2 to No. 6

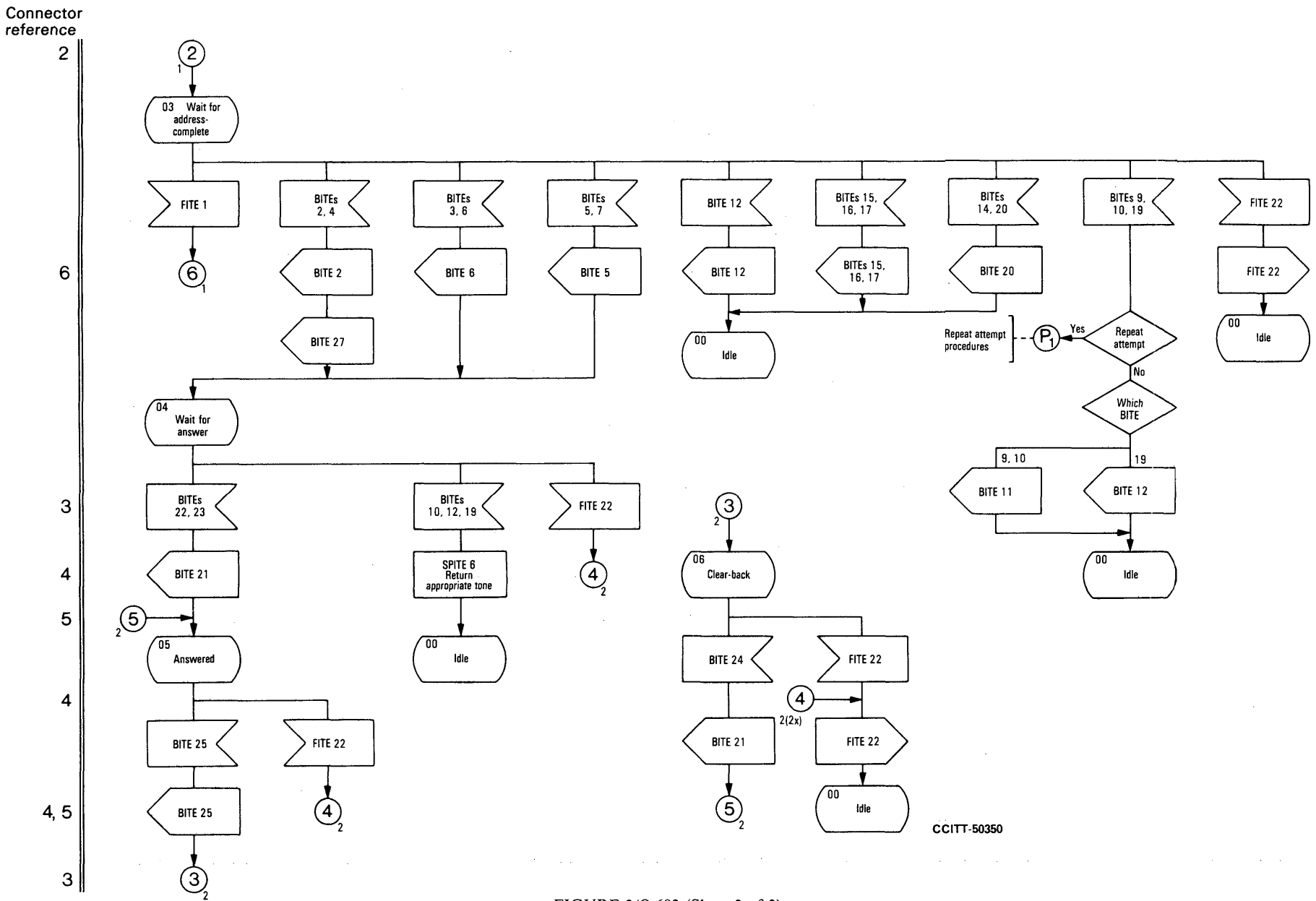
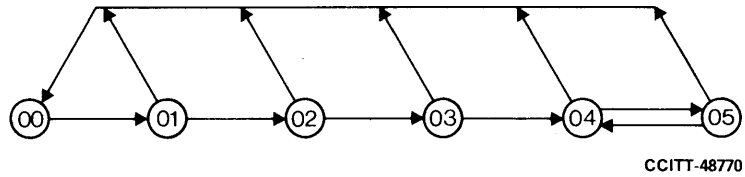


FIGURE 3/Q.683 (Sheet 2 of 2)

Interworking of Signalling System R2 to No. 6

LOGIC PROCEDURES FOR INTERWORKING OF SIGNALLING SYSTEM R2 TO R1



State number	*State description*	*Sheet reference*
00	Idle	1
01	Wait for address-complete	1
02	Wait for register deactivation	1
03	Wait for answer	1
04	Answered	1
05	Clear-back	1

FIGURE 1/Q.685
State overview diagram for interworking of Signalling System R2 to R1

Procedures not shown

Procedure P_1 is not described because no procedure is specified at present in the Signalling System R1 specifications.

FIGURE 2/Q.685
Notes to interworking of Signalling System R2 to R1

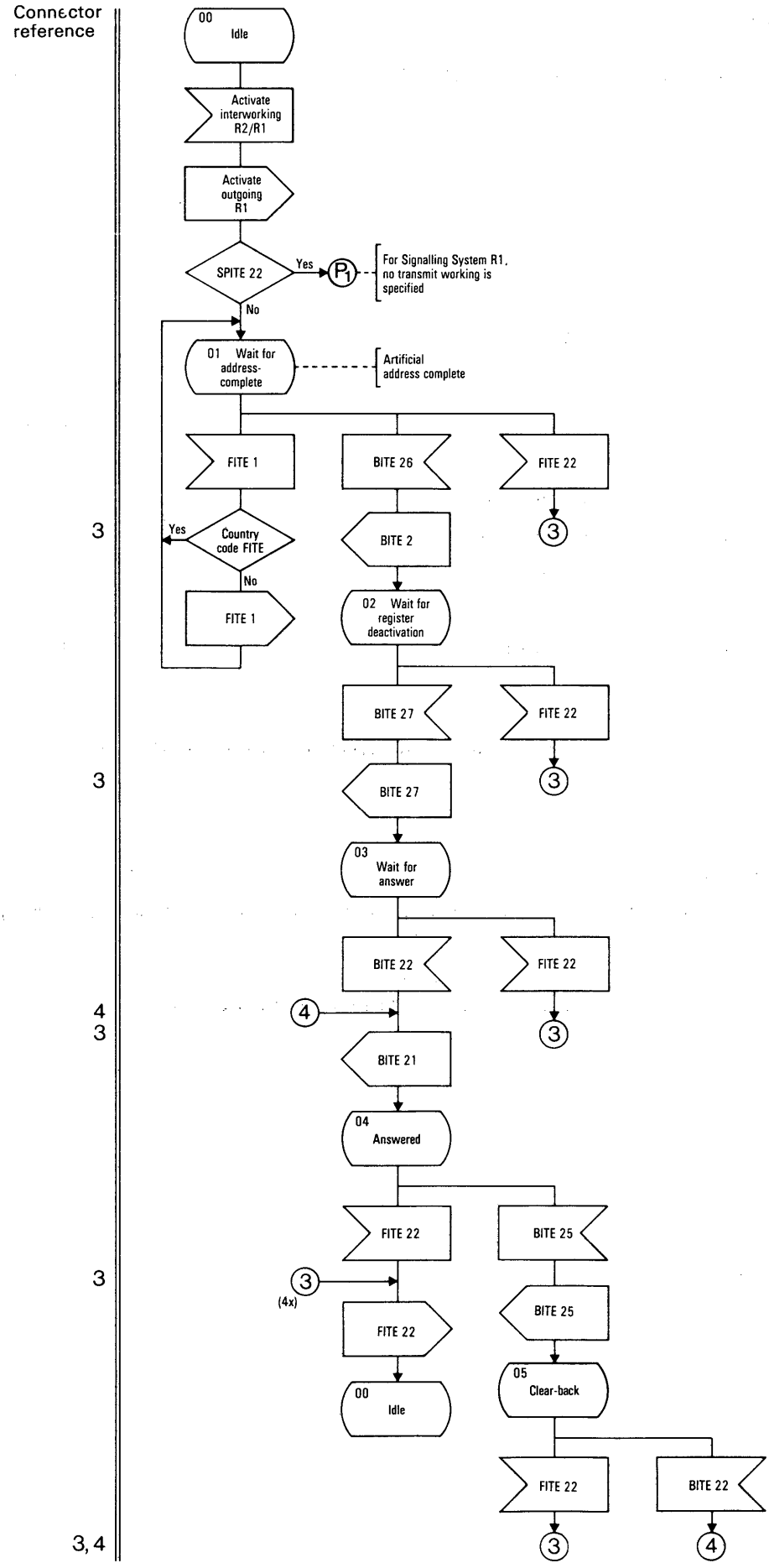


FIGURE 3/Q.685

Interworking of Signalling System R2 to R1

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